Fire Safety Design of Building Envelopes

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Corpo Nazionale dei Vigili del Fuoco, CNVVF, Italy

SICUREZZA ANTINCENDIO: CONFRONTO ITALIA-EUROPA

CONFERENZA INTERNAZIONALE

11 Maggio 2026, ore **09:00-13:00**

Seminario di aggiornamento in presenza

Comando Provinciale VVF Milano

Aula Magna - Via Messina 35, Milano

Agenda

Introduction

Drivers of sustainable buildings

Sustainable buildings fire accidents

Sustainable and fire-resilient buildings

Fire design of Sustainable and fire-resilient buildings

The Italian Fire Prevention Code- IFC

Fire Design of building Envelopes – RTV 13

Conclusions

Fire Fighters what?

CNVVF is the national, public organization for fire and rescue in Italy, under the Italian Ministry of the Interior

Our mission:

Fire and Technical Rescue

- Any kind of **emergency technical rescue**
- Fast response to natural and man-made **disasters** at a national and international level
- Wildfires (nat'l level) and WUI fires

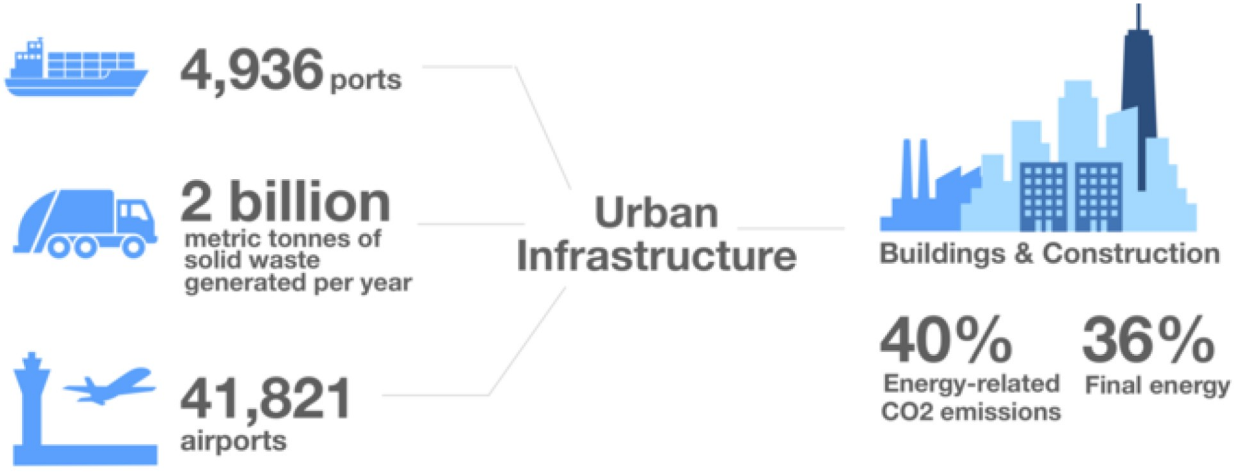
… and

Fire Safety

- **Authority having jurisdiction** over fire prevention for civil and industrial facilities
- Developing **fire safety regulations**
- **Research** on fire safety matters and material testing
- Fire investigation

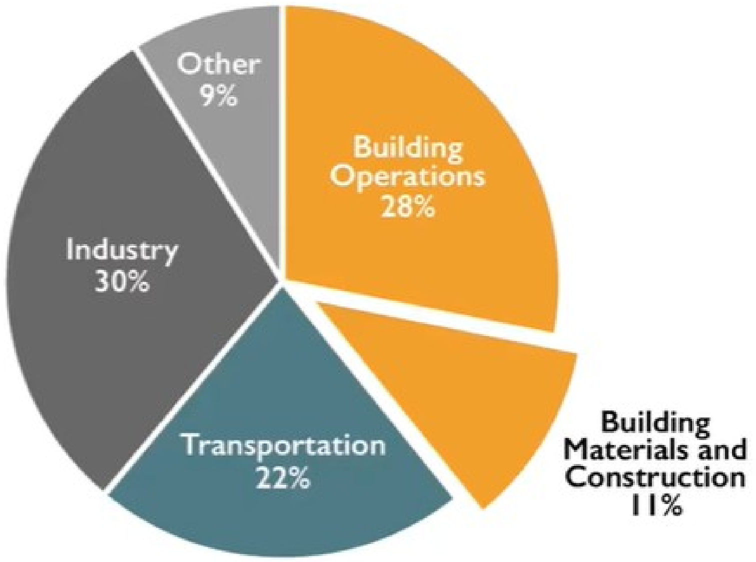
Introduction

Buildings & constructions accounts for **40% of energy-related** CO_2 emissions in cities



Source: REN 21 Renewables in cities 2019 Global Status Report
https://www.ren21.net/

Global CO_2 emissions by sector:

