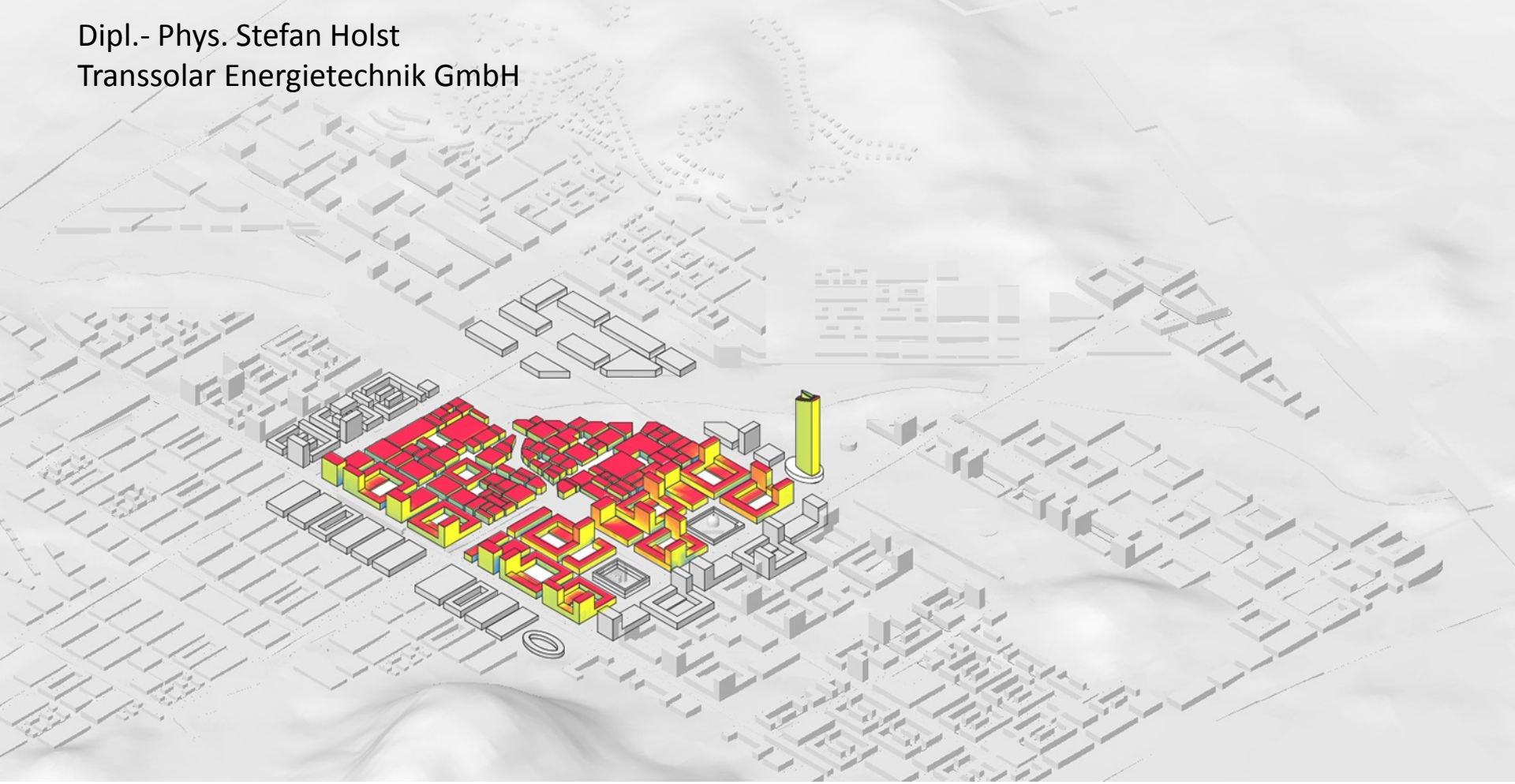
Wege zur Nachhaltigen Stadt:

Gebäudeeffizienz, Energieversorgung und Qualität des öffentlichen Raumes

Strategien, Konzepte und Modellierung dargestellt am Beispielprojekten

Dipl.- Phys. Stefan Holst
Transsolar Energietechnik GmbH



TRANSSOLAR Energietechnik

Technologien für energieeffizientes Bauen und Nutzerkomfort in Gebäuden

Gründung: 1992, 50 Mitarbeiter

Standorte: Stuttgart – München – New York - Paris

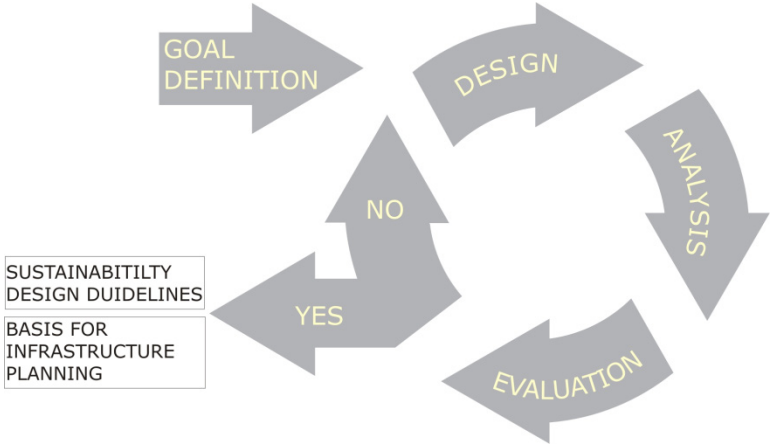
Geschäftsführer: Thomas Auer, Stefan Holst, Dieter Schnelle, Matthias Schuler

Erik Olsen (NY), Helmut Meyer (Paris)

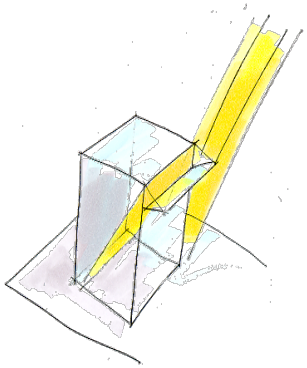
Wichtigste Tätigkeitsbereiche:

- Beratung und Entwicklung von Energie-, Klima- und Lüftungskonzepten
- Entwicklung und Vertrieb von Software für die thermische Gebäude- und Anlagensimulation (TRNSYS)
- Forschungsprojekte
- Ausbildung von Architekten und Ingenieuren im Bereich Klima-Engineering

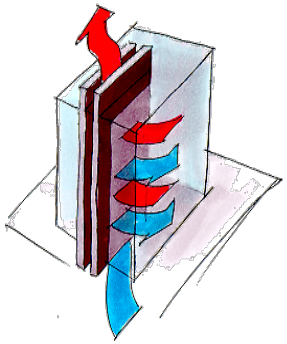
Zielsetzung: HIGH COMFORT – LOW IMPACT



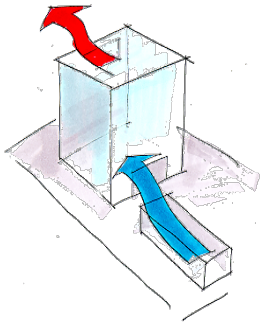
Iterativer Designprozess



Nutzen natürlicher Potenziale



Nutzen physikalischer Effekte



Synergien durch integrale Lösungen

CONSTRUCTING
ATMOSPHERES

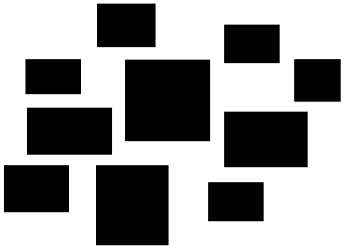
Wege zur Nachhaltigen Stadt:
Gebäudeeffizienz, Energieversorgung und Qualität des öffentlichen Raumes

Strategien, Konzepte und Modellierung dargestellt am Beispielprojekten

Agenda

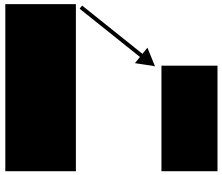
- Masterplan Centenary City Abuja, Nigeria
- Modellierung von Gebäuden und Energiesystemen
- Masterplan Maidar City, Mongolei

STRATEGIE



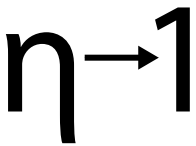
1

Optimierung der Städtebaulichen Struktur für Sonnenenergie, Tageslicht und Außenkomfort



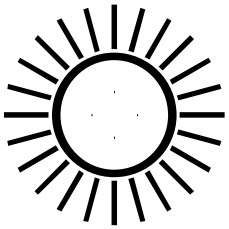
2

Reduktion des Energieverbrauches



3

Effiziente Energieerzeugung



4

Nutzung erneuerbarer Energien

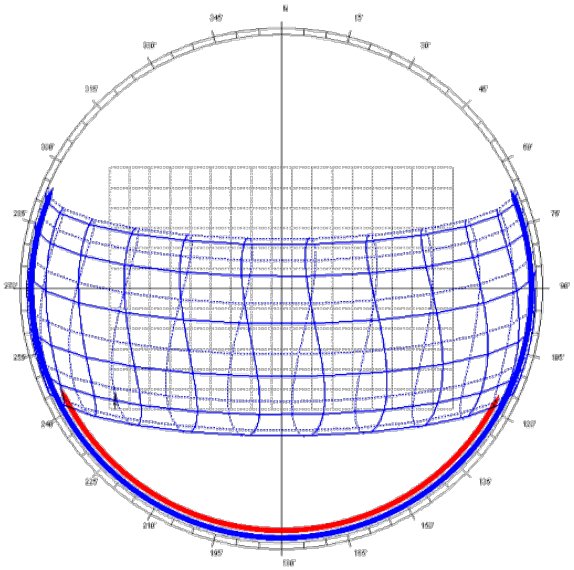
Centenary - City Abuja, Nigeria

Masterplan Centenary City Abuja, Nigeria

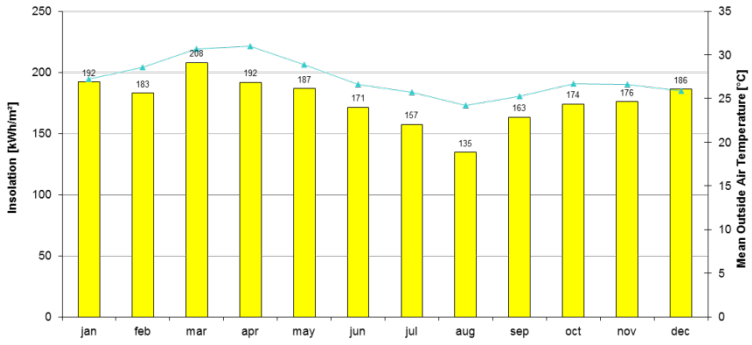
Nachhaltiger Masterplan für ein 13 km² Stadtquartier mit 200 000 Einwohnern, 2013

Auftraggeber:	Centenary City Ltd., Abuja, Nigeria
Stadtplanung, Verkehr:	Albert Speer+ Partner, Frankfurt
Landschaft + Wasser:	Atelier Dreiseitl, Überlingen
Klima + Energie:	Transsolar München
Infrastruktur:	Primetech, Nigeria, Julius Berger Int.

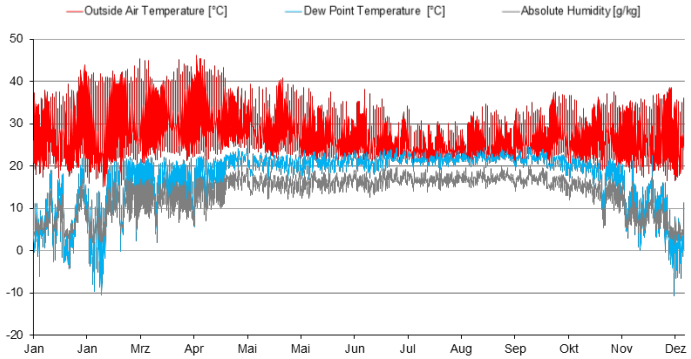
Masterplan Centenary City Abuja, Nigeria



Sonnenstandsdiagram

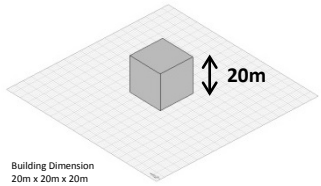


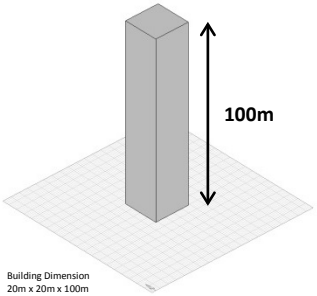
Monatliche Solareinstrahlung ca. 2100 kWh/m²/a
horizontale Globalstrahlung

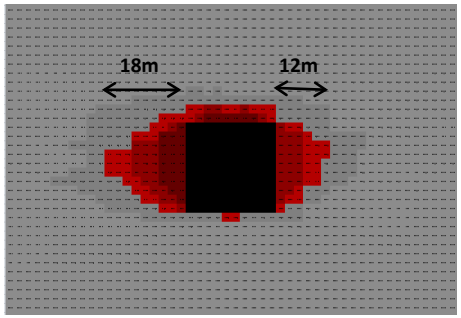


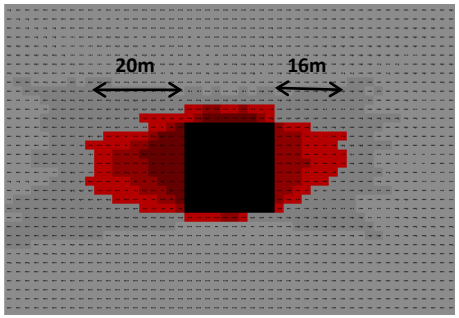
Außenlufttemperatur, Taupunkt und absolute Feuchtigkeit

Einfluss eines Gebäudes auf die Nachbarbebauung am Standort Abuja

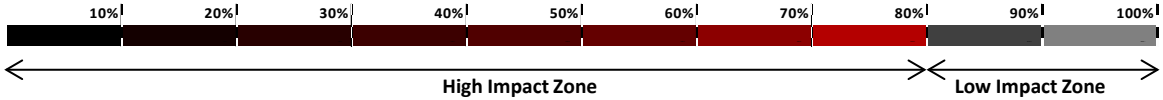








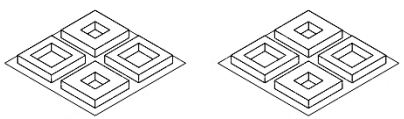
Solar Exposure Reduction



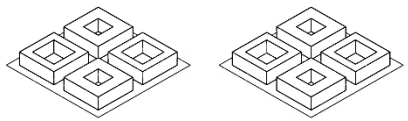
Untersuchung der Lichtqualität im Innenraum von verschieden urbanen Formen

1

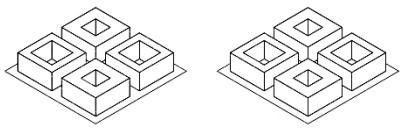
BLOCK 3F **FAR 1.2 | F/A 0.56 |**
DIM: 52.5m x 52.5m x 10.5m
DEPTH: 10m & 15m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



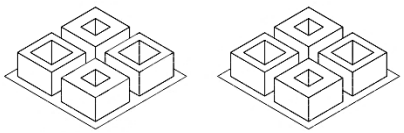
BLOCK 5F **FAR 2.0| F/A 0.56**
DIM: 52.5m x 52.5m x 17.5m
DEPTH: 10m & 15m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



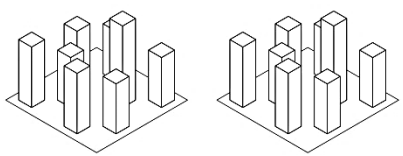
BLOCK 7F **FAR 2.8 |F/A 0.56 |**
DIM: 52.5m x 52.5m x 24.5m
DEPTH: 10m & 15m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



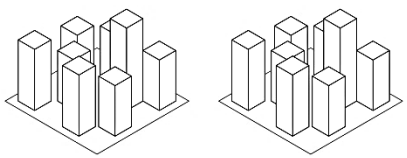
BLOCK 9F **FAR 3.6 | F/A 0.56**
DIM: 52.5m x 52.5m x 31.5m
DEPTH: 10m & 15m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



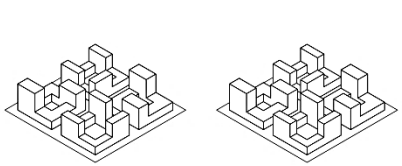
PENCIL TOWERS **FAR 3.5 | F/A 0.7 |**
DIM: 20m x 20m x 66.5-108.5m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



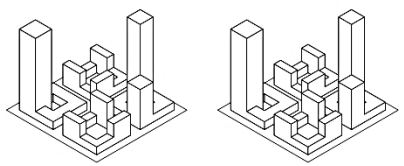
TOWERS **FAR 5.48 | F/A 0.56 |**
DIM: 25m x 25m x 66.5-108.5m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



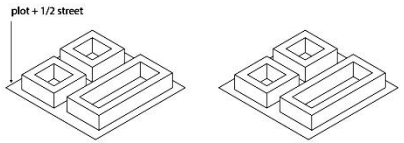
HYBRID LOW RISE **FAR 2.1 | F/A 0.68 |**
DIM: 52.5m x 52.5m x 28m
DEPTH: 10m & 15m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



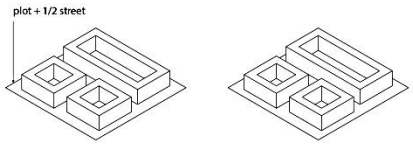
HYBRID HIGH RISE **FAR 3.4| F/A 0.64 |**
HEIGHTS: 10.5 m - 108.5
DEPTH: 10m, 15m, 20m, 25m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



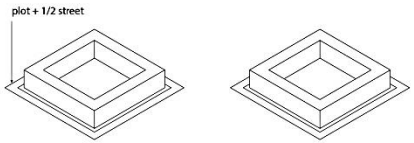
FACE **FAR 1.55 | F/A 0.8 |**
FLOOR h: 4m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



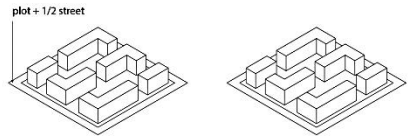
FACE_ROT **FAR 1.55 | F/A 0.8 |**
FLOOR h: 4m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



LARGE BLOCK **FAR 1.74 | F/A 0.53**
FLOOR h: 4m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



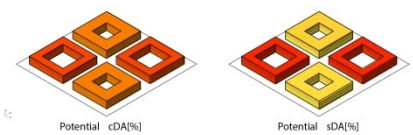
ROW VERTICAL **FAR 1.32| F/A 0.67 |**
FLOOR h: 4m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



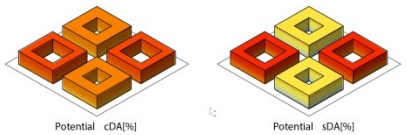
Untersuchung der Lichtqualität im Innenraum von verschieden urbanen Formen

1

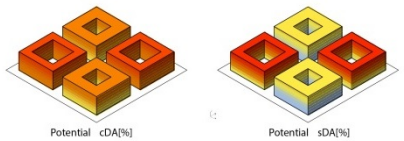
BLOCK 3F **FAR 1.2 | F/A 0.56 | cDA 82% | sDA 75%**
DIM: 52.5m x 52.5m x 10.5m
DEPTH: 10m & 15m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



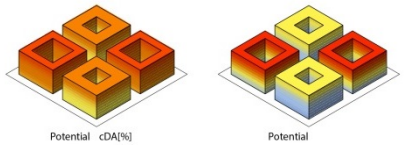
BLOCK 5F **FAR 2.0| F/A 0.56 | cDA 78% | sDA 67%**
DIM: 52.5m x 52.5m x 17.5m
DEPTH: 10m & 15m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



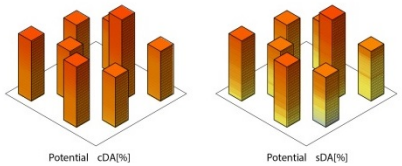
BLOCK 7F **FAR 2.8 |F/A 0.56 |cDA 74% | sDA 57%**
DIM: 52.5m x 52.5m x 24.5m
DEPTH: 10m & 15m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



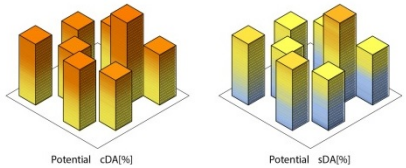
BLOCK 9F **FAR 3.6 | F/A 0.56 | cDA 69% | sDA 49%**
DIM: 52.5m x 52.5m x 31.5m
DEPTH: 10m & 15m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



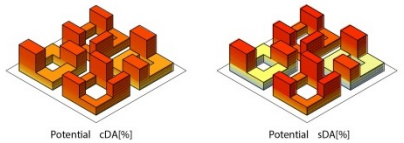
PENCIL TOWERS **FAR 3.5 | F/A 0.7 | cDA 78% | sDA 67%**
DIM: 20m x 20m x 66.5-108.5m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



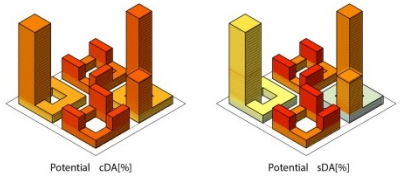
TOWERS **FAR 5.48 | F/A 0.56 | cDA 62% | sDA 38%**
DIM: 25m x 25m x 66.5-108.5m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



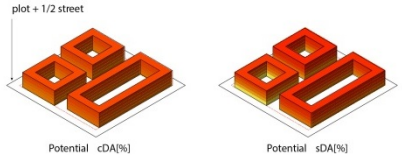
HYBRID LOW RISE **FAR 2.1 | F/A 0.68 | cDA 87% | sDA 88%**
DIM: 52.5m x 52.5m x 28m
DEPTH: 10m & 15m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



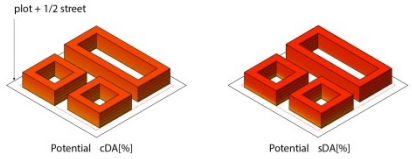
HYBRID HIGH RISE **FAR 3.4| F/A 0.64 | cDA 83% | sDA 75%**
HEIGHTS: 10.5 m - 108.5
DEPTH: 10m, 15m, 20m, 25m
FLOOR h: 3.5m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



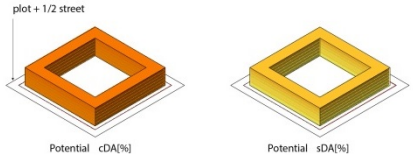
FACE **FAR 1.55 | F/A 0.8 | cDA 84% | sDA 83%**
FLOOR h: 4m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



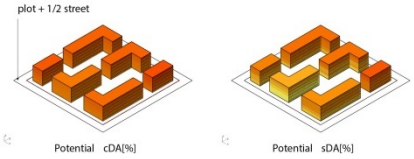
FACE_ROT **FAR 1.55 | F/A 0.8 | cDA 86% | sDA 93%**
FLOOR h: 4m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



LARGE BLOCK **FAR 1.74 | F/A 0.53 | cDA 77% | sDA 57%**
FLOOR h: 4m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



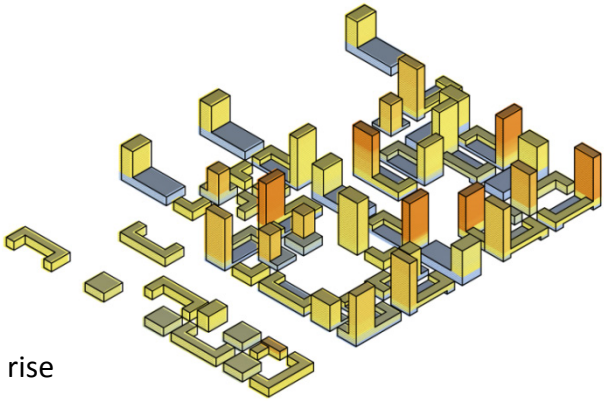
ROW VERTICAL **FAR 1.32| F/A 0.67 | cDA 82% | sDA 69%**
FLOOR h: 4m
WWR: 50%
GLASS: 50% diff
BLIND: 20,000lux 0.3 cut-off
TARGET: 300lux @0.8m h



Vergleich der Tageslichtqualität der bei gleicher Dichte (Kontinuierliche Tageslichtautonomie cDA)

