REflex
Analysis of the European Energy System

COMPARING FUTURE DECENTRAL AND CENTRAL EUROPEAN ENERGY SYSTEMS –

How externalities impact the environment and society from local to a global scale

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European energy system

Energy system

"… it is clear that in order to get to the Paris Agreement's lower temperature goal of 1.5°C, the world needs to make a paradigm shift to zero emissions vehicles"
NewClimate Institute, 2018

Of course there are no **zero-emission** vehicles and zero-emission **mobility."**
(Kraus, W. FIA Eurocouncil, 2018)

Electricity mix

Industries and **building** sector are **the most CO2** contributors, if emissions of **electricity system** are **allocated**.
(EU Commission, 2018)

"… The high energy demand and CO2 emissions are a concern for the future industrial development. Alternative energy system needs to be cleaner to assist industrial technological innovation"
(World Steel Association, 2018)

European energy system

1. Which magnitude the electricity system could slow the pace for climate mitigation?

2. How the scenario High-Res central and decentral could change the situation?

3. Which are the un-intended impacts could “drawback ” in the longer run the support for transformation of the energy system?

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Ensuring environmental and social integrity

Pitfall	Rule of thumb (externalities)
Technological breakthroughs	Adequate performance and reliability of **next- technology generation**
Demand for technologies (and consumables) in global markets	**Analyse the supply chain** and social-technical procedures
Change is technical and local	**Distinguish technical** & **socio-environment** demand in the **global** system
Outline linear (direct) impacts	Recognize the **overall impacts** systematically (potential risks)

