LIFE CLIMATE PATH 2050

Deliverable C1.1, Part 9:

Climate Mitigation 2050 Potentials and Mid-term Challenges

Financing the transition to a low-carbon society in Slovenia, Key challenges and guidance towards policy strategies

Končno poročilo

LIFE ClimatePath2050 (LIFE16 GIC/SI/000043)

Projekt LIFE ClimatePath2050 (LIFE16 GIC/SI/000043) je sofinanciran iz sredstev LIFE, finančnega inštrumenta Evropske unije za Okolje in podnebne spremembe na prednostnem področju Podnebno upravljanje in informacije in iz sredstev Ministrstva za okolje in prostor RS, Sklada za podnebne spremembe.
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Poročilo *Metodologija* je tretji zvezek poročila *Potenciali za zmanjšanje emisij do leta 2050 in srednjeročni izzivi,* pripravljenega v okviru projekta *LIFE Podnebna pot 2050, Slovenska podnebna pot do sredine stoletja* (LIFE ClimatePath2050 »*Slovenian Path Towards the Mid-Century Climate Target,*« *LIFE16 GIC/SI/000043*). Projekt izvaja konzorcij, ki ga vodi Institut *»Jožef Stefan« (IJS)*, s partnerji: *ELEK, načrtovanje, projektiranje in inženiring, d. o. o., Gradbeni Inštitut ZRMK (GI ZRMK), d. o. o., Inštitut za ekonomska raziskovanja (IER), Kmetijski institut Slovenije (KIS), PNZ svetovanje projektiranje, d. o. o., Gozdarski inštitut Slovenije (GIS)* in zunanjimi izvajalci, med drugimi dr. Jonas Sonnenschein, avtor tega poročila.

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Deliverable C1.1, Part 9: Climate Mitigation 2050 Potentials and Mid-term Challenges, Financing the transition to a low-carbon society in Slovenia, Key challenges and guidance towards policy strategies

Končno poročilo C1.1, **Zvezek 9: Potenciali za zmanjšanje emisij do leta 2050 in srednjeročni izzivi. Financiranje prehoda v nizkoogljično družbo v Sloveniji, Ključni izzivi in smernice za politične strategije**

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Vsebina

Projekt LIFE ClimatePath2050 (LIFE16 GIC/SI/000043) je sofinanciran iz sredstev LIFE, finančnega inštrumenta Evropske unije za Okolje in podnebne spremembe na prednostnem področju Podnebno upravljanje in informacije in iz sredstev Ministrstva za okolje in prostor RS, Sklada za podnebne spremembe.
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Summary

The *Deliverable C1.1, A composite report: Climate Mitigation 2050 Potentials and Mid-term Challenges* presents the main findings of the analysis GHG emissions reduction potential prepared in the frame of the project LIFE ClimatePath2050[1] in the period between 2017 and 2021. The results of the analyses of potentials were used in the models, developed or upgraded in the project for the assessment of several scenarios of measures as regards GHG emission reduction, air emission reduction, socio-economic impacts and impacts on sectorial development targets. The analyses were key expert basis for *Slovenian climate long-term strategy 2050 (LTS),* final version of the *Integrated national energy and climate plan of the Republic of Slovenia (NECP), National air pollution control programme* and *Long-term energy renovation strategy for 2050 (DSEPS 2050)* and other strategic documents.

The Deliverable C1.1, A composite report: Climate Mitigation 2050 Potentials and Mid-term Challenges consists of the following parts:

- **Part 0, Summary for decision-makers,** highlights the key results of the analysis of potentials;
- **Part 1, Role of new technologies and fuels and their perspectives by sector,** includes an overview of the GHG reduction potential of the following new technologies and fuels: electrical and thermal storage (short- and long-term), the impact of storage system on the deployment of the other technologies, fuel cells, waste heat and heat pumps, alternative fuels and electric mobility for transport of passengers and goods, smart grids, new technologies in agriculture and also potential for energy efficiency through material efficiency was presented;
- **Part 2, Deep renovation of buildings,** in this part, a comprehensive presentation of potentials for GHG reduction in building sector is given, including an overview of technologies and solutions on building envelope, heating and cooling systems in the buildings, household appliances and lighting (a summary[2]). Two specific analyses are included: analysis of GHG reduction potential at cultural heritage buildings and a summary of the analysis on financial capabilities of households to implement renewable energy (RES) and energy efficiency (EE) measures[3]. In this part, also includes a new typology of buildings, being a basis of the further analyses, and presents the final the results of the assessment of technical and economic potential for GHG emissions reduction in buildings.
- **Part 3, Transport,** includes overview of potentials for GHG reduction in the transport sector. Includes chapters on GHG reduction measures in transport, factors

