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Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

based on a decision of the German Bundestag

European
Climate Initiative
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Climate and energy investment map – Czechia

Status report 2017: Buildings and renewable energy supply and infrastructure

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December 2019

Project in brief

The report is a contribution to Output indicator O.2 of the project "**Climate investment capacity (CIC): climate finance dynamics & structure for financing the 2030 targets**". The project aims to strengthen capacity of the public sector in Latvia and Czechia, gearing and adapting the implementer's knowledge and know-how to the country challenges with help of the implementing partners. Using a learning-by-doing approach, the partners cooperate with the target group to jointly develop prototypes of (i) climate & energy investment maps to track public finance and private investment flows, (ii) investment gap & need analyses to reach 2030 climate and energy targets, and (iii) capital-raising plans to close the invest-ment gap. This report aims to track how much capital was invested in climate and energy transition measures in Czechia in 2017. The map represents a diagram tracking climate and energy investment flows along their lifecycle, starting from the sources of capital and the relevant intermediaries, through instruments used, and uses. The map allows understanding who invests into climate and energy measures, what kind of measures these are, how much the actors invest, whether the public sector supports this investment, and which intermediaries and financial instruments facilitate these flows.

Report abstract

This report aims to contribute to the discussion of EU Member States' National Energy and Climate Plans (NECPs), in which Member States are required to present information on existing investment flows to decarbonisation efforts. The report assesses existing data sources and climate-finance tracking systems to estimate climate and energy investment in Czechia in 2017. It presents a map illustrating the volume of climate and energy investment flows – from the financing sources, through the intermediaries and financial instruments to the recipient sectors. The report in particular focuses on the buildings and renewable energy supply and infrastructure sectors. The map provides insight into who invests how much into what kind of measures in these sectors. The report also points to the status of available information and discusses the various methodological and data challenges encountered in the analysis.

Disclaimer

This project is part of the European Climate Initiative (EUKI – www.euki.de) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). It is the overarching goal of the EUKI to foster climate cooperation within the European Union (EU) in order to mitigate greenhouse gas emissions. The opinions put forward in this report are the sole responsibility of the authors and do not necessarily reflect the views of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

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This report should be cited as follows:

Valentová, M., Knápek, J., Novikova, A. 2019. Climate and energy investment map – Czechia. Status Report 2017: buildings and renewable energy supply and infrastructure. Prague: Czech Technical University in Prague.

Acknowledgements

We would like to express our gratitude to Mr. Miroslav Honzík, Mr. Vladimir Sochor, and Mr. Tomáš Smejkal, of the Ministry of Industry and Trade; Mr. Pavel Zámyslický, of the Ministry of the Environment; Mr. Jan Hromada, of the Ministry of Regional Development; and Mr. Ondřej Vrbický and Mr. Jiří Melč, of the State Environmental Fund, for their support in data collection, discussions, and general guidance.

For their assistance in data collection, communication, and report write-up, we would like to thank our colleagues at the Department of Economics, Management, and Humanities: Mr. Lubomír Lízal, Mr. Miroslav Vítek, and Mr. Julius Bemš.

We are grateful to Mr. Luboš Drhovský, of GfK, and Radek Hacaperka, of APPLiA CZ, for providing the data on energy-efficient appliances; to Mr. Štěpán Chalupa, of the Chamber of Renewable Energy Sources, for his input regarding the development of renewable energy in Czechia; and to Mr. Jiří Karásek for his methodological guidance regarding the renovations of buildings. We would like to thank Ms. Hana Nylander-Kaloudova and Mr. Peter Chovan, of the European Investment Bank, for their information support. Thanks also to the regional government representatives who provided data on the structure of subsidies for the exchange of heating technologies in their respective regions, allowing for a detailed overview of investment flows.

We would also like to thank all of the participants in our project kickoff workshop, held in Prague on 15 January 2019, for their insightful comments on the concept of climate and energy investment tracking, as well as on methodology and data sources. In addition, we are grateful to the participants in the public policy seminar on 3 April 2019 at the Bennett Institute for Public Policy (and specifically Mr. Matthew Agarwala) for the methodological discussions on climate tagging, disclosure, and institutional set-up.

Last but not least, we would like to express our gratitude to our colleagues at IKEM, Mr. Ingmar Juergens and Mr. David Rusnok, for their continuous guidance throughout the write-up of this report.

Acronyms

Acronyms	
ASME	Association of Small and Medium-sized Enterprises and Crafts [Asociace malých a středních podnikatelů a živnostníků]
CCS	Carbon capture and storage
CEIM	Climate and energy investment map
CF	Cohesion Fund
CMZRB	Czech-Moravian Guarantee and Development Bank [Česko-moravská záruční a rozvojová banka]
CZ-NACE	Classification of Economic Activities
ERDF	European Regional Development Fund
ERO	Energy Regulatory Office
ESCO	Energy service company
ESIF	European Structural and Investment Funds
EU	European Union
EU ETS	European Union Emissions Trading System
FIT	Feed-in tariff
GFCF	Gross fixed capital formation
GHG	Greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
IROP	Integrated Regional Operational Programme
LULUCF	Land use, land use change, and forestry
NECP	National Energy and Climate Plan
MoE	Ministry of the Environment
MoIT	Ministry of Industry and Trade
MoRD	Ministry of Regional Development
OP EIC	Operational Programme Enterprise and Innovations for Competitiveness
R&D	Research and development
RES	Renewable energy sources
SEC	State Energy Concept

SEF	State Environmental Fund
TYDP	Ten-Year Development Plan
WEM	With existing measures
WAM	With additional measures

Content

Executive Summary

The Regulation on the Energy Union Governance requires EU Member States to design national energy and climate plans, which must include an assessment of current investment flows to the decarbonisation of their economies.

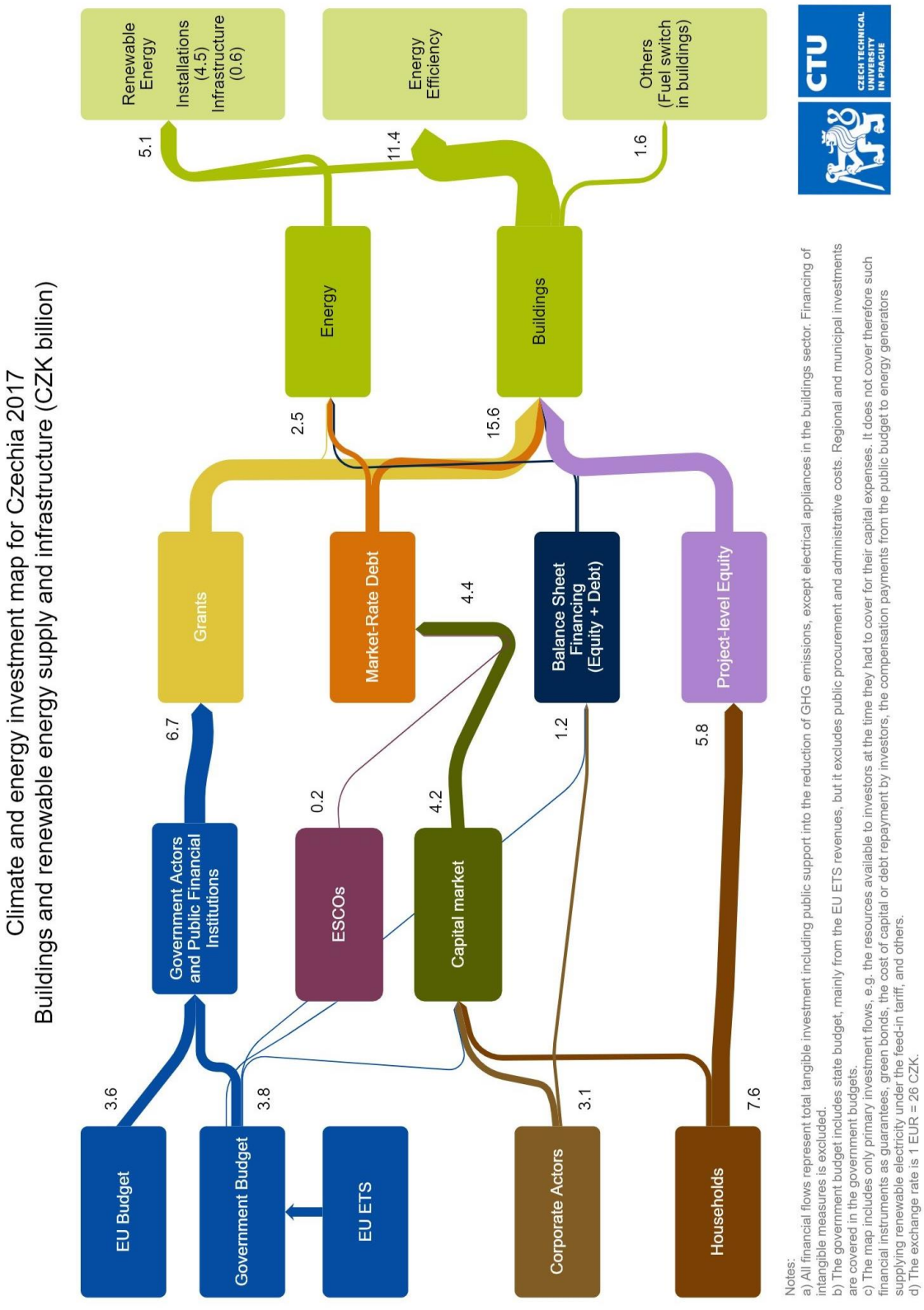
The present report is intended to inform the discussion on current climate and investment flows in Czechia. Using data from the year 2017, it aims to identify, track, and explain the amount of public and/or private money invested in technologies and other tangible measures in Czechia that lead to GHG emission reduction. The report covers the buildings sector as well as the renewable energy supply and infrastructure sector. It is also intended to assess methodological and data challenges.

The principal output of this report is a climate and energy investment map (CEIM) for Czechia for the year 2017. This map, presented below, provides a snapshot of climate and energy investment flows, from the sources of capital through the relevant intermediaries and financial instruments to the recipient sectors.

The map was created using a **bottom-up approach,** tracking **actual 2017 disbursements** at a technology level and aggregating them at sector level. We considered only climate-specific **tangible investment** (e.g. in energy-efficient equipment, buildings, and renewable energy technologies targeting or resulting in greenhouse gas (GHG) emissions reductions). 'Soft measures' (e.g. research and development, information campaigns, and policy development) play a key role in driving the energy transition and climate-change mitigation; however, these measures were excluded from our analysis.

The analysis of the renewable energy supply and infrastructure sector reflects the total capital investment, i.e. the full cost of a technology or practice. **For the buildings sector, the analysis reflects the investment close to the incremental costs.** The incremental investment represents the additional expenditure necessary to invest in a low-carbon technology rather than a business-as-usual practice.

Figure: The 2017 Climate and energy investment map for Czechia with a focus on the buildings sector and renewable energy supply and infrastructure sector, billion CZK



Based on the information available, **we concluded that, in 2017, at least CZK 18.1 billion (EUR 688 million) was invested in GHG measures in both sectors.** Of this volume, **CZK 15.6 billion (EUR 592 million) was invested in the decarbonisation of the buildings sector**, including for thermal efficiency of new and existing buildings, building-integrated renewable energy, fuel switching to low-carbon energy carriers, as well as energy-efficient appliances. **Roughly CZK 2.5 billion (EUR 96 million) was invested in renewable electricity generation, transmission and distribution, and renewable heat production and distribution accounted for in the energy balance sheet of the energy transformation sector.**

If the analysis is conducted by measure, **the largest share of the investment volume flowed into energy efficiency** (CZK 11.4 billion – EUR 432 million, representing 63 % of the total tracked investment). This exceeds the amount of the investment in renewable energy installations (CZK 4.5 billion – EUR 172 million), renewable energy infrastructure (CZK 0.6 billion – EUR 24 million), and fuel switching in buildings (CZK 1.6 billion – EUR 59 million).

Of the amount invested in building envelopes, CZK 10.2 billion (EUR 387 million) was invested in retrofits of existing buildings and CZK 1.5 billion (EUR 58 million) was invested in measures in new buildings. **The investment volume in the retrofit of existing buildings was however insufficient to decarbonise the building stock by 2050 in line with the EU sector target.**

The current policy also does not seem to trigger sufficient investment in renewable energy. The main policies to trigger renewable investment were feed-in-tariffs (FITs) and green bonuses, representing operational support to the renewable energy development. In 2017, investment in the renewable energy supply and infrastructure sector was estimated at only CZK 2.5 billion (EUR 96 million) – significantly lower than the investment levels until 2013. On top of this amount, CZK 2.6 billion (EUR 100 million) was invested in built-in PV installations, biomass boilers, and heat pumps in the buildings sector.

The main source of investment tracked was private investors, consisting of households and corporate actors, which contributed 60 % of the total investment (CZK 10.7 billion – EUR 406 million). The rest of investment flowed from public sources, mainly from EU Funds and the country's public budget, including budgets at national, regional, and local levels. The main intermediaries assisting in the use of instruments were ministries and their agencies, as well as the capital market.

