

Assessing economy-wide employment impacts of the EU Net zero transition

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Introduction

This paper contributes to the existing literature by analysing the employment impacts of the net-zero transition in the EU27, using the GEM-E3-FIT macroeconomic model.

Two policy scenarios are examined: a baseline NETZERO scenario and an alternative approach in which 50% of carbon revenues are recycled into labour market measures.

We examine the impacts on GDP, macro-components (private consumption, investments, trade) and on employment by occupation and by sector.

The GEM-E3-FIT CGE model

The GEM-E3-FIT model is a large scale applied **general equilibrium model** that captures the interdependencies between the economy, energy and the environment.

The model is **frequently peer-reviewed** and its results are published in top ranked scientific journals (incl. NATURE, NATURE climate change, Energy policy, Energy economics).

It has been successfully used to support a series of **climate/energy impact assessments** for the European Commission.

Type

- Macroeconomic, Structuralist, CGE

Countries

- EU27MS+UK+G20 countries individually
- 47 countries/regions covering the whole world

Sectors & Firms

- Households, Firms, Government
- 50 economic branches in each country

Time Horizon

- 2015-2100

Distinctive features

- Semi-endogenous technical progress,
- Technology diffusion (Learning by doing and by R&D,
- Endogenous labour skill supply,
- **(equilibrium) Unemployment**
- **Employment differentiated by occupation (5 categories)**
- Bottom-up energy module, Autonomous or Soft - Link with detailed energy system models

The GEM-E3-FIT CGE model



47 model regions:

- G20 countries
- EU27 Member States
- Global coverage

Interlinked via bilateral trade



50 economic activities:

- key economic sectors
- energy intensive industries
 - fuels and energy
- clean energy technologies

Interlinked via value chains

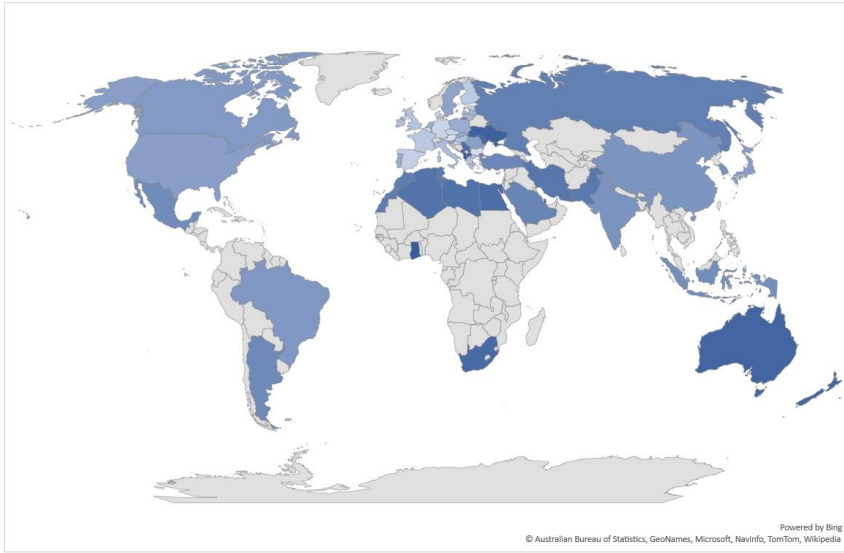


4 economic agents:

- Households
- Firms
- Government
- International sector

Interlinked via institutional transfers





GEM-E3

Regional Coverage

PRISMA - Net0Pathways through ImpRoved IAMs across Sectors, diMensions and sCAles. This project was funded by the European's Union Horizon Europe programme under grant agreement No 101081604

EU 27 + UK		Rest of G-20	
Austria	1	Australia	29
Belgium	2	Canada	30
Bulgaria	3	Saudi Arabia	31
Cyprus	4	USA	32
Croatia	5	India	33
Czech Republic	6	Russian federation	34
Germany	7	South Africa	35
Denmark	8	Turkey	36
Spain	9	Argentina	37
Estonia	10	Mexico	38
Finland	11	Brazil	39
France	12	Japan	40
United Kingdom	13	China	41
Greece	14	South Korea	42
Hungary	15	Indonesia	43
Ireland	16	United Arab Emirates	44
Italy	17	Rest of Europe	45
Lithuania	18	Rest of Energy Producers	46
Luxembourg	19	Rest of the World	47
Latvia	20		
Malta	21		
Netherlands	22		
Poland	23		
Portugal	24		
Slovakia	25		
Slovenia	26		
Sweden	27		
Romania	28		

