

International Seminar on De-carbonizing Buildings of Seoul
Seoul, 13 April 2023

Strategies for Decarbonizing Buildings in Germany and the EU

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**Global think tank for sustainable development,
owned by federal state of NRW**

Founded: 1991

Around 300 employees,

4 Research Divisions:

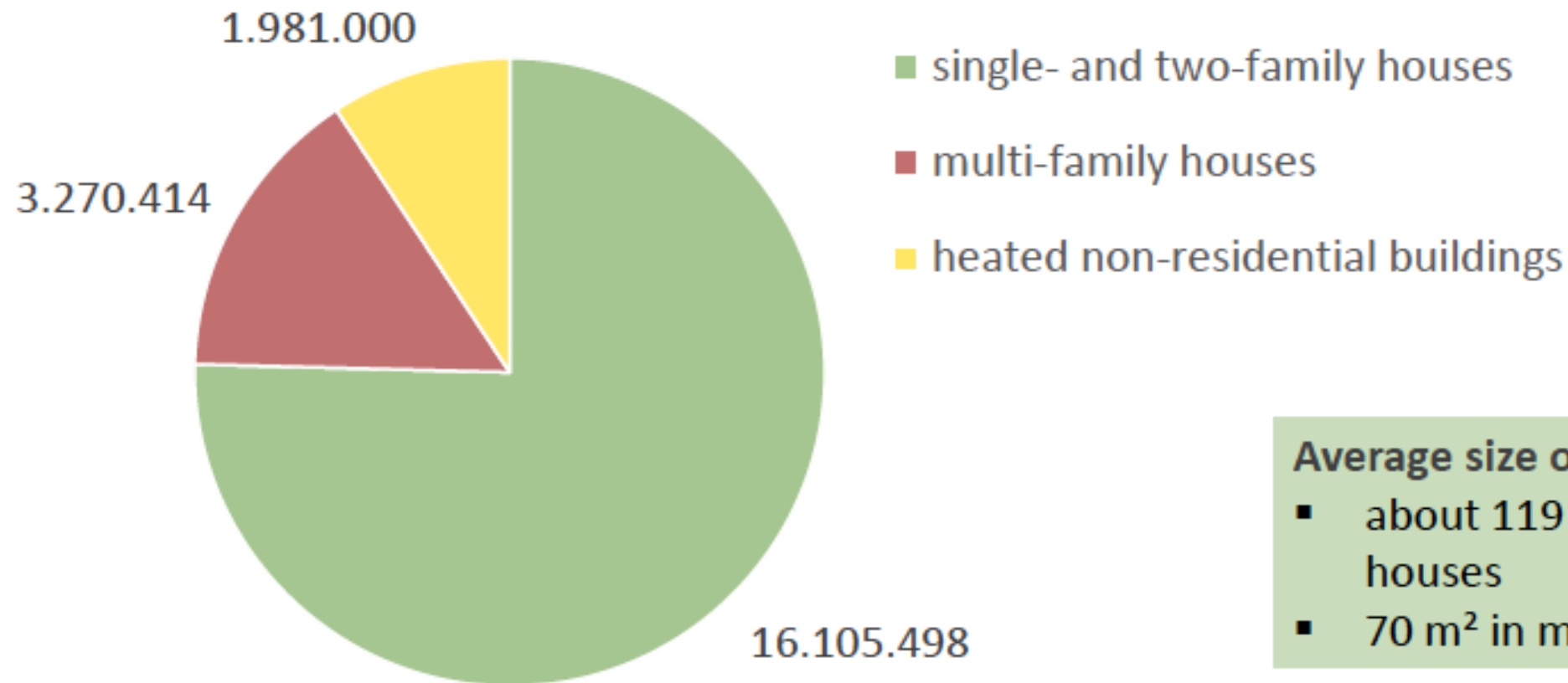
- Future Energy and Industry Systems
- Energy, Transport and Climate Policy
- Sustainable Production and Consumption
- Circular Economy



- 1. Characteristics of the Building Stock in Germany**
- 2. Basic technical decarbonization strategies**
- 3. Potentials and benefits**
- 4. Policy targets, strategies and instruments in Germany**
- 5. Policy targets, strategies and instruments in the EU**
- 6. Conclusions**

Size of the building stock in Germany

- Ca. 40 mn dwellings, half of which are rented (mostly multi-family houses)
- Total heated floor area 5.6 bn m² (3.8 bn m² residential; 1.8 bn m² non-residential)
- Numbers of buildings: see graph



Average size of the dwellings:

- about 119 m² in single- and two-family houses
- 70 m² in multi-family housings

Source: dena 2022, based on Destatis 2022

Growth of the residential building stock in Germany

- Rate of new build less than 1% per year, but still a cause of embedded carbon and land use change
- Can we break this trend?

