IEA Workshop on Energy Technology Roadmaps
15 - 16 May 2008, Paris

Buildings Technology Roadmaps

Challenges and lessons learned using technology roadmaps in the building sector

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CSTB
le futur en construction

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   - WBSCD: EEB
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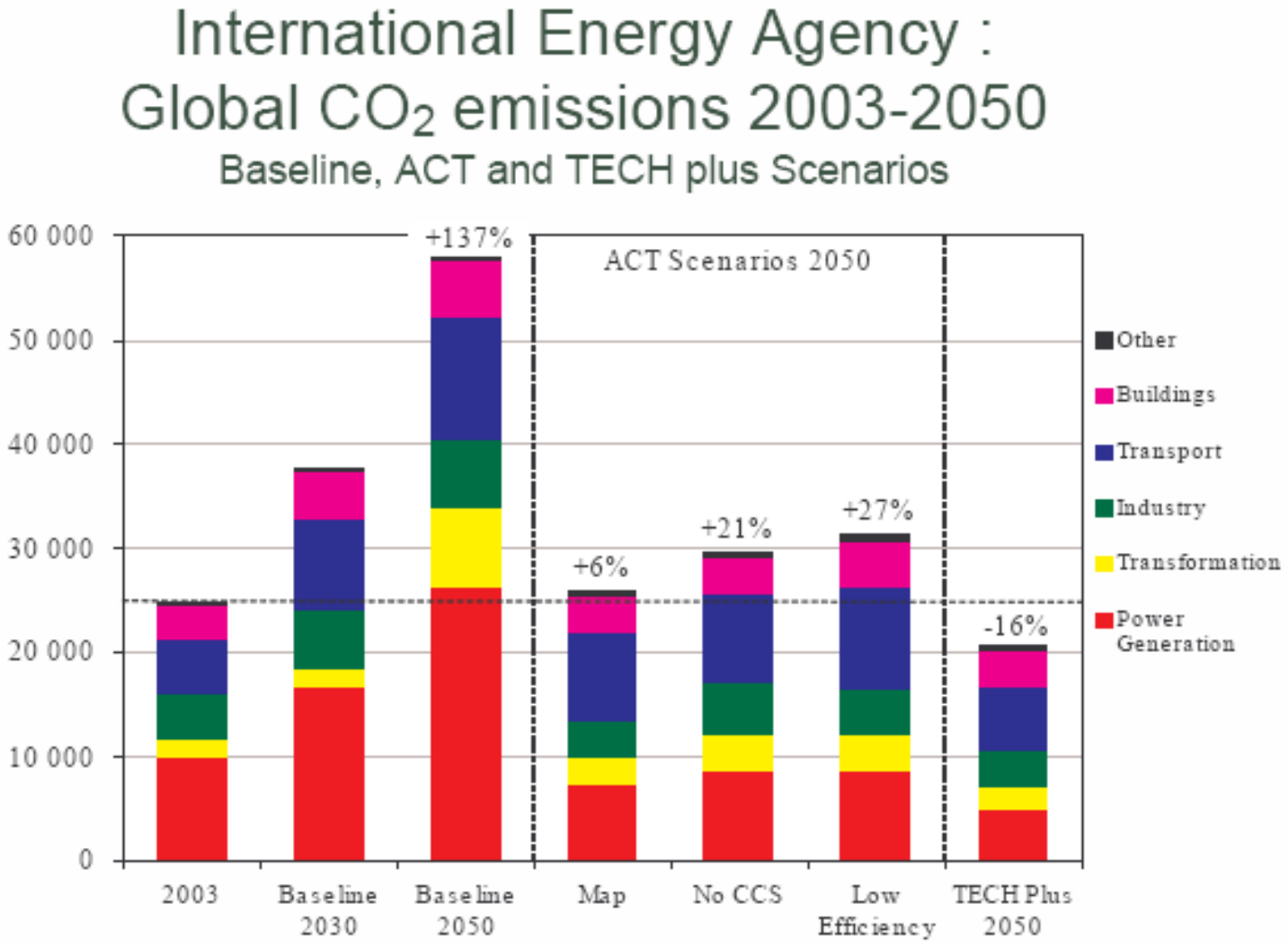
   - E2B JTI (Energy Efficient Buildings Joint Technology Initiative)
   - PREBAT Benchmarking

1. Building and Energy: context and challenges



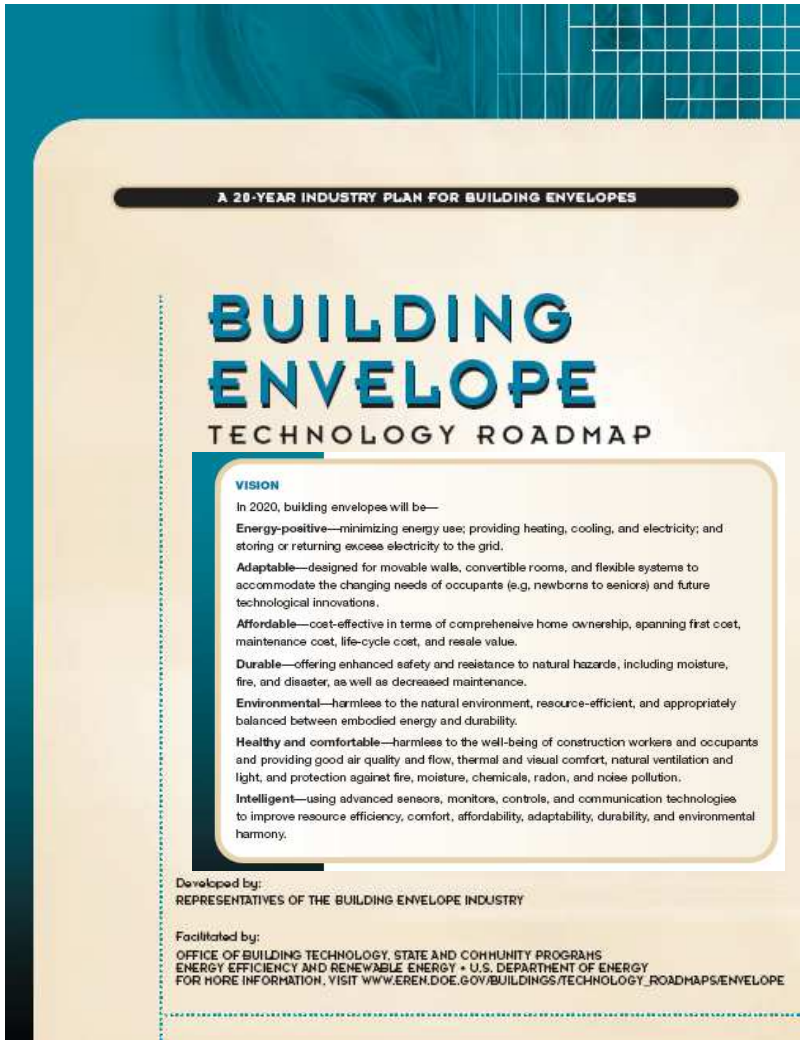
1. Building and Energy: context and challenges

- Heating and lighting of buildings account for ~40% of all energy consumed in Europe.
- Construction activities account for ~5% of energy used, including construction related transport.
- Buildings: the largest source of CO2 emissions (~1/3) in the EU-15 (if their electric power consumption is included).
- Trends towards increased use:
  - Air-conditioning due to climate change.
  - Raising standard of living.
  - Increasing building stock.

- Annual energy consumption in residential buildings:
  - 100-250 kWh/m² - Western Europe.
  - 250-400 kWh/m² - Eastern and Central Europe.
  - 50-100 kWh/m² - Northern Europe, well insulated buildings.
  - < 20 kWh/m² - Passive houses.
- Only 1-2% of building stock is renewed annually.

  ➔Energy consumption of buildings in the next 50 years can be reduced mainly by renovating the existing stock.

2. Some past examples of Technology Roadmaps on Components and/or Buildings



A 20-YEAR INDUSTRY PLAN FOR BUILDING ENVELOPES

BUILDING ENVELOPE TECHNOLOGY ROADMAP

VISION

In 2020, building envelopes will be—

Energy-positive—minimizing energy use; providing heating, cooling, and electricity; and storing or returning excess electricity to the grid.

Adaptable—designed for movable walls, convertible rooms, and flexible systems to accommodate the changing needs of occupants (e.g, newborns to seniors) and future technological innovations.

Affordable—cost-effective in terms of comprehensive home ownership, spanning first cost, maintenance cost, life-cycle cost, and resale value.

Durable—offering enhanced safety and resistance to natural hazards, including moisture, fire, and disaster, as well as decreased maintenance.

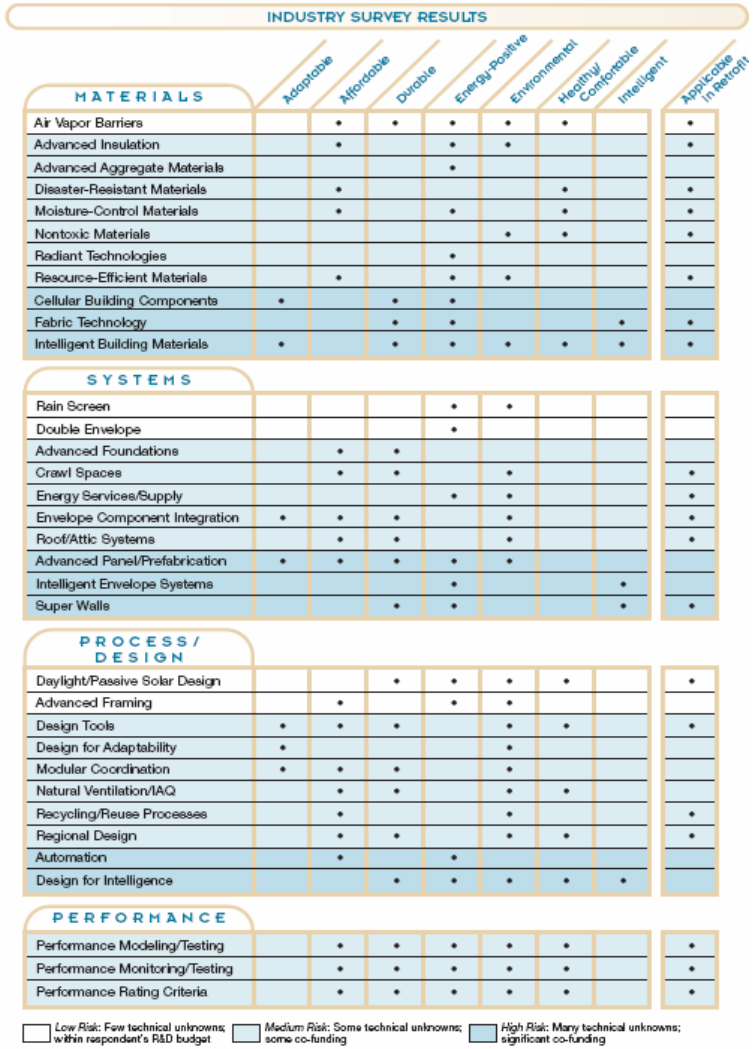
Environmental—harmless to the natural environment, resource-efficient, and appropriately balanced between embodied energy and durability.

Healthy and comfortable—harmless to the well-being of construction workers and occupants and providing good air quality and flow, thermal and visual comfort, natural ventilation and light, and protection against fire, moisture, chemicals, radon, and noise pollution.

Intelligent—using advanced sensors, monitors, controls, and communication technologies to improve resource efficiency, comfort, affordability, adaptability, durability, and environmental harmony.

Developed by:
REPRESENTATIVES OF THE BUILDING ENVELOPE INDUSTRY

Facilitated by:
OFFICE OF BUILDING TECHNOLOGY, STATE AND COMMUNITY PROGRAMS
ENERGY EFFICIENCY AND RENEWABLE ENERGY • U.S. DEPARTMENT OF ENERGY
FOR MORE INFORMATION, VISIT WWW.EREN.DOE.GOV/BUILDINGS/TECHNOLOGY_ROADMAPS/ENVELOPE

