BIMEPD

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ADAPTED SENIOR TRAINING PROGRAM ON BIM METHODOLOGIES FOR THE INTEGRATION OF EPD IN SUSTAINABLE CONSTRUCTION STRATEGIES

2020-1-ES01-KA204-083128

Module 09

Other methodologies of environmental impact calculation from open BIM formats.

COAMU Colegio Oficial de Arquitectos Region de Murcia

iED institute of Entrepreneurship Development

Centro Tecnológico del mármol, piedra y materiales

Warsaw University of Technology

Bulgarian Green Building Council

cype

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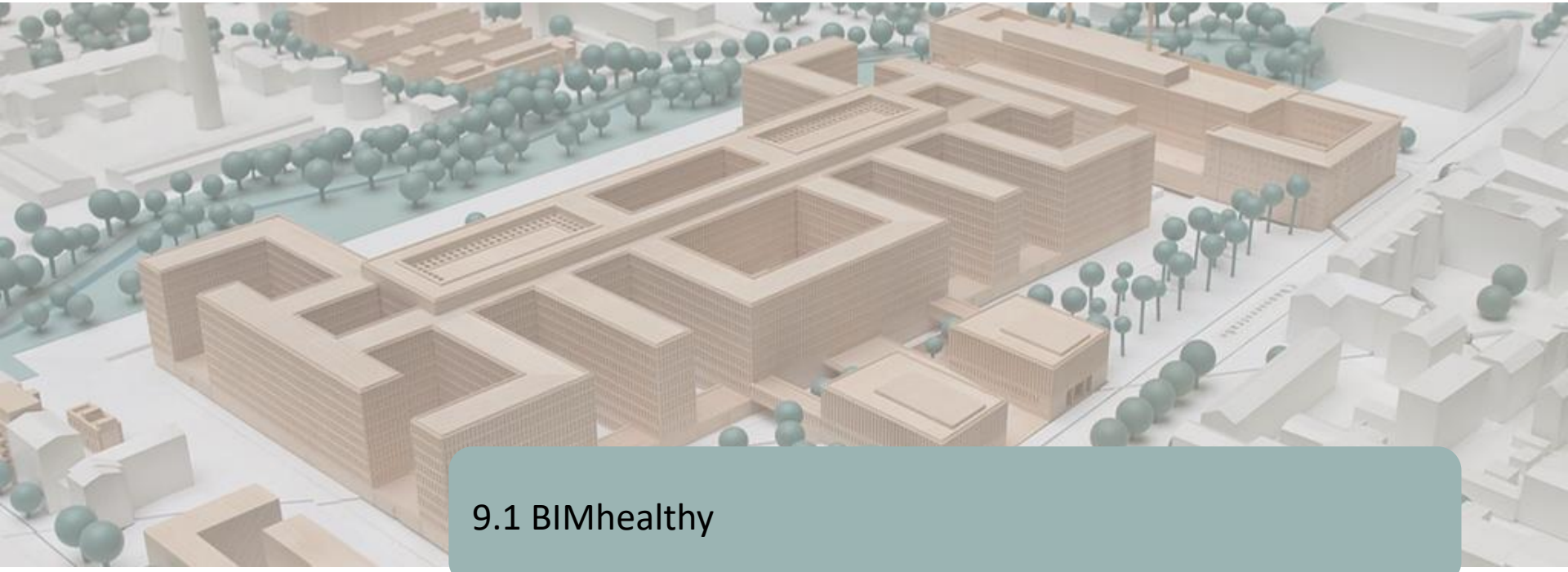

9.1 BIMhealthy

9.2 UrbanBIM

9.3 CircularBIM

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9.1 BIMhelathy

DEFINITION OF THE PROJECT.

OBJECTIVES.

CONSORTIUM AND IMPACT.

INTELLECTUAL PRODUCTS.

BIMhealthy PLUG-IN.

BIMhealthy

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DEFINITION OF THE PROJECT

HOUSING AS A STRATEGY FOR HEALTH PROMOTION FROM AN INTERSECTORAL AND MULTIDISCIPLINARY APPROACH

- The BIMhealthy project develops interoperability between the construction sector and the health and social services sector, in order to promote the establishment of healthy housing as a global habitat model, both from an environmental and public health promotion point of view, through the integration of emerging BIM technologies as design and control tools in building.
- Healthy housing is the conception of housing as an agent of health, which implies reducing existing risk factors as much as possible from its design, micro-location and construction, and then extending to its use and maintenance.
- Numerous studies affirm that there is a positive correlation between the quality of housing conditions and the health of its residents. An inadequate physical and community environment increases the risk of psychological and mental health problems and even leads to higher rates of all-cause mortality.
- The implementation of BIM in Europe is already a reality. In Northern Europe, BIM buildings are already conceptualised, constructed, managed and economically exploited. In Spain, the widespread use of BIM is still low, but it is a growing design resource as it has been made mandatory to use BIM in public infrastructure projects by 2019.

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OBJECTIVES

- Promote and collaborate in the dissemination of information and knowledge transfer on the role of housing as an agent or manager of health.
- Raise awareness of the relationship between housing and health in the most influential strata of the construction sector.
- Raise awareness in the professional sectors by promoting active participation to include and maintain measures that favour health, considering the physical context of the constructive elements of housing.
- Use primary care as a working strength to foster a healthy housing environment through training on environment and health, taking into account intersectoriality and multidisciplinarity.
- To develop an open BIM tool at the service of researchers and the educational field, to analyse the constructive elements of the building in the context of health and energy efficiency.
- To provide information and training to professionals in the field of construction so that they acquire the ability to design housing in the context of health.

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CONSORTIUM AND IMPACT

- Fundación Universitaria San Antonio - Spain.
- Asociación Empresarial y de Investigación Centro Tecnológico del Mármol, Piedra y Materiales – Spain.
- Instituto de Investigación Sanitaria de Alicante - Spain.
- Warsaw University of Technology – Poland.
- Datacomp, soluciones de ingeniería especializadas – Poland.
- Universitatea Transilvania din Brasov - Romania.

The BIMhealthy project is based on the development of an innovative training plan on housing in the context of health, through the integration of BIM methodologies, opening new horizons for architectural design.

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INTELLECTUAL OUTPUTS

- Common learning outcomes for methodologies relating architecture to health and social services.
- BIMhealthy Educational Software.
- BIMhealthy Open Educational Resource.

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BIMhealthy PLUG-IN

Firstly, UCAM coordinated the establishment of a methodology to quantify the HHI (Healthy Housing Index) concept, which will have 6 items with 54 sub-factors of influence.

Of these 6 items, for this plugin, developed by Datacomp with the collaboration of CTMármol, 2 of them allow their integration in BIM through an IFC model.

This IFC model can be used to assign different uses to the surfaces of a house in the BIMvision software (according to items 2 and 3, as we will see below) and automate the selection of the sub-factors established in the calculation.

The rest of the sub-factors will be solved by the user in this tool through a questionnaire integrated in the tool, obtaining the HHI through this plugin.

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BIMhealthy PLUG-IN

1.Definition: The level of potential health, comfort, safety, security, accessibility and sustainability derived for the occupants of a dwelling.

Analytical measurement: on a scale of 0-1, which allows to know the degree of response of a healthy dwelling understood as: healthy, comfortable, safe, accessible and sustainable.

2.Factors: 6 items. Location, programme, surfaces, habitability, facilities and finishes. Sub-factors: 54 items.

3.Weight of the items. 6 Influence coefficient (α:0-1) and 54 Weighting coefficient (β:%).

4. Qualification criteria: 270 criteria in 6 tables.

5. Obtaining the characteristics of the dwelling: 54 characteristics.

6. Rating of each sub-factor according to 4: 0-10 scale.

7. Obtaining computerised results by application (BIM?) or qualitative and quantitative qualification:

HHI Scale				
Very high	High	Medium	Low	Very low
1,00-0,80	0,79-0,60	0,59-0,40	0,39-0,20	0,19-0,00

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BIMhealthy PLUG-IN

Healthy Housing Index HHI

$$IViS = \frac{\sum_{i=1}^{i=n} \alpha_i \cdot F_i}{10}$$

Being:

HHI = Healthy Housing Index, ranging from 0 to 1

IViS Value	Magnitude	Identification color
1,00 – 0,80	Very high	
0,79 – 0,60	High	
0,59 – 0,40	Medium	
0,39 – 0,20	Low	
0,19 – 0,00	Very low	

αi = Coefficient of influence. It varies from 0 to 1. Function of n = 6 types of factors Fi.

Fi = Influence factor. It varies from 0 to 10, being:

$$F_i = \sum_{j=1}^{j=m} \beta_j \cdot C_{ij}$$

βj = Coefficient weighting. It varies from 0 to 100%. Function of m types of sub-factors j on which each Fi depends.

Cij = Rating of the ij sub-factor. Varies from 0 to 10

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BIMhealthy PLUG-IN

FACTOR 1.- VENUE, LOCATION

				Cij rating criteria: positive influence				
		Influence		Very Low	Low	Medium	High	Very high
		Average qualification		1,0	3,0	5,0	7,0	9,0
Factor *i*	Influence coefficient α_i	Sub-factor *j*	Aver-age Coef. β_j	0,0-2,0	2,1-4,0	4,1-6,0	6,1-8,0	8,1-10
1. Venue	0,20	1.1. Location	20%	Cities with> 1,000,000 inhab-itants. Areas with industrial influence <1 km	Traditional urban areas: cities between 500,000 and 1,000,000 in-habitants.	Traditional urban areas: cities between 100,000 500,000 inhab-itants	Urban and rural areas. Between 50,000 and 100,000 inhab-itants.	Rural and forest areas <50,000 inhab-itants
		1.2. Air Quality Index (ICA): results of O_3, particles, CO, SO_2 and NO_2. ($\mu g/m^3$) microgram/m^3	40%	ICA > 200	ICA 200-150	ICA 150-100	ICA 100-50	ICA ≤ 50
		1.3. Climate area (ZC): A, B, C, D and E	10%	(E)	(D)	(C))	(B)	(A)
		1.4. Preferred orientation of the living rooms.	30%	(A) Southwest (B) West (C) Northwest (D) North (E) Northeast	(A) South (B) Southwest (C) West (D) Northwest (E) North	(A) Southeast (B) South (C) Southwest (D) West (E) Northwest	(To this (B) Southeast (C) South (D) Southwest (E) West	(A) Northeast (B) This (C) Southeast (D) South (E) Southwest
		Σ	100%	Sub-factors that, derived from the place where the dwelling is located, have a relevant incidence on the PLACE factor, which contributes a global influence on IVE of 20% (αi = 0.20)				

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BIMhealthy PLUG-IN

FACTOR 2.- PROGRAM / USES

				Cij qualification criterion: positive influence				
		Influence		Very low	Low	Average	High	Very higha
		Average rating		1,0	3,0	5,0	7,0	9,0
Factor *i*	Influence coefficient α_i	Subfactor *j*	Coef. pond. β_j	0,0-2,0	2,1-4,0	4,1-6,0	6,1-8,0	8,1-10
2. Programa / Usos	0,20	2.1. Nº baños	20%	0	1 incompleto	1 completo	2	≥ 3
		2.2. Nº aseos	15%	0	1 incompleto	1 completo	2	≥ 3
		2.3. Nº dormitorios independientes	10%	No hay espacio específico	1	2	3	≥ 4
		2.4. Salón	10%	No hay espacio específico	Salón - comedor	Sólo salón	Salón y estar en un mismo espacio	Salón y estar vinculados pero independientes
		2.5. Comedor	10%	No hay espacio específico	Comedor-salón	Sólo comedor	Comedor y zona de servicio	Comedor y zona de servicio vinculados pero independientes
		2.6.Terrazas - porches	10%	0	1	2	3	≥ 4
		2.7. Cocina	10%	No hay espacio específico	Incluida en salón-comedor	Incluida en comedor	Vinculada con comedor	Independiente
		2.8. Galería	10%	No hay espacio específico	En armario empotrado o similar	Sin posibilidad de tender	Con posibilidad de tender al exterior	Independiente con posibilidad de tender interior
		2.9. Despensa	5%	No hay espacio específico	En estanterías abiertas	En armario empotrado o similar	Independiente	Independiente con ventilación natural
		Σ	100%	Subfactores que, derivados del contenido de la vivienda, tienen una incidencia relevante en el factor PROGRAMA / USOS, que aporta una influencia global sobre el IViS del 20 % (α_i=0,20)				

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BIMhealthy PLUG-IN

FACTOR 3.- SURFACES / SIZES

				Cij rating criteria: positive influence				
		Influence		Very Low	Low	Medium	High	Very high
		Average qualification		1,0	3,0	5,0	7,0	9,0
Factor *i*	Influence coefficient α_i	Sub-factor *j*	Average Coef. β_j	0,0-2,0	2,1-4,0	4,1-6,0	6,1-8,0	8,1-10
3. Surfaces / Size Number of rooms= number of people in bedrooms	0,20	3.1. Bathrooms	5%	1 Unit: < 2 m²	1 Unit: [2-4[m²	1 Unit: [4-6[m²	1 Unit: [6-8[m²	1 Unit: ≥ 8 m²
		3.2. Toilets	5%	1 Unit: < 1 m²	1 Unit: [1-2[m²	1 Unit: [2-3[m²	1 Unit: [3-4[m²	1 Unit: ≥ 4 m²
		3.3. Independent bedrooms	20%	1 Unit: < 6 m² Rest ≥ 6 m²	1 Unit: [6-8[m² All ≥ 6 m²	1 Unit: [8-10[m² All ≥ 6 m²	1 Unit: [10-12[m² All ≥ 6 m²	1 Unit: ≥ 12 m² All ≥ 6 m²
		3.4. Living room	10%	< 3 m²/inhab. ≥ 10 m²	[3-4[m²/inhab. ≥ 12 m²	[4-5[m²/inhab. ≥ 14 m²	[5-6[m²/inhab. ≥ 16 m²	≥ 6 m²/inhab. ≥ 18 m²
		3.5. Dining room	10%	2 m²/inhab. ≥ 4 m²	[2-3[m²/inhab. ≥ 6 m²	[3-4[m²/inhab. ≥ 8 m²	[4-5[m²/inhab. ≥ 10 m²	≥ 5 m²/inhab. ≥ 12 m²
		3.6. Terraces	15%	< 1 m²/inhab.	[1-2[m²/inhab. ≥ 2 m²	[2-3[m²/inhab. ≥ 4 m²	[3-4[m²/inhab. ≥ 6 m²	≥ 4 m²/inhab. ≥ 8 m²
		3.7. Kitchen	10%	< 4 m²	[4-7[m²	[7-10[m²	[9-12[m²	≥ 12 m²
		3.8. Gallery	15%	< 1 m²	[1-2[m²	[2-3[m²	[3-4[m²	≥ 4 m²
		3.9. Pantry	5%	< 0,5 m²	[0,5-1,0[m²	[1,0-1,5[m²	[1,5-2,0[m²	≥ 2,0 m²
		3.10. General height of the house	5%	< 2,2 m²	[2,2-2,5[m²	[2,5-3,0[m²	[3,0-3,5[m²	≥ 3,5 m²
		Σ	100%	Sub-factors that, derived from the size of the pieces that make up the housing program, have a relevant incidence on the SURFACE / SIZE factor, which contributes a global influence on IVi5 of 20% (α_i = 0.20)				

inhab.= inhabitant

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FACTOR 4.- HABITABILITY PARAMETERS

				Cij rating criteria: positive influence				
		Influence		Very Low	Low	Medium	High	Very high
		Average qualification		1,0	3,0	5,0	7,0	9,0
Factor *i*	Influence coefficient α_i	Sub-factor *j*	Average Coef. β_j	0,0-2,0	2,1-4,0	4,1-6,0	6,1-8,0	8,1-10
4. Interior habitability parameters	0,25	4.1. Ventilation - SV: Ventilation system of rooms by means of inlet, passage and exhaust openings	15 %	SV: No Living stays without SV	SV: No. V. Natural. Gaps ≥2.5% S. Useful	SV: Sí V. Natural. Gaps ≥ 5% S. Useful	SV: yes V. Natural Gaps ≥ 7.5% S. Useful	SV: yes SV Natural Gap ≥ 10% S. Useful
		4.2. Living room lighting	10 %	Living rooms without natural lighting	Natural. Gaps ≥ 5% S. Useful	Natural. Gaps ≥ 10% S. Useful	natural Gaps ≥ 15% S. Useful	natural Gaps ≥ 20% S. Useful
		4.3. Humidity - GI: Degree of impermeability of the envelope. 1 low and 5 high	15 %	No waterproofing solutions in the envelent	Rainy zones - GI = 2 Low rainy areas GI = 1	Rainy areas GI = 3 Low rainy areas GI = 2	Rainy areas-GI = 4 Low rainy areas GI = 3	Rainy areas GI = 5 Low rainy areas GI = 4
		4.4. Noise transmitted inside. Acoustic Insulation Facade (AAF) dB	15 %	> 40 dB AAF ≥ 10 dB	≤ 35 dB AAF ≥ 20 dB	≤ 30 dB AAF ≥ 30 dB	≤ 25 dB AAF ≥ 35 dB	≤ 20 dB AAF ≥40 dB
		4.5. Temperature transmitted inside (Inv-Summer). U: transmittance W / m2K, f: facades and c: roof	10 %	< 12° y > 30 ° Uf ≤ 1,00 Uc ≤ 0,70	Between 12° - 30 ° Uf ≤ 0,90 Uc ≤ 0,60	Between 14° - 28 ° Uf ≤ 0,80 Uc ≤ 0,50	Between 16° - 26 ° Uf ≤ 0,60 Uc ≤ 0,40	Between 18° - 24 ° Uf ≤ 0,50 Uc ≤ 0,30
		4.6. Drinking water (ICAg %) Water Quality Index, compared to pure water (0-100%)	20 %	Dangerous ICAg < 50	Tolerable ICAg: [50-60[	Acceptable ICAg: (60-70)	Good ICAg: [70-80[	Excellent ICAg > 80
		4.7. Waste	5 %	No response to waste	Has a waste bin	Has storage space	Has space for ventilated storage	It has a treatment system: collection and recycling
		4.8. Exposure to radio gas: Bq / m3 (Becquerelio / m3). 1 decay / s. Sup Nuclear Council (CSN)	10 %	CSN predictive zone> 300 Bq / m3	Predictive zone CSN 300-250 Bq / m3	CSN predictive zone. 250-200 Bq / m3	CSN predictive zone. 200-150 Bq / m3	CSN predictive zone ≤ 150 Bq / m3
		Σ	100 %	Sub-factors that, derived from the aspects that imply health, sanitation and hygiene in the interior of the home, have a relevant incidence in the HABITABILITY factor, which contributes a global influence on IVi5 of 25% (α_i = 0.25)				

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BIMhealthy PLUG-IN

FACTOR 5.- PREMISES

				Cij rating criteria: positive influence				
		Influence		Very Low	Low	Medium	High	Very high
		Average qualification		1,0	3,0	5,0	7,0	9,0
Factor i	Influence coefficient αi	Sub-factor j	Average Coefficient βj	0,0-2,0	2,1-4,0	4,1-6,0	6,1-8,0	8,1-10
5. Premises.	0,10	5.1. Electricity. Electrification level: Power (kW). SU: Sup Useful	15 %	SU < 100 m² ≤ 3 kW S U 100-200 m² ≤ 4 kW SU ≥ 200 m² ≤ 5 kW	SU < 100 m² [3 - 4[kW S U 100-200 m² [4 - 5[kW SU ≥ 200 m² [5 - 6°kW	SU < 100 m² [4 - 5[kW S U 100-200 m² [5 - 6[kW SU ≥ 200 m² [6 - 7[kW	SU < 100 m² [5 - 6[kW SU100-200 m² [6 - 7[kW SU ≥ 200 m² [7 - 8[kW	SU < 100 m² ≥ 6 kW S U 100-200 m² ≥ 7 kW SU ≥ 200 m² ≥ 8 kW
		5.2. Water supply. ACS: Domestic hot water	15 %	No official	Official tubes: plumb ACS: Yes	Official tubes: copper, steel, PVC ACS: Yes	Official tubes: copper, steel, PVC and descaling. ACS: Yes	Official tubes: copper, steel, PVC and quality control. ACS: Yes
		5.3. Water evacuation	10 %	Without net: to blind well	Without net: to septic tank	At official junction Pipeline: horizontal buried	Link to official evacuation pipeline: vertical and horizontal recordable	At official junction. Network: recordable and with treatment
		5.4. Heating system	15 %	Without installation	Individual mobile sections	Radiators' installation	Underfloor heating installation	Radiant wall and floor installation
		5.5. Cooling (AA)	10 %	Without installation	Installation of partial AA	Traditional complete installation of AA	Complete installation of AA with humidifiers	Complete AA installation with humidification and zoning
		5.6. Ventilation. Qm: Average achievable flow (l/s)	10 %	Without installation	Individual mobile sections Qm (10-15)	Partial network installation Qm [15-20[	Complete network installation Qm [20-25[	Complete installation with anti-pollution filters Qm ≥ 25
		5.7. Telecommunications. Net services (e-resources)	10 %	Without installation	Pre - installation	Partial installation	General installation	General installation connected to 112 or equivalent
		5.8. Home automation	5 %	Without installation	Room control: lighting and temperature	Room control: lighting, temperature and ventilation	Room control: lighting, temperature, ventilation, humidity and noise	Control of all habitability parameters
		5.9. Accessibility	5 %	Non-accessible housing and access	Non-accessible housing	Accessible housing	Adapted housing	Adapted housing and access
		5.10. Fire prevention and countermeasures (RF)	5 %	Without installation and without foresight	No installation and RF walls and ceilings <90	No installation and RF walls and ceilings [90-120[	RF walls and ceilings (90-120) ≥ 1 pc fire extinguisher	RF walls and ceilings (90-120) Alarm and extinction network
		Σ	100%	Sub-factors that, derived from the supplies that are part of the dwelling, have a relevant impact on the FACILITIES factor, which contributes a global influence on the IVE of 10 % (αi = 0.10)				

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BIMhealthy PLUG-IN

FACTOR 6.- ENDINGS

				Cij rating criteria: positive influence				
		Influence		Very Low	Low	Medium	High	Very high
		Average qualification		1,0	3,0	5,0	7,0	9,0
Factor *i*	Influence coefficient a_i	Sub-factor *j*	Average Coef. β_j	0,0-2,0	2,1-4,0	4,1-6,0	6,1-8,0	8,1-10
6. Endings	0,05	6.1. Floor Coating. Colour: 0 to 10. 0 white; 10 black	15 %	No treatment Color≥ 5	PVC and similar material. Colour: (4-3)	Stony and ceramic. Colour: [3-2[	Parquet and attached platforms. Colour: [2-1[	Parquet and floating platforms. Colour ≤ 1
		6.2. Ceiling / roof endings. Colour: 0 to 10. 0 white; 10 black	10 %	No treatment Color≥ 5	Cement mortars stone paints. Colour: [4-3[	Plasters: rough paints. Colour: [3-2[	Plasters: clear smooth paints. Colour: [2-1[	Plaster / lime clear smooth paints. Colour ≤ 1
		6.3. Wall cladding. Colour: 0 to 10. 0 white; 10 black	15 %	No treatment Color≥ 5	Cement and clad mortars. Colour: [4-3[	Plasters: rough paints. Colour: [3-2[	Plasters: smooth paints. Colour: [2-1[	Gypsum cardboard with air chamber. Colour ≤ 1
		6.4. Windows	5 %	Not practicable	Aluminium sliders	Aluminium sliders	Wood and PVC folding	Folding with thermal bridge break
		6.5. Doors	5 %	Sway	Heavy folding	Light folding	Sliding with elastic joint	Sliding with safety spring when closing
		6.6. Radiation regulation / protection	15 %	Without foresight	Curtains and interior blinds	Blinds.	Blinds and slats in the gap	External adjustable lattices
		6.7. Fitted carpet	15 %	High loop fabrics	Nature fabrics	Synthetic fibres.	Vegetal fibres	Without fitted carpets
		6.8. Fumistería y complementos	20 %	Service not guaranteed	Sink, washing machine, refrigerator and hob	Sink, washing machine, dishwasher, fridge, hob and extractor hood	Sink, washing machine, dishwasher, refrigerator, hob, cooker hood, oven and microwave	Sink, washing machine, dishwasher, refrigerator, hob, cooker hood, oven and microwave, dryer and freezer
		Σ	100%	Sub-factors that, derived from the services and coatings of the home, have a relevant incidence on the ENDINGS' factor, which provides a global influence on the IVi5 of 5% (a_i = 0.05)				

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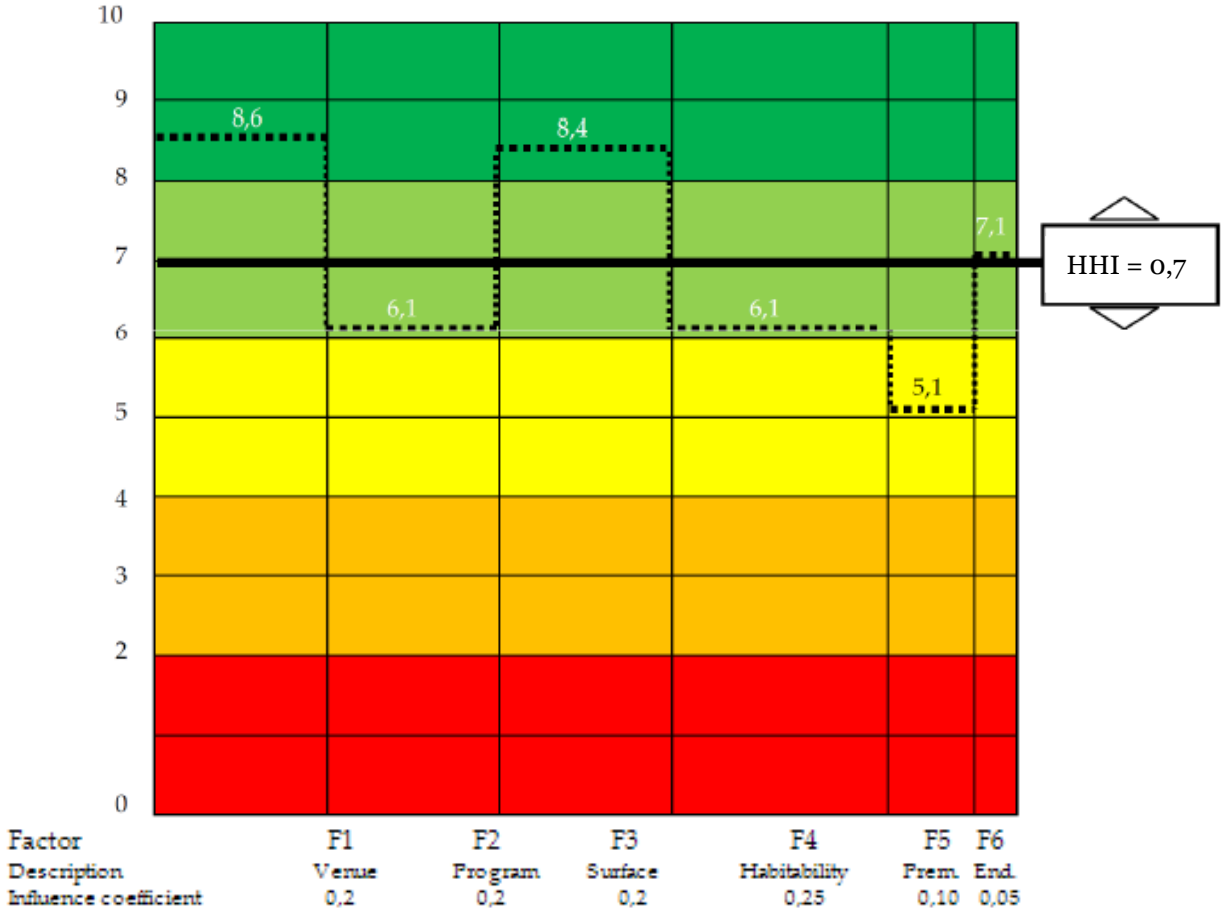
BIMhealthy PLUG-IN



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9.2 UrbanBIM

DEFINITION OF THE PROJECT.

OBJECTIVES.

CONSORTIUM AND IMPACT.

INTELLECTUAL PRODUCTS.

UrbanBIM PLUG-IN.

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DEFINITION OF THE PROJECT

INNOVATIVE EDUCATIONAL INTEGRATION OF URBAN PLANNING BASED ON BIM-GIS TECHNOLOGIES AND FOCUSED ON THE CHALLENGES OF THE CIRCULAR ECONOMY.

Currently, most of the available BIM resources (online documentation, training, software, etc.) are focused on Building (residential - commercial).

In order to make the most of the advantages of BIM for any type of construction project (urbanisation, civil engineering, industrial, etc.), it is necessary to act on the key factors:

- The database.
- Transmission of parameters - data.
- Collaborative work between the different agents.
- The life cycle: from the schematic design (basic project), executive project, construction, operation and maintenance phase and reforms (including demolition).

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OBJECTIVES

- Integrate BIM tools in all aspects of the triple helix: public bodies, companies and universities.
- Implement in municipal public bodies the calculation of CO2 emissions in construction at urban level.
- Provide information on the emissions of each product / building / urban plan.
- Improve interoperability between emerging BIM / GIS technologies.
- Create a software tool open to researchers, architects, engineers in the construction sector, with new metadata capable of managing projects generated by BIM / GIS.

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CONSORTIUM AND IMPACT

- Universitatea Transilvania din Brasov - Romania.
- Asociatia Romania Green Building Council - Romania.
- Universidad de Sevilla - Spain.
- Asociación Empresarial y de Investigación Centro Tecnológico del Mármol, Piedra y Materiales – Spain.
- Warsaw University of Technology – Poland.
- Datacomp, soluciones de ingeniería especializadas – Poland.

UrbanBIM therefore raises awareness of the benefits of the rational use of energy and material resources for students, AIC professionals and public bodies using innovative technologies such as BIM and GIS.

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INTELLECTUAL OUTPUTS

- Collaborative Online Educational Platform UrbanBIM.
- Collaborative Guide to Life Cycle Analysis of building materials at urban level.
- Establishment of common learning outcomes on methodologies for the use of BIM for Life Cycle Assessment calculations during the development of urban planning.
- IT production of integrated UrbanBIM training materials.
- UrbanBIM Educational Software.

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UrbanBIM PLUG-IN

This educational tool allows the calculation of the Carbon Footprint, Water Footprint and Embedded Energy of urban developments for the work units in which these environmental impacts have been calculated.

The company Datacomp, through its BIMvision software, developed this software in collaboration with CTMármol. The environmental database developed by the University of Seville was integrated into this plug-in to proceed to the selection of the different BIM objects in IFC format that make up a BIM model, so that environmental impacts can be assigned to these objects and the total computation of the impacts of urban development can be obtained.

