

# climate responsive design

building shell, volume, climate: form follows performance

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msa 2019

## 1. Prologue Performance:

- 1.1 building shell: Buckminster Fuller
- 1.2 volume: Albert Kahn
- 1.3 climate: Antonin Raymond

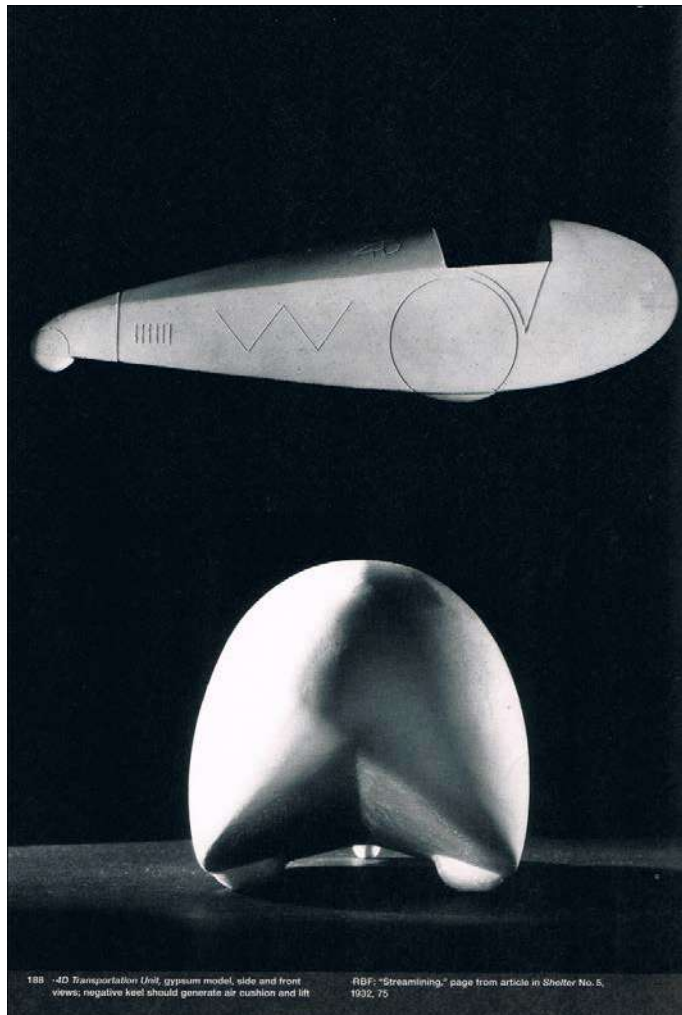
## 2. Efficiency aspects

## 3. Examples RMA/ msa

- 3.1 Haus R, Essen
- 3.2 ZOB, Schwäbisch Hall
- 3.3 Qiagen, Hilden
- 3.4 Ferienpark, Amecke
- 3.5 Dorma, Chennai, Indien
- 3.6 Bäckerei Peter 1 + 2, Essen
- 3.7 Plusenergiehäuser Kassel (msa)

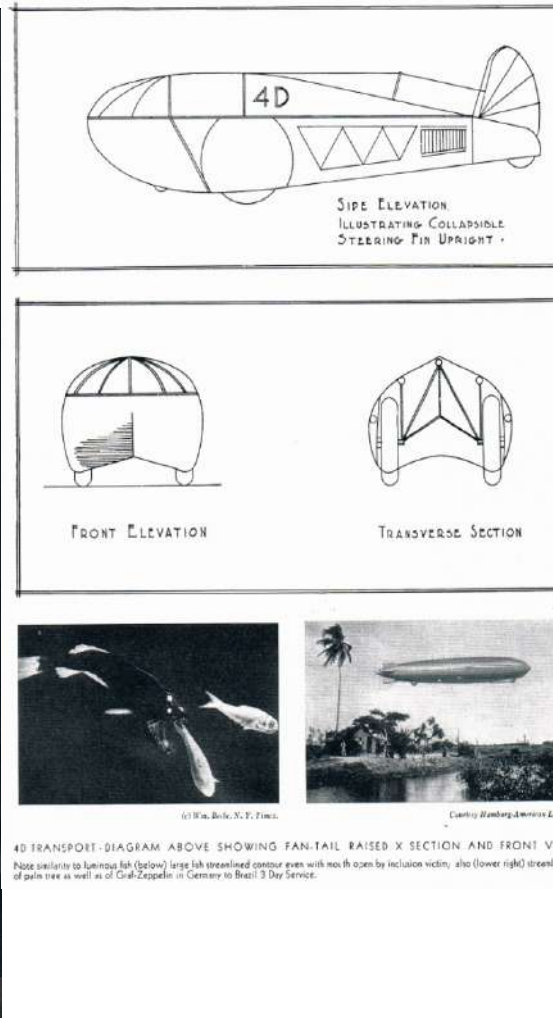
## 4. Ressume

## 5. Sources

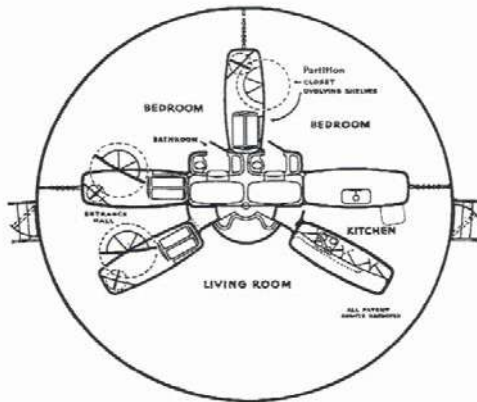
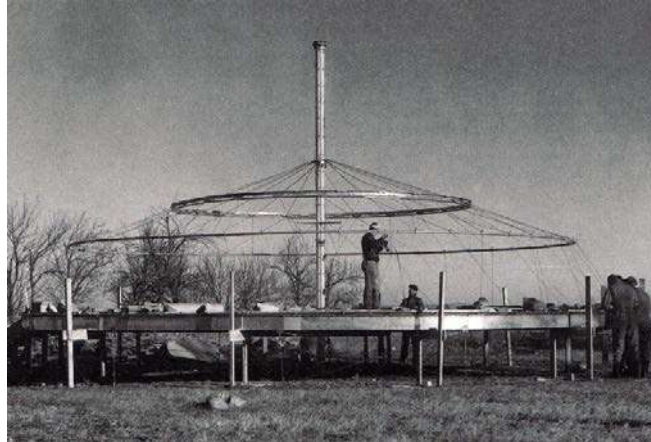
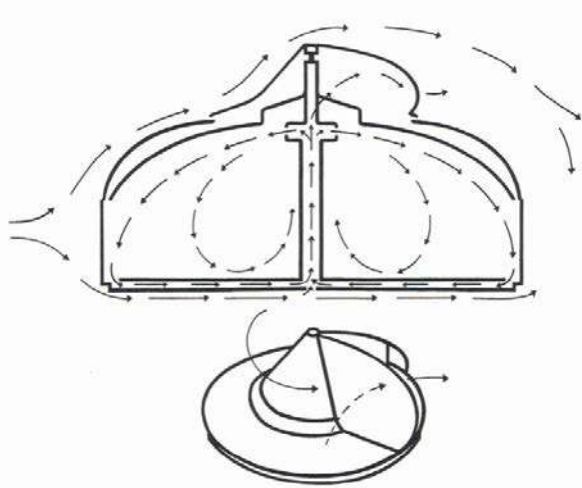


188 -4D Transportation Unit, gypsum model, side and front views; negative keel should generate air cushion and lift

BBF: "Streamlining," page from article in Shelter No. 5, 1932, 75



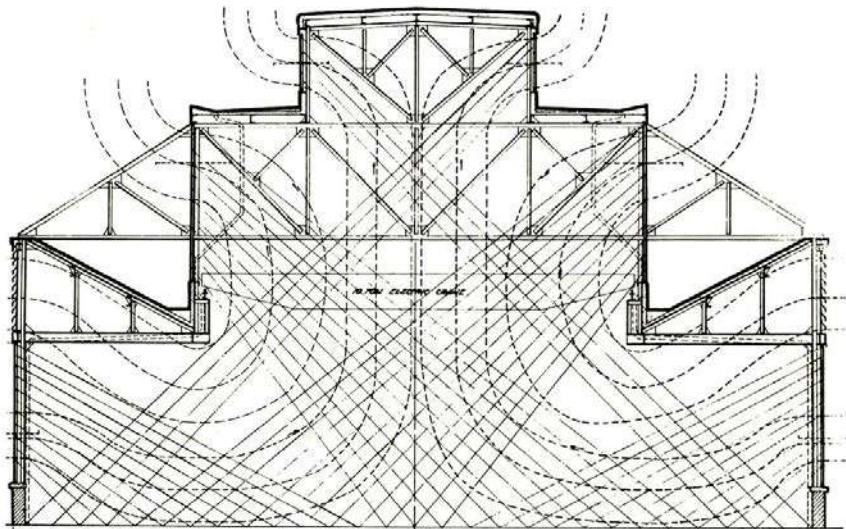
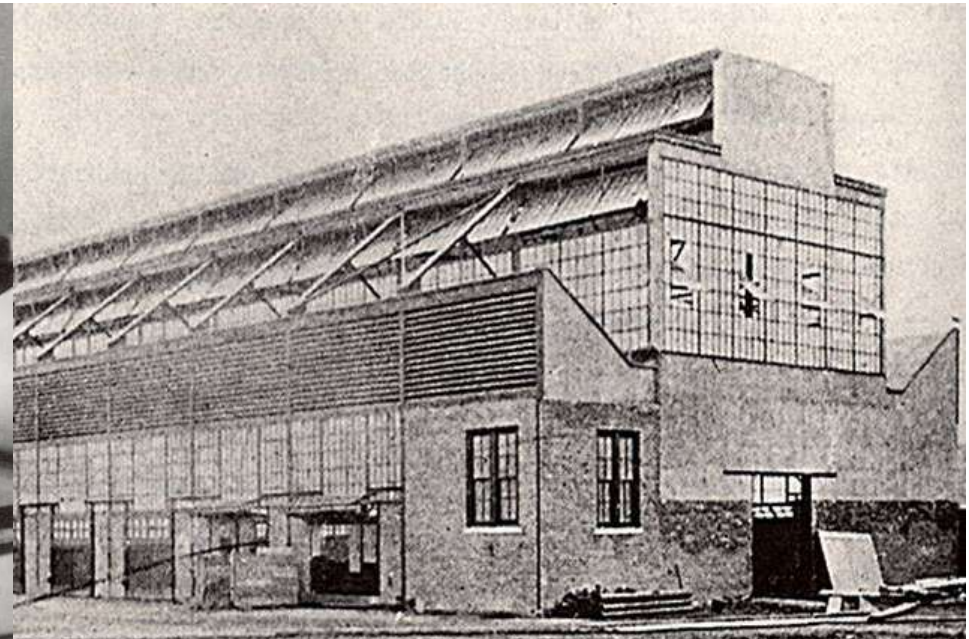
1.1 Hülle: Buckminster Fuller, Dymaxion House, 1946

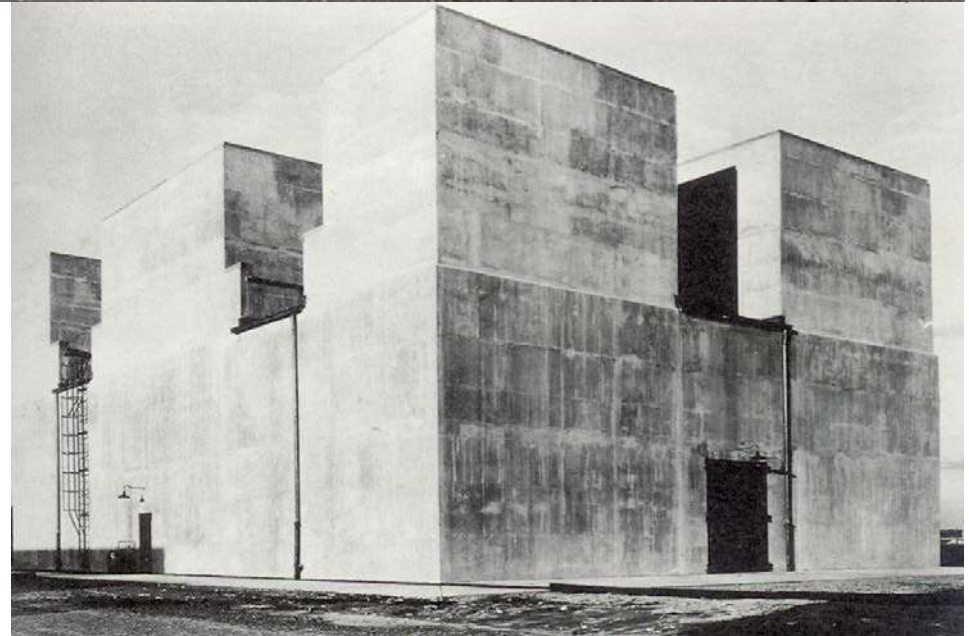
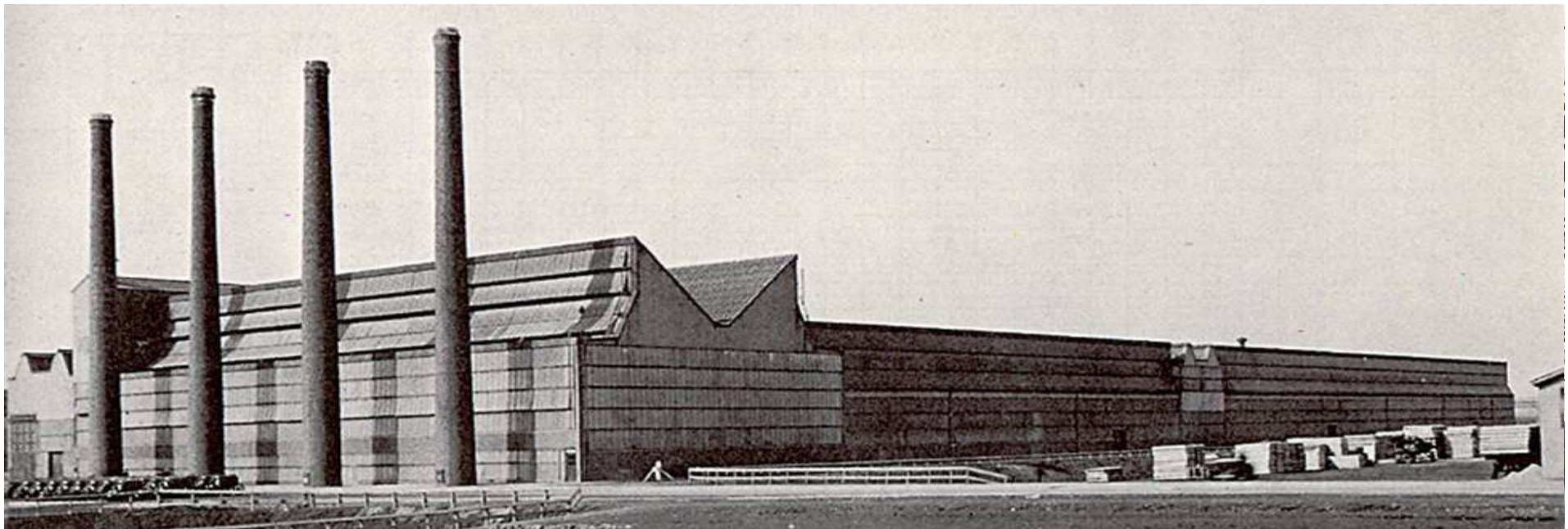


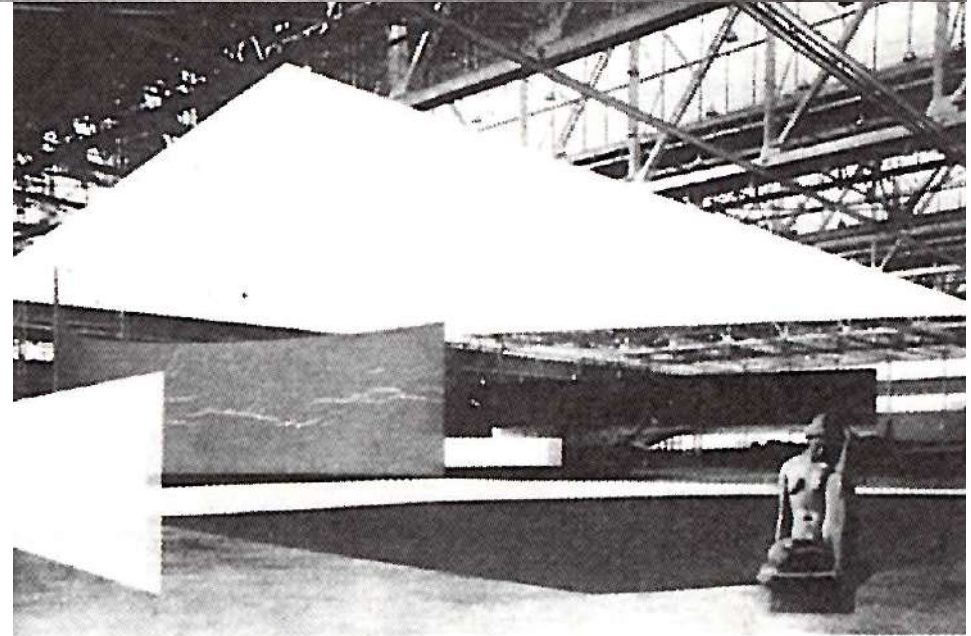
1.1 Hülle: Buckminster Fuller, Dymaxion Shelter, 1932, Fuller Sphere, 1949



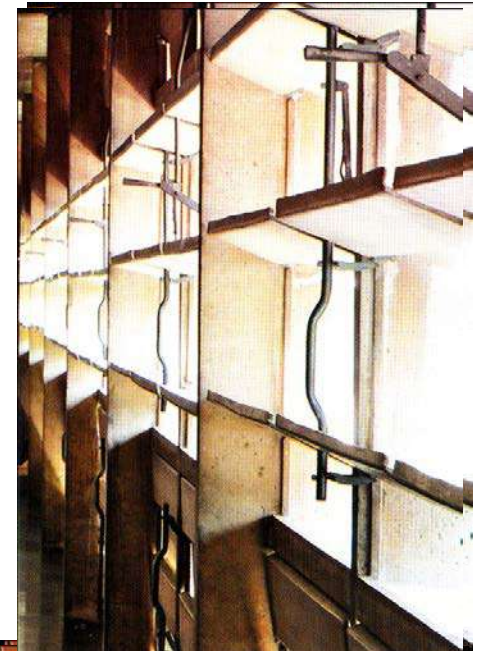
1.2 Körper: Albert Kahn, Packard Forge Shop, Detroit, 1911





