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Carbon Pricing for a Socially Just Energy Transition

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KOPERNIKUS PROJEKTE
ENavi
Die Zukunft unserer Energie

The Kopernikus Project Energy Transition Navigation System, ENavi for short, approaches the energy transition as a process of broad societal change and links scientific analyses to political and social requirements. As one of the four Kopernikus Projects for the Energy Transition, ENavi is funded by the Federal Ministry of Education and Research (BMBF).

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Laying the foundation for a sustainable energy transition

Almost all of the proposals for a climate-neutral energy supply currently being discussed in Germany foresee a carbon pricing mechanism in the form of taxes, levies, or emissions trading. The ENavi Report on the Transformation of the Electricity System (Fahl et al. 2019) evaluates the various proposals from a scientific point of view and shows what form of pricing is preferable. Regardless of what carbon pricing scheme is ultimately put in place, it will result in income effects.

On average, high-income households generate more carbon emissions than low-income households (see Kleinhückelkotten, Neitzke & Moser 2016; Moser, Lannen, Kleinhückelkotten, Neitzke & Bilharz 2016). In the area of mobility it has been shown that, on average, high-income householders fly more frequently, own larger and more powerful cars, and cover further distances with them (Oehlmann et al. 2019). But it's middle- and low-income groups that would bear the brunt of the higher costs associated with carbon pricing. While high-income groups would pay more in absolute terms under a carbon pricing scheme, the relative financial burden (in terms of household income) on middle- and low-income groups would be greater. That's why there is a need to distribute burdens fairly.

The ENavi Report (Fahl et al. 2019) provides quantitative data on the possible distribution effects of both carbon pricing and the phaseout scenarios for coal-based power generation outlined by the Coal Commission. It shows that although income effects will be noticed by most German households, due to their unfair distribution it is mainly the lower middle classes that will feel the pinch. In particular, consumers who live in poorly insulated rented accommodation, cannot afford energy-saving household appliances, and commute by car will be adversely affected. Most political actors in Germany agree that rather than going into the general federal budget, revenues from carbon pricing should be refunded to citizens. A per-capita reimbursement is generally the preferred option because the benefits would be proportionally greater for lower-income groups, even though everyone would receive the same amount – regardless of their income.

This Policy Brief makes an alternative proposal: **Instead of a flat-rate per-capita reimbursement, the revenues should be used to fulfil the following two aims:**

- **Support the achievement of the energy transition by facilitating further reductions in greenhouse gas emissions;**
- **Ensure distributive justice by providing financial relief to those households that carbon pricing puts at an unfair disadvantage.**

With reference to previous empirical findings by IASS and ENavi researchers, the following chapter shows that while people in Germany generally support the energy transition (Energiewende), they believe that the implementation process is socially unjust and badly managed. Furthermore, qualitative investigations conducted in the context of civic forums show that, in the opinion of forum participants, a flat-rate reimbursement of revenues to all citizens would be neither just nor effective. Based on these findings, the following chapters make concrete proposals for measures that could be financed using revenues from carbon pricing in the electricity generation, heating and mobility sectors. All of these measures have been designed to fulfil the two objectives prioritised by surveyed citizens:

- targeted reductions in greenhouse gas emissions and
- financial relief for households that would otherwise be overburdened by high energy prices.
- The policy options described below contribute in one way or another to fulfilling both objectives. They are summarised and appraised in the last chapter.

What do German citizens want?

Ninety per cent of the German population supports the energy transition. The high level of support crosses demographics like income, age, and education level and is also consistent in urban and rural areas (2018 survey by the IASS and ENavi; Setton et al. 2017; Setton 2019). Approval for the energy transition also extends across the political spectrum: the majority of the supporters of all the parties represented in the German Bundestag are in favour of it. The overwhelming majority of the population (80%) feels personally invested in the energy transition and views it as a broad societal task to which everybody – including themselves – should contribute. These two important findings were confirmed in a representative nationwide survey carried out in 2017 and 2018 (see figure 1).