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UrbanBIM PLUG-IN

ECONOMIC Budget
ENVIRONMENTAL Budget

Ranking

bc
ca

Materials

Labour

Machinery

quantification of resources

CO_2

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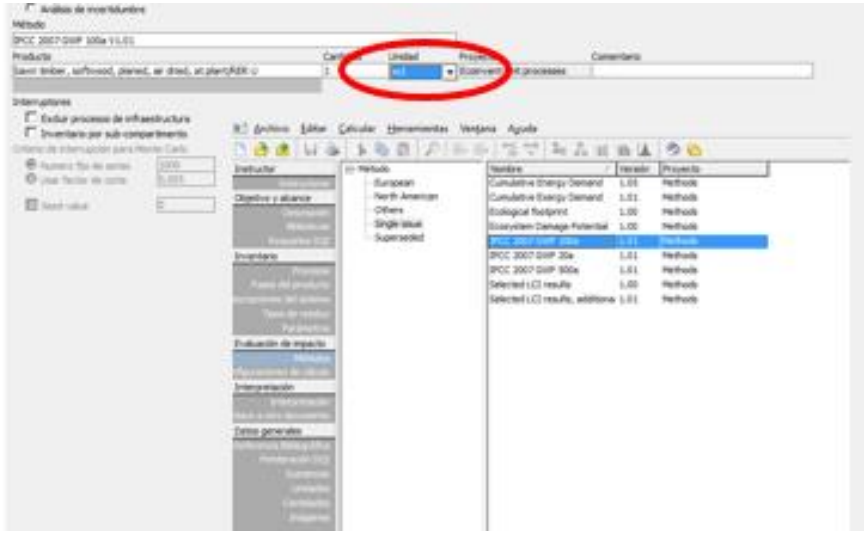
UrbanBIM PLUG-IN

Environmental database

ecoinvent Centre

SimaPro

- Energy calculation (Cumulative energy demand)
- Carbon footprint (IPCC 100A)
- Inventory analysis
- Water Footprint (directly or indirectly from inventory)



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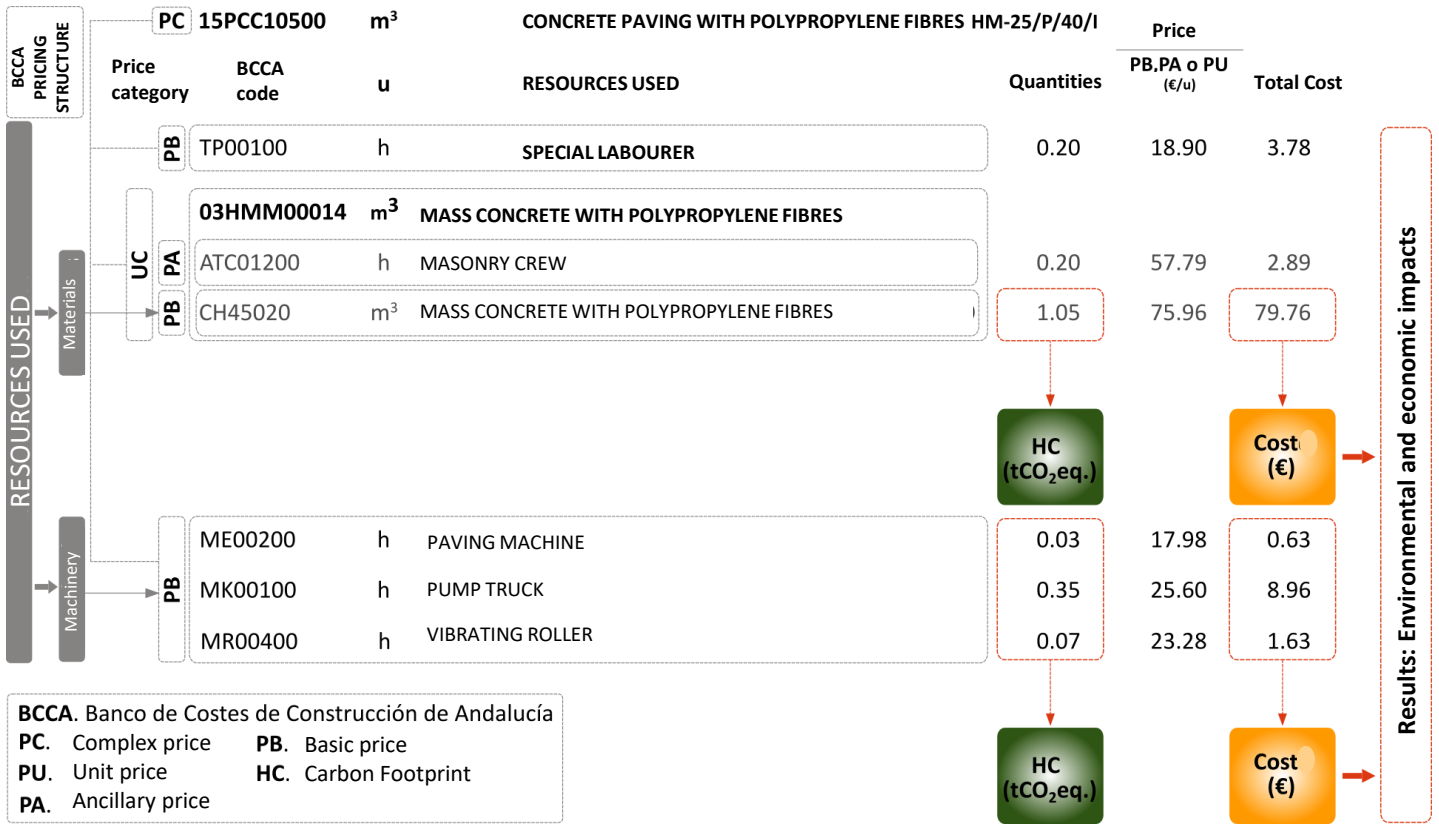
UrbanBIM PLUG-IN

Prices with environmental information



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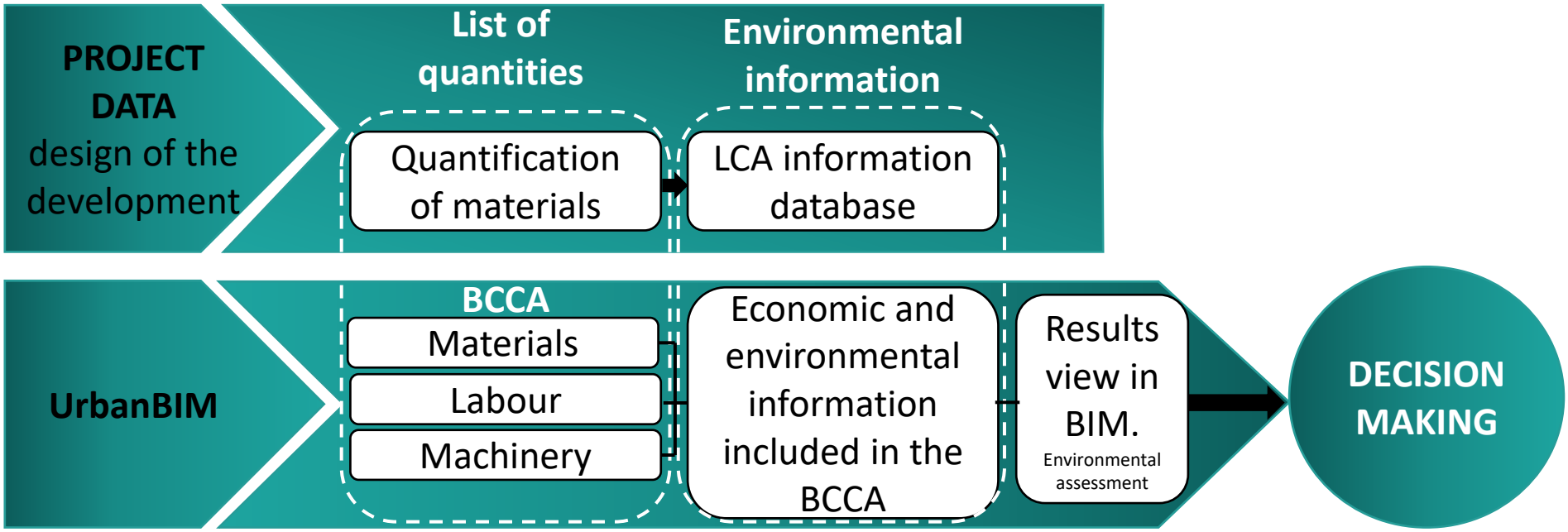
UrbanBIM PLUG-IN

LCA implementation in BIM



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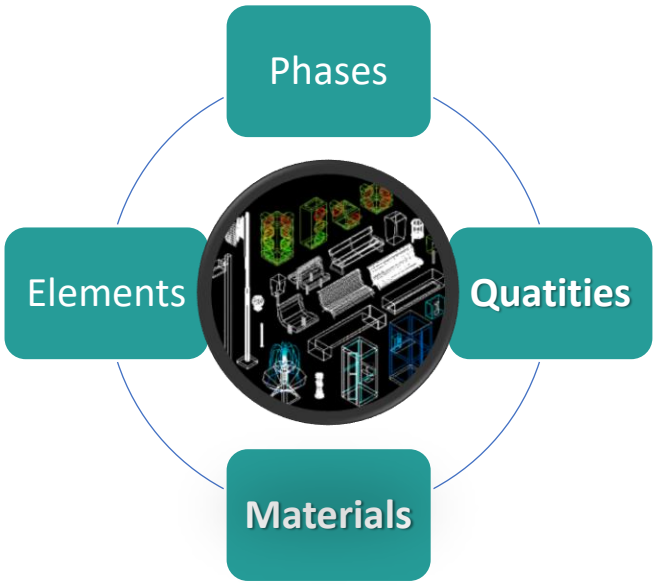
UrbanBIM PLUG-IN

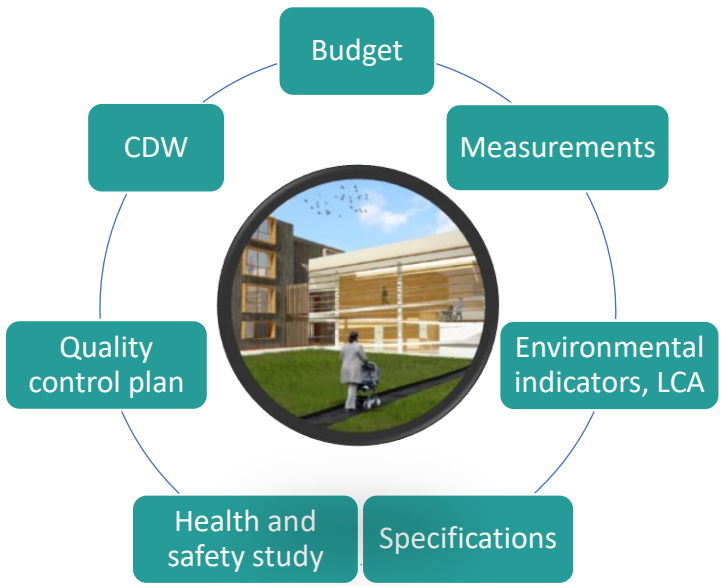
LCA implementation in BIM

IFC models



CAD + Specifications

BIM Plug-in



Additional information for models

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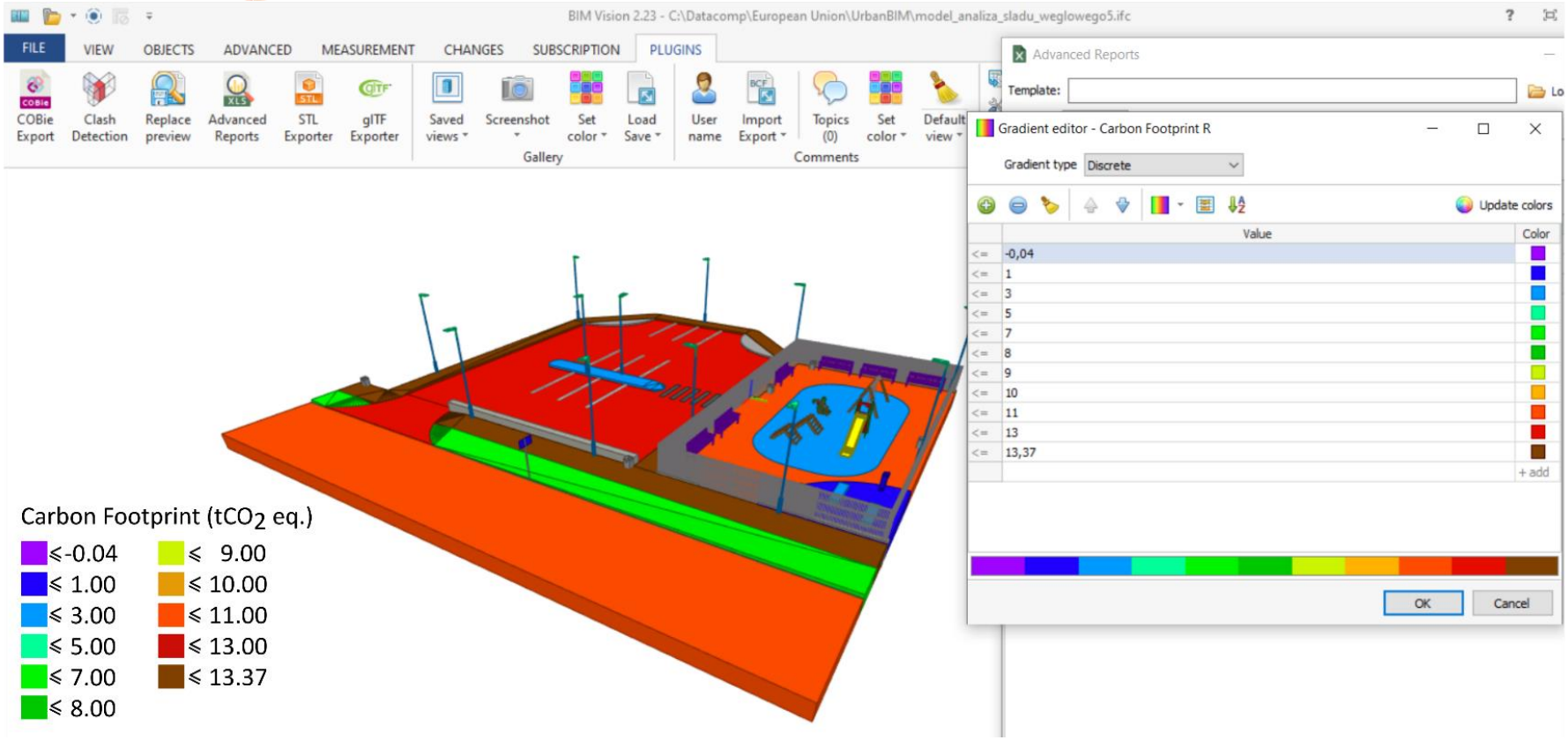
UrbanBIM PLUG-IN

LCA implementation in BIM



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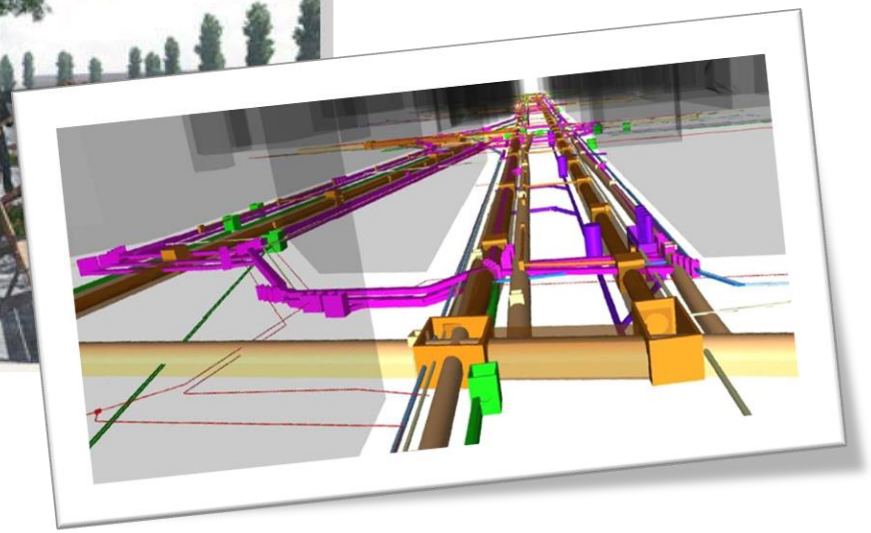
UrbanBIM PLUG-IN

Urbanisation projects in BIM



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Urbanisation projects in BIM

STUDY CASE

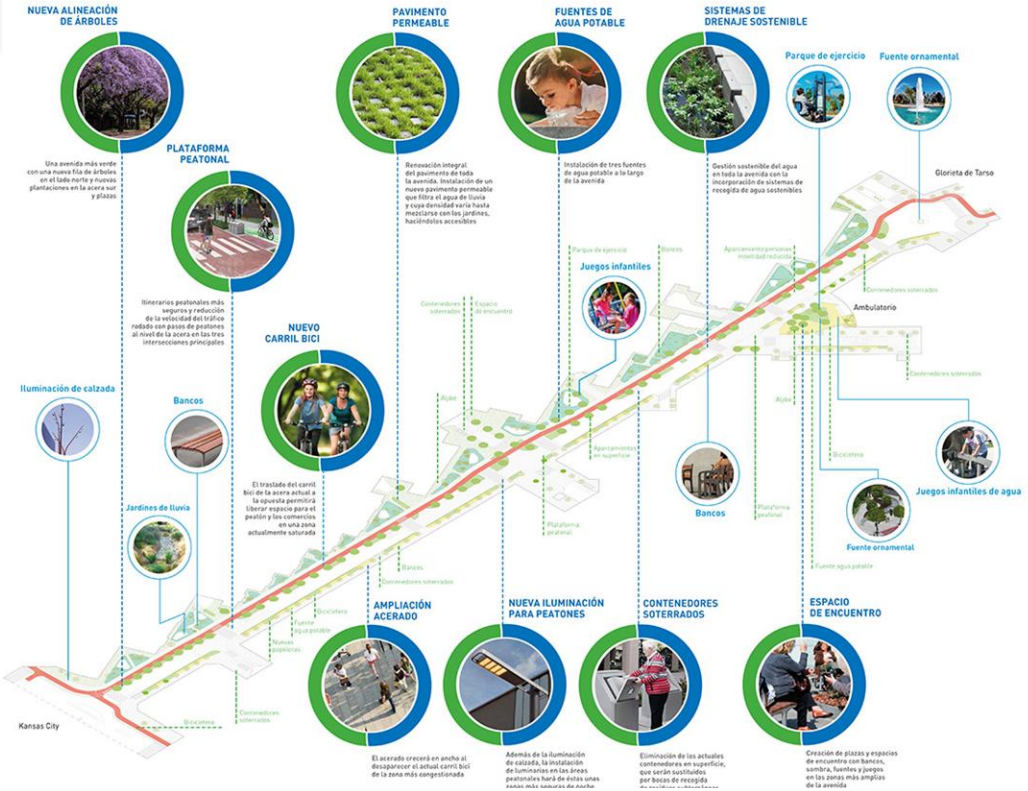
TERRITORIAL SCOPE:

The urban road: Avda. El Greco.

- Area of action: 11.441 m^2
- Urban System within the Urban Water Cycle
- Open spaces (green)
- Public services

CONCEPTUAL SCOPE:

- Isolated" system
- Circular design
- Sustainable technologies



Project to optimise the environmental, urban, health and social parameters within the framework of the integral water cycle in the unique enclave of Avenida del Greco. San Pablo-Santa Justa district. Source EMASESA

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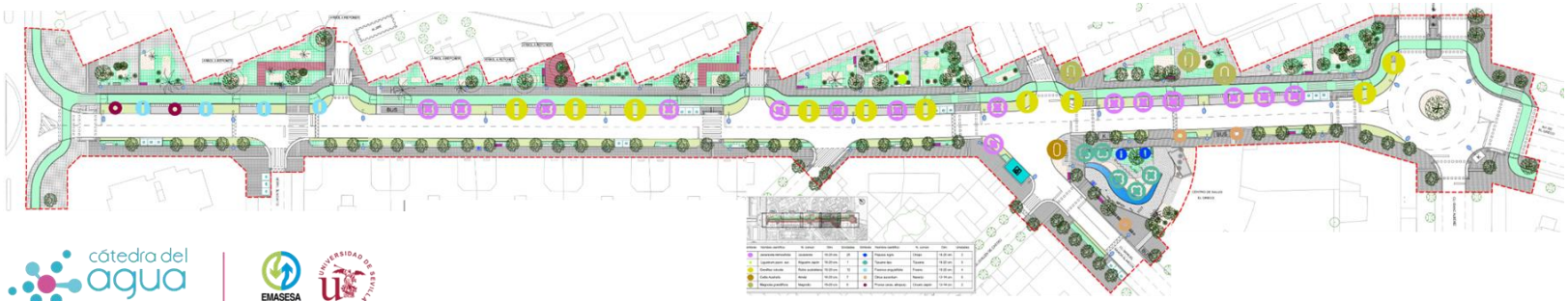
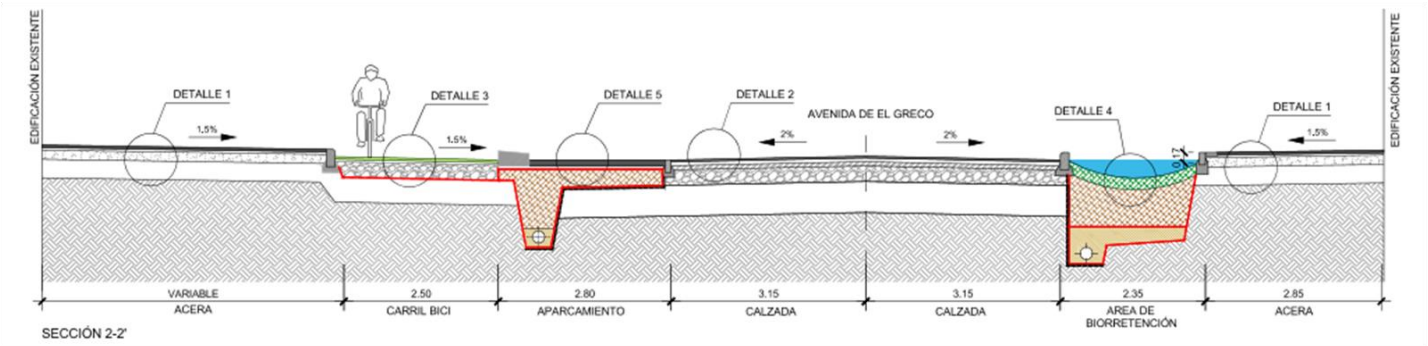
Urbanisation projects in BIM



Planta general del Proyecto



Sección 2-2´sección de la vía

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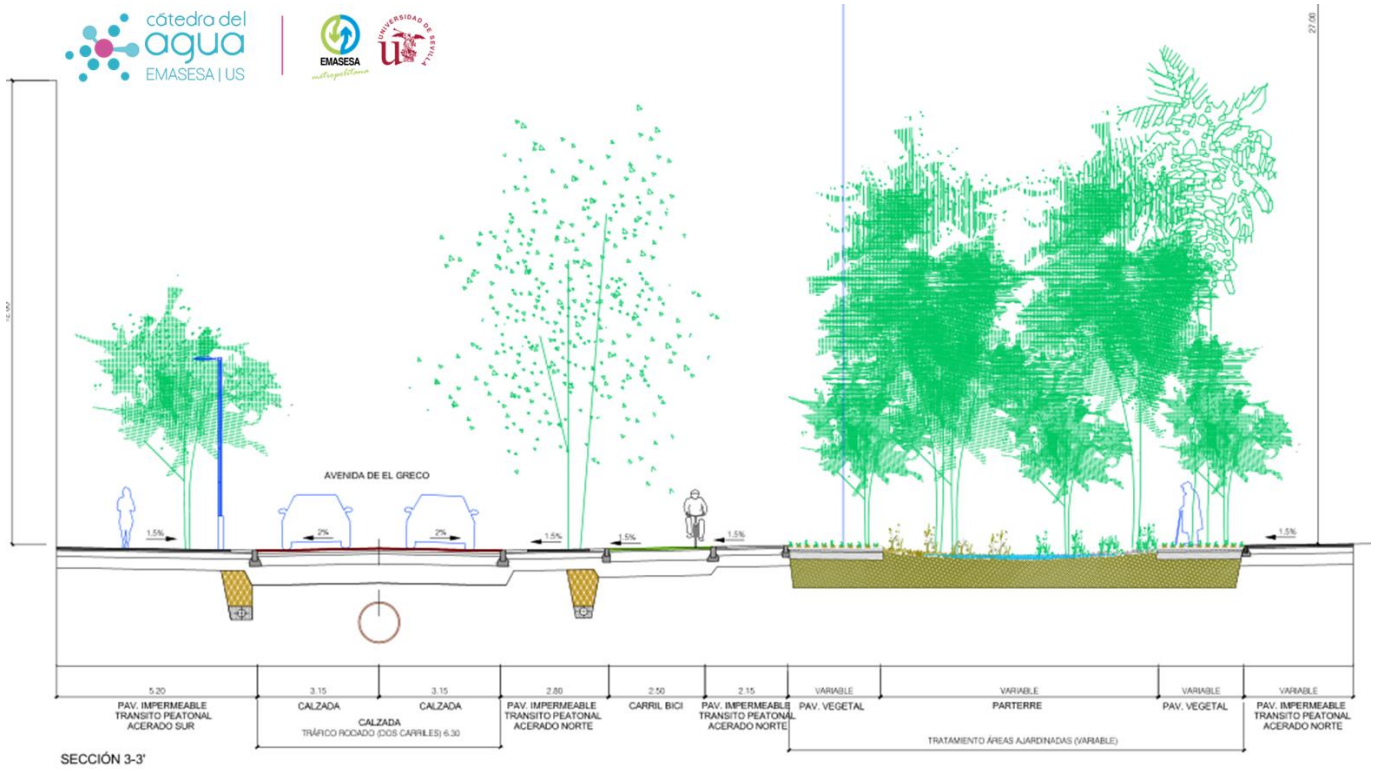
UrbanBIM PLUG-IN

Urbanisation projects in BIM



Sección 3-3´sección de la vía por un jardín de lluvias

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Urbanisation projects in BIM

BUDGET											
Name of chapter/subchapter											
Name of the section											
BCCA CODE										PRICE	AMOUNT
PUC	PUS	*PA*	PB	UNITS	DESCRIPTION				QUANTITY/U REF	PRICE/U REF	AMOUNT
Complex Price Unitary (PUC)				u	Description(PUC)				Quantity (QPUC)	PPUC	IPUC
			Código (PB)	u	MATERIALES				QMAT	PMAT	QMAT*PMAT
			Código (PB)	u	MANO DE OBRA				QMO	PMO	QMO*PMO
			Código (PB)	u	MAQUINARIA				QMAQ	PMAQ	QMAQ*PMAQ
		Auxiliary price code *(PA)*		*u*	**Description PA**			*QPA*		*PPA*	*QPA*PPA*
			Código (PB)	u	MATERIALES			*QMAT*	QMAT*QPA	PMAT	
			Código (PB)	u	MANO DE OBRA			*QMO*	QMO*QPA	PMO	
			Código (PB)	u	MAQUINARIA			*QMAQ*	QMAQ*QPA	PMAQ	
	Código Precio Unitario Simple (PUS)			**u**	**Description PUS**	**QPUS**				**PPUS**	**QPUS*PPUS**
			Código (PB)	u	MATERIALES	**QMAT**			QMAT*QPUS	PMAT	
			Código (PB)	u	MANO DE OBRA	**QMO**			QMO*QPUS	PMO	
			Código (PB)	u	MAQUINARIA	**QMAQ**			QMA*QPUS	PMAQ	
		Auxiliary price code *(PA)*		*u*	**Description PA**			*QPA*		*PPA*	
			Código (PB)	u	MATERIALES			*QMAT*	QMAT*QPA*QPUS	PMAT	
			Código (PB)	u	MANO DE OBRA			*QMO*	QMO*QPA*QPUS	PMO	
			Código (PB)	u	MAQUINARIA			*QMAQ*	QMAQ*QPA*QPUS	PMAQ	

Outline of the structure of budgets adapted to the BCCA according to the Rivero, Muñoz and Marrero Model, 2018.

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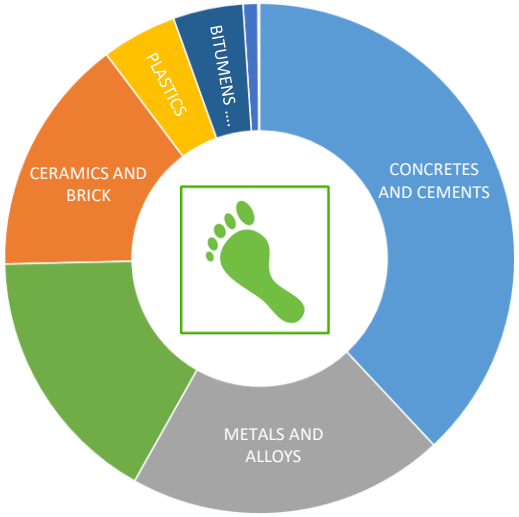
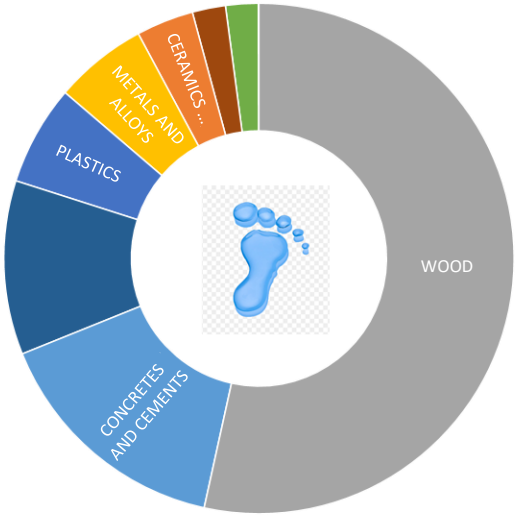
UrbanBIM PLUG-IN

Urbanisation projects in BIM

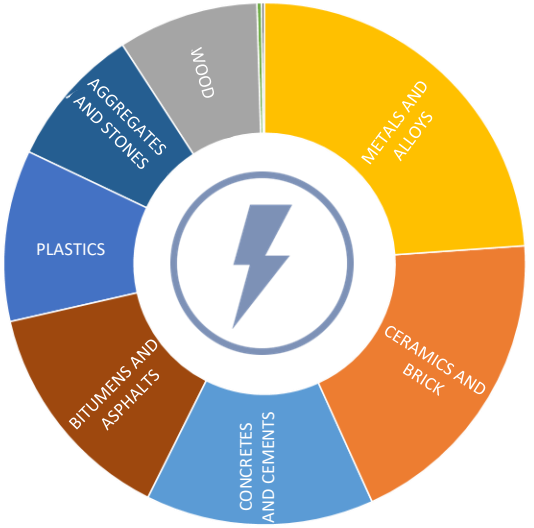
CARBON FOOTPRINT OF MATERIALS
BROKEN DOWN BY FAMILIES (t CO2 eq)



MATERIALS HYDROLOGICAL FOOTPRINT
BREAKDOWN BY FAMILIES (m3)



EMBODIED ENERGY IN MATERIALS
BROKEN DOWN BY FAMILIES (MJ)



Project Environmental Indicators broken down by households

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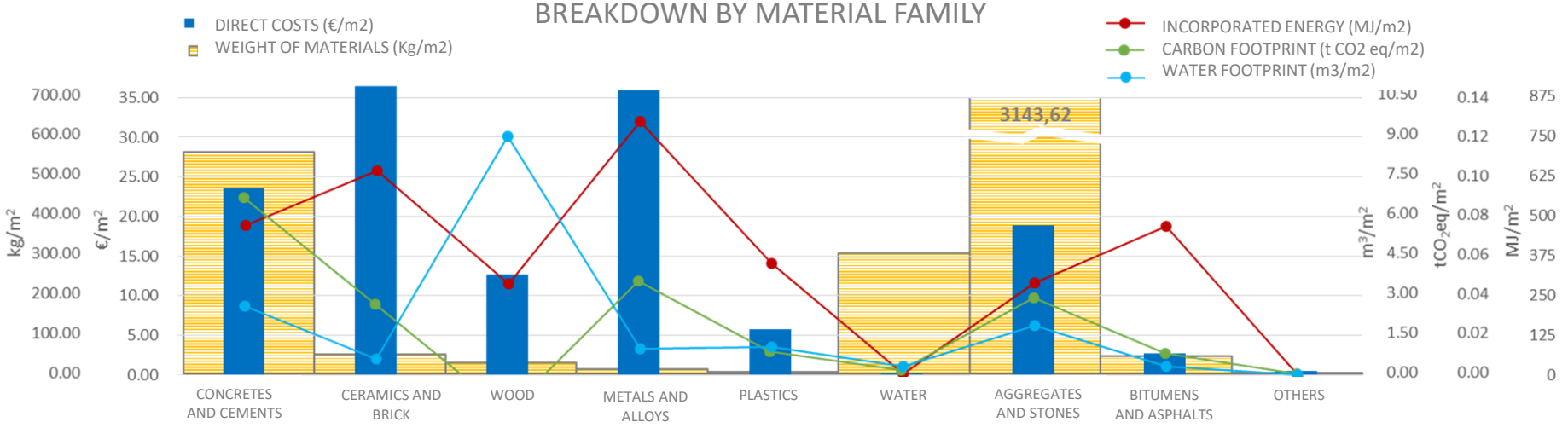
UrbanBIM PLUG-IN

Urbanisation projects in BIM



Breakdown by families of the calculation in unit economic and environmental indicators

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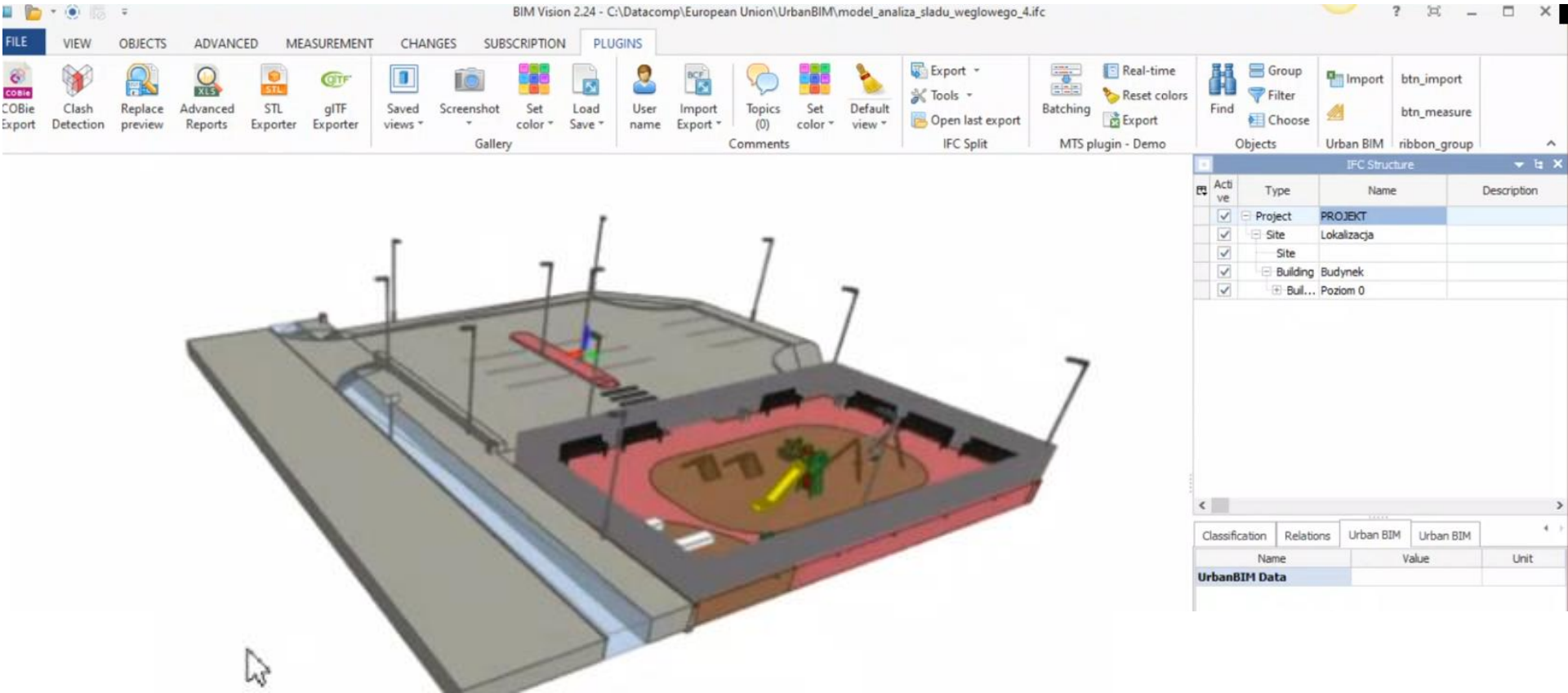
UrbanBIM PLUG-IN

