

2nd Net Zero-Energy Buildings Conference

New Challenges for NZEB in Smart Cities - Energy Flexibility and Building to Grid Interaction



NZEB – an interactive building?

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Overview

Framework

Buildings within Grids

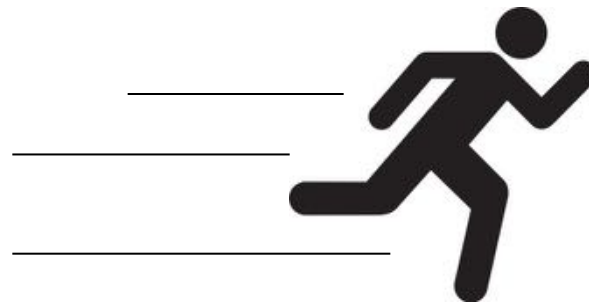
Envelope Solutions

Conclusions

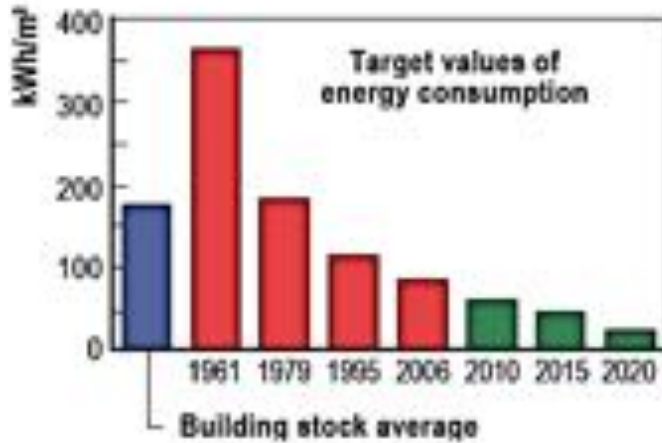
Framework



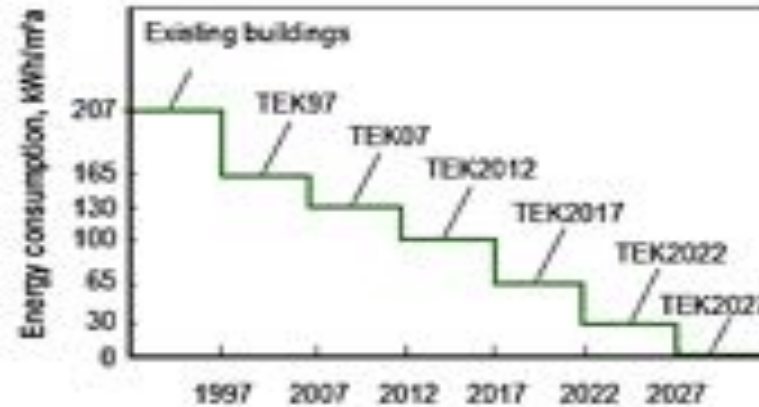
Implementation timeline of EPBD requirements in terms of nZEB



