Evaluating the Implication of COP21 for Energy Security in EU28

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Context and motivation

RIPPLES project: Results and **I**mplications for **P**athways and **P**olicies for **L**ow **E**missions **E**uropean **S**ocieties.

- What is the impact of Nationally Determined Contributions (NDC) on economy and climate?
- Which steps are needed to attain deeper, more ambitious decarbonisation targets.
- Socio-economic consequences of climate policy and COP21 objectives.

Energy security:

- What is the impact on energy security?
- Which of climate scenario is the most suitable for European countries?

Energy Security definition

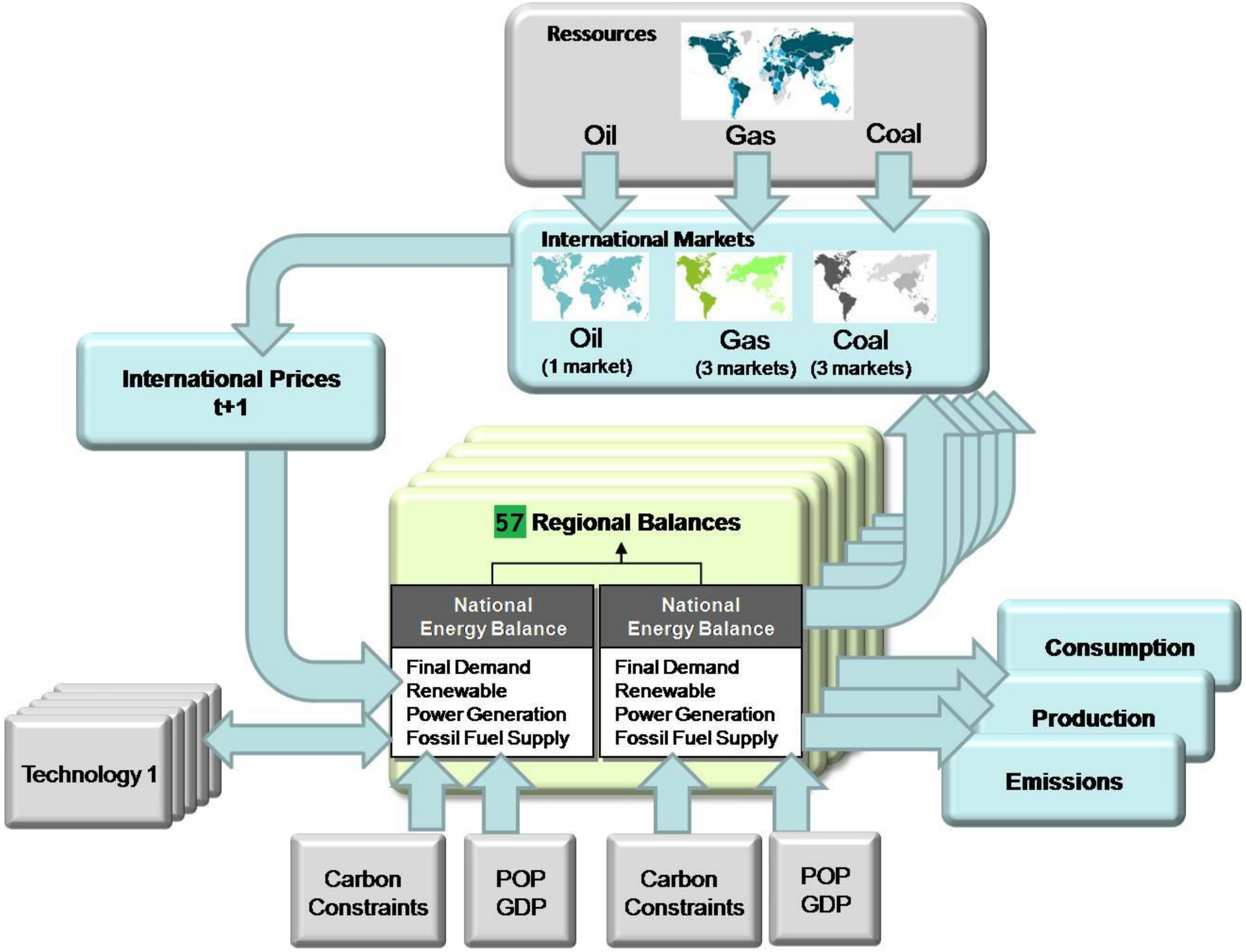
- Energy security policies must ensure (IEA):
  - Uninterrupted availability of energy sources at an affordable price.
  - Cover or reduce risks that affect energy sector.
  - Sustainable development of economy.

- The best way of approaching the question of energy security is to identify and to describe the energy security dimensions.