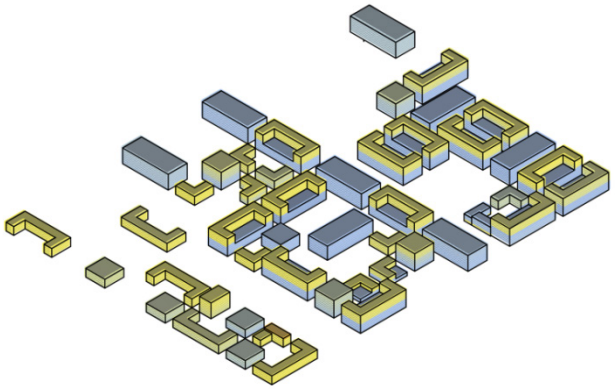
69 %

mixed low + high rise

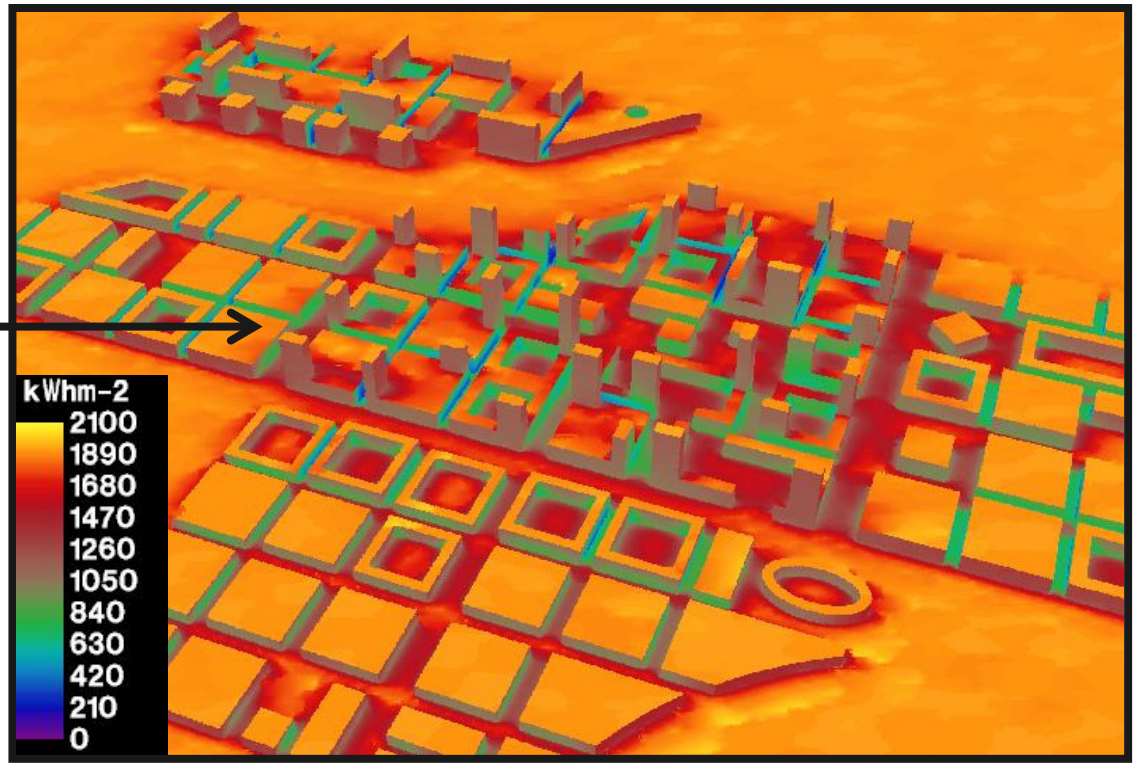


51 %

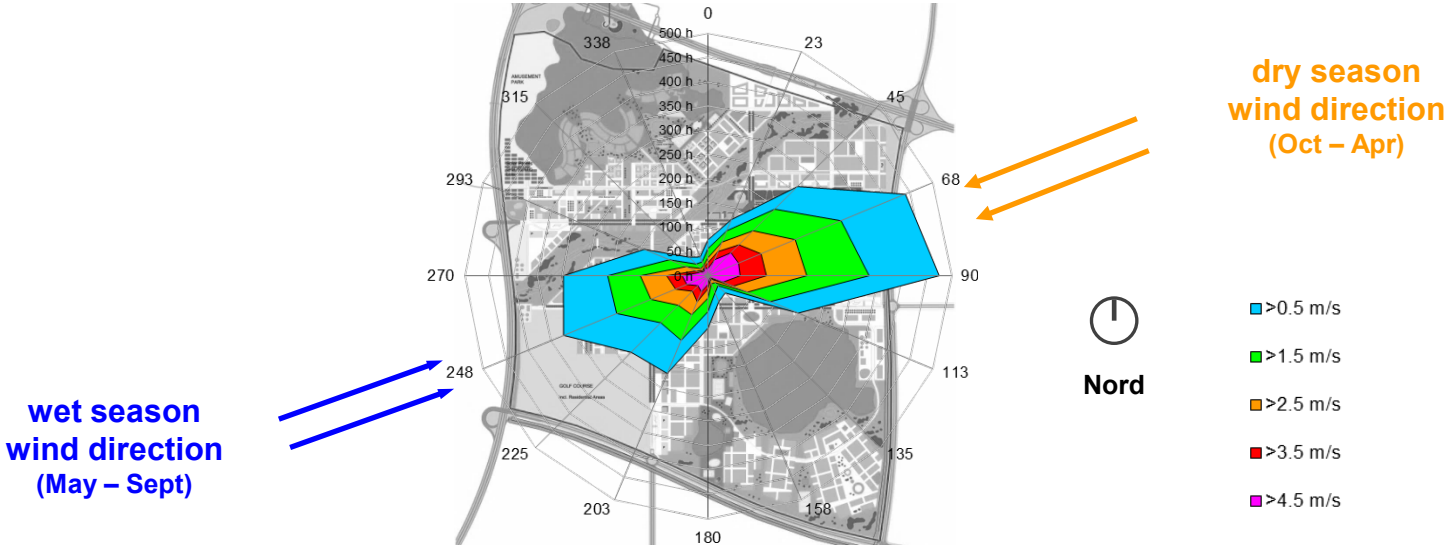
low rise only

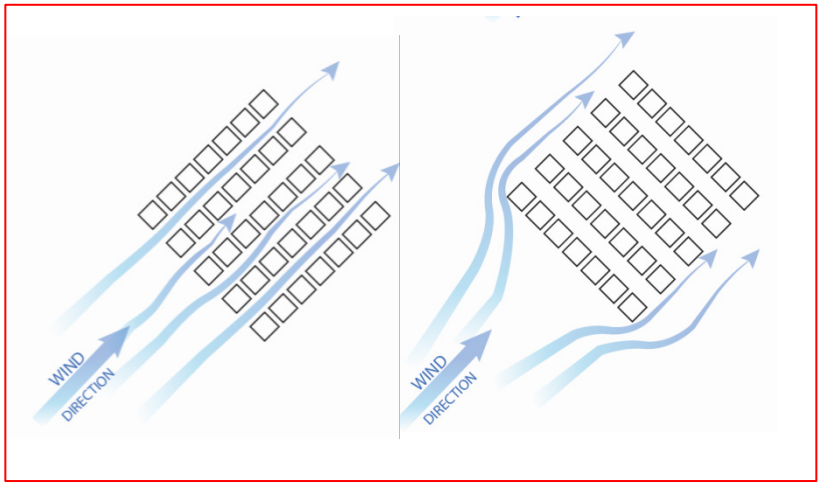


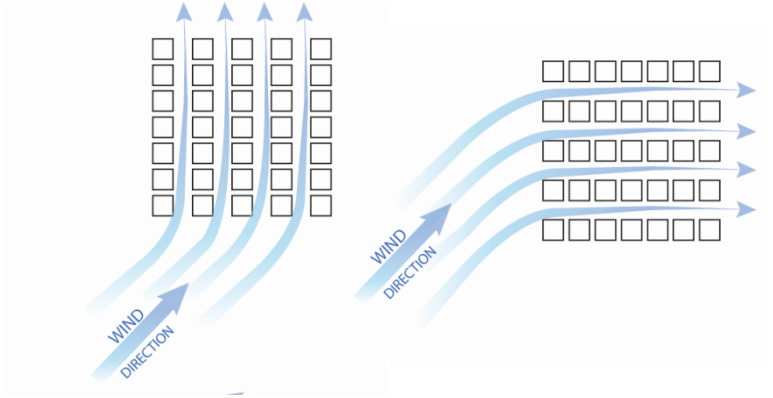
Jährliche Solareinstrahlung auf die Gebäudehülle und öffentlichen Raum



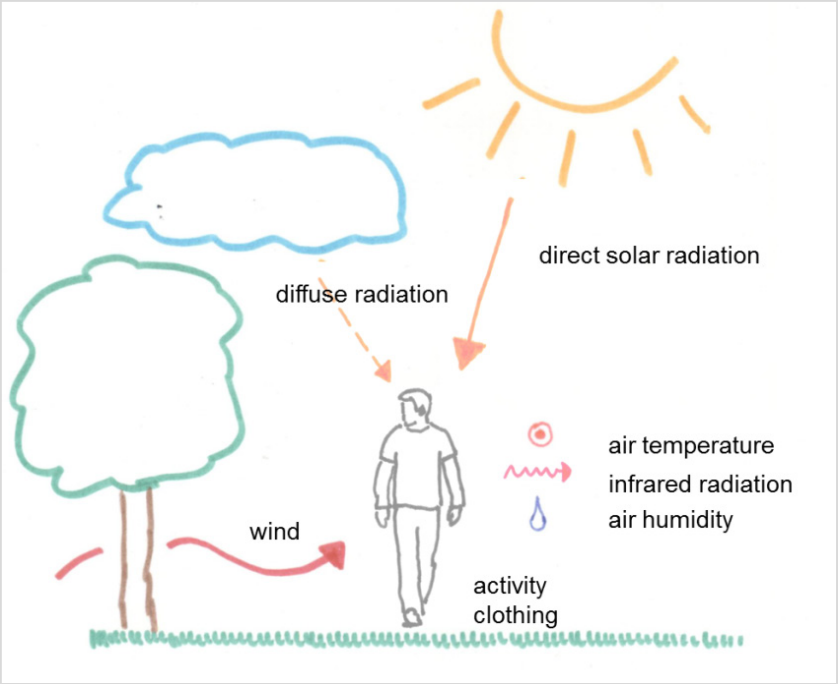
Einfluss des Windes auf die Stadt



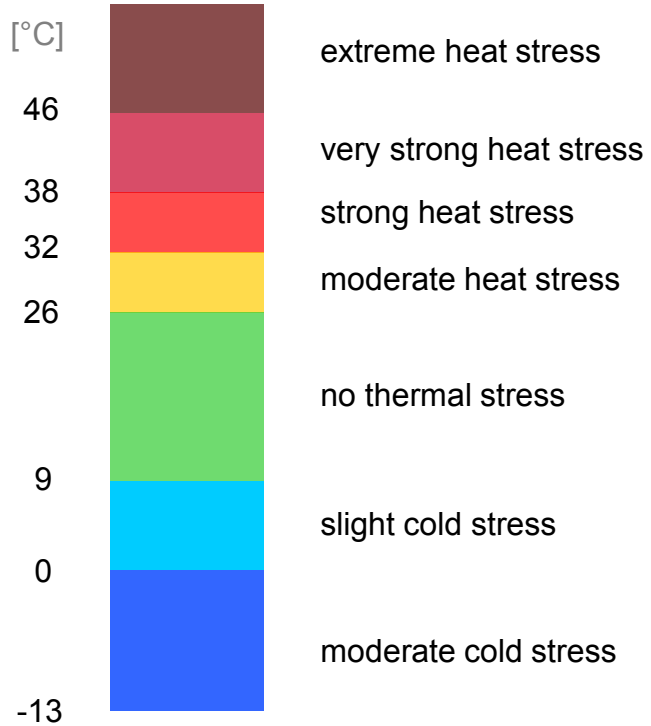




Bewertung des Außenkomforts über den Universal Thermal Climate Index UTCI



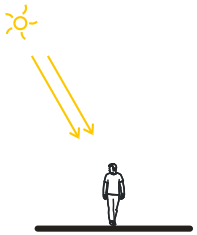
UTCI

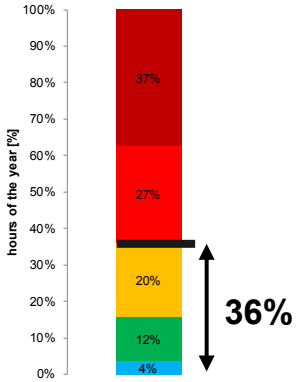


The thermal perception is determined and rated by the UTCI on the base of all relevant comfort influencing parameters

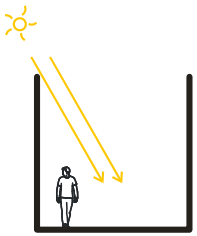
Außenkomfort in Abuja

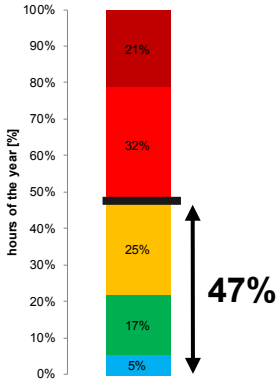
no shading





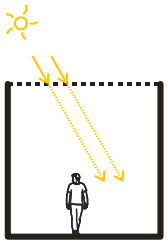
shading by buildings

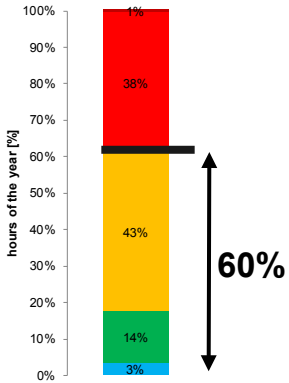




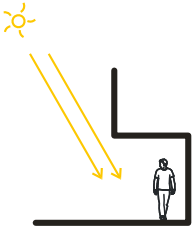
Außenkomfort in Abuja

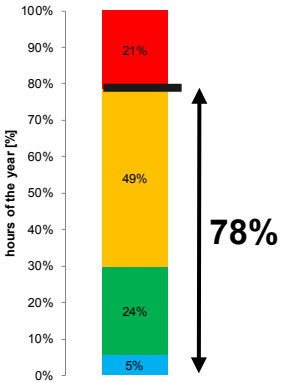
overhead shading screens





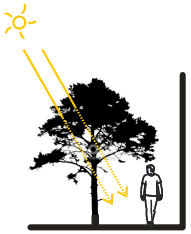
shading by arcaded sidewalks

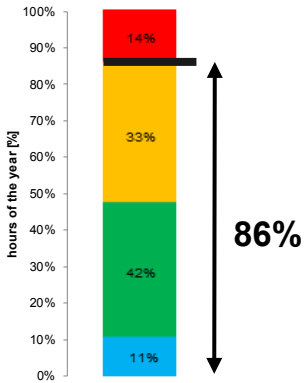




Außenkomfort in Abuja

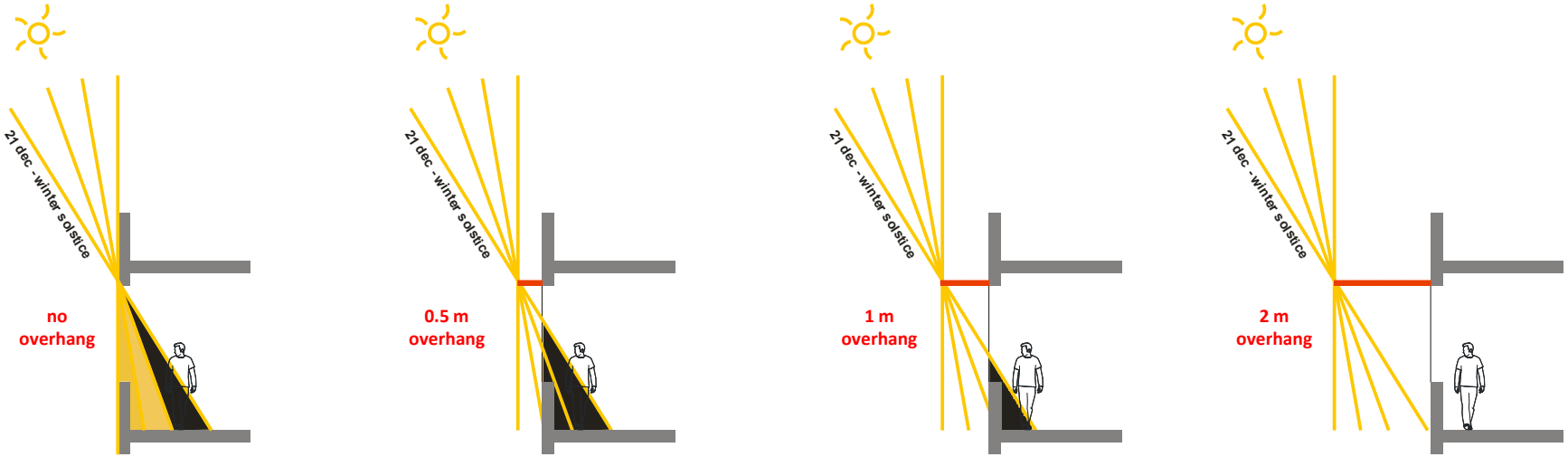
overhead shading
trees + water



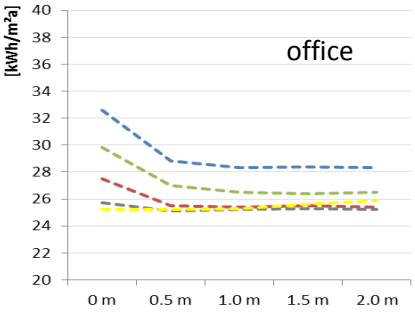


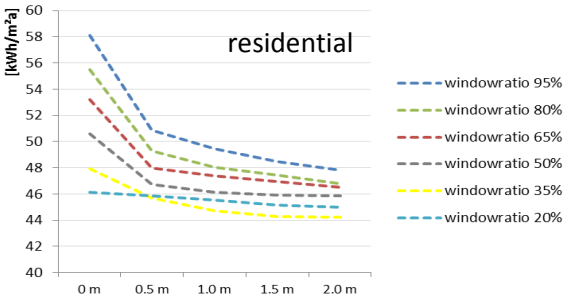
Optimierung der Gebäudehülle / Dachüberstande

2

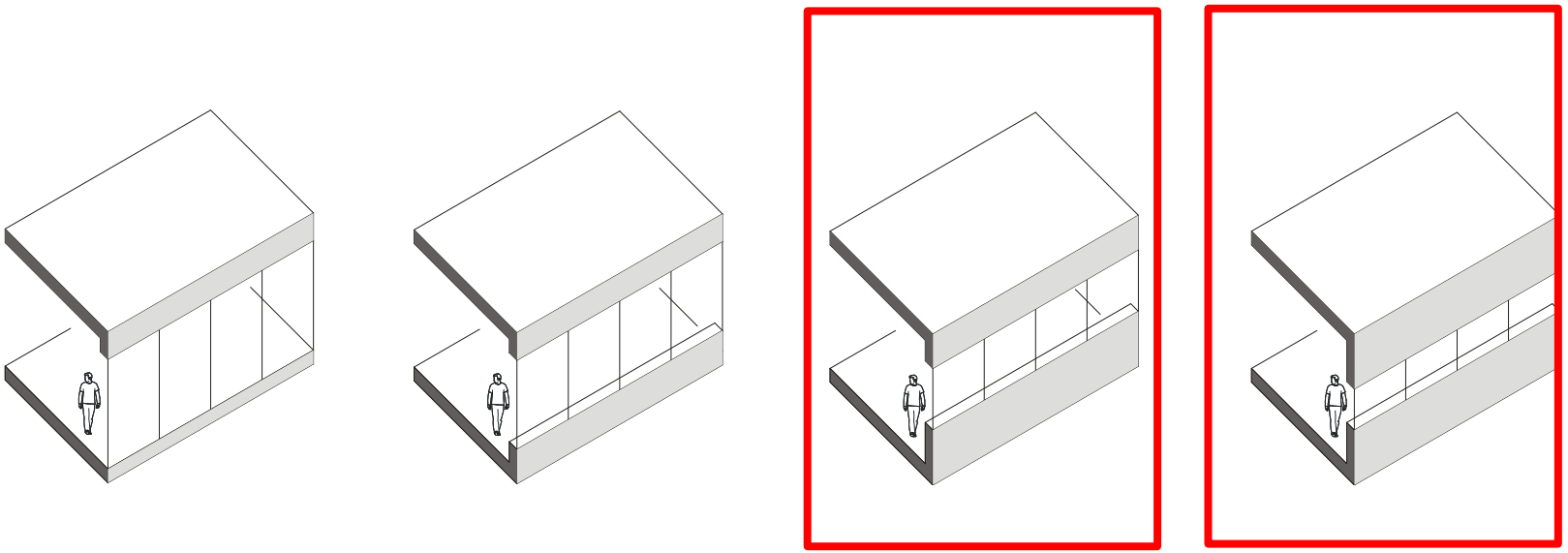


assessment of total electricity for cooling + lighting





Optimierung der Gebäudehülle / Fensteranteil



80%
window/wall ratio

65%
window/wall ratio

✓ **50%**
window/wall ratio

-14% savings

✓ **35%**
window/wall ratio

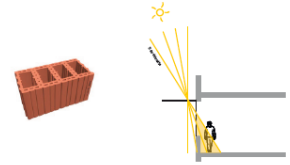
-10% savings

Optimierung der Gebäudehülle / Gebäudetechnik

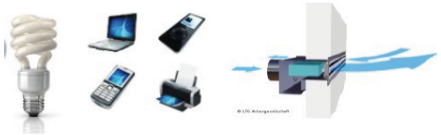
Reference Standard
(Existing Buildings in Nigeria)

