An assessment method for residential buildings in Beirut

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Introduction

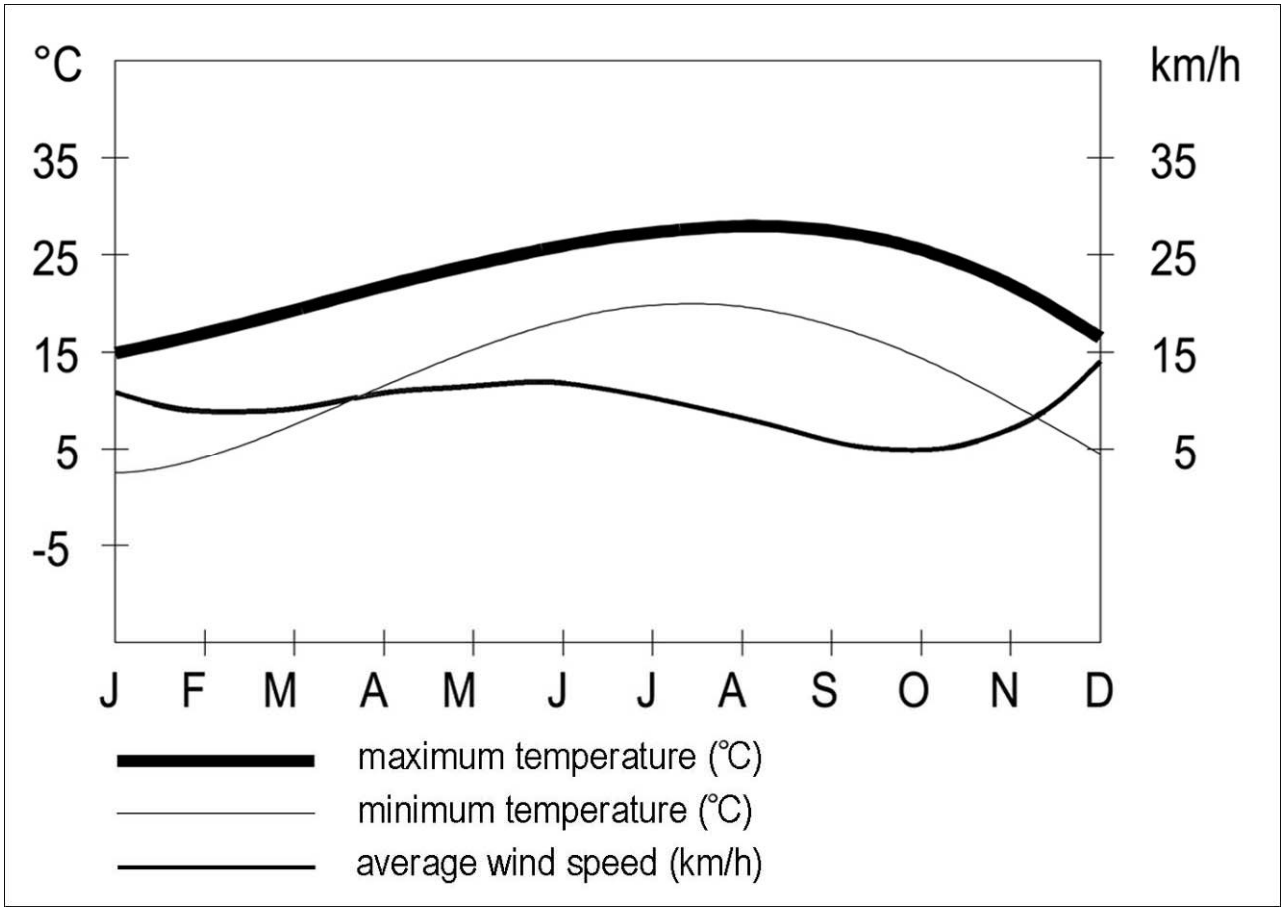
Percentages of building types in the Beirut area

- Residential 65%
- Non-Residential 11%
- Mixed 20%
- Other 4%

CAS Studies, 1996-98 (Lebanon State of the Environment – Ministry of the Environment – LEDO)

