

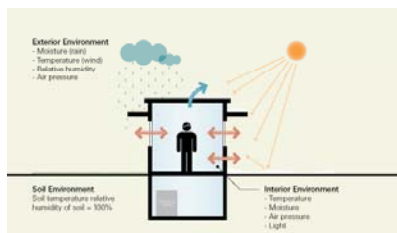
Buildings...

- Provide a safe and healthy place for (human) activity
- Have a typical design lifetime of 50 to 100 years
- Change ownership many times during their lifetime
- Are responsible for about
 - 40% of total energy use
 - 25% of all road traffic
 - 35% of waste



Current Building Design and Realisation

- ...is dominated by lowest price on short term
- ...focusses on current building regulations
- ...does not include flexible use during lifetime
- ...Is based on past climate



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Climate Change: challenges for building sector

- Mitigation of CO₂ production
 - Decreasing energy demands
 - Production of durable energy
 - Use of sustainable materials
 - Application of new techniques
 - Decrease building related traffic
 - Adapting to Climate Change
 - Living with and on the water
 - Extreme weather conditions
 - Dealing with increasing temperatures
1. Energy consumer becomes Energy Producer
 2. Durable and Sustainable use of Materials
 3. Include climate change as factor in design and engineering
 4. Re-set of the construction sector



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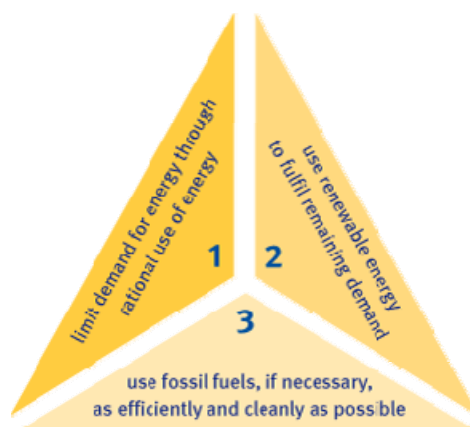
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1. Energy Consumer becomes Energy Producer

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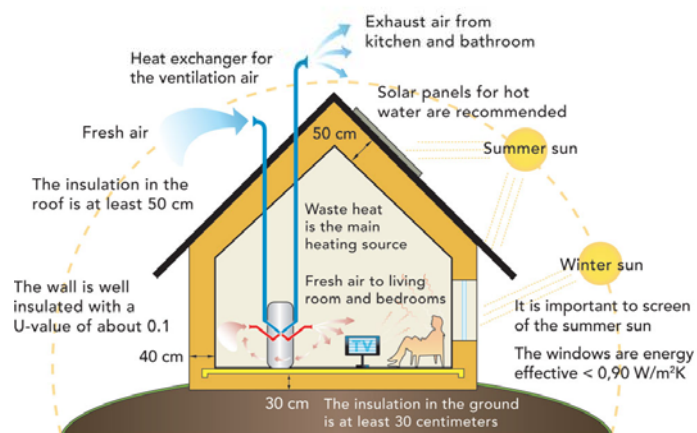
Trias Energetica

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Future houses



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Minimize Energy Losses



Van den Dobbelaars et al., TU Delft

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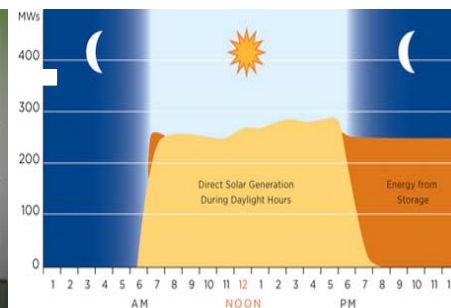
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Sustainable energy: matching supply and demand

Research and Development: Thermo-chemical heat storage

- Seasonal and Day-Night storage
- Integration in Building Systems



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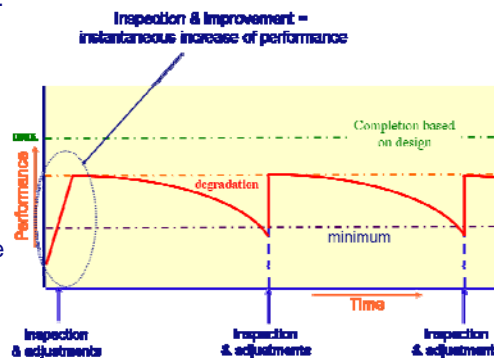
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Energy efficiency as realised

Research in 70 buildings shows:

