ASSESSMENT OF ACIDIFICATION POTENTIAL OF BUILDINGS IN CORPORATIVE AND HIGH SCHOOL DUAL EDUCATION[1]

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Summary: *Construction Cluster DUNDJER from Niš took part in an European FP7 project (FP7, Grant Agreement No. 244130) entitled OPEN HOUSE, having as a main goal to create and propose new method for assessment of buildings using more general and detailed criteria. The proposed methodology consists of the following assessments:*

- *environmental quality,*
- *social-functional quality,*
- *economic quality,*
- *technical quality (characteristics),*
- *process quality (design and construction),*
- *position of the building (location).*

Acidification potential of buildings belongs to criteria for assessment of environmental quality of buildings. Those criteria are not a part of standard curiculae on universities and high schools. Therefore, there are very important topics to study in the frame of non-formal, dual, and corporate education, what is this paper dealing with. As a part of collaboration between industry and high education and research institutions, Construction Cluster DUNDJER and Faculty of Civil Engineering and Architecture of University of Niš are developing methods and procedures for assessment of quality of buildings in whole "life cycle" of buildings (so known LCA – Life Cycle Assessment) what should be a basis for new curricula in high schools and on the university and in addition in appropriate dual education. This pilot project should be implemented in three construction firms, members of Cluster DUNDJER.

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1. INTRODUCTION

The research presented here is initiated by European project OPEN HOUSE (7th FP ENV - 2009.3.1.5.2). OPEN HOUSE methodology consists of the following assessments:

- **environmental quality,**
- social-functional quality,
- economic quality,
- technical characteristics,
- process quality (design and construction),
- the position of the building (location).

Environmental quality assessment consists of 14 separate indicators:

1.1 Global Warming Potential (GWP)
1.2 Ozone Depletion Potential (ODP)
1.3 Acidification Potential (AP)
1.4 Acidification Potential (EP)
1.5 Photochemical Ozone Creation Potential (POCP)
1.6 Risk from Materials
1.7 Biodiversity and Depletion of Habitats
1.8 Light Pollution
1.9 Non-Renewable Primary Energy Demand (PEnr)
1.10 Total Primary Energy Demand and Percentage of Renewable Primary Energy
1.11 Water and Waste Water
1.12 Land Use
1.13 Waste
1.14 Energy Efficiency of Building Equipment (lifts, escalators, etc.).

This paper deals with methodology for assessment of acidification potential of buildings as a part of LCA, with specially emphasizing procedure for calculating and rating, what should be incorporated in dual education curricula.

2. ACIDIFICATION POTENTIAL (AP) (DGNB)

Acidification is the increase of the hydrogen ion concentration in air, water, and soil. Sulfur and nitrogen compounds from anthropogenic emissions react to sulfuric acid or nitric acid in the air, fall down as “acid rain” and cause damage to soil, water, organisms, and buildings. In acidic soils nutrients decompose quickly and can easily be washed out. Furthermore, toxic cations may be released, which affect root systems and cause damage to the nutrient supply of organisms. Another possible effect is the disturbance of the water balance. All in all, the combination of acidification aspects contributes to forest

decline. In addition, in surface water bodies with low chemical buffer capacity, fish decline occurs. Acid rain also affects historic buildings (e.g. sandstone).
The environmental impacts described above are measured using the acidification potential, which is stated in SO_2-equivalents. Acidification causing emissions are e.g. SO_2, NOx or H_2S. For the assessment of the Acidification Potential (AP) of a building life cycle (construction and operation), SO2-eqivalents per area and year are used. The lower the AP value, the lower is the risk of acid rain and the related environmental damage.
The indicator aims at the reduction of buildings` Acidification Potential, thus preventing the environmental impacts described above.

3. ASSESSMENT METHODOLOGY

The indicator is mainly based on the method of Life Cycle Assessment (LCA): LCA results of the building to be assessed will be calculated in a standardized way and evaluated against benchmarks. Thus Acidification Potential is a quantitative indicator. According to the standards EN ISO 14040 and 14044, the method of Life-Cycle Assessment generally consists of four steps: Definition of goal and scope of the study, inventory analysis, impact assessment, and interpretation. The indicators 1.1-1.5, 1.9 and 1.10 are based on LCAs and for all these indicators the same definitions for goal and scope and for the inventory analysis do apply.

