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Good Practice Guide

Decarbonisation and clean energy transition

LGA-WM

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Contents

Summary

The *Good Practice Guide* at hand presents 22 cases of decarbonisation practices gravitating around the energy production and supply sector. All the cases presented have been methodically selected from a significant amount of data that was collected in the context of the EU-funded DeCarb project activity A1.2. The reader will become familiar with (some) technical, environmental, social, policy and economic aspects of current efforts on the part of EU member states to decarbonize the energy sector and make available clean, renewable energy for all.

The cases collected by DeCarb partners from Bulgaria, Poland, Hungary, Romania, Denmark, Germany, Greece, Slovenia and Spain testify to the complex dynamics of fossil fuels' phasing out and the risks associated with it. They also shed light on the conditions for renewable energy supply development and the practices – financial, educational and environmental – contributing to a smooth transition to a decarbonized energy ecosystem. A number of innovative approaches to handling transition problems, leveraging public support, educating the new generations and securing resources for renewable energy sources development, will provide the reader with a good understanding of the different energy requirements and realities of the different regions and countries involved in this research activity. One will finally find inspiring examples that could be transferred in different regional and energy contexts.

Introduction

Decarbonisation: From fossils combustion to clean energy

Decarbonisation is a complex of processes at the intersection of energy, environmental, social and economic policies, bearing multi-layered consequences in several specific policy fields, notably, social cohesion, health, transport, education policy, among others. An accomplished process of decarbonisation could be portrayed as bringing about a state of affairs in which a) the energy mix of a territorial unit is carbon-free, or b) the fossil fuels' mix is significantly less coal-intense, reducing significantly GHG emissions. As the process of decarbonisation is emergent, a great deal of disruptive changes are under way at all scales, from the global to the local. From multinational industries having to pay for GHG emissions and emissions' trade schemes, to consumers of public goods (e.g. transport) and private goods (e.g. home heating) having to assume extra costs for green infrastructures and services, the changes are predicted to be cataclysmic. There are aspects to be explored that help moderate our current perception of decarbonisation as a process whose (socio-economic) cost is unsustainable.

A great deal of emissions' reduction turns around the question of the **coal intensity of energy production**. Reducing emissions from power generation units implies costs that range from investments in equipment and renewables' technology, to coal extraction and processing plants' decommissioning costs as well as increased electricity costs. At the regional scales, these type of costs can be reduced significantly by effective planning and smart and innovative mobilization of resources and tools (e.g. fiscal tools).

The 'best practice guide' at hand presents selected cases of decarbonisation efforts in the DeCarb regions. The evidence collected by project partners concerns six thematic axes of decarbonisation that attempt to capture the entire process in most of its dimensions, with an emphasis on socio-economic ones. The axes, fully developed in the methodological part of DeCarb deliverable A1.2, are the following:

1. Emissions' Reduction Drivers (Principal and secondary)
2. Energy Mix
3. Renewable Energy Sources
4. Energy Economic Instruments affecting demand for renewables
5. Awareness, capacity building, & socio-economic management
6. Post-mining environmental management.

The cases presented were identified through targeted questions capturing key 'metrics' of decarbonisation broadly categorized in the abovementioned categories. The amount of data collected by the DeCarb partners in their regions and countries required a careful qualitative assessment of the respective regions, as they vary considerably in terms of the targets set, the extent of decarbonisation and coal-phasing out as well as the sets of measures initiated to offset negative socio-economic externalities. Each set of regional practices related to decarbonisation was therefore assessed in its own terms, while a number of tentative criteria were used to assess specific practices pertaining to the axes mentioned above. These are:

- Targets achieved (coal-phase out, RES uptake)
- Consultation with stakeholders
- Impact assessment
- Specific relevance/addressing of decarbonisation (coal phase out).

Most cases concern ongoing programs and plans, whose performance cannot be evaluated at this point, unless in terms of interim targets achieved. However, most aspects of decarbonisation-related practices, including those reported for instance, a local energy strategy, are evaluated in terms of whether or not various stakeholders have been consulted, as well as in terms of relevance to the decarbonisation of the energy sector, the extent to which they contribute to coal phasing out and /or RES development.

The first section provides a list of the main policy drivers reported by project partners. The following sections present best practices in infrastructure management and development, economic and fiscal tools, public awareness and post-mining management respectively.

Policy framework in DeCarb countries

Partner	Decarbonisation policies
RDA S-W (RO)	• Romanian Energy Strategy 2018-2030
SZREDA (BG)	• "Regions in Growth" 2014-2020
LGA-WM (GR)	• National Planning for Energy and Climate (NPEC)
HoE (DK)	• Energy Strategy 2050 – from coal oil and gas to green energy
AGENEX (ES)	• Climate Change Strategy for Extremadura 2013-2020
LODZKIE (PL)	• Polish Energy Policy until 2030
KSSENA (SI)	• Renewed Energy Act (Energetski zakon EZ-1, Ministry for Infrastructure – MzI) • National Energy and Climate Plan
ENEREA (HU)	• National Energy Strategy 2030
MWE (DE)	• National Climate protection plan • National Sustainability Strategy of Germany. (NUTS 1 level) • Sustainability Strategy of Brandenburg (updating 2019) (NUTS 2 level) • Energy Strategy 2030 Brandenburg (NUTS 2 level), Ministry of Economic Affairs and Energy • Regional Energy Concept Spreewald – Lausitz (from 2013, regional NUTS 3-level), (review 2019) Regional planning authority Spreewald-Lausitz

Best cases in electricity production decarbonisation

This chapter is divided in 6 sections and 22 subsections. Each section represents one of the analytical axes of decarbonisation. Therefore, Section 1. Emissions' Reduction Drivers (ERD) includes two cases of decarbonisation-related measures that indirectly contribute to the decarbonisation of energy production by focusing on areas of sustainable development, energy efficiency and sufficiency. Section 2. Energy Mix, presents two cases from partnership countries that serve to underline what a clean energy landscape is and how progress in increasing RES can be achieved. Section 3. Renewable Energy Sources, addresses 2 RES development projects, with an emphasis on the tendering processes set in place to ensure the best value for the planned investments. This section also addresses grid connectivity and regulations for energy sales as well as a case of nuclear energy production scheduled for decommissioning. Section 4. Energy Economic Instruments affecting demand for renewables, focuses on the European emissions trading system and the most effective ways in which its potential can be seized. Further subsections herein provide cases of green financing and carbon pricing mechanisms. Section 5. Includes selected cases of awareness and skills for increasing the visibility of decarbonisation and regional leverage in pursuit of regional decarbonisation strategies, while Section 6. Presents cases of post-mining management, with a focus on the management of environmental processes. The order by which the cases are presented is thematic and does not represent a classification with criteria of effectiveness or any similar ordering principle. The table in the following page provides a map of this chapter.

