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Sector Coupling in Facilitating the Integration of Variable Renewable Energy in Cities

Presenter:

- Yong Chen, Sustainable Urban Energy, IRENA

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SPEAKER

Yong Chen
Programme Officer
Sustainable Urban Energy Team
IRENA

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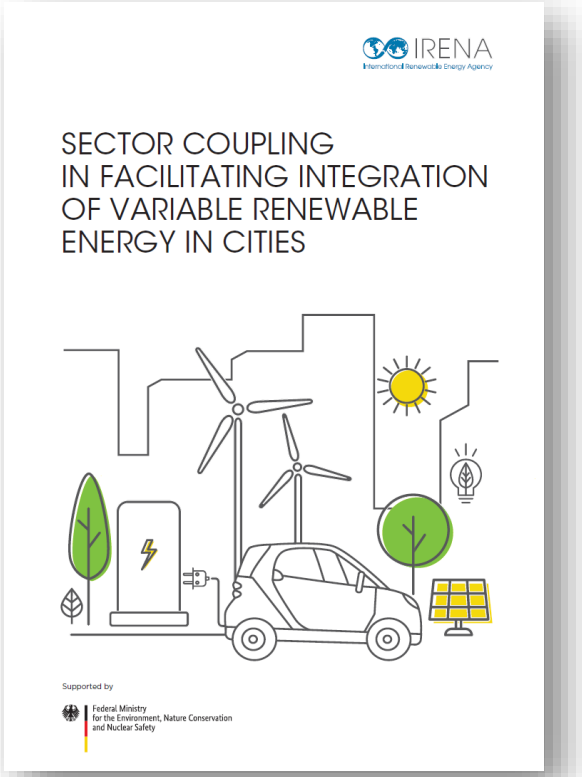
Sector Coupling in Facilitating the Integration of Variable Renewable Energy in Cities

The importance of sector coupling as a key source of flexibility, that cities can explore to stabilise power grid operations when integrating high shares of variable renewable energy sources, and of quantifying sector coupling opportunities



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The importance of cities in shaping global climate action

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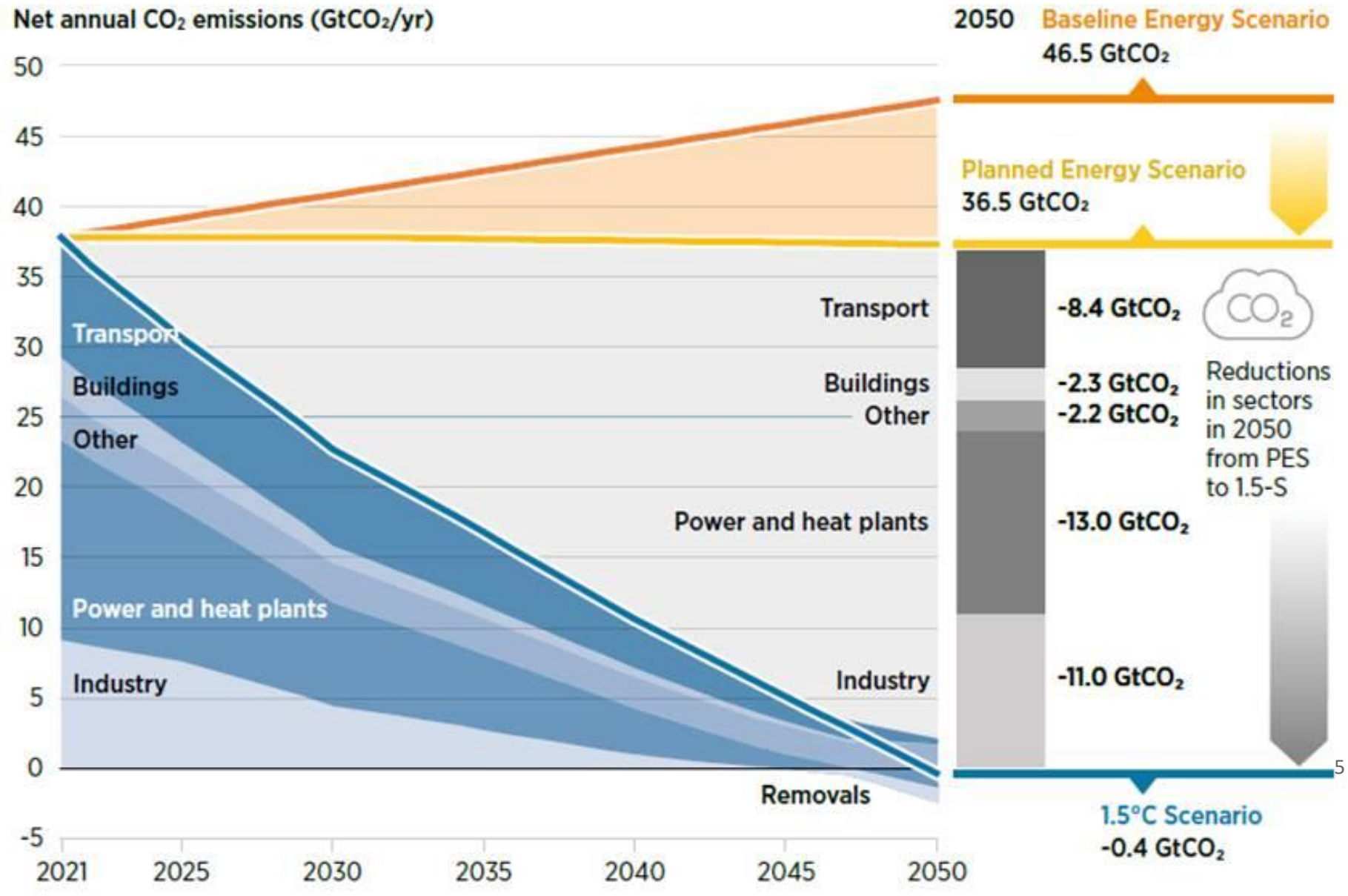
Present

- Over half of the global population lives in cities
- 67-76% of global final energy use
- 71-76% of energy-related CO2 emissions

Future

- 2 out of 3 live in cities by 2050
- Reduced carbon emissions in buildings, transport and industry, power and heating while meeting rising energy demand



Why energy system flexibility is crucial in future?