Working in depth with the rule of thumb – REFLEX life cycle analysis

Indicator set

- Screening technologies
- Identification of supply chain

Conventional and innovative

Future market expansion

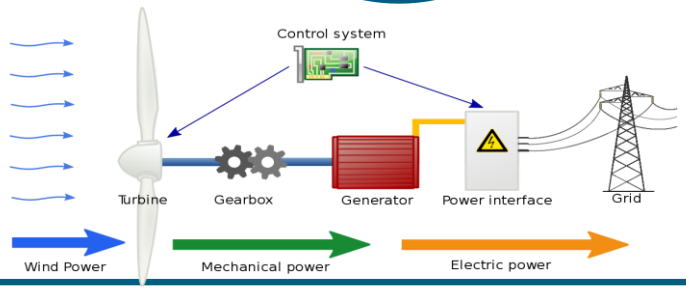
- Continuity
- Upscaling
- Renaissance

- High-Res cent: Upscaling
- High-Res desc.: Renaissance

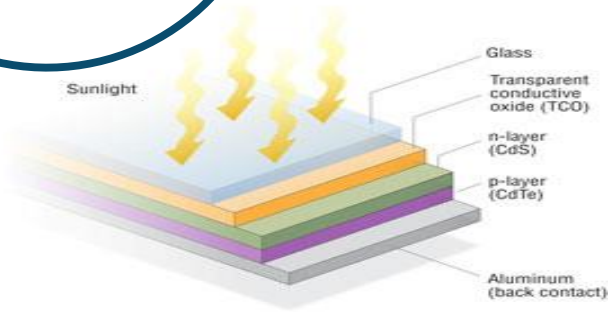
Scenario coupling with ELTRAMOD

End-users

- Industry
- Residential (tertiary)
- Mobility



Identification of potential risks



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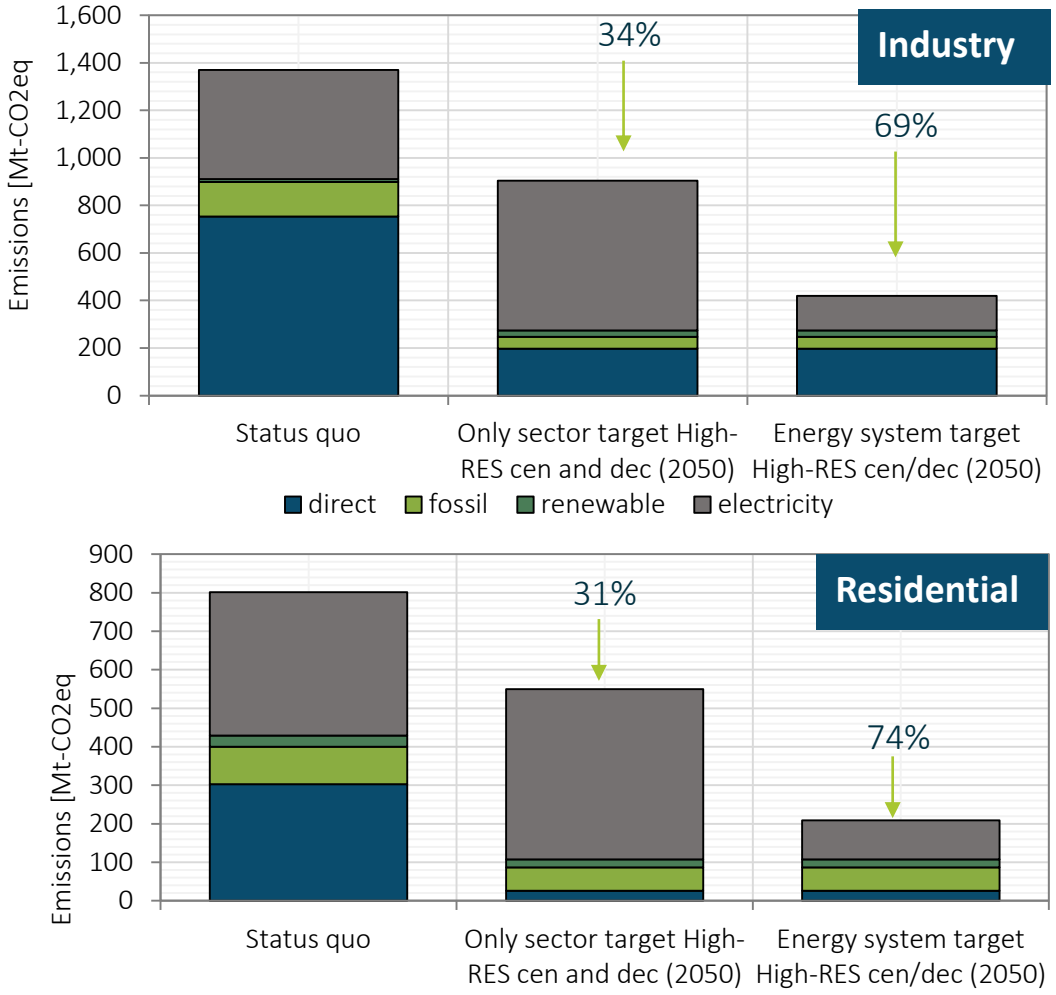
EU greenhouse gases target – comparing upstream and direct emissions