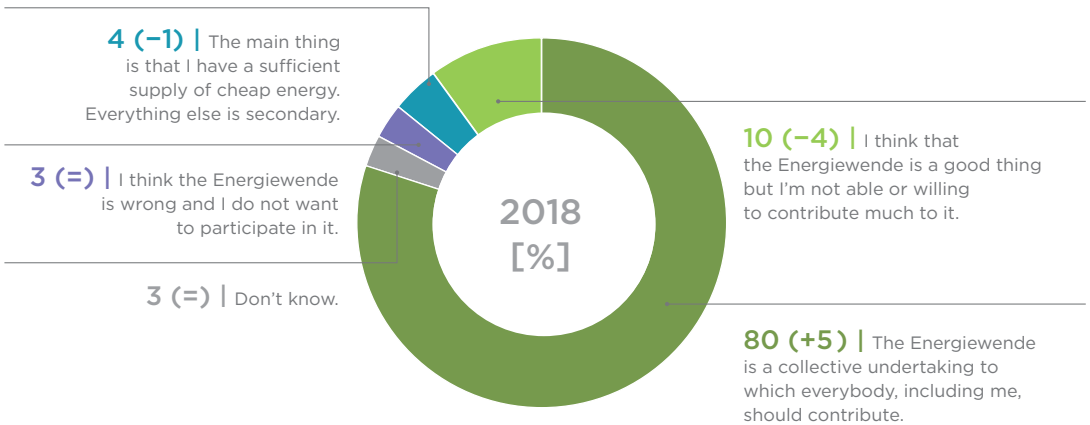

Figure 1:
When you think about your personal contribution to the energy transition, which of the following statements is most applicable to your case?

Source:
IASS/dynamis 2017/2018; n = 6,447 (2018), 7,313 (2017)

The population's assessment of the implementation process is considerably more negative. Criticism of this aspect of the energy transition grew even stronger in the period from 2017 to 2018. In 2018, almost half of respondents were generally critical of the direction the energy transition was taking, an increase of 14% on 2017, when a slim majority viewed the process in a positive light. Not even one out of three people (31%) is satisfied with the way the energy transition is being implemented. A critical attitude also prevails with regard to costs, political management, citizen participation, and fairness.

People are particularly sceptical when it comes to costs. Three quarters of the population (75%) believe that the energy transition costs too much, and only 10% considers it affordable. Public confidence that the energy transition is politically well managed and proceeding according to a convincing plan is also low, with a growing number of respondents (61%) describing the process as "chaotic". Criticism is also mounting with regard to the issue of justice. More than half the population (51%) feels that the energy transition is unjust, and only one in five people (21%) consider it just. This sense of injustice is more prevalent among

low-income households (55%) than other income groups. 57% of East Germans see the energy transition as unjust, compared to 49% of West Germans. Two thirds of the population (67%; 35% "somewhat" and 32% "absolutely") agree with the statement that the costs of the energy transition are being paid for by citizens while businesses and the wealthiest in society are reaping the rewards. Only a small share of respondents (13%) disagrees with this statement.

This brings us to the question of public acceptance for carbon pricing. Of a total of 545 respondents, slightly more than half find minimal price increases for the consumption of fossil fuels acceptable. This attitude is more prevalent among high-income households (68%) than low-income households (47%). For one in five people (22%), even small price increases are not justified. The proportion of car-owners who share this opinion is even higher (38%). They represent a politically significant minority that could be mobilised to protest like the Yellow Vests in France.

Although they agree in principle with moderate fuel price increases for the sake of the climate, as individuals, most Germans are unwilling to pay more for driving, flying, or heating (see figure 2). Only slightly more than a quarter of the population (28%) has no reservations about doing so. Minor differences are apparent between East and West: while almost one in three (30%) West Germans is prepared to pay more, the same is true of only one in five (20%) East Germans. The various income groups also differ in this regard. Among high-income households, the proportion of respondents who are unreservedly willing to pay more is more than double the proportion of like-minded respondents from other income groups (26%). A small proportion of respondents (13%) cannot accept price increases for fossil fuels because they lack the means to pay for them.