Energy Security dimensions

1) **Availability** – the availability of energy resources, diversification and the energy (in)dependency.
2) **Affordability** – *"the capacity to produce energy services at the lowest cost, to have predictable energy prices and to enable equitable access to energy services"* (Sovacool and Mukherjee, 2011)
3) **Sustainability** – preserve and protect the environment and living conditions, tackle climate change. The effects should persist over time.
4) **Resilience to risks** – *"How the energy services can survive unexpected events that disrupt efficient operation?"* (Sovacool and Sanders, 2014)
5) **Economic development** – the ability of domestic economy to maintain or raise the standards of living
6) **Electricity grid reliability** – the capacity of power system to maintain the supply-demand equilibrium at any time.

POLES: year-by-year recursive simulation process



Security dimensions (3) and indicators (18)

Availability

- Energy diversity indexes, where p_i is a share of energy source or supplier:
  - Shannon-Wiener Index.

$$SWI = -\sum_{i=1}^{n} p_i \log(p_i)$$

  - Herfindahl–Hirschman Index.

$$HHI = \sum_{i=1}^{n} p_i^2$$

- Energy intensity.
- Import dependency (ratio).

Affordability

- Energy bill per dwelling

Electricity

- Capacity factor
  - Biomass
  - Oil
  - Coal
  - Natural gas
- Share of solar and wind

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Scenarios up to 2050

Baseline: no climate policy scenario, used for benchmarking.

INDC +30 : Until 2030 countries limit their ambition to the NDCs. The strong acceleration in climate policy and a significant breakthroughs of investment costs are necessary after 2030 to reach 2°C/3°C target.

Early action: early climate policy action is combined with a significant breakthroughs of investment costs in 2020.

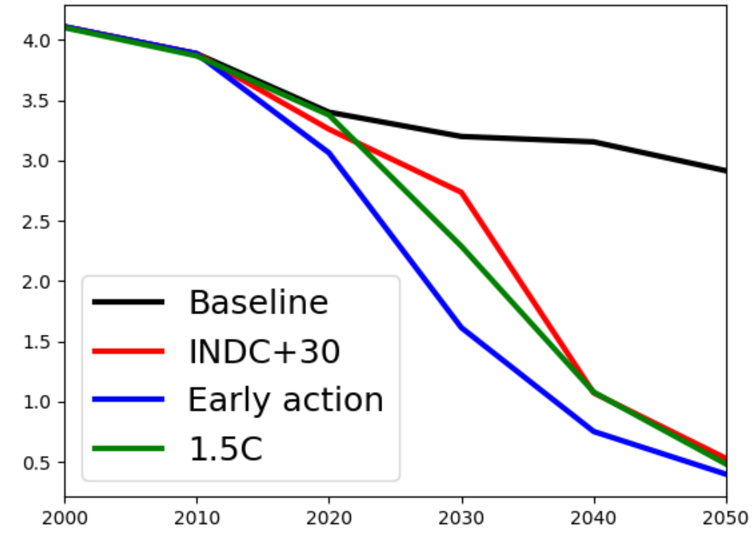
1.5°C : no-RIPPLES scenario, that reaches 1.5°C in 2100, relying on very high carbon prices and a high share of solar and wind in electricity generation.

Scenarios:

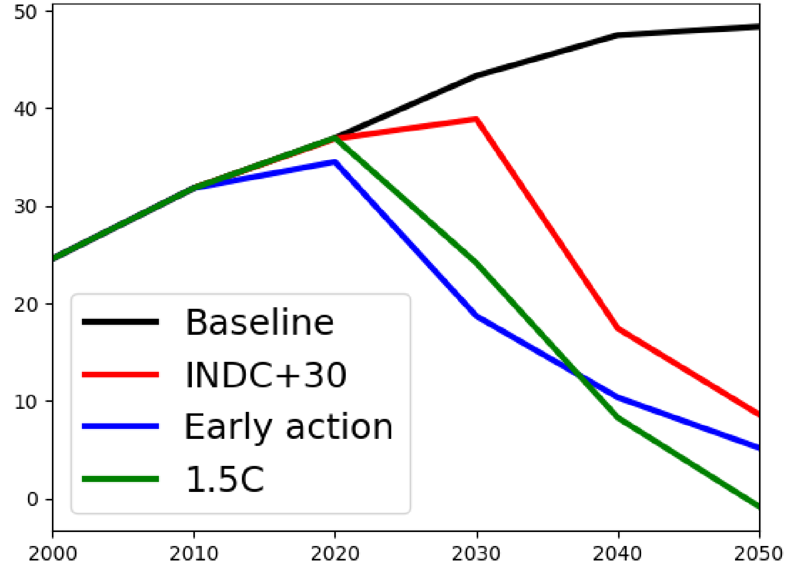
	Type	Carbon price 2050 ($/tCO2)	Emissions 2050 / 2000	World carbon budget 2011-2050 (GtCO2)
Baseline	**7°C**	**0 DEV*** 0 INDEV*	**-29% EU28** +97% World	1700
INDC + 2030	**3°C**	**586 DEV*** 351 INDEV**	**-87% EU28** -65% World	1150
Early action	**2°C**	**586 DEV*** 351 INDEV**	**-90% EU28** -79% World	815
1.5°C	**1.5°C**	**2045 DEV*** 2045 INDEV	**-88% EU28** -103% World	760 400 (for 2011-2100)

