

24.10.2017

ee concept GmbH

Dr.-Ing. Architekt Martin Zeumer

Solar Active Architecture Advanced BIPV Design

Quelle: ee concept GmbH



About me

ee concept
gmbh

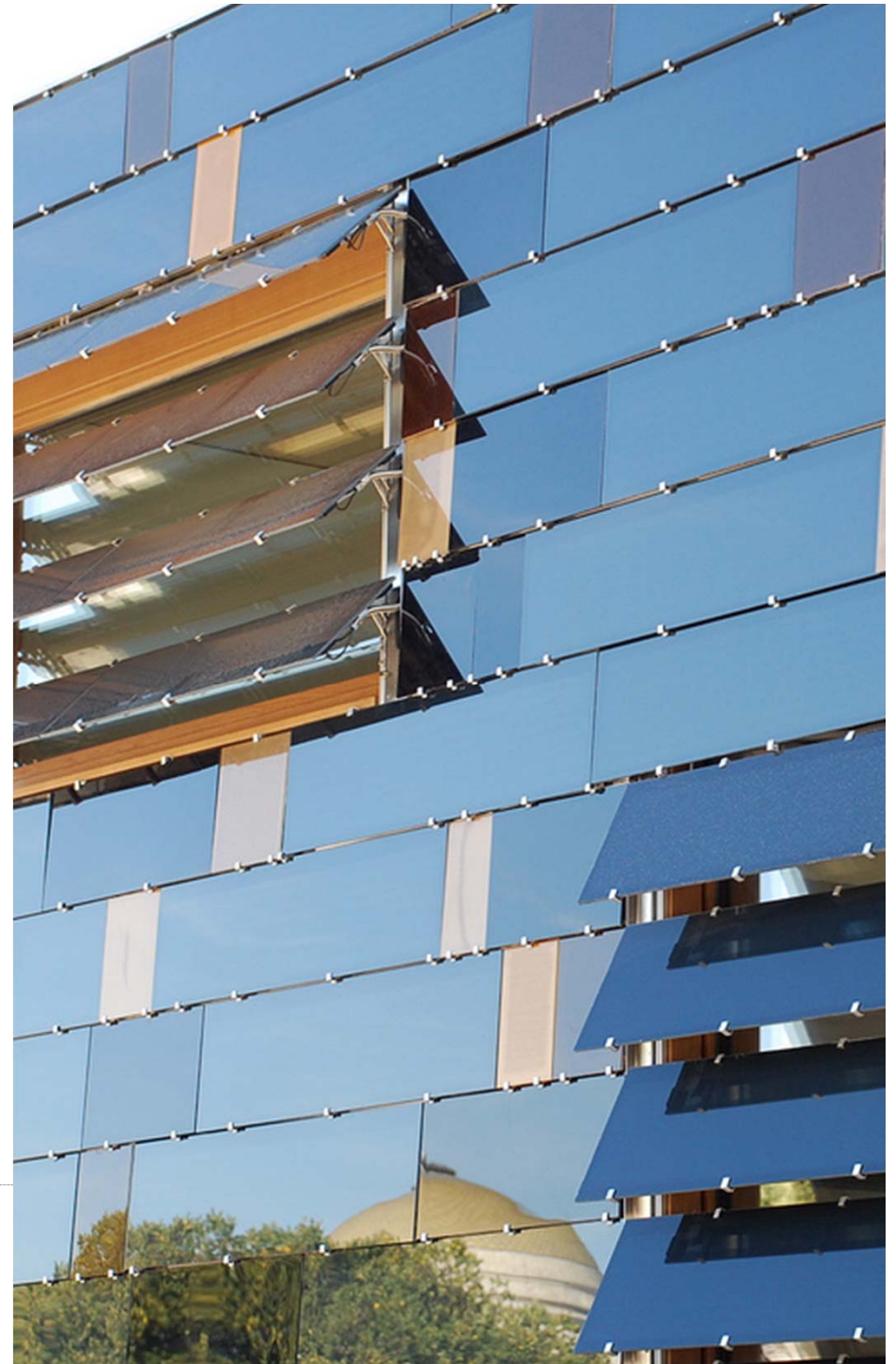


2007



2009





2011



2013



2010



2012



2014

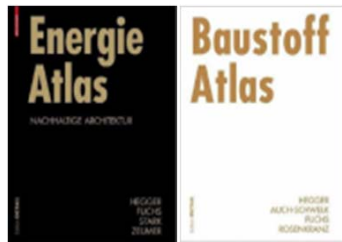




e+KITA in Marburg



Freiham, München



Plusenergiehaus M., Seeheim-Jugenheim

ee concept



Energetic building concepts
Energiekonzepte



Sustainable building certification
Gebäudezertifizierung



Urban space
Stadtquartiere



Building material consultancy
Baustoffberatung



Knowledge transfer
Wissenstransfer



Sustainable design competitions
SNAP Wettbewerbsbetreuung



Pilot projects
Pilotprojekte



Greenpeace Deutschland-zentrale, Hamburg



Katholische Kirche St. Trinitatis, Leipzig



Olympische Winterspiele 2018 in München

BIPV

- **Constructional integration in building elements**
 - Water tight cladding
 - Facade shading

- **Integration in building energy concepts**
 - Use for power (e.g. mechanical ventilation, heat pumps)
 - Use of thermal heat of PV

- **Design integration**
 - Addition
 - Integration
 - Adaption

- **Constructional integration in building elements**
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↓

Actual statements for BIPV development:
The more Integration exists, the better is the product.

Projects

Project information

| | |
|---|---|
| Architects | ee concept GmbH, Darmstadt |
| Energy concept | ee concept GmbH, Darmstadt |
| Building-owner | private |
| Year of construction | 2010 |
| Building Standard | Plus-energy, Effizienzhaus Plus, CO ₂ -neutral |
| Housing space | 255 m ² |
| End Energy demand (heating/power)/m ² | 37,79 kWh/m ² a |
| End Energy production (heating/power)/m ² | 57,92 kWh/m ² a |

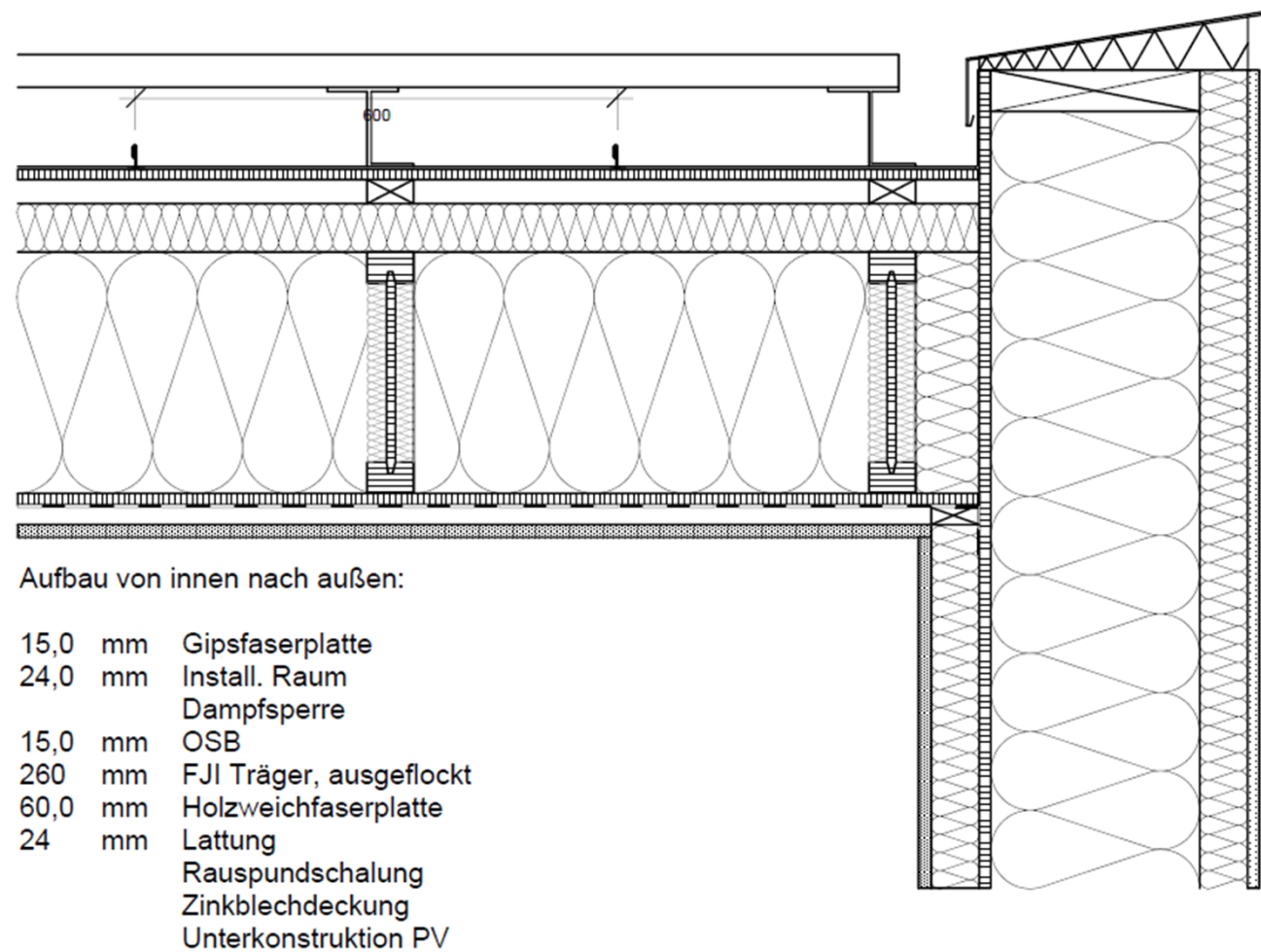
Hegger et al.: Aktivhaus

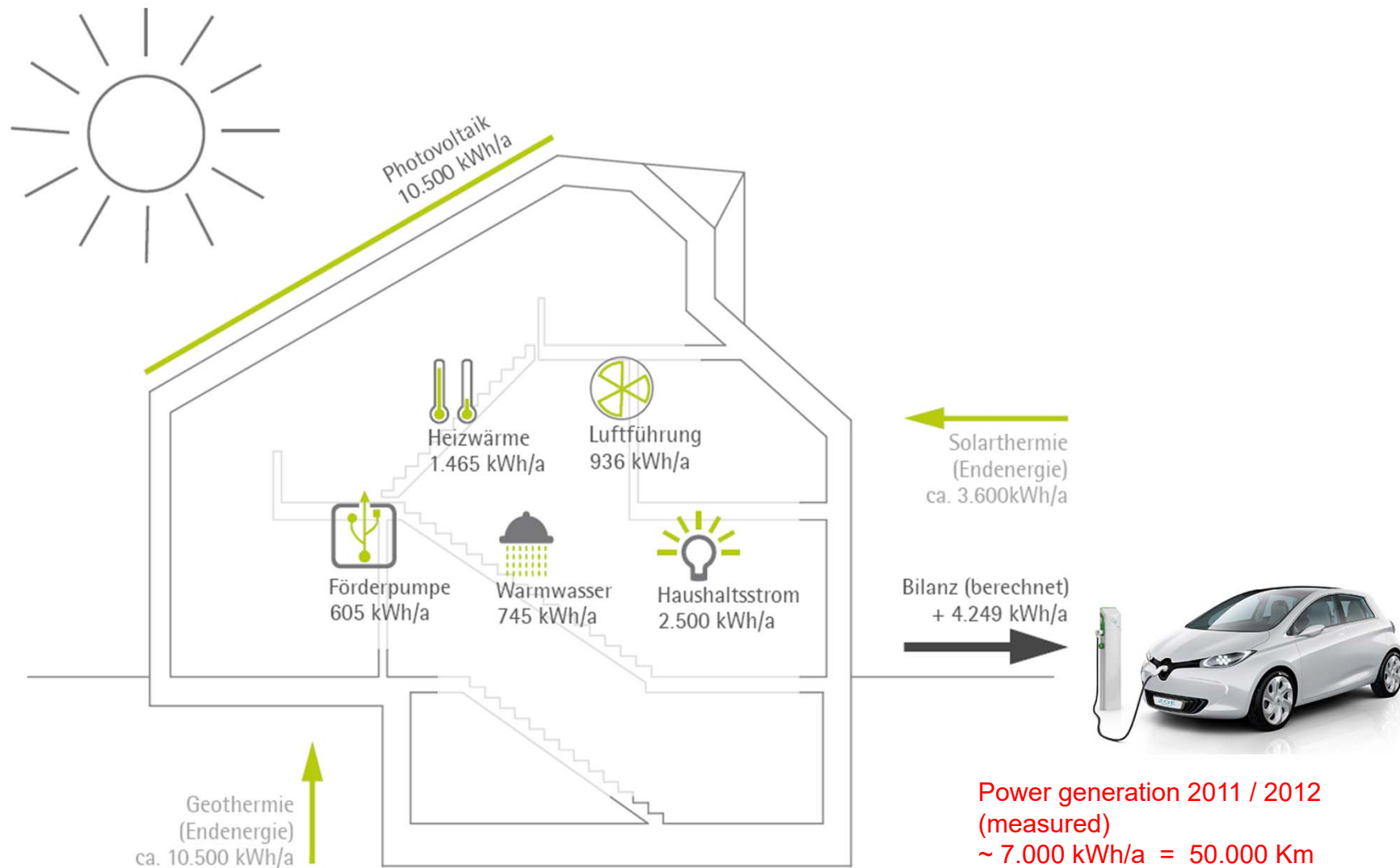


ee concept

Energy concept and design integration
House P, Steinbach i.T.