Emissions' Reduction Drivers (ERD)

Energy specialist, National Energetic Network (HU)

The *Hungarian Energy Efficiency Act* and the *Governmental Decree 122/2015* which entered into force on 21 December 2016, introduced the obligation for all companies above a certain energy input threshold to delegate an energy specialist. The aim of the new policy measure is to continuously take into account energy efficiency and energy saving in the actions of energy-intensive organizations and to promote efficient operation by a professional.

This policy foresees measures for businesses exceeding specific energy demand limits, notably electricity supply, and also natural gas and thermal energy. The energy specialist's mandate tasks him with critical energy monitoring and sustainability interventions.

This is a measure that effectively facilitates the coherence of energy demand and supply measures. In the context of the decarbonisation of the energy sector, keeping track of and enhancing the measures that effectively curb demand, is crucial. The energy specialist constitutes a novel Organisational asset for the businesses whose energy consumption is critical. The benefits of assigning the energy specialist are plural: the energy specialist signals that a business is at a stage of development whereby energy demand is not negligible, and therefore, facilitates the business integration of corporate responsibility practice. The specialist, in addition, saves businesses resources by indicating the appropriate – from an energy conservation point of view – course of operational actions, and employs tools by which the optimal

"The energy specialist plans how energy conservation is implemented in operational procedures and practices, addresses efficiency, devises the appropriate solutions to energy efficiency problems, and promotes energy savings for all procedures."

technologies and energy supply mix are determined, with the purpose of business viability and the curbing emissions. The energy specialist can play an important role in introducing alternative sources of energy supply in operational procedures and effectively contributes to reducing the strain on carbon intensive energy and more specifically electricity demand.

"10.000 solar roofs" (BG)

"10.000 solar roofs" is a national programme for the promotion of renewable energy sources, managed by the German-Bulgarian Chamber of Commerce. It consists in feed-in-tariffs for roof thermal systems. The programme is in support of the implementation of the requirements outlined in 2009/28/EC directive in Bulgaria for the facilitation of the installation of photovoltaic systems in buildings (roofs and facades).

This is a successful initiative situated in the context of concerted policy actions for the removal of bureaucracy barriers in the introduction of RES in the energy mix. The programme implicates key stakeholders, notably, the Bulgarian Photovoltaic Association (BPVA), representing tens of Bulgarian and German companies. The Programme steadily expands the use of small-scale photovoltaic systems despite the existence of administrative barriers to planning and consequently installation. A major target to be achieved to kick-start the widespread expansion of sustainable thermal and solar energy for buildings is the limitation of the necessary time for the relevant administrative procedures within reasonable limits of a few weeks, from a couple of months in average which is the current practice today. In addition, current costs are significant, preventing homeowners from planning RES solutions for their homes. A main obstacle this cluster of stakeholders attempts to lift are the legal requirements regarding the status of the legal entity in request of selling electricity and securing better tariffs.

The “10.000 solar roofs” programme is one key element promoting the removal of legal and administrative obstacles to widespread RES use and for this reason a power industry expert committee has been appointed by the Association to promote these ends. It is designed to support RES uptake – crucially not focusing on finance/subsidies – but rather on making widely available the capacity for decentralized energy production. As such, it is a rather effective approach to curbing demand for carbon-intensive energy, to enhancing energy security by increasing reliance on decentralized renewable energy nodes and therefore, it supports the decarbonisation of the energy sector and the reduction of CO2 emissions for energy production.

“PV systems are designed largely for small scale energy security and self-sufficiency, yet, decentralized supply is critical and to date private houses cannot sell electricity to the national grid.”

This is a key programme driving decarbonisation and thus its high transferability observed: the programme is replicated across the globe in variations and it is considered to be one of the most effective measures for promoting the decentralization of energy grids – a key requirement in the context of decarbonisation of energy production.

Energy mix

Exceeding the 2020 target of 14.7% RES share in energy production (HU)

Coal based electricity production in the Észak Alföld region is 17.6% according to the latest available data. This amounts to 839 GWh/annum in 2016 (of 4778 total). Coal-based heat supply for the same period was 108 GWh/annum (of 9235 total). These low figures in fossils' contribution to the regional energy mix are due to high RES penetration. 60% of total heat demand is supplied from biomass and renewable waste fired plants. The second highest contribution for heat (27% of total regional demand) is provided by geothermal power. One large CHP plant (95 MW) and a number of smaller RES plants (12 biogas, 3 hydro, 2 biomass and 2 wind power) with a total installed capacity of 25 MW operate in the region. Hydropower is the main 'engine' of heat production, significantly reducing the strain on CO2 intense –coal-based – energy production.

The share of renewables in energy production amounts to 11% (2016 data) and it is highly possible that the 2020 national target of 14.7% share of RES will be met and exceeded.

Factoring in total regional consumption, it should be indicated that the total coal-fuelled energy consumption is 4007GWh/annum and the total RES electricity consumption is 524, 3 GWh/ annum. The region, however, consumes more non-

renewable energy than it produces (approximately 4 times more). In terms of curbing emissions and RES uptake, the region performs satisfactorily. The regional energy mix is exemplary in terms of diversity of RES sources, and given the prevalent rates of coal phase out and dependence, a number of measures and incentives aim precisely at curbing demand for coal-based electricity production through supporting RES with public investments and a combination of finance support mechanisms.

"60% of total electricity production comes from hydro power, supplemented by considerable contributions from solar PV, wind and biomass energy sources."

Although the region is in need of enhanced energy security and sufficiency measures in order to curb energy imports, the regional energy mix presents a significant potential for reducing dependence from coal, in terms of either production or coal-intense energy imports. Along with several measures for RES uptake, it constitutes a successful case of decarbonisation worth drawing key lessons from.

100% RES energy supply in Extremadura (ES)

Extremadura is one of the few regions in the EU where domestic demand for electricity is covered 100% by renewable sources. This constitutes a great advancement in regional terms and a significant contribution to the promotion of RES and curbing regional demand for coal-intensive energy.

Regarding the total energy production in the region, 22.5% comes from renewable energy sources. This is incrementally a step further from the 2020 EU energy targets on RES uptake. 60% is attributed to solar energy, a figure that accounts for the fact that Extremadura has the highest number of photovoltaic and concentrated solar power production per inhabitant. Solar energy production is equal to 15% of total energy production in the region. Hydro power is 6.5% of total energy production and 40% of RES energy production.

To give an idea on the scale of this energy landscape, it should be indicated that Extremadura has a non-negligible population of 1.087.778 (2016) and the RES installation of solar power projects in the region represents some 40% of the national total. Wind energy is prominent with 97 wind parks of total output of 1.700 MW. Additional energy output from RES is added every year in the regional mix, effectively increasing clean energy supply for other regions too. Among the latest developments, the region saw the construction of a 40 MW wind farm in 2018.

The wind farm in Merengue has a capacity of reducing emissions by 120, 000 tons of GHGs, producing 155 GWh per year. This output is equal to the average demand/consumption of 44 thousand homes. It costed 40 million euros and for its development approximately 250 people are employed.

