ENVIRONMENTAL PRODUCT DECLARATION

in accordance with ISO 14025 and EN 15804

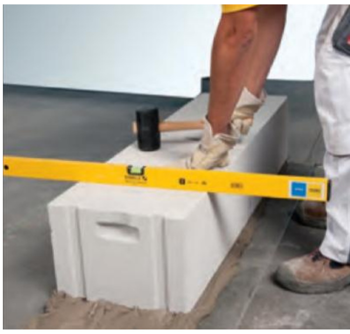
Owner of the Declaration	**Xella Baustoffe GmbH**
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	**EPD-XEL-20120006-IAD1-EN**
Issue date	06.06.2012
Valid to	05.06.2017

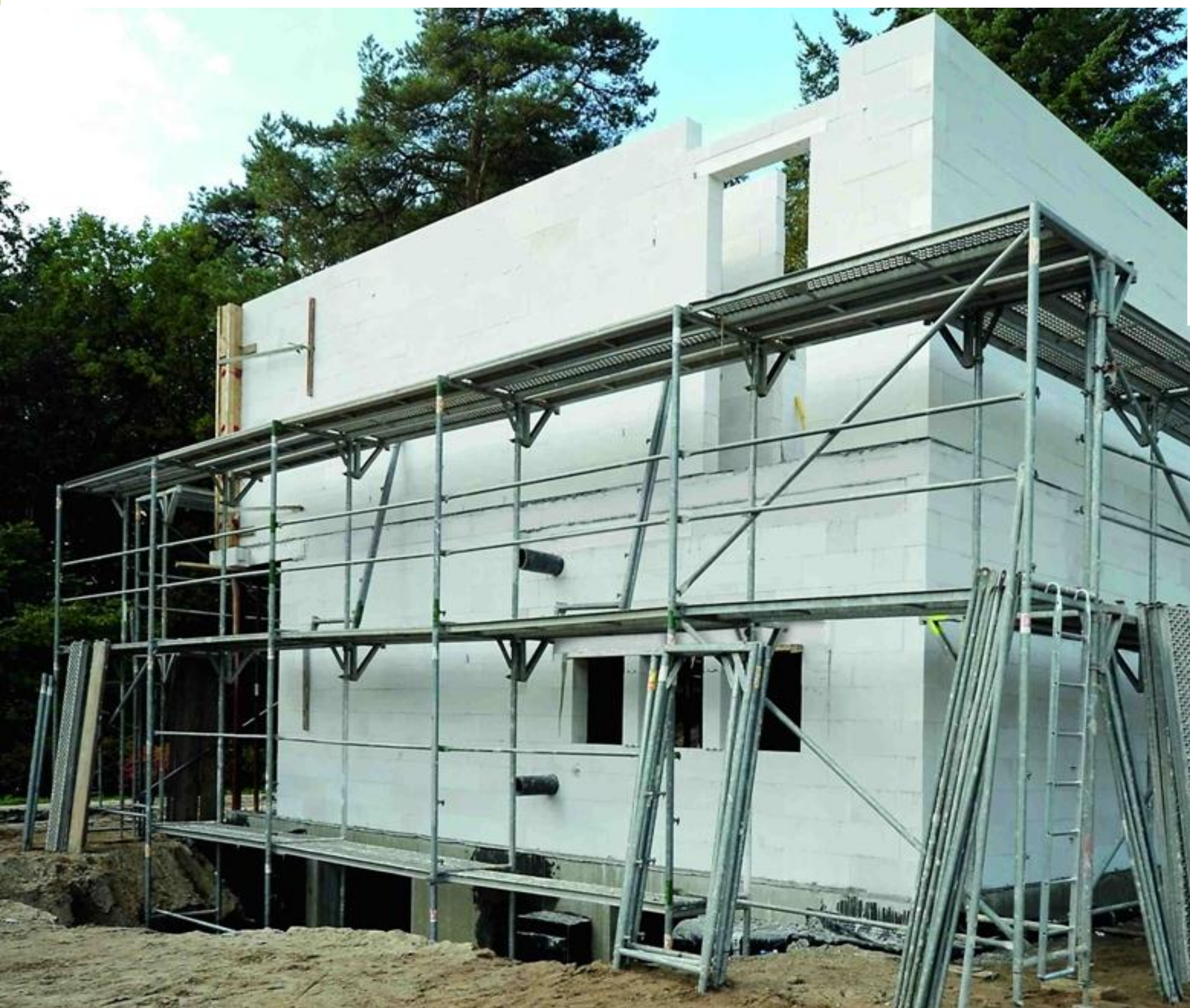
Ytong® Autoclaved Aerated Concrete (AAC)