GEM-E3: sectoral coverage

General Economy	
No	Description
01	Agriculture
02	Ferrous metals
03	Non-ferrous metals
04	Fabricated metal products
05	Chemical Products
06	Basic pharmaceutical products
07	Rubber and plastic products
08	Paper products, publishing
09	Non-metallic minerals
10	Computer, electronic and optical products
11	Transport equipment
12	Other Equipment Goods
13	Consumer Goods Industries
14	Warehousing and support activities
15	Construction
16	Market Services
17	Other Non-Market Services
18	R&D

RES equipment	
No	Description
19	EV Transport Equipment
20	Advanced Electric Appliances
21	Advanced Heating and Cooking Appliances
22	Equipment for wind power technology
23	Equipment for PV panels
24	Equipment for CCS power technology
25	CO2 Capture
26	Batteries

Transport	
No	Description
27	Air transport
28	Land transport
29	Water transport

Energy	
No	Description
30	Coal
31	Crude Oil
32	Oil
33	Gas
34	Power Supply (T&D)
35	Biomass Solid
36	Biofuels
37	Hydrogen
38	Clean Gas

Power Generation	
No	Description
39	Coal fired
40	Oil fired
41	Gas fired
42	Nuclear
43	Biomass
44	Hydro electric
45	Wind
46	PV
47	Geothermal
48	CCS Coal
49	CCS Gas
50	CCS Bio

Labor market

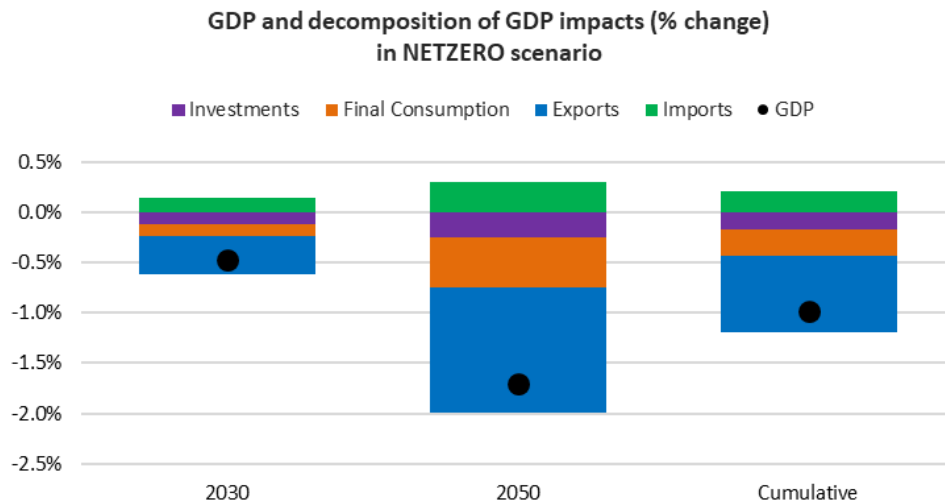
- In GEM-E3-FIT labour is differentiated by occupation and in total 5 distinct categories are identified:
 - ▶ Agricultural and Unskilled
 - ▶ Service and Shop Workers
 - ▶ Clerks
 - ▶ Technicians
 - ▶ Officials and Managers
- The model includes equilibrium unemployment, implying that there are frictions and rigidities that prevent the full clearing of the labour market
- This is achieved by the inclusion of a wage curve which relates inversely the wage level to the level of unemployment
- Wages are determined at the occupational level
- Labour is assumed to be fully mobile between sectors but not between countries
- Labour force is exogenous and is calibrated to the latest available projections (Ageing report for EU27 member states and ILO for extra-EU countries)

	Reference	Climate neutrality (NETZERO)	Climate neutrality + employment focused policies (NETZERO LM)
EU climate policy	Current policies extended to 2050	Fit-for-55 extended to net zero GHG to 2050 EU-ETS1 targets (62% by 2030 w.r.t. 2005) EU-ETS2 targets (42% by 2030 w.r.t. 2005) Full auctioning by 2035	
Global climate policy	Current policies extended to 2050	Current policies extended to 2050	
Carbon price	Carbon price growing with GDP growth rates starting from its 2024 levels	Endogenous	
Revenue recycling (EU27)	Lump sum	Lump sum	50% lump sum 50% labour taxation
EU CBAM	-	EU CBAM Regulation (EU) 2023/956	
Sectors under CBAM	-	cement, iron and steel, aluminium, fertilisers, hydrogen, and electricity	

