Distribution: for publication

van holsteijn en kemna research - design - engineering ift ROSENHEIM

vito vision on technology

Final report

LOT 32 / Ecodesign of Window Products
Task 2 – Market Analysis

VHK: Martijn van Elburg

ift Rosenheim: Norbert Sack, Andreas Woest

VITO: Karolien Peeters, Carolin Spirinckx

3 June 2015

Specific contract No ENER/C3/2012-418-Lot1/03

Multiple framework service contract No ENER/C3/2012-418-Lot 1

VITO NV
Boeretang 200 - 2400 MOL - BELGIE
Tel. + 32 14 33 55 11 - Fax + 32 14 33 55 99
vito@vito.be - www.vito.be

BTW BE-0244.195.916 RPR (Turnhout)
Bank 375-1117354-90 ING
BE34 3751 1173 5490 - BBRUBEBB

Rights / copyright

All rights, amongst which the copyright, on the materials described in this document rest with the authors, to be represented by the Flemish Institute for Technological Research NV ("VITO"), Boeretang 200, BE-2400 Mol, Register of Legal Entities VAT BE 0244.195.916.

The information provided in this document is confidential information of the authors. This document may not be reproduced or brought into circulation without the prior written consent of the authors. Without prior permission in writing from the authors this document may not be used, in whole or in part, for the lodging of claims, for conducting proceedings, for publicity and/or for the benefit or acquisition in a more general sense.

Disclaimer

The project team does not accept any liability for any direct or indirect damage resulting from the use of this report or its content.

The report contains the results of research by the authors and is not to be perceived as the opinion of the European Commission.

Final Report 3 June 2015

SUMMARY

This report presents the outcomes of the TASK 2 Market Analysis of the "ENER Lot 32" Ecodesign Preparatory study, performed by VHK and ift Rosenheim, in collaboration with VITO.

Chapter 3 shows that according the EU statistics office (Prodcom and Comext as made available through Eurostat) some 250 million windows and doors are produced in 2012. As the data source doesn't allow separating doors from windows, no exact production volume or value for windows only could be extracted from EU data.

Extra EU trade is a fraction of intra EU trade. This is particularly so for plastic windows and doors, of which extra EU imports are only 8% of intra EU imports. Extra EU exports are between 14-18% of intra EU exports for plastic windows and doors. For steel and aluminium doors the fractions are slightly higher.

Chapter 4 shows the (façade) window market has changed drastically the most recent years (as of 2009) because of the economic crisis in the EU zone. Third party market studies indicate an overall annual market of some 70 to 90 million standard units (1.23*1.48 m^2), whereby the higher value relates to pre-crisis years. The stock (in 2011) is estimated to be some 3.2 billion standard units.

For roof windows no official data could be retrieved. The current estimate is that the roof window market represents not more than 10% of the façade window market.

Future projections are tightly connected to building forecasts. No source of projections (not even historic sales) could be retrieved. The data to be used for modelling of overall energy are based on construction trends (age of building) and product life. Product life is estimated to lie between 30 and 40 years. No consensus could be reached regarding this as the life is highly influenced by external factors (use, environmental conditions, maintenance or lack of this, etc.)..

Chapter 5 presents market trends related to frame materials (plastic window frame market share slowly rising, but local markets vary enormously), glazing properties (trend towards lower U_W, trends is spectral selective coatings).

The market structure is characterised by a limited number of 'system houses' producing window frames (of PVC or aluminium mainly, together some 80% of the EU market), supplying to a vast number of 'retailer/installers' that assemble the windows and install them. Local markets may show other dominating structures.

Chapter 6 gives the basic consumer expenditure data such as the window purchase prices, and operating costs (energy rates) and applicable discount/escalation rates.

In Chapter 7 no further recommendations for changing the scope or regarding identification of barriers and opportunities are presented.

Final Report 3 June 2013

Final Report 3 June 2015

TABLE OF CONTENTS

Final Report 3 June 2015

Final Report 3 June 2015

LIST OF FIGURES

Final Report 3 June 2015

LIST OF TABLES

Final Report 3 June 2015

LIST OF ABBREVIATIONS & ACRONYMS

AP	Acidification Potential
BAT	Best Available Technology
BNAT	Best Not yet Available Technology
BOM	Bill of Materials
CA	Concerted Action
C&D	Construction and demolition waste
CENELEC	European Committee for Electro technical Standardization
CEN	European Committee for Normalisation
CPD	Construction Products Directive
CPR	Construction Products Regulation
EN	European Norm
EOL	End Of Life
EOTA	European Organisation for Technical Assessment in the area of construction products
EP	Eutrophication Potential
EPBD	Energy Performance of Buildings Directive
EPD	Environmental Product Declaration
EPS	Expanded Polystyrene
ETAG	European Technical Approval Guidelines
EU	European Union
EuP	Energy using Products
ErP	Energy related Products
FDES	Fiches de Déclaration Environnementale et Sanitaire (from the French EPD system)
GWP	Global Warming Potential
HM	Heavy Metals
IAQ	Indoor Air Quality
JRC	Joint Research Centre
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
MEErP	Methodology for Ecodesign of Energy related Products
MEEuP	Methodology for Ecodesign of Energy using Products
MEPS	Minimum Energy Performance Standard
MS	Member State
NEEAP	National Energy Efficiency Action Plan
NMVOC	Non Methane Volatile Organic Compound

Final Report 3 June 2015

NZEB	Nearly Zero Energy Building
ODP	Ozone Depletion Potential
ODS	Ozone Depleting Substance
OEF	Organisational Environmental Footprint
PEF	Product Environmental Footprint
PEFCRs	Product Environmental Footprint Category Rules
PM	Particulate Matter
POP	Persistent Organic Pollutants
POCP	Photochemical Oxidant Creation Potential
PRODCOM	PRODuction COMmunautaire
RES	Renewable Energy Sources
RoHS	Restriction of the use of certain Hazardous Substances in electrical and electronic equipment
CI/SfB	Construction Index/Samarbetskommitten for Byggnadsfrago
SME	Small and Medium sized Enterprise
TC	Technical Committee
TR	Technical Report
VITO	Flemish Institute for Technological Research
VOC	Volatile Organic Compounds

Final Report 3 June 2015

LIST OF ITEMS OF WHICH PROPERTY RIGHTS CAN NOT BE TRANSFERRED TO THE UNION

Final Report 3 June 2015

CHAPTER 1 PREFACE

This report has been prepared by **Van Holsteijn en Kemna BV** (VHK) in collaboration with **ift Rosenheim** (ift) and the **Flemish Institute for Technological Research** (VITO), under the Multiple Framework Contract related to preparatory studies and related technical assistance on specific product groups (ENER/C3/2012-418-Lot 1), and in response to the Terms of Reference included in the Contract for the "Ecodesign study with regard to Windows".

The subject of this report falls under the general context of sustainable industrial policy which aims to foster the development of products with less environmental impacts.

Directive 2009/125/EC ("Ecodesign Directive") is the cornerstone of this approach as it establishes a framework for the setting of Ecodesign requirements for energy-related products (ErPs) with the aim of ensuring the free movement of these products within the internal market. Directive 2009/125/EC targets ErPs as these account for a large portion of the consumption of energy and natural resources, and a number of other environmental impacts, in the Community, in particular during their use phase.

Directive 2010/30/EC on the energy labelling of ErPs is complementary to the Ecodesign Directive as it requires (a.o.) information on the impact by these products on the use of essential resources to be provided to consumers at the point of sale.

Any measure prepared under these directives must be preceded by a study or assessment ('preparatory study') that sets out to collect evidence and stakeholder input, explore policy options and describe the recommended policy mix (ecodesign and/or labelling and/or self-regulation measures).

The product groups considered as priorities for such studies have been listed in the Working Plan 2012-2014 (established according article 16(1) of the Ecodesign Directive) and this list includes "windows". Therefore a preparatory study has been requested by the Commission.

Final Report 3 June 2015

This preparatory study is to be executed according the Methodology for the Ecodesign of Energy-related Products (MEErP, 2011)[1] which identifies eight (1+7) tasks and shall allow stakeholder involvement. This report is the final report of Task 2 or "Market Analysis" of the study.

[1] http://www.meerp.eu/ VHK BV, Netherlands and COWI, Belgium: Methodology Study Ecodesign of Energy-related Products, MEErP Methodology Report, under specific contract SI2.581529, Technical Assistance for the update of the Methodology for the Ecodesign of Energy-using products (MEEuP), within the framework service contract TREN/R1/350-2008 Lot 3, Final Report: 28/11/2011

CHAPTER 2 INTRODUCTION

This chapter introduces the objective of "TASK 2 market analysis" and how the information presented under this task is structured.

2.1. METHODOLOGY FOR ECODESIGN PREPARATORY STUDIES

A full preparatory study follows the methodology for ecodesign of energy-related products established in 2011 (MEErP 2011) which itself is a succession of the former methodology dealing with energy-using products (MEEuP 2005) developed in 2005 to contribute to the creation of a methodology allowing evaluating whether and to which extent various energy-using products fulfil certain criteria according to Annex I and/or II of the Ecodesign Directive that make them eligible for implementing measures.

The full preparatory study is executed according seven tasks, as described below:

Task 1 – Scope (definitions, standards and legislation);

Task 2 – Markets (volumes and prices);

Task 3 – Users (product demand side);

Task 4 – Technologies (product supply side, includes both BAT and BNAT);

Task 5 – Environment & Economics (Base case LCA & LCC);

Task 6 – Design options;

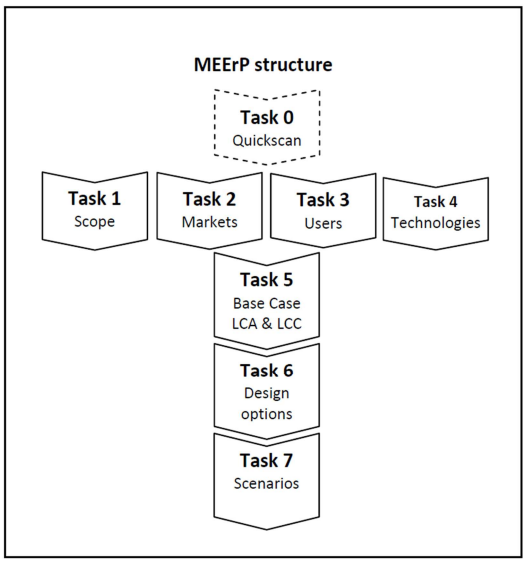
Task 7 – Scenarios (Policy, scenario, impact and sensitivity analysis).

The MEErP structure makes a clear split between:

- Tasks 1 to 4 (product definitions, standards and legislation; economic and market analysis; consumer behaviour and local infrastructure; technical analysis) that have a clear focus on data retrieval and initial analysis;
- Tasks 5 (assessment of base case), 6 (improvement potential) and 7 (policy, scenario, impact and sensitivity analysis) with a clear focus on modelling.

Final Report June 2015

Figure 1: MEErP structure



An optional Task 0 quick scan or first product screening has been introduced in the 2011 methodology for those product groups that are characterised by a large variety of products covered by a generic product group description. It was carried out for this study as well. The findings of this Task 0 are incorporated in the following Task 1 report.

Tasks 1 to 4 can be performed in parallel, whereas Task 5, 6 and 7 are sequential.

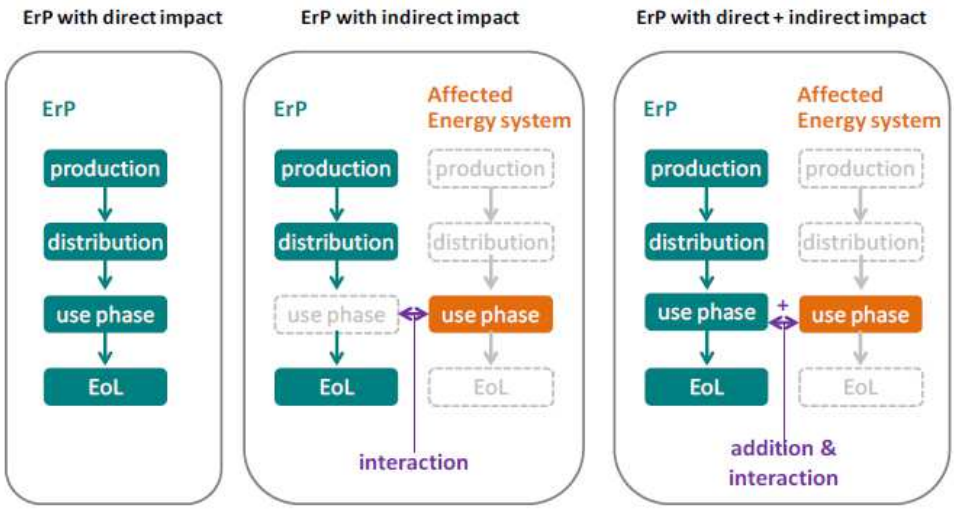
2.1.1. ENERGY RELATED PRODUCTS

The Directive 2009/125/EC defines an energy-related product as *"any good that has an impact on energy consumption during use which is placed on the market and/or put into service, and includes parts intended to be incorporated into energy-related products covered by this Directive, which are placed on the market and/or put into service as individual parts for end-users and of which the environmental performance can be assessed independently"*.

The impact on energy consumption during use of an energy-related product may take different forms and the MEErP methodology defined these as either direct and/or indirect impacts. The relevance of this lies in the analysis required and which should or should not include affected energy systems.

The MEErP introduced a grouping of energy related products into products with only direct impacts, only indirect impacts or both.

Figure 2: Three types of ErP (VHK, 2011)



Considering the above indicated grouping in MEErP of ErP products windows are an example of ErP with indirect impact.

2.2. OBJECTIVE AND STRUCTURE

The objective of this Task 2 market Analysis of "Windows" follows from the request for services ENER/C3/2012-418 LOT1/03, the subsequent proposal by the Consortium and the comments made during the preliminary discussions with the Commission.

The analysis will describe:

1. Generic economic data

2. Market and stock data

3. Market trends

4. Consumer expenditure base data

5. Recommendations

And all the required subtasks where relevant

It will set out to describe as much as possible or relevant market data based on sources such as:

- Official EU statistics;
- Other market studies (e.g. VFF study);

- Questionnaires to window producers.

→ **Objective**

The objective of Task 2 is to present the economic and market analysis related to the products. The aims are:

1. to place the product group within the total of EU industry and trade policy (subtask 2.1);
2. To provide market and cost inputs for the EU-wide environmental impact of the product group (subtask 2.2);
3. To provide insight in the latest market trends so as to indicate the place of possible Eco-design measures in the context of the market-structures and ongoing trends in product design (subtask 2.3, also relevant for the impact analyses in Task 3); And finally,
4. To provide a practical data set of prices and rates to be used in a Life Cycle Cost (LCC) calculation (Subtask 2.4).

According the MEERP study Task 2 entails the following activities:

Task 2 MARKETS

2.1 Generic economic data

Identify and report

a. EU Production;

b. Extra-EU Trade;

c. Intra-EU Trade;

d. EU sales and trade= production + import - export.

Data should relate to the latest full year for which at least half of the Member States have reported to Eurostat. Preferably data should be in physical volume (e.g. units) and in money units and split up per Member State.

Information for this subtask should be derived from official EU statistics so as to be coherent with official data used in EU industry and trade policy.

