ICCS-NTUA

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PLAN. INNOVATE. ENGAGE

Research and Innovation Priorities for facilitating the Energy Transition and the realization of the future Smart Island Energy Systems

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PANTERA Regional Workshop – 13 February 2020, Athens

ETIP SNET's mission

2016

- **Set-out a vision for RD&I for Smart Networks for Energy Transition** and engage stakeholders in this vision.
- **Prepare and update the Strategic Research and Innovation Roadmap**.
- Report on the **implementation of RD&I activities at European, national/regional and industrial** levels.
- Provide **input to the SET Plan action 4** which addresses the technical challenges raised by the transformation of the energy system.
- **Identify innovation barriers**, notably related to regulation and financing.
- Develop enhanced knowledge-sharing mechanisms that **help bring RD&I results to deployment**.
- Prepare **consolidated stakeholder views** on Research and Innovation to European Energy Policy initiatives.

ETIP SNET's stakeholders

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- Transmission System Operators (TSOs)
- Distribution System Operators (DSOs)
- National Representatives
- Research & Academia
- Storage (technology and services providers)
- Consumers (aggregated and not aggregated)
- Thermal Generation (flexible)
- Renewable Energy Sources Generation
- ICT, Network and Software providers
- Equipment manufacturers and suppliers (non-ICT)
- Interface to Other Energy Carriers (Heat, Transport, Gas, ...)
- Regulators

ETIP SNET's organisation

European Commission

Governing Board
(30+ members representing key European stakeholders)

Exco (9 members)

ETIP SNET Secretariat
(Intensys4EU)*

Experts coordination
via Working Groups
(5 permanent WGs)

National stakeholders coordination
(Ministry representatives, funding agencies, regulators, national platforms)

* Intensys4EU is a coordinating consortium formed under the European Commission's Horizon2020 initiative which supports ETIP SNET in delivering RD&I monitoring reports, Roadmaps and implementation plans.

WG1
Reliable, economic and efficient smart grid system

WG2
Storage technologies and sector interfaces

WG3
Flexible Generation

WG4
Digitisation of the electricity system and customer participation

WG5
Innovation implementation in the business environment

NSCG
National Stakeholders Coordination Group

THREE GOALS OF EU ENERGY POLICY

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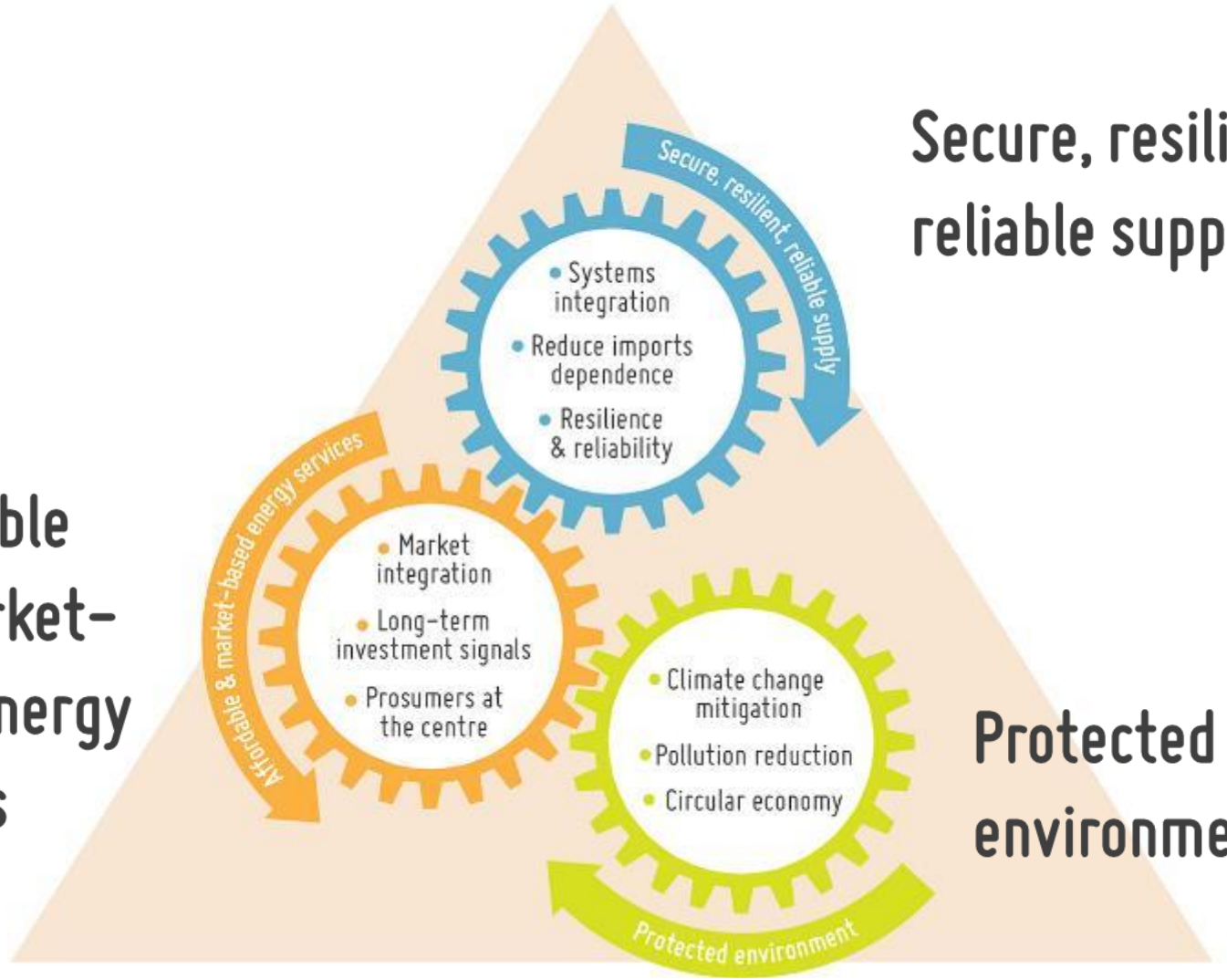
Secure, resilient, reliable supply



Affordable and market-based energy services

Protected environment

2050 VISION GOAL

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A low-carbon, secure, reliable, resilient, accessible, cost-efficient, and market-based **pan-European integrated energy system**

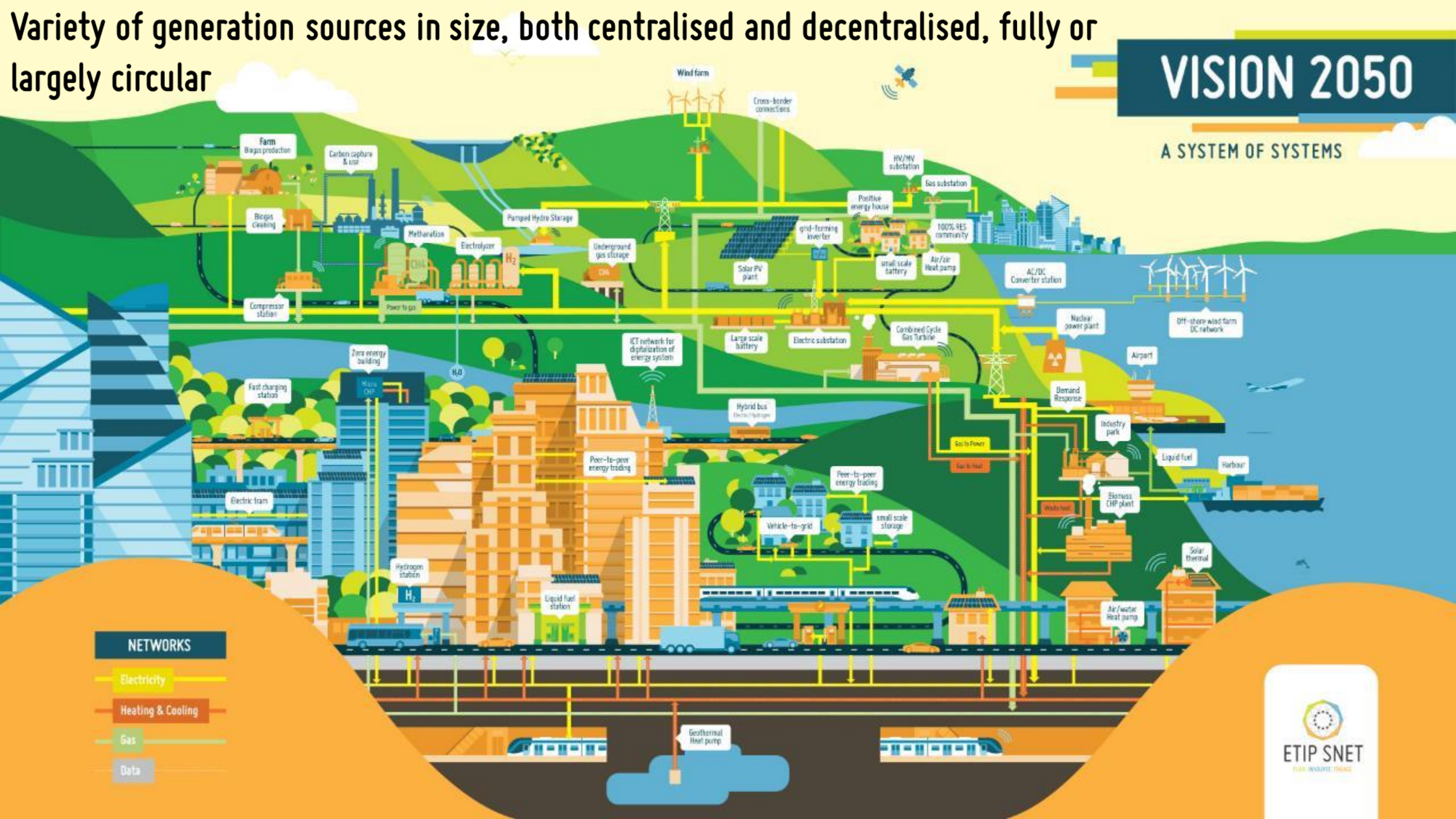
supplying the whole economy and paving the way for a **fully CO2-neutral and circular economy by the year 2050**,

while **maintaining and extending global European industrial leadership** in energy systems during the energy transition.