Optimized Standard

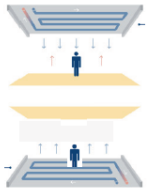
Optimized Building Facades:
20% savings

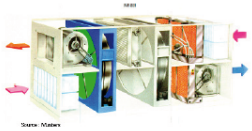


Optimized Building Operation:
19% savings

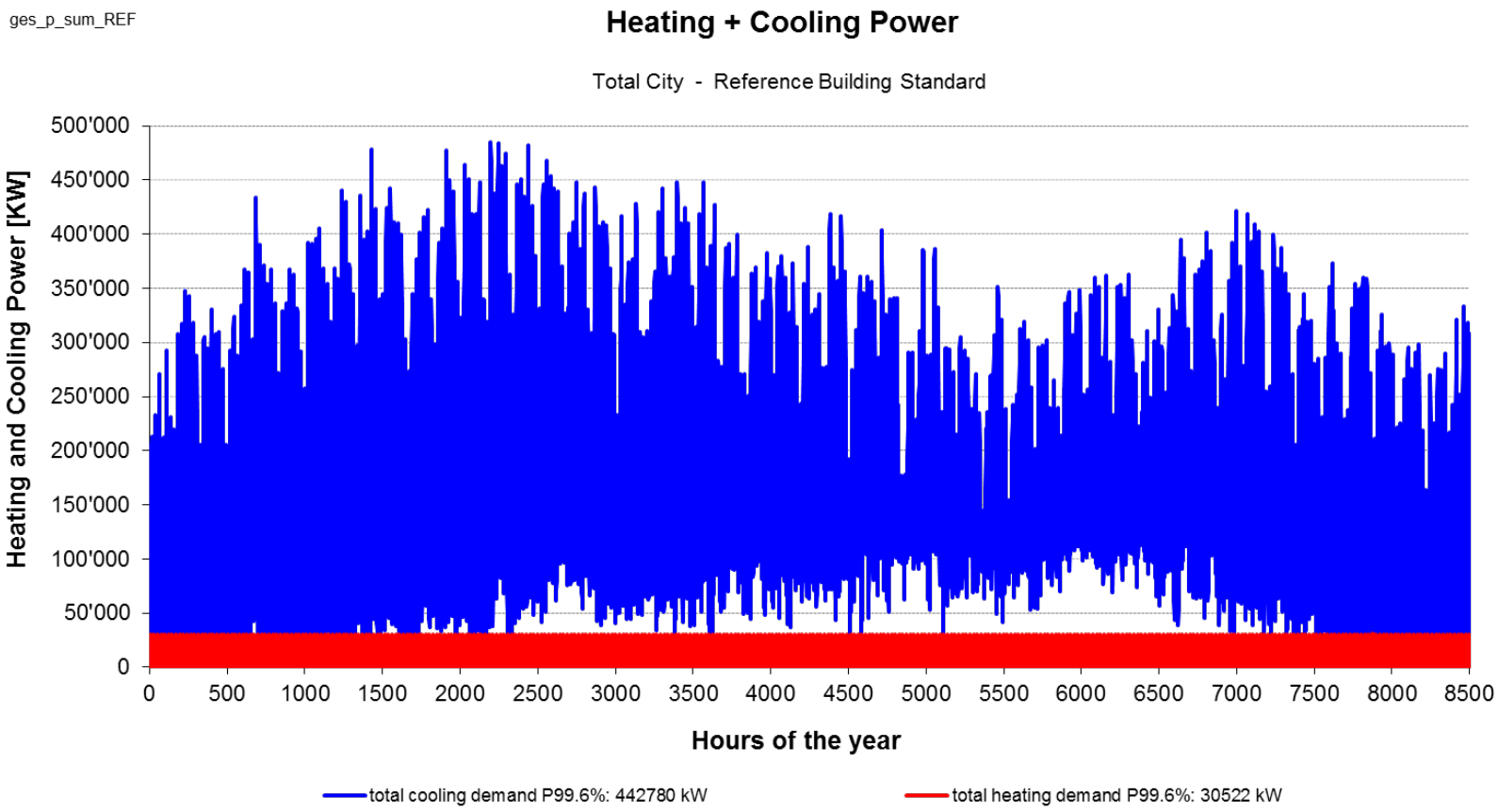


Optimized Building Systems:
16% savings

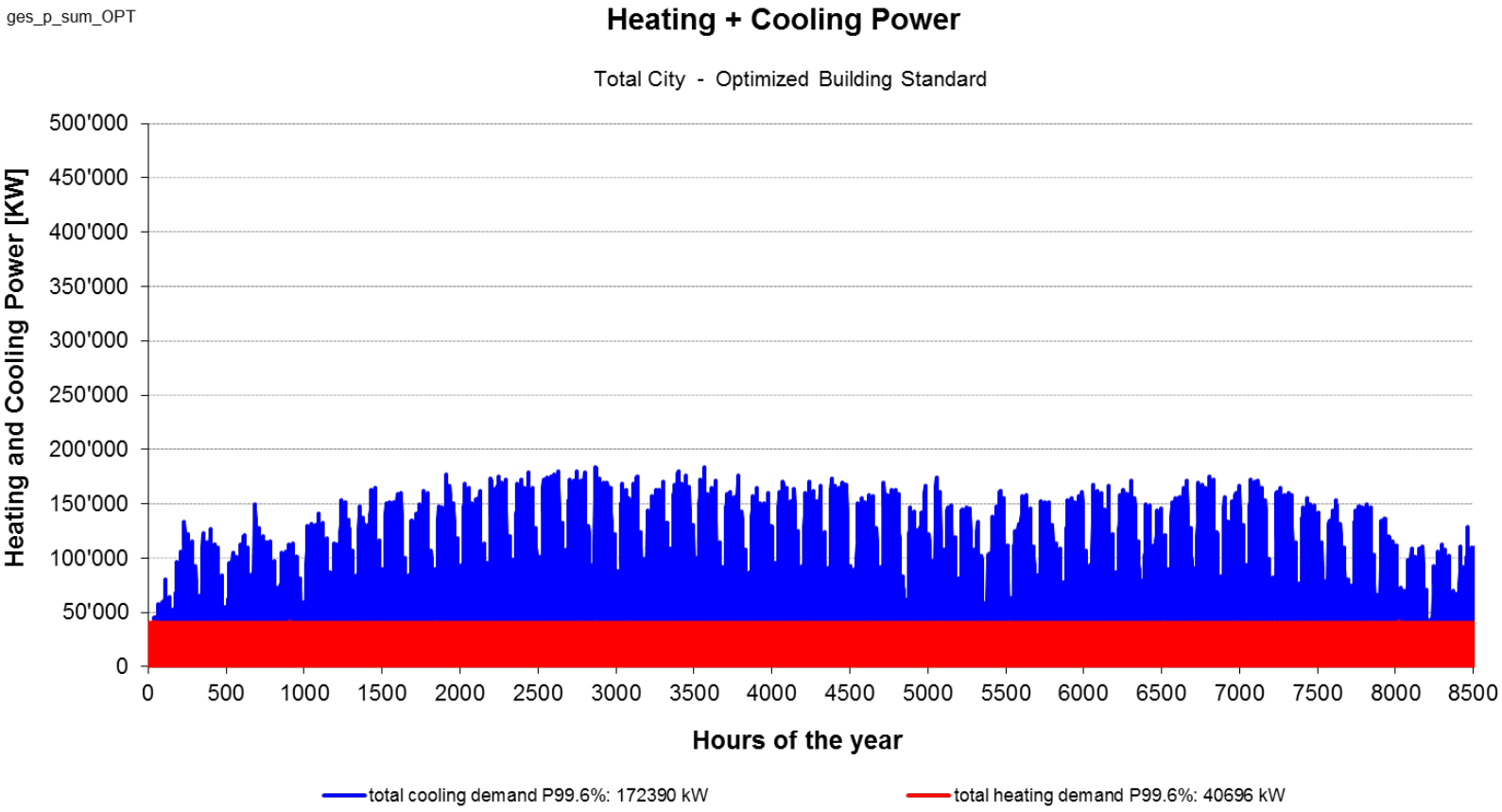




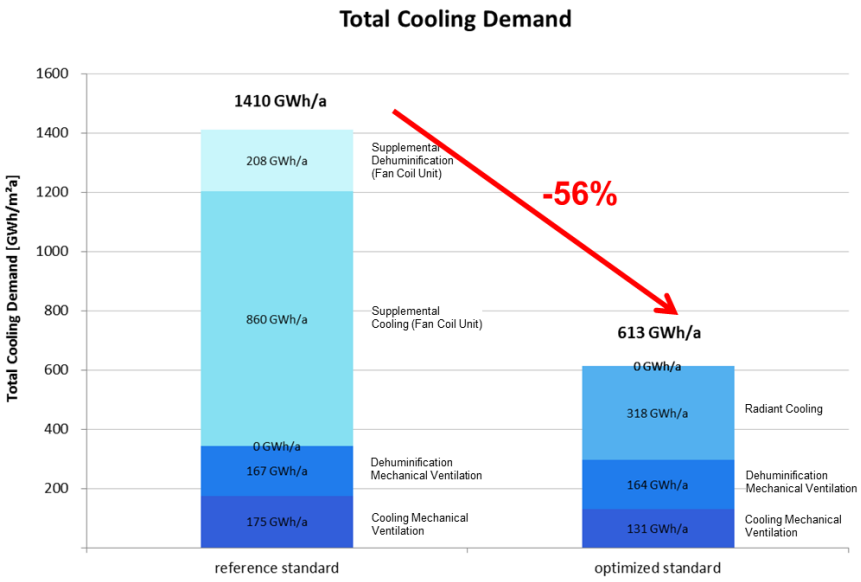
Ergebnisse der thermischen Simulation

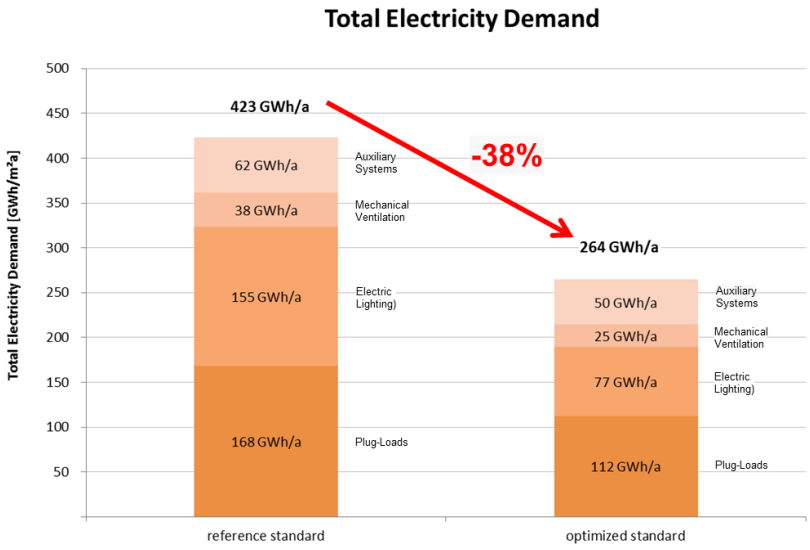


Ergebnisse der thermischen Simulation



Ergebnisse der thermischen Simulation

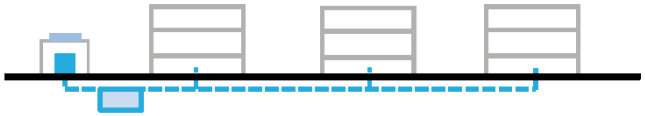




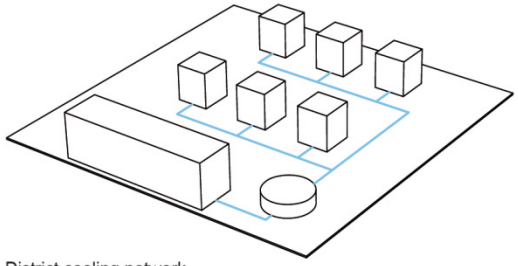
Effiziente Kühlsysteme / Kälteerzeugung

Cooling system per floor (e.g. facade split-system)

Cooling system per building (basement or roof systems)



District cooling (central top eff. chillers / heat rejection+storage+net)



District cooling network

High-efficiency chiller unit

Insulated pipes for cooling

η→1

Effiziente Kühlsysteme / Kälteerzeugung

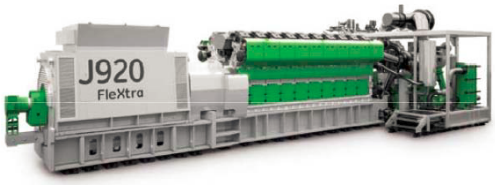
3

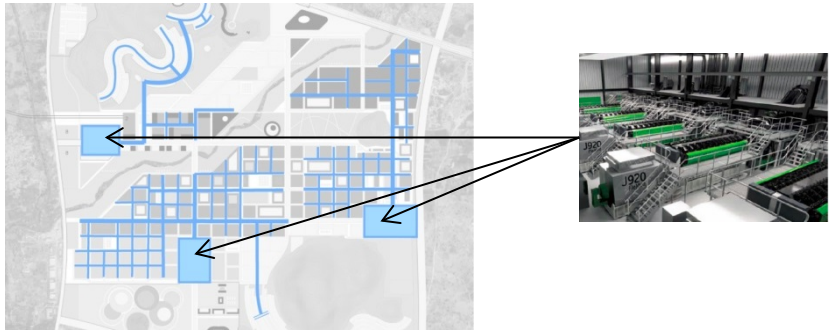
CHPP Combined Heat and Power Production

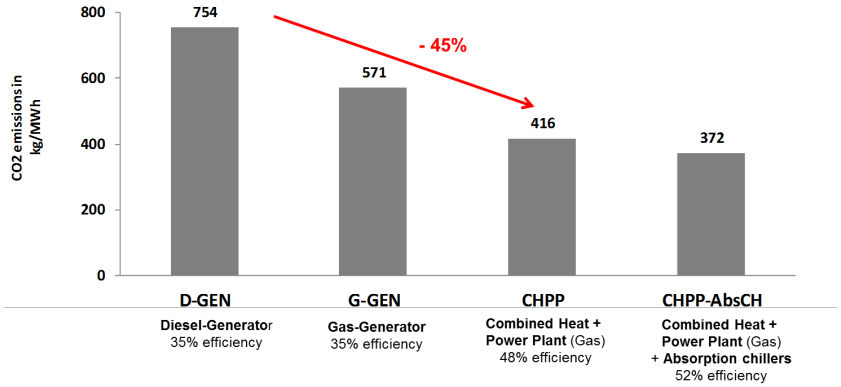
Example:

Jenbacher 920 cogen unit

Electrical power output:	9.5 MW
Thermal power output (70°C / 90°C):	s8.1 MW
Electrical efficiency:	48%
Thermal efficency:	42%
Total efficiency:	90%





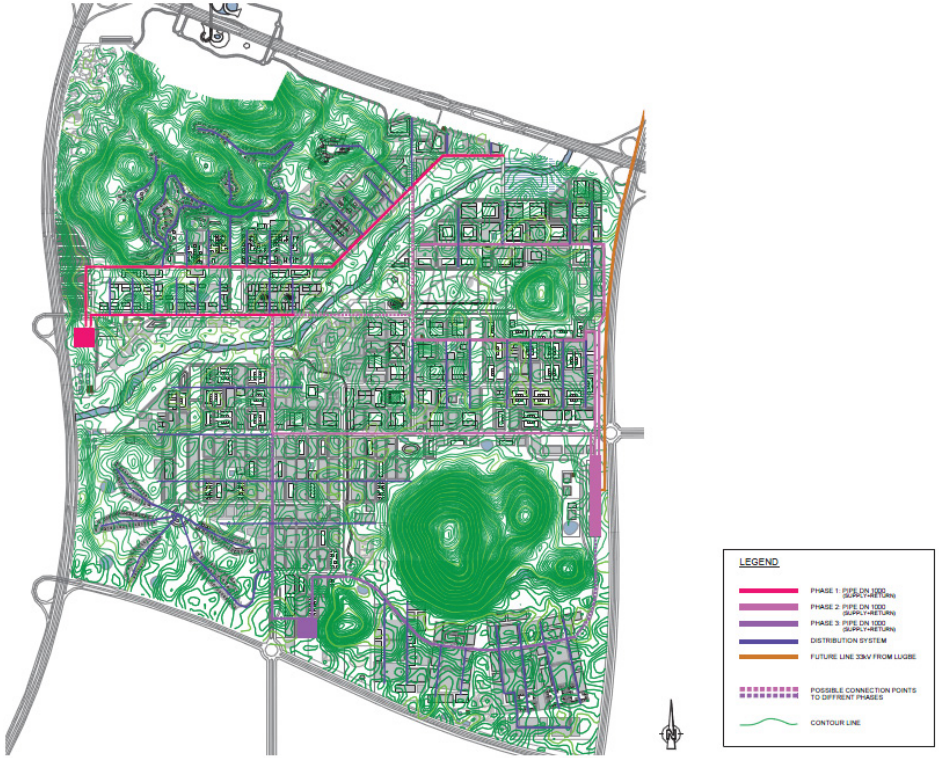


η→1

Effiziente Kühlsysteme / Kälteerzeugung

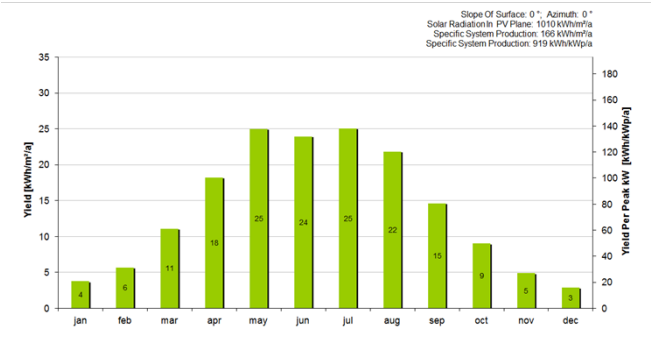
3

Technical Facility Layout Initial plant size layout - to be revised during next design phase	Phase 1	Phase 2	Phase 3
Cooling Plant + Network			
Peak Cooling Load	83 MW	141 MW	104 MW
Building Area	**1576 m²**	**2655 m²**	**1991 m²**
Cooling Net - Pipe Dimensions (rough estimate)	**DN 1000 + 10cm Insulation**	**DN 1000 + 30cm Insulation**	**DN 1000 + 10cm Insulation**
Cooling Net - Number of Supply Pipes (@ 2m/s)	**2**	3	**2**
Cooling Net - Number of Return Pipes (@ 2m/s)	**2**	3	**2**
Electricity Plant			
Area of building integrated photovoltaik modules	216919 m²	364424 m²	286333 m²
Peak Load after Renewables	27 MW	51 MW	33 MW
Plot Area Diesel Plant i	**2072 m²**		
Plot Area Gas Plant		**2857 m²**	**1905 m²**



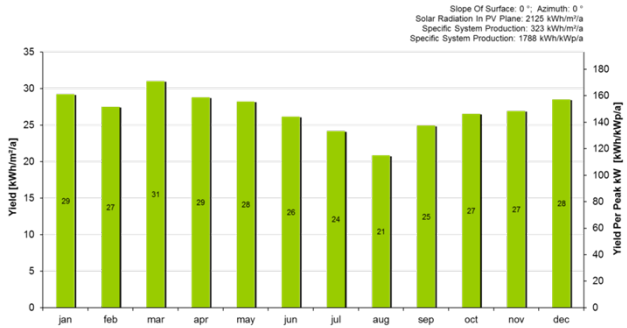
Anwendung erneuerbarer Energien

London



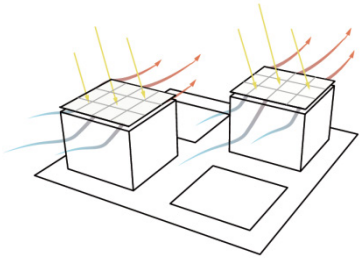
Electric Output in London:
919 kWh/a per kWp <> 166 kWh/m²a

Abuja

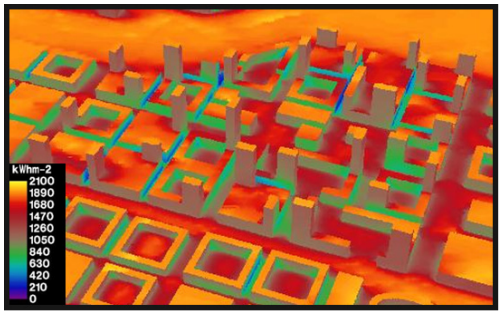


Electric Output in Abuja:
1788 kWh/a per kWp <> 323 kWh/m²a

100% → **195%**



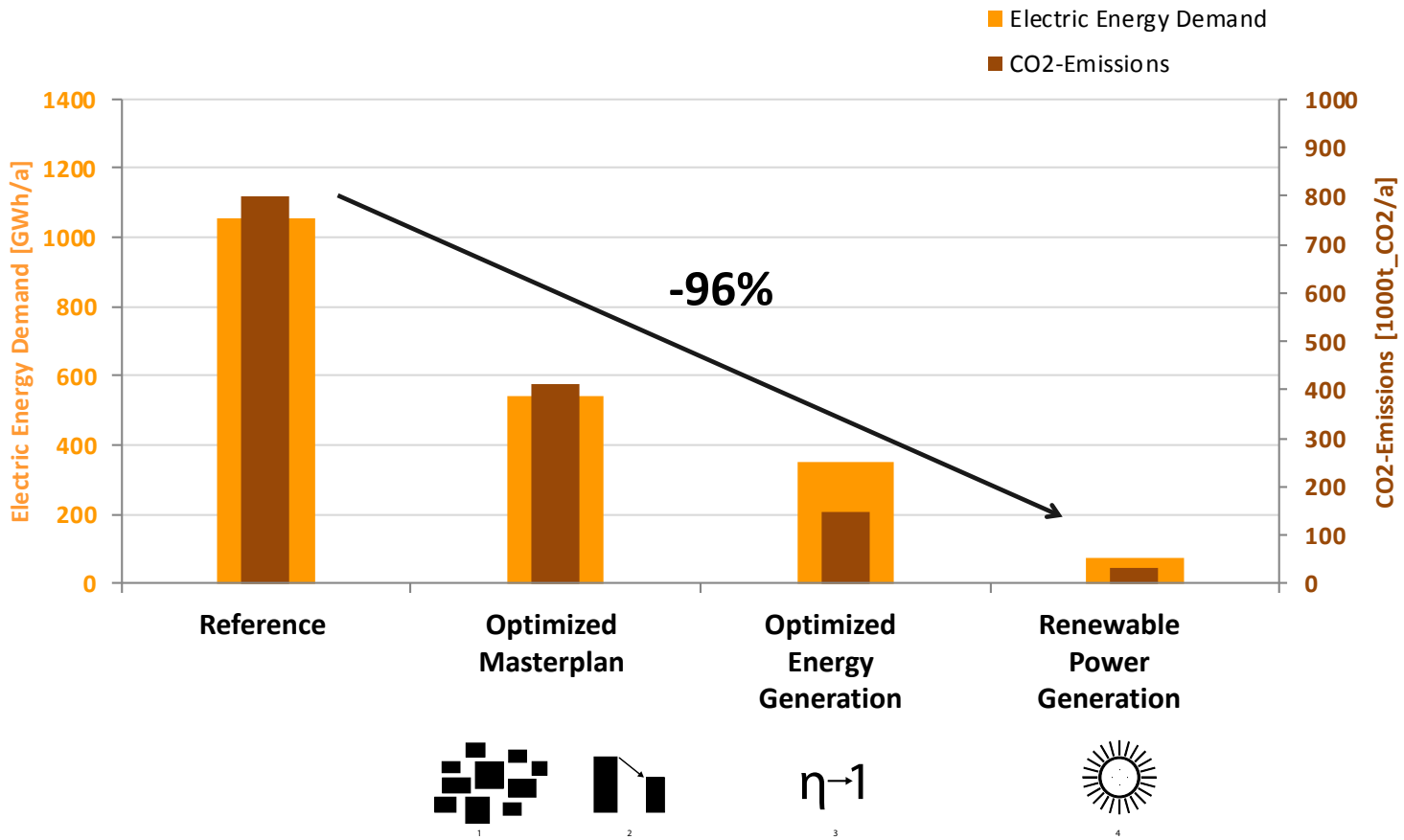
Horizontally mounted ventilated photovoltaic modules on roof tops
-> Shading of buildings and public realm
-> Generate renewable energy



50% of all roof area equipped with PV modules

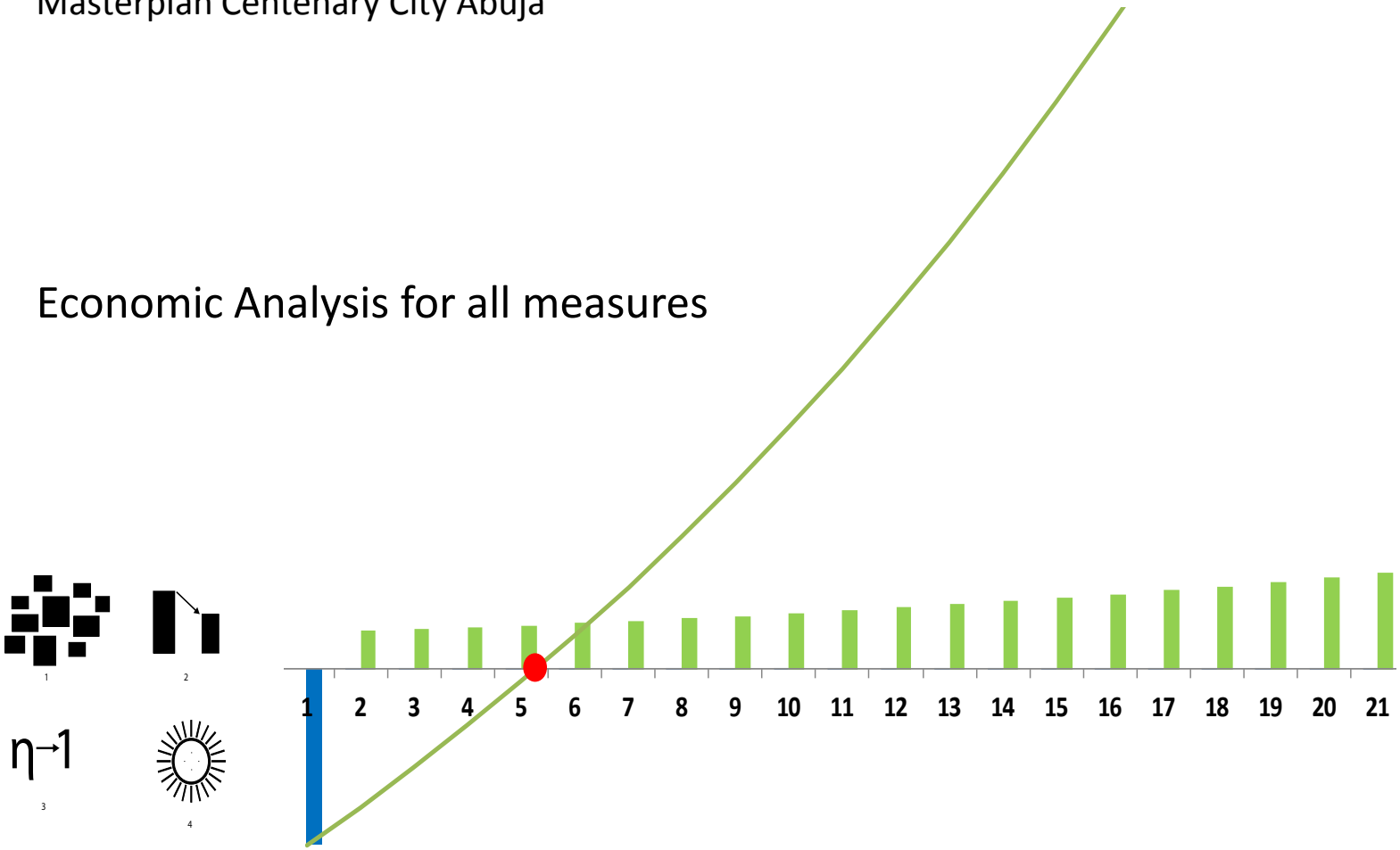
-> 810‘000 m² of PV -> 147 MW electrical power

Solar Electricity: 261 GWh per year


Electric Energy Demand
CO2-Emissions
Electric Energy Demand [GWh/a]
CO2-Emissions [1000t_CO2/a]
1400
1200
1000
800
600
400
200
0
1000
900
800
700
600
500
400
300
200
100
0
-96%
Reference
Optimized Masterplan
Optimized Energy Generation
Renewable Power Generation
η→1

Masterplan Centenary City Abuja

Economic Analysis for all measures



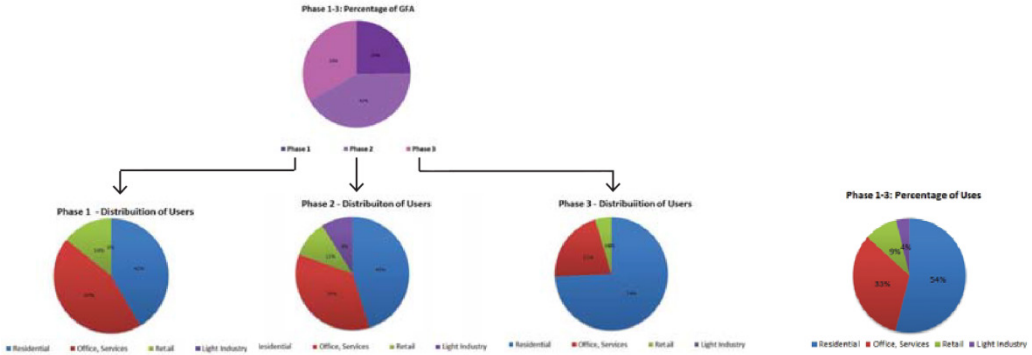
premium for sustainable city: **+8.5%** of total invest for city

cashflow

savings on running costs over **> 20%** of premium per year

return of invest after **5.5 years**

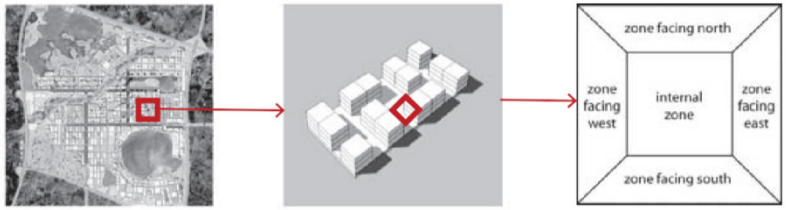
Modellierung von Gebäuden + Energiesystemen