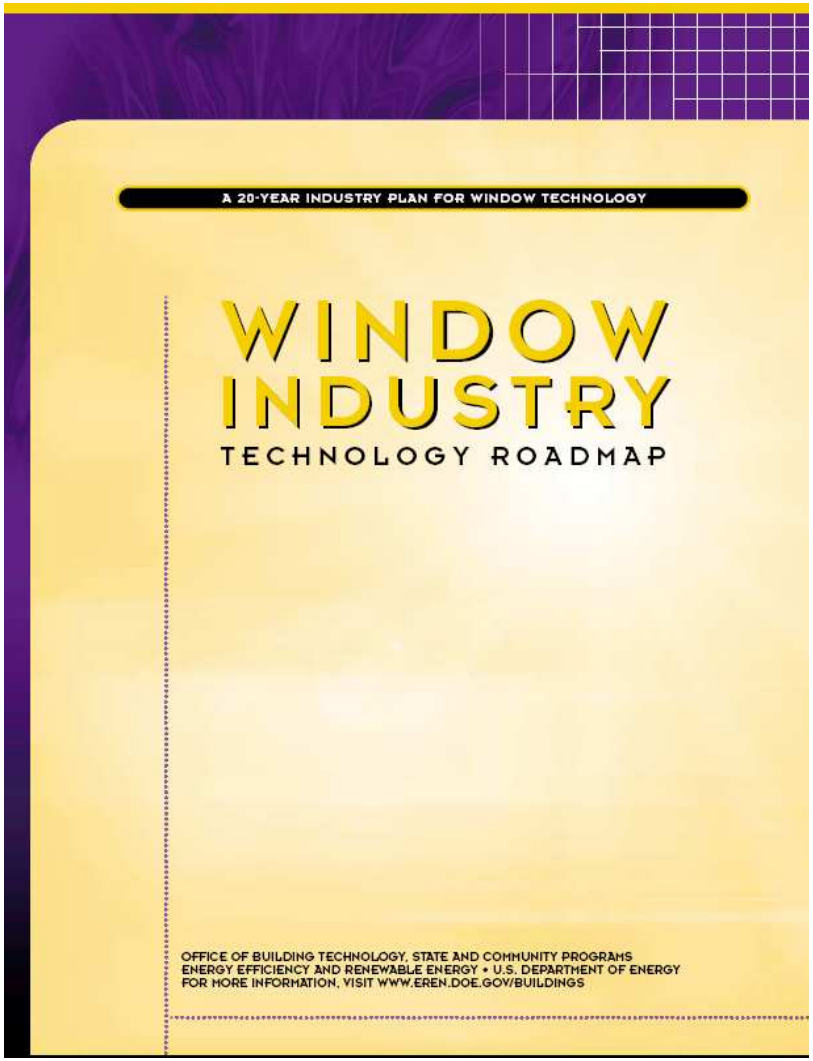


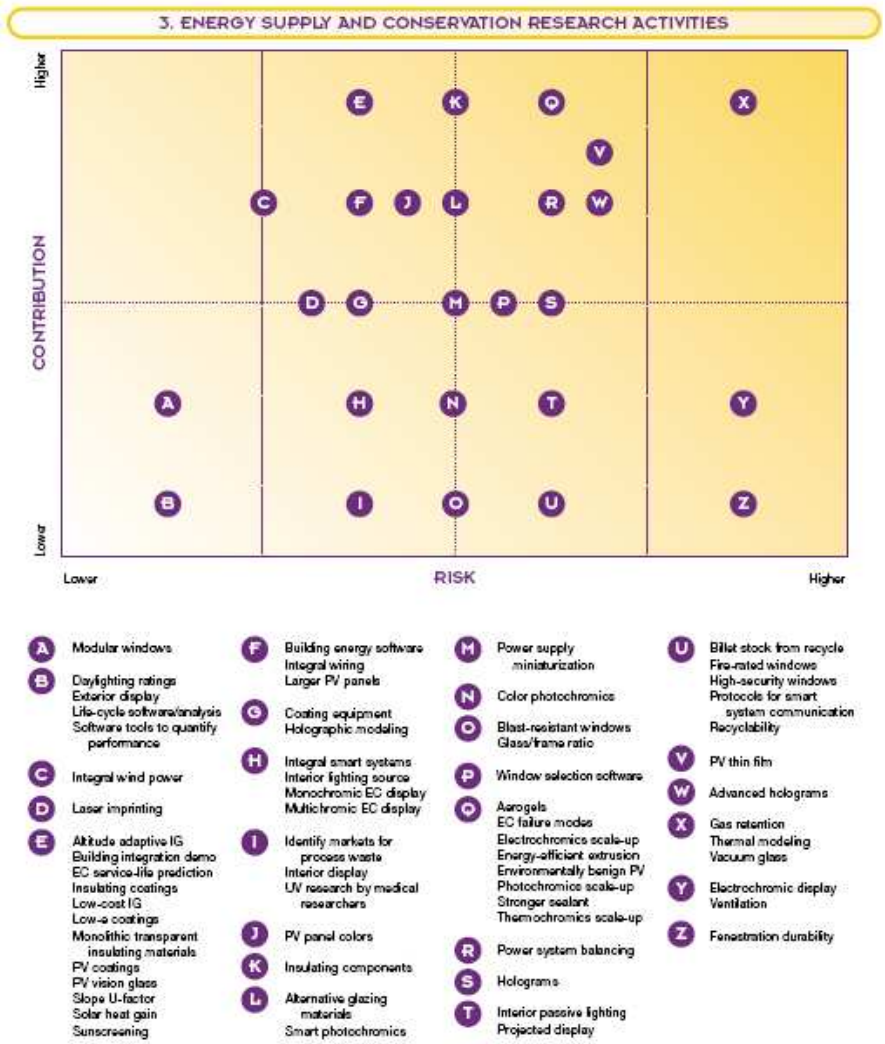
INDUSTRY SURVEY RESULTS

	Adaptable	Affordable	Durable	Energy-Positive	Environmental	Healthy/ Comfortable	Intelligent	Applicable in Retrofit
MATERIALS								
Air Vapor Barriers		•	•	•	•	•		•
Advanced Insulation		•		•	•			•
Advanced Aggregate Materials				•				
Disaster-Resistant Materials		•				•		•
Moisture-Control Materials		•		•		•		•
Nontoxic Materials					•	•		•
Radiant Technologies				•				
Resource-Efficient Materials		•		•	•			•
Cellular Building Components	•		•	•				
Fabric Technology			•	•			•	•
Intelligent Building Materials	•		•	•	•	•	•	•
SYSTEMS								
Rain Screen				•	•			
Double Envelope				•				
Advanced Foundations		•	•					
Crawl Spaces		•	•		•			•
Energy Services/Supply				•	•			•
Envelope Component Integration	•	•	•		•			•
Roof/Attic Systems		•	•		•			•
Advanced Panel/Prefabrication	•	•	•	•	•			
Intelligent Envelope Systems				•			•	
Super Walls			•	•			•	•
PROCESS/ DESIGN								
Daylight/Passive Solar Design			•	•	•	•		•
Advanced Framing		•		•	•			
Design Tools	•	•	•		•	•		•
Design for Adaptability	•				•			
Modular Coordination	•	•	•		•			
Natural Ventilation/IAQ		•	•		•	•		
Recycling/Reuse Processes		•			•			•
Regional Design		•	•		•	•		•
Automation		•		•				
Design for Intelligence			•	•	•	•	•	
PERFORMANCE								
Performance Modeling/Testing		•	•	•	•	•		•
Performance Monitoring/Testing		•	•	•	•	•		•
Performance Rating Criteria		•	•	•	•	•		•

Low Risk: Few technical unknowns; within respondent's R&D budget
Medium Risk: Some technical unknowns; some co-funding
High Risk: Many technical unknowns; significant co-funding

2. Some past examples of Technology Roadmaps on Components and/or Buildings





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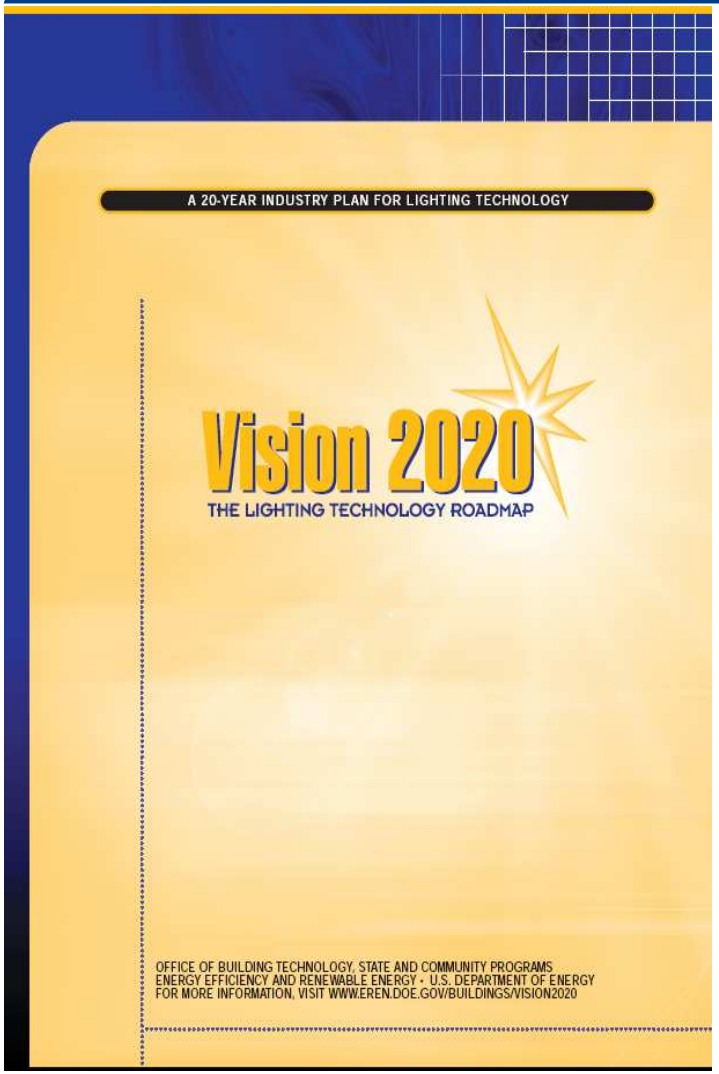

TECHNOLOGY DEVELOPMENT

STRATEGY 5—Develop advanced source and ballast technologies that enhance quality, efficiency, and cost effectiveness

Attribute/Capability	Timeframe
✓ Achieve dimmability that still maintains energy efficiency, color, and lamp life.	S M
✓ Extend lamp life (less turnover).	M
✓ Develop low-cost electronic ballasts for compact fluorescent lamps (CFLs).	S
✓ Develop point source for optical fibers and pipes (high efficiency).	S M
✓ Create advanced solid-state structures such as LEDs, LEPs, and ceramics.	M
• Maintain color throughout lamp life and from lamp to lamp.	M
• Increase efficacy: greater than 100 lumens per watt at high CRI (>90 CRI).	M
• For fluorescent lamps, develop two-photon phosphor technologies with efficiencies approaching 200 lumens per watt with CRI greater than 90.	M L
• For incandescent lamps, improve IR films to increase efficiency (50 to 100+ lumens per watt).	M
• For incandescent lamps, improve efficiency of incandescing filaments by increasing the emissivity in the visible range (+10% to 15% efficacy) and increasing the temperature capabilities of these new materials (+25% to 30% efficacy).	M
• For incandescent lamps, develop low-cost coatings to increase efficiencies from the current level of 20 lumens per watt to 30 lumens per watt.	M
• Develop improved design tools that incorporate daylighting concepts.	S M
• Develop toxic-free lamps and ballasts.	M
• Develop electrodeless metal halide technology, replacing mercury with xenon.	M
• Develop new geometrical optics, efficient packaging, and efficient light distribution systems.	M
• Create area sources (thin, flat panels).	M
• Redesign ballasts and conduct materials research to solve the lumen depreciation/color shift problem that accompanies electrode degradation.	M
• Develop new phosphor materials, electrode materials, and advanced ballast designs to produce gas discharges with quantum efficiencies greater than 1.5.	M
• Develop universal ballasts.	S M

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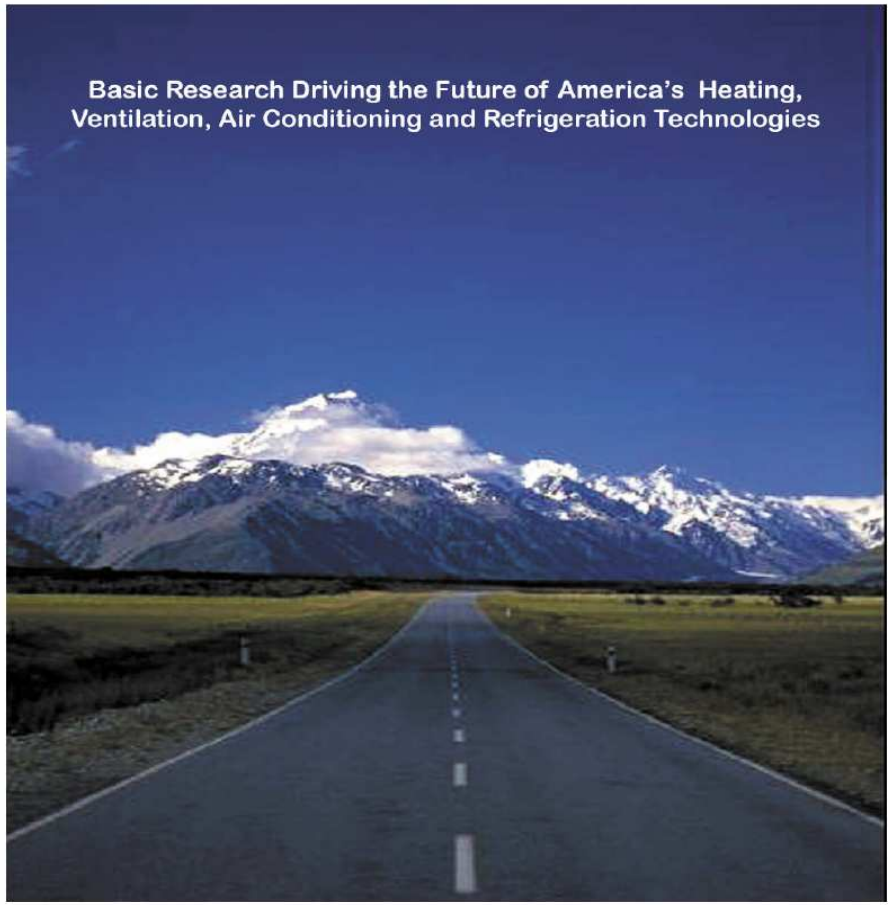


ARTI
Research Roadmap
Air-Conditioning and Refrigeration Technology Institute, Inc.

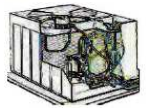
Commercial Buildings

GOAL: Realize energy consumption and peak electric energy demand reductions of 25% in new buildings by 2020. This would include reducing average annual ventilation and air conditioning use from 8,800 BTU/ft² to 6,600 BTU/ft².

Rooftop Air Conditioner	Chillers	Space Constrained Products	System Optimization	Comfort and Noise	Distribution Systems
Affordable 13 EER Rooftop Air Conditioner	Increase Energy Efficiency of Chillers by 25%	Improve Efficiency of Space Constrained Products by 25%	Decrease Energy Use by 10% Through Better Selection of Equipment and Components	Improve Comfort and Reduce Noise in Commercial HVAC&R Equipment	Reduce Energy Use by 15% Through Improved Distribution Systems

Emerging Technologies

GOAL: Continually review and monitor research in the HVAC&R arena and elsewhere for breakthroughs that could contribute to achieving the goals within the three application sectors.