* DEV – all developed countries, EU28, Russia, South Korea
** INDEV – other countries (Africa, Asia, South America, Mexica)

CO2 emissions in EU28 (GtCO2)



Worldwide CO2 emissions (GtCO2)

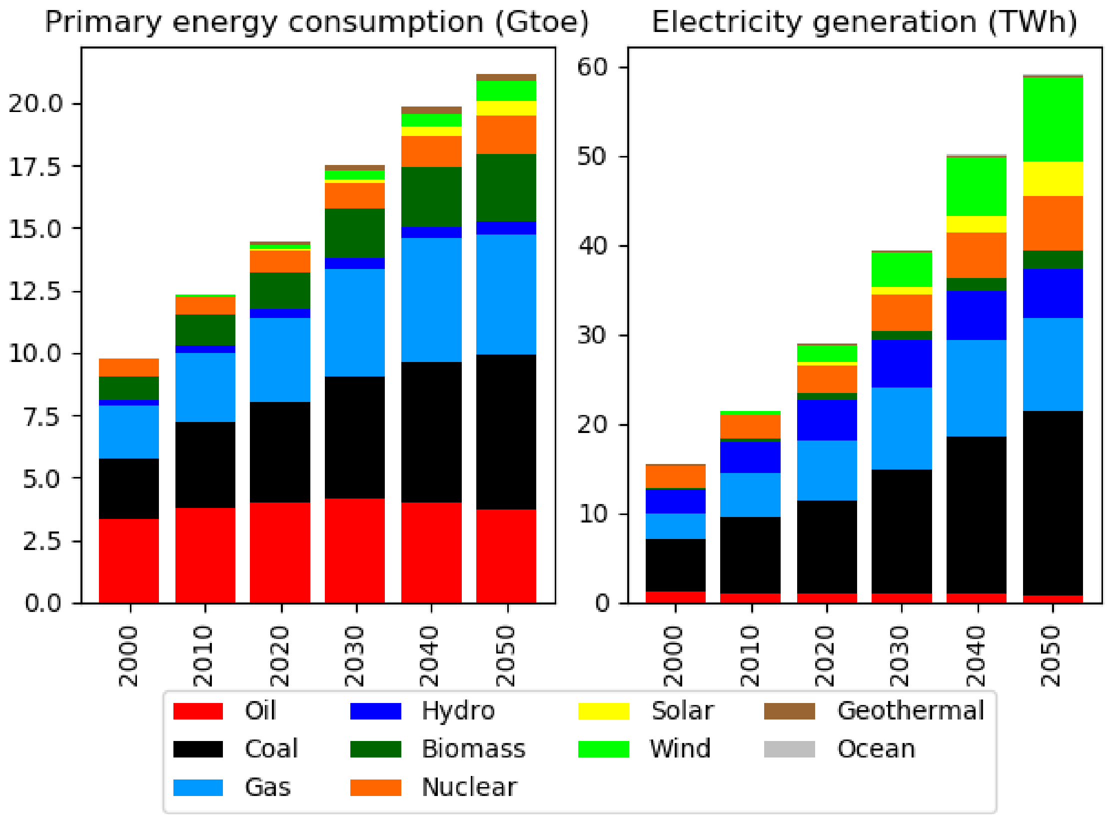


World in Baseline scenario

Compared to 2010:

- Primary energy, coal and gas consumption +70%
- Oil consumption remains stable.
- High increase of biomass consumption (+220%).
- Solar and wind account for 22% in electricity generation.