- Average energy use of buildings is 25% higher than expected
- 70% of HVAC-systems do not work according to intended use
- 90% of comfort complaints are related to building services

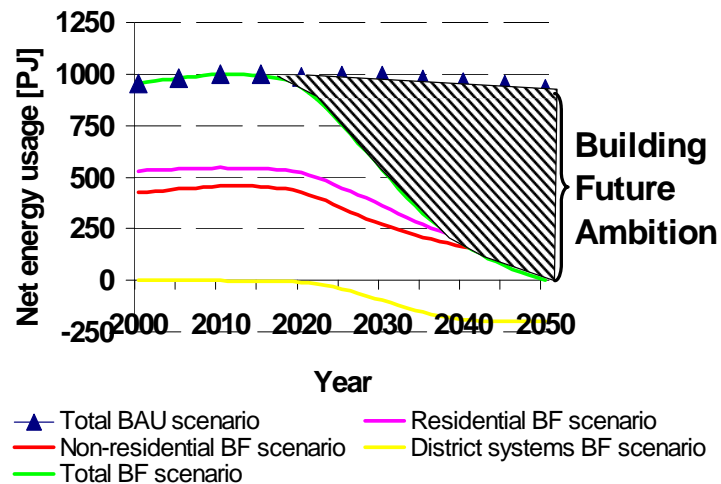


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Energy Producing Built Environment



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E2B

E2B Mission statement

"The overall objective of E2B European Initiative (E2B EI) is to deliver, implement and optimise **building and district concepts** that have the technical, economic and societal potential to drastically **decrease the energy consumption and reduce CO2 emissions** due to **existing and new buildings** at the overall scale of the **European Union**.

The E2B EI will speed up research on key technologies and develop a competitive industry in the fields of **energy efficient construction processes, products and services**, with the main purpose of reaching the goals set forth for **2020 and 2050** to address climate change issues and contribute to improve EU energy independence thereby transforming these challenges into a business opportunity."

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2: Durable and Sustainable Materials

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New Materials

- combining knowledge of:
 - mix-design
 - photocatalytic materials
- Aim
 - efficient use of TiO_2
 - cost-efficient paving blocks



Jos Brouwers et al.

Castorweg, Hengelo

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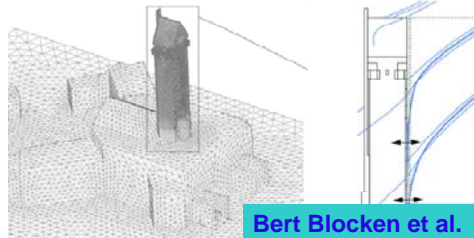
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building envelope hygrothermal behaviour



Building envelope heat and mass transfer
Urban heat and mass transfer
Building envelope durability



Bert Blocken et al.



Climate Change effects on building materials (1)

- Higher temperature
 - Limited decrease in number of freeze-thaw cycles
 - Less near zero days → less deicing salts
 - Faster biocolonization, increased biodegradation
- Higher precipitation
 - Deeper moisture penetration in façades
- Combined effect higher temperature – higher precipitation
 - Limited decrease in freeze-thaw cycles but more wet materials → possibly more damage
 - Effect on RH cycli and (indoor) salt damage
 - Changing biocolonization patterns (different species)



Climate Change effects on building materials (2)

- Combined effect higher precipitation – wind load
 - Increased erosion high-rise buildings
- Increased solar radiation
 - Possible lower durability bituminous roofings, plastics, etc.
 - Negative effect on preservation historic polychromy etc.
 - Increased degradation of exterior timber

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Climate Change effects on building materials (3)

- Soil moisture contents
 - Lower
 - Drying → shrinkage, subsidence, cracking walls
 - Wooden pile foundations exposed to oxygen
 - Less damage due to rising damp
 - Higher
 - More damage due to rising damp
- Increased salinity ground water
 - Higher salt load porous building materials



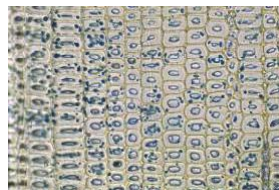
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Adaptation: biocolonization

- Smart materials
 - Slow controlled release
 - Low water retention
 - Water repellents



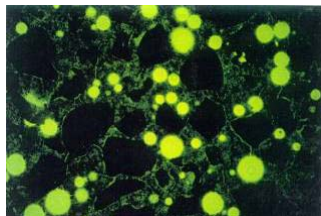
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Adaptation: freeze-thaw damage

- More resistant materials, especially mortars
 - Gap-graded sand
 - Air-entraining agents