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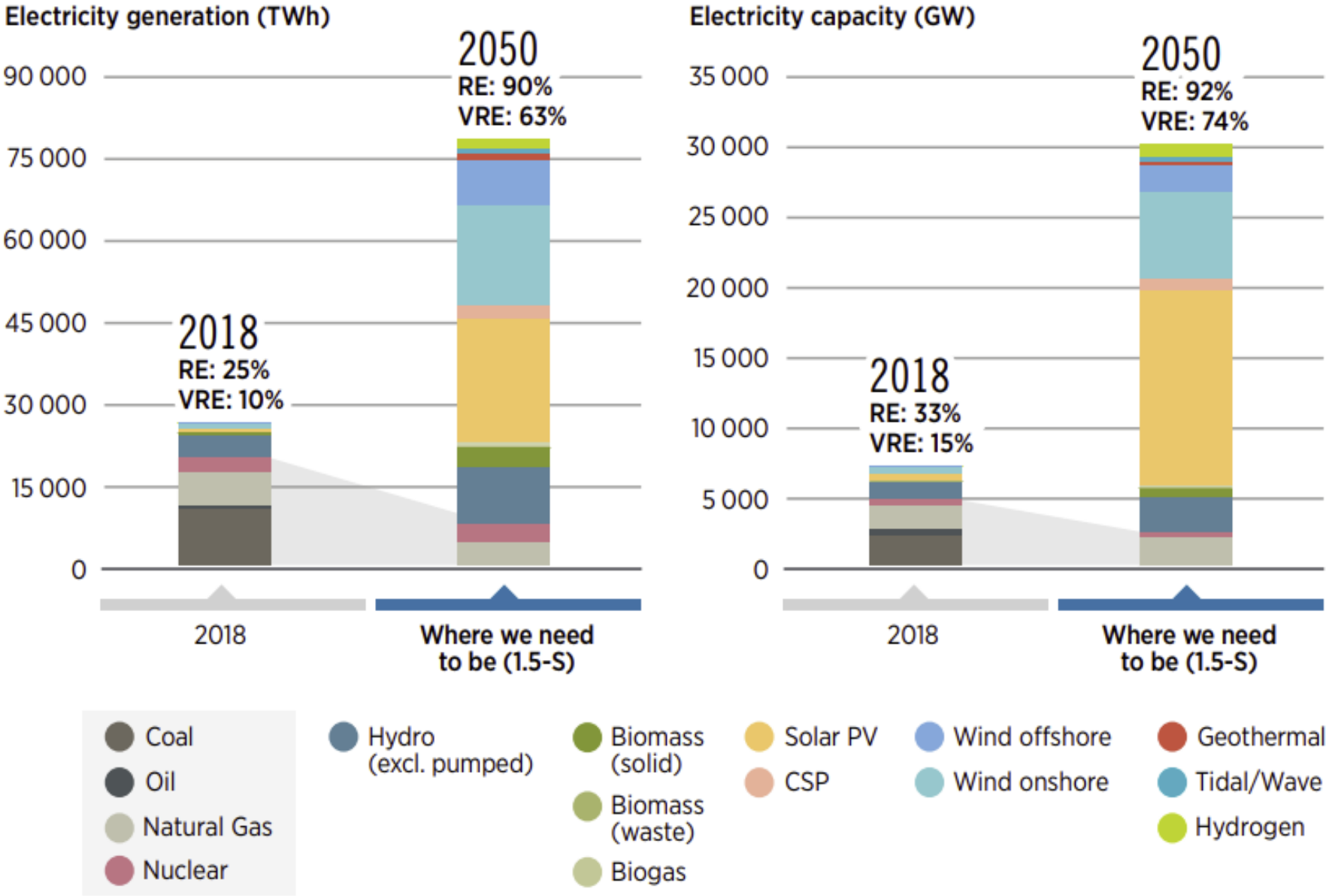
- By 2050, power generation triples compared to today's level, and renewables supply 90% of total electricity up from 25% in 2018.
- VRE: 74% in power generation capacity; 63% in electricity generation.



Sector coupling: evolving from electrification to flexibility

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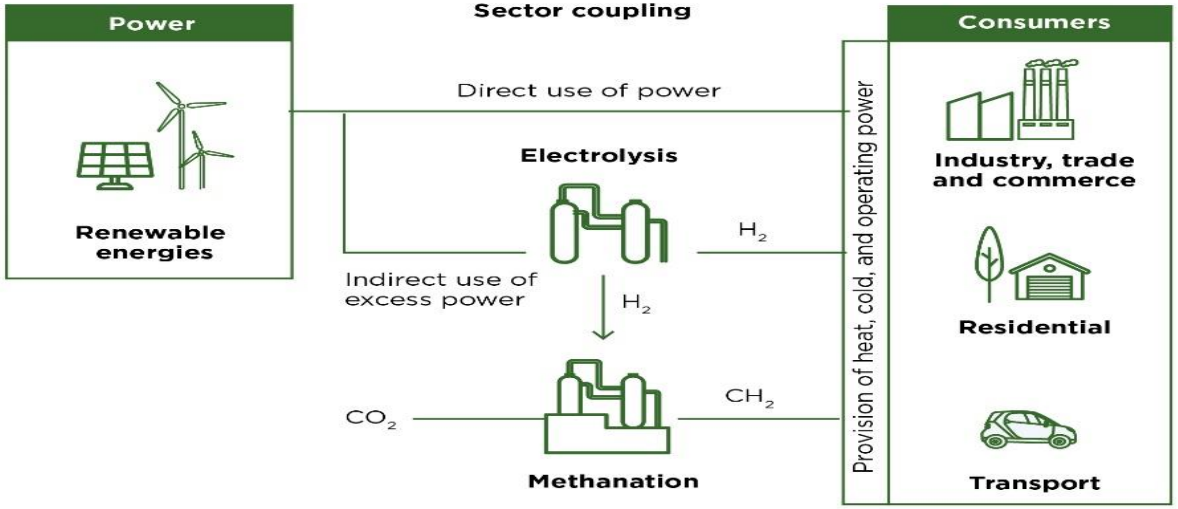
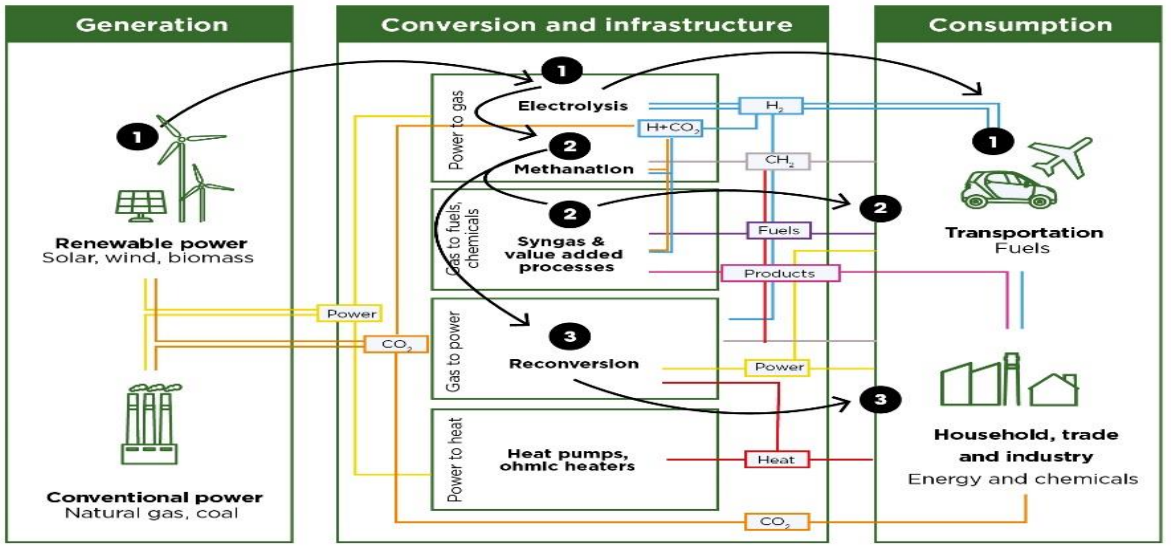
- **What is sector coupling?**
  - no universally agreed definition
  - IRENA: it can be defined as the process of interconnecting the power sector with the broader energy sector (e.g. heat, gas, mobility)

