# Just Transition, Mitigation and Climate Impacts and socioeconomic implications

**Johannes Emmerling, EIEE**

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RFF CMCC European Institute on Economics and the Environment

NAVIGATE

# Outline

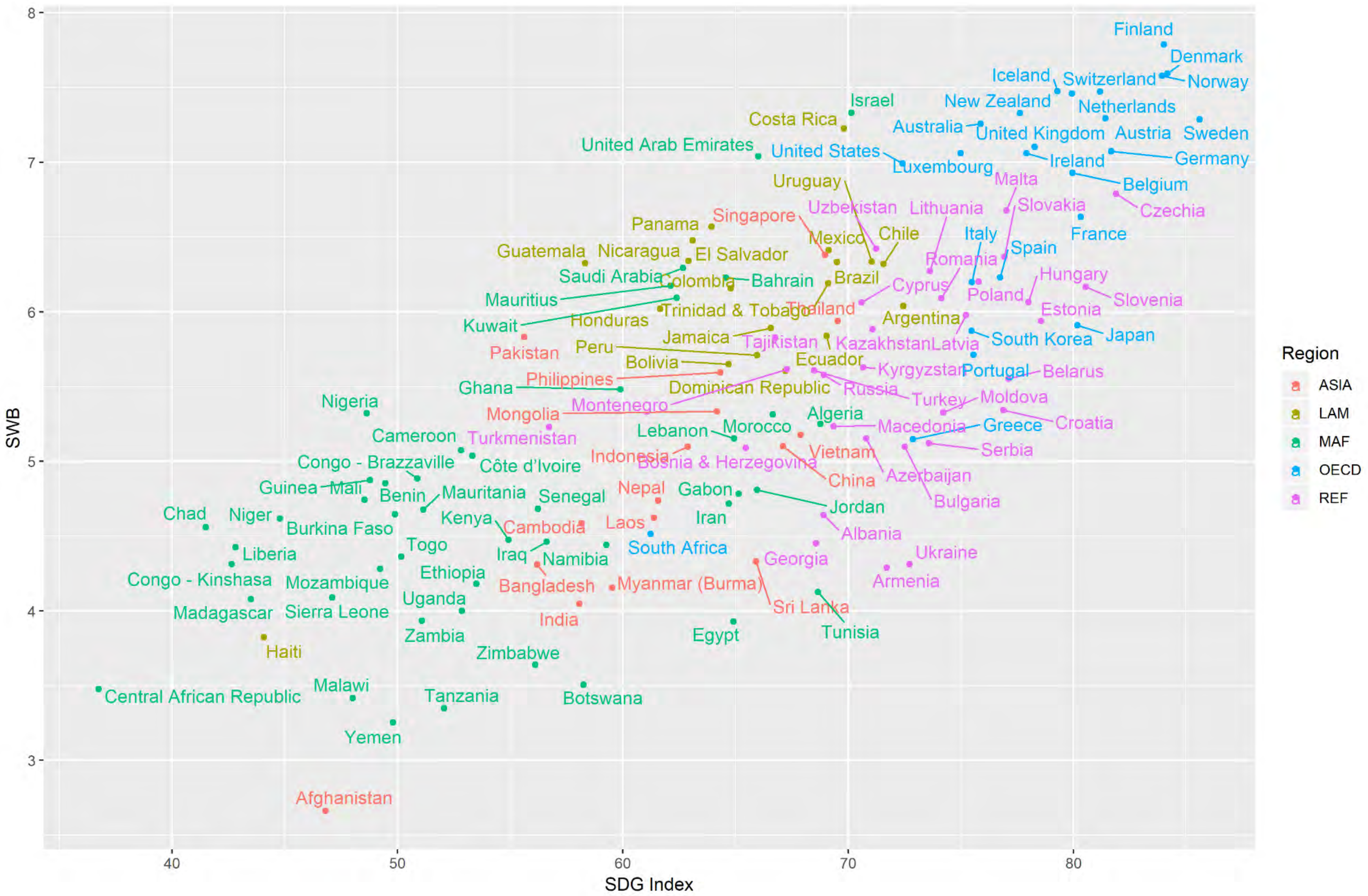
1. Welfare and Well-being
2. Employment and the Energy Sector
3. Equity and distributional outcomes
4. Climate Impacts and Integration
5. Distributional Impacts
6. Open source IAMs, development, and exploitation

*Between the best and worst possible life,*
*how would you rank how you feel*
*personally about your life at this point?*

*on a scale from 0 to 10.*

# Well-being and Welfare

# Well-being – macro and micro




R(Pearson) = 0.77

SDSN (2018): SDG Index and Dashboards Report 2018. Gobal responsibilities. Implementing the Goals. Bertelsmann Stiftung and Sustainable Development Solution Network.

# Well-being – macro and micro

Related literature

- Barrington-Leigh and Galbraith (2019, NatComms)
- Rehdanz and Maddison (2005, EcolEcon): one year of data, multivariate country analysis
- Bjørnskov et al. (2007) explore multivariate macro factors on individual WVS data
- Easterlin et al. (2010) updates the Easterlin paradox
- Welsch (2003), Ferreira et al. (2013), and Zhang et al. (2017) find negative impact of air pollution
- Mazur (2011) examines impact of energy/electricity consumption
- Other dimensions
  - Life expectation
  - Education, Urbanisation (SSP dimension)
  - Biodiversity/Forest/recreational value

# 3. Determinants and Categories

| Dimension | Variable | Source | References | Hypothesis | Unit |
|---|---|---|---|---|---|
| Economy | Income or GDP | IMF-WEO | (Mikucka et al., 2017) | + | $[2005, MER] |
| Economy | Rate of economic growth | IMF-WEO | (Easterlin et al., 2010) | +/ (0) | % |
| Economy | Unemployment | WDI | (Di Tella et al., 2001) | - | % |
| Economy | Inflation | WDI | (Di Tella et al., 2001) | - | % |
| Environment | Air pollutant emissions (Mt/year) | CEDS | for AQI, SO2, NO2, PM10 | - | Emissions/land area |
| Environment | SO2 mean annual concentration (µg/m3) | EDGAR/CEDS | (Zhang et al., 2017) (Ferreira et al., 2013) | - | Emissions/land area |
| Environment | NO2, lead | EDGAR/CEDS | (Zhang et al., 2017) (Welsch, 2003) | - | Emissions/land area |
| Environment | Natural capital / Forest area | World Bank, WDI | (Engelbrecht, 2009) | + | % |
| Energy | Energy consumption | IEA | (Mazur, 2011) | + | Per capita energy and electricity consumption |
| Energy | Electricity consumption | IEA | (Mazur, 2011) | + | Per capita energy and electricity consumption |
| Socio-demography | Share of population living in urban areas | WDI, SSP | (Sørensen, 2014) (Li and Kanazawa, 2016) | - | % of population |
| Socio-demography | Population density | WDI, SSP | (Sørensen, 2014) (Li and Kanazawa, 2016) | - | 1000 inhabitants / km2 |
| Socio-demography | Number of young/old | Wittgenstein Centre | (Di Tella et al., 2001) | (+) / - | years |
| Socio-demography | Education | Wittgenstein Centre | (Elgar et al., 2011) | + (-) | Years, share of secondary and tertiary education |
| Socio-demography | Literacy rate | WDI | (Cornali, 2011) | + | % |
| Socio-demography | Life expectancy (years) | WDI | | + | years |
| Socio-demography | Relative income, Gini | WDI, IMF-WEO | (Di Tella et al., 2001) | - | Index, or relative income |
| Institutions | Government Effectiveness | WBGI | (Bjørnskov et al., 2010) | + | |
| Institutions | Index of democracy | Polity IV | (Bjørnskov et al., 2010) | + | |

# Well-being – macro and micro

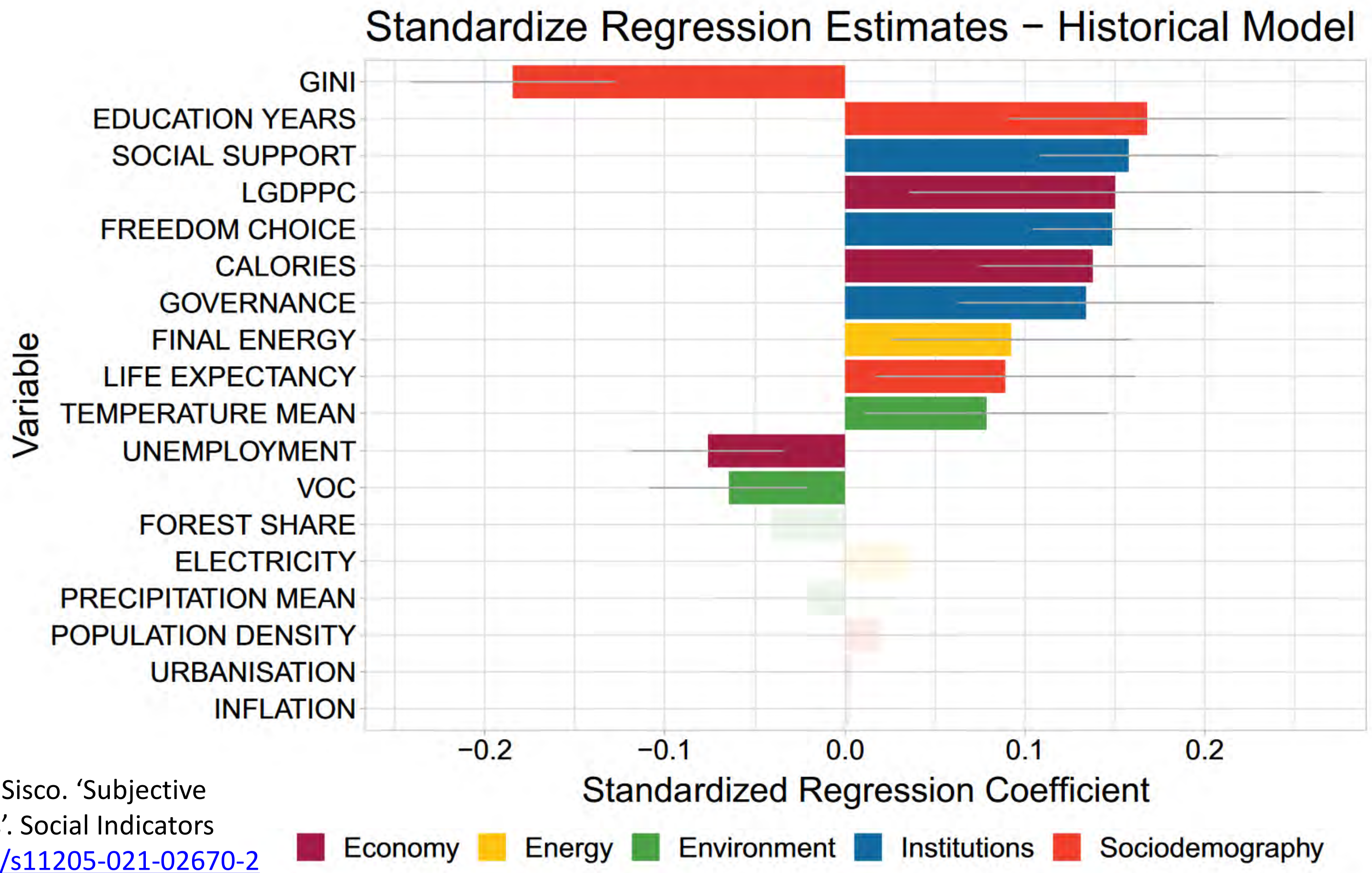
| | *OLS* | | | *linear mixed-effects* | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| lgdppc | 0.18$^{***}$ (0.05) | 0.22$^{***}$ (0.05) | 0.53$^{***}$ (0.20) | 0.18$^{***}$ (0.05) | 0.39$^{***}$ (0.11) |
| energy_enduse | 0.0000$^{**}$ (0.0000) | 0.0000 (0.0000) | 0.0003$^{***}$ (0.0001) | 0.0000$^{**}$ (0.0000) | 0.0001$^{*}$ (0.0000) |
| inflation | 0.002 (0.002) | 0.003 (0.003) | −0.004$^{***}$ (0.002) | 0.003 (0.002) | −0.003$^{**}$ (0.002) |
| educgrownups23 | 0.28 (0.18) | 0.38$^{**}$ (0.19) | −1.00$^{***}$ (0.32) | 0.21 (0.18) | −0.87$^{***}$ (0.27) |
| gini_swiid | −2.15$^{***}$ (0.35) | 0.29 (0.32) | −1.02 (1.25) | −2.13$^{***}$ (0.35) | −0.26 (0.80) |
| government_effectiveness | 0.37$^{***}$ (0.05) | 0.17$^{***}$ (0.05) | 0.42$^{***}$ (0.08) | 0.38$^{***}$ (0.05) | 0.34$^{***}$ (0.07) |
| urbanisation | −0.002 (0.002) | 0.01$^{***}$ (0.002) | −0.02$^{*}$ (0.01) | −0.001 (0.002) | 0.003 (0.005) |
| life_expectancy | 0.01$^{**}$ (0.01) | 0.05$^{***}$ (0.004) | −0.03$^{**}$ (0.01) | 0.01$^{*}$ (0.005) | 0.003 (0.01) |
| calories | 0.0003$^{***}$ (0.0001) | 0.0000 (0.0001) | 0.0003 (0.0002) | 0.0002$^{***}$ (0.0001) | 0.0001 (0.0002) |
| population_density | −0.30$^{***}$ (0.10) | −0.57$^{***}$ (0.10) | −2.35$^{*}$ (1.32) | −0.35$^{***}$ (0.10) | −0.60$^{**}$ (0.25) |
| CO | −0.004 (0.003) | 0.001 (0.003) | 0.0003 (0.003) | −0.001 (0.003) | 0.001 (0.003) |
| electricity | 0.06$^{***}$ (0.02) | 0.10$^{***}$ (0.03) | −0.15 (0.12) | 0.06$^{***}$ (0.02) | −0.004 (0.07) |
| unemployment | −0.02$^{***}$ (0.004) | −0.04$^{***}$ (0.004) | −0.03$^{***}$ (0.01) | −0.02$^{***}$ (0.004) | −0.04$^{***}$ (0.01) |
| education_years | 0.04$^{**}$ (0.02) | −0.02 (0.02) | 0.10$^{*}$ (0.06) | 0.04$^{**}$ (0.02) | 0.05 (0.04) |
| temperature_mean | 0.01 (0.01) | 0.04$^{***}$ (0.01) | 0.23$^{*}$ (0.14) | 0.005 (0.01) | 0.03 (0.02) |
| temperature_max | −0.005 (0.01) | −0.05$^{***}$ (0.01) | 0.02 (0.08) | −0.002 (0.01) | −0.02 (0.03) |
| precipitation_mean | −0.003$^{***}$ (0.001) | −0.005$^{***}$ (0.001) | −0.003 (0.01) | −0.003$^{***}$ (0.001) | −0.002 (0.002) |
| precipitation_max | 0.002$^{***}$ (0.001) | 0.003$^{***}$ (0.001) | 0.001 (0.002) | 0.002$^{***}$ (0.001) | 0.001 (0.001) |
| I(year - 2015) | −0.01$^{**}$ (0.01) | −0.02$^{***}$ (0.01) | 0.01 (0.01) | | |
| REGIONr5asia | 2.91$^{***}$ (0.45) | | | | |
| REGIONr5lam | 3.75$^{***}$ (0.46) | | | | |
| REGIONr5maf | 2.60$^{***}$ (0.41) | | | | |
| REGIONr5oecd | 2.69$^{***}$ (0.44) | | | | |
| REGIONr5ref | 2.27$^{***}$ (0.43) | | | | |
| Constant | | 0.04 (0.39) | 0.60 (2.89) | 3.03$^{***}$ (0.49) | 2.22$^{**}$ (0.95) |
| Country | No | No | FE | No | RE |
| Region | FE | No | No | RE | No |
| Year | Trend | Trend | Trend | RE | RE |
| Observations | 1,078 | 1,078 | 1,078 | 1,078 | 1,078 |
| $R^2$ | 0.99 | 0.76 | 0.94 | | |
| Adjusted $R^2$ | 0.99 | 0.75 | 0.93 | | |
| Log Likelihood | | | | −904.13 | −497.84 |
| Akaike Inf. Crit. | | | | 1,852.26 | 1,039.69 |
| Bayesian Inf. Crit. | | | | 1,961.88 | 1,149.31 |

*Note:* $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

*Individual level*
*Variance Decomposition:*
*77% idiosyncratic*
*18% explained Macro*
*5% unexplained Macro*

# Well-being – macro and micro

- How to evaluate pathways in terms of well-being?
- Subjective well-being (SWB [0-10]
- Inequality and Unemployment biggest negative determinants




Source: Emmerling, Johannes, Paula Navarro, and Matthew R. Sisco. 'Subjective Well-Being at the Macro Level—Empirics and Future Scenarios'. Social Indicators Research, 157, pages899–928 (2021). https://doi.org/10.1007/s11205-021-02670-2
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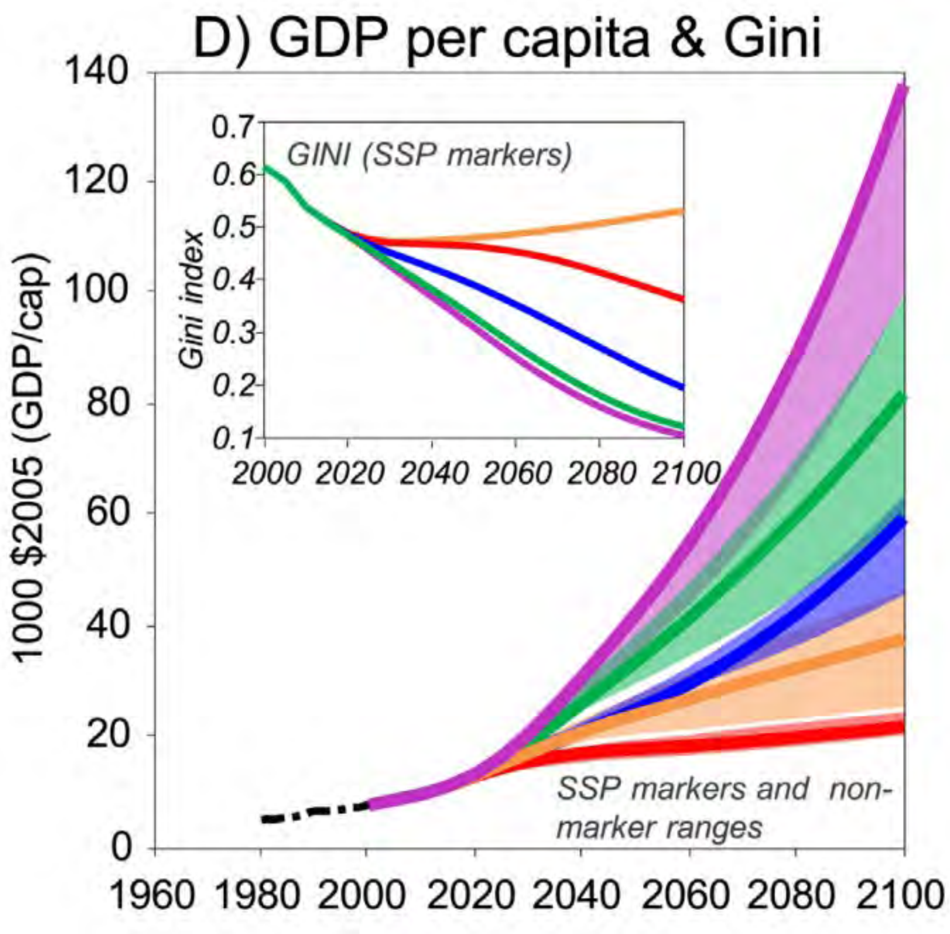
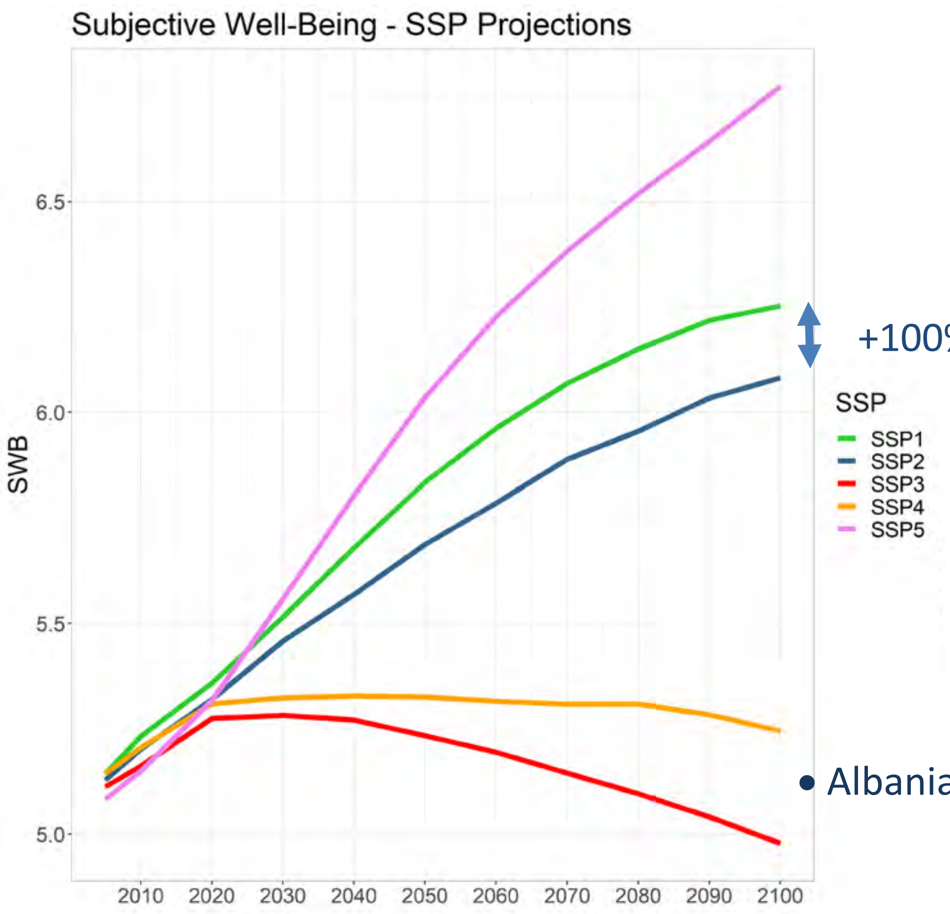
# Well-being – macro and micro