Scenario definition

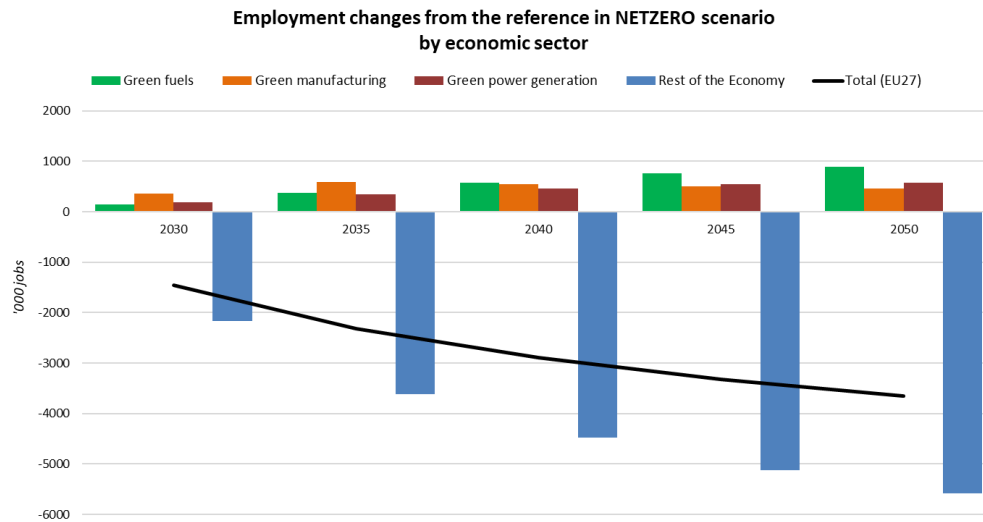
- ▶ Each scenario is compared to the Reference case
- ▶ The reference is a constructed scenario in the sense that the model is calibrated to exogenous projections with respect to GDP growth, population growth etc.
- ▶ The two scenarios assumed the adoption of the Fit-For-55 package for EU27 member states as well and the adoption of the Carbon Border Adjustment Mechanism (CBAM) as described in Regulation 2023/956.
- ▶ CBAM is introduced as a tariff to the model
- ▶ The two scenarios differ in the recycling of carbon revenues
- ▶ In the main scenario we assume that carbon revenues are recycled as lump sum transfers to households.
- ▶ In the second scenario 50% of these revenues is directed to labor market measures and more specifically in the reduction of social security contributions

Netzero scenario - macroeconomic impacts



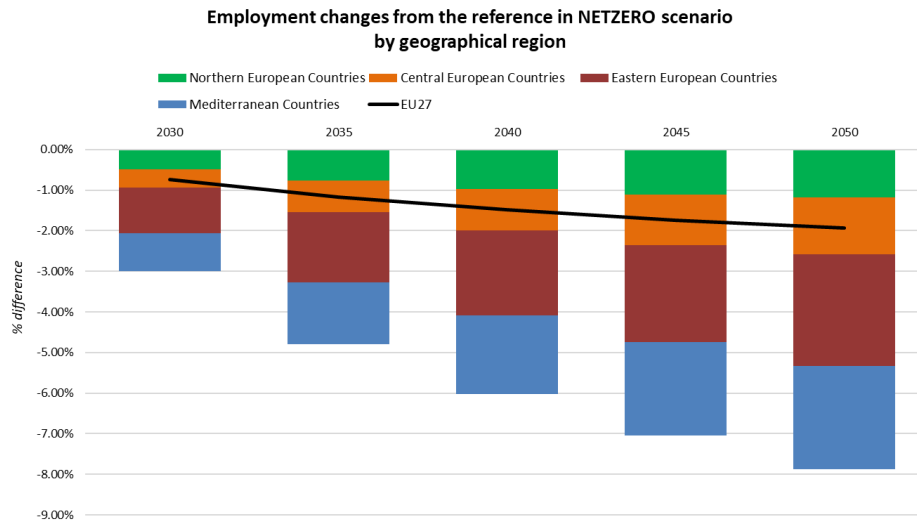
- ▶ GDP records losses compared to the reference throughout the projection period:
 - ▶ -0.5% in 2030
 - ▶ -1.7% in 2050
 - ▶ Cumulative losses, i.e., over the whole projection period, are calculated to 1%
- ▶ GDP impacts are driven by changes in trade
- ▶ Exports fall because of competitiveness losses:
 - ▶ Carbon taxation increases the cost of fossil energy
 - ▶ Capital intensity of the transition
 - ▶ CBAM also increases the cost of intermediate inputs for down-stream sectors which lead to production cost increases

