



Future technological trends

– for the building industry

Guus Mulder





About TNO

- › The Netherlands Organisation for Applied Scientific research is an independent not-for-profit research organisation whose expertise and research make an important contribution to the competitiveness of companies and organisations, to the economy and to the quality of society as a whole.

Develop
fundamental
knowledge

Knowledge
development

Knowledge
application

Knowledge
exploitation

With
universities



With
partners



With
customers



Embedded in the
market





About me

Guus Mulder

- › MBA: specialization in innovation and cooperation – 2008
- › TNO: Researcher Innovation in the Built Environment, since 2008

Relevant projects:

- › RRE: Assessment of Scenarios and Options towards a Resource Efficient Europe; An Analysis for the European Built Environment, European Commission, 2014
- › Emininn: Investigating the impact of innovation in the built environment, FP7 2014
- › BAREnergy: Investigating barriers to the reduction of energy reduction in European households, FP7 2012
- › Sectoral Innovation Watch: Cross sectoral analysis of innovation barriers and opportunities in nine sectors, Competitiveness and Innovation Framework Programme, 2010



Innovation in the building industry: A lot is happening

Process innovation

- › Conceptual design
- › Prefabrication
- › Co-opetition
- › Building Information Management

Product innovation

- › Adaptable buildings
- › Energy producing buildings

Technical innovation

- › Replacement of traditional material
- › Design for disassembly
- › New materials
- › Smart materials



Proces innovation



Conceptual design



Advantages

- › Standardization
- › Optimization
- › Cost reduction
- › Strategic cooperation between disciplines
- › Competition on quality





Prefabrication

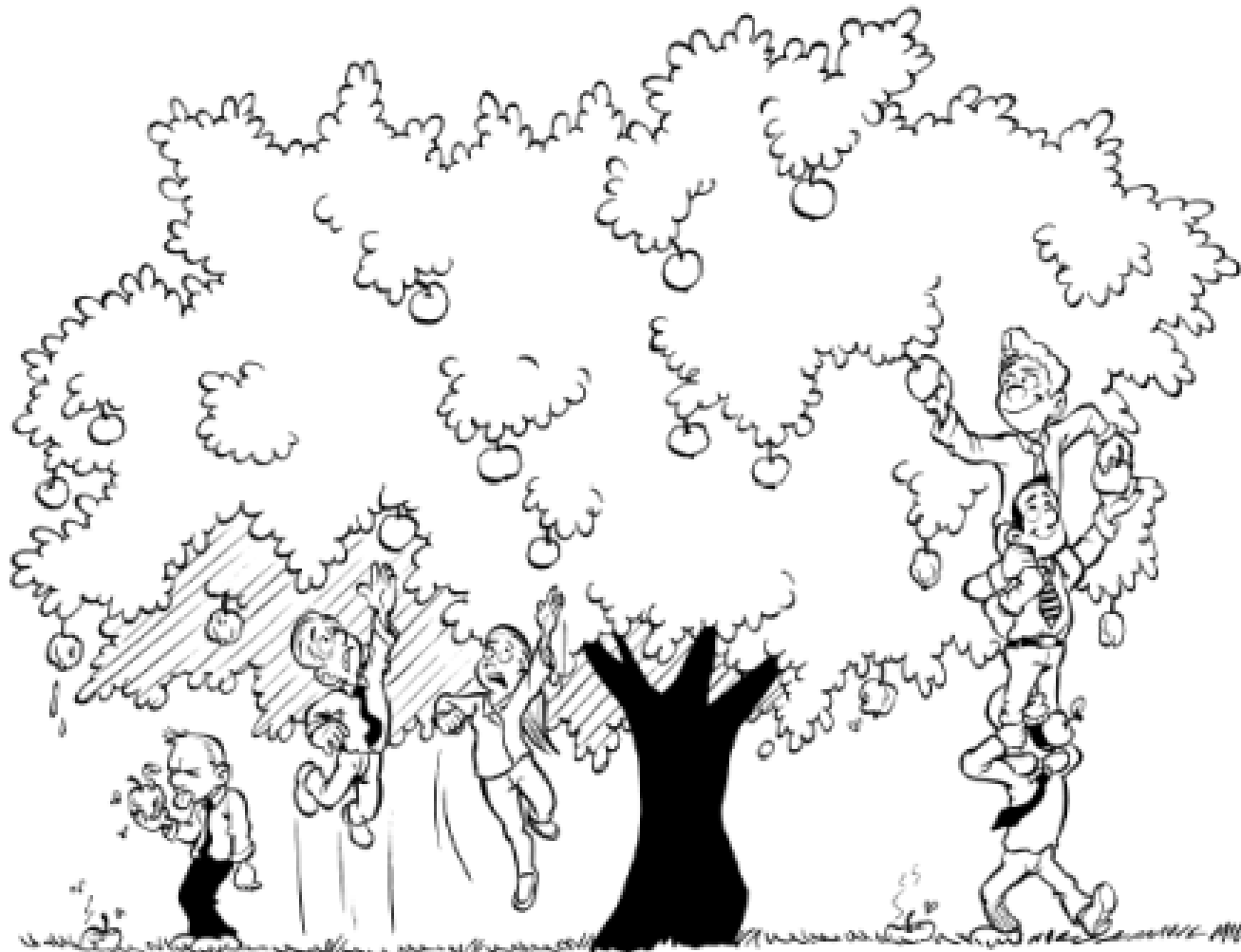
- › Buildings and parts
- › New built and renovation



- › Integral design and optimisation
- › On site time reduction
- › Small scale projects

