European Commission

Renewable heating solutions and energy efficiency in the building sector

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Preface

This document provides a review of renewable energy options for the Karlovy Vary Region, with a focus on renewable heating solutions and energy efficiency in the building sector. The document has been developed as part of the EU Coal Regions in Transition Initiative's Secretariat Technical Assistance to Regions in Transition (START).

Disclaimer

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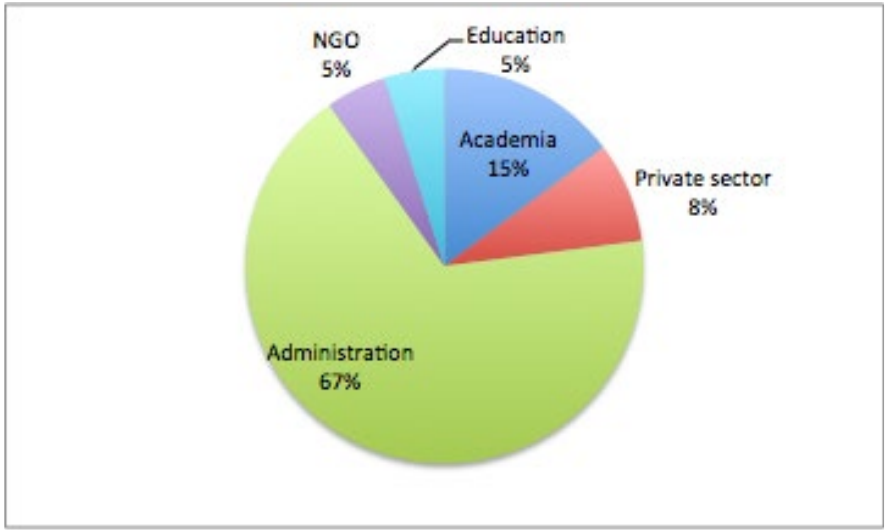
Survey on RES opportunities in Karlovy Vary region

"Survey on longer term deployment of renewable energy sources (RES) and their role in the future energy mix in the Karlovy Vary region"

- Online survey to gather expert views on the long-term opportunities for renewable energies in the region
- Conducted from 25/02 to 23/03 2021
- 61 completed answers
- Represents a summary of expert knowledge in the region. It is not a substitute for regional scenarios and models

Breakdown of survey participants



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01 Opinions on long term RES potential

- Participants were asked to give an estimation of the available economic potential of renewable energy sources in the Karlovy Vary region and in Czechia
- The results represent only an opinion of the survey participants. Nonetheless, the respondents are considered to have a good knowledge of the Karlovy Vary region
- The survey results are similar to findings from other sources: the potential of renewable energy in Karlovy Vary is considered lower than in other regions of Czechia, especially for solar energy, biomass, biogas, and biofuels
- Geothermal resources, wind, and heat pumps are considered as the technologies with the most promising potential for the Karlovy Vary region relative to Czechia as a whole

01 Survey results: estimation of the long term of RES

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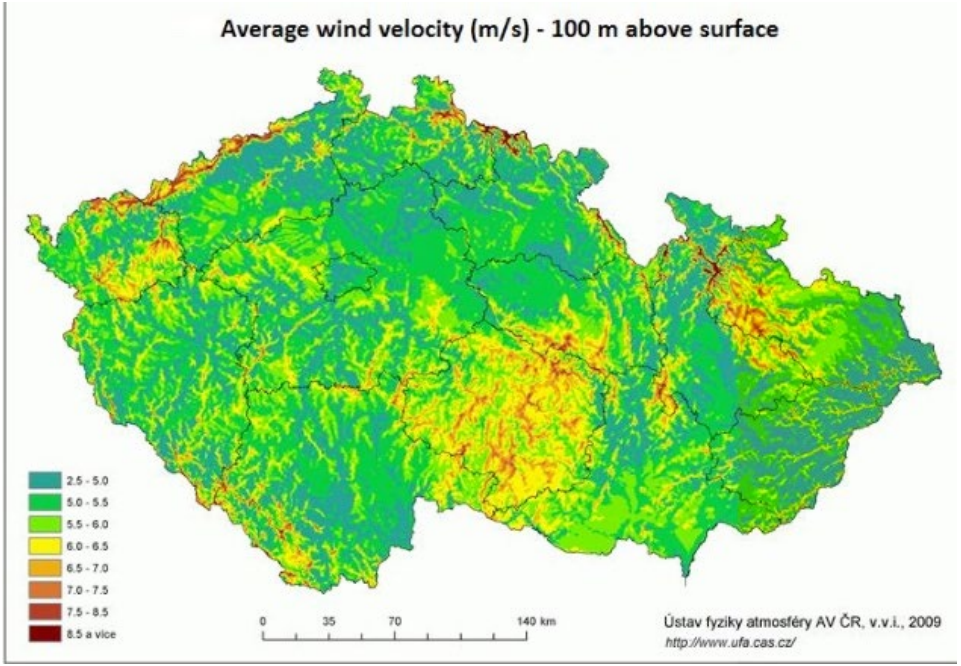
01 Wind potential in Czechia

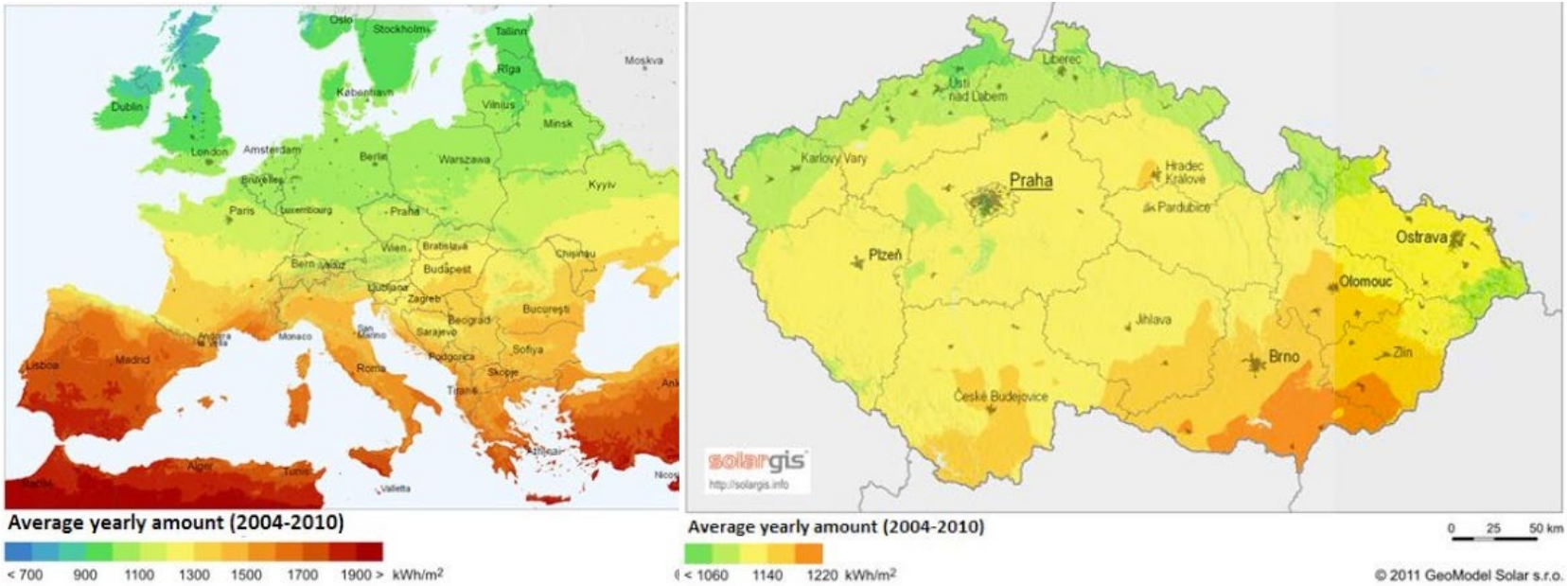
- Estimated wind energy potential is almost 20 times higher than currently installed capacity
- Conflict with nature protection, as suitable locations are often in national parks and protected areas



Source: Cabovská 2018

01 Solar potential in Czechia

- Solar potential of the Karlovy Vary region is lower than the national average.