Simultaneously, a great deal of RES project are underway (Las Jaras and Miraflores photovoltaic plants [50 and 20 MW respectively]), making Extremadura one of the regions of choice for RES projects and investors and therefore one of the exemplars in terms of attracting RES investments and reducing effectively CO2 emissions.

"In Extremadura CCS functions as supportive of CO2 emissions reductions, rather than a driver for construction or continuation of coal plants' operations."

Extremadura is a case in point, regarding RES mix, because while it entirely relies for consumption on own RES, it does actively employ CCS technology to remove CO2 from the atmosphere. The net carbon capture in Extremadura has increased in recent years. While in the period 1990-2000, a total of 1.349.417 tC per year were removed from the atmosphere. In the period 2000-2006 the amount was raised to 2.548.661 tC per year. In this context, CCS functions as supportive of CO2 emissions reductions, rather than a driver for construction or continuation of coal plants' operations. This is due to the neutral character of CCS, which, depending on the overall policy and infrastructural context, can facilitate or impede decarbonisation.

Renewable Energy Sources

200 MW Solar park in Kozani (GR)

A 200-MW solar park is under construction in the area of Kozani in northern Greece. The park will produce around 260,000 MWh a year, offsetting 300,000 tons of carbon dioxide emissions. 600 million EUR will be invested in the project, which will be developed by JUWI Hellas.

The project was accepted through a process of auction whereby projects of total 635 MW competed for 437 MW. Specifically, a 200 MW solar project by JUWI, a 200 MW solar project by PPC Renewables and two other projects by Spes Solaris, competed The accepted project is bound to be the most extensive PV project in South-East Europe. A feed-in-premium of 5.73 cents / KWh was determined for the company undertaking the development and management, and the park is going to be connected to the grid by 2021.

The area in which the park is going to be developed is an area of 400 hectares.

The total electricity output will be around or over 10% of the total electricity production in the region (4,250 MW). Considering the environmental impact of such output it is important to note that local lignite reserves have been estimated at 50 million tons and the soil removed for the extraction process of this volume of lignite is over 300 million tons. The devastating impact on biodiversity, land erosion and environmental pollution are alarming and such projects could see the replacement

of coal activities in favor of RES. The said project is bound to trigger further solar PV projects in the region and further.

Open tender for RES development partnership in Western Macedonia (GR)

To increase clean energy production capacity and reduce coal dependence, several stakeholders are implicated in a process to develop new, high-performing RES infrastructure. The development of a biomass CHP plant is currently underway to meet sustainable energy requirements. The nominal capacity of the proposed plant is 25MWe of electricity and 45MWth of heat. An area has been reserved for the construction of the plant in the vicinity of an existing thermal power plant in the Municipality of Amyntaio, foreseeing grid connectivity issues.

The entire process of development is led by PPC Renewables S.A. (the PPCR), a wholly-owned subsidiary of Public Power Corporation S.A. The company has in the course of the previous years been engaged in planning and conducting studies regarding all aspects of the project development after which it acquired a Production License from the Regulatory Authority of Energy.

An open tendering process has been initiated in 2017 for the selection of a strategic partner to build and operate the biomass CHP plant. The partner selected will hold a majority stake and take over the planning, funding, construction and operation of the unit. Up to date, 12 companies or joint ventures have expressed interest in the tender launched by PPC Renewables. The interested parties qualified through the pre-selection process are companies from countries as diverse as China, Spain and Saudi

Arabia. Several stages of selection are planned to ensure full compliance to terms and conditions, technical eligibility and numerous other criteria.

This process is indicative of likely the most effective course of action for regional decarbonisation of energy supply. Several factors contribute to that, including detailed planning and consultations, feasibility studies, open tender processes increasing transparency and partnerships between the public and the private sectors.

"Up to date, 12 companies or joint ventures have expressed interest in the tender launched by PPC Renewables."

Grid renewal and net metering (GR)

Grid renewal and development to support RES is key to the long-term decoupling of energy supply from coal mining and processing. In Greece, grid development is subject to a central planning procedure outlined in the *Development Study of the Greek Transmission Grid (2017-2026)*. Transmission grid renewal is driven by RES uptake, whereby the grid operator is obliged to purchase all electricity from renewable sources in PPAs.

In the previous decade, a Feed-in Tariff was utilized which amounted to 0.09 EUR/ KWh. The FiT was cut in 2019 to 0.085 EUR / KWh. The initial fixed price offered to electricity producers was deemed 'unsustainably high' and was accumulating public debt.

The pay off period under the FiT scheme was about 10 years for small residential net metering, which proves to be an obstacle in PV uptake.

The new policy framework abandons the feed-in tariff (FIT) policy in favour of a feed-in premium scheme for systems over 500 kWp. In practice, this means the new PV power plants will be participating in the energy market and will be given a variable premium, on top of the standard market price for the generated green power. The amount of the premium for renewable power plants will depend on some market variables (e.g. the system's marginal price) and a tariff set via competitive tenders. The feed-in premium will be valid for 20 years. The new law does not apply to Greece's non-interconnected islands.

Under the current virtual net metering scheme, PV electricity producers up to 500KWp can use some or all of that electricity any time rather than when it is produced.

HELAPCO – the Hellenic Association of Photovoltaic Companies – has proposed two measures aimed to promote net metering. First, the extension of virtual net metering to all net metering investors, and, second, the elimination of fees for various social costs from net metering bills. Such fees are named 'Services for Public Utility'. These fees currently apply even for the cases where electricity is produced for own use. The fees are linked to subsidies for non-interconnected electricity generation on remote Greek islands and for poorer households. Disturbing the electricity market in this way is not conducive to net metering and further caused loss of jobs associated with PVs given that their uptake was effectively stalled.

"Under the current virtual net metering scheme, PV electricity producers can use some or all of that electricity any time rather than when it is produced."

Nuclear energy: considering social costs (ES)

All non-renewable energy production in Extremadura comes from one nuclear power plant (Almaraz I & II), and it represents 77.5% of the total energy production and supply. The Almaraz power plant is located in Cáceres, in the autonomous Community of Extremadura and it provides 16 billion KWh per annum. The regional government has the will to close down this nuclear power plant by 2030-35, in line with the national strategy of decommissioning nuclear power plants and phasing out non-renewable energy production. The Spanish National strategy of nuclear phase-out reflects considerations regarding the low levels of public acceptance of nuclear energy.

The decommissioning of the Almaraz plant corresponds to a 'low nuclear' scenario. Extremadura is applying a decarbonisation strategy highly reliant on clean energy and RES. The nuclear energy produced in Extremadura is for regional export since all the electricity supplied regionally is 100% from RES. The region is thus sufficient in terms of energy needs and nuclear phase out does not throw out of balance regional energy supply-demand equilibrium. In all other cases where the energy mix is heavily reliant on fossil fuels' combustion and with a share

"Extremadura, investing heavily on RES leads effectively to an energy ecosystem free of both fossils and nuclear energy social costs."

of nuclear, CCS retrofitting would need to be taken up in rapid rates, in order to reach the goals of the EU 2020 and 2030 Energy strategy.

