IMPLEMENTING THE EPBD: WHAT DRIVES TARGET ACHIEVEMENT?

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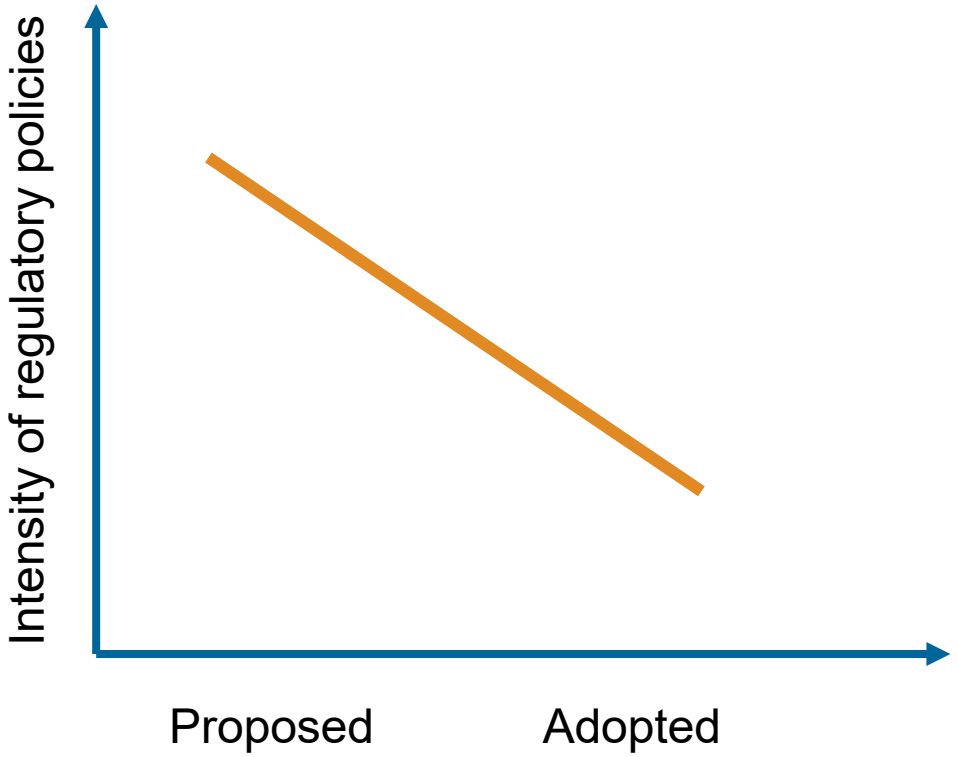
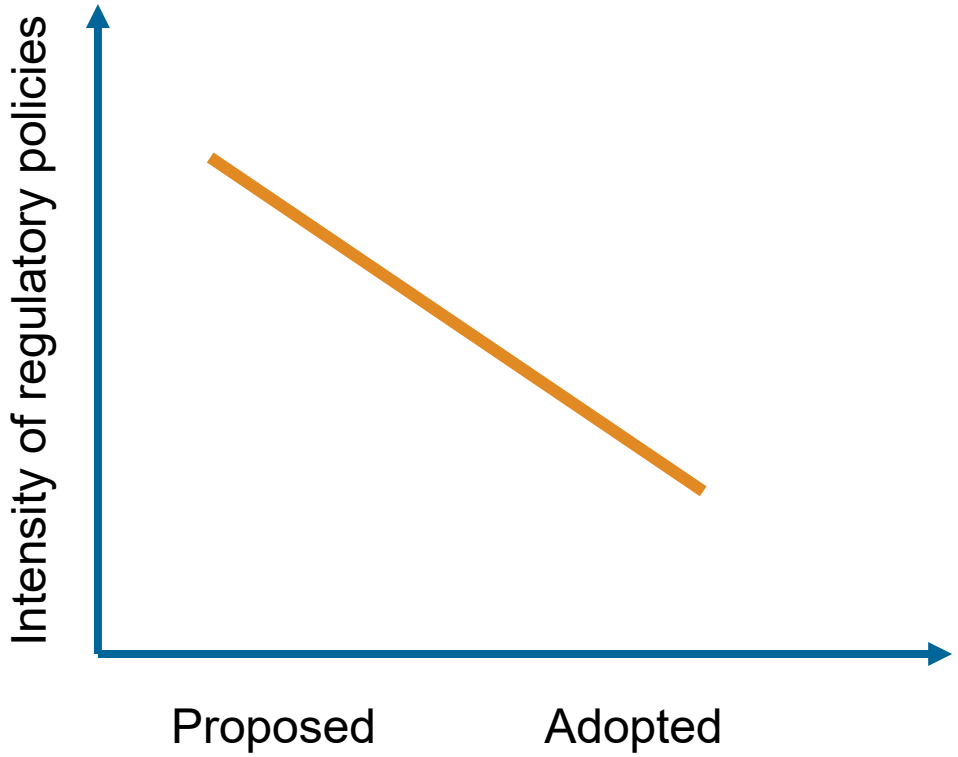

Intensity of regulatory policies
Proposed
Adopted

- Building Energy Act, Germany
- Renewable Heat Act, Austria
- EU energy performance of buildings directive (2024/1275)
  - MEPS (Minimum Energy Performance Standards) for non-residential buildings
  - National trajectories for residential buildings (mandatory for MS, but not for building owners)
- …

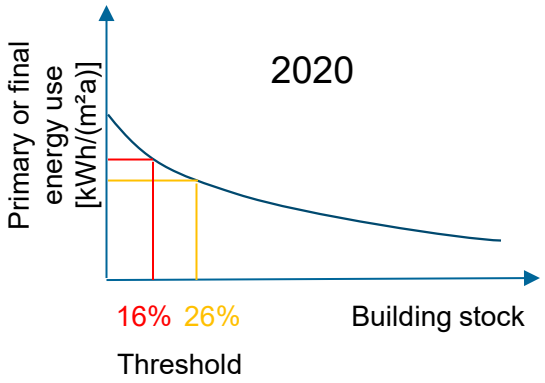


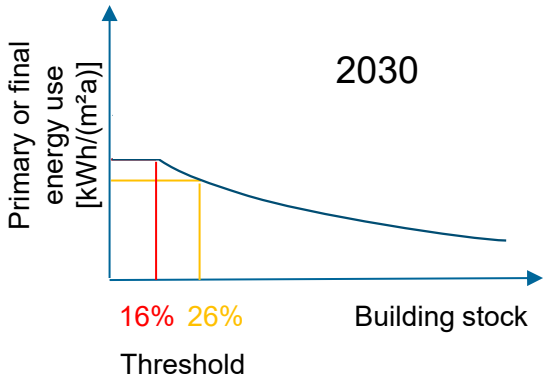
New policy provisions in the EPBD (2024/1275)

