AALBORG UNIVERSITY
DENMARK

EBC
Energy in Buildings and Communities Programme

Seminar om Ventilation, Indeklima og Energi
Annex 80 - Resilient Cooling

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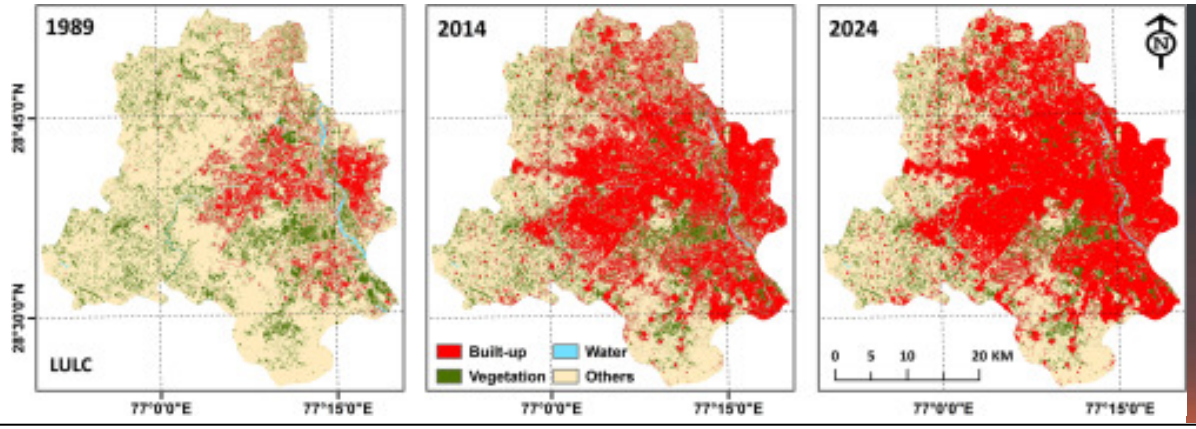
Background and Motivation

The world is facing a rapid ***increase of air conditioning*** *of buildings.*
This is driven by multiple factors, such as ***urban growth, climate change and elevated comfort expectations.***

It is the motivation *of the Annex 80* ***to develop, assess and communicate solutions of resilient cooling and overheating protection*** *(…) to withstand, and also prevent, thermal stress and building cooling demand increase due* ***to higher ambient temperatures*** *and increased frequency and severity of* ***heat wave events.***



P. Tripathy, A.Kumar, 2019

Source: https://annex80.iea-ebc.org/

Scope: Definition of Resilient Cooling

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IPCC definition of resilience:

> *the ability of a system and its components parts to **anticipate**, **absorb**, **accommodate**, or **recover** from the effects of a hazardous event in a timely and efficient manner, including through ensuring the **preservation**, **restoration**, or **improvement** of its essential basic structures and functions*