- **Electrification v.s. flexibility**:
  - excess/surplus variable renewable electricity
  - electrification, essentially, is in line with the concept of resource efficiency
  - power system operation: reliable, stable and affordable
  - Growing mismatch between variable REe and uncontrollable demand putting power system operation at risk





How cities can help enhance flexibility?

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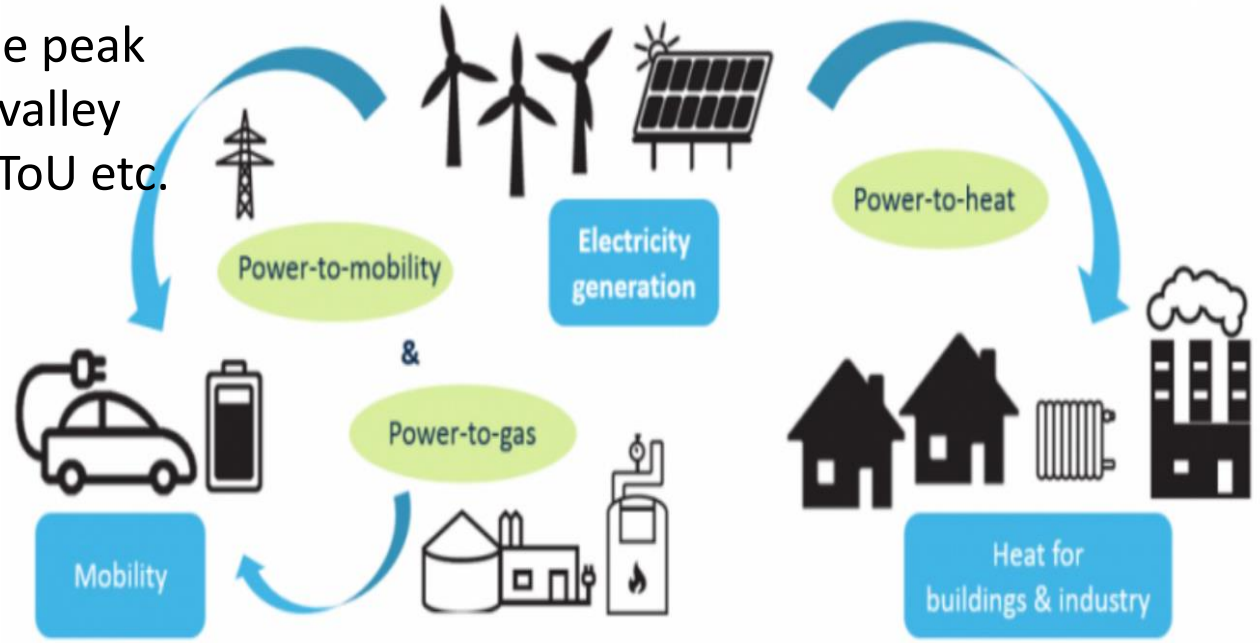
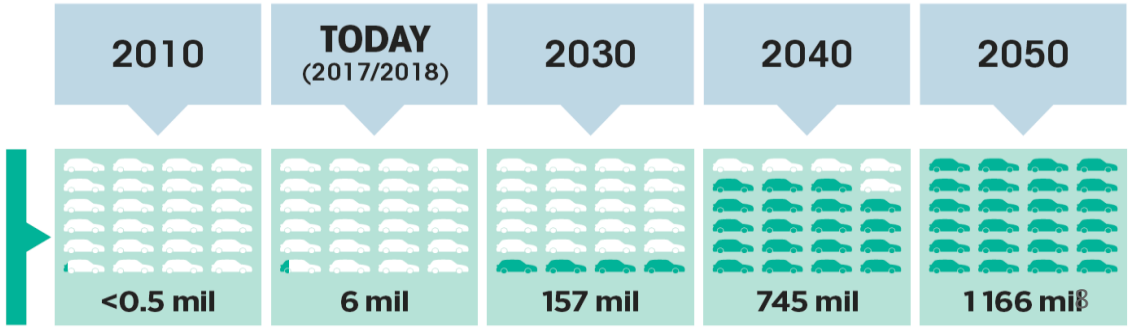
- **Demand side management (conventional)**
  - Aim is to reshape the load profiles to reduce the peak
  - Many techniques such load shedding, shifting, valley filling, energy efficiency and conservation, DR, ToU etc.
- **New elements in enhancing flexibility**:
  - Aim is to reshape the load profiles to match the REe generation curves
  - Sector-coupling technologies/strategies
  - System inter-operationality
  - market designs
- **Smart charging for EVs** holds potential of 14 - 9 TWh battery storage capacity to provide grid services by 2050
- **Thermal Energy Storage** for district heating and cooling and for individual buildings among end-users





