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REGULATIONS FOR PLUS ENERGY BUILDINGS®

PLUS® ENERGY BUILDING

„Solar architecture is not about fashion, it is about survival"

Lord Norman Foster, London

Chesa Futura, St. Moritz

Norman Foster Plus Energy Buildings guarantee a most simple, energetically, climatically, ecologically and economically most successful implementation of the Paris Agreement until 2050

Conclusion

Paris Climate Agreement: Let's save the planet…

The eight theses of Lord Norman Foster for *"sustainable architecture in the 21th century"* form an optimal prerequisite for the implementation of the Paris climate agreement. The theses are the bases of the regulations for Plus Energy Buildings (PEB) and are found in Art 7. They guarantee a most energy-efficient, ecologically effective, and economically extraordinarily successful reduction of CO_2 by 2050. Art 8 addresses the architectural and technical measures to reduce the average energy losses of 80% in buildings and to generate solar power. The measures of Art 9 and Art 10 (c) of the PEB regulations aim to provide comfort and aesthetics instead of global warming and environmental destruction.

Minergie-P/passive house insulation: Two important theses of Norman Foster must be realized: Carefully and *completely integrated solar systems* into the building envelope. If possible, they replace inactive roof elements on the entire surface with active ones and, if necessary, facade elements from the first floor upwards. In addition, there are the necessary insulation measures mentioned in Art 10 (c) of the PEB regulations with U-values of about 0.10 to 0.12 W/m^2K. They are the most important measures for CO_2-free solar power surpluses that allow to supply the building sector as well as the transport sector without any CO_2-emissions. The best and most cost-effective way to achieve these objectives is with a *Minergie-P/passive house mineral wool insulation* of about 30 cm or a comparable insulation. The legal basis for this can be found mainly in Art 8 to 10 of the PEB regulations.

Buildings and applicable law: Buildings must comply with applicable law. With the entry into force of the Paris Agreement in 2015 and the international commitment of 194 countries to limit CO_2-emissions to 1.5 degrees by 2050, Norman Foster's theories get an even greater significance: Norman Foster-PEB can avoid CO_2-emissions more than any other buildings (Art 9). Generally, whoever intends to construct or renovate a building in accordance with the PEB-theses has the right for a building permit; otherwise it means a violation of the Paris Agreement and/or the guarantee of ownership. What is valid for Switzerland, is in principle also valid for the other countries of the world, at least for all OECD countries.

The key to the most simple and successful implementation of the Paris Agreement by 2050 lies in Art 10 (c) of the PEB regulations. Fig. 4 (p. 26) shows that the implementation of the climate agreement based on the Norman Foster Theses for residential and commercial PEB is not only energetically and ecologically safe, but also hardly beatable from an economical point of view: Solar electricity for 3 cts/kWh (Art. 10 lit. e and art. 17). The incentive investments will pay back about eight times by 2050. In addition, PEB and pumped storage power plants guarantee the largest, most ecological and cheapest electricity storage in Central Europe from today's perspective. The Norman Foster PEB winners of 2019 attest on p. 26/27 how elegantly CO_2-free PEB solar power surpluses can supply 45 or 75 electric cars emission-free and reduce CO_2-emissions.

London/St. Moritz, April 2020/Ca.

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REGULATIONS FOR PLUSENERGYBUILDINGS®

Norman Foster PlusEnergyBuilding Jury

I. PEB REGULATIONS AND PROCEDURE

1. Principles and responsible body of the PlusEnergyBuilding Solar Prize

Principles: At the occasion of the 20th Swiss Solar Prize in September 2010, a Solar Prize for the best **PlusEnergyBuildings** (PEB) and a **Norman Foster Solar Award** for those PEB with best integrated installations were announced and awarded for the first time.

Responsible body: This PEB Solar Prize is organised by Solar Agency Switzerland (SAS) in cooperation with other responsible bodies. The first four Solar Prizes were financially supported by Repower (former Rätia Energie AG), the Swiss Greina Foundation (SGS), and further Solar Prize partners. The following PEB regulations are established based on "Lord Norman Foster's eight theses for PlusEnergyBuildings" (part II) and Art 3.4 of the Solar Prize regulations.

Since 2010, **Solar Agency Switzerland** (SAS) has been organising the Solar Prize for PlusEnergyBuildings and the Norman Foster Solar Award (NFSA) for *aesthetically exemplary PEB* under the auspices of the Federal Department of Energy (BFE), Energy Switzerland, the cantonal directors of energy and the cantonal delegates of energy in cooperation with other related institutions and PEB partners in Europe. Participants of the Swiss and European Solar Prize are also qualified to apply for the PEB Solar Prize. The same conditions apply to all European PEB participants.

2. Spirit and purpose of the NFSA and PEB Solar Prize

Constitutional obligation: It is the purpose of the PEB Solar Prize to promote renewable energies, in particular solar energy, as well as energy-efficient buildings within the scope of Art 73, 74 and 89 of the Swiss Federal Constitution as well as Art 194 of the Lisbon Treaty. The PEB Solar Prize and Norman Foster Solar Award are awarded by the PEB Solar Prize Committee for the best PEB in Switzerland and Europe.

Professional education and sustainable standards: It is the purpose of the PEB Solar Prize to establish PlusEnergyBuildings as state-of-the-art and to embed them as an integral part in the general professional education of architects, engineers and building experts as well as of authorities and universities, in order to realise environmentally friendly PEB comprehensively in future. *Solar energy supply and a sustainable energy consumption must become an inherent part of the design phase.* With help of the PEB Solar Prize/NFSA, the technological revolution that has been taking place in central and northern Europe in building engineering since 2000 shall be further supported. The Prize is aiming to establish the highest state of technology as standard in the building sector.

Energy self-supply and aesthetics: The PEB Solar Prize is designed to lead to an increase in energy efficiency and comfort by a systematic reduction of energy losses in the building sector. On the other hand, it aims to efficiently promote decentralized energy self-supply through optimum integration of solar installations on roofs and facades. For the implementation of these aims, the ground-breaking aesthetic, architectural and quality standards according to the solar architecture of Lord Norman Foster as well as the recommendations of the Swiss and European Solar Prize shall be observed.

Along with a completely self-sufficient energy supply, **the long-term aim** is a carbon-neutral energy balance for the operation of the buildings with due regard to their production energy (grey energy) in order to achieve the greatest possible sustainable energy self-supply of the whole building sector with energy-efficient PlusEnergyBuildings. Therefore, particular consideration is given to those aesthetically and architecturally exemplary PEB that do not only have a solar self-supply, but also produce the highest possible amount of energy for transport purposes (1,500 kWh/a per accommodation unit for passenger cars and/or public transport) or for other activities of the inhabitants. In the long-term and in accordance with the Stanford energy study, it is the stated aim to replace at least 6 TW through PEB worldwide. [1]

3. PlusEnergyBuildings and system boundaries

State-of-the-art in building technology: The state-of-the-art in building technology is generally defined by the newest professional and energy-efficient constructions of innovative architects, engineers, and entrepreneurs. These heated buildings are consuming less and less energy whilst still providing maximum comfort; furthermore, they are producing an ever-greater CO_2-free solar energy surplus by using carefully integrated PV systems on roofs and facades[2]. It is the goal of the PEB Solar Prize to establish this solar building technology and CO_2-free energy supply as state-of-the-art for the entire building sector in Switzerland, Europe and worldwide.

PlusEnergyBuildings (PEB): PlusEnergyBuildings produce more than 100% of their average annual energy need for heating, hot water, and electricity (incl. household and operating current) on the heated and/or cooled building itself (energy index [EI] in kWh/m^{2}a). The energy surplus, which must be substantiated by the PEB owner, is fed into the public grid or supplied to a third party as heat or electricity. [3] In cases of doubt, the PEB owner must prove that the average annual energy production of the PEB over 12 months is at least 1.00 kWh/m^{2}a higher than the total annual energy need of the PEB. Decisive are the final energy values measured per energy reference area. [4]

System boundaries: Generally, the outer shell of the (main) building including its components according to Art 642 (2) of the Swiss Civil Code is regarded as the "system boundary". If there are any installations that produce renewable energies on the same estate and provided that they are connected permanently to the (main) building (Art 644 (2) Swiss Civil Code), the energy output of these installations will also be included in the calculation of the self-supply of the building. These PEB standards are directly or analogously applied for the evaluation of all buildings.

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1 **Stanford plan for an emission-free world**: University of Stanford, Prof Mark C. Jacobson/Deluchi. Scientific American, Nov. 2009, p. 58-61, substituting 6 TW by PEB equals a substitution of 8,500 large NPPs, each with a performance of 7.5 TWh/a. According to empirical values from European Solar Prize winners, an energy need for transport purposes of approximately 1,500 kWh/a per accommodation unit is assumed. Energy efficient electric cars drive about 10,000 to 15,000 km/a with 1,500 kWh/a from solar energy; see Swiss Solar Prize (SolP) 2005, p. 30; SolP 2011, p. 30: With an electricity surplus of 55,000 kWh/a, it is possible to drive around the world 12 times with an electric Peugeot. SolP 2013, p. 54 and 56 with 454% PEB; SolP 2014, PEB-refurbishments p. 38, p. 48 wit 301% PEB and 114% PEB; reduction of energy losses by 88% p.64; SolP 2015, p. 46 with 238% PEB, p. 52-N-S: each PEB with a substantial CO_2-free solar energy surplus for the transport sector.

2 **CO_2-free solar electricity,** see Art 15 (a-c)

3 **Minergie-P/passive-house standard:** Main prerequisite for PlusEnergyBuildings is an optimum thermal insulation (building envelope) according to the Minergie-P/passive-house standard. **Examples:** Some of the first commercial and service PlusEnergyBuildings in Switzerland: Jos. Gasser AG, Chur (2000); Wattwerk, Holinger/BL (2004: 175%); MFH Wenk, Riehen/BS (2008: 140%); KMU Züst, Grüsch/GR (2009: 112%); SFH Ospelt, Vaduz/FL (2010: 182%); Swiss and European Solar Prizes 2000, 2001, 2004 and PEB since 2005, e.g. 2016: 345% PEB Anliker (1765), electricity for 46 e-cars; 2017: 150% PEB for 300 i.e. 378 e-cars p. 70 and 90; 2018: 114% 1 MW PEB, p. 28; 557% PEB, p. 36; 2019: 182% PEB housing estate, 221% PEB church, 184%/127% PEB MFH/SFH p. 34 and 42-47.

4 **Verification procedure:** If the PEB energy index or the indicated energy surplus are doubted or challenged by a third party, the PEB owners must prove their accuracy (Art 8 Swiss Civil Code). The energy self-supply of the PEB (i.e. supply without any external energy) must be at least 1.00 kWh/m^{2}a higher than the total average energy need for heating, hot water, and electricity (incl. household and operating current) of the PEB over 12 months (**ERA** = energy reference area). In 2010, building refurbishments achieved an energy self-supply of 180%; 2016: 345%; 2017: newly established PEB 687% and SME 557%.

4. Requirements for participation in the PEB competition

Each PEB participating in the PEB competition must be completed and operated on time (see Art 11). For each PEB, at least the following evidence must be furnished in written form together with pictures, photographs and possibly plans:

a)

General information on the building	***surface***	***final energy consumption***
Energy reference area (heated/cooled surface)	…. m^2a	
Insulation of the building envelope	…. cm	U-value: …. in W/m^2K
Windows (installed)		U-value: …. in W/m^2K

b)

Energy need of the PEB per year	**kWh/m^2a**	**%**	**total in kWh/a**
Heating			
Ventilation/Heat pump electricity			
Hot water			
Electricity (total household/operating current)			
Total energy need:			

c)

Energy supply of the PEB (ESS)			
1. Energy production per year	**kWh/m^2a**	**%**	**total in kWh/a**
Solar-thermal			
PV solar electricity			
Environmental heat/HP final energy consumption			
Total energy production on the PEB itself			
2. Energy supply from external sources			
Electricity			
Other energies….			
Total need of external energy of the PEB:			
3. Overall energy supply of the PEB			
4. Energy surplus to public grid/third parties			

d)

Energy balance of the PEB	**kWh/m^2a**	**%**	**total in kWh/a**
Total energy need (Art 4b)			
1. Energy self-supply (Art 4c (1))			
2. Energy from external sources (Art 4c (2))			
☐ Electricity surplus (Art 4c (1/4))			
☐ Heat surplus (Art 4c (1/4))			
3. Energy/solar electricity surplus of the PEB			

e)

Summary (final energy)	**kWh/m^2a**	**Annual average in kWh/a**
Energy surplus PEB (net)	….kWh/m^2a	….kWh/a (final energy)
Energy/solar electricity surplus for solar-operated electric cars	….kWh/a	....% of the building's overall energy need

5. Prize categories of the Norman Foster and PEB Solar Prizes

Solar Prizes for PlusEnergyBuildings (PEB) are awarded in the following categories:

a) **Norman Foster Solar Award for PEB:** Those PEB with the best integrated PV systems are awarded the **"Norman Foster Solar Award"** (NFSA). As for all other PEB, prerequisites are ecological construction methods, an efficient energy consumption and the utilisation of renewable energies, particularly solar energy. Eligible PEB are characterized by PV systems that are very carefully and ideally integrated in the building envelope. They meet the *highest architectural and aesthetical standards* and are landmarks for the building and solar architecture of the 21st century.

b) **PEB Solar Prize for performance, efficiency and building complexity**: The PEB Solar Prize for performance, efficiency and building complexity particularly considers the PEB's energy performance, its efficiency, its energy self-supply, size, and complexity. The entire average energy need during the year must be produced environmental-friendly by the building's own solar and/or heat energy installations.[5] In case of doubt, the higher CO_2-free solar electricity surplus is decisive.

c) **Only renewable energies for PEB Solar Prizes:** PEB Solar Prizes are only awarded to buildings that are using *renewable energies exclusively* to cover their average annual energy need.[6] To award a PEB building that partially uses also fossil energy sources, the Jury needs a three-quarters majority for building refurbishments and unanimity for new buildings.

d) **PEB abroad/in the EU**: At least one PEB award goes to a PEB in Switzerland and one to a PEB in the European Union/Europe.