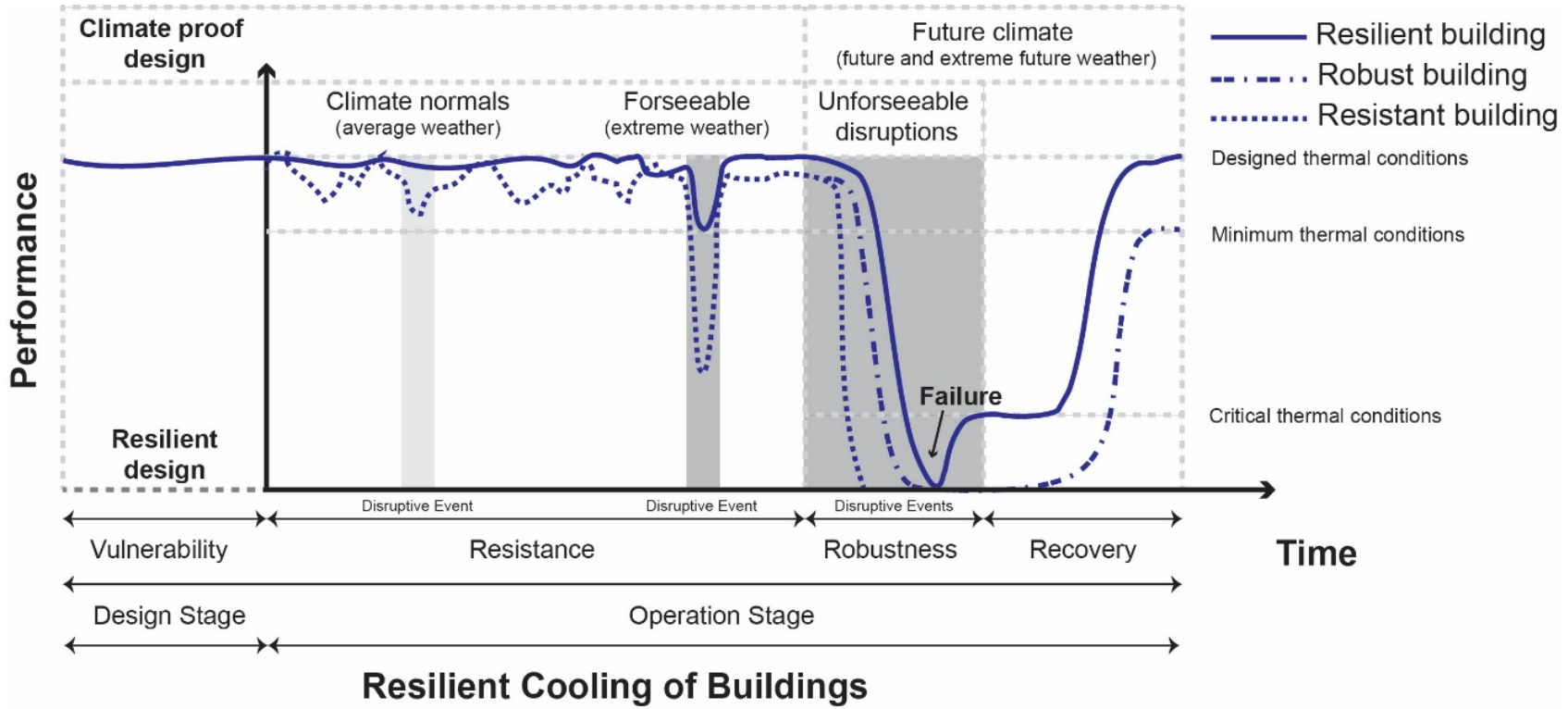
https://archive.ipcc.ch/pdf/special-reports/srex/SREX-Annex_Glossary.pdf

Ecology

Psychology

Engineering

Definition of Resilient Cooling



The cooling of a building is resilient when the capacity of the cooling system integrated in the building allows it to withstand or recover from disturbances due to disruptions, including heat waves and power outages and to adopt the appropriate strategies after failure (robustness) to mitigate degradation of building performance (deterioration of indoor environmental quality and /or increased need for space cooling energy (recoverability).

Sources: S. Attia, R. Levinson, E. Ndongo, etc., 2020 (submitted)

Cooling Technologies and Solutions

1. **Reduce externally induced heat gains to indoor environments**
    i. Advanced solar shading/advanced glazing technologies
    ii. Advanced cool materials
    iii. Green roofs, green facades, ventilated roofs and ventilated facades
2. **Remove sensible heat from indoor environments**
    i. Ventilative cooling
    ii. Thermal mass utilization including, PCM and off-peak ice storage
    iii. Adiabatic/evaporative cooling
    iv. Compression refrigeration
    iv. Absorption refrigeration, including desiccant cooling
    v. Natural heat sinks, such as ground water, borehole heat exchangers, ground labyrinths, earth tubes, sky radiative cooling, roof ponds
3. **Enhance personal comfort apart from space cooling**
    i. Comfort ventilation (elevated air movement)
    ii. Micro-cooling and personal comfort control
4. **Remove latent heat from indoor environments**
    i. High performance dehumidification including desiccant humidification

