
Cross-Border Renewables Cooperation

The impact of national policies and regulation on the cost
of onshore wind across the PENTA region and priorities
for cooperation

STUDY

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The impact of national policies and regulation on the cost of onshore wind across the PENTA region and priorities for cooperation

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Preface

In July 2018, European Union legislators set a binding EU-wide energy target for 2030: at least a 32% share of renewables in gross final energy consumption. To meet this target, over 50% of the power generation mix will have to consist of renewable energy. In some countries or regions, the percentage will be even higher.

A variety of EU regulations on renewables, power market design and state aid are in place to improve cross-border cooperation. So far, however, EU countries have collected little practical experience with cross-border renewable collaboration. The few existing initiatives show that cross-border collaboration could make better use of resources and generate renewable energy at a lower cost. At the same time, choices made by project developers and investors indicate that permitting regimes, grid connection conditions, taxation rules and access to finance are just as important as the availability of resources and the renewable energy support framework.

The problem, of course, is that the regulatory environment differs significantly from country to country. How

can cross-border cooperation support an efficient and effective deployment of renewables then? What are the practical consequences for cross-border collaboration? How can the opening of national support schemes work politically and economically meaningful?

To answer these questions, this study quantifies the effects of national policies and regulations on the costs of onshore wind projects for the Pentalateral Energy Forum region (Austria, Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland) and suggests pragmatic steps for addressing differences in the costs of renewable energy projects that result from regulatory and administrative conditions.

I hope you find the study inspiring and enjoy the read! Comments are very welcome.

Yours sincerely,

Patrick Graichen,
Executive Director of Agora Energiewende

Key findings at a glance:

1

In the PENTA region, effects from differences between national regulatory environments for the cost of renewables projects are significant and can even be larger than cost effects from differences in resource availability.

Cumulated cost effects from national regimes on planning, permitting, grid connection and usage, taxation and financing range from 12 EUR/MWh in Germany to 26 EUR/MWh in Belgium. A wind park in Belgium would thus need to have 20% more full load hours than a German wind park to equalise these effects of the national policy environment.

2

EU rules on renewable energy push for enhanced cross-border cooperation, but currently do not offer a consistent framework for implementation.

Cross-border cooperation on renewables is addressed i.a. in the EU Renewable Energy Directive, in the EU Regulation on the Governance of the Energy Union and in EU State Aid rules. A prerequisite for successful implementation is to better understand how national regulatory environments outside renewable energy support frameworks shape investor choices.

3

Cross-border renewables cooperation needs to address the impacts of differing regulatory conditions on LCOE.

Governments and regulators involved may agree on the coordinated convergence of some regulatory conditions towards recognised best practice. Where convergence is not feasible or desirable, the focus will be on whether and how to account for existing differences in the design of competitive auctions.

4

Insights from cross-border renewables cooperation are essential for future European approaches. These learnings will be relevant e.g. in the context of the EU 2030 renewables gap filler mechanism or the Renewable Energy Projects of European Interest.

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Executive Summary

The decarbonisation of the European energy system rests on continuous investment in renewables. By 2030, at least 50% of the EU's power mix will have to come from renewable energy sources (RES), the main ones being solar PV and wind. Regional cross-border cooperation between countries will become more and more important as a way to maximise the security of the electricity supply and to lower the costs of integrating rising shares of renewables into the power system.

In European debates, another major justification for more regional cooperation on renewables is that it makes better use of natural resources, increases the market value of renewable electricity and, by extension, reduces any premium payments that arise on power market revenues. Recent examples of cross-border collaboration have shown, however, that resource potential is not the only factor driving costs. A country's regulatory environment plays an important role as well.

A variety of EU regulations are in place to improve cross-border cooperation and increase the share of renewable electricity in the European power mix. But cross-border cooperation brings with it economic and practical challenges that we need to better understand if we are to establish effective and efficient systems.

In order to contribute to this understanding, the present study evaluates the variance in cost impacts that result from differences in countries' regulatory environment - by applying a sensitivity analysis - and discusses the effect these differences may have on the distribution of renewables investments. The empirical case study region is the Pentalateral Energy Forum, comprising Austria, Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland. The study is based on empirical data gathered through a stakeholder survey.

The core aim of this study is to understand the regulatory factors that impact divergence in renewable energy project costs from one country to the next and to illuminate the parameters that should become topics of discussion - and action - in regional cooperative measures.

It focuses on the following elements of the broader regulatory environment that strongly impact the levelised cost of electricity (LCOE) of onshore wind projects:

- Planning and permitting
- Grid connection
- Taxation
- Financing

Resource availability as traditional argument for regional RES deployment

Typical configurations of wind onshore projects may vary between countries, e.g. regarding the size and the amount of full load hours per year. These differences have clear economic implications. However, to compare the cost impacts of the regulatory environment between countries, calculations in this study are based on a reference project that consists of six 3 MW wind turbines, each with a generation potential of 3,000 full load hours per year and a main investment cost of 1,200 EUR/kW. Taking into account all relevant capital and operational expenditures, fiscal regimes and financing costs, we arrive at an LCOE of 79.60 EUR/MWh.¹

Wind resource availability, represented by the annual full load hours, and the technology costs, represented by the main investment costs, have a strong influence on LCOE. For example, a 10% increase in full load

1 See Table 3 in Annex 1 for the relevant cost and project data for the LCOE calculation.

hours decreases the LCOE by 8%. If the investment costs increase by 10%, LCOE increases by 5.5%.

It is LCOE sensitivity to resource availability that has traditionally fuelled arguments for a regional or even EU-wide allocation of renewables, i.e. building wind plants where wind speeds are highest and PV plants where solar irradiation is most intense. Critically, though, this view neglects the economic effects of different policy and regulatory environments on RES deployment costs.

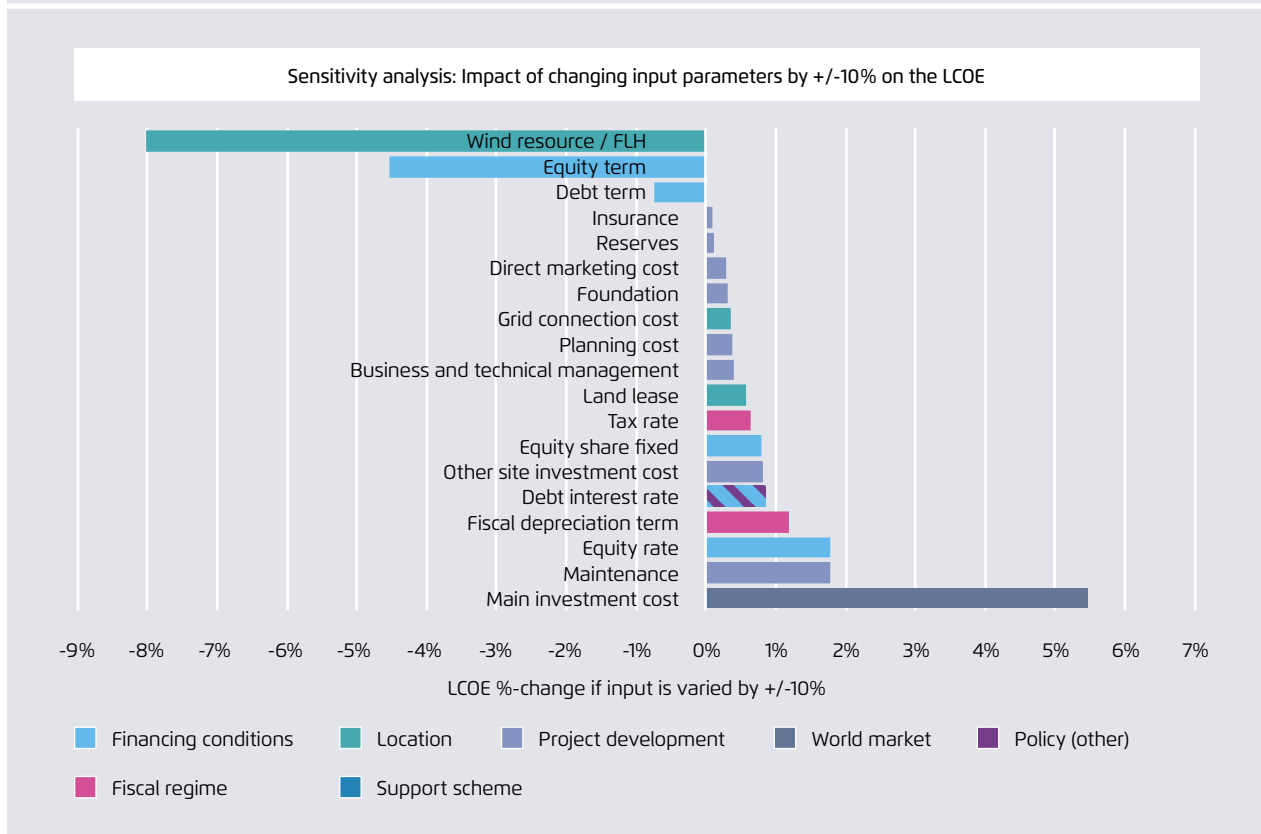
Together, the national policy and regulatory environment can have a greater effect on the cost of renewables than natural resource availability

To identify the most relevant parameters affecting the LCOE of onshore wind projects, the study performed sensitivity calculations for the Pentilateral Forum Region. The sensitivity of a cost factor indicates how a variation of this factor by x% affects overall LCOE (all other things being equal). In this way, we can identify which factors have the strongest effect on costs.

Figure ES1 shows the results of changing the cost factors by +/-10%. It reveals substantial differences between the various parameters. In practice, the variation of the cost factors - within and

Correlation of input parameters with LCOE when applying a sensitivity analysis of +/-10%.*

Figure ES1



Ecofys

*In reality, the variation in input parameters deviates significantly from the +/-10% depicted in this figure.

between countries - deviates significantly from the +/-10% depicted in the graph. Larger variations can be observed between countries in particular for those parameters that are directly influenced by policies and regulation (e.g. grid connection costs, planning and permitting cost, fiscal regimes).

Most importantly, the analysis shows that in the PENTA region the combined effect of individual LCOE impacts for planning and permitting, grid connection, financing costs and taxation can even be larger than the effect of variations in wind resource availability. For example, a 10% decrease in the full load hours increases the LCOE of the aforementioned wind project by 6.4 EUR/MWh. By contrast, the combined effect of the individual policy and regulatory cost components ranges from 12.2 EUR/

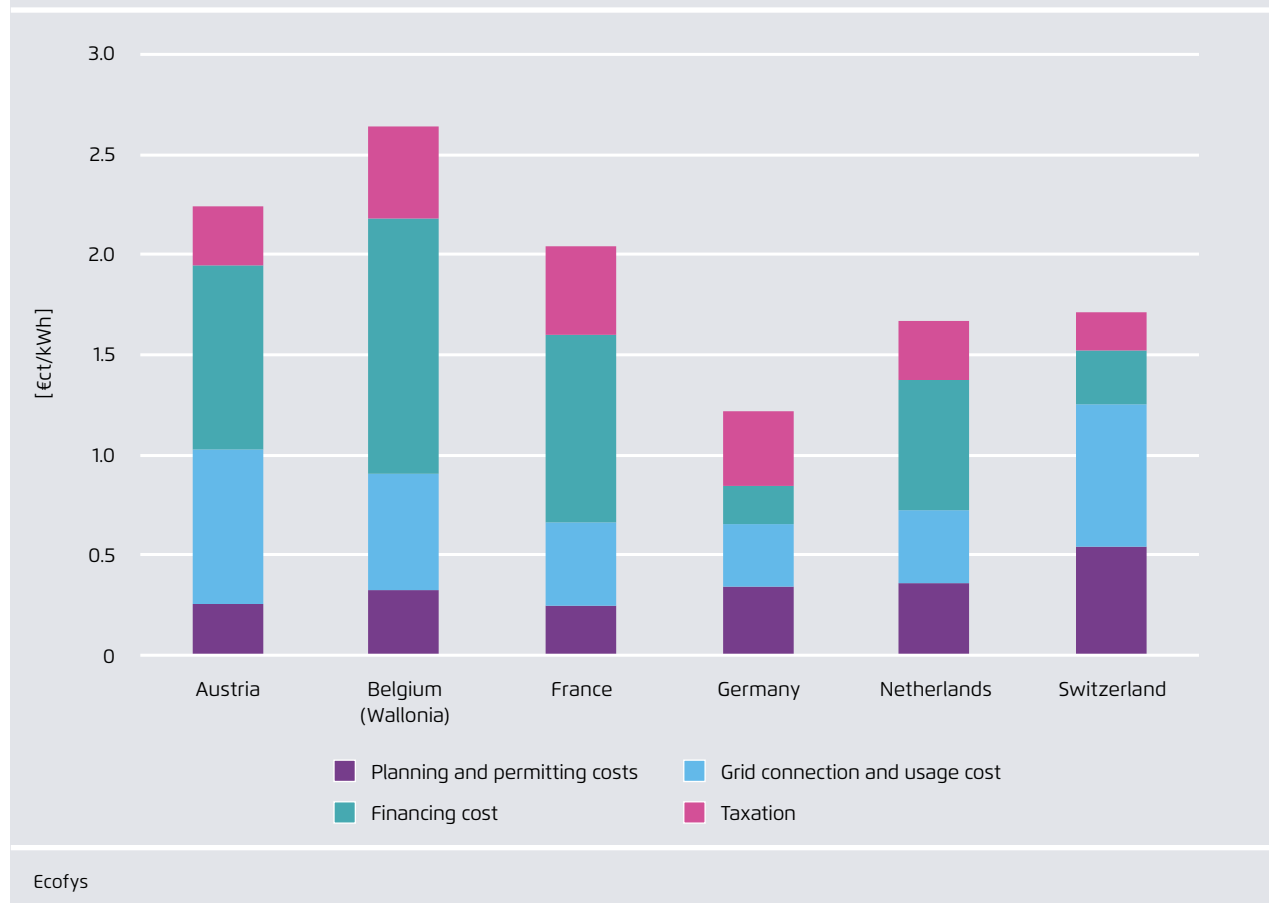
MWh in Germany to 26.4 EUR/MWh in Belgium (see Figure ES 2).

Significant differences between countries of the PENTA region can be observed for all analysed parameters. Out of the four parameters, grid connection and financing costs have the largest impact and also the largest variation.

Regulation-induced cost impacts also vary *within* countries. This variation depends on the regulatory conditions themselves and on the circumstances under which the project is developed, most importantly its location. Planning, permitting and grid connection costs strongly depend on the project location, which for example determines the type of environmental assessments that are required for the permit-

Combined effects of analysed factors on the LCOE.

Figure ES2

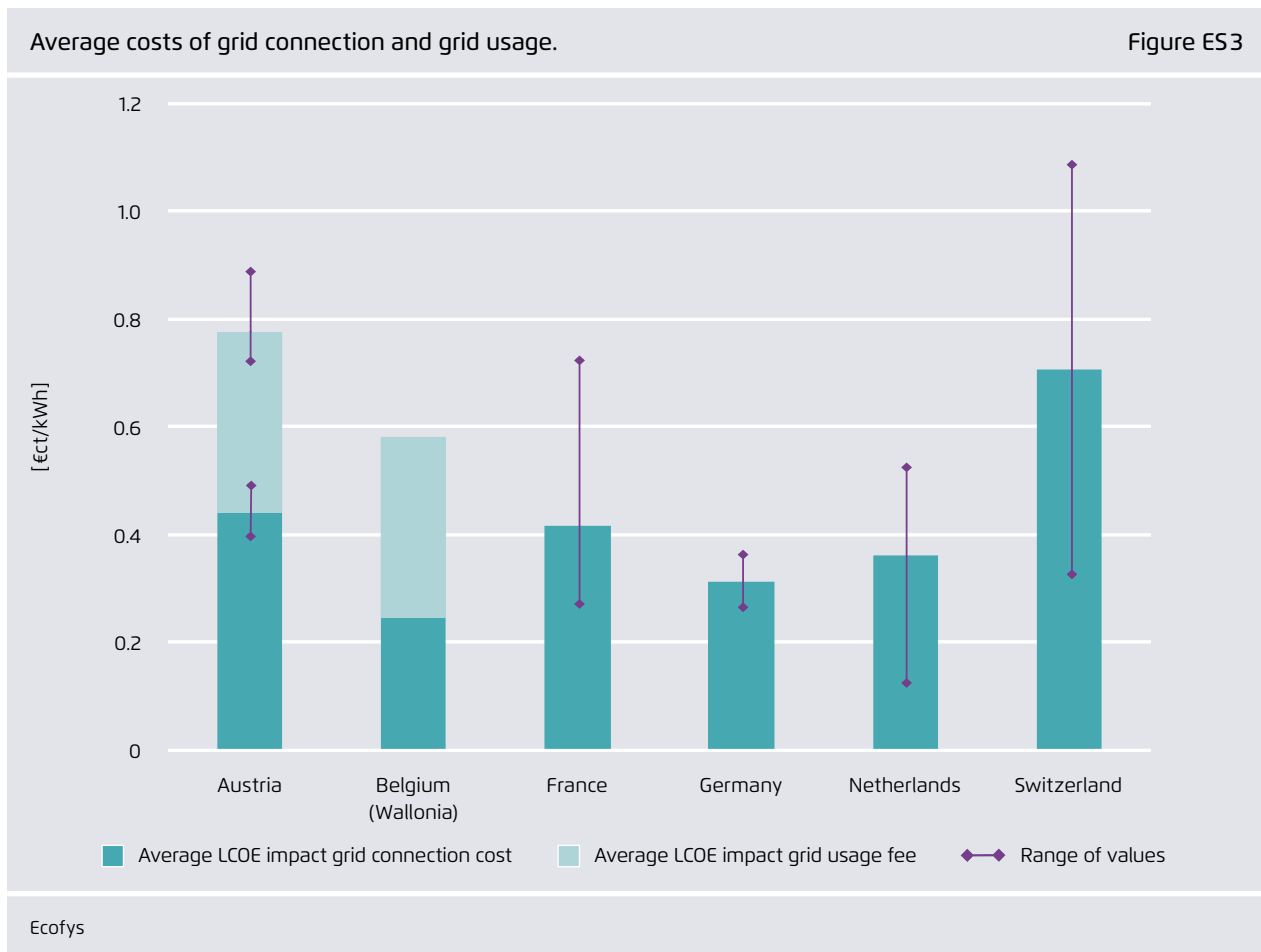


ting process as well as the length of the cable connecting the wind farm to the grid. Costs also vary according to the type of project. The costs and associated risks for the expansion of an already existing wind project are lower than those involved in the development of a new wind project. To some degree, costs also depend on the project developer. Local project developers may have an advantage insofar as they have the support of the community, which can reduce the likelihood of a project getting tied up in court.

