Caution: This is work-in-progress

Why do mitigation pathways differ?

The role of scenario assumptions and model features

Richard Green
Joint work with Jim Skea,
Alaa al Khourdajie,
Raphael Slade, Iain Staffell

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Aim of the project

Econometrics of IPCC Scenarios

- Outputs from over 1600 model runs are in the IPCC database of mitigation scenarios
  - Emissions, energy supply and demand
- Many use standardised socio-economic scenarios as inputs
- Can we explore how outputs vary between models and scenarios?

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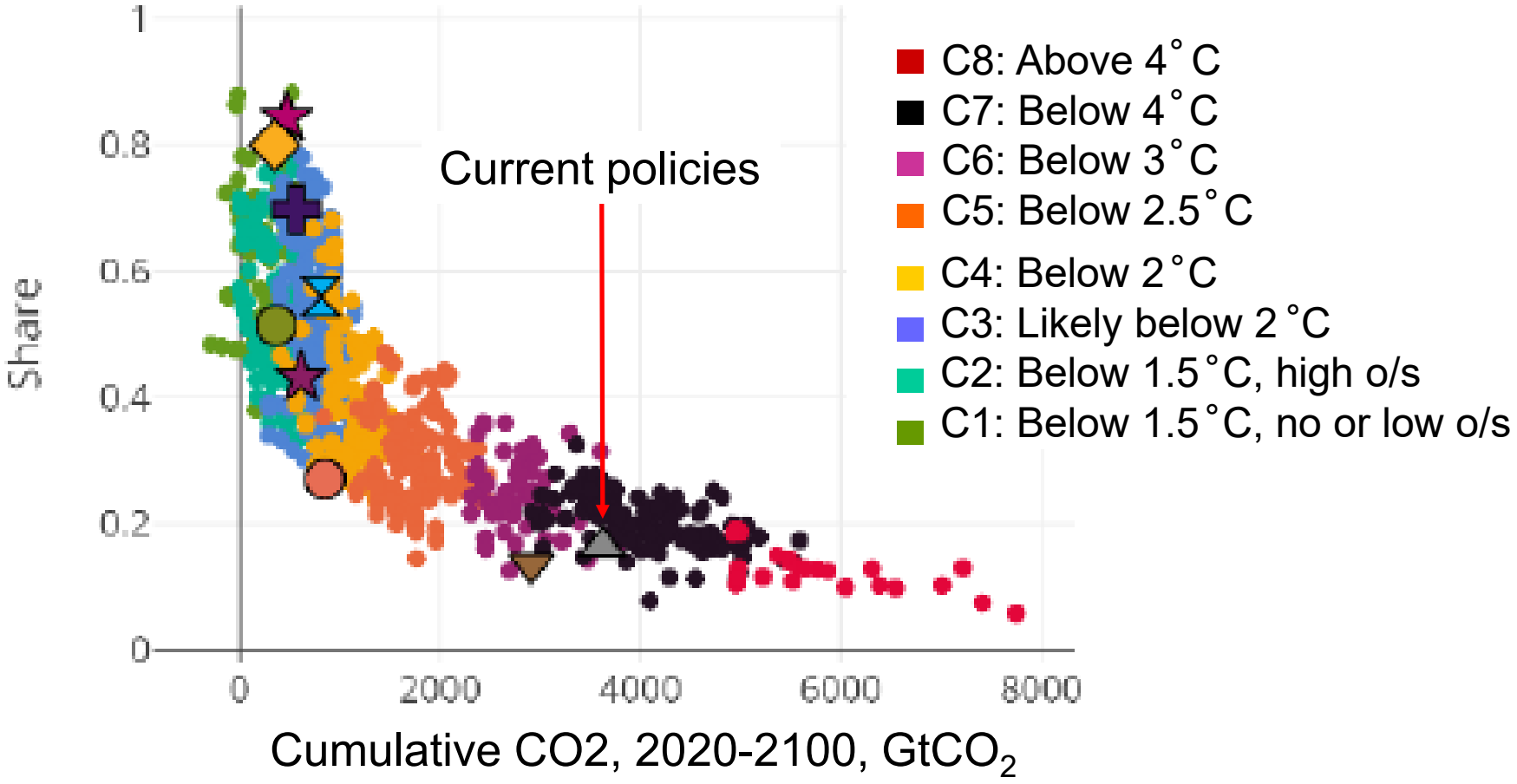
Renewables in 2050

Outputs grouped by climate outcome



IPCC AR6 WGIII Report, Fig 3.15 (part)

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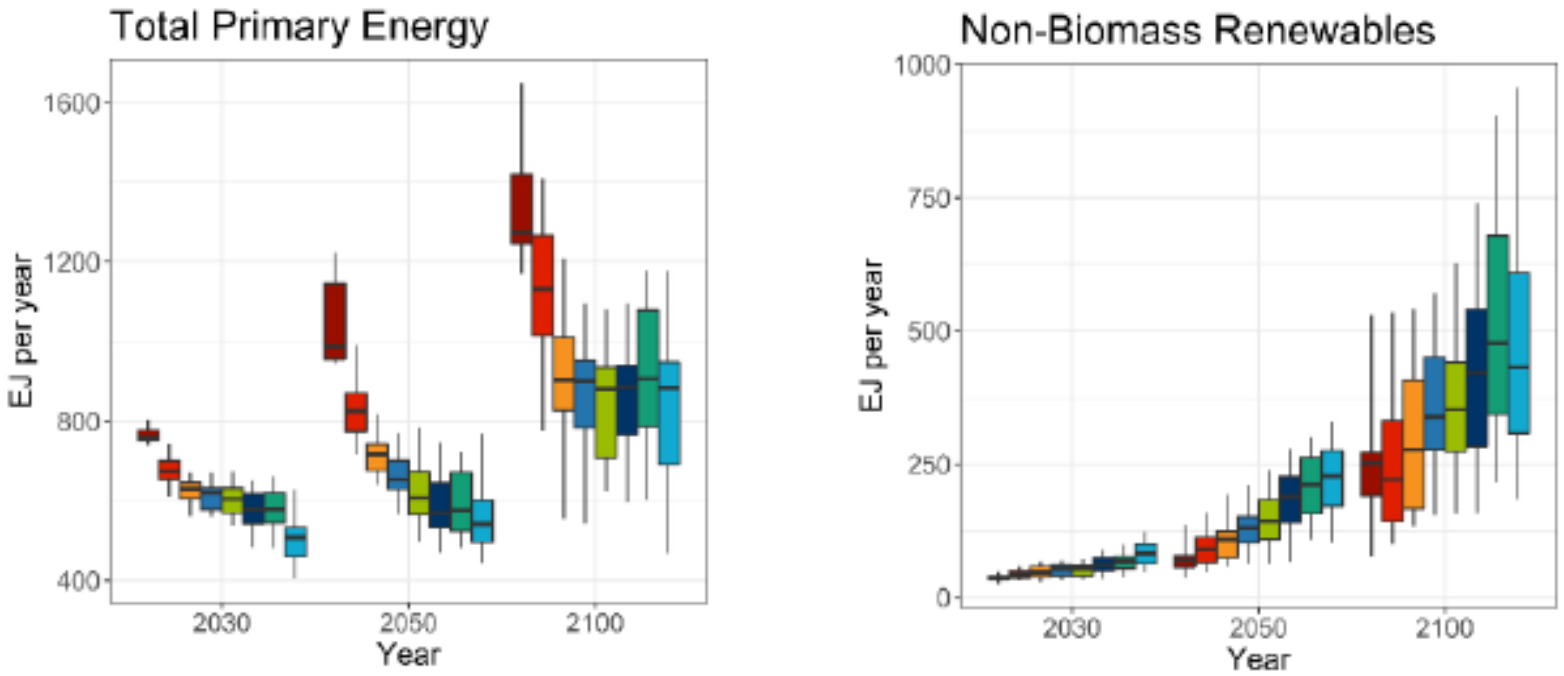
Energy over time

Outputs grouped by climate outcome



- C8: Above 4°C
- C7: Below 4°C
- C6: Below 3°C
- C5: Below 2.5°C
- C4: Below 2°C
- C3: Likely below 2°C
- C2: Below 1.5°C, high overshoot
- C1: Below 1.5°C, no or low o/s

IPCC AR6 WGIII Report, Fig 3.22 (part)

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Models in our study

Key characteristics

	Model type	Electricity Sector	Technical change
AIM-CGE	CGE	Logit	Exogenous
COFFEE	CGE	Merit order	Exogenous (?)
GEM-E3	CGE	Nested	Endogenous
IMAGE	Partial Eq.	Merit order	Endogenous
MESSAGEx	LP Optimisation	Merit order	Exogenous
POLES	Partial Eq.	Merit order	Either
REMIND	CGE	Merit order	Endogenous
TIAM-ECN	Partial Eq.	Merit order	Exogenous
WITCH	Optimal growth	Nested	Endogenous

Speaker's interpretation, mostly of information at
https://www.iamcdocumentation.eu/index.php/IAMC_wiki

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Research methodology

- Use econometrics to study the impact of model choice on key out-turn variables (i.e. predictions)
  - Choice of model
  - Cumulative carbon emissions (*sic.*)
  - Socio-economic scenario
    - GDP per capita
    - Population
- Test for fixed effects vs random effects
- First, do the eye-conometrics!

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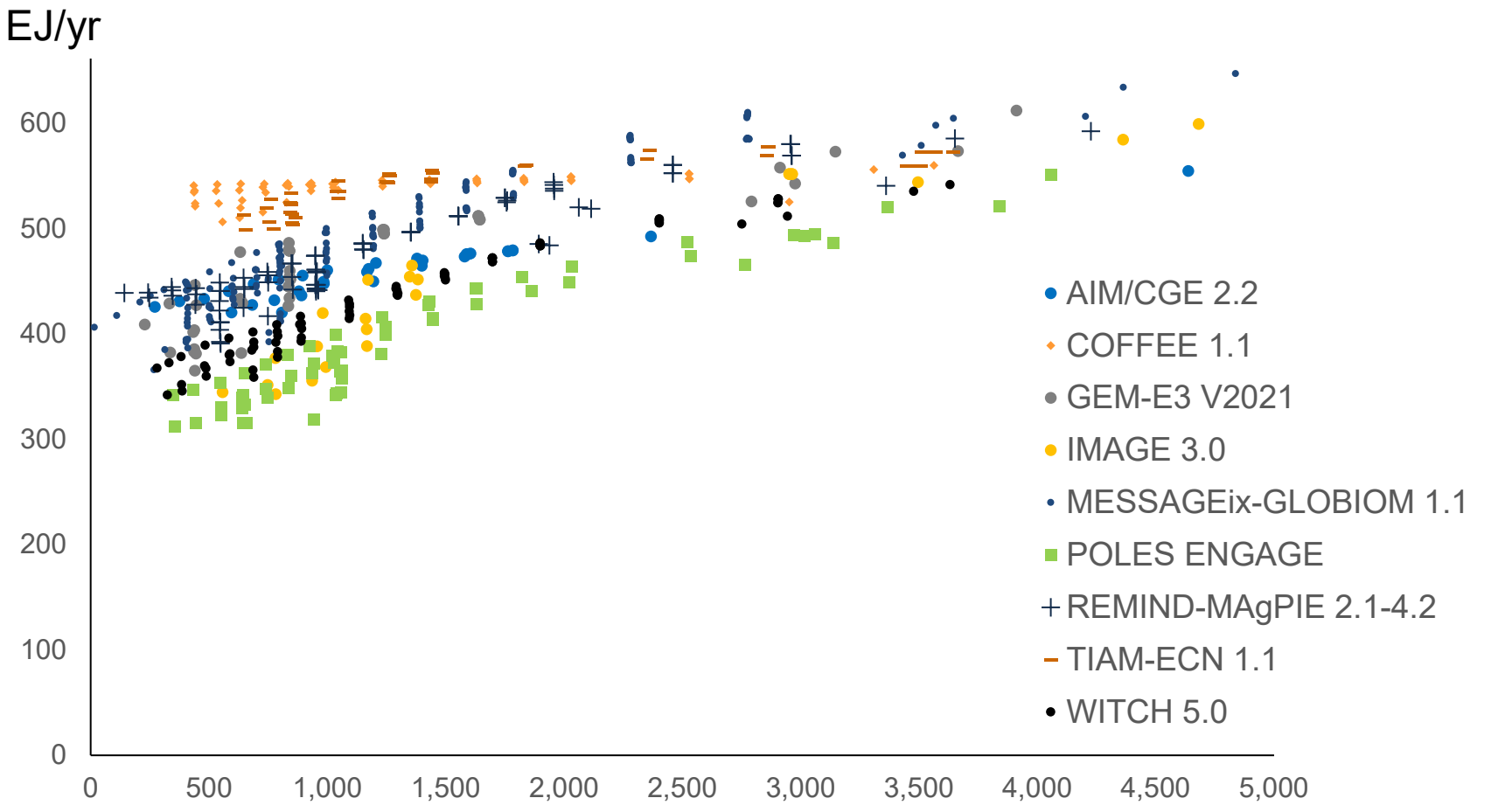
Final Energy Demand in 2050