[1] LIFE ClimatePath2050 (*Slovenian Path Towards the Mid-Century Climate Target*)

[2] In *Part 2*, summary on lighting in buildings is included, the entire analysis on prospect of lighting until 2050, is presented in *Deliverable C1.1, Part 7,* was carried out by external assistance of Fakulteta za elektrotehniko/Faculty of Electrical Engineering, University of Ljubljana.

[3] *Deliverable C1.1, Part 2a, Analysis of factors related to the financial capacity of households influencing energy efficiency investment decisions,* includes the entire analysis, carried out by external assistance of Center poslovne odličnosti Ekonomske fakultete Univerze v Ljubljani, CPOEF, Centre of Business Excellence of the School of Economics and Business, University of Ljubljana,.

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influencing transport load, analysis of new technologies and services and basis for estimation of the impacts on transport load, emission reduction, other benefits and impacts, e-mobility and alternative fuels in transport;

- **Part 4, Industry,** includes overview of potentials for GHG reduction in the industrial sector. The overview of technologies includes technologies used in energy intensive branches by branch, waste heat use and horizontal technologies including energy efficient electric motors, compressed air, lighting, renewable energy technologies and cogeneration. The report presents also results of the pool among industrial companies and is concluded by the results of the assessment of technical potential for GHG emissions reduction in energy intensive industrial branches and by horizontal technologies;
- **Part 5, Transformation,** includes results of the analysis of GHG emission reduction potentials in the transformation sector. The analysis comprise overview of technical and economic potentials for hydroelectric power plants, solar power plants (summary), nuclear power plants, technology and fuel switching, carbon capture and storage, cogeneration of heat and electricity, small hydropower plants, smart flex technology, onshore wind farms, advanced (smart) networks, geothermal power plants and concentrator solar power plants. The energy storage is entirety, including the potential for penetration of mature technologies, discussed in Part 1 on new technologies;
    - **Part 5a, The analysis of shallow geothermal energy potential in Slovenia until 2050,** consists of overviews of economic aspects of geothermal energy exploitation, the other factors and limitations, preparation of concept and model for potential calculation, results for the case study Maribor and results of the analysis of potential for densely populated areas Slovenia;
    - **Part 5b, The analysis of the Photovoltaic Rooftop Potential in Slovenia by 2050,** provides a comprehensive presentation of potentials for reducing GHG emissions in Slovenia by electricity from rooftop PV systems and stand-alone systems in degraded areas Analysis includes data on insolation, surfaces, climatic conditions, technology degradation over the years, technology development, possible surface utilization, barriers, electricity grid, demand, energy storage options, economic parameters for potential assessments, and the results of the assessment of technical and economic potential;
    - **Part 5c, Study of roof orientations of the existing building stock in Slovenia,** presents results of an upgrade of the analysis photovoltaic rooftop potential, including a more detailed analysis of roofs orientation. The analysis includes data on cadastre and airborne laser scanning, calculations and results of the calculated segments by classes of slopes and roof orientation;
- **Part 6, Other Sectors - LULUCF,** which presents the situation in the field of reducing GHG emissions and increasing sinks in the sector of land use, land use change and forestry (LULUCF), and gives overview of measures and analysis technical potential in forest, land and other land categories.
- **Part 7, Analysis lighting in Slovenia until 2050,** which presents perspectives in the field of lighting technology development and their use in households, industry and buildings of the service sector and outdoor lighting, including new technologies.

