Mitigation scenarios for the global building sector: a model intercomparison study

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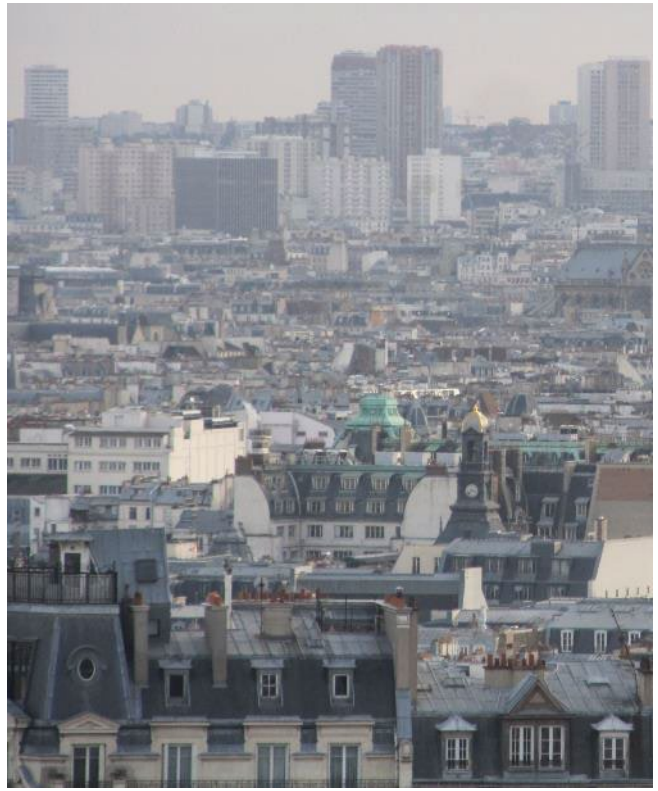
Introduction

Buildings account for 21% of global GHG emissions in 2020 and play a **crucial role in climate change mitigation**
Ref: IPCC AR6 WGIII Chapter 9

Global **Integrated Assessment Models (IAMs)** require improvements in representing demand-side interventions



Objectives:

Explore a comprehensive set of mitigation scenarios towards net-zero emissions for the global buildings sector

Run a **model intercomparison study** using the IAMs with improved end-use sectors representation

Building sector models in this study

IAM	Instit.	Overall approach	Methods	Regions	Time step (years)
IMACLIM-R	CIRED	Hybrid	Simulation	12	1
IMAGE	PBL	Hybrid	Simulation	26	1
MESSAGEix	IIASA	Bottom-up	Simulation	60	5-10
PROMETHEUS	E3M	Top-down	Simulation	10	1
REMIND	PIK	Top-down	Optimization	12	5-10
WITCH	CMCC	Hybrid	Optimization	17	5

Key model improvements:

- Model granularity

Context, sub-sectors, buildings - household types

- Floorspace representation

Key indicator for service level
Exogenous or endogenous projections

- Stock turnover dynamics

Integrated in some of the models, e.g. using Material Flow Analysis MFA

- Energy efficiency improvement

Discrete choice models/logit functions integrated in some of the models.
Linkages with the energy supply-side via IAM

Scenarios setup

Building sector policies

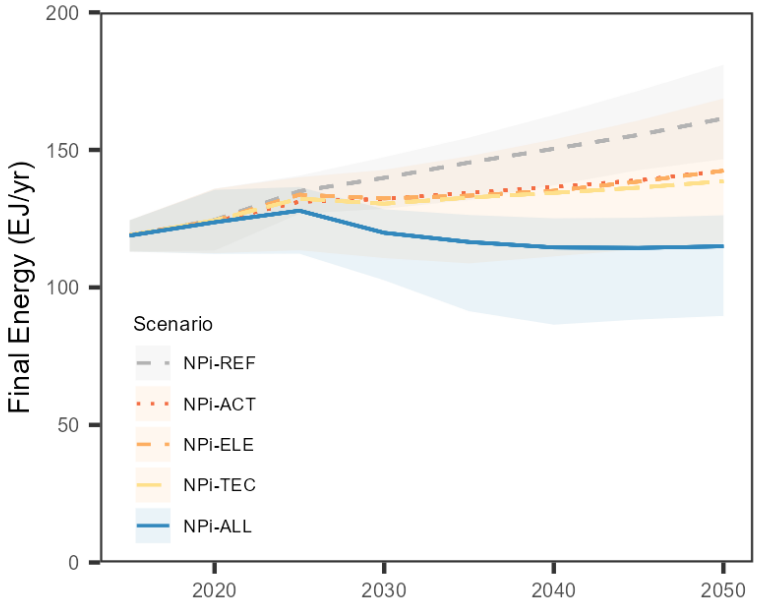
REF Reference	Continuation of current policies
ACT Activity shifts and reductions	Reduction in floorspace Shift to multi-family housing Conservative temperature set-points
ELE Electrification and fuel switches	Heat-pump adoption Phase-down of fossil fuel On-site renewable energy sources
TEC Technology and energy efficiency	Improvements in building insulation and HVAC systems Increased renovation rates
ALL All strategies combined	All policies combined

