



Co-funded by the Horizon 2020
Framework Programme
of the European Union



BUILDINGS AS MATERIAL BANKS



EPEA - THE CRADLE OF CRADLE TO CRADLE®



Founded in 1987 by Prof. Dr. Michael Braungart

Internationally active consulting and research
institute (private-sector)

Headquarters in Hamburg
A total of 22 locations and representatives on
four continents

Interdisciplinary and international team of
scientists and engineers.



ZIELSETZUNG

- Strategieentwicklung
- Roadmaps



KOMMUNIKATION

- Cradlebility™ Report
- Quality Statement



EPEA

The Cradle of
Cradle to Cradle



ANALYSE

- C2C® QuickScan
- C2C® Material-
bewertung
- Machbarkeitsstudie



AKKREDITIERUNG

- C2C Certified™
- Circularity Passports



OPTIMIERUNG

- C2C® Beratung
- System- und
Produktinnovation
- Workshops & Trainings



Co-funded by the Horizon 2020 Framework Programme of the European Union



CONTENT



CRADLE TO CRADLE® - PRINCIPLES



Waste equals Food

Everything is a nutrient / resource for something else



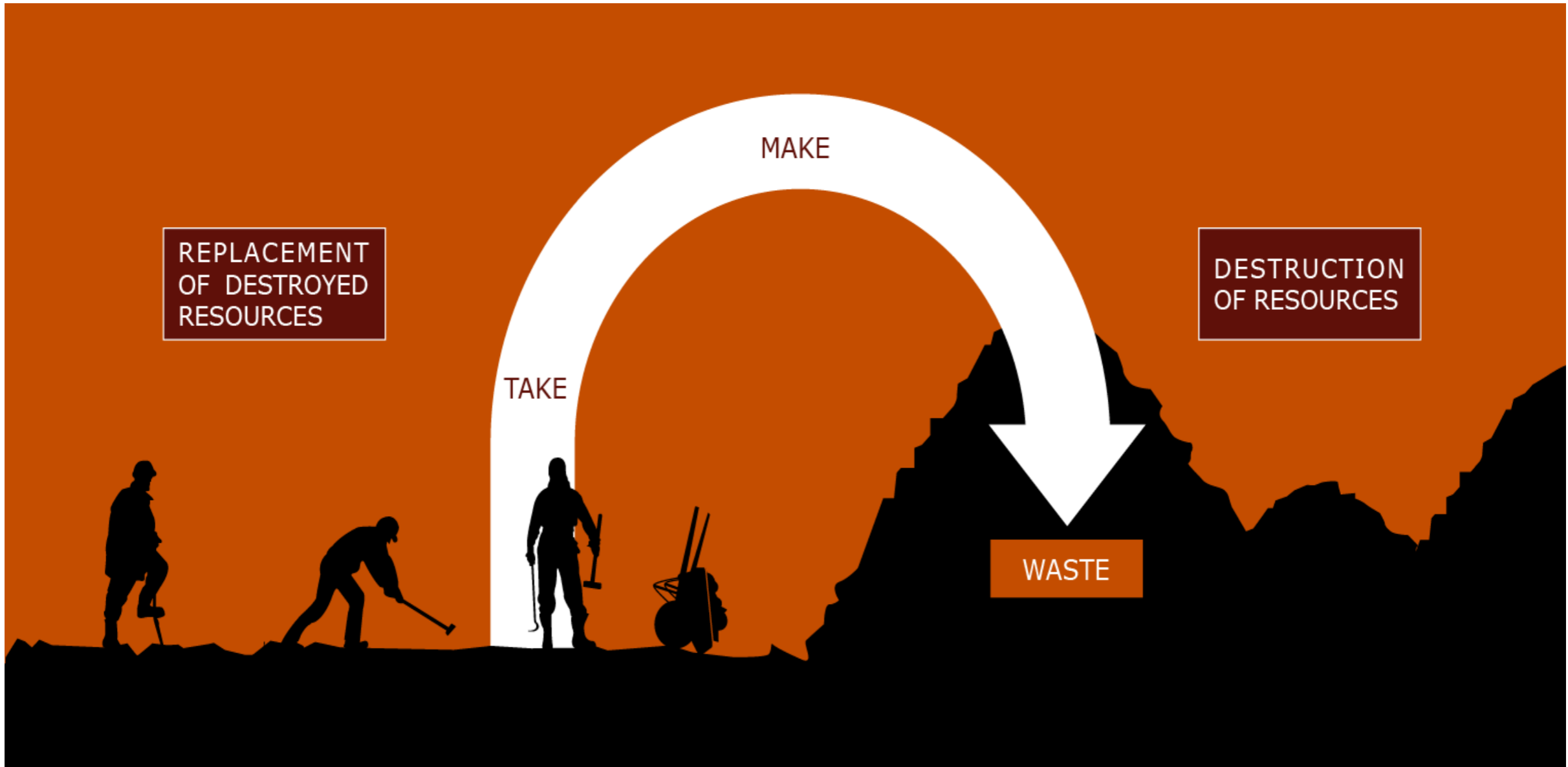
Use of Renewable Energy



Celebrate Diversity

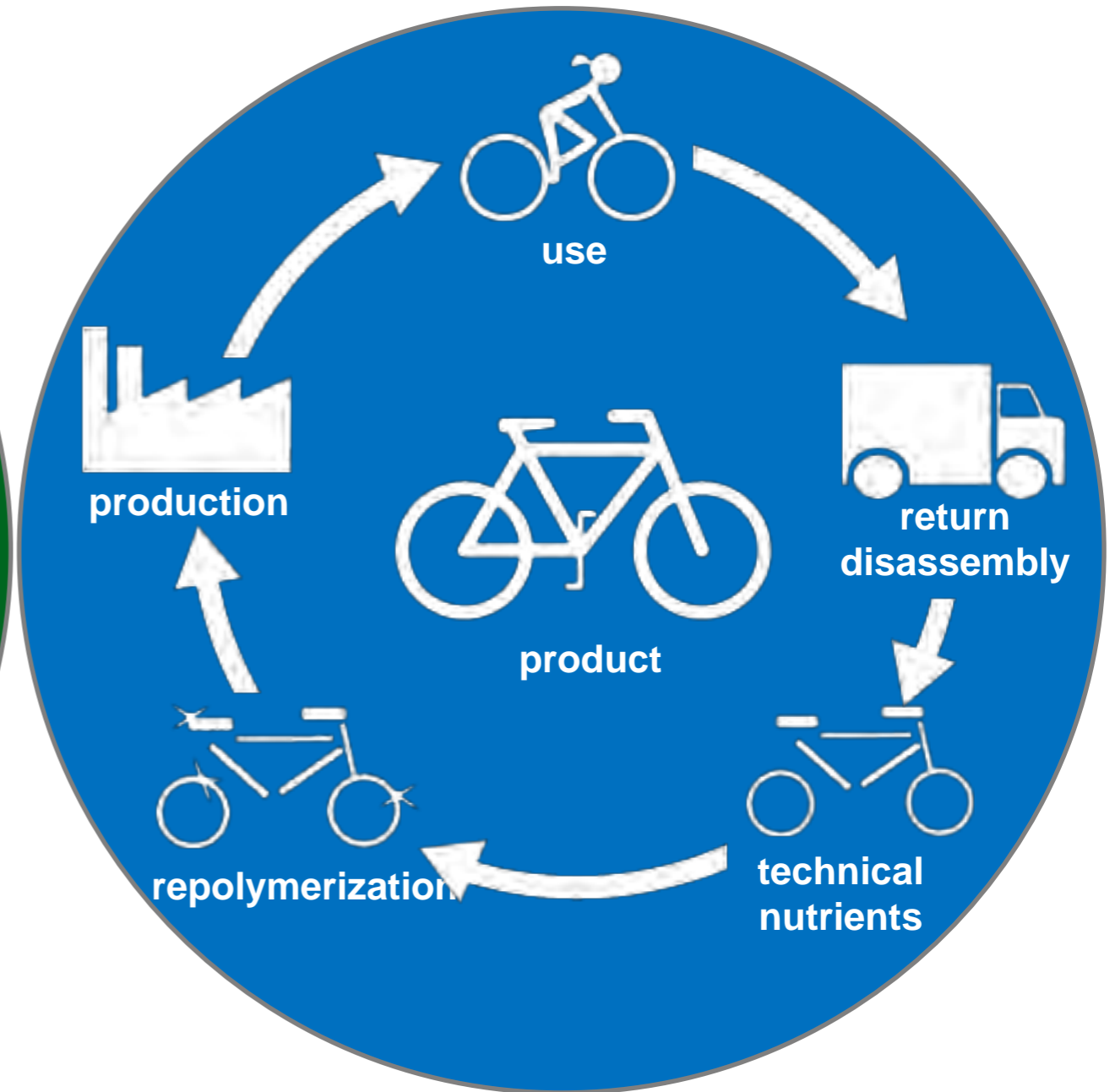
Biodiversity, cultural diversity, conceptual diversity

CRADLE TO GRAVE DESIGN





Biological Cycle
Consumption Products



Technical Cycle
Service Products

MATERIALS PASSPORTS BACKGROUND

- Products and buildings are not designed for the recovery of valuable materials
- Usually there is no information on product composition and residual value
- The materials passport concept offers a solution option*
- Example Venlo Town Hall
 - New financing model based on the value of the building materials
 - EPEA developed Circularity Passports® for the documentation and tracking of Venlo's building materials
- BAMB intends to further develop the passports concept in an EU level and to combine it with new solutions of reversible building design.