6. Prerequisites and procedure

a) **Prerequisites** for all PEB prizes are the PEB prize criteria mentioned in Art 3 to 5. Furthermore, there must be at least *three eligible PEB candidates* per prize category. Otherwise, the prize categories will be merged in the initial phase into one PEB prize category.

b) **The Norman Foster/PEB Jury** will rank all PEB with an average solar electricity surplus. Generally, only *three* prizes per main category are awarded, i.e. at the maximum *three Norman Foster Solar Awards* (Art 5 (a)) and *three awards for the PEB Solar Prize categories of performance, efficiency and building complexity* (Art 5 (b)) with a **highest-possible energy self-supply.**

c) **PEB diplomas**: In addition, the Jury can also issue NFSA and PEB diplomas and specifically honour residential and commercial buildings by awarding a *PEB prize* or *PEB diploma* for *commercial*, *service*, *agricultural and industrial* buildings that fulfil the PEB requirements or by certifying and publishing such buildings. The final decision resides with the Norman Foster/PEB Jury in agreement with Lord Norman Foster.

d) **Factual and legal basis** for all NFSA and PEB Prizes is a proper assessment of the PEB by the Technical Commission (TC). The Technical Commission will rank all PEB in order of their performance in accordance with Art 3 (2) and Art 5 (b) of the PEB regulations and will also mention the quality of the installations wherever possible.[7]

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[5] **For the calculation of the PEB's energy self-supply** only the energy that has been produced and used as environmental-friendly as possible on or *in the building in form of electricity or heat* (final energy consumption in kWh/a) according to Art 642 (2) of the Swiss Civil Code is considered. If a storage medium is used, preference is given to the most environmental-friendly technology *with the highest energy self-supply over the longest period*.

[6] **Lord Norman Foster,** see Art 7 and 12 incl. footnotes with opinion of Norman Foster, saying that energy efficiency and a sustainable energy supply are equally important as aesthetics (**Lex Cadosch** 2016: no awards for fossil-operated buildings).

[7] **Avoidance of defects and damage:** As far as possible, the TC also points out quality, safety, care of integration or possible defects of installations in order to prevent or avoid damage (see up to 42% energy losses from installations damaged by storm or animals as a result

e) **PEB cover 85% of the total (national) energy need** (85% NES): PEB with an energy self-supply of 100% and an additional solar electricity surplus of 1,500 kWh/a per accommodation unit are *individually* covering their average transport energy need und thus 85% of the national energy supply (NES) per person (buildings: 50%; transport: 35%).[8]

f) **Process and prioritisation:** From the TC ranking in accordance with Art 5 (b) of the PEB regulations, the Norman Foster/PEB Jury normally determines *three NFSA according to Art 5 (a)*. *From the remaining PEB*, three PEB are selected for the PEB Solar Prizes for *performance, efficiency and building complexity* according to their ranking provided that the Norman Foster/PEB Jury has no evidence for any calculation errors or obviously false assumptions in the TC's basis. According to Art 5 (b), a maximum of *three* buildings with the highest energy self-supply will be selected from all PEB.

g) **Changes in the performance ranking require a three-quarters majority**: The Norman Foster/PEB Jury may change the order of the PEB ranking according to Art 5 (b) with a three-quarters majority based on important *objective criteria* such as prioritisation of size, performance, efficiency, building complexity or location. *Priority is given to refurbishments* compared to new buildings, to *multi-family houses* instead of single-family houses, to well-integrated solar installations instead of poorly or not completely integrated solar installations etc.

II. NORMAN FOSTER'S 8 THESES FOR PLUS ENERGY BUILDINGS

7. Sustainable Architecture in the 21st century

1. *The quest for a sustainable architecture should never be an excuse for compromising quality of design. (LNF, 2010)*
2. *The building responds to its location and local weather patterns, with its bubble-like form allowing windows and balconies on the southern side to open up to the sunlight and panoramic views, while the colder, north facade is more closed, punctuated with deep window openings in the Engadin tradition. (LNF, 2005)*
3. *I have never seen a conflict between the pursuit of aesthetic delight and high performance in terms of sustainability. I would go further and say that responding to more demanding criteria should produce more beautiful buildings. (LNF, 2010)*
4. *The way we shape our buildings, our neighbourhoods and our global lifestyles has now become even more important than ever - we must ensure that sustainability becomes as inseparable from our design processes as time, cost and quality. (LNF, 2005)*
5. *The Swiss Solar Prize is truly unique. It is an indication of the unremitting dedication to solar energy and sustainable architectural technologies within Switzerland. Crucially, the prize not only considers the environmental performance of buildings, but also considers the essential problem of how sustainable technologies can be an integral part of good architectural design and practice. (LNF, 2005)* [9]

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of incorrect mounting etc.); Photon1/2013, p.57; coloured solar installations may have performance losses of up to 39% (SolP 2017, p. 84); no award for installations with defects.

[8] According to the **Swiss Federal Council**, buildings consume around 50% of Switzerland's total energy need of 250 TWh/a, of which an average of **80%** is **due to energy losses** (IP R.W. 10.3873); the transport sector accounts for 35% of the total energy need (Swiss final energy statistic 2013, p. 4 ff.). Thus, buildings and the transport sector are responsible for about 85% of the total national energy need with the respective CO_2-emissions leading to climate warming.

[9] **Lord Norman Foster,** Swiss Solar Prize 2005, p. 3.

6. *Architects, designers, and planners cannot continue to ignore the damage our buildings inflict on the natural environment. As the consequences of our past inaction become ever more apparent, designing for a sustainable future becomes a necessity, not a choice. (LNF, 2005)*

7. *The Swiss Solar Prize and its Jury can show how the wider application of the les-sons learnt from this competition could have dramatic effects across a nation, in terms of shifting the emphasis of energy production. (LNF, 2010)* [10]

8. *My hope is that over the years the prize will show a future in which the beauty of a clean and renewable source of energy is mirrored in a sunny architecture of corresponding beauty. (LNF, 2010)*

8. Architecture and CO_2-free electricity for PEB and e-mobility

PEB distinguish themselves by a most-possible sustainable construction and operation. Especially if there are several similar PEB to be evaluated per category, the following criteria are given priority:

a) Ecological building materials: Use of most ecological building materials and components from the region.

b) Exemplary solar architecture: An exemplary solar architecture does not only stand out by an optimum use of daylight and an ideal thermal insulation with good U-values (at least Minergie-P/passive-house or similar construction standard for new buildings), but rather by a carefully integrated, fully covering solar installation as a building component (NF thesis no. 4). Solar installations replace inactive roofs as fully as possible and facades as far as possible from the first floor up.[11] So-called performance installations are primarily ranked according to performance, efficiency and building complexity in the meaning of Art 5 (b) of the PEB regulations; aesthetics will be considered as far as possible as well.

c) Operating energy: Solar installations and other energy systems produce *operating energy* in kWh or GWh/a; such energy is used as *driving energy* for motors and machines or for heat pumps to produce heat. It must be *produced annually* and is to be *distinguished* from *grey energy* (rounded figures).

d) Grey energy is the production energy of a product; it is needed only *once to produce* the respective product.[12] Thus, grey energy is the *accumulated amount of energy* in MJ or kWh needed for *production*[13] and all preceding processes including the mining of the respective raw materials (primary energy)[14], as well as subsequent dismantling[15].

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[10] **Lord Norman Foster,** Swiss Solar Prize 2010, p. 3 and 4.

[11] **Recommendation of Stefan Cadosch,** certified architect ETH/SIA, President SIA, vice-president Norman Foster PEB Jury.

[12] **Grey energy is production energy:** Grey energy corresponds to the *production energy of a product.* According to SIA it includes *the whole amount of non-renewable primary energy needed for all preceding processes, from raw material mining to manufacturing and processing and for disposal, including the necessary transports and auxiliary materials* (see SIA 2023, 1.1.1.15 ff and SIA trail for energy efficiency, status report on grey energy, SIA basics for documentation D 0216 and SIA No. 2032, Ueli Kasser, February 2004). It must be distinguished *clearly* between the *production energy* needed to produce a building or product *only once* and the *annually needed operating energy* of the building in kWh/a or GWh/a (waste wood can become operating energy).

[13] **Energetic amortisation and CO_2-free electricity:** University of Applied Sciences in Aalen, energetic amortisation, Aalen, June 2008, p. 8 et seq. When determining the solar energy production of a building, it must be considered that the production energy of solar installations is *compensated, i.e. "paid back", within 0,8 to 2.2 years* (see following footnote to Energy Pay Back Time). Therefore, since PEB energetically "pay back" the total production energy of their solar installation *within 2.2 years*, they are producing **CO_2-free solar electricity** from that point on. Only the *solar electricity surplus* of *PEB solar installations* that are producing *CO_2-free electricity* additionally to their annually needed "operating energy" allows to **"pay back"** the **grey energy** of solar installations and buildings; this means that without a *PEB solar electricity surplus,* solar electricity production just covers the *CO_2-free* operating energy need.

[14] **"The Energy Pay Back time (EPBT)** *is the length of deployment required for a photovoltaic system to generate an amount of energy equal to the total energy that went into its production."* U.S. Department of Energy, PV FAQs, 2004; E. Alsema; R. Dones; K. Kato; K. Knapp; W. Palz etc.; see Prof. Dr. Anulf Jäger-Waldau, EU Commission, DG JRG, Ispra, 2011; M. V. Fthenakis et al., Renewable and Sustainable Energy Review, 2009: Module + Frame* + BOS: With a radiation of 1700 kWh/m²/a (η= 8.5 –14%) the EPBT amounts to **0.8 –1.3 years** and with 1,000 kWh/m²/a to **1.4 –2.2 years**. Location and the use of PV electricity for the PV production and installation may further reduce the EPBT. This increasingly applies to PEB production and installation sites.

e) Thermal insulation: Insulation consists of **as much air and as little material** as possible[16]. Therefore, the production of mineral insulating material requires much air and little „production material". The production of mineral insulating material thus causes little "grey" energy and few emissions. If CO_2-free energy is used for production, the production itself can even be CO_2-free.[17]

f) Minimum thermal insulation and cost transparency: It must be differentiated between an optimum Minergie-P or passive-house insulation and the minimum thermal insulation[18] according to law such as MuKEn (Model Provisions of the Cantons in the Energy Sector), Minergie etc.[19] Anyone complying with the minimum requirements only or even less, acts illegally.[20]

g) Optimum Minergie-P thermal insulation: With Minergie-P insulation, triple-glazed windows have been standard according to Art 44 (4) in correlation with Art 45 Federal Energy Law for years and are implicitly part of PEB such as other efficiency measures[21]. Minergie-P buildings, PEB or similarly well insulated buildings (e.g. mineral wool such as Flumroc) have an 'energetic amortisation' of 0.5 to 2.0 years [22] – depending on the insulating material and

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15 **Production of bricks and insulating material:** See AUB, environmental declaration for mineral wool insulation, Deutsche Rockwool; life cycle assessments in the construction sector, 2009/1, Ecobau, edition of January 2011; sustainability of insulating material, Energy Department Schleswig-Holstein, 2003; life cycle assessment of Flumroc mineral wool products, April 2011, p. 4 and 6 (with 474 MJ, the energetic payback period of bricks is approximately twice as high as the payback period of insulation material with 205 MJ). Thus, it becomes apparent that every product or building has a certain amount of production energy or grey energy that has nothing to do with its operating energy.

16 **Prof. Armin Binz,** FHNW, 23.3.2020; The *comparison of bricks and insulating material* shows that insulating material is less energy intensive.

17 **CO_2-free production of insulating material and solar electricity:** If the insulating material and/or solar cells are produced with *renewable CO_2-free* energy instead of fossil-fuel energy, the grey energy i.e. production energy of these materials causes *no CO_2-emissions*.

18 **Insufficient insulation with Minergie and MuKEn.** By ratifying the Paris Agreement 2017, the Federal Parliament decided to reduce *Switzerland's CO_2-emissions by 50% until 2030* (Official bulletin of the Council of States of 7.6.2017; Swissinfo.ch, 7.6.2017). Therefore, whoever does not comply with the minimum insulation according to law, MuKEn or Minergie is *neglecting* the legal provisions of the Federal Council and Parliament of 2017. In fall 2019, the Council of States clearly specified: "*The **Cantons** will probably clearly **miss the climate target**, if in future **only the model provisions (MuKEn) of 2014** are applied"* (see Official bulletin of the Council of States, spokesman of the commission CS Damian Müller, Sept. 23, 2019 and message of the Federal Council of Dec. 1, 2017, p. 253 concerning longevity of carbon dioxide (CO2) - „Emissions are to be stabilized to *a net zero* in the second half of this century").

19 **A minimum thermal insulation** with insulating material of 18 to 20 cm corresponds to the building standard of 1995-2000 (for individual buildings even 1986) and is no longer enough. The lower the insulation, the *higher the operating energy need* due to high energy losses of the buildings. The minimum insulation's low amount of grey energy takes a brutal revenge in extremely *high national energy losses of 90 TWh/a* (Federal Council IP 10.3873). The building owners bear the costs with a high need of operating energy in kWh/a or GWh/a for the whole life cycle of the building of approximately 40 years or almost two generations. Such annual energy costs *must be added* to the grey energy of the building. *Cost transparency* according to Art 7 (2) Federal Energy Law is only given if both factors are added up in order to determine the *real CO_2-burden* of the building.

20 **Minimum thermal insulation according to MuKEn/Minergie:** The Federal Council approved the Paris Agreement in 2015, and the Federal Parliament ratified it in 2017. With the reception of the ratification document on October 6, 2017, in New York, Switzerland became an official member of the Paris Agreement. For Switzerland, the **Paris Agreement** came into force on *November 5, 2017* (media information of Federal Council of Oct. 6, 2017). Therefore, whoever does not comply with the goals of the Paris Agreement *after November 5, 2017, acts illegally* [as to the Paris Agreement] (see Official bulletin of the Council of States SR 17.071, especially Sept. 23 and 25, 2019, Federal Council Simonetta Sommaruga, spokesman of the commission CS Damian Müller, CS D. Berberat, R. Comte, R. Cramer, R. Noser, F. Olivier, P. Rechsteiner, B. Rieder, B. Vonlanten and R. Zanetti to Paris Agreement; especially CS Damian Müller on Sept. 23, 2019).

