October 2021

Report

The socio-economic impacts of renewable energy in EU regions

Strengthening local benefits of renewable energy deployment

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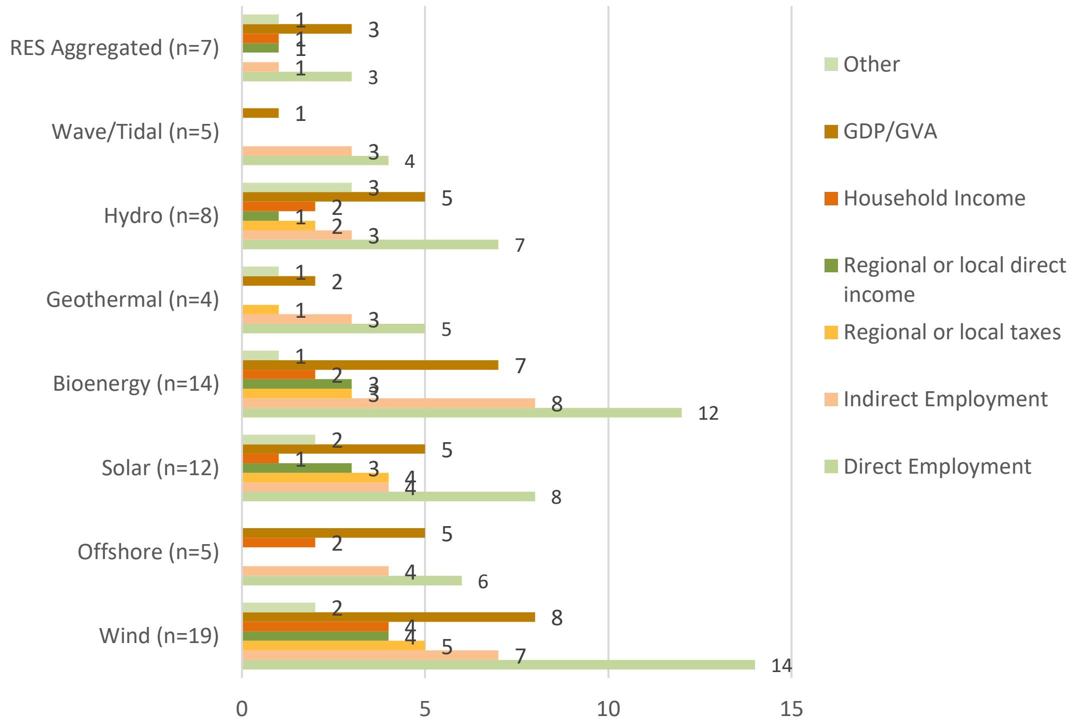
CONTENTS

1. EXECUTIVE SUMMARY

The Climate Law and its strengthened 2030 greenhouse gas reduction target requires a substantial acceleration of RES deployment in the EU in the next years. Ensuring socio-economic benefits for local communities will be key to the social and political acceptability of this rapid energy transition.

While most of the literature on the economic effects of renewable energy is focused on the global or national levels, this report uses a semi-systematic literature review and 5 case studies to assess the evidence of socio-economic impacts associated with the deployment of renewable energy (RES) at the level of EU regions, and seeks to identify key factors that shape them.

Figure ES1: Assessed economic impacts per renewable energy technology in reviewed literature (n=38)

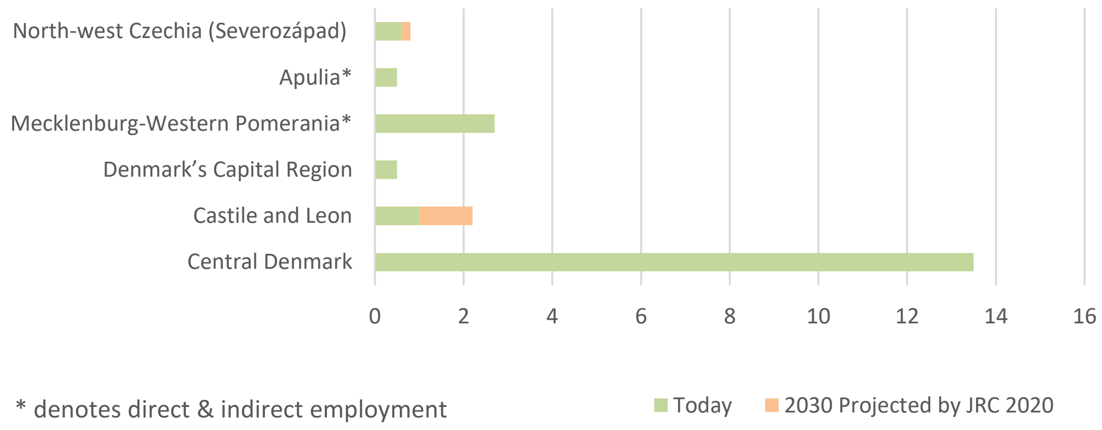


As shown in Figure ES1, the primary focus of the literature is on wind, followed by solar and bioenergy, while the major focus of socio-economic impact analysis is on employment, followed by GDP and value added, with broader indicators like health and wellbeing all but absent. Given the methodological diversity in the literature, as well as the wide range of regional contexts, the rapid development of the RES sector and policy frameworks and generally weak availability of data at regional level, care must be taken in extrapolating conclusions from one region to the next. Nonetheless the following headline findings have been identified in the literature, many of which are further supported by the case studies.

What are the socio-economic impacts of RES deployment in EU regions?

- **The impact on employment** is found to be generally positive, although often limited – RES jobs representing around 2% or less of regional workforces in our case study regions (see Figure ES2). RES employment exhibits low intensity and concentration, and varies by stage of RES deployment and the extent to which upstream activities are located within or outside the region. There is evidence that jobs are driven by SMEs in some regions, including those in Germany and Spain. Employment impacts may not be net positive, however, for a small number of transition regions with high levels of employment in fossil fuel industries, and especially where renewable energy potential is low.

Figure ES2: Share of workforce directly employed in RES in a selection of EU regions



Source: Own calculations based on case study analysis and JRC (2020) projections.

- **The impact on regional GDP or value-added** is found to be positive for nearly all regions, and given the low employment intensity of RES, is considered by many researchers to be the most significant socio-economic benefit. Similarly to employment, the extent of this impact is found to relate to the location of upstream and related industries, as well as to the ownership structure of industries. Avoided fossil fuel import costs can have expansionary effects. Some regions can further benefit from energy export-led development. There is evidence that higher levels of RES investment regionally are associated with higher levels of R&D investment regionally, leading to longer term innovation and enhanced competitiveness.

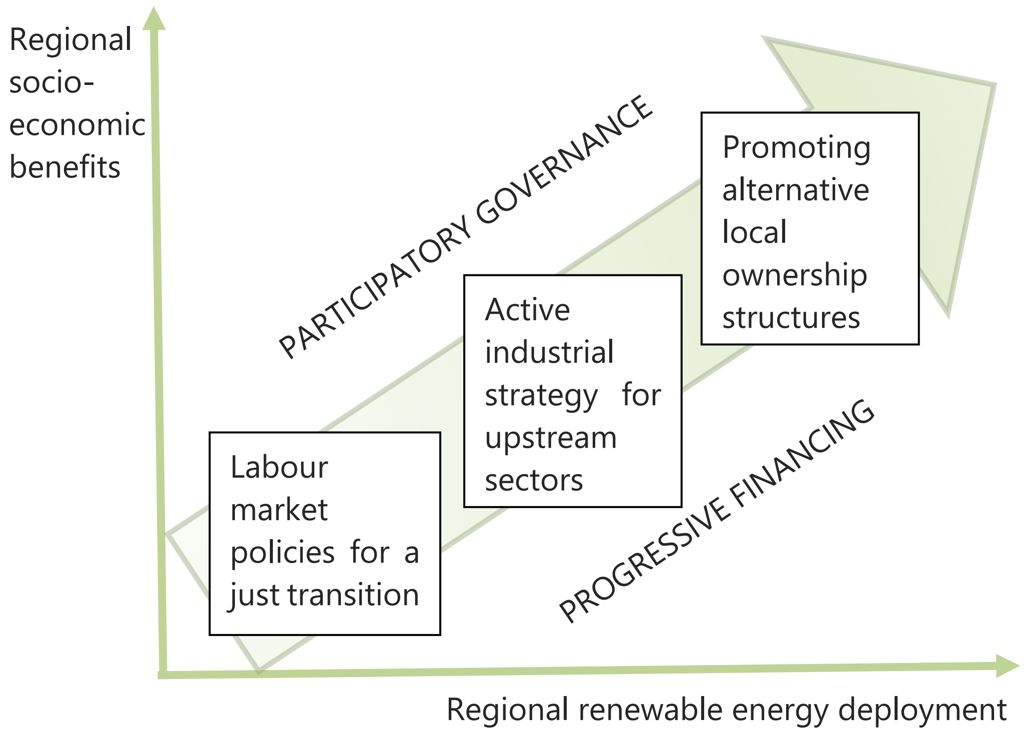
- **The impact on household income** has received less attention in the literature, although there is evidence of regressive distributional impacts of some RES financing approaches like consumer charges, as well as of the positive impacts associated with local ownership of RES assets and land (more so than other benefit-sharing schemes).

Which factors affect the extent of these socio-economic impacts?

The extent to which regions can realise these (and other, under-researched) socio-economic benefits, depends to a large extent on the natural endowments – and resulting RES potential – as well as the underlying socio-economic characteristics of regions. Transition, peripheral and rural regions all face particular challenges assessed in the literature.

However, policy choices can nonetheless make a significant difference. Five policy areas emerged from the literature and case studies as being particularly important in shaping socio-economic outcomes, as depicted in Figure ES3.

Figure ES3: Policy levers to increase the socio-economic benefits associated with scaled-up renewable energy deployment in EU regions



- **Labour market policies** are widely assumed to be essential to ensuring a just transition for workers in fossil fuel industries, through creating re-training and re-employment opportunities and other social safety nets, although hard evidence assessing such policies remains scarce, as few regions have yet to implement such policies in practice. Beyond measures to address fossil fuel workers, investing in developing a skilled labour force, especially in upstream and related RES industries, is found to be a critical enabler of socio-economic benefits across many regions.

- **Industrial strategy** at the national and regional level is found to be critical to guide investment and build capacity in local RES suppliers and upstream sectors and to maximise local industrial synergies – such as with the ship-building sector in some coastal regions. Ensuring RES R&D, design, manufacturing and construction are sourced from within the region maximises the region's socio-economic benefits, although there is evidence that other regions are also likely to benefit from spill-over effects.

- **Alternative models of local ownership and community benefit-sharing –** where effectively promoted – are widely found in the literature to substantially enhance regional socio-economic benefits. However, many barriers to local ownership have been identified including capacity issues, opposition from corporate owners, access to capital and the increasing size of many RES projects. Trade-offs have also been found between the degree of local ownership and control and the speed and scale of deployment.

- **Regional governance arrangements** are extensively discussed in the literature. There is much evidence of bureaucratic and procedural hurdles delaying RES deployment, and of the benefits associated with strengthened regional governance capacity based on clear regional development and socio-economic objectives. Meaningful public consultation processes are found to be a key enabler of social acceptability of RES deployment.

- **Financing options** can have decisive socio-economic implications. Using consumer fee-based approaches are found to be regressive in some cases, unless proceeds are re-invested in local communities. Auctions may prioritise speed of deployment and larger-scale, established actors over small-scale and local alternatives, unless carefully designed. EU level funding – including the Just Transition Mechanism and Modernisation Fund – are key in some regions. Rural Development Funding offers as yet seemingly untapped potential.

Based on the regulatory signal given by the Climate Law and the rapidly falling costs of RES, the EU energy transition is now inevitable and irreversible, but the extent to which it achieves socio-economic benefits for local communities is not.

This study suggests that positive socio-economic impacts are easier to achieve in certain regions, based on their natural endowments or existing socio-economic context. But policy choices can nonetheless be decisive. A combination of labour market policies, industrial strategy, promotion of alternative ownership models, effective and participatory governance and progressive financing options can all help to maximise the socio-economic gains – and likely therefore the social acceptability – of RES deployment in EU regions.

2. GLOSSARY

CZ – Czechia (Czech Republic)

DE - Germany

DK – Denmark

EAFRD – European Agricultural Fund for Rural Development

ES – Spain

EC – European Commission

ECA – European Court of Auditors

EU – European Union

FIT – Feed-in-tariff

GDP – Gross Domestic Product

JRC – Joint Research Centre

ILO – International Labour Organisation

IRENA – International Renewable Energy Agency

IT - Italy

NECP – National Energy and Climate Plan

NUTS - Nomenclature of territorial units for statistics

RES – Renewable Energy

RES – Renewable Energy Source

SDG – Sustainable Development Goal

3. INTRODUCTION

In recent decades, renewable energy (RES) deployment in the EU has increased significantly – growing from under 10% of final energy consumption in 2004 to around 20% in 2020 - driven by a combination of policy decisions at EU, Member State (MS) and local levels and the falling costs of RES technologies. But progress has not been even across the EU, either between MSs – with Sweden reaching approximately 56% compared to Luxembourg at just 7%, for example – or at the regional level within them.

The Climate Law and its strengthened 2030 greenhouse gas reduction target requires a significant acceleration in RES deployment this decade. The European Commission's (EC's) proposed revision to the Renewable Energy Directive (REDII) targets at least 40% of energy from RES by 2030, for example. Critical to accelerating deployment will be ensuring that RES brings not only environmental, but also socio-economic benefits to local populations as part of a just transition.

