Towards development of a label for Zero Emission Buildings: A Tool to evaluate potential Zero Emission Buildings

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Overview

- Requirements of ZEB-ISTIS Concept for tool
- Development of ZEB Assessment Tool
- Application of ZEB Assessment Tool
- Evaluation of ZEB Assessment Tool

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Requirements of ZEB-ISTIS concept for tool

- Evaluation of **existing** buildings (→ case studies)
- Assessment of
  - Energy
  - Biomass
  - Water
  - Qualitative aspects
- Applicable to different countries of location (partner countries)
- Incorporation of various environmental impacts

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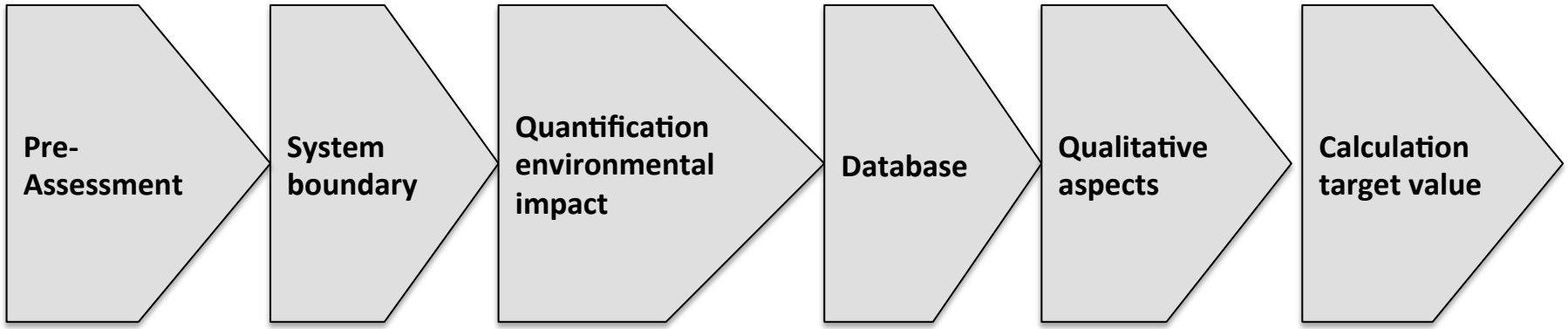
- Process: evaluation of decision parameters



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Pre-Assessment

Considerations:

- How can a pre-assessment be easily conducted in order to determine if the building is eligible for a further examination with the tool?
- What method can be applied to ensure the building address the three sectors to a minimum level?

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Pre-Assessment: Eligible Technologies

Table 2: Eligible technologies for the assessment of the three sectors of the Zero Emission Building (ZEB) Concept. At least two sectors with at least two technologies each ought to be implemented in a building in order to qualify for further evaluation.

Sector	Eligible technologies
Water	Rainwater harvesting, water saving devices, decentralized wastewater treatment, water re-use, urine separation
Energy	Photovoltaic, solar thermal collectors, wind turbine, geothermal energy, highly insulated envelope, heat recovery, use of waste heat, passive energy use
Biomass	Composting of organic waste, composting of faeces, vermicomposting, nutrients recovery from urine, production of fertile soil, biochar production, food production on site (soil based or soilless, such as hydroponic, aquaponics), biomass production on site

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Pre-Assessment: Eligible Technologies

Conditions for further assessment:

- 2 implemented eligible technologies to fulfil sector
- 2 fulfilled sectors fur further assessment with ZEB Tool

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System boundary

Considerations:

- What processes should be considered?
- Which processes have an environmental impact?