VISION 2050

A SYSTEM OF SYSTEMS

Variety of generation sources in size, both centralised and decentralised, fully or largely circular



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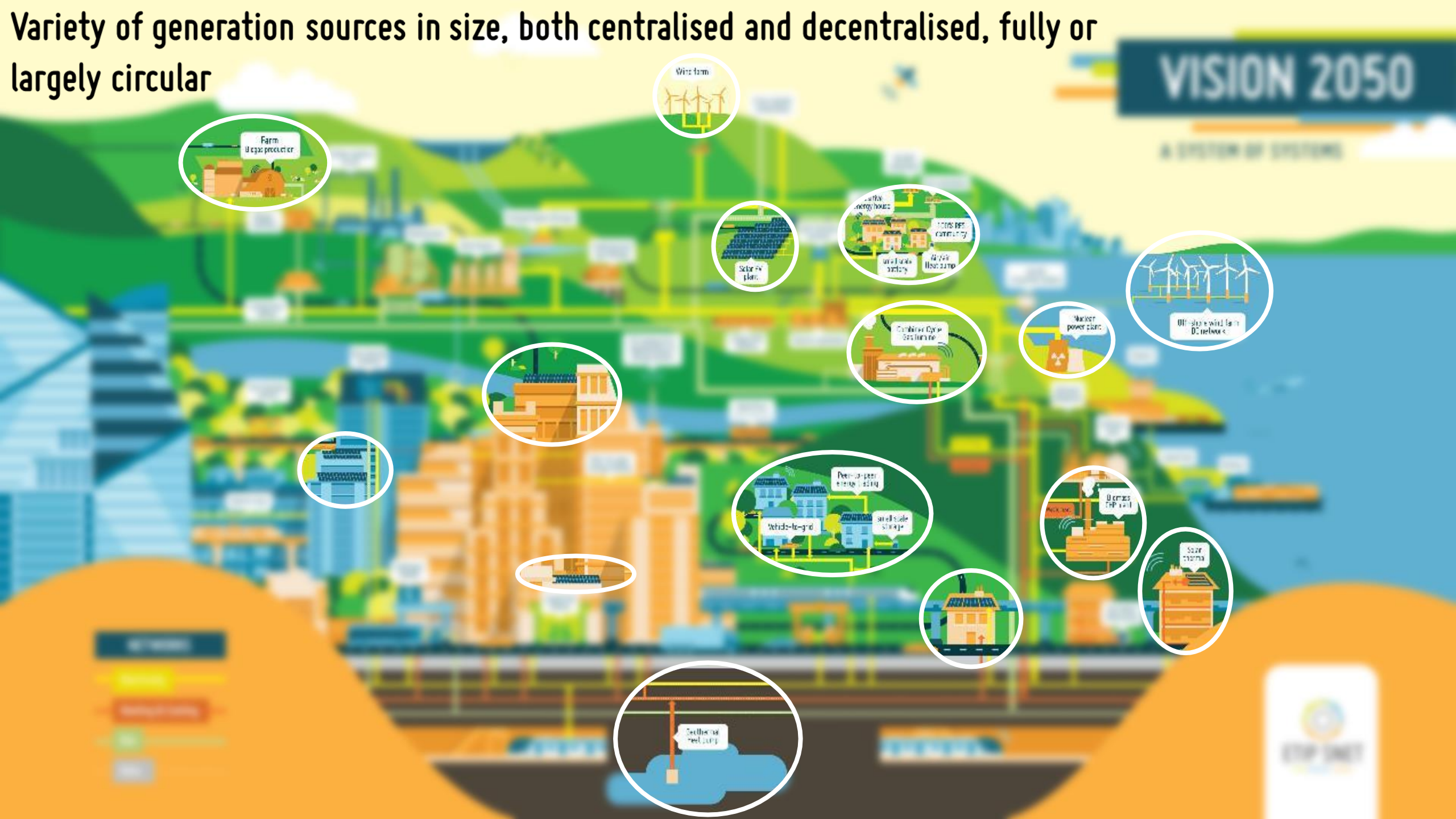
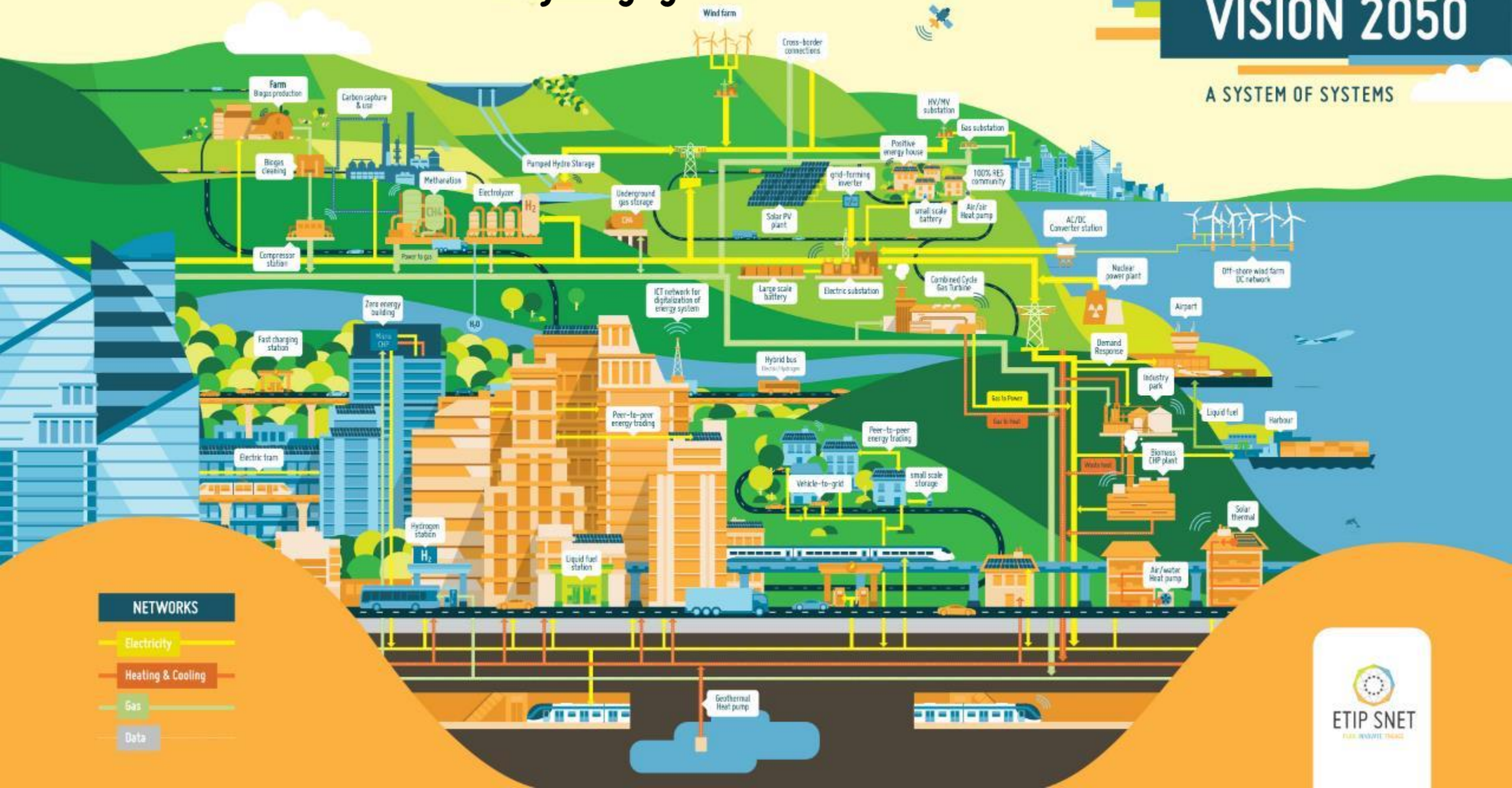


In 2050 the Customer is fully engaged



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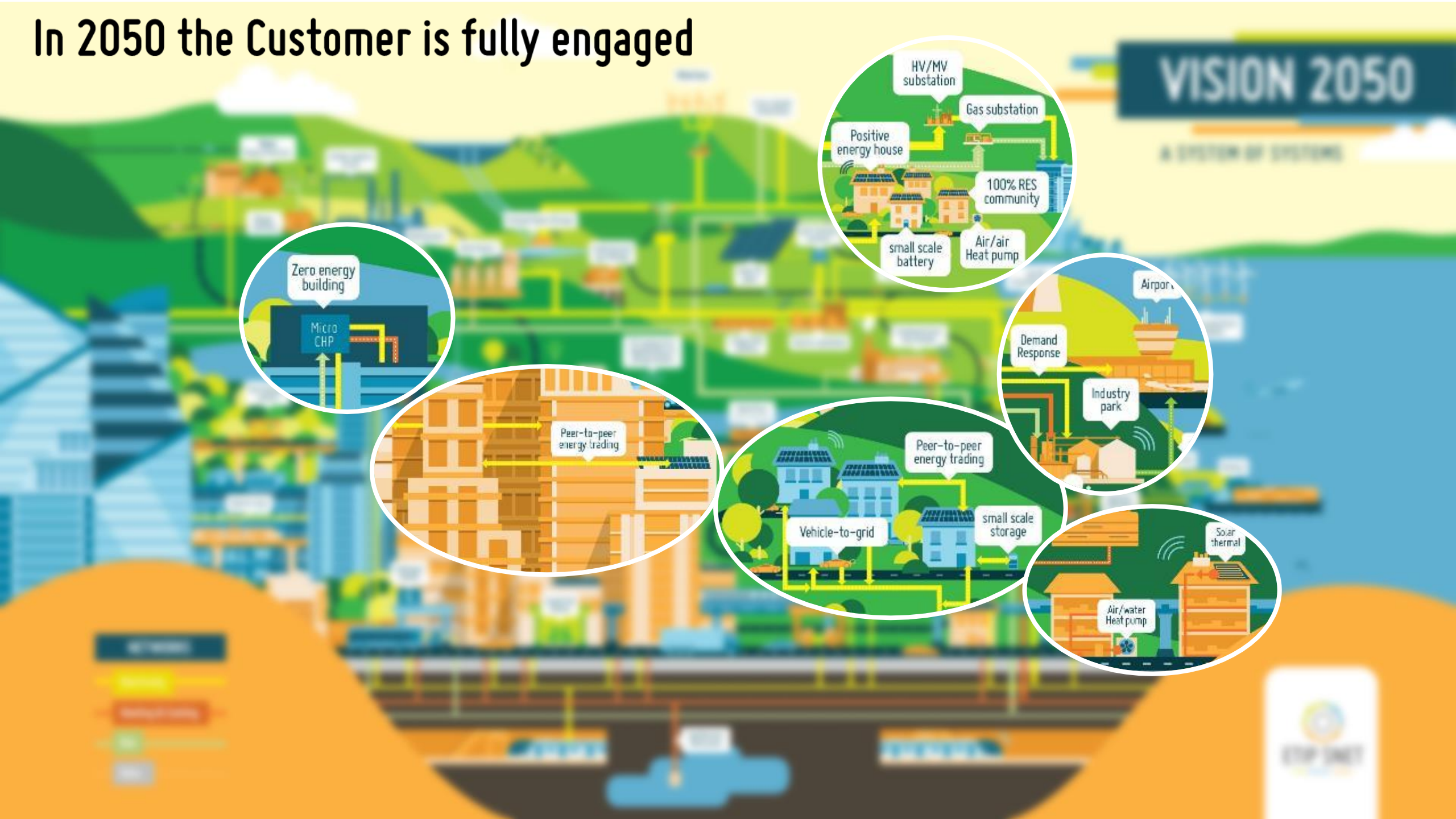