A key question, therefore, is what socio-economic impacts may be associated with RES deployment in EU regions, and – critically – what are the key factors that seem to shape those impacts? Most attention has been paid in the research literature on the economic effects of RES policy to the global, European or national levels (Jenniches 2018), but it is at the regional level that a lot of the most important socio-economic impacts will be felt and the politics of social acceptability of RES deployment will be shaped.

At the global level, high level analyses suggest that the transition to an economy powered by renewable energy will have a net positive employment effect (Pai et al 2021). According to the International Labour Organisation (ILO), 18 million net jobs can be created globally by 2030 through changes in the economy to achieve the 2°C Paris Agreement goal by the end of the century (ILO 2018). Pai et al find a net increase of 5 million jobs in the energy sector globally under a "well-below 2°C scenario," the vast majority in renewables. IRENA (2016) similarly notes significant increases in employment and GDP growth, but also even greater increases in social well-being if the share of renewables is doubled by 2030.

However, these positive global figures may conceal significant shifts in employment and broader and geographically-differentiated socio-economic effects. Renewables create employment and economic activity in a more geographically dispersed manner than conventional energy industries, potentially supporting local, dispersed economic activity and employment, but also de-concentrating economic activity in ways that may have profound social, economic and political implications, particularly at the regional and local level. Notably, the

European Commission (JRC 2020b) finds net positive impacts on GDP and jobs at EU level but notes that national and regional differences may occur.

Assessing the regional economic impacts of RES in the EU may be particularly important in regions where these developments have weak popular or political support, since illustrating the regional benefits may lead to increasing social and political acceptance. Relying on national or international assessments does not give a full picture of the impacts or potential at regional scale.

This report explores the socio-economic impacts of the deployment of renewable energy in EU regions and tries to identify factors that are conducive (or not) to a "successful" energy transition, meaning a transition to a renewables-based energy system which fosters (directly and indirectly) sustainable and just socio-economic development in EU regions. It follows two approaches: a semi-systematic review of academic and grey literature related to the question of regional level socio-economic effects of renewable energy deployment, with a focus on the EU, complemented by five case studies on a variety of EU regions.

4. METHODOLOGY

4.1 Literature review

A semi-systematic English language literature review (Snyder 2019) was conducted (see Section 11 for full methodological details). The review used search engines to identify peer-reviewed and grey literature featuring keywords related to renewable energy deployment and a range of socio-economic indicators at the regional or local level in the EU.

The review was limited to literature published since 2010 due to the dynamic, fast developing nature of the renewable energy industry. Articles related to renewable energy for transport, to energy storage and batteries, to hydrogen and those focusing specifically on public opinion or perceptions of renewable energy were excluded.

This yielded a focus sample of 38 articles, as listed in the Annex. The bulk of the identified literature is from the UK (7), Germany (8), and Spain (6). Other countries featured include: Finland, Sweden, France, Romania, Slovakia, Austria, Italy, and the Netherlands.

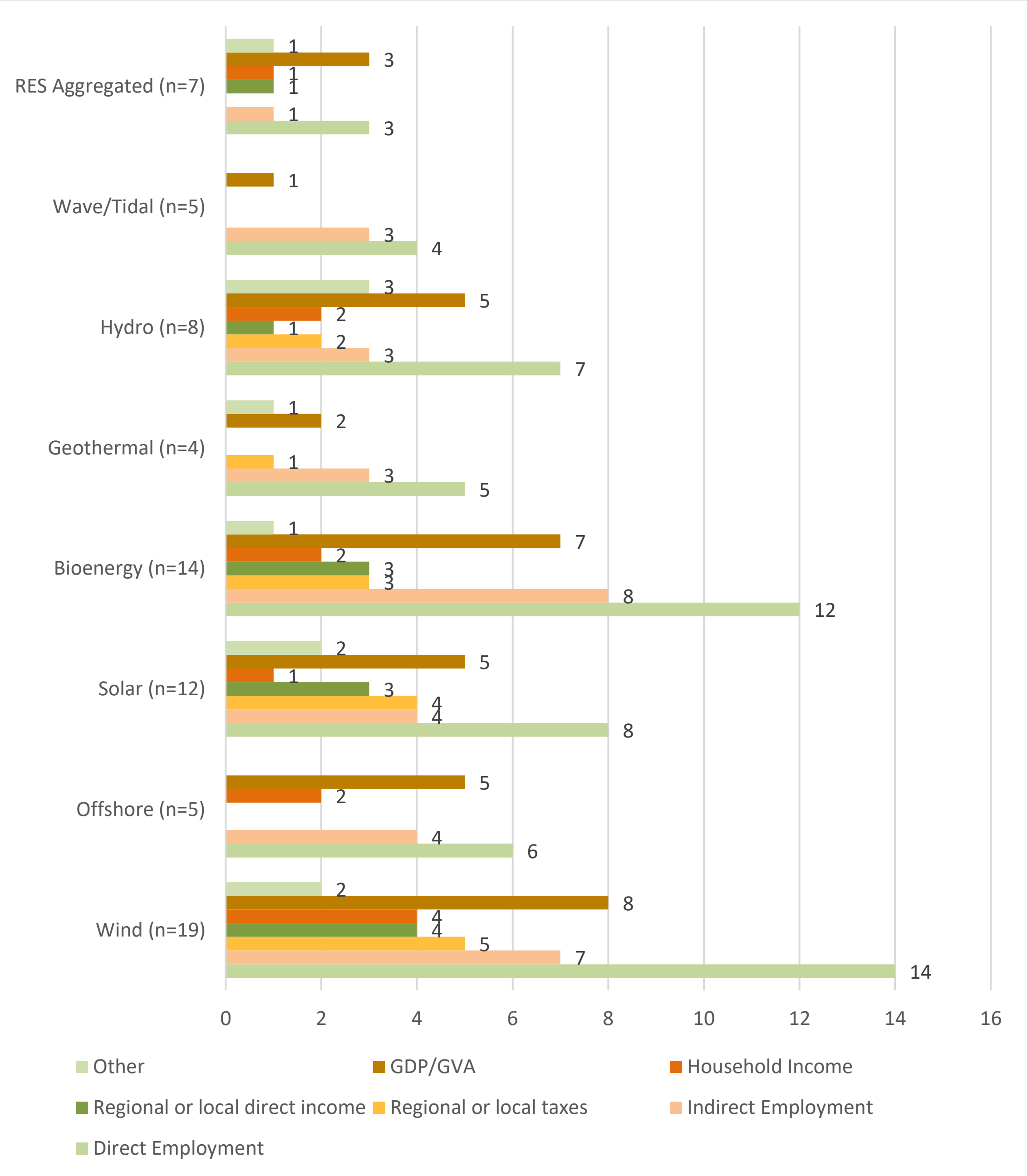
These articles all have a regional focus. They may focus on one region or compare between regions. The size of region is variable, ranging from NUTS-1 to NUTS-3. It is notable that rural and peripheral regions received significantly more attention than transition regions.

The literature covers a range of renewable energy technologies and a range of socio-economic factors. As shown in Figure 1, the largest focus of the literature is on wind power, followed by bioenergy and solar. In terms of socio-economic impacts, the overwhelming focus of the literature is on employment, with considerable attention given also to GDP and value added, while other economic issues are only marginally considered, and the use of broader socio-economic indicators, including health or wellbeing metrics, were either only minimally addressed or entirely absent in the literature analysed (see Fudge et al 2021).

The identified literature was then assessed for findings and results presented related to two principal research questions:

- What is the evidence of socio-economic impacts associated with renewable energy deployment in EU regions?
- Which factors may determine the nature and extent of socio-economic impacts?

Figure 1: Assessed economic impacts per renewable energy technology in reviewed literature (n=38)



4.2 Methodological reflections and limitations

Care is needed when drawing conclusions from this literature for a number of reasons.

Firstly, critical reviews of the literature have noted the complexity of fully accounting for the systemic social and economic effects from renewable energy deployment, including accounting for opportunity costs, 'crowding out' investment, dynamic technological effects, lower environmental, healthcare, and security costs, and increased security of supply (Fanning & Jones 2014). These are sometimes taken into account but are not often integrated into economic models or research methods.

One exception is in Jenniches & Worrell (2019) which includes detailed calculations of the health and economic benefits of avoided air pollution based on solar PV deployment in the Aachen region. However, many articles simply mention that health related benefits exist and could be accounted for, but are not specifically quantified within the scope of their methodologies, for example: Gerbelová et al (2020), Aniello et al (2019), Magnani & Vaona (2013). Many other articles are focused on a particular economic variable and do not even mention broader considerations of well-being or comprehensive impact assessment.

The main impact assessment models used in the literature, roughly in order of complexity, are (Jenniches 2020):

1. **Employment ratios** - simple, based on available information, but very region and technology specific;
2. **Supply chain analyses** - give a precise view of a particular industry in a particular region, can be easily updated, but detailed proprietary information is needed;
3. **Input-output (IO) models** – the most common method, IO tables show the flow of goods and services between the industries in an economy from their production to their final use. National IO tables can be adapted for regional use to show a reasonably detailed economic model, albeit with some simplification;
4. **Computable general equilibrium models** – computerised simulations that model shifts. These are the most dynamic and detailed models but are difficult to apply due to data availability and may contain certain economic assumptions.

These all have advantages and disadvantages and may be used in combination depending on the resources and data available and the research question. For a detailed discussion of their relative merits see Jenniches (2020).

Some of the models used for regional modelling are somewhat simplistic due to the relative lack of data compared to the national level. Even where more sophisticated models are used, these still rely on a number of assumptions and simplifications that do not allow for a full picture of dynamic developments as a result of renewable energy. For example, the effects of innovation, economies of scale, and increasing productivity may not be taken into account (Jenniches 2020).

The vast majority of the literature focuses on more easily identifiable economic benefits (e.g. through job generation), and most often lack a comprehensive analysis of additional benefits, such as changes in regional economic perspectives (e.g. leading to improved export chances), innovation dynamics and spill-overs, as well as further macroeconomic effects through improved public health and other factors. Therefore many factors are missing that would be important from a comprehensive regional economic evaluation perspective, let alone a broader sustainable development perspective (Jenniches 2020).

Additionally, many studies may present only gross impacts without a full net economic analysis (although such net analyses as exist do not indicate a significantly different picture in terms of employment and economic benefit) (Jenniches 2020). Simple analysis of gross economic effects may still be a useful indicator of economic benefits and for "analyzing the long-term structural effects of job creation" (Pahle et al 2016).

Another group of studies takes a more political approach to the question of RES deployment and looks at patterns of institutional and political support and their interaction with the socio-economic effects of RES, for example Abegg (2011), Klagge & Brocke (2011), Hecher (2016), and Spijkerboer et al (2016). These more qualitative studies provide insights into the governance and political enabling conditions for the socio-economic benefits arising from RES deployment.

In analysing the economic impact assessment literature, two relevant themes emerged as being of particular interest within the scope of this study which have received a significant amount of academic attention: rural development based on renewable energy, as well as the effect of local ownership or benefit sharing. An effort has been made to include studies into these questions in this review, which have their own broader literature also hitting on more political, theoretical and very local implications.

Beyond this methodological diversity, care must be taken in drawing conclusions from the identified literature also because of the diversity of regions studied, the different technologies involved, different time scales, different institutional frameworks, the rapid development of the renewable energy industry, changes in climate and energy framework policies, and the generally low and delayed availability of relevant data in most (if not all) regions.

In fact, one of the clearest conclusions derived from the literature is that considerable care needs to be taken in extrapolating conclusions from one region to the next, and to distinguish clearly between different technologies and the different phases of the renewable energy life cycle (Llera Sastresa et al 2010; Jenniches 2020).

4.3 Case studies

The English language literature review has been complemented with a closer, more detailed analysis of the two research questions based on sources in local languages and available data in five regions, including analysis of available quantitative data which is not systematically available at EU level.

The case study regions have been selected in order to provide a range of NUTS-II level regions, based on the following criteria:

- Including Northern, Western, Southern and Eastern European regions;
- Including both urban and more rural regions, and both coastal and in-land regions;
- Including regions where the renewable energy transition is more and less advanced;
- Including regions where GDP/capita is higher and lower.