Grants offered by public actors played a very important role in driving energy and climate investment in Czechia. This is particularly the case for the buildings sector, where direct subsidies

(grants) represented 56 % of total sector investment (excluding appliances), and 90 % of flows originating from public sources. **There is therefore a need, and the potential, for the introduction of a wider variety of financial instruments to trigger investment in the buildings sector.**

At present, data availability and format make a comprehensive and unbiased overview of climate finance in Czechia challenging. **Future climate and energy investment mapping would benefit from the introduction of systematic tracking procedures for domestic public climate finance and climate programmes implemented by public banks and agencies.** Possible approaches to such procedures include the introduction of climate tagging in public budgets and/or the establishment of annual evaluation procedures. For this, it will be useful to review the lessons learned from relevant legislation implemented elsewhere, such as in France, and from the application of climate markers by the EU Commission. **It is also useful to introduce a regular survey of private entities (households and corporate actors) regarding climate investment financing.** To design the survey, it could be useful to learn from the experience of France, where the investors are already required by the law to report their climate related expenditure.

Further discussions should also address **how and to what extent climate-related measures having GHG mitigation as a co-benefit should be accounted for**. Similarly, **approaches to calculating incremental costs of climate investment** should be developed further to prevent an over- or underestimation of related investment. There is also a need to improve the methodology for allocating climate investment to a specific year, given that the investment process may take long time.

1. Introduction

1.1. Background and report objective

Acting as a leader in energy transition, the European Union (EU) has set ambitious energy and climate targets through the year 2030 to tackle the urgency of addressing global climate change. The European Commission estimated that reaching these targets will require at least EUR 180 billion of additional annual investment, both private and public, by 2030 (European Commission 2018). As one of the core elements to ensure the contribution of individual EU Member States towards the progress in this transition, the Regulation on Governance of the Energy Union and Climate Action (European Parliament and the Council 2018) requires Members States to establish and submit National Energy and Climate Plans (NECPs) for the period 2021–2030. The plans outline the contribution of the respective Member States towards achieving EU targets. As part of the NECPs, Member States must provide information on the current climate investment flows.

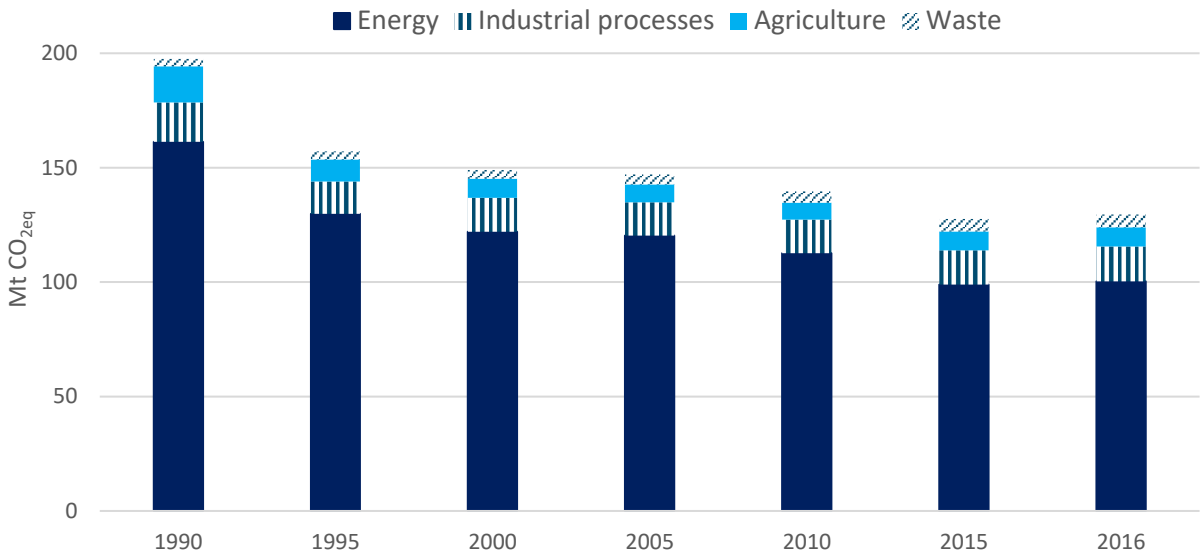
The present report is intended to contribute to knowledge and debate on the current investment flows into climate and energy transition projects in Czechia. It does so by providing an overview and quantitative assessment of such investment in 2017, the year for which the most recent data are available. To our knowledge, this assessment is the first of its kind in Czechia.

1.2. Czechia's climate commitments and investment needs

By 2016, the greenhouse gas (GHG) emissions in Czechia had declined by 35% relative to 1990 levels, with most of the reduction attributable to industry transformation in the early 1990s (Figure 1).[1] If emissions are reported using the GHG inventory methodology of the Intergovernmental Panel on Climate Change (IPCC), the largest share of 2016 GHG emissions (62%) was derived from the direct combustion of fuels, or the energy sector, and 17% from the transport sector (Cenia, n.d.). Looking closer at the energy sector, emissions from manufacturing industries and construction declined by more than 80% since 1990, while emissions from energy industries (one of the focuses of the present report) remained stable and were responsible for more than 40% of country's total GHG emissions. Therefore, energy industries are among the key targets of the country's decarbonisation policy.

[1] Disregarding the decline from 1990–1995, the GHG emissions reduction would be roughly 50% lower.

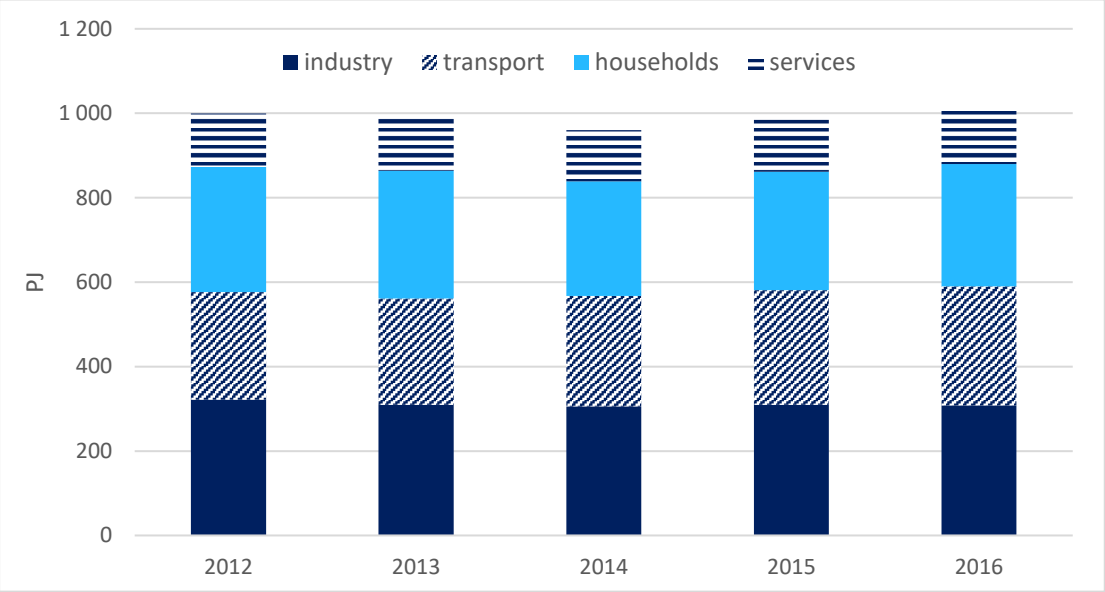
Figure 1: GHG emissions (excluding LULUCF) broken down by IPCC inventory categories, 1990-2016



Source: (Ministry of Industry and Trade 2018b)

Final energy consumption, with the building sector representing more than 40%, declined in the early 2010s but started to grow in 2014 (Figure 2). In 2017, it grew by 3% relative to 2016 levels. Most of the growth can be attributed to greater activity in industry, services, and transport, as well as to demographic and household lifestyle changes. Such developments more than offset the energy efficiency gains in the country as a whole (Odyssee-Mure 2018). Because the buildings sector accounts for a large share of the country's energy consumption and emissions, it is also a key sector for mitigation policy.

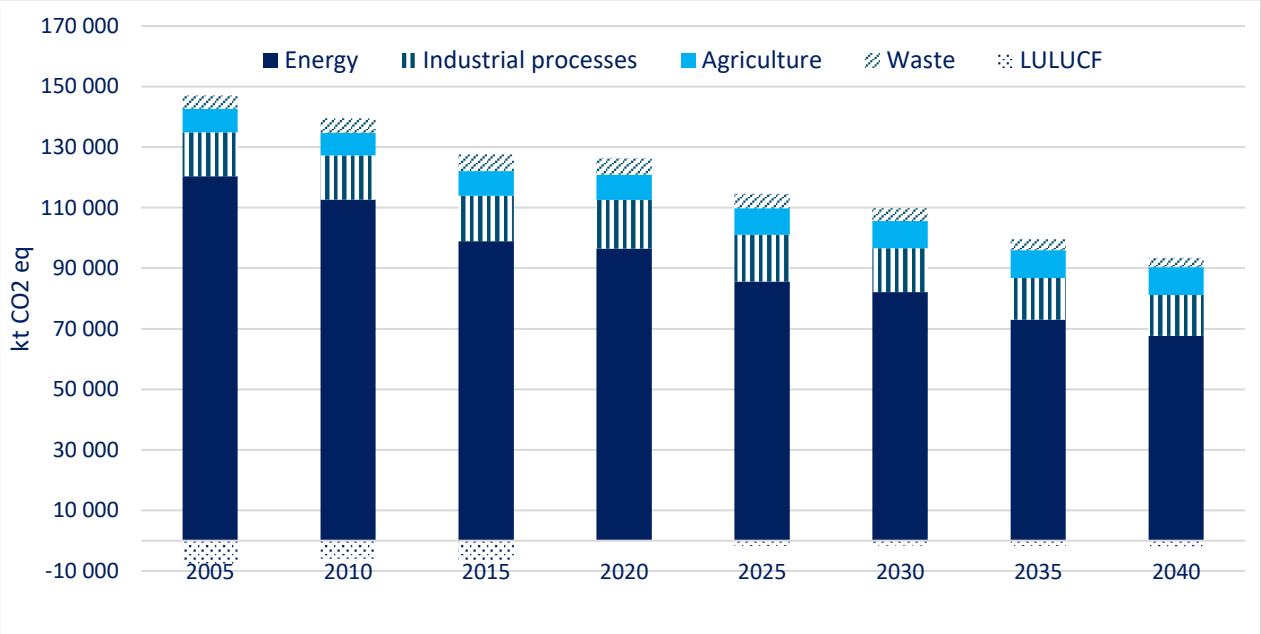
Figure 2: Final energy consumption by sector in Czechia



Source: (Ministry of Industry and Trade 2018b)

In December 2018, the country submitted the Czech National Energy and Climate Plan (NECP) (Ministry of Industry and Trade 2018b). The NECP and the Climate Protection Policy (Ministry of the Environment 2017a) commit to reducing the country's GHG emissions by at least 44 Mt CO_2-eq., or 30%, by 2030 relative to 2005 levels. The indicative reduction in GHG emissions by 2050 is 80% against 1990 levels. The planned trajectory developed by the Ministry of the Environment to meet the targets is presented in Figure 3. The energy sector is expected to account for the largest reduction, due to a planned increase in renewable energy sources (RES) and decrease in coal use for power and heat production, combined with energy efficiency gains in all sectors (Ministry of the Environment 2017a).

Figure 3: Projections of country's GHG emissions through 2040 in the WEM scenario



Source: (Ministry of Industry and Trade 2018b)
Note: WEM = With Existing Measures, as opposed to WAM = With Additional Measures (European Parliament and the Council 2018)

The Climate Protection Policy (Ministry of the Environment 2017a) provides a rough estimate of the investment needed to reach the above-mentioned GHG emission targets. Among the defined categories of scenarios presented in Table 1, only the ones categorised as "C" in the Climate Protection Policy meet the goal to reduce emissions by 80% by 2050, assuming aggressive decarbonisation measures.[2] All scenarios in category "C" assume significant energy-efficiency gains and changes in consumer behaviour; they differ mainly in the levels and origin of energy from renewable sources and nuclear installations. Total costs (expressed as a net present value) range from CZK 29–33 trillion (roughly EUR 1.2–1.3 trillion) over the period 2010–2050. These include discounted variable costs (in particular fuel and other operating costs), fixed operating costs, and investment costs. Total costs also include investments in the infrastructure for transmission and distribution networks, the cost of energy savings, and the cost of importing primary energy sources.

[2] Scenario A is the reference scenario. The B group of scenarios do not meet the 80% GHG emission reduction targets.

Table 1: Total investment costs of decarbonisation scenarios for the period 2010–2050 (in CZK billion)

Category	A	B				C		
Scenario / Sector	Reference	Extrap-olation of SEC	Nuclear	Green	Econ reces-sion	Electricity and biomass import	CCS de-velop-ment	RES, nuclear and energy efficiency
Fossil fuels	6 948	5 649	4 403	4 334	3 908	3 648	5 123	3 723
Bioenergy	3 105	3 610	3 610	3 669	3 669	3 939	3 105	3 669
Electricity	1 423	1 904	1 841	1 696	1 803	1 269	1 544	1 929
Buildings	1 718	2 195	2 111	2 317	1 987	2 317	2 037	2 244
Transport	10 969	11 888	11 427	11 186	9 741	11 186	11 427	11 186
Industry	304	709	6 780	6 780	508	6 780	6 780	6 780
CCS	0	0	0	0	0	0	2 986	0
Total	24 467	25 955	30 171	29 983	21 616	29 140	33 002	29 532

Source: Enviros in (Ministry of the Environment 2017a).