3.1. Goal and scope definition

The goal of all LCA studies is to analyze and later benchmark the environmental performance of the respective buildings` life cycles. The scope of the building assessment therefore includes the following life cycle stages:

- production: raw material supply, transport to manufacturing, manufacturing and transport to the construction site of products used in the building (Figure 1, modules A1-A4),
- use stage: a scenario is defined including use and replacement, including end-of-life of replaced products (Figure 1, modules B1 and B4); in addition the operational energy use is considered. (Figure 1, module B6),
- end-of-life stage: waste processing and disposal of the building, (Figure 1, modules C3 and C4),
- a scenario for potential benefits and loads beyond the system boundaries, including loads for reuse and recycling as well as benefits from recycling potentials (Figure 1, module D).

<table>
<tr><th colspan="15">BUILDING ASSESSMENT INFORMATION</th></tr>
<tr><th colspan="14">BUILDING LIFE CYCLE INFORMATION</th><th>SUPLEMENTARY INFORMATION BEYOND THE BUILDING LIFE CYCLE</th></tr>
<tr><th colspan="3">A1 – 3</th><th colspan="2">A4 – 5</th><th colspan="5">B1 – 7</th><th colspan="4">C1 – 4</th><th>D</th></tr>
<tr><th colspan="3">PRODUCT STAGE</th><th colspan="2">CONSTRUCTION PROCESS</th><th colspan="5">USE STAGE</th><th colspan="4">END OF LIFE STAGE</th><th>Benefits and loads beyond the system boundary</th></tr>
<tr><td rowspan="4">A1 Raw materials Supply</td><td rowspan="4">A2 Transport</td><td rowspan="4">A3 Manufacturing</td><td rowspan="4">A4 Transport</td><td rowspan="4">A5 Construction – installation process</td><td>B1</td><td>B2</td><td>B3</td><td>B4</td><td>B5</td><td rowspan="4">C1 Deconstruction</td><td rowspan="4">C2 Transport</td><td rowspan="4">C3 Waste processing for reuse, recovery or recycling</td><td rowspan="4">C4 Disposal</td><td rowspan="4">Reuse Recovery Recycling Potential</td></tr>
<tr><td>Use</td><td>Maintenance</td><td>Repair</td><td>Replacement</td><td>Refurbishment</td></tr>
<tr><td colspan="5">B6 Operational Energy use</td></tr>
<tr><td colspan="5">B7 Operational Water use</td></tr>
</table>

Figure 1. Building Life Cycle Phases according to FprEN 15978

The following processes are not included, but should be taken in consideration:

- Construction – Installation process (Figure 1, module A5),
- Energy use for user equipment during reference study period,
- Operational water use (Figure 1, module B7),
- Maintenance, repair and refurbishment during reference study period (Figure 1, modules B2, B3 and B5),
- Deconstruction and transport to waste processing / disposal (Figure 1, modules C1 and C2),
- Transport to recycling (Figure 1, module C2).

The reference study period is defined with 50 years.

The functional equivalent (quantified functional requirements, intended use and/or technical requirements (prEN 15643-1:2010: Sustainability of construction works – Sustainability assessment of buildings – Part 1: General framework), which is used as basis for comparison, is defined to be m² NFA * a (square meter net floor area * year).

3.2. nventory Analysis and Impact Assessment

During the inventory analysis of an LCA, emissions and resource consumption are identified, calculated and summed up over the life cycle of a product. Within building LCAs, separate calculations are carried out for the buildings' elements (product and end-of-life stage) and for the determination of emissions and resource uses during operation (see Equations 1, 2 and 3).
The inventory analysis of the buildings` elements mainly consists in providing quantitative information on the building elements used (see also Documentation Guidelines). Building compartments to be included are:

1. Foundations,
2. Exterior walls,
3. Windows,
4. Interior walls,
5. Ceilings,
6. Roofs,
7. Service equipment (More information can be found in the Open House Assessment Forms).