Energy Economic Instruments affecting demand for carbon and/or renewables

Using the ETS to leverage RES infrastructure development (DK)

The Nordjyllandsværket power station traditionally produces combined energy and heat from 3 coal and 1 gas turbine. The plant was owned and operated by the private company Vattenfall until 2015, when the plant was taken over by the district heating company Aalborg Forsyning and in order to secure a conversion to RES-based energy production, which Vattenfall would not guarantee.

In 2008 Vattenfall planned the development of CCS infrastructure at the Nordjylland Power Station. The aim of the project was to capture CO_2 by means of a post-combustion plant. The scale of the planned intervention was to address the problem of capturing 1.8 million tons out of 2.8 million tons of CO_2 emitted from annual combustion of 800,000 tons of coal. Economic and social opposition reasons led the company to postpone and eventually cancel the planned investment. Local communities established an organisation 'No to CO2 storage' and their opposition was articulated in the context of consultations and public meetings.

The ETS system played a role in the process of abandoning the CCS project and opting for securing an RES solution. The Danish Energy Agency, which allocates ETS quotas

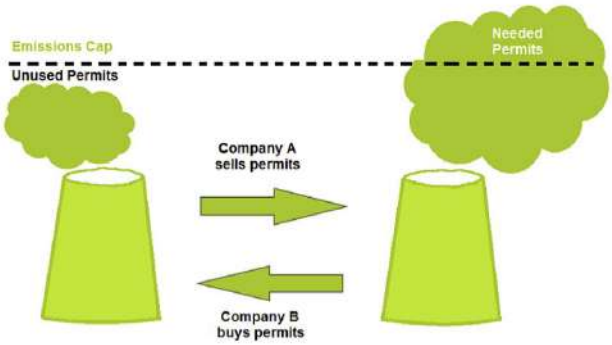
in Denmark, allocated 335.507 quotas to Nordjyllandsværket in 2013 and reduced that number to 77.196 in 2020.

The effect of CCS technology is not straightforward in terms of promoting decarbonisation. Although it can and it does contribute to CO2 emissions reductions, it is simultaneously considered by many to be a fossil-fuel subsidy when governments decide to subsidize CCS development. The reason is clear: CCS perpetuates coal extraction and combustion and the amount of time necessary for the development of adequate and effective CCS, to 'bridge', as it were, the gap between CO_2 reductions and the abandonment of fossil fuels. It is often argued that government spending on CCS is reducing the level of investment in non-fossil fuel energy. In other words, CCS investments incentivize the continued use of fossil fuels.

"Increasing the price of allowances and decreasing their number has a positive effect on RES uptake, if RES licensing is not unfavorable."

In sharp contrast, the decision of the Danish Energy Agency to decrease the number of CO2 emission allowances for the Nordjylland Power station – or what happens in many other cases, that is, the increase in the price of allowances – brings about an immediate effect on RES uptake, as long as RES development licensing is not unfavorable.

EU ETS and backloading (SI)



In line with the EU provision on nationally determined contributions (NDC) towards the realization of the Paris Agreement as well as the targets regarding EUs climate and energy framework until 2030 (36% decrease compared to 2005 baseline), the is divided into two sub-objectives, one related to ETS and the other to non-ETS sector emissions. As previously described, the milestones elaborated in national policy and strategy are to reduce GHG emission by 15% until 2030 in non-ETS sectors while the target for ETS sectors is achieving a 43% reduction of GHG emissions until 2030.

ETS is already and will further become one of the main drivers for the decarbonisation of the energy sector, simply due to the fact that carbon intensive activities are to become economically unsustainable. Carbon allowances prices have increased more than 400 % from May 2016 (from a low of 5,72 to over 25 EUR per tonne of CO_2) to 2019 respectively. The implementation of the 4th stage of the ETS from 2021 onwards, which will increase the rate of annual reductions of available allowance to 2, 2% will further exacerbate the issue. Energy producers like TEŠ are already having difficulty in terms of operating at a financial loss, but the operations are still manageable as the power plant is owned by the HSE, which is able to cover deficits from revenues of economically superior energy production units (for e.g. hydropower). The funds allocated to cover ETS carbon allowances already surpass the value of supplying the power plant with its main energy carrier (lignite) and with

respect to the trend observed in the previous years, this will most likely be the main driver responsible to the premature shutdown of all coal-fired units of TEŠ.

The low cost of CO_2 allowances (as little as 2.81 euros in 2014; current prices approximate 20 EUR in average), has not been confirmed to function in the desired direction. Although, in the case in question the ETS strongly dis-incentivizes the continued reliance on carbon and forces the adoption of RES technologies in energy production, the fact that the ETS has come to be seen as partly as a support mechanism for member states with lower per capita GPD, in general, has signaled a revival of a perception of lignite as competitive power source, impeding thus its phase out. Considering that allowances can be purchased at the secondary market and their oversupply, tools such as backloading, whereby, the surplus allowances are removed and cannot be auctioned, are increasingly useful.

"Backloading offsets oversupply of allowances by removing them from auctioning."

Green financing system and Economic Greening System (HU)

The Kyoto Protocol to the UN Framework Convention on Climate Change introduces international quota trading, i.e. the sale and purchase of greenhouse gas emission rights. Hungary has significant quota surpluses, first sold in the world in 2008, and revenue from the sale of Kyoto units on the basis of quota agreements. The Green Investment System (ZBR) has been used for climate protection and the Green Financing System (ZFR) was set up in 2013 to use the EU ETS quota revenues.

The ZBR and ZFR can finance R&D and climate change adaptation research and demonstration projects, the development of energy from renewable sources and the promotion of energy efficiency, the transition to low-emission transport and public transport. Within this framework, the ZFR focuses, amongst other, on increasing the use of renewable energy sources, building low-energy buildings, investments to improve the efficiency of district heating systems, modernization of lighting and public lighting systems, promotion of the installation of GHG sinks and the replacement of household appliances. In addition to the development of renewable energy production, ZBR focuses on the development of other technologies promoting participation in European strategic initiatives, the transition to a low-carbon economy, and low-and medium-income households to improve energy efficiency. Resources can also be provided for 50% of the GZR's national offer for the Green Climate Fund and for the installation of electric charging infrastructure. The principles of ZBR and ZFR / GZR include supporting only those measures that are most likely to reduce

greenhouse gas emissions, so that their sub-programs can be considered the most supportive climate support programs in Hungary. Their main objective is to support energy saving investments among the most deprived individuals, housing fabrics and construction companies. Building modernization is of paramount importance in climate protection, as building-related emissions account for 30% of total domestic CO_2 emissions.

"Their main objective is to support energy saving investments among the most deprived individuals, housing fabrics and construction companies."

