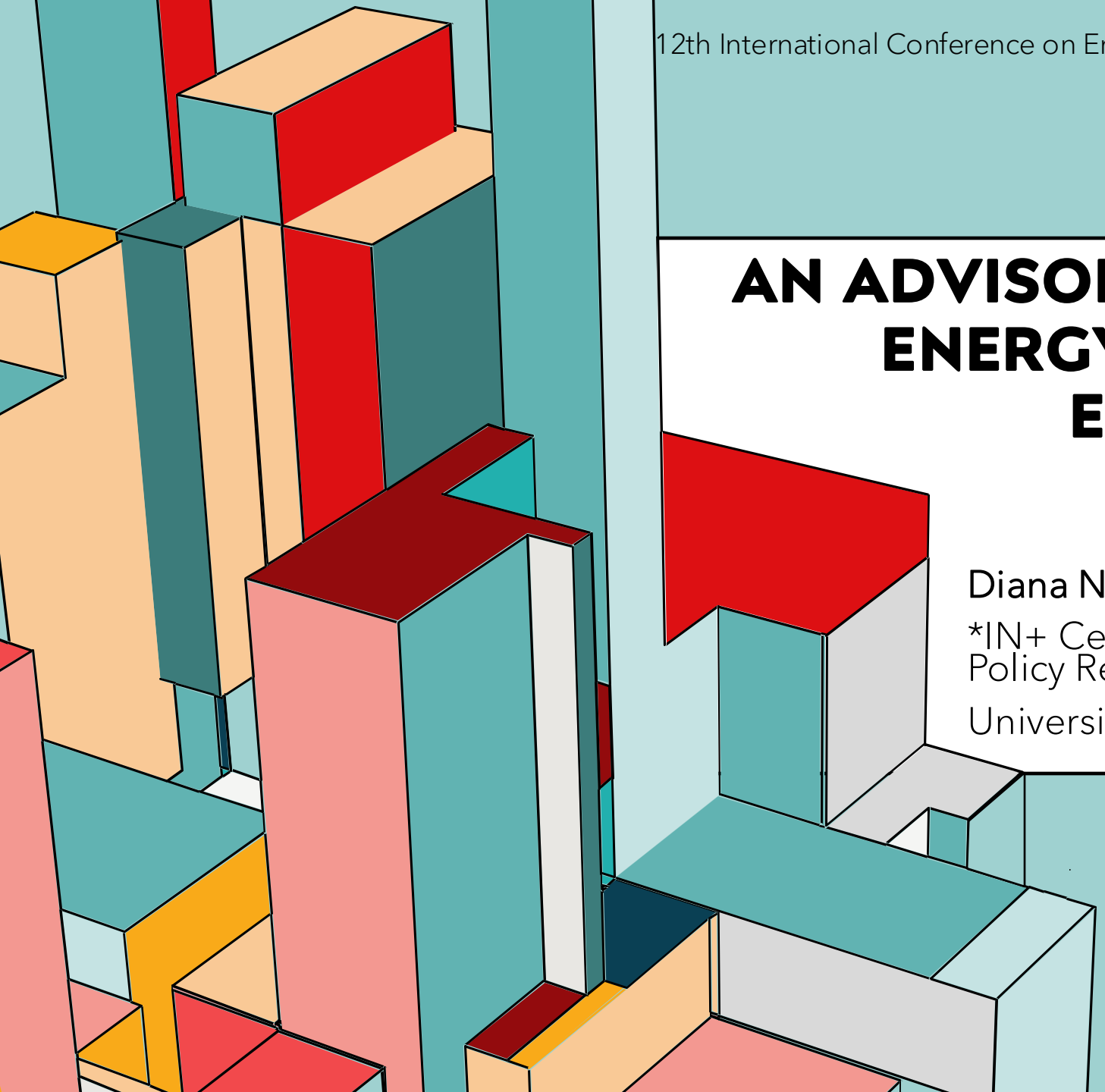
12th International Conference on Energy Efficiency in Domestic Appliances and Lighting (EEDAL'24)