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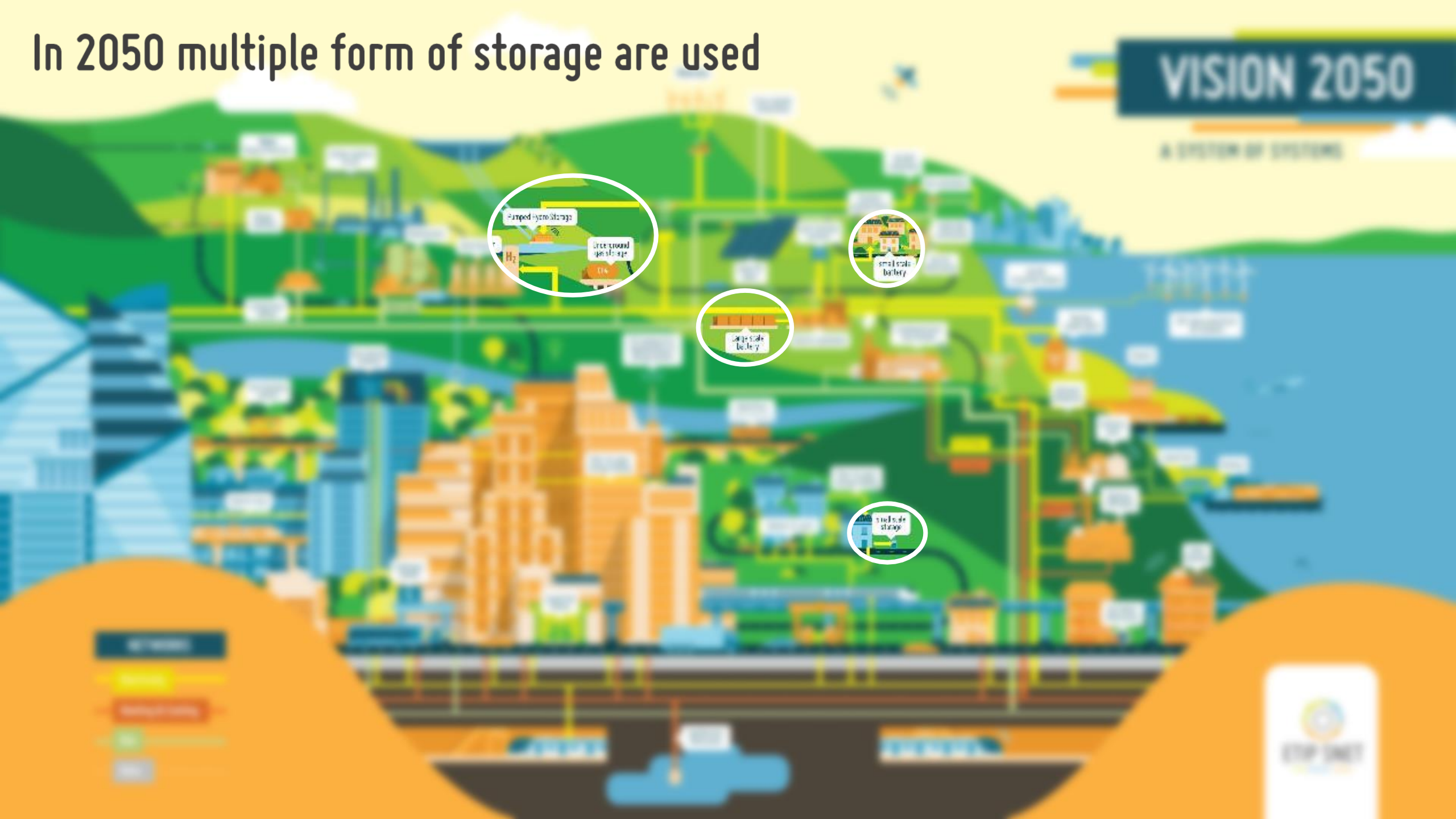

Conversion technologies are widely needed

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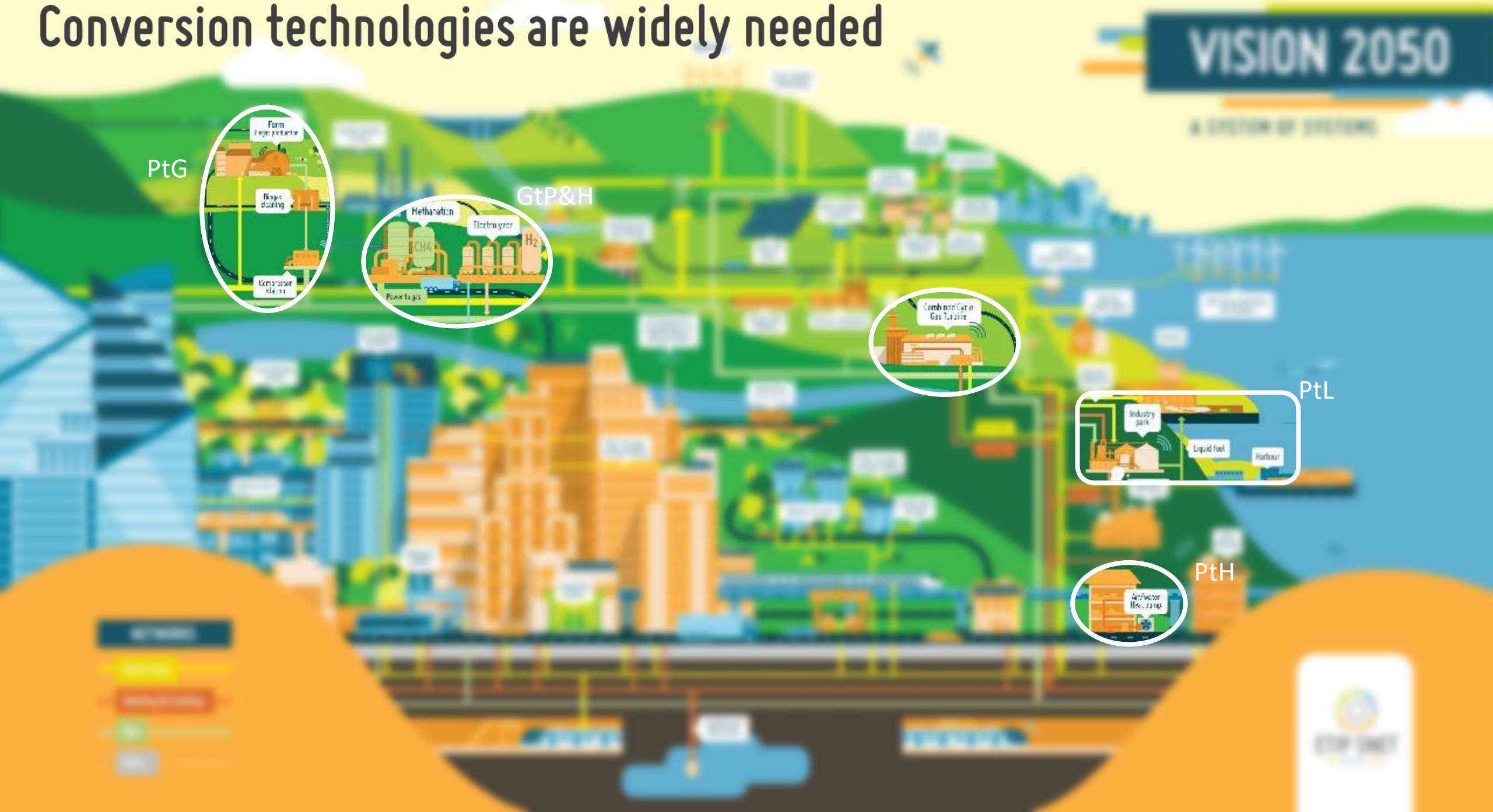
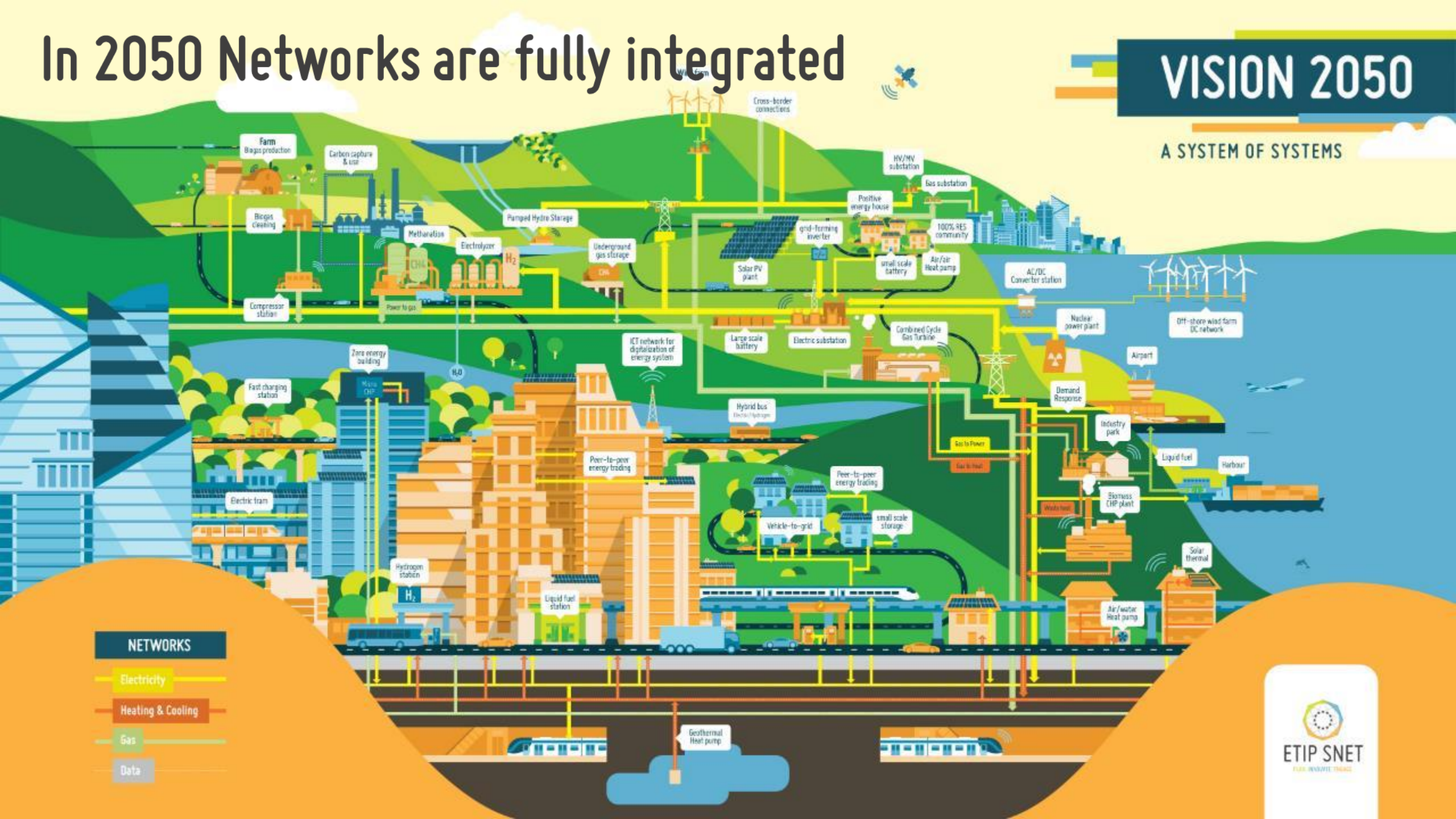