For all these, sets of representative datasets have been picked out from the ESUCO (Other LCA data bases can be used generally, but the ESUCO is the basis of the LCA tool prepared and suggested for the OPEN HOUSE case studies) database, which include environmental profiles of the used component: for the respective component, a standardized LCA has been conducted earlier and the results are provided within this database format. For the analysis of the use stage, a scenario has to be set up, including supply and disposal systems and repairs. For supply and disposal, values for end energy consumption for electricity and heat have to be derived from the respective national implementation of the EPBD directive (Module A5 currently is not regarded due to a lack of data). For heating units as well as for the electricity demand calculated values have to be listed and linked to predefined ESUCO datasets. For repair, calculations have been made for all materials, building components and surfaces with service lives of less than 50 years. Sources for service lives are the "Guideline for Sustainable Building" for construction materials and the VDI 2067 for building services.
Also for the end-of-life stage, scenarios for the recycling and disposal of the building materials that remain in the building after the end of the reference study period have been defined and included into the datasets. So for each material, one end-of-life options has been chosen and linked to the respective ESUCO dataset:

- Metals ->recycling -> "metal recycling potential",
- Mineral building materials ->recycling -> "construction rubble processing",
- Materials with a heating value -> thermal recycling -> respective material group in ESUCO database,
- Heat producers ->Dataset corresponding to the manufacturing process,
- All other materials that can be deposited at construction or household waste sites -> disposal at waste site ->appropriate ESUCO dataset.

Within the impact assessment, the emissions determined in the inventory analysis are classified regarding their contributions to different environmental impacts and then characterized. Using characterization factors, they are converted into equivalents of lead emissions for the different impact categories (example: emissions contributing to Acidification Potential are transformed to CO_2 equivalents, emissions contributing to Acidification Potential are transformed to SO_2 equivalents).
By using environmental profiles such as provided by ESUCO, the step of impact assessment has already been done by the data providers: Environmental profiles are given by providing the LCA results for the respective component in form of different environmental impact categories. These results are then used within the building LCA.
Resulting impacts are then evaluated against reference values to determine the respective indicator assessment.

4. CALCULATION AND RATING

When calculating the acidification potential for the building ("Designed Building"), the calculation rules, as given below, must be followed.
Generally, the AP for the building life cycle is composed of the AP caused by the building construction and of the AP caused during operation.

$$AP_{LC} = AP_C + AP_O \qquad (1)$$

where
AP_{LC} acidification potential of the life cycle of the entire building,
AP_C building's construction, maintenance, dismantling, and disposal including building systems technology as an average annual value of acidification potential over the time reference study period t_d in [kg SO_2 equiv./(m²NFA $*$ a)],
AP_O predicted annual acidification potential for the operation of the building as constructed, derived from end energy demand according to national implementation of EPBD directive in [kg SO_2 equiv./(m²NFA $*$ a)],
NFA Net Floor Area of the building.

Based on the modules as defined in Figure 1, the value for construction AP_C is calculated as follows:

$$AP_C = \frac{(AP_{MA} + AP_{MC})}{t_d} + AP_{MB1,4} \qquad (2)$$

where
AP_{MA} predicted value of acidification potential created during the modules A1- 4 (Module A5 currently is not regarded due to a lack of data), including building's manufacture (construction and building systems technology) and transports to construction site in [kg SO_2 equiv./(m²NFA $*$ a)],

AP_{MC} predicted value of acidification potential created during module C3 and C4 (Modules C1 and C2 currently are not regarded due to a lack of data), the building's end-of-life (design and building systems technology) in $[\text{kg SO}_2 \text{ equiv.}/(\text{m}^2\text{NFA} * \text{a})]$,

$AP_{MB1,4}$ predicted value of acidification potential created during modules B1 and B4 (Modules B2, B3 and B5 currently are not regarded due to a lack of data) on a yearly basis, the building's use and replacement (construction and building systems technology) in $[\text{kg SO}_2 \text{ equiv.}/(\text{m}^2\text{NFA} * \text{a})]$,

t_d time period for the reference study period for certification in [a]. This time period is set at 50 years.