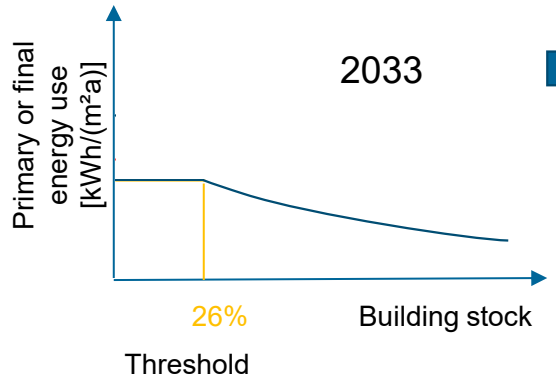
- Minimum Energy Performance Standards (MEPS) for non-residential buildings (Art 9 (1))
- Trajectories for progressive building renovation in residential buildings (Art 9 (2))
- Although the targets are defined, Member States (MS) have some degree of freedom in the implementation, in particular for Art 9 (2)

Minimum Energy Performance Standards (MEPS) for non-residential buildings (Art 9(1)) and trajectories of progressive building renovation (Art 9(2)) for residential buildings

Non-residential buildings - MEPS

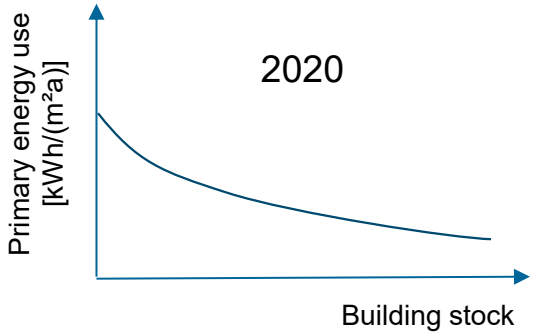


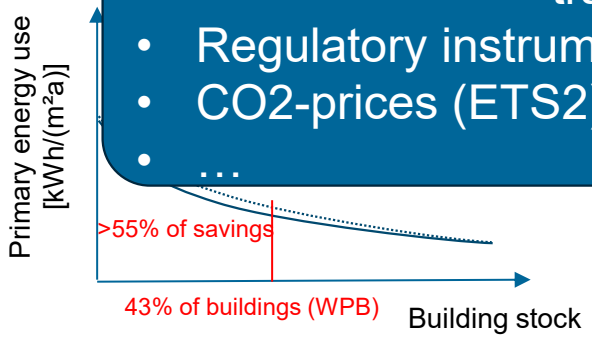




2040/2050

Residential buildings - trajectories

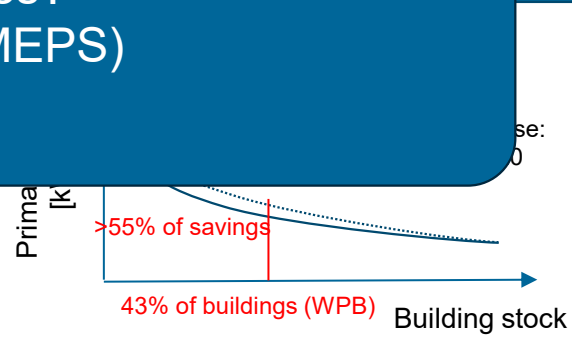




How to achieve progressive renovation trajectories?

- Regulatory instruments (MEPS)
- CO2-prices (ETS2)
- …

2040/2050



Target indicator for Art 9(2)
Trajectories of progressive building renovation for residential buildings

$$average\ specific\ primary\ energy\ demand = \frac{\sum_{i,j} PEF_i \cdot FED_{i,j}}{\sum_j GFA_j}$$

PEF ... $Primary\ energy\ factor$
FED ... $Final\ energy\ demand$
GFA ... $Gross\ floor\ area$
i ... $energy\ carrier$
j ... $building\ type$

Target achievement depending on

- Changes in final energy demand
- Changes in primary energy factors and mix of final energy carriers used
- New building construction and demolition (according to the Commission Guidance document)

Research questions

- How do different policy choices to implement MEPS in non-residential buildings (Art 9(1)) and the trajectories for progressive building renovation in residential buildings (Art 9 (2)) affect the overall achievement of targets in the national building renovation plan of different Member States and EU-27 as a whole?
- How do MEPS instruments compare with purely economic incentives in the form of CO2-prices?

- Project-and publication background:
  - EPBD.wise: Bringing European Building Policy to Life (2023-2026)
  - Pathways for Energy Efficient Heating and Cooling, ENER/2020/OP/0019, 2024
  - Transitioning buildings to full reliance on renewable energy and assuring inclusive and affordable housing. The Decarb_Inclusive project, supported by the ACRP program; 2020
  - Müller et al (2024), Why renovation obligations can boost social justice and might reduce energy poverty in a highly decarbonised housing sector. Energy Policy 191, 114168. https://doi.org/10.1016/j.enpol.2024.114168

