

# Hotel Barceló Aran Mantegna, Roma, Italia – 25 & 26 Ottobre 2017

## 17th International Water Mist Conference



A Necessary Ethical & Creative Design Transformation

## Sustainable Fire Engineering



# Building & Fire Codes/Regulations

**Fire Safety Objective:** Ensure the Safety of Building Users ... and Protect Property **only** insofar as it is necessary to ensure the safety of those Building Users.



## Vulnerable Building Users ?



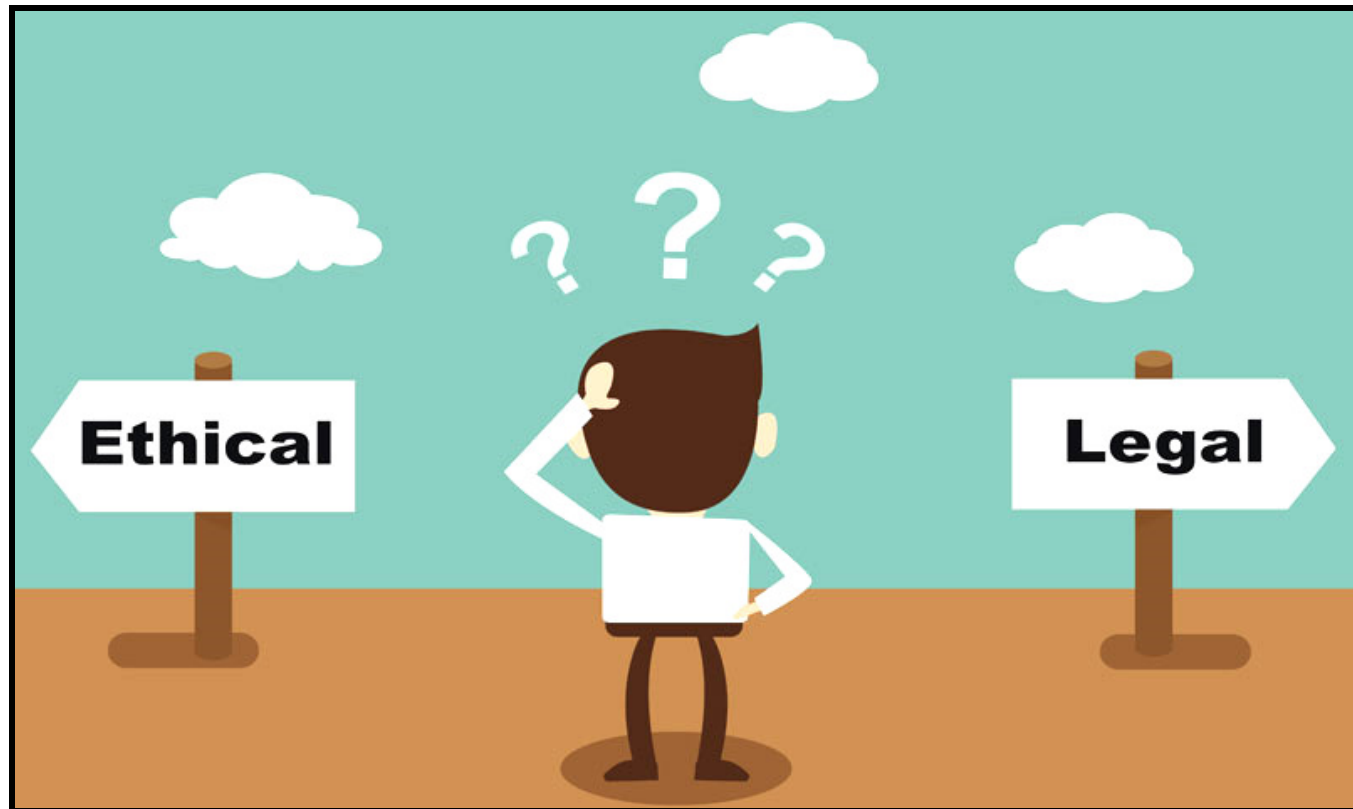
*Nobody Left Behind !*

## Firefighters ?



*Everyone Goes Home !*





**Legal Compliance Is NOT Enough ! Towards Ethical Practice ...**





# New Design Language of Sustainability

**Complex New Spatial Planning & Architectural Concepts ... Innovative Building Forms, Products & Structural Systems**  
**Minimal Compartmentation** in order to use **Natural Patterns of Air Movement** for Heating, Cooling & Ventilation  
**'Positive Energy Buildings'** producing far more energy than they consume ... Excess returned to **Regional or Local Intelligent Grids**  
**Frontline Firefighters** facing serious problems ... **Not Supported** by Specialist Structural Engineering & Hazard Appraisal Units  
**Conventional Fire Engineering** does not understand this Language ... **It Cannot Respond** creatively or collaboratively