World profile in Baseline scenario



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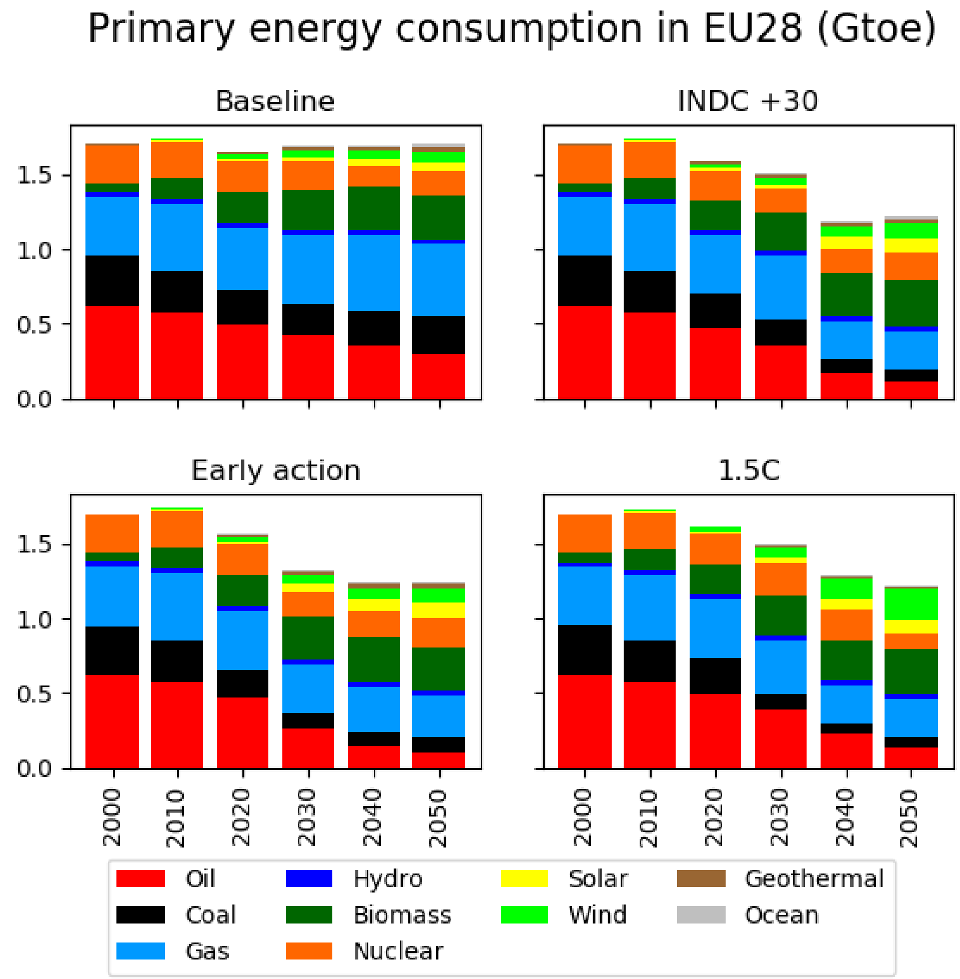
Diversity : Primary Energy consumption

- Primary consumption remains stable in **Baseline** scenario and decreases in mitigation scenarios (-29%).
- Increased diversity in all scenario (in average +25%) ➔ primary energy diversity does not the result of a strong climate policy (in EU28).
- **1.5°C** scenario has the lowest increase of diversity.

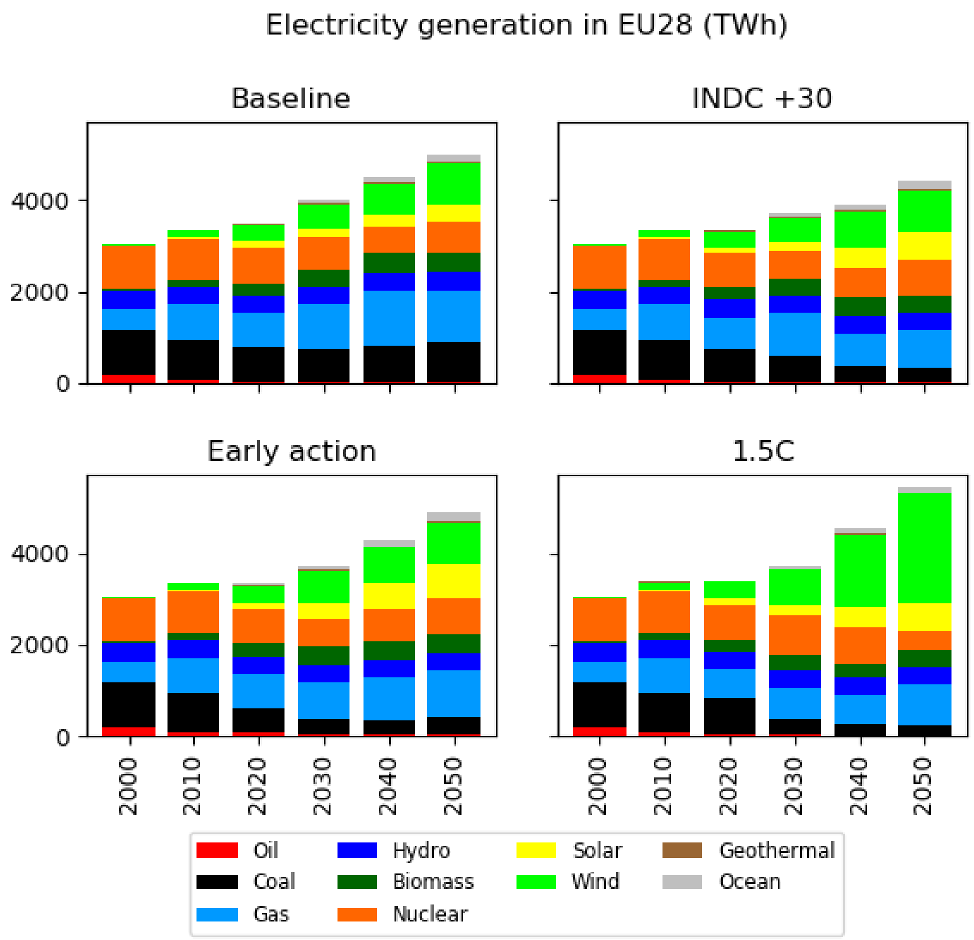
	EU15	*EU other*	*World*
Baseline	2nd best	3rd	2nd
INDC + 2030	2nd best	2nd	**1st**
Early action	**1st best**	**1st**	**1st**
1.5°C	3rd best	4th	2nd