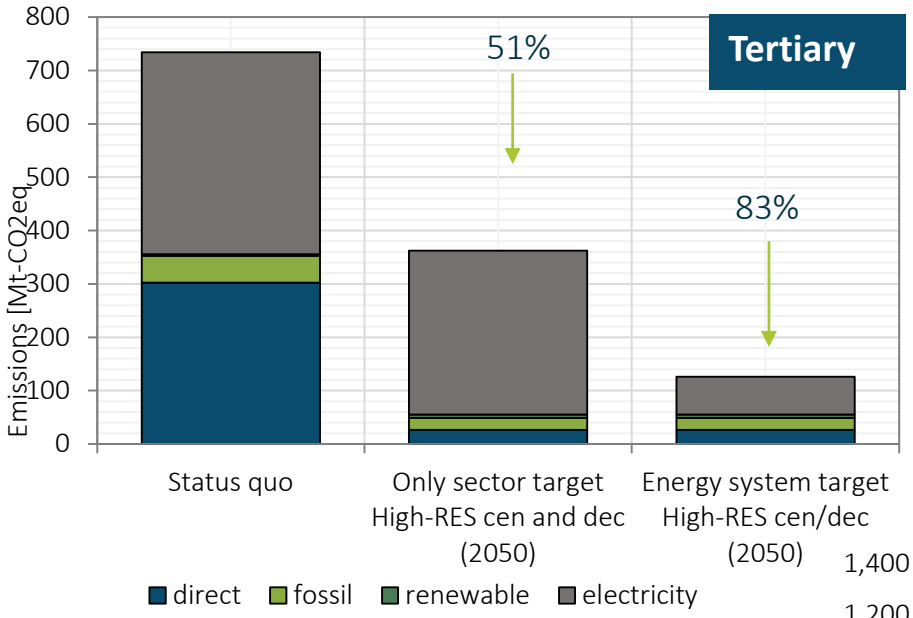
Top-down

Electricity target for High-RES

Bottom-up

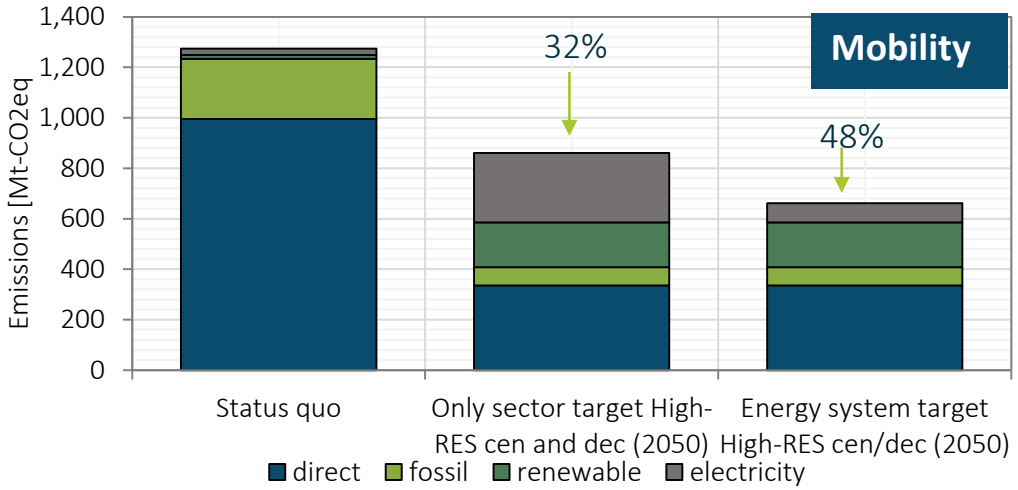
Sectoral targets for High-RES

EU greenhouse gases target – comparing upstream and direct emissions

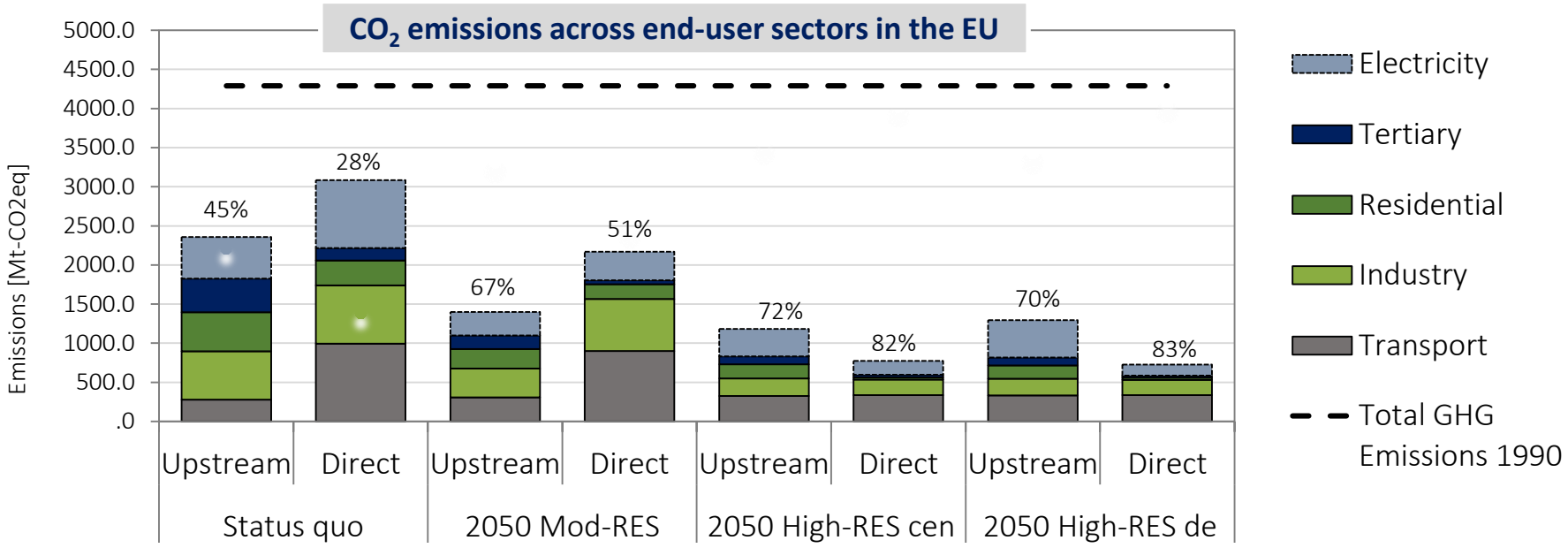


Transition to new scenarios from coal to higher demand for electricity:

- Tertiary is the end-sector that could reduce the most emissions by ca. 83%
- The increasing demand for services by modes (shipping and air) will require combustion of biofuels and fossils still reflecting high direct emissions.



EU greenhouse gases target – comparing upstream and direct emissions



Total EU GHG emissions in 1990 accounted 4,290 Mt-CO2eq (EEA 2016)

1. **Direct:**

- Overall emission reduction of 80% in decentral and central scenario can be achieved (total emissions = 726 Mt-CO2eq in 2050)
- Energy demand sectors reducing emissions by ca. 69% in decentral and central scenario in 2050
- High CO2 prices of at least 150 EUR/tCO2 are necessary to achieve -80% GHG emission reduction target

2. **Upstream:**

- Overall emission reduction of 70% in decentral and central scenario contribute to global climate mitigation action.