21 **Minergie-P insulation with implied energy efficiency:** An optimum Minergie-P or passive-house insulation with 30 cm or 32 to 35 cm of mineral wool and *triple-glazed* instead of double-glazed windows includes also a *strongly improved building technology* with efficient +++devices, a *heat pump* possibly combined with a *soil sensor* and eventually with heat recovery, a hot water circuit combined with service water etc. (see Swiss Solar Prizes since 2012, e.g. Solar Prizes 2013, p. 32, p. 36, p. 52 and Swiss Solar Prizes 2014, p. 38, p. 40, p. 42, p. 48, p. 64, p. 66 etc).

22 **Optimum insulation: Prerequisite to fulfil the Paris Agreement:** According to EMPA (Swiss Federal Laboratories for Materials Science and Technology), the grey energy, i.e. *production energy* of insulating materials *incl. mounting* is "paid back" by energy savings and CO_2 reduction within approximately **18 months**. After only two years and thereafter for decades, a non-insulated or only minimally insulated building according to law consumes *several times more operating energy* with respective CO_2-emissions (see Art 8 (f) and (g) incl. footnote; Official bulletin of Council of States of Sept. 23 and 25, 2019, especially spokesman of the commission CS Damian Müller (see also Art. 10 (c) incl. fig. 3 PEB regulations). As a matter of fact, the legal provisions of the Paris Agreement can **only** be fulfilled with an optimum **Minergie-P insulation** (see Official bulletin of the Council of States of Sept. 23 and 25, 2019, to CO_2-law and Swiss Solar Prizes since 2014, p. 38, p. 40, p. 42, p. 48, p. 64, p. 66 etc.).

its thickness.[23] During this period, all accumulated energy needed for the production of the insulation up to 38 cm and all preceding processes including mining of raw materials is energetically paid back (which is much faster than the payback time of a poorly insulated, heated building)[24].

h) Paris Agreement determines minimum standards: When comparing renewable and non-renewable energies, their different ecological impacts must be considered.[25] This applies particularly for the *operating energy* and the *grey energy, i.e. production energy*. The same principle must be considered for the *Minergie-P building standard*. Therefore, only *legal building standards* that are *eligible for approval* may be compared. Since a minimum insulation is *necessary by law in order to achieve an approvable building standard,* it is not allowed to attribute the whole production energy *of the insulation* of e.g. 30 to 32 cm to the Minergie-P standard, but only the **difference** of **20 to 30 cm**.[26]

i) Energetic amortisation: "The time for energetic amortisation"[27] corresponds to the time "the installation needs to produce the same amount of energy[28] that was used for its production[29] including all preceding processes[30].

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[23] **Grey energy and insulation calculations:** According to Art 8 (d) above, this part of the building's *grey energy including its implied lower energy efficiency as well as the additionally needed annual operating energy* including the respective CO_2-emissions and energy costs during approximately 40 years or two generations must be *added*. Only by doing so, we get the final sum of *grey energy* in kWh/a or GWh/a.

[24] **Art 8 (d)** and especially (f) to (h) PEB regulations.

[25] **Improper energy comparison:** The ecological impact of renewable and non-renewable energies is completely different: A *non-renewable* fossil-nuclear energy production almost always comes along with the combustion of carbon (C) (see PEB building study 2019, p. 125 ff) leading to *CO_2-emissions* and therefore *global warming,* and/or carbon monoxide (CO), *a toxic gas* causing the formation of ozone at ground level such as nitrogen oxides as a precursor (see also Art 9 (h) of the PEB regulations). As to *renewable solar heat,* it is the solar infrared rays that are responsible for the production of heat energy. "Light" and *solar induction* allow to produce renewable solar electricity – with monocrystalline solar cells mainly by means of silicon cells. *Solar cells* cannot cause any CO_2-emissions because neither pure silicon nor solar light contain carbon. Due to these fundamental differences and the fact that „equal is treated equally in accordance with its equality and unequal is treated unequally in accordance with its inequality" (Art 8 Swiss Federal Constitution; BGE 139 I 242 ff., BGE 138 I 265 E. 4.1), **renewable and non-renewable energies cannot be compared** without considering their respective impact on the environment and the climate.

[26] **According to the Paris Agreement**, Art 1, Paragraph 2 (a) to (c), Art 5 (a) to (c) and Art 7 (2) Energy Law *it is imperative to improve* the insulation of Minergie, MuKEn and other building standards with insufficient insulating material of only 18 to 20 cm and/or poor U-values of more than 0.11 or 0.12 W/m^{2}K. Otherwise, they are not eligible for approval due to the Paris Agreement (see Official bulletin CS, especially CS Damian Müller on Sept. 23, 2019). Therefore, the production energy of Minergie, MuKEn or a similar insulation up to 20 cm cannot be imposed on the Minergie-P building standard. Only *legal building standards* which are eligible for approval may be compared with each other (BGE 132 I 157 E. 4.1 S. 162).

[27] **Comparison of Minergie-P insulating material and CO_2-emissions:** In order to produce one cubic meter of Flumroc insulation (≈ 85 kg), approximately *340 kWh/a* (1 kg = 4 kWh/a) are needed. With one cubic meter of insulating material it is possible to insulate a surface of 10 m^2 with a thickness of 10 cm (see Art 8 (h)). For apartments with a floor surface of 100 m^2 and a height of 3 m an **additional insulation** of approximately ***90 m²*** with a thickness of 10 cm is needed (40 m^2 x 3 m [minus 25% windows surface, Swiss Solar Prize 2019, p. 56, paragraph 5 (b) and (c), ClimaBau, BFE study, 29.12.2017, p. 111-113]; see also Art 8 (g), footnote 20, and Art 8 (h) to minimum standards according to Paris Agreement and improper comparisons of grey energy figures). **9 m³ of insulating material** are enough for an insulation surface of 90 m^2 with a thickness of 10 cm; for this, approximately *3,060 kWh/a* are needed (**≈** 9 m^3 x 340 kWh/a). If the implied energy efficiency of a Minergie-P insulation (triple-glazed windows etc. see Art 8 (g), footnote 21) is added *with its rounded double value,* this results in (3,060 kWh/a x 2 ≈ 6,120 kWh/a x 0.3 kg CO_2-emissions ≈ 1,836 kg) ≈ **2 t** of CO_2-emissions of grey energy for a *Minergie-P insulation*. These basic principles can generally be used as reference values for other insulation materials (see also Art 8 (h)).

[28] **Energy need and CO_2 comparison of Minergie-P and MuKEn:** An apartment with a floor surface of 100 m^2 and Minergie or MuKEn standard has an energy need of (100 m^2 x 65 kWh/m^{2}a) ≈ 6,500 kWh/a, i.e. in 40 years **260,000 kWh/a** und in 50 years *325,000 kWh/a*. A Minergie-P apartment has an energy need of (100 m^2 x 32 kWh/m^{2}a) ≈ 3,200 kWh/a, i.e. in 40 years ≈ **128,000 kWh/a** and in 50 years *160,000 kWh/a.* The yearly *additional need of a MuKEn apartment compared to a Minergie-P apartment amounts to 3,300 kWh* (≈ 1.1 t of CO2-emissions), i.e. in 40 years ≈ *132,000 kWh/a* and in 50 years *165,000 kWh/a.* A Minergie or MuKEn apartment is emitting 260,000 kWh/a (x 0.3 kg of CO_2-emissions) i.e. **78 t of CO_2-emissions** compared to a Minergie-P apartment ≈ *128,000 kWh/a* and (x 0.3 kg of CO_2-emissions) **38.4 t of CO_2-emissions**. For the grey energy of the improved insulation of 20 to 30 cm, 7,000 kWh/a or *2 t of CO_2-emissions* must be added leading to a total of **40.4 t** of CO_2-emissions.

[29] **Minergie-P apartment: 48% less CO_2-emissions.** Over a period of 40 years, a Minergie-P apartment with a floor surface of 100 m^2, an implied energy efficiency including improved insulation of 30 to 32 cm of mineral wool, triple-glazed windows etc. (see Art 8 (g), footnote 20) is emitting (78 – 38.4 + 2 t ≈ 40.4 t) **37.6 t or *48.2% less CO_2-emissions*** than a MuKEn apartment; this corresponds to the lower energy need of 3,200 instead of 6,500 kWh/a.

[30] **MuKEn apartment with 18 times more CO_2-emissions** compared to the grey energy of a **Minergie-P insulation** for an apartment with a floor surface of 100 m^2. The *additional Minergie-P insulation* has a grey energy of 7'000 kWh/a with approximately 2 t of CO_2-emissions. This amount must be added to the 38.4 t (operating energy) leading to a total of 40.4 t of CO_2-emissions. Therefore, the grey energy of the *additional Minergie-P insulation is 37.6 t or 18.8 times lower than the 78 t of CO_2-emissions* of the MuKEn apartment over a period of 40

The so-called energy payback time (EPBT)[31] or amortisation of silicon cells lies between 0.8 to 2.2 years. **Conclusion:** After their energetic amortisation of 0.8 to 2.2. years, the respective solar installations are therefore producing *CO_2-free energy* in form of *CO_2-free electricity* or *CO_2-free heat*.[32] After having "paid back" its total production energy (grey energy) including all preceding processes and dismantling, the *solar installation starts to pay back the grey energy of the building*.[33]

9. Comfort and aesthetics instead of global warming and pollution

a) **CO_2-free overall energy supply:** The above-mentioned principles and regulations are the basis for implementing Norman Foster's PEB theses. They are an alternative to global warming and environmental pollution and demonstrate how society and economy can guarantee aesthetics and comfort at a good price with an environmental-friendly and CO_2-free overall energy supply.

b) **Reduction of energy losses of more than 75%:** More than three-quarters of today's total energy need are energy losses that increase global warming without leading to more comfort. This is not of any public nor private interest. The losses are not contributing any benefit to society and they are against the constitutional principle of proportionality (Art 5 (2) Swiss Federal Constitution) claiming that "…to achieve a target of public interest, the *needed measures* must not only be *appropriate*, but also *reasonable and proportionate* to the ends sought."[34] As long as the energy losses of 75% are therefore not eliminated as requested by Art 89 (1) and (3) Swiss Federal Constitution, a high fossil-nuclear energy production and unnecessary impacts on the landscape are disproportionate[35].

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years. Even when considering the total insulation of 30 cm, the result would be 6 times better (3 x 2 t ≈ *6 t instead of 37.6 t* of CO_2-emissions).

[31] **The actual difference to Minergie-P** lies today practically only in the **costs of the insulating difference** of about **10 to 12 cm** including the mentioned energy efficiency measures (see above, Art. 8 (g), footnote 21). This leads to optimal *U-values of 0.10 to 0.11 W/m²K* and eliminates practically all energy losses. The *costs for the building procedure, approval requests,* installations on the construction site, scaffolding etc. for an insufficient insulation are mostly the same than for an optimum insulation (see PEB building study 2019, p. 96 and PEB main study, p. 165-170; U-values of 0.16 with 20 cm and **0.11 W/m²K with 30 cm** of external thermal insulation (see M. Thoma, Flumroc, 2.4.2020; note: mineral wool is considered as "not flammable").

[32] **PEB and multifunctional solar installations** fulfil several building functions: Optimally integrated solar installations do not only produce energy but can also protect against bad weather or take the function of a roof. Therefore, such diversified functions must be considered regarding energy consumption, grey energy, investments, economics etc. Art. 8 Swiss Federal Constitution asks for equality before the law. „*Equality of rights is violated* in particular **if equal is not treated equally in accordance with its equality**, or *unequal is not treated unequally* in accordance with its inequality." (Decision of the Federal Court 114 Ia 1 p. 3): Therefore, if a *fully and optimally integrated solar installation* is not only producing energy, but also *has the function of a roof*, the *additional energy need* for the realisation of a traditional roof (tile, eternit, copper etc.) must be considered when determining the amount of grey energy. The same legal principles must be considered for investment and energy costs as well.

[33] **Energetic post-payback:** As soon as a solar installation has produced the total energy amount that was necessary for its production incl. all preceding processes (for example 20,000 kWh/a), the solar installation has *"paid back" its total amount of grey energy*. It normally takes about two years until *each used kWh/a* is "paid back". Now, the phase of the *energetic "post-amortisation"* begins. On the building itself, this is only possible by means of *a PEB solar installation with a solar surplus that is higher than the annually needed operating energy.* Traditional building materials such as **tiles, iron sheets, eternit, copper,** concrete, stone, or structural steel **never generate any kWh/a** to "pay back" the grey energy of a building – not even in 100 years.