Source: https://annex80.iea-ebc.org/

Objectives and Subtasks

- Subtask A: Impact Assessment
  - Definition of Resilience in terms of Cooling
  - Development of Resilient Cooling qualities, criteria and KPIs
- Subtask B: Solutions
  - Systematic technology assessment
  - Specitifc R&D project
- Subtask C: Fieldstudies
  - Real-performance evaluation
  - Analysis performance gaps and development of solutions
- Subtask D: Policy Actions
  - Support of policy actions

Source: https://annex80.iea-ebc.org/

Weather Data Task Force

- Need a well-defined **set of weather data** for the elaboration of the Resilient Cooling 'Technology Profiles'
- Need an agreement on how to **describe climate characterisics** for all our Annex reports
- Need an agreement on **methodology, sources and minimum quality levels** when deriving individual weather data sets for National Research Items within the Annex

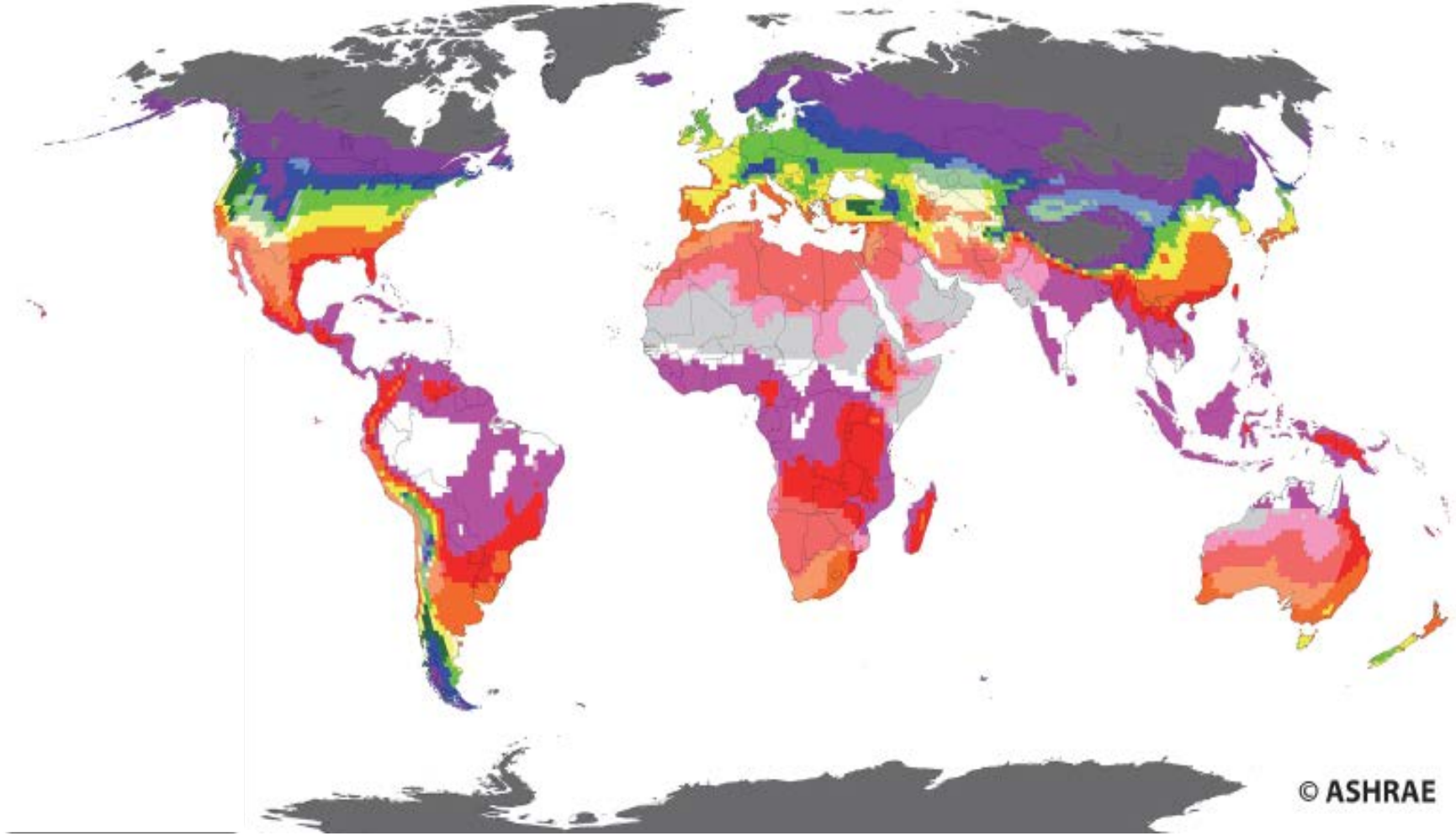
The **WEATHER DATA TASK FORCE** was created to agree on a common and scientifically robust methodology to **produce sets of weather data of characteristic climate zones & representative cities**