Source: Cabovská 2018

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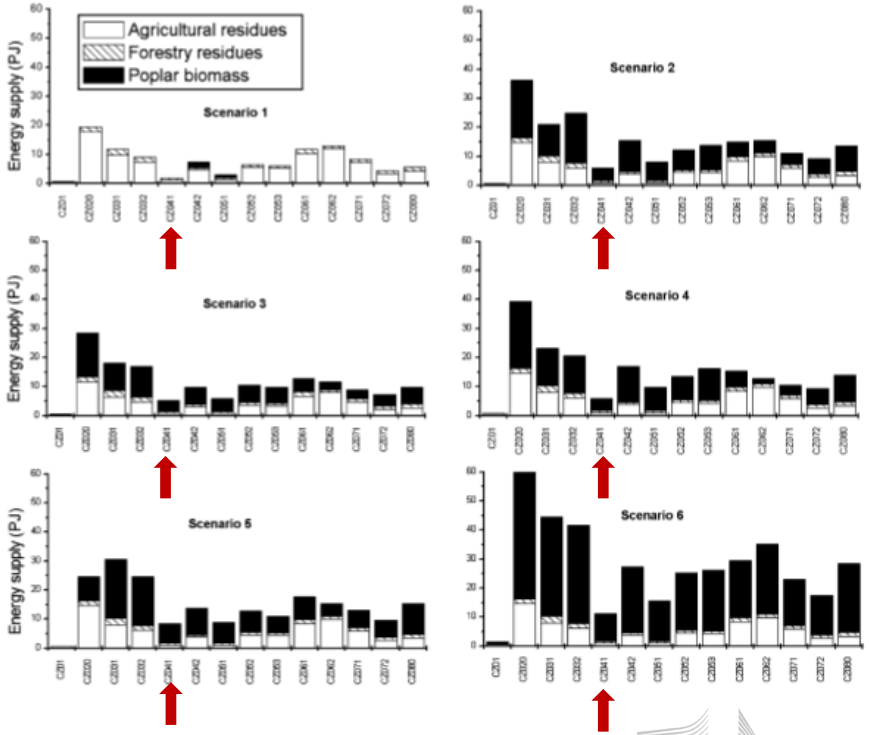
01 Biomass potential in Czechia (NUTS-3 regions)

- Karlovy Vary region (CZ041) has a potential of 2 – 11 PJ energy supply
- Biomass potential of Karlovy Vary region is lower than in other Czech regions.

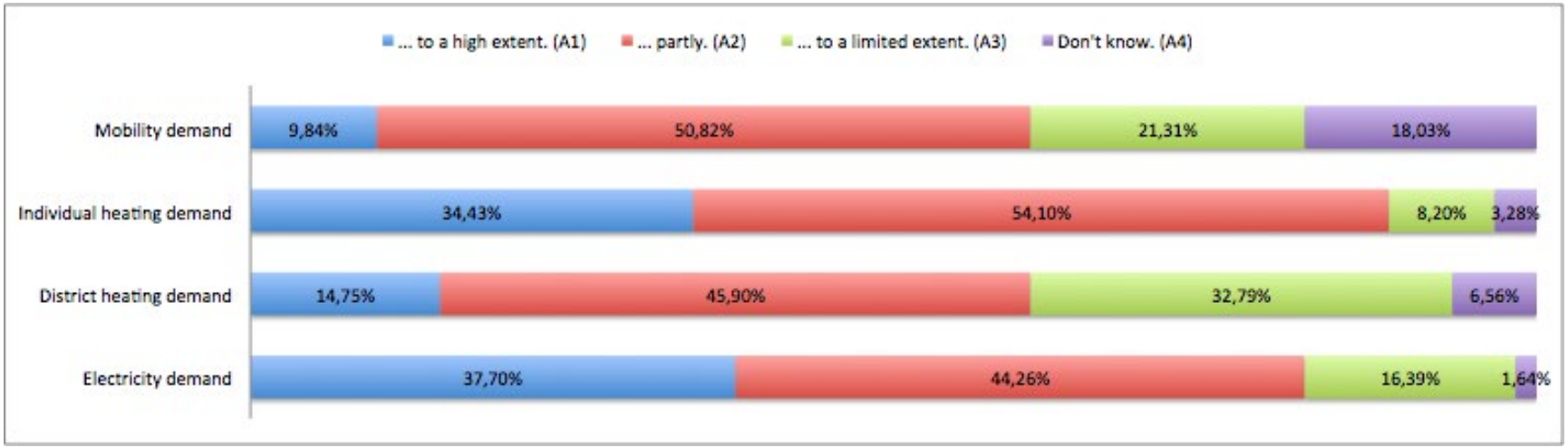


Source: Lewandowski et al (2006)

01

Survey results: to what extent can future energy needs in the region be addressed by RES, by 2050?

- Respondents indicate that especially future electricity and individual heating demand in Karlovy Vary region can be covered by renewable energy sources



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01 Influence of driving forces on the deployment of renewable energy in Karlovy Vary region

Respondents were asked to rate different factors according to their positive or negative influence on renewable energy deployment in the region (% of respondents)

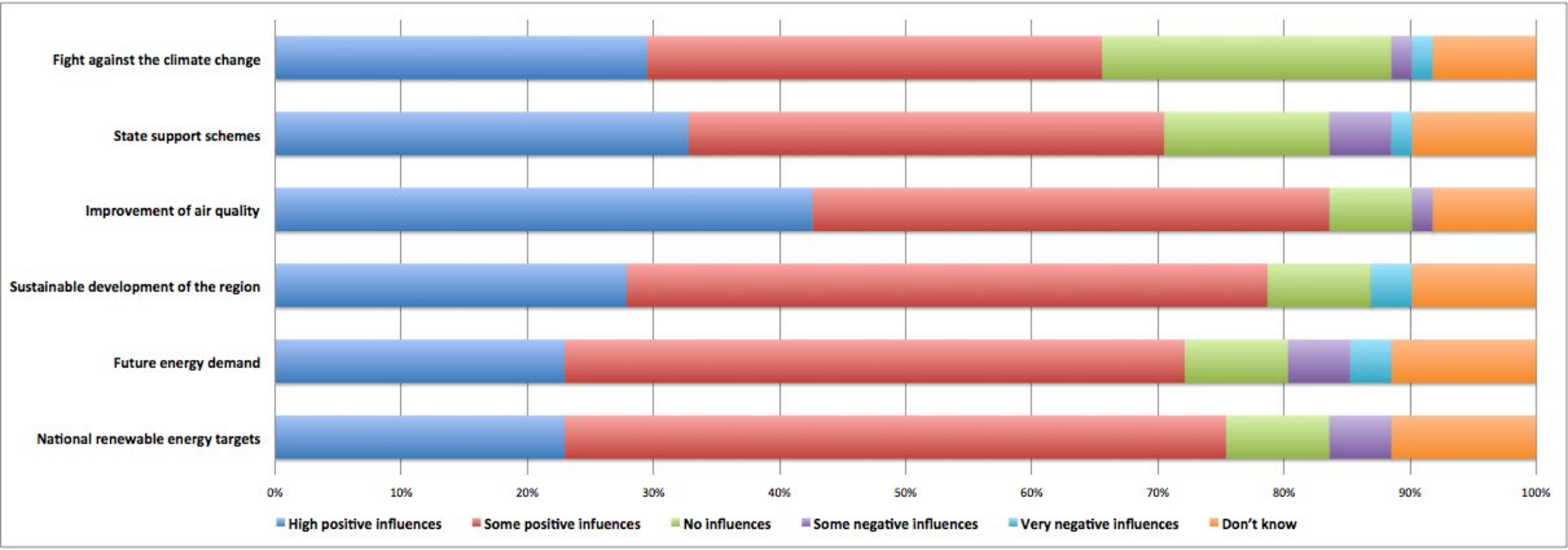
Strongest positive factors:

- Improvement of air quality (high positive influence 43%, some positive influence 41%)
- Sustainable development of the region (high positive influence 28%, some positive influence 51%)
- Fight against climate change (high positive influence 30%, some positive influence 36%)
- State support schemes (high positive influence 33%, some positive influence 38)

Most controversial (negative) influencing factor:

- Existing energy infrastructure (high positive influences 10%, some positive influences 33%, no influences 20%, some negative influences 18%, very negative influences 5%)

01 Survey results: influence of driving forces on the deployment of renewable energy in Karlovy Vary region (1 of 2)



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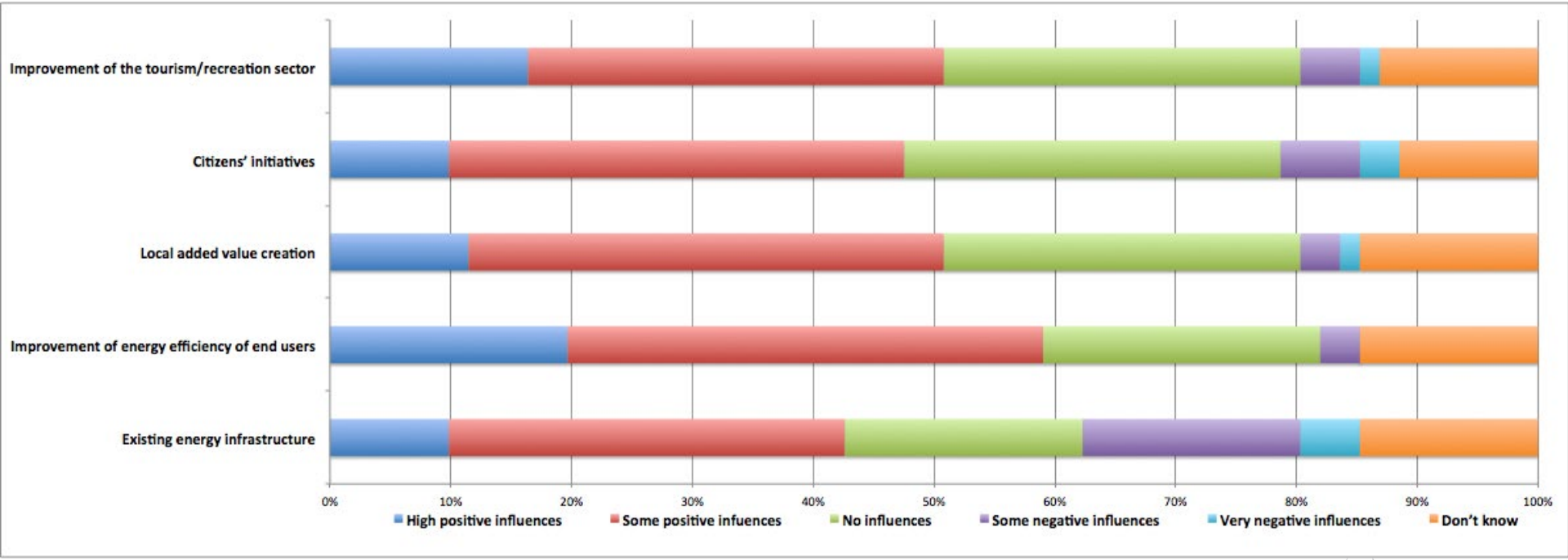
01 Survey results: influence of driving forces on the deployment of renewable energy in Karlovy Vary region (2 of 2)