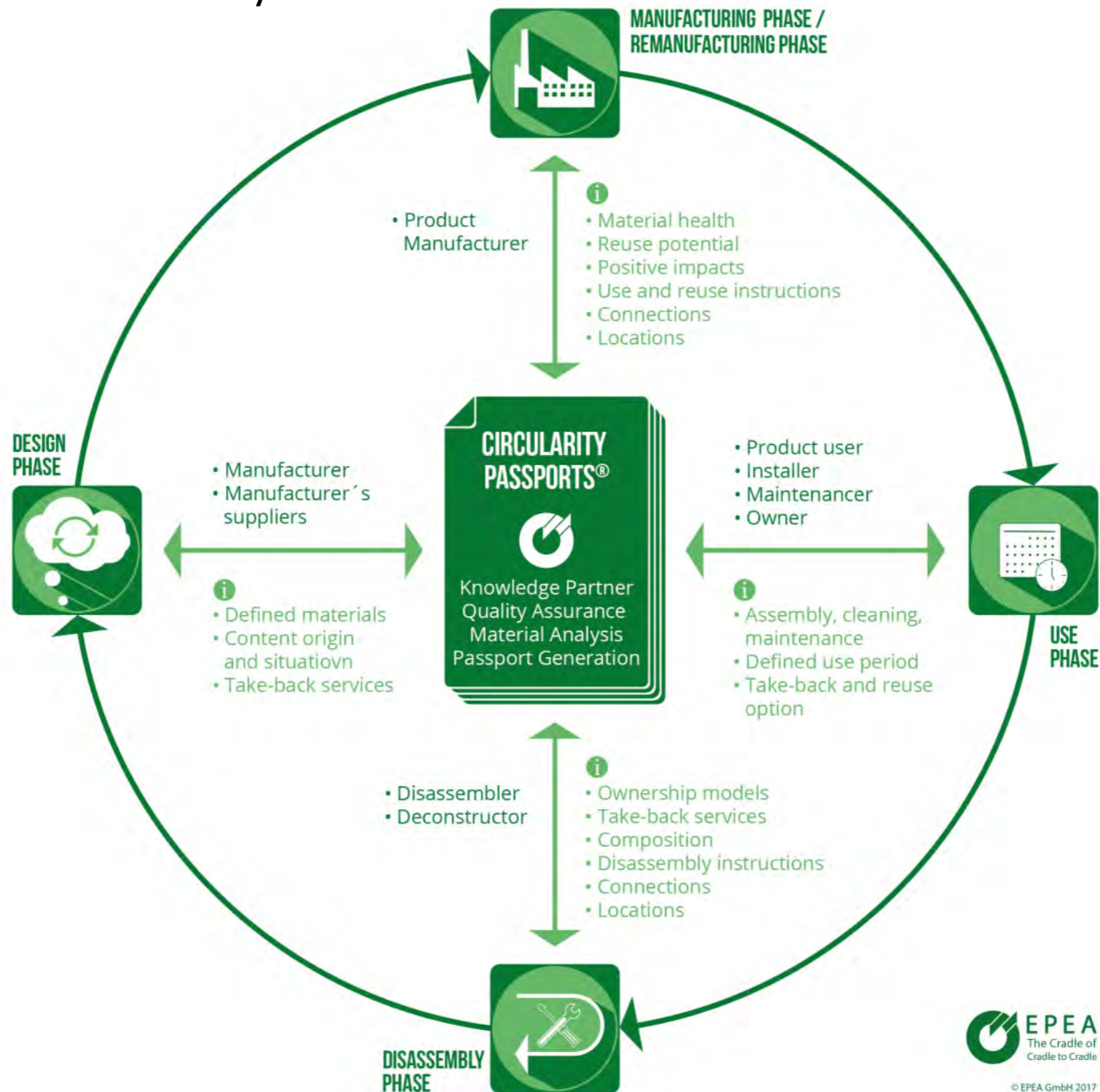


* Literature Examples:

2003: Towards a sustaining architecture for the 21st century: the promise of cradle-to-cradle design UNEP Industry and Environment; Braungart and McDonough.

2010, Springer Encyclopedia of Sustainability Science and Technology accepts for publishing; Resource Repletion, Role of Buildings, introducing Nutrient Certificates ; Hansen, EPEA partners.

EPEA Circularity Passports®: a tool for information sharing throughout the value chain to enhance product reuse and value recovery.







Afbeelding: Mostert de winter

BAMB PROJECT

Buildings as Material Banks: Integrating Materials Passports with Reversible Building Design to Optimise Circular Industrial Value Chains

Horizon 2020 – WASTE 1 2014 – Moving towards a circular economy through industrial symbiosis

- Start: September 1st, 2015
- Duration 3.5 Years
- 15 Partners from 7 EU Countries
- + Bamb Stakeholders Network



UNIVERSITEIT TWENTE.



Universidade do Minho



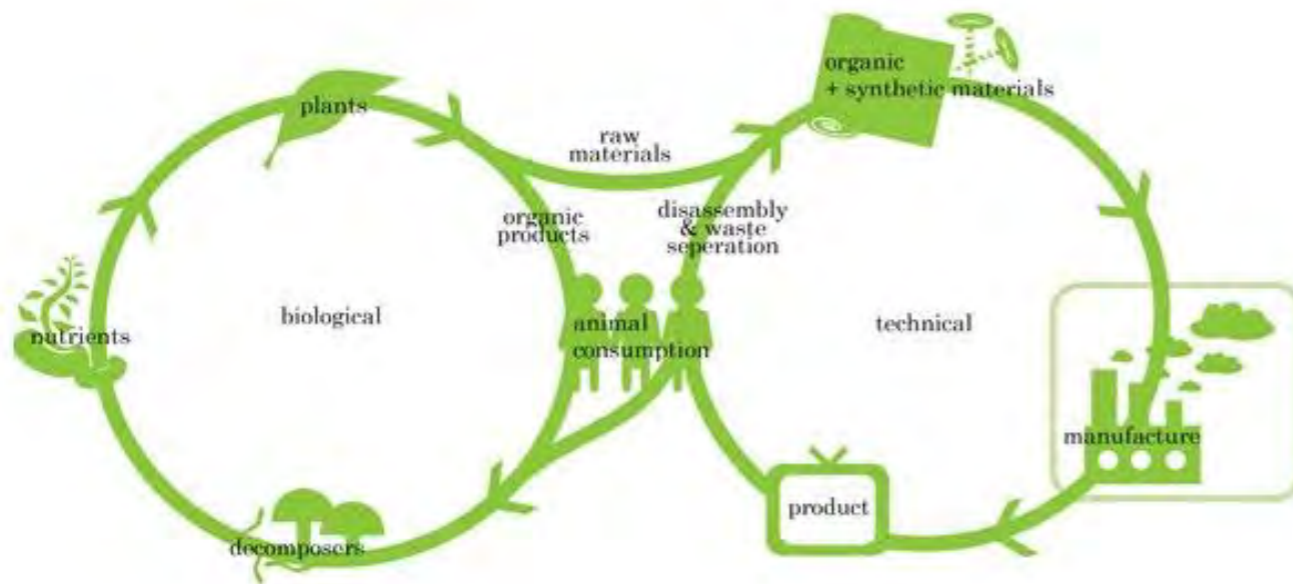


BAMB GOALS

- Transform the construction industry, where buildings are designed as material banks for the future
- Eliminate construction and demolition waste
- Reduce use of virgin resource consumption and increase use of recycled materials
- Shift the construction industry towards a circular economy through symbiotic partnerships amongst material users
- Engage all the stakeholders to increase material value and enhance the knowledge about the products specified and the design methods by integrating two complementary value-adding frameworks:

MAIN TOPICS OF RESEARCH & DEVELOPMENT

Materials Passports



Reversible Building Design



Source: loblolly-house, Maryland, USA, 2006

<http://kierantimberlake.com/pages/view/20/loblolly-house/parent:3>

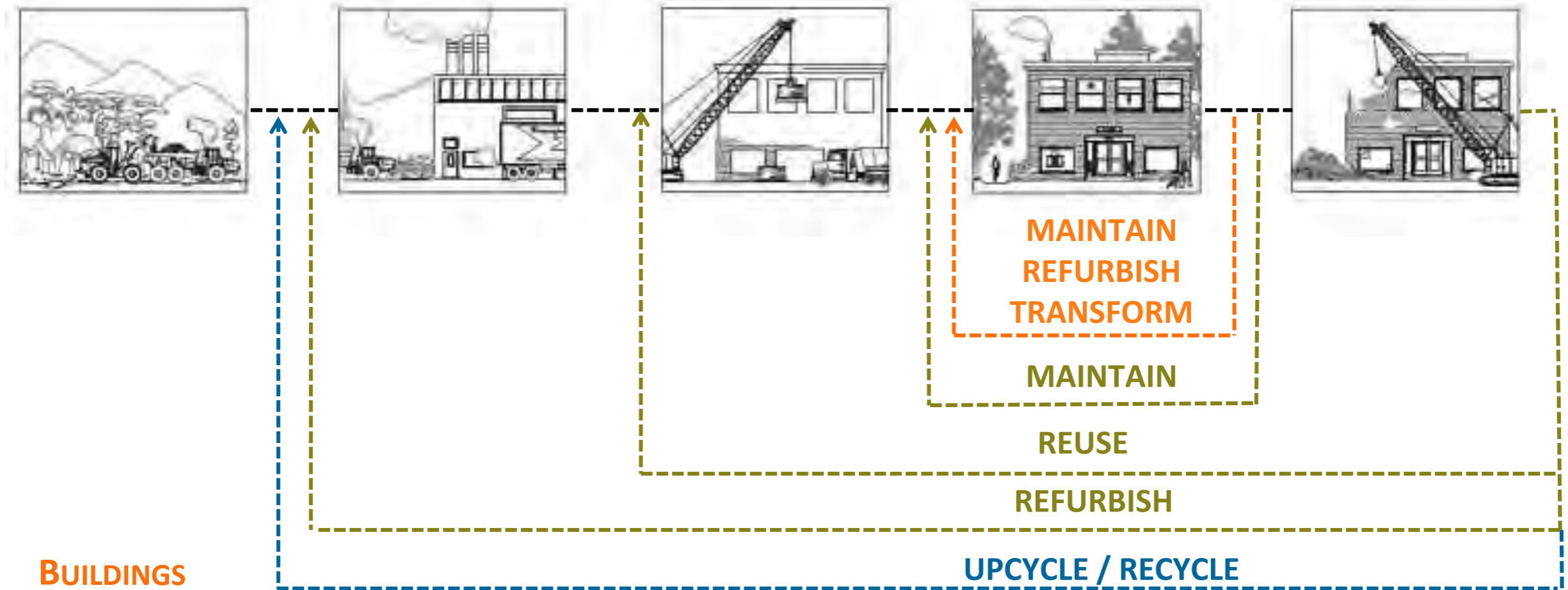
CONCEPT

From a linear and static building industry...

