SOLAR ARCHI-TECTURE

NOW AND FOR THE FUTURE

SITE INFORMATION

PUBLISHER
EnergieSchweiz, Swiss Federal Office of Energy SFOE
Mühlestrasse 4, CH-3063 Ittigen. Mailing address: CH-3003 Bern
Info line: 0848 444 444, www.infoline.energieschweiz.ch
energieschweiz@bfe.admin.ch, www.energieschweiz.ch,
twitter.com/energieschweiz

THIS PUBLICATION AND ITS CONTENTS WERE CREATED IN COLLABORATION WITH
CREnergie GmbH
BS2 AG
SWISSOLAR Swiss Solar Energy Association
Driven GmbH

SALES
www.bundespublikationen.admin.ch
Item number 805.522 (G/F/I)

March 2019 Version

GROSSPETER TOWER BASEL, 2017
Burckhardt+Partner AG

SOLAR ARCHITECTURE - NOW AND FOR THE FUTURE

ARCHITECTS SHAPE THE FUTURE OF SOLAR

As an architect, you have a significant influence on the design of our surroundings, from individual objects to spatial planning. The process of architectural creation integrates a wide range of perspectives and demands on the disciplines involved in the work and fuses them into a carefully designed whole. Architecture has always been part of a cultural, economic and technological continuum, drawing on the past and the present to shape the future.

The house of the future is not a zero-energy house. It will, however, need much less energy, and what it needs does use it will draw from clean local sources. It is just an ordinary house and not a machine. Solar architecture has shed its experimental character and is increasingly becoming the standard. The journey is not over yet, and there is plenty of room to shape it actively.

SOLARIS RESIDENTIAL BUILDING, ZURICH 2017
huggenbergerfries Architekten AG ETH SIA BSA

AN OPPORTUNITY FOR EVERYONE

Transformation of the existing building stock is a Herculean task, but at the same time offers immense potential for everyone involved – from building owners and users to the scientific community and manufacturers, to engineering and installation companies. Yet architecture is more than merely the most efficient technologies and systems. The tendency to consider the two spheres separately, which has been prevalent up to now, has given rise to a number of prejudices and some monstrous results. This pamphlet points to examples that show there is another way and demonstrate that the process can result in success. It provides a brief overview of the key fundamentals of solar architectural design to stimulate the creative process and further development.

WHY SOLAR ARCHITECTURE?

The zero-energy house does not exist and will not exist. From construction to operation to demolition, every building requires a great deal of energy, and this has always come largely from the sun, either directly or indirectly. What has changed continuously is the way in which this inexhaustible source of energy is used, the technologies and processes required to do so, and the quantity of energy consumed, which in turn have had an impact on architecture as well as housing structures, and later, urban structures. The technologies required for this transformation have come out of their original niche existence thanks to dramatic cost reductions and increases in efficiency. There has also been a surge in development in the field of building integration: today, photovoltaic modules and solar collectors are offered as custom-made components in a wide variety of surfaces and colors. As structurally and architecturally integrated components, they serve a number of functions within the building envelope, not only improving the operating energy balance, but also the gray energy balance and overall cost. These numerous synergies make technology a logical component of architectural work.

AN INTEGRATIVE CONCEPT

Solar architecture is more than just architecture plus solar technology. Solar architecture uses the locally available energy passively (e.g. windows) or actively (photovoltaics and solar collectors), stores it and releases it at the right time and in the right form. Besides energetic and technical integration, structural, creative and economic integration is becoming increasingly important. The technology can add creative flair or be completely invisible, while the energy produced can either be consumed by the producer or sold to tenants or neighbours. All this has a major impact on acceptance by the populace and the authorities, and favors systems that are economically efficient. As such, addressing these issues should be taken into consideration at an early stage of the project and continuously refined. Like any other technology, the different solar energy systems have their own specific characteristics – understanding their principles and the essential metrics provides a solid basis for a confident and exciting collaboration with specialized engineers and contractors. We shed light on the various aspects of solar architecture below.

SOLAR ARCHITECTURE IS A SENSIBLE SOLUTION

Interesting architectural approaches for dealing with new design elements
+
Mature technologies, proven concepts and exciting new developments
+
Huge potential space for energy generation on the top and sides of buildings
+
Great environmental value and altered emotional relationship to buildings for residents
+
Local energy, local value creation and economic potential

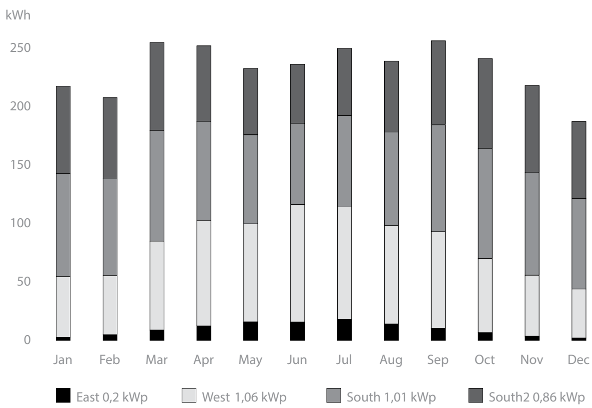
In the Paris Climate Agreement, Switzerland committed itself to work on ensuring that global warming does not exceed 2 degrees and, if possible, the critical 1.5 degrees. This target demands drastic changes across all levels of the society. Based on the principles of equality and historical responsibility, Switzerland should be carbon neutral by the end of 2038, which equates to a linear reduction of 3.6% per annum. (‘CO_2-Budget der Schweiz’ EBP, 2017)

It is undisputed that Switzerland’s existing buildings must be transformed due to their energy requirements and associated climate-damaging emissions and thus put on a sustainable path. In addition to energy efficiency, the transition to renewable sources of energy, above all the use of solar energy, plays an important role.

SOLARES DIREKTGEWINNHAUS, ZWEISIMMEN 2014
n11 architects

ENERGY POTENTIAL

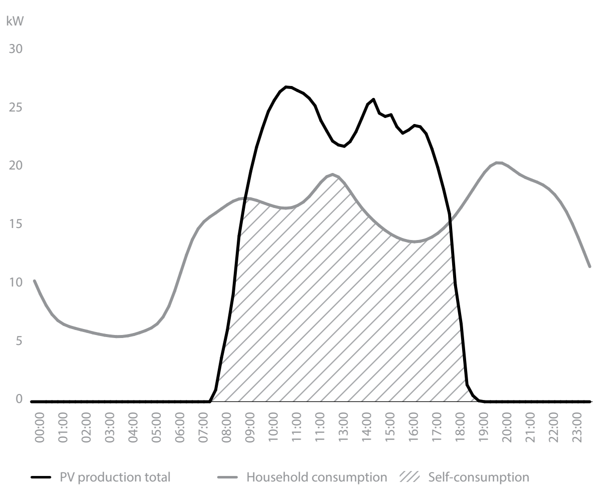
A recent Meteotest study commissioned by Swissolar indicates that potential for solar energy in Switzerland is very high. With an optimal combination of photovoltaics and solar thermal energy, 10.8 TWh (8.2 roofs, 2.6 façades) can be produced per year with solar thermal and 17 TWh with photovoltaics in a technically, economically and socially sound manner. If photovoltaics alone were used, the sustainable acceptable annual production potential would be 24.6 TWh on roofs and 5.6 TWh on façades, which equates to 51% of Swiss electricity production in 2017. (Meteotest Switzerland, 2017)



SIMULATION ANNUAL ENERGY YIELD
Constant monthly yields of a photovoltaic façade
Source: CR Energie GmbH

ON-SITE POWER CONSUMPTION

Self-consumption of solar energy is enshrined in the Energy Act and is therefore permitted throughout Switzerland. Self-consumption means that the solar energy produced is used on site. Generation costs are usually lower than the cost of purchasing energy from the public grid. On the other hand, energy suppliers tend to remunerate excess solar power at low prices. That means that higher consumption on site can significantly improve the profitability of the PV system.



