Renewable Energy Options for Cities

Energy Solutions for the Urban Future

Supported by:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

based on a decision of the German Bundestag

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Role of renewables in global energy transformation at the city level

The importance of urban energy: current status

World urbanization trend (UN):

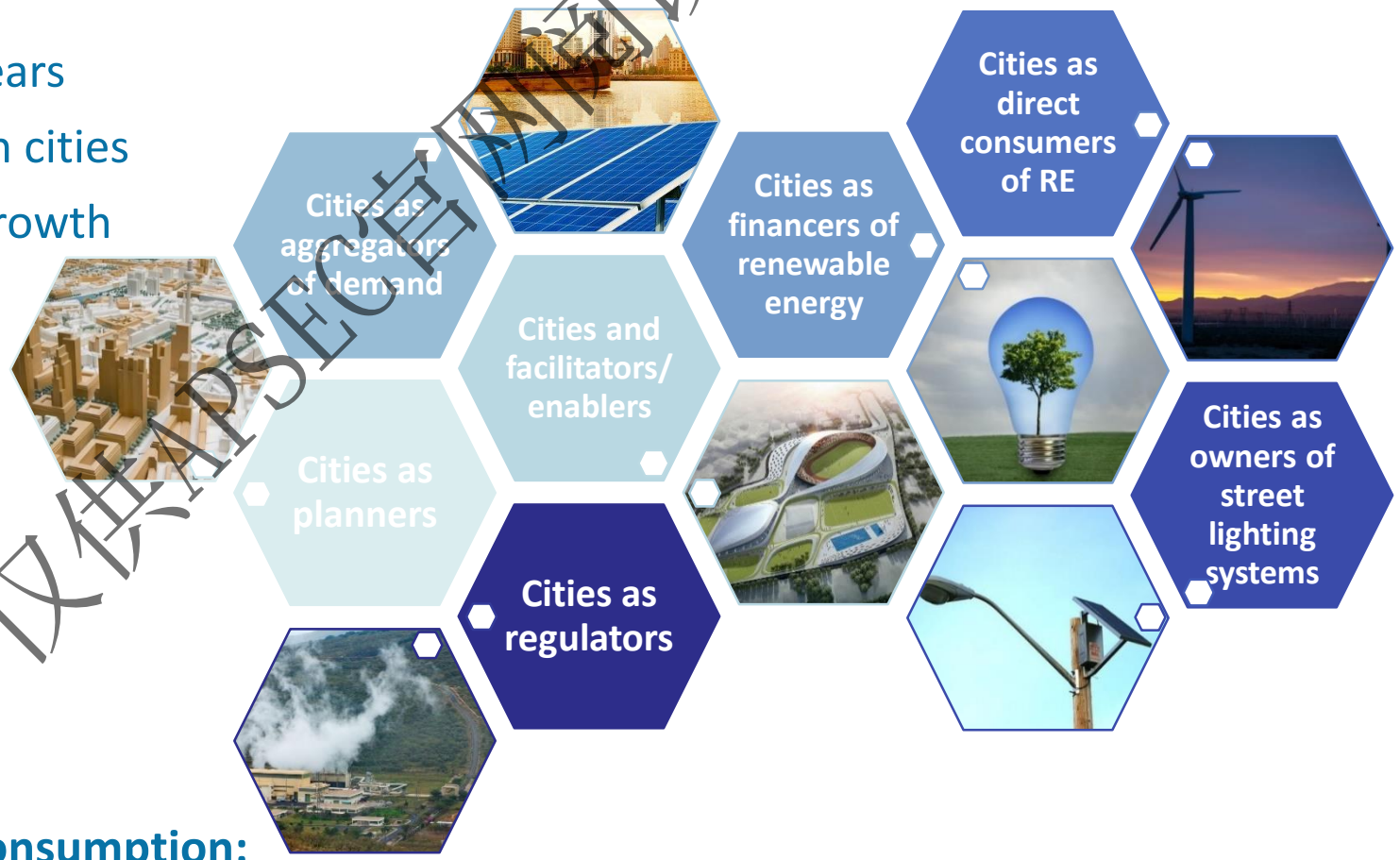
- Urban population quadrupled over 50 years
- Over half of the global population lives in cities
- 2 out of 3 live in cities by 2050, 90% of growth from Asia & Africa

Energy-related emission from cities:

- 67-76% of global final energy use
- 71-76% of energy-related CO2 emissions
- Global energy transition will impact city energy supply and use profoundly

RE accounts for 20% of the urban energy consumption:

- 1/3 for transport
- 2/3 for buildings



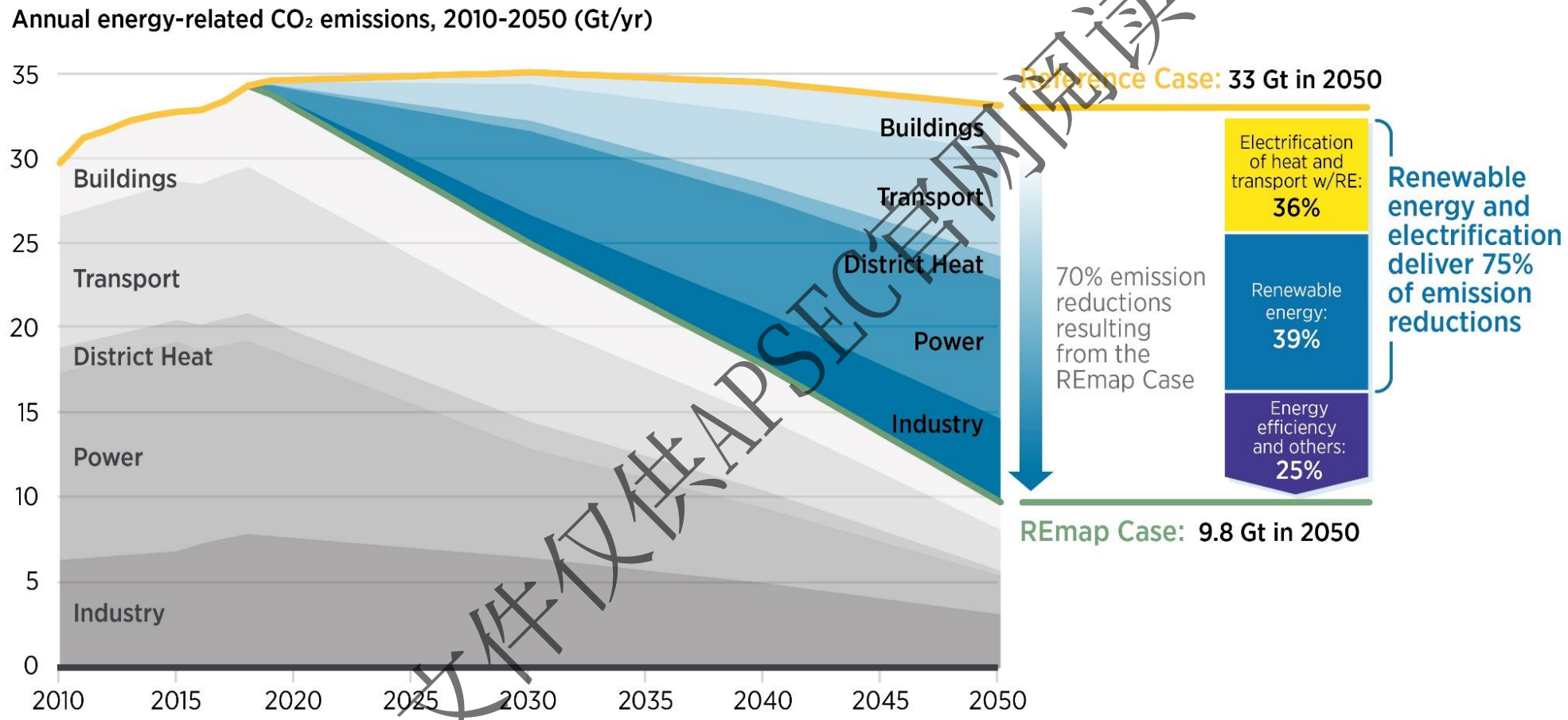
Future urban citizens and consumers

The youth: Being part of the solution NOT the pollution –framing the future paradigm