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Adaptation: salt damage

- Desalination
 - Poultices
 - Electro-osmosis
- Salt resistant repair materials
 - Crystallization inhibitors
 - Salt transporting or salt accumulating plasters



More information: HERON 54, volume 1 (2009)
<http://heron.tudelft.nl>

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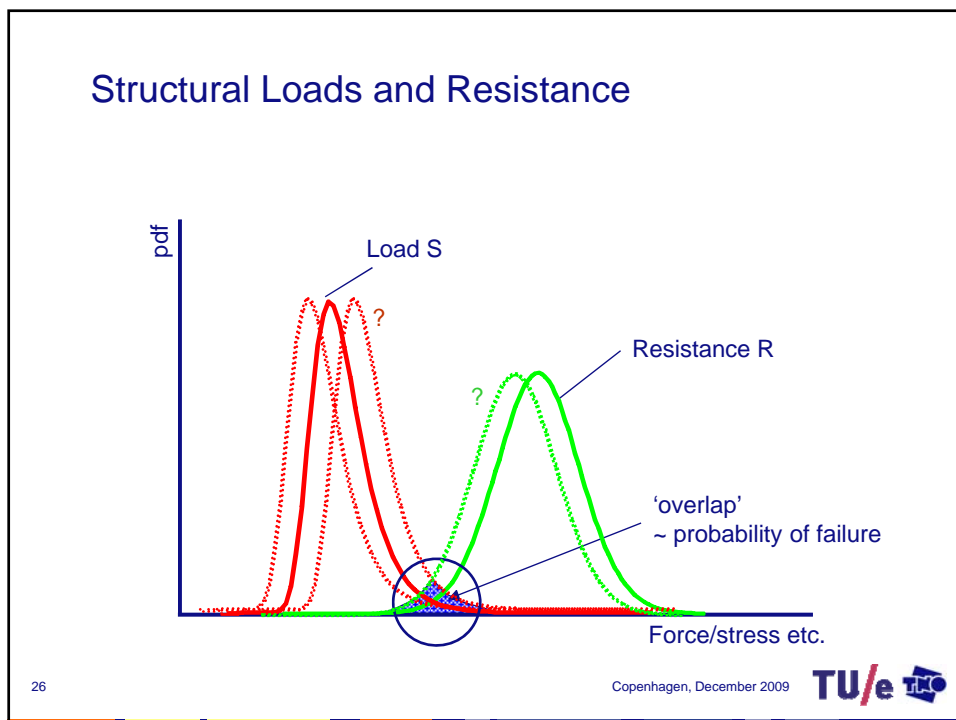
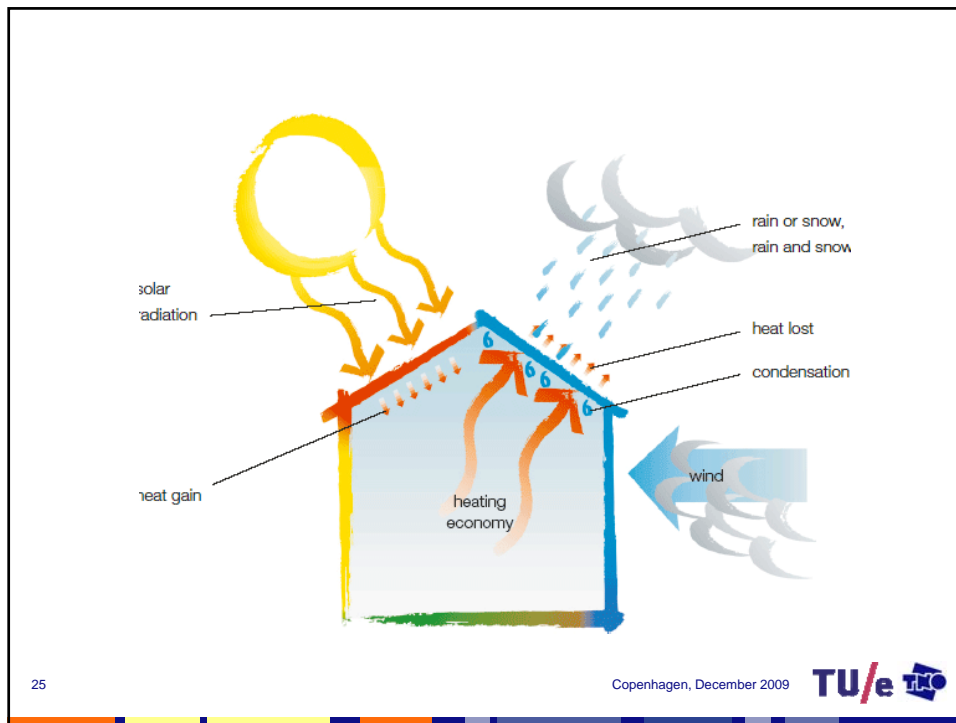