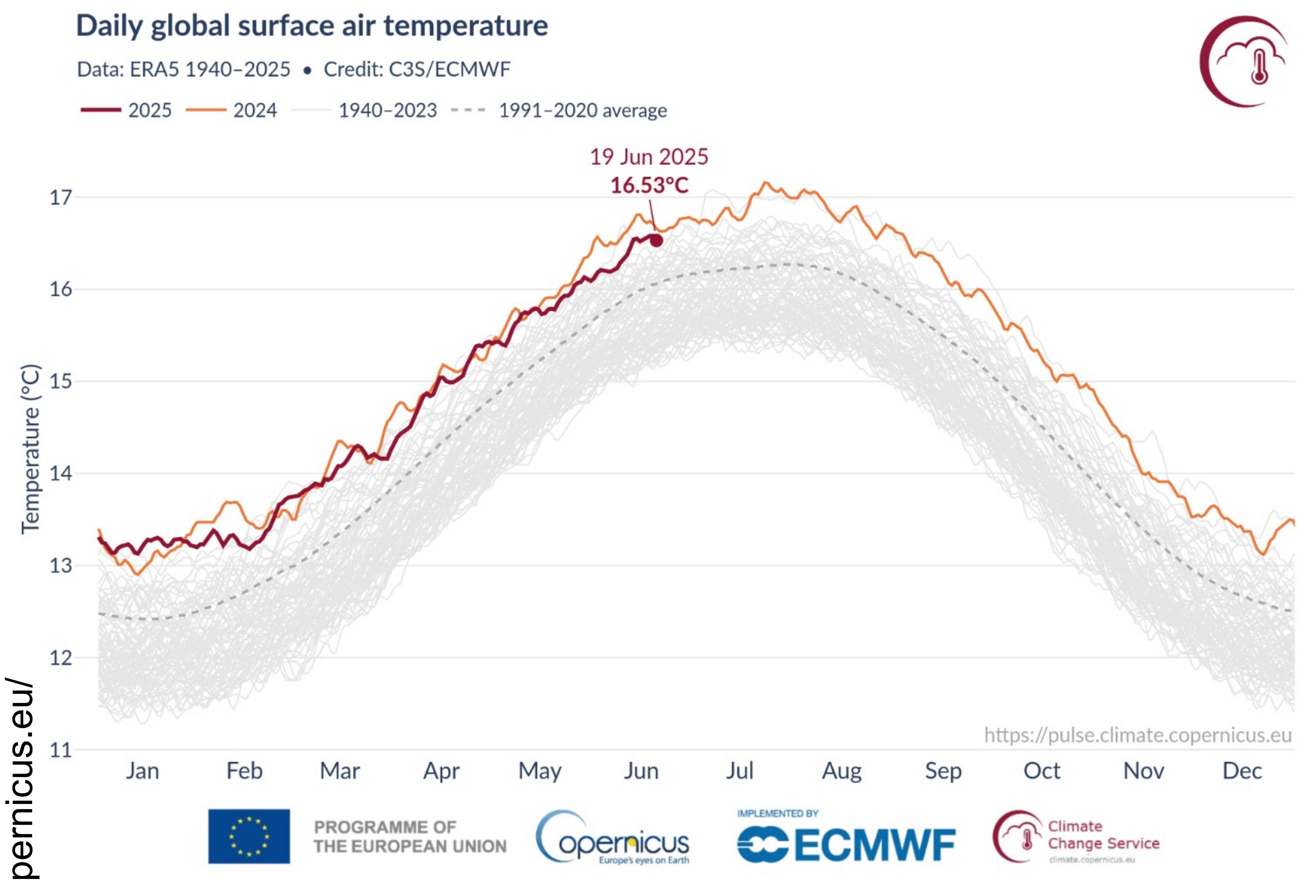


Source: https://architecture2030.or/new-buildings-emboided

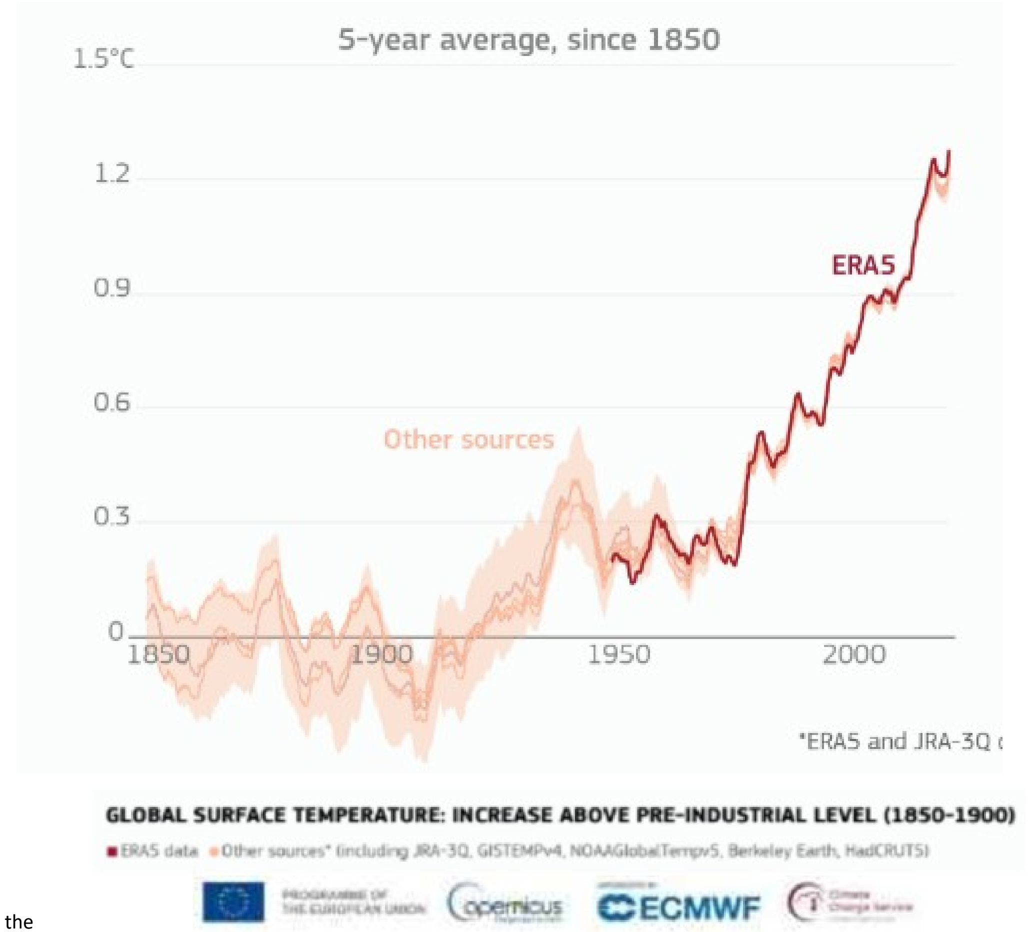
Introduction

Average global temperature **1940-2025**

https://pulse.climate.copernicus.eu/



The main driver of climate change since the last ice age is the **rising greenhouse gas concentrations…Humans are causing global warming!**

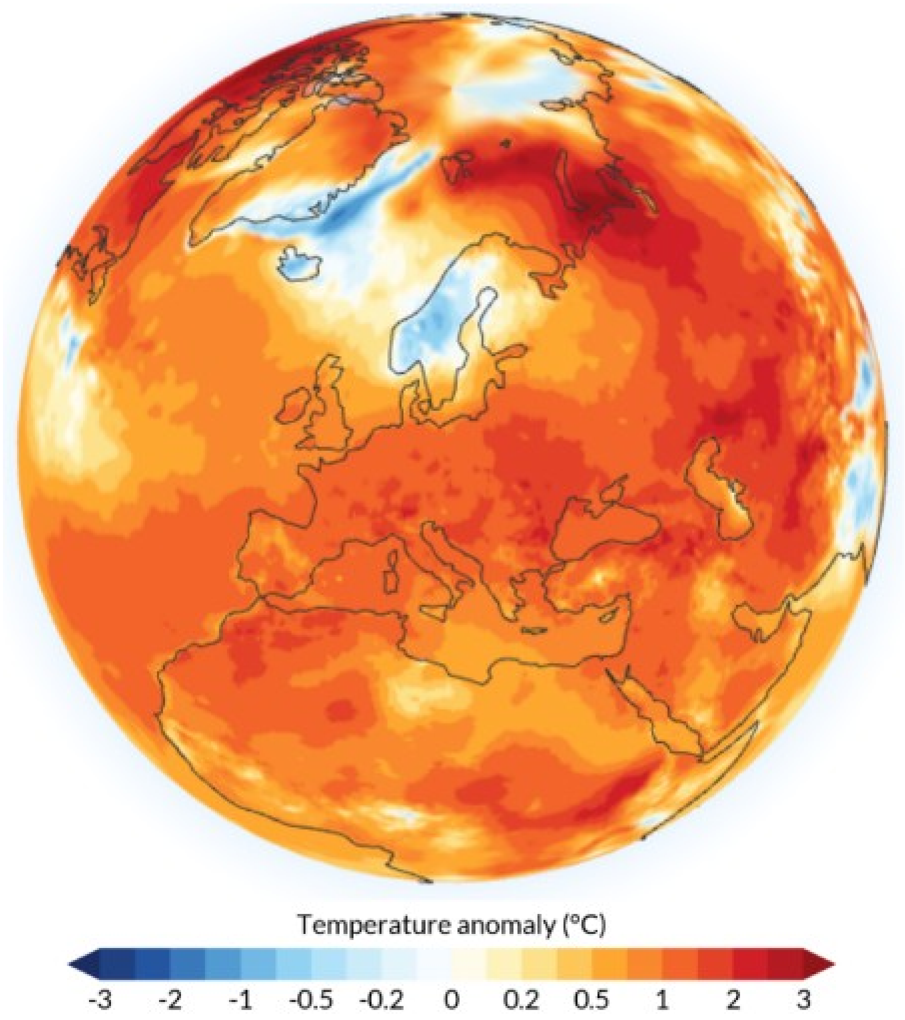


The magnitude and rate of warming over the last 150 years **far surpasses** the magnitude and rate of changes over the last 24,000 years.

Source: Osman, M.B., Tierney, J.E., Zhu, J. et al. Globally resolved surface temperatures since the Last Glacial Maximum. Nature 599, 239–244 (2021). https://doi.org/10.1038/s41586-021-03984-4

Introduction

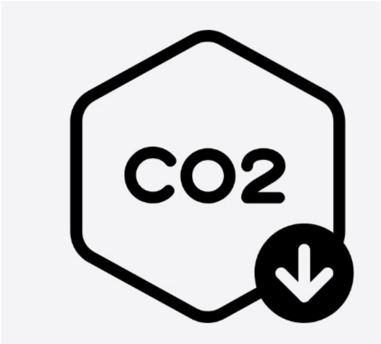
Thermal anomalies 2024



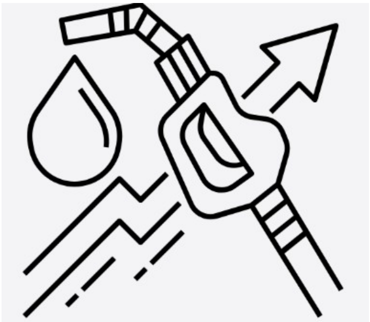
Climate ~~**change**~~ or …better climate **emergency**

Drivers of sustainable buildings

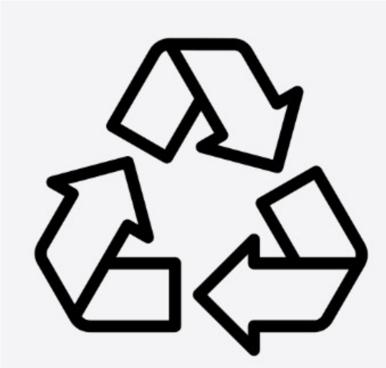
Global demand for more sustainable buildings/building technologies:



- Reduce carbon emission;



- Reduce energy from fossil fuel;



- Reduce construction materials;
- Reduce urban transportation impact from fuels.