**Projects by Ar. Vincent Callebaut - Belgium**

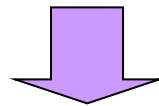


# What is Sustainable Development ?

World Commission on Environment & Development [WCED]  
1987 Report: 'Our Common Future' - Chapter 2, Paragraph #1

**#1.** Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- the **concept of 'needs'**, in particular the essential needs of the world's poor, to which overriding priority should be given ; and
- the **idea of limitations** imposed by the state of technology and social organization on the environment's ability to meet present and future needs.



## 1992 UN Rio Declaration on Environment & Development

[1992 United Nations Framework Convention on Climate Change + 1997 Kyoto Protocol]



## 1972 UN Stockholm Declaration on the Human Environment

[1985 UN Vienna Convention for the Protection of the Ozone Layer + 1987 Montreal Protocol]



# What is Sustainable Development ?

World Commission on Environment & Development [WCED]

**1987 Report: 'Our Common Future' - Chapter 2, Paragraphs #2, #3 & #4 - Key Phrases**

**#2.** Thus, the goals of **economic and social development** must be defined in terms of sustainability in all countries - developed or developing, market-oriented or centrally planned. Interpretations will vary, but must **share certain general features** and must flow from a **consensus** on the **basic concept of sustainable development** and on a **broad strategic framework for achieving it**.

**#3.** Development involves a **progressive transformation of economy and society**. A development path that is sustainable in a physical sense could theoretically be pursued even in a rigid social and political setting. But physical sustainability cannot be secured unless development policies pay attention to such considerations as changes in **access to resources** and in the **distribution of costs and benefits**. Even the narrow notion of physical sustainability implies a concern for **social equity between generations**, a concern that must logically be extended to **equity within each generation**.

**#4.** The satisfaction of **human needs and aspirations** is the major objective of development. The essential needs of vast numbers of people in developing countries - for food, clothing, shelter, jobs - are not being met, and beyond their basic needs these people have legitimate aspirations for an **improved quality of life**. A world in which poverty and inequity are endemic will always be prone to ecological and other crises. **Sustainable development requires meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life.**



# Sustainable Human & Social Development

**Sustainable Design International [SDI]**

Development which meets the responsible needs of this generation - without stealing the life and living resources from future generations ... especially our children, their children, and the next five generations of children.

[ 'Responsible Needs' are the fundamental rights, freedoms and protections defined and elaborated in the 1948 Universal Declaration of Human Rights, subsequent International Rights Legislation, and the United Nations 2015-2030 Sustainable Development Agenda. ]

**Transforming Social Organization ...** the **Ultimate Goal** is to arrive, quickly, at a dynamic and harmonious balance between a Sustainable 'Human' Environment and a flourishing, not just a surviving, 'Natural' Environment ... with the **Overall Aim** of achieving Social Wellbeing for All.

## Social Wellbeing for All

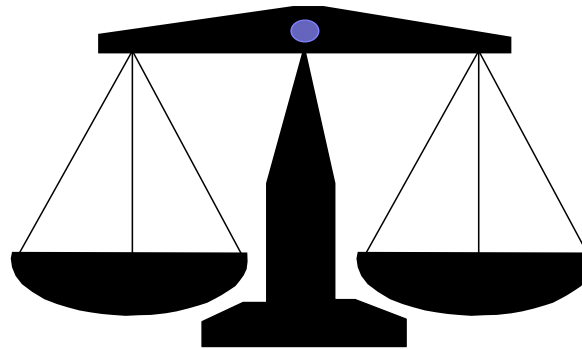
A general condition – for every person in a community, society or culture - of health, happiness, creativity, responsible fulfilment, and sustainable development.



