Mapping climate adaptation options in energy efficiency projects

Task WP4.1 of the CAMS project

Task led by Stockholm Environment Institute Tallinn Centre

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Definitions

Above minimum standard – measures implemented under stricter conditions and criteria (voluntarily) are referred to in this report as being implemented above the minimum standard. These measures achieve a higher level of energy efficiency or other standards (i.e. more innovative approaches).

Adaptation measures – actions that significantly reduce the vulnerability or avoid the negative consequences of climate change events. For buildings, some of the adaptation measures applied might be included in the standard building regulations without being classified as adaptation measures per se. These standards 1. might vary in different countries; 2. even when the regulations are in place, they may need upgrading to include rules to respond to extreme weather events.

Energy efficiency BSR projects – Interreg BSR or other EU funded projects that focus on the topic of energy efficiency and have an impact in the BSR Region.

Minimum standard – defined in this report as the implementation of a measure according to general national standards as defined by law or as a generally accepted level of energy efficiency achievements.

Mitigation measures – actions that are taken to reduce and curb greenhouse gas emissions.

Synergies of climate change mitigation and adaptation measures – climate measures, which help reduce greenhouse gas emissions and adapt to the effects of climate change at the same time. Measures can be either adaptation measures that have an impact on mitigation or mitigation measures that have an impact on adaptation.

1. Executive Summary

Climate adaptation options in energy efficiency projects can be implemented as an aim on its own or in synergy with climate mitigation options. Creating synergies between mitigation and adaptation aims to strengthen climate-related projects, e.g. in housing together with increasing its energy efficiency. The study developed a methodology for mapping the synergies between mitigation and adaptation options in newly built and renovated buildings in 5 Baltic Sea Region countries, as well as among the European Union funded (mainly Interreg BSR) research projects in the Baltic Sea Region. By synergies, it is meant climate measures, which help reduce greenhouse gas emissions and adapt to the effects of climate change at the same time. Measures can be either adaptation measures that have an impact on mitigation or mitigation measures that have an impact on adaptation. For collecting data in both parts of the study, a questionnaire method was used. The questionnaires for analysed projects are attached to this report as Annexes 1 and 2.

In terms of the analysed EU funded mitigation (energy efficiency) and adaptation oriented BSR projects, the research concluded that the mitigation and adaptation remained as a separate focus of the project and very few synergies were encountered between those two major climate policy areas. Measures and actions that combined mitigation and adaptation were integrated and considered due to casual coincidences and practical reasoning during implementation in an ad hoc manner, not directly aiming for adaptation or programmed and planned integrity of mitigation and adaptation.

As for the building projects, few special adaptation measures are enforced by law, and thus their implementation depends more on the willingness or knowledge of a developer. If any adaptation guidelines exist for buildings, it is mostly for newly built houses and rarely for the ones that need renovation, since the conditions of existing building stock may limit or exclude the harmonized approach for integrating adaptation measures.

The analysed examples from the Baltic Sea Region indicated that the feasible measures that enhance the adaptation of existing buildings to changing climate are automated indoor climate; maintenance of plant cover and removal of dangerous trees near the buildings; permeable roads and car parks surrounding the building as well as the stronger attachment of elements fastened to buildings (rain gutters, antennas, and lights).

In building new houses, it is feasible to implement more innovative measures to address risks of climate change by mitigation and adaptation synergies such as green roofs and higher foundations (so that basement floors are located at a higher level) and to use construction materials that can cope with excessive moisture (various facade materials, Synthetic Roof Underlayment).

Even though most synergies are positive between mitigation and adaptation, some possible negative effects of the measures were also mapped in this study. In the planning of the measures, these negative effects should be considered and compensated by a combination of measures if possible.

Adaptation measures are adopted via building regulations, via building permits or certification systems. Manuals or guidelines for construction companies are available. To be allowed to build a new house, the municipality must approve the planning and drawing of the house, and the plan must follow the regulations in the spatial plan (for example a specific lowest threshold for keeping flooding out). In Sweden and Germany, the municipalities are taking greater actions in the form of local spatial plans that set quite demanding adaptation requirements. Municipalities should map and analyse the risks for flooding and erosion due to climate change and have an action plan for adaptation. In countries such as Estonia, Latvia, Russia, and Poland, there are fewer or no local municipality action plans for the adaptation.

The results increased the understanding of why mitigation and adaptation are delivered as two separate policy areas. The programming EU climate policy should challenge more and more specialized and narrow objective setting and a rather technocratic approach of eligibility instead of supplementing the horizontal value merit which may seek for the synergic effect. The experts from most countries agreed that the existing norms for buildings should be updated (mandatory requirements also linked with issuing of grants), especially related to a few very specific/most important topics such as heat islands and excessive humidity.

2. Introduction

Climate Adaptation and Mitigation Synergies in Energy Efficiency Projects (CAMS) is a project financed by Interreg Baltic Sea Region Programme and led by Tartu Regional Energy Agency (TREA). The project has partners from 6 different countries: Latvia, Estonia, Russia, Poland, Germany, Sweden.

The project activities form four Work Packages (WPs). This research task is WP4.1, which is part of the overall WP4 and is led by Stockholm Environment Institute Tallinn Centre.

Task WP4.1 aims to produce an open-source, public report that includes several best practices from project partner countries. Existing energy efficiency projects results were screened and report on best practices as well as obstacles and barriers for applying adaptation measures in energy efficiency projects were compiled based on existing experiences. The report is based on both questionnaires to all project partners as well as on the desktop study of publicly available literature, articles and case studies describing the situation in different countries how together with achieving energy efficiency as a primary goal, the renovation of buildings could and should contribute to resilience to long-term negative effects of climate change.

Such a report aims to provide input for policy dialogue and prepare policy recommendations for mainstreaming climate into new European Structural and Investment Funds (ESIF) programming and developing guidelines for climate-proofing of energy efficiency projects. Higher technical and vocational educators could use the report as a basis for introducing the topic to relevant professionals. Also, policy planners and practitioners responsible for energy audits, design, and implementation of energy-efficient renovation of buildings are among the target groups of the report.

3. Structure and Methodology

This report consists of 5 main content related chapters:

Impacts of Climate Change in the Baltic Sea Region for the urban areas and buildings

As the adaptation measures depend on the possible climate change consequences, first, a brief overview of the climate change impacts that are most likely for the urban areas and buildings of the Baltic Sea Region is given. The main literature sources used for this chapter were the article of Jouni Räisänen from the University of Helsinki "Future Climate Change in the Baltic Sea Region and Environmental Impacts" and report prepared by the Union of the Baltic Cities "UBC cities adaptation actions to extreme weather events". Also, the study made by Lahtvee et al. in 2015 "Estonian Climate Adaptation Strategy for Infrastructure and Energy" provided a good platform for mapping the impacts of climate change for buildings explicitly.

Mitigation and adaptation measures related to the built environment in the Baltic Sea Region

This chapter relates the identified significant climate change impacts with mitigation and adaptation measures that can help to tackle these impacts. A good source for adaptation measures was the report "Estonian Infrastructure and Energy Sector Climate Change Adaptation Strategy" that was prepared by SEI Tallinn as part of the Estonian National Climate Adaptation Plan. A primary source for mitigation measures was the IPCC Fifth Assessment Report (2014), Chapter 9 on Buildings.

Mapping the synergies among measures related to the built environment

This chapter describes the synergies between the mitigation and adaptation measures, as mapped by the authors of this report and the methodology behind it. Both positive and negative impacts have been highlighted per each measure.

Synergies between Mitigation and Adaptation in EU funded BSR Projects & Assessment of energy efficiency projects in the Baltic Sea Region

These chapters present the results of the CAMS survey, which discloses the use of climate mitigation and adaptation measures among BSR projects, and new and retrofitted buildings in the project partner countries.

For this purpose, the authors prepared a questionnaire for all project partner countries. The aim was to collect at least two building project cases per country (residential building, office, or mixed-use house of 2–5 stories):

The questionnaire in Excel format includes the following pages:

- 0 Instructions;
- 1 General questions (main characteristics of the building);
- 2-1 Adaptation approach (main climate change impacts);
- 2-2 Adaptation approach (free format questions about possible adaptation approaches);
- 3 Mapping of measures.

The questionnaires were filled in either by the project partners or the contact persons of each building project via the coordination of the project partner. A more detailed methodology is described in Chapter 7 of this report.

A separate questionnaire (Annex 2) was prepared for mapping the synergies among BSR projects.

Summary and conclusions

The final chapter brings together the main findings of the report and concludes the current practices of mitigation and adaptation measures in the built environment.

4. Impacts of Climate Change in the Baltic Sea Region for the urban areas and buildings

The regional characteristics and effects of future climate change in the Baltic Sea countries have been explored in several research and cooperation projects supported by the EU funding sources. The potential future climate changes in the Baltic Sea Region and the environmental impacts of the changes are comprehensively discussed in the first and second BACC assessments (BACC Author Team, 2008), (BACC II Author Team, 2015). This sub-chapter summarises the article by Räisänen (2017), which is based on the BACC assessments.

The warming in the Baltic Sea region is likely to increase mainly in the winter of northern parts of the area. The lowest winter temperatures can warm even more than the winter mean temperatures. During the winters, the warming will be accompanied by a general increase in precipitation. However, since a smaller fraction of it will be snow and midwinter snowmelts will be more common, the amount of snow is likely to decrease.

In summer, precipitation may either increase or decrease with a bigger chance of drying in the northern parts of the region. Short term summer precipitation extremes are likely to become more severe, even in the areas where the mean summer precipitation does not increase.

The changes in the average wind speed over the Baltic Sea are rather uncertain. It is expected that the water temperature of the Baltic Sea will increase, salinity and ice cover will decrease. (Räisänen, 2017) Table 1 summarises the above-described impacts.

Table 1. Main projected impacts of climate change in the BSR

Temperature	Precipitation	Snow and ice	Wind Speed	Climatic extremes	The Baltic Sea
Increasing – particularly during winter in the northern parts	Increasing (especially during the winter, in summer it can be both – chance of drying)	Less snow and ice	Most likely to increase	Will be more common (e.g. higher temperatures during the winter; summer precipitation extremes)	Increased water temperature, reduced salinity, less ice cover

Source: Authors' summary table based on Räisänen, 2017.

Urban areas can often be more vulnerable to climate change than surrounding landscapes. The built-up land and the urban heat island effect will intensify the consequences of the predicted rise in temperature and more extreme weather events.

According to the Fifth Assessment Report of IPCC, urban climate change-related risks are increasing (including rising sea levels and storm surges, heat stress, extreme precipitation, inland and coastal flooding, landslides, drought, increased aridity, water scarcity, and air pollution) with widespread negative impacts on people (and their health, livelihoods, and assets) and on local and national economies and ecosystems (Revi et al., 2014).

The Union of the Baltic Cities has published a report "UBC cities' adaptation actions to extreme weather events" pointing out the main expected weather events and adaptation results in 25 cities of the Baltic Sea region (BSR): Estonia, Finland, Germany, Latvia, Lithuania, Norway, Poland, and Sweden. (Paju, 2019) **Tõrge! Ei leia viiteallikat.** below summarises the climate hazards as described in the report according to five categories of climate variables: 1) Precipitation; 2) Temperature; 3) Flood and sea-level rise; 4) Storm and wind; 5) Water scarcity, and pulls out the main impacts for both urban environments in general and for buildings more in detail. For buildings, both positive and negative impacts are highlighted.

Table 2. Main climate change impacts in the BSR on urban areas and buildings

Climate variable	**Changes in climate variables**	**Impacts in urban areas** Source: Adapted from "UBC cities' adaptation actions to extreme weather events" (Paju, 2019)	**Impacts on buildings** Source: Lahtvee et al. (2015)
Precipitation	More extreme precipitation, such as heavy rainfall, rainstorm, fog, heavy snow	• Heavy water run-off affects every aspect of urban life – from transport and logistics to the residential sector and public health; • Damage to the city infrastructure and properties due to flooding.	**Negative impacts:** • Moisture penetrating the building's insulation materials will reduce their effectiveness which means that the ventilation needs will grow. • Higher humidity can damage building facade materials (including brick, concrete, and wood) from heavy rain towards walls; • Oblique rain places an additional load on external walls and windows. • As a result of extended rainy periods, higher relative humidity will increase the corrosion of steel. • The risk of moisture reaching building structures will increase, including the pooling of rainwater on flat roofs and penetrating building structures from there. • Risk of growth of moss and fungi, such as mildew and other moisture-dependent organisms in building structures that damage attics and building foundations and increase the exposure of residents to mildew and mold spores. • The increase in precipitation will accelerate plant growth around or on the building and result in increased maintenance needs. • Despite the increase in the annual precipitation, the average snow cover will likely decrease. The decrease light will impact the energy output of the solar panels if these are part of the building structure. **Positive impacts** • Higher efficiency of solar panels. No need to clean snow from them. • Reduced winter snow cover will reduce the load of potential snow accumulations on rooftops, and the risk of collapsed roofs will decrease.
Temperature	More heatwaves and extremely hot days	• Temperature increase and heatwaves can increase the heat island effect that includes: - melting asphalt, - increased asphalt rutting due to material constraints, - thermal expansion affecting bridge joints and paved surfaces, - damage to bridge structure materials. • Increasing demand for public health services since it is more difficult for the elderly, children, people with chronic diseases and of low socio-	**Negative impacts:** • A growing need for cooling and proper ventilation during heat waves. • The temperature rise impacts the lifespan of many materials, including plastic, rubber, paint, varnish, and wood. • The increasing amount of days with 0 degrees and higher precipitation during the winters will lead to more icy roads. The building projects, which include roads and parking lots, must take that aspect into account. • The dropping amount of sunlight will influence the effectiveness of renewable energy sources (solar panels and collectors) as well as passive heat generation in residential buildings. The greater need for artificial light will also increase energy needs.