Example of the application of the UrbanBIM plug-in in a BIM model:



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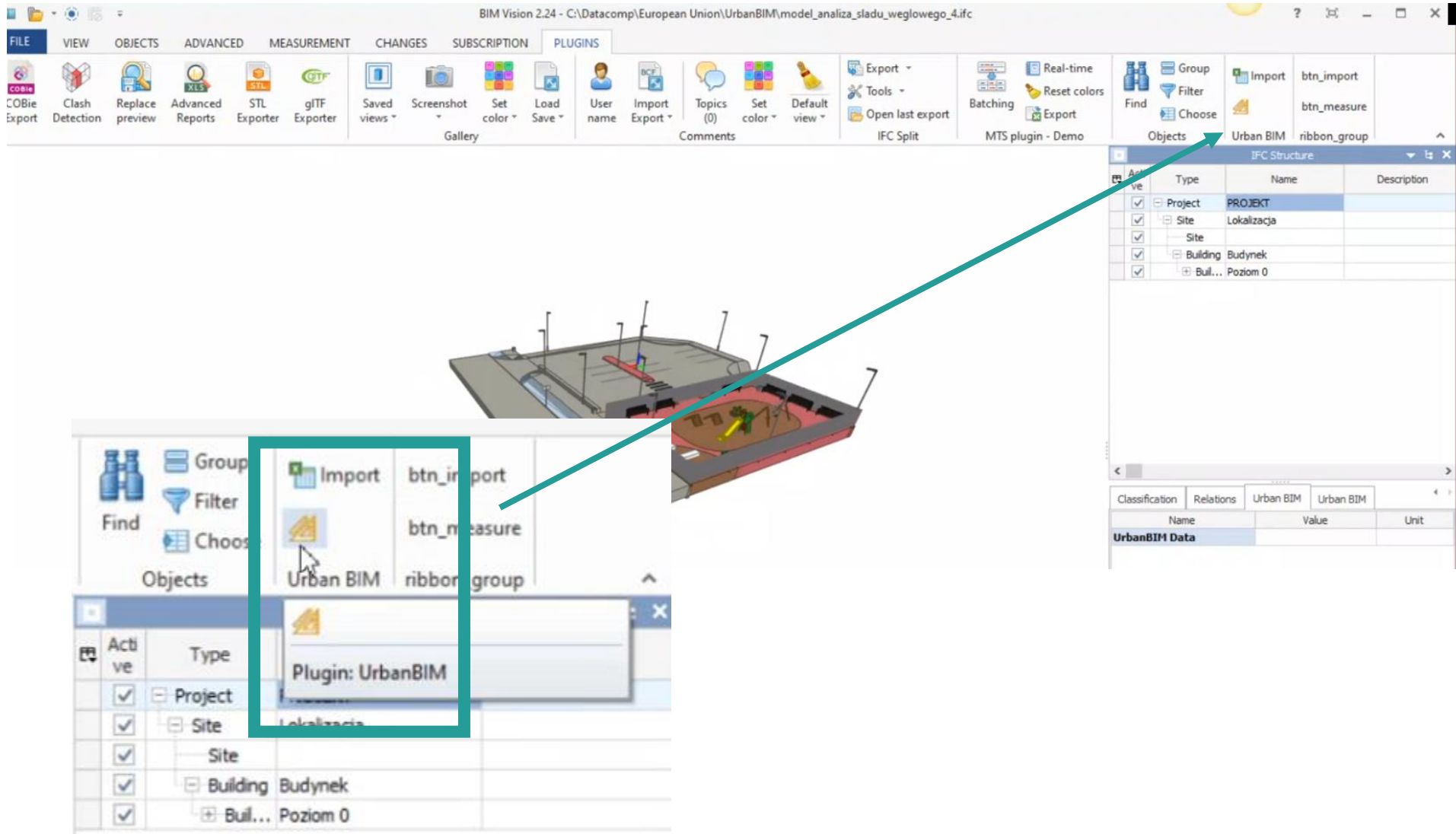
UrbanBIM PLUG-IN



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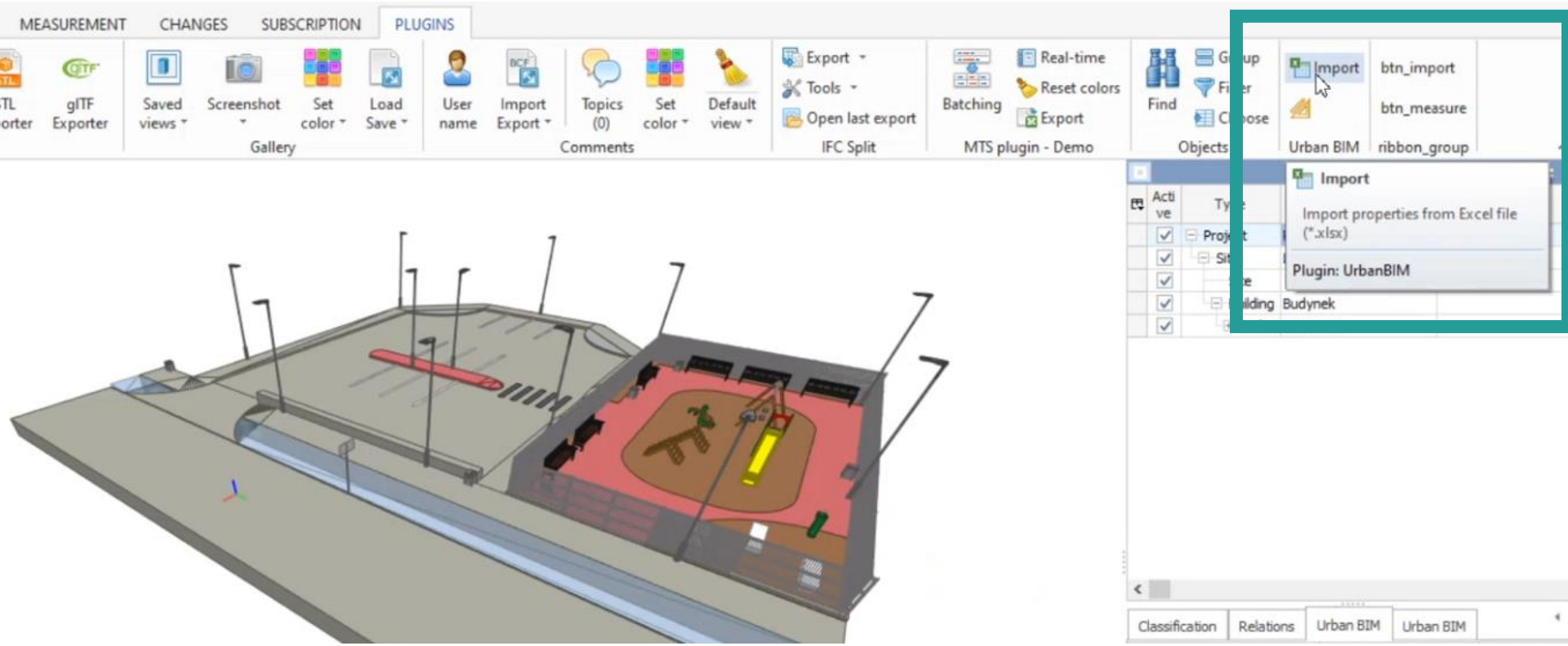
UrbanBIM PLUG-IN

Import of environmental databank developed in the project:



After loading the model into BIM Vision, we can read the external database with the environmental impact values by clicking on the import icon. The database is saved in Excel format

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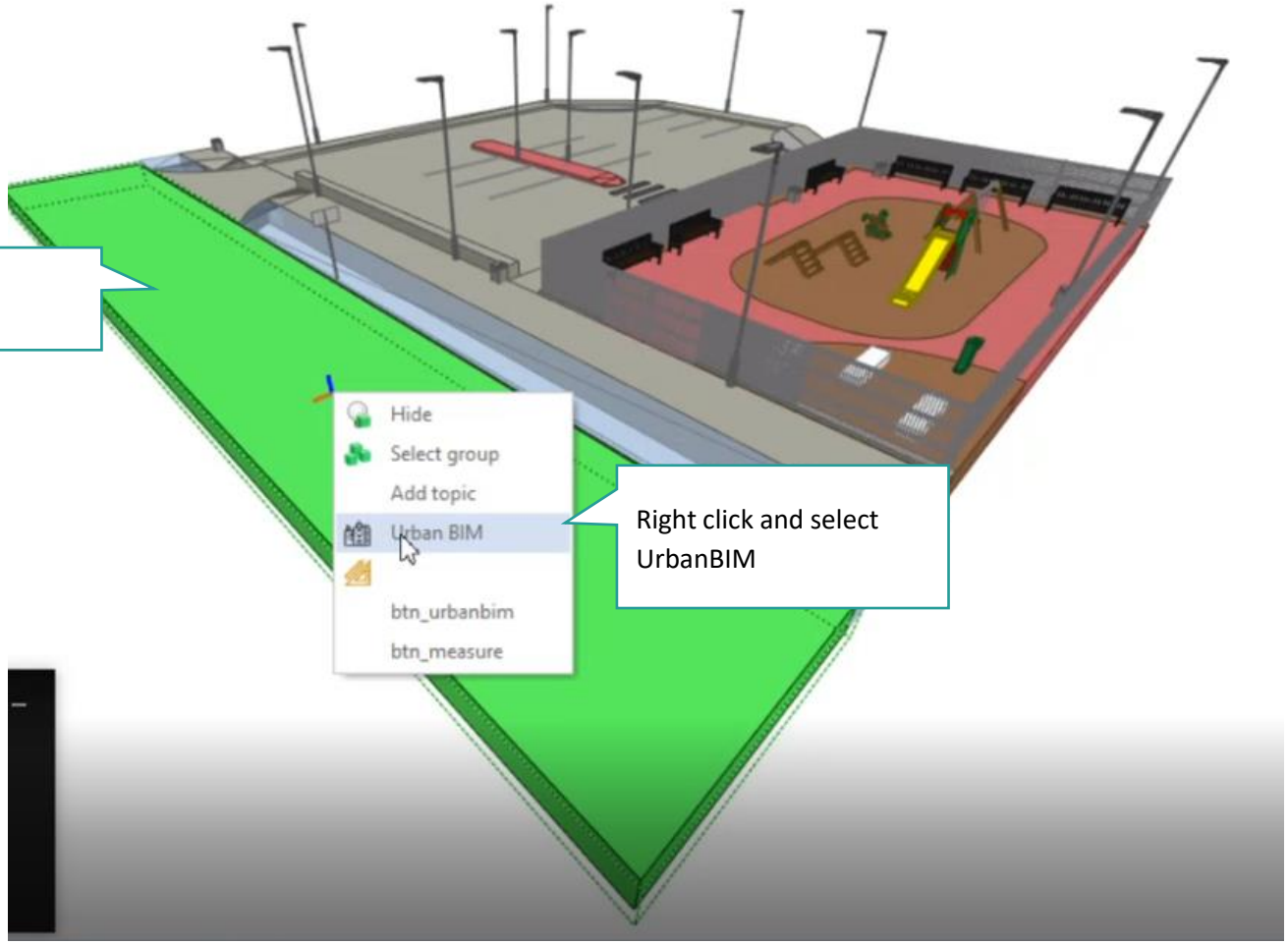
UrbanBIM PLUG-IN

Selection of modelling elements and application of the UrbanBIM plug-in:



Application of the plug-in to each building element individually to determine the impacts of each element.

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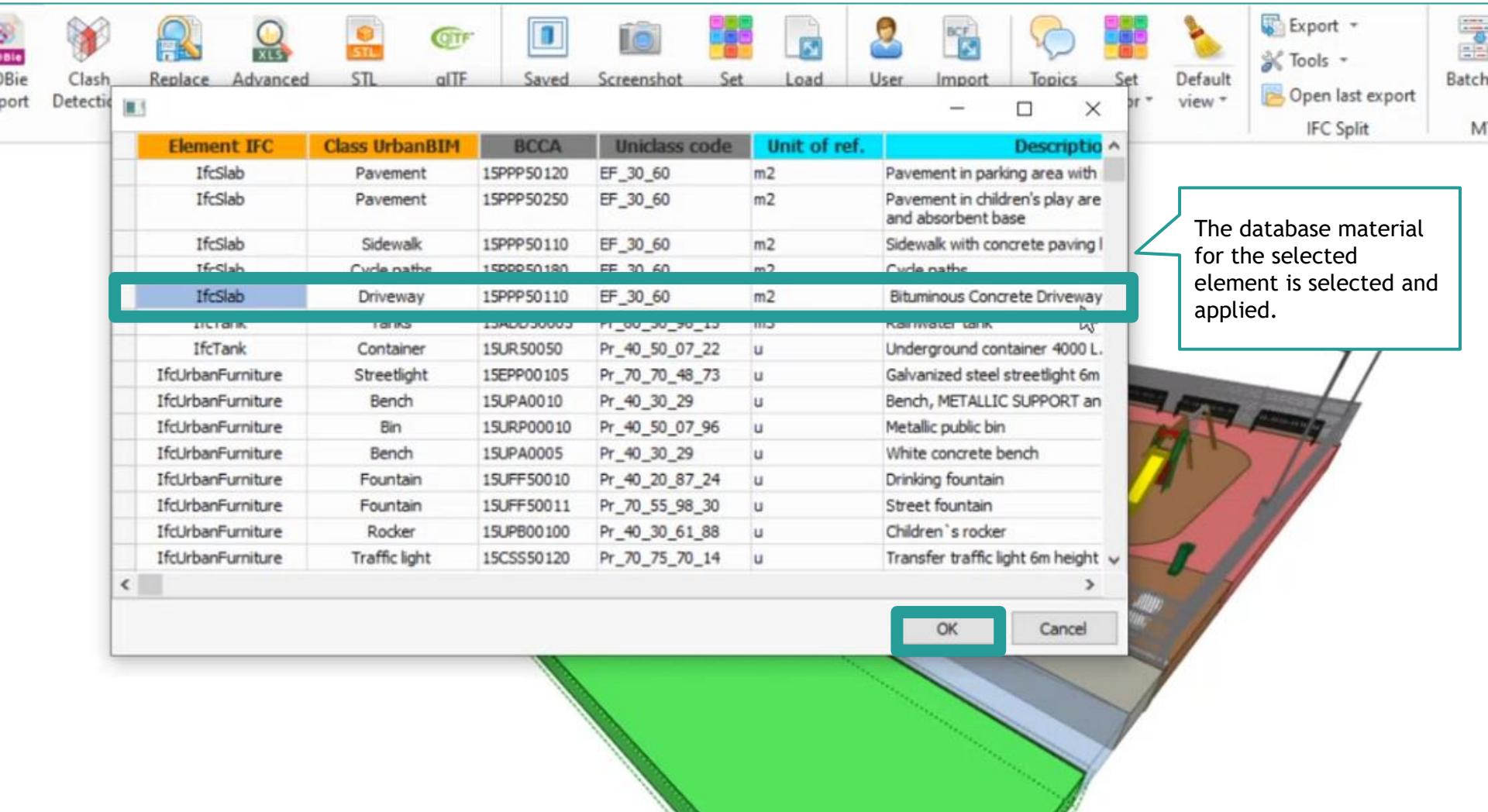
UrbanBIM PLUG-IN

Selection of the material of the modelling element:



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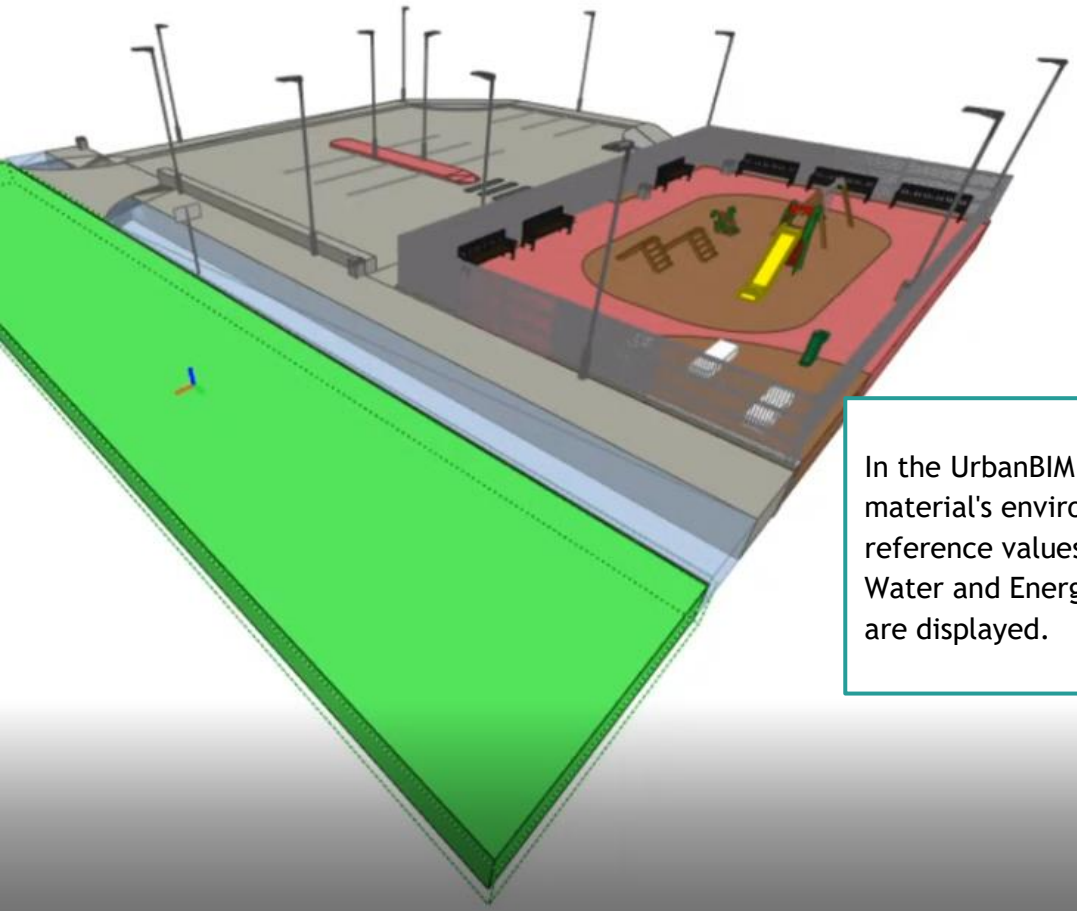
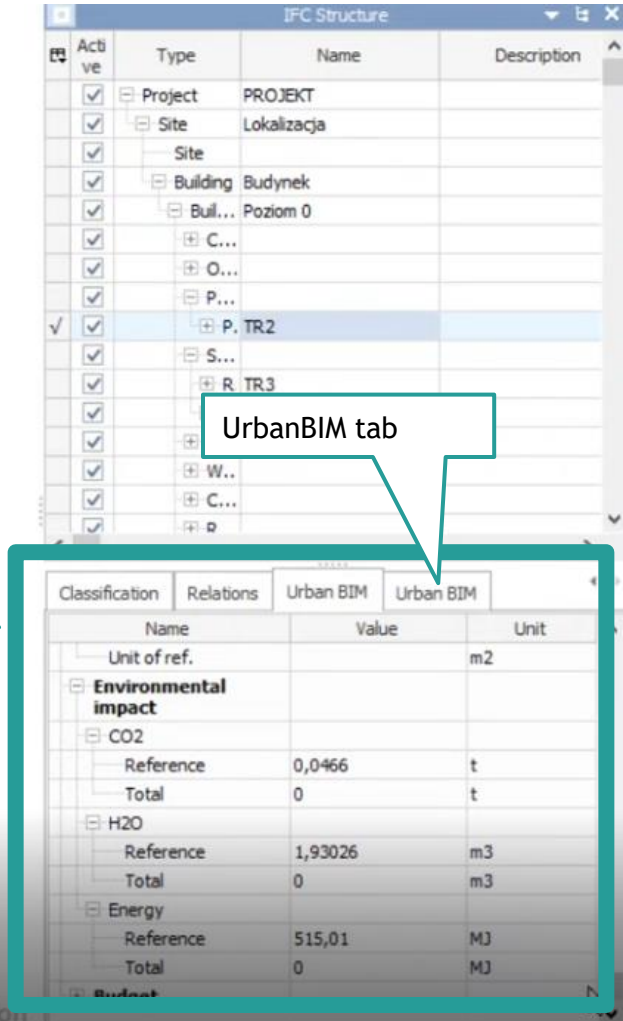
UrbanBIM PLUG-IN

After material selection, the software outputs the environmental impact results:



In the UrbanBIM tab, the material's environmental reference values for CO2, Water and Energy per m2 are displayed.



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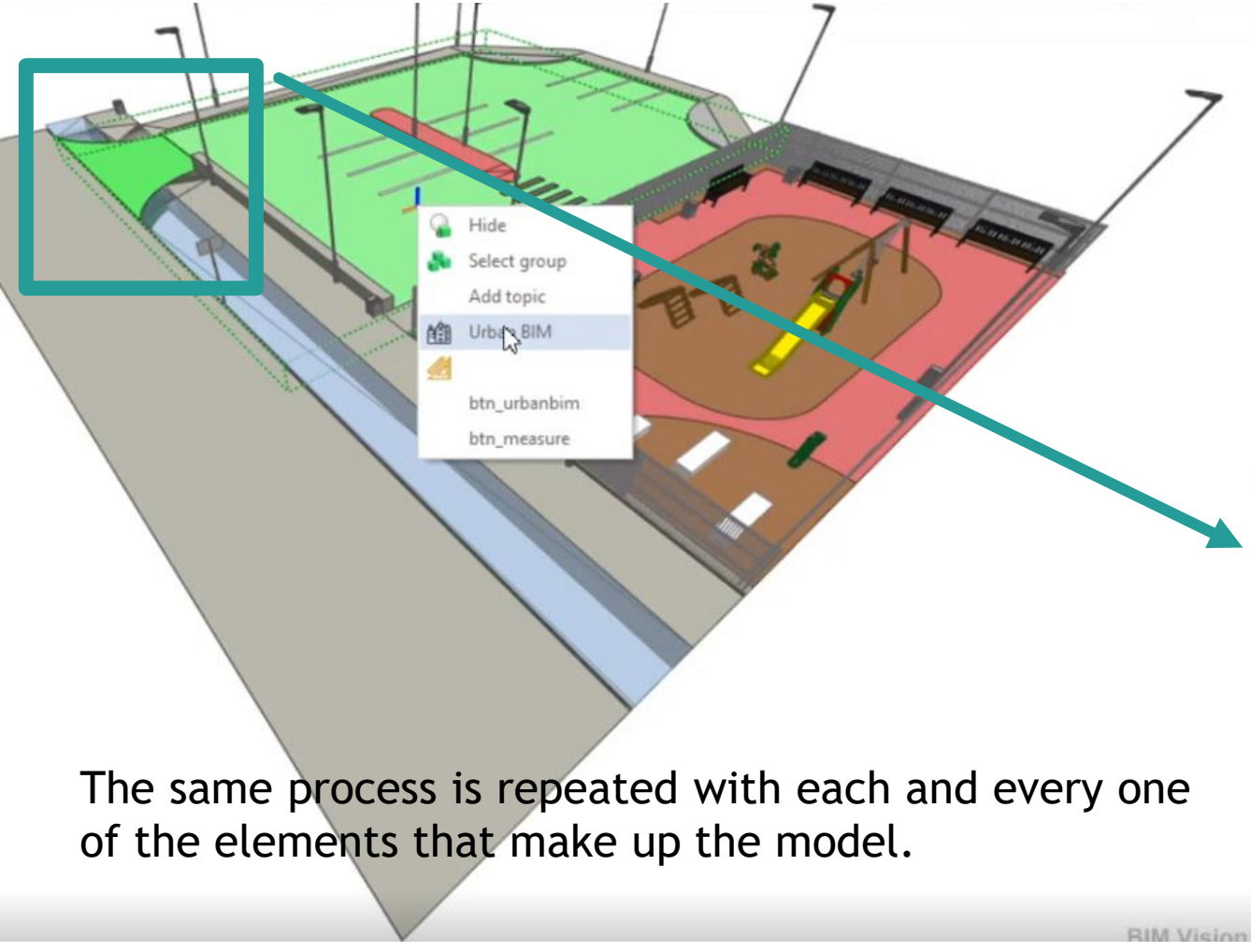
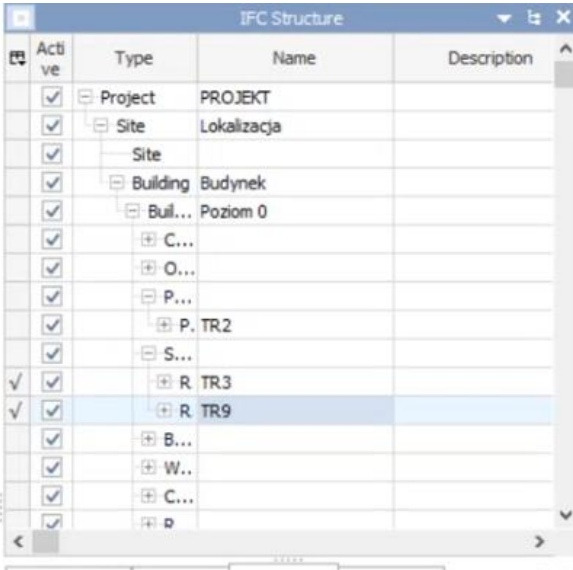
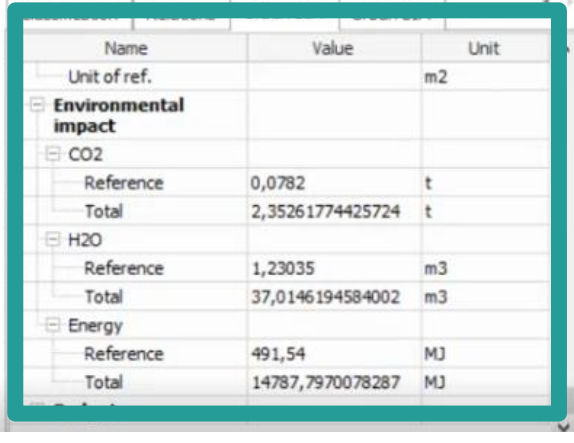
UrbanBIM PLUG-IN

Selection of the different materials for each construction element:







The same process is repeated with each and every one of the elements that make up the model.

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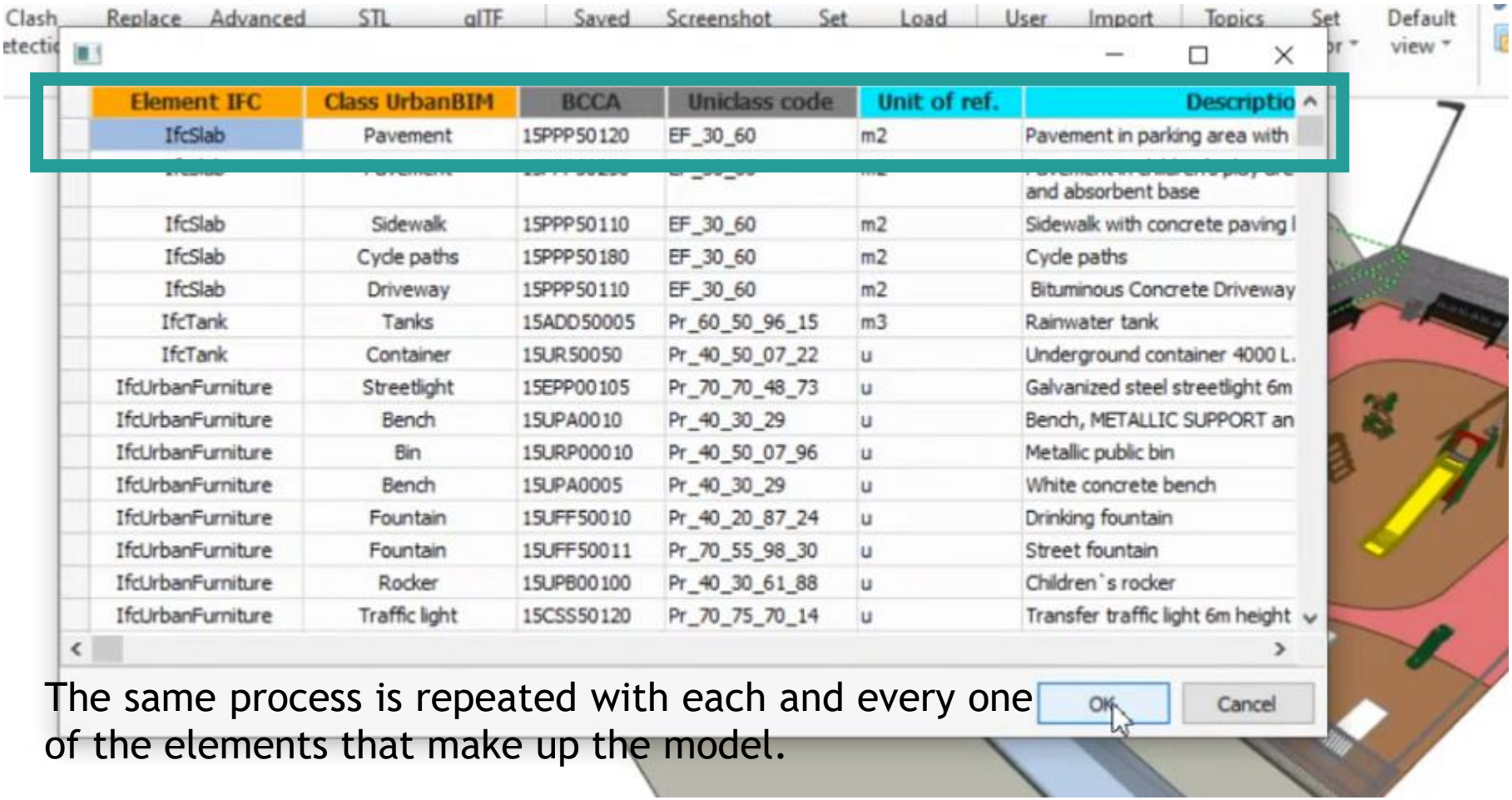
UrbanBIM PLUG-IN

Selection of the different materials for each construction element:



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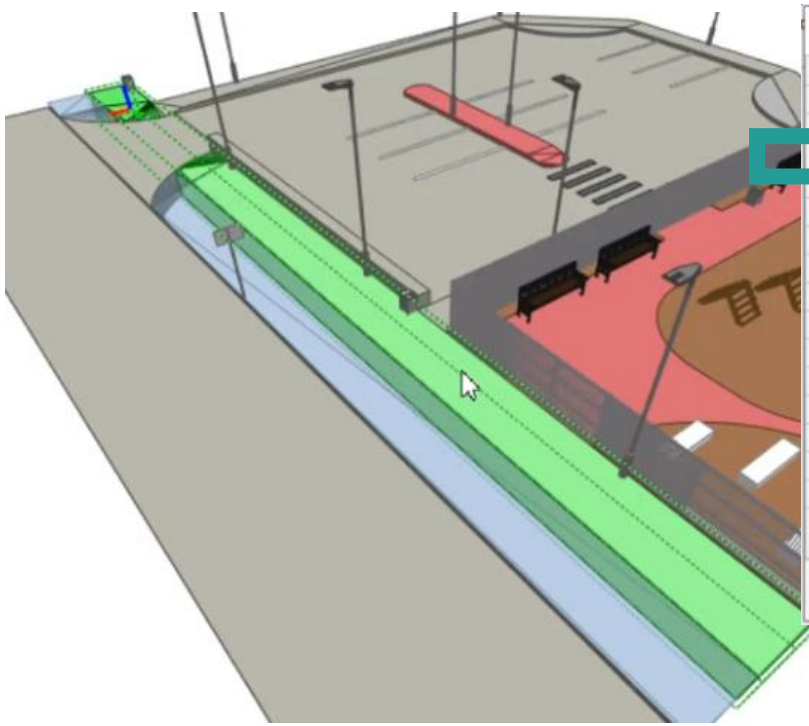
UrbanBIM PLUG-IN

Selection of the different materials for each construction element:



Element IFC	Class UrbanBIM	BCCA	Uniclass code	Unit of ref.	Descript
IfcSlab	Pavement	15PPP50120	EF_30_60	m2	Pavement in parking area wi
IfcSlab	Sidewalk	15PPP50110	EF_30_60	m2	Sidewalk with concrete pavin
IfcSlab	Driveway	15PPP50110	EF_30_60	m2	Bituminous Concrete Drivew
IfcTank	Tanks	15ADD50005	Pr_60_50_96_15	m3	Rainwater tank
IfcTank	Container	15UR50050	Pr_40_50_07_22	u	Underground container 4000
IfcUrbanFurniture	Streetlight	15EPP00105	Pr_70_70_48_73	u	Galvanized steel streetlight 6
IfcUrbanFurniture	Bench	15UPA0010	Pr_40_30_29	u	Bench, METALLIC SUPPORT
IfcUrbanFurniture	Bin	15URP00010	Pr_40_50_07_96	u	Metallic public bin
IfcUrbanFurniture	Bench	15UPA0005	Pr_40_30_29	u	White concrete bench
IfcUrbanFurniture	Fountain	15UFF50010	Pr_40_20_87_24	u	Drinking fountain
IfcUrbanFurniture	Fountain	15UFF50011	Pr_70_55_98_30	u	Street fountain
IfcUrbanFurniture	Rocker	15UPB00100	Pr_40_30_61_88	u	Children`s rocker
IfcUrbanFurniture	Traffic light	15CSS50120	Pr_70_75_70_14	u	Transfer traffic light 6m heig
IfcUrbanFurniture	Sign	15CRR10102	Pr 70 75 72 30	u	Vertical traffic sign

OK Cance

Classification | Relations | Urban BIM | Urban BIM

Name	Value	Unit
Unicode	EF_30_60	
Description	Sidewalk with concrete paving blocks	
Unit of ref.		m2
Environmental impact		
CO2		
Reference	0,0813	t
Total	0	t
H2O		
Reference	1,29024	m3
Total	0	m3
Energy		

The same process is repeated with each and every one of the elements that make up the model.