1.3. Research output, questions and structure

The aim of the report is to provide an overview and quantitative assessment of the climate and energy investment flows in Czechia for the year 2017. To do so, the report uses a method of climate and energy investment mapping that identifies and visualises the actors investing in climate change mitigation and the energy transition, the amount that they invested, the financial intermediaries and instruments that played key roles in this process, and the sectors and types of technological installations that absorbed these investments. The report focuses on the buildings sector and the renewable energy supply and infrastructure sector as two of the key areas of Czech climate policy.

The specific research questions discussed in this report include:

- How much capital was invested in climate and energy transition measures in 2017?
- Who were the main investors and what made this investment possible?
- What financing instruments were the most common?
- What types of measures received investment?

This report is organised as follows: chapter 2 introduces the analytical and methodological framework. Chapters 3 presents the results of our research for 2017, including sources and intermediaries delivering the investment, instruments supporting them, and sectors in which investment was made. Chapter 4 concludes by summarising the main results and policy implications.

2. Methodology

2.1. Analytical framework

The core output of this report is the CEIM for the Czech Republic. In this report, "climate and energy investment" is defined as spending by public and private actors for gross fixed capital formation (GFCF) leading to a reduction in GHG emissions. According to EUROSTAT guidelines (European Parliament and the Council 2013), GFCF covers expenditures to acquire physical assets, such as buildings and energy infrastructure. The methodology in this report covers expenditures for durable goods (e.g. appliances) acquired by households, even though these do not fall under the definition of GFCF.

The map represents climate and energy investment flows from the sources of capital and the relevant intermediaries to the recipient sectors and identifies the specific instruments used. The construction of the diagram uses a bottom-up approach, tracking investment at a technology level and aggregating it at sector and then country level. The map provides insight into the types of actors that invest, how much they invest, which sectors and types of technological installations receive these investments, and which intermediaries and financial instruments facilitate these flows.

The methodological framework used in this report replicates the methodology of the 2016 Climate and Energy Investment Map prepared for Germany (Novikova et al. 2019). The latter, in turn, is based on the method for producing a climate finance landscape developed by the Climate Policy Initiative, first in 2011 at the global level (Buchner et al. 2011) and then at national level (Juergens et al. 2012).

2.1.1. Sources of investment

The CEIM differentiates public and private sources of investment. Public sources refer to **EU budget** expenditures disbursed through EU funding programmes. For the sectors covered, these include the European Regional Development Fund (ERDF) and the Cohesion Fund (CF) through their Operational Programmes (OPs). Public sources also include national **government budgets**, including those at state, regional, and local levels. Spending provided by these entities can take two forms. It can be disbursed either as a direct investment in low-carbon public assets (e.g. as an investment in energy efficiency and renewable energy generation deployed in municipal buildings) or as public finances provided to private and public actors as a financial incentive to invest (e.g. as grants for energy efficiency measures and renewable energy installations).

Private sources of investment are **households** and **corporate actors** in the selected sectors.[3]

For the purposes of this report, private sources do not include Czech public expenditures for GHG mitigation measures implemented in other countries or private foreign direct investments in the Czech Republic.

2.1.2. Intermediaries

Intermediaries enabling investment in climate mitigation are **government actors**, **public financial institutions**, and **commercial financial institutions**. Czech government actors serving as intermediaries are national ministries and government agencies. Public financial institutions include the European Investment Bank (EIB), the State Environmental Fund (SEF), and the Czech-Moravian Guarantee and Development Bank (CMZRB). Commercial financial institutions represent different actors, such as commercial banks, pension funds, and investment funds. Although they play an important role in financing climate mitigation, for the purposes of this report we could only quantify investment flowing from them as a co-financing of public-driven investment. That is because no data are available to quantify the rest of the investment flowing exclusively through private intermediaries.

2.1.3. Financial instruments

This report covers a wide range of financial instruments that support investment in climate mitigation. These instruments include **grants**, **concessional loans**, **project-level market-rate debt**, **balance-sheet financing (debt)**, **balance-sheet financing (equity)**, and **project-level equity**.

In line with the methodology used in Novikova et al. (2019), we tracked only primary investment flows, e.g. the resources that were available to investors when they had to cover for their capital expenses or that they could reliably call in to cover their expenses immediately after incurring the expenses. For this reason, we excluded risk-management instruments such as guarantees, the cost of capital or debt repayments, repayment grants, FITs or green bonuses, and green bonds issued in Czechia, although we acknowledge that they can play an important role in enabling investment in climate mitigation. Accounting for some of the flows may result in double counting. For the definition of financial instruments mentioned here, see the recent version of the CPI report "Global Landscape of Climate Finance" (Buchner et al. 2017).

[3] See section 0 for the sector definition.

2.1.4. Recipients

In this first CEIM for the Czech Republic, we tracked investment in two sectors: the energy sector and the buildings sector. For the energy sector, we focused on investment in renewable electricity generation, transmission, and distribution, as well as renewable heat production and distribution accounted for in the energy balance as the "energy transformation sector". We refer to this sector as the "renewable energy supply and infrastructure sector". For the buildings sector, we focused on the energy efficiency of buildings and systems as well as fuel switching, i.e. the installation of building-integrated renewable energy systems in residential, commercial, and public buildings.

The sectors were defined according to energy balances for the Czech Republic (Czech Statistical Office 2018) and the official classifications according to the Classification of Economic Activities (CZ-NACE) (Czech Statistical Office 2007), as well as the delineation presented by the IPCC (Krey et al. 2014). Our sector definitions are described in greater detail in Table 2 below.

Table 2: Sector delineation

Sector	Sector boundaries
Renewable energy supply and infrastructure	Covers technologies and practices implemented by Section D ("Electricity, gas, steam, and air conditioning production and distribution"), but focuses primarily on D35.1 ("Electric power generation, transmission, and distribution"). We account for the **deployment of renewable energy technologies (for both heat and power), as well as for infrastructure designed to transmit and distribute electricity and heat from renewables.** Waste incineration was not included in this sector.
Buildings	Covers technologies and practices implemented in **buildings that belong to households, public and commercial actors**. The latter largely corresponds to Sections F to S of the CZ-NACE (Czech Statistical Office 2007). We account for such investment as the thermal efficiency improvement of envelopes for existing buildings, construction of buildings with better thermal performance than is required under the current building code, installations of energy-efficient building systems, installation of building-integrated renewable energy systems, and improvements in the energy efficiency of appliances and equipment.

It is important to note that we did not track investment in renewal and major renovation of renewable energy installations in the energy generation and infrastructure sector. However, we did track investment in thermal efficiency retrofits of the existing building stock.

In the CEIM diagram, investment in the sector recipients was further grouped into three categories of technological installations, namely 'Renewable energy', 'Energy efficiency', and 'Others'. Investment

in the ‘Renewable energy’ group includes investment in renewable energy installations and renewable energy infrastructure. The ‘Others’ group includes fuel switching in buildings. Annex 1. Energy generation and infrastructure: assumptions’) and

Annex 2. Buildings: assumptions') provide information on all investment flows identified in our assessment, grouped according to sector and technology type.

2.2. Scope and boundaries

2.2.1. Temporal scope

This report tracks climate and energy investment that occurred in 2017, i.e. not the investment that was planned or committed for that year. The year 2017 is the most recent year for which energy statistics, public budgets, annual reports of financial institutions, and monitoring reports of public subsidy programmes were available at the time of data collection (January–June 2019).

2.2.2. Investment scope: specific versus related

Measures could relate to climate actions to a different degree, from a very narrow and specific climate focus to a weak but still trackable link to it. This report relies on the definitions developed and used by Juergens et al. (2012), namely:

- **Climate-specific** investment refers to capital flows that target investment resulting in climate change mitigation or avoidance of emissions. Adaptation and climate resilience, though also important, are not covered in the present report due to a lack of data.

- **Climate-related** investment refers to financial flows into measures that, while not primarily intended to mitigate climate change, deliver climate co-benefits in terms of reduction or avoidance of emissions.

For the purposes of this report, we have included climate-specific and climate-related investment. The latter was fully accounted for, because even though the main priority of the expenditure (according to the ESIF's Operational Programme Environment) is 'Improving Air Quality', the actual measures fall under the definition of climate-specific investment.

2.2.1. Investment scope: tangible versus intangible

Investment in energy and climate may support different types of measures and practices. They could be 'hard', or tangible, investment in physical assets like machinery, equipment, and buildings. They could also be expenditures for 'soft', or non-tangible, measures resulting in less visible changes, such as changes in practices and behaviour due to research and development (R&D), information, training, or capacity building. The present report focuses on 'hard' or **tangible investment flows**. Intangible

investment in energy and climate, such as investment in R&D or support to information programmes, was excluded.

2.2.2. Investment scope: total versus incremental

The most useful analysis for policy-makers is tracking additional or incremental investment in the energy and climate transition. Incremental investment refers to the additional expenditure necessary to create a new asset or an equivalent asset in a manner different from the business-as-usual practice.

The incremental approach provides a more realistic picture of the actual progress towards the energy transition. However, in this case, tracking only incremental investment was not always possible, because the nature of, and investment, in the business-as-usual case are not known in Czechia. Discussing the total investment overestimates the contribution to energy and climate-transition actions; as a result, caution should be used when comparing the results to the investment needs for the energy transition.

For the buildings sector, however, the levels of investment tracked in the report lie between the total capital cost and the incremental cost. The reason is that the investment mostly flowed through grants from public programmes, which had relatively strict cost eligibility criteria excluding a significant part of business-as-usual costs. The only exception would be the line on Energy Performance Contracting through ESCOs, where such assumption cannot be made. For appliances, the report was able to track the incremental investment. For the renewable energy supply and infrastcture sector, the total cost was tracked. Table 3 further illustrates the deliniations of measures, investment, and costs.

Table 3: Summary of measure, investment, and cost deliniations

	Climate-specific investment		Climate-related investment	
	Incremental cost	Total capital investment	Incremental cost	Total capital investment
Tangible	Buildings sector: Electric efficiency	Buildings sector[1]: Thermal efficiency Renewable energy Energy and infrastructure sector: Transmission grids and distribution networks related to renewable energy	-	Energy: Renovation and modernisation of the distribution grid
Intangible	All sectors: R&D, information policies, training, and capacity building			

Covered by the report Not covered by the report

[1] For the thermal efficiency of buildings and building systems, the share of investment tracked in the report falls between the total capital cost and incremental cost.

2.2.3. Investment scope: avoiding double counting

The report only tracks primary investment flows, i.e. those creating new or additional assests. If financial instruments used in other sectors (not covered in the present report) were considered, the flows would not reflect the cost of capital or debt repayment by investors, as the latter would result in double-counting the investment. Similarly, there would be no quantification of the role of government guarantees provided to public banks or the grant-equivalent value of concessional loans. Accounting for these flows would result in greater energy and climate financing, adding to the contribution of the public sector in supporting private investment. However, this, too, might lead to double counting.

2.3. Data analysis

Data were collected and categorised by sources, intermediaries, instruments, and measures. For comparative purposes, the data sources and structure used here are the same as those in Juergens et al. (2012) and Novikova et al. (2019).

2.3.1. Renewable energy supply and infrastructure sector

Energy infrastructure

Data on investments in transmission system (electricity) and distribution systems (electricity) was analysed for the year 2017. Czechia has one transmission system operator (ČEPS, a.s.) and three distribution companies: PREdistribuce, a.s. (Prague region), ČEZ Distribuce, a.s. (northern half of Czechia), and E.ON Distribuce, a.s. (southern part of Czechia). Data on transmission system investment were taken from the Ten-Year Development Plan of the Czech Transmission System (TYDP) for the years 2017–2026 (ČEPS 2016). The information was complemented with data from the annual reports of ČEZ Distribuce, a.s., and E.ON Distribuce, a.s.4 Further investment was tracked through the analysis of the projects supported by the Operational Programme Enterprise and Innovation for Competitiveness (OP EIC) implemented with the support of EU Funds, namely the ERDF.

Renewable energy installations

The main sources of data on (newly) installed capacity were the annual ERO and MoIT statistics. These included the Report on the Renewable energy sources in 2017 by the Ministry of Industry and Trade (Ministry of Industry and Trade 2018a) and the Energy Regulatory Office Report on the Operation of the Czech Electrical Grid in 2017 (ERO 2018).

The statistics on newly installed capacity was supplemented (checked) against other information from the operators of individual types of facilities (renewable energy association's pages), statistics of equipment manufacturers, and data on holders of electricity generation licenses (ERO database). Information on subsidies for renewable energy installations is taken from OP EIC - Calls for Renewable Energy and Energy Savings (photovoltaics (PV) for own consumption). Information on the specific investment costs of individual categories of renewable energy was taken from the ERO Decree 296/2015 Coll. on "Technical and economic parameters for setting FITs for electricity production and green bonuses for heat and on determining the useful life of electricity and heat generation plants from renewable energy sources" (Decree on technical and economic parameters). For categories, where this Decree does not report specific investment costs, alternative data sources are used, such as the associations of renewable energy providers, and expert media.