Drivers of sustainable buildings

Environmentally Sustainable buildings seeks to **reduce negative impacts** from

- construction materials;
- construction technologies;
- Systems & plants.

They also feature on the environment and the **health and comfort of occupants**, improving building performance

Drivers of sustainable buildings

Official Journal of the European Union | EN L series

2024/1275 | 8.5.2024

DIRECTIVE (EU) 2024/1275 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 24 April 2024

on the energy performance of buildings

Improving energy performance of buildings take into account

- climatic conditions, including adaptation to climate ~~change~~ (…emergency),
- local conditions as well as the indoor climate and cost-effectiveness.

but … Not affecting other requirements :

- accessibility
- **fire safety**
- **seismic safety**
- **intended use** of the building

Drivers of sustainable buildings

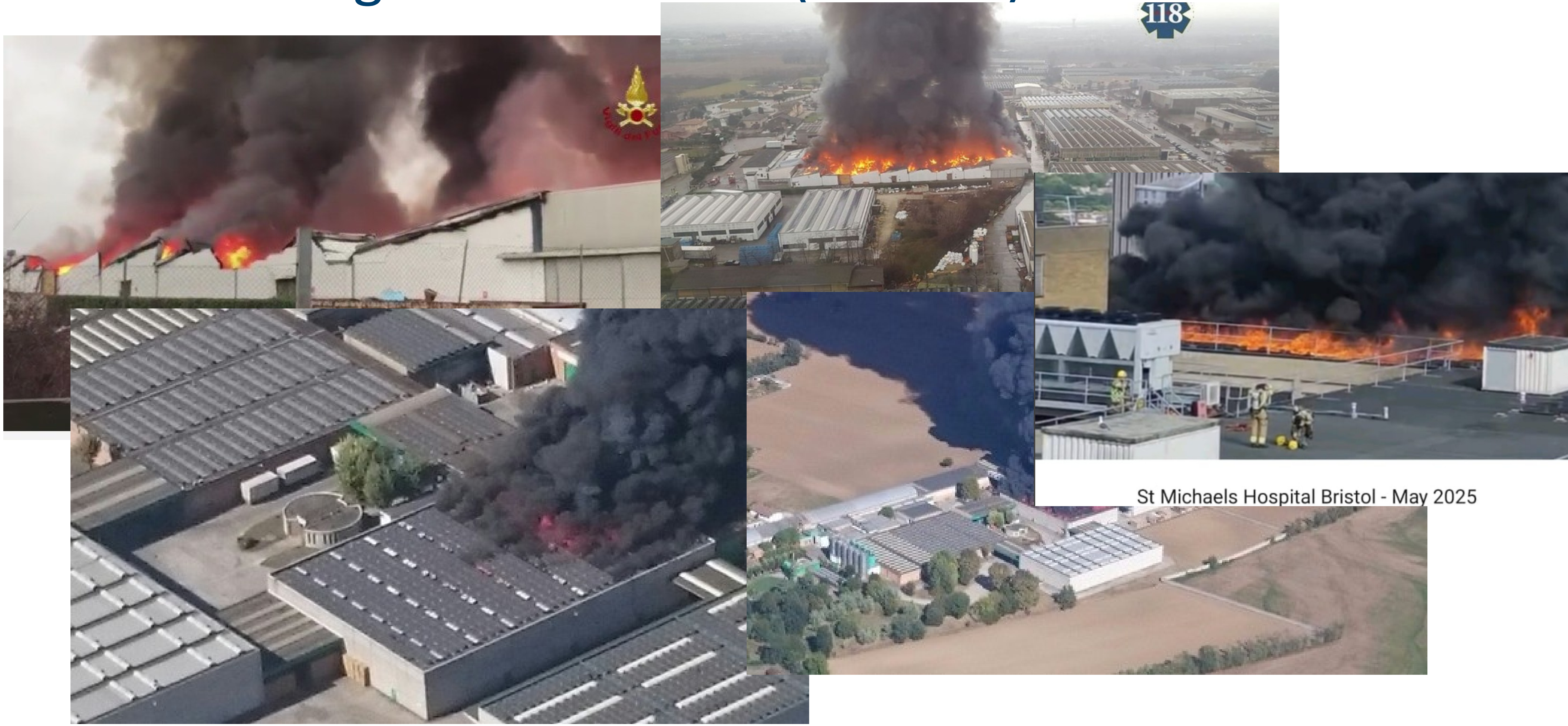
Sustainable buildings are becoming complex **"systems of systems"** (…new innovative materials, new energy sources, innovative construction technologies, new boundary conditions, …)

…But "**green building** could always be considered **safe**"?

Sustainable buildings fire accidents

Sustainable buildings fire accidents

Renewable energies related fires (PV fires):



St Michaels Hospital Bristol - May 2025

Sustainable buildings fire accidents

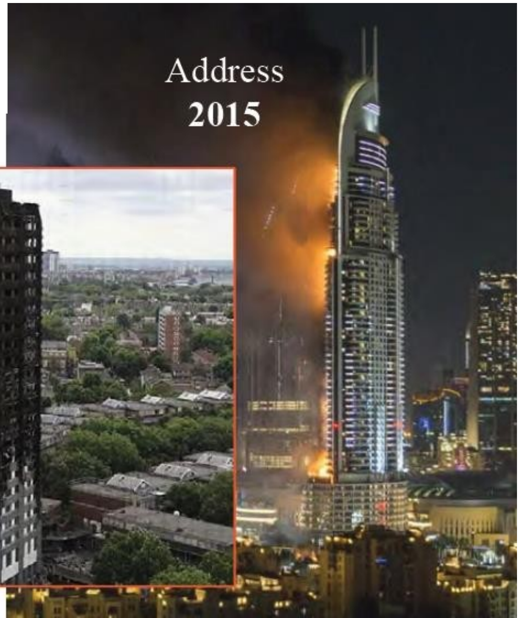
Facades fires:

Atlantic City 2007 | Busan 2010 | Roubaix 2012 | Sharjah 2012 | Dubai 2012 | Melbourne 2014 | Marina Torch 2015, 2017 | Ajman One 2016

Instabul 2018 Hospital

Torre del Moro Milano, 2023

Grenfell 2017



..and many more...

Sustainable buildings fire accidents

Energy storage systems (ESS) fires (lithium-ion batteries)

South Korea Identifies Top 4 Causes for ESS Fires

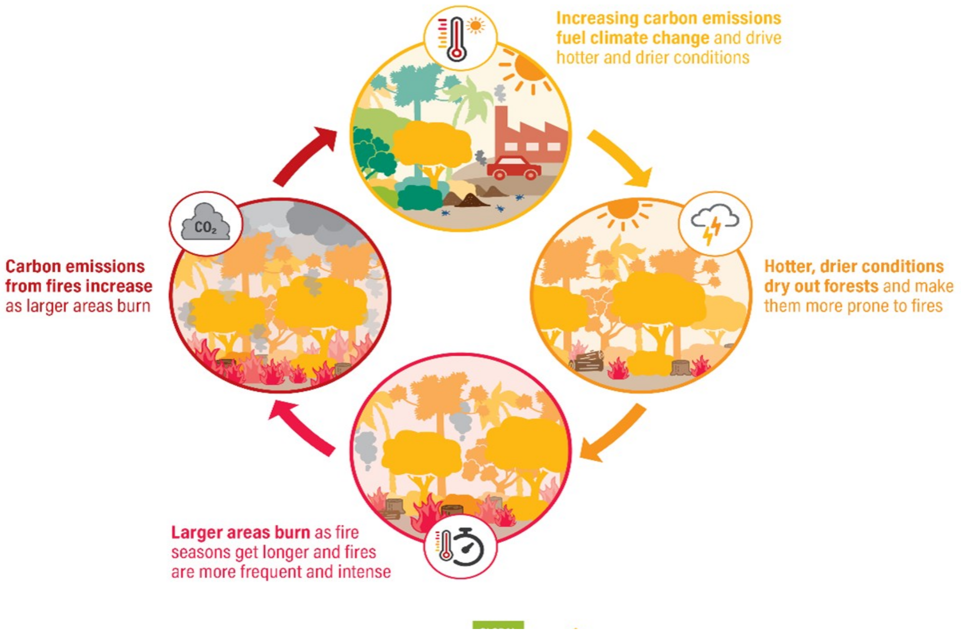
June 14, 2019 | Posted by Steve Cummings