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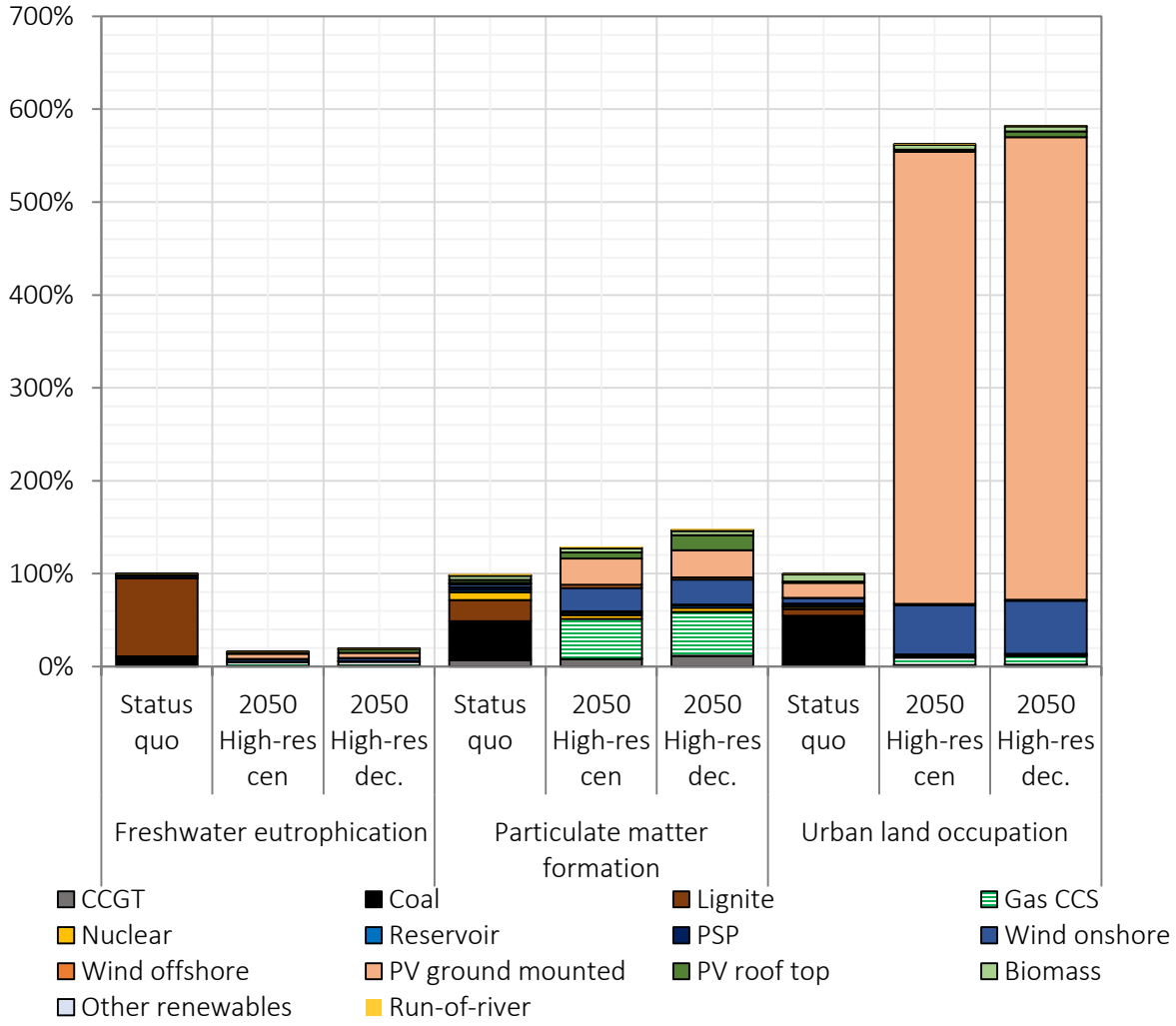
