MILESECURE-2050

Multidimensional Impact of the
Low-carbon European Strategy on Energy Security, and
Socio-Economic Dimension up to 2050 perspective

Energy Security Scenarios for Europe by 2050
Assessing the impacts of societal processes in a low carbon context

Christophe Cassen, Meriem Hamdi-Chérif (SMASH)
Giancarlo Cotella, Jacopo Toniolo (POLITO)

AESOP conference

Prague, 15th July

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 320169

Outline

- Context and motivation
- Features of societal processes
- Presentation of the scenarios
- Implication in terms of energy security
- Concluding remarks and perspectives

Context and motivation

- Energy security and climate change are two intertwined priorities for EU:
  - Sustainability, security of supply and competitiveness: three complementary pillars of the European energy policy (COM (2006, 2010))
  - Included in the Climate package, Roadmap 2050 and EU's 2020 to 2030 transition framework for climate and energy policies (COM (2014).
- Low energy and carbon trajectories (2°C) requires deep transformations (AR5) triggered by:
  - Technologies
  - Societal processes
- Energy security and climate issues: two sides of a same coin?

Objectives of the Milesecure project

- Understand the importance of “societal processes” as a product of the interaction of multiple intended and unintended elements (operational, cognitive and pre-cognitive processes) in the transition towards a low energy and carbon society at the EU level

- Assess by 2050 the legitimacy and efficacy of policies in terms of the capacity for Europe to transition to low energy and carbon society and to consider the long-term socio-economic impact of such options.

Methodology

- Identifying the societal processes, human factors of low energy and carbon transition
  - Analysis of a set of anticipatory experiences (AEs) at the local level
- Exploring alternative futures of Europe considering potential development of significant changes in lifestyles, environmental and energy security issues
  - The IMACLIM model (EU aggregated level)
- Assessing the results against energy security issues and their policy implications

Identification of societal processes

- A big part of the MILESECURE-2050 research has been based on the identification of a series of "**anticipatory experiences**" of energy transition,
  - incorporate and anticipate the basic features of a more complex transition to environmentally sustainable ways of producing, consuming, and distributing energy.
- Such experiences were understood as **already existing "parts” of a future post-carbon society** allowing to focus on **concrete factual elements** and not mere hypotheses

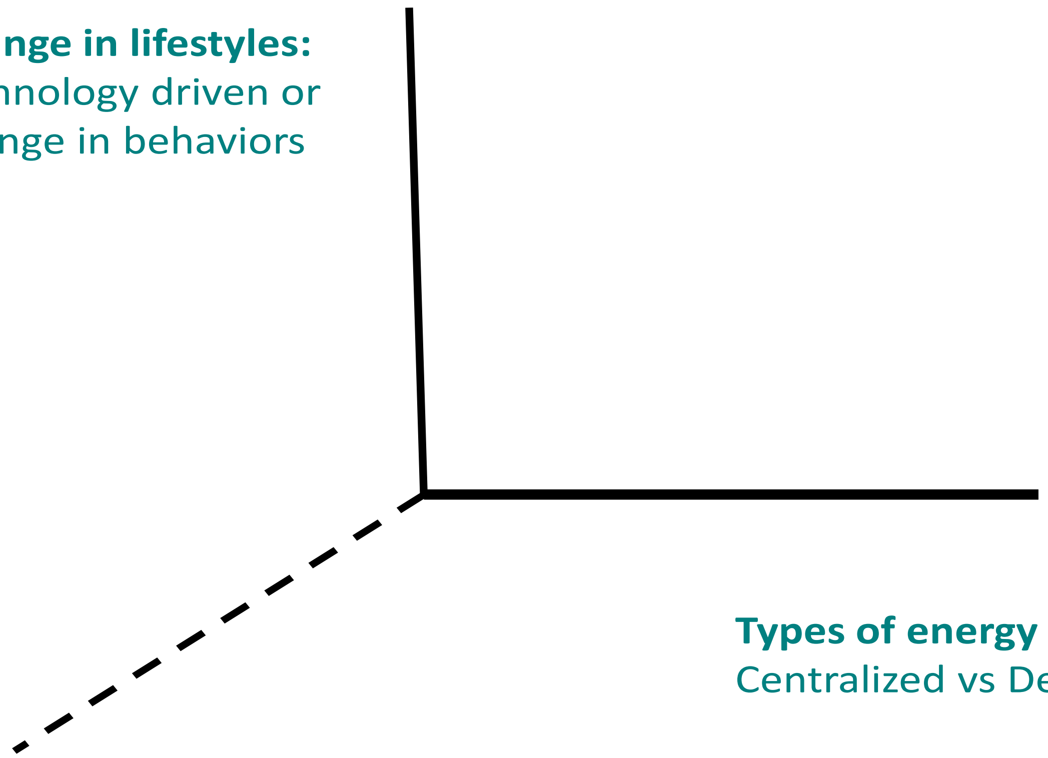
The scenarios/storylines: what is considered?