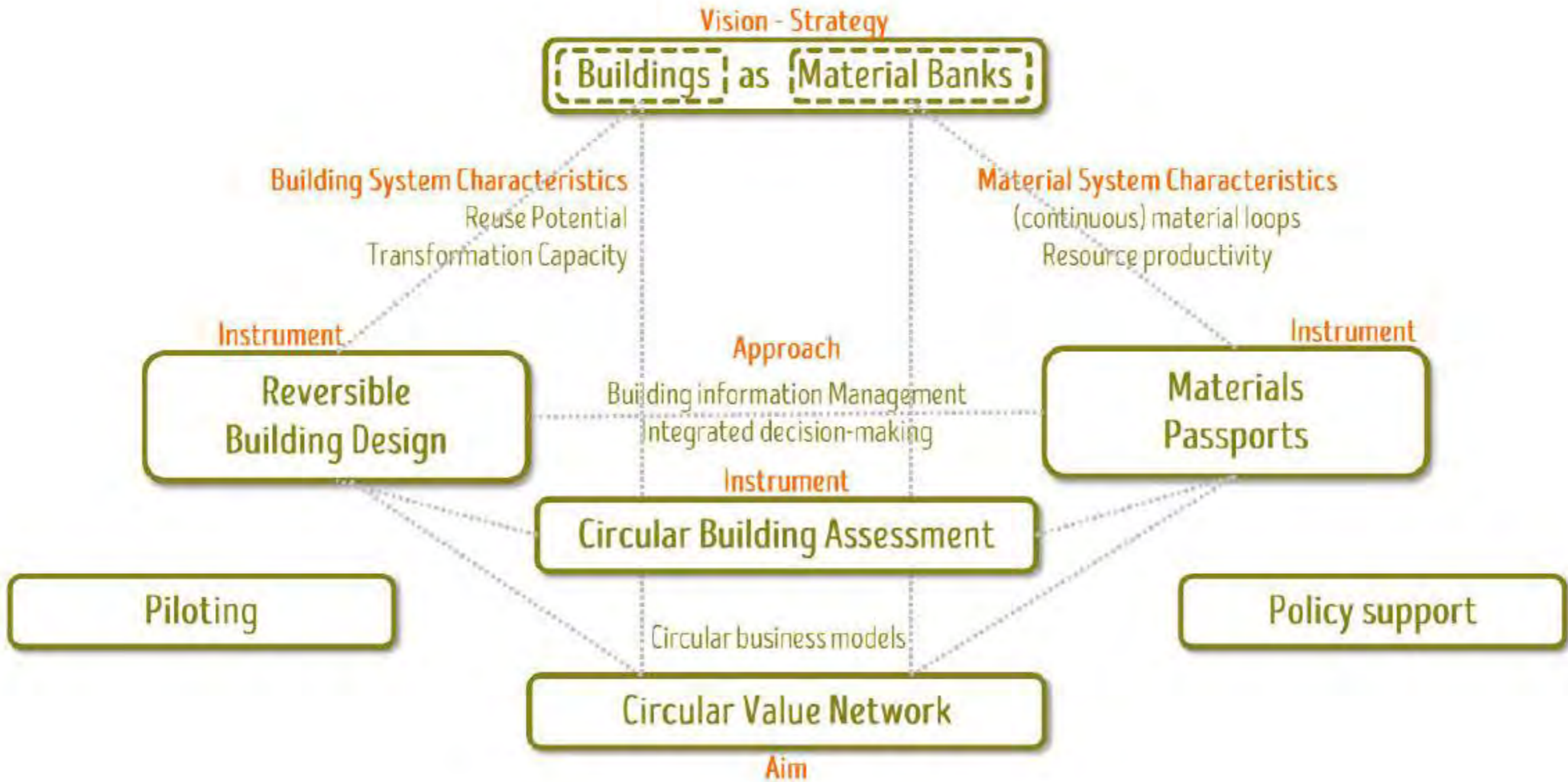


CONCEPT

... to a dynamic and circular building industry



- BUILDINGS
- BUILDING PRODUCTS & SYSTEMS
- RAW MATERIALS



2. Reversible Building Design



Reversible
Building
Design
Dimensions

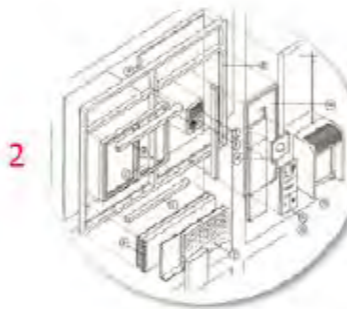
THREE INDICATORS OF REVERSIBLE BUILDING

Translated into key design requirements for the circular procurement



Reversibility of space

Adapt space



Reversibility of structure/

**Reconfigure /upgrade
structure**

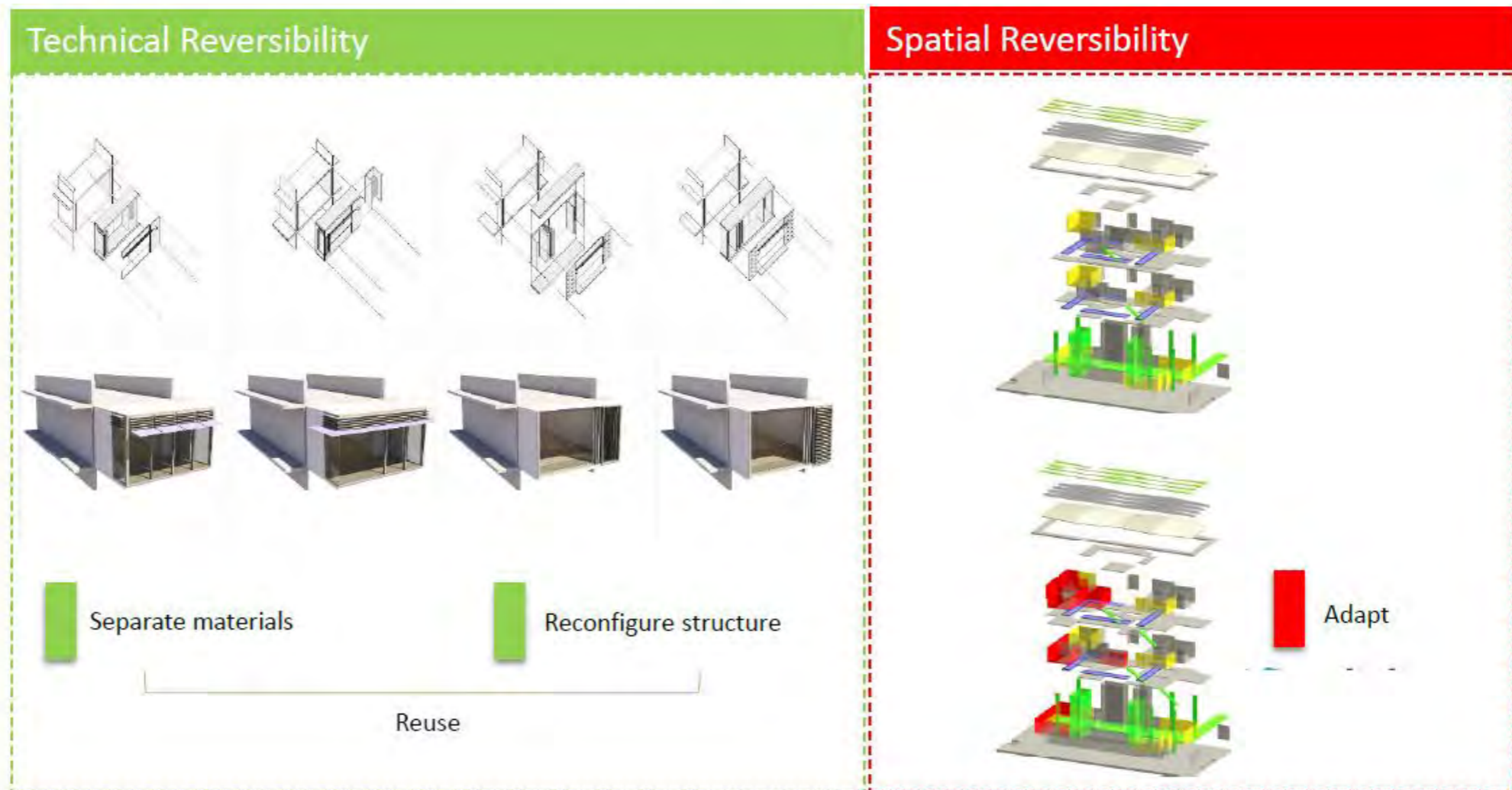
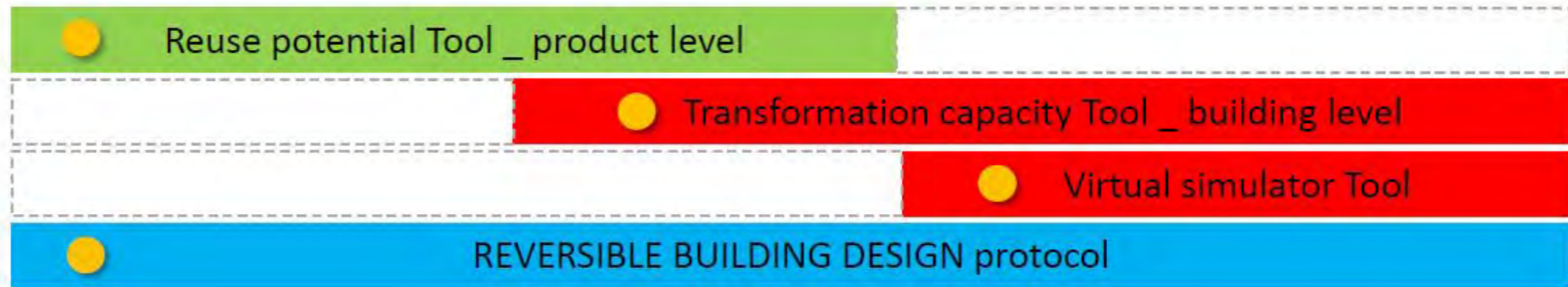


Reversibility of material/

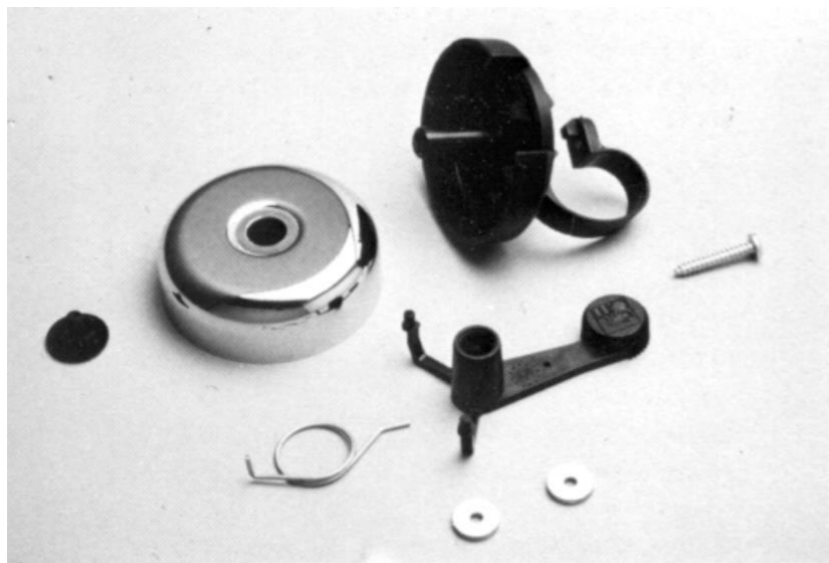
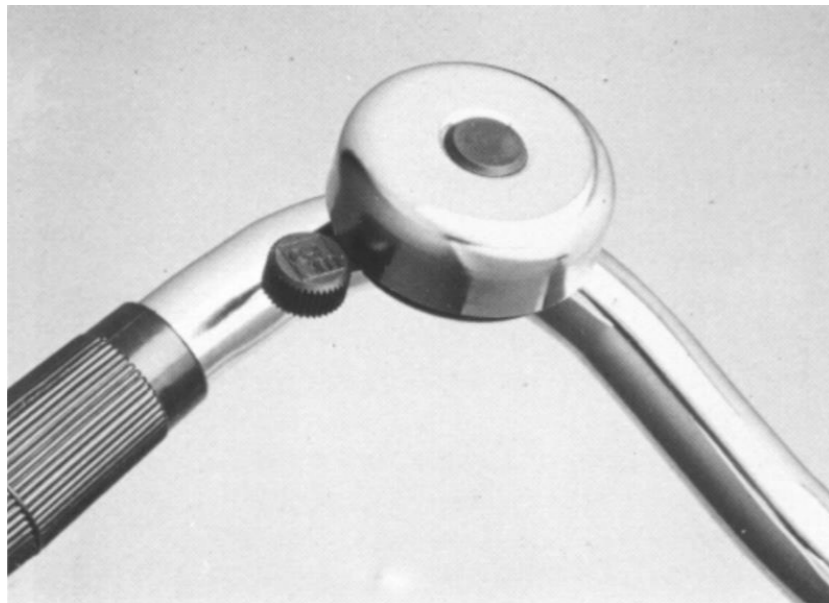
**Separate elements/
material**

© Dr. Elma Durmisevic

Reversible Building Design Toolkit



© Dr. Elma Durmisevic



ALL ITEMS CONTAINED IN THE KIT APPEAR BELOW



REPLACEMENT BODY AND INTERIOR PARTS

- 1 × Replacement body shell
- 1 × Left hand light pod housing
- 1 × Right hand light pod housing
- 1 × Front bumper
- 1 × Rear bumper
- 1 × Bonnet
- 1 × Boot lid N.B. body and panels are unpainted
- 1 × Heater grill
- 1 × Front laminated windscreen
- 1 × Front windscreen rubber
- 1 × Front screen rubber chromed plastic filler strip
- 1 × Burr walnut veneered dashboard
- 1 × Pair of seat retrim cover assemblies
- 1 × Full interior black carpet set
- 1 × Full wiring loom (state alternator or dynamo preference)
- 1 × Interior centre console
- 1 × Pair interior screen pillar trims
- 1 × Pair underdash board wiring cover trims
- 1 × Pair door panel trims
- 1 × Pair door panel firmers