Denmark

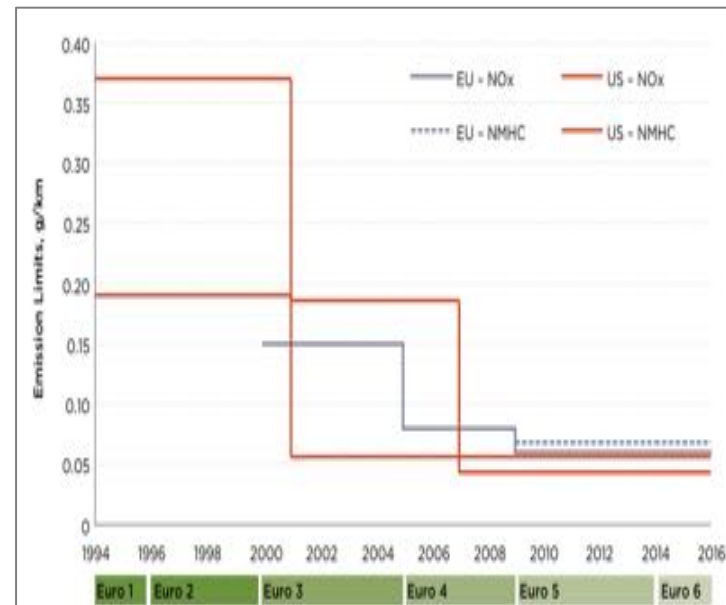
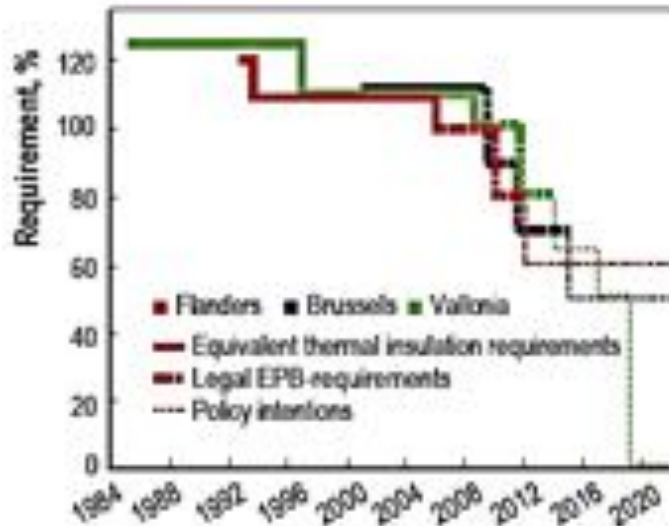


Norway



Rehva 2011

Belgium



TransportPolicy.net





Buildings within Grids

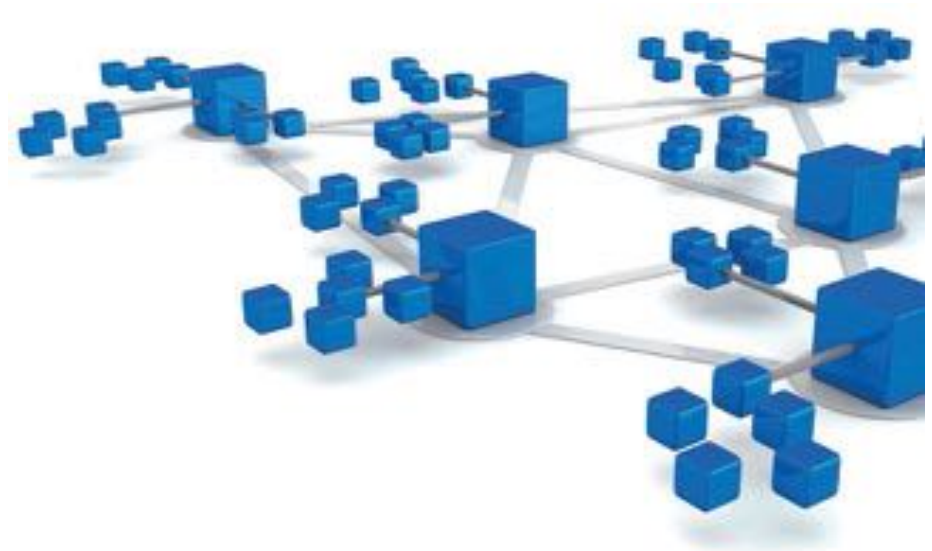
Interactive Buildings

- Building design
- Envelope solutions
- Energy management
- User interaction

Urban networks

- Movement between buildings*
- Energy networks
- Waste*
- Open space* (street lighting, urban forestry, interaction between citizen and urban...)