[4] PREdistribuce was not relevant for this study as it covers Prague territory only.

2.3.2. Buildings sector

The data on investment flows in renewable energy and energy efficiency measures in buildings were gathered through the reporting of relevant public programmes and their intermediaries. These include the Ministry of the Environment, Ministry of Regional Development, Ministry of Industry and Trade, and the State Environmental Fund. The disbursments of 2017 were taken as the basis for the data analysis. The breakdown to individual supported measures allowed to split the finance flows into measures, i.e. to differentiate between finance flows into energy efficiency measures (typically improvements of thermal properties of buildings), and renewable energy integrated into buildings (typically heat pumps, local sources of heat from biomass, PV, and solar thermal collectors).

Total eligible costs to financial instruments provided by these public programmes were taken as a proxy for total project costs. The eligible costs cover the costs related to energy efficiency and renewable energy measures in the programmes, leaving out the unrelated costs.

We estimated the climate and energy investment that does not go through the public sector by using the data on the renovation rates; to avoid double counting, we deducted the measures supported by public programmes. This part of the investment does not represent actual disbursement; therefore, we have not included it in the map. However, the estimate provides an order of magnitude for this type of investment that is very useful for policy-makers and we include into the discussion of the sector in the results section. Such estimate was prepared because the statistics on investment channeled exclusively by the private financial intermediaries or realized by private actors without the support of public financial intermediaries is not available.

For efficient appliances and equipment, the market data on sales of appliances according to the energy class formed the basis of the calculation (APPLiA CZ 2019; GfK 2019). However, only the main (big) household appliances were covered in the report. Therefore, the actual investment is probably higher.

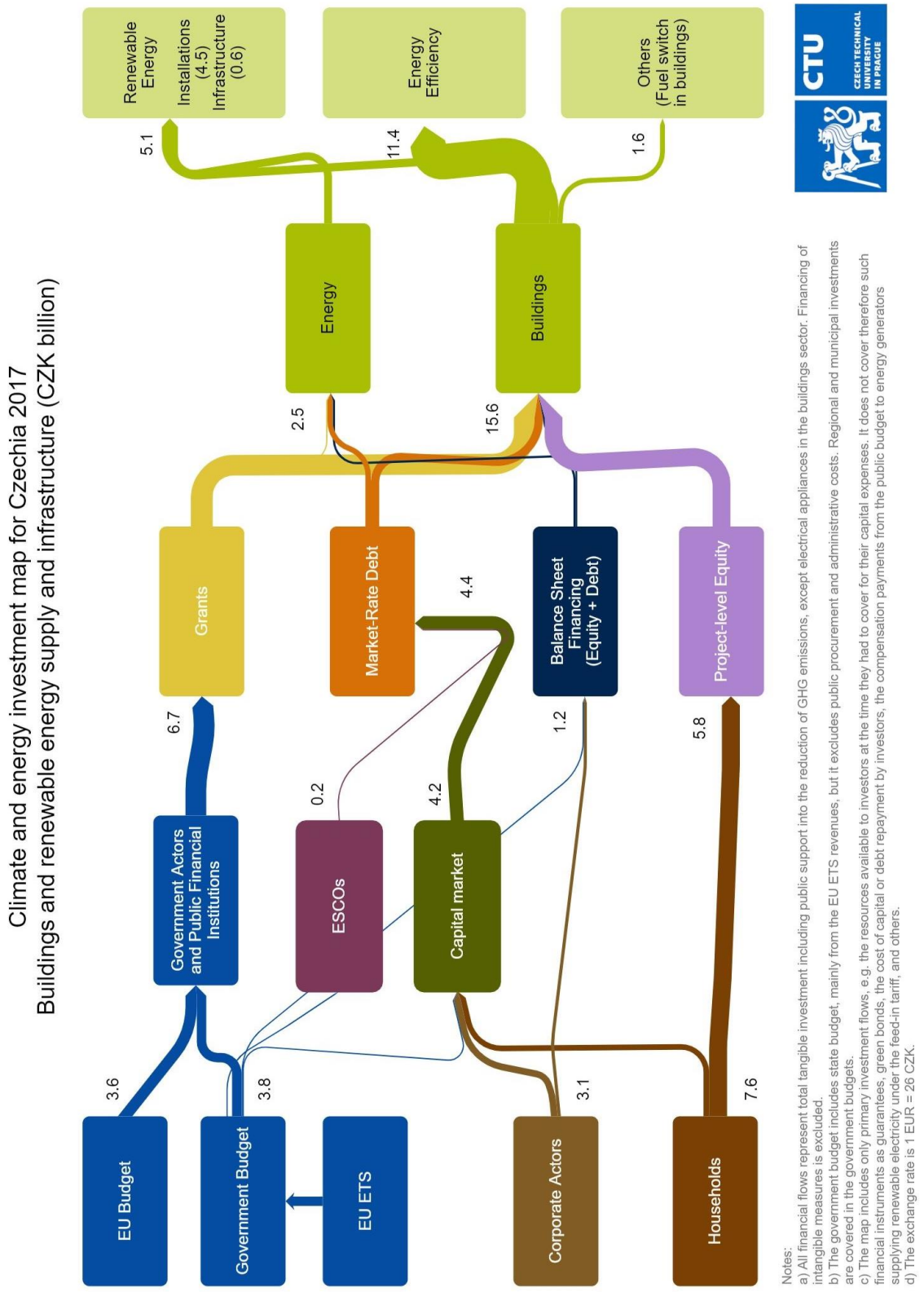
3. Results

Figure 4 presents the 2017 climate and energy investment map for Czechia for two sectors: buildings and energy. For the energy sector, we focus on renewable energy supply and infrastructure. The map shows total capital investment, which reflects the full cost of a technology or practice.[5] The map includes only climate-specific tangible investment, i.e. energy-efficient equipment, infrastructure, buildings, and renewable energy technologies targeting or resulting in GHG emission reduction. Soft measures (i.e. research and development, information campaigns, and policy development) play a key role in driving the energy transition and climate change mitigation but were excluded from our analysis. The investment flows tracked for this report represent actual disbursements in 2017 and not those planned and/or committed for that year.

Total investment in all considered technologies amounted to CZK 18.1 billion [6] in 2017. The text below provides an analysis of the total investment volume except where explicitly stated otherwise.

[5] Except for electrical appliances, for which the incremental costs were included in the total investment figure. The incremental investment represents the additional expenditure necessary to invest in a low-carbon technology instead of a business-as-usual practice.
[6] In 2017, the average EUR exchange rate was 1 EUR = 26.33 CZK (European Central Bank online).

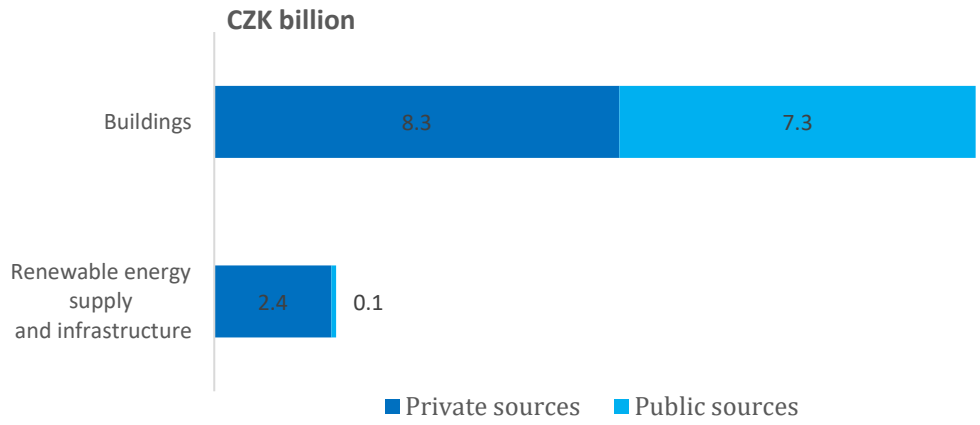
Figure 4: The 2017 Climate and Energy Investment Map for Czechia (buildings sector and renewable energy supply and infrastructure), in CZK billion



3.1. Sources of finance

Of the total investment, private sources provided 59% (CZK 10.7 billion) and public sources 41% (CZK 7.4 billion) in 2017 (Figure 5). Investment in renewable energy supply and infrastructure flowed mostly from private sources. Investment in the decarbonisation of the buildings sector flowed almost equally from private and public sources.

Figure 5: Climate and energy investment by sector and by source in 2017 (in CZK billion)



3.1.1. Public sources

In 2017, the EU funds contributed CZK 3.7 billion in the form of grants to climate-specific investment in the renewable energy supply and infrastructure and building sectors. These grants include:

- Support from the CF in the amount of CZK 2.9 billion, mainly for technology measures (heat exchange) in residential buildings.

- Support from the ERDF in the amount of CZK 0.8 billion for thermal efficiency retrofits, energy efficiency building systems in residential and non-residential buildings, and renewable energy installations in the renewable energy supply and infrastructure sector.

The government budget of Czechia also provided CZK 3.8 billion, mostly in the form of grants, for climate-specific investment in the buildings sector and in the renewable energy supply and infrastructure sector. Of this amount, CZK 3.1 billion represented an inflow to the government budget of revenue derived from the EU Emission Trading System (EU ETS). This revenue was mainly used to finance thermal efficiency retrofits of residential buildings. The remaining CZK 0.7 billion from the government budget consisted of other contributions from national, municipal, and regional budgets.

3.1.2. Private sources

Of private sector sources, households contributed the largest share of investment (CZK 7.6 billion), followed by corporate actors (CZK 3.1 billion). These volumes are lower estimates, because we were unable to track the full amount of private investment due to a lack of data, especially in the building sector.

3.2. Intermediaries

Nearly 70% of the investment covered by our analysis was financed through programmes of public intermediaries, mainly grants. These include the State Environmental Fund, the Ministry of Industry and Trade, and the Ministry of Regional Development.

The State Environmental Fund (SEF) was founded in 1992 and is the main Czech institution providing and mediating subsidies, concessional loans, and contributions towards interest on loans to projects aiming to improve the environment. Projects co-financed by the SEF include those designed to improve air quality, develop RES, and improve the energy performance of buildings. The SEF is subordinate to the Ministry of the Environment. Currently, it manages two programmes targeting decarbonisation of the building sector: the Operational Programme Environment and the New Green Savings Programme. The Operational Programme Environment is co-financed by the CF and the ERDF within the Multiannual Financial Framework for 2014–2020, and the relevant priority axes are priority axis 2 (improving air quality) and priority axis 5 (energy savings). In the Operational Programme Environment, EUR 669 million (roughly CZK 17 billion) is allocated to priority axis 2 and EUR 646 million (roughly CZK 17 billion) is allocated to priority axis 5 (Ministry of the Environment 2019). The New Green Savings Programme aims primarily at the thermal efficiency retrofits of residential buildings, and new buildings in high energy efficiency standards. The indicative allocation of the New Green Savings Programme is CZK 27 billion for the period 2013–2020 (Ministry of the Environment 2017b)[7].

The Ministry of Industry and Trade (MoIT) is the managing authority of the OP EIC of the ERDF. The programme is the main country's programme, which finances energy efficiency, renewable energy installations, and other low-carbon measures in the industry and commercial sector. The expenditure is eligible under priority axis 3 on efficient energy management, development of energy infrastructure and RES. The programme's intermediary body is the Business and Innovation Agency (API), which is

[7] Additionaly, the SEF manages the National programme for Environment, which provides loans to pre-finance the exchange of boilers, supported in the Operational Programme Environment. This programme started only in 2019, and therefore is not reflected in our diagram.

subordinate to the MoIT. The total allocation of the OP EIC to energy efficiency and renewable energy measures for the period 2014–2020 was EUR 2.4 billion (approximately CZK 61 billion).

The Ministry of Regional Development is the authority responsible for functions including regional and housing development in Czechia. It is a managing authority of the Integrated Regional Operational Programme (IROP) of the ERDF, which supports energy efficiency measures in multi-apartment buildings under priority axis 2. The total allocation of the IROP to energy efficiency in these buildings is EUR 440 million (approximately CZK 11 billion) for the period 2014–2020 (Ministry of Regional Development 2019b).

The **Czech-Moravian Guarantee and Development Bank** assists and offers concessional loans and guarantees to small and medium-sized enterprises (SMEs) as well as to municipalities. Two specific programmes devoted to energy efficiency are ENERG and Energy Savings. However, in 2017, no projects were financed through these programmes (Gross 2019).

In 2017, the **EIB** paid out EUR 593 million in Czechia to all projects. On average, 13 % EIB projects in Czechia are related to energy and the environment, which would mean EUR 77 million in 2017 (EIB 2019). Because the EIB did not report the actual disbursements for climate action, we did not include this amount in the investment map.

Some **commercial banks** and other financial insitutions offer financial products intended to promote energy savings and RES. To our knowledge, the data on the outcomes of these products are not tracked and therefore could not be incorporated in our analysis.

Similarly, **institutional investors** (e.g. insurance companies, pension funds, and investment funds) increasingly express their interest in diversifying their investment portfolio towards sustainable projects, including climate mitigation (Ceska sporitelna 2018). However, because we were unable to locate and quantify their role in climate and energy investment, we have excluded them from our analysis.

