Where to start:
Understanding building energy use

Buildings: Session 1

Buildings energy efficiency sessions in partnership with:

BEEP

INDO-SWISS BUILDING ENERGY EFFICIENCY PROJECT

UCL ENERGY INSTITUTE

UCL

Energy Efficiency Training Week: Buildings Program

1. **Where to start:** Understanding energy use in buildings
2. **Where to start:** Energy efficiency potential in buildings
3. **Toolkit:** Energy efficient building design
4. **Toolkit:** Energy efficient building technologies

   Where do I get help? IEA's Technology Collaboration Programmes
5. **Toolkit:** Enabling investment with energy efficiency policies
6. **What are the steps :** Building energy codes and standards

   Site Visit: Schneider Electric
7. **What are the steps:** Set targets and develop policies
8. **Did it work:** Evaluating the multiple benefits of energy efficiency
9. **Did it work:** Tracking progress with energy efficiency indicators

   Where do I get help? International and regional energy efficiency initiatives
10. **Energy Efficiency Quiz:** Understanding energy efficiency in buildings

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Energy Efficiency Training Week: Buildings Program

1. **Where to start: Understanding building energy use**
2. **Where to start:** Energy efficiency potential in buildings
3. **Toolkit:** Building technologies for low energy buildings
4. **Toolkit:** Linking buildings energy efficiency policy to investments and finance
5. **Toolkit:** Building energy efficiency policies
6. **What are the steps:** Set targets and develop policies
7. **What are the steps :** Building energy codes and standards
8. **Did it work:** Evaluating the multiple benefits of energy efficiency in buildings
9. **Did it work:** Tracking progress with energy efficiency indicators
10. **Energy Efficiency Quiz:** Understanding energy efficiency in buildings

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1. Where to start: Understanding energy use in buildings

Trainers: Brian Dean and Ian Hamilton

Session: 1 hour

Purpose: To teach the fundamentals of how and why buildings use energy.

Scenario: An influential NGO is urging for all new construction to be zero emission or net zero energy buildings. *What factors are key to achieving zero emission or net zero energy buildings?*

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Drivers of building energy use

Building form

Building function / services

Population and wealth

Climate and weather



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Drivers of building energy use: form








Form causes energy use: including through shape, size, materials, window placement.
Form enables energy efficiency: including thermal mass, passive solar and natural ventilation.

Sources: GBPN and IEA

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Drivers of building energy use: function









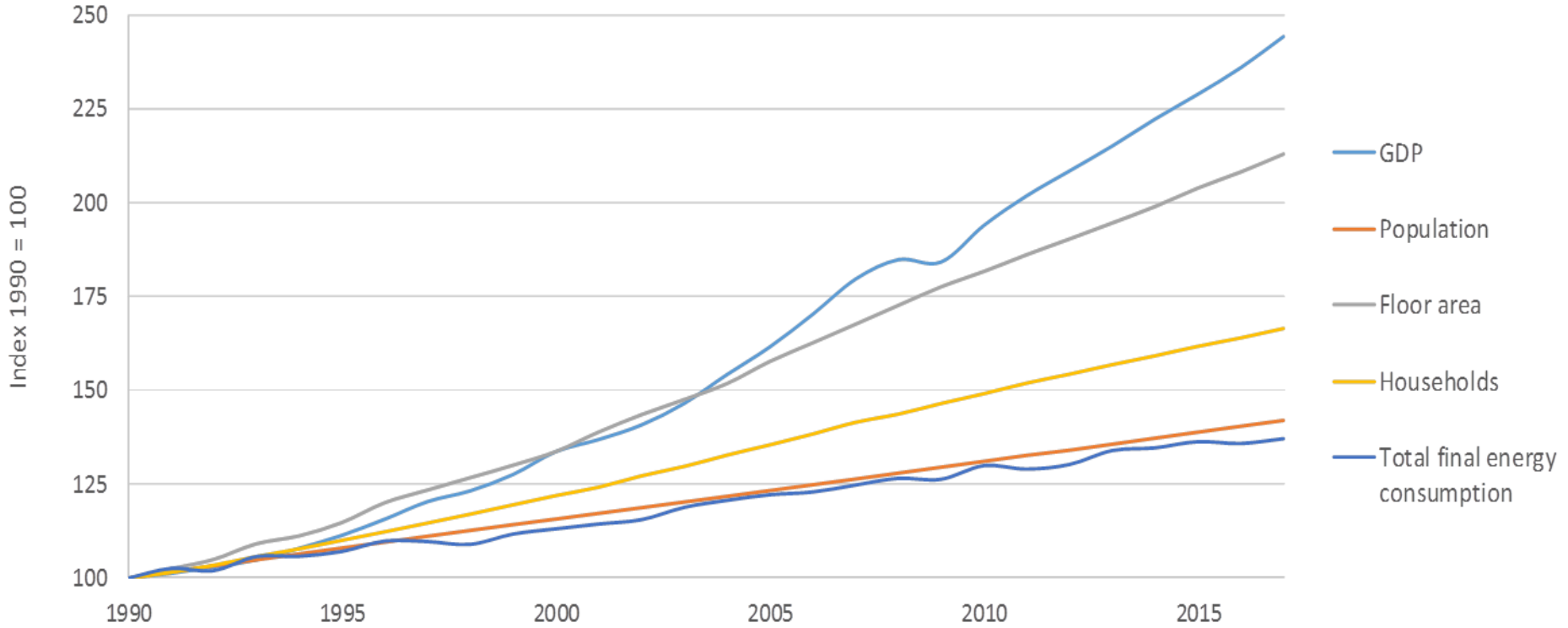


Energy follows function : people don't demand energy, they demand energy services

Sources: GBPN

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Drivers of building energy use: people (population)