Diversity : Electricity production

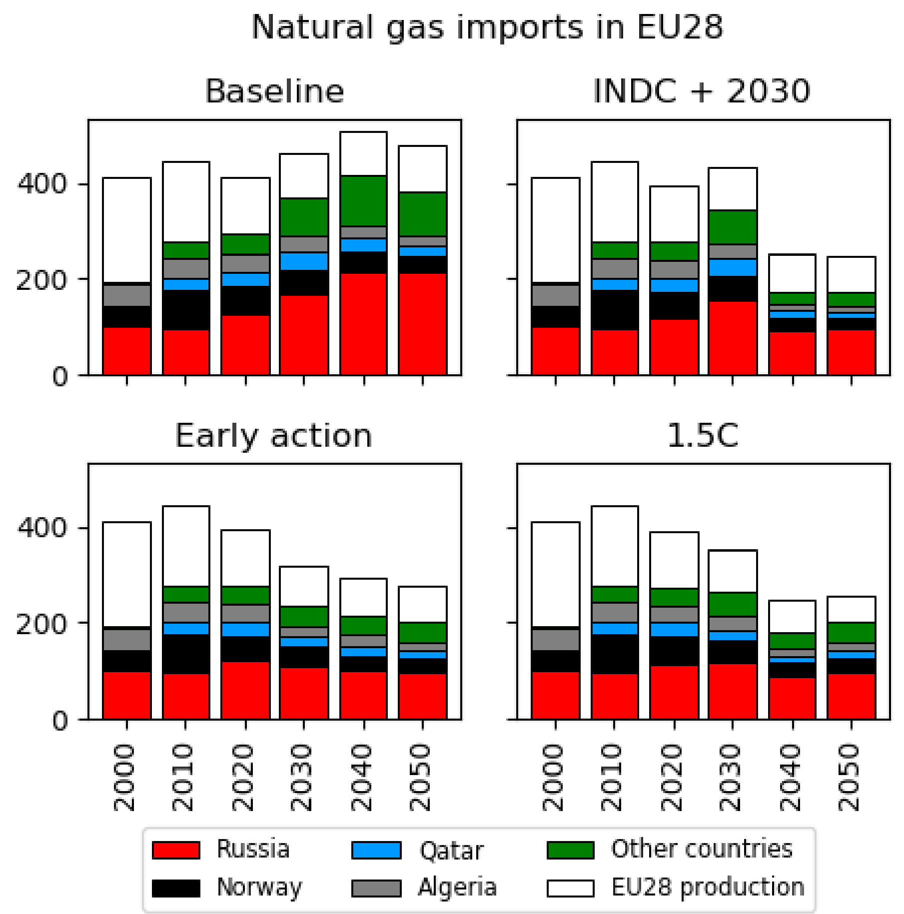
- Electricity production increases in all scenarios because electricity is a key lever to reduce GHG emissions.
- Electricity diversity increases between 2010 and 2050 in all scenarios, except for 1.5C° (high share of intermittent renewables).
- The highest diversity of European electricity is in Baseline scenario, but higher in **INDC+30** and **Early action** scenarios for the rest of the World.

	EU15	EU other	World
Baseline	**1st**	**1st**	2nd
INDC + 2030	2nd	3rd	**1st**
Early action	3rd	2nd	**1st**
1.5°C	4th	4th	3rd



Diversity : Natural gas imports

- Gas imports to Consumption ratio: 70% in **INDC+30** and 80% in other scenarios
- Share of Russian gas imports: 48%-55%
- The best diversity of imports is in **Early action** scenario, however there is little difference compared to **Baseline**.
- The only way to reduce gas dependency of some EU countries: common European gas market.



