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Belgium's Renewable Energy Target: Facts, Figures and Outlook

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Belgium's Renewable Energy Target: Facts, Figures and Outlook

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Extended abstract

Following the EU Renewable Energy Directive, Belgium should achieve a 13 % share for renewables in gross final energy consumption by 2020. In 2017, a share of 9.1 % was achieved, suggesting that additional measures might be necessary to achieve the national target. The main contribution of this paper is to assess whether Belgium could be able to achieve its 13 % share by 2020. We conclude that this is unlikely by solely relying on domestic means. The total deficit, compared to the regional plans, amounts to a yearly renewable energy (RES) generation of 6.7 TWh. There are two reasons underlying this total deficit and both are illustrated in Figure 1. The first reason is an underestimation of the gross final energy consumption (GFEC). In 2015, the four ministers of environment and/or energy finalized the intra-Belgian burden sharing agreement which states the regions' (the federal level, and the Flemish, Walloon and Brussels regions) contributions towards Belgium's climate targets. The agreement assumed that Belgium's 2020 GFEC would be 378 TWh, based on the indicative energy efficiency targets. Belgium's GFEC will, however, be substantially higher, thereby also requiring more renewable energy to achieve the 13 % share. The regional targets (in absolute numbers) are thus too low, leaving a gap of about 5.0 TWh yearly RES generation (compare '2020 required' and 'Burden sharing' in Figure 1). The second reason for Belgium's deficit is the inability of some of the regions and the federal level to attain their targets as defined in the burden sharing agreement. Most notably, the Brussels plan includes a gap of 0.3 TWh, whilst both the federal and the Flemish plans bear a deficit of 1.7 TWh each. The additional efforts of the Walloon region—which will have an excess of 2.0 TWh—do not fully compensate the gap left by the other regions. In total, this leaves an additional deficit of 1.7 TWh (compare 'Burden sharing' and 'Regional plans' in Figure 1). Based on these numbers we estimate that, according to the regional plans, Belgium's domestic production will attain a renewable share of about 11.4 % in 2020, 1.6 percentage points below the target. Although the analysis is subject to a significant level of uncertainty, the shear size of the aggregate gap does affirm the insufficiency of current plans to meet the 13 % RES target. Moreover, we only focus on reviewing the regional plans and refrain from making any assumptions on whether these projections will actually materialize. Figure 1 illustrates that there still is a substantial gap between these plans and what has been achieved (compare '2017 achieved' with 'Regional plans'). Whether the regional plans will be achieved remains uncertain, but is out of the scope of this paper.

A second contribution of this paper is to outline three options on how to cope with this deficit. A detailed evaluation of the different options—considering regulatory, technical and political aspects—goes beyond the scope of this report. The first option would be an accelerated role-out of renewable capacity to achieve the target domestically, which seems practically infeasible. The second alternative would be to risk not achieving the mandatory 13 % RES target. If this was the case, Belgium might be subject to a penalty payment for the failure to fulfill an obligation under the Treaties. The level of this penalty payment, if any, is not known in advance and thus induces a significant level of risk-exposure. This option also entails several political considerations such as public opinion aspects and Belgium's national climate

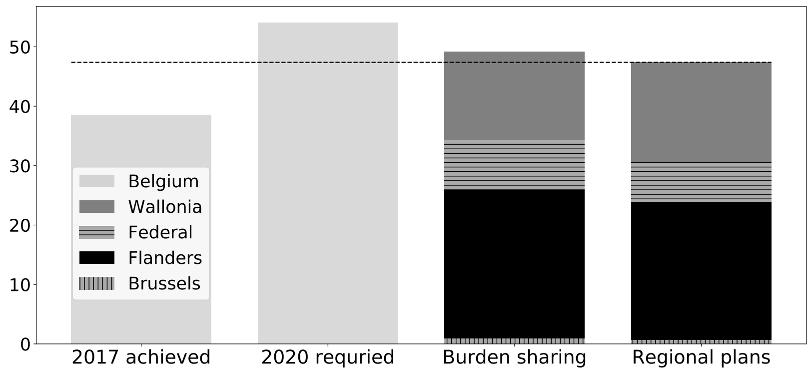

Figure 1: Yearly renewable energy generation in 2020 (in TWh) based on (i) achieved RES generation in 2017 (2017 achieved), (ii) requirements set by the expected gross final energy consumption (2020 required), (iii) burden sharing agreement (Burden sharing), and (iv) contribution according to the regional plans (Regional plans).

reputation. The third option is to import renewable energy from other Member States. Indeed, the EU has introduced a set of cooperation mechanisms which allow to attain the renewable energy targets more efficiently. One of these mechanisms, called statistical transfers, can be used to compensate for a national deficit in RES production. Under statistical transfers, renewable energy produced in one Member State is virtually transferred to the RES statistics of another Member State. The over-complying Member State is then financially compensated by the RES-importing Member State. In 2017, eleven Member States already exceeded their national RES quota and might be willing to sell their excess to Belgium. We will show that importing renewable energy could be relatively inexpensive. The cost, however, depends on the EU's RES target achievement and we highlight a trade-off between making appropriate arrangements as soon as possible, and waiting until the EU 2020 RES projections are refined.

A final contribution of this paper is to provide a set of policy guidelines on the way forward towards 2030. The EU is aiming to achieve a share of at least 32 % for renewables in final energy consumption by 2030. To achieve this, individual Member States are asked to contribute RES generation. Each country states the contribution that they are willing to make (Belgium proposed 18.3 %, an increase of 5.3 percentage points from its 2020 target). The Commission will then issue recommendations to Member States whose contributions it deems insufficient. The latter is assessed based on indicative national targets for which the calculation key has been published. We estimate that Belgium's indicative target would be somewhere around 25 %. The reason for the discrepancy between Belgium's offer and its indicative target, is that Belgium uses a bottom-up approach. The resulting 18.3 % is the combination of all stated contributions from the different regions and thus relates to Belgium's renewable potential for domestic production, which indeed could be relatively limited. The philosophy behind EU's indicative targets is fundamentally different and states national contributions that are fair, whilst expecting the use of cooperation mechanisms to adjust for varying RES potentials. As such, it is highly likely that the Commission will recommend Belgium to increase its level of ambition.