AN ADVISORY TOOL TO ADDRESS ENERGY POVERTY THROUGH ENERGY COMMUNITIES

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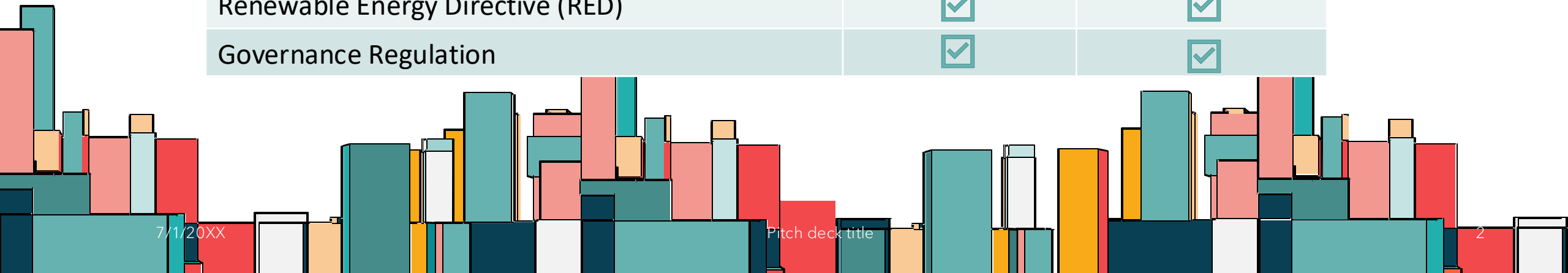
STATISTICS AND LEGISLATIVE CONTEXT

In 2022, 9.3% of the European population was unable to keep their homes adequately warm

Clean Energy for All Europeans Package introduces directives that address EP & EC

Directive	Energy Communities	Energy Poverty mitigation
Energy Performance of Buildings Directive (EPBD)		☑
Energy Efficiency Directive (EED)		☑
Electricity Directive (ED)	☑	☑
Renewable Energy Directive (RED)	☑	☑
Governance Regulation	☑	☑



ENERGY POVERTY VULNERABILITY

high energy expenditure

low levels of income

low energy performance of buildings and appliances

- Global problem, but dependent on socio & geographical contexts, with major incidence among minorities
- Energy poverty vulnerability index
- Multiple studies yet based on static models

ENERGY COMMUNITIES

Goals	Scale	Locations	Participants	Technologies	Economic interaction models
CO2 savings	Building	Urban	Residential (SFH, MAB)	Renewable generation	Collective self-consumption
Increase self-sufficiency	Neighbourhood	Rural	Services	Flexibility	Peer-to-Peer (P2P)
Reduce energy bill	Municipality	Industrial/ Commercial	Industrial	Storage	
Fight energy poverty				Aggregation	

RESEARCH GAP

Energy Poverty (EP) is a multidimensional problem

Energy communities (EC) are tool for energy transition

Missing connection of how EC can support EP mitigation

Development of a modelling tool capable of advising policymakers on prioritising EC deployment considering EP vulnerability, using Urban Buildings Energy Modelling

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URBAN BUILDING ENERGY MODELLING (UBEM)

- Provides **quantitative data** on energy demand and efficiency in buildings
- **Optimize energy consumption patterns** in cities
- Offer **data-driven insights for urban planning** and decarbonization strategies, as retrofitting meausures

1.Create a **physics-based engineering baseline** for building energy dynamics

2. **Address the energy gap** between static and dynamic models

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ADVISORY TOOL FRAMEWORK

Geographical Module

- Geographical area
- Building areas and coordinates
- Topography
- Weather data

Energy Poverty Module

Socio-economic parameters

Buildings' characteristics

Energy Expenditure

Energy Community Module

- Renewable energy generation potential
- Electricity demand
- Electricity tariffs

Priority Level (P1, P2, P3)

- Scoring (0-100)
- Cost of investment (€ & €/people affected)
- Self Sufficiency ratio (%)
- CO2 Savings (ton CO2 & ton CO2/people affec
- Families' income increase (%) due to EC