Xella Baustoffe GmbH

Institut Bauen und Umwelt e.V.

www.bau-umwelt.com





Xella

1. General Information

Xella Baustoffe GmbH	Ytong® Autoclaved Aerated Concrete (AAC)
Programme holder IBU - Institut Bauen und Umwelt e.V. Rheinufer 108 D-53639 Königswinter	**Owner of the Declaration** Xella Baustoffe GmbH Düsseldorfer Landstraße 395 47259 Duisburg
Declaration number EPD-XEL-20120006-IAD1-EN	**Declared product/Declared unit** 1m³ non-reinforced Ytong® autoclaved aerated concrete (AAC) with an average gross density of 445 kg/m³.
This declaration is based on the product category rules: Aerated Concrete, 08-2012 (PCR tested and approved by the independent expert committee)	**Scope:** The LCA is based on consideration of all German Xella Group AAC works and the data basis of 2010. The owner of the declaration shall be liable for the underlying information and evidence.
Issue date 06.06.2012	
Valid to 05.06.2017	**Verification** The CEN standard DIN EN 15804 serves as the core PCR Independent verification of the declaration and data in accordance with ISO 14025 ☐ internally ☒ externally
Prof. Dr.-Ing. Horst J. Bossenmayer (President of Institut Bauen und Umwelt e.V.)	
Prof. Dr.-Ing. Hans-Wolf Reinhardt (Chairman of SVA)	Dr.-Ing. Wolfram Trinius Independent tested appointed by SVA

2. Product

2.1 Product description
The declared products are non-reinforced AAC building blocks of various shapes. AAC belongs to the porous steam-cured light weight concrete group.

2.2 Application
Non-reinforced building blocks for brick-built monolithic load-bearing and non-load-bearing walls. Normally, structural engineering ensures that direct contact with water is avoided.

2.3 Technical data

Constructional data

Name	Value	Unit
Gross density	300 - 800	kg/m^3
Compressive strength	2 - 10	N/mm^2
Tensile strength	0.24 – 1.2	N/mm^2
Bending tensile strength (longitudinal)	0.44 – 2.2	N/mm^2
Modulus of elasticity	750 - 3250	N/mm^2
Equilibrium moisture at 23 °C, 80 %	4	M.-%
Shrinkage according to DIN EN 680	0.2	mm/m
Thermal conductivity according to DIN 12664	0.08 – 0.18	W/(m*K)

2.4 Placing on the market/Application rules
DIN V 20000-404 and DIN V 4165-100 and also general building authority approvals.

2.5 Delivery status
Building blocks according to DIN V 4165-100 and DIN 4166.

2.6 Base materials /Ancillary materials

Sand	60 – 70 M-%
Cement	15 – 30 M-%
Quicklime	10 – 20 M-%
Anhydrite/gypsum	2 – 5 M-%
Aluminium	0.05 – 0.1 M-%
Formwork oil	Ancillary material

In addition, 50 – 75 M-% water is used (based on the solid materials).

Sand: the sand used is a natural raw material which naturally contains minor and trace minerals in addition to the main mineral quartz (SiO_2). Quartz is the base material for the hydrothermal reaction during steam curing.

Cement: in accordance with DIN EN 197-1; cement serves as a bonding agent and is manufactured mainly from limestone marl or a mixture of limestone and clay. The natural raw materials are burnt and subsequently ground.