The five regions chosen thus represent a variety of different socio-economic and geographic conditions which allow for a reasonably balanced sample of different conditions for renewable energy (RES) deployment in EU regions, as depicted in Figure 2. They are:

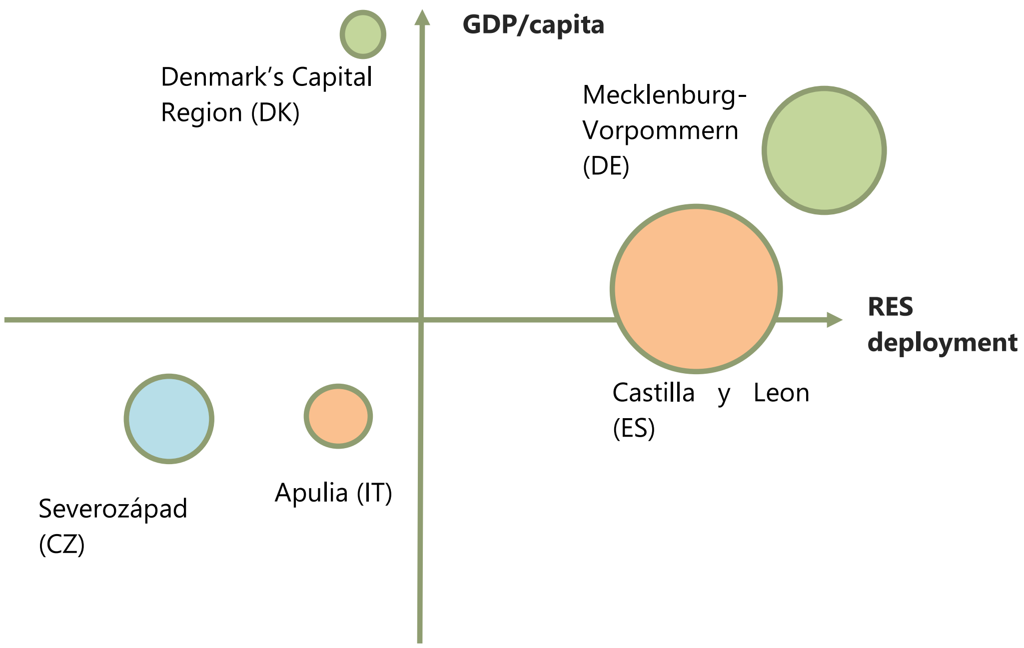
- **Castile and León (*Castilla y León*)** (ES): a rural, in-land region (25.6 persons/km) with a medium to high level of RES deployment, and below average GDP/capita (80% of average EU GDP/capita). It is a former coal region, but has little history of heavy industry.
- **Mecklenburg-Western Pomerania (*Mecklenburg-Vorpommern*)** (DE): a relatively rural region (71.3 persons/km) with a high level of RES deployment, and near average GDP/capita (93% of average EU GDP/capita). It is coastal with some older industry but today mainly tourism and technology focused.
- **Northwest Czechia (*Severozápad*)** (CZ): a somewhat urbanised region (131.7 persons/km) with a low level of RES deployment, and low GDP/capita (47% of average EU GDP/capita). It is an inland coal region in transition, with the highest level of wind power in Czechia.

- **Denmark's Capital Region (*Region Hovedstaden*)** (DK): an affluent (221% of average EU GDP/capita), urban (756 persons/km), coastal region. Medium level of RES deployment although in a national context of high deployment.

- **Apulia (*Puglia*)** (IT)**:** a region with medium density (210 persons/km), a relatively low GDP/capita (63% of average EU GDP/capita). It has an average level of RES deployment and some legacy of fossil fuel industry.

Pertinent findings that support or contradict findings in the literature review have been incorporated into sections 5 and 6, short summaries of each case study are included in section 7, and fuller case study reports included in the Annexes.

Figure 2: Case study selection criteria overview



Smaller circles indicate higher population density, larger circles indicate lower population density. Green circles indicate Northern regions, blue circles indicate Eastern regions and orange circles indicate Southern regions.

5. WHAT IS THE EVIDENCE OF SOCIO-ECONOMIC IMPACTS OF RES DEPLOYMENT IN EU REGIONS?

Key findings

- Employment is the most studied economic effect of RES deployment in EU regions, and found to be generally positive, if often limited, but with the exception of a small number of transition regions with high concentrations of fossil fuel workers and limited RES potential.
- Direct and indirect employment in RES is not particularly intensive, is less concentrated geographically than in fossil fuel industries, and varies considerably by the phase of the project.
- GDP and/or value added are also widely studied economic effects of RES deployment, and generally found to be positive for nearly all regions, particularly where upstream and related industrial synergies are exploited.
- Taxes are an important part of capturing local value for the region, but some authors argue these need to be carefully modulated so as not to discourage investment.
- The distributional effects on household income are heavily influenced by how the RES is financed and the extent of local ownership, and can be regressive without careful policy design.
- No clear evidence of a negative effect on tourism has been found.
- It is hard to draw broad conclusions to differentiate between technologies across regions, except with regard to biomass, which has more complicated effects than other technologies.

5.1 Findings related to indicators of socio-economic impact

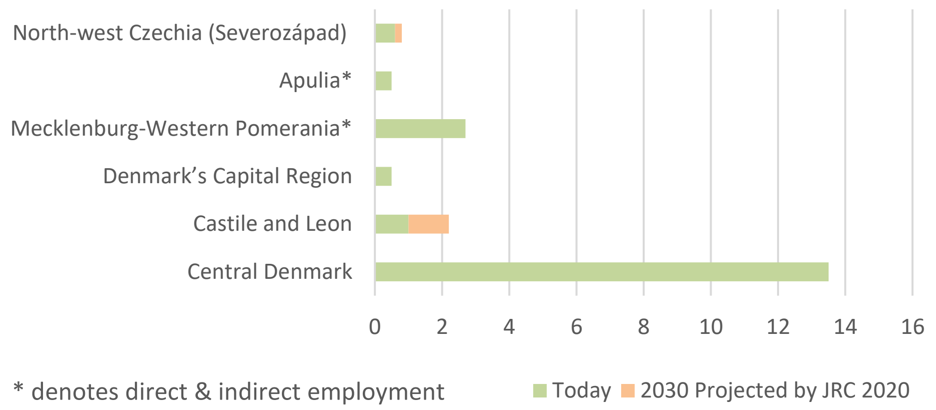
5.1.1 Employment

Generally positive

Effects on jobs are generally found to be positive across all studies and all technologies. Different studies and methodologies come to different estimates of the degree of benefit, ranging from relatively small to significant. Not all studies consider both direct and indirect employment, however, while relatively few consider induced employment (Jenniches 2020; Aldieri et al 2019).[1]

For example, the European Commission (JRC 2020) determined broad estimates of direct regional employment potential based on national level data in a range of coal regions, finding total jobs per region ranging from a few hundred to several tens of thousands (see section 6.1.3). Analysis of data from our case study regions indicates that direct employment in RES may constitute around 2% of the workforce in regions with high RES potential like Mecklenburg-Western Pomerania and Castile and León, and less in others. By comparison, the share of employment in Central Denmark – likely the region with the highest share in the EU – reaches nearly 14% today (see Figure 3).

Figure 3: Percentage of workforce directly employed in RES in a selection of EU regions



Source: Own calculations based on case study analysis and JRC (2020) projections.

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[1] The definition of indirect jobs varies, but usually refers to the supply and support of the RES industry at a secondary level, e.g., materials (e.g., cast iron and steel) and services consumed on the upstream supply chain. A further extension is the consideration of consultancies and minor components not directly related to the sector. *Induced jobs* emerge due to spending originating from direct and indirect employment.

It is important to note, however, that in some transition regions with low renewable energy potential and/or high levels of employment in the fossil fuel energy sector the net effects on employment may be negative in the long term (see also section 6.1.3). This is confirmed in the case study for Czechia, for example, with only about 0.1-0.7% of current employment in RES, with a projection of only about 0.8% of potential employment in the electrical sector in RES (JRC 2020), whereas almost 2% of employment is in the coal industry today.

Regional spill-over effects

Investment in regional RES installation and industries can have a positive effect on regional employment by driving up wages and attracting labour from other regions, with potentially continuing effects even after the initial projects cease, especially if a local supply chain for the industry is developed (Gilmartin & Allan 2014) (see section 6.2.2). This is an effect on employment that is not accounted for in many studies, as they rely on IO models that cannot include this dynamic effect, while a CGE model such as Gilmartin & Allan use can.

Ulrich et al (2012) show that in Germany even regions that are not the most well suited for renewable energy benefit from deployment in other regions due to indirect effects: "Indirect effects spread out over the whole country and, although they are not evenly distributed among the regions, one can see that gross employment can greatly benefit also in the federal states in the south of Germany."

Cameron and Zwaan (2015) have posited that it is possible that RES will lead to more jobs economy-wide simply because it needs a higher installed capacity due to variability (although the full systemic economic effects of this shift remain to be fully analysed). This could be important at a regional scale, particularly where a high RES potential leads to a regional energy export strategy to supply the broader energy grid or energy storage. Rural or peripheral regions with high RES potential could therefore build up specialisation in RES as an important jobs strategy.

Low concentration and low intensity

The structure of employment in renewable energy is fundamentally more distributed than is the case in traditional, fossil fuel energy industries which tend to have concentrated, localised jobs (Bryan et al 2015). While seemingly self-evident, this characteristic has fundamental implications for the economic consequences of RES.

Employment in RES is also generally not intensive (Aldieri et al 2019), so the employment effects of re-investment, particularly in labour intensive activities, has been shown to be much more significant than direct employment (Okkonen & Lehtonen 2016) (see section 6.2.3). Okkonen & Lehtonen found that "strategic re-investments of revenues in local social services generate about tenfold additional employment and income impact compared with the impact of wind power production."

Dynamic changes over time

Some researchers highlight that employment intensity will likely decrease as technologies mature (Bryan et al 2015).

RES jobs can be precarious and have fluctuated significantly in response to government policy. In many cases local industries have been reliant on government subsidy frameworks and a small number of key actors making them potentially fragile (Bere et al 2016).

Numerous researchers insist on the importance of disaggregating the phases of the life cycle of a RES project when discussing the socio-economic impacts, as they can be quite different. The literature has identified the following phases of a renewable energy project life cycle (Llera Sastresa et al 2010):

- research and design,
- development and manufacture,
- construction and installation,
- operation and maintenance (O&M) or service,
- updating and/or dismantling

Most researchers use only an aggregated version of the lifecycle by dividing it into two stages which are:

1. manufacturing, construction, installation, and
2. operation, maintenance.

However, it should be noted that manufacturing and installation are in fact quite different from an economic point of view, as most regions will have some capacity for local installation, even when they do not have manufacturing capacity (Jenniches 2020).

Construction and installation will often be the most labour-intensive phase. It is also usually possible to source a significant portion of this labour locally. However, it is also relatively short lasting, and is not a given that the labour will be sourced locally depending on the skills available locally, the size of the project, and the technology in question (Ejdemo & Söderholm 2015).

Manufacturing can also be an important source of employment, including in the longer term. Numerous studies point to the location of manufacturing within the region as critical to the level of economic benefit (Ejdemo & Söderholm 2015; Slattery et al 2011; Hartono et al 2020) (see section 6.2.2). Manufacturing and installation are the most economically intense in terms of employment and value added but are not the most important over the life cycle of the projects (Heinbach et al 2014). However, as an IRENA report notes, manufacturing for RES is easier to localise than it is for fossil or nuclear technologies, and in any case manufacturing still only accounts for maximum 19% of jobs in RES (IRENA 2020).

Although there may not be a large number of jobs created during the operation & management phase, these tend to be permanent jobs, and can often be "high quality" jobs, and particularly when compared to the alternatives available regionally (del Rio & Burguillo 2009). Some argue that the most long-term benefits for given regions are linked to the location of high-tech companies and research institutes which focus on R&D, but these will also be the least likely to be located in a given region (Dvořák et al 2017).

However, jobs in this phase tend to be permanent and highly specialized, as well as potentially generating innovation and further development of the industrial and business base of the region (Llera Sastresa et al 2010; Horbach & Rammer 2018). These effects can develop even without a regional strategy but could be greatly enhanced if a strategy is put in place to develop a regional renewable energy industry according to Llera-Sastresa et al (see section 6.2.2).

5.1.2 GDP/Regional value added

More significant than employment benefits

Some studies find a potentially significant impact on GDP or regional value added (Varela-Vázquez 2015; Phimister & Roberts 2012) while others find a small net impact (Többen 2017). Kahouli and Martin (2017) found this was most significant during the investment phase for an offshore project in France, confirming the general consensus across studies.

Given the low employment intensity of RES, according to Slee (2019), the contribution of renewable energy to regional GDP is very likely to be more significant than the employment effect during the operation and maintenance phase. This is especially true in regions with high renewable energy potential which become net exporters of energy and are able to benefit from the income generated (Slee 2019).

For example, Mecklenburg-Western Pomerania is now a net exporter of electricity, and renewable energy production accounts for 7.5% of GDP in the region (while it accounts for just under 3% of employment). Simulations have projected that this will keep rising and account for faster economic growth than in a baseline scenario with less RES.

Balance of payments benefits

Magnani and Vaona (2013) report a significant positive effect on regional economic growth from renewable energy and that "renewable energy generation alleviates balance-of-payments constraints and reduces the exposure of a regional economy to the volatility of the price of fossil fuels".

Alleviation of the burden of paying to import fossil fuels is frequently cited as a significant potential benefit for regional economies (Peura et al 2018). However, it should be noted that in some cases the replacement of fossil fuels may be more expensive, depending on the cost of renewables in the regions concerned, although in general these are expected to continue to fall in the years ahead (IRENA 2021).

Corporate income benefits

Raupach-Sumiya et al (2015) find that business profit from RES system operation rather than income from local employment is the most important, long-term source of regional value-added.

Challenges in transition regions

On the other hand, regions with low potential for RES or which have existing fossil fuel industries may see a negative effect on regional GDP (Többen 2017) from a broader switch to RES (see also section 5.1.2). While most coal regions can expect to compensate for lost fossil jobs with jobs in the RES industry, there are a handful of regions in the EU which will not be able to do so, including in our case study region of Northwest Czechia (JRC 2020). However, there are other industrial options, for example in energy storage or energy efficiency, which can help to compensate if these are fostered correctly. As the case study in Castile and Leon demonstrates, other areas with legacy fossil industries can more than compensate for lost economic activity through renewable energy, at least in the medium to longer term, with the necessary just transition support measures.