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01 Main obstacles of further renewable energy development

Respondents were asked to rate the influence of different obstacles on further renewable energy development (% of respondents)

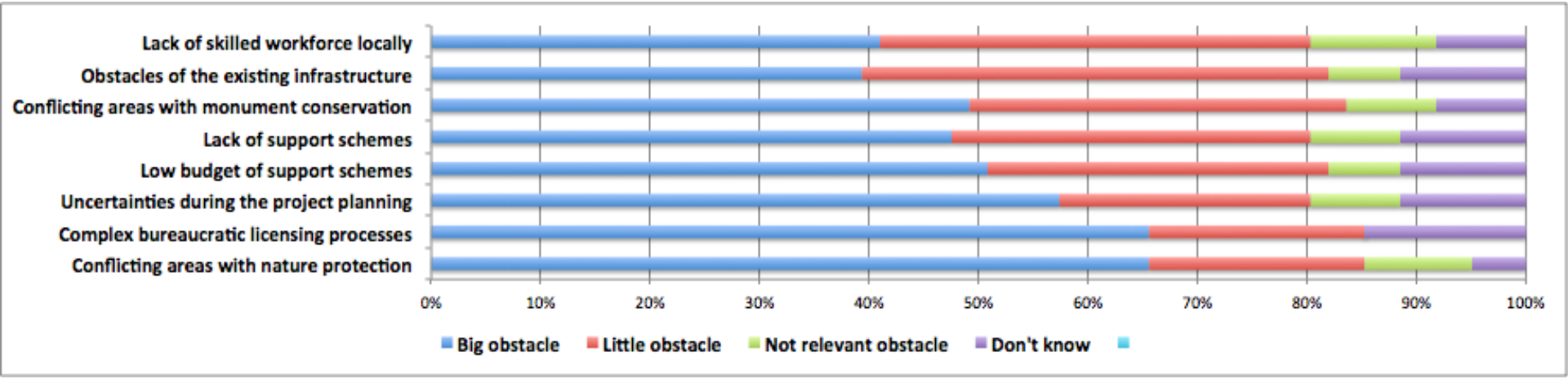
Most important obstacles to RES development:

- Conflicting areas with nature protection (big obstacle 66%, little obstacle 20%, not relevant 10%)
- Complex bureaucratic licensing procedures (big obstacle 66%, little obstacle 20%, 0% not relevant)
- Uncertainties during project planning (big obstacle 57%, little obstacle 23%, not relevant 8%)

Least important obstacles to RES development:

- Low energy performance of district heating (big obstacle 20%, little obstacle 31%, not relevant 20%)
- Low energy efficiency of end energy users (big obstacle 21%, little obstacle 38%, not relevant 20%)

01 Survey results: main obstacles to further renewable energy development (1 of 2)



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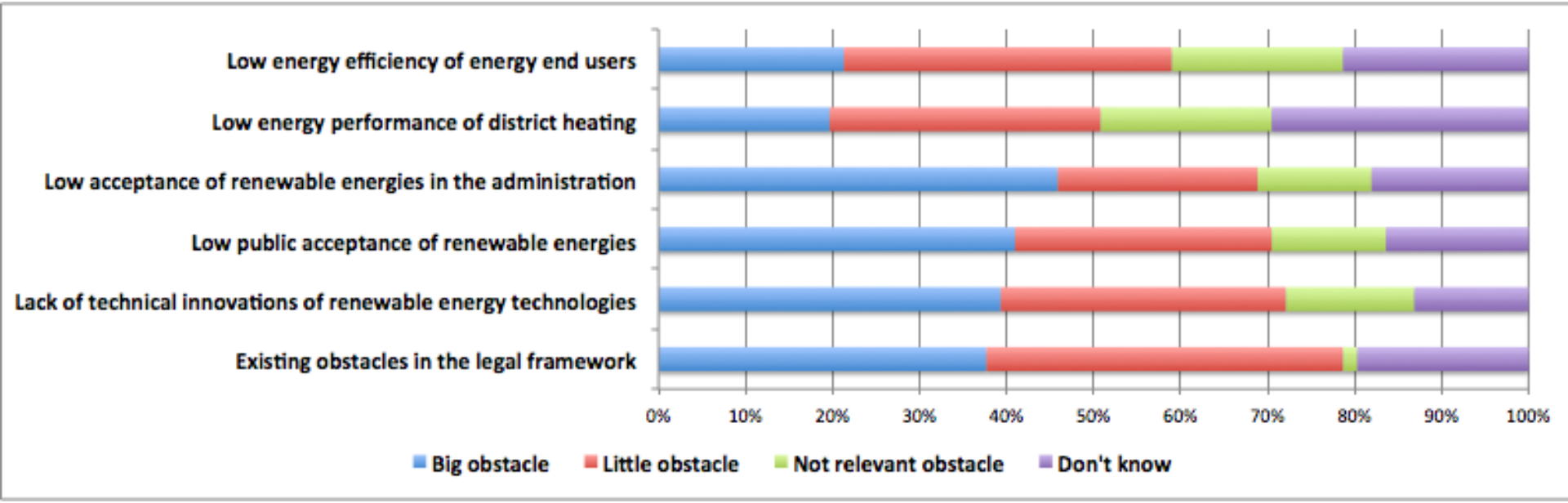
Survey results: main obstacles of further renewable energy development (2 of 2)



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01 Special locational strengths and weaknesses in the Karlovy Vary region

Strengths:

- Availability of areas of former mining activities
- Mountain areas / landscape
- Potential for more environmentally friendly energies

Weaknesses:

- Unfavourable demographic, social and educational structure of the region
- Lack of innovative companies and research infrastructure
- Economic weakness of the region
- Unclear regional strategy
- Too complex administration
- Dependence on coal-related activities

01 Summary of the survey results (1 of 2)

- The potential of geothermal direct use, heat pump technologies, and wind energy are considered as being above the average for Czechia
- Biomass, biogas, biofuels, PV/solar thermal and hydro potentials are regarded as less favourable
- Application areas consider to have highest potential for future use of RES are:
  - Individual heating
  - Electricity demand
- There are concerns about increasing energy needs and future energy prices
- The most important influencing factors the further renewable energy development are:
  - Environmental and sustainability aspects of RES
  - National/European renewable energy targets and support schemes

01 Summary of the survey results (1 of 2)

- The most important obstacles of the further renewable energy development are
  - Conflicting areas with nature protection / monument conservation
  - Complex bureaucratic licensing processes
  - Uncertainties during the project planning
  - Low budget of support schemes
  - Lack of skilled workforce
- Key recommendations coming from the survey findings:
  - Include renewable energy options in the regional strategy
  - Implement awareness raising activities, especially for solar and wind energy
  - Develop one-stop-shops for information and support for RES technologies
  - Integrated coordination of regional development activities