ACC - area calc (AS&P 11.11.2013) Status: 11.11.2013	Gross Floor Area														
	Phase 1					Phase 2					Phase 3				
Land Use Category	Residential [m²_GFA]	Office, Services [m²_GFA]	Retail [m²_GFA]	Light Industry [m²_GFA]	Total [m²_GFA]	Residential [m²_GFA]	Office, Services [m²_GFA]	Retail [m²_GFA]	Light Industry [m²_GFA]	Total [m²_GFA]	Residential [m²_GFA]	Office, Services [m²_GFA]	Retail [m²_GFA]	Light Industry [m²_GFA]	Total [m²_GFA]
Centenary City Center	0	0	0	0		73634	49089	122723	0	245446	0	0	0	0	
Downtown	94524	75619	18905	0	189048	477698	382158	95540	0	955395	111070	88856	22214	0	222140
African Business District / Convention / Archive	44750	402748	0	0	447498	5152	46364	0	0	51516	0	0	0	0	
Commercial - Mall / Hotels	0	0	185410	0	185410	0	0	0	0		0	0	5502	0	5502
Central Areas	0	0	0	0		354591	101312	50656	0	506558	101804	29087	14543	0	145434
Residential *Low-Rise*	142470	5936	0	0	148406	0	0	0	0		351639	14652	0	0	366291
Residential *Mid-Rise*	334541	35010	19450	0	389001	0	0	0	0		877495	91831	51017	0	1020344
Residential *High-Rise*	1290	135	75	0	1500	224116	23454	13030	0	260601	78690	8235	4575	0	91500
Science Campus	18033	102185	0	0	120218	31974	181188	0	0	213162	0	0	0	0	
Light Industry	0	0	0	0		0	0	0	240569	240569	0	0	0	0	
Social Infrastructure	19495	77980	0	0	97475	39444	157777	0	0	197222	53744	214977	0	0	268722
Subtotal	**655102**	**699614**	**223840**	**0**		**1206609**	**941342**	**281948**	**240569**		**1574443**	**447638**	**97852**	**0**	
Total					**1578555**					**2670468**					**2119932**
Cumulated Total by Phase					**1578555**					**4249023**					**6368955**

ACC - area calc (AS&P 11.11.2013) Status: 11.11.2013	Net Floor Area Conversion Factor 0.9														
	Phase 1					Phase 2					Phase 3				
Land Use Category	Residential [m²_NFA]	Office, Services [m²_NFA]	Retail [m²_NFA]	Light Industry [m²_NFA]	Total [m²_GFA]	Residential [m²_NFA]	Office, Services [m²_NFA]	Retail [m²_NFA]	Light Industry [m²_NFA]	Total [m²_GFA]	Residential [m²_NFA]	Office, Services [m²_NFA]	Retail [m²_NFA]	Light Industry [m²_NFA]	Total [m²_GFA]
Centenary City Center	0	0	0	0	0	66270	44180	110451	0	220901	0	0	0	0	0
Downtown	85071	68057	17014	0	170143	429928	343942	85986	0	859856	99963	79970	19993	0	199926
African Business District / Convention / Archive	40275	362473	0	0	402748	4636	41728	0	0	46364	0	0	0	0	0
Commercial - Mall / Hotels	0	0	166869	0	166869	0	0	0	0	0	0	0	4952	0	4952
Central Areas	0	0	0	0	0	319132	91180	45590	0	455902	91623	26178	13089	0	130891
Residential *Low-Rise*	128223	5343	0	0	133565	0	0	0	0	0	316475	13186	0	0	329662
Residential *Mid-Rise*	301087	31509	17505	0	350101	0	0	0	0	0	789746	82648	45915	0	918309
Residential *High-Rise*	1161	122	68	0	1350	201705	21109	11727	0	234540	70821	7412	4118	0	82350
Science Campus	16229	91966	0	0	108196	28777	163069	0	0	191846	0	0	0	0	0
Light Industry	0	0	0	0	0	0	0	0	216512	216512	0	0	0	0	0
Social Infrastructure	17546	70182	0	0	87728	35500	142000	0	0	177500	48370	193480	0	0	241850
Subtotal	**589592**	**629652**	**201456**	**0**		**1085948**	**847208**	**253753**	**216512**		**1416999**	**402874**	**88066**	**0**	
Total					**1332972**					**2403421**					**1907939**
Cumulated Total by Phase					**1420700**					**3824121**					**5732060**

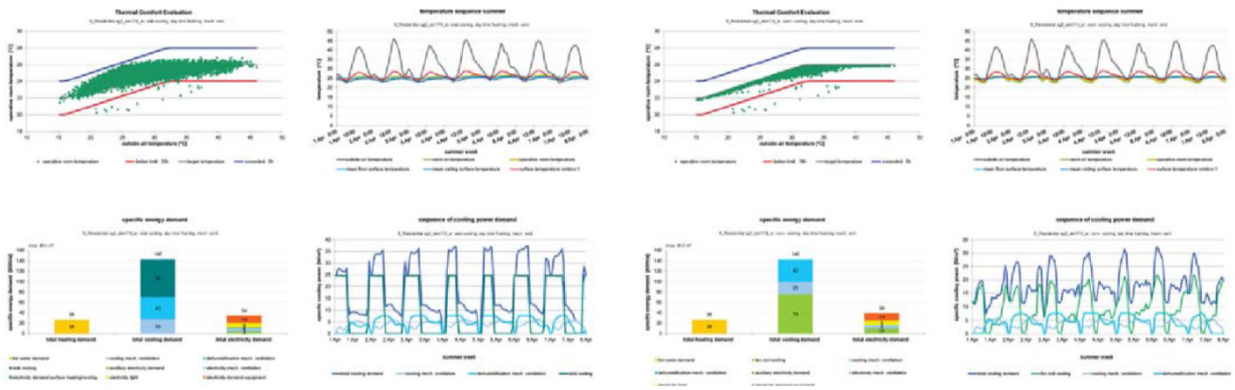
Modellierung von Gebäuden + Energiesystemen



Masterplan Scale | Building Scale | Zone Scale

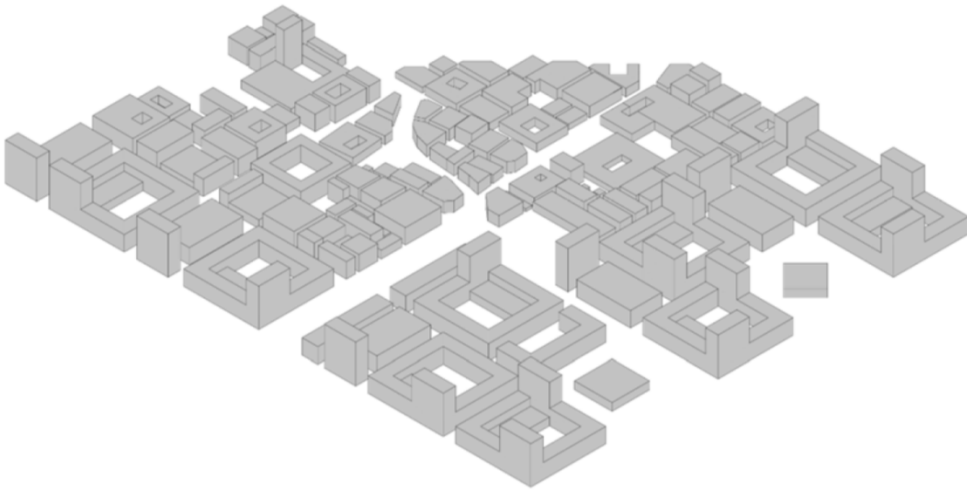
Performance Check: Impact of Active Slab vs. Fan Coil Unit

Active Slab System | Fan Coil Unit

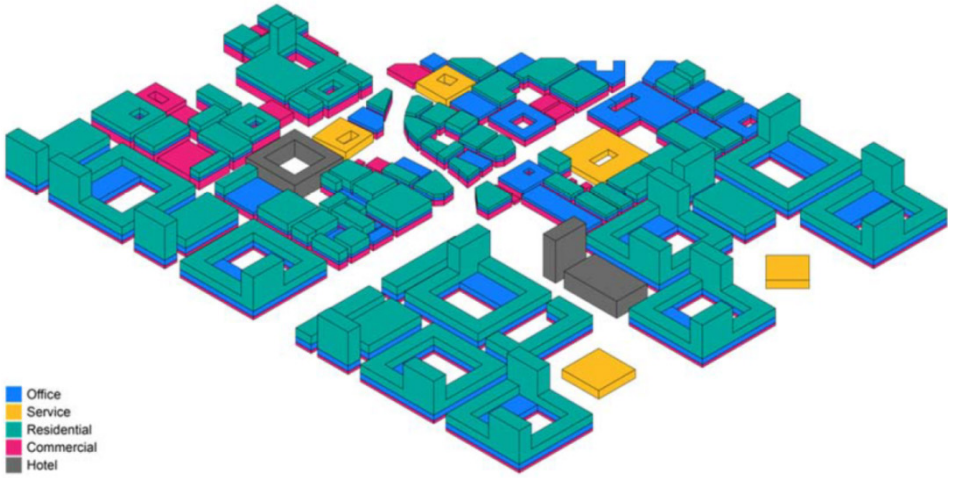


Modellierung von Gebäuden + Energiesystemen

Stadtmodel

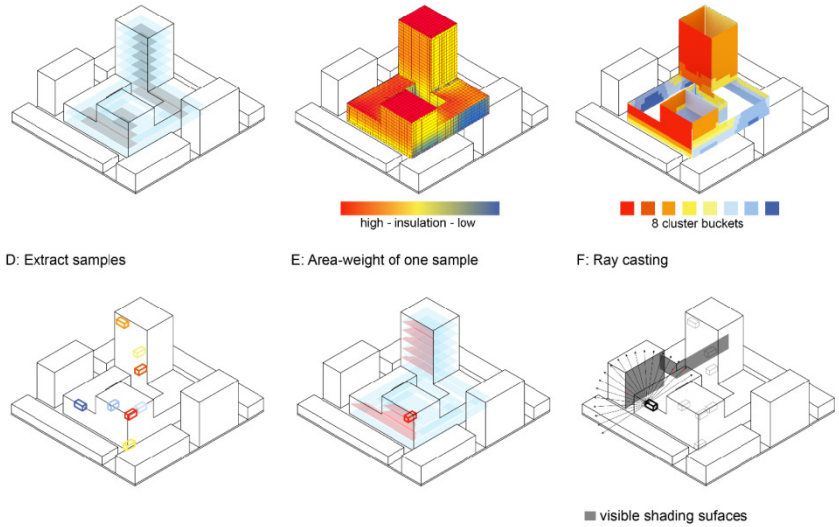


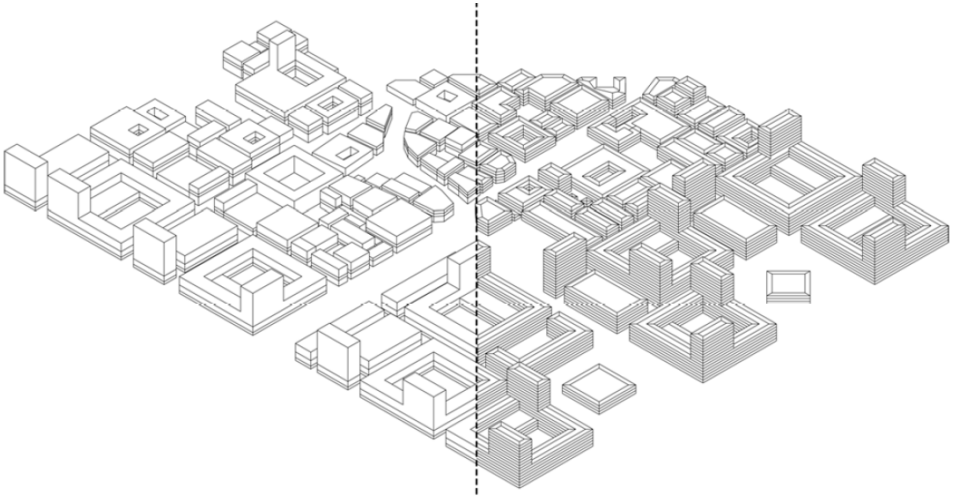
Nutzungen



Modellierung von Gebäuden + Energiesystemen

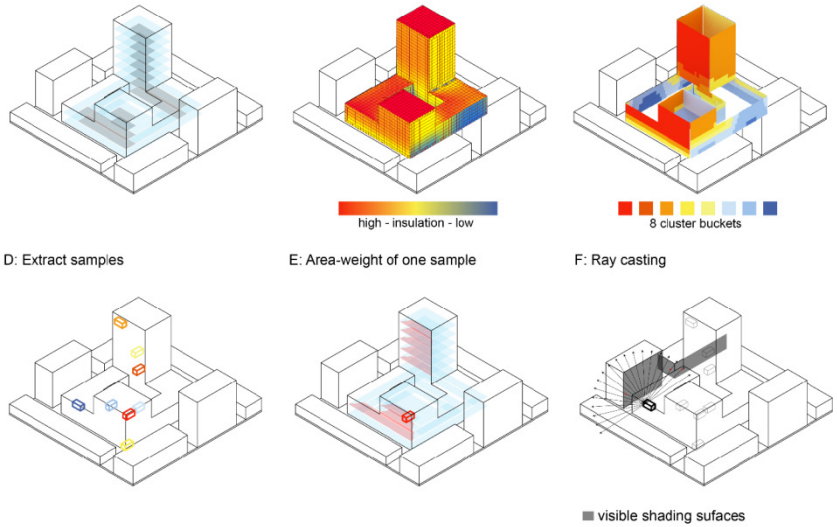
Automatische Gebäudezonierung





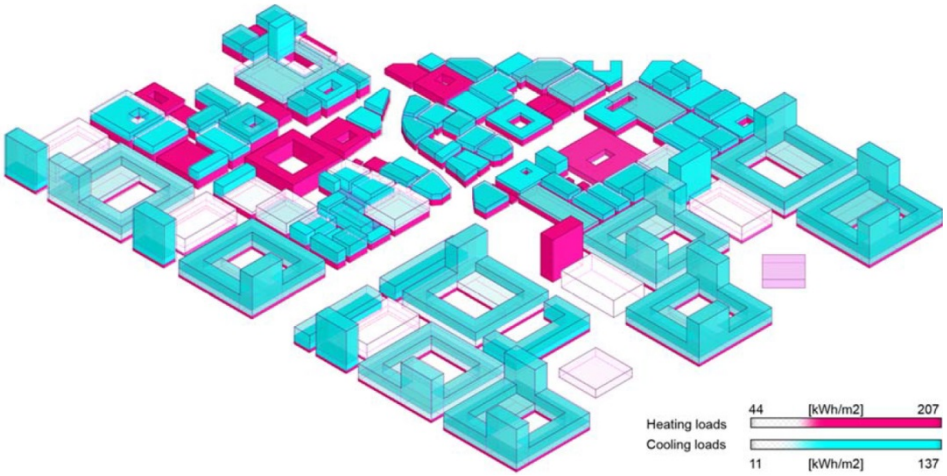
Modellierung von Gebäuden + Energiesystemen

Automatische Gebäudezonierung



TRNSYS

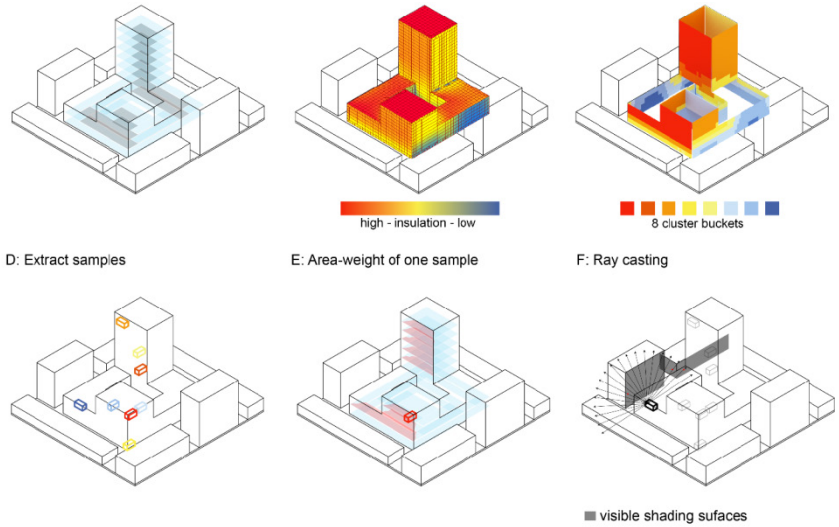
Simulation

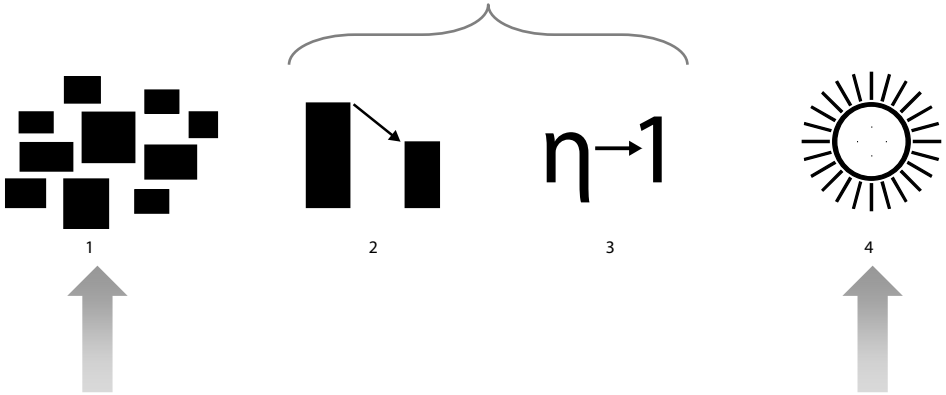


Ergebnisse der thermischen Simulation

Modellierung von Gebäuden + Energiesystemen

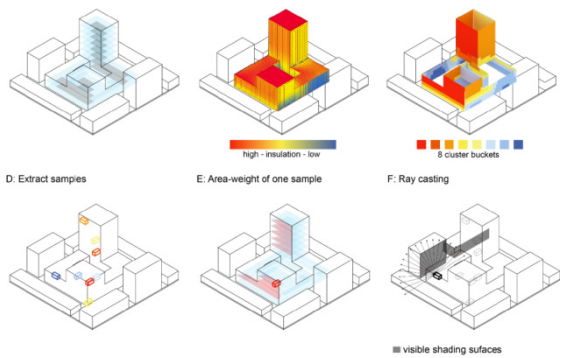
Automatische Gebäudezonierung





Parametrische Modellierung

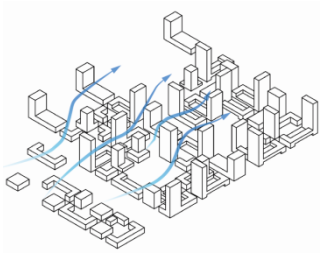
Entwicklung eines parametrischen Stadtmodells



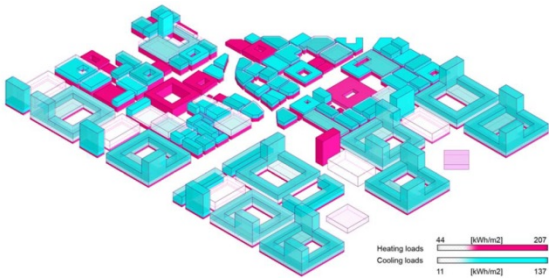
Gebäudezonierung

TRNSYS

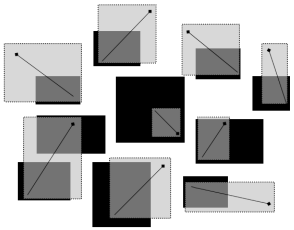
Thermische Simulation



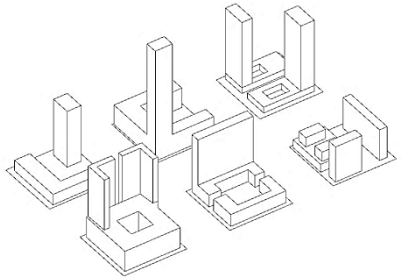
Umströmungsbewertung



Ergebnisse / Zielfunktion



Parametrische Modellierung
(Genetischer Algorithmus)



neue Varianten

Maidar - Ulaanbaatar, Mongolia

Maidar Eco City Masterplan

Ulaanbaatar
Mongolia

Client: Maidar City LLC, UB

Architect / Urban Planner: RSAA, Stefan Schmitz, Köln

Traffic: Ramboll, Finnland

Water Management: IB Kraft, Berlin

Auditor DGNB: Drees & Sommer, Stuttgart

MAIDAR CITY

Mongolia

MAIDAR CITY

- Land area: ≙ 5 x Germany
- Population: 3.2 Million (≙ Berlin)
- Mean altitude: +1500m

MAIDAR CITY

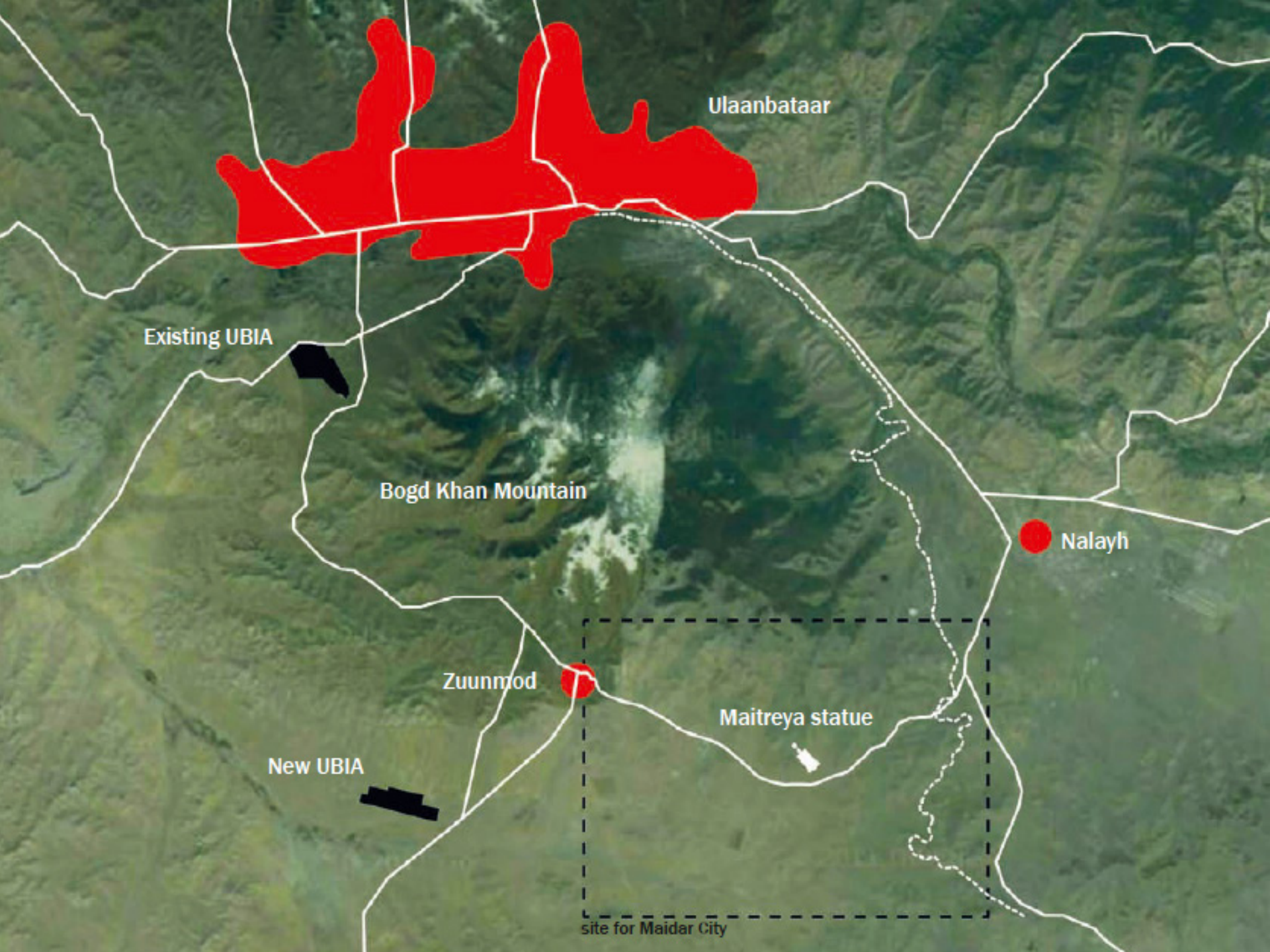
евермвц хэв шинжийг агуулсан, байгальд эелтэй (экo), соен гэгээрүүлэх, амралт чөлөөт цагийн цэцэрлэгт хүрээлэн байхын зэрэгцээ Будда ланд бүхий хүүхэд, залуучуудын чөлөөт цагаа зөв боловсон өнгөрүүлэх, үзвэр үйлчилгээний, өлөн үлсын цогцолбор байх юм.