Climate policies

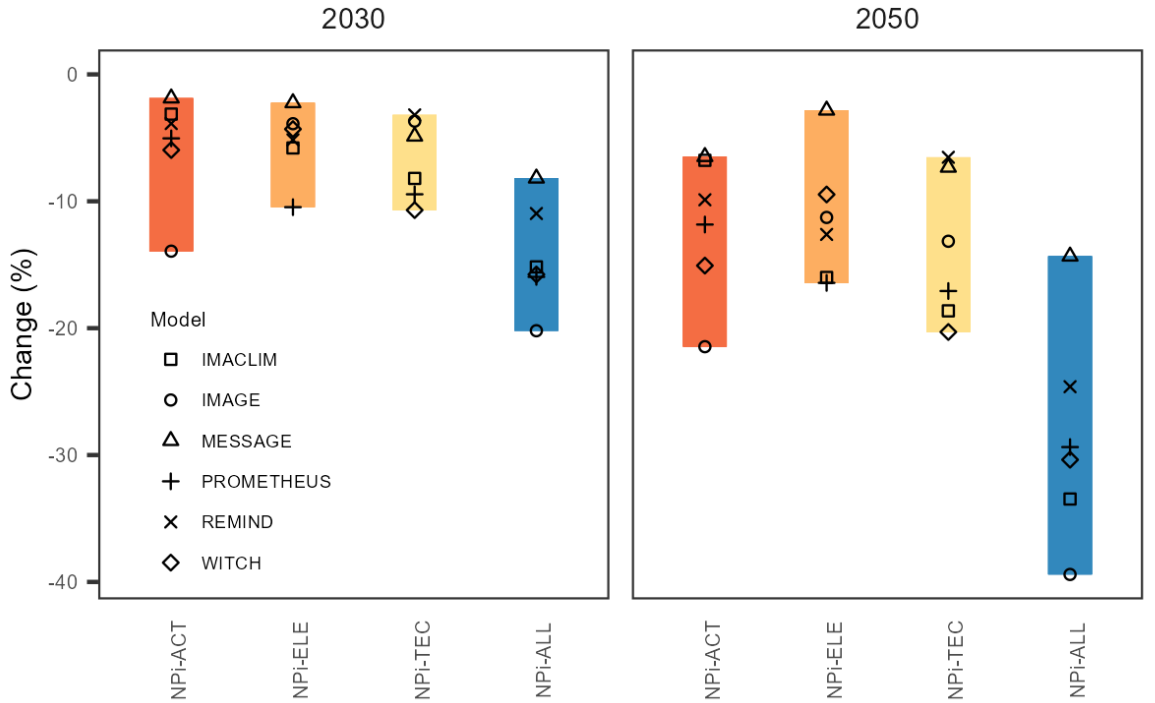
NPi Current National Policies	Continuation of current national policies No stringent climate policies
2.0C Stringent climatic policies	Climate policies consistent with 2.0C targets
1.5C Stringent climatic policies	Climate policies consistent with 1.5C targets with low overshoot