Final Report 3 June 2015

2.2 Market and stock data

In physical units, for EU-27, for each of the categories as defined in 1.1 and for reference years

a. 1990 (Kyoto and "20-20-20" reference);

b. 2010 (or most recent real data);

c. 2013-2016 (forecast, presumable entry into force of measures);

d. 2020-2030-2050 (forecast, years in which all new products sold today will be absorbed by the market).

the following parameters are to be identified:

a. Installed base (“stock”) and penetration rate;

b. Annual sales growth rate (% or physical units);

c. Average Product Life (in years), in service, and a rough indication of the spread (e.g. standard deviation);

d. Total sales/ real EU-consumption, (also in €, when available);

e. Replacement sales (derived);

f. New sales (derived).

2.3 Market trends

2.3.1. General market trends (growth/ decline, if applicable per segment), trends in product-design and product-features.

2.3.2 Market channels and production structure; identification of the major players (associations, large companies, share SMEs, employment);

2.3.3 Trends in product design/ features, illustrated by recent consumer association tests (anecdotal, not necessarily valid for the whole of the EU);

2.4 Consumer expenditure base data

For each of the categories defined in subtask 1.1, determine:

a. Average EU consumer prices, incl. VAT (for consumer prices; street price)/ excl. VAT (for B2B products), in Euro.

b. Consumer prices of consumables (detergent, toner, paper, etc.) (€/kg or €/piece);

c. Repair and Maintenance costs (€/product life);

d. Installation costs (for installed appliances only);

e. Disposal tariffs/ taxes (€/product).

For electricity, fossil fuel, water, interest, inflation and discount rates use values for Jan. 2011 in MEErP Chapter 3, including the average annual price increases mentioned there .

For regional differentiation of consumer prices (for sensitivity analysis) also see Chapter 3

2.5 Recommendations

Make recommendations on

3.4.1 refined product scope from the economical/ commercial perspective (e.g. exclude niche markets)

3.4.2 barriers and opportunities for Ecodesign from the economical/ commercial perspective

The subsequent analysis will provide the Commission with information that allows scrutiny of the proposed measure(s) against article 15 criteria of the Ecodesign Directive 2009/125/EC and article 10(3.b/.c) of the Energy Labelling Directive 2010/30/EC (the "Ecodesign or Labelling point of view"). The authors of the preparatory study assume that scrutiny against the criteria as described in article 15(2/3/4/5) of Directive 2009/125/EC is adequate to fulfil the requirements of article 10(3.b/.c) of Directive 2010/30/EC.

Final Report 3 June 2015

→ **Structure**

Accordingly, the structure of this Task 2 report is based on these criteria. These tasks are covered by the study according the structure described below.

Table 1: Overview Task 2 objectives and structure

Task 2 Objective	Covered by:
Subtask 2.1	Chapter 3 – Generic economic data
Subtask 2.2	Chapter 4 – Market and stock data
Subtask 2.3	Chapter 5 – Market trends
Subtask 2.4	Chapter 6 – Consumer expenditure base data

CHAPTER 3 Generic Economic Data

This chapter sets out to describe the generic economic data related to production and trade of window products in the EU27.

The generic economic data refers to EU production PRODCOM and trade COMEXT data. An extract of such data is provided below.

3.1. GENERIC ECONOMIC DATA

The table below gives the descriptions applied in the PRODCOM and CN (COMEXT)nomenclature.

Table 2: Summary of PRODCOM and CN codes for windows[2]

PRODCOM CODE	PRODCOM Code Description	CN Code	CN Code Description
16.23.11.10	Windows, French-windows and their frames, of wood	4418[.10(.10 + .50 + .90)]	WINDOWS, FRENCH WINDOWS AND THEIR FRAMES, OF WOOD
		(-.10)	*of Okoume, Obeche, etc.*
		(-.50)	*of coniferous wood*
		(-.90)	*of other woods*
22.23.14.50	Plastic doors, windows and their frames and thresholds for doors	3925 20	DOORS, WINDOWS AND THEIR FRAMES AND THRESHOLDS FOR DOORS, OF PLASTICS
25.12.10.30	Iron or steel doors, thresholds for doors, windows and their frames	7308 30	DOORS, WINDOWS AND THEIR FRAMES AND THRESHOLDS FOR DOORS, OF IRON OR STEEL
25.12.10.50	Aluminium doors, thresholds for doors, windows and their frames	7610 10	DOORS, WINDOWS AND THEIR FRAMES AND THRESHOLDS FOR DOOR, OF ALUMINIUM (EXCL. DOOR FURNITURE)

Final Report 3 June 2015

Note: All data from generic trade and production databases is **not limited to window frames** only, but also **includes doors, doorframes and or thresholds and related products**. The trends may therefore be considered to apply to windows, but the actual trade and production value/volume includes products **outside** the scope of this assessment.

Production and trade of "m^2" **(sheet) glass** cannot be used to assess production and trade of windows as sheet glass is also used for among other construction works and home furnishings (for example curtain walling and other uses of architectural glass to greenhouses and other industrial, commercial or domestic uses such as mirrors and glazing for paintings) and the automotive sector, to name few possible other uses.

[2] picture from IPTS Technical Background "windows and doors" (2012)

3.1.1. EU PRODUCTION (PRODCOM)

Production data is based on extracts from the Prodcom database[3].The figures below present the EU27 production in respectively value ('000 euro), volume ('000 units)

Figure 3 EU27 Windows (incl. doors) production value by frame type

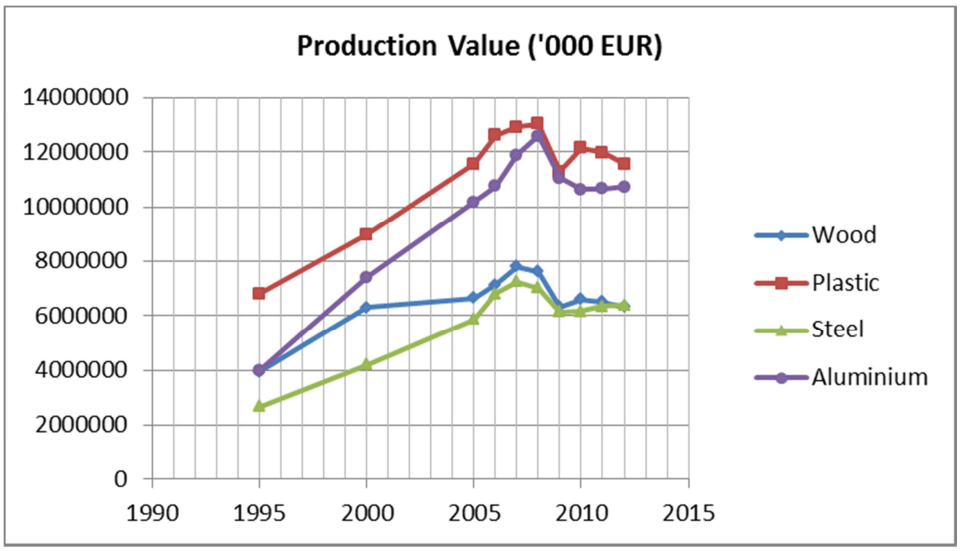
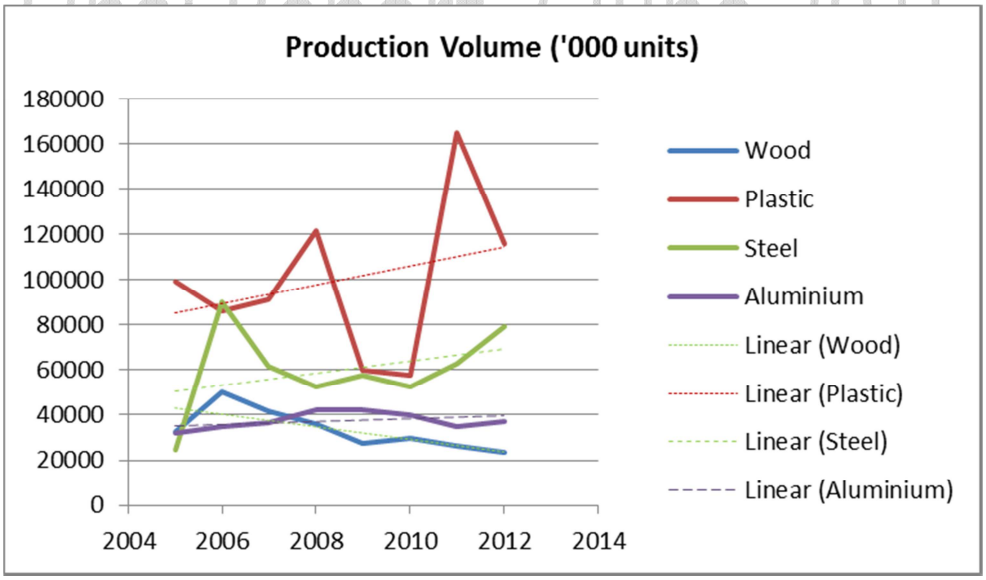
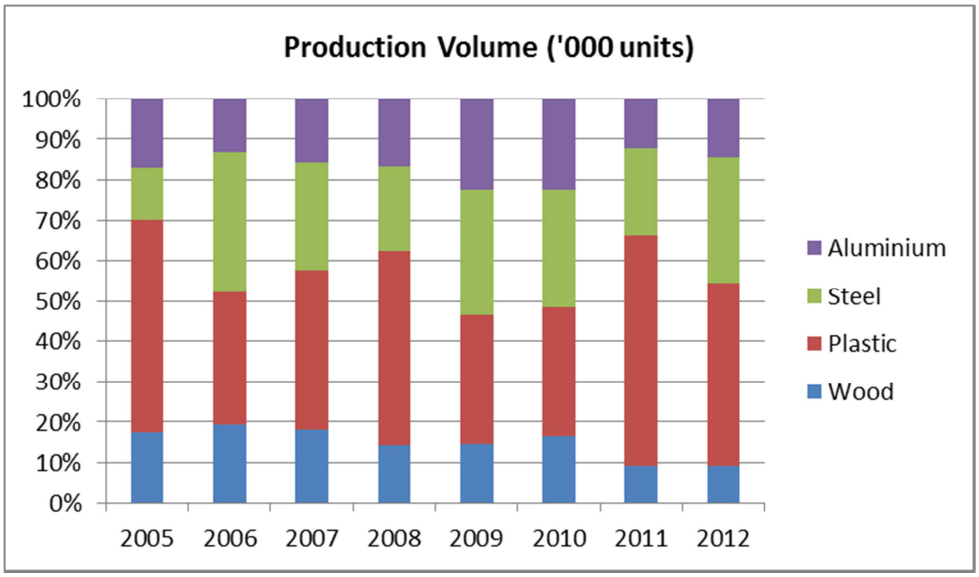


Figure 4 EU27 Windows (incl. doors) production volume by frame type



[3] http://epp.eurostat.ec.europa.eu/portal/page/portal/prodcom/data/database and http://epp.eurostat.ec.europa.eu/newxtweb/

Figure 5 EU27 Windows (incl. doors) production volume by frame type, expressed as % of 100%



Volume data of before 2005 showed a very scattered image and can be shown to be faulty for various entries. Therefore the above figures show data from 2005 onwards.

The table below shows the production by Member States both in value and volume, by frame type. Note: again the data includes doors and thresholds etc.

Table 3: Overview of PRODCOM data on window production 2012

PRODCOM Code	16231110 / wood	22231450 / plastic	25121030 / steel	25121050 / aluminium	Grand Total	16231110	22231450	25121030	25121050	Grand Total
	wood	plastic	steel	aluminium		wood	plastic	steel	aluminium	
Reporter	(units '000)	(units '000)	(units '000)	(units '000)	(units '000)	EUR ('000)	EUR ('000)	EUR ('000)	EUR ('000)	EUR ('000)
Belgium	187	1063	17642	1011	19903	96417	431366	119099	470313	1117196
Bulgaria	11	547	27	296	882	2549	77256	6075	53153	139033
Czech Republic	243	1906	702	255	3106	68543	324943	62559	80151	536195
Denmark	1548	1801	15	226	3589	465965	131404	18771	113093	729233
Germany	2298	12307	4467	3197	22269	873151	3324964	1759625	1699030	7656771
Estonia	268	117	40	39	463	52439	16232	35525	35111	139307
Ireland	80	1084	19657	554	21375	5921	78995	34879	45301	165096
Turkey	0	0	0	0	0	0	0	0	0	0
Greece	27	414	108	71	619	7485	23868	9991	19502	60846
Spain	332	509	2377	4054	7272	55017	155308	405625	779538	1395487
France	1939	5918	4824	13570	26250	614196	1987484	965159	2183942	5750781
Italy	5049	1786	2837	5816	15488	1654188	576547	1176336	2629550	6036621
Cyprus	0	0	0	0	0	0	0	0	0	0

Latvia	76	129	34	32	272	26445	22260	18630	10870	78204
Lithuania	120	358	64	29	572	39462	51067	28499	8349	127377
Luxembourg	0	0	0	0	0	0	0	0	0	0
Hungary	748	598	108	673	2127	78381	70687	17728	39252	206047
Malta	0	0	0	0	0	0	0	0	0	0
The Netherlands	321	55841	504	291	56956	219615	204304	268074	234676	926669
Austria	1108	1710	611	321	3751	456972	484535	210423	237952	1389882
Poland	2680	7438	22177	460	32757	511561	976161	275278	196194	1959193
Portugal	75	132	1083	2065	3355	15957	29705	146402	421179	613244
Romania	178	5581	43	216	6017	26772	223048	11868	37312	299000
Slovenia	124	387	0	48	560	42277	86692	0	73166	202135
Slovakia	3	1000	39	319	1361	1681	163611	7192	34760	207244
Finland	1018	12	273	0	1303	217207	5432	74468	79556	376662
Sweden	1716	5015	0	0	6731	403105	8597	0	0	411702
The United Kingdom	0	10257	766	2100	13124	383935	2102288	463753	1039879	3989854
EU27 total	20148	115911	78398	35643	250100					

Stakeholders have commented that the Finnish most common window frame is a wood-aluminium, representing 80% of total production. The Eurostat data does not reflect accurately the real situation.

Final Report 3 June 2015

3.1.2. EXTRA/INTRA EU TRADE (COMEXT)

International trade data is based on extracts from the ComExt database[4]. The trade in plastic, steel or aluminium windows frames (including doors, thresholds, etc.) is mainly located between EU countries themselves. The largest trade value is established by imported plastic frames (in 2012 almost 1.5 billion euro). The ComExt does not show trade data related to wooden windows (frames).