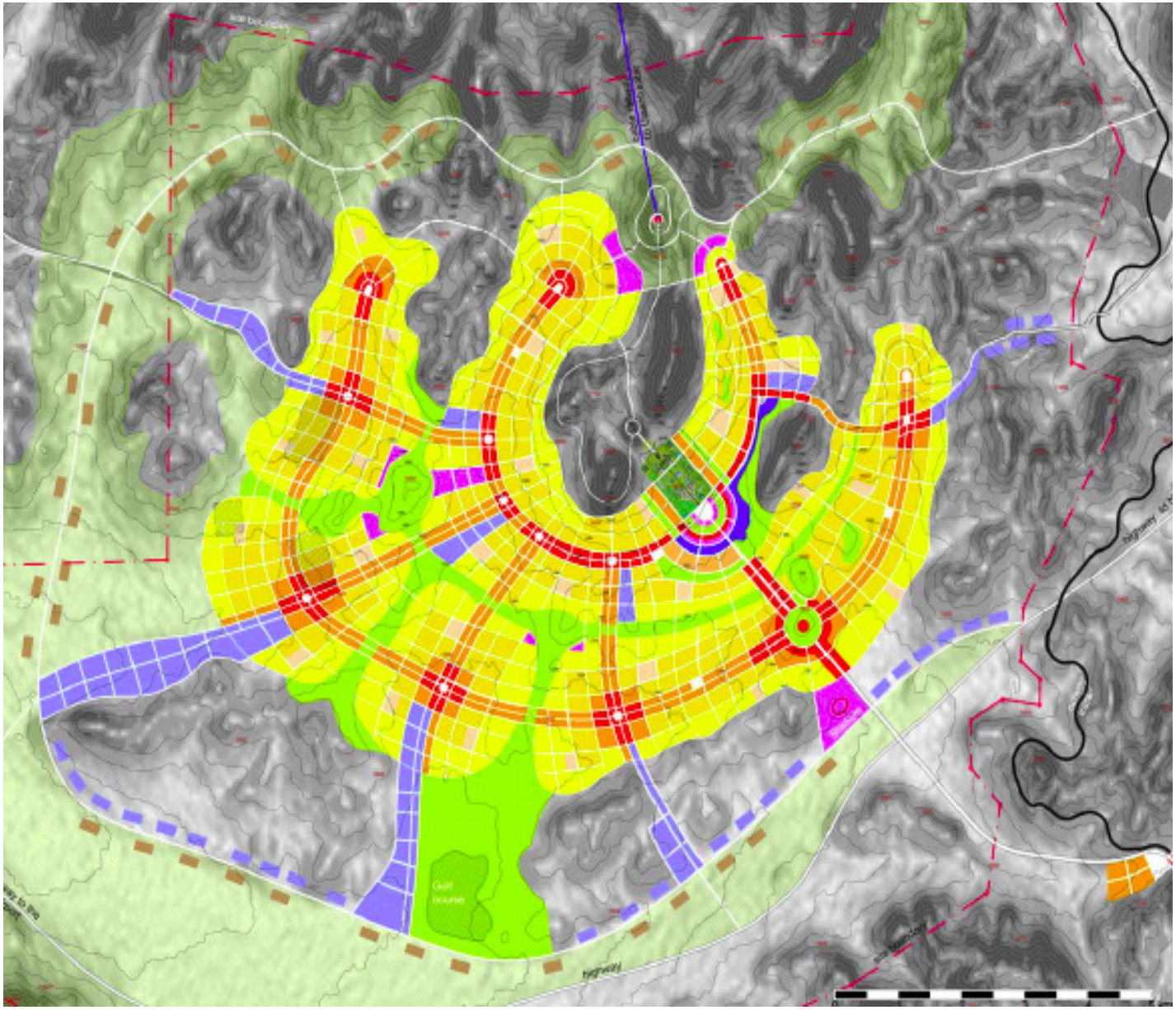
177 feet 1 inch
(54 meters)

MAIDAR CITY

Нью Иорк хот дахь
Эрх чөлөөний хөшөө /46 метр/
Төлөвлөж буй
Их Майдар бурхан /54 метр/

Stage 1:
8 km²
40,000
people
Stage 4:
54 km²
280,000
people

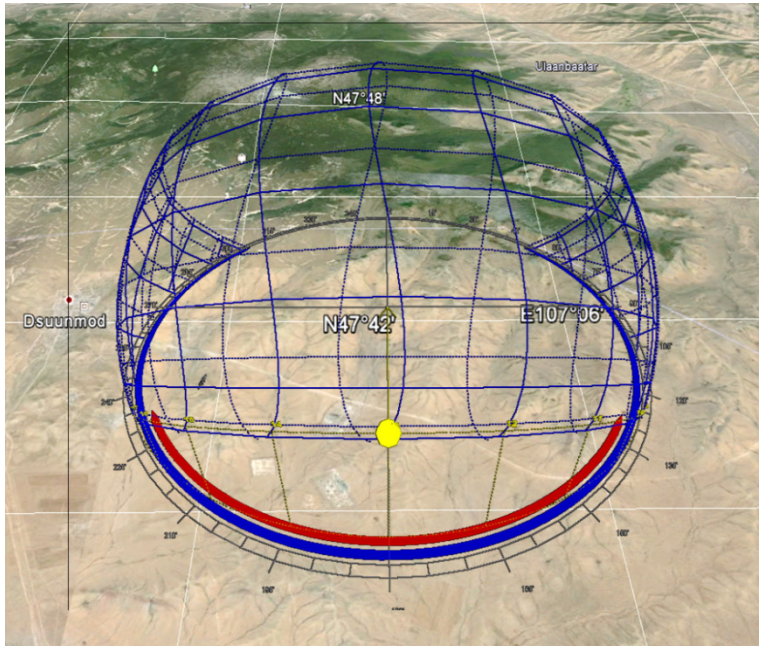

Ulaanbataar
Existing UBIA
Bogd Khan Mountain
Nalayh
Zuunmod
Maitreya statue
New UBIA
site for Maidar City



MAIDAR CITY

- Residential low density
- Residentail high density
- Mixed use
- Commercial / Offices / Center Uses
- University
- Public buildings / School
- Culture
- Cultivated green
- Industry / Trade
- Agricultural facilities

The site…



Annual sun path over site

Ulaanbaatar, Mongolia
General character: semi-arid steppe climate with cold winters

Ulaanbaatar is located at an altitude of 1730m in the heart of Mongolia.

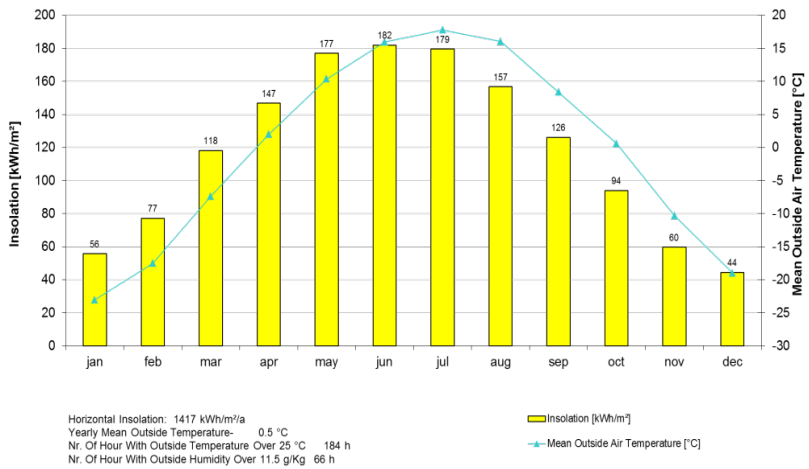
Both annual an diurnal temperature differences are high with winter lows well below -30°C and summer highs up to about 35°C. Daily swings between day and night can be as high as 20 – 30 K.

Horizontal annual solar insolation is high at about 1400 – 1700 kWh/m²a.

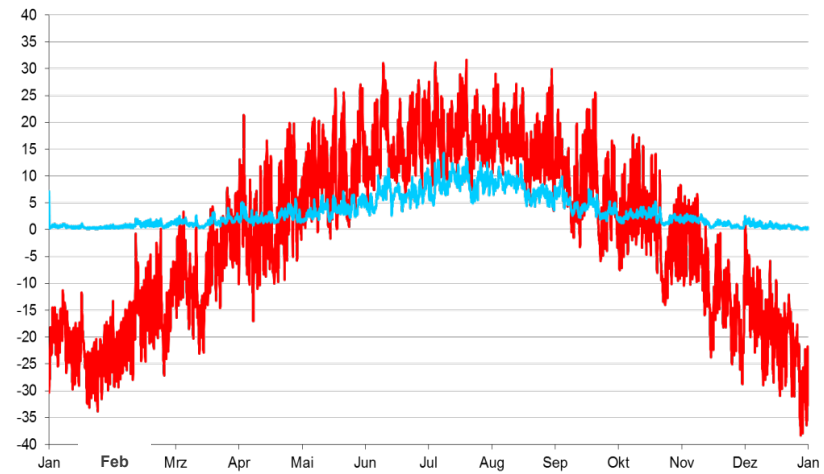
Absolute humidity levels remain below 15 g/kg.

Winds are prevailing from North throughout the year and remain at moderate wind speeds.

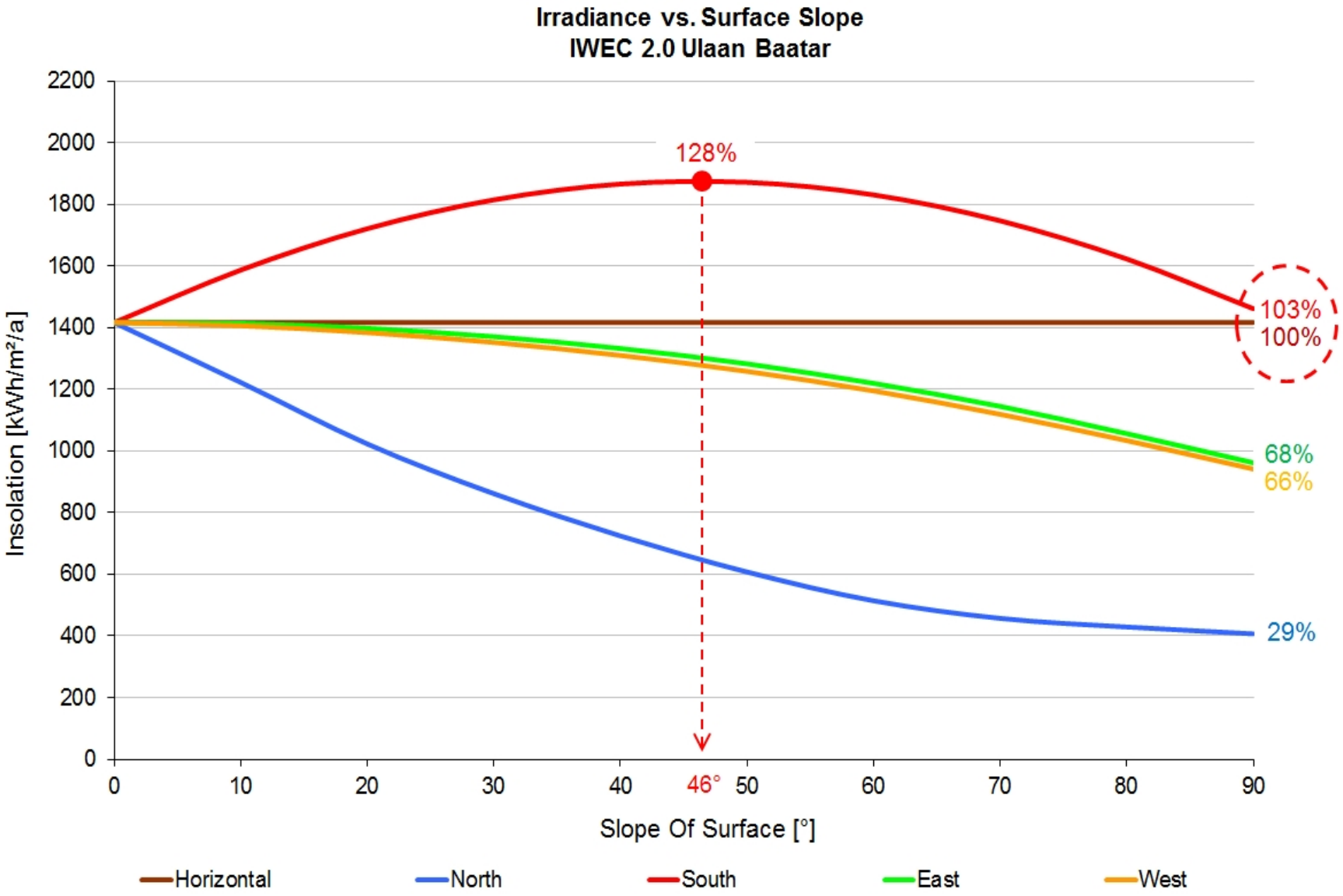
Total annual Precipitation averages at about 220 mm, which mainly occurs during the summer season (May – September).



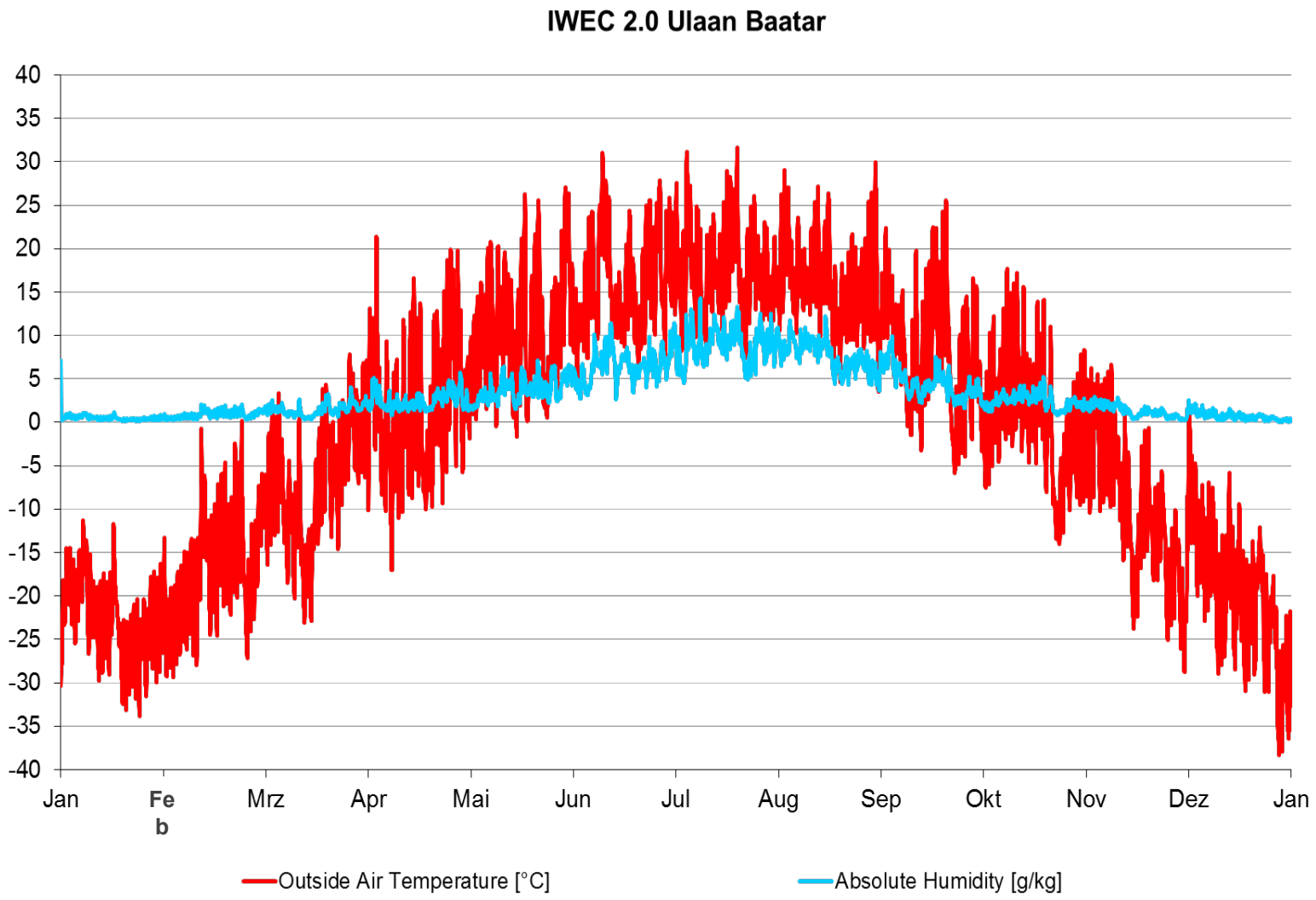
Monthly solar radiation and av. ambient temperatures



Hourly profile of ambient temperatures and water content of air

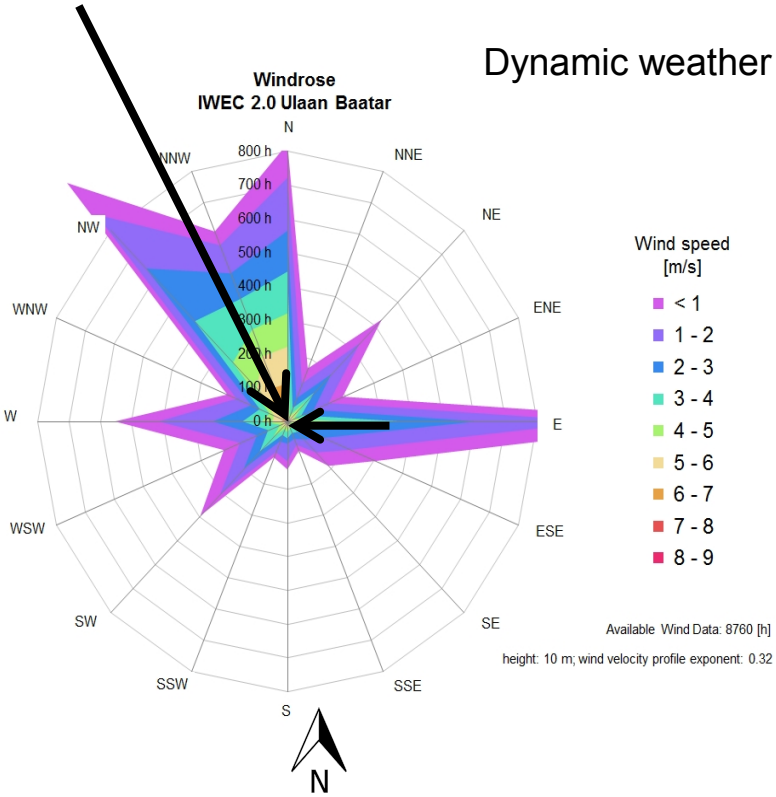

Irradiance vs. Surface Slope
IWEC 2.0 Ulaan Baatar
Insolation [kWh/m²/a]
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
128%
103%
100%
68%
66%
29%
0
10
20
30
40
46°
50
60
70
80
90
Slope Of Surface [°]
Horizontal
North
South
East
West

Sequence of Temperature and Humiditiy

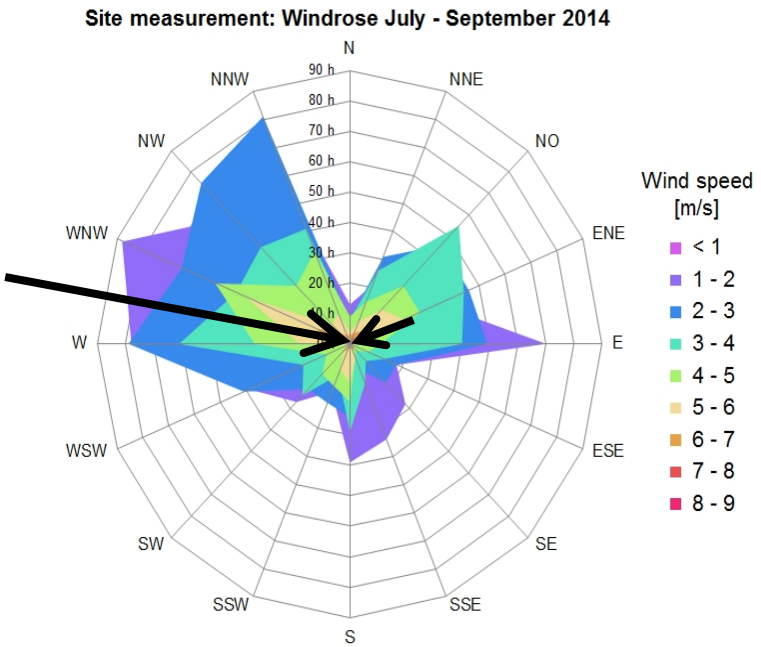


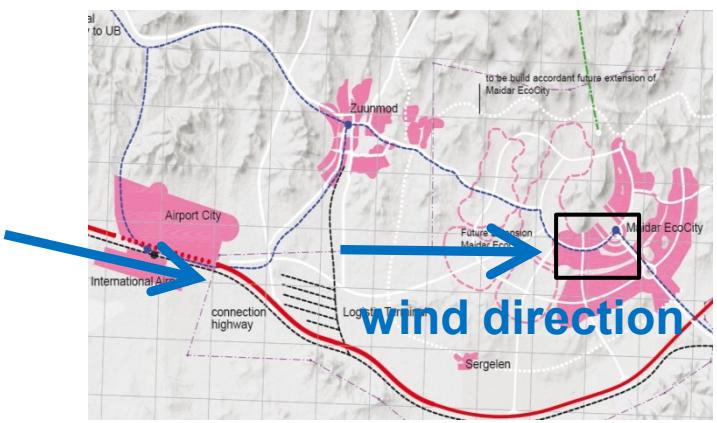
Maidar Weather Station Data Evaluation

Dynamic weather data set



Total data collected on site

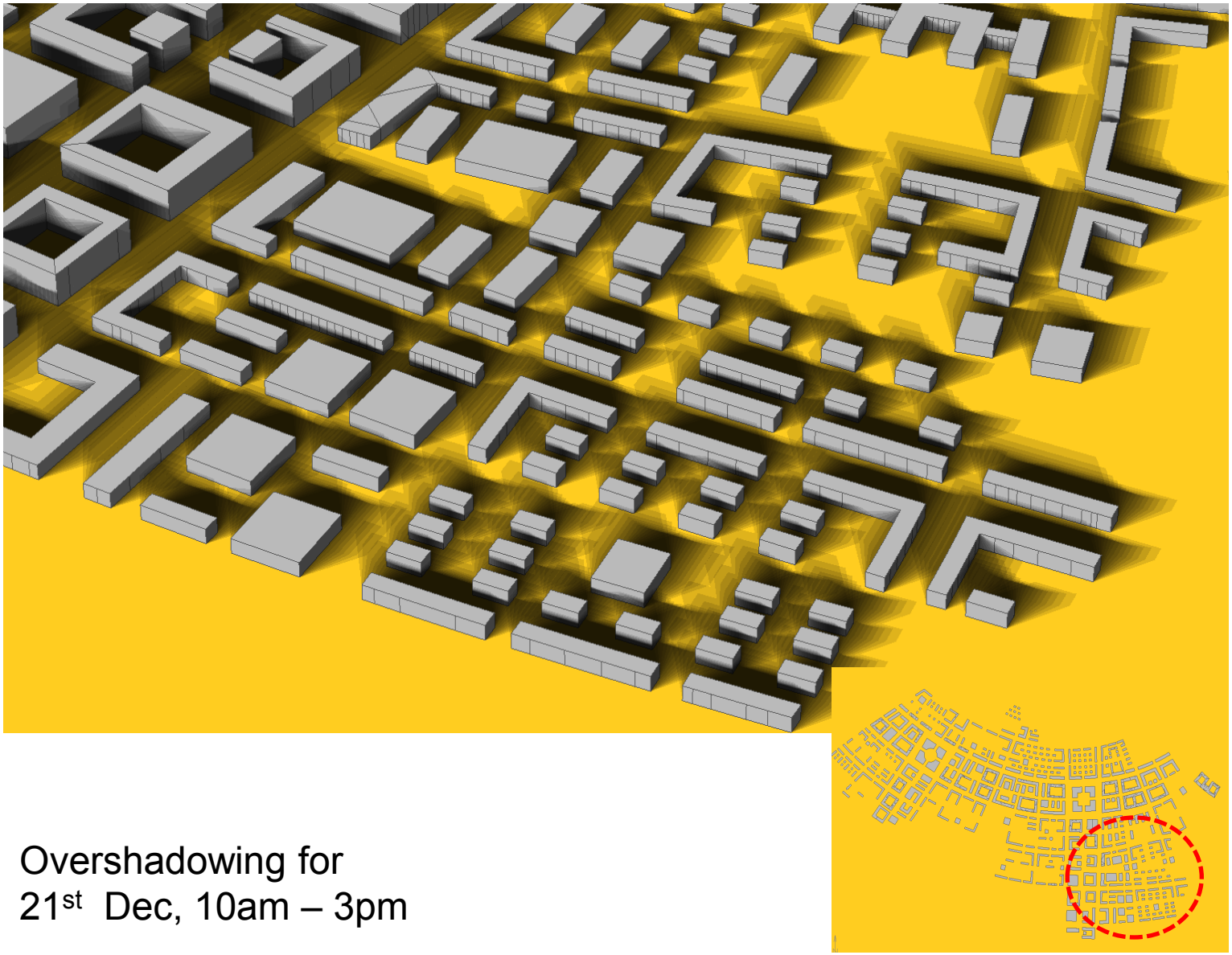




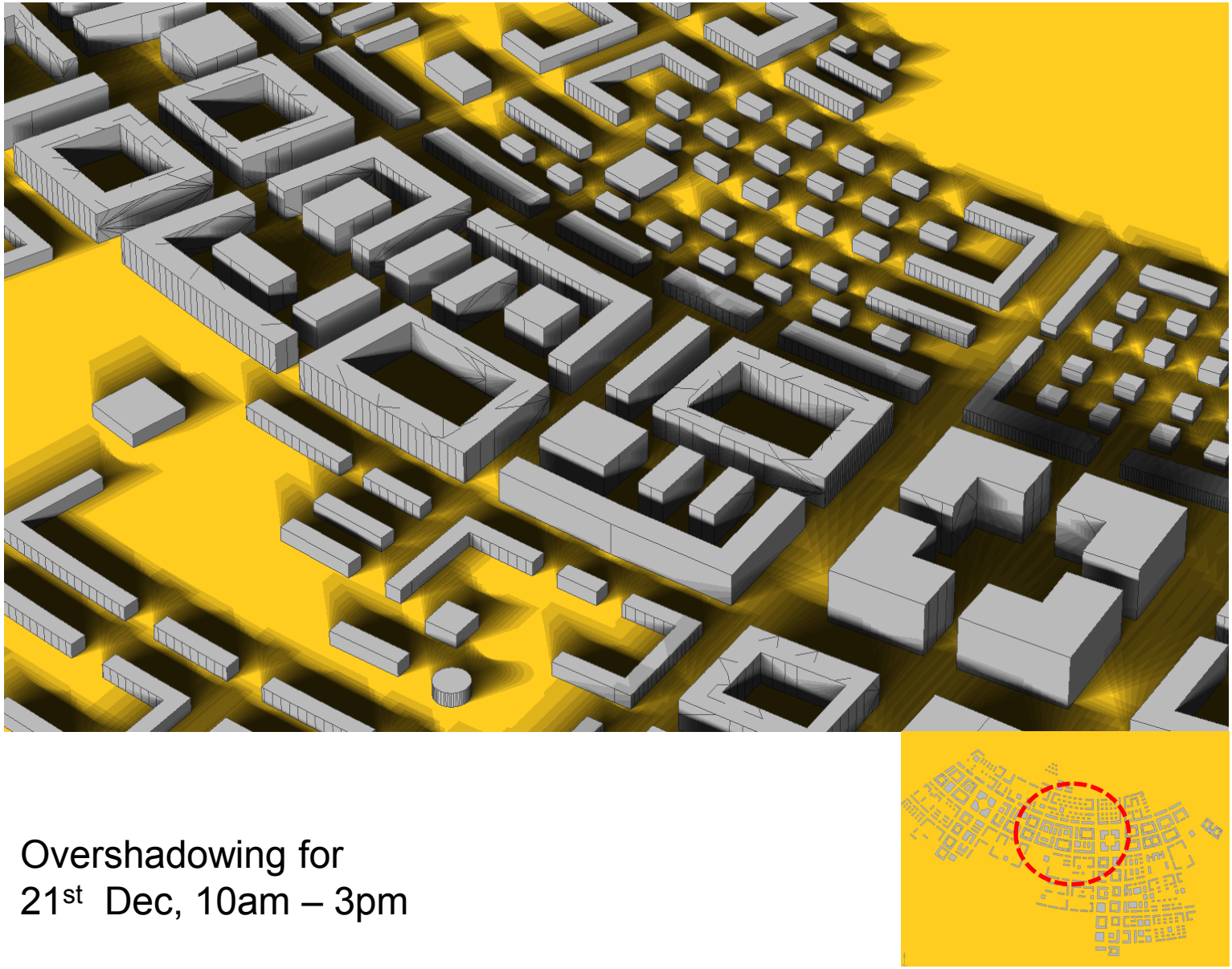
Prevailing wind direction: Western directions
(according to New UBA orientation,
confirmed by site measurements July – September 2014)