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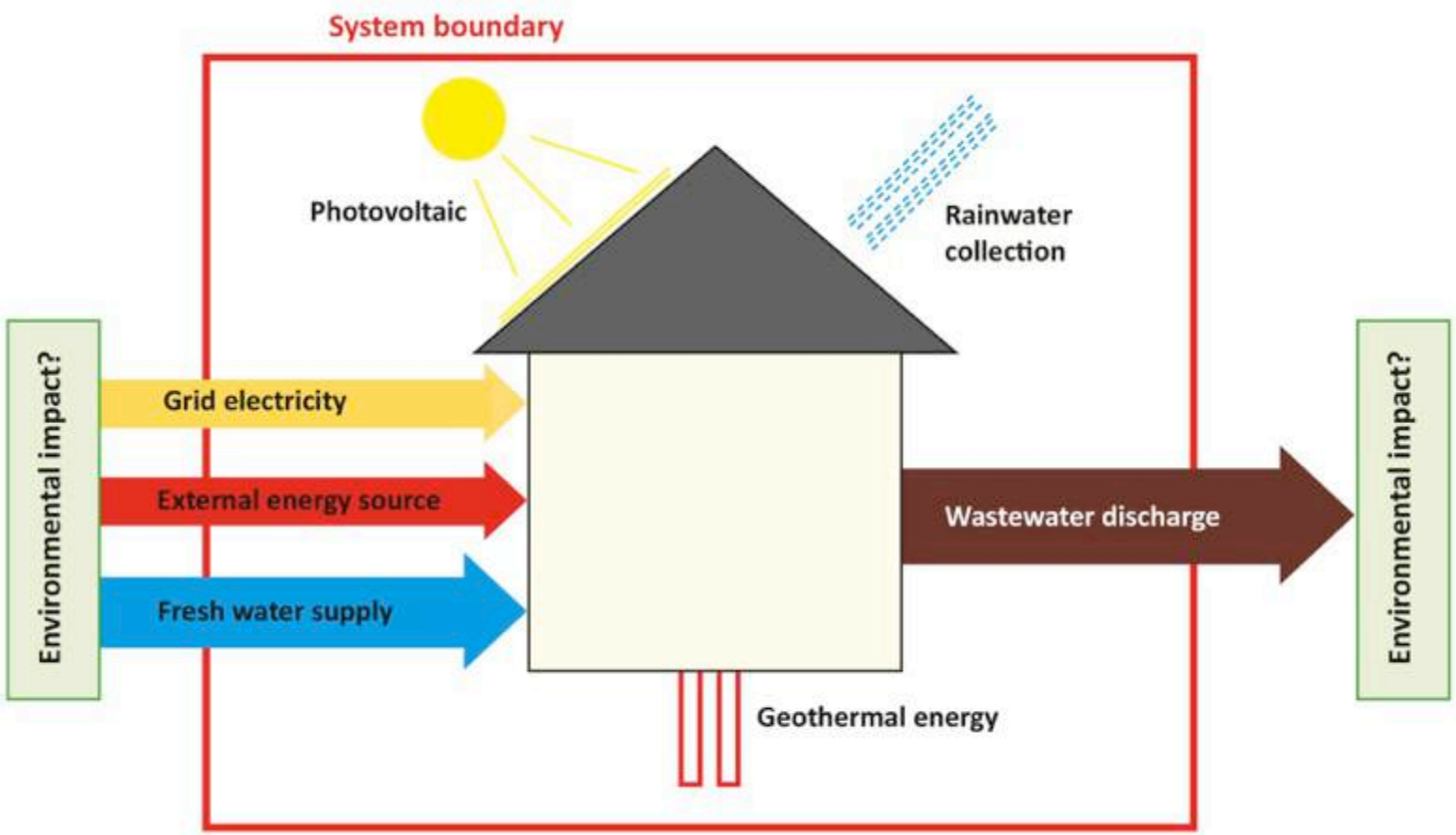

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System boundary: *Site boundary*

Considered flows:

- Flows into the system boundary
- Flows out of the system boundary
- Flows conveyed by human activity

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System boundary: *Site boundary*

Relevant energy and resource flows (energy & water):

- Grid electricity consumption (Grid electricity)
- Consumption of external energy sources (External energy)
- Consumption of freshwater from central supply facility (Freshwater)
- Discharge of wastewater into central treatment plant (Wastewater)

Different considerations for biomass

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Quantification of environmental impact

Considerations:

- How can the environmental impact be quantified?
- Which method fulfils the requirements of the ZEB concept?