Figure 6 EU27 Windows (incl. doors) intra EU trade value, by frame type

[4] http://epp.eurostat.ec.europa.eu/portal/page/portal/international_trade/data/database

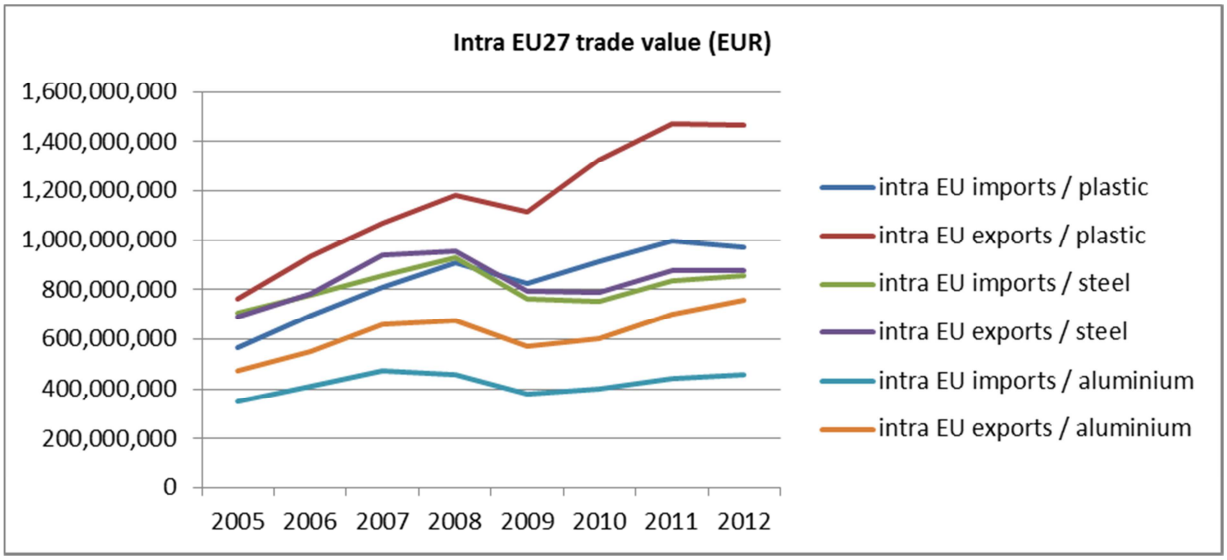


Figure 7 EU27 Windows (incl. doors) extra EU trade value, by frame type

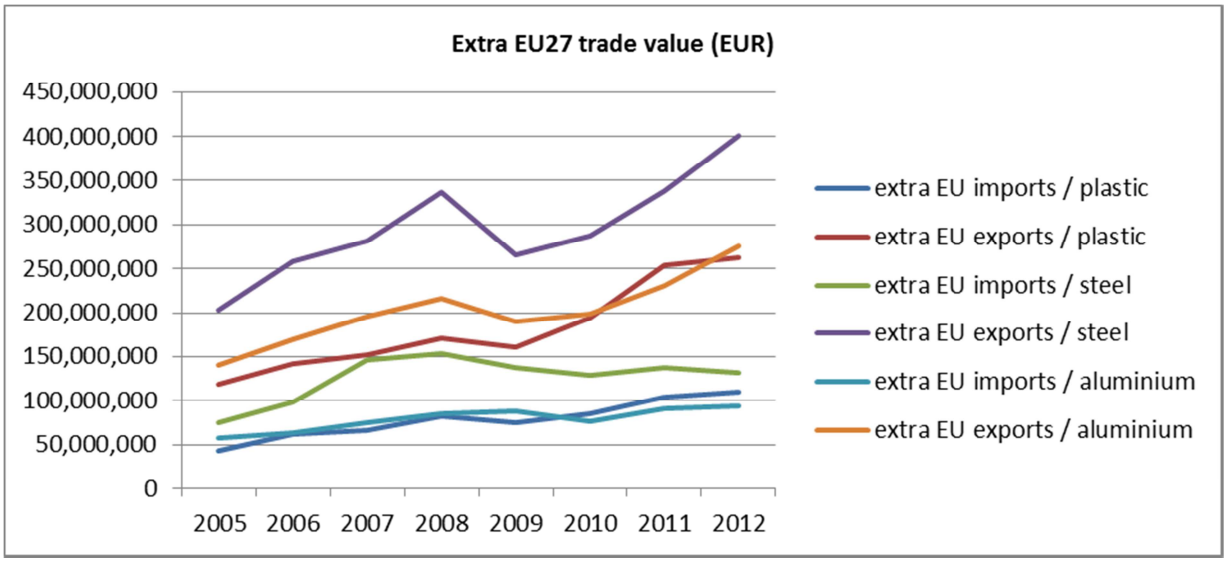


Figure 8 EU27 Windows (incl. doors) extra EU trade volume, by frame type

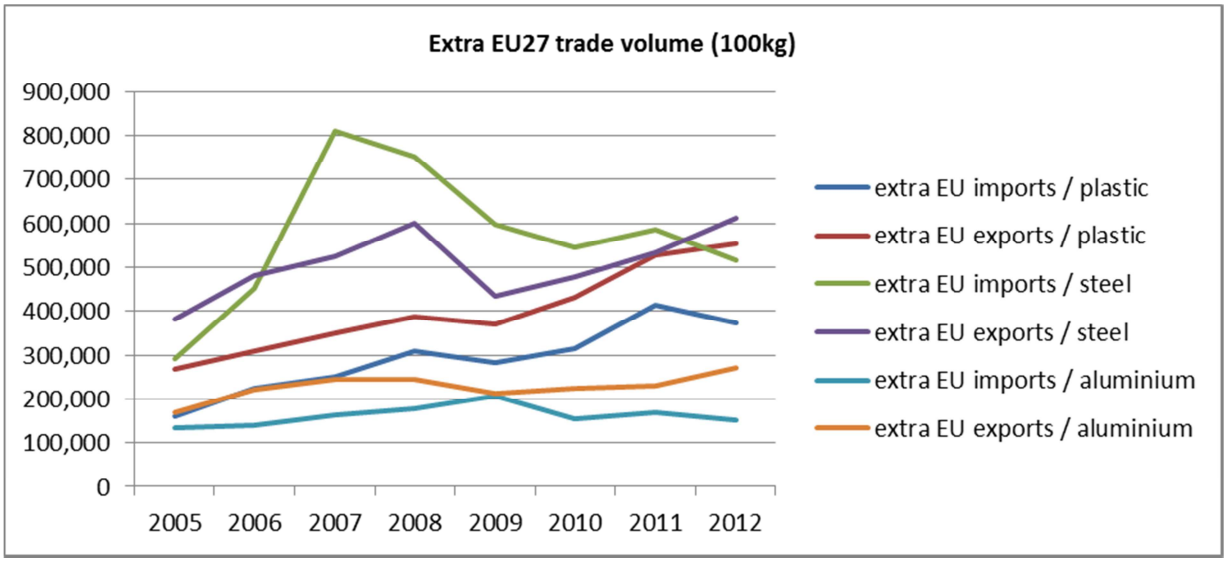
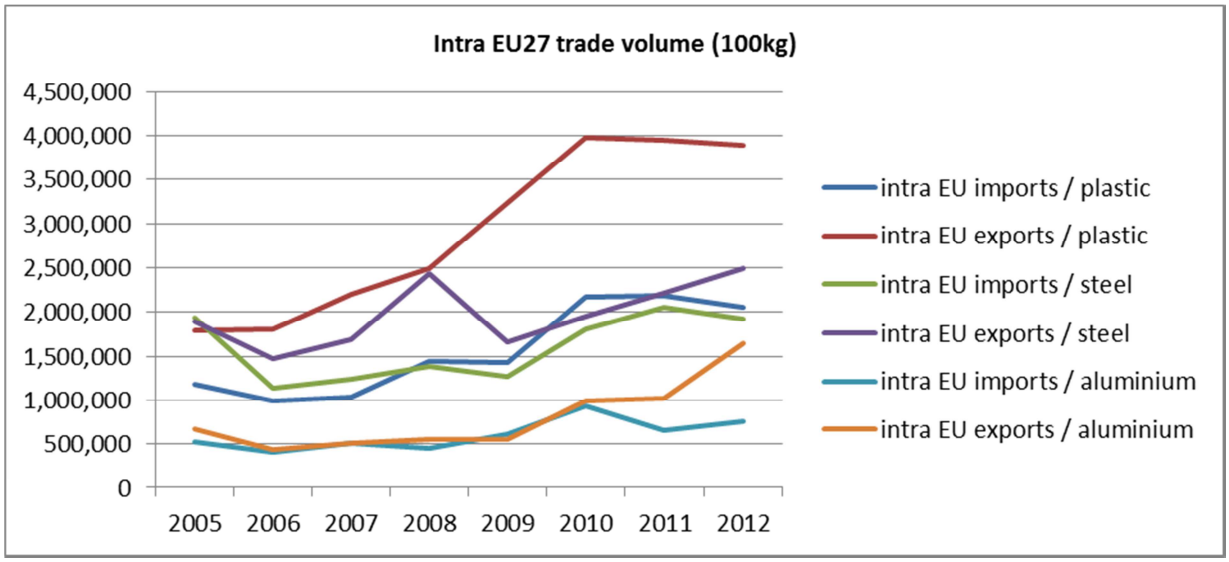


Figure 9 EU27 Windows (incl. doors) intra EU trade volume, by frame type



The table below shows that extra EU trade is a fraction of the intra EU trade. This is particularly so for plastic windows and doors, of which extra EU imports are only 8% of intra EU imports. Extra EU exports are between 14-18% of intra EU exports for plastic windows and doors.

For steel and aluminium doors the fractions are higher, meaning that extra EU trade is relatively more important for windows and doors made of these materials. The exact percentages are given in the table below (the percentages express the trade ratio (in %), expressed as extra EU trade divided by intra EU trade, for both export and import).

Final Report 3 June 2015

Table 4 Trade ratio (extra EU trade divided by intra EU trade) for both import and export

		2005	2006	2007	2008	2009	2010	2011	2012
DOORS, WINDOWS AND THEIR FRAMES AND THRESHOLDS FOR DOORS, OF PLASTICS	IMPORT	8%	9%	8%	9%	9%	9%	10%	11%
	EXPORT	16%	15%	14%	15%	14%	15%	17%	18%
DOORS, WINDOWS AND THEIR FRAMES AND THRESHOLDS FOR DOORS, OF IRON OR STEEL	IMPORT	11%	13%	17%	17%	18%	17%	16%	15%
	EXPORT	29%	33%	30%	35%	33%	37%	39%	46%
DOORS, WINDOWS AND THEIR FRAMES AND THRESHOLDS FOR DOOR, OF ALUMINIUM (EXCL. DOOR FURNITURE)	IMPORT	16%	15%	16%	19%	23%	19%	21%	21%
	EXPORT	30%	31%	30%	32%	33%	33%	33%	36%

3.1.3. APPARENT CONSUMPTION

Please note that:

1. The information available from ComExt does not include wood as frame material.
2. The trade 'value' data shows that plastic window-s/frames is the most intensively traded group, both to outside the EU (extra EU exports) and within the EU (intra EU imports and exports).

The combination of both production and trade data seems to indicate that in the most recent year of which data is available (2012) the value of the market (the apparent consumption, calculated as production plus imports minus exports) for plastic and aluminium are quite similar (approximately 10 to 11 billion euro). As there is no data for trade in wooden windows (and doors, etc.) this frame material could not be included in this calculation of market value.

Table 5 Approximation of apparent 'consumption' of windows, year Prodcom + ComExt 2012

EU27 - year 2012	Production value	Imported to EU27	Imp. as % of Prod.	Exported from EU27	Exp. as % of Prod.	Apparent Consumption (prod.+imp.-exp.)	Cons. as % of Prod.
wood	6,319,240,615	no data		no data		no data	
plastic	11,556,752,006	109,525,110	0.95%	262,183,943	2.27%	11,404,093,173	99%
steel	6,390,000,000	131,971,011	2.07%	401,288,607	6.28%	6,120,682,404	96%
aluminium	10,729,110,249	94,403,076	0.88%	275,160,363	2.56%	10,548,352,962	98%
combined, excl. wood	28,675,862,255	335,899,197	1.17%	938,632,913	3.27%	28,073,128,539	98%

3.1.4. CONCLUSIONS REGARDING GENERIC ECONOMIC DATA

All conclusions to be drawn from above information and sources is only partially applicable to the scope of this study, as the product categories include doors and thresholds, and is thus not limited to production of windows solely.

Nonetheless, it can be assumed that over the last 7 years (2005-2012) the production 'volume' trends clearly show a significant growth in plastic (PVC) windows, whereas steel and aluminium show a more modest increase. Wood as material shows a decrease over this period.

In production 'value' plastic and aluminium are very close, which can be explained by aluminium being a more costly base material.

Stakeholders have commented that information on market shares or size of sliding windows should be added, but this information was not available in the information sources consulted.

TASK 3 and TASK 7 show that the window model calculates an overall market of some 36-37 billion euro for 2010-2020. Eurostat data results in a market of some 28 billion, and with some 6 billion euro of wooden windows added, some 34 billion in total. This however includes an unknown share of doors.

Final Report 3 June 2015

Whether Eurostat is underestimating window data (it may miss turnover from small enterprises) or whether the model is overestimating market size, cannot (yet) be concluded on basis of available data.

CHAPTER 4 MARKET AND STOCK DATA

This section describes the preliminary results of an assessment of market and stock volume and structure.

4.1. FAÇADE WINDOW MARKET & STOCK / VOLUME AND VALUE

4.1.1. MARKET

→ **VFF 2013**

One of the most recent assessments of the EU 27 market for windows is produced by VFF, the German-based Verband Fenster+Fassade.

They assessed the market of window units, both by volume (standard window units of 1.3 by 1.3 meter) and by window frame type (wood, PVC, metal (aluminium) and metal-wood)[5].

The VFF study estimated the EU27 market for windows in 2012 at a total of 73.23 million 'units'. As one unit represents a standard windows sized 1.3 by 1.3 meter this translates into 123.8 million m^2 in 2012. In 2008 (before the crisis) the market was estimated to be some 90 million units or 150 million m^2.

Table 6 EU27 Window market and stock according VFF 2013 (million window units)

	Stock (million window units)	% of total EU 27 stock	Activity index (% points)	Market volume (million window units)					
	2011	2011	2011	2007	2008	2009	2010	2011	2012
EU27 **(10^6 units 1.3*1.3 m = 1.69m²)**	3422			93,7	89,9	80,1	76,2	74,6	73,2
EU27 (10^6 m²)	5783			158	152	135	129	126	124
EU27 **(10^6 units recalculated to 1.23*1.48 m = 1.82m₂)**	3177			86.8	83.5	74.2	70.9	69.2	68.1
Belgium	75	2%	3.3	2.5	2.5	5.45	2.45	2.47	2.43
Bulgaria	50	1%	0.93	0.6	0.7	0.57	0.51	0.46	0.44
Denmark	38	1%	3.18	1.4	1.4	1.27	1.22	1.22	1.22
Germany	560	16%	2.3	11.6	11.7	12.04	12.46	12.86	13.3
Estonia	9.2	0%	1.78	0.4	0.4	0.18	0.16	0.156	0.17
Finland	37	1%	2.54	1.1	1.1	0.95	0.92	0.94	0.95
France	434	13%	2.63	12	12.2	11.6	11.4	11.4	11.2
Greece	77	2%	1.47	2	2.1	1.93	1.29	1.14	0.98

[5] The VFF standard unit size of 1.3 * 1.3 m differs from one of the unit sizes defined in standard EN 14351-1 (1.23 m x 1.48 m). The reason for this is unclear.