Quicklime: in accordance with DIN EN 459; quicklime serves as a binding agent and is manufactured by burning natural limestone.
Anhydrite / gypsum: in accordance with DIN 1168; the sulphate medium used serves to influence the setting time of the AAC and originates from natural sources or is produced technologically.
Aluminium: Aluminium powder or paste serves as a pore-forming agent. Metallic aluminium reacts to the release of hydrogen gas in the alkaline milieu, which forms pores and dissipates once the expanding (rising) process is complete.
Water: the presence of water is the basis for the hydraulic reaction of the bonding agent. Water is also necessary to produce a homogenous suspension.
Formwork oil: formwork oil is used as a separating agent between the mould and the aerated concrete mass. PAK-free mineral oils are used with long-chained additives to increase viscosity. This prevents draining off in the mould and permits economic use.

2.7 Manufacture

The ground quartz sand is mixed with quicklime, cement and crushed recycled AAC material to a watery suspension in a mixer whilst water and aluminium powder or paste are added and then poured into casting moulds. The water purges the quicklime whilst producing heat. The aluminium reacts in the alkaline environment. Gaseous hydrogen is formed which produces the pores in the mass and dissipates without residue. The pores mostly have a diameter of 0.5 – 1.5 mm and are exclusively filled with air. After initial hardening, semi-solid raw blocks are formed from which the AAC blocks are cut by machine and with great precision.
AAC properties are finally formed during the subsequent steam curing for 5 – 12 hours at approximately 190 °C and pressure of approximately 12 bar in steam pressure chambers, so-called autoclaves. Here, the raw materials used form calcium silicate hydrates which are equivalent to the mineral tobermorite, which occurs naturally. The reaction of the material is completed when removed from the autoclave. After the hardening process is finished, the steam is used for further autoclavings. The condensate is used as process water. In this way, energy is saved and contamination of the environment with steam and waste water is avoided.
Finally, the AAC building blocks are stacked on wooden pallets and shrink-wrapped in recyclable polyethylene (PE) film.

2.8 Environment and health during manufacturing

Mutual indemnity association regulations apply. No special measures to protect employees' health are required.

2.9 Product processing

AAC building blocks are processed by hand. Lifting gear is required for components with a mass of more than 25 kg. Building blocks are cut with bandsaws or by hand with carbide metal saws because they produce practically only coarse and no fine dust. High-speed tools such as angle grinders are not suitable for processing AAC because they release fine dust!
The AAC blocks are joined to one another with thin-bed mortar according to DIN 1053-1 as with other standardised building materials; normal or lightweight mortar (11 kg mortar / m³) may also be used in special cases. AAC building blocks can be plastered, coated or painted. Lining with small-format parts or the attachment of facing shells to DIN 1053-1 is possible. Mutual indemnity association regulations apply. No special measures to protect the environment are required during processing of the building product.

2.10 Packaging

Any packaging or pallets accumulated on the building site must be collected separately. The polyethylene shrink-wrap is recyclable. Any PE sheets that have not been soiled and the reusable wooden pallets can be returned to building material suppliers (reusable pallets for a refund via the deposit system) and handed back by them to the AAC plants. They pass on the sheets to the foil manufacturer for recycling.

2.11 Condition of use

As described in 2.7 Manufacture, AAC consists mainly of tobermorite, a natural mineral. It also contains non-reacted raw components, mainly coarse quartz and possibly carbonates. The pores are completely filled with air.

2.12 Environment and health during use

As far as is currently known, AAC does not emit any hazardous substances such as VOC.
The natural ionising radiation of AAC products is extremely low and permits unlimited use of this material from a radiological point of view (see 7.1 Radioactivity).

2.13 Reference service life

AAC does not change once it leaves the autoclave. When used as intended, it is indefinitely stable.

2.14 Extraordinary effects

Fire

No toxic gases or vapours can form in case of fire.

Fire protection in accordance with EN 13501 – 1

Name	Value
Building material class	A1
Flue gas development	s1
Flaming droplets	d0

Water

AAC has a slight alkaline reaction when exposed to water (e.g. floods). No substances are washed out which could be harmful to water.

Mechanical destruction

No information.

2.15 Re-use phase

AAC remains can be taken back by AAC manufacturers and recycled or re-used. This has been done for decades with broken material from production. This material is either processed in granulate products or added to AAC mixtures as a sand substitute.