To illustrate the variation of cost impacts within countries, Figure ES 3 shows grid connection costs and grid usage fees for the reference wind onshore project in the countries of the PENTA region. Costs related to grid connection vary considerably between member States depending on the grid connection

regime, ranging from 2.4 EUR/MWh in Belgium to 7.1 EUR/MWh in Switzerland.

The figure reveals large cost ranges *within* countries. Especially in France, the Netherlands and Switzerland, project developers face strong variations in grid connection costs. Project-specific costs depend to a large extent on the project's size, its distance to the next network connection point and the connection voltage level. The distance to the connection point is usually the most important cost factor. However, for countries with a "shallow-deep" or "deep" grid connection regime, the "reinforcement" can also vary according to project location. In a competitive cross-border allocation of support payments, such differences in grid connection costs would cause significant distortions.



Average LCOE impacts for all parameters (in ct/kWh).

Table ES1

	Austria	Belgium (Wallonia)	France	Germany	Netherlands	Switzerland
Planning and permitting (ct/kWh)	0.25	0.33	0.25	0.34	0.36	0.54
Grid connection & usage (ct/kWh)	0.78	0.58	0.42	0.31	0.36	0.71
Financing (ct/kWh)	0.92	1.28	0.94	0.19	0.65	0.27
Taxation (ct/kWh)	0.30	0.46	0.44	0.38	0.30	0.19

Ecofys

The smallest absolute impacts and variations between countries was observed for corporate taxation, which ranged from 1.9 EUR/MWh in Switzerland to 4.6 EUR/MWh in Belgium.

The average LCOE impacts for all parameters are summarised in Table ES 1.

Some regulatory factors impacting LCOEs are more relevant in regional cooperation than others

Resource availability is a key factor in the cost of renewables. However, our analysis shows that – at least in the Pentalateral Region – regulatory conditions can even have a greater effect on the LCOE of renewable energy projects. Given the gradual alignment of renewable energy support frameworks in recent years (e.g., competitive tendering, market premium payments) this seems an important finding indeed: It suggests that broader regulatory conditions impacting on cross-border cooperation require much more attention in political and legislative debates. Specifically, the sensitivity analysis conducted for this study suggests that governments and regulators engaging in cross-border cooperation projects should address the LCOE impacts resulting from planning and permitting, grid connection, financing conditions, corporate taxation, risks related to project realisation, site restrictions and requirements.

Planning and permitting

The average LCOE impacts of planning and permitting range from 2.5 EUR/MWh (France) to 5.4 EUR/MWh (Switzerland). However, project-specific planning and permitting costs can deviate significantly from these average costs also within countries. The main issues related to planning and permitting are linked to a lack of standardization in permitting requirements and procedures, a lack of coordination between different levels of administration, the length of planning and permitting procedures and legal challenges.

It is important to note that planning and permitting procedures are impacted by EU regulation (e.g. "one-stop-shop" permitting, simplified permitting in case of re-powering, environmental impact assessments) and involve different levels of governance within member states (e.g. role of municipalities in spatial planning). As there might be good reasons for differing approaches to planning and permitting, it is unlikely that full convergence across countries can be reached in this area. However, based on the cost impacts and the underlying complexity of planning and permitting procedures, this issue merits attention in regional cooperation forums with a view to further establishing a level playing field for cross-border RES investments and to identifying best practices.

Grid connection costs

Grid connection costs vary considerably between member states depending on the grid connection regime, which can be “shallow” or “deep”. The average cost of a grid connection ranges from 2.4 EUR/MWh in Belgium to 7.1 EUR/MWh in Switzerland, but costs vary widely within countries. Especially in France, the Netherlands and Switzerland, project developers face strong variations in grid connection costs. In addition to grid connection costs, generators in Austria and Belgium are charged for grid usage. In both cases, grid usage charges significantly increase operational expenditures – and as a result, LCOE – by more than 3 EUR/MWh on average.

Member states may have different preferences or technical contexts that may require them to define grid connection regimes differently. For some use shallow grid connection costs to avoid competition between project developers for the lowest cost grid connection and ensure the use of sites with the most resources. Others use deep connection charges to send a price signal to project developers at the investment stage in order that they select sites that are easily connected to the grid. Dialogue between cooperating member states on these issues will foster a better understanding of where the differences come from and how cross-border auctions could address them.

Financing conditions

Debt interest rates, debt share and debt term are the direct result of market factors, but *indirectly* reflect regulatory conditions. Indeed, specific financing conditions and the cost of financing are an important indication of perceived political and regulatory risk. Even though financing conditions are currently quite favourable and the reported differences between countries are not as big as they have been in the past, their impact on LCOE is still significant and reveals differences of more than 10 EUR/MWh. The large differences between countries are a clear indication of the strong influence financing conditions may have on the outcome of competitive cross-border cooperation.

Despite the complexity of the topic, member states would benefit from discussions of how best to improve overall investment conditions so that they converge across member states. If it is not possible to achieve similar financing conditions, additional de-risking measures would create a more level playing-field.²

Corporate taxation

Costs related to corporate taxation are purely determined by regulation and reflect broader political priorities. Hence, it seems unlikely that the desire to deepen regional cooperation on renewables will trigger agreement on regional convergences of corporate taxation regimes. This said, differences in taxation impact cross-border competition on renewables. The impact of different taxation regimes on cross-border renewable energy cooperation is another reason to discuss the broader issue among member states. Cross-border auctions could include a bonus-malus system for each bid. This system would reward or penalize a project depending on its country's taxation rules and so reduce the effects of taxation differences.

Project realization period / Risk of non-realization

The project realization period ranges from planning to the start of plant operation and includes all necessary assessments, permitting, construction and grid connections. Realization periods average range from six to nine years, though project durations can vary widely within a country. The overall time needed for a project can impact not only cost but also the ability to qualify for auctions, each of which stipulate specific prerequisites and realisation periods.

The risk of non-realization is the possibility that a project already underway does not finish. It is an indicator of uncertainty in the regulatory investment conditions, and project developers must take into account the sunk costs from a possible non-realiza-

² The recently proposed multi-year EU budget allows member states to “de-risk” some of the financing risks related to renewable energy investments.

tion in their financial planning. The risk of non-realization varies greatly between EU countries, from 33% in France to 70% in Austria.

Project realization periods and the risk of non-realization would be important topics of discussion at regional forums because they can influence the competitiveness of projects in open auctions. They are also relevant because member states would seek to realize effective RES deployment in open auctions and would thus want to avoid exposing their deployment targets to larger realization risks than would be the case in national auctions.

Site restrictions and requirements

Site restrictions are regulations restricting the availability of land that is suitable for the development of wind onshore projects. Strict site restrictions may increase the average LCOE of wind onshore projects in a member state where the competition for available sites is high (resulting in higher land costs) and the other available sites suitable for wind projects have lower average full load hours.

Site restrictions proved to be among the key elements in determining the outcome of the German-Danish open auction in 2016. In addition, they have been the subject of intense debates within member states and thus represent an opportunity in the regional context to discuss best practices and the potential convergence of national regulations.

Cross-border renewables cooperation should include dialogue addressing LCOE impacts resulting from different regulatory conditions

Differences in regulatory conditions between member states can have a larger impact on the LCOE of RES projects than variations resulting from differences in resource availability do. Actors involved in cross-border cooperation on renewables, whether bilaterally or regionally, must decide whether and

how to address competitive impacts from differences in regulatory conditions. This suggests that a dialogue addressing LCOE impact from different regulatory conditions should be seen as part and parcel of enhanced cross-border renewables cooperation.

In such dialogue, the reduction of the cost impact of differing regulatory regimes will obviously be a major issue. For some regulatory conditions, governments and regulators may agree on a gradual convergence towards recognised best practice. For others, convergence may not be feasible or desirable. Here the focus would be instead on how to account for such differences or for the resulting competitive effects in auction design.

The EU pushes for enhanced cross-border renewables cooperation but lacks a consistent framework

To stress again, the impact of different national policy environments in the PENTA region on LCOE – which varies as much as 14 EUR/MWh – can even be greater than the impact of resource availability. Accordingly, national policy differences will shape the distribution of RES deployment in a system of open auctions at the regional level. But while EU regulation is pushing for enhanced cross-border cooperation on renewables, it does not yet provide a consistent framework for ensuring a level playing field throughout Europe.

The current EU Renewable Energy Directive, which applies until the end of 2020, includes some provisions on cross-border cooperation designed to facilitate the achievement of national renewable energy targets at a lower cost. But the cooperation mechanisms that the directive introduces have seen little use due to their complexity and high transaction costs. Under EU state aid law as currently interpreted by the European Commission, member states must partially open their national support schemes for renewable energy installations located in other member states. This has led some governments to redesign their schemes to avoid such obligations, given political and practical concerns.

The EU framework that comes into effect in 2021 – which includes a new EU Renewable Energy Directive, new EU laws regulating the power market and the monitoring and safeguarding of the electricity supply, new EU state aid guidelines for energy and environmental protection, new EU rules on integrated climate and energy planning, and a new multi-year EU budget – will further strengthen the push for cross-border collaboration on climate and energy, particularly at the regional level.

Nevertheless, neither existing EU rules nor the EU framework that will apply starting in 2021 take into account the role that regulatory conditions may play in the success or failure of cross-border cooperation projects. Some examples:

- The opening of national renewable energy support schemes mandated under EU state aid may not be effective unless differences in the regulatory conditions are better understood and addressed by member states.
- Regional or EU-wide tendering of renewable energy capacity in the event that individual member states are unwilling to contribute their “fair share” in achieving the collective EU renewable energy target (at least 32% by 2030) is unlikely to result in the desired outcome without a better understanding of the competitive effects from differences in domestic regulatory conditions.

A pragmatic approach to enhanced cross-border renewables policy cooperation in Europe

Enhanced cross-border cooperation on renewables will continue to play a role in European climate and energy law. Based on the insights from this study, we recommend the following measures to maximise the benefits of bilateral and regional-level renewable energy cooperation:

1. Analyse the effects of regulatory conditions on RES project costs

A better understanding of how regulatory conditions influence the LCOE of RES projects is a necessary first step. Our analysis suggests that the priority should lie on analysing the effects of

- planning and permitting conditions,
- grid connection regimes,
- taxation rules,
- financing conditions and
- the risks associated with project planning and site restrictions.

This analysis must, in our view, precede the implementation of the new EU Renewable Energy Directive, particularly given its detailed provisions on planning, permitting and grid connection.

The drafting of integrated National Energy and Climate Plans (iNECPs) and the outlining of opportunities for regional cooperation will also facilitate knowledge sharing. Identifying differences in regulatory conditions will not only help prepare for cross-border collaboration in an open support architecture but also provide an occasion for member states to discuss the best regulatory practices.

2. Assess impact of differences in regulatory conditions on cross-border renewable energy cooperation

A concrete opportunity for member states to assess the impact of differences in regulatory conditions is during the drafting of the integrated national energy and climate plans required by the new Regulations on the Governance of the Energy Union. We believe that understanding the impact of regulatory differences on the LCOE of renewable energy projects is crucial for the effective operation of the EU renewable energy financing mechanism, which is stipulated in Article 27 of the new Energy Union regulation. It is also critical for successful dialogue between member states on enhanced cross-border collaboration.

3. Agree on a coordinated convergence of select regulatory conditions

One potential approach for coping with important differences is to agree on a coordinated convergence of select regulatory conditions. Obviously, any such convergence should be oriented towards existing best practice standards.

The Pentilateral Energy Forum and other conferences on regional cooperation will play an important role in reaching an agreement. In addition to holding discussions, these can, say, install working groups on cross-border renewable energy cooperation. One possible approach to creating a more level playing field is the capping of permit fees and the limiting of other fees to those associated with the permitting process.

4. Design cross-border collaboration on renewables in a way that reflects differences in regulatory conditions

Convergence is not the same thing as outright harmonisation. Some differences in regulatory conditions will remain, particularly where these reflect broader political priorities outside renewable energy. One way to address remaining differences is to change the design of competitive auctions. For example, a bonus-malus system, adjusting the bid levels to reflect differences in national regulation could be considered to level the playing field. A thorough assessment of potential consequences on bidding strategies and auction results should precede any auction design decisions, however. The key focus should be on improving the regulatory framework.

5. Use the lessons learned from regional cooperation to identify the best EU-level practices

Adjusting regulatory conditions in response to bilateral or regional support schemes and incorporating shared regulatory knowledge will help member states identify successful practices. Accordingly, enhanced regional-level collaboration should serve as a laboratory for determining the best approaches to use at the EU level. The history of regional initiatives in Europe

has shown that regional cooperation is often a promising setting to try new ideas and progressive solutions. For example, the introduction of flow-based market coupling was first tested in the Pentilateral Forum region and has since been expanded from there.

6. Approach enhanced cross-border renewables collaboration as an integral part of better regional cooperation in European climate and energy policy

The regulatory conditions that impact the LCOE of RES should also feed into and consider other regional forms of cooperation. These regulatory conditions include the development of the National Energy and Climate Plans, which require regional consultation and cooperation. They also include the interactions discussed in this report and other issues being addressed in existing and planned regional cooperation forums. This covers the broader integration of RES into grids and markets, the efficient regional use of flexibility options, the alignment of power market design (e.g. the use of RES in balancing and re-dispatch markets) and cross-border infrastructure planning. Another area to address is EU funding for renewable energy projects of European interest, which is likely to become available in the near future. As our findings suggest, insights from regional consultation and cooperation on regulatory conditions for RES investments will provide a valuable contribution to other forms of regional cooperation.

Conclusions and recommendations

Cross-border cooperation on climate and energy is becoming increasingly important. EU climate and energy laws (both those in effect today and those that will apply after 2020) expressly require member states to significantly strengthen bilateral and regional cooperation, particularly in the power sector. This study shows that regulatory conditions outside the renewable energy support framework will

become increasingly relevant for successful bilateral and regional cooperation in this area.

The key elements that need addressing are planning and permitting, grid connection regimes, financing conditions, project planning risks and site restrictions. All these elements pertain to the impact of national differences on a variety of components in cross-border cooperation, such as open support schemes, regional or EU-wide renewable auctions.

Based on our analysis, we recommend that member states advance cross-border collaboration on renewable energy by taking the following pragmatic measures:

1. Analyse the effects of regulatory conditions on RES project costs.
2. Assess impact of differences in regulatory conditions on cross-border renewable energy cooperation.
3. Agree on a coordinated convergence of select regulatory conditions.
4. Design cross-border collaboration in a way that reflects differences in regulatory conditions.
5. Use the lessons learned from regional cooperation to identify the best EU-level practices.
6. Approach enhanced cross-border renewables collaboration as an integral part of better regional cooperation in European climate and energy policy.

1 Introduction

This study explores the costs associated with divergent regulatory and policy environments for national investment in renewable energy sources (RES) while giving special consideration to their effects on cross-border renewables cooperation. The key finding of this study is that these differences can have profound effects on the levelised cost of electricity (LCOE) from RES projects.

As part of negotiations on the Clean Energy for All Europeans Package (CE4All package),¹ policymakers have suggested a variety of EU-wide RES target for 2030, ranging from at least 27% (as advocated by the European Commission and member states) to 35% (as advocated by the European Parliament). With the adoption of a 32% RES target in June 2018, RES are expected to provide more than half of the electricity generated in the EU by 2030, and full decarbonisation remains the goal for 2050.²

Achieving the RES target will increase the need for cooperation between member states, as the binding EU target will not be broken down into binding member state targets. At the same time, the growing Europeanisation of energy policy is visible in a range of objectives and initiatives, including in particular the aim of implementing an Internal Energy Market (IEM). The underlying rationale for the imple-

mentation of the IEM is that a larger market size can achieve economies of scale, support decarbonisation and increase security of supply. As a supplement to pan-European perspectives and long-standing national approaches to energy policy, regional cooperation – that is, collaboration between two or more member states in the same macro-region – has gained importance as a means of tackling many IEM implementation challenges. The advantages of regional cooperation are numerous. Cooperation within larger and better-connected regions leads to higher security of supply while also reducing the need for (fossil) backup capacity in a system with high shares of RES. Furthermore, improving policy coordination through cooperation can decrease the cost of RES deployment thanks to the improved utilisation of resource availability.

Slated for adoption in 2018, the CE4All package recognises the need for greater regional cooperation on RES and should provide a strong impetus to regional collaborative efforts. Specifically, Article 11 of the Governance Regulation calls on member states to describe plans for regional cooperation.³ Furthermore, Article 5 of the Renewable Energy Directive II stipulates the progressive opening of renewable electricity support schemes.⁴ Today, member states are already cooperating in order to promote the stable operation of electricity grids across Europe and to improve cross-border trade while alleviating bottlenecks at interconnection

1 On the Clean Energy for All Europeans Package see: <https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans>

2 Ecofys and TU Wien have calculated the effects of different levels of ambition regarding the EU-wide RES target for 2030 as well as the effects of an increased energy efficiency target on renewables deployment at member state-level. See Felix von Blücher et al. (2017): National Benchmarks for a more ambitious EU 2030 renewables target: https://www.bee-ev.de/fileadmin/Publikationen/Positionspapiere_Stellungnahmen/Englisch_Website/National_benchmarks_for_a_more_ambitious_EU_2030_renewables_target_21Jun2017.pdf

3 European Commission (2017), Proposal for a Regulation of the European Parliament and the Council on the Governance of the Energy Union. 2016/0375 (COD). 23.02.2017: https://eur-lex.europa.eu/resource.html?uri=cellar:f9f04518-b7dc-11e6-9e3c-01aa75ed71a1.0001.02/DOC_1&format=PDF

4 European Commission (2017), Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (recast). 2016/0382 (COD). 23.02.2017: ec.europa.eu/energy/sites/ener/files/documents/1_en_act_part1_v7_1.pdf

points. To be sure, plans for expanding RES in Europe mean that regional collaboration on issues linked to RES investment will grow in importance.