- Finland 2020

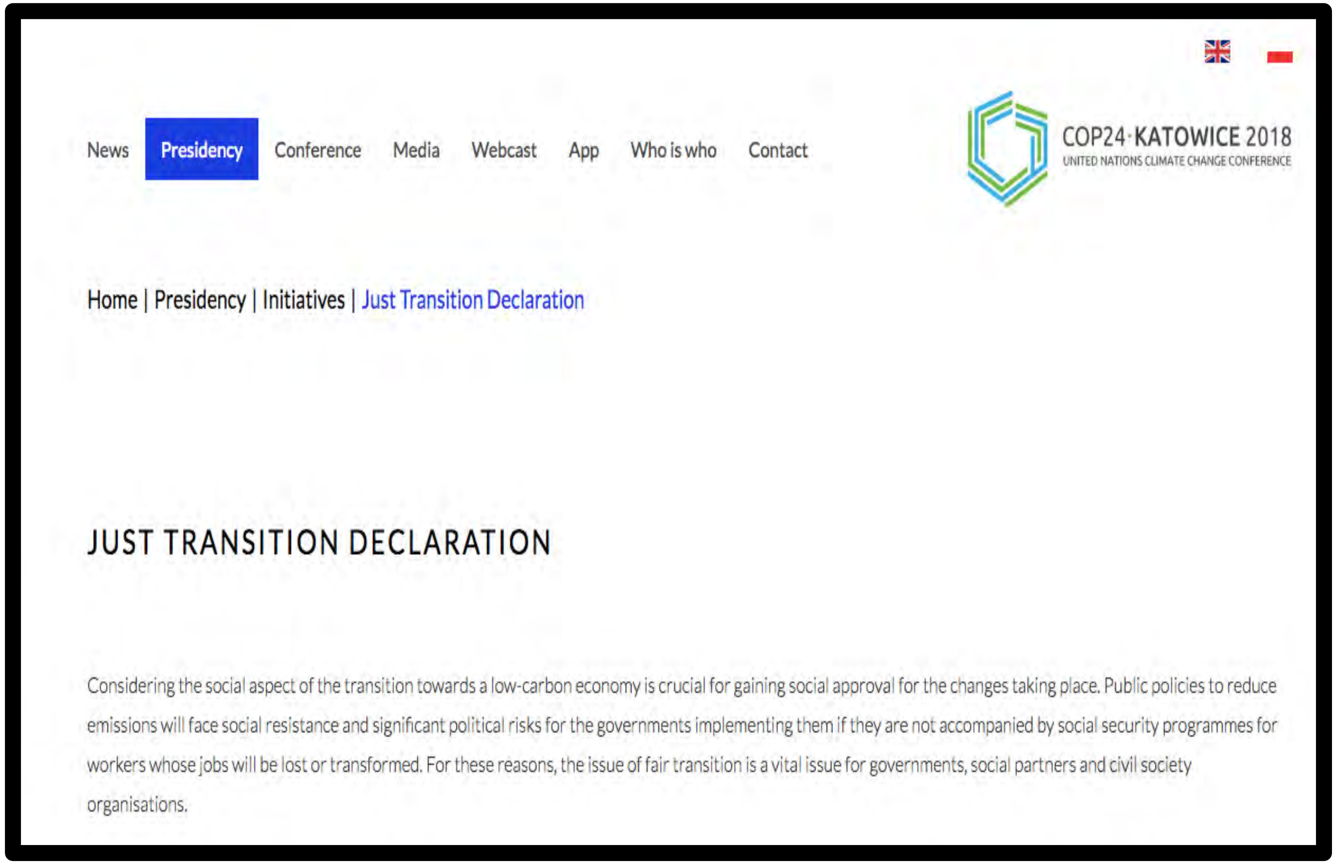
+100% GDPpc

- Albania 2020

*Future fork: application to sub-national and regional level (WVS, …)*

# Just transition

- Climate policies will face political & social resistance in the absence of just transition plans
- From a justice point of view it's important to think about workers livelihoods
- Just transition endorsed by
  - ILO
  - UNFCCC
  - COP24



# Just transition – energy jobs

**What will happen to the livelihood of millions of coal & other fossil fuel workers?**

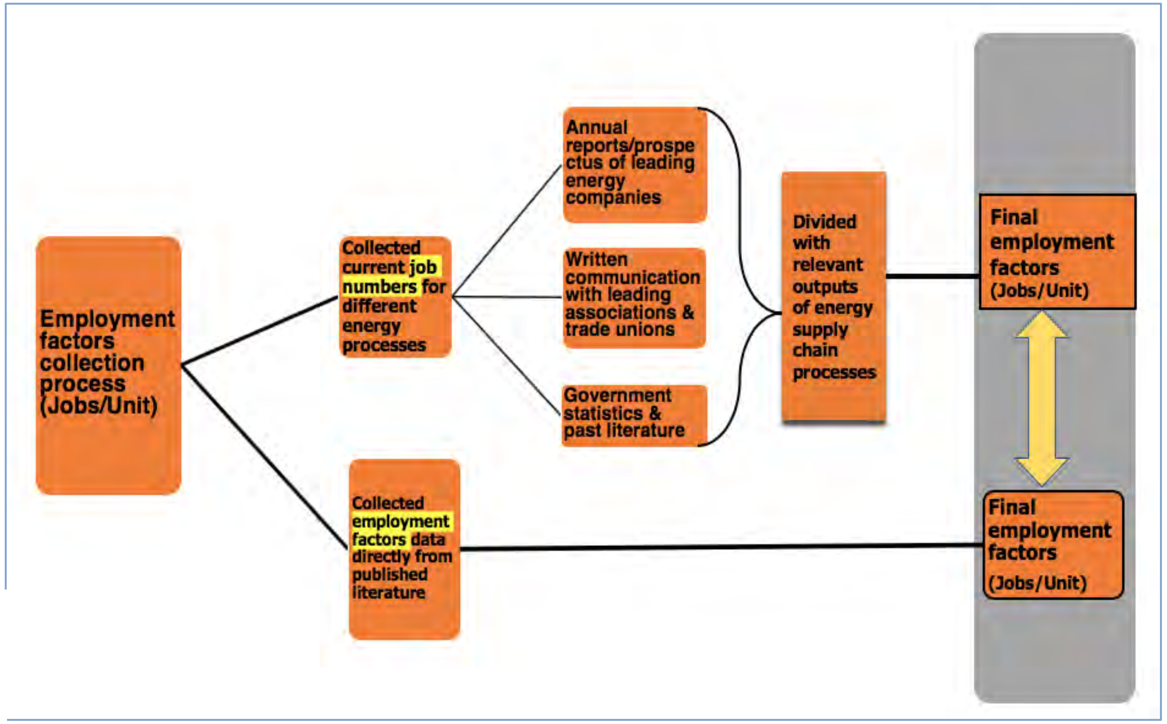
# Jobs Data is difficult to obtain…

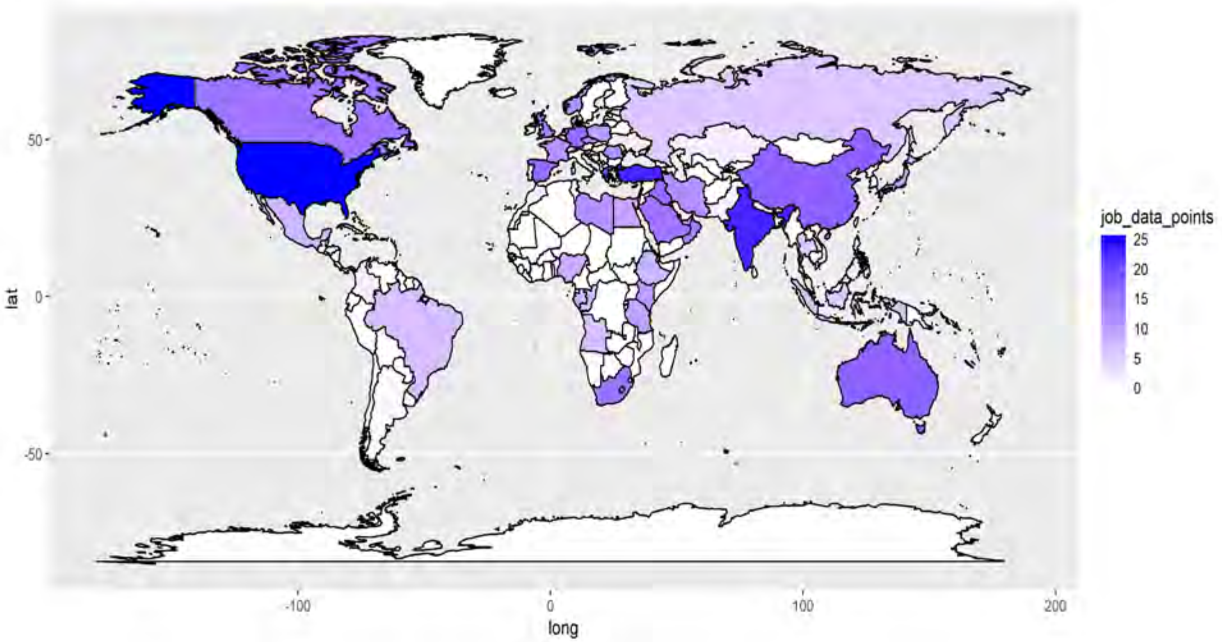

## 50+ country dataset

- **Annual reports**
  - Big oil companies
    - Saudi Aramco (Saudi Arabia), Gazprom (Russia), Sinopec (China), and Pemex (Mexico),
  - Big coal companies
    - Coal India (India), SUEK Ltd (Russia)
- **Written communications**
  - World Nuclear Associations
  - Trade unions like the Federation of Oil Unions (Iraq), Central de los Trabajadores y Trabajadoras (Brazil)
- **Official statistics from countries**
- **International Organizations (IRENA)**

# Quantifying today's global direct energy jobs

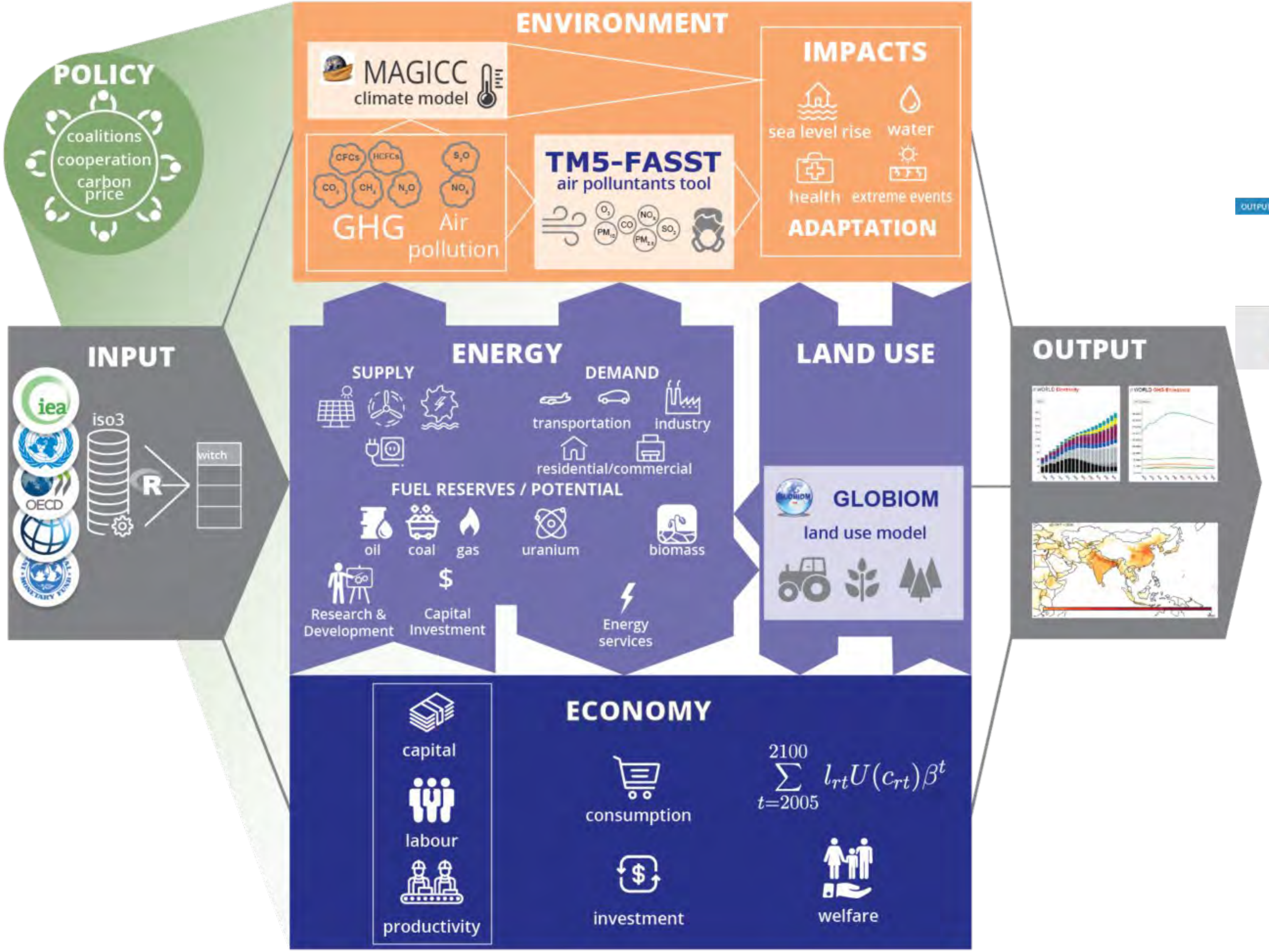
- 11 Energy Technologies
- 5 job categories
- 529 datapoints in total
- Country-level were available
- Covering 83% of total energy jobs

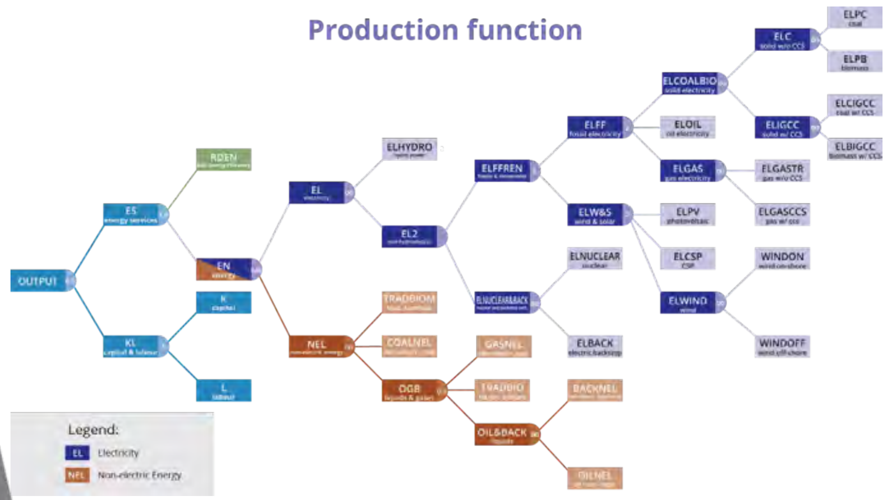


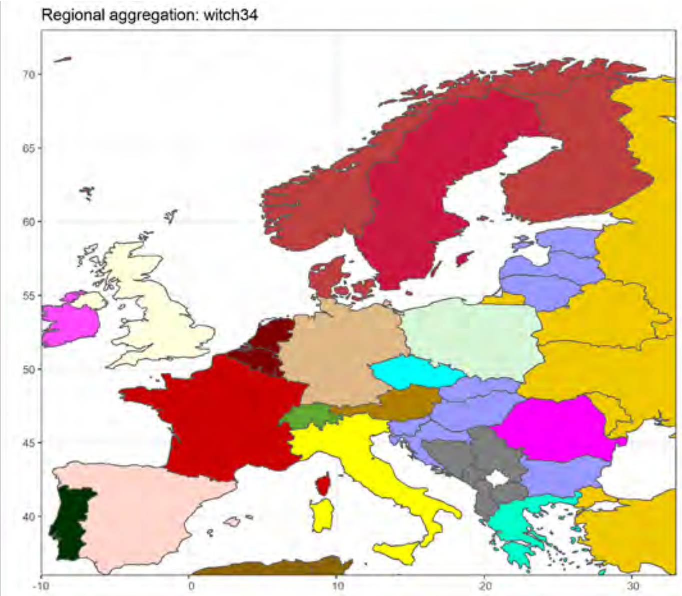




- **Direct jobs**
- ~~Indirect jobs (further value chain)~~
- ~~Induced jobs~~

# IAM Model


POLICY
coalitions
cooperation
carbon price
ENVIRONMENT
MAGICC
climate model
CFCs
HCFCs
S₂O
CO₂
CH₄
N₂O
NO₂
GHG
Air pollution
TM5-FASST
air pollutants tool
IMPACTS
sea level rise
water
health
extreme events
ADAPTATION
INPUT
iea
iso3
OECD
R
witch
ENERGY
SUPPLY
DEMAND
transportation
industry
residential/commercial
FUEL RESERVES / POTENTIAL
oil
coal
gas
uranium
biomass
Research & Development
Capital Investment
Energy services
LAND USE
GLOBIOM
land use model
OUTPUT
ECONOMY
capital
labour
productivity
consumption
investment
welfare
$$\sum_{t=2005}^{2100} l_{rt} U(c_{rt}) \beta^t$$


Production function
OUTPUT
ES
EN
KL
K
L
RDEN
EL
NEL
ELHYDRO
EL2
ELFFREN
ELFF
ELCOALBIO
ELOIL
ELGAS
ELW&S
ELNUCLEAR
ELBACK
ELPV
ELCSP
ELWIND
ELC
ELPC
ELPB
ELIGCC
ELCIGCC
ELBIGCC
ELGASTR
ELGASCCS
WINDON
WINDOFF
TRADBIOM
COALNEL
OGB
GASNEL
TRADBIO
BACKNEL
OIL&BACK
OILNEL
Legend:
EL Electricity
NEL Non-electric Energy