Novel Components	Novel Equipment	Novel Systems
For Example: Novel Heat Exchangers (Microchannel, Plastic, Carbon Foam)	For Example: Magnetic Cooling and Other Advanced Cycles.	For Example: Enhanced Carbon Dioxide Refrigeration, Heat Pump and Air Conditioners

2. Some past examples of Technology Roadmaps on Components and/or Buildings

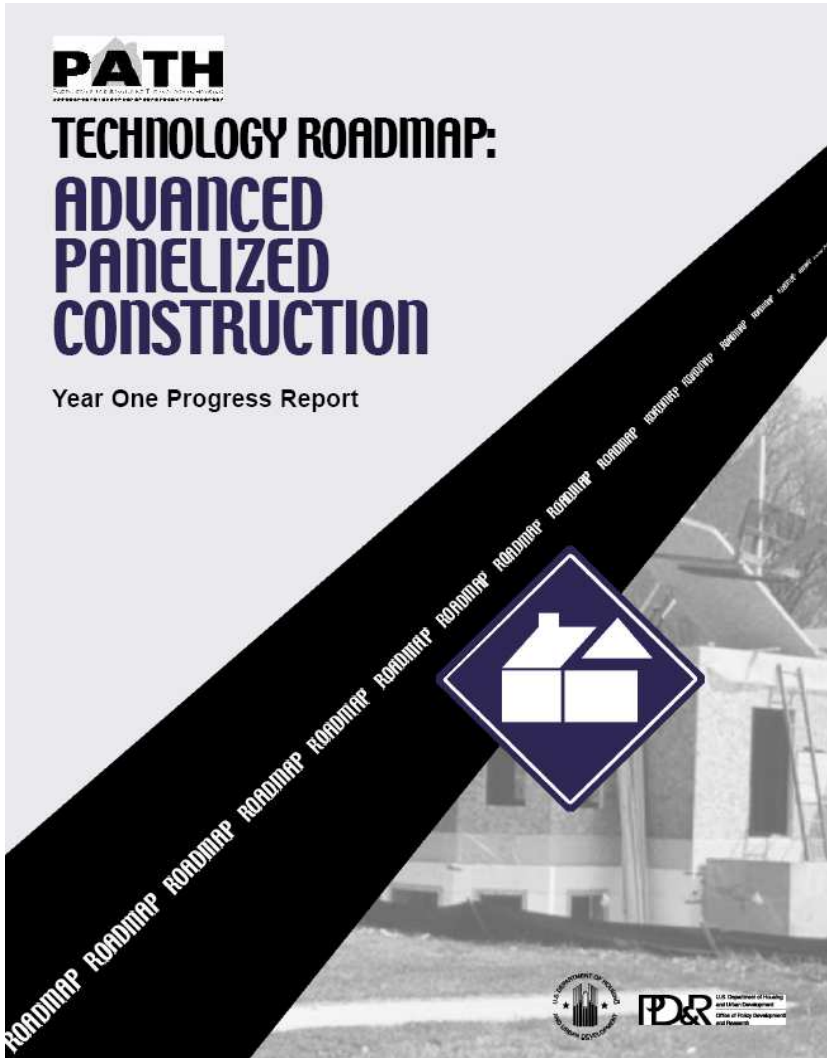
A VIEW OF A POSSIBLE FUTURE

Commercial buildings in 2020 will feature:

- Organic, dynamic envelopes (like human skin)
- Microscale thermal conditioning sources, individually controlled
- Dynamic, personalized ventilation (decoupled from conditioning)
- Organic composite materials
- "Plug-and-play" components and systems
- Waste source materials
- Solid-state sources for lighting, coupled with dynamic levels and daylighting
- Distributed energy resources at the site level (photovoltaic, fuel cells, combined cooling, heating, and power)
- Water resources, biological treatment integrated with technological, zero discharge
- Digital wireless microsensors, personalized building controls, and metering
- Product as service: lease rather than purchase

Buildings will be considered as part of a larger "whole community" (where the best building may be no building). The focus of building finance will become long-term, taking into account life-cycle benefits (versus today's 3-year horizon).

2. Some past examples of Technology Roadmaps on Components and/or Buildings



Technology Roadmapping

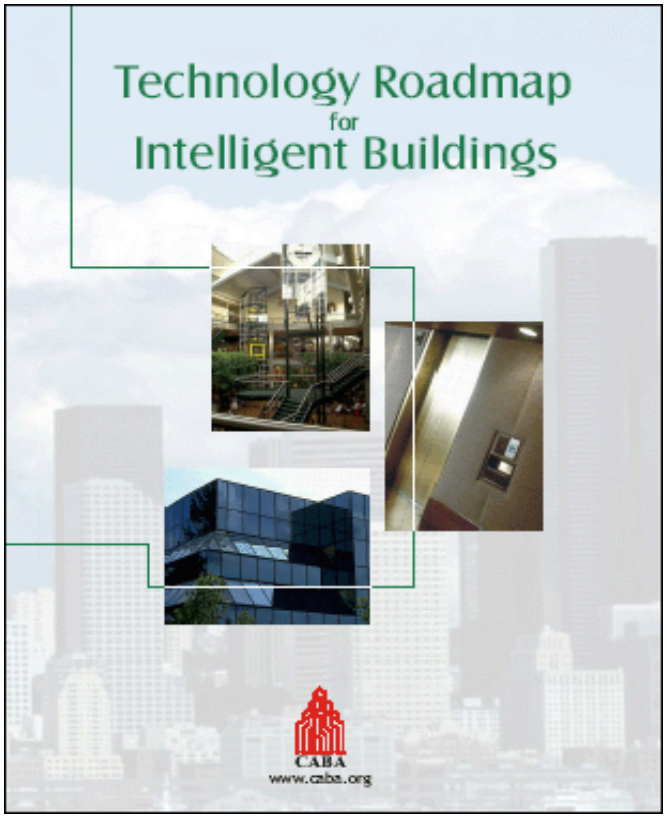
- IRC has support/funded 6 in past 2 years
  - Capital Projects
  - Intelligent Buildings Technologies
  - Municipal Infrastructure
  - Building Envelope
  - Indoor Environment
  - Lighting Technologies (DOE)

2. Some past examples of Technology Roadmaps on Components and/or Buildings

CABA's Intelligent & Integrated Buildings Conference

CABA

Canada's Construction Technology Centre
Institute for Research in Construction
Centre canadien de technologie de la construction
L'Institut de recherche en construction



Technology Roadmap for Intelligent Buildings:

- **A collaborative $110,000 project**
- **Industry and 5 federal government departments/agencies**
- **Managed by the Continental Automated Buildings Association**
- **Focused on commercial, institutional and high-rise residential buildings**
- **Final report - in-depth examination of intelligent buildings technologies**

2. Some past examples of Technology Roadmaps on Components and/or Buildings

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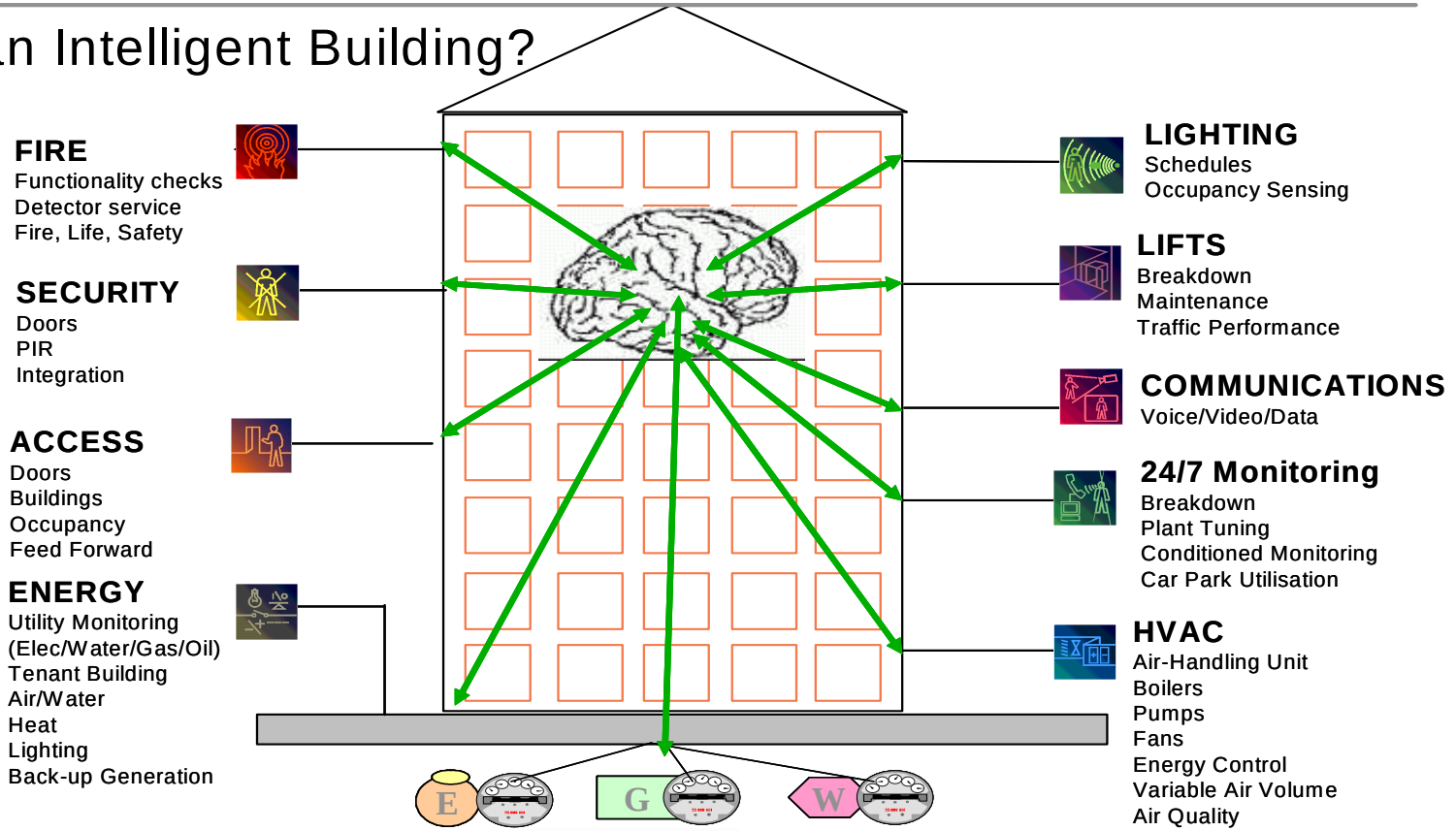
What is an Intelligent Building?



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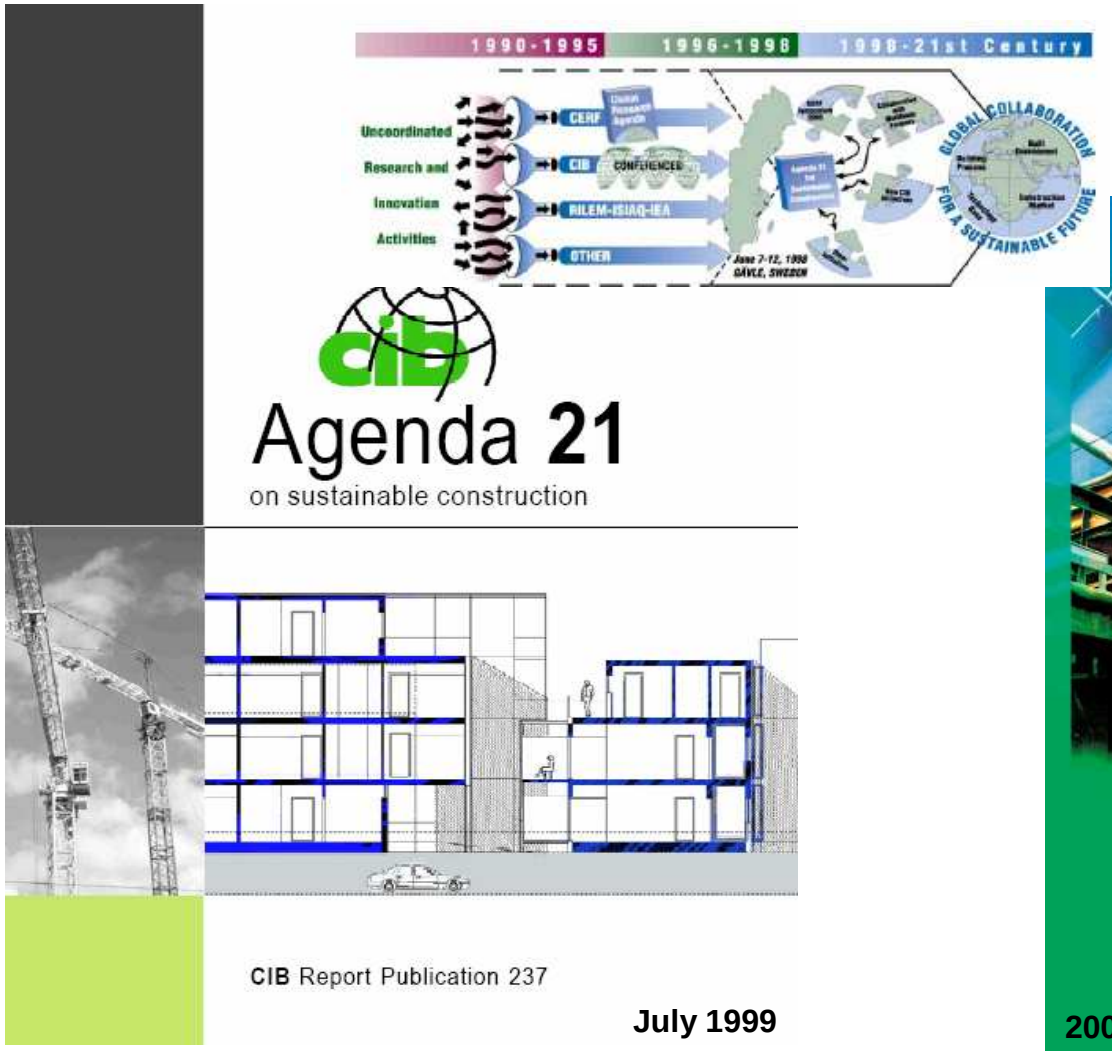