The EU's call for cross-border cooperation is based on the insight that deeper integration should enable the more efficient deployment of renewables. In theory, a cross-border approach to developing renewables should allow member states to better harness renewable resources, and thus reduce RES support costs. However, top-down analyses of potential gains from cooperation usually fail to consider the cost aspects of renewables deployment that are mediated by regulatory conditions. The relevance of cooperation and coordination in this field is underlined by recent results from the opening of RES support schemes to projects in other countries. In the fall of 2016, Denmark and Germany carried out cross-border auctions for solar photovoltaics resulting in all winning bids being located in Denmark. In the German cross-border auction, the strike price for a sliding market premium with a support duration of 20 years was remarkably low at 5.38 ct/kWh. The volume-weighted average bid level of Danish bids was much lower (6.44 ct/kWh) than the German bids (7.65 ct/kWh).⁵ Better natural potential – i.e. higher full load hours – was only one of many local advantages for solar PV projects in Denmark that led to this one-sided result. Other reasons were related to differences in regulatory conditions, which lead to lower land lease costs in Denmark (in Denmark solar PV projects can be developed on agricultural lands whereas German site restrictions forbid such development) and a slightly lower tax burden. In addition, the competition in Denmark was much stronger due to a lack of alternatives for project sup-

port, as the support mechanism for large-scale solar PV plants in Denmark was terminated only months before the cross-border auction. The outcome of these auctions triggered a broader debate on differences in regulatory conditions for RES investment.⁶ This is a highly topical issue, as several member states are currently exploring options and establishing the legal requirements for the opening of their support schemes (e.g. the Netherlands, Italy, Estonia).

The core aim of this study is to understand the factors that impact divergence in renewable energy project costs from one country to the next, and, by extension, to illuminate the parameters that should become topics of discussion – and action – in regional cooperative measures. The study fills a gap in the European debate by comparing variance in the cost impacts of regulatory conditions between countries and discussing how this variance may affect the distribution of renewables investments. Moreover, it reveals potential knock-on effects for national regulatory frameworks.

Regulatory factors influencing RES project costs include RES auction design, permitting and grid connection regimes, tax codes, site restrictions and other rules that can hardly be harmonised in a top-down manner by the EC. Accordingly, regional cooperation could play an important role in removing existing barriers to cost-effective RES deployment in national regulatory environments. In addition, cooperation can help to minimise differences in the regulatory and policy environments between member states, which can produce benefits in other areas.

5 Fact sheet on the results of the cross-border auction between Germany and Denmark. Bundesnetzagentur: „Hintergrundpapier: Ergebnisse der geöffneten Ausschreibung für Solaranlagen mit dem Königreich Dänemark vom 23. November 2016 – Stand: 21.12.2016“: https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Unternehmen_Institutionen/ErneuerbareEnergien/Intern_Ausschreibungen/Hintergrundpapier_DK_2016.pdf?__blob=publicationFile&v=2

6 Welt: „Warum wir jetzt für dänische Solarparks zahlen“: <https://www.welt.de/wirtschaft/article159841311/Warum-wir-jetzt-fuer-daenische-Solarparks-zahlen.html>
Manager magazin: „Dänemark blamiert deutsche Ökostrom-Lobby“: <http://www.manager-magazin.de/unternehmen/energie/energiewende-daenemark-blamiert-deutschland-bei-solarstrom-a-1123455.html>
Solarbranche.de: „Dänen gewinnen länderübergreifende EEG-Ausschreibungen“: <http://www.solarbranche.de/news/nachrichten/artikel-32634-daenen-gewinnen-laenderueberreifende-eeq-ausschreibungen>

To complement existing studies focusing on the grid or market aspects of regional cooperation, this paper adopts an investor's point of view. Taking the form of empirical case study, it focuses on the Pentatlantal Energy Forum region (Austria, Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland), but strives to provide guidance to member states beyond the PENTA region.

To assess which factors affect RES project costs, on-shore wind was used as an example to ensure comparability between countries. The study is based on new empirical data gathered through a stakeholder survey and uses a sensitivity analysis to identify factors that generate differences in the levelised cost of electricity (LCOE) across countries. Our survey data and LCOE calculations illuminate the areas in which stronger regional cooperation and the progressive alignment of regulatory conditions can provide the largest benefits. These findings are then used to reflect on current proposals for regional cooperation in different EU legislative processes in the context of the CE4All package. However, rather than developing suggestions concerning the forums and institutions that should be used to implement regional cooperation, the report focuses on specific areas for collaboration that are likely to yield tangible benefits in terms of making the expansion of renewables more efficient at a national and regional level while also facilitating a truly European approach to reaching climate and energy targets.

2 Assessing the cost impacts of regulatory conditions on the development of onshore wind: Methods

2.1 Our approach

This study compares how divergent regulatory conditions impact costs associated with the development of onshore wind projects while using the levelised cost of electricity (LCOE) as an operative metric.

Our approach assumes the implementation of cross-border renewables auctions in which the main elements of the support scheme design are aligned (e.g. type and duration of support payments). The cost impacts induced by differences in the design of the support scheme are therefore not examined in this report. Furthermore, we give no consideration to optimising market value of renewable energy by means of market premium design, as this topic is beyond the scope of this study. Our calculations are based on the assumption that all successful bidders receive a “contract for difference” that guarantees stable revenues, such that differences in market values between countries do not affect the results of our cash flow analysis.

Cross-border renewables auctions are a hotly discussed model for the competitive development of renewables across borders. The rapid advancement of auction schemes in Europe in recent years, driven by State Aid provisions,⁷ facilitates renewables cooperation between member states.⁸ To implement

cross-border RES collaboration between countries, existing national auction schemes can be extended to bidders in other countries without having to establish joint support schemes or funds. The segmented nature of auctions allows one to define specific eligibility and selection criteria for certain volumes of renewable deployment and thereby keep national and cross-border auctions distinct. The cross-border auctions carried out between Denmark and Germany in 2016 are a first example of this type of cooperation and more cross-border auctions are expected in the coming years. The results of this study, however, are relevant for almost all forms of cross-border renewables cooperation.

Cross-border auctions create direct competition between project developers from different countries facing different natural resource potentials (e.g. solar radiation or wind intensity), market conditions and regulatory conditions. As a consequence, country-to-country differences in these factors have direct effects on the auction outcome and, by extension, the cost of renewables support.

When looking at regulatory conditions, it is important to distinguish between support scheme design and regulatory conditions that are not part of the support system. The support scheme design comprises the auction rules (e.g. maximum bid sizes, realization period, etc.), the type of remuneration (e.g. fixed versus sliding market premium, permissibility of additional revenues through guarantees of origin) and the duration of support payments. In cross-border auctions, these conditions have to be the same for all participants to make bids comparable. In other words, in cross-border renewables cooperation, the same support scheme design should apply to all bidders.

7 This trend has been largely driven by the Guidelines on State aid for environmental protection and energy 2014–2020, (2014/C 200/01): <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52014XC0628%2801%29>

8 For an overview of the use of RES auctions in Europe see Mora et al. (2017): Auctions for renewable energy support – Taming the beast of competitive bidding: <http://auresproject.eu/sites/aures.eu/files/media/documents/aures-final-report.pdf>

Regulatory conditions that are not part of the support scheme are, for example, corporate taxation, planning and permitting rules, conditions for grid connection, eligible areas and sites, and environmental requirements. In cross-border auctions, these conditions will deviate between the cooperating countries. This is due to the fact that cross-border alignment of these aspects is difficult in the short term, since they reflect a broader regulatory and political context (e.g. corporate taxation). Therefore, the conditions that prevail in the country where the installation is to be located will usually apply.

This study focuses on how country-to-country differences in regulatory conditions impact the LCOE of onshore wind projects. We examine regulatory conditions pertaining to the following:

- Planning and permitting
- Grid connection
- Financing conditions
(debt interest rate, share and term)
- Taxation

Differences between these country-specific investment conditions play an important role in determining the outcome of cross-border renewables auctions and thus the geographic distribution of support payments. The effects of differing regulatory conditions can be very strong, as has been demonstrated in previous studies that, for example, analyse the cost of financing renewables in Europe.⁹ Depending on the specific conditions, regulation-induced costs may exert a greater influence on the selection of a lowest-cost project than the availability of natural resources or their market value. This highlights the need to consider national

regulatory frameworks when debating how to achieve pan-European climate and energy goals while using cross-border renewables deployment. In addition, the results of this study indicate the cost savings that could potentially be achieved if member states were to align some of their regulatory conditions.

The results of this report are based on the Ecofys cash-flow model, which determines the levelised cost of electricity (LCOE). The LCOE is the net present value of the total cost of building and operating a plant over its financial life, converted into equal annual payments. Thus, it is a metric for economically assessing the cost of an energy-generating system, including all costs over its financial lifetime. In other words, in contrast to a system modelling perspective, the LCOE reflects the costs of project development from an investor perspective, including the costs arising from regulation at all project development phases. The LCOE of a project determines the required revenues (i.e. market revenues plus support premium) and is thus the most important parameter for determining investors' bidding prices. By conducting an LCOE analysis, we can single out the cost impact of individual aspects of the regulatory framework. In the context of cross-border cooperation, this can tell us which regulatory aspects are most significant for the distribution of successful RES bids between cooperating countries. This, in turn, enables a very targeted and pragmatic approach to regional cooperation. However, the information acquired from an LCOE analysis is also relevant for purely domestic renewables deployment.

This study analyses regulatory conditions affecting the LCOE of onshore wind projects in the PENTA countries. Our focus on one RES technology ensures comparability across countries since most regulatory conditions have technology-specific impacts.

Our analysis is based on a *ceteris paribus* examination of the impact variation of a specific regulatory condition between PENTA countries. To this end, we define a "base case" onshore wind project that applies to all PENTA countries. As part of this base case, we assume

9 See Ian Temperton (2018): Reducing the cost of financing renewables in Europe. Study on behalf of Agora Energiewende: https://www.agora-energiewende.de/fileadmin2/Projekte/2016/De-Risking/Agora_RES_CRF-Dialogue_WEB.pdf and DiaCore (2016): "The impact of risks in renewable energy investments and the role of smart policies": <https://www.ecofys.com/files/files/diacore-2016-impact-of-risk-in-res-investments.pdf>

certain values for capital and operational expenditures, the fiscal regime and financing costs. Our methodology is explained in more detail in the following sections.

2.2 Applied methodology

As a first step in our LCOE analysis, we used a triangulation approach. Our triangulation is based on expert estimates of selected LCOE cost components in member states, which in turn were collected from eclareon's detailed barrier database¹⁰ and literature review¹¹. A survey among project developers was

¹⁰ <https://www.re-frame.eu/>

¹¹ Literature reviewed on the cost of development of onshore wind included:
 Deutsche WindGuard (2015): Kostensituation der Windenergie an Land in Deutschland. Update: https://www.wind-energie.de/sites/default/files/download/publication/kostensituation-der-windenergie-land-deutschland-update/20151214_kostensituation_der_windenergie_an_land_in_deutschland_update.pdf
 Fachagentur Wind (2015): Dauer und Kosten des Planungs- und Genehmigungsprozesses von Windenergieanlagen an Land: https://www.fachagentur-windenergie.de/fileadmin/files/Veroeffentlichungen/FA-Wind_Analyse_Dauer_und_Kosten_Windenergieprojektierung_01-2015.pdf
 Ecofys (2017): Kostprijsanalyse Windenergie op Land: <http://www.nwea.nl/images/PDFs/Ecofys-Kostenprijsanalyse-Wind-op-Land-170405.pdf>
 Pöyry (2016): Observatoire des coûts de l'éolien terrestre: http://fee.asso.fr/wp-content/uploads/2016/12/Poyry_FEE_Observatoire_couts_eolien_terrestre_final-1.pdf
 SER (2014): ETAT DES COÛTS DE PRODUCTION DE L'ÉOLIEN TERRESTRE EN FRANCE. Analyse économique de la Commission Eolienne du SER: <http://www.enr.fr/userfiles/files/Brochures%20Eolien/Etat%20Co%20C3%BBt%20de%20production%20C3%A9olien%20terrestre%20VF.pdf>
 NREL (2017): 2015 Cost of Wind Energy Review: <https://www.nrel.gov/docs/fy17osti/66861.pdf>
 EWEA (2016): EWEA position paper on network tariffs and grid connection regimes (revisited): <http://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA-position-paper-on-harmonised-transmission-tariffs-and-grid-connection-regimes.pdf>
 Zoveel kost een windmolen en zoveel brengt hij op: <https://www.mo.be/analyse/zoveel-kost-eeen-windmolen-en-zoveel-brengt-hij-op>

used to confirm or refine these estimates. These differing cost components were then entered into the Ecofys cash-flow model in order to calculate the LCOE.

The following steps were taken, which are explained in more detail below:

- Step 1: Defining a base case and a support scheme for an onshore wind project
- Step 2: Selection of cost factors for further analysis based on LCOE sensitivity analysis
- Step 3: Analysis of national regulatory conditions for onshore wind development in the PENTA region
- Step 4: Estimation and survey of cost implications of national provisions
- Step 5: Calculation of LCOE value of country-specific provisions

2.2.1 Step 1: Defining a base case and a support scheme for an onshore wind project

The first step was to define a "base case" onshore wind project that is representative of projects in the PENTA countries. Typical configurations of onshore wind projects may vary between countries, e.g. regarding the size and the amount of full load hours per year. Taking these differences into account, Ecofys' in-house experts, who have extensive practical experience in onshore wind project development, defined a base case while aiming to reflect average values for the PENTA region.

The base case project consists of six 3 MW wind turbines, each 140 meters high. The generation potential is fixed at 3,000 kWh per Kilowatt per year. The base case assumes values for all relevant capital and operational expenditures, the fiscal regime and financing costs, of which the most important are shown in Table 1. More detailed values are shown in Annex 1.

Values of base case project.

Table 1

Parameter	Base Case value
Main investment cost	1,200 EUR/kW
Grid connection cost	76 EUR/kW
Project planning	85 EUR/kW
Operational cost	8.5 EUR/kW/yr
Tax rate	29%
Debt interest rate	3%
Debt term	12 years
Debt/Equity ratio	80/20

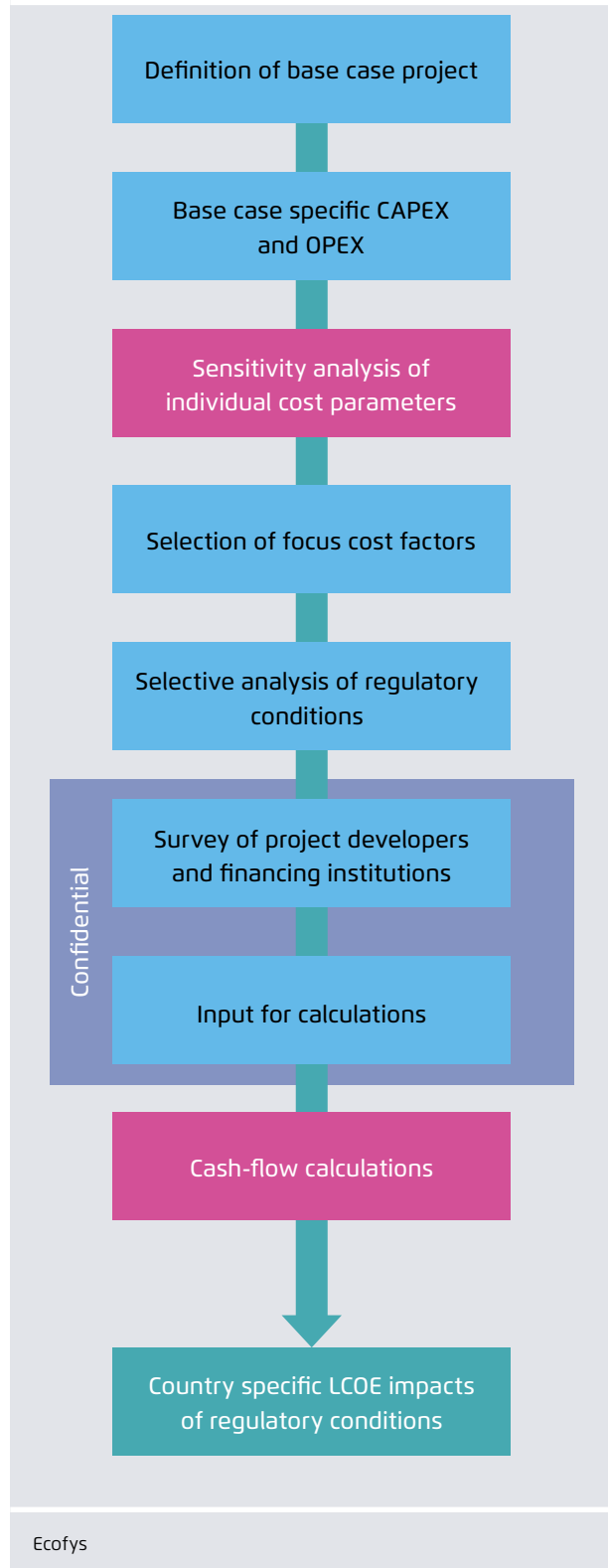
Ecofys

In addition, we defined the most important design parameters of the support scheme. In our base case, a contract for difference is granted for a period of 20 years, which means that generators are paid the difference between the “strike price” and the “reference price” (usually the average market price). This guarantees stable revenues at a pre-agreed level. Fixing the natural potential and defining a certain support scheme design is necessary in order to assess the regulatory conditions that impact the LCOE. As described above, the alignment of support schemes is a minimum requirement for cross-border auctioning. A contract for difference leaves market value difference out of the equation.

2.2.2 Step 2: Selection of cost factors for further analysis based on LCOE sensitivity analysis

To identify the most relevant parameters affecting the LCOE of onshore wind projects, sensitivity calculations were conducted for each of the LCOE factors in the base case project. The sensitivity of a cost factor indicates how a variation of this factor by x% affects, *ceteris paribus*, the overall LCOE. It thus reveals which factors have a disproportionately strong influence on costs. The aim of our sensitivity analysis was to identify the main cost factors that can be influenced by the regulatory and policy environment.

Flow-chart of the method for assessing the cost impacts of regulatory conditions Figure 1



Two sensitivity calculations were carried out: The first sensitivity calculation applied the same standard deviation to each input parameter. In the second calculation, individual sensitivities were applied to parameters that can be influenced by regulatory measures.