Regional aggregation: witch34
70
65
60
55
50
45
40
-10
0
10
20
30

# An accounting exercise

- Summarizing jobs across 11 technologies, 5 job categories and countries:

$$TotalJobs = \sum_e jobint_{e,construction} \cdot I\_EN_e + \sum_e jobint_{e,manufacturing} \cdot I\_EN_e + \sum_e jobint_{e,O\&M} \cdot K\_EN_e + \sum_e jobint_{e,fuel\_production} \cdot Q\_OUT_e + \sum_e jobint_{e,refining} \cdot Q\_PES_e.$$

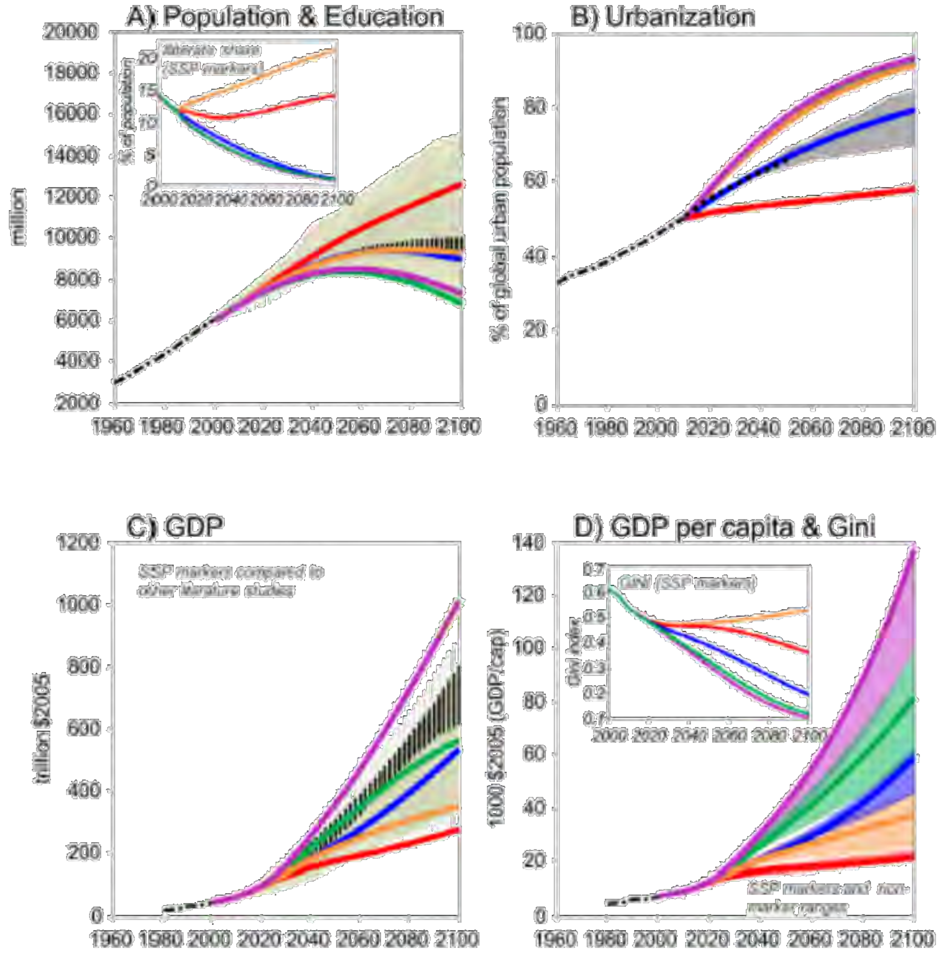
Using country-level job intensities, and energy statistics (IEA WEB, IRENA, WPDB)

→Comparable, consistent and complete dataset across countries

→Data analysis and visualization

# Scenarios assessed

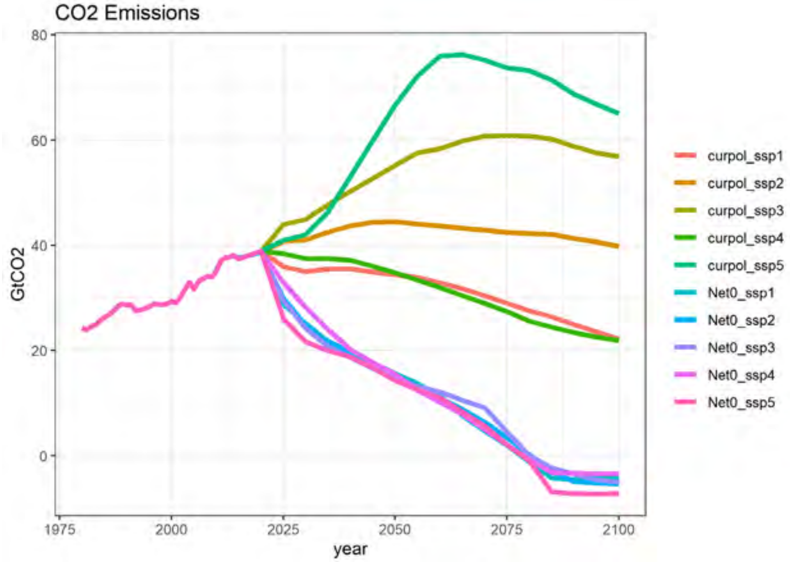
## Shared Socioeconomic Pathways (SSP)




Source: Riahi et al. (2017)

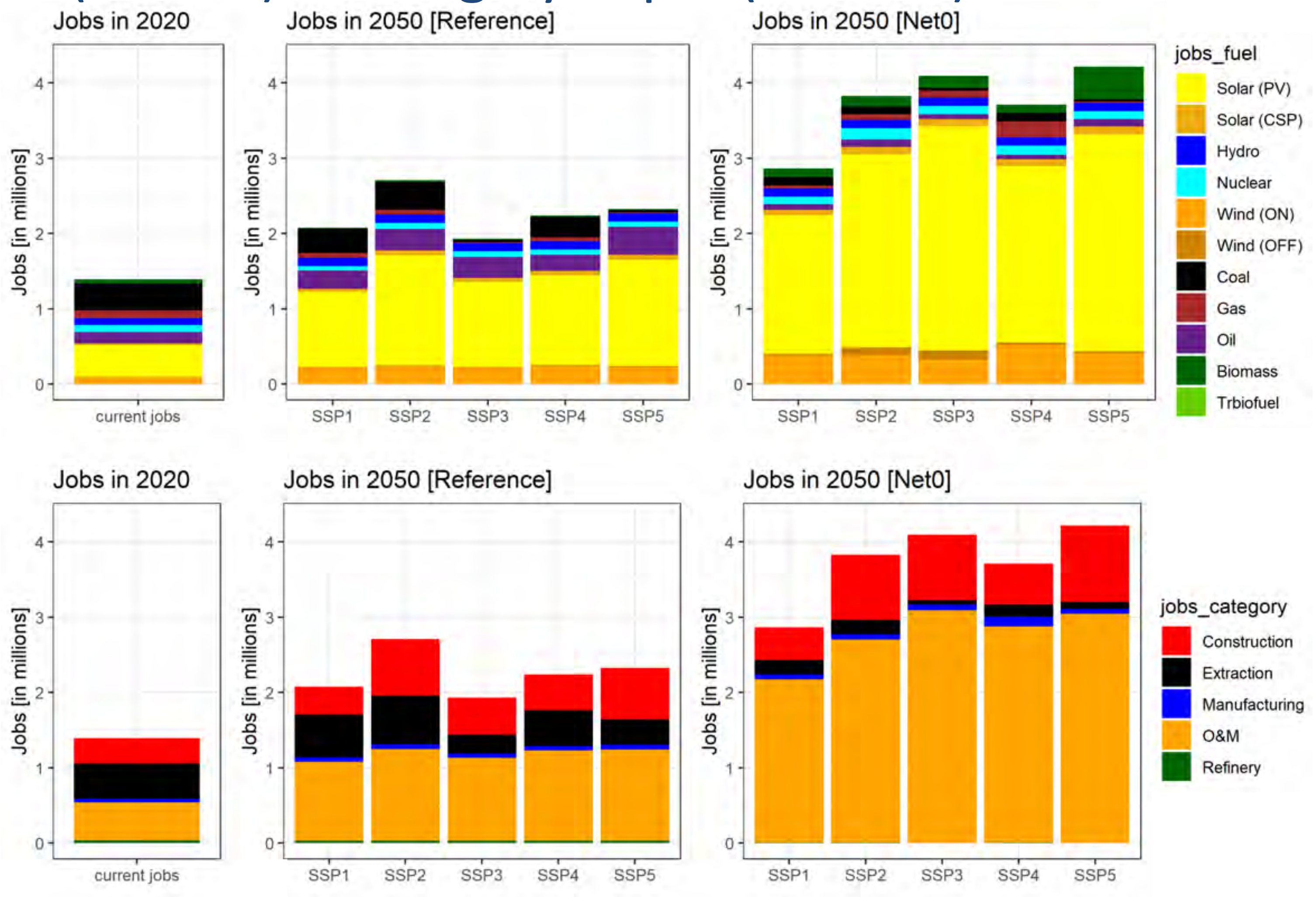
## Scenarios:

1. Reference
   (continued current policies as of 2020)
2. Net0 within Europe by 2050, global WB2C carbon budget of 1150 GtCO2



# Today’s Energy Jobs in Europe

- In Europe, around 1.3 million direct jobs today, expected to double (CurPol) or roughly triple (in Net0)

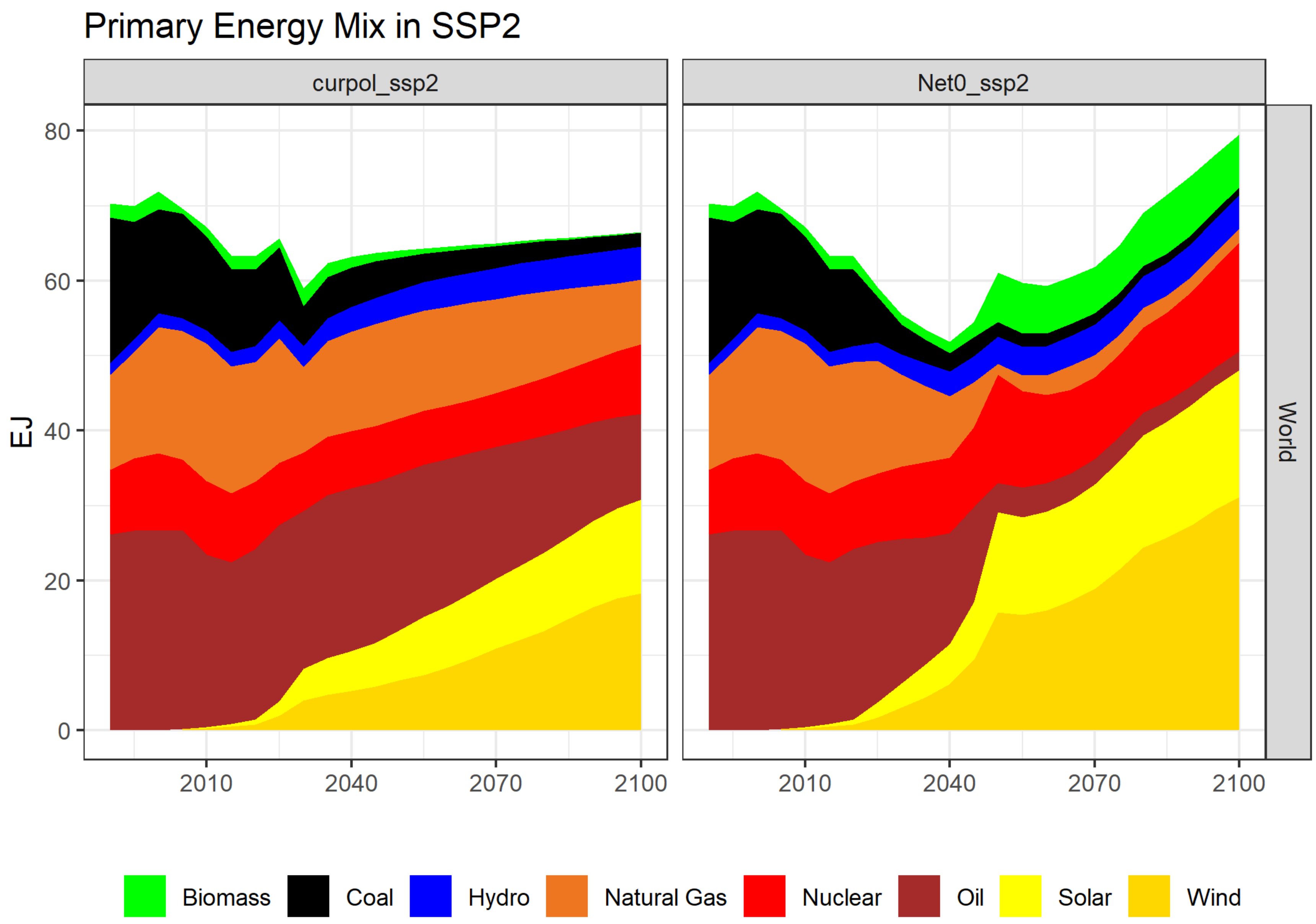



Solar highest share in the future, highest employment factor

Already in the baseline PV additions substantial

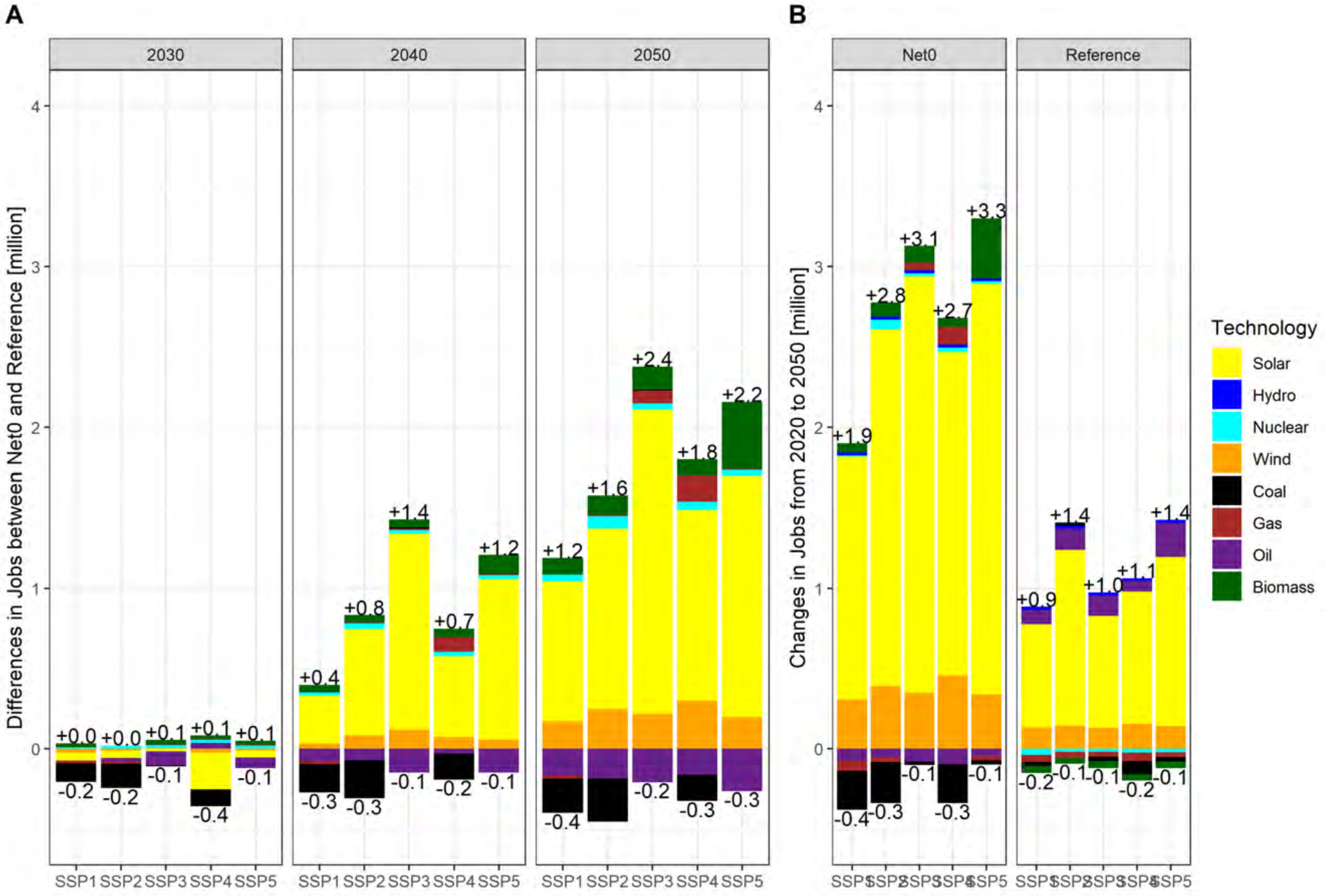
1150 Budget only (2degrees: 2-3Mio!)