# Many Aspects to Sustainable Development

**Social** + **Economic** + **Environmental** + **Institutional**  
[Social Organization]  
+ **Political** + **Legal** + **Judicial**  
[Regional & National]

... in a context of **Effective International Law & Lasting Peace**



**Synchronous, Balanced Implementation of  
All Aspects is a Fundamental Value & Principle !**

[compare with 2007 Leipzig Charter on Sustainable European Cities]







**'Tao Zhu Yin Yuan' (Agora Garden) in Taipei, Taiwan – Ar. Vincent Callebaut  
Sustainable Residential Tower (21 Storeys) – Completion June 2018**







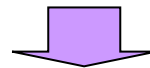
**'Il Bosco Verticale' in Milan, Italy – Ar. Stefano Boeri  
2 Residential Towers (27 & 18 Storeys) – Completed 2014**



# Transformation of Fire Engineering



The creative, person-centred and ethical **Fire Engineering** response,  
in resilient built form and smart systems,  
to the concept of **Sustainable Human and Social Development**  
... the many aspects of which must receive synchronous, balanced consideration.



EXPLORING ISSUES

**Fire Safety for All**

@firesafety4all

**Sustainable Fire Engineering**

@sfe2016dublin



FireOx International

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# Sustainable Fire Engineering Design

## Reality - Reliability - Redundancy - Resilience

To protect Society, User Welfare and the Client's Best Interests ... and to maintain core building functionality under the dynamic, complex conditions of fire, **Project-Specific Fire Engineering Design Objectives** must typically cover the following spectrum of issues :

- ◆ **Protection of the Health of All Building Users** ... including **People with Activity Limitations** (2001 WHO ICF), **Visitors** to the building or facility who may be unfamiliar with its layout, and **Contractors or Product/Service Suppliers** temporarily engaged in work or business transactions on site ;
- ◆ **Protection of Property from Loss or Damage** ... including the **Building** or **Facility**, its **Contents**, and **Adjoining or Adjacent Properties** ;
- ◆ **Safety of Firefighters, Rescue Teams & Other Emergency Response Personnel** ;
- ◆ **Ease & Reasonable Cost of 'Effective' Reconstruction, Refurbishment or Repair Works after a Fire** ;
- ◆ **Sustainability of the Human Environment** (social, built, virtual, economic, etc) - including **Fitness for Intended Use** and **Life Cycle Costing** of fire engineering related products, systems, etc ... fixed, installed or otherwise incorporated in the building or facility ;
- ◆ **Protection of the Natural Environment from Adverse Impacts & Harm.**



# European Union

**Regulation (EU) No. 305/2011** of the European Parliament and of the Council, of 9 March 2011, laying down Harmonized Conditions for the Marketing of Construction Products and *Repealing Council Directive 89/106/EEC*

## **ANNEX I - 'Basic Requirements for Construction Works' 1 & 2 (of 7) ...**

### **1. Mechanical Resistance & Stability**

The construction works must be designed and built in such a way that the loadings that are liable to act on them during their construction and use will not lead to any of the following:

- (a) collapse of the whole or part of the works ;
- (b) major deformations to an inadmissible degree ;
- (c) damage to other parts of the construction works or to fittings or installed equipment as a result of major deformation of the load-bearing construction ;
- (d) damage by an event to an extent disproportionate to the original cause.

### **2. Safety in Case of Fire**

The construction works must be designed and built in such a way that in the event of an outbreak of fire:

- (a) the load-bearing capacity of the construction can be assumed for a specific period of time ;
- (b) the generation and spread of fire and smoke within the construction works are limited ;
- (c) the spread of fire to neighbouring construction works is limited ;
- (d) occupants can leave the construction works or be rescued by other means ;
- (d) the safety of rescue teams is taken into consideration.

... / ...





# EU Regulation 305/2011 (contd.)

## ANNEX I - 'Basic Requirements for Construction Works' 3, 4 & 7 ... Selected Extracts ...

### 3. Hygiene, Health and the Environment

The construction works must be designed and built in such a way that they will, throughout their life cycle, not be a threat to the hygiene or health and safety of workers, occupants or neighbours, nor have an exceedingly high impact, over their entire life cycle, on the environmental quality or on the climate during their construction, use and demolition, in particular as a result of any of the following:

- (b) the emissions of dangerous substances, volatile organic compounds (VOC's), greenhouse gases or dangerous particles into indoor or outdoor air ;

### 4. Safety and Accessibility in Use

The construction works must be designed and built in such a way that they do not present unacceptable risks of accidents or damage in service or in operation such as slipping, falling, collision, burns, electrocution, injury from explosion and burglaries. In particular, construction works must be designed and built taking into consideration accessibility and use for disabled persons.