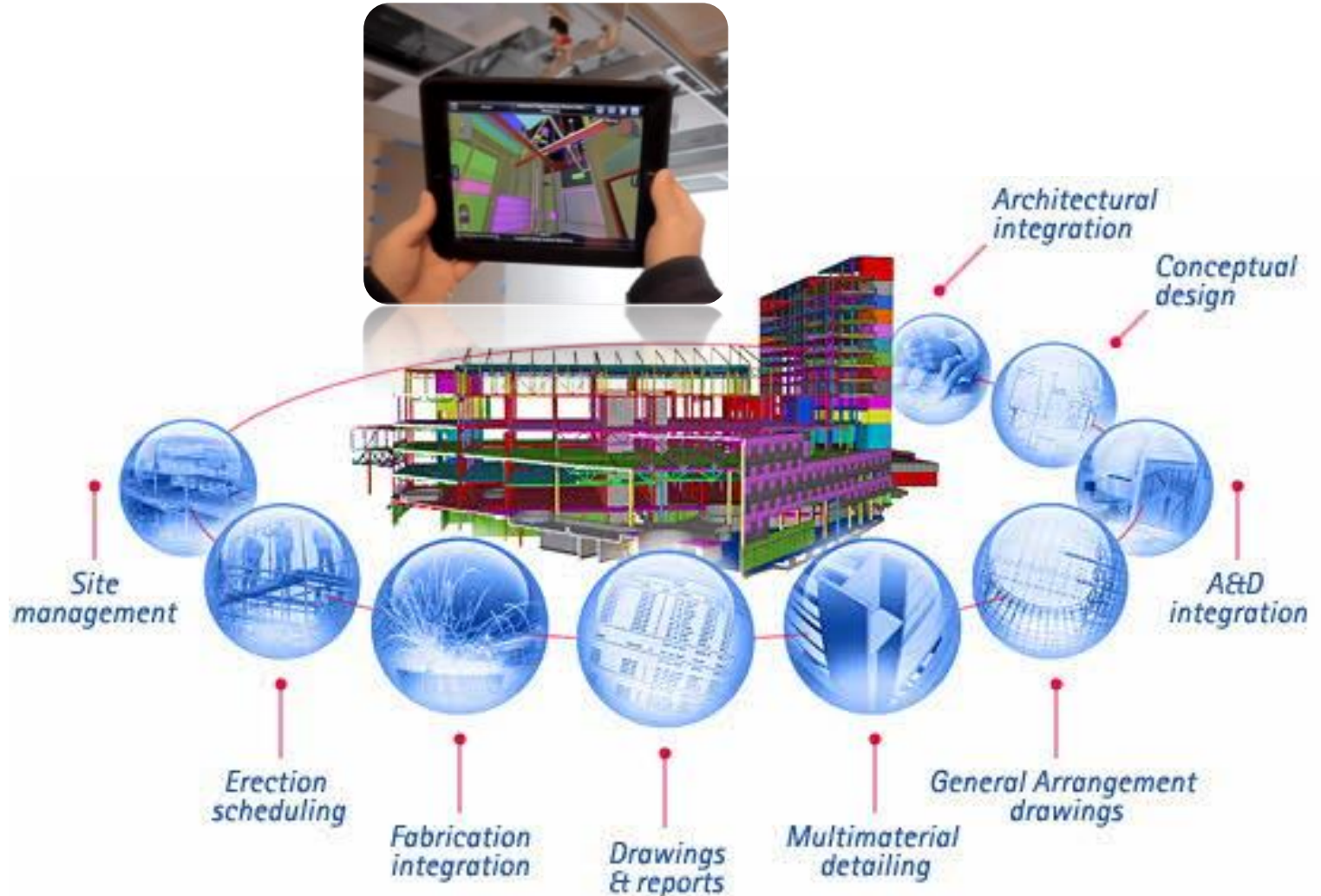


Co-opetition





Building Information Management



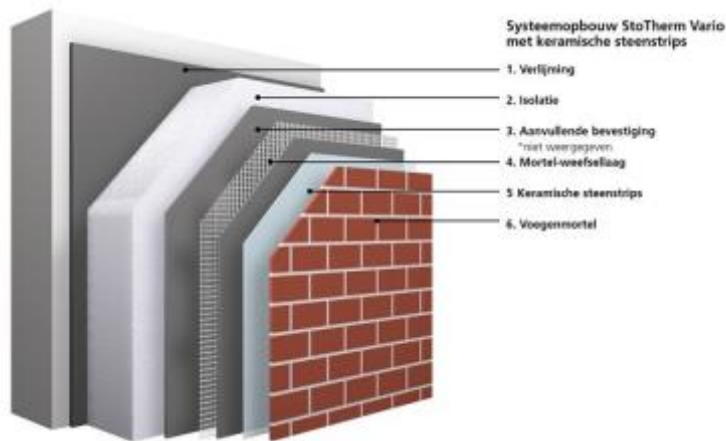


Technological innovation



Replacement of traditional material

- › In renovation and new built for increased thermal isolation



**Increased thermal
isolation**



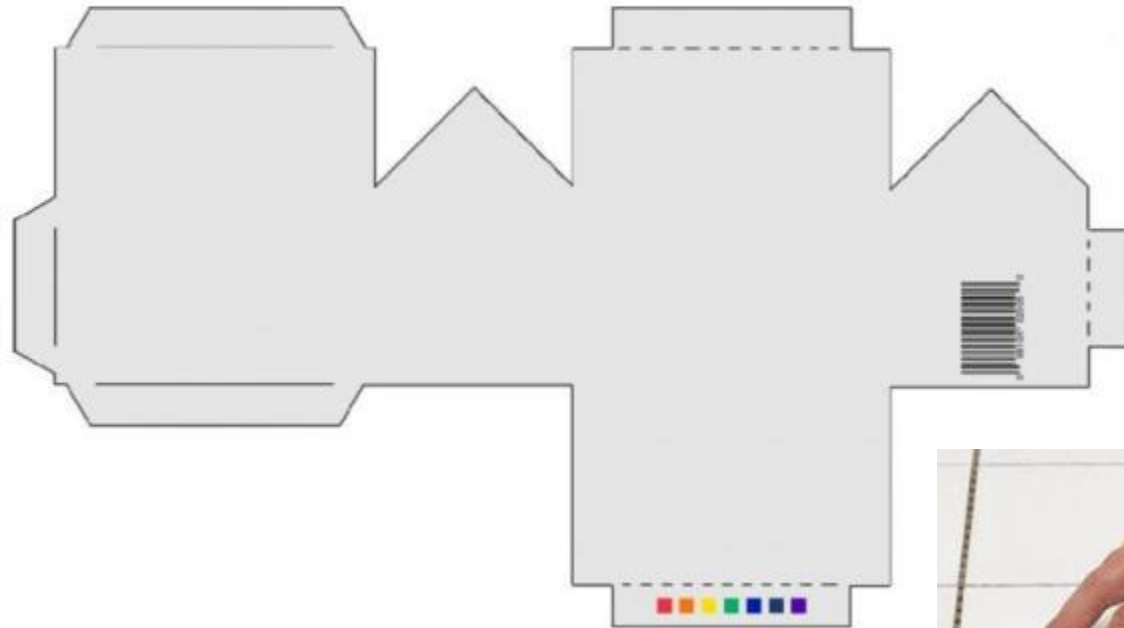
**Material / weight
reduction**



Design for Disassembly

DfD

Design for Disassembly:
a cradle-to-cradle guide
of building design principles



Reversible binders



New materials

- › Reduce energy intensive steps
- › Biobased materials
- › Recycling



All-waste, lightweight
concrete with increased
insulation