Voice of the future generation

- Important player in tackling climate challenge
- Initiatives (examples): Youth for climate action, Youth Climate Report, Youth Solutions Report….
- Urging the local elected officials to action within their capacity on curbing emissions
- Sustainable consumption: sustainability is no longer a slogan but a standard that the future consumers will be adopting

Key driver for global energy transformation



Annual energy-related CO2 emissions under current and planned policies – the Reference Case – are expected to remain flat, at 33 Gt CO2 in 2050. Yet they must be reduced by 70% to limit temperature rise to the well below 2°C climate goal. Renewable energy and energy efficiency measures, combined with deep electrification, provide over 90% of the reductions required by 2050

Renewable energy in building sector

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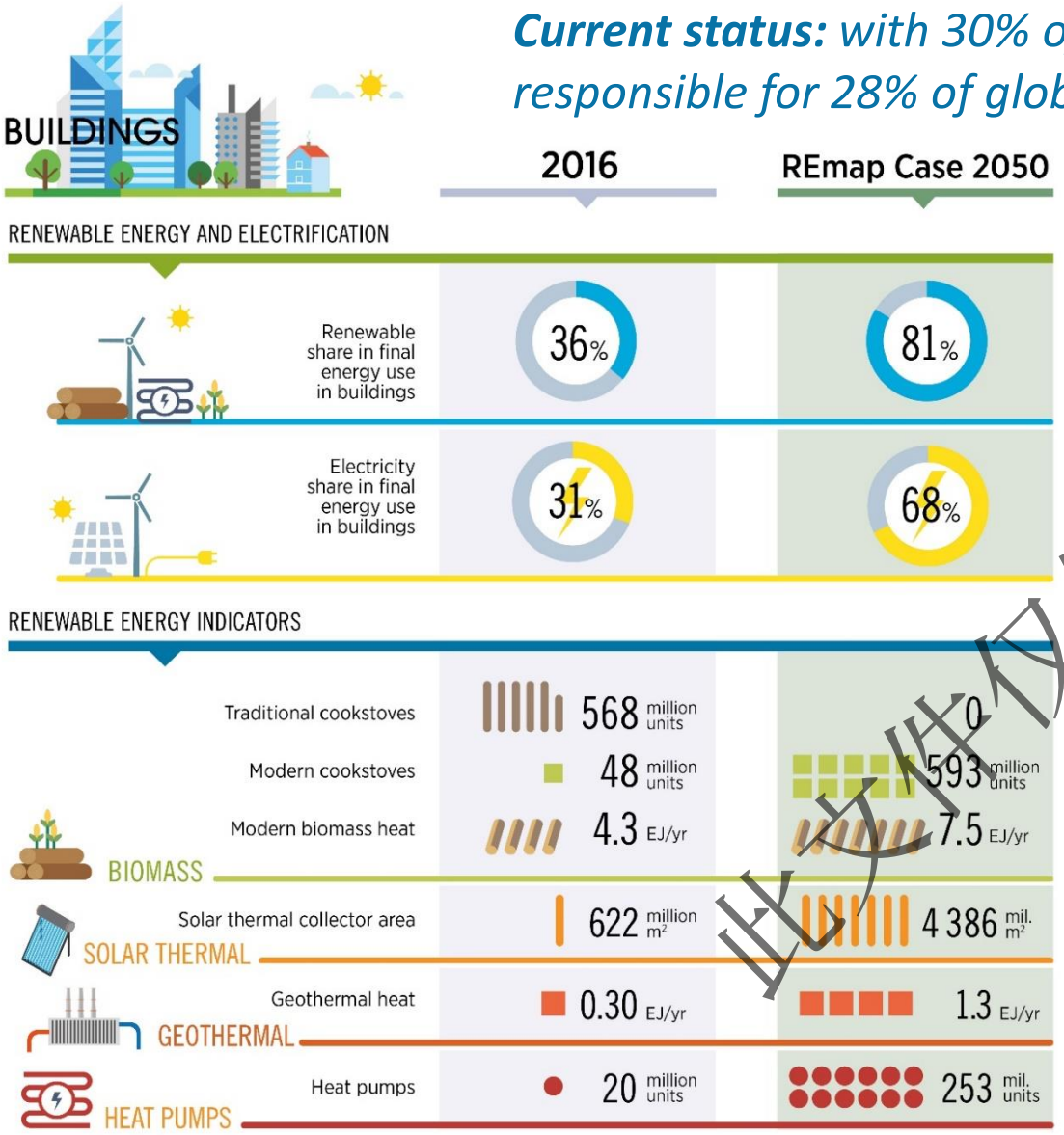
Current status: *with 30% of global final energy consumption, the building sector is responsible for 28% of global energy-related CO2 emissions*



REmap case 2050

- **Renewable electricity** in the buildings sector could reach 68% in share by 2050
- With direct-use of (non-power) renewables**, the overall RE share** could ramp up to 81%, from 36% today;
- consequentially leading to a reduction by 75% of **CO2 emissions** in 2050 compared to reference case

- **Improved building energy efficiency** would curb the building energy consumption in 2050 to 4/5 of today's level, despite the additional 1 billion households