In the first sensitivity analysis, a deviation of +/-10% was applied to each quantitative input parameter in the base case. The results are shown in Table 4 in the Annex. Taking into account all relevant capital and operational expenditures, the fiscal regime and financing cost, the levelised cost of electricity (LCOE) for the "base case" project amount to 79.6 EUR/MWh. The wind resource availability, represented through the annual full load hours, and the technology cost, represented mainly by the "main investment cost",

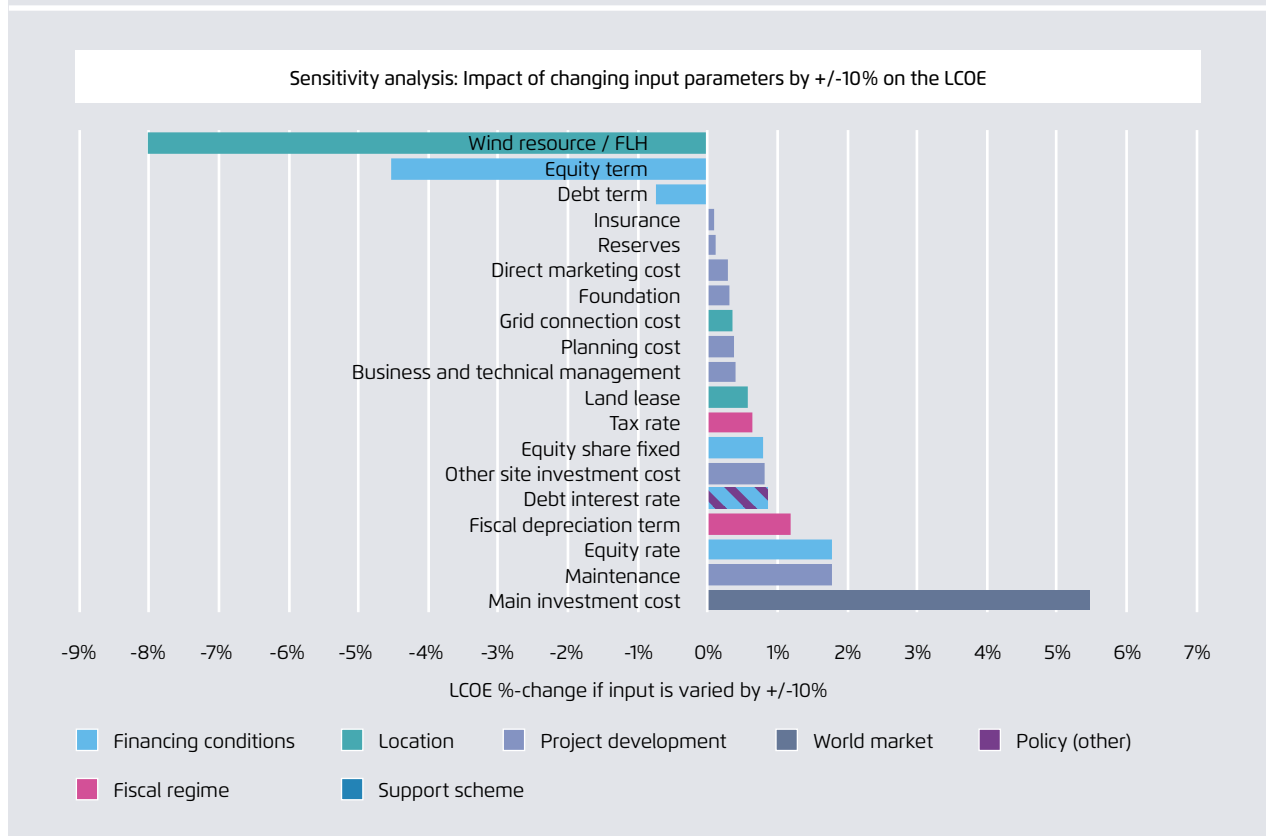
have a strong influence on the LCOE. According to our sensitivity analysis, a 10% increase in the full load hours decreases the LCOE by 8%. If the investment cost increase by 10% the LCOE increase by 5.5%.

The figure below is a simplified visualisation of the correlation of the individual LCOE input parameters when changing each parameter by + and -10%. It shows that full load hours, the equity term, and debt term have an inverse effect on the LCOE. In other words, when increasing any of these parameters, LCOE is reduced. For all others, the correlation between the factors and LCOE is positive.

Overall, this figure shows substantial differences in the effects exerted by the parameters. However, in reality, the variation in the input parameters within

Correlation of input parameters with LCOE when applying a sensitivity analysis of +/-10%.*

Figure 2



Ecofys

*In reality, the variation in input parameters deviates significantly from the +/-10% depicted in this figure.

and between countries deviates significantly from the +/-10% depicted in the figure. Also, many of these parameters cannot be directly influenced by policies and regulation and are therefore not subjected to further consideration in this study. For example, the main investment costs related to the construction of the wind turbine (including its purchase, transportation, and installation) can hardly be influenced through legislation other than tax deduction schemes. These costs should therefore be more or less similar in all PENTA countries. Other cost parameters – for example, the cost related to planning and permitting – are to large extent determined by regulatory conditions. These factors, which can deviate significantly between countries, receive significant attention in this report.

A second sensitivity analysis was conducted while focussing on the LCOE parameters that can be influenced directly through regulatory measures. The aim of this second sensitivity analysis was to select for further analysis the most relevant LCOE parameters with the highest regulation-induced cost impacts. To this end, more specific variations for LCOE parameters that are directly influenced by regulation were estimated ex-ante by in-house onshore wind experts. These variations reflect the range that can be typically observed for these factors more accurately than the +/-10% deviation used in the first sensitivity analysis. For example, the costs related to grid connection and project planning/permitting were estimated to vary by at least +/-80% and +/-40%, respectively, between the PENTA countries, resulting in LCOE variations of up to 4.4 EUR/MWh (calculated as difference between 77.4 and 81.8 EUR/MWh) for grid connection costs and 2.5 EUR/MWh (difference between 78.3 and 80.8 EUR/MWh) for planning and permitting costs. The presumed sensitivities and their related impact on LCOE are shown in Table 5 in the Annex.

The selection of cost factors for further analysis was based on three main criteria:

(1) the impact of the factors on overall LCOE;

(2) the potential of regulatory conditions to influence the factor; and

(3) the expected variance of the factor between the PENTA countries. The following parameters were ultimately selected for subsequent analysis:

- Planning and permitting
- Grid connection
- Financing conditions (debt interest rate, debt/equity ratio and debt term)
- Taxation

In addition to these parameters, there are important regulation-induced differences between countries that are difficult to express in terms of LCOE. Some of these parameters (including project realization period, risk of non-realization, site restrictions and environmental requirements) are examined in section 3.2.

2.2.3 Step 3: Analysis of national regulatory conditions for onshore wind development in the PENTA region

Based on the results of the sensitivity analysis, we explored regulatory conditions for onshore wind development in the PENTA countries. In this connection, relevant legislation was identified and evaluated with a view to uncovering salient differences between countries. Eclareon's extensive databases on country specific regulatory provisions and barriers to onshore wind development were used as the starting point for this analysis. The information on specific regulatory provisions was obtained from the RES LEGAL Europe database.¹² The REveal database provided information on barriers to onshore wind development.¹³ This information was then enhanced with input from experts on each country. The information thus collected served as the initial basis for our cost estimations.

¹² <http://www.res-legal.eu/>.

¹³ A comprehensive collection of information on barriers to the deployment of RES technologies across all RES sectors, see <https://www.re-frame.eu/>

2.2.4 Step 4: Estimation and survey of the cost implications of national provisions

In step 4, the cost values that served as an input for the subsequent cash-flow calculations under step 5 were estimated for each regulatory condition in each country and linked to one of the selected LCOE parameters. These estimates were derived based on prior studies and other literature, as well as cost calculations from in-house experts.¹⁴

These estimates were enriched with empirical data from sector experts and industry stakeholders from across the region. A questionnaire was designed and distributed to project developers, renewables asso-

ciations and financing institutions with experience in onshore wind development in the PENTA countries. In the questionnaire, stakeholders were asked to provide data based on the project configuration of the base case (see 2.2.1) and on current average values for 2017 in order to ensure comparability of the answers. The received survey response data were then analysed to cross-check cost estimates.

In general, project developers hesitate to disclose the costs of individual aspects of project development. However, the questionnaires sent to the stakeholders already included initial cost estimates, which encouraged the participants to provide their insights regarding cost information for this report. Detailed responses – 25 in total – were received from all countries except Luxembourg, thus furnishing new and up-to-date empirical data. The survey process was accompanied by targeted follow-up interviews of project developers in each country to provide additional feedback on the estimated costs of specific regulatory provisions.

2.2.5 Step 5: Calculation of LCOE value of country-specific provisions

In this last step, the country-specific average costs associated with each LCOE parameter were calculated based on the data provided in step 4. In addition, cost ranges were defined for most LCOE parameters to reflect the ranges in the feedback provided by the participating stakeholders. These variations indicate that the impact exerted by regulatory conditions on the cost of a specific wind project depends in part on other general conditions such as the project development strategy, the technical configuration of the project, specific location of the project, and support from local stakeholders, among other factors. Thus, cost variations cannot only be found between, but also within, the observed countries.

Using the Ecofys cash-flow model, the country-specific LCOE values for each parameter were calculated. For this purpose, the base case value was replaced with the country-specific cost values derived in

14 Literature reviewed on the cost of development of onshore wind included:

Deutsche WindGuard (2015): Kostensituation der Windenergie an Land in Deutschland. Update: https://www.wind-energie.de/sites/default/files/download/publication/kostensituation-der-windenergie-land-deutschland-update/20151214_kostensituation_der_windenergie_an_land_in_deutschland_update.pdf

Fachagentur Wind (2015): Dauer und Kosten des Planungs- und Genehmigungsprozesses von Windenergieanlagen an Land: https://www.fachagentur-windenergie.de/fileadmin/files/Veroeffentlichungen/FA-Wind_Analyse_Dauer_und_Kosten_Windenergieprojektierung_01-2015.pdf

Ecofys (2017): Kostprijsanalyse Windenergie op Land: <http://www.nwea.nl/images/PDFs/Ecofys-Kostenprijsanalyse-Wind-op-Land-170405.pdf>

Pöyry (2016): Observatoire des coûts de l'éolien terrestre: http://fee.asso.fr/wp-content/uploads/2016/12/Poyry_FEE_Observatoire_couts_eolien_terrestre_final-1.pdf

SER (2014): ETAT DES COÛTS DE PRODUCTION DE L'ÉOLIEN TERRESTRE EN FRANCE. Analyse économique de la Commission Eolienne du SER: <http://www.enr.fr/userfiles/files/Brochures%20Eolien/Etat%20Co%20C3%BBt%20de%20production%20C3%A9olien%20terrestre%20VF.pdf>

NREL (2017): 2015 Cost of Wind Energy Review: <https://www.nrel.gov/docs/fy17osti/66861.pdf>

EWEA (2016): EWEA position paper on network tariffs and grid connection regimes (revisited): <http://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA-position-paper-on-harmonised-transmission-tariffs-and-grid-connection-regimes.pdf>

Zoveel kost een windmolen en zoveel brengt hij op: <https://www.mo.be/analyse/zoveel-kost-eeen-windmolen-en-zoveel-brengt-hij-op>

step 4.¹⁵ The resulting country-specific LCOE values for each parameter are presented in section 3.

2.3 Dealing with data variation and limitations

Rather than aiming for full statistical representativeness, this study's methodological approach checks data from the literature, prior projects, and expert estimates against insights from a new survey of market stakeholders. This methodology of cross-checking different sources provides the best available figures for national cost factors.

However, it should be noted that a given regulatory feature does not generate a specific cost figure within a country. Instead, regulation-induced cost impacts vary within countries, which is reflected by the ranges in the input data provided by the stakeholders, as mentioned in section 2.2.5. The regulation-induced cost impacts on a wind project depend not only on the regulatory conditions themselves, but also on the circumstances under which the project is developed, most importantly its exact location. Planning, permitting and grid connection costs strongly depend on the project location, for the location influences various cost-relevant factors, including, for example, the type of environmental assessments that are required for the permitting process as well as the length of the cable connecting the wind farm to the grid. Costs also vary according to the type of project. Costs and associated risks for the expansion of an already existing wind project are lower compared to the development of a new wind project. To some degree, costs also depend on the type of project developer. A local project developer may have an advantage in gaining local support from the community, which can reduce the risk of lengthy project appeals. To account for these variations, cost ranges were defined for

most LCOE parameters and are shown in the results in section 3.

The publicly available data and survey responses were limited for some countries. For Luxembourg, no cost information is currently available. In this country, the onshore wind market is very small. As a consequence, developers active in Luxembourg were not willing to disclose their costs. Switzerland currently has no wind parks of the same size as the base case (18 MW). Cost estimations in this country are thus based on smaller projects that already exist or are currently in planning. In the case of Belgium, the cost information retrieved and analysed is based on the regulatory and market conditions in Wallonia and does not represent the regions of Flanders and Brussels.

Our methodology deliberately factors out the influence exerted by project size, as we assume the development of a project with identical features across all countries. Interviewees were requested to provide cost information based on their understanding of the market and apply these to our base case project parameters. Sunk costs from non-realised projects are not included in the data.¹⁶

15 A different approach was chosen to calculate the LCOE impact of the country-specific financing costs. This approach is explained in section 3.1.3.

16 From a project developer's perspective, the sunk costs of non-realised projects have to be covered by the economic performance of their overall project portfolio.

3 The cost impacts of regulatory conditions

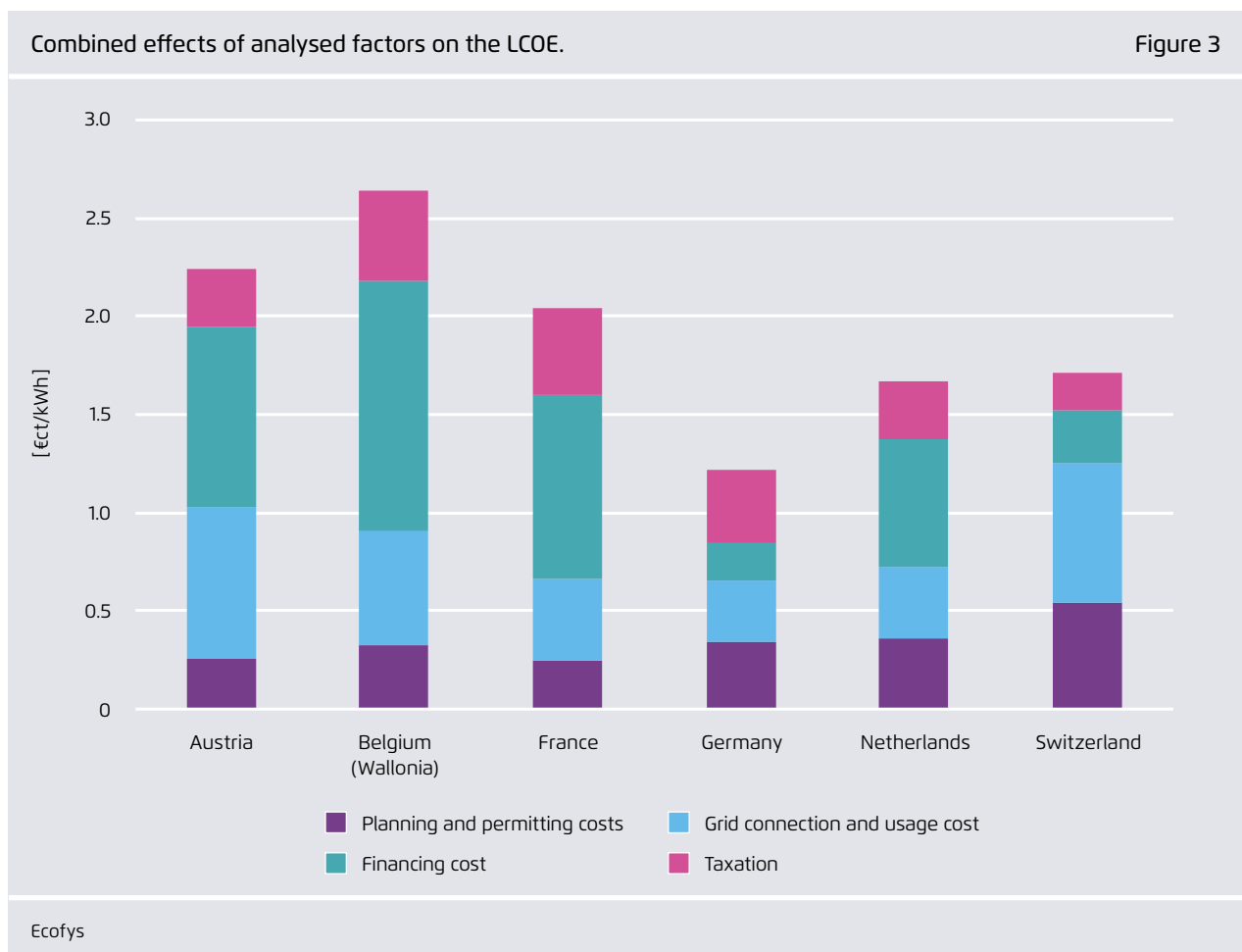
The following sections explore the country-specific average cost impacts of regulations governing planning and permitting, grid connection, financing conditions and corporate taxation. Project developers and financing institutions were asked to provide current average cost information for 2017.

3.1 Cumulative effects of analysed factors

The country-specific cumulative average cost figures are shown in the following graph. They are an approximation of the typical costs for a representative project.

Project specific costs may of course deviate from these average values. This is reflected by the cost ranges that are shown in the individual graphs for each LCOE parameter in the following subsections. These cost ranges are based on data provided by project developers, financing institutions and associations (see section 2.2). The costs of most projects developed in a specific country should be within these ranges.

Examining the combined effect of the individual average LCOE impacts for planning and permitting, grid connection, financing costs and taxation, we find significant differences between countries, ranging from a cumulative cost of 1.22 ct/kWh for Germany



to 2.64 ct/kWh for Belgium,¹⁷ a difference of 1.42 ct/kWh. In a situation of cooperation between countries based on competitive cross-border auctions, such a difference can have a strong determining effect on the distribution of successful RES bids.

Significant cost differences between the PENTA countries can be observed for all analysed parameters. Of the four parameters, grid connection and financing costs have the largest impact and the largest variation. The smallest absolute impacts and variations between countries can be observed for corporate taxation, ranging from 0.19 ct/kWh in Switzerland to 0.46 ct/kWh in Belgium. The average LCOE impacts for all parameters are listed in the following table.

3.1.1 Planning and permitting

The columns in Figure 2 show the average LCOE impact of planning and permitting provisions for each country. The cost category of planning and permitting includes all internal and external costs borne by the project developer that are related to the administrative procedures of planning and permitting (preliminary site assessments, securing of land, all types

of assessments and permits). Not included are costs related to preparing the site or planning/implementing construction activities, etc. This parameter was chosen because costs, time requirements and risks related to administrative procedures and permitting vary significantly between member states and are to large extent driven by regulatory conditions.

The average LCOE impacts of planning and permitting range from 0.25 ct/kWh (France) to 0.54 ct/kWh (Switzerland). However, project specific planning and permitting costs can deviate significantly from these average costs, which is reflected by the black line showing the cost ranges that were reported by surveyed stakeholders. Cost ranges are particularly large in Germany (0.18–0.44 ct/kWh) and in the Netherlands (0.27–0.63 ct/kWh). The Netherlands and Switzerland have the highest average planning and permitting costs. In both countries, costs can range up to 0.63 ct/kWh.