		economic background to cope with the heat waves. • Energy, residential, and transport sectors will be affected by the heatwaves.	• A more extended vegetative growth period will result in more maintenance of plant cover. Landscaping that is neglected or established without careful consideration may damage building facade materials and structures. **Positive impacts:** • Reduced heating at homes. • Reduced freezing and degradation of concrete and brick building structures. • A longer vegetative period for plants allows new species of plants to be used in landscaping (including on facades and roofs).
Storm and wind	More windy weather events (severe wind, storm surge, lightning, thunderstorms; tornado and extratropical storm)	• Damages to road infrastructure (fallen trees on roads and power lines); • Increased maintenance costs; • Danger also exists to inhabitants.	Negative impacts: • Extreme weather events such as storms will increase heating needs in residential buildings for short periods. • Extreme weather conditions put pressure on roof structures. Structures with poor construction quality may fail in the case of high winds. As wind speed grows, special attention must be paid to the elements fastened to buildings, such as rain gutters, antennas, and lights that can become risks if installed improperly. • High winds may topple trees and thereby damage building structures.
Flood and sea-level rise	More coastal flood, flash/surface flood, river flood	• All areas of the urban infrastructure are affected – from transport to the well-being of the local inhabitants; • Damage to infrastructure, building walls and basements; • Disturbing the accessibility; • Floods can cause the mixing of sewage and drinking water; • Erosion and risk of landslide.	Negative impacts: • Moisture damage in buildings (i.e. construction materials); • The rise of the groundwater level will create the need for local drainage systems while constructing foundations; • Impacts the choice of location of buildings and limit construction along the beach.
Water scarcity	More drought, lower groundwater levels	• Affects the well-being of a city: from food production to biodiversity and ecosystem services in the urban areas; • Might also affect normal water supply.	Negative impacts: • Risk of expanding areas not suitable for buildings; • Risk of cracks in house ground when the groundwater level is going down.

5. Mitigation and Adaptation Measures related to the Built Environment in the Baltic Sea Region

5.1 Mitigation measures

According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), out of 32% of all emissions from buildings in 2010. Due to population growth, migration to cities, household size changes, increasing levels of wealth and lifestyle, the need for housing will increase. This need plays an important role in defining how the energy-related needs in buildings will be provided as this significantly impacts the energy use and related emissions of buildings (Lucon et al., 2014).

In the IPCC Fifth Assessment Report, the following mitigation options have been identified in four categories of mitigation strategies for buildings (Lucon et al., 2014):

- **Carbon efficiency.** Examples of mitigation options: Building-integrated RES (renewable energy sources); Fuel switching to low-carbon fuels such as electricity; Solar electricity generation through buildings' rooftop photovoltaic (PV) installations; Use of natural refrigerants to reduce halocarbon emissions; Advanced biomass stoves.
- **Energy efficiency of technology**. Examples of mitigation options: High-performance building envelope; Efficient appliances (ovens, dishwashers, washing machines, fridge); Efficient lighting, heating, and ventilation; Building automation and control systems; Indirect evaporative cooling to replace chillers in dry climates; Smart meters and grids.
- **System (infrastructure) efficiency**. Examples of mitigation options: Passive House standard (PH); Nearly/net zero and energy plus energy buildings (NZEB); Integrated Design Process; Urban planning; District heating/cooling; Commissioning; Advanced building control systems; High efficiency distributed energy systems, co-generation, trigeneration, load leveling, diurnal thermal storage, advanced management; Smart grids; Utilization of waste heat.
- **Service demand reduction**. Examples of mitigation options: Behavioural/lifestyle change. Some of the building retrofit plans have included educational programs.

5.2 Adaptation measures

While climate change impacts can be either positive or negative for buildings, the adaptation measures are linked to the negative effects of the changing climate.

Several measures can help build more resilient houses and their surroundings to the **increased amount and frequency of precipitation**. These measures are, for example, adjusting building construction; adaptation of building material selection; green roofs; creating more green areas and parks; using less hard surfaces; designing larger dimensions for street water, and better capacity for pumps.

Examples of adaptation actions and measures related to increased amount and frequency of precipitation from the BSR cities (Paju, 2019):

- Stormwater risk mapping (Helsinki, Finland);
- Cloudburst mapping (Malmö, Sweden);
- Piloting the blue-green factor in city planning (Turku, Finland);
- Prioritised streets and roads for snow clearance (Umeå, Sweden).

The measures for more resilient buildings to the **increased temperature** include nature-based solutions, such as tree planting and creating more green space; sun screening above windows; centralized cooling systems; adaptation of material selection for facades; cool roofs (roofs with a high albedo, e.g. painted with a white coating).

Examples of adaptation measures related to increased temperatures from the BSR cities (Paju, 2019):

- Portable cooling units to eldercare sheltered homes and city hospital (Kemi, Finland);
- Analysing heat resistance in public buildings (Växjö, Sweden).

The measures for more resilient buildings to the **increased wind speed and storms** include wind studies for new buildings and adjustment of building constructions.

Examples of adaptation actions and measures related to increased wind speed and storms from the BSR cities (Paju, 2019):

- Hazard resistant infrastructure design and construction (Örebro, Sweden);
- Underground cabling of the power grid (Turku, Finland);
- Strengthening the expertise of construction control staff in licensing and control functions (resilience and resistance measures for buildings) (Lahti, Finland).

The measures for more resilient buildings to **floods and sea-level rise** include not building on lowlands (building regulation) or land with risk for landslide, more tight building constructions, and larger capacity for street water and sewage.

Examples of adaptation actions and measures related to floods and sea-level risefrom the BSR cities (Paju, 2019):

- Inventory of calculated highest flows (Växjö, Sweden);
- Coordination team for high flows and dams (crisis management including warning and evacuation systems) (Växjö, Sweden);
- Coastal protection strategy (Trelleborg, Sweden).

Water scarcity and droughts increase the risks of expanding areas not suitable for buildings and appearing of cracks in house ground when the groundwater level is going down. The measures for more resilient building projects to water scarcity and droughts include nature-based solutions, e.g. water-delaying measures for storing more water in the landscape; adaptation of building constructions.

Examples of adaptation measures related to water scarcity and droughts from the BSR cities (Paju, 2019):

- Water butts/rainwater capture – Region Gotland decided upon irrigation bans and ran the campaign “Save Water” with information and ads (Visby, Sweden);
- Water-delaying measures in a changing climate – construction of irrigation ponds, bio coal ditches, phosphor ponds, multifunctional urban pond, two-stage ditches, integrated riparian zones, restoration of wetlands in agricultural landscapes (City of Västervik, Sweden).

6. Synergies between Mitigation and Adaptation in EU funded BSR Projects

Six Interreg BSR projects (BEA-APP; LowTemp; LUCUA; Co2mmunity; Effect4buildings; Act Now) and 1 Finland-Russia CBC ENI project (Green ReMark) were evaluated with a questionnaire (Annex 2) to see what climate change-related categories, if any, did these projects consider in assessing climate change-induced risks and identifying adaptation measures to mitigate the risks. Also, European Union Civil Protection and Humanitarian Aid funded CASCADE and DG Echo projects on community action for supporting climate adaptation were assessed to understand the adaptation logic for the mitigation. It supports conceptualizing and programming the mitigation-adaptation more cohesive interplay. Adaptation measures need to be integrated into policy implementation and support across BSR. It enables local policymaking and energy-environmental planning for adaptation in combination with mitigation actions.

The selected projects were related to the topic of energy efficiency and renewable energy, except CASCADE and DG Echo, which aim for climate adaptation and disaster risk management at the community level (Table 3). Energy efficiency projects, their implemented actions, cases, and pilots deliver and represent the mitigation policy scene and mode of policy practices across the Baltic Sea Region. The aim was to explore synergies with the seeking and strengthening adaptation axis of the climate-energy policy. The questionnaires were filled by the project managers of each project.

Table 3. Project name versus its main focus

Project acronym	*Topic of the project/main focus*
Projects aimed at mitigation/energy efficiency	
BEA-APP (Interreg Baltic Sea Region)	Spatial planning of renewable facilities
Effect4buildings (Interreg Baltic Sea Region)	Energy efficiency in buildings and developing toolbox
Act Now (Interreg Baltic Sea Region)	Tackles energy efficiency in the existing building stock of smaller and larger cities around the Baltic Sea
LowTemp (Interreg Baltic Sea Region)	Energy efficiency in district heating
LUCIA (Interreg Baltic Sea Region)	A systems approach to the development of outdoor lighting
Co2mmunity (Interreg Baltic Sea Region)	Fostering community energy (CE)development as enhancing tool for increasing renewable energy share and decentralization of energy systems
Green ReMark (European Union, the Russian Federation and the Republic of Finland)	Support for innovations in green energy production and use
Projects aimed at adaptation	
CASCADE (European Union Civil Protection and Humanitarian Aid)	To develop risk assessment methodologies focusing on climate change risks, tailor-made for the local community level
DG Echo (European Union Civil Protection and Humanitarian Aid)	Integrated Climate Risk assessment

In terms of the outputs of the mitigation/energy efficiency projects, if any adaptation aspect was considered at all, then it was **mostly done within pilot projects, districts, and sites; stakeholder and citizen involvement, and renewable energy measures**. The least – within landscaping and ecosystem services, tools, project objectives, and aims (Figure 1).

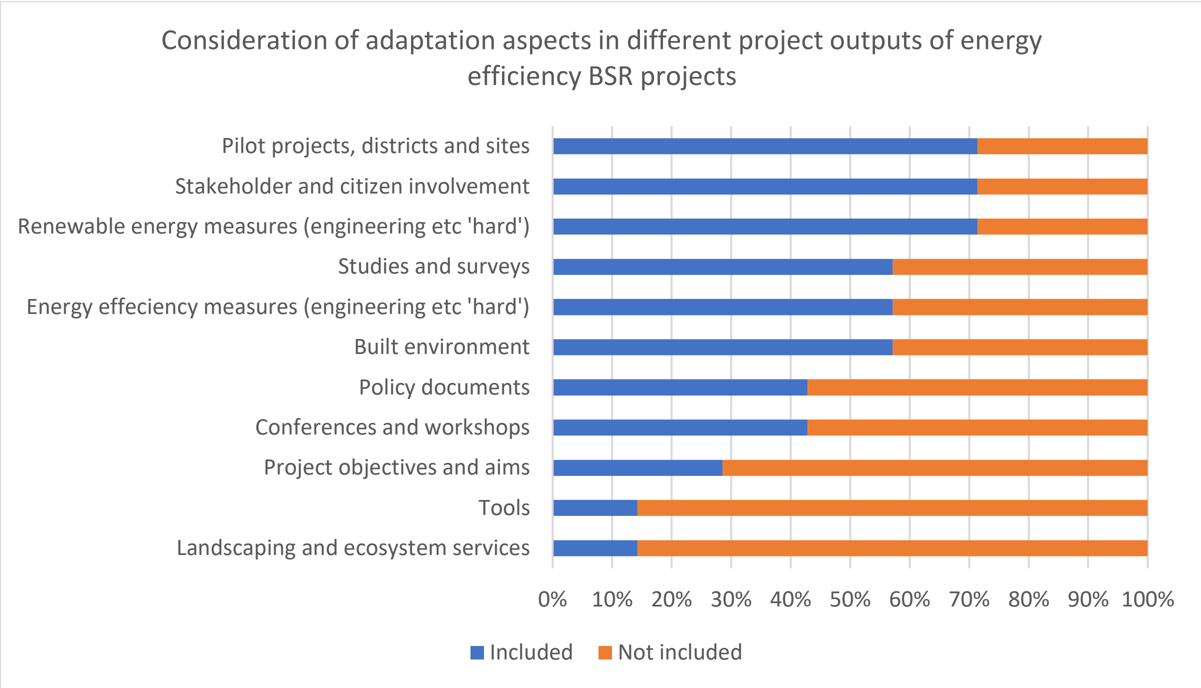


Figure 1. Consideration of different climate impacts in energy efficiency BSR projects

The **most important climate change impact** considered in most of the projects (via possible synergies) is **temperature**, **the least considered impact was flood and sea-level rise**. (Figure 2)

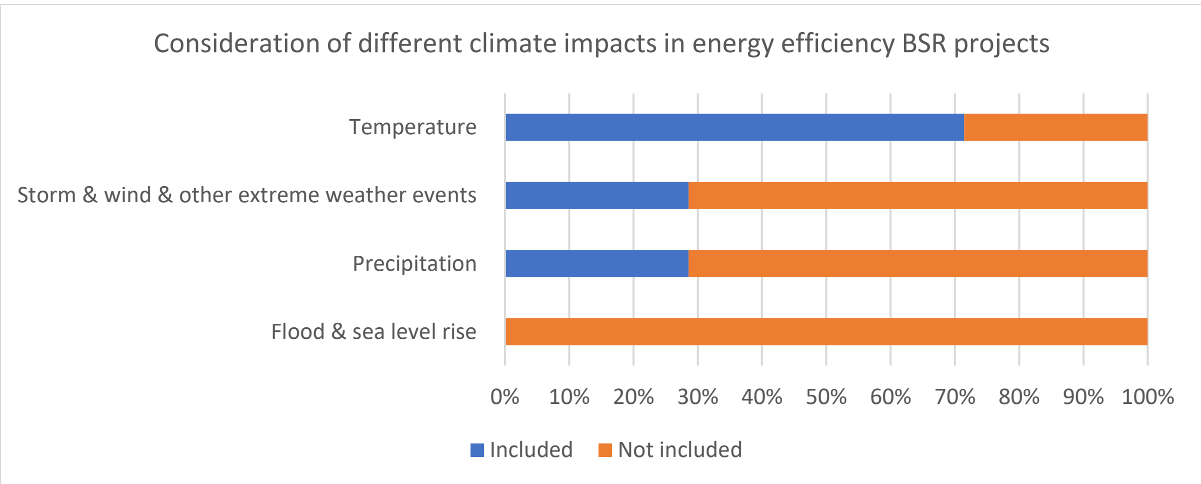


Figure 2. Consideration of adaptation aspects in different projects outputs of energy efficiency BSR projects

Some examples of mitigation and adaptation synergies applied in the energy efficiency projects are given in Table 3.