- 1 × Hood storage tray
- 1 × Hood frame
- 1 × Soft top hood P.V.C. (mohair optional)
- 1 × ¼ Tonneau cover (mohair optional)
- 30 × Female tanax fasteners
- 30 × Male tanax fasteners
- 1 × Packet hood buttons
- 1 × L/H door shell
- 1 × R/H door shell
- 1 × Crash pad on top of dash

REPLACEMENT MECHANICAL PARTS

- 1 × Lotus galvanised chassis
- 2 × Rear springs
- 2 × Rear shock absorber inserts
- 4 × Rotoflex drive couplings
- 24 × Rotoflex bolts
- 24 × Rotoflex nyloc nuts
- 1 × Engine mounting – left hand
- 1 × Engine mounting – right hand
- 1 × Gearbox mounting
- 2 × Bottom shock absorber bush kits
- 2 × Top shock absorber bush kits
- 2 × Anti-roll bar lower link bushes
- 2 × Top differential mount bushes
- 2 × Top rear suspension mountings
- 4 × Rear suspension large 'A' frame bushes
- 4 × Rear suspension small 'A' frame bushes
- 2 × Rear suspension 'A' frames
- 1 × Steering rack (rebuilt unit on exchange basis)
- 2 × Steering rack mounting bushes
- 2 × Front shock absorbers complete with springs



- 8 × Front suspension tubular wishbones 'with bushes fitted'
- 2 × Top front suspension ball joints
- 1 × Front suspension L/H bottom trunion
- 1 × Front suspension R/H bottom trunion
- 1 × Trunion bush kit for both trunions

Trunion and top ball joint nuts/bolts

£2,875 + Vat

LIMITED PERIOD ONLY

Open 7 days, kit on display at Northwich. All goods are offered subject to availability, the Company reserve the right to alter or modify without notice, prices are subject to alteration without notice.

Christopher Neil Sportscars would like to point out that they have no association whatsoever with Lotus Cars Ltd, nor do they purchase parts directly from the Lotus factory. Now in our 10th year of business with literally thousands of satisfied customers worldwide the parts we sell are all Christopher Neil parts, proprietary parts or genuine Lotus parts.