* McKinsey & Company



Envelope Solutions

Building envelope design and materials determine

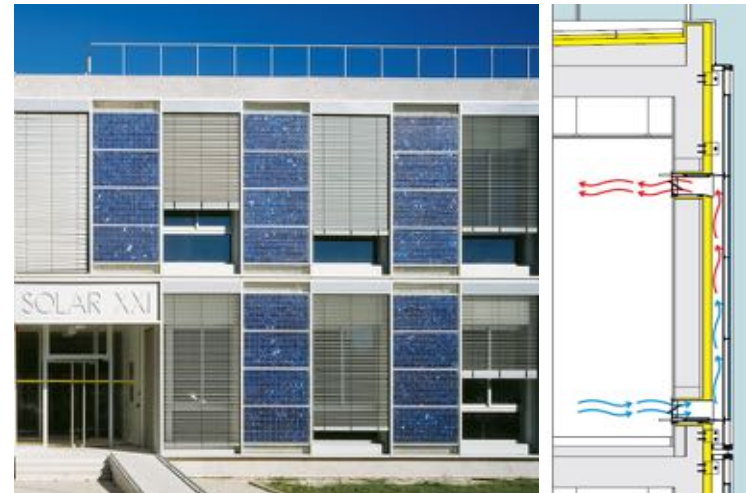
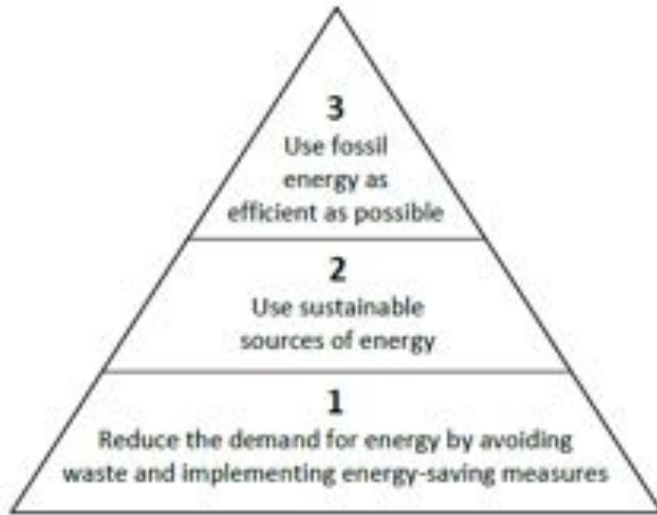
- Energy use (heating and cooling)
- Amount of lighting
- Air sealing
- Embodied energy
- Sound insulation

The interface between the interior of the building and the outdoor environment plays an important role in maintaining a comfortable indoor environment relative to the outside environment!

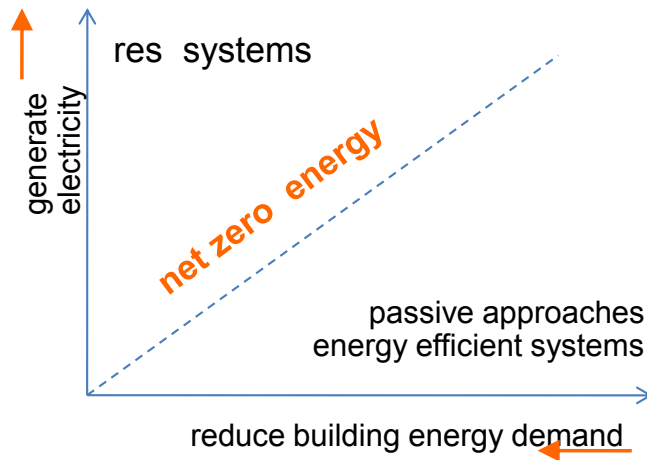


Q: Are current standards and practices capable of providing the needs in terms of zero energy and low carbon challenges?

Envelope Solutions – what type?



