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ETIP SNET
EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM
SMART NETWORKS FOR ENERGY TRANSITION

Parallel session 1 - WG1

Sector coupling concepts and framework WG1 white paper in progress

ANTONIO ILICETO WG1 chair

Description

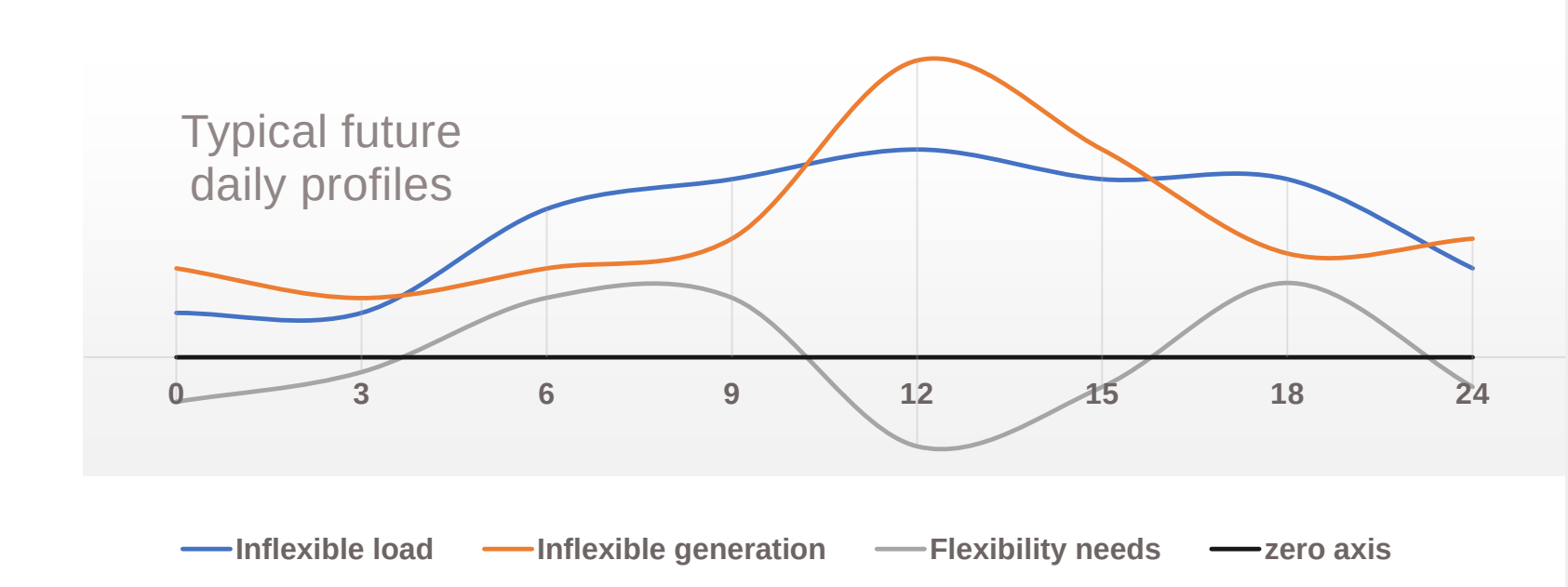
- Among other activities, WG1 is elaborating some White Papers, on:
  - Holisitic architectures → published March 2019
  - TSO-DSO coordination in grid planning → expected early 2020
  - Sector Coupling → expected by end 2019

- White Paper intended half way between Tutorial and Position Paper

- Technologies/processes covered with technical details:
  - Role of storage for sector coupling
  - Power to heating & cooling
  - Power to mobility
  - Power to Gas/Fuels

- Leader: Marie Munster , Danish Technical University

Beyond present concept of ‘residual load profile’



Beyond present concept of ‘residual load profile’

- Evolution of electric system operating philosophy:

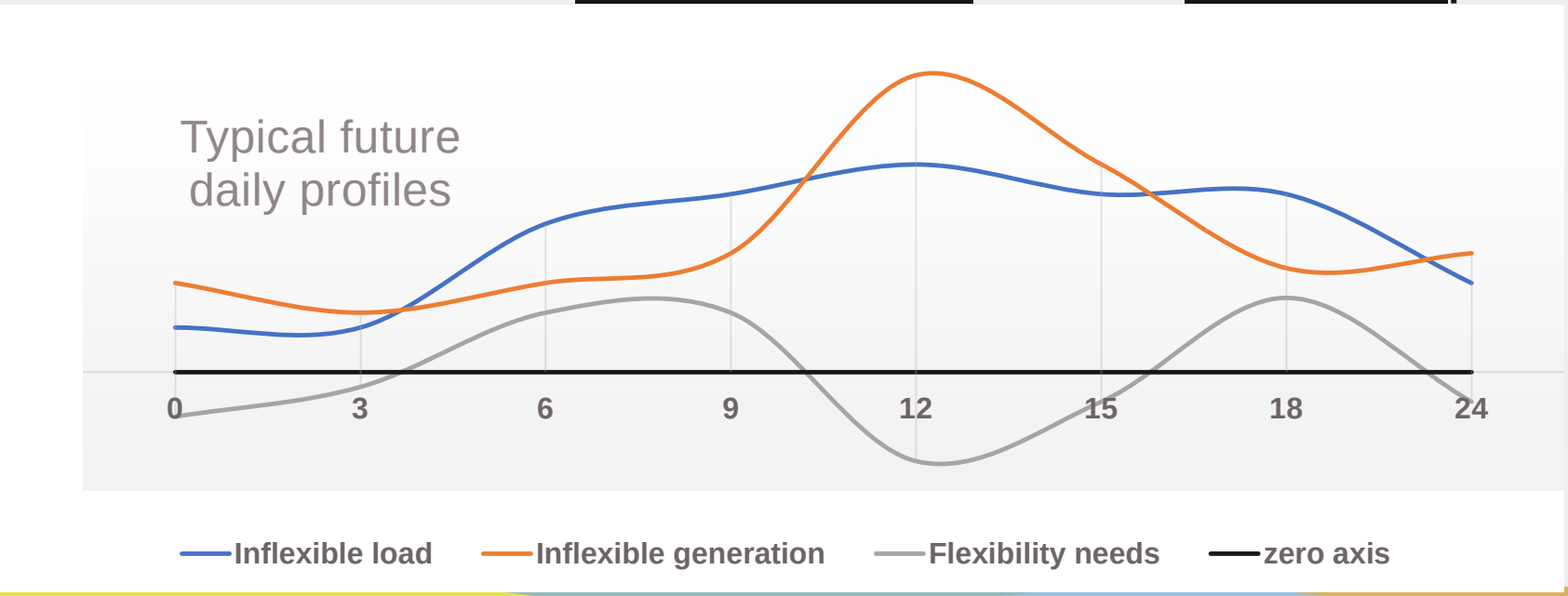
Generation follows Load

THE PAST → Load profile given as independent variable, generation has to follow the load

THE PRESENT →Residual load profile (total load minus variable RES generation) covered by flexible generation + pioneering flexibility means

THE FUTURE → Dominance of <u>inflexible generation</u> but also of <u>flexible loads</u> plus a wide portfolio of <u>flexibility means</u>

Load follows Generation



Independent variables to be optimised grow exponentially

- Under the overarching objective of facilitating defossilisation/decarbonisation also of other sectors with renewable electricity, the main goal of power system management shall become:

  - Operation: how to best use and combine the many flexibility means available to optimise RES generation having quasi-zero variable cost

  - Planning: optimise development of the grid in coordinated manner with development of many other indipendent actors and sectors: not only generation and load, but also new services and new interfaces

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- Main goal of power system management shall become:
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  - Planning: optimise development of the grid in coordinated manner with development of many other indipendent actors and sectors: not only generation and load, but also new services and new interfaces

Grid use	Flexible generation	Flexible loads	Storage within electric system	Storage in other energy systems
- Extended use of grid components -Interconnections - Exchanges with neighbouring areas	- Traditional plants' modulation - Enhanced ancillary services - Improved performances (ramps, response speed, capability range, start-stop sequences, duty cycles)	- Demand response - Interruptible customers - Balancing services - Aggregators - Market & trading mechanisms - Smart EV charging	- Grid batteries - Fly wheels - CAES/LAES - Supercapacitors - Pump Hydro	- Electric vehicles - Thermal - Thermochemic. - Chemicals - Gases/Liquids