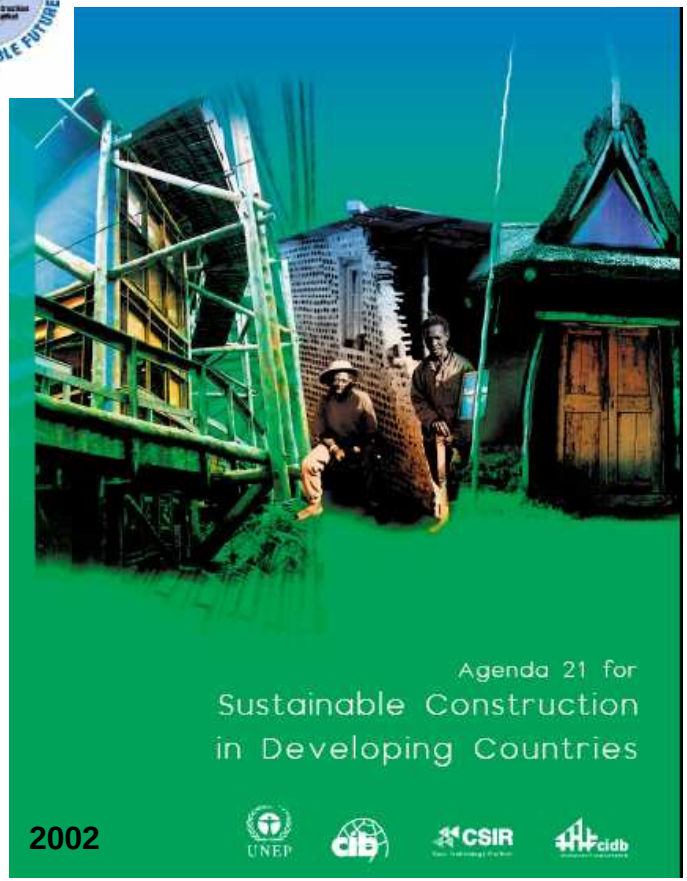

2. Some past examples of Technology Roadmaps on Components and/or Buildings

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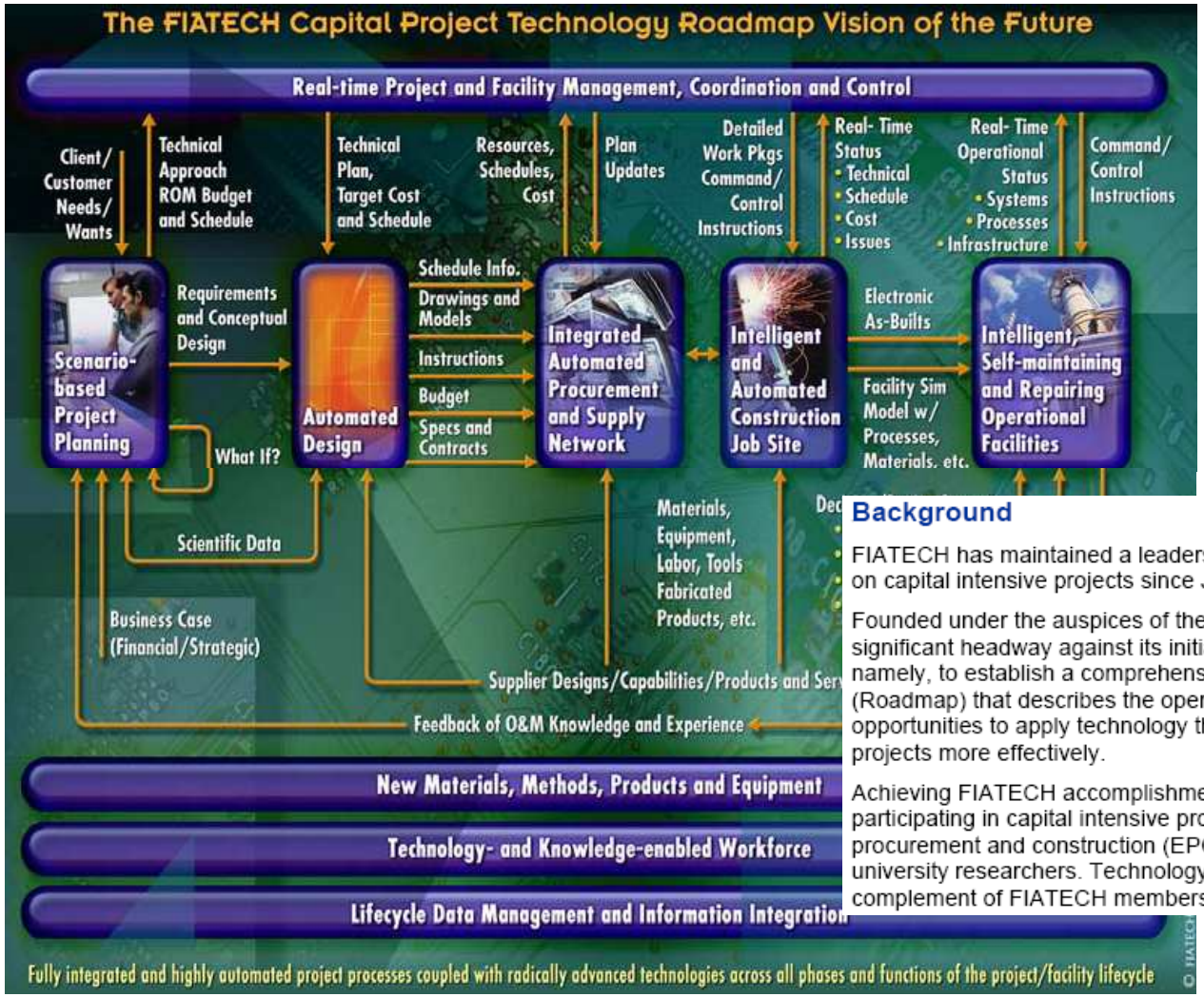
3. Recent Roadmap developments - FIATECH



Background

FIATECH has maintained a leadership position among industry organizations focusing on capital intensive projects since July 2000.

Founded under the auspices of the University of Texas at Austin, FIATECH has made significant headway against its initial objectives as described in its founding charter; namely, to establish a comprehensive Capital Projects Technology Roadmap (Roadmap) that describes the operational context for a capital project, and to identify opportunities to apply technology that integrates and automates execution of capital projects more effectively.

Achieving FIATECH accomplishments to date has involved every industry segment participating in capital intensive projects from owner/operators, and engineering, procurement and construction (EPC) companies to architects, facility managers and university researchers. Technology and equipment manufacturers round out the complement of FIATECH members and project participants.

3. Recent Roadmap developments - WBSCD-EEB

The WBSCD initiative on Energy Efficiency in Buildings
(source: Lafarge)

3. Recent Roadmap developments - WBSCD-EEB

- Mission and objectives
  - Understand the sector
  - Raise awareness
  - Show business opportunities
  - Issue recommendations and commitments
- Actions
  - Wbcsd.org/web/eeb
  - Roadmap for change: Scenario planning, best practice & recommendations
  - Forums around the world
    2008: Sao Paolo, Berlin Washington
    2009: Mexico, Tokyo, Paris

3. Recent Roadmap developments - WBSCD-EEB

http://wbcsd.org/web/eeb

Facts & Trends

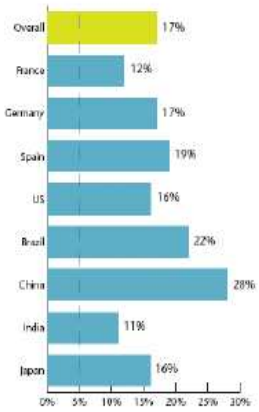
3. Recent Roadmap developments - WBSCD-EEB

Professionals overestimate cost premium and underestimate environmental impact

Figure 11: Estimates of buildings' contribution to total emissions

(Question: "What percentage of CO_2 emissions do you think buildings give rise to – directly and indirectly?")

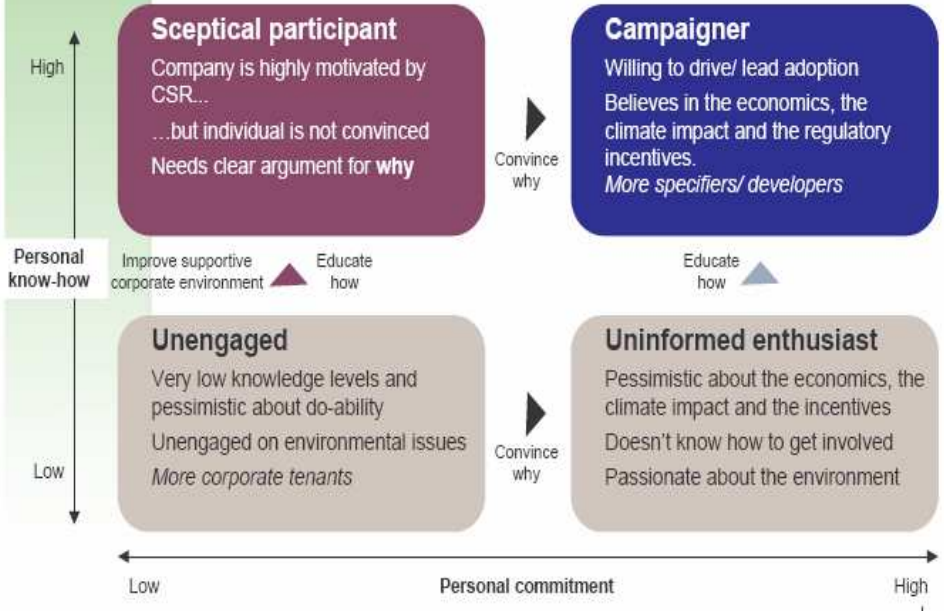
Figure 12: Estimates of cost premium for "a certified sustainable building"



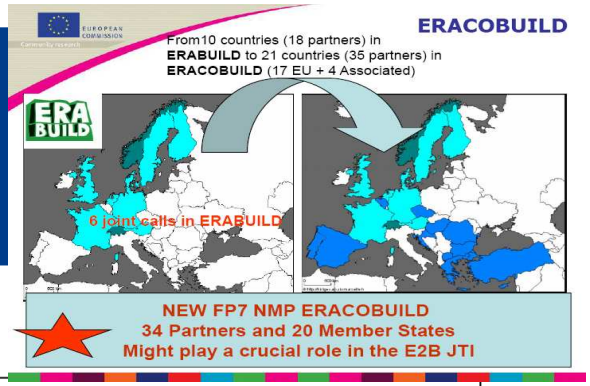
(Question: "How much more do you think a certified sustainable building would cost to build relative to a normal building?")

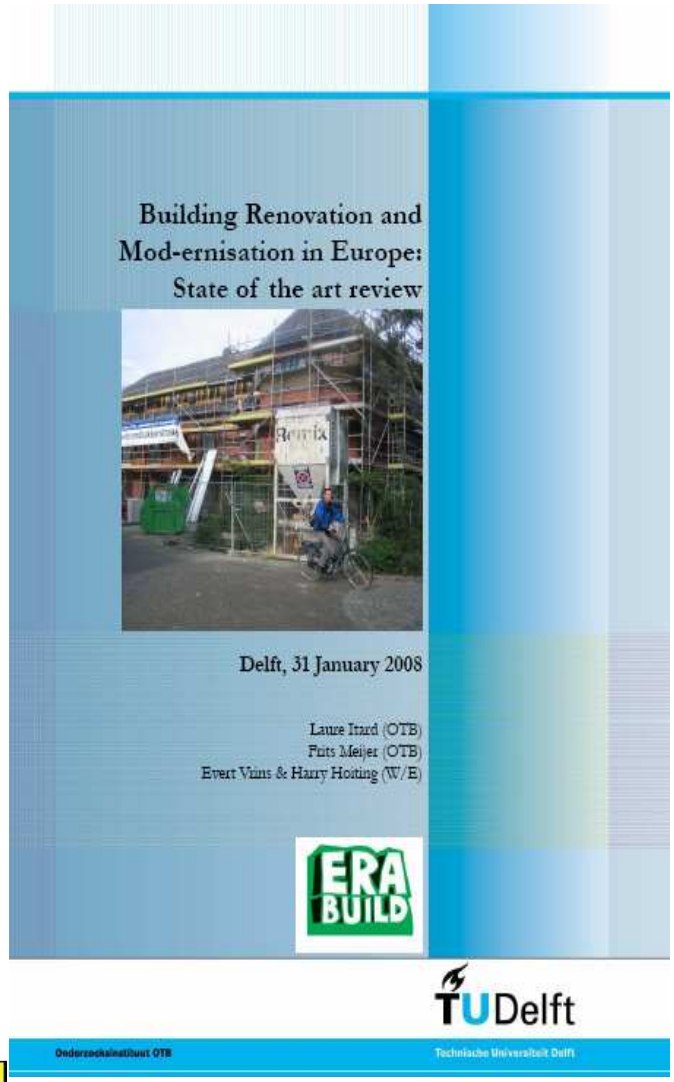
Source: WBCSD EEB Perception Study | 13

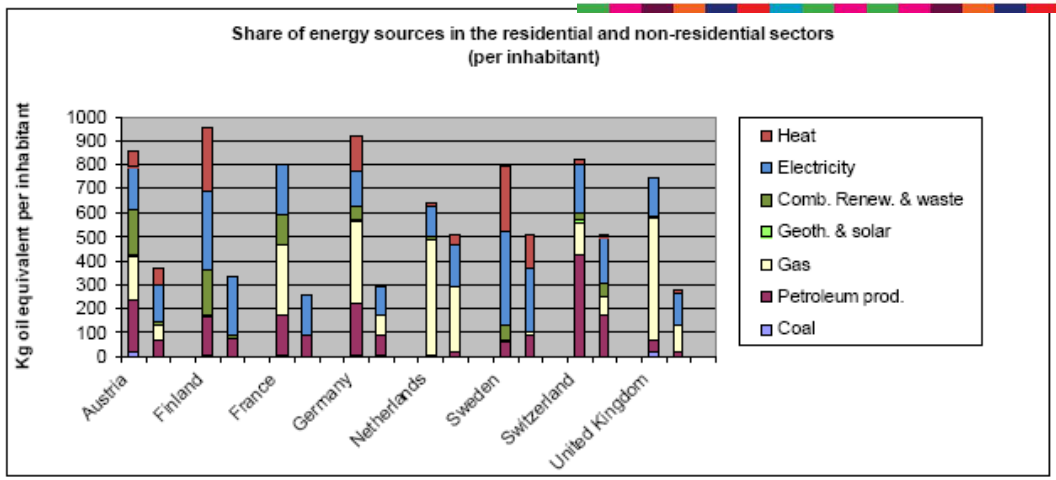
Segmentation of attitudes: Personal know-how drives individual behavior