[34] **Federal Court demands proportionality of measures** according to Art 5 (2) Swiss Federal Constitution and declares: „A measure is *disproportionate* if the goal can be achieved *with a less* serious encroachment of fundamental rights" (BGE 136 I 87 E. 3.2, S. 91 f). After November 5, 2017, this principle also applies regarding the implementation of the Paris Agreement (see Art 8 (f), footnote 21)

[35] **Emissions and global warming:** The annual reports of the Intergovernmental Panel on Climate (IPCC) have been confirming for years that there is a causal connection of global warming (mainly due to CO_2-emissions) and increasing damages on constructions, nature, environment because of floods, rockfalls and landslides, ridges etc. (see melting permafrost in the Alps/rockfalls in Bondo/GR, see SOS, 23.8.2017).

c) **Fossil-nuclear energy is neither CO_2-free nor amortizable:** The combustion of *1 kg of oil* i.e. fuel oil pollutes the atmosphere with approximately *3 kg* of CO_2-emissions. The energy content of 1 kg of oil is about 10 kWh[36]; *10 kWh of natural gas* create *2 kg* of CO_2-emissions; *10 kWh nuclear electricity ≈ 1 kg* of CO_2-emissions; i.e. the nuclear processing of nuclear fuel leads to about **100 g of CO_2-emissions** for *1 nuclear kWh*.[37] This shows that *every* fossil-nuclear kWh including nuclear energy is heating up the climate. And neither fossil nor nuclear energy is amortizable, since *each new kWh* is needing *additional fossil-nuclear fuel*, which cannot be renewed nor regrown, but leads to an irretrievable resource depletion.

d) **In line with the Paris Agreement:** Norman Foster's PEB solar architecture for new buildings and building refurbishments with good U-values (Art 8 (g) and (h) of PEB regulations) is characterized by carefully integrated, fully covering solar installations over the full surface as part of the building envelope (Art 8 (b) and Norman Foster theses no. 1 to 4 in Art 7 of the PEB regulations). The energy scenarios of the PEB study 2019 evince how Norman Foster PEB can guarantee on the short and medium term a *CO_2- and fossil-nuclear-free* **overall energy supply** in line with the Paris Agreement (Art. 10 (c) including table, i.e. fig. 3 of the PEB regulations). An overall supply on 365 days is best accomplished with pump storage power plants (PSPP) and/or other environmental-friendly and renewable energies.[38]

f) **Norman Foster's theses are confirmed by history:** Norman Foster's theses number 2 to 4 that are the *basis for the Norman Foster PEB Solar Prizes* are confirmed by the achievements of our architectural and cultural history which is more than 2,000 years old. Our ancestors always used the *best and newest building materials* for churches and other important buildings. Since roofs and facades were continuously exposed to weather or were regularly destroyed by war or fire, such **"expendables"** had to be replaced very often.[39] In the past, the building culture always followed the technological development. This is shown by the Acropolis, by Notre Dame de Paris and many other historic examples and structures.[40] The building history of our ancestors therefore teaches us the following: When cultural buildings and other structures were renewed or refurbished, the focus was always on aesthetics, elegance, comfort, beauty and perfection. Innovative technologies and always better materials were used, and new achievements were integrated.[41]

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36 **Comparison of energy contents:** 1 kg of heating oil ≈ 10 kWh (≈ 11,63 kWh ≈ 41,9 MJ). 100 MJ ≈ 2,4 kg of heating oil ≈ 6,4 kg of wood ≈ 27,7 kWh; 1 kg of hard wood ≈ 4,3 kWh.

37 **Comparison of emissions:** See study of University of Sydney, Australia 2006. German Eco-Institute and 2005 Jan Willem Storm van Leeuwen: According to region and quality, generally about 3 to 9 g of uranium can be extracted from one ton of soil/iron ore mined for nuclear energy production.

38 **Existing pump storage power plants** are already developed in terms of energy and transport. They can be modified into pump storage power plants quickly, at reasonable price and without major landscape interventions, allowing to balance the daily solar peaks and lack of wind at any time according to demand.

39 **Notre Dame** in Paris, several churches and cathedrals after wars, especially after 1945 in Germany, England, Vienna (St. Stephen's Cathedral in April 1945) or after fires in Glarus (1861) and Lucerne (Kappell's bridge in August 1993) etc.

40 **Acropolis, Greece:** Reconstruction after its destruction in 460 BC with *the best materials known at that time* (see Swiss Solar Prizes 2016, p. 56). Built in 1163, the early Gothic **Notre Dame** Cathedral in Paris was initially made all of stone. After 1230, technological development led to several replacements such as flat terraces instead of pitched roofs on the side aisles and larger clerestory windows for a better lighting of the nave. Metal jackets became possible, window rosettes with diameters of up to 13 m were framed with lead, roofs were covered with lead plates and the Cathedral was continuously modernised and enlarged until the 15th century. During the French revolution after 1789, royalist symbols were destroyed, then renovated after 1830, and in 1866 the spire was built on the nave. Large parts of the Cathedral were destroyed by the fire in April 2019; restoration is on its way. Similar modifications were made at Zurich's *Grossmünster* with the adjustment of the uneven towers in 1487 and 1492 with **elegant gothic spires** followed by octagonal **blunt towers** after the fire of 1793 which still exist today.

41 **The Reichstag dating from 1894** in Berlin was fully refurbished by Norman Foster from *1995 to 1999.* It now has a new cupola open to the public (similar to the rectangular cupola of 1910), a panorama terrace and a PV installation of 3,600 m^2. Today, the Reichtag's energy supply is 100% renewable (also thanks to biodiesel) (information: Reichstag Administration, Jan. 2020). Today, Norman Foster's energetically refurbished Reichstag has more than 2 million visitors per year and is **world famous**. It is a symbol for openness and parliamentary transparency: „Sun and light in the plenary hall" (as a contrast to the terroristic Nazi era from 1939 to 1945). Norman Foster's refurbishment of the Reichstag proofs that a professional solar architecture contributes significantly to preservation, embellishment and elegance of architectural monuments and does not damage or destroy at all (see Art 9 (i)).

Otherwise, electricity would be unknown in the 21st century and we would still live and work in unheated apartments without glass windows and hot water.

g) Building permission for optimally integrated solar installations: Art 26 (1) Swiss Federal Constitution guarantees the right to own property – also in the building sector. Construction bans by the authorities or measures that prevent or restrict the solar use of roofs and facades, constitute a restriction on ownership.[42] They require a respective legal basis.[43] Solar installations on residential or commercial buildings that have been awarded the *Norman Foster PEB Solar Prize* are characterized by solar installations that are "carefully and completely *integrated in the building envelope as a constituent part of the building*."[44] According to Art 642 (2) Swiss Civil Code, a constituent part is "*anything* which (…) is held to be an *essential part* of an object and which *cannot be detached without destroying*, damaging or altering it. If a building owner decides to replace an *inactive* roof and/or parts of the facade of an existing building by an *active* and de facto identical roof and/or facade surfaces or components with a carefully integrated, fully covering solar installation, there is a fundamental *legal right* for approval according to Art 26 (1) Swiss Federal Constitution, provided that the partially or completely new building component corresponds to the replaced building component according to Art 642 (2) Civil Code in *size and form*. If the building differs only slightly to the former building in terms of the replaced material, **the townscape is not affected** or changed either. It then corresponds to a **repair replacement.**[45] The legal basis for the protection of the townscape can be found in Art 78 (2) Swiss Federal Constitution and Art 5 Federal Act on the Protection of Nature and Cultural Heritage (NCHA). Neither in Art 78 (2) Swiss Federal Constitution nor in Art 4 or 5 NCHA there is a *legal basis* to force building owners to

Fig. 2: Chesa Futura, St. Moritz: Norman Foster demonstrates the elegance of a Minergie-P insulation (≈ 30 cm) – and with 50 cm even more than Minergie-P. *"The elegance of an insulation does not depend on the bulky of the insulation, but on the knowhow of the architect."*

[42] **Ownership restrictions: Revenue losses of CHF 1.4 million and increase of CO_2-emissions by 70 t.** Ownership restrictions can lead to massive revenue losses and an increase of CO_2-emissions: If, for example, the *solar production* of a PEB housing development with 32 apartments consuming 130,000 kWh/a and producing **236,000** kWh/a of **CO_2-free electricity** was **forbidden,** *CO_2-emissions* would increase by approximately 70.8 t (130,000 CO_2-free kWh/a x 0.3 kg/CO_2-kWh). This *contradicts* the Paris Agreement (see message of the Federal Council of Dec. 1, 2017, p. 253) and based on a life cycle of 40 years this leads to revenue losses of more than *CHF 1.4 million* (236,000 kWh/a x 0.15 Centimes/kWh ≈ CHF 35,400 x 40 years ≈ CHF 1.41 million) (see above, Art 8 (f), footnote 17; 182% PEB housing development Tobel, Swiss and European Solar Prize 2019, p. 32-35, as well as Art 9 (h) to (l) of the PEB regulations).

[43] **Federal Court Decision, BGE** 116 Ia 181 E. 3c; see Art 9 (h) to (l) of the PEB regulations.

[44] **Art 8 (b)** PEB regulations: Norman Foster PEB are characterized by *completely* into the building envelope integrated solar installations with the same size and form than inactive building components. The only difference lies in a "better" material and maybe a "fresher" colour, which changes over the years anyways (see fig. 2 with about 250,000 wood shingles).

[45] **Repair replacement:** A replacement of damaged building components does not require a building approval since the existing approval is still valid. Without a formal legal basis, an existing approval cannot be repealed since this would lead to a restriction of ownership.

use certain materials and colours. On the contrary: Art 45 (1) Energy Law explicitly demands to avoid "unjustified technical barriers to trade". Fig. 2 shows that any regulation to use only certain materials is „an undisputed encroachment on the constitutionally protected guarantee of ownership (Art 26 Swiss Federal Constitution)."[46]

h) **Roofs and facades are consumable materials** that had to be replaced since time immemorial. Replacing *inactive* components by *active* roofs or facade surfaces corresponds to the replacement of *damaged shingles*, sheet metal, eternit or brick components. Material replacements have been made for centuries to guarantee the buildings' functionality in the long term. The Chesa Futura in St. Moritz (fig. 2) demonstrates how shingles, i.e. materials and colours, change in the course of time.[47] In terms of Art 78 (2) Swiss Federal Constitution and Art 5 NCHA *the townscape*, however, its form and skyline are *not changed at all*. In Switzerland, there is therefore no constitutional legal basis to forbid certain building materials as long as they are not toxic.[48] Material replacements are not only allowed, but according to Art 45 (1) Energy Law the cantons are in fact obliged within their legal framework *"to create favourable conditions for the economical and efficient use of energy and the use of renewable energies.*[49] *They support the implementation of consumer standards for an economical and efficient use of energy".* These principles also apply to new buildings that respect the local building regulations within the framework of federal law.

i) **Entitlement for Minergie-P insulation under federal law:** According to Art 45 (4) Energy Law, energy-efficient *„heated buildings with at least Minergie, MuKEn or a similar standard may exceed the building height limits, the minimum distances between buildings, borders, waterways, roads or parking spaces as well as building lines by maximally 20 cm with their insulation or installations*[50] *for a better use of local renewable energies.*"[51] An improved Minergie-P insulation must therefore be accepted by all building authorities *without* requirements and conditions; otherwise, the authority violates federal law. The townscape is *not influenced by the material* of a building component, but by *form, size, outline* and **„exterior appearance".**[52] Therefore, a building permission includes all technically necessary roof, facade and window components which must be approved.[53] Regardless of the townscape, the used materials need to fulfil mainly *technical and hygienic requirements*, and they must be replaceable at any time in case of fire or other damages. Furthermore, they must guarantee national and international standards on strength, chemical and physical properties of the building materials, quality, safety, resistance, fire, and explosion safety. This, however, has

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46 **Federal Court Decision, BGE 1C_578/2016,** E. 4.6.

47 **Nature changes roof and facade colours:** Chesa Futura, St. Moritz from golden-yellow (2002) to black-grey-yellow-orange 2020.

48 **Fire of Notre Dame:** After the big fire of Notre Dame in April 2019 scientists and authorities noted that the soil around the Cathedral is contaminated with lead. The roof and the tower were covered with approximately 460 t of lead. (Tages Anzeiger, Aug. 18, 2019; Die Zeit/DE, Aug. 19, 2019; ZEIT ONLINE; dpa, AP, AFP). Even if (eventually ideological) preservationists demand the restoration of the original building condition, there is no doubt that materials being hazardous must be removed from all buildings and construction sites (see Art 26 et seq. Federal Act on the protection of the environment; SR 814.01).

49 **Art 44 (4) in correlation with Art 45 (1) and (4) Energy Law:** New materials such as environmental-friendly monocrystalline solar cells of pure silicon are not only allowed, but according to federal law even wanted: With their CO_2-free electricity production they contribute considerably to a *reduction of CO_2-emissions* in order to fulfil the legal provisions of the Paris Agreement. This statement does not apply, or at least not unconditionally, to solar cells with toxic components or heavy metals. But to refuse environmental-friendly monocrystalline solar cells in a building part must be considered as an unjustified technical barrier to trade and therefore as a violation of Art 45 (1), last sentence, Energy Law.

50 Solar installations that are carefully integrated over the full surface of the roof and/or facade as a building component **based on Art 8 (b) of the PEB regulations** are permissible according to and Art 45 (4) Energy Law. If roof and facade edges are made as professionally and carefully as comparable new systems, the building approval may not be refused due to the constitutional guarantee of ownership **(**BGE 1C_578/2016, E. 4.6) and equal treatment (BGE 114 Ia 1 S. 3).

51 Based on Art 190 Swiss Federal Constitution, **Art 45 (4) Energy Law cannot be repealed or changed** by municipal or cantonal law.

52 **ISOS:** *For the townscape* it is mainly **the „appearance"** that is decisive (see Prof. Dr. Arnold Marti, comment to Federal Court Decision 1C_398/2011 of March 7, 2012, in: ZBl 2013 p. 388; BGE of June 28, 2017, 1C_578/2016, E. 4.6).