3. Climate change as factor in design

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Storm Resistant Design

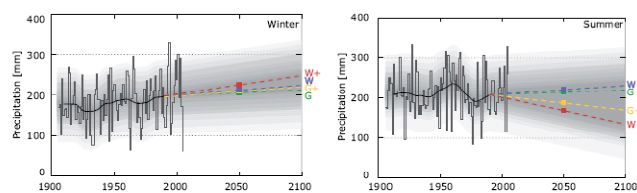
- Focus on extreme events
 - Typically $R=1000$ years
 - Short duration : 1 to 3 seconds
- Trends
 - Exposed value increases
 - Wind sensitive locations (delta)
 - New materials introduced
 - New functions added
 - Climate Change (?)



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Ponding

- Basis for design
 - extreme in 5 minutes, $R = 50$ years
 - Observation period 1906-1990
- KNMI'06 scenarios
 - Winter: average (+4% .. +14%)
 - Summer: 1-day (+5% .. +27%)
 - 5 minute extremes not estimated
 - Indicates increase of extremes



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Upernigen, December 2009

Snow loads

- Increasing temperatures may lead to less snow, but
- Increased extreme precipitation may lead to higher extremes
- No information from scenario's
 - Adaptation required ?



More information: HERON 54, volume 1 (2009)
<http://heron.tudelft.nl>

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4. Innovation of the building sector

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Realisation and Renovation Process



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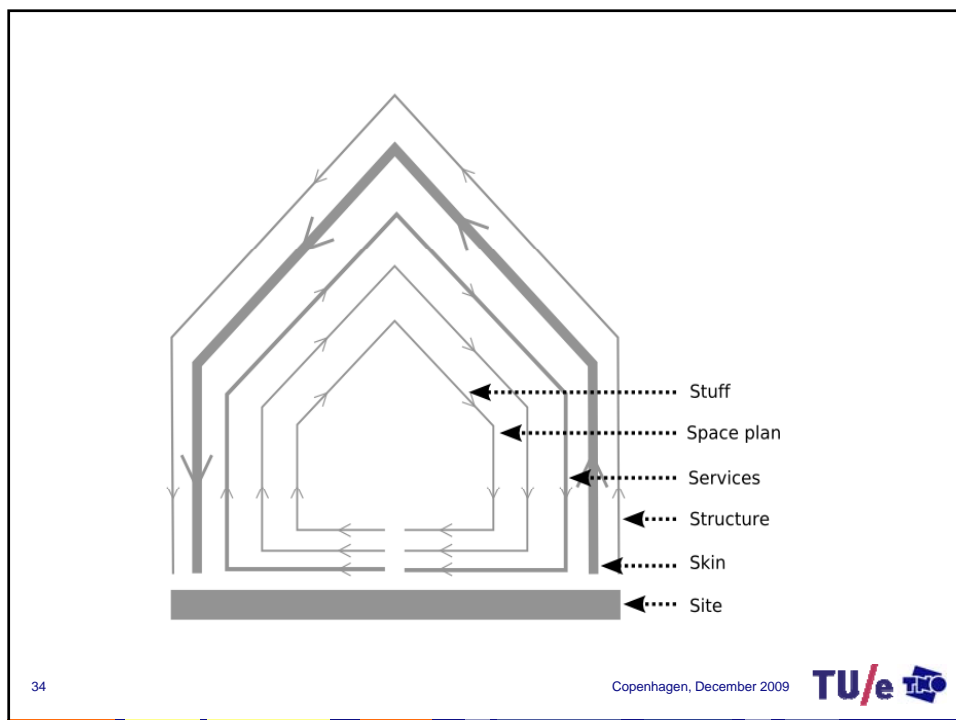
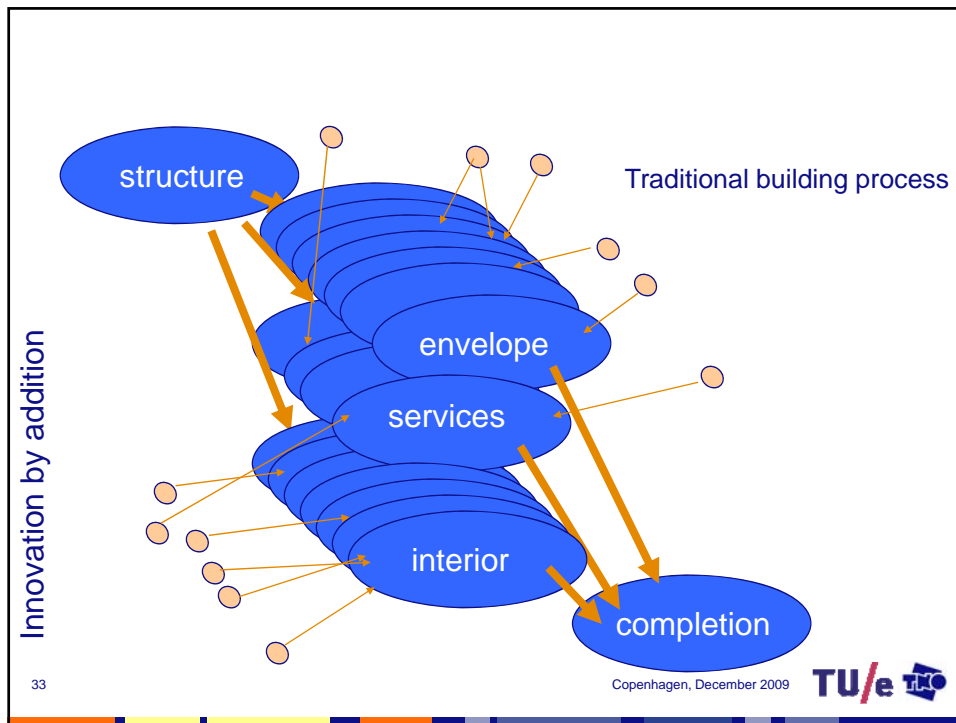
Solar Energy Roofs