Outputs grouped by model



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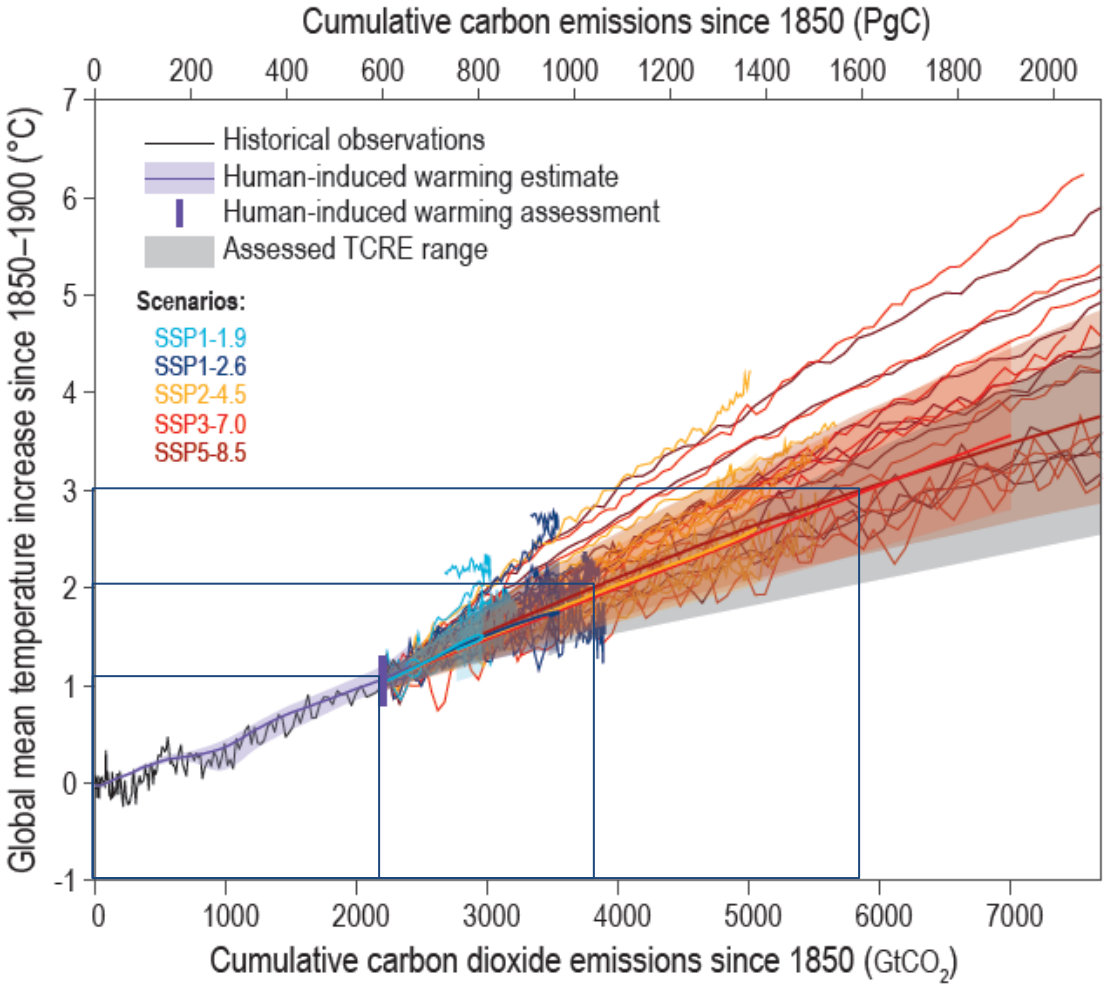
Emissions and temperature

A near-linear relationship



IPCC AR6 WGI Report, Fig TS.18 (a)

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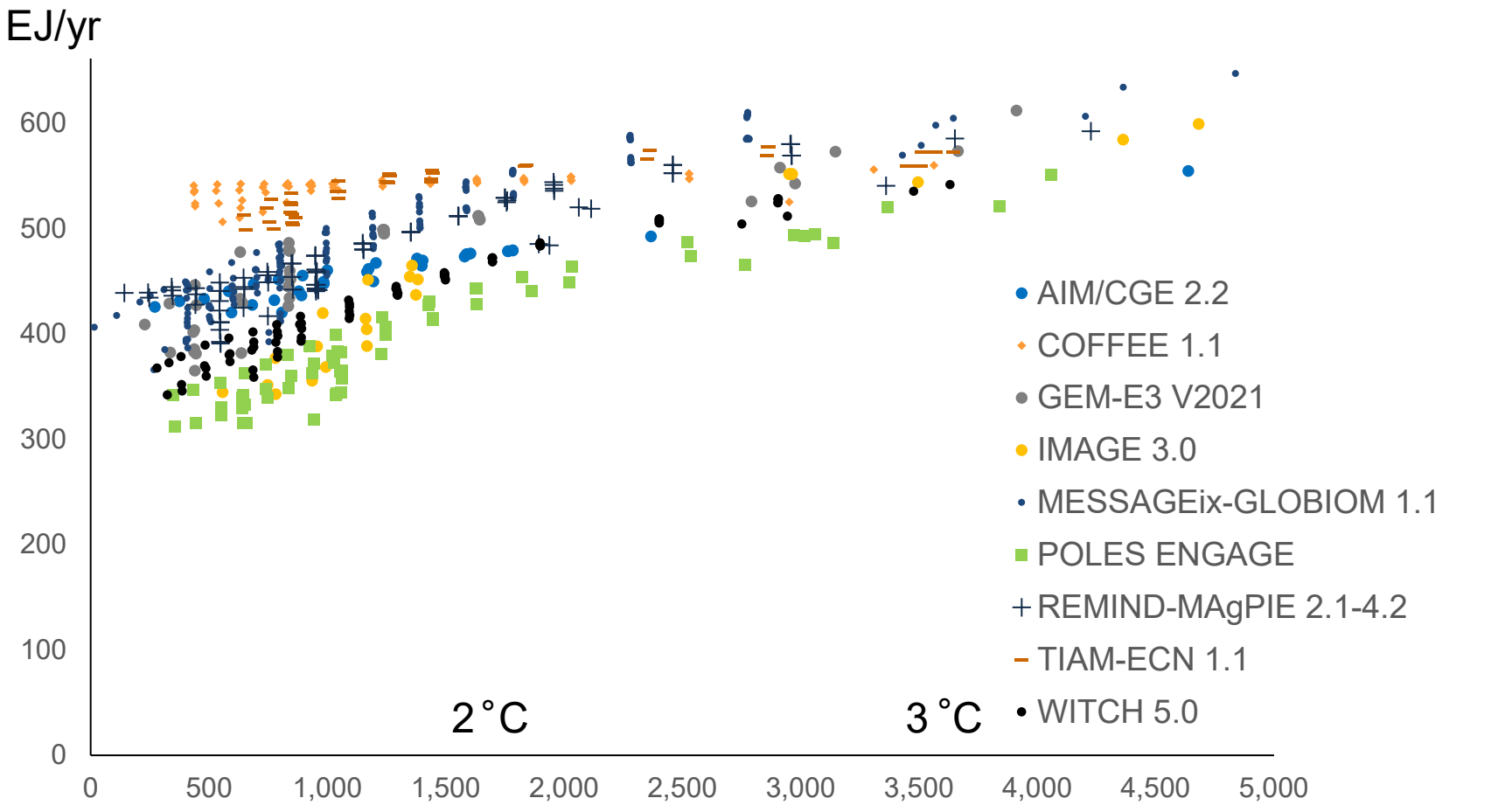
Final Energy Demand in 2050

Outputs grouped by model



Cumulative Emissions, 2020-2100, $GtCO_2$

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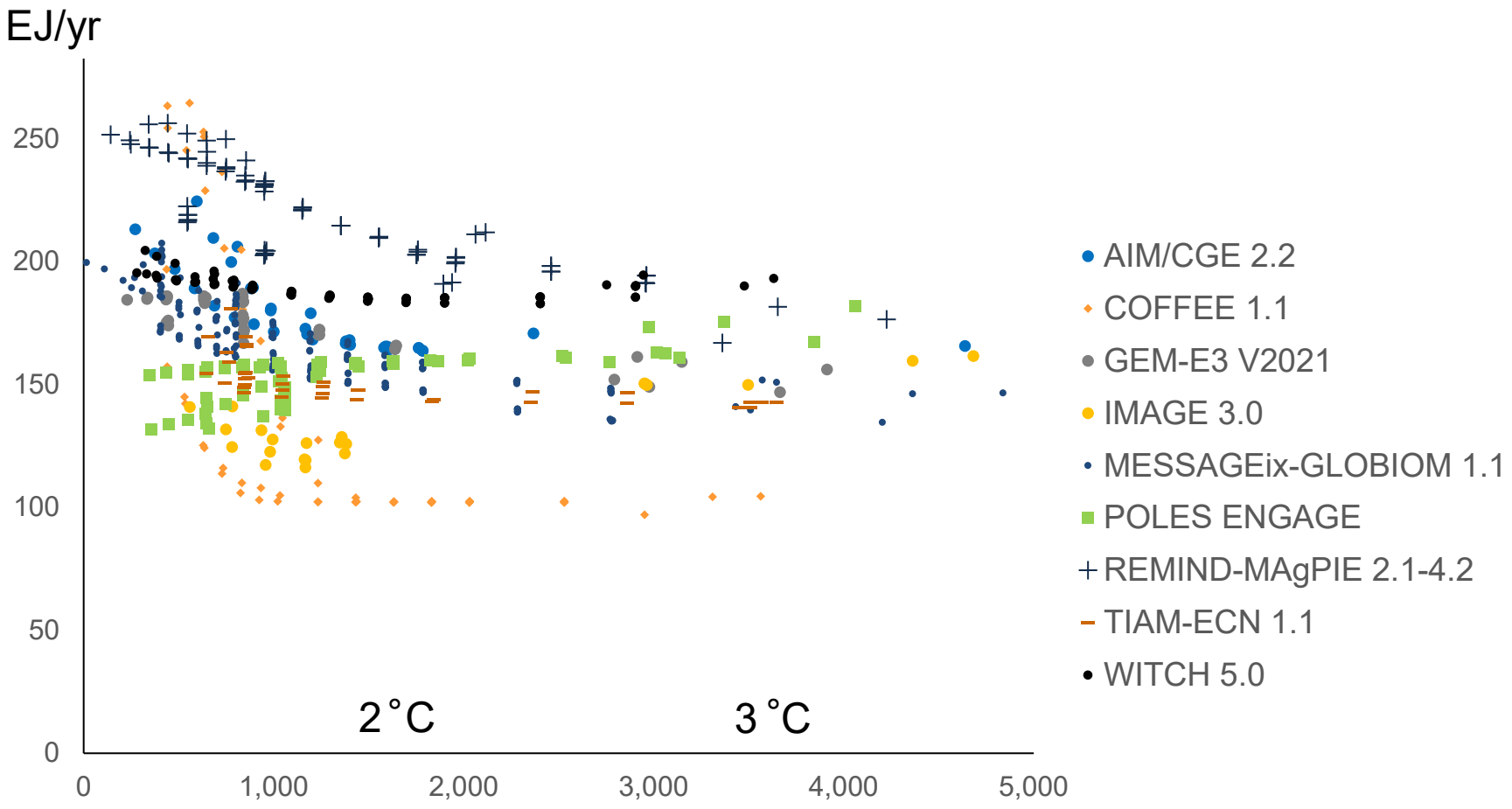
Electricity supply in 2050

Outputs grouped by model



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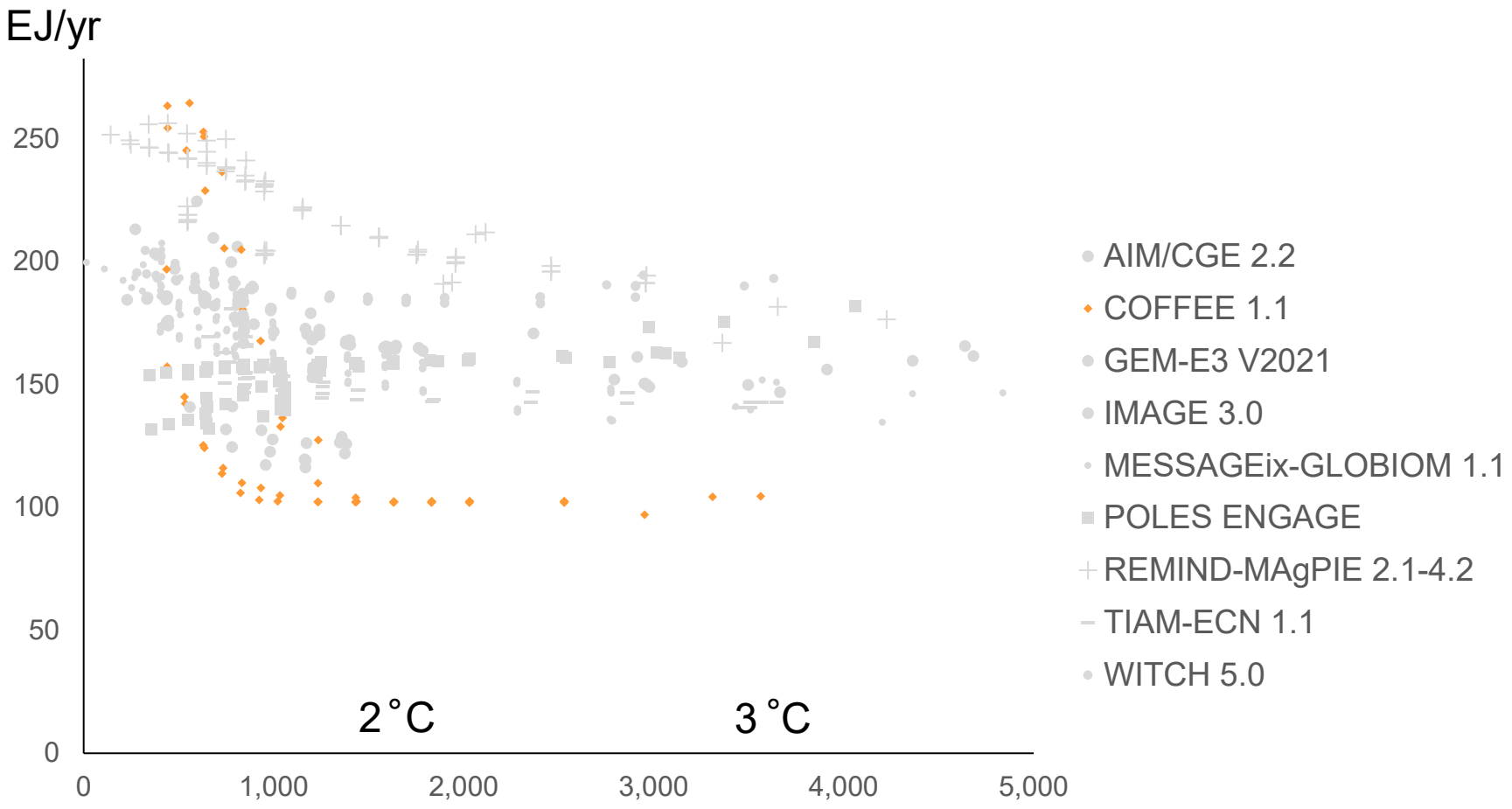
Electricity supply in 2050

