Navigating the Roadmap for Clean, Secure and Efficient Energy Innovation

SET-Nav
Strategic Energy Roadmap

SET-Nav Pathways Definition

SET-Nav Regional Workshop, Budapest, Feb 26th, 2019

Dr. Pedro Crespo del Granado, Norwegian University of Science and Technology
Dr. Gustav Resch, Technische Universität Wien

NTNU Norwegian University of Science and Technology

TU WIEN TECHNISCHE UNIVERSITÄT WIEN

SET-Nav Case Studies

Fossil fuel markets

Scenarios for the global fossil fuel markets

Capture the interdependence between European low-carbon policy and global fossil fuel prices and renewable energy markets as well as technological progress

Energy in Buildings

Energy in buildings and the role for RES market integration

How does energy efficiency improvement in buildings, heating system choice, flexibility options (demand response) and on-site RES affect market integration of RES and CHP?

Industrial Sector

Innovative technologies to decarbonize industrial process heat

What is the contribution of RES, energy efficiency and CCS technologies in decarbonizing the industrial process heat sector?

Transport Sector

Ways to a cleaner and smarter transport sector

Which measures can accelerate the transition of the transport sector from a fossil fuel based towards an energy efficient and low-carbon system ?

Electricity grid

Decentralized vs. centralized development of the transmission grid

What are the main grid architectures that should be considered? Impacts of solar and wind?

Gas sector

Projects of Common Interest (PCI) and gas producers pricing strategy

What are the gas infrastructure projects that should be prioritized? How vulnerable will Europe be to the suppliers' pricing strategy?

Carbon Capture

Role for Carbon Capture and Storage in the Future Energy Mix

What will be Europe's CCS infrastructure needs? What is the impact of CCS on total system costs?

RES policy

Diffusion rate of renewable electricity generation

Capability of the system to accommodate RES volatile generation by coupling energy carriers and other innovation measures in the system

Flexibility gas-elec.

Unlocking flexibility and synergy in electric power and gas systems

Integrate electricity and natural gas supply flexibility options to deal with high levels of predictable short-term load variability and uncertain variability in supply and demand

Nuclear power

Perspectives for nuclear power – a closer look at cost developments

Conduct a comprehensive technology assessment of nuclear power with a focus on cost estimates and future developments

Macro economy

Macroeconomic impacts of sustainable energy sector innovation

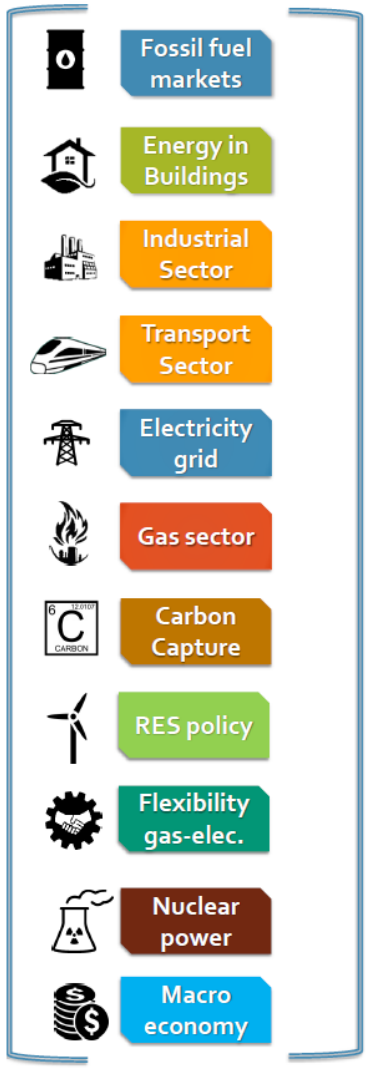
Interaction and feedback loops between the broader economy and the energy sector will provide boundary conditions for what can be achieved and how to achieve it

ET-Nav
egic Energy Roadmap

SET-Plan Challenges

ET-Nav
egic Energy Roadmap

SET-Nav Case Studies



SET-Nav
Strategic Energy Roadmap

What is a Pathway?