5.1.3 Taxes

Local taxes can be an important, even critical way of capturing value added for the region (Copena et al 2019), but according to Raupach-Sumiya et al (2015), care is needed to balance between capturing value and discouraging investment. Overall, direct income and profits are shown to be significantly more important as an overall economic impact (Heinbach et al 2014).

5.1.4 Household income

Distributional income effects of consumer tariffs

One potential net-negative for household incomes can arise if renewable energy is financed through a consumer tariff on energy charges. In this case, the charge can have a negative or contractionary effect regionally if the renewable energy investments are made disproportionately outside of the region, or the region is dependent on fossil fuel intensive industry (Aniello et al 2019).

In general, distributional issues are not dealt with by most of the literature. However, it has been noted that increases in energy prices and levies for the financing of renewable energy can have a regressive character if they aren't designed carefully (Aniello et al 2019, Többen 2017). In Germany, the decline in disposable income associated with feed-in tariffs was found by Többen (2017) to have a regressive character.

It has been shown in the case study of Mecklenburg-Western Pomerania that 64% of Mecklenburg-Western Pomeranians stated that they think the energy transition will burden them financially. The design of the German energy tariff for renewable energy, without sufficient protections for low-income groups, can be partially credited for this perception (See Case Study 4).

The Italian region of Apulia is pioneering legislation designed to address energy poverty and provide access to clean energy for all. It will provide vulnerable households with access to small-scale renewable power. The details are still being finalised as of 2021 but it will be financed at regional level through the credits generated by selling unused electricity to the national market (See Case Study 1).

Some studies also assess distributional issues in relation to access to the ownership of renewable energy (Clausen & Rudolph 2020) where problems can arise when only those with ready access to capital can become owners, potentially reinforcing income and social disparities.

Income benefits for landowners

Income for landowners based on use of their land for RES installations can potentially be an important source of income, of particular importance in peripheral rural areas where this income can potentially change the entire economic dynamic. However, the level of income can vary considerably and depends on the legislative framework in this regard, as well as the capacities of landowners to negotiate with developers (Copena & Simon 2018).

Phimister & Roberts (2012) found with respect to wind development in a rural region of Scotland that with no local ownership, while rural GDP increases, there is almost no effect on household incomes due to the limited direct linkages of the on-shore wind sector (Phimister & Roberts 2012) (see section 6.2.3).

According to Phimester and Roberts, local ownership increases the household income benefits but there are still limited positive spill-over effects on the wider economy unless factor income is re-invested in local capital. With re-investment, farm household ownership gives rise to the largest increase in total household income, but community ownership gives rise to the largest increase in rural (non-farm) household incomes and welfare (Phimister & Roberts 2012).

5.1.5 Tourism

Little evidence of negative impact

While operators express concern over a negative impact on tourism from the installation of renewable energy, particularly wind power, it does not appear that tourism is negatively affected (Aitchison 2012). Some studies show that tourists say that they would change their destination on the basis of windmills (Hecker et al 2014), but in practice little evidence has been found that this is in fact happening.

Evidence from the German case study shows that tourism has steadily increased despite extensive deployment of windmills. In fact, it is possible that renewable energy can be beneficial in this regard through a cleaner image and possible removal of carbon intensive infrastructure (See Case Study 4).

5.2 Findings related to types of renewable energy technologies

The effects of different types of RES are quite context specific and hard to usefully compare at a high level. Factors that hinder a side-by-side comparison are (to name a few) geographical factors and very different potentials by region, labour cost differences, differences over time, institutional and governance factors, not to mention significant methodological differences that are too numerous to detail here. It is worth again reiterating that the literature makes it quite clear that it is not really possible to make precise quantitative extrapolations of socio-economic effects from region to region (or even within regions over time).

Most types of RES can be broadly compared in terms of their socio-economic effects, as they essentially rely on distributed technological deployment reliant on manufacturing and design off-site. The technology itself is not the most important factor to compare, rather the policy environment. However, it is worth commenting in more depth on biomass, as this has a quite different mode of deployment and economic model.

5.2.1 Biomass/Bioenergy

An investigation of the effect of growing biomass for heating regionally (in Austria) found that short term effects on employment and regional GDP were positive, but that a significant increase in land rent occurs when agricultural land is used for producing most types of biomass, including woody biomass. As this crowds out traditional (and more labour intensive) farming, the net employment impact turns negative for those pre-energy biomass products that are most land intensive (Trink et al 2010).

However, the authors point out that given longer term trends toward lower labour intensity of agriculture this may not be a huge net negative in the long run. The region can also be highly vulnerable and sensitive to international price changes for commodities with potentially negative effects on long term welfare. High levels of subsidies for bioenergy can divert capital from other agricultural sectors and may prove to be an overall social cost (Muscat et al 2020).

An important conclusion is that forestry-based bioenergy tends to have a stronger positive economic impact than agro-based bioenergy, since it is less likely to crowd out otherwise more labour-intensive agricultural activities (Steininger 2011). However, Muscat notes that this is a relatively under-studied area that will need further integration of biophysical and socio-economic models to gain a fuller understanding.

In rural regions where significant spending currently goes toward fossil fuel energy sourced outside the region, if this can be diverted toward local production, for example of biomass, this can have significant regional economic benefits in terms of employment and value added. However, the increased costs of bioenergy vs. fossil fuels constituted a net loss for the economy as a whole according to one study from Finland (Peura et al 2018). Studies from Finland confirm the potential role of bioenergy in revitalising peripheral forest regions and reviving forest based industrial towns (Lehtonen & Okkonen 2016; Lehtonen & Tykkyläinen 2011).

6. WHICH FACTORS MAY DETERMINE THE NATURE AND EXTENT OF SOCIO-ECONOMIC IMPACTS?

Key findings

- The renewable energy potential and the socio-economic characteristics (including local labour availability and manufacturing capacity, for example) of a region significantly shape the nature and extent of the socio-economic impacts associated with RES deployment. Transition, peripheral and rural regions all face particular challenges in this regard.
- However, policy choices in five areas can nonetheless make a critical difference to socio-economic outcomes: labour market policies; active industrial policies; ownership and benefit-sharing arrangements; governance; and financing.
- Labour market policies are essential – especially in transition regions – for ensuring a just transition through the effective re-training and support to workers in fossil fuel industries, as well as the availability of skilled workers for RES and related sectors.
- Industrial policy can play a key role in promoting the development of upstream manufacturing and R&D sectors, and the revitalisation of other regional industrial sectors (eg ship building), to strengthen the employment and value-added benefits to regions.
- The higher the level and degree of regional ownership of RES assets and land the higher the regional benefits, but communities must be better supported to capitalise on these opportunities.
- RES governance frameworks can help to retain and support economic activity and income within the region, but they are often not designed to do so (they are often more focused on speedy deployment, headline targets, or on catering to large corporate suppliers). Clarity of objectives, targeting, and planning are important

for both stable and effective RES deployment and socio-economic benefits.

- Local stakeholder engagement and consultation are important in building trust and support.
- The financing mechanisms chosen to pay for renewable energy deployment can have significant distributional consequences, as well as affecting ownership structures, and should be carefully tailored to local circumstances.

6.1 Local characteristics

6.1.1 Natural endowments

The climate and geographical layout of a region are self-evidently important for its renewable energy potential. RES is much more dependent on local conditions than fossil fuel power generation for which the fuels can be imported, with the partial exception of biomass. Regional RES strategies need to be tailored to local conditions, with important implications for local economic benefits depending on the type of region (see below an exploration of the implications for peripheral, rural, and transition regions). Many studies look at the potential of different renewable energies at regional level in the EU, setting an important baseline for the socio-economic benefits (for example: Ruiz Castello et al 2019; JRC 2020).

6.1.2 Social and economic characteristics

Existing economic structure and industrial synergies

One study suggested that local manufacturing capacity enhances the employment impacts of the RES construction period by approximately 138%, confirming similar previous studies (Ejdemo & Söderholm 2015). Overall, the most important segment for jobs in the wind industry is manufacturing (58% of jobs) (Ortega-Izquierdo & del Rio 2020). The presence of local manufacturing capacity can also have important spill-over effects and create agglomeration effects and synergies for other local industries (Varela-Vázquez & Sánchez-Carreira 2015) and is also directly linked to the level of local innovation (Horbach & Rammer 2018), which in turn can spur further economic development.

However, if manufacturing is done mostly outside the region, many studies conclude that the ultimate economic benefit for the region can be marginal (Allan et al 2020; Kahouli & Martin 2017; Dvořák et al 2017). One problem with manufacturing is that the jobs are not always stable, and fluctuate significantly based on the state of the industry. As Dvorak argues, factories for assembly of renewable energy facilities and units provide a less secure type of regional employment – highly dependent on the cost of a low and semi-skilled labour force, such factories are easily moved to other regions (Dvořák et al 2017).

Some researchers argue that direct employment gains are likely to diminish when technologies become mature. Long-term employment can, however, be sustained when RES expansion is successful as a green industrial policy, i.e. in building up an industry that is globally competitive (Pahle et al 2016). This is clearly the case in Denmark where the wind industry has been fostered over decades. The region of Central Denmark now has almost 14% of employment directly in the RES industry, also leading to a much stronger than average green business sector in Denmark as a whole: about 5% of total exports in 2015 consisted of green energy technologies. This leads also to spillover effects in neighbouring regions, such as the Capital Region (See Case Study 3).

Skills availability

An important factor in a region's ability to fully benefit from the economic opportunities presented by renewable energy is the availability of skilled labour locally. This is particularly true for the research & design phase but is found across all phases to some extent. The rapid growth in the RES sector has created high demand for highly educated/skilled workers like project managers, engineers and operating workers as well, and there is a general shortage of workers with the needed skills for the sector (Lucas et al 2018).

This is a particular problem in Central European countries which have seen many skilled workers move to the West (Dvořák et al 2017). The skills shortage may reward first-movers and those regions which have already invested in the industry and promote agglomeration effects. With careful planning and resourcing, important skills from legacy fossil fuel industries can be transferred or upgraded for renewable energy industries, possibly providing important added value in transition regions (Gerbelová et al 2020).

6.1.3 Regional types

The literature has looked in-depth at three different types of regions of particular interest. Transition regions which are currently dependent on carbon-intensive industry and power, peripheral regions and predominantly rural regions.

Transition regions

Regions which have carbon-intensive industry or power sectors are of particular interest with regard to the socio-economic impacts of renewable energy because of the magnitude of the changes required to transition to a low-carbon economy.

As discussed above (see section 5.1.1), the nature of renewable energy jobs is less concentrated than those from traditional fossil fuel reliant industries and power generation. This is in many ways an advantage but can also present a significant challenge in terms of replacing highly concentrated and localised existing employment from these industries. Even as renewable energy will generate more employment on a system-wide basis, these localised effects could potentially be serious for some regions.

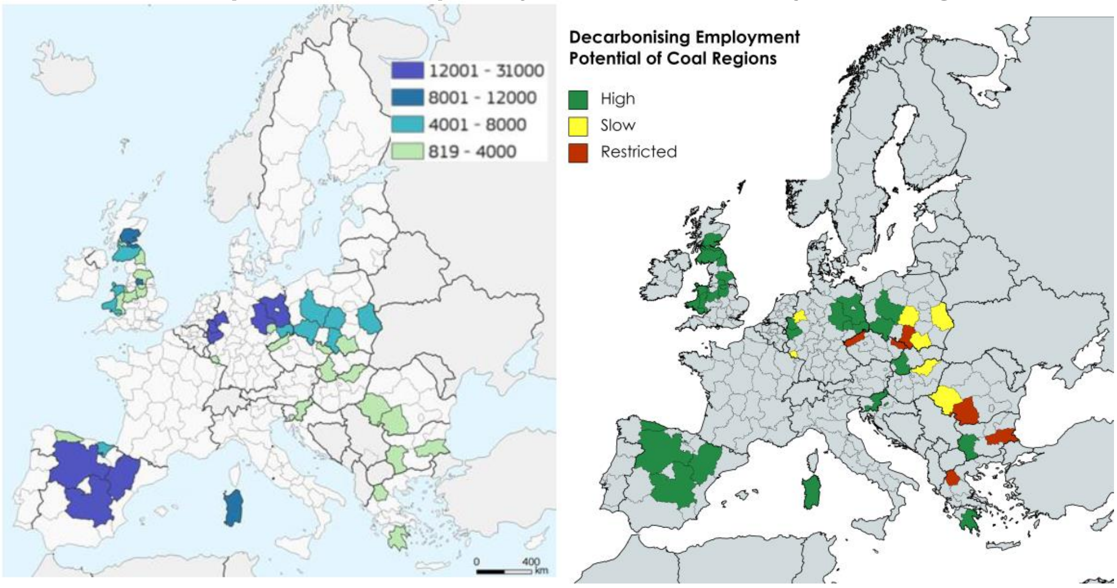
The JRC conducted an in-depth study of the employment prospects in coal regions from renewable energy (2020). The report finds that the potential of regions to replace the jobs lost in the energy transition varies considerably from region to region based on their renewable energy potential, and it categorises these regions in the European Union (see Figure 4).

Most regions have the clear potential to replace and even surpass current coal related employment based on renewable energy, while some have the potential to do so with transitory imbalances. A small number – 6 regions out of 41 (including our case study region in North-western Czechia) – however, do not have good potential to replace coal related jobs with renewable energy jobs alone and will need additional strategies to replace the existing employment. These are regions which will potentially need significant outside assistance to help with a just transition and to build a new economic base. The case study in Castile and Leon (a region classified as exhibiting high decarbonising employment potential by JRC) shows that it will take time to replace all of the lost jobs, but that with broad and inclusive just transition processes, effective plans can be put in place to mitigate job losses and allow the regions to move forward with cleaner development (See Case Study 2).