Dependence: Energy intensity

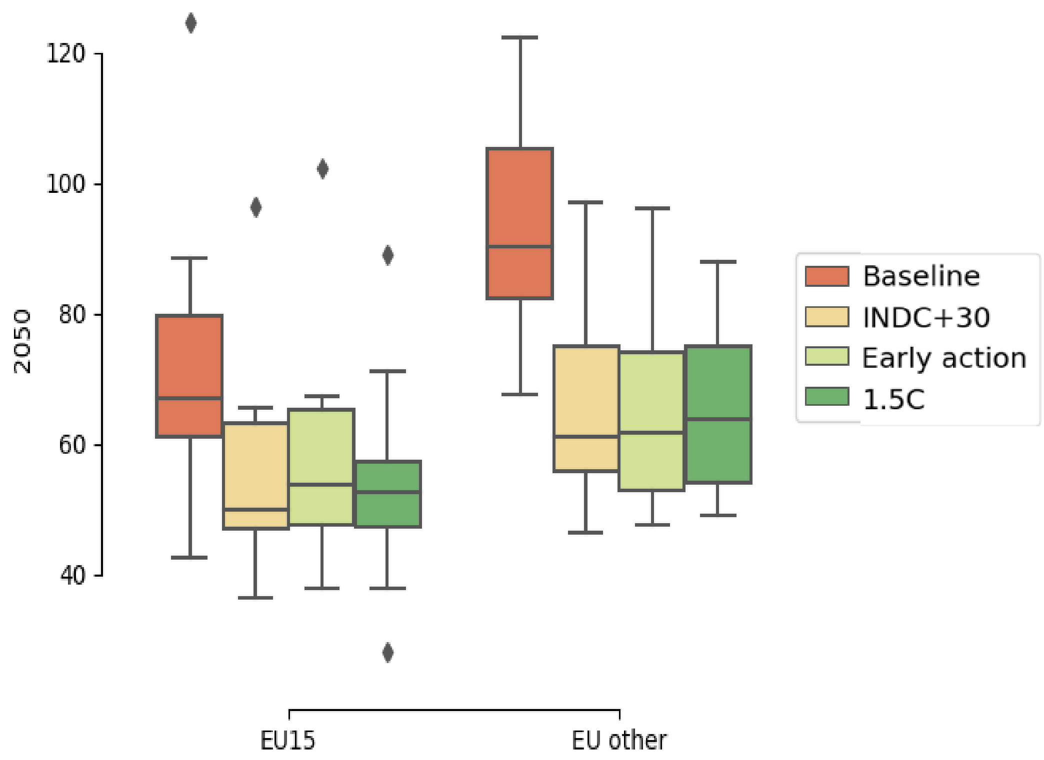
- European dependency on energy decreases in all mitigation scenarios.

- The energy intensity decreases more quickly in no-EU15 countries.

- Which scenario is the most suitable?
  - **1.5°C** for a half of EU28.
  - **INDC+30** and **Early action** for another half.

  - Country specific climate policy is more suitable that a common one (that is one of objective of RIPPLES project).

Energy intensity of GDP in EU28 (toe/$)