Outputs grouped by model



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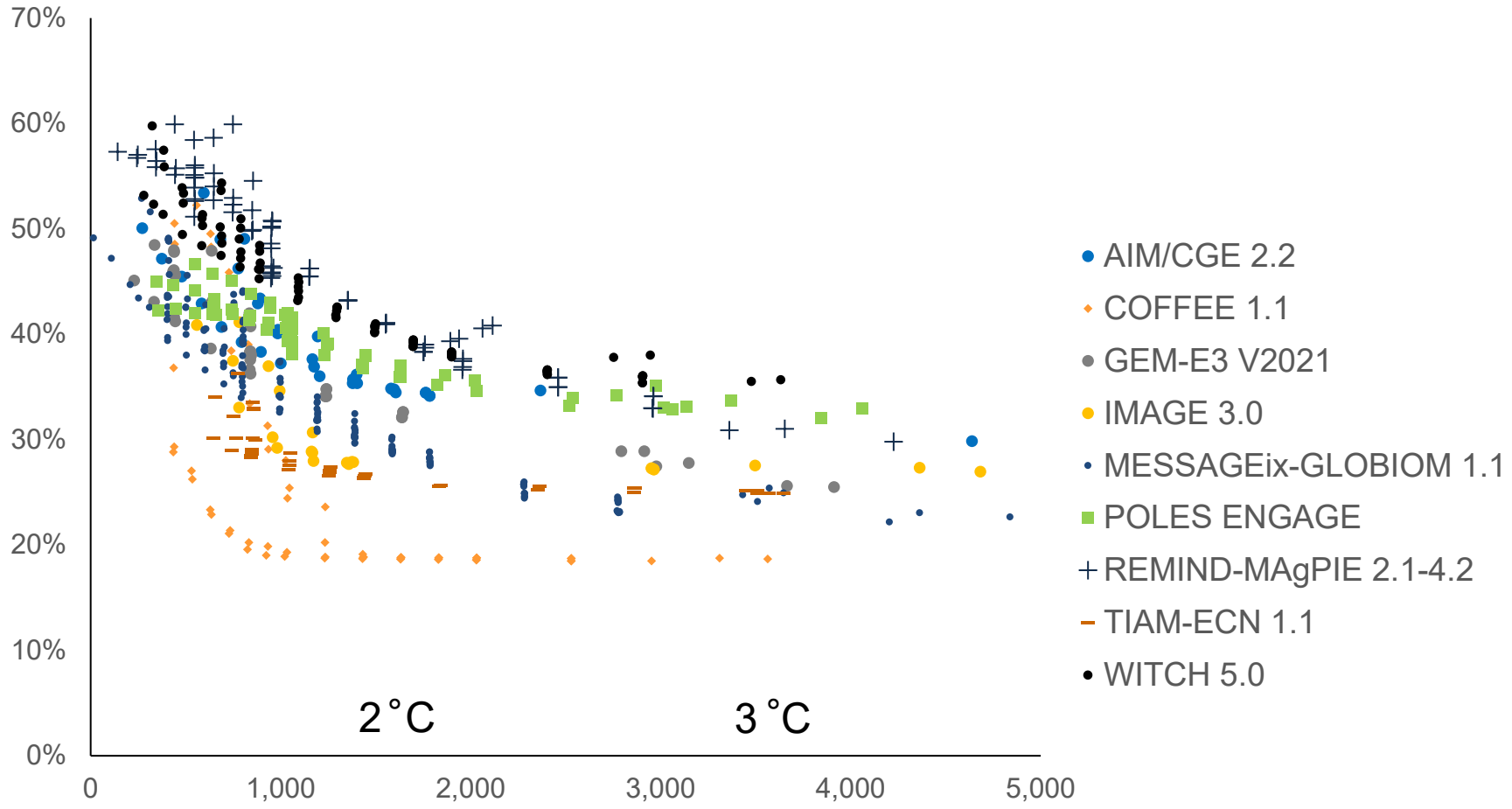
Electricity (% of final demand)

Outputs grouped by model



Cumulative Emissions, 2020-2100, $GtCO_2$

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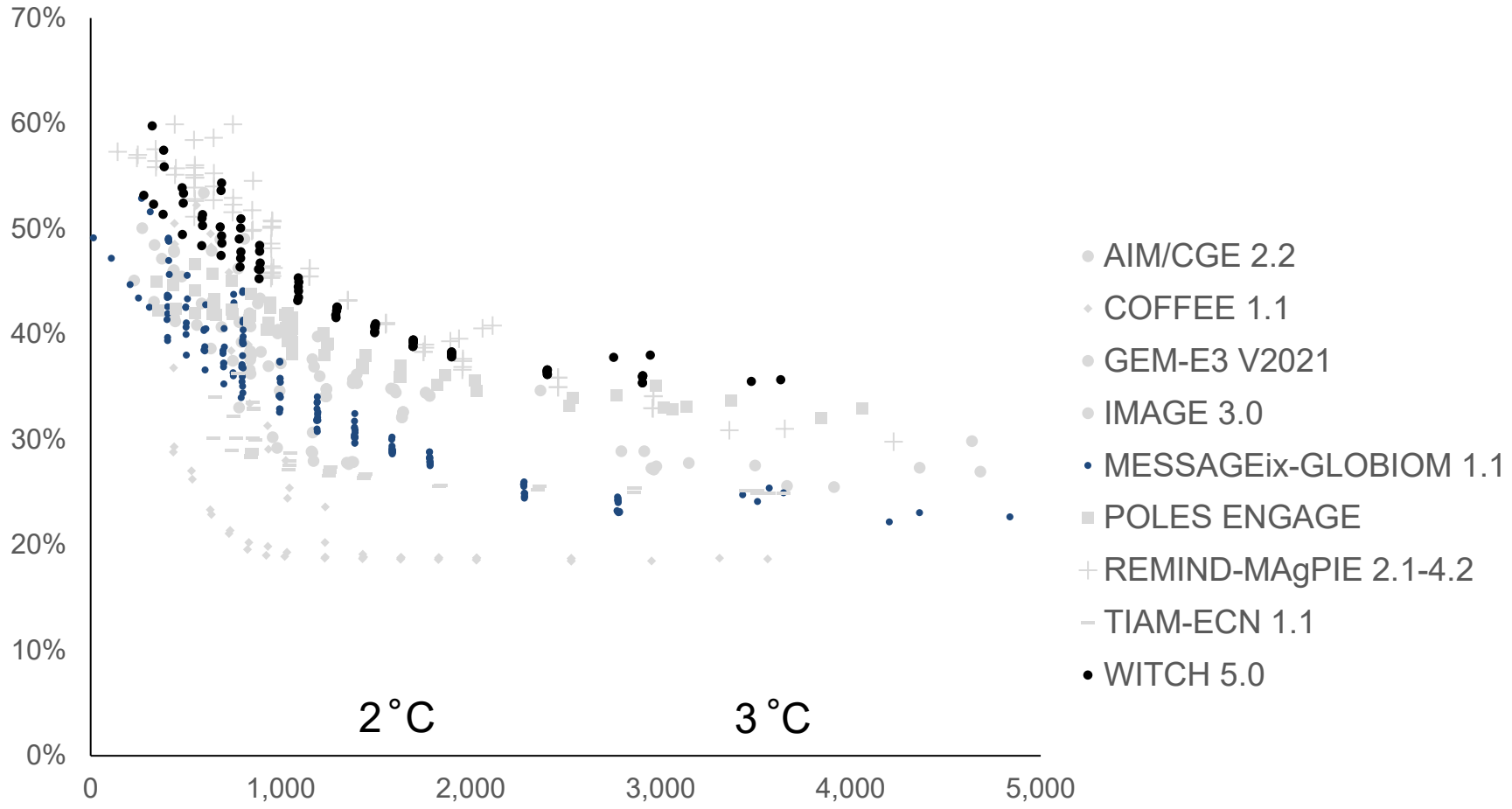
Electricity (% of final demand)

Outputs grouped by model



Cumulative Emissions, 2020-2100, $GtCO_2$

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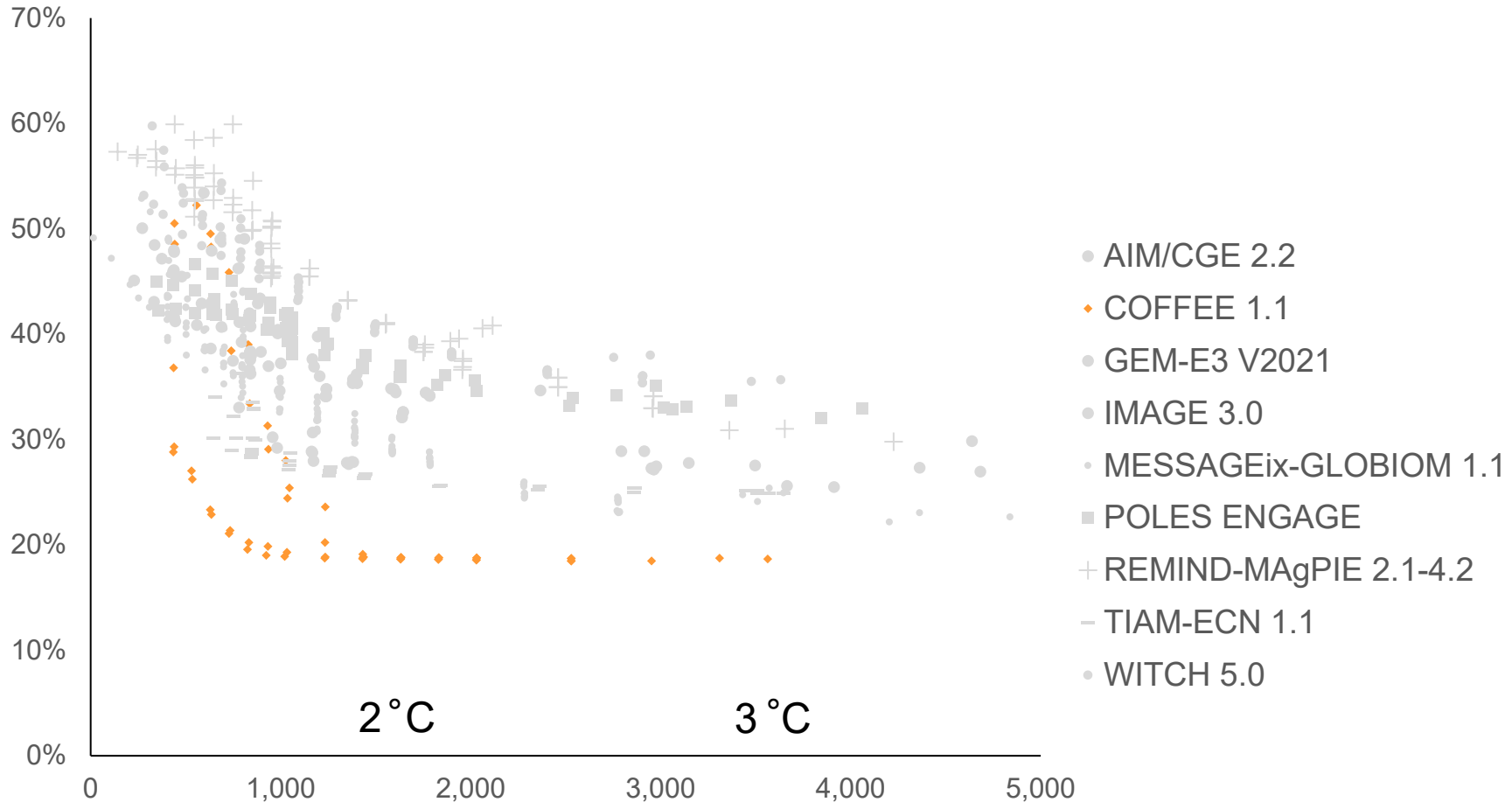
Electricity (% of final demand)

Outputs grouped by model



Cumulative Emissions, 2020-2100, $GtCO_2$

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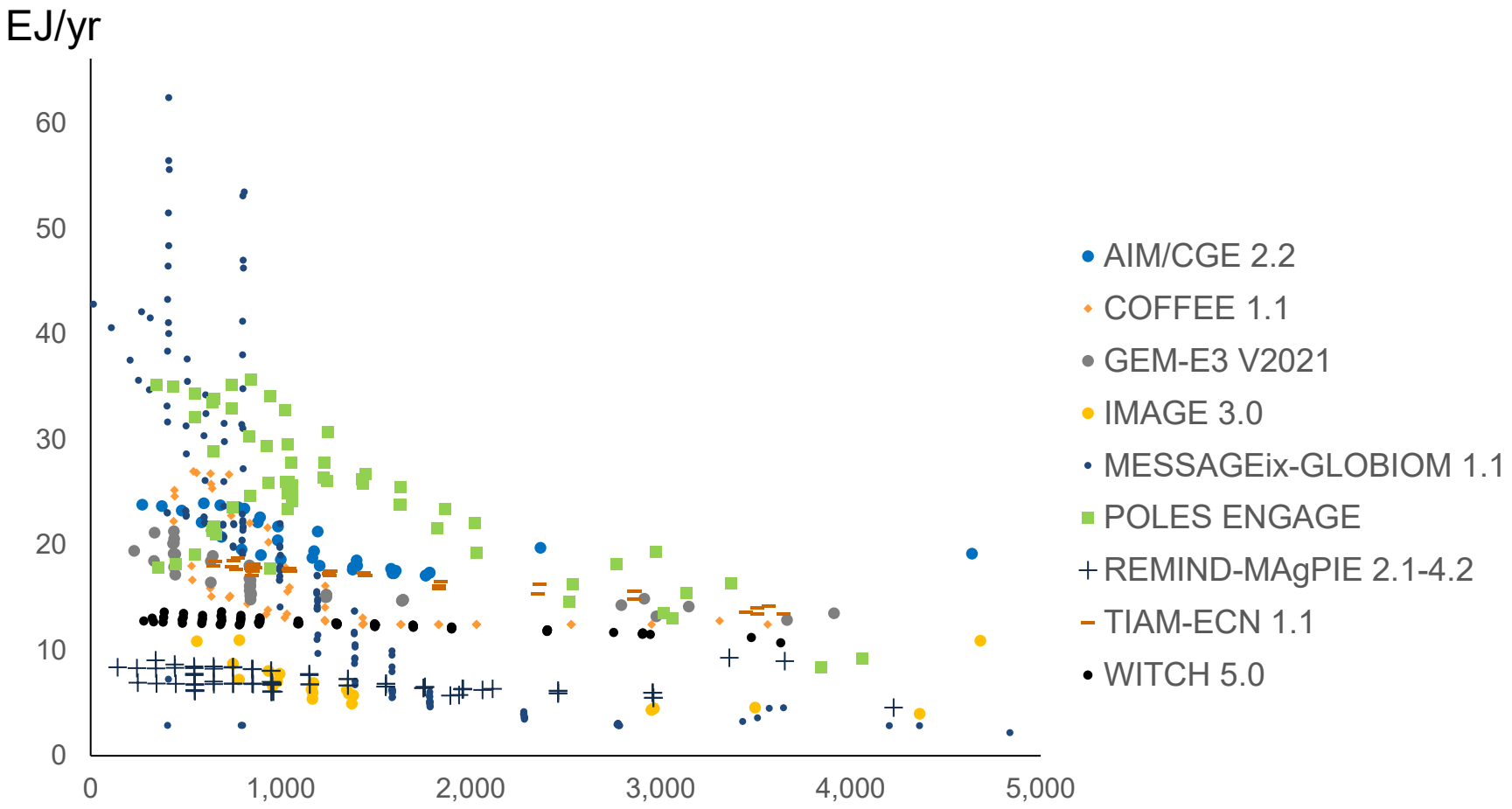
Nuclear generation in 2050