Table 4 Examples of mitigation and adaptation synergies applied in BSR projects

Project	Output where adaptation is considered	Adaptation & mitigation synergies
BEA-APP	Pilot projects, districts, and sites	Many pilot sites combined renewable installation with ecosystem services etc. adaptation measures.
	Renewable energy measures (engineering etc. 'hard')	Combining renewables with additional adaptation component was a quite natural choice.
Green ReMark	Conferences and workshops	A special section at the conference in SPbPU workshops for SMEs in Mikkeli and SPb
LowTemp	Pilot projects, districts, and sites	Low-temperature district heating (LTDH) allows for more flexibility in pricing the construction of facilities grids with considerably reduced heat losses (for a bigger number of heating degree days).
LUCIA	Pilot projects, districts, and sites	Six pilot sites in BSR cities, outdoor lighting systems operating in various weather and climatic conditions
	Stakeholder and citizen involvement	Co-creation process for the involvement of end-users in the system development: promotion of modern approaches such as mitigation of light pollution and climate changes
Co2mmunity	Policy documents	Policy recommendations for national or regional level policymakers include references to climate change and challenges.
Effect4buildings	Tools	More offices and premises need cooling in summer, and energy-efficient cooling systems were promoted.
Act Now	Stakeholder and citizen involvement/Conferences and workshops	Adaptation was communicated in context with mitigation discussions

The climate adaptation projects CASCADE and DG Echo considered all climate impacts in the projects. However, while adaptation was considered to a large extent in many of the planned project outputs (was also an aim), then mitigation was hardly taken into account, except in a few cases, i.e. CASCADE project developed tool/methodology for carrying out climate risk assessments, which is a step to climate change adaptation activities related to these risks.

7. Synergies between Mitigation and Adaptation Measures in Building Projects

7.1. Choice of best practices evaluated

The aim was to analyse at least two building project cases per project partner country and to evaluate the synergies of the implemented mitigation and adaptation measures among them. The building projects selected per country had to be either residential building or office or mixed-use houses (preferably 2–5 stories but can variate) and be in the following two categories:

- One retrofit building project with the implementation of significant energy efficiency measures that is wholly or partially supported by EU funding,
- One new construction project which describes the state of the art in planning for the combined mitigation and adaptation measures.

Tõrge! Ei leia viiteallikat. summarises the studied best practices. The cases were selected by the CAMS project partners and the questionnaires for each project were filled in by themselves or by the contact persons of the building projects (under the supervision of CAMS partners).

Table 5 Analyzed best practices by types of building projects and countries

Country	Retrofit building project and the year of completion	Net area (m^2)	Cost	New buildings	Net area (m^2)	Cost
Germany	Residential building, Am Brunnenhof/Gilbertstraße, Hamburg , Am Brunnenhof 17 /Gilbertstraße 43 17, 2008	1471	NA	Residential building, Klima Wohl Herzkamp, Hannover Bothfeld, 2018-2020	25 000	NA
Estonia	Residential building (Koondise St 9/11/13, Saue), 2019	6508	2,162,500 €	Office building (Järvevana 7b, Tallinn), 2018	7500	7,5 M €
	Residential building (Kalevi St 8, Tartu), 2019	2069	1,200,000 €			
Latvia	Residential building (Katoļu St 17, Jelgava), 2015	7131	754,815 €	Office building Riga Business Garden Building C, 2019	9470	10,5 M €
	Residential building (Rīgas St 18, Valmiera), 2018		266,856 €	Office building Riga Business Garden Building X3, 2019	9780	10,5 M €
Poland	School/Administration offices, Public utility (former School of Commerce), Sopot, 18/20 Kosciuszki st., 2015	960	NA	Residential building (multifamily house with groundfloor shops), Gdansk, Kielnenska st., 2019	672	NA
Russia	Residential building (Chaikovskogo 36a, St Petersburg), 2018	8057		Residential building (Babushkina street 82/3, St Petersburg), 2019	31 200	45 M €
	Residential building (Ruzovskaya 29a, St Petersburg), 2018	3941				

Sweden	Office building (Dalarna County Board office, Falun), 2020	6600	897,000 €	Dwellings and workplaces (Norra Djurgården urban area development, Stockholm), 2011-2030	236 ha	Millions of euros (the exact number is not known)
				An example of a typical newly built building project by a company Castellum – www.castellum.se; Castellum follows very high sustainability criteriums and their projects are all over Sweden. The questionnaire was filled by considering the measures that generally would be implemented in all Castellum projects.		

7.2. Mapping the synergies among measures related to the built environment

The following chapter explains the methodology for mapping the synergies between the mitigation and adaptation measures in building projects. The chapter also presents the results of this mapping by explaining and highlighting the synergies.

First, the analysed list of mitigation and adaptation measures for the built environment was compiled together with the project partners based on the literature review. The list consists of 50 measures in 10 categories (Table 6):

1. Site selection
2. Building envelope and fixtures
3. Energy supply for the building
4. Water supply and use of water
5. Ventilation, air conditioning, cooling
6. Electrical appliances and lighting
7. Architectural form
8. Origin and quality of building materials
9. Building surroundings and landscaping
10. Project management, commissioning

Secondly, four categories of possible impacts of measures on mitigation were identified based on the literature review:

M1 – Carbon reduction from the reduced need for space heating

M2 – Carbon reduction from reduced need for electricity (for final consumption)

M3 – Mobility related to carbon reduction (modal shifts, electric vehicles, etc.)

M4 – Carbon reduction from lower embodied energy of construction materials and processes

For adaptation, five categories of measures were identified:

A1 – Adaptation measures related to impacts of precipitation changes

A2 – Adaptation measures related to impacts of temperature changes

A3 – Adaptation measures related to impacts of storm and wind

A4 – Adaptation measures related to impacts of flood and sea-level rise

A5 – Adaptation measures related to impacts of water scarcity and droughts

For assessing the impact of measures on mitigation, it was looked at what mitigation aspects (M1–M4) each measure relates to the most to help reduce emissions. Similarly, for assessing the impact on adaptation, it was looked at what adaptation aspects (A1–A5) each measure relates to the most.

For evaluating the relations, the authors of this study used the following scale: strong relation, weak relation, there is no relation to certain sub-categories at all.

Correlation scale:

STRONG	WEAK	NONE

As a result of such mapping, four main types of measures were identified:

1. A – adaptation measures
2. AM – adaptation measures with possible impact (synergy/anergy) on mitigation
3. M – mitigation measures
4. MA – mitigation measures with possible impact on adaptation

Table 6 draws the results of the mapping study by placing all measures within each of the four above mentioned categories. The negative impacts of mitigation and adaptation measures are indicated in red colour.

Table 6. Results of mapping synergies between the positive and negative impacts of the mitigation and adaptation measures

		IMPACT ON MITIGATION				IMPACT ON ADAPTATION				
CATEGORY AND MEASURE		**M1**	**M2**	**M3**	**M4**	**A1**	**A2**	**A3**	**A4**	**A5**
Site selection										
Consideration of building at coastal and riparian areas or areas of high risks of flooding	**A**							Adaptation to sea-level rise, floods, storms and risk for landslides		
Access to renewable energy sources	**M**	Carbon reduction from the reduced need for space heating and electricity consumption								
Existing infrastructure that allows adopting efficient (heating) systems (central heating, use of waste heat, etc.)	**M**	Carbon reduction from the reduced need for space heating								
Site selected to induce minimal car mobility	**M**			Carbon reduction from change in mobility						
Architectural form										
Shading due to building form	**AM**		Reduction in need for air conditioning					Adaptation to a growing need for cooling and proper ventilation during heat waves		
Passive solar heating, glazing to wall ratio	**AM**	Reduction of heating required during sunny cold periods of the year	Possible increase in electricity demand from AC in the hot periods					Possible increase in indoor temperature and discomfort during heat waves		
Building envelope and fixtures										
Foundation built higher (e.g. basement floors are on a higher level)	**A**				More building materials may imply higher carbon footprint of materials				Adaptation to the rise of groundwater level and flooding	
Stronger building envelope (load-bearing walls) and roof structure	**AM**				Higher requirements on building materials may imply higher			Adaptation to extreme weather conditions (storms)		

					carbon footprint of materials					
Moisture removal measures on external walls and windows	**A**					Adaptation to increased precipitation2				
Adequate gutter sizing	**A**					Adaptation to increased precipitation		Adaptation to storms		
Elements fastened to buildings must be attached stronger (rain gutters, antennas, and lights)	**A**							Adaptation to extreme weather conditions (storms)		
Use of building materials that can cope with excessive moisture (various facade materials, Synthetic Roof Underlayment)	**A**					Adaptation to increased precipitation (e.g. oblique rain)		Adaptation to increased storms	Adaptation to increased flooding	
Reflective materials	**AM**		Possible reduction in air conditioning requirement		Higher requirements on building materials may imply higher carbon footprint of materials			Helps avoid overheating the indoor climate – adaptation to the temperature rise 2		
Green roofs	**AM**				Carbon reduction from lower embodied energy of construction materials and processes	Water storing capacity in case of flat roofs – adaptation to increased precipitation and temperature		Water storing capacity		Possible increased demand for watering the green roof
Better airtightness	**MA**	Carbon reduction from the reduced need for space heating					Adaptation to the temperature rise			
Insulation of building envelope (Passive House standard (PH), Nearly/net zero and energy plus energy buildings (NZEB))	**MA**	Carbon reduction from the reduced need for space heating and lower embodied energy of construction materials and processes			Higher requirements on building materials may imply higher carbon footprint of materials	Insulation materials may or may not deal well with a future increased level of precipitation (and moisture)	How does higher insulation affect the indoor climate with hotter summers?			

Glazing technologies	**MA**	Carbon reduction from the reduced need for space heating					Adaptation to the temperature rise			
Shutters	**MA**		Carbon reduction from reduced need for electricity consumption				Adaptation to the temperature rise			
Energy supply for the building										
Automated heating systems that can cope with changing temperatures[1]	**AM**	Carbon reduction from the reduced need for space heating					Adaptation to the temperature rise	Adaptation to the stronger winds		
Energy-efficient heating systems	**MA**	Carbon reduction from the reduced need for space heating	Carbon reduction from the reduced need for electricity				Adaptation to the temperature rise			
Solar electricity generation through buildings' rooftop photovoltaic (PV) installations	**MA**		Carbon reduction from reduced need for electricity consumption				Reduction of PV efficiency from increasing average temperatures			
District heating	**M**	Carbon reduction from the reduced need for space heating								
Waste-heat utilization	**M**	Carbon reduction from the reduced need for space heating								
Smart grids linked to reduced need for heating due to rising temperature	**AM**	Carbon reduction from the reduced need for space heating					Adaptation to the temperature rise and stronger winds	Adaptation to the temperature rise and stronger winds		

[1] In Sweden, for instance, it is considered as basic technology for all heating systems in every building. The standard/building regulations already include very many rules that must be followed, especially if a building owner also is certified. So, building owners don't see most of it as adaptation measures, but as normal procedures.