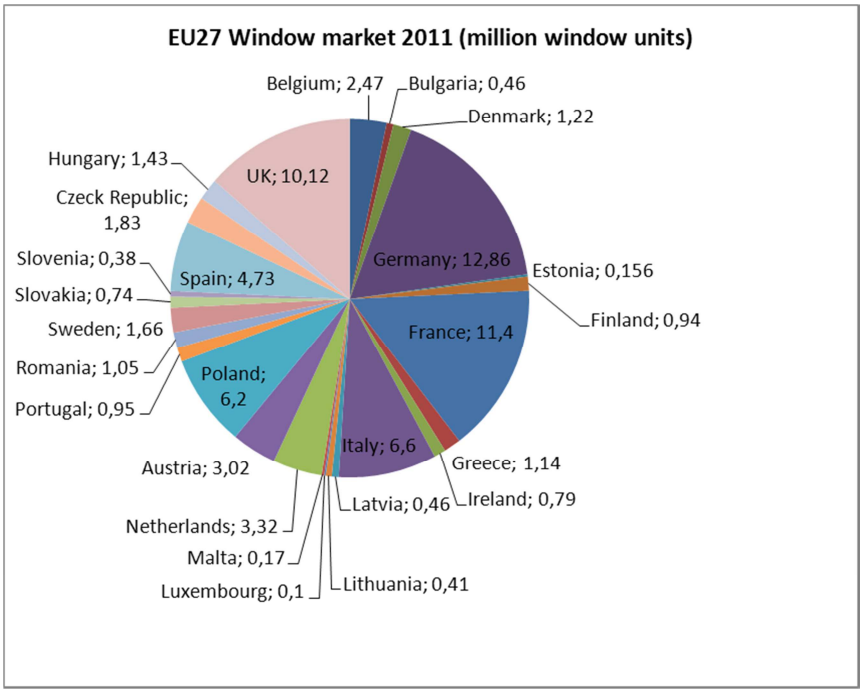
	Stock (million window units)	% of total EU 27 stock	Activity index (% points)	Market volume (million window units)					
Ireland	31	1%	2.52	1.5	1.1	0.94	0.84	0.79	0.78
Italy	415	12%	1.59	7.6	7.5	6.98	6.73	6.6	6.43
Latvia	14	0%	3.28	0.8	0.9	0.5	0.45	0.46	0.47
Lithuania	22	1%	2	0.9	1	0.45	0.41	0.41	0.42
Luxembourg	3.6	0%	2.84	0.1	0.1	0.1	0.1	0.1	0.1
Malta	2.9	0%	5.93	0.2	0.2	0.19	0.18	0.17	0.16
Netherlands	115	3%	2.9	3.7	3.7	3.53	3.29	3.32	2.92
Austria	58	2%	5.22	2.7	2.8	2.88	2.96	3.02	3.06
Poland	264	8%	2.35	5.1	6.2	6.23	6.14	6.2	6.38
Portugal	72	2%	1.31	1.4	1.3	1.17	1.06	0.95	0.83
Romania	146	4%	0.72	1.9	1.9	1.27	1.08	1.05	1.02
Sweden	65	2%	2.55	1.9	1.9	1.71	1.62	1.66	1.62
Slovakia	37	1%	2	0.9	0.9	0.83	0.77	0.74	0.72
Slovenia	14	0%	2.7	0.5	0.5	0.45	0.4	0.38	0.37
Spain	316	9%	1.49	14.7	12	7.92	6.14	4.73	4.16
Czech Republic	72	2%	2.54	2.1	2.2	2.01	1.89	1.83	1.84
Hungary	68	2%	2.1	2.1	2.1	1.81	1.64	1.43	1.34
UK	426	12%	2.37	14	11.5	10.12	10.07	10.12	9.92

Final Report 3 June 2015

How much of the above m^2 are actually 'curtain walls' is not known, as this differentiation was not possible when collecting the data.

The annual growth or decline of the market is presented by the 'Activity index' in the table above and is between 1-3 % points for the largest EU countries.

Figure 10 EU27 Window market 2011 (million window units)



The VFF data shows a 12% difference to the market size based on EU production (see table 2, section 3.1.1). The EU production data does not include international trade, as no wood trade data is available. However, knowing that apparent consumption is some 98% of the production by value, a similar relation would indicate a 10% difference between VFF (lower value) and apparent consumption calculated on PRODCOM and COMext (higher value).

The largest markets according the VFF study are Germany, France, UK, Italy and Spain. Together these countries represent almost two/thirds (63%) of the total EU27 market.

Final Report 3 June 2015

Similar to Prodcom/Comext data this VFF data shows the decline in sales due to the economic crisis since 2008.

→ **Glazing units**

Note that the above mentioned sales volume relates to 'windows' and not to 'glazing'. As identified in section 4.2.2 the IGU (glazing unit) of a window is replaced - on average - once during the product life of a window. As the product life of the IGU is thus about half of that of the window itself, the total amount of glazing placed on the market, as expressed in million m^2, is roughly twice that of windows alone.

Good sales data of glazing alone is however very hard to come by, as the glazing may be used for very different applications. Relevant stakeholders have been contacted but did not / could not provide further information.

→ **Eurowindoor**

The VFF data means an increase compared to Eurowindoor estimates quoted in the background study for the Ecodesign Working Plan 2012-2014. Eurowindoor indicated a total market for windows to be close to 137 million m^2, equivalent to some 81 million window units (1.3*1.3 m)[6].

Table 7: Market of windows (and external doors) for the EU2 20117

Market segment	Windows		External doors	
	million units	million m2	million pcs.	million m2
Total market	81.1	137.1	8.1	13.7
Plastic	38.1	64.4	3.8	6.4

[6] Source: Eurowindoor 2011

Aluminium	21.7	36.7	2.2	3.7
Wood	17.2	29.1	1.7	2.9
Wood-Metal	3.3	5.6	0.3	0.6
Steel (max 1% share)	0.8	1.4	0.1	0.1

1 WU (window unit) = 1.3 m x 1.3 m = 1.69 m²

Eurowindoor estimated the market for external doors to be some 10% of the window market. Roof windows are not included in the above assessment.

→ **Global markets**

The JRC study 'Evidence base for Windows and external doors'[7] presented the following information as regards the EU market in comparison to other global markets.

Through to 2015, demand for energy efficient windows and external doors is expected to rise faster than the overall market. This has been attributed to increasing consumer awareness and government support e.g. the Energy Star in the US21 and the Programmes in Canada22. China, due to its rapid economic growth and increasing house sizes, is the world's largest national window and external door market, accounting for 27% in 2010 and expected to expand to 30% in 2015. The US market for windows and external doors is expected to recover and grow by 7.7% through to 2015. This is after experiencing a decline of approximately 25% between 2008 and 2010 due the countries major economic recession. Demand in Japan and Western Europe is expected to recover after declines in 2009 and 2010. The developing nations of the Africa/ Middle East region and Latin America are also forecast to experience especially fast growth between 2008 and 2013, despite a deceleration from the pace of the period 2003-2008. Table 13 shows global demand across a number of regions.

4.1.2. STOCK

Final Report 3 June 2015

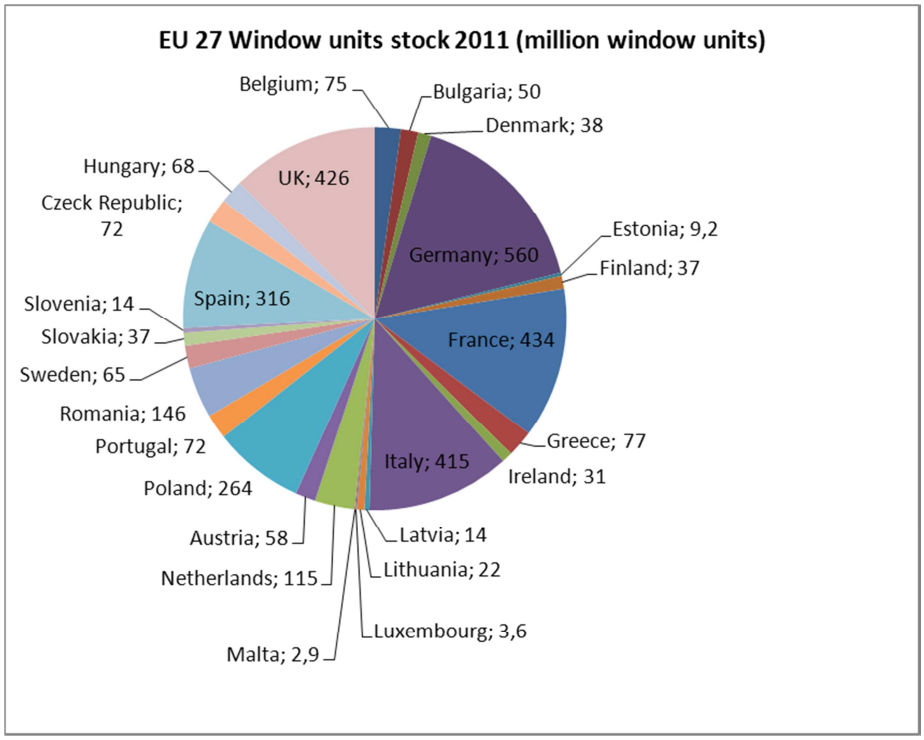
→ **VFF 2013**

The VFF study calculated the EU27 stock, expressed in standard window units, to be some 4322 million units, or 5783 million m^2 in the year 2011.

In related studies such as the DG ENTR Lot 6 Ventilation study the total building volume was assessed at 110 billion m^3. With an overall 5.8 billion m^2 of window stock this results in 19 m^3 per m^2 window, or 1 m^2 window per room volume of 2.65 by 2.65 by 2.65 meter (which is a window to floor ratio of 14% of both residential and non-residential combined). No source has been identified to verify this value, but the value appears to be realistic.

Figure 11 EU27 Window stock 2011 (million window units)

[7] Green Public Procurement - Windows and External doors / technical background report, by JRC IPTS 2012, for DG Environment.



The stock can be further differentiated into window types (single glazing, double glazing with low-E coating, etc.) . As an example, the window stock in Germany is given below[8] .

Final Report 2 June 2015

Table 8 Stock of windows by type in Germany 2011

	Million units[9]	% of DE stock
Single glazing	25	4%
Double window	52	9%
Double glazing (no Low-E coating)	235	40%
Double glazing with Low-E coating	257	44%
Triple glazing with Low-E coating	12	2%

The TASK 3 and TASK 7 show more detailed information as to what window stock has been assumed.

Penetration rate

Although the MEErP methodology asks for a "penetration rate"[10] to be established, it is quite obvious that this is 100% for all buildings concerned. The actual amount of m2 per building (or dwelling, whatever is more appropriate) is specified in Task 3.

4.2. ROOF WINDOW MARKET & STOCK / VOLUME AND VALUE

For the European market it is also assumed that at maximum some 10% of the market is roof windows. This is thus some 10-15 billion m2/year. No information was retrieved for the stock of roof windows.

[8] Source: VFF/BF study "Mehr Energie sparen mit neuen Fenstern" (2011 update).

[9] Totals for DE different from other VFF study (4% higher).

[10] For domestic appliances the "penetration rate" is the total number of products present in households, divided by the total number of households. For televisions the penetration rate exceeds 100% (on average more than 1 television per household).

Relevant stakeholders have been consulted but were not able to provide more detailed data.

4.3. SOLAR SHADING MARKET AND STOCK

The average data of sales for shutters were based on information submitted by ESSO.

Table 9 Market size of solar shading devices (2012)

Solar shading device	Volume
Awnings (Folding arm, terrace, …)	1 854 592
of which motorised	*995 654*
External roller blinds (markisolette, …)	987 593
of which motorised	*503 774*
External venetian blinds	3 207 854
of which motorised	*1 418 406*
Internal blinds (made to measure)	24 425 866
of which motorised	*560 064*
Panel shutters (sliding, hinged, …)	2 444 000
of which motorised	*20 550*
Roller shutters	18 561 253
of which motorised	*8 980 980*
Total volume	**51 481 157**
of which motorised	*12 479 428*
Total combined solar shading with window	
(shutters + EVB + ext. roller blinds)	**7 165 977 (7-10% of total window unit sales)**
of which motorised	*2 646 101 (36% of total sales shading devices))*
	Combined: some 3% of new windows have motorised shading devices
Country sales for combined shutter with window (selection)	
AUSTRIA	23 832
BALKANS	98 000
BELUX	142 000
FRANCE	1 697 713
GERMANY	1 623 500
GREECE	220 000
IBERIA	1 440 000
ITALY	190 000
POLAND-BALTIC	382 600
SE EUROPE	101 850
UK & IRELAND	2 800
Country sales for combined window shutter for half lintel	
FRANCE	84 929

Final Report 3 June 2015

According this overview roughly 7 million windows were, from factory gate, equipped with solar shading devices. This corresponds to approximately 7%-10% of the market (overall window sales range from 90 million in 2008 to some 73 million in 2012).

For roof windows, it is possible to purchase shading devices (external and internal) that fit with the standard sizes of roof windows. The shading market for roof windows consist therefore of standardized sizes, and shading devices are being produced for stock. Shading devices can be purchased together with the roof window.

Shading devices (internal and external) are relevant in both summer situations (to keep the heat out of the building) and in winter situations (to keep the heat inside the building)

It is important to differentiate between manual and automated shading devices as they have different effect on the energy performance.

About 1/3 of shading devices sales is motorised. Automation for shading market exists of mainly 3 types of automation devices

1. Timer (including twilight);
2. sun control (or other types of sensor control);
3. master control.

The relative sizes are:

- 70% with master control only
- 20% with timer
- 10% with sun control

Some 30% of the motors for shading are automated by control systems.

The market for motorized shading products is as follows:

Table 10 Market size of motors in solar shading devices

Shading motors in EU ('000)	2008	2009	2010	2011	2012
textile	730	730	780	770	750
external venetian blind	1007	1006	1110	1160	1300
shutter	8840	8700	9500	10180	10060
TOTAL	10577	10436	11390	12110	12110

Final Report 3 June 2015

The stock of shading devices is not presented in data supplied by ES-SO. An estimate can be made, assuming that sales have been constant over the last years. Assuming a product life of 20 years, the stock can then be calculated to be some 1 billion units. The window stock is some 3 billion units and all this suggests that some 34% of the window stock has known window covering applied. There may of course be more window coverings present in the stock, but there is no data supplied that allowed to derive other values.

Table 11 Share of window covering type in window stock

Solar shading device	Sales volume, all	% of window stock (assuming 20 yrs shading device life)	Sales volume, motorised only	% of window stock (assuming 20 yrs shading device life)
Awnings (Folding arm, terrasse, …)	1,854,592	1%		
of which motorised			995,654	1%
External roller blinds (markisolette, …)	987,593	1%		
of which motorised			503,774	0%
External venetian blinds	3,207,854	2%		
of which motorised			1,418,406	1%
Internal blinds (made to measure)	24,425,866	16%		
of which motorised			560,064	0%
Panel shutters (sliding, hinged, …)	2,444,000	2%		
of which motorised			20,550	0%
Roller shutters	18,561,253	12%		

of which motorised			8,980,980	6%
Total volume	51,481,157	34%		
of which motorised			12,479,428	8%
total windows	3017000000			

4.4. PAST AND FUTURE PROJECTIONS

As the objective is to sketch the development of energy/resource(related) consumption from 1990 towards ultimately 2050, the past and future market and stock needs to be assessed as well.

The market and stock of windows is naturally very much related to the market and stock of buildings, including projections of new builds, renovations (deep and shallow) and replacement (window renovations of glazing or glazing + frame).

4.4.1. CONSTRUCTION INDUSTRY TRENDS

Until early 1998 construction output in Europe had increased rather steadily; but with the economic and financial crisis output began to decline quite dramatically. Since spring 2008 the level of total construction in the EU-28 has been on a more or less constant decline. The most recent level of the index (April 2013) for the EU-28 is more than 26 percentage points lower than the pre-crisis index (Figure below).

The development of overall construction was very similar for the EU-28 and the Euro area (EA-17) (Table below). However there is a noticeable difference between the development of the construction of buildings (residential and non-residential) which accounts for around 78 % of total construction and the development of the construction of civil engineering works (e.g. railways, roads, bridges, airport runways, dams) which accounts for around 22 % of total construction.

Final Report 3 June 2015

The crisis in the building sector hit all EU-28 countries albeit to a different extent. All countries experienced a decline in building production ranging from an extreme reduction of -54.4 % in Lithuania in 2009 to almost stable activity levels in Germany and Austria. In several countries (e.g. the Baltic countries, Spain, France, Hungary) growth rates had already begun to move downwards around the year 2005 while in several other countries the drop in building activities happened in a more sudden way and was shorter.