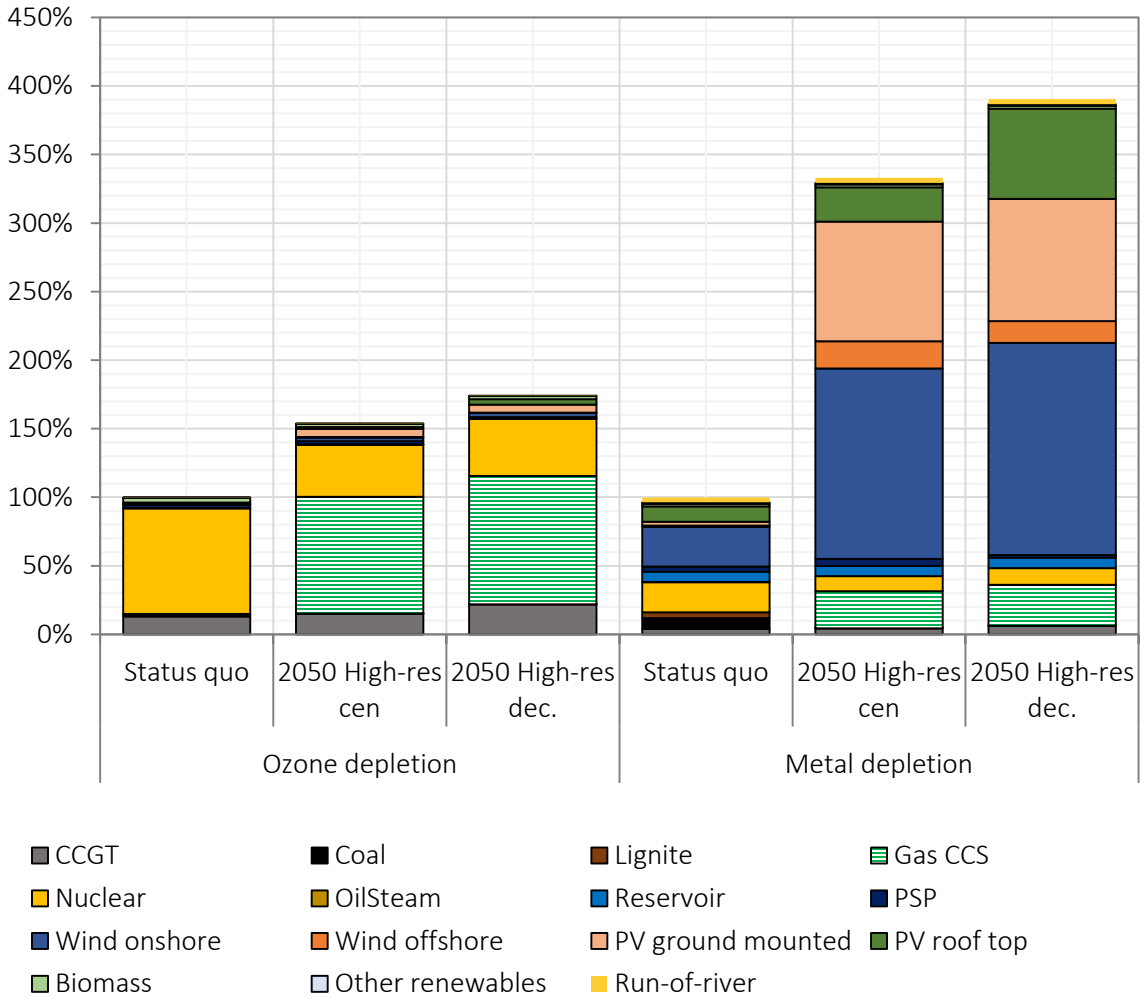
Electricity system – overlap of local to global environmental impacts