Renewable energy in transportation sector

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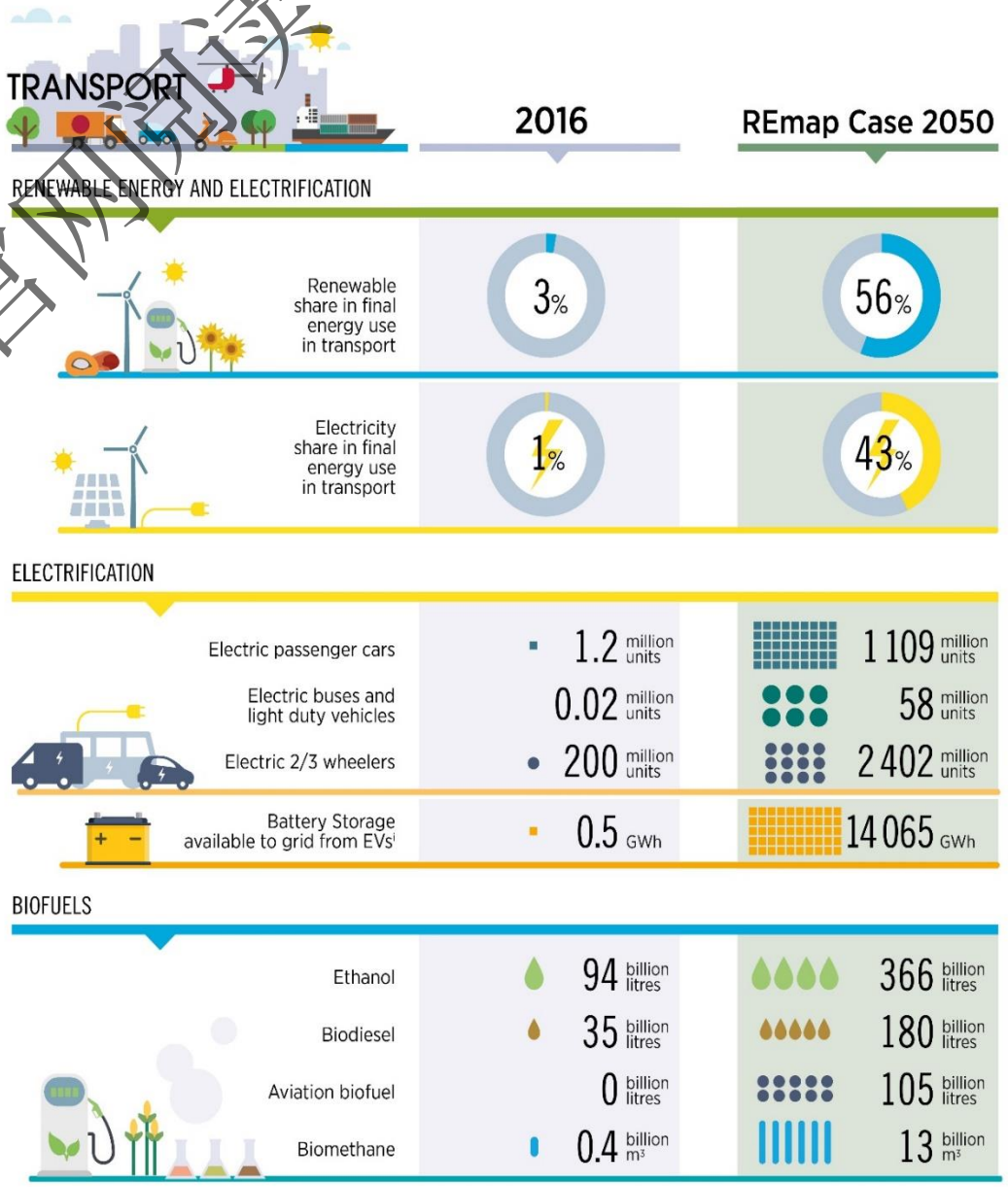
Current status: *with 28% of final energy consumption, the transport sector is responsible for 20% of global energy-related CO2 emissions*

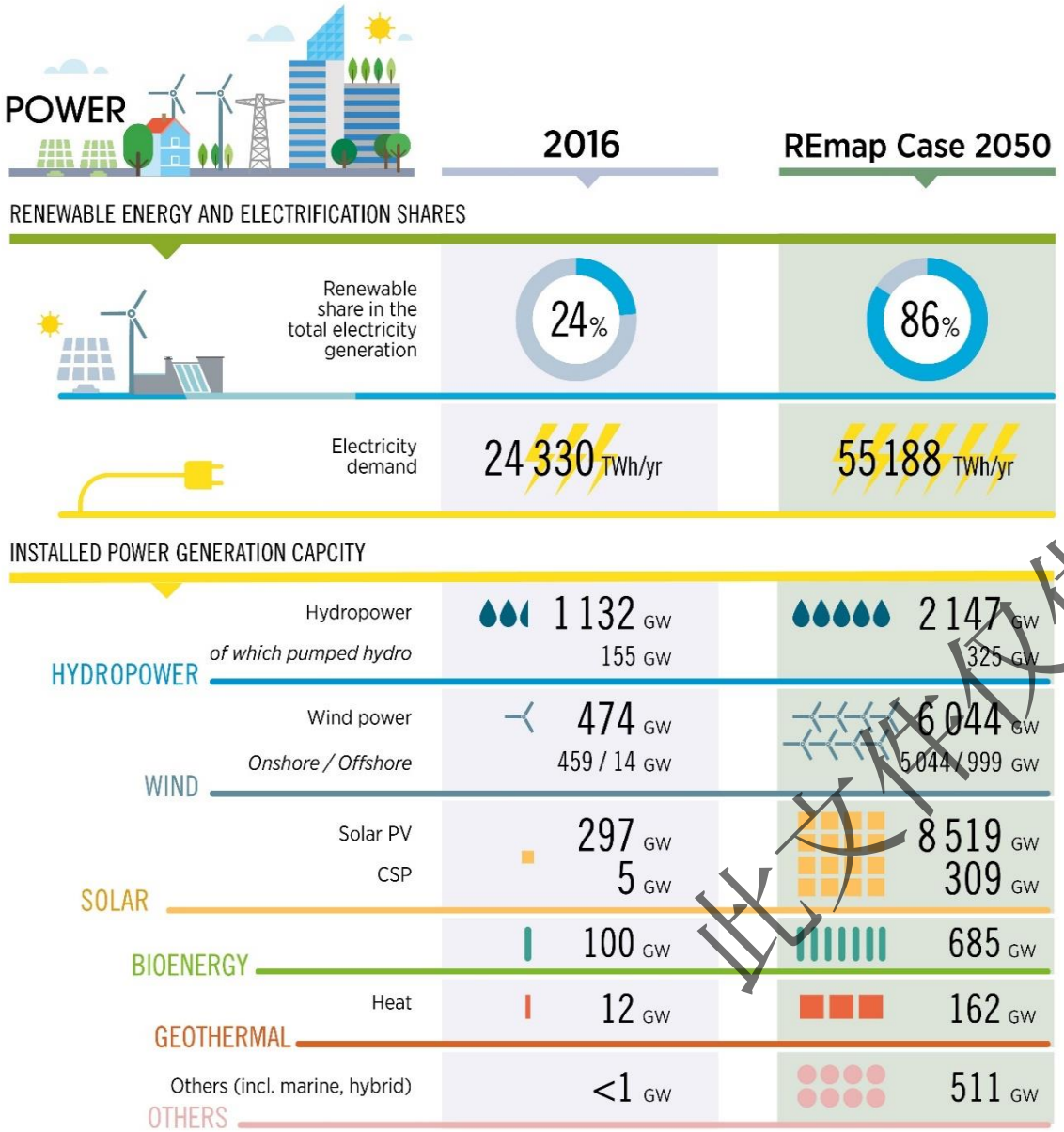
REmap case 2050

- **Renewable electricity** in the transport sector could reach 43% in share by 2050
- With biofuels, the overall share could reach to 56% from today's 3%;
- consequentially leading to a reduction by 72% of CO2 emissions in 2050 compared to reference case