2.16 Disposal

In accordance with the waste disposal ordinance dated 27/04/2009 valid in Germany, AAC should be stored on Class I disposal sites (see. 7.2 Leaching behaviour).
Waste code according to EAKV: 17 01 01.

2.17 Further information

Further information is available at www.ytong-silka.de.

3. LCA: Calculation rules

3.1 Declared unit

The environmental product declaration is based on the production stage (module A1-A3) of 1 m³ of non-reinforced Ytong®-AAC with an average gross density of 445 kg/m³.
The results represent Xella's (Germany) average production mix.

Declared unit

Name	Value	Unit
Declared unit	1	m^3
Gross density	445	kg/m^3
Conversion factor for 1 kg	0.002247191	-

3.2 System boundary

EPD type: cradle to gate The LCA for Ytong® AAC takes into account the lifecycle phases of product manufacture (A1-A3).
Product installation (module A4-A5) and the use stage (module B) are not considered in this study. Disposal (module C) is also not considered in this study.
No benefits and loads outside the system boundary arise from assessing the modules considered.

3.3 Estimates and assumptions

Specific GaBi procedures are not available for all additives and ancillary materials. The following assumptions have been made:
In the case of grinding media and cutting wire the mass fraction amounts to < 0.2%. The data record used: "DE: sheet metals" represents steel manufacture including further processing steps which are similar to those of grinding media and cutting wires.
The wooden pallets used are reusable pallets within a deposit system. These are not considered within the scope of the declared modules.

3.4 Cut-off criteria

All operating data collected i.e. raw materials used according to the formulation, the thermal energy used and also electricity and diesel consumption are considered in the assessment. Assumptions were made as to transport expenses for all in- and outputs considered or the actual transport distances used. Material and energy flows with a share of less than 1 percent were thus also considered.
It can be assumed that the procedures not included would have contributed less than 5% to the considered impact categories.
The manufacture of the machines, plant and other infrastructure required to produce the articles considered was not considered in the LCAs.

3.5 Background data

The GaBi 5 software system for integrated assessment developed by PE INERNATIONAL AG was used to model the manufacturing of Ytong®-AAC. The consistent data records contained in the GaBi database are documented in the online GaBi documentation. The basic data of the GaBi database was used for energy, transport and ancillary materials. The LCA was produced for the reference area of Germany. This means that apart from the production processes under these basic conditions the pre-stages relevant for Germany such as electricity or energy source provision were used. The electricity mix for Germany for the reference year of 2008 is used.

3.6 Data quality

All background data records relevant for manufacturing were taken from the GaBi 5 software database or provided by Xella. The last revision of the background data used was less than three years ago. The production data is current industrial data from Xella from 2010.

3.7 Period under review

The data basis for this LCA is based on data records for AAC manufacture from 2010. The quantities of energy and raw, ancillary and operating materials are taken as average values across 12 months in 11 plants.

3.8 Allocation

AAC products of various shapes which may be reinforced or non-reinforced are manufactured in the plants.
The manufacture of reinforced AAC has not been considered in this study. Reinforced AAC is produced by Xella in Germany at three sites. The energy and material inputs for AAC with and without reinforcement were allocated and calculated separately for these sites in accordance with the production data:
Energy consumption for the manufacture of reinforced AAC is around twice as high as for non-reinforced products, a fact which was also considered in the LCA.
AAC breakage accumulates during production which is to a large extent further processed into AAC granulate. The environmental impact of AAC manufacture and the breakage which is used to produce AAC granulate was allocated according to mass.
AAC dust also accumulates during production which is returned to the manufacturing process (closed-loop recycling).

3.9 Comparability

Basically, a comparison or assessment of EPD data is only possible if all data records to be compared were produced in accordance with EN 15804 and the building context and the product-specific characteristics are taken into account.

4. LCA: Scenarios and further technical information

Modules A4-D are not considered in this LCA.