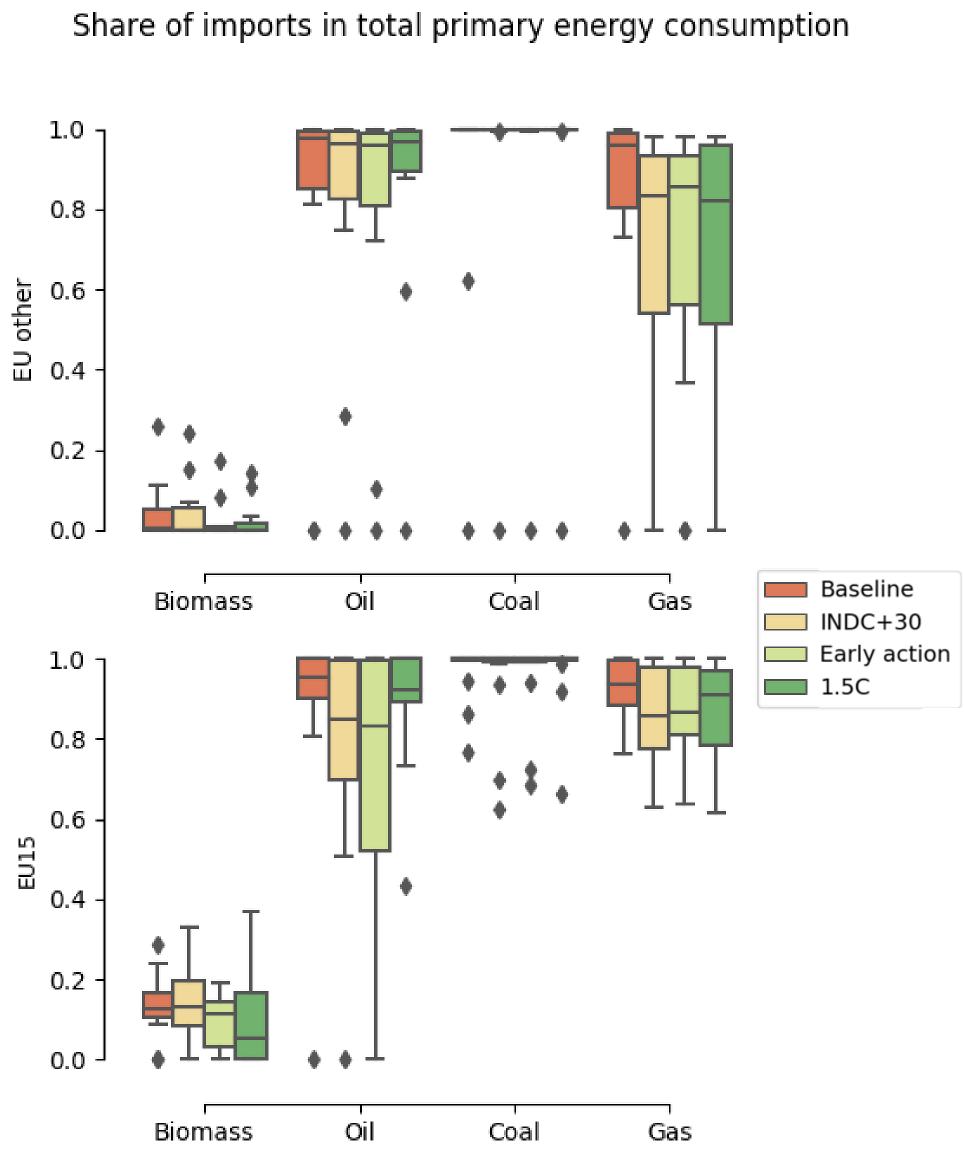
Import dependency ratio

- Increased biomass consumption, but 300 Gtoe in all scenarios. At worst, the import ratio is 37% for Greece (1.5°C).

- A strong decrease of gas import dependency ratio in no EU15 countries.

- Number of countries per scenario with the lowest import rate compared to other scenarios:

	Biomass	Oil	Coal	Gas
Baseline	2		Any significant change, except for: Poland (0% → 100%) R. Czech (100% → 0%)	1
INDC + 2030				**7**
Early action	6	**All**		6
1.5°C	**15**			**15**

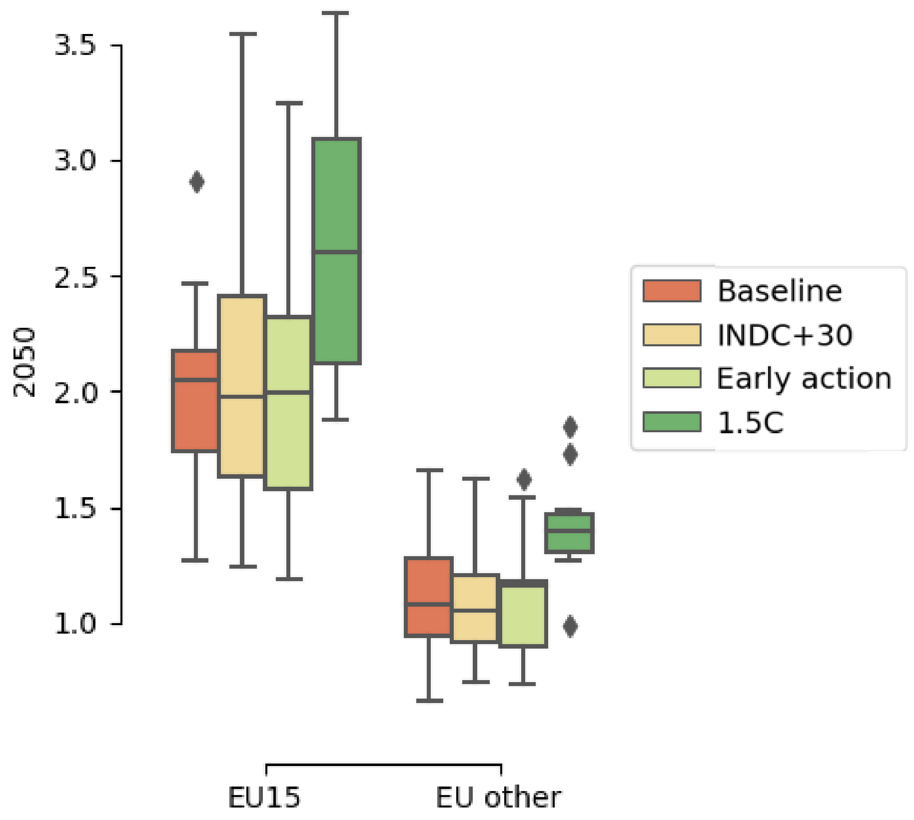


Affordability: energy bill per dwelling

- **Small difference** between no 1.5°C scenarios, but slight increase for EU15 countries (8) and two no EU15 countries (Bulgaria and Estonia).
- Currently, Bulgaria has the highest rate of fuel poverty in EU28 ➔ cannot afford climate policy
- Energy bill is 30-70% higher in 1.5°C.