Focus on interfaces with other utilities and energy systems

Storage within electric system	Storage in other energy systems	Conversion interfaces with other industrial processes
- Batteries - Fly wheels - CAES/LAES - Supercapacitors/ Supermagnetes - Pump Hydro	- Electric vehicles →	- Charging/Discharging mobile batteries
	- Thermal →	- Alternative energy source for heat/steam/freeze production for industrial uses and for buildings
	- Thermochemical →	- Alternative energy source for desalination and energy industry
	- Chemicals →	- Endo/Eso-thermic chemical reactions and no-losses energy storage
	- Gases/Liquids →	- Electro-synthesys of Ammonia, Methanol
		- Synthetic fuels no-fossil production
		- Electrolysis

Focus on interfaces with other utilities and energy systems

Storage within electric system	Storage in other energy systems	Conversion interfaces with other industrial processes	Planning and/or operational coordination with other systems
- Batteries - Fly wheels - CAES/LAES - Supercapacitors/ Supermagnetes - Pump Hydro	- Electric vehicles	- Charging/Discharging mobile batteries	- TRANSPORT & MOBILITY
	- Thermal	- Alternative energy source for heat/steam/freeze production for industrial uses and for buildings	- DISTRICT & INDUSTRIAL HEATING/ COOLING
	- Thermochemical	- Alternative energy source for desalination and energy industry	- DESALINATION & ENERGY INDUSTRY
	- Chemicals	- Endo/Eso-thermic chemical reactions and no-losses energy storage	- CHEMICAL INDUSTRY
	- Gases/Liquids	- Electro-synthesys of Ammonia, Methanol	- FUELS INDUSTRY
		- Synthetic fuels no-fossil production	- HYDROGEN AS: ▪ INDUSTRIAL PRODUCT ▪ STORAGE MEAN ▪ ENERGY CARRIER
		- Electrolysis	- METHANE/LNG GRID

Perimeter of Sector Coupling

Storage within electric system	Storage in other energy systems	Conversion interfaces with other industrial processes	Planning and/or operational coordination with other systems
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- Supercapacitors/ Supermagnetes	- Thermochemical	- Alternative energy source for desalination and energy industry	- DESALINATION & ENERGY INDUSTRY
- Pump Hydro → **Water basins management**	- Chemicals	- Endo/Eso-thermic chemical reactions and no-losses energy storage	- CHEMICAL INDUSTRY
	- Gases/Liquids	- Electro-synthesys of Ammonia, Methanol	
		- Synthetic fuels no-fossil production	- FUELS INDUSTRY
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SECTOR COUPLING: optimisation among multi-energy options for feeding industrial processes

ADVANCED SECTOR COUPLING: additionally, an alternative option to electrical transmission

Storage, Flexibility, Sector Coupling: not synonyms

Typology --> Characteristics	Pure load (traditional)	Flexible Load	Storage in electric sytem	Storage in other energy systems	Molecules (chemicals & gases)
Energy Conversion / End Use	End Use	End Use	Conversion	Conversion	Conversion
Energy Flow reversible	NO	NO	YES	YES	YES
Controlled by electricity actors	YES	YES	YES	NO	NO
Providing storage capabilities	NO	NO	YES	YES	YES
Providing flexibility capabilities	NO	YES	YES	YES	YES
Energy carrier capabilities	NO	NO	NO	NO	YES

Storage

Flexibility

Energy carrier

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SECTOR COUPLING

POWER – TO - X

Storage

Flexibility

Energy carrier

Conceptual components of Sector Coupling

➢ Energy conversion process towards an adjacent industrial sector, where energy can follow different paths:

- stored more easily than within the electric system, for successive re-conversion to electricity: shift in time and in some cases also in space
- consumed, if it is cheaper/cleaner than other energy sources typical of that sector, either temporarily (operational optimisation) or permanently (electrification, which increases the amount of coupling potentials)
- transported, in some cases where transport performances can be higher than transmitting electricity

➢ Many combinations of the above options → sector coupling is a complex multi-variables optimisation problem, with the objective of minimal cost, with given decarbonisation targets & boundary conditions