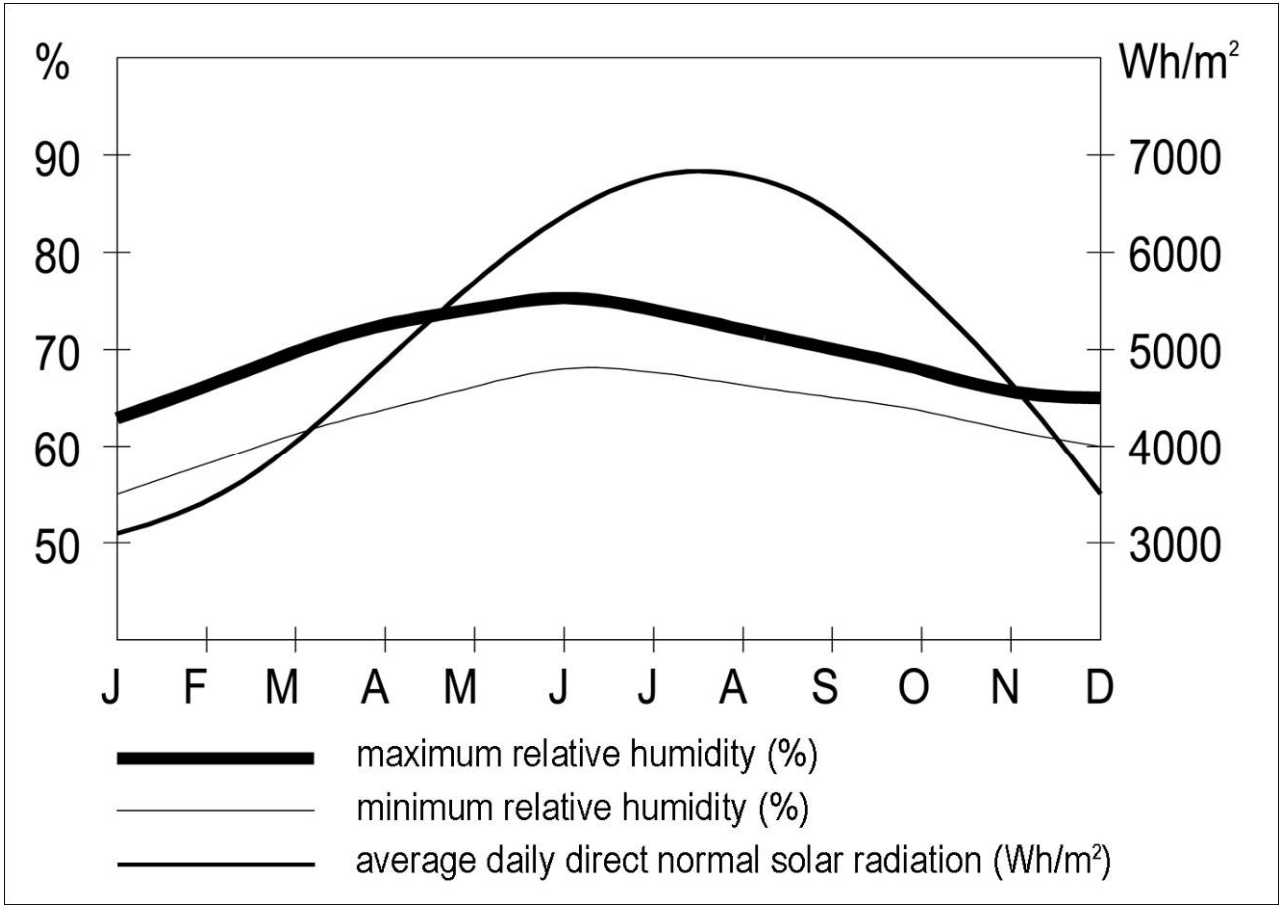
Climate and environment in Beirut

Temperature and wind speed



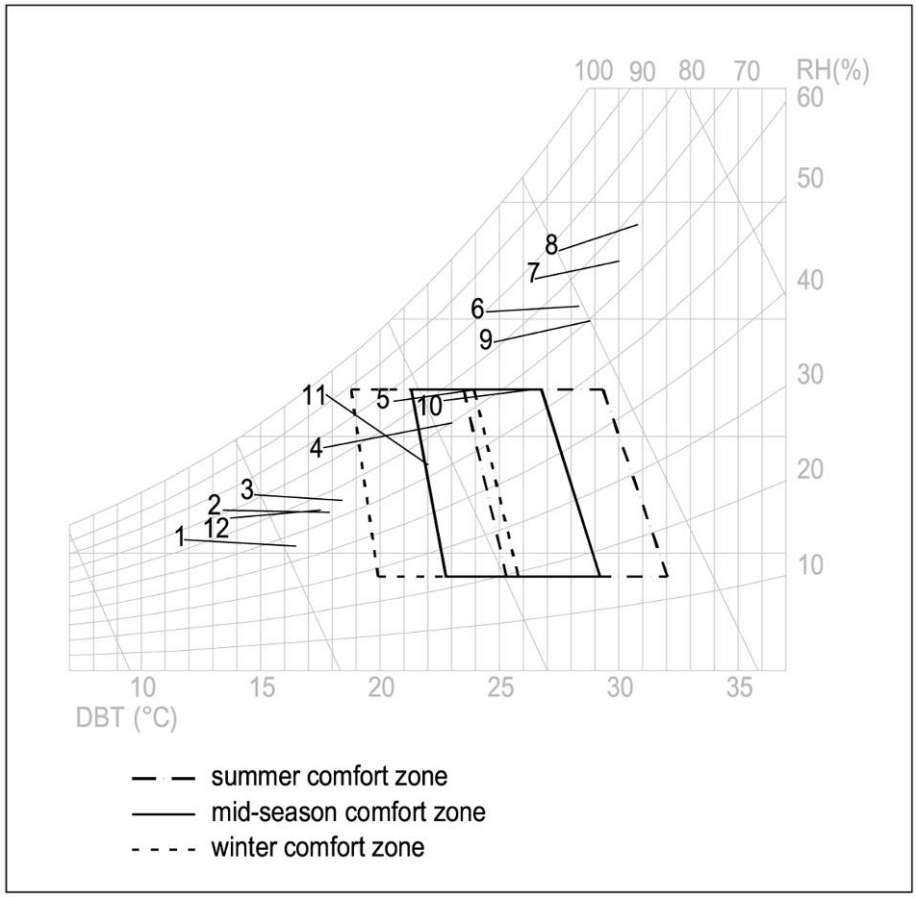
Climate and environment in Beirut

Relative humidity and solar radiation



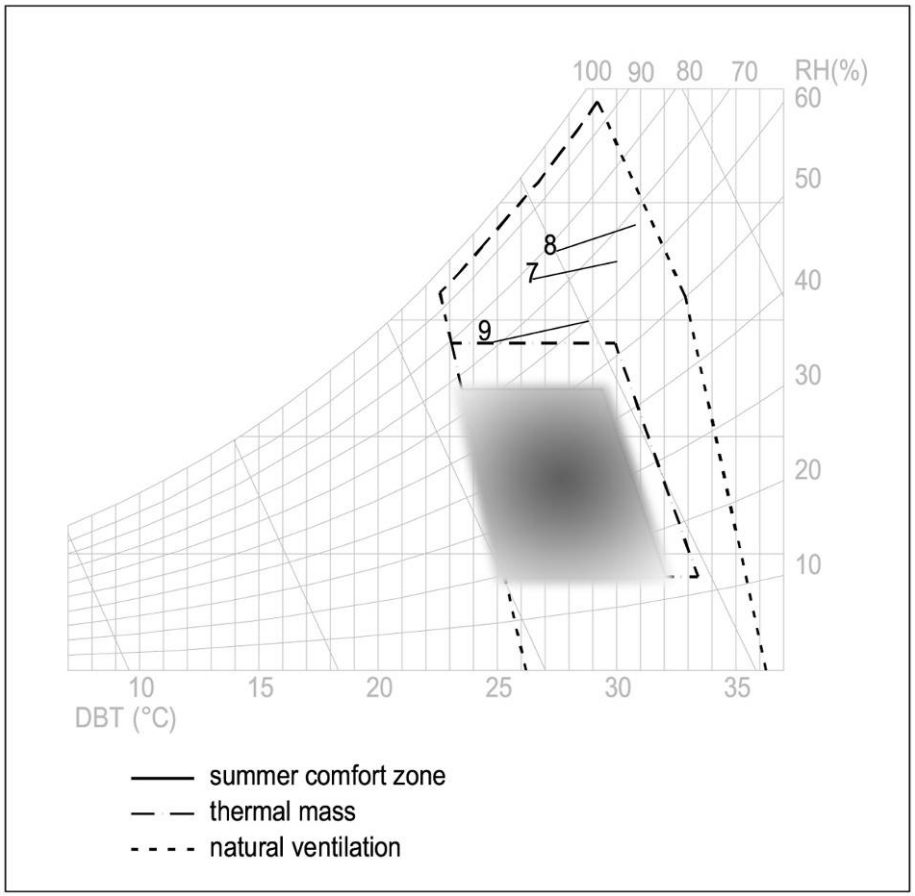
Climate and comfort

Comfort zones with yearly climatic conditions



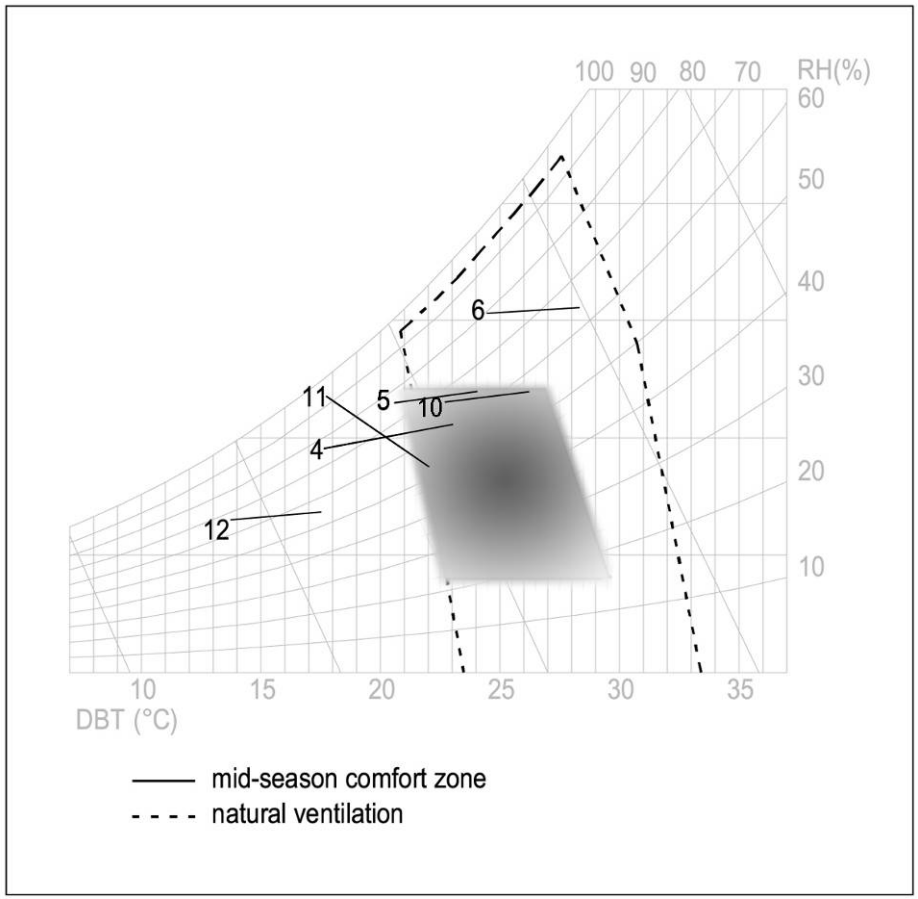
Passive strategies

Summer season



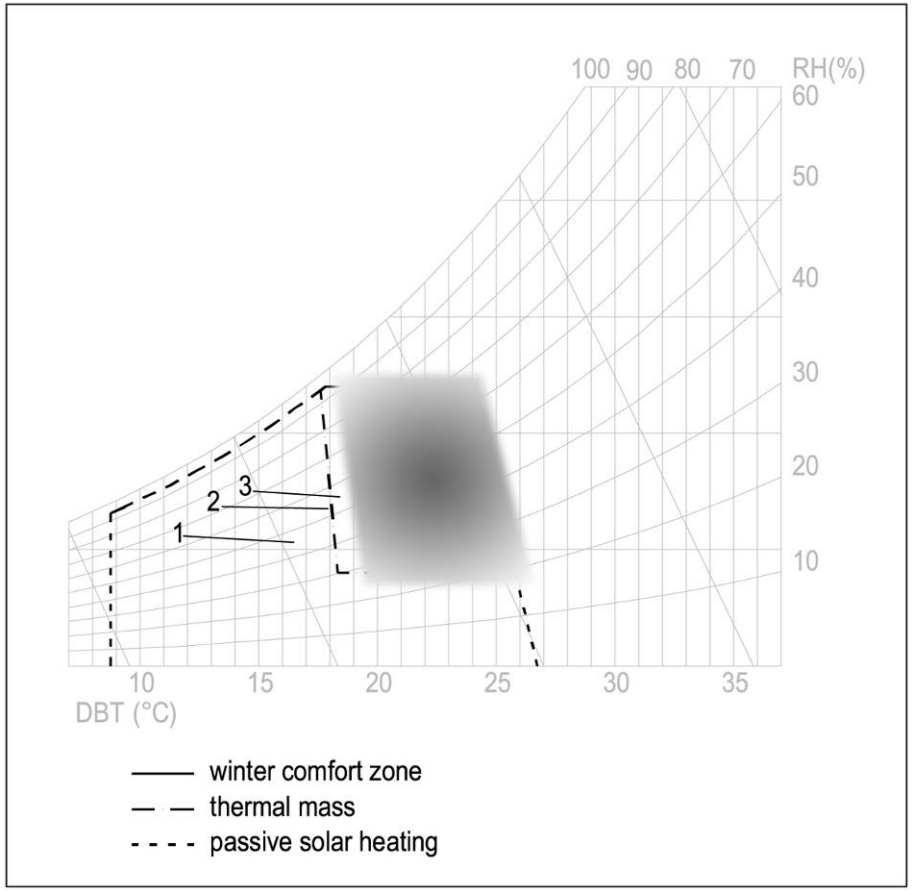
Passive strategies