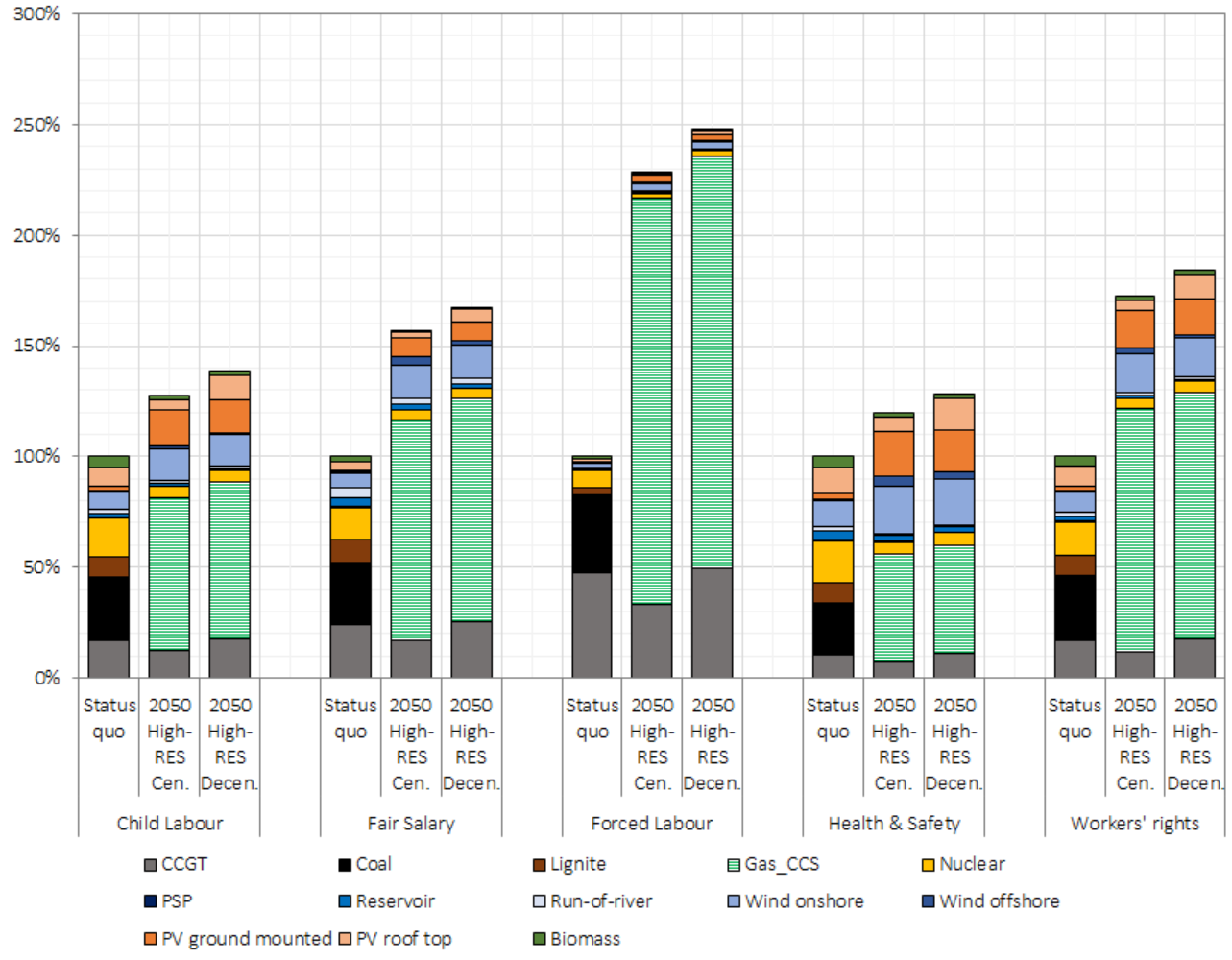
- Concrete benefit:
  - Minimization of freshwater eutrophication by 85% (High cen.) and 80% (High dec.)
- Environmental trade-off:
  - Photovoltaic ground mounted will require not only larger availability of land (e.g., marginal land), but the local resistance due to visual.
  - Natural gas contains other hydrocarbons that slow the pace of minimization of particulate matter impact during processing and transport (global), as the substitute of a dominated fossil energy carrier.