SELF-CONSUMPTION OF SOLAR ENERGY
High-rise Sihlweid with photovoltaics on all four sides
Source: HTA Burgdorf PVLab

STRATEGIC PLANNING

How this potential can be reaped and how energy can be produced and used in and on a building should be defined in the overall energy and architectural concept of a construction project. It is preferable to do this in the initial phase of planning. Various web-based tools offer rough calculations of energy yields and self-consumption in just a few steps. For extensive or complex projects, it is advisable to bring in a specialized solar designer during the strategic planning phase or the preliminary study.

FURTHER INFORMATION
www.sonnendach.ch
www.sonnenfassade.ch
www.energieschweiz.ch/solarrechner

FIND A SUITABLE SPECIALIST AT
www.solarprofis.ch

PRELIMINARY STUDY

The following calculations and information are relevant for defining a construction project more precisely:

- Determination of the solar collection areas with calculation of the production yields
- Yield simulations with shading models for façades that are often shaded
- Cost estimates for the mounting structure, solar modules and electrical components and their assembly.
  Interfaces to related trades should be defined as precisely as possible
- Profitability calculations taking into account the fluctuations in energy costs and the possible increase in self-consumption, e.g. through e-mobility.

SELF-CONSUMPTION CONSORTIUM (SCC)
Since the beginning of 2018, several adjoining plots of land, along with multi-family homes can be interconnected. The resulting SCA acts as a single customer of the utility company. The admixture of different households and building types boosts self-consumption.

FURTHER READING
«Leitfaden Eigenverbrauch»
Published by EnergieSchweiz, 2018
«Solarstrom Eigenverbrauch: Neue Möglichkeiten für Mehrfamilienhäuser und Areale»
Published by EnergieSchweiz, 2018

TECHNOLOGY

Solar technology has been refined over decades and has developed into well-functioning, mature technology. Photovoltaic and solar thermal components are available in countless variants, for a range of applications from various manufacturers. Selecting the right technology based on the goals of the construction project and intended use is crucial. The combination of storage options, controllers and other complementary energy technology can further optimize a building's energy system for high efficiency, comfort and good economy.

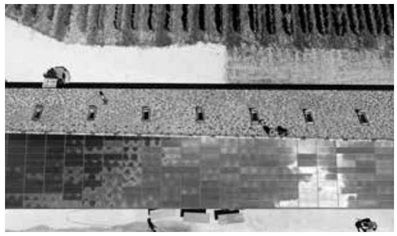
HAUS SCHNELLER BADER, TAMINS 2016
Bearth & Deplazes Architects
Valentin Bearth – Andrea Deplazes – Daniel Ladner

PHOTOVOLTAICS (PV)

Photovoltaics converts light energy directly into direct-current electrical energy by means of solar cells made of different semiconductor materials. The current is collected by metallic contacts and either used on site in this form or stored. Generally, the direct current is converted into alternating current by an inverter and likewise used locally or else fed into the public grid. Silicon, the second most common element in the earth's crust after oxygen, is usually used as the semiconductor.

CRYSTALLINE MODULES
Polycrystalline
Monocrystalline

ROOF



SERVICE BUILDING CHATEAU D'AUVERNIER
Product: ISSOL Suisse SA, Neuchâtel
Solar company: Gottburg SA, Boudry

FAÇADE

LETZIPARK ZURICH
Product: Megasol Energie AG, Deitingen
PV design: energiebüro AG, Zurich
PV installer: Planeco GmbH, Münchenstein

THIN FILM
Amorphous silicon
Copper indium (gallium) diselenide (CIS, CIGS)

PARKING LOT FOR ELECTRIC CARS WITH FLEXIBLE SOLAR MODULES
Product: Flisom AG, Niederhasli

© Michaela Chlebanova

PRODUCT: FLISOM AG, NIEDERHASLI
Product: NICE Solar Energy GmbH, Schwäbisch Hall (D)
Distributor: Solarmarkt GmbH, Aarau

SOLAR THERMAL (ST)

Solar thermal systems convert solar radiation into heat. Solar thermal systems are mainly used for heating domestic hot water or to supplement space heating. Solar collectors can be easily integrated into a heating system and combined with other heat sources.

FLAT PLATE COLLECTORS

ROOF

MFH OBERBURG
Product: Jenni Energietechnik AG, Oberburg bei Burgdorf

FAÇADE

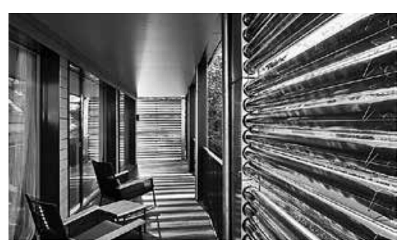
© Ernst Schweizer AG, Hedingen

MULTIPURPOSE HALL EICHHALDE, ZURICH
Product: DOMA Solar Technology, Satteins (A)

EVACUATED TUBE COLLECTORS

© Loeliger Strub Architecture GmbH

HOHES HAUS WEST, ZURICH
Architecture: Loeliger Strub Architecture GmbH, Zurich
Product: Conergy, Hamburg



© R. Rötheli

MULTIPURPOSE HALL ZURICH HÖNGG
Architecture: kämpfen für architektur AG, Zurich

HYBRID SOLAR TECHNOLOGY (PVT)

Photovoltaics and solar heat can also be combined within a collector. From the outside, the elements look like normal PV modules. However, an absorber mounted on the back also enables heat generation. This cools the photovoltaics, thus increasing power yield. Due to the lower temperatures compared to conventional solar collectors, this type of collector is primarily suitable for preheating such as in combination with geothermal probes or for swimming pools.

SLANTED ROOF

CHURCH ST. FRANCIS (KIRCHE ST. FRANZISKUS, EBMATINGEN
Architecture: Daniel Studer, Villnachern
Product: BS2 AG, Schlieren

FLAT ROOF

SUURSTOFFI ROTKREUZ
Product: 3S Solar Plus AG, Gwatt

AN OVERVIEW OF MODULES AVAILABLE ON THE MARKET CAN BE FOUND AT: WWW.SOLARCHITECTURE.CH

PASSIVE SOLAR

The passive use of solar energy aims to use structural measures to make optimum use of natural solar radiation in the form of heat or light energy. The design of the building shell and volumetry, placement of transparent elements such as windows and glazing and the use of solid components in the interior optimize solar gain, emission and storage. The focus is on the energy-optimized orientation of buildings and floor plans based on the course of the sun and shading, taking seasonal changes into account.

ZENTRUM TOBEL
Use of solar energy: Fresh air is preheated in the façade and conducted naturally into the interior without installation of technical equipment.
PlusEnergy superstructure according to the 2000-Watt Society model, architecture: Fent Solare Architektur, Wil


M

MFH HOFWIESEN-ROTHSTRASSSE, ZURICH 2016
Viridén + Partner AG

SOLAR ENERGY IN SYSTEMS

There is a diverse range of solar energy systems: from a simple solar shower to sophisticated district heating and cooling systems with seasonal storage and a self-consumption pool. What they all have in common is that they consider buildings within the local energy context. They consist of an integrated system of absorption surfaces for the conversion of solar radiation, a short, medium or long-term storage capacity, a delivery system and a control unit for the system. The system topology is largely dependent on local context, use, available surfaces (building envelope), energy targets and not least on the financial investment and the anticipated operating costs.