# Energy and Electricity Mix EUROPE

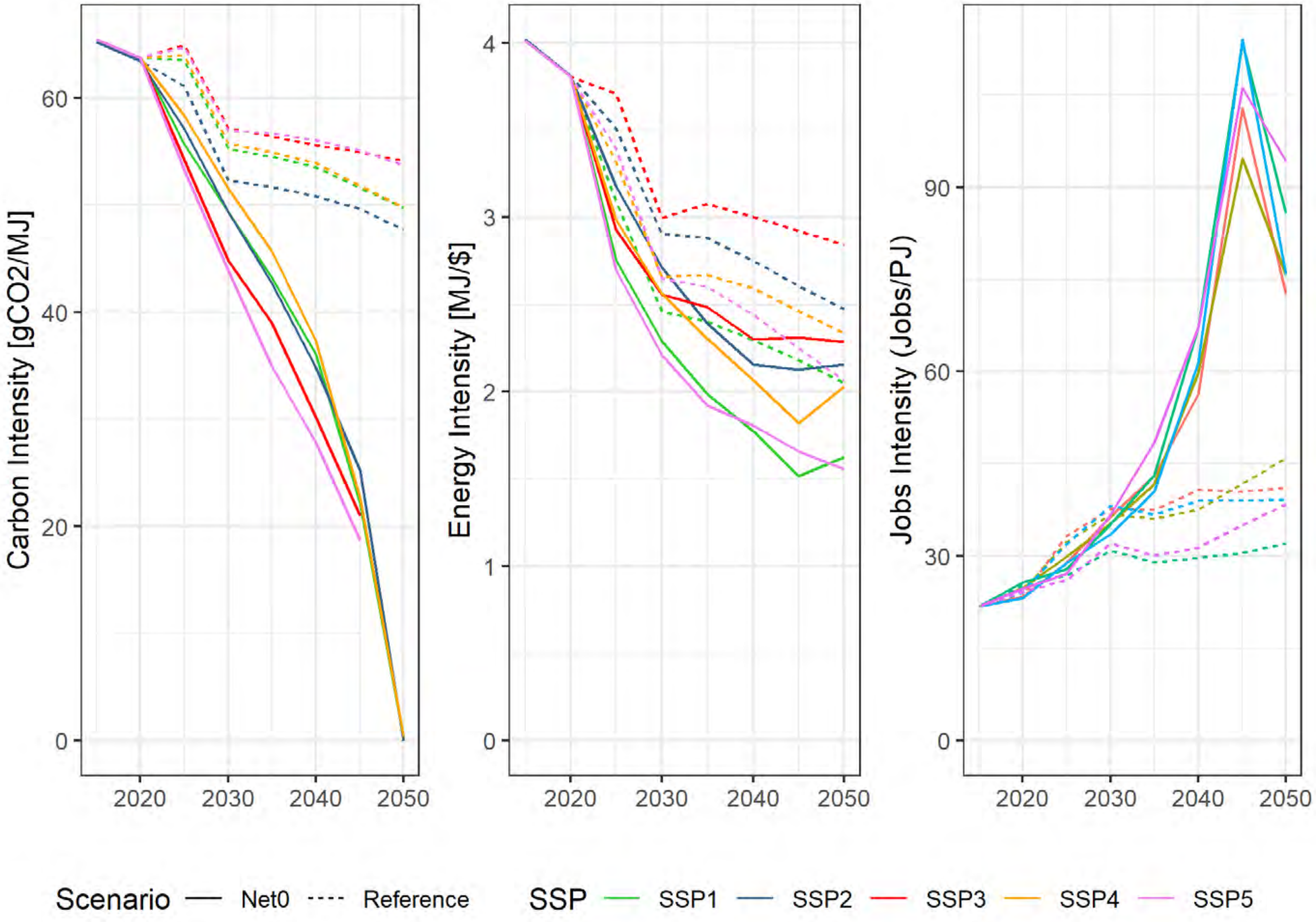


# Tgains and Losses by fuels

- Extraction and Coal generation loses most



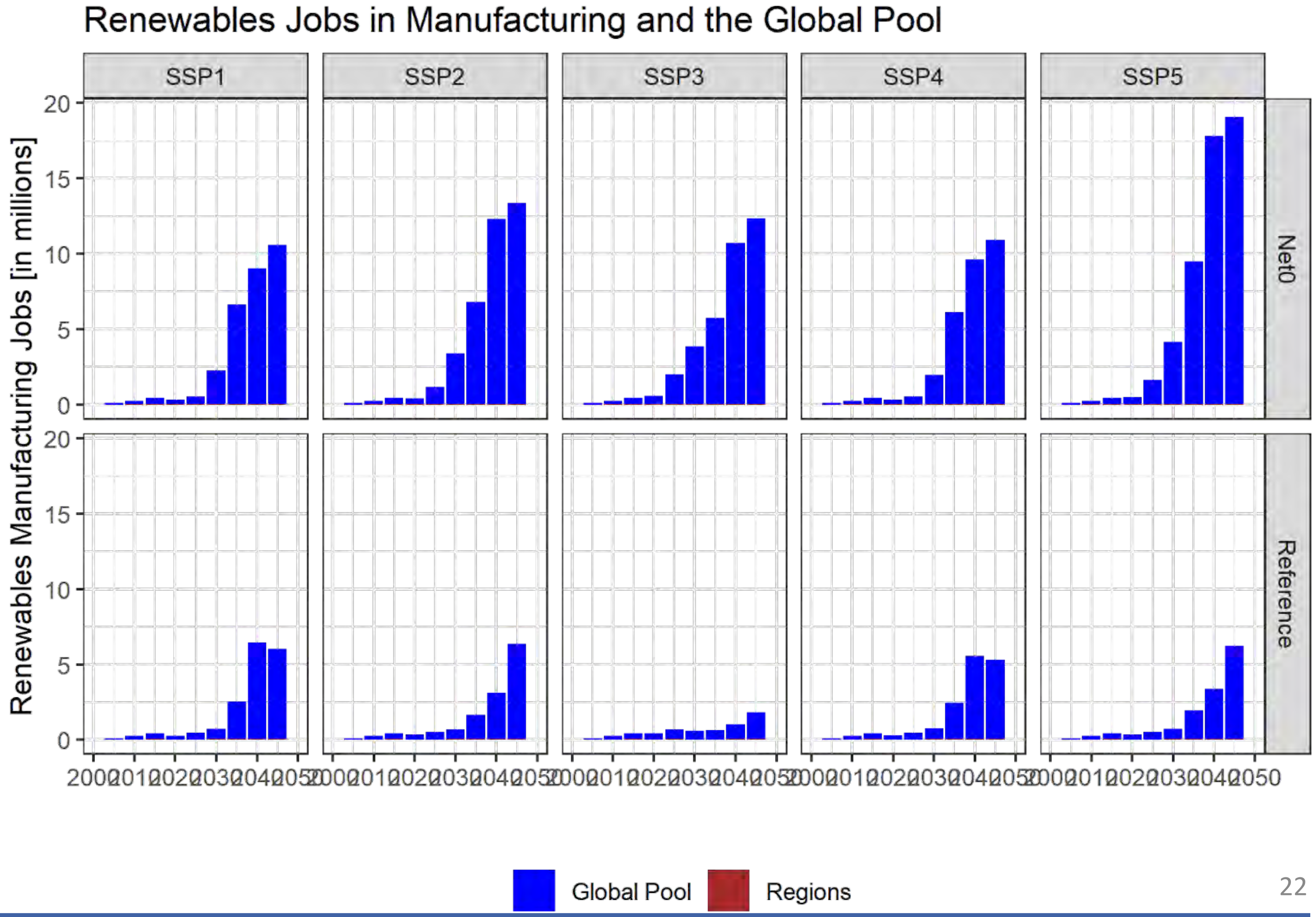
# Changes over time and intensities



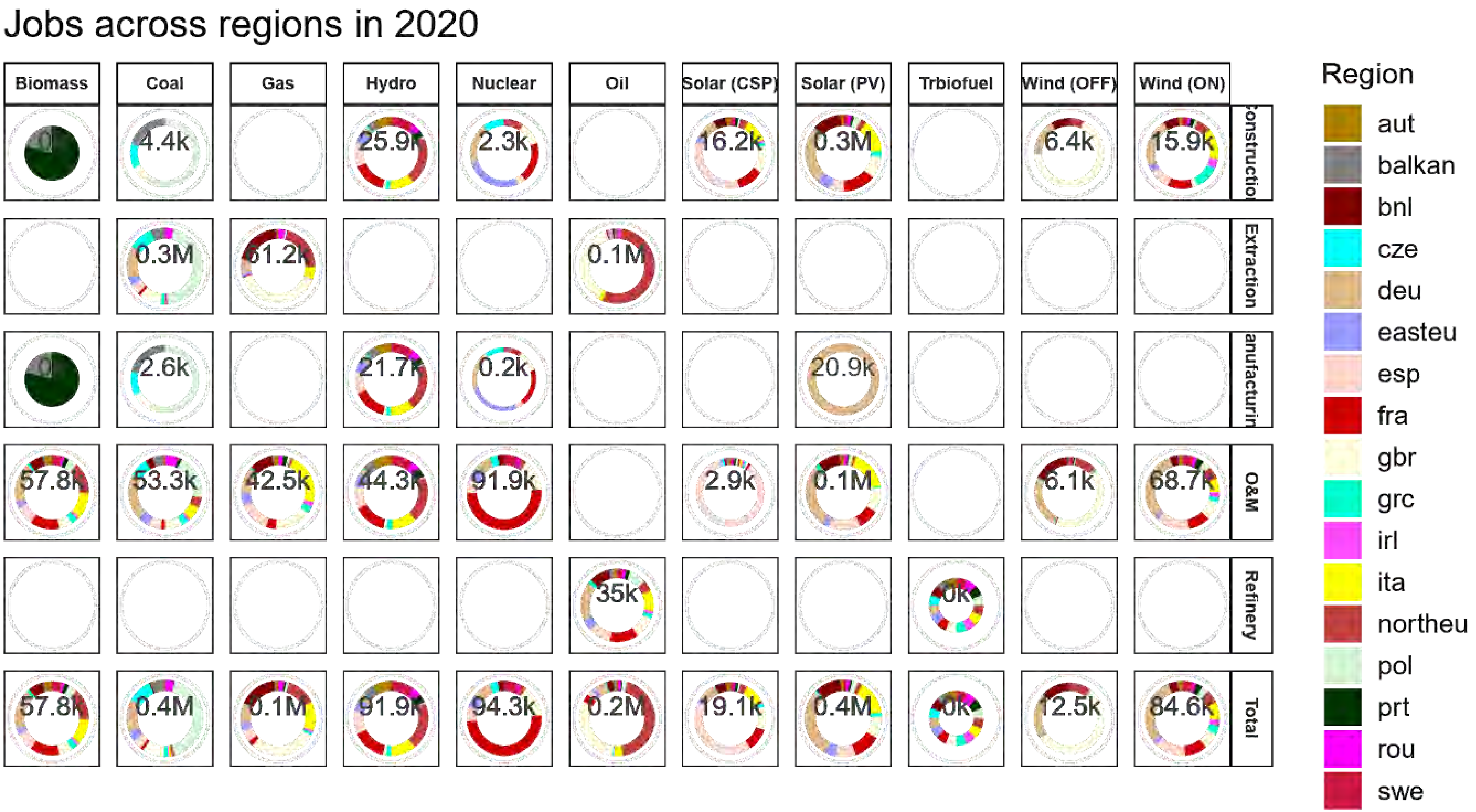

1PJ = energy consumption of about 8,000 people in EU

# The global Pool

- Solar and Wind Manufacturing, country of production depends on many factors --> 10-15 millions globally, EU potential depends mostly on industrial policy

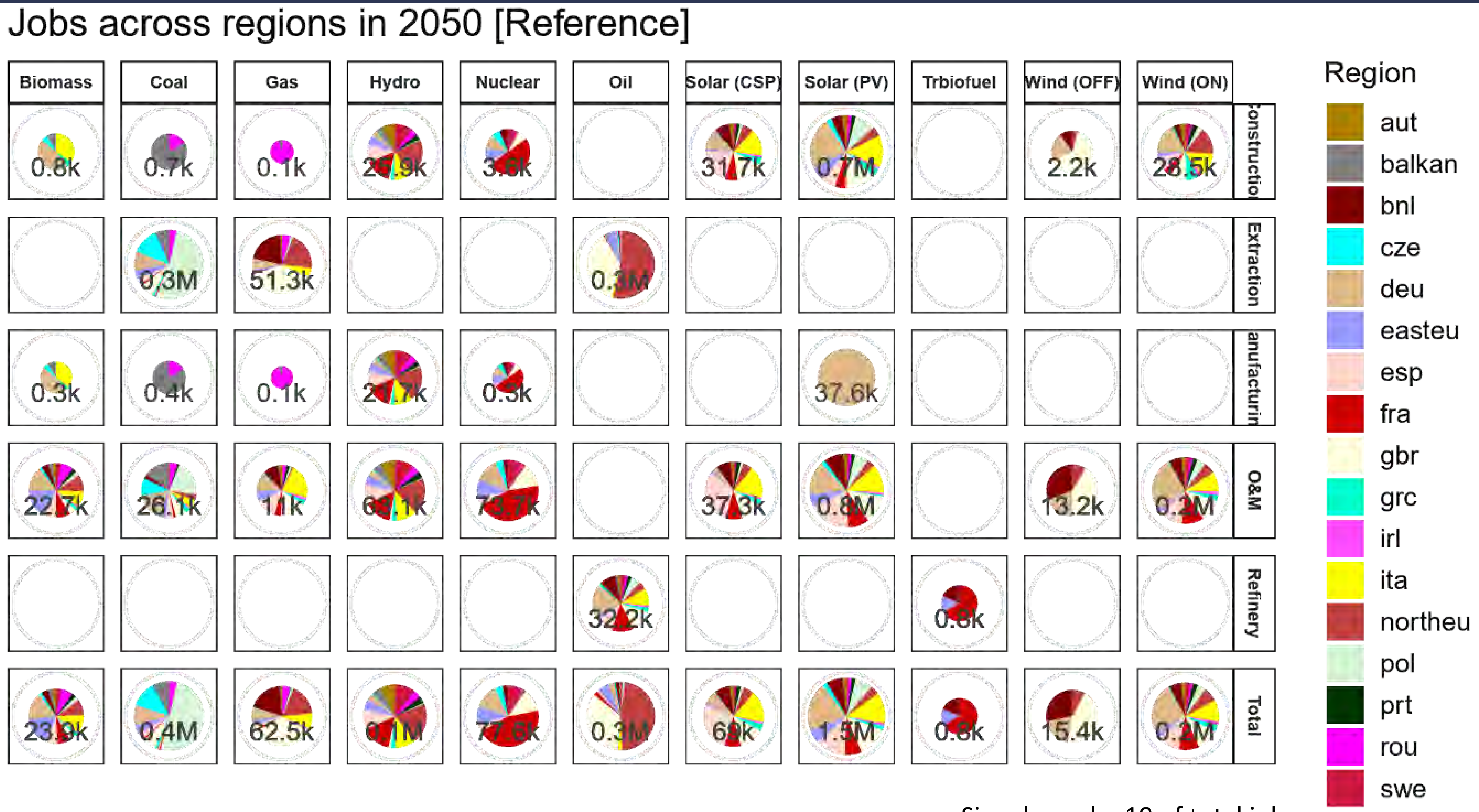


# Energy Jobs across countries in 2020




Size shows log10 of total jobs

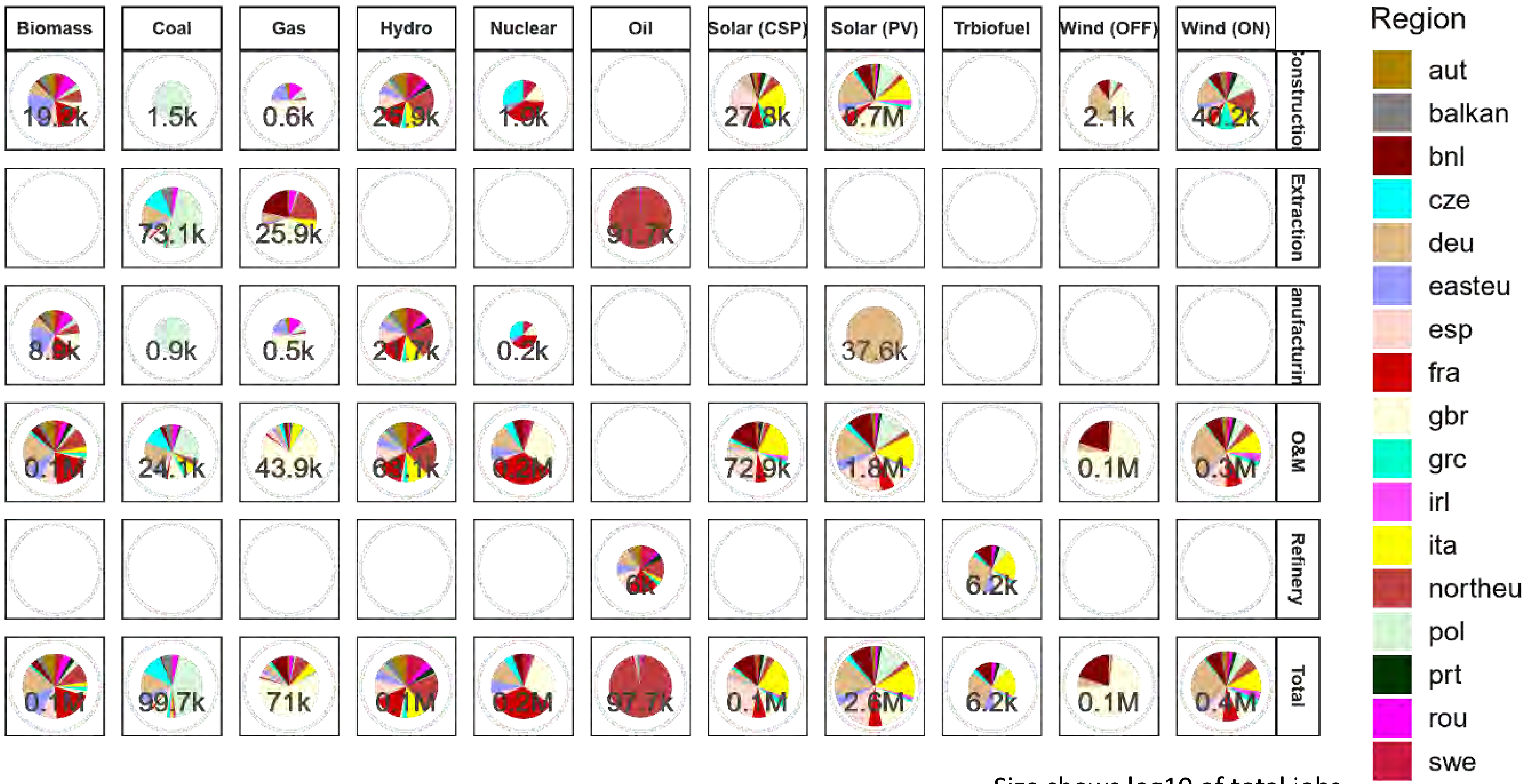
# Energy Jobs across countries in 2050 (Reference)




Size shows log10 of total jobs

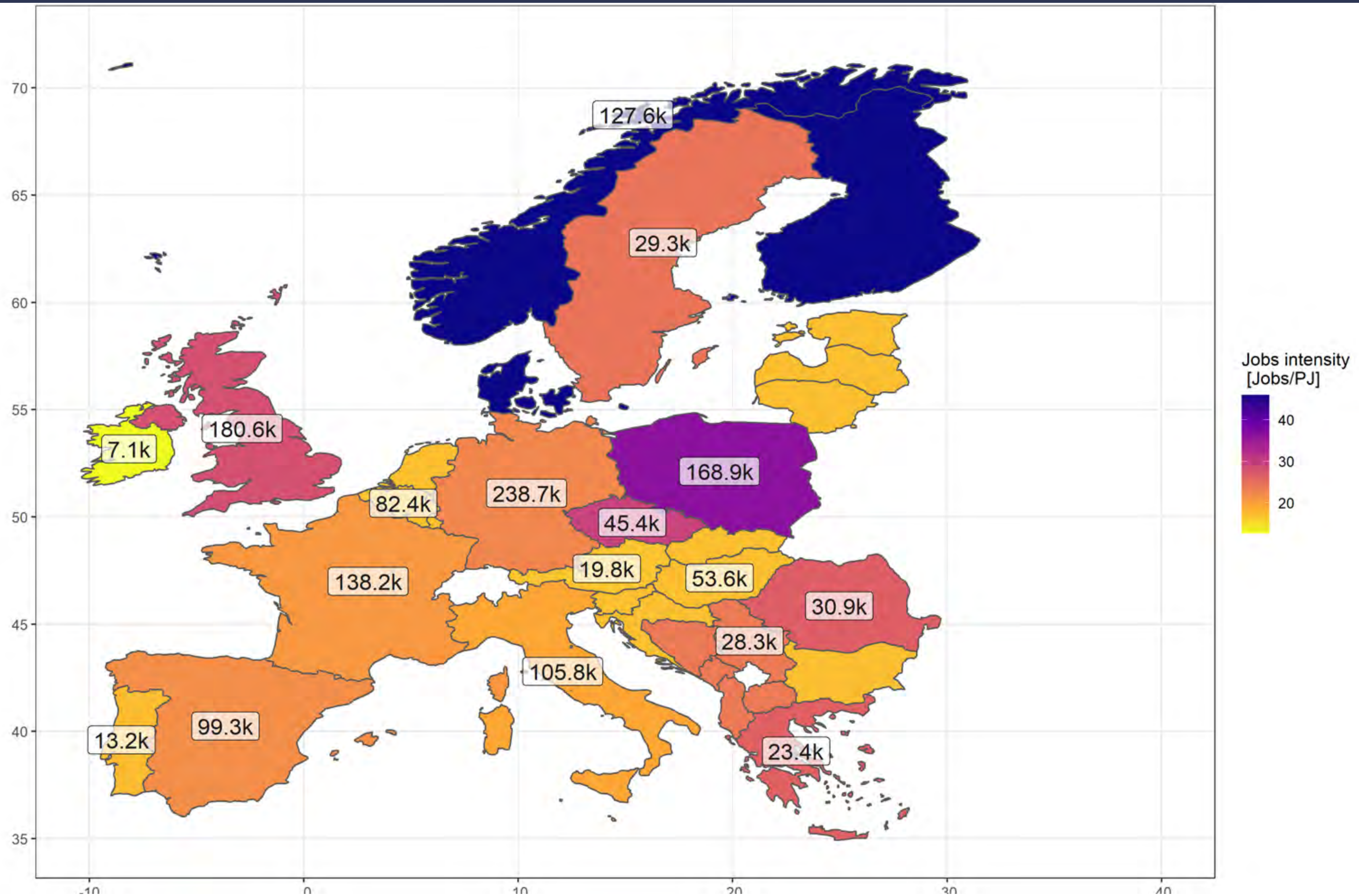
# Energy Jobs across countries in 2050 (Net0)

Jobs across regions in 2050 [Net0]