Results: Building sector policies

Final energy demand



Change compared to NPi-REF in 2050

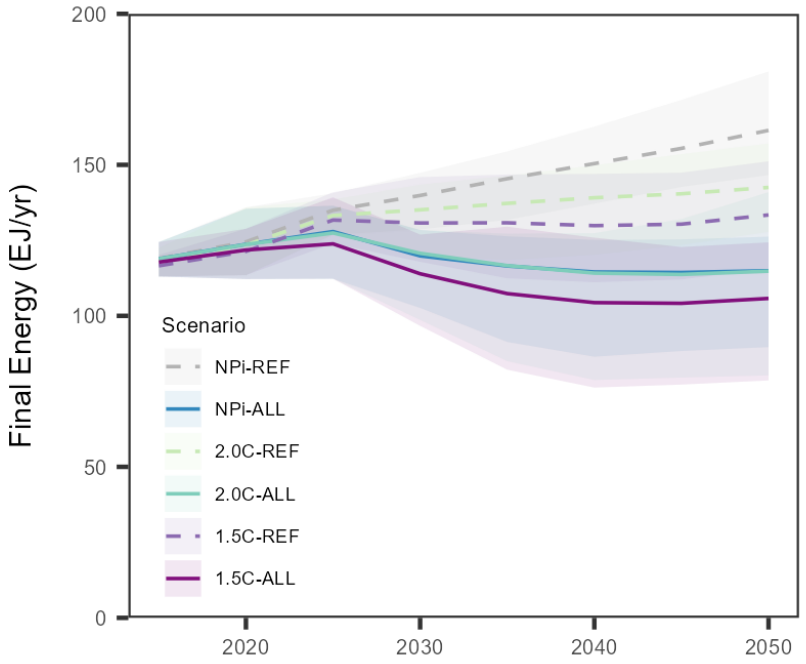


Final energy reduction potential compared to reference (NPi-REF) in 2050:
- All policies combined (NPi-ALL): **30%** average across models
- Complementarity of sectoral policies

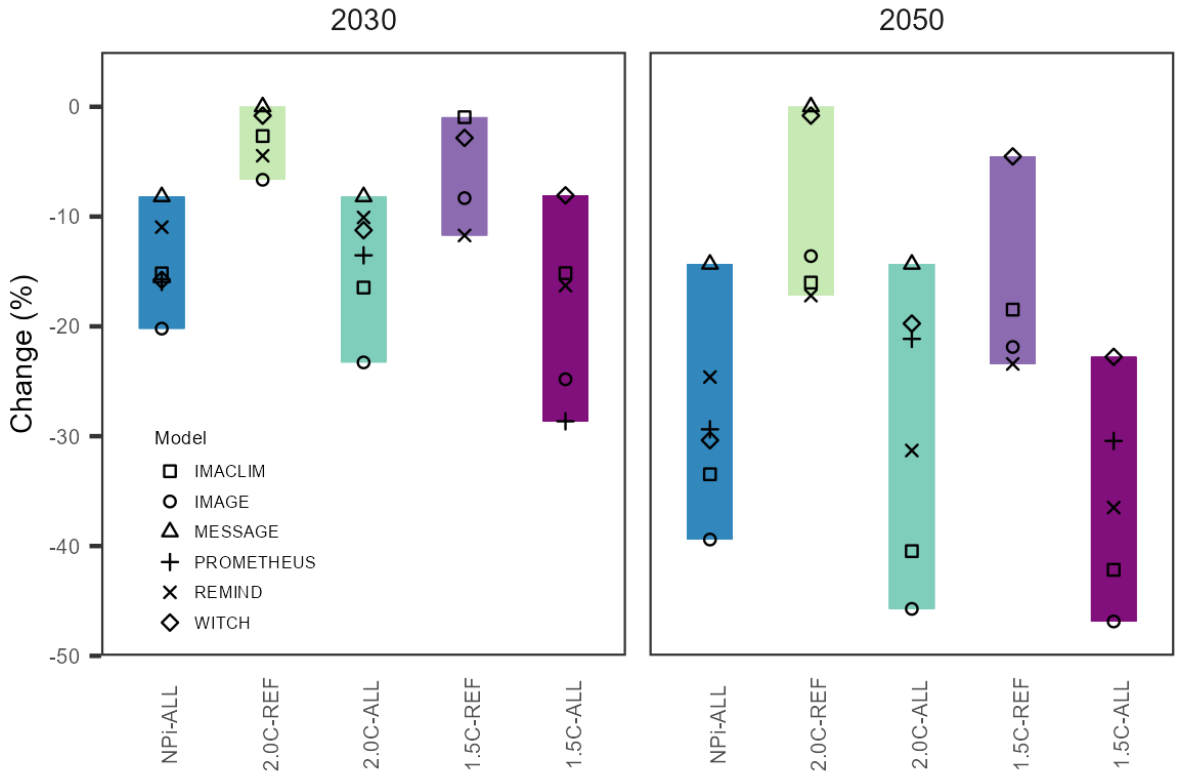
Preliminary results: please, don't cite or distribute