The average annual value for use AP_O generally consists of the AP caused by the building's electricity and heating demand during operation:

$$AP_O = AP_{MB6,E} + AP_{MB6,H} \tag{3}$$

where

$AP_{MB6,E}$ acidification potential for module B6, electricity demand during use, calculated with the national implementation of the EPBD directive, multiplied by the AP factor for electricity of the ESUCO database in $[\text{kg SO}_2 \text{ equiv.}/(\text{m}^2\text{NFA} * \text{a}),]$

$AP_{MB6,H}$ acidification potential for module B7, heating demand during use, calculated with the national implementation of the EPBD directive, multiplied by the AP factor of the specific energy sources in the ESUCO database in $[\text{kg SO}_2 \text{ equiv.}/(\text{m}^2\text{NFA} * \text{a})]$.

4.1 Rating Method

The "designed building" is rated against a case-specific reference building.

Acidification Potential for Reference Building

$$R_{AP} = AP_{LC_{ref}} = AP_{C_{ref}} + AP_{O_{ref}} \tag{4}$$

where

$AP_{LC_{ref}}$ reference value for the acidification potential of the life cycle of the reference building,

$AP_{C_{ref}}$ reference value for the average annual value of acidification potential for the building's construction, maintenance, dismantling, and disposal including building systems technology over the reference study period t_d, calculated from an average office building in [kg SO_2 equiv./(m²NFA $*$ a)], ($AP_{C_{ref}}$ will be derived from the case studies),

$AP_{O_{ref}}$ reference value for the annual acidification potential created by building operations, derived from the reference value according to the national implementation of the EPBD directive in [kg SO_2 equiv./(m²NFA $*$ a)].

The reference value for construction AP_{Cref} is calculated as follows:

$$AP_{C_{ref}} = \frac{(AP_{MA_{ref}} + AP_{MC_{ref}})}{t_d} + AP_{MB1,4ref} \tag{5}$$

where

$AP_{MA_{ref}}$ reference value for acidification potential created during the modules A1- 4 (Module A5 currently is not regarded due to a lack of data), including building's manufacture (construction and building systems technology) and transports to construction site in [kg SO_2 equiv./(m²NFA $*$ a)],

$AP_{MC_{ref}}$ reference value for acidification potential created during module C3 and C4 (Modules C1 and C2 currently are not regarded due to a lack of data), the office building's end-of-life (design and building systems technology) in [kg SO_2 equiv./(m²NFA $*$ a)],

$AP_{MB1,4ref}$ reference value for annual acidification potential created during modules B1 and B4 (Modules B2, B3, and B5 currently are not regarded due to a lack of data) on a yearly basis, the office building's use and replacement (construction and building systems technology) in [kg SO_2 equiv./(m²NFA $*$ a)],

t_d reference study period in [a]. This time period is set to 50 years.

The reference value for use AP_{Oref} is calculated as follows

$$AP_{O_{ref}} = AP_{MB6,E_{ref}} + AP_{MB6,Href} \tag{6}$$

where

$AP_{MB6,E_{ref}}$ acidification potential for the national reference value for Building's annual electricity demand (end energy) according to the national implementation of the EPBD directive in [kg SO_2 equiv./(m²NFA $*$ a)],

$AP_{MB6,H_{ref}}$ acidification potential for the national reference value for the building's annual heating demand (end energy) according to the national implementation of the EPBD directive in [kg SO_2 equiv./(m²NFA $*$ a)],

$R_{AP} = AP_{LC_{ref}}$
$AP_{C_{ref}}$ will be derived from case studies,
$P_{O_{ref}} = AP_{MB6,E_{ref}} + AP_{MB6,H_{ref}}$

where
$AP_{MB6,E_{ref}} = European\ Conversion\ Factor\ EI$ (*From ESUCO data base)*→ $AP * EI_{Ref}$
$AP_{MB6,H_{ref}} = European\ Conversion\ Factor\ H$ (*From ESUCO data base)*→ $AP * H_{Ref}$,
where
EI_{Ref} reference value for the building's electricity demand (end energy) according to the national implementation of the EPBD directive in [kWh/(m² NFA *a)],
H_{Ref} reference value for the building's heating demand (end energy) according to the national implementation of the EPBD directive in [kWh/(m² NFA *a)].