In more challenging regions, such as that described in the North-western Czechia case study, a more robust industrial strategy will be required, including substantial and well-directed funding from the European Union. As the case study for this report indicates, if funding from the Modernisation Fund, the Just Transition Fund, and other proceeds of the ETS are used in a way that does not simply advantage large existing entities and promotes SMEs to develop local RES and other green industries, these regions can also prosper despite a more challenging starting position. However, as things stand, community energy projects will receive only

1.5% of funds, representing a missed opportunity to encourage community ownership, and thus the most important source of local economic benefits (See Case Study 5).

Figure 4: Total jobs (FTE) induced by wind, solar and bioenergy in 2030 in coal regions (left-hand side) and potential to replace jobs lost in coal by 2030 (right-hand side)



Source: JRC (2020) (left-hand side) and authors' elaboration of JRC (2020) (right-hand side)

Peripheral regions

Peripheral regions, those characterised by institutional thinness, slow economic growth and a low level of innovative performance have also been studied in relation to renewable energy (Varela-Vázquez & Sánchez-Carreira 2015). Varela-Vázquez and Sánchez-Carreira find that investment in renewable energy had significant economic benefits for the region of Galicia in Spain, and that "wind power could constitute an alternative to traditional declined agglomerations with positive effects on production and employment in industrial as well as knowledge-based activities." Investment in the wind sector had significant positive effects on other industrial sectors in the region, GDP and employment.

However, some research has found that peripheral regions are less well able to fully capitalise on some of the benefits of RES deployment (Okkonen & Lehtonen 2016). RES development offers possibilities to maintain, develop and renew local industries outside the regional core which would efficiently support the aims of place-based policy. Additionally, as discussed above (see section 5.1.5) research has found no negative effect on tourism from wind or other renewable energy developments (Aitchison 2012). Quite the contrary, renewable energy can promote a good image and clean environment conducive to tourism among some groups.

Okkonen and Lehtonen argue that re-investment in peripheral regions is critical, but – "government financing alone will not sustain community action on energy. Thus, the social enterprises also need local activity and full engagement, which could be linked with bottom-up place-based approaches to regional policy. Locals should be involved with the planning of re-investments, as they potentially have the best knowledge about the local strengths and capitals which are the basis of place-based thinking."

Rural regions

A significant area of study is the possibilities for rural development arising from renewable energy deployment because rural areas often have significant potential for renewable energy development and synergies with agricultural and forestry activities (ECA 2018). This is a potential that is often highlighted as unfulfilled, including by the European Court of Auditors.

Enhanced policy measures are needed to support the rural development of renewable energy (Aceleanu et al 2018). The importance of local ownership for economic benefits in rural areas is heavily emphasised in this literature (Benedek et al 2018; Copena) The scarcity of skilled labour in some rural areas leads to economic benefits from employment leaking outside the region even when opportunities are present (Aldieri et al 2020). Aceleanu et al point out the need for retraining for long-term economic competitiveness particularly in a rural context where educational levels are often lower than average.

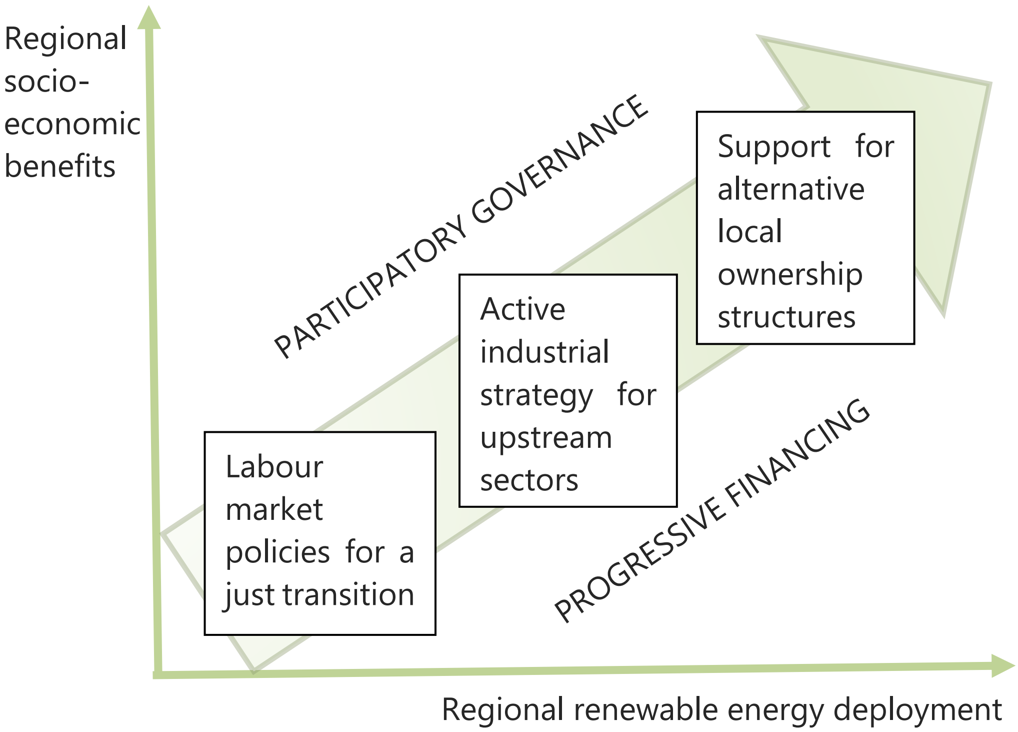
Although, Germany has a relatively good tradition of community ownership, and while stipulations exist in federal and state law in Mecklenburg-Western-Pomerania to enhance local ownership, the manner of implementation and a time lag until benefits manifest for the public, these have so far failed to significantly impact local communities in that state (See Case Study 4). This is an area of policy which could be further developed in the rural German context.

The Danish case study shows that this is an area where rural areas have some advantage over urban areas because of their available space, although urban areas have more potential for solar due to roof top deployment. However, it also shows that it is not a zero-sum game, as Copenhagen is benefiting from the wind industry in Jutland through a very strong national industry based there, with R&D facilities disproportionately based in the city (See Case Study 3). Other cities, such as Madrid, are also able to benefit from the strong renewable potential of their neighboring regions as shown in Castile and Leon (See Case Study 2).

6.2 Policy choices

Beyond the natural endowments and RES potential in different regions, however, policy choices are nonetheless found to be critical in shaping the nature and extent of regional socio-economic benefits. Five key areas of policy are identified as most important: labour market policies, industrial policy, ownership, governance and financing (see Figure 5). EU policy choices are briefly discussed.

Figure 5: Policy levers to increase the socio-economic benefits associated with scaled-up renewable energy deployment in EU regions



6.2.1 Labour market policies

Just transition policies and strategies, coordinated between all levels of government, are critical for ensuring that regions with a legacy of fossil fuel industries can take full advantage of the socio-economic benefits from RES (Gerbelová 2020). A number of researchers (Nikas et al 2020; The Green Tank 2020) have looked at the dynamics of just transition from a more general perspective, with a focus on relevant regions and countries, but the specific relationship of renewable energy at regional level with just transition is not much covered in the research on the impact of RES, possibly because the concept is relatively new and has only entered into policy frameworks in a practical way recently.

Coal regions such as North-western Czechia clearly need significant support to transition from coal dependent jobs to new industries in RES and beyond, given the lower potential in RES, and significant existing employment (JRC 2020). However, other transition regions such as Castile and Leon, with much higher RES potential also need resources and a framework for retraining and support to communities. The recently agreed regional just transition framework is a good step in the direction of supporting workers to transition toward both digital and RES jobs, while providing support to older workers who may be harder to retrain. Although this agreement is very new it is a promising step toward ensuring that the remaining jobs lost following mine and power plant closures will be regained within the region. It can take time to implement changes, and in affected communities this is a time when a real support framework is needed or there is a significant risk of depopulation and other social problems (See Case Studies 2 & 5).

Ensuring that workers are adequately trained and available within the region to meet the demands of the industry is another important factor to meeting the socio-economic potential for regional development. Dvořák et al (2017) highlight the difficulties some regions, and investors have in finding workers with the required skills and training, particularly due to the boom in the industry, and notably (but not only) in Central European countries. This can be a particular problem in rural regions (see section 6.1.3). Skills shortages as the population ages are noted in Mecklenburg-Western Pomerania. This skills gap requires broader educational and vocational planning and a push to match potential workers with the training needed, particularly in regions with good renewable energy potential.

6.2.2 Active industrial policy

As also explored in sections 5.1.1 and 6.1.2, there is significant evidence in the literature to suggest that an active industrial policy, including investment in upstream RES manufacturing and R&D sectors, can substantially increase the socio-economic benefits for regions – notably in the form of employment and value-added.

Several articles note the possible synergies with other industries and potential for RES to form the basis for business and industrial development, even in areas without significant industries initially (Varela-Vázquez & Sánchez-Carreira 2015; Mikulić et al 2018; Gilmartin & Allan 2014).

Phimister & Roberts (2012) highlight the importance of links to local economic activities in order to maximise other economic benefits. A number of studies, for example Gerbelová (2020), find that there are potentially important synergies with legacy industries, and this has been demonstrated in our case study of Mecklenburg-Western Pomerania in the ship building sector and off-shore wind (See Case Study 4).

However, important local economic and employment benefits are not precluded in the absence of local manufacturing industries because the on-going economic activity arising from the operations phase is more important in the long-term, assuming that "a reasonable number of participating companies and investors are located within the region" (Heinbach et al 2014).

Research in the Spanish context has found that investment in R&D by the wind sector was significantly higher than the average for business across Spain, and that this was also manifested in regions with higher levels of wind deployment (Gutiérrez-Pedrero et al 2020). This is seen as a positive indicator for future economic investment, innovation and dynamism.

Renewable energy development in one region can have demonstrated benefits for business and industrial development in neighbouring regions where they have the capabilities to supply parts, even when RES is not deployed at a significant scale in that region (Ulrich 2012).

Other articles demonstrate scepticism about the general ability of peripheral or rural regions to use RES for industrial development without existing industries, and that this is acknowledged by industry actors as well as a justification for the frequent use of 'community benefit' systems for 'affected communities' (Munday et al 2011). Generally, it can be concluded that industrial development is possible, but is generally reliant on local characteristics, 'first mover advantage', or a very significant industrial strategy and investment.

6.2.3 Ownership and benefit-sharing

The single clearest result of the collected literature is that the degree and structure of local ownership and benefit sharing schemes makes a big difference to the ultimate regional socio-economic benefits. Although more research is needed across different types of community projects, and a systematic approach would be beneficial, Berka and Creamer (2018) conclude that the "results across various types of renewable energy demonstrate that regional stimulus generated from local ownership (of wind, biofuel and hydro installations) vastly outweighs that generated from commercial (or 'absentee') ownership".

The extent of community ownership heavily influences the share of revenue generated by renewable energy projects which is received by the local community (Callaghan & Williams 2014). As Callaghan and Williams describe, arrangements may include:

- community ownership of the renewable asset and the land;
- community ownership of the renewable asset alone;
- a community stake in the renewable asset; or
- the community receiving a community fund payment from the owners.

Full ownership can result in twice as much direct revenue for the communities involved compared to a simple community trust payment. Munday et al (2011) find that, at least in the Welsh context, local payments from onshore wind generators to landowners, or to communities in compensatory 'benefit' schemes, are small compared with the value of the electricity generated.

Investment into the local public sector and labour-intensive sectors, such as social services or agriculture, as compared to consumption, lead to the best economic outcomes locally because households tend to invest or purchase from outside the region (Berka & Creamer 2018). However, even modest rates of revenue sharing can lead to significantly enhanced economic benefits (Ejdemo & Söderholm 2015).

One study found that wind energy projects with 100% local ownership generate twice the number of long-term jobs and 1–3 times the economic impact of absentee-owned wind projects (Benedek et al 2018). Another study identified restricted local ownership, and local agency, as a factor reducing regional economic benefits from wind projects in Galicia (Copena et al 2019).

Reinvestment of revenues in local communities and regions had the potential to be highly significant for employment, with one study from Scotland suggesting that strategic re-investments of revenues in local social services generate about a tenfold additional employment and income impact compared with the impact of wind power production alone (Okkonen & Lehtonen 2016). Benefit sharing is also found to be very important for local acceptance of renewable energy projects (Allan et al 2011).

However, communities typically lack access to capital, professional advice, and strategic services. National planning tends to favour corporate and institutional developments. As Clausen says, "The wider economic effects of RES projects, no matter how they may be activated or realized, are usually treated as non-material planning considerations, which means that they are not considered as criteria in determining the approval of projects" (Clausen & Rudolph 2020). Thus the community and economic benefits of RES projects are most often neglected, even when these are theoretically goals that governments want to promote. These goals need to be integrated into any strategic planning to realise their potential (see below on governance).

Both Denmark and Germany have good traditions of community ownership of renewable energy resources. However, with the increasing size and number of RES projects, and some would argue a more market-oriented approach to RES, modern legislation to ensure a degree of local ownership has been criticised as being ineffective in achieving a significant level of community ownership (Leer Jørgensen et al 2020; see Mecklenburg-Western Pomerania case study).