NTNU
Norwegian University of
Science and Technology

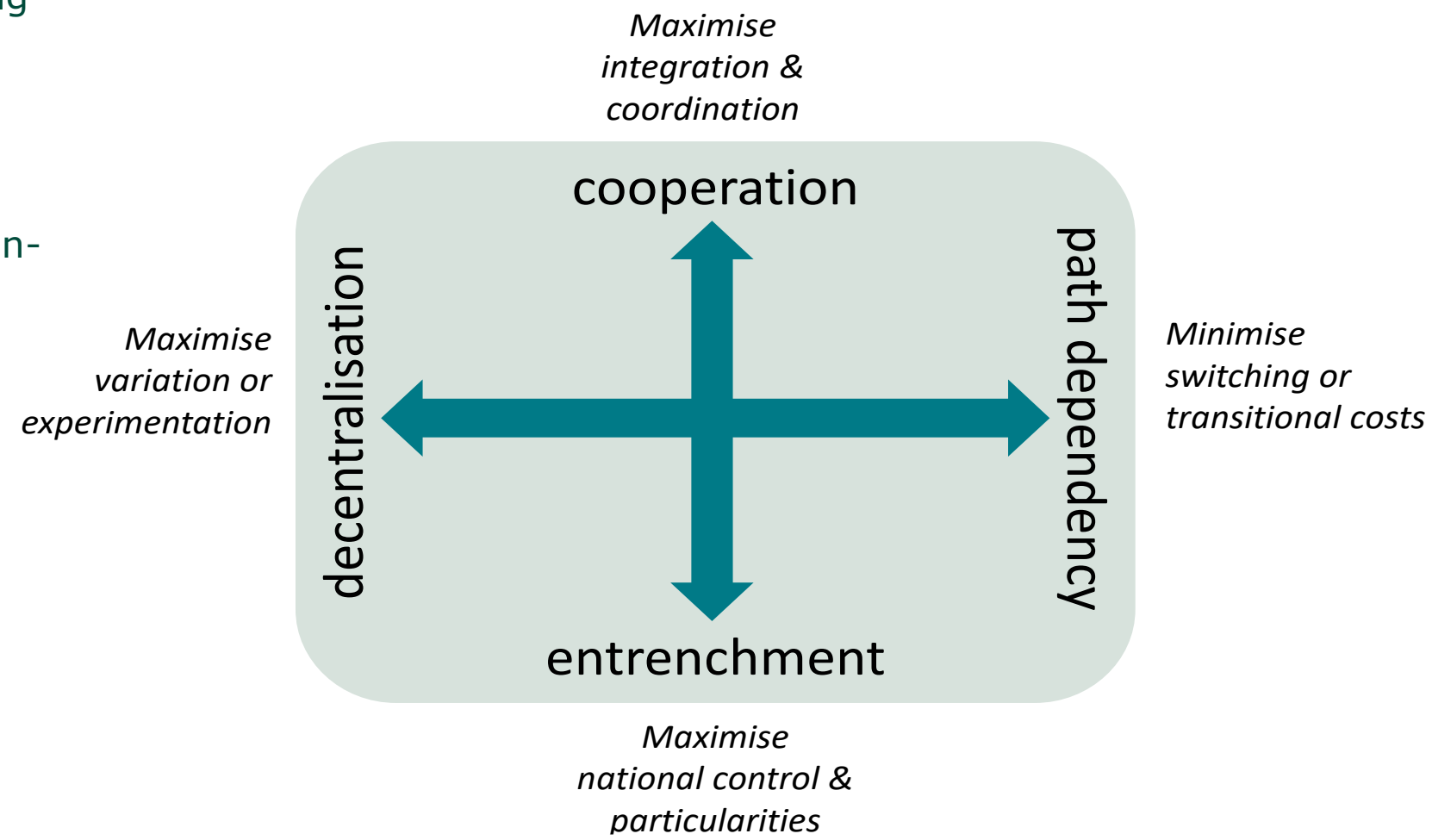
SET-Nav Pathways
for the Energy Transition
- Brief Introduction

SET-Nav
Strategic Energy Roadmap

- The EU Energy Roadmap 2050 and various stakeholders' discussions with the European commission outlined **four main decarbonisation routes for the energy sector**, these are:
  - **Energy Efficiency,**
  - **Renewable Energy Sources (RES),**
  - **Nuclear**
  - **Carbon Capture & Storage**.
- … → The design of the **SET-Nav pathways** is looking into *drivers, factors and scenario dimensions* affecting these decarbonisation options.

