Navigating the Roadmap for Clean, Secure and Efficient Energy Innovation
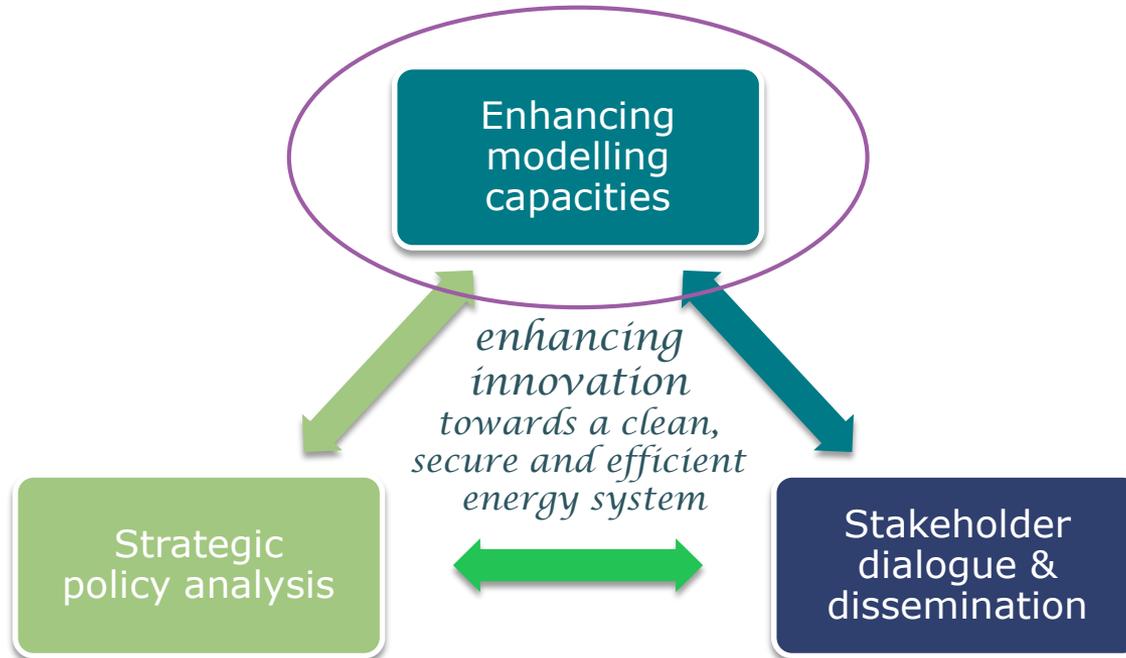
SET-Nav – Modelling Strategy

H2020 Contractors' Workshop on Energy System Modelling - 30 June 2016, Brussels, Belgium

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SET-Nav Three Pillars

- Combining theory of **technology innovation**, diffusion & spill-overs with large-scale numerical **energy-economy-engineering models**.

- Developing the methodological framework & technical infrastructure for effective **model integration** to adequately capture interdependencies across levels, energy carriers, and sectors.

MODELLING WITHIN SET-NAV

Three pillars of model integration

One model (or even family of models) cannot adequately capture all **relevant interdependencies** for strategic analysis of the SET plan.

- We need to develop a **subsidiarity principle** to effectively describe the economy-energy-innovation nexus, allowing a flexible & modular integration.

- Over the first year, the SET-Nav consortium will develop…

  o Model integration **methodology** across aggregation levels & sectors.

  ➤ Modeling workshop to be held at NTNU Trondheim in November 2016, more workshops throughout the project

  o Definitions of **interfaces** between participating models.

  ➤ First step within different case studies, linking groups of models for specific questions – then use this as starting point for general linkage

  o Technical **infrastructure** (database, website, programming interface).

  ➤ Use IIASA's existing web database (used for IPCC, model comparison projects, etc.) as starting point for a holistic model integration platform

FROM MACRO TO THE SYSTEM

SET-Nav
Strategic Energy Roadmap

A classification of models

We need to integrate a wide variety of models…

… across different levels, sectors, and spatial/temporal disaggregation

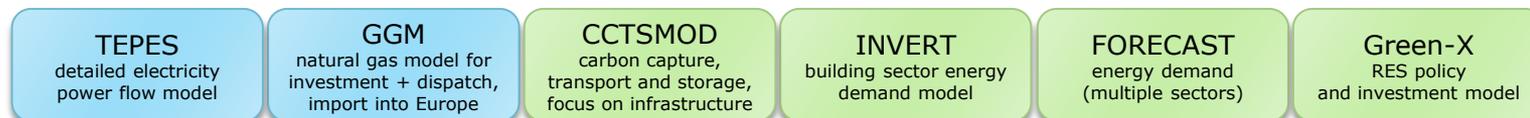➤ Feedback between the **the wider economy** and the energy system