DISTRIBUTED ELECTRICAL AND THERMAL STORAGE

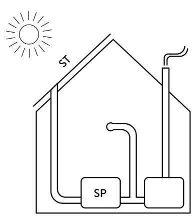
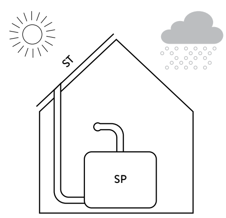
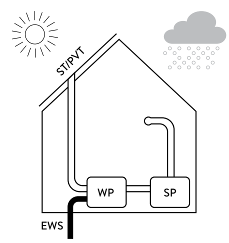
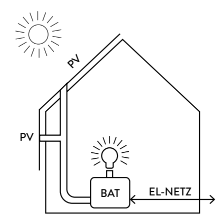
The use of distributed storage systems can increase efficiency and self-consumption within an energy system. Battery systems can temporarily store excess solar power for individual buildings or entire developments, and then release it on demand. One interesting application is the use of electric vehicles as an alternative to or an extension of power storage for a building. Battery storage systems can increase self-consumption by around 50%–80%.
Heat accumulators can store excess energy from solar thermal systems or surplus power generated by photovoltaics by operating a heat pump.

FURTHER READING
«Stationäre Batteriespeicher in Gebäuden»
Energie Schweiz brochure, 2018
«PV-Anlagen mit Batterien»
Swissolar datasheet, 2016

BUILDING CONTROL

Systemically engineered building services can also significantly increase the efficiency of a building energy system. This can take the form of coordinated interaction between energy generation and storage systems or the coordinated control of consumers. Particularly large household appliances such as washing machines and dryers should be programmed for use during the day when energy is being produced.

COMMON SYSTEM TOPOLOGIES

DIAGRAM	SYSTEM A	SYSTEM B	SYSTEM C	SYSTEM D
ENERGY FORM	Thermal energy (heat/cold)			energy (electricity)
SYSTEM	HW/heating combined	HW/heating seasonal	HW/Heating/Cooling seasonal	Photovoltaics
SCHEMATIC				
DESCRIPTION	System for partial coverage of hot water and/or heating requirements	System for complete coverage of hot water and/or heating requirements, seasonal storage	System for complete coverage of hot water and/or heating and cooling requirements, seasonal storage, conversion via HP	Photovoltaics for electricity production, short-term storage
PARAMETERS	Additional energy generation necessary (as renewable as possible), ideally with radiators	Large roof or façade areas and sufficient storage space available, ideally with radiators	Large roof or façade areas, boreholes or ice storage possible, ideally with surface heating or convectors	Combination with any thermal system possible, ideally with heat pump and other large power consumers
ENERGY PRODUCTION	Heat, high temperature with covered solar heat collectors (flat or tube collectors) HW: 30–50% Heating: 20–30%	Heat, high temperature with covered solar thermal collectors (flat-plate or tube collectors) HW: 100% Heating: 100%	Heat and cooling, low temperature with uncovered solar thermal or PVT collectors HW: 60–100% Heating: 75–100% (100%, if electricity is also produced locally)	Electricity, photovoltaic modules Electricity: 10% to 100% Mainly dependent on financial operating concept (investments, self-consumption, feed-in tariffs)
PRIMARY STRENGTHS	Simple system, small space requirement (roof and storage)	100% solar, no additional system necessary	Up to 100% solar, small internal storage, cooling possible	Simple system, power for self-consumption or sale

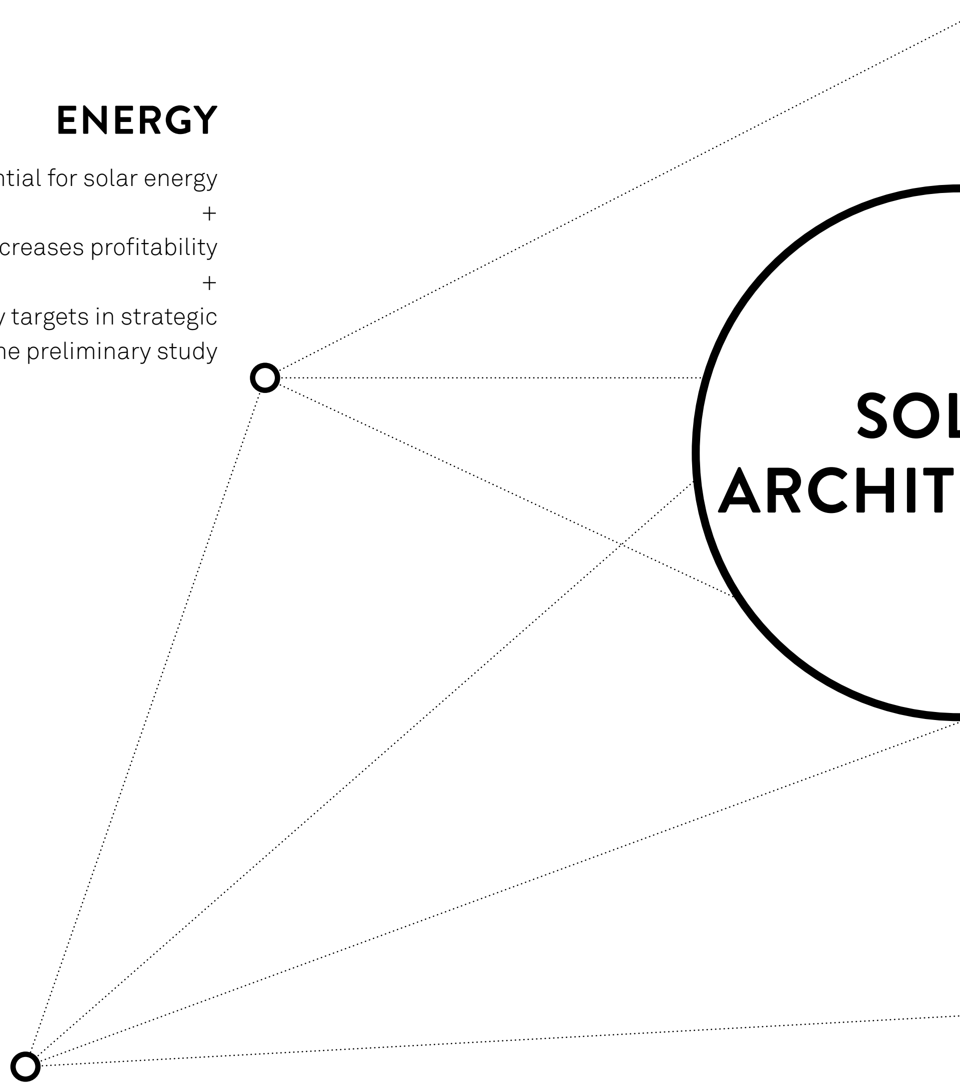
BAT Battery
GTP Geothermal probe
PV Photovoltaics
PVT PV/SC combined in one module
ST Storage
SC Solar collector
HP Heat pump
HW Hot water

SOLAR ARCHITECTURE – AN INTEGRATIVE CONCEPT

Overall, there is considerable potential for the use of solar technology in architecture – the sun shines on almost every roof and on most façades. But just how this integration takes place is highly project-specific. What is almost always sensible for environmental and energy reasons can have consequences on urban planning. Conversely, in many contexts, a homogeneous building envelope is very valuable. However, this results in inefficient modules. As is the case everywhere in architecture, it is important to consider a number of aspects simultaneously and find the optimum:

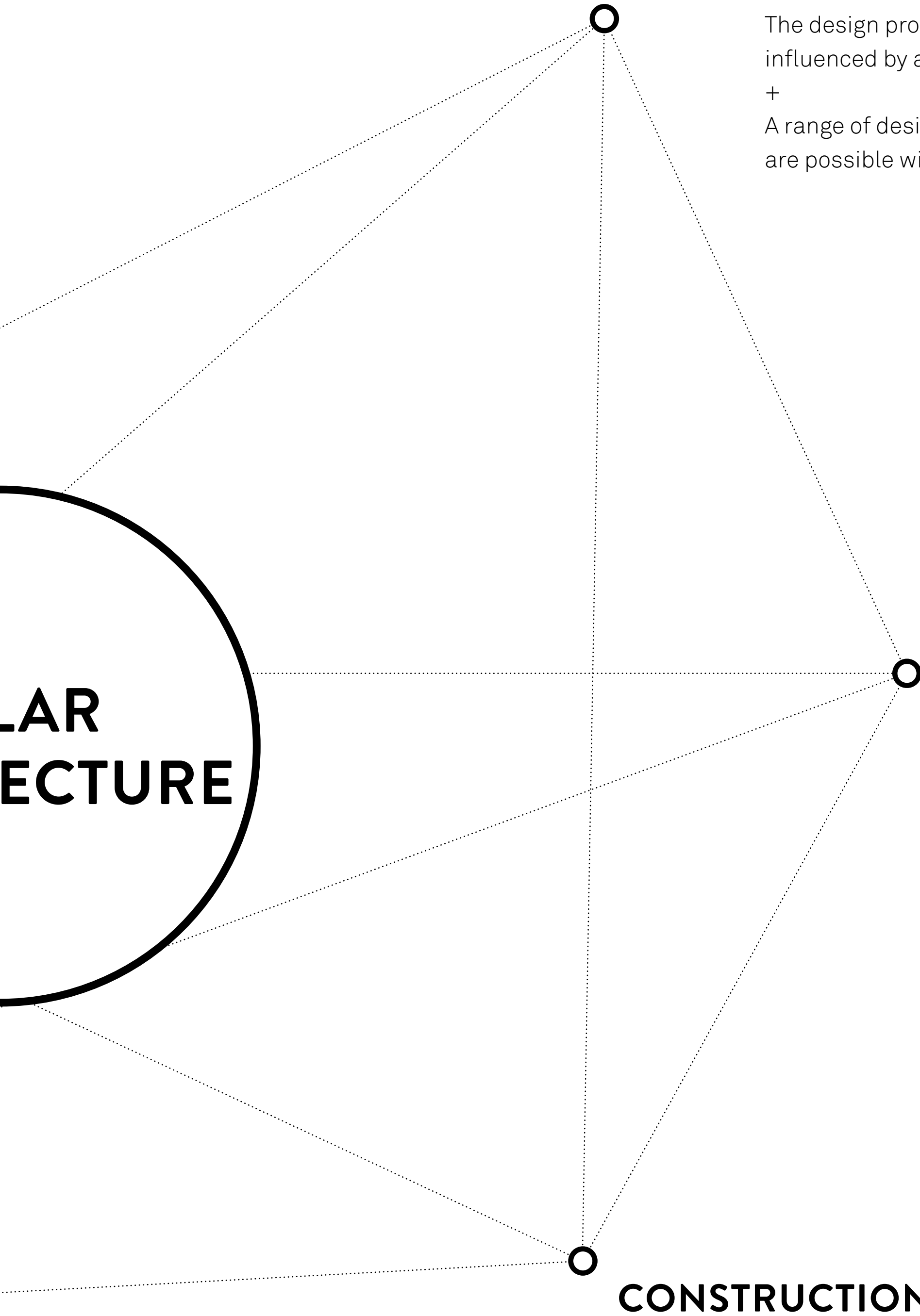
ENERGY

High potential for solar energy
+
Self-consumption increases profitability
+
Integration of energy targets in strategic planning or in the preliminary study



TECHNOLOGY

Well-functioning and mature technology
+
Countless variants of photovoltaics and solar-thermal components
+
In combination with other technologies, maximum potential can be tapped



DESIGN

Consider the different scales
+
The design process for a solar façade can be influenced by architecture or technology
+
A range of design and integration options are possible with solar technology

ECOLOGY AND ECONOMY

Gray energy, environmental impact and life cycle analysis are all part of the economics of the building industry
+
Weigh investments and costs in relation to revenue and amortization
+
Integrated solar energy can also generate returns

CONSTRUCTION

Solar equipment is also a building material
+
Versatile integration options are possible
+
Consider specific properties of solar collectors and PV modules and incorporate them into
the planning process
+
Use of custom or standard systems

DESIGN

Architectural design with solar energy implies consideration of different scales, from urban planning down to the individual solar cell.

The basis for a successful process is an architectural approach that builds on this and clearly defines goals, strategies and available resources. It is continuously refined and ensures good communication, both internally within the planning team and in discussions with the client or authorities.

CHURCH AND COMMUNITY CENTER RIF-TAXACH (A) 2013
Georg Kleeberger, Walter Klasz

ARCHITECTURAL ATTITUDE

For years, the only way to make active use of solar energy for building operation was to apply rigid industrial products to the roof. Thanks to massive cost reductions, increases in efficiency and increased demand for individually manufactured and diverse products, opportunities are increasingly opening on the supply side, which in turn create a jumping-off point for different architectural concepts. The design process for a solar façade can be influenced by both architecture and technology. The design of the façade can be developed based on the possibilities the existing technology enables (e.g. of a specific photovoltaic module) or, conversely, the individual design of a façade can further develop existing products or technologies.

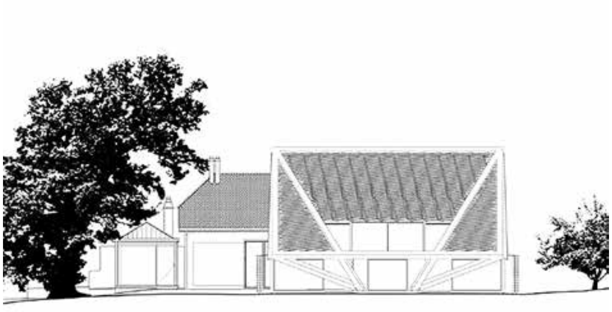
HIGHLIGHTING THE TECHNOLOGY
Adaptive solar façade at ETH Zurich, Architecture and Building systems, Prof. Dr. Arno Schlüter
First implementation on the campus of ETH Zurich, 2015

The character that defines the design can be explored further down to the cell level; for instance, by creating a mosaic of the different reflections and colors of the solar cell doping. Revealing or discreet, hidden or suggested, exploring the depth of the material or letting everything flow behind a homogeneous layer? As with other technologies that have made their way into architecture in the past, such questions also arise when designing a solar façade.

PAINSTAKING INTEGRATION: RENOVATION OF THE GLASERHAUS, BUILT IN 1765 IN AFFOLTERN I. E.
Product: 3S Solar Plus AG, Gwatt
Architecture: Christian & Elisabeth Anliker, Affoltern i. E.
Design and realization: clevergie AG, Wyssachen

URBAN DEVELOPMENT

It makes sense to begin the concept on a large scale. The immediate spatial environment and the energy context have a fundamental impact. Which energy flows are available and can be tapped? What synergies can arise from a local network; for example, the use of waste heat from the neighborhood or pooling several buildings to form a self-consumption pool? Once these possibilities have been clarified (and if the energy requirements still have not been met), the building's potential is evaluated: A precise analysis of solar yields, the geographic orientation of the building, as well as shading precisely analyzed for both active and passive use. In the urban context, the shading situation caused by neighboring buildings must be carefully considered,



THE CHIGNY HOUSE
INTEGRATED INTO THE HISTORIC CENTER AND THE VINEYARDS
Architecture: dieterdietz.org, Zurich and Lausanne | Dieter Dietz, Vincent Mermod, Manuel Potterat

taking future changes into account. If, for example, zoning law permits a currently low building to be raised by two floors, this can have a major impact on the yield of a façade installation on a nearby building. The same applies to the vegetation in the immediate vicinity. In contrast to urban areas, vegetation and sometimes topography in rural areas are more critical in terms of the shading situation.

