Background

Model	Total Regions	European Regions	Economic Theory	Open Source
REMIND	21*	8 EU regions	Energy-economy general equilibrium (Ramsey-type growth model coupled with an energy system model); cost optimisation solution	Yes (with dependency on GAMS)

MESSAGE	11	2 european regions (including both EU and non-EU countries) +1 region for Former Soviet Union	5-module modelling framework with an energy system basis, and a general equilibrium approach; optimisation solution	Yes (with dependency on GAMS)
IMAGE	26	2 european regions (including both EU and non-EU countries) + 1 region for Ukraine + 1 region for Russia	Partial Equilibrium; Simulation solution	No
WITCH	13	2 EU regions + 1 non-EU region	Inter-temporal optimal growth model; general equilibrium; optimisation solution	Yes (with dependency on GAMS)
POLES	66	27 regions for all 27 EU countries + Individual regions for Norway, Switzerland, Iceland, Turkey, Russia, Ukraine	Global sectoral simulation model	No
COFFEE	18	2 european regions (including both EU and non-EU countries) + 1 region for Russia	Linear programming optimization model	No
AIM	17	1 EU + 1 Rest of Europe + 1 Turkey + 1 region for Former Soviet Union	Computable general equilibrium	No

GCAM	32	2 EU regions + 1 EFTA + 1 Ukraine + 1 non-EU Europe	Partial Equilibrium recursive dynamic	Yes**
TIAM*	36	2 european regions (including both EU and non-EU countries) +1 Former Soviet Union	Partial Equilibrium welfare cost-optimization	The TIMES source code is open; dependecies on GAMS and the VEDA software for input/output handling
GEM-E3	46	27 regions for all 27 EU countries + 1 region for Rest of Europe, + Individual regions for the UK, Turkey, Russia	Recursive dynamic computable general equilibrium	No (ongoing efforts to open the source code); reliance on GTAP
EPPA	18	1 region for EU-27 including Croatia, Norway, Switzerland, Iceland and Liechtenstein (capabilities for 13 regions in the EU)	Computable general equilibrium	No
C-ROADS	Aggregations at 3, 6, and & 7 regions	1 region for the EU	System dynamics simulation	No (available only as an online simulator)
MERGE-ETL	10	1 region for EU29+ + 1 region for Russia	General Equilibrium; Intertemportal optimisation	No

Table S1: Overview of major IAM models

*REMIND features configurable spatial resolution; the 21-region setting (including 8 EU regions) corresponds to recent applications of version 3.3.1 (Schreyer et al. 2025).

Table S1 highlights a gap in terms of fully open-source models (including the execution environment) with a high regional disaggregation at the EU-level, including representing all EU member states separately. Although GCAM-Europe aims to fill this gap, it should be noted that country-level formulations are not necessarily always

the preferred option. IAMs may deliberately adopt a sub-regional EU aggregation to balance regional detail with global model scope for policy assessment, especially in the light of potential computational limitations. In this context, GCAM-Europe should be seen not as a substitute for existing aggregated EU representations, but as an additional tool of the climate-economy modelling community that enables Member State–level analysis within a globally consistent framework, while remaining computationally tractable for policy applications.