In 2050 Networks are fully integrated

VISION 2050

A SYSTEM OF SYSTEMS



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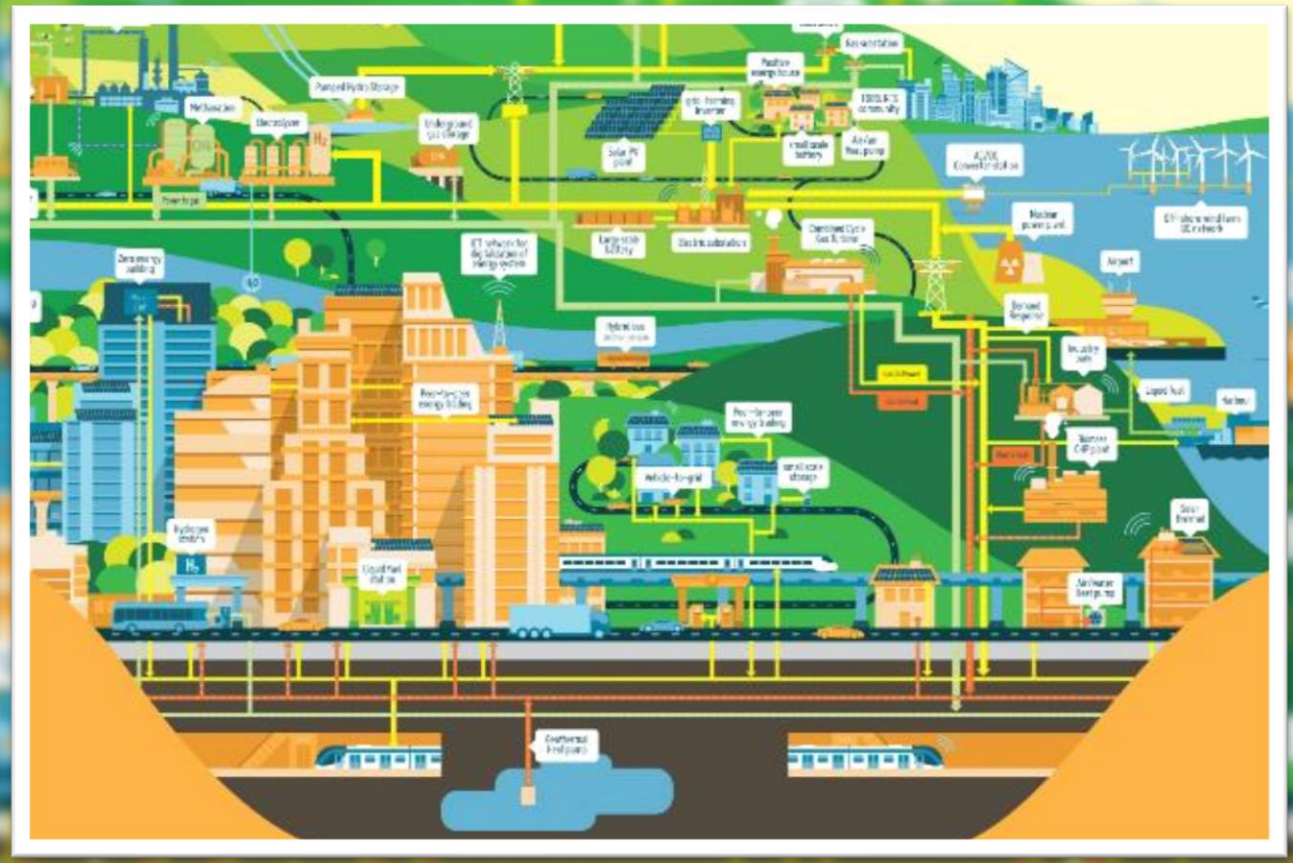

VISION 2050

A SYSTEM OF SYSTEMS

NETWORKS

Electricity

Heating & Cooling

Gas

Data

In 2050 Digitalisation is all around

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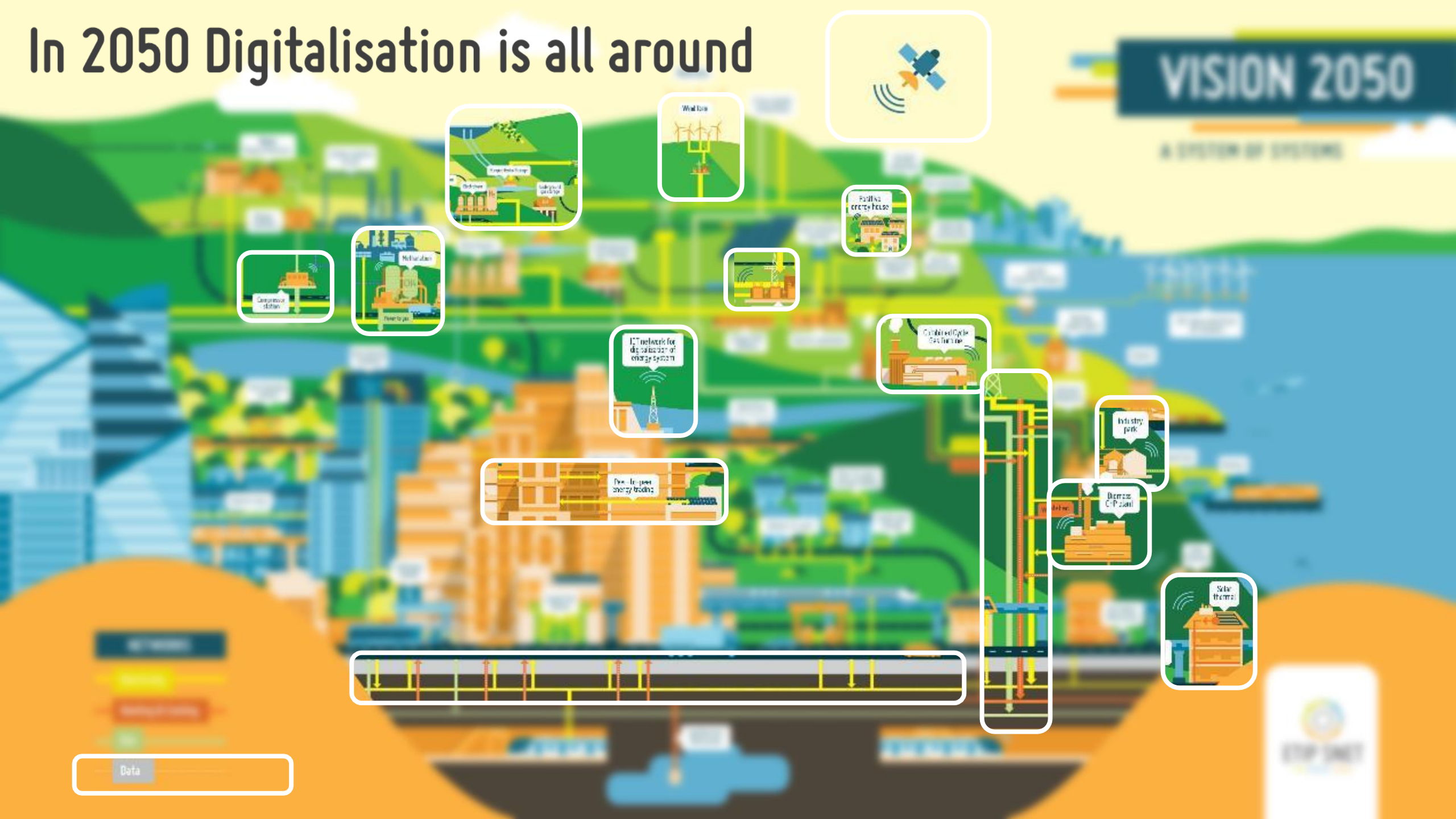