Figure 12 Construction sector production index July 2000-2013[11]

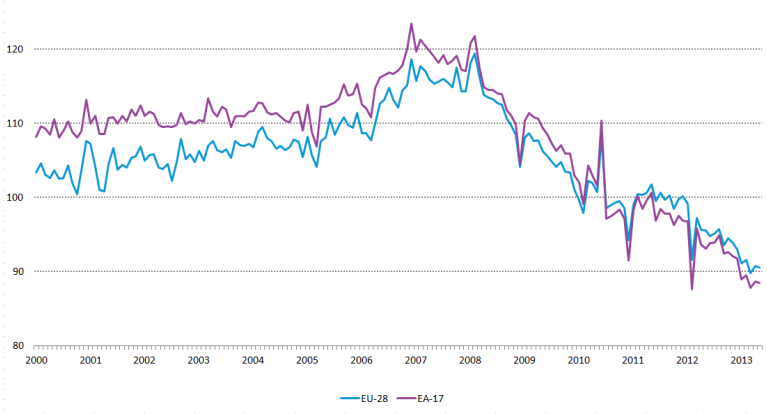


Table 12 Building area index, rate of change compared to previous year, gross (%)

[11] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/ Construction_production_%28volume%29_index_overview

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
EU-27	Buildings	:	-2.0	-4.5	4.0	4.8	1.7	7.1	-2.9	-18.4	-20.5
	Residential buildings	1.8	-4.2	0.0	9.9	8.2	4.0	5.3	-9.4	-26.4	-20.3
	One-dwelling	1.5	-4.5	-1.9	4.5	2.2	0.1	3.0	-11.7	-22.2	-18.8
	Two- and more dwellings	9.3	-4.3	2.0	16.8	14.6	7.6	9.9	-7.2	-26.4	-19.8
	Residences for communities	:	-9.1	-9.0	14.9	-0.4	-3.5	5.6	19.9	-6.8	-33.0
	Non-residential buildings	0.2	2.0	-8.2	-2.0	1.4	-1.0	12.2	6.2	-12.2	-21.0
	Office buildings	13.0	12.0	-18.8	-4.6	-14.0	-6.6	25.9	11.4	-0.3	-32.5
	Other non-residential	-0.2	0.9	-7.0	-1.5	2.7	-0.8	11.7	5.8	-13.4	-18.6
Euro area	Buildings	:	-3.9	-5.0	3.8	3.7	2.5	8.0	-4.2	-20.3	-23.7
	Residential buildings	2.5	-7.3	0.4	9.9	7.0	4.4	4.9	-10.2	-24.9	-22.6
	One-dwelling	5.5	-6.7	-0.4	6.7	3.1	2.4	2.9	-13.9	-18.6	-20.5
	Two- and more dwellings	6.7	-8.3	-0.5	12.3	9.0	4.6	9.8	-7.0	-25.7	-20.3
	Residences for communities	:	-11.1	-7.8	14.1	1.2	-5.2	4.7	23.4	-9.4	-31.9
	Non-residential buildings	1.8	1.7	-9.6	-2.9	0.0	-0.4	15.8	5.8	-14.8	-23.9
	Office buildings	21.5	15.1	-21.5	-2.8	-16.5	-9.2	34.3	16.2	-1.4	-33.7
	Other non-residential	1.7	0.2	-8.2	-2.6	1.6	0.0	15.2	4.9	-16.2	-20.9

Source: Eurostat (sts_cobpgr_a)

Outlook

Renovation of the existing building stock is key for reducing the energy consumption in Europe. The building sector is the sector with the largest cost-effective opportunity for energy savings. According this study some 2/3 of floor area (and arguably window area as well) is in residential buildings. The potential for energy savings in the existing building stock is, therefore, primarily in the residential sector.

4.4.2. PRODUCT LIFE

With annual EU27 sales varying between 74 to 90 million window units[12] (in 2011 and 2007) respectively and the stock being 3422 million m^2 (year 2011), the product life (in a rather constant market) can be calculated to be between 38 and 46 years. One may conclude windows have a product life of between 30 to 40 years (average).

Final Report 3 June 2015

This corresponds to the Eurowindoor statement that the IGU (insulated glass unit) has a product life of some 20 years and the frame double of that[13]. Therefore, pane change is included in the assessment of window costs (see Task 6). The standard deviation of the product life could not be identified (neither by stakeholders).

ISO 15686 gives methods for assessing service life. Important to note is that life expectancy is not simply a question of materials, but is foremost a question of appropriate maintenance.

A study by Napier University (Edinburgh, UK)[14] presented information on product life of windows according which wood, wood + metal and aluminium windows can be characterized as having a product life of more than 35 years (average between 40-50 years), whereas PVC windows are claimed to have a product life of 25-30 years (main cause of reduced life is likely to be ageing through ultra-violet radiation).

Again, it should be stated that proper installation and maintenance exert a very high influence on the window product life, and is likely to be a more relevant parameter for product life than the type of frame material itself.

4.4.3. SALES & STOCK ANTE AND POST 2011

The sales data of windows ante (pre) 2011 will be based on the VFF data and then adjusted according the change in the Production in construction index.

The sales of windows post (after) 2011 will be based on estimates or projections regarding the future 'Production in construction index'.

The stock will be constructed from these sales projections. The renovation potential of buildings in Europe is described in TASK 3.

[12] The VFF study window unit measures 1.3 * 1.3 m

[13] EuroWindoor position on stakeholder consultation for the second set of Green Public Procurement (GPP) criteria - Product Sheet - Windows, Glazed Doors and Skylights, Frankfurt 05/09/2009.

[14] Sustainability analysis of window frames, by M Asif, T Muneer and J Kubie, published in BUILDING SERV ENG RES TECHNOL 2005; 26; 71 (online: http://bse.sagepub.com/cgi/content/abstract/26/1/71).

CHAPTER 5 MARKET TRENDS

This sections focuses on market trends other than volume and or value described in the preceding paragraphs. The previous paragraphs have already indicated the relative trends of various frame materials.

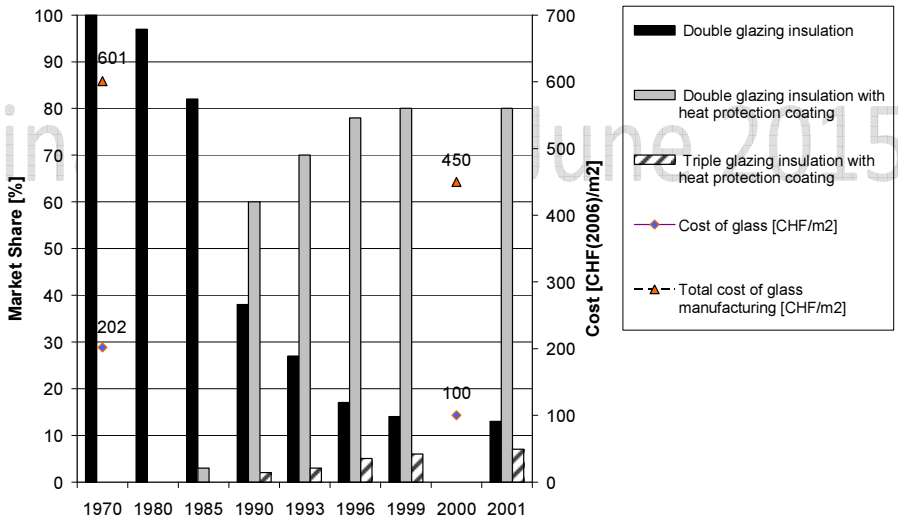
5.1. TRENDS IN PRODUCT DESIGN & FEATURES

This section presents information on the construction industry as a whole and the window products more specifically.

5.1.1. TRENDS IN WINDOWS GLASS PROPERTIES

During the 2011 Background study for the Ecodesign Working Plan stakeholders have suggested that triple-glazing is rapidly becoming the norm in Scandinavian countries and gaining market share, particularly in Germany where 40% of sales are triple glazing. In this context it is relevant to note that the long product life of windows (slow refurbishment rate) means that if a suboptimal solution is applied, this will be present in the stock for a long time.

Figure 13 Market penetration rate and price developments of energy efficient glass[15]



Final June 2015

According a TNO report[16] for Glass for Europe from 2011 the distribution of glazing in the EU building stock is as shown below. This is not believed to have changed drastically in the recent years.

Table 13: Distribution of glazing in the EU building stock

[15] Development of the relative production output (quantity-based) for double and triple glazing in Switzerland, 1970–2001 (%) and the price difference for glass manufacturing between 1970 and 2006 (CHF (2006)/m2). Source: DG ENTR, based on data from: Jakob and Madlener 2004, p.16 and 17

[16] Bakker, L., TNO Report Glazing type distribution in the European building stock, TNO, The Netherlands for Glass for Europe, February 2011.

Glazing type	EU27	North	Central Marine	Central continental	South	Baltic states	Poland	Central Europe	Romania, Bulgaria
single	44%	6%	47%	30%	59%	33%	32%	42%	49%
double	42%	38%	38%	45%	40%	54%	50%	52%	48%
double gl. with low-e	12%	36%	15%	24%	1%	2%	5%	3%	1%
triple	2%	20%	0%	1%	0%	11%	13%	3%	2%

Note: The available literature on the distribution of glazing types in Europe is limited. The provided figures are a result of figures on the building stock from literature and known market introductions of different types of glazing and estimations of applied glazing types per region, per period.

The fact that some 44% of the windows in the EU are still single glazing is not due to the fact that people replace old single glazed windows by new single glazed windows, but mainly due to the fact that renovation/refurbishment rates are very low, especially since upfront costs for window replacement are relatively high.

For the roof window market for residential buildings there is a clear trend regarding solar protected glazing. Windows with solar protected glazing are sold to a large extent in Southern Europe (including France) but to a little extent in Northern Europe.

5.1.2. TRENDS IN WINDOWS FRAME MATERIALS

The VFF market study indicated that the market share of plastic (PVC) window materials is on the rise, whereas that of metallic frames has reduced by the same percentage. Wood frame windows show a small decline, but combined metal-wood frame materials show a slight increase.

Final Report 3 June 2015

Table 14 Market trends in frame material (VFF study 2013)

Frame material	2008	2009	2010	2011
PVC	58.0	57.6	59.9	60.9
Metal	22.0	21.3	19.7	19.0
Wood	17.0	17.5	16.9	16.7
Metal-Wood	3.0	3.5	3.4	3.4

Besides the above frame materials also glass fibre reinforced polymer matrix composites (GFRP) are being looked at as frame materials[17]. Although commercially available[18], such windows however do not represent a noticeable share of the market today.

As regards roof windows the frames are made of wood, PU or PVC. The exterior of the frame is metal-clad as a standard.

5.1.3. TRENDS IN SHADING DEVICES

For façade windows and windows in general there is a trend for increased use of shading devices. This includes an increased use of automated (therefore motorized) shading devices. Proper shading solutions shall therefore be part of the energy-saving construction methods. The IEA Technology Roadmap, lists exterior shades among the 'low cost solutions' for curtailing energy consumption for cooling. In new buildings, says the report, *'exterior shading, proper orientation and dynamic solar control should become standard features globally in new buildings and can also be applied to existing buildings'*.

[17] Source: Development of a slim window frame made of glass fibre reinforced polyester, by David Appelfeld∗, Christian S. Hansen, Svend Svendsen, Department of Civil Engineering, Technical University of Denmark (published in Energy and Buildings 42 (2010) 1918–1925).

[18] Source: http://www.protecwindows.com/en-GB/Front-page/Low-energy/GRP.aspx

For roof windows, it is possible to purchase shading devices (external and internal) that fit with the standard sizes of roof windows. The shading market for roof windows consist therefore of standardized sizes, and shading devices are being produced for stock. Shading devices can be purchased together with the roof window. The scope for the inclusion of shading devices in the preparatory study should therefore not be limited to integrated shading (in between the panes) or pre-installed shading devices, as this is not standard for the roof window market.

5.2. MARKET STRUCTURE

This section describes the market structure and sales channels. It describes the route from production to final customer, and the various parties involved.

For windows, much like many other construction products, the market structure and sales channels differ across the European countries. Roughly one can define three major market structures:

1. In certain countries it is quite common that window frame and glass are sold separately. One party is responsible for the frame and installs this. Another party then installs the glazing. This approach is typical for placing windows in projects where engineering companies (contractors) are involved trying to reduce costs by giving different contracts to manufacturers for framing members and glazed infills and is not typical for a geographic market.
2. More dominant (especially considering the residential market) is the approach where a complete window (frame and glass combined) is bought from and installed by the same responsible company, especially as the replacement of each window unit has to take place during the same day. This approach entails that windows are produced for individual purposes, which leads to the situation that nearly every window is unique (has different dimensions). Aluminium windows are most of the time individually produced (made to measure) for specific projects. Window sizes as well as the set of components that are being chosen to provide the desired technical or aesthetical result are not constant. Therefore, for aluminium windows, scenario 2 is valid for the entire EU-28 market;
3. In again other countries certain large manufacturers may offer windows in standardised dimensions and most windows are produced for stock. This situation is for instance typical in Sweden. Roof windows market is characterized by in standardized dimensions and most roof windows are produced for stock. This is also the case for solar shading for roof windows. Standard sized solar shading can be purchased with a roof window or later. Vertical windows can also be purchased in Do-It-Yourself stores, but the quantities sold this way today are very low, most probably due to three reasons:
    - The sizes and size range of vertical windows is much wider than the ones of roof windows;
    - Assistance of window installers on site is required in most cases;
    - In most buildings, vertical window sizes are NOT standard.

Final Report 3 June 2015

Of course the above description is still generic and various types of market structures may exist simultaneously in the same country or markets segments / sectors.

→ Metal and PVC façade windows[19]

Looking from a more technical perspective, the market can also be structured according the window frame material. The metal (aluminium) and polymer (mostly PVC) frames are often produced by a "system-house", responsible for the development and testing of the products (design of frame). Furthermore they define the complete window product, consisting of the frame profile, the transparent filling element (glazing), the gaskets or seals and the additional hardware. In a so called "system description" all the components that are necessary to build the complete window are stated in detail. The system description is the manual for the final window manufacturer to produce a window product. For all the window products that can be produced according to the system description the system-house is in possession of the documents necessary to place the product on the market. System houses do not produce the windows themselves.

Examples of system houses for PVC windows are: Aluplast, Gealan, Internorm, Inoutic, Profine (with different brands), Rehau, Salamander, Schüco, Veka

Examples of system houses for aluminium windows are: Alcoa/Kawneer, Alumil, Akotherm, Etem, Heroal, Hueck-Hartmann, Reynaers, Sapa (with different brands), Secco, Schüco.

[19] Data presented in this section is derived from the study "Branchenstrukturanalyse des deutschen Fenster- und Haustürenmarktes 2011" The study is available in German language and can be ordered via the Verband Fenster + Fassade, Frankfurt.

In general the window itself is built by smaller companies having a licence/contract to use the system description. The system house assists the manufacturer in placing the product on the market. The manufacturer is allowed to use the necessary tests for the window belonging to the system house. The relevant documents are forwarded by the system-house to the manufacturer to enable him to declare the necessary characteristics. As far as CE marking is concerned this procedure is called cascading of type testing.

Further assistance given by the system house to the manufacturer:

- marketing
- technical support
- education
- guidance for necessary machines/production lines
- question concerning legal and normative issues

Information box: The role of the system houses in the window and curtain walling sector

Historically, a few companies, called system houses, started to elaborate window, door and curtain walling frame systems, which are used by the window, door and curtain walling industry. Throughout the European Union a relatively small number of system houses supply thousands of Micro, Small and Medium-sized Enterprises SMEs with the necessary goods to produce perfect products for the building envelope.