Netzero scenario – employment impacts



- ▶ In 2030:
 - ▶ approximately 1.5M jobs are projected to be lost
- ▶ In 2050:
 - ▶ 3.7M jobs are expected to be lost
 - ▶ 896,000 additional jobs in green fuel production (hydrogen and biofuels)
 - ▶ 583,000 additional jobs from RES electricity production
 - ▶ 458,000 additional jobs in manufacturing of green energy equipment (mainly associated to the expansion of the EV industry)
 - ▶ Larger losses associated to manufacturing activities which record competitiveness losses and secondarily from services which fall as a result of lower income and spending

Netzero scenario – employment impacts



- ▶ Different response of countries depending on the extent to which they rely on fossil fuels and their economic structure
- ▶ Northern European countries are found to be marginally affected, recording employment losses of 1.2% in 2050
- ▶ The Mediterranean and Eastern European countries are the main contributors to the overall decline in workforce numbers across the EU, accounting for 35% and 34% respectively of the overall reduction in EU27.
- ▶ Mediterranean countries record employment losses of almost 2.6% in 2050
- ▶ Eastern European countries record employment losses of almost 2.8% compared to the reference
- ▶ The most significant impacts (in relative terms) both in 2030 and in 2050 are found for Eastern member states: Estonia, Latvia, Lithuania, Bulgaria, Croatia and Poland.

Netzero scenario

- employment impacts



Significant increase in the number of unskilled jobs in all green energy related sectors.



These types of jobs account for approximately 58% of total additional “green” jobs.



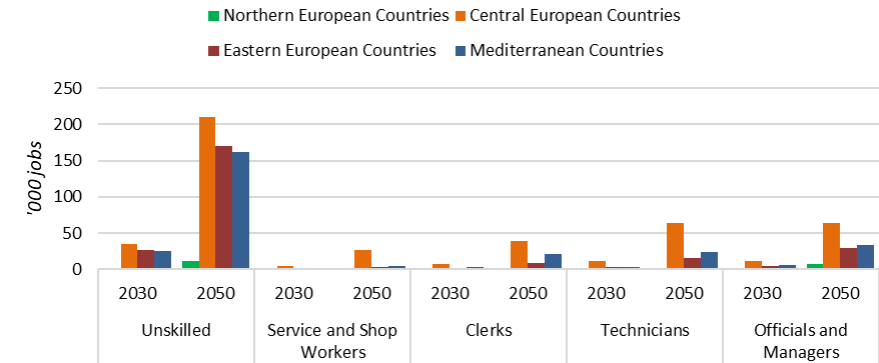
The increase is higher in Central and Eastern Europe and is associated to the development of the EV transport equipment and biofuels.



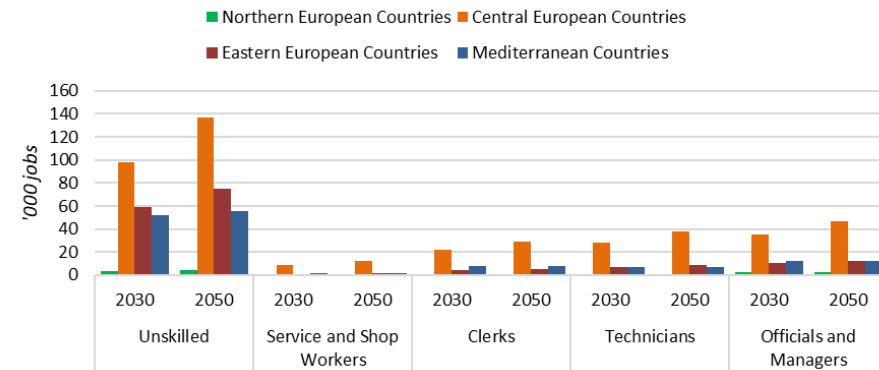
These two sectors combined create approximately 228,000 additional unskilled jobs in 2050.