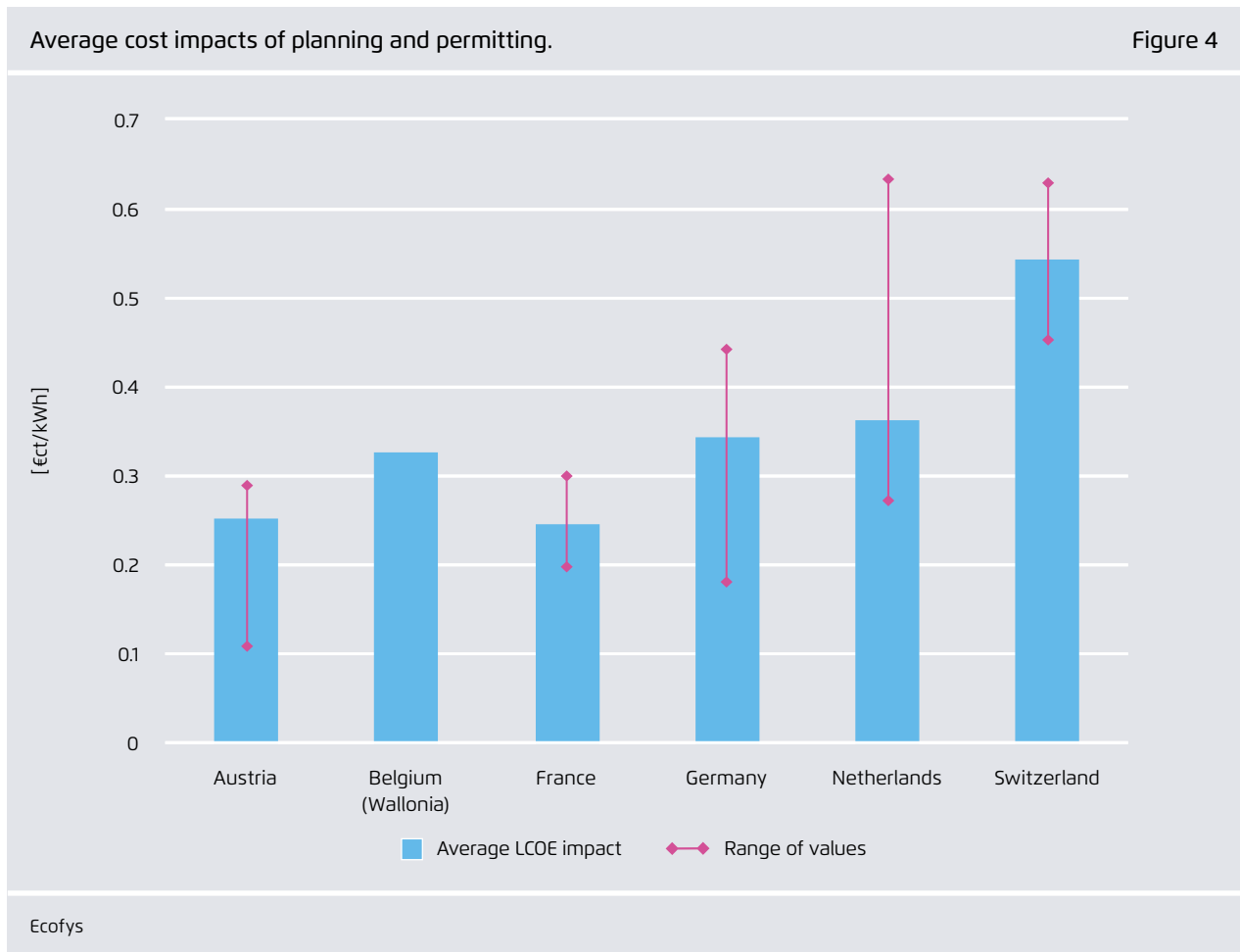
According to the surveyed stakeholders, the main problems related to planning and permitting are a lack of standardisation in permitting requirements and procedures, a lack of coordination between different levels of administration, the length of planning and permitting procedures, and court appeals. These barriers are further explained below.

17 The overall LCOE, including all CAPEX, OPEX and financing costs, ranges from 6.8 ct/kWh (DE) to 8.3 ct/kWh (BE), according to our cash-flow calculations.

Average LCOE impacts for all parameters (in ct/kWh).

Table 2

	Austria	Belgium (Wallonia)	France	Germany	Netherlands	Switzerland
Planning and permitting (ct/kWh)	0.25	0.33	0.25	0.34	0.36	0.54
Grid connection & usage (ct/kWh)	0.78	0.58	0.42	0.31	0.36	0.71
Financing (ct/kWh)	0.92	1.28	0.94	0.19	0.65	0.27
Taxation (ct/kWh)	0.30	0.46	0.44	0.38	0.30	0.19



Project developers in Germany, France, the Netherlands and Switzerland reported that there is a lack of standardisation in permitting requirements and procedures, which can lead to the arbitrary handling of permitting by responsible authorities. As a result, there is a lack of transparency and cost predictability related to permitting.

In Germany, permitting procedures vary between the federal states, and project developers reported that differences are high enough to distort competition. Project developers assert that due to non-standardisation, there is no official, binding, transparent and publicly accepted process to develop and approve a wind project. Unforeseen issues can arise at any stage of planning and permitting.

In Switzerland – the country with the highest average planning and permitting costs – project developers expressed a need for clear requirements concerning environmental impact assessments in order to increase planning reliability, especially related to the protection of birds and bats.

In France, permitting problems often arise due to interference with military radar, training grounds and flight zones. This problem impacts large parts of the country. Decisions by the military whether or under which conditions wind power plants can be developed are perceived as arbitrary by project developers.

The Netherlands has the second highest average planning and permitting costs. Administrative fees related to permitting are said to comprise a large

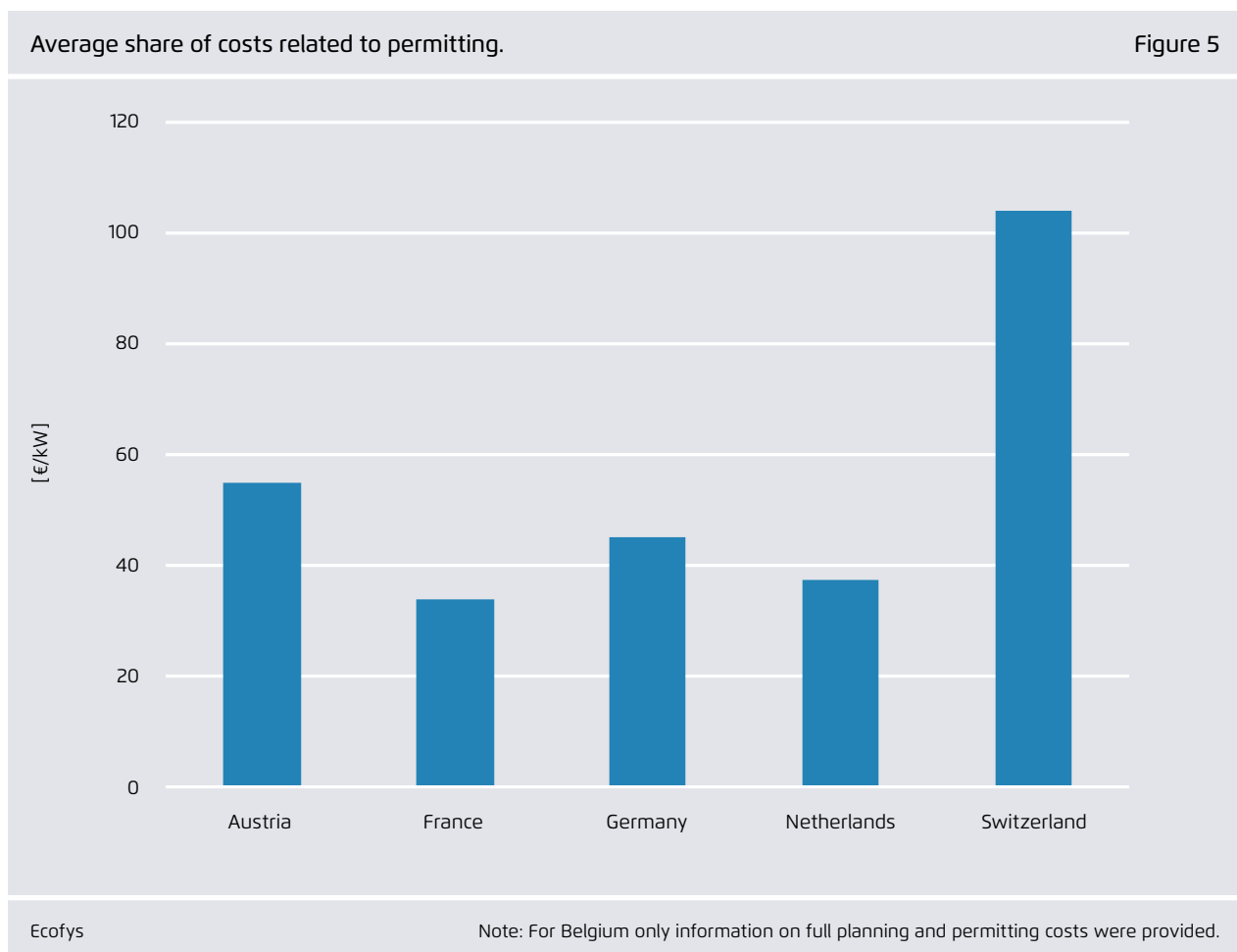
share of development costs and are very inconsistent across the country. Project developers state that some municipalities generate revenues by demanding permitting fees that largely exceed that warranted by cost recovery for their administrative activities.

Figure 4 shows the average costs related only to permitting in EUR/kW. Permitting is directly linked to regulatory provisions. Differences in permitting costs between countries are thus first and foremost a result of differing regulatory requirements. Permitting costs include all required assessments and administrative fees for obtaining necessary permits. Costs are determined by the type of assessments required (environmental, avifauna, landscape, noise, shadow flickering, interference with radar, military/flight zones, minimum distance to urban areas, natural conservation

areas, coast lines, etc.) as well as by the time required for assessment and the administrative fees.

Lack of clarity about the assessments that are required and intransparent procedures can increase the risks, duration and ultimately the costs of the entire planning and permitting process. Average permitting costs range from 34 EUR/kW in France to 104 EUR/kW in Switzerland. Project developers from several countries (e.g. Germany and Austria) stated that the provisions for environmental impact assessments are becoming increasingly stringent, requiring assessment periods of multiple years.

Project developers from several countries reported that the lack of coordination between different levels of administration is a challenge, and they suggested



a more coordinated and aligned permitting process at all levels of government (municipal, regional and national). Similarly, the extensive possibilities for filing appeals as well as the duration of appeal procedures can be a major barrier to predictable and efficient wind project development. Court appeals against projects during the development phase were the most important reason for project delays in all analysed countries, causing higher project development costs and an increasing risk of non-realisation. Sections 3.2.1 and 3.2.2 discuss issues related to the duration of project realisation and risk of non-realisation in more detail.

The above-mentioned issues have the potential to distort competition at the regional, national and cross-national levels. It is beyond the scope of this report to develop or assess tailored regulatory solutions that would level the playing field between countries. With regard to permitting, however, debate is already underway in the analysed countries concerning how to increase the predictability of procedures and costs. Recommendations currently being considered include the definition of national standards for required assessments and the permitting procedure, putting a national cap on permit fees, and ensuring that permit fees do not exceed expenses incurred by authorities for the permitting process. Creating one point of contact (i.e. a "one-stop shop"¹⁸) for all permit requests for a specific project could improve coordination and align processes between different levels of authority. Another idea is to shift responsibility and/or costs for carrying out environmental, landscape and radar assessments to public authorities.

With regard to legal appeals, the streamlining of legal proceedings and introduction of time limits for courts' decisions could potentially reduce differences and risks in project development. In some cases, one could consider restricting the right to lodge legal appeals.

¹⁸ Wallonia has implemented a one-stop shop.

3.1.2 Grid connection

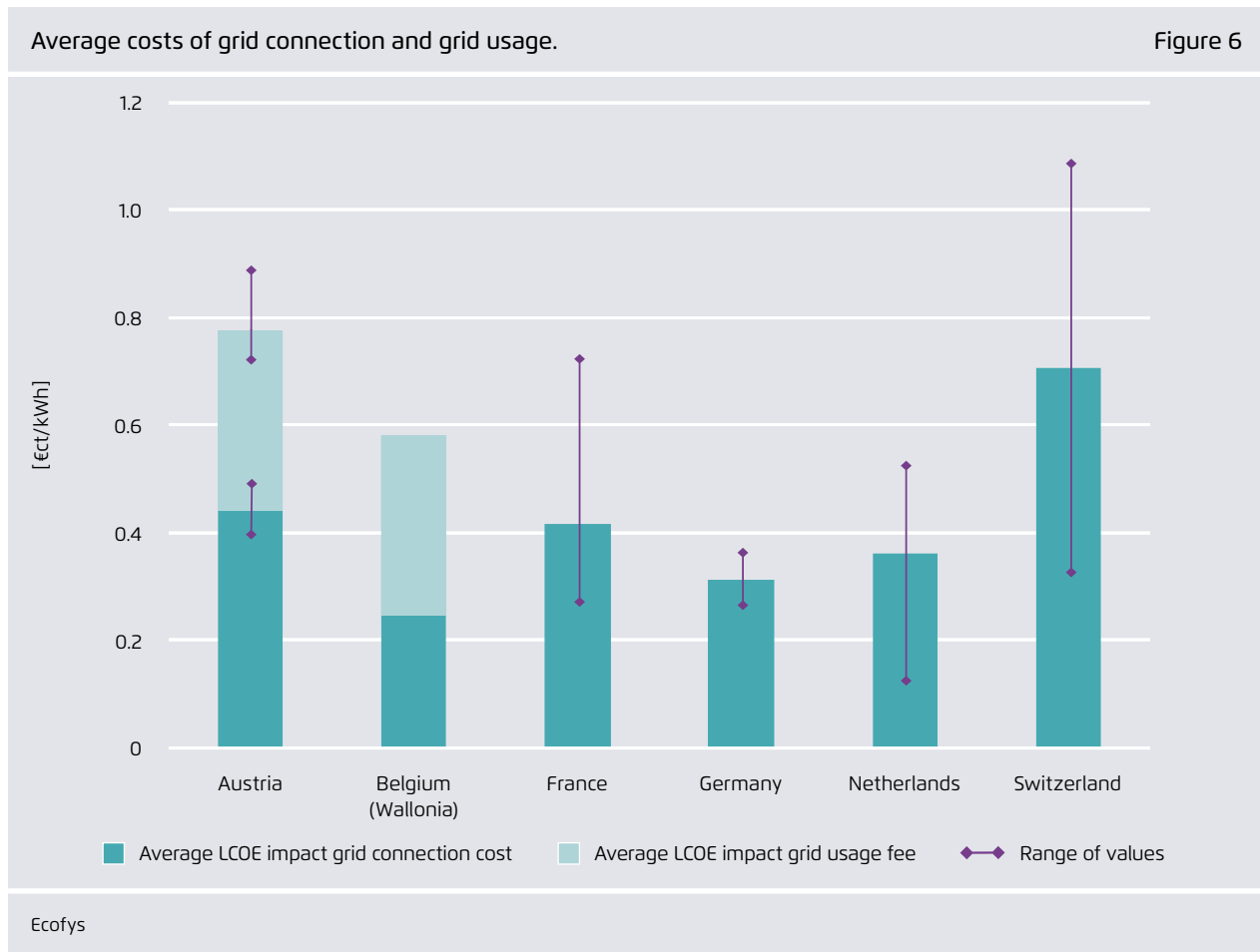
Grid connection costs includes all costs borne by the project developer that are related to the connection of the plant to the grid and, if applicable, grid reinforcement. Average grid connection costs are shown in Figure 5. In addition, grid usage fees were taken into account in countries in which they apply (Austria and Belgium).

Costs related to grid connection vary considerably between member states depending on the grid connection regime, which can be "shallow" or "deep". A "shallow" grid connection policy means that generators only pay the cost of connection assets. All costs related to the reinforcement of the grid are either paid by the TSO or shared among network users. Under a "deep" connection policy, generators are obliged to pay all the connection costs plus the costs related to the expansion and strengthening of the grid. The "deep" connection approach is therefore cost-reflective and provides a locational signal. Some countries chose hybrid "shallow-deep" approaches, obliging generators to pay some of the reinforcement costs.

In addition to the grid connection costs, generators are charged for grid usage in Austria and Belgium. In both cases, grid usage charges significantly increase operational expenditures and thus the LCOE by more than 0.3 ct/kWh on average.

As a result of differing grid connection regimes, the average cost of grid connection varies significantly between the observed countries, ranging from 0.24 ct/kWh in Belgium to 0.71 ct/kWh in Switzerland. If grid usage costs are added to grid connection costs, generators in Austria face the highest average grid-related costs of 0.82 ct/kWh. Generators in Germany – where a "shallow" grid connection regime and no grid usage fees are implemented – have the lowest average grid related costs of 0.31 ct/kWh on average.

However, Figure 5 also reveals large cost ranges within countries. Especially in France, the Netherlands and Switzerland, project developers face strong variations



in grid connection costs. Project-specific costs depend to a large extent on the project's size, its distance to the next network connection point and the voltage level to which it is connected. The length of the cable is usually the most important cost factor. However, for countries with a "shallow-deep" or "deep" grid connection regime, grid reinforcement requirements can also vary according to the project location. In France, for example, grid connection costs are the sum of three components: the connection costs, a local reinforcement contribution ("quote part") and a regional reinforcement contribution ("contribution"). The "quote part" and the "contribution" vary according to the location.

In France and the Netherlands, project developers specifically mentioned lack of transparency in grid connection costs as an issue. Project developers in the Netherlands expect that costs of grid connection

could be lowered considerably if grid operators were forced by legislation to be transparent about the actual costs they incur by connecting a wind project. In France, grid connection costs often change during the planning of the project and may be much higher by the time construction has started. Furthermore, French project developers report facing very long waiting times for grid connection imposed by the responsible corporation Enedis.

In Austria, wind farm operators have to pay a fee for reinforcement of 135,000 EUR/MW of capacity in addition to the costs of the grid connection. Furthermore, wind farm operators pay grid usage costs which consist of three parts: (1) a fee for ancillary services, which is the same across Austria, (2) a network loss charge, which differs between federal states and network level, and (3) a contribution to the

cost of primary reserves used for balancing the system. On aggregate, grid usage costs have increased in recent years and currently range from 0.25 to 0.4 ct/kWh depending on the location and grid level. As a result, generators in Austria have a competitive disadvantage in relation to German generators, who currently operate in the same power market area.¹⁹ In a competitive cross-border allocation of support payments, such differences in grid connection costs would cause significant distortions.