ee concept

Energy concept and design integration
 House P, Steinbach i.T.

Project information

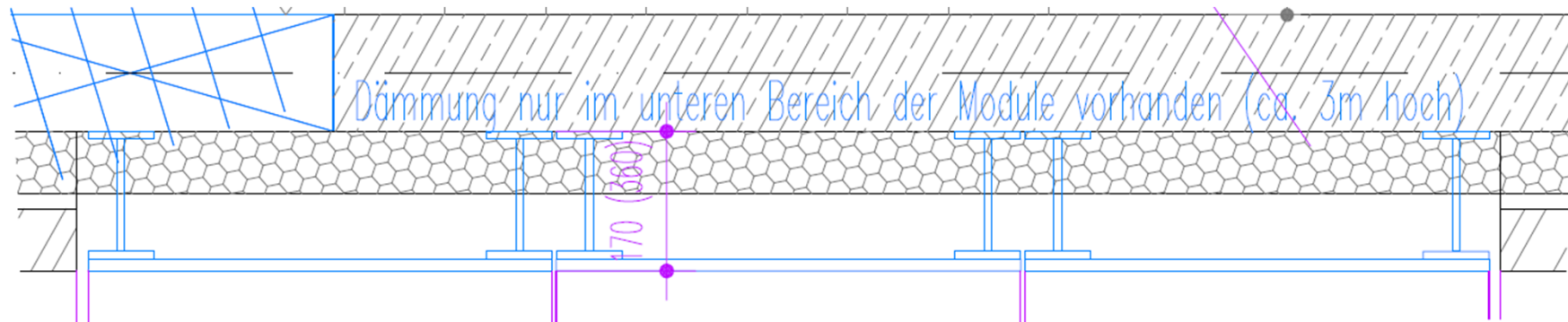
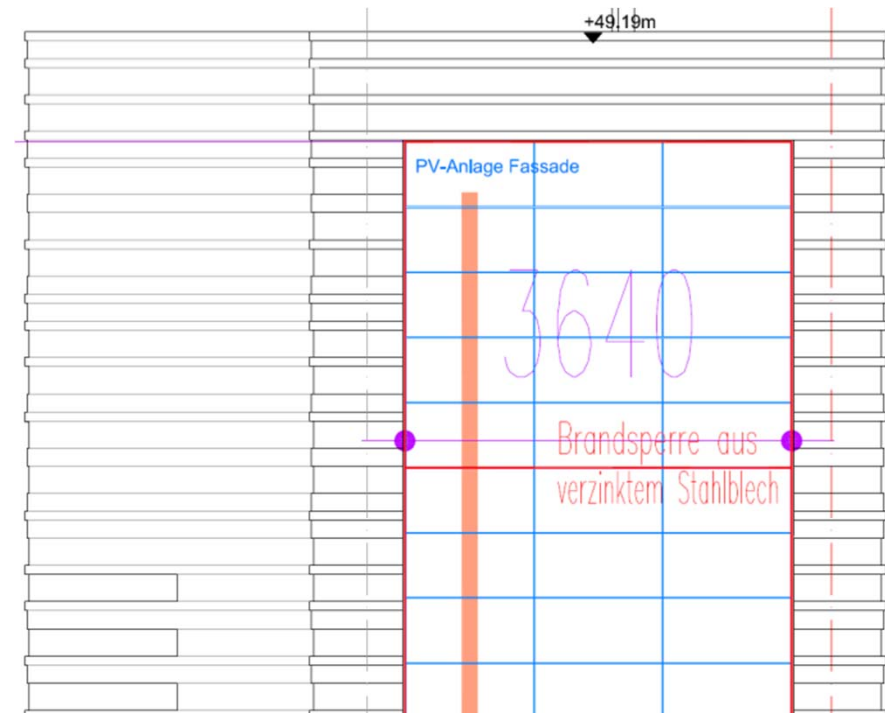
| | |
|---|---|
| Architects | Schulz & Schulz architekten |
| Energy concept | ee concept GmbH, Darmstadt |
| Building-owner | Katholic church |
| Year of construction | 2014 |
| Building Standard | KfW-40 (Unterschreitung EnEV 2009 um 69%) |
| Building space | 1900 m ² |
| End Energy demand (heating/power)/m ² | 37,8 kWh/m ² (housing) 40,6 kWh/m ² (church) |
| End Energy production (heating/power)/m ² | 26,3 kWh/m ² |

Hegger et al.: Aktivhaus



Energy concept and design integration
St. Trinitatis Church, Leipzig

150 m² PV-power plant
(15,6 kW_{peak}) → 10 MWh/a



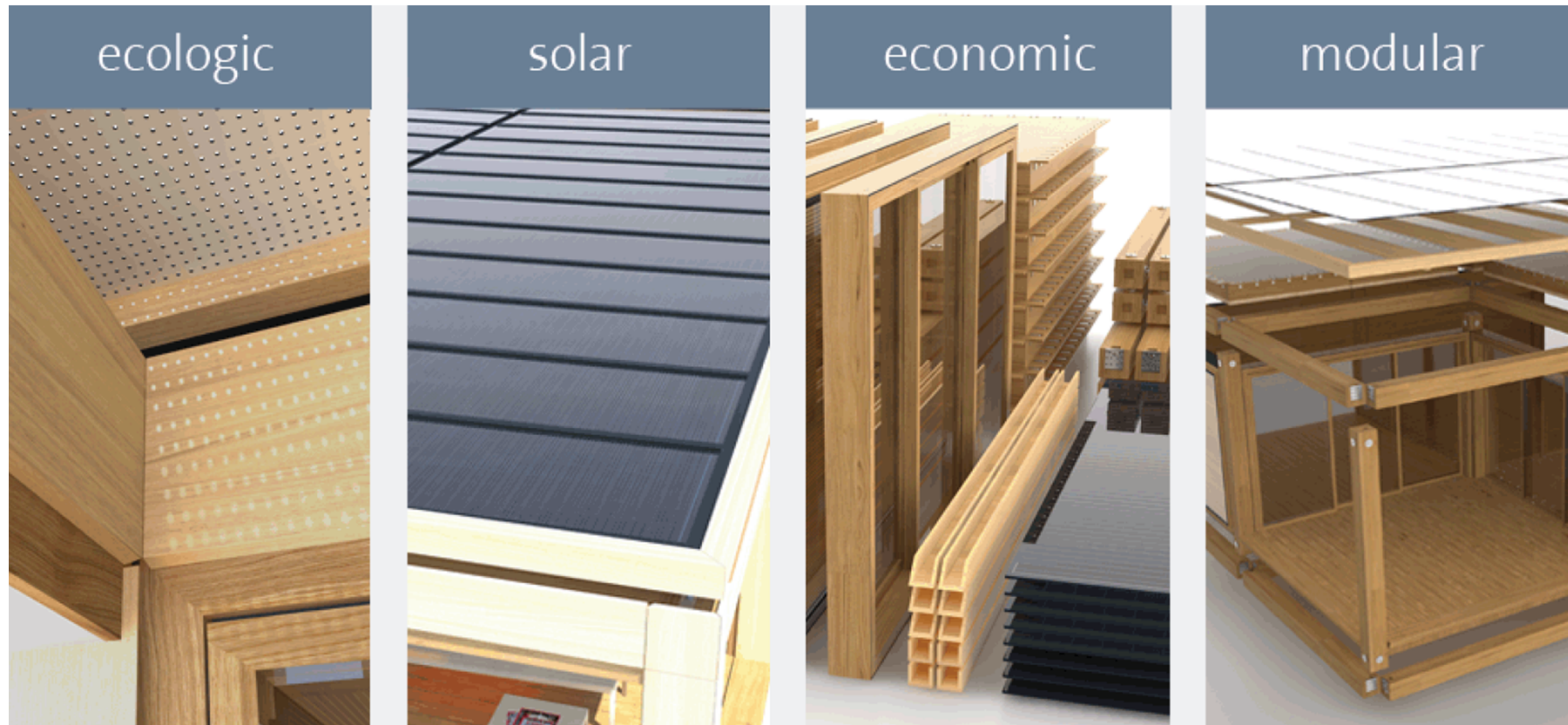
MLT Medien Licht Technik Ingenieure, Leipzig