UBEM integration

Criteria

Renewable Production

Energy Efficiency

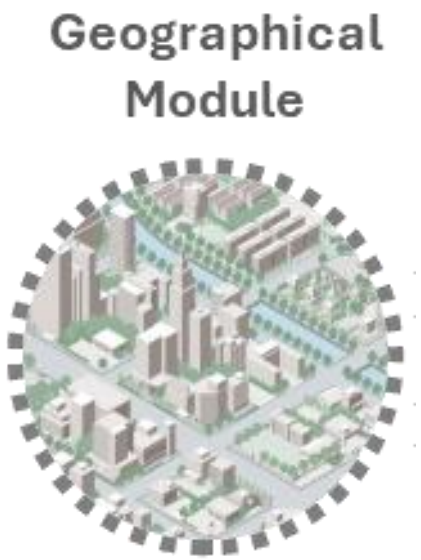
Consumer Protection

Cost-Effectiveness

Increased Impact

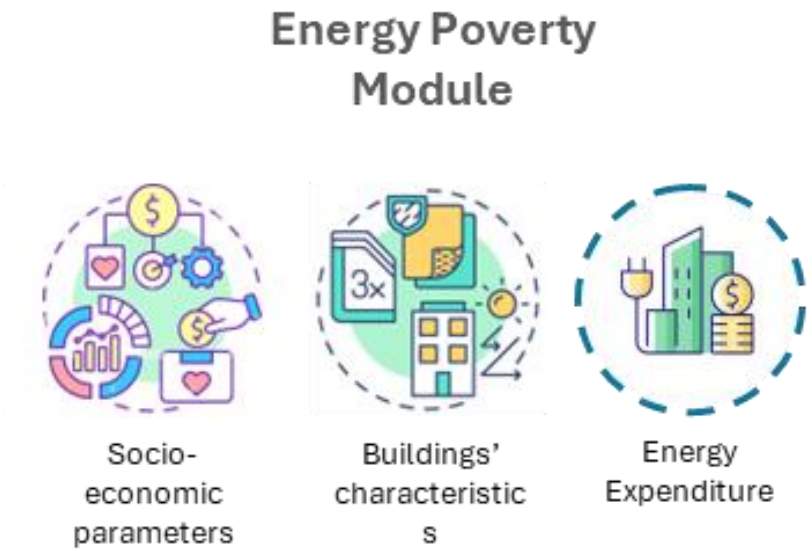
Results

ADVISORY TOOL FRAMEWORK:
1) GEOGRAPHICAL MODULE



- Delimitation of the **geographical frame for analysis**: information about the buildings (geometries & typologies)
- Definition of **EC scale**: building, block, etc
- **Weather data**: climate data regarding PV or wind production, or building needs (cooling and heating demand

ADVISORY TOOL FRAMEWORK:
2) ENERGY POVERTY MODULE



Type of data retrieved:

- Socio-economic parameters
- Geographical parameters
- Buildings' parameters
- Energy performance parameters

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ADVISORY TOOL FRAMEWORK:
3) ENERGY COMMUNITY MODULE

- **Renewable energy generation potential** – rooftop solar PV generation potential
- **Energy demand** – Energy demand modelled through UBEM according to each building archetype
- **Economic interaction**: Assumed to be collective self-consumption, with proportional sharing coefficients; tariffs of energy shared/traded are defined according to national regulations

ADVISORY TOOL FRAMEWORK:
INTEGRATION ON UBEM

Define Criteria

↓

Optimization

↓

Results

Using multi-criteria decision analysis (MCDA)

- Scoring EC locations according to priority Level (map)
  - **Economical** - cost of investment: total and per people affected; Payback
  - **Environmental** - Self-sufficiency ratio Energy production/energy consumption, and CO2 savings
  - **Socio-economic**: Available income per household (from energy bill reduction after EC).