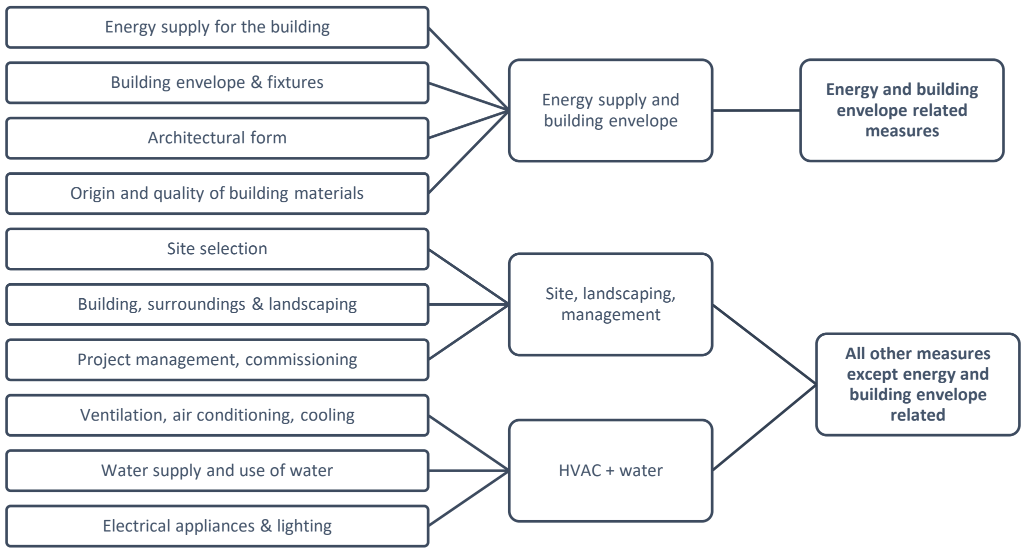
Automated indoor climate	**MA**	Carbon reduction from the reduced need for space heating	Carbon reduction from the reduced need for electricity				Adaptation to the temperature rise			
Green power purchase schemes	**M**		Carbon reduction from reduced need for electricity consumption							
Water supply and use of water										
Use of rainwater in the building	**A**					Adaptation to increased precipitation				Adaptation to water scarcity and droughts
Efficient water systems (water-saving toilets, taps and other water-related appliances)	**A**									Adaptation to water scarcity and droughts
Solar water heater	**MA**		Carbon reduction from reduced need for electricity consumption 2				Adaptation to the temperature rise			
Hot water circulation	**M**		Carbon reduction from reduced need for electricity consumption							Adaptation to water scarcity and droughts
New domestic hot water systems (with heat recovery)	**M**	Carbon reduction from the reduced need for space heating								
Ventilation, air conditioning, cooling										
Inclusion of moisture removal in the ventilation units	**AM**		Possible increase in electricity demand			Adaptation to increased precipitation				
Installation of new and efficient air conditioning units (HVAC)	**MA**	Carbon reduction from the reduced need for space heating and electricity				Adaptation to increased precipitation, temperature rise, and extreme weather conditions				
Improve natural ventilation	**MA**	Carbon reduction from the reduced need for space heating				Adaptation to increased precipitation and temperature rise				

District cooling	**M**		Carbon reduction from reduced need for electricity consumption							
Efficient heat recovery ventilation	**MA**	Carbon reduction from the reduced need for space heating and electricity consumption				Adaptation to increased precipitation, temperature rise, and extreme weather conditions				
Electrical appliances & lighting										
More resilient local electricity system (cable structure) and other stormproof appliances	**A**					Adaptation to increased precipitation		Adaptation to floods and high winds which may topple trees and damage above-ground power lines		
Upgrade in lighting systems (use of T5 lamps, high electronic discharge lamps, and LEDs)	**M**		Carbon reduction from reduced need for electricity consumption 2							
Smart meters	**MA**	Carbon reduction from the reduced need for space heating	Carbon reduction from the reduced need for electricity consumption				Adaptation to the temperature rise and extreme weather conditions			
The embodied energy of materials and processes										
Whole building life-cycle assessment	**M**				Carbon reduction from lower embodied energy of construction materials and processes					
Energy-efficient/sustainable building materials	**M**				Carbon reduction from lower embodied energy of construction materials and processes					
Building surroundings & landscaping										
Permeable roads and car parks surrounding the building	**A**					Smaller burden on the stormwater system – adaptation to increased precipitation		Helps to cope with future increased rainfall and flood risks		

Maintenance of plant cover and removal of dangerous trees near the buildings	**A**							Adaptation to high winds which may topple trees and thereby damage building structures		
Greenery planned within the building project	**A**					Adaptation to increased precipitation		Adaptation to storms	Adaptation to floods	
Sustainable stormwater systems integrated into the design of the building, such as rain gardens	**A**					Adaptation to increased precipitation 2		Adaptation to storms	Adaptation to floods	
Bicycle parks included in the buildings complex	**MA**			Carbon reduction from change in mobility				Possible increased flood risk if the covered (paved) area increases		
Electrical charges for electric cars/bicycles	**M**			Carbon reduction from change in mobility						
Project management, commissioning										
Complexity assessment	**A**							Adaptation to extreme weather conditions		
Special (energy efficiency) courses for builders or other site workers, before or during the implementation of the project	**MA**	Carbon reduction from the reduced need for space heating and electricity					Adaptation to the temperature rise			
Citizens/inhabitant courses	**AM**	Carbon reduction from the reduced need for space heating and electricity				Adaptation to all climate change impacts				

7.3. Assessment of mitigation and adaptation measures in building projects

For further analysis, the categories of mitigation and adaptation measures from Table 6 were aggregated into two clusters of categories:



The structure of the analysis was divided between these two categories and separately between newly built and retrofit buildings.

Individual graphs were made for each analysed project that allows to draw some comparisons between different countries and help to give a quick overview. In all the figures below:

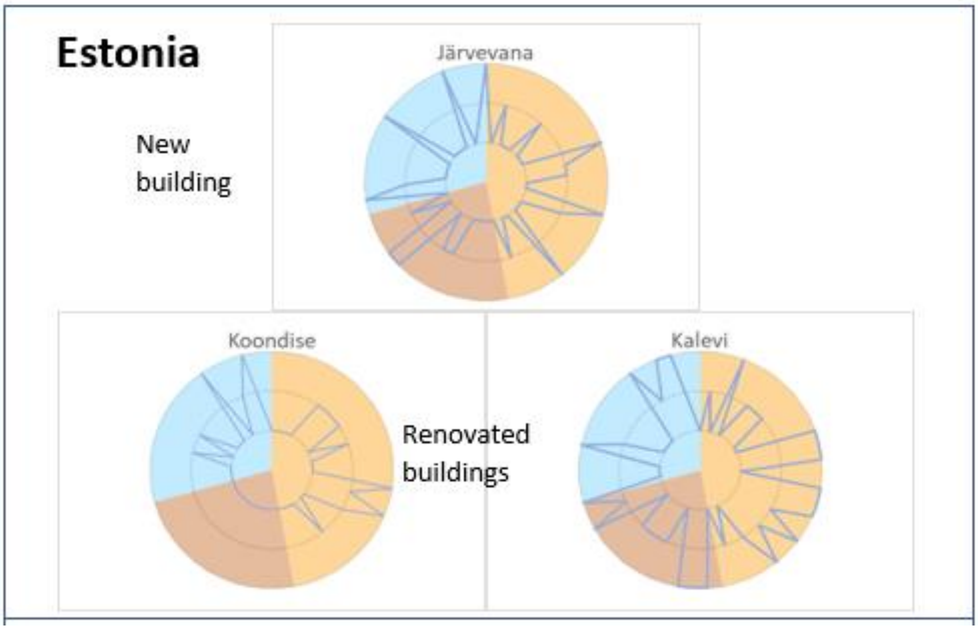
- Blue area marks measures related to HVAC + water[2]
- Brown area marks measures related to site, landscaping, management[3]
- Yellow area marks measures related to energy supply and building envelope[4]
- The blue line on the diagrams shows the extent to which the measures in each of the areas were implemented: not implemented at all (inner circle), to a minimum standard (middle circle), or above the minimum standard (outside circle).

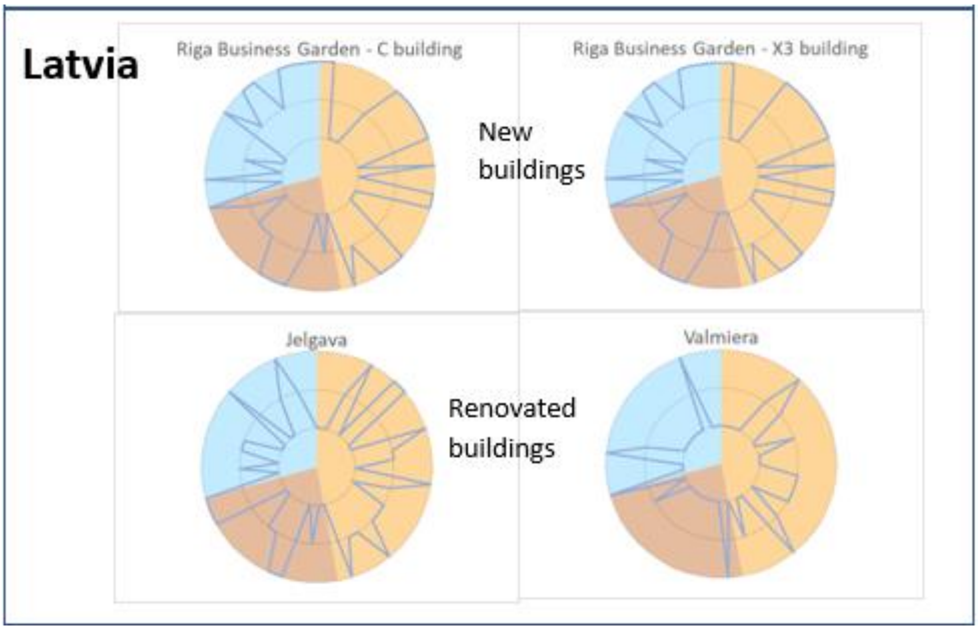
[2] List of measures in this category: Citizens/inhabitant courses; Use of rainwater in the building; Efficient water systems (water-saving toilets, taps, and other water-related appliances); Solar water heater; Hot water circulation; New domestic hot water systems (with heat recovery); Inclusion of moisture removal in the ventilation units; Installation of new and efficient air conditioning units(HVAC); Improve natural ventilation; District cooling; Efficient heat recovery ventilation; More resilient local electricity system (cable structure) and other storm-proof appliances; Upgrade in lighting systems(use of T5 lamps, high electronic discharge lamps, and LEDs); Smart meters

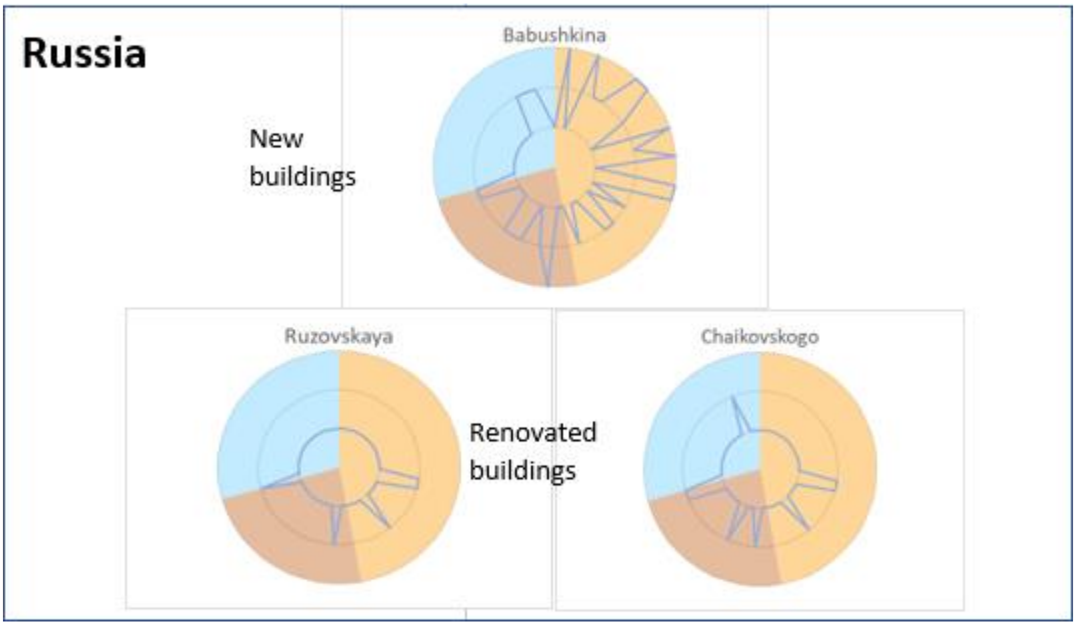
[3] List of measures in this category: Consideration of future sea level rise/building at coastal and riparian areas or areas of high risks of flooding; Access to renewable energy sources; Existing infrastructure that allows to adopt efficient (heating) systems (central heating, use of waste heat etc); Site selected to induce minimal car mobility; Permeable roads and car parks surrounding the building; Maintenance of plant cover and removal of dangerous trees near the buildings; Greenery planned within the building project; Sustainable storm water systems integrated in the buildings design, such as raingardens; Bicycle parks included in the buildings complex; Electrical charges for electrical cars/bicycles; Complexity assessment; Special (energy efficiency)courses for builders or other site workers, before or during the implementation of the project

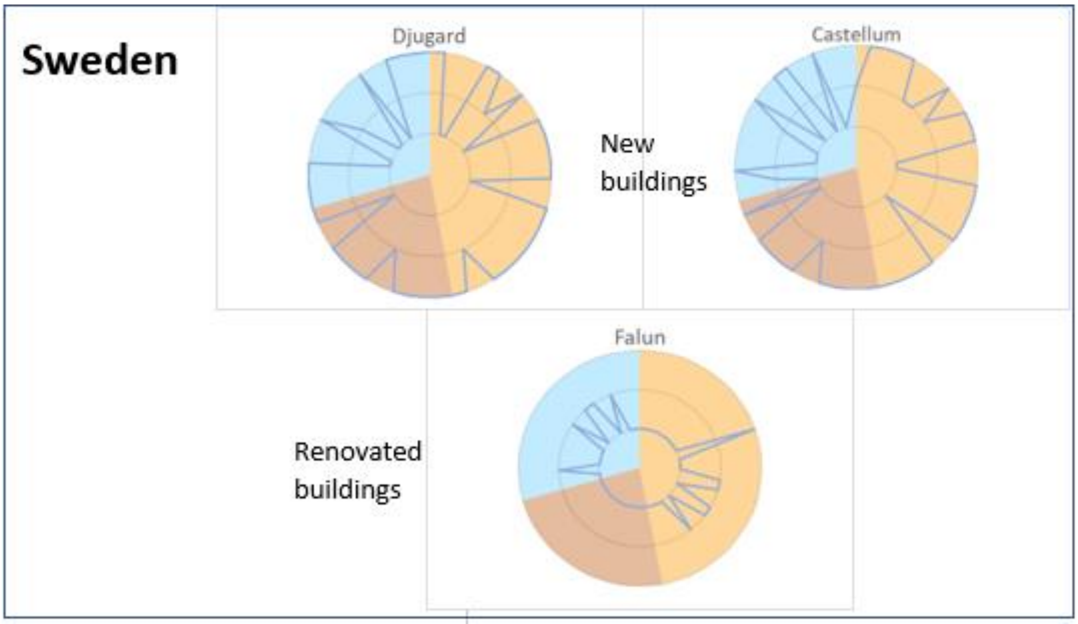
[4] List of measures in this category: Shading due to building form; Passive solar heating, glazing to wall ratio; Foundation built higher (e.g. basement floors are located higher); Stronger building envelope (load-bearing walls) and roof structure; Moisture removal measures on external walls and windows; Adequate gutter sizing; Elements fastened to buildings must be attached stronger (rain gutters, antennas and lights); Use of building materials that can cope with excessive moisture (various facade materials, Synthetic Roof Underlayment); Reflective materials; Green roofs; Better air-tightness; Insulation of building envelope (Passive House standard (PH), Nearly/net zero and energy plus energy buildings (NZEB)); Glazing technologies; Shutters; Heating systems that can cope with changing temperatures; Energy efficient heating systems; Solar electricity generation through buildings' roof-top photo voltaic (PV) installations; District heating; Waste-heat utilization; Smart grids linked to reduced need for heating due to rising temperature; Automated indoor climate;
Green power purchase schemes; Whole building life-cycle assessment; Energy efficient/sustainable building materials