Mapping Pathways

- Scenario topology: Exploring two key uncertainties
- Proposed 2x2 scenario typology = cooperation-boundaries x decentralisation-path dependency

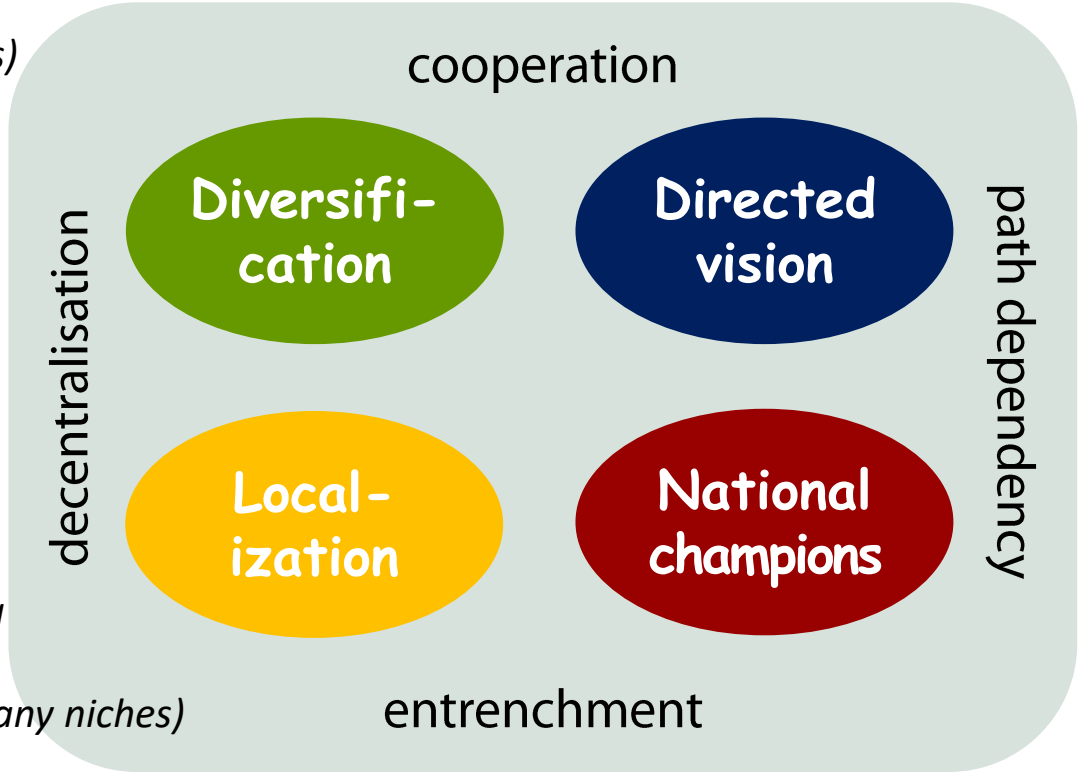


SET-NAV: PATHWAY ANALYSIS

SET-Nav
Strategic Energy Roadmap

Pathway analysis: **Pathway definition / Storylines**

- *heterogeneous actors*
- *coordination (beyond markets)*
- *digitalization (open IP)*
- *regulatory change*
- *disrupt incumbents*



- *EU/state-directed*
- *shared vision*
- *strong EU policy framework*

- *local resources resistance to big infrastructure developments*
- *experimentation & diversity (many niches)*
- *digital winners-take-all*

- *utilities & incumbents*
- *regulatory capture*
- *low transition costs*

NTNU
Norwegian University of Science and Technology

SET-Nav Pathways
for the Energy Transition
- Common assumptions for the different pathways

SET-Nav
Strategic Energy Roadmap

- **85% to 95% GHG reduction as default target at EU level**,
- **Pathways have a 2030 intermediate GHG target** (40% GHG reduction) in which policy adjustments or checkpoints might be included (e.g. ideas and lessons learnt from case studies).
- All pathways follow the concept of the PRIMES reference scenario for the near future (2020) – i.e. assuming that 2020 EU energy and climate targets are met (GHG, energy efficiency and RES targets)

SET-Nav Pathways
for the Energy Transition
- Underlying Research Questions and objectives

SET-Nav
Strategic Energy Roadmap

The design of the SET-Nav pathways is guided by two sets of research questions:

- **driver questions** related on *why* the pathway scenario happens,
- **pathways elements questions** highlighting *'what happens'*, and focused on the outcome of the pathways (modelling work and implementation).

Research questions on pathways drivers (or critical uncertainties). These questions explore critical uncertainties to define a scenario topology space so as to then identify and vary key assumptions. This provides the setting to come up with assumptions and reasoning on why the scenario happens.

1. For each pathway, **which 2030 intermediate actions should be implemented** to achieve 2050 targets?
2. Which **next steps and priorities** should be taken **for the SET-Plan?**
   →SET-Nav case study analyses provide detailed insights from each sector: On one hand, for each case study, what was the less beneficial way to go? And on the other hand, what would be the most optimistic/beneficial way to go? Include these lessons in the pathways.
3. **How do policies** (e.g. energy efficiency, carbon price, renewables support) **complement each other** to achieve the EU's 2030 and 2050 targets?