We argue that Belgium should be making wise use of cooperation mechanisms, which can lead to significant cost reductions. Nevertheless, we also highlight a caveat of renewable cooperation. Given that cooperation mechanisms typically imply supporting the renewable energy portfolio of the cooperating Member State, this directly affects the type of technologies that are being promoted. For instance, cooperation with the Baltic states may very well imply subsidizing wood-burning, whilst cooperation with e.g. Denmark implies supporting wind energy technologies. Belgian policy makers should thus reflect on which technologies they want to promote, and by extension, which countries to cooperate with. Note that this final issue is only valid towards 2030, and not for compensating the 2020 deficit. For this latter case, renewable cooperation will solely be used to balance country-level deficits and excesses and as such, does not directly impact additional renewable capacity development. For 2020, Belgium could simply select the most inexpensive option.

1 Introduction

Growing climate change concerns have led to a strong promotion of renewable energy. The European Union, for example, is committed to reach a 20 % share for renewables in final energy consumption by 2020. To achieve this, the European Council has adopted mandatory differentiated national targets for each of the Member States [1].

Although Belgium should attain a renewable energy (RES) target of 13 % in 2020, the most recent statistics disclose an achieved share of 9.1 % in 2017 [2]. Consequently, there is an ongoing discussion on whether Belgium will be able to fulfill their quota obligation. Our primary contribution is to tackle this question. As such, we draw upon publicly available data on the regional renewable energy plans. We start with analyzing the burden sharing agreement, in which the four Belgian jurisdictions (the federal level, and the Flemish, Walloon and Brussels regions) decided upon each jurisdiction's contribution towards the Belgian aggregate goals. Additionally, we separately zoom in on each jurisdiction to assess the attainment of their individual regional target. The analysis of course is subject to a significant level of uncertainty. As we will show that there is a considerable gap between the actual plans and required RES target in 2020, the domestic attainment of Belgium's 13 % RES quota will probably not be met. According to the regional plans, Belgium will most likely experience a renewable energy deficit in 2020, even under the most favorable conditions. Finally, we enlist options on how to deal with this deficit up to 2020, and on how to achieve the longer-term 2030 targets more cost-effectively.

The remainder of this paper is structured as follows. In Section 2, we provide background information relevant to the Belgian case, including a review on the EU renewable energy legislation along with a brief summary of current (Belgian and EU) progress towards the renewable energy goals. Section 3 discusses the agreement between Belgium's jurisdictions on how each region should contribute to the attainment of Belgium's aggregate goal, and Section 4 zooms in on the individual jurisdictions. The main conclusions of Sections 3 and 4 are combined in Section 5 to present a summary on Belgium's total RES deficit. Section 6 then sets forth a set of policy guidelines both on the short (2020) and longer (2030) term. Section 7 concludes this paper.

2 Background

In December 2008, the European Parliament, the Council and the Commission agreed upon a climate and energy package, generally known as the 20-20-20 targets. Within this framework, the 2020 renewable energy directive aims to achieve a 20 % share for renewables in gross final energy consumption by 2020. These ambitions were renewed for 2030, inter alia to include an EU-wide 32 % RES share. In this Section, we review the EU renewable energy legislation for both 2020 (Subsection 2.1) and 2030 (Subsection 2.2). The review is confined to elements relevant for Belgium. Furthermore, we include a summary of current progress towards these renewable energy goals (Subsection 2.3).

2.1 EU 2020 renewable energy legislation

The 2020 renewable energy directive [1] imposes mandatory and differentiated national targets for each of the Member States. These national targets were calculated by taking the difference between the 2020 goal (20 % on the EU level) and the existing RES volume in 2005 (8.4 % on the EU level), and by allocating this EU-wide gap to the different Member States based on a flat-rate component and a GDP-per-capita component [3]. Belgium ended up with a target of 13.0 %, an increase of 10.8 percentage points (pp) relative to their 2005 RES share (2.2 %).

Although such an allocation scheme might be considered fair since relatively rich countries are contributing more towards achieving the target, it is highly inefficient. The allocation scheme does not incorporate the varying renewable energy resource potentials between the

Member States[1]. For instance, wind energy is cheaper in the UK than in Germany and Spain is better suited for photovoltaic (PV) installations than Belgium. To attain the same amount of renewable energy, it would thus require less renewable capacity when installed within the borders of relatively high-potential Member States, accompanied by reduced renewable investment costs. Since the EU was unable to agree on differing potentials when defining the national quotas, relatively low-potential Member States may bear stringent quotas, requiring excessive renewable energy investments (the prime example being Luxembourg). Conversely, high-potential Member States might enjoy modest quotas, leaving their lower-cost resources largely untapped. The inefficiency of this allocation scheme has already been extensively validated in the academic literature (see [4] and [5] for an overview). For instance, Aune et al. [6] estimate that the additional energy system cost (due to the renewable target) could be reduced by 70 %. Similarly, Unteutsch and Lindenberger [4] calculate a 41 % to 45% reduction of the additional electricity system cost if targets had been defined more appropriately.

The European Union acknowledged this issue from the outset, and has introduced a legal framework for the use of cooperation mechanisms [1, 7]. More specifically, Member States can employ statistical transfers, implement joint projects (also with third countries) and set up joint support schemes. These cooperation mechanisms, if designed and used properly, allow to approximate the most cost-effective distribution of renewable energy across the Member States, whilst the distributional effects from the national quota definitions still apply (i.e. richer countries contribute more). Statistical transfers might be most important for achieving the Belgian 2020 RES goals (see Section 6). Under this cooperation mechanism, renewable energy produced in one Member State is virtually transferred to the RES statistics of another Member State. The over-complying Member State is then financially compensated by the RES-importing Member State. Both countries gain from this transaction[2] [7]. The RES-importing Member State enjoys lower support costs as the country can indirectly tap into the RES-exporting Member State's lower-cost resources. The RES-exporting Member State will see an increase in its support costs, but is financially compensated by the RES-importing country. Generally, total RES investment expenditures are reduced because renewable capacity is being displaced from low-potential and high cost areas towards high-potential and lower cost areas. These cost savings then are allocated to the participating countries based on the price of statistical transfers. Luxembourg, for instance, recognizes the benefit and already made agreements to import renewable energy from both Estonia and Lithuania via statistical transfers in 2020 [8].