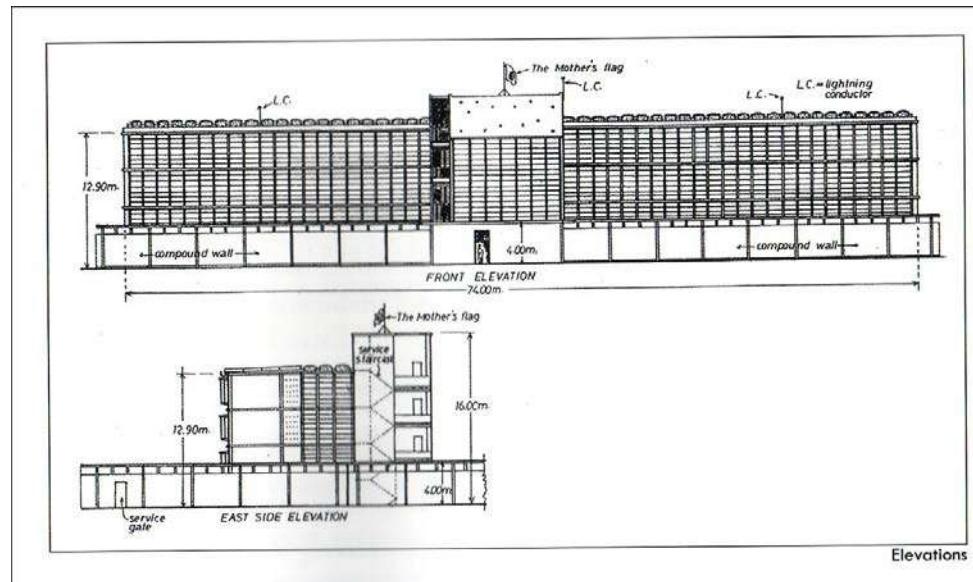


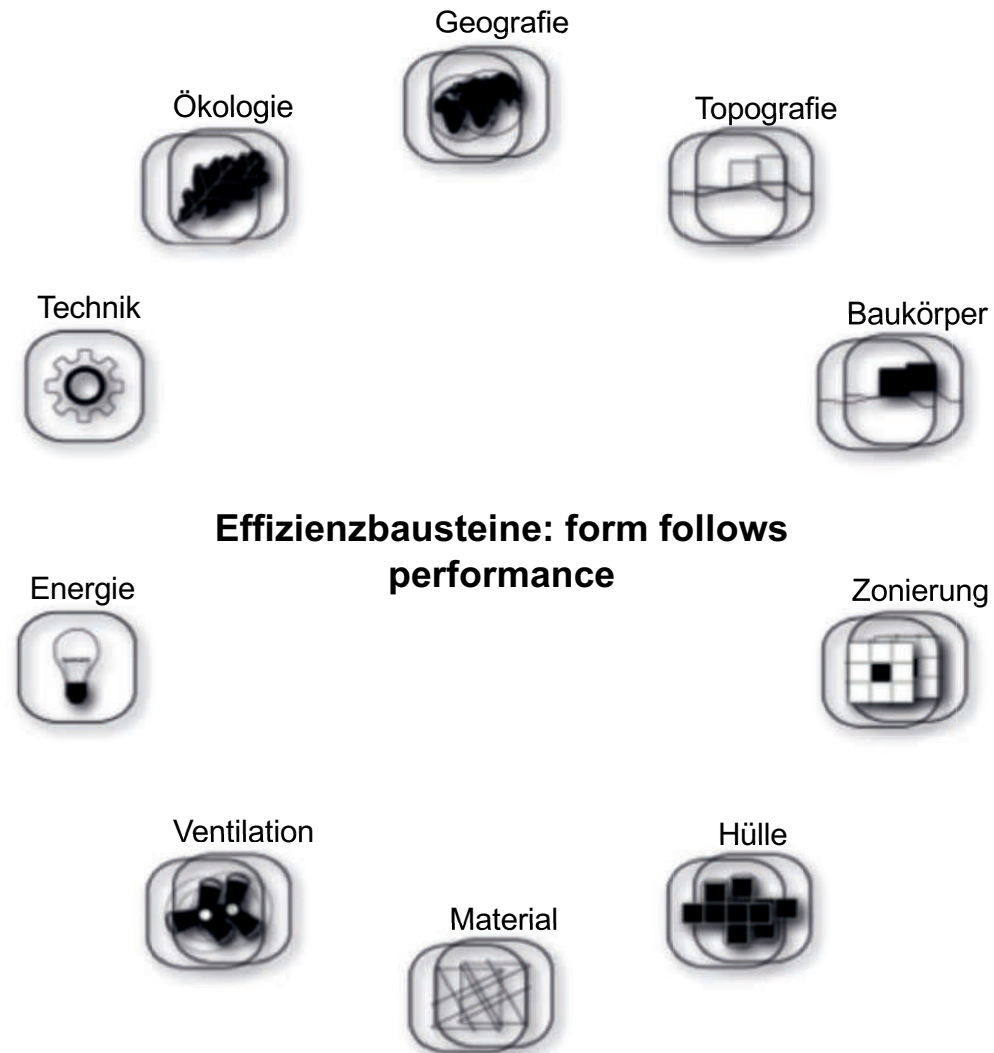
1.3 Klima: Anthonin Raymond, Golconde House, Pondicherry, Indien, 1935 - 1948





### 1.3 Klima: Anthonin Raymond, Golconde House, Pondicherry, Indien, 1935 - 1948

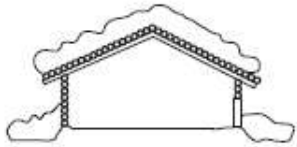




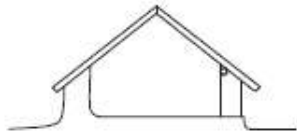


Klimazonen der Erde

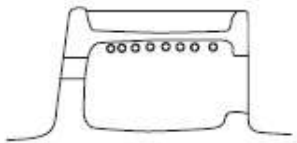
Polar Zone  
(kalt) 2



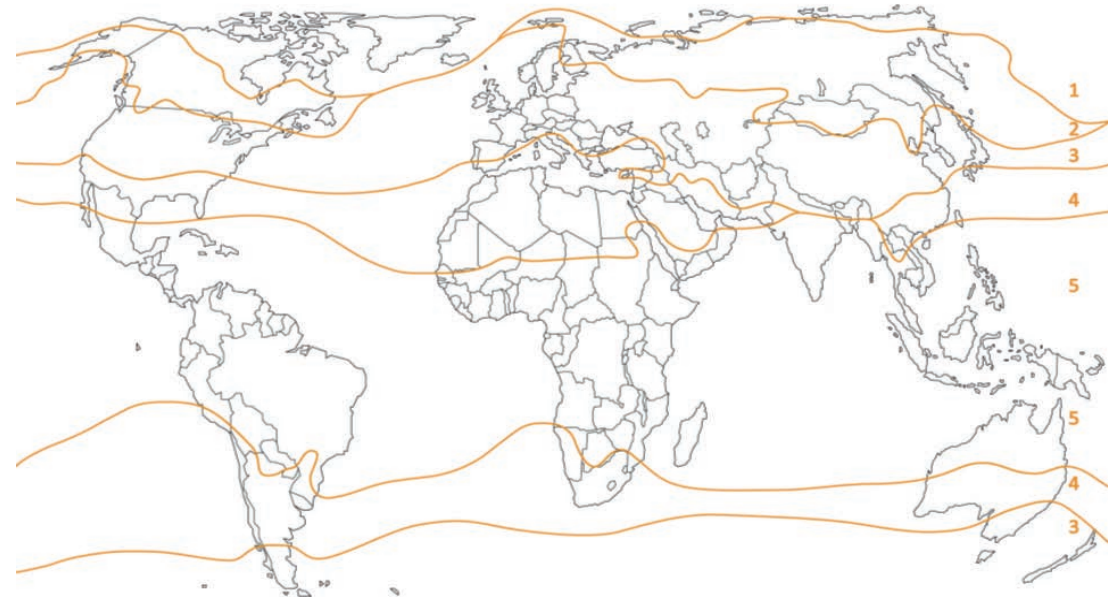
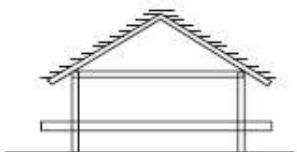
Gemässigte Zone  
(gemässigt) 3



Trocken  
(trockenheiss) 4



Subtropen  
(feuchtwarm) 5





Klimazonen der Erde

2



Polar Zone  
(kalt)

4



Trocken  
(trockenheiss)

3



Gemäßigte Zone  
(gemässigt)

5

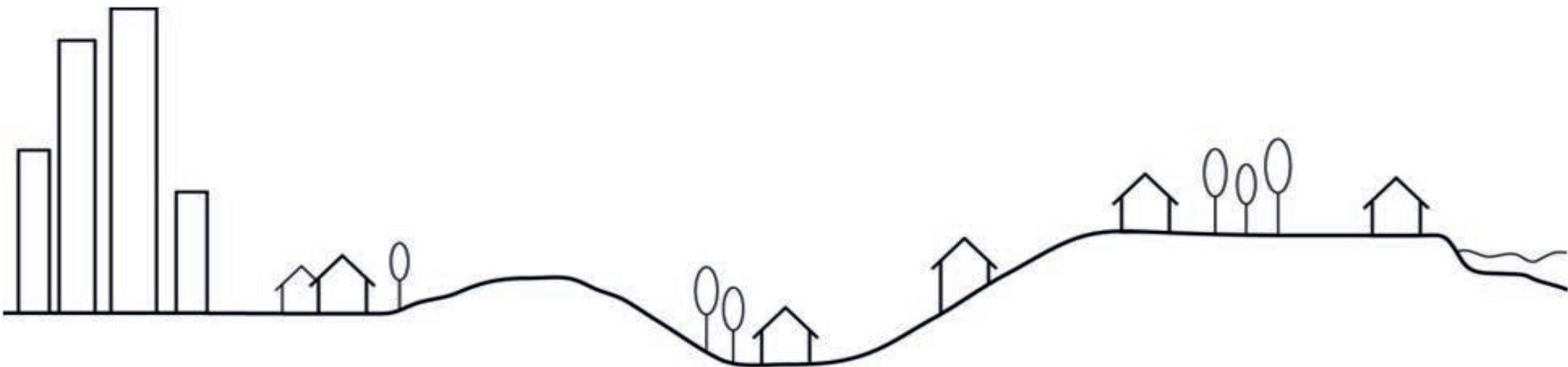


Subtropen  
(feuchtwarm)



**Wichtige Standortfaktoren:**

- + geografische Lage
- + Sonneneinstrahlung
- + Lufttemperatur und -schwankungen
- + Luftdruck
- + Luftfeuchtigkeit
- + Windstärke und -richtung
- + Niederschlagsmenge
- + Verdunstung



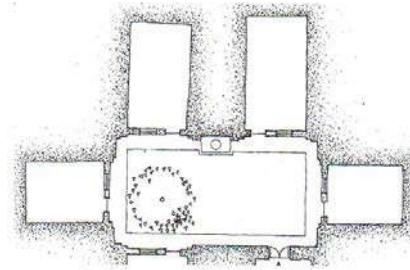
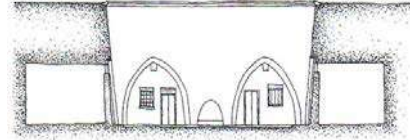


Topografie



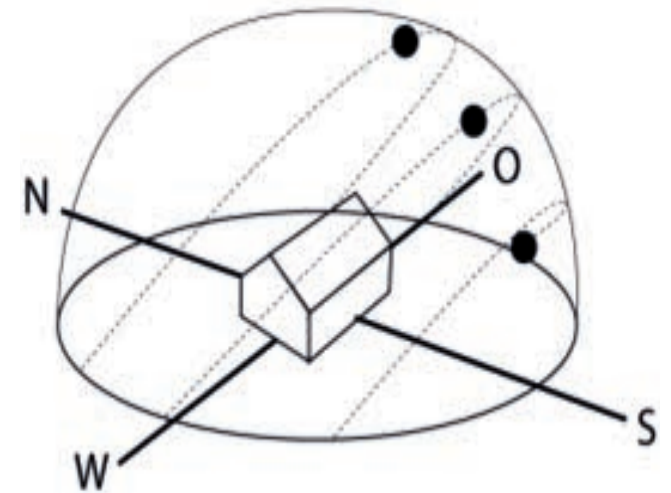
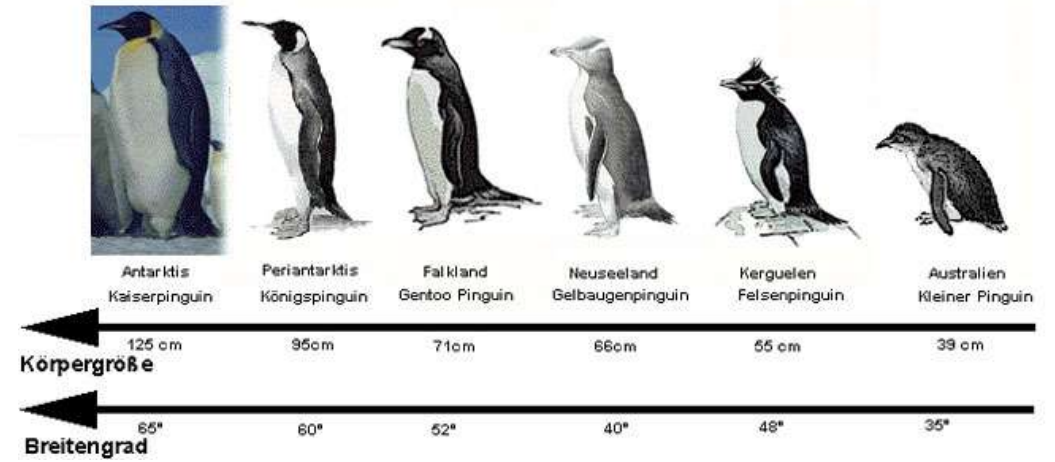
Geografie

**RMA** | Reichardt - Maas - Assoziierte  
Architekten GmbH & Co. KG



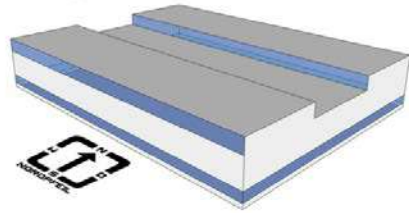


### Größenvergleich und Verbreitung bei Pinguinen

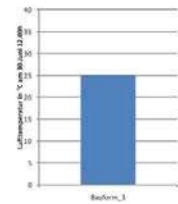




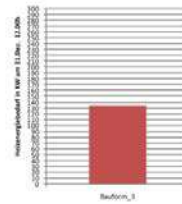
Bauform\_03



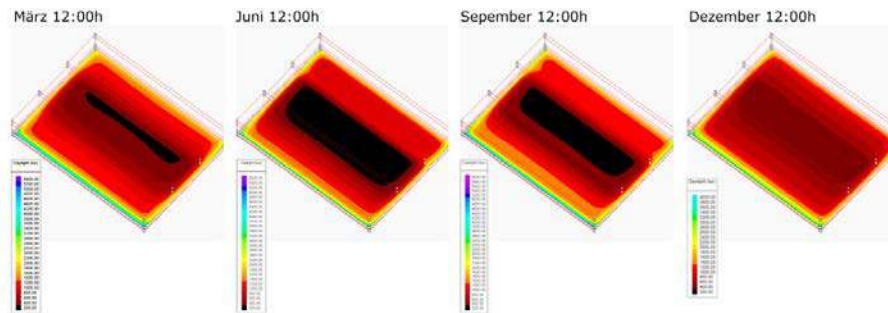
30.Juni Innentemperatur  
12.00h - 25,05°C



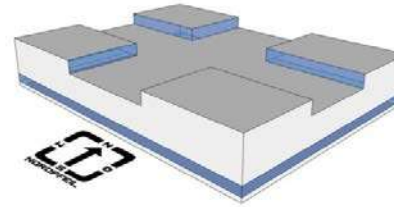
31.Dezember Heizbedarf  
12.00h - 134,21KW



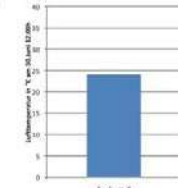
Tageslichtsimulation(lux):



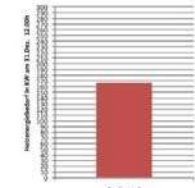
Bauform\_08



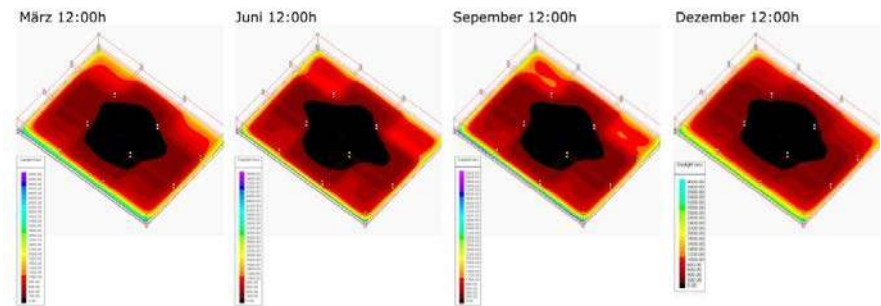
30.Juni Innentemperatur  
12.00h - 24,17°C



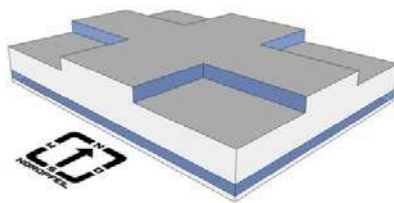
31.Dezember Heizbedarf  
12.00h - 167,41KW



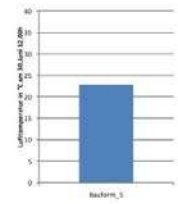
Tageslichtsimulation(lux):



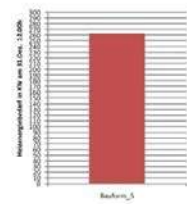
Bauform\_05



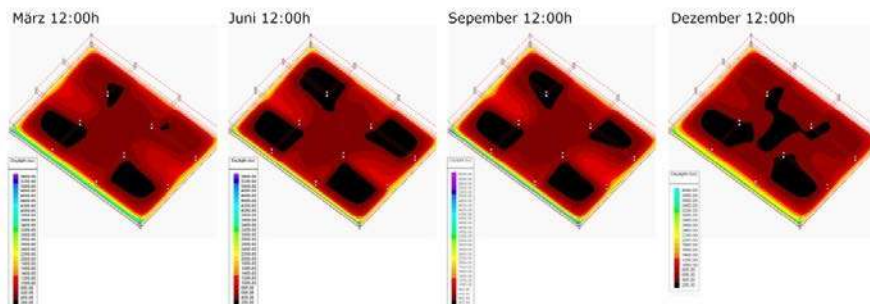
30.Juni Innentemperatur  
12.00h - 22,80°C



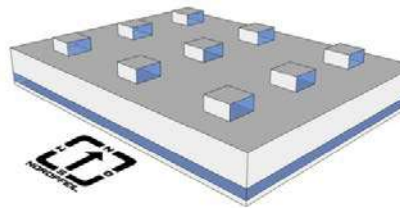
31.Dezember Heizbedarf  
12.00h - 262,61KW



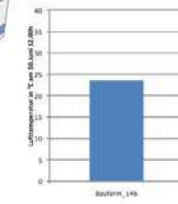
Tageslichtsimulation(lux):



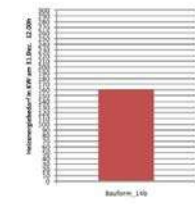
Bauform\_14b



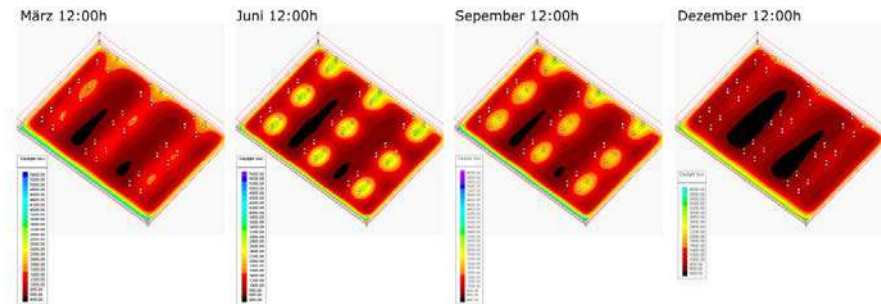
30.Juni Innentemperatur  
12.00h - 23,67°C