Additional results

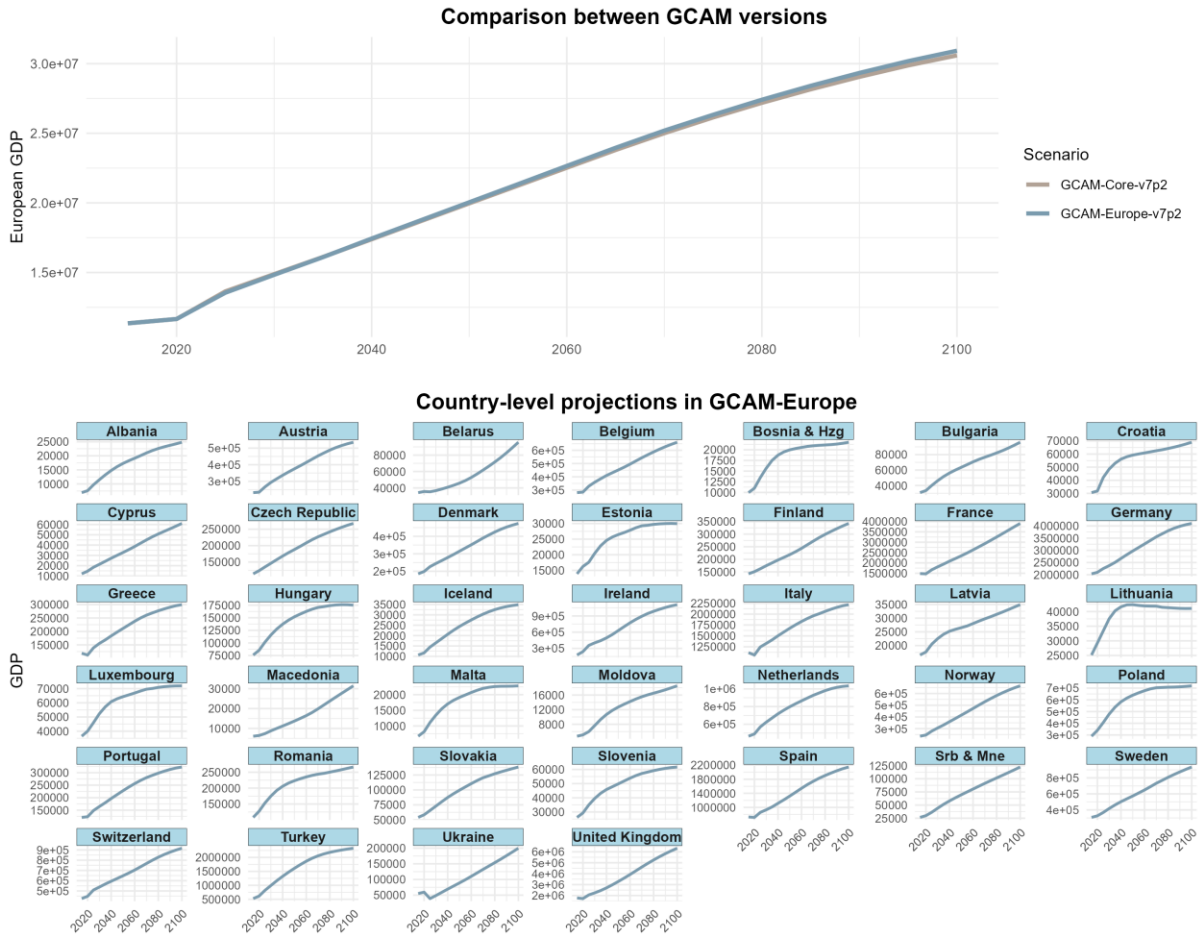

Figure S1: GDP by period, region, and scenario (Million$1990). Panel A compares GDP projections between the GCAM-Europe and the core baseline scenarios. Panel B shows population projections by European country in the GCAM-Europe baseline.

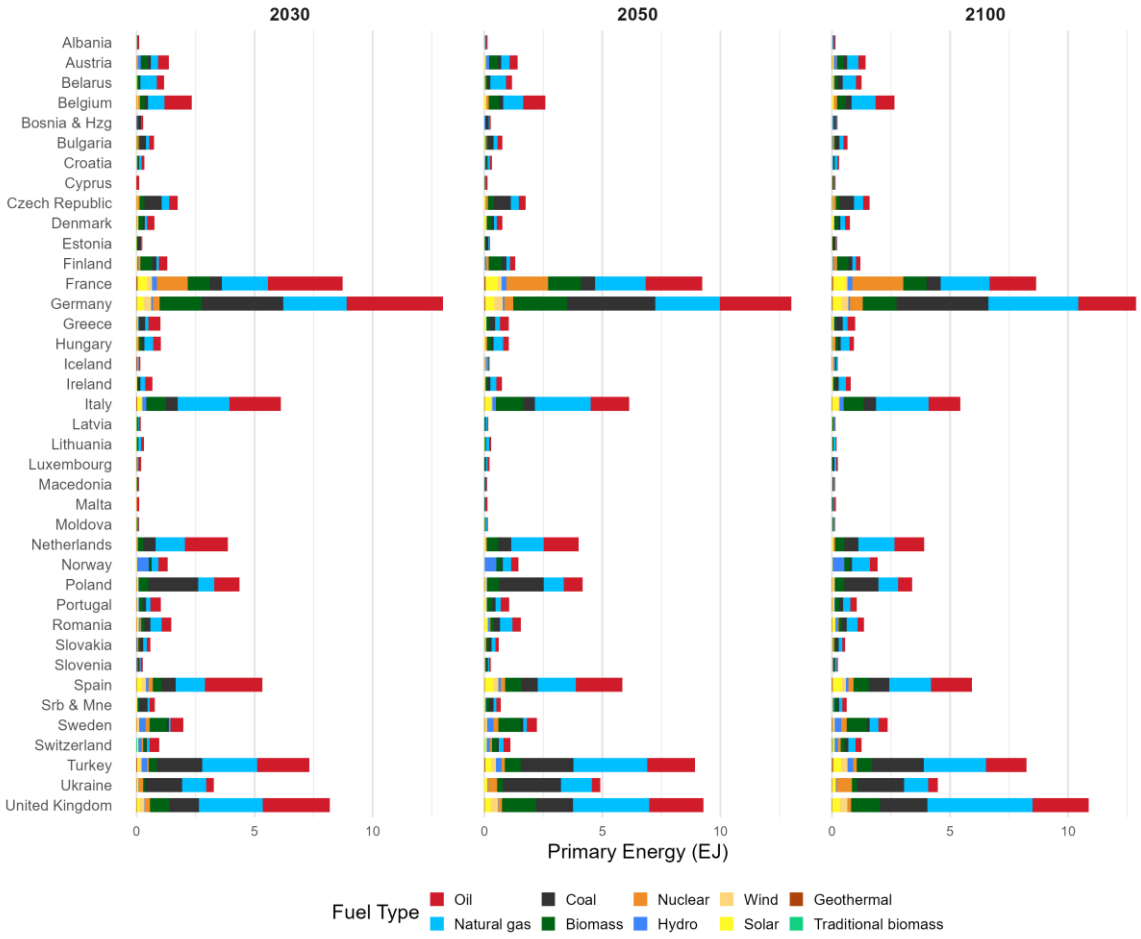

Figure S2: Total primary energy by period, fuel and country (EJ) in the GCAM-Europe baseline scenario.

