‘Pushing design boundaries to optimize the energy performance in the built environment’
Agenda

1. Short Introduction ABT
2. Energy in the Built Environment & Design Vision
3. ABT’s Energy Design Strategy
4. Examples Integral Design Concepts
5. Examples Research Projects
6. Discussion: Q & A
Innovation ... ‘Building on ambitions’

Creative Collaboration

Innovative advice that actually brings a result.
It immediately adds value ...
... and offers the opportunity to stand out.
ABT designs the new Amsterdam Airport Schiphol Terminal with international consortium KL AIR: an integrated design and BIM coordinated project.
The façade consists of 64 segments and 26 rows, which means that the project incorporates 26 unique spherical curved glass panels. A technical masterpiece! ABT (Building Envelope Engineering (BEE) has proven that the reflective façade is technically and financially feasible.
In the design for the new Naturalis building, parametric modelling has been used to generate the shape of the complex shaped concrete façade elements. By combining the parametric model directly with Virtual Reality, alternatives can be experienced on an actual scale and in the context of the building as a whole and be adapted “live” straight away.
The structure of the glazed facade consists of UV bonded, solid glass bricks. Not only the bricks, but also the frames and even the panel door are made of glass. A self-bearing facade has never before been made with solid glass bricks.
Energy in the Built Environment & Design Vision
Energy in the Built Environment
Energy in the Built Environment

- Built Environment Consumes > 40% global energy use (30% global CO₂)
- 2010: Free Gas Neighbourhoods (New households no connected to gas pipeline)
- 2018: 49% CO₂ reduction
- 2030: 95% CO₂ reduction
- 2050:
Current Energy Strategy in Building Design (standards)

1. Minimise the demand for energy
2. Use sustainable energy
3. Use fossil fuels as cleanly & efficiently as possible

Trias Energetica → Zero Energy Buildings → On site energy generation

- Energy production
- Energy consumption
Challenge: Mismatch Supply & Demand

Intermittent Supply

Electrical Cables

Demand
Challenge: Mismatch Supply & Demand

![Graph showing the mismatch between production and demand over time. The graph indicates that there is an overproduction during certain times and shortages at others.](image)
Challenge: Mismatch Supply & Demand

The graph illustrates the mismatch between supply and demand over time. The x-axis represents time, with 12:00 as the midpoint, and the y-axis represents power. The red area indicates a shortage, while the green area represents overproduction. Throughout the day, there are periods of overproduction before and after the noon time, and a shortage at that time.
Zero Energy Buildings become too expensive to run...
ABT’s Energy Design Strategy
Design Strategy: Matching Supply & Demand

Intermittent Supply

Electrical Cables

Demand
Design Strategy: Matching Supply & Demand

Intermittent Supply

Minimizing mismatch supply & demand

Electrical Cables

Demand
Integral Design Approach

Integrating passive and active design strategies to minimize the mismatch at the building and district level.
Results: Minimizing Mismatch

- Decreasing peak production
- Decreasing peak loads

Buffering (production-demand shifting)

Shortage
Overproduction
Integral Design Concepts
Energy Hotel

Design Goal: Minimize mismatch supply and demand at building level
Energy Hotel

Design Approach: Designing a building with an inverse energy profile that its surrounding buildings

Energy price is at its maximum (Then...Let’s sell it!)

Deliver energy produced cost money (Then...Let’s keep it!)

Power

Time

Shortage

Overproduction
Energy Hotel

Passive Design Solutions

Vertical forest
- Softening extreme conditions
- Green views

Central patio
- Natural ventilation
- Natural daylight
- Contact with nature
Energy Hotel

Active Design Solutions

PV Panels
Electrical buffer
Smart Controller
Thermal buffer

Selling / buying heat
Selling / buying cold
Selling / buying electricity
Electricity to heat
Electricity to cold
Smart Energy Districts

Design Goal: Minimize mismatch supply and demand at district level
Smart Energy Grids - From buildings to Districts

1. Shaving demand peaks
   The energy demand peaks are reduced within district level by mixing buildings with different energy demand profiles (buildings with different functions).

2. Shaving supply peaks
   Electrical and thermal energy storages reduces the energy supply peaks within the corresponding energy level.