53 **According to Art 642** (2) Swiss Civil Code.

nothing to do with townscape protection where *local circumstances* may have an influence on *form and design of local buildings, superstructures, and extensions*.[54]

As a matter of fact, the Federal Act on the Protection of Nature and Cultural Heritage (NCHA) *does not include any provisions on building materials,* which might *contradict* the mentioned safety regulations.[55] Accordingly, townscape protection is about „maintaining the *appearance*" of a town when it comes to *building size and outline,* but not about *building materials*, as the Federal Court determined *before the Paris Agreement came into force.*[56] It must be added that building materials are „only noted from *short distance* and upon closer inspection.[57] Furthermore, the Swiss inventory of sites of national importance worthy of protection (ISOS) can only be applied indirectly: „Nothing else results from the protective provisions of the ISOS. If a modern building material such as aluminium does not affect the *present appearance* (...) and if the *aesthetic requirements are met,* it is also *compatible* with the existing ISOS objective "preservation of substance", in particular because this inventory only has an *indirect effect* on regulations for residential areas (just obligation to consider according to the decision of the Federal Court, BGE 135 II 209 E. 2.1). It usually only focuses on the **appearance** and in contrast to monument protection inventories it does not give any detailed design recommendations.[58]

k) Solare building components comply with Paris Agreement: Solar installations that are optimally integrated in roofs or facades are a constituent part of the building. According to Art 642 (2) Swiss Civil Code they can "not be detached without destroying, damaging or altering". A building permission comprises all building components and must therefore be granted also to a building with a solar installation as an "integrated building part". Without a clear legal norm, the state lacks a basis to *request a certain roof material* such as tiles, eternit and others or to *forbid a solar use of the roof or facade*.[59] According to the Paris Agreement and Art 45 (1) Energy Law, the cantons are obliged to create „*favourable conditions* for an economical and *efficient use of energy* and *the use of renewable energies"*. There is no doubt that a solar roof fulfils this federal legal condition much better than a tile, metal sheet or eternit roof *without any active* renewable and emission-free electricity or heat production.[60] Solar installations that are integrated over the full surface according to Art 8 (b) of the PEB regulations *fully comply* with the requirements of *townscape protection* if they do not differ in size[61] and location etc. from comparable traditional roof or facade components (see

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[54] **Facades can have all colours of this world** by increasing the space between the most-efficient monocrystalline solar cells: It is then the underlying plaster colour that **determines the facade colour.** Contrary to traditional monument protection (see Notre Dame, Eiffel tower, Acropolis etc.), where always the best materials were used, there are attempts today to cover solar cells with paint which impedes an efficient energy use according to Art 45 (1) Energy Law. The painting of solar cells can lead to performance losses of up to 39% (Swiss Solar Prize 2017, p. 84/85; Swiss Solar Prize 2018, p. 79). If private persons destroy 30 or 40% of the solar energy potential instead of using it, it is a private matter if the investment is financed privately. However, if public funds were used, this would be a contravention of Art 5 (2) and Art 89 Federal Constitution as well as Art 45 (1) Energy Law and therefore not allowed. Depending on the situation, the liability for work and services according to Art 368 et seq. Swiss Code of Obligations also seems worth considering.

[55] **Art 5 NHG** is the basis for ISOS standards and defines townscape protection. However, it does not say anything on *legal principles* or definitions of *building materials*; see Art 1 (1a) NHG; Art 3 (1) NHG; Art 4 (1) NHG; Art 13 (1) NHG; Art 23 (1g) NHG.

[56] **Federal Court Decision, BGE 1C_578/2016**, E. 4.3, decision of June 28, 2017, before the Paris Agreement came into force.

[57] **Federal Court Decision, BGE 1C_578/2016**, E. 4.3: relates to the use of aluminium instead of wood shutters in the city of Chur.

[58] **Prof. Dr. Arnold Marti**, in the place indicated, ZBl 2013 p. 388; decision of the Federal Court of June 28, 2017, 1C_578/2016, E. 4.6.

[59] **No legal basis:** Even if a cantonal or municipal law provides a „*sufficient legal basis*", such request or ban is still an „undisputed **encroachment** of the constitutionally protected **guarantee of ownership** (Art 26 Swiss Federal Constitution). It *needs a legal basis* on one side, as well as a *public interest* on the other side *and must be proportionate"* (BGE 1C_578/2016). The Federal Act on the Protection of Nature and Cultural Heritage **(NCHA) does not provide a legal basis** either. Nevertheless, there is often a demand for material continuity for protected monuments. „Material continuity is not as important for unprotected buildings. Using **the same material** seems **less important** when it comes to maintain a good **overall appearance** *of a town***.** In such case, the focus is not on *individual* building protection, but on a *coherent picture as a whole* and *less on individual parts* (see Christoph Winzeler, in: Mosimann/Renold/Raschèr [Hrsg.], Culture, Art, Law: Swiss and international law, 2009, monument protection, p. 220; see also BGE of June 28, 2017, 1C_578/2016, E. 4.6). Since materials and their maintenance often cause "*substantial additional costs*, such request is considered an **unproportionate encroachment of the guarantee of ownership**". (BGE of 28.6.2017, 1C_578/2016, E. 4.6).

[60] **Art 45 (2) Energy Law** obliges the Cantons to give preference to an economical and **efficient use of energies** and of renewable energies where possible.

[61] **Norman Foster PEB** are characterized by carefully integrated, *fully covering* solar installations. With this, they fulfil the mentioned ecological and economical provisions of Art 8 to 10 of the PEB regulation and create the legal conditions for an implementation of the Paris

Art 9 (g) to (k) of the PEB regulations). Despite their material, active roof and facade surfaces are practically the same, i.e. "optically identical" as traditional and until now *approvable* surfaces. Additionally, a CO_2-free solar production of active (instead of inactive) building envelopes fulfils the requirements of the Paris Agreement in two respects: **each square meter of monocrystalline solar cells** used for a CO_2-free electricity production in the building and traffic sector **reduces** *CO_2-emissions 50 to 100 times more* than a square meter of central European wood.[62] These facts must be considered positively when it comes to *public interest* according to Art 45 (1) Energy Law and as an important *contribution to CO_2-reduction*.[63]

l) Ownership restrictions for monuments: As mentioned above, restrictions of private ownership are only „acceptable on a *legal basis*, if they are of *public interest* or under certain circumstances provided that they are *proportionate*".[64] To *forbid the demolition* of a building „results in an *ownership restriction* which is only permissible if it has a legal basis (Art 36 (1), first sentence, Swiss Federal Constitution). Significant restrictions must have their basis in a federal act (Art 36 (1), second sentence, Swiss Federal Constitution)."[65] According to Federal Court practice "the subordination of a building under the protection of monuments is to be qualified as a *serious encroachment on property.* The formal legal basis must therefore be verified if essential constructional measures that are necessary for a *permanently profitable use* of the building *are made impossible"*.[66] „Ownership restrictions for the *protection of monuments* are generally of public interest. However, it must be verified for each case how far *public interest* goes and *which objects* are worth monumental protection and to *what extent"*.[67] As explained in Art 8 (b) and Art 9 (g) to (i) of the PEB regulations, solar installations that are carefully and completely integrated in the building envelope as a building part[68] form a multi-functional and **inseparable building component** that must be approved for *new buildings* with the overall building permission.[69] If certain restrictions lead to a construction ban also for optimally integrated solar installations, the constitutionality of such provisions must be examined. According to the Paris Agreement, the use of a solar installation that is optimally integrated in the building envelope for a CO_2-free energy production is generally to be welcomed and to be preferred to a ban. Without constitutionality, there cannot be a construction ban either. If the restriction nevertheless proves to be compliant with the constitution, it may at most be considered for protected monuments. In all other cases, a building restriction due to monumental protection must be considered as a „*serious encroachment* of property rights"[70], for which the Federal Court requests a legal basis.[71] Monuments of national importance are listed in the federal inventory.[72] Based on the principle of proportionality, even such cases might justify only a partial ban, e.g. by using only the roof or the facade of the monument for solar energy production.[73] In case there is a public interest on a *new*

Agreement. An only partial solar use of roofs and facades with an energy potential of 150 to 200 kWh/m²a contradicts Art 5 (2) Federal Constitution and Art 45 (1) Energy Law and undermines protection of diversity. To gain just 1 or 2 kWh/m²a, a water, landscape and/or biodiversity surface that is **150 to 200 times larger** than the unused roof surface would be affected or even destroyed. And compared to PEB refurbishments, the affected or destroyed surface is even 600 to 800 times larger.

62 **PV reinforces Paris Agreement:** 1 m² of *non*-coloured monocrystalline solar cells produces ≈ 200 kWh/a and reduces CO_2-emisions by approximately60 kg/a (10 kWh/a oil ≈ 3 kg CO_2-emissions); 1 ha wood binds 6.1 t of CO_2-emissions per year: 1 m² ≈ 0.6 kg/a. (see BAFU 2015/2020).

63 **Art 45 (1) Energy Law,** last sentence.

64 **Federal Court Decision, BGE** 116 Ia 181 E. 3c and BGE 115 Ia 350 E. 3a, see also Art 9 (g) PEB regulations.

65 **Federal Court Decision, BGE 1P.57/2007** E.3.1

66 **Federal Court Decision, BGE 1P.57/2007** E.3.2; BGE 118 Ia 384 E. 4a p. 387

67 **Federal Court Decision, BGE** 119 Ia 305 E. 4b

68 **Art. 8 (b)** PEB regulations, Swiss Solar Prize

69 **According to Art 642** (2) Swiss Civil Code, a constituent part of the building is *anything* which… is held to be an essential part of an object and which *cannot be detached* without destroying, damaging or altering it". Detaching parts of a PEB results in its destruction; and new buildings generally are *not under monumental protection*.

70 **BGE 1P.57/2007** E.3.2; BGE 118 Ia 384 E. 4a, p. 387

71 **BGE** 116 Ia 181 E. 3c and BGE 115 Ia 350 E. 3a, see Art 9 (g) PEB regulations.

72 **Monuments** of national importance listed as individual objects in the Swiss inventory of October 6, 1966.

73 **The principle of proportionality** demands that a (…) *measure* is *appropriate and necessary* for achieving a goal of public (…) interest and that it proves *reasonable and proportionate* (…) for the persons concerned. (…) A measure is *disproportionate*, if the *goal* could be achieved with a *less serious encroachment* of fundamental rights" (BGE 136 I 87 E. 3.2, S. 91 f).

PlusEnergyBuilding, the interest is limited to an approval for the whole building with an optimally and inseparably integrated solar installation as a building component. Based on supreme court ruling (see above, Art. 9 (g), footnote 42), a *full compensation* of at least the refused CO_2-free solar production for a life cycle of 40 years seems appropriate if the overall building approval is refused.[74]

m) Norman Foster PEB: Optimization for tenants, landlords and SME. Contrary to many other technologies, the integrated solar technology of PlusEnergyBuildings having received a Norman Foster Solar Award does not *damage* or destroy monuments, but often helps to *protect* witnesses from the past, to save and improve the building structure and to increase comfort. In many cases, an integrated solar technology leads to more perfection, beauty and elegance as Norman Foster's refurbishment of the Reichstag in Berlin from 1995 to 1999 perfectly demonstrates.[75] Other examples are the "hipped roof house" dating from 1819 in Uettligen/Canton of Berne, which was saved in 2010[76], or the saving of the "glazier house" dating from 1765 in Affoltern i.E./Canton of Berne.[77] According to Art 45 (2) Energy Law, the Cantons are obliged to define regulations "for an economical and efficient use of energy in *new* and *existing* buildings". The constitutional basis for such regulations is laid down in Art 73, Art 74, Art 78 (1) and Art 89 of the Swiss Federal Constitution. If tenants, landlords, SMEs, and other building owners implemented Norman Foster's theses 1 to 8 according to Art 8 and 9 of the PEB regulations, residential and commercial buildings could be optimized energetically, ecologically, and economically. All protective measures must observe the principle of proportionality of *Art 5 (2) Federal Constitution* as requested by Art 3 (3) NCHA regardless of the object's importance as well: „A measure may not go any further than necessary for the protection of the object and its environment."

o) Conclusion: Art 8 (a) to (m) describes the technical, energetic, ecological, and partially also economic measures and regulations to implement Norman Foster's theses 1 to 8. This allows to meet the requirements of the Paris Agreement of 2015 ecologically, energetically and economically.[78] Art. 9 (a) to (o) explains the current situation, the future situation in terms of energy, climate and environment, the effects and goals of the Paris Agreement, as well as questions concerning procedure, restrictions, and optimization that can be answered and implemented on the basis of the following three regulations of Art 10.

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74 **Art 26 (2) Federal Constitution:** „Any restriction on ownership that is equivalent to compulsory purchase shall be compensated in full".

75 **Norman Foster's buildings** are characterized *„by a perfect combination of technology, aesthetics and functionality. The buildings are of an individual and incomparable beauty that captures and fascinates the eye of the beholder. Uncompromisingly modern, they are always an expression of respect for the past, they blend in with their environment and yet stand out. A meaningful example is the place of work of the German Bundestag, the Reichstag in Berlin. Our thanks today go to a visionary architect who has enriched us and many others with his work of art"* (speech by the president of the Bundestag, Dr. Wolfgang Thierse for the 70th birthday (1.6.2005) of Norman Foster in Berlin in September 2005).

76 **Swiss Solar Prize** 2011, p. 60/61: „Solar architecture saving" instead of "last-minute-job" 2010 with **new protection** of one of the last "hipped roof house" dating from 1819 in Uettligen/Canton of Berne.

77 **Swiss and European Solar Prize** 2016, p. 42/43: „Saving instead of edging" with 345% PEB solar refurbishment of the former „glazier house" dating from 1765 in Affoltern i.E./Canton of Berne by family Anliker.

78 **Art 9 (d): PEB building study** 2019, PEB energy scenario part V (c), p. 130 to 136.