Vision 2050

Building Blocks:
The Ingredients of the Vision

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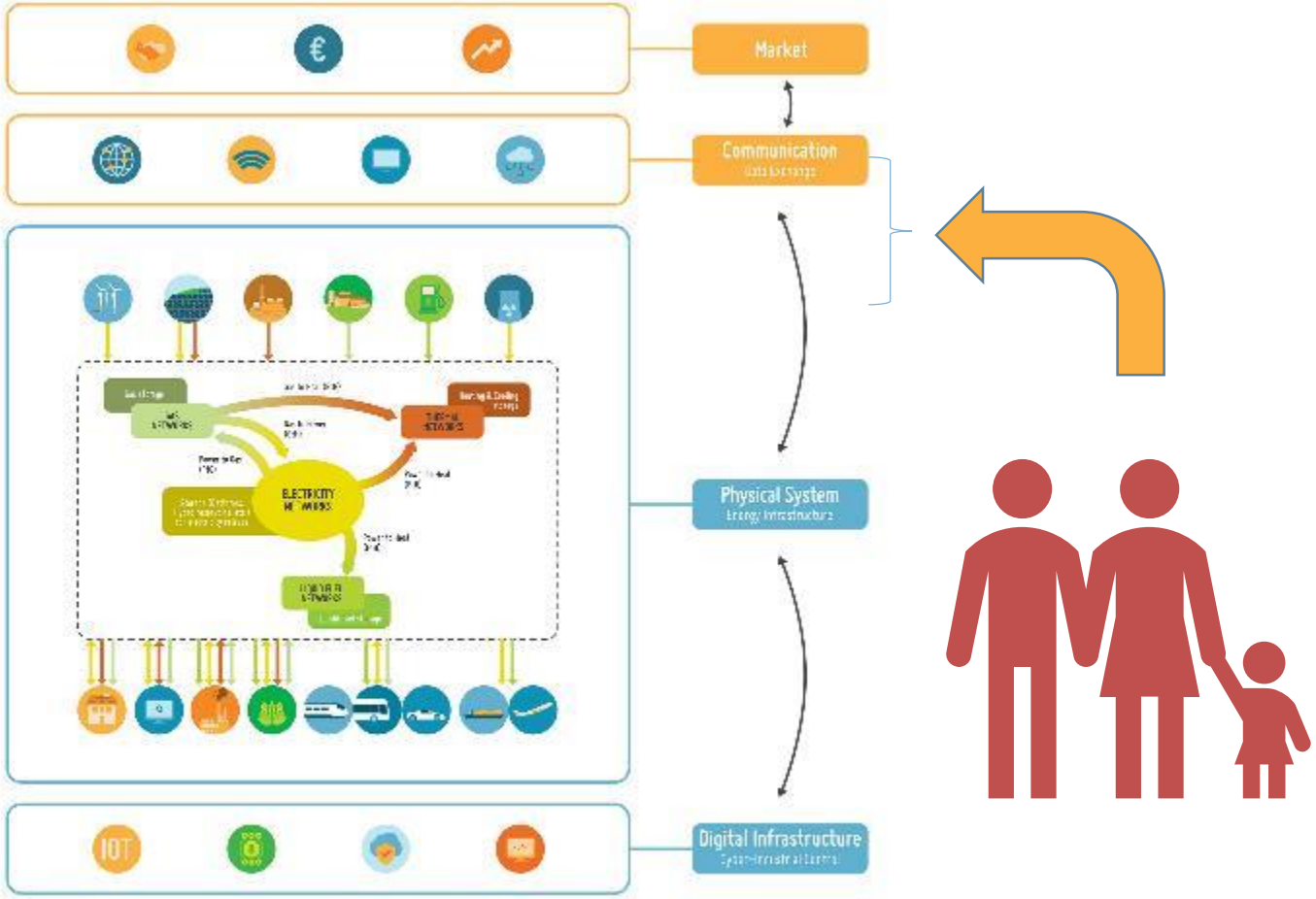
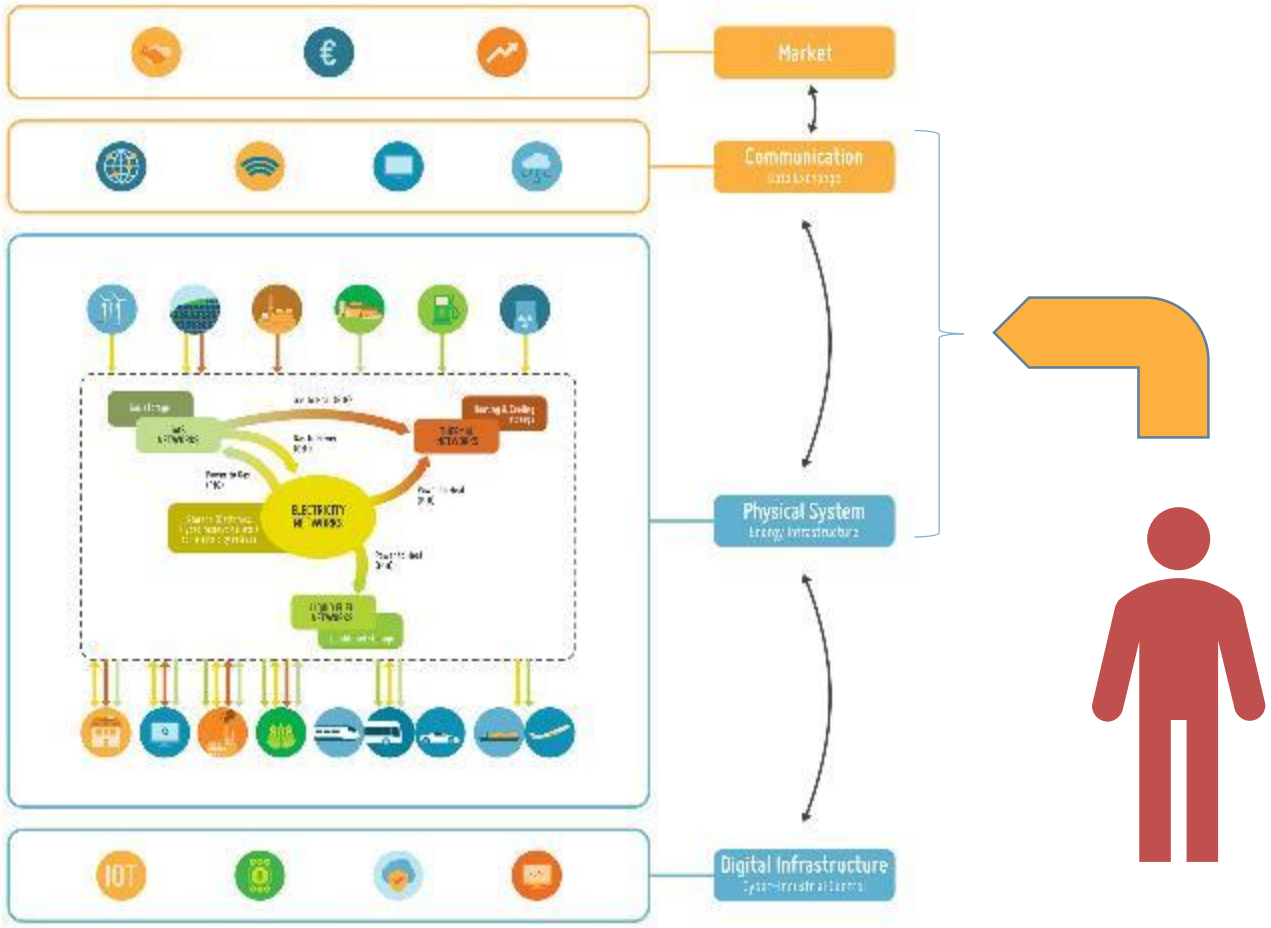
Customers and Markets ...



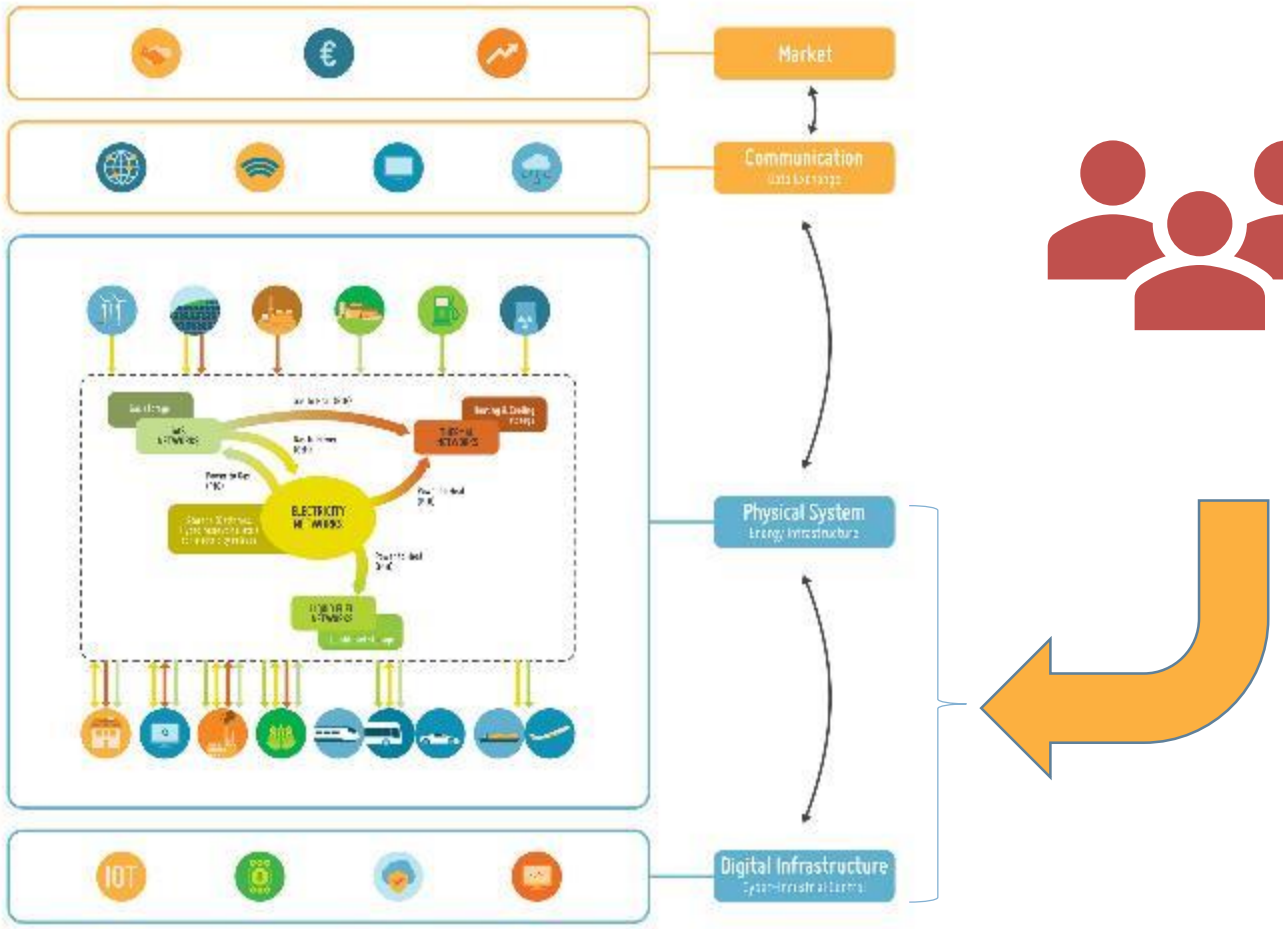
- **enable price-based coordination**: based on wind, sunshine, and cost-reflective customer choices (no subsidies any more)
- **enable diverse use of resources**: optimal use of renewable resources, weather and demand across Europe.
- **enable use of biomass and synthetic gas**: must be integrated efficiently (with hydro, ocean and nuclear energy)
- **enable end-use value**: for industrial processes or for aviation, shipping and long-distance trucking.
- **enable daily or seasonal energy storage**: Value of energy in storage, from seasonal to hourly

