reflex
Analysis of the
European Energy System

MODELLING OF FLEXIBILITY AND TECHNOLOGICAL PROGRESS

Angelo Martino, TRT Trasporti e Territorio srl

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EMP-E: Energy Modelling Platform for Europe

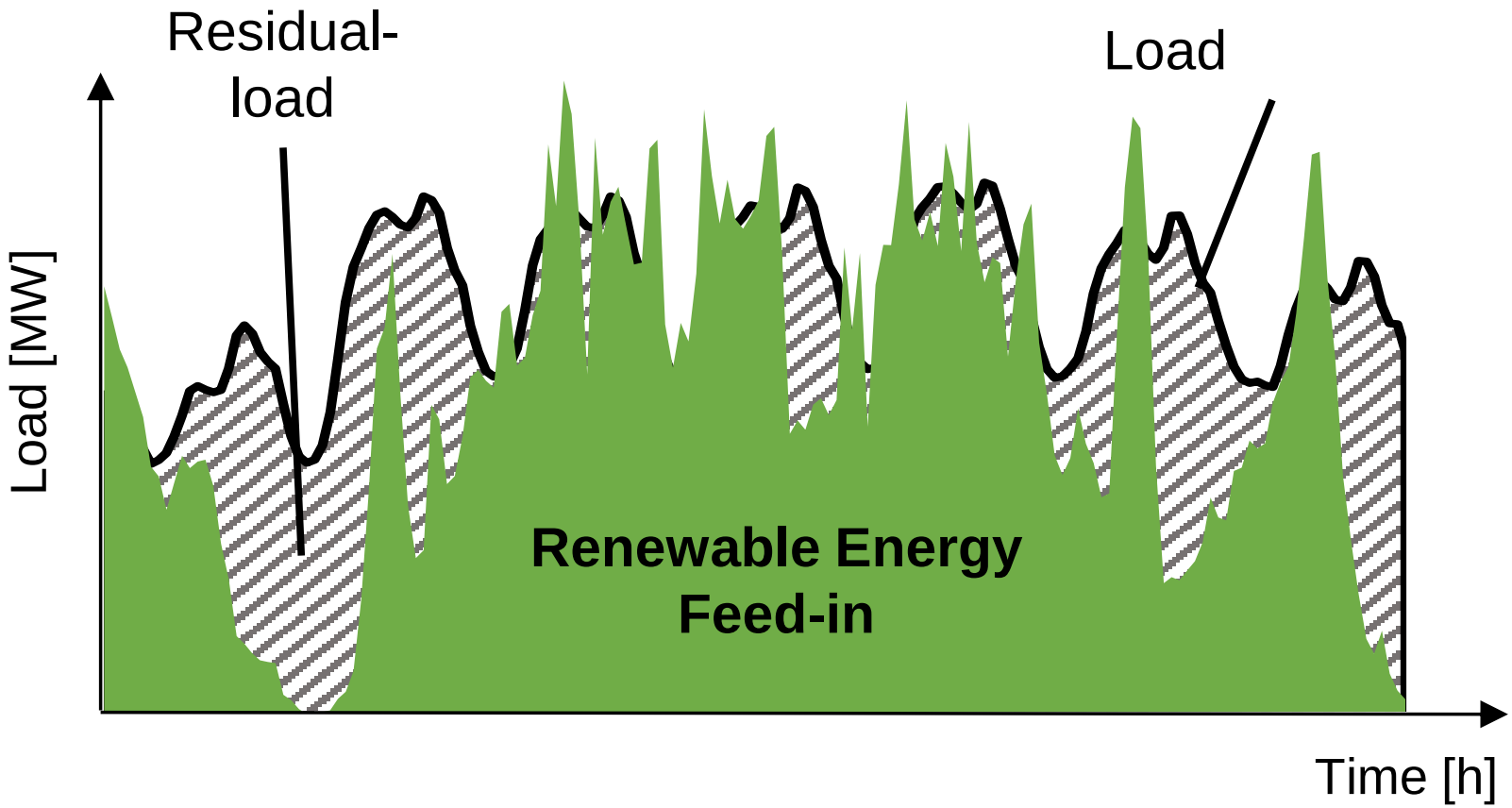
The Reflex project

- The core objective of the REFLEX project is to analyse and evaluate the development towards a low-carbon energy system with focus on flexibility options in the EU up to the year 2050 to support a better system integration of renewables.