Sustainable buildings fire accidents

WUI (Wild Urban Interface fires)

Pescara, 2021

Roma, 2022



S INSTITUTE

Savona, 2022

ken on Aug. 1, 2
Italy's southern
ers/Handout via

Incendio interfaccia Villanova d'Albenga (SV), 7 agosto 2022, 120 evacuati, 400 ha

Blaze caused cloud of smoke behind St Peter's, showers of ash
ROME, 05 July 2022, 12:26
Redazione ANSA

Grosseto, 2017

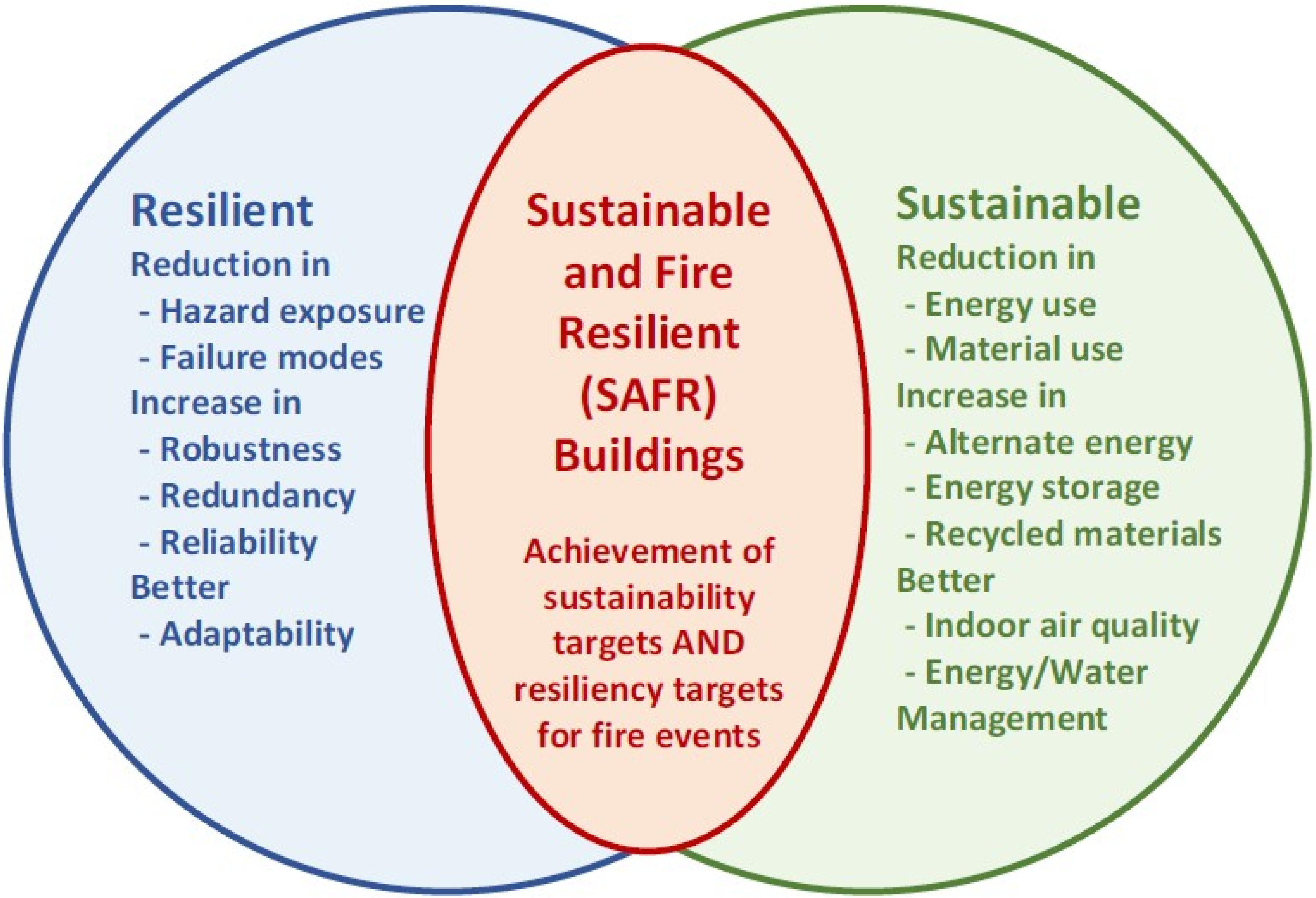
Incendio interfaccia, Marina di Grosseto, 27 auto bruciate, 16 luglio 2017

Sustainable and fire-resilient buildings (SAFR)

Sustainable and Fire Resilient buildings (**SAFR Buildings**) are ones in which sustainable **or 'green' objectives** do not conflict with **fire safety** objectives,

and where the building **is resilient** to **internal** and **external threats from fire**.

Sustainable and fire-resilient buildings (SAFR)



Meacham, B. and McNamee, M. (2020). Fire Safety Challenges of Green Buildings – 2020 Update. FPRF. Quincy, MA

Fire design of building and building envelopes

Fire design of Sustainable and Fire Resilient buildings requires **innovative solutions**;

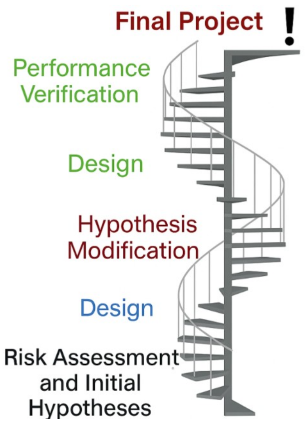
Innovative solutions (construction materials, technologies, …) require **pioneering approaches**;

Therefore, a **holistic and integrated approach** to fire safety design of SAFR buildings is essential.

Fire design of building and building envelopes

The Italian Fire Safety Code, IFC (Codice di Prevenzione incendi, DM 3 Agosto 2015 e s.m.i) has a **holistic and integrated approach**:

- Define the **scope**
  - Select the **safety objective** (life safety, property protection, business continuity, environmental safety, …)
    - **Assess** the **fire risk** & **risk profiles** determination

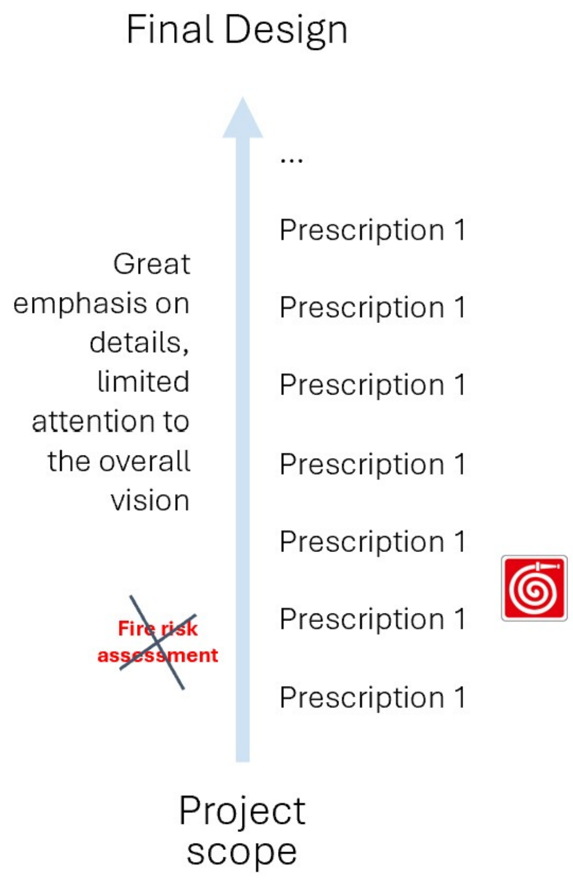


Implement the fire safety strategy selecting the level of performance of the 10 safety measures