Electricity system – the global environmental impacts



- <u>Environmental trade-off:</u>
  - Demand for natural gas slows the pace to minimize ozone depletion impact, due to the high risk of leakage in the pipelines.
  - High demand for metals for renewable technologies put pressure on mining activities (e.g., steel (wind), copper, indium (solar)).

Potential risk associated with selected social impact categories



Main consideration for EU 28 REFLEX scenarios:

- Social risk levels show an **increasing trend** in all categories for 2050 scenarios.
- <u>Key drivers in High-RES:</u>
  - **Natural gas** (CCGT and Gas w/ CCS) the **main driver**.
  - Amongst the rest, **Photovoltaics** (ground mounted and roof top) and **Wind** (onshore) are the **dominating drivers**.
- <u>Common aspects of key drivers:</u>
  - Are **labor intensive** per energy unit output
  - have a **risky supply chain**
  - have a **large share in the production mix**

Potential risk associated with selected social impact categories

	Child Labor	Fair Salary	Forced Labor	Health & Safety	Workers' rights
Potential Hotspots	• Gas supply chain, esp. from Algeria • PV panel production • Materials for windmill parts (esp. metals)	• Plant construction and operation in EU • Gas supply chain, esp. from Russia	• Gas supply chain, esp. from Russia (90%)	• Gas supply chain • Plant construction (EU) • PV panel production	• Production/distribution of natural gas in Northern Africa

- Risks in High-RES scenarios mainly arise:
  - Natural gas - from **fuel supply** (esp. supply chain from Russia (38%) and Northern Africa (11%))
  - Wind - from **plant construction and installation,** and **production of parts and materials for wind power plant** (esp. metals and their supply chains)
  - Solar - from **panel and cell production,** and **plant construction and installation**

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Implications of electricity scenarios on end-users

Today

- High demand **for fossils** and **electricity**
- Main drivers of risk: **fuel oil, gas** and to some extent **electricity**.

- **Electricity** is the **key driver** of the **environmental and social risk** in High-RES scenarios.

2050

General highlight

Secure supply chain as the core issue to minimize social and environmental risks.

Involvement of local stakeholders is essential (especially for land use)

Industry	**Residential & Tertiary**	**Mobility**
Substitution of fossils with electricity (+30%) and ambient heat (+10%)	Substitution of fossils with RES (+13%), ambient heat (+14%) and electricity (+15%)	Substitution of fossils to biofuels (+15%), hydrogen (+15%) and electricity (+20%)

• hydrogen,: key driver of environmental and social risk associated due to energy intensive to produce.
  • Will be enough oversupply? Further R&D necessary.
	• Environmental risks (acidification, eutrophication) decrease by between 45% - 70%
	• Social risks are, in all categories, decreasing by between 20-40%
	• Sector hold the most environmental rucksack of electricity system
		• Substitution of conventional fossils to biofuels not necessarily an improvement from environmental and social perspective.
		  • Bioethanol and biokerosene are main drivers for land use and eutrophication.

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Wrap-up (recommendation) stage

Ozone depletion

Particulate matter

Land use

Metal depletion

The transformation of the European energy system is an **irreversible** practice due to climate commitments.
Beyond the scalability, acceptance and the promise for a secure renewable energy system for the upcoming future, there is the need to ensure the **capacity of the environment to sink** any **further impacts** beyond greenhouse gases and a **society** who **needs to work in favor** of it and **absorb the impacts**.

Child labour

Unfair salary

Forced labour

Work rights

Health & Safety

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Thank you! Questions?

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