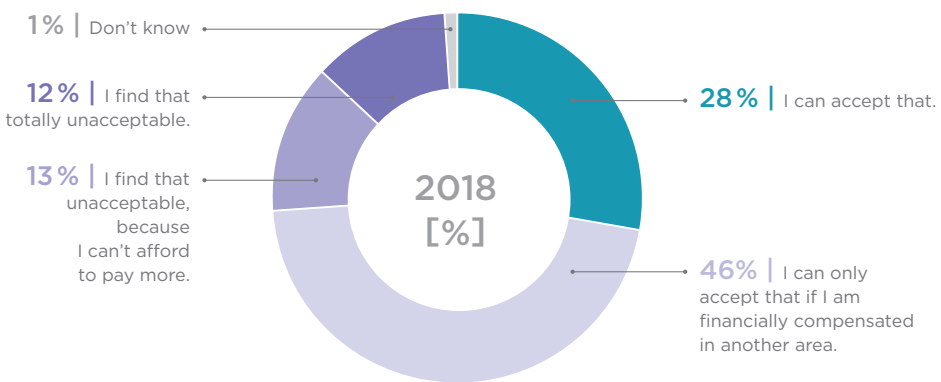

Figure 2:
Majority seeks compensation for rising fossil fuel prices: What would you think if, for climate protection reasons, you had to pay more for driving a car with a combustion engine, flying, or heating with oil or gas.

Source:
IASS/dynamis 2017/2018; n = 6,476 (2018)

The introduction of carbon pricing will probably only secure broad public acceptance if it is accompanied by a convincing compensation mechanism. While it's likely that the Fridays for Future movement has raised the level of public support for a political shift towards more rigorous climate protection measures, they will not be accepted at all costs. A workable solution has to be socially equitable and advance the energy transition at the same time. Thus rather than a per-capita reimbursement, what's actually needed is a targeted redistribution of costs to ensure fair burden sharing and effective climate protection. It's vital that the compensation provided to people who feel particularly burdened by rising costs and limited in their capacity to change their behaviour/reduce emissions is palpable and clear for all to see. If that is the case, then rising costs are more likely to be accepted by the broad majority of Germans.

Representative surveys are of limited value in the search for answers to very complex issues where many different options have to be weighed up. That's why the IASS and ENavi research team drew on so-called civic forums to explore the question of how possible revenues from carbon pricing should be used. A civic forum is a small group of randomly selected citizens that discusses a complex issue over an extended period of time with access to the best available expertise before making a final recommendation in a so-called Citizens' Report. From September to October 2018, the research team organised three one-day civic forums in Wuppertal (North Rhein-Westphalia), Riedlingen (Baden Wuerttemberg) and Potsdam (Brandenburg). The resulting Citizens' Report thus takes account of the experiences of citizens from two cities and one rural region in a total of three federal states (*Länder*). Confirming the findings of the representative nationwide survey, participants in all three citizen dialogues judged the current distribution of electricity costs to be unjust. Progressive electricity tariffs, where households and businesses that use large amounts of electricity pay more per unit than those who use less, were viewed as a particularly fair option. All three forums voted in favour of using additional revenues from carbon pricing to finance measures that would advance the energy transition while also relieving the financial pressure on low-income households. A flat-rate reimbursement to all citizens was rejected as a "one-size-fits all approach".

These are the findings of studies carried out in 2017 and 2018, with new data due to be gathered in 2019. But the the fact that the data available even prior to the discussion on how to use carbon pricing revenues showed such clear preferences (as a measure of people's intuitive reactions) makes the per-capita reimbursement option all the more problematic. It leaves us in no doubt that climate-related use of these revenues with an inbuilt compensation mechanism for lower-income groups would meet with far greater public approval than the proposed flat-rate reimbursement. While the former option would also contribute to advancing the energy transition, the flat-rate reimbursement would have no steering effect in this regard and would run completely contrary to the preferences of most citizens.

The following recommendations are oriented on two objectives: advancing the energy transition and distributing costs fairly among different income groups.

Maintain electricity price stability

Measures that cause retail electricity prices to rise will have a regressive effect (i.e., they will disproportionately affect low-income households) – this is true of carbon pricing as well as the Renewable Energy Sources Act (EEG) and grid fees (Frondel and Sommer 2014). The targeted allocation of revenues from carbon pricing either to prevent further price increases or lower prices could cushion social hardships and advance the energy transition.

Introduce a means-tested incentive scheme to promote the purchase of energy-efficient appliances and heating systems

Targeted measures to reduce energy or electricity consumption deliver the greatest proportionate relief to lower-income households, which are often unable to make the necessary investments on their own. The provision of means-tested grants for the purchase of particularly energy-efficient appliances and heating technologies would both cushion social hardships due to carbon pricing and provide climate benefits by reducing electricity demand.

