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DURABILITY AND/OR CHANGE ?

Master’s Thesis D-ARCH HS 22
Evening Seminars

DOES THIS COUNT ?

or:

What we always wanted to ask about our climate footprint – but maybe don’t want to know…

31.08.2022, 18:30, via Zoom

BUILDINGS AS PROBLEM AND SOLUTION

Dr. Rolf Frischknecht

treeze Ltd. Uster, Lecturer ETH Zurich

Prof. Dr. Guillaume Habert

ETH Zurich, D-BAUG, IBI, Chair of Sustainable Construction

Prof. Dr. Arno Schlüter

ETH Zurich, D-ARCH, ITA, Chair of Architecture and Building Systems

14.09.2022, 18:30, via Zoom

AGAINST PRECONCEPTIONS

Prof. Dr. Karen Scrivener

EPF Lausanne, STI, Construction Materials Laboratory

Prof. Dr. Werner Sobek

University of Stuttgart, Institute for Lightweight Structures and Conceptual Design

20.09.2022, 18:30, via Zoom

CO_2-/ H_2-STRATEGIES

Christian Bauer

Paul Scherrer Institute, Laboratory for Energy Systems Analysis LEA

Prof. Dr. Anthony Patt

ETH Zurich, D-USYS, Climate Policy Lab

The zoom links are available before the start of the event at:
https://gigon-guyer.arch.ethz.ch

Recommended as an introduction: Video tutorial (German) by Arend Kölsch on the reader part “VADEMECUM” with LCA data and parameters, also available on the above-mentioned website.

For further information:

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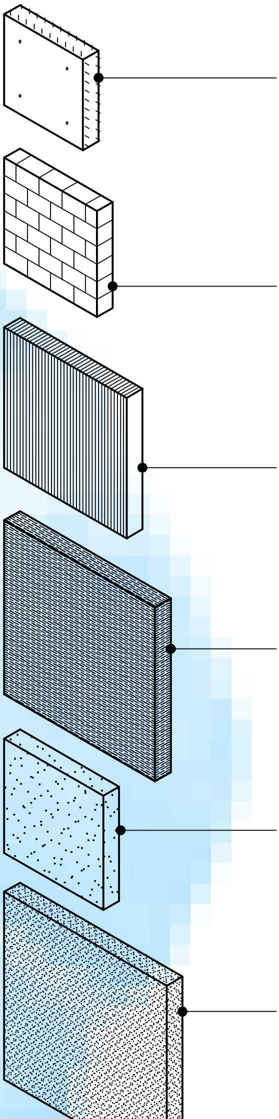
The Swiss population emits greenhouse gases (GHG) of approx. 5.5 t CO_2-eq* per capita per year. Together with emissions/imports from abroad, this amounts to as much as 11–14 t CO_2-eq per capita per year, twice as much as the global average. To achieve the climate goals of the Paris Agreement, a reduction to 2 t per capita and year should take place by 2030, and even to net zero by 2050.
*** CO_2-eq refers to all the different greenhouse gases in their effect compared to CO_2.**

Buildings and households influence around one third to one half of Swiss GHG emissions: Directly via operating energy consumption and construction, indirectly via mobility induced depending on the location.



1 m^2 reinforced concrete wall causes approx. 73 kg CO_2-eq of greenhouse gases during construction (embodied emissions)

(Construction concrete CEM I, 20 cm thickness ≙ 46 kg CO_2-eq + 1 % steel reinforcement ≙ 27 kg CO_2-eq)[1]

This is roughly equivalent to

1.4 m^2 brick wall

(20 cm Swissmodul; 1 m^2 ≙ 53 kg CO_2-eq)

2.4 m^2 glued laminated timber wall

(1 m^2, thickness 20 cm ≙ 30 kg CO_2-eq)

3.7 m^2 rock wool insulation panels

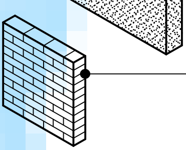
(1 m^2, thickness 20 cm ≙ 20 kg CO_2-eq)