Reference service life

Name	Value	Unit
Reference service life with appropriate use	unlimited	a

5. LCA: Results

The environmental impacts for 1 m³ Ytong® non-reinforced AAC with an average gross density of 445 kg/m³, manufactured by Xella in Germany, are shown here.
The modules to DIN EN 15804 marked with an “x” in the following overview are addressed:
The following tables show the results of the indicators of the impact estimates, resource use and also waste and other output streams with reference to 1 m³ Ytong® AAC.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

Production stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundary
Raw material supply	Transport	Manufacture	Transport from gate to site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction / demolition	Transport	Waste processing	Disposal	Reuse/ recovery/recycling potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

RESULTS OF THE LCA – ENVIRONMENTAL IMPACT: 1m³ Ytong® AAC

Parameter	Unit	A1 - A3
Global warming potential	[kg CO_2-Eq.]	219.3
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	1.26E-7
Acidification potential of land and water	[kg SO_2-Eq.]	0.219
Eutrophication potential	[kg PO_4^{3-}- Eq.]	0.029
Formation potential of tropospheric ozone	[kg Ethylene Eq.]	0.022
Abiotic depletion potential for non-fossil resources	[kg Sb Eq.]	1.35E-4
Abiotic depletion potential for fossil resources	[MJ]	1699.3

RESULTS OF THE LCA – RESOURCE USE: 1m³ Ytong® AAC

Parameter	Unit	A1 - A3
Renewable primary energy as energy carrier	[MJ]	81.7
Renewable primary energy resources as material utilisation	[MJ]	0
Total use of renewable primary energy resources	[MJ]	81.7
Non-renewable primary energy as energy carrier	[MJ]	1804.2
Non-renewable primary energy resources as material utilisation	[MJ]	0
Total non-renewable primary energy	[MJ]	1804.2
Use of secondary materials	[kg]	0
Renewable secondary fuels	[MJ]	23.21
Non-renewable secondary fuels	[MJ]	244.4
Use of net fresh water resources	[m³]	78.7

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1m³ Ytong® Autoclaved Aerated Concrete (AAC)

Parameter	Unit	A1 - A3
Hazardous waste disposed	[kg]	-
Non-hazardous waste disposed	[kg]	468.9
Radioactive waste disposed	[kg]	0.04
Components for re-use	[kg]	-
Materials for recycling	[kg]	-
Materials for energy recovery	[kg]	-
Exported electrical energy	[MJ]	-
Exported thermal energy	[MJ]	-

Note on the first indicator in the third table "Hazardous waste disposed ": in accordance with DIN EN 15804, hazardous waste is modelled up to the end of the waste characteristic.

6. LCA: Interpretation

The aggregate indicators of the lifecycle inventory analysis and the indicators of the estimated impact are interpreted below in relation to the declared unit giving specifications which significantly influence the result.
As part of a dominance analysis, it is clear that the environmental impacts of AAC manufacture are dominated both by the use of thermal energy and the associated emissions and by bonding agent manufacture. Quicklime and cement manufacture are each based on energy-intensive combustion processes as a result of which environmentally relevant emissions are produced.
When examining the abiotic consumption of resources the requirement for gypsum is reflected strongly in the preceding cement production chains.
Some 49% of abiotic fossil resource consumption in AAC manufacture is made up by the use of energy (electricity and thermal energy). The manufacture of the binders with quicklime and cement is reflected as 30%.
The global warming potential of the manufacture of 1 m³ of AAC is dominated more than 97% by carbon dioxide emissions. 26% of these originate from the manufacturing process and the production of thermal energy from natural gas as well as the preceding electricity supply chains makes a significant contribution to global warming potential. 64% of carbon dioxide emissions can be attributed to bonding agent manufacture; this is divided equally between quicklime and cement manufacture. Mainly R11 and R114 emissions from the electrical supply pre-chain contribute to ozone destruction potential.
Acidification potential from the manufacture of 1 m³ of non-reinforced AAC is dominated to 51% by sulphur dioxide emissions and to 41% by nitric oxides. Around 28% of the AP comes from the energy provision processes for manufacturing. The production of quicklime and cement bonding agents causes around 40% of the AP.
Eutrophication potential is affected to 81% by nitric oxides. Around 45% of EP is attributable to the manufacture of the quicklime and cement bonding agent.
Sulphur dioxide emissions contribute around 22%, NMVOC 41% and nitric oxides some 24% to summer smog potential. These in turn accumulate mainly in the cement manufacture pre-chains and also the production of thermal energy.
Looking at the PENRT, the dominance of the energy produced directly in the works and used during the process of manufacturing of AAC building blocks is evident. Around 35% of the PENRT is attributable to thermal energy requirements and a further 9% to electricity requirements. The manufacture of the quicklime and cement bonding agent contributes 31% to the PENRT.
With the PERT, apart from the regenerative share of the electricity consumed, packaging shows itself to be influential, both directly in manufacturing and in the raw material, pre-product and cement manufacture pre-chains. This can be attributed to the use of wooden pallets and in particular the solar energy required for wood to grow.
Secondary raw materials are not used during manufacture. Company-internal AAC breakage and AAC granulate are used in AAC manufacture, but they are not attributable as secondary raw materials according to DIN EN 15804.
The share of secondary raw materials results mainly from the cement production pre-chain. In 2009, the ratio of derived fuels to the total fuel energy use of the German cement industry was 58%.
Modules A1-A3 require around 78 m³ of water to manufacture 1 m³ of AAC including pre-chains. Around 34% is used in manufacturing (module A3), which is mainly attributable to the electricity supply pre-chains. A further 27% is attributable to quicklime and cement production; energy supply once again plays a significant role. The proportion of direct water requirement for AAC manufacture directly in the plant is less than 1%.
Assessment of the accumulation of waste is shown separately for the three main categories of disposed non-hazardous waste (including mining waste materials, ore processing residues, municipal waste and the domestic refuse and commercial waste contained therein), hazardous waste for disposal and disposed radioactive waste**.**
Non-hazardous waste represents the greatest proportion in AAC production. Mining waste materials accumulate mainly in the electricity supply pre-chain from extraction of energy sources and also in the bonding agent manufacture pre-chains during raw material and energy source extraction.
Radioactive waste accumulates exclusively through electricity production in nuclear power plants.