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- **Part 8, The Analysis of financial capacity factors influencing investment choices of end users,** includes analyses of characteristics of households that have made individual investments for energy efficiency, which have used the incentives of the Eco fund, characteristics of households and their equipment, and in terms of ability to finance the required volume of investments;
- **Part 9, Financing transition to low-carbon society in Slovenia - Key challenges and guidance towards policy strategies,** is addressing the following topics and challenges: current structure of public financing with climate relevance, investments in low-carbon options, institutional set up related to the governance of public climate finances, financial sector's set-up and distributional issues and acceptance;
- **Part 10, Methodology,** which provides selected chapters on methodologies for potential assessments: framework for assessing technical and economic potential for shallow geothermal energy, assessment of solar energy potential, analysis of factors related to household financial capacity to implement EEU and RES measures and assessment of the potential for exploitation of excess heat in industry. Selected methodologies are highlighted in this report, while the other methodologies are described in parts 1-7 of this composite report**;**
- **Supplement 1, Summary of results and materials of technical workshops,** includes summaries of the outcomes, agendas and presentations of workshops: *Exploitation of solid biomass for energy purposes and potentials until 2050, reports* and *The future of natural gas and development of carbon-free alternative fuels includes*. Material of the other workshops on the analysis of potentials, see the project website (and *Deliverable C5.3, Documentation published on the project web page: A Synthesis of Outcomes and Documentation of Workshops on Scenario Analysis*).

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1 Context: Financing the transition to a low-carbon society in Slovenia

The EU aims to reduce CO_2 emissions by 80-95% by 2050 [1], Slovenia's draft Climate Change Act has the target to achieve carbon neutrality by 2050 [2], and the latest IPCC synthesis of scenarios that are consistent with achieving the targets of the Paris Agreement indicates that the decarbonisation of industrialised countries has to happen even sooner than 2050 [3]. Irrespective of the precise date, it is clear that a rapid transition towards a low-carbon society (LCS) needs to happen and achieve carbon neutrality the very latest by 2050. This transition will require large investments by governments, the private sector and households, which in turn have to be financed.

In order to achieve the Paris Targets, annual global investment needs in the energy system have been estimated to be 2% of world GDP (or 2.38 trillion USD_{2010}) until 2035, which would imply an increase of total annual investment by merely 1.5%; and if the transport system and other infrastructure are included these figures will at least double [4]. The EU has estimated that the continent's annual investments in the energy system have to increase from currently 2% of GDP to ca. 2.8%, which will require additional investments in the range of 175 to 290 billion EUR_{2013} in order to achieve the 2050 climate targets [1]. Investment needs for a municipal level transition depend on city size and structural factors and can reach around 1 billion EUR for a city of around 500,000 inhabitants [5]. For Slovenia overall estimates do not exist, yet. The economic impact assessment for the National Climate and Energy Plan will provide such figures for the 2030 time perspective [6].

While there is no projection about investments needs (yet), there is more data about the status quo. Investments (gross fixed capital formation) in the Slovenian energy sector accounted on average for about 1.3% of GDP over the last decade, which meant investments of roughly 500 million EUR per year (see Figure 1). Of this about 150 million EUR are spend every year on the electricity grid, with the plan to spend 1.8 billion EUR on the grid in the ten year period between 2017 and 2026 [7]. Investments in the transport sector are somewhat higher at about 700 million EUR per year (1.8% of GDP); but they are more strongly associated with economic development. For the six year period 2020-2025 the draft Investment Plan for Transport and Transport Infrastructure foresees total investments of 5.6 billion EUR of which 3.1 billion from the State [8].

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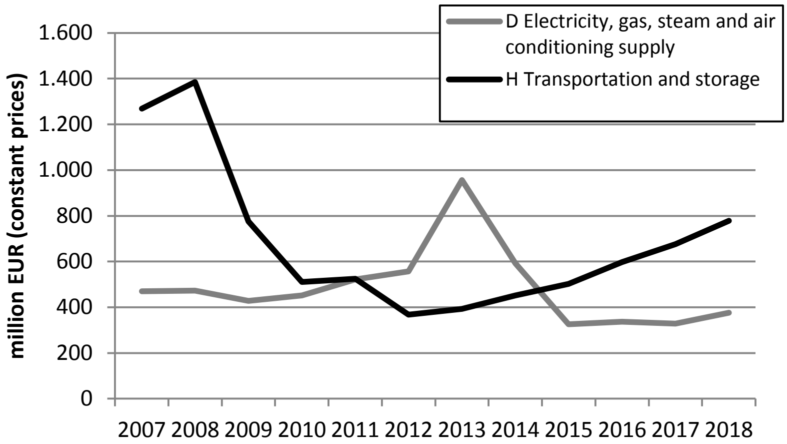