Outputs grouped by model



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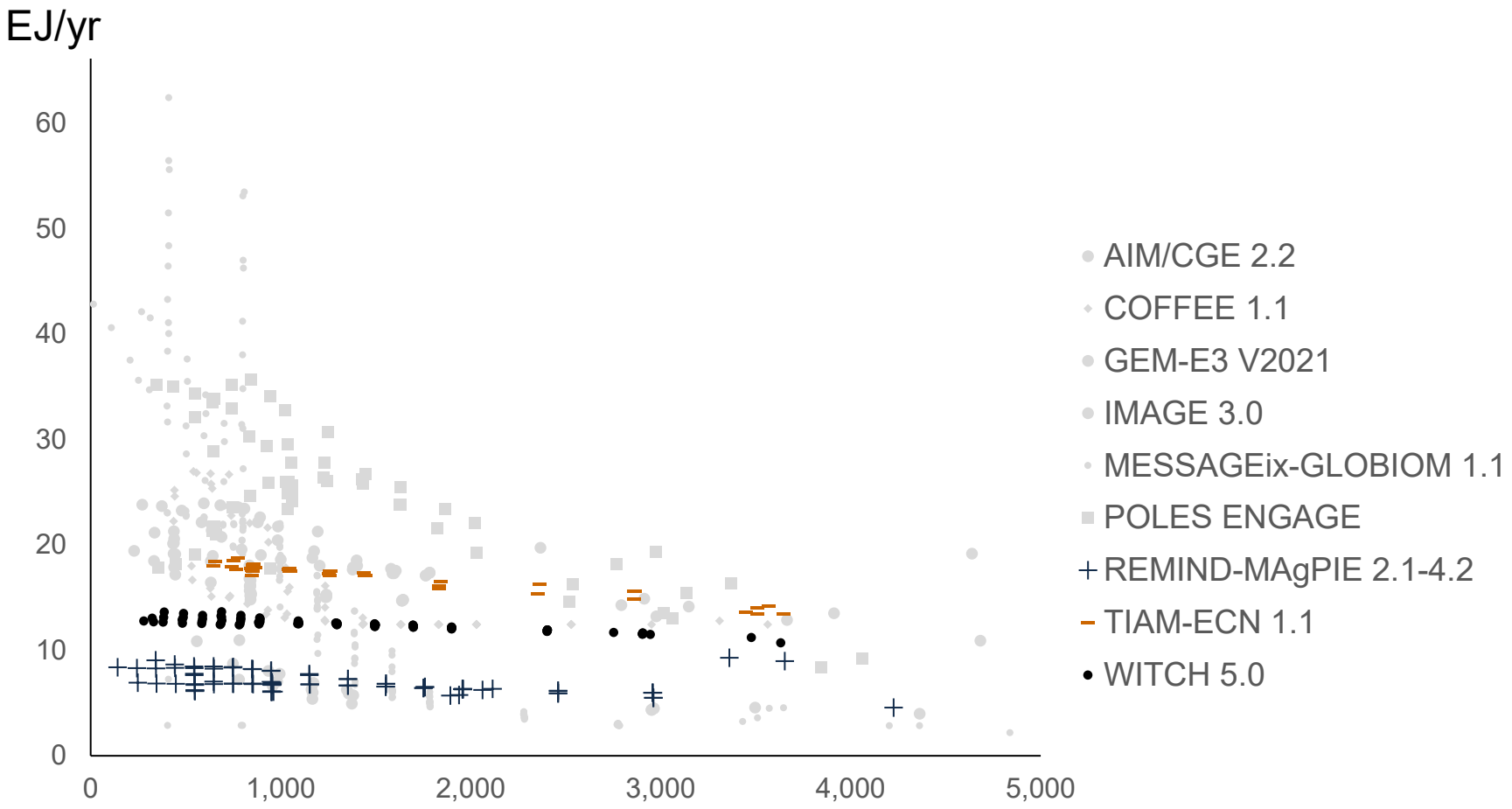
Nuclear generation in 2050

Outputs grouped by model



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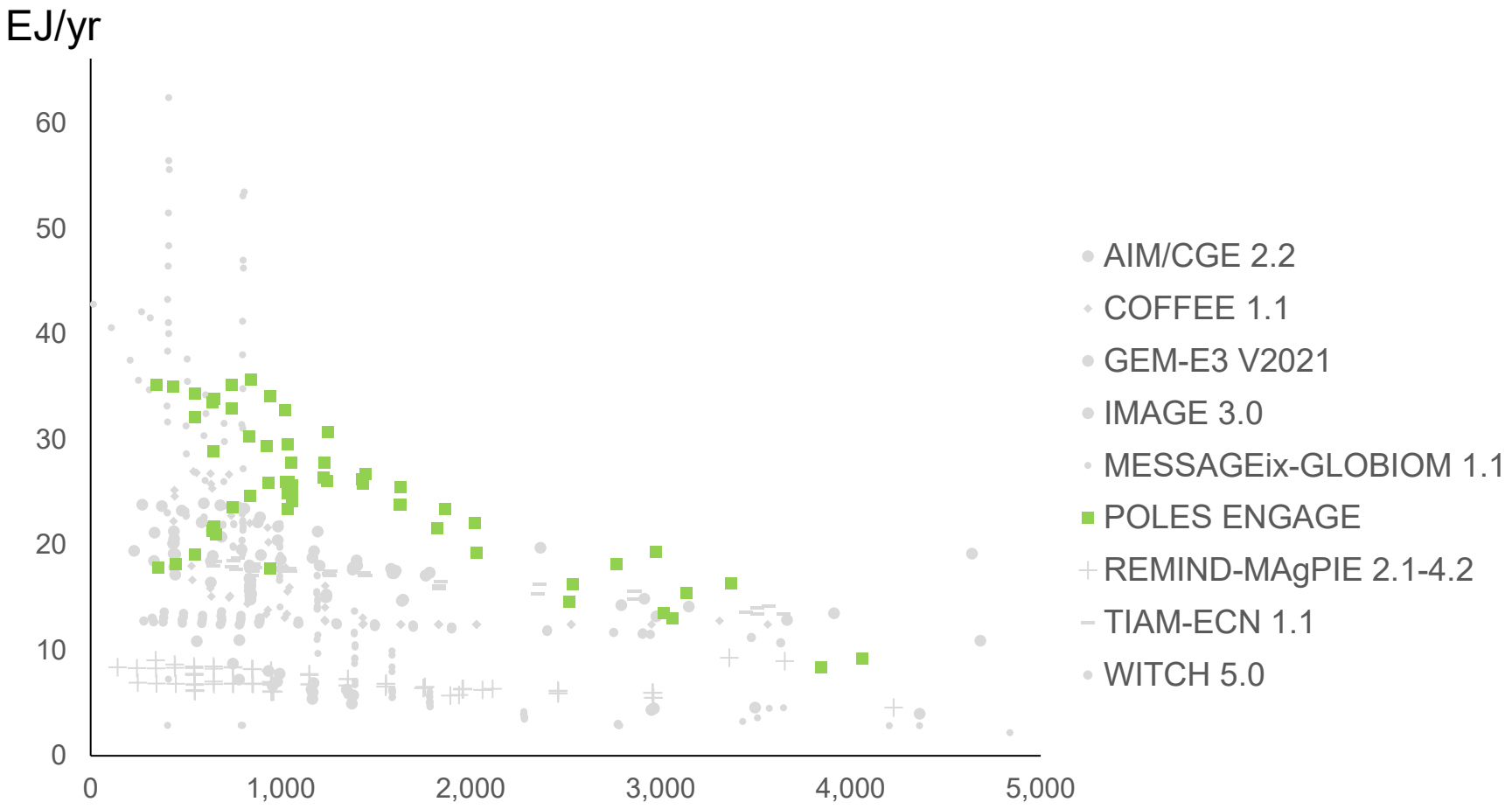
Nuclear generation in 2050

Outputs grouped by model



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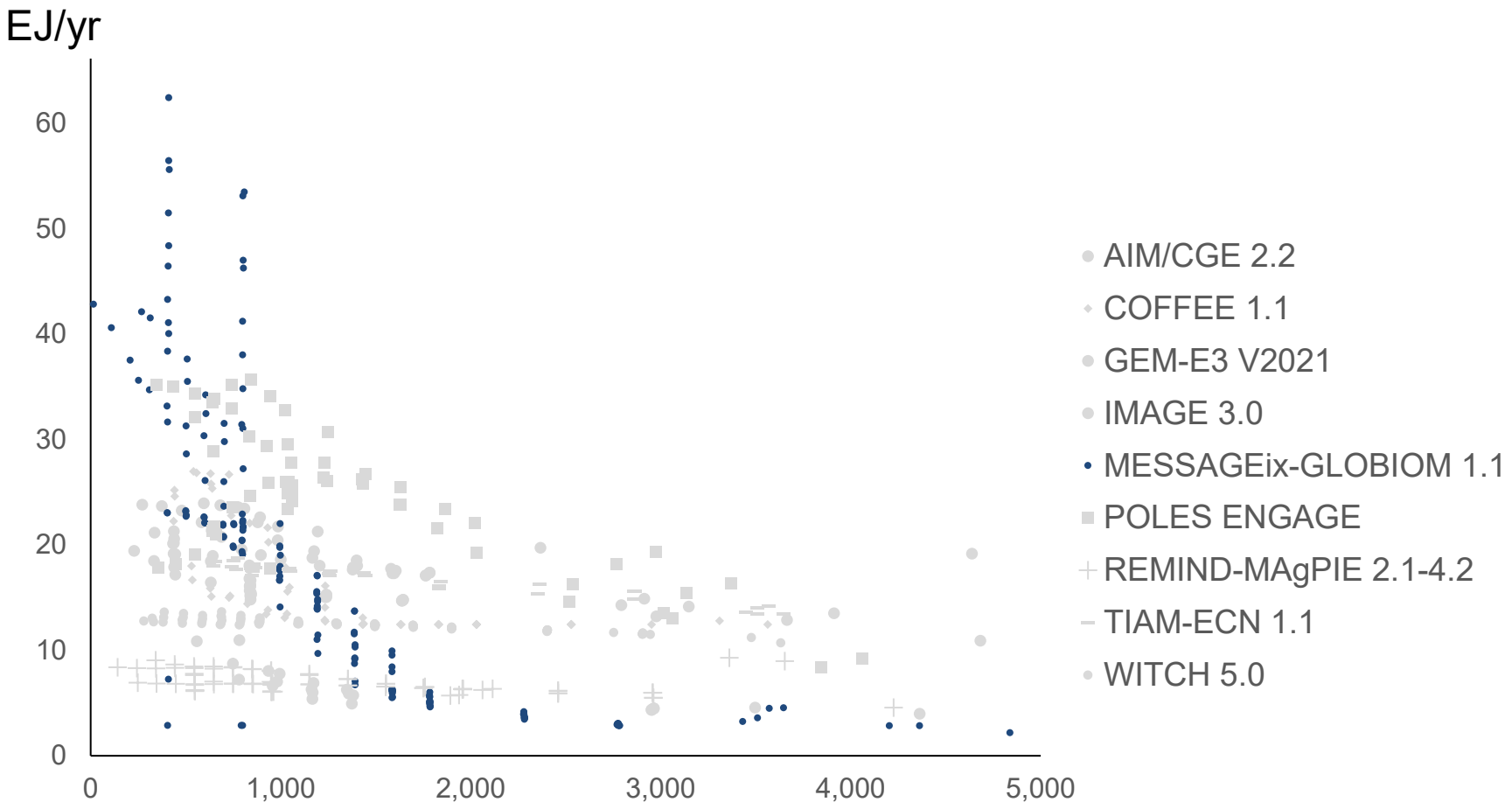
Nuclear generation in 2050