3. Predict & Control
   The controller optimizes the energy transport between the three different energy networks (vertical transport) and other energy districts (horizontal transport). The best control strategy is decided based on the prediction of energy supply, demand and price.

- Selling surplus electricity
- Buying electricity
- Selling surplus heat
- Buying waste heat
- Selling surplus cold
- Buying waste cold
Design Concept Example 1

Design Goal: Optimizing Visual Comfort & Maximizing Electricity Production
Design Concept Example 1

Design Goals: ‘Optimizing Visual Comfort & Maximizing Electricity Production’

- Internal visual comfort
- Architectural appearance
- Energy production
Design Concept Example 1

Generiek daglichtmodelmodel:

- Dominante parameters:
  - hoek pv-paneel
  - lengte pv-paneel
  - gevel orientatie
  - schaduwval
  - interne reflectie factoren
  - daglichtfactor
  - lichtdoorlatendheid glas
  - pv-opbrengst
Design Concept Example 1

- **Paneel 4 0°**
  - Breedte PV-paneel: 450 mm

- **Paneel 4 15°**
  - Breedte PV-paneel: 466 mm

- **Paneel 4 30°**
  - Breedte PV-paneel: 520 mm

- **Paneel 4 45°**
  - Breedte PV-paneel: 636 mm

- **Paneel 4 60°**
  - Breedte PV-paneel: 900 mm

- **PV-opbrengst 4 0°**

- **PV-opbrengst 4 15°**

- **PV-opbrengst 4 30°**

- **PV-opbrengst 4 45°**

- **PV-opbrengst 4 60°**
Design Concept Example 2

Design Goal: Optimizing Thermal Comfort & Maximizing Heating Production
Design Concept Example 2

Design Goals: ‘Optimizing Thermal Comfort & Maximizing Heating Production’

Characteristics

- Long and narrow hallway
- Large glazed south facade (>5 meter)

Design challenges

- Thermal comfort (indoor temperature & draft effect)
- Heat in occupied areas needs to be removed
Results

- The climation system is able to remove heat gains
- Indoor temperature & draft within the required comfort levels
Design Concept Example 3

Design Goal: Optimizing Ventilation System
Goal

Reduction ventilation energy
(25% of total energy consumption)

Design challenges

Define HVAC layout and ducts size
Design Concept Example 3
Design Concept Example 3
ProGETone

Design Goal: Innovative integrated system to optimize energy, seismic structure & comfort
Design Goal: Innovative integrated system to optimize energy, seismic structure & comfort
Smart Modular Facades which integrate technology
Smart Modular facade

- Seismic strengthening
- Energy optimization (passive measures)
- Social acceptance
- Renewable Energy Sources
- Comfort increase
Results

- Lighting decrease: 30-58%
- Energy savings: 77-87%
- Comfort satisfaction: ~34%
TRECO-Office

Design Goal: Analysis of the occupant behaviour influence on the energy demand of an office
Goal: Analysis of the occupant behaviour influence on the energy demand of an office building

Step 1. Real Data Collection: Occupant Movement Detection and Tracking
Goal: Analysis of the occupant behaviour influence on the energy demand of an office building

Step 1. Real Data Collection: Energy Monitoring

- Record images
- Send data
- Edit image and call server
- OCR software
- Gas meter info available

Image of recording the images

Images are edited and sent to server

Graph of daily gas consumption
Goal: Analysis of the occupant behaviour influence on the energy demand of an office building

Step 2. Data Analysis: Quantitative Analysis Presence Influence

Models Built
1. Model 1: including the occupancy
2. Model 2: excluding the occupancy
3. Model 3: independent from the occupancy

Results
The quantitative analysis confirm that a 3% of the heating energy demand is due to the presence-based parameters and gives indications that the occupant behaviour influence is null or minimal.

\[
Q_{\text{demand}} [\text{kW.h}] = \text{Constant} + C_1 (T_{\text{outdoor KNMI}}) + C_2 (T_{\text{outdoor roof}}) + C_3 (Q_{\text{solar}}) + C_4 (\text{Occupancy}^t) + C_5 (\text{Occupancy}^{t-2}) + C_6 (T_{\text{indoor air}})
\]
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