BUILDING PERMIT SPATIAL PLANNING

Article 18a of the Federal Spatial Planning Act (RPG) governs the permitting of solar installations in building and agricultural zones. 'Adequately adapted' solar systems only require registration with the building authorities, rather than a building permit. However, cantonal law may require a building permit in certain clearly defined protection zones – in central zones, for instance.

ENVELOPE TO VOLUME RATIO (E/V RATIO)

The Model Regulations of the Cantons in the Field of Energy (MuKEn) require new buildings to produce a portion of the electricity they consume on or in the building itself. Photovoltaics is a good way to do this in most cases. In multistorey buildings, inclusion of the façade integration is explicitly desired. This means that generously designed building envelopes with a sub-optimal E/V ratio achieve the minimum requirements thanks to their positive energy balance, especially with the help of solar façades, thereby increasing the latitude for architectural design.

DUAL USE OF FAÇADE CLADDINGS

As a fundamental part of the architecture, the façade has a protective function for the building. With solar modules as façade cladding, a multifunctional structure is created, which also ensures the building's energy supply. The solar panels, as well as their supporting structure, must meet the requirements for rear-ventilated façades; that is, structural design, moisture protection and fire protection must be taken into account. Solar modules for building integration usually consist of laminated safety glass (LSG). The longevity of the products is equivalent to that of LSG façade claddings, and the stability of the electrical power output can be assumed to be >80%, even after 25 years of operation. A module with a technical defect can be replaced to compensate for a loss of power generation.
However, modules with electrical faults can also be left in the façade, as they continue to fulfill their function as protection from the elements.

ORIENTATION OF SOLAR SURFACES

Differences in how surfaces are oriented generate different peak yields over the course of the day and year. Thus, the design of the roof and the building envelope, and the use of these areas can strongly influence energy generation potential. Solar plants oriented towards the east and west can break up midday peaks and bring the yield closer to the requirements. Integrating solar technology into the façade smooths out annual production to produce a relatively greater amount of electricity during the winter.

SOLAR MODULE SELECTION: MASS PRODUCT OR CUSTOM-DESIGNED FAÇADE CLADDING

There are basically two options for the selection of suitable solar modules for façades:

- Use of low-cost standardized, mass-produced products. The technoid appearance and the fixed external dimensions place special demands on the architectural design as well as on integration into the rest of the structure. Manufacturers and engineers must be consulted to determine the suitability of these products as building materials.
- Alternatively, many solar module manufacturers – European companies, in particular – offer customer-specific products. Special sizes, colors and surface finishes can be defined according to architectural requirements. The freedom of design these products offer makes it possible to give every solar façade its own distinctive character. Disadvantages include reduced electrical output due to the often less than maximal coverage of the surface with solar cells, up to 20% lower output due to color coatings, comparatively higher product costs, and the increased design expense.

STANDARD MODULE: KLEIN MATTERHORN VALLEY STATION
Product: Megasol Energie AG, Deitingen
Solar company: Bouygues E&S InTec Schweiz AG,
Helion business unit, Zuchwil

CUSTOM SOLUTION: SOLARIS RESIDENTIAL BUILDING, ZURICH
Modules developed in-house with corrugated safety glass matched to the color of the surroundings (Rote Fabrik Zurich).
Architecture: huggenbergerfries Architects AG ETH SIA BSA, Zurich
Product: ertex solartechnik GmbH, Amstetten (A) in cooperation with research partner Prof. Dr. Stephen Wittkopf, Lucerne University of Applied Sciences and Arts

HOF 8, WEIKERSHEIM (D) 2014
Architectural office Klärle, Rolf Klärle Dipl.-Ing. freelance architect BDA

DESIGN POSSIBILITIES FOR PHOTOVOLTAIC 'BUILDING MATERIALS'

In addition to the physical and technical characteristics of solar equipment, the material also offers a number of features that can be used as design elements to architectural effect. Design of the solar elements offers numerous possibilities, influences the design and has a major impact on energy production and cost.
Listed below are six different design options are listed that underline the wide array of possible design options.

DIMENSION	Most manufacturers offer standard sizes. However, it is also possible to order a broad spectrum of special sizes.
SHAPE	Most solar components are embedded in flat rectangular glass. However, it is also possible to design other shapes and even curved elements. Flexible thin film technologies can also be used to form complex shapes.
COLOR	There is a wide range of colors and technologies. Currently, the color is usually applied to the front glass, completely or partially covering the cells, which reduces efficiency by up to 20% depending on the process.
GLASS TEXTURE	The glass texture can be varied. The possibilities range from simple smooth glass to satin or restructured finishes, or even corrugated glass as a substrate.
TRANS-LUCENCY	In addition to the well-known opaque elements. it is also possible to create semitransparent or highly transparent modules.
GRAPHICS	The inner structure of the modules can be revealed or made completely invisible. This is accomplished by varying the spacing of the cells or by varying or covering up the cells' electrical contacts. Frameless modules can lend a sleek, homogeneous appearance.

POTENTIAL APPLICATIONS

Not only can solar components be integrated into the façade or roof, they can also be purposely used in other variants of multiple-use components such as shading, directing daylight, and cooling.

LIGHTING CONTROL IN THE INTERIOR OF THE STUTTGART LIBRARY WITH PV-MODULES ON THE ROOF
Architecture: Eun Young Yi, Cologne/Seoul

BALCONY BALUSTRADES WITH POLYCRYSTALLINE PV-MODULES FOR A MULTI-FAMILY HOUSE ON ZWYSSIGSTRASSE, ZURICH
Architecture: kämpfen für architektur AG, Zurich

SOLAR-ACTIVE SLIDING SHUTTERS FOR A MULTI-FAMILY HOME ON WIESENSTRASSE, KÜSNACHT
Architecture: Vera Gloor AG, Zurich
Specialist partner for photovoltaics: Leutenegger Energy Control, Küsnacht

CONSTRUCTION

Solar collectors and PV modules are building materials with specific properties that must be taken into account in both design and construction. They cannot be modified at the construction site, for instance, and they require advance planning of plumbing and electrical systems. With proper preparation, assembly is comparable to a conventional glass façade, however.

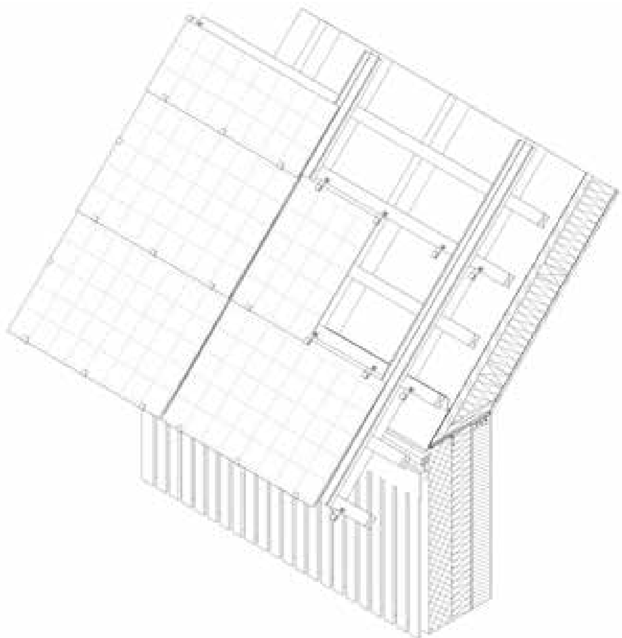
There is a wide range of possibilities for integrated construction, going far beyond to mere roof integration. Solar-active components can also be used in façades or as elements for shading or balustrades. There are both standard fastening systems and custom-designed options for structural integration. This means that today we have a broad spectrum of structural means at our disposal for attaining the desired impression through design.