SET-Nav Pathways
for the Energy Transition
- Underlying Research Questions and objectives

SET-Nav
Strategic Energy Roadmap

The design of the SET-Nav pathways is guided by two sets of research questions:

- **driver questions** related on *why* the pathway scenario happens,
- **pathways elements questions** highlighting *'what happens'*, and focused on the outcome of the pathways (modelling work and implementation).

Research question on pathways outcomes or consequences (modelling results).

1. For each pathway, **what are the important elements, drivers and factors** of the energy transition and their cost-effective solutions?
2. **How large are the cost differentials associated with alternative strategies** towards the achievement of the 2050 target(s)?
3. What are the **long term impacts of alternative mitigation options** on the economy, the energy sectors and technology development?
4. A common set of questions can then be answered by models in each pathway: e.g.,
   (1) what is the **optimal electricity supply mix**?
   (2) **what level of stringency is needed** to ensure 2030 and 2050 goals?
   (3) **what is the spatial density of new energy infrastructure**?

LINKING MODELS - WHY

SET-Nav
Strategic Energy Roadmap

Need consistent & coherent quantitative representation of pathways across models

Models have different…

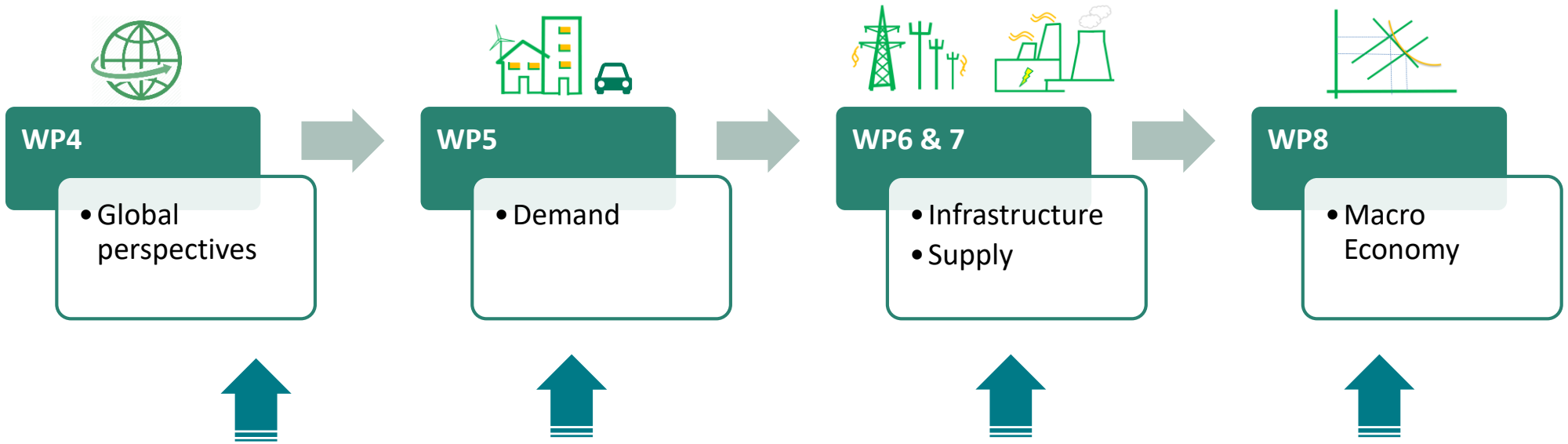
- Approaches (econ perspective; math approach)
- Foci: strengths & weaknesses
- Scopes, scales, granularities, info struct (stat-dynam; det-stoch; open-closed loop)
- Exogenous (parameters) vs endogenous variables: boundary conditions
- units of measurement, e.g., physical vs monetary representation;
- Features give complementary strengths but pose challenges for exchanging data

Use each model's strengths by using one model's results as another's boundary conditions

- but generally mismatch in scopes, granularities, etc.