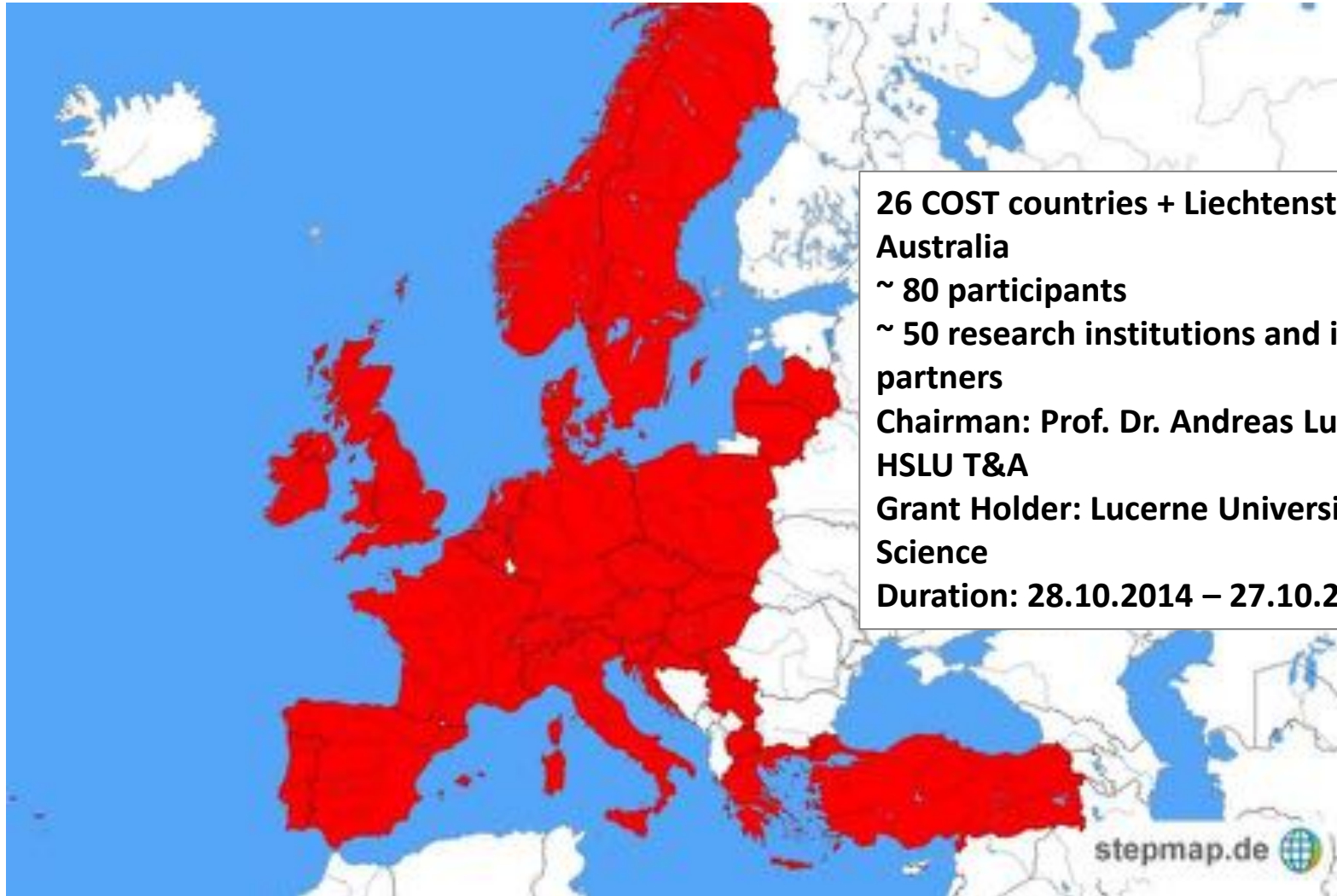
Solar XXI – LNEG, Portugal



Building envelopes are subjected to dynamic environmental conditions!

Adaptive or dynamic facades may offer buildings the flexibility needed and they have been already identified as a key envelope requirement for (near) zero-energy buildings!