Energy concept and design integration
St. Trinitatis Church, Leipzig



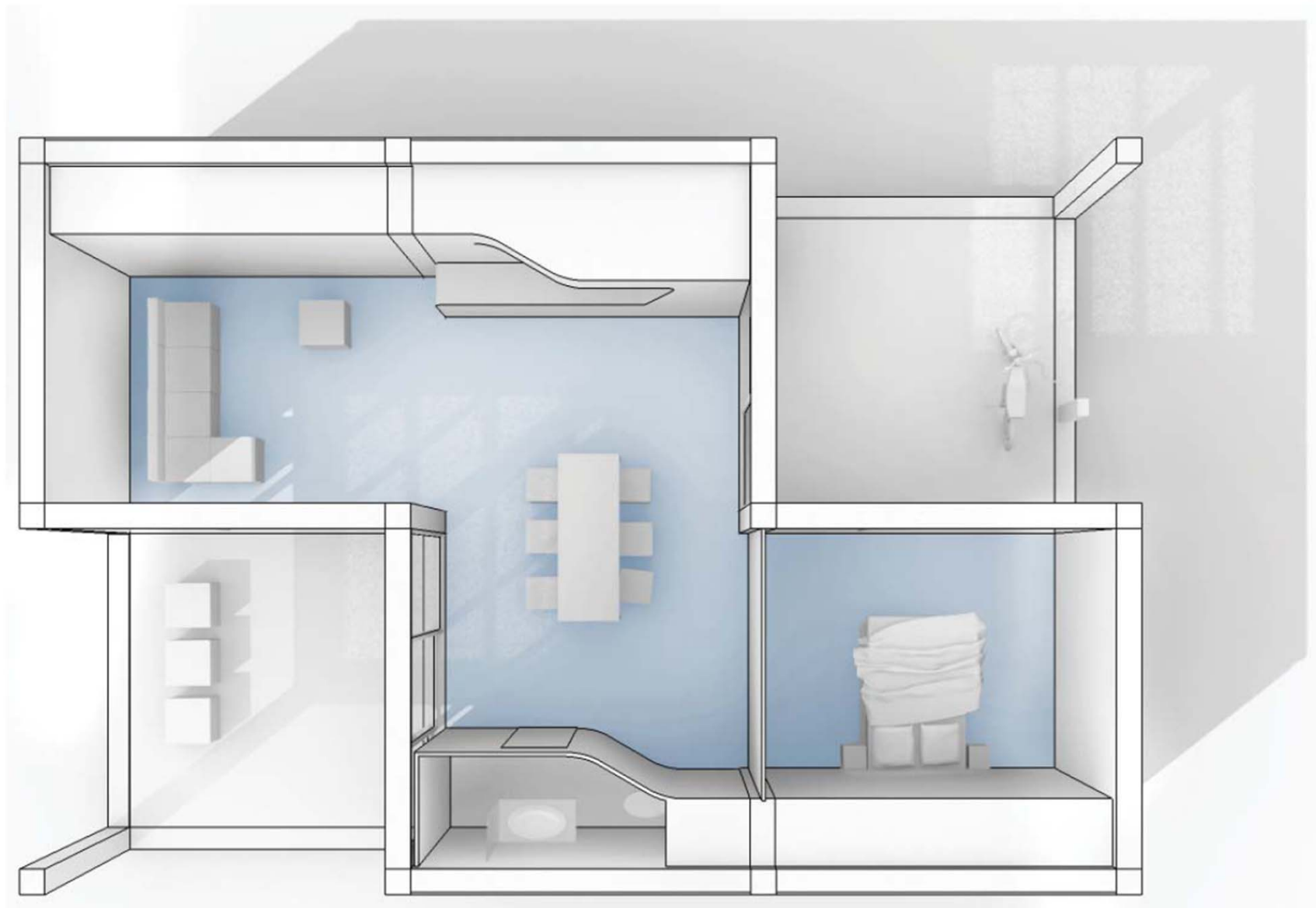
Quelle: Bild Sto AG, StoVentec ARTline Invisible

Energy concept and design integration
St. Trinitatis Church, Leipzig



Team ECOLAR HTWG Konstanz

Functional, energetic an design integration
 ECOLAR Home, HTWG Konstanz



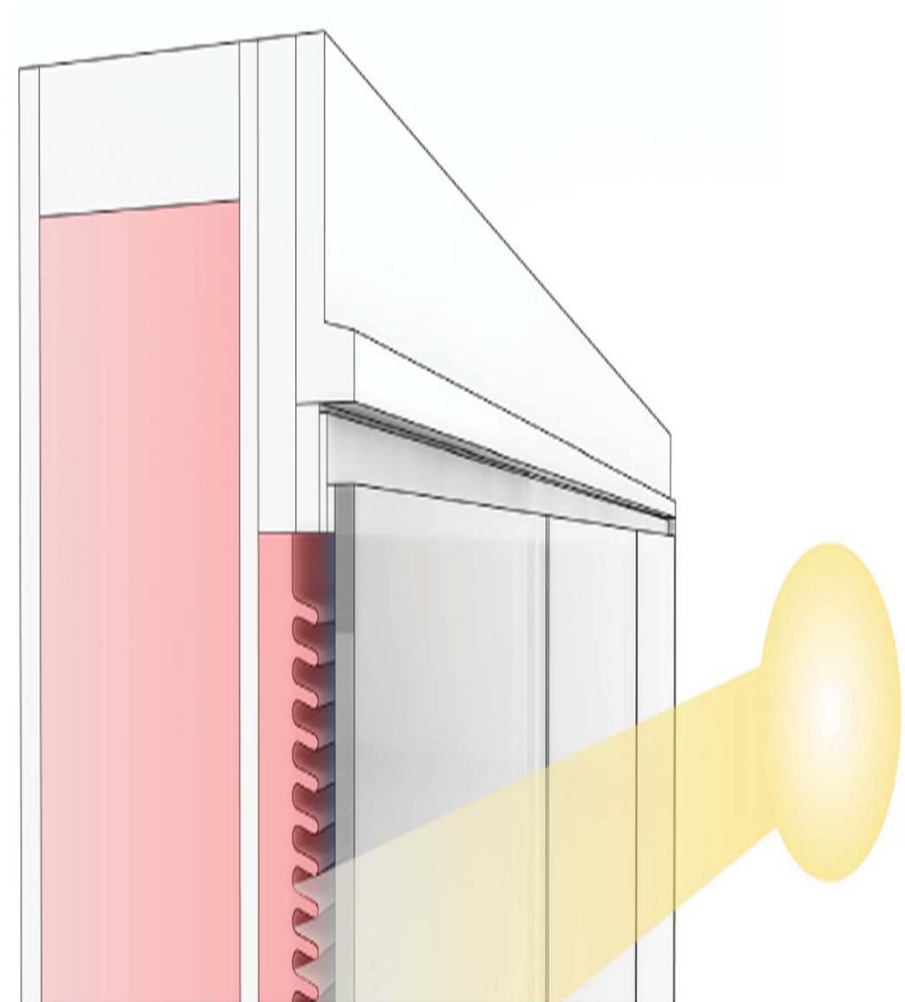
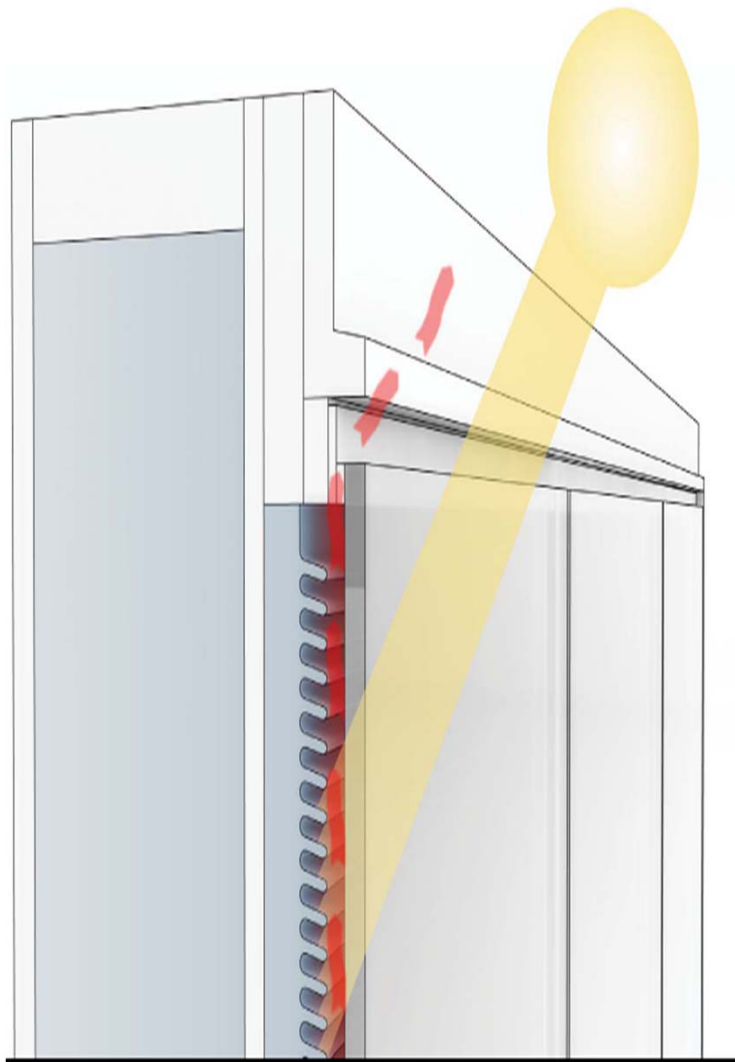
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Team ECOLAR HTWG Konstanz

Functional, energetic an design integration
ECOLAR Home, HTWG Konstanz

Design process

Nursery school Vitos-Area, Marburg

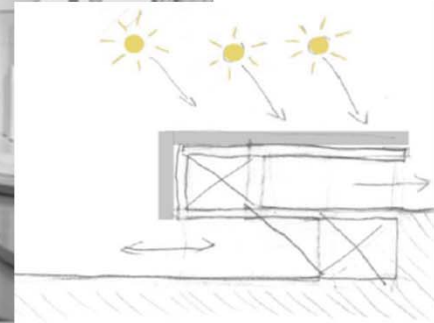
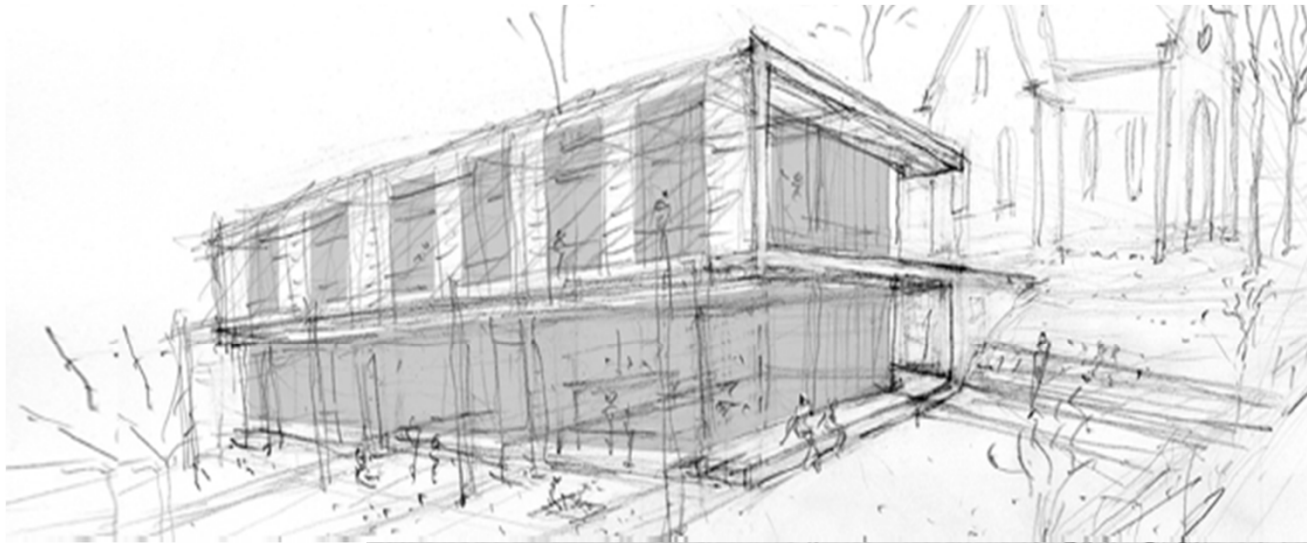
| | |
|---------------------------------|------------------|
| Building-owner: | City of Marburg |
| Project executing organization: | SEG Marburg |
| architects: | OPUS Architekten |
| Building services: | Plan4Life |
| Electrical planning: | Schaub & Kühn |
| Energy concept: | ee concept GmbH |
| Beginn planning: | autumn 2012 |
| completion: | spring 2014 |



e+ Kindertagesstätte Marburg

e+ Kita Marburg
Site

33 **ee concept**
gmbh







Quelle: Opus Architekten

e+ Kita Marburg
1st design sketch







e+ Kita Marburg
Local vegetation

| | | | | | | | | | | | | | |
|---------------------------------|--|--|---|------------------|--|--------|--------------------|------|--|-------------|---------------------|---------|---------------------|
| | spez. PE Strom 142,6 kWh/m ² a | Primärenergie gesamt 95.569 kWh/a | Endenergie gesamt 36.757 kWh/a | | | | | | | | | | |
| PV-Flächen | | | | | | | | | | | | | |
| Wirkungsgrad PV-System 12,0% | spez. Ertrag PV-System 118,8 kWh/m ² a | | spez. Ertrag PV-System 28.512 kWh/m ² a | | | | | | | | | | |
| | notwendige Modulfläche 309 m ² | | notwendige Modulfläche 309,4 m ² | | | | | | | | | | |
| | | <table><tr><td colspan="2">Flächenpotenzial</td></tr><tr><td>Dach 1</td><td>324 m²</td></tr><tr><td>Dach</td><td></td></tr><tr><td>Gartenhütte</td><td>31,5 m²</td></tr><tr><td>Fassade</td><td>86,4 m²</td></tr></table> | | Flächenpotenzial | | Dach 1 | 324 m ² | Dach | | Gartenhütte | 31,5 m ² | Fassade | 86,4 m ² |
| Flächenpotenzial | | | | | | | | | | | | | |
| Dach 1 | 324 m ² | | | | | | | | | | | | |
| Dach | | | | | | | | | | | | | |
| Gartenhütte | 31,5 m ² | | | | | | | | | | | | |
| Fassade | 86,4 m ² | | | | | | | | | | | | |
| | | notwendige installierte Leistung 37,1 kWhpeak | | | | | | | | | | | |

| Neigung Modulfläche [°] | nutzbare Solarfläche [%] | spezifische Einstrahlung [%] | nutzbare Einstrahlung [%] |
|---|--------------------------------|------------------------------------|---------------------------------|
| 0  | 100 | 100 | 100 |
| 10  | 75 | 106 | 80 |
| 20  | 61 | 111 | 68 |
| 30  | 53 | 113 | 60 |