The system houses bear a high responsibility towards their costumers, the window, door and curtain walling industry, by providing them with:

• Advanced and sophisticated systems made up of frame profiles, gaskets, hardware

• Testing and evidence of conformity

• Engineering services for design and calculation

• Documentation and training for assembly

• Sales engineering

• Project support

The system houses also run all necessary or requested prototype testing of their systems on behalf of the window and curtain walling manufacturers. This includes, for instance fire safety testing according to the specific national building regulations.

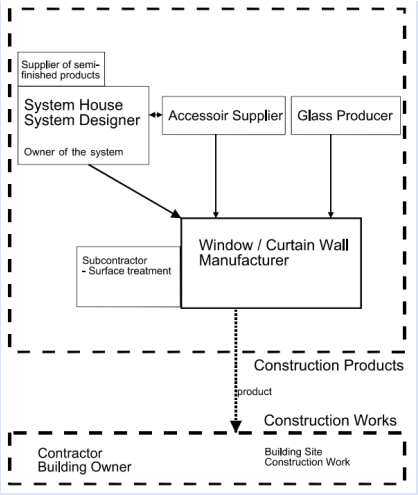
The system houses do not only supply components and provide services for the final product but also take care of further developments of the systems in order to meet new regulations and take them a step further, for example with regard to sustainability or simplification of processes. These challenges and the aim to fulfil the end costumer's needs are answered by continuous research and development, carried out mainly by the system houses.

The window, door and curtain walling manufacturers produce the final product based on the relevant guidelines and rules provided by the system house and according to the requirements of the construction works and the specifiers.

This division of work has been applied for a long time and is not only accepted but also has proven its worth both in the European market and throughout the world. Similar systems are applied to all relevant materials, metal, wood and plastics.

Added to which, the European standards in the sector are based on this system, including the standards and test methods prepared in the framework of the CPD.

Figure 14 Graphic representation of relations system house, manufacturer, etc.



→ **Wooden windows**

For wooden windows there are in general no system houses. The consequence is that the manufacturer is responsible for all necessary activities (development, testing etc.). In the past some solutions were developed to provide also small wood window manufactures with the necessary documents. For example the company VBH, selling hardware to window manufacturers developed a system[20] that provides test reports for wood window manufactures. Although VBH does not produce profiles it acts as a kind of system house.

Wooden windows are more often designed and produced locally, by SME-sized (or micro-sized) enterprises. Exclusions do exist, for instance in Sweden where most frames are made of wood and larger production houses produce large volumes of frames (and may also include the glazing to offer a complete window).

Final Report 3 June 2015

→ **Roof windows**

Nowadays, the global market major industry players are three companies: Danish Velux, Polish FAKRO and German Roto. Other manufacturers with marginal market share are: Claus, Faelux, Inlux and Axel (Italy), Okfel (Slovenia), Fenestra, Kubeso, Zima, Solára (Czech Republic), OKPOL, Oman (Poland), Keylite (GB), Andersen (USA), Colambia (Canada), AHRD (China), Folis (RSA), Induro (Spain), Tostem, YKK and Panasonic (Japan). None of them have more than 1% share in the global market[21].

Trends in roof windows reflect primarily national/local preferences.

5.2.2. MANUFACTURER SIZES

The following information presents a (limited) picture of the German window market and is based on VFF data.

According to the VFF study almost 80% of the companies producing windows have not more than 20 employees. Companies with a staff more than 150 persons are below 1% of the total window producing companies. In 2011 there were in total approx. 6500 window producing companies in Germany.

The sales area of small companies (< 20 employees) is mainly local (county area) to regional (province). Big companies (>150) are distributing approximately ¾ of their products on an international level (Germany and other countries).

For the distribution of the windows there are two main sale channels:

1. The manufacturer of the window sells his product to the end customer/consumer. There is a direct contact between the manufacturer and the end customer.

[20] www.ce-fix.de

[21] Source: http://www.fakro.co.uk

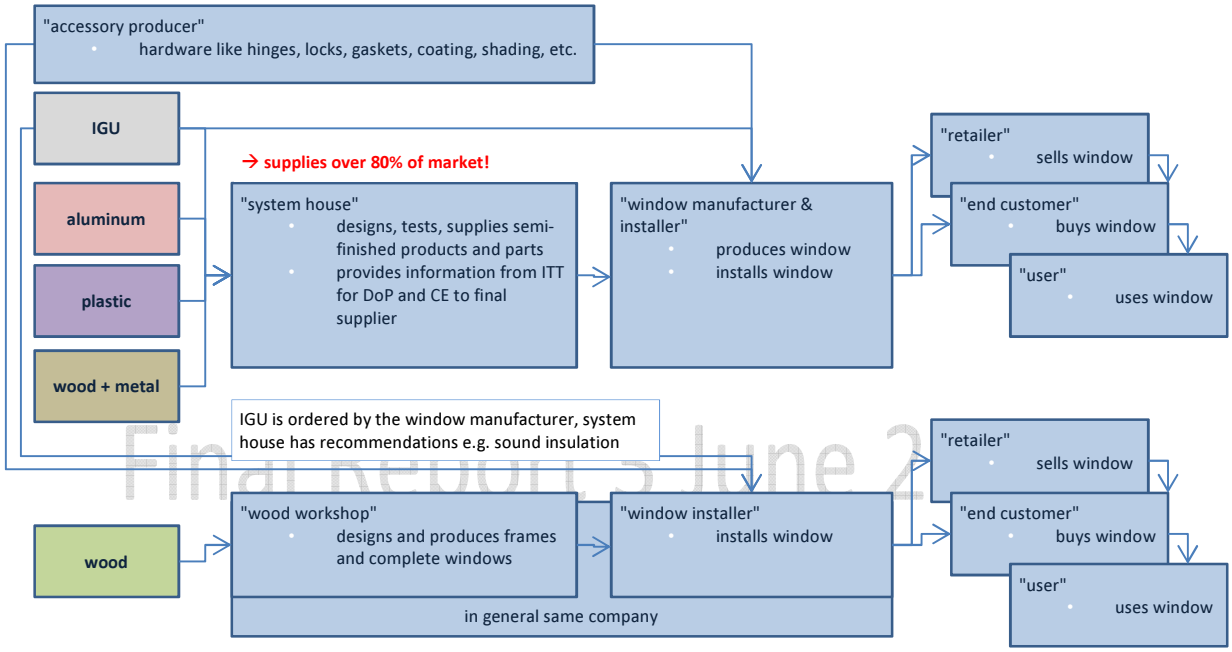
2. The manufacturer sells his window to his retailers. The retailer has the direct contact with the end customer.

Whereas small companies are distributing their windows mainly directly to the end consumer larger companies are selling more windows by retailers. The biggest companies are distributing almost 90% of their windows through their retail channels.

In 2011 the German window manufacturers had a maximum capacity of approx. 16.3 Mio window units. Just less than 20% of that capacity is captured by small enterprises (80% of all manufacturers), 80 % of the capacity belongs to the rest of the manufacturers.

As typical 'system house' windows (aluminium, plastic have significant shares in other member States, it can be assumed that a limited number of system house (approximately 50 companies) supply a large part (possibly two-thirds) of the market. Manufacturers of windows and installers are typically micro-SMEs, counting to over several thousands in the EU.

Table 15 Overview of manufacturing structure



Final Report 3 June 2

5.2.3. REPRESENTATION

Eurowindoor (EPW, FAECF, FEMIB, and UEMV)

EuroWindoor is the umbrella organization of the European manufacturers of fenestration and door sector FAECF, FEMIB, EPW and UEMV for the three frame materials metal, wood and plastic and the infill material glass. EAA Building represents major system houses[22].

On a European scale EuroWindoor represents more than 50.000 companies and more than one million employees. The European window industry is mostly an industry which consists of small and medium sized companies, with local employees. In view of the construction supply chain, the window industry supplies local construction companies with building components and is thereby a part of a local supply chain with local employment.

The goal of EuroWindoor is to ensure the progress of the glazing and the window industry and to ensure high quality in products and work. The goal is to ensure the right quality for the customers and to work for a long-term efficiency for society. This includes also working for the use of the environmental and energy saving possibilities of energy efficient windows that may include Low-E-glass, solar control glass, thermally improved profiles and spacers as well as blinds and shutters and improved air tightness of the window offers.

Glass for Europe

[22] http://www.alueurope.eu/applications/building/

Glass for Europe is the trade association for Europe's manufacturers of building, automotive and transport glass, all derived from the base material known as flat glass.

Glass for Europe has four member companies, AGC Glass Europe, NSG Group, Saint-Gobain Glass and Sisecam-Trakya Cam, and works in association with Guardian. Together, these five companies employ over 16,000 people across the EU, run 52 of the 58 float lines based in the EU and represent 90% of Europe's flat glass production.

European Aluminium Association (EAA)

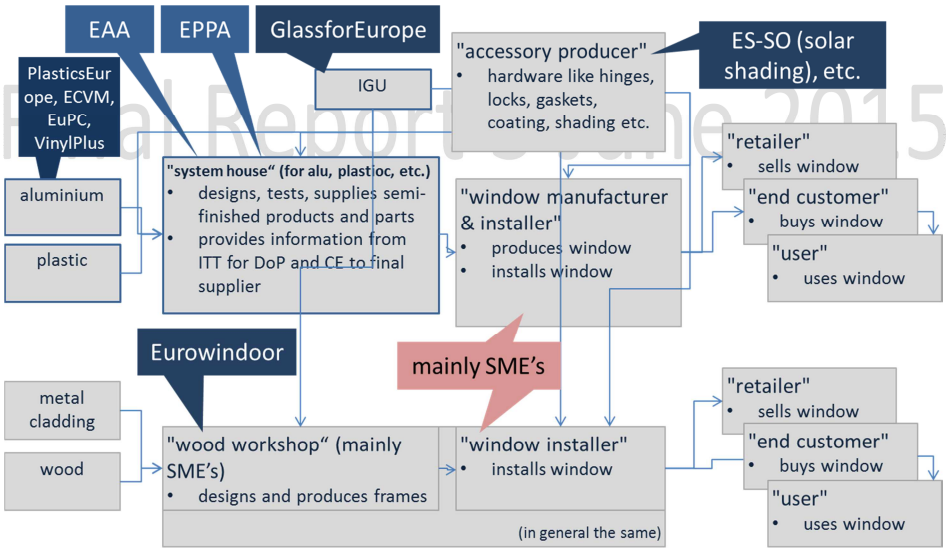
The European Aluminium Association (EAA) was founded in 1981 and represents the aluminium industry in Europe. It encompasses primary aluminium producers, downstream manufacturers, producers of recycled aluminium and national aluminium associations representing the manufacturers of rolled and extruded products in 18 European countries. The Organisation of European Aluminium Remelters and Refiners (OEA) and the European Aluminium Foil Association (EAFA) are also members of the EAA.

European Solar-Shading organization (ES-SO)

ES-SO is a not-for-profit organization to Belgian Law (ES-SO vzw) established in Brussels. It is the umbrella organization of the professional solar shading associations in the various Member States of the EU and includes some non-EU members. In countries where no professional trade association is in existence, prominent individual companies are invited to join as associate members.

While the solar shading industry in Europe consists typically of small to medium-sized companies, it does employ more than 400,000 people across the 27 Member States and generates annual sales of over € 15 billion. ES-SO's is the voice of the solar shading industry in the European institutions and aims to make a positive contribution towards the EU meeting its ambitious energy efficiency commitments. ES-SO is also involved in various EU projects and acts in both a contributory and advisory capacity.

Figure 15 Overview of representation



CHAPTER 6 CONSUMER EXPENDITURE BASE DATA

This section presents information relevant for the calculation of consumer expenditure and the life cycle costs of the products concerned. Consumer expenditure is determined by:

1. Purchase costs;
2. Installation & Maintenance costs;
3. Operating costs (direct costs and indirect costs, through costs for conditioning (heating and/or cooling) the space);
4. Costs for disposal.

6.1. PURCHASE AND INSTALLATION COSTS

6.1.1. FAÇADE WINDOWS

Sources for window purchase price information

One of the most recent EU studies that looked into window prices is the JRC 'Evidence Base for Windows and Doors' study, performed in 2011-2012. This study presented €265 as standard price for windows sized 1.2 m^2, excluding installation. Installation was assessed to be some €100/standard window. This results in €365 for the complete installed window or €304 for 1 m^2.

Prices of windows obviously depend on technical properties, and the JRC study presented prices for 'improved' windows that are twice as high as the standard window, depending on the market (geographic zone). The main difference however being the properties of the insulated glass unit (IGU).

Final Report 3 June 2015

To assess the costs for windows in Europe a questionnaire was drafted and published on the website of the Ecodesign Project. The stakeholders were asked to fill the survey.

Unfortunately only few comments and data were submitted. Therefore the authors decided to estimate typical costs of windows using the following further sources:

- Study: Policies to **EN**force the **TRA**nsition to **N**early **Z**ero **E**nergy buildings in the EU-27 (ENTRANZE)[23], see also Annex I
- Study of the "Verband Fenster und Fassade e.V." and the "Bundesverband Flachglas e.V.": "Energetische Modernisierung von alten Fenstern[24] "

The data from the ENTRANZE study shows that prices range considerably across Member States.

The study "Energetische Modernisierung von alten Fenstern" showed (for Germany) that although prices can be quite different per frame material, the price difference of an 'improved' window is about the same, as this is mainly due to changes in the IGU.

[23] www.entranze.eu – Using the data cost tool extracted from the website May 2014. The current (Aug 2014) data cost tool on the website doesn't show the window costs.

[24] Mehr Energie sparen mit neuen_Fenstern Aktualisierung Juli 2011 der Studie "Im neuen Licht: Energetische Moderniesierung von alten Fenstern', by VFF Verband Fenster und Fassade, Frankfurt and BF Bundesverband Flachglas e.V., Troisdorf. (http//www.bundesverband-flachglas.de/upload/publikationen /VFF-BF-Studie_Mehr_Energie_sparen_mit_neuen_Fenstern.pdf)

Table 16: Window investment costs in Germany [Error! Bookmark not defined.]

Window, by frame material (window prices incl. installation and taxes. Size: 1.3*1.3m.	U_w = 1.3 W(m^2K) g=60% (€/window)	U_w = 0.95 W(m^2K) g=60% (€/window)	Price difference (€/window)
Wood	502	590	88
Wood-metal	649	737	88
Plastic	370	451	81
Aluminium	818	988	81
Average window (weighted, excluding aluminium)	421	504	83
Average window (weighted, including aluminium)	499	581	82

The stated average costs (indicative for period 2010 – 2015 and representing the combined average of EU28 prices) are including the installation of the window. The costs are without VAT.

Calculation of EU28 average window purchase price

This section uses the base case description of windows as explained in Task 4 and 5

The product price (street price) is based upon the following data:

The average window in Germany costs 499 EUR, including installation and VAT. The actual price range is however much wider as this depends largely on the frame material and to lesser degree on energy properties. However, the model will be based on the relation between energy properties and cost price.

The value of 499 EUR applies to a window of 1.3*1.3 m^2, and results in 295 EUR/m^2 window. This is the costs of one square meter window type 3 or 4 (with U_W 1.3 – 1.7, g-value 0.6 – 0.65). The other window types (1-11) are based on this window, however corrected for material consumption and complexity.

Final Report 3 June 2015

Installation costs are estimated to be some 20 EUR/m perimeter or 104 EUR for the window of 1.3*1.3 m, which is 61 EUR/m^2 (assumed including VAT on labour). The window before installation costs 295-61 is 233 EUR/m^2 incl. VAT or 196 EUR/m^2 excl. VAT (19% in Germany). The 196 EUR consists of approximately 50% (98 EUR/m^2) material costs, some 20% (39 EUR/m^2) are labour costs and the remaining 30% (59 EUR/m^2) are overhead and margins of the supply chain. For other countries different values apply as VAT and labour rates are vastly different.