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Methodology

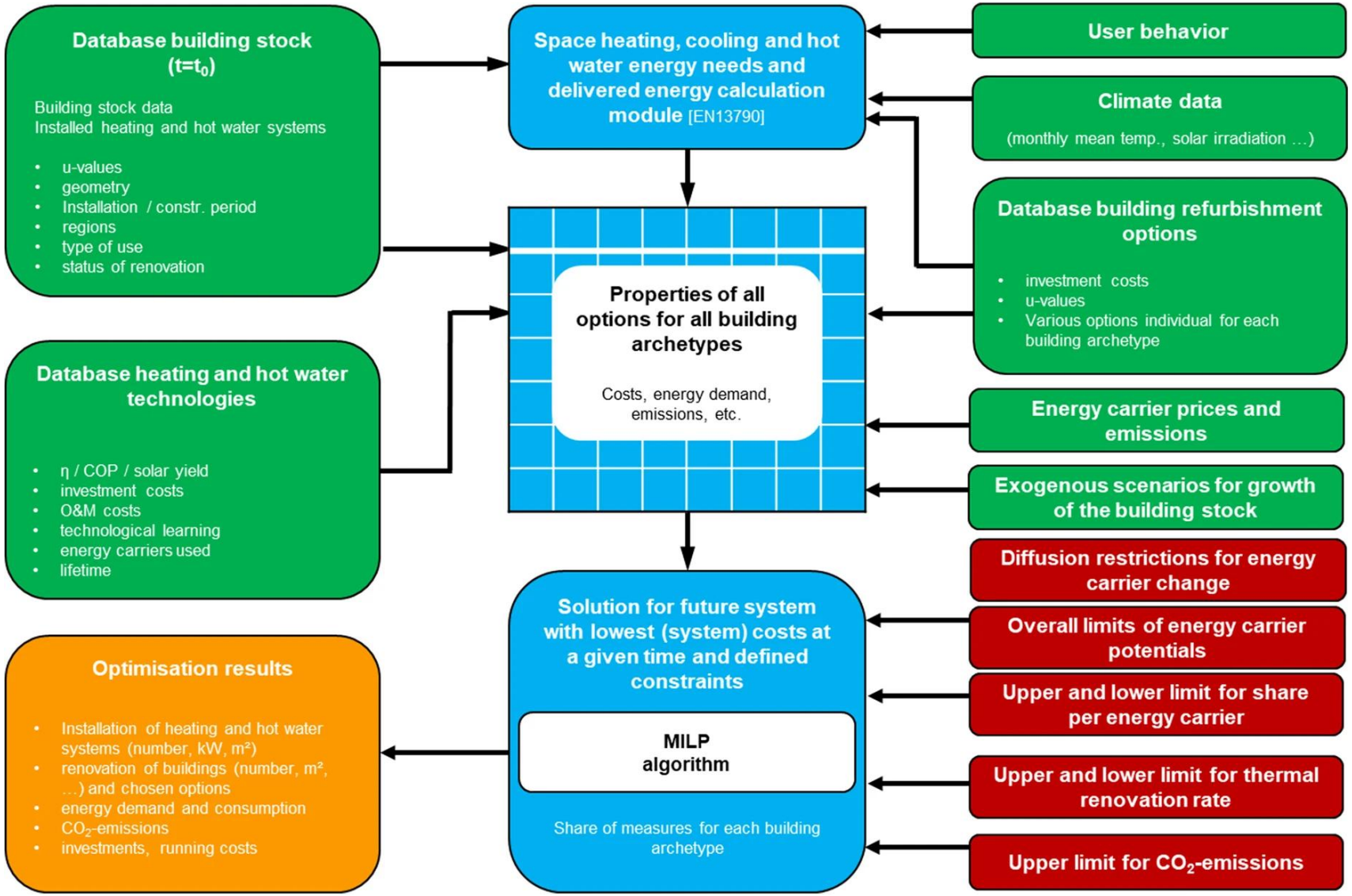
Adapt the building stock model Invert by updating the building stock data, cost database and policy settings according to Art 9 EPBD provisions.

Definition of MEPS-thresholds for non-residential buildings and the identification of worst performance buildings (WPB) for the residential sector (according to Art 9, EPBD)

Scenario analysis for EU-27 (presented for selected countries) by modifying different policy settings and testing to which extent the assumed policies achieve targets.

Invert/Opt

- Part of the Invert – Building stock modelling family
- MILP core
- Adapted by MEPS-thresholds and WPF definitions
- Updated calibration and building stock data



Reference: e.g. Hummel, M., Müller, A., Forthuber, S. *et al.* How cost-efficient is energy efficiency in buildings? A comparison of building shell efficiency and heating system change in the European building stock. *Energy Efficiency* **16**, 32 (2023). https://doi.org/10.1007/s12053-023-10097-6

Scenario Settings

Comparing five policy scenarios with varying CO2-prices, subsidies, and regulatory instruments:

Scenario	CO_2-price	Subsidy budget	Fossil ban	MEPS in RES	MEPS in Non-RES
Regulatory+	75 €/t	Moderate	Yes	Yes	Yes
Regulatory	75 €/t	Moderate	No	Yes	Yes
Mix	300 €/t	High (ETS2 linked)	No	No	Yes
Moderate	75 €/t	Moderate	No	No	Yes
Pure economic	300 €/t	High (ETS2 linked)	No	No	No

Primary Energy Factors (PEFs)

Electricity & DH: decreasing towards decarbonization target by 2050 OR constant at current levels

Residential MEPS Variant

Optional inclusion of MEPS for residential buildings (beyond EPBD requirements)