The architects point of view

Quelle: Hegger, Fuchs, Stark, Zeumer: Energie Atlas

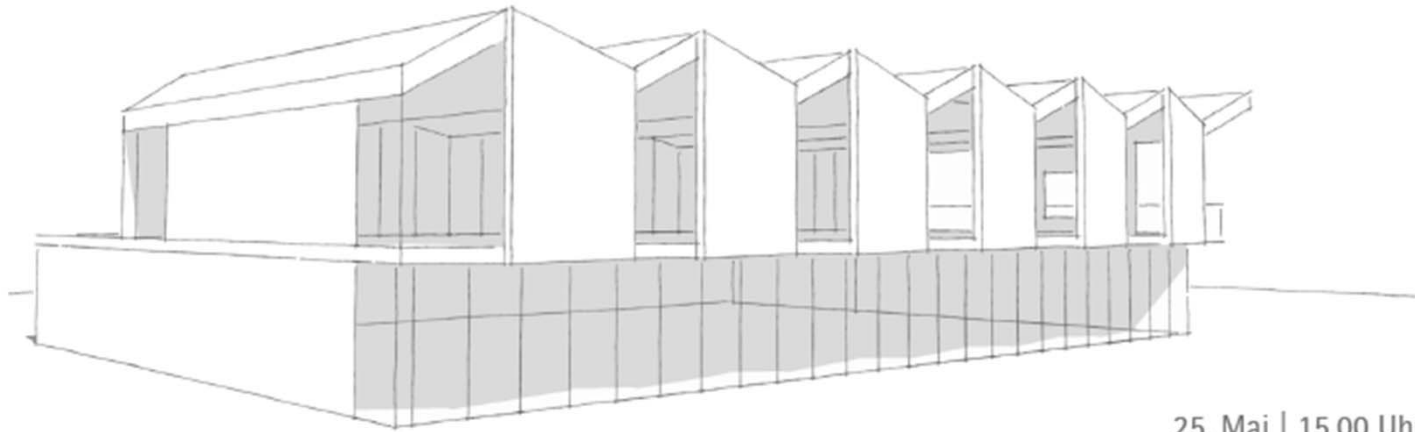
| Neigung Modulfläche [°] | nutzbare Solarfläche [%] | spezifische Einstrahlung [%] | nutzbare Einstrahlung [%] |
|---|--------------------------------|------------------------------------|---------------------------------|
| 0  | 100 | 100 | 100 |
| 10  | 75 | 106 | 80 |
| 20  | 61 | 111 | 68 |
| 30  | 53 | 113 | 60 |

The public utilities point of view

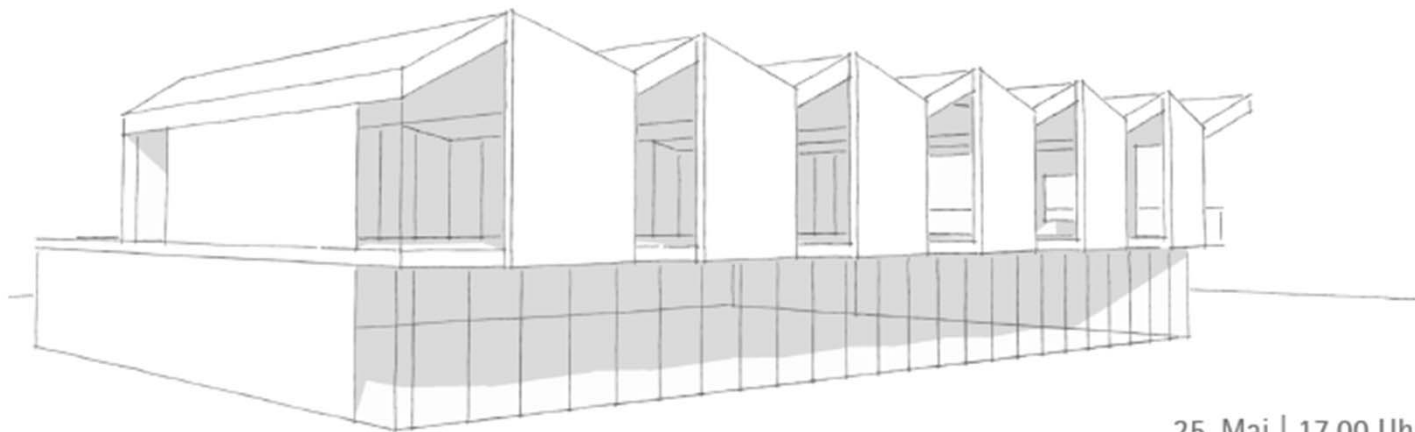
Quelle: Hegger, Fuchs, Stark, Zeumer: Energie Atlas

| Neigung Modulfläche [°] | nutzbare Solarfläche [%] | spezifische Einstrahlung [%] | nutzbare Einstrahlung [%] | The buildings point of view for high performance and cost efficiency |
|---|--------------------------------|------------------------------------|---------------------------------|---|
| 0  | 100 | 100 | 100 | |
| 10  | 75 | 106 | 80 | |
| 20  | 61 | 111 | 68 | |
| 30  | 53 | 113 | 60 | |

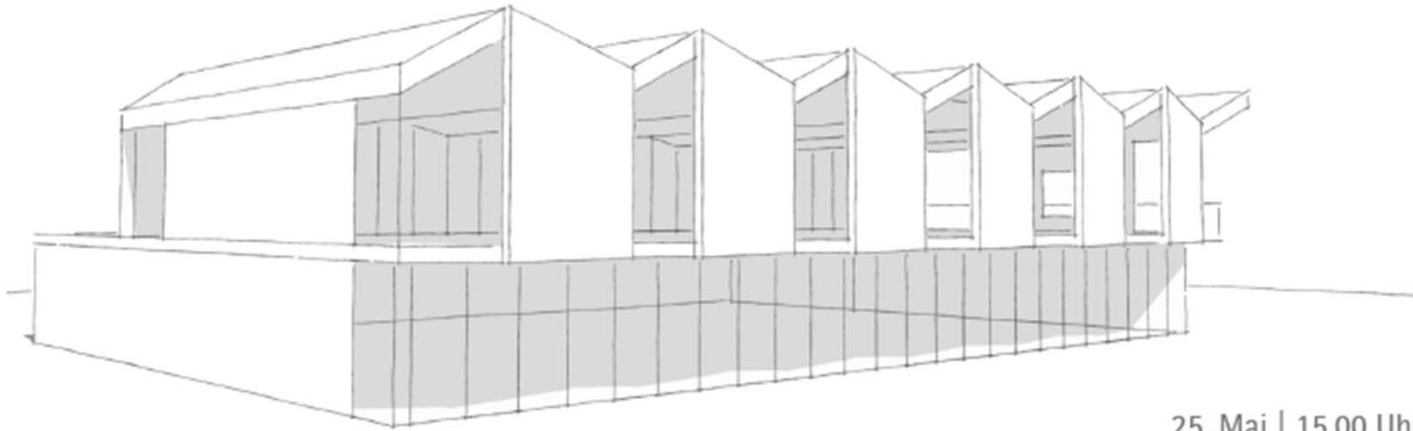
Quelle: Hegger, Fuchs, Stark, Zeumer: Energie Atlas



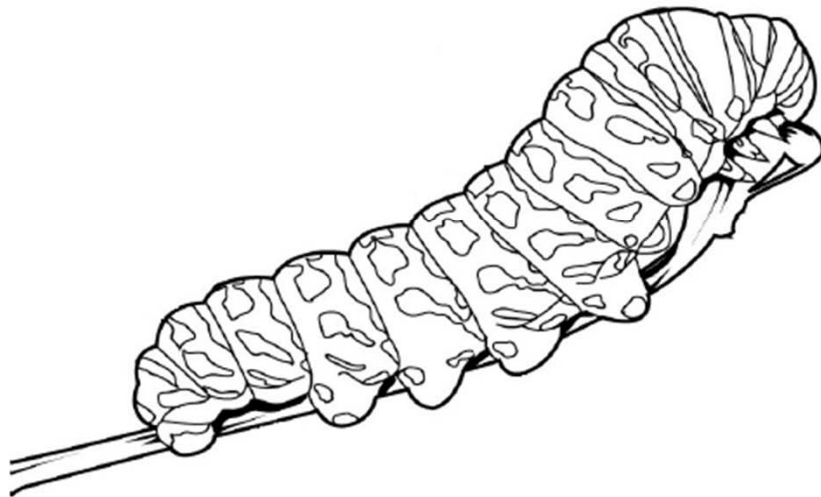
25. Mai | 15.00 Uhr



25. Mai | 17.00 Uhr



25. Mai | 15.00 Uhr



„Solarraupe“
„Solar caterpillar“



Grafik: e+ Kindertagesstätte Marburg, opus Architekten, ee concept GmbH

e+ Kita Marburg

Optimized design sketch – Image

| | | | |
|---------------------------------|--|---|---|
| | | Primärenergie gesamt 106.791 kWh/a | Endenergie gesamt 41.073 kWh/a |
| PV-Flächen | | | |
| Wirkungsgrad PV-System 14,0% | spez. Ertrag PV-System 129,5 kWh/m ² a | | spez. notw. Ertrag PV-System 41.073 kWh/m ² a |
| | | <div>notwendige Modulfläche 317,2 m²</div> <div> <div>Flächenpotenzial</div> <div> <div>Dach 1288 m²</div> <div>Fassade67,5 m²</div> </div> </div> | |
| | | notwendige installierte Leistung ca. 53,3 kWhpeak | |

Mögliche Photovoltaikmodule bei solaraktiver Fläche 3,0 m

Dach Mittelteilung

| No | Modul-Hersteller | Modul-Typ | Modulwirkungsgrad [%] | Rasthmaß | | | | Ästhetik | |
|----|---|-----------|-----------------------|-----------|------|----|-------|---------------------------------------|---|
| | | | | a | b | c | | | |
| 1 | AneEnerji Production Industry and Trade INC | | 14.05; | 1507/1663 | 992 | 33 | 2x1.5 | schwarz, linienhafte Kontakte, Rahmen | ✓ |
| 2 | Apollo Solar Energy Co. Ltd. | | 16.22 | 1481 | 666 | 45 | 2x1.5 | schwarz, linienhafte Kontakte, Rahmen | ✓ |
| 3 | AxSun Solar GmbH Co. KG | | 14.1,14.5 | 1495 | 995 | 42 | 2x1.5 | Schwarz, linienhafte Kontakte, Rahmen | ✓ |
| 4 | CentroSolar | | 14.11-15.46 | 1503 | 990 | 40 | 2x1.5 | Schwarz, linienhafte Kontakte, Rahmen | ✓ |
| 5 | Ligitek Photovoltaic Co. Ltd. | | 14.14-14.91 | 1486 | 1309 | 50 | 2x1.5 | schwarz, linienhafte Kontakte, Rahmen | ✓ |
| 6 | GESOLAR Sainty International Group | | 14.96 | 1482 | 992 | 42 | 2x1.5 | schwarz, linienhafte Kontakte, Rahmen | ✓ |
| 7 | Seraphim Solar System Co.Ltd. | | 14.62-15.64 | 1482 | 994 | 40 | 2x1.5 | schwarz, linienhafte Kontakte, Rahmen | ✓ |
| 8 | ZEN Renewables | | 14.72 | 1507 | 992 | 33 | 2x1.5 | Schwarz, linienhafte Kontakte, Rahmen | ✓ |