Solar Optimization of City Layout

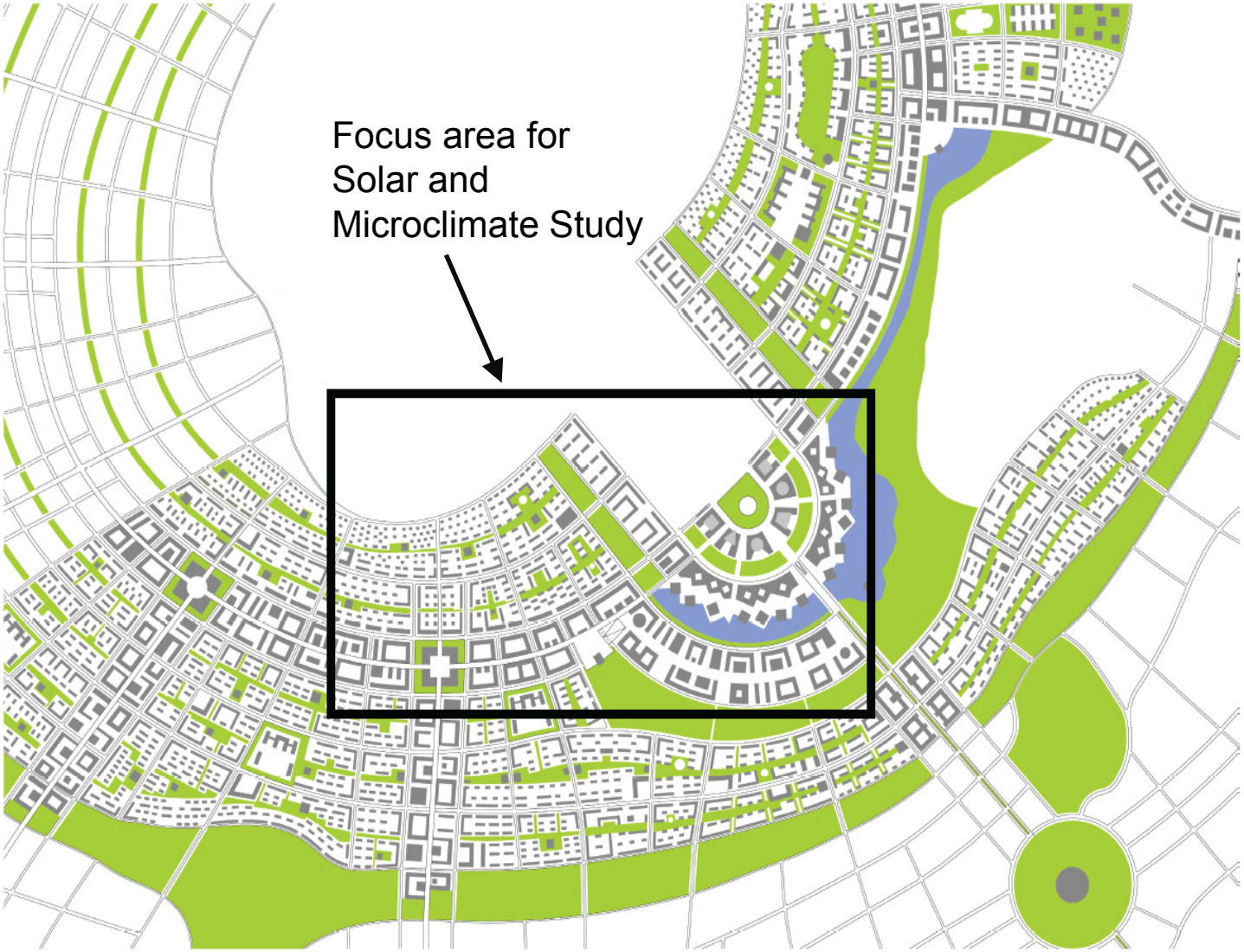
Solar Optimization: Overshadowing of facades for intermediate massing



Overshadowing for
21st Dec, 10am – 3pm

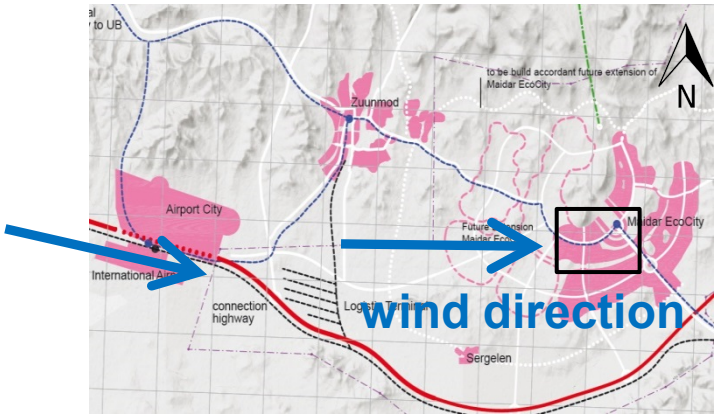


Overshadowing for
21st Dec, 10am – 3pm

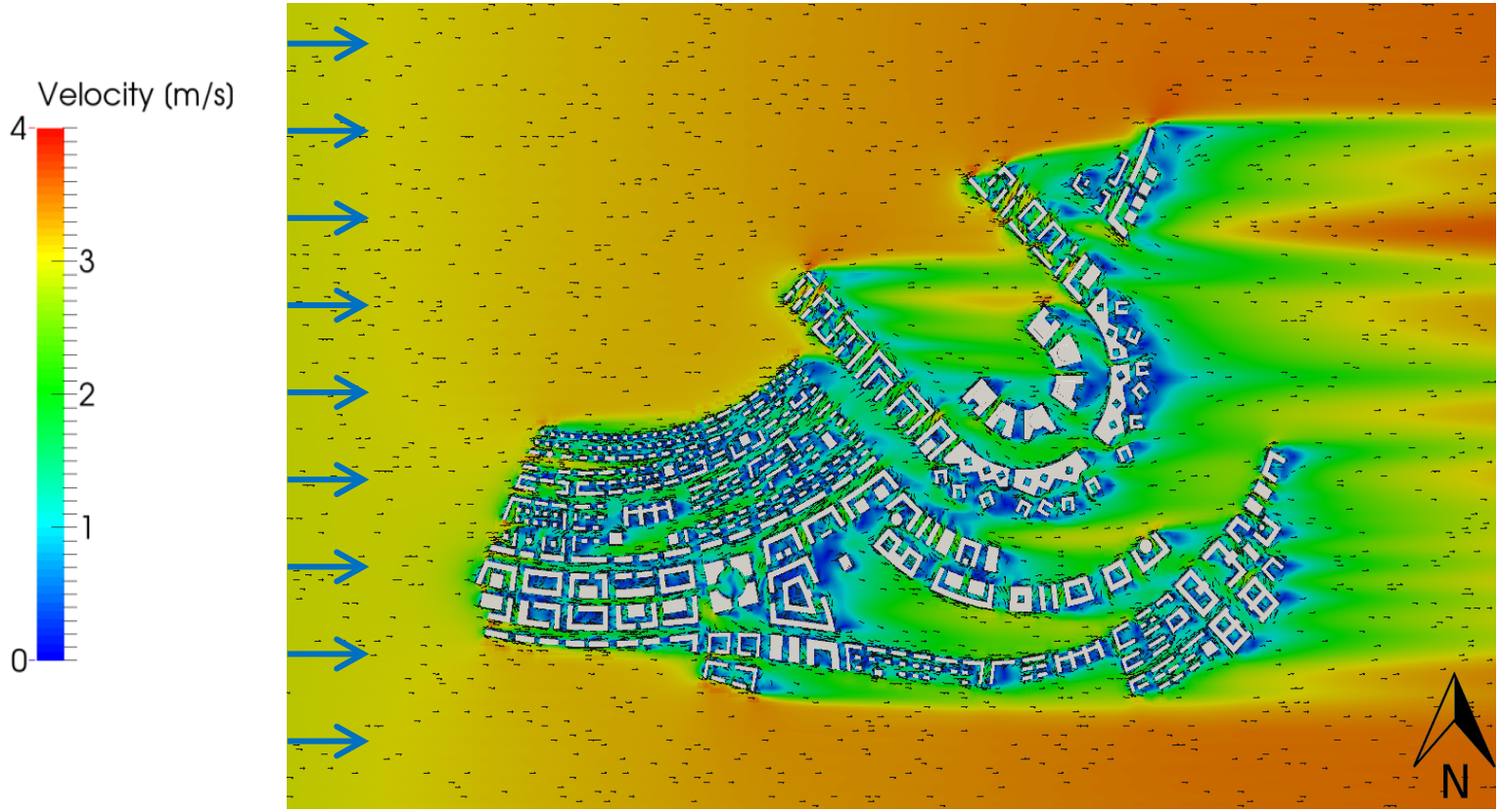

Focus area for
Solar and
Microclimate Study

Winter
(December)
Solar radiation (kWh/m²a)
0
15
30
45

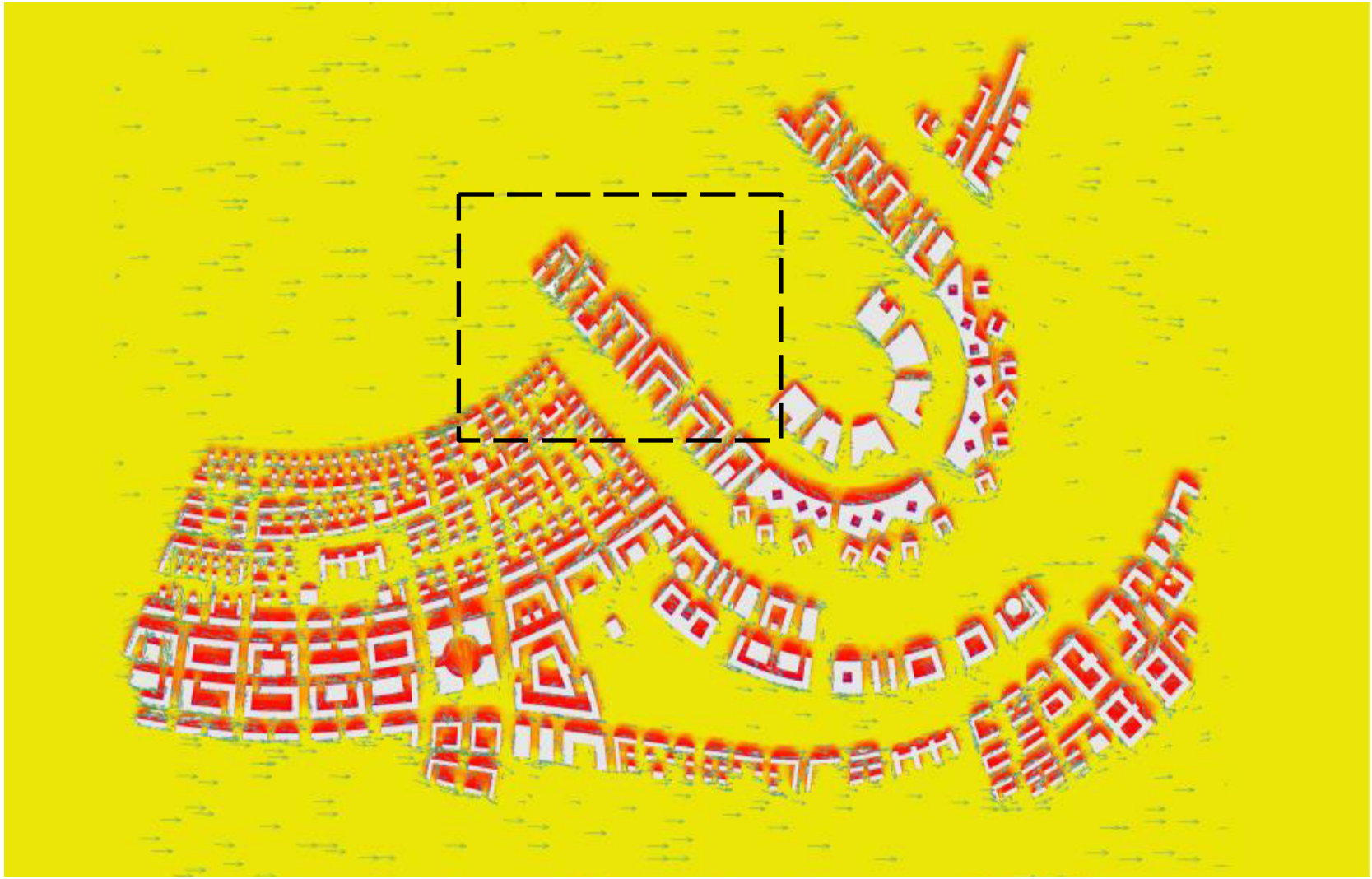
Microclimate Study: City wind distribution



Prevailing wind direction: West



Microclimate Study: Solar Access of Urban Space



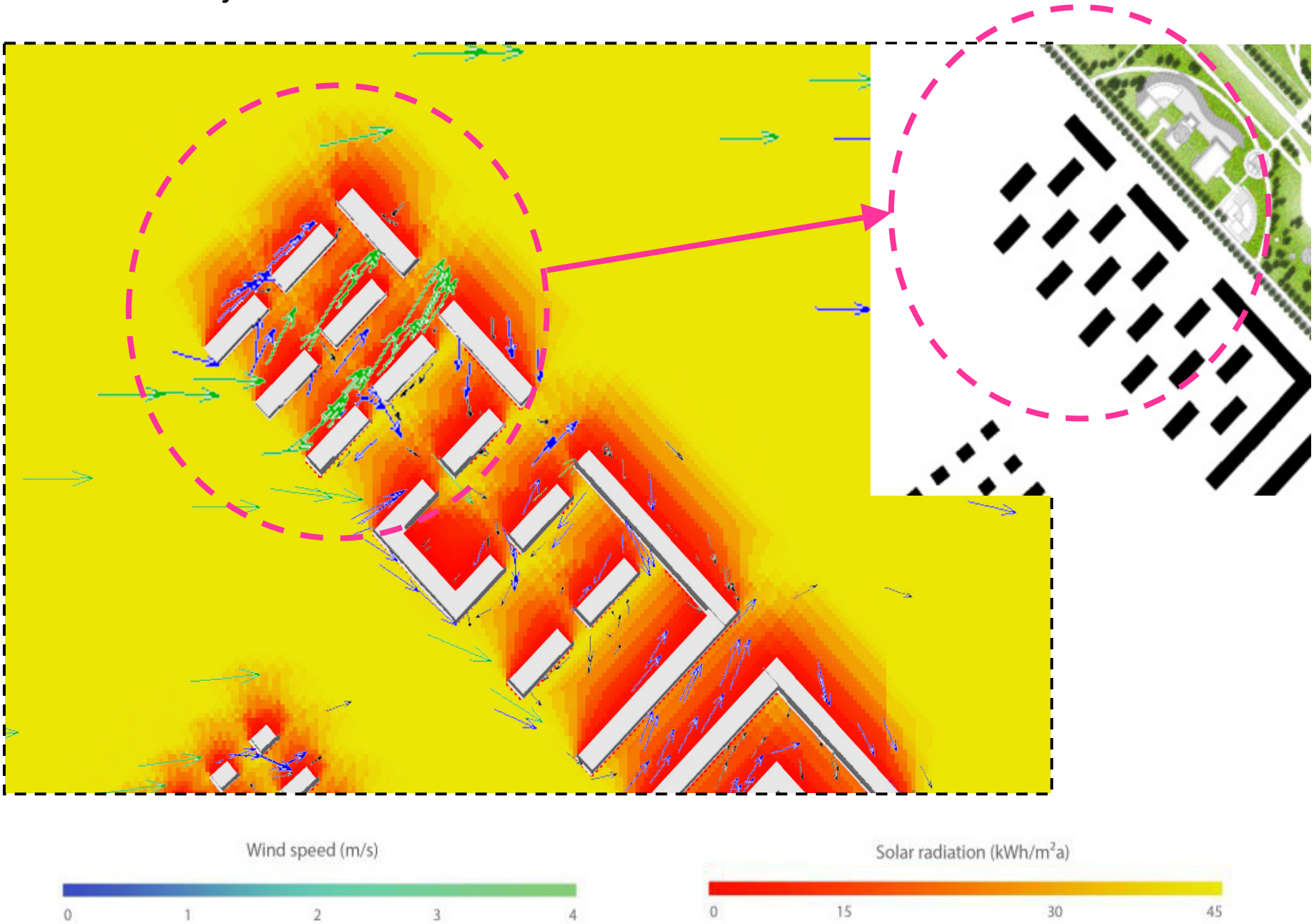
Wind speed (m/s)

0 1 2 3 4

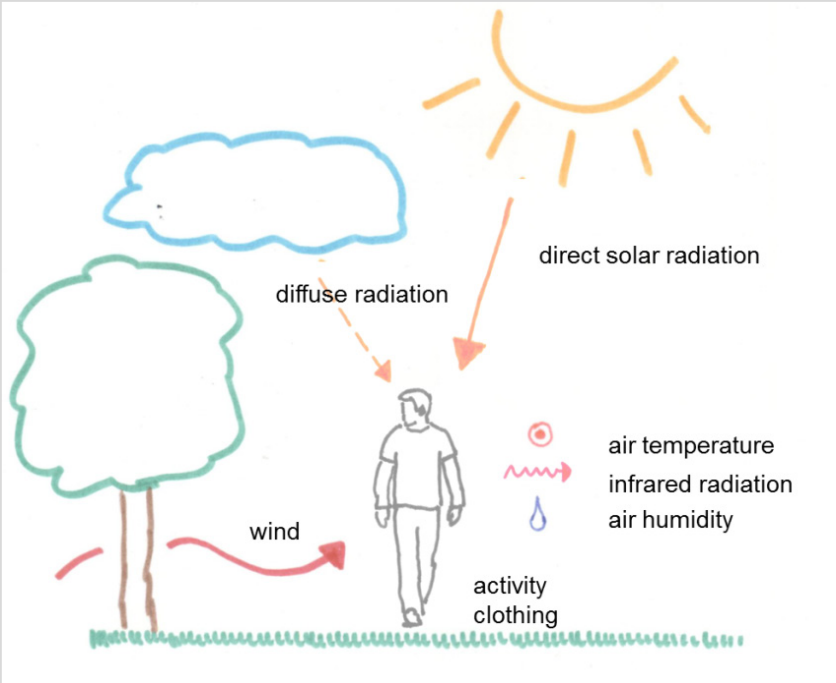
Solar radiation (kWh/m^{2}a)

0 15 30 45

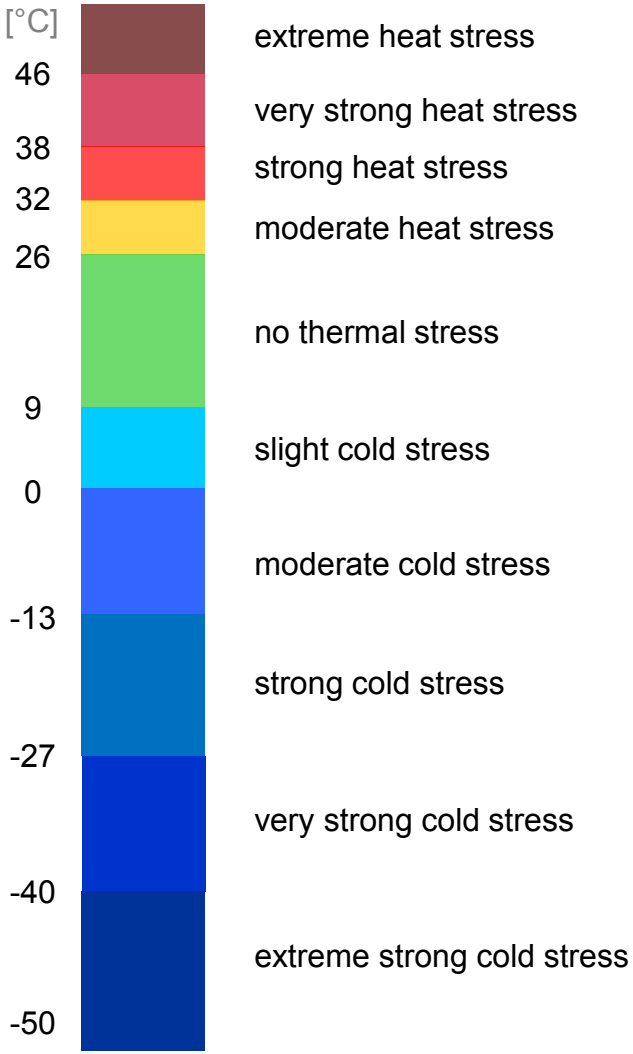
Microclimate Study: Localized Outdoor Comfort



Bewertung des Außenkomforts über den Universal Thermal Climate Index UTCI

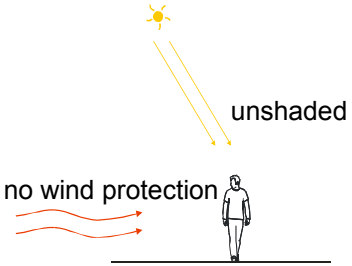


UTCI



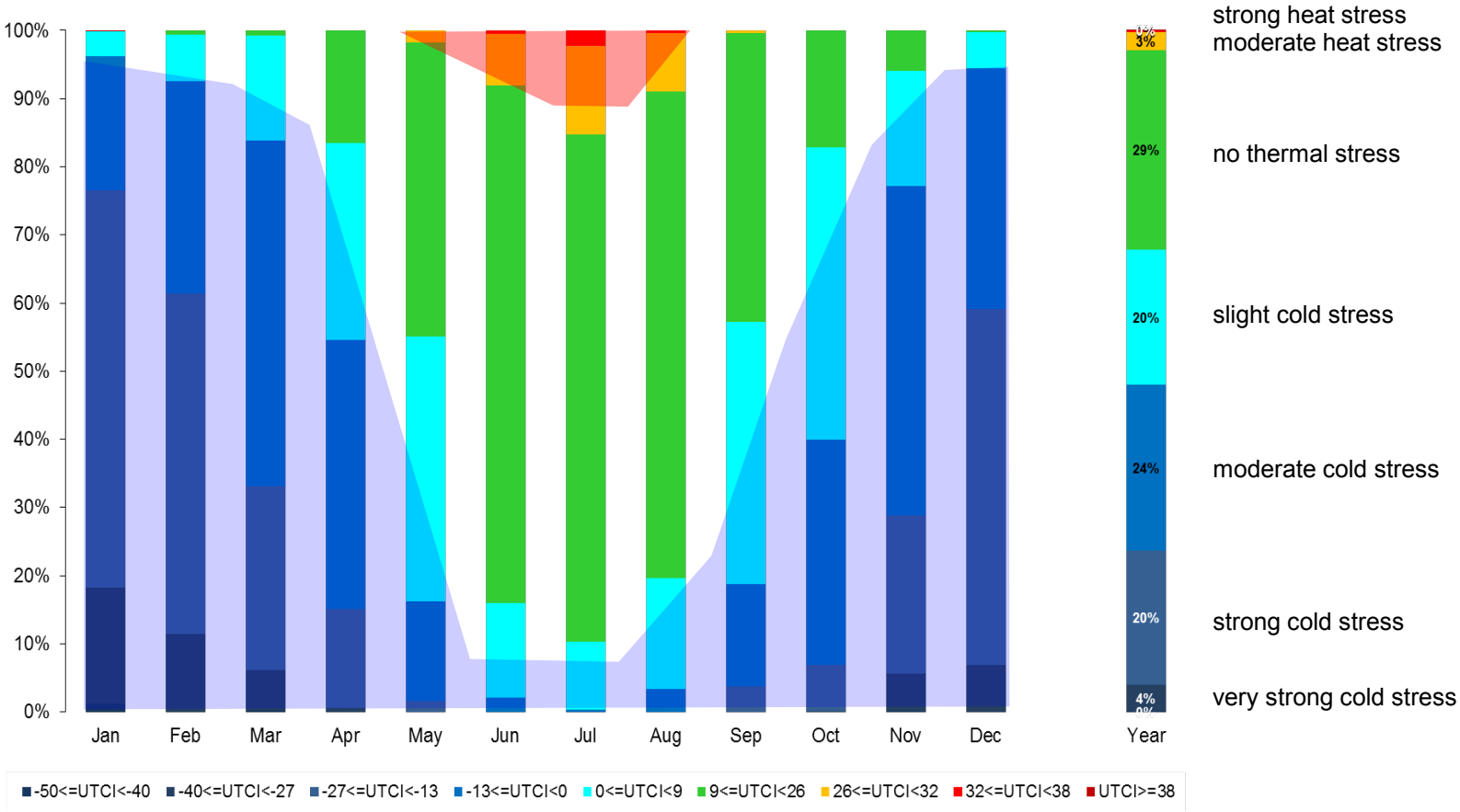
The thermal perception is determined and rated by the UTCI on the base of all relevant comfort influencing parameters