PRISMA - Net0Pathways through ImpROved IAMs across Sectors, diMensions and sCAles. This project was funded by the European's Union Horizon Europe programme under grant agreement No 101081604

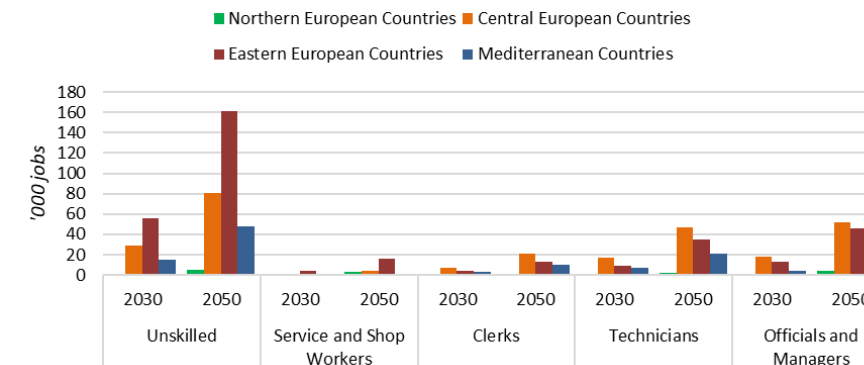
Employment changes from the reference in NETZERO scenario for the Green Fuels sectors



Employment changes from the reference in NETZERO scenario for the Green Manufacturing sectors

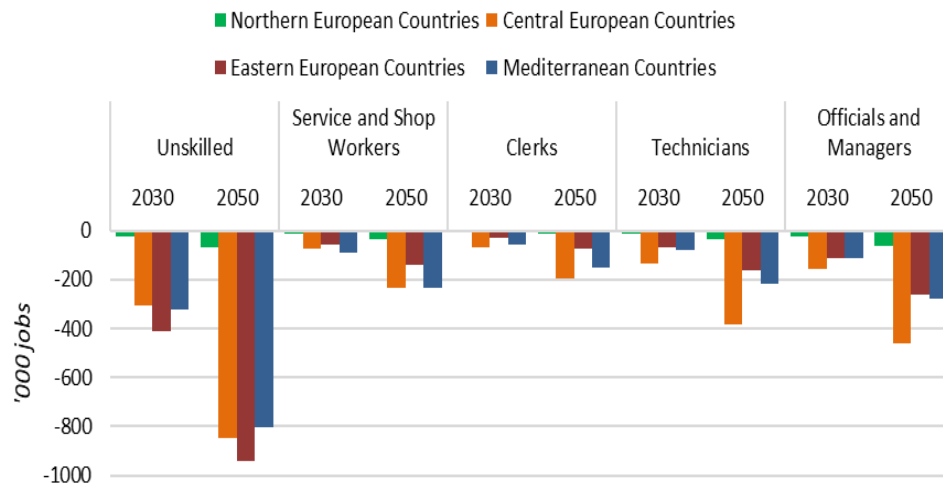


Employment changes from the reference in NETZERO scenario for the Green Power Generation sectors