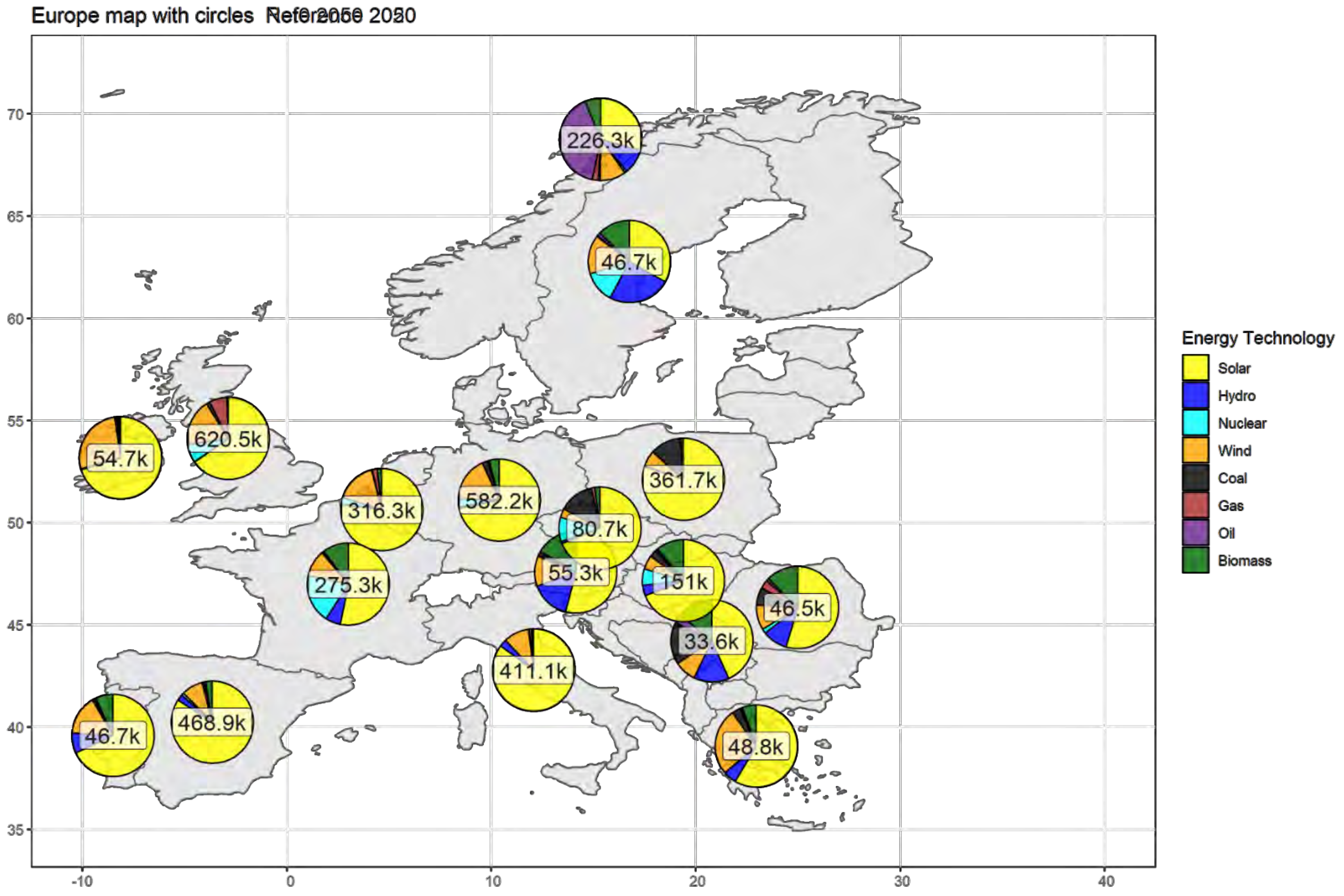



Size shows log10 of total jobs

# Results for the EU (Reference, 2020)

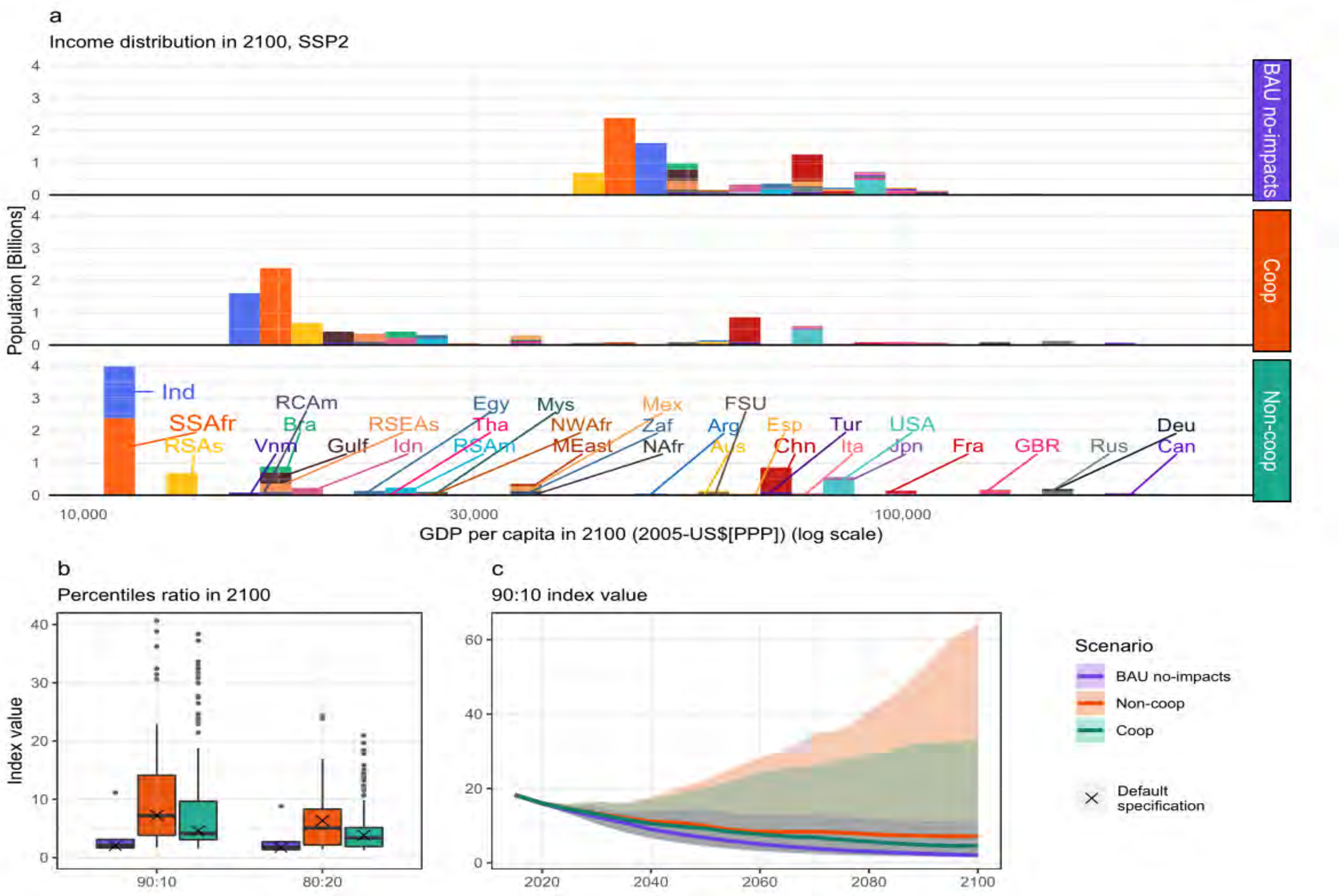


# Results for the EU (2020 and 2050)



# Distributional incidence of mitigation, impacts, and redistribution

- RICE50+ model, CB-IAM, almost at country level, DICE based




Source: Gazzotti, Paolo, Johannes Emmerling, Giacomo Marangoni, Andrea Castelletti, Kaj-Ivar van der Wijst, Andries Hof, and Massimo Tavoni. 'Persistent Inequality in Economically Optimal Climate Policies'. *Nature Communications* 12, no. 1 (8 June 2021): 3421. https://doi.org/10.1038/s41467-021-23613-y.

# Distributional incidence of mitigation, impacts, and redistribution

- Welfare:

$$W = \sum_{t=1}^{T} \left[ \frac{1}{1-\eta} \left( \sum_{n \in clt} l_{t,n} \left( \frac{Y_{t,n}(1-s_{t,n})}{l_{t,n}} \right) \right)^{\frac{1-\eta}{1-\gamma}} - 1 \right] (1+\rho)^t$$

now based on deciles in the optimization

- Welfare function:

$$W = \sum_{t=1}^{T} \left[ \frac{1}{1-\eta} \left( \sum_{n \in clt} l_{t,n} \left( \left( \sum_{dist=1}^{10} \left( \frac{Y_{t,n,dist}(1-s_{t,n})}{l_{t,n}/10} \right)^{1-\gamma^{int}} \right)^{\frac{1}{1-\gamma^{int}}} \right)^{1-\gamma} \right)^{\frac{1-\eta}{1-\gamma}} - 1 \right] (1+\rho)^t$$

# Distributional incidence of mitigation, impacts, and redistribution

- Baseline quantiles $q^{ref}_{dist,t,n}$ based on SSP projection

$$YGROSS_{t,n,dist} = YGROSS_{t,n} * q^{ref}_{dist,t,n} \tag{1}$$

- Income across deciles:

$$\begin{aligned} Y_{t,n,dist} &= YGROSS_{t,n,dist} \\ &- DAMAGES_{t,n} * w^{\xi}_{t,n,dist} \\ &- (ABATECOST_{t,n} + ctax_t * EIND_{t,n}) * w^{\omega}_{t,n,dist} \\ &+ TRANSFER_{t,n,dist} \end{aligned} \tag{2}$$

with

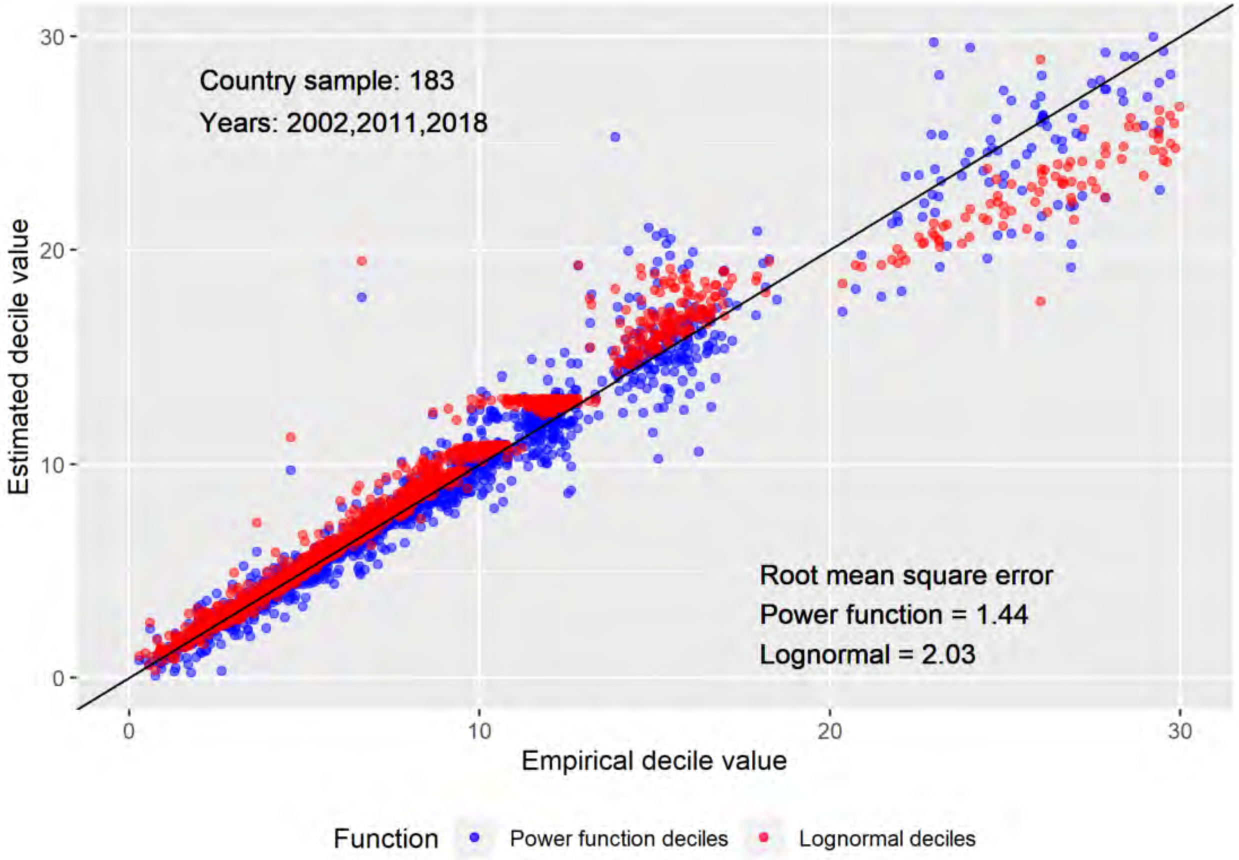
$$w^{\xi}_{t,n,dist} = \frac{\left(q^{ref}_{t,n,dist}\right)^{\xi}}{\sum_{dist}\left(q^{ref}_{t,n,dist}\right)^{\xi}} \text{ and } w^{\omega}_{t,n,dist} = \frac{\left(q^{ref}_{t,n,dist}\right)^{\omega}}{\sum_{dist}\left(q^{ref}_{t,n,dist}\right)^{\omega}}. \tag{3}$$

- Redistribution of carbon tax revenues as

$$\sum_{dist} TRANSFER_{t,dist} = ctax_t * EIND_t$$

# Lognormal vs. deciles based inequality

- Lognormal assumption vs. Deciles
- 1961 to 2018 projection and fit comparison



# Distributional incidence of mitigation, impacts, and redistribution

Decomposition based on the Theil index GE(0) $GE(0) = \frac{1}{N}\sum_{i=1}^{N} \ln\left(\frac{N^{-1}\sum_{i=1}^{N} x_i}{x_i}\right)$

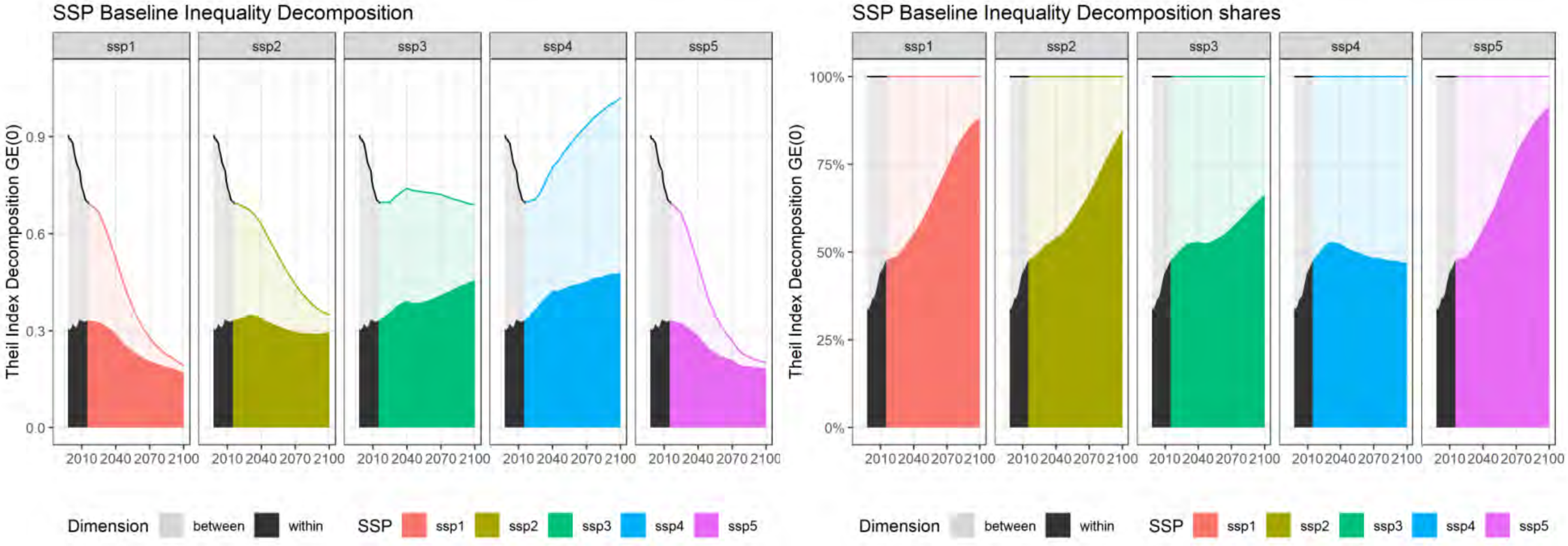
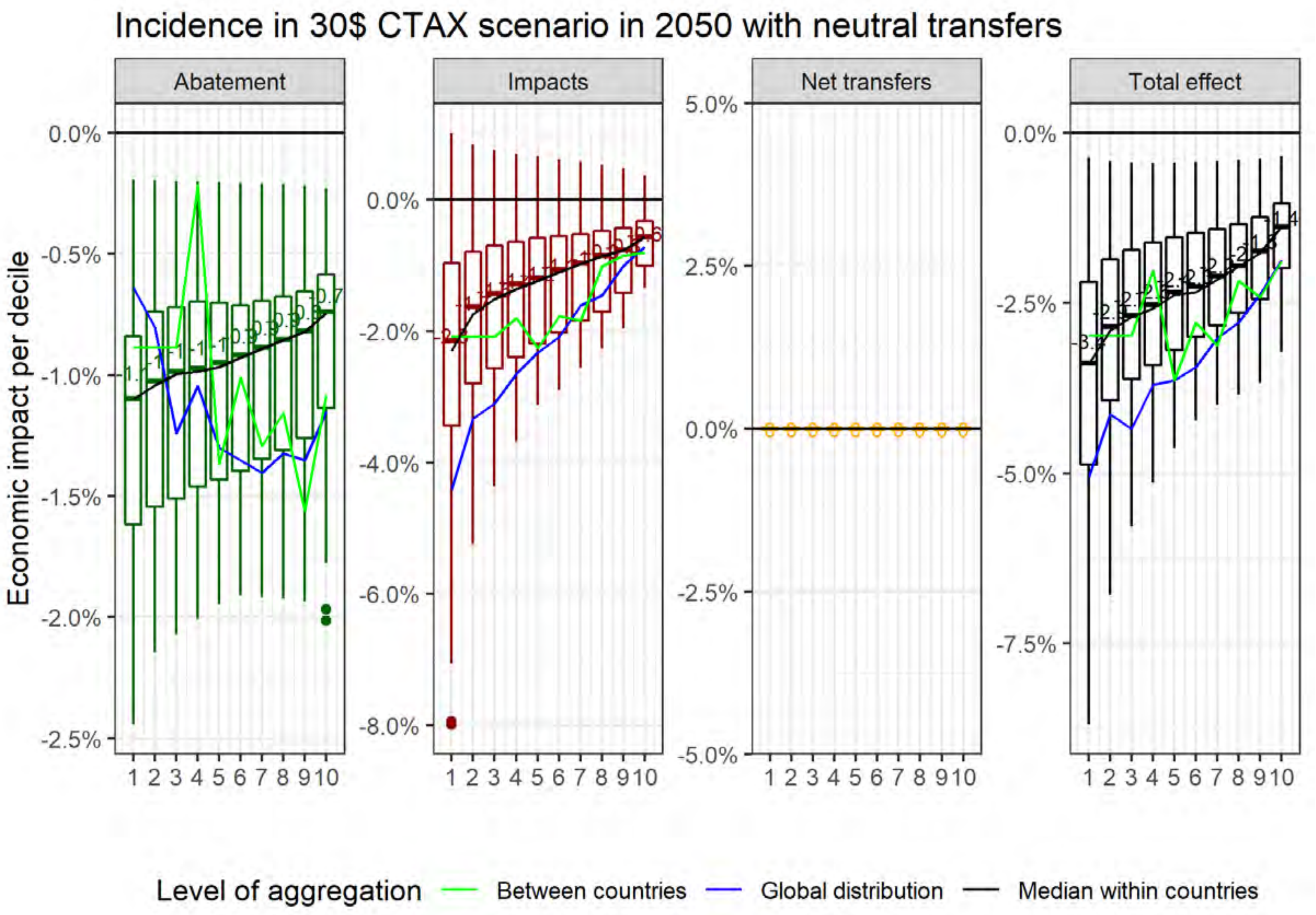



Figure: Inequality decomposition (left) and full income distirbution in 2014 and 2050 across SSPs (right)

