

The University of Texas at Austin Etter-Harbin Alumni Center Austin, Texas I Feb. 16 – 20, 2015

UT Energy Week - Building Bridges to a Sustainable World Transitioning to low-carbon electricity generation

Sustainable Energy Policies and Future-Oriented Building Design

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Fiction Facts Action Future

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Fiction

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Facts

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CO₂ Concentration in ppm

Source: National Climatic Data Center - http://www1.ncdc.noaa.gov/pub/data/cmb/images/indicators/800k-year-co2-concentration.gif, retrieved on Feb. 1, 2015

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Global Land Temperature Anomalies

Source: National Climatic Data Center - http://www.ncdc.noaa.gov/cag/time-series/global, retrieved on Feb. 8, 2015

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Extreme weather and climate events due to human influences:

- decrease in cold temperature extremes
- increase in warm temperature extremes
- increase in extreme high sea levels
- increase in the number of heavy precipitation events

Leading to severe, pervasive and irreversible impacts for people and ecosystems.

Source: http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_SPMcorr1.pdf, retrieved on Feb. 8, 2015



About 70.000 additional cases of death during the heat-wave summer of 2003 in Europe*



Heat stress



Cold stress

UTC (Universal Thermal Comfort Index) 13:00

*Robine et al. 2007

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Urgent need to limit global CO₂ emissions



Limits

To keep global warming below 2° C it is required to limit the overall man-made emissions of CO₂ to 14,5 billion tons/year



Germany

If all people on this planet caused as much CO₂ emissions as the average German, we would **need 4 planets**



Global average

Currently, with 7 billion people living on this planet, man-made CO_2 emissions are above 30 billion tons/year. We would need **2 planets** to sustain our current life style.



USA

... or even **9 planets**, if every inhabitant of this planet adopted the life-style of the average US American citizen

Source: http://images.zeit.de/wissen/umwelt/2009-12/42-klima-infografik.pdf

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Action

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Energy Concept of the German Government / European Directive 2012/27/EU



Source: Bundesministerium für Wirtschaft und Technologie, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit: Energiekonzept – für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung. Berlin, 2010 and http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:FULL:EN:PDF, retrieved on Sept. 7, 2013

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Vision of a Sustainable Future: 2000-Watt-Society: Everybody is involved!



 1800 -> 500 Watt
 1700 -> 450 Watt
 750 -> 250 Watt
 750 -> 250 Watt
 150

 Lowering our personal energy demand from
 6500 Watts to 2000 Watts
 150

Source: http://www.novatlantis.ch/fileadmin/downloads/2000watt/LeichterLeben2010_e.pdf, retrieved on Sept.7, 2013

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Buildings account for 1/3 of the global CO₂ emissions

Source: Building Research & Information, <u>Volume 35</u>, <u>Issue 4</u>, 2007. <u>Special Issue: Climate Change: National Building Stocks</u>, mitigating CO₂ emissions from energy use in the world's buildings. Diana Ürge-Vorsatz, L. D. Danny Harvey, Sevastianos Mirasgedis & Mark D. Levine, pages 379-398. Published online: 08 Feb 2011.

60% of the world's electricity needs are related to the building sector

Source: World Energy Outlook 2009. International Energy Agency, Paris. Institute of Energy Efficient and Sustainable Design and Building





This includes around 12% of the global water consumption and approximately 40% the world's waste

Source: http://www.unep.org/greeneconomy/Po

ger/9.0 Buildings.pdf, retrieved on 9.6.2014



Political Goals:

Energy concept of the German government 2010 / 2011 (after Fukushima, March 11, 2011)

Improvement of the thermal performance of the building stock and energy efficient building:

- 2020: Reduction of heating demand by 20%
- 2050: Reduction of primary energy demand by 80% (Largely carbon-neutral building stock)



Towards Carbon Neutral Buildings

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Regional Scale

COST Action TU1104

- Investigation of the drivers and barriers that may impact on the long term creation of low carbon regions in Europe
- Identification of what can be done to assist the large scale implementation of low carbon technologies and processes
- Main focus will be on new and retrofit of existing buildings, their operation, embodied energy and potential for using low and zero energy supply

Download: <u>http://www.smart-er.eu/content/wg1-</u> publication-smart-energy-regions-download-singlesections

SMART ENERGY REGIONS

Editors: Phil Jones, Werner Lang, Jo Patterson and Philipp Geyer.