Outputs grouped by model



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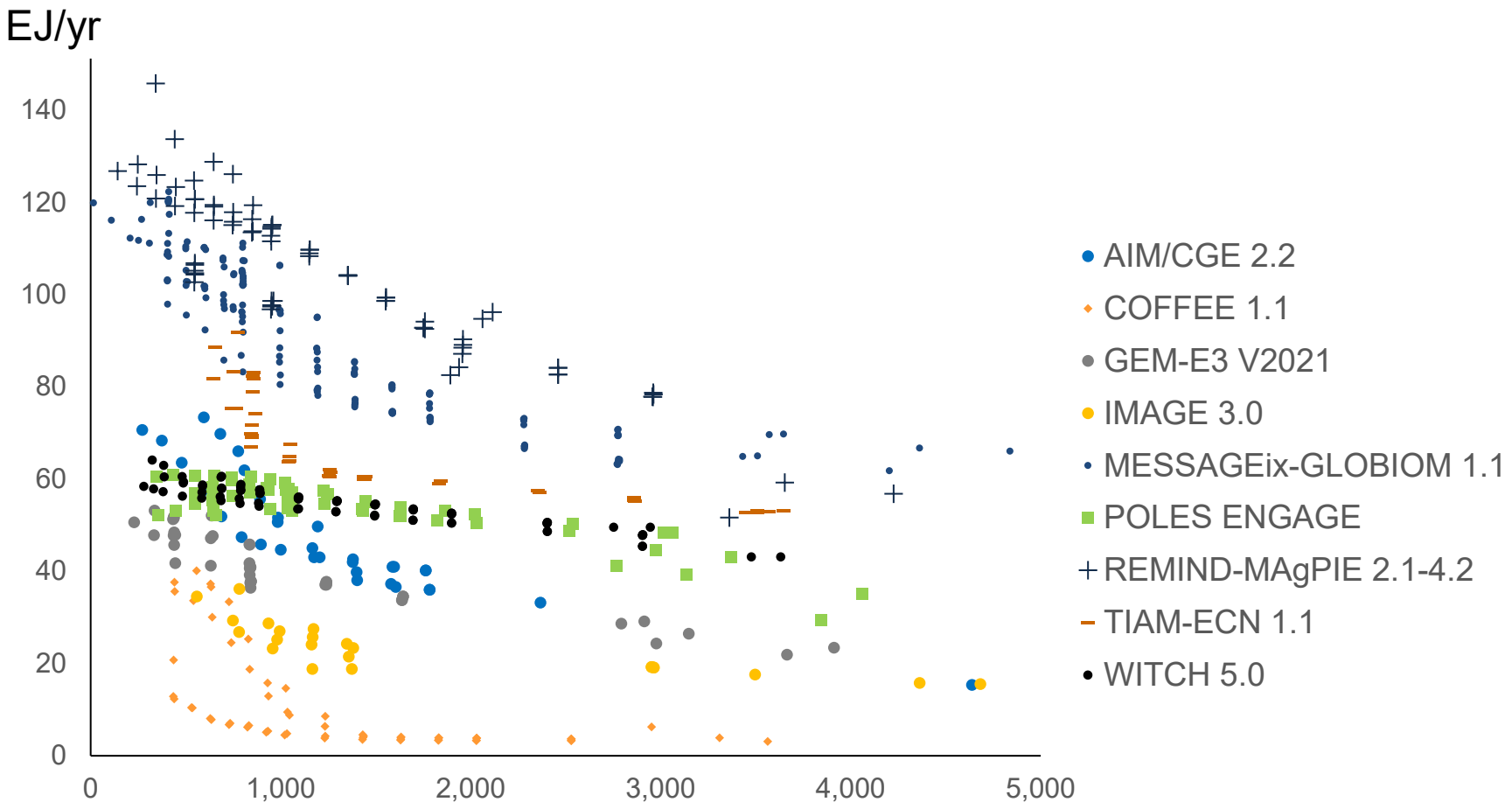
Solar generation in 2050

Outputs grouped by model



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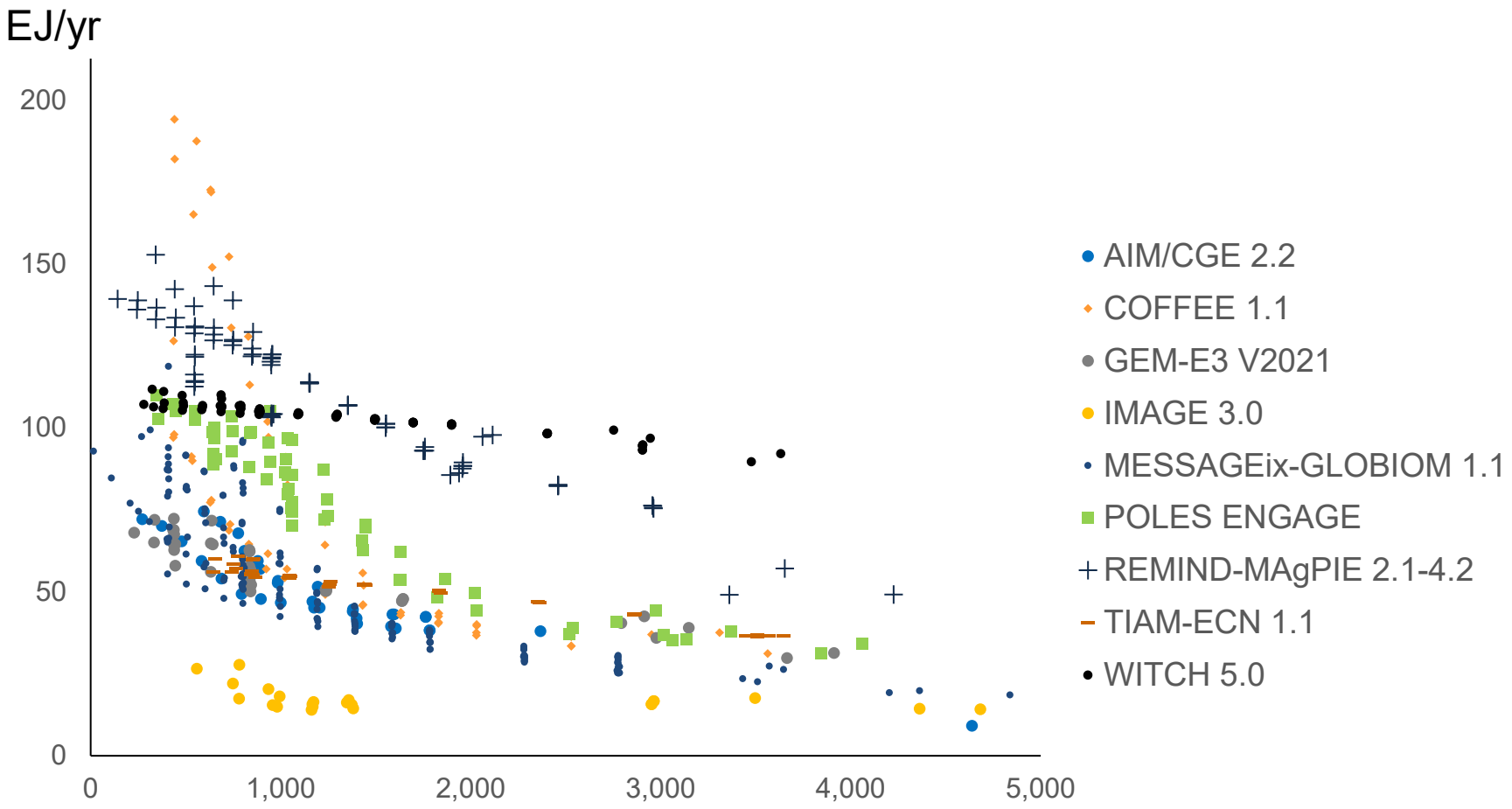
Wind generation in 2050

Outputs grouped by model



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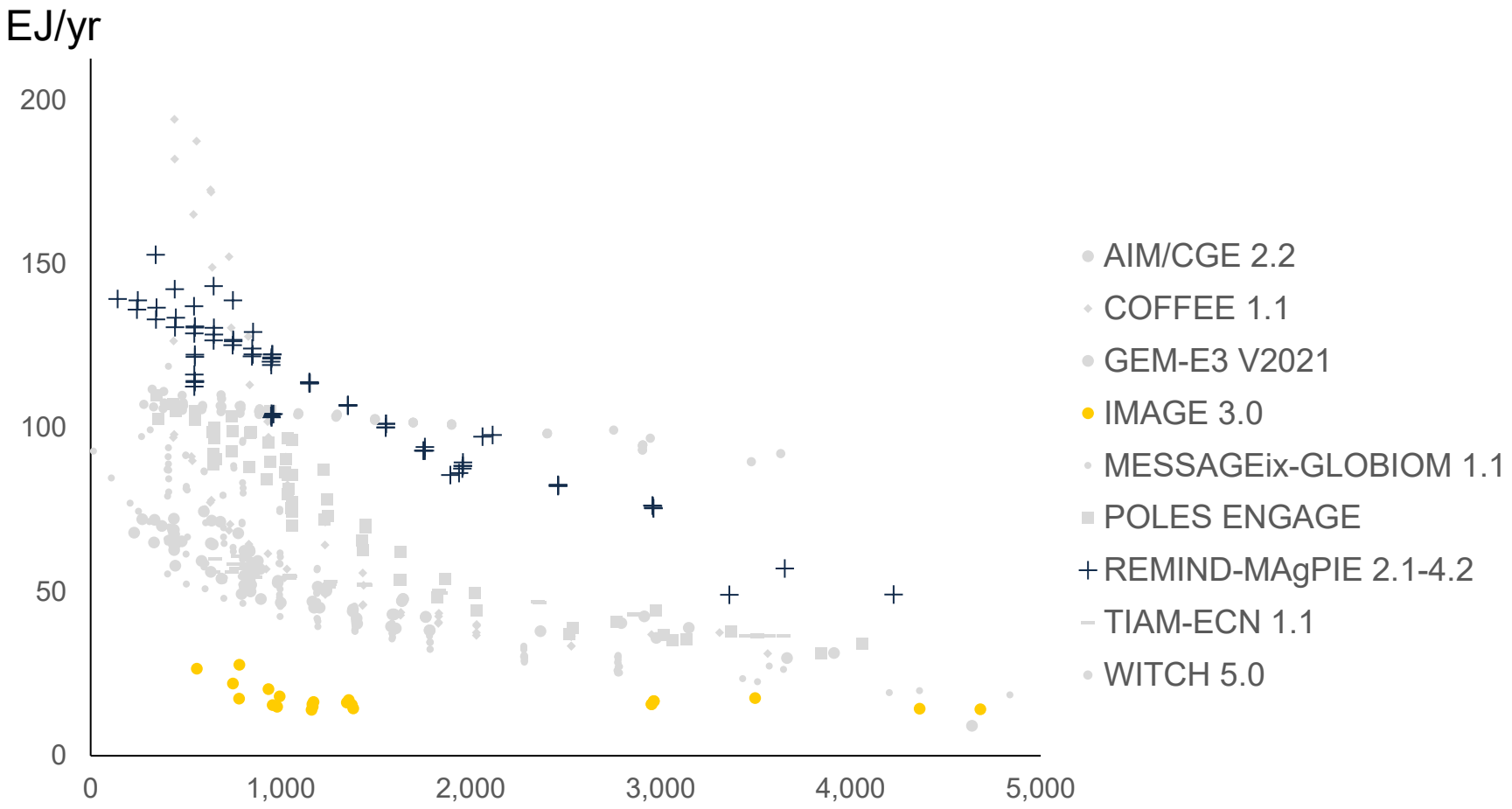
Wind generation in 2050

Outputs grouped by model



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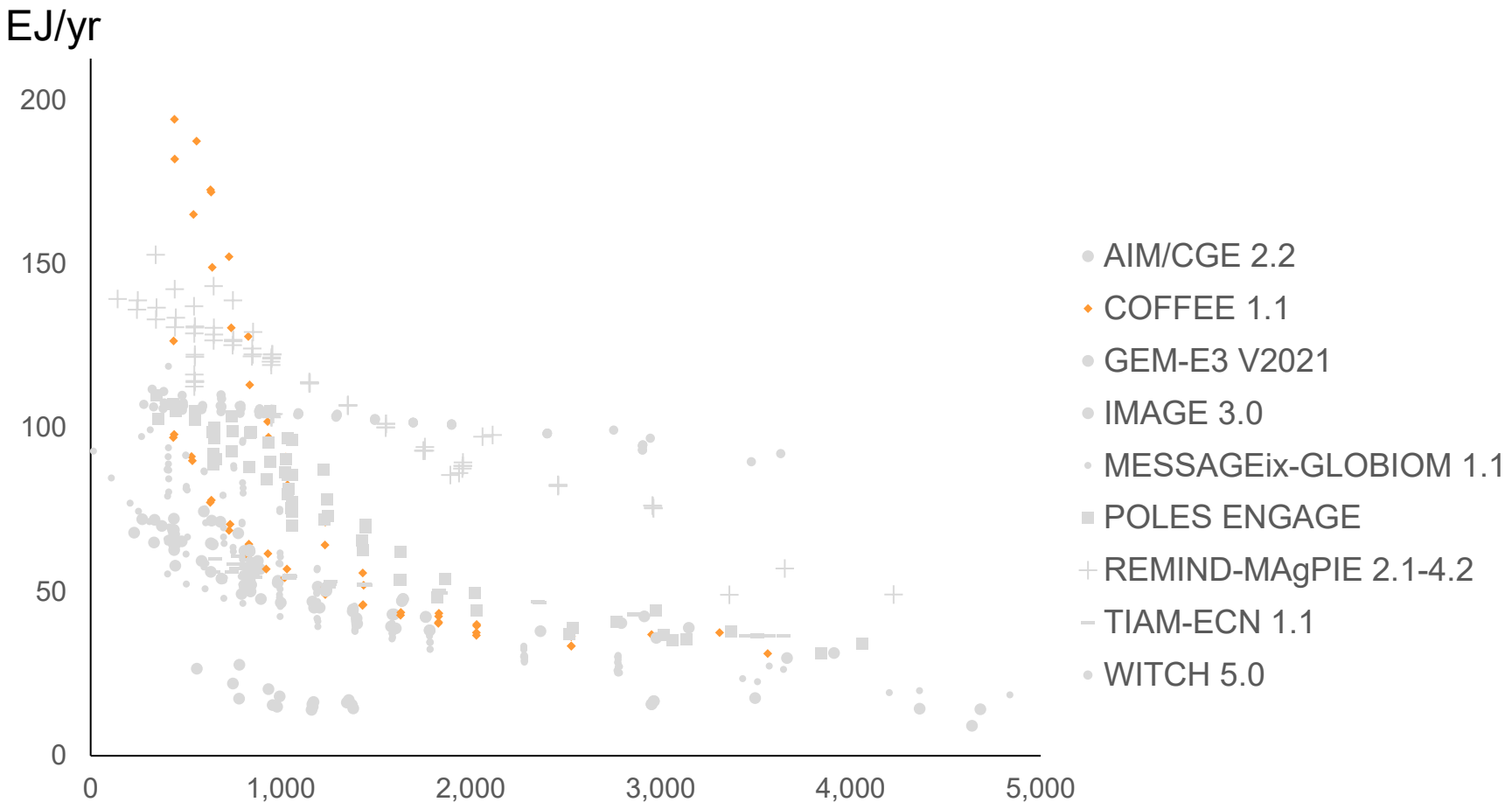
Wind generation in 2050