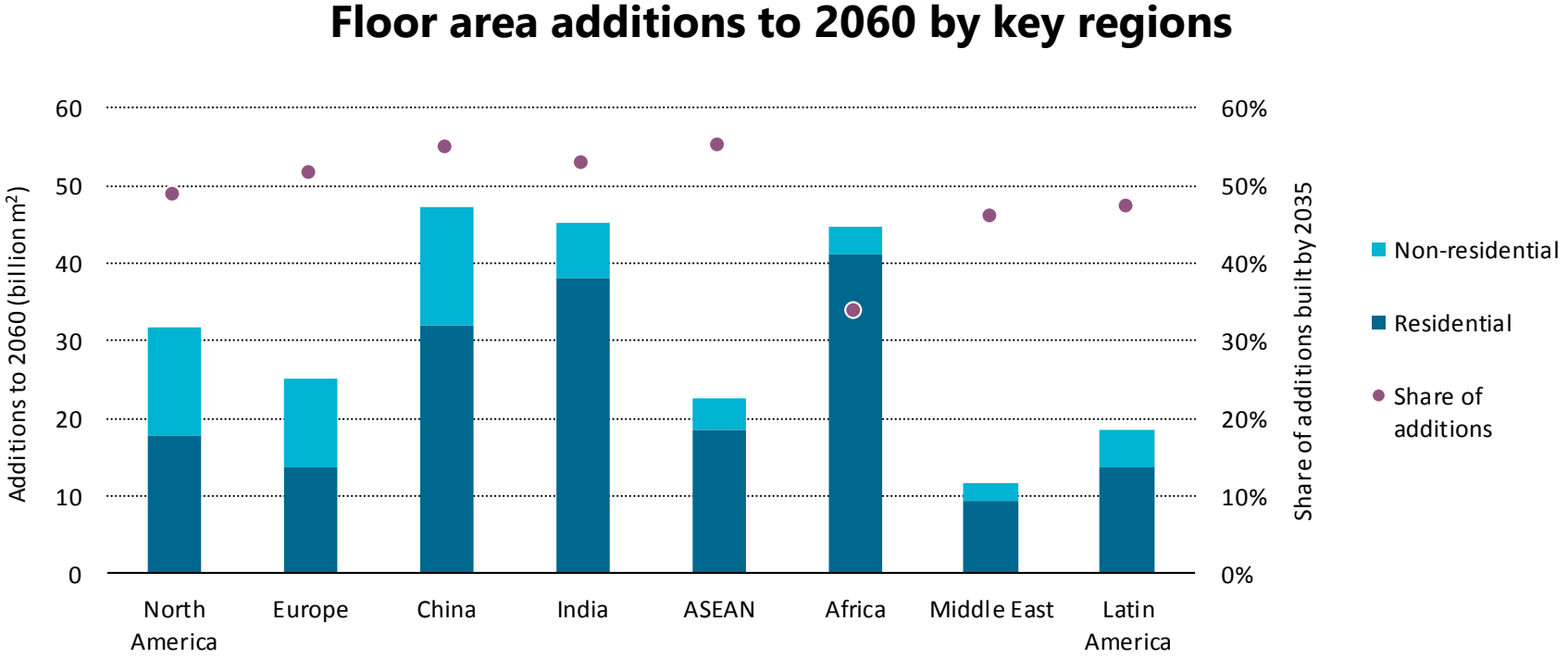


Despite energy efficiency improvements, the energy consumed in buildings is still highly correlated to population growth.

Sources: IEA Energy Statistics, IMF 2014, UN DESA 2014

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Drivers of building energy use: floor area (population and wealth)



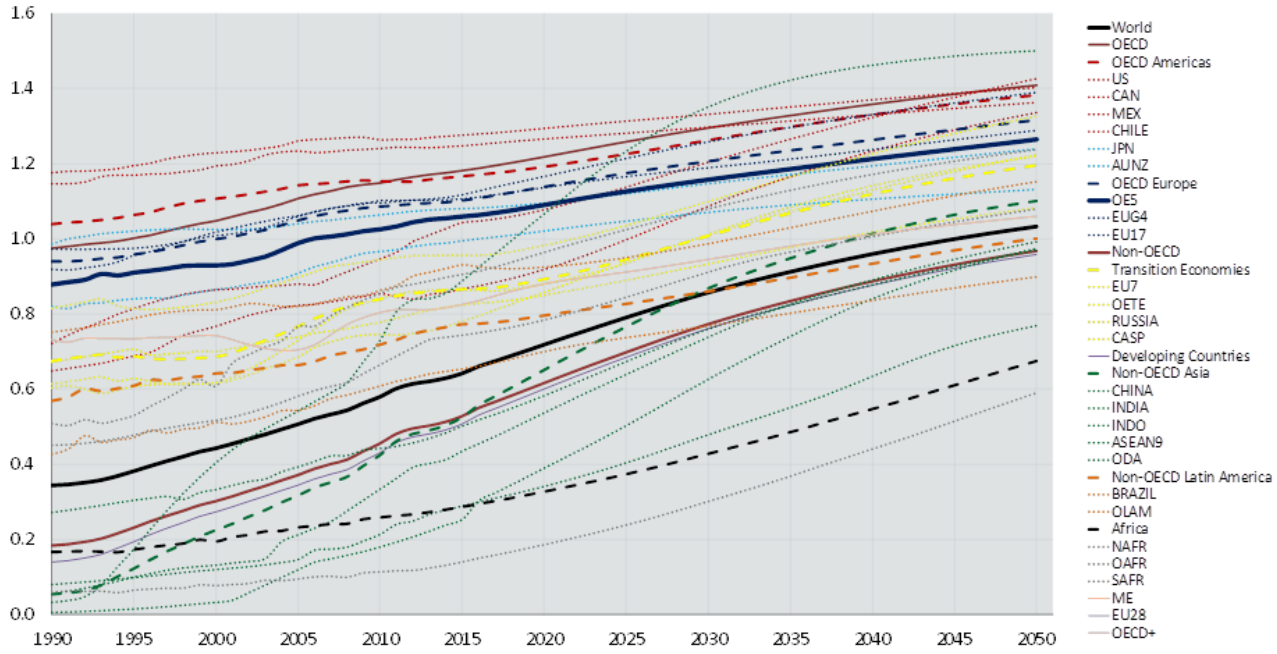
Population and wealth are both driving increased floor area in buildings

Source: IEA Energy Technology Perspective 2017

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Drivers of building energy use: ownership (population and wealth)