	EU15	*EU other*	*World*
Baseline	3rd	2nd	**1st**
INDC + 2030	2nd	**1st**	3rd
Early action	**1st**	3rd	2nd
1.5°C	4th	4th	4th

Energy expenditure per dwelling (k$)



Capacity factor of power plants

If share of Solar + Wind in electricity generation < 55%:

- No significant relation between share of I-RES and back-up capacities.

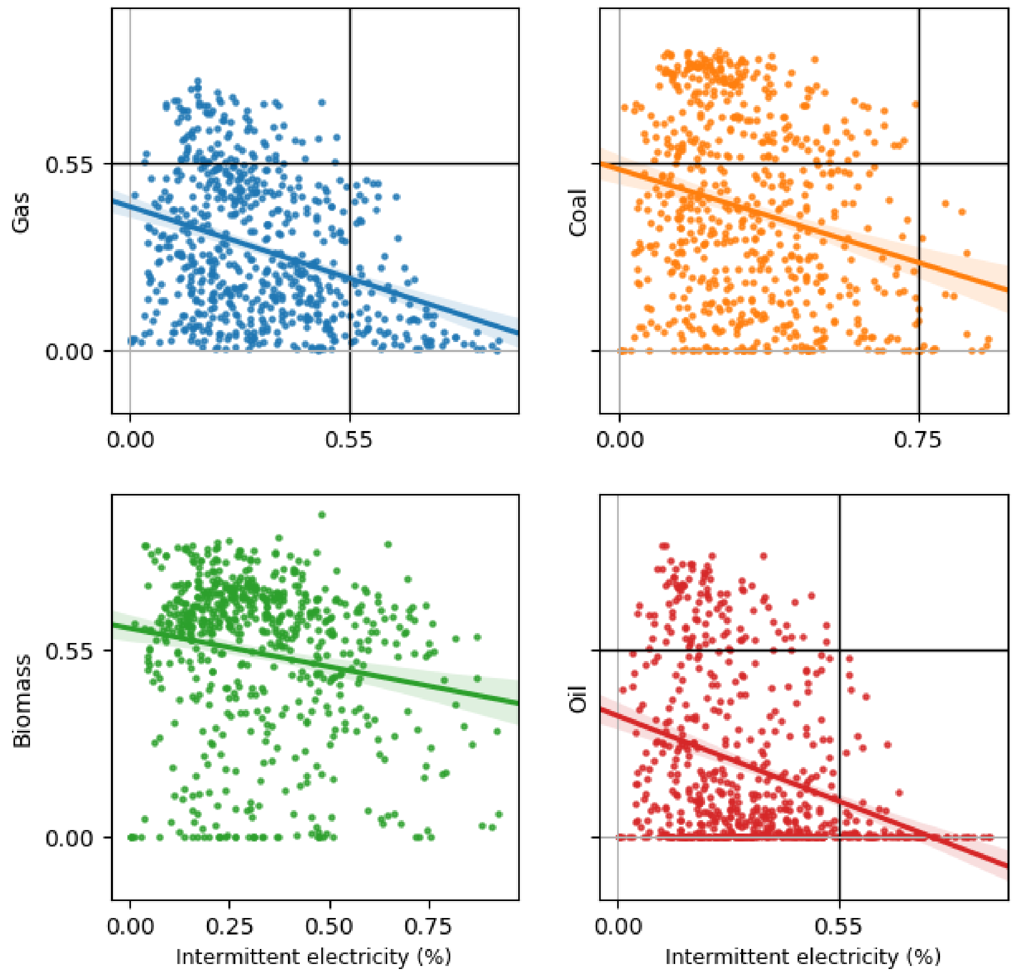
If solar + wind > 55%:

- Capacity factor of oil and gas plant decreases.

If solar wind > 75%:

- Low use of coal plants.

Relationship between share of intermittent renewables and power plant capacity factor



Energy security in EU15 ➔ Early action

	Diversity			*Import dependency*					*Affordability*	*Solar Wind*	
	Primary energy	Electricity	Gas imports	Energy intensity	Oil	Coal	Biomass	Gas	Energy bill	Capacity factor	Energy security
Baseline											1
INDC + 2030											3
Early action											6
1.5°C											2

Energy security in no EU15 ➔ INDC +30

	Diversity			*Import dependency*					*Affordability*	*Solar Wind*	
	Primary energy	Electricity	Gas imports	Energy intensity	Oil	Coal	Biomass	Gas	Energy bill	Capacity factor	Energy security
Baseline											1
INDC + 2030											5
Early action											4
1.5°C											3

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Conclusions

- The climate policies are rather positive or neutral effect on European energy security:
  - Decrease energy dependency (included imports of fossil fuel and biomass).
  - Diversify primary energy consumption.
  - Does not increase energy expenditure in well balanced mitigation scenarios.
  - Positive impact is higher for developing countries.

- Can lead to some negative impacts in the case of high share of intermittent renewables and high carbon prices (e.g. +50/+70% for energy bill in dwellings).

Thank you for your attention