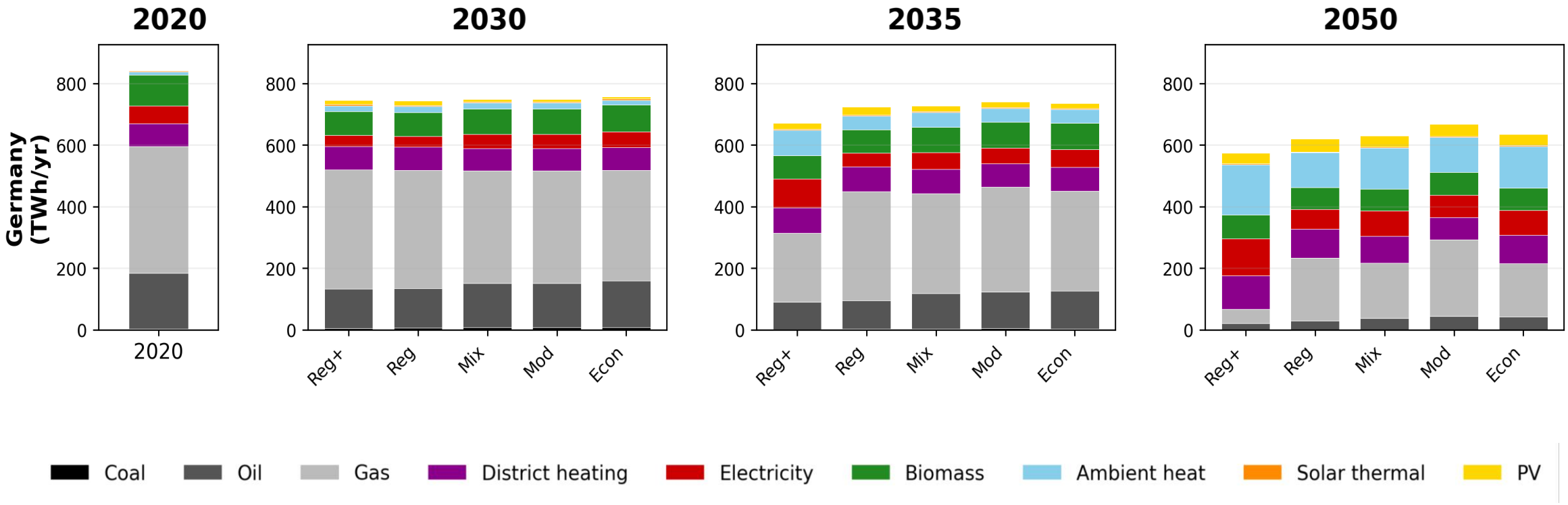
Higher CO2-prices (ETS2) lead to higher subsidies (linked to carbon revenues)

Selected countries

	Renovation+ (MEPS implementation, CO2 price at 75€/t, ban of fossil fuel boilers, constant PEF)					
Country	Croatia	Czechia	Germany	Ireland	Italy	Lithuania
Expected growth in gross floor area 2020–2050	-0.06	+0.06	+0.05	+0.27	0.00	-0.03
Share of direct fossil fuels 2020	0.38	0.41	0.71	0.83	0.60	0.20
Heating degree days 2016 [8]	2265	3248	3009	2744	1766	3830
Primary energy factor electricity	1.78	3.15	2.27	1.95	2.02	1.77

[1] GFA_2020 - GFA_2050) / GFA_2020, Data retrieved from Invert/EELab, https://www.invert.at/
[2] Source: Invert/EE-Lab model calculations (https://www.invert.at/) based on Eurostat energy balance data
[3] Source: Invert/EE-Lab model calculations (https://www.invert.at/) based on Eurostat energy balance data