Appliance ownership is increasing…





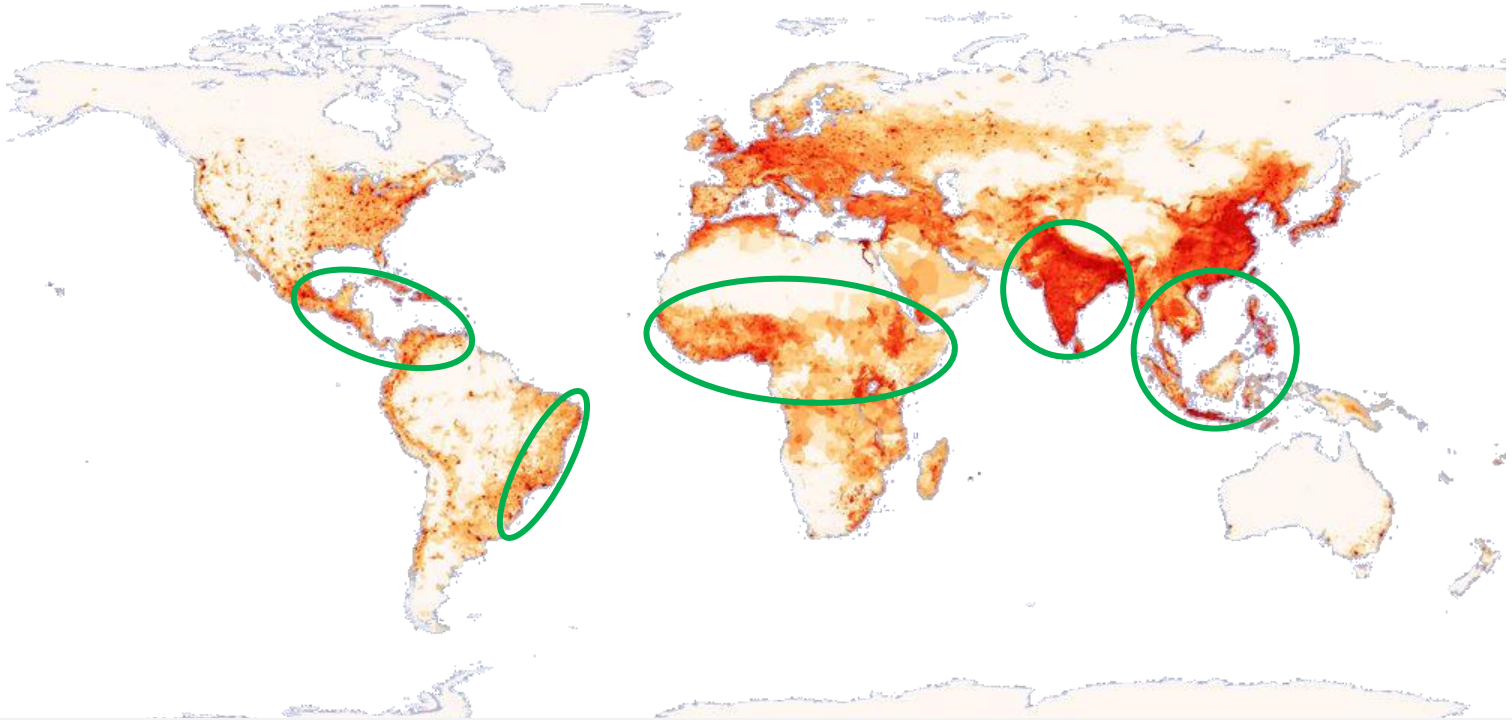


Global refrigerator ownership doubled in the last 25 years.

Sources: GBPN and IEA Energy Technology Perspective 2017

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Drivers of building energy use: population location

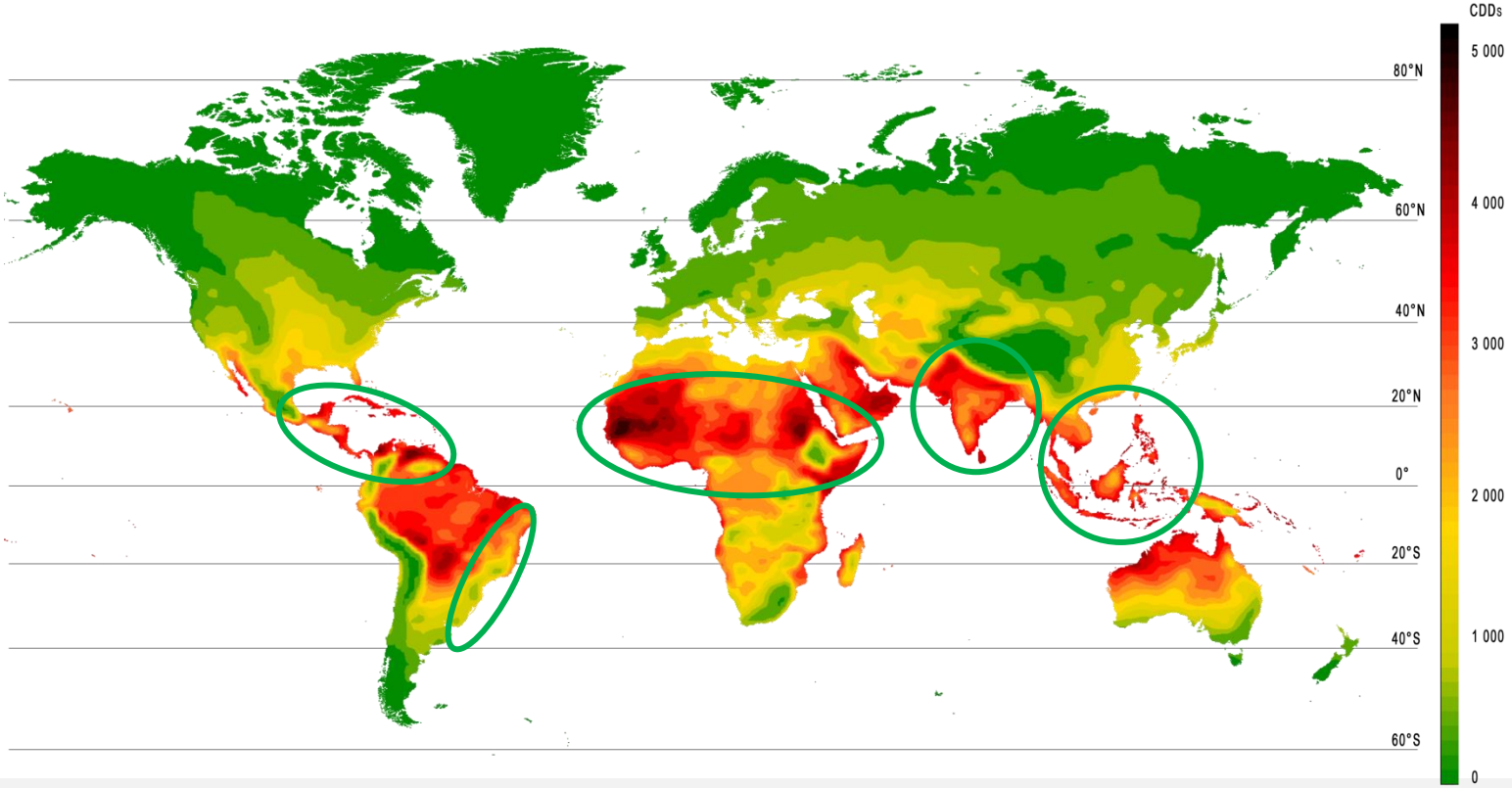


Hot locations with large population: India, South East Asia, Africa, Central America, South America
~50% of world population suffers from hot weather, while <10% have access to mechanical cooling

Sources: BEEP India and http://allthatsinteresting.com/map-population-density

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Drivers of building energy use: climate