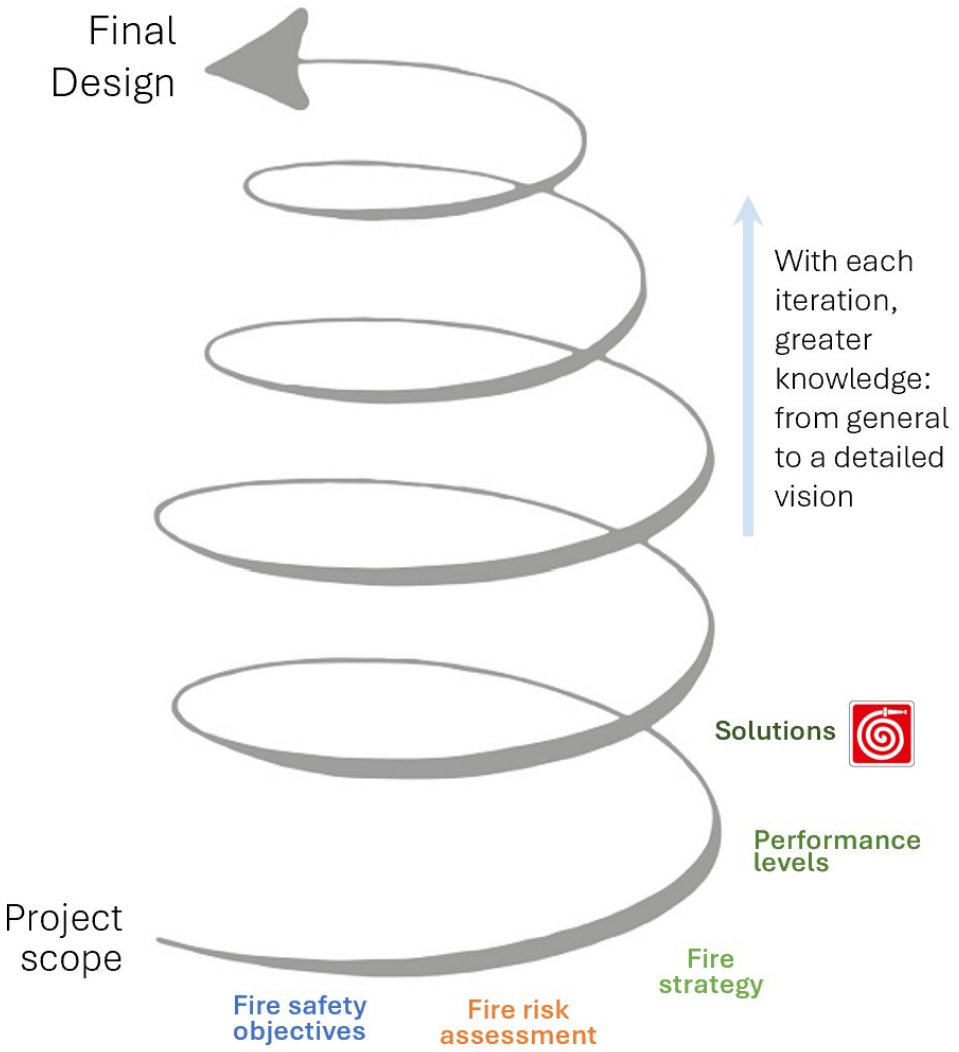
- **Apply** deemed to satisfy **or design** alternative (Performance Based) solutions

Fire design of building and building envelopes

...Old and new



Traditional prescriptive regulation



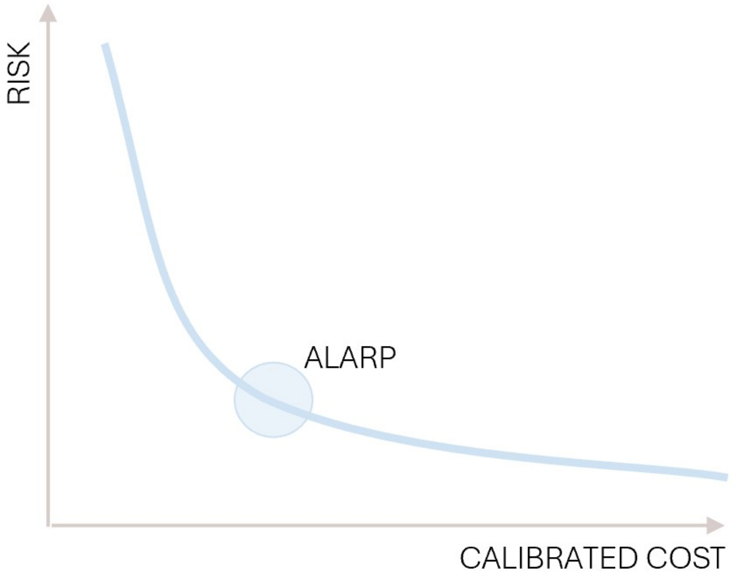
2015 fire code

Fire design of building and building envelopes

FIRE SAFETY OBJECTIVES

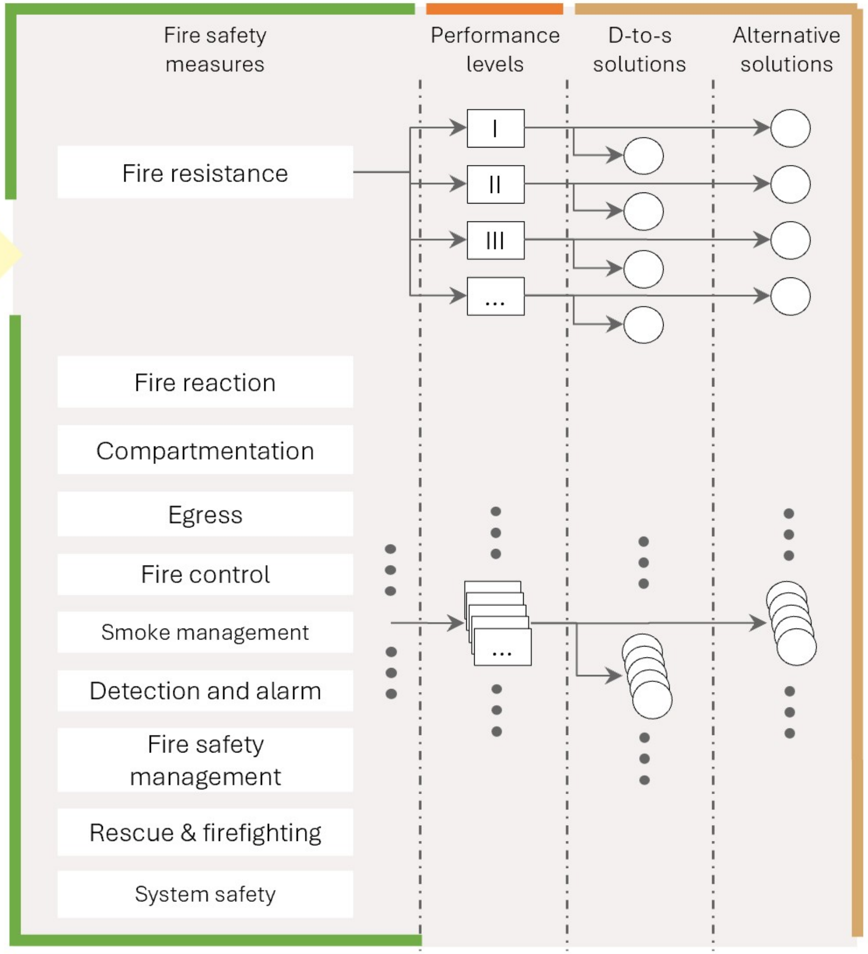
Life safety, property protection, environmental protection