Final energy demand, space heating, cooling, hot water, TWh, Germany



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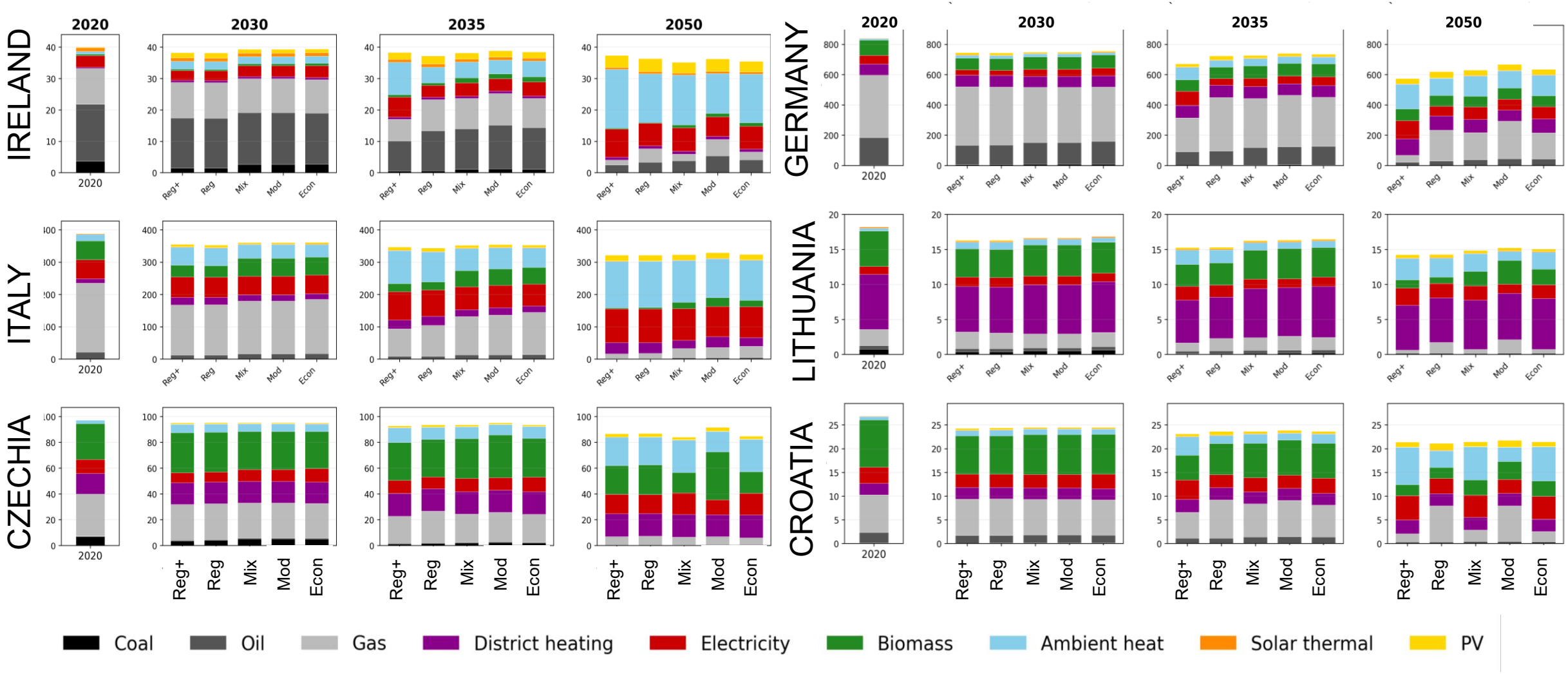
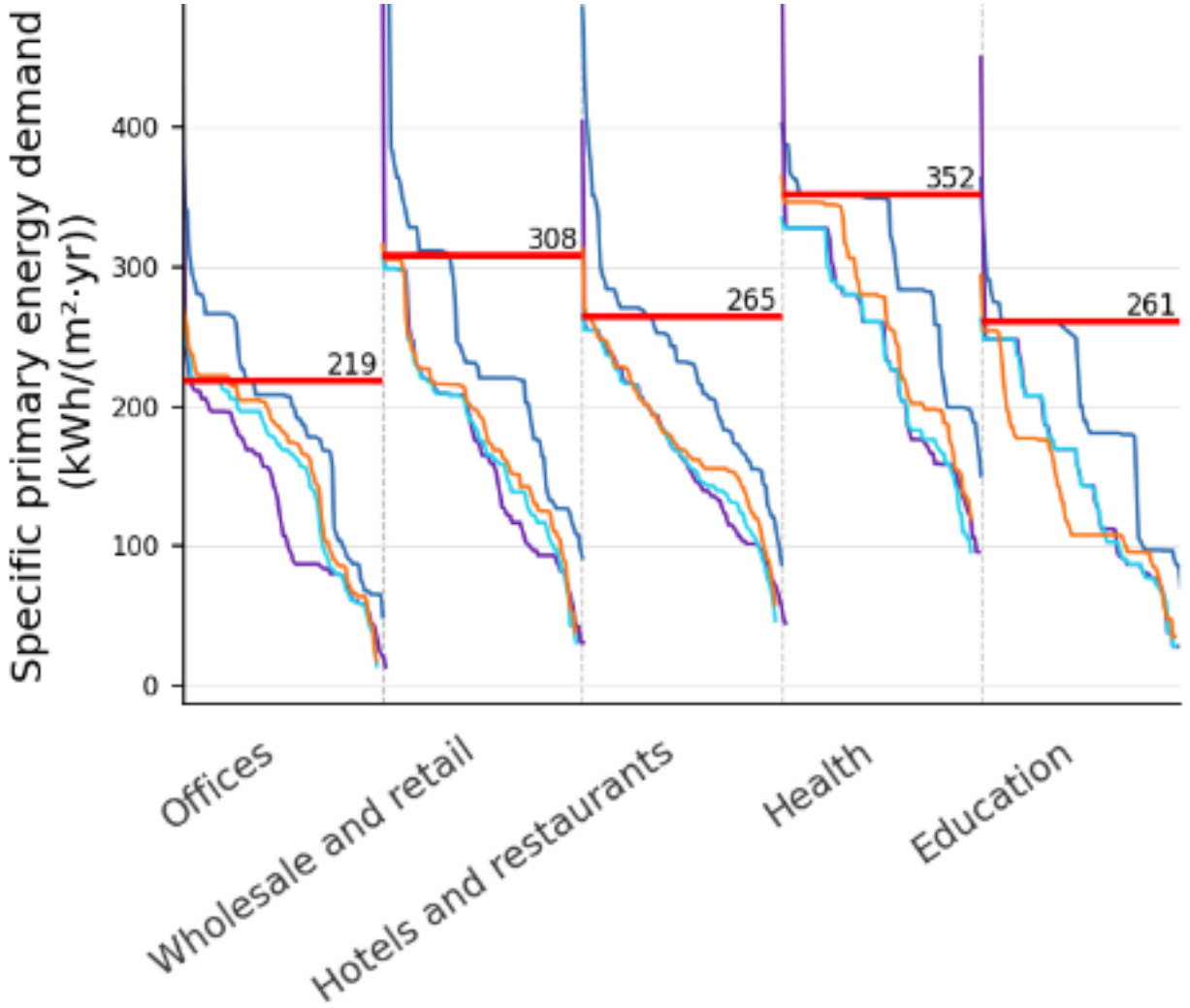


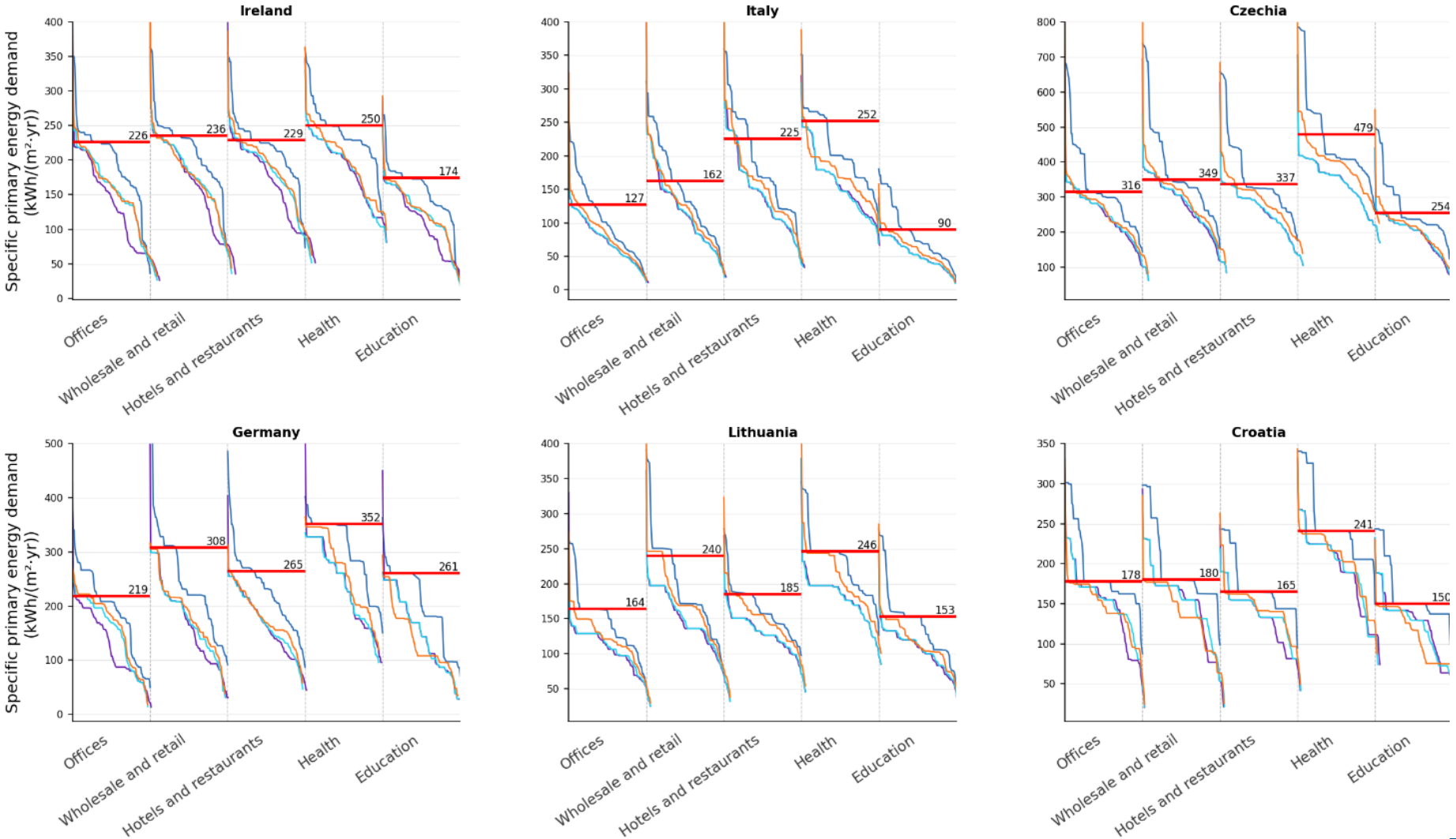
Specific primary energy demand over floor area and MEPS thresholds, Germany