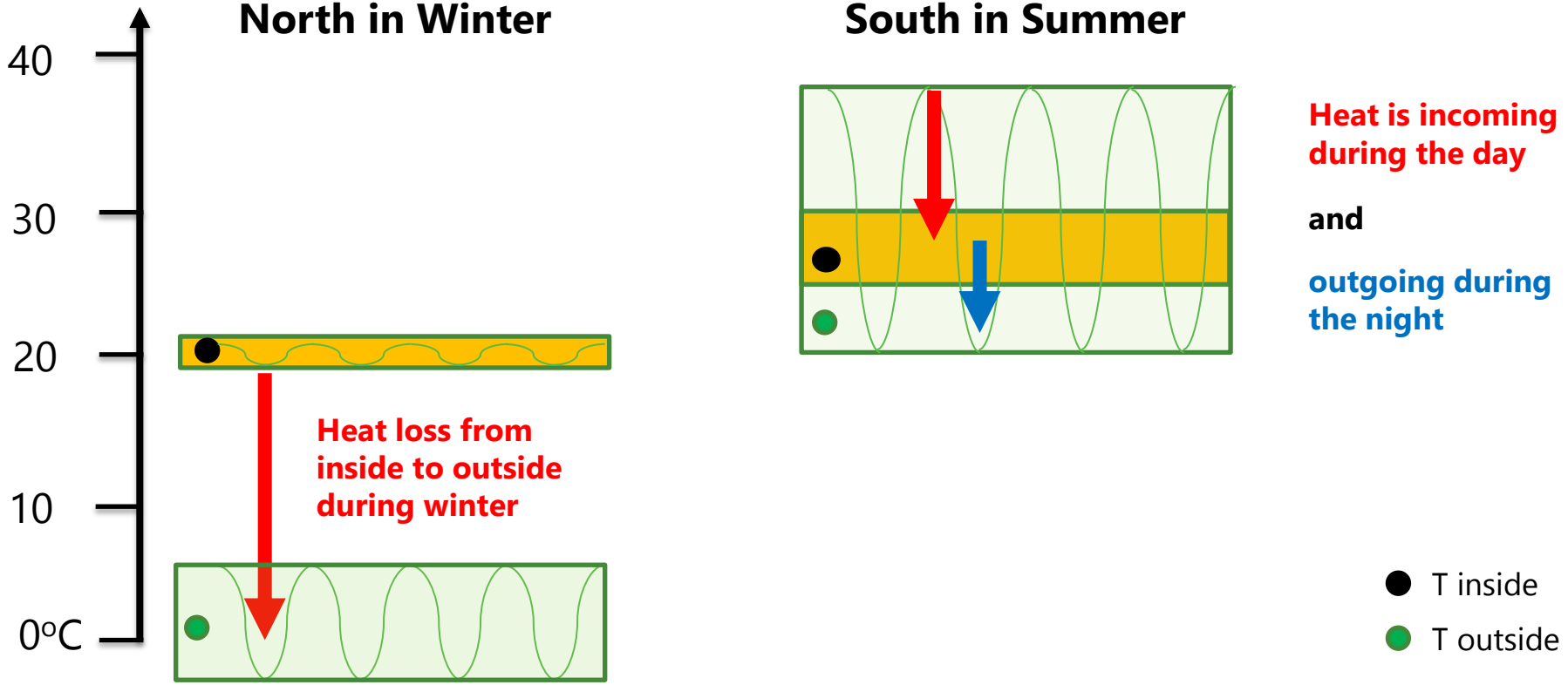


Climate impacts occupant comfort and building energy use.
Climate can also impacts where people live.

Sources: IEA Future of Cooling 2018

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Drivers of building energy use: climate

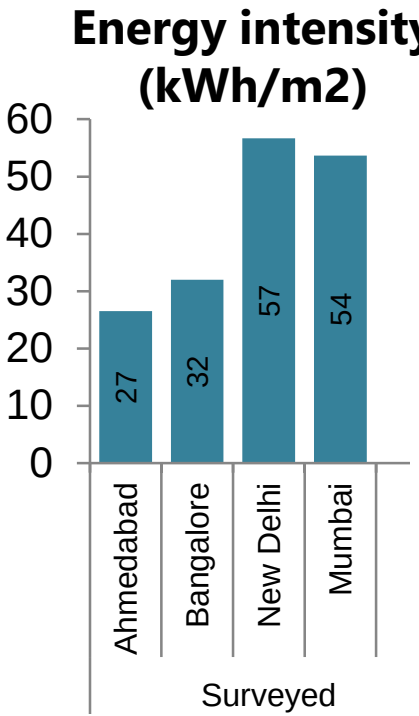


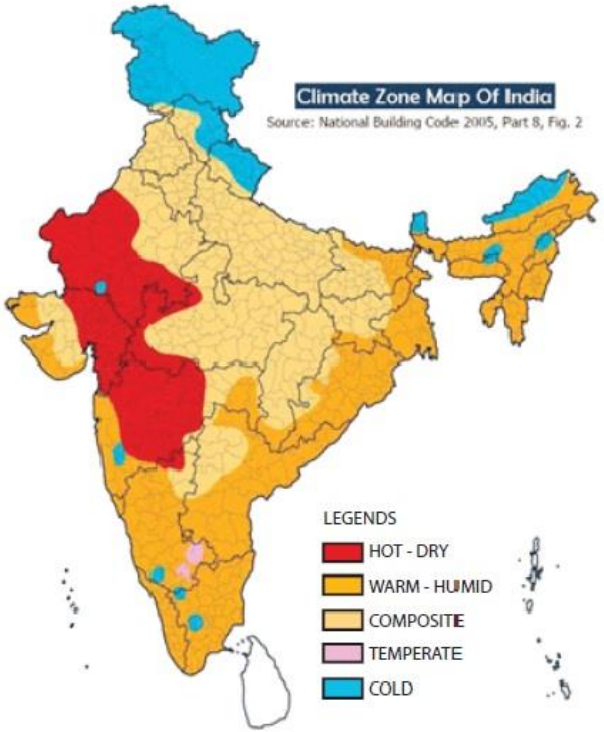
Building physics are the same everywhere, but,
buildings in cold and hot climates have different dynamics depending on temperatures

Sources: BEEP India

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Drivers of building energy use: climate example in India





Four Cities and Climate Zones

Ahmedabad:

- Hot and Dry

Bangalore:

- Moderate

New Delhi:

- Composite

Mumbai:

- Warm and Humid

Building energy use is dependent on both climate and energy efficiency standards

Sources: GBPN, India BEE

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Building energy use

Building lifecycle

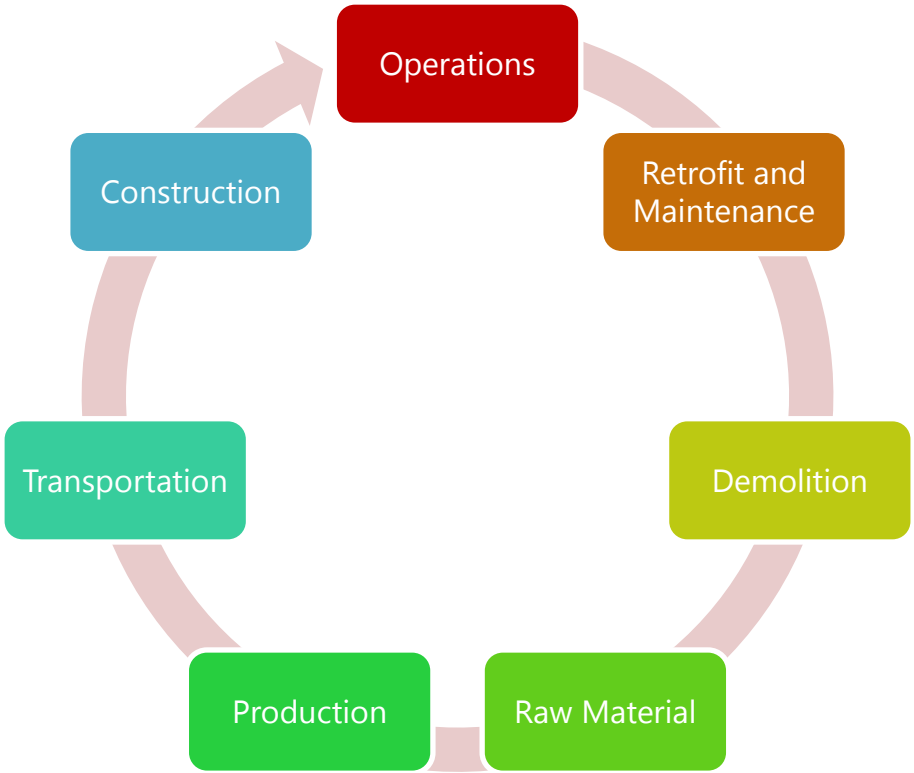
Historic and projected

End-use consumption



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Building energy use: over the building lifecycle



- Embodied plus operational energy and emissions
- Lifecycle analysis can estimate the impacts of each stage of the building life
-

Each step of the lifecycle of the building results in energy input and emissions output

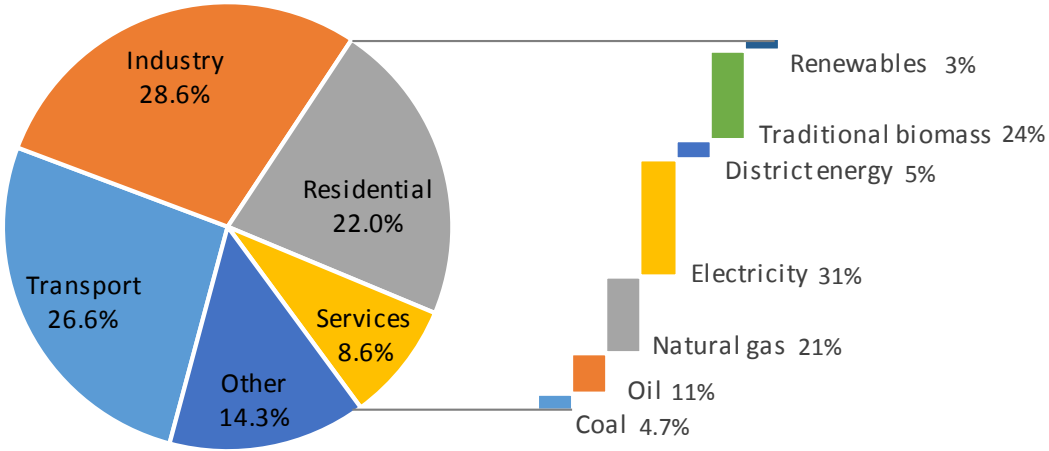
Source: Adapted based on Built Constructions Magazine

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Building energy use: globally

Buildings account for…

- over 30% of global final energy demand
- 55% of global electricity use,
- more than a quarter of energy-related CO_2 emissions,
- two-thirds of halocarbon,
- and 25–33% of black carbon emissions (GEA 2012)

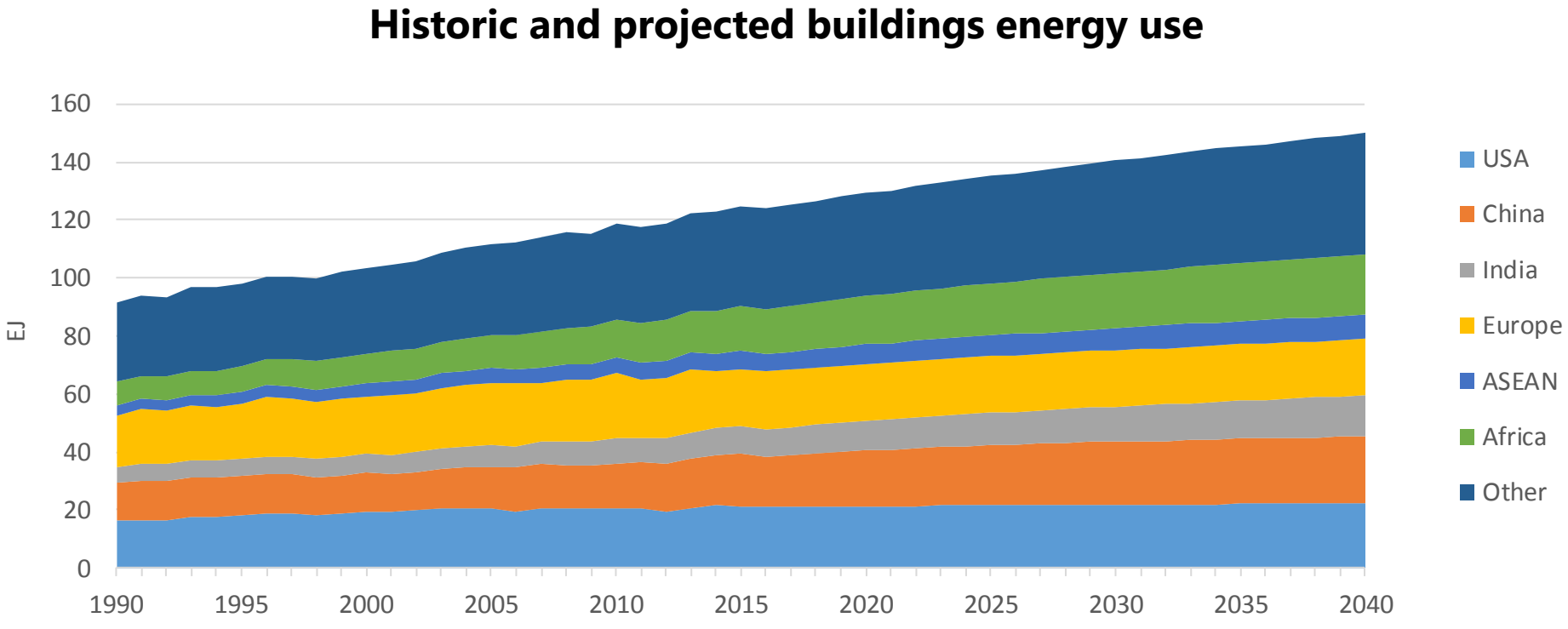


Building energy use plays a large role in the global energy system.