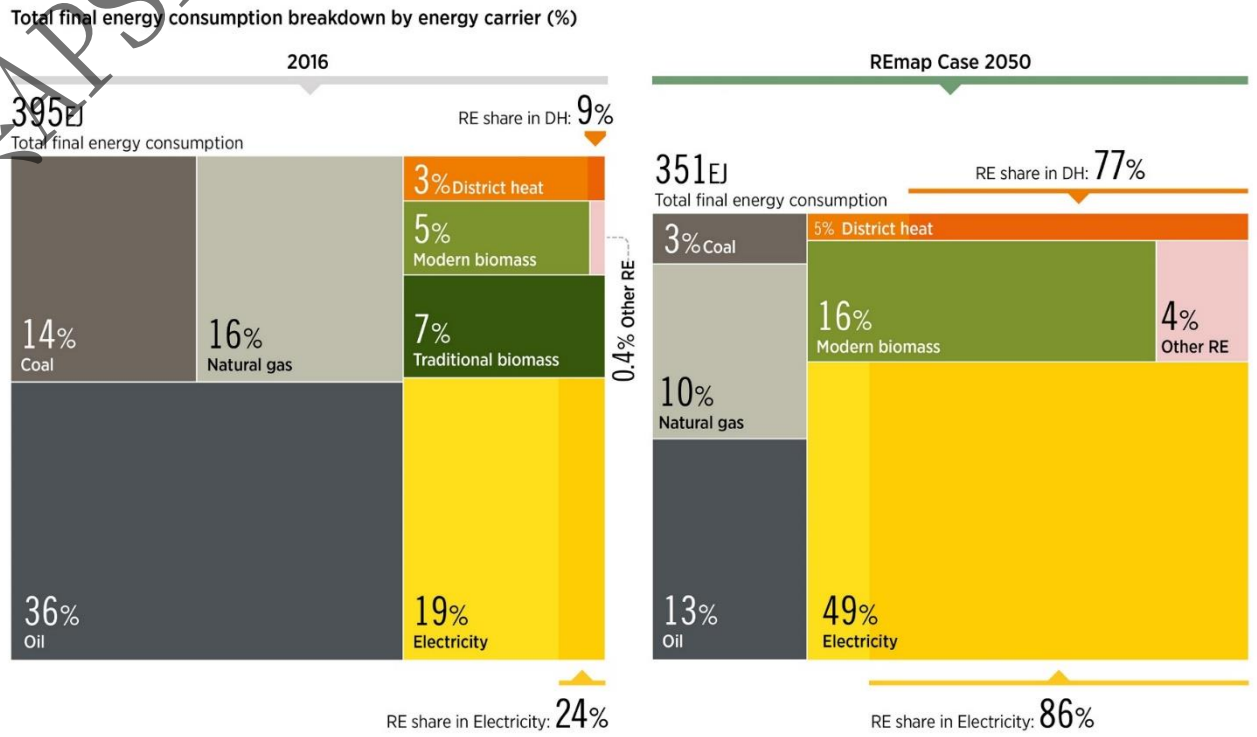
- **However, charging infrastructure for EVs** should be smart charging enabling EVs a source of flexibility for power systems- facilitating integration of VRE



Power: scale-up of RE generation and electrification

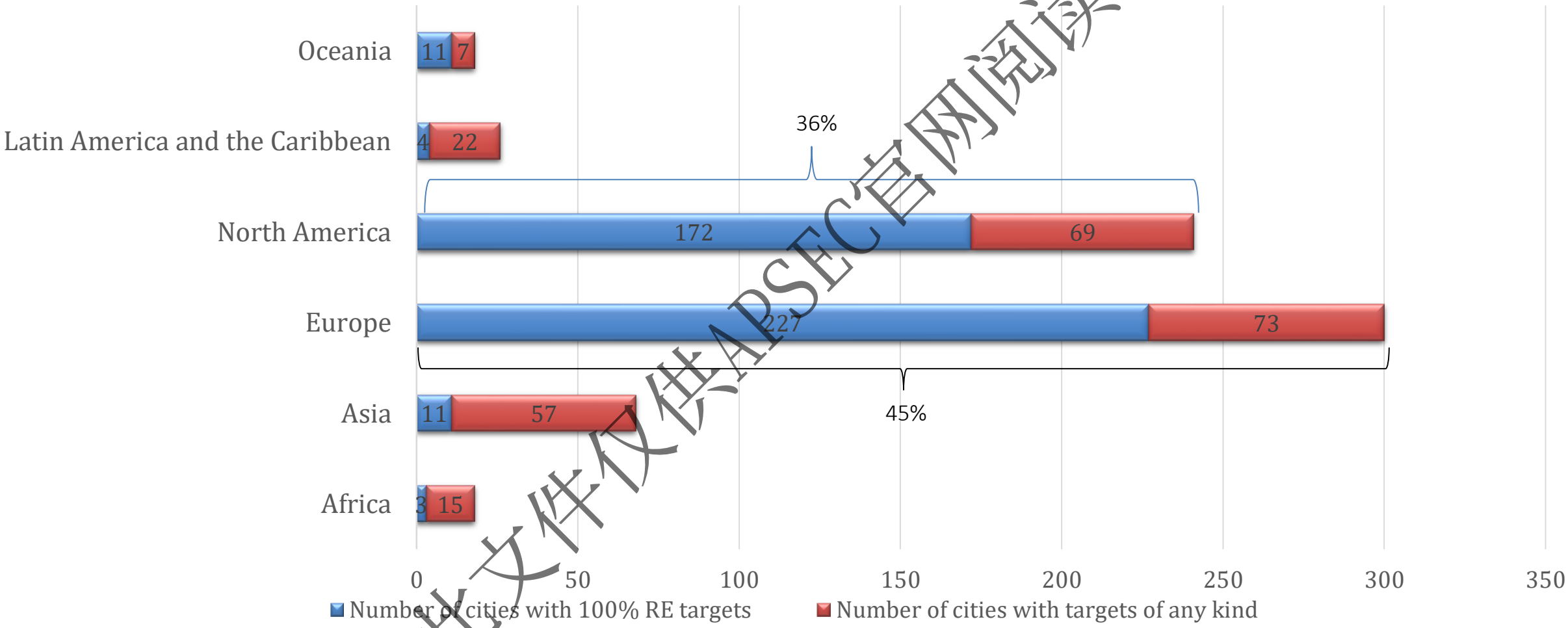


- **Scaling up electricity from renewables** will be crucial for the global decarbonisation – 86% by 2050.
- **Enhanced electrification of end-use sectors** is accelerating the power sector transformation



Opportunities for urban renewables: resources, technologies and tools for urban energy system planning

Global distribution of cities with RE targets



*The targets were collected from various databases (CDP city target database and REN21 Renewables 2019 Global Status Report) and initiatives (the Sierra club, UK100, the Covenant of Mayors for Climate and Energy, Carbon Neutral Cities Alliance, C40 cities, ICLEI Local Governments for Sustainability carbon Climate Registry, the US Climate Mayors, Under2MOU and the Go100RE map)