Increase funding to programmes for energy-efficient refurbishments and establish a sliding scale of grants based on social criteria

The exhaustion of relevant programmes points to untapped opportunities to improve energy efficiency. Establishing a sliding scale of grants based on social criteria would remove a major obstacle to refurbishment by reducing investment costs. In order to further increase the number of energy refurbishments, the volume of funding provided to government refurbishment programmes should be increased. A sliding scale of investment aid could be introduced based on means-testing (for homeowners) or average rents per square metre (for rental properties), so that homeowners with low or average incomes and owners of rental properties with relatively low rents would receive greater support.

Introduce high energy-efficiency standards in social housing

High energy-efficiency standards can reduce relative housing costs for low-income households over the longer term. Higher energy-efficiency standards usually translate into higher investment costs. At minimum, these additional costs should be borne by the federal government. This measure would also have the positive effect of relieving pressure on the housing market as a whole.

Highlight alternatives to private passenger vehicles

Investment in high-quality public transport, cycling and pedestrian infrastructure is a must if we wish to alter mobility behaviour across society. A substantial part of the revenues from carbon pricing must be earmarked for this purpose and distributed by the federal government among the *Länder* and municipalities, where the money should be used to finance the expansion of public transportation capacities and networks as well as the development of sustainable cycling and pedestrian infrastructure, modelled on Amsterdam or Copenhagen.

Foster acceptance through targeted relief measures and communications

Financial relief should be provided to low-income commuter households. This could be delivered though a means-tested commuter allowance of, for example, 40 instead of 30 cents per kilometre for low-income households. At the same time, people who commute by public transport should receive a higher allowance than those who use their cars. In addition, easily understood and targeted communications outlining the *climate benefits* of carbon pricing are needed to foster broad acceptance among the population.

Modifying the electricity sector

INFRASTRUCTURE

Expand electricity grids

The electricity grid in Germany is a regulated monopoly: the cost of expanding grid infrastructure is clawed back from consumers through the grid fee. Further infrastructure is required in order to facilitate the expansion of renewable energy generation and smooth out intermittency in the wider European grid. This will entail significant investments. The two 500- to 700-kilometre-long SuedLink transmission corridors are expected to cost around 10 billion euros alone (TenneT 2019). In total, some 7,700 kilometres of new transmission lines are planned under the Federal Requirement Plan and the Power Grid Expansion Act (EnLAG), of which 1,100 kilometres have been built to date (Bundesnetzagentur 2019)[1]. The costs for consumers are significant: in 2018, household grid fees were between 5 and 9 cents per kilowatt hour, depending on the respective region. These costs have risen by around 1.5 cents per kilowatt hour since 2010, a rise driven mainly by the cost of grid expansion and the integration of renewable energies (Bundesnetzagentur 2019).

Carbon pricing could be used to fund direct investment grants with the aim of reducing the costs incurred by grid operators and, indirectly, their customers. Revenues from carbon pricing could also be used to subsidise grid operators' investments, for example through subsidised loans.

Support a market entry programme for energy storage technologies

The growing share of intermittent renewable energy sources will require more and new grids as well as the widespread adoption of energy storage facilities. The scale of the facilities required is difficult to estimate. Battery costs have fallen by 50 to 90% in recent years (Schmidt et al. 2017) and continue to fall. How much an expansion of storage capacities would cost depends on storage requirements – this in turn is determined by the electricity mix and grid expansion efforts in Germany and neighbouring countries. Scientific studies generally calculate demand for storage capacities at the European rather than the national level. They have identified projected capacities of several hundred gigawatts and up to 1,000 terawatts as economically optimal (e.g. Bussar et al. 2014, Gils et al. 2017). Irrespective of whether short-term storage facilities (e.g. batteries) or long-term storage facilities (e.g. hydrogen) are the main focus of expansion, investments totalling several hundred billion euros will be required, which will not be covered by revenues from carbon pricing alone.