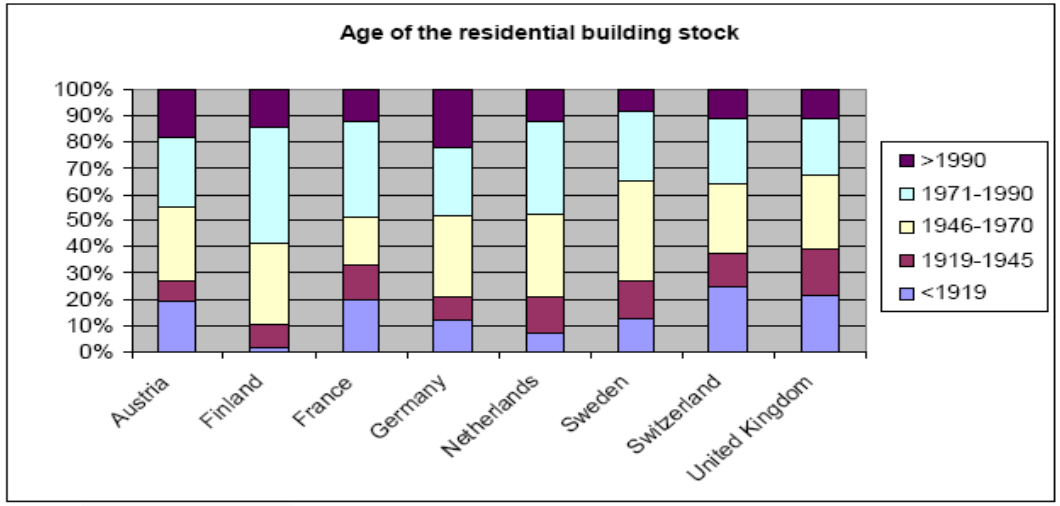


3. Recent Roadmap developments - ERACOBUILD







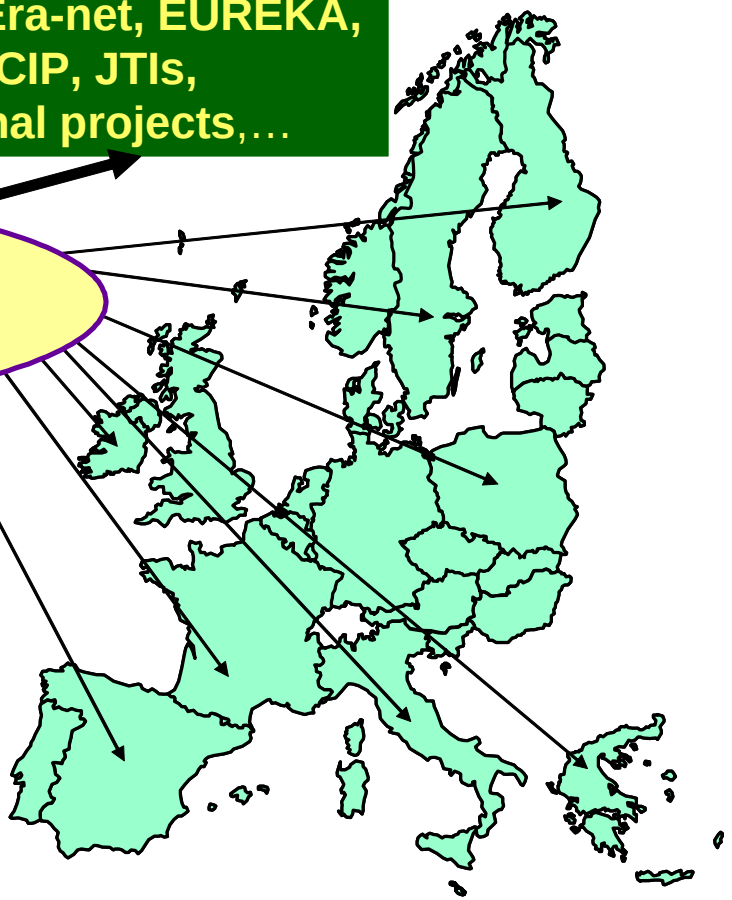


3. Recent Roadmap developments - ECTP

→ New RDI strategies
- to improve competitiveness and
- to satisfy societal needs

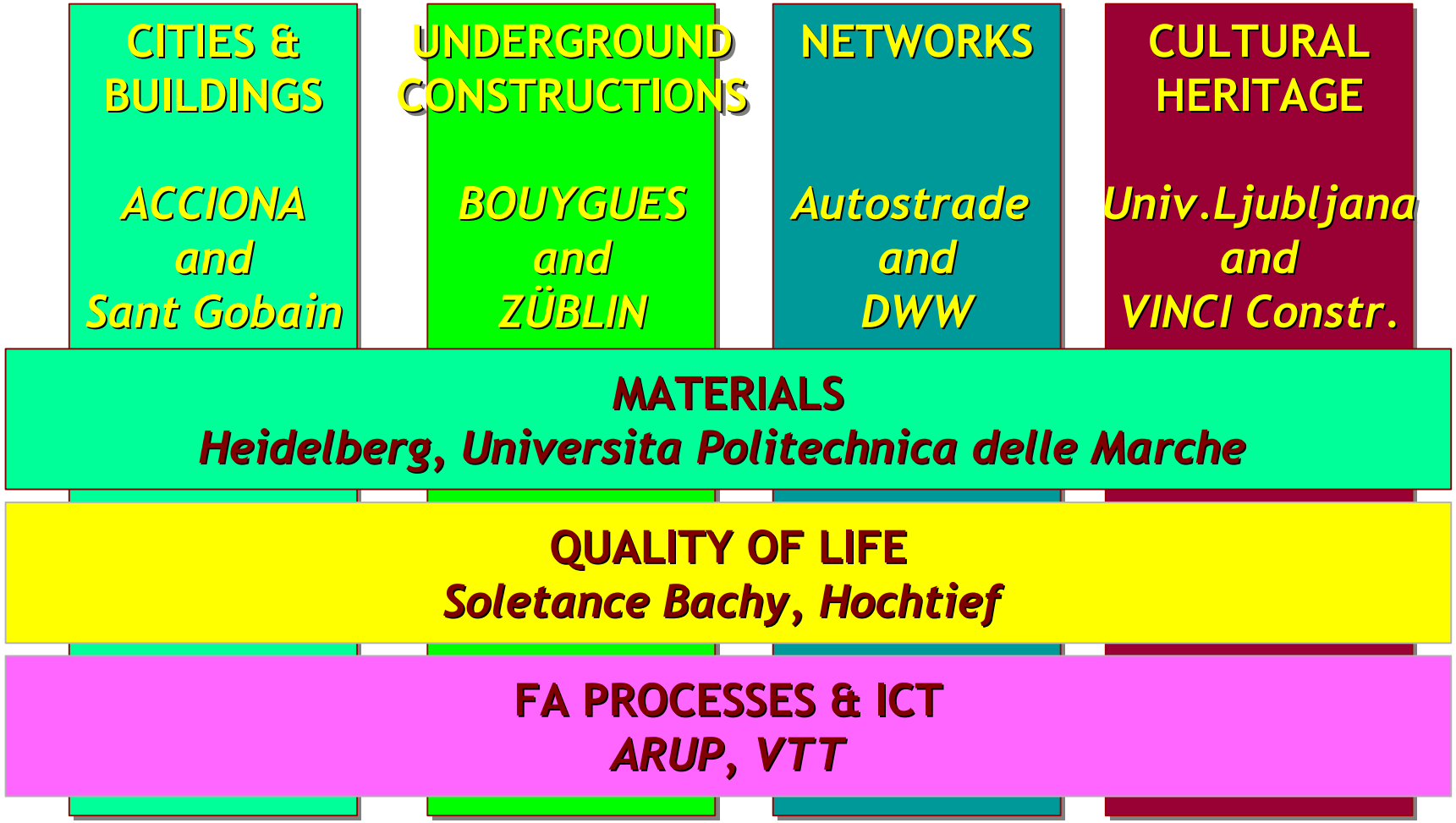
FP7, Era-net, EUREKA, Cost, CIP, JTIs, National projects,…

- All European countries together
- Group of countries
- Each country alone



STAKEHOLDERS:
- Industries
- Researches & Universities
- Clients and Users
- Financial Organizations
- Public Authorities, …

3. Recent Roadmap developments - ECTP



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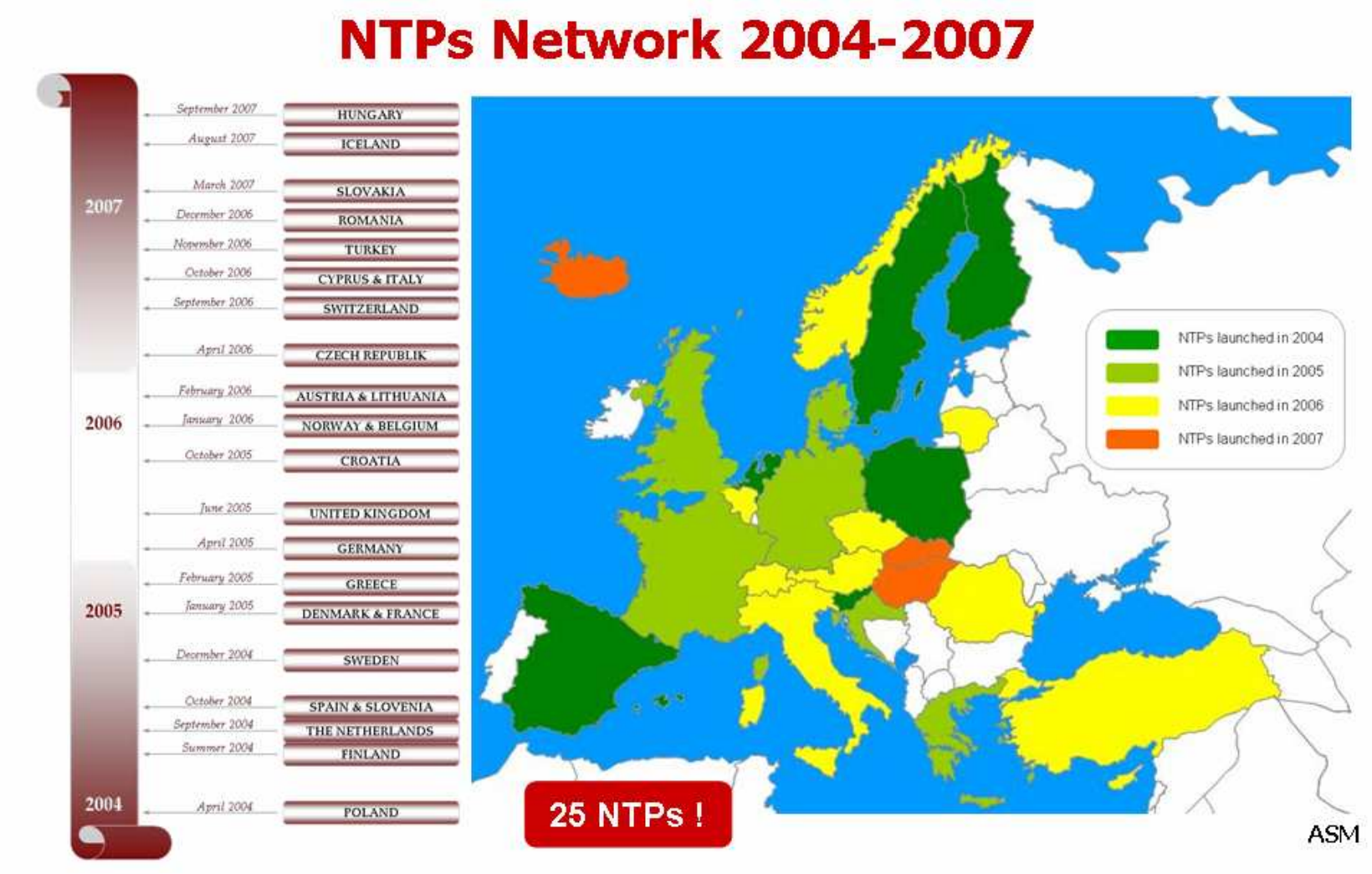