Figure 1: Gross fixed capital formation (investments) in selected NACE 2 sectors (source: SURS)

At the aggregate level additional investment needs do not appear to be large if compared to GDP or total investments, but available funds have to be channelled to the sectors and actors that need them to invest in low-carbon infrastructure and technologies or have to be at least consistent with decarbonisation scenarios [4]. Few additional investments are needed in the energy supply system, while the investment needs in end use sectors (industry and households) are more significant [9]. However, in order to achieve the needed progress, all investments in all sectors have to be programmed towards, not only the additional investments. Furthermore, overall investments in low carbon technologies and infrastructure have to come from different institutional sectors, including government, business and households (see Figure 2). Therefore, the main challenge for governments is not only to re-route own investments towards decarbonization, but also to create the framework conditions that trigger a shift of investments by the business sector and households towards low-carbon energy technologies and infrastructure. This will imply large structural changes at the national and local level which will, in turn, face large barriers and bring with it additional challenges.

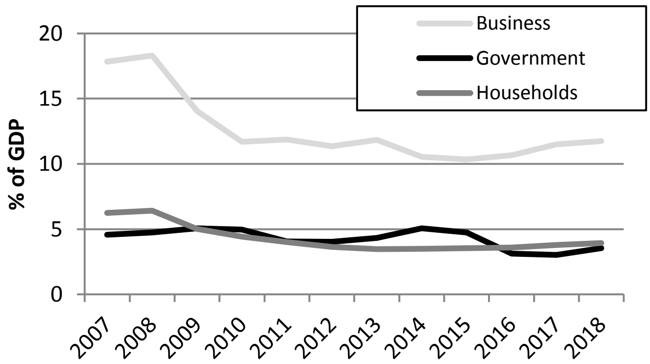

Figure 2: Total investments by institutional sectors as share of GDP (source: Eurostat)

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2 Key challenges in financing the transition and policy strategies to address them

While the most obvious challenge in financing the transition towards a LCS might be – simply put – a lack of funds, this is by far not the only challenge, possibly not even the most significant one. The following sections provide an overview of challenges in financing the transition to a LCS and presents some policy strategies addressing these challenges.

2.1 Current structure of public financing with climate relevance

A large challenge in financing the transition towards a LCS is the status quo, i.e. the current policies for financing sectors with high climate relevance, including energy, transport and industry. To start with there are still several environmentally harmful subsidies (EHS), the majority of which are related to the production and combustion of fossil fuels and, hence, can be considered to be a barrier in the transition to a LCS. For a long time there has been the commitment to phase-out environmental harmful subsidies (EHS), both at EU level [10] and in Slovenia. This has not happened, yet. On the contrary, fossil fuel related EHS have increased over the last decade [11]. It is important to note, though, that the majority of these subsidies do not provide direct financing in the form of grants or loans, but subsidise the use of fossil fuels indirectly via tax exemptions and refunds. EHS are not the only challenge as there are various additional public subsidies that are often not classified as EHS but that still promote high-carbon activities and technologies, including (but not limited to) capacity expansions of the road network, the construction of buildings that do not fulfil highest energy efficiency standards and some payments under the Common Agricultural Policy, e.g. for the intensive farming of livestock.

Policy strategies to address these challenges

- **Phase-out of EHS**

  Starting with the obvious, financing the transition to a LCS will not be possible if at the same time there are still direct or indirect subsidies to the combustion of fossil fuels. The phase-out of EHS should happen gradually but quickly, with a clear schedule, and where needed be accompanied by policies to reduce distributional issues [12].

- **Reallocation of financing**

  In addition to the quick phase-out of EHS, it is also important to reallocate financing related to carbon-intensive infrastructure and technologies (that is not classified as EHS) to low carbon energy technologies and their infrastructure [9]. This will require monitoring of budget allocations and financing instruments across all climate-relevant sectors. In this context, the new multiannual financial framework (MFF) for the EU

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budget 2021-2027, which is planned to increase spending on climate issues [13], will be a great opportunity to also programme national (co-)financing towards climate change mitigation

- **Earmarking revenues**

  One strategy to make sure that public funds are available to finance the transition towards a LCS is to earmark revenues from carbon-energy pricing for investments into low-carbon technologies and infrastructure. In Slovenia this is partly implemented by using revenues from selling allowances of the EU Emissions Trading Scheme for the Climate Fund.