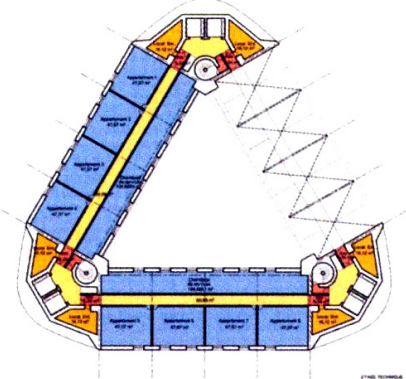


### 7. Sustainable Use of Natural Resources

The construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable and in particular ensure the following:

- (a) re-use or recyclability of the construction works, their materials and parts after demolition ;
- (b) durability of the construction works ;
- (c) use of environmentally compatible raw and secondary materials in the construction works.



# 'Evacuation' Design & Safer Structural Forms

 <p><b>Multi-Core Design</b></p>		 <p>Denis Sloan, architecte; Peter Terrell et Geoff Rooke, ingénieurs structures; et Claude Delalande, ingénieur sécurité (ex-Officier BSPP, Paris-Expo) - France.</p>
 <p><b>PolyCentric</b> <b>Tower</b></p>		

**2005 NIST(USA) Report on 9-11 WTC 1 & 2 Tower Collapses - Recommendation #18**



### Reasonable Provision of Space !

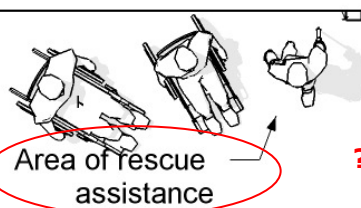


**Firefighter Rescue**

Robust, fire resisting construction

Communication system, 800 - 1100 mm above floor

Evacuation chair



?? m<sup>2</sup>

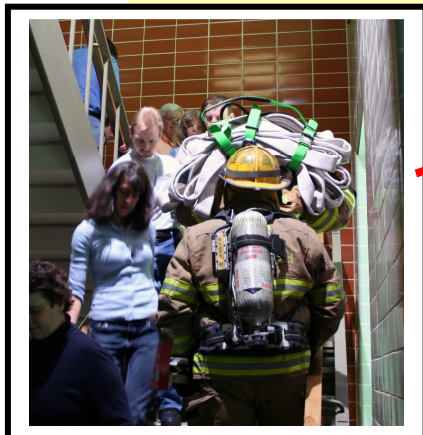
Fire extinguishers, handle 800 - 1100 mm above floor, 600 mm from corner

Continuous handrails

1500



**Assisted Evacuation**



**Contraflow**

UP

Recessed fire resisting doorset with glazed vision panels at high and low levels

Fire protected corridor

### Fire Evacuation Staircase - ISO 21542 : 2011 (rev)

[Adjacent lifts/elevators in a building must also be used for fire evacuation]





# Safe, Accessible Routes to 'Places of Safety'



'Places of Safety' must be located a remote distance from a Fire Building, and be clearly signposted. The Routes to these Places must be **Safe** (e.g. from falling construction debris, flying glass, and firefighting equipment) ... and must be **Accessible for All**, especially People with Activity Limitations. **Firefighter Awareness ?**



**Firefighter Safety** begins with Building Design ! After 9-11 & Tianjin ... Frontline Firefighters must be supported by Specialist Structural Engineering & Hazard Appraisal Units.



# Immediate Fire Suppression Needed !

Low Fire Compartmentation Reliability > Total Failure in Grenfell Tower Fire

(Pitch Dark, Smoke-Logged Single Staircase)

Fire Resisting Doorsets ? Fire Sealing of Penetrating Services ? Staircase Pressurization ?