Revenue generated through carbon pricing could be invested in research projects and a market entry programme with the aim of improving the quality of technologies, reducing their production costs and enhancing market-readiness – a kind of Renewable Energy Sources Act (EEG) for energy storage. Efforts are currently being made to achieve these goals

[1] To put this in context, the existing German extra-high voltage grid (>220 kV) spans roughly 36,000 kilometres.

through other Federal Government policies and through the European Battery Alliance (EU) with a focus on batteries for e-vehicles and stationary use as well as stationary fuel cells. However, Asian competitors already hold a large technological lead, and it will be difficult to catch up with them (Lee & Malerba 2017). Such an outcome cannot be ruled out, however, as the success of the Chinese photovoltaic industry shows (Quitzow 2015).

SUBSTITUTION MEASURES

(Co-)finance the expansion of renewables

Roughly 30 billion euros are allocated to renewable energy producers through the EEG surcharge (EEG-Umlage). This surcharge on electricity consumers is about 6.4 cents per kilowatt hour in 2019. Over the past decade, the surcharge has risen by around 5 cents per kilowatt hour; this represents a significant share of the overall increase in electricity prices (BMWi 2018, Bundesnetzagentur 2019). Revenues from carbon pricing could be used to abolish the surcharge, either entirely or partially, and/or to reduce the electricity tax. Another option would be to finance the further expansion of renewable energy generation (Edenhofer et al. 2019, Untersteller 2019). This would effectively reduce household expenditure on electricity in Germany.

Substantial investments will be required if Germany is to realise its current ambition of sourcing 65 per cent of its electricity consumption from renewables by 2030 (up from 38 percent in 2018). With the cost of new photovoltaic and wind power plants falling and the imminent closure of older plants with higher operating costs, achieving this target will only require a moderate increase in the surcharge. According to calculations by Agora Energiewende (2018), the surcharge is expected to increase by around 0.4 cents per kilowatt hour by 2030. This could be cushioned by the targeted allocation of revenues from carbon pricing. As the available renewable resources are primarily suited to fluctuating electricity generation from wind and PV plants, volatility will remain the central technical challenge for the German energy transition. Controllable generation technologies, such as biomass or concentrated solar power (CSP), have great potential in Europe, but not in Germany. Revenues from carbon pricing in Germany could be used to finance an expansion of controllable generation, especially CSP, in Europe, for example in Spain or Italy. This would enhance the future stability of the electricity system without triggering surcharge increases that would burden German consumers.

EFFICIENCY

Introduce a means-tested incentive scheme to promote the purchase of energy-efficient appliances

After space and water heating, household appliances account for the bulk of electricity consumed in private households (UBA 2019a). Energy-efficient appliances deliver the same services while consuming far less electricity. The most energy-efficient appliances (rated A+++) consume as much as 50% less electricity than those with the worst energy efficiency rating (A+). However, low-income households cannot always afford these appliances. Carbon pricing revenues could be used to finance a means-tested incentive scheme to promote the purchase of energy-efficient appliances.

Efficient heating

In Germany, about one third of final energy is used for space and water heating in buildings (BMWi 2018). Space heating requirements alone accounted for around 60% of the approximately 210 million tons of carbon emissions generated by the residential sector in 2015 (this is approximately one third of energy-related greenhouse gas emissions in Germany) (UBA 2018). Due to their long lifespan, currently existing structures will account for the lion's share of the building inventory in 2050. This makes the refurbishment of existing buildings a key prerequisite for the reduction of energy consumption and greenhouse gas emissions in Germany. Each building that is only refurbished to a minimum standard of energy efficiency is a missed opportunity to protect the climate with long-term repercussions.

BEHAVIOUR

Promote refurbishment roadmaps through an improved funding scheme and proactive communications

The complexity of effective and efficient building refurbishment is a significant barrier to investment for many homeowners (Stieß et al. 2010). Refurbishment roadmaps can help to overcome this by making it easier for owners to plan their finances, as they provide clear information on the energy status of the building and on the preferred sequence and timing of modernisation steps. Advice provided in the course of their development can alleviate concerns and reservations about energetic refurbishments (see ibid.) and bring projects into the realm of the possible.

A scheme introduced in June 2017 allows homeowners to recover 60% of the costs of developing tailored roadmaps, with upper limits of 800 and 1,100 euros respectively for single-family, two-family and apartment buildings (dena/ifeu 2018). The demand for these grants has been restrained, with uptake limited to around 7,000 cases per year so far (BAFA 2019). To put this in context, according to official figures some 10 million residential buildings are in need of refurbishment (BMWi 2014). Raising the level of funding available to private households to 80%, for example, could encourage greater uptake.