Interconnected systems through coupling technologies

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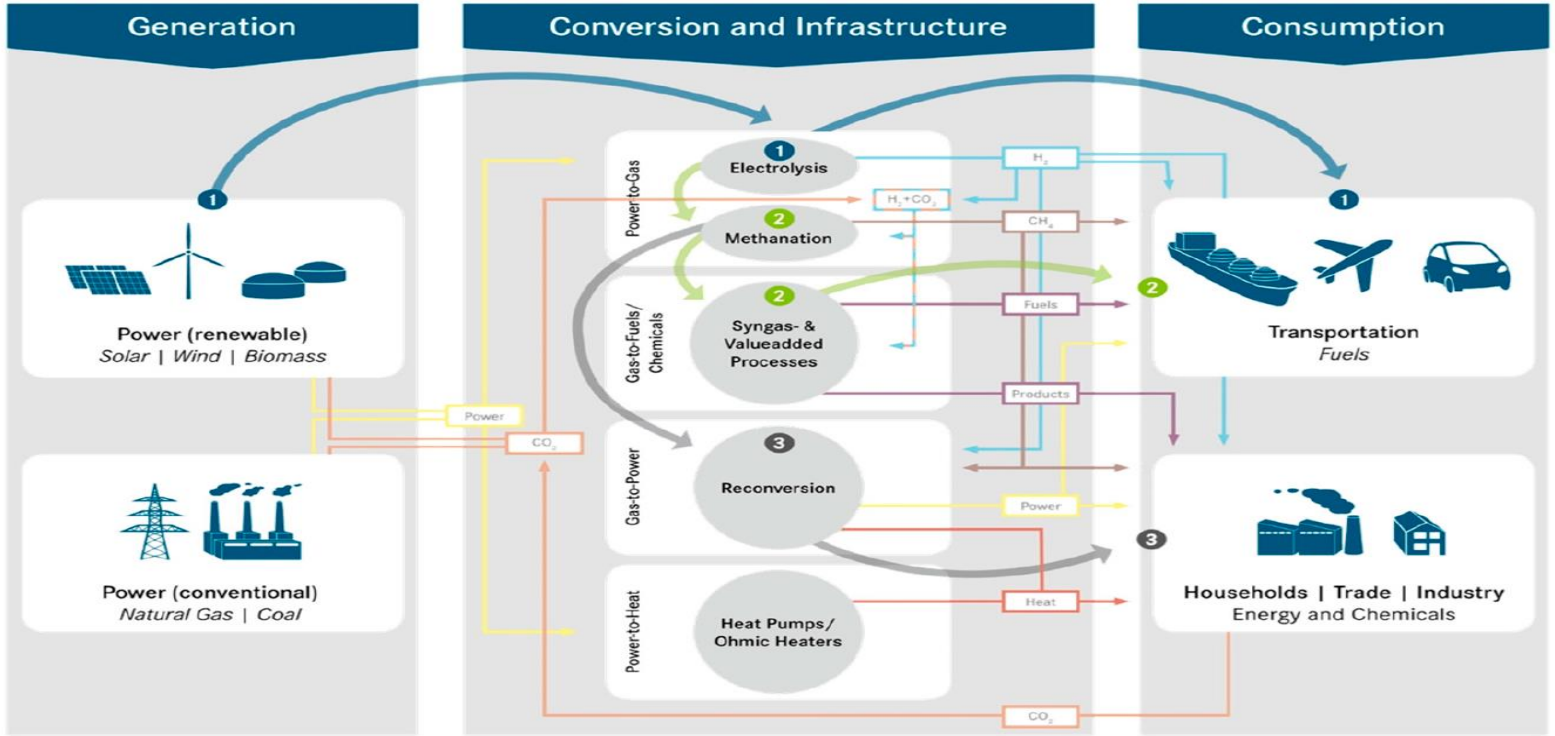
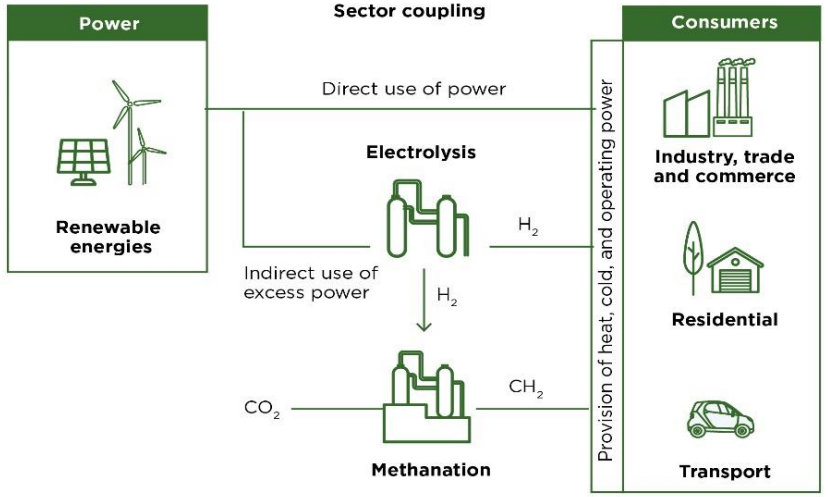
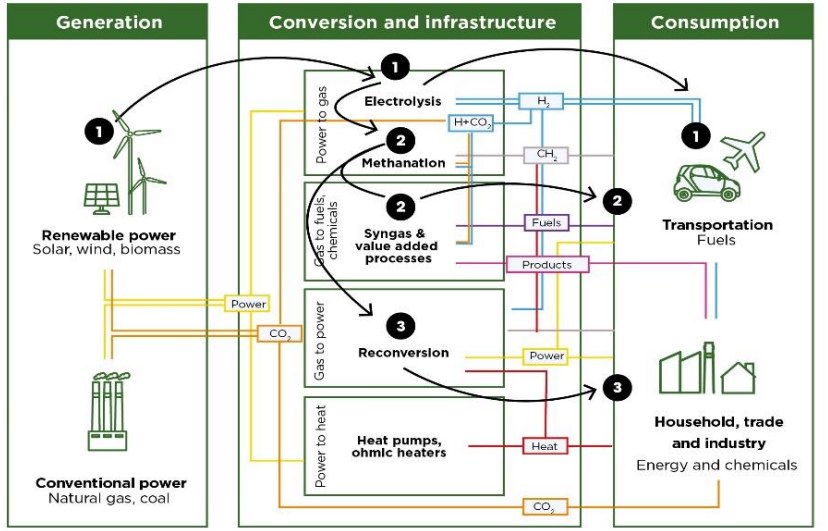
- Conventional demand response remains effective for power system operation
- Coupling technologies (e.g. power-to-X, electrification of heating and transportation) offer additional options to unlock greater flexibility potential on demand side (in industrial, building and transport sectors)
- Yet, the interconnected systems operation must be smart and intelligent