Legislation to ensure community ownership in Spain and Italy are still relatively new and the concept is still developing there. In Czechia this issue is not addressed in legislation and will need to be addressed in the forthcoming transposition of the Recast Renewable Energy Directive (RED II) (or RED III if it is superseded).

It is hard to get accurate data about the level of local and community ownership in practice, so it hard to draw firm conclusions in this regard from our case studies. However, the evidence suggests rather low levels of local ownership in most or our focus regions. One way to overcome this to some extent is through the deployment of distributed micro-RES, an approach that is being promoted in Castile and Leon and to some extent in Apulia. A programme to support low-income households in this approach in Apulia is also planned. However, with larger and larger RES projects being planned, a broader legislative approach is needed to include local owners in a bigger proportion of projects (See Case Study 1).

Community ownership is not without its complications and trade-offs: how to administer and distribute community benefits can be a contentious issue, how to design benefit sharing schemes without discouraging future investment, and how to ensure local capacity to both administer the projects and absorb the investments productively.

6.2.4 Governance

Findings suggest the explicit identification of multiple objectives, including sustainable development, clear communication and management of expectations, and a broad and transparent set of indicators for monitoring and evaluation are important to successful strategic implementation of renewable energy for socio-economic benefits (Pahle et al 2016).

The availability of sound and comprehensive data is crucial to ensure regulatory stability and sustainable policies. The case studies conducted show that data availability is not consistent at the regional level, and that comprehensive regional planning is often not taking place (See Case Studies).

Numerous researchers find that the setting up of consultation processes and the involvement of local stakeholders are critical to local acceptance and successful implementation of renewable energy policies locally and regionally (Hecher et al 2016). However, the full dynamics of local support or opposition are complicated and depend on a variety of local cultural and institutional dynamics which are beyond the scope of this report. Klagge and Brocke (2011) find that local actors and political coalitions are the most important actors for initiating locally important RES projects, though supportive national and regional policies and institutions are also important.

Asymmetries between developers and local stakeholders or landowners can lead to local stakeholders receiving relatively low levels of income even when there are benefit sharing arrangements (Copena & Simon 2018). For example, landowners have much less knowledge of regulations, the business environment and production data, and may be able to rely on tools such as expropriation depending on the framework available.

Bureaucratic and regulatory hurdles and slow approvals processes were overwhelmingly identified as significant obstacles to timely RES deployment, and thus as a sustainable development strategy, in our case studies. This was particularly the case in Apulia, but also in Spain and Germany. Different simplification procedures have been put in place, for example increasing the size of installation that needs special approvals (Apulia) and removing prior approvals for micro-RES altogether (Castile and Leon). Ultimately, it is necessary for all levels of government and their agencies to "buy-in" and have responsibility for plans to speed the deployment of renewable energy.

Opposition from local residents can also slow down projects, for example in the form of litigation, as noted particularly in the German and Italian case studies. This is particularly a problem for wind turbines and may be to some extent mitigated through proper consultations and local ownership and benefit sharing initiatives. However, these can themselves slow down the process and are not without complications (see also Ownership and benefit-sharing above). It is also the case that some opponents explicitly reject ownership and benefit sharing as a form of "bribery" and have objections they feel cannot be addressed through monetary incentives (Leer Jørgensen et al 2020).

Another potentially important issue is jurisdictional. Depending on the governance structure of the country, the regional and local governments may have a very important role to play in the deployment of renewable energy, but their priorities and capacities may not be aligned with national policy. Regional and local governments need to be intimately involved in the planning processes around renewable energy and climate policy more generally.

Lutz et al (2017) have suggested that one success factor for regions is well structured, comprehensive planning processes for the energy transition which allow them to be more resilient and more efficient. However, the case studies illustrate that regions frequently do not have a comprehensive plan, and some research highlights that, despite positive rhetoric, regions often "lack vision upon how such benefits might be materialized" (Spijkerboer et al 2016).

The Danish Capital Region's regional and municipal cooperation project on renewable energy deployment, setting regional targets and strategic plans is a good example of inter-governmental cooperation to help achieve regional (and national) climate and energy objectives. Where regions have an important role to play, for example in Italy, formal cooperation with the national government is key. Formal effort sharing targets and regional strategies, including a vision of socio-economic development, could be important tools, as proposed in the Italian case study (See Case Study 1). These can help to build political and administrative buy-in and responsibility for RES deployment regionally.

6.2.5 Financing and taxes

Although the cost of RES has dropped dramatically, and several case studies identified bureaucratic hurdles as the largest obstacle, installation can still be capital intensive, and the method of financing will be very important to the net economic benefits regionally.

For example, a consumer level levy, such as that used in the German EEG (Renewable Energy Sources Act) can have a contractionary effect due to reduced disposable incomes on a regional level if new investment does not match it (Aniello et al 2019). In addition, this reduction in disposable income can have a regressive character, as in the case of Germany (Többen 2017).

However, equally, if a region takes advantage of such financing mechanisms to invest in RES, the effect should be expansionary, and the majority of households should experience positive net impacts. Still, policy must account for the potential regional differences and distributional issues raised (see also section 5.1.4).

As research by Schinko et al (2020) shows, “national support schemes, such as feed-in tariffs (FIT), play an important role in fostering RES deployment at the regional scale. In order to ensure macroeconomic efficiency, subsidies have to be set at the right level for specific technologies. Relatively high subsidies for otherwise not cost competitive technologies (e.g. biogas or biomass in the case of Austria) will lead to higher electricity generation prices, higher direct and indirect costs for the average consumer and reduced government income. If energy policy instruments, such as feed-in tariffs, are designed based on the goal to eventually foster regional economic development in certain sub-national areas and/or individual economic sectors, this could come at net-costs at the national level.” Policy makers should therefore address the question of who should eventually benefit from an energy transition at sub-national level when designing the policies designed to pay for RES.

However, given the need to support RES and drive down prices through government action, some researchers argue that such subsidies are justified even if there are some undesirable side-effects. However, any subsidy scheme needs to be flexible enough to allow for dynamic updates over time as well as being clear about its objectives (is it only for maximum RES deployment or does it include regional development goals as well?) In doing so, unforeseen technological breakthroughs leading to substantial cost decreases (for instance as in the case of PV) or changes in fuel costs (for instance biomass) can be tackled.

An alternative to feed-in-tariffs are auctions (also known as competitive bidding or tenders). The potential strengths of auctions are that they allow the government to better control the amount of new installed capacity and that competitive bidding in the right setting may push down costs (Schinko et al 2020). However, there are concerns “that an auctions system will disadvantage and decrease private citizens’ initiatives to invest in RES-E, will lead to an overly slow installation of new RES-E capacity and may not lead to cost-effective outcomes.”

An auctions support scheme could also have distributional consequences with a bias towards large scale institutional investors, since they generally have more resources available to handle the bureaucratic requirements and are less sensitive to losing on one single bid. To circumvent the potential systemic disadvantage of small-scale investors, countries could include exemption clauses for specific investor groups in their RES legislation. Germany, for example, decided that citizens energy cooperatives that win in the auction should be paid the highest winning bid, regardless of their actual bid; all other winning actors are paid their submitted bid only.

Magnani and Vaona (2013) highlight that a feed-in-tariff (FIT) "can especially contribute to a diffusive local and regional development in various ways." A FIT is more open to different scales of operators, project sizes and non-traditional actors like ''prosumers''.

It is noted in the Czech case study that overly generous long-term incentives in past funding frameworks for solar energy have undermined the credibility of renewable energy policy as a whole, as it has led to windfall profits for certain private investors at significant cost to the public, while not optimising solar deployment given the changing cost structure (See Case Study 5).

As discussed in Section 5.1.3, taxation is one of the most important ways for regions to keep benefits of RES in the region. However some researchers argue that this must be done without discouraging investment and deployment, as it has been demonstrated that in some jurisdictions, such as Italy, complicated permitting in combination with taxation may be discouraging deployment of RES (Carfora et al 2017). Targeted tax incentives for micro or small-scale renewable energy producers have been identified as a possible way to encourage the development of small-scale, distributed RES. This is a tool recently being employed in Castile and Leon to speed up distributed RES deployment (See Case Study 2).

Structuring taxes on the renewable energy industry in a way that municipalities and regions can benefit is an important way of ensuring that full benefits accrue to the region (Copena et al 2019). Taxes need to be set in such a way to gain benefits regionally while not discouraging investment (Raupach-Sumiya et al 2015). The authors argue that "it seems to be more effective to adopt policies that effectively stimulate local investment into RES technologies, promote regional clusters and value chains in RES, foster local ownership and participation by local citizens, and raise the acceptance for RES by the local community" rather than raising local fixed asset taxes.

6.2.6 EU policy

Funding under the EU budget has been identified as potentially very important for the development of regional RES. Lutz et al (2017) identified a diversity of funding sources, including from the EU, as a factor for success in regional RES deployment. One factor that may be preventing better use of EU funding is a lack of regional administrative capacity (Carfora et al 2017).

EU funding can be used to promote local RES ownership as was seen in the case of a small wind turbine project developed and owned wholly by the Dyfi Valley community in Wales. This project is one of very few community-owned projects in Wales, and EU money proved “vital” in funding the capital costs under the ERDF (Munday et al 2011). The development of this small-scale project benefited from a stable end-user contract and good rates of return (with the supportive Centre for Alternative Technology near Machynlleth), and proponents were able to draw upon existing community knowledge of green energy, and possessed the skills to access EU aid.

The European Court of Auditors identified EU rural development funding as a potentially significant support for RES deployment in rural regions, also to help meet national RES targets, but also argued that “the Commission has not provided sufficient clarification or guidance in this regard, nor how the EAFRD should complement the existing EU and national funding schemes” (ECA 2018). Increased guidance and prioritisation for synergised RES and rural development funding could an important added value for EU policy.

As the Czech case study makes clear, EU funding and legislation may well be the catalyst for change and ambition at national and regional levels, as well as one of the key tools for financing the energy transition, particularly in poorer or more vulnerable regions. This is increasingly the case as ETS costs and revenues increase, and Member States are required to meet more ambitious targets (See Case Study 5).

7. CASE STUDY SUMMARIES

7.1 Apulia (Puglia), Italy

GDP per capita	€18,842 (2019)
Population	3,926,931 (2020)
Population density	200/km^2
Unemployment rate	14.1% (2020)
People at risk of poverty or social exclusion	37.4%
Share of renewable energy (% of gross final energy consumption)	16.5%
Total installed RES capacity	5,750 MW (2019)
Employment in RES	0.5% (direct & indirect 2020)

RES in the region

As for renewable energy progress in the region, the Apulian RES share (including RES-E and RES-H/C, excluding RES-T) of final energy consumption was 16.5% in 2018 (latest year for official figures). RES-E production in Apulia already contributes to 50% of regional electricity consumption, while the national average is around 35%. The biggest source of renewable energy is PV, followed by wind and bioenergy. It is notable that the coal power plant in Brindisi is among the 10 largest in Europe but is scheduled to close by 2025.

Socioeconomic impact of RES

The latest figures on socio-economic impacts of renewables in Italian regions refer to 2016 and rank Apulia as the top region for investments in the sector. As for employment figures, which include both direct and indirect jobs in the RES sector, Apulia is the Italian region with the highest number of temporary workers (3,200 Annual Works Units – AWU), while ranking fourth in terms of permanent workers (also 3,200 AWU). Apart from exceptional cases, most RES-related employment in Apulia seems to be located in subsectors such as planning and permitting sectors, products assembling, installation, and Operations & Maintenance of power plants.

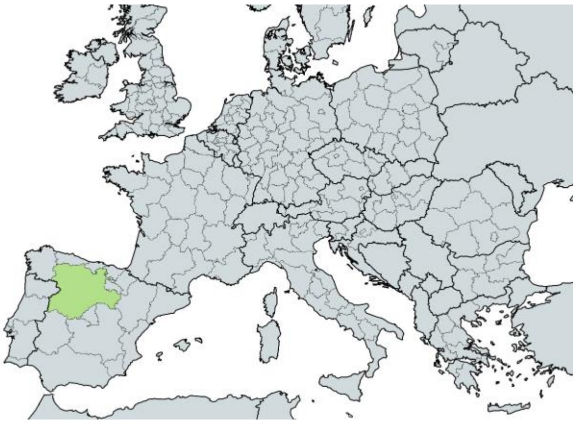
Key conclusions and policy recommendations

1. The main factor hampering a strong RES growth in the region today is not economic costs, but rather bureaucracy and permitting procedures. The relatively high potential of the region for both RES deployment and its socio-economic benefits is not being fully exploited as a result. In Italy, a key role in this

issue is played by the Ministry of Culture and linked regional authorities, who have been particularly restrictive. Another key role is played by local communities and citizens, who often delay the deployment of RES because they have faced some negative consequences for past planning and procedural mistakes; there is need for a broad and dedicated involvement of citizens for them to fully understand the potential of RES deployment in the region.

2. Wind power growth in Apulia is mostly about replacing many outdated power plants. For PV, deployment efforts will need to be driven both towards small-scale deployment as well as large-scale plants; for the latter, it will be crucial to support the deployment of large-scale PV power plants in rural areas by means of a careful regulation, in order to avoid conflicts with primary production and consent complications. Small-scale PV is relatively under-deployed, considering the potential, and could be a very important factor in increasing the local ownership of RES in order to promote socio-economic benefits in the region.
3. The key role that regions play in the transition towards climate neutrality, particularly in the Italian context, including for RES deployment, needs to be made clear and enhanced. A new regional effort sharing scheme would be a solution for a broader and more effective involvement of regions in climate and energy targets. Our case study shows that there is no monitoring and no enhancement of the great local spill overs in terms of jobs and economic growth from the RES sector, despite the great potential of the region. Apulia, just like many other Regions in Italy still lacks a local strategy for industrial development in the RES sector, which would be essential to maximize socio-economic benefits in the region.