Cold manufactured bricks



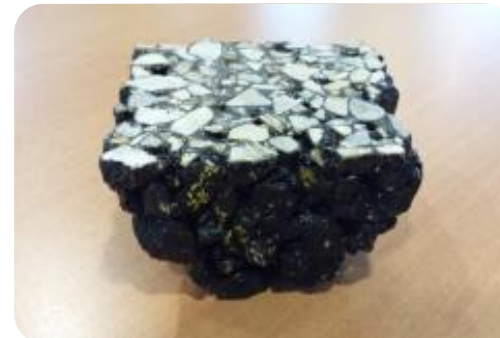
Biobased insulation



Biobased paint



Geopolymers

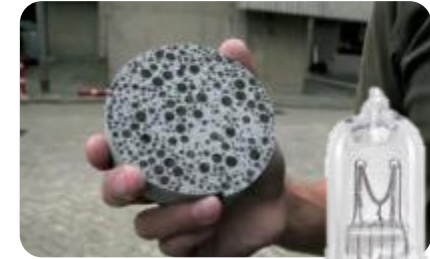


Lignin asphalt



Smart materials

- › Adaptation to different circumstances
- › Maintenance



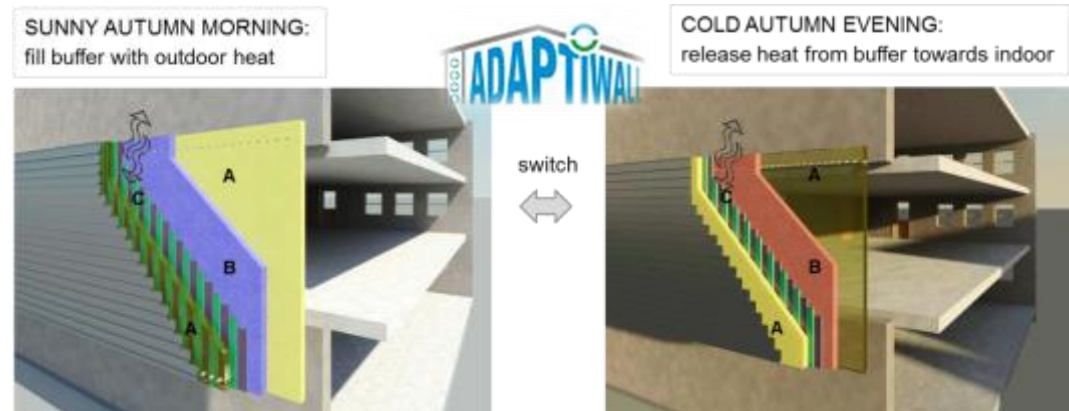
Self healing concrete



RFID tagging and sensors



Smart coatings



Smart system / material interaction



Product innovation

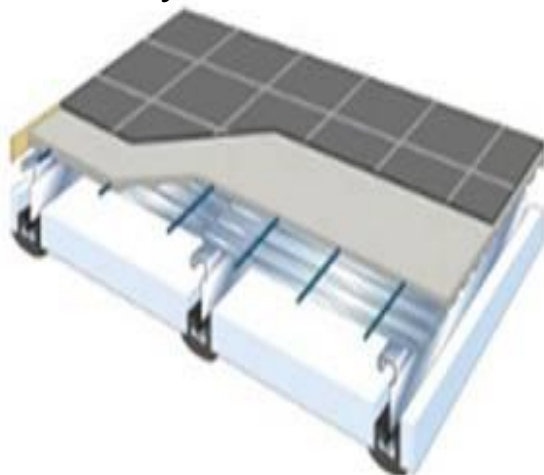


Adaptable buildings

- › Emancipation
- › Individualisation
- › Customization
- › Economic inequality
- › Cleaner, climate friendly and energy-efficient
- › Liveability within cities under pressure