For completion, we mention that the cooperation mechanisms mentioned above should not be confused with guarantees of origin (GOs). Guarantees of origin are a labeling mechanism that allow end-consumers to distinguish between renewable and non-renewable electricity. Electricity producers receive a certificate per MWh of renewable electricity produced, which they can sell to retailers. As such, GOs are frequently traded cross-border (hydro-powered Norway serves as the prime exporter [9]). In contrast to the cooperation mechanisms discussed above, however, GOs have no function in terms of a Member State's compliance with the national RES quotas and should be considered as an independent instrument [1].

2.2 EU 2030 renewable energy legislation

By 2030, the European Union is aiming to achieve a share of at least 32 % for renewables in gross final energy consumption[3]. Having taken note of the argument presented above, significant amendments were made compared to the 2020 legislation. Most notably, the EU would aim for a share of 32 % on the EU level, and refrain as much as possible from imposing national targets. In practice, however, less ambitious Member States would most likely constrain their contribution, imperiling reaching the EU-wide target. The European Commission anticipated this issue and set up an Energy Governance Regulation [11], which states that each Member State is expected to contribute to the EU-wide target achievement. More specifically, each

[1] Although the 2005 starting position of individual Member States can be considered as a proxy for renewable potential, the increase required to attain the 2020 goals is based solely on a flat-rate component and a GDP-per-capita component. The final 2020 RES share to be achieved by individual Member States is thus only partly and imperfectly driven by renewable potential considerations.

[2] Depending on the pricing of statistical transfers, some exceptions may exist [5].

[3] The corresponding directive allows for an upwards revision clause by 2023 [10].

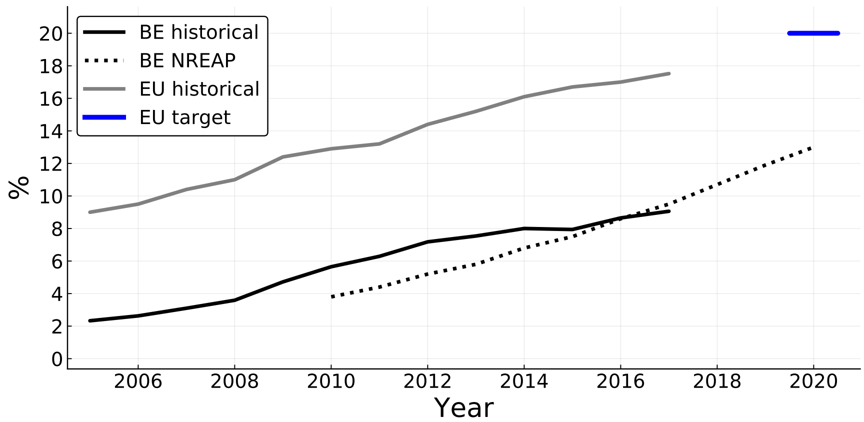

Figure 2: Historically achieved locally produced renewable share for Belgium and the European Union, along with the Belgian targets as specified in their national renewable energy action plan (NREAP). Own illustration based on [2].

country states the contribution that they are willing to make (as a share for renewables in gross final energy consumption, analogous to the 2020 target definition). If there still is a gap between these aggregate country-level contributions and the EU 2030 targets (which is likely), the Commission will issue recommendations to Member States whose contributions it deems insufficient. The Energy Governance Regulation also declares that the Commission can propose measures and exercise its powers at Union level to ensure the collective achievement of the targets. Finally, a Member State must attain its established contribution by 2030. Although the Renewable Energy Directive and Energy Governance Regulation never mention it explicitly, this system again boils down to nationally binding targets.

In spite of this more comprehensive procedure, the final 2030 national targets will still result from a political bargaining procedure and not directly from economic considerations. As such, the 2030 RES targets will again not be cost-effective—although arguably more efficient than their 2020 counterparts. The EU (partly) mitigates this issue by expanding the legislation surrounding renewable cooperation mechanisms. Besides the three mechanisms mentioned above, the EU introduced a Union renewable development platform (URDP) and a Union renewable energy financing mechanism. The URDP basically resembles a centralized market for statistical transfers, whereas up till now only bilateral agreements were possible [11]. The renewable energy financing mechanism collects voluntary contributions from individual Member States used to tender support for new renewable energy projects in the entire Union [10]. The renewable energy generated by installations financed by this mechanism will be statistically attributed to the participating Member states, reflecting their relative payments. In addition, the Commission may be introducing an obligation for the use of cooperation mechanisms as of 2023, thereby alleviating the concern that cooperation mechanisms currently remain underused [5, 10]. In sum, the 2030 legislation again points towards national targets that will be fair, whilst employing a correction via a set of cooperation possibilities to make them more efficient as well.

2.3 Current progress

Before moving towards the discussion on whether Belgium will attain its renewable energy quota of 13% by 2020, it is relevant to first look at the historical progress. Figure 2 presents the actually achieved shares of renewable energy production in Belgium and the EU [2]. In 2010, all Member States had to issue a national renewable energy action plan (NREAP), indicating a trajectory for achieving their 2020 quota. The Belgian NREAP is presented in Figure 2 as well.