Source:(Robinius, Otto, Heuser, & Welder, 2017)

IRENA's planning platform for cities

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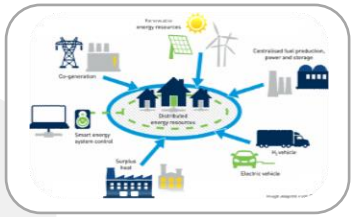
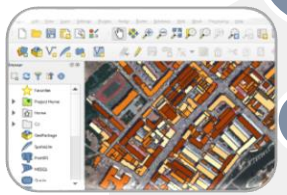
Demand assessment



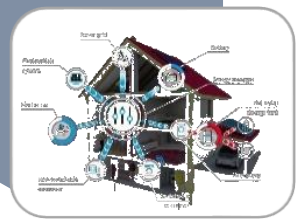
Operating strategy
- Sector coupling
- Building system
- Trade-offs retrofitting
- Long-term planning



RE local potential

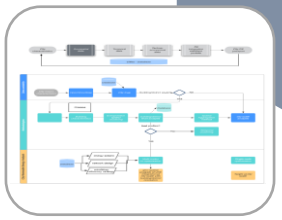
IRENA's tool for urban energy systems

Solution design
- Energy system
- Building system



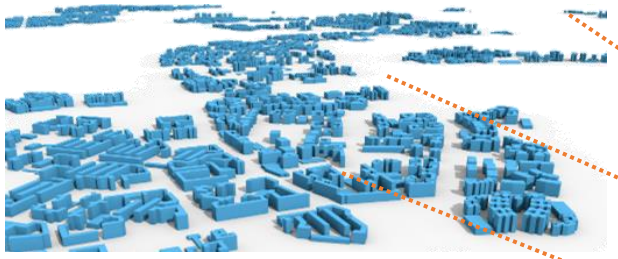
Portfolio of energy solutions

Methodology selection based on data availability



- Sustainability
- Heating and cooling
- Energy efficiency
- RE technology

City-level



INDUSTRY

CO2 EMISSION REDUCTION

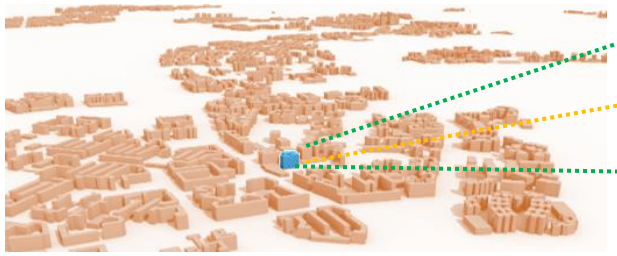
MOBIILITY

District-level

DISTRICT HEATING AND COOLING

ENERGY STORAGE

