Energy Use and Buildings

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Overview

Introduction

Background

Research and Solutions

existing building stock
new buildings
building integration
wind energy
Introduction

• Wind Engineering

• Building Systems

• TNO and TU/e

• Technology of the Building Envelope
Background
Energy Balance of a House
In: solar energy
In: Energy for domestic use
In: Production by human beings
Out: losses by ventilation
Out: Transmission and Infiltration
Out: Hot water
Balance

Zon
Gas
Elektriciteit
Bewoners

Ventilatie/Infiltratie
Transmissie
Warmwater
Energy Use in Existing and New Homes

![Energy Use Chart]

- **Existing**
  - Heating: 200 kWh/m²/yr
  - Ventilation: 80 kWh/m²/yr
  - Lighting: 50 kWh/m²/yr
  - Pumps: 30 kWh/m²/yr
  - Hot water: 100 kWh/m²/yr
  - Electricity: 150 kWh/m²/yr

- **New**
  - Heating: 180 kWh/m²/yr
  - Ventilation: 70 kWh/m²/yr
  - Lighting: 40 kWh/m²/yr
  - Pumps: 25 kWh/m²/yr
  - Hot water: 120 kWh/m²/yr
  - Electricity: 130 kWh/m²/yr

Total Use, kWh/m²/yr:

- **Existing**: 560 kWh/m²/yr
- **New**: 500 kWh/m²/yr

The chart illustrates the energy use in existing and new homes, highlighting the breakdown of energy consumption by category.
Electric equipment 1966

8 sockets
34 sockets

Electric equipment 2009
Electricity Use Households EU27

2%/ year increase

Source: Eurostat
1. Limit demand for energy through rational use of energy
2. Use renewable energy to fulfil remaining demand
3. Use fossil fuels, if necessary, as efficiently and cleanly as possible
# Measures

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(Building Future) Ambit

- In 2050: Energy Neutral Built Environment (NL)
- Reduction (75%) in existing buildings
- Energy delivering new buildings (from 2020)
- Energy production at district level
Existing Houses
In total 7,000,000 Houses in The Netherlands

Built in 1945 – 1975 period : 2,500,000
30% detached and semi detached  
750,000

40% terraced housing  
1,000,000

30% appartments  
750,000
Blue columns: persons per dwelling

Yellow line: m² per person

Source: Consument gericht toeleveren in de 21ste eeuw NVTB
Preferred dimensions:

9 – 12 m²

28 – 39 m²
Apartment buildings
Typical apartment (built before 1966)
Mostly social housing sector

Room area = 15.8 m²
To be expanded to at least 23.4 m²

Usually 6.20 to 6.40 m
Source: NOVEM
Rc value floor 0.17 m²K/W (U value = 5.9 W/m²K)

Rc value wall 0.4 m²K/W (U value = 2.5 W/m²K)

Rc value roof 0.3 m²K/W (U value = 3.3 W/m²K)

Single pane windows
U = 5.1 W/m²K

Thermal bridges

Characteristic vertical section Housing, built in 1945-1965 period
Directions for solutions in existing stock

- **Research and Development**
  - **Rigoureus (TNO, ECN, TUD, DHV)**
    - 5 concepts developed
    - Buildings, installations, user behaviour
    - Terraced houses
  - **Reflex (TNO and industrial partners)**
    - 1 concept, until prototype
    - Building and installation
    - Apartment buildings
  - **Slimrenoveren (TU/e)**
    - Concept
    - Building and installation
    - Terraced houses
Solutions

• Building Technology

• Installation technology

• User behaviour
Rigoureus Concept 1: VEH

Target Group: House Owners

- Phased approach
- Action when needed
- Larger area (draagvlak)

- properties concept
  - light components
  - Heat pump + LTH
  - standby killers, A++ apparatus
  - 3 m² collector + 150 l vessel, 20 m² PV
Rigoureus Concept 2: Shadowroof

• Solar energy not possible
  • relevant for large part of existing stock
  • in house, during renovation

• properties concept
  • medium
  • zoning + internal insulation
  • Heat pump + Low Temp Heating
  • Strong change in user behaviour
Rigoureus Concept 3: Champions

• Environmental idealists and cultural creatives
  • Minimise energy demand
  • No loss of comfort / status

• properties concept
  • advanced
  • Heat pump + LT heating
  • standby killers, A++ apparatus
  • 8 m2 collector + 600 l vessel, (only) 2 m2 PV
Rigoureus Concept 4:Prefab Housing Sector

• focus: Social Housing Sector
  • Large scale,
    Optimal building process
  • Building envelope (not installation)

• Properties concept
  • advanced
  • HR-ketel
  • Adjustment user behaviour
  • 14 m2 PV
Rigoureus Concept 3: Traditional