In some of the observed countries, the coordination of grid planning and spatial planning in wind zones could be improved. Better coordination between local authorities and grid operators in jointly preselecting potential wind farm areas could streamline procedures, ease permitting and reduce the costs of grid connection and reinforcement.

3.1.3 Financing conditions

Financing conditions – specifically, interest rates on debt financing, debt/equity ratios and debt terms – are determined by market factors that can only be influenced indirectly by regulatory conditions. However, they are an important indication of the perceived regulatory risks in investment conditions, especially reflecting risks related to the support scheme design (exposure to market price and other revenue risks), planning and permitting (potential of non-realization or changes in project configuration and operation) and political stability (potential of retro-active changes in support schemes).

Previous studies have examined the significant variation in financing conditions between EU countries, as well as their influence on the overall LCOE.²⁰ In

this study, we asked project developers and financing institutions to indicate the current average debt interest rate, debt/equity ratio and debt term for wind projects in their country. These cases were compared to a “theoretic financing case” that we defined for our base case project. The “theoretic financing case” provides very favourable conditions. It has a debt interest rate of 2%, debt term of 17 years and a debt/equity ratio of 85/15. Figure 5 shows the difference in the LCOE impact of each national financing case compared to the “theoretic financing case”.

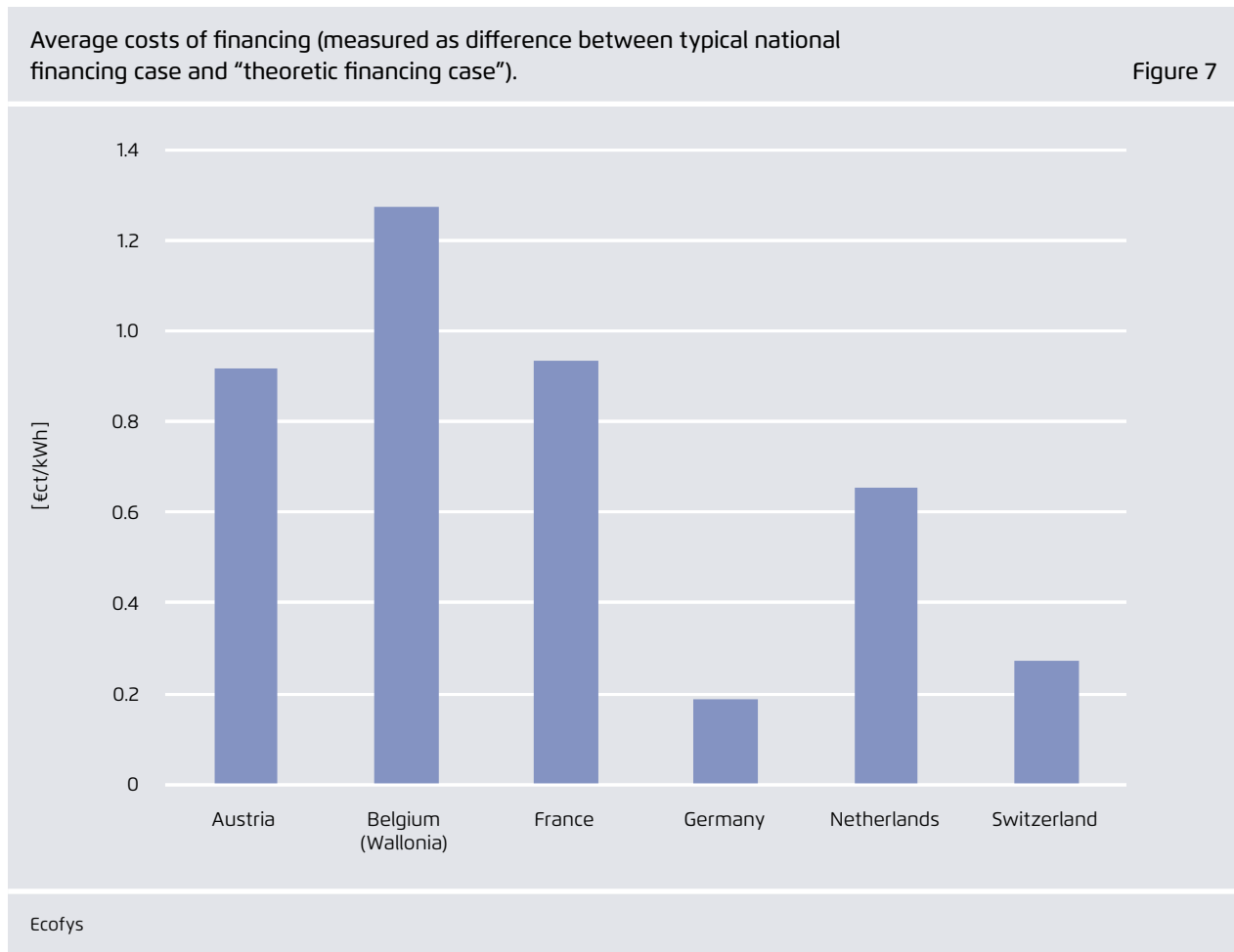
Despite the fact that financing conditions are currently rather beneficial and that the reported differences between the countries are not as large as they have been in the past, their variation is still significant in terms of their impact on the LCOE. Figure 6 reveals a large degree of variation, ranging from 0.19 ct/kWh in Germany to 1.28 ct/kWh in Belgium.

The large differences between countries are a clear indication of the strong influence financing conditions can have on the outcome of competitive cross-border auctions. However, the exact differences shown in Figure 6 need to be interpreted with caution. First, it should be noted that the LCOE impact of the financing conditions is highly sensitive to all three input factors (debt interest rate, debt term and debt/equity ratio). The results shown above are snapshots of the current situation. Financing conditions can, however, change within months. Second, the interviewees provided us with financing cost information against the backdrop of the support schemes that are currently in place in the countries in which they operate. Support scheme aspects, such as the duration of support payments, influence financing conditions. Thus, there is the possibility that financing conditions will to some degree align between countries if they introduce a common support scheme design when implementing cross-border auctions.

19 The single Austrian-German wholesale market price zone will be split in October 2018.

20 Ian Temperton (2018): Reducing the cost of financing renewables in Europe. Study on behalf of Agora Energiewende: https://www.agora-energiewende.de/fileadmin/Projekte/2016/De-Risking/Agora_RES_CRF-Dialogue_WEB.pdf
DIA-CORE (2016) “The impact of risks in renewable energy investments and the role of smart policies”.

Ecofys & eclareon (2017) “Pricetag: Mapping the cost of capital for wind and solar energy in south-eastern European member states”.



Preferential loans granted by public entities could reduce the differences in financing conditions between countries. A similar idea has been developed by eclareon and Agora Energiewende, who have elaborated options to implement a “Renewable Energy Cost Reduction Facility” at the EU level. This proposal aims to reduce the high cost-of-capital gap that currently exists between many member states in Central and South-Eastern Europe by reducing the risk of RES investments in these countries.²¹

21 Ian Temperton (2018): Reducing the cost of financing renewables in Europe. Study on behalf of Agora Energiewende: https://www.agora-energiewende.de/fileadmin2/Projekte/2016/De-Risking/Agora_RES_CRF-Dialogue_WEB.pdf

3.1.4 Corporate taxation

Costs related to corporate taxation are purely determined by legislation and reflect much broader political priorities. Accordingly, there is no easy way of harmonising corporate taxation in the context of cross-border RES cooperation. Nevertheless, differences in taxation are an obvious source of distortion to cross-border competition, and have stimulated public debate in the German-Danish cross-border auctions for solar PV held in December 2016.²² How-

22 Welt: “Warum wir jetzt für dänische Solarparks zahlen”: <https://www.welt.de/wirtschaft/article159841311/Warum-wir-jetzt-fuer-daenische-Solarparks-zahlen.html>
 Manager magazin: „Dänemark blamiert deutsche Ökostrom-Lobby”: <http://www.manager-magazin.de/unternehmen/energie/energiewende-daenemark-blamiert-deutschland-bei-solarstrom-a-1123455.html>



ever, the LCOE impacts of corporate taxation are smaller in absolute terms compared to the other observed parameters. Also, the differences observed between countries is smaller, ranging from 0.19 ct/kWh in Switzerland to 0.46 ct/kWh in Belgium.

3.2 Further regulation-induced differences in onshore wind project development

There are important regulation-induced differences between countries beyond those shown in the LCOE calculations in section 3.1. In our survey, project developers, financing institutions and renewables associations provided us with input on the following three indicators of such regulation-induced differences:

- Project realization period
- Risk of non-realization
- Site restrictions and requirements

The first two indicators correlate with the cost-impacts described in section 3.1. If the permitting regulations, for example, require comprehensive environmental assessments over multiple years, this has implications for both the costs of permitting as well as the duration of the entire permitting process, and, by extension, the time it takes to realise a project. Similarly, a lack of clear rules and standardization in permitting and appeals procedures increases the costs of project development and can also increase the risk of non-realisation.

The third aspect listed above can have very significant impacts on the cost of onshore wind develop-

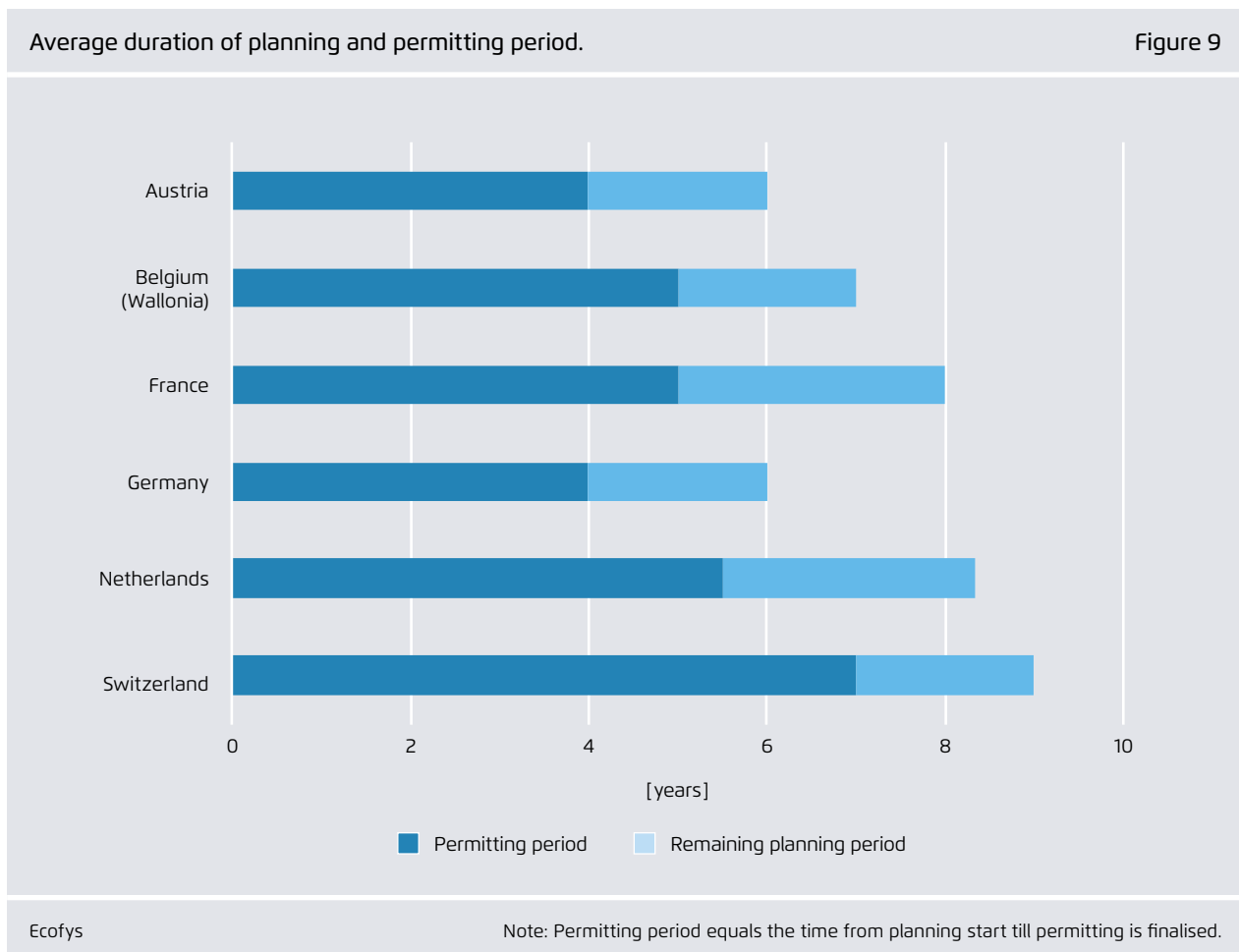
ment. Regulations that restrict the availability of land for the development of onshore wind, e.g. minimum distance rules, can increase land lease costs. Regulatory requirements, such as height limitations and provisions limiting noise and shadow flickering, can have strong impacts on full-load hours.

Differences in these aspects between countries reveal the necessity to look beyond mere cost implications when countries assess the possibilities of cross-border cooperation. In addition, they give an indication of the potential for adjusting the regulatory framework to reduce costs and enhance convergence, thus potentially facilitating a more level playing field between countries.

3.2.1 Project realisation period

The project realisation period encompasses all activities from project start to finish, from the initiation of project planning to the retrieval of necessary permits, connection to the grid and the start of wind power plant operation.

The number of years required to realise an onshore wind project provides an indication of the complexity of the processes involved. While regulatory requirements related to planning, permitting and grid connection reflect broader policy goals (related to, for example, environmental protection and ensuring public acceptance), they can complicate the expansion of onshore wind development and may cause undesired effects. Long project realisation periods increase the costs of project development as well as the risk



of non-realisation. The longer it takes to acquire the necessary final permits for construction, the higher the probability that the initial planned configuration of the project will no longer be feasible, forcing the development to be aborted or reconfigured (e.g. by changing the overall size of the project, turbine specifications, exact location, etc.), which induces additional costs.

The survey results revealed large differences in the average planning periods between countries. They range from 6 years in Austria and Germany to 9 years in Switzerland.

Legal challenges to projects during the development phase were mentioned as one particularly important issue by project developers. Indeed, legal appeals were the most important reason for project delays in all analysed countries. Project developers criticised both the numerous opportunities for filing court appeals and the duration of appeal procedures. Especially in Belgium, France and Switzerland, project developers asserted that appeal procedures are often abused by the opponents of onshore wind energy. French project developers stated that more than 80% of onshore wind projects in France are appealed and that in 80% of these cases, project developers prevail in the legal proceedings. Lengthy appeals procedures not only prolong the development phase of a project. They also generate costs and increase the risk of non-realisation, as described in the following section.

3.2.2 Risk of non-realisation

This section describes the risk of non-realisation faced by projects at the beginning of the planning stage. Multiple reasons for non-realisation exist, including, for example, failing to receive the required permits, successful legal appeals, and regulatory requirements or other factors that would limit the operation of the project or make it uneconomic (e.g. changing financing conditions). The average percentage of projects at the beginning of the planning stage that go unrealised, as shown in Figure 9, is a measure of the uncertainties of project development. This uncertainty is strongly in-

fluenced by the transparency and efficiency of administrative procedures and likelihood of legal appeal. The higher the share of planned projects that go unrealised and the later the decision to abort a project, the higher the sunk costs that developers need to recover through successfully completed projects.

The reported risk of non-realisation differs substantially between countries, ranging from 33% in France to 70% in Austria. However, stakeholders within given countries, including Belgium, France, Germany and Switzerland, also diverged considerably in the non-realisation rates they reported. No ranges were reported for Austria and the Netherlands. The largest intra-country variation in non-realisation was reported by German developers, with rates ranging from 33% to 80%. The large variation in the reported rates indicates that the risk of non-realisation does not only depend on the complexity of regulatory requirements and procedures, but also on the specific context in which a project is planned. Key factors in this regard include the specific location of the project, the project developer's strategy in project planning, the technical configuration of the project and support by local stakeholders.

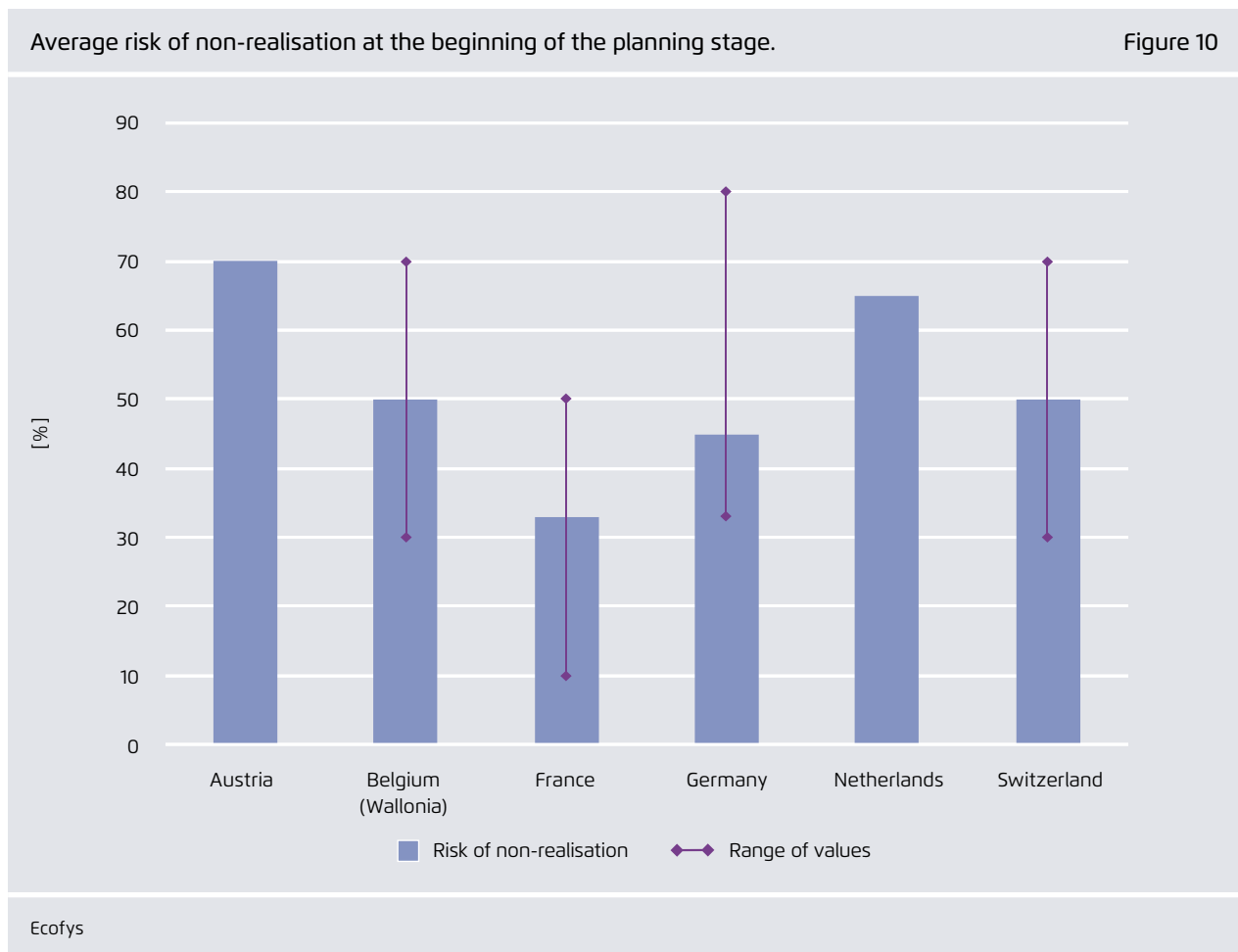
The risk of non-realisation, as depicted in Figure 9, cannot be directly compared between the countries, as various factors need to be taken into consideration: First, what are the main reasons for the abortion of projects? And second, at which stage of project planning and after how many years of planning are projects usually aborted?