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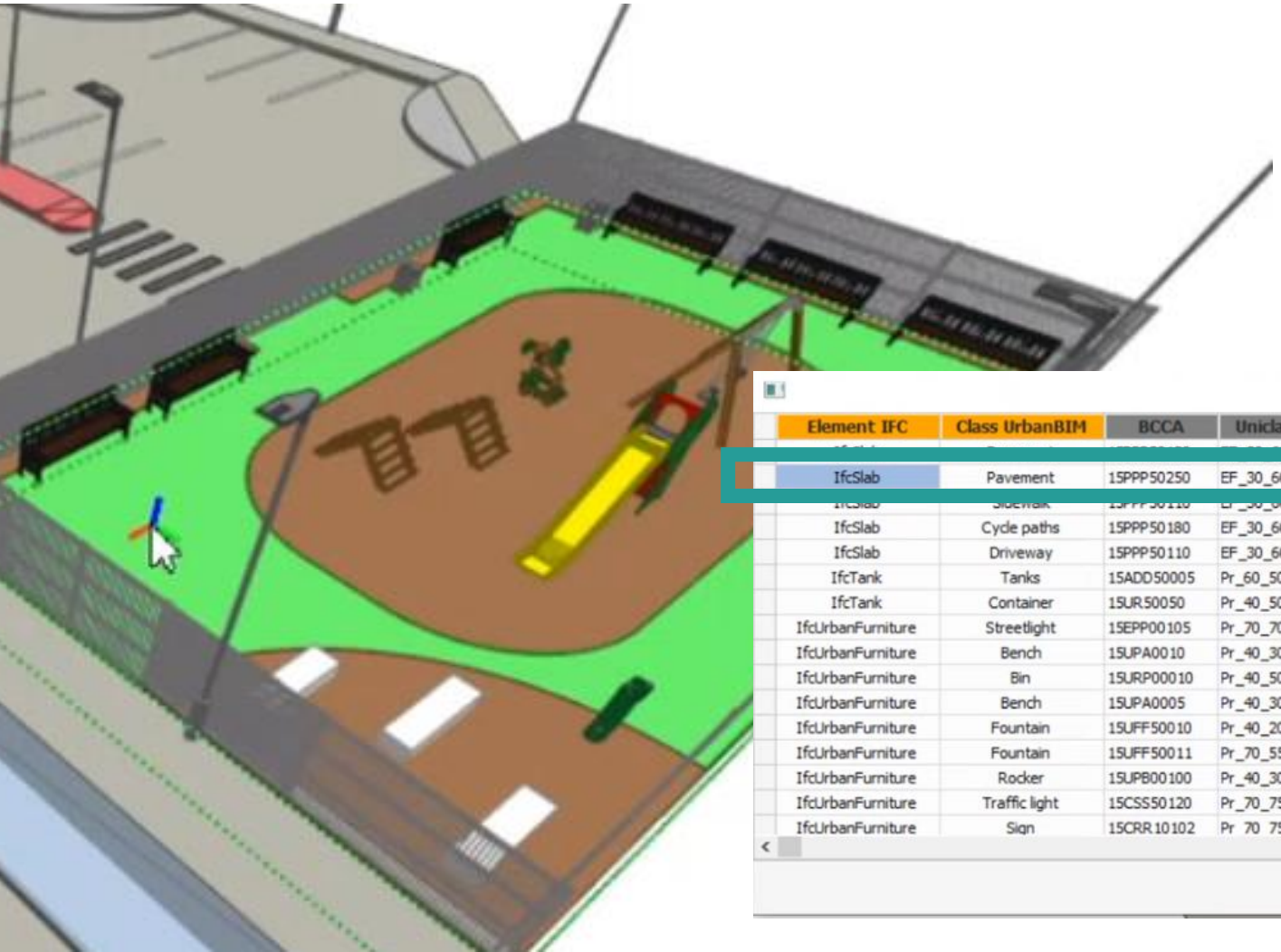
UrbanBIM PLUG-IN

Selection of the different materials for each construction element:



The same process is repeated with each and every one of the elements that make up the model.

Element IFC	Class UrbanBIM	BCCA	Uniclass code	Unit of ref.	Descriptio
IfcSlab	Pavement	15PPP50250	EF_30_60	m2	Pavement in children's play are
IfcSlab	Cycle paths	15PPP50180	EF_30_60	m2	Cycle paths
IfcSlab	Driveway	15PPP50110	EF_30_60	m2	Bituminous Concrete Driveway
IfcTank	Tanks	15ADD50005	Pr_60_50_96_15	m3	Rainwater tank
IfcTank	Container	15UR50050	Pr_40_50_07_22	u	Underground container 4000 L.
IfcUrbanFurniture	Streetlight	15EPP00105	Pr_70_70_48_73	u	Galvanized steel streetlight 6m
IfcUrbanFurniture	Bench	15UPA0010	Pr_40_30_29	u	Bench, METALLIC SUPPORT an
IfcUrbanFurniture	Bin	15URP00010	Pr_40_50_07_96	u	Metallic public bin
IfcUrbanFurniture	Bench	15UPA0005	Pr_40_30_29	u	White concrete bench
IfcUrbanFurniture	Fountain	15UFF50010	Pr_40_20_87_24	u	Drinking fountain
IfcUrbanFurniture	Fountain	15UFF50011	Pr_70_55_98_30	u	Street fountain
IfcUrbanFurniture	Rocker	15UPB00100	Pr_40_30_61_88	u	Children`s rocker
IfcUrbanFurniture	Traffic light	15CSS50120	Pr_70_75_70_14	u	Transfer traffic light 6m height
IfcUrbanFurniture	Sign	15CRR10102	Pr_70_75_72_30	u	Vertical traffic sign

OK Cancel

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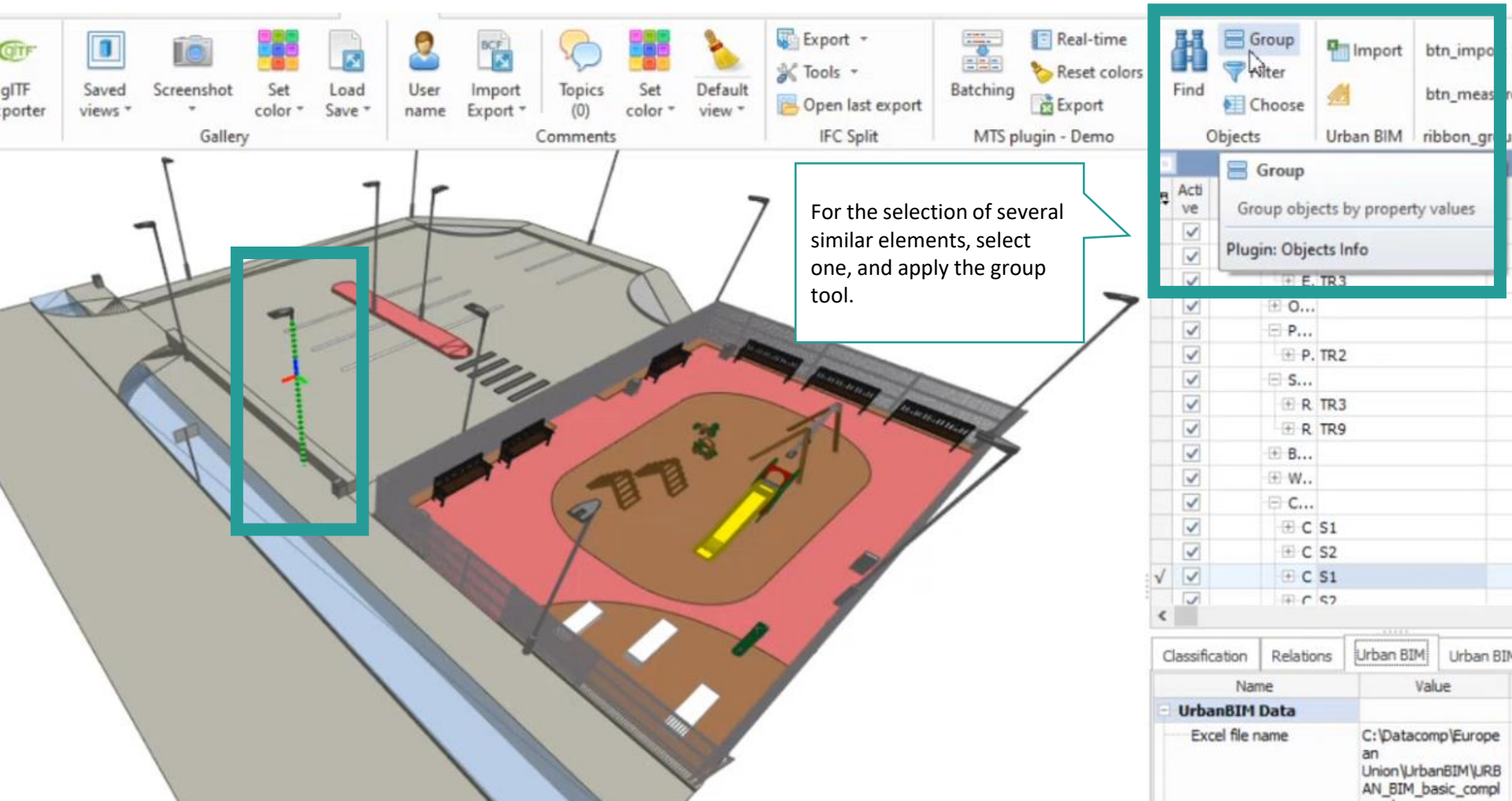
UrbanBIM PLUG-IN

Selection of the different materials for each construction element:



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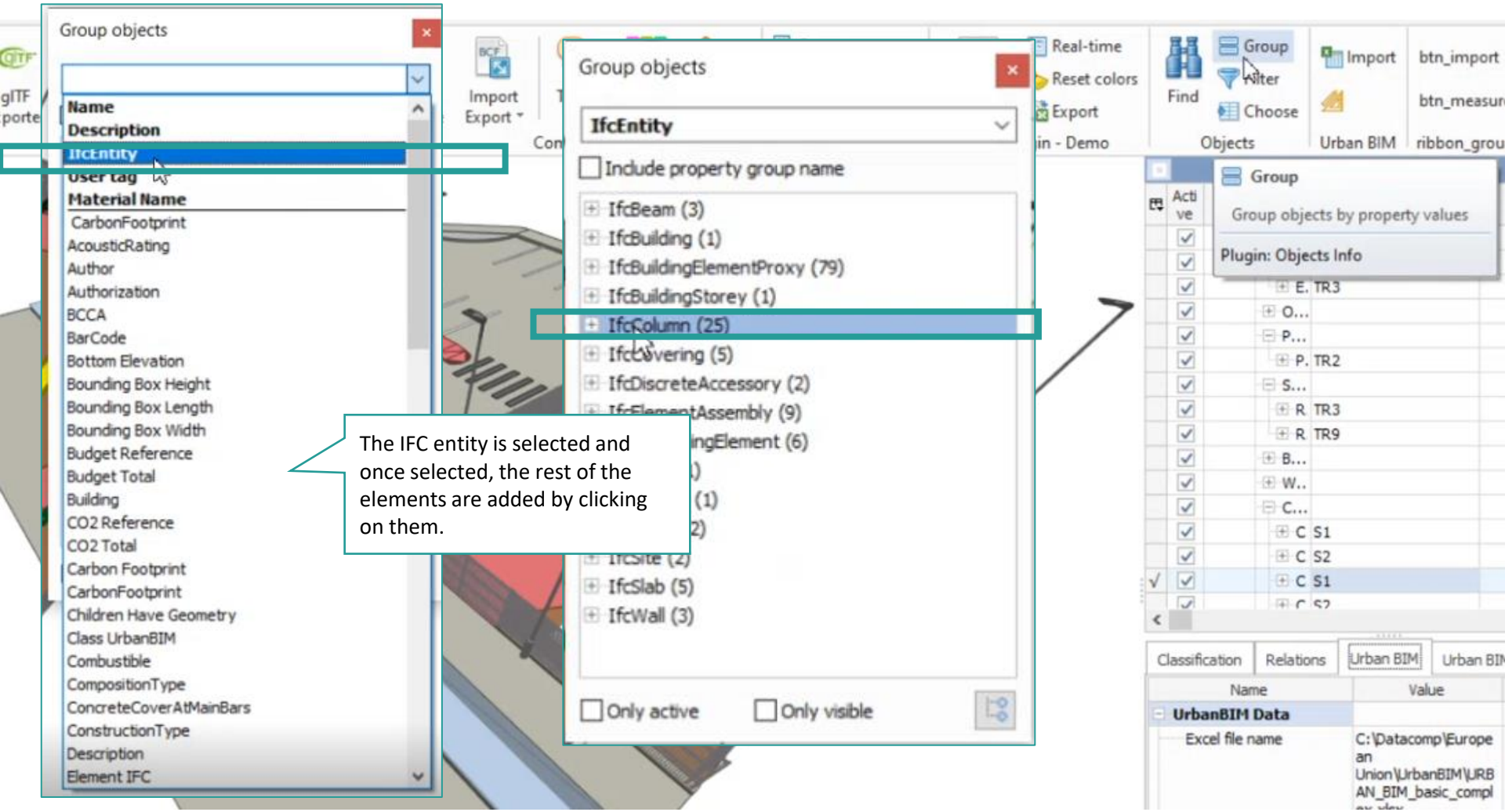
UrbanBIM PLUG-IN

Selection of the different materials for each construction element:



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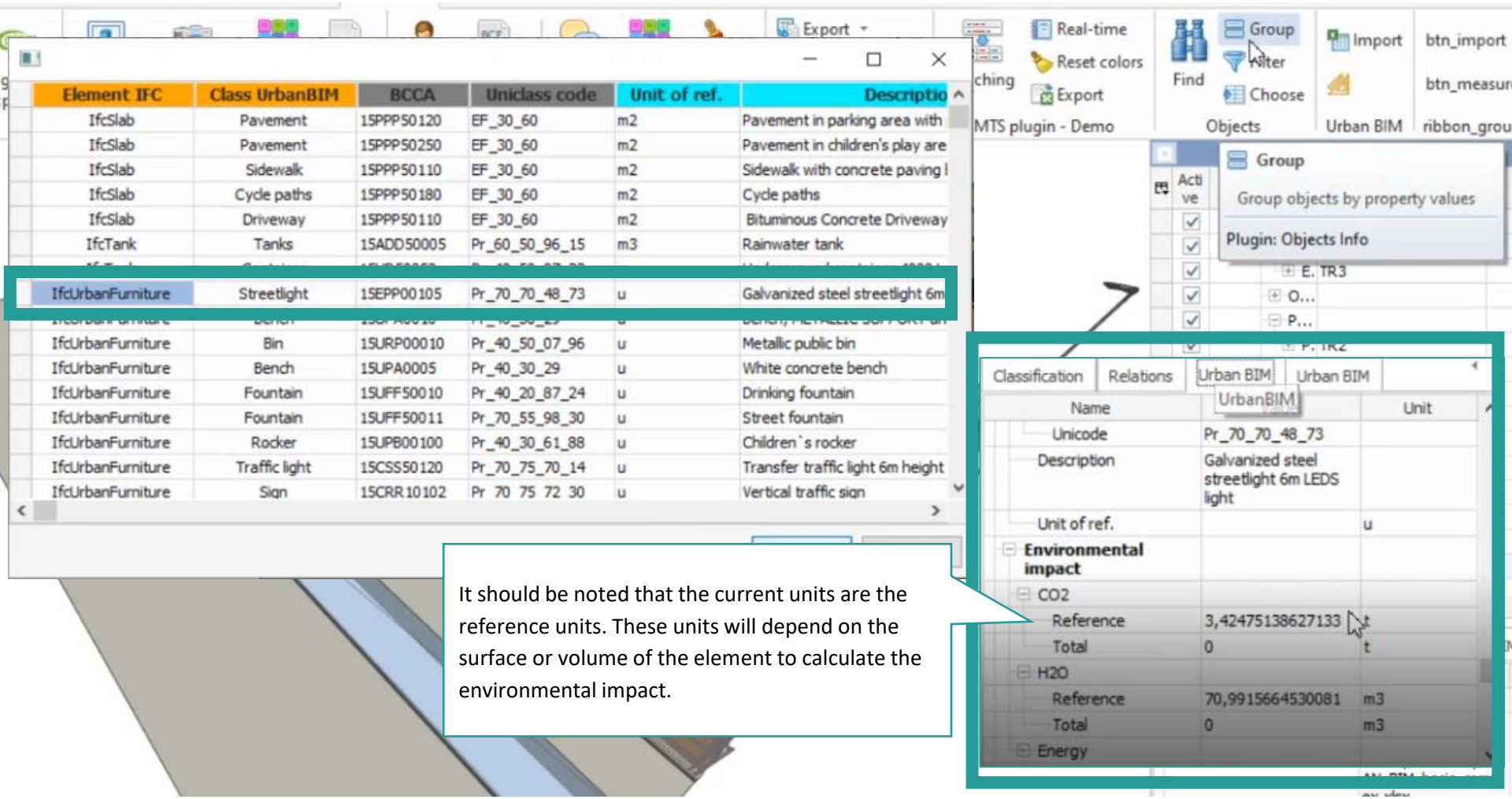
UrbanBIM PLUG-IN

Selection of the different materials for each construction element:



Element IFC	Class UrbanBIM	BCCA	Uniclass code	Unit of ref.	Descriptio
IfcSlab	Pavement	15PPP50120	EF_30_60	m2	Pavement in parking area with
IfcSlab	Pavement	15PPP50250	EF_30_60	m2	Pavement in children's play are
IfcSlab	Sidewalk	15PPP50110	EF_30_60	m2	Sidewalk with concrete paving
IfcSlab	Cycle paths	15PPP50180	EF_30_60	m2	Cycle paths
IfcSlab	Driveway	15PPP50110	EF_30_60	m2	Bituminous Concrete Driveway
IfcTank	Tanks	15ADD50005	Pr_60_50_96_15	m3	Rainwater tank
IfcUrbanFurniture	Streetlight	15EPP00105	Pr_70_70_48_73	u	Galvanized steel streetlight 6m
IfcUrbanFurniture	Bin	15URP00010	Pr_40_50_07_96	u	Metallic public bin
IfcUrbanFurniture	Bench	15UPA0005	Pr_40_30_29	u	White concrete bench
IfcUrbanFurniture	Fountain	15UFF50010	Pr_40_20_87_24	u	Drinking fountain
IfcUrbanFurniture	Fountain	15UFF50011	Pr_70_55_98_30	u	Street fountain
IfcUrbanFurniture	Rocker	15UPB00100	Pr_40_30_61_88	u	Children`s rocker
IfcUrbanFurniture	Traffic light	15CSS50120	Pr_70_75_70_14	u	Transfer traffic light 6m height
IfcUrbanFurniture	Sign	15CRR10102	Pr_70_75_72_30	u	Vertical traffic sign

It should be noted that the current units are the reference units. These units will depend on the surface or volume of the element to calculate the environmental impact.

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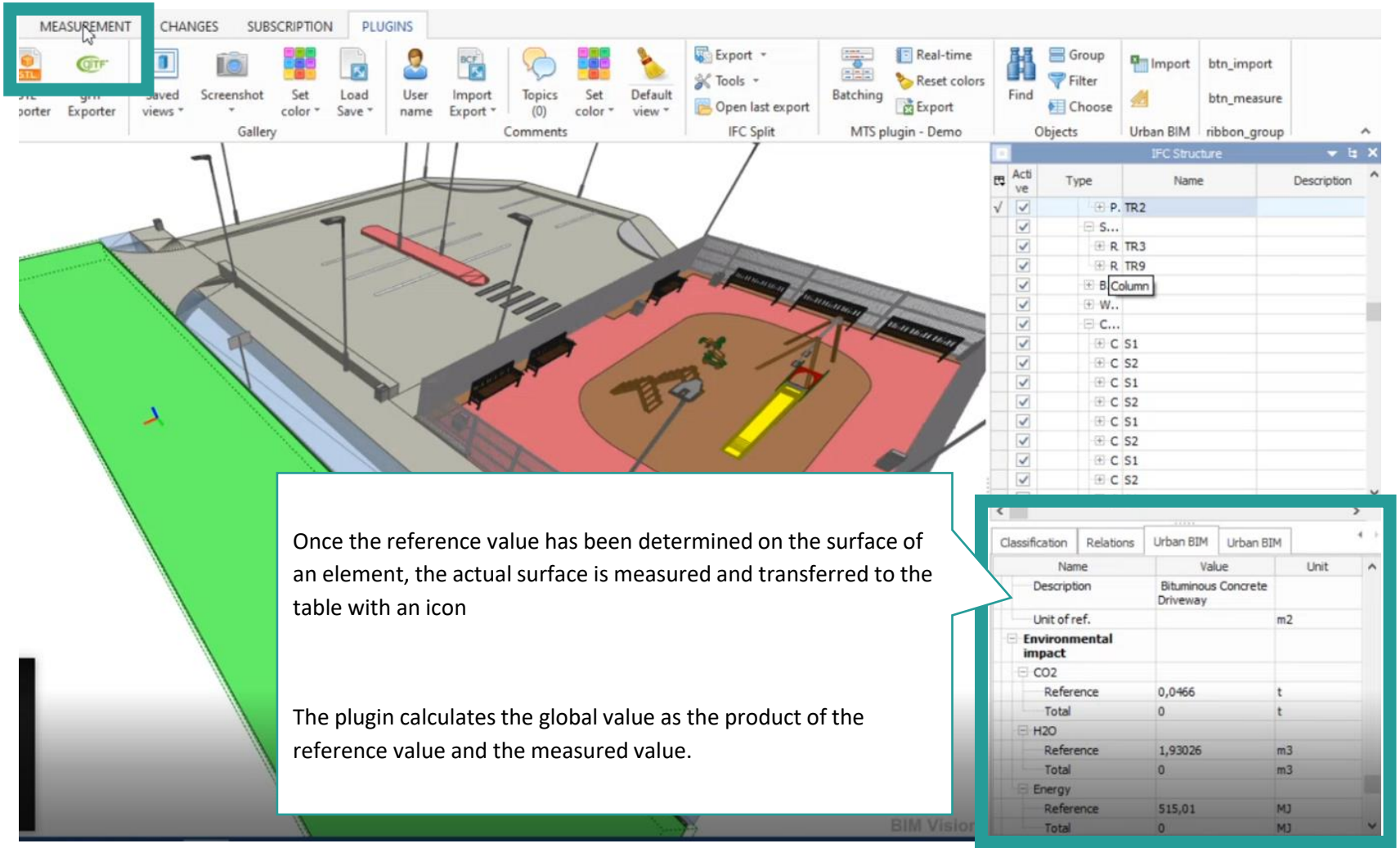
UrbanBIM PLUG-IN

Application of measurements to quantify impact:



Once the reference value has been determined on the surface of an element, the actual surface is measured and transferred to the table with an icon

The plugin calculates the global value as the product of the reference value and the measured value.

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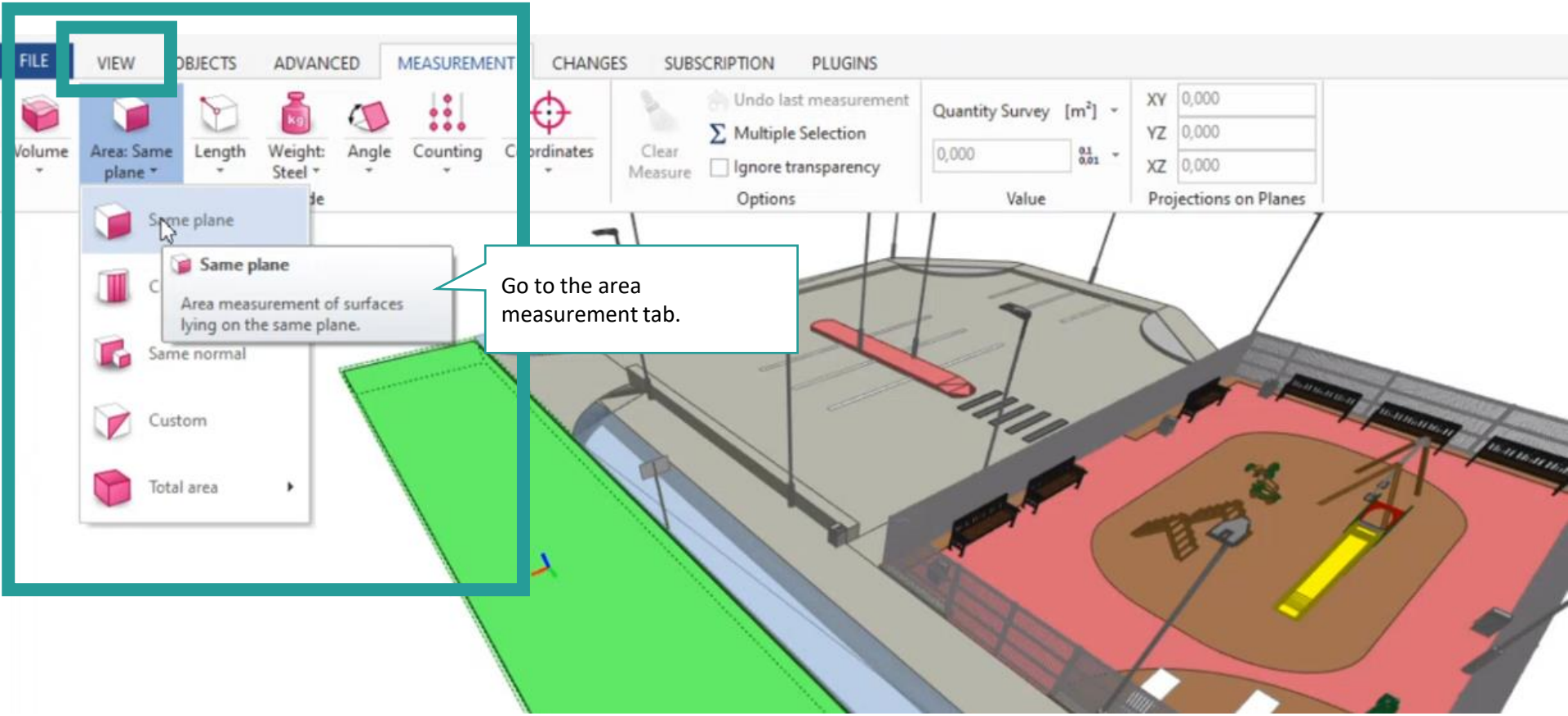
UrbanBIM PLUG-IN

Application of measurements to quantify impact:



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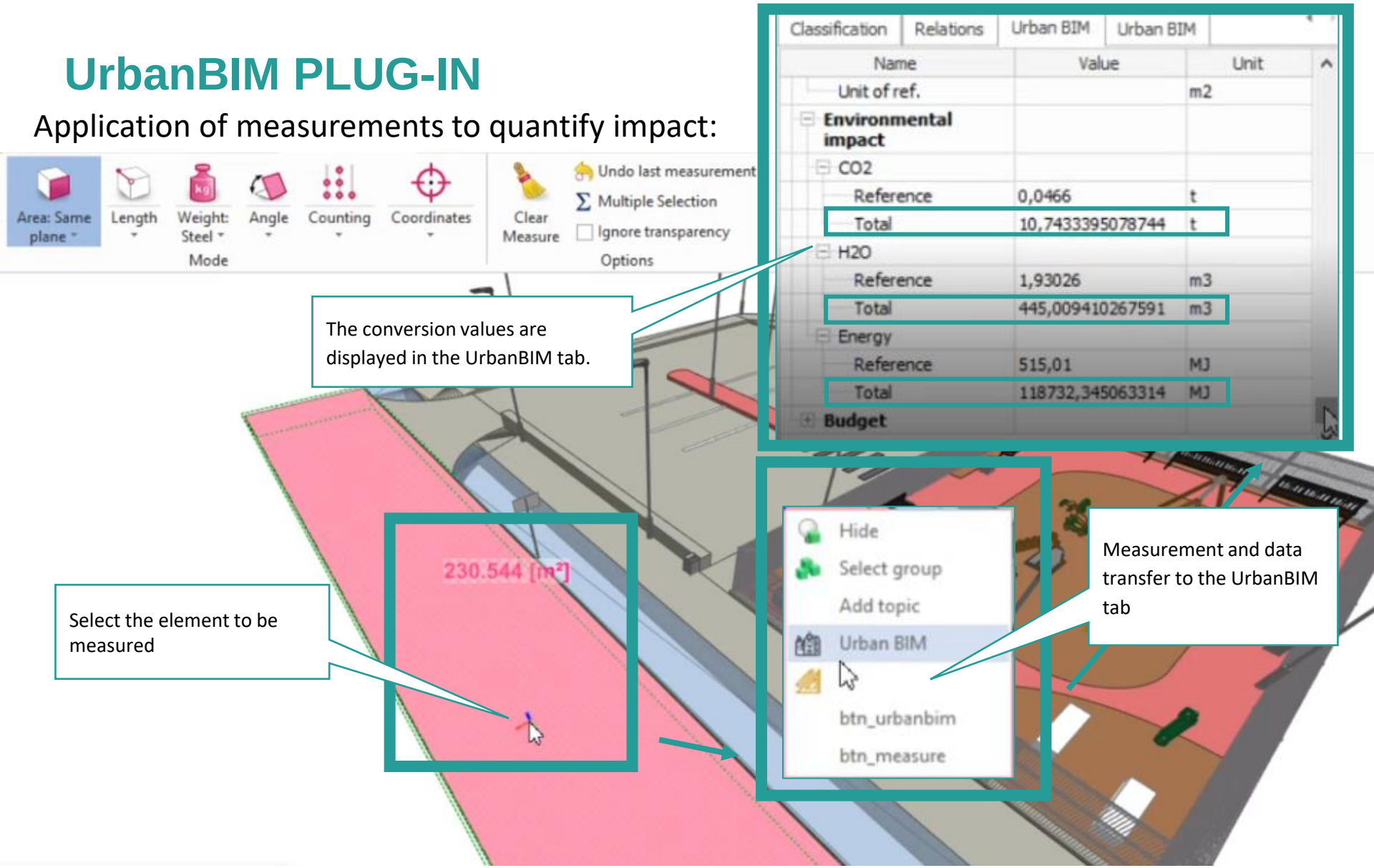
UrbanBIM PLUG-IN

Application of measurements to quantify impact:



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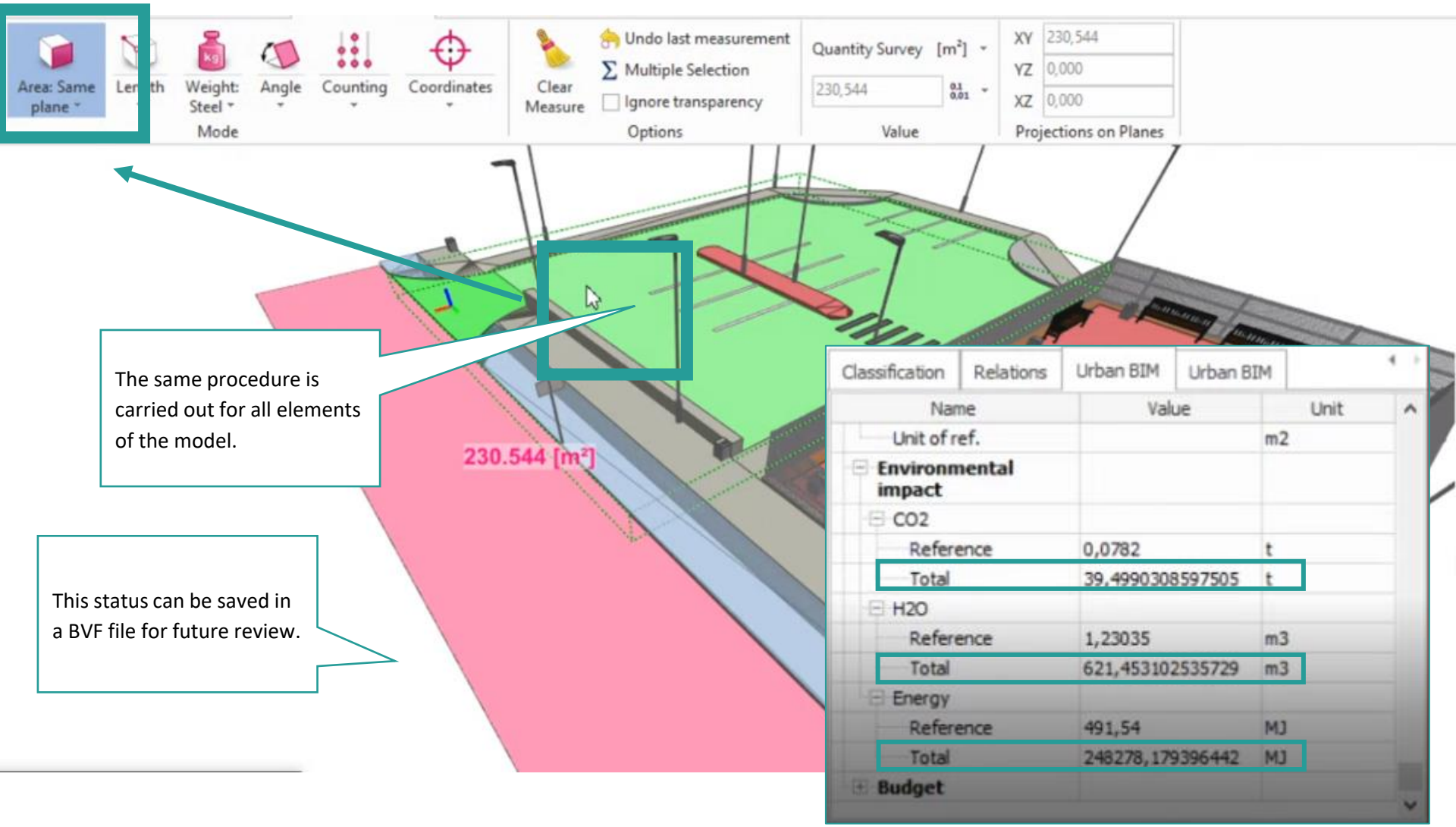

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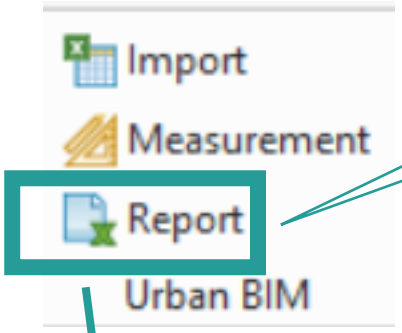
Consultation of impact data:

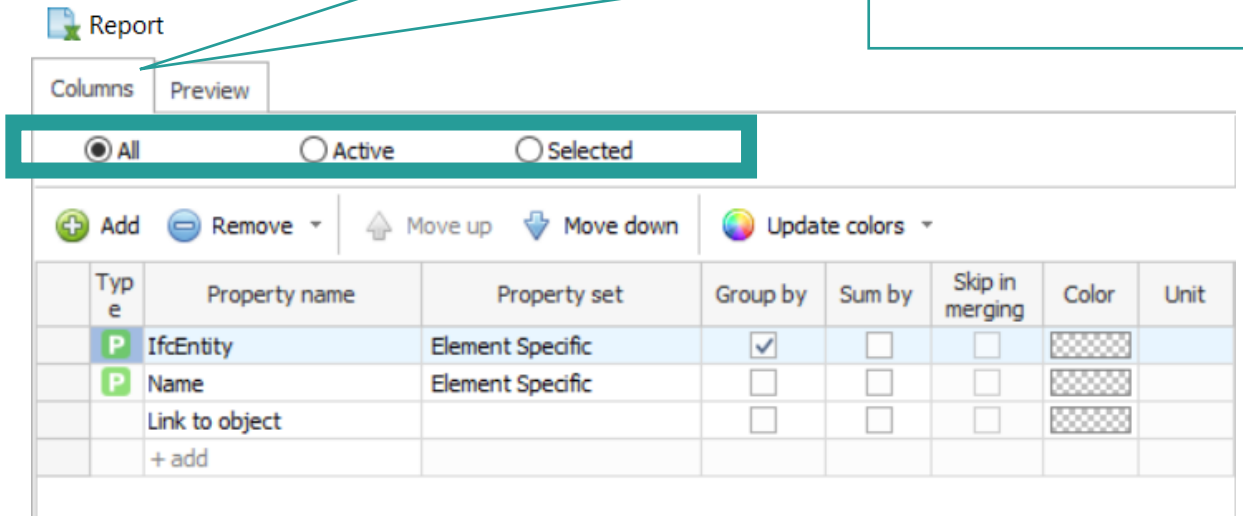


Access the Report module

In the Columns tab, we select the objects of the BIM model, which will be considered in the report.

We have three options:

- **All** - all objects in the model are selected.
- **Active** - only those objects that are labelled Active are selected.
- **Selected** - only selected objects are selected (in BIMvision they are highlighted in green).



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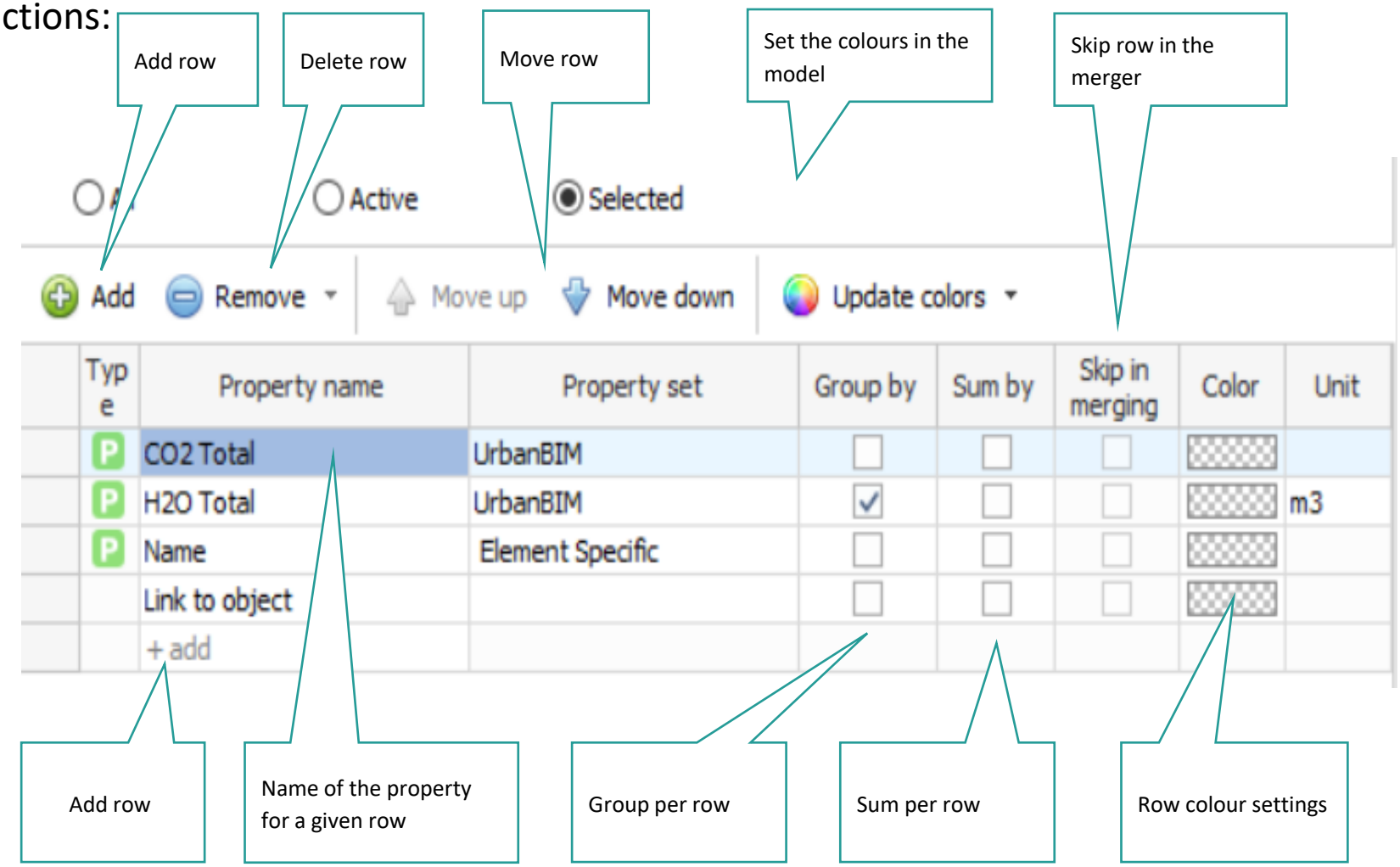
Functions:



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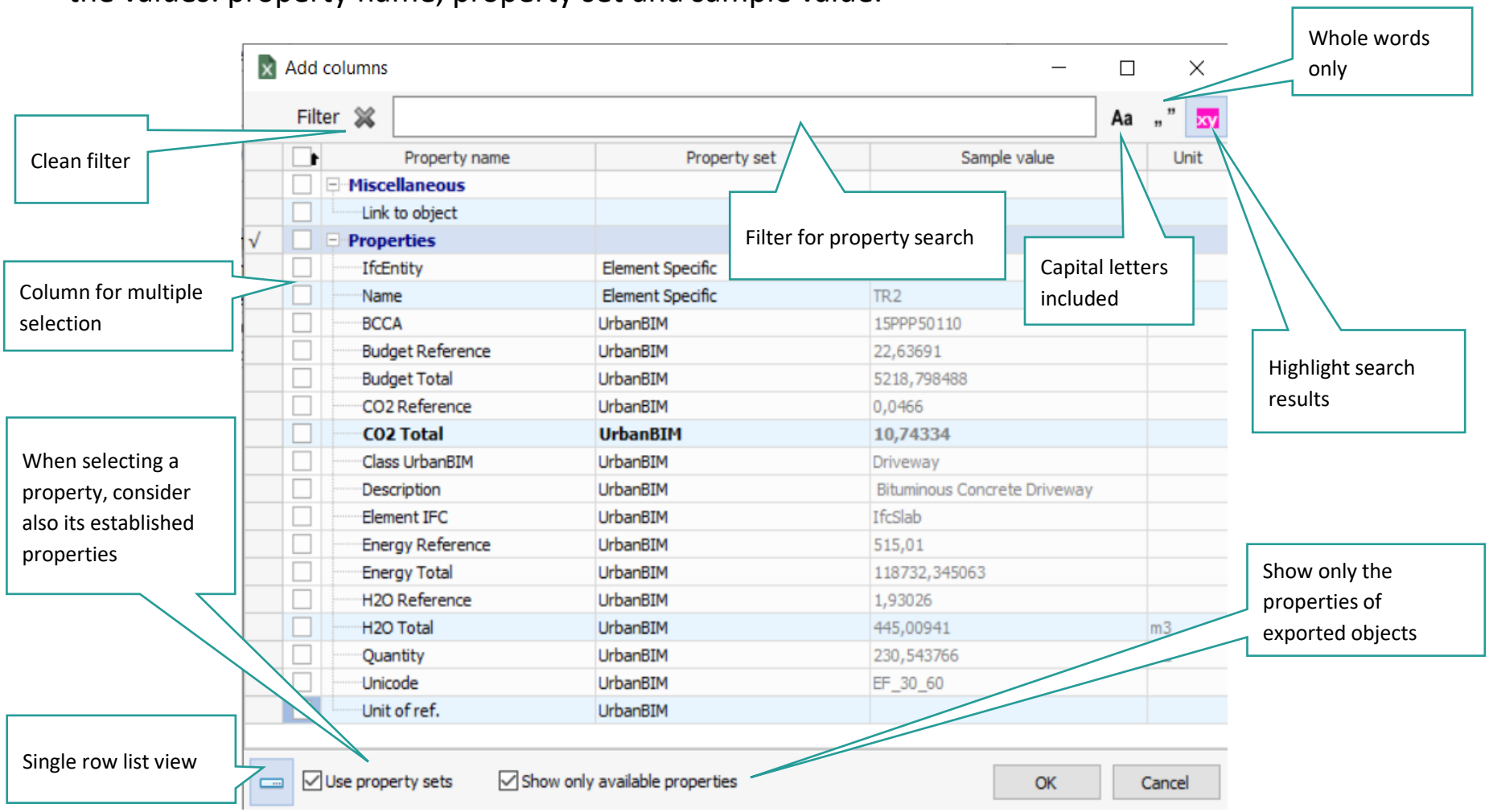
This window displays the list of properties of the BIM model. The three columns of the table show the values: property name, property set and sample value.



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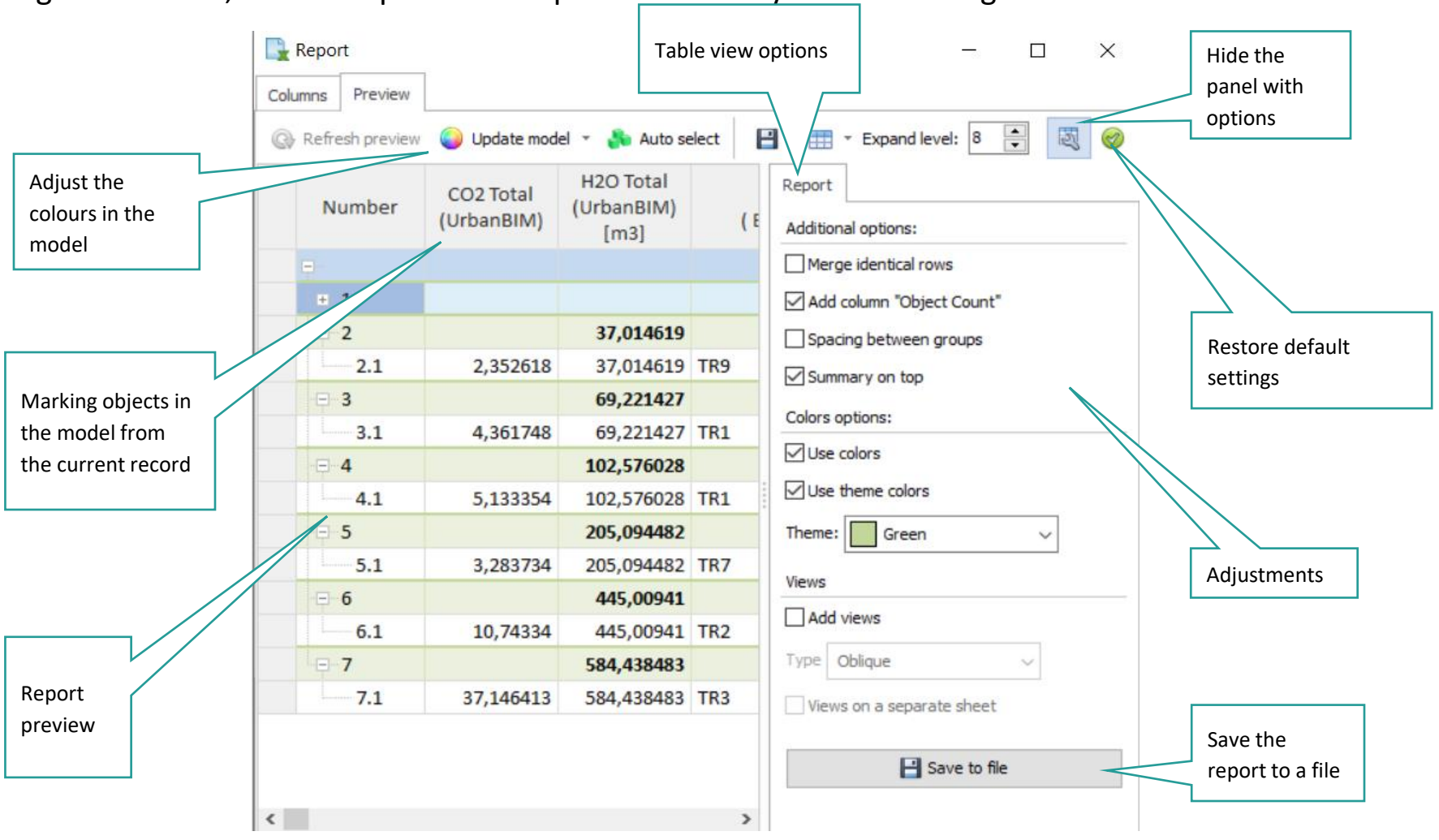
In the Preview tab, in the central part, you can see how the resulting report will be displayed. On the right hand side, there is a panel with options to modify the formatting.



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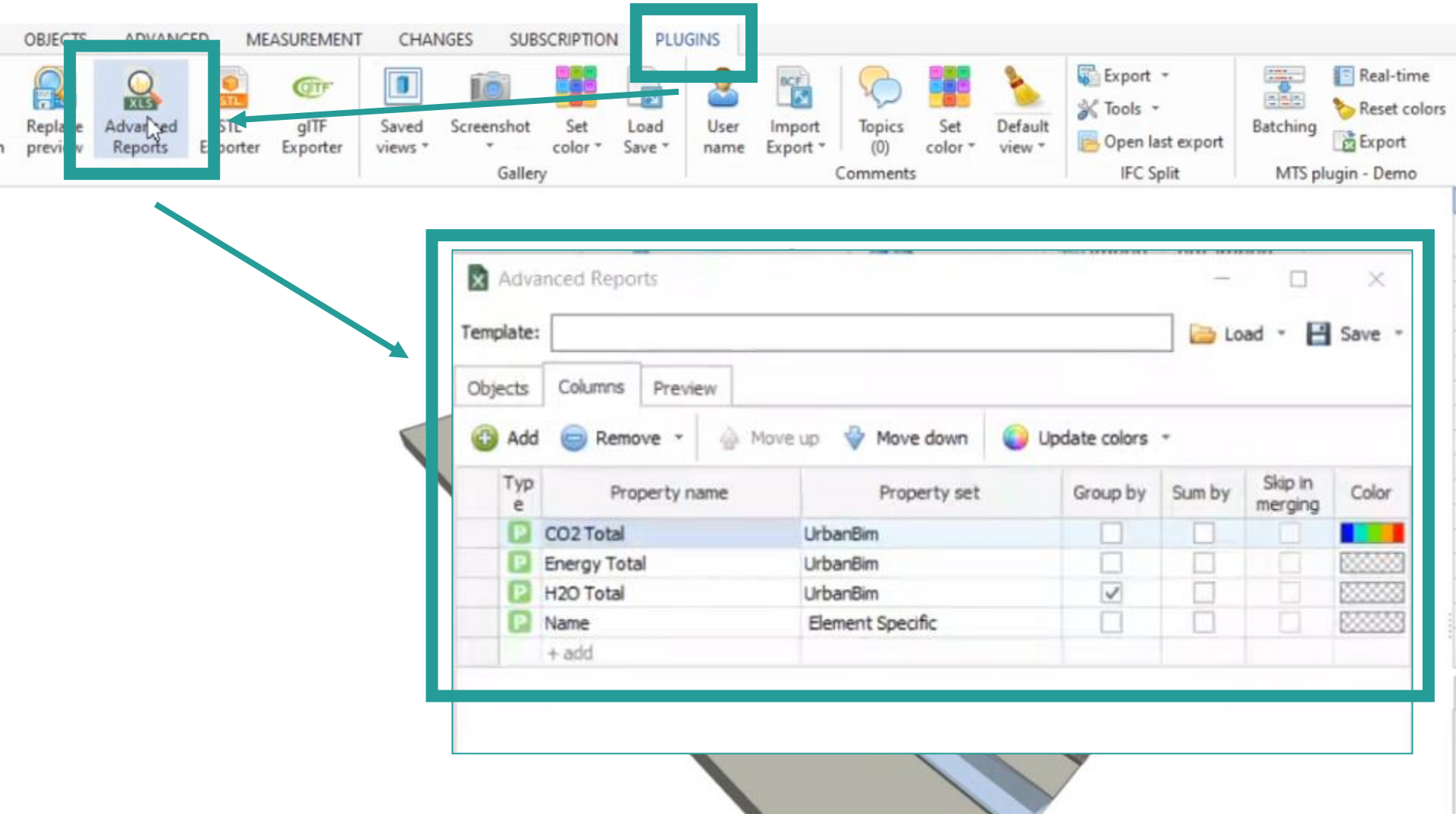
Consultation of project impact data by item:



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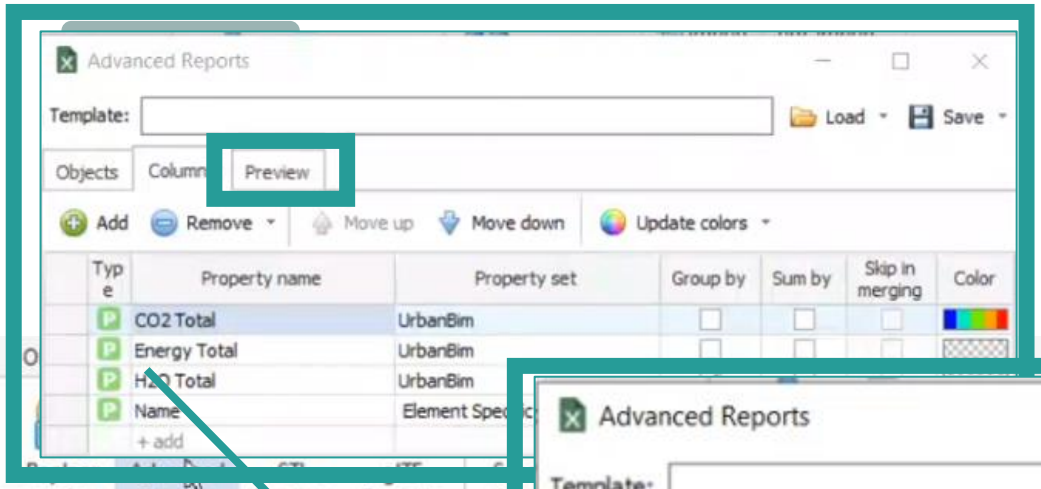

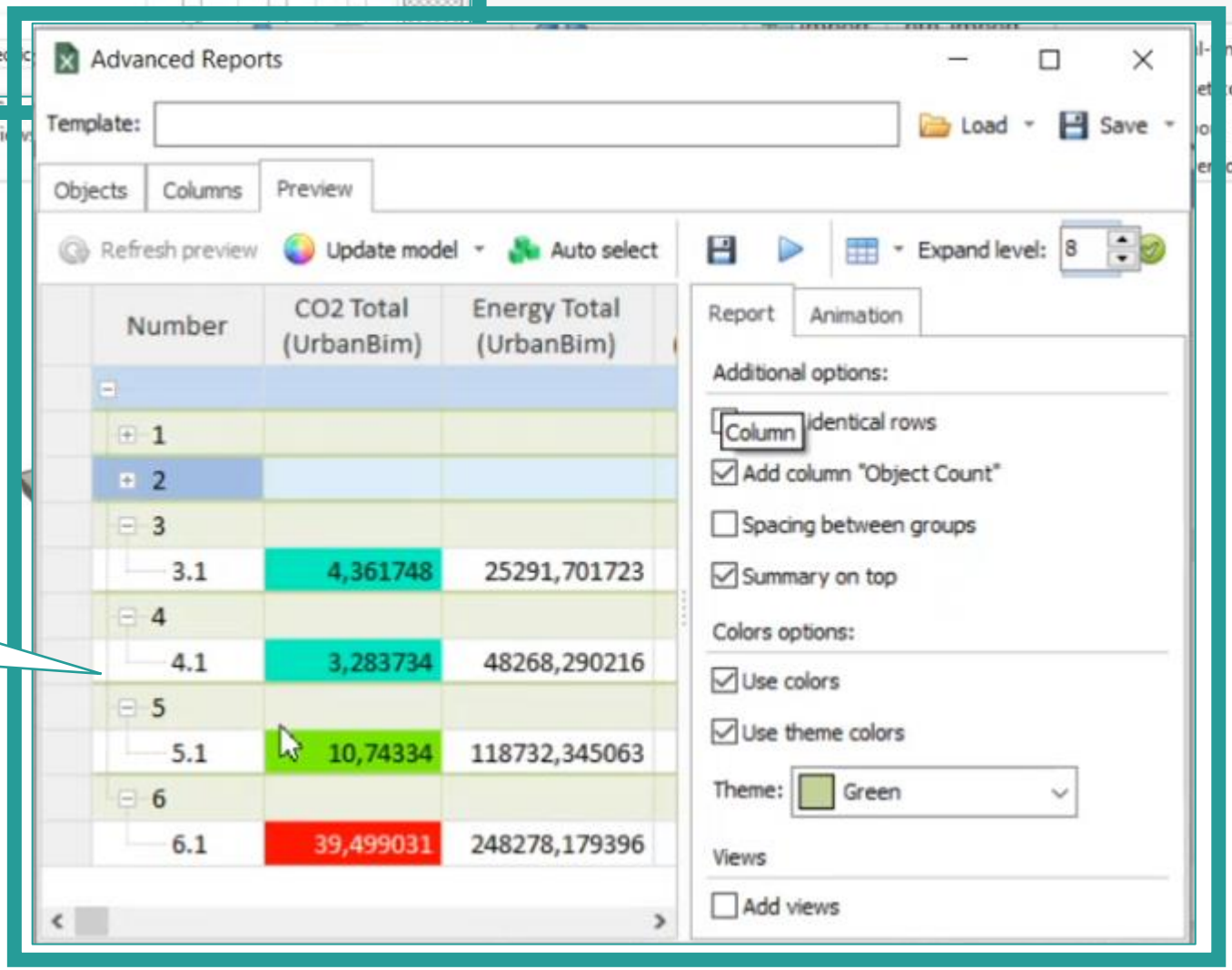

Consultation of the environmental impact report generated by our project

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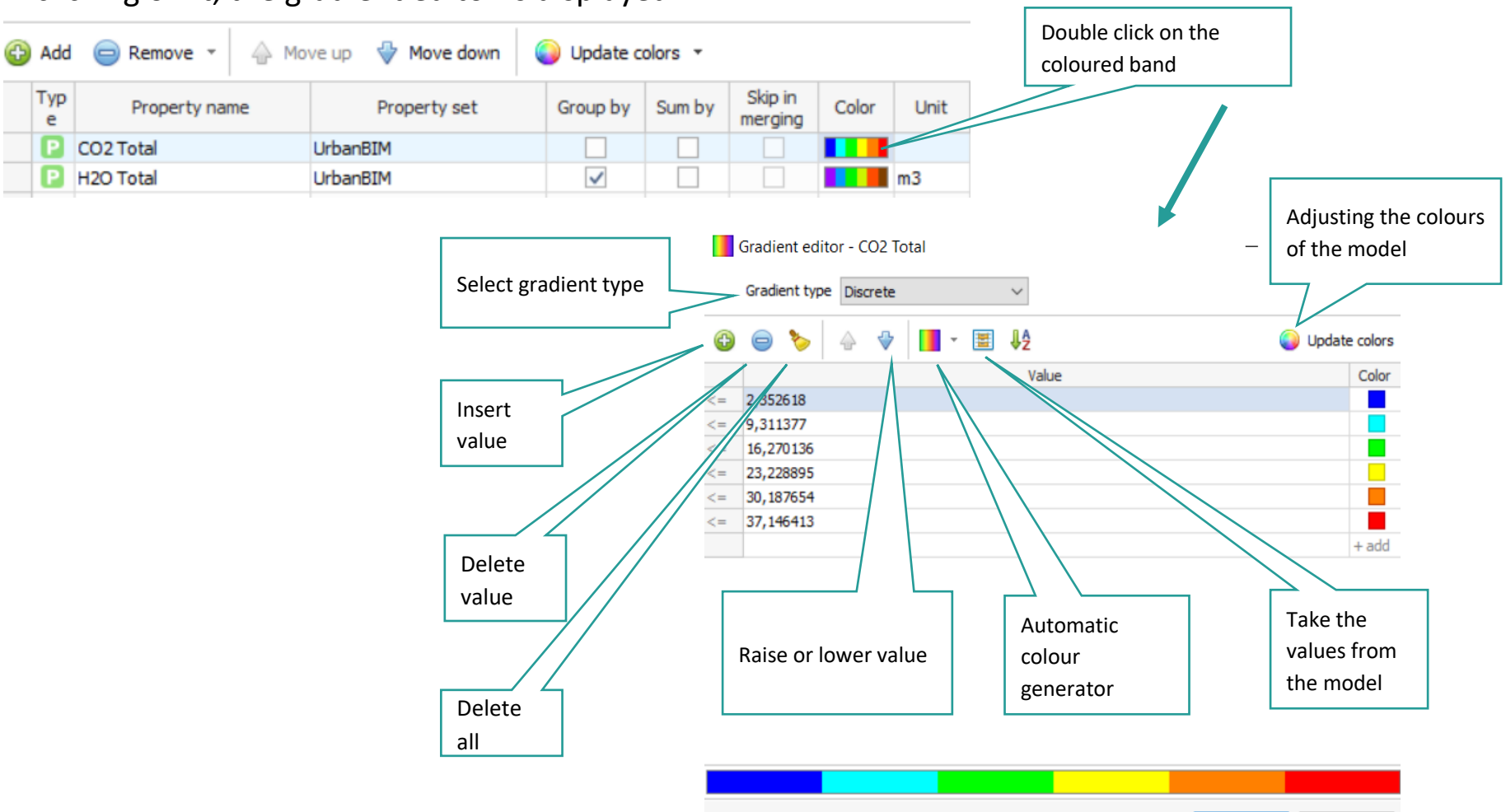
The impact window allows you to set the colour depending on the value of the property that is assigned to the column. In the table of the Columns tab, the Colour column is available and after clicking on it, the gradient editor is displayed:



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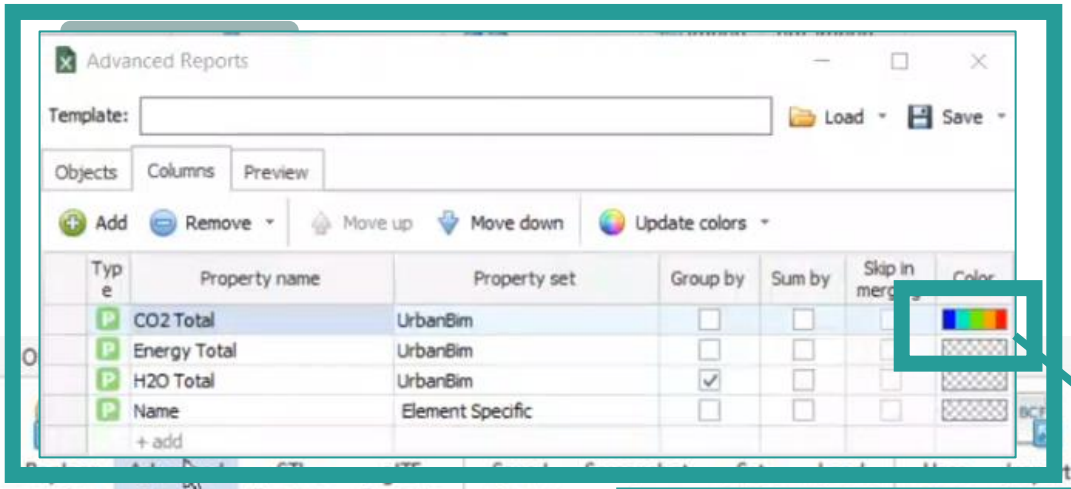
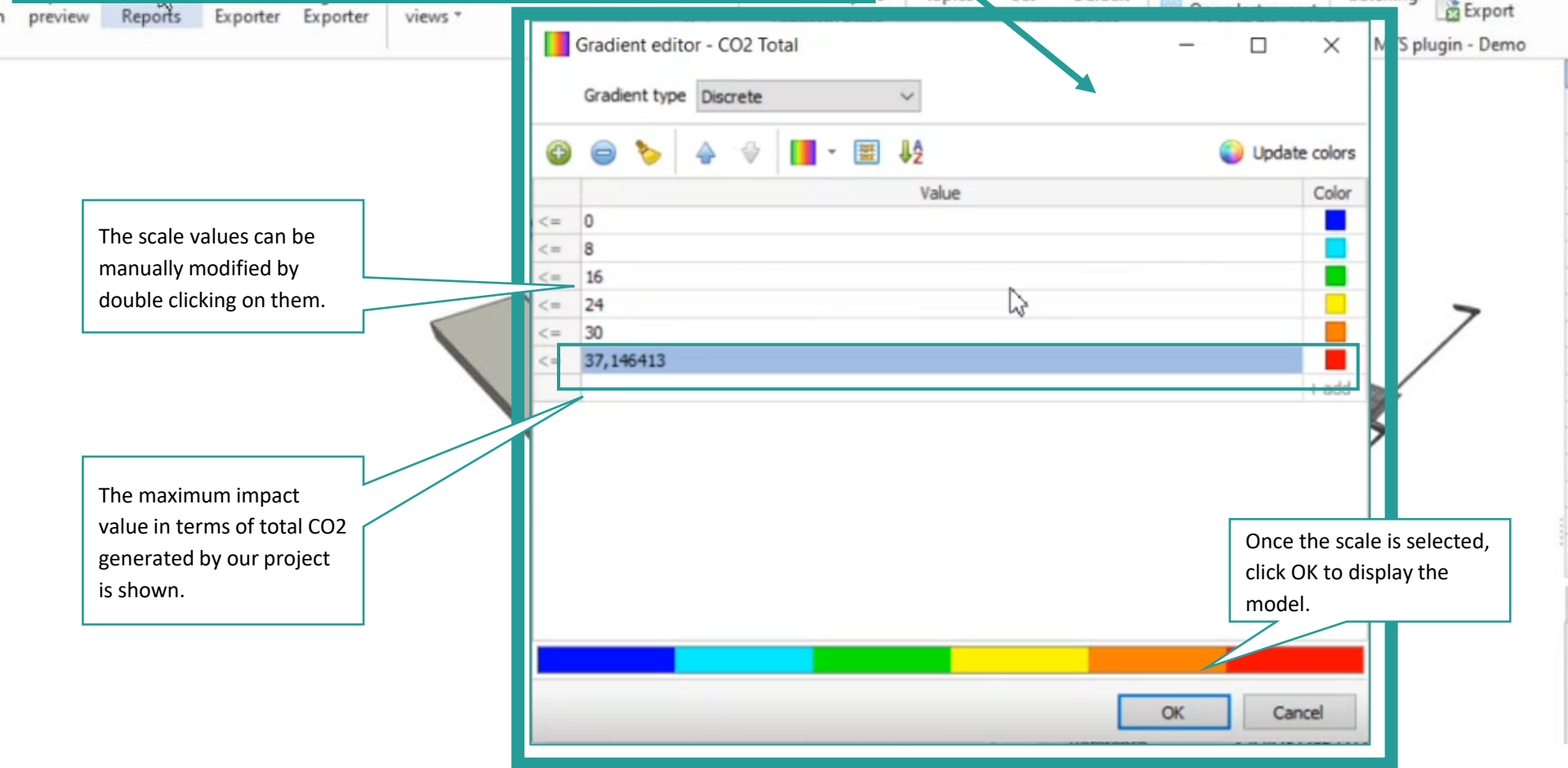


Double click on the coloured band



The scale values can be manually modified by double clicking on them.