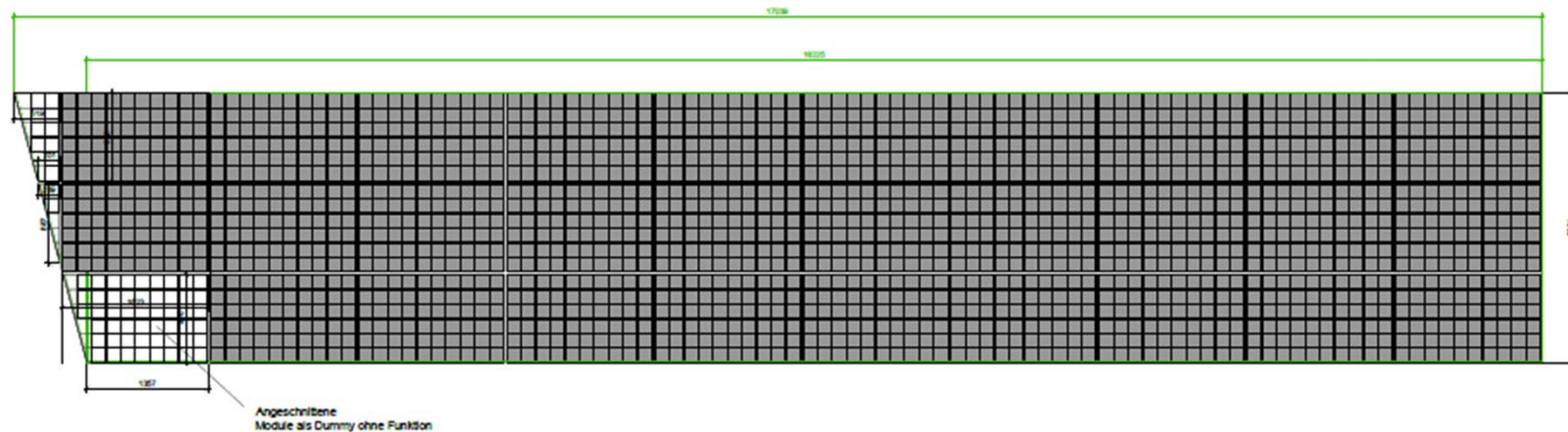
Fassade 3 fach Teilung

| No | Modul-Hersteller | Modul-Typ | Modulwirkungsgrad [%] | Rasthmaß | | | | Ästhetik | |
|----|-------------------------|------------------|-----------------------|----------|------|------|--|-----------------|---|
| | | | | a | b | c | | | |
| 1 | Shurjo Energy Pvt. Ltd. | CIGS | 10,18 | 982 | 1300 | 40 | | Schwarz, Rahmen | ✓ |
| 2 | GE Energy | GE-CIGS150 | 12,23 | 977 | 1255 | 35,0 | | Schwarz, Rahmen | ✓ |
| 3 | Solar Frontier | SF155-L | 12,62 | 977 | 1257 | | | Schwarz, Rahmen | ✓ |
| 4 | Würth Solar GmbH Co. KG | WSF0002E140-140W | 11,4 | 977 | 1257 | | | Schwarz, Rahmen | ✓ |

Mögliche Photovoltaikmodule bei solaraktiver Fläche 2,8 m

Dach Mittelteilung

| No | Modul-Hersteller | Modul-Typ | Modulwirkungsgrad [%] | Rasthmaß | | | | Ästhetik | |
|----|------------------|-----------------|-----------------------|----------|------|----|--|---------------------------------------|---|
| | | | | a | b | c | | | |
| 1 | Asola GmbH | 200W/48m Solrif | 14.21 | 1386 | 1015 | | | Schwarz, linienhafte Kontakte, Rahmen | ✓ |
| 2 | Sillia Energie | 48 M 200 Solrif | 14.20 | 1337 | 1001 | 17 | | Schwarz, linienhafte Kontakte, Rahmen | x |
| 3 | Solar-Fabrik AG | | 14.02, | 1377 | 991 | | | Schwarz, linienhafte Kontakte, Rahmen | ✓ |
| 4 | Solvis d.o.o. | SV48-200BES | 14.10, | 1388 | 1022 | 30 | | Schwarz, linienhafte Kontakte, Rahmen | ✓ |

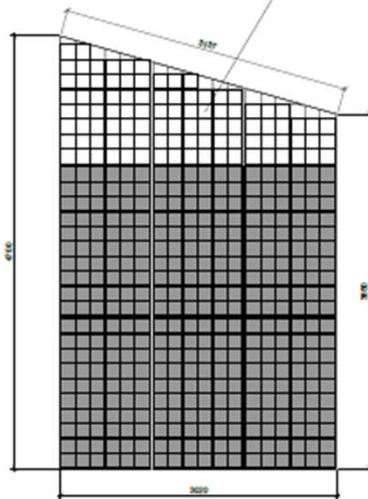


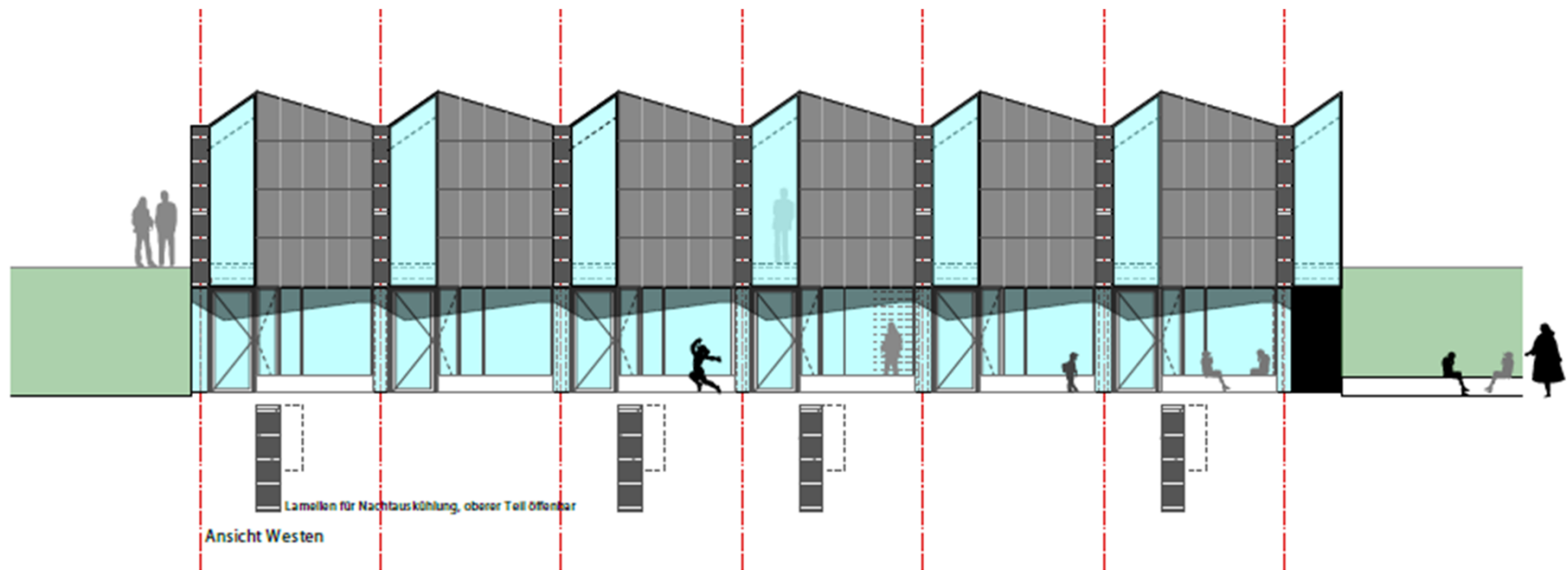
Fassadenelement belegt mit je
6 LG SIC monokristallinen Modulen
Modulleistung 250 Wp/Modul
1.5 kWp/Fläche

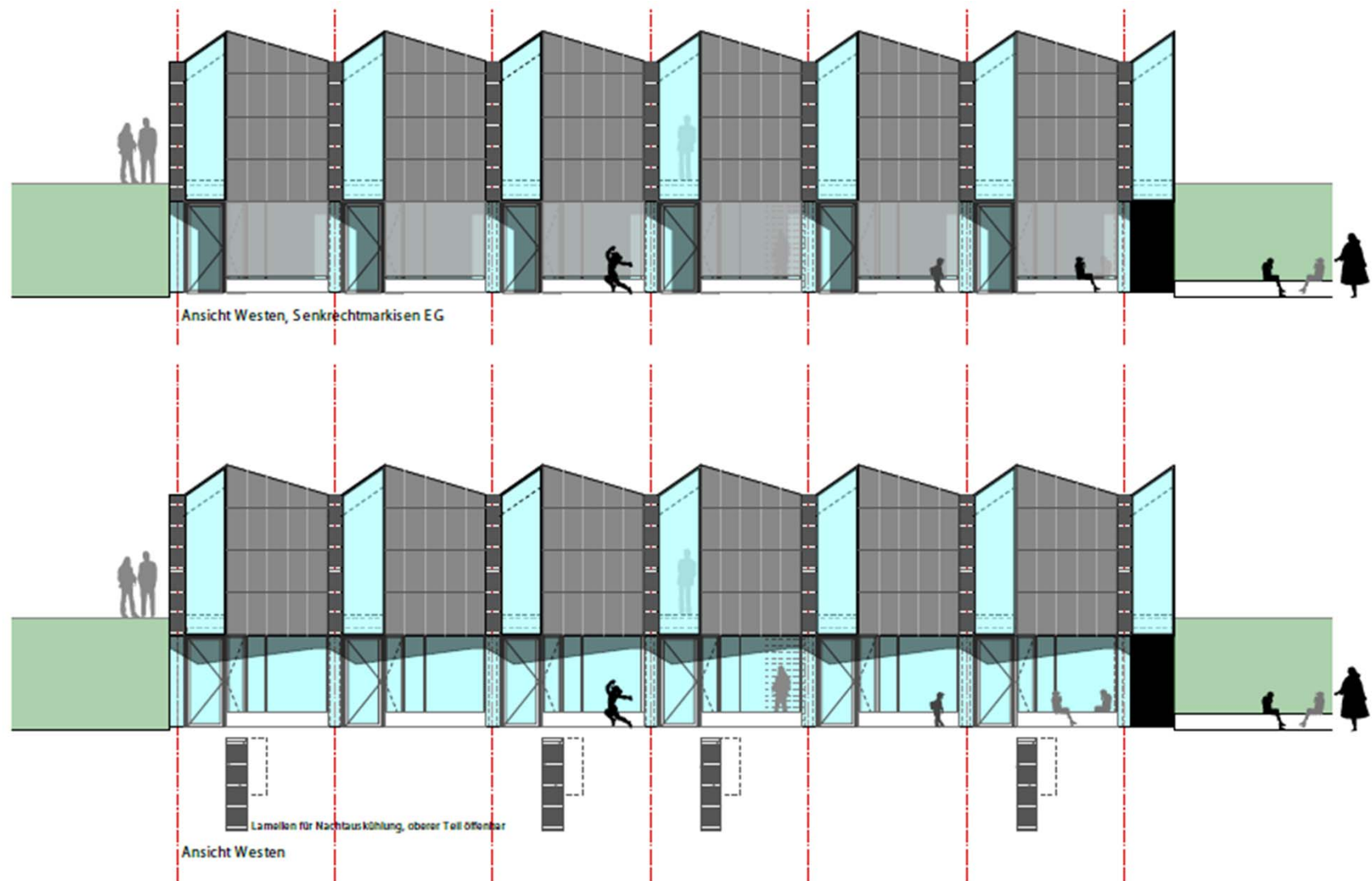
Dachanlage belegt mit je
29 LG SIC monokristallinen Modulen
Modulleistung 250 Wp/Modul
7.25 kWp/Fläche