31.Dezember Heizbedarf  
12.00h - 160,03KW

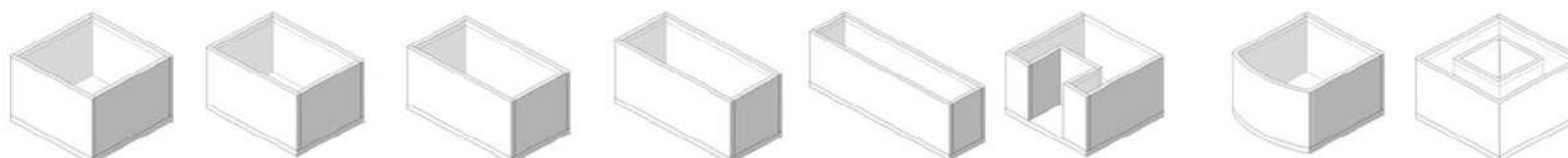


Tageslichtsimulation(lux):

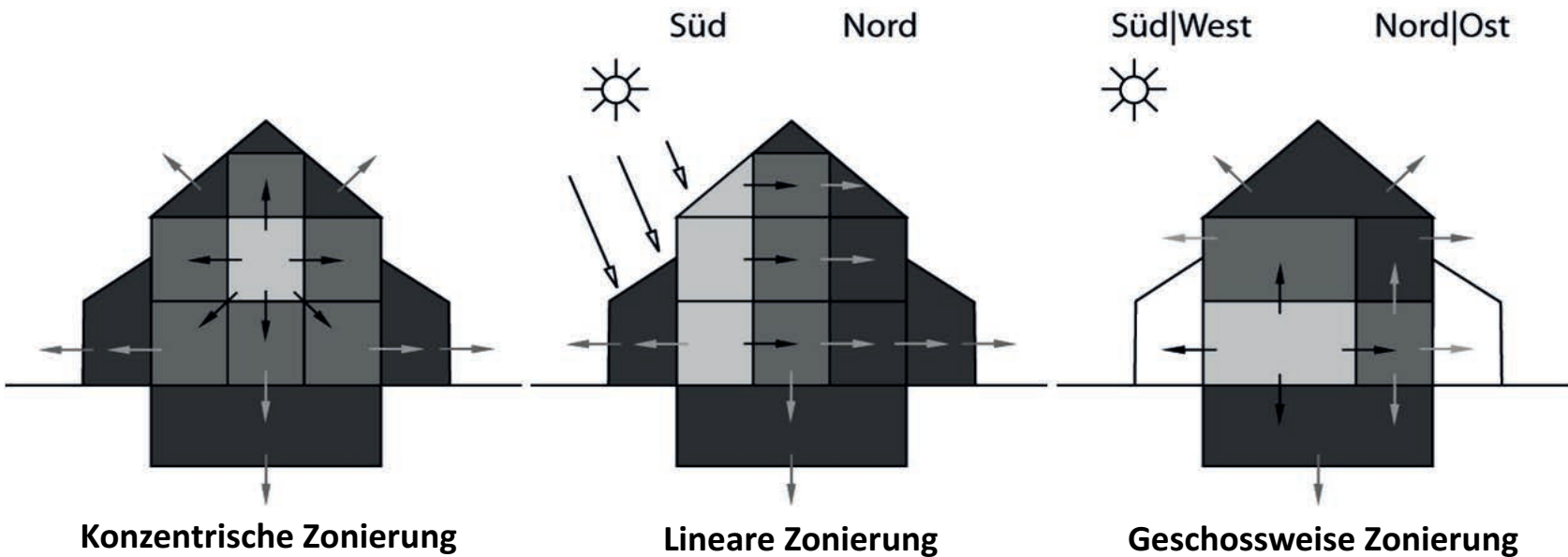
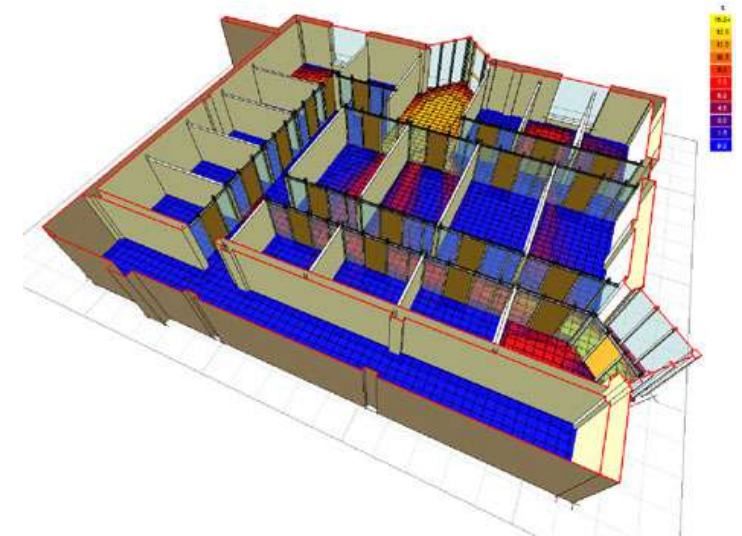
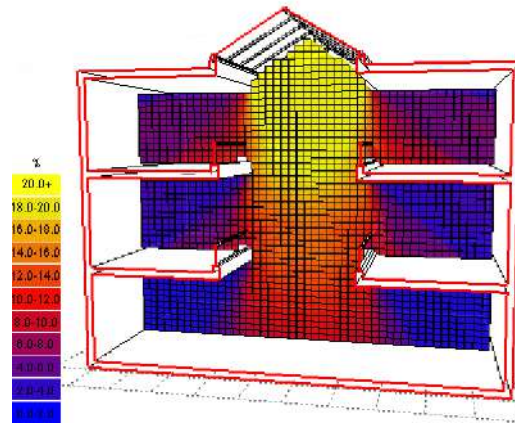
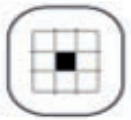




Solareintrag auf die Fassade bei verschiedenen Bauformen  
Testreferenzjahr 05-Essen

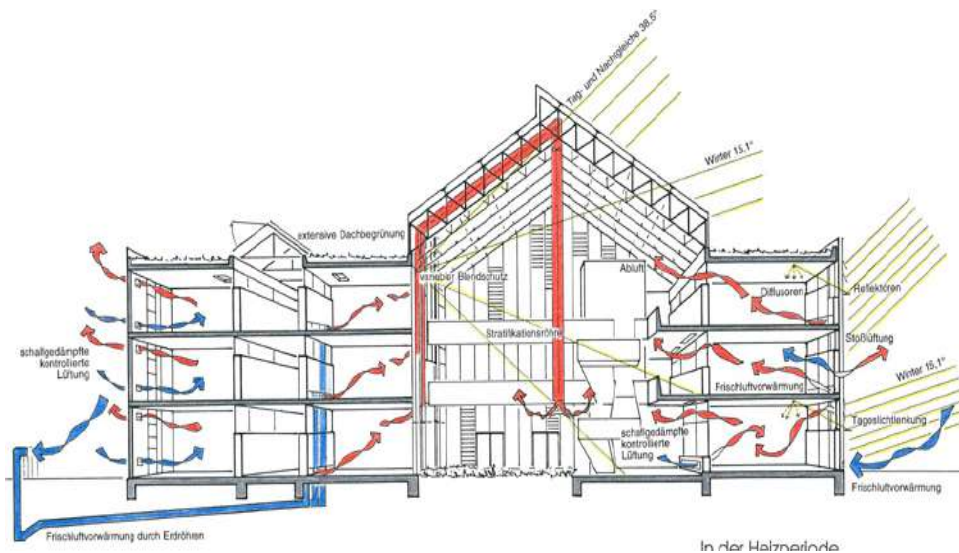


Bauform	-	A	B	C	D	E	F	G	H
Nettofläche	[m <sup>2</sup> ]	77,44	77,44	77,44	77,44	77,44	77,44	77,44	77,44
Bruttofläche	[m <sup>2</sup> ]	92,16	92,37	92,88	93,63	96,77	99	91,73	102,94
Höhe	[m]	6	6	6	6	6	6	6	6
Volumen	[m <sup>3</sup> ]	552,96	554,22	557,28	561,78	580,62	594	550,38	617,64
Umriss	[m]	38,4	38,93	40,2	42,06	49,92	53	37,12	63,77
Hüllfläche	[m <sup>2</sup> ]	414,72	418,32	426,96	439,62	493,06	516	406,18	588,5
A/V	[1/m]	0,750	0,755	0,766	0,783	0,849	0,869	0,738	0,953
<b>Solareintrag</b>									
Jahr		106.731,98	103.903,27	103.831,60	105.615,04	118.245,87	144.365,38	102.782,81	169.771,00
West	[kWh/(m <sup>2</sup> a)]	39.638,76	33.611,14	29.305,70	25.861,35	18.972,64	57.951,35	36.503,80	61.318,75
Ost		26.838,13	22.757,02	19.841,95	17.509,89	12.845,77	41.459,13	24.715,55	44.493,49
Süd		40.255,09	47.535,11	54.683,95	62.243,81	86.427,46	44.954,90	41.563,46	63.958,76
Sommer		69.892,81	67.214,35	66.457,21	66.457,21	73.292,68	95.251,28	67.275,44	112.713,16
West		27.515,07	23.331,03	20.342,43	17.951,54	13.169,78	39.593,40	25.338,96	42.731,69
Ost		18.498,37	15.685,44	13.676,20	12.068,82	8.854,04	28.421,69	17.035,37	30.681,14
Süd		23.879,36	28.197,88	32.438,58	36.923,09	51.268,86	27.236,19	24.901,12	39.300,33
Winter		36.839,17	36.688,93	37.374,39	38.671,59	44.953,19	49.114,10	35.507,37	57.057,83
West		12.123,69	10.280,11	8.963,28	7.909,81	5.802,87	18.357,95	11.164,85	18.587,06
Ost		8.339,76	7.071,58	6.165,74	5.441,07	3.991,73	13.037,44	7.680,18	13.812,34
Süd	16.375,73	19.337,23	22.245,37	25.320,71	35.158,60	17.718,70	16.662,34	24.658,43	





- + Sonnenschutz
- + Blendschutz
- + Energetische Bilanzierung  
Sommer/Winter
- + Wandlungsfähigkeit / Flexibilität
- + Energiegewinn
- + EnergieverlustNiederschlagsmenge
- + Reinigung





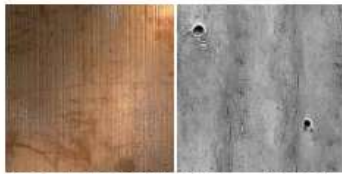
- 1800
- Einführung der Begriffe Wärmefluss, Temperaturgefälle und Wärmeleitfähigkeit
  - Einführung des k-Wertes als Kennwert für die Wärmeleitfähigkeit (heute U-Wert)
- 1850
- Kristallpalast in London
  - Einführung des Begriffs Wärmeverlust durch Transmission und Lüftung
  - Patent für Isolierglas
  - erste solare Luftkollektorfassade (USA)
- 1900
- erste Doppelfassade: Produktionshalle Steiff (D)
  - Patente für Dämmelemente aus Kork
  - erste vorgehängte Glasfassade: Halladie Building (USA)
  - Marktreife von Isolierglas
  - Erfindung des Sonnenschutzglases
- 1950
- Entwicklung von mineralischen Dämmstoffen
  - Entwicklung von Wärmedämmverbundsystem
  - Einführung des Begriffs Bauphysik
  - Entwicklung der Trombewand
- 2000
- Passivhaus
  - Plusenergiehaus



Kristallpalast London 1851  
Joseph Paxton



Fagus-Werk in Alfeld 1911  
Walter Gropius



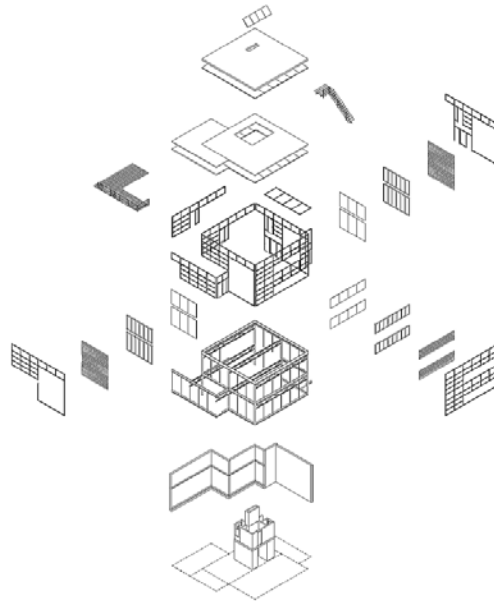
2.53 Stahl 188.400 MJ 2.54 Beton 1.764 MJ



2.55 Glas 35.000 MJ 2.56 Nadelholz 609 MJ



2.57 Granit 9.837 MJ 2.58 Lehm 158 MJ

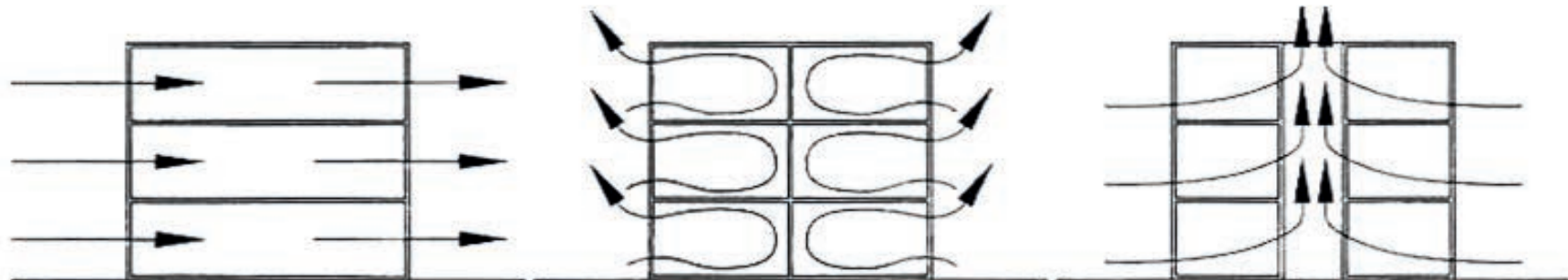
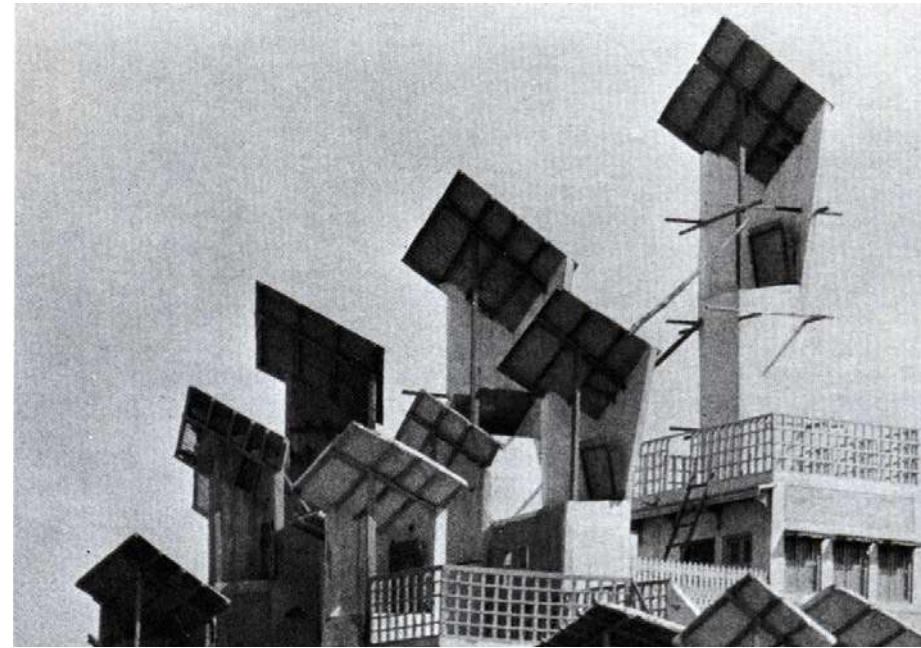
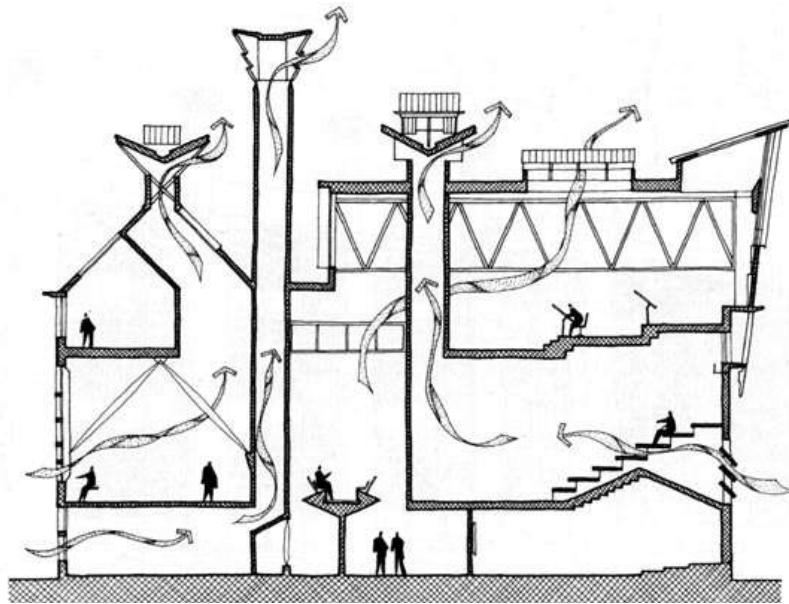


- + Trennbare Materialien / Systeme
- + Recyclingfähigkeit
- + Bilanzierung enthaltener Primärenergie
- + Gesundheitsaspekte
- + Klimatische Aspekte/Speicherfähigkeit
- + Schallschutz
- + Wandlungsfähigkeit/Flexibilität

„Bausatz“

„Building Information Modeling“







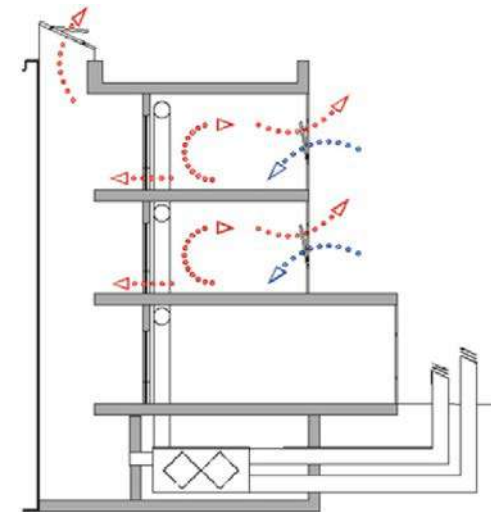
Die Grundlage natürlicher Lüftung sind Druckdifferenzen zwischen Bereichen infolge

- von Druckunterschieden
- Windeinwirkung (Unter- & Überdruck)
- Thermischer Auftrieb

Es wird unterschieden zwischen

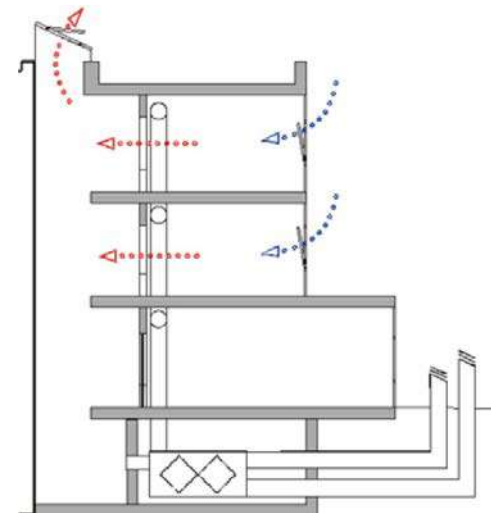
- Freier Lüftung über die Gebäudehülle
- Optimierung der Gebäudegeometrie zur
- Nutzung oder Erzeugung von Wind oder Thermik