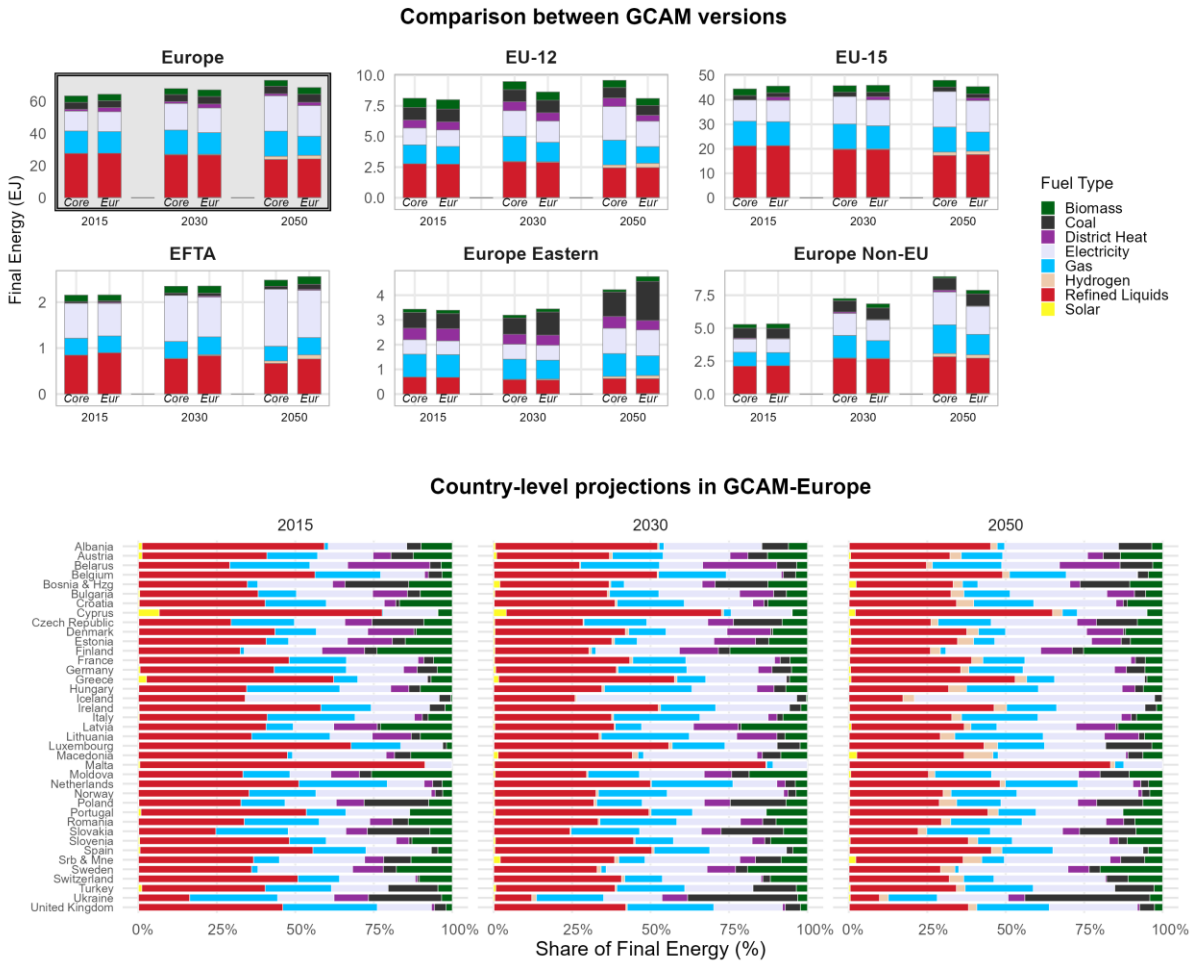

Figure S3: Total final energy in 2050 by fuel, region, period, and scenario. The top panel shows total final energy for the European continent (EJ). The bottom panel shows the share of different fuels in each country's final energy mix in the GCAM-Europe baseline scenario (%).