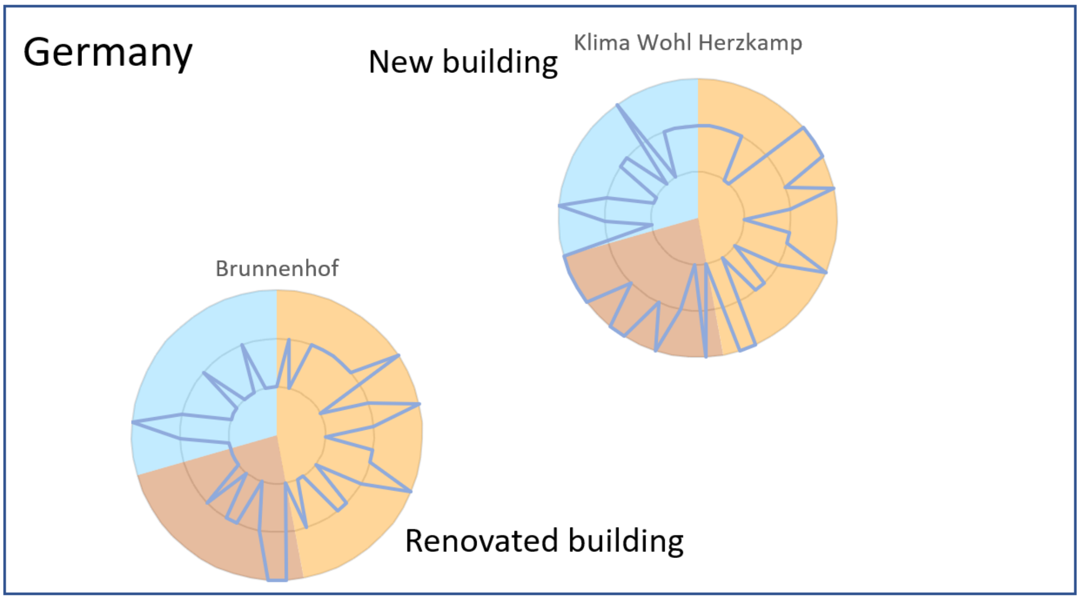
The selection between the two levels of implementation of a measure – the minimum standard and above minimum standard – was made by the questionnaire respondents.

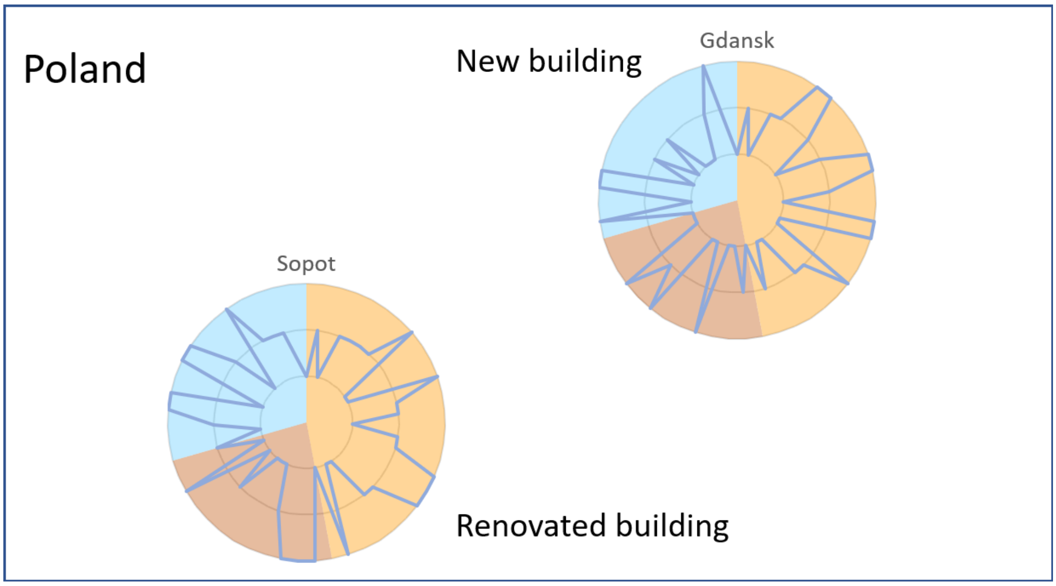





Russia
Babushkina
New
buildings
Ruzovskaya
Chaikovskogo
Renovated
buildings


Sweden
Djugard
Castellum
New
buildings
Falun
Renovated
buildings


Germany
New building
Klima Wohl Herzkamp
Brunnenhof
Renovated building


Poland
New building
Gdansk
Sopot
Renovated building

Main conclusions that can be drawn from the graphs above are:

- In Sweden, the example of a renovated municipal building project is a rather typical energy efficiency project.
- The renovated buildings in Latvia, Poland, and Germany have rather undergone an extensive renovation process and the results of those equal to some newly built houses.
- In new buildings, all measures have generally been implemented to a greater extent above minimum standards compared to renovated buildings.
- Compared to all other countries, Russia has the lowest level of implementation of measures among both new and renovated buildings.
- Most of the measures implemented for both new and refurbished buildings fall into the category of energy supply, building façade, and external features. This division is also due to the larger number of possible measures in this category in general. Measures related to landscaping, general project management, and water supply were implemented less.

7.3.1. Energy and building envelope related measures

Figures 3 and 4 below illustrate the implementation of energy and building envelope related measures for both newly built (Figure 1) and retrofitted buildings (Figure 2). The main outcomes, according to these graphs, are:

- **In new buildings, the evaluated measures have been implemented to a large scale above minimum standard** (large presentation of dark green colour in Figure 1). Most popularly implemented measures were glazing technologies[1], passive solar heating[2], better airtightness[3], energy-efficient heating systems, automated indoor climate, energy-efficient, and moisture-proof building materials[4].

[1]Newly built residential building in Russia: Three-chamber metal-plastic double-glazed windows used; Newly built office buildings in Riga: low energy spacers between glazing, triple glazing implemented; Newly built office building in Estonia: Stimulated G value for each window. Different G values used on different facades.
[2]Retrofitted residential building in Latvia: balconies of the building were upgraded with translucent plastic balcony-enclosing structure that allows the sun to pass through and creates additional warmth in the winter.
[3]Newly built office building in Estonia: PIR insulation was used to raise the air tightness and overall insulation of the building. Retrofitted residential buildings in Latvia: Building has an interlocking window structure, usually made of wood cladding. During retrofit it was sealed with air-tight materials, and additionally equipped with diffusion-proof membranes.
[4] Newly built residential building in Russia: moisture proof building materials such as bitumen-polymer surfaced materials and energy efficient building materials such as basalt wool, extruded polystyrene; Newly built office buildings in Riga: moisture proof building materials such as Koster TPO roof membrane, facade with aluminium composite panels, glazing, aluminium curtain wall and energy efficient building materials that are in line with LEED to fulfil platinum requirements; Newly built office building in Estonia: Façade is covered with wooden boards.

- **In retrofitted buildings, most measures were implemented to the minimum standard or not at all.** Most popularly implemented measures were automated heating systems that can cope with changing temperatures[5], energy-efficient heating systems[6], automated indoor climate[7], better airtightness[8].

[5]Retrofitted residential building in Estonia: Automated heating system; Retrofitted residential buildings in Russia: Systems of heating regulation according to external temperature, installed equipment. Retrofitted residential building in Latvia: an outside temperature sensor is installed on the facade of the yard. This ensures heat supply depending on the outdoor temperature.
[6]Retrofitted residential and office buildings in Estonia, Latvia and Sweden: Smart solution and full automation.
[7]Retrofitted residential buildings in Latvia and Russia/retrofitted school in Poland: Valves/thermoregulators installed on radiators.
[8]Retrofitted residential buildings in Latvia: Wooden windows were replaced with PVC windows. Steam and wind barrier tapes were installed. Retrofitted school in Poland: forced ventilation applied

- In terms of synergies, **the retrofitted building projects especially have more mitigation measures implemented that have implications on adaptation than vice versa.** These are mostly measures that are related to energy efficiency improvements such as better airtightness, energy-efficient heating systems, and automated indoor climate. For newly built buildings there is a stronger implementation of other measures under this category as well, such as glazing technologies and PV installations[9].

[9]Newly built residential/office buildings in Sweden and Estonia: Panels on the roof for on-site solar energy production; Newly built residential building in Germany: roof top with mix af photo voltaic installations and solar collectors

- **Although there is a stronger implementation of mitigation measures in general; adaptation measures have still been taken relatively seriously, especially in some newly built building projects,** such as elements fastened to buildings stronger[10], moisture-proof building materials[11]. In newly built houses, the measures also include green roofs[12], passive solar heating[13,] and shading.

[10]Newly built office buildings in Riga: all elements have been hidden in facade. Gas supply line fixed to concrete column; Newly built office building in Estonia: wooden façade was fixed with stainless steel screws; Retrofitted residential buildings in Latvia: ends of the gutters are equipped with a protective grille, which is designed to protect the gutter against physical damage and also serves as a decorative element. Also new, stronger, more durable reinforcements were installed to protect engineering communications on the roof in case of stronger winds and weather conditions.
[11]Retrofitted residential buildings in Latvia: waterproof, synthetic materials for roofing that provides more airtight insulation; facades painted with water repellent paint. Retrofitted school in Poland: phenol foam weber PH930 (Kooltherm K5) was used.
[12]Newly built office buildings in Riga: roofs above underground garage; Newly built urban area with residential buildings in Stockholm: 16700 sqm green roofs built; Company Castellum in Sweden is constantly considering green roofs on their buildings, especially in the city centres. New residential building in Germany: extensive green roofs for all buildings, Kindergarden with retention roof.
[13]In Sweden there is new regulation for the minimum amount of daylight in a building to reach a good indoor climate, requiring large windows which are usually built together with the shading systems. In case of newly built office buildings in Riga: ratio between glazed/non-glazed facade parts 30/70; in the retrofitted residential building of Russia: the design of the exterior walls is made using modern insulation materials, three-chamber plastic double-glazed windows retain heat in cold weather and do not actively heat the room in hot weather.

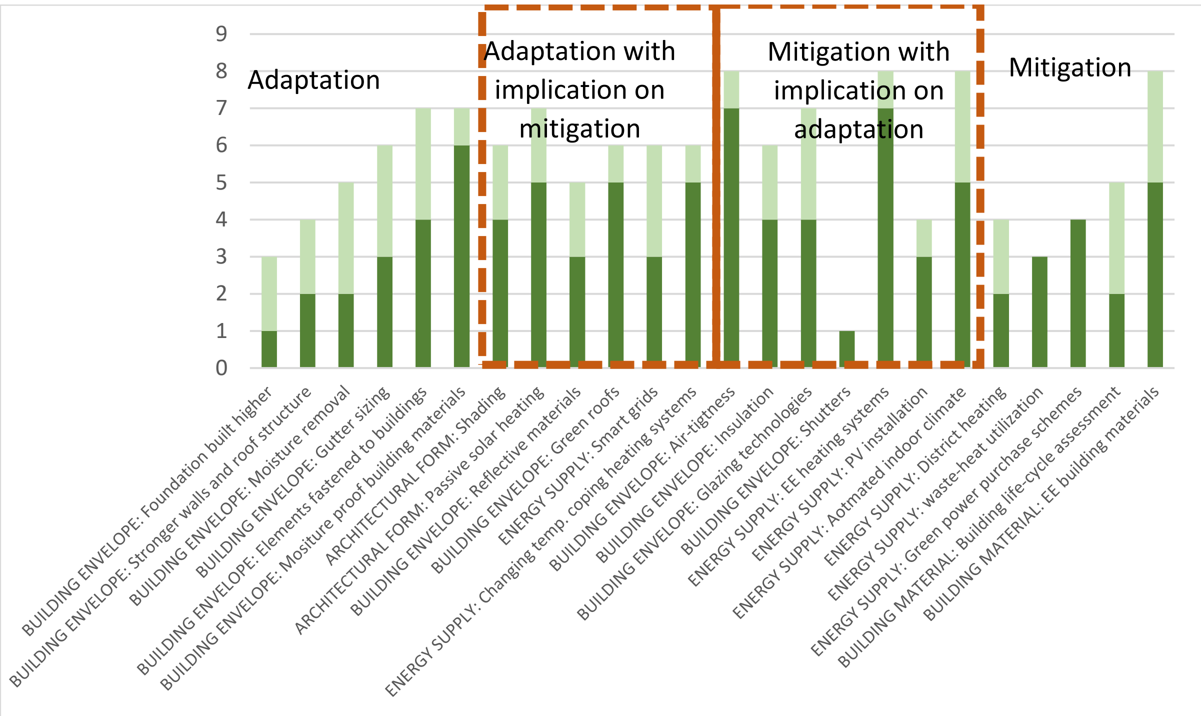


Figure 3 Energy and envelope related measures for new buildings. Light green – measure implemented to the minimum standard; Dark green – measure implemented above the minimum standard.