7.2 Castile and León (Castilla y León), Spain



GDP per capita	€24,261 (2020)
Population	2,394,918 (2020)
Population density	26.1/km^2
Unemployment rate	11.82% (2020)
People at risk of poverty or social exclusion	16,7%
Share of renewable energy (% of gross final energy consumption)	N/A
Total installed RES capacity	11,606 (MW) out of 12,197 (MW) (2020)
Employment in RES	1% direct (2020 est)

RES in the region

Castile and Leon is the region with the highest share of RES generation in Spain. In 2020, the power generation structure of the region was largely dominated by renewable energy with 87% of total power generation. By energy source, during the 2015-2021 period both nuclear and coal production virtually ended in the region while wind (51%) and solar energy power (7%) have grown. Hydropower has remained stable at 36% of total energy generated.

Socioeconomic impact of RES

According to our own rough estimation, in 2020 the workforce in the renewable energy sector could potentially amount to 8,317 workers (just under 1% of total workforce), a growth of 38% with respect to 2009. According to the JRC of the European Commission, by 2030 the sector could employ up to 21,379 workers in the renewable energy sector, mostly in the wind energy sector. This makes Castilla y Leon the region with the highest potential for job creation among the coal transition regions in the EU. Although the region lost jobs through the closure of coal mines and nuclear and coal power plants in recent years, a robust just transition plan and strong renewable energy potential mean that the region should see a net improvement in socio-economic conditions as a result of the energy transition.

Key conclusions and policy recommendations

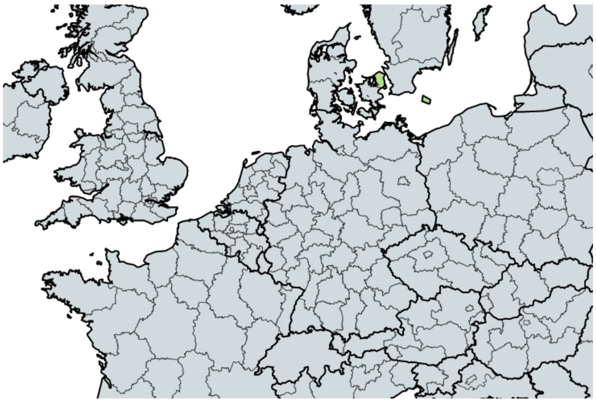
1. Public support remains one of the biggest enablers for the decarbonisation of the energy systems and the consequent socio-economic benefits. To maximise employment and other socio-economic benefits, both the regional and national governments should make sure an appropriate legislative framework is put in place in order to eliminate as much as possible administrative burdens, further incentivize the deployment of renewable energy installations and

create an ecosystem that maximizes economic benefits. Recent moves to promote household ownership through tax incentives and simplified approvals of micro-RES are a good example but more is needed.

2. Ensure a Just Transition. Public administrations and other relevant stakeholders must work together to ensure these communities can continue to prosper. This region has seen significant economic and employment disruption, but new RE opportunities should be more than sufficient to compensate if affected workers and communities are supported in retraining when possible. The regional Just Transitions Guidelines approved in November 2020 are a good example.

3. Given the potential for renewable energy of the region and the geographical position of the region, Castile and Leon can become a very important exporter of renewable energy for neighbouring regions such as Madrid and Portugal. Studies show a very significant opportunity for employment and value added regionally, particularly if the industry can develop strategic technological specialisations.

7.3 Denmark's Capital Region (Greater Copenhagen), Denmark



GDP per capita	€51,000 (2018)
Population	1,835,562 (2019)
Population density	720/km^2
Unemployment rate	5.1% (2019)
People at risk of poverty or social exclusion	17.5%
Share of renewable energy (% of gross final energy consumption)	17% (2015)
Total installed RES capacity	3,300 MW (2015)
Employment in RES	0.5% direct (2016)

RES in the region

Denmark has a relatively high level of gross final energy consumption from renewable sources at 37% in 2019, or 4th highest in the EU. However, for the Copenhagen region it is only 17%. By far the largest source of renewable energy is biomass. The net import of electricity is a notable feature of the region, amounting to 70% of electricity, much of which was still generated by coal as of 2018.

Socioeconomic impact of RES

Denmark is a strong player in the renewable energy industry, particularly wind and bioenergy, and the green economy more broadly. Early investment into renewable energy technologies, continued R&D in the sector, and ambitious domestic climate goals have played a role in the development of this industry. However, most of the economic activity is centred in Jutland, and Denmark's Capital Region is itself under-represented in terms of jobs and turn-over in the sector mostly because it is a densely populated urban region without a large potential for renewable energy development. It imports a significant share of its electricity from other regions and will continue to do so. Nonetheless, the region is home to at least 4000 jobs in the RES industry, with a relative over-representation in R&D. A number of important bioenergy companies are based in the region. With continued planned increases in deployment regionally, particularly in rooftop solar, but also wind, there is still considerable potential for growth in employment in the industry. Denmark has a relatively strong tradition of local ownership, but most RES in the region is owned by utilities and corporate entities, partly reflecting the large biomass installations in the region, and less emphasis on community ownership in recent years.

Key conclusions and policy recommendations

1. Employment in RE is relatively low compared to other Danish regions, probably because of the relatively low level of RE deployment, itself a result of being a densely populated urban region. The renewable energy potential of the region is relatively limited, and it will remain dependent on energy imports for other regions. However, the current employment figures available likely under-count the number of jobs due to some jobs in district heating not being fully counted. Rooftop solar is also potentially a good source of jobs in the region in coming years that is so far only in its initial phase of development.
2. The region has a relatively high proportion of research-related jobs in renewable energy, and many more jobs in other "green industries" (such as related to energy efficiency) possibly as a result of urban agglomeration effects. These are areas of significant potential employment growth in coming years and are not directly linked to local RE deployment.

The regional distribution of jobs and economic activity in Denmark shows the importance of building up RE infrastructure and manufacturing capacity for broader employment and economic benefits as well as the first mover benefits.

7.4 Mecklenburg-Western Pomerania (Mecklenburg-Vorpommern), Germany

GDP per capita	€28,590 (2020)
Population	1,609,675 (2018)
Population density	69/km^2
Unemployment rate	7.9%
People at risk of poverty or social exclusion	23.2% (Eurostat)
Share of renewable energy (% of gross final energy consumption)	39%
Total installed RES capacity	5,796 MW (2017)
Employment in RES	2.7% (direct & indirect)

RES in the region

Mecklenburg-Western Pomerania's share of renewables in total primary energy demand was 39% in 2016, by far the highest out of all federal states. In electricity consumption, the share of renewable energy was at 72%; in gross electricity generation, it was at 173%, both the highest values out of all federal states. Thus, the state has developed into a net electricity exporter. The most relevant electricity source is wind, which constitutes 48.2% of electricity production in 2017 – 39.1% of it onshore and 9.1% offshore. Other renewable energy sources are biomass (15.6%), photovoltaic (8.1%) and hydropower (0.1%).

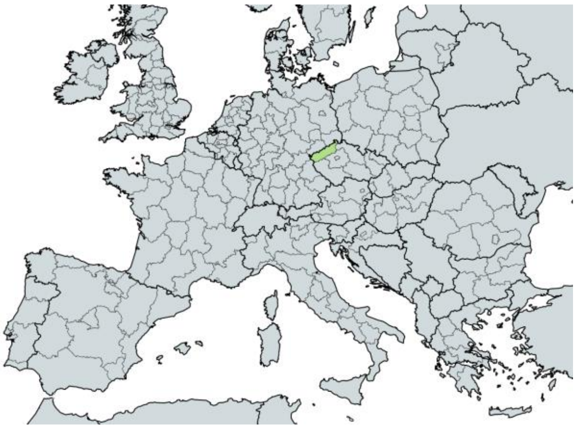
Socioeconomic impact of RES

Renewable energy companies in Mecklenburg-Western Pomerania constitute almost 2% of all companies, the highest share out of all German federal states. A study shows that in 2016, 2.71% of Mecklenburg-Western Pomeranian employees can be attributed, directly or indirectly, to the renewable energy sector, which is the second highest share among all the federal states. A study commissioned by the German Ministry for Economic Affairs and Energy found that in total, 14 870 people were employed directly or indirectly in the renewable energy sector in the state in 2016. The importance of the renewable energy sector also becomes visible when looking at the share that the renewable energy production has on the whole GDP (7.47%). Synergies with existing industries such as ship building have enhanced the role of renewable energy in the region's economy.

Key conclusions and policy recommendations

1. The renewable energy sector has been expanding in Mecklenburg-Western Pomerania during the last decade. Its relative economic importance is higher than in most other German states, and models predict a positive effect of the energy transition on the state's economy in the next decade.
2. Figures support the contention that RE's effects are more important in terms of overall value added or GDP growth than in terms of employment, although employment benefits are also significant in the region.
3. Correspondingly, the renewable energy sector has been identified as a growth factor in the region by the Mecklenburg-Western Pomeranian government. It especially supports the expansion of wind energy industry for the state to become a key electricity producer in Germany. While the political focus lies strongly on promoting the wind sector onshore and offshore, more focus is needed for other renewable sources, especially solar.
4. In general, federal policies, a shortage of skilled workers, permission procedures, local resistance and lack of public support could be factors that hamper the expansion of the sector. National laws to promote local ownership have so far not achieved their objective to the extent desired.

7.5 Northwestern Czech Republic (Severozápad), Czech Republic



GDP per capita	€19,200 (2018)
Population	1,115,629 (2020)
Population density	128/km^2
Unemployment rate	4%
People at risk of poverty or social exclusion	21.5%
Share of renewable energy (% of gross final energy consumption)	N/A
Total installed RES capacity	1,549 (GWh) out of 29,522 (GWh) (2019)
Employment in RES	0.1-0.7% (est)

RES in the region

Today, the highest share of electricity production is produced by lignite power plants, and RES sources produce only 5.2% of electricity in the region. The region is very important for national electrical production, producing 34% of the national total. The region produces 14% of total national RES for electricity, which is a considerable proportion of the national total. 46% of the Czech installed capacity of wind energy was installed in the Northwest region, while this region accounted for 9% of the total installed capacity of photovoltaics. The level of installed capacity has not changed considerably since 2010, in the case of photovoltaics it even decreased.

Socioeconomic impact of RES

The socio-economic impact of RE deployment is minimal today due to very low levels of deployment. The JRC estimated the number of potential jobs created by RES-E development under the maximum technology deployment projection of around 828 FTE jobs in wind power deployment, 194 FTE jobs in deployment of photovoltaics and 1305 in bioenergy for a total of 2327. Compared with around 10,000 jobs in the coal industry today, this shows that RE deployment alone will not compensate for jobs lost in the low-carbon transition. However, other opportunities exist within heating, sustainable transport and in other areas of decarbonisation such as energy efficient housing. It is thus a region that needs significant support to develop alternative economic development pathways to ensure a just, successful energy transition.

Key conclusions and policy recommendations

1. Ambition on the national level regarding new RES installations (as set in the NECP and related strategies) is low, however, external incentives (soaring price

of EU ETS allowances, Modernization Fund, falling prices of new RES installations) will drive a new wave of RES deployment. The government should enable a smooth transition by removing regulatory barriers for RES deployment and related services, creating a stable environment in the RES sector, promoting local ownership, which has so far been neglected, ensuring an equitable distribution of Modernisation Fund allocations, including to community projects, and setting ambitious goals.

2. The character of support together with the legislative environment will determine the main economic beneficiaries of the transition. Past mistakes in the policy framework for the solar industry have led to public distrust and uneven and disproportionate benefits accruing to certain private actors from RES deployment in the country.

   RES-E deployment in the Northwest region will bring around 2,300 new jobs according to the Joint Research Center of the European Commission. Although this is a somewhat conservative estimate, and does not include heating or transport, given that there are around 10,000 jobs in the Northwest coal industry, it will be necessary to create other viable economic alternatives outside the energy sector in order to compensate for the expected job losses.

8. CONCLUSIONS

This study has shown that the literature concerning socio-economic impacts of RES deployment in EU regions has primarily focused on wind, followed by solar and bioenergy, and on employment, GDP or value-added and to a lesser extent household income. Health benefits are generally not quantified or explored in-depth, while broader considerations of sustainable development – such as well-being – are all but absent.

While methodological diversity, data limitations at regional level and the dynamic nature of the RES sector all mean that care must be taken in extrapolating results from one region to another, some headline findings have nonetheless been identified, many of which are also supported by one or more of our case studies.

What are the socio-economic impacts of RES deployment in EU regions?

- **The impact on employment** is found to be generally positive, although often limited – RES jobs representing around 2% or less of regional workforces in our case study regions. RES employment exhibits low intensity and concentration, and varies by stage of RES deployment and the extent to which upstream activities are located within or outside the region. There is evidence that jobs are driven by SMEs in some regions, including those in Germany and Spain. Employment impacts may not be net positive, however, for a small number of transition regions with high levels of employment in fossil fuel industries, and especially where renewable energy potential is low.