# Distributional incidence of mitigation, impacts, and redistribution

- RICE50+ model, CB-IAM, almost at country level, DICE based



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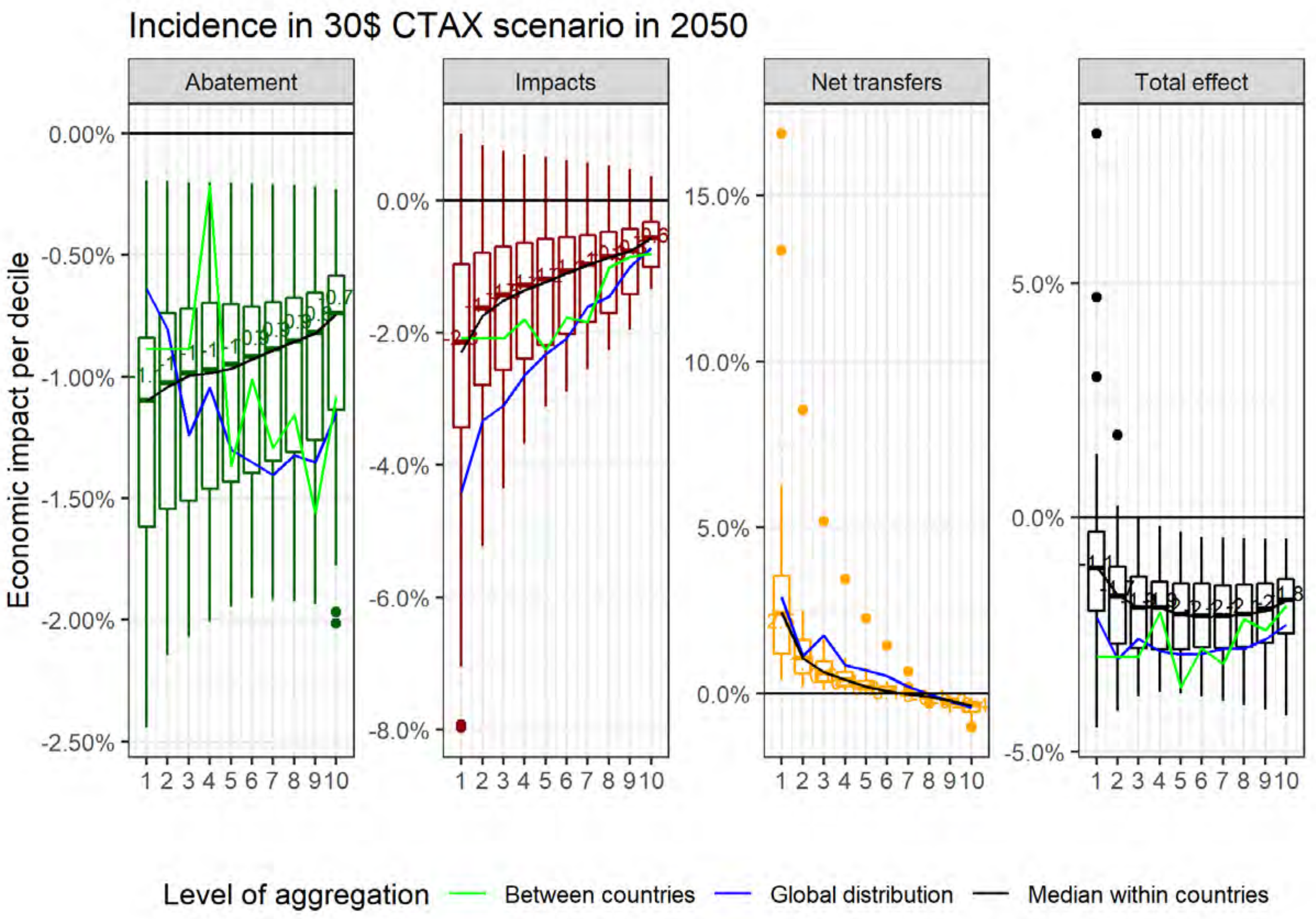
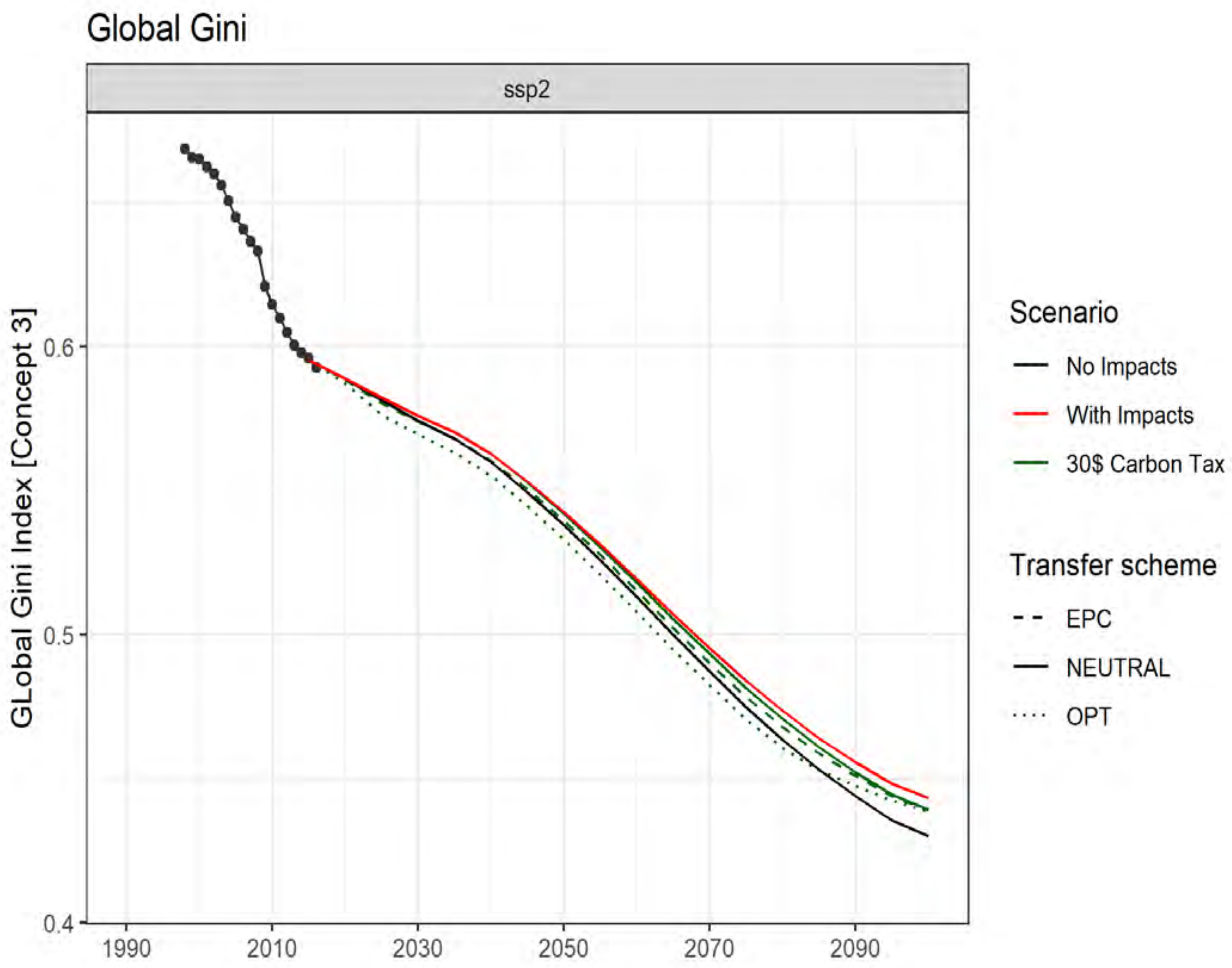


# Distributional incidence of mitigation, impacts, and redistribution

- RICE50+ model, CB-IAM, almost at country level, DICE based



# Distributional incidence of mitigation, impacts, and redistribution

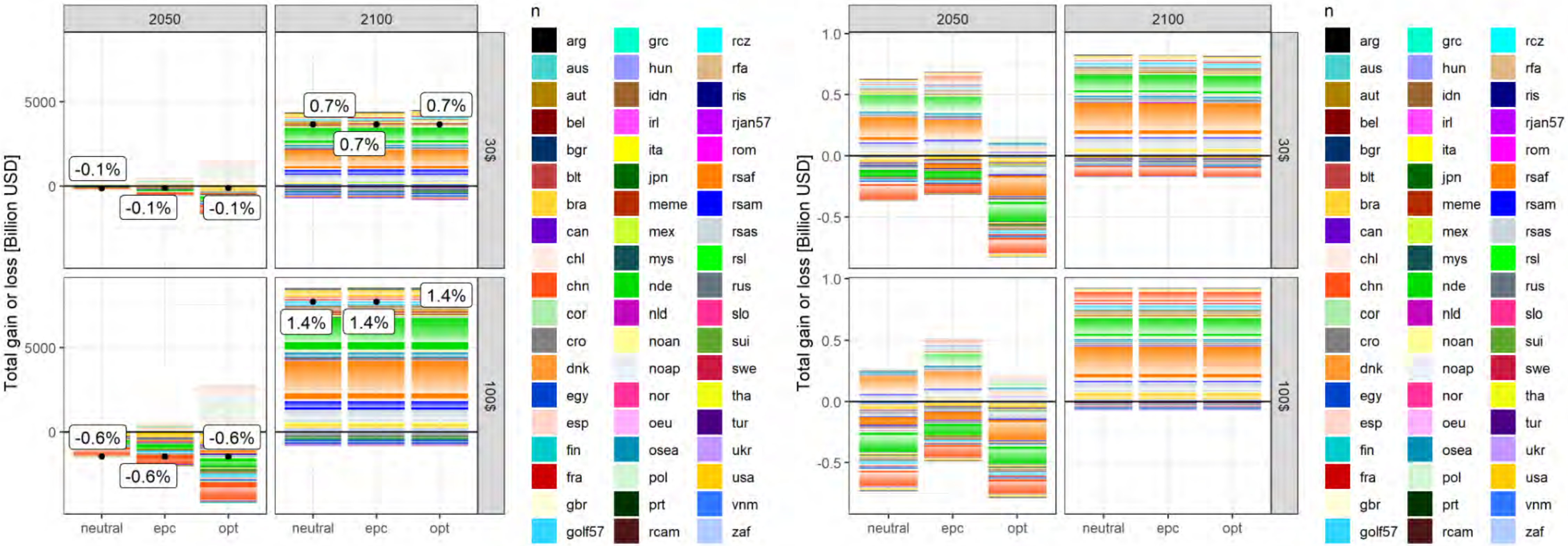
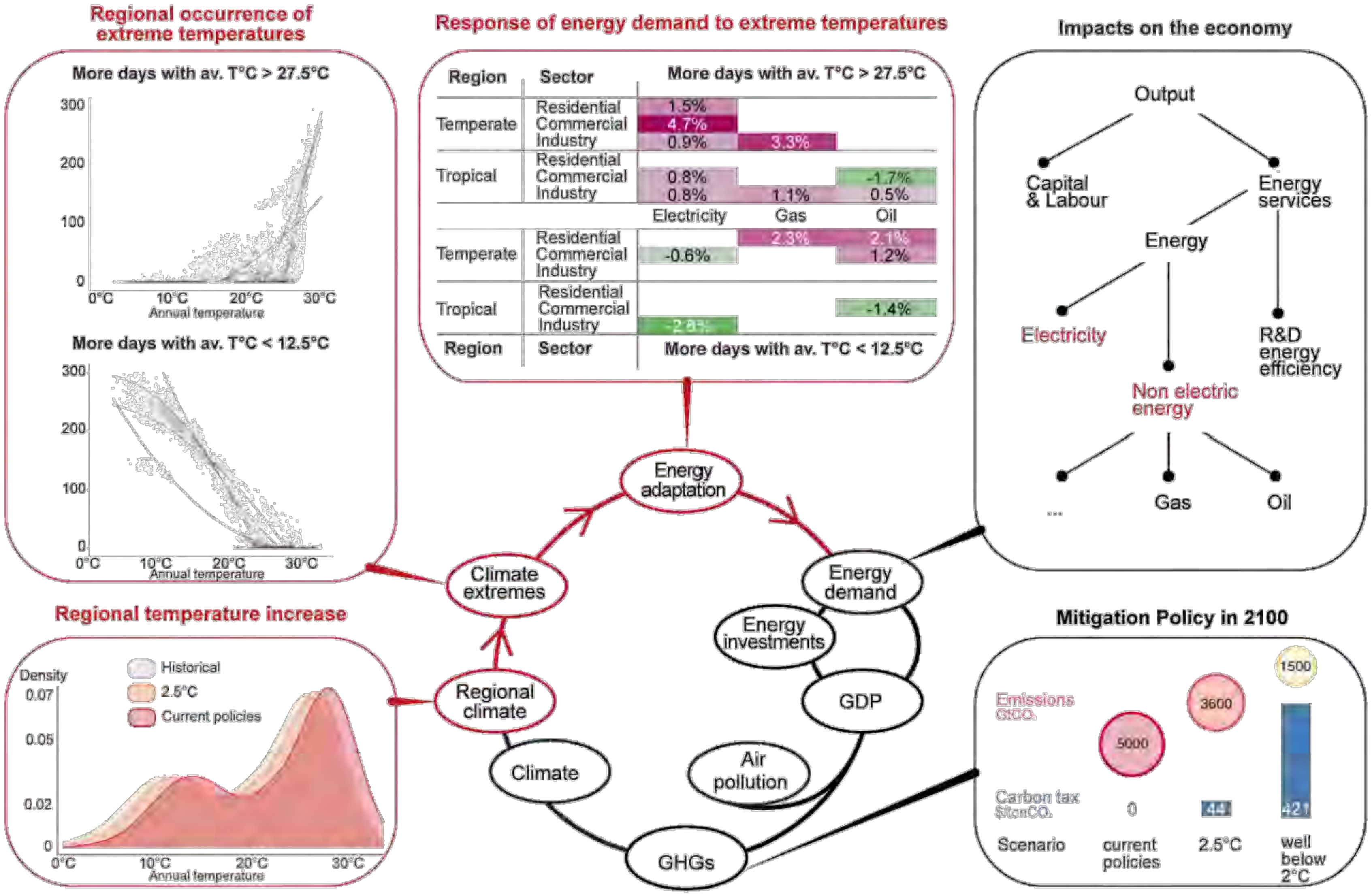



Figure: Distribution of winners and losers (in total economic impact (left) and population shares (right))

# Impacts and the Integration with Equity, Mitigation, and Adaptation

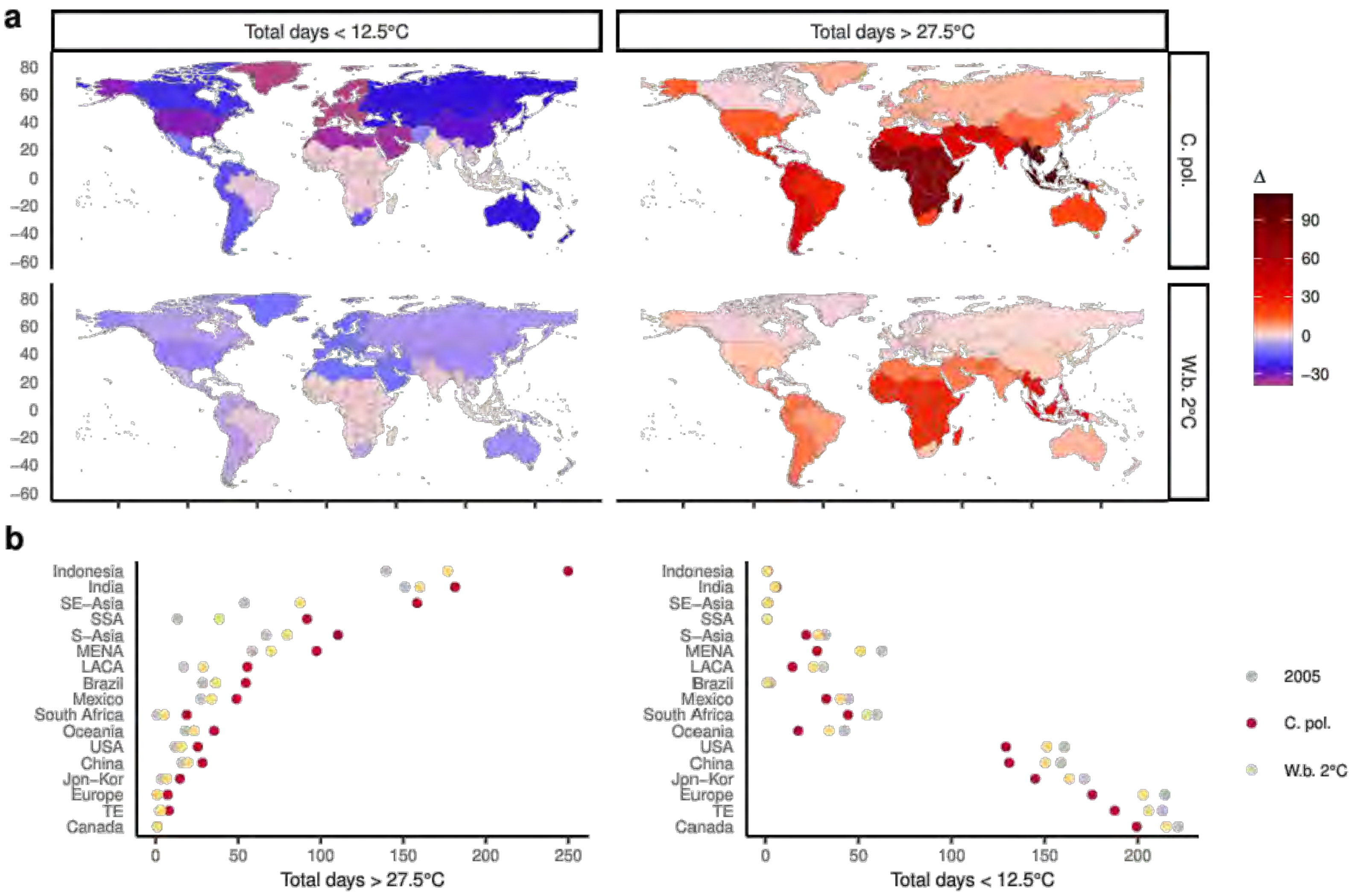
- Mitigation, Impacts, and Adaptation: here on Energy Demand




Source: Colelli, Emmerling et al., 2022, forthcoming NComms

# Impacts

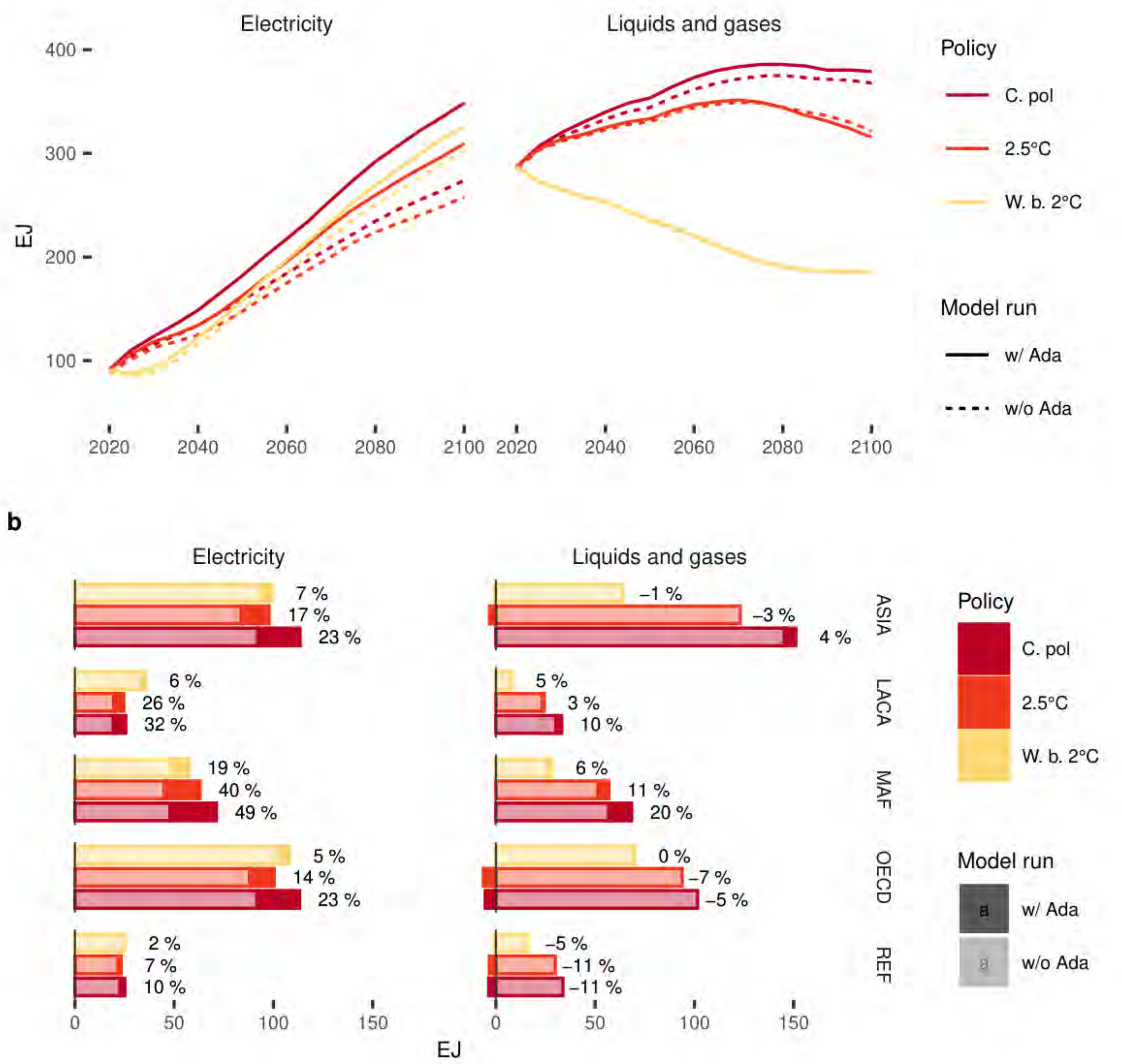
- Mitigation, Impacts, and Adaptation: here on Energy Demand