3.3. Financial instruments

In 2017, grants played a key role in supporting investment in the low-carbon transition of the buildings sector, including energy efficiency, integrated renewable energy installations, and fuel switching.

Investors in these measures co-financed the grants with several instruments, such as household savings (project-based equity), market-rate debt, and/or balance-sheet financing of corporate actors and municipalities (equity and/or debt).

In the renewable energy supply and infrastructure sector, the FITs (as a form of operational support) was the main trigger of the investment in renewable energy installations. Grants supported a small share of investment in renewable energy infrastructure. Sector investment flowed mainly from private sources, which acquired market-rate debt co-financing it with its balance sheet (equity and/or debt).

Table 4: Breakdown of climate-specific investment by financial instrument in 2017 (in CZK billion)

Grants	Project-level market-rate debt	Balance-sheet financing (debt and equity)	Project-level equity
6.7	4.4	1.2	5.8

Note: Due to data limitations, volumes given for project-level market-rate debt, balance sheet financing, and project-level equity should be compared with caution. The expenditure reports of public actors were more readily available than was information on private investments; therefore, the volume and role of these three instruments may be underestimated.

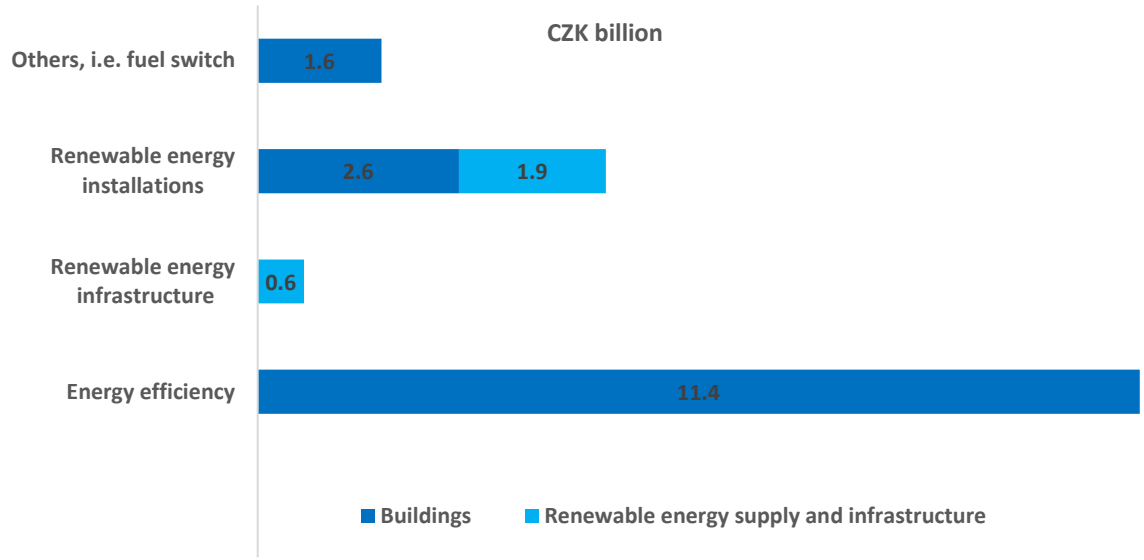
3.4. Recipients

Table 5 and Figure 6 provide an overview of investment in 2017 by sector and technology type. The buildings sector attracted CZK 15.6 billion in 2017, with two thirds flowing into energy efficiency measures (mainly different insulation levels of existing buildings). In the renewable energy supply and infrastructure sector, investment amounted to CZK 2.5 billion, with the main share of investment flowing to renewable energy installations.

Table 5: Breakdown of 2017 total climate-specific investment in Czechia by sector and by technology type (in CZK billion)

Sector / Technology	Buildings sector	Renewable energy supply and infrastructure sector
Energy efficiency	11.4	-
Renewable energy infrastructure	-	0.6
Renewable energy installations	2.6	1.9
Others, i.e. fuel switch	1.6	-
Total	**15.6**	**2.5**

Figure 6: Breakdown of 2017 total climate-specific investment in Czechia by sector and by technology type, CZK billion



3.4.1. Renewable energy supply and infrastructure sector

The energy sector plays a key role in Czechia's low-carbon transition. As shown above, it is responsible for up to 77 % of Czechia's GHG emissions. Total GHG emissions in the energy sector decreased by 38 % between 1990 and 2016. The main reasons for the decline were the fall in primary energy consumption (from 1915 PJ to 1727 PJ), decrease in coal (solid fossil fuel) utilisation (from 891 to 703 PJ), and increase in power generation at RES power plants (from 3.1 to 9.4 TWh).

Box 1 Energy sector in Czechia

Coal still plays a significant role in Czech power generation, as illustrated in Figure 7. The share of coal-fired power plants in power generation is declining slowly: it was 58 % in 2008 but only 48 % in 2017 (brown and hard coal, gross generation). The share of natural gas-fired power plants in (gross) power generation increased only slightly, from 3.1 % in 2008 to 3.9 % in 2017.

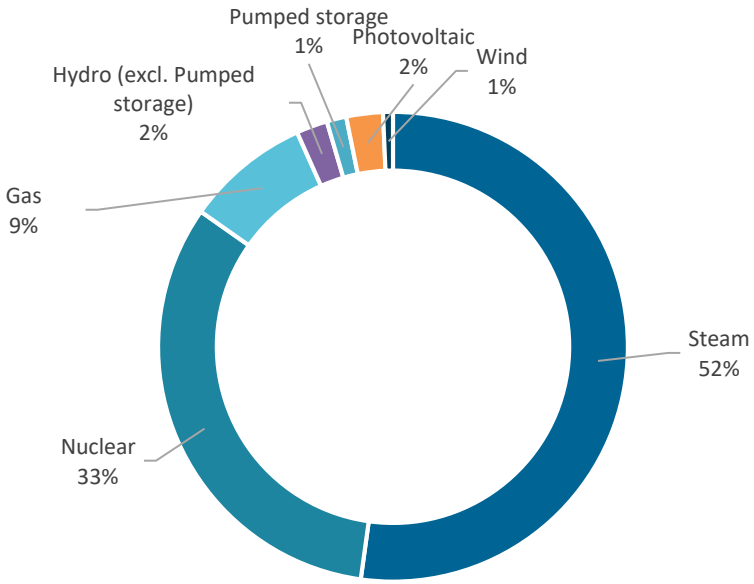
Electricity generated from renewable energy sources increased quickly between the years 2008 and 2013, in particular from PV and biogas stations, and slowed down thereafter (Figure 8). The initial burst was triggered by support for renewable energy power plants in the form of FITs and feed-in premiums (FIP), which by 2013 had reached approximately CZK 45 billion/year. Legislative changes in 2012 adjusting the level of support from 2013 to the market situation have significantly slowed down the further growth of renewable power generation capacity. In 2017, the growth of renewable power generation was 4 % compared to the previous year (Ministry of Industry and Trade 2018b).

Heat delivery to the final heat consumers based on RES also developed slowly over the last five years. The total heat production from solid biomass combustion (excluding firewood burning by households) increased by 9 % between 2013 and 2017. Heat production in all types of biogas plants grew by 28 % in the same period. Total gross heat production (and delivery to consumers) from renewable energy increased by 12 % between the years 2013 and 2017.

The power transmission system is essential for the further development of renewable power generation and the management of cross-border power flows. The TYDP for the Czech transmission system (ČEPS 2016) *explicitly addresses the need for investment in power grid expansion to absorb increased amounts of power from renewable energy plants, in particular large wind parks. Most of the investment is, however, directed towards improving the stability and reliability of grid operation. The TYDP of the transmission system also envisages investment in the connection of new power generation capacity of gas-fired power plants, as well as nuclear power plants.*

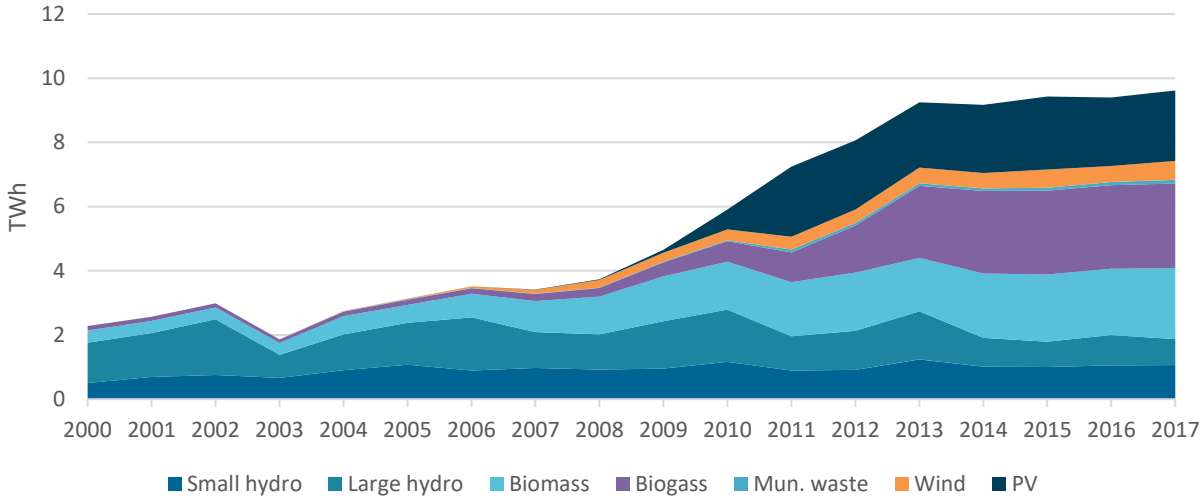
Power distribution companies explicitly direct their investment towards connecting new customers, modernising the grid to allow for future smart metering, and realising the smart grid concept. The connection of new customers includes new residential and other buildings, as well as new business companies and production facilities. Some investments are also related to future charging infrastructure for electric vehicles (CEZ 2018; E.on. 2018). Annual reports of distribution companies for the year 2017 do not include information on investment directly related to the increase in renewable power generation.

Figure 7: Gross power generation structure in 2017



Source: (Energy Regulatory Office 2018)

Figure 8: Development of power generation from RES in Czechia [TWh/y]



Source: (ČEPS 2016)

Table 6 presents total climate-specific investment in the renewable energy supply and infrastructure sector in Czechia in 2017. The table divides investments into two categories: investments in renewable energy technologies (including both power and heat) and investments in transmission- and distribution-related measures linked directly to renewable energy development in Czechia. The investment

in renewable energy technologies excludes technologies integrated into the buildings, and in other sectors.

Table 6: Climate finance in the renewable energy supply and infrastructure sector, in CZK million

Source	Renewable energy	Transmission system	Total
Public	10	62	72
Private	1 885	558	2 443
Total	1 895	620	**2 515**

What was the total climate-specific investment in the sector?

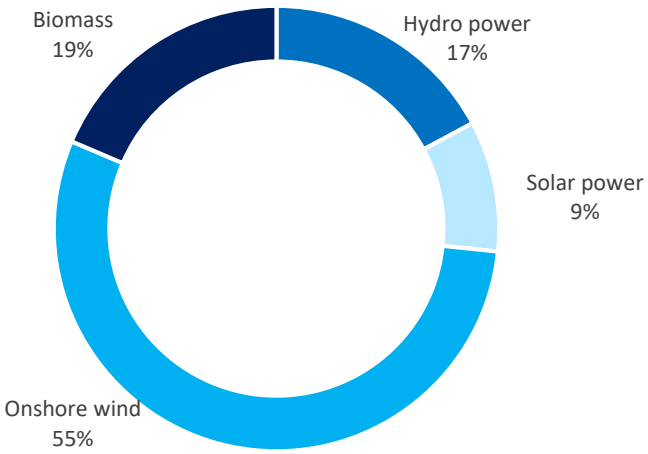
- In 2017, the total climate-specific investment in the renewable energy supply and infrastructure sector was CZK 2.5 billion, with more than 70 % attributable to renewable energy technologies and the rest to the transmission and distribution system.
- Our methodology excludes tracking of all FITs, which form the main type of public support to renewable energy in Czechia, but it does track the investment that should be triggered by them.[8]

Which were the key sector segments, technologies or practices attracting investment?

- More than 50 % of the total investment (CZK 1.4 billion) flowed into onshore wind power generation. Only 9 % of the total investment (CZK 180 million) flowed into solar technologies (including both power generation and heat production). However, this figure excludes the investment in buildings-integrated renewable technologies, which was CZK 350 million in small PV installations supported by grants. Similarly, it excludes CZK 2.2 billion investment in biomass boilers and heat pumps accounted for in the buildings sector.

[8] In some cases, stopping the existing feed-in tariffs would mean that the existing renewable energy sources would stop operating.

Figure 9: Investment in renewable energy by technology, 2017



Who were the main investors?

- The private sector invested CZK 2.4 billion, which represented 97 % of the total climate-specific investment identified in 2017 in the renewable energy supply and infrastructure sector. Public sources were used mainly for investment in the expansion of the transmission grid and came from EU funds.
- In the private sector, the main (and only) investors were corporate entreprises.
- It is important to note that these investment flows reflect the actual investment in capital assets and they do not reflect FITs or green bonuses that are a form of operational support (conversely to investment support).