Building-level

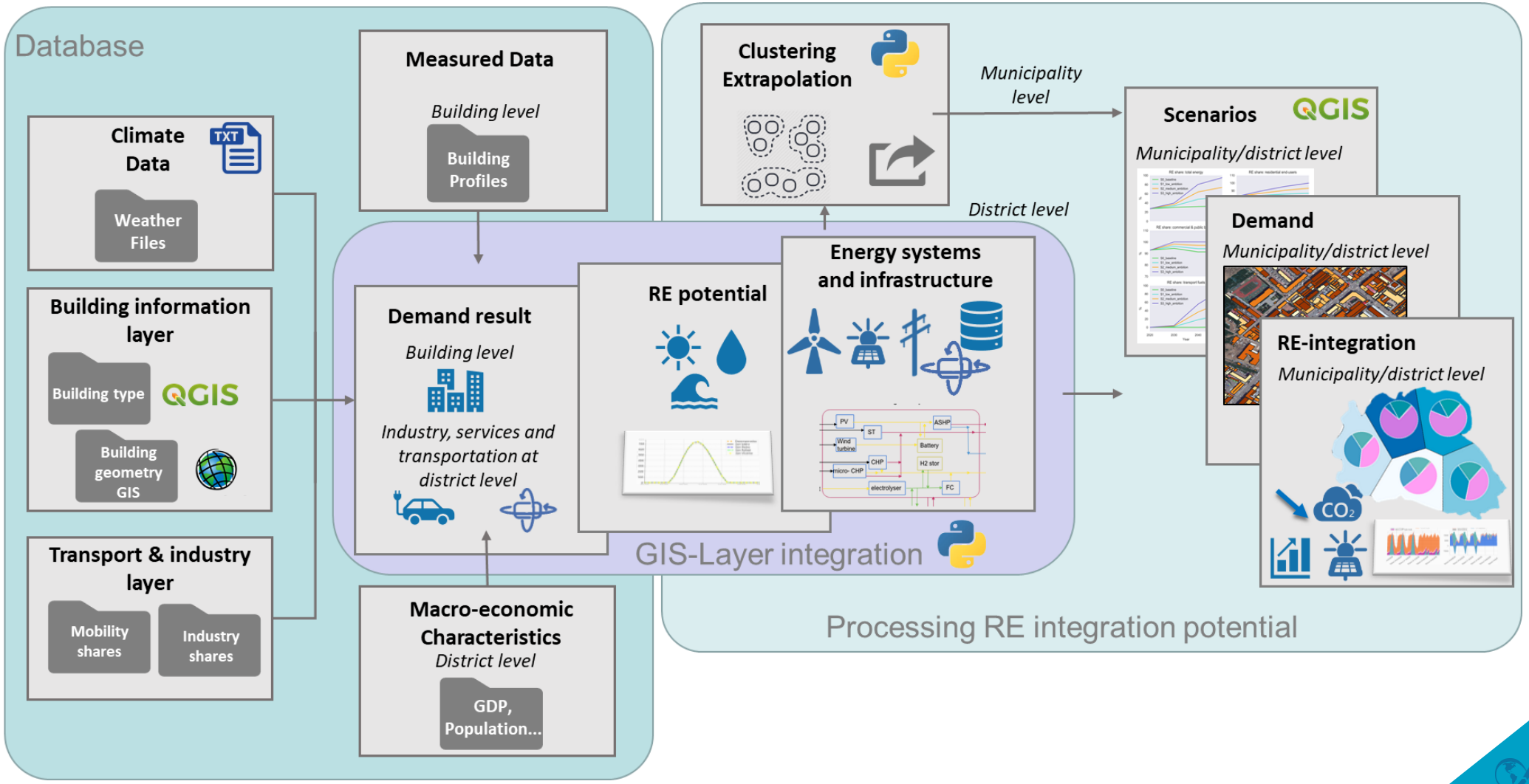


SMART LIGHTNING

ROOFTOP PV

RETROFITTING

Overview Methodology



RE planning platform for cities

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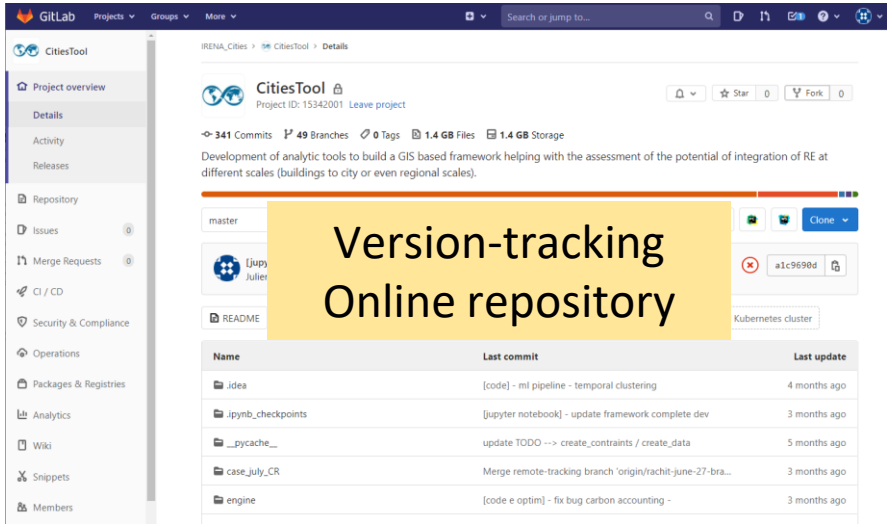
About the Tool

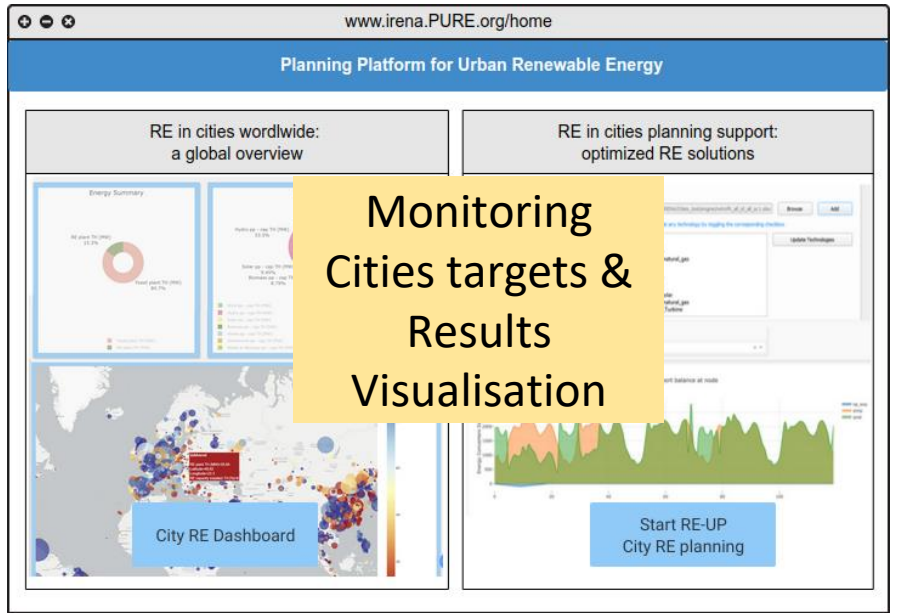
Modular: A variety of in-depth customization options are also available such as the input of specific electricity profiles and tariffs, specific urban building stocks, network design constraints, etc.

User-friendly: the plug- in is developed in a very intuitive user-friendly and interactive manner making use of dropdown menus, easy input data fields and an interactive map to visualize the current status and the results of the chosen analysis

Version-tracking: The tool uses a git repository, which creates a collaborative environment to foster the expansion of the tool and its usage.