Zoning free and adaptable



Adaptable flooring system

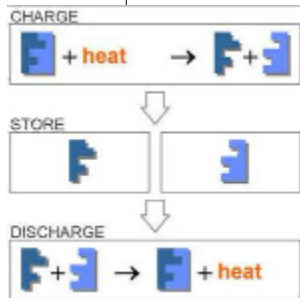
- › Which leads to:
 - › A need to make buildings adaptable to changing needs
 - › A need to intensify the use of buildings
 - › Higher demands on building quality



Powerplant of the future



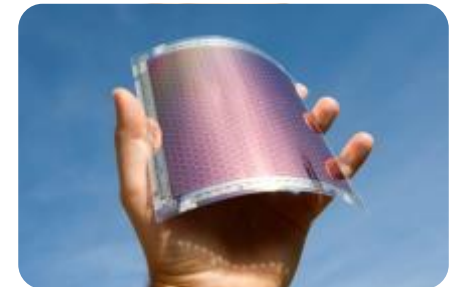
› Elektriciteit and heat/cold



Thermo chemical storage



Thin film PV



Organic PV

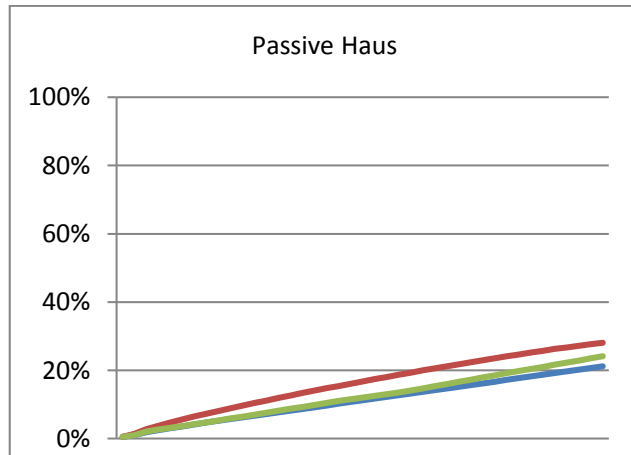
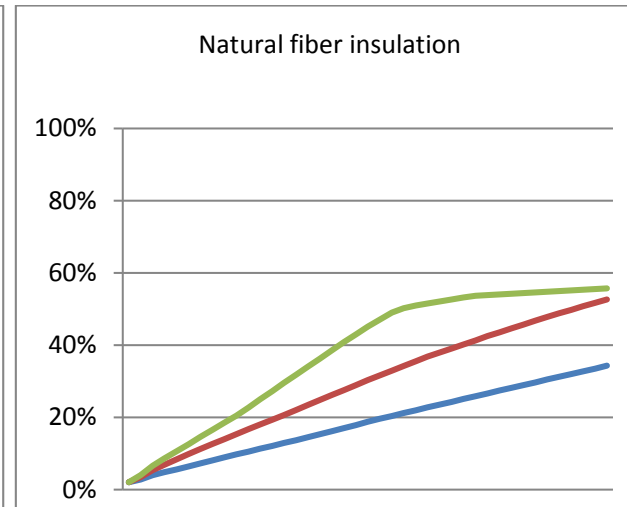
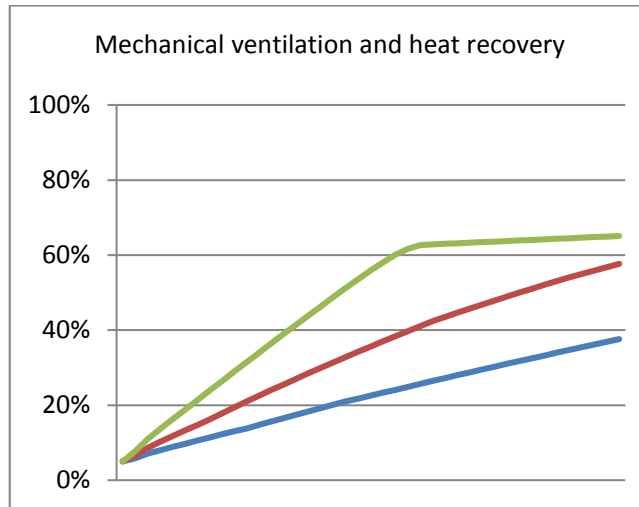