1.6 m^2 EPS insulation panels

(1 m^2, thickness 20 cm ≙ 46 kg CO_2-eq)

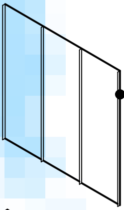
4.3 m^2 wood fibre insulation mats

(1 m^2, thickness 20 cm ≙ 17 kg CO_2-eq)



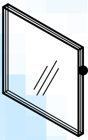
0.8 m² brick clinker shell

(1 m², thickness 11.5 cm, incl. mortar + fastening ≙ 89 kg CO_2-eq)



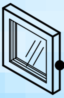
2.2 m² chrome steel sheet

(1 m², thickness 1 mm ≙ 33 kg CO_2-eq)



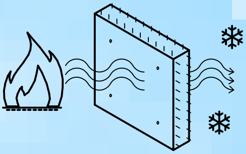
0.9 m² triple insulating glazing

(1 m², U_g-value 0.5 ≙ 78 kg CO_2-eq)



0.4 m² wood-metal framed window

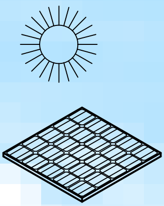
(1 m², with sunshade ≙ 180 kg CO_2-eq)



approx. 73 kg CO2-eq is also emitted by a natural gas heating system every year, assuming the heat losses through 1 m² of uninsulated concrete wall in Zurich.

(With 20 cm insulation λ 0.035, the GHG emissions for heating amount to 3-4 kg CO_2-eq, and if heating is also provided with a ground-source heat pump, only approx. 0.5 kg!)

The embodied emissions of 1 m² of photo-voltaic system today correspond to approx. 4 m² of concrete walls. **(– Less and less in the future!)**



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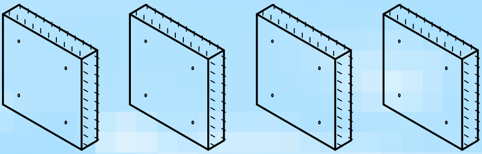
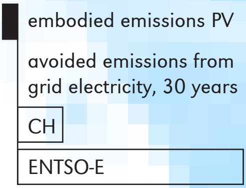
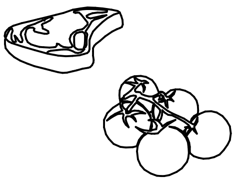




However: the PV system amortises its original GHG expenditure in about one third of its lifetime

(provided it is well oriented, not shaded, without colour layers), compared to the CH electricity mix; compared to the European ENTSO-E electricity mix even in 2 years!

Building materials are long-lasting (60 years plus). But even one-off actions like eating and travelling can have climate footprints of comparable magnitude:

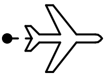


approx. 70–80 kg CO_2-eq is caused by the consumption of 1 kg of beef from Brazil[2] or 2.5 kg of organic cherry tomatoes from the greenhouse in March[2].

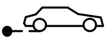
(Why is there no CO_2 information on the product labels of Migros, Coop and Aldi?)

or, for example, a journey of …

(operating energy and share of vehicle production)

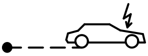


260 km by airplane



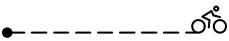
340 km in an average car

(occupancy 1.6 passengers)



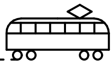
780 km in an electric car

(occupancy 1.6 passengers, Swiss grid electricity)



1 000–2 000 km with an E-bike[2]

9 000 km by Swiss railways



In turn, the greenhouse gas emissions of a single Bitcoin transaction are roughly equivalent to those of 5 m^2 of the mentioned concrete walls.