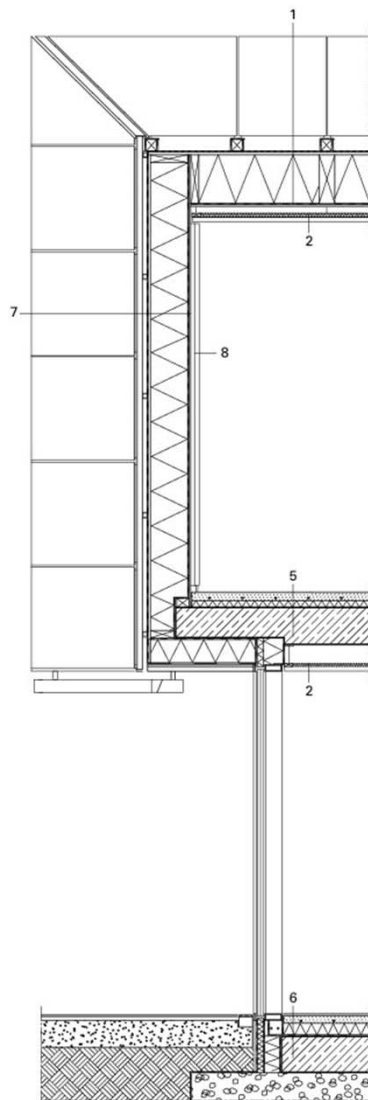
Anlagengesamtleistung
Dachanlage 43,5 kWp
Fassadenanlage 9 kWp

Ertrag Dachanlage ca. 925 kWh/kWp = 40237 kWh/a
Ertrag Fassadenanlage ca. 439 kWh/kWp = 3951 kWh/a









Vertikalschnitt Westfassade, M 1 : 50

Construction:

Roof:

BIPV

Facade PV:

BIPV

Facade:

triple glazing
aluminum

U-Values:

Facade UG

= 0,135 W/m²K

Facade OG

= 0,15 W/m²K

Roof

= 0,15 W/m²K

Window

= 0,82 W/m²K

Floor

= 0,116 W/m²K

U_g-Value glazing

= 0,6 W/m²K

Blower-Door: n₅₀

≤ 0,69 /h

Energy demand EnEV

Primary energy demand Q_p : 40,18 kWh/m²a

Energy demand

Primary energy demand Q_p : - 24,0 kWh/m²a

End energy demand Q_e : - 9,3 kWh/m²a

According to Effizienzhaus Plus (inkl. power for usage and energy surplus PV)

End energy demand Q_e : - 3,9 kWh/m²a

According to AktivPlus (inkl. power for usage and energy surplus PV)