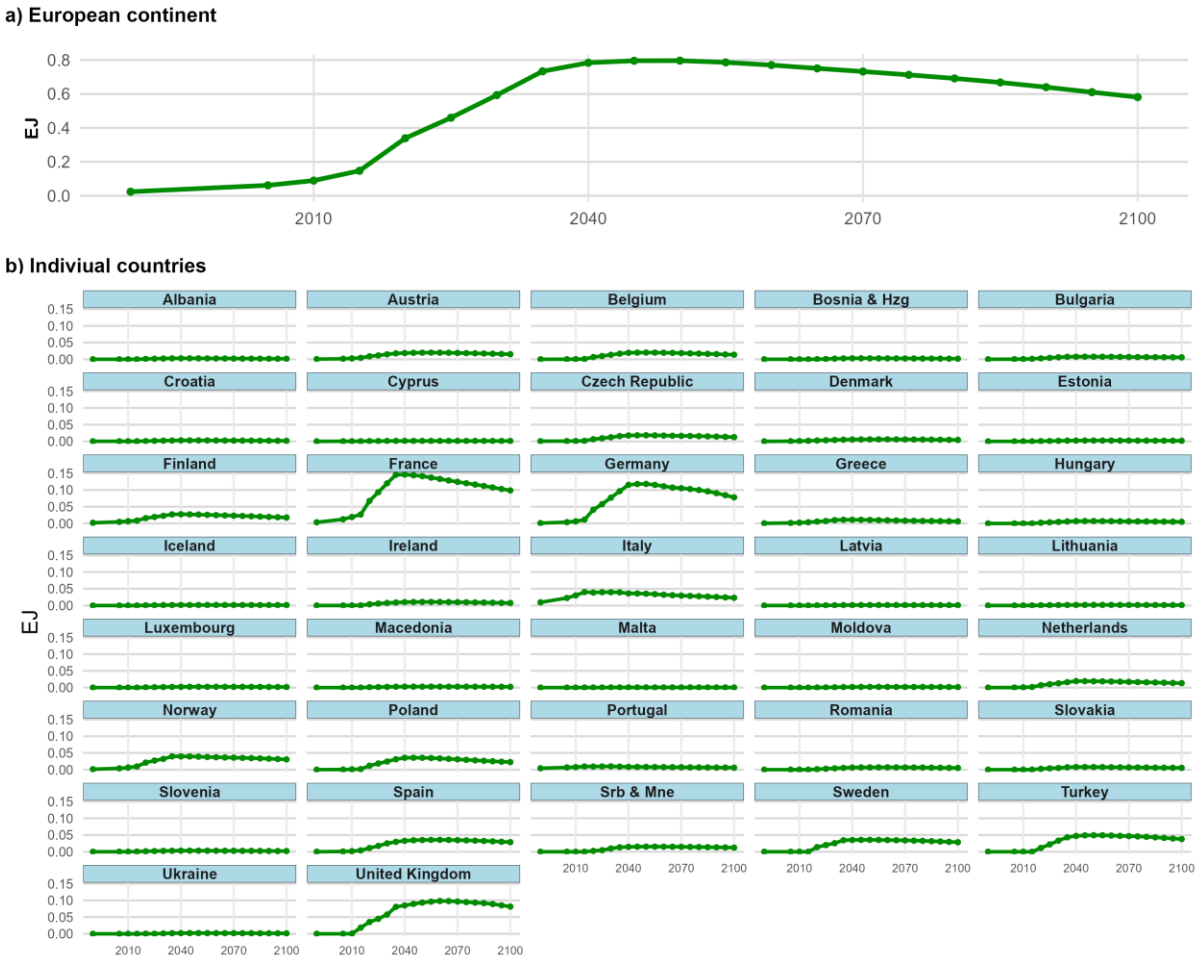

Figure S4: Adoption of heat pump technologies by region and period in the GCAM-Europe baseline scenario (EJ).

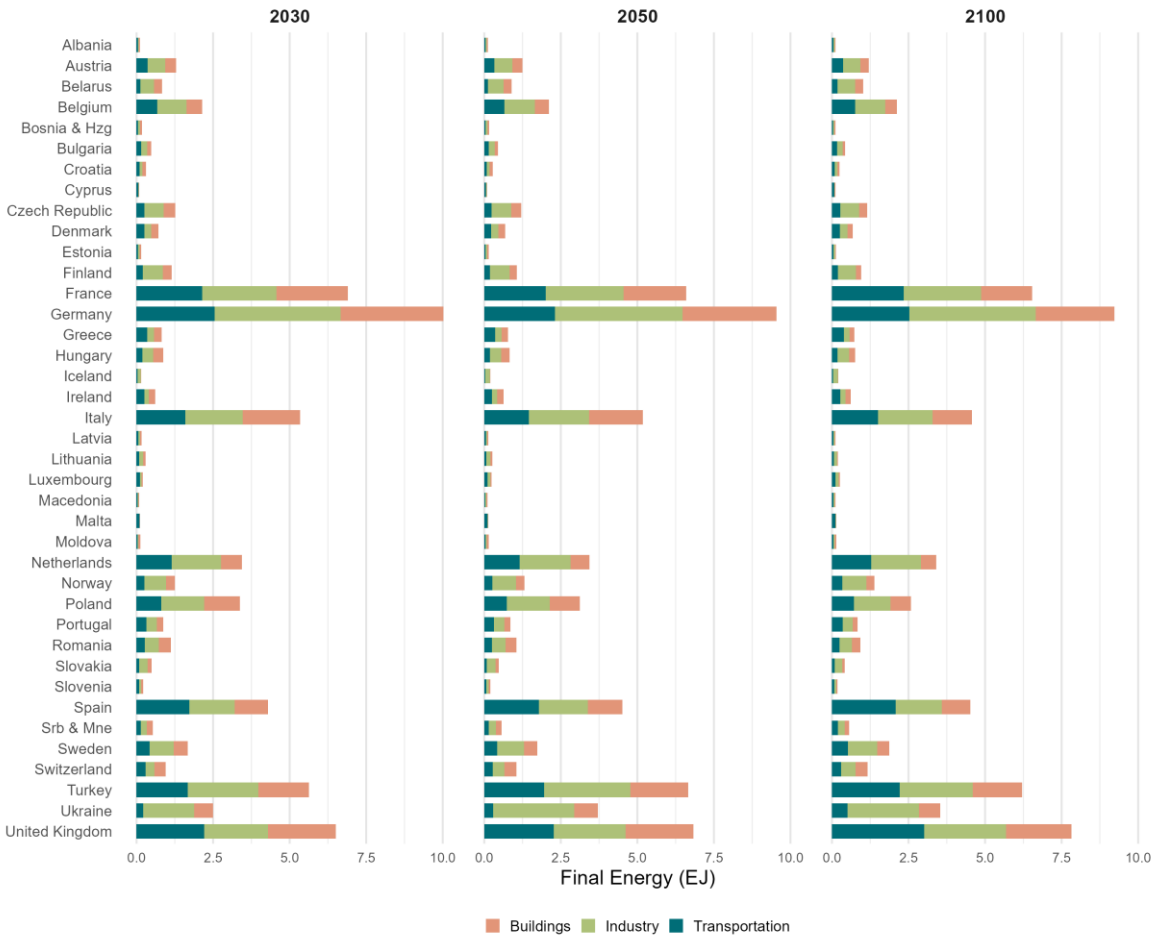

Figure S5: Total final energy by period, fuel and country in the GCAM-Europe baseline scenario (EJ).