Source: IEA Energy Technology Perspective 2017

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Building energy use: by region



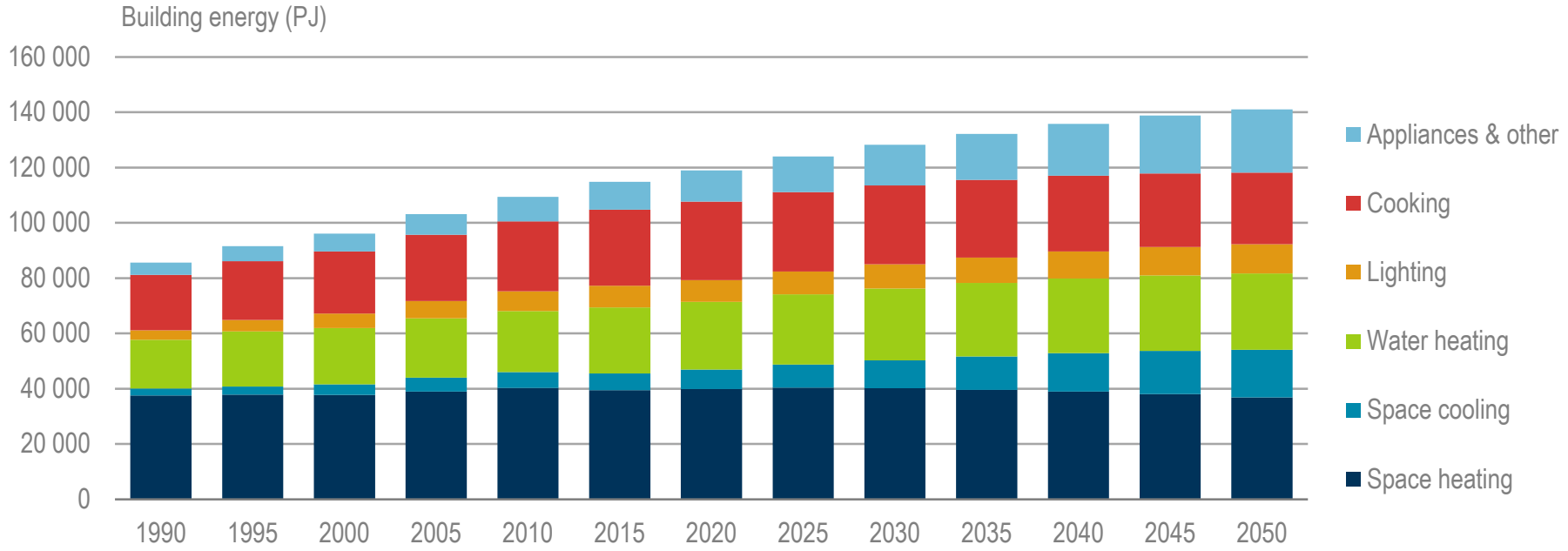
Building energy use in business as usual scenario (RTS) is expected to increase further.

Source: IEA Energy Technology Perspective 2017

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Building energy use: by end-use

Historic and projected buildings energy use

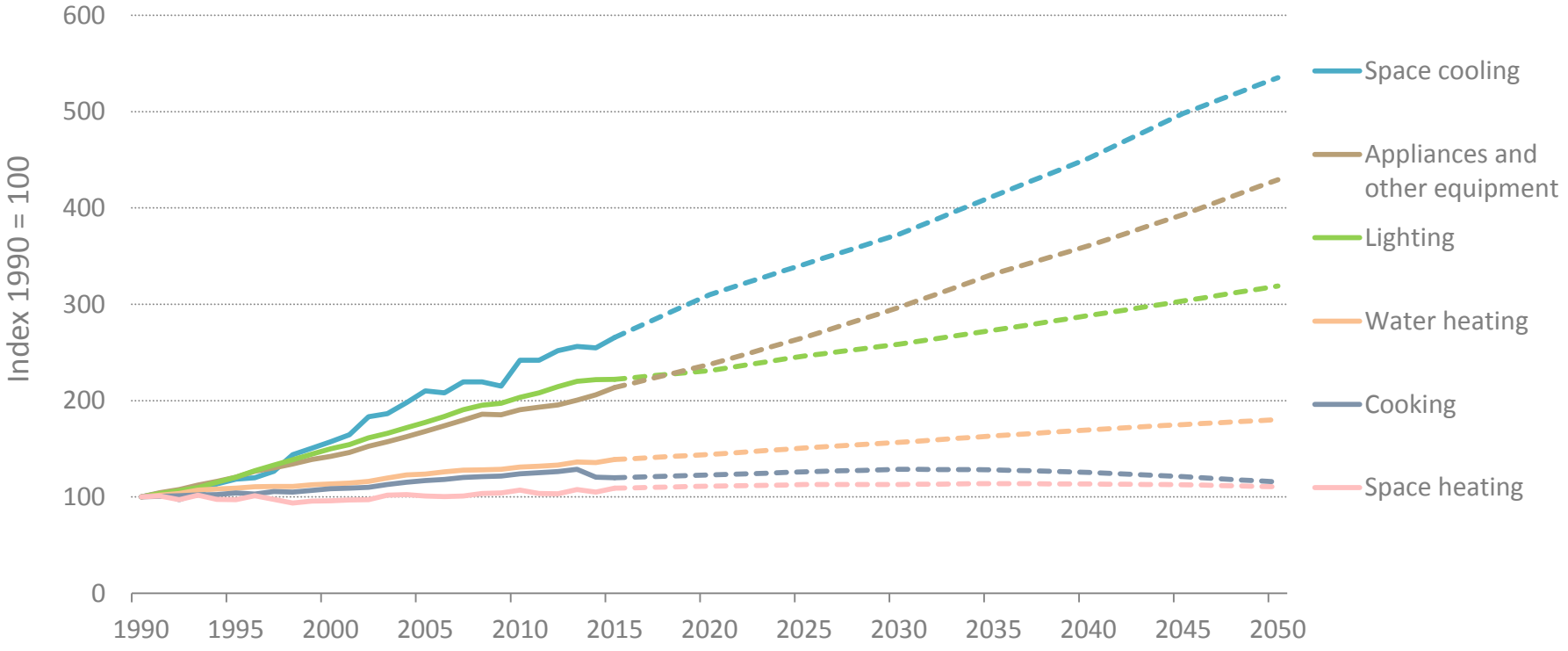


Building energy use in business as usual scenario (RTS) is expected to increase further.

Source: IEA Energy Technology Perspective 2017

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Building energy use: how important is space cooling becoming?