Fire risk assessment

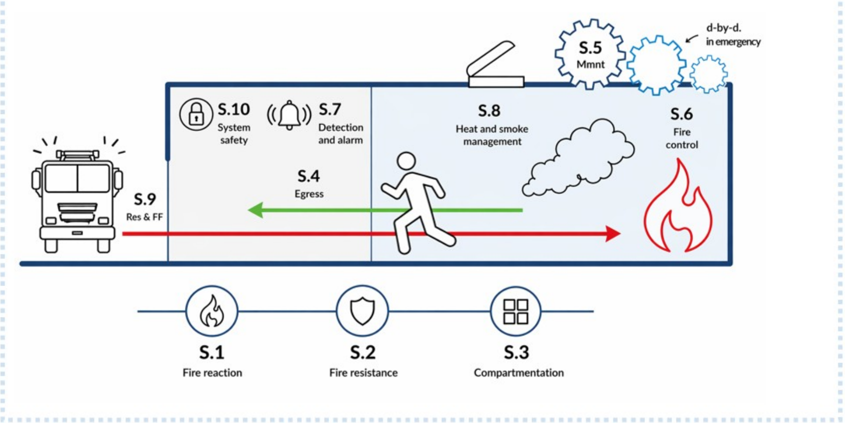


Source: https://www.therunwaycentreline.com/

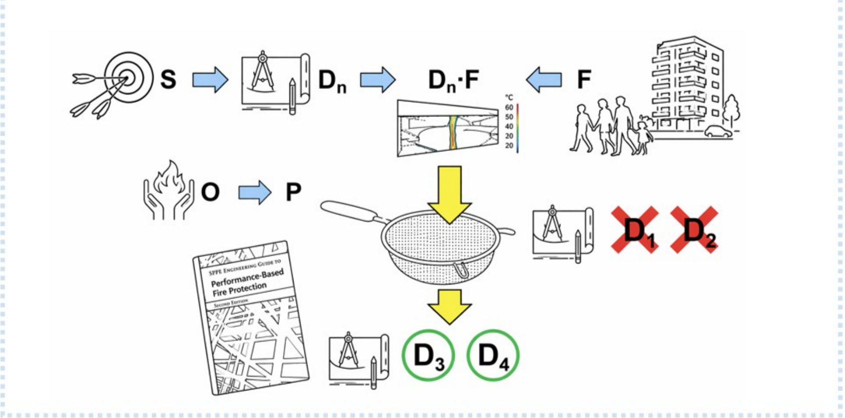
FIRE SAFETY STRATEGY



One fire strategy, 10 fire safety measures



State-of-the-art fire safety engineering



Fire design of building envelops & IFC

The IFC has a specific «vertical» technical regulation addressing the fire safety design of building envelopes, **RTV 13**

REGOLE TECNICHE VERTICALI

Capitolo V.13 Chiusure d’ambito degli edifici civili

IFC fire safety strategy design requires all the 10 safety measures

RTV adds specific or additional requirementes

RTV 13 Fire safety **objectives**:

- Reduce the likelihood of **fire propagation through** building envelopes;
- Reduce **falling parts** of building's envelopes ensuring the safety evacuation of occupants and the safety operations of rescue teams.

RTV 13 hazardous classifications:

SA	**i. buildings heights -1 m < h ≤ 12 m, total occupancy ≤ 300 occupants, and do not include compartments with Rlife D1, D2;** **ii. above-ground buildings with a single floor;**
SB	buildings heights h ≤ 24 m do not include compartments with Rlife equal to D1, D2;
SC	**Any other building configurations (not SA, not SB)**

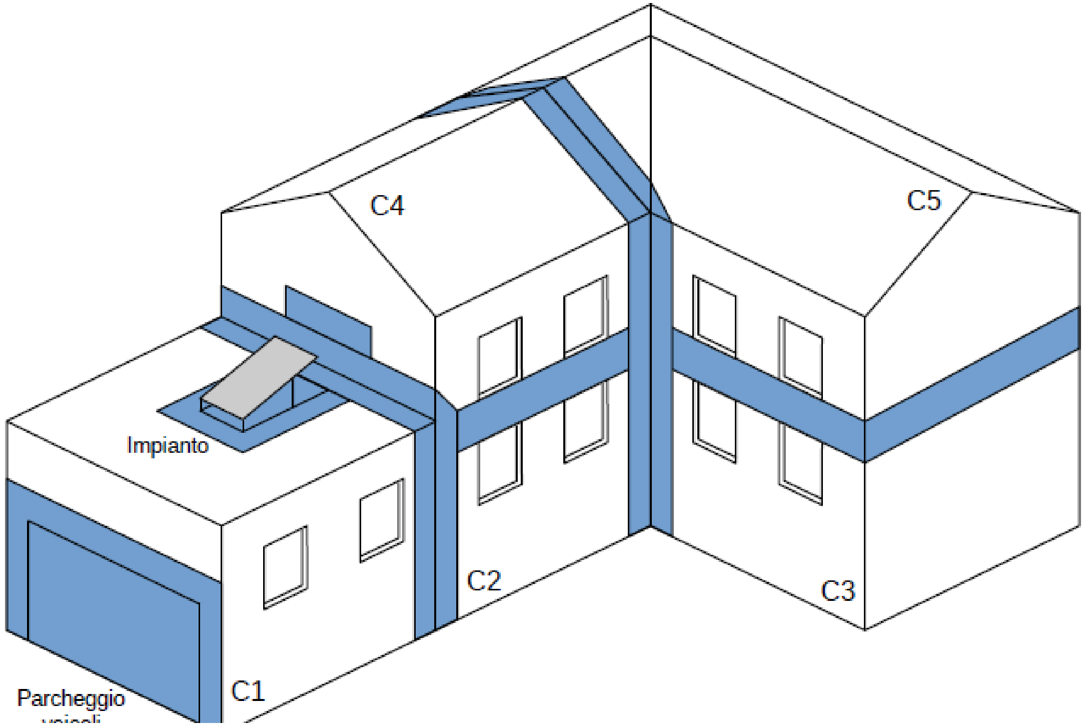
i.e. building height h = 10 m and occupancy of 400 occupants is classified as SB;
SC any building whit Rlife D1 or D2

RTV 13 deemed to satisfy solution: Reaction to fire

SA	Not requested
SB	GM2 - B-s2,d0
SC	**GM1** **A2-s1,d0 (roof coverings, non protected thermal insulation materials)** **B-s1,d0 (others materials)**

RTV 13 deemed to satisfy solution: **Fire resistance and compartmentations**

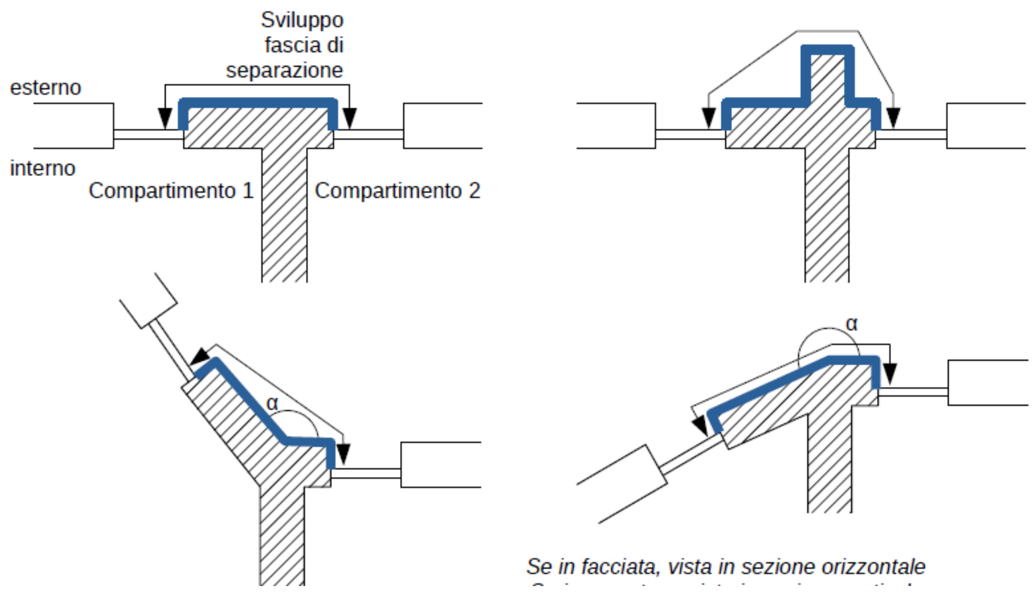
SA	**No fire resistance requisites** **No compartment limitations** *** No fire resistance if in any building compartments specific fire load ≤ 200 MJ/m²**
SB	Fire resistant separation bands not combustible (A2-s1,d0) and EI 30 (both in vertical and horizontal compartment boundaries)
SC	**Fire resistant separation bands not combustible (A2-s1,d0) and EI 60** (both in vertical and horizontal compartments boundaries)