Mid season



Passive strategies

Winter season



Existing assessment methods

- EcoHomes
- Leadership in Environmental and Energy Design (LEED)
- Building Materials Assessment System (BMAS)

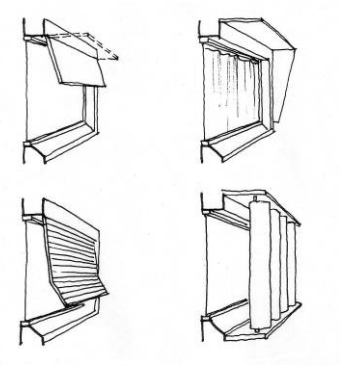
Development of the design ecology index (DEI)

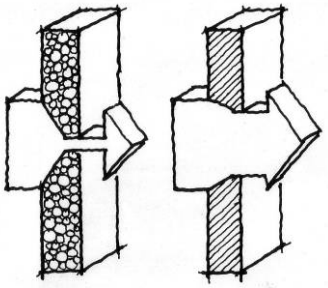
Parameters to be considered for the evaluation

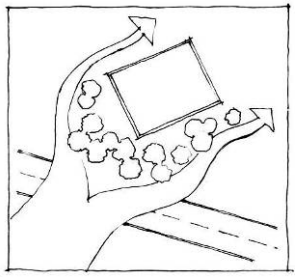
Description	Weight
• Massing of the building	3 points