Fire-Induced Progressive Structural Damage > WTC 7

Can Commence Before Fire Compartment Boundaries Fail



## Sustainable Buildings

- Air-Tight, Super Energy Efficient
  - Smart, Double Skin Façades
  - Minimal Compartmentation
  - Renewable Energy Systems
  - Extensive Electronics & Wiring (Smart Performance - M&T - IoT)
- Elaborate Building Ducting & Cavities



## Firefighter Safety

Research - More Research

Heritage Buildings & Precious Contents

GHG's > Sustainability Impact Assessment (SIA)





# Water Mist Suppression Systems !!

Smart, Hybrid Water Mist & Sprinkler Suppression Systems ?

Disproportionate Damage & Earthquake Resistance ?

Special Applications for Water Mist Systems

- Single Occupation Dwellings
  - Health Facilities
- People with Activity Limitations (2001 WHO ICF)
  - Firefighter Safety
  - Lift Lobbies & Shafts
  - Evacuation Staircases
  - Areas of Rescue Assistance
- Floors of Temporary Refuge in Tall Buildings



Torn House Hotel, Russia  
2017-09-21



Timber-Framed Housing, Ireland  
2015-03-31



# Wrap Up

**Sustainable Fire Engineering** fulfils a Critical Role in the  
Realization of a Safe, Resilient & Sustainable Built Environment for All

**Sustainable Fire Engineering** facilitates Positive Progress towards meeting  
the United Nation's 2015 Sustainable Development Goals & Performance Targets

**Sustainable Fire Engineering** fast-tracks Full Compliance with the Basic Requirements for  
Construction Works in E.U. Construction Products Regulation 305/2011



## Fire Engineering Transformed - Beyond Codes

### **2016 Dublin Code of Ethics**

Design, Engineering, Construction & Operation of a Safe,  
Resilient & Sustainable Built Environment for All

**Fire Engineer** is a Creative Member of a Collaborative Building Design Team





[www.sfe-fire.eu](http://www.sfe-fire.eu)

# Appendix



# A Sustainable 'Human' Environment

## **Social Environment**

The complex network of real and virtual human interaction - at a communal or larger group level - which operates for reasons of tradition, culture, business, pleasure, information exchange, institutional organization, legal procedure, governance, human betterment, social progress and spiritual enlightenment, etc.

The Social Environment shapes, binds together, and directs the future development of the Built and Virtual Environments.

## **Built Environment**

Anywhere there is, or has been, a man-made or wrought (worked) intervention by humans in the Natural Environment, e.g. cities, towns, villages, rural settlements, service utilities, transport systems, roads, bridges, tunnels, and cultivated lands, lakes, rivers, coasts, seas, etc ... including the Virtual Environment.

## **Virtual Environment**

A designed environment, electronically generated from within the built environment, which may have the appearance, form, functionality and impact - to the person perceiving and actually experiencing it - of a real, imagined and/or utopian world.

The Virtual and Built Environments continue to merge into a new Augmented Reality.