- Key factors of energy transition identified in AEs
  - Changes in behaviors and types of energy use (development styles)
  - Specific social and governance dynamics of consumption and energy production (decentralized vs centralized)
- Drivers and barriers of energy transition
  - European environmental and energy policies (Roadmap2050, Frame2030…)
  - Technical change and penetration of decarbonized technologies
  - Investments

  Depend on technologies' availability, transformation of energy production modes, social acceptance, economic's agents expectations etc…
- Geopolitical context
  - Global Energy markets dynamics
  - Process of international climate negotiations (Copenhagen and beyond)

The scenarios/storylines: the key dimensions

Change in lifestyles:
technology driven or
change in behaviors



Types of energy production systems
Centralized vs Decentralized

Climate policies

Three main scenarios … Three worlds

- Business-As-Usual

  (Mile-BAU)

- Centralized Energy Transition

  (CENT)

- Social Energy Transition

  (SET)

Business-As-Usual scenario *(Mile-BAU)*

- A continuation of "current state of affairs"

  No significant change in people's behaviors and consumption styles, no major changes in technology, economics, or policies

  → No climate policies

- Mainly to assess the costs of the transition toward a Low Carbon Society

CENT
A "top-down" policy vision

- The transition towards a LCS occurs within the framework of
  - Centralised energy production modes
  - High fossil fuel dependency
  - No specific actions on infrastructures

- **Climate policies = Mitigation of GHG (CO_2) emissions**

- **Targets:**
  - **Europe:** -20%, -40% and -80% respectively in 2020, 2030 and 2050 /2005 (consistent with Roadmap2050 and Frame 2030)
  - **Rest of the World:** Copenhagen pledges for the rest of the World (very less constrained!)
    - Rest OECD, China, India, Brazil
    - Rest of the World (ME, Russia, Africa, rest of Asia)→ **not constrained !!**

Social Energy Transition scenario
(SET) - A “bottom-up” policy vision

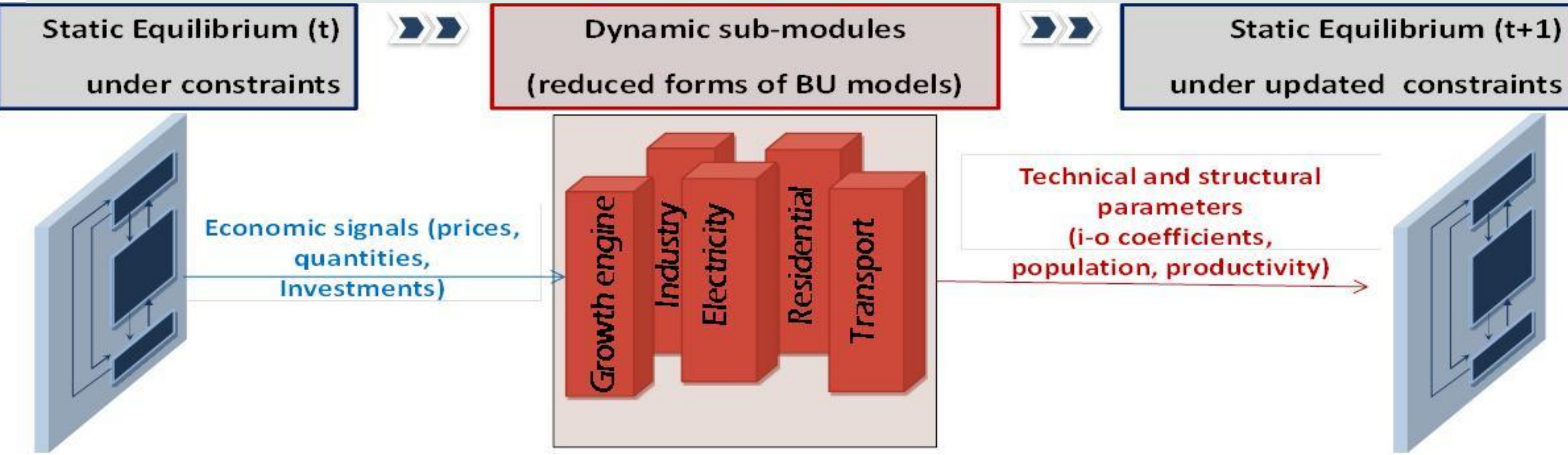
- **Same climate objectives** (in terms of emissions reductions) for Europe and the Rest of the World