What was the role of the public and private intermediaries in supporting private and public investment?

- The largest share of investment for the renewable energy supply and infrastructure sector was assisted by the capital market. In particular, commercial banks played a major role, providing up to 80 % of total project costs.
- Due to an established system of renewable energy support with FITs, there is limited direct investment support for these technologies from public financial intermediaries. Thus, in 2017, the Ministry of Industry and Trade provided CZK 71.8 million in the form of grants through its OP EIC, financed by the ERDF.

How was the climate investment financed?

- The main instrument for financing renewable energy development in 2017 was market-rate debts (nearly 70 % of the total investment). Furthermore, 27 % of the investment was financed through private equity and 3 % through public grants. The public grants (financed from the EU Funds in the financial framework 2014-2020) only started to be disbursed in 2017. The investment was triggered by the existence of the system of FITs and green bonuses, which were the main instrument to support renewable energy technologies.

Is the sector on track to reach its targets?

- Czechia managed to reach its relatively low 2020 target for renewable energy (13 % in the total gross final energy consumption) as early as 2015/2016 (Ministry of Industry and Trade 2015). This was mainly due to the sharp increase in installed renewable power capacity between 2006 and 2013. (The production of renewable electricity grew from 3.5 TWh in 2006 to 9.2 TWh in 2013.) There was also a massive increase in PV and biogas stations in that period. Such a massive increase in renewable energy capacity placed a very high burden on the public budget for renewable energy support, currently reaching CZK 45 billion per year. To avoid further uncontrolled growth, in 2013 Czechia adopted legislation that de facto paralysed further renewable energy development.

3.4.2. Buildings sector

The buildings sector plays a particular role in Czechia's energy transition. It is estimated that the operation of buildings is responsible for up to 44 % of national GHG emissions (Lupíšek 2016). Buildings accounted for a large share of electricity consumption and district heat production in Czechia. While emissions associated with the generation of electricity and district heat are attributable to the energy sector, these energy carriers are consumed in the building sector and therefore account for the building sector's indirect emissions.

The Climate Protection Policy of Czechia does not envisage a specific emissions reduction target for the buildings sector (Ministry of the Environment 2017a). However, the document acknowledges the importance of buildings in the overall reduction targets and highlights their potential, especially for public and municipal buildings. The NECP of Czechia (Ministry of Industry and Trade 2018b) estimates the total investment needed to reach the 2030 energy efficiency target as CZK 400 billion–600 billion (in the period 2021–2030).

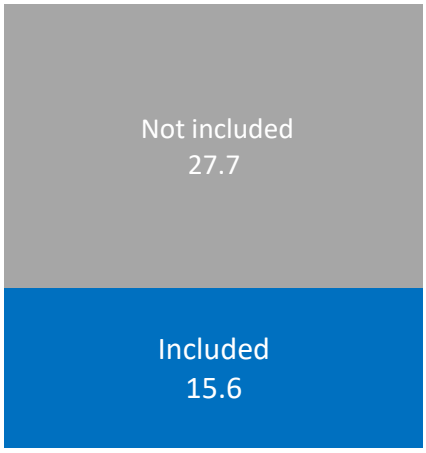
Table 7 presents the total climate-specific investment in the buildings sector in Czechia in 2017. It is divided into energy efficiency measures (the improvement of thermal properties of buildings and energy-efficient appliances), investment in built-in renewable energy technologies, and other technological measures that lead to a reduction of GHG emissions, mostly entailing fuel switch in heating technologies.

Table 7: Climate-specific investment in the buildings sector in 2017 (in CZK million)

Source	Energy efficiency	Renewable energy	Other (fuel switch)	Total
Public	4 331	1 850	1 168	7 349
Private	7 055	794	397	8 246
Total	11 386	2 644	1 565	**15 595**

It is important to note that the current analysis (and the map) only covers the trackable investment, which in our case means investment that partially passes through public intermediaries or originates from public sources (such as grants and their co-financing). Due to a lack of data and insufficient climate tracking, the map does not cover investments made without public incentives. This includes even the investment channelled to Czech commercial banks by the EIB. Figure 10 shows how much is potentially not tracked.[9] It must also be noted that this figure is primarily intended to point to the order of magnitude of underlying uncertainties, which stem mainly from the lack of official data statistics.

Figure 10: Estimates of investment into the buildings sector not included in the map in 2017 (in CZK billion)



[9] For further information, see Annex 2.

What was the total climate-specific investment in the sector?

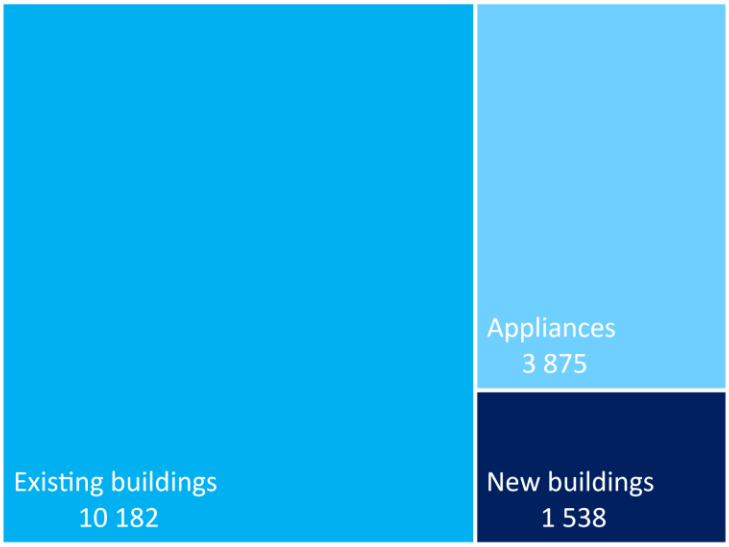
- In 2017, the total climate-specific investment was calculated as at least CZK 15.6 billion. This represents an estimate close to the incremental costs[10] of building sector decarbonisation.
- This is because the estimate was based mainly on investment flows through grants from public programmes. For investment in building retrofits, these programmes have relatively strict cost eligibility criteria excluding a large portion of business-as-usual costs. For new buildings, the programmes only subsidised the construction of houses complying with the passive house standard. In the latter case, the subsidy only covered the additional costs of building the passive house above the business-as-usual standard.

Which were the key sector segments, technologies or practices attracting investment?

- If the total amount is broken down by sub-sectors and actors, CZK 12.1 billion was invested in residential buildings, CZK 2.6 billion in public buildings, and CZK 0.8 billion in commercial buildings.
- If the total amount is broken down by measure, CZK 7.5 billion was invested in thermal efficiency measures, CZK 3.9 billion in energy-efficient electrical appliances, CZK 2.6 billion in building-integrated renewable energy, and CZK 1.6 billion in fuel switching (emission reduction from fossil fuels).
- Of the total amount invested in building envelopes, CZK 10.2 billion was invested in the retrofit of existing buildings and only CZK 1.5 billion was invested in measures in new buildings. In addition, CZK 3.9 billion was invested in efficient appliances in both new and existing buildings (Figure 11).

[10] For appliances, only incremental investment was calculated.

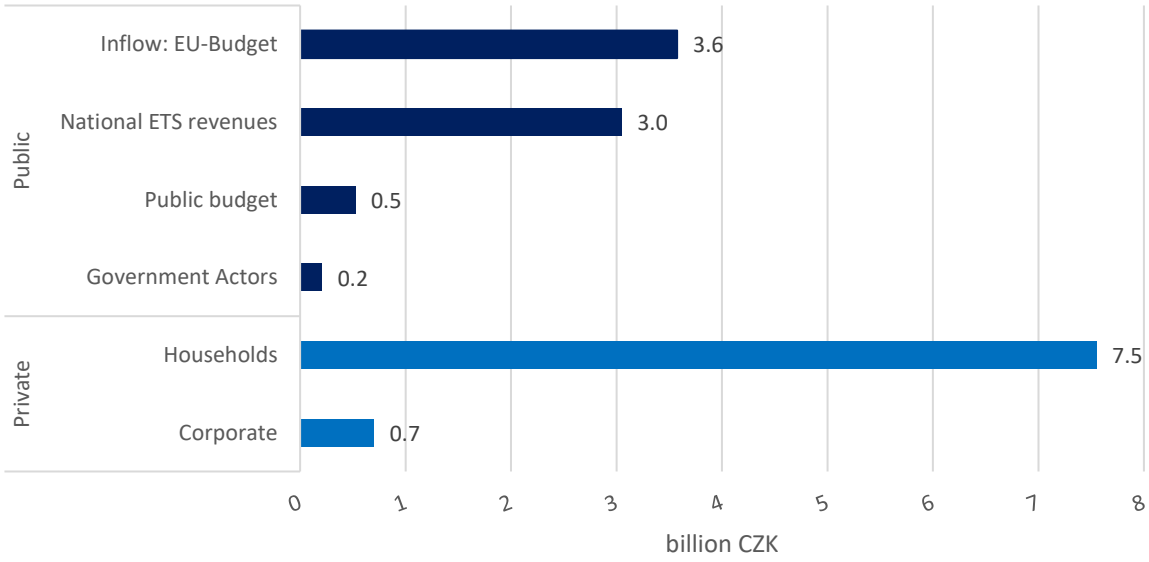
Figure 11: Climate-specific investment in Czechia by building type, 2017 (CZK million)



Who were the main investors?

- The private sector invested CZK 8.2 billion, which was 52 % of the total climate-specific investment identified in 2017. The rest of the amount (CZK 7.3 billion) was invested by the public sector.
- Households were the largest source of private investment, accounting for over 90 % of the total identified in this category. The remaining private investment came from cooperatives and flat owners' associations (Figure 12). Public sources relied mainly on the EU budget (48 %), specifically the CF and ERDF, as well as on EU ETS revenue (41 %). The remainder came from public budgets at different levels of governance, with the largest share from municipalities.

Figure 12: Public and private climate and energy investment in buildings sector in in 2017 (in billion CZK)



What was the role of the public and private intermediaries in supporting private and public investment?

- The main intermediary in Czechia was the State Environmental Fund (and the Ministry of Environment), which operated both the largest programme aimed at households (New Green Savings Programme) and the main programme providing finance to public entities (Operational Programme Environment). The Ministry of Regional Development (which focused mainly on the energy efficiency of multi-apartment buildings) and the Ministry of Industry and Trade (which focused on energy efficiency in enterprises and industry) also played significant roles.

- The State Environmental Fund was the main climate finance provider, accounting for 40 % of the total investment identified in 2017 in buildings sector, or CZK 6.2 billion. It was the single major public intermediary. In 2017, the SEF financed 56 % of the tracked investment in existing residential dwellings in Czechia.

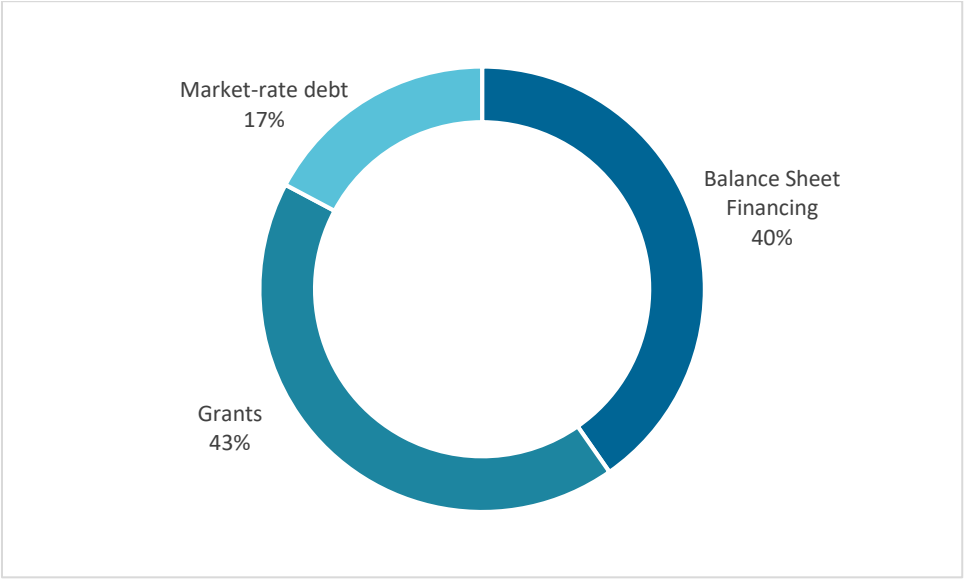
- Commercial banks played an important role as intermediaries, co-financing the subsidised projects (20 % of the investment) and financing non-subsidised low-carbon measures in households.[11]

[11] However, as mentioned, the latter is not captured in the landscape due to a lack of data.

How was the climate investment financed?

- Grant subsidies were the primary and most important financial instrument for decarbonising Czech residential and non-residential buildings, with CZK 6.6 billion (of the total CZK 15.6 billion) financed through grants in 2017 (Figure 13).
- Conversely, concessional loans (which play a decisive role in countries including Germany and Slovakia) were virtually non-existent (and partially impossible to track) in Czechia. In 2017, the State Housing Developemnt Fund allocated CZK 247 million to the modernisation of panel buildings under its programme Panel 2013+, which offered concessional loans. However, the programme did not specify any energy/low-carbon criteria, apart from requiring an energy assessment of buildings.
- The Energy Services Companies (ESCO) market supported a relatively small share: slightly under 2% of the total identified investment in buildings (excluding appliances) and 8% in the public buildings sector; there is therefore clear potential for an increase.