Implications of technological trends

Rebounds and health issues

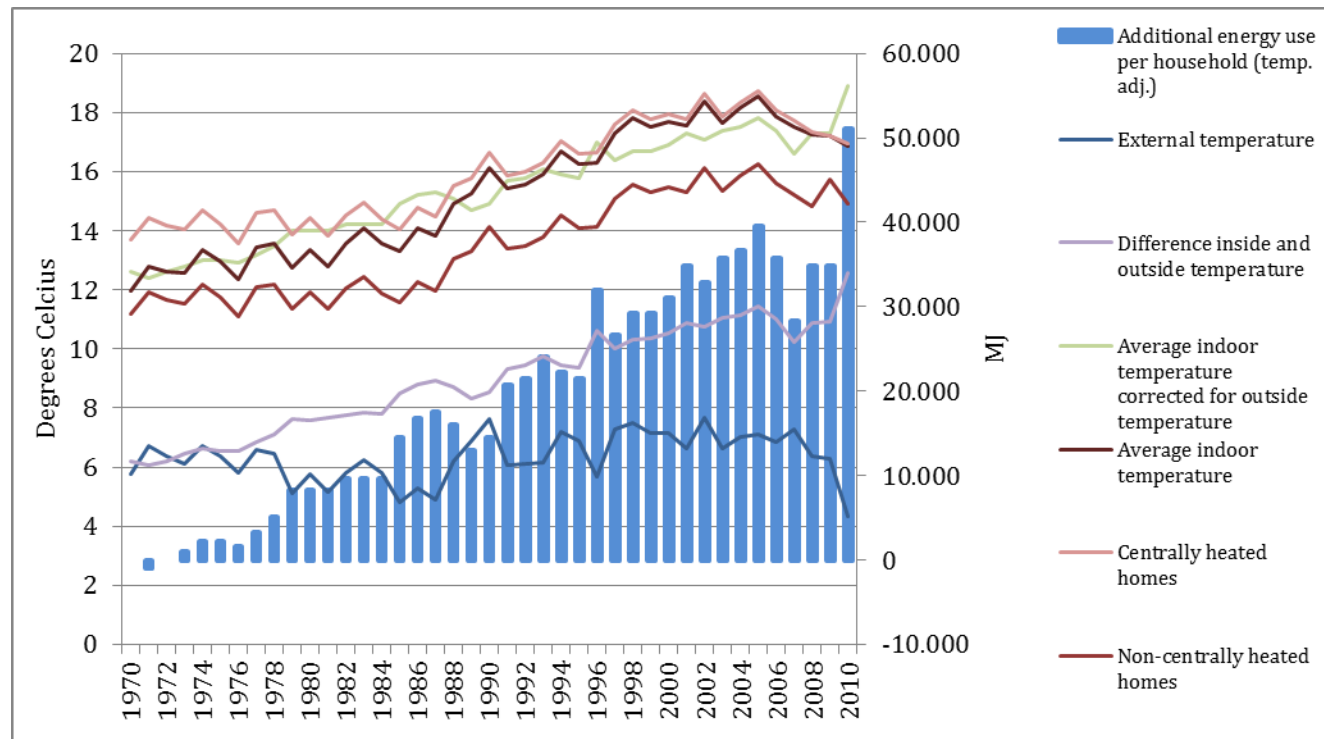


Diffusion scenarios for EU 2050



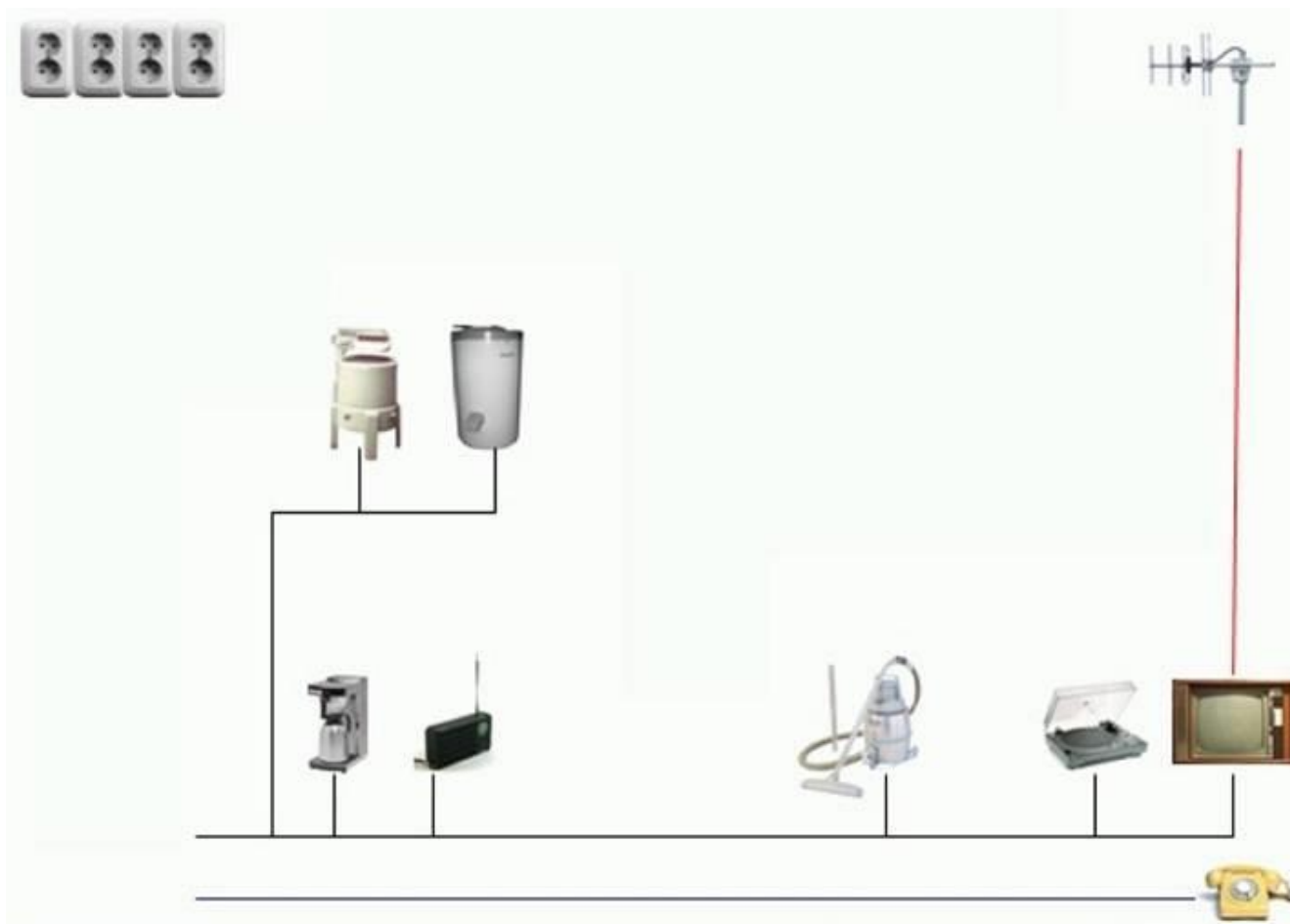


Rebound, behaviour and prosperity





1966



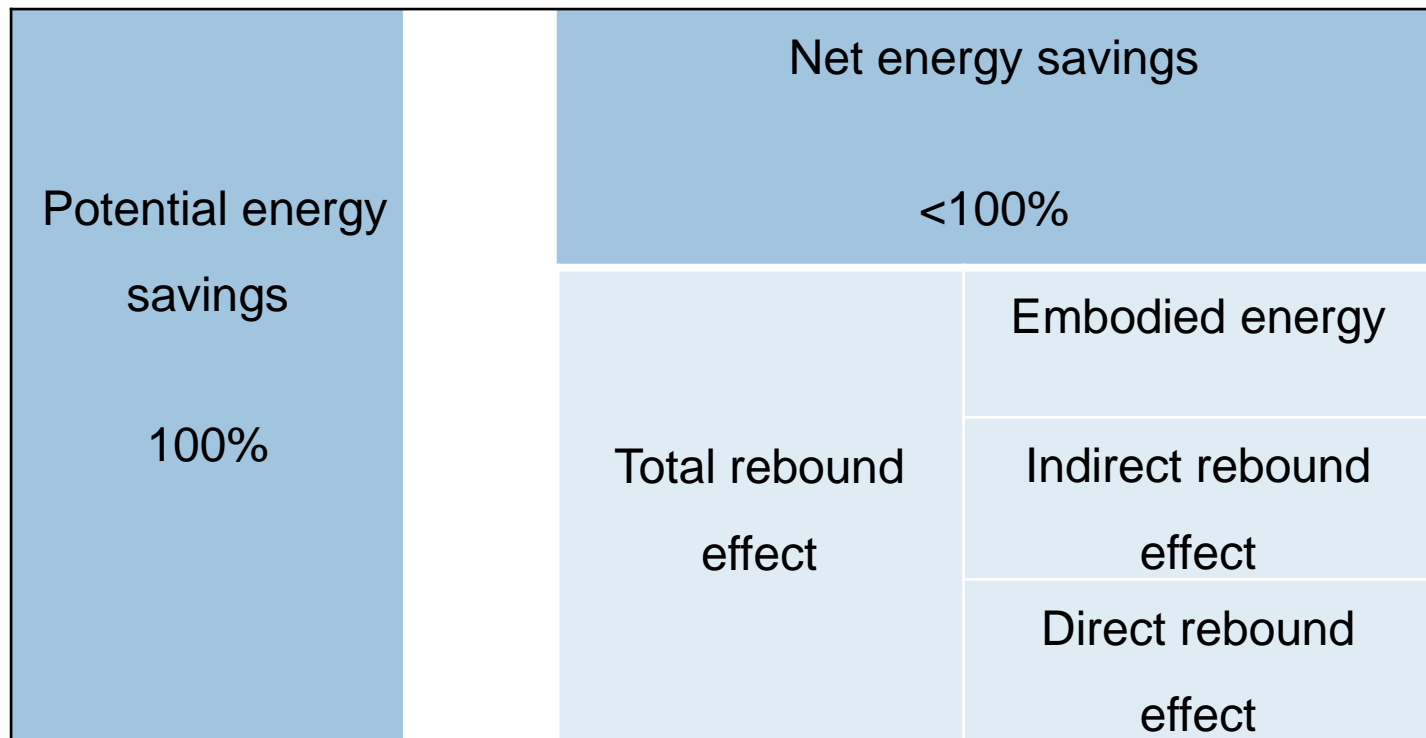


2014





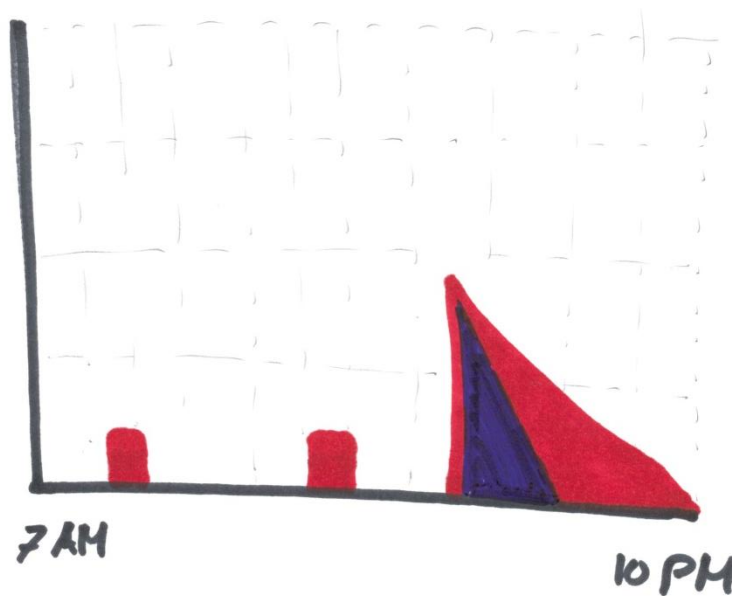
Rebound effects





Health issues

- › Humidity
- › Particulates
- › CO₂



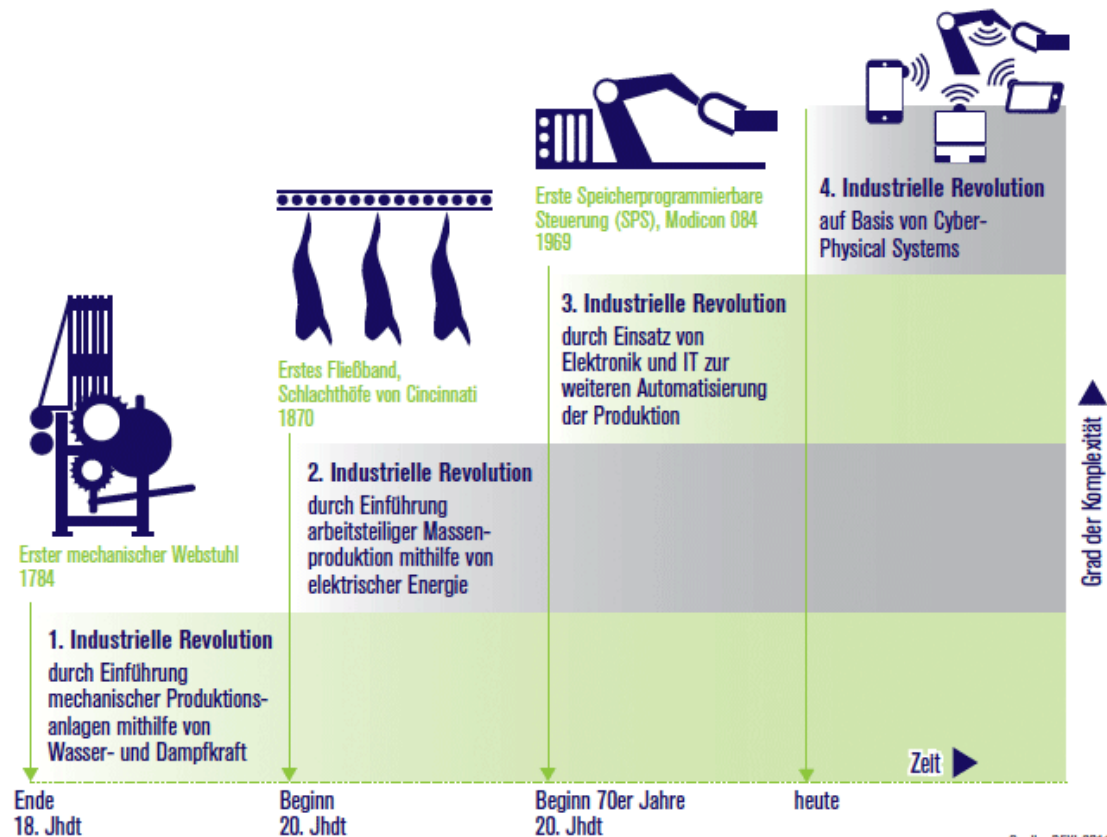


Future developments

From artisans to industry 4.0



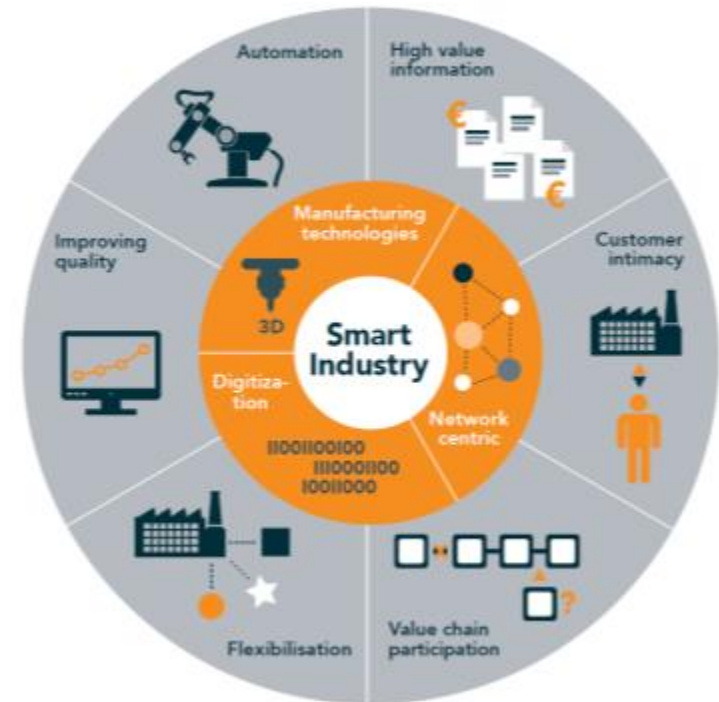
Industry 4.0 – “Smart Industry”





Industry 4.0 – “Smart Industry”

*Smart Industries are industries that have a high degree of **flexibility** in production, in terms of product needs (specifications, quality, design), volume (what is needed), timing (when it is needed), resource efficiency and cost (what is required), being able to (fine)tune to **customers needs**, enabled, networked and driven by ICT and the latest available proven manufacturing technologies.*





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Appendix





Construction industry – fact and figures

- › 6 to 10% of EU's GDP (depending on the source)
- › 2.9 million companies
- › Biggest industrial employer in the EU63
- › 16.4 million operatives which is 7.2% of EU workforce
- › Uses 40 - 50% (depending on sources) of all materials extracted
- › Contributing 8 % to total EU-15 GHG emissions in 2007
- › Physically demanding and often hazardous working conditions
- › Buildings use 30% of the primary energy use in OECD countries
- › Responsible for 10-30% of all solid waste globally, 40-50% of total waste in Europe