COST Action TU1403 – Adaptive Facades Network



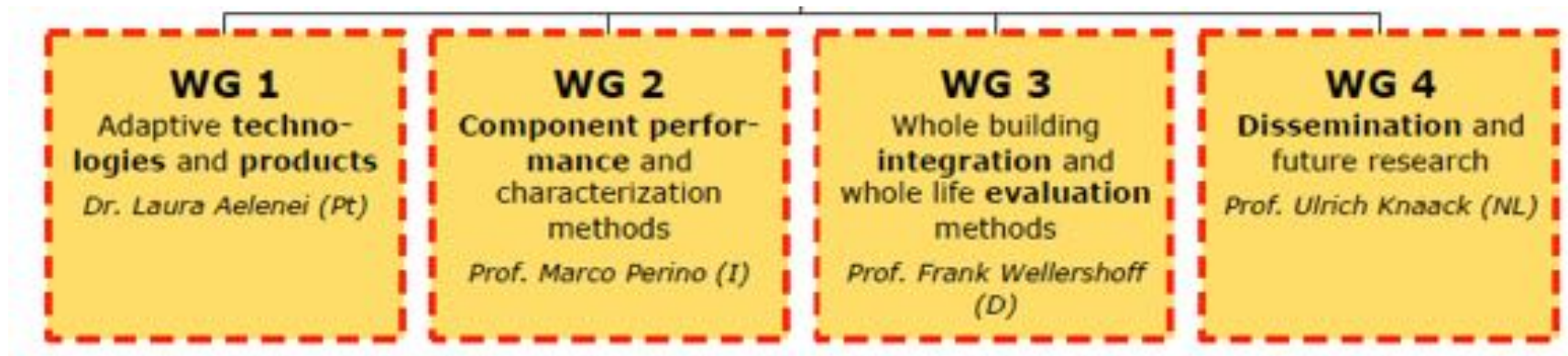
**26 COST countries + Liechtenstein, China,
Australia**
~ 80 participants
**~ 50 research institutions and industry
partners**
**Chairman: Prof. Dr. Andreas Luible, CCFM,
HSLU T&A**
**Grant Holder: Lucerne University of Applied
Science**
Duration: 28.10.2014 – 27.10.2018

COST Action TU1403 – Adaptive Facades Network

Objectives

Harmonize, share and disseminate technological knowledge on adaptive facades between industry and academia and foster their collaboration;

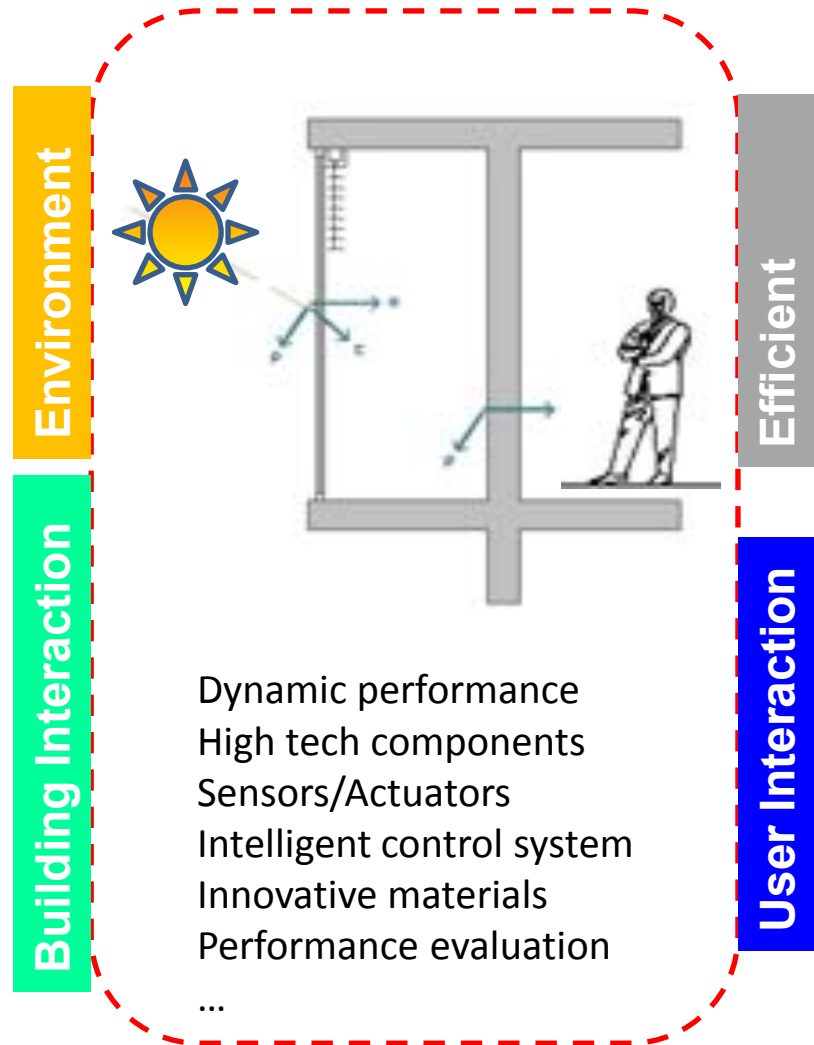
Foster the development of novel concepts, technologies and new combinations of existing technologies for adaptive facades, as well as the development of new knowledge such as effective evaluation tools / design methods for adaptive facades.