Inhabited floor area/person

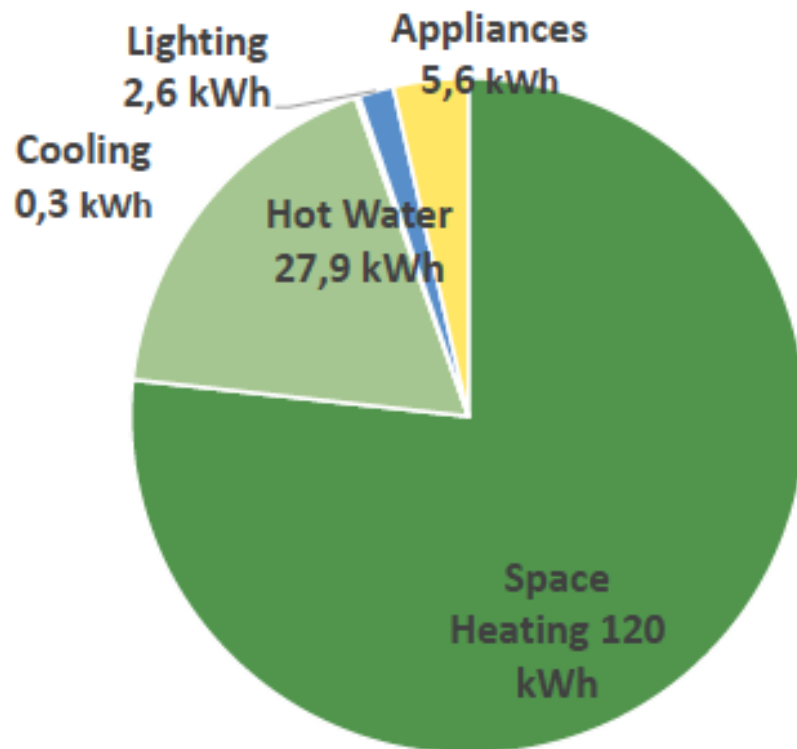


Source: Destatis 2023

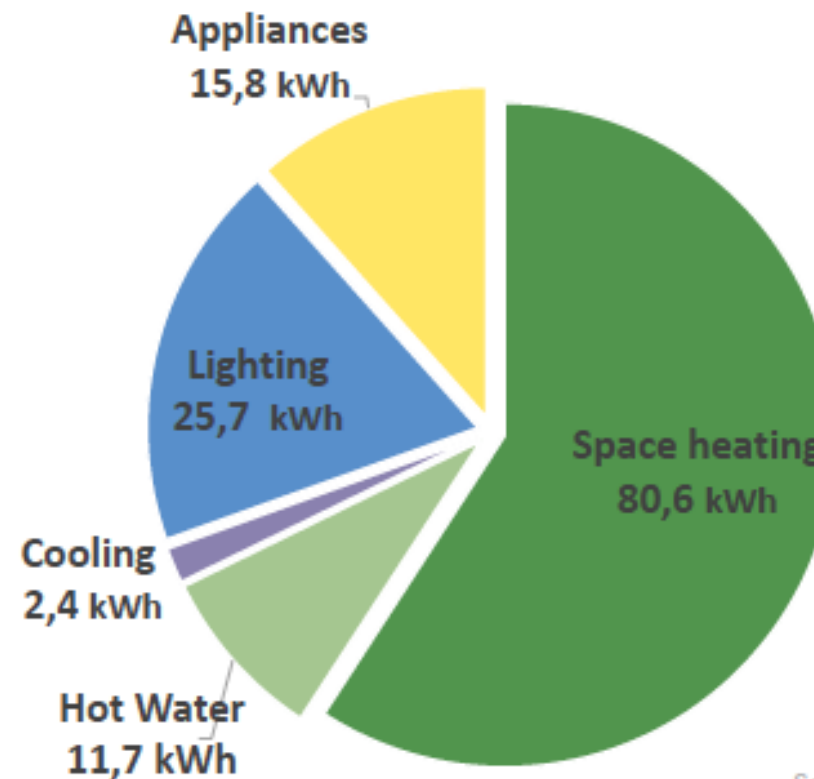
Energy consumption and intensity in Germany's buildings

- In total, around 850 TWh/yr, of which ca. 600 TWh/yr residential
- 2/3 fuels and heat; of which 50% gas, 25% oil; 1/3 electricity
- See graph for shares of end uses and energy intensity (ca. 3,500 HDD/yr; 10 to 50 CDD/yr)

kWh/m²/2020 (residential buildings)



kWh/m²/2020 (non-residential buildings)



Source: BMWK Energy Data 2022

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1. Insulate the building envelope (save 70 to 80% vs. pre-1980 practices); save power

- Thermal insulation: Walls ($U < 0.2 \text{ W/m}^2/\text{K}$), roof (same), windows ($U < 1 \text{ W/m}^2/\text{K}$), basement ceiling
- Heat recovery ventilation (not very common yet but needed)
- Retrofit fan, lighting, and pumping systems to save power (particularly non-residential)

2. Heating systems based on renewable energy sources

- Heat pumps with green electricity (on-site and grid): 60+ % of all buildings in the decarbonized future
- Green district heating from heat pumps, solar thermal, geothermal, waste heat: ca. 30%
- Rest: mostly biomass

3. Optimize building use: stop growth in dwelling/building area per capita

- Support exchange of dwellings and restructuring; also for non-residential

Basic technical decarbonization strategies (new build)