© Dr. Elma Durmisevic

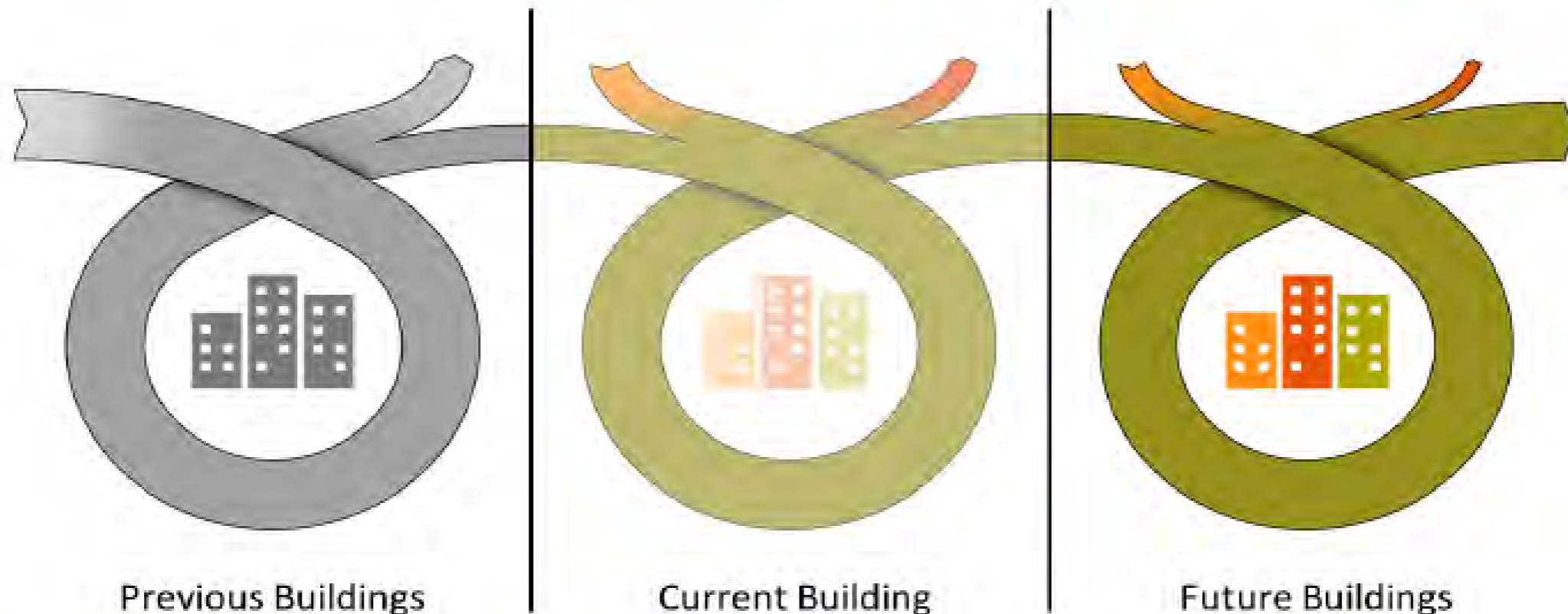


© Dr. Elma Durmisevic

Shaping the world of tomorrow

Building Demolition and Construction Waste is a Design Mistake

© Dr. Elma Durmisevic



Previous Buildings

Current Building

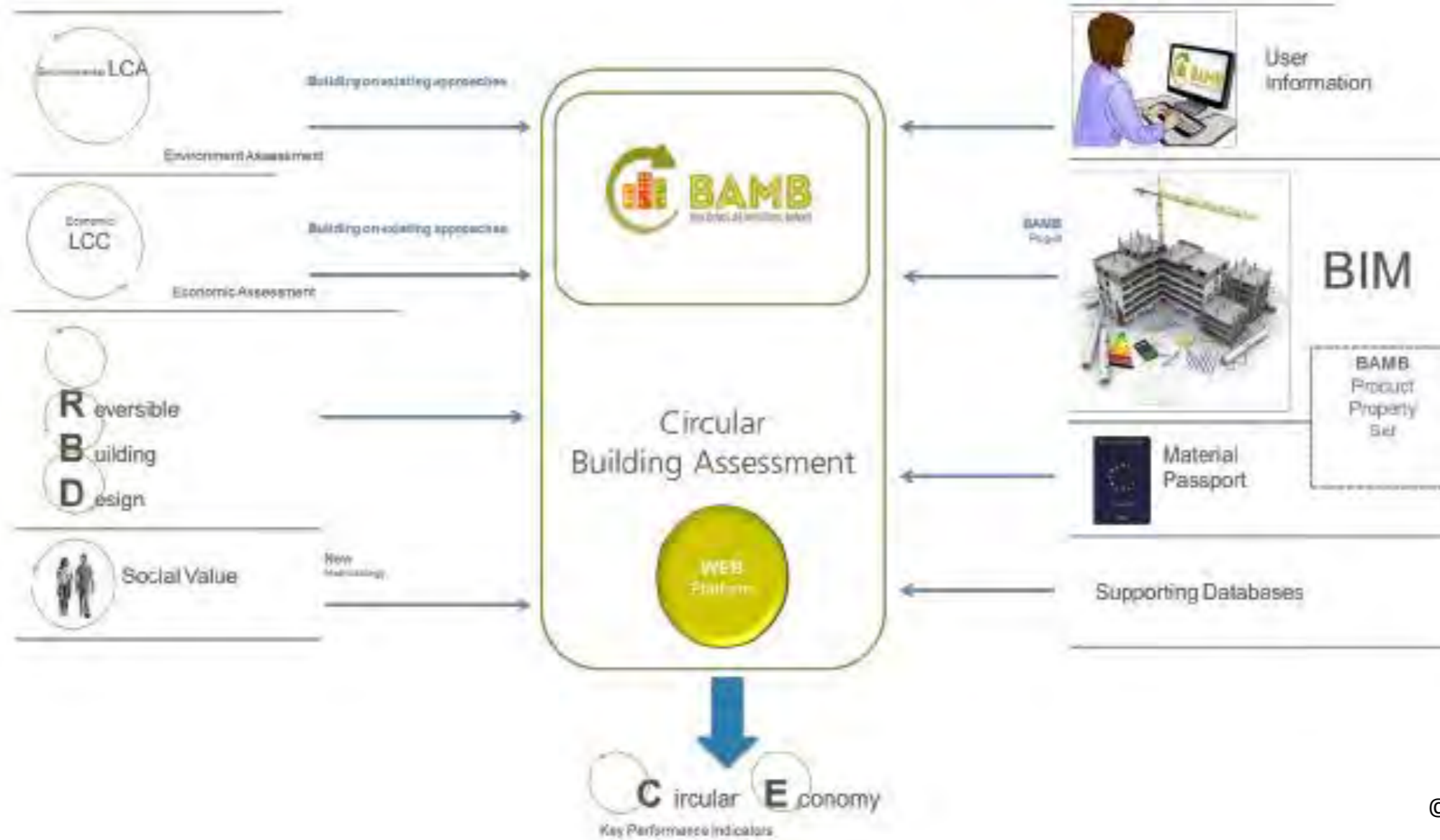
Future Buildings

Displacing new products & materials

Transformation capacity

Future reuse potential

© BRE



© BRE

PILOT PROJECTS



❖ **BUILD REVERSIBLE IN CONCEPTION (B.R.I.C.)**



❖ **GREEN TRANSFORMABLE BUILDING LAB (GTBL)**



❖ **NEW OFFICE BUILDING**



❖ **CIRCULAR RETROFIT LAB**



❖ **REVERSIBLE EXPERIENCE MODULES (REM)**



❖ **GREEN DESIGN CENTRE**

BRIC - IBGE





Transformation option of Green Design Center © Elma Durmicevic

CIRCULAR RETROFIT LAB - VUB

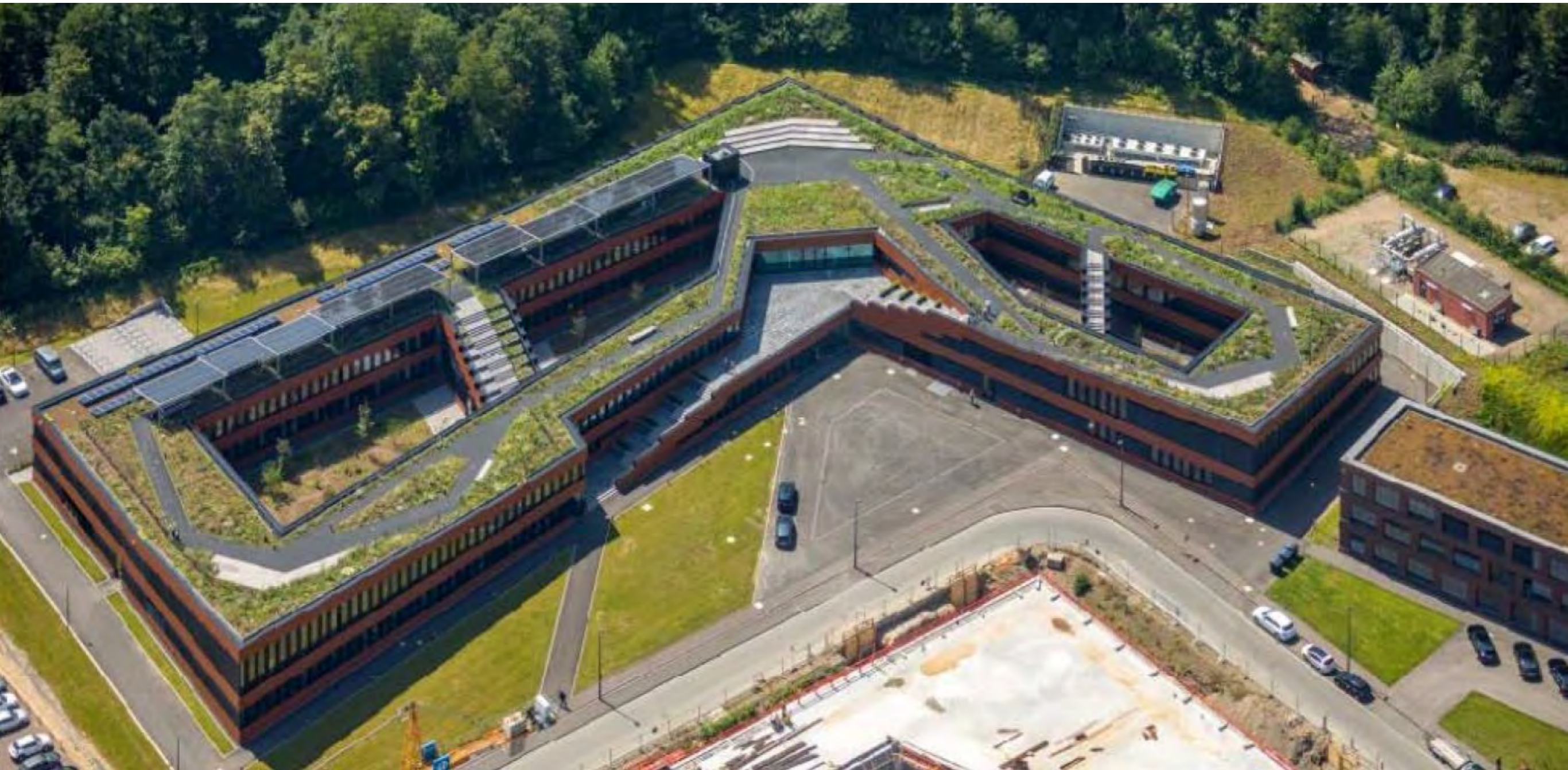


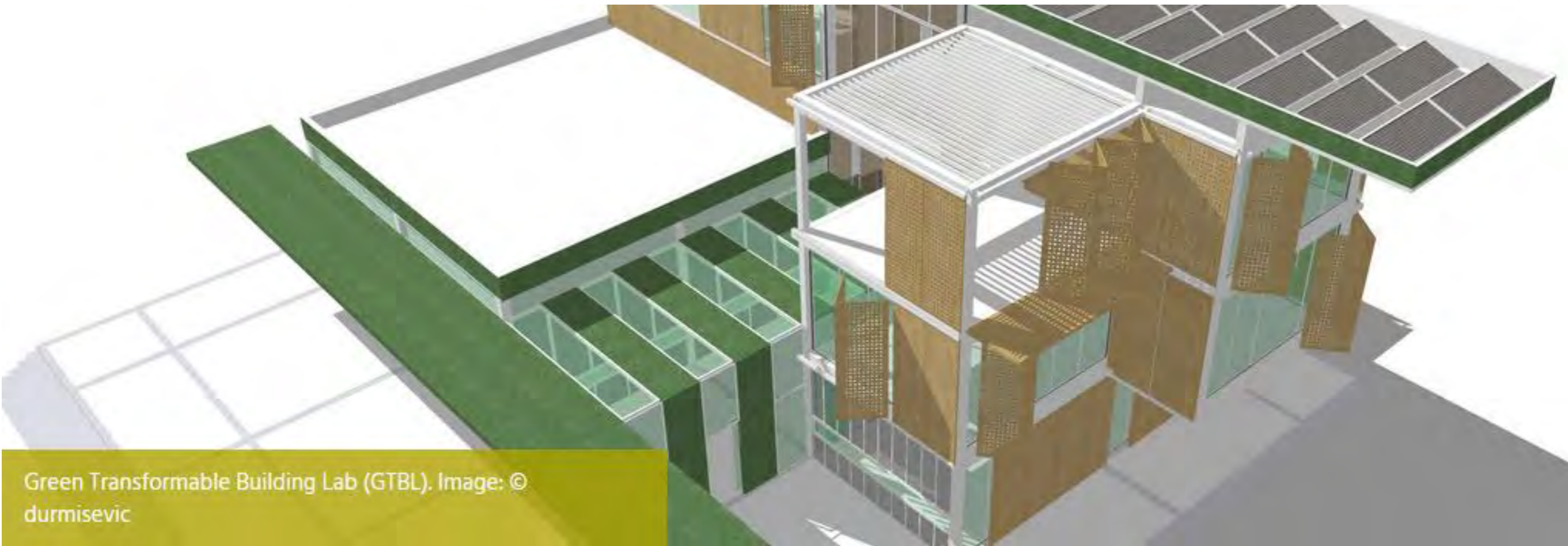


Co-funded by the Horizon 2020 Framework Programme of the European Union



RAG BUILDING - DREES & SOMMER





Green Transformable Building Lab (GTBL). Image: ©
durmisevic

REMs

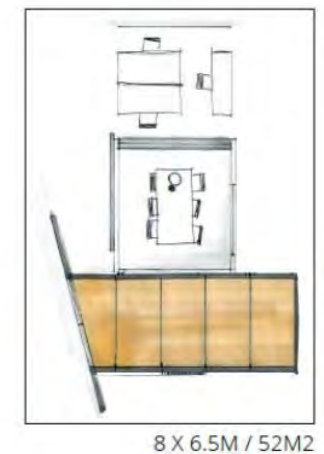
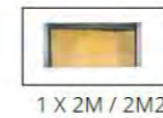


PILOT PROJECTS EXAMPLES

Area: varies
 Function: showcase
 Location: multiple

Reversible Experience Modules – EPEA

- Transportable and modular exhibition: Different locations and variable configurations
- Interactive learning modules demonstrating
 - Materials passports
 - Reversible design.



At each location the units can be re-arranged to form floor plans optimized for the available space.



Co-funded by the Horizon 2020
Framework Programme
of the European Union



MATERIALS PASSPORTS



WHY MATERIALS PASSPORTS?



WHY MATERIALS PASSPORTS?

STRUCTURAL WASTE IN THE BUILT ENVIRONMENT

CONSTRUCTION



- **10-15%** of building material wasted during construction
- **0-0.5%** productivity increase per year in most European countries 1990-2015, whereas 2% per year achieved in some countries

UTILISATION



- **60%** of European offices are not used even in working hours
- **50%** of residential dwellers report living in too much space

USAGE



- **20-40%** of energy in existing buildings can be profitably conserved
- Passive building standards at or near profitability for most new-build segments, but still only constitute a minority of buildings

END OF LIFE



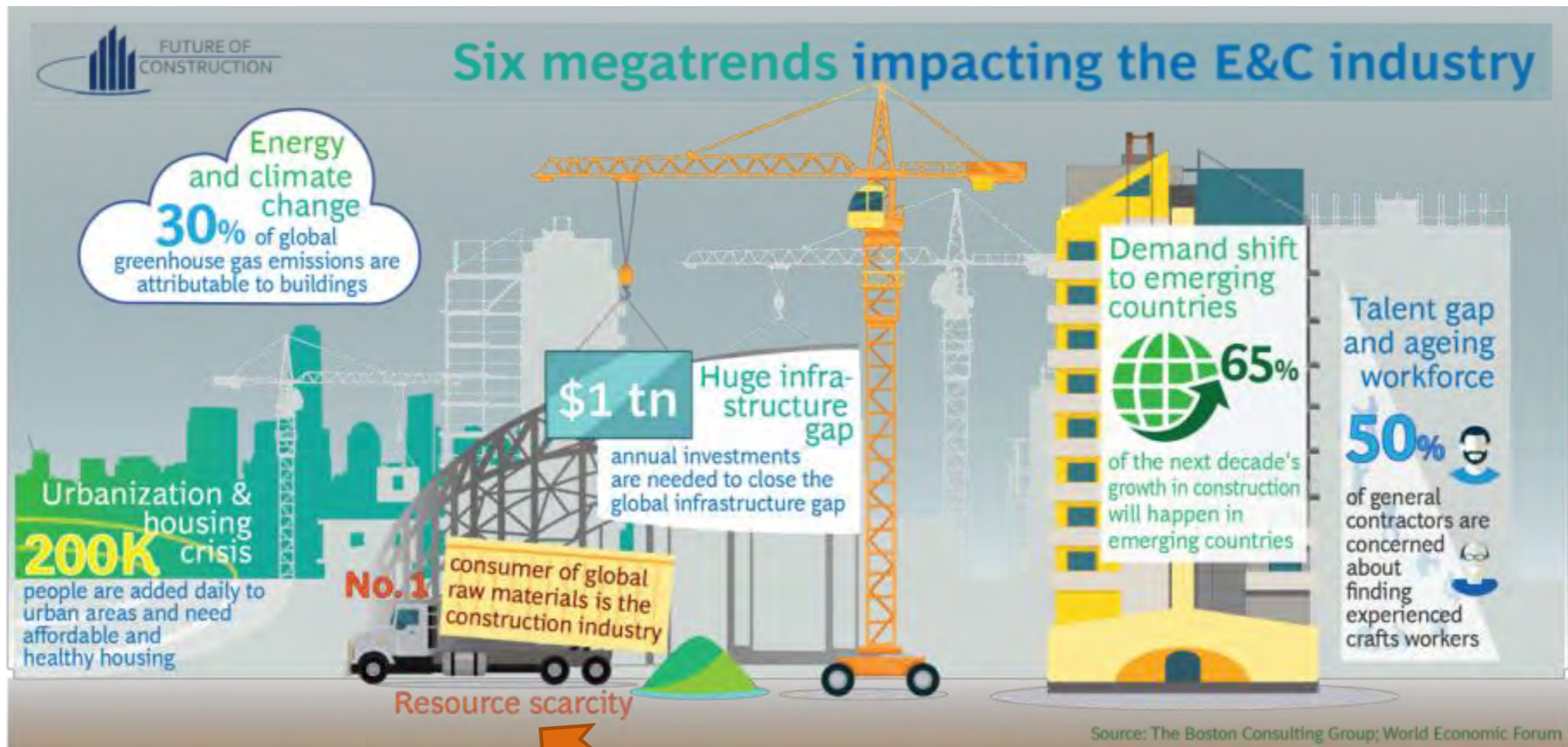
- **54%** of demolition materials landfilled, while some countries only landfill 6%
- Most materials unsuitable for reuse as they contain toxic elements

URBAN PLANNING:

- 50% of most city land dedicated to infrastructure
- 11 million households experience severe housing deprivation
- Congestion cost 2% of GDP in many cities

Source: Norm Miller, *Workplace Trends in Office Space: Implications for Future Office Demand*, University of San Diego, 2014; GSA Office of Governmentwide Policy, *Workspace Utilization and Allocation Benchmark*, 2011; Flexibility.co.uk, *Shrinking the office*; IEA Statistics © OECD/IEA (<http://www.iea.org/stats/index.asp>) Energy Statistics and Balances of Non-OECD Countries, Energy Statistics of OECD Countries, and United Nations, *Energy Statistics Yearbook*; European Commission, *Service contract on management of construction and demolition waste*, 2011.