Web page: <http://tu1403.eu/>

Adaptive Facades Challenges

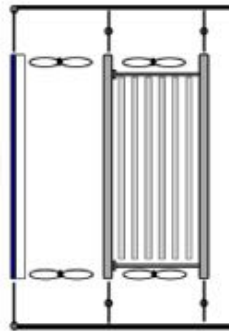
Developing climate adapted and cost effective concepts based on the interface between buildings and their surrounding site, taking into account climate, integrating RES challenges and user comfort requirements, for new and existing building envelopes is an easy task...



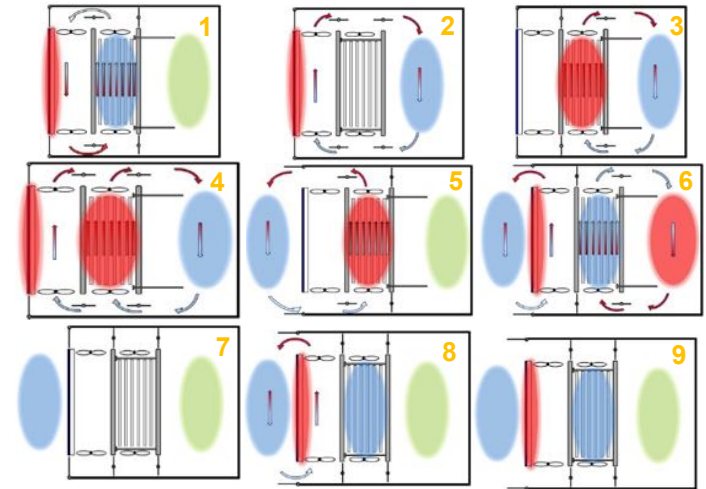
Adapted from Andreas Luible WSED 2015, Wels

What examples are out there?

Hybrid façade integrating functional elements



Features integrated active solar technologies. With PV modules, air cavity, PCM movable battery and fans. By ventilating the air gap behind the PV and by recovering the heat released in the conversion process it improves and stabilizes (PCM) the indoor thermal comfort.



Nine operating modes that will vary the open/closed status of gates and drawers and on/off status of the fans

Dr. Laura Aelenei, LNEG
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Large area transparent thin film thermoelectric devices for smart window and flexible application.

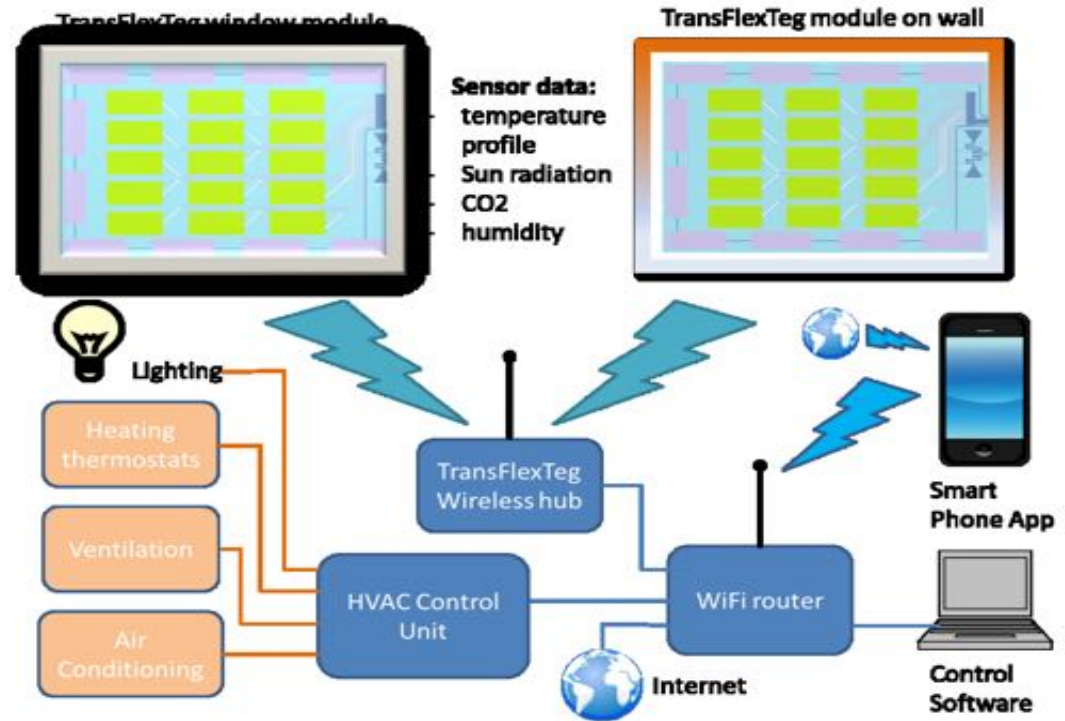
Objective: to develop novel large area distributed sensor network integrating transparent thin film thermoelectric devices and sensors for multifunctional smart windows and flexible high impact volume applications (smart window able to measure air quality and environmental parameters such as temperature, sun radiation and humidity).