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Quantification of environmental impact: *Ecological Scarcity*

- "Distance to target" based method
- Based on environmental laws and political targets
- Unit: UBP (Umweltbelastungspunkte, Eco-Points)
- Advantages:
  - Incorporates various environmental impacts
  - Different values for each country

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Database for UBP

Considerations:

- Which databases can be used to look up the values for the relevant flows?

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Database for UBP*: Ecoinvent Database, KBOB-list, own calculations*

- Ecoinvent Database: Most comprehensive international database for Life Cycle Inventory Data
- KBOB-list: Life cycle assessment data for building industry
- Considerations for biomass:
  - Difficult to determine environmental impact of biomass input (food)
  - Cannot be avoided anyway

  → Calculation of potentially avoided UBP if specific processes were implemented (i.e. composting, nutrients recovery)

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Quantification of qualitative aspects

Considerations:

- How can qualitative aspects be assessed in a quantitative way?
- Which criteria should be considered?
- How can sensible benchmarks be established?

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Quantification of qualitative aspects: *Additional UBP*

- Set of criteria
- Allocation of grade:
  - «Fully applies»
  - «Partially applies»
  - «Does not apply»
- Benchmarks

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Table 6: Compilation of criteria for the evaluation of qualitative aspects

	Criteria	***Fully applies***	***Partially applies***	***Does not apply***
	Additional Points	**+ 0 Points**	**+ 800 Points**	**+ 1600 Points**
1	Good connection to public transport	Public traffic connection within 300 m	Public traffic connection within 1 km	Public traffic connection over 1 km
2	Integration of greenery into the building	Roof and façade greening	Roof or façade greening	No greening
3	Building construction is suitable for a potential change of use	Suitable location and building shape	Suitable location or building shape	None of both
4	Building is constructed of ecological materials, i.e. recycled materials or readily available primary raw materials (Caspar & Rütter-Fischbacher, 2010)	80 – 100 %	40 – 80 %	0 – 40 %
5	Grey energy of construction (per energy reference area, 60 years lifetime; according to bulletin SIA 2032 (Gugerli et al., 2008))	< 30 kWh/m^{2}a	30 – 60 kWh/m^{2}a	> 60 kWh/m^{2}a
6	Building design fits to the surrounding environment	Adapted shape and materials	Adapted shape or materials	None of both

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Calculation of target value

- How can consideration be given to different building purposes and corresponding variation of resource consumption?
- How should the target value be calculated and expressed?

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Calculation of target value:

Classification into building types

Different benchmarks

Calculation of degree of achievement

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Classification & Benchmark

Table 7: Classification of buildings with benchmarks based on the energy consumption indicator of Minergie. The benchmark value corresponds to zero degree of achievement for the particular type of building.

Building type	**Minergie energy consumption indicator (kWh/m^2)**	**Consumption Index**	**Benchmark (Rating Points)**
Industry Store	20	1	**100’000***
Sport installation	25	1.25	125’000
Apartment building Single-family Home	38	1.9	190’000
Administration Sales School Meeting venue Special construction	40	2	200’000
Restaurant/ Hotel	45	2.25	225’000
Hospital	70	3.5	350’000

* The 100'000 Rating Points benchmark represents the basic benchmark for the ZEB Assessment Tool. It was established based on experimental data of buildings examined with the ZEB Assessment Tool

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Calculation of degree of achievement

The achieved number of UBP for the assessed object was calculated as follows:

$$Achieved\ UBP = \frac{UBP_{Water} + UBP_{Energy} + UBP_{Biomass}}{Area} + Additional\ UBP$$

Subsequently, the degree of achievement was calculated:

$$Degree\ of\ achievement\ (\%) = 100 - \frac{100 * Achieved\ UBP}{Benchmark}$$

Min. **80%** degree of achievement to achieve the “ZEB Label”

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Application ZEB Assessment Tool – Input data

Table 8: Input parameters and units for the ZEB Assessment Tool. Units FA, PA and NA denote "*fully applies*", "*partially applies*", and "*does not apply*", respectively.