Building Stock in Bavaria: Development of the primary energy demand



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Source: <u>http://www.passiv.de</u> (02/03/2008)

Buildings stock has a great influence on the success of the energy transition

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Refurbishment of existing home



Built in 1971

Reduction of energy demand for heating

- minimization of energy losses of the building envelope
- maximization of energy gains: direct use of solar energy (passive use)
- maximization of energy gains: indirect use of solar energy (active use)
- optimized daylight in buildings



After thermal improvement



Fighting Climate Change on an Urban Scale

Centre for Urban Nature & Climate Adaptation

Research project for developing strategies for reducing greenhouse gas emissions and adapting Bavarian cities to the climate change. Institute ENPB together with the Chair for Strategy and Management of Landscape Development, Prof. Dr. Stephan Pauleit, TUM



Local Effects of Climate Change (Bavaria)



LfU 2007

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The heat-island effect will become larger







Key Factors in Urban Planning

Availability of information and resources Performance of institutions and governance

Source: according to Mehrotra et al. 2011, modified

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Economic and sociodemographic factors

Function of green spaces in cities

Source: http://mephisto976.de/news/immer-mehr-optimisten-leipzig-46828, retrieved on Dec. 3, 2014

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Ecosystem services of urban green spaces

Providing food, energy, natural products

Modulating climate, air, water, carbon

Relaxation, health, experiencing nature

Source: 1) www.buerger-ag-frm.de, 2) www.camping.de, 3) www.br.de, 4) www.native-plants.de

Supportive functions, such as nutrient cycle formation of soil, etc.

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Building Scale: Energy-Plus-Homes

e-MOBILie: Energy self-sufficient electromobility in the Smart-Micro-Grid Project partners: BMW AG, SMA Solar Technology AG TUM, Dynahaus GmbH

Energy management system / Smart-Micro-Grid

Electric car with Wallbox

BMW ActiveE

Battery capacity: 32 kWh

Range: 160 km

Active communication between Wallbox and energy management for optimal including of the car charging

Including and preconditioning of the car

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Future

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Cradle to Cradle for Buildings

- Waste equals food
- Use current solar income
- Celebrate diversity

USE CURRENT SOLAR INCOME

Alt, Franz: Die Sonne schickt uns keine Rechnung, 3. ed., Muenchen 1995, p. 16 Sun:

radiates 10,000 – 15,000 times the amount of energy we consume world-wide

Wind: contains 35 times the amount of energy we need

Biomass: produces 10 times the amount of energy we need

Hydro power: contains 50% of the energy we need

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WASTE EQUALS FOOD

Source: http://www.innochem-online.de/en/about-us/cradle-to-cradle/index.html, retrieved on Feb. 11, 2015

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CELEBRATE DIVERSITY

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Vision of a Positive Future: The transition from eco-efficiency to eco-effectiveness

Source: http://www.c2cn.eu/sites/default/files/C2C_PS_buildC2C_.pdf, retrieved on Sept.7, 201

Cradle to Cradle for Buildings

Energy Efficiency Center of the Bavarian Center for Applied Energy Research in Würzburg

Lightweight building envelopes for smart buildings and technologies

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NATURAL LIGHTING AND SHADING

PASSIVE INFRARED COOLING

$$q = q_{rad} + q_{conv} + q_{ev}$$

COP > 20 because energy is only Needed for the water pumps

Parameter	Value
storage volume	101 m ³
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roof area	300 m²
average cooling demand	14.1 kW
volume flow	6 m³/h

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