The maximum impact value in terms of total CO2 generated by our project is shown.

Once the scale is selected, click OK to display the model.

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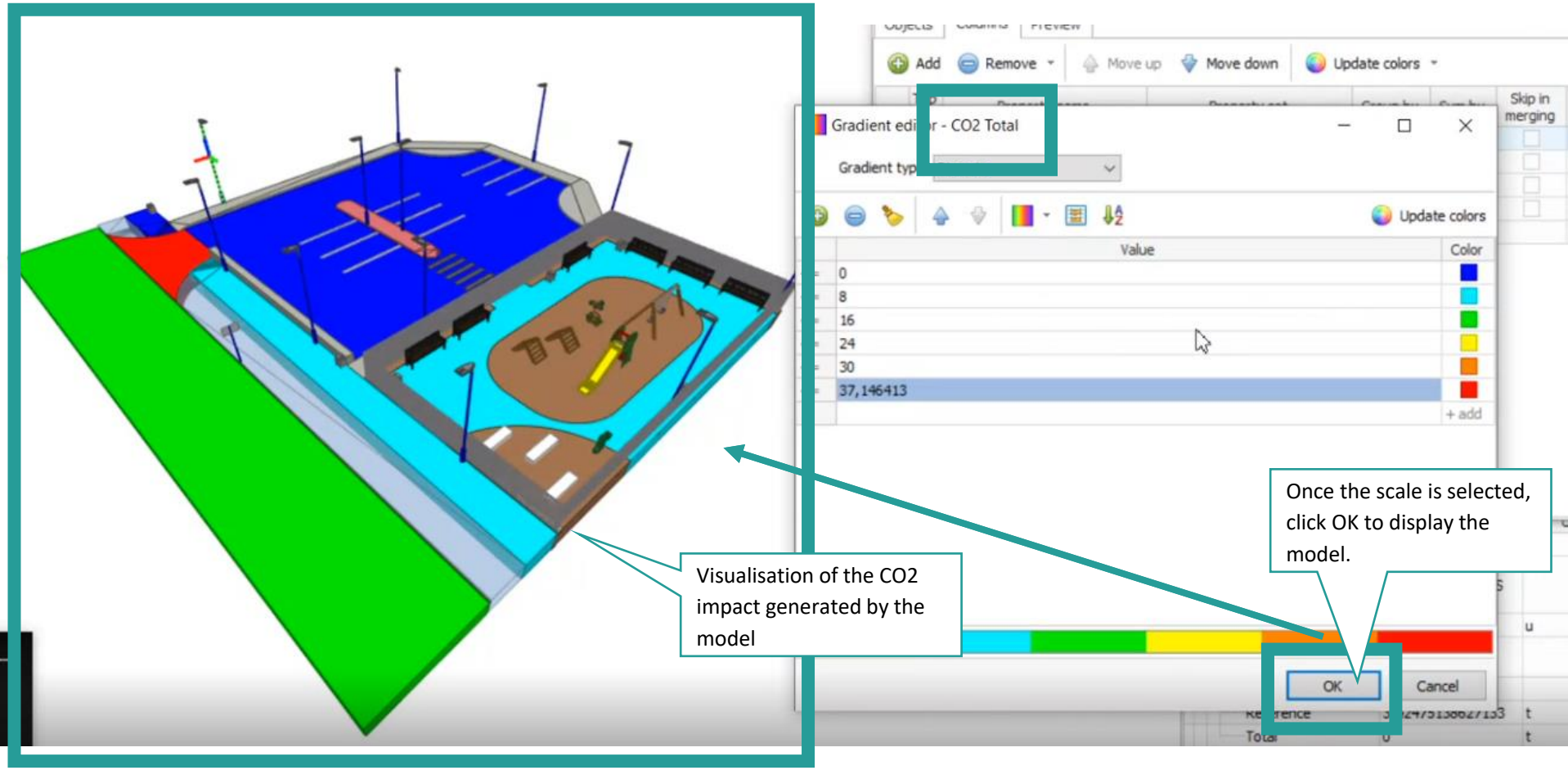
UrbanBIM PLUG-IN

Visualisation of the environmental impact on the model:



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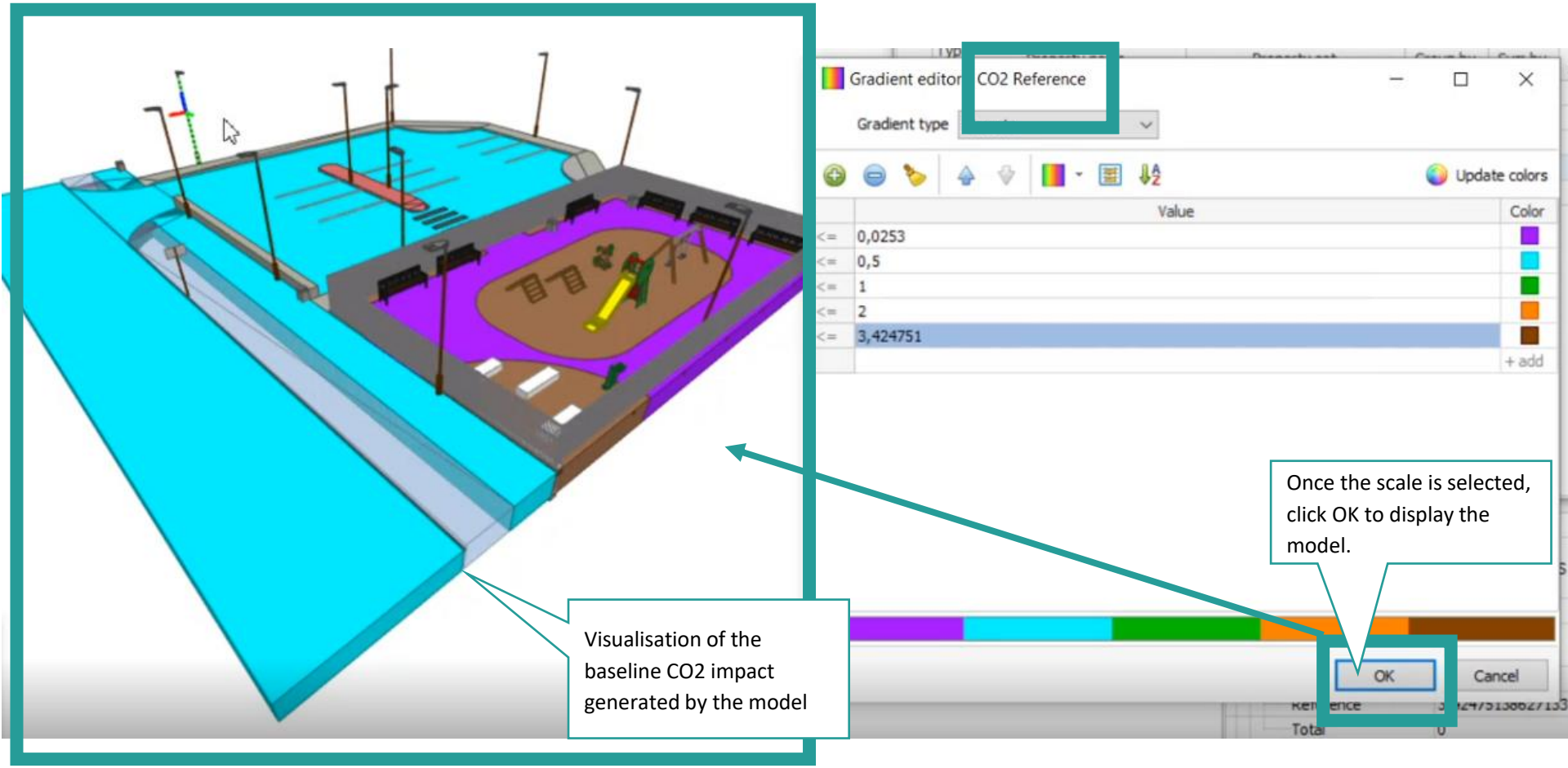
Visualisation of the environmental impact on the model:



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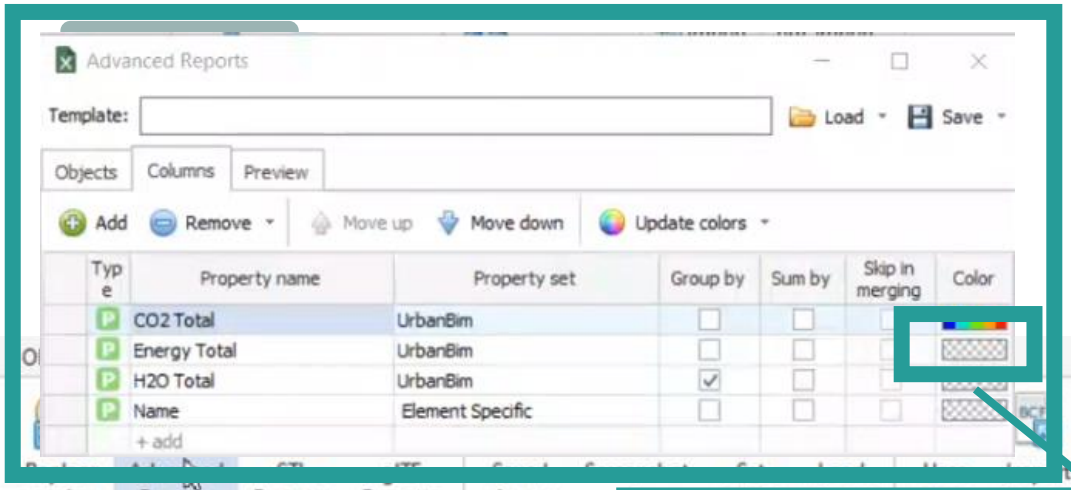

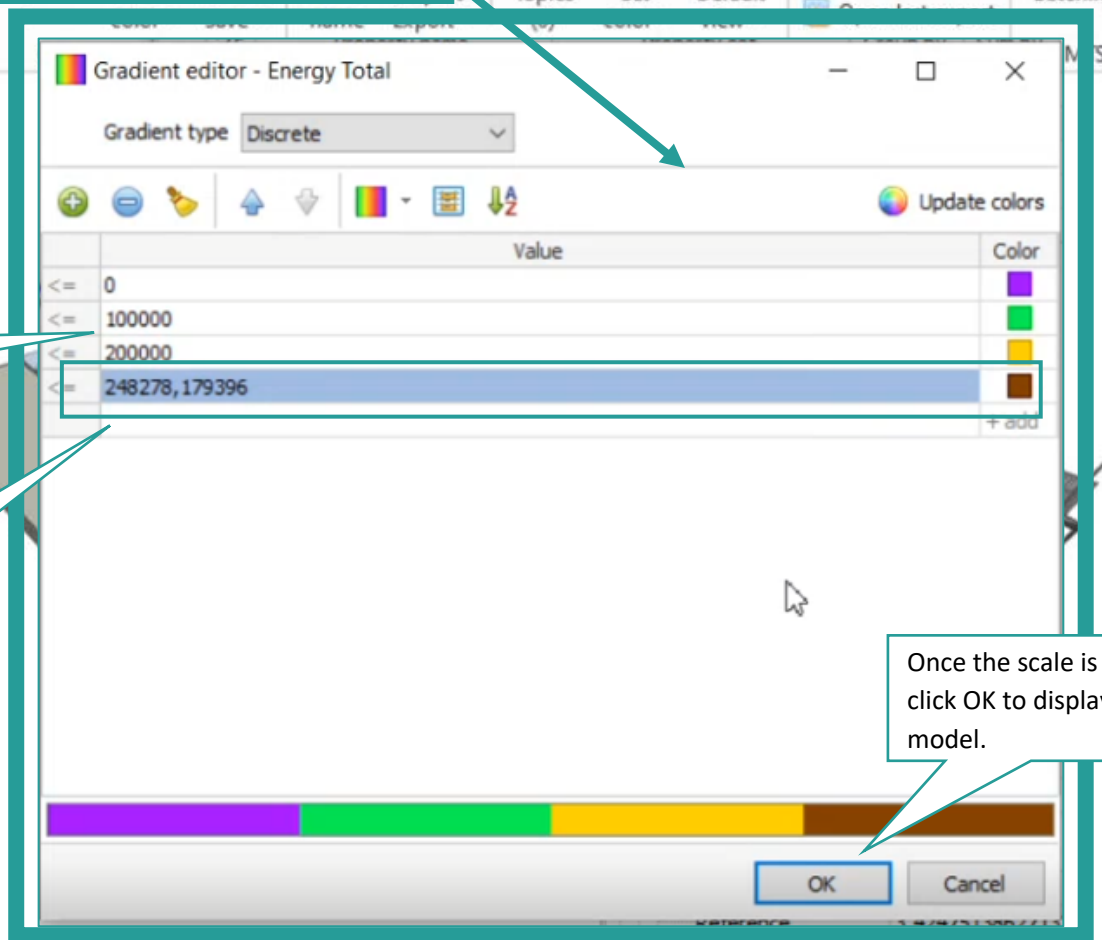

The scale values are modified by double-clicking on them.

The maximum impact value in terms of Total Energy generated by our project is observed.

Once the scale is selected, click OK to display the model.

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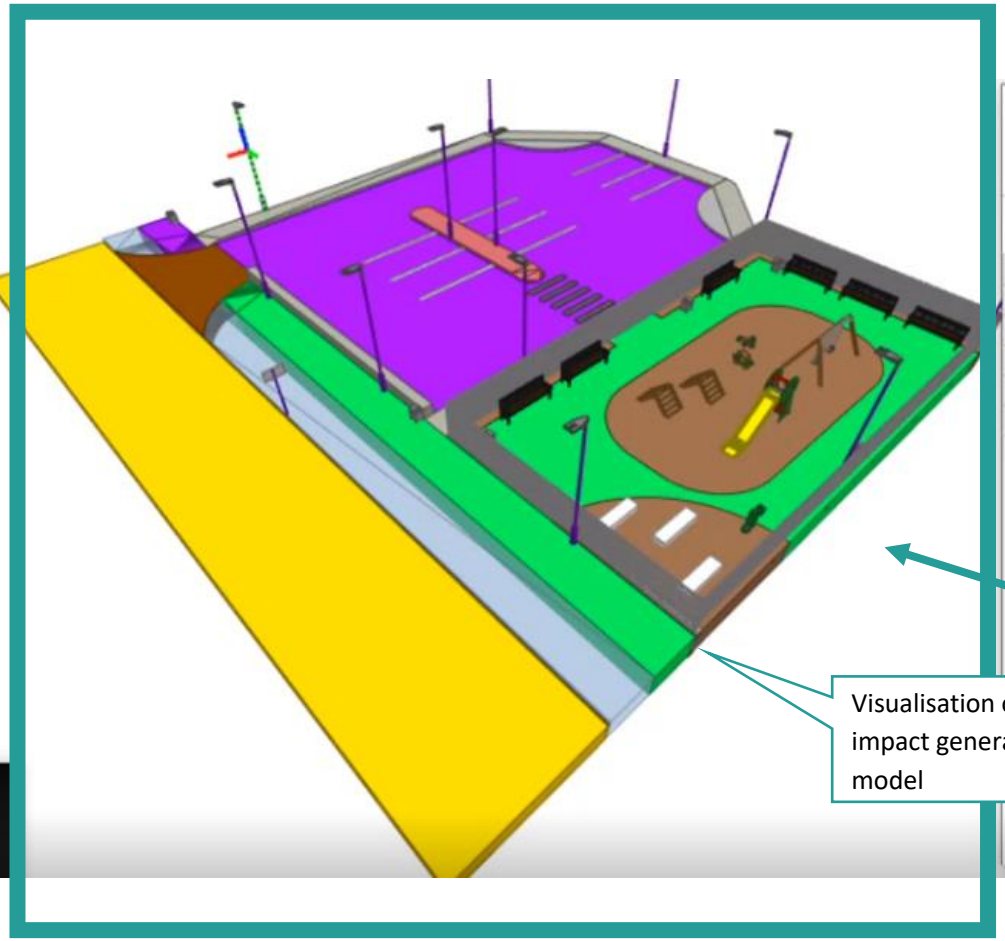
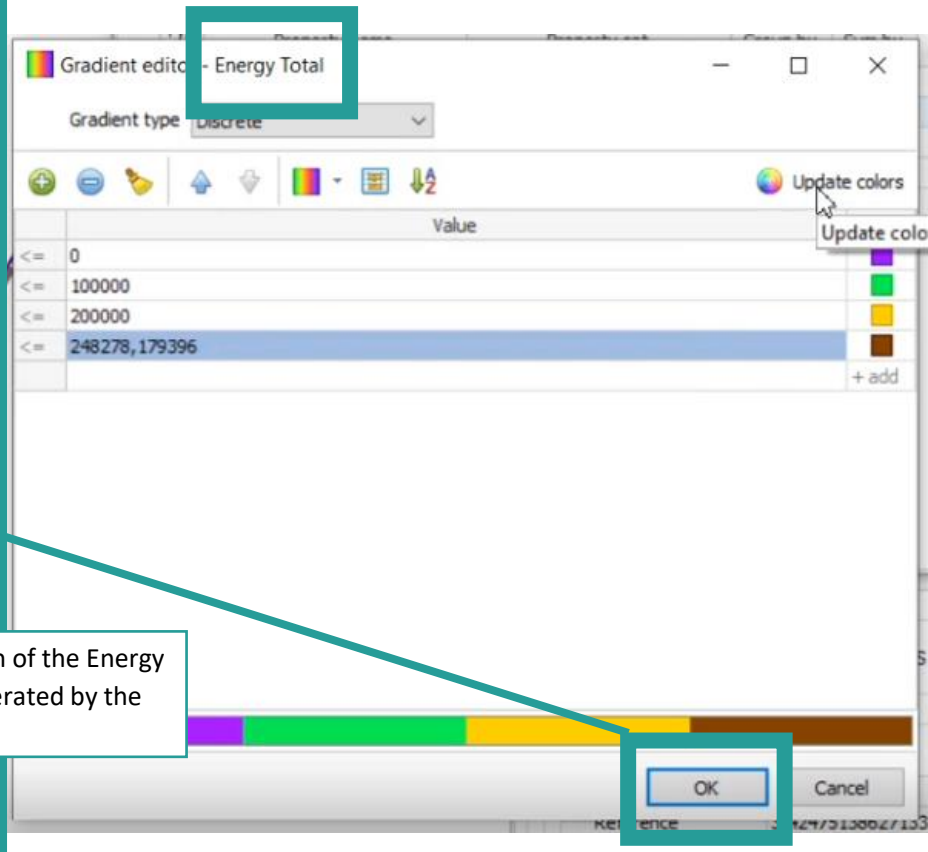
UrbanBIM PLUG-IN

Visualisation of the environmental impact on the model:





Visualisation of the Energy impact generated by the model

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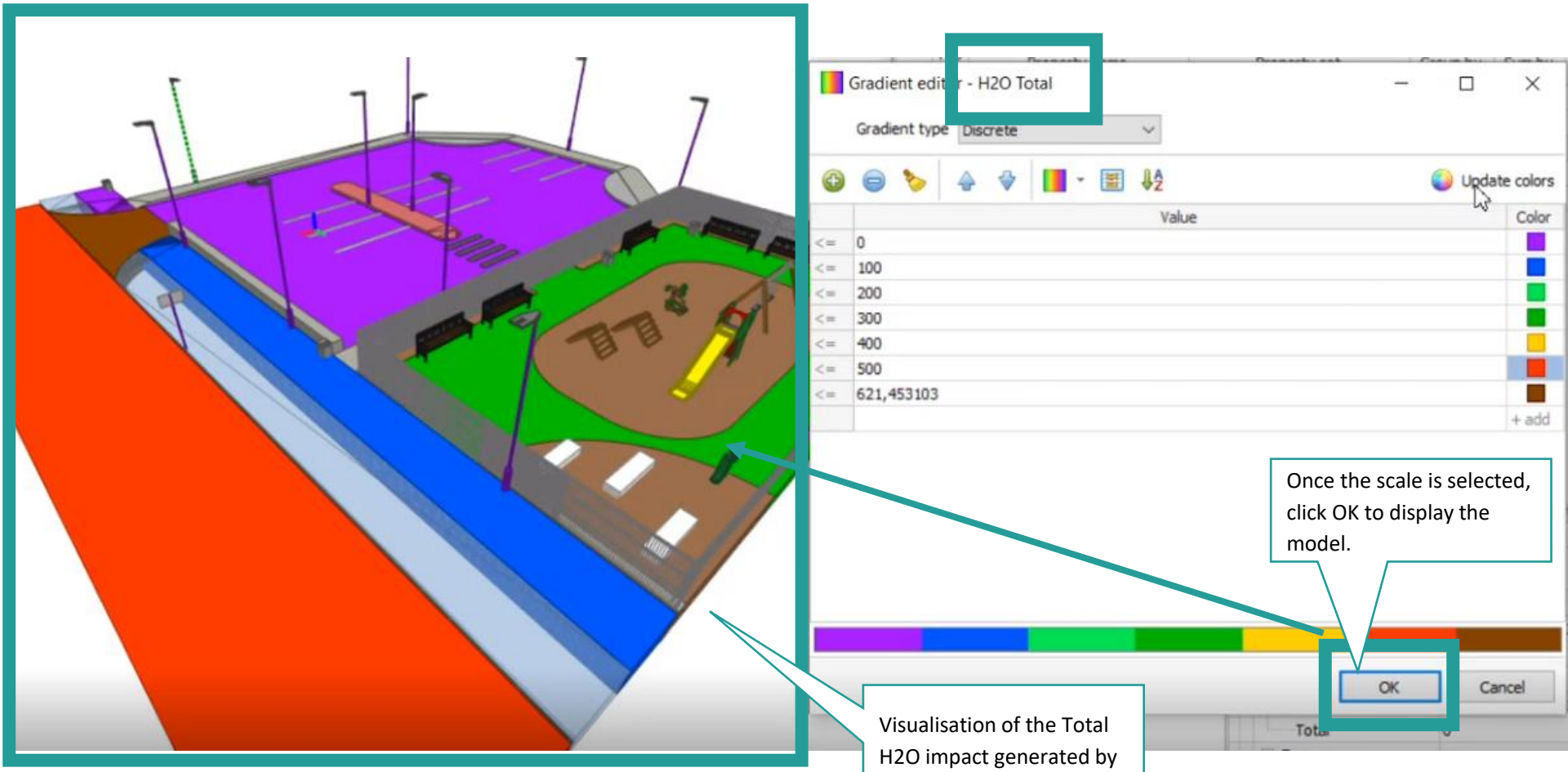
Visualisation of the environmental impact on the model:



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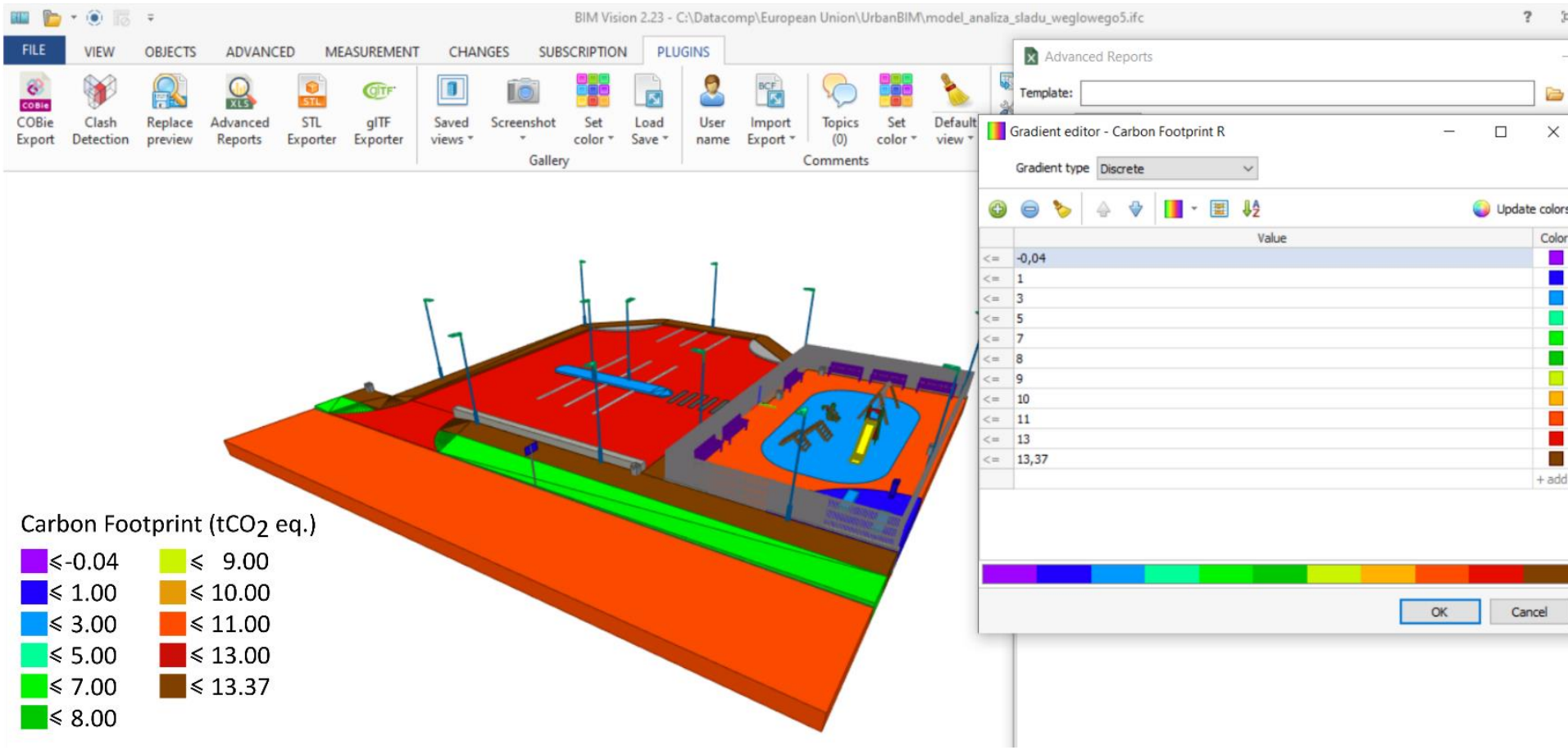
UrbanBIM PLUG-IN

Visualisation of the environmental impact on the model:



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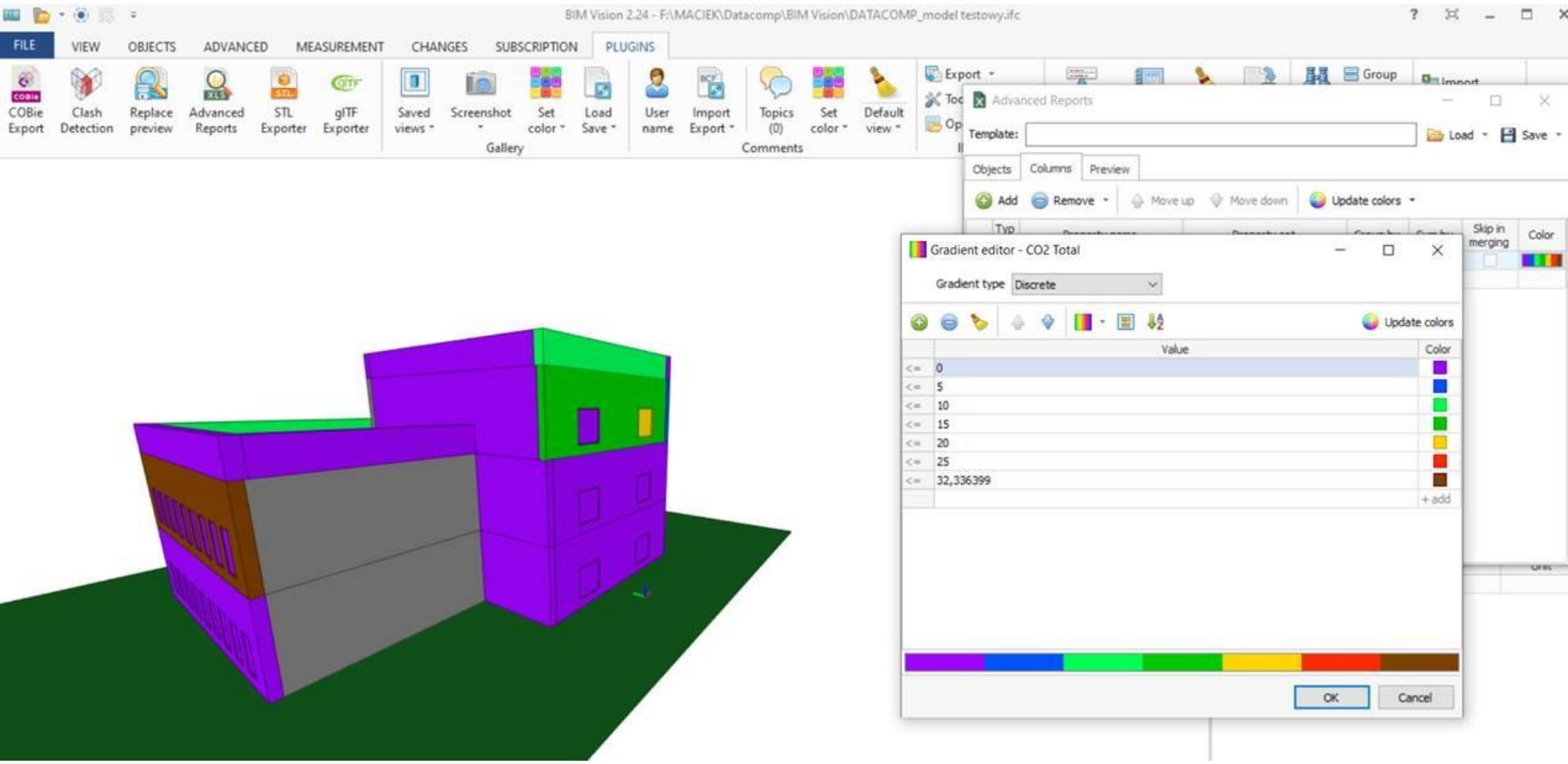
UrbanBIM PLUG-IN

Visualisation of the environmental impact on the model:



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9.3 CircularBIM

DEFINITION OF THE PROJECT.

OBJECTIVES.

CONSORTIUM AND IMPACT.

INTELLECTUAL PRODUCTS.

CircularBIM PLUG-IN.

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DEFINITION OF THE PROJECT

EDUCATIONAL PLATFORM FOCUSED ON ADVANCED STRATEGIES FOR THE RE-INSTALLATION OF BUILDING MATERIALS IN THE INDUSTRIAL VALUE CHAIN TO PROMOTE THE TRANSITION TO THE CIRCULAR ECONOMY THROUGH THE USE OF BIM LEARNING TECHNOLOGIES.