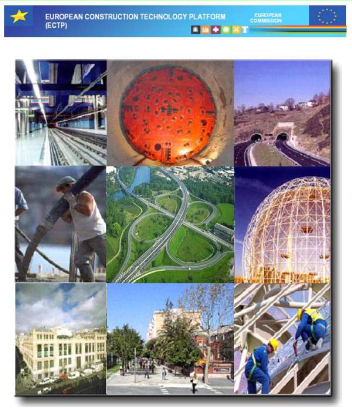
3. Recent Roadmap developments - ECTP

National Technology Platforms

7 Focus Areas
2 AGs + 2WGs

Achieved Goals

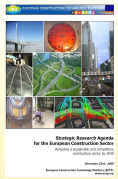
Vision 2030



Identification

Prioritising + Roadmap

Agenda 2030



❑ Research areas

Meeting Client Requirements

Becoming Sustainable

Transformation Of The Construction Sector

Indoor Environment
New Image of Cities
Using Underground Space
Mobility and Supply

Energy and Resources
Reduce Environmental Impact
Transport & Utility Networks
Cultural Heritage
Safety and Security

New Construction Process
ICT & Automation
High Added Value Materials
Attractive Workplaces

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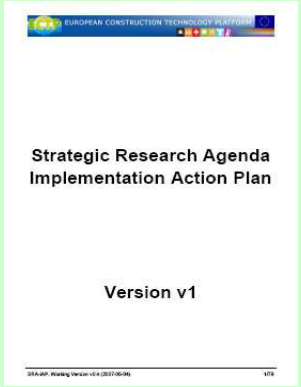
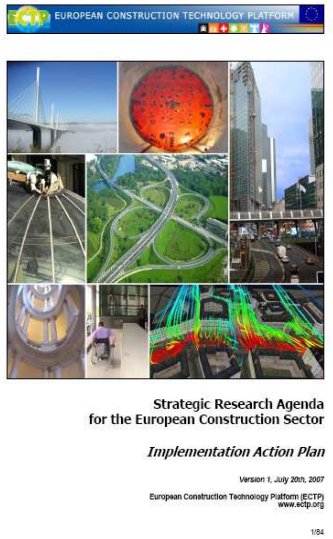


February 2005 — **November 2005** (+ FAs SRAs) — **June 2007**

3. Recent Roadmap developments - ECTP

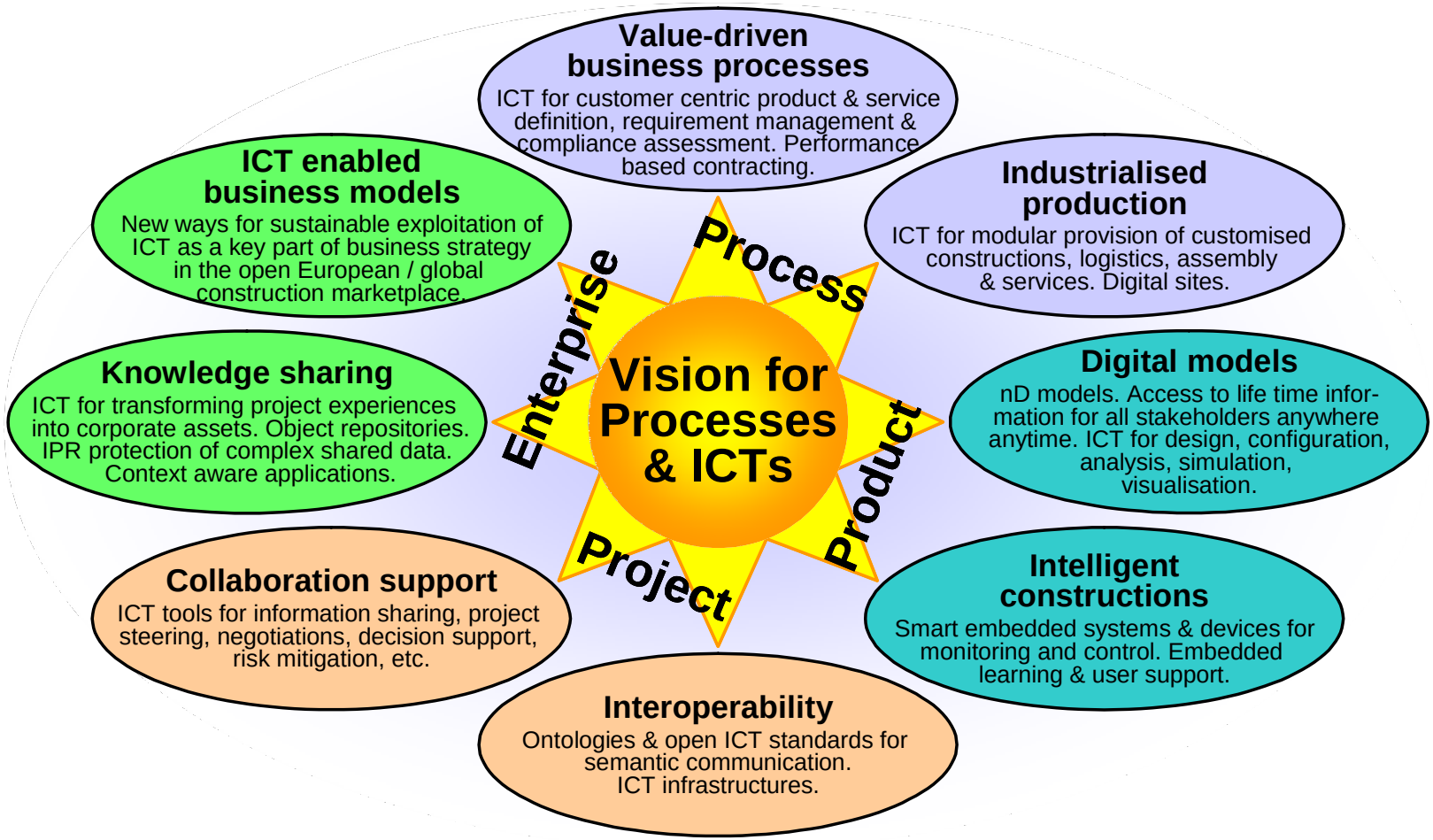
SRA Implementation Action Plan Priorities

A	Technologies for Healthy, Safe, Accessible and Stimulating **Indoor Environments** for All
B	Innovative Use of **Underground Space**
C	New Technologies, Concepts and High-tech Materials for **Efficient and Clean Buildings**
D	Reduce Environmental and Man-made **Impacts of Built Environment and Cities**
E	Sustainable **Management** of Transports and Utilities **Networks**
F	A Living **Cultural Heritage** for an Attractive Europe
G	Improve **Safety and Security** within the Construction Sector
H	New Integrated **Processes** for the Construction Sector
I	High Added Value Construction **Materials**



3. Recent Roadmap developments - ECTP

ECTP FA7: Roadmapping themes



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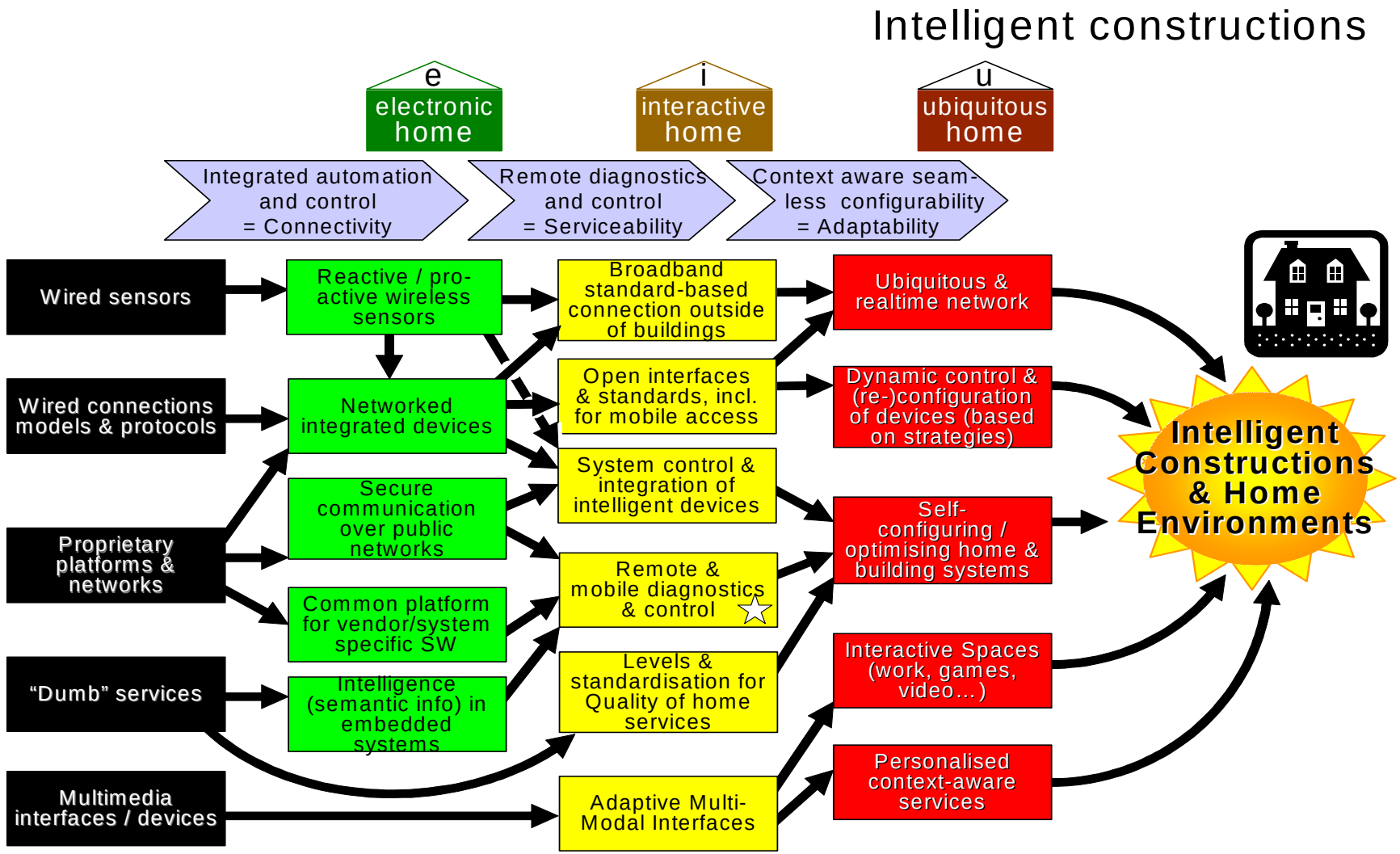


3. Recent Roadmap developments - ECTP

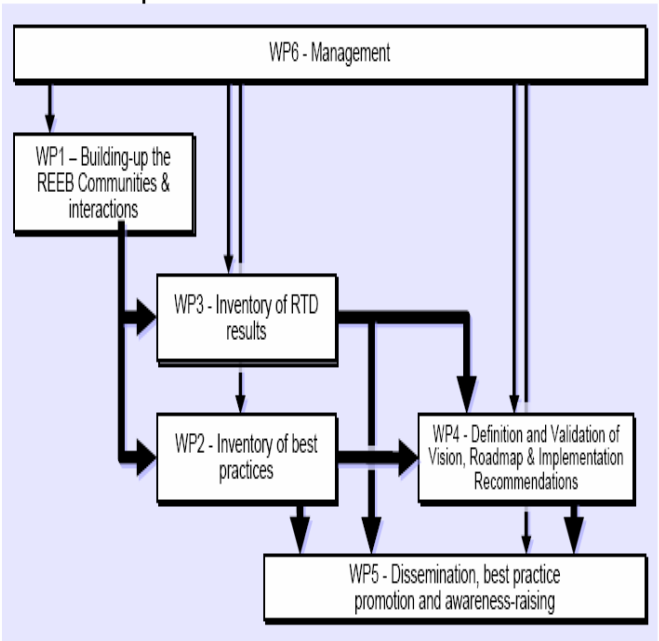
CSTB REEB: facts & figures

→ A Co-ordinated Action:

- In EC FP7: Theme 3 "Information and Communication Technologies" - ***ICT for Environmental Management & Energy Efficiency***
- Project full title: ***The European strategic research Roadmap to ICT enabled Energy-Efficiency in Buildings and constructions***
- Grant agreement no.: 224320 – Starting Date: ***1st May 2008***
- Consortium:

Centre Scientifique et Technique du Bâtiment (coordinator)	CSTB	**FR**
Technical Research Centre of Finland	VTT	**FI**
Commissariat a l'Energie Atomique	CEA	**FR**
Fundación LABEIN	Labein	**ES**
Acciona Infraestructuras	Acciona	**ES**
Arup Group Ltd.	ARUP	**UK**
University College Cork	UCC	**IR**
Technische Universität Dresden	TUD	**DE**

- Objective: *co-ordinating & rationalising current and future RTD in the area of ICT support to Energy Efficiency (EE) in the built environment of tomorrow*
- Overall work plan



3. Recent Roadmap developments - Other ETPs

20 out of 37 ETPs address construction.
12 address smart / E.E buildings

- **ARTEMIS:** Energy savings in buildings. Home ambient intelligence. Digital home. Intelligent infrastructures e.g. buildings.
- **eMobility:** Home networks.
- **EPoSS:** Safe home management. Assisted living for the elderly. Home care. Smart homes. Energy management.
- **ESTEP:** Recyclability of materials and components. Suitability for refurbishment and industrialised production.
- **ESTTP:** Heating and cooling without fossil fuels using solar thermal energy.
- **FOREST:** Wood as construction material reduces energy consumption, binds carbon and is recyclable as bio-fuel.
- **MANUFUTURE:** Virtual representation of (factory) buildings. Reduction of energy consumption by manufacturing processes and products over their whole life cycles;
- **NESSI:** Service oriented business models (in all sectors). ICT platforms from embedded systems to distributed environments
- **PHOTOVOLTAIC:** PV modules mounted on roofs or integrated in building components. Functional integration with shading, thermal systems, ventilation etc.
- **SMARTGRIDS:** Customer-side energy management, demand forecasting & balancing. Response to price signals. End-user Behaviour. Smart metering & customer interfaces. Multiple energy carrier systems in cities and buildings.
- **SUSCHEM:** Insulation materials. Coatings for windows. Electrochromatic smart windows. Phase changing materials. Organic light emitting diodes. Energy-generating components.