- Specific primary energy demand and resulting thresholds vary between non-residential building categories
- MEPS can significantly drive down specific primary energy demand, if implemented stringently (penalties and clear regulatory framework)



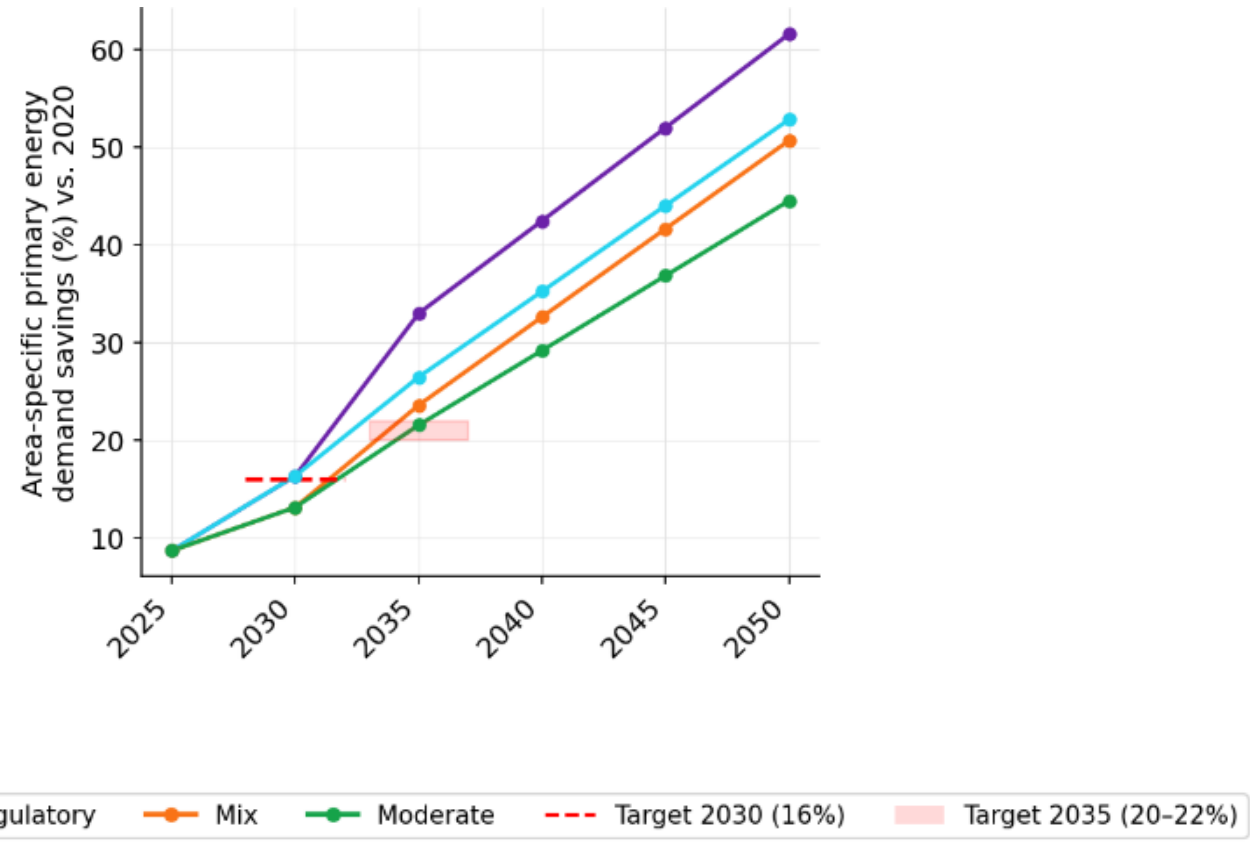
Specific primary energy demand over floor area and MEPS thresholds

- Despite some freedom of the model to choose a penalty and not implementing MEPS, scenario results lead to a mostly achieved threshold in 2033 in all scenarios implementing MEPS.