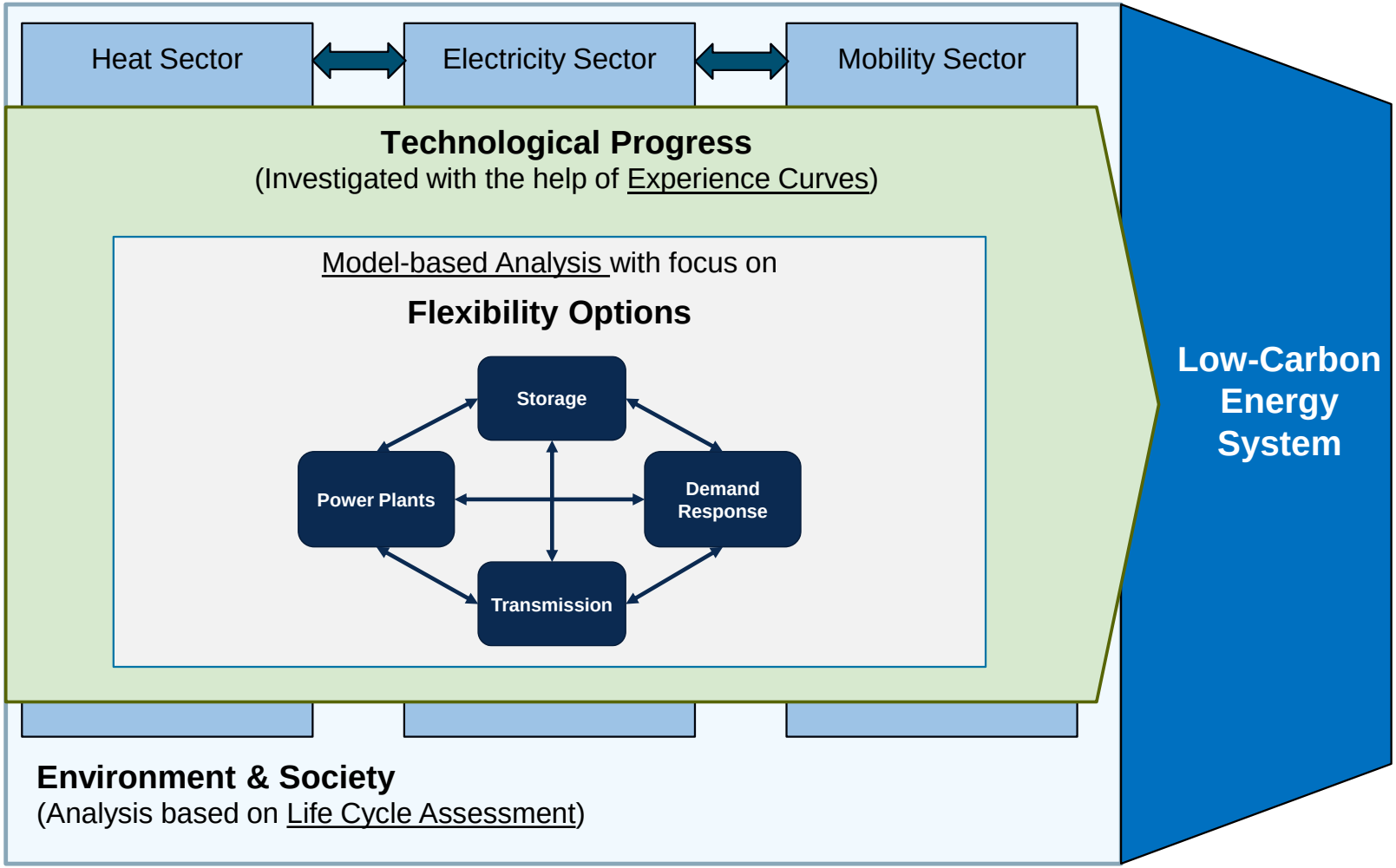
- The analysis comprises a comparative assessment of all relevant energy technologies as to the related impacts and the sustainability performance on the environment, society and economy based on a cross-sectoral perspective.

- The assessment is based on a modelling environment that considers the full extent to which current and future energy technologies and policies interfere and how they affect the environment and society while considering technological learning of low-carbon and flexibility technologies.