• Shading of openings	3 points
• Natural ventilation	3 points
• Orientation of the building	2 points
• Thermal mass	2 points
• Landscaping	2 points
• Winter passive solar gain	1 point

Weighting is from 1 to 3 (3 being the best score)

Max score = 48 average = 32 low = 16







Development of the material ecology index (MEI)

- BMAS → EF (ecology factor)
- Material = EF x W (weight)

Material ecology index = sum of the ecology factors x weight

$$MEI = \Sigma (EF \times W)$$

Application of the method

A Residential Building

Application of the method

Design Ecology Index (DEI)

	score	x	weight	
• Massing of the building	2	x	3	= 6
• Shading of openings	3	x	3	= 9
• Natural ventilation	1	x	3	= 3
• Orientation of the building	1	x	2	= 2
• Thermal mass	1	x	2	= 2
• Landscaping	1	x	2	= 2
• Winter passive solar gain	2	x	1	= 2

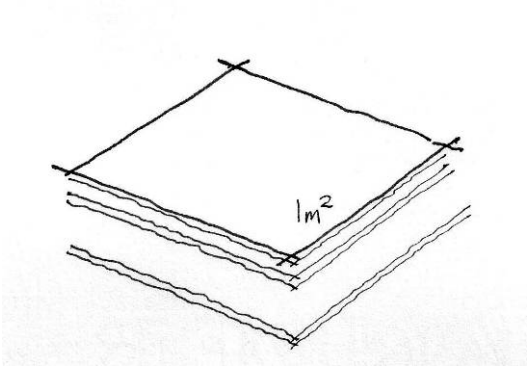
Total = 26 medium DEI

Application of the method

Material Ecology Index (MEI)