- large area high performance transparent thermoelectric thin films deposited on flexible substrates for thermal energy harvesting;
- low cost high throughput thin film thermal sensors for thermal mapping and gesture sensing;
- flexible smart windows and walls with energy harvesting, environmental sensing and wireless communication functionalities.

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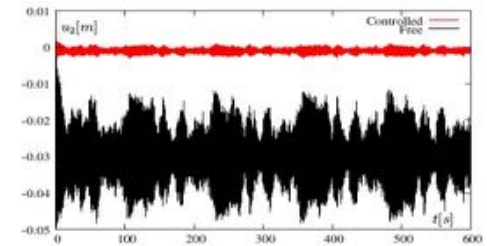
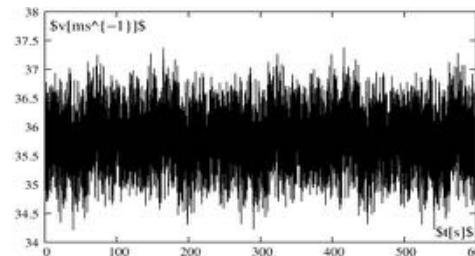
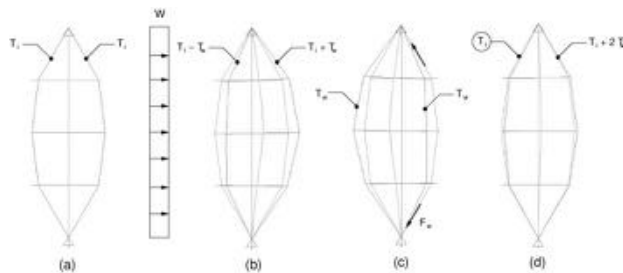
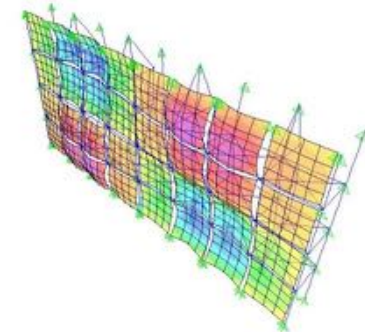
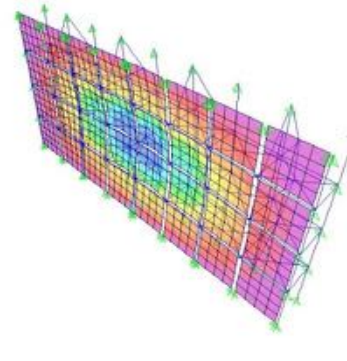
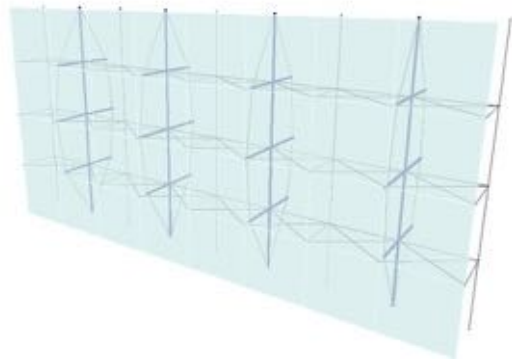
www.TransFlexTeg.eu