Cities with target have RE power plants installed

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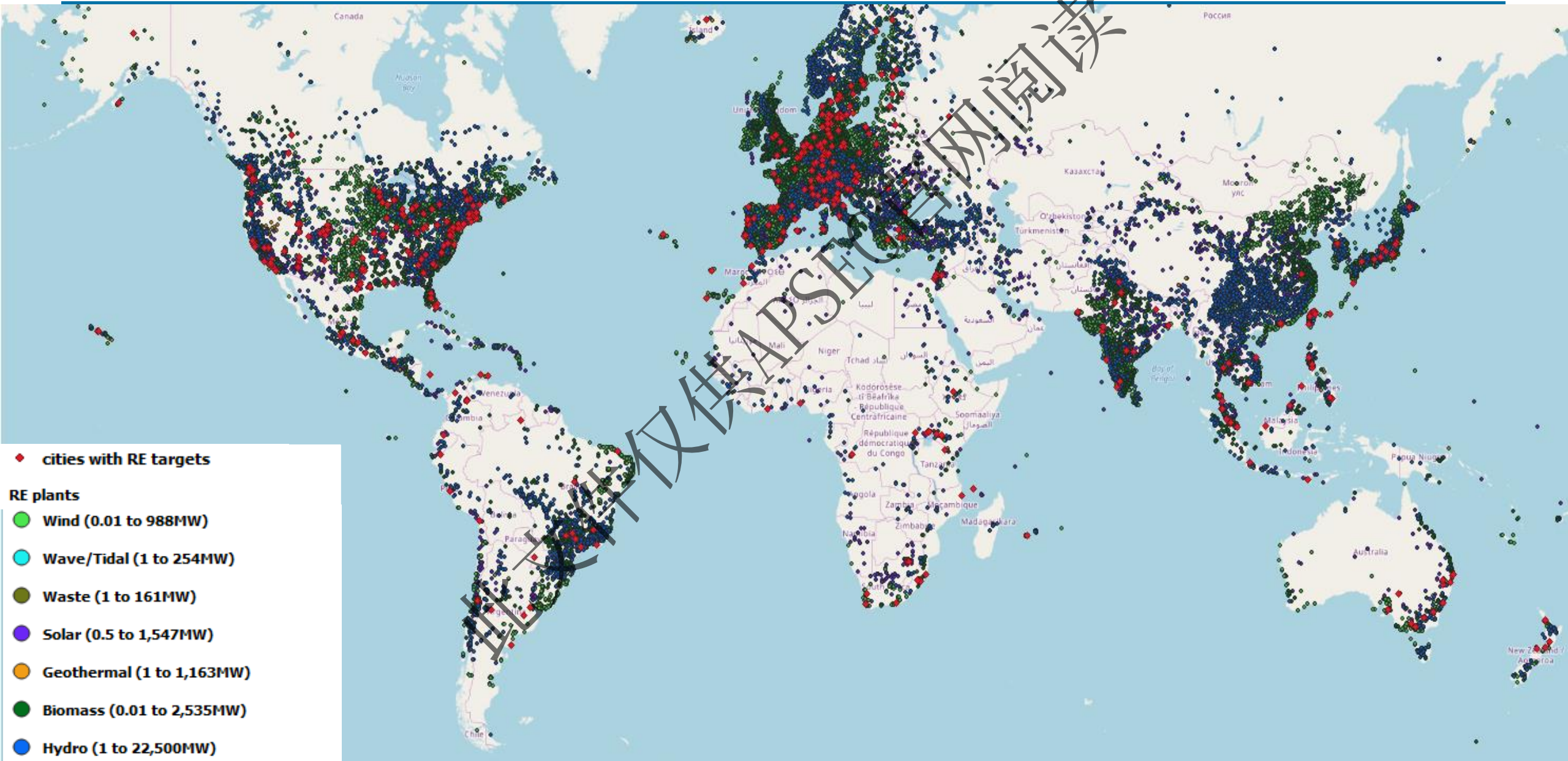

Untapped potential for urban RE replacing fossils

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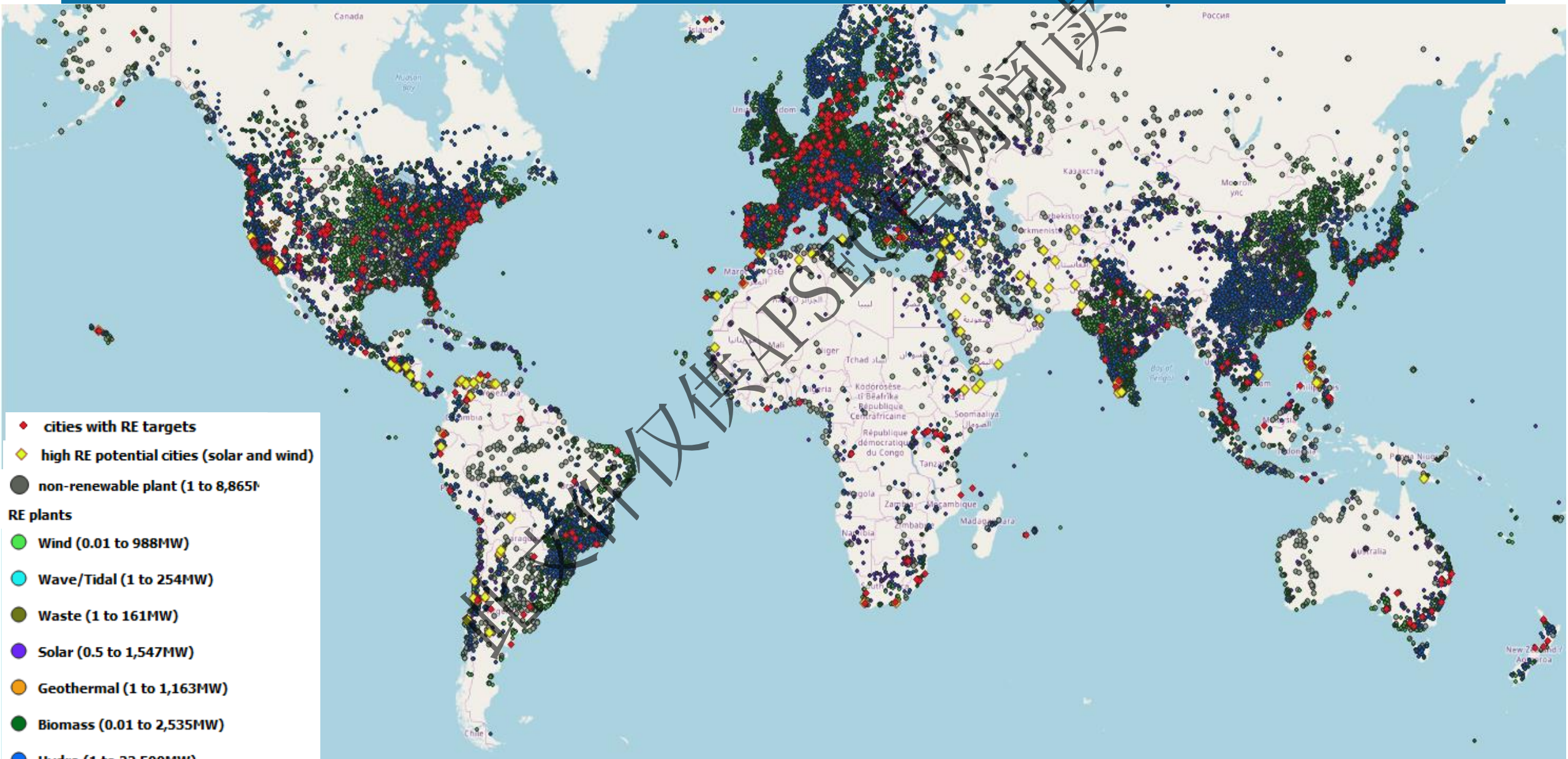