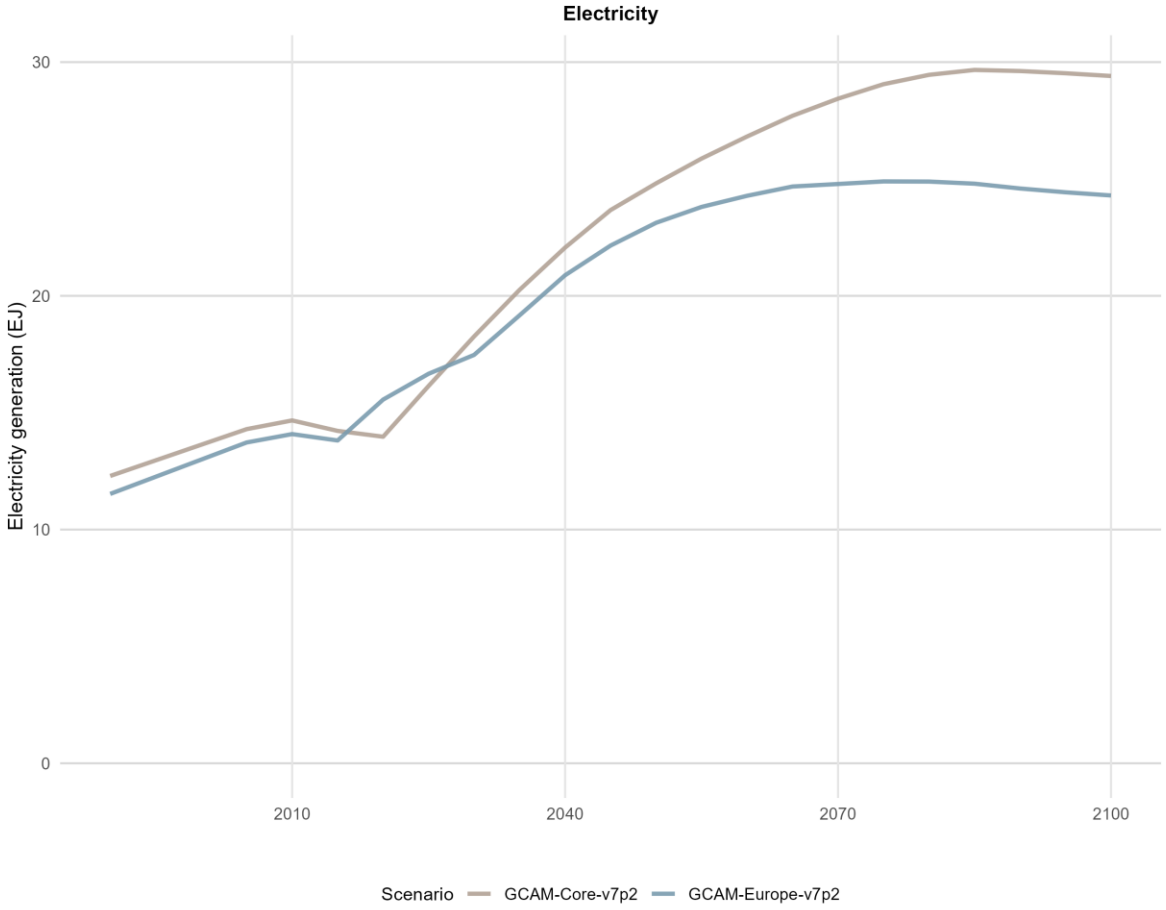

Figure S6: Electricity generation in Europe by period and scenario (EJ).