Input parameter	**Unit or Description**
Country	-
Building type	-
Total effective area of building	m^2
Average occupancy per day	Number of people
Freshwater*	m^3/a
Wastewater*	m^3/a
Grid electricity*	kWh/a
Electricity product	-
External energy*	MJ/a
Application of:	
- Composting of faeces	YES / NO
- N recycling from urine for fertilizer	YES / NO
- P recycling from urine for fertilizer	YES / NO
- Nutrients recovery of organic kitchen waste	YES / NO
- Good connection to public transport	FA / PA / NA
- Integration of greenery into the building	FA / PA / NA
- Construction is suitable for a potential change of use	FA / PA / NA
- Building is constructed of ecological materials	FA / PA / NA
- Grey energy of construction	FA / PA / NA
- Building design fits to the surrounding environment	FA / PA / NA

* Notation according to the definition in point *2.2.2 System boundary*

Application ZEB Assessment Tool – Pre-Assessment

ZEB Assessment Tool

Project: New Monte Rosa Hut

Pre-Assessment

Sector	Eligible technologies	
Water	☒	Rainwater harvesting
	☒	Water saving devices
	☒	Decentralized wastewater treatment
	☒	Water re-use
	☐	Urine separation
Energy	☒	Photovoltaic
	☒	Solar thermal collectors
	☐	Wind turbine
	☐	Geothermal energy
	☒	Highly insulated envelope
	☐	Heat recovery
	☐	Use of waste heat
	☐	Passive energy use
Biomass	☒	Composting of organic waste
	☐	Composting of faeces
	☐	Vermicomposting
	☐	Nutrients recovery from urine
	☐	Production of fertile soil
	☐	Biochar production
	☐	Food production on-site
	☐	Biomass production on-site
Further Assessment	YES	

Figure 3: Pre-Assessment in the ZEB Assessment Tool

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Application ZEB Assessment Tool – Assessment of Energy, Water & Biomass

Country	Switzerland
Building type	Restaurant/ Hotel
Total effective area of building (m2)	698
Average occupancy (people/day)	100

Choose from the box
Fill in the yellow fields

Water

Freshwater		**Wastewater**	
Water use (m3/a)	0	Discharge water (m3/a)	0
Ecological scarcity (UBP/m3)	362.9	Ecological scarcity (UBP/m3)	4077.2
UBP	0	UBP	0

Energy

Grid electricity		**External energy**	
Electricity use from grid (kWh/a)	0	Energy source 1	Rapeseed oil
Electricity product	CH Label-certified electricity	Energy consumption (MJ/a)	237600
Ecological scarcity (UBP/kWh)	50.618	Energy source 2	NO
		Energy consumption (MJ/a)	0
		Avg. ecological scarcity (UBP/MJ)	15.51
UBP	0	UBP	3685176

Biomass

Total ecological scarcity (UBP)		22514088
Processes		**Avoided UBP**
Composting of faeces	NO	0
N recycling from urine for fertiliser	NO	0
P recycling from urine for fertiliser	NO	0
Nutrients recovery of organic kitchen waste	YES	153750
e.g. composting, use of digestate		
	UBP	22360338.00

Total UBP of operation	26045514
UBP/m2	37314

Figure 4: Assessment of the three sectors Water, Energy and Biomass in the ZEB Assessment Tool.