Customer, Communication, Digitalisation



- **Information:** IoT with smart meters and sensors for real-time monitoring and control
- **Analytics:** Data mining, machine learning, digital twins
- **Connectivity**: Massive data exchange including M2M

Customer, Physical System and Digital infrastructure

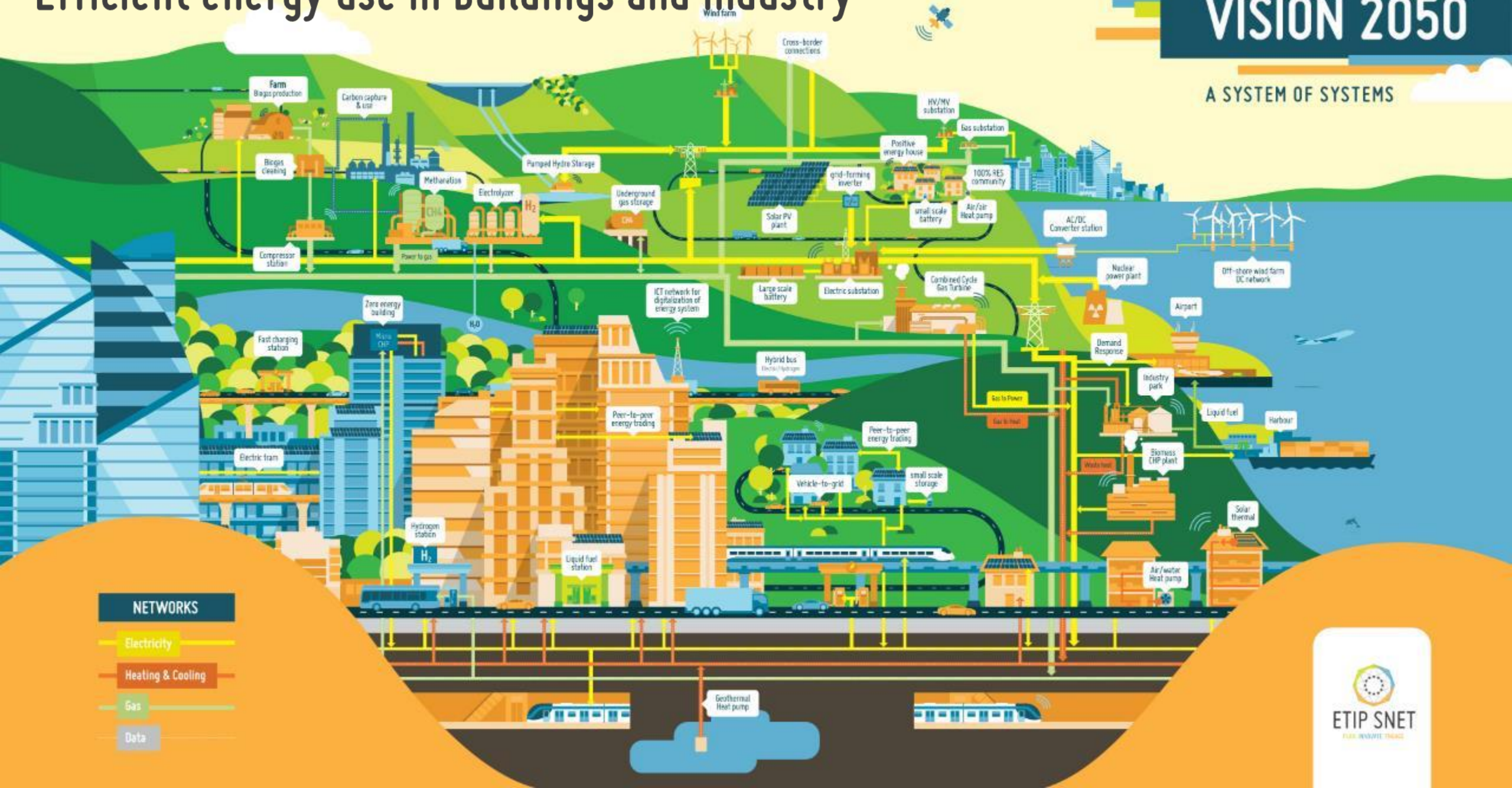


- **Enable cooperation**: TSO & DSO, both electricity and gas, from building to pan-european (and heat/cooling district/locally)
- **Enable subsidiary**: Actions are optimised at the most immediate level. Actions that cannot be handled locally are handled at the next level.
- **Enable automation**: handle the available physical capacities through new, automated services for flexible energy network resources

Efficient energy use in buildings and industry

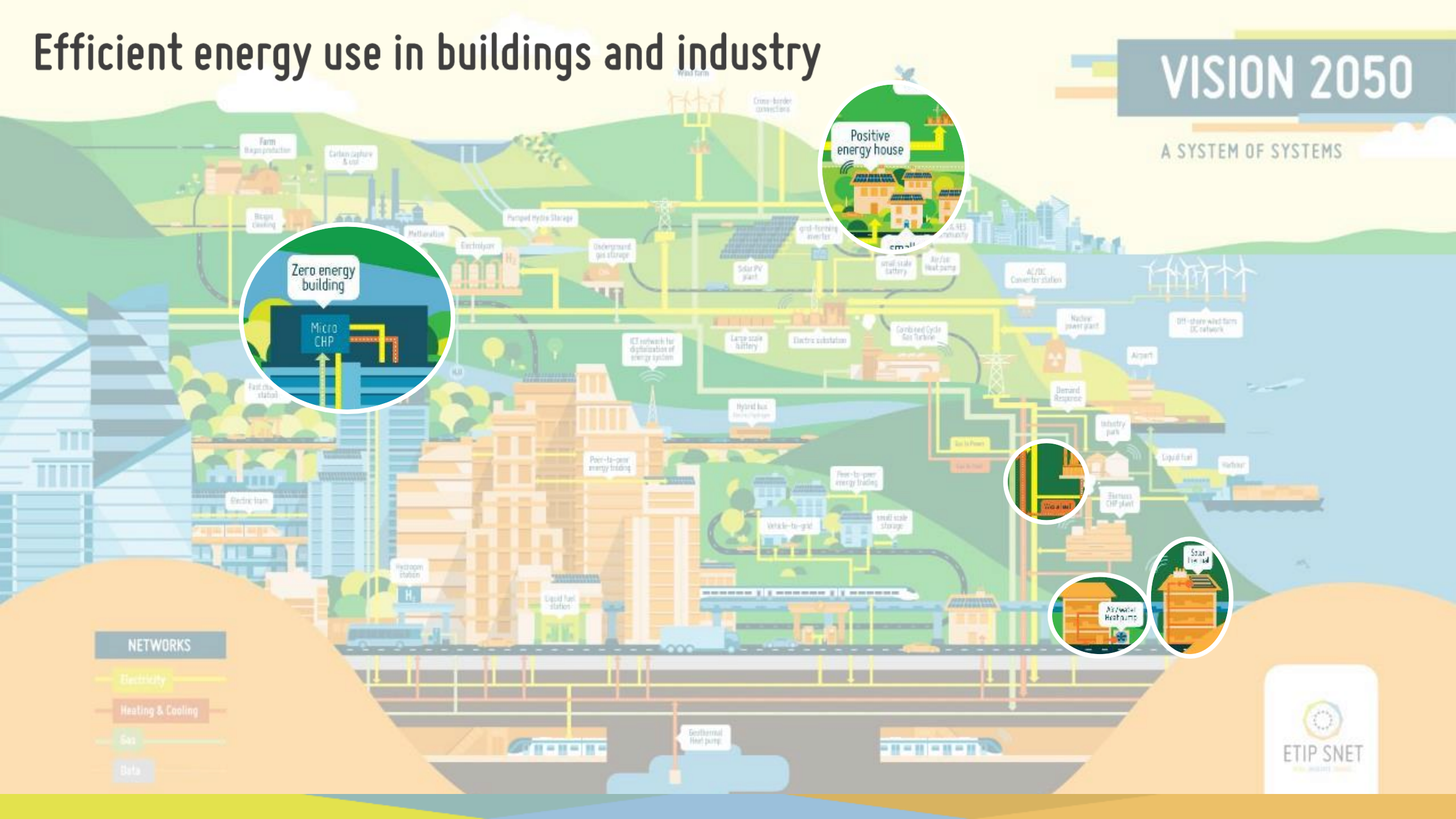
VISION 2050

A SYSTEM OF SYSTEMS



ETIP SNET

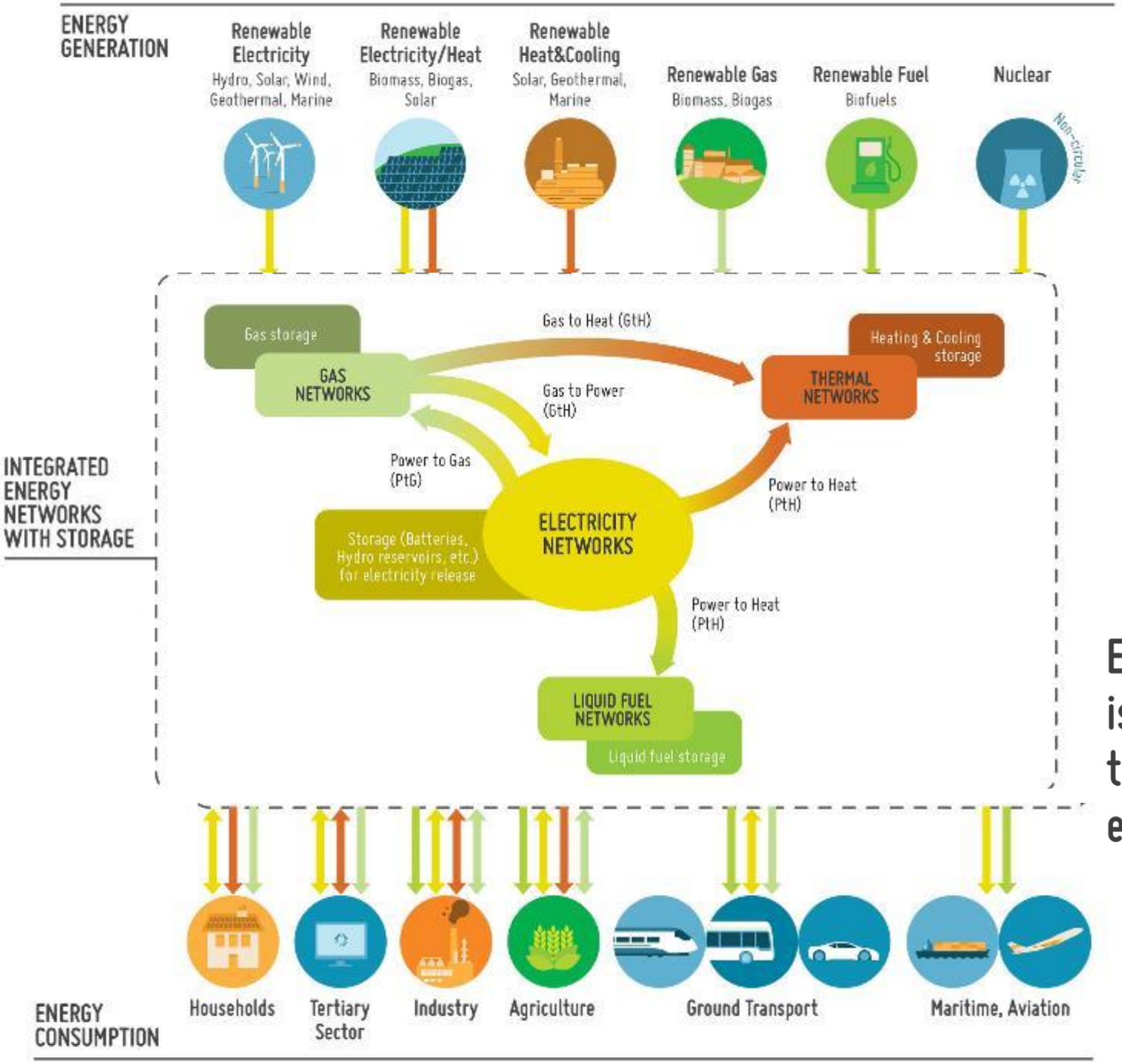
Efficient energy use in buildings and industry