Limit value and target value calculation

Limit value *L* and target value *T*, needed to supplement the criterion's evaluation, are determined as follows:

$$L = X * R_{local} \tag{7}$$
$$T = Y * R_{global} \tag{8}$$

where
local reference value based on local or national requirements,
global will be derived from case study results.

The values X and Y are set as follows:

$$X = 1.4 \tag{9}$$
$$Y = 0.7 \tag{10}$$

4.2 Evaluation

The evaluation consists of a simultaneous optimization of carbon equivalent for design and operation over the entire lifecycle.

1.3 Acidification Potential	**Points**
APLC = 0,7 * Rglobal	**100**
APLC = according to local definition (default: 0,76 * R_{global})	**90**
APLC = according to local definition (default: 0,82 * R_{global})	**80**
APLC = according to local definition (default: 0,85 * R_{global})	**75**
APLC = according to local definition (default: 0,88 * R_{global})	**70**
APLC = according to local definition (default: 0,94 * R_{global})	**60**
APLC = R_{local} ($AP_{LC,ref}$, reference value)	**50**
APLC = according to local definition 1,175 * R_{local})	**40**
APLC = according to local definition (default: 1,35 * R_{local})	**30**
APLC = according to local definition (default: 1,525 * R_{local})	**20**
APLC = 1,7 * R_{local} (limit value)	**10**
Minimum Requirements not fulfilled	**0**

5. DOCUMENTATION GUIDELINES

The following documents will be needed to assess the building:

For Basic & Quick Assessment:

Only the following documents are required:
- Filled LCA Questionnaire,
- LCA Calculation Results: (generated automatically by Sustainable Building Specifier).

For Complete Assessment:

Filled LCA Questionnaire:

Verification of input data of LCA Questionnaire, especially:
- Detailed calculation of surface areas for all constructional parts of the building (e.g. exterior walls, foundation, interior walls, ceilings, roof, ...),
- Verification of calculation for surface areas by design plans with respective dimensioning,
- Detailed sectional drawings of cross-sections for all constructional parts indicating different materials, layers and thicknesses,
- National energy calculation according to requirements of the EPBD, indicating building energy supply, applied technical appliances and energy carriers,

- Information on elements of the building energy supply covered by the energy calculation.

Filled Questionnaire Expansion of System Boundaries:

LCA Calculation Results (generated automatically by Sustainable Building Specifier)

The necassary data for calculation are as follows:

1. Building surface and volume,
2. Building components or surfaces / materials with service lives (amount and estimated service life),
3. Electricity and heat demand for the building to be certified and reference values according to to the national implementation of the EPBD directive; the calculation and a reference to the national implementation must be included,
4. Quantity determination of the building envelope surfaces (external walls including windows / facade, foundation slab, roof) from the energy calculation in compliance with the national implementationof the EPBD directive and allocation to assessed building components,
5. Windows / French doors / post-and-beam facade with information on frame size, a depiction of a cross-section of the main profile system, the number of windows that can be opened, and the type of glazing,
6. Quantity determination of interior walls and supports; plausibility analysis for floor plans with information on types of interior walls / supports,
7. Inside doors; amount (number and area), list of most important types, and description of calculation,
8. Quantity determination of ceiling, divided into stories,
9. Representation of building components as a series of strata with layer thickness, estimeted gross density, and alocation to a data set in the ESUCO database,
10. Representation of quantity determination for foundations,
11. For reinforced concrete, the share of reinforcement is to be given in kg/m^3 or in kg/m^2 of the building component. Alternatively, the reinforcing steel can be verified in an overall summary of the project,
12. Documentation of heating unit,
13. Documentation of transport distances and means of transport from manufacturing to construction site.

Most of previous requirements can be met by providing a bill of materials (including masses, materials in a hierarchical structure, number of pieces, surface areas and volume of the building),

14. Documentation required for ecological footprint results:
    a. Manufacture,
    b. Use (electricity and heat),
    c. Use (maintenance)
    d. End of life (dismantling/recyclyng/disposal).