Technologies for renewables in cities

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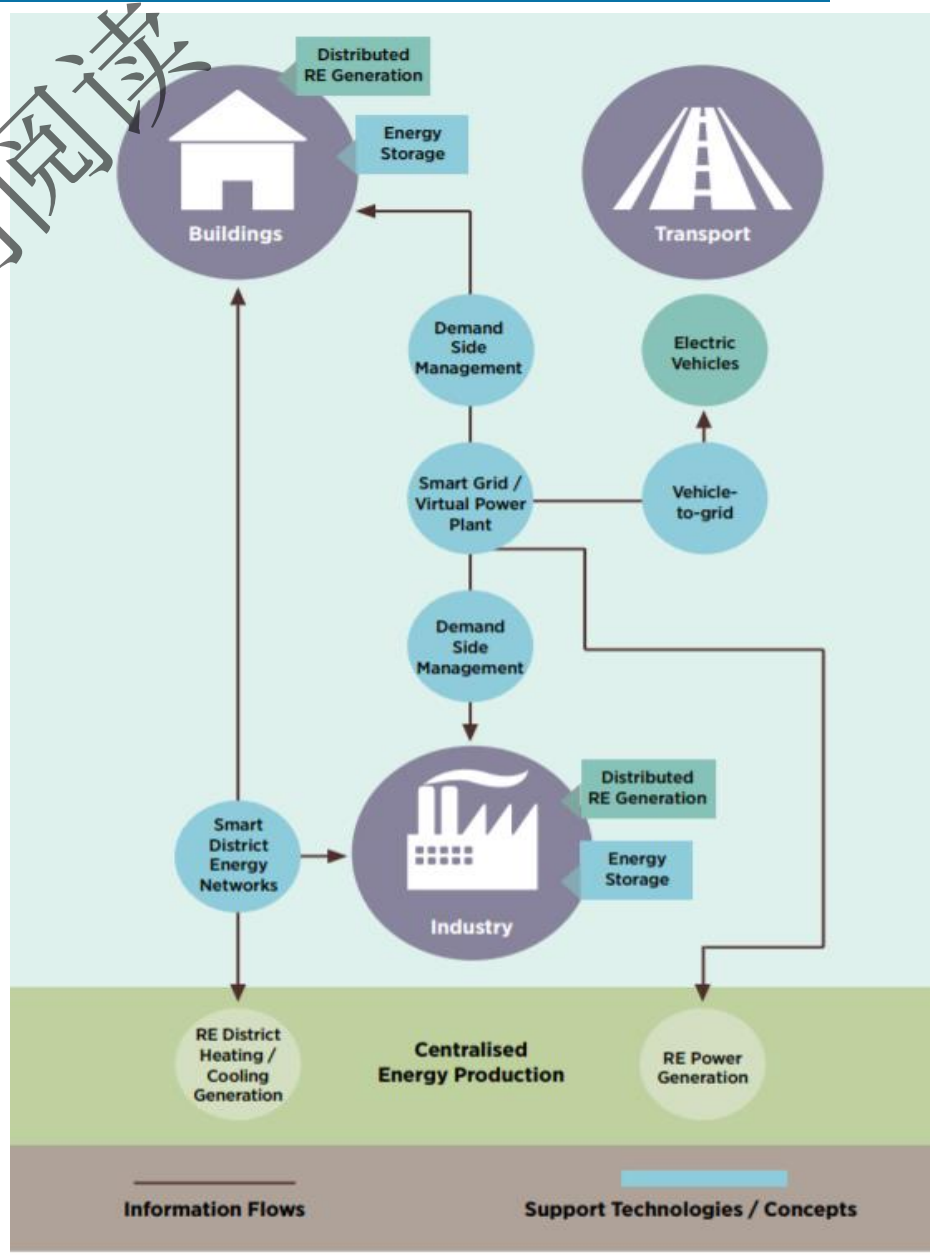
Renewable energy technologies

- Urban solar PV: from rooftop to BIPV
- Solar thermal energy
  - Solar water heating systems
  - Solar district heating
  - Solar thermal cooling
- Solar photovoltaics-thermal (PV-T)
- Waste-to-Energy
- Direct use of geothermal energy
- Urban wind power



Technologies for renewables in cities

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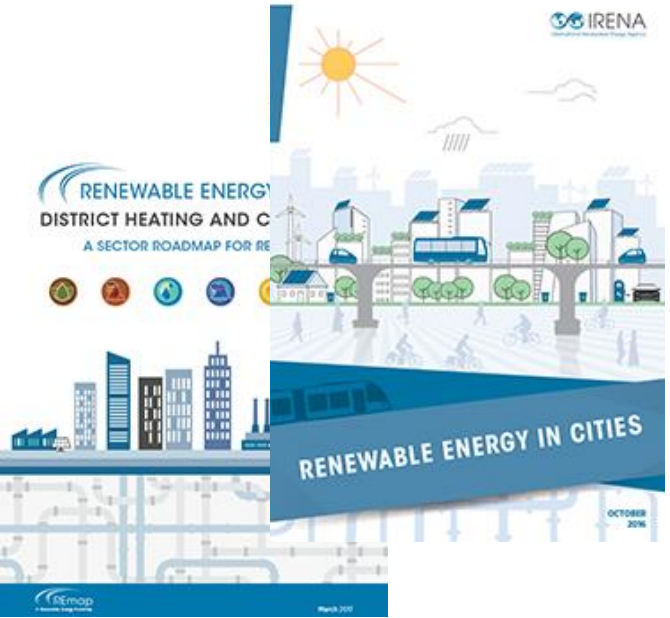
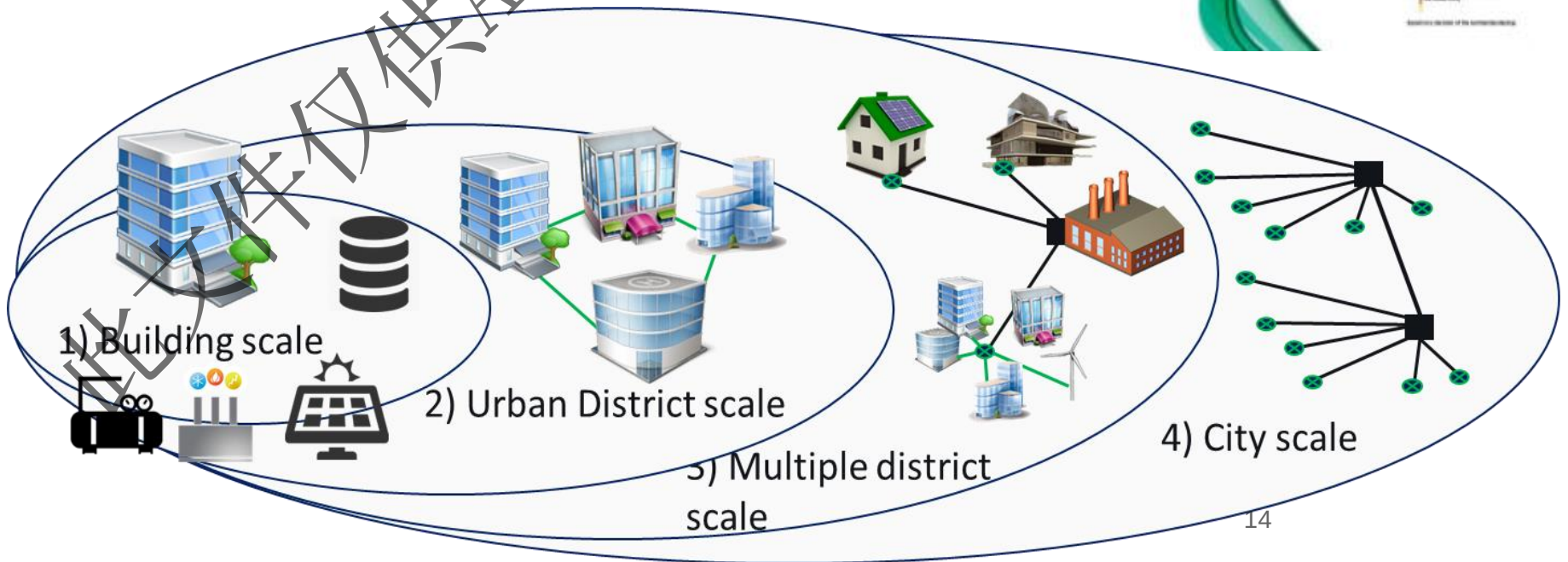
Technologies supporting the integration of RE in cities