- The raw materials present on the planet are a finite, limited and, on many occasions, non-renewable resource, which is why the current consumption model is depleting many of these resources. For this reason, investment in research is necessary to promote new production models, if possible, based on the revaluation and reuse of industrial waste, encouraging the study and search for new markets for these recovered resources, considered as waste. In this way, industries are encouraged to adapt to the circular economy model with the environmental, social and economic advantages that are so necessary for our planet.
- The unsustainability of the current linear model, imposed as the dominant pattern of economic development, requires progress towards the implementation of a growth model that optimises the use of available resources and materials, while preserving their value in the system for as long as possible, the circular economy.

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DEFINITION OF THE PROJECT

EDUCATIONAL PLATFORM FOCUSED ON ADVANCED STRATEGIES FOR THE RE-INSTALLATION OF BUILDING MATERIALS IN THE INDUSTRIAL VALUE CHAIN TO PROMOTE THE TRANSITION TO THE CIRCULAR ECONOMY THROUGH THE USE OF BIM LEARNING TECHNOLOGIES.

- To this end, waste management plays a crucial role in the circular economy. The way waste is managed can lead to high recycling rates and the return of valuable materials to the economy or, on the contrary, to an inefficient system where most recyclable waste ends up in landfills or is incinerated, with potentially harmful effects on the environment and significant economic losses. Basically, understanding that waste generated during a production process is one of the fundamental keys to start the transition process.

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CONSORTIUM

- Universidad de Sevilla – Spain.
- Asociación Empresarial y de Investigación Centro Tecnológico del Mármol, Piedra y Materiales – Spain.
- CYPE SOFT SL – Spain.
- Centro Tecnológico de la Cerámica y el Vidrio – Portugal.
- Universitatea Transilvania din Brasov – Romania.
- Asociatia Romania Green Building Council - Romania.
- Universidades do Minho – Portugal.

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INTELLECTUAL OUTPUTS

- Establishment of a common curriculum focused on placement methods based on circular economy criteria, Life Cycle Assessment (LCA) and regulations.
- Development of a new interactive BIM learning method for Circular Economy.
- CircularBIM Online Educational Resource (OER).
- IT production of CircularBIM integrated training materials.

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CircularBIM PLUG-IN

CircularBIM development:

- **Application of the Arditec methodology**, which, based on the breakdown carried out by the systematic classification of the budget, makes it possible to quantify the environmental impacts of the basic resources.
- **Implementation of this environmental information in the open BIM software**, thus generating a tool for quantifying the reduction of environmental impact, so that the environmental impacts of new solutions can be compared with traditional construction solutions..

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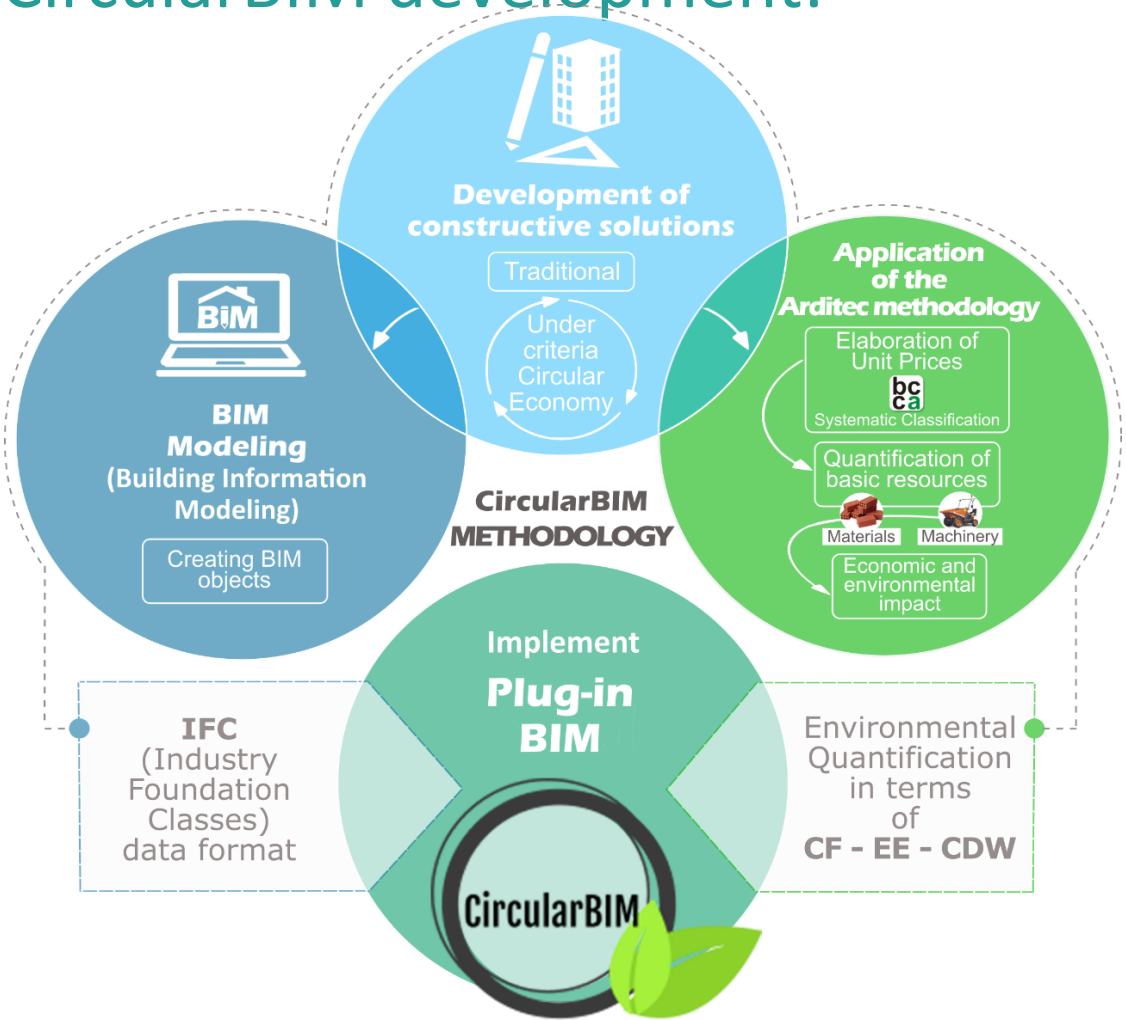
CircularBIM PLUG-IN

CircularBIM development:



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CircularBIM PLUG-IN

CircularBIM development:

The methodological development is divided into two parts: the application of the Arditec methodology, which, based on the breakdown carried out by the systematic classification of the budget, makes it possible to quantify the environmental impacts of the basic resources; and the implementation of this environmental information in the open BIM software, thus generating a tool for quantifying the reduction of the environmental impact, so that the environmental impacts of the new solutions can be compared with traditional construction solutions.

Firstly, constructive solutions are developed based on circular economy criteria, respecting the technical and regulatory requirements, to subsequently assess the environmental viability of the solutions through the LCA methodology.

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CircularBIM PLUG-IN

CircularBIM development:

Methodological flow chart:

1. Development of construction solutions with circular economy criteria.
2. Assessment of the environmental viability of the solutions through LCA.
3. Creation of BIM objects of the construction solutions developed.
4. Assignment of the environmental impact of the materials that make up the solutions.
5. Integration of environmental information in the BIM software by means of plug-ins.

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CircularBIM PLUG-IN

CircularBIM development:

DEVELOPMENT OF CONSTRUCTION SYSTEMS WITH CIRCULAR ECONOMY CRITERIA.

The methodology followed for the development of construction details with circular economy principles began with the analysis of the current basic construction systems used to build a house, such as the slab, the façade envelope, the enclosure, the type of slab, the interior partition walls and the enclosures. In order to subsequently propose alternatives to these same construction solutions from the point of view of the circular economy and incorporating sustainable materials.

To do this, all the construction options were considered and an analysis was made of how the house could be built taking into account more sustainable criteria.

By way of example, instead of a sanitary floor slab of vaults, mortar and one-way slab, a floor slab made up of bolted metal joists (so that they can be dismantled) and collaborating sheet metal has been chosen.

Instead of using a brick masonry façade, a façade will be analysed with the main leaf formed by a bolted metal load-bearing structure on which the auxiliary structure and the same cladding will be supported.

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CircularBIM PLUG-IN

CircularBIM development:

ASSESSMENT OF THE ENVIRONMENTAL FEASIBILITY OF SOLUTIONS THROUGH LCA.

All construction systems have been studied and replaced by others that include demountable elements (to be used after their useful life) and recycled materials.

All the materials and elements included in the study have their EPD, so the environmental impact data are quantified and verified by a Programme Manager.

The materials of the sustainable solutions have been selected under environmental criteria, specifically materials that, in addition to fulfilling the technical conditions required for their function within the construction solution, have the eco-label III (EPD) and have a percentage of recycled material in their composition, so they are certified in their corresponding eco-label.

This ensures the incorporation of materials produced under circular economy criteria, as well as the certainty that these materials are available on the market.

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CircularBIM PLUG-IN

CircularBIM development:

CREATION OF THE BIM OBJECTS OF THE DEVELOPED CONSTRUCTIVE SOLUTIONS.

Based on the above, the BIM objects of the developed construction solutions were created. These BIM objects are composed of the families of materials that define the construction systems developed, which were subsequently assigned the calculated environmental impact and integrated into the open BIM software via a plug-in.

The new options included in the construction elements (bolted beams, supporting structures of ventilated facades, etc.) will be modelled in BIM so that information is available on their belonging to the specific construction system, use and assembly in terms of quantities, dimensions, shape, location and orientation, etc.

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CircularBIM PLUG-IN

CircularBIM development:

ALLOCATION OF THE ENVIRONMENTAL IMPACT OF THE MATERIALS THAT MAKE UP THE SOLUTIONS.

For the inclusion of Life Cycle Assessment in BIM, the project is based on the methodology for quantifying the environmental impact.

This environmental impact calculation methodology, based on the Ecological Footprint (HE) indicator, is part of the project budget and has been adapted to measure the complete life cycle of the building: urbanisation, use and maintenance, and rehabilitation or demolition. They also study other indicators such as embodied energy (EE), carbon footprint (CF) and water footprint (WF), as they are the most interesting indicators in the construction sector thanks to the simplicity of their message and the fact that they are based on the quantification of resources carried out for the economic control of projects.

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CircularBIM PLUG-IN

CircularBIM development:

ALLOCATION OF THE ENVIRONMENTAL IMPACT OF THE MATERIALS THAT MAKE UP THE SOLUTIONS.

The methodology is based on simple and accessible data processing, as the data come from freely accessible databases or information sources and can be consulted by anyone, anywhere in the world, such as the generic LCA databases. All these databases are proposed as an ideal tool for carrying out economic quantification or budgeting and also as an integrating element as their system of decomposition and hierarchisation allows the introduction of a standardised process.

The basic concept of all of them is to divide a complex problem into simpler parts that can then be added, without overlapping or repetition, to define the complete development of the projects.

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CircularBIM PLUG-IN

CircularBIM development:

ALLOCATION OF THE ENVIRONMENTAL IMPACT OF THE MATERIALS THAT MAKE UP THE SOLUTIONS.

In Spain, construction cost bases (BCC) have their own CICS and their scope of application is usually the geographical environment: The Construction Technology Institute of Catalonia (ITeC, 2012), the PRECIOCENTRO of Guadalajara (Colegio Oficial de Aparejadores, 2012), the BPCM of Madrid (Ministerio de Medio Ambiente y Ordenación del Territorio, 2007), the BDEU of the Basque Country (Department of Housing, 2012), the BDC-IVE of Valencia (Ministry of Infrastructures, Territory and Environment, 2012), and the Andalusian Database of Construction Costs (ACCD) (Marrero and Ramírez-De-Arellano, 2010).

The latter is the one used in the development of the model; because it belongs to the geographical area in which the Arditec model has been developed and presents a robust systematic classification, of simple and schematic application, which allows an estimation and quantification of the basic resources, to which the different environmental indicators can be applied to obtain the environmental impact of the different construction solutions.

CircularBIM PLUG-IN

CircularBIM development:

ALLOCATION OF THE ENVIRONMENTAL IMPACT OF THE MATERIALS THAT MAKE UP THE SOLUTIONS.

Environmental indicators based on LCA are recognised by the scientific community and can be easily understood by society.

In the present work the Carbon Footprint (CF) indicator has been used, it is an indicator whose use is very widespread, so there is a large number of literature reviews related to the use of the CF indicator in construction.

Through the decomposition into basic resources (materials and machinery) provided by the systematic classification of the ACCD of the different construction solutions, the ARDITEC model is applied (Marrero, Rivero-Camacho and M Desirée Alba-Rodríguez, 2020), which translates this quantity in terms of the impact produced by the resources during their life cycle, expressed through the CF indicator. The main objective is to be able to predict the impact that a project will generate at the design stage, quantifying the quantities of the project, identifying the materials that generate the greatest impact throughout its life cycle and replacing them with others that reduce their impact. Existing project cost control tools can be used as a tool to introduce sustainability considerations.

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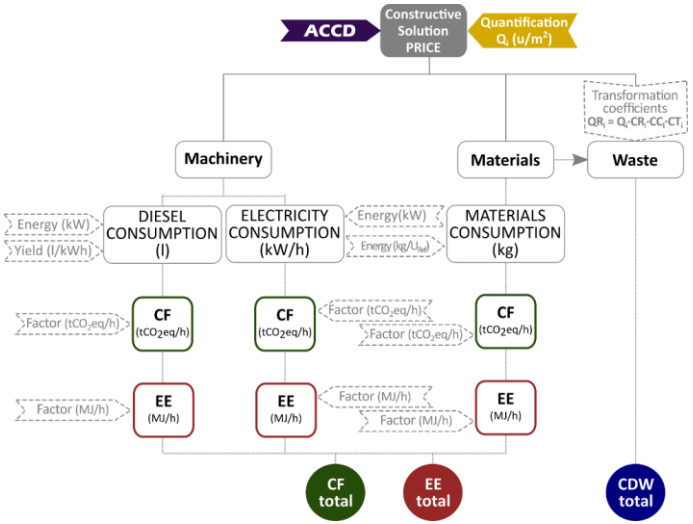
CircularBIM PLUG-IN

CircularBIM development:

ALLOCATION OF THE ENVIRONMENTAL IMPACT OF THE MATERIALS THAT MAKE UP THE SOLUTIONS.

The sustainability of construction works, as well as the environmental performance and the calculation method, define the life cycle of the building according to the UNE-EN 15978 standard (UNE-EN_15978, 2012). The system boundaries on which this study focuses are the manufacturing phase of building materials and the waste they produce at the end of their life cycle.



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CircularBIM PLUG-IN

CircularBIM development:

INTEGRATION OF ENVIRONMENTAL INFORMATION INTO BIM SOFTWARE BY MEANS OF PLUG-INS.

Once the environmental impact quantification model has been developed, and given that the final objective is to automate environmental budgets through BIM tools, the next step will be to include the environmental information obtained through BIM.

In order to include this new environmental information in BIM, it is necessary to create this information in what is known as IFC (Industry Foundation Classes) data format, whose particularity is that it allows the exchange of data from one information model to another without generating data loss or distortion. It is an open, neutral format, not controlled by software producers, born to facilitate interoperability.

It is designed to produce all the information about the building throughout its life cycle, from preliminary design through the different phases of design and planning to execution and maintenance.

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CircularBIM PLUG-IN

CircularBIM development:

INTEGRATION OF ENVIRONMENTAL INFORMATION INTO BIM SOFTWARE BY MEANS OF PLUG-INS.

Most of the BIM resources currently available are focused on construction and, within this, on the residential sector. Therefore, in the research that is being carried out and with the aim of taking advantage of the benefits offered by BIM, the aim is to extend its application to the different phases of the building's life cycle, delving into the benefits it can bring to sustainability, more specifically, how to incorporate circular economy criteria through BIM.

Thanks to IFC models, it is possible to create a virtual model of the building that is not a simple 3D representation, but a model that contains geometric information, materials, cost quantification, complex elements such as structures, installations, thermal characteristics and even information related to the different phases of the building's life cycle.

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CircularBIM PLUG-IN

CircularBIM development:

INTEGRATION OF ENVIRONMENTAL INFORMATION INTO BIM SOFTWARE BY MEANS OF PLUG-INS.

The association of this additional information is achieved because the structure of the IFC is based on the semantics, relationships and properties of the modelled objects, created to describe the different components of the buildings (columns, beams, walls, slabs, etc.) being able to add specific properties to each object; the quantification of costs through budgets, the quantification of materials through measurements, and what is intended in this research, the environmental quantification through the adhesion of the Arditec methodology based on environmental indicators and LCA.

And, through measurement software such as Archimedes, Open BIM or Quantities, a plug-in will be created in which the data (environmental, budget and quantities) of each of the construction solutions considered in the research of this project will be quantified, being able to obtain an economic and environmental budget.

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Capítulo					€	kg	HC tCO2eq		EI (MJ)		RCD reciclables en seco (kg)	
14FVL00002	**m2**	**FACHADA VENTILADA CON TRASDOSADO INTERIOR DE LÁMINA DE MADERA Y ACABADO EXTERIOR CON TABLERO DE MADERA**										
Hoja principal de fachada ventilada, apoyada sobre el forjado y enrasada, de 11,5 cm de espesor, de fábrica de ladrillo hueco doble, para revestir, 24x11,5x9 cm, con juntas horizontales y verticales de 10 mm de espesor, recibida con mortero de cemento industrial, color gris, M-5, suministrado a granel; formación de los dinteles mediante vigueta prefabricada T-18, revestida con piezas cerámicas, colocadas con mortero de alta adherencia. Aislamiento de paredes con placas de corcho conglomeradas de densidad 110 kg/m3 de 60 mm de espesor, colocado sobre superficies planas, incluso corte y colocación y material complementario. Revestido de paredes con placas de madera lisa para trasdosado autoportante de muros, colocado sobre perfilería de madera, incluso replanteo, limpieza, nivelación, aplomado, ejecución de ángulos, pasos de instalaciones y repaso de juntas; construido según especificaciones del fabricante de los paneles. Revestimiento exterior de fachada ventilada, de tableros compuestos HPL en madera natural para revestimientos exteriores. Forma parte de kit constructivo para el revestimiento de fachadas ventiladas formado por paneles de madera natural y su correspondiente subestructura. Cada panel está compuesto por un cuerpo de baquelita de alta densidad, revestido con una chapa de madera natural tratada en su superficie a base de resinas sintéticas y un film exterior de PVDF que aporta mayor durabilidad a los paneles, con propiedades antiadherentes, para proteger el tablero de la radiación solar, los agentes atmosféricos, la suciedad y los ataques de productos químicos (antigraffiti). Debido a su alta resistencia no requieren el mantenimiento habitual de otras maderas para exteriores. Materiales con más de un 8% de materia prima de origen reciclado y ecoetiqueta III. Medida la superficie ejecutada.											
TO02100	2,72	h	OFICIAL 1ª	19,85	53,99	0,00	0,00000	0,00000	0,000	0,000		
TA00200	2,52	h	AYUDANTE ESPECIALISTA	19,04	47,98	0,00	0,00000	0,00000	0,000	0,000		
TP00100	0,5	h	PEÓN ESPECIAL	18,90	9,45	0,00	0,00000	0,00000	0,000	0,000		
MW00300	0,258	h	PLATAFORMA ELEVADORA TELESCOPICA	7,50	1,94	0,00	0,04186	0,01080	687,360	177,339		
06LHM00005	1	m2	FÁBRICA 1 PIE LADRILLO H/D	29,64	29,64	377,51	0,07170	0,07170	832,440	832,440	0,70	264,26
09APP00250	1	m2	AISLAMIENTO PAREDES, PLACAS CORCHO 60 mm	14,44	14,44	6,71	-0,00398	-0,00398	354,099	354,099	1,00	6,71
10LWW90202	1	m2	REV. PAREDES TRASDOSADO AUTOPORTANTE DE PLACAS DE MADERA	19,51	19,51	15,22	0,03881	0,03881	967,241	967,241	1,00	15,22
10LWW90300	1,01	m2	REV. EXTERIOR DE FACHADA VENTILADA DE PANELES DE MADERA NATURAL	83,97	84,81	13,08	0,02480	0,02505	678,000	684,780	1,00	13,08
WW00400	2	u	PEQUEÑO MATERIAL	0,30	0,60	0,04	0,00016	0,00032	2,652	5,304	0,00	0,00
				TOTAL EU	262,36	412,56	TOTAL HC	0,14269	TOTAL EI	3021,203	TOTAL RCD	299,26
											% reciclabilidad total	0,73

14FVL00001	**m2**	**FACHADA VENTILADA CON TRASDOSADO INTERIOR DE PLACA DE YESO Y APLACADO EXTERIOR DE PI**	€/UD	€	kg	HC tCO2eq		EI (MJ)		RCD reciclables en seco (kg)	
Hoja principal de fachada ventilada, apoyada sobre el forjado y enrasada, de 11,5 cm de espesor, de fábrica de ladrillo hueco doble, para revestir, 24x11,5x9 cm, con juntas horizontales y verticales de 10 mm de espesor, recibida con mortero de cemento industrial, color gris, M-5, suministrado a granel; formación de los dinteles mediante vigueta prefabricada T-18, revestida con piezas cerámicas, colocadas con mortero de alta adherencia. Aislamiento térmico compuesto por panel de lana mineral, según UNE-EN 13162, de 60 mm de espesor, resistencia térmica 1,75 m²K/W, conductividad térmica 0,034 W/(mK), colocado entre los montantes de la estructura portante, incluso p.p. de elementos de fijación, corte y colocación. Subestructura soporte regulable en las tres direcciones, para la sustentación del revestimiento exterior, de placas de piedra natural, de 60x30x2 cm, mediante el sistema de anclaje horizontal continuo oculto, formada por: perfiles verticales en C y perfiles horizontales continuos con uña oculta para el cuelgue del revestimiento, de aluminio extruido de aleación 6063 con tratamiento térmico T6, escuadras de carga y escuadras de apoyo de 80x60x100x5 mm, de aluminio extruido de aleación 6063 con tratamiento térmico T5. Incluso tirafondos y anclajes mecánicos de expansión de acero inoxidable A2, para la fijación de la subestructura soporte. Revestido interior de paredes con placas de yeso de 13 mm de espesor para trasdosado autoportante de muros, colocado sobre perfilería de acero galvanizado con fijaciones mecánicas, incluso replanteo, limpieza, nivelación, aplomado, ejecución de ángulos, pasos de instalaciones y repaso de juntas; construido según especificaciones del fabricante de los paneles. Revestimiento exterior de fachada ventilada, de placas mecanizadas de arenisca Caliza Capri, acabado abujardado, de 60x40x4 cm; colocación mediante el sistema de anclaje horizontal continuo oculto, sobre subestructura soporte regulable en las tres direcciones, de aleación de aluminio EN AW-6063 T6. Incluso tirafondos y anclajes mecánicos de expansión de acero inoxidable										
TO02100	2,72	h	OFICIAL 1ª	19,85	53,99	0,00	0,00000	0,00000	0,000	0,000		
TA00200	2,52	h	AYUDANTE ESPECIALISTA	19,04	47,98	0,00	0,00000	0,00000	0,000	0,000		
TP00100	0,5	h	PEÓN ESPECIAL	18,90	9,45	0,00	0,00000	0,00000	0,000	0,000		
MW00300	0,258	h	PLATAFORMA ELEVADORA TELESCOPICA	7,50	1,94	0,00	0,04186	0,01080	687,360	177,339		
06LHM00005	1	m2	FÁBRICA 1 PIE LADRILLO H/D	29,64	29,64	377,51	0,07170	0,07170	832,440	832,440	0,70	264,26
09TPP00161	1	m2	AISLAMIENTO PAREDES PANEL LANA MINERAL 60 mm	11,14	11,14	12,38	0,01829	0,01829	282,263	282,263	1,00	12,38
QP01100	1	m2	CHAPA DE ALUMINIO CONFORMADA 0,7 mm ESP.	19,06	19,06	1,93	0,02312	0,02312	372,389	372,389	1,00	1,93
10LWW90201	1	m2	REV. PAREDES TRASDOSADO AUTOPORTANTE DE PLACAS DE YESO LAMINADO 13mm	18,18	18,18	19,97	0,08599	0,08599	1457,446	1457,446	1,00	19,97
RA05300	1	m2	PLACA PIEDRA CALIZA 3 cm, TAMAÑO ESTÁNDAR	0,00	0,00	28,55	0,00026	0,00026	1,499	1,499	1,00	28,55
WW00400	2	u	PEQUEÑO MATERIAL	0,30	0,60	0,04	0,00016	0,00032	2,652	5,304	0,00	0,00
				TOTAL EU	191,98	440,38	TOTAL HC	0,21048	TOTAL EI	3128,679	TOTAL RCD	327,09
											% reciclabilidad total	0,74

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10SMS90013 m2 TARIMA HAYA MACIZA 22 mm (M BLANDA)				€/UD	€	kg	HC tCO2eq		EI (MJ)		RCD reciclables en seco (kg)	
Tarima maciza de haya formada por tablas de 22 mm de espesor y 129 mm de ancho, machihembradas en sus cuatro lados, lijada y barnizada en fábrica, colocadas como tarima flotante mediante sistema de clips de acero instalados en las ranuras de cada tabla cada 50 cm, colocado sobre lámina de polietileno; construido según CTE. Medida la superficie ejecutada.												
TO00300	0,3	h	OF. 1ª COLOCADOR	19,85	5,96	0,00	0,00000	0,00000	0,000	0,000		
TP00100	0,3	h	PEÓN ESPECIAL	18,90	5,67	0,00	0,00000	0,00000	0,000	0,000		
RS05250	1,05	m2	TARIMA MACIZA HAYA 129X22 mm	73,53	77,21	14,13	-0,01633	-0,01714	242,880	255,024	1,00	14,13
RW01650	17	u	CLIPS DE ACERO	0,20	3,40	0,14	0,00006	0,00108	1,061	18,034	1,00	0,14
XI01100	1,05	m2	LÁMINA POLIETILENO 0,2 mm	0,60	0,63	0,21	0,00050	0,00052	17,723	18,609	0,80	0,16
				TOTAL EU	92,86	14,47	TOTAL HC	-0,01554	TOTAL EI	291,667	TOTAL RCD	14,43
											% reciclabilidad total	1,00

05ACS00000 kg ACERO PERFILES LAM. EN CAL. EN SOPORTES SIMPLES				€/UD	€	kg	HC tCO2eq		EI (MJ)		RCD reciclables en seco (kg)	
Acero en perfiles en caliente S 275 JR en soportes simples, incluso, corte, elaboración y montaje, lijado, con capa de imprimación antioxidante y p.p. de soldadura de cabeza y base casquillos y piezas especiales; construido ségun NCSR-02, CTE. Medido en peso nominal.												
TA00200	0,02	h	AYUDANTE ESPECIALISTA	19,04	0,38	0,00	0,00000	0,00000	0,000	0,000		
TO01600	0,02	h	OF. 1ª CERRAJERO-CHAPISTA	19,85	0,40	0,00	0,00000	0,00000	0,000	0,000		
CA01600	1,08	kg	ACERO PERFILES S 275 JR, SOPORTES SIMPLES	0,74	0,80	1,08	0,00193	0,00209	30,695	33,150	1,00	1,08
WW00300	0,06	u	MATERIAL COMPLEMENTARIO O PZAS. ESPECIALES	0,55	0,03	0,00	0,00016	0,00001	2,652	0,159	0,00	0,00
WW00400	0,08	u	PEQUEÑO MATERIAL	0,30	0,02	0,00	0,00016	0,00001	2,652	0,212	0,00	0,00
				TOTAL EU	1,63	1,08	TOTAL HC	0,00211	TOTAL EI	33,521	TOTAL RCD	1,08
											% reciclabilidad total	1,00

06DPC80415 m2 TABIQUE MÚLTIPLE PL. YESO LAMINADO 13+13+46+13+13 (98 mm)				€/UD	€	kg	HC tCO2eq		EI (MJ)		RCD reciclables en seco (kg)	
Tabique múltiple con dos placas de yeso laminado de 13 mm de espesor por cada cara y espesor final de 98 mm, cubriendo la altura total de suelo a techo, atornillado a entramado de acero galvanizado con una separación de montantes de 60 cm, incluso nivelación, ejecución de ángulos, pasos de instalaciones y recibido de cajas, encintado y repaso de juntas; construido según especificaciones del fabricante de las placas. Medido deduciendo huecos.												
TA00200	0,3	h	AYUDANTE ESPECIALISTA	19,04	5,71	0,00	0,00000	0,00000	0,000	0,000		
TO00900	0,3	h	OF. 1ª MONTADOR	19,85	5,96	0,00	0,00000	0,00000	0,000	0,000		
FP00500	1	m2	ENTRAMADO METÁLICO PARA TABIQUE PLACAS DE YESO LAMIN. 46x600 mm	2,50	2,50	2,75	0,00099	0,00099	16,724	16,724	1,00	2,75
FP01200	4,2	m2	PLACA DE YESO LAMINADO DE 13 mm	4,16	17,47	49,14	0,00419	0,01760	71,072	298,501	1,00	49,14
FP01800	1,6	kg	PASTA PARA JUNTAS DE PLACAS DE YESO LAMINADO	1,02	1,63	1,60	0,00001	0,00001	0,062	0,098	0,50	0,80
WW00300	2	u	MATERIAL COMPLEMENTARIO O PZAS. ESPECIALES	0,55	1,10	0,04	0,00016	0,00032	2,652	5,304	0,00	0,00
WW00400	0,5	u	PEQUEÑO MATERIAL	0,30	0,15	0,01	0,00016	0,00008	2,652	1,326	0,00	0,00
				TOTAL EU	34,52	53,54	TOTAL HC	0,01899	TOTAL EI	321,954	TOTAL RCD	52,69
											% reciclabilidad total	0,98

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07IGF00011	m2	FALDÓN DE PANEL AISLANTE CHAPA CONF. TIPO SANDWICH	€/UD	€	kg	HC tCO2eq		EI (MJ)		RCD reciclables en seco (kg)	
Faldón de panel aislante de chapa conformada tipo sandwich de 30 mm de espesor, formado por dos chapas conformadas de acero galvanizado de 0,5 mm de espesor, acabados exteriormente con resina de poliéster silicona y relleno interiormente por inyección con espuma de poliuretano rígido con una densidad de 40 kg/m3, incluso p.p. de tapajuntas de 0,7 mm de espesor del mismo material y acabado que las chapas del panel. Medido en verdadera magnitud deduciendo huecos mayores de 1 m2.											
ATC00100	0,25	h	CUADRILLA ALBAÑILERÍA, FORMADA POR OFICIAL 1ª Y PEÓN ESP.	37,51	9,38	0,00	0,00000	0,00000	0,000	0,000		
QP00800	1,01	m	TAPAJUNTA CHAPA LISA PARA PANEL SANDWICH ACAB. POLIÉSTER	3,99	4,03	20,21	0,15843	0,16002	2652,029	2678,549	1,00	20,21
QP02000	1,01	m2	PANEL SANDWICH 30 mm ACABADO INT. Y EXT. EN POLIÉSTER	22,70	22,93	37,08	0,32404	0,32728	5613,736	5669,874	0,40	14,83
WW00300	1	u	MATERIAL COMPLEMENTARIO O PZAS. ESPECIALES	0,55	0,55	0,02	0,00016	0,00016	2,652	2,652	0,00	0,00
WW00400	1	u	PEQUEÑO MATERIAL	0,30	0,30	0,02	0,00016	0,00016	2,652	2,652	0,00	0,00
				TOTAL EU	37,18	57,33	TOTAL HC	0,48761	TOTAL EI	8353,727	TOTAL RCD	35,04
											% reciclabilidad total	0,61

07IPF00001	m2	FALDÓN DE PIZARRA	€/UD	€	kg	HC tCO2eq		EI (MJ)		RCD reciclables en seco (kg)	
Faldón de pizarra fijada con ganchos clavados a entablado de madera de pino, incluso p.p. de rastreles. Medido en verdadera magnitud deduciendo huecos mayores de 1 m2.											
ATC00100	0,6	h	CUADRILLA ALBAÑILERÍA, FORMADA POR OFICIAL 1ª Y PEÓN ESP.	37,51	22,51	0,00	0,00000	0,00000	0,000	0,000		
CM00200	0,03	m3	MADERA DE PINO EN TABLA	195,18	5,86	15,30	-0,49808	-0,01494	7220,245	216,607	1,00	15,30
CM00800	2	m	RASTREL PINO FLANDES 60x30 mm	1,63	3,26	1,84	-0,00090	-0,00179	12,996	25,993	1,00	1,84
QZ00100	1,01	m2	PIEZAS DE PIZARRA PARA TEJADO	12,56	12,69	14,93	0,00382	0,00385	124,858	126,106	1,00	14,93
WW00300	2	u	MATERIAL COMPLEMENTARIO O PZAS. ESPECIALES	0,55	1,10	0,04	0,00016	0,00032	2,652	5,304	0,00	0,00
WW00400	1	u	PEQUEÑO MATERIAL	0,30	0,30	0,02	0,00016	0,00016	2,652	2,652	0,00	0,00
				TOTAL EU	45,71	32,12	TOTAL HC	-0,01241	TOTAL EI	376,662	TOTAL RCD	32,06
											% reciclabilidad total	1,00