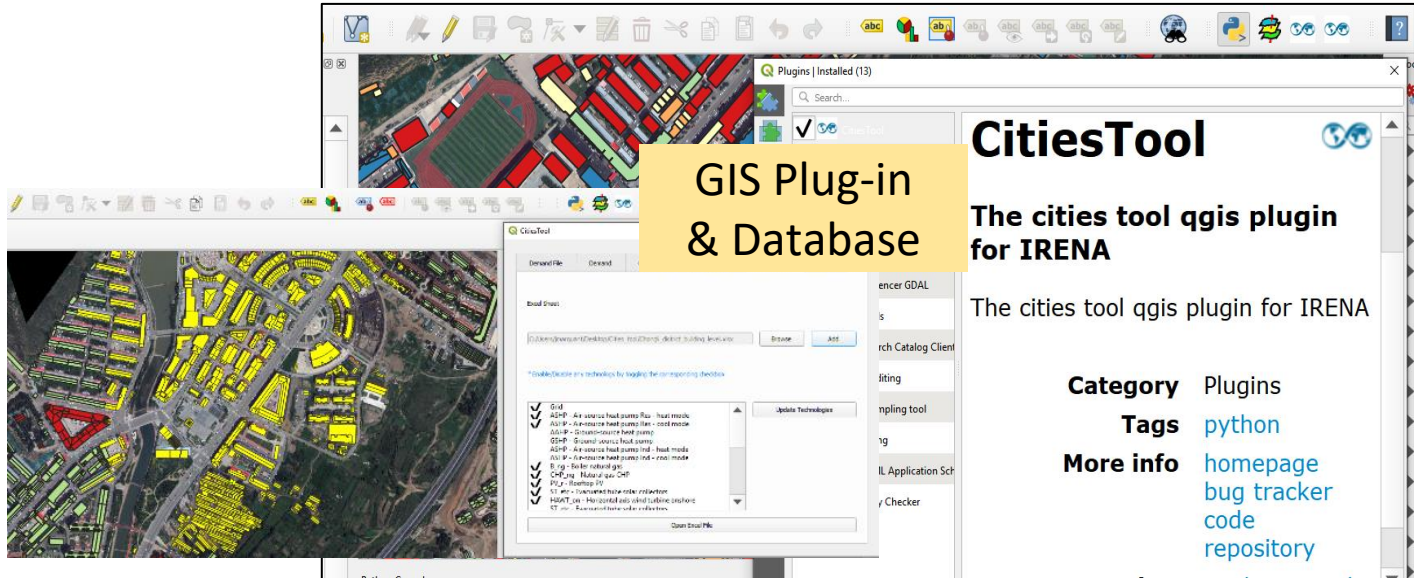
Version-tracking
Online repository



Monitoring
Cities targets &
Results
Visualisation

Key open-source packages & software

- GitLab
- Q-GIS & database
- Python distribution
- Sketchup
- Energy Plus
- Solver - Gurobi



GIS Plug-in
& Database

PURE platform – Overview

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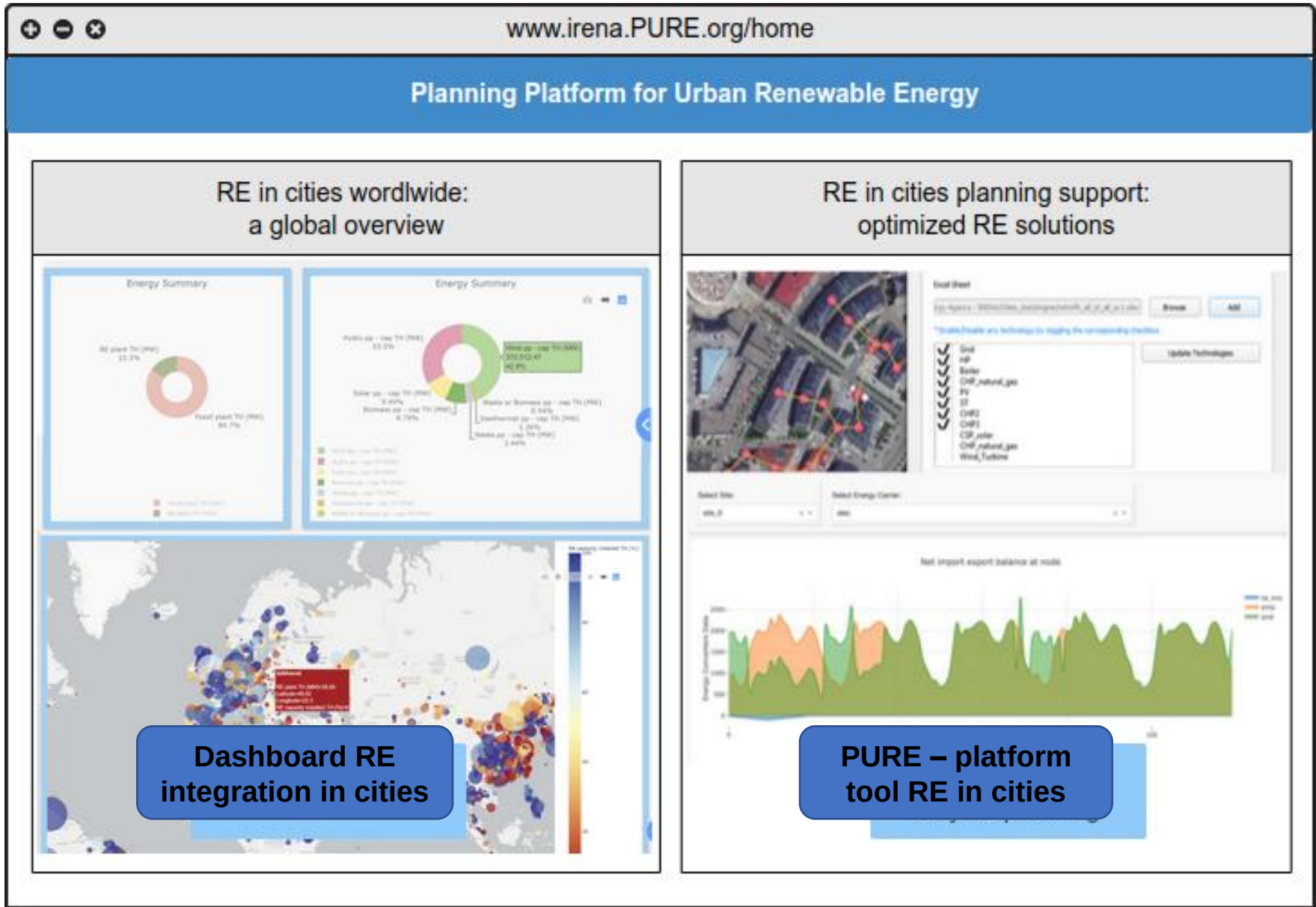
- An overview of cities renewable energy deployed capacity, and long-term RE targets is provided.
- A platform for the analysis of multi-energy systems integration, assessing optimal pathways for the deployment of renewable energy in cities.