Sources: IEA EBC Annex 80, Weather data workshop: Day 1, 15th Sep 2020

Criteria to select representative climate zones and cities

1. At least **one city for climate zones** considering the ASHRAE classification

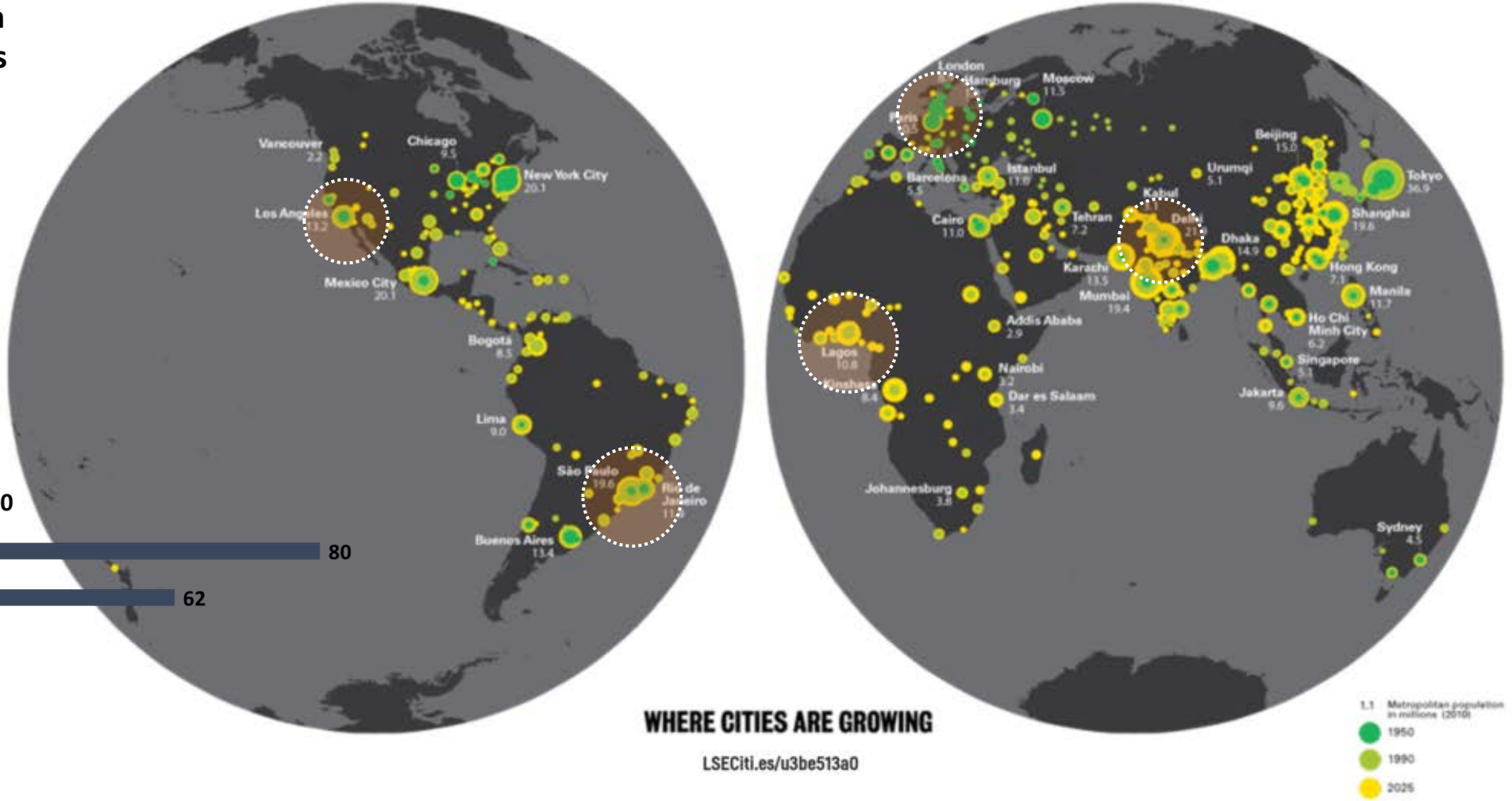
CZ	Description
0A	Extremely Hot Humid
0B	Extremely Hot Dry
1A	Very Hot Humid
1B	Very Hot Dry
2A	Hot Humid
2B	Hot Dry
3A	Warm Humid
3B	Warm Dry
3C	Warm Marine
4A	Mixed Humid
4B	Mixed Dry
4C	Mixed Marine
5A	Cold Humid
5B	Cold Dry
5C	Cool Marine
6A	Cold Humid
6B	Cold Dry