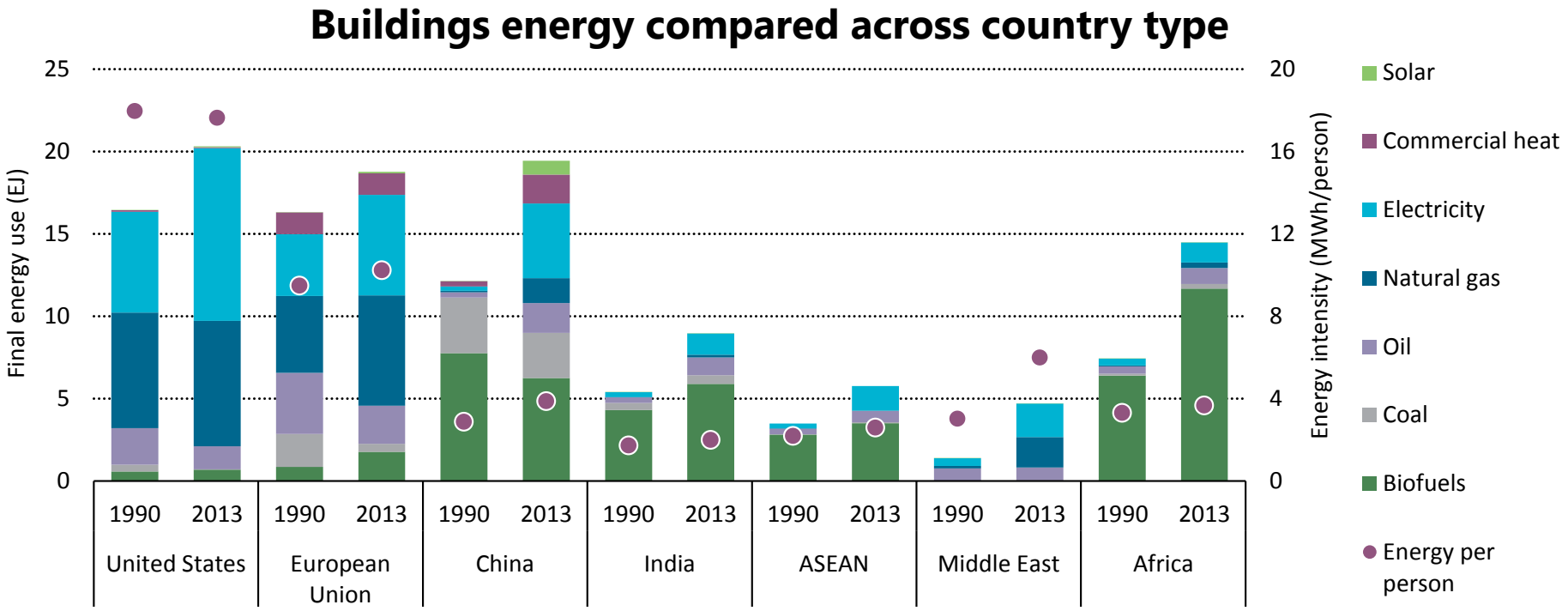


Space cooling energy use in business as usual scenario (RTS) is expected to have significant increases due to increased ownership.

Source: www.iea.org/eemr16

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Building energy use: comparison



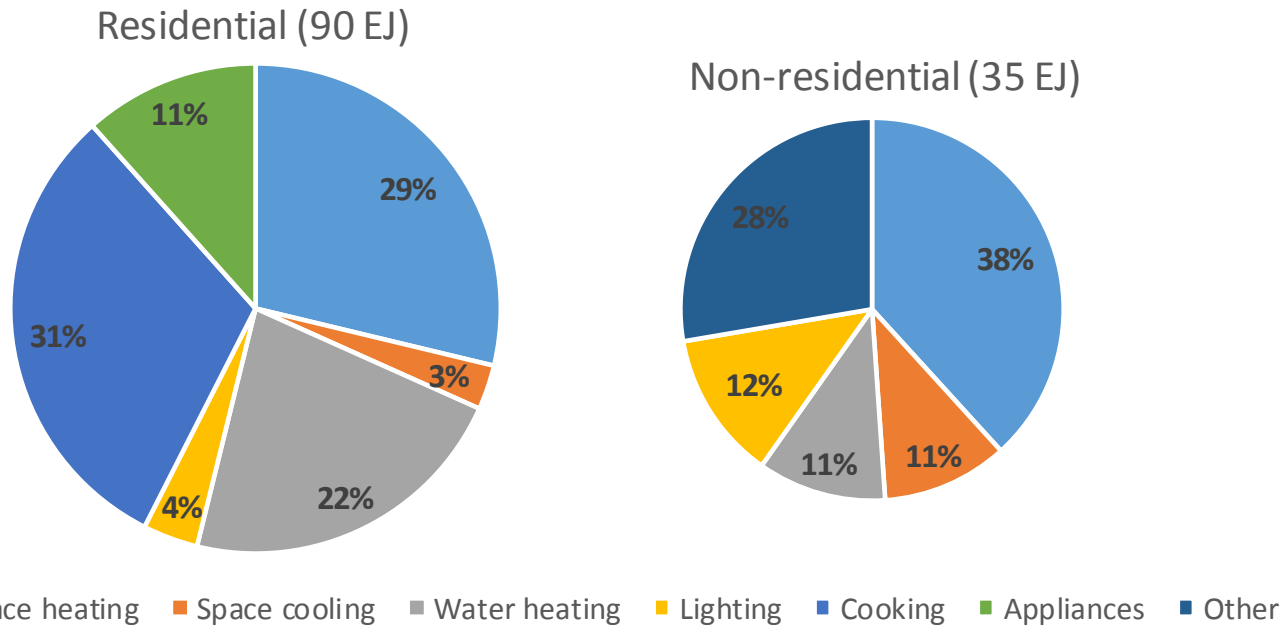
Building energy use is different between countries, especially with biomass.

Source: IEA Energy Technology Perspective 2017

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Building energy use: by building type

Residential and non-residential buildings…



Residential buildings use more energy for cooking and water heating.
Non-residential buildings use more energy for space cooling, lighting and other equipment.

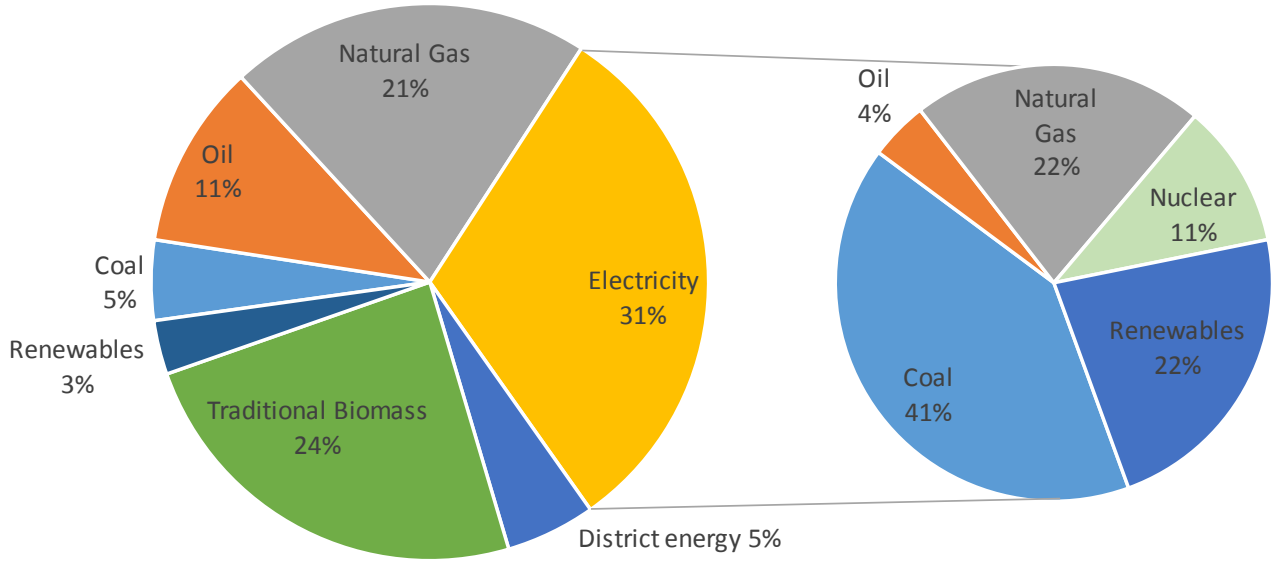
Source: IEA Energy Technology Perspective 2017