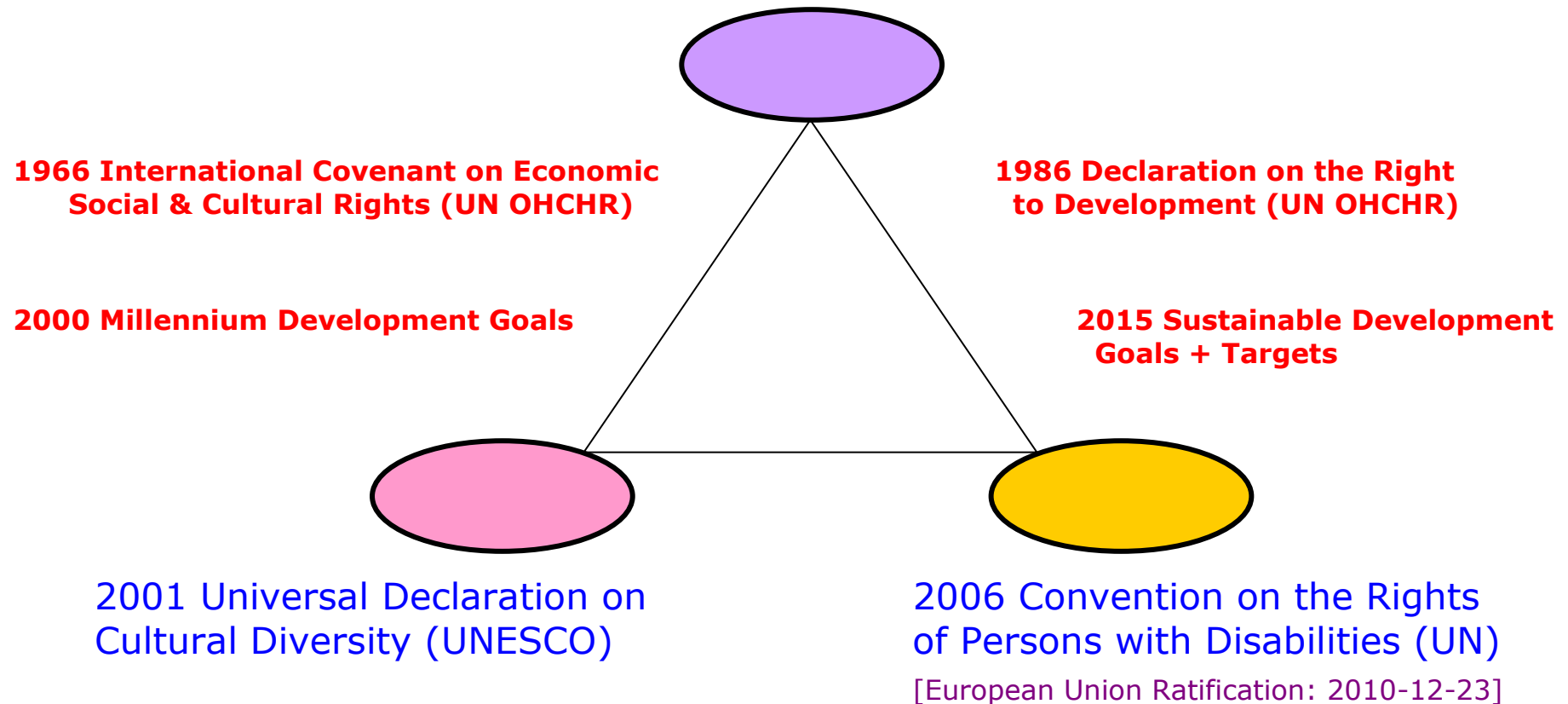
## **Economic Environment**

The intricate web of real and virtual human commercial activity – operating at micro and macro-economic levels – which facilitates, supports, but sometimes hampers or disrupts, human interaction in the Social Environment.



# International Rights Legislation Framework

1948 Universal Declaration of Human Rights (UN OHCHR)





# International Law Association (ILA)

**Extracts from:  
2002 New Delhi Declaration of  
Principles of International Law relating to Sustainable Development**

+

**2012 Sofia Guiding Statements on the Judicial Elaboration of the 2002 New Delhi Declaration**

**Noting** that sustainable development is now widely accepted as a global objective and that the concept has been amply recognized in various international and national legal instruments, including treaty law and jurisprudence at international and national levels,

**Emphasizing** that sustainable development is a matter of common concern both to developing and industrialized countries and that, as such, it should be integrated into all relevant fields of policy in order to realize the goals of environmental protection, development and respect for human rights, emphasizing the critical relevance of the gender dimension in all these areas and recognizing the need to ensure practical and effective implementation,

**Is of the Opinion** that the realization of the international bill of human rights, comprising economic, social and cultural rights, civil and political rights and peoples' rights, is central to the pursuance of sustainable development,

**Considers** that the application and, where relevant, consolidation and further development of the following principles of international law relevant to the activities of all actors involved would be instrumental in pursuing the objective of sustainable development in an effective way:

... / ...



... / ...

1. The Duty of States to Ensure **Sustainable Use of Natural Resources**
2. The Principle of **Equity and the Eradication of Poverty**
3. The Principle of **Common but Differentiated Responsibilities**
4. The Principle of the **Precautionary Approach to Human Health, Natural Resources and Ecosystems**
5. The Principle of **Public Participation and Access to Information and Justice**
6. The Principle of **Good Governance**
7. The Principle of **Integration and Interrelationship**, in Particular in Relation to Human Rights and Social, Economic & Environmental Objectives