APARTMENT HOUSE, ZURICH-SCHWAMENDINGEN 2017

kämpfen für architektur AG

ROOF INTEGRATION

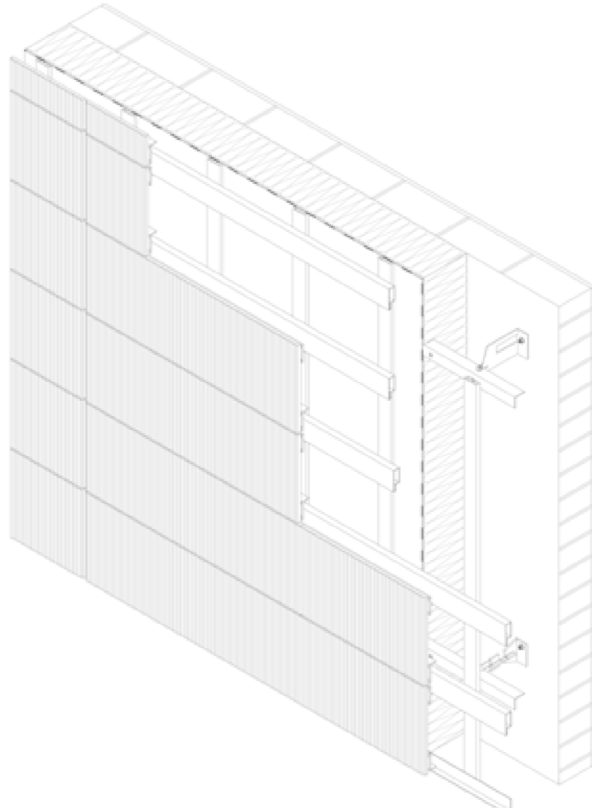
Integrated solar roof systems replace conventional roofing. The manufacturer's specifications for the roof structure must be observed when using these products. Beyond a certain incline, a jointless sub-roof must be laid to ensure the runoff of condensation or water that penetrates the top layer caused by driving rain or blowing snow. When selecting a membrane for the sub-roof, heat resistance suited to the design should be taken into account. For each project, the suitability of the product must be tested in accordance with local presumed snow and wind loads, in accordance with SIA 261 'Impacts on Structures'. To guarantee the functionality of the roof, all work on the roof as well as on the flashing and coping should be carried out by roofers or tinsmiths.



SYSTEM ISOMETRY SCHNELLER BADER HOUSE, TAMINS
Source: www.buk.arch.ethz.ch/Solardatenbank

FAÇADE INTEGRATION

Curtain-type, rear-ventilated façade systems form the substructure for integrating photovoltaic or solar-thermal modules into façades. There are a variety of fastening systems to choose from, whether anchor points, linear or glued fasteners are used depends on the architecture and project budget. The supplier is required to demonstrate proof of structural certification for the supporting structure, consisting of the cladding and fasteners. Electrical cable ducts or the piping for collectors must be integrated into the design process at an early stage, so that any penetrations of the fastening structure can be taken into account and to avoid any problems during installation. The choice of materials for the supporting structure and insulation must conform to the fire protection regulations of the Swiss Cantonal Fire Insurance Association (VKF).



SYSTEM ISOMETRY SOLARIS RESIDENTIAL BUILDING, ZURICH
Schematic representation
Source: www.buk.arch.ethz.ch/Solardatenbank

INTEGRATION INTO RAILINGS AND GLASS-METAL STRUCTURES

In most cases, solar modules tailored to the specific project are required when photovoltaics are integrated into railings or glass roofs. The space between the silicon cells or perforations in thin-film cells determines their degree of translucence. The type of glass used, its thickness and the type of joint selected all ensure that structural requirements are met. The specifications contained in SIA 261 'Actions on Structures' and SIA 358 'Railings and Balustrades' must be met and verified. Ideally, electrical connections and cables are integrated into a metal structure. This creates high-quality structures with a pleasing appearance and cables that are safely protected from contact, moisture and water. To avoid any problems in the integration of the cables, they should be included in project engineering at as early a stage as possible.

ECOLOGY AND ECONOMY

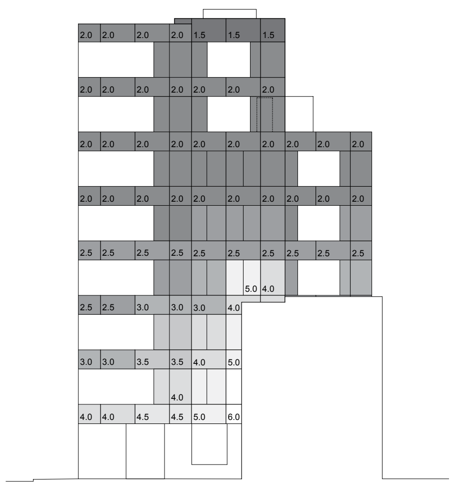
Renewables also have an impact on the environment on various levels. This environmental impact must be systematically analyzed in relation to costs and the technical potential of each of these sources of energy. In terms of price, technical potential and low environmental impact, solar energy has by far the greatest potential of the various energy sources.

MULTI-FAMILY HOME WITH AN ENERGY FUTURE, ZURICH 2017

A project by Umwelt Arena Switzerland
in cooperation with René Schmid Architekten AG

GRAY ENERGY

Constructing buildings requires a lot of energy, so-called gray energy. Installations for the production of solar energy or other renewable energies can amortize the gray energy required for their production. The use of active solar technology therefore has the potential to transform a building from a pure energy consumer into an energy producer. The decisive factor in determining the amortization time of gray energy is how much energy the solar plant produces. The efficiency of the components, the location, the type of integration and orientation of the array all influence the energy balance of the system.



SIMULATION OF THE PAYBACK TIME OF GRAY ENERGY IN PHOTOVOLTAIC MODULES IN THE FAÇADE IN YEARS
Project: Office for Environment and Energy, Basel
Architecture and source: jessenvollenweider architektur, Basel

ENVIRONMENTAL IMPACT

The environmental impact is typically analyzed in terms of gray energy amortization, CO_2 emissions, or with a comprehensive environmental balance, in which other criteria are included, such as the consumption of resources or land. Various studies show that renewable energy sources perform better than conventional ones. In a CO_2 balance, nuclear energy can still keep pace with renewable energy sources, but in a comprehensive environmental balance it clearly falls short. Compared with solar energy, wind and hydro power have even better environmental balances. The gap is relatively small and will continue to close in the future. Overall, solar technologies offer the greatest potential by far for minimizing the negative environmental impact of energy generation and as such are especially well suited to avoiding CO_2 emissions.