- **Social Housing Sector**
  - Traditional approach
  - Renewable energy
  - collective approach

- **Properties concept**
  - medium
  - HR-ketel
  - standby killers, A++ apparatus
  - 3 m² collector + 150 l vessel, 24 m² PV
Rigoreus Concepts: Energy Demand

vergelijking concepten

energieverbruik 100%
75%
50%
25%
0%
-25%
voor
renovatie
VEH
prefab
ambachtelijk
schaduw dak
koplopers concept

PV elektr gebruiker elektr, gebouw ruimteverw tapwater koken
Smart Renovation
Reflex
Example (do it yourself)

- Bird nesting
- Wood stove
- Heat exchanger gas heat pump
- Passive Solar with screens
- Solar thermal with storage on roof
- PV system, integrated
- Floor heating
1. Limit demand for energy through rational use of energy

2. Use renewable energy to fulfil remaining demand

3. Use fossil fuels, if necessary, as efficiently and cleanly as possible
Passive Houses
Passive House

Reduction of Heat Losses
Optimisation of energy gains

Active solar energy use
Passive solar energy use
Solar thermal coll. (optional)

Super insulation

Ventilation system with heat recovery

ground heat exchanger

www.passiv.de
Measures

1) Orientation

- Large windows south
- Small windows north
- Sun shading in summer
Measures

1) Orientation

2) Thermal Insulation
   - $R_c > 8 \text{ m}^2\text{K/W}$
   - Avoid thermal bridges
Measures

1) Orientation
2) Thermal Insulation
3) Detailing: Windows and Doors
   - Triple glazing
   - No thermal bridges
Measures

1) Orientation
2) Thermal Insulation
3) Detailing: Windows and Doors
4) Ventilation
   - Balanced ventilation
   - Heat recovery
   - Excellent air tightness
     \( \text{(N50 < 0.6 h}^{-1}) \)
Passivhaustechnik
Germany: Factor 10

The diagram illustrates the energy balance of a building in Germany, focusing on the reduction of energy consumption through passive house components. The chart shows the energy losses and gains for various parts of the building, such as the attic, windows, and external walls, as well as the internal gains from solar radiation.

Key points:
- The current energy consumption for the building is approximately 204 kWh/(m².a).
- Sanierung mit Passivhaus-Komponenten (Sanitation with passive house components) is projected to reduce energy consumption to 27 kWh/(m².a).
- The diagram emphasizes the significant impact of passive house components in reducing energy losses and increasing energy efficiency.
Parkhaus Pinnasberg, Hamburg
Quality assurance
Quality assurance
Quality assurance
Blower Door Test

Requirement in Austria:
Standard house $n_{50} < 3.0$
Passive house $n_{50} < 0.6$

Quelle: www.magnum-board.com
© BlowerDoor GmbH
www.blowerdoor.de
© BTI

Quelle: www.magnum-board.com
Some architecture....
Building Integrated Solar Energy
Building Integrated solar energy

- Photo voltaics
- Solar thermal
- PVT
Grid connected systems
Stand alone Systems
Solar Energy

- Orientation
  - 10% limits: SW-SE

- Roof pitch
  - optimal NL: 36°
  - 10% limits 20° - 50°
Roof Surface vs. Energy Use

10 m² roof surface with PV

= 1 kWp installed

= 800 kWh solar energy / year

= 800 kg CO₂

= yearly electricity use of 1 person
Solar Roofs: Energy prices
Building Integration
added to building envelope

(existing buildings)
Building integration
part of waterproofing layer
Building integration
part of outer layer
Building Integration

- Storm resistance
  - Legislation
  - Design rules
  - Calculation/testing

- Water proof
  - Cables
  - Mechanical fixing
  - Critical details at integration

- Size and dimensions
  - Adjust buildings
  - Adjust systems

- Robustness
  - PV roof covering/facade
  - Failure costs
Adapt products to building design
or
Adapt building design to available products
Standards
Future…

• Lower the costs
  • Cheaper panels
  • Mounting methods
• Complete solar roofs (e.g. prefabricated)
• Use the sun for cooling
• Optimal orientation
  (at level of neighbourhoods)

Include during design
(+ all parties on the table)
Total irradiation in year, Uccle

15° inclination

YIELDS 85-100%
Wind Energy
Wind energy on buildings
Wind energy on buildings
Attention

- Location
- Performance
- Safety
- Noise
- Vibrations
- Maintenance
- Sun reflections
- Birds, Cats....
Resume

• Trias Energetica

• Optimization on four levels
  • Building
  • Installation
  • Household Appliances
  • User

• Variety of Solutions possible

• Large Challenges in existing building stock
Announcement

International Conference on Wind Engineering
Amsterdam, 10 – 15 juli 2011
www.icwe13.org