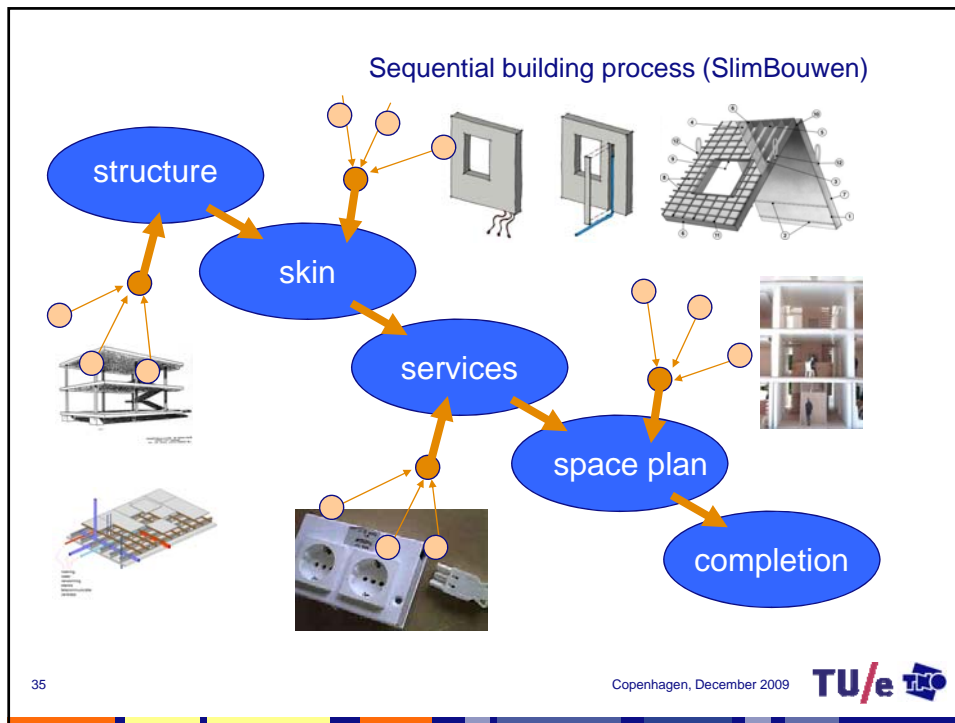


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Reduction of material use, volume, waste, energy, transport, pollution, CO₂ emission,...

High Quality Level in architecture, comfort, acoustic insulation,

Substantial cost savings by Process Efficiency

 + €

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TU/e

Kraanspoor
(commercial building)
Amsterdam