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Building energy use: impact on energy markets

Primary energy use depends on energy utilities…

Buildings sector final energy consumption (125 EJ)



Buildings depend heavily on upstream energy and emissions (electricity and commercial heat).

Source: IEA Energy Technology Perspective 2017

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Driving energy use down

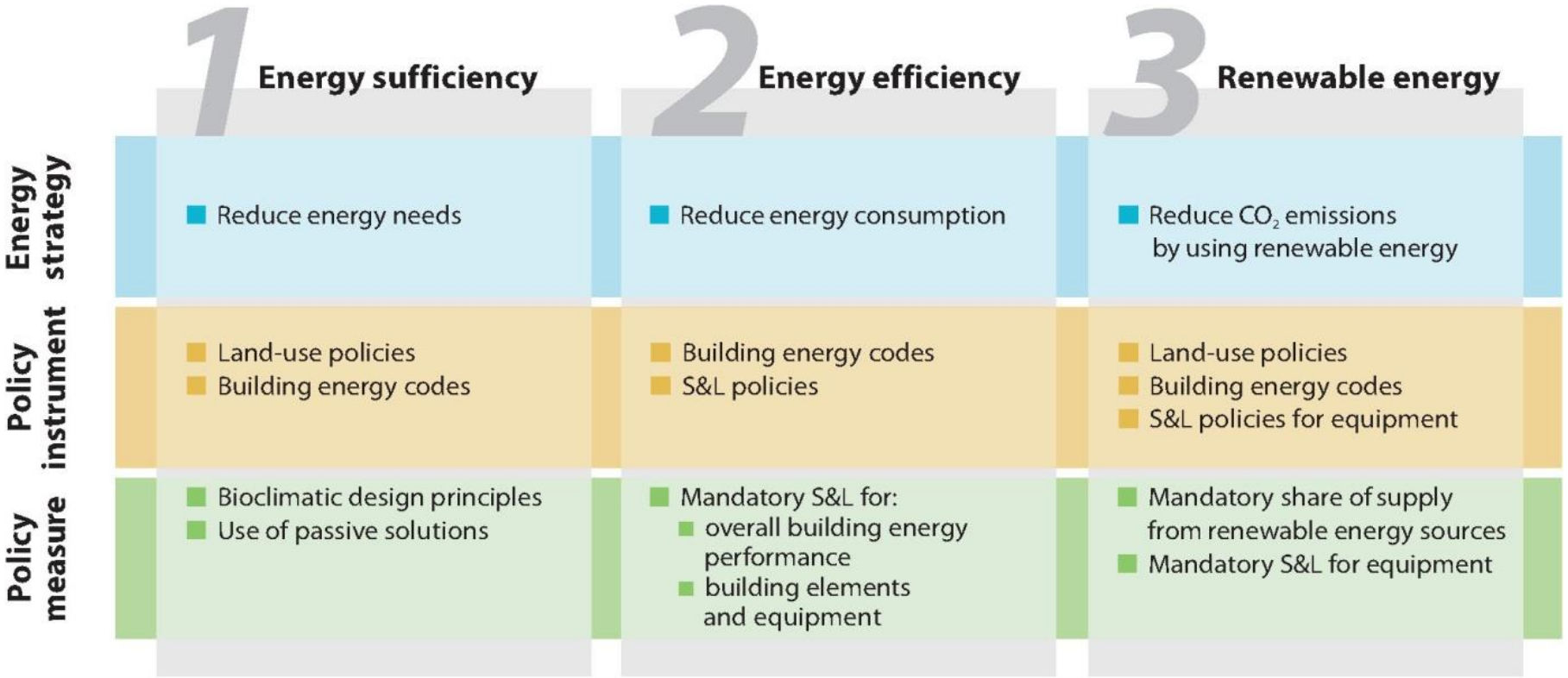
The path to “net zero” and “low-energy”



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Path to zero emissions or net zero energy buildings

Items to consider for building renovation or construction:



Source: www.iea.org/publications/policypathwaysseries/

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Path to low-energy existing buildings

- **Retro-commission**: ensure that all technologies are properly installed and operating as they were designed to operate.
- **Reduce electrical loads**: ensure all lighting is upgraded, ensure all appliances and electronic devices are high efficiency and emit less heat.
- **Improve building envelope**: highly cost effective insulation and air sealing are essential. Window measures can also dramatically reduce building energy and increase thermal comfort.
- **Systems**: Improve the existing systems if they are not being replaced.
  - Otherwise, upgrade to advanced systems including heat pump or other high efficiency technology that can be integrated with renewable energy (grid or on-site).

Source: Adapted from ENERGY STAR

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Path to low-energy new buildings

- **Design it right:** have integrated design team that examines life-cycle energy use in each design and construction phase.
  - **Electrical loads:** ensure all lighting is latest technology, ensure all appliances and electronic devices are high efficiency and emit less heat.
  - **Building envelope:** highly cost effective insulation and air sealing are essential. New buildings also have minimal upgrade costs for energy efficient window measures that can also dramatically reduce building energy and increase thermal comfort.
  - **Systems:** Include advanced systems such as heat pump or other high efficiency technology that can be integrated with renewable energy (grid or on-site).
- **Construct with commissioning:** ensure that all technologies are properly installed and operating as they were designed to operate.

Source: Adapted from ENERGY STAR

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Scenario:

An influential NGO is urging for all new construction to be zero emission or net zero energy buildings.

What factors are key to achieving zero emission or net zero energy buildings?

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Discussion and questions

- What are the most important energy services required for buildings to provide in your jurisdiction?
- What factors are driving demand for energy services in your jurisdiction?
- Which building type offers the greatest energy savings potential?
- Which policy measures might reduce demand for space cooling and growth in electricity consumption?
- Which policy measures might influence the behaviour of building occupants to promote energy conservation?



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