Environmental Transformation of the Built Environment

Thomas Auer, Transsolar/TUM
positive proof of **Global Warming**


credit: BDir Dipl.-Ing. Hans-Dieter Hegner
Bundesministerium für Verkehr, Bau und Stadtentwicklung
CO₂ TO ZERO

WE NEED TO REDUCE OUR EMISSIONS
Desired CO₂ Emissions in Stuttgart --- and Reality ---

Abbildung 2: Verlauf der CO₂-Emissionen der Stadt Stuttgart bis 2005 (ab 2001 geschätzt) und Ziele bis 2020 (minus 40%) bzw. bis 2050 (minus 90%)

Wuppertal Institut für Klima, Umwelt, Energie GmbH
Lost in Transformation?
PERFORMANCE by DESIGN
Welcome to the breathtaking
Tokyo Water Park
37°C + / 60% RH
hot + dry air layer

25°C - 35°C C / 100% RH
warm + humid air layer

cool + dry air layer
18°C / 40% RH
Venice Biennale 2010 cloudscapes
Venice Biennale 2010 cloudscapes
Manitoba Hydro - Winnipeg
architect: KPMB

photo: Gerry Kopelow
Climate - Winnipeg

70 K!
Boiling water at $-35^\circ \text{C}$

Instant Sublimation
Summer Time: Cooling
Energy use of Canadian buildings

*as of September 2010*
Manitoba Hydro Place - Annual Rolling Energy Totals

Model = 88 kWh/m²a
French School - Damascus

architect: Atelier Lion, Paris

photo: Adria Goula
Historic city of Damascus
Fixed shading + vegetation
Climate concept  summer day
Shaded Patio
between the
buildings
Net Zero by Design
Comfortable and Energy Efficient, Building Performance by Design
Framework for net-zero energy concept

VISION

high-comfort net-zero energy building
Implement adaptive comfort approach

conventional approach

operative Temperature 24°C

adaptive comfort approach

operative Temperature 29°C
tempered air + elevated air speed
Thermal zoning of School of Design building, overview

**Natural Cross Ventilated, 46%**
- with elevated air speed
- social Plaza and social interaction spaces
- modeling areas, work shops
- smart green home

**Hybrid Tempered, 26%**
- library, design studios
- Theatrette, offices

**Full AC, 17%**
- green building technology lab
- energy lab, computer lab

**Photovoltaic**
- renewable energy

**Circulation**
- micro climate, wind
- vegetation, green and blue

**Mech and aux rooms 10%**
Thermal Comfort without elevated air speed

Operative Temperature: 29°C
Air speed: 0.15 m/s
PMV: 1.2

Thermal comfort comparison with online tool of Berkeley University
Thermal Comfort with elevated air speed

- Operative Temperature: 29°C
- Air speed: 0.7 m/s
- $\text{PMV}_{\text{eas}}$: 0.3
schedule occupancy and internal gains

4 m² per person  
MET 1.2  
Summer CLO 0.6

max: 0.7 m/s  
14 m² per fan

60 W per person  
15 W/m²

min 300 Lux  
6 W/m²

operation time: 5 working days
Maximal renewable energy production with PV system defines the available electrical energy to operate the building on net zero.
Challenge the client design brief
Optimize the envelope for thermal comfort and energy and glare and daylight
Maximal energy efficiency of a/c systems
Design for adaptive comfort with hybrid system
great fresh air, tempered and elevated air speed
Get the details right
Inform and improve the building design step by step with design charrettes
Comfort with elevated air speed
Sustainable Cooling Concepts for the Tropics
Centenary City Abuja, Nigeria

Masterplan for a Sustainable City Development

Client:
Centenary City Ltd, Abuja

Design Team:
AS+P – Albert Speer + Partner, Frankfurt
Transsolar Energietechnik, Munich
Atelier Dreiseitl, Überlingen
Primetech Design + Engineering, Abuja

Land Area: 10 km²
Total GFA: 6 Mio m²
Inhabitants: 135 000
Construction 2015 - 2025
Centenary City Abuja

Framework for sustainability concept

**VISION**

A self-sustaining energy efficient city of the future
Centenary City Abuja

Framework for sustainability concept

STRATEGY

1. Optimize city layout for solar & daylight potential
2. Minimize building energy demand
3. Maximize efficiency of energy production
4. Maximize renewable energy production
The site
View from the mountain
Local Weather Conditions

Air temperature and humidity over the course of a year

- Outside Air Temperature [°C]
- Dew Point Temperature [°C]
- Absolute Humidity [g/kg]
Step 1: Optimize city layout

Solar Access
Step 1: Optimize city layout

Optimized city ventilation

- **Dry season wind direction** (Oct – Apr)

- **Wet season wind direction** (May – Sept)
Step 1: Optimize city layout

Outdoor Comfort

overhead shading
trees + water

86%
Step 2: Minimize Building Energy Consumption

Optimize Shading vs. Daylighting

-10% savings

assessments of total electricity for cooling + lighting
Step 3: Maximize Efficiency of Energy Generation

Efficient power generation

- **Diesel Generator (exist)**: 35% efficiency, 754 kg CO₂/MWh
- **Diesel Generator (opt)**: 46% efficiency, 574 kg CO₂/MWh
- **Gas Generator**: 38% efficiency, 526 kg CO₂/MWh
- **Combined Heat + Power Plant (Gas)**: 48% efficiency, 416 kg CO₂/MWh

- Decrease of 45% in CO₂ emissions compared to the existing setup.
Centenary City Abuja

- Electric Energy Demand
- CO2-Emissions

-96%
Centenary City Abuja

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

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

return of invest after 5.5 years
"Transforming Our Built Environment through Innovation and Integration: Putting Ideas into Action"

- Successful at all scales
- Holistic and Synergetic
- Environmental Quality – Creating Delight
- Aspirational and Inspirational
At a Bar in Hong Kong...
Thank you