Figure 13: Climate and energy investment in the buildings sector by financial instrument, 2017



Is the sector on track to reach its targets?

- The Czech strategy documents do not specify GHG emission reduction targets for the buildings sector. However, Czechia has to contribute to the overall EU targets, which stipulate a GHG emission reduction of 37–50 % by 2030 and 88–91 % by 2050 (European Commission 2011).

- According to the calculation in Lupíšek (2016), emission reductions of this magnitude are only feasible if there are additional efforts involving deep renovation practices in buildings. It is therefore likely that greater efforts may be needed to decarbonise the buildings sector. This conclusion is in line with the stringent efforts specified in the scenarios of the Czech Climate Protection Policy.

4. Conclusions

The Regulation on the Energy Union Governance requires EU Member States to create national energy and climate plans, which must include an assessment of current investment flows to the decarbonisation of Member State economies. The present report is intended to contribute to the discussion of these flows in Czechia. Using 2017 data, it aims to identify, track, and explain the amount of public and/or private money invested in technologies and other tangible measures in Czechia that lead to GHG emissions reduction. Thanks to the common methodology, the results can be compared with data from other EU Member States where the analysis has been carried out, in particular Germany and Latvia.

This report covers the buildings sector as well as the renewable energy supply and infrastructure sector. As the two primary contributors to GHG emissions in Czechia, the energy transformation and buildings sector have the potential to achieve significant emissions reductions and are therefore among the key sectors to decarbonise.

Our report shows that the buildings sector attracted a higher volume of investment than did the renewable energy supply and infrastructure sector.

In 2017, CZK 18.1 billion (EUR 688 million) was invested in climate-specific actions in both sectors.[12] Of this amount, CZK 15.6 billion (EUR 592 million) was invested in the decarbonisation of the buildings sector, including thermal efficiency of new and existing buildings, building-integrated renewable energy, fuel switching to low-carbon energy carriers, and energy-efficient appliances. Roughly CZK 2.5 billion (EUR 96 million) was invested in renewable electricity generation, transmission, and distribution, as well as renewable heat production and distribution accounted for in the energy balance of the energy transformation sector.

Of the measures analysed, energy efficiency attracted the most investment.

If each measure is analysed separately, the largest share of the investment volume flowed to energy efficiency (CZK 11.4 billion - EUR 432 million, or 63 % of the total tracked investment). This exceeds the investment in renewable energy installations (CZK 4.5 billion – EUR 172 million), renewable energy infrastructure (CZK 0.6 billion - EUR 62 million), and fuel switching in buildings (CZK 1.6 billion).

[12] Compare these values to those documented in CENIA's report on the status of the environment: in 2017, the total investment in environmental protection reached CZK 35 billion, with roughly 62 % from private sources and 38 % from public investment (Čermáková et al. 2018; CENIA 2019).

Private investors were the main source of tracked investment. However, a very large share of this investment was financed through grants from EU funds and the country's public budget.

The main sources of investment were private entities (households and corporate actors), which contributed 60 % of the total investment (CZK 10.7 billion - EUR 406 million). The rest of the investment flowed from public sources, mainly from EU funds and the country's public budget, including budgets at national, regional, and local levels. The main intermediaries assisting in the use of instruments were ministries and their agencies, as well as the capital market.

There is a need (and the potential) for a wider variety of financial instruments that can trigger investment in the building sector.

The key instrument supporting climate-specific investment in Czechia was subsidies (grants), while other financial instruments (such as concessional loans) were scarce. This was particularly the case in the buildings sector, where direct subsidies (grants) represented 56 % of total sector investment (excluding appliances) and 90 % of flows from public sources.

The volume of investment to retrofits of existing buildings is significant but does not seem sufficient to decarbonise the building stock by 2050.

Of the amount invested in building envelopes, CZK 10.2 billion (EUR 387 million) was invested in retrofitting existing buildings, and CZK 1.5 billion (EUR 58 million) was invested in measures in new buildings. This ratio is disproportionate to the dominant share of the floor space of the existing building stock and may signal insufficient financing for retrofits. Hence, increasing the retrofit rate remains a key challenge and may require additional financial incentives and other policy tools to facilitate investment.

The current support does not seem to trigger sufficient investment in the renewable energy supply and infrastructure sector.

The main policies that triggered investment in the renewable energy supply and infrastructure sector were FITs and green bonuses, providing operational support to renewable energy development. In 2017, investment in the sector was estimated at only CZK 2.5 billion (EUR 96 million), a value significantly lower than that until 2013.[13] On top of this amount, investment in distributed RES energy generation was included in the buildings sector; this covered investment in built-in PV installations, biomass boilers, and heat pumps (all together worth CZK 2.6 billion - EUR 100 million).

[13] Year in which the support scheme for renewable energy sources changed significantly. See Box 1 for further details.

The clear taxonomy of climate investment and systemic use of the climate markers by the European Commission may provide further consistency and granularity in the overview of Czech climate finance.

We have tracked climate-specific investment in our study (i.e. investment with climate change mitigation as the main target), and partially climate-related investment (i.e. investment with climate change mitigation as a secondary target). For instance, we tracked a programme to exchange high-polluting boilers, whose primary goal was to reduce local pollution; but the investment led fully and directly to the reduction of GHG emissions.

The line between the climate-specific and climate-related investments is often blurred. The categories can overlap entirely, as in the example above; however, this is not the case for many other measures, and it is not always clear which part of the investment is related to climate. Because our analysis focused on climate-specific investment, we had to exclude a range of climate-related measures with indirect benefits/co-benefits. Further discussion is needed on how and to what extent climate-related measures can be accounted for.

Clarifying the definitions and taxonomy will not only help track climate investment, but also assist in reporting on the use of EU funds, which require the dedication of a specific investment volume to tackle climate targets.

A combination of regular, systemic tracking of public climate finance and regular surveys and reporting from the private sector will help establish a comprehensive overview of climate investment in Czechia.

Data on investment from public sources and information on public subsidies are generally available. However, the structure and details of the data may not always coincide with the needs of climate and energy investment tracking. To obtain a realistic overview, it is necessary to track only actual investments, i.e. the finances disbursed to individual projects rather than those committed and/or allocated. In addition, tagging climate expenditures and regular reporting from all relevant financial institutions (such as the European Investment Bank) would make tracking far more comprehensive.

The private sector is the most important source of, and intermediary for, climate and energy investment in Czechia. As in the case of public finance, we encountered a lack of clear climate tagging and categorisation of investment by private companies and financial institutions. Private initiatives, such as the Task Force on Climate-related Financial Disclosures, provide access to such information. However, these initiatives operate on a voluntary basis and therefore (as of this writing) only cover a limited share of the total market.

The following measures would improve the quality of energy and climate investment tracking and increase the transparency of climate-related public expenditures:

- Systematically and regularly tracking the domestic public climate finance covering national budgets and climate programmes implemented by public banks and agencies, e.g. by introducing public budget climate tagging and/or establishing annual evaluation procedures. The EU Technical Expert Group on Sustainable Finance has developed a classification system for sustainable activities, which establishes criteria for actions that can make a substantial contribution to climate change mitigation and adaptation.
- Regularly surveying private entities (households and corporate actors) about the financing of climate investments. To design the survey, it could be useful to learn from the experience of France, where investors are already required by law to report their climate-related expenditures.

A methodology is needed to determine the total investment and incremental share that actually contributes to the low-carbon transition.

The most useful analytical technique for policy-makers is tracking the additional or incremental share of investment associated with the energy and climate transition. The incremental share provides a more realistic picture of actual progress towards the energy transition and can be compared to investment needs assessments, which usually calculate incremental investment needs. Further development of practicable approaches to calculating the incremental costs of climate-specific investment would prevent the over- or underestimation of related investments.

There is a need for a methodology to deal with investment time lags.

The methodology for tracking climate investment must be improved to accommodate the fact that the investment flow may take a long time. For instance, there is a lag between the actual investment and the subsequent request for payment of the subsidy supporting it. Similarly, multi-year renewable energy projects call for a regular assessment of the investment map to obtain a full picture of all relevant activity.

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Annexes

Annex 1. Energy generation and infrastructure: assumptions

Programme/Measure	Source	Amount (CZK mil)	Year	Methods / Assumptions / Limitations	References
RES power generation					
Operational Programme Enterprise and Innovation					
	public	0	2017	(sub) program RES – construction and reconstruction of small hydro PP, no supported proecjts with operation start in 2017.	(OP EIC 2019)
Small hydro power plants (<10 MW)	private	325	2017	Increase of installed power in 2017: 2.5 MW. Specific investment cost according to ERO degree No. 296/2015, assumption that 50% are PPs in new locations and 50% reconstructed or renewed PPs thus average specific investments are CZK 130 000/kW. Own construction is assumed to be 2 years, similar new installed capacities in previous years (2016 increase 2.7 MW, 2015 7.3 MW, 2014 1.3 MW) – i.e. all the investment cost of new capacities in 2017 allocated for the year 2017.	(ERO 2018; SPVEZ 2018; ERO 2015)
	public	0	2017	(sub) program Energy savings, first call for PV only in mid of 2017, no supported projets with operation start in 2017.	(OP EIC 2019)
PV PP (excluding non-licenced included in part Buildings)	private	180	2017	ERO and MoIT statistics includes only licenced PV PPs (>10 kWp) and also do not specify installed power in PV applicaions with stop of operation. Estimate based on statistics of sold PV panels (web SolarniNovinky.cz) – after subtraction of those used for the repair – e.g. impact of wind storm Herwart in autumn 2017: new licenced PVs app. 6 MW (while small PVs non-licenced are estimated to be app. 3 MW – included n section Buildings). Specific investment cost estimated from the MoIT database of supported projects: 30 th. CZK/kWp	(ERO 2018; Solarni novinky 2018; TZB-Info 2018; OP EIC 2019)
	Public	0	2017	Support from OP is not available	(Ministry of Industry and Trade 2016)
Wind power plants	private	1037.5	2017	Increase of installed power in 2017: 26.2 MW. New wind PP prior 2017 were put into operation in 2014, 2015-2016 stagnation. Specific investment cost according to ERO degree No. 296/2015: CZK 44 000/kW, 90% of total investment cost allocated to the year 2017	(CSVE 2017; ERO 2018; 2015)
	public	0	2017	Support from OP is available only for heat delivery not for power generation from biogas.	(OP EIC 2019; Ministry of Industry and Trade 2016)
Biogas power plants – waste water treatment	private	50	2017	Increase of installed power in 2017: 1 MW. ERO degree No. 296/2015 does not include this category, investment cost estimated from the previous ERO degree No. 475/2005 for the year 2012: 50 th. CZK/kW. All the cost allocated to the year 2017.	(ERO 2018; 2011)

	public	0	2017	Support from OP is available only for heat delivery not for power generation from biogas.	(OP EIC 2019; Ministry of Industry and Trade 2016)
Biogas power plants - agriculture	private	270	2017	Increase of installed power in 2017: 2.7 MW. Specific investment cost according to ERO degree No. 296/2015: 100 th. CZK. Stagnation – continuation of the trend between 2014-2016 in new biogas PP, All the investment costs are allocated to the year 2017.	(ERO 2015; 2018; Ministry of Industry and Trade 2018a)
	public	0	2017	(sub) program RES – construction of cogeneration based on burning of solid biomass	(OP EIC 2019; Ministry of Industry and Trade 2016)
Biomass power plants – solid biomass	private	0	2017	Category includes co-firing (burning of biomass with the coal in coal fired PP) and PP (power blocks) were solid biomass is exclusive fuel. Power generation stagnates between 2015-2017 on the level 2.07- 2.2 TWh. Also number of installation is almost the same – it is assumed that there is no new power generation capacity based on burning of solid biomass	(ERO 2018; Ministry of Industry and Trade 2018a)
RES heat production					
Operational Programme Enterprise and Innovation					
	public	9.08	2017	Available support for the heat delivery (construction of the delivery system). 3 projects for the heat delivery from biogas PP were supported in 2017 (operational start in 2017)	(OP EIC 2019)
Biogas power plants - agriculture	private	32.4	2017	New installed capacity (typically in already existing biogas PP for the utilization of waste heat): 3 MWth. Specific investment cost estimated based on data from supported projects within OP EIC: 9 mio. CZK/project of typical biogass PP (installed capacity 520-550 kW, power generation efficiency 40%, 3 MWth is eq. of app. 3.6 average biogas PP), i.e. total investments are estimated to be 3.6x9 mio. CZK=32.4 mio. CZK	(OP EIC 2019; Ministry of Industry and Trade 2016)
	public	0	2017	(sub) program RES – construction of cogeneration and heating plants based on burning of solid biomass	(OP EIC 2019)
Biomass power plants – solid biomass	private	0	2017	Heat production based on solid biomass burning stagnates between the years 2015 and 2017 (2015: 22.2 PJ, 2017: 21.9 PJ). Several projects were started in 2016-2017 with expected operation start in 2018-2020 (as indicated in the list of supported projects within OP EIC). No new proecjts in the year 2017.	(Ministry of Industry and Trade 2018a)
Power grid infrastructure					
Operational Programme Enterprise and Innovation					
	public	62	2017	(sub) program Smart Grids 2. Two supported projects realized in 2017 (substation Hradec – finished in 12/2017, substation Vítkov started in 2016, expected finish in 1/2020).	(OP EIC 2019; Ministry of Industry and Trade 2016)