⇒ **The same strategies as for existing buildings**

⇒ **Achieve (nearly) zero-energy or plus-energy buildings**

⇒ **plus:**

4. low-carbon building designs and materials

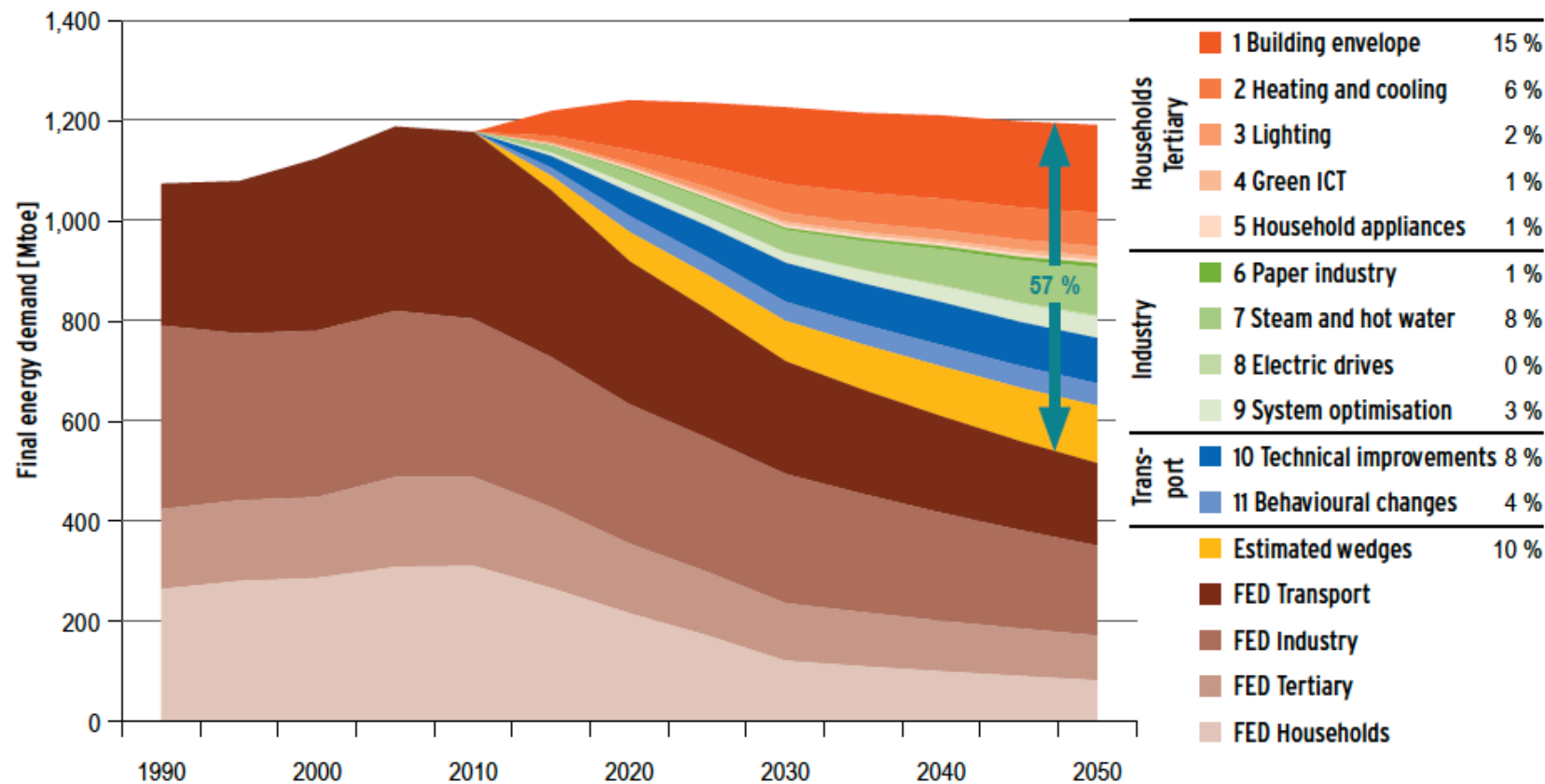
➤ **Reduced mass**

➤ **E.g., wood for construction; biomass-based insulation materials**

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Energy efficiency improvement: key for securing energy supply and mitigating climate change

**Energy Demand and saving potentials in the EU by 2050:
57% on final energy
=> worth €500 bn per year in 2050**

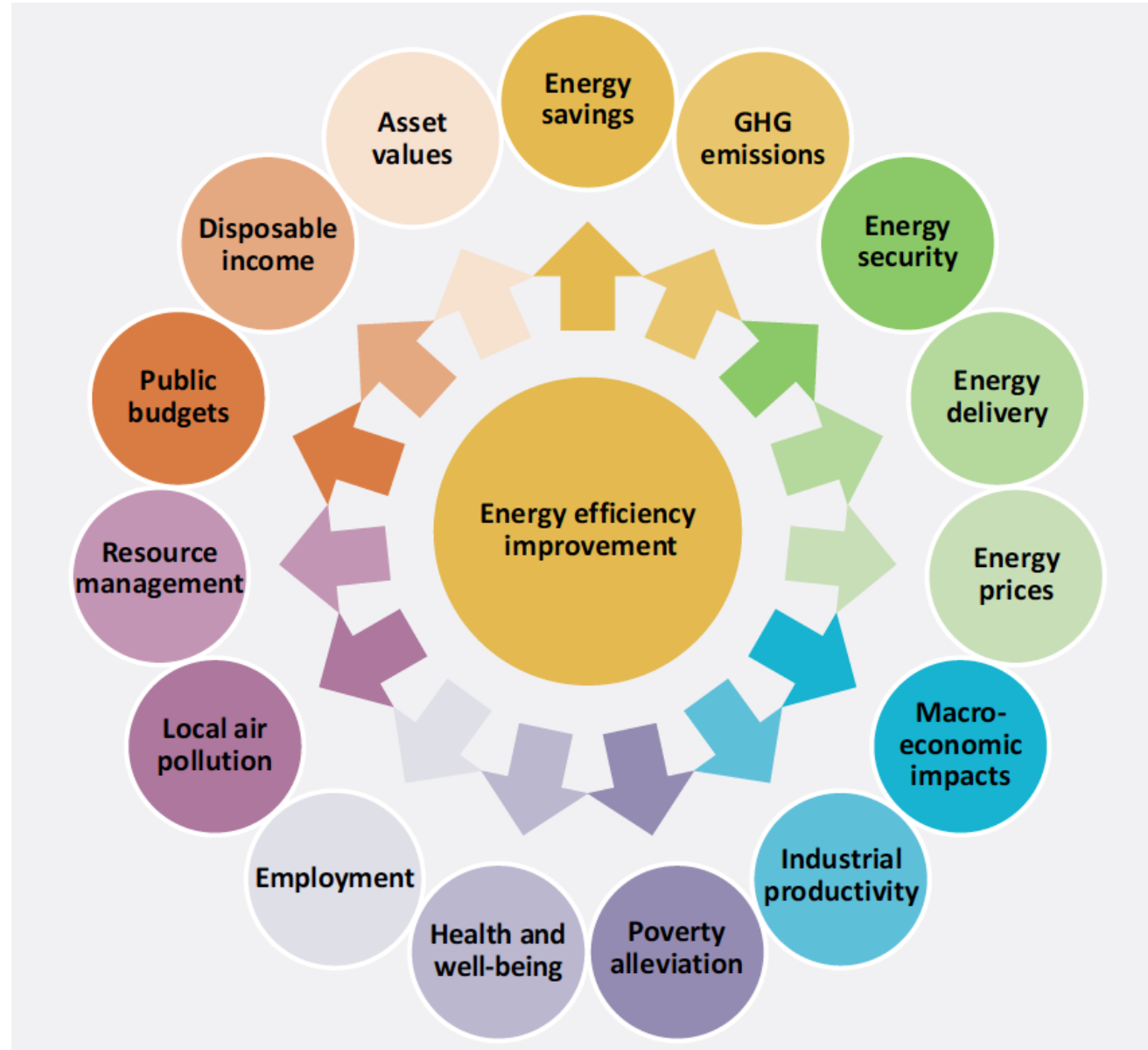


Source: Fraunhofer ISI (2012)

Energy Efficiency Policy: Harness the multiple benefits

Ground-breaking publication
by the IEA (2014):