07ITF90001	m2	FALDÓN DE TEJAS CURVAS DE CERÁMICA PRIMERA CALIDAD SOBRE RASTRELES	€/UD	€	kg	HC tCO2eq		EI (MJ)		RCD reciclables en seco (kg)	
Faldón de tejas curvas de cerámica de primera calidad colocadas por hiladas paralelas al alero, con solapes no inferiores a 1/3 de la longitud de la teja, colocación en seco sobre rastreles. Incluso parte proporcional de piezas especiales. Medido en verdadera magnitud deduciendo huecos mayores de 1 m2.											
ATC00100	0,55	h	CUADRILLA ALBAÑILERÍA, FORMADA POR OFICIAL 1ª Y PEÓN ESP.	37,51	20,63	0,00	0,00000	0,00000	0,000	0,000		
CM00200	0,03	m3	MADERA DE PINO EN TABLA	195,18	5,86	15,30	-0,49808	-0,01494	7220,245	216,607	1,00	15,30
CM00800	2	m	RASTREL PINO FLANDES 60x30 mm	1,63	3,26	1,84	-0,00090	-0,00179	12,996	25,993	1,00	1,84
WW00300	2	u	MATERIAL COMPLEMENTARIO O PZAS. ESPECIALES	0,55	1,10	0,04	0,00016	0,00032	2,652	5,304	0,00	0,00
WW00400	1	u	PEQUEÑO MATERIAL	0,30	0,30	0,02	0,00016	0,00016	2,652	2,652	0,00	0,00
QT00700	43,2	u	TEJA CERÁMICA CURVA	0,32	13,82	86,40	0,00165	0,07129	30,649	1324,038	1,00	86,40
				TOTAL EU	44,97	103,59	TOTAL HC	0,05503	TOTAL EI	1574,594	TOTAL RCD	103,53
											% reciclabilidad total	1,00

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07HTW00100 m2	CUBIERTA PLANA TRANS. NO VENT. CON SOLADO FLOTANTE SOBRE TANGANILLOS.			€/UD	€	kg	HC tCO2eq		EI (MJ)		RCD reciclables en seco (kg)	
Cubierta plana transitable, no ventilada, con solado flotante sobre soportes, tipo convencional, pendiente del 1% al 5%, para tráfico peatonal privado. FORMACIÓN DE PENDIENTES: mediante encintado de limatesas, limahoyas y juntas con maestras de ladrillo cerámico hueco doble y capa de arcilla expandida, vertida en seco y consolidada en su superficie con lechada de cemento, proporcionando una resistencia a compresión de 1 MPa y con una conductividad térmica de 0,087 W/(mK), con espesor medio de 10 cm; con capa de regularización de mortero de cemento, industrial, M-5 de 4 cm de espesor, acabado fratasado; AISLAMIENTO TÉRMICO: panel rígido de lana mineral soldable, hidrofugada, de 50 mm de espesor; IMPERMEABILIZACIÓN: tipo monocapa, adherida, formada por una lámina de betún modificado con elastómero SBS, LBM(SBS)-40-FP, totalmente adherida con soplete; CAPA SEPARADORA BAJO PROTECCIÓN: geotextil no tejido compuesto por fibras de poliéster unidas por agujeteado, (200 g/m²); CAPA DE PROTECCIÓN: pavimento flotante de baldosas de cemento de 40x40 cm, apoyadas sobre soportes regulables en altura de 30 a 50 mm. El precio no incluye la ejecución y el sellado de las juntas ni la ejecución de remates en los encuentros con paramentos y desagües.											
TO02100	0,27	h	OFICIAL 1ª	19,85	5,36	0,00	0,00000	0,00000	0,000	0,000		
TP00100	0,38	h	PEÓN ESPECIAL	18,90	7,18	0,00	0,00000	0,00000	0,000	0,000		
TO00700	0,12	h	OF. 1ª IMPERMEABILIZADOR	19,85	2,38	0,00	0,00000	0,00000	0,000	0,000		
TA00200	0,12	h	AYUDANTE ESPECIALISTA	19,04	2,28	0,00	0,00000	0,00000	0,000	0,000		
TO00900	0,05	h	OF. 1ª MONTADOR	19,85	0,99	0,00	0,00000	0,00000	0,000	0,000		
TA00100	0,05	h	AYUDANTE	19,04	0,95	0,00	0,00000	0,00000	0,000	0,000		
FL00300	0,003	mu	LADRILLO CERÁM. HUECO DOBLE 24x11,5x9 cm	83,82	0,25	9,12	0,69023	0,00207	8706,737	26,120	0,70	6,38
XT00200	0,1	m3	ÁRIDO LIGERO ARCILLA EXPANDIDA 400 kg/m3	135,87	13,59	40,00	0,14603	0,01460	1909,804	190,980	1,00	40,00
AGL00100	0,01	m3	LECHADA DE CEMENTO CEM II/A-L 32,5N	116,28	1,16	28,26	0,41142	0,00411	1972,600	19,726	0,50	14,13
GW00100	0,014	m3	AGUA POTABLE	0,55	0,01	14,00	0,00740	0,00010	30,509	0,427	0,00	0,00
GC00200	0,075	t	CEMENTO CEM II/A-L 32,5 N EN SACOS	92,54	6,94	75,00	0,78609	0,05896	3777,509	283,313	0,50	37,50
XT11500	1,05	m2	PANEL RÍGIDO FIB. VIDR. RECUBIERTO ESP. 40 mm DENS. 110 kg/m3	14,20	14,91	4,62	0,01169	0,01228	203,388	213,557	0,90	4,16
XI01800	1,1	m2	MEMBRANA BETÚN MODIF. ARM. DOBLE POLIETILENO 4 mm	6,65	7,32	5,28	0,00277	0,00305	262,198	288,417	0,00	0,00
QW00800	1,05	m2	TEJIDO ANTIPUNZONAMIENTO 100 gr/m2	0,90	0,95	0,11	0,00025	0,00027	9,042	9,495	0,80	0,08
XW00500	7,5	u	SOPORTE REGULABLE "PLOT" NEGRO RESISTENTE A INTEMPERIE Y CARGA DE 750KG	1,06	7,95	4,38	0,00190	0,01426	52,089	390,670	1,00	4,38
RS03400	1,05	m2	BALDOSA TERRAZO 40x40 cm GRANO MEDIO	6,98	7,33	3,43	0,00003	0,00003	0,171	0,180	1,00	3,43
				TOTAL EU	79,55	184,19	TOTAL HC	0,10973	TOTAL EI	1422,885	TOTAL RCD	110,06
											% reciclabilidad total	0,60

10SHS90002 m2	SOLADO EN SECO CON BALDOSAS HIDRÁULICAS DE 20x20 cm 9 PASTILLAS			€/UD	€	kg	HC tCO2eq		EI (MJ)		RCD reciclables en seco (kg)	
Solado con baldosas hidráulicas de 20x20 cm de nueve pastillas, solocadas en seco, fijación a presión, incluso nivelado con capa de arena de 2 cm de espesor medio, enlechado y limpieza del pavimento; construido según CTE. Medida la superficie ejecutada.												
TO01100	0,3	h	OF. 1ª SOLADOR	19,85	5,96	0,00	0,00000	0,00000	0,000	0,000		
TP00100	0,15	h	PEÓN ESPECIAL	18,90	2,84	0,00	0,00000	0,00000	0,000	0,000		
AA00200	0,02	m3	ARENA FINA	12,92	0,26	33,65	0,01529	0,00031	140,504	2,810	1,00	33,65
AGL00100	0,001	m3	LECHADA DE CEMENTO CEM II/A-L 32,5N	116,28	0,12	2,83	0,41142	0,00041	1972,600	1,973	0,50	1,41
RS02600	26	u	BALDOSA HIDRAULICA 20x20 cm	0,18	4,68	3,18	0,00010	0,00248	0,441	11,468	1,00	3,18
				TOTAL EU	13,84	39,66	TOTAL HC	0,00320	TOTAL EI	16,250	TOTAL RCD	38,24
											% reciclabilidad total	0,96

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CircularBIM PLUG-IN

CircularBIM development:

ALLOCATION OF THE ENVIRONMENTAL IMPACT OF THE MATERIALS THAT MAKE UP THE SOLUTIONS.

EXAMPLE:

A ventilated façade has been chosen as a constructive solution to compare using traditional materials (S01) and sustainable materials (S02).

S01. Traditional ventilated façade:

14FVL00001	m2	FACHADA VENTILADA CON TRASDOSADO INTERIOR DE PLACA DE YESO Y APLACADO EXTERIOR DE PI	€/UD	€	kg	HC tCO2eq		EI (MJ)		RCD reciclables en seco (kg)	
Hoja principal de fachada ventilada, apoyada sobre el forjado y enrasada, de 11,5 cm de espesor, de fábrica de ladrillo hueco doble, para revestir, 24x11,5x9 cm, con juntas horizontales y verticales de 10 mm de espesor, recibida con mortero de cemento industrial, color gris, M-5, suministrado a granel; formación de los dinteles mediante vigueta prefabricada T-18, revestida con piezas cerámicas, colocadas con mortero de alta adherencia. Aislamiento térmico compuesto por panel de lana mineral, según UNE-EN 13162, de 60 mm de espesor, resistencia térmica 1,75 m²K/W, conductividad térmica 0,034 W/(mK), colocado entre los montantes de la estructura portante, incluso p.p. de elementos de fijación, corte y colocación. Subestructura soporte regulable en las tres direcciones, para la sustentación del revestimiento exterior, de placas de piedra natural, de 60x30x2 cm, mediante el sistema de anclaje horizontal continuo oculto, formada por: perfiles verticales en C y perfiles horizontales continuos con uña oculta para el cuelgue del revestimiento, de aluminio extruido de aleación 6063 con tratamiento térmico T6, escuadras de carga y escuadras de apoyo de 80x60x100x5 mm, de aluminio extruido de aleación 6063 con tratamiento térmico T6. Incluso tirafondos y anclajes mecánicos de expansión de acero inoxidable A2, para la fijación de la subestructura soporte. Revestido interior de paredes con placas de yeso de 13 mm de espesor para trasdosado autoportante de muros, colocado sobre perfilería de acero galvanizado con fijaciones mecánicas, incluso replanteo, limpieza, nivelación, aplomado, ejecución de ángulos, pasos de instalaciones y repaso de juntas; construido según especificaciones del fabricante de los paneles. Revestimiento exterior de fachada ventilada, de placas mecanizadas de arenisca Caliza Capri, acabado abujardado, de 60x40x4 cm; colocación mediante el sistema de anclaje horizontal continuo oculto, sobre subestructura soporte regulable en las tres direcciones, de aleación de aluminio EN AW-6063 T6. Incluso tirafondos y anclajes mecánicos de expansión de acero inoxidable										
TO02100	2,72	h	OFICIAL 1ª	19,85	53,99	0,00	0,00000	0,00000	0,000	0,000		
TA00200	2,52	h	AYUDANTE ESPECIALISTA	19,04	47,98	0,00	0,00000	0,00000	0,000	0,000		
TP00100	0,5	h	PEÓN ESPECIAL	18,90	9,45	0,00	0,00000	0,00000	0,000	0,000		
MW00300	0,258	h	PLATAFORMA ELEVADORA TELESCOPICA	7,50	1,94	0,00	0,04186	0,01080	687,360	177,339		
06LHM00005	1	m2	FÁBRICA 1 PIE LADRILLO H/D	29,64	29,64	377,51	0,07170	0,07170	832,440	832,440	0,70	264,26
09TPP00161	1	m2	AISLAMIENTO PAREDES PANEL LANA MINERAL 60 mm	11,14	11,14	12,38	0,01829	0,01829	282,263	282,263	1,00	12,38
QP01100	1	m2	CHAPA DE ALUMINIO CONFORMADA 0,7 mm ESP.	19,06	19,06	1,93	0,02312	0,02312	372,389	372,389	1,00	1,93
10LWW90201	1	m2	REV. PAREDES TRASDOSADO AUTOPORTANTE DE PLACAS DE YESO LAMINADO 13mm	18,18	18,18	19,97	0,08599	0,08599	1457,446	1457,446	1,00	19,97
RA05300	1	m2	PLACA PIEDRA CALIZA 3 cm, TAMAÑO ESTÁNDAR	0,00	0,00	28,55	0,00026	0,00026	1,499	1,499	1,00	28,55
WW00400	2	u	PEQUEÑO MATERIAL	0,30	0,60	0,04	0,00016	0,00032	2,652	5,304	0,00	0,00
				TOTAL EU	191,98	440,38	TOTAL HC	0,21048	TOTAL EI	3128,679	TOTAL RCD	327,09
											% reciclabilidad total	0,74

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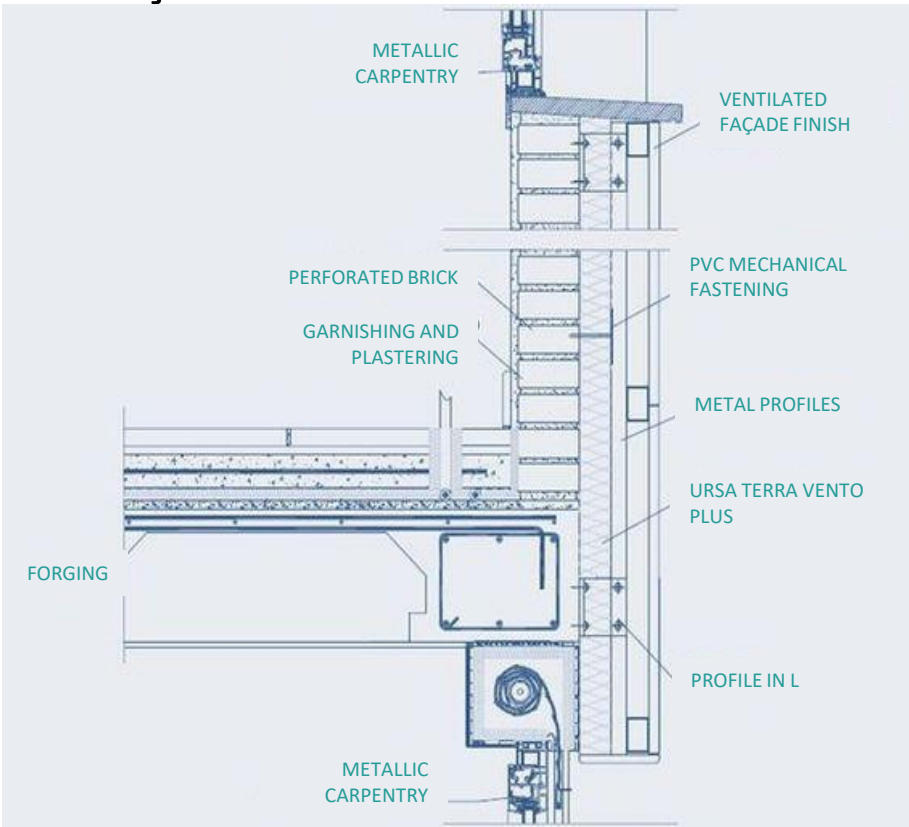
CircularBIM development:

EXAMPLE:

S01. Traditional ventilated façade:



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CircularBIM development:

EXAMPLE:

S02. Sustainable ventilated façade:

The materials of the S02 solution have been selected under environmental criteria, specifically materials that, in addition to meeting the technical conditions required for their function within the construction solution, have the eco-label III (DAP) and have a percentage of recycled material in their composition, so they are certified in their corresponding eco-label. This ensures the incorporation of materials produced under circular economy criteria, as well as the certainty that these materials are available on the market.

Capítulo				€	kg	HC tCO2eq		EI (MJ)		RCD reciclables en seco (kg)	
14FVL00002	m2	FACHADA VENTILADA CON TRASDOSADO INTERIOR DE LÁMINA DE MADERA Y ACABADO EXTERIOR CON TABLERO DE MADERA									
Hoja principal de fachada ventilada, apoyada sobre el forjado y enrasada, de 11,5 cm de espesor, de fábrica de ladrillo hueco doble, para revestir, 24x11,5x9 cm, con juntas horizontales y verticales de 10 mm de espesor, recibida con mortero de cemento industrial, color gris, M-5, suministrado a granel; formación de los dinteles mediante vigueta prefabricada T-18, revestida con piezas cerámicas, colocadas con mortero de alta adherencia. Aislamiento de paredes con placas de corcho conglomeradas de densidad 110 kg/m3 de 60 mm de espesor, colocado sobre superficies planas, incluso corte y colocación y material complementario. Revestido de paredes con placas de madera lisa para trasdosado autoportante de muros, colocado sobre perfilería de madera, incluso replanteo, limpieza, nivelación, aplomado, ejecución de ángulos, pasos de instalaciones y repaso de juntas; construido según especificaciones del fabricante de los paneles. Revestimiento exterior de fachada ventilada, de tableros compuestos HPL en madera natural para revestimientos exteriores. Forma parte de kit constructivo para el revestimiento de fachadas ventiladas formado por paneles de madera natural y su correspondiente subestructura. Cada panel está compuesto por un cuerpo de baquelita de alta densidad, revestido con una chapa de madera natural tratada en su superficie a base de resinas sintéticas y un film exterior de PVDF que aporta mayor durabilidad a los paneles, con propiedades antiadherentes, para proteger el tablero de la radiación solar, los agentes atmosféricos, la suciedad y los ataques de productos químicos (antigrafiti). Debido a su alta resistencia no requieren el mantenimiento habitual de otras maderas para exteriores. Materiales con más de un 8% de materia prima de origen reciclado y ecoetiqueta III. Medida la superficie ejecutada.										
TO02100	2,72	h	OFICIAL 1ª	19,85	53,99	0,00	0,00000	0,00000	0,000	0,000		
TA00200	2,52	h	AYUDANTE ESPECIALISTA	19,04	47,98	0,00	0,00000	0,00000	0,000	0,000		
TP00100	0,5	h	PEÓN ESPECIAL	18,90	9,45	0,00	0,00000	0,00000	0,000	0,000		
MW00300	0,258	h	PLATAFORMA ELEVADORA TELESCOPICA	7,50	1,94	0,00	0,04186	0,01080	687,360	177,339		
06LHM00005	1	m2	FÁBRICA 1 PIE LADRILLO H/D	29,64	29,64	377,51	0,07170	0,07170	832,440	832,440	0,70	264,26
09APP00250	1	m2	AISLAMIENTO PAREDES, PLACAS CORCHO 60 mm	14,44	14,44	6,71	-0,00398	-0,00398	354,099	354,099	1,00	6,71
10LWW90202	1	m2	REV. PAREDES TRASDOSADO AUTOPORTANTE DE PLACAS DE MADERA	19,51	19,51	15,22	0,03881	0,03881	967,241	967,241	1,00	15,22
10LWW90300	1,01	m2	REV. EXTERIOR DE FACHADA VENTILADA DE PANELES DE MADERA NATURAL	83,97	84,81	13,08	0,02480	0,02505	678,000	684,780	1,00	13,08
WW00400	2	u	PEQUEÑO MATERIAL	0,30	0,60	0,04	0,00016	0,00032	2,652	5,304	0,00	0,00
				TOTAL EU	262,36	412,56	TOTAL HC	0,14269	TOTAL EI	3021,203	TOTAL RCD	299,26
											% reciclabilidad total	0,73

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CircularBIM development:

ALLOCATION OF THE ENVIRONMENTAL IMPACT OF THE MATERIALS THAT MAKE UP THE SOLUTIONS.

EXAMPLE:

After applying the methodology described in both construction solutions, the economic cost (euros) and the environmental impact in terms of Carbon Footprint (CF), Embodied Energy (EE) and Waste (CDW) of each of them has been obtained.

Firstly, attention is focused on the total results, both economic and environmental, of both ventilated façade solutions, represented graphically in the following slide.

It can be seen how solution S01, composed of materials traditionally used in construction, has a lower economic cost than solution S02, which incorporates materials with environmental and recyclability criteria. However, when comparing the economic cost with the environmental impact, it can be seen that the environmental cost of solution S02 is lower in any of the three indicators (CF, EE and CDW) used in the analysis.

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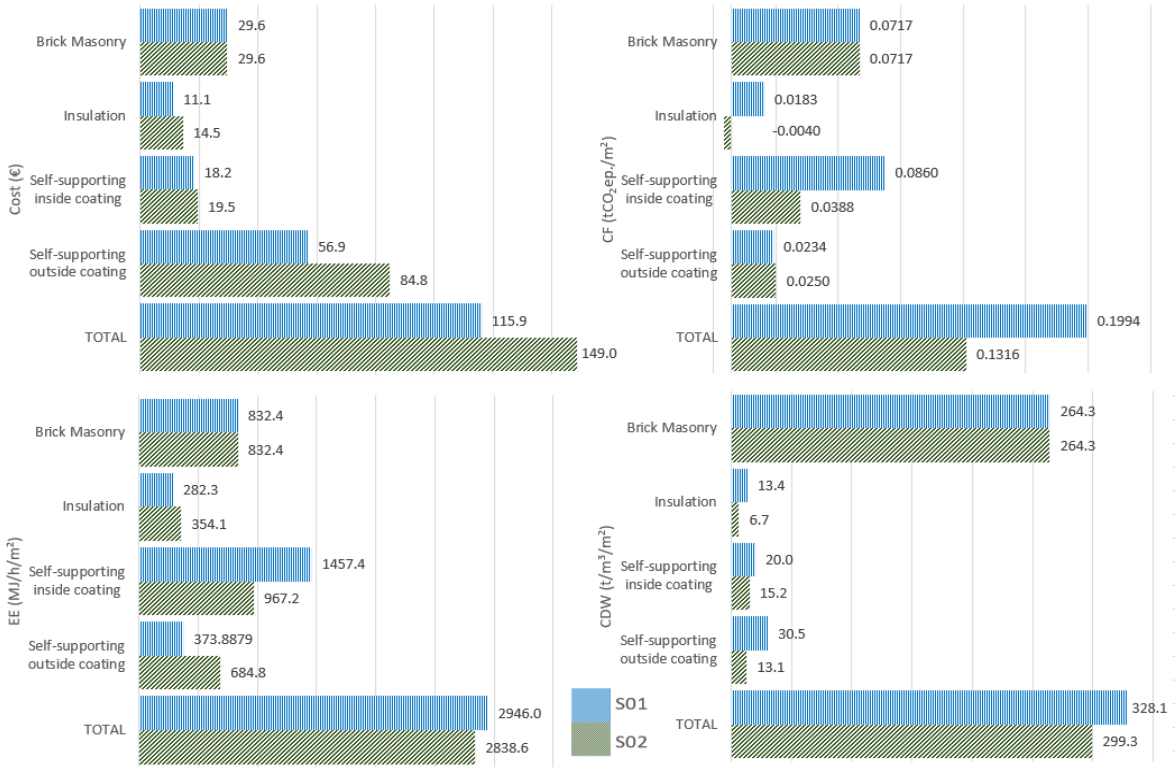
CircularBIM development:

ALLOCATION OF THE ENVIRONMENTAL IMPACT OF THE MATERIALS THAT MAKE UP THE SOLUTIONS.

EXAMPLE:

S01:

S02:



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CircularBIM development:

ALLOCATION OF THE ENVIRONMENTAL IMPACT OF THE MATERIALS THAT MAKE UP THE SOLUTIONS.

EXAMPLE:

On the other hand, when comparing the CDW generated by both solutions, it can be seen that with the S02 solution, the generation of CDW is reduced by around 5%, thanks to the fact that the cladding panels of this solution have a high percentage of recyclability and contain more than 8% of raw materials of recycled origin, certified through the type III ecolabel.

Continuing with the analysis of the results by materials, it is worth highlighting the comparison between the insulating materials used in the construction solutions, where the CF of the insulating materials of the S02 solution stands out, which is represented in the graph in negative terms. This is due to the fact that the cork used as insulating material in the S02 solution during its manufacturing process produces fewer emissions than the CO2 sequestration carried out by the cork oak trees (the tree from which the cork raw material comes) in its life cycle analysis, which translates into a negative balance of the carbon footprint.

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ALLOCATION OF THE ENVIRONMENTAL IMPACT OF THE MATERIALS THAT MAKE UP THE SOLUTIONS.

EXAMPLE:

The material that produces the greatest environmental impact of the solution should be highlighted in two of the indicators used in the analysis (CF, EE), namely laminated plasterboard, the lining material of the interior plaster that constitutes solution S01. This element represents around 43% of the FC and 49% of the EE of the construction solution, due to the high impact it generates from its extraction as a raw material, through its entire life cycle to its generation as waste, as this material has few possibilities for reuse and recycling, and is therefore far from the circular economy criteria.

In the S02 solution, this material is replaced by recycled wood sheets, thereby reducing the CF of the solution by around 55% and the EE by 34%, as well as contributing to the reuse and recycling objectives pursued by the circular economy.

CircularBIM PLUG-IN

CircularBIM development:

ALLOCATION OF THE ENVIRONMENTAL IMPACT OF THE MATERIALS THAT MAKE UP THE SOLUTIONS.

EXAMPLE:

To conclude the analysis, the indicator referring to CDW allows us to glimpse the amount of waste generated by the materials that make up the different construction solutions and thus analyse the possibility of recirculation and recyclability of this waste.

According to the results obtained, all the elements of solution S02 generate less waste than the elements that make up S01.

From this analysis, the outer leaf stands out, which generates 53% less waste in the S02 solution than in the S01 solution. This is due to the potential use of the wood materials that make up the outer leaf of solution S02. In the analysis of the results of this indicator, it is necessary to consider, in addition to the waste generation of the different elements, the percentage of recyclability of such waste.

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EXAMPLE:

Given that the ventilated façade solutions analysed in this work are characterised by their capacity for disassembly, the percentage of recyclability of the same is increased. Specifically, in the case of solution S01, considering the total weight of the construction solution (440.38 kg), the recyclability of the total of its components is around 74%, while solution S02 (total weight 412.56 kg) has a recyclability of 73%.

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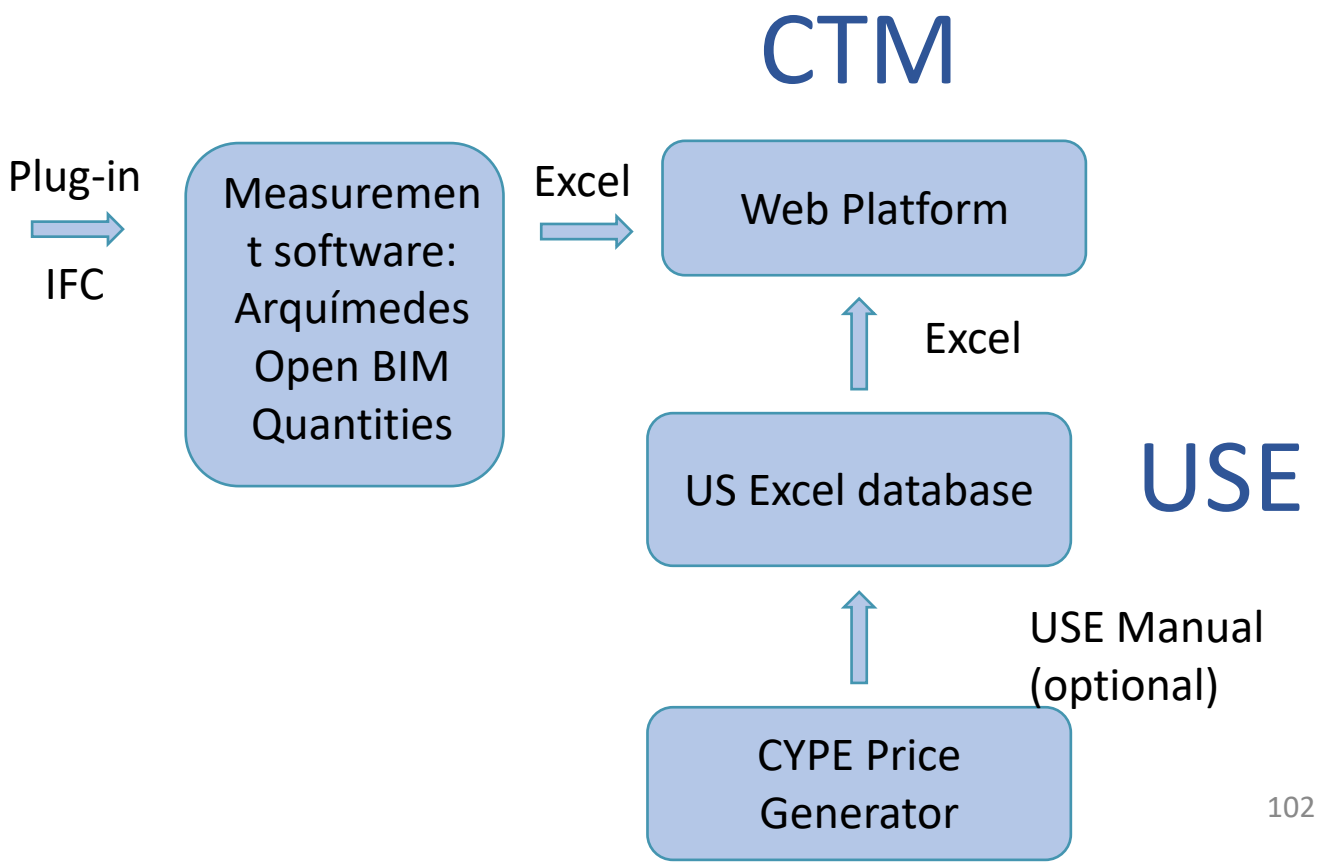
CircularBIM development:

Workflow diagram:



Steps:
BIM model
Database

SOURCES

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Website del proyecto CircularBIM. https://circularbim.eu/

Website del proyecto BIMhealthy. https://bimhealthy.eu/

BIMEPD

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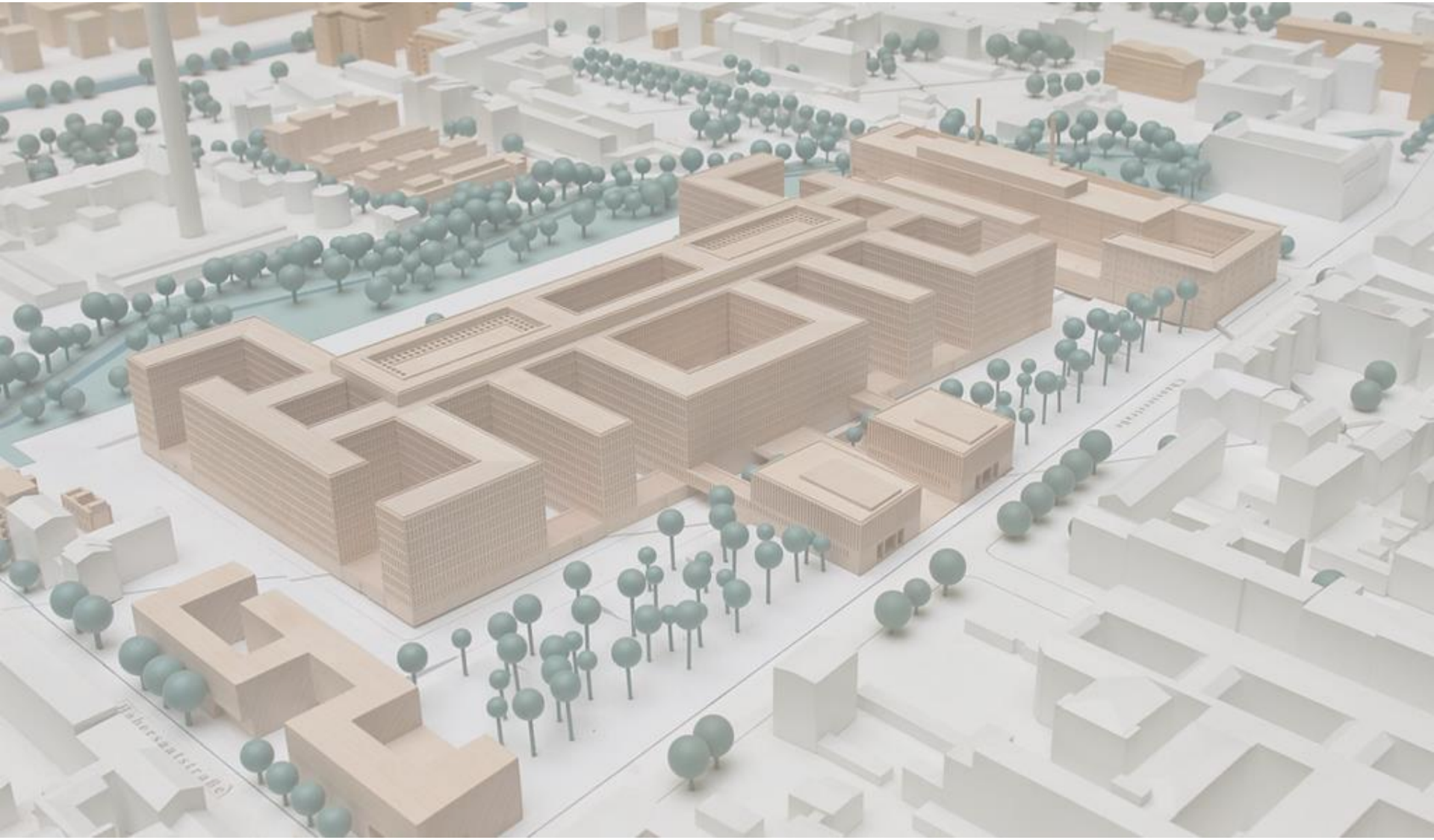

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