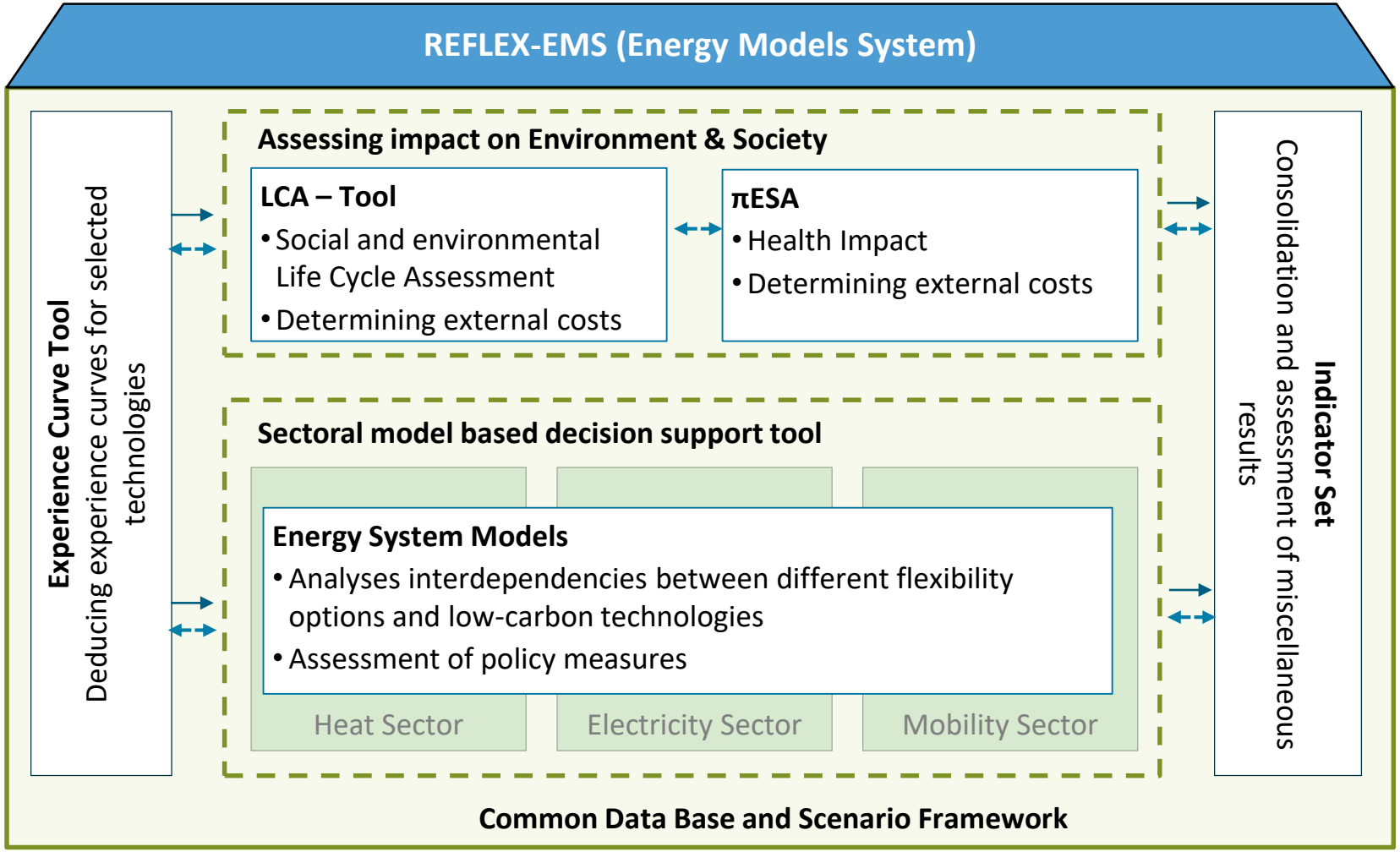
The intermittent feed-in from Renewable Energy Sources