Adaptive glass facades under wind loadings

Smart glass façade based on a bow-string truss solution which is able to continuously adapt its shape to compensate the wind dynamic displacements

Dynamic analysis of the facade

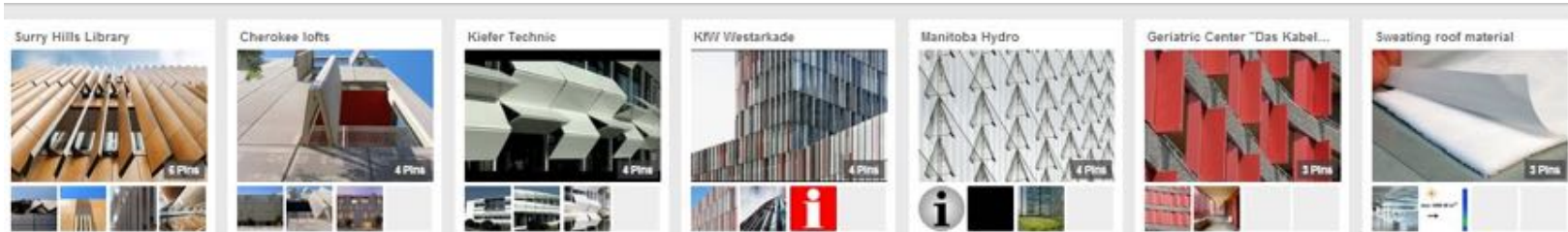


(a) Negative wind pressures.

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Generation of artificial wind series with promising response

Other Projects



BIQ house', Hamburg, Germany. (Splitterwerk, Arup & Colt international). Features integrated microalgae which are used as bio-reactors inside panels.



The Oval Offices in Cologne (arch. Sauerbruch and Hutton, 2010). Features vertical axis glazed sun louvers for light regulation (photo by M. Brzezicki).

Roel Loonen, Adaptive façade systems are available in many different shapes and colors. On www.pinterest.com/CABSoverview

Basis for systematic characterization of adaptive facades

Goal / purpose	Responsive function	Operation	Technologies (materials & systems)	Response time	Spatial scale	Visibility	Degree of adaptability
Thermal comfort	Prevent, Reject, Admit or Modulate (Store, Distribute) <u>solar gains</u> , and conductive, convective and long-wave radiant <u>heat flux</u>	Intrinsic	Shading	Seconds	Building material	No	On-off
		Extrinsic	Insulation	Minutes	Façade element	Low	Gradual
			Switchable glazing	Hours		High	
			PCM	Day-night	Wall		
			Solar tubes	Seasons	Penetration		
Indoor air quality	Controlled porosity for exchange and filtering of <u>outside air</u>		BIPV and solar thermal systems	Years	Roof		
			Shape memory alloys	Decades	Whole building		
Visual performance (illuminance, glare, view)	Prevent, Reject, Admit or Redirect <u>visible light</u>		Façade openings				
Acoustic quality	Prevent, Reject, Admit or Redirect <u>sound pressure</u>		Kinetic systems				
			Radiant glazing				
Energy generation	Collect and convert <u>wind energy</u> and <u>sunlight</u> into electricity and thermal energy		—				
Personal control	User interaction and adaptation to individual needs						

Loonen R., Aelenei L., et al., Design for façade adaptability – Towards a unified and systematic characterization, Energy Forum 2015

Do NZEB need adaptive/interactive façades?

Future (adaptive) façades features:

- Reliable;
- Flexible: be able to handle bi-directional energy flows;
- Energy efficient;
- Adaptive: reduce peak loads by matching supply and demand;
- Sustainable;
- Cost efficient

Adaptive façades may be simply defined as “the tools used to provide the proper comfort into a building” –

(Winfried Heusler / Schüco – Delft Cost TU1403 Meeting)



Thank you for your attention!