### Fensterlüftung (reine Fensterlüftung)



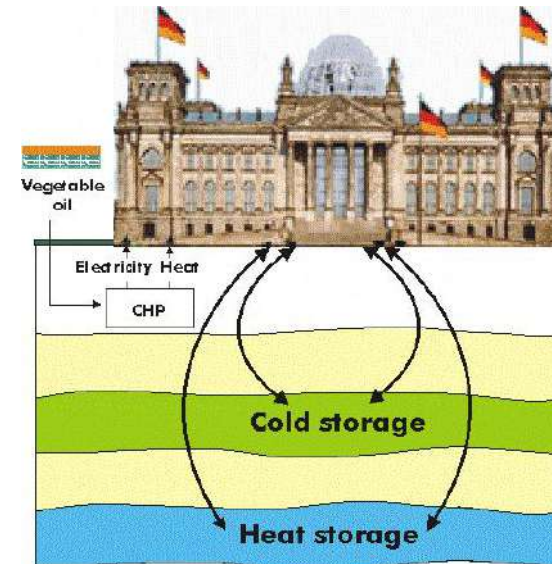
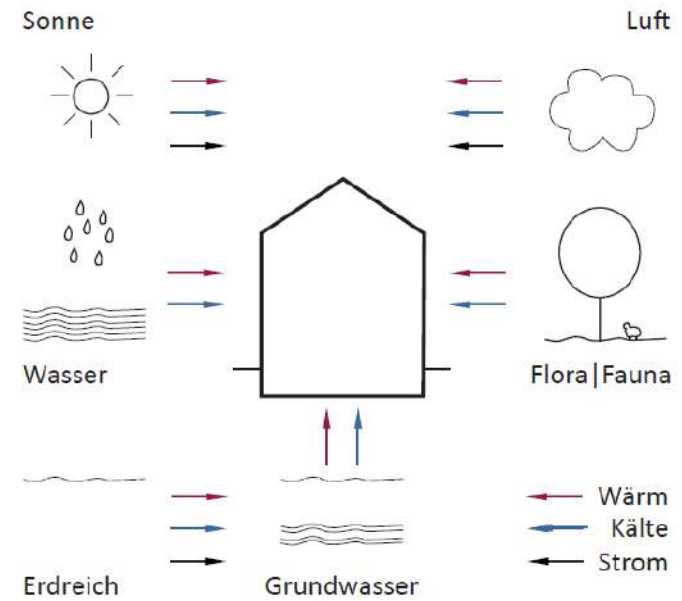
Lüftungsführung bei Nachtlüftung

### Durchströmung (reine Thermik)

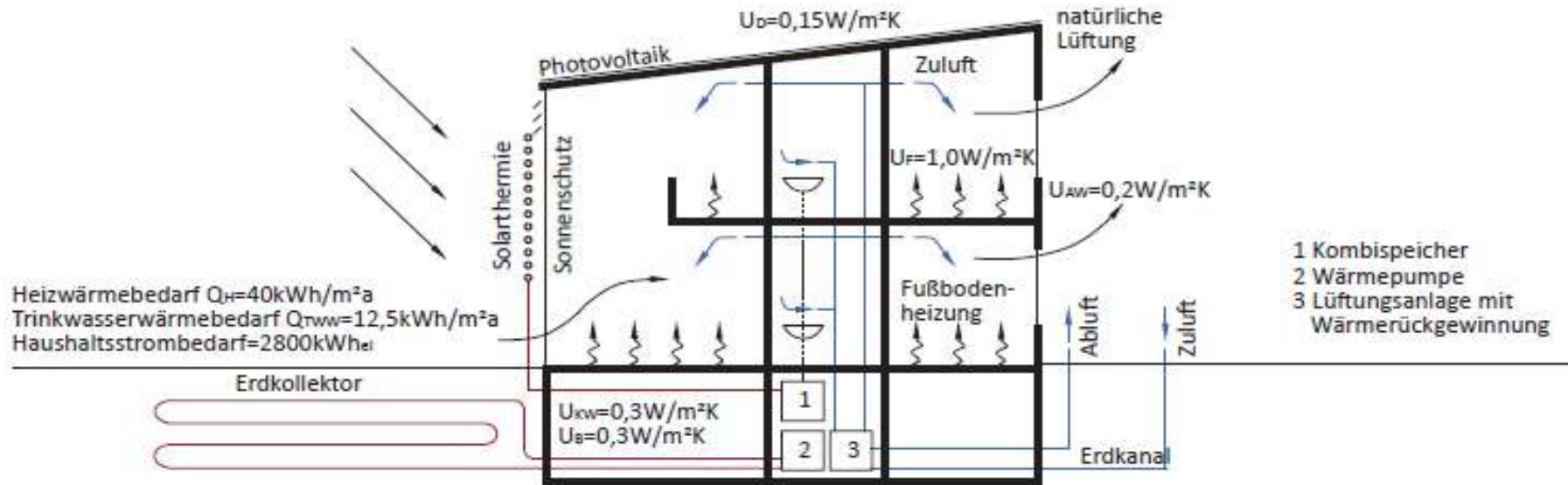


Lüftungsführung bei Nachtlüftung

Quelle:  
ZUB





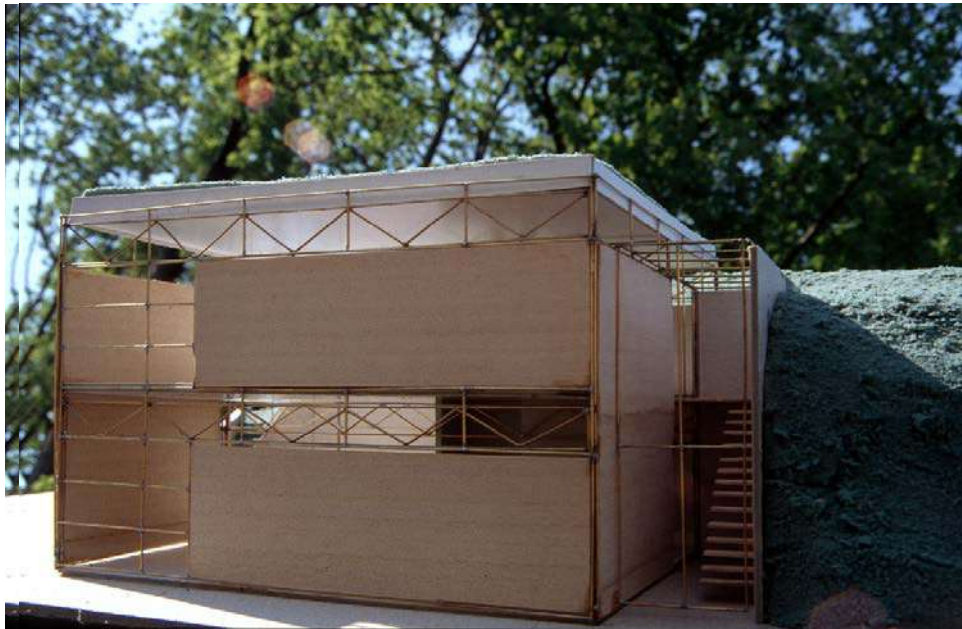
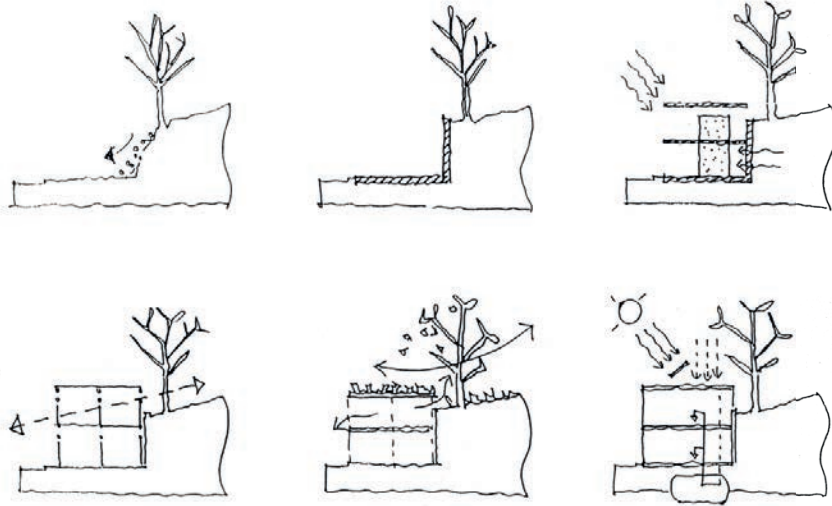




- + natürliche Baustoffe
- + lokale Baustoffe
- + Begrünung der Architektur

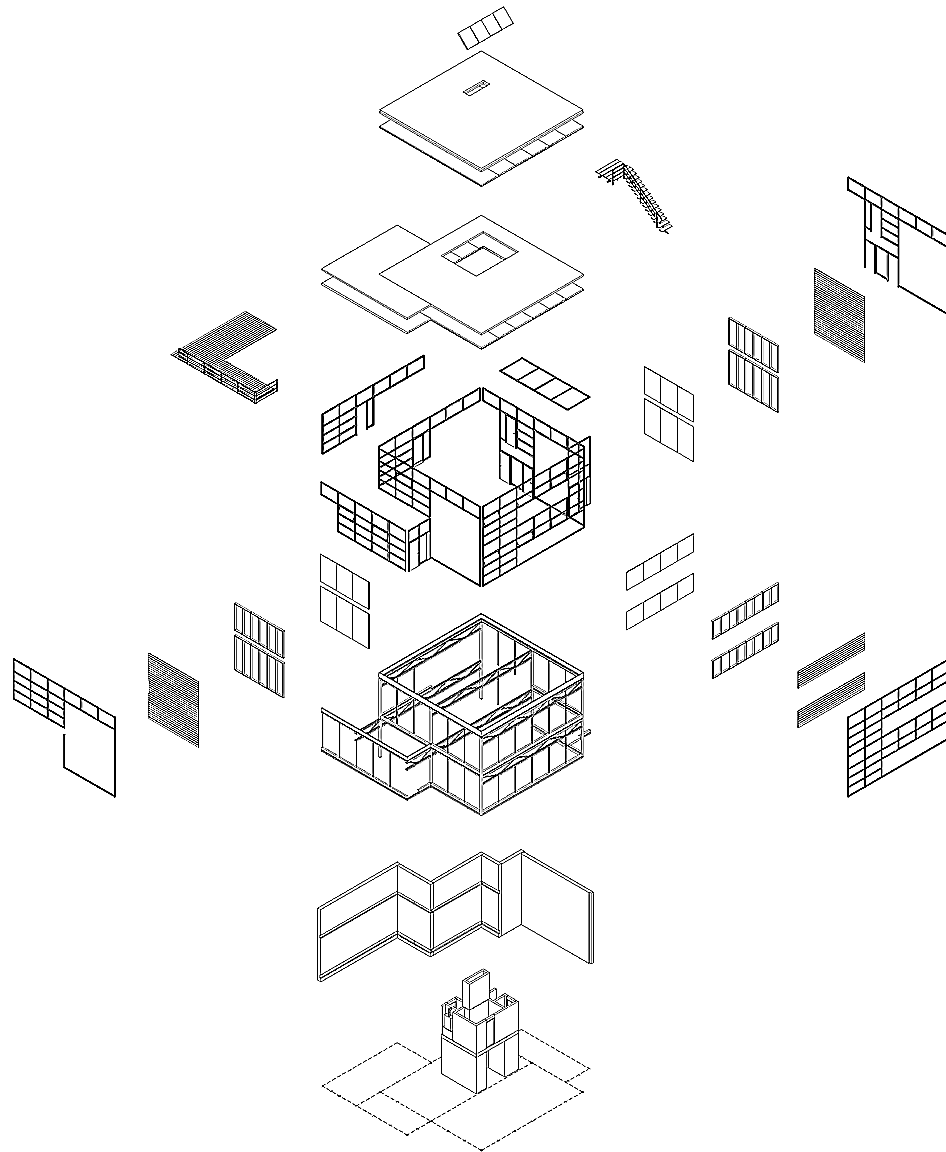


### 3.1: Haus R, Essen





### 3.1: Haus R., Essen





### 3.1: Haus R., Essen





### 3.1: Haus R., Essen





### 3.1: Haus R., Essen





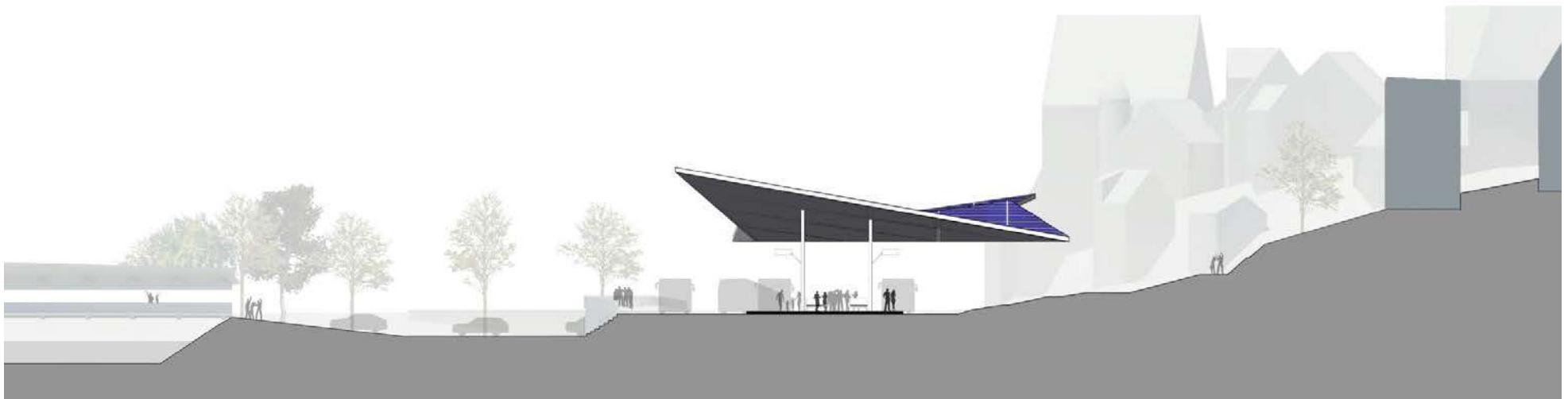
### 3.1: Haus R., Essen





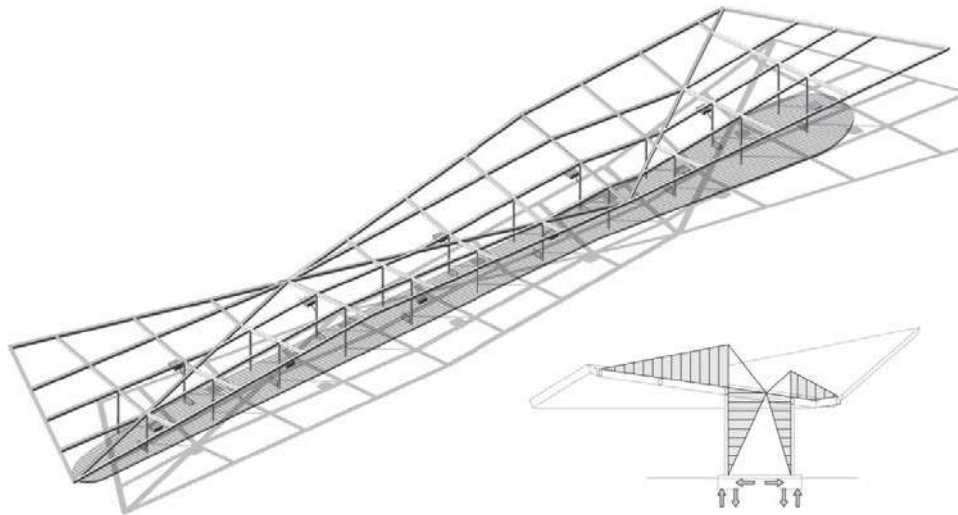
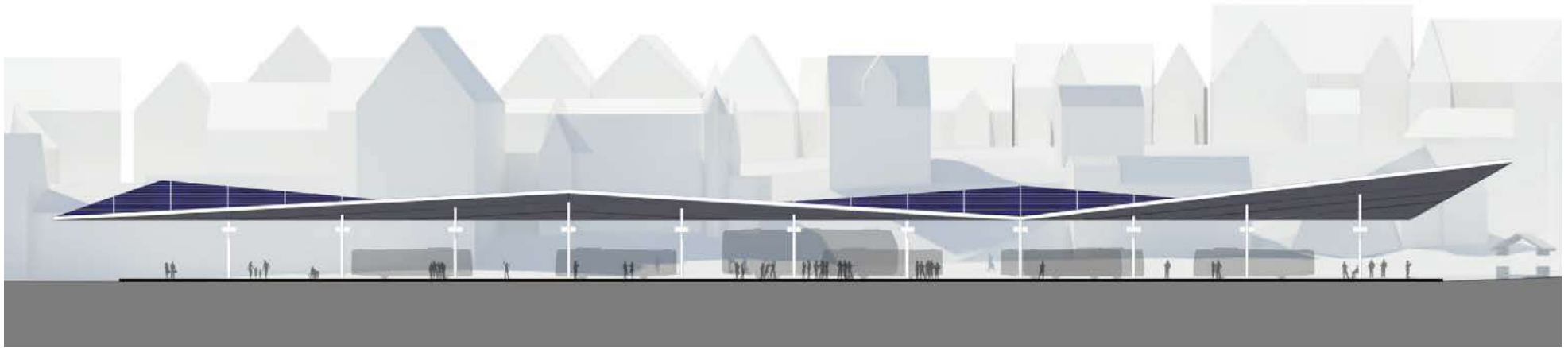


### 3.2: ZOB, Schwäbisch Hall



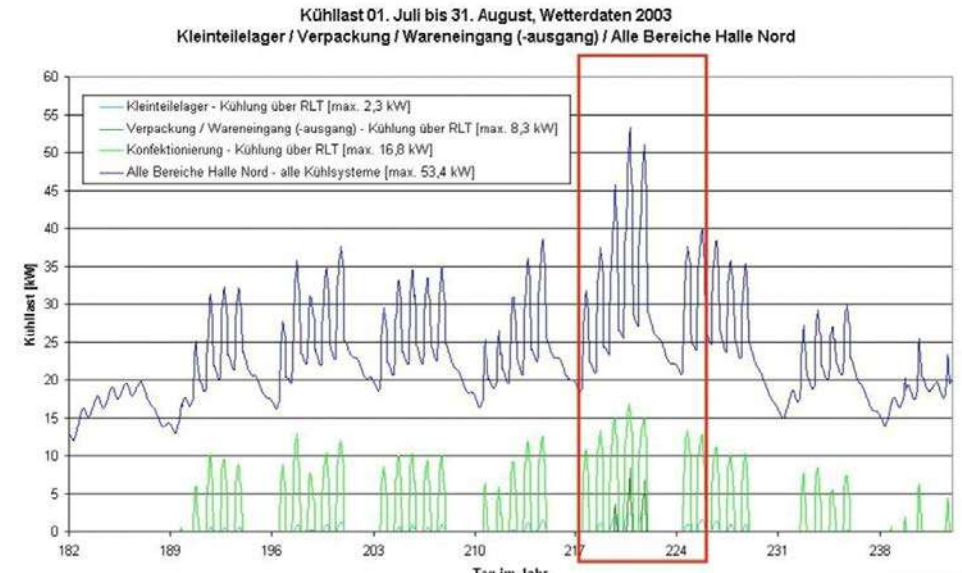
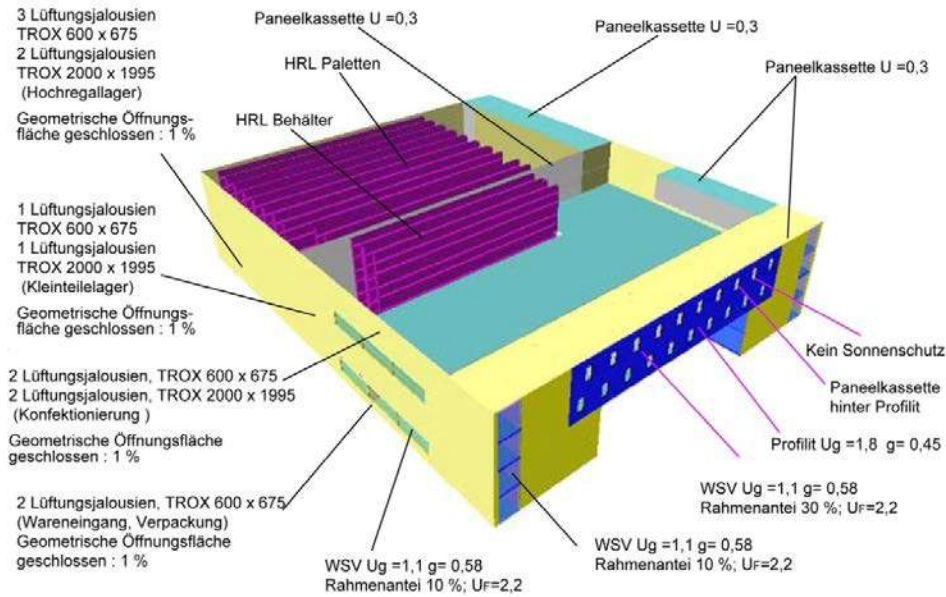