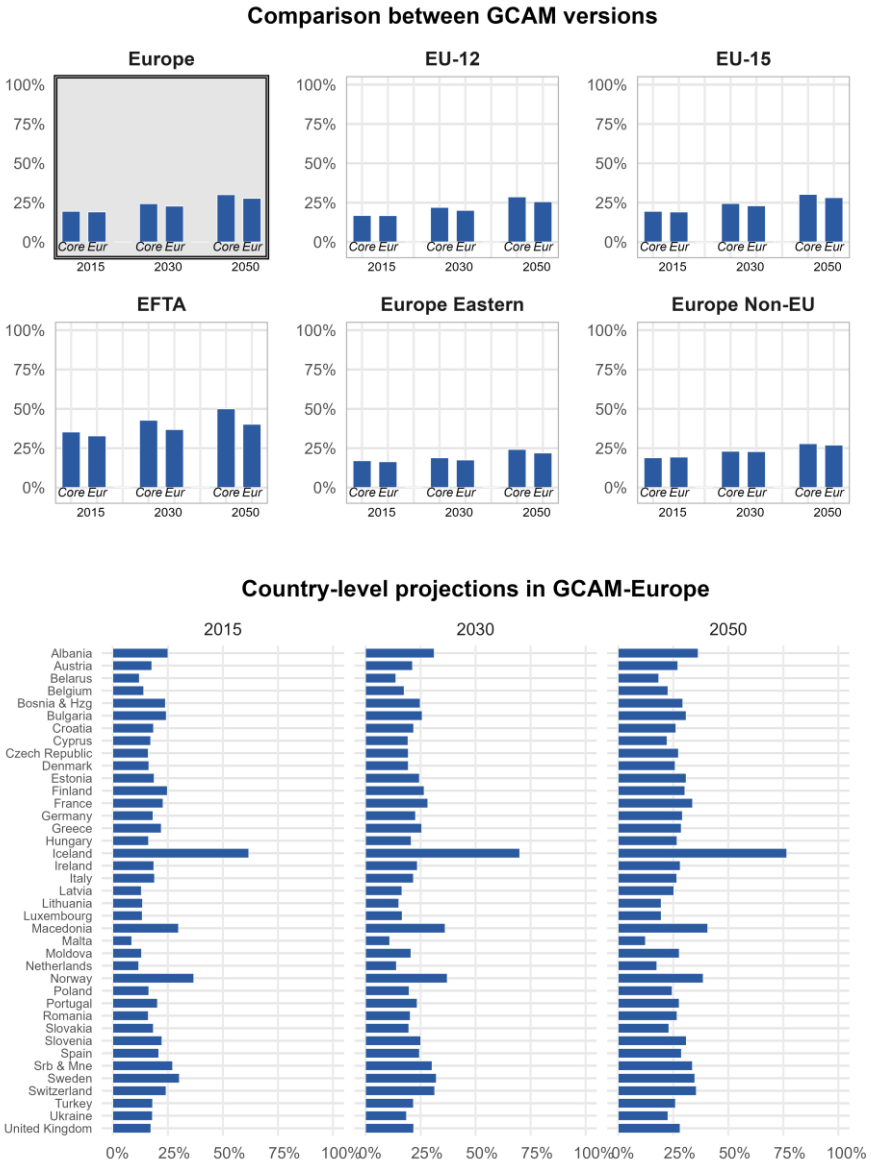

Figure S7: Share of electricity in total final energy by scenario, region, and period. The top panel shows shares for the European continent and the five core European regions (%). The bottom panel shows the share of electricity in each country's final energy demand in the GCAM-Europe baseline scenario (%).

Figure S8: Share of electricity in total final energy by scenario, region, period and sector (%).

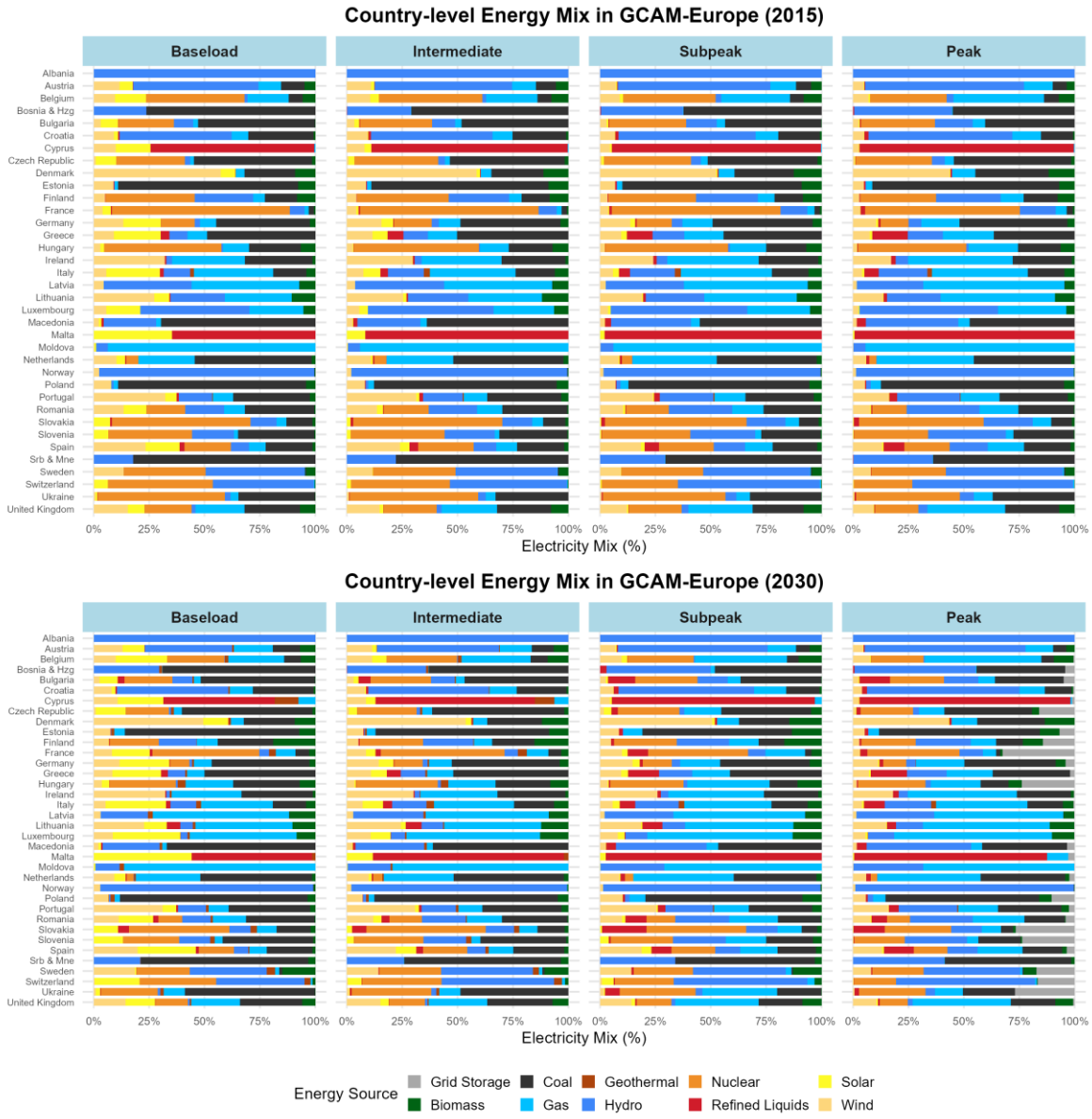

Figure S9: weight of different sources in each country's final electricity mix (%) in the GCAM-Europe baseline in 2015 (top) and 2030 (bottom).

