

Technological, social and systemic innovations to impact on energy demand change in buildings

Alessio Mastrucci

International Institute for Applied Systems Analysis (IIASA)



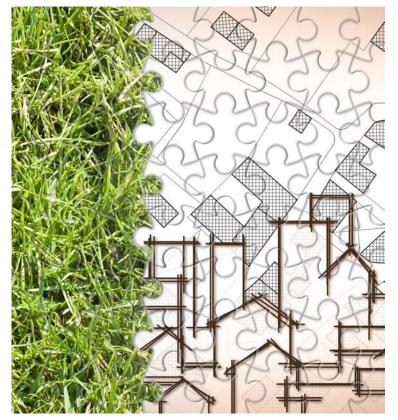












© Dreamstime.com

Buildings are a key component of the built environment, supporting human activities and wellbeing, but driving significant energy and material demands

Buildings account for 21% of global GHG emissions in 2019: 57% indirect, 24% direct, 18% embodied emissions

Global mitigation potential of buildings 61% by 2050 compared to a baseline scenario

Ref: IPCC AR6 WGIII Chapter 9









### A complex sector...

The building sector is fragmented, heterogenous, tightly linked to local contexts, and involving by multiple actors

**Global North**: mitigation potential strongly relying on the renovation of older and inefficient buildings

Global South: unprecedented stock expansion expected.

Providing low carbon buildings while improving decent living standards is key



2 and 3 November 2023 **Progress by Innovation**#IVECForum23









# Low-energy demand transformations in buildings

#### Socio-behavioral

- Individual behavioral and lifestyle changes
- Social norms and nudges
- Participatory governance

# 2 and 3 November 2023 **Progress by Innovation**#IVECForum23









#### Socio-behavioral-Infrastructural

- Floorspace sufficiency
- Choice of living and working places
  - Shared services and facilities
    - Longer use and reuse
  - · Positive energy districts

Low energy demand

transformations in buildings

### Socio-behavioral-technological

- Purchase decision on energy- efficient appliances
- Investment decisions on building renovation
  - Switch to on-site renewable sources (prosumers)
    - Efficient operation of technology by the users
    - Monitoring of and feedback on consumption to shift behavior

#### Infrastructural

- Low-carbon building design and materials
- Urban forms and floorspace rationalization
- Community-centered approaches

### Infrastructural-technological

- Energy service focus for energy efficiency
- Technology leapfrogging for buildings transformation (e.g., prefabricated renovation systems)

### **Technological**

- Energy-efficient appliances, lighting, and heating, ventilation, and air-conditioning (HVAC)
- Energy-efficient buildings
- Whole building approaches

Ref: Mastrucci, Niamir, Boza-Kiss, et al. *Modeling Low Energy Demand Futures for Buildings:* Current State and Research Needs. Annual Reviews of Environment and Resources (In press)

### Technological transformation

- Energy-efficient buildings
- Energy-efficient appliances, heating and cooling systems
- Whole-buildings solutions and on-site renewable energy sources















# 2 and 3 November 2023 **Progress by Innovation** #IVECForum23

### Infrastructural transformation

- Low-carbon design and materials
- Urban forms and floorspace sufficiency
- Community-centered approaches

















# 2 and 3 November 2023 **Progress by Innovation** #IVECForum23

### Socio-behavioural transformation

- Behavioural and lifestyle changes
- Social norms and nudges
- Participatory governance



















## Megatrends

### Digitalization

Teleworking, smart meters, buildings information modelling (BIM), 3D printing

### Sharing economy

Co-housing and co-working, sharing of appliances, community-based services

### Circular economy

Reuse, re-purposing of buildings, lifetime extension, low-carbon and recycled materials

# Decent living standards

Durable and affordable housing, sufficient space, access to clean and affordable technologies

2 and 3 November 2023 **Progress by Innovation** #IVECForum23











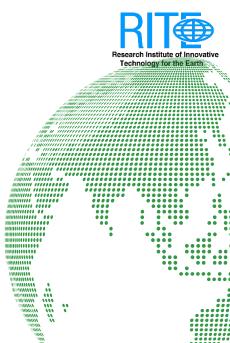
### Conclusions

- Buildings play a key role in the decarbonization of cities while supporting human activities and wellbeing
- Technological, infrastructural and socio-economical transformations and innovation are crucial in energy demand change in buildings
- Importance of holistic strategies addressing the whole life-cycle of buildings, and systemic approaches bridging across different sectors and dimensions











# Thank you for your attention!

### **Alessio Mastrucci**

Energy, Climate, and Environment (ECE) Program
International Institute for Applied Systems Analysis (IIASA)

mastrucc@iiasa.ac.at

# 2 and 3 November 2023 **Progress by Innovation**#IVECForum23