### 3.2: ZOB, Schwäbisch Hall

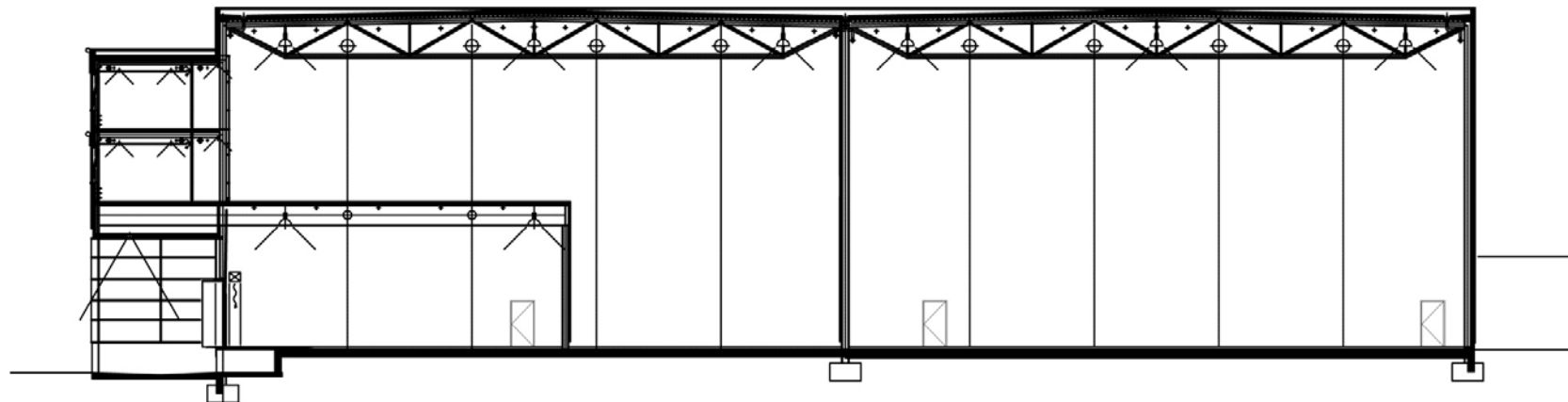




### 3.3: Qiagen, Hilden

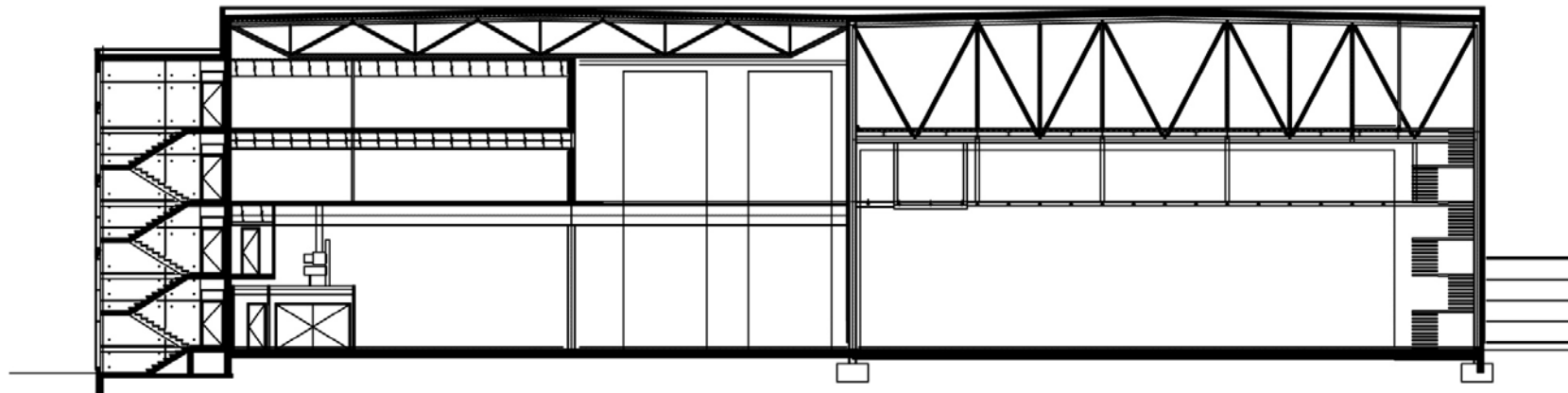
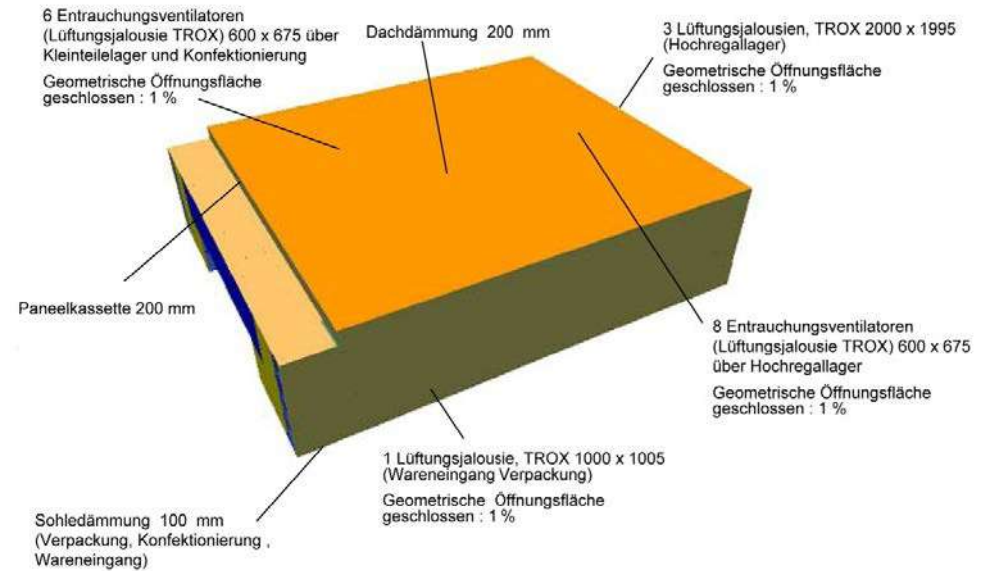
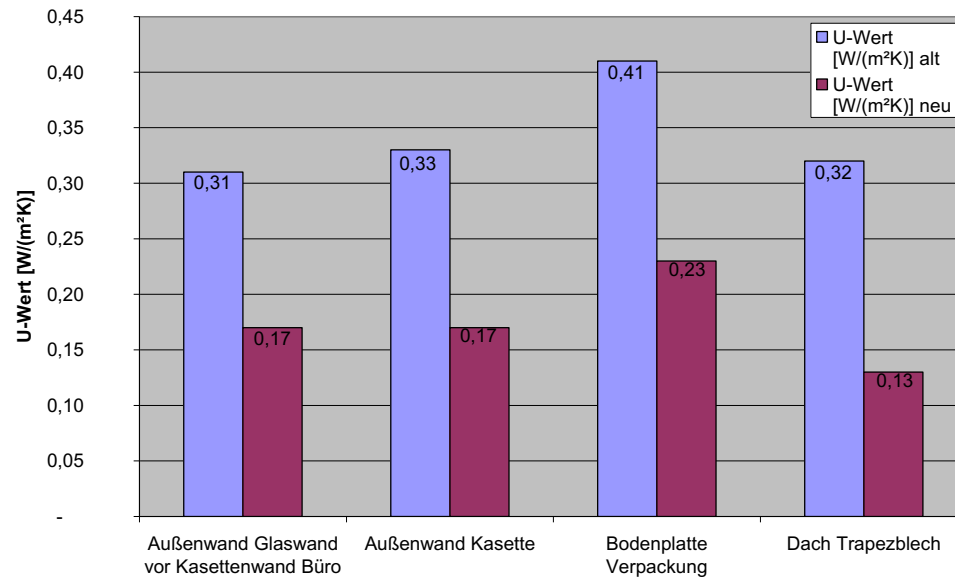