NEMESIS	REMES
interaction between economy, prices, energy demand	interaction between economy, prices, demand, trade between regions

➤ Scenarios of **global resource markets** and their impact on the fuel mix

MultiMod	EMPIRE / RAMONA	Enertile
global energy system energy balance by country	electricity and natural gas investment + dispatch	power sector dispatch and investment model

➤ In-depth analysis of **specific sectors** (electricity, gas, buildings, …)

TEPES	GGM	CCTSMOD	INVERT	FORECAST	Green-X
detailed electricity power flow model	natural gas model for investment + dispatch, import into Europe	carbon capture, transport and storage, focus on infrastructure	building sector energy demand model	energy demand (multiple sectors)	RES policy and investment model

➤ Theory of **innovation**, technology diffusion, learning and spillovers

COMBINING THEORY & PRACTICE

We will build …

… on the **academic literature** for existing theory of model integration

… and further develop existing **applied implementations** of model linkages.

▶ Integrating CGE (**top-down**) and energy system (**bottom up**) models
(Böhringer & Rutherford, 1998, 2008)

▶ Linking (linear) models using **Generalized Nash equilibria** (GNE)
"The math to guarantee convergence", numerical efficiency (Harker, 1991)

▶ Already existing **bilateral model linkages** in SET-Nav consortium

REMES		NEMESIS	
	MultiMod	EMPIRE / RAMONA	Enertile
TEPES	GGM	CCTSMOD	INVERT	FORECAST	Green-X
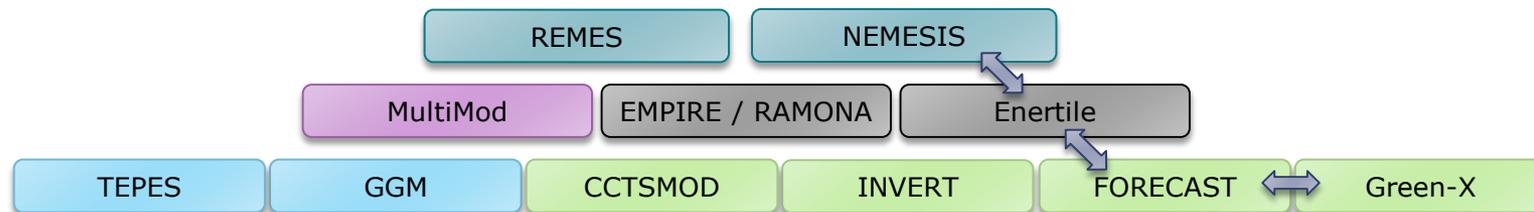
▶ The methodological research question:
How to link across **multiple models**, ensuring consistency
of model results and numerical convergence…

Methodological challenges

STANDARDIZING INTERFACES

Common definitions

In the first year of the project, we will run …

… define interface and **workflow implementation** for a subset of models

… focusing on a specific research question

All case studies will use the **same data exchange structure** and templates

Later on, these model linkages will serve as basis for the **full integration**

Example – Case study 6.2:
Analysis of **centralised vs. decentralised electricity supply**

Optimal dispatch & generation mix, prices
Transfer capacity between regions

Enertile   ⟲⟳   TEPES

Investment requirements
and system costs

Outcome of this case study:

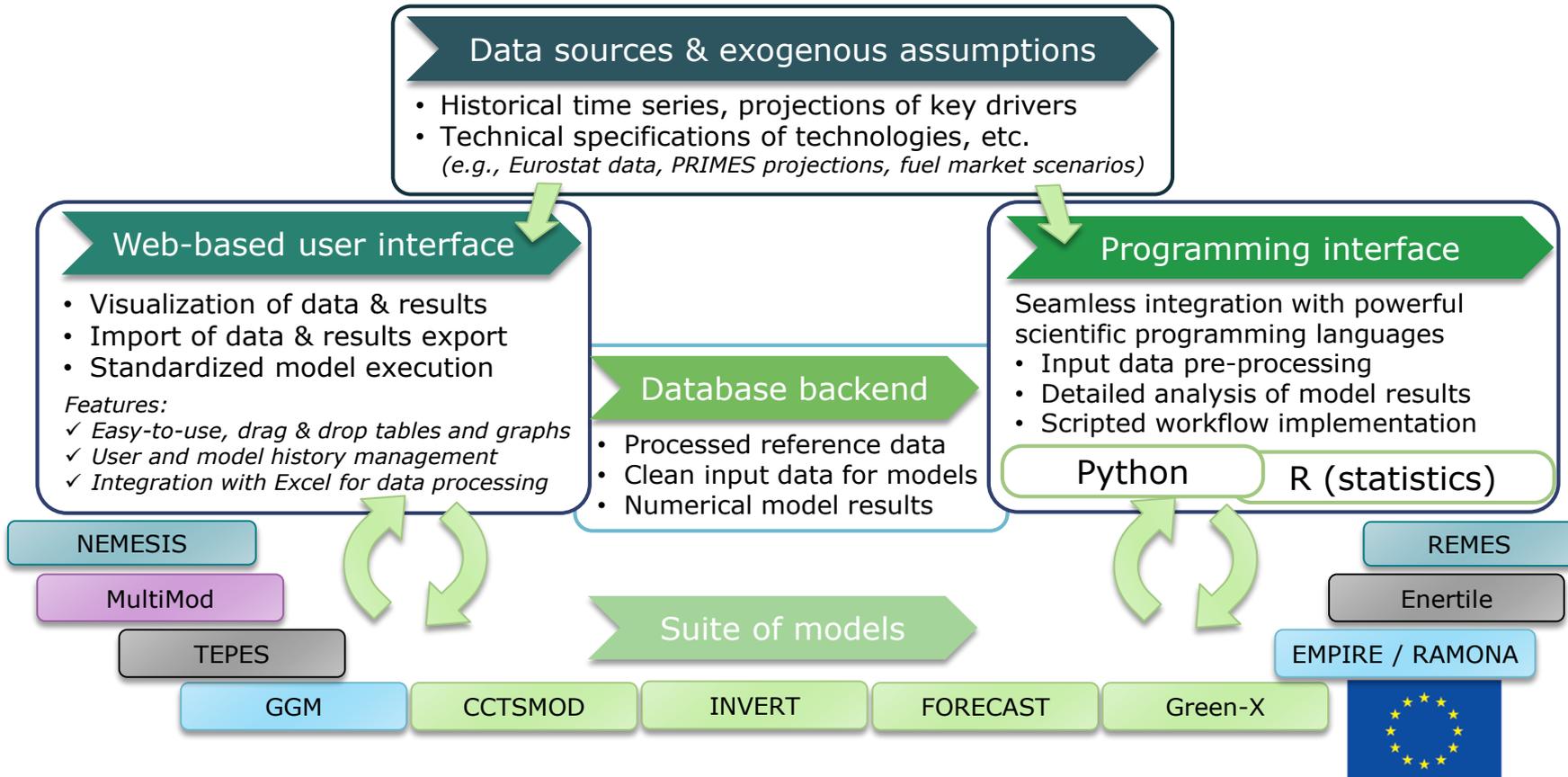➤ Policy insight on **alternative grid investment** strategies

➤ **Added benefit**: Interface definitions and workflow

MODEL INTEGRATION PLATFORM

SET-Nav
Strategic Energy Roadmap

The technical infrastructure

IIASA's existing web databases are already used by the **IPCC** as well as many **EU FP7 and Horizon 2020** projects (CD-LINKS, AMPERE, LIMITS)

We currently extending this to the following platform/framework:

Data sources & exogenous assumptions

- Historical time series, projections of key drivers
- Technical specifications of technologies, etc.
  (e.g., Eurostat data, PRIMES projections, fuel market scenarios)

Web-based user interface

- Visualization of data & results
- Import of data & results export
- Standardized model execution

Features:
- ✓ *Easy-to-use, drag & drop tables and graphs*
- ✓ *User and model history management*
- ✓ *Integration with Excel for data processing*

Database backend

- Processed reference data
- Clean input data for models
- Numerical model results

Programming interface

Seamless integration with powerful scientific programming languages
- Input data pre-processing
- Detailed analysis of model results
- Scripted workflow implementation

Python   R (statistics)

NEMESIS

MultiMod

TEPES

Suite of models

GGM   CCTSMOD   INVERT   FORECAST   Green-X

REMES

Enertile

EMPIRE / RAMONA

Summary & Outlook

We envisage broad **participation of the wider modelling community** to exchange best practice examples and share lessons learned…

Ambition of our consortium

- Invite **academics and practitioners** to our workshop series on …
  - *Top-down-bottom-up modelling*, NTNU Trondheim, November 2016.
  - *Modelling of risk and uncertainty for infrastructure*, ETH Zürich, spring 2017.
  - *Aggregating load profiles,* Universidad Pontifica de Comillas, Madrid, fall 2017.
  - Two later workshops with topics still to be decided.
- Publication of **methodological developments** using green open access.
- Aim for **transparency & openness** of all modelling groups in the consortium.
- Ensure easy access as well as **discoverability & intelligibility** of …
  - Numerical modelling results of case studies and pathways
  - Underlying data and assumptions used by the models

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