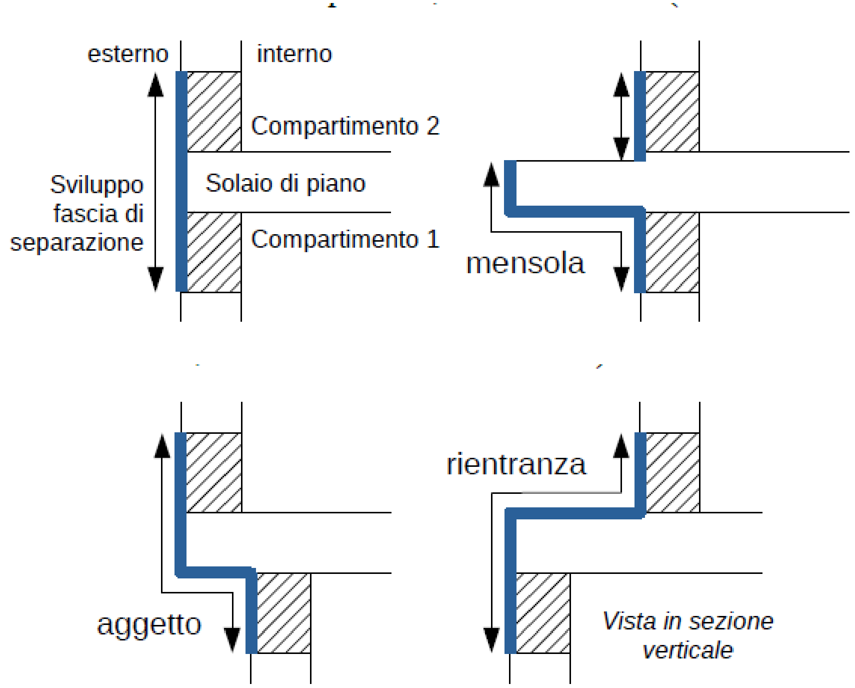
RTV 13 deemed to satisfy solution: **Separation band configurations**

At least 1 m height or length…

Vertical separation band configurations (roof covering or façade)

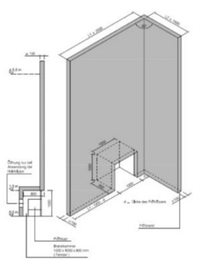


Horizontal separation bands (facades)



Fire design of building envelops & IFC

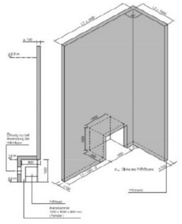
RTV 13 alternative solution: both FSE or hazardous parameter of existing fire tests can be utilized



DIN 4102-20

BS 8414

MSZ 14800-6



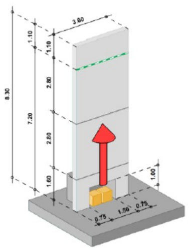
ÖNORM B 3800-

Standard	BS 8414-1	LEPIR II	MSZ 14800-6	SP FIRE 105	Önorm B 3800-5	PN-90/ B-02867
Country	UK	F	H	S, DK	A	PL
Fire exposure	Wood crib, peak heat 3.5 MW, 4500 MJ	600 kg wood crib	650 kg wood crib, 3 MW approx. (controlled)	60 l heptane	25 kg wood / 320 kW propane	20 kg wood crib + wind towards the wall (2 m/s)
Max. heat flux on surface	70 kW/m² at 1 m height	Not specified	Not specified	15 or 80 kW/m²	Not specified	Not specified
Max. temperature on surface	600°C / 20 min	Average 500°C, peak 800°C (read at 150 mm from the surface)	600°C 0.5 m high / 50 min	450°C / 12 min	Not specified	800°C peak
Test duration	30 min	60 min 30 min fire exposure	60 min	Min. 12 min	30 min	30 min
Test specimen	Corner 2.5 m × 8.0 m + 1.5 m × 8.0 m	Flat wall 5.0 m × 6.6 m	Flat wall 6.0 m × 7.0 m	Flat wall 4.0 m × 6.7 m	Corner 3.0 m × 6.0 m + 1.5 m × 6.0 m	Flat wall 2.3 m high
Substrate	Masonry or light frame	Any	Masonry	Aerated concrete	Aerated concrete	Masonry
Criteria[a]	Temp. limits	Flame spread, system integrity, temp. rise, falling parts[b]	Temp. rise, fire spread, falling parts[b]	Flames 2 floors above; Falling parts	Temp. rise, fire spread, falling parts[b]	Temp. limits; Burning particles

Fire design of building envelops & IFC

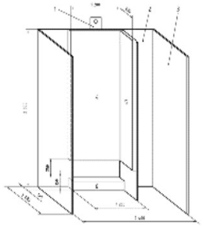
RTV 13 alternative solution: **both FSE or hazardous parameter of existing fire tests can be utilized**