Results: Sectoral and climate policies

Final energy demand



Change compared to NPi-REF in 2050



Final energy reduction potential compared to reference (NPi-REF) in 2050:

Averages across models

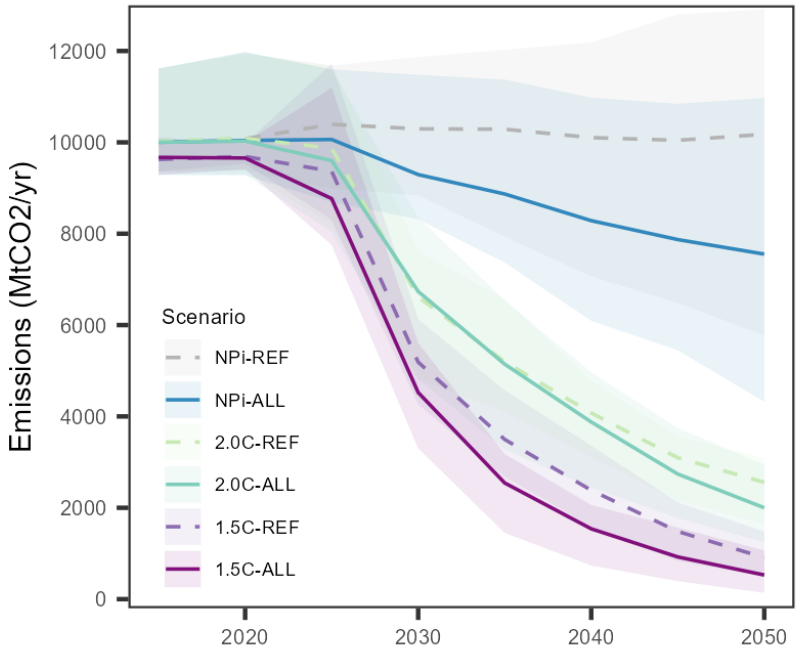
Climate policies: **10%** (2.0C-REF) **– 17%** (1.5-REF)

Climate policies + Sectoral: **30%** (2.0C-ALL) **– 35%** (1.5-ALL)

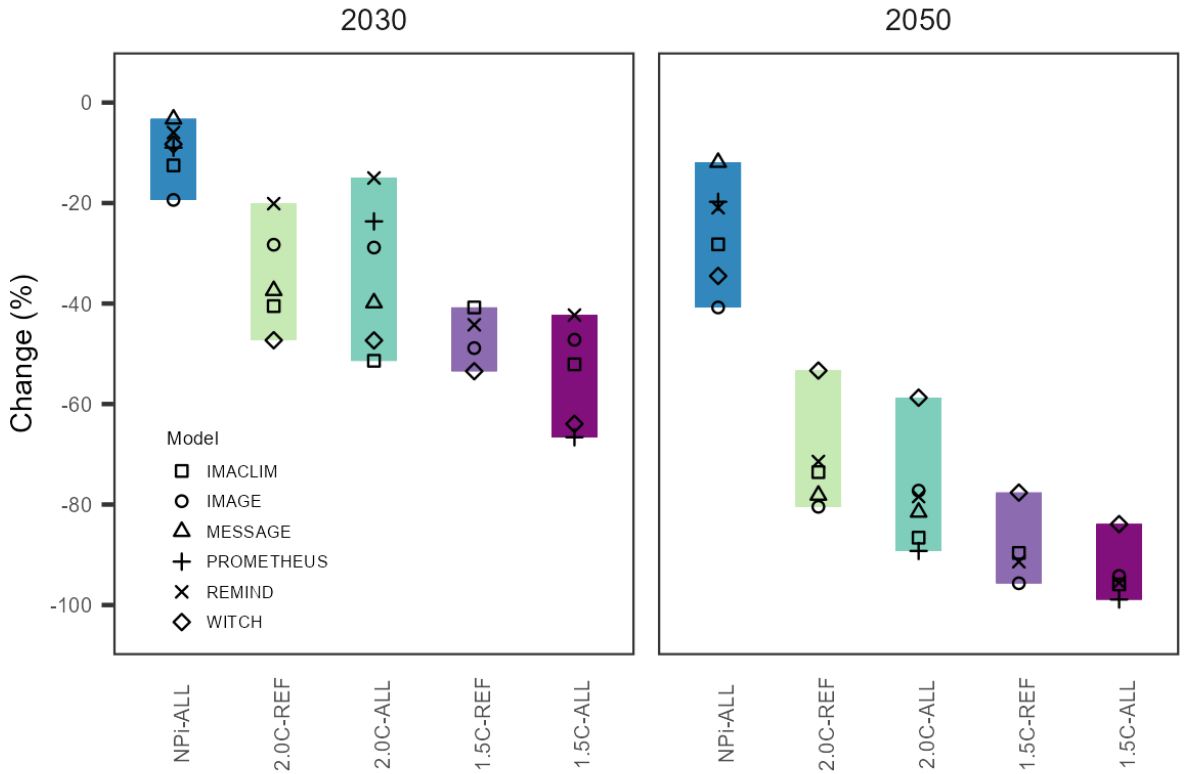
Preliminary results: please, don't cite or distribute