Outputs grouped by model



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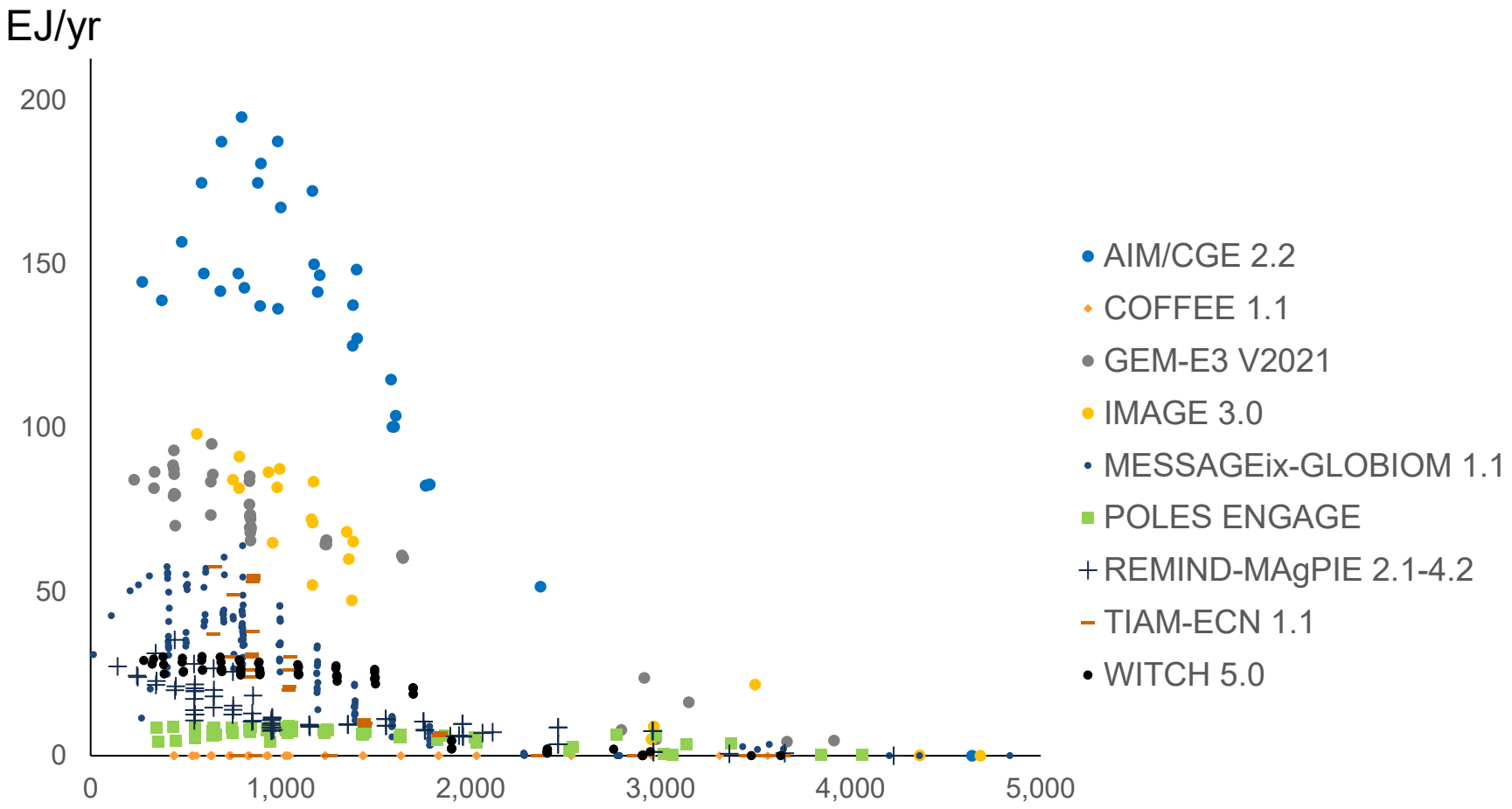
Fossil generation with CCS

Outputs grouped by model



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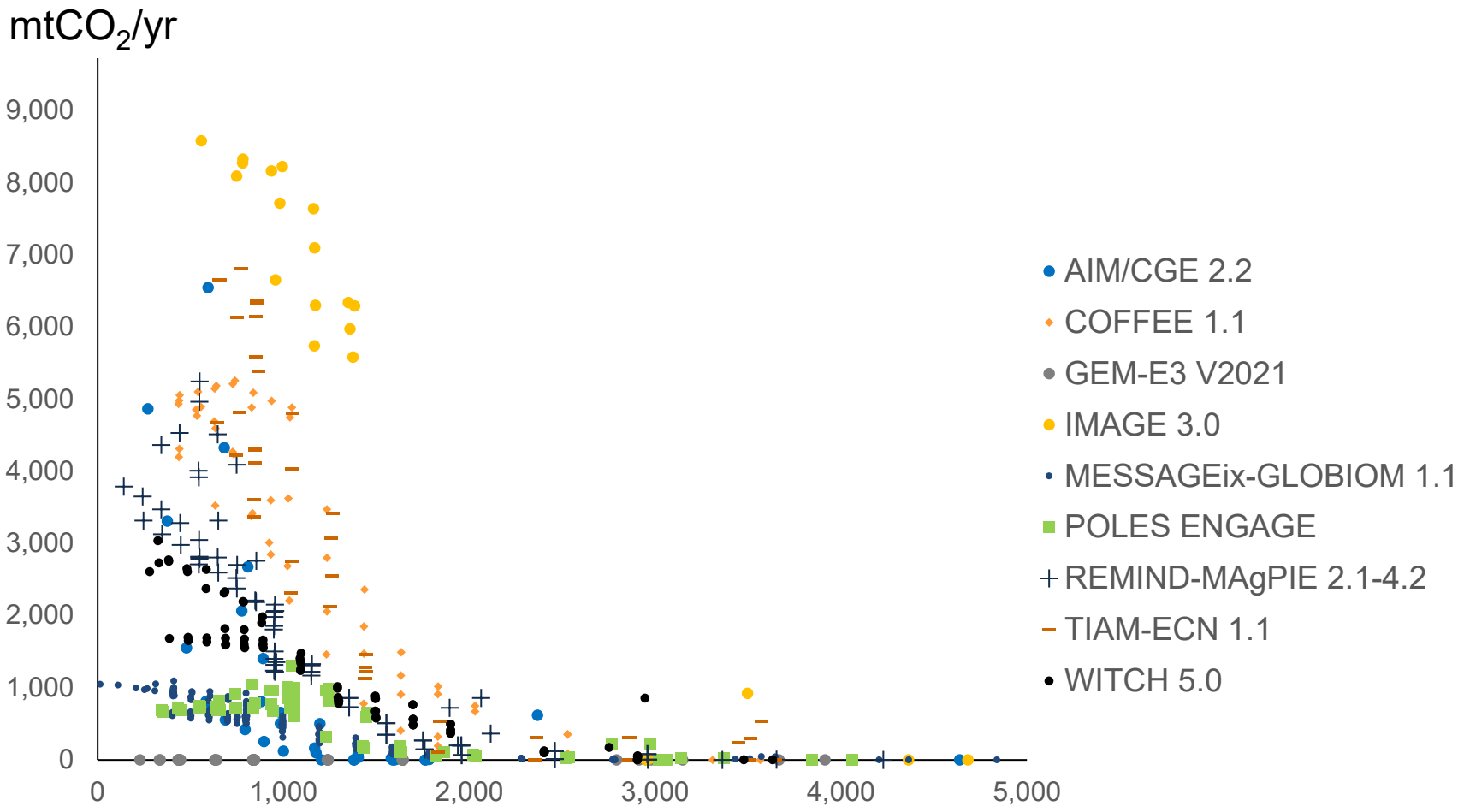
Biomass sequestration: CCS

Outputs grouped by model



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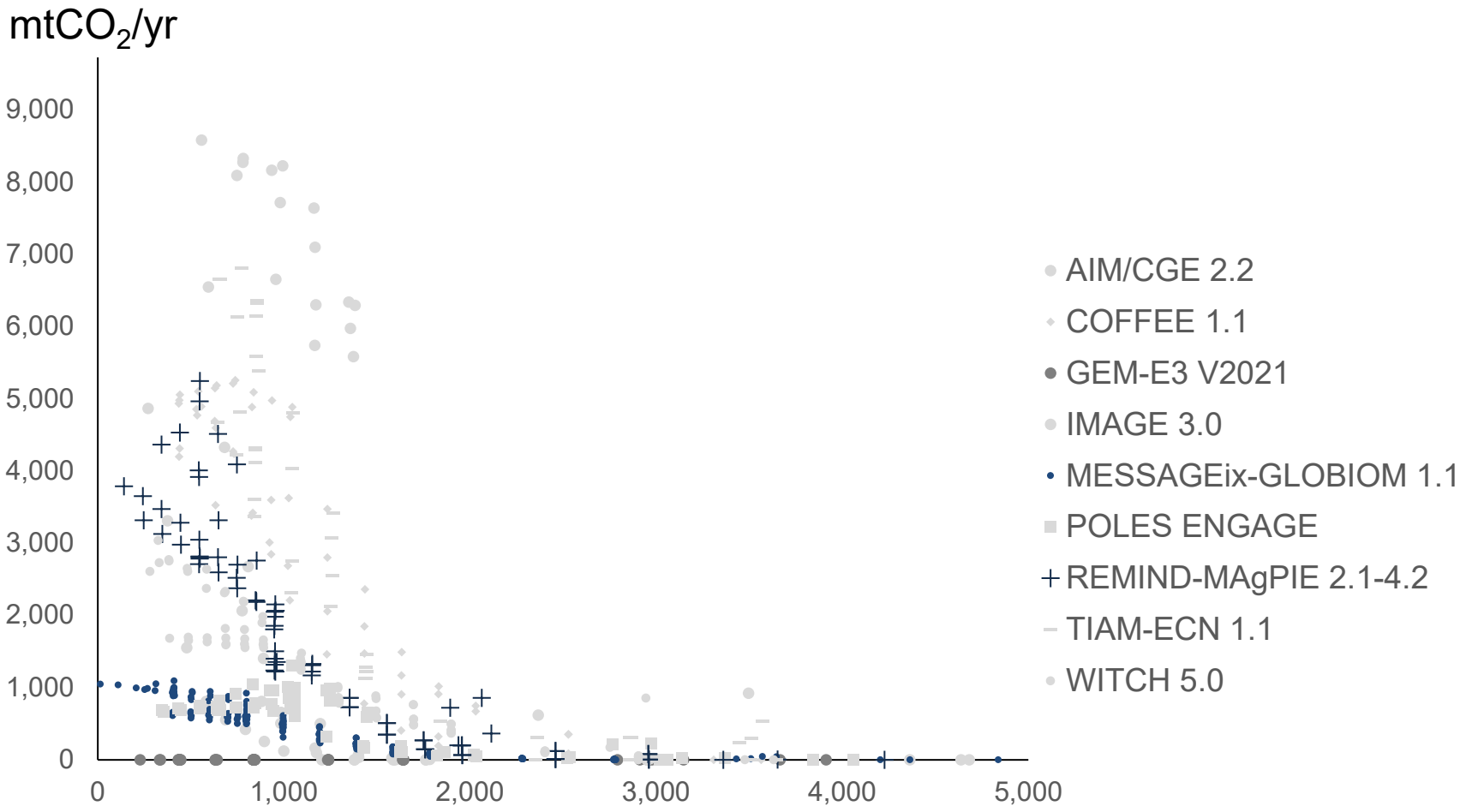
Biomass sequestration: CCS

Outputs grouped by model



Cumulative Emissions, 2020-2100, $GtCO_2$

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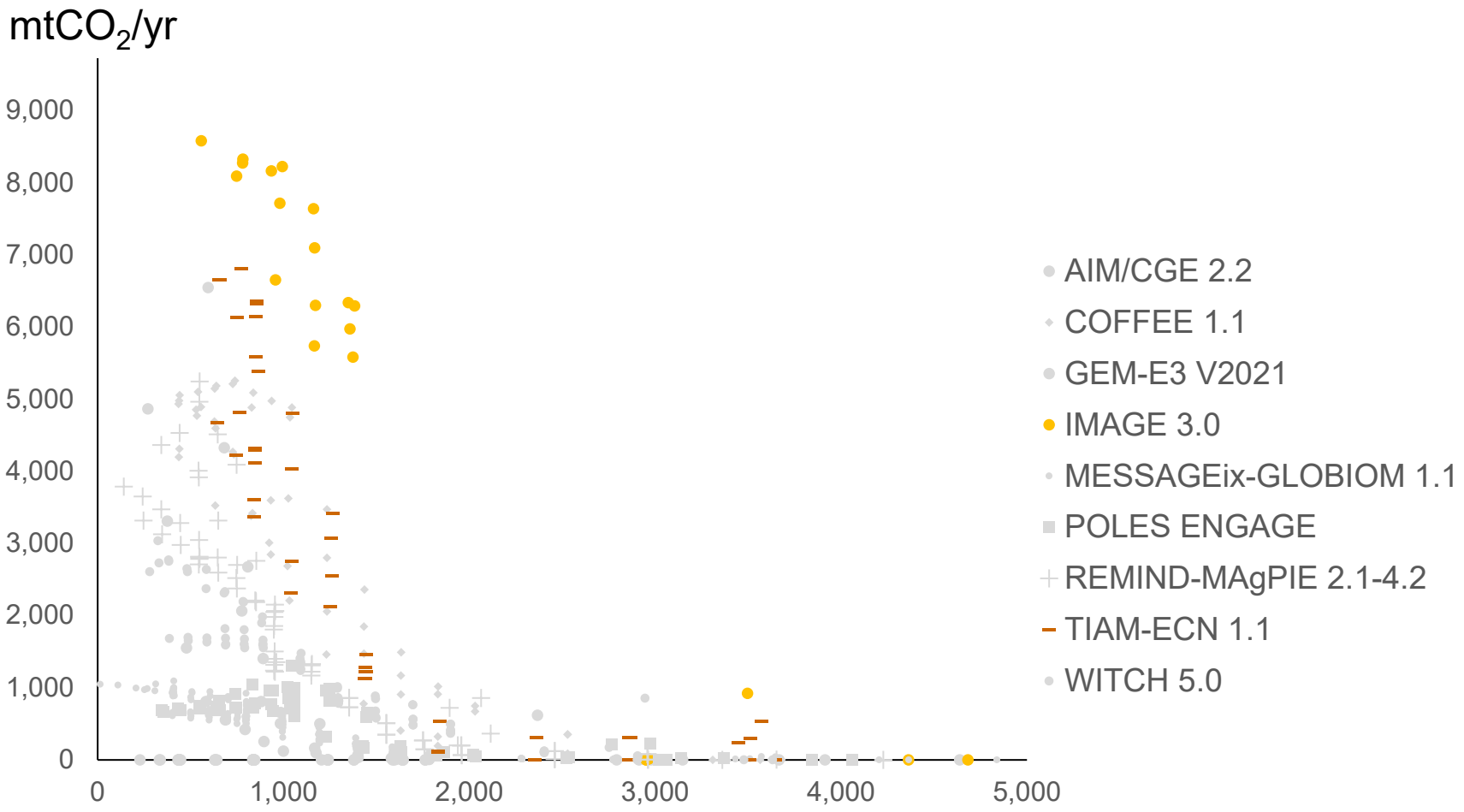
Biomass sequestration: CCS