10. Paris Agreement: Norman Foster's PEB solar trilogy

a) Since 2010, **Norman Foster's 8 theses** in Art 7 of the PEB regulations have been the planning and legal bases for PlusEnergyBuildings (PEB) that are eligible for the Norman Foster Solar Award.[79] They guarantee an *ecological, energetically safe and economically* very successful implementation of the Paris Agreement from 2015 to 2050 under the condition that an implementation is possibly made according to energy scenario C of the PEB study 2019.[80] The *architectonical* and *technical measures* for a *CO_2-free electricity and overall energy supply* for *buildings* and the *traffic sector* are defined in Art 8 of these PEB regulations, whereas Art 9 and 10 of the same regulations guarantee *comfort and aesthetics* instead of *global warning and environmental damage* (especially Art 10 (3))

b) **A successful implementation** of the Paris Agreement is based on Norman Foster's theses 1 to 4 with a huge electricity potential of elegant building envelopes combined with a reduction of 80% of energy losses by Minergie-P/efficiency measures in the building sector: Only such measures or similar building standards lead to such an economical *CO_2-free solar surplus*.[81] They are indispensable to supply the traffic, service and industrial sector with enough CO_2-free electricity and *CO_2-free* heat.[82]

c) **Minergie-P insulation trilogy**: Two important theses of Norman Fosters need to be implemented: The **solar installations** must be carefully and **fully integrated** into to building envelope. They replace *inactive* roofs as completely as possible and if necessary also facade elements from the first floor up *by active* elements.[83] *Insulation elements* with (minimum) U-values of 0.10 to 0.12 W/m^{2}K as outlined in Art 8 of the PEB regulations complete the measures.[84] With the following ‚**Minergie-P insulation trilogy'** the set goals can be achieved relatively simply, sustainably and economically[85]:

1. **50% less energy losses:** A Minergie-P insulation of about 30 cm is in the interest of the Paris Agreement. With the *‚first 10 cm of insulation'*[86]*,* the extremely high average energy losses in the building sector[87] can be reduced by approximately 50% from 250 kWh/m^{2}a to about 120 kWh/m^{2}a*.*
2. **50% less energy losses:** With the *‚second 10 cm of insulation' (*i.e. about 20 cm of insulation) another 50% of the remaining energy losses of 120 kWh/m^{2}a can be reduced to approximately 65 kWh/m^{2}a.
3. **50% less energy losses:** The ‚*third 10 cm of insulation'* (i.e. up to 30 cm of insulation) reduce[88] the remaining energy losses of approximately 65 kWh/m^{2}a by another 50% to about 32 kWh/m^{2}a.[89]

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79 **Definition** of PlusEnergieBuildings (PEB) in Art. 3 (2) of the PEB regulations.

80 **Art 9 (d): PEB study** 2019, PEB energy scenario (ES) part V (C), p. 130 to 136; Fig.113 in annexe 1 (or A, B or D).

81 **PEB study** 2019, p. 14 with an annual solar production of approximately **200 kWh/m^{2}a** compared to biomass with 2 kWh/m^{2}a or hydropower with 1 kWh/m^{2}a! If building construction is to become CO_2-free in future, this can only be achieved with CO_2-free Min.P/PEB (see Art 8 (d) PEB regulations).

82 **PEB study** 2019, PEB energy scenario C, p. 130 to 136; fig.113 in annexe 1

83 **Norman Foster's** theses 3 and 4; **Stefan Cadosch,** certified architect ETH/SIA, President SIA, vice-president Norman Foster PEB jury.

84 **U-values, insulation** and energy indexes etc. are all rounded figures.

85 **Prof. Armin Binz** stands for the principle that every *additional* **insulation of 10 cm** reduces the extremely high energy losses in the building sector by approximately 50%. Similar justification: „The cheapest kWh/a is the one that must not be produced" (Michael Glos, Minister of Economy CSU/Germany 2005 to 2009.

86 **Mineral wool** such as Flumroc (see M. Thoma, 2.4.2020).

87 **Federal Council** IP RW 10.3873

88 Swiss Solar Prizes 2014 to 2019; Prof. Armin Binz, former FHNW

89 **Minergie-P insulation** pays off 8.5 times (see fig. 3): The additional insulation causes costs of about CHF 2,340 (9 m^3 x CHF 260). However, these additional costs save energy costs of (39,000 – 19,200 ≈) CHF 19,800 (besides additional CO_2-fees and legal uncertainty regarding CO_2-law and Paris Agreement). With such higher energy costs, the additional Minergie-P insulation can be financed 8.5 times – and at the same time CO_2-emissions are reduced by 50%.

Results of the Norman Foster PEB solar trilogy: In order to focus on the crucial causal connection of the Paris Agreement (reduction of 80% of energy losses in the building sector and CO_2-free electricity supply) with the most important factors, the very volatile price, annual, tariff and currency fluctuations etc. are avoided and a uniform energy price of 15 Centimes/kWh is applied (rounded figures):

1. M/P NF	2. Insulation	3. U-value W/m²K	4. EI kWh/m²a	5. E-need kWh/GWh/a	6. E self-supply kWh/GWh/a	7. Surplus kWh/GWh/a	8. CO_2-emiss. t per year	9. CO_2-emiss. t/40 years	10. E-need in 40 years	11. Costs/Reven. CHF 40 years	12. Costs/Reven. $CHF_{1,000}$ 40 y.	13. Costs/Reven. CHF 1 mil 40 y.
1.	0 cm	-	250	25,000	0	0	≈ 7.5	300	1 GWh	- 150,000	-150 mil	-150 bil
2.	10 cm	0.30	120	12,000	0	0	≈ 3.6	144	0.48 GWh	- 72,000	-72 mil	-72 bil
3.	20 cm	0.20	65	6,500	0	0	≈ 1.95	78	0.26 GWh	- 39,000	-39 mil	-39 bil
4.	30 cm	0.11	32	3,200	0	0	≈ 0.96	38.4	0.128 GWh	- 19,200	-19.2 mil	-19.2 bil
5.	30 cm	0.11	32	3,200	+6,600	+3,400	- 1.98	-79.2	0.128 GWh	+39,600	+39.6 mil	+39.6 bil
6_{1000}	30 cm	0.11	32	$3.2_{GWh/a}$	+6.6 G	+3.4 G.	-1,980	-79,200	+128 GWh	+39.6 mil	+39.6 mil	++39.6 bil

Fig. 3: Paris Agreement: The second row describes the **insulation** of 0.0 cm, 10 cm, Minergie/MuKEn ≈ 20 cm and *Minergie-P/passiv house* ≈ *30 cm***.** The third row confirms the insulation with the **U-values,** whereas the **energy index (EI)** in kWh/m²a in the 4th row is the direct causal connection of the three factors (2+3+4). Accordingly, the 5th row shows the annual **total energy need** (e.g. 25,000 kWh/a or 3,200 kWh/a with Minergie-P insulation). Row number 6 documents the **Norman Foster PEB** with an average CO_2-free electricity supply of **6,600 kWh/a** per unit with an energy reference area of 100 m²; With an annual need of 3,200 kWh/a, there is a **PEB solar electricity surplus** of 3,400 kWh/a in row 5 (lines 5 and 6). The **CO_2-emissions** are documented in tons *per year* in row 8, and the emissions over 40 years in row 9. Since NF-PEB have a CO_2-free solar electricity supply, they do not cause **any CO_2-emissions.** On the contrary: the CO_2-free solar electricity surplus ***decreases* CO_2-emissions** of other buildings or provides the traffic sector with **CO_2-free electricity** as confirmed in rows 8 and 9, lines 5 and 6. Row 10 summarizes the total energy need in **GWh/a** over 40 years, whereas row 11 shows the energy costs per house. Row 12 shows the energy costs for **1,000** units and row 13 for **one million** apartments. In contrast to this stand the **Norman Foster-PEB:** They produce a considerable amount of solar energy including an electricity surplus (row 10), as well as savings and revenues from electricity sales (row 11). Besides the *energetic-ecologic advantages* of NF-PEB, row 12 documents the **economic facts** for **1,000** and in row 13 for **one million** NF-PEB-apartments.

d) **Causal connection:** Fig. 3 documents the causal connection between *insulation depth, U-values, energy index (EI)* and *CO_2-emissions* for different building standards. The effects of suboptimal building standards (**1st** no insulation, **2nd** 10 cm of insulation and **3rd** about 20 cm of insulation with Minergie-/MuKEn) are high – not only with regards to environmental pollution and high CO_2-emissions, but also from a financial perspective. On the other side there are the **Norman Foster PEB** based on **Minergie-P standard**: After a pay-back-time of 1.5 to 2 years, they guarantee a **CO_2-free overall energy supply** of the buildings including a solar surplus for a CO_2-free traffic sector. As it is shown in energy scenario C in annexe 1, all incentive investments are paid back within *nine years* by energy efficiency measures and revenues from solar electricity sales (see annexe 1).

e) **Conclusion:** Provided that all building technologies are treated equally, Norman Foster PEB allow to produce **solar electricity for 3 Centimes/kWh** (BGE 132 I 157 E. 4.1 and see annexe 1). PV-roofs with a minimum inclination of 8° (also East-West) are water-bearing and provide the same protection against rain, snow, and wind as traditional roofs. Such an *additional* multi-functional *protection* must therefore be *considered* by factoring in the costs for e.g. traditional roof investments of CHF 150/m² (CHF 250 – CHF 150 = CHF 100/m²). The actual investment costs for a PV roof in integrated **Norman Foster PEB** are therefore CHF 100/m² – generating CO_2-free solar electricity after two years for 3 Centimes/kWh.

11. Deadline for applications for the PEB Solar Prize until April 15th

Each year, the deadline for application is **April 15th**. Accepted are only buildings that have been completed and went into operation between 1st of January of the pre-previous year and 15th of April of the application year (27.5 months). Applications must be sent to: Solar Agency Switzerland, Carole Klopfstein, Aarbergergasse 21, P.O. Box 592, 3000 Berne 7. The date of the postmark is decisive.

a) **Completeness:** The application must include the **fully completed official application form** for *persons/institutions, buildings and/or energy installations*. The form must be signed,

and all energy indexes, especially sections **A and B1 to B6**, must be *fully completed*. The TC and NF-PEB-Jury do not have to consider incomplete applications; they can be rejected, and the owner will be informed accordingly. If missing energy figures are not provided upon demand, the legal presumption applies.[90]

b) **Construction plans:** Additionally, **ground-plans/section views and construction plans in A3 format**, plus at least one **view of the entire building** (colour photo) and a corresponding **detail picture of the solar installation** must be sent (in writing) by postal mail. *Additional* pictures and media reports etc. can also be sent by e-mail to info@solaragentur.ch. By doing so, you will enhance your chances for the Swiss Solar Prize.

12. Pre-examination by the Technical Solar Prize Committee (TC)

A competent and professional Technical Committee (TC) of at least 5 members will evaluate the applications for the PEB Solar Prize.

The TC examines the applications according to the directives and regulations of the respective solar prize category. It conducts the necessary reviews and presents the best PEB with a short, written justification (including duly completed matrix according to Art 4 (a) to (e) of these statutes) to the Solar Prize Jury.

13. The Swiss Solar Prize Jury as proposer

The Swiss Solar Prize Jury consists of at least seven independent solar prize experts who are active both in the energy sector and in the academic sector and who are entitled to vote. They must guarantee an objective, impartial and technically substantiated judgement.

The Solar Prize Jury examines the PEB solar prize proposals and definitively decides on the Swiss PEB proposals for the international Norman Foster/PEB Jury. The PEB proposals for the international Norman Foster/PEB Jury must fulfil all effective and legal prerequisites for the Swiss Solar Prize or comparable prerequisites for a PEB nomination; the proposed PEB, however, do not have to be nominated for a Swiss or European Solar Prize.

14. The international Norman Foster and PEB Jury

The final evaluation of the Norman Foster and PEB Solar Prizes is made by an independent Norman Foster/PEB Jury of at least 5 members – consisting primarily of university architecture professors and architects from Switzerland, the EU or other countries who are known internationally for their sustainable solar architecture. If the PEB Prizes are financed mainly by Swiss sponsors, the majority of the Jury members must have residence in Switzerland.

The Norman Foster/PEB Jury can only award nominated PEB that have an average annual solar energy surplus of at least 1 kWh/m^2 according to Art 3 (2) of these PEB statutes. If there are no such PEB in a prize category, the Norman Foster/PEB Jury decides with a three-quarters majority on a reduction of the number of PEB prizes or if a PEB award should be skipped for one year and transferred to the following year. Within the budget, the Jury also decides on the respective prize money, giving equal emphasis to both prize categories (Art 5 (a) and (b)). [91]

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[90] **Legal presumption:** If Solar Prize candidates do not provide the necessary energy figures (e.g. energy reference area of the building) on time or if they do not seem authentic despite demand, the heat need is presumed as 220 kWh/m^{2}a and the electricity need as 30 kWh/m^{2}a, i.e. a total of 250 kWh/m^{2}a (R. Stulz).

[91] On August 2, 2010, **Lord Norman Foster** was the opinion that architecture and aesthetics of a building are of course important, but that energy efficiency and energy self-supply of the building are at least equally important. Therefore a 50:50 split of the prize money is justified. The Norman Foster/PEB Jury supported Lord Norman Foster's proposal unanimously.

15. Reasons for withdrawal for Norman Foster/PEB Jury members

a) **Withdrawal of Jury members:** If Norman Foster/PEB Jury members are directly or indirectly participating in or affected by an eligible building, they must leave the room during the relevant evaluation – if necessary, after having given detailed information about the building in question.

b) **Reasons for withdrawal**: Reasons for withdrawal of a Norman Foster/PEB Jury member are **in any case** if the examined solar installation belongs to the Jury member, to one of his relatives (up to the 3rd degree of relationship) or to a legal person or community where the respective Jury member is holding office (employment, board of managers or directors etc).

c) **Final decision:** The decision of the Norman Foster/PEB Jury is final and there will be no correspondence about it. Objections or new facts, especially by measurements, may be submitted for the attention of the next Jury meeting according to Art 8 of the Swiss Civil Code (facts must be circumstantiated). It is up to the Jury to decide if the case is accepted or not, how new facts and legal issues are treated, and in which form revised decisions are published. Swiss law is applicable. Objections must be sent within 30 days after notification to Solar Agency Switzerland, Sonneggstrasse 29, CH-8006 Zurich for the attention of the Norman Foster/PEB Jury. Art 10 (3) of the Swiss Solar Prize Regulations (determination of category) remains reserved.

d) **In priority cases** and in case of obvious mistakes or wrong data, the presidents of the Jury (Swiss Solar Prize and Norman Foster/PEB Awards) and the chairman of the Technical Committee in the respective category (installations, new buildings or refurbishments) will correct their decision according to the correct facts. Such corrections must be approved at the subsequent Jury meeting at the latest.

16. Conferment of the PEB Solar Prizes

Conferment of the PEB Solar Prize: The Solar Prizes are generally awarded in late summer/autumn in cooperation with and with the support of the solar prize partners. The conferment is public.