- Smart grid development through innovation
- District thermal energy networks
- Charging Infrastructure for Evs
- Heat pumps





Introduction of IRENA's Planning Platform for Urban Renewable Energy

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Urban energy system planning tool

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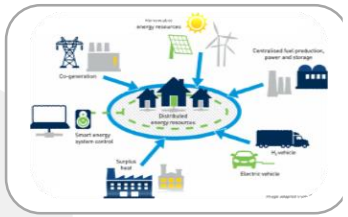
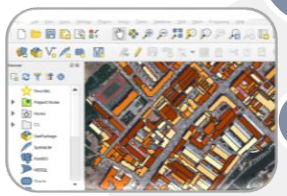
Demand assessment



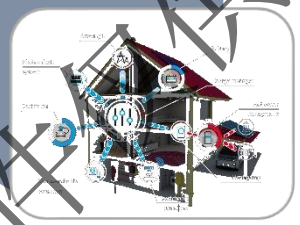
Operating strategy
- Sector coupling
- Building system
- Trade-offs retrofitting
- Long-term planning



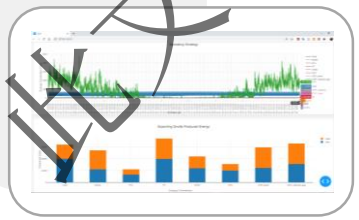
RE local potential

IRENA's tool for urban energy systems

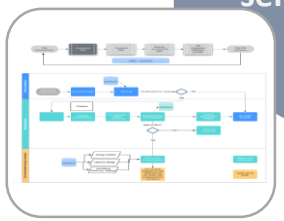
Solution design
- Energy system
- Building system



Portfolio of energy solutions



Methodology selection based on data availability



City-level

SUSTAINABILITY
HEATING & COOLING
ENERGY EFFICIENCY
RENEWABLE TECHNOLOGY

CO2 EMISSION REDUCTION

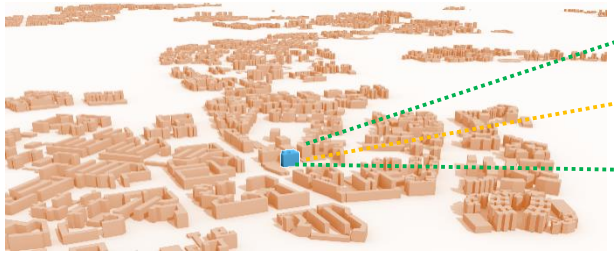
MOBIILITY

District-level

DISTRICT HEATING AND COOLING

ENERGY STORAGE

Building-level



SMART LIGHTNING

ROOFTOP PV

RETROFITTING

Tool Application

A - Energy Demand Simulation

1. Building Archetypes

SketchUp

2. Retrofitting Scenarios

3. Demand Mapping

QGIS

1) *Building characteristics*
2) *3D building model*
3) *Building energy usage patterns and services*
4) *Demand assessment*

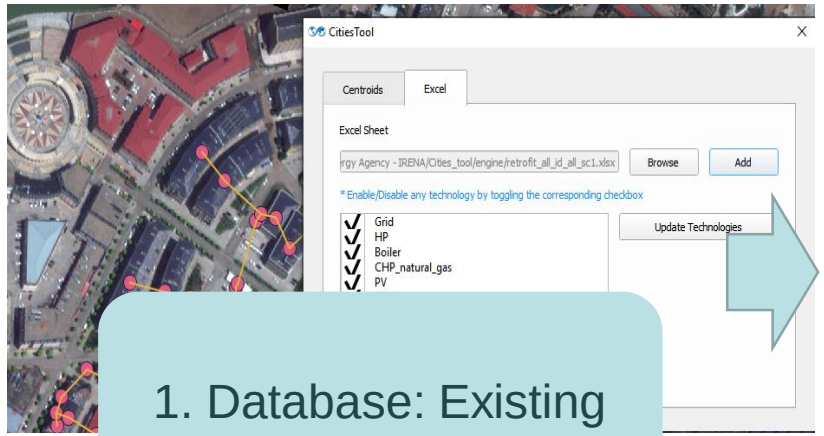
1) *Retrofitting measures*
   - *U-values*
   - *Glazing ratio*

2) *Improvement assessment*

1) *GIS data*
2) *Archetype demand database*

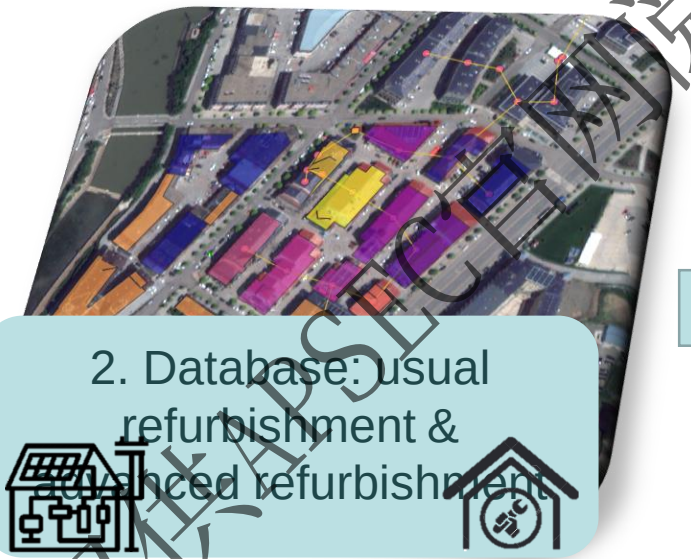
Tool Application

B - Energy Systems database and RE potential



1. Database: Existing systems database

1) *Existing energy system installed at building level*
2) *Existing energy system installed at city level*