Outputs grouped by model



Cumulative Emissions, 2020-2100, $GtCO_2$

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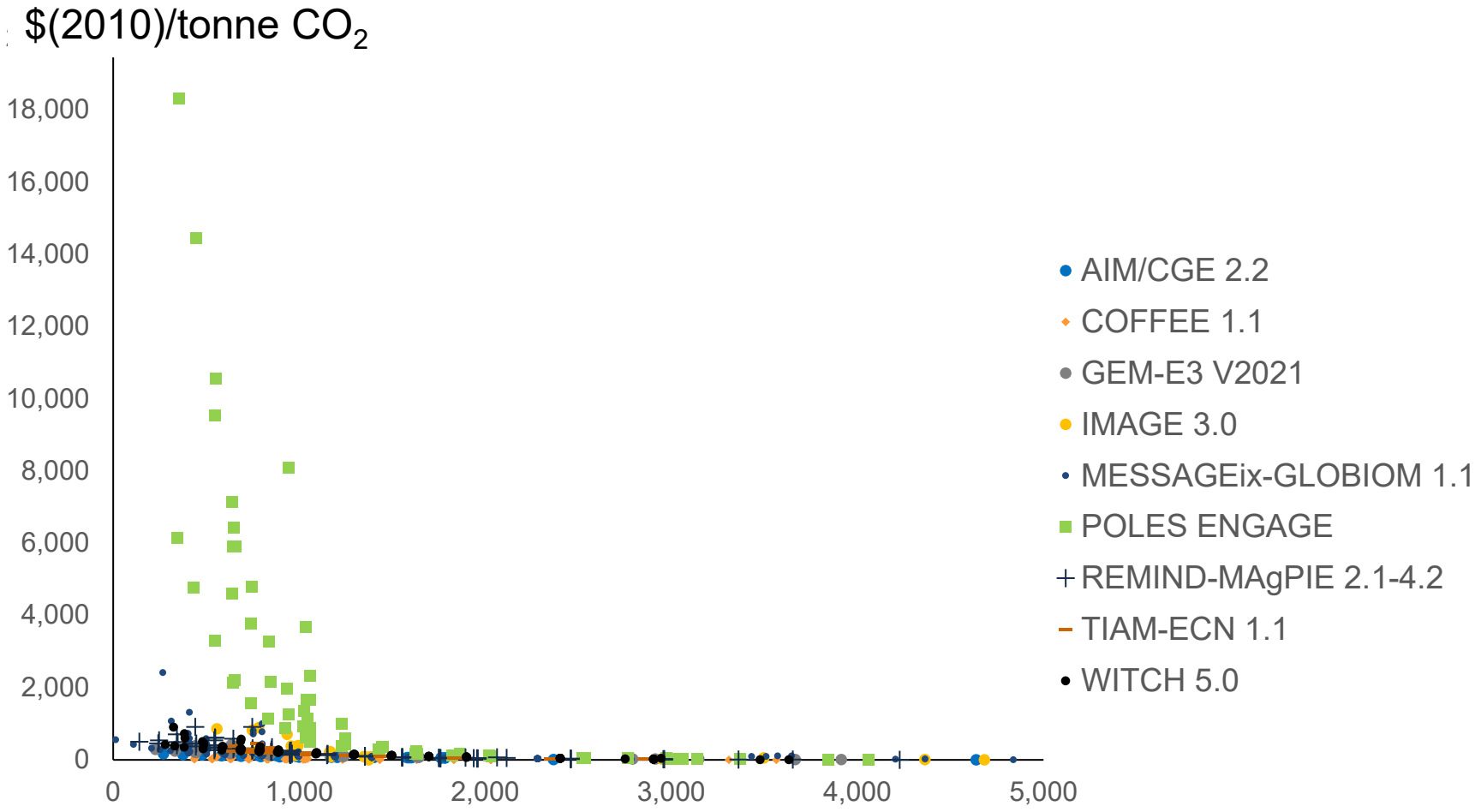
Carbon price in 2050

Outputs grouped by model



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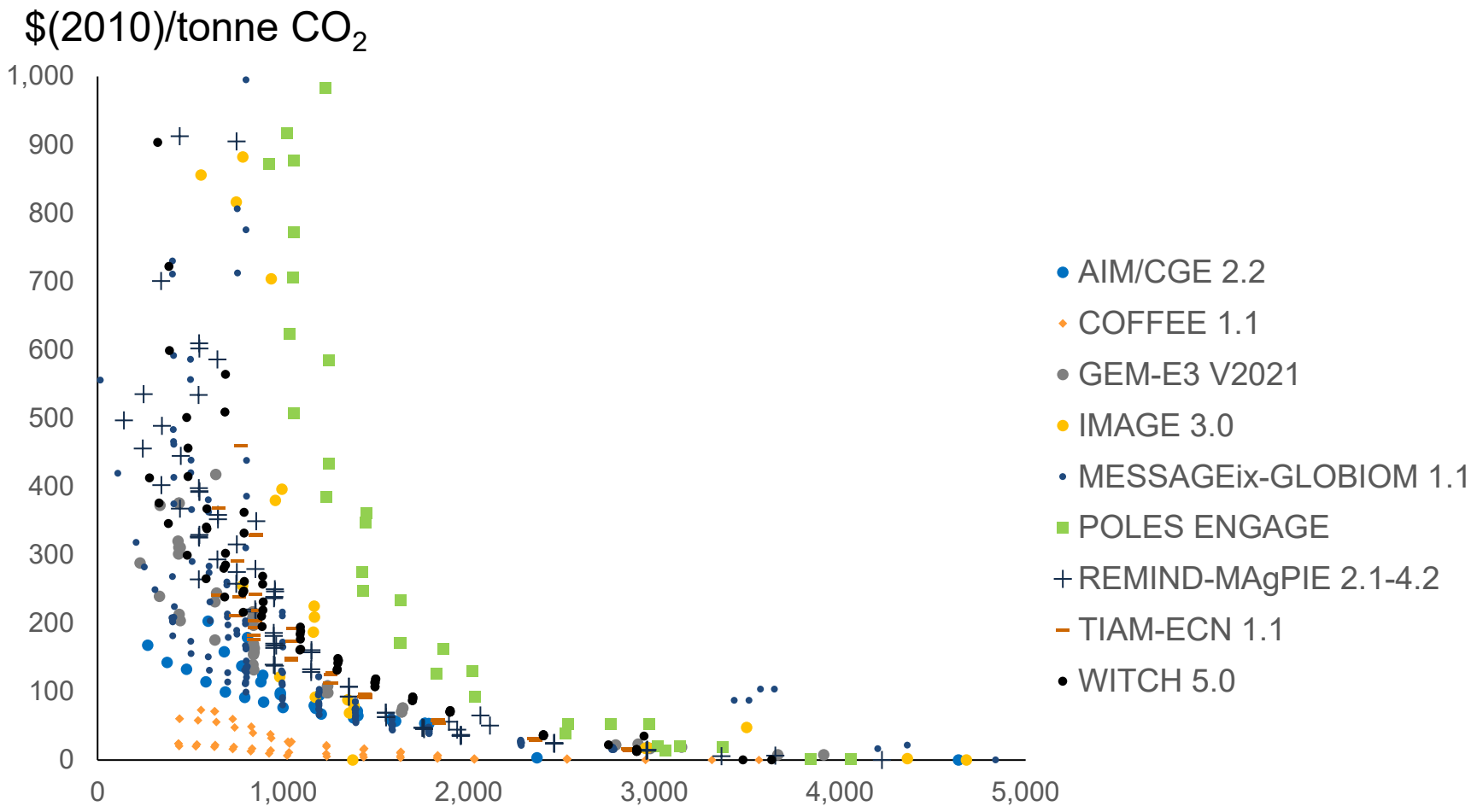
Carbon price in 2050

Outputs grouped by model



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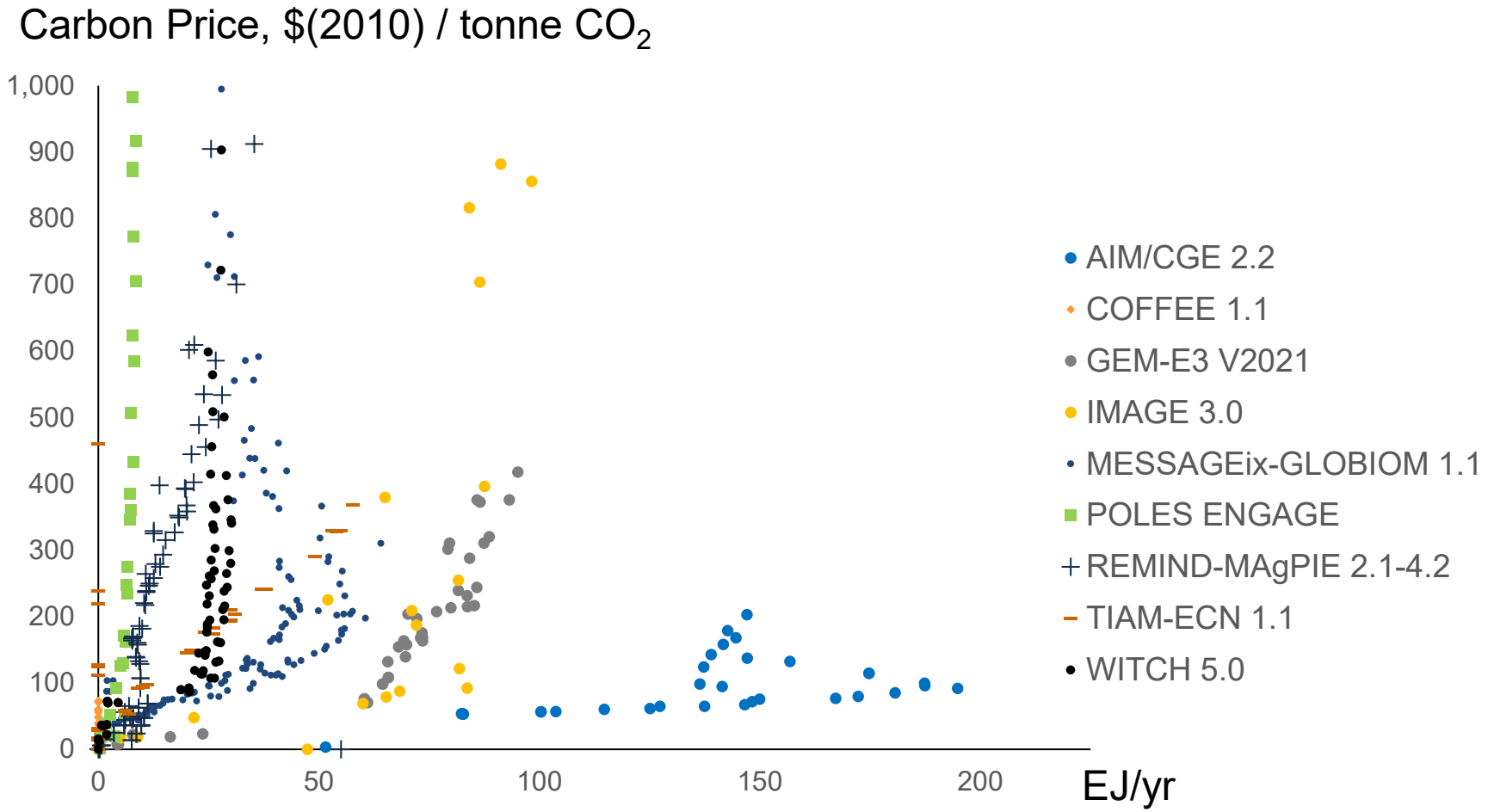
Fossil generation with CCS