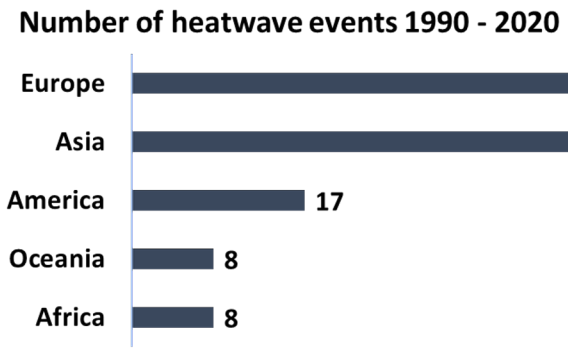


Sources: IEA EBC Annex 80, Weather data workshop: Day 1, 15th Sep 2020

Criteria to select representative climate zones and cities

1. At least **one city for climate zones** considering the ASHRAE classification
2. High **population and growth**
3. Cities in **different continents**





Picture: Urban Age project, LSE Cities (2013) |Data (tables): https://worldpopulationreview.com/world-cities/ , based on the United Nations, World Urbanization Prospects 2019

Sources: IEA EBC Annex 80, Weather data workshop: Day 1, 15th Sep 2020

Workshop

To explain the methodology to generate the following weather datasets for each city:

Typical meteorological years (.epw)
- Historical
- Future : medium term (~2050)
- Future: long term (~2100)

Heat wave data :
- Historical
- Future : medium term (~2050)
- Future: long term (~2100)

Introduction to future climate scenarios and projections, Mamak Pourabdollahtootkaboni

Extraction and formatting of CORDEX data, Anais Machard, Mamak Pourabdollahtootkaboni, Prof. Ilaria Ballarini

Outputs: Hourly weather datasets for the three periods in .csv format

Description of **bias-adjustment methodology of CORDEX data using historical observations**, Dr. Abishek Gaur

Implementation of the methodology using R, Dr. Abishek Gaur

Outputs: "Bias-adjusted" Hourly weather datasets for the three periods in .csv format

Generation of TMY - Typical Meteorological Years from the multi-year hourly datasets, Mamak Pourabdollahtootkaboni & Anais Machard,

Detect and characterize heatwaves across the hourly bias-adjusted datasets, Anais Machard