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III. PEB PRINCIPLES AND LEGAL INFORMATION

17. Solar energy: CO_2-neutral electricity and heat for 3 Cts/kWh

a) **CO_2-free solar electricity:** All solar installations are producing CO_2-free electricity *on the building* as soon as their production energy (EnAZ) is paid back after 0.5 to 2.2 years according to Art 8 (f). This was also confirmed by the US Department of Energy: *"Producing electricity with photovoltaic (PV) emits no pollution, produces no greenhouse gases, and uses no time fossil resources."*[92] From this point on, the energy payback time remains always positive and helps to pay back the grey energy of the whole building and to produce **solar electricity for 3 Centimes/kWh** (Art 10 (e) and annexe 1).[93]

b) **CO_2-free solar heat:** As with solar electricity, the same applies analogously to *CO_2-free solar heat,* which has an energy payback time of only 0.5 years; after this point, thermal solar installations have positive energy payback times that help to pay back the grey energy of the building each year with their solar performance.

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[92] **U.S. Department of Energy,** PV FAQs, What is the energy payback time for PV (EPBT), January 2004: According to the DOE, the energy payback time is between 2 and 3.5 years; E. Alsema; R. Dones; K. Kato; K. Knapp; W. Palz etc. Similar terms are energetic amortisation, flyback time etc.

[93] **Energy Payback Time:** See also Art 8 (c) to (f) footnotes; **solar power for 3 Centimes/kWh**, see PEB study 2019 p. 113 and Solar Prize 2019 p. 55.

c) **Conclusion:** Only PEB solar installations are producing CO_2-free electricity and heat on the building which not only reduces or pays back the production energy (grey energy) of the solar installations, but also the grey energy of the building within 0.5 to 2.2 years. Other materials such as tiled, eternit or copper roofs never generate energy on the building.

d) **CO_2- and grey-energy-free NFSA/PEB:** As known so far, NFSA and PEB are *the only buildings* worldwide that are producing CO_2-free electricity and CO_2-free heat thanks to their solar energy surplus (Art 3 (2), Art 8 (c) to (f) and Art 15 (a)). After the respective energetic amortisation of 0.5 to 2.2 years, the grey energy of the solar thermal and PV installation is paid back as well. [94] From this moment on, we have the *so-called energetic post amortisation*, which means that the grey energy of the whole building is paid back each year with the respective solar performance. *After this energetic post amortisation of the building*, NFSA/PEB are therefore the only buildings worldwide that are functioning CO_2-free and without any grey energy at all.

18. The ecological batteries for PEB: Sun, water, wind…

a) **Complete security of supply:** Instead of base load energy, PEB increasingly need peak-load energy for their unlimited energy supply around the clock. PEB produce more energy on the annual average than they need. However, besides their energy self-supply, they depend on a storage possibility, especially pumped-storage power plants, for their energy compensation with renewable energies to function day and night, in summer and winter. 20,000 to 25,000 PEB need approximately 1 GW of pumped-storage possibility. With this, the public grid can guarantee full comfort with CO_2-free electricity around the clock.

b) **Europe's extraordinary ecological opportunity:** The interaction between renewable energies and the existing and potentially optimized public grid is an extraordinary ecological opportunity for Europe with its huge stochastic wind energy potential on the northern and western coasts as well as its storage and pumped-storage power plants in the Alps. The same also applies for other mountain and valley regions with high storage capacities and low natural water inflow to produce hydroelectricity. The high wind production during winter in Northern Europe complements solar production ideally.

c) **Ecological pumped-storage power plants (EPSPP):** In the Alpine region, several pumped-storage power plants (PSPP) are planned or are currently being built to complement the existing storage power stations. (see e.g. PSPP Nant de Drance/VS, Lagobianco at Bernina/GR, Linth-Limmern and Grimsel). With the surplus of wind and solar energy, they can be operated cheaply and in an environmentally friendly manner, even if 20 to 25% of the surplus is needed for the pump energy.

d) **Complete and CO_2-free energy supply with renewable energies:** Ecologically operated PSPPs can massively reduce the disproportionately high energy dependency of Switzerland (80%) and the EU (50%) on fossil-nuclear energies of approximately CHF 10 billion per year. The energy scenarios of the PEB building study 2019 provide the basis to become independent of the non-renewable energies such as oil, gas and uranium that will come to an end in the 21st century.[95]

19. Market-based prices and external energy costs

a) From an **economic point of view**, it is unquestioned, that **state subsidies and privileges** of a product *must be considered* when determining the purchase price. De jure, measures that *"are manipulating the free market by advantaging individual businesses"* are not allowed (decision of the Federal Court 111 Ia 186). With equal market conditions for all in the

[94] **Renewable energies:** See Art 8 (c) to (f).

[95] The **potential of coal** is bigger but little environmental-friendly.

energy sector and **without subsidised liability costs**, **1 kWh of nuclear electricity** would cost about **3 CHF**.[96] Of even greater consequence are the disposal costs of radioactive waste with a half-life of 24,000 years or 960 generations.[97] Not forgetting the high costs of decommissioning old nuclear power plants.[98] If today's price of solar electricity of approximately 3 to 10 Centimes/kWh is compared to the huge subsidies that go into nuclear production in terms of the decision of the Federal Court, BGE 111 Ia 186, it is clear: Even today, solar electricity is at least 10 to 30 times cheaper than "market-based nuclear power".

b) Solar utilisation without 'external energy costs': The utilisation of solar energy seems expensive, because all energy costs have to be paid at the time of investment and therefore in advance (and are not paid by the government or by future generations). On the other hand, and in contrast with *fossil energy sources*, solar energy does not produce any *external energy costs* due to climate damages, health hazards or structural damages.[99]

IV. FINAL CLAUSE AND TEMPORARY ARRANGEMENTS

20. Norman Foster-PEB-Jury und additional regulations

a) Additional regulations: Within the framework of these regulations, the Solar Agency Switzerland can enact complementary or specifying regulations.

b) Election of the Norman Foster/PEB Jury: The Solar Agency Switzerland elects the Norman Foster/PEB Jury in accordance with the PEB Solar Prize partners, ensuring that the organs are as objective, highly qualified, independent and impartial, linguistically and regionally balanced as possible.

c) PEB promotion: To promote PEB, the PEB trademark can be given to third parties for a licence fee of at least CHF 100/year. PEB are awarded a licence for single use relating to the awarded PEB or NFSA.

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[96] **Governmental liability for nuclear energy:** According to Art 12 of the Swiss liability law for nuclear energy (KHG), the government has to assume liability for all nuclear power plants in Switzerland: "In 1992, a German study commissioned by the Kohl government (CDU/CSU/FDP) concluded that 1kWh of nuclear electricity should cost **CHF 3 per kWh/a** (DM 3.60**)** instead of CHF 0.05 per kWh/a if the nuclear power plants were privatised and carried their own risks. For risk covering alone, the companies would have to pay 70 billion francs" (see CASH, 3.3.2000), Federal Department of Economics, Sept. 1992, p.6. *"The **Federal Government** insures the **liable party** against **nuclear damages** up to **one billion Swiss Francs**... plus 100 million CHF for interests..."* From a market economy perspective, it is therefore obvious that a purchase price must also include all **privileges and subsidies** of a product, since measures that *"manipulate free competition by advantaging individual businesses"* are not allowed (decision of the Federal Court 111 Ia 186).

[97] **The half-life** of plutonium is 24,000 years. This corresponds to at least 960 generations. After 24,000 years, the radioactive radiation has decreased to 50% of its initial radiation etc. When disposing of the nuclear waste, all disposal costs including costs for "final storage", future earthquakes, security, water penetration etc. have to be considered *source-related* for at least **960 generations** *(Swiss* Federal Constitution 73/74) (URANIUM 235-half-life: 24,000 years ≈ 25 y. ≈ 960 generations) See also radioactive waste deposit, Asse 2008/09 in Germany.

[98] According to the Federal Department of Energy, **abandonment costs** for Switzerland's nuclear power plants amount to approximately CHF 16 billion. The reality in Germany shows, however, that the decommissioning of nuclear power plants is taking far more time than was initially assumed. In May 2018, the Federal Council calculated the **total cost** of nuclear waste disposal at **CHF 24.6 billion** (see Swissinfo, May 9, 2018).

[99] **External costs:** Contrary to conventional power plants (gas, oil, coal or nuclear) that *never pay off* and partly cause massive external energy and climate costs for our future generations, renewable energies regenerate naturally thanks to the natural cycle and the regenerative properties of the biosphere. From today's perspective, this natural cycle will persist for about 4 billion years. It is important, however, that today's polluting throughput economy gives way to an *ecologically and economically sustainable circular economy*. All polluting products of today's linear, throughput economy must be charged according to the polluter-pays principle (Art 74 Swiss Federal Constitution) in order to prevent external energy costs in future. As a matter of fact, $C0_2$-free *solar electricity is 5 to 10 times cheaper than market-based nuclear power*: In the nuclear sector, external energy costs are extremely high*;* the nuclear catastrophes of Chernobyl (1986) and Fukushima (2011) have shown this.

d) **For more information:** Solar Agency Switzerland, Sonneggstrasse 29, 8006 Zurich, info@solaragentur.ch ; +41 44 252 40 04
For Solar Agency Switzerland; G. Cadonau, managing director

e) **Enactment:** These PEB/NFSA regulations replace those of 31st March 2010(1), 31st March 2011(2), 5th April 2012(3), 26th March 2013(4), 26th March 2014(5), 16th March 2015(6), 14th December 2015(7), 29th March 2018(9), and came into force after acceptance by the SAS project management and the PEB Prize partners on 30th January 2020.

For the Norman Foster Solar Awards and PlusEnergyBuildings

Lord Norman Foster, London

Gallus Cadonau, Zurich

Prof. Dr. Daniel Lincot, Paris

Prof. Dr. Wolfgang Palz, Bruxelles

Paul Kalkhoven, Foster&Partners, London

Prof. Peter Schürch, Berner Fachhochschule

Prof. Dr. Franz Baumgartner Zürcher FH ZHAW, Winterthur

Dr. Hartmut Nussbaumer Zürcher FH ZHAW, Winterthur

NR Leo Müller Co-president SAS

NR Priska Seiler Graf Co-president SAS

NR Dr. Christoph Eymann Co-president SAS

e.SR Dr. Eugen David Co-president SAS

London/Berne/Paris/Bruxelles/Geneva/Zurich, 30th January 2020 (10th edition)

Energy scenario C of the PEB study 2019 (Part V (C), item 10)

Paris Agreement can be implemented successfully until 2050

Scenario C	Building per year	Incentive scheme[100]	Accumulated incentives	Installed performance	Electricity and red. of energy losses	Revenues/sav. p. year at 15 Cts./kWh	Accum. revenues/ savi. p. year at 15 Cts/kWh	Accumulated reduction of CO_2-emissions[101]	Imports	Reduction of dependency on foreign sources
	in 1,000	in CHF bil	in CHF bil	in GW[102]	in TWh/a	in Mrd. Fr.	in Mrd. Fr.	in Mio. t	in TWh/a	
after 1 year	84.9	2.44	2.44	3.7	6.18	0.93	0.93	2.63	195	78%
after 5 ys	424.5	2.44	12.2	18.5	30.91	4.65	14.0	13.15	164	65.6%
after 10 ys	849	1.22	24.4	37	61.82	9.30	51.2	26.3	133	53.2%
after 15 ys	1,274	1.22	30.5	55.5	92.73	14.0	111.6	39.45	102	40.8%
after 20 ys	1,698	0	36.6	74	123.6	18.6	195.3	43.8	71	28.4%
after 25 ys	2,123	0	36.6	92.5	154.5	23.3	302.3	48.2	40	16%
after 30 ys	2,547	0	36.6	111	185.5	27.9	432.5	52.6	10	4%

Fig. 4 shows the energetic, ecological, and economical effects of incentive investments of 30% of the respective construction investments. In 25 years, 154.5 TWh/a could be substituted; in 30 years, 185 TWh/a. CO_2-emissions would decrease enormously, in the first 10-15 years by 2.63 million tons annually; from the 15th year, the decrease would be only 1/3 or 0.87 million t per year. This corresponds to a reduction of (39.45 + [5 x 2.63 x 1/3) ≈ 4.38 million t of CO_2-emissionen in five years. With yearly adjustments of the reduced CO_2-emissions, the figures could be more precise – however, this would be at the expense of predictability and legal security. The incentive investments will be paid back in 25 years about 8 times (CHF 36.6 billion ≈ CHF 302 billion) – mainly as savings and reimbursements, the rest as revenues from electricity sales. Assumption: Successful energetic, ecological and economical implementation of the Paris Agreement. (Fig. 4 corresponds to fig. 113 of the PEB study 2019, part V (A), item 10 et seq. and (C), see p. 121 et seq.).

Energy efficiency: „Globally, 80% of the potential to increase energy efficiency in the building sector and more than 50% of the potential in the industrial sector remain unused".[103]

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100 **Minergie-P/passive-house building standard:** The energetic, economic and ecological effects correspond to fig. 36/38/43/45 of the PEB study 2019.

101 **From the 15th year** fig. 104 and 109 of the building study assume a CO_2-reduction by only 1/3 (due to more efficient buildings, PEB and increasing e-mobility).

102 **For an installed performance in GW** the energetic, economic and ecological effects correspond to the figures 36/39/42 of the PEB study 2019.