Target achievement Art 9(2) for residential buildings, Germany (decreasing PEF)

- In 2030, only regulatory instruments achieve the targets
- In 2035, all scenarios achieve the targets

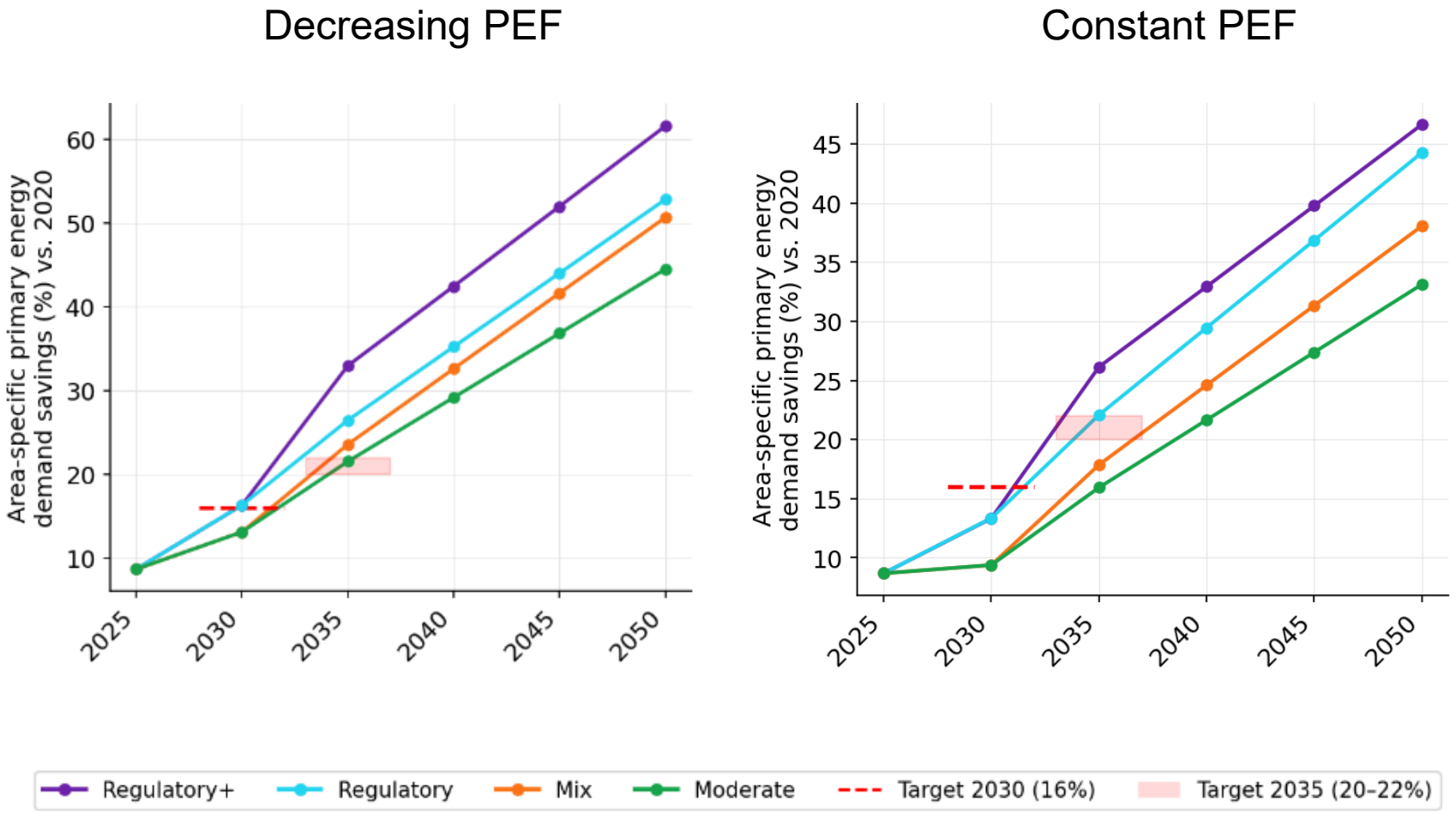


Target achievement Art 9(2) for residential buildings, Germany

- In 2030, only regulatory instruments achieve the targets
- In 2035, all scenarios achieve the targets

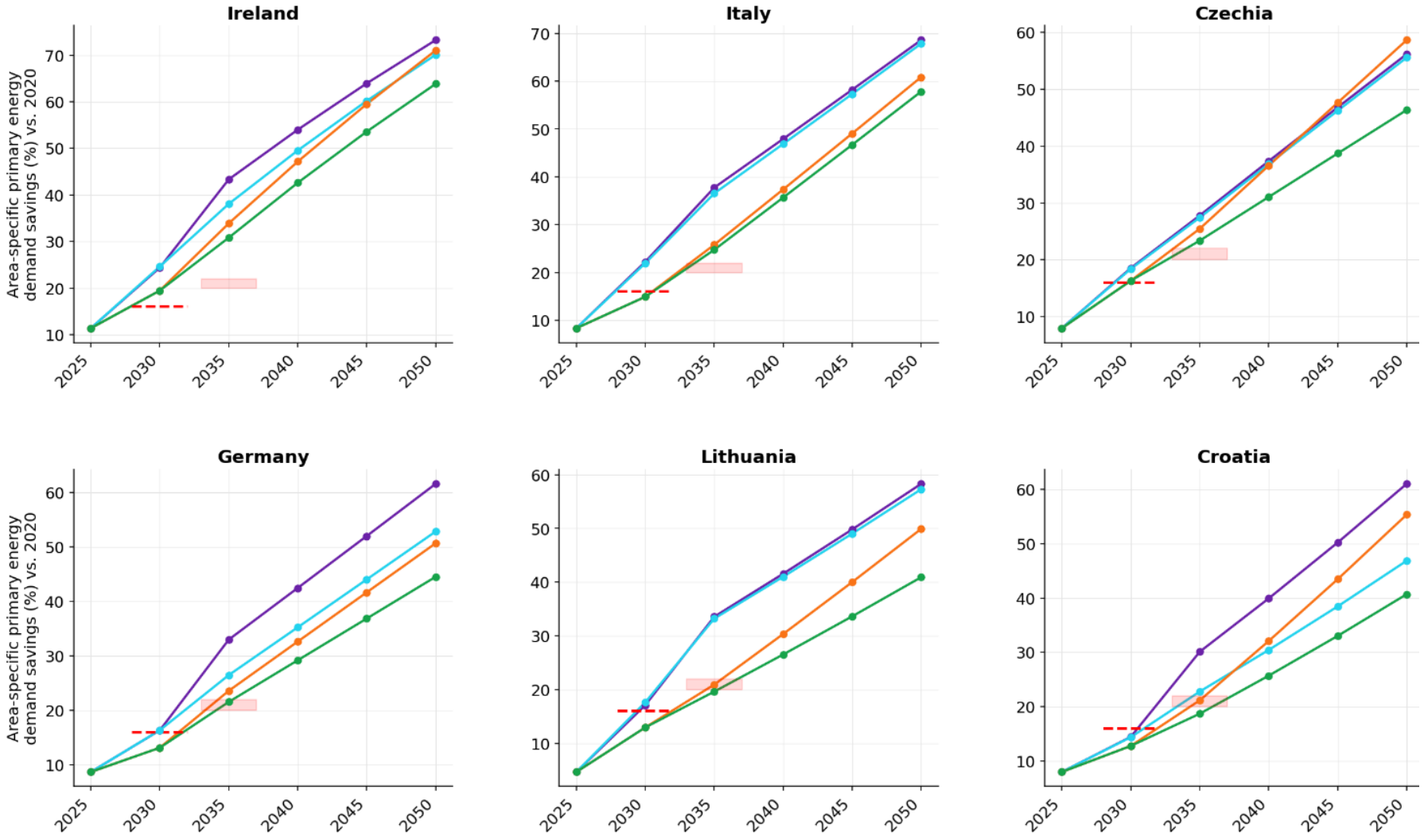
- Primary energy factors (PEF) are an important driver.