**On-Line Database of Sustainable Development Law**

<http://cisdl.org/tribunals/>



# 2007 Leipzig Charter on Sustainable European Cities

## The Ministers Declare:

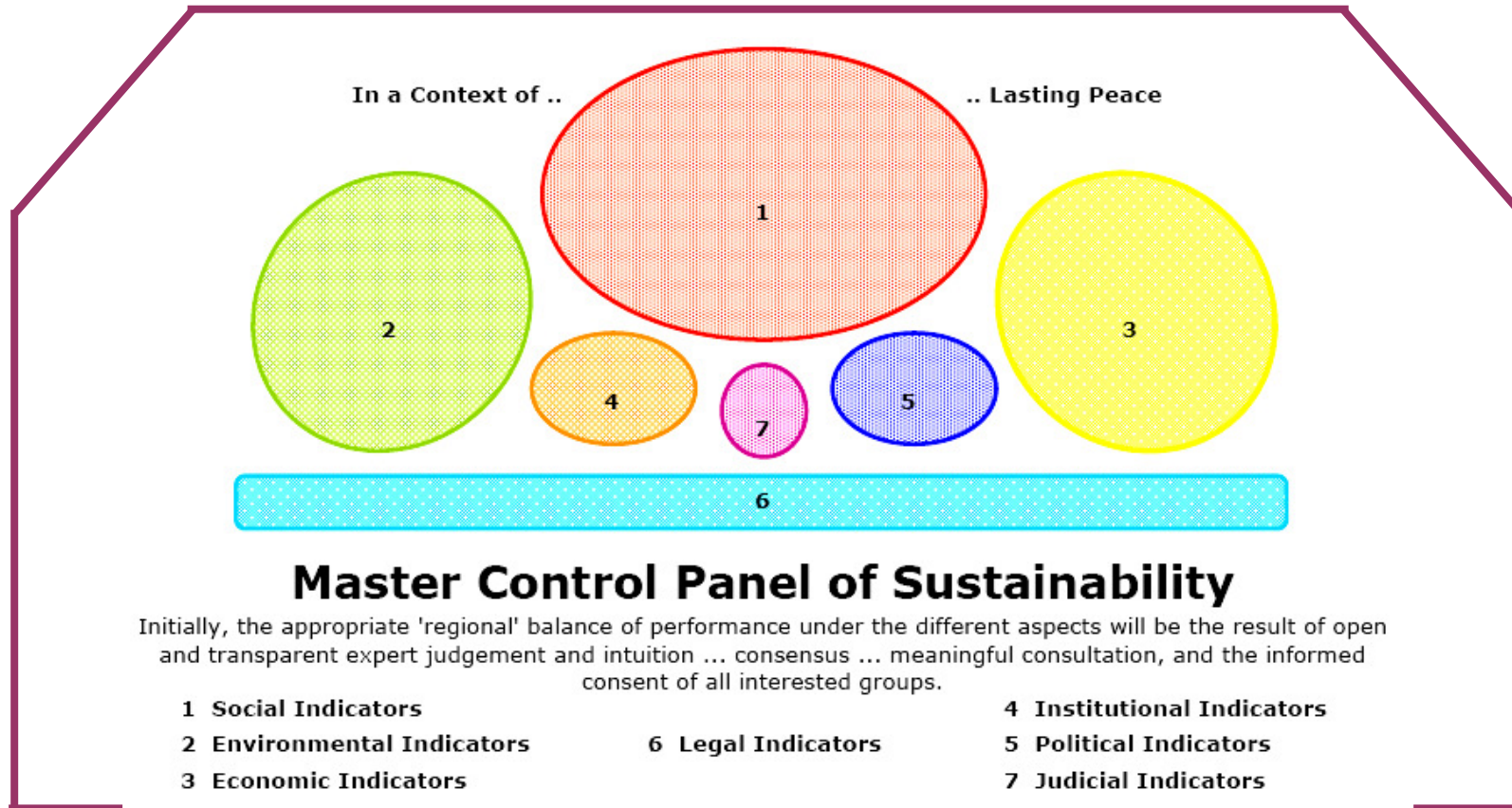
### Paragraph #2 ...

' With the objective of protecting, strengthening and further developing our cities, we strongly support the EU Sustainable Development Strategy, building on the Lille Action Programme, the Rotterdam Urban Acquis and the Bristol Accord. In doing so, **all dimensions of sustainable development should be taken into account at the same time and with the same weight.** These include economic prosperity, social balance and a healthy environment. At the same time, attention should be paid to cultural and health aspects. In this, due attention should be paid to the institutional capacity in the Member States.'