(– according to other sources even 15 m^2).[3,4]

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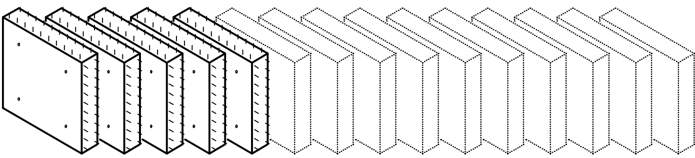

But why are we still comparing with concrete walls? – Shouldn't we architects switch to wood, hemp, straw, clay, solid stone, etc. anyway? Is it possible to increase the production of biogenic materials in order to largely substitute CO_2-intensive building materials such as concrete, steel and brick worldwide? What would that mean?

And: If biogenic raw materials are not burnt but used for construction – could buildings thus at least serve as temporary carbon stores before the CO_2 is released again at the end of their useful life?

From yet another angle: How much CO_2 do the best buildings produce today per m^2 and year for construction and operation (life cycle of 60 years)? The SIA efficiency path requires 12 kg/(m^2×a) (residential, new, construction + operation). Who checks the calculations and the actual performance?

What responsibility should the building users bear, e.g. with their ventilation habits, their expectations with regard to room temperature levels and hot water consumption?

How do we ever get to net zero by 2050?

Do we even need to bother with these piles of figures and data when research is currently advancing on CCS (Carbon Capture and Storage), CCU (Carbon Capture and Use)?

Couldn't hydrogen make an important contribution? – Even though today more than 95 % of the global H_2 production is still based on fossil raw materials, even though electrical catalysis has poor efficiency and renewable electricity is as yet a very rare form of energy? Could hydrogen at least be valuable as a storage medium, for future, short-term surpluses of renewable energy from wind and sun?

Thousands of buildings in Switzerland should and could be energetically upgraded to meet climate targets – but in combination with our high standards, norms and building laws today (sound insulation, fire protection, earthquake protection, etc.) this usually leads to demolition and replacement buildings.
How should we strike a balance here – and who?

Do our architectures now have to become autonomous power plants that help save the world, and must design quality take a back seat to this?

Where are the major points of leverage?
Where must and can we start?

And how can we achieve the necessary broad carbon literacy? Or is it not enough that specialists and politicians are familiar with greenhouse gases, forms of energy, numbers?
Why should we all teach ourselves the complicated "alphabet" of greenhouse gases – and at present almost entirely autodidactically?

Or why isn't there at least a reliable and comprehensive source of information from the federal government or the ETH where we could find out about various aspects on a continuous basis?
A low-threshold CO_2 info kiosk / calculator for all of us?

AND: Who can come up with motivating, convincing narratives to tackle the uncomfortable data and facts? (Or do the data speak for themselves?)

Can we architects provisionally agree on a
"3×5 points recipe" for climate-friendly building
to immediately apply what we already know and can do?

Five points (I) – Materials and construction

- Preserve end energetically upgrade existing buildings
- If possible: reuse building materials and elements
- If not: prefer renewable building materials
- Use lightweight, durable, recyclable constructions
- Apply more than 20 cm thermal insulation, non-fossil

Five points (II) – Design and technology

- Design compact, space-efficient buildings
- Minimise basements
- Window area : floor area ≤ 1 : 3, and sun protection
- Use heat pumps, preferably geothermal/groundwater
- Integrate well-oriented photovoltaics

Five points (III) – City and society

- Reduce land sealing
- Protect and create urban greenery
- Tend to reduce space requirements per capita
- Keep transport distances and car traffic to a minimum
- Collect data, make it accessible, communicate

1) Data on building materials and travel routes based on Ökobilanzdaten im Baubereich KBOB / ecobau / IPB 2009/1:2022
2) Data on food and E-bikes from Mike Berners-Lee, "How bad are Bananas? The Carbon Footprint of Everthing", London 2020
3) http://explore-ip.com/2021-The-Carbon-Emissions-of-Bitcoin-From-an-Investor-Perspective.pdf (accessed 06.07.2022)
4) https://www.derstandard.at/story/2000132519190/umweltsuende-bitcoin-so-schaedlich-ist-die-kryptowaehrung (accessed 06.07.2022)