The scheme could also have a greater impact if public and private energy consultants were to adopt a more proactive approach to outreach (for example, by contacting homeowners with a personal letter or similar). Many owners are overly positive in their assessment of their building's energy status, fail to see the need for refurbishment measures, or simply do not wish to deal with such difficult issues (Stieß et al. 2010). Personalised outreach activities can encourage engagement, address information deficits, and help homeowners to identify windows of opportunity.

EFFICIENCY

Increase funding to programmes for energy-efficient refurbishments and establish a sliding scale of grants based on social criteria

The construction and renovation programmes administered by the KfW (Kreditanstalt für Wiederaufbau) are being fully utilised (BMF 2019). Despite this, the current renovation rate is well below the requirements and targets established in federal government policy (Löschel et al. 2018). Funding for these programmes should be increased substantially to address this deficit. Extensive renovations to enhance energy efficiency entail considerable investment and lengthy amortisation periods of 15 to 30 years or more as a result of low fuel prices among other things (FfE

2009, Galvin/Sunikka-Blank 2012).[2] Homeowners have identified the high cost of investment as one of the most significant constraints in the context of energy-efficient building renovations (Stieß et al. 2010). In addition to this increase in programme funding, an increase in individual investment support could make energy-efficient renovations more cost-effective and increase renovation rates.

Establishing a sliding scale for individual funding could make energy-efficient renovations feasible for new groups. An income-based sliding scale could improve uptake among homeowners, by offering low- and middle-income households higher repayment subsidies.[3]

This would benefit families and senior citizens nationwide, especially homeowners in the former East German states given the existing income disparities between East and West (Statistische Ämter des Bundes und der Länder 2018). In the case of rented buildings, a sliding scale based on the average rent per square metre of living space would make sense. This would mean higher subsidies for the owners of buildings with relatively low average rents, stimulating the refurbishment of this building stock and providing financial relief to low-income tenants. In addition, the introduction and consistent enforcement of a so-called "ecological rent index" could ease the landlord/tenant dilemma (BMVBS 2013).

Boost support for the construction of social housing

Affordable apartments are in short supply in Germany's metropolitan regions. Rents have climbed considerably in the past few years (Statista 2019c). Protests in Berlin calling for the expropriation of large real estate companies to bring housing under public control highlight the tense situation on the housing market (Die Welt 2019). Meanwhile, the social housing stock has shrunk considerably (Statista 2019a). As a result, low-income households are struggling to find affordable housing in metropolitan areas. In order to ease housing tensions, the federal government could expand its efforts in the area of social housing construction beyond its annual spending targets of one billion euros for 2020 and 2021 and act as a frontrunner in housing sustainability and climate protection[4] by constructing buildings to an energy-efficiency standard that exceeds the requirements of the Energy Saving Ordinance (EnEV) 2016, which will also be reflected in the Building Energy Act 2019 (Gebäudeenergiegesetz 2019). Higher energy-efficiency standards do not necessarily translate into substantial additional expenditure (ITG 2018). The federal government should not shy away from this, as this spending will contribute to the government's long-term climate targets and provide long-term relief for tenants in the area of housing costs.

[2] Carbon pricing measures specifically targeted at oil and natural gas could help to shorten lengthy amortisation periods (ifeu 2018). Extending the scope of the EEG surcharge to the heat and transport sectors could also contribute to this goal and, where economically feasible, facilitate sector coupling at the same time (Gährs et al. 2017).

[3] 30% of homeowners in Germany have a monthly net household income of 2,000 euros or less and 60% have a net income of 3,200 euros or less (Statistisches Bundesamt, 2016).

[4] As part of its commitments to the 2030 Agenda for Sustainable Development, the federal government has set itself the goal of reducing the rate of land consumption in Germany to less than 30 hectares per day by 2030 (Bundesregierung 2018). Increasing land take and soil sealing for real estate development would conflict with efforts to achieve this goal. Instead, innovative approaches that allow urban areas to be developed in a way that delivers cultural, social and environmental benefits should be explored more closely and included in funding programmes (for more information, see UBA 2019b).