Source: Colelli, Emmerling et al., 2022, forthcoming NComms

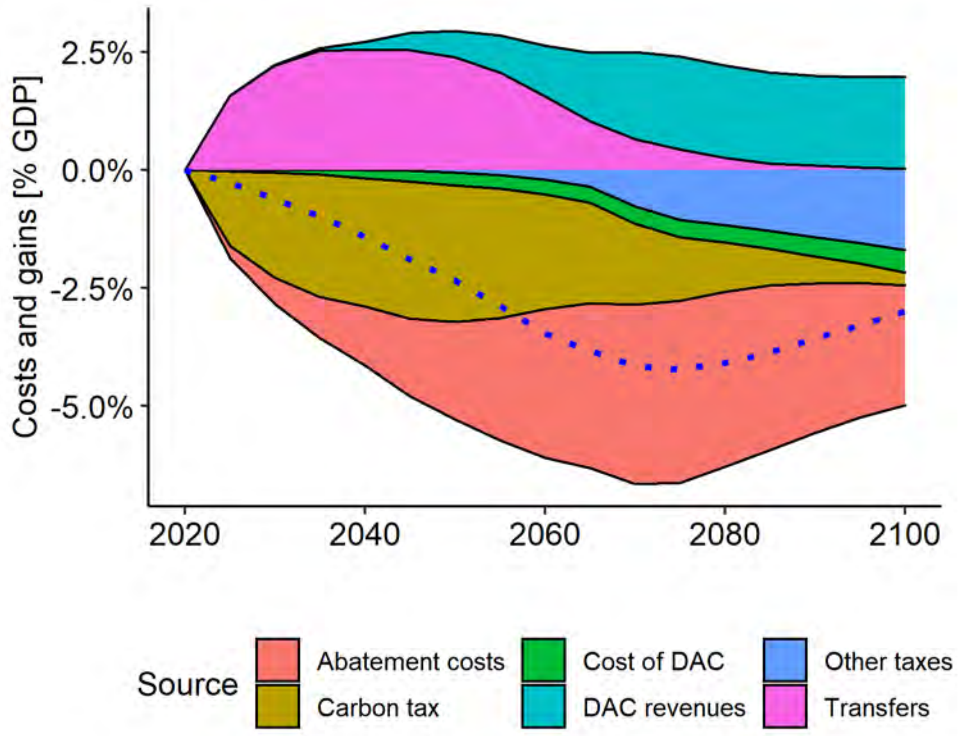
# Impacts

- Mitigation, Impacts, and Adaptation: here on Energy Demand

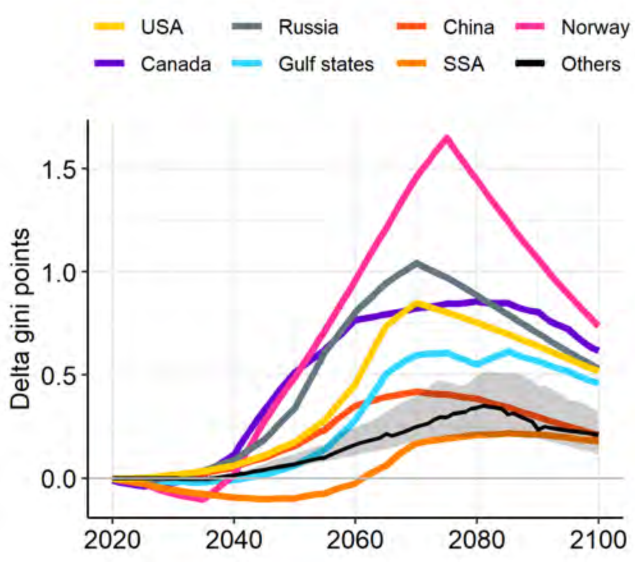


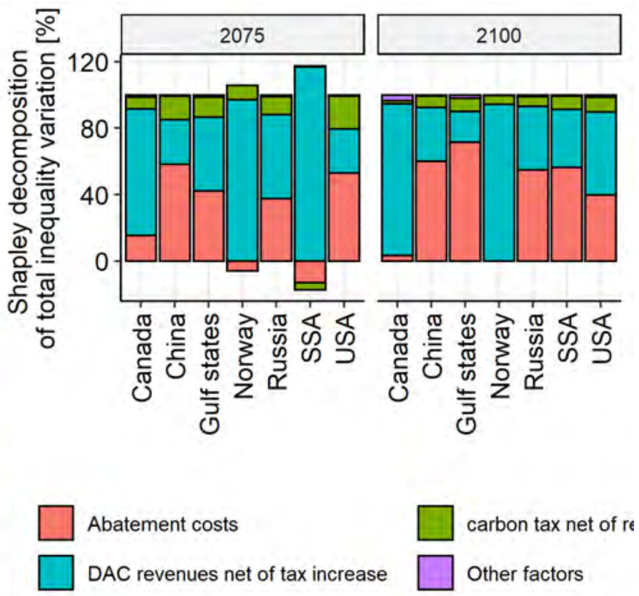

Source: Colelli, Emmerling et al., 2022, forthcoming NComms

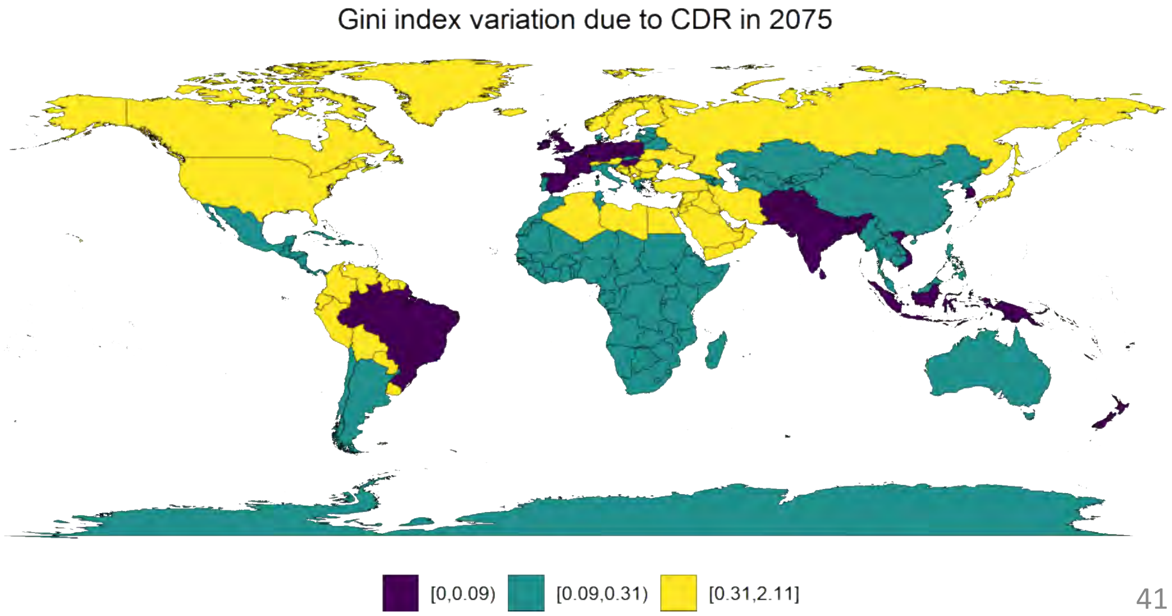
# DAC and Inequality



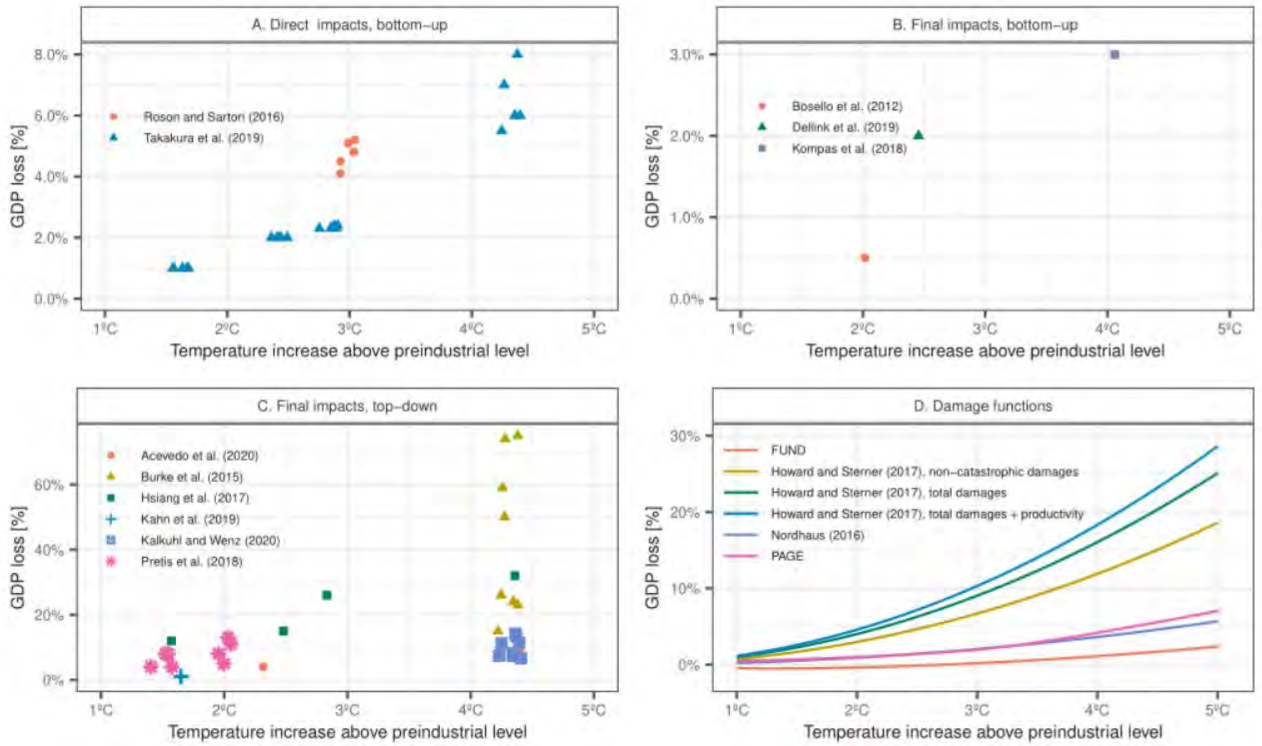

Aggregated financial flows in a 1.5deg scenario



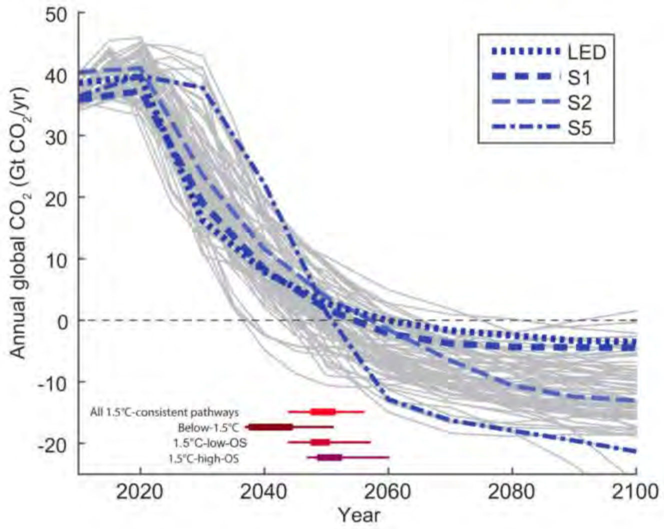
# Cliamte Impacts - Macroeconomic effects on GDP and damage functions



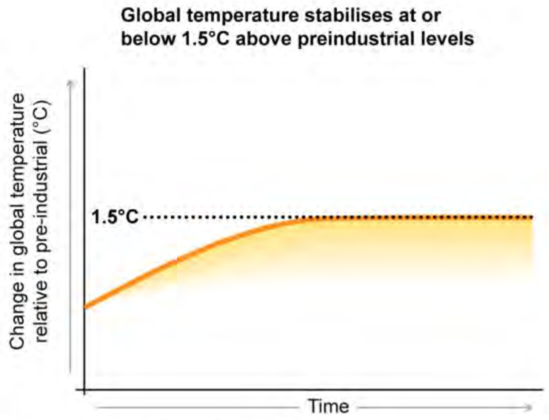

Source: Piontek *et al.* (2021)

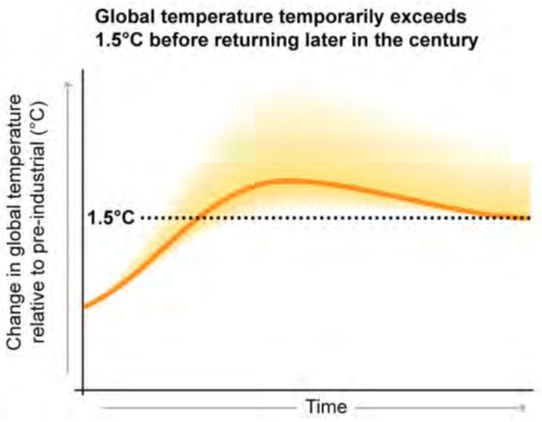
1. Burke *et al.* (2015), growth-based, final impact, top-down
2. Howard & Sterner (2017), level-based, damage function, meta-analysis
3. Takakura *et al.* (2019), level-based, direct impact, bottom-up

# Climate IMPACTS – post processed implementation and




- Many trajectories for climate stabilization
- Importance of baseline and time discounting
- Allow for temperature exceedence: 'overshoot'
- Rely on negative emissions

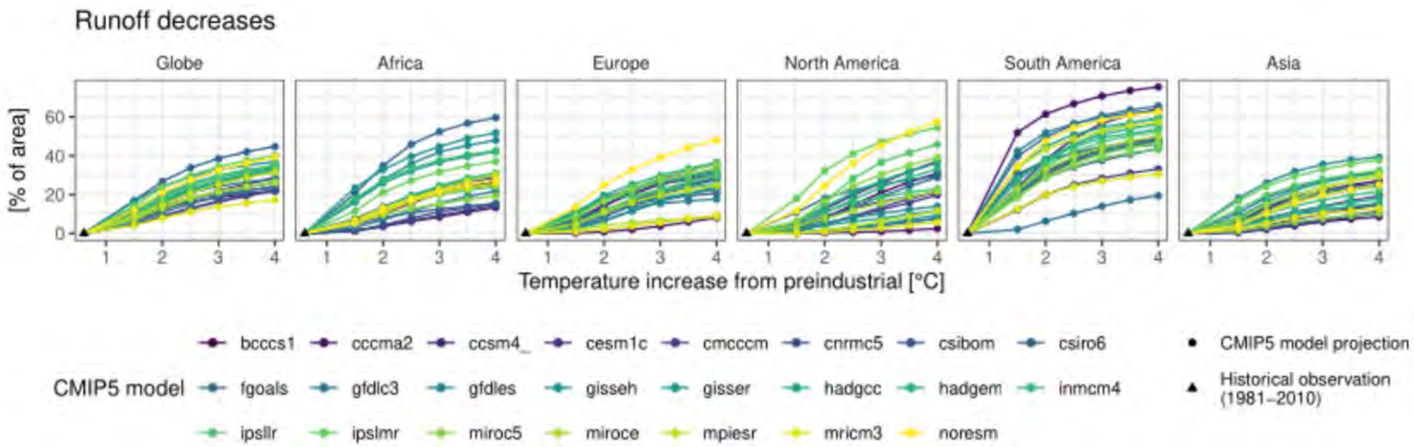


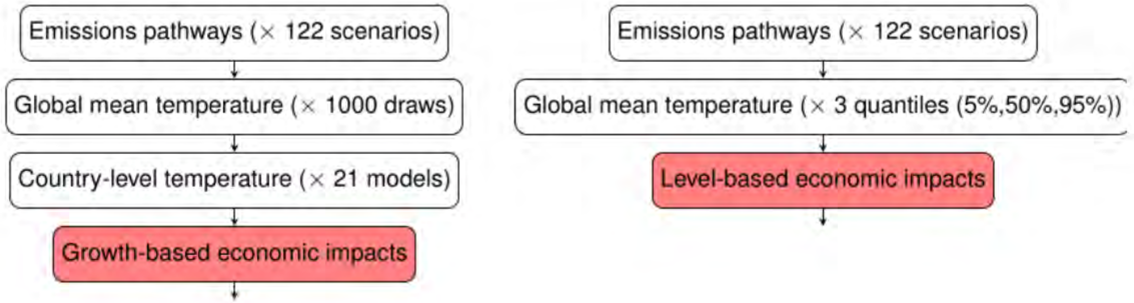

Source: IPCC SR 1.5C

We apply 15 impact response functions (Arnell *et al.*, 2019). Global + 5 regions. 23 CMIP5 models.