- **The impact on regional GDP or value-added** is found to be positive for nearly all regions, and given the low employment intensity of RES, is considered by many researchers to be the most significant socio-economic benefit. Similarly to employment, the extent of this impact is found to relate to the location of upstream and related industries, as well as to the ownership structure of industries. Avoided fossil fuel import costs can have expansionary effects. Some regions can further benefit from energy export-led development. There is evidence that higher levels of RES investment regionally are associated with higher levels of R&D investment regionally, leading to longer term innovation and enhanced competitiveness.

- **The impact on household income** has received less attention in the literature, although there is evidence of regressive distributional impacts of some RES financing approaches like consumer charges, as well as of the positive impacts associated with local ownership of RES assets and land (more so than other benefit-sharing schemes).

Which factors affect the extent of these socio-economic impacts?

The extent to which regions can realise these (and other, under-researched) socio-economic benefits, depends to a large extent on the natural endowments – and resulting RES potential – as well as the underlying socio-economic characteristics of regions. Transition, peripheral and rural regions all face particular challenges assessed in the literature.

However, policy choices can nonetheless make a significant difference. Five policy areas emerged from the literature and case studies as being particularly important in shaping socio-economic outcomes.

- **Labour market policies** are widely assumed to be essential to ensuring a just transition for workers in fossil fuel industries, through creating re-training and re-employment opportunities and other social safety nets, although hard evidence assessing such policies remains scarce, as few regions have yet to implement such policies in practice. Beyond measures to address fossil fuel workers, investing in developing a skilled labour force, especially in upstream and related RES industries, is found to be a critical enabler of socio-economic benefits across many regions.

- **Industrial strategy** at the national and regional level is found to be critical to guide investment and build capacity in local RES suppliers and upstream sectors and to maximise local industrial synergies – such as with the ship-building sector in some coastal regions. Ensuring RES R&D, design, manufacturing and construction are sourced from within the region maximises the region's socio-economic benefits, although there is evidence that other regions are also likely to benefit from spill-over effects.

- **Alternative models of local ownership and community benefit-sharing –** where effectively promoted – are widely found in the literature to substantially enhance regional socio-economic benefits. However, many barriers to local ownership have been identified including capacity issues, opposition from corporate owners, access to capital and the increasing size of many RES projects. Trade-offs have also been found between the degree of local ownership and control and the speed and scale of deployment.

- **Regional governance arrangements** are extensively discussed in the literature. There is much evidence of bureaucratic and procedural hurdles delaying RES deployment, and of the benefits associated with strengthened regional governance capacity based on clear regional development and socio-economic objectives. Meaningful public consultation processes are found to be a key enabler of social acceptability of RES deployment.

- **Financing options** can have decisive socio-economic implications. Using consumer fee-based approaches are found to be regressive in some cases, unless proceeds are re-invested in local communities. Auctions may prioritise speed of deployment and larger-scale, established actors over small-scale and local alternatives, unless carefully designed. EU level funding – including the Just Transition Mechanism and Modernisation Fund – are key in some regions. Rural Development Funding offers as yet seemingly untapped potential.

Based on the regulatory signal given by the Climate Law and the rapidly falling costs of RES, the EU energy transition is now inevitable and irreversible, but the extent to which it achieves socio-economic benefits for local communities is not. This study suggests that positive socio-economic impacts are easier to achieve in certain regions, based on their natural endowments or existing socio-economic context.

But policy choices in the five identified areas can nonetheless be decisive. A combination of labour market policies, industrial strategy, promotion of alternative ownership models, effective and participatory governance and progressive financing options can all help to maximise the socio-economic gains – and likely therefore the social acceptability – of RES deployment in EU regions.

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10. CASE STUDY COMPARISON TABLE

	Population	Population density (people per square km)	Share of RES (as % of gross final energy consumption) (2020)	RES Capacity	Renewable energy production by type (over total energy produced)[i]	Renewable energy production by sources (over total renewable energy produced)	Employment in RES indicators[ii]	GDP/capita (EUR)	Overall unemployment rate	People at risk of poverty or social exclusion (2019)
Apulia	3,926,931 (2020)	200	16.5%	5,750 MW (2019)	Photovoltaic (21%) Wind (19%) Bioenergy (2.6%) **Total: 43%** (of total installed capacity)	Photovoltaic (49%) Wind (45%) Bioenergy (6%) (of total installed capacity)	3,200 permanent; 3,200 temporary (AWU direct and indirect) [iii] 0.5% of total	18,842 (2019)	14.1% (2020)	37.4%
Castile and Leon	2,394,918 (2020)	26.1	N/A	11,606 MW (2020)	Wind (51%) Hydropower (36%) Photovoltaic (7%) **Total: 94%**	Wind (54%) Hydropower (38%) Photovoltaic (7%)	8,317 (direct) est. ca. 0.9% of total (2020)[iv]	24,261 (2020)	11.82% (2020)	16.7%
Denmark's Capital Region	1,835,562 (2019)	720	17% (2015)	3,300 MW (2015)	Wind & Solar (1%) Biomass (18%) **Total: 19% (2012)**	Wind & Solar (6%) Biomass (94%)	4,310 (direct) (2016) 0.5% of total	51,000 (2018)	5.1% (2019)	17.5%
Mecklenburg-Western Pomerania	1,609,675 (2018)	69	39%	5,796 MW (2017)	Wind (48%) Biomass (16%) Photovoltaic (8%) Hydropower (0.1%) **Total: 72%**	Wind (55.7%) Biomass (18%) Photovoltaic (9.4%) Hydropower (0.1%)	14,870 or 2.71% of workers (direct and indirect) (2016)	28,590 (2020)	7.9% (2019)	23.2%
Northwest Czechia (Severozápad)	1,115,629 (2020)	128.4	N/A	440 MW	Wind (1%), Photovoltaic (0.6%) Biomass (2.5%) Hydropower (1%) **Total: 5.1%**	Wind (20%) Biomass (48%) Photovoltaic (12%) Hydropower (20%)	~800 (direct) est. in solar and wind; up to 3000 in biomass.[v] 0.1-0.7% of total	19,200 (2018)	4% (2020)	21.5%

[i] Excluding transport

[ii] Methods of counting employment and data availability vary widely from jurisdiction to jurisdiction. Numbers reflect what is available. Total working population based on Eurostat: https://ec.europa.eu/eurostat/databrowser/view/lfst_r_lfe2emp/default/table?lang=en

[iii] Annual Work Units

[iv] Estimated based on 2009 figures (latest available) and extrapolated based on growth in RES capacity

[v] Estimated if region reflects the proporation of national employment figures based on regional installed capacity.

11. METHODOLOGICAL NOTES

For this report, a semi systematic English language literature review was conducted (Snyder 2019), complemented by five case studies to delve into more detail and focus on regional specificities in a representative sample of EU regions.

The literature review was conducted using the Google Scholar search engine and a series of search terms (outlined below).

Selection criteria:

- *Results were limited to articles published since 2010 in the English language*. The time frame was chosen to focus on research since the wide-spread deployment of RES in the EU, and because it is a dynamic and fast developing industry; older research may be less relevant at this point. The language restriction is mainly practical, and the use of case studies is designed to access some literature in non-English language sources.
- *Academic publications or publications by governments or international organisations were considered as long as they dealt primarily with the socio-economic effects of renewable energy deployment at a regional scale*.
- *Most renewable energy technologies were considered, except for those primarily related to transport (and thus biofuels)*. Issues around energy storage, energy efficiency, batteries, CCS, and hydrogen were not considered here.
- *For the purposes of this review "regional" can refer to different scales, ranging from NUTS-1 to NUTS-3 in the EU nomenclature, as long as the research was focused on sub-national, but not purely local or municipal scale*. Being overly restrictive in this regard risked excluding useful research. Articles focused specifically on a "local" level were not included unless they touched on implications for a larger geographical level as well. Some articles which were focused on a national level have been included where their research contained elements of relevance to regional level findings. There is a level of ambiguity at times between local or national and regional level research, depending on what size of "region" one is considering, but in the interest of focus publications have only been included where there were very clear implications for a sub-national, but not purely local level of analysis.
- *The focus is on the EU (including the UK)*. A very few other articles have been included from outside the EU when these are very frequently cited or are prominent in the literature. Regional level research from outside the EU is overwhelmingly focused on the USA, but there are some articles from other countries as well.

- *Meta-analysis or literature reviews of the broader field of socio-economic impacts of RES have been considered*.

Search Terms & Article Identification:

Combinations of the below terms were used to conduct initial searches:

'socio-economic/social/jobs/employment/income/health/rights/wellbeing/rural development/sustainable development/economic development/distributive/economic growth'

+ 'renewable/renewables/low carbon'

+ 'EU/Europe/European' (also omitted for a general global search)

+ 'regions/regional/urban/peripheral'

Following identification of relevant articles using the search terms above and the selection criteria, further searches to find relevant articles both citing and being cited by those articles were conducted using the feature in Google Scholar to allow this and analysis of the articles' bibliographies and literature reviews. Following identification of new articles, this process can be repeated until no new relevant articles can be identified. The majority of articles were found in this way, not from the initial search terms, but the initial searches found a broad base of articles from which to explore a very wide range of articles, including different thematic, methodological, and geographical approaches. Several existing literature reviews, focusing on the socio-economic effects of renewable energy more broadly (Breitschopf et al 2011; Cameron & Zwaan 2015; Sheikh et al 2016; Zerrahn 2017; Saftwat & Bassim 2019; Aldieri et al 2019), as well as regionally (Jenniches 2018; 2020), and in terms of rural development (Benedek et al 2018) and local ownership (Berka & Creamer 2018) which emerged as important themes in the literature, were identified to help ensure a robust and inclusive sampling of articles that should avoid problems of recursive citations or focusing only on niche sub-areas.

Sub-selection

A sub-selection of articles focusing on socio-economic effects in a specific EU region or regions was also conducted in order to gain an understanding of the number of case studies or original research on the socio-economic impacts of RES in specific regions. These included all types of methodological approaches, including ex ante, ex post, qualitative, and quantitative in order to gain an understanding of conclusions and observations from different perspectives and approaches. (It should be noted that articles with a primary focus on public perception or opinions were not included.) 38 such articles were identified. (Listed below)

- Abegg. (2011)
- Allan, McGregor & Swales. (2017)
- Aniello, Többen, & Kuckshinrichs. (2019)
- Benedek, Sebestyén, & Bartók. (2018)
- Bere, Jones, Jones, & Munday. (2017)
- Blanco, Ferraso, & Bares. (2021)
- Bryan, J., Evans, N., Jones, C., & Munday, M. (2015).
- Carfora, A., Romano, A. A., Ronghi, M., & Scandurra, G. (2017).
- Connolly. (2020)
- Copena, D., & Simón, X. (2018).
- Copena, Pérez-Neira, & Simón. (2019)
- Ejdemo. & Söderholm. (2015)
- European Commission. Joint Research Centre. (2020).
- Fanning, Jones, & Munday. (2014)
- Gerbelova, Spisto, & Giaccaria. (2020)
- Gilmartin & Allan. (2014)
- Gutiérrez-Pedrero, Ruiz-Fuensanta , Tarancón. (2020)
- Hecher, Vilsmaier, Akhavan, Binder. (2016)
- Heinbach, K., Aretz, A., Hirschl, B., Prahl, A., & Salecki, S. (2014)
- Horbach & Rammer. (2018)
- Jenniches, & Worrell. (2019)
- Kahouli & Martin. (2017)
- Klagge, B. & Brocke, T. (2011)
- Lehtonen, & Okkonen. (2016)
- Lehtonen, & Tykkyläinen. (2010)
- Llera Sastresa, Usón, Bribián, & Scarpelli. (2010)
- Marolin, M., Drvenkar, N., & Unukić, I. (2020)
- Okkonen & Lehtonen. (2016)
- Peura, P., Haapanen, A., Reini, K., & Törmä, H. (2018)
- Phimister & Roberts. (2012)
- Raupach-Sumiya, J., Matsubara, H., Prahl, A., Aretz, A., & Salecki, S. (2015)
- Sievers, L., Breitschopf, B., Pfaff, M., & Schaffer, A. (2019)
- Slee. (2020)
- Spijkerboer, R., Trell, E-M., & Zuidema, C. (2016)
- Többen, J. (2017)

- Trink, T., Schmid, C., Schinko, T., Steininger, K. W., Loibnegger, T., Kettner, C., Pack, A., & Töglhofer, C. (2010)
- Ulrich, P., Distelkamp, M., & Lehr, U. (2012)
- Varela-Vázquez & Sánchez-Carreira. (2015)

Case Studies

Data availability is a significant issue for research at a sub-regional level in the EU. The level of availability for different metrics and definitions used varies significantly from Member State to Member State, and even where available this data is often several years old. One problem is simply jurisdictional, with competences allocated differently from country to country. The level of direct quantitative comparability is thus limited.

Notes

The focus has been on socio-economic impact assessments of renewable energy at the regional level in the EU. In practice, the focus of the literature is overwhelmingly on economic factors, mainly employment and GDP, but also a few other factors, such as household income and tax revenues (See Table 1). Environmental, health and well-being factors are sometimes mentioned, but not considered in a systematic way in the regional literature. Although broader definitions of socio-economic development are starting to be considered in the regional development literature, the use of wellbeing metrics is still not widely used in the literature analysed (Fudge et al 2021).

The bulk of literature is from the UK, Germany, and Spain. Other countries featured include: Finland, Sweden, Denmark, France, Romania, Slovakia, Austria, Italy, and the Netherlands.

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