Application ZEB Assessment Tool – Qualitative aspects

Qualitative and superior aspects	Fully applies	Partially applies	Does not apply
Good connection to public transport	○	○	◉
Integration of greenery into the building	○	○	◉
Building construction is suitable for a potential change of use	○	◉	○
Building is constructed of ecological materials	◉	○	○
Grey energy of construction	◉	○	○
Building design fits to the surrounding environment	○	◉	○
		Additional UBP	4800

Figure 5: Assessment of qualitative aspects in the ZEB Assessment Tool

Application ZEB Assessment Tool – Output data

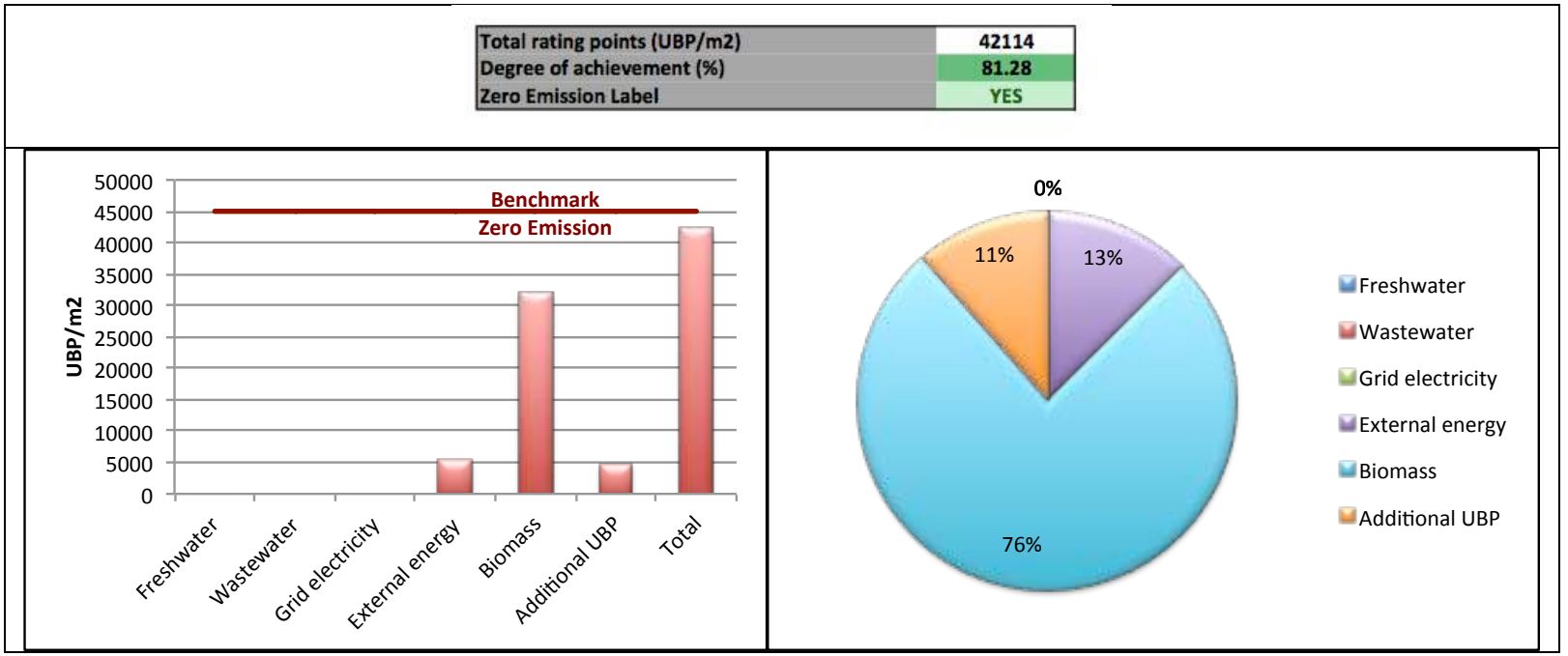

Figure 6: Output data of the ZEB Assessment Tool

Evaluation of ZEB Assessment Tool

Advantages ZEB Assessment Tool:

- Requires small amount of input data
- Allows simple primary assessment of a specific building
- Covers the aspects of energy, water and biomass
- Incorporates qualitative aspects
- Applicable in different countries
- Considers various environmental impacts

→ The ZEB Assessment Tool is well adapted to the requirements of the ZEB concept