Capturing the Multiple Benefits of
Energy Efficiency

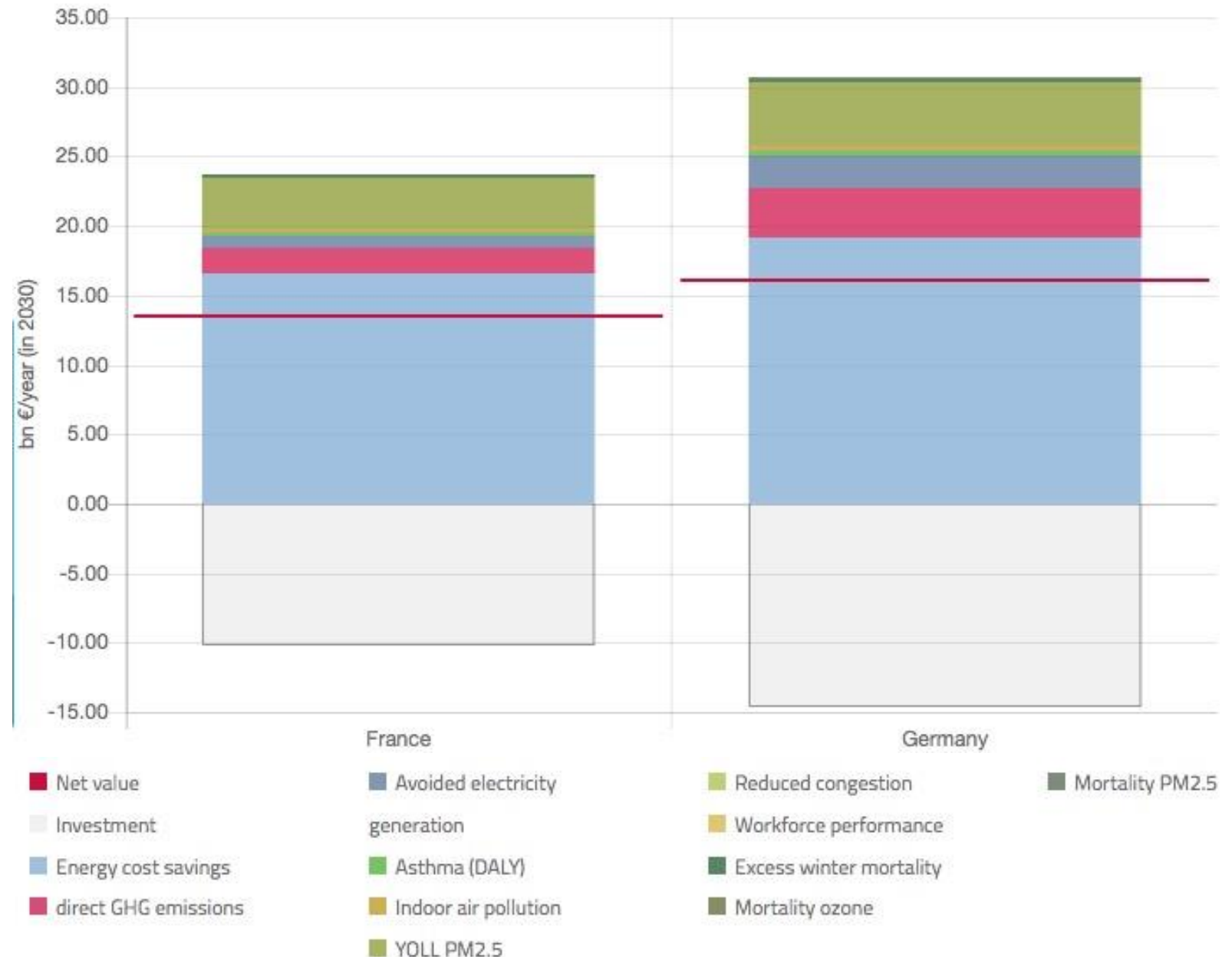


Energy Efficiency Policy: Harness the multiple benefits – results and tools in the EU

EU project COMBI:

- Calculating and Operationalising the Multiple Benefits of Energy Efficiency in Europe (2015-18)
- Quantified Multiple Impacts for a scenario similar to 2018 EU energy efficiency targets for 2030
- Impacts that can be monetised improve cost-effectiveness by 30 to 50 %
- All results online:
<https://combi-project.eu/tool/>

New project MICAT will launch interactive tool soon:
<https://micat-project.eu/>



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Ruling of the Federal Constitutional Court:
... obliges the state to take action to "prevent any future disproportionate restrictions in the fundamental liberties of today's young generation."



Tightening the targets of the Climate Law (6/2021)
 in comparison to the status of the old Climate Law (2019)

Maximum permissible sector budgets
2020-2030: A strong political self-commitment!

Germany to achieve climate neutrality earlier

- Greenhouse gas emissions
 - By 2030: 65% less CO₂ (current target 55 %)
 - By 2040: 88% less CO₂
 - 2045: Climate neutrality (current target 2050)
- Permissible annual CO₂ emissions for individual sectors such as energy, industry, transport and buildings to be reduced.



Annual emission budgets in millions of tones of CO ₂ equiv.	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Energy	280		257								108
Industry	186	182	177	172	165	157	149	140	132	125	118
Buildings	118	113	108	102	97	92	87	82	77	72	67
Transport	150	145	139	134	128	123	117	112	105	96	85
Agriculture	70	68	67	66	65	63	62	61	59	57	56
Waste and others	9	9	8	8	7	7	6	6	5	5	4

Enhanced targets

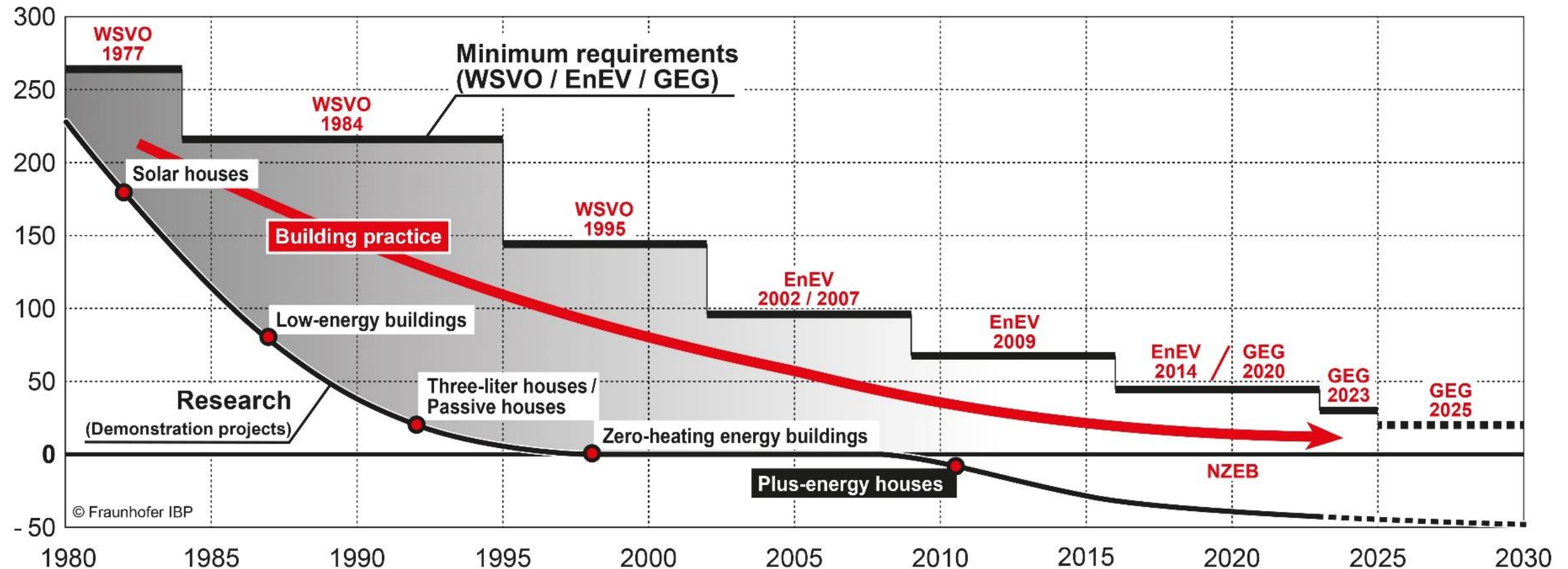
- ▶ Since 2021, zero carbon target for 2045 (↔ Fridays for Future et al./ 1.5°C: 2035 needed)
- ▶ New government (social democrats, greens, liberals) since 2021:
 - 80 % of renewables in electricity by 2030 (now 50%) => new capacity/yr of PV, wind: 4 to 6 times vs. 2021
 - Hydrogen: 10 GW of electrolysers by 2030
 - Strengthen building codes, reallocate funding to renovation (less for new build)
 - 65 % of renewables in any new heating system from 2024; 50% of green heat by 2030 (now 17%)