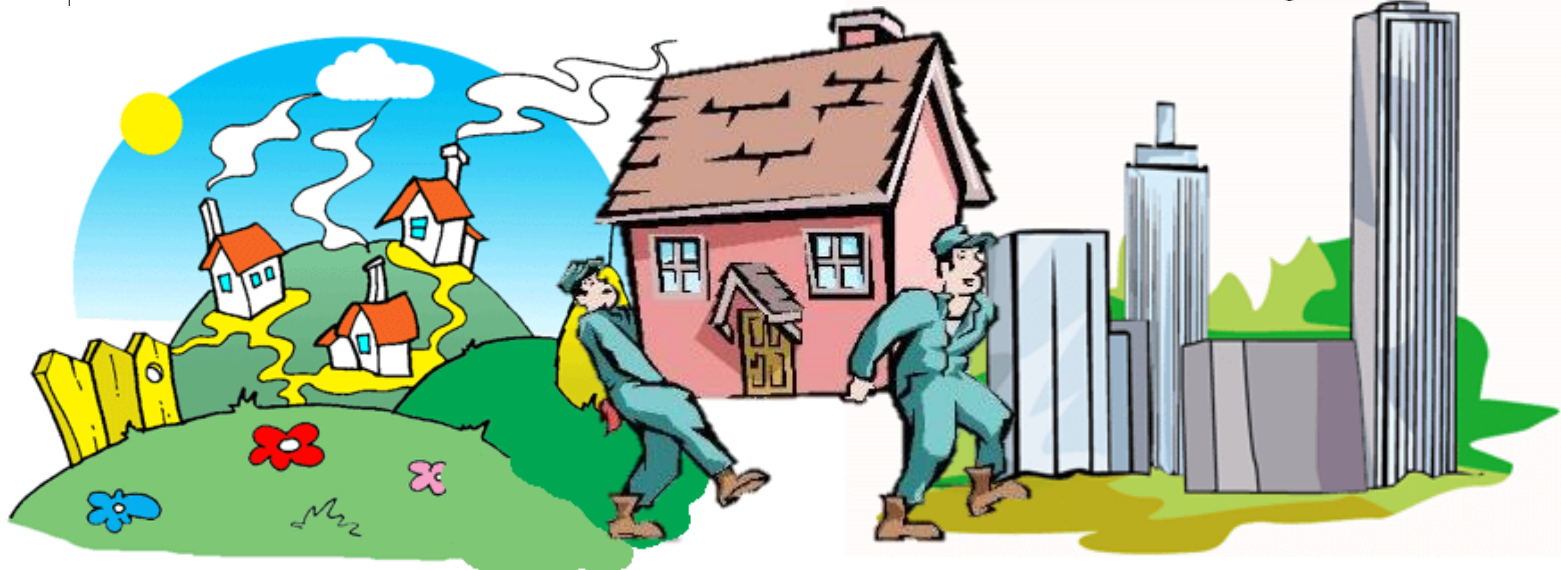
Cement industry – fact and figures

- › 27% of emissions of the industry is contributed to cement manufacture
- › Globally the cement industry produces approximately 5% of man-made CO₂.
- › Total emissions in EU-27 for cement manufacture in 2007 were 107.570 Gg CO₂ equivalents



Demographic trends

- › Which leads to:
 - › Inner city development
 - › Small scale projects
 - › More and smaller households
 - › More multi-family households





Societal trends

- › Emancipation
- › Individualisation
- › Custimization
- › Economic inequality
- › Cleaner, climate friendly and energy-efficient
- › Liveability within cities under pressure
 - › Which leads to:
 - › A need to make buildings adaptable to changing needs
 - › A need to intensify the use of buildings
 - › Higher demands on building quality



Economic trends

- › Customization
- › Co-opetition
- › Flexible working constructions
- › Environmental and climate policies tends to favour domestic production
- › Economic inequality (poor-rich) increases
- › Prices of energy and resources will rise



Technological trends

- › Technological acceleration, convergence of technologies
- › Further integration of ICT in society
- › Key Enabling Technologies:
 - › nano technology,
 - › advanced materials,
 - › micro-en nano-electronics,
 - › photonics,
 - › biotechnology and
 - › advanced production and processing



Ecological trends

- › The consequences of climate change are becoming visible and will lead to an increase in damages (storm, ice/snow, water)
- › Awareness of consumers and companies will rise
- › Trend towards cleaner, climate friendly and energy-efficient industry will continue among others because of scarcity of resources
- › Global footprint rises
- › The liveability within cities comes more and more under pressure
- › Pressure on ecosystems, loss of bio diversity



Political trends

- › Two diverging trends on global level: on the one side growth of internationalisation, on the other hand countries will focus more and more on their own interest and loss of influence of international institutions
- › Legitimacy of government under pressure. Relationship government – society changes: much space for societal initiatives. It is a question whether the trend of liberalisation at EU level continues.
- › Further tuning of investments at EU level, for example on climate and energy objectives.
- › The transition towards a green economy is characterised by different speeds EU, US and Asia.



Social trends

- › The average standard of living grows and stimulates consumption
- › Proceeding of the trend towards individualization and emancipation, with a growing amount of two income households
- › Independent citizens demand transparency and a say in the matter
- › Social- economical tensions in cities
- › Climate change and natural disasters lead to international migration



Drivers and barriers



Drivers for innovation in the building industry

- › The Energy Performance in Buildings directive, which regulates the introduction of performance targets and a certification system for buildings.
- › Building codes, certification and labelling.
- › The technical potential for energy efficiency in buildings
- › Climate change represents a constant driver for eco-innovations in every part of the construction sector



Barriers for innovation in the building industry

- › Large upfront investment.
- › Focus on risk reduction
- › Split incentive
- › Circle of blame
- › R&D spending is low
- › Unsufficient knowledge of other disciplines (construction/installation)
- › Higher skill level is required throughout the construction value chain



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