# Monitoring & Targeting Sustainability

**Sustainable Design International [SDI]**



[Refer to - <http://www.sustainable-design.ie/sustain/internationalpapers.htm#bari>]





# Fundamental Matrix of Construction Indicators

## Sustainable Design International [SDI]

Design, Construction & Logistics			<u>Social</u>			<u>Economic</u>			<u>Environmental</u>			<u>Institutional</u>			<u>Political</u>		
			<u>Driving Force</u>	<u>State</u>	<u>Response</u>	<u>Driving Force</u>	<u>State</u>	<u>Response</u>	<u>Driving Force</u>	<u>State</u>	<u>Response</u>	<u>Driving Force</u>	<u>State</u>	<u>Response</u>	<u>Driving Force</u>	<u>State</u>	<u>Response</u>
<b>1 Design</b>	<b>a Spatial Planning</b>	i Region															
		ii Urban															
		iii Rural															
		iv Marine															
	<b>b Architectural</b>	<b>There Are No Reliable Fire Statistics. Eurostat ... ??</b>															
<b>c Engineering</b>																	
<b>d Industrial</b>																	
<b>2 Construction</b>																	
<b>3 Use</b>																	
<b>4 Maintenance</b>																	
<b>5 Adaptation</b>																	
<b>6 De-Construction</b>																	
<b>7 Disposal</b>	i Re-Use																
	ii Recycle																
	iii Waste																
<b>8 Products (EU Reg.305/2011)</b>																	
<b>9 Services</b>																	
<b>10 Incentives</b>																	



# Reliable Design, Supply & Construction

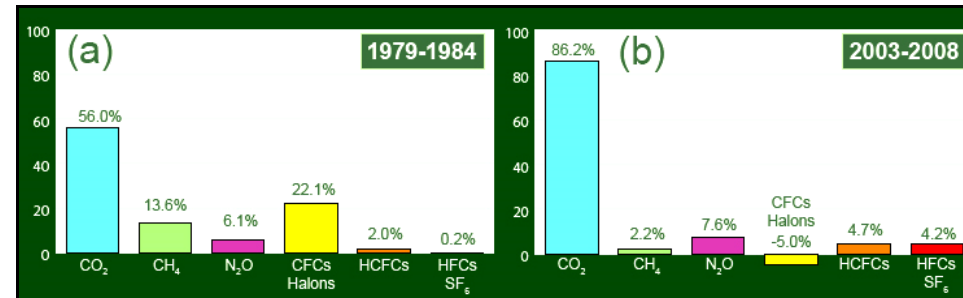
## Sustainable Fire Engineering

- 1.** Design of the works is exercised by an independent, appropriately qualified and experienced architect/engineer/fire engineer, with design competence relating to the fire protection of buildings ;
- 2.** Supply of fire safety related construction products/systems to the works is undertaken by reputable organizations with construction competence, particularly in relation to the fire protection of buildings ;
- 3.** Installation/fitting of fire safety related construction products/systems is exercised by appropriately qualified and experienced personnel, with construction competence relating to the fire protection of buildings ;
- 4.** Supervision of the works is exercised by appropriately qualified and experienced personnel from the principal construction organization ;
- 5.** Regular inspections, by appropriately qualified and experienced personnel familiar with the design, and independent of both the design and construction organizations, are carried out to verify that the works are being executed in accordance with the design.



# Climate Change as Sustainability Driver

International efforts at **Climate Change Mitigation** continue to disappoint, and fail ...



UN WMO, Greenhouse Gas Bulletin No. 5 - Published 23 November 2009

The solution ... **Climate Change Adaptation** ... encompassing urgent and immediate actions at local, national, regional and international levels ... to reduce the vulnerability and strengthen the resilience of the Human Environment, including ecological and social systems, institutions and economic sectors, to present and future adverse effects of climate change, including variability and extremes, and the impacts of response measure implementation ... in order to minimize the local threats to life, human health, livelihoods, food security, assets, amenities, ecosystems and sustainable development ... is also the most important driving force for Sustainability.

**Adaptation** to Climate Change is **Urgent** ... **Reliable Implementation** is the **Challenge** ... **Integration** into Resilient Sustainability Strategies is **Essential**.

[Refer to - <http://www.cjwalsh.ie/cib-w108-climate-change-the-built-environment/>]