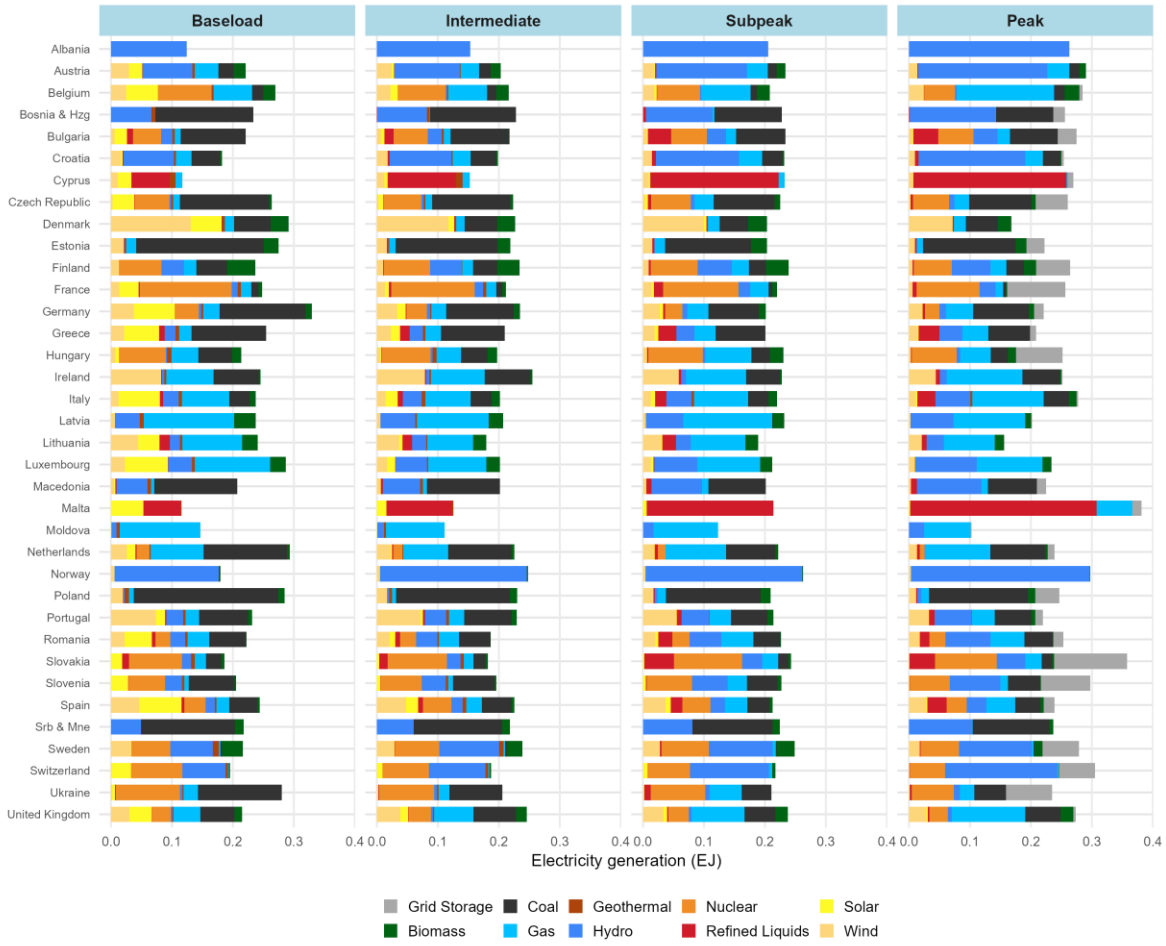

Figure S10: Electricity generation in 2050 by period, fuel, segment and country (EJ) in the GCAM-Europe baseline scenario.