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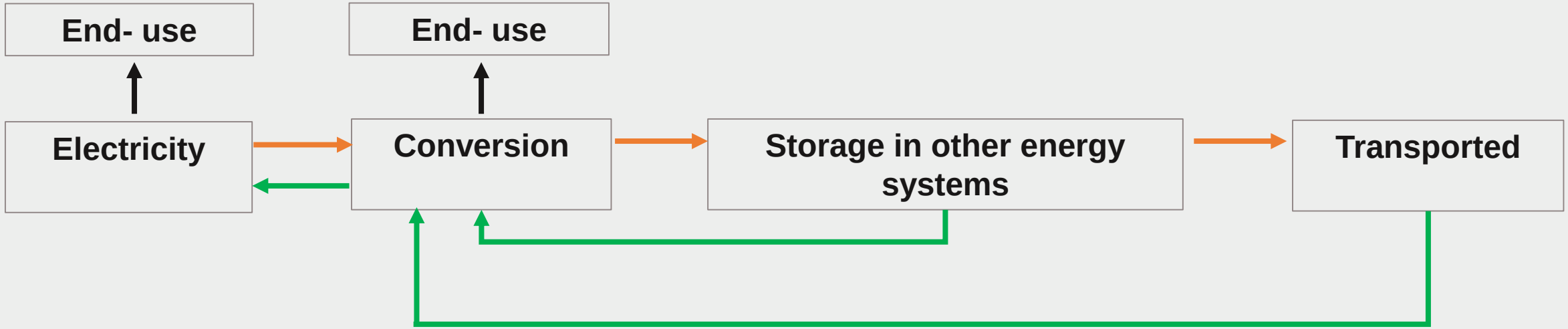