WHY MATERIALS PASSPORTS?



WHY MATERIALS PASSPORTS?



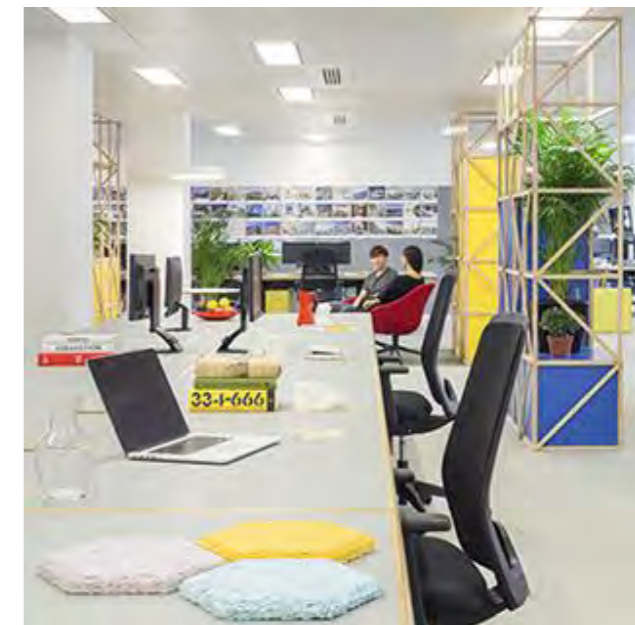
Source: <https://s3.amazonaws.com/hbnweb.dev/uploads/images/buildings-with-orange-endpoint-icons.jpg>

WHY MATERIALS PASSPORTS?

Cundall's new office in London focused on improved indoor air quality, including continuous monitoring of air and the use of healthy materials.

These has saved the company £200,000 due to a reduction of 4 sick days per year/employee and a 27% reduction in staff turnover.

CUNDALL



Source:

http://www.worldgbc.org/sites/default/files/compressed_WorldGBC_Health_Wellbeing_Productivity_Full_Report_Dbl_Med_Res_Feb_2015.pdf

http://www.worldgbc.org/sites/default/files/WorldGBC%20-%20Doing%20Right%20by%20Planet%20and%20People%20-%20April%202018_0.pdf

https://cundall.com/UploadedImages/04912731-4ad9-4f9b-b73b-7e6941905aed___Selected.jpg

WHY MATERIALS PASSPORTS?

Regions make innovation happen: Värmland County wins the AER Regional Innovation Award 2014

17 April, 2014 By Alexandre Brechx



As an illustration of the strategic role that regions play in making innovation happen in Europe, our Assembly also unveiled its Regional Innovation Award (RIA) winner: Värmland County Council (SE). The region was awarded the prize following the building of a hospital in Karlstad, which aimed at monitoring and assessing an environmentally conscious choice of materials, as well as phasing out harmful chemicals in the construction of a new department for premature babies at the hospital.

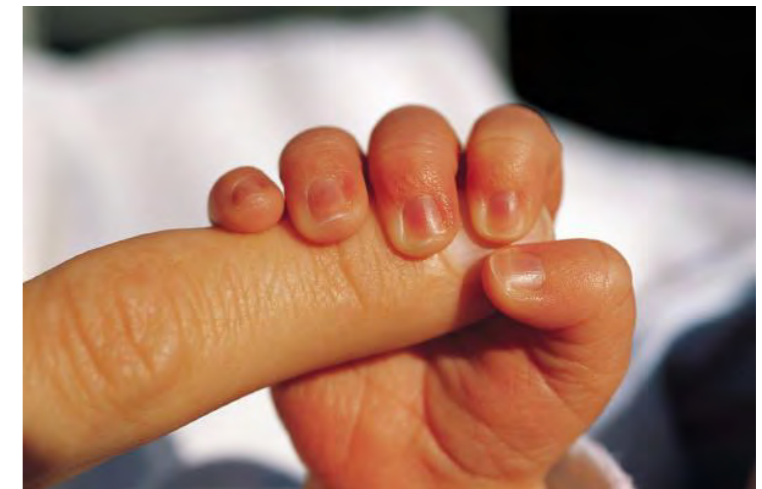
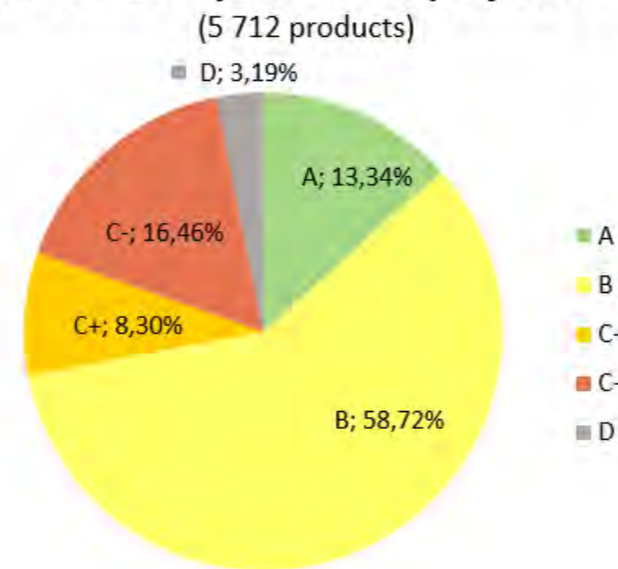
The project builds on Värmland Landstinget's long established tradition in choosing the best environmentally friendly products in buildings. By controlling the selection of materials and managing the outputs, the project tries to avoid using material which will cause the structure to be in need of sanitizing or decontamination at a later stage or which might cause illness.

Award in Sweden for most sustainable public procurement.

WHY MATERIALS PASSPORTS?

- Only flooring
 - 440 kg phthalates
 - 1,1 ton PVC
- Total reduction of:
 - 800 kg phthalates
 - 1,6 ton PVC
 - The contents of the products were registered as well as the places in the building.
- Instructions for maintenance were also connected to the products and places.
- The total extra cost 0,33 %.

Distribution of products in projects 2015



WHY MATERIALS PASSPORTS?

WHAT TYPE OF INFORMATION DO WE NEED TO REACH A MORE CIRCULAR AND HEALTHY BUILT ENVIRONMENT?

What is in the product?

How to take it out of the building?

Who owns it?

Can it be reused as is?

Can it be recycled?

Can it be recovered?

Is it in bulk?

Metal	5,000 kg
Wood	5,000 kg
Glass	600 kg
Walls	250,000 kg
Ceilings	100,000 kg
Floor	30,000 kg

WHY MATERIALS PASSPORTS?

THE SIGNIFICANCE OF MATERIALS CONTENT

Different levels of information give different possibilities for insights.

5 000 ton steel: What type of steel is it?

Search results : 610 substances with 677 substance name	
Substance name	
acid proof stainless steel	
AISI 1020 Carbon Steel (UNS G10200)	
AISI 1215 carbon steel	
alloy steel	
alloy steel	
aluminium copper steel alloy	
aluminium plated steel	
aluminium zinc plated steel sheets	
aluminium-zinc plated steel sheets, chromium plated	
aluzinc plated steel sheets	
aluzinc plated steel sheets SS1151-20 SS-EN 10 215 (1.0226)	
Aluzinc steel sheets DX51D AZ150	
Aluzinc steel sheets DX51D AZ185	
ballast for LED - steel	
black phosphated carbon steel	
black steel	
black steel EN 10241	
black steel sheets	
blue passivated steel	
blue zinc passivated steel	
brass and nickel plated steel	
brass-plated steel	
C35E/Ck35 steel	
cadmium plated steel sheets	
Carbofil steel	
carbon steel ASTM A-526	
carbon steel ASTM A715	
Carbon steel C1020	
carbon steel C1022	
carbon steel C38D	
carbon steel C76D (1.0614)	
Carbon steel DC01 EN 10130	
carbon steel DD11 (1.0332): EN 10111-2008	
Carbon Steel EN 10132-4	
carbon steel grad 4.8	
Carbon steel SAE 1010	
carbon steel SAE 1015	
carbon steel SAE 1016L	
carbon steel SAE-AISI 1022 (G10220)	
carbon steel SS 1370	
carbon steel2142	
carbon steel2172	
carbon steel2391	
carbon steel520 M	
carbon-manganese-steel (ASTM A449-83a) zinc plated	
cermented carbide steel	
chrome plated steel	
chromium plated galvanized steel	
chromium plated nickel plated steel	
chromium plated steel	
chromium plated steel 16MnCr5	
chromium plated steel, 100Cr6	
chromium plated steel, unspecified	
chromium plated, zinc plated steel	
chromium steel	
chromium steel Cr/Ni 18-8	
chromium(III)-plated steel	
coated DX51D steel	
cold rolled steel DC-05 EN 10130	

WHY MATERIALS PASSPORTS?

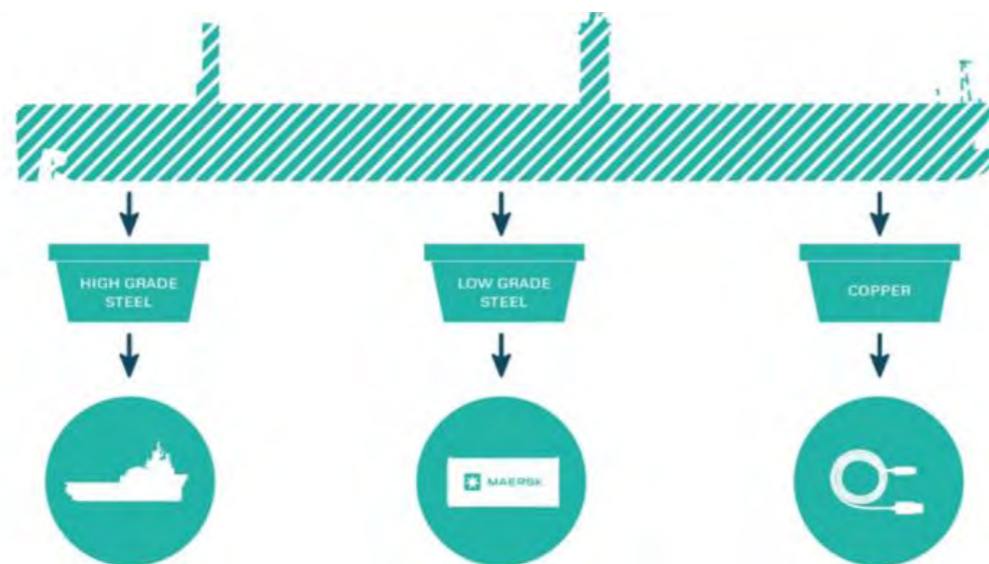


Circular.Cloud



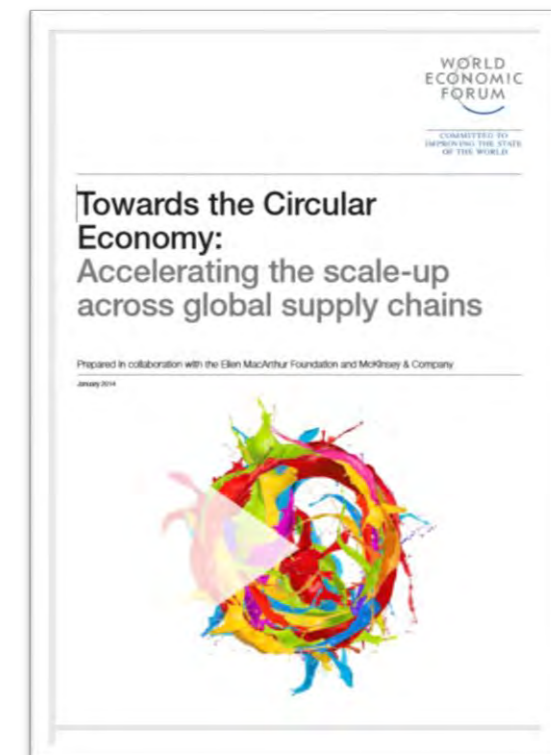
MATERIALS PASSPORTS

- In 2003, Materials Passports for buildings concept is described in peer-reviewed literature in *Towards a sustaining architecture for the 21st century: the promise of cradle-to-cradle design* UNEP Industry and Environment April – September 2003 p.15. Braungart and McDonough.
- In 2010, Springer Encyclopedia of Sustainability Science and Technology publish Resource Repletion, Role of Buildings, introducing Nutrient Certificates a.k.a. Materials Passports. Criteria in the publication are used as the basis for passports developed by EPEA and EPEA partners.
- In 2010, Cradle to Cradle® Materials Passports for the new Maersk Triple E class of container ships is developed with EPEA. It has been reported in the Sustainable Shipping Initiative.