02

Examples from Germany:
Trends, scenarios, targets and policy measures

02

Achieving net zero climate emissions: scenarios for Germany

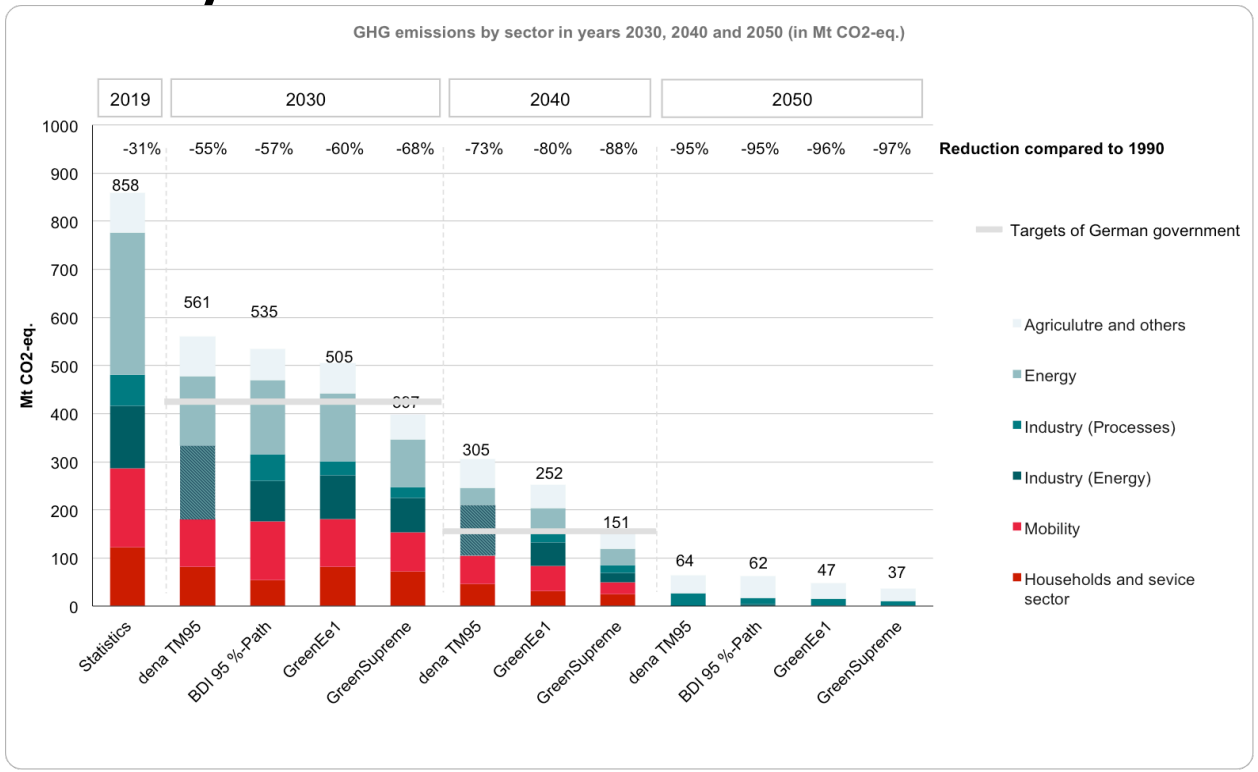
- Following the decision of the Federal Constitutional Court, Germany's government must revise its emission reduction targets
- Under the new targets, Germany aims to reach nearly net zero climate emissions by 2045 rather than 2050 as initially planned.
- The current most ambitious scientific climate protection scenarios for Germany aim at a reduction of GHG emissions by 95-100 % by 2050:
  - Umweltbundesamt (UBA, German Federal Environmental Agency), 2019, *Pathways to resource-efficient greenhouse gas neutrality – RESCUE*
  - Bundesverband der deutschen Industrie (BDI, Federal Association of German Industry), 2018, *Climate pathways for Germany*, prepared by BCG & Prognos
  - Deutsche Energieagentur (dena, German Energy Agency), 2018, *Lead study, Integrated Energy Transition*

02

Comparison of selected climate protection scenarios for Germany

UBA (2019) GreenEe1	UBA (2019) GreenSupreme	BDI (2019) 95%-path	dena (2018) TM95
• GHG neutrality by 2050 and focus on resource conservation • Focus on energy efficiency	• GHG neutrality by 2050 and focus on resource conservation • Combines high technical innovations with strong changes in lifestyles • Most ambitious scenario of the study	• 95% GHG reduction by 2050 • Focus on cost efficiency and CCS • Examines impacts of climate change mitigation pathways on GDP	• 95 % GHG reduction until 2050 • Technology mix: wide variation of technologies & energy sources

Comparison of selected climate protection scenarios for Germany



Source: Kobiela et al (2020)

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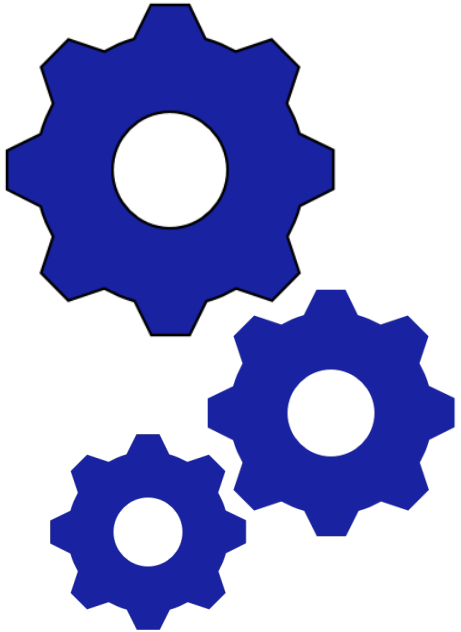
How to achieve (nearly) climate neutrality in the building sector?

Sufficiency: How much living space is enough?



Efficiency: How efficient should the buildings be?

Consistency: How should the buildings be heated?

Source: Kobiela et al (2020)

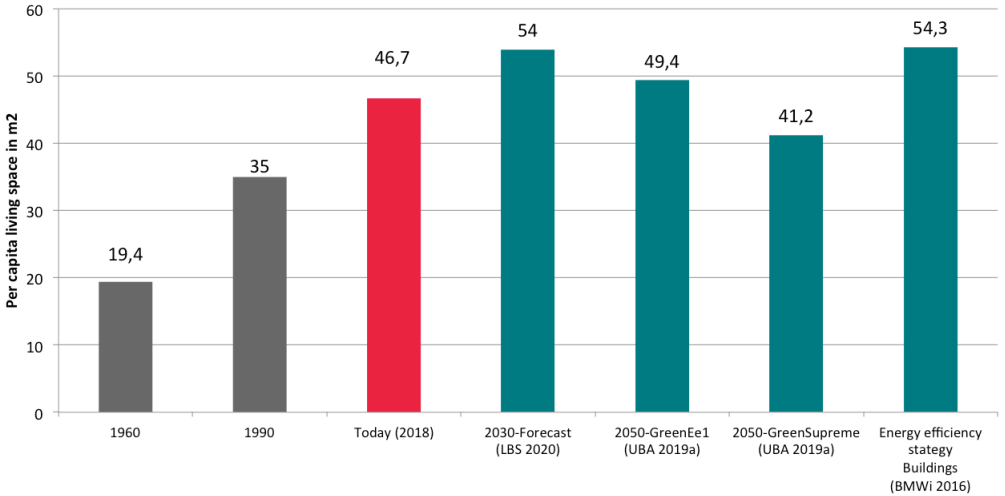
02

Development of living space in Germany: past, present and future

Sufficiency: How much living space is enough?

- Increasing per capita living space means increased land and resource consumption, but also increased energy demand for housing.
- Reversing the trend in the growth of living space helps to reduce the living space to be heated and thus the overall demand for space heating

Average per capita living space – over time and projected



Source: Wuppertal Institut (2020)

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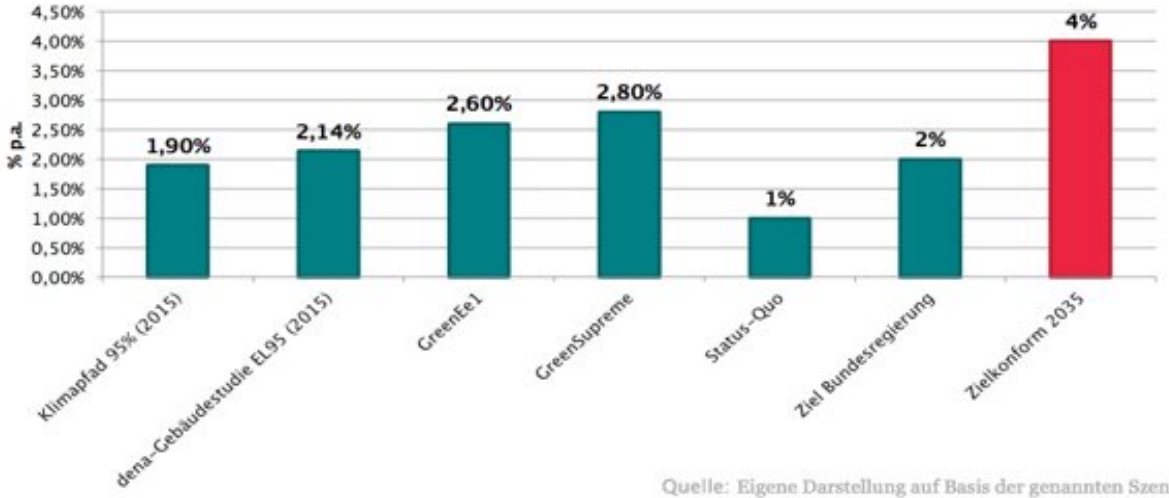
02 Average renovation rate in Germany: current versus required

Efficiency: How efficient should the buildings be?

- Current 1% p.a. renovation rate in Germany is absolutely insufficient
- Climate protection scenarios with near climate neutrality by 2050 require average renovation rates of 1.9 to 2.8% p.a
- A renovation rate of 4% would be required to achieve climate neutrality in 2035

Average renovation rate in selected climate protection scenarios (base year until 2050) – average proportion of dwellings/residential space that should be comprehensively renovated each year



Quelle: Eigene Darstellung auf Basis der genannten Szenarien

Source: Wuppertal Institut (2020)

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02

Thermal efficiency of buildings to achieve (nearly) climate neutrality

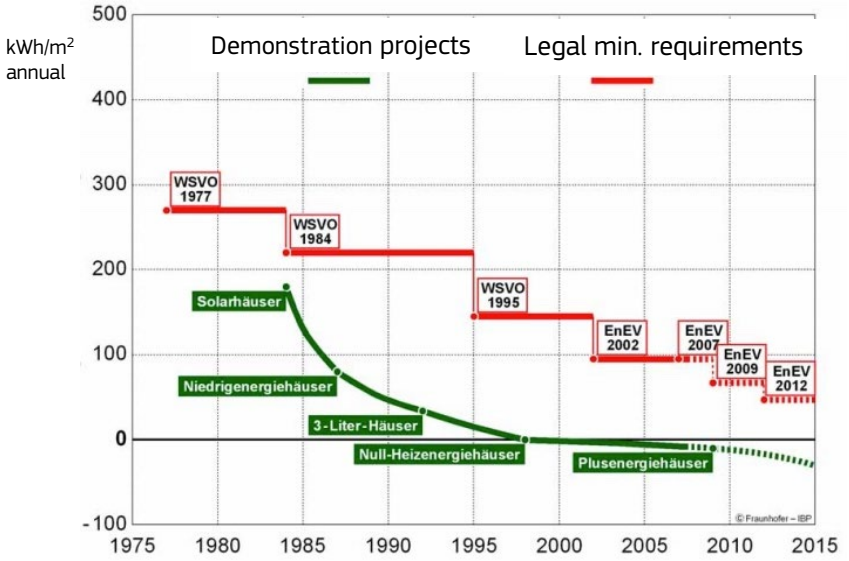
Efficiency: How efficient should the buildings be?