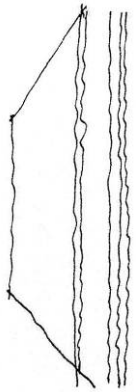
The weight per square meter of slab, by material, is equal to (from top to bottom):

- Floor tiles: 2.5 cm thick 55 kg/m2
- Mortar bed: 2 cm thick 44 kg/m2
- Fill: 10 cm thick 185 kg/m2
- Hourdi slab: 25 cm thick 450 kg/m2
  (approx. 400 kg/m2 concrete and 50 kg/m2 steel reinforcement)
- Plaster: 2 cm thick 44 kg/m2



The weight per square meter of wall, by material, is equal to (from outside to inside):

- Stone cladding: 5 cm thick 105 kg/m2
- Mortar: 3 cm thick 66 kg/m2
- Hollow concrete block: 20 cm thick 376 kg/m2
- Rigid insulation: 5 cm thick 1.8 kg/m2
- Hollow concrete block: 10 cm thick 200.5 kg/m2
- Plaster: 2 cm thick 44 kg/m2



Application of the method

Material Ecology Index (MEI)

Material	Weight
• Cement	1710 tons
• Aggregate	9142 tons
• Metal reinforcement	205 tons
• Sand	2123 tons
• Stone cladding	130 tons
• Aluminium	10 tons
• Glass	35 tons
• Tiles	356 tons

Application of the method

Cement

	Criteria	R	R^2	W	P	Remarks
Extraction	Damage to the environment in the extraction of raw material	3	9	3	27	Quarries are confined to particular areas.
	Extent of the damage relative to the amount of material produced	3	9	2	18	The limited quarries result in a large amount of material used for construction purposes.
	Abundance of source or renewability of material	4	16	4	64	Limited quarries but not abundant or renewable.
	Recycled content.	4	16	3	48	Can't be recycled.
Manufacture	Solid and liquid wastes in manufacture and production	4	16	3	48	Water is wasted when washing the material and cleaning klinkers.
	Air pollution in manufacture and production	3	9	4	36	Most production plants provide continuous air filtering.
	Embodied energy (energy used for its production)	4	16	5	80	Some companies are improving the process. The high temperature burners consume a lot of energy.
Construction	Energy used for transportation to the site	3	9	3	27	Air polluting trucks and mixers transport material to construction sites.
	Energy used on site for assembly and erection	3	9	1	9	Pumps and site installed concrete mixers consume energy provided by diesel engine generators.
	On site waste including packaging	1 1	1 1	2 2	2 2	Residual material from the concrete mixers. Dust and paper bags result from the cement that is received and mixed on site.
In use	Maintenance required during life cycle	1	1	3	3	Needs some maintenance due to carbonation resulting from the existing air pollution.
	Environmental effects during life cycle (toxic emissions)	0	0	3	0	Does not produce any toxic emissions.
Demolition	Energy use in and effects of demolition at the end of the life cycle	4	16	2	32	Jackhammers and swingballs are methods used to demolish cement. It is a time consuming process.
	Recyclability of demolished material	2	4	4	16	Most of the material is used as backfill or under-tile screed.
Ecology Factor					418	

R: Rating W: Weight P: Product

Application of the method

Material	EF x W
• Cement	714780
• Aggregate	3729936
• Metal reinforcement	26855
• Sand	866184
• Stone cladding	53040
• Aluminium	610
• Glass	2100
• Tiles	90068
Total material ecology index	5483573

Application of the method

replacing a percentage of the opaque components (cement, aggregate, sand and stone cladding) with glass

→ the index decreases by approximately 17% when the opaque elements are reduced and the glass is increased by 25%.

→ the index decreases by around 37% when the opaque components are reduced and the glass is increased by 50%.

Conclusion

- This assessment method is a starting point in trying to initiate awareness pertaining to how a building is environment friendly.

- At the early stages of the design process, it provides a measure for architects to analyse and better understand the behaviour of the building. By varying the parameters included in the calculations, designers can implement changes to improve its performance.

  It can also be applied to existing buildings for a comparative purpose.

- Substantial work need to be executed n order to fine tune the value of the ecology factor for each material.

Thank you for your presence