The EU as a whole has attained a renewable energy share of 17.5 % in 2017, 2.5 percentage points short of their 2020 target. It remains unclear whether the EU will achieve its quota by 2020. Two years ago, it was estimated that the EU would in fact exceed the 20 % RES

Table 1: Regional renewable energy generation targets for 2020

	Federal	Flanders	Wallonia	Brussels	Total
2020 renewable generation target [ktoe]	718	2,156	1,277	73	4,224
2020 renewable generation target [TWh]	8.35	25.07	14.85	0.85	49.12
Estimated share [%]		10.1	13.5	4.4	13

share in gross final energy consumption, but statistics for 2016 and 2017 depicted a slower than expected growth (averaging 0.4 pp per year). Eleven EU 28 Member States already achieved or exceeded their targets in 2017. Most notably, Sweden had the highest share (54.5 %), followed by Finland (41.0 %), Latvia (39.0 %) and Denmark (35.8 %). Correspondingly, all these countries will have a RES excess. At the opposite end of the spectrum, the Netherlands (7.3 pp from its national 2020 objective), France (6.7 pp), Ireland (5.3 pp), the UK (4.8 pp) and Luxembourg (4.6 pp) are the furthest away from their 2020 targets [2].

As can be expected, the Belgian NREAP reaches a share of exactly 13 % by 2020 (Figure 2). The historically achieved shares started at approximately 6 % in 2010, higher than anticipated in the NREAP (4 %). Nevertheless, the historical trajectory has a rather concave shape and falls below the planned trajectory in 2017. Although these trends indicate a predicament, it would be rather unjustified to directly assume the inability of Belgium to achieve its renewable energy share. Indeed, the actual deficit in 2017 compared to the NREAP remains rather small. Sections 3 and 4 will therefore analyze the Belgian renewable energy plans in-depth.

3 The burden sharing agreement

In December 2015, six years after the EU Renewable Energy Directive entered into force, the four ministers of environment and/or energy finalized the intra-Belgian burden sharing agreement. The consenting law to the agreement was officially published in the Moniteur Belge in 2018 and declares i.a. the regions' contributions towards Belgium's climate targets [12]. Regarding renewable energy, it was agreed that the 13 % RES target corresponds to an absolute value of 49.12 TWh renewable energy generation in 2020, based on the indicative energy efficiency target of 378 TWh final energy consumption. Furthermore, the absolute target is distributed across the jurisdictions as shown in Table 1. The federal contribution solely comprises offshore wind energy, whilst the regional contributions comprise all eligible RES sources within their territory, including renewable electricity, renewable heating and cooling, and blended biofuels used in transport[4]. Furthermore, Table 1 presents the regions' estimated renewable energy shares based on their historical consumption share, and assuming the achievement of the indicative energy efficiency target. Although these values thus are fairly rough estimates, they do allow to gain a better understanding on the absolute targets' stringency. The Brussels region is largely exempt from contributing renewable energy (estimated share of 4.4 %), reflecting their limited resource potential. In addition, the share of Wallonia is higher than that of Flanders, again likely driven by potential considerations. The remaining gap (8.35 TWh) remains to be bridged by the Federal contribution (offshore wind).

The major concern regarding the burden sharing agreement is the assumption that Belgium will attain its indicative energy efficiency targets, which may have been overly optimistic. As the EU did not impose legally binding efficiency targets, the possible Belgian inability to achieve these targets would normally be without consequence. However, the burden sharing agreement decided to define the absolute amount of renewable generation in 2020 based on these efficiency targets. As a consequence, not achieving a gross final energy consumption of 378 TWh in 2020 implies forfeiting the renewable energy quota of 13 % (which is legally binding), even if all jurisdictions perfectly achieve their absolute targets as defined in Table 1.

[4]The mandatory blending obligation of biofuels actually is a federal competence, but the corresponding renewable energy yield contributes towards the regional statistics (not the federal ones). It also is noteworthy to mention that, besides an overall renewable energy quota, Belgium is subject to a 10 % renewable energy share in transport. Renewable energy in transport, and specifically biofuels, will thus significantly contribute towards the overall regional statistics. In contrast to the overall RES target, however, attaining the renewable target in the transport sector is the sole responsibility of the federal level.

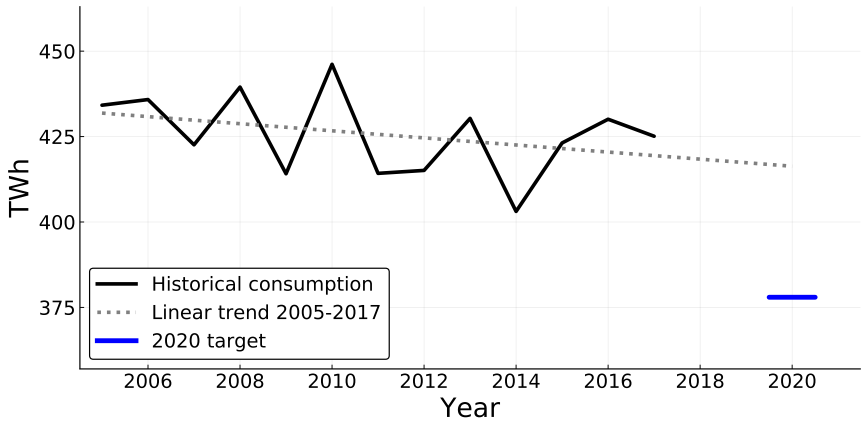

Figure 3: Gross final energy consumption in Belgium. Own illustration using data from [12], [2].

Figure 3 presents the historical gross final energy consumption (GFEC) based on Belgium's renewable progress reports [2] and thus in accordance with the renewable energy directive [1]. The fluctuations between the years largely stem from the dependency of final energy demand on climate conditions. The Belgian energy consumption typically is higher during colder years (due to an increased demand for heating). Figure 3 also presents the linear trend between 2005 and 2017, along with the indicative energy efficiency target of 378 TWh by 2020. Based on the historical trend, one might expect the gross final energy consumption to be around 416 TWh in 2020, leaving a significant gap of 38 TWh between actual consumption and the efficiency target. This value also is supported by the federal planning bureau, which arrived at a gross final energy consumption of 418 TWh in 2020 [13]. Put differently, if Belgium is going to achieve their energy efficiency target, the country should decrease its GFEC by 11 % relative to the 2017 level, over a timeframe of only three years. Given the country's historical progress, such ambitions have become unrealistic.