- With constant PEF, only regulatory scenarios achieve targets in 2035 (and in 2030 no scenario).



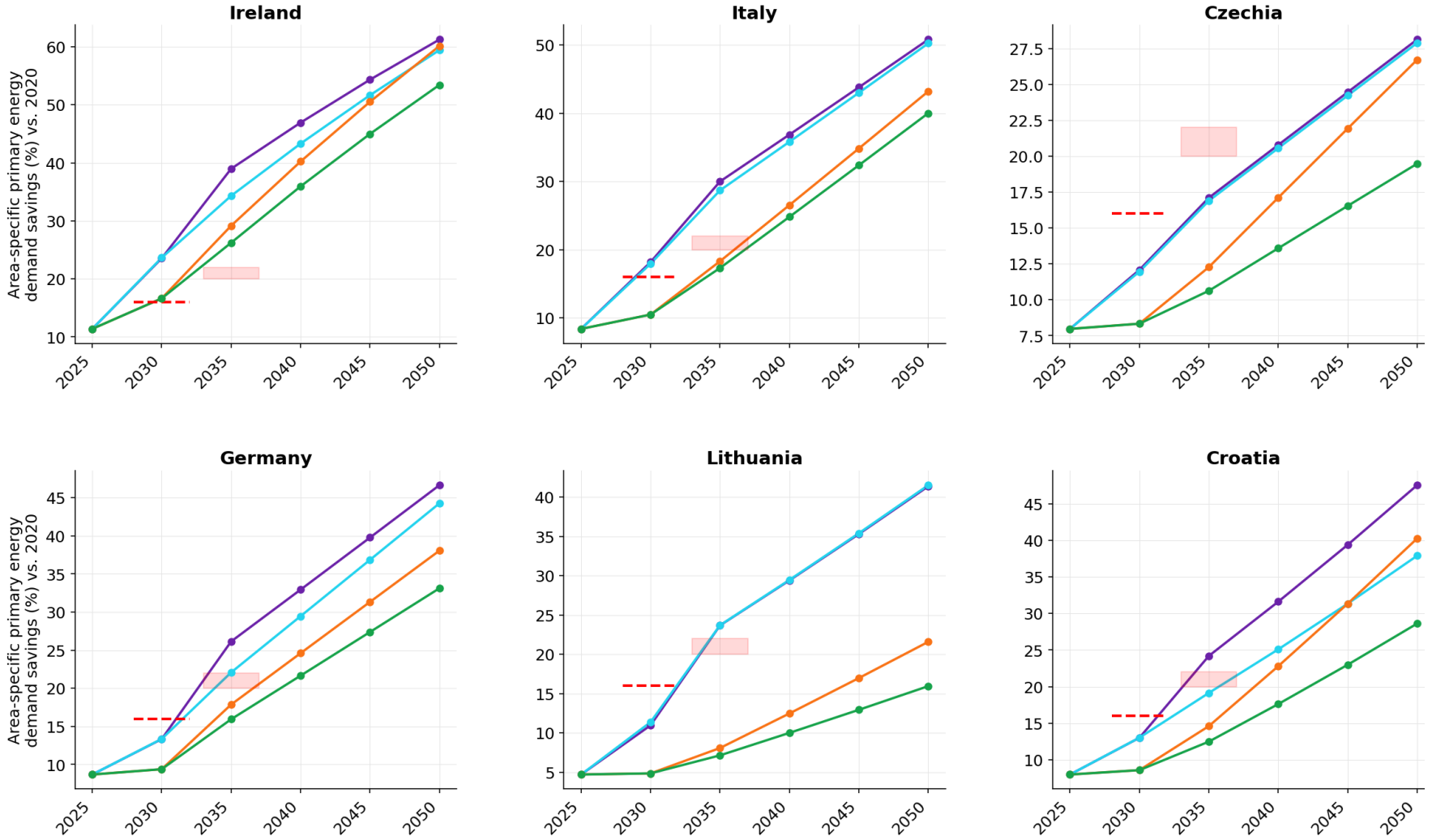
Target achievement Art 9(2) for residential buildings (decreasing PEF)

- Under decreasing PEF most countries achieve targets by 2035
- Growth of building stock makes it easier (IE in contrast to LT)
- High potential to reduce PEFs in some countries (e.g CZ)



Target achievement Art 9(2) for residential buildings (constant PEF)

- With constant PEF for most countries only strong regulatory measures lead to target achievement in 2035



Conclusions

- **PEF Reduction amplifies energy savings**
- **Electricity decarbonization: necessary but not sufficient**
- **Regulatory frameworks accelerate progress and necessary, in particular if PEF reduction would not progress as planned**
- **New buildings accelerate target achievement**
  - Including new ZEB construction (per EC guidelines) contributes significantly to target achievement in some MS by diluting average PE use across the stock.
  - Not necessarily the initial intention of the EPBD

- Specifying the contribution of PEF changes and new building construction in the national building renovation plans would help to understand the real ambition level of “progressive building renovation”.

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