Results: Sectoral and climate policies

Total CO2 emissions



Change compared to NPi-REF in 2050



Total CO2 emission reduction potential compared to reference (NPi-REF) in 2050:

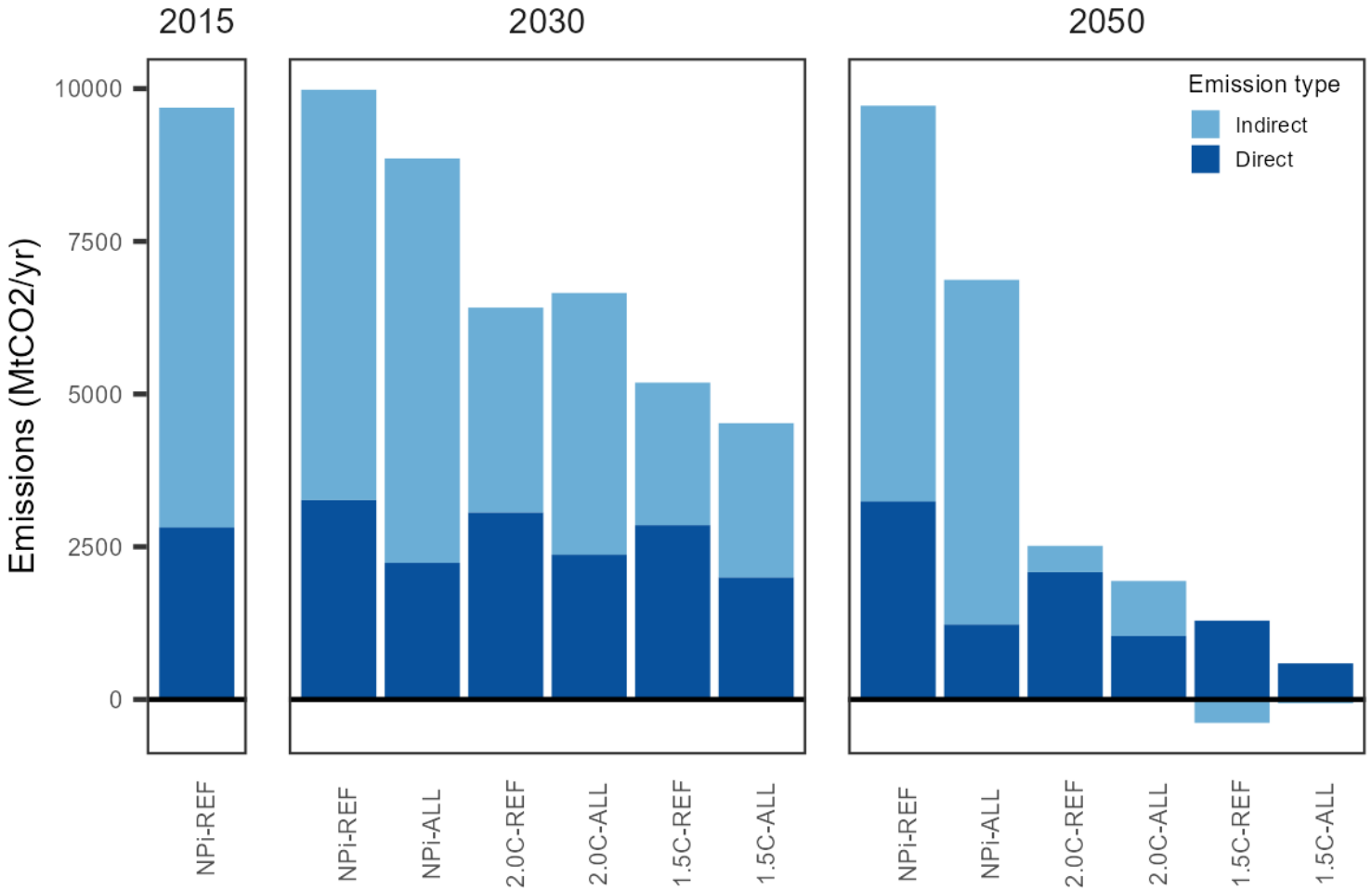
Averages across models

Climate policies: **75%** (2.0C-REF) **– 90%** (1.5-REF)

Climate policies + Sectoral: **80%** (2.0C-ALL) **– 95%** (1.5-ALL)

Preliminary results: please, don't cite or distribute

Results: Sectoral and climate policies



Averages across models

Building sector policies:

- reducing direct emissions
- limiting negative indirect emissions in ambitious climate policy scenarios.

Residual direct emissions persist in all scenarios until 2050.

Preliminary results: please, don't cite or distribute

Conclusions

- **Building sector policies**, including activity shifts, electrification, and technology improvements **can reduce the energy demand of global buildings by 30%** (averages across models) in 2050 compared to a reference scenario.
- **Combining building sector and stringent climate policies can reduce total buildings CO_2 emissions up to 95%** (averages across models) in 2050 compared to a reference scenario.
- **Co-benefits of building sector policies:** improved thermal comfort, energy poverty reduction, employment effects, reliance on proven technologies.

Thank you for your attention!

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NAVIGATE
Next generation of advanced integrated assessment modelling to support climate policy making