7. Requisite evidence

A manufacturer's declaration is available according to which the composition of the basic materials, the manufacturing process and the product properties of the Xella® products named have remained unchanged since the issue of the following evidence. The evidence is therefore completely valid.

7.1 Radioactivity
Measurements of the nuclide content in Bq/kg for Ra-226, Th-232, K-40
All mineral-based materials contain small amounts of naturally radioactive substances. The measurements show that the natural radioactivity permits unlimited use of this building material from a radiological point of view. /BfS 2008/

7.2 Leaching behaviour
The leaching behaviour of AAC is of significance for the assessment of its impact on the environment after use during disposal.
Measuring location: LGA Institut für Umweltgeologie und Altlasten GmbH , Nürnberg
Result:
All criteria for disposal on Class 1 waste disposal sites in accordance with the waste disposal ordinance dated 27/04/2009 valid in Germany are fulfilled. In accordance with the decision of the Council (2003/33/EC) of 19th December 2002, AAC is to be classified as non-hazardous waste.

8. References

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Institut Bauen und Umwelt e.V.	**Publisher** Institut Bauen und Umwelt e.V. Rheinufer 108 53639 Königswinter Germany	Tel Fax Mail Web	+49 (0)2223 29 66 79- 0 +49 (0)2223 29 66 79- 1 info@bau-umwelt.com **www.bau-umwelt.com**
Institut Bauen und Umwelt e.V.	**Programme holder** Institut Bauen und Umwelt e.V. Rheinufer 108 53639 Königswinter Germany	Tel Fax Mail Web	+49 (0)2223 29 66 79- 0 +49 (0)2223 29 66 79- 1 info@bau-umwelt.com **www.bau-umwelt.com**
Xella	**Owner of the declaration** Xella Baustoffe GmbH Düsseldorfer Landstraße 395 47259 Duisburg Germany	Tel Fax Mail Web	0049 203 8069002 0049 203 8069540 info@xella.com **www.ytong-silka.de**
PE INTERNATIONAL EXPERTS IN SUSTAINABILITY	**Author of the Life Cycle Assessment** PE INTERNATIONAL AG Hauptstraße 111 70771 Leinfelden-Echterdingen Germany	Tel Fax Mail Web	0049 711 34 18 17-0 0049 711 341817-25 info@pe-international.com **www.pe-international.com**