Response to crisis

- ▶ Substitute Russian gas, oil and coal by other suppliers (complete by end of 2022), energy efficiency, renewables
- ▶ Nuclear phase-out (last 3 reactors) delayed by 3.5 months (15 April 2023 instead of 31 December 2022)

Development of energy-efficient construction and energy building codes in Germany

Primary energy need semi-detached house – Heating [kWh/m²a]



Source: Hans Erhorn, Head of Department of Energy Efficiency and Indoor Climate, Fraunhofer IBP

Energy performance requirements for new buildings in Germany

With the coalition agreement of 2021 and the "relief package" of March 24, 2022, the German government decided to tighten the energy requirements for new buildings in the Building Energy Act (GEG)

- **Since 2016**, new buildings must be constructed in such a way that the **primary energy requirement is a maximum of 75% of a reference building** (2005 standard)
- **As of Jan. 1, 2023**, the new-build standard was tightened to the previous subsidized standard *Effizienzhaus (Efficient House) 55*, but only for the primary energy requirement, not for thermal insulation
- **From 2025**, the previous *Effizienzhaus 40* subsidy standard is to become the mandatory standard for new buildings

Financial incentives for energy efficiency renovation and RES heating systems in Germany

- Budget funding for financial incentives and soft loans for the energy efficiency of buildings and the use of renewable heat is provided since ca. 2005
- The last major revision of the programs was on 01.07.2021.
- Renovation rate used to be ca. 1 % per year; should accelerate to at least 2 %, better 3 to 4 % per year
- Funding now focuses on the **renovation of buildings and RES heating systems**; little funding is provided for low-carbon new construction.
- The total amount of government spending for these programs used to be around € 2 billion/year and was increased to around € 5 billion/year in 2021/22 as a countermeasure against the recession caused by Covid-19. The government plans to increase it to **€ 12-14 billion/year in 2023 to 2026.**

New heating systems to run at least 65% on renewable energy sources

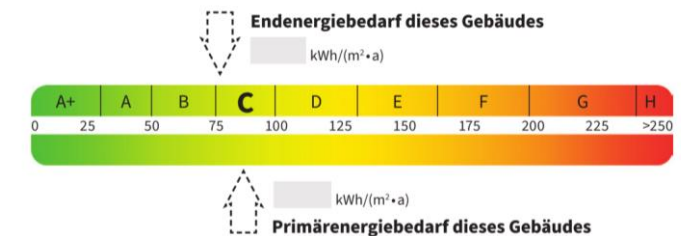
- From 2024, every newly installed heating system is to be powered by at least 65% renewable energy. This means:
- ... in new buildings and when replacing existing heating systems, a renewable heat generator (e.g., heat pump) must always be installed at least for the base load that covers at least 65% of the heat demand.
- ... fossil heat generators may only be used as a supplement for peak loads on particularly cold days.
- ... the standard business of heating engineers and contractors (exchange of gas/oil for gas) is no longer permitted.

This also means new challenges:

- As early as 2020, there was a shortage of around 65,000 skilled installation workers in Germany
- There is a high need for qualification programs in renewable energies
- Investment decisions for building owners are becoming increasingly complex, so the need for consultancy is also rising

Other existing and planned policies for decarbonizing the building stock in Germany

- Several staged **energy advice and coaching** programmes; **renovation passport** (building-specific roadmap for staged ‘deep’ renovation, “individueller Sanierungsfahrplan”), voluntary, with 80% subsidy of energy audit costs
- **Energy Performance Certificates** required for sale and lease, including rudimentary recommendations for energy efficiency renovation
- **Municipal heat planning** mandatory in two federal states, soon nationwide; with financial support for local authorities
- **Energy taxes plus CO₂ price** (currently 30 Euros/tonne; increase to 60 Euros/tonne by 2026); landlords may pass CO₂ price through to tenants but only for very energy-efficient homes; if inefficient, landlord pays up to 90%
- Landlords may **increase rent by up to 8% per year** of incremental costs of energy efficiency renovation (above “normal” maintenance)
- **R&D** on energy-efficient and low-carbon buildings



Recommendation for further improvement of the policy package for decarbonizing the building stock in Germany

	Stopping growth in floor area	Energy efficiency	Green heat
Signal to market	Sector targets Climate and Energy: Fit for 1,5 degrees		
	Targets on maximum floor area	Targets on renovation rate & depth, oil and gas phase out	
Direction & Support	Strengthen governance: dena, BfEE, Länder energy agencies		
	Financial support to local one-stop-shops and city district management		
Cost effectiveness	Step up CO ₂ price faster and further after 2025, use revenues to fund the transition; make price pass-through to tenants depend on energy efficiency standards		
Information basis	By 2028: Building Renovation Passports for all buildings built before 2001; Master plans for cities/districts		
Standards & Funding	Support remodelling, moving	Min. energy performance standards in existing buildings, KfW40+ in new build; funding to make it cost-effective, incl. for tenants	
			heat networks and green feed-in
Innovation	For example project aggregation, industrial preconstruction, support for increase in production		
Capacity	Capacity building, digitalisation and communication campaigns		
Incitement	Demonstration and pilot projects, networking and exchange		

Source: Wuppertal Institute 2022

Could we achieve GHG neutrality in heating by 2035 already?