https://www.navigate-h2020.eu/

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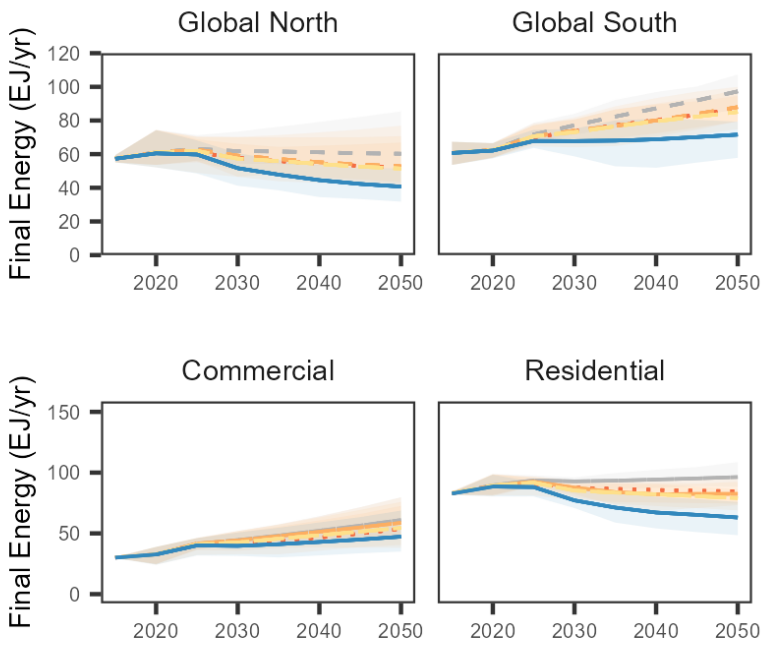
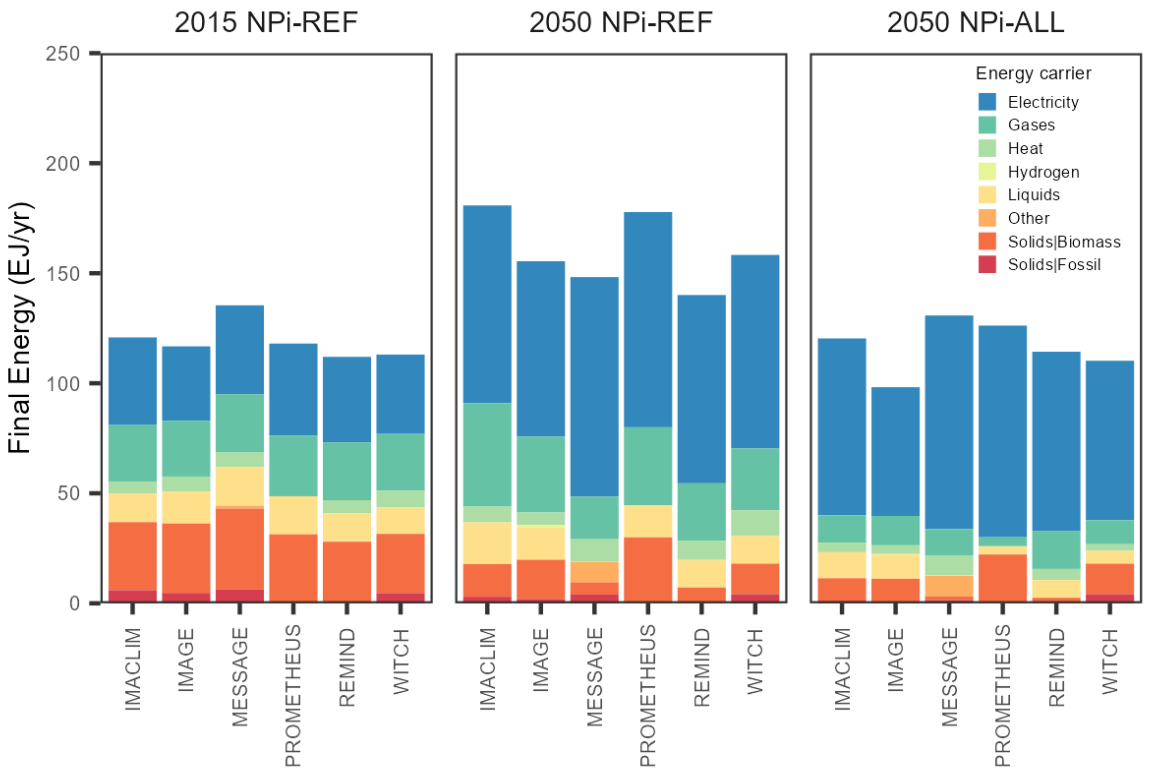
Results: Building sector policies

Final energy demand





Building sector policies:

- large effect in the Global South and in the residential sector
- higher share of electricity by 2050; lower share of fossil fuels, but residual use in 2050

Preliminary results: please, don't cite or distribute

Modelling protocol - Buildings

Scenario	Description
Activity reduction and shifts	- Regional cap of 40 m2/cap (25m2/cap) by 2050 for residential (commercial) floorspace - Share of population in multi-family housing increases by 10% - Set-point temperatures shift to 20C for heating and 25C for cooling
Electrification and fuel switches	- All new buildings adopt heat pumps by 2030. - 70 % of space and water heating is electricity-based by 2050 - Phase down of non-clean heating fuels - Ban on new natural gas connections - Renewable energy covers 50 % of heating/cooling demand in the Global North by 2050.
Technological improvements and energy efficiency	- The NZEB level for insulation in new construction will be 0.3 W/m^2K on average by 2030 - Energy savings for renovation are at least 40 % by 2030. - Improvements in conversion efficiency of heating and cooling systems - Doubling of the current retrofit rate to yearly 2 % in the Global North

Modelling protocol – Climate policies

Scenario	Description / Carbon budget
NPi	National policies implemented. Only current policies but no additional plans.
Likely 2°C	CO2 budget of 1150 Gt CO2 from 1.1.2020 onwards should never be exceeded, i.e. peak as well as end-of-century budgets equal 1150 Gt CO2
1.5°C with low overshoot	Peak budget 650 Gt CO2 (2020 (included) to peak), end-of-century budget: 400 GtCO2 (2020 (included) – 2100). Models that cannot achieve these budgets aim for the lowest budgets feasible.