  (See also policy strategy 'Fee and dividend' further below)

2.2 Low investments in low-carbon technologies and infrastructure by business and households

Most of the investments that are needed to achieve a LCS by 2050 will have to come from business and households and not from the State [4] (see also Figure 2 above). Therefore, the political framework conditions for low-carbon investments play a crucial role for financing the transition. For households, a key challenge is access to affordable financing for low-carbon investments that have high upfront costs and long payback times. But not only access to financing is a challenge, as even with access to financing the market conditions are often not favourable for investments into low-carbon technologies; and if they are favourable, various market and behavioural favours keep households from investing [14].

In the industry sector, in particular in energy intensive industries, climate policy has mainly been concerned with marginal emission reductions and their costs and benefits on the short run [15]. This led to investments in energy efficiency improvements but did not trigger sufficient investments in (developing) innovative technologies that are consistent with full decarbonisation by mid-century. Delaying such investments is problematic as investment cycles in industry can be very long [15]. Moreover, focussing on marginal efficiency improvements has the risk of investing in assets that become obsolete before the end of their life-span due to decarbonisation requirements (stranded assets).

Policy strategies to address these challenges

- **Creation of a favourable regulatory and market environment**

  An enabling environment for investments in low-carbon energy technologies and infrastructure includes policies, regulations and institutions that drive the business sector to invest (more) in general, and to focus their investment on low-carbon technologies and services in particular [16]. This will require a comprehensive policy mix, including both carbon-energy pricing and regulation. The modest price incentives of the current EU ETS and the Slovenian carbon tax are not sufficient to give investors the certainty they need to invest in the transition (and not keep on focussing on marginal efficiency improvements) [15], [17].

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- **Subsidies**

  If, despite carbon-energy taxes and regulation, there is no business case for investments into low-carbon technology, yet, public subsidies can be used to stimulate demand for these solutions. Such subsidies are implemented in Slovenia with the type of schemes that are currently managed by Eko Sklad, including grants and preferential loans. However, there have been several years when the Eko Sklad funds programmed for co-financing renewable energy and energy efficiency investments of individuals and businesses ran out long before the end of the year.

2.3 Institutional set-up for governing public financing

There are (at least) three challenges associated with the institutional set-up of public financing of the transition to a LCS: silo-thinking in the institutions that have to govern the transition, short-termism in budgeting cycles, and lack of administrative capacity. First, programming the investments of the public sector towards low-carbon technologies and infrastructure requires the participation and collaboration of various public institutions, including ministries, public financing institutions and agencies. This is a very challenging task, as in most countries climate change is one topic among many, typically located at ministries for the environment, which easily leads to thinking in silos. Budget procedures appear to be particularly affected by this type of thinking, reaching from the EU budget [18], to national budgets and finally to municipal budgets [19]. Second, short-termism in climate change policy (and financing) can be driven by short electoral cycles, budget planning cycles and the lack of representation of younger and future generations in decision-making [20]. This is particularly problematic for public financing of long-term infrastructure projects such as, for example, railway infrastructure. Finally, administrative capacity can become a bottleneck. There are various dimensions of this challenge that go beyond a lack of resources and staff, including aspects such as analytical capacity, regulatory capacity or (inter-sectoral) coordination capacity [21].

Policy strategies to address these challenges

- **Climate policy integration**

  One important strategy to overcome challenges in the institutional set-up for public climate financing is policy integration. Climate policy integration means the “incorporation of the aims of climate change mitigation and adaptation into all stages of policy-making in other policy sectors (non-environmental as well as environmental)” [22]. Many concepts and labels have been used in the context of such a policy integration of climate financing, including climate budget tagging [23], input, output and results tracking [18], and finally the climate mainstreaming of government budgets [18], [19]. What all these concepts have in common is that they include a system of monitoring policy progress at the sectoral level. In addition to monitoring climate financing, there are various instruments that can further drive policy integration, including communicative instruments (e.g. sectoral climate strategies, reviews, reporting obligations), organizational instruments (e.g. working

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groups, combinations of departments) and procedural instruments (e.g. green budgeting, impact assessments, obligatory consultation rights for environmental departments) [22].