As a consequence, we will not assume the attainment of the energy efficiency target, but rather follow the trend to obtain a more realistic estimate of 416 TWh during 2020. Taking this into account, a renewable energy share of 13 % by 2020 corresponds to an absolute RES generation level of 54.08 TWh, provoking a deficit of 4.96 TWh yearly RES generation compared to the aggregate target set forth in the burden sharing agreement. Conversely, if all jurisdictions fulfilled their targets as defined in Table 1 and the GFEC was in fact 416 TWh, Belgium would only attain a RES share of 11.8 %. Note, however, that the gross final energy consumption strongly depends on weather conditions and thus, our 2020 estimate remains highly uncertain. Figure 3 illustrates that the fluctuations of Belgium's historical GFEC yield a maximum difference of about 20 TWh relative to the trend. Multiplied by the quota requirement (13 %), this translates into an uncertainty of 2.60 TWh required RES generation. The RES deficit resulting from the underestimation of Belgium's GFEC will thus be exacerbated or compensated by about 2.60 TWh if we experience a very cold or warm year in 2020, respectively. Even under very favorable climate conditions, there will still be a deficit[5]. In the remainder of this paper, we simply use the GFEC point estimate of 416 TWh. Although it will not alter the main conclusion (i.e. there will most likely be a RES deficit), the uncertainty surrounding this value should be kept in mind.

4 The regional renewable energy plans

In this Section, we will discuss the second rationale behind the total Belgian deficit, namely the fact that some of the jurisdictions will not be able to attain their regional targets set forth in the burden sharing agreement. The following Subsections dilate upon each region in detail, but a summary already is presented in Table 2. The federal level (only offshore wind energy)

[5] 2.36 TWh (= 4.96 TWh - 2.60 TWh)

Table 2: Comparison between the 2020 regional targets and projected contributions

	Federal	Flanders	Wallonia	Brussels	Total
Renewable generation target [TWh]	8.35	25.07	14.85	0.85	49.12
Renewable generation projected [TWh]	6.63	23.32	16.84	0.59	47.38
Deficit compared to burden sharing [TWh]	1.72	1.75	-1.99	0.26	1.74

will bear an estimated deficit of 1.72 TWh, largely because most of the extensions to existing wind parks are planned to become operational during 2020, thereby not generating for a full year. In fact, if all planned projects were operational before 2020, the federal deficit would only amount to 0.41 TWh. The Flemish deficit arises from a gap in the most recent renewable energy plan (1.42 TWh), along with an overestimation of PV generation during 2020 (inducing an additional 0.33 TWh deficit). Wallonia plans to exceed its target set forth in the burden sharing agreement by 1.99 TWh. Finally, Brussels expects to bear a deficit of 0.26 TWh.

In total, this comprehensive review on the regional plans reveals a total deficit of 1.74 TWh compared to the target set forth in the burden sharing agreement. Notice that we assume a perfect fulfillment of the (amended) regional plans. Not fulfilling certain regional capacity targets (e.g. PV or wind) may introduce an additional deficit. Nevertheless, we focus on illustrating the deficits of the current plans and refrain from making assumption on what will actually be realized.

4.1 Federal contribution

According to the burden sharing agreement, the federal level should attain a renewable energy generation target of 8.35 TWh by 2020 (Table 1). As stated above, only offshore wind energy contributes towards its statistics. At the beginning of 2019, Belgium's offshore wind capacity was 1,186 MW [14], which will roughly double by the end of 2020. In fact, the Norther project is projected to be completed in 2019, increasing offshore wind capacity by 370 MW. Two additional projects (Northwester 2 and Seamade)—accounting for an additional capacity of 711 MW—are planned to become operational in 2020, thereby increasing the total Belgian offshore capacity to 2,267 MW [15]. Based on these planned capacities, one could calculate whether or not these expansions will be sufficient. According to Elia [16], the average yearly capacity factor of offshore wind turbines in Belgium lays between 0.38 and 0.42, depending on wind conditions. This directly implies that the 2020 Belgian total offshore capacity (2,267 MW) will be able to generate a yearly energy yield of 8.34 TWh if weather conditions are favorable, thereby just achieving the federal target.

Unfortunately, such analysis is flawed because of two reasons. First, a significant amount of capacity (711 MW) is expected to become operational during 2020, not at the start of the year. Consequently, the actual contribution of the two projects to be completed in 2020 will be reduced since the turbines are not generating for an entire year. Second, the renewable energy directive specifies a normalization rule for wind energy to account for annual fluctuations in wind conditions[6] [1]. As such, wind power generation statistics will not be biased by atypical climate conditions[7].

Based on this normalization rule, one can calculate the normalized historical offshore wind generation, along with estimates for 2019 and 2020. The result is graphically presented in

[6] The directive also specifies a similar rule for hydro generation to account for annual fluctuations in precipitation, but not for PV generation and gross final energy consumption.

[7] More specifically, the renewable energy directive imposes the following normalization rule:

$$Q_t^{Norm} = \frac{C_t + C_{t-1}}{2} \cdot \frac{\sum_{i=t-4}^{t} Q_i}{\sum_{j=t-4}^{t} \frac{C_j + C_{j-1}}{2}} \tag{1}$$

In which t stands for the reference year, Q_t^{Norm} for the normalized wind generation in year t [MWh], Q_t for the actual wind generation in year t [MWh], and C_t for the capacity installed at the end of year t [MW]. The first factor in Eq. 1 thus approximates the average capacity during year t, whilst the second factor represents the average full load hours (FLHs) over the preceding four years.