Efficient energy use in transport sector

Efficient energy use in transport sector

The future integrated energy systems with conversion and storage devices



Electricity network is the backbone of the integrated energy system

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ETIP SNET: RDI FOR THE INTEGRATED ENERGY SYSTEM BY 2030 TOWARDS THE VISION 2050

ETIP SNET Stakeholders

ETIP SNET Roadmap 2020-2030

2020-30
24-34
…

ETIP SNET Implementation Plans

2020-23
22-25
…

EC & [Trans-]National Calls for co-funded RDI Projects

Horizon Europe
2021-2027

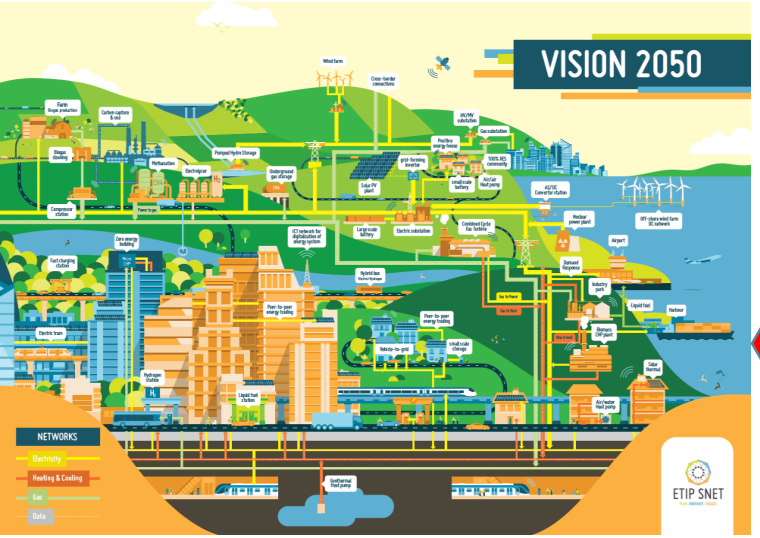
National
Research Calls

RDI Projects

European Projects
Transnational Projects
National Projects
Regional Projects

ETIP SNET RDI Project Monitoring and Regional Workshops

ETIP SNET Roadmap 2020-30: The Functionalities 2030



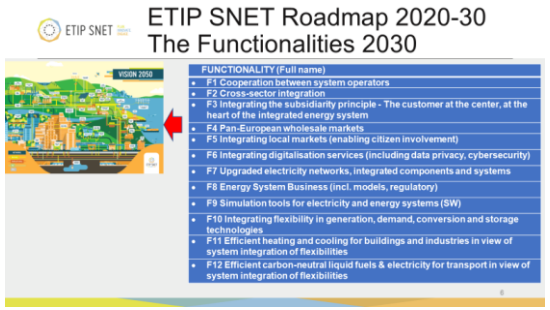
FUNCTIONALITIES 2030

The building blocks of the ETIP SNET Vision 2050 are translated into FUNCTIONALITIES which need to be realised in the integrated energy system by the year 2030

ETIP SNET Roadmap 2020-2030: FUNCTIONALITY	ETIP SNET Vision 2050: Building Block
• F1 Cooperation between system operators	• The Efficient Organisation of Energy Systems
• F2 Cross-sector integration	
• F3 Integrating the subsidiarity principle - The customer at the center, at the heart of the integrated energy system	
• F4 Pan-European wholesale markets	• Markets as key enablers of the energy transition
• F5 Integrating local markets (enabling citizen involvement)	
• F6 Integrating digitalisation services (including data privacy, cybersecurity)	• Digitalisation
• F7 Upgraded electricity networks, integrated components and systems	• Infrastructure for integrated energy systems as key enablers of the energy transition
• F8 Energy System Business (incl. models, regulatory)	
• F9 Simulation tools for electricity and energy systems (SW)	
• F10 Integrating flexibility in generation, demand, conversion and storage technologies	• Efficient Energy Use
• F11 Efficient heating and cooling for buildings and industries in view of system integration of flexibilities	
• F12 Efficient carbon-neutral liquid fuels & electricity for transport in view of system integration of flexibilities	

ETIP SNET Roadmap 2020-30
6 Research Areas

Functionalities 2030 (the real-world systems and environments)



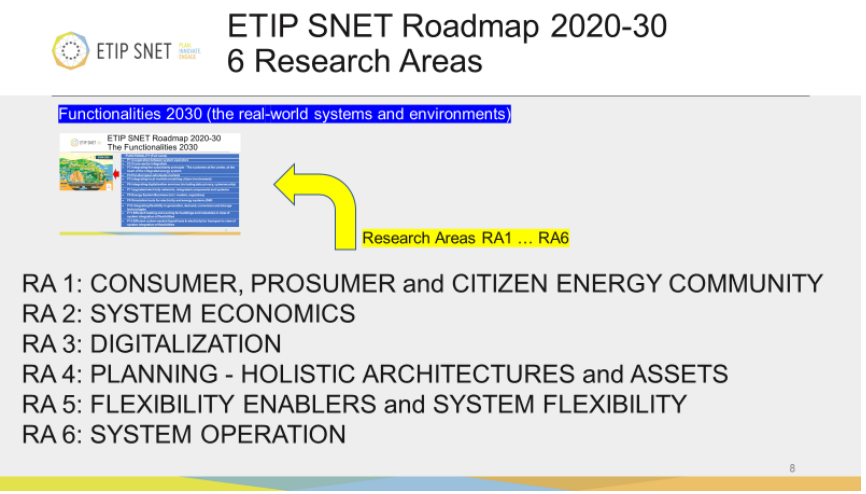
Research Areas RA1 … RA6

RA 1: CONSUMER, PROSUMER and CITIZEN ENERGY COMMUNITY
RA 2: SYSTEM ECONOMICS
RA 3: DIGITALIZATION
RA 4: PLANNING - HOLISTIC ARCHITECTURES and ASSETS
RA 5: FLEXIBILITY ENABLERS and SYSTEM FLEXIBILITY
RA 6: SYSTEM OPERATION

Explanation of each RA

RA No.	Research Area (RA)	RA-Explanation
1	CONSUMER, PROSUMER and CITIZEN ENERGY COMMUNITY	Citizen and prosumer empowerment and engagement
2	SYSTEM ECONOMICS	Business models, market design and market-governance
3	DIGITALIZATION	Digitalisation, communication and data handling
4	PLANNING - HOLISTIC ARCHITECTURES and ASSETS	Energy system architectures, design and planning, new materials, technological solutions, asset management, maintenance; System Stability
5	FLEXIBILITY ENABLERS and SYSTEM FLEXIBILITY	Adapting all energy components to provide flexibility to the system (Flexibility in Demand, Generation, Storage & Energy Conversion, Network, Transport)
6	SYSTEM OPERATION	Reliability, forecasting, monitoring, control and automation (State estimation and supervision, short-term, medium and long-term control)

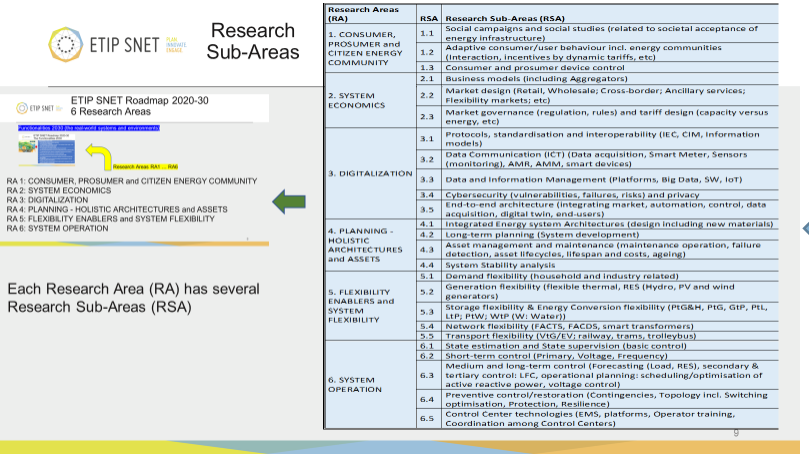
Research Sub-Areas



Each Research Area (RA) has several Research Sub-Areas (RSA)