- **Deployment of AEs**

→ Significant changes in
  - ✓ Consumption patterns and
  - ✓ Energy production modes (more decentralized)
  - ✓ Location issues (activities, housing…)

- Two ways of integration in IMACLIM-R:
  - Transport module
    (Urban forms, Production/Distribution process)
  - Energy production modes

IMACLIM-R: a recursive and modular architecture to study transition pathways



- Global multi-region, multi-sector general equilibrium model
  → representing 12 regions including EUROPE
- Relies on Hybrid matrix: consistency between money and physical quantities (Calibrated on GTAP & IEA energy balances)
- Describes dynamic trajectories in one year step through the recursive succession of:
  - **Top-Down Static equilibria (CGE):** Equilibrium of the economy
  - **Bottom-Up Dynamic modules:** Evolution of technical and structural constraints

SET
Two ways of integration in IMACLIM-R

Urban forms and Transportation:

- A progressive **reduction of households' basic mobility** (essentially commuting): to represent a spatial reorganization at the urban level (more dense cities) and soft measures towards less mobility-dependent conglomerations.

- Shifts in the modal structure of investments in transportation infrastructures **favoring public modes** instead of private vehicles

- **Reorganizations in production/distribution process/logistics** allowing a decrease of freight transportation needs

Energy production modes: Much more optimistic scenario in terms of low-carbon technologies (availability and penetration):

Dimension	Technology	Parameters
Power generation decarbonization	**Nuclear**	Maximum Market Share [min-max]
	Renewables	Maximum Market Share of renewables, Learning rate for renewables investments costs
	Carbon Capture and Storage	CCS learning rate, start date, max market share at the end of the bottleneck phase, growth phase, max market share at the end of the growt phase, mauration phase, mx market share at the end of the maturation phase
Low Carbon end-use technologies	**Electric Vehicles**	EV "bottleneck phase", Maximum market share at the end of the period, growth rate, maximum market share at the end of the period, maturation phase, maximum market share
	Energy Efficiency	Freight energy consumption, Freight fuel consumption elasticity to fuel prices, Buildings energy consumption per m2
	Biofuels	Time scale of reactive anticipation for biofuels production, biofuels supply
Alternative liquid fuel supply	**Coal-to-liquids**	Oil price threshold for CTL production start, Maximum production growth in 2030, 2035, 2050