Reference (= Raw weather data, No measures to enhance outdoor comfort)



Evaluated period: Full year, 8:00 – 20:00

too hot



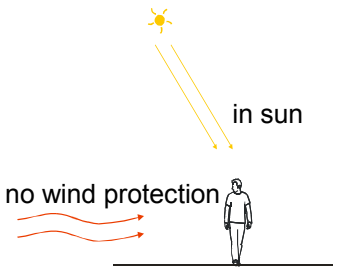
too cold

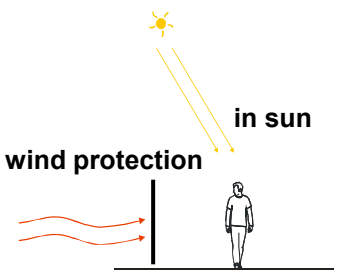
Universal Thermal Comfort Indicator (UTCI)

Recommended strategy to enhance outdoor comfort

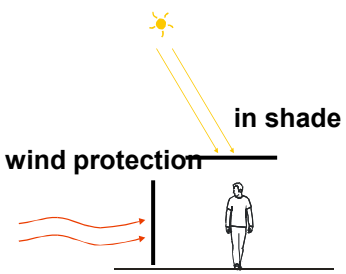
Resulting overall recommendation

Evaluated period:
Full year, 8:00 – 20:00

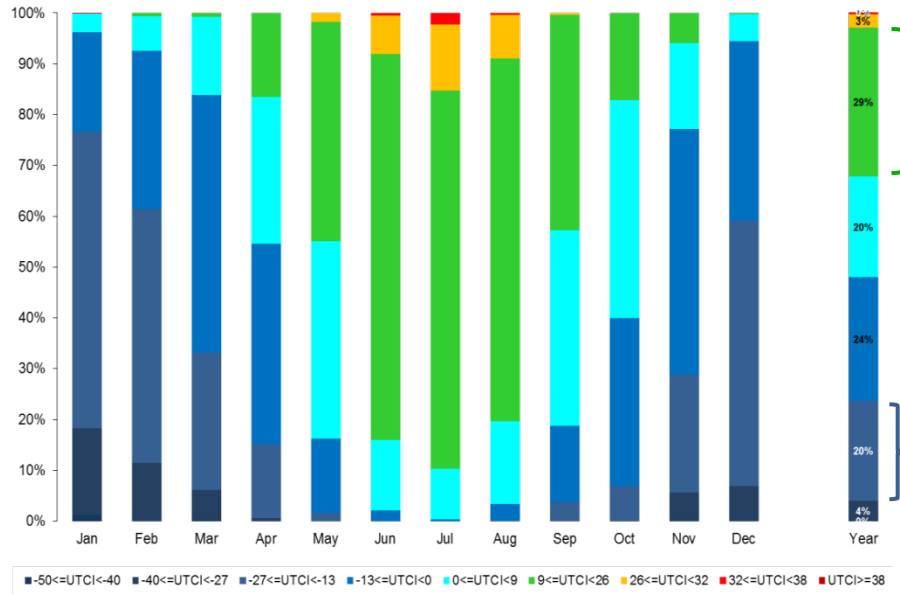




Winter

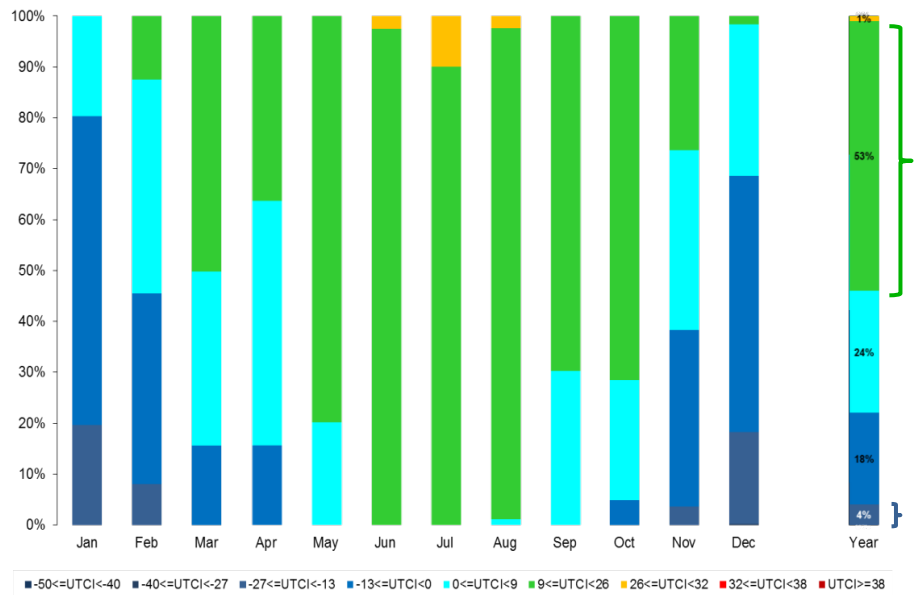


Summer



29%: no thermal stress

20%: strong cold stress

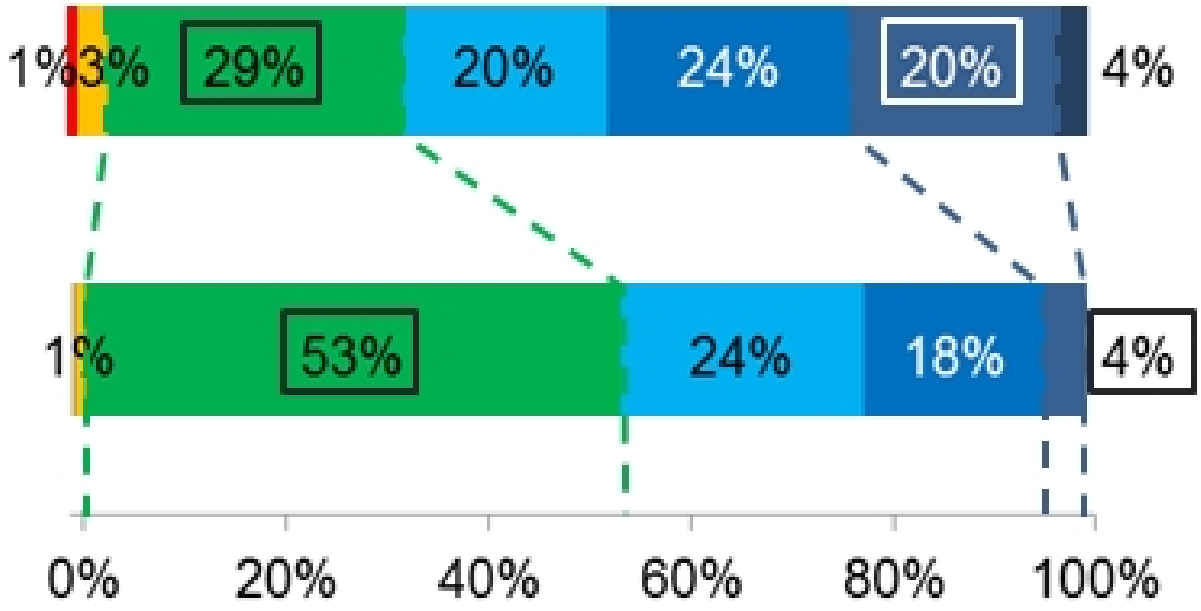


53%: no thermal stres

4%: strong cold stress

No measures
(unmitigated outdoor conditions)

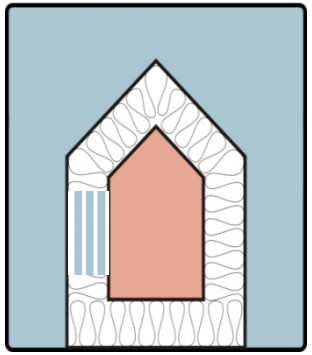
Combined Optimization Potential
(for summer and winter)



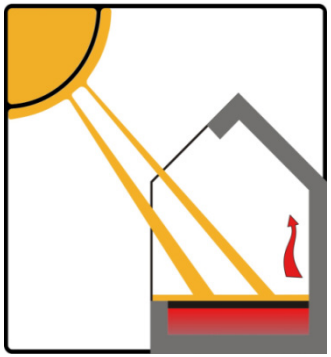
Building Performance Study

2

THERMAL INSULATION

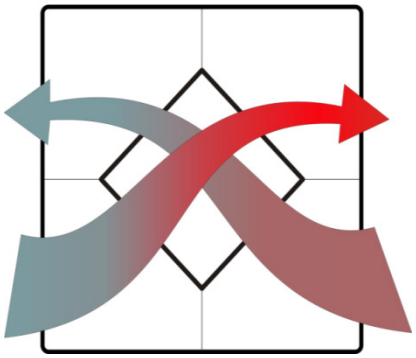


PASSIVE SOLAR GAIN



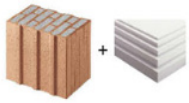
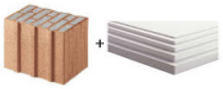
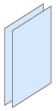
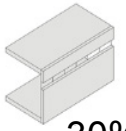
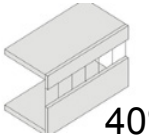
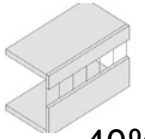
BUILDING AIR TIGHTNESS

HEAT RECOVERY UNIT

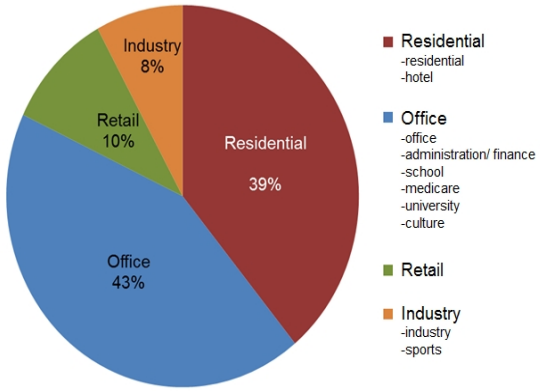


43

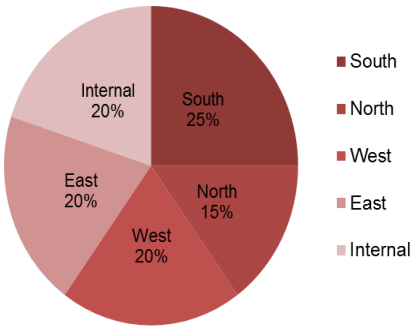
Building Performance Standards: Updated Scenarios

	EXISTING (EXT)	ENHANCED (ENH)	MAXIMIZED (MAX)
Walls	u = 2.0 W/m²K	 u = 0.19 W/m²K	 u = 0.13 W/m²K
Windows	 u_g = 2.8 W/m²K u_f = 2.5 W/m²K	u_g = 0.7 W/m²K u_f = 1.5 W/m²K	u_g = 0.5 W/m²K u_f = 1.0 W/m²K
Fenestration Ratio *(residential North 2/3)*	 30%	 40%	 40%
Infiltration rate	0.50 h^{-1}	0.20 h^{-1}	0.10 h^{-1}
Mechanical ventilation Heat recovery	---	(non-residential only) 60%	80%
Artificial lighting power	(100%)	- 40%	- 40%
Elec. equipment power	(100%)	≈ 100%	- 30%

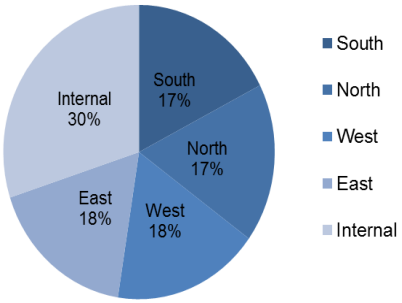
Comparison of Energy Performance Standards by dynamic simulation study

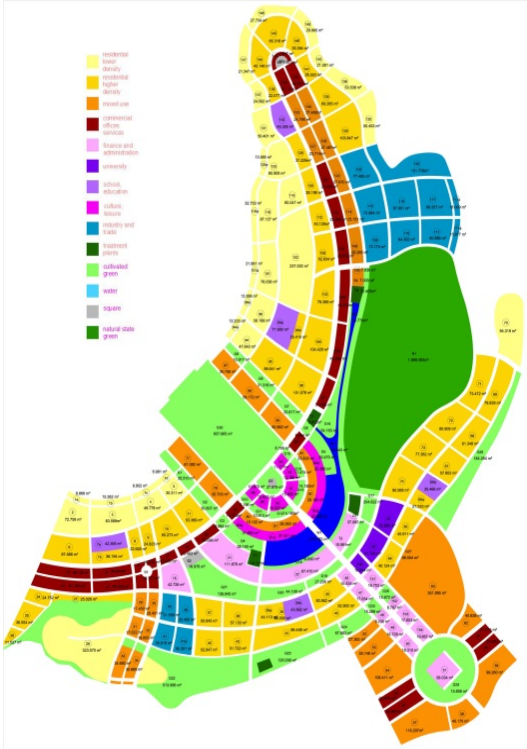


Residential

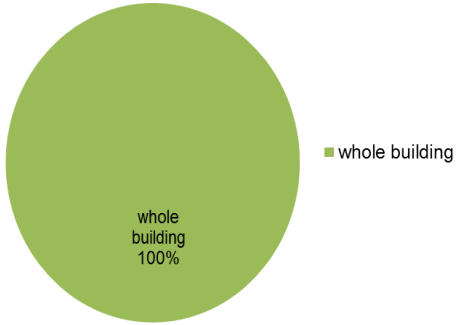


Office

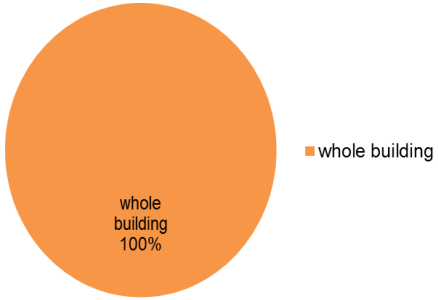




Retail



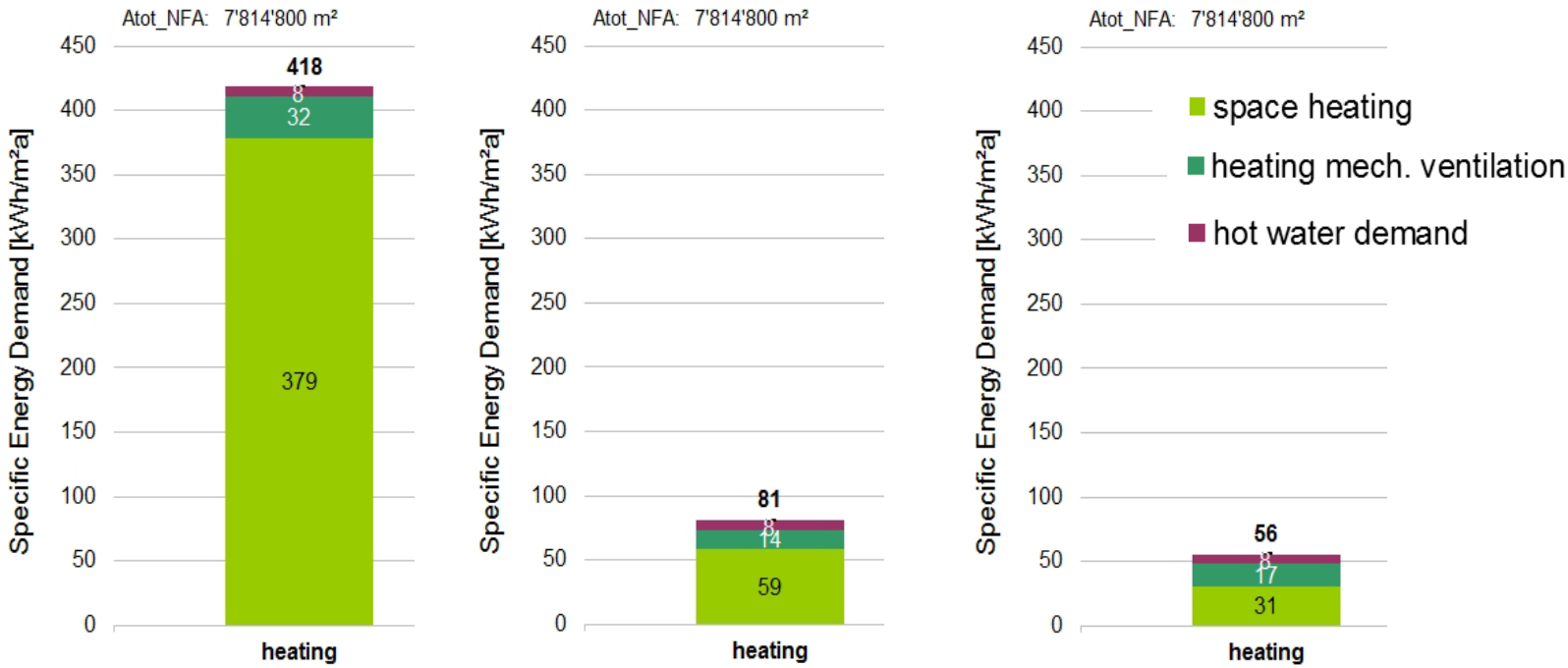
Industry



	Residential Lower Density	Residential Higher Density	Business Offices	Retail / Shops / Resturants	University	Finance / Admin	Culture	School	Industry	Hotel / Catering	Medical Treatment	Sports	**Total**
Residential Lower Density	93%			5%								2%	100%
Residential Higher Density		70%	5%	10%			5%	5%			5%		100%
Mixed use		25%	40%	20%						10%	5%		100%
Commercial/Offices/Services		15%	65%	15%						5%			100%
University					100%								100%
Finance Administration						100%							100%
Culture/Leisure							95%			5%			100%
School								100%					100%
Indsutry/Trade									100%				100%
Total [m²]	**787'683**	**2'366'197**	**1'828'044**	**875'808**	**127'898**	**888'638**	**509'693**	**358'819**	**746'634**	**279'993**	**212'533**	**16'939**	**8'998'880**
%	9%	26%	20%	10%	1%	10%	6%	4%	8%	3%	2%	0%	100%

Comparison of Energy Performance Standards

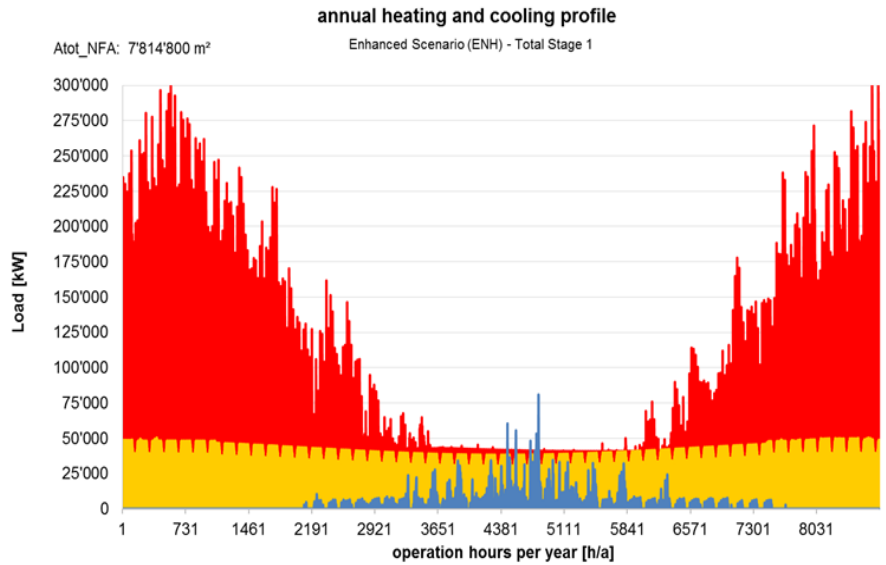
EXT **ENH** **MAX**

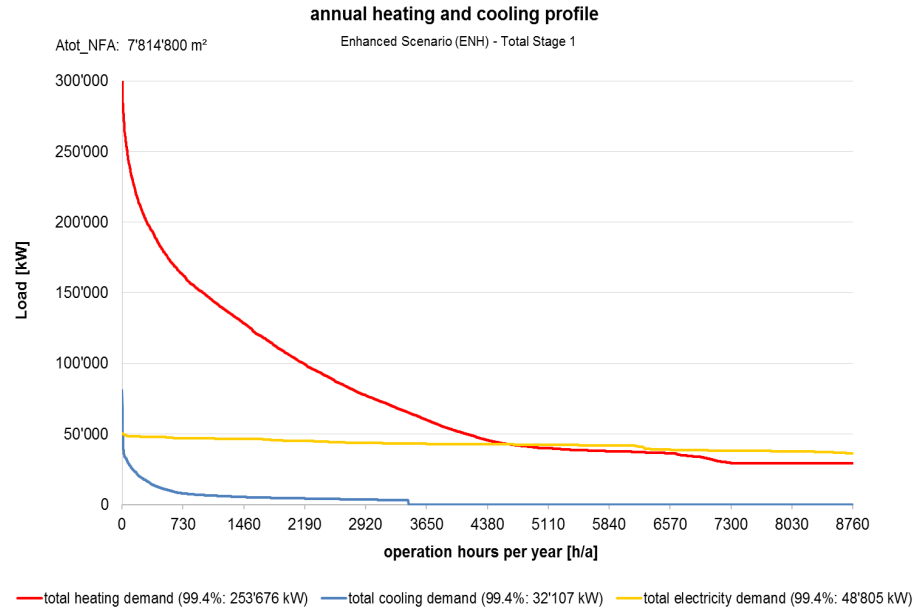


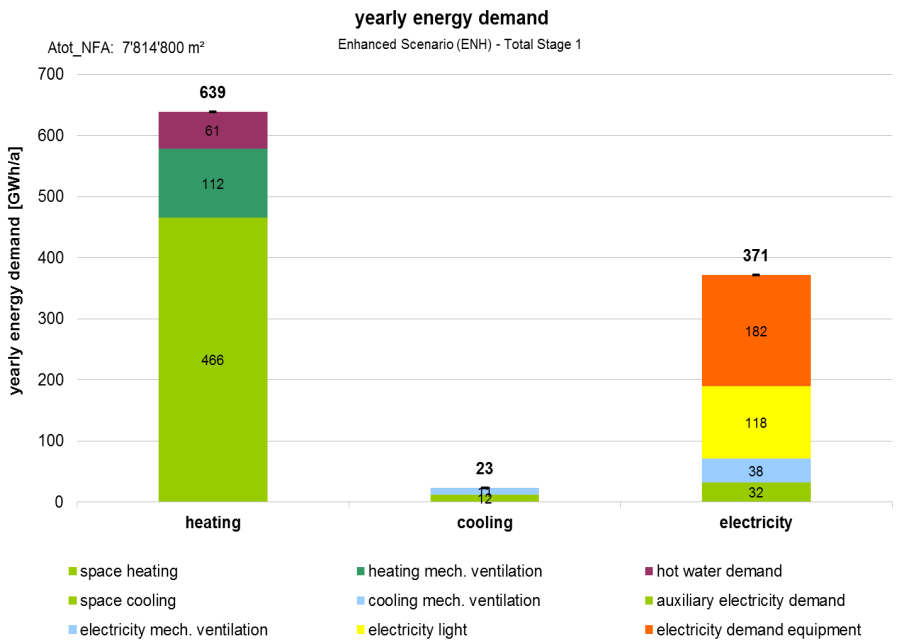
Comparison of heating demand (excluding domestic hot water):