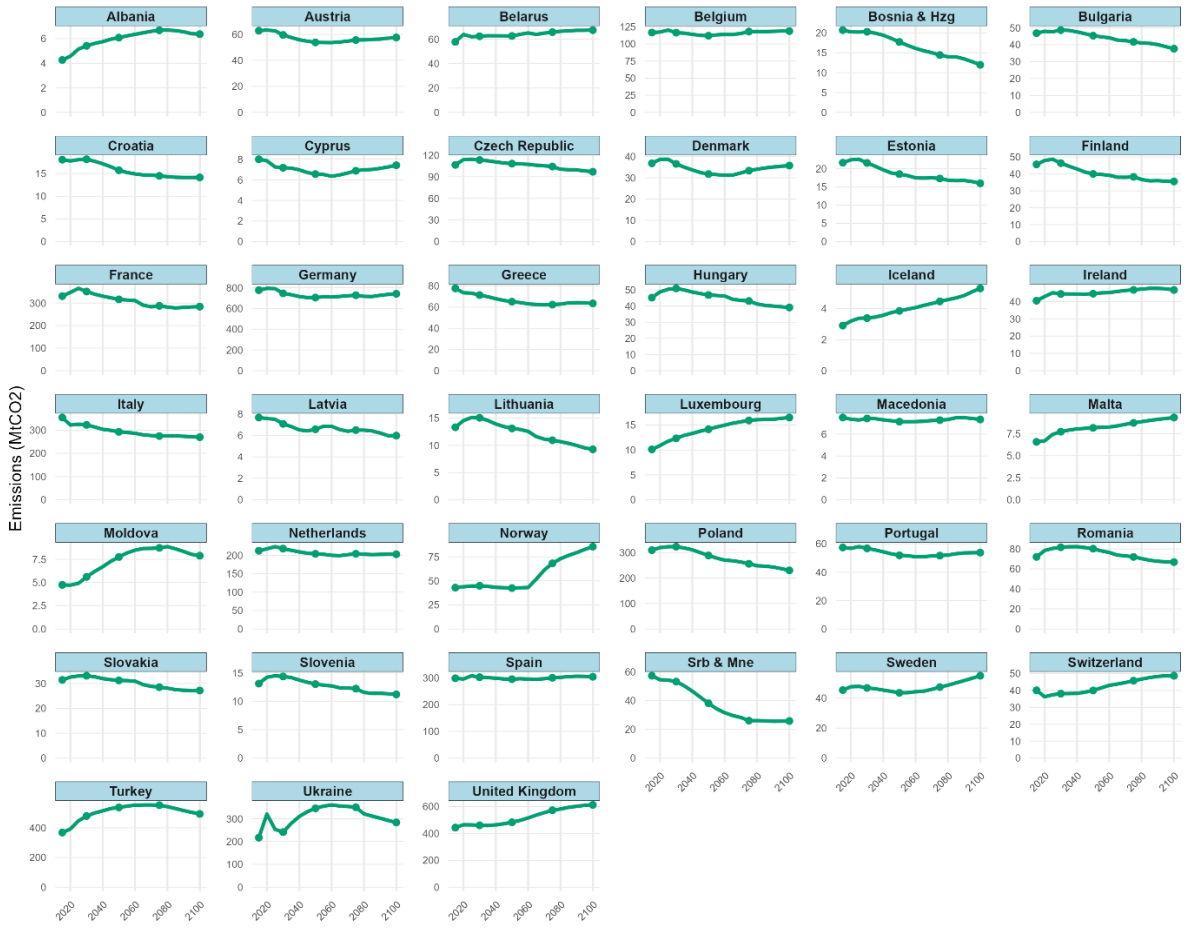

Figure S11: CO2 emissions by country and period in the GCAM-Europe baseline scenario (MTCO2)

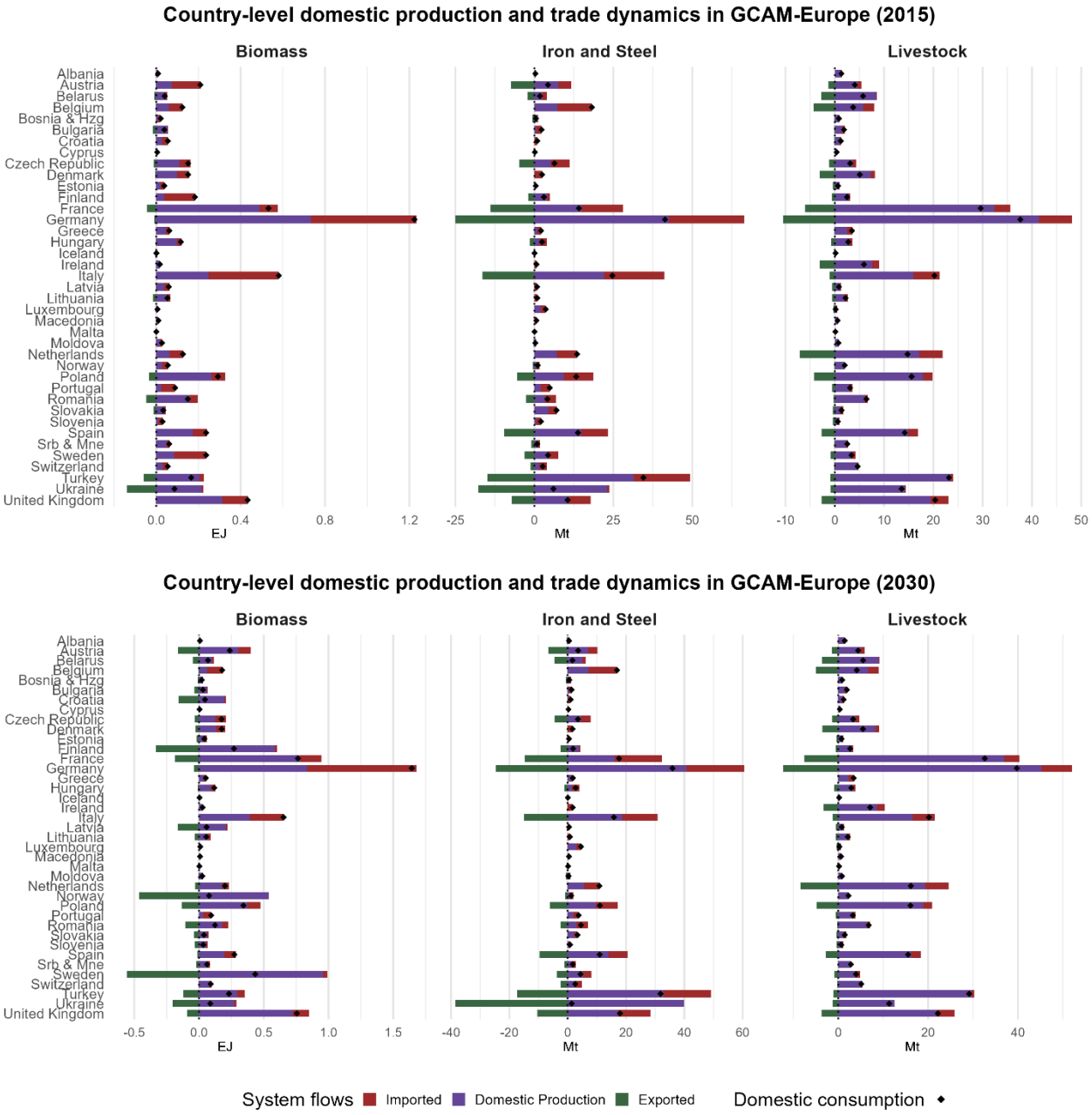

Figure S12: Trade dynamics by country and commodity for 2050 in the GCAM-Europe baseline in 2015 (top) and 2030 (bottom)