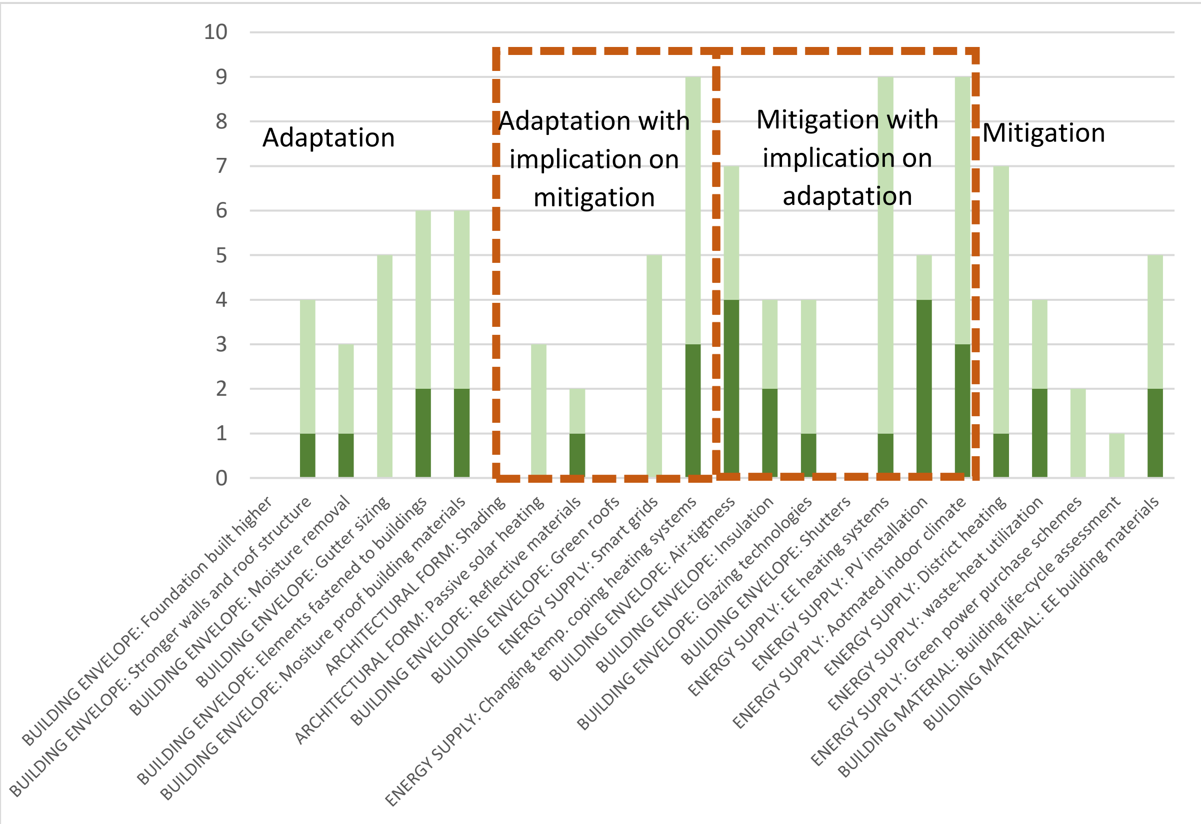


Figure 4. Energy and envelope related measures for retrofits. Light green – measure implemented to the minimum standard; Dark green – measure implemented above the minimum standard.

7.3.2. All other measures except energy and building envelope measures

Figures 4 and 5 below illustrate the implementation of measures other than energy and building envelope for both newly built (Figure 3) and retrofitted buildings (Figure 4). These are measures related to HVAC + water and site, landscaping, and management.

Main outcomes according to these graphs are:

- **Newly built building projects have implemented more measures in general and more measures were implemented above minimum standard compared to retrofitted building projects**. Most popularly implemented measures for newly built buildings have been measures such as efficient water system[14], permeable pavements, planned greenery[15], upgraded lighting system[16], as well as special courses for builders and other building users[17].

[14]General water saving toilets and taps in most projects to reach the certificates.
[15]That measure is especially popular in Sweden were Green Space Index is used when planning buildings: 8,2 sqm green area per inhabitant, park area within 2000 m to all. Newly built residential building in Germany: planning of green areas as important part of planning process.
[16]Most newly built building projects use LED lighting.
[17] Workers are instructed to work with new insulation materials (PIR) and thermally activated building structures (TABS) or green building certification program LEED rating system; actively consulted on sustainability requirements on materials; separate instructions/courses for buildings maintenance companies.

- **In terms of synergies, there is again the stronger implementation of mitigation measures that have implications on adaptation than vice versa**. Most popularly implemented measures under this category for both retrofit and newly built buildings projects are heat recovery ventilation[18] and smart meters[19]. In newly built buildings, the implemented measures also include special courses for builders and other users of the building (maintenance companies), solar water heater, efficient air conditioning, and bicycle parks[20].

[18]In most newly built building projects heat recovery ventilation was used in all houses. Newly built office buildings in Riga: air handling unit (AHU) was equipped with rotary heat exchanger with high efficiency. In terms of some of the examples of retrofitted residential buildings that were evaluated for this project, exhaust air heat pump was installed.
[19]Newly built residential building in Russia: smart meters used on outdoor lighting; Newly built office buildings in Riga: MODbus system, Connected to BMS; Retrofitted residential building in Estonia: remote automated system installed. Newly built residential building in Poland: Smart Home system controls lighting and other electric energy use.
[20]Most newly built buildings include bicycle storages (in underground parking), bicycle stands next to the entrance of the buildings.

- **Although there is a stronger implementation of mitigation measures in general; adaptation measures especially in newly built buildings have still been taken relatively seriously**, most popularly planned greenery and permeable pavements[21]. In terms of newly constructed buildings also efficient water systems, site selection, sustainable stormwater systems, and wiser use of rainwater, in general, are important[22].

[21]In Sweden it is common that in city areas with a lot of hard surface water magazines have been built, for example having gravel on a parking area instead of asphalt. For instance in case of Norra Djurgård Royal Seaport area development in Stockholm courtyards and roofs retain the stormwater by directing it to various plant beds and containers to be used for irrigation at a later stage, new solutions have been tested and developed, such as new cesspits for stormwater as well as solutions for draining water from the courtyards to the parks, and biochar plant beds. In newly built office buildings of Riga storm water systems have been also integrated in landscape.

[22]Newly built office building in Estonia: rain/groundwater collection tanks for water used in toilets has been implemented. In Sweden rainwater is collected for irritation such as in case of Norra Djurgård Royal Seaport area development in Stockholm. Newly built residential building in Poland: rainwater collected in the ground to be used for gardening or heat exchange.

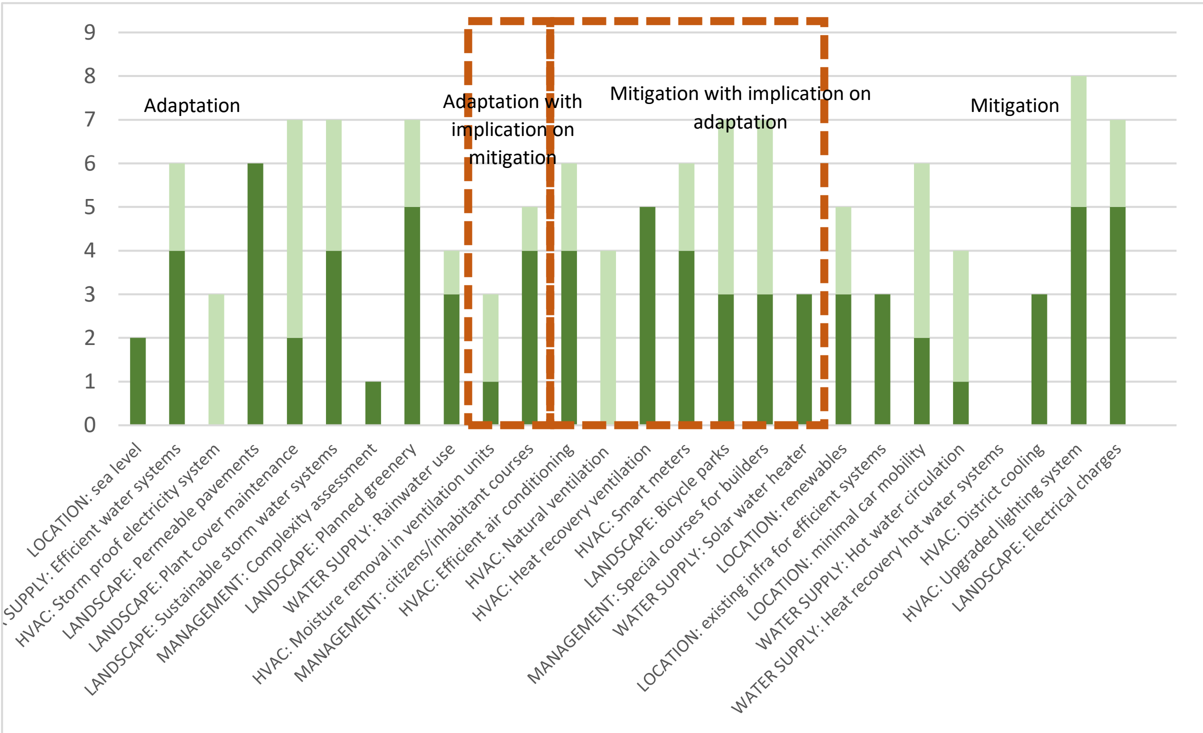


Figure 5. All except energy and envelope related measures for new buildings. Light green – measure implemented to the minimum standard; Dark green – measure implemented above the minimum standard.

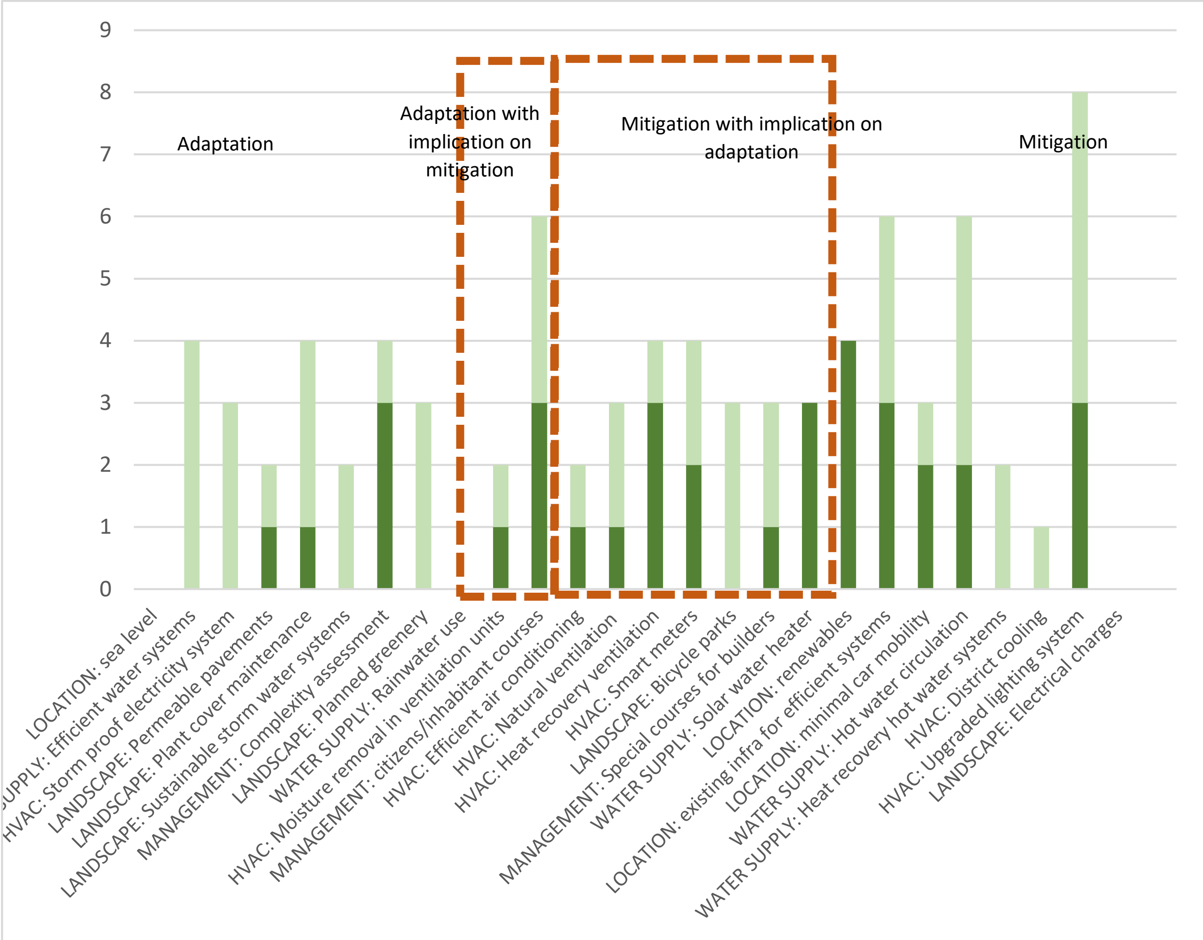


Figure 6. All except energy and envelope measures for retrofits. Light green – measure implemented to the minimum standard; Dark green – measure implemented above the minimum standard.