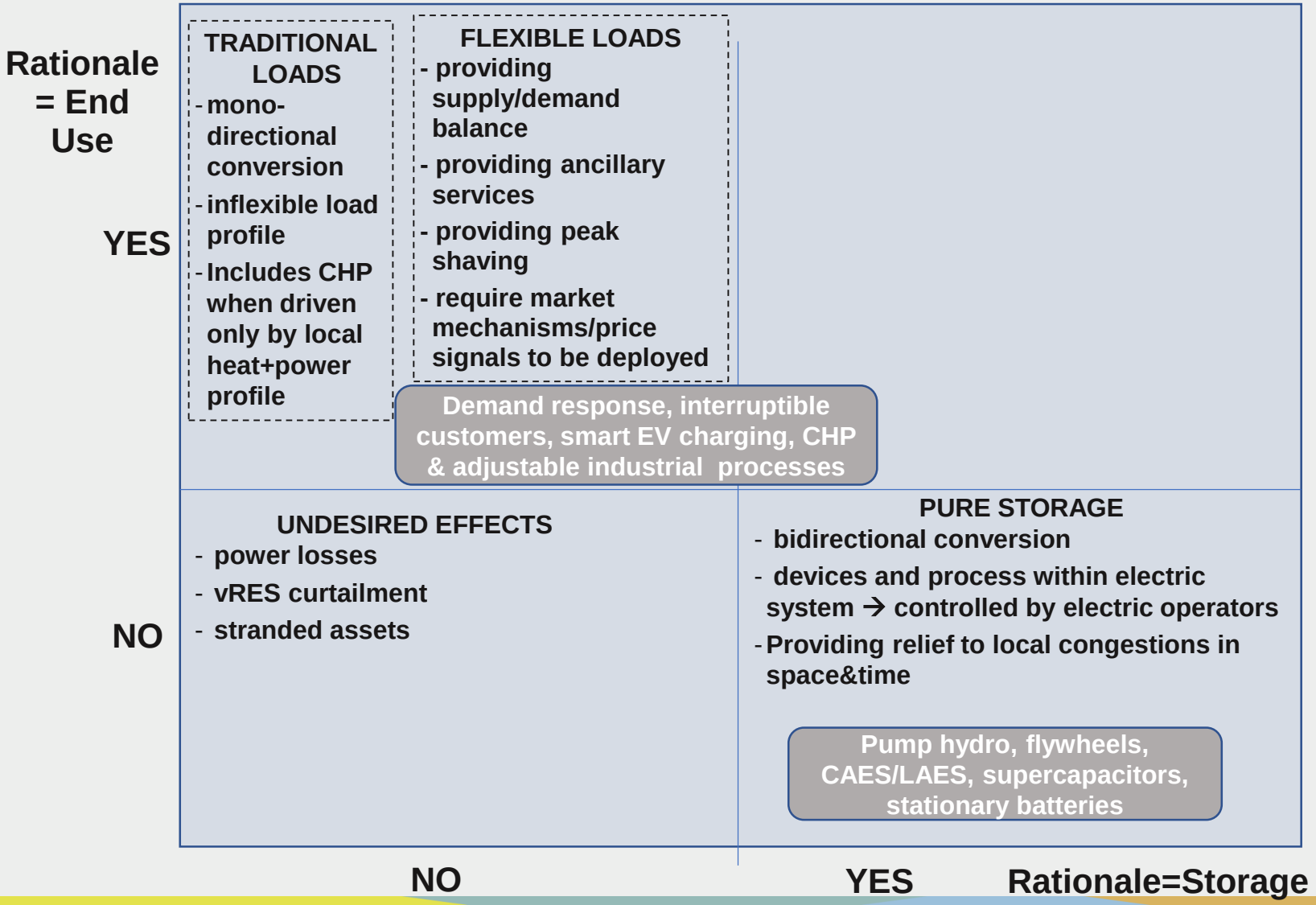
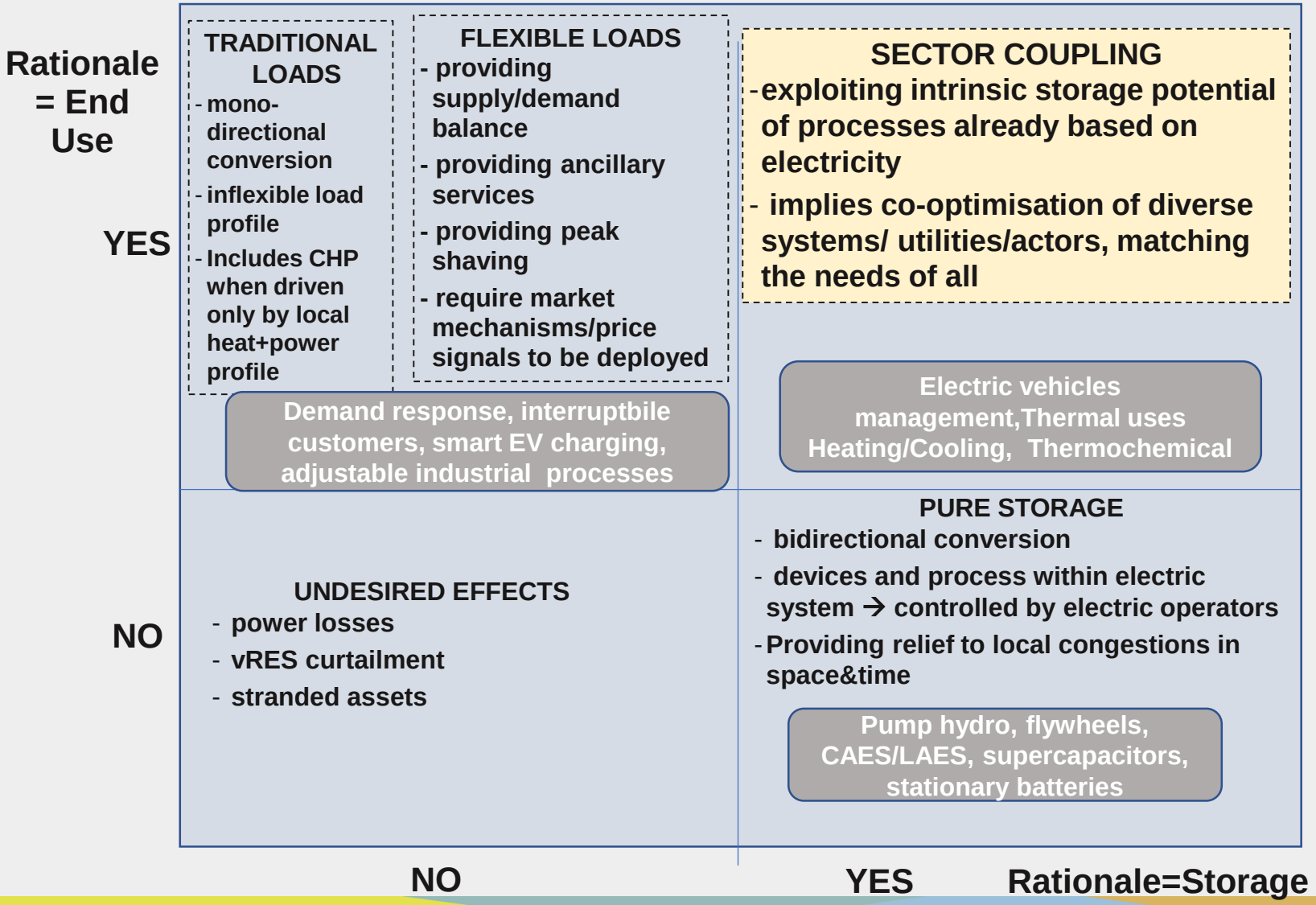