Case study: reaching 100% RE in Chongli through cross-sectorial measures

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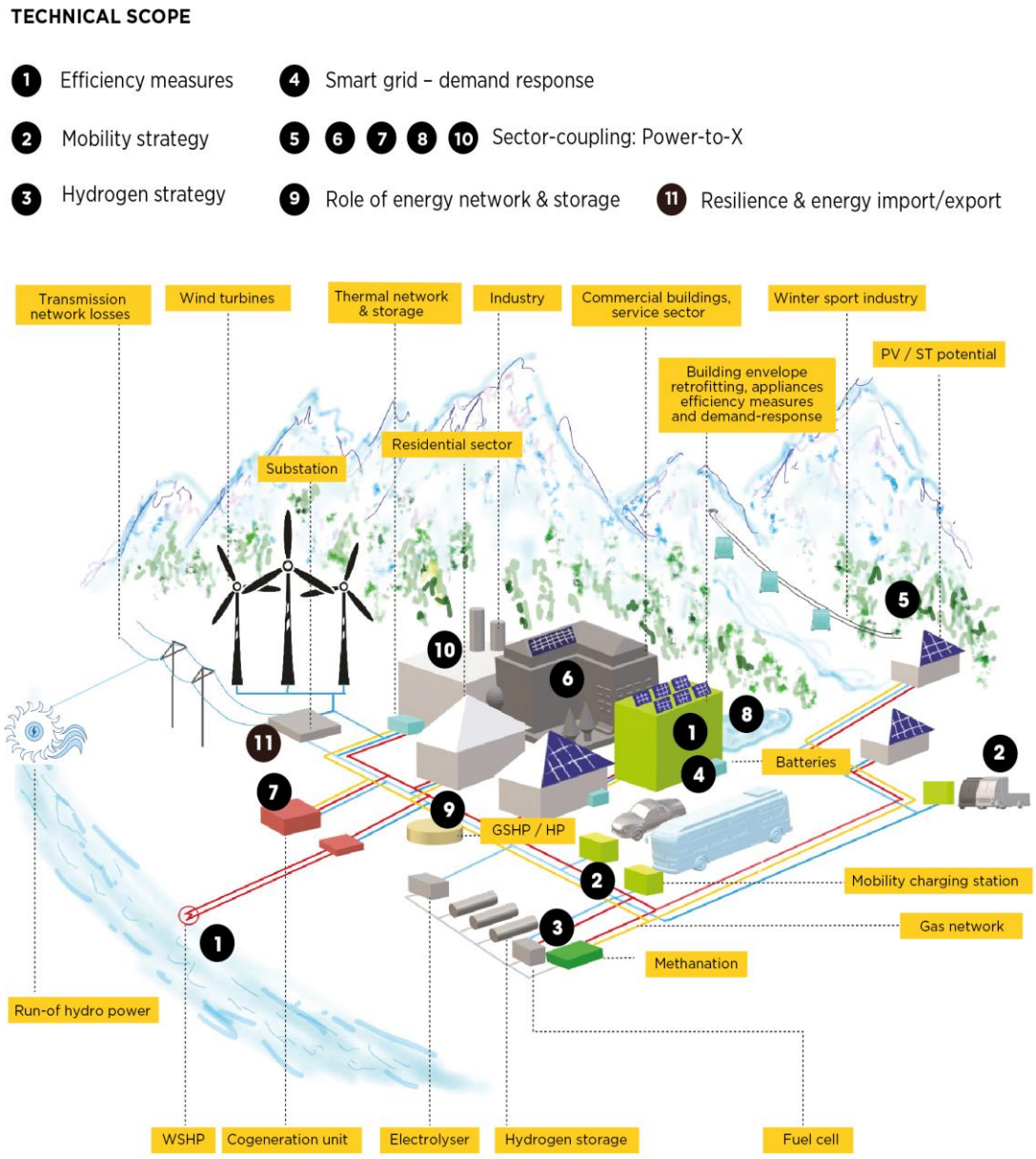
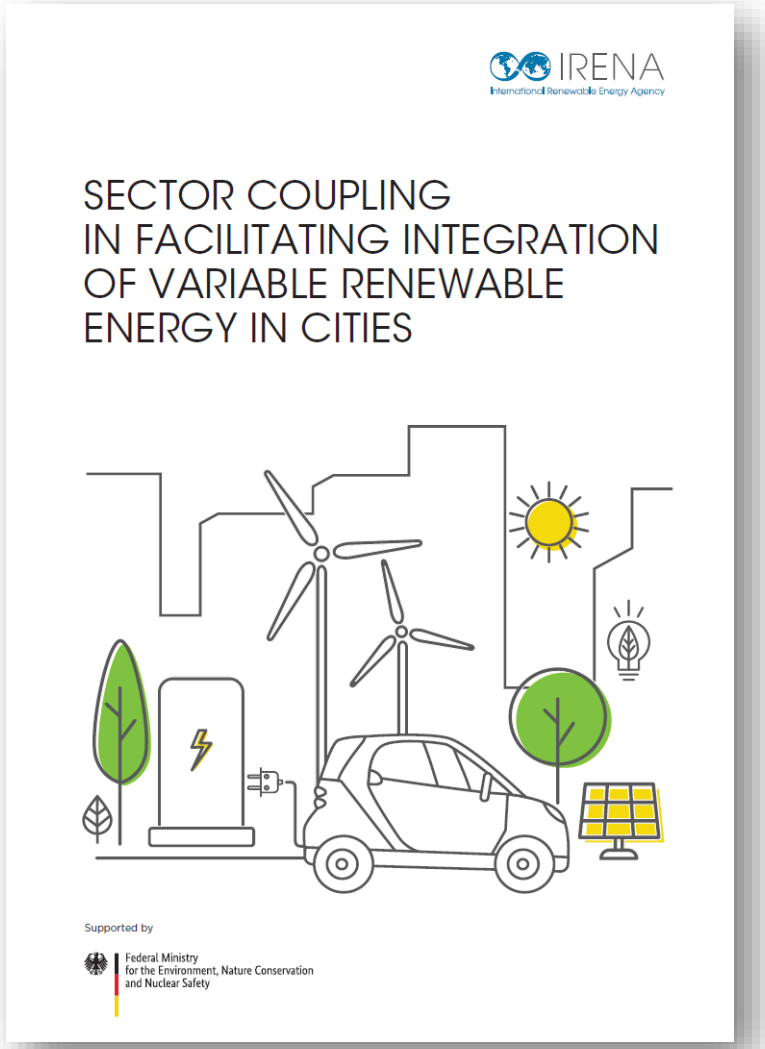
- Energy efficiency is always the first option and could play an enabler role for sector coupling. Improving the building energy performance can save Chongli up to 37% of the final energy consumption by 2050.
- Decarbonising the heating systems through sector coupling with estimated 360GWh of surplus electricity consumed for the heating purpose.
- Sector coupling options in the public transport sector (electrification and green hydrogen fuel cell) with different cost implications
- Power-to-hydrogen option is due to climatic factor (cold climate) and in view of grid flexibility with energy storage capacity and other applications.





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Q & A
10 min

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