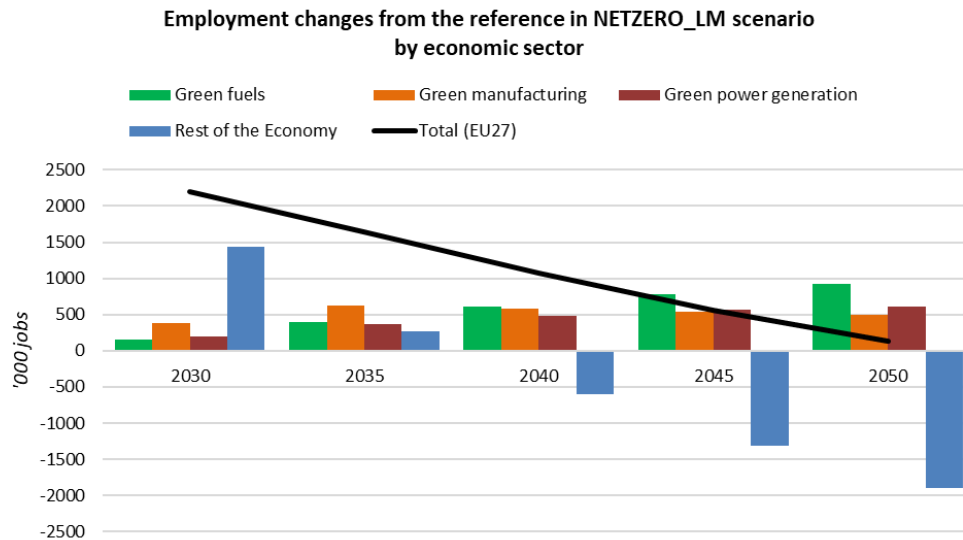
Netzero scenario – employment impacts

Employment changes from the reference in NETZERO scenario
for the Rest of the Economy



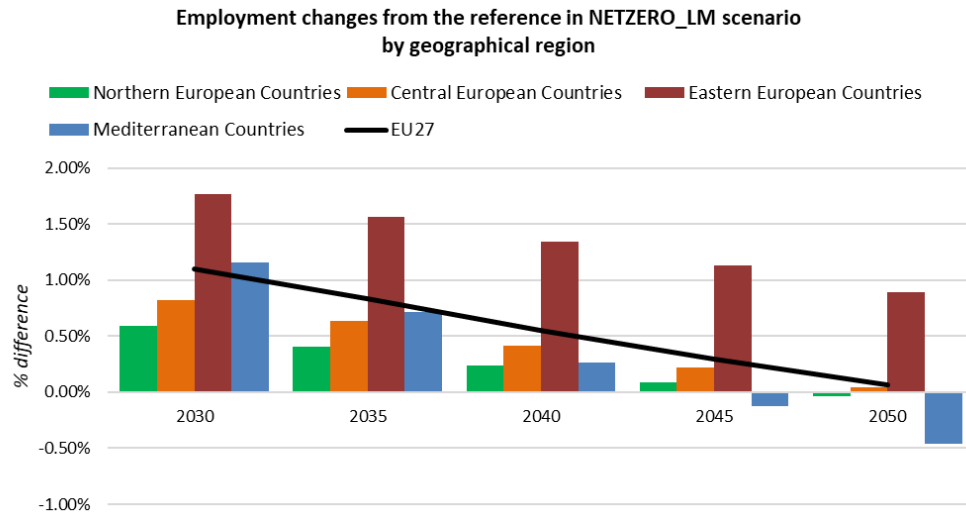
- ▶ Overall jobs associated to managerial positions and with no specific specialization are found to be more affected compared to other occupations
- ▶ In 2030 it is found that approximately 600,000 agricultural and unskilled jobs will be lost while in 2050 the respective number reaches 1.5 million jobs
- ▶ Managers positions are mostly found in service sectors (almost 75% of total)
- ▶ Unskilled jobs account for approximately 61% of total manufacturing jobs
- ▶ Unskilled jobs in the manufacturing sector accounts for approximately 38% of total unskilled jobs

Netzero scenario LM - employment impacts



- ▶ In the early years of the transition, the mixed recycling overshoots the negative impacts of carbon pricing and leads to GDP gains.
- ▶ In 2030, employment increases by approximately 1.1% and by 0.07% in 2050.
- ▶ In 2050 approximately overall employment is higher by 126,000 jobs compared to the reference,
- ▶ Green sectors, which are expected to generate an additional 2 million jobs by 2050.
- ▶ Other sectors also benefit recording employment gains up to 2035
- ▶ Services record approximately +1.1 million jobs in 2030 compared to the reference

Netzero scenario LM - employment impacts



- ▶ Eastern European countries are projected to experience the highest increase across all sectors by 2050, with an increase of 0.9%
- ▶ Countries that benefit the most are Lithuania, Latvia, Bulgaria, Romania
- ▶ Mediterranean countries are expected to experience employment growth until 2040, followed by a decline compared to the reference scenario, resulting in a -0.48% reduction (net loss of approximately 228K jobs)

Policy reccomendations

Recycling carbon tax revenues through targeted reductions in labour taxes, particularly for lower-income groups, can help support employment and ease the transition for affected workers.

Lump-sum transfers, while simple to implement, are generally less effective in promoting job creation and should not be the default option

Investing in clean infrastructure and workforce training can support long-term economic resilience.

Special attention should be given to policies that support lower-skilled workers, who are likely to be most affected by the transition, including targeted job placement programs, upskilling initiatives and transitional income support.