- **Create an institution to govern the (financing of the) transition**

  In order to oversee the process of policy integration, and with the aim to achieve coherent policies towards financing the transition towards a LCS, a new long-term institution is needed. One example for such an institution is the 2019 German Climate Change Act [24], even though it remains to be seen how the Act will perform in practice. At the core of it is an annual review mechanism to see whether all relevant sectors (and associated ministries) are on track to meet the agreed (sectoral) climate targets. If not, additional measures (including financing measures) have to be taken to bring the respective sector back on track.

- **Increase administrative capacity**

  In order to use the State budget to drive climate change mitigation, new types of knowledge will have to be integrated into the budget preparation process as "climate change has not traditionally been a key expertise of finance ministries, nor of most of those involved in budget preparation in other ministries or agencies", and new capacities will also have to be built in the follow up and control of public spending by state controllers and the audit office [22]. The increase of administrative capacity is certainly not limited to employing more (specialised) staff, but will require exchange with research institutions, learning from international good practices, and capacity building seminars and trainings.

- **Long-term budgeting approaches**

  Long-term budgeting approaches are particularly relevant to finance infrastructure projects with long investment periods, including for example railway infrastructure. The institutional set-up to finance such infrastructure has to deliver long-term financing security that is not always provided by the annual budget process. In Switzerland, for example, revenues from road usage fees were programmed to be used for some large and very costly rail infrastructure projects (incl. the Gothard tunnel).

2.4 Financial sector set-up and stranded assets

The challenge is not only to finance decarbonisation, but at the same time to decarbonise finance. In the context of the financial system, challenges associated with financing the transition centre around the topic of climate change (mitigation) risks. A climate stress-test of the financial system identified "direct and indirect exposures to climate-policy-relevant sectors represent a large portion of investors' equity portfolios, especially for investment and pension funds. Additionally, the portion of banks' loan portfolios exposed to these sectors is comparable to banks'

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capital.” [25] This is risky in a world that needs (and has started transitioning towards) decarbonisation.

Average lifespans for energy-related capital stock (like power plants, buildings or transport infrastructure) can span from a couple of decades to more than 100 years [26]. They typically have high upfront investment costs and it often takes decades until the socio-economic benefits exceed the financial investment costs. If the respective energy-related capital stock is associated with high CO_2 emissions, it is not compatible with decarbonisation pathways until 2050 and might end up as stranded asset [27]. For the State (but also for public and private companies) investing in anything but low-carbon energy-related capital is associated with high risks. Also in industry there is a high risk associated with the depreciation of assets whose value is connected to the value and availability of fossil energy resources. Depreciation of such assets may trigger changes in industrial structure, require the adaptation of worker skills, and may even affect the stability of financial, insurance and social security systems, which are often heavily invested in carbon-based assets [4].

Policy strategies to address these challenges

- **Carbon risk screening and fostering transparency**

  In order to manage climate related financing and investment risks, the first step is to measure them. For that purpose risks associated with climate change (and stringent decarbonisation requirements) have to be systematically monitored and assessed. The latest tool that aims to become the standard for these kinds of assessments is the EU taxonomy for sustainable finance which has a clear focus on climate related risks and is accompanied by a guidance document [28]. By creating a standard tool to screen and categorise risk, the taxonomy will contribute to more transparency on the financial market, as more clarity is needed about what are climate-friendly and what are harmful investments.

- **Directing lending and investment activities of public (development) banks**

  The public sector has the strongest control over the lending and investment activities of public (development) banks such as the EIB at the European level and the SID Banka in Slovenia. On the one hand, this means that financing of fossil fuel (related) projects can be ruled out. On the other hand, this also means that the financing of technologies and infrastructure that are needed for the transition can be supported.

- **Divestment**

  In order to reduce the climate-related financial risks from publically held assets (e.g. pension funds), these assets should be screened and assessed according to their compatibility with pathways towards LCS. For assets with high risks (and a large climate impact), a gradual but quick divestment plan needs to be drafted and implemented [29].