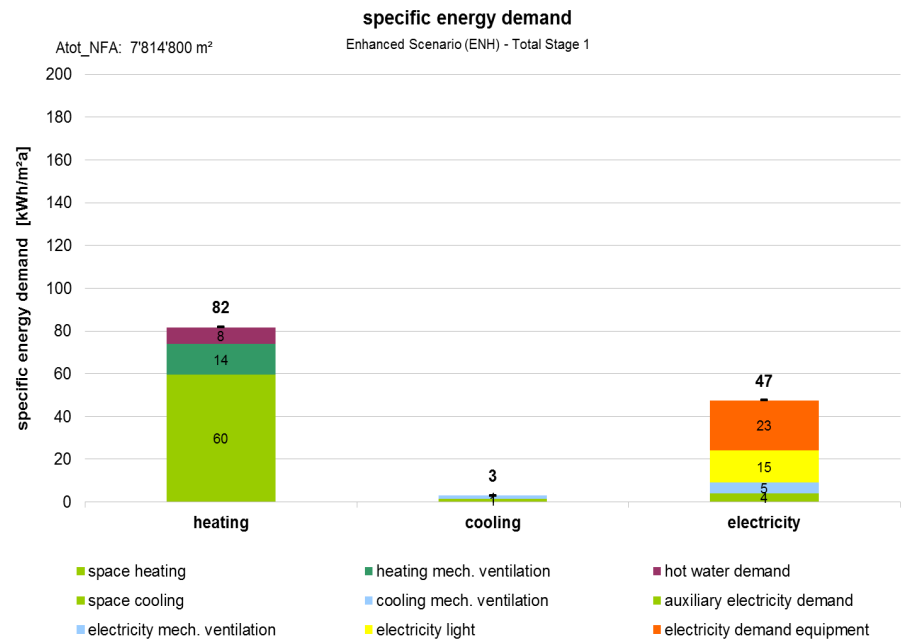
Mongolia:	**411 kWh/m²a**	**73 kWh/m²a**	**48 kWh/m²a**
Germany reference values: (indicative)	**≈ 150 kWh/m²a**	**≈ 45 kWh/m²a**	**15 kWh/m²a** **„Passivhaus"**

Energy Demand: ENHANCED (ENH) Building Standard



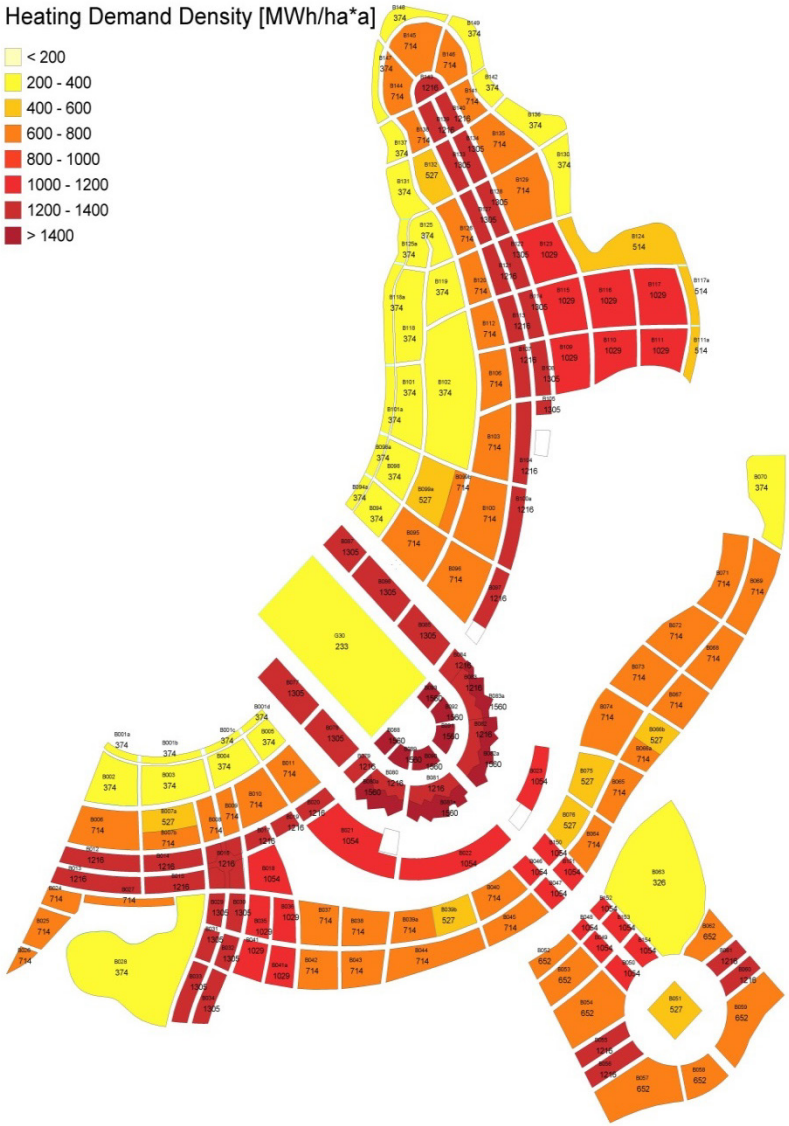




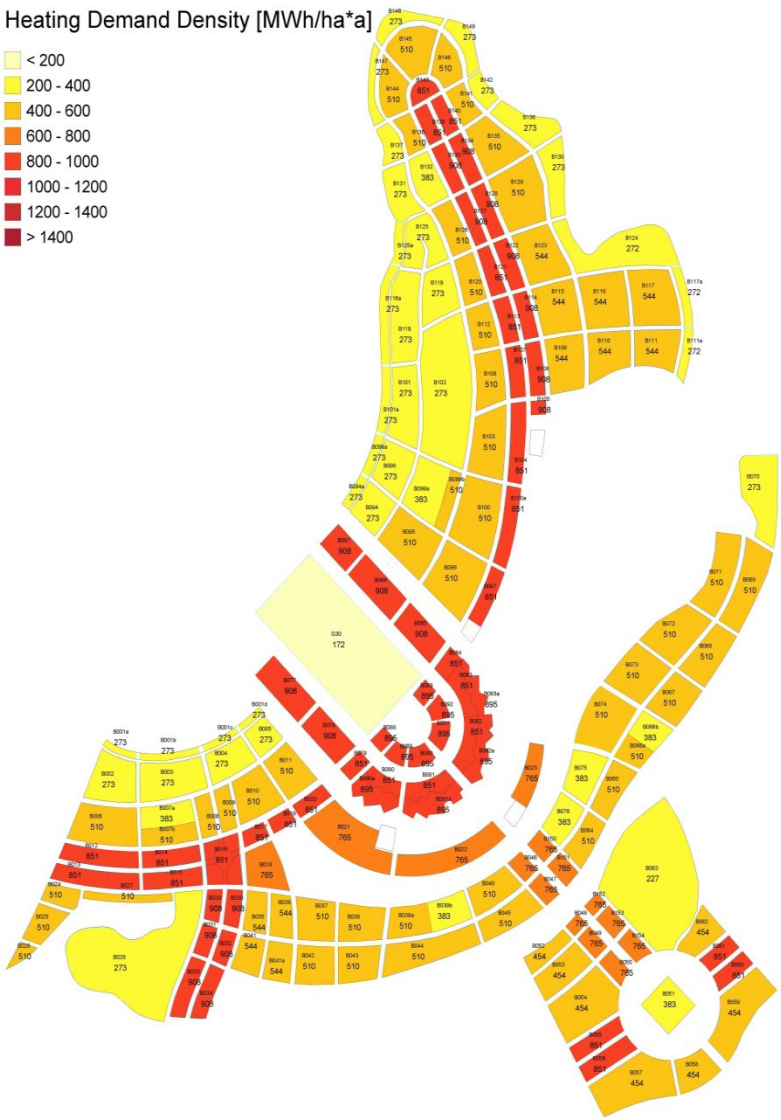


Annual Heating Demand Density per Block

ENHANCED (ENH) Building Standard

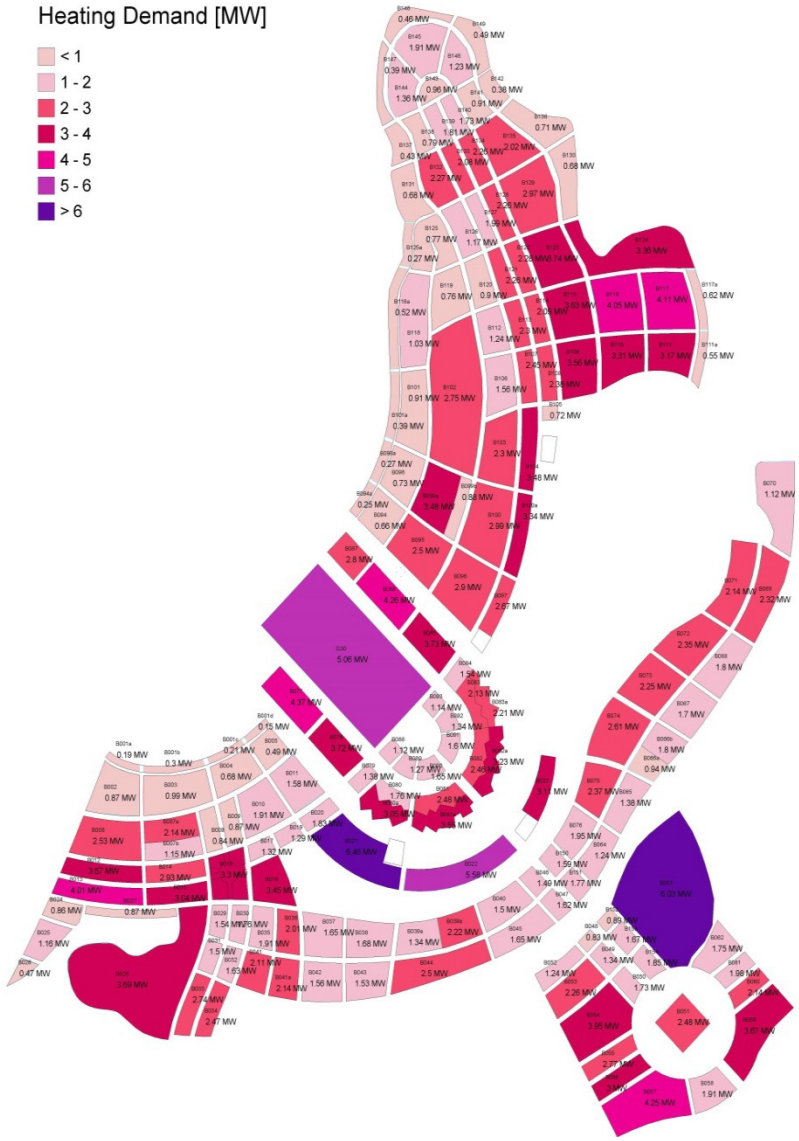


MAXIMIZED (MAX) Building Standard

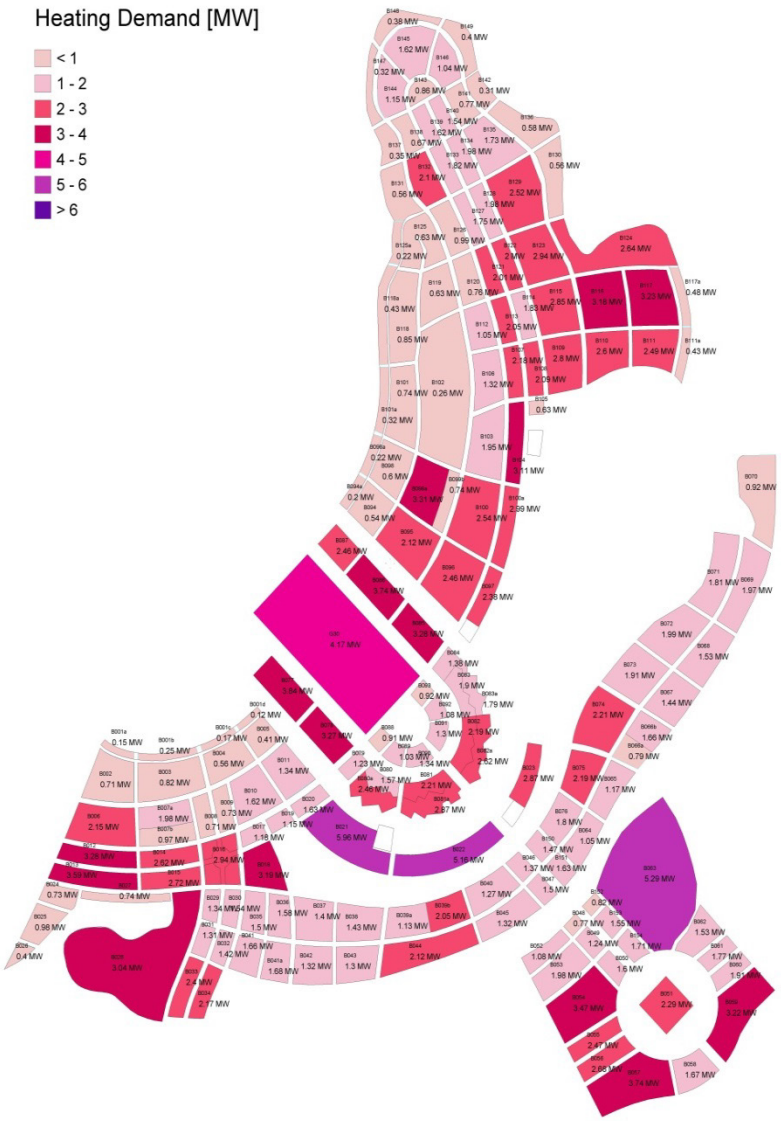


Heating Power per Block

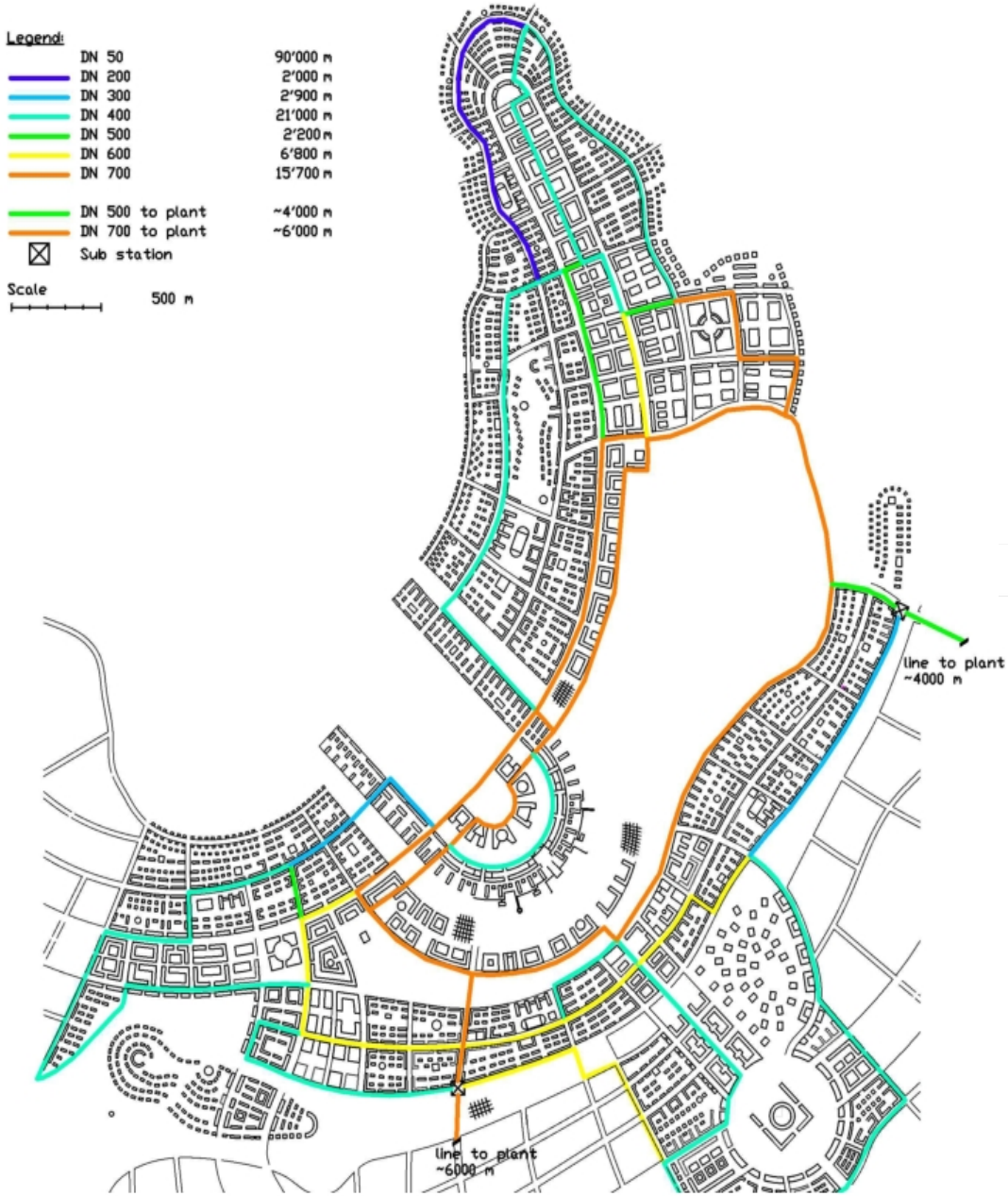
ENHANCED (ENH) Building Standard

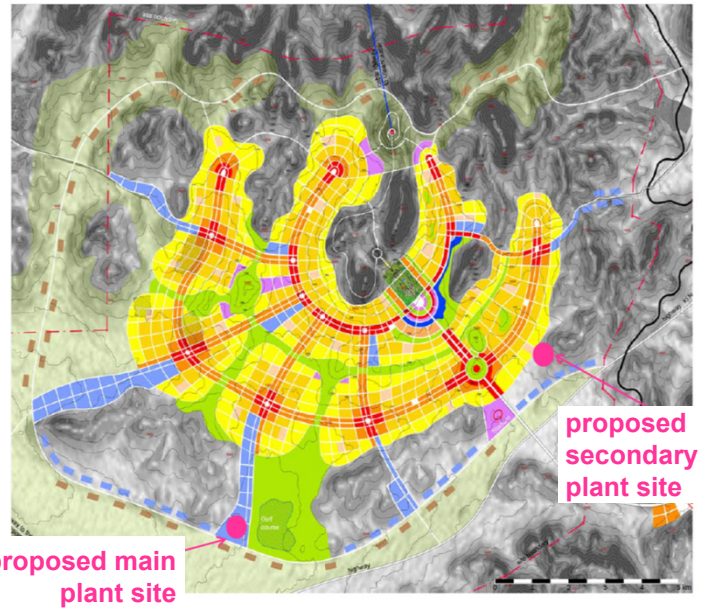


MAXIMIZED (MAX) Building Standard



District Heating Network



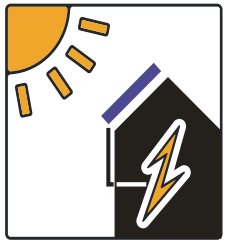


System resilience strategy:
Additional supply point and plant
for central district heating network

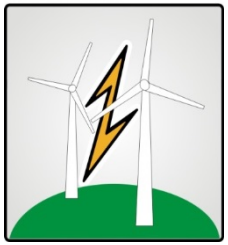
Energy supply options

WASTE TO ENERGY

PHOTOVOLTAICS

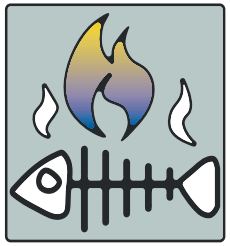


WIND POWER

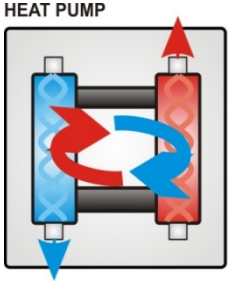


BIOMASS

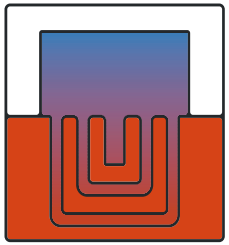
BIO GASIFICATION



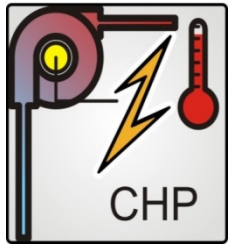
HEAT PUMP



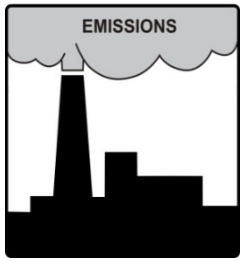
GEOTHERMAL



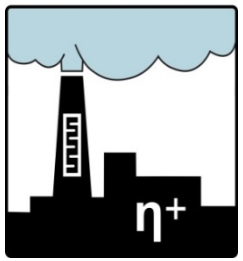
COMBINED HEAT AND POWER PLANT



COAL FIRED POWER PLANT



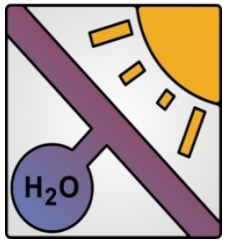
COAL FIRED POWER PLANT



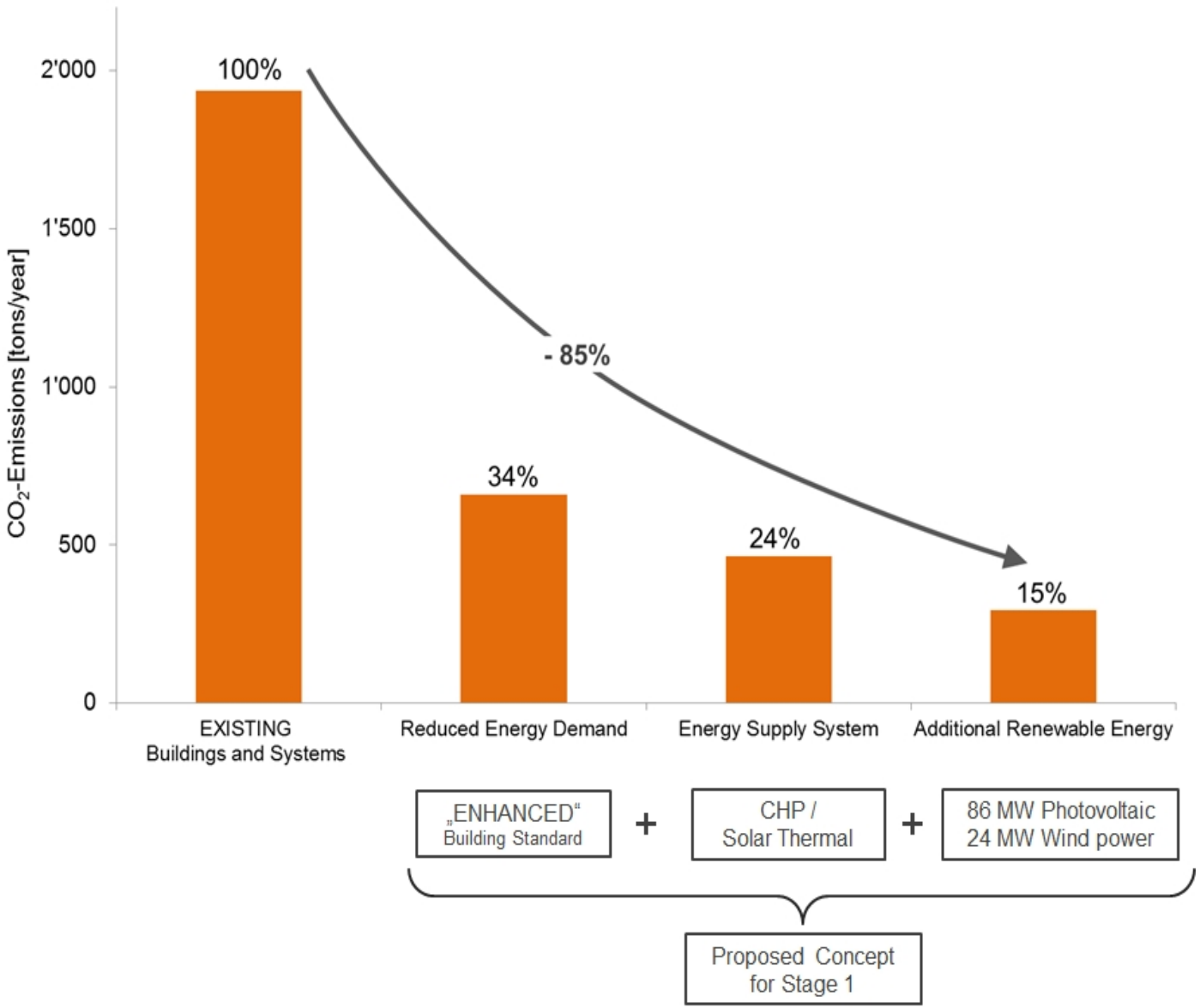
GRID

DISTRICT HEATING

SOLAR THERMAL



Summary


2'000
1'500
1'000
500
0
CO_2-Emissions [tons/year]
100%
- 85%
34%
24%
15%
EXISTING
Buildings and Systems
Reduced Energy Demand
Energy Supply System
Additional Renewable Energy
„ENHANCED"
Building Standard
+
CHP /
Solar Thermal
+
86 MW Photovoltaic
24 MW Wind power
Proposed Concept
for Stage 1

MAIDAR EcoCity+

Maidar Eco City

According to the spirit of Maitreya the city will follow the principles of an ecological urban development – a "City of the Future" in which sustainability, low carbon emission, environmental protection and social harmony are the main objectives for the urban design.

PROJECT ABOUT

CULTURE
RELIGION, TRADITION CENTER

2014-2024
FOR 10 YEARS CONSTRUCTION

POPULATION 280,000
URBAN POPULATION