For Post Construction Stage (Assessment):

The documentation requierements are the same as for planning stage.

6. RELATION TO OTHER INDICATORS

Data acquisition is the same for the indicators of
- 1.1 Global Warming Potential
- 1.2 Ozone Depletion Potential
- 1.3 Acidification Potential
- 1.4 Eutrophication Potential
- 1.5 Photochemical Ozone Creation Potential
- 1.9 Non-Renewable Primary Energy Demands (PEnr)
- 1.10 Total Primary Energy Demands and Percentage of Renewable Primary Energy.

REFERENCES

[1] ISO 14040: 2009-11: *Environmental Management – Life Cycle Assessment – Principles and framework.* International Organization for Standardization.
[2] ISO 14044: 2006-10: *Environmental Management – Life Cycle Assessment – Requirements and Guidelines.* International Organization for Standardization.
[3] FprEN 15978: 2011: *Sustainability of construction works —Assessment of environmental performance of buildings — Calculation method*. European Committee for Standardization CEN.
[4] prEN 15804: 2010: *Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products.* European Committee for Standardization CEN.
[5] *Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.*
[6] Kreißig, J., Binder, M. (2007): *Methodische Grundlagen- Ökobilanzbasierte Umweltindikatoren im Bauwesen.* Methodenbericht zum BMVBS-Projekt „Aktualisieren, Fortschreiben und Harmonisieren von Basisdaten für das nachhaltige Bauen“ (AZ 10.06.03 – 06.119) Mai 2007.
[7] United Nations (1998): *Kyoto Protocol to the United Nations Framework Convention on Climate Change*, 1998, http://unfccc.int/resource/docs/convkp/kpeng.pdf.
[8] Bundesministerium für Verkehr, Bau- und Wohnungswesen: *Guideline for Sustainable Building.* Eigenverlag, 2001.
[9] *Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the Energy Performance of Buildings.*
[10] VDI 2067: *Economic Efficiency of Building Installations – Fundamentals and Economic Calculation.* Verein Deutscher Ingenieure, 2000.

OCENA POTENCIJALA POVEĆANJA KISELOSTI OKOLINE U PROGRAMU KORPORATIVNOG I DUALNOG OBRAZOVANJA

Rezime: *Gradjevinski Klaster DUNDJER iz Niša učestvovao je u Evropskom FP7 projektu (FP7, Grant Agreement No. 244130) pod nazivom OPEN HOUSE, koji je imao za glavni cilj formiranje i predlaganje novog metoda za ocenu (poslovnih) zgrada koristeći opštije i detaljnije kriterijume. Predložena metodologija sadrži sledeće ocene:*

- *kvalitet zaštite okoline,*
- *socialno-funkcionalni kvalitet,*
- *ekonomski kvalitet,*
- *tehnički kvalitet (karakteristike),*
- *kvalitet procesa gradnje (projektovanje i gradnja),*
- *lokacija zgrade.*

Potencijal kiselosti zgrade pripada kriterijumima ocene kvaliteta zaštite okoline. Ovi kriterijumi nisu deo standardnog programa nastave u formalnom obrazovanju. Ovi kriterijumi su zato vrlo važne teme nastave u okviru neformalnog, dualnog i korporativnog obrazovanja, što je tema ovog priloga. Kao deo saradnje, Klaster DUNDJER i Fakultet za gradjevinarstvo i arhitekturu Univerziteta u Nišu razvijaju metode i procedure za ocenu kvaliteta zgrada u čitavom „životnom ciklusu“ zgrada (tzv. LCA – Life Cycle Assessment), što bi trebalo da bude osnova za novi program u viskokim školama, na univerzitetu i odgovarajućem dualnom obrazovanju. Rezultati ovog projekta treba da budu testirani u tri firme Klastera kao deo korporativnog obrazovanja.

Ključne reči: *Ocena zgrada, Ekološki kvalitet, Potencijal kiselosti, Dualno obrazovanje, Profesionalna obuka, Korporativno obrazovanje*