In 2015, GZR's resources were used to distribute electro mobility within the framework of the Jedlik Ányos Plan, while the resources of ZBR and ZFR were allocated through energy efficiency tenders of the Otthon Melege program (replacement of household appliances, modernization of building energy).

Meanwhile, Hungary is not only generating revenue from quota sales at international level, but as a member of the EU, on a voluntary basis, offered twice a billion HUF in 2015 to support the Green Climate Fund and other bilateral and multilateral international climate finance programs.

Effective pricing of carbon (DK)

According to the OECD, Denmark has the highest environmental tax globally. The revenues from the taxes in question in 2014 ranged at 3.97% of the GDP, when the average in 34 member countries and partner economies is at 2.0%.

A pricing scheme is in implementation, according to which the prices of carbon-intense fuels for transport are higher than fuel for electricity generation, for heating and process purposes (7.12 EUR/GJ & 2.2 EUR/GJ respectively). Companies working with the extraction of oil and gas in the Danish territory on the North Sea are met with a 52 % carbon tax.

"Carbon taxing is effective in increasing the visibility of the social costs of carbon emissions."

The benefits of carbon taxing are that these types of taxation aim at offsetting the increased, compared to market prices, social costs of carbon emissions. They are extremely effective as well to increase the visibility of the social cost of pollution.

The principle is simple, constituting in effect a demand-curbing measure, increasing the price of goods in correlation to the CO_2 emissions associated with them.

Linking carbon taxing in an integrated manner with other RES promoting measures has significant results in terms of RES uptake. This is a precondition for the effective deployment of carbon taxing to serve environmental reasons, namely, that it is in the

service of an integrated environmental and energy policy of RES promotion and coal phase out.

Revolving RES funding (BG)

In Bulgaria, electricity from renewable sources is mainly financed through a premium tariff. All power plants using renewable energy and CHP with an installed capacity of 4 MW and higher sign contracts with the Electricity System Security Fund (ESSF) on the granting of a premium to offset the difference between the stock price and the price in the long-term contracts that RES-E producers have with the National Electricity Company (NEK). The use of renewable energy for heating and cooling is promoted through a subsidy from the European Regional Development Fund, several loan schemes and through an exemption for building owners from property tax.

Biofuel Support

An important RES promotion measure in place is the quota system for transport fuels. This scheme obliges companies importing or producing petrol or diesel to ensure that biofuels make up a defined percentage of their annual fuel sales. Furthermore, biofuels are supported through a fiscal regulation mechanism. As indicated in previous and further sections, the transport sector is a key sector for driving decarbonisation of energy production. Locally produced biofuel gains a competitive advantage once the quota system is in place, since there is immediate demand formation.

The EERSF

The 'Energy Efficiency and Renewable Sources Fund' (EERSF) is an exemplar public-private funding body operating in a revolving mode, having raised its initial funds from international and domestic donors including the Global Environment Fund (GEF), the International Bank of Reconstruction and Development (IBRD), the Government of Bulgaria and Austria, as well as from the private sector in Bulgaria. The purpose of the fund is to provide technical assistance and finance services to the private and public sector.

A central role of the EERSF is to directly contribute to CO_2 emissions reduction. A concrete target has been set of halving energy intensity, and therefore, reducing CO_2 output. Enterprises, municipalities and citizens can receive technical assistance and consultancy services in the area of RES and energy efficiency projects.

"Companies producing petrol or diesel are obliged to ensure that biofuels make up a share of their annual fuel sales"

Since its inception, the fund has managed and streamlined financial assets worth over 11,2 million EUR for the first period of operation (2005-2008), and it doubled its total contributions by the end of the next period (2014, 23,4 million EUR) to 170 projects in total. The projects financed by the fund directly linked to the decarbonisation of the energy sector and the development of RES are:

- Energy efficiency in industrial processes, buildings in all sectors
- RES heat sourcing and distribution

- Street lighting to reduce electricity demand through sustainable public infrastructure
- Demand side small RES projects
- All projects are financed through a multi-step selection procedure preceded by an energy audit.

Financial support for individual residential wind mills (DK)

Denmark has doubled its wind-generated power, currently amounting to well over 14,700 GWh/ annum. This energy output, by far the greatest share of RES-wind globally, covers as much as 45% of energy requirements. The goal of Denmark is to reach 50% wind power penetration by 2050. A feed-in tariff for wind in the 1990s and further premium tariffs helped the sector to expand exponentially with offshore projects financed by utilities companies and large infrastructure projects by private investments.

Investments for wind farms initially came from individuals through cooperatives. In proprietary terms, wind power capacity is largely owned by individuals and associations, continuing on a stream of small-scale wind power generation tradition that lasts over a century in Denmark. The association for Wind Power Turbine Owners was established as early as 1978 (Danske Vindkraftvaerker).

"Wind turbine shall produce 50% of electricity consumption in 2020."

The Danish support scheme for electricity generation based on renewables and other environmentally benign electricity production consists in a number of measures to support energy supply from renewable sources (price supplement, fixed settlement price, contract for difference). For household wind turbines (up to 25MW) there is a fixed settlement price indicating a varying support cost in proportion to the market price. The settlement price, according to the

Danish Energy Agency, is calculated by deducting the electricity market price from a fixed settlement price.

Awareness, capacity building & socio-economic management

The Forum of Mayors (GR)

Local mayors in the region of West Macedonia in Greece have reiterated the need for the Just Transition of the region away from lignite and attempt to find alternative income opportunities for the region. To this aim, a new discussion platform – the Forum of Mayors – was initiated in Kozani in 2018.

The Forum of Mayors came about as a necessity to facilitate, in terms of coordination and peer support, the Just Transition to decarbonized economies. The initiative was taken by the Energy Municipalities Network in Greece, aiming at bringing together a number of municipalities across Europe whose economies are deeply enmeshed in energy production from fossil fuels. Mayors and administrative staff of coal regions from countries including Germany, Poland, Slovakia, Bulgaria and Romania participated in the first forum that was organized. The purpose of the Forum is essentially not only sharing experiences, problems and solutions, but also to collectively work out concrete trajectories for managing the socio-economic effects of a rapidly changing energy environment.

From the outset, the Forum of Mayors sought to create a broader and solid international network to increase the visibility of the impact decarbonisation has on local societies and economies and to ensure the capacity to benefit from financial

support stemming from the EU. The forum liaises with the "Coal Regions in Transition Platform", seeking to promote the availability of means for local authorities to engage in transition-related activities.

Essentially, what is distinctive about the Forum is the focus on the balanced distribution of the Just Transition Fund resources. Due to the complexity of support streams for decarbonisation, the forum sets out to address in detail the problem that certain municipalities are highly burdened by transition-related socio-economic and environmental shifts, much more so than others. Yet, international support streams made available at the level of central government cannot ensure that a just allocation has been made, such that the municipalities facing the highest risks and suffering grave consequences are given priority in receiving discriminatory support. The Forum seeks to address these conundrums and contribute to fostering the conditions for a smooth transition to decarbonized, energy secure regional development.