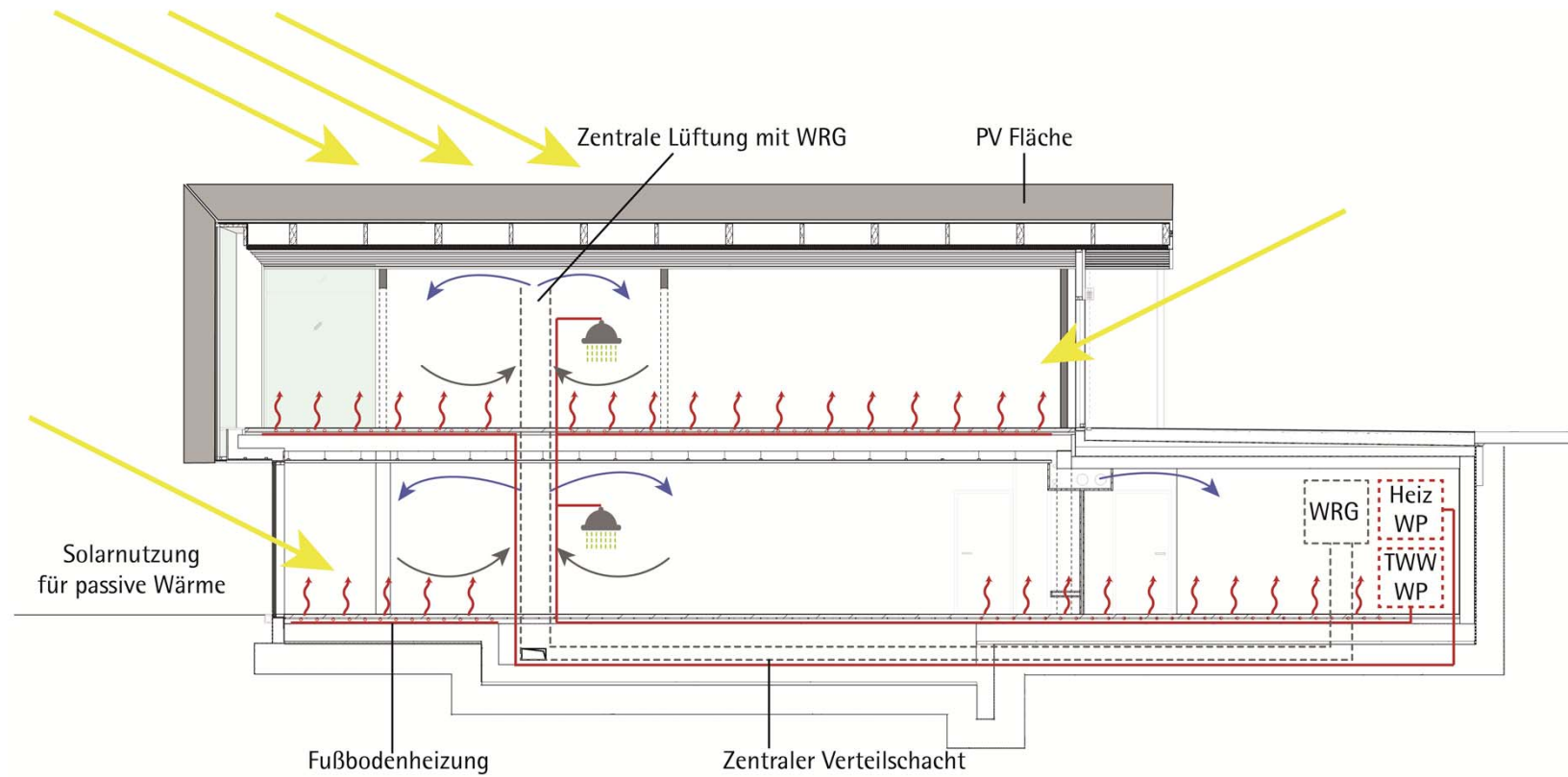


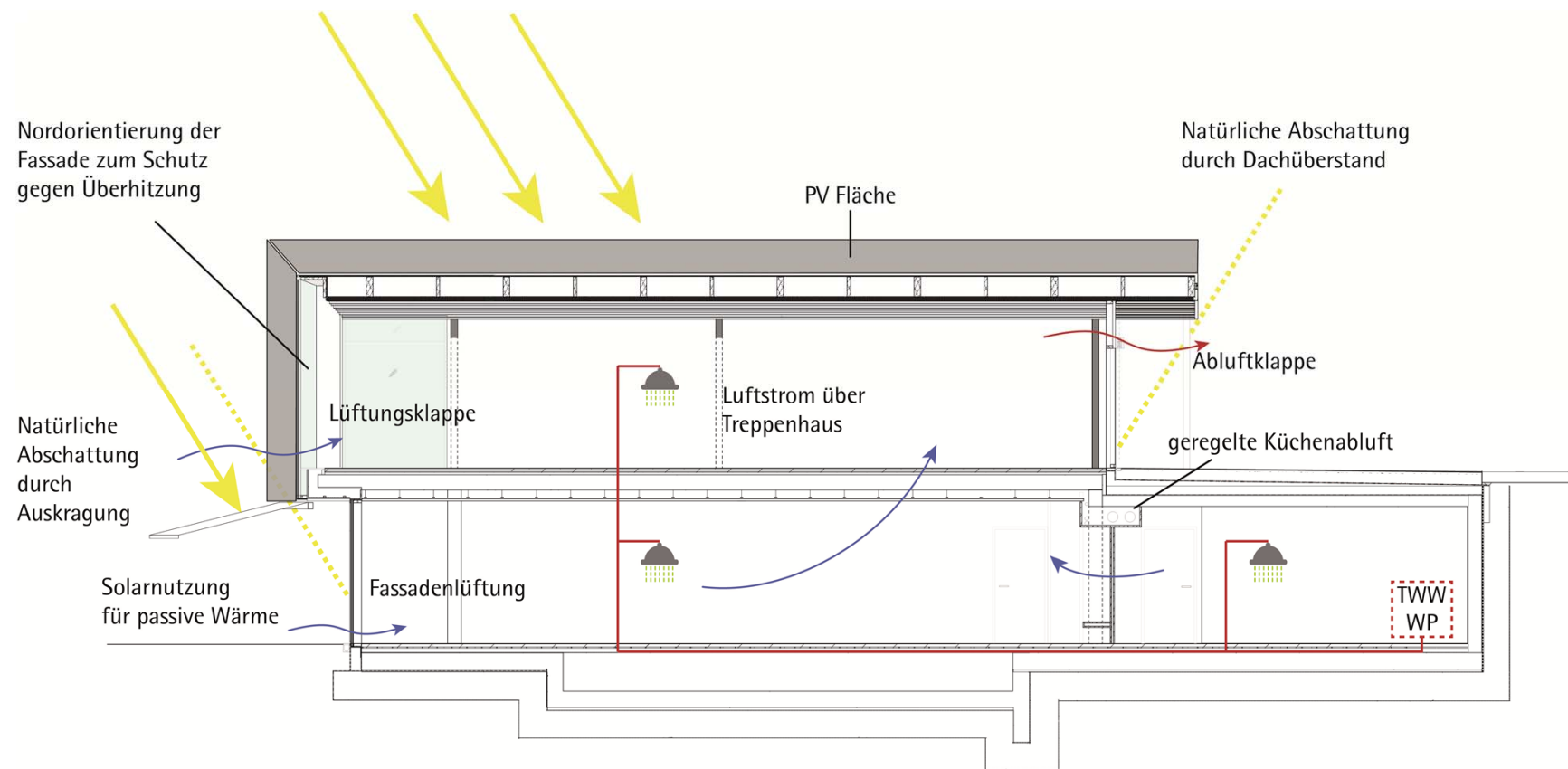
Building services

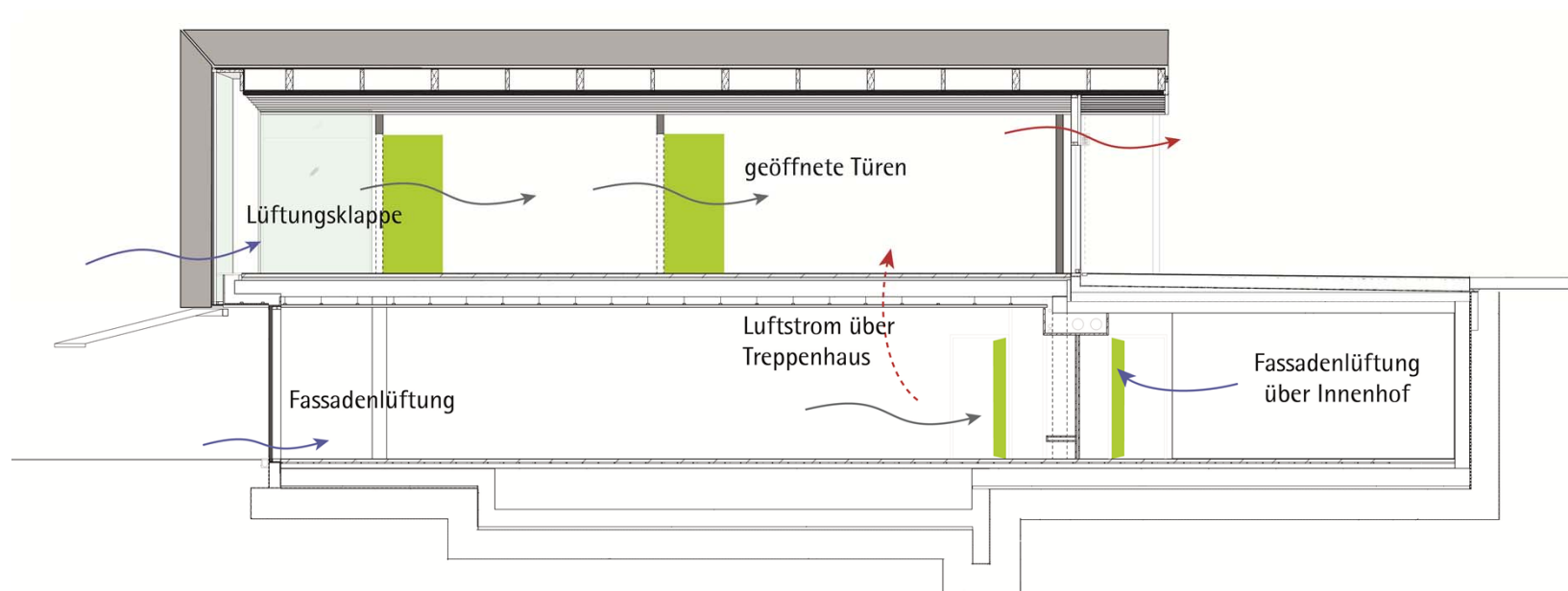
Mechanical ventilation with high efficient heat recovery (Kitchen without heat recovery), underfloor heating

Two air-water-heat pumps for drinking water and heating with indirect thermal storage