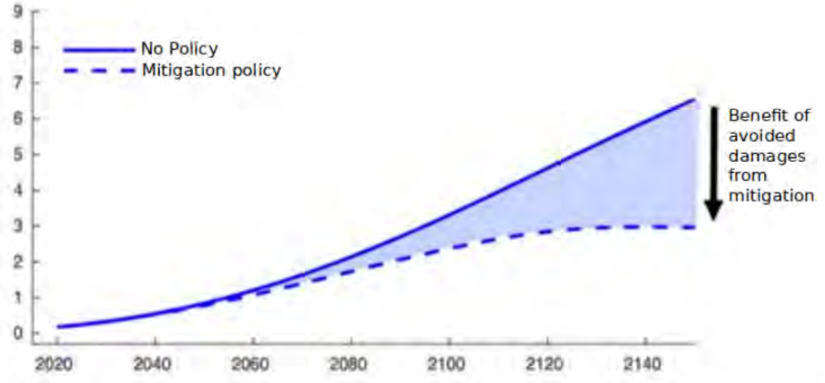
| |
|---|
| Agricultural drought frequency [% chance], duration [% of time] |
| Frost days [days/years], Heating Degree Days [°C] |
| (Major) Heatwave frequency [% chance], duration [days/years], Cooling degree days [°C] |
| Reduction in crop duration [days]: Maize, Rice, Soybean, Spring/Winter Wheat |
| Runoff increases, decreases [% of area] |



## Computation of economic impacts

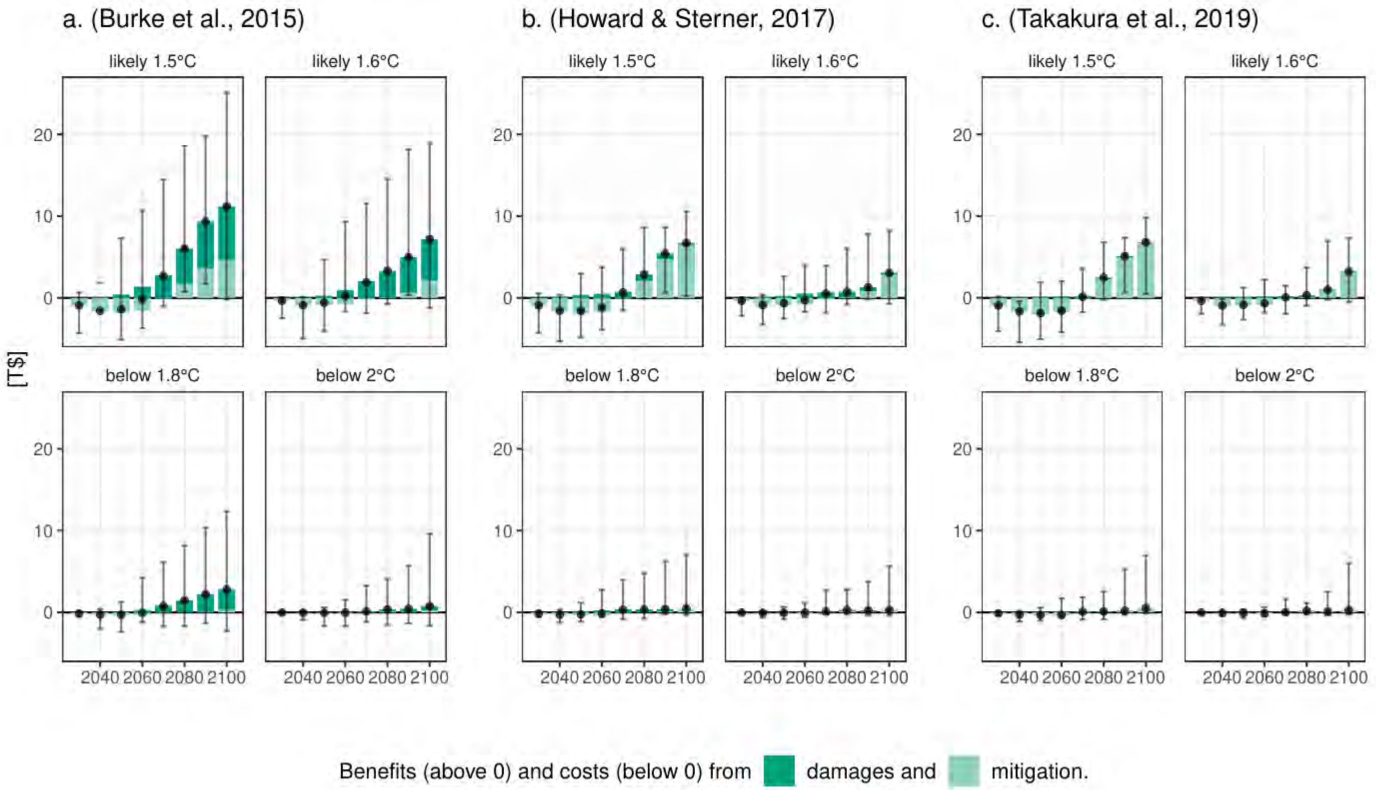



## Avoided impacts




Brown *et al.* (2020)

# Global net benefits from not overshooting

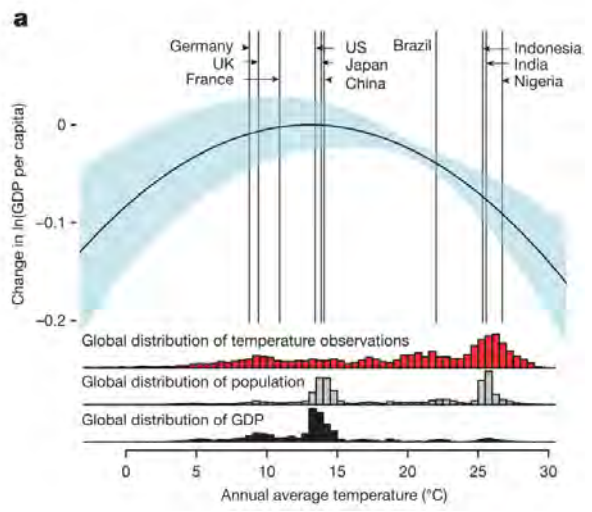


# Overview and related literature

- Impact of climate and weather on economic outcome variables, namely GDP (Burke et al., 2015; Newell et al., 2021; Dell et al., 2012, Kalkuhl and Wenz, 2021)
- Climate change exacerbates **between-country** inequality (Diffenbaugh and Burke, 2019)
- Only few studies on within-country inequality (Vietnam (de Laubier Longuet Marx et al., 2019) and India (Sedova et al., 2019))
- Absolute poverty also likely to increase (Hallegatte and Rozenberg, 2017)
- Important: distinguish Weather and Climate (Tol 2021)

# Conceptual framework

To investigate the climate impacts on economic productivity we typically look at GDP per capita growth (Burke et al. (2015)




- The inequality indices are typically bounded between 0 & 1
- We consider the absolute change of an index as dependent variable →$\Delta y_{it} = \Delta Gini_{it}$
- Alternatively, we derive an *equality index* based on the Sen/Foster welfare function:

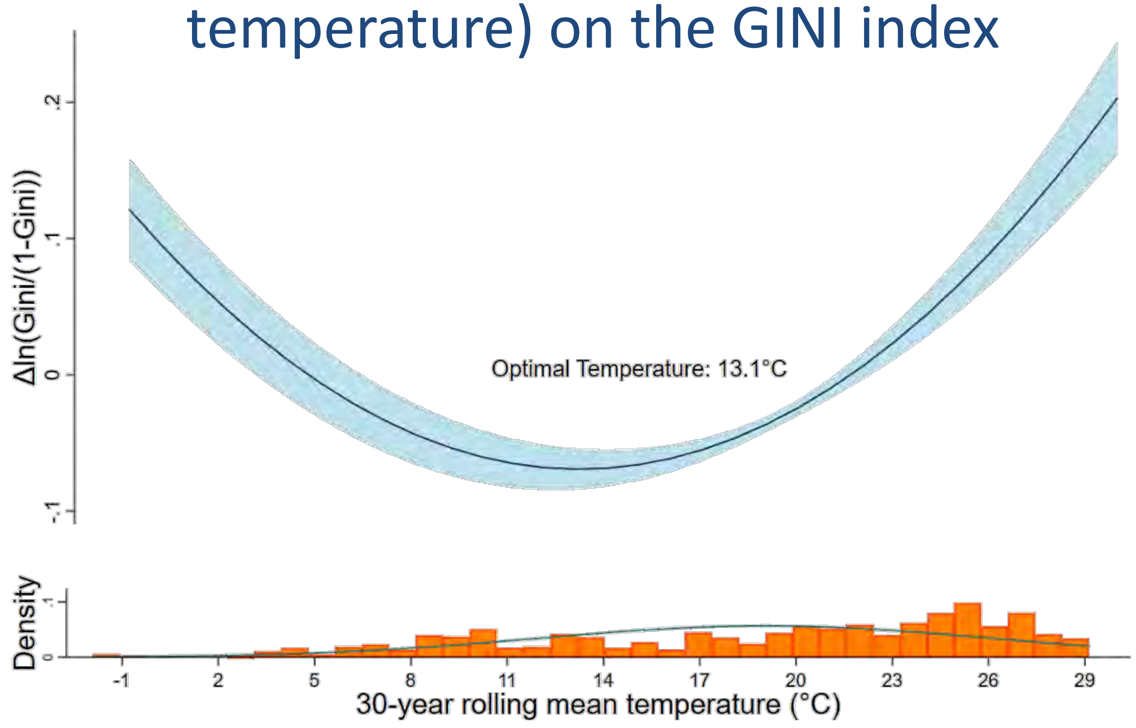
$$W = GDPpc(1 - G)$$

  - →$\Delta y_{it} = \Delta \ln(1 - Gini_{it})$
  - To compute the adjusted growth rate *i* of this equality index
  - W can be derived by a Atkinson/rank utility function

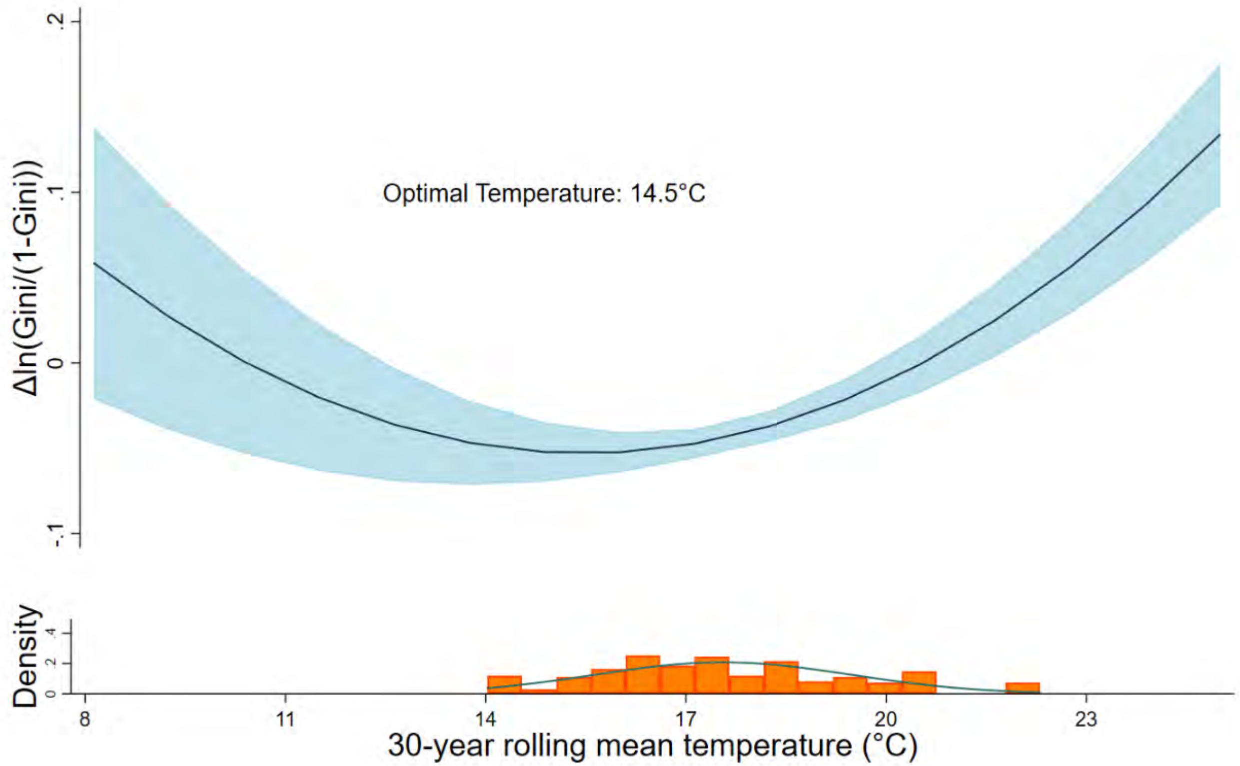
# The inequality module – inclusion of impacts

- So far only mitigation
- Adding Impacts:
  - Based on Climate econometric works
  - Impact of climate (30year average of temperature) on the GINI index

$$\Delta\, log\left(\frac{Gini_{it}}{1 - Gini_{it}}\right) = \tau_1 T_{it} + \tau_2 T_{it}^2 + \beta \boldsymbol{X}_{it} + \alpha_i + \gamma_t + \epsilon_{it}$$




Global (country level)




South Africa (district level)

# IAMs Open Source and Data results / visualization

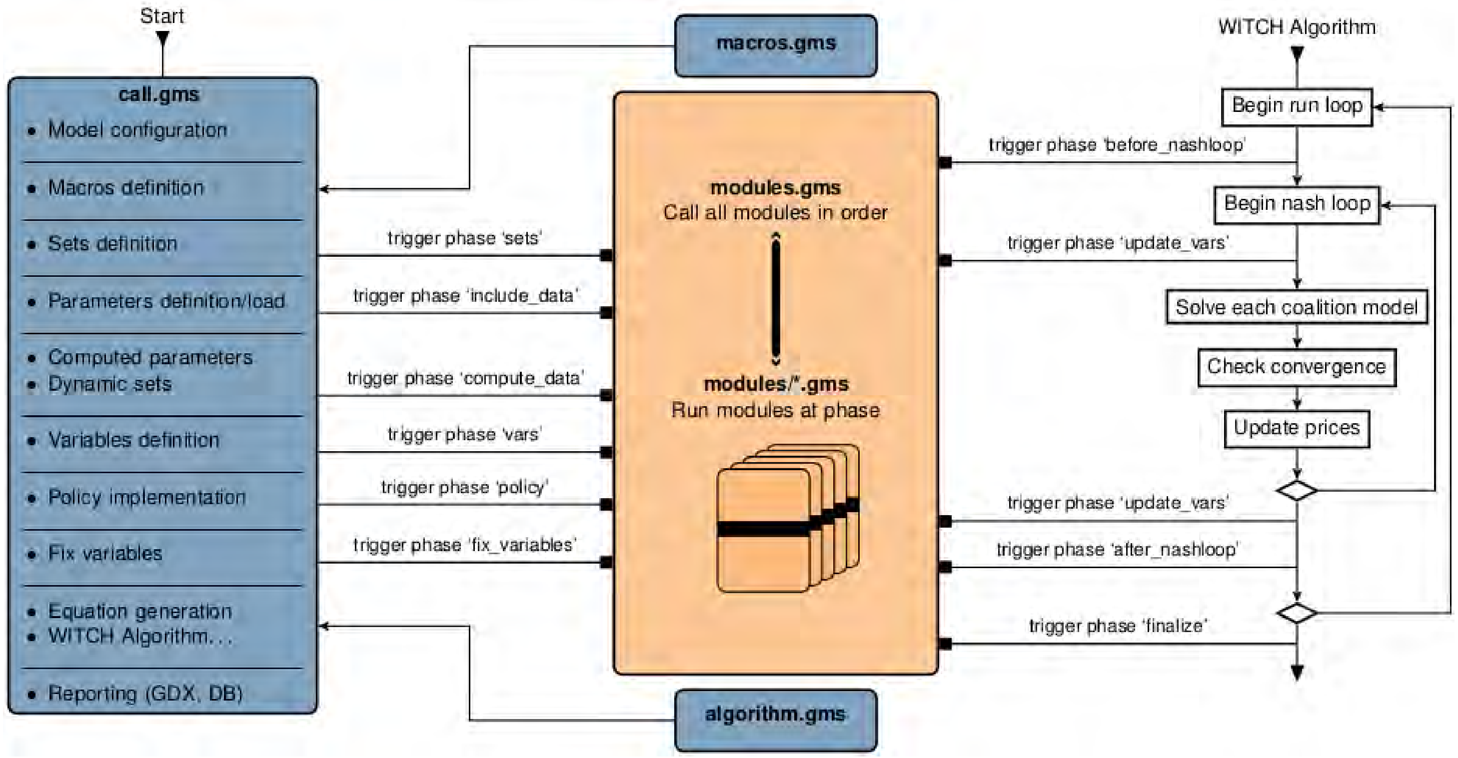
- Version Control (Github etc.)!
  - Get to know commit, push, revert, checkout, branch, fork etc.
- Reproducible input data routine
  - Load raw or API data, reproducible aggregation manipulation etc.
- Modular code structure (by topic / feature / sector etc.)
  - See next slide for an example
- Quick and easy output evaluation / plotting

# IAMs open source status

1. DICE: https://williamnordhaus.com/dicerice-models
2. GreenDICE: https://github.com/BerBastien/GreenDICE
3. GCAM: https://github.com/JGCRI/gcam-core
4. ReMIND: https://github.com/remindmodel/remind
5. MESSAGEix: https://github.com/iiasa/message_ix
6. WITCH: https://github.com/witch-team/witchmodel
7. RICE50x: https://github.com/witch-team/RICE50xmodel

# Modular structure: the example of WITCH

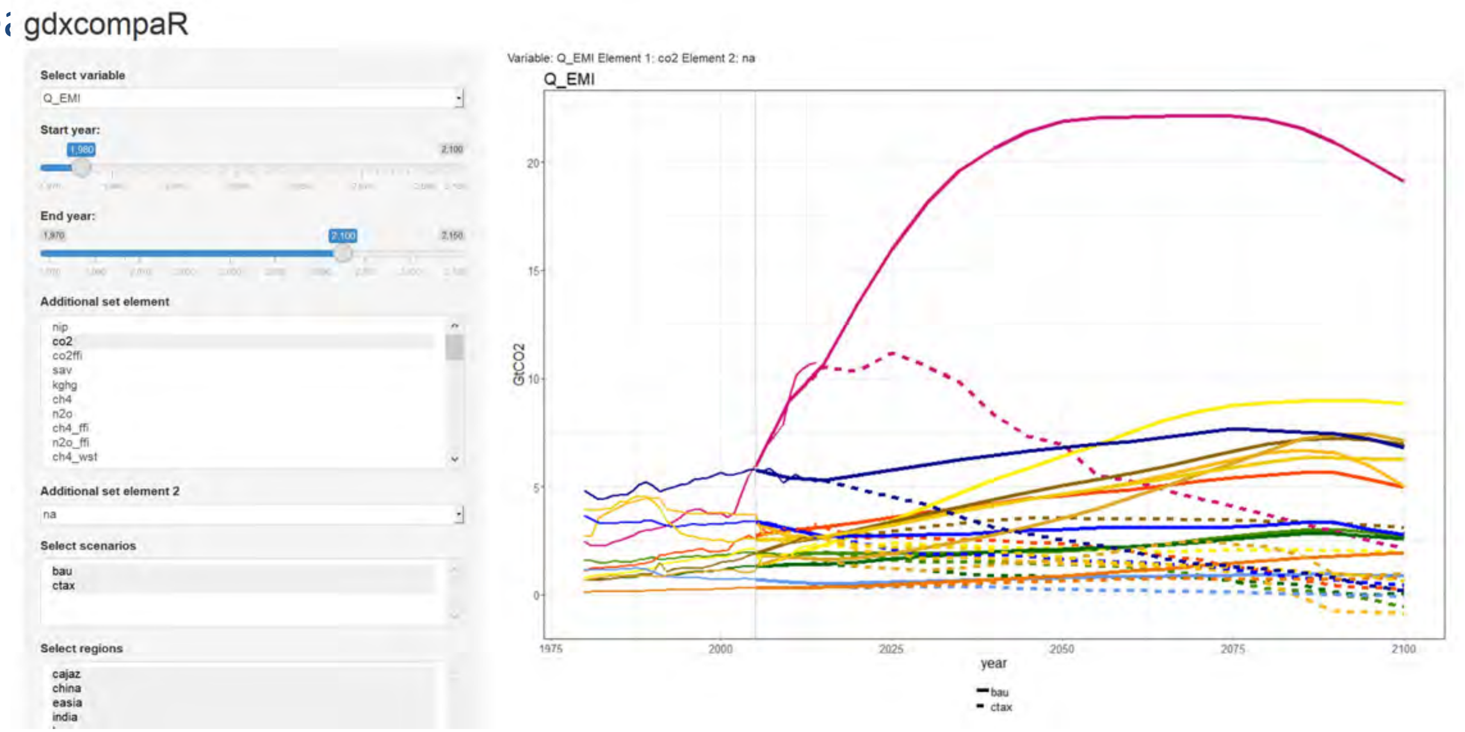
- Algorithmic flow chart and module structure
  - **modules**: contain code relating to one technology or option or topic
  - **phases**: sequential structure in which the model is run (runs through each module in each phase)




- Others: Mimi.jl framework (https://www.mimiframework.org/)

# WITCH – Practical steps

- Postprocessing and Figures
  - Find your own way that works best for you
    - Easy and Fast: GAMS IDE or Excel
    - General and more complex: Python (Matplotlib) or R (tidyverse, ggplot2) or Matlab
    - Fast and general: witch-plot repository on GitHub with many predefined functions and gdxcompa



# Results and Sharing (e.g., IPCC databases)

- IAMC data format

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | **Model** | **Scenario** | **Region** | **Variable** | **Unit** | **2005** | **2010** | **2015** |
| 2 | MESSAGE | CD-LINKS 400 | World | Primary Energy | EJ/y | 462.5 | 500.7 | ... |

- See Python packages pyam, openentrance and others
  - https://pyam-iamc.readthedocs.io/en/stable/

- IPCC databases: new and alternative models still required and invited to contribute, validation and vetting, etc. AR7....

# Conclusions

*Happy to discuss!*

*(And I am most certainly out of time)*

*johannes.emmerling@eiee.org*

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NAVIGATE

# *Thanks*

RFF CMCC
European Institute on Economics and the Environment