"The Forum of Mayors sets out to bridge the gap between international support schemes to central government and fair allocation of decarbonisation resources locally."

Forest schools (HU)

Forest schools are the prime means of inducing environmental sustainability for a decarbonized era. With the development of forest schools and the training of instructors and field professionals in the forest schools in Hungary, a total of 35 forest schools have received support in which the process of teaching and learning takes place in different environments – in a natural environment, such as a botanical garden, arboretum, unlike traditional school communication, targeting the development of an approach to raising environmental consciousness. Knowledge transfers in forest schools are basically based on active, cognitive activities of children (e.g. creating the right and proper relationship between man and nature), but they also go beyond creating a personality development opportunity for the participants. Forest schools therefore have a crucial role to play in changing production and consumption patterns, helping children to acquire environmentally conscious behaviors from an early age. By improving the infrastructure and content development of the qualified forest schools and forest nursery services, the implemented projects contribute to the important strategic issue of nature conservation, the improvement of environmental education and its physical conditions.

In coal-dependent contexts it is not uncommon for the regions to face serious environmental degradation due to mining activities. Forest schools transmitting to

young people the mentality and associated practices of safeguarding and restoring local environments is crucial in order to create the conditions for the future generation to look at the problems of energy, sustainability, resources and environmental balance from a different and more profound perspective of resilience and. As the case is, this is not only about teaching children of the negative consequences of resource extraction for energy production, or even about the catastrophic impact of CO_2 emissions on the environment. To a large extend this is about practice and about the immediate involvement of communities in restoration. Hence it is rather significant for regions to enact measures that will soothe the transition into post-coal mining. In particular, involving the younger people *en masse* in re-forestation and land restoration projects is one of the most effective long-term approaches to gaining visibility for sustainability issues and gaining legitimacy for the transition to carbon-free economies.

RES ACADEMY (RO)

The Romanian Wind Energy Association (RWEA) together with the Ministry of Energy and the University of Petrosani and its companies such as Monsson - RESS and CEZ Romania are planning to found an **Academy for Renewable Sources and Distribution of Electricity in the Jiu Valley**. The Academy will seek access to funds through the Transboundary Carboniferous Platform, during the 10-year project implementation period, to train about 5,000 wind energy specialists and 3,000 electric, mechanic and hydraulic power specialists per year, for a total of up to 8,000, The certifications to be awarded are foreseen to enable workers to work in the installation, operation and maintenance of renewables' projects. The program is designed to make it possible for a trainee to work in wind farms within 6 months of training.

This is a decisive step towards sustainable decarbonisation and RES development. The link that ensures the viability of plans of coal-phase out, is the focus on training RES specialists. What is more, training former miners and specialists working in fossils' combustion, takes advantage of transferable specialization skills, ensuring therefore social cohesion, by giving the opportunity to workers to re-skill for RES.

RES-related HE specializations (HU)

As indicated previously in the 'green employability' section, not only general public education is crucial, but significantly skills provision for professionals at all levels. In Hungary there are a number of RES related higher education degree specializations and titles offered cited below:

Debrecen University is a case in point in energy research, as the University is involved in renewable energy research, offering Renewable energy specialization courses on how to exploit the renewable energy (solar, geothermic and wind) and manage environmental protection (Geography MSc).

The National Renewable Energy Action Plan of 2010 (NREAP) foresees the gradual development of new vocational specializations including renewable energy manager, renewable energy consultant and green industry specialists. Existing specializations and training programmes focus on skills for engineers for gas and heat producing installation. The policy framework in Hungary is in line with the 'SEE-REUSE" (Strengthening European Education in Renewable Energy Utilization for Sustainable Economy. Further programmes under development have been prepared for adaptation to the National Qualification Register (Renewable Energy Technician & Biomass Installation Technician).

Taking into account public and private training programmes and their integration with the job market and the RES business environment, including associations such as the Hungarian Solar Association, the Hungarian RES training landscape is wide in scope and expanding.

Post-mining environmental management

"100,000 trees planted in 24 hours" and land restitution (RO)

The Oltenia Energetic Complex is applying a series of measures to reduce the adverse effects of mining. The most important are:

- Reconstruction of the land in the forestry or agricultural circuit free of technological burdens;

- Monitoring the stability of the waste dumps and environmental factors;

- Maintaining the safety zone against the inhabited areas;

- Compliance with dump technology to avoid land degradation phenomena.

With the release of technological land plots, the following stages are being carried out: reconstruction, modeling, greening and landscaping in the economic circuit.

Until now, an area of about 3,500 ha has been re-introduced into the economic (agricultural and forestry) circuit.

On 5 June 2015 (World Environment Day), in Targu Jiu, the "100,000 trees planted in 24 hours" was launched. The project is proposed by the Global Inclusion Association, together with the Gorj Young Youth Initiative Group. The uniqueness of this project is that it has been designed in a bottom up manner and driven essentially by the civil society.

The Oltenia Energetic Complex provided the land to be afforested, and the juvenile will be provided by the Gorj Forestry Directorate.

Post-mining digital database and land restoration (PL)

The Spółka Restrukturyzacji Kopalń, a mine restructuring company, is involved in the management, reclamation and revitalization of the acquired post-mining areas, including the protection of heritage and industrial buildings, while its vision is to increasingly attract new investors for alternative jobs in coal mining regions. More specifically, the company:

- Prepares model action programmes for the development of mining communes with indication of potential funding opportunities, which will aim at the development of alternative branches of the economy providing jobs in the regions with a significant share of the mining industry or a monoculture of employment in the mining industry.
- Coordinates post-mining land reclamation processes with programmes carried out by local government units as part of municipal programmes or local revitalization plans (proper coordination of reclamation activities with municipal revitalization programmes). Among its plans is funding for reclamation of post-mining areas will be provided from funds generated by the hard coal mining sector.
- Create a digital database of post-mining areas with development of visualizations and projects of creating “eco-space”.

The company has a considerable record of technical works accomplished or under way, including, the dewatering of 13 mines as well as methane capture from three mines, selling 25 million cubic meters in 2018.

Lusatia land restitution projects (DE)

For over a century, at least 136 villages and 30,000 residents have been relocated for the development of the lignite mines in Lusatia. The detrimental effects on biodiversity have been widely documented. Aside the environmental damage caused by mining, the region has been vulnerable to pollution from lignite combustion – 1 tonne of coal produces one tonne of CO_2. Dust, Sulphur and mercury are emitted from the coal plant towers on a constant basis. What is more, mining activities require groundwater extraction, which, in turn, causes serious problems of ground draught and cracks in houses and on the roads in nearby villages.