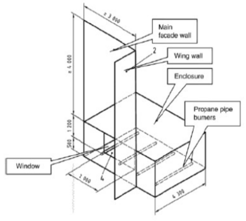

PN-B-02867:2013


Prüfbestimmung für Aussenwandbekleidungssysteme


LEPIR 2


SP Fire 105


ISO 13785-1



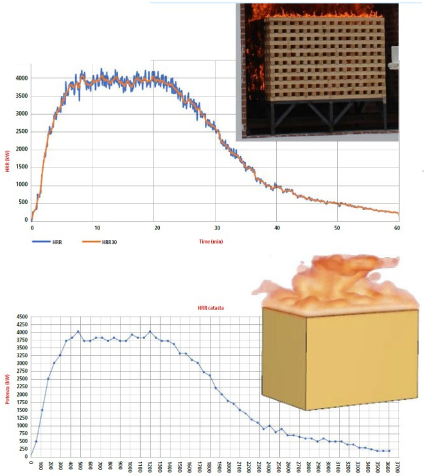
ISO 13785-2

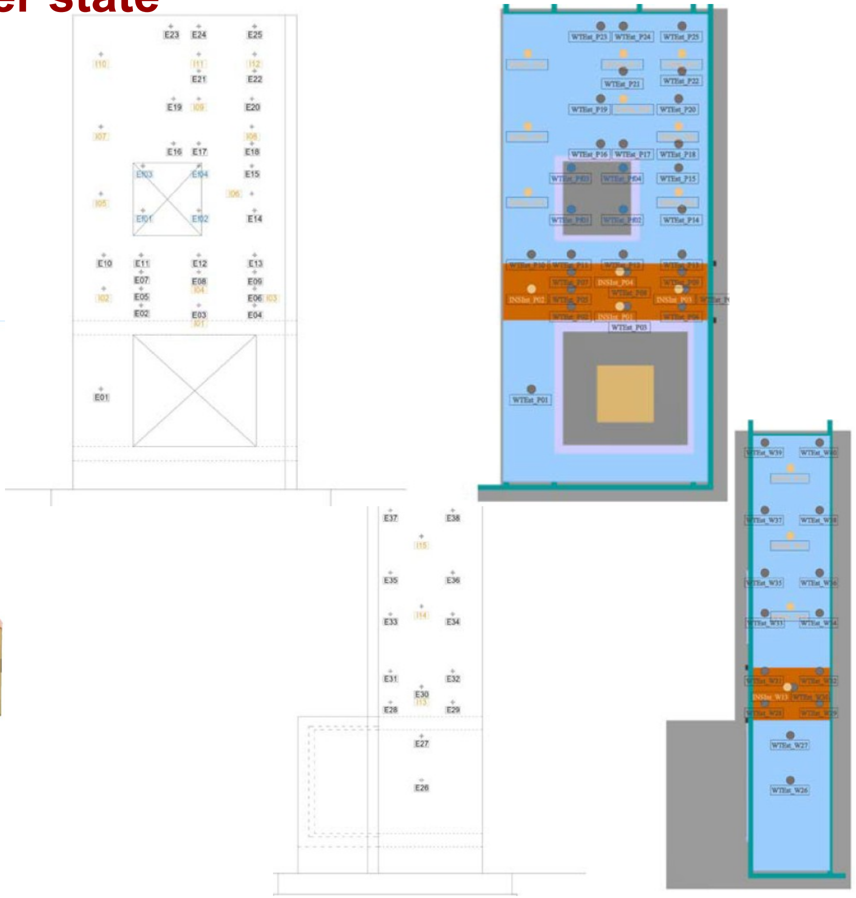
Standard	DIN E 4102-20	DIBT procedure	Procedure No. 281 – construction phase	Procedure No. 281 – finished phase	EOTA draft TR073 Exp. 1	EOTA draft TR073 Exp. 2	prEN 1364-6
Country	D	D	I	I	EU	EU	EU
Fire exposure	25 kg wood / 320 kW propane	200 kg wood crib	30 kW propane burner	300 kW propane burner	30 kg wood crib	382.5 kg wood crib	Standard temp./time curve
Max. heat flux on surface	70–95 kW/m² at 1 m height	Not specified	55–60 kW/m²	Not specified	Not specified	Not specified	N/A
Max. temperature on surface	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Defined by standard temp./time curve
Test duration	21 min gas, 30 min wood	60 min 25 min fire exposure	15 min 10 min fire exposure	15 min 10 min fire exposure	60 min 30 min fire exposure	60 min 30 min fire exposure	Customer declaration
Test specimen	Corner 3.0 m × 5.2 m + 2.0 m × 5.2 m	Corner 4 m × 9.8 m + 2 m × 9.8 m	3 m × 3 m insulation product uncovered	3 m × 3 m finished ETICS system	Corner 2.8 m × 5.5 m + 1.5 m × 5.5 m	Corner 2.8 m × 9.0 m + 1.5 m × 9.0 m	10 × nominal width of cavity barrier, max 3 m
Substrate	Aerated concrete	Aerated concrete	According to "end-use condition"	According to "end-use condition"	Any substrate	Any substrate	Aerated concrete
Criteria[a]	Temp. rise, fire spread, falling parts[b]	Not included	height of the damaged area < 250 cm and not extending to the edges; droplets not igniting the specimen	height of the damaged area < 250 cm and not extending to the edges	Temp. rise, fire spread, falling parts[b]	Temp. rise, fire spread, falling parts[b]	Integrity and insulation (180 K max temp. rise)

Fire design of building envelops & IFC

Central Directorate for Technical Safety, Fire Prevention and Energy Safety – **Rome – Research activities**

Large scale tests according to EU project as a member state





Large scale experimental set-up and numerical façade-fire models validation

Conclusions

Climate **emergency** requires greenhouse gas (CO_2) emissions reduction;

Sustainable building design must take into account the **fire safety aspects**;

Sustainable building fire safety design **is a very challenging task**, especially for the fire performance of the envelopes;

The IFC offers a design method that is holistic, innovative, and risk assessment-based ready for the **fire safety design of sustainable and fire-resilient building envelopes.**

References

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- FORUM position paper - The growing global wildland urban interface (WUI) fire Dilemma: Priority needs for research - Fire Safety Journal Volume 100, September 2018, Pages 64-66

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- M. Bonfatti, C. Castaldo, R. Vancetti, M. Minoia, F. Cosi & E. Cereda
- "La sicurezza antincendio delle facciate degli edifici: analisi CFD e test in scala reale a confronto", Antincendio, Gennaio 2024 EPC Editore (in Italian)

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SICUREZZA ANTINCENDIO: CONFRONTO ITALIA-EUROPA
CONFERENZA INTERNAZIONALE

The Italian Fire Safety Code, IFC and the PV Systems

S.10.6.2 Impianti fotovoltaici

1. In presenza di impianti fotovoltaici installati sulle coperture e sulle facciate degli edifici, devono essere utilizzati materiali, adottate soluzioni progettuali ed accorgimenti tecnici che limitino la probabilità di innesco dell'incendio e la successiva propagazione dello stesso anche all'interno dell'opera da costruzione e ad altre limitrofe.
2. L'installazione degli impianti fotovoltaici deve garantire la sicurezza degli operatori addetti alle operazioni di manutenzione nonché la sicurezza dei soccorritori.

Nota Utili riferimenti sono costituiti dalle circolari DCPST n°1324 del 7 febbraio 2012 e DCPST n°6334 del 4 maggio 2012.

- PV Systems show a valuable cause of fire ignitions, modify fire spreading, add additional risks during maintenance and fire fighting operations;

The Italian PV fire safety establishes the minimum standard for the layout design and installation of solar PV systems and is intended to mitigate PV fire safety issues;

- The Italian guideline:
  - Is a performance-based regulation where scope and safety targets can be met through **"deemed to satisfy solutions"** or **"alternative solutions"** established on the fire risk assessment and mitigation tools;
  - has a holistic approach to PV fire risk mitigation requiring passive and active fire protection measures as well as management procedures (**maintenance, the safety of the personnel & rescue teams**, ..)

The Italian Fire Safety Code, IFC and the BESS

REGOLE TECNICHE VERTICALI

Capitolo V.1 Aree a rischio specifico

Campo di applicazione

Strategia antincendio

Lithium-ion technologies **show** fire safety issues;

Thermal run away due to mechanical, electrical or thermal abuse **can lead to a fire or an explosion** (or both);

Fire safety design of appliances, activities or vehicles energised by li-ion batteries must be done using a **holistic approach;**

Prevention measures, as well as protection measures can be put in place to mitigate the **fire risk to an acceptable level** (ALARP approach).

The Italian Fire Safety Code, IFC and the BESS

REGOLE TECNICHE VERTICALI

Capitolo V.1 Aree a rischio specifico

Campo di applicazione

Strategia antincendio

m_it.DCPREV.REGISTRO UFFICIALE.U.0021021.23-12-2024

Ministero dell'Interno

DIPARTIMENTO DEI VIGILI DEL FUOCO, DEL SOCCORSO PUBBLICO E DELLA DIFESA CIVILE

DIREZIONE CENTRALE PER LA PREVENZIONE E LA SICUREZZA TECNICA, ANTINCENDIO ED ENERGETICA

Alle Direzioni Regionali/Interregionale dei vigili del fuoco, del soccorso pubblico e della difesa civile

Ai Comandi dei vigili del fuoco

E, p.c. Alle Direzioni Centrali del Dipartimento dei vigili del fuoco, del soccorso pubblico e della difesa civile

All' Ufficio del Capo del Corpo Nazionale dei Vigili del fuoco

OGGETTO: Linee guida per la progettazione, realizzazione e l'esercizio di Sistemi di Accumulo di Energia Elettrica ("*Battery Energy Storage System - BESS*").

The Italian Fire Safety Code, IFC and the BESS

REGOLE TECNICHE VERTICALI

Capitolo V.1 **Aree a rischio specifico**

Campo di applicazione

Strategia antincendio

LINEE GUIDA DI PREVENZIONE INCENDI PER L'INDIVIDUAZIONE DELLE METODOLOGIE PER L'ANALISI DEL RISCHIO E DELLE MISURE DI SICUREZZA ANTINCENDIO DA ADOTTARE PER LA PROGETTAZIONE, LA REALIZZAZIONE E L'ESERCIZIO DI SISTEMI DI ACCUMULO DI ENERGIA ELETTRICA ("BATTERY ENERGY STORAGE SYSTEM")

Articolo 1. Scopo e campo d'applicazione

Le presenti linee guida si applicano alla progettazione, alla realizzazione e all'esercizio di dispositivi elettrochimici destinati all'accumulo di energia elettrica conosciuti come Battery Energy Storage System (BESS).

Per BESS si intende l'insieme di accumulatori elettrochimici all'interno di un armadio (battery rack) o di un container (battery container) con lo scopo di immagazzinare energia elettrica ed utilizzarla quando richiesto.

Fire design of Sustainable and fire-resilient buildings

NEEDS-PERFORMANCE ANALYSIS		
SAFETY	**WELL-BEING**	**MANAGEMENT**
mechanical resistance	water tight	reduction of energy consumption
control of thermal expansions	thermal insulation control	maintainability
safety in case of fire	thermal inertia control	durability
intrusion resistance	interstitial condensation control	sustainability of disposal
	soundproofing	economy