Operative targets that would be needed

Deep Energy Renovation:

- at least 3 %, better 4 % per year, to highly efficient component standards (today: 1 %/yr)

Heating systems (20 mn buildings):

- From 2025 ca. 1 mn heat pumps/year (2023: 0.24 mn), 12 mn new units by 2035: 60+% of heat demand
- 50 mn m² new solar thermal rooftop systems, ca. 500.000 units/year from 2025
- From 2025, connecting ca. 150.000 buildings per year to district or neighbourhood heat: 30% of heat demand (15% today)
- District heat generation: in 2030, 65% from renewable energies (17% today), 2035 nearly 100%

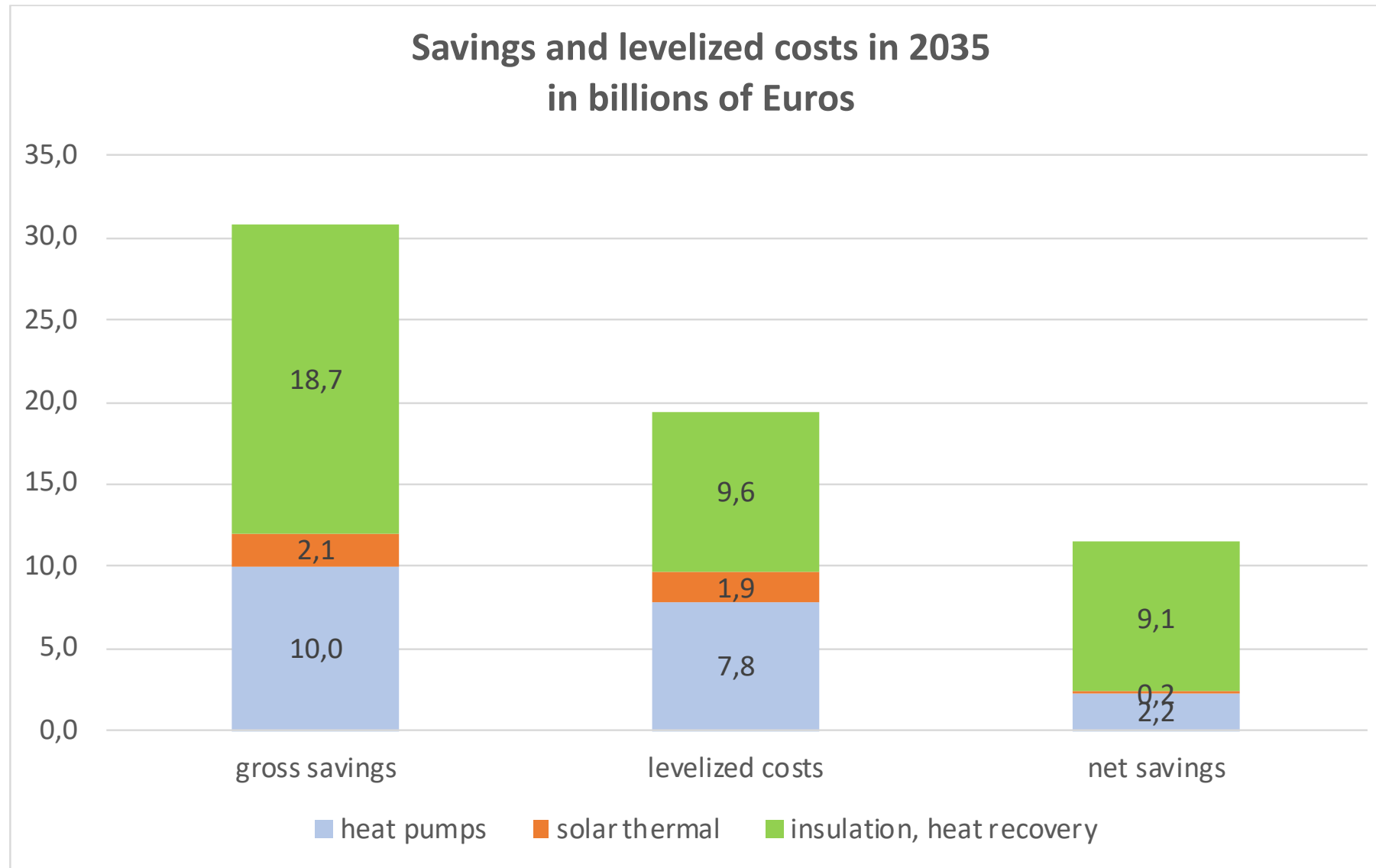
=> **Impossible with financial incentives alone, will require regulation**

Source: Thomas et al. 2022: „Heating without oil and gas by 2035“

6-point immediate action programme suggested:

Legislation	Financial incentives
1. law on phase-out of using oil and gas boilers <ul style="list-style-type: none">• from 2024, prohibition to install oil and gas heaters;• step plan for mandatory exchange by 2035	2. Existing financial support programme for sustainable heating in individual units adapted to make boiler replacements possible
3. Minimum energy performance standards for inefficient buildings: increased standards must be achieved over time , with environmental criteria for the insulation	4. Existing financial support programme adapted for deep energy renovation of at least three per cent per year of the building stock with environmental criteria
5. Renewable Heat Network Law: set targets: <ul style="list-style-type: none">• District heat completely decarbonised by 2035,• expanded (30 % of heat demand in buildings by 2030),• converted to low temperature heat networks;• Plus further regulations, i.a.• mandatory heat demand and supply plans,• financial support for them,• price regulation for district heat	6. financial support programme for future-proof heat networks (already in place: up to 45% of investment as grant, but needs increased funding)