For Lusatia, the plan that was developed was to convert the abandoned mine sites into a lake district surrounded by croplands, green spaces and forest. The objective was not to return the site into its previous form but to create a natural landscape that will restore the area's natural functions and ecosystem services, and importantly improve the citizens' quality of life. The Company worked in this area for more than ten years, running 30 projects in total for new landscapes across the region, which has severely suffered from coal driven activities. Through flooding, several decommissioned lignite opencast mines were transformed into recreational lakes, making what was previously a coal intensive region the largest artificial district of lakes in Europe. The district covers an area of 80 kilometers across the states of Saxony and Brandenburg, and includes 26 artificial lakes of different size and use. The majority of lakes are accessible and earmarked for several recreation activities

such as water sports and cycling; some have been deliberately left undeveloped to protect wildlife and act as (protected) nature reserves. Around the two most developed lakes (Senftenberger lake and Geierswalder lake), a complex of facilities has been developed, geared to provide services to families and visitors, offering accommodation and food and beverage services (e.g. restaurants, cafes, hotels, campsites, floating rental apartment) as well as leisure time and sports activities such as fishing and horse riding to quad-biking and diving. Restoration interventions also included replanting forests, creating fishing communities in lakes, making agricultural land, and constructing marinas and other recreational facilities such as exhibition centers and towers for gazing over the former mines.

The entire project has a total cost of 2.2bn EUR to date.

Šoštanj Thermal Power Plant decommissioning (SI)

The Šaleška dolina is a valley in Savinjska region in the northern part of Slovenia and is home to one of the biggest deposits of lignite in the country. The valley as the location of the only operating coal mine and the biggest power plant in the country presents one of the largest energy pools in Slovenia. During the previous century the Šaleška valley and its inhabitants severely experienced the consequences of coal mining which supplied reliable electricity to the country. Concentrations of air pollutants often exceeded limit values and local environment is extensively changed. The Lake Velenje, formed as a result of the underground excavation of lignite, together with the Paka River, was considered "dead" with no living organisms in it. For these reasons, the population of Šaleška valley has started ecological protest back in 1987, which accelerated the ecological rehabilitation of the valley. In the same year the Šoštanj Thermal Power Plant introduced **the Ecological Rehabilitation Programme**.

Nowadays, the most visible consequences of lignite mining in the area of Šaleška dolina valley is the subsidience of the ground and the formation of 3 lakes (Velenjsko jezero, Škalsko jezero, Družmirsko jezero). Underground excavation of lignite in the Velenje and energy production in the nearby thermal power plant without a doubt resulted in a significant transformation of the landscape in Šaleška valley (Velenje and Šoštanj); however much effort has been put into the ecological rehabilitation of the

valley and a lot has been achieved in the field of environmental protection and improvement of living conditions in the past years. Velenje Coal Mine and TEŠ aimed to prevent and eliminate any negative environmental impacts of its operations and has played an active role in land rehabilitation and air/water protection programmes in the Šaleška valley as well as in regularly monitoring its environmental impacts.

The surface of Velenje Coal Mine extraction area amounts to 1104 hectares, of which 532 hectares are located in the territory of Municipality of Velenje and 572 hectares in Municipality of Šoštanj. The extraction area of the Velenje Coal mine is divided in following zones: the extraction preparation area, area that is immediately impacted during the time of excavation and an area that is restored and recultivated as the extraction is finished. During and after the extraction, the Velenje Coal Mine invests a share of its assets in rehabilitation of extraction area. The watercourses, roads, public infrastructure and facilities are protected and restored, re-cultivation is carried out in the areas that will not be subject to extraction effects for several years and the maintenance of forests and plantations as well as complete reclamation of degraded surfaces and reconstruction of buildings is executed.

In the past years, the Municipality of Velenje has also put great efforts in regeneration of municipality-owned areas exposed to degradation caused by coal mining so far. The Municipality of Velenje has invested in the development of the area around the man-made lakes above the mine and in broader surroundings (Velenje lake, Škale lake). This has resulted in an attractive tourist location with a great offer of recreational activities (swimming, surfing, SUPing, cycling, hiking, horse riding, sport fishing, etc.). The Lake Velenje is furthermore suitable for bathing, which has encouraged a construction of the beach on the lakeshore, used by thousands of swimmers each year (80.000 visitors in the season of 2018).

In 2018, the Velenje beach (Velenjska plaža) received an award for the best natural bathing place in the country. The municipality's vision is to continue with the transformation and further development of this area. The newest project of the MOV is a regeneration of a Velenje lake nearby area, where the big event stage (2,375 m^2) together with the event area will be constructed. The construction work will start in July 2019 and it is expected that the project will be finalized in December 2020. The main result of the project will be a revitalized area of 46,090 m2. The total project investment cost will be 8,8620,512.43 million euros, of which MOV's share will be 2,861,274.43 million euros. The remaining amount is co-financed by EU funds (Integrated Territorial Investment – ITI) and by the state budget.

The clearest proof of sustainable development of the Šaleška valley is the tourist and recreational area that has been developed around the man-made lakes above the mine and in broader surroundings. As a result of common efforts and a major environmental rehabilitation in the past three decades, one of the most environmentally burdened landscapes in Slovenia has changed to a post-industrial landscape with quality natural, social and economic environment.

Closure of the Trbovlje thermal power plant (SI)

The most recent experience with concluding operations in coal-powered energy is the closure of the Trbovlje thermal power plant (Termoelektrarna Trbovlje-TET). The company permanently shut down the coal-fired unit (125 MW) and underwent liquidation procedures beginning in 2014 after enduring long-term loses due to overall poor economic performance. The framework for shutting down the plant was however set already in July 2000 with the passing of the law on the gradual closure of the Trbovlje-Hrastnik mines and development restructuring of the region (Zakon o postopnem zapiranju Rudnika Trbovlje-Hrastnik in razvojnem prestrukturiranju regije - ZPZRTH), which anticipated the commercial exploitation of the resource until 2007, closure operations to commence until 2012 as well as the scope of financial resources required to fund said operations. The law underwent several amendments, which also saw the extension of the deadline for exploitation until 2009/2012 (ZPZRTH-A, ZPZRTH-B) and the extension of the deadline for final closure by the end of 2018. The law set the budget allocation with the timeline for all closing operations as well as for the regional development activities.

It can also be anticipated that a post mining land restoration plan could be set by the law on the gradual closure of the Velenje coal mine (to be prepared) whereby the

funds for the implementation of the mine closing program would be probably provided from the state budget of the Republic of Slovenia and from the own sources of the Velenje Coal Mine as this was the case with most recent closure of the Trbovlje-Hrastnik mines. In April 2019, the National Assembly of the Republic of Slovenia already called on the Government of the Republic of Slovenia to establish a working group to prepare a timetable and a fair plan for the early closure of Velenje Coal Mine (the only operating coal mine in the country) and the abandonment of fossil fuels at the Šoštanj Thermal Power Plant. Based on this call, the Ministry of Infrastructure prepared documentation on the establishment of a government working group, which will be responsible for determining the timetable by the end of 2020 and coordinating the activities related to the decarbonisation, fair energy transition and restructuring of coal regions.