Research Areas (RA)	RSA	Research Sub-Areas (RSA)
1. CONSUMER, PROSUMER and CITIZEN ENERGY COMMUNITY	1.1	Social campaigns and social studies (related to societal acceptance of energy infrastructure)
	1.2	Adaptive consumer/user behaviour incl. energy communities (Interaction, incentives by dynamic tariffs, etc)
	1.3	Consumer and prosumer device control
2. SYSTEM ECONOMICS	2.1	Business models (including Aggregators)
	2.2	Market design (Retail, Wholesale; Cross-border; Ancillary services; Flexibility markets; etc)
	2.3	Market governance (regulation, rules) and tariff design (capacity versus energy, etc)
3. DIGITALIZATION	3.1	Protocols, standardisation and interoperability (IEC, CIM, Information models)
	3.2	Data Communication (ICT) (Data acquisition, Smart Meter, Sensors (monitoring), AMR, AMM, smart devices)
	3.3	Data and Information Management (Platforms, Big Data, SW, IoT)
	3.4	Cybersecurity (vulnerabilities, failures, risks) and privacy
	3.5	End-to-end architecture (integrating market, automation, control, data acquisition, digital twin, end-users)
4. PLANNING - HOLISTIC ARCHITECTURES and ASSETS	4.1	Integrated Energy system Architectures (design including new materials)
	4.2	Long-term planning (System development)
	4.3	Asset management and maintenance (maintenance operation, failure detection, asset lifecycles, lifespan and costs, ageing)
	4.4	System Stability analysis
5. FLEXIBILITY ENABLERS and SYSTEM FLEXIBILITY	5.1	Demand flexibility (household and industry related)
	5.2	Generation flexibility (flexible thermal, RES (Hydro, PV and wind generators)
	5.3	Storage flexibility & Energy Conversion flexibility (PtG&H, PtG, GtP, PtL, LtP; PtW; WtP (W: Water))
	5.4	Network flexibility (FACTS, FACDS, smart transformers)
	5.5	Transport flexibility (VtG/EV; railway, trams, trolleybus)
6. SYSTEM OPERATION	6.1	State estimation and State supervision (basic control)
	6.2	Short-term control (Primary, Voltage, Frequency)
	6.3	Medium and long-term control (Forecasting (Load, RES), secondary & tertiary control: LFC, operational planning: scheduling/optimisation of active reactive power, voltage control)
	6.4	Preventive control/restoration (Contingencies, Topology incl. Switching optimisation, Protection, Resilience)
	6.5	Control Center technologies (EMS, platforms, Operator training, Coordination among Control Centers)

200+ RDI Tasks, each with RDI Journey towards 2030+



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- Each Research Sub-Area (RSA) has several RDI-Tasks
- Each RDI-Task has an expected **RDI-Journey:** When to go from Research (Red) via Demonstration (orange) towards Innovation (=Deployment) (green)
- Each RDI-Task contributes to one or more of the **FUNCTIONALITIES**.

RA	RSA	Task No	TASKS ETIP SNET ROADMAP 2020-2030	23	25	27	30	30+	TASK CONTRIBUTES TOWARDS FUNCTIONALITIES
		2.3.6	Regulatory Framework including the remuneration schemes for new market stakeholders aggregators, providing related to added value of DER (distributed generation,storage and DR) i the provision of grid services (balancing, reserves, ancilliary services, etc.) and flexibilty at the distribution level and the impact in the transmission level	🔴	🔴	🟠	🟠	🟢	F8, F3, F10, F5, F1,
		2.3.7	Regulatory arrangements to allow temporary use of distributed DER for grid n agement purposes by DSO and TSO (DER is distributed pr. definition)	🔴	🟠	🟠	🟢	🟢	F5, F8, F10, F3, F9,
		2.3.8	Regulatory bodies: regulatory f nework to promote the use of DR (Demand Response) based n the cost-benefit anal	🔴	🟠	🟠	🟢	🟢	F8, F10, F11, F12, F5, F4,
3	3.1.	3.1.1	Open Protocols (expert systems) for stochastic model-based han g of market operations on different timescales for improved reliability	🔴	🔴	🟠	🟠	🟢	F4, F5, F9, F8, F1, F3, F10,
		3.1.2	Create recommendations regardi protocols to be promoted for specific communications purposes within the ene communication network system, e.g., the IEC 61850 standard serie IEC 61970 (CIM) dard series, IEC 61968 (CIM) standard series, IEC 62325 (CIM), IEC 61400-2 standard es, ISO/IEC 9594 standard series, ITU-T X500 standard series	🟠	🟠	🟢	🟢	🟢	F6, F8, F7, F1,
		3.1.3	Application guidelines and recommended practices for implementation of protocols with open Source/open protocol solutions	🟠	🟠	🟢	🟢	🟢	F6, F8, F7, F1,

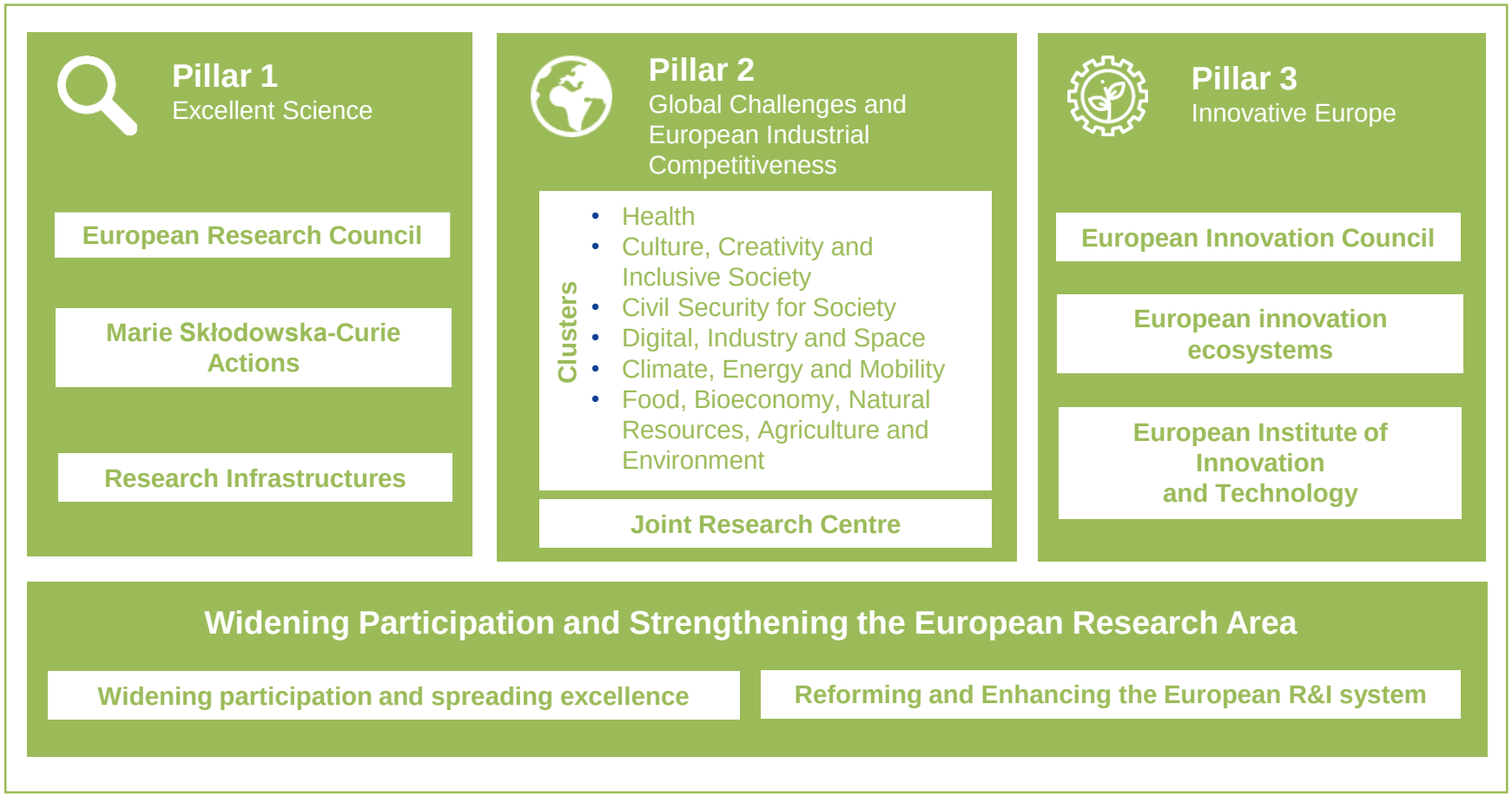
The Energy Island Framework

There are more than 2200 inhabited islands in the EU. Despite having access to renewable sources of energy, such as wind and wave energy, many of them depend on expensive fossil fuel imports for their energy supply.

Based on the aforementioned, an initiative that provides a long term framework to help islands generate their own sustainable, low-cost energy, will result in:

- Reduced energy costs and greatly increased production of renewable energy and the construction of energy storage facilities and demand response systems, using the latest technologies
- better energy security for islands, which will be less reliant on imports
- improved air quality, lower greenhouse gas emissions, and less impact on islands' natural environments
- the creation of new jobs and business opportunities, boosting islands' economic self-sufficiency.

Horizon Europe: Preliminary structure



European Commission

CLUSTER 5 Climate, Energy and Mobility
Key features

More **impact-focused R&I** – supporting the implementation of EU policy goals and links between fuels/electricity (supply-side) and transport (demand-side)

New **holistic / system-wide / integrated view** – e.g. focus on citizens, industry and user needs

More **synergies** across R&I areas, along the full innovation cycle:

- between thematic areas (e.g. low-emission mobility, energy & climate)
- between clusters (e.g. digital and automated mobility)
- between pillars (through wide / joint Missions)
- with other EU / funding instruments (e.g. CEF, LIFE)

Mainstreaming and thus more impact of Social Sciences & Humanities, citizen & consumer empowerment, economic & behavioural aspects, standardisation and innovation-friendly frameworks

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#Vision2050

The INTENSYS4EU Project supports ETIP SNET activities and has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 731220

The EU's Islands

According to EUROSTAT, an island is defined as an area of at least 1 km^2, located at a distance of at least one kilometre from the continent, that has a permanent resident population of at least 50 people, has no permanent link with the continent and does not host an EU capital. On the basis of this definition the European Commission's DG REGIO has identified 286 EU islands.

- Together, they are home to almost 10 million people occupying an area of 100,000 km^2.
- Their population varies from 50 people to five million in Sicily. The population of the latter exceeds that of EU member states like Luxembourg and equals that of Finland.
- EU islands are located in three major geographical areas: the Atlantic, the North and – accounting for 85% of the population – the Mediterranean.
- The 286 islands belong to eleven EU countries, with five member states accounting for over 75% of the islands.

With few exceptions islands' economic and social situation is less favourable than that of the country to which they belong. Their GDP per capita is thus usually lower. According to Bradley Dunbar[1] the average living standard is 72% of the EU average, with considerable differences among the group. Political autonomy also varies widely, with places such as the Åland islands being very autonomous while others having no administrative powers of their own.

The EU's islands are diverse: a few islands are very densely populated, while a very large number of small islands are sparsely populated. This evidently leads to varying market and investment conditions: the smaller the population, the smaller the market, and thus the greater the challenge of establishing a sustainable energy system.

It is worth mentioning that the EU definition for islands is not always straightforward. While islands within the territory of EU member states are included in the definition, island member states such as Malta and Cyprus are not. Nevertheless, they are also very much affected by the challenges islands face in terms of power systems.

EURELECTRIC
EU Islands: Towards a Sustainable Future

June 2012

European Commission