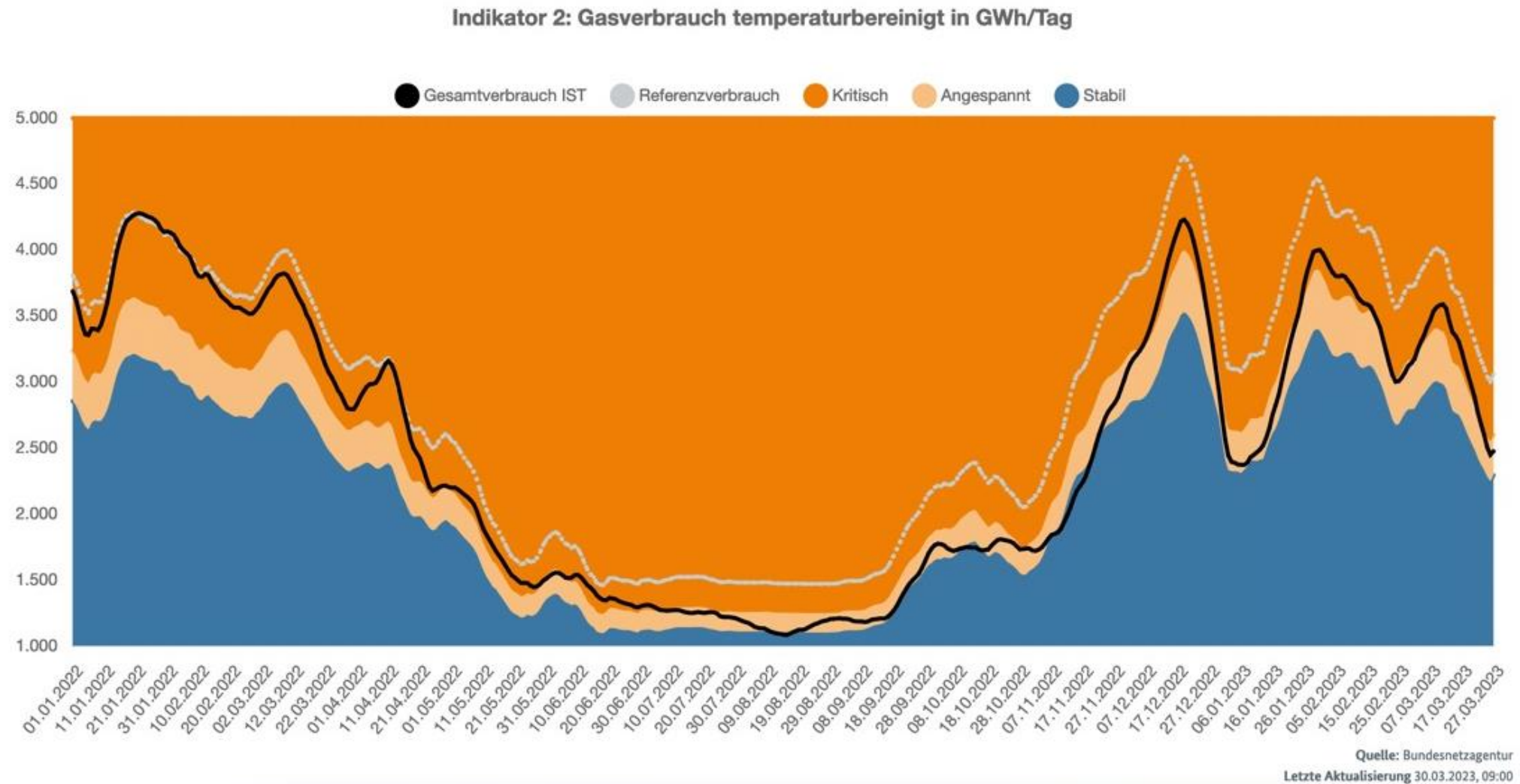
Study „Heating without oil and gas by 2035“: Savings and levelized costs



Source: Wuppertal Institut

Gas consumption in Germany in GWh/day

- White dotted line: calculated based on degree-days and averages 2018-21
- Black line: actual consumption in 2022/23
- Reduction of 19% in winter 2022/23
- Gas prices to consumers doubled vs. 2021; capped at 12 ct/kWh (7ct for industry)



Source: Bundesnetzagentur (Federal energy regulation authority)

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Overarching targets for energy efficiency and renewable energies

Energy Efficiency Directive (EED) as of 2018 (first: 2012) – Directive (EU) 2018/2002

- Art. 3 Energy efficiency target for 2030: **32.5%** vs. reference scenario of 2007 (defined as target max. consumption: 1,126 Mtoe of primary, 846 Mtoe of final energy)
=> became basis for new reference scenario of 2020
- Member States to formulate indicative own targets and policies (National Energy and Climate Plans, every 5 years); European Commission checks if they sum up to the EU target; if not, recommendations to increase ambition
- Actual values in 2020 (Covid-19!): 1,236 Mtoe of primary, 907 Mtoe of final energy
- Art. 7 targets: 0.8 % per year of energy savings to be proven every two years by each Member State through evaluation of energy efficiency policies and energy services

Renewable Energy Directive (RED) as of 2018 (first: 2009) – Directive (EU) 2018/2001

- Target for share in gross final energy use for 2030: **32%** (ca. 270 Mtoe, + 70 Mtoe vs. 2020)

Energy Efficiency Directives for Buildings and Equipment

Directive on the Energy Performance of Buildings (EPBD), Directive (EU) 2018/844

- First in 2002; requires Member States to have energy building codes for new buildings and ‘major renovation’, requires Energy Performance Certificates, advice, financial incentives to be linked to energy efficiency levels, regular inspection of boilers, etc.
- Amendment of 2018: e.g. stricter standards for new buildings (nearly zero energy buildings) by 2020, but still large variation between Member States