2. Database: usual refurbishment & advanced refurbishment

1) *Retrofitting measures*
   - *U-values*
   - *Glazing ratio*

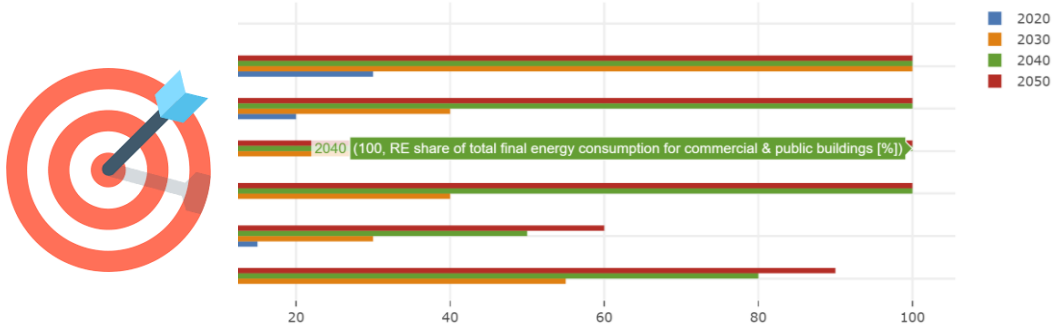
2) *Improvement assessment*

3. Database RE technologies and costs

1) *RE technologies options (solar thermal, solar pv, district network, biomass, heat pumps)*
2) *RE technologies costs*
3) *Storage options (battery storage, thermal storage)*

Tool Application

C - Energy Supply Optimisation

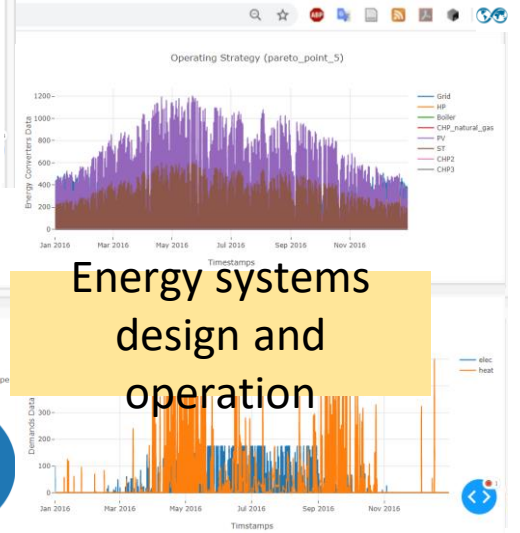


1. Emission targets

1) *Quantification of the feasibility of the targets which can be achieved by energy demand or supply measures.*

Trade-offs minimizing costs and emissions

Potential district heating network

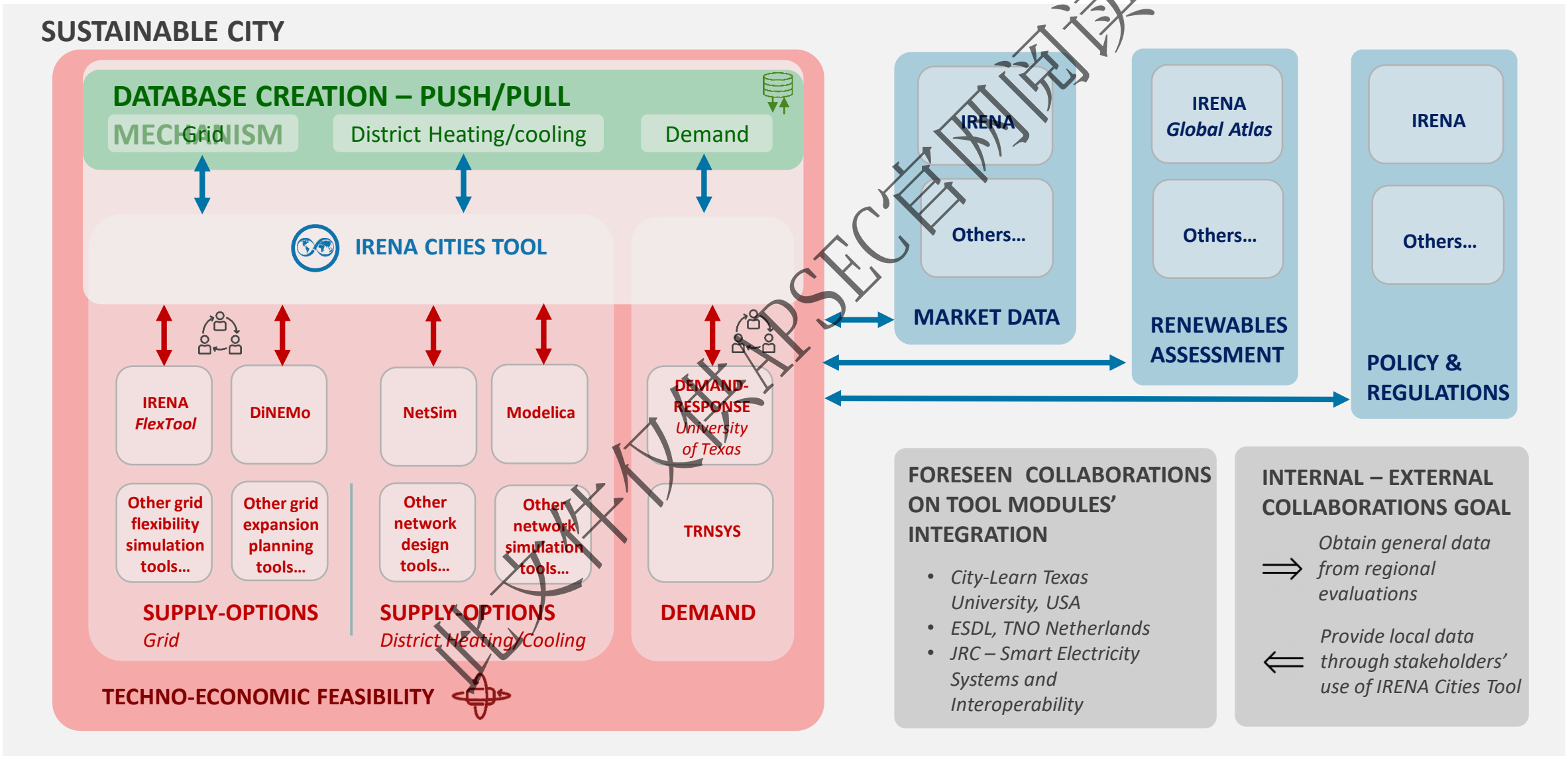


Energy systems design and operation

2. RE supply options

1) *Portfolio of technologies 100% RE or predefined target*
2) *Sector coupling options*
3) *Location of technologies*
4) *Layout of potential district network*

Collaboration for future development



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