BIPV









BIPV

Intransparent Monocrystalline PV

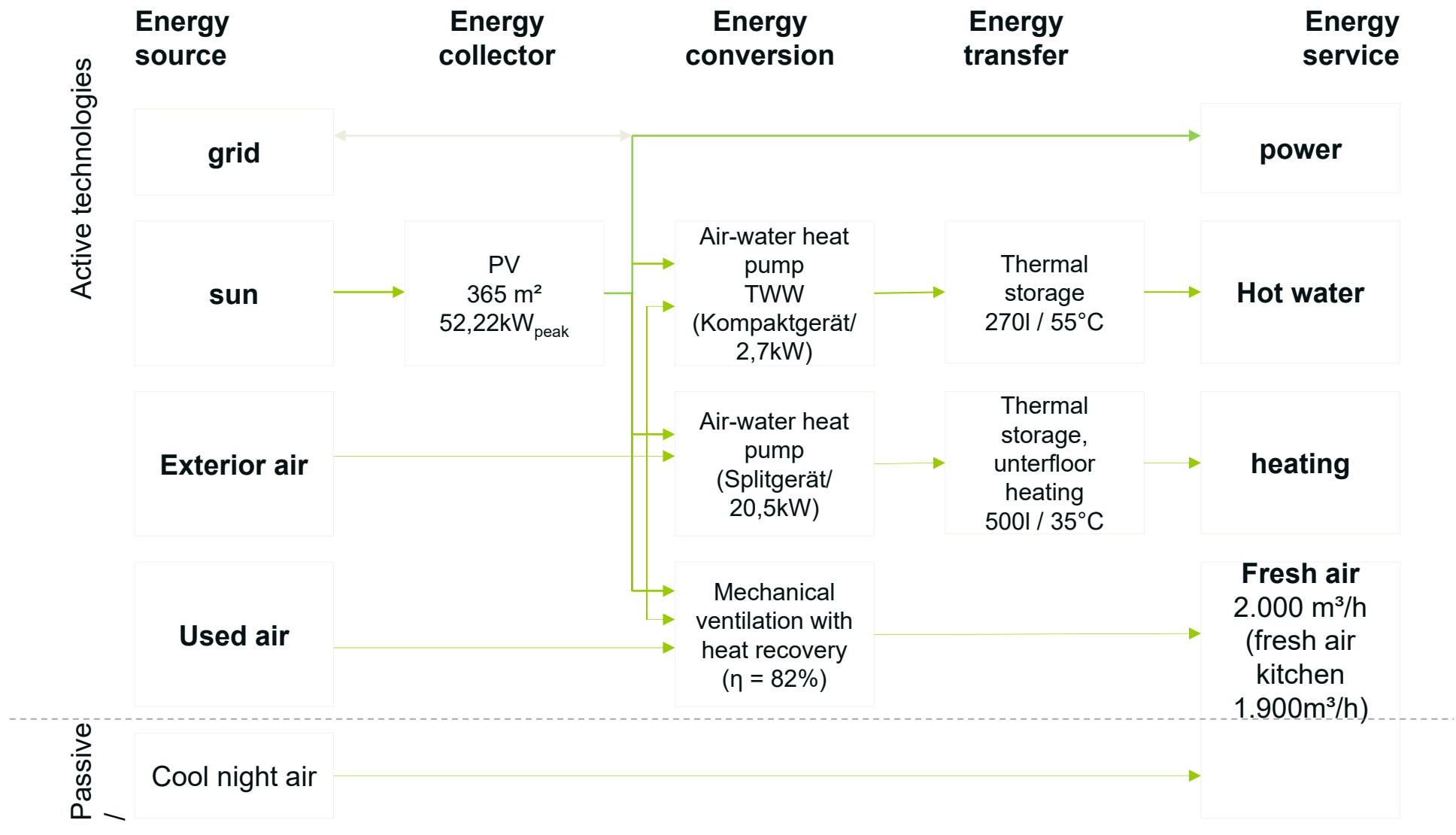
Installed power: 55 kWp

Orientation: south

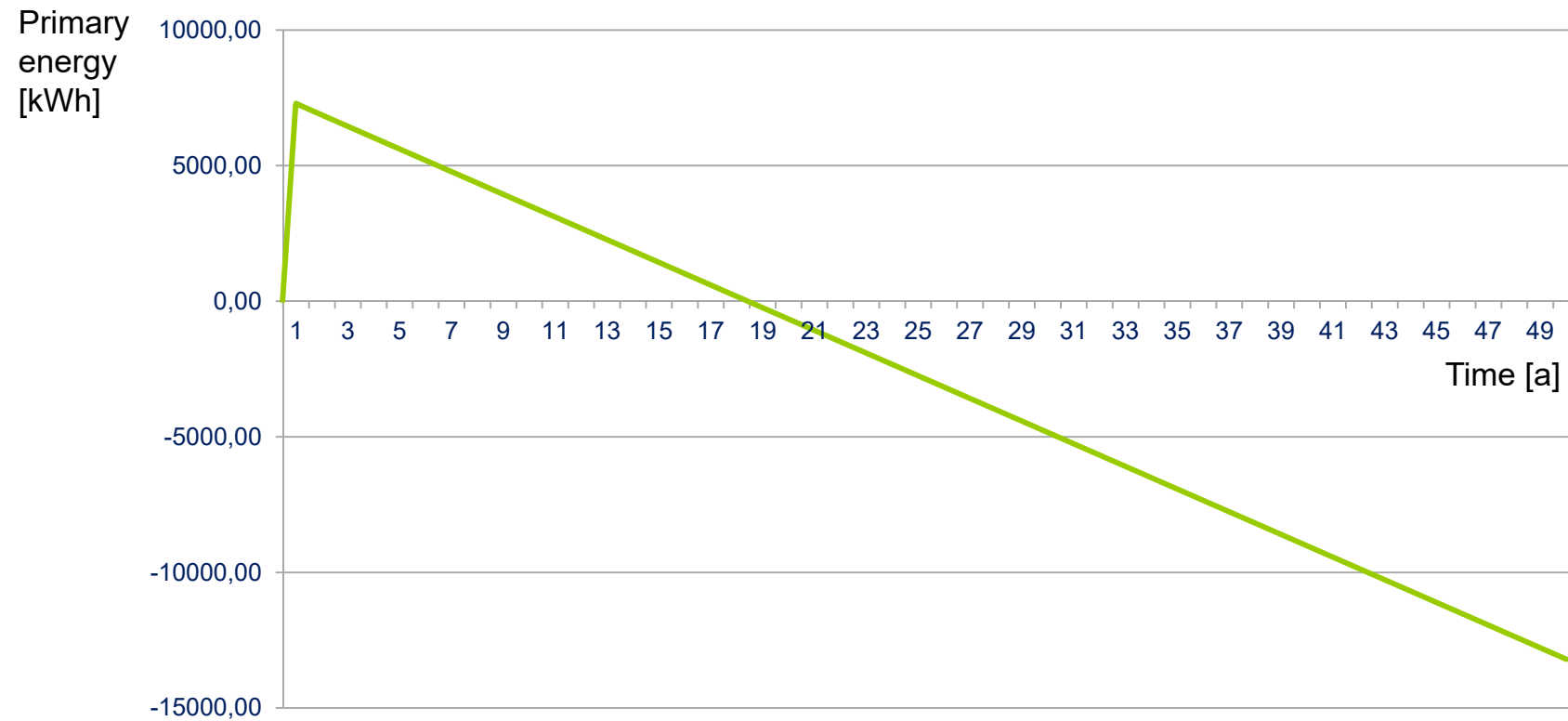
PV-Modul: 360 ErtexSolar

surface: 365 m²

Annual end energy gain PV:
40 690 kWh/a

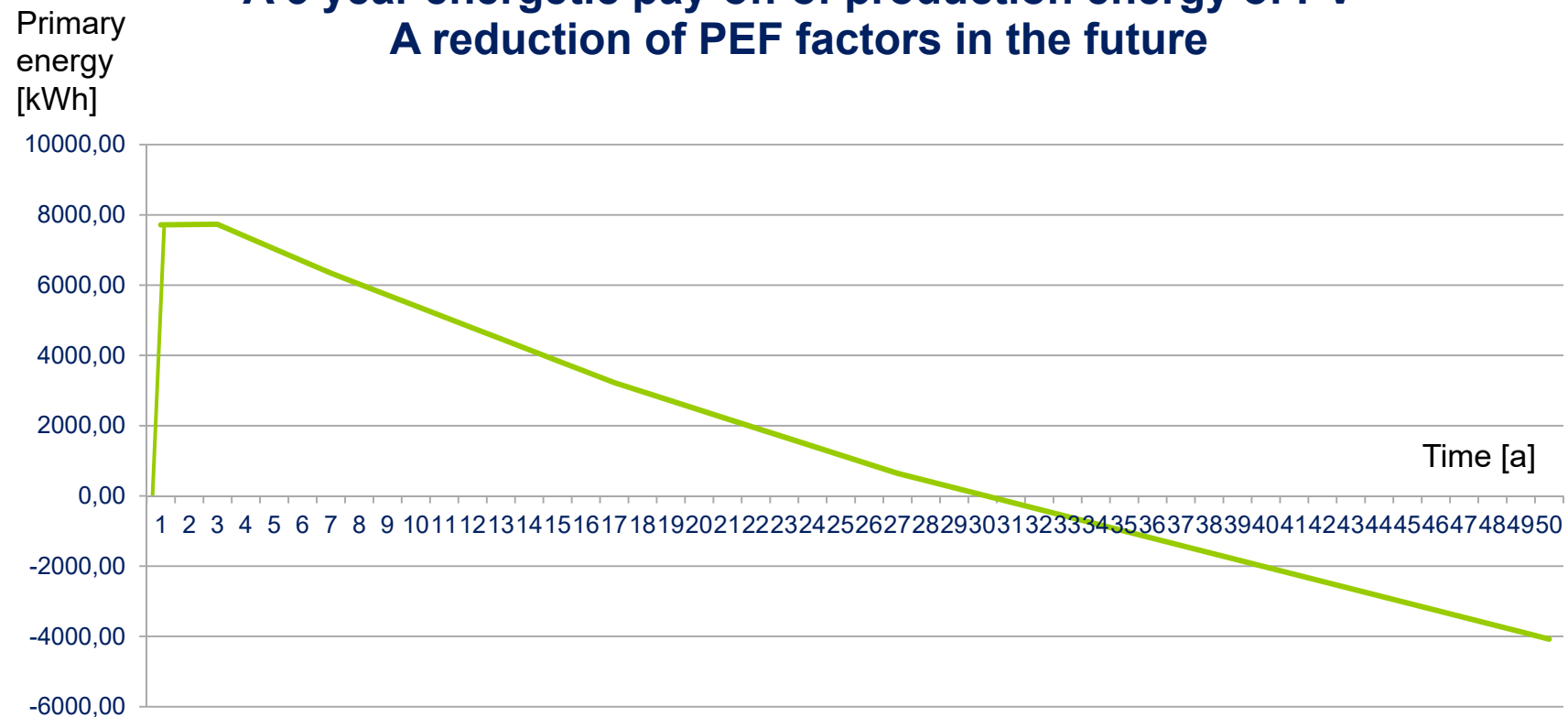


PEI gas including all produced power

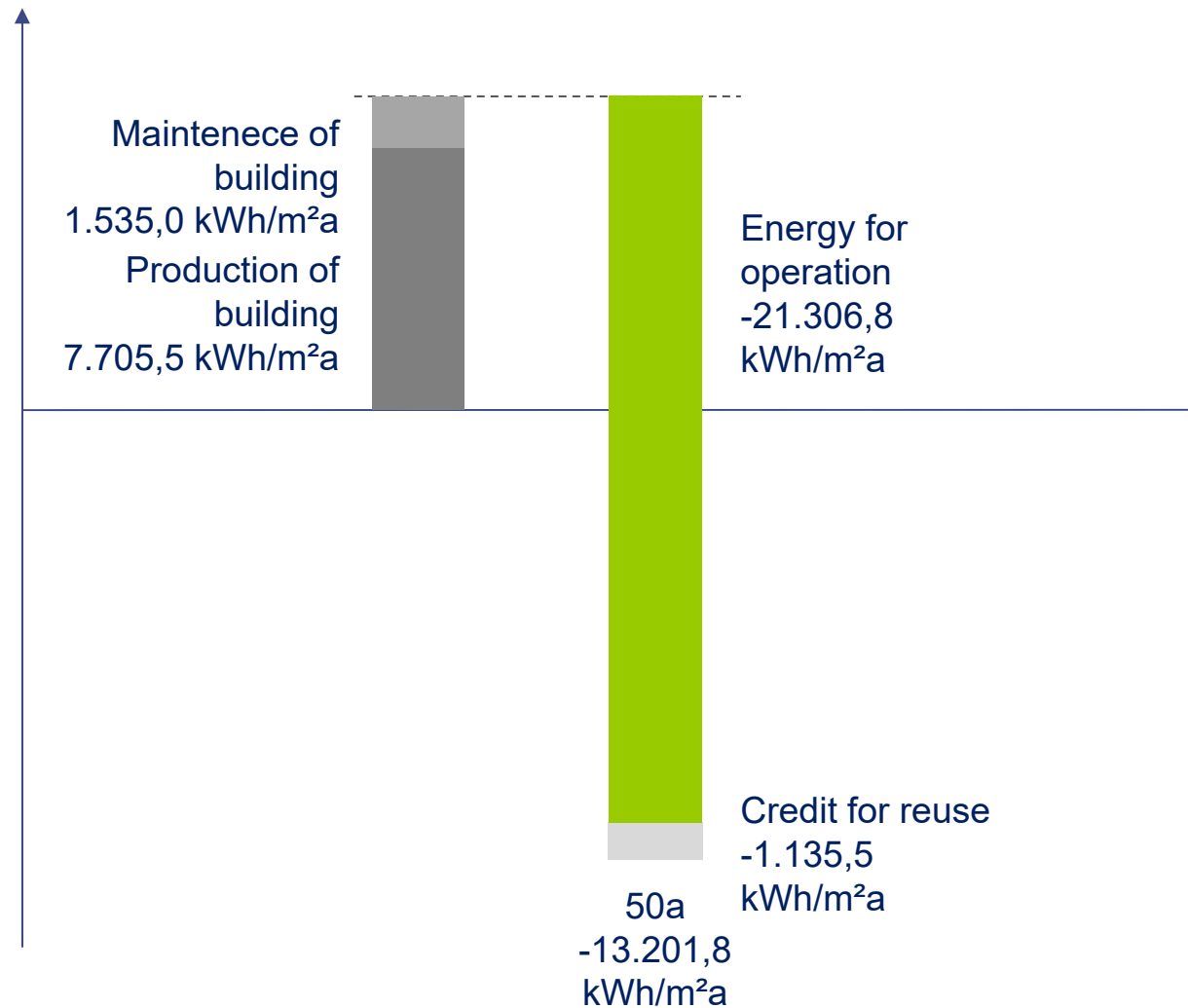


Calculated with PEF = 2,4

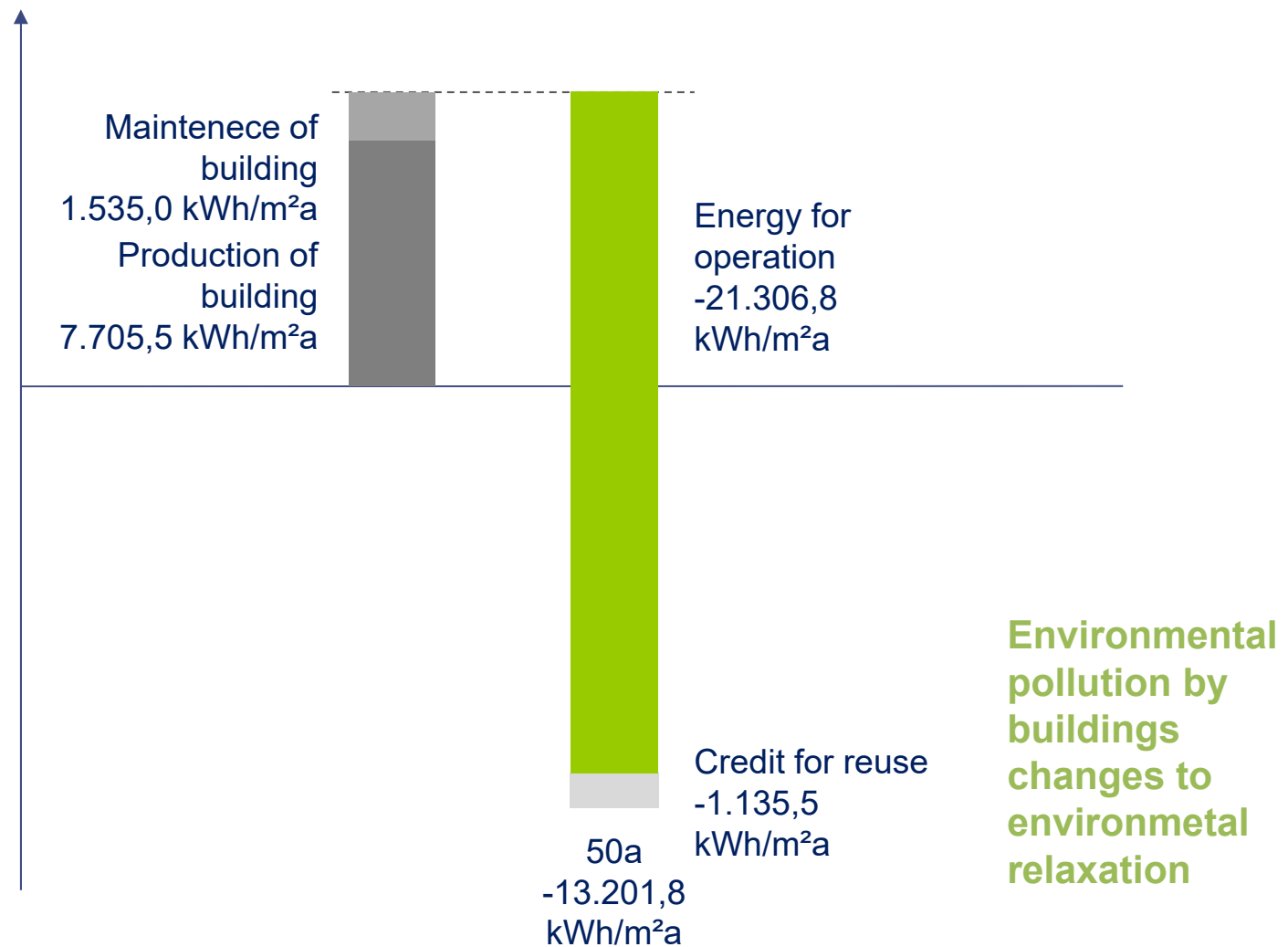
PEI gas including all produced power
A 3 year energetic pay-off of production energy of PV
A reduction of PEF factors in the future



PEI ges over 50 years



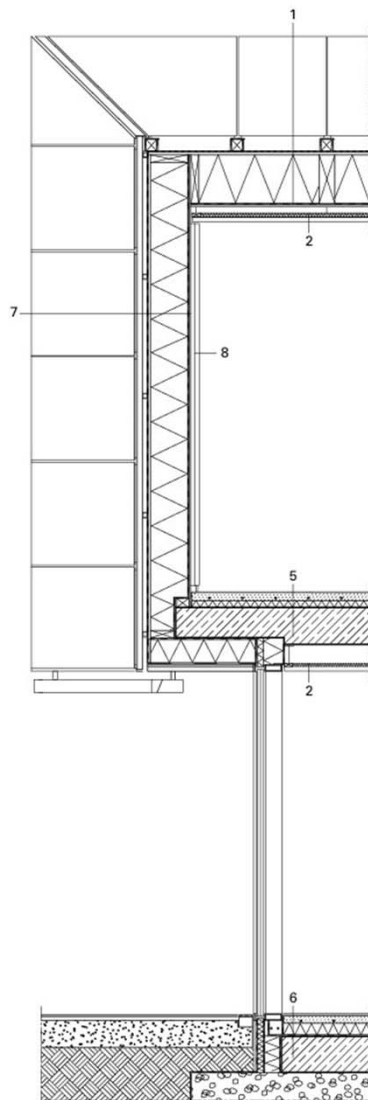
PEI ges over 50 years



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 - Facade shading
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Actual statements for BIPV development:
The more Integration exists, the better is the product.

- **Constructional integration in building elements**

- Cladding against driving rain
- UV-protection of building materials
- Water tight cladding
- Facade shading

Increased durability of building components

Leads to reduction of „anyway-costs“

- **Integration in building energy concepts**

- Use for power (e.g. heat pump technology)
- Use of thermal heat

- **Design integration**

- Addition
- Integration
- Adaption

- **Constructional integration in building elements**

- Cladding against driving rain
- UV-protection of building materials
- Water tight cladding
- Facade shading

Increased durability of building components

Leads to reduction of „anyway-costs“

- **Integration in building energy concepts**

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- Use of thermal heat

- **Design integration**

- Addition
- Integration
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Addition allows a wide integration of PV in building design, if it allows flexible maintenance and disassembly

24.10.2017

ee concept GmbH

Dr.-Ing. Architekt Martin Zeumer

zeumer@ee-concept.de

Solar Active Architecture Advanced BIPV Design

Quelle: ee concept GmbH