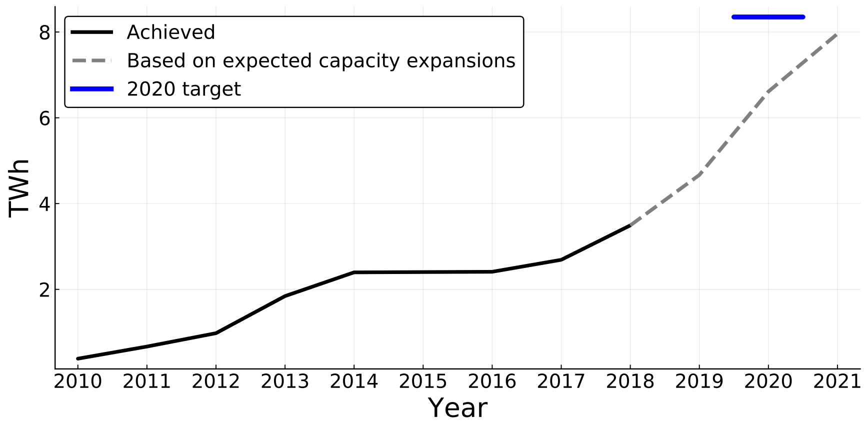

Figure 4: Achieved and estimated yearly offshore wind generation, normalized in accordance with the renewable energy directive [1]. Own illustration based on historical load factors [16], historical capacities [14] and planned expansions [15].

Figure 4. Note that we approximate the average full load hours (FLHs) of historical capacity using data from Elia [16] between the years 2014-2018 (being 3385 h). Furthermore, we take into account that the soon-to-be installed turbines will have a higher yield than the historical capacity and therefore use 3800 FLHs[8]. Finally, we assume that future projects will be installed mid-year, thereby reducing their effective full load hours by half[9] in the year of installation.

Figure 4 illustrates that the federal target will not be achieved by Belgium's current offshore fleet, nor with the planned expansions. Although the planned expansions certainly are impressive, practically doubling current capacity over a time-frame of two years, these simply are one year too late. Compared to the federal target (Table 1), our estimates leave a deficit of approximately 1.72 TWh yearly RES generation. If all planned projects were operational before 2020, the deficit would only amount to 0.41 TWh.

4.2 Flemish contribution

During 2017, the Flemish region generated an amount of 19 TWh renewable energy [17], thereby achieving 76 % of their absolute regional target (Table 1). Renewable electricity accounted for 44 % in total RES generation, whilst renewable heat/cooling and transport accounted for 39 % and 17%[10], respectively. Figure 5 illustrates Flanders' historical progress based on [17]. The non-monotonic increasing behavior can again be explained by the dependency of heat demand on climate conditions. Specifically, relatively warm years require less energy consumption for heating and by extension, less renewable heat generation. The amount of renewable electricity and transport has mostly been steadily increasing over the years.

Bart Tommelein, former Flemish minister of energy, brought forward multiple renewable energy plans, each presenting sub-goals per technology type. The former minister's most recent renewable energy plan [18] reports significant changes compared to previous versions, thereby reacting to unforeseen retractions. More specifically, the bankruptcy of the biomass power plant in Langerlo and the annulment of state-aid for BEE Power's biomass plant in Gent left a gap of 3.2 TWh yearly RES generation. Correspondingly, the most recent Flemish renewable energy plan increased the 2020 ambition for yearly PV (3.5 TWh instead of 2.7 TWh) and wind (3.0 TWh instead of 2.1 TWh) generation. Smaller changes were made for the renewable heat sub-goals. The aggregate goals of Tommelein's renewable energy plan are presented in Figure 5. Notably, the most recent plan leaves a deficit of 1.42 TWh (named 'onbestemd' in

[8] Press releases report approximately 3738 FLHs for the Northwester 2 project.

[9] This assumption also is generous. According to the latest press releases, Northwester 2 (224 MW) is expected to be operational in the first half of 2020, while the Seamade (487 MW) project is planned to start generating at the end of 2020.

[10] In this paper, we consider blended biofuels to be the only renewable energy source in transport. Electric vehicles and rail transport also consume renewable electricity, but this already contributes towards the renewable electricity statistics.

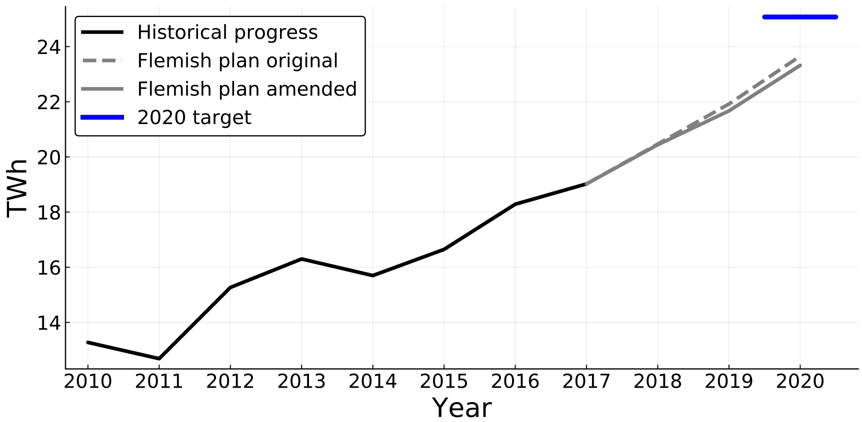

Figure 5: Achieved and planned total renewable energy generation in the Flemish region. Own illustration based on [17] and [18].

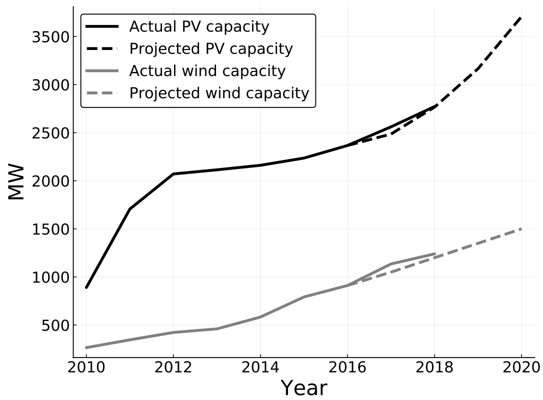

Figure 6: Historical and projected wind turbine and photovoltaic (PV) capacity in Flanders. Own illustration based on [17] and [18].