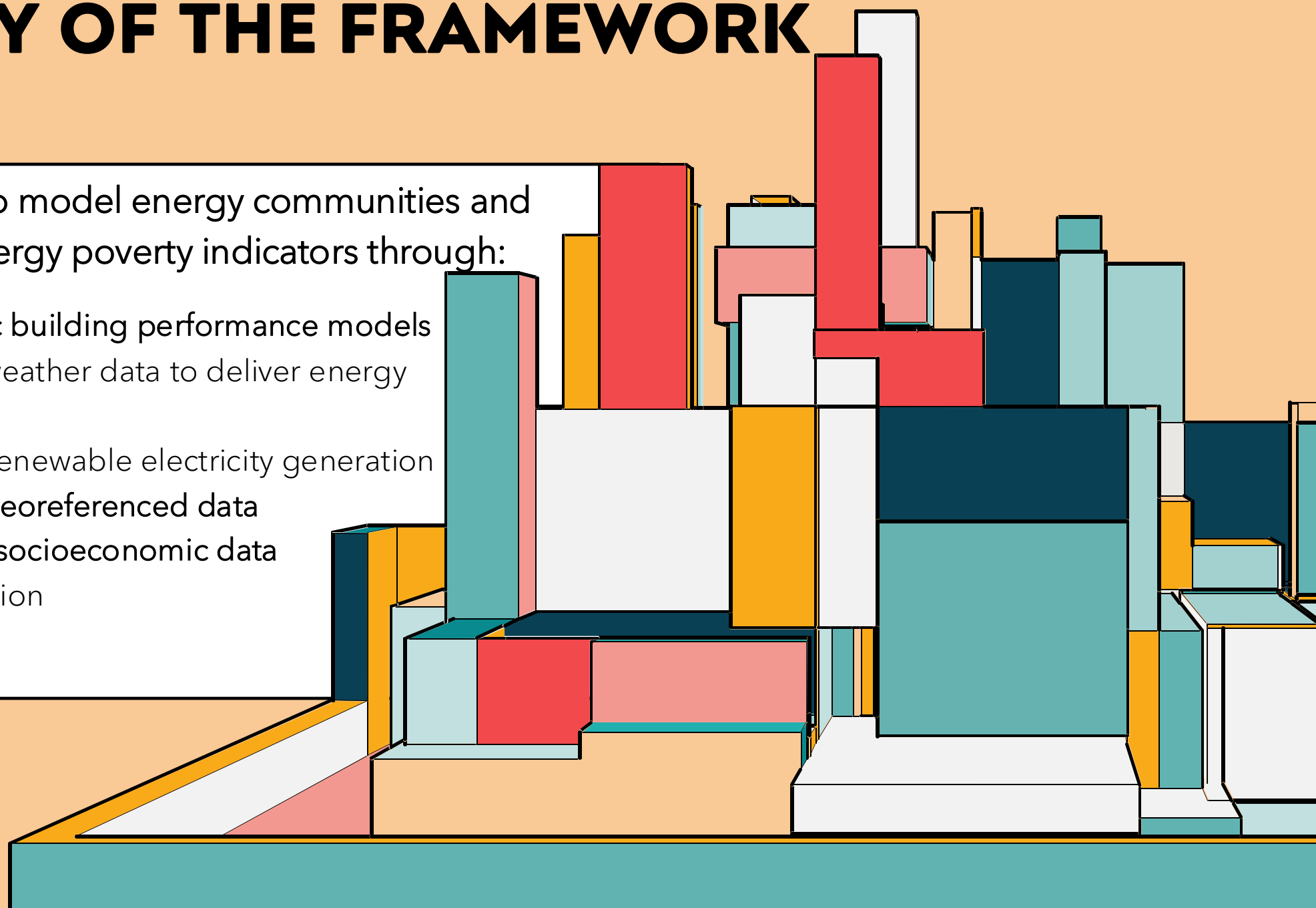
ADVISORY TOOL FRAMEWORK:
SUPPORTING POLICYMAKERS

- Test multiple criteria regarding each stakeholder's priorities on energy poverty mitigation
- Understand where to prioritize Energy Communities' deployment
- Access public funding and other financial instruments (such as the EU Just Transition Fund) available to mitigate the energy poverty regarding Invested Euro versus effectiveness on EP reduction

NOVELTY OF THE FRAMEWORK

Using UBEM to model energy communities and integrating Energy poverty indicators through:

- Using **dynamic building performance models** according to weather data to deliver energy demand data
- preview local renewable electricity generation according to **georeferenced data**
- Integrate with **socioeconomic data** of the population