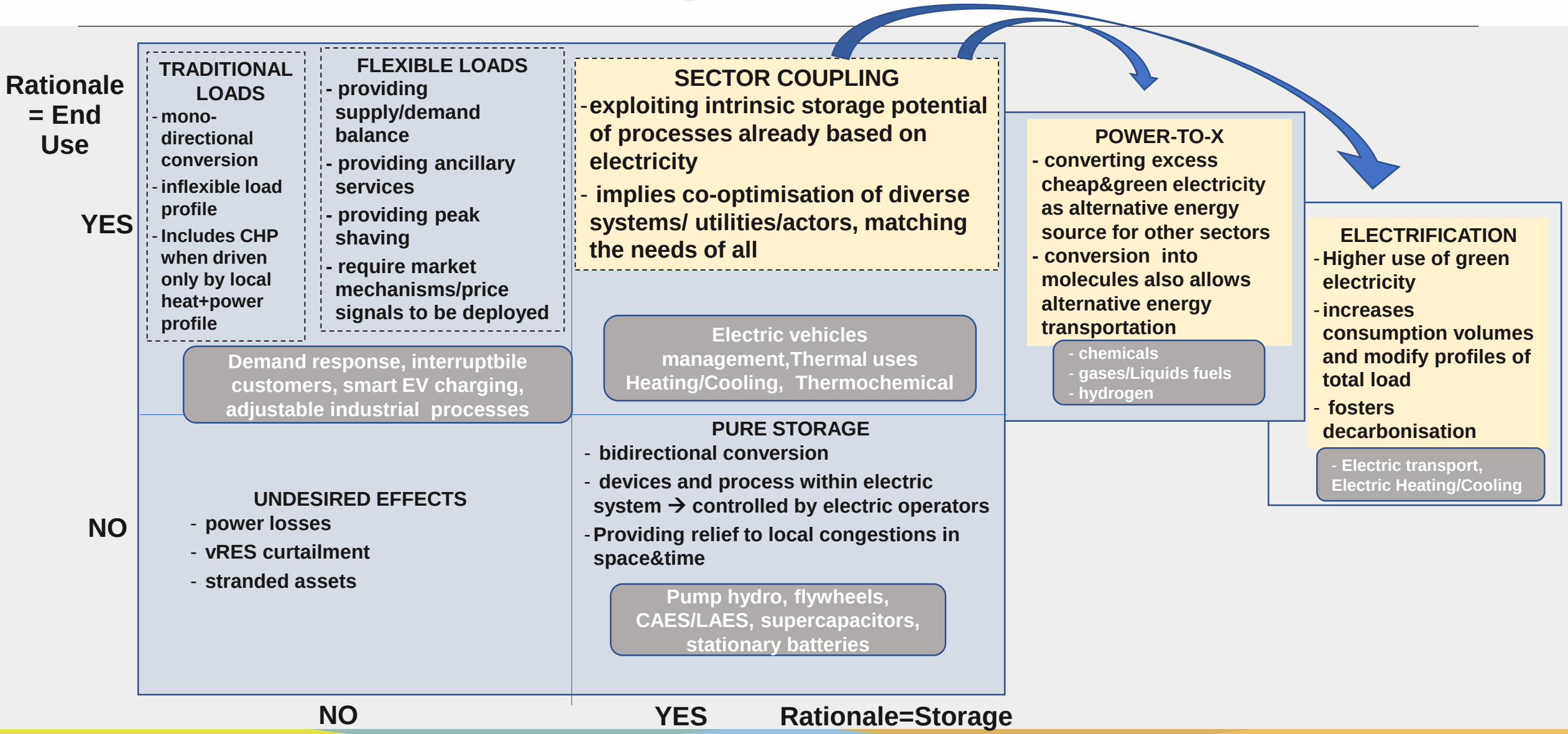
Rationale and characteristics of electricity conversion processes - 1