Variante 5





### 3.3: Qiagen, Hilden





### 3.2: Qiagen, Hilden





### 3.3: Qiagen, Hilden



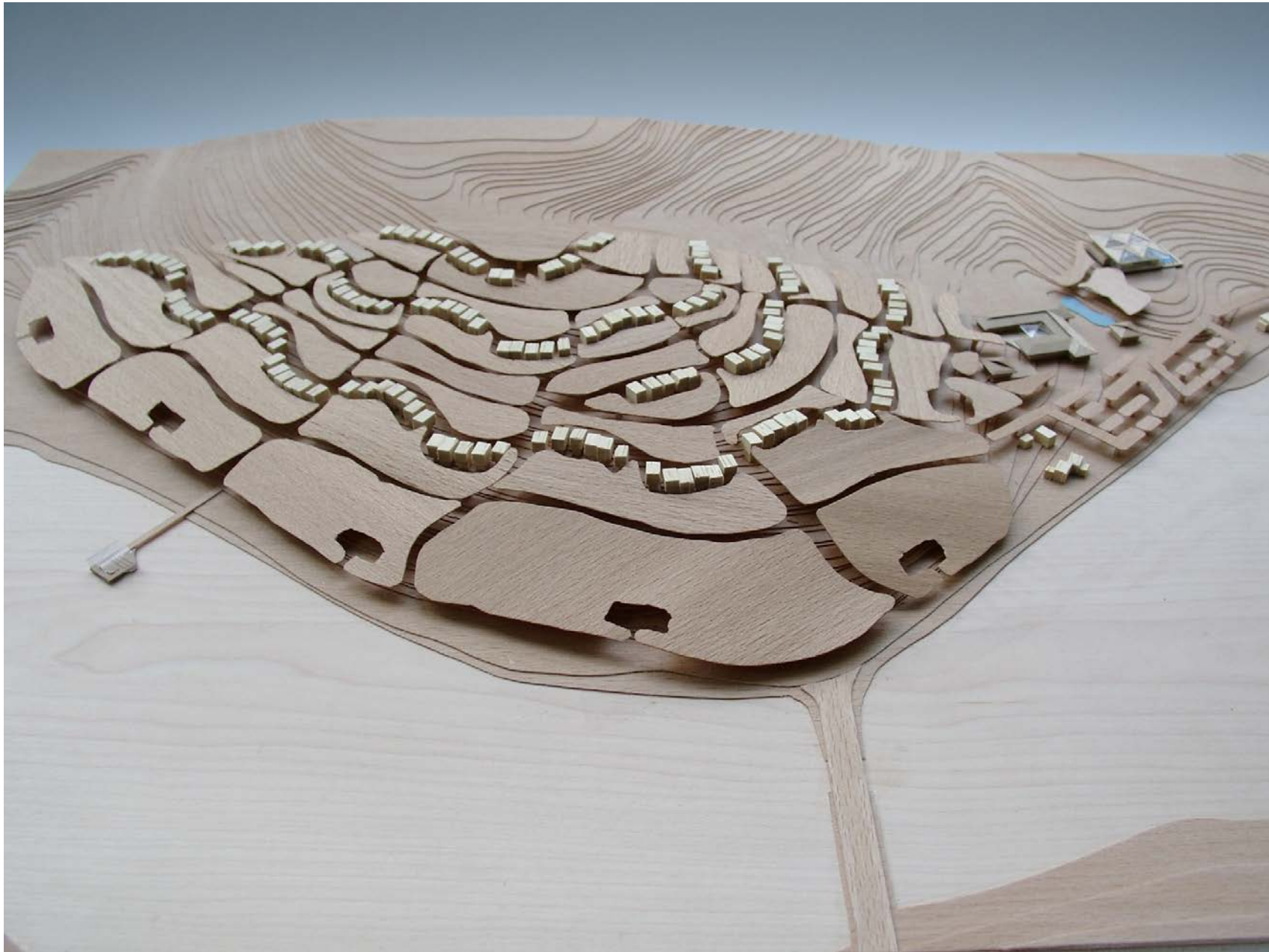


### 3.3: Qiagen, Hilden





### 3.4: Ferienpark, Amecke





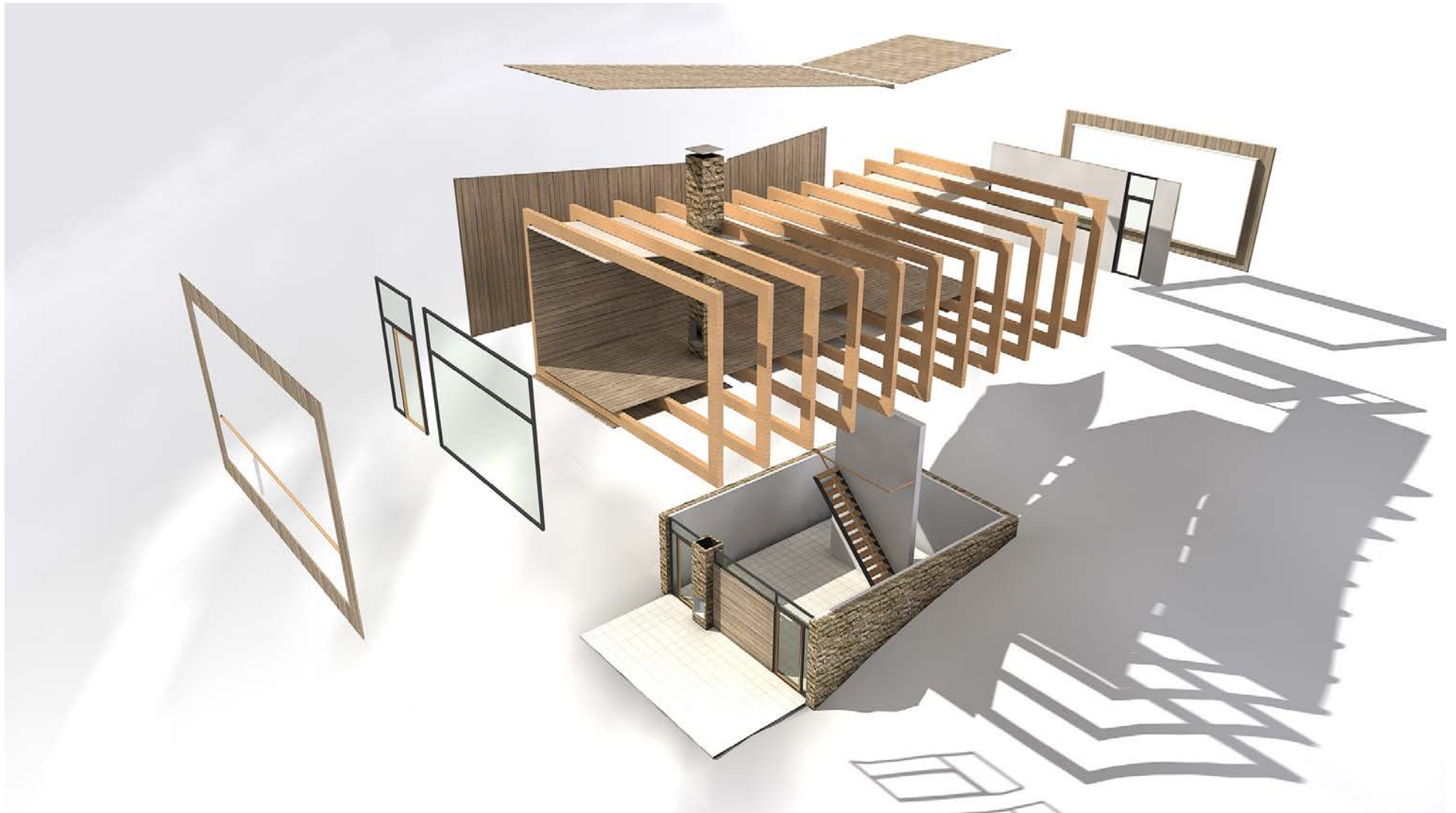


### 3.4: Ferienpark, Amecke





### 3.4: Ferienpark, Amecke





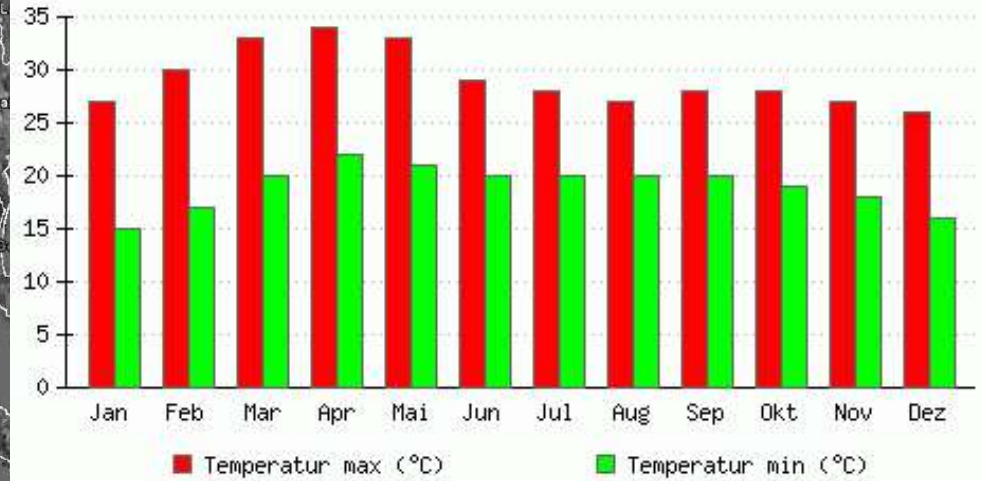
### 3.4: Ferienpark, Amecke



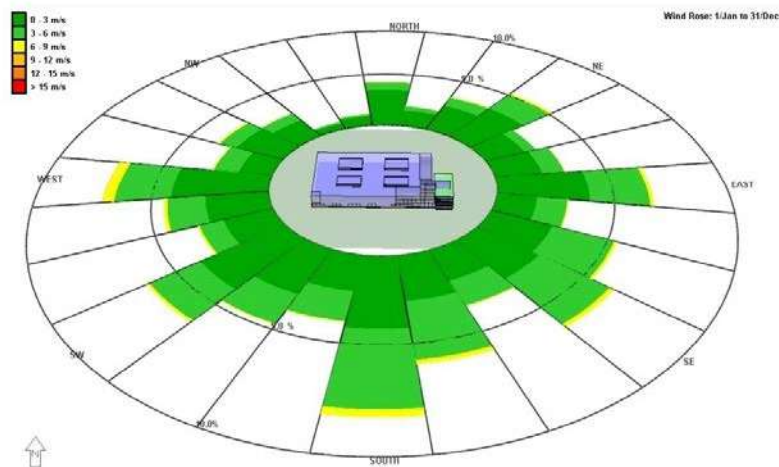


### Indien, Chennai/Madras

Klimatabelle: Temperaturen max/min (°C), monatlich, gemittelt



### Hauptwindrichtungen im Jahresverlauf



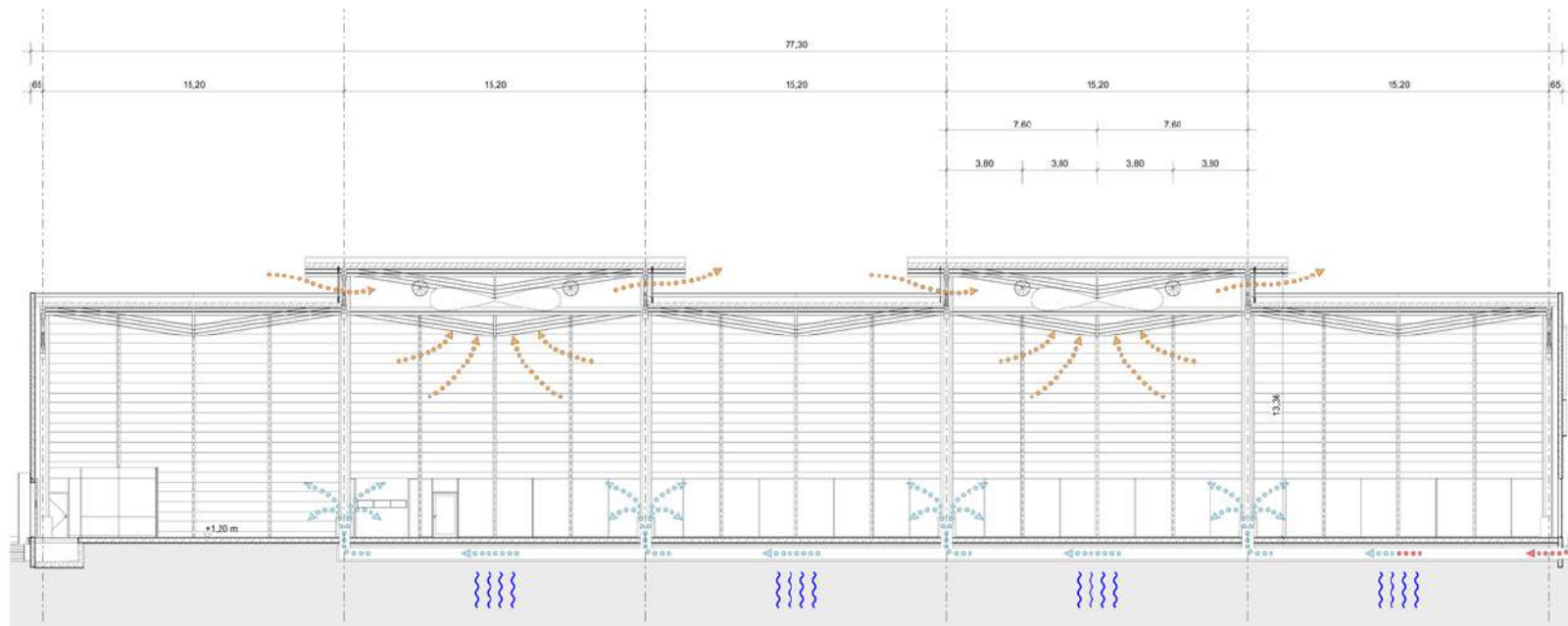
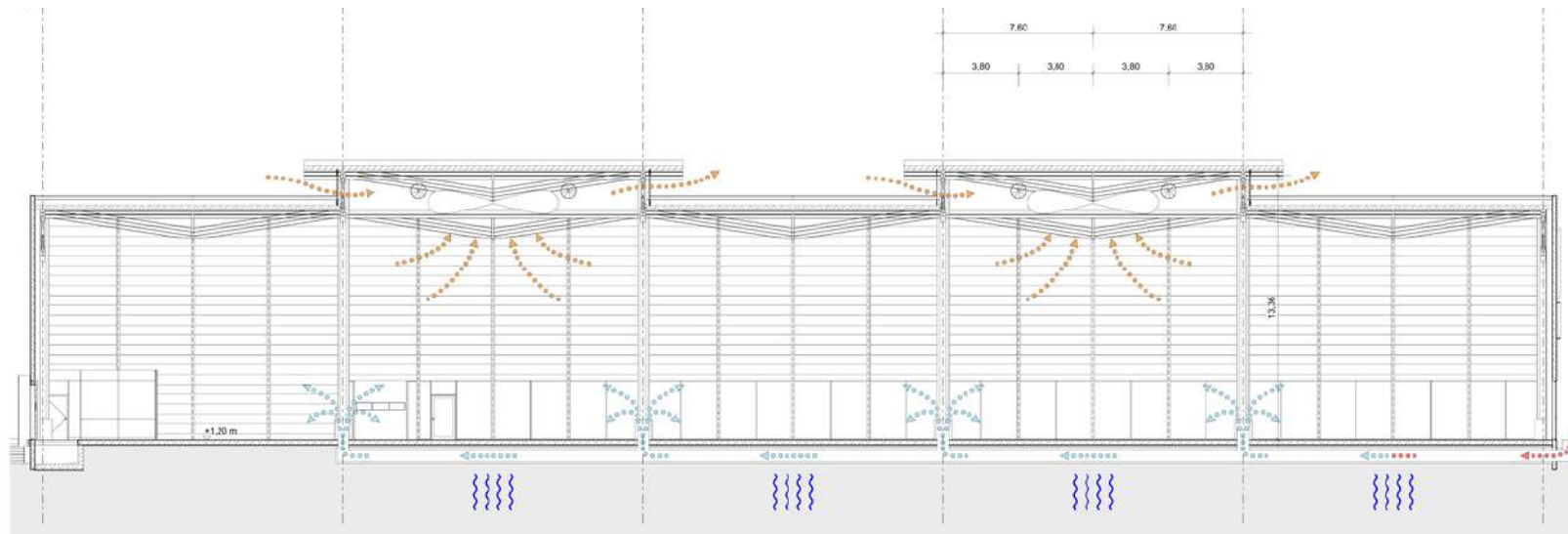


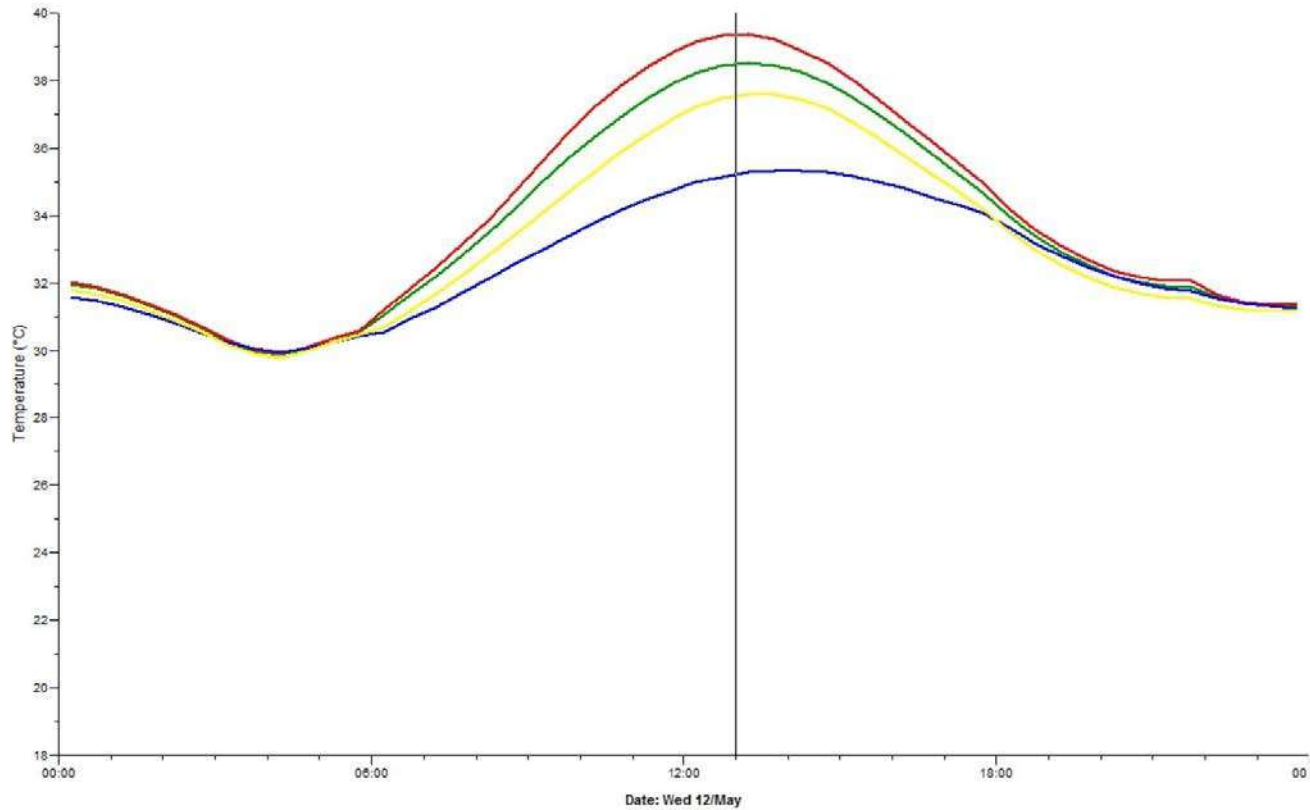
### 3.5: Dorma India, Chennai





### 3.5: Dorma India, Chennai

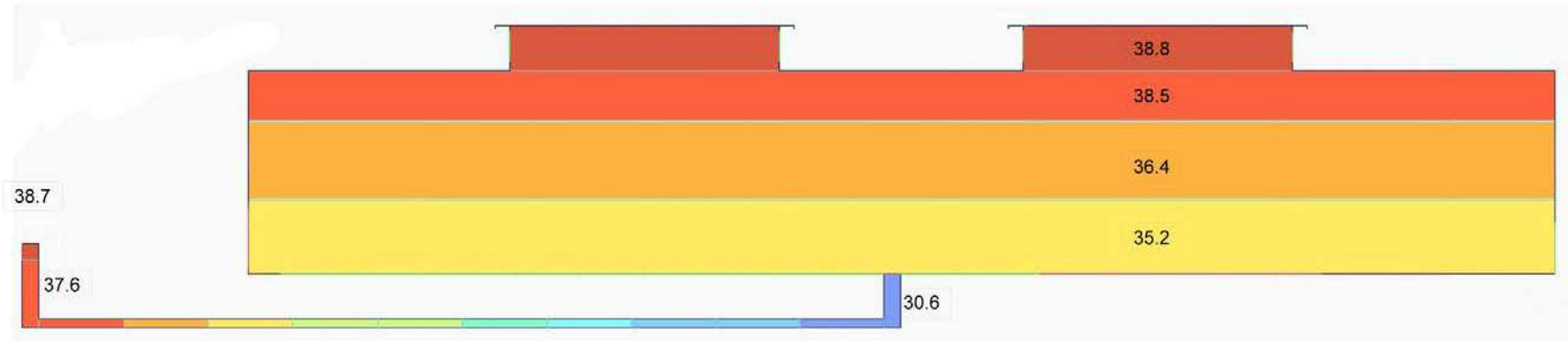




Earth tube	Location	wall windows open 15%	Number of tubes	Air temperature (°C)
no earth tubes	00 - Hall - production	open/natural ventilation	---	39,4
50x50cm	00 - Hall - production	open	32	38,5
50x50cm	00 - Hall - production	open	64	37,5
50x50cm	00 - Hall - production	closed	64	35,2



### 3.5: Dorma India, Chennai





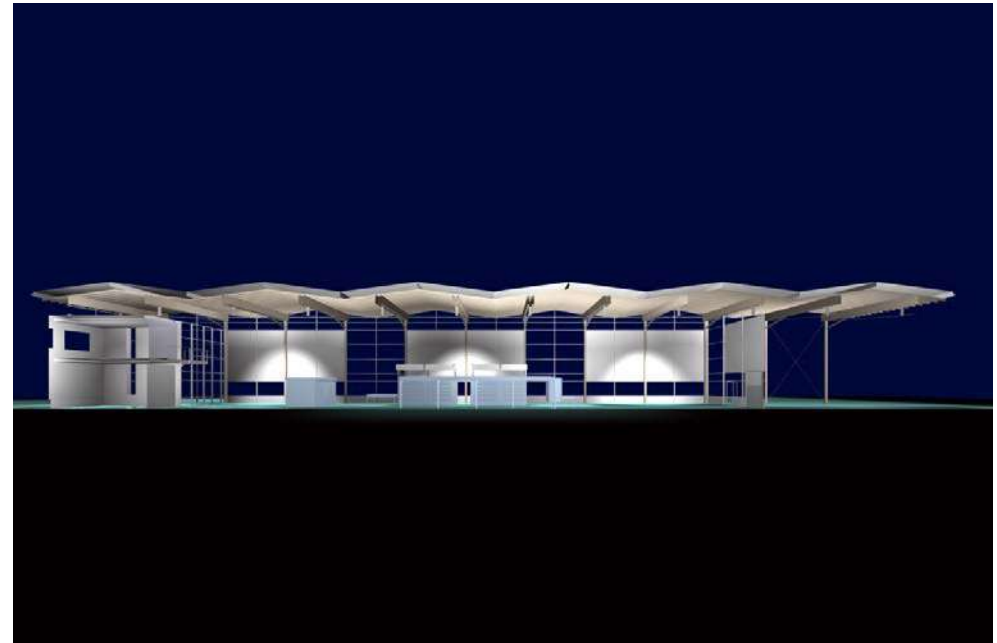
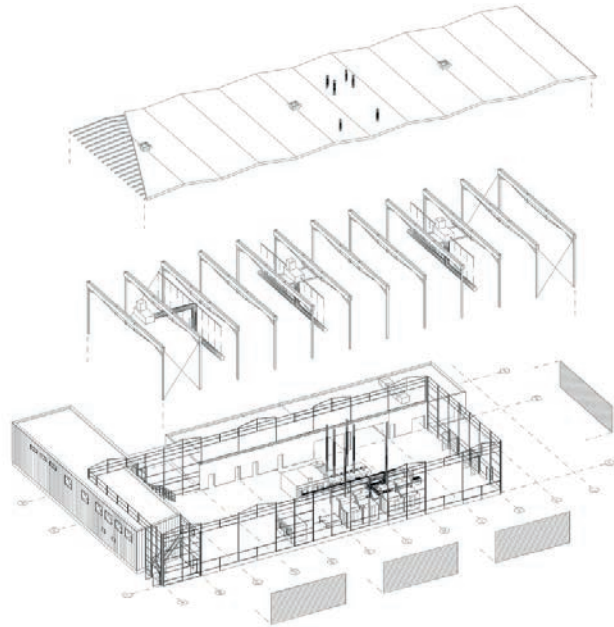


3.5: Dorma India, Chennai

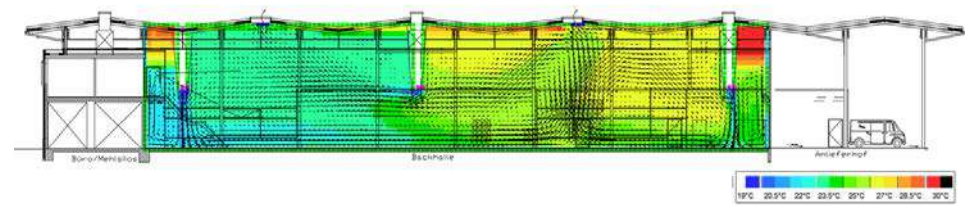




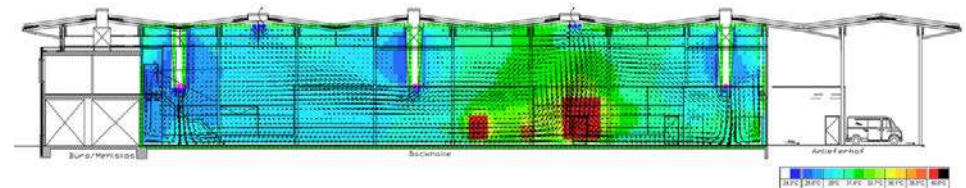
### 3.6: Bäckerei Peter 1, Essen



LUFTEMTEMPERATUR



STRAHLUNGSTEMPERATUR





### 3.6: Bäckerei Peter 1, Essen





### 3.6 Bäckerei Peter 1, Essen

**RMA** | Reichardt - Maas - Assoziierte  
Architekten GmbH & Co. KG





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**RMA** | Reichardt - Maas - Assoziierte  
Architekten GmbH & Co. KG





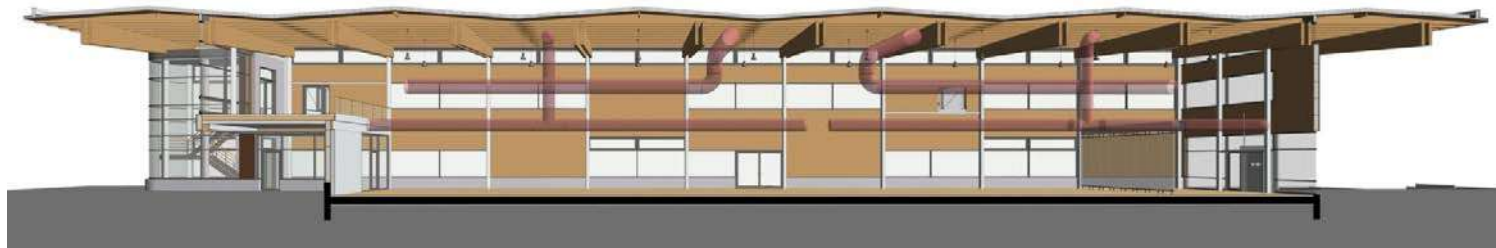
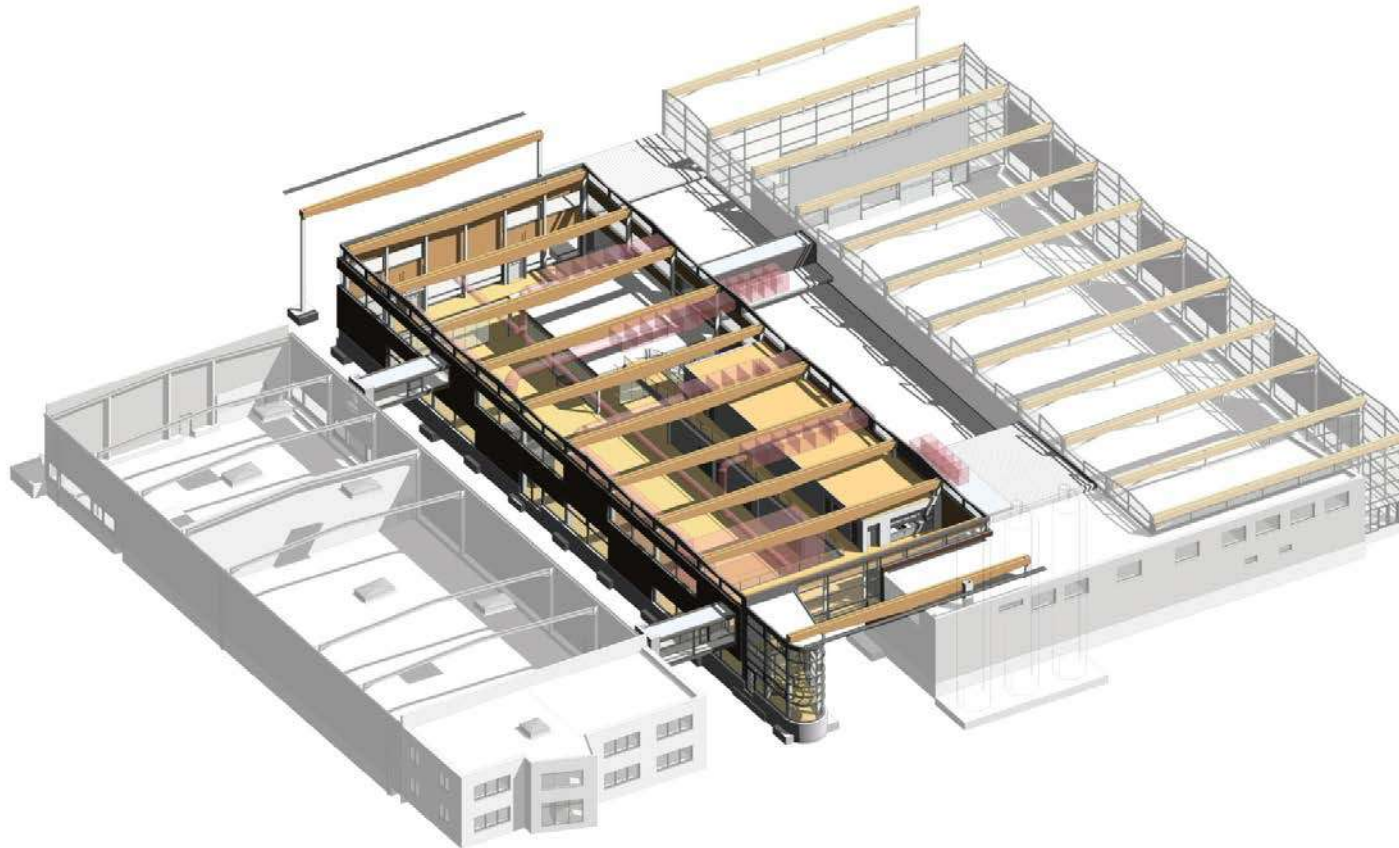
### 3.6 Bäckerei Peter 2, Essen