REFLEX Project Scope and Applied Approaches



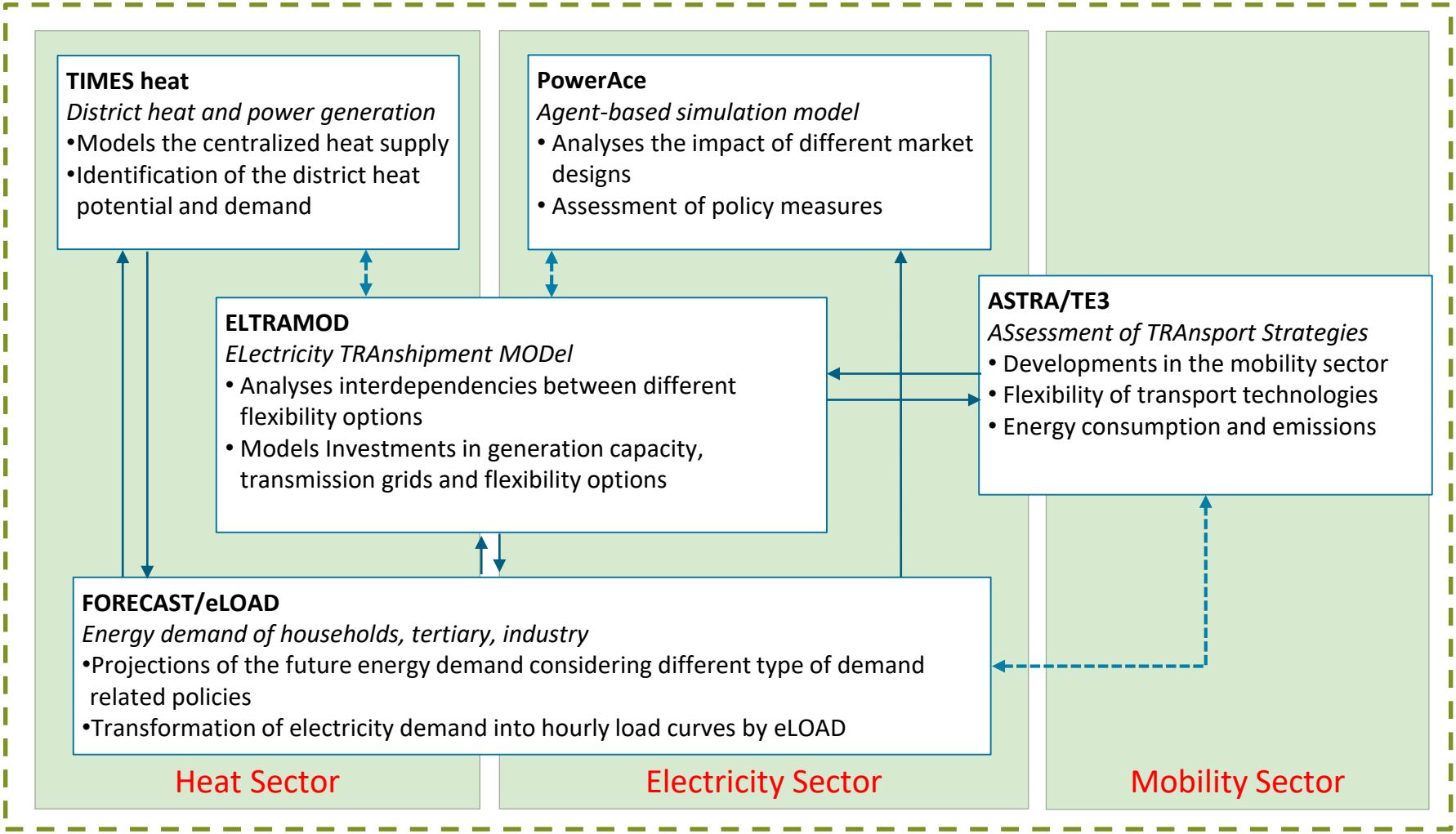
The Energy Models System (EMS) provides model based decision support tools for different actors



REFLEX-EMS: The Experience Curve Tool

- Experience curves for selected energy technologies
- Special attention given to determination of uncertainty ranges of progress ratio's
- For technologies that depend strongly on either the available geographical potential (e.g. wind onshore, offshore, biomass) or on raw material prices, the experience curve ids decomposed using a multi-level experience
- Determination of the most important factors behind cost development, such as variations in steel or oil prices, as well as scale effects
- The experience curves are incorporated in the sectoral models as well as in the LCA-Tool

REFLEX-EMS: The sectoral model based decision support tool



REFLEX-EMS: Tool for assessing the impact on environment and society

Assessing Impact on Environment & Society

LCA – Tool

- A transparent methodological framework for assessing environmental, social and economic impacts in modelled future energy systems using a life-cycle approach
- The framework is applied for life-cycle inventory data for these systems, coordinated with the experience curve approach
- The framework assesses the external costs of environmental impacts, including the external associated with direct combustion emissions

πESA

- Calculates changes of environmental states in relation to air quality and human health for different energy scenarios that will be elaborated in the project
- These include concentration and deposition maps of SO2, NOx, PM, Hg, as well as health impacts of people's long-term exposure to fine particulate ($PM_{2.5}$) air pollution