Implications in terms of Energy Security issues

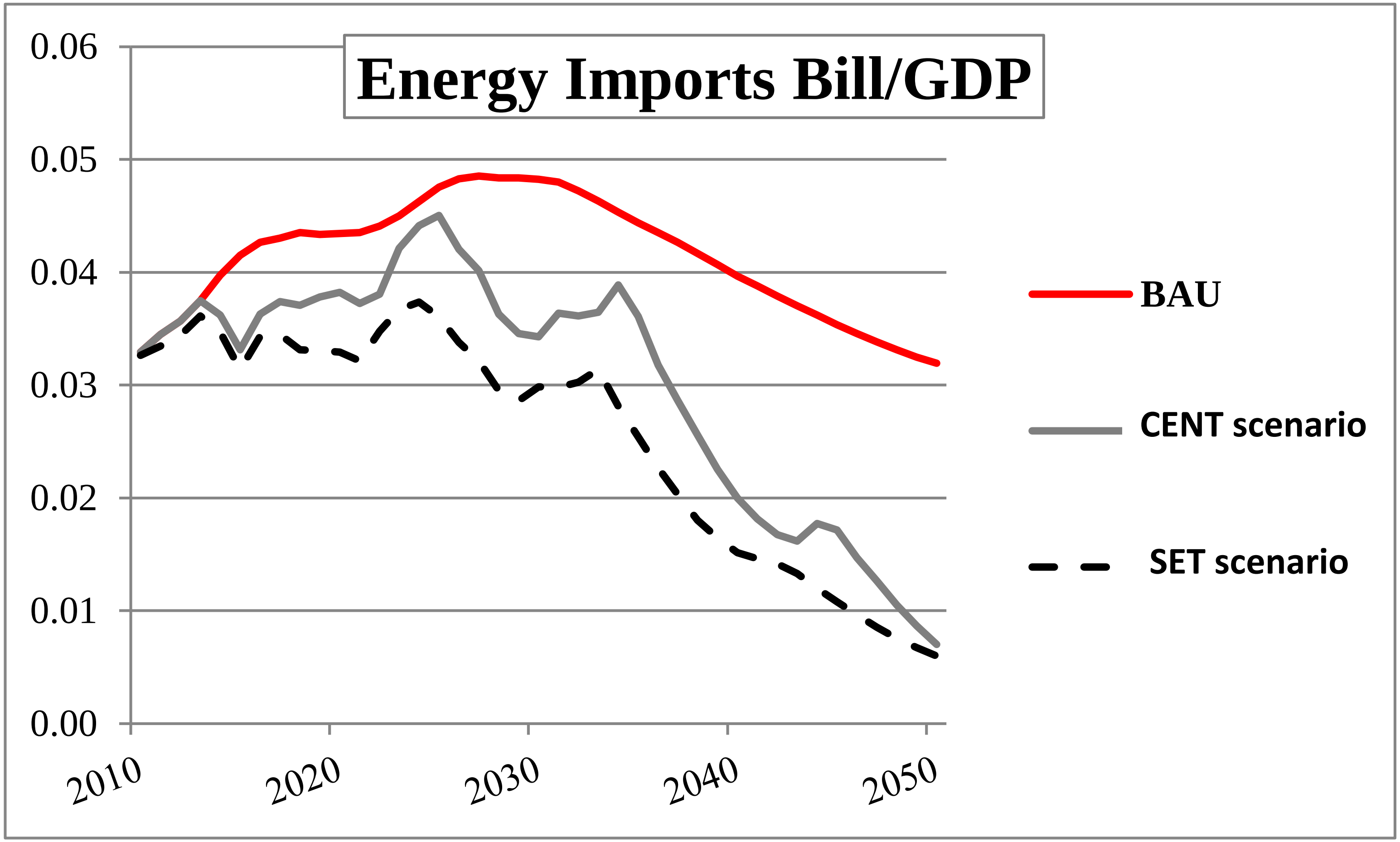
- Energy security is a multi-faceted concept
- A Energy secure system is one “*evolving over time with an adequate capacity to absorb adverse uncertain events, so that it is able to continue satisfying the energy service needs of its intended users with ‘acceptable’ changes in their amount and prices*” (Gracceva and Zeniewski, 2012)
- Energy security is “low vulnerability of vital energy systems’” (Cherp, 2012)

A set of indicators to measure dimensions of energy security

- Quantify the effects of climate policies on these indicators
- Based on WP1, we consider 4 dimensions (Sovacool and Brown (2010), Kruyt et al. (2009) and Chester (2010))

Dimensions of the energy security concept	Selection of indicators
Availability and diversity	- Production/Resources (oil) - Diversity of Imports (oil) (Herfindahl-Hirschmann index –market concentration)
Dependence	- TPES/GDP - Imports/TPES
Affordability	- Households energy budget (share of revenues) - Energy import bill/GDP
Sustainability and acceptability	- Carbon content of TPES - Installed nuclear capacity

less energy vulnerability of the economy
(Preliminary results)