8. Main Barriers and Recommendations for Combining Climate Adaptation while Planning and Implementing Energy Efficiency Projects

The experts from each partner country (except Poland) highlighted the main barriers related to the implementation of adaptation measures on buildings and provided some recommendations on how to limit those barriers. The results of this can be seen in Table 7 below.

Table 7. Barriers and recommendations

BARRIERS TO WIDER IMPLEMENTATION OF CLIMATE CHANGE ADAPTATION IN BUILDING SECTOR (when retrofitting or building new buildings)	Legal barriers – the absence of legal rules/guidelines that require the stricter implementation of adaptation measures while building new buildings or retrofitting.	Lack of funding – enough for energy efficiency improvement related measures but not enough to implement additional adaptation measures such as moisture removal measures on external	Lack of knowledge, specific guidance, or awareness on the national, local and individual level (planners, builders, developers, architects)	General comments

		walls and windows or using rainwater in buildings		
Sweden[5]	The standard/building regulations already include very many rules that must be followed, especially if a building owner also is certified. So, building owners don't see most of it as adaptation measures, but as normal procedures.	No funding for buildings, neither energy efficiency nor adaptation.	There is always room for more knowledge, even though there are enough written guidelines that must be implemented.	In theory, there are not many barriers in Sweden that limit the wider implementation of adaptation measures, but in practice, the main issue is the interest of conflicts. For example, facade and building materials made of wood have fewer impacts on climate change (emissions wise) but can be less resilient to extreme weather events (moisture, rainfall, flooding) than concrete for instance.
Estonia[6]	Building codes/regulations should send stronger signals about climate mitigation and adaptation topics.	Funding could be improved but linked with stronger regulations in terms of applying mitigation and adaptation measures.	The main barrier as the implementation of climate mitigation and adaptation measures seem to be so far applied voluntarily and therefore heavily depending on the awareness.	
Russia[7]	General legal rules at the national level have been created. The task is to convert them into concrete plans at regional and industry levels, but regional authorities do not consider adaptation for climate change as the priority task.	At the moment there are no economic mechanisms for support of adaptation measures (only administrative influences).	Main barrier for Russia.	Russian building industry does not consider adaptation for climate change as the priority task.
Latvia[8]	- The renovation procedure involves many legal players that often do not have a clear common understanding of the process itself. - Rules and requirements are being changed often making the process time consuming and heavy - Legal framework is ambiguous, and so is the role of each institution involved in the process. -Renovation procedure comes with a bureaucratic burden - Lack of legitimate expectation that the rules will remain unchanged at the time	- Lack of allocated funding from the state budget to renovation projects. There is not enough funding even for energy efficiency measures - Lack of understanding of the individual financial responsibility from households/building owners, especially apartment owners. - "messy" ESCO market share development process. Currently, the Ministry of Economics is organizing the process by developing a template for energy service contracts as well as improvements	- Lack of individual understanding of the risks caused by climate change and the importance of mitigation and adaptation measures. Since climate change in Latvia is not evolving rapidly, there is not a visible threat to an individual's property and investment. -Those who are implementing energy efficacy projects in the public sector lack understanding of climate goals as well as construction project management	

[5] Source: Expert input from Marit Ragnarsson, County Administrative Board of Dalarna, Sweden, CAMS project partner PP2
[6] Source: Expert input provided during the local stakeholder meeting held on 20.05.2020
[7] Source: Expert input from Yury Nurulin, Peter the Great St.Petersburg Polytechnic University, CAMS project partner PP10
[8] Source: Contribution of several experts from the Latvian Ministry of Economics

	of project submission and implementation	in the regulatory framework to improve the ESCO market environment.	-There are no official guidelines for zero energy building construction developed by public administration -Lack of available data on energy savings and benefits from energy efficiency and adaptation measures	
Germany	Climate change mitigation as well as adaptation is a general topic in national legislation (BauBG Baugesetzbuch). This law has an impact on urban planning. e.g. soil saving measures are demanded (not that binding in reality) or it is forbidden to settle in flood risk areas. In the process of building permission, Germany must deal with federal bylaws (LBO Landesbauordnungen of federal states). Mitigation is a topic in terms of energy-saving measures. Adaptation is only tangentially a topic, in terms of prevention of overheating in summer times or prevention of harmful impacts (by extreme weather events such as storms, heavy rain could be such harmful impacts).	Mitigation is a general goal in national funding programs (KfW Bank), but not adaptation. There are some special national funding programs for policy level, creating recommendations, communication tools, etc. (ruled by the Ministry of Environment) There are some federal or local funding lines for green roofs or use of rainwater in buildings.	Mitigation is quite an old topic already; adaptation topic comes slowly in. There is more knowledge on how to implement mitigation measures than adaptation measures. Owners usually have not much awareness or see a correlation between very hot summers, climate change, and their buildings.	In theory, there are no national and local level general rules to support adaptation as well as and mitigation measures. In practice, there are too many other practical rules in the building process. Frequently the budgets of owners are needed to comply with these rules (e.g. fire protection measures, sound protection) so that little additional funds if any are left for adaptation measures
RECOMMENDATIONS	**Legal**	**Funding related**	**Knowledge, guidance, or awareness related**	
Sweden	Implementing more adaptation measures into certification systems.	Help to calculate climate change risks would increase motivation to implement adaptation measures, and to estimate profitability.	Seminars, training, and spread of best practices.	
Estonia	Implementing more measures into building regulations, especially related to a few very specific topics such as heat islands and excessive humidity.	Allocation of funding sources more in line with adaptation requirements.	Share more links to websites with best practices and guidelines in such a way that the awareness and knowledge would reach out to developers explicitly.	
Russia	Existing norms for buildings should be updated on the base of climate change	By analogy with energy-saving: subsidies for construction should be	For centralized heating and cooling systems: influence of climate change on living	

	monitoring for selected climate zones.	related to the fulfilment of mandatory requirements for adaptation to climate change.	conditions and economy topics (warm winters, temperature jumps in spring and autumn, cooling in hot arid summer, etc.).	
Latvia	- Ensure legitimate expectation that the rules will remain unchanged at the time of project submission and implementation. In case it is not possible to ensure this – simplify the process and decrease the fragmentation of legal parties - For the local governments (municipalities in Latvia) to strengthen cooperation with NGO and private companies who are working with energy efficiency and renewable energy.	- It is not sustainable to heavily rely on EU funding for renovation projects; allocation of financing from the State budget for renovation projects as well as financing for adaptation measures in new projects is needed. -Monitor progress and payback from previous investments to have clear visible data to inform the next budget - Instead of just funding renovation and construction projects, funding should also be allocated for more innovated developments in zero energy buildings, sustainable materials for buildings, etc.	- Lead-by-example approach from the local governments. When the government starts to increase its awareness, funding for the implementation of adaptation measures public sector buildings, only then it can be expected that the private sector follows. When you lead by example, you make it easy for others to follow you. By investing in public buildings, not only energy is saved but also taxpayers money. - Make data available for benchmarking and showing examples of the potential energy savings and costs savings for others to identify their own energy-savings opportunities.	
Germany	Strengthen aspects of adaptation in national legislation, i.e stricter regulation of soil saving measures and retention areas.	KfW credit line or other national funding for easy measures like green roofs, gravel on a parking area instead of asphalt, etc.	Trainings and communication on the local level, with house owner associations, building cooperatives, etc.	

9. Summary and Conclusions

In a total of 17 energy-efficient building projects and 8 EU funded projects with an impact in the BSR Region, were evaluated in terms of the implementation of climate change mitigation and adaptation measures and their synergies. A separate questionnaire was created for the assessment of BSR projects and building projects (Annex 1 and 2).

The building projects which were evaluated in more detail in two main groups: Retrofit and newly built building projects represent the current best practices of the project partner countries. In both groups, climate measures were divided into two main categories:
1. Energy and building envelope related climate measures; 2. All other climate measures except energy and building envelope related. The synergies of the given mitigation and adaptation measures were already mapped for the interviewees beforehand by the project experts, and the results of this mapping can be seen in Table 6. The categories of the measures in terms of the synergies were identified in 4 groups as follows:

1) 15 Adaptation measures (A)
2) 13 Mitigation measures (M)
3) 14 Mitigation measures with implications on adaptation (MA)
4) 8 Adaptation measures with implications on mitigation (AM)

For the assessment of the BSR projects, the questionnaire focused on mapping the adaptation/mitigation aspects in the main project outcomes of each project and possible synergies combined in those. Even though most synergies are positive between mitigation and adaptation, it is important to note that some of the measures may also have possible negative effects. Table 6 in this report summarized those measures and their impacts. Many of those measures that may also have some negative impacts are already implemented in today's buildings such as passive solar heating, that may cause a possible increase in indoor temperature and discomfort during heat waves; stronger building envelope (load-bearing walls and roof structure) and insulation of building envelope may lead to higher requirements on building materials which may imply higher carbon footprint of materials; bicycle parks included in the buildings complex may lead to possible increased flood risk, if the amount of paved area increases. In those cases, it is important to revalue the implementation of those measures together with the future climate impacts and consider further actions (such as combine some measures, i.e. build bicycle parks only with permeable pavements) were possible and necessary.

The research concluded that in cases where adaptation is included or combined with the mitigation projects, it is more a coincidence than an intentional decision. Due to the specific objectives of the EU projects, the adaptation remains secondary if it is not exactly the focus of the project. In terms of the buildings, while adaptation is mainly foreseen in new buildings, it is not necessarily a rule as some renovated buildings equal to newly built houses in terms of the implementation of both adaptation and mitigation measures. The extent of the implementation of the measures depends on the project itself, not so much on the country, the origin of the source of funding, or whether it is the renovation of an old building or the construction of a new one. Rather, the implementation of measures seems to be based on specific decisions and depends on the team of a specific project (in any country), the availability of funding, a possible technical solution, and to a large extent also awareness and other circumstances.

The research found that there is no specific communication or policy support on mitigation and adaptation synergies to the target groups nor designated deliverables and outputs, no direct aiming nor planned integrity. Investigating the linkages between mitigation and adaptation through a project framework provides new knowledge for climate policy implementation, climate change planning, and decision-making. The results increase the understanding of why mitigation and adaptation are delivered as two separate policy areas. The programming EU climate policy should challenge more and more specialized approach attempting to integrate the mitigation and adaptation policies as horizontal value merit.

In most countries, mitigation is a general goal in national funding programs, but adaptation is not. The standard/building regulations already include very many rules that must be followed and are linked with adaptation, such as issues related to flooding for instance. But are not directly considered as adaptation. The experts from most countries agreed that the existing norms for buildings should be updated (mandatory requirements also linked with issuing of grants), especially related to a few very specific/most important topics such as heat islands and excessive humidity.

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Annex 1. CAMS 4.1 questionnaire for building projects – separate file

Annex 2. CAMS 4.2 questionnaire for BSR projects – separate file

Annex 3. National Adaptation Requirements for Buildings

National frameworks for mitigation and adaptation in the built environment

The information on how mitigation and adaptation measures are integrated into legislation was collected from the project partner countries. Additionally, Norway, Finland, and Lithuania were included in this analysis, to bring more examples from the Baltic and Nordic countries.

From the review of national adaptation requirements for buildings, it can be concluded that in Sweden, Norway, Finland, and Germany, the adaptation requirements for buildings have been implemented not only in the climate plans but also within the national land use and building legislations and draw more specific guidelines for local municipalities as such. In countries such as Estonia, Latvia, Lithuania, and Poland, the climate adaptation measures for buildings, are somewhat described in the national adaptation or energy and climate plans, but so far remain more as national guidance rather than stricter more specific rules for local municipalities. In Russia, the adoption of a national climate adaptation plan has happened very recently. However, some adaptation requirements have already been included in the current legislation, and the adoption of regional climate plans looks promising in the near future.