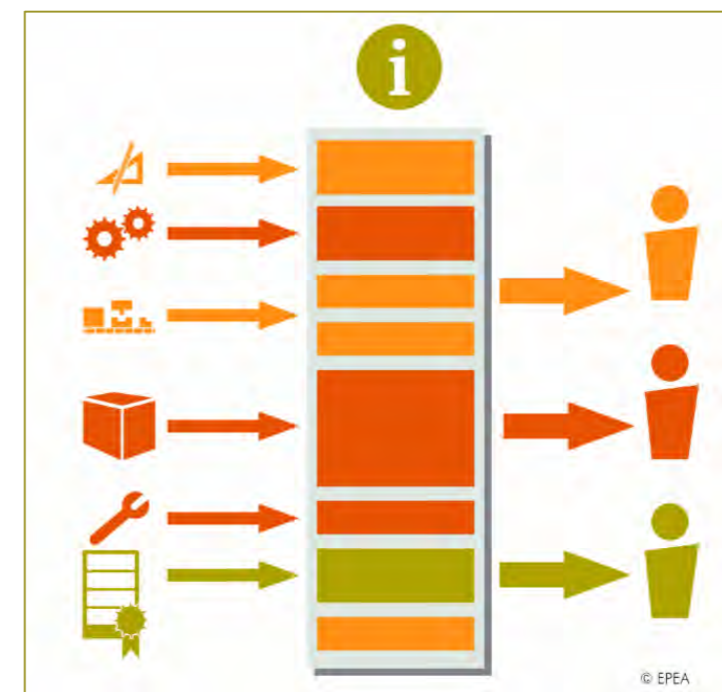
MATERIALS PASSPORTS

- In 2013, the European Commission pushes for product passports, to encourage a move to a circular economy in which the material content of obsolete products re-enters the production cycle.
- In 2013-14, materials passports are cited as scaling up mechanisms for circular materials by Ellen MacArthur Foundation, McKinsey & Co. and the World Economic Forum in *Towards the Circular Economy*.

A screenshot of the European Commission website. The top navigation bar is blue with the text "ENVIRONMENT Eco-innovation Action Plan". Below it, there are links for "Home", "About us", "Policies", "Funding", "Legal compliance", and "News & out". A green bar contains "ABOUT THE ACTION PLAN", "ABOUT ECO-INNOVATION", and "NEWS AND". A social media share button is visible. The main content area features a headline: "European Resource Efficiency Platform pushes for 'product passports'", dated 08/07/2013. A blue box on the left contains the text "RESOURCE EFFICIENCY Using less, living better". The main text states: "The European Resource Efficiency Platform (EREP), a high-level group set up to guide European policymakers, has published an interim set of recommendations. Among them is a proposals for 'product passports' – a set of information about the components and materials that a product contains, and how they can be disassembled and recycled at the end of the product's useful life."

MATERIALS PASSPORTS DEFINITION

BAMB materials passports are (digital) sets of data describing defined characteristics of materials and components in products and systems that give them value for present use, recovery, and reuse.





+ Add Product

Products

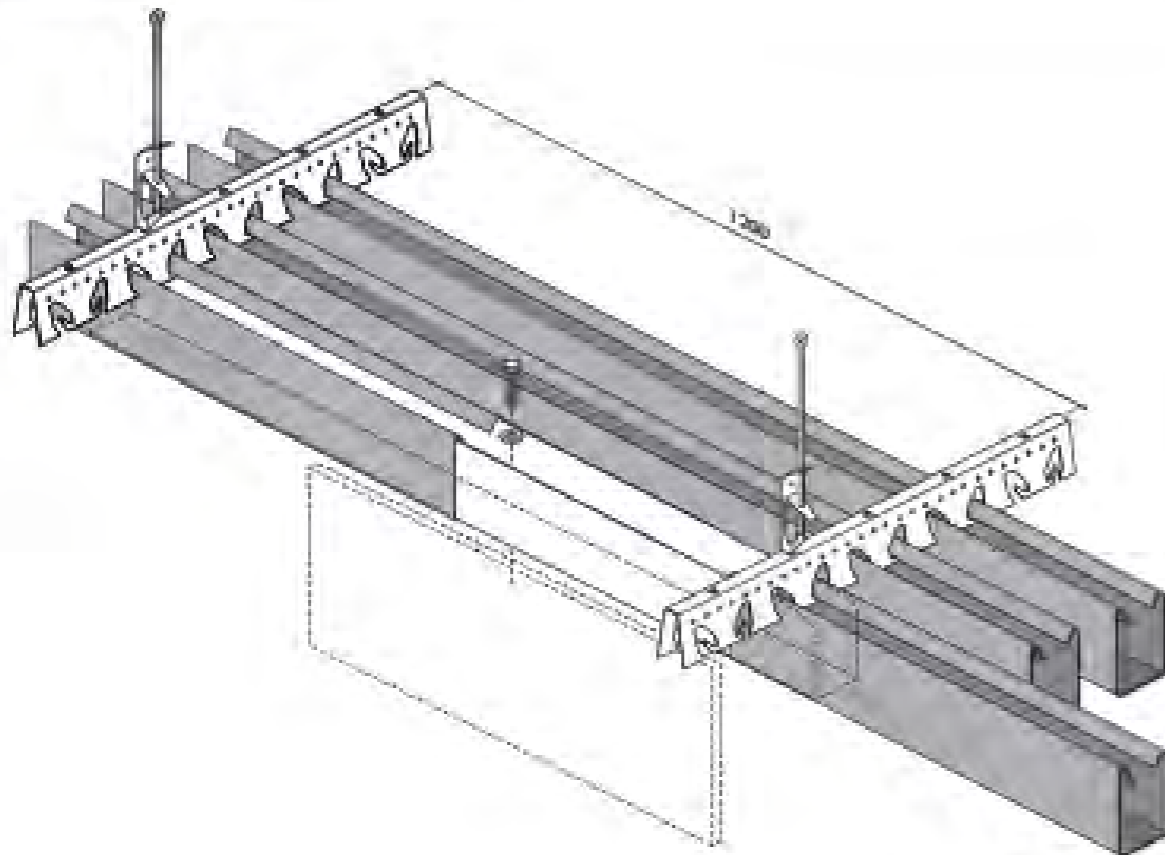
Name ↓	Brand Name	Manufacturer	GTIN/EAN
Accoya® Wood	Accsys Technologies	Accsys Technologies	Unknown
Acrovyn® 4000 Wall Protection	Acrovyn® 4000	Construction Specialties Inc.	Unknown
airmaster	Desso	Desso	Unknown
Aluminium Door Furniture	AMI BV	AMI	Unknown
Axia 2.0 Office Chair	BMA Ergonomics	Flokk	
Balance Desk	Ahrend	Ahrend	Unknown
BB Light LEDpipe EVO	EVO/ BB Light Concepts	BB Light	Unknown
Vihrea	Vihrea	Vihrea	Unknown
Wictec 50 glass facade element	SAPA	SAPA	unknown



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642384.

6

No interconnections



Product complexity

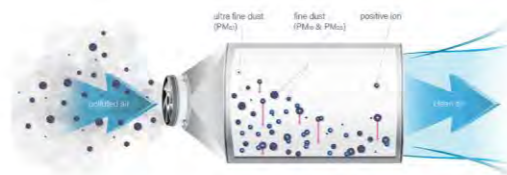
- Basic Product comprised of components & materials that can be mostly disassembled by unskilled workers using tools. However, might include coatings or ingredients requiring further reprocessing. e.g. steel reinforcing, steel beams, framing wood.

VISUAL OVERVIEW OF CIRCULARITY FEATURES

ENS
Clean air solutions

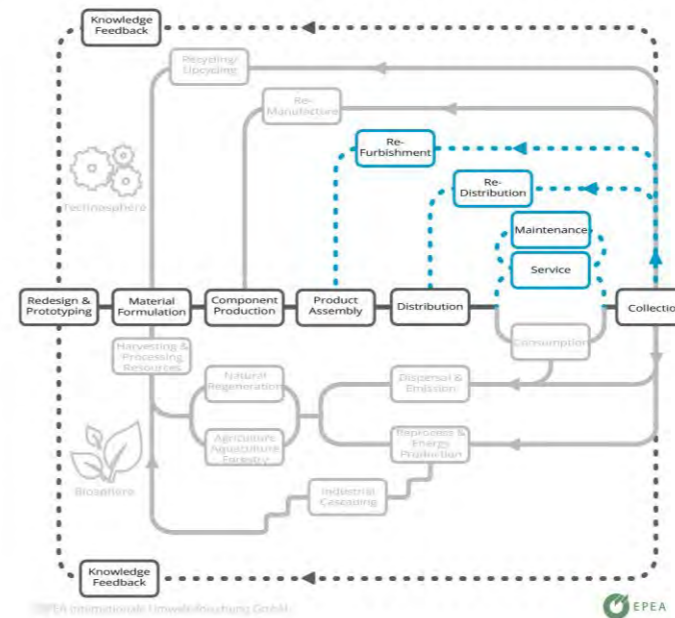
MANUFACTURER: ENS TECHNOLOGY
PRODUCT: MERLIN

AIR PURIFICATION SYSTEM



Product features

- + eliminates fine and ultrafine dust
- + no filters or disposables
- + minimal energy consumption