The impacts (sunk costs) of non-realisation depend mostly on the timing of project abandonment. The later the decision to abort a project, the higher the sunk costs. In Austria, developers reported that the decision not to realise a planned project usually comes at an early stage of the planning. Likewise, in the Netherlands, the country with the second highest risk of non-realisation, developers reported that almost all projects that enter the permitting phase are realised, meaning that projects are usually aborted in the pre-permitting phase. Project developers from Bel-

gium and Switzerland, however, report that very often the decision not to realize a project comes at a late stage in project development. In Belgium, legal appeals may take place even after an official permit has been granted. In Switzerland, negative community votes often occur shortly before the construction phase. This divergence in the timing of project abortion should also be considered when defining qualification requirements in cross-border auctions. Material qualification requirements (e.g. confirmation of certain permits, or the grid operator’s consent to connect a wind power plant at a certain location), are usually defined to ensure serious bids and increase the chance of realisation. Countries implementing cross-border auctions would thus be advised to determine the stage of project development in which there is a comparable likelihood of project realisation

in the cooperating countries. At the same time, the costs incurred by bidders to fulfil the material qualification requirements should not diverge to an extent that distorts the principle of fair competition.²³

23 See Kreiss et al. (2017) for more detail on the challenges of setting adequate pre-qualification criteria and penalties: *Appropriate design of auctions for renewable energy support – Prequalifications and penalties*: <http://auresproject.eu/sites/aures.eu/files/media/documents/auctions-reskreissehrharthaufe160704.pdf>; and Mora et al. (2017): *Auctions for renewable energy support – Taming the beast of competitive bidding*: <http://auresproject.eu/sites/aures.eu/files/media/documents/aures-finalreport.pdf>



3.2.3 Site restrictions and requirements

Site restrictions can have very significant impacts on the costs of onshore wind development. All countries have multiple regulations that restrict the availability of land that is suitable for the development of onshore wind projects, including minimum distance requirements from urban zones, radar towers and environmentally protected areas. Depending on the extent of these limitations and the remaining availability of land with favourable wind conditions, these restrictions can increase the competition for available land with good wind potential and thus lead to higher land leasing costs. In the context of the German-Danish cross-border auctions for solar PV, more stringent site restrictions in Germany (including the exclusion of agricultural land for the development of solar PV) appear to have disadvantaged German bidders by as much as 0.4 ct/kWh, according to our estimations, and were thus a key determinant of the auction outcomes. Site restrictions may also impact grid connection costs, if they increase the distance to the grid.

Site restriction can even lead wind power projects to operate at lower average full load hours. This is the case if site restrictions are very extensive and drastically reduce the availability of sites with good wind potential. In small countries, this effect will be observed more quickly.

It is difficult to conduct a general assessment of site restrictions or compare their impact between countries. For example, the same minimum distance requirement from urban areas implemented in two countries can have different impacts due to divergent urban development patterns. Nevertheless, countries implementing cross-border auctions should assess the impacts arising from site restrictions and evaluate whether they have the potential to decisively disadvantage bidders in one of the cooperating countries.

In the surveys, project developers emphasised the importance of regulatory requirements that have direct effects on the configuration and operation of wind power plants. Countries implement requirements that

limit the height of wind power plants or limit their operation under certain circumstances – for example, to reduce noise and shadow flickering, or to protect birds and bats. These types of limitations can significantly reduce the full load hours of projects and thus increase the LCOE. However, they strongly depend on the exact location of the wind power plant. Thus, it is not possible to determine the country-specific LCOE impacts of certain regulatory requirements.

4 Regulatory conditions and cross-border cooperation in the EU policy debate

Section 3 discussed the LCOE cost impacts associated with various regulatory conditions that mediate RES investment. Under certain conditions, the economic effects induced by attractive regulatory conditions may be the main factor motivating investors to develop a RES project in a given location. This section first interprets the results of section 3 and then discusses various elements of the Clean Energy for all Europeans package (CE4All package)²⁴ while touching upon the regulatory conditions analysed above. The CE4All package sets forth various provisions on regional cooperation that are linked to the results of our analysis in two ways: On the one hand, provisions in the Energy Union Governance Regulation on regional cooperation may include imply regulatory conditions of cooperation (cf. Article 11).²⁵ On the other hand, the proper implementation of several provisions of the CE4All package requires member states to jointly address the regulatory conditions governing RES investment. Specifically, regulatory factors need to be addressed as part of the partial opening of national support schemes in the revised version of the Renewables Directive (RED II) (Art. 5)²⁶ as well as in connection with the “gap filling mechanism” (Art. 27 of the Governance Regulation). In the following sub-

sections we discuss pragmatic approaches that member states can adopt to address regulatory differences.

4.1 Overview and interpretation of results

Resource availability is a key factor influencing the cost of RES. Accordingly, variation in RES potential among member states are the primary reason cited by the European Commission (EC) in pushing for cooperation among member states on RES investment, as making use of RES potential where it is best available can lower overall RES deployment costs. Yet aside from natural resource endowment, regulatory conditions can have a significant impact on the LCOE of RES. Relevant regulatory conditions include not only the design of renewable energy support schemes, but also the regulatory conditions that were at the centre of our ex-ante assessment. Our results clearly show that regulatory conditions impacting the LCOE of RES merit further examination, and that member states should devote attention to such regulatory issues when engaging in opened auctions. The following sections interpret our results and discuss potential causes for cost differences. We also explore how dialogue between cooperating countries can help to illuminate and potentially alleviate such cost differences. However, this report does not develop or assess specific regulatory solutions for the analysed regulatory aspects that would help to level the playing field between countries.

→ **Planning and permitting:** The average LCOE impacts of planning and permitting range from 0.25 ct/kWh (France) to 0.54 ct/kWh (Switzerland). This indicates that planning and permitting exert a significant impact on the bids submitted in a cross-border auction. However, project-specific

24 On the Clean Energy for All Europeans Package see: <https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans>

25 European Commission (2017), Proposal for a Regulation of the European Parliament and the Council on the Governance of the Energy Union. 2016/0375 (COD). 23.02.2017: https://eur-lex.europa.eu/resource.html?uri=cellar:f9f04518-b7dc-11e6-9e3c-01aa75ed71a1.0001.02/DOC_1&format=PDF

26 European Commission (2017), Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (recast). 2016/0382 (COD). 23.02.2017: ec.europa.eu/energy/sites/ener/files/documents/1_en_act_part1_v7_1.pdf

planning and permitting costs can deviate significantly from these average costs, both within and between countries. According to the interviewed stakeholders, the main issues related to planning and permitting are the lack of standardisation in permitting requirements and procedures, the lack of coordination between different levels of administration, the time required for planning and permitting procedures, and court appeals.

It is important to note that planning and permitting procedures are impacted by EU legislation (e.g. regarding environmental impact assessments) and are at the same time deeply engrained at different governance levels in member states (e.g. with regard to local spatial planning). As there might be good reasons for differing approaches to planning and permitting, it is unlikely that full convergence will be reached in this area. However, given the cost impacts and the underlying complexity of planning and permitting procedures, this issue merits attention in regional cooperation forums, as there is a clear need to promote a level playing field for cross-border RES investment and to identify best practice.

→ **Grid connection:** Costs related to grid connection vary considerably between member states depending on the grid connection regime, which can be “shallow” or “deep” (see 3.1.2). The average cost of grid connection ranges from 0.24 ct/kWh in Belgium to 0.71 ct/kWh in Switzerland, and there are also large cost ranges within countries. Especially in France, the Netherlands and Switzerland, project developers face strong variations in grid connection costs. In addition to the grid connection cost, generators are charged for grid usage in Austria and Belgium. In both cases, grid usage charges significantly increase operational expenditures and thus the LCOE by more than 0.3 ct/kWh on average.

Member states may have different preferences and/or technical circumstances that necessitate divergent grid connection and cost regimes. Some

countries, for example, might embrace the policy of shallow grid connection costs in order to avoid competition between project developers for the lowest cost grid connection (in order to effectively use the sites with the most resources available). Other countries may prefer deep connection charges in order to encourage project developers to select sites that are easily connected to the grid. Promoting dialogue between member states on these issues will help to clarify the origins of such differences and how they can be addressed as part of cross-border cooperation.

→ **Financing conditions:** Debt interest rates, debt/equity ratios and debt terms are determined by market factors that can only be influenced indirectly by regulatory conditions. Nevertheless, prevailing financing conditions are an important indication of perceived investment risk arising from the regulatory environment. Even though financing conditions are currently rather beneficial and the reported differences between countries in the PENTA region are not as large as they have been in the past, they still exert a significant LCOE impact that diverges between the assessed countries by more than 1 ct/kWh. These large differences between countries indicate that financing conditions can exert a strong impact on the outcome of competitive cross-border auctions.

Despite the complexity of this topic, member states stand to benefit from exchanging knowledge on how to improve overall investment conditions so as to promote convergence between member states. In the event it is not possible to achieve similar financing conditions, even over the mid-term, then additional de-risking measures might be warranted.

→ **Corporate taxation:** Costs related to corporate taxation are determined purely by legislation and reflect much broader political priorities. Accordingly, inducing convergence in the specific context of cross-border RES cooperation might be challeng-

ing. Nevertheless, differences in taxation obviously distort cross-border competition, as witnessed with the German-Danish cross-border auctions for solar PV held in December 2016. The impacts of corporate taxation on cross-border auctions can furnish a basis for discussing broader underlying issues between MS. Alternatively, cross-border auctions can be designed to take such differences into account, for example, by including a bonus/malus system for each bid, depending on each country's taxation rules, in order to level the playing field.

→ **Project realisation period/risk of non-realisation:**

The average project realisation period (from initial planning to completion) ranges from 6 to 9 years in the analysed countries, but there are also large variations within each country. Beyond its cost impacts, the required time frame to realise a project impacts the ability of projects to participate in an auction, depending on the defined pre-qualification requirements and realisation periods.

- **The risk of non-realisation** represents the risk that a project that is already in planning cannot be realised due to factors outside of the control of a developer. It is an indicator of the uncertainty of regulatory and investment conditions. Sunk costs that arise from abandoning a project must be recovered by developers through successfully completed projects. The risk of non-realisation varies widely, ranging from 33% in France to 70% in Austria.

Project realisation periods and the risk of non-realisation are important aspects to be discussed in a regional cooperation forum, as they influence the competitiveness of projects in a cross-border context.

- **Site-restrictions and requirements:** Site restrictions are regulations restricting the availability of land that is suitable for the development of onshore wind projects. This may increase the average LCOE of onshore wind projects in member states if the competition for available sites and thus the cost of

land is increased and/or if remaining available sites suitable for wind projects have lower than average full load hours.

Site restrictions were a key determinant of the German-Danish cross-border auction in 2016. They are the subject of intense debates within member states and thus merit attention as a topic for the sharing of best practice knowledge in the context of regional cooperation.

The discussed differences in regulatory conditions and their impact on the LCOE of RES projects draw attention to the need for convergence between member states so as to ensure a more integrated internal market based on enhanced cross-border collaboration. But given the depth and complexity of the specific topics and the range of underlying reasons for differences in regulatory conditions, the following question arises: In which areas – and based on which standards – should convergence be pursued?

Focussing solely on overall cost may suggest convergence toward the lowest possible cost, potentially inducing a "race to the bottom" in applicable standards. Reducing the cost of RES deployment is indeed a key motivation for regional cooperation. However, when it comes to environmental impact assessments, grid connection costs, and corporate taxation, there may be very good reasons not to choose the cheapest regulatory design option, but one that meets objectives beyond the cost effectiveness of RES deployment, such as environmental protection, balanced grid development or ensuring adequate contributions from the RES industry to the tax revenues of a member state.²⁷ Nonetheless, even if different objectives and preferences in

²⁷ Further objectives that may be pursued within an auction are discussed in Steinhilber and Rosenlund Soysal (2016): Secondary Objectives in Auctions. AURES report.: http://auresproject.eu/sites/aures.eu/files/media/documents/policy_memo_1_-_secondary_objectives_251016.pdf; and Mora et al. (2017): Auctions for renewable energy support - Taming the beast of competitive bidding: <http://auresproject.eu/sites/aures.eu/files/media/documents/aures-finalreport.pdf>

member states result in different regulatory conditions, it is essential for member states engaged in cross-border collaboration to make such differences transparent and to discuss which differences may be overcome through convergence around a common standard and which differences to maintain. There are numerous regulatory conditions (e.g. length and complexity of permitting procedures) that can be significantly improved across member states by identifying best practices and by aligning or harmonising some of them. In an ideal case, regional exchange on regulatory conditions can create a deep understanding among member states on existing differences and options for overcoming them. In the absence of discussion on these issues at the regional level or higher, the realisation of an internal energy market that includes regional collaboration in developing renewable energy is unlikely.

4.2 A new drive for regional cooperation from the Clean Energy Package

The EU Renewable Energy Directive, which is valid until 31 December 2020, addresses cross-border RES cooperation. While the Directive establishes “cooperation mechanisms” for renewable energy development,²⁸ these have only been used in very few cases,²⁹ mostly due to their technical complexity, related transaction costs, and a lack of political will by the member states.³⁰ Furthermore, cross-border cooper-

ation is an issue in the context of the European Commissions’ **state aid clearance** for new and reformed RES support policies. Indeed, the recent Danish-German cooperation agreement resulted from a commitment made by the German government to the EC while seeking state-aid approval for its reformed Renewable Energy Act (EEG 2014).

An important opportunity to address the issue of cross-border cooperation on renewables in a more systematic manner is currently offered by current EU-level deliberations on the CE4All package in conjunction with the review and updating of the EU Energy and Environment State Aid Guidelines (EEAG) in 2019–20.

In this section, we discuss how current developments in EU legislation relate to our findings. We highlight those aspects of the regulatory framework that seem particularly important in mandating, enabling or incentivising cross-border cooperation on renewable energy.

4.2.1 Regional cooperation to achieve RES targets is enshrined in the new Governance Regulation

As proposed by the EC, the Regulation on the Governance of the Energy Union explicitly asks member states to cooperate in all five Energy Union dimensions, hence also including RES investment. Article 7 of the proposed Regulation requires that member states describe in their National Energy and Climate Action Plans (NECPs) “measures to ensure regional cooperation.” Article 11, which is dedicated to regional cooperation, calls for member states to “cooperate at (the) regional level to effectively meet the targets, objectives and contributions set out in their integrated national energy and climate plan”. Given the significant impact exerted by regulatory conditions on the cost of RES deployment, regulatory policy would appear to be a necessary domain for the regional cooperation, required under Article 11 of the Governance Regulation.

28 See on the implementation of the Cooperation Mechanisms <http://res-cooperation.eu/>

29 Namely, in the Swedish-Norwegian Joint Support Scheme, the German-Danish cross-border PV auction and statistical transfers between Luxembourg and Lithuania/Estonia.

30 For an overview of the state of play in regional cooperation and different approaches to regional cooperation see Malte Gephart, Lucie Tesnière and Corinna Klessmann (2015): Driving regional cooperation forward in the 2030 renewable energy framework: https://eu.boell.org/sites/default/files/hbfecofys_regional_cooperation.pdf; and Klessmann et al. (2014): Cooperation between EU MS under the RES Directive: https://ec.europa.eu/energy/sites/ener/files/documents/2014_design_features_of_support_schemes_task1.pdf

While the Council is largely in favour of the EC's proposal, the European Parliament advocates to include the concept of "macro regions", which are seen as "necessary for member states to implement, jointly, certain policies and measures contributing to the achievement of common targets and objectives in a cost-optimal manner" (recital 21). The European Parliament requests in Art. 11 of the Governance Regulation, that member states "cooperate with each other at macro-regional and regional level, taking into utmost consideration all existing and potential forms of cooperation".³¹

Our assessment of the foregoing provisions in light of the LCOE analysis conducted herein is as follows:

- Article 11 of the Governance Regulation does not specifically define the topics that are to be addressed in regional cooperation. This leaves the choice of cooperation formats and subjects to member states. However, given the strong cost impact that regulatory conditions have on RES investment, there appears to be a strong need for member state cooperation on this topic.
- The empirical findings presented in this report represent a valuable starting point for selecting issues to be addressed in regional cooperation, e.g. planning and permitting, grid connection regimes, and financing conditions.

→ Regulatory conditions could well be part of the recommendations to be issued by the ECC to member states (according to Art. 28 of the Governance Regulation) in order to improve the overall investment framework.

4.2.2 The opening of national support schemes can be impacted by differences in regulatory conditions

While the Governance Regulation broadly asks member states to cooperate, there are specific operational measures in both the proposed RED II and proposed Governance Regulation that would be impacted by differences in regulatory conditions. These measures, which relate to the opening of national support schemes (Art. 5 of the RED II) and "gap filling measures" (Art. 27(4) of the Governance Regulation), aim to ensure achievement of the collective EU RES target for 2030.

As proposed by the EC, Article 5 of the RED II requires member states to partially open up their national support schemes to installations in other member states, and sets forth minimum targets of 10% in 2021-2025 and 15% in 2026-2030 for newly supported capacity. There are various options for implementing this provision, including open tenders, joint tenders, open certificate schemes, and joint support schemes, all of which must be based on cooperation agreements. In 2025, the cost-effectiveness of these measures will be assessed, followed by a potential increase in the targets for cross-border support. In the RED II proposal, the EC also states that a "progressive opening of support for renewable electricity is needed to address fragmentation of the internal market and ensure cross-border tradability" and to "increase the necessary cost-optimal deployment across the Union." The impact assessment adds that the opening of support schemes would lower overall system costs by 1 billion euros annually in 2021-2030 and would reduce support costs by 3%. The EC thereby acknowledges the potential benefits of cooperation in target achievement, but leaves unaddressed the effect that regulatory conditions may have on the opening of support schemes.