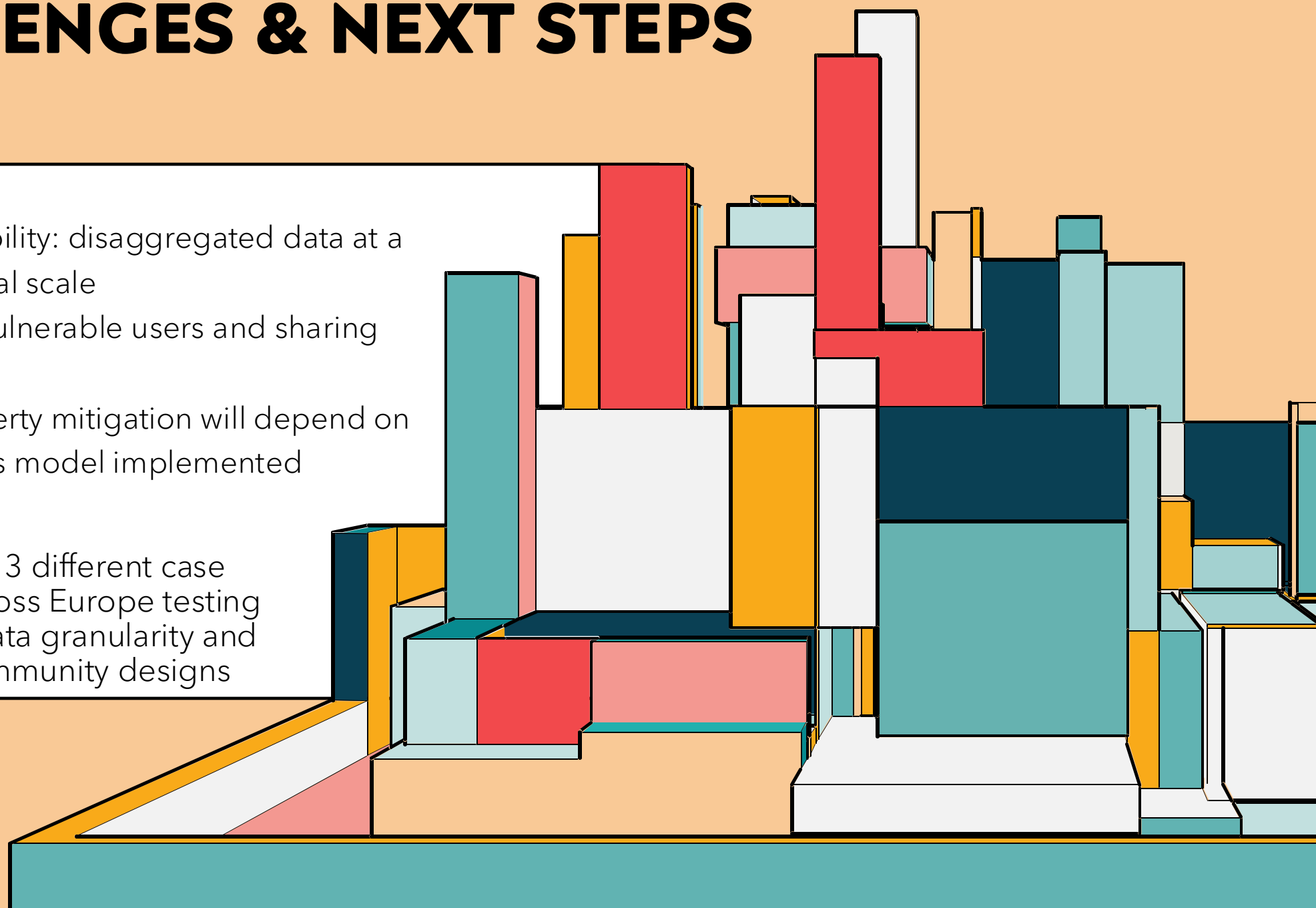
CHALLENGES & NEXT STEPS

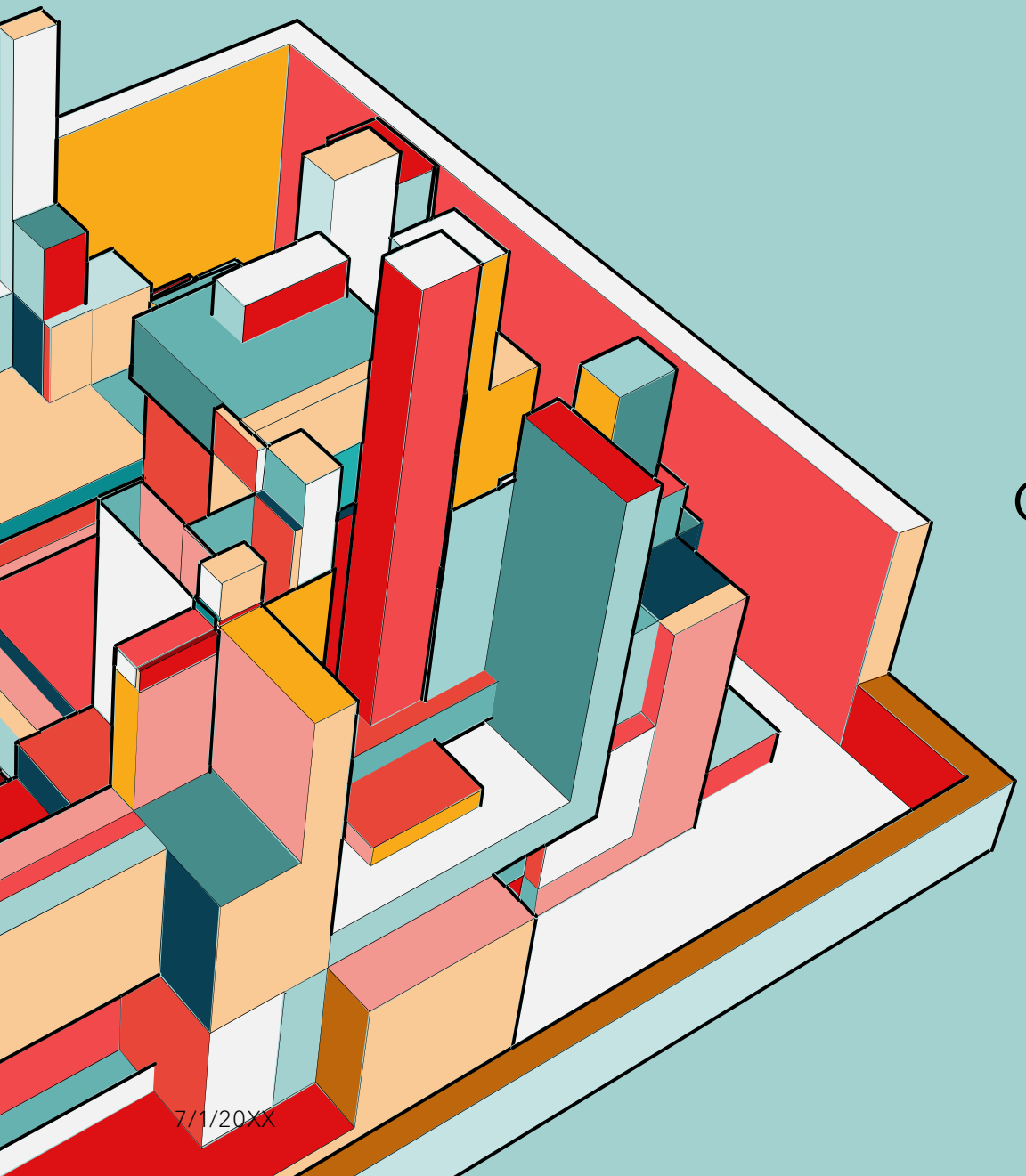
Challenges

- Data availability: disaggregated data at a geographical scale
- Engaging vulnerable users and sharing related data
- Energy poverty mitigation will depend on the business model implemented

Next Steps

- Implement 3 different case studies across Europe testing different data granularity and energy community designs





THANK YOU

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