Moreover, the typical share of frame materials is very different from market to market, which is a major reason for differences in the price of an average window between national markets.

As no public material (at least no information that can be reprinted in this report) is available as regards the exact make up, by frame material of markets, the basic material price of 98 EUR in Germany was taken as reference for the whole EU (assuming that material prices do not differ significantly within the EU). Then for each member state the costs of labour and overhead were corrected for the respective labour cost index of that Member State. The final street price was corrected for the applicable VAT in that Member State. Note, this calculation does not take into differences in shares of frame materials (as already stated above).

The reference costs for materials where corrected by factors that take into consideration the average material input (factor A in table below) and a correction factor to take into account the complexity of producing a window and which is used to tune the outcome of the EU28 average costs to represent the values indicated in the 31 October meeting.

The resulting EU28 street prices for the various window types (base cases, as introduced in Task 4 and so on) are presented in the table below.

Table 17 EU28 Purchase prices per window type and split-up

EU28	U_W (W/m^2*K)	g (-)	Street price, incl. inst.+VAT	installation (per 1 m^2)	VAT	overhead (corr. B)	labour (corr. B)	correction factor B	correction factor A	material (corr. A*B)
01_single	5.8	0.85	154	61.5	21%	26	17	0.6	0.66	41
02_double IGU, standard	2.8	0.78	234			37	25	0.85	1.00	88
03_double IGU, lowE, argon	1.7	0.65	255			41	28	0.95	1.00	98
04_double IGU,lowE, argon, impr	1.3	0.60	256			41	28	0.95	1.00	98
05_triple IGU, lowE, argon	1.0	0.55	298			41	28	0.95	1.36	134
06_triple IGU, lowE, argon, impr.	0.8	0.60	403			59	39	1.35	1.36	190
07_coupled	1.0	0.58	370			50	33	1.15	1.50	178
08_quadruple	0.6	0.47	510			59	39	1.35	2.00	279
09_as 02, solar	2.8	0.35	288			48	32	1.1	1.00	113
10_as 04, solar	1.3	0.35	299			50	33	1.15	1.00	119
11_as 06, solar	0.8	0.35	456			68	45	1.55	1.36	218

Final Report 3 June 2015

Due to differences in Member States the EU28 margins are slightly different to that of Germany: EU28 material is 59%, labour is 17% and overhead is 25% share of purchase costs.

The price elasticity is not determined in accordance with MEERP 2011 (which asks for a linear relationship). The available data comprises all available window types and therefore the average price can be calculated on the basis of the window sales.

This approach results in the following street prices for windows (base cases, as introduced in Task 4 and so on) sold in Member States and the EU28.

Table 18 Street prices (purchase costs) of windows per Member State(EUR/m²)

	01_single	02_double IGU, standard	03_double IGU, lowE, argon	04_double IGU, lowE, argon, impr	05_triple IGU, lowE, argon	06_triple IGU, lowE, argon, impr.	07_coupled	08_quadruple	09_as 02, solar	10_as 04, solar	11_as 06, solar
AT	181	267	291	291	334	448	410	554	327	339	505
BE	208	300	326	326	369	494	451	601	366	380	556
BG	62	121	134	134	177	249	233	356	155	161	285
CY	118	187	205	205	246	335	309	437	232	241	380
CZ	92	157	173	173	216	299	277	405	198	206	340
DE	180	265	289	295	331	445	407	550	325	337	502
DK	217	313	341	341	385	515	471	626	382	396	581
EE	88	152	168	168	211	292	271	398	192	199	332
EL	107	177	194	194	238	328	303	437	221	230	372
ES	137	212	232	232	274	371	342	476	262	272	420
FI	184	272	297	297	340	458	419	567	334	346	516
FR	194	282	307	307	349	468	428	574	345	357	527
HR	89	155	172	172	215	299	277	408	196	204	340
HU	78	142	157	157	201	281	262	392	180	187	321
IE	174	258	281	281	325	437	400	544	317	329	493
IT	164	246	268	268	311	420	385	526	302	314	474
LT	71	132	147	147	190	265	247	373	168	175	303
LU	193	278	303	303	344	460	420	562	340	352	517
LV	72	133	148	148	191	268	249	376	170	177	306
MT	99	165	182	182	224	308	285	413	207	215	350
NL	189	275	300	300	342	459	420	565	337	349	517
PL	81	145	160	160	204	284	264	393	183	191	324
PT	98	166	183	183	227	313	290	422	208	217	356
RO	68	130	144	144	188	264	247	374	166	173	302
SE	226	323	352	352	396	530	484	641	395	409	597
SI	109	178	196	196	239	327	302	434	222	231	372
SK	83	147	162	162	205	285	264	391	185	193	324
UK	139	215	235	235	278	377	347	483	265	276	427
EU28	154	234	255	256	298	403	370	510	288	299	456

Final Report 3 June 2015

The countries with the highest prices are: Sweden, Denmark, Belgium, France, Luxembourg, Netherlands. Countries with lowest prices are: Bulgaria, Romania, Lithuania, Estonia, Latvia and Hungary. Italy is just above the average EU28 price, and Spain and UK are just below that price.

The above overview is not corrected for differences in market shares of frame materials. The reason is that these costs will be used to assess the impacts of changes in energy related window properties. The inclusion of frame material as another variable would distort or obscure the effect of energy properties on the window price. As an example: The fact that aluminium as frame material has a higher market share could explain the relative high costs for windows in Spain in the ENTRANZE dataset, and does not necessarily mean these windows have a higher energy performance.

It has to be noted that the requirement on the energy performance is not the only characteristic that influences the construction of the window. Also other requirements have an significant impact on the detailed construction of the window and therefore on the price, such as:

- Sound insulation;
- Safety and security;
- Burglary resistance;
- Fire resistance.

These aspects have not been considered in the establishment of purchase costs.

→ **Maintenance costs**

Maintenance costs comprise two main components: Glazing replacement and general servicing/maintenance (such as small repairs and paint jobs).

Some countries promote energy renovation works applying a lower VAT rate for labour and/or materials (e.g. 5,5% in France). Such specifics have not been taken into account.

Glazing replacement

Glazing replacement is included in maintenance costs. Stakeholders expressed different views on product life of window and glazing unit. To accommodate most of the viewpoints expressed we developed a two way approach:

Final Report 3 June 2015

If the window life is set at no longer than 30 years, it is assumed that no glazing replacement takes place as the chances somebody replacing glazing (if not an emergency) while the window itself is estimated to be replaced soon as well can be neglected.

if the window life is set at more than 30 years, it is assumed that a single glazing replacement takes place.

The cost price of the glazing unit is assumed to be equal to its share of the total window weight (weight share of IGU of 35% means 35% of purchase costs of the respective window). This figure includes installation and VAT (as this is included in the overall window price as well).

General servicing / maintenance

General servicing / maintenance costs have been decided on the following indicative data: Wooden windows require a paint job every 5 year (recommended). Assuming a house of 130m2 and a window-to-floor ratio of 20% this means 26m2 of windows in that house. Assuming the total costs for painting all 26m2 of windows is an indicative 2000 euro (assumed average for whole EU), this comes down to (2000/5/26) 15 euro per window per year.

As some 20% of the stock is wooden windows this means 3 euro/m2 per year for the average EU window. Costs for maintenance of plastic (60% of stock) and aluminium windows (19% of stock), which is essentially cleaning, need to be added. All in all, the maintenance costs are assumed to be maximum 5 euro/m2 window per year.

Costs for disposal are set at zero, similar to the ENTRANZE cost tool.

Of course this is a very approximate value, and real costs may differ significantly, but it is expected to be sufficiently representative for the purpose of the cost assessment in TASK 6.

***

Combined with the glazing replacement costs (see above), the total annual maintenance costs can be calculated for the 11 window types. The table below shows the calculation steps (note: the IGU replacement costs are spread over 20 years life, as window product life is set at 40 years).

Table 19 Calculation of total annual maintenance costs

Window type	Purchase price (EUR/unit)	IGU share of total weight (%)	IGU replacement costs (EUR/unit)	Other maintenance (EUR/yr)	Total annual costs (EUR/yr)
01_single	154	34%	52.50	5	7.63
02_double IGU, standard	234	45%	105.64	5	10.28
03_double IGU, lowE, argon	255	45%	115.47	5	10.77
04_double IGU, lowE, argon, impr	256	45%	115.98	5	10.80
05_triple IGU, lowE, argon	298	50%	148.38	5	12.42
06_triple IGU, lowE, argon, impr.	403	50%	200.63	5	15.03
07_coupled	370	45%	167.41	5	13.37
08_quadruple	510	45%	230.57	5	16.53
09_as 02, solar	288	45%	130.22	5	11.51
10_as 04, solar	299	45%	135.14	5	11.76
11_as 06, solar	456	50%	226.75	5	16.34

6.1.2. ROOF WINDOWS

To analyse the costs for roof windows in Europe a questionnaire was drafted and published on the website of the Ecodesign Project. The stakeholders were asked to fill the survey. On the basis of the submitted costs by VELUX and further price information available in published price lists of other roof window manufacturers (ROTO, FAKRO), average prices for different design options of roof windows were estimated.

The information received is shown below.

Final Report 3 June 2015

Table 20 Window roof prices (standard size)

Roof window examples, Germany (Size 1,14 x 1,4 m^2)	Germany Purchase price ex. VAT (2014)	France Purchase price ex VAT (2014)
Metal clad - wood, double glazing with Low E coating, non-laminated	€ 458	
Metal clad - wood, double glazing with Low E coating, laminated,, solar protected glazing		€ 504
Metal clad wood, triple glazing with Low E coating, laminated	€ 814	€ 828
Metal clad - PU, double glazing with Low E coating, non-laminated	€ 548	
Metal clad - PU, double glazing with Low E coating, laminated, solar protected glazing		€ 595
Metal-clad PU triple glazing with Low E coating, laminated	€ 904	€ 915
double, low-E, gas, warm edge (U_W 1.3, g 0.66)		€ 446

Table 21 Window roof prices NORTHERN Europe (standard size, excl. installation or VAT)

U_w in W/m^2K	g	type	Price if Wood + metal	Price if Plastic (e.g. PVC/PU)+metal	Remark	price per m^2
2.8	0.78	double glazing	€ 270*	€ 350 *	*EU hist.price	range 169 - 219 avg 194
1.3	0.66	double, low-E, gas, warm edge	€ 480	€ 580	UK (Note: 1 GBP = 1.325 EUR), smaller size window	range 357 - 431 avg 394
1.2	0.55	double, low-E, gas, warm edge	€ 458	€ 548	Germany	range 287 – 343 avg 315
1	0.5	triple, lowE, gas, warm edge	€ 814	€ 904	Germany	range 510 – 566 avg 538

U_w in W/m^{2}K	g	type	Price if Wood + metal	Price if Plastic (e.g. PVC/PU)+metal	Remark	price per m^2
0.8	0.5	triple, lowE, gas, warm edge	€ 943	€ 1033	Germany	range 591 – 647 avg 619
0.51	0.45	triple + double, lowE, gas, warm edge, automated PV	€ 1504,00	€ 1875	Germany	range 942 – 1174 avg 1058

Remarks. Purchase prices all without VAT. The size of the listed roof windows window is 1,14 m x 1,4 (except 1.3/0.66 which is 1.14*1.18 m^2).

Table 22 Window roof prices SOUTH Europe (standard size, excl. installation or VAT)

U_w in W/m^{2}K	g	type	Price if Wood + metal	Price if Plastic (e.g. PVC/PU)+metal		price per m^2
2.8	0.78	double glazing	€ 270*	€ 350 *	*EU hist.price	range 169 - 219 avg 194
1.3	0.64	double, low-E, gas, warm edge	€ 511,00	€ 603,00	Italy	range 320 - 378 avg 349
1.3	0.66	double, low-E, gas, warm edge	€ 370	€ 446,00	Portugal	range 232 – 279 avg 256
1	0.5	triple, lowE, gas, warm edge	€ 828,00	€ 915,00	France	range 519 – 573 avg 546
0.8	0.5	triple, lowE, gas, warm edge	€ 811,00	€ 903,00	Italy	range 508 – 566 avg 537
1.2	0.3	double, lowE, gas, warm edge, solar control	€ 504,00	€ 595,00	France	range 316 – 373 avg 344

Remarks. Purchase prices all without VAT. The size of the listed roof windows window is 1,14 m x 1,4.

When averaged for the three glazing types and the two frame materials, the prices are as in the table below.

Table 23 Window roof prices – averaged, per m^2

Final Report June 2015

	double	triple	double+solar
wood	€ 287	€ 514	€ 316
PU	€ 343	€ 570	€ 373
average	€ 315	€ 542	€ 344

On the basis of the costs and further price information available in published price lists of roof window manufacturers, average prices for different design options of roof windows were estimated.

Installation costs were estimated (by lack of stakeholder information on exact prices) to be some 200 euro/m^2 for a window in Germany, assuming 4 hours labour and average labour costs of 50 euro/hour. Installation costs for other countries have been defined by the relative difference with the German average labour wages.

The costs are stated in Table 24.

Table 24 Representative costs for different design options of roof windows

No.	U_w in W/m^{2}K	g	Description	Costs in €/m^2 (excl. inst., VAT)	Street purchase price (incl. installation and VAT), in €/m^2
1	5.8	0.85	Single glazing; Frame: metal-wood, no or bad thermal break	Not available on the market	not assessed
2	2.8	0.78	Double IGU; Standard frame (metal-wood or metal-PVC/PU, Metal)	only for inhabited rooms	not assessed
3	1.3	0.60	Double IGU with Low-e coating and argon filling; Frame metal-PVC/PU or metal-wood	300	480
4	1.0	0.50	Triple IGU with Low-e coating and argon filling; thermally improved spacer; Frame metal-PVC/PU or metal-wood	475	708
5	0.8	0.50	Triple IGU with optimized Low-e coating and argon filling, thermally improved spacer; Frame metal-PVC/PU or metal-wood	600	913
6	1.3	0.35	Double IGU with Low-e coating and argon filling and solar control glazing; Standard frame metal-PVC/PU or metal-wood	350	578

VAT EU28 average: 21%
Installation costs roof window EU28 average: 159 euro/m^2 window

The analysis shows that in contrast to façade windows there are less design options for roof window as far as the energy performance is concerned. Roof windows with single glazing are not available on the European market. An, Insulating Glazing Unit (IGU) with Low-e coating is virtually standard for roof windows.

6.1.3. SOLAR SHADING

As regards purchase costs of solar shading products, the following information was received from ES-SO.

Table 25 Acquisition costs of solar shading for façade windows

Roof window	Av. price	Drive	Typical surface (m)	Avg. euro/m2
Awnings (Folding arm, terrace, …)	3 000 €	(motorised)	W 6,0 x H 3,5	143
External roller blinds (markisolette)	600 €	(motorised)	W 1,5 x H 2,0	200
External venetian blinds	600 €	(motorised)	W 1,5 x H 2,0	200
Panel shutters (sliding, hinged, …)	400 €	(manual)	W 1,2 x H 1,5	133
	1 600 €	(motorised)	W 1,2 x H 1,5	533
Roller shutters	400 €	(motorised)	W 1,2 x H 1,5	133
Internal blinds (made to measure)	150 €	(manual)	W 1,2 x H 1,8	69
	400 €	(motorised)	W 1,2 x H 1,8	185

Final Report 3 June 2015

The prices are for a standard window as part of a larger order, and not actually the average cost per m2, as the relation of price and surface is not linear.