Outputs grouped by model



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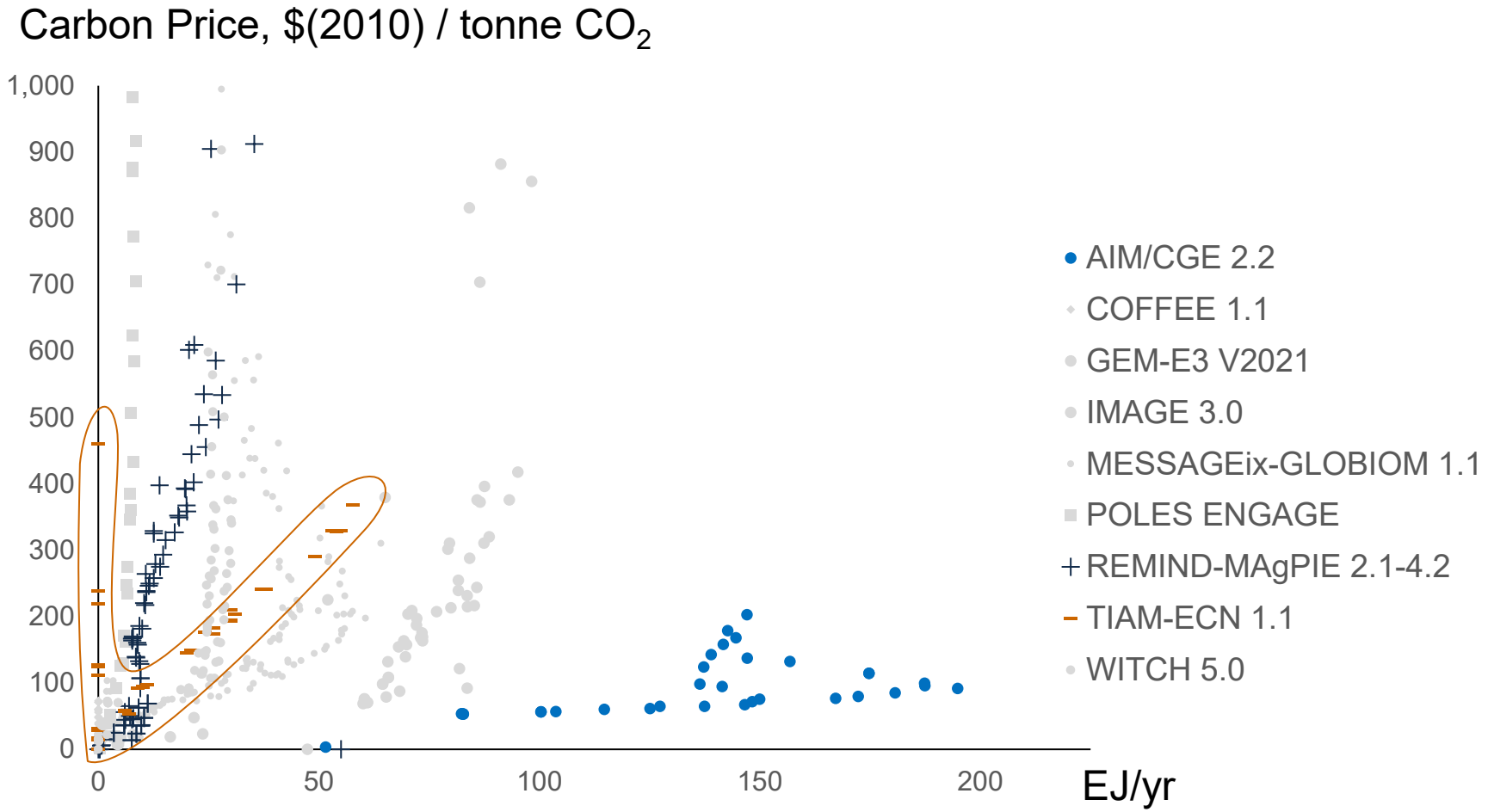
Fossil generation with CCS

Outputs grouped by model



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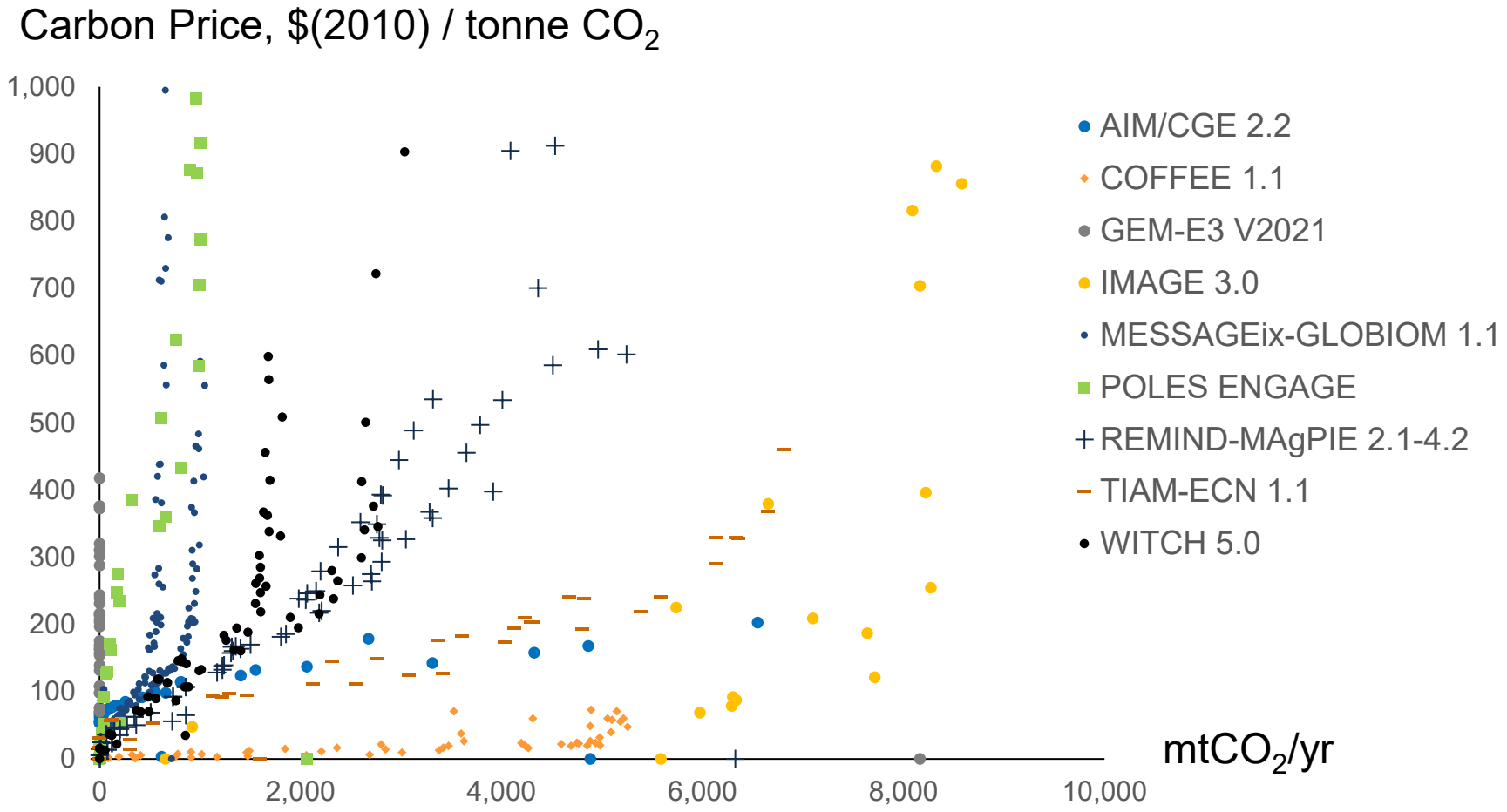
Biomass sequestration: CCS

Outputs grouped by model



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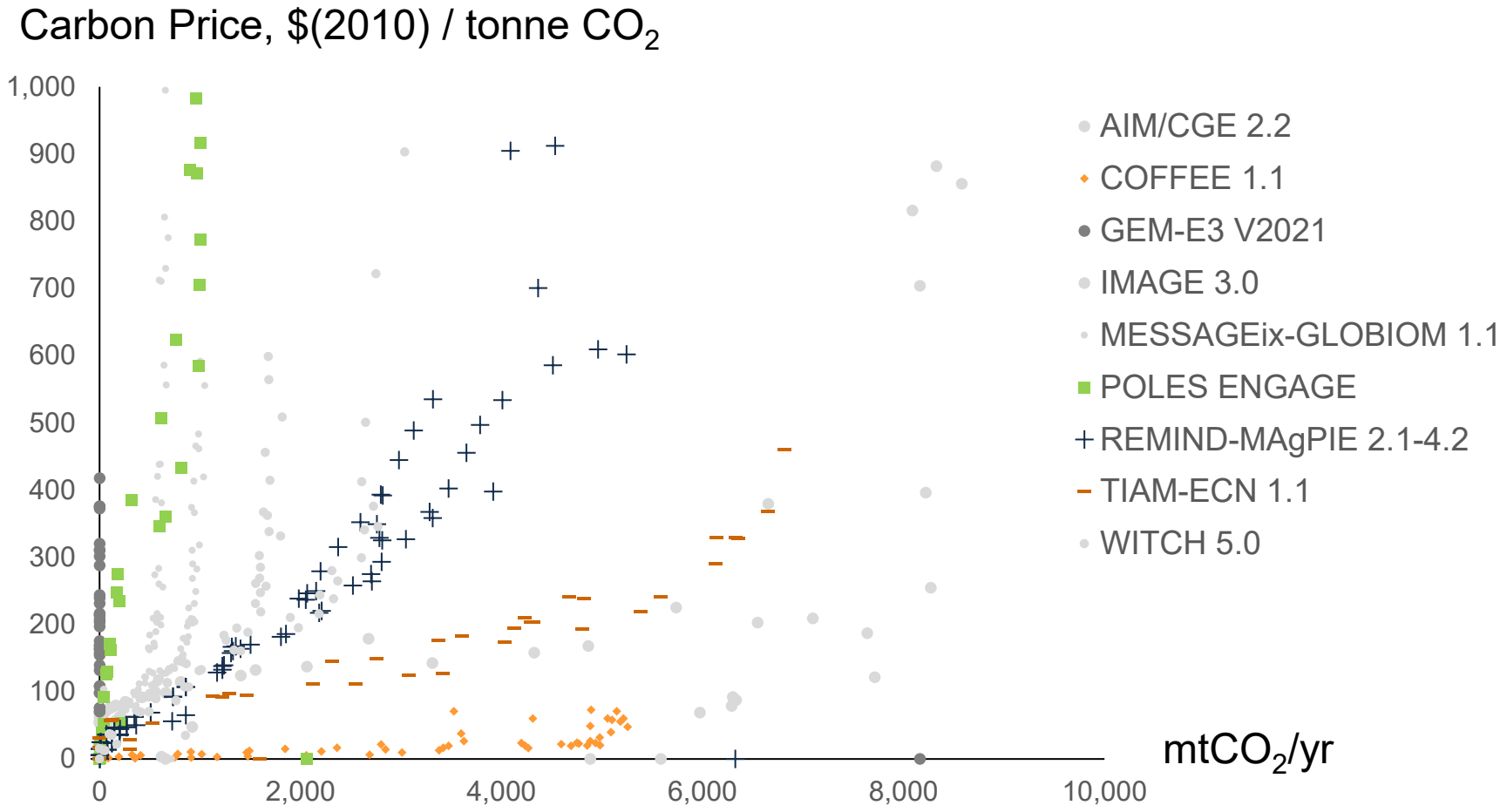

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Biomass sequestration: CCS

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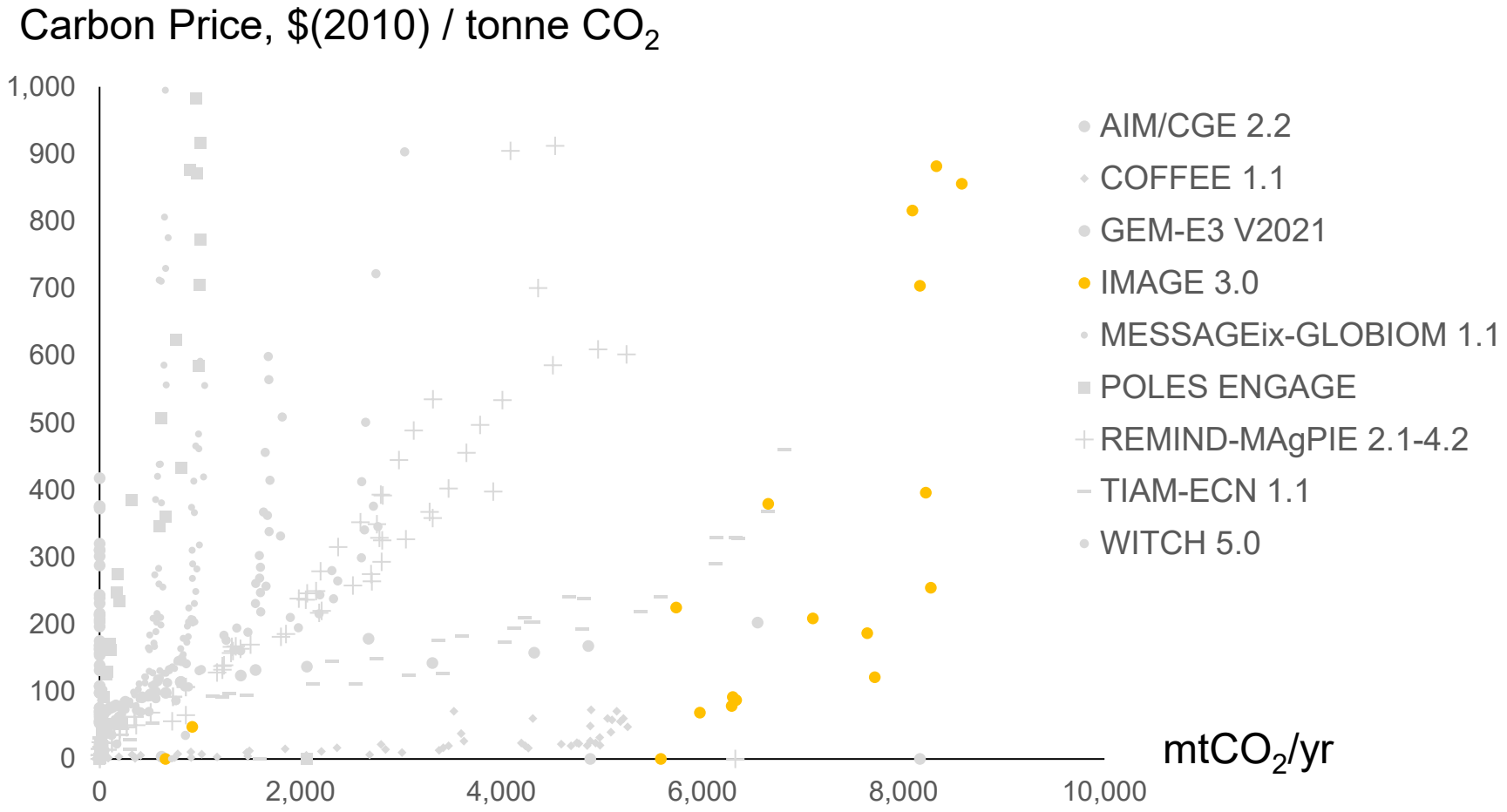

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Next steps

- This is not the kind of presentation I was expecting to give!
- Remember all models are wrong, but some are useful
- Can we analyse further and understand the differences?
  - Econometrics including model type, key assumptions?
  - Deep-dive comparisons between model pairs?
- Is a wide range of results a blessing or a curse?

Thank you