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- **Subsidies**

  Another activity of the financial sector is investments in equity and venture capital (VC). With respect to the flow of equity and VC into companies that develop low-carbon solutions, the State can support this form of financing by providing subsidies in the form of grants, preferential loans and loan guarantees. Moreover, there are some examples of public institutions also taking a share in supported companies [30]. In many cases public financing can help to crowd in private VC or equity investments.

2.5 Distributional issues and acceptance

Physically every tonne of CO_2 emissions reduction is the same, but the economic and social aspects of emissions abatement may differ significantly. To start with, subsidies that are meant to help financing expensive low-carbon technologies can be of regressive nature. Examples include subsidies for electric vehicles in Norway, the German feed-in tariff system for electricity from renewable energy sources, and surcharges included in the electricity price in general. The negative welfare effects of higher energy costs are positively correlated to the share of energy related expenditures in a household's budget, which is high for low- and middle-income households; and these higher costs are typically not offset by non-market co-benefits (e.g. reduced air pollution) of climate policies for the poor [4]. It is important to note that climate policies, such as carbon pricing, may be either regressive (e.g. in the case of electricity consumption) or progressive (e.g. in the case of air travel) depending on the sector [31]. In extreme cases increased energy costs can even lead to energy poverty [32]. In Slovenia energy poverty is also a challenge, particularly in the poorest two income quintiles [33] and in the regions Pomurje and Zasavje [34]. Moreover, Slovenia is among the countries where energy poverty is most strongly associated with health problems and depression [35].

Further distributional issues arise between households and industry, as they often have differentiated burdens for financing low-carbon technologies [31]. Regularly industry pays lower energy-carbon taxes and lower electricity price surcharges (for renewable energy and energy efficiency) than households, thereby contributing less to financing the transition.

Distributional and fairness issues also arise when widening the scope of climate financing to an international perspective [36]. Historical emissions are higher in EU countries than in developing countries and EU countries have a higher capacity to finance the transition to a LCS, so that a fair burden sharing between countries requires that climate finance assistance has to be provided to developing countries.

Similarly, there are distributional implications of widening the temporal scope to include future generations [36]. Not acting on climate change now (and financing the transition) means stronger impacts from climate change in the future and higher mitigation costs for future generations.

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Policy strategies to address these challenges

- **Compensation**

  A straightforward way to deal with the issue of regressive climate policies is to compensate for the extra costs from carbon-energy taxation by recycling (some of) the tax revenues back to the people. There are various way this can be done, including lump sums, reductions in social security contributions, targeted social transfers or by reducing other regressive taxes such as VAT [31].

- **Fee and dividend**

  One specific way to recycle revenues back to the people is the idea of a carbon fee and dividend [37], which is implemented in Switzerland, where two thirds of the revenues from the carbon fee are returned to all Swiss on an equal per capita basis via the health insurance bills, while one third goes into the energy renovation of buildings. The fee and dividend model is particularly attractive for high carbon price levels as it has higher acceptance due to its regressive nature [38]

- **Design less regressive policies**

  There are many different ways to design less regressive policies [31]. To start with the highest carbon-energy taxes could be focussed on sub-sectors where such pricing is progressive, as for example aviation. Moreover, policies could be designed in a less regressive way, for example by financing renewable energy or energy efficiency schemes through taxes instead of transfer systems that are based on surcharges on electricity prices.

- **Deep energy efficiency**

  It has been convincingly argued that combining the two policy goals of carbon neutrality by mid-century and energy poverty eradication makes a good case for deep efficiency improvements [32]. This would require targeted energy efficiency support measures for income poor households in order to reduce their energy bills and thereby reduce energy poverty more permanently than with social transfer payments.

3 The need for further research and expertise in Slovenia

In order to fully assess current financing challenges in the context of the transition to a LCS and to develop policy strategies in response to these challenges, further research is needed among others in the following areas:

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- Modelling and rough estimation of (additional) investment needs for the transition towards a LCS by 2050, differentiated by sectors (energy, transport, industry, households) and actors (business, government, households).
- Comprehensive assessment of all (significant) public investments and expenditures with respect to their role in the transition towards a LCS (e.g. barrier, driver, not relevant)
- A more detailed policy evaluation of key strategies, measures and instruments to finance the transition to a LCS. Such an evaluation should include assessment criteria such as environmental effectiveness, side effects, cost-effectiveness and distributional effects.
- Research of the specific needs for institutional reforms and additional administrative capacity.

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