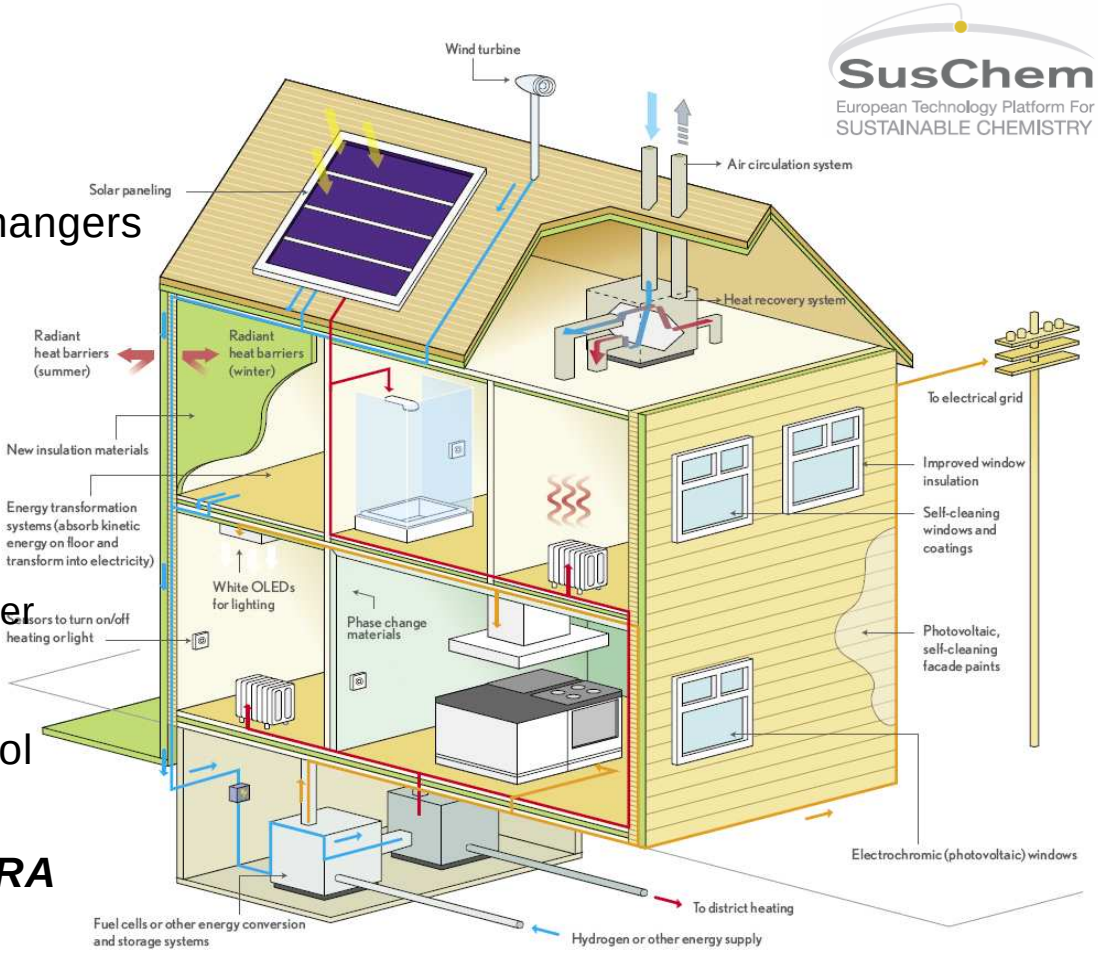
3. Recent Roadmap developments - Other ETPs

Energy-generating home

Technologies e.g.

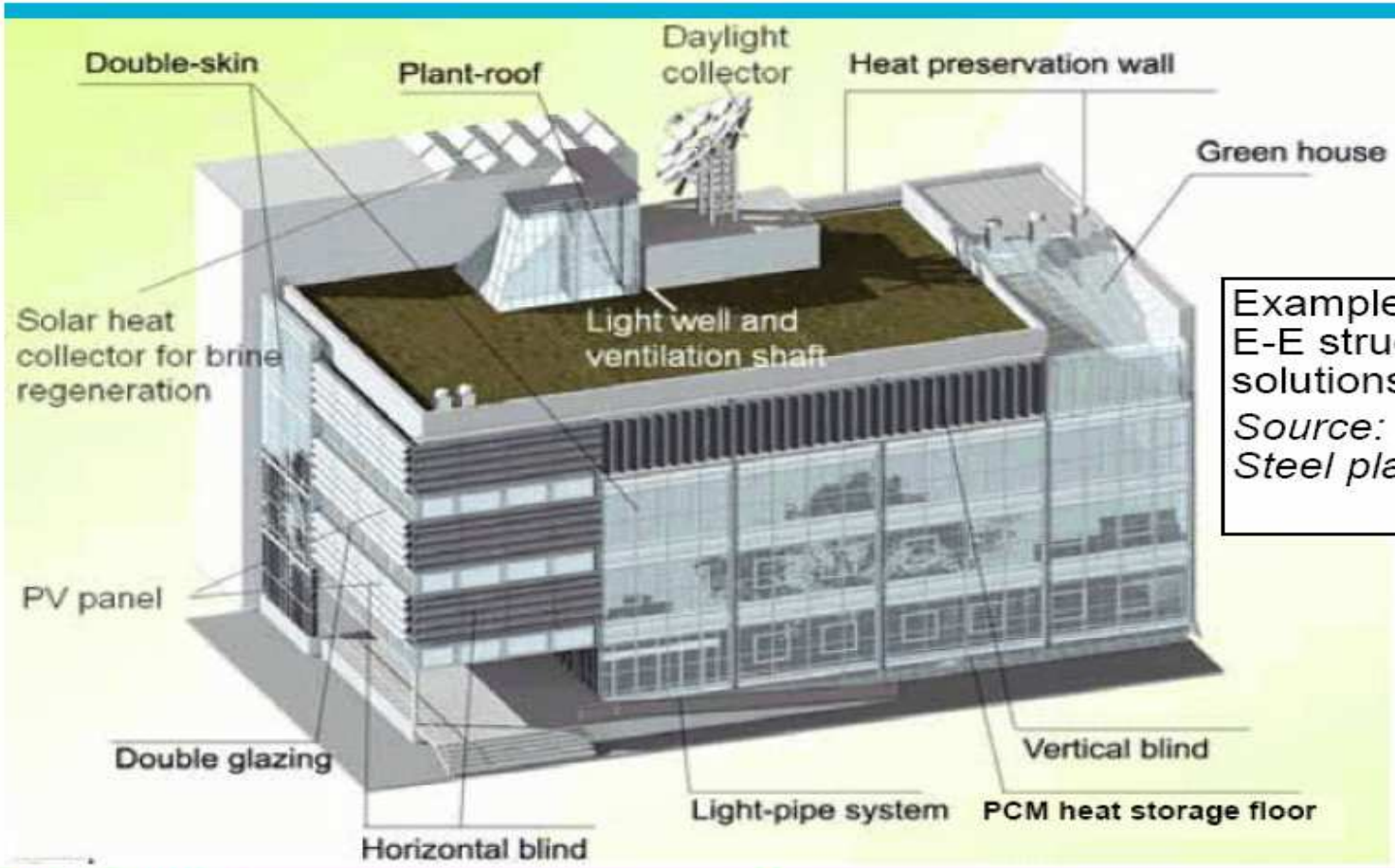
- Wind turbine
- Solar panels
- Fuel cells
- Heat pumps & exchangers
- Energy recovery & transformation
- OLED lighting
- Sensors
- New materials:
  - Insulation
  - Phase changing
  - Radiant heat barrier
  - Photovoltaic
  - Electrochromatic
- Automation & control
- Feeding into grid

Source: ***SUSCHEM SRA***



3. Recent Roadmap developments - Other ETPs

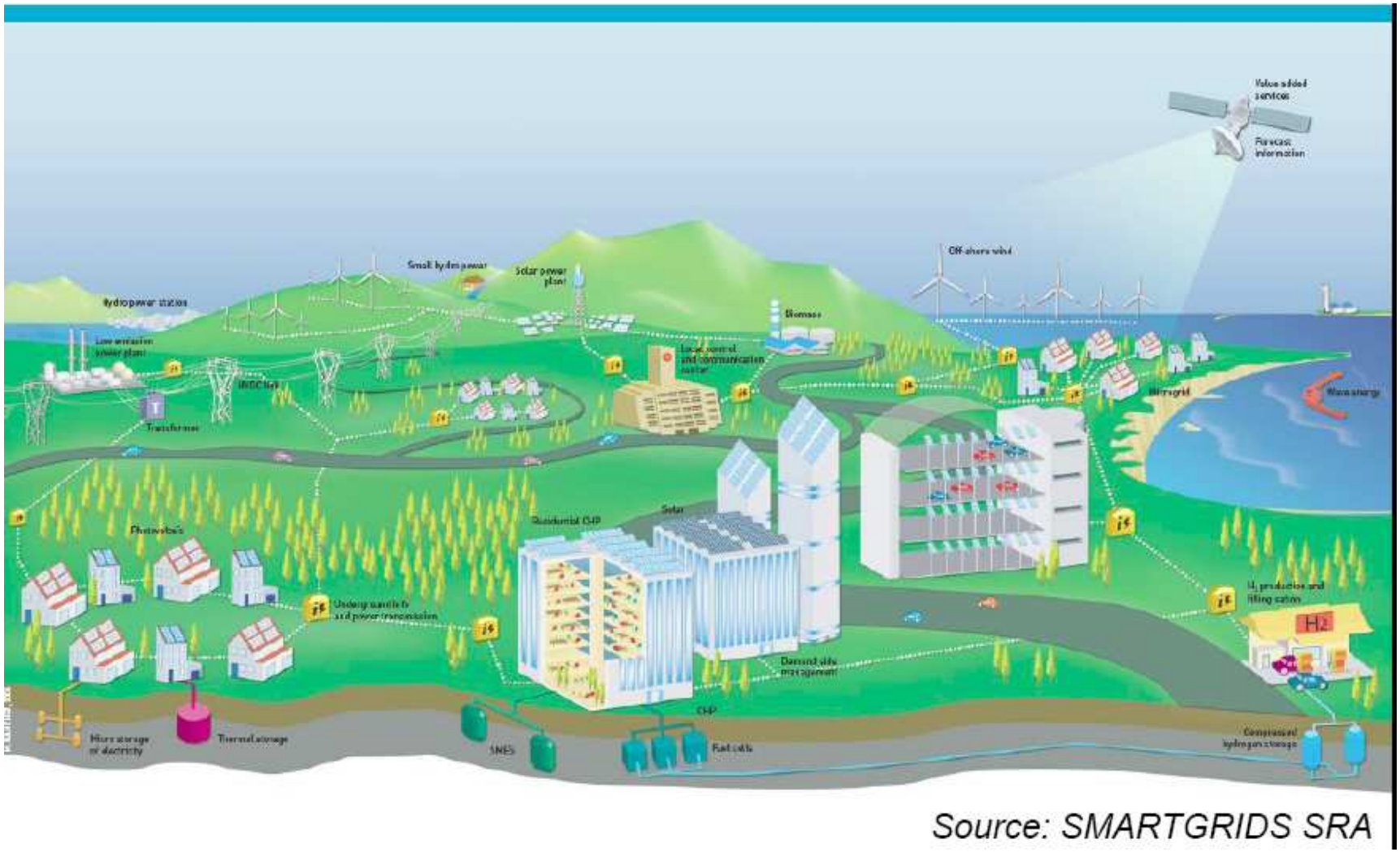
Energy-efficient steel construction



Examples of E-E structural solutions

Source: ESTEP Steel platform

3. Recent Roadmap developments - Other ETPs



Source: SMARTGRIDS SRA

3. Recent Roadmap developments
- E2B Joint Technology Initiative

EUROPEAN COMMISSION
Community research

E2B

E2B JTI

ECTP

Energy Efficient Building Joint Technology Initiative

acciona Infraestructuras
BOUYGUES
EDF
isolaton
maxit
Mostostal

3. Recent Roadmap developments - E2B Joint Technology Initiative

2. The Big Challenge

*E2B JTI stands for: **E**nergy **E**fficient **B**uildings **J**oint **T**echnology **I**nitiative*

" The overall objective of E2B JTI is to deliver, implement and optimize building and district concepts that have the technical, economic and societal potential to drastically cut the energy consumption and reduce CO_2 emissions due to existing and new buildings at the overall scale of the European Union.
E2B JTI will speed up research on key technologies and develop a competitive industry in the fields of energy efficiency products and services, with the main purpose to reach the goals set forth for 2020 and 2050 to address climate change issues and contribute to improve EU energy independence thereby transforming this challenge into a business opportunity "





3. Recent Roadmap developments - PREBAT Benchmarking

- International Benchmarking Study on:
  - Operation Programmes
  - Technology « Bricks »
  - R&D Programmes
- Roadmap elements towards Low Energy (and Zero energy) Buildings
- Objective: Factor 4