PROCESS FOR EACH PATHWAY

SET-Nav
Strategic Energy Roadmap



NTNU
Norwegian University of Science and Technology

Implementation Process, modelling teams:

SET-Nav
Strategic Energy Roadmap

EMPIRE

CCTS Mod

CCS development and costs

EGMM

GGM

Gas Prices

Gas sector

Forecast

Multi-Mod WP4

INVERT

Astra

ENERTILE

GREEN-X

TEPES

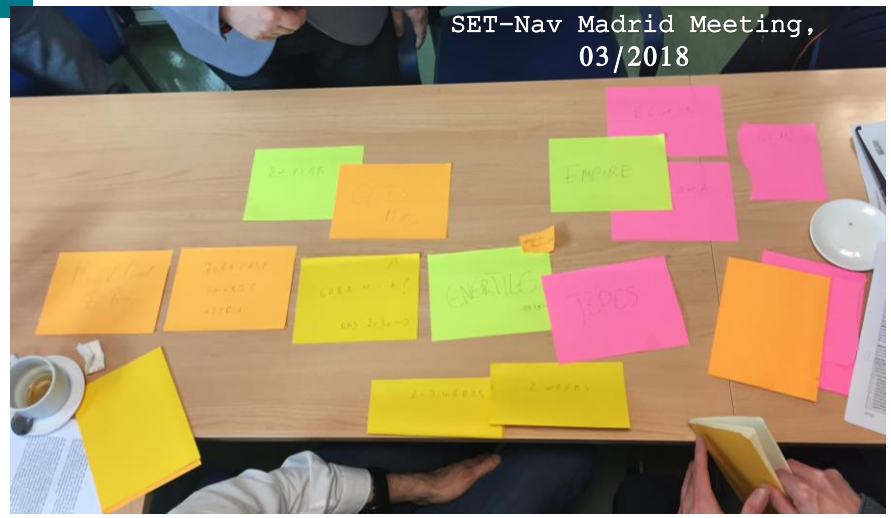
Macro Models

Robustness Control Tool

EMPIRE

Nexus Security

EMPIRE



Pathways Main overall outcomes (presentations today)

SET-Nav
Strategic Energy Roadmap

- All pathways require the implementation of strong measures to achieve expected outcomes and trigger an effective energy transition
- In the power system: Wind energy will be central along with a strengthen transmission grid
- Natural gas in the (European) energy transition: part of the problem, or part of the solution?
- Will available technologies be sufficient to decarbonize the industry sector?
- What CO2 prices will be expected?

SET-Nav
Strategic Energy Roadmap

Project Coordinator

Dr. Gustav Resch
Vienna University of Technology,
Institute of Energy Systems and Electric Drives,
TU Wien, EEG - Energy Economics Group

Website: www.eeg.tuwien.ac.at
E-mail: resch@eeg.tuwien.ac.at
Tel: +43-1-58801-370354

Visit our Website

www.set-nav.eu

Follow us

WP9 leader *"Comparative assessments: technology/policy options and path-ways"*

Prof. Dr. Ruud Egging and Dr. Pedro Crespo del Granado
Department of Industrial Economics and Technology Management
Norwegian University of Science and Technology

Website: https://www.ntnu.edu/iot
E-mail: ruude@ntnu.no ; pedro@ntnu.no
Tel: +47 735 97612

SET-Nav: Pathway Analysis

SET-Nav
Strategic Energy Roadmap

Pathway analysis: **Pathway definition / Storylines**

dimensions of uncertainty	cooperation decentralisation	cooperation path dependency	entrenchment decentralisation	entrenchment path dependency
alternative acronyms	**proliferation**	**direction**	**localisation**	**continuation**
key elements of scenario storyline	- many new entrants - heterogeneous actors - support for coordination (beyond markets) - digitalisation and open platforms - active consumers - regulatory opening (for new business models) - disruption of incumbents	- shared vision for direction of change (buy-in to targets & EU as global leader) - strong guiding role of state (EU) - engagement with stakeholders (but favouring large actors) - durable and stable policy framework - strong coordination between member states	- exploitation of local resources - differences in national strategies - public resistance to big new infrastructure - experimentation & diversity (many market niches) - digitalisation and national coordination (winner-takes-all)	- minimisation of transition costs - strong role for incumbent firms & utilities - regulatory capture of new policy - large-scale projects - low transition costs
broad policy framework derived from storyline	regulatory opening up market to new entrants, mechanisms to ensure grid capacity	strong market guidance (regulations, standards, taxes), cross-country harmonisation	differentiated policies, variation between countries, weak EU harmonisation	policies minimise transition costs & disruption, favouring centralised systems & incumbents
SET Plan emphasis: Priority Areas (WP3)	(decentral) renewables, efficiency, smart grid, e-mobility	(central) renewables, efficiency, (new) nuclear, CCS, e-mobility	(decentral) renewables, efficiency, (existing) nuclear, CCS (localised), e-mobility	(central) renewables, efficiency, (new and existing) nuclear, CCS, e-mobility