- Figures (next slide) show the development of energy-saving architecture in Germany
  - Upper lines show the minimum requirements of the Energy Saving Ordinance (formerly the Thermal Insulation Ordinance)
  - Lower lines show efficiency of research projects of the Fraunhofer Institute for Building Physics, which triggered a corresponding development in building practices
- High minimum energy standards are necessary for both new construction and renovation of existing buildings
- High minimum energy standards are an effective instrument for reducing energy demand
- Specifications and refurbishment practice have so far lagged far behind technological potential

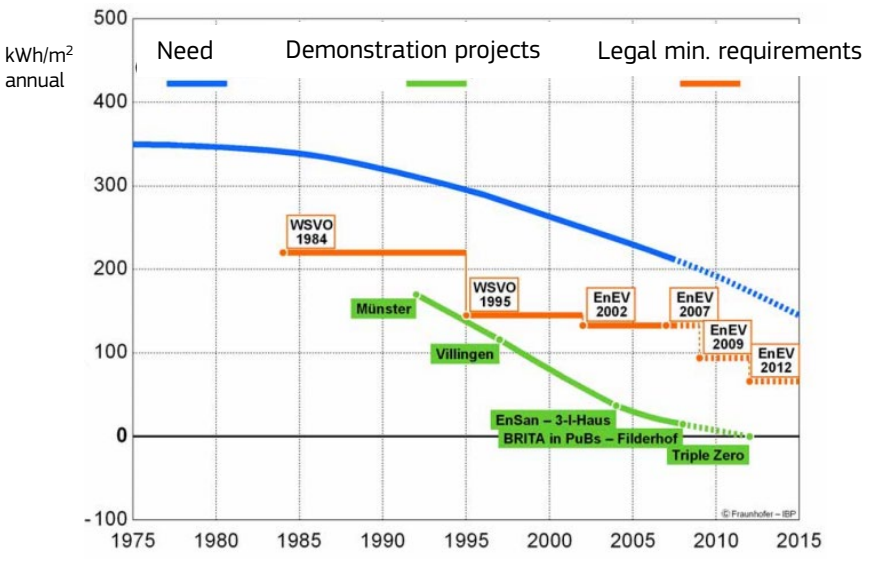
Source: Fraunhofer IBP

02 Energy efficiency of buildings in Germany: legal requirements compared to demonstration projects

Primary energy need in new buildings



Primary energy need in existing buildings



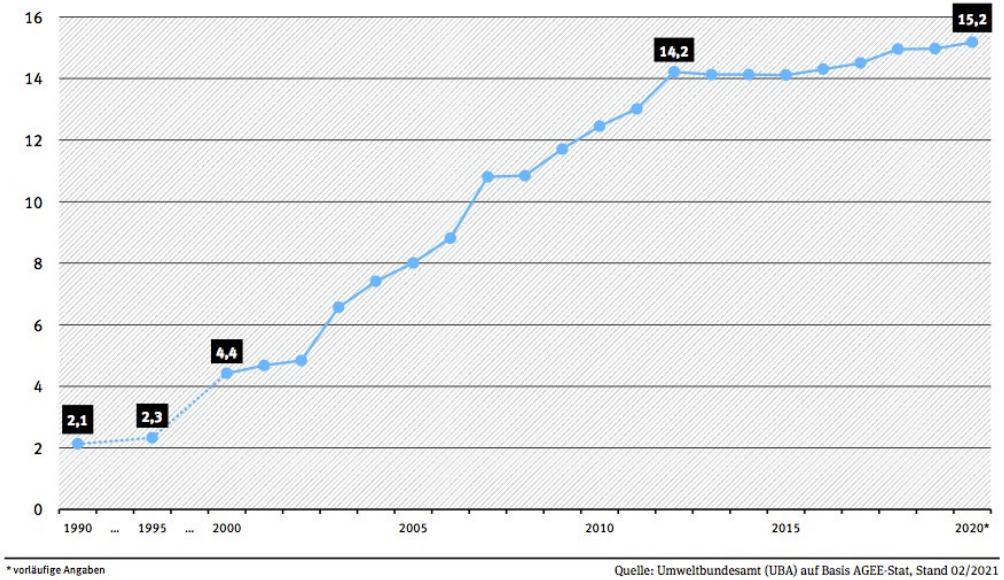
Source: Fraunhofer IBP

02 Building heating structure in Germany

Consistency: How should buildings be heated?

- Stagnation in the use of renewable energies for heat generation (households, tertiary sector and industry) since 2012
- Most newly installed heating systems continue to be fossil-fueled, especially with natural gas

Share of RES for heat generation in Germany (%)



Source: UBA 2021a

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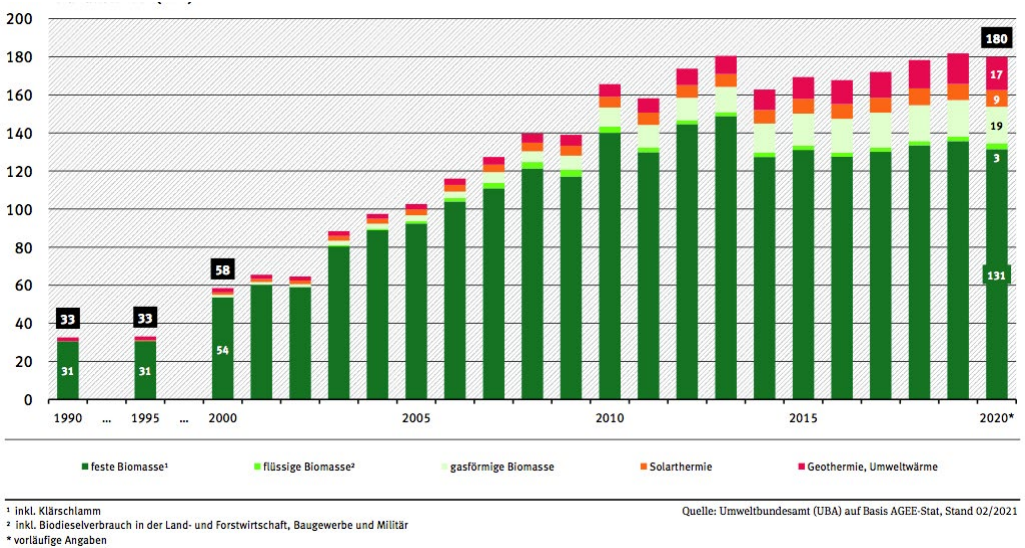
02 Building heating structure in Germany

Consistency: How should buildings be heated?

- Biomass still dominates renewable heat generation in Germany

Development of heat consumption from RES in Germany (TWh)



Source: UBA 2021a

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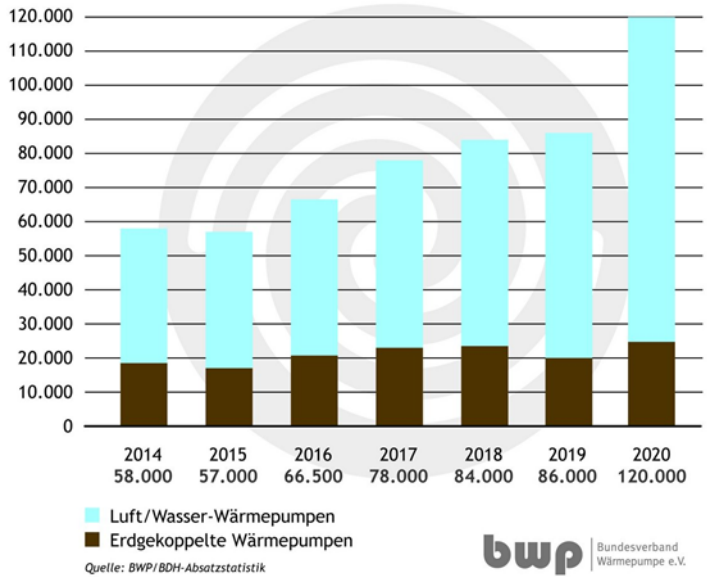
02 Building heating structure in Germany

Consistency: How should buildings be heated?