Mitigating environmental harm (DE)

One of the most common environmental hazards associated to mining is the presence of iron-hydroxide in mining affected rivers, due to discharge of iron rich waters. The problem becomes acute as the hydroxide flocs are not shiftily sedimented threatening pollution downstream. There are a number of technical approaches to managing this pollution factor. Many of these solutions require technical infrastructure and it is unclear how much they contribute to hydroxide retention in the river system.

In Lusatia, it is reported, the groundwaters became rich in ferrous iron with concentrations up to 400mg/L. The Mining Administrative Company needed to take targeted interventions (engineering and mechanical processes) to remove iron hydroxide dislodged and harmful chemicals from the soil and phosphorus and other pathogens from lake water.

At present, to prevent the deterioration of the rivers there are two strategies followed:

First, stopping the iron loads from entering protected areas. One of these is the Spreewald area, a forest of significant environmental and touristic value. This method has the advantage of demarcating areas of hydroxide retention. The iron sludge is periodically removed, however citizens and authorities request “retention at source”. As this is not always possible due to iron diffusion at various parts, local measures are implemented such as pumping wells and ditches which are tested regularly.

It is established by experts that the impact of water pollution from mining activity reaches the river Spree in Berlin and has measurable impact on drinking water reservoirs in Berlin and Frankfurt (Oder). The plan under parliamentary scrutiny and process for approval includes the development of a system of reservoirs and dams to guarantee safe drinking water supply. The project is going to be established in the form of a strategic plan. Such strategic plan is to be accompanied by monitoring, control and reporting measures regarding the pollution in rivers, lakes and groundwater bodies to ensure adequate data collection and transparency.

Concluding remarks

This best practice guide presented fragments of regional decarbonisation processes, in their technical/technological, socio-economic and political dimensions. Collecting cases from 9 countries, the major findings can be re-iterated in a summary form:

1) Despite overall progress in decarbonisation, more sustained efforts are required. The overall tendency across the partnership is to take steps towards decarbonisation of the energy sector, however efforts need to accelerate to attain both the 2020 and the 2030 targets for the reduction of CO_2 emissions. In many cases, it is clear that economic reasons, 'locked in' investments and fossils' availability, prevent following through with timely phase out of fossils' combustion. Needless to say, a number of decisions are a matter of central, national energy policy, and indeed, effecting considerable shifts in a national energy mix long dependent on fossils, is not a straightforward matter. However, there is plenty of scope in regional terms for small, incremental progress in performance metrics of decarbonisation.

2) It is important *how* various decarbonisation tools and drivers, such as the EU ETS, are used in each energy production and supply context. A finding inviting reflection is that there are several ways in which financial instruments or schemes for the reduction of emissions can be deployed. The variation observed suggests a wide range of effects, from impeding decarbonisation and incentivizing the continuation of energy supply from fossils, to direct positive impacts. This is suggestive of another key remark:

3) Political choice is what matters the most. Despite the fact that the *de facto* long-term interest of all is in the immediate termination of energy production from fossils, and deep decarbonisation across all sectors, it is clear that in decisions regarding energy mix planning, there are different conceptions of self- and societal interest at

play. Decisions in this respect appear to be driven by more simple and less far-sighted understandings of 'interest'. Precisely because high level policy decisions are often taken under pressure and circumstances of urgency, indeterminacy and severe constraints, it is rather important that a change in perceptions, regarding the necessity of decarbonisation, of what constitutes societal, regional and, eventually, self- interest, and a change in energy consumption patterns, should come from the 'bottom-down' – as a social demand with concrete and innovative proposals and facilitated by administration. Administrations – regional or otherwise – are faced with a realist dilemma: either proceed to deep decarbonisation of the energy sector and manage resistance from society, or respond to current societal energy needs and impede effective and timely decarbonisation. The obvious solution to the dilemma is that which alters the terms of its formulation: make deep decarbonisation a win-win scenario, so that regional societies not only will embrace decarbonisation, but will contribute actively to changing energy consumption patterns towards the direction of rendering fossils' combustion obsolete. This requires a great deal of mentality shifts, initiatives promoting RES, sustained education at all levels, as well as plenty of support and financial resources. It is of outmost importance that administration is on the receiving end of societal signals indicating that decarbonisation is not an obstacle to development, but the only possible way to any further development.

4) Regional administrations and national energy authorities can take advantage of several RES development and funding opportunities. Many cases among those presented indicate that careful finance planning, linking carbon pricing with RES infrastructure development, drawing on co-funding options and providing adequate incentives to curb fossils' energy demand, can significantly contribute to increasing demand for RES, and curbing demand for fossils.

5) At the regional level significant contributions can be made in the context of post-mining environmental management and land restitution. In this respect, there have been rather successful approaches to mitigating environmental risks and restoring the properties of the natural environment or even completely changing the outlook of a landscape. Along with other environmental initiatives – planting trees projects – land restitution, constitutes a prime CO_2 reductions factor, neither on the supply nor on the demand side of energy production. However, if regional communities have concrete plans of restoring ex-mining landscapes in a way that further mitigates harm from emissions, the gain is multiplied.

6) Regions in collaboration with national authorities should do a great deal of work on education in a planned and consistent manner. Taking on board some of the previously mentioned remarks, a shift in mentality in terms of how energy matters are conceived, requires interventions in education, as, currently, the majority of social groups, including young people, have very little understanding of just how energy is produced, what it takes for it to be transferred, what alternatives there are and how they are to be pursued, or, simply, how energy-demanding the practices they are engaging daily in actually are. Making people more environmentally conscious is not a simple procedure, but it cannot but start from a bold intervention in education with the introduction of sustainable development and environmental protection as a compulsory module in all curricula. Providing ample opportunities for environmental education, horizontally for all primary school, and selectively for more senior students, increasing technical and higher education programmes and specializations on sustainable energy, sustainable development, RES development, are some of the best means authorities have in their disposal to effect meaningful change in the long run.

This guide has been developed with a diverse audience in mind. Policy stakeholders, regional authorities, sustainable development planners, members of the public, can all approach this guide from a different angle. That said, the cases presented are beneficial for any regional stakeholder in decarbonisation processes, as one can find inspiration in what transpired in a different setting and adjust accordingly their own practice.

In particular, the staff of regional authorities involved in various types of planning activities – from environmental planning to social policy planning – can benefit greatly from drawing lessons from practice in other regions and countries.

Simultaneously, policy makers will find in the preceding pages a summary, as it were, of the plurality of approaches to decarbonisation and gauge aspects they may not be familiar with. Such approach, valorizing perspectivism, can be beneficial, as there are several paths of change in terms of energy decarbonisation.

Finally, it should be re-iterated that although there are general provisions, high-level targets to be attained and constraining factors beyond the reach of regional capacity for interventions, regions can do a lot to lead decarbonisation and steer it to a long-term beneficial direction, rather than being subjected to its adverse in societal terms effects.

Further resources:

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