How are the benefits of Europe’s decarbonization distributed?

Kais Siala*
Cristina de la Rúa
Technical University of Munich
Chair of Renewable and Sustainable Energy Systems

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Motivation

Decarbonization of Europe’s electricity system will lead to an unprecedented expansion of renewable energy capacity.

Cost-optimal expansion would probably favor areas with good potentials.

→ What are the implications of the geographic discrepancies on other aspects (direct and indirect emissions, jobs, value added, etc.)?
Workflow

Expansion planning with urbs

update

model calibrated?

no

create model for 2015

build extended MRIO

yes

create model for 2030

adjust energy and CO₂ emissions

create model for 2050

define final demands for technologies

estimate total impacts
Optimization results: energy mixes

Legend
- Solar
- Onshore wind
- Offshore wind
- Other ren. tech.
- Conv. CO2-emitting
- Nuclear and large hydro
- Not included in MRIO

2015 2030 2050
Optimization results: energy costs

Legend
Energy production costs in €ct/kWh
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- Not included in MRIO
Optimization results: direct emissions

Legend
Direct CO2 emissions in Mio. tons
- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 120
- 120 - 140
- 140 - 160
- 160 - 180
- 180 - 200
- 200 - 220
- 220 - 240
- > 240
- Not included in MRIO

2015

2030

2050
Optimization results: CO$_2$ intensity

Legend
CO$_2$ emission intensity in g/kWh produced
- 0 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 833
- Not included in MROI
Coupling with MRIO: Total emissions

Legend
Total CO2 emissions in Mio. tons
- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 120
- 120 - 140
- 140 - 160
- 160 - 180
- 180 - 200
- 200 - 220
- 220 - 240
> 240
Not included in MRIO

2015
~12 Mio. tons ~ 1 %

2030
~13 Mio. tons ~ 3 %

2050
~16 Mio. tons ~ 19 %
Coupling with MRIO: Total emissions

Legend
Absolute values
- Red: Electricity demand in TWh
- Blue: Total CO2 emissions in 2015 in Mio. tons
- Blue: Total CO2 emissions in 2030 in Mio. tons
- Light blue: Total CO2 emissions in 2050 in Mio. tons
- Grey: Not included in MRIO

Scale
- 500 TWh
- 250 Mio. tons CO2

Rest of the world
Coupling with MRIO: Total emissions

Legend
Shares in %
- Electricity demand
- Total CO2 emissions in 2015
- Total CO2 emissions in 2030
- Total CO2 emissions in 2050
- Not included in MRIO

Scale
20%
Focus on individual countries

Summary and next steps

Countries with high total emissions do not necessarily have the highest emissions intensities → how to share responsibility fairly?

A 95% reduction of (direct) CO₂ emissions would require higher indirect emissions outside of Europe.

In the near future: expansion of the analysis on other economic aspects (ongoing).