- In new buildings, primary energy requirements must comply with the Energy Saving Ordinance
- Since 2016, despite high electricity costs, heat pumps play an important role in meeting requirements
- In existing buildings, heat pumps are especially used in deep renovations

Sales of heat pumps in Germany by type



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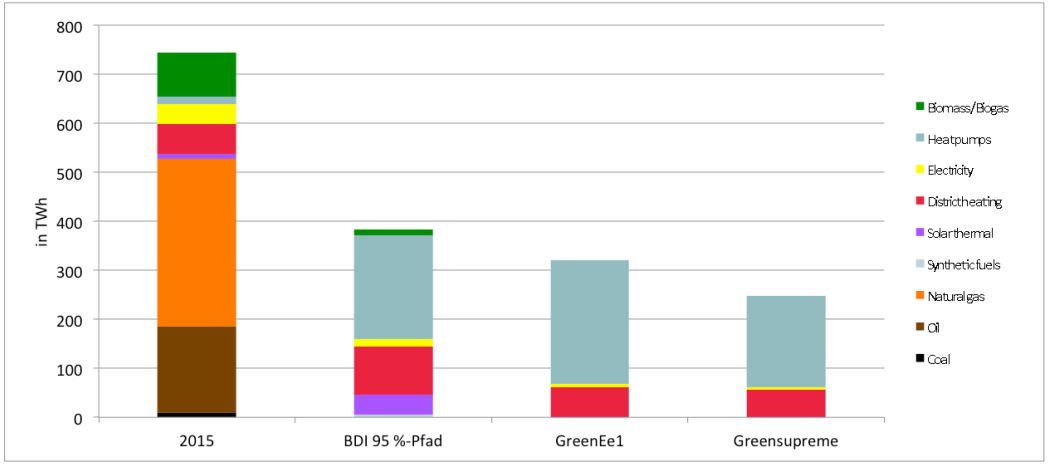
02 Heating structure to achieve (nearly) climate neutrality

Consistency: How should buildings be heated?

- Energy scenarios assume a significant electrification: most buildings will be heated using heat pumps
- High levels of energy efficiency necessary to avoid:
  - Massive increase in electricity demand (system view)
  - High investment costs (heat pump + heat source) and high operating costs (user perspective)

Composition of building heating in Germany in 2050 under different scenarios (TWh)



Sources: UBA 2019, BCG & Prognos 2018

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02

Heating structure to achieve (nearly) climate neutrality: energy scenarios for Germany

- By 2050, GHG reductions in the building sector will be achieved, firstly, by reducing final energy consumption through renovation (40-66%) and, secondly, by phasing out the use of oil, coal and fossil gas.
- Heat pump technologies uniformly emerge as a key technology, with high market penetration in all target scenarios. The role of air-source and ground-source heat pump technologies is assessed differently in the scenarios.
- Differences emerge between existing and new buildings:
  - In new buildings, primary energy requirements must be met in accordance with the Energy Saving Ordinance, with heat pumps playing an important role already since 2016, despite high electricity costs.
  - In existing building sector, heat pumps account for only about 2% of all heating systems. Sales of heat pumps for existing buildings account for about one third of the market, with a focus on deep renovations.

02

Heating structure to achieve (nearly) climate neutrality: energy scenarios for Germany

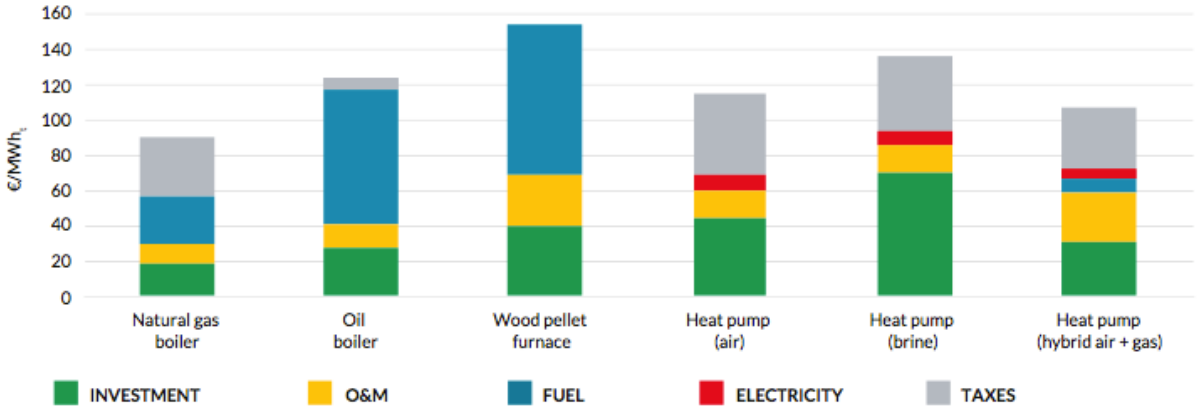
- Significant electrification of heat generation requires high levels of energy efficiency to limit increase in electricity demand. Higher demand for electricity in winter is particularly relevant.
- Path dependencies (technological 'lock-in'):
  - The age structure of heating systems in buildings creates restrictions for further development of the stock of heating technologies. Fossil-fuel boiler systems that are newly installed today will continue to produce CO_2 emissions for many years into the future (25-30 years).
  - This is exacerbated when old systems breaking down during the heating season and are then replaced one-to-one in the shortest possible time.
- Inertia of the building sector highlights the need to initiate change in the generation structure at an early stage, in order to be able to achieve long-term decarbonisation targets.

02 Cost comparison of heat generation for individual buildings

Consistency: How should buildings be heated?

- Individual heat pumps are currently not cost competitive with natural gas, due to high taxation and electricity costs, but are a good solution compared to fuel oil boilers and wood pellets
- Grid operators can apply lower electricity charges if entitled to turn off heat pumps for upto 2 hours in periods of peak demand. Operator discounts can reduce variable costs of heating by up to 20%

Cost comparison for heating of individual buildings (€ / MWh)



Estimates for Germany for a single household with 18 MWh of annual heat consumption. Fixed costs calculated over a period of 20 years.

Source: Forum Energii (2018)

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02

Summary of sufficiency, efficiency, and consistency considerations for building heating

Sufficiency:

- Slowing down the per capita increase in living space; for example, through new, municipally supported housing models (multi-generational, flexible use, ...)

Efficiency:

- Increasing the annual renovation rate
- Successively increasing renovation requirements for existing buildings to reach passive house standard
- Increasing standards for new buildings to reach passive house standard

Consistency (renewable energies):

- Expanding renewable heating technologies and switching to renewable heat sources

Comprehensive and holistic solutions are needed

Policy packages to overcome typical barriers in the building sector

03 Support for renewable heating solutions and energy efficiency in the building sector

Context and guiding principles

- Building sector is characterised by complex value chains involving many different actors
- A well-designed mix of policies and measures is needed to assist various actors to overcome the barriers
- A comprehensive and coherent policy package for building energy efficiency will usually contain a sound balance of clear mandatory measures, incentives, information and capacity building

03

Support for renewable heating solutions and energy efficiency in the building sector

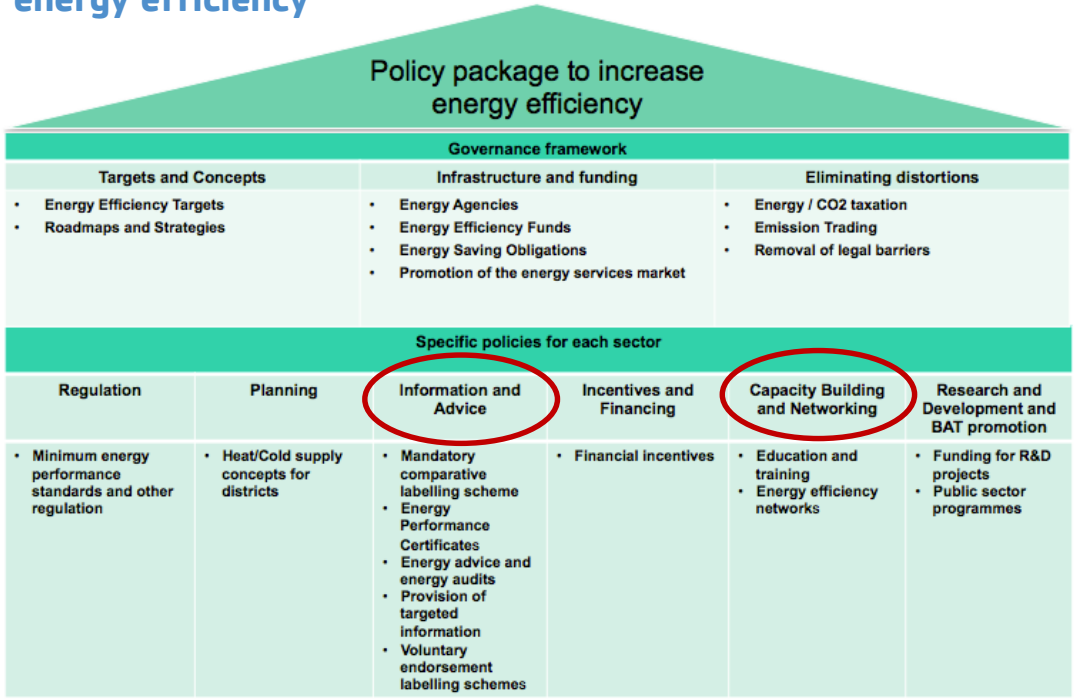
Barriers for deep building renovation

Financial	Technical	Informational	Legal/institutional	Social
• High upfront investment • Access to funding/low supply of market financing offers • Incompatibility with traditional investment approaches • Competing investment options • Landlord/tenant dilemma • Perceived economic risks • Distorted energy prices • Low market demand	• Building characteristics • Lacking market supply of (integrated) technical solutions • Performance gap of building technologies	• Difficult access to information; contradicting information • Low awareness of building energy efficiency and its benefits • Lack of awareness of innovative technologies • Low supply of skilled supply side actors	• Volatile and/or unpredictable regulatory framework • Unclear, complex or insufficient provisions • Lack of enforcement/responsible authority • Conflicting regulation (heritage rules, fire safety provisions, rent caps/barriers for cost recovery) • Cumbersome and time-consuming administrative procedures	• Low acceptance of/resistance from tenants • Risk aversion • Transaction costs/hassle

Source: DREEAM Report 2019

03 Support for renewable heating solutions and energy efficiency in the building sector

Policy package for energy efficiency



Source: DREEAM Report 2019

03

Support for renewable heating solutions and energy efficiency in the building sector

Elements of a prototypical policy package for energy efficiency (1 of 4)

- **Targets and concepts** are a necessary basis for long-term investment decisions. They provide a reliable planning framework for market actors and reduces investment risk for investors. It is crucial to set ambitious, yet achievable energy saving targets and to develop comprehensive medium to long-term strategies.
- **Infrastructure and funding**, including an energy agency or similar institution for coordinating activities. Furthermore, government energy efficiency funds and/or an obligation of energy companies to achieve energy savings via energy efficiency programs are required.
- **Elimination of distortions.** It is essential to gradually remove subsidies for energy production or subsidies on energy prices. Moreover, energy or CO2 taxes or market-based CO2 pricing (e.g. via an Emission Trading System) will internalise externalities (e.g. environmental damage and/or threats to health) into final energy prices.