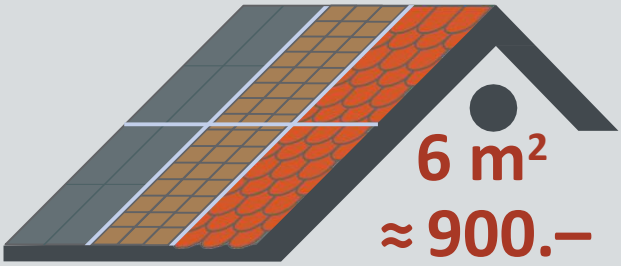
103 **Message of the Federal Council** on the revision of the Energy Law of Sept. 4, 2013 (13.074), p. 26

Annexe 1

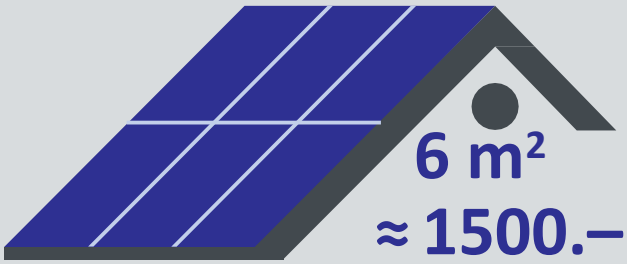
Solar electricity for 3 Cts/kWh

for new buildings and roof replacements*

Metal sheet, eternit or tile roof (CHF 150/m²)*



PV-roof: 6 m² ≈ 1 kWp ≈ 1000 kWh/a



SFH-roof: 120 m² -> revenue: 0 kWh/a
Household electricity costs ≈ 20 Cts./kWh

Additional costs: CHF 600.–5%
interest/amort. of CHF 600 = CHF 30 for 1000 kWh/a = 3 Cts./kWh of solar electricity

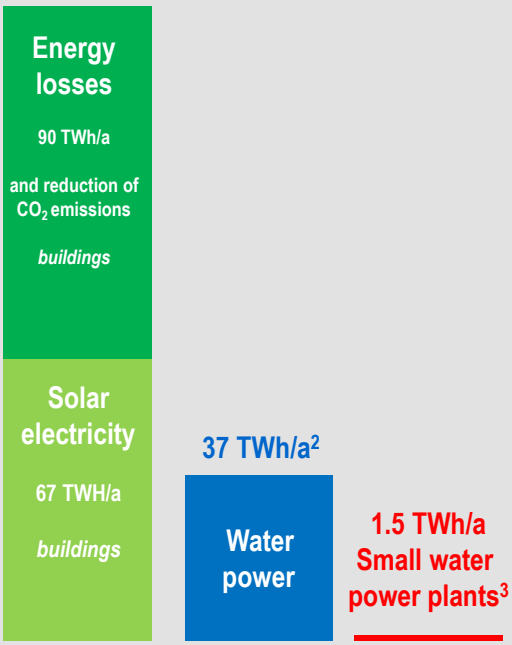
***Equal treatment:** Offers for traditional roofs from 5 Cantons (GR/LU/SG/SH/ZH) 2018: CHF 150 per m² (average of CHF 100/250 per m²).Traditional metal sheet, eternit and tile roofs are water-bearing and protect against rain, snow, and wind. PV-roofs with a minimum inclination of 8° (also East-West) provide the same protection. Therefore, PV roofs and PV facades having the same building function and providing the same protection as traditional roofs must be treated equally according to Art 8 Federal Constitution and Art 45 (1) Energy Law. The same applies for roof refurbishments flush with the ridge, the sides and the eaves and that visually barely differ from a new roof. The Federal Court decided that „equal is treated equally in accordance with its equality and unequal is treated unequally in accordance with its inequality" (BGE 132 I 157 E. 4.1 p. 162).

***A correct price for solar electricity takes multifunctionality into account:** PV-roofs and PV-facades are multifunctional. In addition to their protective function they produce about 1,000 kWh/a per kWp or up to 200 kWh of solar electricity per m² and year (kWh/m²a). On the basis of equal treatment, such an additional multi-functional protection and/or replacement function must therefore be considered by factoring in the costs for a traditional roof or facade (CHF 250 – CHF 150 = CHF 100/m²). The actual investment costs for a PV roof on optimally integrated **Nor- man Foster PEB** are therefore CHF 100 per m² of PV roof surface – generating CO_2-free solar electricity after two years for **3 Centimes/kWh.** Swiss Solar Agency 2020

PEB: „Virtually the best we can actually do".

Federal Council: With 157 TWh/a, PEB are Switzerland's biggest CO_2-free energy and electricity potential

157 TWh/a[1] **Energy potential according Federal Council**



37 TWh/a[2]

1.5 TWh/a Small water power plants[3]

KEV/EVS payback for energy relevant investments:
Max. 30% Max. 60% 200% - 400%

PEB: guarantee greatest CO_2 reduction[4]

Solar electricity from buildings:	67 TWh/a
Energy losses (CO_2 emissions):	90 TWh/a
Substitution Federal Council (from Min.P/PEB)	157 TWh/a
Water power	37 TWh/a
Small water power plants	1.5 TWh/a

1 Federal Council/Office of Energy, 15.4.2019/IP RW 10.3873 ≈ substitution of **157 TWh/a** (reduction of energy losses by 90 TWh/a + 67 TWh/a of solar electricity); incentive of max. **30%** according to Art 25 Energy Law (PEB study 2019, p. 72 ff.)

2. Swiss Electricity Statistic 2018, p.11 and Art 26 Energy Law; incentive of up to 60%.

3 NC Kurt Fluri (FDP/SO) IP 12.4237/12.3884, average: 16.5 Centimes/kWh; 38.5 Centimes/kWh RR ZG, 13.6.2018 with incentive of 200-400% for energy-relevant building investments;

4 Official bulletin CS: FC S. Sommaruga to IP 19.4273, CS H. Germann, 5.12.2019/; f.FC D. Leuthard: „PlusEnergyBuildings are **great**" CS 19.9.2016/Solar Agency Switzerland/ca

Annexe 2: **PEB with 157 TWh/a: Switzerland's greatest CO_2-free electricity potential**

European Solar Prize PlusEnergyBuildings (PEB) 2016

Norman Foster PEB-Solar Award

345% PEB refurbishment Anliker, Affoltern i.E./BE

Built in 1765

Total energy	%	kWh/a
Need before refurb.:	750	196'800
Need after refurb.:	100	26'200
Energy self-supply:	345	90'500
Energy surplus:	245	64'300
46 CO_2-free e-cars		

European Solar Prize PlusEnergyBuildings (PEB) 2018

Norman Foster PEB-Solar Award 2019

182% PlusEnergy housing development Tobel/TG

Total energy:	%	kWh/a
Energy need:	100	129'500
Self-supply:	182	236'300
Energy surplus:	82	106'800
77 CO_2-free e-cars		

With parliamentary Min.P/PEB initiatives of

- NC **Leo Müller compensation of three atomic power plants (Mühleberg, Beznau 1 + 2) within 10 years**
- NC **Christoph Eymann**/NC **Priska Seiler G: Implementation of Paris Agreement until 2050**
- **PlusEnergieBuilding study 2019,** 145 pages, www.somedia-buchverlag.ch

Annexe 3: **Largest ecological electricity storage capacity in Europe**

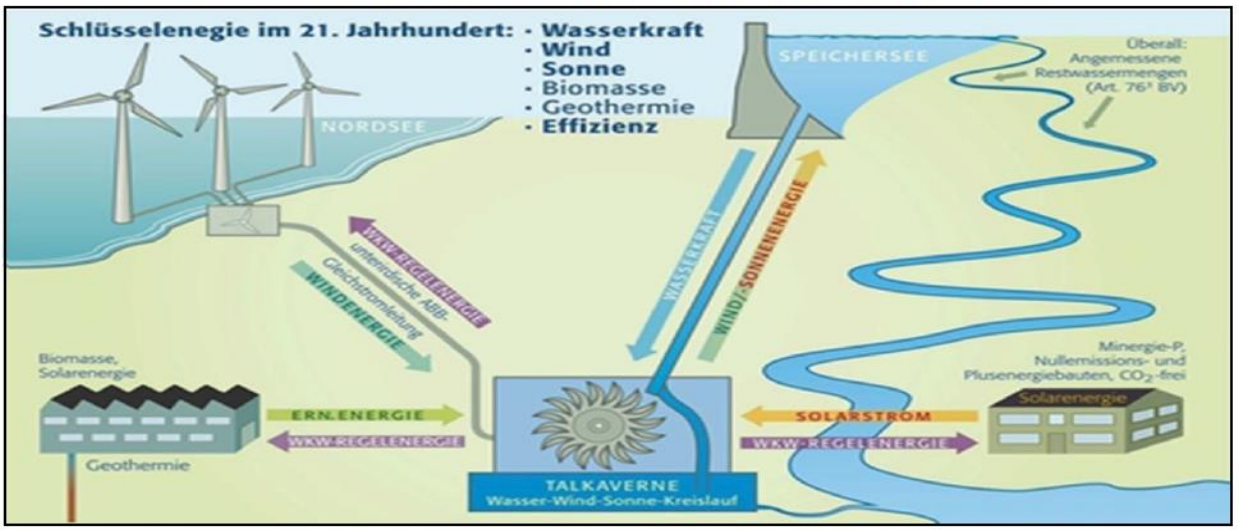


Fig. 7: Pumped-storage power plants (PPT) pump solar power surpluses during the day and high wind power surpluses in winter into existing or renovated storage lakes. At night, when there is no wind and on days with little sunshine, the PPT can generate CO_2-free electricity in the GW range for Central Europe (cf. PEB building study 2019, pp. 67-69).

German wind power surplus of 1 TWh/a per winter day!

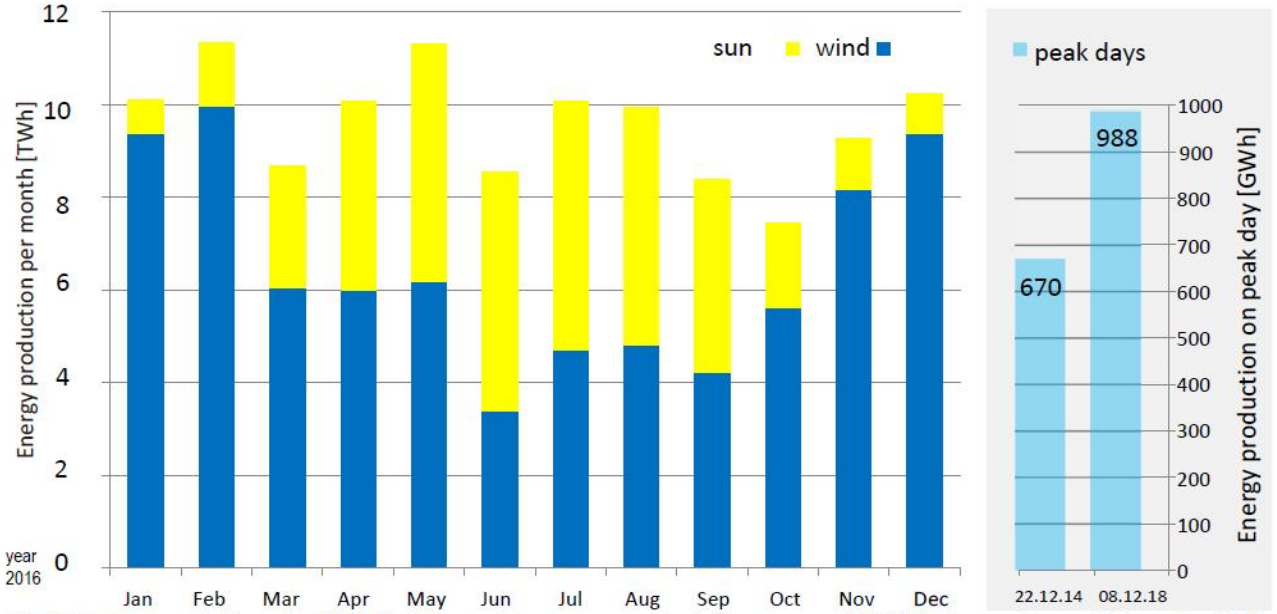


Fig. 8 Wind power: In December 2014, the highest wind power production in Germany was 670 GWh; 4 years later, on 8 December 2018, it rose to 988 GWh. The largest hydroelectric power plant built in Switzerland in the last 30 years (Ilanz 1+2) needs 4 years to generate the same amount of electricity of 988 GWh (see PEB Building Study 2019, Part I lit. C no. 6)

Plus Energy Buildings and pumped storage power plants work complementarily

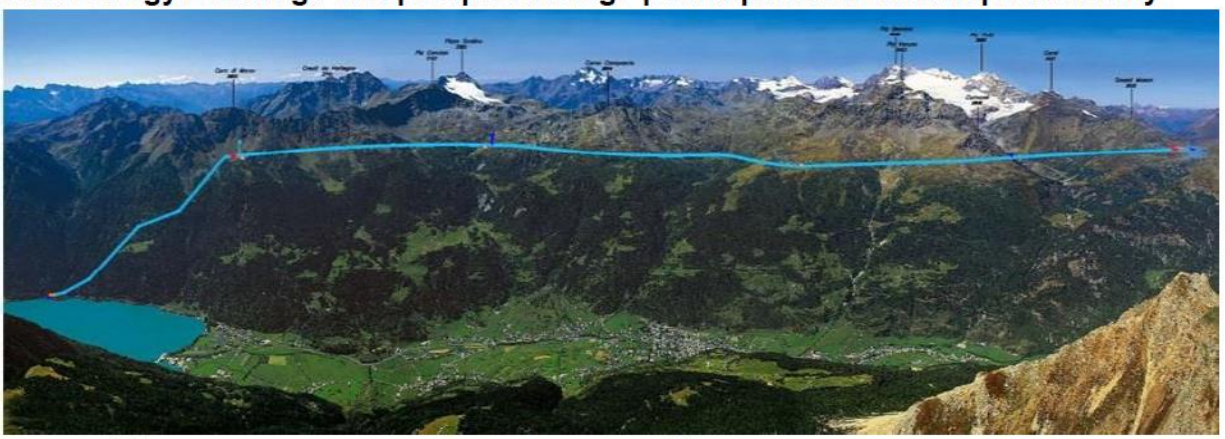


Fig. 9: The 1.05 GW PPT planned on the Bernina/GR costs around CHF 2.5 billion; the same battery storage capacity for a comparable service life of 80 years would currently cost around CHF 25 billion. (cf. PEB building study 2019; Part I lit. C no. 1).