Sources: IEA EBC Annex 80, Weather data workshop: Day 1, 15th Sep 2020

Participants

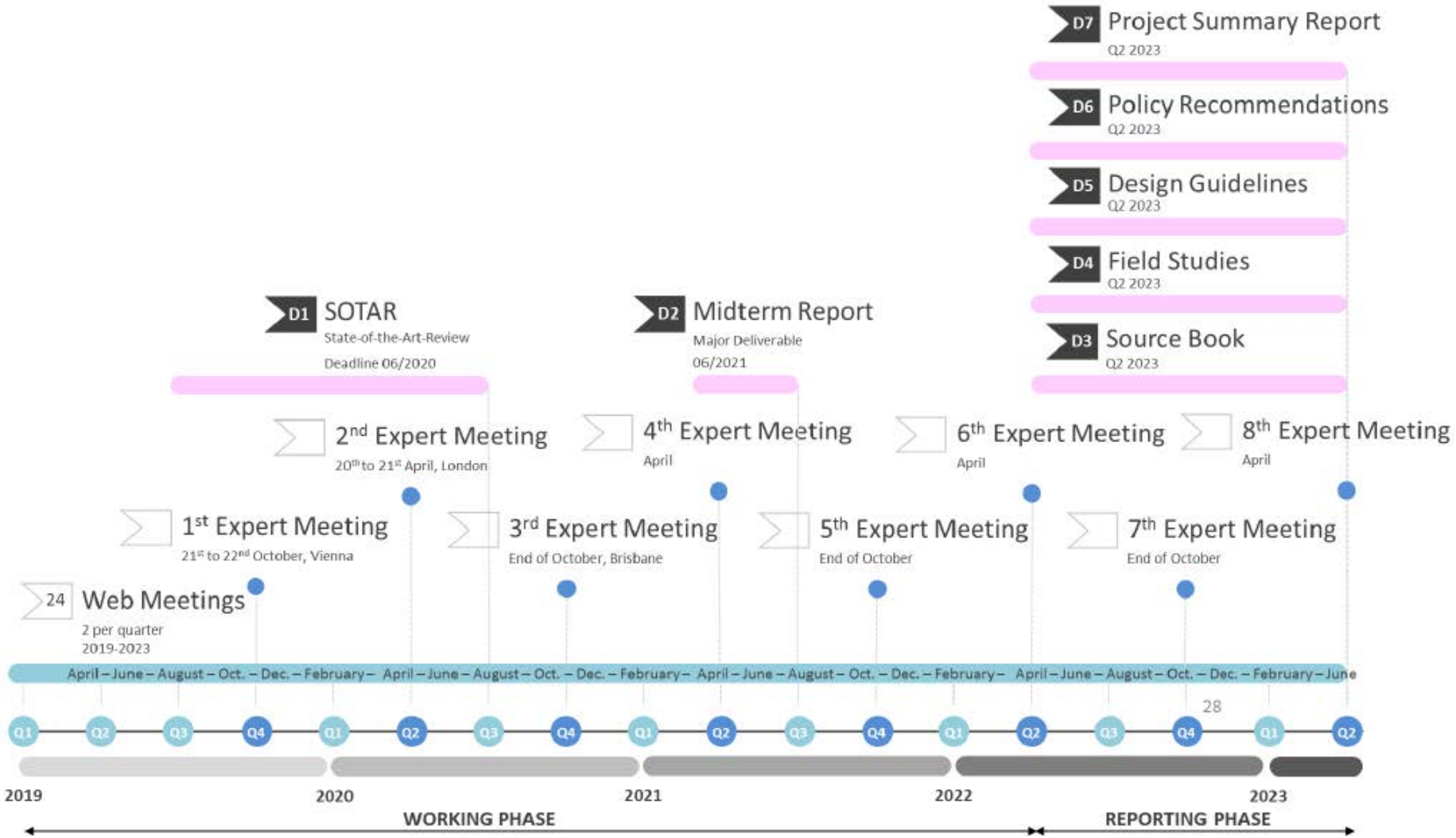
31 institutes from 15 countries

Australia, Aistria, Belgium, Canada, China, Denmark, France, Germany, Italy, Mexico, Norway, Sweden, Switzerland, UK, USA

With 39 National Research Items

Sources: Annex 80 -Resilient Cooling of Buildings 2nd Expert Meeting Minutes, 22nd April, 2020

Timeline



Sources: Annex 80 Resilient Cooling 1st Expert Meeting Minutes, 21-22 Oct 2019

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