Reuse potentials

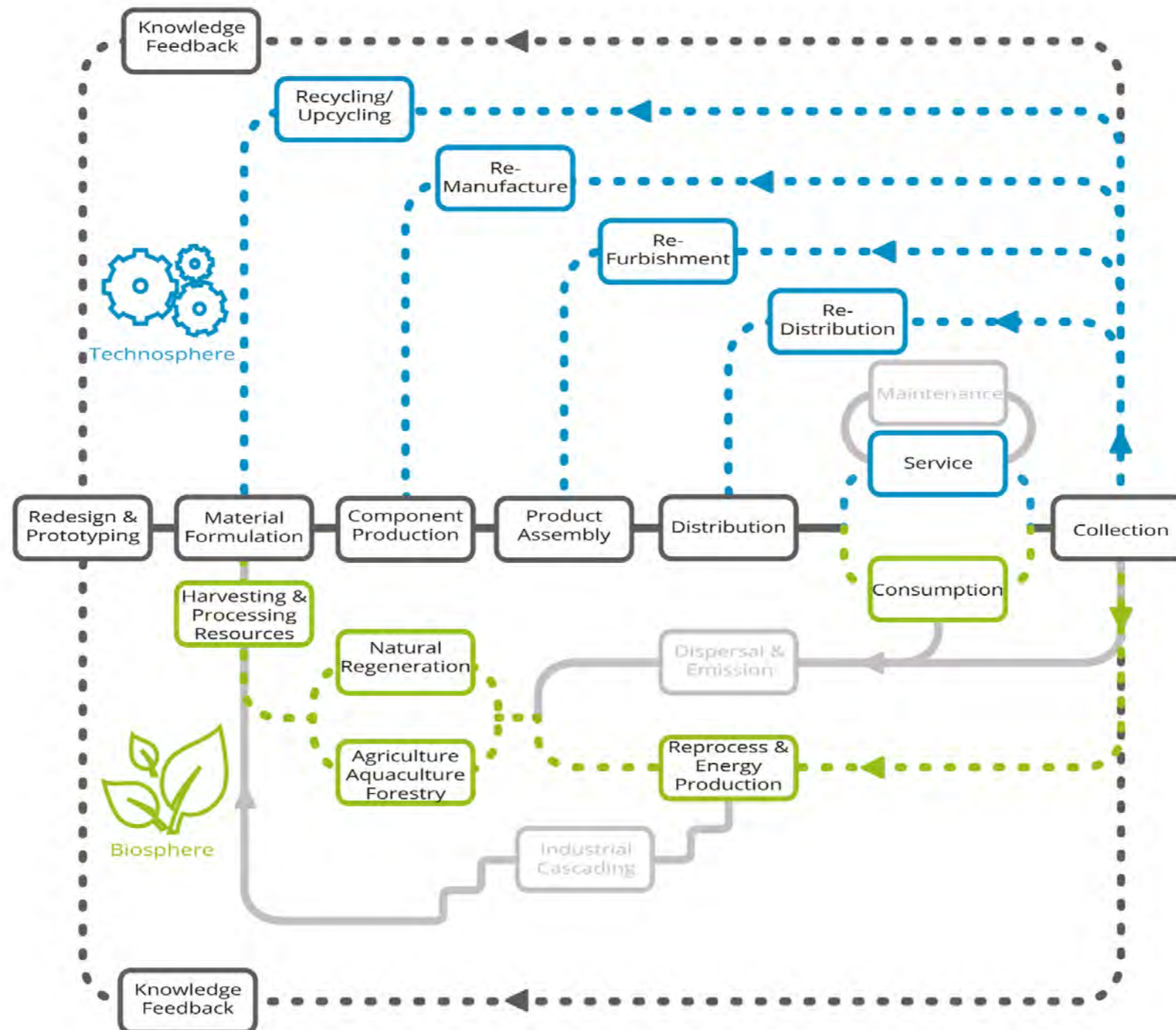
The product requires very little maintenance throughout many years. The product can be reused as new with a simple refurbishment.

Product story

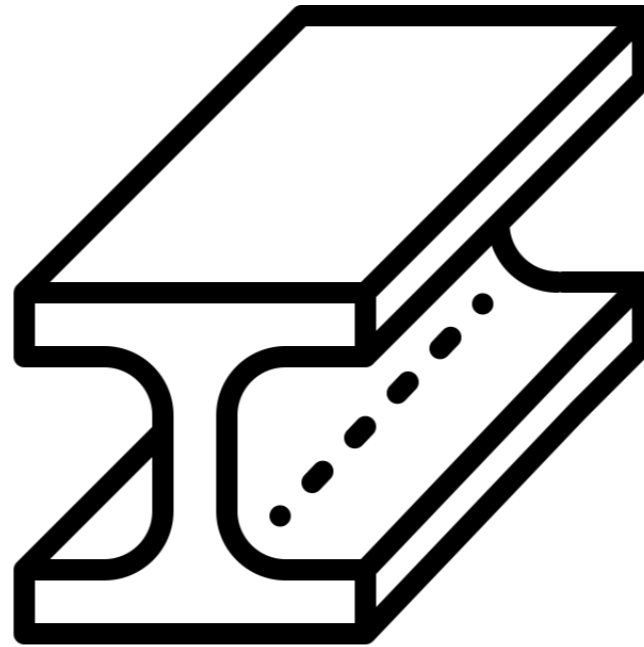
ENS has developed an ionizing technology that is essential to capturing finedust out of the air. The technique is now being applied in other applications as well, with a goal of creating clean air for everyone.

MATERIAL HEALTH ASSESSED	REVERSE LOGISTICS IN PLACE	(PARTS) DESIGNED FOR BIOSPHERE	(PARTS) DESIGNED FOR TECHOSPHERE	CONTAINS RENEWABLE CONTENT	CONTAINS RECYCLED CONTENT

CIRCULAR REUSE POTENTIALS DIAGRAM



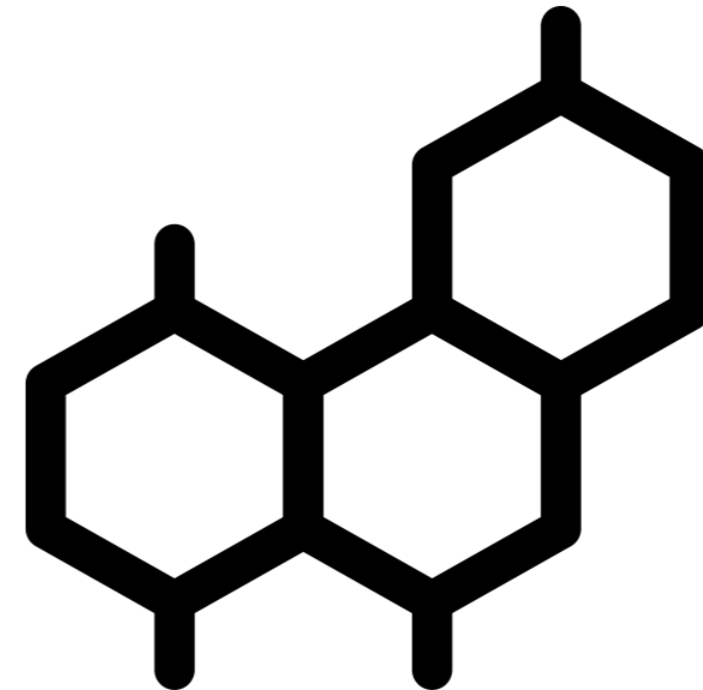




Created by Ben Davis
from Noun Project



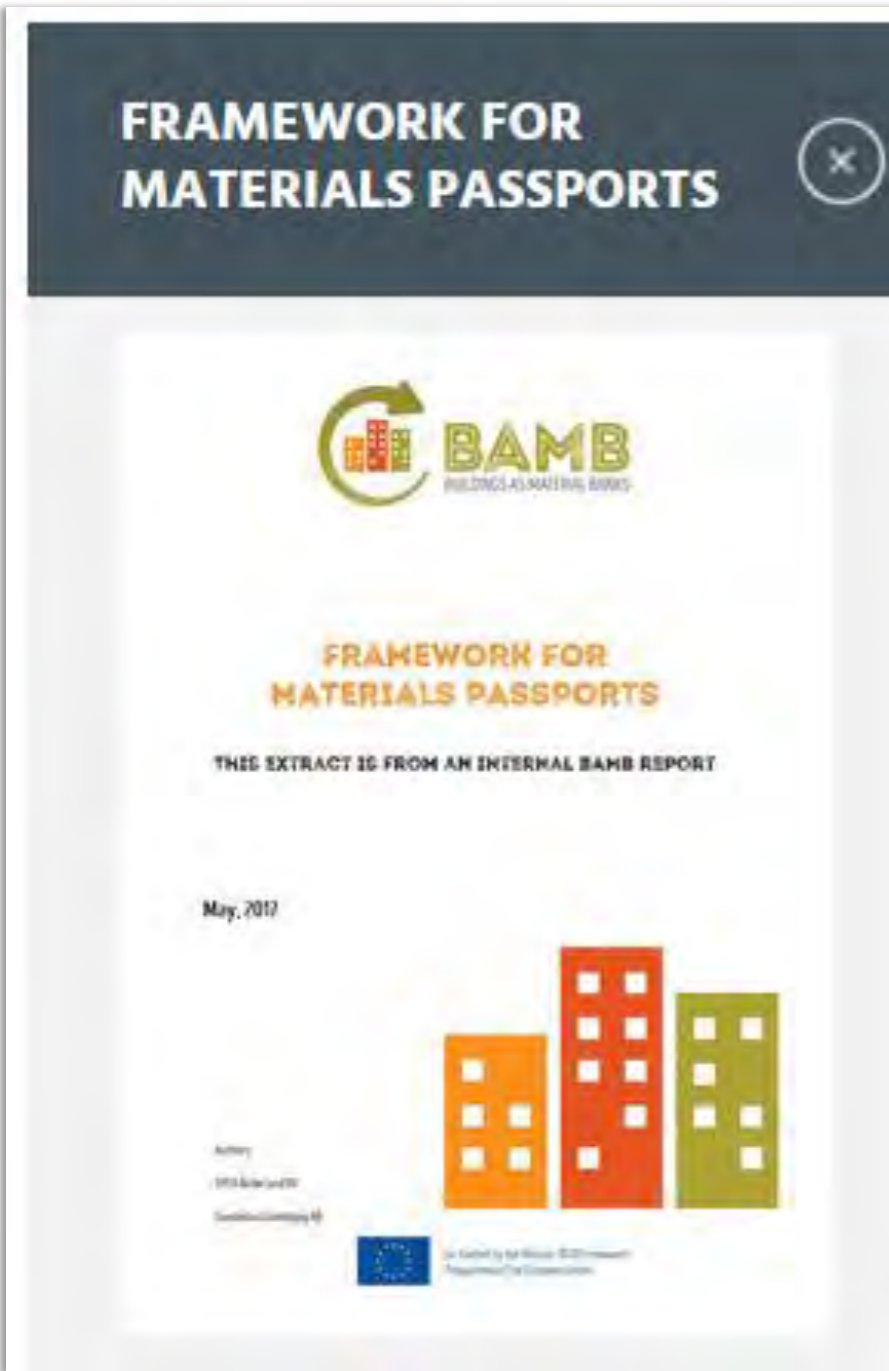
Created by Abdul Karim
from Noun Project



Created by Royyan Wijaya
from Noun Project



Co-funded by the Horizon 2020 Framework Programme of the European Union




Materials Passport Platform **Prototype** Products Buildings Instances ? Logout

Search

Products

Name ↓↑	Brand Name	Manufacturer	GTIN/EAN
Accoya® Wood	Accsys Technologies	Accsys Technologies	Unknown
Acrovyn® 4000 Wall Protection	Acrovyn® 4000	Construction Specialties Inc.	Unknown
airmaster	Desso	Desso	Unknown
Aluminium Door Furniture	AMI BV	AMI	Unknown

 [+ Add Product](#)

STAKEHOLDER NETWORK - 6 SPECIAL INTEREST GROUPS

1.
Materials Passports



2.
Reversible Building
Design



3.
Data management
(including BIM)



4.
Business Models



5.
Policies and Standards



6.
Case Studies
and Pilots



Subscribe at: www.bamb2020.eu



Co-funded by the Horizon 2020
Framework Programme
of the European Union



Thank you

Lars Luscuere
luscuere@epea.com