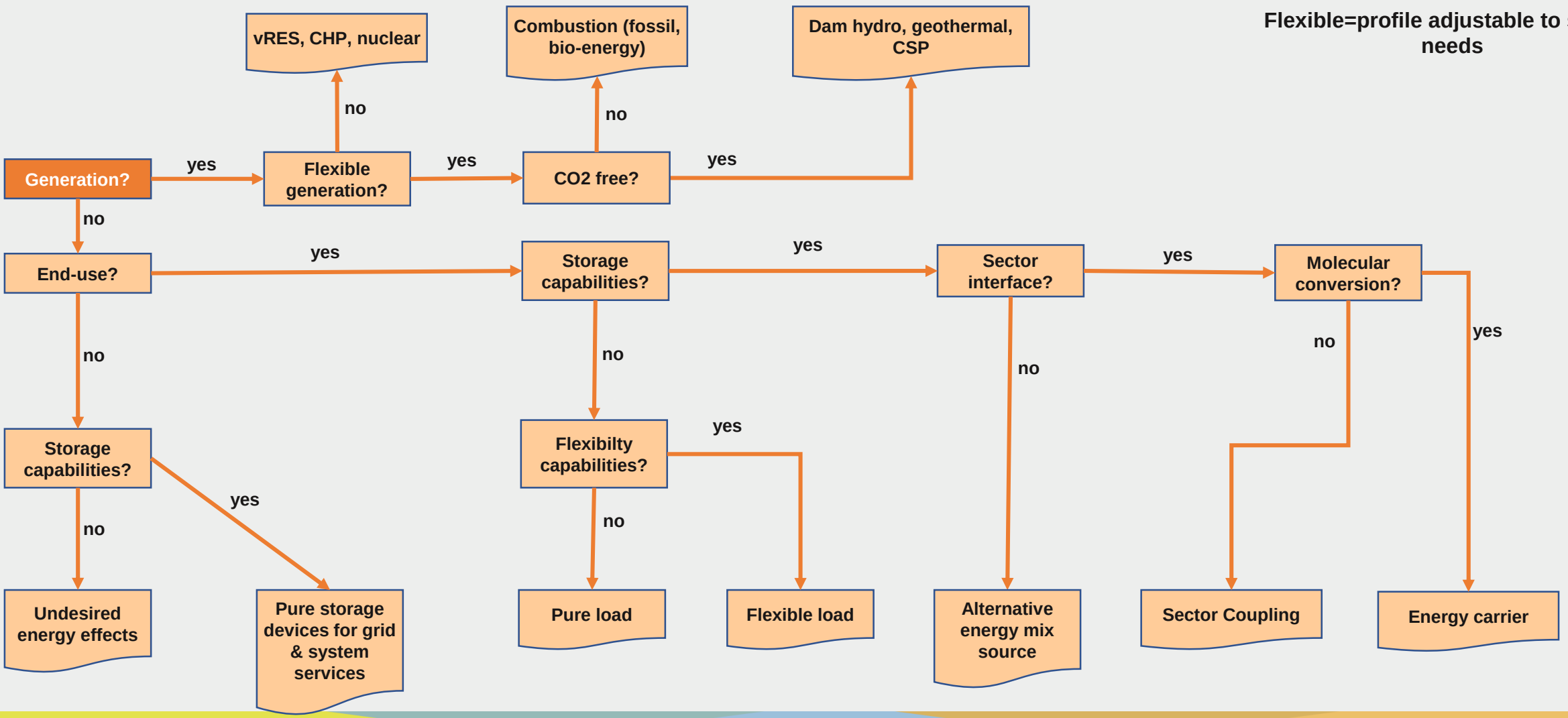
Rationale and characteristics of electricity conversion processes - 2



Rationale and characteristics of electricity conversion processes - 3



Classification of system components according to flexibilty capablitiy



Conclusions and White Paper aim

- Important Topic to investigate , being at center of energy system integration
- Mapping main technologies, their TRL, potentials and barriers
- Deployment prospects and impact of the most promising solutions
- Needs for future R&I activities and especially of demo/pilot projects at limited footprint but full scale
- Involvement of other sectors' operators and decision makers (market actors, regulators, local utilities, specific industries