03

Support for renewable heating solutions and energy efficiency in the building sector

Elements of a prototypical policy package for energy efficiency (2 of 4)

- **Regulation:** Mandatory minimum energy performance standards (MEPS) for existing buildings undergoing major renovation as well as for building components and heating and cooling systems are an important regulatory instrument.
  - MEPS should be controlled at the local level in cases of major renovation.
  - For renovation of existing building, MEPS should be accompanied by individual advice and financial incentives.
  - Other statutory requirements such as individual metering, energy management for larger buildings and building portfolios, or regular inspections of heating, ventilation, and air conditioning systems can complement the legal framework to ensure energy-efficient operation of buildings.
- **Heating-/cooling concepts and plans** for residential building districts can guide the way to a more sustainable heating/cooling supply system.

03

Support for renewable heating solutions and energy efficiency in the building sector

Elements of a prototypical policy package for energy efficiency (3 of 4)

- **Information and advice instruments** to disseminate the results, to raise awareness for energy efficiency opportunities in renovation and to develop more energy-efficient and cost-effective technologies and concepts for building renovation. This may include, for example:
  - Building energy performance certificates (EPCSs) and energy labels for components (where useful)
  - Show-casing of demonstrated good practice building renovations and award competitions for very energy-efficient renovations.
  - Additionally, individual advice, such as energy audits need to show building owners what they (or their tenants) can save and what is cost-effective, and coaching can be essential to assist investors in implementing the retrofits.
- **Incentives and financing:** Scaling up investment in energy efficiency is crucial to achieve a sustainable energy future. Financing instruments target the barrier of insufficient availability of, or access to, capital for financing the incremental up-front costs of energy-efficient buildings or retrofits.

03

Support for renewable heating solutions and energy efficiency in the building sector

Elements of a prototypical policy package for energy efficiency (4 of 4)

- **Capacity building and networking** to meet the need for a sufficient number of skilled providers willing and able to perform the energy-efficient renovation tasks**.**
- **Innovation support** through R&D funding and promotion of best available technologies.

03 Support for renewable heating solutions and energy efficiency in the building sector

The EmBuild project supported local public authorities in countries of Southeast Europe to prepare long-term strategies for mobilising investments in the energy efficient renovation of the building stock.

Key recommendations for local renovation strategies and the acceleration of information spread:

- Promote the benefits of renovations
- Promote the importance of building renovation strategies
- Share good examples
- Capacity building and training
- Assistance for financing renovations

Source: https://www.buildup.eu/sites/default/files/content/snapshotbuilding_renovation_strategies_final_lr.pdf

Roadmaps for individual building renovation

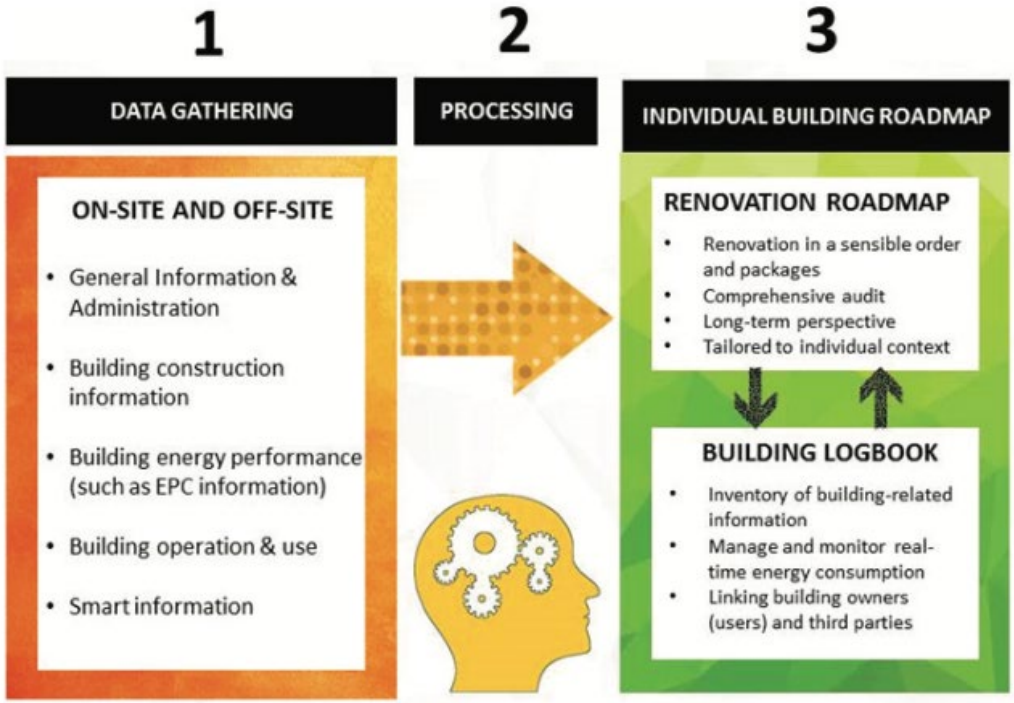
04 Roadmaps for Individual Building Renovation

Development of Individual Building Renovation Roadmaps:

- Develop a long-term (10-20 years) renovation strategy for an individual building
- Consider the occupants' needs and specific situation (e.g. age, financial situation, composition and expected evolution of the household, etc.)
- Incentivize a renovation that is as deep as possible
- Check the compatibility of stepwise renovation measures against the long-term target
- Develop an optimal package of measures and points to consider in the case of staged renovations
- An Individual Building Renovation Roadmaps can be combined with a building logbook, that is a repository where all the building-related information can be stored and continuously updated

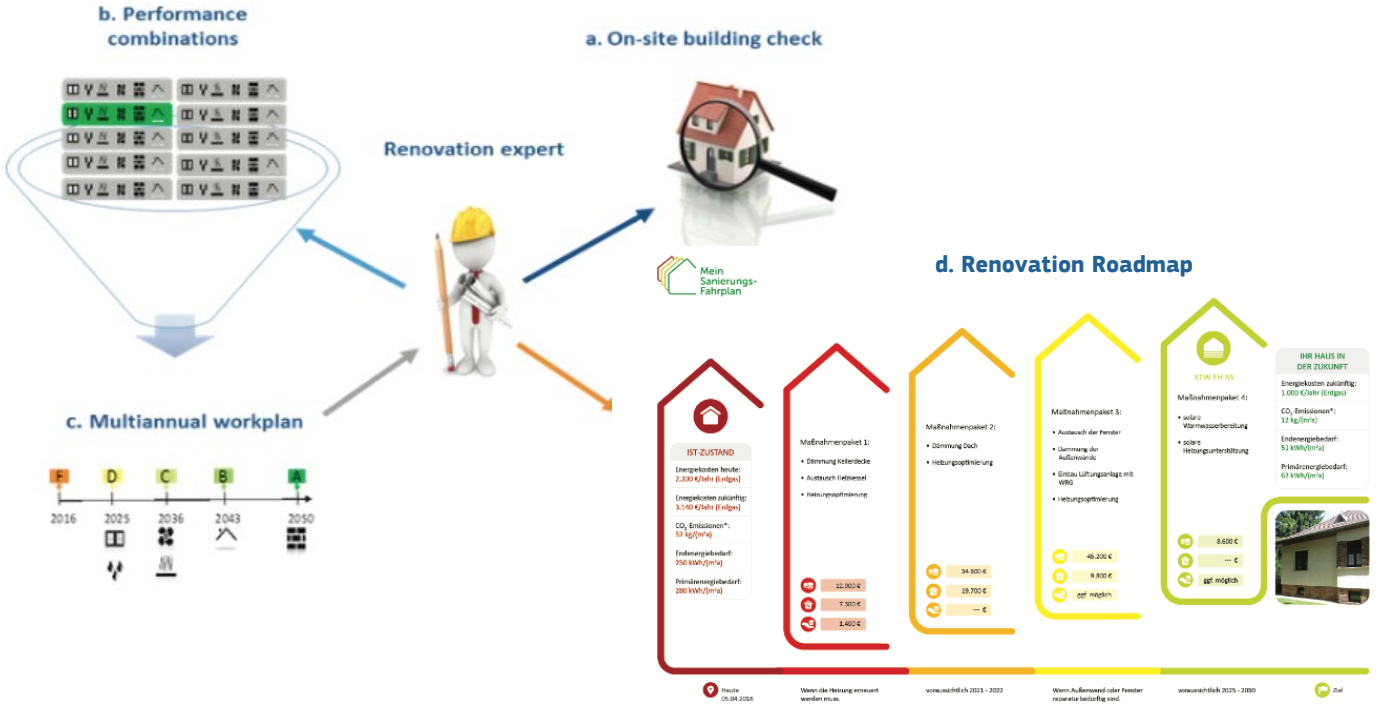
04 Roadmaps for Individual Building Renovation