Sweden – Sweden's Integrated National Energy and Climate Plan The adaptation chapter highlights that as the climate change adaptation involves many different fields, the work is largely governed by existing national and international regulations, frameworks, and objectives. These include the goals of the 2030 Agenda and the Planning and Building Act (2010:900). In June 2018, as a result of the National Climate Change Adaptation Strategy, the Government commissioned the National Board of Housing, Building, and Planning to coordinate work on climate change adaptation in the built environment In 2012, the Government commissioned the SMHI to set up the National Knowledge Centre for Climate Change Adaptation to assist municipalities, regions, authorities and other stakeholders with their climate adaptation work. In 2019, the centre had a budget of around SEK 20 million for this work. **The Planning and Building Act (2010:900) was amended in 2018 to stimulate further progress. As a result of these amendments, the municipalities can take greater account of climate adaptation aspects in the communal planning process.** Approximately 6 out of 10 municipalities respond that they comply with the new regulations in the Plan and Building Act. The most important documents are that every region has a climate adaptation plan and almost every municipality is working systematically with the issue, not least in spatial planning. Each municipality should map and analyse the risk of flooding and erosion due to climate change and have an action plan for adaptation. So, the focus is more on the placement and height of new buildings, not so much on building materials. Also on water issues and how to solve them, for example, green roofs, parks/vegetation areas, and gravel areas for parking. (Matschke Ekholm, Hanna; Nilsson, Åsa , 2019)
Finland – Finland's Integrated Energy and Climate Plan From the adaptation side, the plan refers to the National Climate Change Adaptation Plan. It says that the climate change adaptation policy is implemented cost-effectively by mainstreaming adaptation into normal planning and decision-making processes in different sectors. **Adaptation measures in the field of land use are directed at ensuring that national land use objectives, the Land Use and Building Act, and the guidance for land use planning provide a sufficient basis for preparing for climate change.**
Norway – White Paper on Climate change adaptation in Norway

The White Paper on Climate Change Adaptation in Norway refers to the **Planning and Building Act and the technical regulations under the Act which are the key instruments for the planning and building authorities in preventing the harmful effects of climate change.** Clear, up-to-date, and effective legislation provides guidelines for adaptation efforts in the construction industry. This is emphasized in a white paper from the Ministry of Local Government and Regional Development on building policy (Gode bygg for eit betre samfunn, Meld. St. 28 (2011–2012), in Norwegian only). The white paper highlights the importance of focusing on climate change and the need for adaptation to future climate change when building today. According to the white paper, the need to amend legislation in the light of new knowledge about the impacts of climate change will be considered. This applies particularly to amendments to the regulations on technical requirements for buildings. The white paper also states that the Government will promote competence-building in the municipalities and the development of a better factual basis on climate change adaptation and climate risks. The introduction of new tools and methods to make it easier for municipalities to take climate change into account will be considered. For example, tools that ensure good moisture management will be considered to ensure that this is taken seriously throughout building processes.

Germany – National Energy and Climate Plan

The German Strategy for Adaptation to Climate Change sets sectoral targets for buildings. The main message in it for buildings is that the requirements are different for different regions and localities so that the federal and länder authorities should adapt the standards to take account of climate change. **For different regions and locations, principles reflecting building specifications for the individual climatic conditions and existing local circumstances have been developed (Federal Building Code and relevant ordinances and guidelines).** Construction planning, technology, and execution have reached a high standard in Germany and are suitable for a wide variety of climatic demands or can be adapted to meet the latter.

Main points from the building chapter of the adaptation strategy:
* Construction guidelines are already regionalized and can be adapted if necessary
* Some aspects that are considered extreme events need to be taken into account as an adaptation measure (dealing with hang slides, construction in flood-prone areas)
* existing instruments need to be further developed, and if necessary, new ones need to be developed
* regulations and planning tools need not only be based on past statistics but should include future developments
* possibilities how to support public and private construction, adapted to climate change, should be sought
* changes regarding the needed technical equipment and the planning of thermal comfort (heating/cooling) need to be taken into account
* the degree to which construction materials withstand extreme weather events will play a bigger role in the construction
* monitoring systems and guidelines in the adaptation sector will play a big role.

Russia – National Action Plan for the first stage of adaptation to climate change for the period until 2022

In Russia, the first phase of adaptation to climate change until 2022 has been approved very recently at the beginning of 2020. According to the plan, the federal executive authorities must approve sectoral climate change adaptation plans until September 30, 2021. Regional authorities must organize work on adaptation to climate change and approve regional adaptation plans for climate change until May 10, 2022. For the monitoring of the national plan realization, the Ministry of Economic Development of Russia must present the progress report to the Government Russian Federation annually, until June 15. The Ministry of Economic Development of Russia must submit to the Government of the Russian Federation by December 30, 2022, a draft national plan of measures for the second stage of adaptation to climate change for the period until 2025.

Current regulations include some adaptation measures:

- A set of Rules «Building climatology» SP 131.13330.2012; available at:
  - http://docs.cntd.ru/document/1200095546
  - It contains recommendations for the selection of parameters for calculation and construction of buildings considering climate zones and temperature regimes on the base of previous climate observations.
- Energy Efficiency Recommendations of Residential and Public Buildings, stated by the Committee on Construction of Saint-Petersburg 02/04/2019; available at:
  - http://www.insolar.ru/2019/rekomendacii-pmd-23-16-2019
  - It contains recommendations developed on the base of previous observations that do not take into account any climate change process.

Estonia – Estonian national energy and climate plan 2030 (NECP 2030)

From the adaptation aspect, the plan refers to Climate Change Adaptation Development Plan until 2030. From the perspective of the buildings sector, the plan highlights ensuring the durability, energy efficiency of buildings, and convenient indoor climate for people in changing climate conditions. The main aim is to ensure that the energy efficiency of buildings has not decreased due to climate change. **The specific adaptation requirements are missing from the National Building Code.**

Latvia – Latvia's national energy and climate plan 2021–2030

From the adaptation side, the plan refers to Latvia's climate change adaptation plan for the period until 2030. This, in turn, sets main measures related to risks on buildings associated with higher rainfall and heatwaves. On a legal level, Latvia has the regulation on climatology in the construction and renovation sector (i.e. Cabinet of Ministers Regulation Nr.432 "Regulations on Latvian Building Code LBN 003-19 "Climatology". The abovementioned regulation has been regularly updated and amended taking into account the climatology aspect. The latest update for the next upcoming amendments is that the Ministry of Economics has procured and now is awaiting the results of the research on the changes of climatology in the last 30 years. As a result, the ministry is going to prepare new amendments for the abovementioned regulation.

Lithuania – National Energy and Climate Action Plan for the Republic of Lithuania for 2021–2030

The plan has a separate section for climate adaptation; however, there is not much specific said for buildings, but the focus is on spatial planning in general. The strategic goal highlighted in the adaptation perspective is to reduce vulnerabilities of natural ecosystems and the country's economic sector through measures to maintain and increase their resilience to climate change and ensuring favourable living and economic conditions for society. The implementation of the strategic goal will be assessed in terms of specific climate adaptation change targets in the most sensitive sectors of the country's economy (agriculture, forestry, and forestry) biodiversity protection, water management, energy, transport, industry, public health, etc.). **The Lithuanian Law on Construction does not include specific climate adaptation requirements for buildings.**

Poland – Poland's National Energy and Climate Plan for years 2021–2030

This plan includes a comprehensive chapter dedicated to climate adaptation. Regarding the buildings sector, the plan highlights a vision such as the development and implementation of new quality standards of equipment, devices, building, construction, and consumption materials allowing to prevent or reduce the negative effects of extreme climate phenomena. **However, the National Building Law has not been updated regarding the adaptation requirements for buildings.**

Annex 4. Adaptation Guidelines for Buildings in the BSR Countries and Norway

In line with the national adaptation guidelines and building legislations, we also analyzed different other, more innovative adaptation guidelines that were found from the listed countries. Again, these were mostly found from countries such as Sweden, Norway, Finland, and Germany. In the box below, some of these findings per country are listed. However, it seems that most of the guidelines are meant for newly built buildings, and there are no specific ones meant for retrofit projects. In Sweden, for instance, there are several guidance documents and handbooks specifically meant for local municipalities and for experts who work with the Planning and Building Act.

Sweden

Online game for climate adaptation planning
www.smhi.se/klimat/utbildning/klimatanpassningsspelet
The climate adaptation game has been developed by the National Knowledge Center for Climate Adaptation at SMHI in collaboration with Linköping University and with high school teachers. The game is suitable for use in teaching about sustainable development or to get started on climate adaptation work in a municipality.
In the game you plan a society, spending money on different measures and losing money when heat, storms, or floods come.

PBL Knowledge Bank – a handbook on the Planning and Building Act
www.boverket.se/sv/PBL-kunskapsbanken/Allmant-om-PBL/teman/ekosystemtjanster/platser/byggnader/starka-stodja-eller-skydda-ekosystemtjanster-pa-byggnader/
The PBL Knowledge Bank was developed by Boverket – the Swedish National Board of Housing, Building, and Planning, which is a central government authority assorted under the Ministry of Finance.
It is aimed at those who work with the Planning and Building Act and who want to gain a better understanding of the entire PBL system and its overall function for community planning and construction.
It highlights that climate adaptation on a site should benefit three main functions:

- Control and reduction of increased rainfall;
- Regulation of the local climate and
- Adaptation to a lower groundwater level.

But other climate adaptations may also be needed, such as against extreme weather with storms and floods or adjustments to a higher sea level.
Measures mentioned:

- Stormwater handling – biofilters,
- Controlling local climate through vegetation for example,
- Green walls – facades covered with climbing plants,
- Green roofs – plant beds.

Climate Adaptation in physical planning – guidance from the country administrative boards
www.lansstyrelsen.se/uppsala/tjanster/publikationer/klimatanpassning-i-fysisk-planering---vagledning-fran-lansstyrelserna.html

This guidance was published by Swedish county administrative boards for municipalities in Sweden. Climate change affects Sweden differently depending on the geographical position of the area.
This guidance groups climate change effects into three groups: higher temperatures, increased rainfall, and rising sea levels, risks of landslide and erosion. It also brings out different measures for local municipalities for streets and buildings, such as stormwater systems, reinforcement measures in soil and embankment, green roofs, and facades.

BREEAM-SE
www.sgbc.se/app/uploads/2018/06/BREEAM-SE-2017-1.1-English-version.pdf
This document was put together by The Swedish Green Building Council. The scheme document and the information detailed within is intended for use by trained, qualified, and licensed BREEAM-SE Assessors in accordance with the procedural and operational requirements of BREEAM-SE (as described in the SGBC BR 004 Operational Scheme Document) under the terms and conditions of a BREEAM-SE license.

This document is the technical manual for the BREEAM-SE New Construction 2017 Scheme, based on BREEAM International New Construction 2016. It describes an environmental performance standard against which new buildings in Sweden can be assessed and achieve a BREEAM-SE New Construction rating.
Measures mentioned in this document:

- Thermal comfort – to prevent increasing the risks of overheating.
- Reduction of energy use – to maximize energy efficiency contributing to low carbon emissions resulting from decreasing energy demands.
- Low carbon energy use – to minimize water demands in periods of drought.
- Designing for durability and resilience – to avoid increased risks of deterioration and higher maintenance demands.
- Surface water run-off – to minimize the risks of increased flood risk and surface water run-off affecting the site or others.

Boverkets Buildings Regulations BBR
www.boverket.se/globalassets/publikationer/dokument/2019/bbr-2011-6-tom-2018-4-english-2.pdf
This document was put together by Swedish Housing Agency, and it includes regulations and general advice. Boverket's building regulations should be followed when new buildings are being built and when existing buildings are altered. BBR also consists of details on how to fulfill the design requirements of buildings. For instance, surface water installations shall be able to drain away rainwater and meltwater to ensure the risk of flooding, accidents, or damage to buildings and the ground are limited. Changes to the environment and climate may involve other technical designs for the alteration than those in the existing building. These changes may be a higher groundwater table and an increased risk of flooding from watercourses.

Finland

Guide for flood preparedness in buildings
helda.helsinki.fi/handle/10138/135189
This document was published by the Finnish Environment Institute. The recommendations that are mentioned in this document are not only meant for local planning and construction authorities, but also for all entities and individuals planning to build in coastal areas or otherwise use the area.
It contains recommendations for determining the lowest building elevations in inland shore areas and along the Baltic Seashore.

Helsinki Metropolitan Area Climate Change Adaptation Strategy
www.hsy.fi/sites/Esitteet/EsitteetKatalogi/Julkaisusarja/11_2012_Helsinki_Metropolitan_Area_Climate_Change_Adaptation_Strategy.pdf
It has been prepared jointly by the region's cities, municipal federations, and other organizations. The regional strategy is a compilation of policy guidelines, and shorter-term policies (2012–2020). Through these, the Helsinki metropolitan area can adapt to the impacts of climate change and extreme weather events and reduce the region's vulnerability to them. It includes adaptation policies and steps to be taken for the buildings sector.

Norway

Guideline for TEK17
dibk.no/byggereglene/byggteknisk-forskrift-tek17/
This guide is managed by the Norwegian Building Quality Directorate, and this guide is for anyone planning to do construction work.
This guide explains the requirements of the regulations on technical requirements for construction work and provides pre-accepted benefits that will meet the requirements.

Germany

German Climate Preparedness Portal / Deutsches Klimavorsorgeportal – KliVO
www.klivoportal.de/DE/Home/home_node.html
The Federal Government's Interministerial Working Group on Adaptation to Climate Change (IMAA) acts as a steering committee for the KliVO portal. The German Climate protection portal bundles data and information on climate change as well as climate adaptation services that support in dealing with the consequences of climate change. The KliVO portal is aimed at people who want to deal with and prepare for the consequences of climate change at federal, state, county, and municipal levels in measure programs or adaptation strategies. Many services are suitable for businesses and citizens also.

KlimaMORO spatial development strategies for climate change
www.klivoportal.de/SharedDocs/Steckbriefe/DE/UBA_KlimaMORO/KlimaMORO_steckbrief.html
KlimaMORO is edited by the Federal Institute for Building, Urban Affairs and Spatial Development (BBSR). The knowledge portal KlimaMORO is for spatial planners, state and regional planners, regional administrations, city planners, and local governments.

The knowledge portal KlimaMORO bundles essential findings, results, and products from the research area "Spatial Development Strategies for Climate Change" within the research program "Model Projects of Spatial Planning" (MORO). To this end, regional climate protection and climate adaptation strategies were developed in two phases as part of spatial planning instruments and tested in eight model regions. In a third phase, these results were evaluated, saved, and further developed. There are numerous products from this process (e.g. brochures, information sheets) to which the portal offers access. Particularly noteworthy are the "KlimaMORO advisory module" and the "Aid to climate-friendly regional plan" (as PDF and online tool) from the final phase of the project. It provides guidelines, online tools, good examples, and expertise on regional climate adaptation in a clear manner, with understandable explanations and arranged according to spatial planning fields of action and process steps.