INFRASTRUCTURE

Improve access to vocational and further training in sanitation, heating and energy technology

The investment flows resulting from existing measures and those proposed in this policy brief will to a large extent benefit German companies and workers. These measures wil also have positive impacts on the public budget (Kuckshinrichs et al. 2015). However, the German economy and the climate will not benefit from this to the extent possible unless the necessary human resources are available in the construction and renovation sectors. Skilled tradespeople and planners are valued sources of information and partners for building owners. They enjoy a high level of trust among homeowners (Stieß et al. 2010) and influence decision-making around energy-efficiency projects. The energy transition places new demands on skilled workers in the construction sector – thermal insulation, flexible heat pumps and heat storage technologies are all strategic components of the future heat supply system (Fraunhofer IWES/IBP 2017) – and they should receive further training to update their skills. As well as providing more support for further training, the federal government could make it mandatory. In particular, further training and retraining measures that would support the transformation of the heating sector could be ramped up during periods of sluggish economic performance and increased unemployment.

The construction and heating sectors are already adversely affected by a shortage of skilled labour. The average vacancy period for skilled positions in the construction, sanitation, heating and energy technology sectors is currently between four and six months (Statista 2019b)[5]. In addition to this, the outflow of skilled workers entering retirement has outstripped the intake of trainees across these sectors for many years now. As a consequence, the building sector must now grapple with a net loss of three to five thousand skilled workers per year (Hauptverband Bauindustrie 2018). This trend must be reversed if the energy transition is to succeed in the heating sector. To this end, the financial and training incentives offered to school-leavers and lateral entry employees should be improved in an attempt to make these professions more attractive in the short term and to highlight their long-term prospects.

[5] The "vacancy period" is the time taken to fill a reported vacancy subject to income tax and social security contributions.

Sustainable Mobility

If carbon pricing is going to make it more expensive to use fossil-based modes of transport (cars, airplanes), alternatives need to be found, promoted, and adopted on a significant scale. Investment in ecomobility infrastructure (public transport, cycling and walking) is essential. But the determinants for using environmentally friendly modes of transport vary depending on where one lives (Schubert, Wolbring & Gill 2013). Rural areas are generally less well served by public transport than suburban or urban areas, and they also lack social infrastructure (e.g. kindergartens, medical services, shops), which means that greater distances have to be travelled by car to get to these amenities. Rising rents, particularly in conurbations (Dustmann, Fitzenberger & Zimmermann 2018), often force people with low incomes to move to suburban or rural areas. As a result, they have a longer commute to work and are more dependent on cars to get them there. So in addition to better infrastructure, measures to relieve financially stretched households are also needed.

INFRASTRUCTURE

Redistribute revenues to *Länder* and municipalities as ring-fenced funding

As the "socio-technical process of transforming the transport sector" towards sustainable development, the mobility transition calls for new kinds of infrastructure (Becker & Renn 2019, p. 110). We need to find appropriate mechanisms for redistributing carbon pricing revenues from central government to the *Länder* and municipalities so that the latter can also benefit from these revenues in the form of ring-fenced funding. While the construction and maintenance of motorways and major roads are financed by central government, public transport is paid for mainly by the *Länder*, and the costs of cycling and pedestrian infrastructure by municipalities. Instead of being used to pay for roads or aviation infrastructure, revenues from carbon pricing should be provided to the *Länder* and municipalities as funding earmarked solely for the purpose of improving public transport infrastructure, the railway network, and active mobility (cycling and walking).

Expand networks and capacities for public transport, railways and cycling

Expanding and improving public transport networks and increasing passenger capacity are necessary steps to encourage a shift from motorised private transport to public transport. To seize the opportunities presented by digitalisation, efforts to provide across-the-board broadband solutions for public transport and develop a ticket app (along the lines of the prototype Mobility Inside www.mobilityinside.de) should be stepped up. By making it possible to purchase a single digital ticket that can be used in all of Germany's public transport networks, the latter would keep the barriers to using public transport as low as possible. The provision of more park-and-ride and bike-and-ride facilities and bicycle stands at regional train stations would support intermodality, where different modes of transport are combined in one journey.