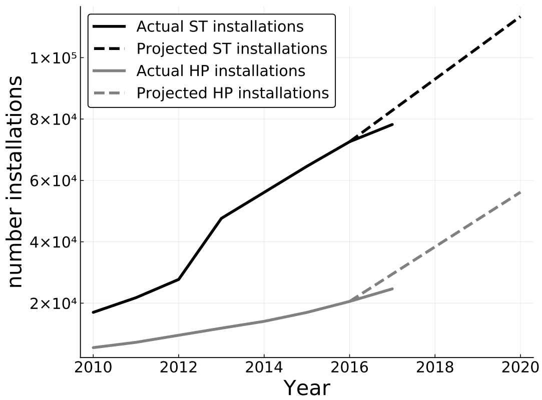

Figure 7: Historical and projected solar thermal (ST) and heat pump (HP) installations in Flanders. Own illustration based on [17] and [18].

the plan), indicating that the increased ambitions for wind and PV could not fully compensate the loss of both large-scale biomass power plants[11].

Note also that we slightly amended the calculations put forward in Tommelein's plan. The average capacity factors for renewable electricity are reasonable (e.g. including efficiency improvements for onshore wind turbines), but the plan has unrealistic expectations on the energy yield of PV capacity installed in 2020. Similar to the discussion on offshore wind energy (Section 4.1), actual PV generation should be reduced in the year of installment, reflecting the fact that newly installed capacity is not available for an entire year. We assume that PV capacity is installed evenly throughout the year, effectively reducing the aggregate generation of newly installed capacity by half during the year of installation. This leads to an additional deficit of about 336 GWh.

There will thus be a total yearly deficit of 1.75 TWh compared to the regional target, even if all capacity targets as specified in the Flemish renewable energy plan are achieved. This last

[11] The 2020 gap has decreased in the Flemish 2021-2030 energy plan due to a budgeted increase of the use of biofuels in transport [19]. This resulted from a higher than expected mandatory share of renewables in transport by 2030, and the assumption that the Belgian blending obligation would be directly increased to follow a linear trajectory up to 2030—thereby also impacting the 2020 value. As mentioned, however, this remains a federal jurisdiction and as such, the Flemish government will be asking the federal government to increase the mandatory blending obligation. We, however, question whether the request will be granted by 2020, thereby not taking this into account in this paper. As before, this will not change the main conclusion.

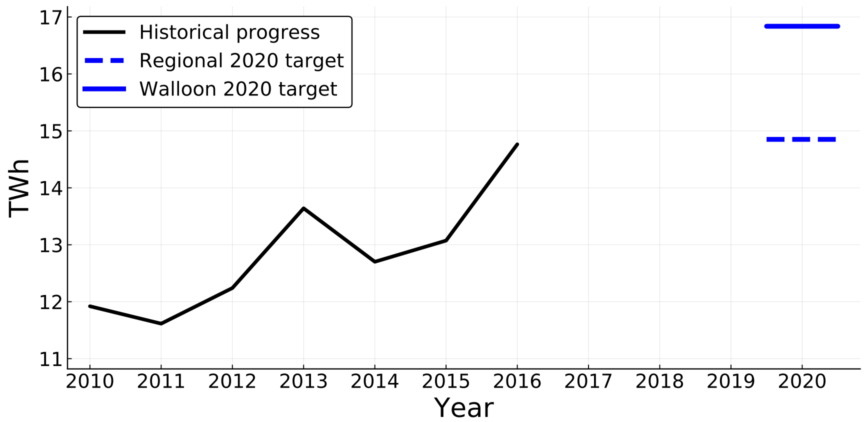

Figure 8: Achieved total renewable energy generation in the Walloon region. Own illustration based on [20] and [21].

condition, however, might be questioned. Certain sub-targets such as biomass-fueled heat and power generation, hydro power generation, geothermal heat generation, etc. are mostly based on actually planned projects and their realization is fairly certain. The main uncertainties arise from renewable power and heat equipment to be installed by households, and possibly also from onshore wind power. Figure 6 presents the historical progress of Flemish onshore wind and PV capacity [17], along with the targets for these sub-goals. One can see that the targets for onshore wind power correspond to the historical trend, contrasting with those for PV capacity. In fact, the future installation rate for PV capacity should roughly correspond to the one Flanders experienced between 2008-2012, which was nourished by a generous subsidy scheme. Similarly, Figure 7 illustrates the historical progress of solar thermal (ST) and heat pump (HP) installations [17]. Planned solar thermal installations follow the historical trend, whilst the heat pump installation rate should increase. In the remainder of this paper, we take on a rather optimistic view by assuming a full achievement of the Flemish capacity targets. Correspondingly, the total Flemish deficit accounts to 1.75 TWh, or about 7% of their regional target.

4.3 Walloon contribution

The Walloon region currently is the only jurisdiction well on track to meet its renewable energy goal as defined by the intra-Belgian burden sharing agreement. Figure 8 illustrates the historical progress and shows that the region already attained 14.8 TWh (corresponding to 99% of the regional target) yearly RES generation in 2016 [20]. Renewable electricity accounted for 30 % in total RES generation, whilst renewable heat/cooling and transport accounted for 59 % and 11 %, respectively. In contrast to Flanders, the Walloon region thus obtains the bulk of their renewable energy generation from the heating and cooling sector, mostly by the combustion of biomass fuels. During 2016, the region generated 3.6 TWh of heat from wood-products, of which 3.1 TWh was generated in residential wood stoves. Other biomass products represent the second largest contribution and are being converted into electricity (1.4 TWh) and heat for self consumption (3.2 TWh) [20].

As such, it is certain that the region will attain and exceed their regional target. In fact, the Walloon contribution to the integrated national energy and climate plan discloses an expected yearly RES generation of 16.8 TWh during 2020 [21], thus overachieving their regional target by 2.0 TWh. To the authors' knowledge, there are no detailed 2020 sub-goals publicly available and consequently, we simply assume that the Walloon contribution will reach 16.8 TWh RES generation.