Developing an Individual Building Renovation Roadmap to overcome barriers to improved energy performance



Source: BPIE

04 Roadmaps for Individual Building Renovation



Source: iBROAD

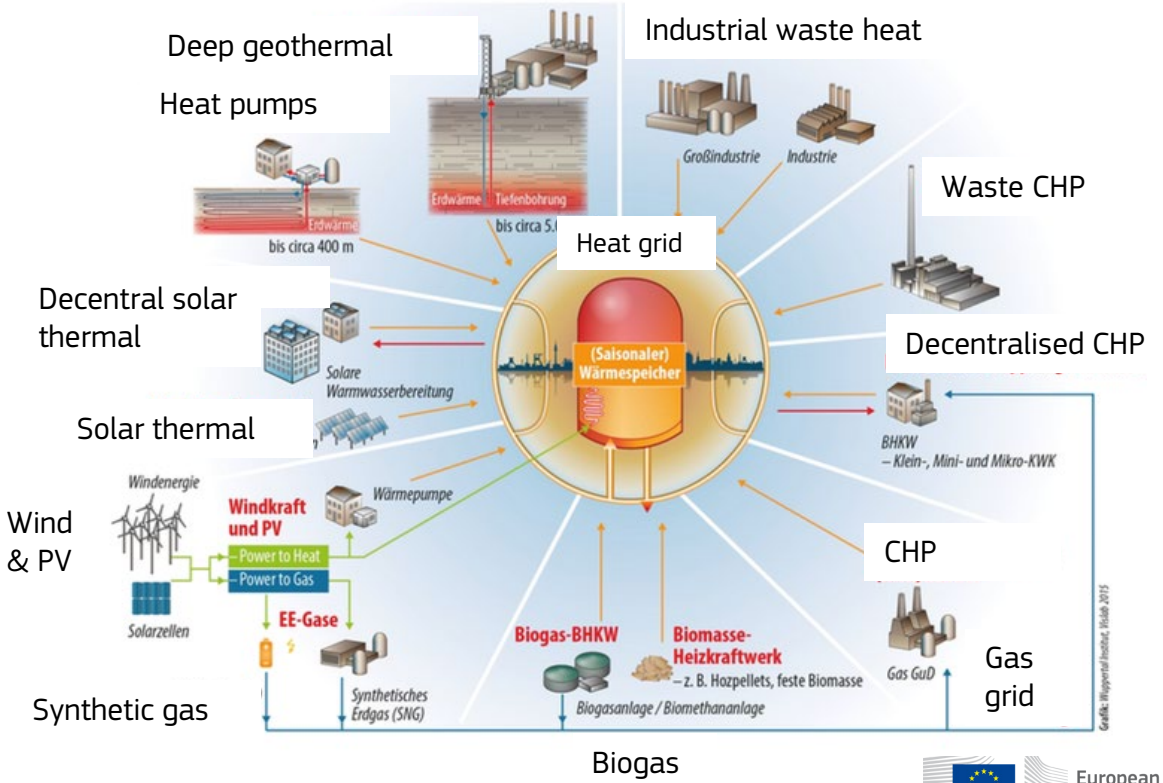
Heat grids

05 Heat grids

- Heat grids are a potential supply option in all sufficiently densely populated areas
- Heat grids can be a solution for district heating operators and (industrial) heat suppliers faced with the major task of switching from fossil fuel to non-fossil fuel heat generation
- Heat grids offer great potential for delivering low-GHG and economically attractive heat supply if developed consistently with local renewable energy supply
- Areas to be analysed for understanding and enhancing local renewable heat potential:
  - Development of local renewable energy sources (e.g. open-space solar thermal on former mining sites)
  - Use of heat pumps (in combination with PV), which can be suitable for many new buildings and refurbished existing buildings with low heat demand and relatively large available surface (roof) area, particularly when combined with so-called cold grids that allow recovery of low-temperature waste heat from commercial and industrial buildings.
  - Recovery of industrial waste heat

05 Heat grids

Heat grids are generally capable of integrating a wide range of different heat sources



Source: Schüwer et al (2020)

05 Conversion of district heating systems

Steps for local and regional administrations to support conversion

1. Develop regional/municipal heating master plan (see example of Denmark) and designate district heating priority areas
2. Based on the master plan, support implementation of conversion and/or expansion of district heating systems (e.g., with a subsidy programme)
3. Take actions to overcome any legal hurdles to energy-efficient building refurbishments
4. Create incentives for energy-efficient refurbishment that (also) cover buildings supplied by district heating systems (e.g., through adjusted primary energy factors).
5. Take actions to exploit industrial and municipal waste heat potential
6. Introduce of digital billing systems for district heating, including a billing system of bonus/malus that rewards investments in energy efficiency measures (e.g, for heat insulation measures and use of panel radiators)

Source: Kobiela et al (2020)

05 Heat plans

Examples

- In Baden-Württemberg, there is a legal obligation for larger municipalities to prepare municipal heat plans by 31 December 2023. These plans must be updated at least every seven years, taking into account further developments. For densely populated areas heat plans should become a central component for delivering regional or municipal energy/heat requirements.
- In Denmark, future scenarios for heat consumption and regional heat plans have been developed. These define which technologies should be used and where to apply them. Consequently, concrete plans for new construction, conversion, or expansion of the heat supply structure have been elaborated.

Source: Kobiela et al (2020)

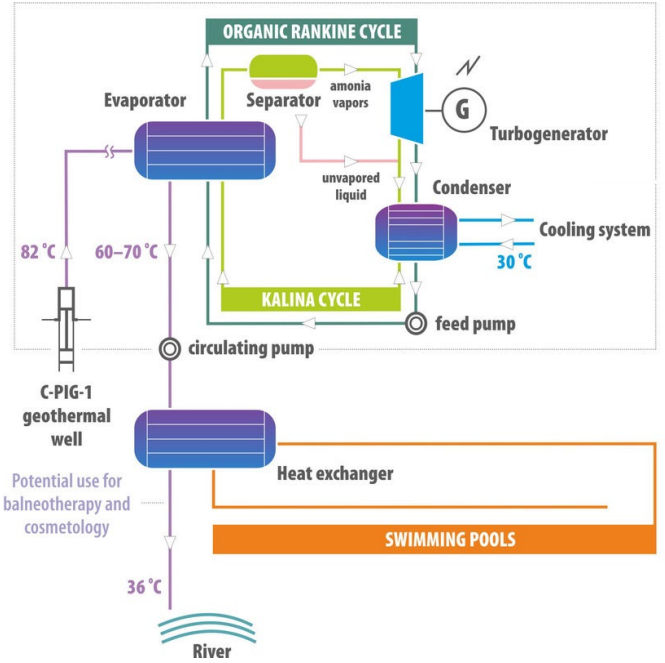
Collaborative use of geothermal water resources for energy/agriculture and balneology

Collaborative use of geothermal water resources: context

The geothermal potential in the Karlovy Vary region is large, but further drilling is prohibited in some protected areas in the region. Exploitation of waste heat from balneology uses id a possibility for the future.

Examples of cascade/collaborative use of thermal water for energy and balneology in Central and Eastern Europe:

- DARLINGe project for sustainable utilisation of existing but still largely untapped deep geothermal resources in the heating sector (Bosnia & Herzegovina, Croatia, Hungary, Romania, Serbia, Slovenia)
- Research in thermal regions in Poland: Małopolskie Voivodship, Mogilno–Lodz.
- Slovak Health Spa Pieš & Kremnica



Source: Kaczmarczyk et al 2020

06 Collaborative use of geothermal water resources

- Cascade use of geothermal water is not a new concept
- The development of heat pump technologies has opened new opportunities especially in the use of law-enthalpy geothermal resources.
- Considerable amount of energy can be saved when the full energy potential is exploited by releasing the used geothermal water
- Detailed study of the existing facilities is necessary to evaluate the possibilities of energy use

Recommendations for local and regional administrations to support conversion:

- Awareness rising towards the advantages of geothermal heating and cascade utilization
- Support cooperation among key players of the geothermal sector

Conclusions

Conclusions: renewable heating solutions and energy efficiency in the building sector

- Heat pumps emerge as a uniform key technology for the building sector in numerous German scenarios
- Support of deep building renovation activities are inevitable when the electrification in the building sector takes place
- Long-term thinking in the building sector is necessary to avoid technology “lock-in”
- Local/regional strategies and roadmaps are necessary to support the promotion of renewable heating solutions and energy efficiency improvements in the building sector, including measures for information provision and capacity building
- Instruments are needed to trigger a long-term renovation perspective (e.g., individual building renovation plans, municipal/regional heat plans)

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