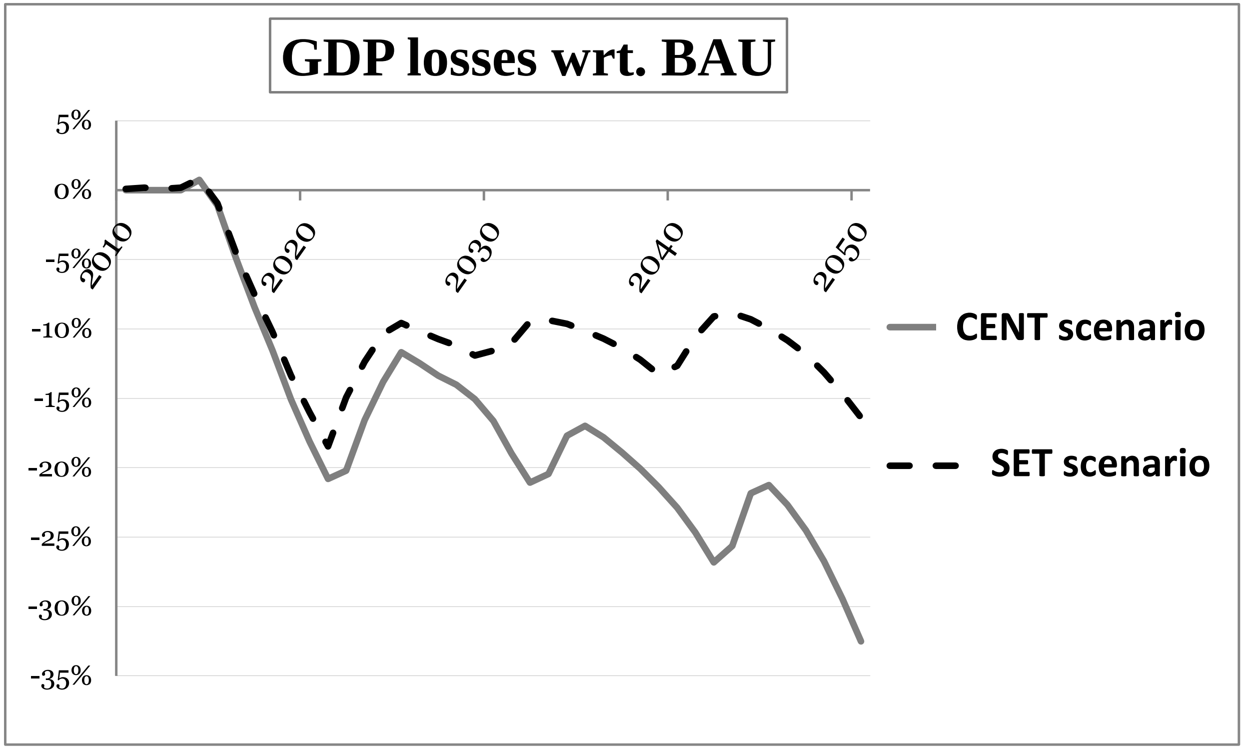


And less energy vulnerability of households (Preliminary results)

	2010	2020	2030	2050
BAU	9%	10%	10%	7%
CENT scenario	9%	24%	20%	24%
SET scenario	9%	22%	14%	13%

Share of Energy in Households' Budget

Incorporating societal processes: less transition costs (Preliminary results)



Concluding remarks and perspectives

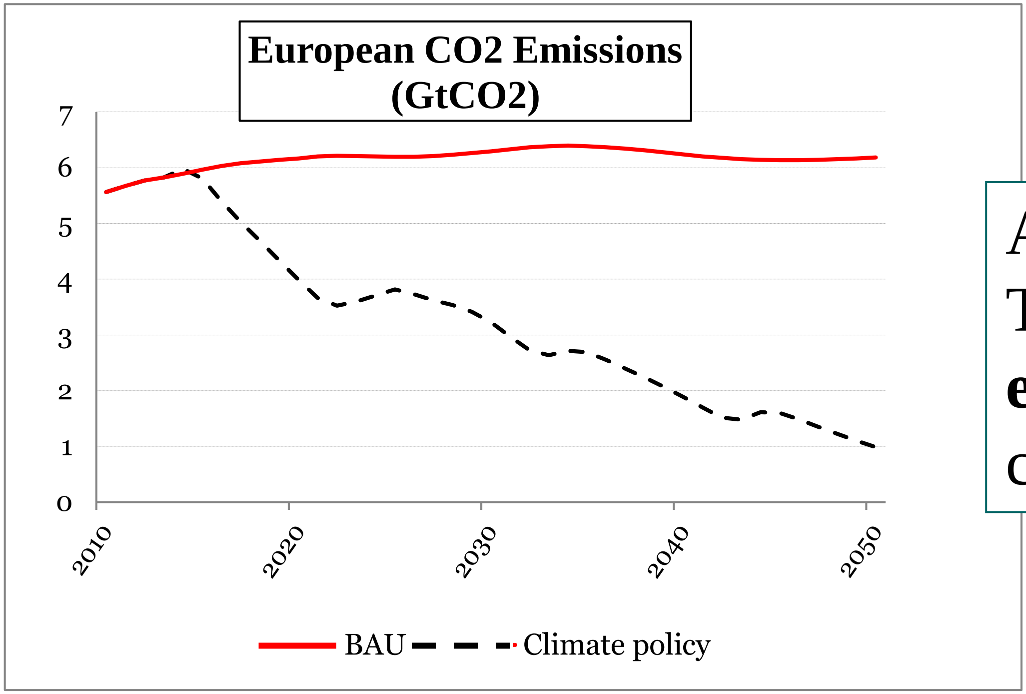
- Identification of societal processes that may play in favoring or constraining both energy transition and energy security
- Integration into LT scenarios quantitatively assessed by an Energy-Economy-Environment model
- Key result: a transition pivoted around a more decentralized approach improves energy security in a context of low carbon transition than one that counts on top-down imposed measures
- Perspective: broader assessment of energy security indicators, sensitivity to energy shocks

Thank you!

http://www.imaclim.centre-cired.fr/

How climate policy is implemented?

Given a **prescribed** CO_2 emission objective



At each date,
The **carbon price** is **endogenously calculated** to curve carbon emissions