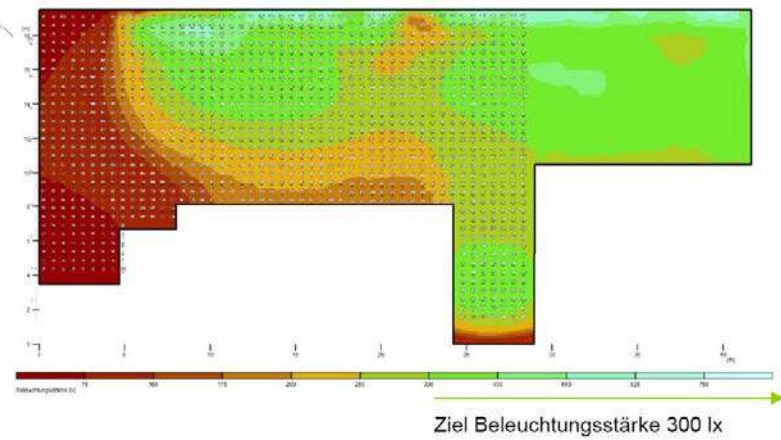
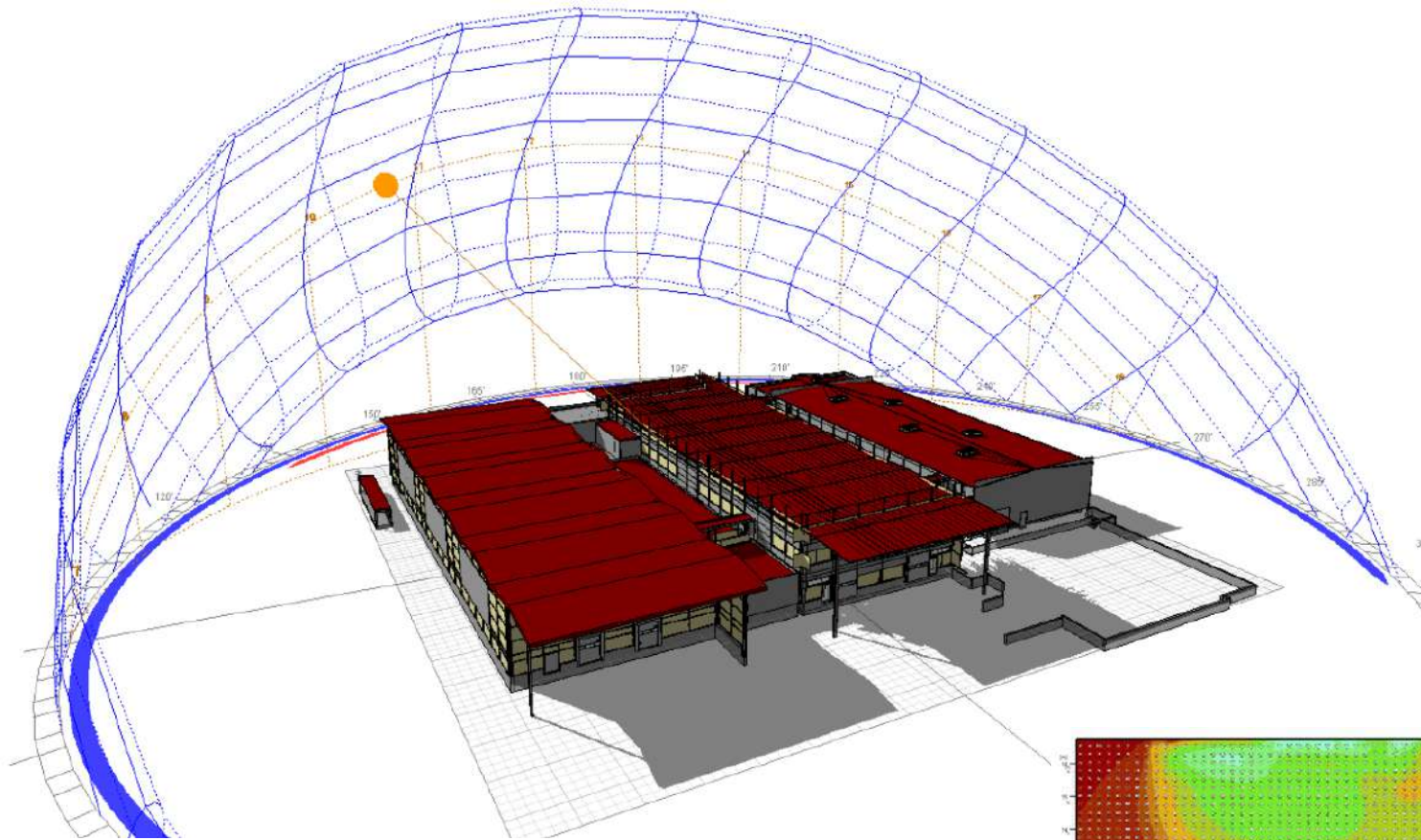
### 3.6: Bäckerei Peter 2, Essen

**RMA** | Reichardt - Maas - Assoziierte  
Architekten GmbH & Co. KG





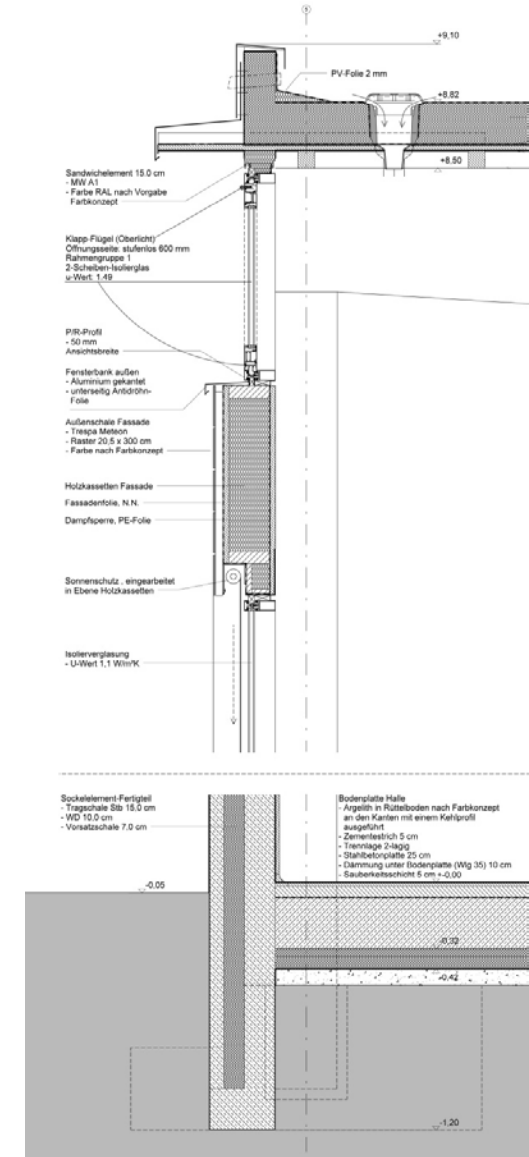
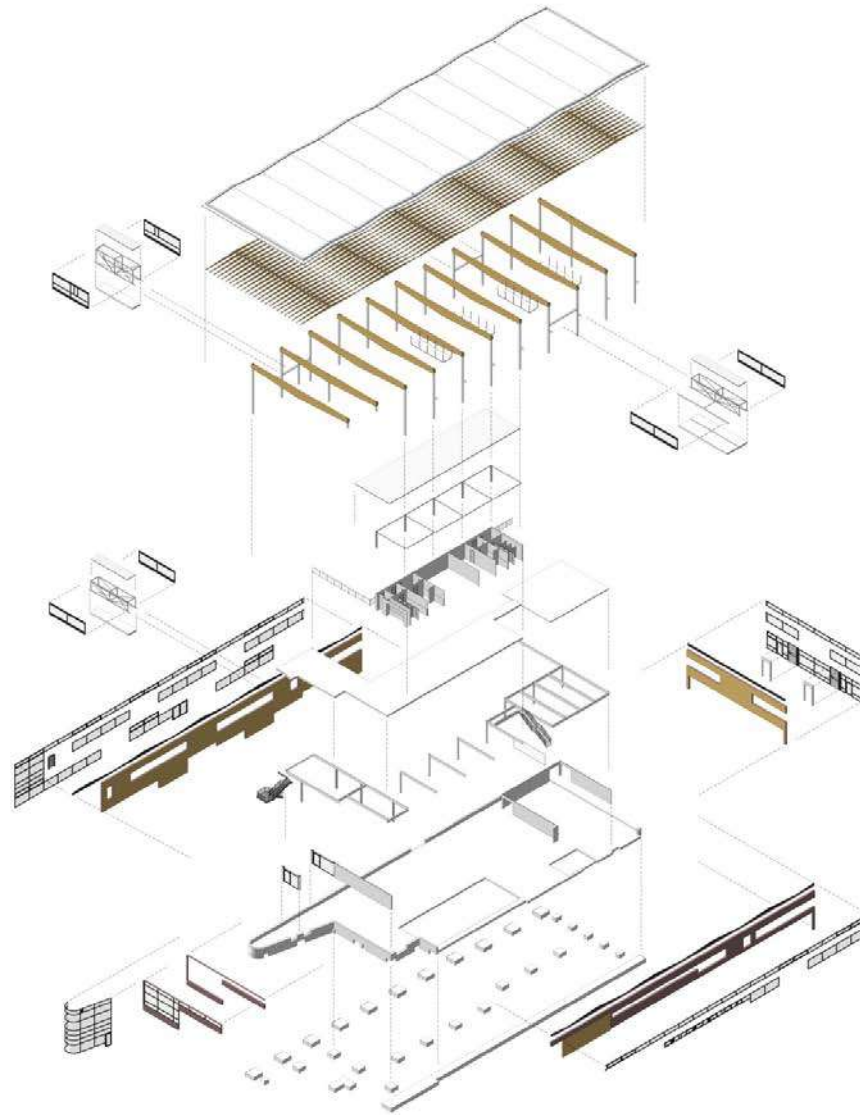
### 3.6: Bäckerei Peter 2, Essen