Possible Scenarios for Shaping the European Energy System – Focus in REFLEX

CENTRALIZED

Fossil and nuclear based energy system

Existing System

Mod-RESFlex Scenario (central)

GHG emission reduction:

- project result (explorative approach)

RES-share in power generation:

- ~55% in 2050[1)]

High-RESFlex Scenario (central)

GHG emission reduction:

- ~ -80% in 2050[2)]

RES-share in power generation:

- 80-90% in 2050
- trend to centralized wind power

European energy system is based on 100% renewable energy sources

Conventional ⟷ **Renewable**

High-RESFlex Scenario (decentral)

GHG emission reduction:

- ~ -80% in 2050

RES-share in power generation:

- 80-90% in 2050
- trend to decentr-alized solar power

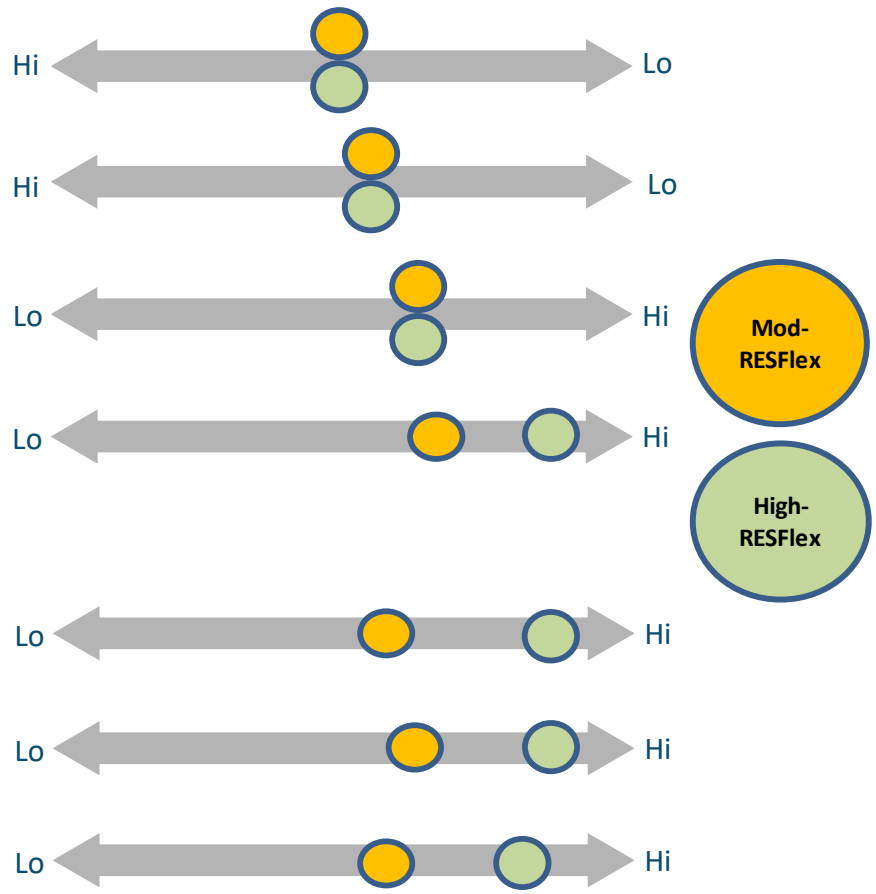
Focus in REFLEX

DECENTRALIZED

1) EU Reference Scenario 2016 (Capros et al. 2016) 2) EC Roadmap for moving to a competitive low carbon economy in 2050 (COM 2011/0112)

Scenarios to Determine the Required Flexibility

Framework conditions	Source	Less ambitious	More ambitious
Population	Population growth (CAGR) until 2050 EU Reference Scenario 2016	Hi	Lo
Economic growth	GDP growth (CAGR) until 2050 EU Reference Scenario 2016	Hi	Lo
Fossil fuel prices	Wholesale prices in 2050 EU Reference Scenario 2016	Lo	Hi
CO_2 prices	EUA prices in 2050 EU Reference Scenario 2016 & REFLEX	Lo	Hi
Policy targets			
GHG emissions reduction	Overall emissions reduction in 2050 compared to 1990	Lo	Hi
RES share	Share or renewable energy in power generation in 2050	Lo	Hi
Energy efficiency	Share of technical potential exploited in 2050	Lo	Hi



Partners of the REFLEX-Project

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Milano

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Thank you!

Angelo Martino
TRT Trasporti e Territorio srl

www.reflex-project.eu

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