PRÉB4T

PROGRAMME DE RECHERCHE
ET D'EXPERIMENTATION
SUR L'ENERGIE DANS LE BÂTIMENT

3. Recent Roadmap developments - PREBAT Benchmarking

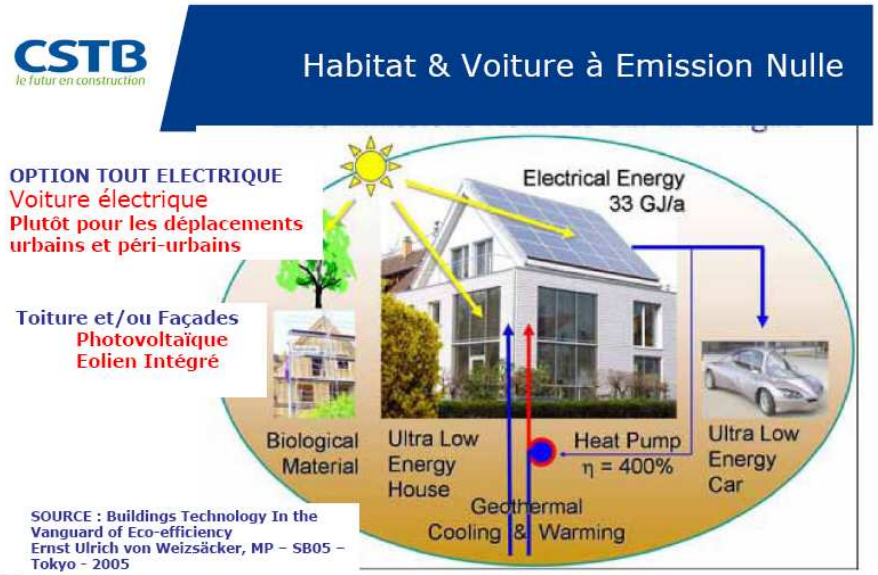
	N°	"Briques Technologiques"	Experts CSTB	Expert Extérieur
Envelop	1	Parois Opaques (murs, toitures, planchers …)	Hafiane Cherkaoui Marc Colombart-Prout	Svend Svendsen - DK Fritz Oettl - AT Robert Schild – AT
	2	Parois Transparentes (Fenêtres, Baies Vitrées…)	François Olive JF Arenes	Svend Svendsen - DK Fritz Oettl - AT Robert Schild - AT
	3	Systèmes Constructifs Comparés	Jean-Luc Salagnac	Svend Svensen (DTU – DK)
Systems	4	Ventilation Double Flux avec Récupération d'Energie	Bernard Collignan Orlando Catarina	Anne Tissot CETIAT
	5	Systèmes Compacts Ventilation/Chauffage/ECS	Emmanuel Fleury Orlando Catarina	Anne Tissot CETIAT
	6	Micro-Cogénération	Ahmad Husaunndee Orlando Catarina	Christian Feldmann (COSTIC)
	7	Climatisation/Rafraîchissement - Basse Consommation	Emmanuel Fleury Orlando Catarina	EMP – D. Marchio
Solar	8	Systèmes Solaires Combinés	Dominique Caccavelli Nadine Roudil	Jean-Christophe Hadorn (Base Consultant – CH)
	9	Stockage de Chaleur	Peter Riederer Orlando Catarina	Jean-Christophe Hadorn (Base Consultant – CH)
	10	Systèmes Photovoltaïques	Rodolphe Morlot	Univ. Australie - South Wales
Miscel.	11	Réseaux de Chaleur	Peter Riederer Chantal Laumonier	Robin Wiltshire (BRE)
	12	Eclairage	Michel Perraudeau Chantal Laumonier	Arnaud Deneyer (CSTC)
	13	Approche Intégrée	Daniel Quenard Jean-Luc Salagnac Marc Colombart-Prout	Robert Hastings (AEU Gmbh – CH)

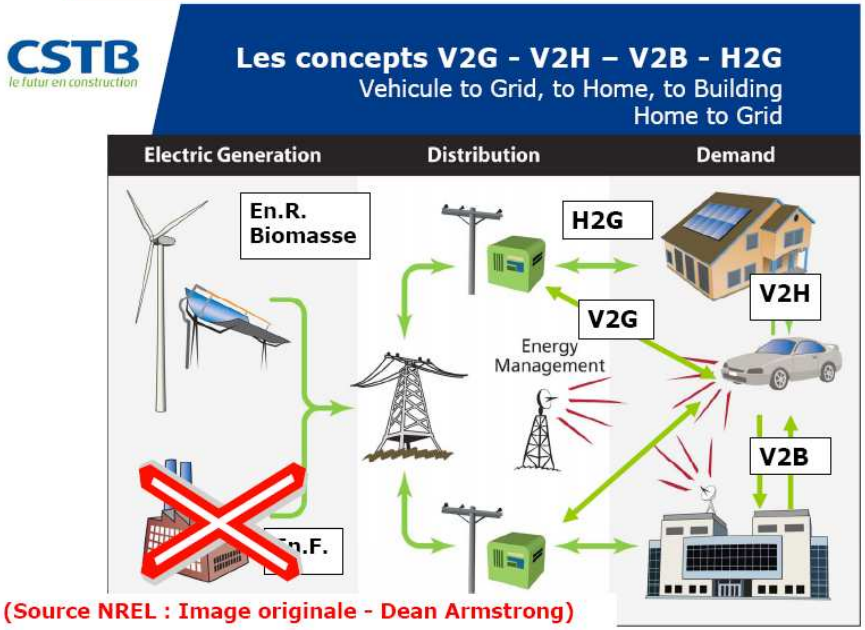
3. Recent Roadmap developments - PREBAT Benchmarking

Solaire : Stockage SWOT

Forces	Faiblesses
Taux de couverture solaire proche de 100% : le solaire monovalent devient possible ou avec un appoint minimum en terme d'énergie annuelle **Productivité** annuelle des capteurs double d'une installation avec stockage diurne seulement (env 500 kWh/m² an), ce qui permet de mieux rentabiliser les capteurs Stockage d'énergie gratuit ou moins cher. Peut alléger la maintenance de systèmes de production en limitant le nombre d'enclenchement/déclenchement d'appareils **Diminution de la puissance installée**	Système auxiliaire, qui sera utilisé en appoint ou en sécurité dans le meilleur des cas Investissement initial élevé, notamment pour les MI Marché de niche surtout pour l'habitat neuf, d'une certaine taille (100 logements) et à isolation très poussée Technologies souterraines difficilement reproductibles telles quelles dans un autre site Technologies non souterraines consomment de l'espace en surface à coût non négligeable **Stockage saisonnier : pertes thermiques assez importantes du fait de la longue durée du stockage, marché limité, Pas de profession identifiée et structurée, réflexion très en amont, études lourdes** Le stockage n'enthousiasme ni les professionnels, ni les clients par rapport à des techniques considérées plus "nobles", comme le solaire.
Opportunités	**Menaces**
Augmentation du prix des énergie fossiles, taxes CO2 sur les fossiles ? Aides pour le développement du solaire thermique ou des réseaux de chaleur bois **Développement des PAC dans les grands ensembles** Profession est de plus en plus sensible à la vision systémique et aux notions de performance de système. **Le développement des réseaux de chaleur est une opportunité de développer le stockage.**	Bas prix relatif des fossiles pour le chauffage pour longtemps encore. Marché du solaire thermique avec stockage court terme a encore tout le futur devant lui avant que le stockage saisonnier ne soit considéré comme vraiment important. Concurrence des pompes à chaleur air/eau pour la villa Durcissement de la législation sur la qualité sanitaire de l'eau.

3. Recent Roadmap developments - PREBAT Benchmarking





(Source NREL : Image originale - Dean Armstrong)

3. Recent Roadmap developments - PREBAT Benchmarking

State of the art and trends: new buildings

→ 4 types of buildings on the way towards Positive Energy Buildings

1. Low-energy Buildings
   - ➢ Well disseminated (ex: « Minergie » in Switzerland)
   - High insulation
   - HP double glazing
   - Double flux ventilation
   - HP energy system (heat pumps, wood burners, condensing boilers…)

   + High attention to air tightness and thermal bridges
   - ➢ Overcost <10% and users seem satisfied
   - ➢ Trend: higher insulation, air heat exchanger…
   - ➢ « Consensual system » for stakeholders

3. Recent Roadmap developments - PREBAT Benchmarking

State of the art and trends: new buildings

→ 4 types of buildings on the way towards Positive Energy Buildings

2. Solar Buildings
   - Improved insulation
   - Bioclimatic design
   - Solar heating + SDHW
   - ➢ Needs increase in popularity and lower costs of solar systems
   - ➢ From small entreprises to large ones (heating, windows) → Interest gets higher for stakeholders without opposition

3. Recent Roadmap developments - PREBAT Benchmarking

State of the art and trends: new buildings

→ 4 types of buildings on the way towards Positive Energy Buildings

3. Passive Buildings
   - ➢ Example: « Passive House » in Germany
   - Very high insulation (30-40 cm)
   - Excellent air-tightness, no thermal bridges
   - No traditional heating system
   - Compact systems: ventilation + slight heating + DHW
   - ➢ Technology changes
   - ➢ Breakthrough for many stakeholders because not a traditional construction technique (may depend on countries)
   - ➢ OK for some stakeholders (insulation, ventilation…), not for others

3. Recent Roadmap developments - PREBAT Benchmarking

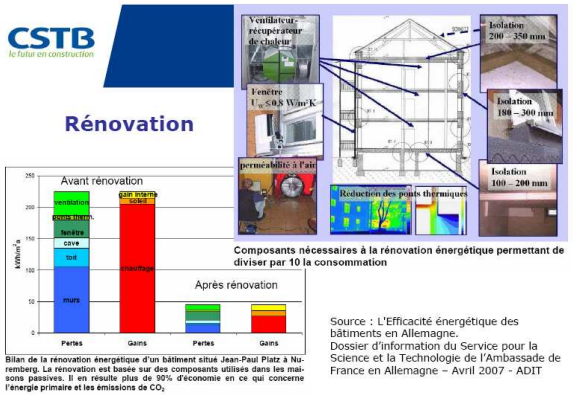
State of the art and trends: new buildings

→ 4 types of buildings on the way towards Positive Energy Buildings

4. Positive Energy Buildings
   - Low-energy or solar buildings + solar PV/thermal roofs
   - ➢ Can be envisaged today only with grants in order to limit the overcost linked to PV systems
   - ➢ Large scale development needs strong changes regarding PV costs → technology breathrough

3. Recent Roadmap developments - PREBAT Benchmarking

State of the art and trends: existing buildings



→ Much less feedback in this field

- Solutions close to those used for new buildings
  - ┼ Very high insulation
  - ┼ Double/triple glazing
  - ┼ Double flux ventilation
    (per dwelling or per room)
  - ┼ Heat pumps or wood boilers
    - + Solar DHW
    - + PV systems

… 20 millions de logements avant le première réglementation - 1975

Bâtiment situé Jean-Paul Platz 4 à Nuremberg, rénové par la société WBG : Avant et après rénovation

Source : L'Efficacité énergétique des bâtiments en Allemagne.
Dossier d'information du Service pour la Science et la Technologie de l'Ambassade de France en Allemagne – Avril 2007 - ADIT

- 2 approaches
  - Looking for global solutions in heavy retrofit operations (envelop + systems) → architectural changes (prefabricated components, atrium…)
  - Acting on some components (boilers…) → CO2 reduction, but not low-energy

3. Recent Roadmap developments - PREBAT Benchmarking

Elements for an Action Plan

1. Disseminate Low-energy or Positive Energy Buildings
   - Mobilize actors through market segments (socio-eco-technical aspects); example (FR):
     - Existing individual houses (14 millions dwellings))
     - Multi-property-building flats (6)
     - Institutional/social buildings (flats / « grouped-houses ») (4)
     - Public buildings (5)
     - Private office buildings (5)
   - 3 Steps
     - Demonstration HP1, HP2, HP3
     - Labels HP1, HP2, HP3
     - Dissemination (regulation): HP1→HP2→HP3

3. Recent Roadmap developments - PREBAT Benchmarking

Elements for an Action Plan

2. QM Tools to build and retrofit
   - Referential
   - Sets of technical solutions (per building type and HP target)
   - Training/Information tools
   - Financing tools
   - Knowledge feedback syste

3. Recent Roadmap developments - PREBAT Benchmarking

Elements for an Action Plan

3. Make technologies available; some objectives:

- Decrease losses
- High insulation without thermal bridges in new and existing buildings
- Thin insulation for retrofit
- Ventilation systems with heat recovery for all building types and enabling good air quality control
- Air tighteness
- Renewable energy
- Winter/summer glazed components
- Retrofit solutions for existing heating systems
- Storage for low cost thermal solar systems (SF > 50%)
- PV integration
- Natural lighting systems
- .Energy management (multi-sources, multi-needs)
- …

4. Put technologies together

- Systemic research: tools and method to insure coherency of the various elements in the building
  - Define requirements for components and sub-systems
  - Develop performance assessment methods for components and sub-systems within a final « assembly »
  - Develop tools to predict global behaviour of the building
  - Develop virtual or real « demonstrators » (« concept buildings »)

Conclusion

"[We propose] Buildings that, like trees, are net energy exporters, produce more energy than they consume, accrue and store solar energy, and purify their own waste water and release it slowly in a purer form."

The Next Industrial Revolution
From Cradle to Cradle
William Mc Donough

More information

- CIB: www.cibworld.nl
- IEA: www.iea.org
- FIATECH: www.fiatech.org
- WBSCD: www.wbscd.org
- ECTP: www.ectp.org (secretariat.ectp@cstb.fr)
- ERABUILD: www.erabuild.net
- Strat-CON: www.strat-con.org
- Other ETPs: http://cordis.europa.eu/technology-platforms/individual_en.html
- E2B JTI: www.e2b-jti.eu/
- PREBAT: www.prebat.net
  - Benchmarking: www.prebat.net/benchmark/benchmark.html