For external venetian blinds and roller shutters, the difference between motorized and manual systems is considered negligible (sometimes manual systems are even more expensive).

The above data are quite specific for the size indicated. The association also provided (very indicative) data for average products (without VAT, incl. installation). These values can however not be used to calculate costs of any dimension for the reasons stated above and should be regarded as very generic values:

1. External venetian blind, power operated: approx. 140 €/m2
2. External roller blind, power operated: approx. 90 €/m2
3. Internal venetian blind, manual operated: approx. 40 €/m2
4. Internal roller blind, manual operated: approx. 40 €/m2
5. External build in roller shutter/top mounted roller shutter box; manual operated: 90€/m^2 additional costs for motor: 140 €

The "average" solar shading device relevant for this study is external and a mix of awnings, roller blinds, venetian blinds, panel shutters, where roller shutters form the majority of sales. The cost analysis in Task 6 will be based on a low-cost shutter, such as a roller shutter.

For roof windows blinds and shutters are produced in standard sizes and purchased together with the roof window or after.

Table 26 Purchase costs of solar shading for roof windows

Type (1.23*1.48 m^2)	NORTHERN	Remarks	SOUTHERN	Remarks
Roller blind (fabric) (awning blind)	€ 73,00	Germany, manual	€ 66	France, manual
Roller blind (fabric) (awning blind)	€ 356,00	Germany, electrical	€ 319	France, electrical
Roller shutter (Aluminium)	€ 306,00	Germany, manual	€ 292	France, manual
Roller shutter (Aluminium)	€ 610,00	Germany, photo voltaic	€ 694	France, photo voltaic
Roller blind (fabric)	€ 140,00	Germany, manual, white	€ 114	France, manual, dark blue

Roller blind (fabric)	€ 253,00	Germany, photo voltaic, white	€ 250	France, photo voltaic, dark blue

6.2. OPERATING COSTS

The assessment of operating costs will be based on the impacts of window characteristics on related energy systems, these being climatisation systems (for heating and cooling). Impacts on lighting costs could not be established in this study.

An extensive model has been developed to describe the various energy and cost aspects. This has been described in TASK 3 and TASK 7 (Scenario's).

6.2.1. ELECTRICITY AND FUEL RATES

Window units do not consume energy but do affect energy consumption of space heating and cooling systems, thus energy rates for such systems are relevant. Such energy rates differ between small commercial/residential clients and industrial/large commercial clients, which ideally should be taken into account. Finally, the price increase of both electricity and fuels, in absolute value and at constant prices are relevant for calculations in the remaining tasks. The table below gives a summary of the rates used (source: MEErP 2011, based on Eurostat).

Table 27 Energy rates EU27 for reference years, long term increments (users 3500 kWh/a)

Description	Value
RESIDENTIAL rates	
Electricity rate 1.1.2006 [€/ kWh electric] Eurostat	0,152
Electricity rate 1.7.2009[€/ kWh electric] Eurostat	0,164
Electricity annual price increase	2%
Electricity annual price inflation corrected (2%)--> constant prices 2005	0%
Gas rate 2005 [€/ kWh primary GCV]	0,047
Oil rate 2005 [€/ kWh primary GCV]	0,061
2005 average space heating mix rate [€/ kWh primary GCV] : rates as above, weighting at 76% gas, 21% oil, 3% electric	0,053
[€/ kWh primary GCV];	0,058
Eurostat official annual fuel price increase July 2007-July 2009. Note that avg. annual fuel price increase over period Jan 2006-July 2009 from 14,7 to 16,21 €/GJ was higher, at 9%. But Eurostat was used.	7,30%
Fuel annual price increase inflation corrected (2%) --> constant price 2005	5,30%
[€/ GJ primary GCV]= € 0,102/kWh; Used in LCC-calculations. Fuel price halfway product life, starting 2010/2011	28,5

Final Report 3 June 2015

Table 28 Energy rates EU27 for reference years, long term increments (industrial/larger commercial users)

Description	Value
NON-RESIDENTIAL rates	
Electricity rate 1.7.2009[€/ kWh electric] Eurostat	0,107
Electricity annual price increase	2%
Electricity annual price inflation corrected (2%)--> constant prices 2005	0%
Gas rate 2005 [€/ kWh primary GCV]	0,0216
Gas rate 2009 [€/ kWh primary GCV]	0,0388
Oil rate 2009 [€/ kWh primary GCV]	0,044
2005 average space heating mix rate [€/ kWh primary GCV] : rates as above, weighting at 76% gas, 21% oil, 3% electric	0,036
Eurostat official industrial gas price increase 2005-2009 is from 6,01 to 9,40 EUR/GJ. This is an average annual increase of 9,3%	9,30%
Fuel annual price increase inflation corrected (2%) --> constant price 2005	7,30%

[€/ GJ primary GCV]= € 0,102/kWh; Used in LCC-calculations. Fuel price halfway product life, starting 2010/2011	19,9

A split-up of energy rates per country is presented in TASK 3 (also used for TASK 7).

Average price increases of the fuel and electricity have been considered by inclusion of a Present Worth Factor PWF, together with product life, interest and inflation rate (see hereafter).

6.2.2. INTEREST, INFLATION, DISCOUNT RATES AND PRODUCT LIFE

In an LCC calculation running costs have to be discounted to current prices, using the Present Worth Factor PWF. For the calculation of PWF the following long-term rates are relevant:

- Product life *N = 40* years (see section 4.2.2)[25];
- Inflation rate 2%;
- Interest rate 6%;
- Discount rate= interest minus inflation = 4% (parameter *r*).

The equation for PWF is PWF= $\{1 - 1/(1+r)^N\}/r$. This is used in the life cycle cost calculation with the general format LCC= PP + PWF*OE, where PP is the purchase price and OE is the annual operating expense.

6.3. END-OF-LIFE COSTS

The survey sent to stakeholders did not result in specific information related to window end-of-life costs.

One can assume that disposal costs for the residential sector are covered by costs for municipal waste unless a window installer takes care of removal and disposal, which renders waste windows to be commercial waste. The costs then depend on material and waste collection scheme. It is imaginable that disposal costs for aluminium windows are negative (not costs but value).As disposal costs most likely do not depend on window (energy) performance, the assessment neglects window disposal costs.

Final Report 3 June 2015

[25] The JRC Evidence base study used a product life of 30 years

CHAPTER 7 RECOMMENDATIONS

According the methodology for preparatory studies, this Chapter is required to cover recommendations on:

- a refined product scope from economical / commercial perspective (e.g. excluding niche markets);
- and barriers and opportunities for Ecodesign from the economical / commercial perspective.

7.1. REFINED SCOPE

The TASK 2 Market analysis did not result in further information that requires a revision or fine-tuning of the study scope from economical / commercial perspective.

The exclusion of certain types of windows from scope as defined in TASK 1 continues to apply.

7.2. BARRIERS AND OPPORTUNITIES

Barriers and opportunities for Ecodesign from the economical / commercial perspective have been dealt with in TASK 1.

Final Report 3 June 2015

ANNEX I - ENTRANZE WINDOWS COST DATA

[more detailed data can be retrieved from the ENTRANZE project bureau]

(*) Nominal thermal conductivity of the new insulation layer λ=0,034 W/mK

	Measure	Constructive solution	Description of the measure	Variants	Cost Criteria	Unit	Code	Italy Final Costs MC + LC + BP&GE + PF + Disposal	Spain Final Costs MC + LC + BP&GE + PF + Disposal	France Final Costs MC + LC + BP&GE + PF + Disposal	Austria Final Costs MC + LC + BP&GE + PF + Disposal	CzRepublic Final Costs MC + LC + BP&GE + PF + Disposal	Romania Final Costs MC + LC + BP&GE + PF + Disposal	Germany Final Costs MC + LC + BP&GE + PF + Disposal	Bulgaria Final Costs MC + LC + BP&GE + PF + Disposal	Finland Final Costs MC + LC + BP&GE + PF + Disposal
	IMPROVE THE THERMAL QUALITY OF THE WINDOW	BASE REFURBISHMENT LEVEL OF WINDOWS	Repair/restoration the old window components (glasses and frames) for aesthetic/functional/security reasons	-	<100m² of window area	€/m²	80	112.1	71.3	105.8	94.3	27.5	15.7	82.6	32.5	77.0
					>100m² of window area	€/m²	81	100.8	66.3	82.8	94.3	27.5	16.3	82.6	32.5	74.5
		Window glazing substitution	Windows glazing substitution, keeping the actual frames.	Double glass with air cavity (16mm) New thermal transmittance value of glazing U_g= 2,7 W/m²K; g= 0,78; T_{vis}= 0,82	<100m² of window area	€/m²	82									
					>100m² of window area	€/m²	83									
				Double glass with air cavity (16mm) and a low-e glass New thermal transmittance value of glazing U_g= 1,7 W/m²K; g= 0,72; T_{vis}= 0,81	<100m² of window area	€/m²	84								104.0	
					>100m² of window area	€/m²	85								89.7	
				Triple glass with argon cavity (2x16mm) and low-e glass New thermal transmittance value of	<100m² of window area	€/m²	86								169.0	

			glazing U_g= 1,0 W/m²K; g= 0,64; Tvis= 0,74	>100m² of window area	€/m²	87								148.2	
	Window replacement	Replacement of the old single-glazed or double-glazed windows by highly efficient, airtight double-glazing windows. This solution will therefore improve the tightness.	Double glass with air cavity (16mm) New thermal transmittance value of glazing U_g= 2,7 W/m²K; g= 0,78; T_{vis}= 0,82 New thermal transmittance value of frame U_f=2,2 W/m²K Reduce air permeability of the window at least to 2nd class (27 m³/hm²) of the standard "EN 12207 Windows and doors - Air permeability - Classification"	<100m² of window area	€/m²	88	356.4	389.0	334.7						126.7
				>100m² of window area	€/m²	89	324.0	350.1	334.7						126.7
			Double glass with air cavity (16mm) and a low-e glass New thermal transmittance value of glazing U_g= 1,7 W/m²K; g= 0,72; T_{vis}= 0,82 New thermal transmittance value of frame U_f=1,4 W/m²K Reduce air permeability of the window at least to 3rd class (9 m³/hm²) of the standard "EN 12207 Windows and doors - Air permeability - Classification"	<100m² of window area	€/m²	90	390.0	496.6	380.7	269.9	212.5	159.5	313.1		360.0
				>100m² of window area	€/m²	91	354.5	453.2	380.7	269.9	200.6	159.2	313.1		360.0
			Triple glass with argon cavity (16mm) and a low-e glass New thermal transmittance value of glazing U_g= 1,0 W/m²K; g= 0,64; T_{vis}= 0,74 New thermal transmittance value of frame U_f=1,0 W/m²K Reduce air permeability of the window at least to 4th class (3 m³/hm²) of the standard "EN 12207 Windows and doors - Air permeability - Classification"	<100m² of window area	€/m²	92	455.7	580.0	472.7	303.7	275.0	192.5	354.0		392.7
				>100m² of window area	€/m²	93	414.3	524.0	472.7	303.7	259.6	191.8	354.0		392.7
			Triple glass with argon cavity (18mm) and a low-e glass New thermal transmittance value of glazing U_g= 0,65 W/m²K; g= 0,6; T_{vis}= 0,733 New thermal transmittance value of frame U_f=0,95 W/m²K Reduce air permeability of the window at least to 4th class (3 m³/hm²) of the standard "EN 12207 Windows and doors - Air	<100m² of window area	€/m²	94				337.4		338.9	400.8		516.3
				>100m² of window area	€/m²	95				337.4		338.9	400.8		516.3

Final report

				permeability - Classification"												
		Double window (Adding a new window to the existing one)	Addition of a new window in the wall thickness maintaining the existing one. The new window will be installed in the opposite alignment of the wall to the existing one.	New window with simple glazing with thermal transmittance value (frame + glazing) U_w= 5 W/m²K	<100m² of window area	€/m²	96									
					>100m² of window area	€/m²	97									
				New window with double glazing with thermal transmittance value (frame + glazing) U_w= 2,7 W/m²K; g= 0,78; Tvis= 0,82W/m²K	<100m² of window area	€/m²	98									
					>100m² of window area	€/m²	99									
		Sealing of joints	The weather-stripping around the perimeter of the frame seals the window, eliminating drafts and creating a thermal barrier. Reduce air permeability of the window at least to 3rd class (9 m³/hm²) of the standard "EN 12207 Windows and doors - Air permeability - Classification".	Reduce air permeability of the window up to 3rd class (9 m³/hm²) of the standard "EN 12207 Windows and doors - Air permeability - Classification"	<100m² of window area	€/m²	100		40.0			26.0	13.7			
					>100m² of window area	€/m²	101		35.0			25.0	13.7			
MEASURES TO REDUCE COOLING LOADS	SOLAR SHADING	BASE REFURBISHMENT LEVEL OF EXISTING SOLAR SHADING	Repair/restoration on the old solar shading devices for aesthetic/functional/security reasons		<100m² of window area	€/m²	102	61.1	53.8	63.3				100.0	32.5	
					>100m² of window area	€/m²	103	55.0	45.0	57.5				100.0	32.5	
		Drop-arm awnings	Drop-arm awnings offer the ideal	-	<100m² of window area	€/m²	104	67.0		74.8						

Final Report 3

		installation	solution for providing shade for windows and balconies only in summer periods. Opacity coefficient of the awning material 0,7.		>100m² of window area	€/m²	105	61.0		74.8						
		External window blinds		-	<100m² of window area	€/m²	106	337.5	187.5	506.0	135.3	156.3	86.5	216.0	140.4	172.5
					>100m² of window area	€/m²	107	306.9	168.8	506.0	135.3	150.0	84.0	216.0	132.6	159.7
		Automation of solar shading devices	Installation of electrical motors, electrical control for shading devices, solar radiation sensors, etc.	-	<100m² of window area	€/m²	108	144.3	125.0	120.3	184.0	100.0	82.8	247.2	75.4	112.9
					>100m² of window area	€/m²	109	129.9	112.5	113.6	173.8	100.0	80.3	247.2	75.4	106.6
	SOLAR CONTROL GLASS	Window glazing substitution	Replacement of old single-glazed or double-glazed windows by highly efficient ones, airtight double-glazing with solar control.	New thermal transmittance value of glazing U_g= 1,7 W/m²K; g= 0,39 (solar control glass); T_{vis} = 0,70	<100m² of window area	€/m²	110	231.1								
					>100m² of window area	€/m²	111	210.1								
		Solar control vinyl		-	<100m² of window area	€/m²	112		45.0		22.4					
					>100m² of window area	€/m²	113		40.0		22.4					
		Window replacement (therefore tightness improvement)	Replacement of the old single-glazed or double-glazed windows by highly efficient ones, airtight double-glazing windows with solar control glasses.	New thermal transmittance value of glazing U_g= 1,7 W/m²K; g= 0,39 (solar control glass); T_{vis} = 0,70	<100m² of window area	€/m²	114				393.6	81.3				
					>100m² of window area	€/m²	115				393.6	78.0				

Final Report

	NATURAL VENTILATION	Automatized natural ventilation	This solution includes electrical motors, electrical control for opening, internal partitions grids, outdoor temperature sensor, etc.	-	<100m^2 of window area	€/m^2	116	**314.3**	**241.3**	**257.9**	**394.6**	**214.4**	**166.9**	**242.1**	**140.4**	**242.1**
					>100m^2 of window area	€/m^2	117	**285.7**	**217.1**	**232.1**	**394.6**	**214.4**	**160.6**	**217.9**	**140.4**	**217.9**

[end section]

Final Report 3 June 2015