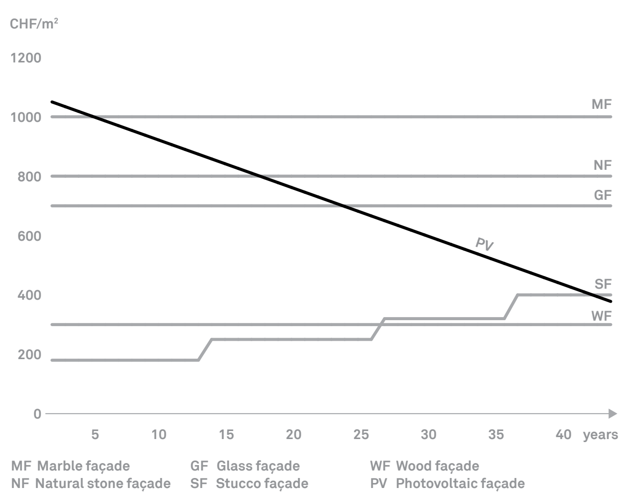
RECYCLING AND DISPOSAL

At the end of their service life, most photovoltaic modules installed in Switzerland can simply be recycled. This saves energy and costs and reduces environmental pollution. The most widespread photovoltaic modules consist mainly of silicon, which can be easily recovered through technical means. Solar cells containing cadmium or other heavy metals instead of silicon (CIS or CIGS) are subject to special disposal regulations and processes. An organization has been established under the SENS eRecycling brand which operates a turn-in system for electrical and electronic equipment throughout Switzerland. This also includes solar modules and components that can be dropped off at the SENS collection points. Manufacturers or importers not affiliated with a recognized turn-in system, must guarantee and finance the subsequent disposal.

FURTHER INFORMATION
www.erecycling.ch

INVESTMENT AND COSTS

The investment for integrating solar technology into the roof and building envelope can vary greatly due to the wide range of design and application options, which is why it is advisable to prepare a project-based cost estimate. Only the added investment compared to a conventional façade solution should be considered an investment. This additional investment is amortized from the proceeds of the solar energy sold and the cost savings resulting from the lower production cost of electricity for self-consumption. The additional costs of photovoltaics over a conventional glass façade amount to around 300–400 CHF/m2. The added investment for simply designed systems can be paid down after just 15 years; in more complex systems, it takes correspondingly longer. Systems have a guaranteed lifetime of 25 years, though in practice it is much longer. This makes it possible to generate a return on the added solar investments. Furthermore, the investment in one's electricity production and consumption is a hedge against rising energy costs.



COST COMPARISON OF FAÇADE TYPES

PROJECTS

3/4
GROSSPETER TOWER BASEL, 2017
ARCHITECTURE—Burckhardt+Partner AG, Basel
DEVELOPER—PSP Real Estate AG, Zurich
PRODUCT—NICE Solar Energy, Schwäbisch Hall (D)
SOLAR ENGINEERING—energiebüro AG, Zurich
SOLAR COMPANY—Planeco GmbH, Münchenstein
PHOTOGRAPHY—Adriano A. Biondo

7/8
SOLARIS RESIDENTIAL BUILDING, ZURICH 2017
ARCHITECTURE—huggenbergerfries Architekten AG ETH SIA BSA, Zurich
DEVELOPER—hbf futur AG, Zurich
PRODUCT—ertex solartechnik GmbH, Amstetten
RESEARCH PARTNER—Lucerne University of Applied Sciences and Arts/CC Envelopes & Solar Energy
SOLAR ENGINEERING—sundesign GmbH, Stallikon
SOLAR COMPANY—Suntechnics Fabrisolar AG, Küsnacht
FAÇADE DESIGN—Gasser Fassadentechnik AG, St. Gallen
PHOTOGRAPHY—huggenbergerfries Architekten AG ETH SIA BSA

11/12
SOLARES DIREKTGEWINNHAUS, ZWEISIMMEN 2014
ARCHITECTURE—n11 architects, Zweisimmen
DEVELOPER—Private
PRODUCT—Solardach SUNSTYLE®, Ostermundigen
ENGINEERING—Energiebüro Hanimann, Zweisimmen; Pfleger Stöckli Architekten, Chur
PHOTOGRAPHY—Katharina Wernli Photography

15/16
HAUS SCHNELLER BADER, TAMINS 2016
ARCHITECTURE—Bearth & Deplazes Architekten | Valentin Bearth – Andrea Deplazes – Daniel Ladner, Chur
DEVELOPERS—Georgina Schneller and Sascha Bader
PRODUCT—3S Solar Plus AG, Gwatt
SOLAR COMPANY—Bouygues E&S InTec Schweiz AG, Helion business unit, Zuchwil
PHOTOGRAPHY—Juan Rodriguez

19/20
MFH HOFWIESEN-ROTHSTRASSSE, ZURICH 2016
ARCHITECTURE—Viridén + Partner AG, Zurich
DEVELOPER—Private
USER AND INVESTOR IN THE SOLAR FAÇADE—EcoRenova AG, Zurich
PRODUCT—WINAICO
SYSTEM PROVIDER—GFT Fassaden AG, St.Gallen
BIPV ENGINEERING AND REALIZATION—Diethelm Fassadenbau AG, Hermetschwil
LOAD MANAGEMENT—e4plus AG, Kriens
PHOTOGRAPHY—Nina Mann Fotografie, Zurich

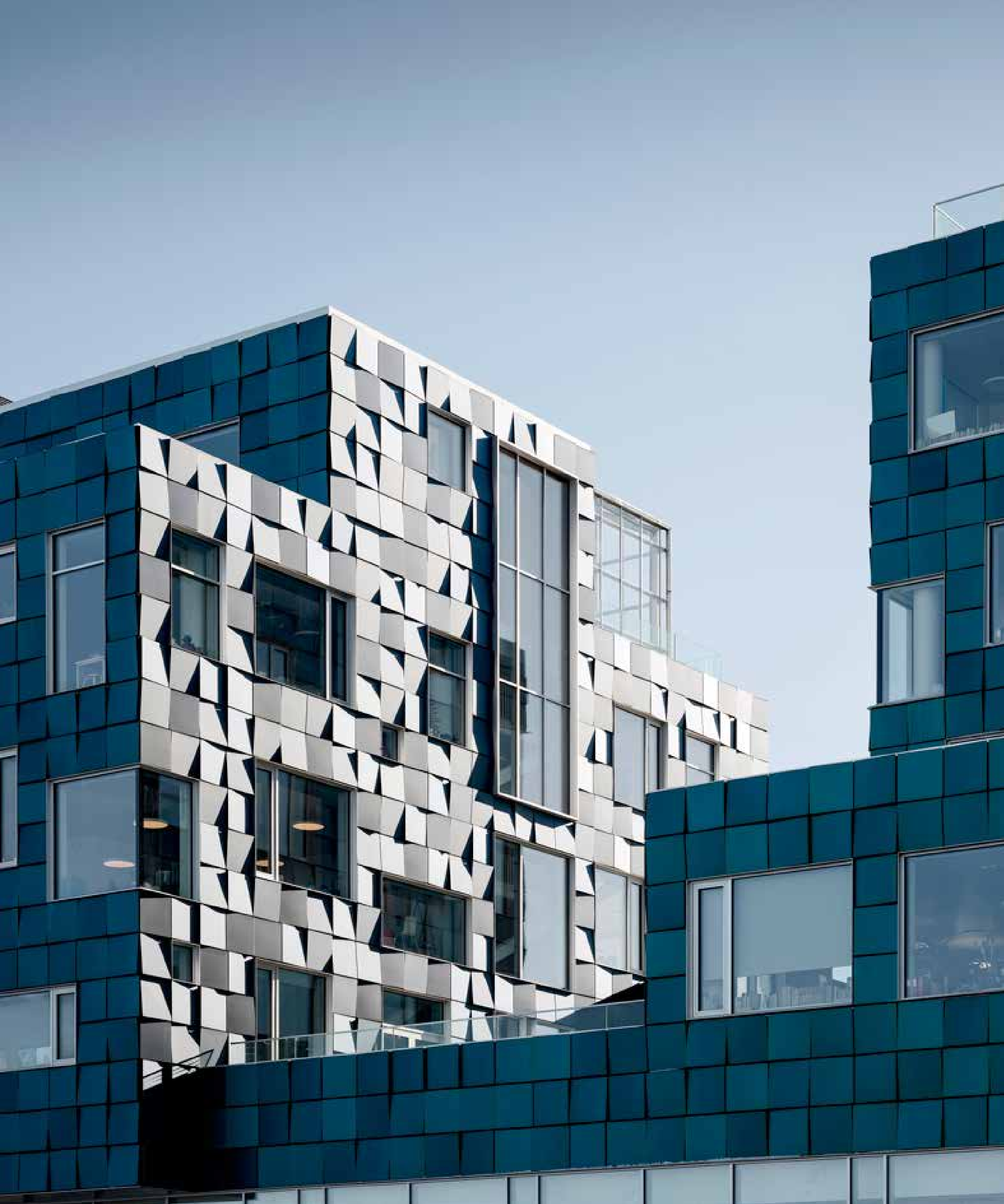
25/26
CHURCH AND COMMUNITY CENTER RIF-TAXACH (A) 2013
ARCHITECTURE—Walter Klasz, St. Sigmund
DEVELOPER—Roman Catholic Church of the Blessed Albrecht
GENERAL ENGINEERING—Paul Schweizer with Martin Embacher, Salzburg
PHOTOGRAPHY—Andrew Phelps