Transmission grid	private	558	2017	Development of transmission grid is done by Ten Years development Plan - TYDP). This plan includes individual bigger projects with estimate of investment cost and timing. Total investments of CEPS, a.s. (operator of tramission system) were CZK 3.5 billion in 2017, of which investments for the new customers are CZK 1.24 billion. Part of this investments is related with increase of absorption capacity of the grid for new RES PP, part is related with other custmers and grid enhancement. Based on TYDP estimated that 50% these investments are related with new RES.	(ČEPS 2016)
	public	0	2017	(sub) program Smart Grids 1. No supported projects explicitely related with RES finished in 2017.	(OP EIC 2019; Ministry of Industry and Trade 2016)
Distribution grid	private	0	2017	Annual reports of distribution companies do not contain information about the RES specific investments.	(ČEZ Distribuce 2018; E.on. 2018)

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Annex 2. Buildings: assumptions

Programme/Measure	Source	Amount (CZK mil)	Year	Methods / Assumptions / Limitations	References
Energy efficiency					
Electrical appliances, electronics, and equipment Investments by the residential, commercial, and public sector: Incremental share	private	3 875	2017	The total investment was calculated as a sum of individual estimates for each appliance. These were determined by multiplying the number of units sold for each energy efficiency class above the BAU energy efficiency class by the difference in price between that class and the price of the BAU energy efficiency class. The BAU energy efficiency class was assumed as a minimum energy performance standard at the EU market in 2017. The next assumptions and limitations were applied: – Seven major domestic appliances are covered: refrigerators, freezers, dishwashers, washing machines, tumble dryers, cooking hobs, and range hoods. The estimate represents a lower bound as it does not include appliances and equipment other than those listed. – Sales numbers and structure by energy efficiency classes are tracked for the year 2017 as provided by the GfK. The total sales were cross checked with the data by the association of the appliance producers APPLiA CZ. – BAU classes were assumed as A+ for washing machines, A+ for refrigerators and freezers, A+ for dishwashers, B for hobs, F for range hoods, and B for tumble dryers. – Prices by energy efficiency classes are deduced from the sales in CZK according to class. – For the purposes of categorisation, we assume that all appliances are bought for residential buildings.	(APPLiA CZ 2019; GfK 2019)
New Green Savings Programme					
Subsidy on improving thermal properties of residential buildings - subfield of support A0	public	180	2017	The amount of disbursed subsidy in 2017.	(Melč 2019; State Environmental Fund 2019a)
Co-financing of the Subsidy on improving thermal properties of residential buildings – subfield of support A0 (loans and equity)	private	380.5	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 30 % by loans and 70 % own funds (equity) of the households, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Melč 2019; State Environmental Fund 2019a)

Subsidy on improving thermal properties of residential buildings – subfield of support A1-A2	public	734	2017	The amount of disbursed subsidy in 2017.	(Melč 2019; State Environmental Fund 2019a)
Co-financing of the Subsidy on improving thermal properties of residential buildings –subfield of support A1-A2 (loans and equity)	private	1 261	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 65 % by loans and 35 % own funds (equity) of the households, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Melč 2019; State Environmental Fund 2019a)
Subsidy on improving thermal properties of residential buildings – subfield of support A3	public	97	2017	The amount of disbursed subsidy in 2017.	(Melč 2019; State Environmental Fund 2019a)
Co-financing of the subsidy on improving thermal properties of residential buildings – subfield of support A3 (loans and equity)	private	129	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 85 % by loans and 15 % own funds (equity) of the households, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Melč 2019; State Environmental Fund 2019a)
Subsidy on construction of residential buildings in passive house standard– field of support B	public	245.6	2017	The amount of disbursed subsidy in 2017.	(Melč 2019; State Environmental Fund 2019a)
Co-financing of the subsidy on construction of residential buildings in passive house standard – field of support B (loans and equity)	private	707	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 90 % by loans and 10 % own funds (equity) of the households, based on an expert. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Melč 2019; State Environmental Fund 2019a)
Energy Performance Contracting	public	205.9	2017	We included all the projects for which the installation was handed over in 2017. There were 9 projects in total, for three the contract was signed already in 2016, for the rest, the whole project took place in 2017.	(Association of Energy Services Providers 2019)
New Green Savings Programme 2013 – public buildings	public	1 584.7	2017	The amount of disbursed subsidy in 2017.	(State Environmental Fund 2019a)
Integrated Regional Development Programme					
Subsidy for energy efficiency measures in multi-apartment build-	public	94.3	2017	The amount of disbursed subsidy in 2017.	(Hromada 2019; Ministry of Regional Development 2019a; Melč 2019)

ings (cooperatives, flat owners associations, limited company, natural persons)					
Co-financing of the subsidy for energy efficiency measures in multi-apartment buildings (cooperatives, flat owners associations, limited company, natural persons) – loans and equity	private	206.2	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 65 % by loans and 35 % own funds (equity) of the entities, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Hromada 2019; Ministry of Regional Development 2019a; Melč 2019)
Subsidy for energy efficiency measures in multi-apartment buildings (municipality)	public	12.5	2017	The amount of disbursed subsidy in 2017.	(Hromada 2019; Ministry of Regional Development 2019a; Melč 2019)
Co-financing of the subsidy for energy efficiency measures in multi-apartment buildings (municipality) – loans and equity	public	16.2	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 65 % by loans and 35 % own funds (equity) of the municipalities, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Hromada 2019; Ministry of Regional Development 2019a; Melč 2019)
Operational Programme Environment					
Subsidy for energy efficiency measures in public buildings	public	337.1	2017	The amount of disbursed subsidy in 2017.	(State Environmental Fund 2019b; Ministry of the Environment 2019; Association of Small and Medium Enterprises and Crafts 2014)
Co-financing of the subsidy for energy efficiency measures in public buildings – loans and equity	private	505.7	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 60 % by loans and 40 % own funds (equity) of the municipalities, based on a survey among the subsidy recipients. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(State Environmental Fund 2019b; Ministry of the Environment 2019; Association of Small and Medium Enterprises and Crafts 2014)

Operational Programme Enterprise and Innovation					
Subsidy for energy efficiency measures in buildings owned by large enterprises	public	62.6	2017	The amount of disbursed subsidy in 2017.	(Honzík, Pavlica, and Fiala 2018; Ministry of Industry and Trade 2016; Association of Small and Medium Enterprises and Crafts 2014)
Co-financing of the subsidy for energy efficiency measures in buildings owned by large enterprises – loans and equity	private	97.7	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 48 % by loans and 52 % own funds (equity) of the enterprises, based on a survey among the subsidy recipients. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Honzík, Pavlica, and Fiala 2018; Ministry of Industry and Trade 2016; Association of Small and Medium Enterprises and Crafts 2014)
Subsidy for energy efficiency measures in buildings owned by small and medium enterprises	public	255.1	2017	The amount of disbursed subsidy in 2017.	(Honzík, Pavlica, and Fiala 2018; Ministry of Industry and Trade 2016; Association of Small and Medium Enterprises and Crafts 2014)
Co-financing of the subsidy for energy efficiency measures in buildings owned by small and medium enterprises – loans and equity	private	398.4	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 48 % by loans and 52 % own funds (equity) of the enterprises, based on a survey among the subsidy recipients. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Honzík, Pavlica, and Fiala 2018; Ministry of Industry and Trade 2016; Association of Small and Medium Enterprises and Crafts 2014)
Renewables					
New Green Savings Programme					

Subsidy on replacement of heat sources with heat pumps – field of support C	public	52.2	2017	The amount of disbursed subsidy in 2017.	(Melč 2019; State Environmental Fund 2019a)
Co-financing of the subsidy on replacement of heat sources with heat pumps – field of support C (loans and equity)	private	117.5	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 10 % by loans and 90 % own funds (equity) of the households, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Melč 2019; State Environmental Fund 2019a)
Subsidy on replacement of heat sources with biomass boilers – field of support C	public	6.6	2017	The amount of disbursed subsidy in 2017.	(Melč 2019; State Environmental Fund 2019a)
Co-financing of the subsidy on replacement of heat sources with biomass boilers – field of support C (loans and equity)	private	7.9	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 10 % by loans and 90 % own funds (equity) of the households, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Melč 2019; State Environmental Fund 2019a)
Subsidy on installation of solar and PV panels – field of support C	public	116.6	2017	The amount of disbursed subsidy in 2017.	(Melč 2019; State Environmental Fund 2019a)
Co-financing of the subsidy on installation of solar and PV panels – field of support C (loans and equity)	private	232.7	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 10 % by loans and 90 % own funds (equity) of the households, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Melč 2019; State Environmental Fund 2019a)
Subsidy on installation of recuperation – field of support C	public	27.5	2017	The amount of disbursed subsidy in 2017.	(Melč 2019; State Environmental Fund 2019a)
Co-financing of the subsidy on installation of recuperation – field of support C (loans and equity)	private	24.7	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 10 % by loans and 90 % own funds (equity) of the households, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Melč 2019; State Environmental Fund 2019a)
Operational Programme Environment					

Subsidy for exchange of polluting heat sources in households, distributed through regions – biomass boilers	public	522.0	2017	The amount of disbursed subsidy in 2017. The share of various types of heat sources was estimated based on information on the structure of disbursed subsidy in the regions (information provided by the regional administration authorities.)	(Ministry of the Environment 2019; Melč 2019; State Environmental Fund 2019b)
Co-financing of the subsidy for exchange of polluting heat sources in households, distributed through regions – biomass boilers (loans and equity)	private	130.5	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 10 % by loans and 90 % own funds (equity) of the households, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Ministry of the Environment 2019; Melč 2019; State Environmental Fund 2019b)
Subsidy for exchange of polluting heat sources in households, distributed through regions – heat pumps	public	1 125.1	2017	The amount of disbursed subsidy in 2017. The share of various types of heat sources was estimated based on information on the structure of disbursed subsidy in the regions (information provided by the regional administration authorities.)	(Ministry of the Environment 2019; Melč 2019; State Environmental Fund 2019b)
Co-financing of the subsidy for exchange of polluting heat sources in households, distributed through regions – heat pumps (loans and equity)	private	281.3	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 10 % by loans and 90 % own funds (equity) of the households, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Ministry of the Environment 2019; Melč 2019; State Environmental Fund 2019b)
Emission reduction in fossil fuel					
New Green Savings Programme					
Subsidy on replacement of heat sources with gas condensing boiler	public	2.4	2017	The amount of disbursed subsidy in 2017.	(Melč 2019; State Environmental Fund 2019a)
Co-financing of the subsidy on replacement of heat sources with gas condensing boiler (loans and equity)	private	8.0	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 10 % by loans and 90 % own funds (equity) of the households, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Melč 2019; State Environmental Fund 2019a)
Operation Programme Environment					

Subsidy for exchange of polluting heat sources in households, distributed through regions – combined coal-biomass boilers	public	762.2	2017	The amount of disbursed subsidy in 2017. The share of various types of heat sources was estimated based on information on the structure of disbursed subsidy in the regions (information provided by the regional administration authorities.)	(Ministry of the Environment 2019; Melč 2019; State Environmental Fund 2019b)
Co-financing of the subsidy for exchange of polluting heat sources in households, distributed through regions – combined coal-biomass boilers (loans and equity)	private	254.1	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 10 % by loans and 90 % own funds (equity) of the households, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Ministry of the Environment 2019; Melč 2019; State Environmental Fund 2019b)
Subsidy for exchange of polluting heat sources in households, distributed through regions – gas condensing boilers	public	403.7	2017	The amount of disbursed subsidy in 2017. The share of various types of heat sources was estimated based on information on the structure of disbursed subsidy in the regions (information provided by the regional administration authorities.)	(Ministry of the Environment 2019; Melč 2019; State Environmental Fund 2019b)
Co-financing of the subsidy for exchange of polluting heat sources in households, distributed through regions – gas condensing boilers (loans and equity)	private	134.6	2017	We related the project costs as the total eligible costs of the projects, for which the subsidy was disbursed in 2017. We assume that the co-financing of the subsidy is 10 % by loans and 90 % own funds (equity) of the households, based on an expert estimate. We further assume that the time of the co-financing correlates with the the time of disbursement of the subsidy.	(Ministry of the Environment 2019; Melč 2019; State Environmental Fund 2019b)
Not tracked investment in residential and non-residential buildings estimate	Private	27 706	2017	We estimated the number dwelling renovated outside the subsidy programmes based on renovation rates, and deducting the dwellings that that have been supported by the public programmes in the given year. The depth of renovations was estimated through the structure of the support in the public programmes. For non-residential buildings, we used the number of constructions permits a proxy, rather than renovation rates. WE stratified the on-residential buildings based on the results of a survey by Chance for Buildings, and deducted the buildings that have been supported by public programmes. We have disregarded public buildings in this estimate assuming they are covered by the public programmes and energy performance contracting.	('Zebra 2020' 2019; Antonín 2016; State Environmental Fund 2019a; 2019b; Honzík, Pavlica, and Fiala 2018)