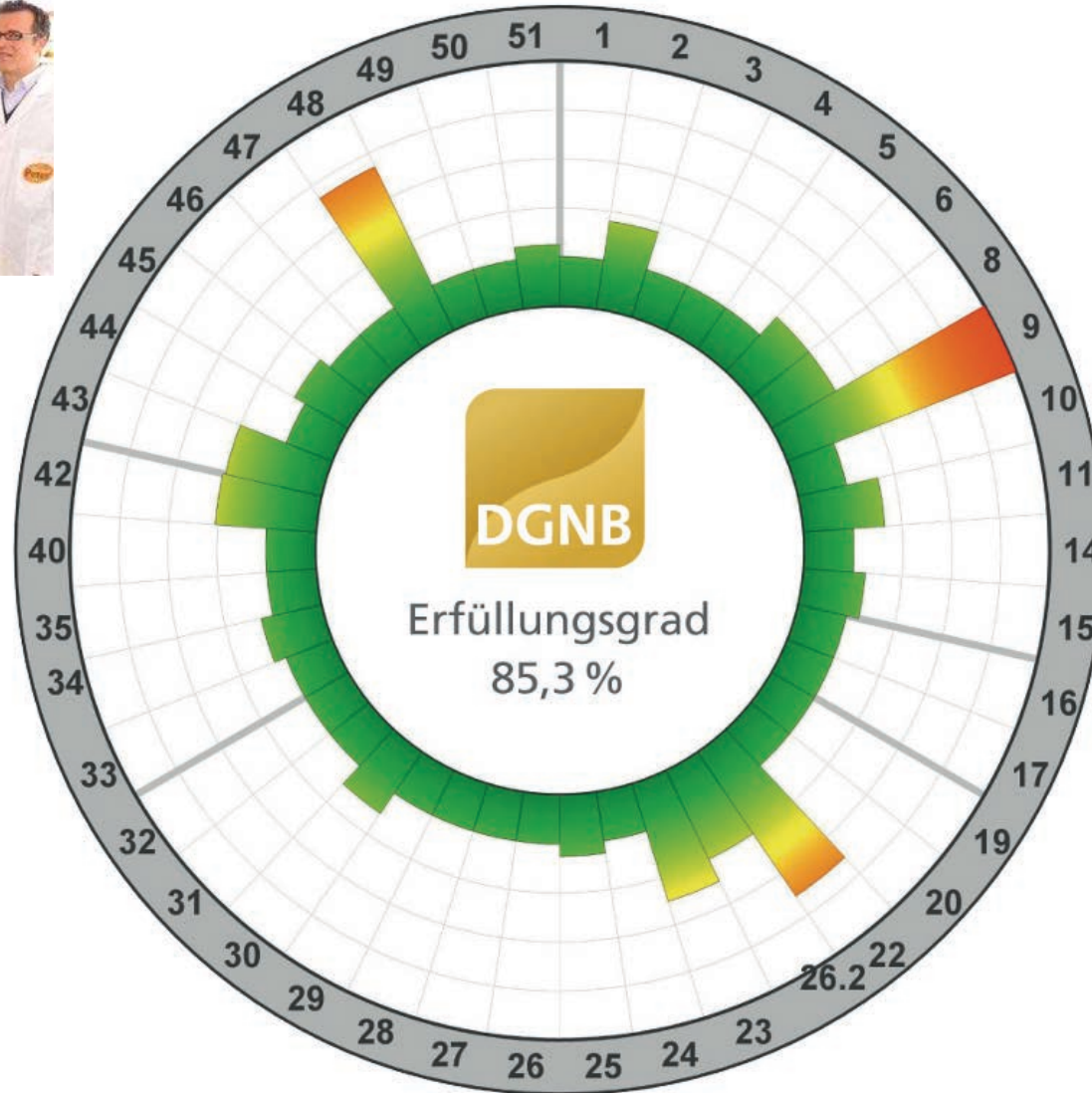


### 3.6: Bäckerei Peter 2, Essen





### 3.6: Bäckerei Peter 2, Essen



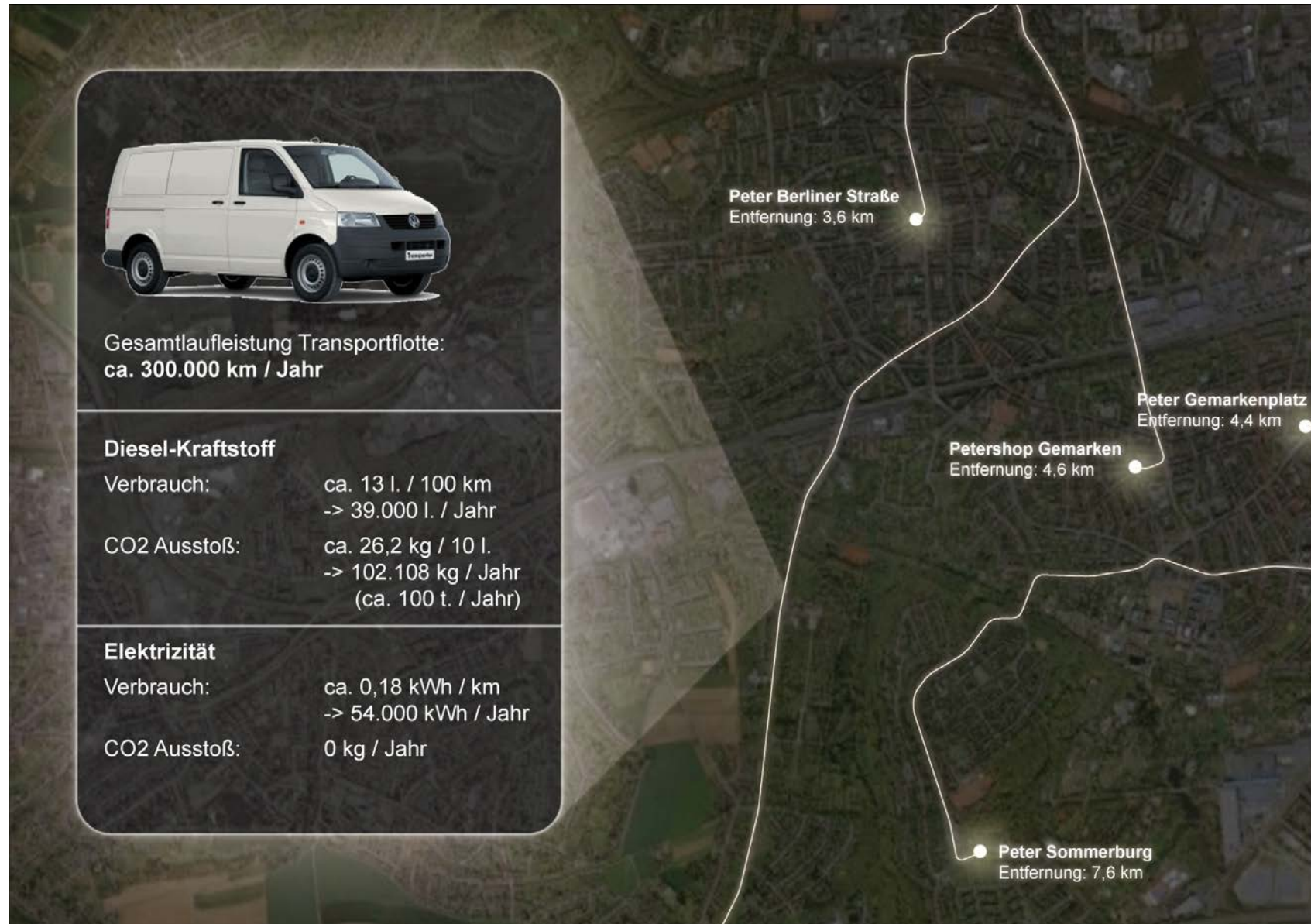


### 3.6: Bäckerei Peter 2, Essen





### 3.6: Bäckerei Peter 2, Essen

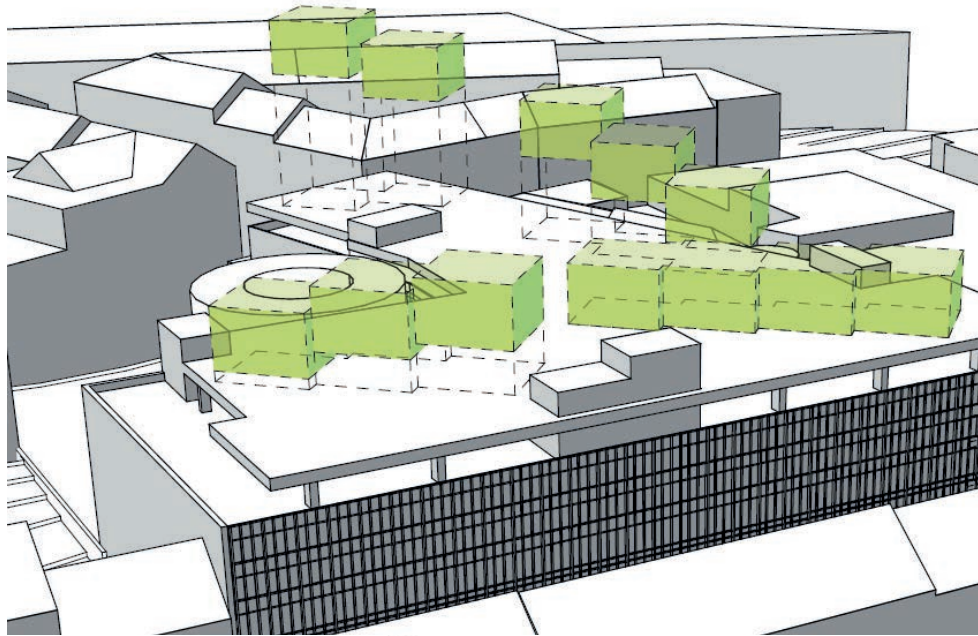




### 3.6: Bäckerei Peter 2, Essen

**RMA** | Reichardt - Maas - Assoziierte  
Architekten GmbH & Co. KG





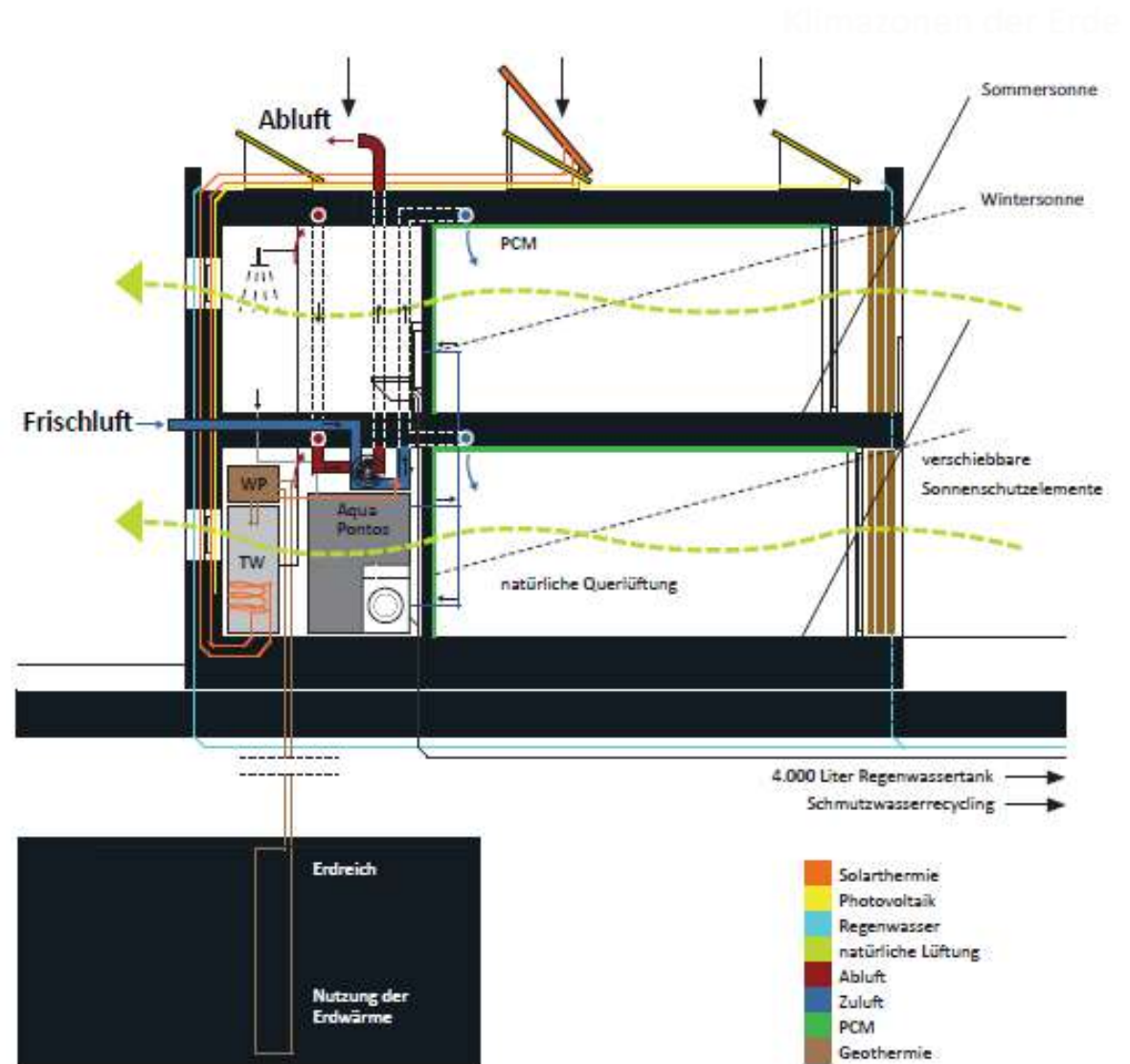
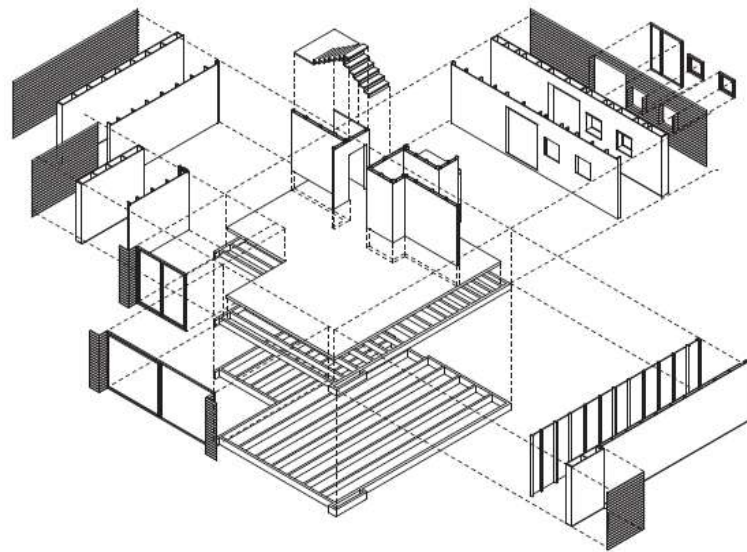
Grundriss EG Typ 1  
1:100

Abteilraum	2,50m <sup>2</sup>
Flur	4,56m <sup>2</sup>
Wc	1,50m <sup>2</sup>
Technikraum	6,88m <sup>2</sup>
Küche	8,83m <sup>2</sup>
Wohnen	21,01m <sup>2</sup>
Essen	11,83m <sup>2</sup>
<b>Wohnfläche EG</b>	<b>57,11m<sup>2</sup></b>



Treppe nach Norden ohne Kamin    Treppe nach Norden mit Kamin    Treppe nach Westen ohne Kamin    Treppe nach Westen mit Kamin

Grundriss Varianten EG 1:500



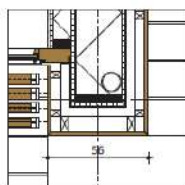
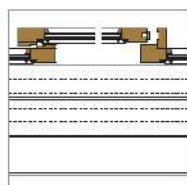
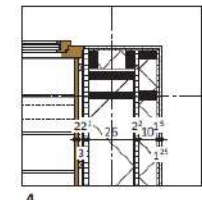
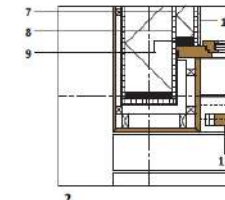
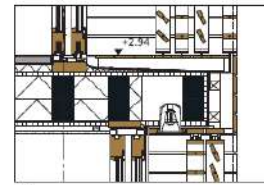
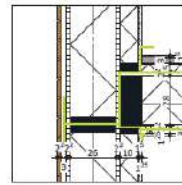
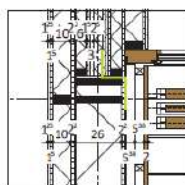
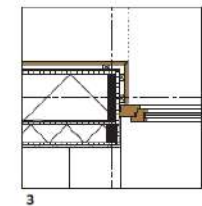
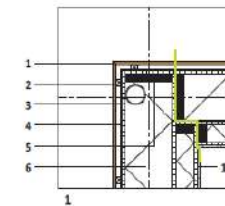
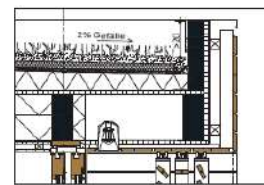
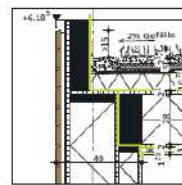
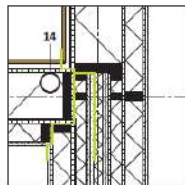
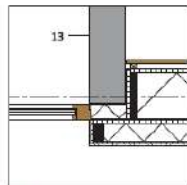


### 3.7: msa, A, Wolkensinger, Plusenergieh. Kassel.

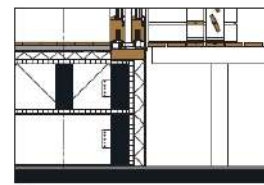
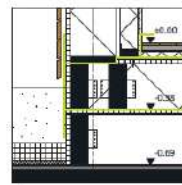
#### Gewinne und Verluste monatlich

Monat	Gewinne [kWh/Monat]	Verluste [kWh/Monat]	Faktor Nacht- absenkung	Ausnutzungs- grad	Qh [kWh/Monat]
Jan	1106	1277	0,881	0,91	120
Feb	1409	1096	0,885	0,68	10
Mrz	1755	1017	0,893	0,52	1
Apr	1896	740	0,902	0,35	0
Mai	1987	468	0,909	0,21	0
Jun	1871	269	0,91	0,13	0
Jul	2023	177	0,91	0,08	0
Aug	2038	196	0,91	0,09	0
Sept	1833	398	0,91	0,2	0
Okt	1538	676	0,905	0,4	0
Nov	1153	972	0,894	0,74	17
Dez	995	1194	0,886	0,93	136
<b>Σ</b>	<b>19604,58</b>	<b>8480,22</b>			<b>284,17</b>

Klimazonen der Erde

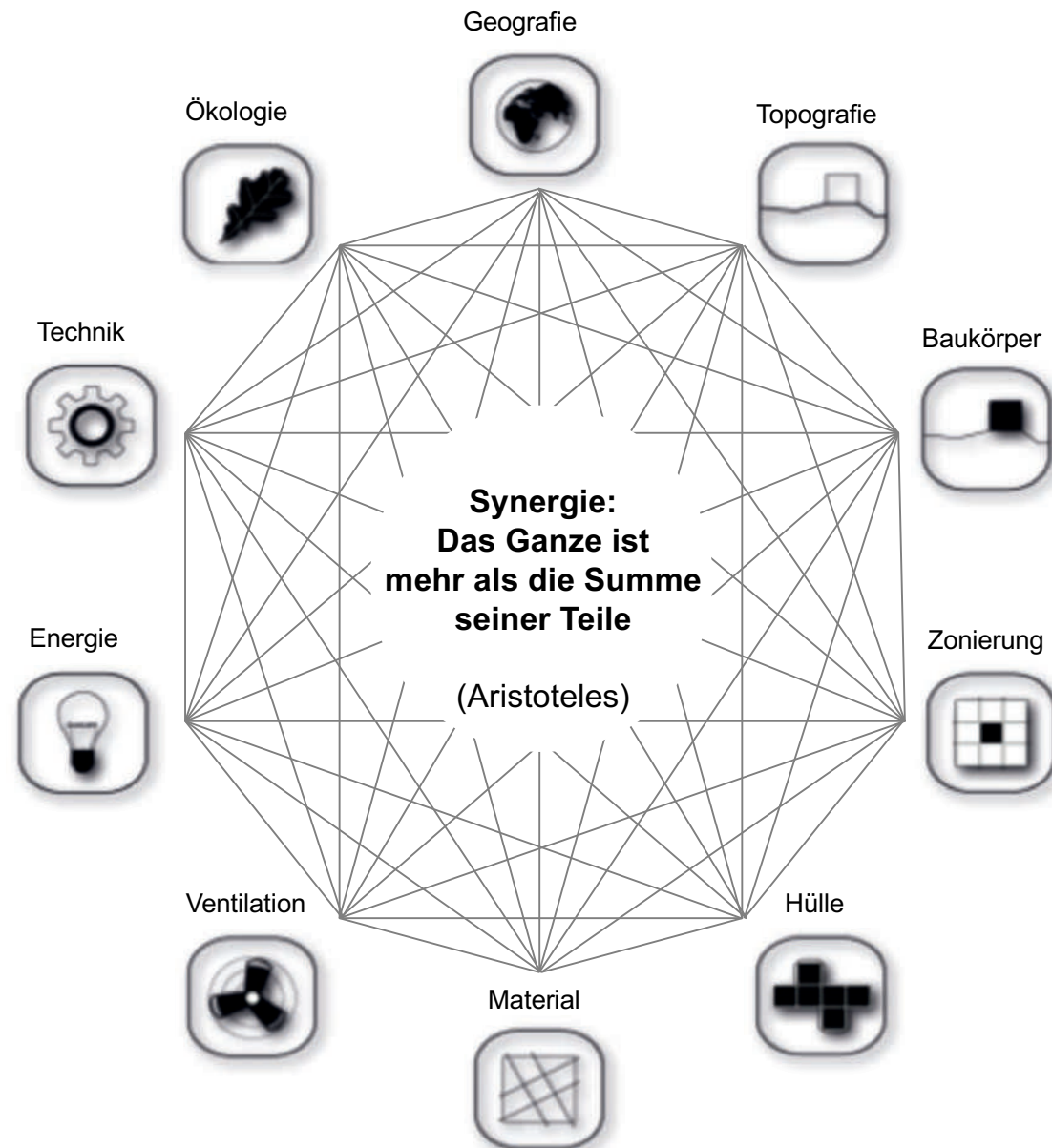


Grundriss Details 1:20



- Wandaufbau**  
von außen nach innen
- 1 20mm Holzschalung Robinie
  - 2 30mm Holzbohle
  - 3 30mm Windspeic
  - 4 22mm OSB-Platte
  - 5 40/260mm Vertikalständer mit Neptunbällen ausgefüllt
  - 6 23mm OSB-Platte
  - 7 23mm OSB-Platte
  - 8 50/100mm Vertikalständer mit Neptunbällen ausgefüllt
  - 9 15mm OSB-Platte
  - 10 12,5mm Glasfaserplatte PCM verspaubt
  - 11 12,5mm Glasfaserplatte PCM verspaubt
  - 12 verschleißbarer Sonnenschutz
  - 13 Betonwand
  - 14 Fahrrohr
- Montagestoß





Ashram Trust  
Udar one of mothers children, Sri Aurobindo Ashram Trust  
Pondicherry India

Blundell Jones, P.  
Hugo Häring, Stuttgart,  
London 1999

Correa, C./ Ganju, A.  
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Designing for Industry, The Architecture of Albert Kahn  
The Massachusetts Institute of Tecchnology 1974

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Reichardt, J.  
Planungsprinzip "Bausatz" – Mehrwert ganzheitlichen Planens und Bauens  
individueller Holzkonstruktionen,  
Tagungsband Hochschul-Praxistage NRW – Update!  
Neues Wissen für den Holzbau, Düsseldorf 2005, S. 15 ff.

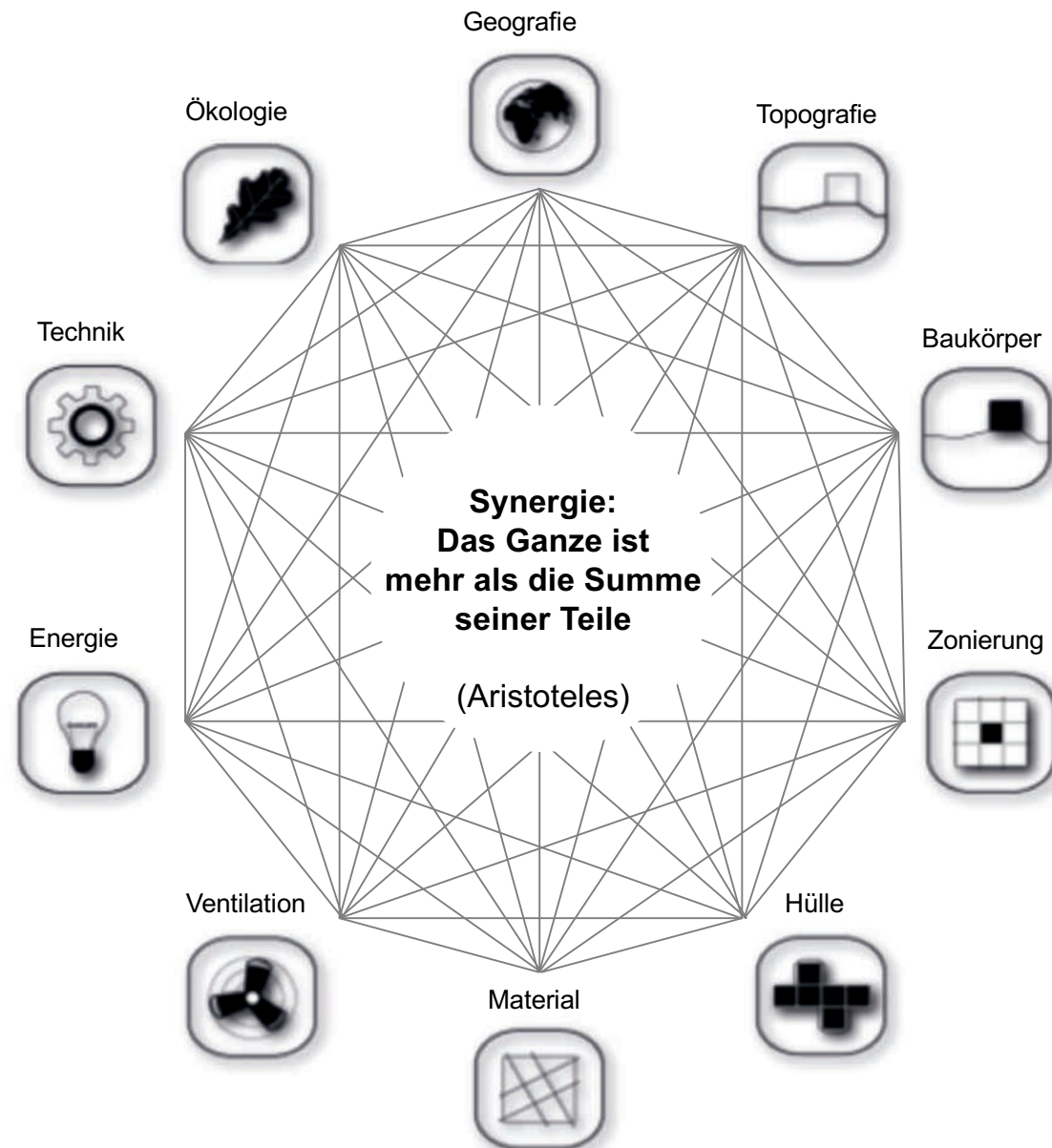
Reichardt, J.  
Ästhetik – Industrie Gewerbe Verwaltungsbauten  
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S. 10 ff.

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S. 41 ff.

Wiendahl, H.-P. / Reichardt, J. / Nyhuis, P.  
Handbuch Fabrikplanung –  
Konzept, Gestaltung und Umsetzung wandlungsfähiger Produktionsstätten  
München Wien 2009



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