Energy Labelling and Ecodesign

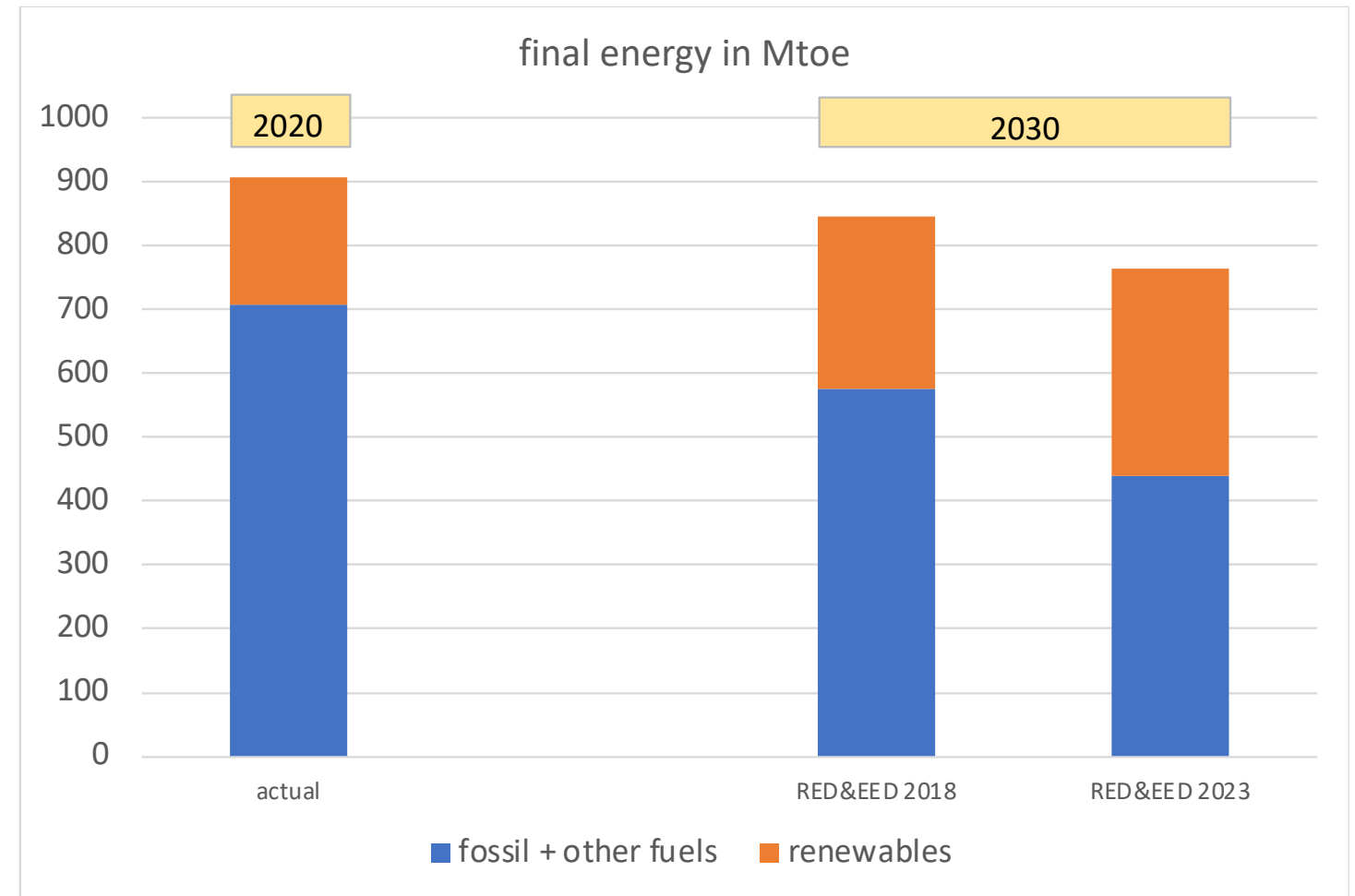
- Regulation 2017/1369 on energy labelling: back to A to G scales, A to be empty at start
- Ecodesign Directive (2009/125/EC) implemented for almost 30 product groups including heating systems, fans, circulator pumps, lighting products
- Directly valid in all Member States

The EU's enhanced energy and climate targets and response to the energy crisis

**EU zero carbon target 2050,
minus 55% by 2030**

**=> New EED/RED targets for 2030
(March 2023)**

- ▶ **Energy efficiency target**
11.7 % vs. 2020 reference (993 Mtoe primary, 763 Mtoe final energy):
12/10 % less than EED 2018 target
- ▶ **Renewable energy target**
42.5 % of gross final energy
(10.5 % more,
but only+ 54 Mtoe vs. RED-II)
- ▶ Means **38% less fossil** (and nuclear)
input for final energy than 2020



Eurostat and legal texts / own calculations and graph

2023 recast of the EED – other provisions

- New Art. 3 introducing the Energy Efficiency First principle for large projects and policies
- Art. 7 now Art. 8, targets strengthened: average 1.49 % per year, increase to 1.9 % (2030)
- Several provisions on energy efficiency for vulnerable energy consumers/customers

2023 recast of EPBD, Ecodesign (ongoing):

- EPBD to define *zero energy buildings*;
require *minimum energy performance standards* for worst-performing buildings by 2027/2030/2033;
require *harmonised A to G scale* for energy performance certificates;
introduce voluntary *renovation passports* (staged energy efficiency renovation)
- Ecodesign Directive for energy-related products (2009/125/EC) sets framework for regulations that so far aim for high energy savings whenever cost-effective;
revision planned to add requirements towards *circular economy*

6. Conclusions

- Energy efficiency in buildings has **multiple benefits**. It usually is a win-win-win option for all aspects of sustainability, including limiting global warming to 1.5 ° C, energy supply security, mitigating high energy prices
- We need much more **evaluation and communication** of these multiple benefits – to citizens, companies, and politicians!
- Energy efficiency will still only to a part happen by itself
- because of the manifold and strong market **barriers**
- **Targets and strategies, governance and policy packages** for energy efficiency and sufficiency are needed to tap the full potential and develop energy efficiency markets – **from the EU to the national level to the support for local governments' activities**
- Evaluation shows they can achieve around 2% per year of additional energy savings – we need more policy evaluation too
- => Set **strong targets and strategies** for energy efficiency and sufficiency
- => **Facilitate international exchange** on sectoral and cross-sectoral innovative technology solutions, policy roadmaps, market mechanisms, business and financing models, etc

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**Thank you very much
for your attention**

www.wupperinst.org

Why do we need governance for innovation, particularly for energy efficiency?

To overcome the plethora of barriers

- Energy efficiency = many small to medium technical improvements
 - lack of oversight (where to start?),
 - lack of information (both consumers and technology providers!),
 - sometimes small financial gains from an improvement
- => lack of priority
- sometimes lack of funds
- Energy prices too low (subsidies?) => Energy cost savings too low
- split incentives between investors and users or between technology/building providers and buyers
- => make energy efficiency easy, attractive, and eventually the default
- => **policy packages** with more information, practical guidance, regulation, and financing support needed
(„the sticks, the carrots, and the tambourines“)

Reducing GHG emissions to practically zero

Reduction of 93 Mt CO₂-equivalents by 2030 and 168 Mt CO₂-equivalents by 2035, incl. Electricity, district heat, and GHG-emissions of supply chain.

- for sectoral target for buildings according to German climate law (KSG 21): by 2030 minus 75 Mt CO₂-eq. (-64%) instead of -53 Mio. t (KSG 21)

Employment effects

- Almost 500.000, of which 260.000 in construction, mostly additional to today
- Feasibel? Equivalent to 12 % of employees in construction sector, mathematically 36% of workforce for new build
=> implement policies for optimising the use of existing dwelling floor space in order to make workforce available for the heat transition in the stock?
- However, strong capacity building programme needed anyway.

Heat demand and supply plans

- Mandatory for local authorities, but with financial support
- For decision: where green networked heat, where heat pumps, or maybe green gases?
- Expansion of heat networks and green heat generation (BEW)
- Decommissioning gas networks (financial compensation?; enable to end concessions at all)

Organising the transition

- Financial support programme for One-Stop-Shops in every city or rural district and district energy management:
- Active outreach to building owners (part. private landlords, condominiums of owners)
- Organisation of implementation, esp. aggregation of renovation projects: overcome practical barriers, reduce costs, ensure the appropriate order of action: insulate first, then install the heat pump (saves costs for bigger radiators)