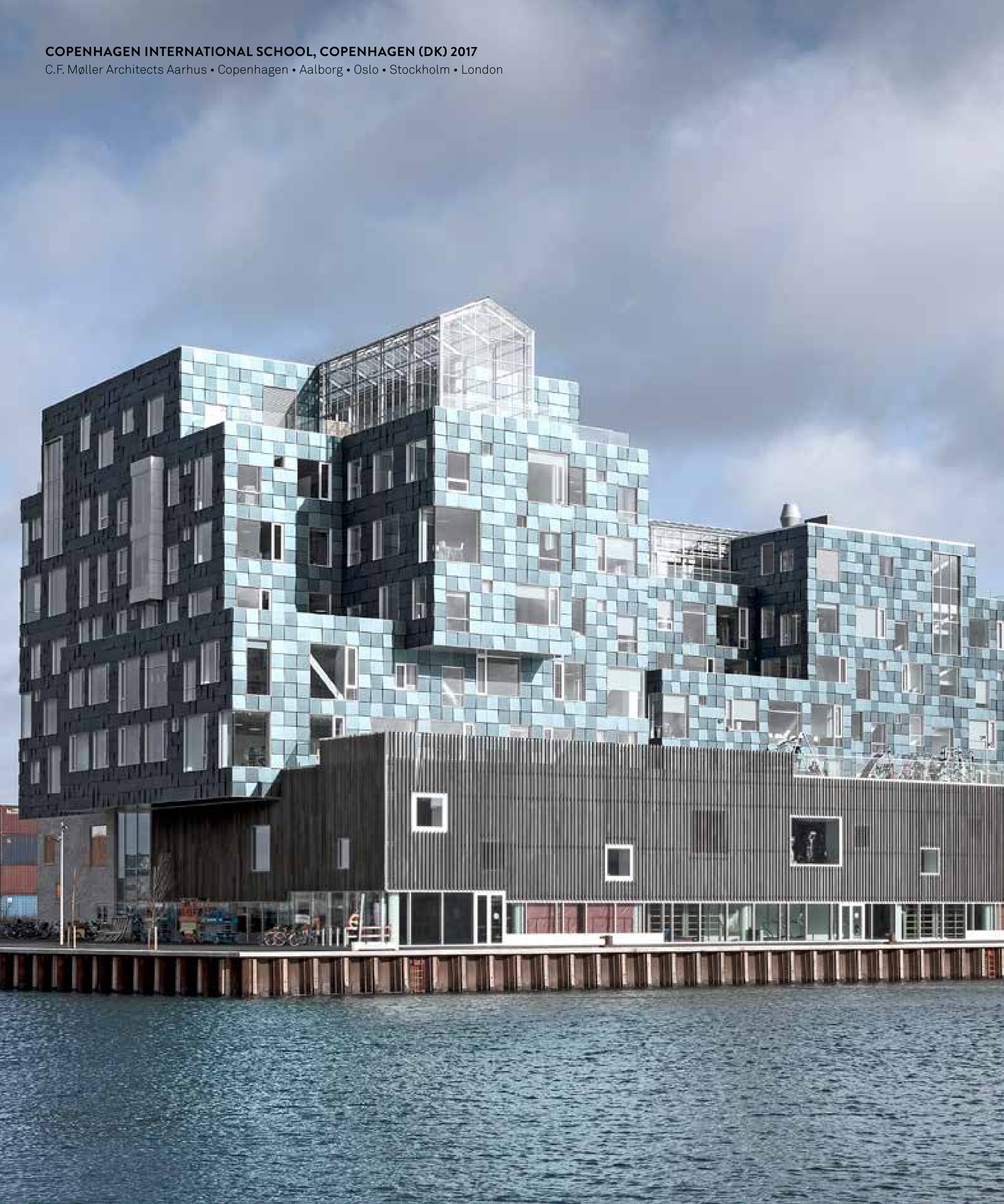
29/30
HOF 8, WEIKERSHEIM (D) 2014
ARCHITECTURE—Architekturbüro Klärle, Rolf Klärle Dipl.-Ing. freelance Architect BDA, Bad Mergentheim (D)
DEVELOPER—Prof. Dr. Martina Klärle and Andreas Fischer-Klärle
PRODUCT—Trina Solar, Aschheim/Munich (D)
PHOTOGRAPHY—Brigida Gonzales

33/34
APARTMENT HOUSE, ZURICH-SCHWAMENDINGEN 2017
ARCHITECTURE—kämpfen fur architektur AG, Zurich
DEVELOPER—Private
PRODUCT—DOMA FLEX large-area collector with Kromatix special glazing
HVAC ENGINEERING—Naef Energietechnik, Zurich
ENERGY SPECIALIST—Edelmann Energie, Zurich
PHOTOGRAPHY—Andreas Hekler

37/38
MEHRFAMILIENHAUS MIT ENERGIEZUKUNFT, ZURICH 2017
An Umwelt Arena Schweiz project in cooperation with René Schmid Architekten AG, Zurich
PRODUCT—PVP Photovoltaik, Wies (A), Distributor CH: Stephan Kobler, Wollerau
MOUNTING SYSTEM ENGINEERING—René Schmid Architekten AG
ELECTRICAL ENGINEERING—BE Netz, Ebikon
INSTALLATION—Max Vogelsang Holzbau AG, Wohlen

41/42
COPENHAGEN INTERNATIONAL SCHOOL, COPENHAGEN (DK) 2017
ARCHITECTURE—C.F. Møller Architects Aarhus • Copenhagen • Aalborg • Oslo • Stockholm • London
DEVELOPER—Property Foundation Copenhagen International School (ECIS)
PRODUCT—Emirates Insolaire, Dubai. A joint venture of SwissINSO (EPFL spin-off) and Emirates Glass
PHOTOGRAPHY—Adam Mørk





COPENHAGEN INTERNATIONAL SCHOOL, COPENHAGEN (DK) 2017
C.F. Møller Architects Aarhus • Copenhagen • Aalborg • Oslo • Stockholm • London

This publication is a climate-neutral product
printed on FSC-certified paper.

03.2019 8212 860437657

swiss energy
Our commitment: our future.