31 The European Parliament's position on Article 11 of the Governance Regulation further states that MS "shall, well before submitting their draft integrated national energy and climate plan to the Commission pursuant to Article 9(1), identify opportunities for macro-regional and regional cooperation, taking into consideration existing macro-regional cooperation, in particular the Baltic Energy Market Interconnection Plan (BEMIP), Central and South-Eastern Europe Connectivity (CESEC), Central-West Regional Energy Market (CWREM), the North Seas Countries' Offshore Grid Initiative (NSCOGI), the Euro-Mediterranean Partnership and consult neighbouring member states. [...] When engaging in macro-regional cooperation, member states shall agree on a governance structure allowing for meeting at ministerial level [sic] at least annually."

The Council is opposed to a mandatory opening of national support schemes, asserting instead that member states should “have the right to decide [...] to which extent they support energy from renewable sources which is produced in a different member state”. The Council’s position is that member states should be “encouraged to [...] aim for this share to be, in each year, at least 10% between 2021 and 2025 and at least 15% between 2026 and 2030”. This formulation could well end up serving as a benchmark target for the opening of support schemes, and might be integrated into the upcoming EEAG for the period after 2020. In addition, the Council’s position is that MS “may ask for proof of physical import”, which links the opening of support schemes to the actual levels of interconnection between member states. This would allow member states to restrict the opening of support schemes to member states with whom they share a direct grid connection.

The European Parliament (EP) broadly supports the EC’s call for mandatory opening, but instead envisions targets of 8% and 13% for 2021 and 2025, respectively. Moreover, the EP would like to add exemptions for member states with insufficient interconnection capacity, insufficient natural resources or whenever “detrimental effects on energy security or the smooth functioning of the energy market” can be expected. In contrast to the EC, the EP explicitly addresses regulatory conditions and calls for cooperation agreements to be signed that include “conditions for participation and disbursement of funding [while] taking into account different taxes and fees”. These agreements are to “harmonize the administrative framework conditions in the cooperation countries to ensure a level playing field”.

Even if the adopted RED II only includes provisions for the voluntary opening of support schemes, it seems very likely that the legal push for a further opening of national support schemes will continue through state aid disciplines, given the well-established legal reasoning and decision-making practice in this area.

Our assessment of cross-border auctions in light the LCOE analysis conducted herein is as follows:

- As demonstrated by our analysis, regulatory conditions impact the cost of RES and will thus impact the outcomes of cross-border auctions. Even small structural differences in regulatory conditions can influence the distribution of successful RES bids among member states in competitive cross-border auctions. It is important to note that while cross-border auctions may lead to the one-sided allocation of RES installations to a certain member state, and that this might be seen as a political problem to due lost opportunities for job creation, general benefits such as energy security (if grid connections are sufficient) and benefits at the European level, (e.g. for emissions reductions) can be realised regardless of the location of installations.
- As differences in regulatory conditions heavily influence the outcome of cross-border auctions, then the gradual opening of support schemes will increase the need for member states to address this issue and promote greater alignment.
- The need for member states to effectively address (and potentially align) regulatory and investment conditions depends on a combination of the following elements:
 - *Extent of existing distortions*: Logically, the larger the distortions stemming from regulatory conditions, the more important the need to address them. A pragmatic assessment of the actual need for alignment is nevertheless required, as full alignment is not a prerequisite for cross-border auctions or other types of cooperation.
 - *Volume of cross-border cooperation*: The greater the volume of energy being tendered in cross-border auctions, the more investment will be effected by the effects described above, and the more important it is for member states to at least be aware of existing difference and their impacts.
 - *Share of cross-border cooperation in total new RES capacities*: The share of the cross-border cooperation in overall new RES capacity put to

auction will determine the extent to which local project developers are confronted with the varying regulatory conditions of the other member state.

- *Geographic scope (number of involved countries)*: While the impacts that will result from differing regulatory conditions in two member states might be more or less straightforward, if the number of member states participating in a cross-border cooperation increases, assessing the impacts of regulatory conditions and potentially aligning them becomes more complex.

4.2.3 Regulatory conditions will impact the outcome of the EU gap filling mechanism

Another case in which the regulatory conditions of the opening of support schemes will be relevant is the proposed financing platform in the new Energy Union Governance Regulation, the so-called EU "gap filling mechanism". The financing platform would effectively enable regional or EU-wide auctioning of RES capacity missing to achieve the collective EU 2030 RES target. The financing platform is one of several options in Article 27 (4) to ensure collective target achievement. Article 27 (4) foresees that if member states' national contributions to the EU target are insufficient, they may be asked by the EC to fill the gap by taking "national measures to increase deployment of renewable energy", by "adjusting the share of renewable energy in the heating and cooling sector", by "adjusting the share of renewable energy in the transport sector" or by "making a voluntary financial contribution to a financing mechanism [...] set up at Union level, contributing to renewable energy projects and managed directly or indirectly by the Commission". As regards the latter, the EC (or an organization for the EC) may auction RES support across various member states.

The Council spells out more details on the gap filler, asserting that member states shall retain the right to decide whether, and if so, under which conditions [...] they allow installations located on their territory to receive support from the financing mechanism." In addition, the Council requires an implementing act

which would define the exact design of the EU RES auctions.

The EP largely supports the EC proposal for the EU financing platform, but adds that supported projects should have "an Energy Union interest".

Our assessment of the EU financing platform in light of our LCOE analysis is as follows:

- Despite differences in the positions of the EC, Council and EP, there is a consensus that an EU gap filling mechanism will be established. This "gap filler" may include RES auctions organized at the EU level, i.e. RES capacities being supported across MS.
- In terms of the effects of varying regulatory conditions in member states, the gap filler is very similar to the case of cross-border auctions. If, for instance, a number of member states accept to receive RES capacities from the gap filling mechanism in their territory, the distribution of projects across these member states will not only depend on available resources, but also on prevailing regulatory conditions.
- In this case, member states will have to analyse the impacts of their regulatory conditions on the outcome of the auctions, potentially with strong involvement of the EC.

In summary, there are various provisions in the CE4All package that call for regional cooperation, but which do not yet explicitly highlight the need for coordinating in the area of regulatory conditions. The results of our analysis could serve to stimulate discussion on this subject. Other CE4All package provisions, such as the opening of support schemes and potential gap-filling auctions, clearly give rise to a need for addressing differences in regulatory circumstances, as this will be essential for ensuring acceptable outcomes and providing a level playing field for RES investment. In the next section, we will outline the steps member states can take to strengthen regional cooperation.

4.3 Six steps for regional cooperation on regulatory conditions

As shown in Section 3, regulatory conditions can have a significant impact on the LCOE of RES projects. While some attention is devoted to cross-border cooperation on renewables in the current EU RES framework (RES Directive, EEAG) as well as in legislation currently under discussion (RED recast, Governance Regulation), these elements do not (yet) add up to a consistent framework that can facilitate or enable enhanced cross-border cooperation on RES in light of the relevant regulatory factors identified in our research.

Against this backdrop, we offer the following recommendations on how to advance cross-border cooperation on RES regulatory conditions:

1. Improve knowledge base on differences in regulatory conditions

This report sought to enhance our understanding of how regulatory conditions influence the LCOE of RES projects in cross-border support schemes. This represents a first step. Member states should make their own efforts to assess which potentially relevant regulatory conditions differ from their neighbours, why and to what extent.

International dialogue can help member states to better understand how regulatory conditions differ between countries. The existing forums for regional cooperation – such as the Pentalateral Energy Forum – could establish task forces or working groups on dedicated subtopics (e.g. permitting), thus allowing national experts to compare regulatory conditions.

Knowledge exchange will also be facilitated by the requirement that member states draft a National Energy and Climate Plan (NECP), as this will provide a context for outlining opportunities at the regional level for cooperation. Clearly, identifying differences in regulatory conditions will not only help member states to prepare for cross-border auctions, but also furnish a basis for exchange on regulatory best practice.

2. Assess impacts of differences in regulatory conditions

After conducting a thorough inventory of regulatory differences, one needs to quantify how these differences may impact the outcomes of cross-border auctions. This is because differences alone will not necessarily lead to distorted outcomes; the mere existence of difference does not warrant remedial action. The introduction of the gap-filling mechanism might be a motivation for countries to assess the cost impact of regulatory differences if they aim to attract projects financed through this mechanism.

3. Define priority areas for national adjustment of regulatory conditions

Divergent regulatory conditions can impair the development of a level playing field in cross-border auctions, regardless of the form they take (bilateral, multilateral, voluntary or mandatory under RED II). These differences can have a strong impact on the outcome of cross-border cooperation, as demonstrated by the pilot auction between Denmark and Germany. Accordingly, after estimating the impacts of regulatory divergence, countries should develop a concrete convergence programme that highlights priority areas for adjusting regulatory environment. Working toward the creation of a level playing field between member states – without inducing a race to the bottom and without conditioning any form of cooperation on fully equal starting conditions – can help improve the results of cross-border collaboration. When implementing a convergence program, member states may mutually agree on changing provisions in one area of regulation or may tackle the regulatory aspects that create the greatest discrepancies.

4. Design cross-border support for renewables while acknowledging differences in regulatory conditions

While RED II and the EEAG push for an opening of support schemes, opening may also be initiated on the part of member states on a voluntary basis. Whatever the origin of such opening, when developing cross-border RES auctions, member states should

acknowledge differences and potentially design their auctions to reflect these differences. Auctions that are tailored to take divergent regulatory environments into account would appear particularly advised when differences have significant impacts on auction outcomes but cannot be easily remedied as part of the convergence dialogue conducted between member states. For example, regulatory differences concerning grid connection costs could be offset in the bid selection process by adding a premium to bids in the market with more favourable conditions. While the “artificial” creation of a level playing field would improve opportunities for bidders from both countries, it would also be likely to reduce the savings potential offered of the cross-border auction. In any event, prior to making a decision on adopting premiums to compensate for regulatory differences, one should conduct a thorough assessment of the likely consequences to the results of a cross-border auction. It is also important to acknowledge the risk of a “race to the bottom”, and avoid to choosing lower-cost options as the default approach.

5. Evaluate further potential for policy convergence and share findings at the EU level

As member states share knowledge on regulatory conditions and adjust their regulatory frameworks in order to enable improved cross-border cooperation, this should lead to a growing body of best practice knowledge. Regional collaboration can serve as a laboratory for testing policy convergence and tailored auction design solutions. The best practice thus developed can then be shared at the EU level, e.g. to determine optimal auction design schemes for the gap-filling mechanism. The history of regional initiatives in Europe shows that multi-level policy development is often a wellspring of new ideas and progressive solutions. For example, the introduction of flow-based market coupling was first tested in the Pentalateral Energy Forum region, and has been expanded from there.

6. Connect the issues raised by regulatory conditions to the wider topic of regional cooperation

Actors engaged in other regional cooperative activities should take note of the regulatory conditions that impact the LCOE of RES. In particular, this could benefit NECP development, which requires regional consultation and cooperation. Indeed, there are numerous points of overlap between elements discussed in this report and other issues being addressed in existing and planned regional cooperation forums and instruments. Points of overlap include: regional cooperation on the integration of RES into the grid and markets in a broader sense; the efficient regional use of flexibility options; the alignment of power market design (e.g. regarding the participation of RES in balancing and upcoming re-dispatch markets); and cross-border infrastructure planning. Such issues are also relevant in the context of “Renewable Energy Projects of European Interest”, which will be entitled to receive funding from an expanded and reformed Connecting Europe Facility. Accordingly, the insights developed from regional consultation and cooperation on regulatory conditions for RES investment are sure to be beneficial to additional ongoing processes on regional cooperation and will at the same time benefit from knowledge developed in these other cooperation forums.

5 Conclusions and recommendations

Cross-border cooperation on climate and energy is becoming increasingly important. EU climate and energy laws (both those in effect today and those that will apply after 2020) expressly require member states to significantly strengthen bilateral and regional cooperation, particularly in the power sector. This study shows that regulatory conditions outside the renewable energy framework will become increasingly relevant for successful bilateral and regional cooperation in this area.

Importantly, the analysis shows that the combined effect of individual LCOE impacts for planning and permitting, grid connection, financing costs and taxation in the PENTA region can even be larger than the effect of variations in wind resource availability. For example, a 10% decrease in the full load hours increases the LCOE of a wind project by 6.4 EUR/MWh. By contrast, the combined effect of the individual policy and regulatory cost components ranges from 12.2 EUR/MWh in Germany to 26.4 EUR/MWh in Belgium.

Accordingly, national policy differences will shape the distribution of RES deployment in a system of open auctions at the regional level. But while EU regulation is pushing for enhanced cross-border cooperation on renewables, it does not yet provide a consistent framework for ensuring a level playing field throughout Europe.

The key elements that would need addressing are planning and permitting, grid connection regimes, financing conditions, project planning risks and site restrictions. All these elements pertain to the impact of national differences on a variety of components in cross-border cooperation, such as open support schemes, regional or EU-wide renewable auctions.

As enhanced cross-border cooperation on renewables will continue to play a role in European climate and energy law, we recommend the following measures to maximise the benefits of bilateral and regional-level renewable energy cooperation:

1. Analyse the effects of regulatory conditions on RES project costs.
2. Assess impact of differences in regulatory conditions on cross-border renewable energy cooperation.
3. Agree on a coordinated convergence of select regulatory conditions.
4. Design cross-border collaboration in a way that reflects differences in regulatory conditions.
5. Use the lessons learned from regional cooperation to identify the best EU-level practices.
6. Approach enhanced cross-border renewables collaboration as an integral part of better regional cooperation in European climate and energy policy.

6 Annexes

Annex 1: Onshore Wind Base Case Project

Detailed values of base case project including CAPEX and OPEX.

Table 3

Parameter	Base Case value
Installed capacity	18000 kW
Resource/FLH	3000 kWh/kW
Support scheme duration (temporal stretching of costs)	20 years
Type of support	Contract for Difference
Tax rate	29%
Fiscal depreciation term	15 years
Fiscal depreciation type	straight-line
Main investment cost	1200 EUR/kW
Foundation	70 EUR/kW
Grid connection cost	76 EUR/kW
Other site investment costs	180 EUR/kW
Project planning	85 EUR/kW
Maintenance	12.60 EUR/MWh
Land lease	5.5% of operating income
Operational cost	8.5 EUR/kW/yr
Insurance	2.10 EUR/kW/yr
Reserves	2.64 EUR/kW/yr
Direct marketing costs	2 EUR/kW/yr
Debt interest rate	3%
Debt term	12 years
Equity rate	9%
Equity term	15 years
Equity share fixed	20%

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Annex 2: Sensitivity Analysis

LCOE of base case and from carrying out sensitivity analysis per input parameter of +/-10%.

Table 4

LCOE factor	Sensitivity analysis	LCOE with parameter change down (-10%) [EUR/MWh]	LCOE Base Case (LCOE _{base}) [EUR/MWh]	LCOE with parameter change up (+10%) [EUR/MWh]
Basic project configuration				
Resource/FLH	+/-10%	86.6	79.6	73.8
Capital expenditures				
Main investment cost	+/-10%	75.2	79.6	83.9
Foundation	+/-10%	79.3	79.6	79.8
Grid connection cost	+/-10%	79.3	79.6	79.8
Other side investment costs	+/-10%	78.9	79.6	80.2
Planning cost	+/-10%	79.2	79.6	79.9
Operational expenditures				
Maintenance	+/-10%	78.1	79.6	81.0
Land lease	+/-10%	79.1	79.6	80.0
Business and technical management	+/-10%	79.2	79.6	79.9
Insurance	+/-10%	79.5	79.6	79.6
Reserves	+/-10%	79.5	79.6	79.6
Direct marketing costs	+/-10%	79.3	79.6	79.8
Fiscal regime*				
Tax rate	+/-10%	79.1	79.6	80.1
Fiscal depreciation term	+/-10%	79.1	79.6	81.0
Financing cost				
Debt interest rate	+/-10%	78.9	79.6	80.2
Debt term	+/-10%	78.6	79.6	77.4
Equity rate	+/-10%	78.1	79.6	81.0
Equity term	+/-10%	85.1	79.6	77.8
Equity share fixed	+/-10%	78.9	79.6	80.2

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* Fiscal depreciation type was set to linear depreciation (straight line) in the base case.

Table 5 shows the presumed individual sensitivities of those factors that are largely determined by regulatory measures (shown in red). These sensitivities were used to carry out the second sensitivity analysis

(see section 2.2.2). The results of the sensitivity analysis are shown in the columns "LCOE with parameter change down/up".

LCOE from carrying out sensitivity analysis per input parameter with selected specific deviations.

Table 5

LCOE factor	Sensitivity analysis	Can be influenced by policies?	LCOE with parameter change down (-x%) [EUR/MWh]	LCOE _{base} [EUR/MWh]	LCOE with parameter change up (+x%) [EUR/MWh]
Basic project configuration					
Resource/FLH	+/-25%	yes	100.6	79.6	66.9
Capital expenditures					
Main investment cost	+/-10%	no	75.2	79.6	83.9
Foundation	+/-10%	no	79.3	79.6	79.8
Grid connection cost	+/-80%	yes	77.4	79.6	81.8
Other side investment costs	+/-10%	no	78.9	79.6	80.2
Planning cost	+/-40%	yes	78.3	79.6	80.8
Operational expenditures					
Maintenance	+/-10%	no	78.1	79.6	81.0
Land lease	+/-50%	yes	77.3	79.6	81.9
Business and technical management	+/-10%	no	79.2	79.6	79.9
Insurance	+/-10%	no	79.5	79.6	79.6
Reserves	+/-10%	no	79.5	79.6	79.6
Direct marketing costs	+/-50%	yes	78.4	79.6	80.7
Fiscal regime					
Tax rate	+/-20% ³²	yes	78.7	79.6	80.5
Fiscal depreciation term	+/-30%	yes	78.4	79.6	83.1
Financing cost					
Debt interest rate	+/-30% ³³	yes	77.3	79.6	81.9
Debt term	+/-30%	yes	83.1	79.6	73.8
Equity rate	+/-10%	no	78.1	79.6	81.0
Equity term	+/-10%	no	85.1	79.6	77.8
Equity share fixed	+/-30%	yes	77.6	79.6	81.5

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³² Calculated as +/-5 percentage points.

³³ Calculated as +/-1 percentage points.

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