VAT on train tickets should be lowered to make the train a more attractive option for long-distance travel than the car or plane. While a Europe-wide kerosene tax is needed in the long term, a kerosene tax on domestic flights, similar to that already in existence in the Netherlands and Norway, would be a step in the right direction and an added incentive to take the train for journeys within Germany. The expansion of cycling infrastructure (safe cycle lanes, safe parking facilities, fast cycling routes for commuters, traffic lights timed to stay green for cyclists), the physical separation of cycling and pedestrian traffic, and better signage for footpaths are vital to promoting a shift to active modes of transport (i.e. cycling and walking). Examples from neighbouring European countries show that investing in cycling infrastructure leads to significant cost savings in the long term

(see, for example, Davis 2010; Fishman, Schepers & Kamphuis 2015).

A nationwide purchasing scheme for cargo bikes intended for private use (e.g. 1,000 euros per bike) could discourage young families in particular from buying a first or second car. Since the current purchasing scheme only applies to cargo bikes intended for commercial use, it is of no benefit to private individuals and families. Any purchasing scheme for cargo bikes for private use should be coupled with an additional financial incentive for people to get rid of their cars for good. Such a scheme is already in operation in the city of Stuttgart.

TARGETED RELIEF MEASURES AND COMMUNICATIONS

Compensate commuters

To keep red tape to a minimum, it makes sense to provide financial relief to commuters via existing allowances and compensation mechanisms. The commuter allowance (*Pendlerpauschale*) is an important starting point for directly compensating low-income households, especially in rural and suburban areas. It applies to job-related mobility, when employees have to commute to their place of work. Households with a relatively low annual income should be entitled to a tax-free commuter allowance of 40 instead of 30 cents per kilometre travelled. As in other European countries like Finland, Norway or Switzerland, people who commute by public transport should be rewarded with a proportionately higher commuter allowance than those who use the car. Exceptions to this rule could, however, be made for health reasons or where it can be shown that it is not feasible to make the journey by public transport (Bach, Kloas & Kuhfeld 2007).

Transparent and targeted communications: Climate benefits not carbon pricing

A lack of awareness about the direct and indirect benefits of carbon pricing makes it difficult for it to find broad public acceptance (Baranzini & Carattini 2016). For that reason, communications should focus on the ultimate goal of this measure – climate benefits – and avoid the term carbon pricing. The positive effects of carbon pricing such as social justice, the intergenerational justice the Fridays For Future movement is rightly calling for, and effective climate protection should take centre stage.

Conclusion

All of the options for using carbon pricing revenues proposed here are oriented on two objectives: climate protection and a socially just distribution of burdens. Some of the measures are more focused on the first objective, others on the second. Table 1 shows how the different measures contribute to both objectives. The decision on what measures to implement will depend on the relative priority given to both objectives and the extent to which the measures are compatible with a given political agenda.

Sector	Mobility	Financial relief	Climate benefits	Acceptance
Electricity	Grid expansion	✔	✔	?
Electricity	Development/expansion of energy storage	✔	✔	?
Electricity	Promotion of renewable electricity in Germany and/or abroad	✔	✔	?
Electricity	Co-financing of energy-efficient appliances for low-income households	✔	✔	?
Heating	Promote refurbishment roadmaps	?	✔	✔
Heating	Increase funding to programmes for energy-efficient refurbishments and establish a sliding scale of grants based on social criteria	✔	✔	?
Heating	Introduce high energy-efficiency standards in social housing	✔	✔	?
Heating	Improve access to vocational and further training in sanitation, heating and energy technology	○	✔	✔
Mobility	Redistribution to Länder and municipalities as ring-fenced funding	?	✔	✔
Mobility	Expand public transportation networks and capacities, support intermodality	?	✔	✔
Mobility	Make train travel a viable alternative to short-haul flights	✔	✔	✔
Mobility	Improve cyclist and pedestrian safety	✔	✔	✔
Mobility	Purchase incentives for cargo bikes	✔	✔	✔
Mobility	Financial relief for commuters	✔	✕	✔
Mobility	Communication: Climate benefits not Carbon pricing	○	○	✔

Table 1: Assessment of the measures in terms of their contribution to relieving low-income households, climate protection, and public acceptance.[6]

✔ Positive impact

? Impact unclear

✕ Negative impact

○ Neutral

[6] Data on acceptance is based on the Social Sustainability Barometer for the German Energiewende (Setton 2019) and the authors' own assessments.

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