4.4 Brussels contribution

Following the intra-Belgian burden sharing agreement, the Brussels region should attain a yearly RES generation of 849 GWh by 2020. This roughly corresponds to a renewable energy share of 4.4 % in the region, reflecting their limited potential (see Table 1). Indeed, the region is small, densely-populated and exposed to restrictions from the national airport. All these factors severely limit the potential for large-scale wind turbines[12]. As such, the region currently is focusing on renewable electricity from PV and biomass, along with renewable heat from solar thermal, heat pumps and biomass.

According to the regional energy balance, Brussels attained an absolute value of 532 GWh RES generation in 2016, thereby achieving 62 % of their regional target [23]. The Brussels contribution to the integrated national energy and climate plan [24], however, discloses that this value is not conform with EU regulation. Indeed, the accounting rules for Neder-Over-Heembeek's incinerator were opaque and the document states that, as a consequence, the RES value presented in the regional energy balance should be decreased by about 80 GWh. Brussels thus attained about 452 GWh RES generation in 2016, thereby achieving 53% of their regional target.

The Brussels contribution to the national energy plan also discloses that the region expects a yearly RES generation of 594 GWh during 2020[13] [24]. Put differently, they expect to bear a deficit of about 0.26 TWh. Note that this gap is small compared to the numbers presented in earlier Sections, and its effect is negligible.

5 The total Belgian deficit

Figure 9 graphically presents the discussion set forth in Sections 3 and 4. Based on the Belgian historical trend (Figure 3), we assumed a gross final energy consumption of 416 TWh in 2020. This directly implies that an absolute value of 54.1 TWh RES generation should be attained to fulfill the 13 % renewable quota.

The first reason for Belgium's aggregate deficit is an underestimation of the gross final energy consumption. The intra-Belgian burden sharing agreement assumed a yearly GFEC of 378 TWh, thereby attaining the Belgian energy efficiency targets. A 13 % share for renewables then corresponds to an absolute amount of 49.1 TWh RES generation, which has been distributed across the four jurisdictions. We showed that the attainment of Belgium's energy efficiency targets has become unrealistic, leaving a deficit of 5.0 TWh (1.2 pp) yearly RES generation.

The second reason for the Belgian deficit relates to the fact that some jurisdictions are struggling to attain their regional targets as defined by the burden sharing agreement. Projected federal offshore expansions lead to a gap of 1.72 TWh, whilst the Flemish and Brussels region bear a deficit of 1.75 TWh and 0.26 TWh, respectively. The additional efforts of the Walloon region (1.99 TWh) do compensate, but are not able to fully offset these gaps. In total, the aggregate regional plans depict a RES generation of 47.38 TWh, leaving a deficit around 1.74 TWh (0.4 pp) compared to the burden sharing agreement (49.1 TWh).

In sum, the Belgian renewable energy plans represent a deficit of about 6.7 TWh. Given a GFEC of 416 TWh, the 2020 renewable share will be around 11.4 %, 1.6 percentage points below the EU target. Note that this percentage assumes a full attainment of the regional renewable energy plans. Figure 9 illustrates that, compared to 2017 levels, an additional yearly RES generation of 8.9 TWh is required to achieve these regional plans. In this paper, we simply assume that this will be achieved, although naturally, it remains highly uncertain.

One should be aware of the many uncertainties underlying these numbers and we certainly do not claim that these predictions will prove to be accurate. Instead, we focused on illustrating the deficits of the region's renewable energy plans. Throughout this paper, we highlighted some of the key uncertainties (e.g. gross final energy consumption, federal biofuel policy, regional capacity target achievement, etc.). Given the shear size of the aggregate gap, however, the

[12]Several studies found small-scale city-turbines to be viable and exploitable in the region, but the number of projects remains limited [22].

[13]The report only presents expected RES generation for the electricity and heating/cooling sectors (totaling to 330 GWh). We took the 2020 biofuels consumption in transport (264 GWh) from [25].

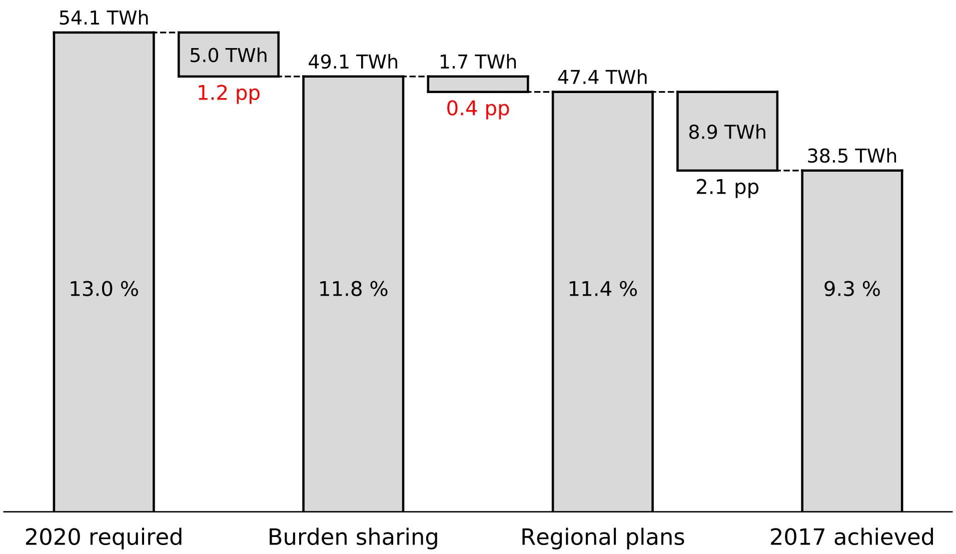

Figure 9: Yearly renewable energy generation in 2020 based on (i) the requirements set by a gross final energy consumption of 416 TWh (2020 required), (ii) the burden sharing agreement (Burden sharing), (iii) the contribution according to the regional plans (Regional plans), and (iv) the achieved RES generation in 2017 (2017 achieved). All percentages are expressed relative to a gross final energy consumption of 416 TWh[14].

aggregate of these uncertainties cannot alter the main conclusion: current regional plans are insufficient to meet the EU 2020 renewable energy target—at least when solely relying on domestic means.

6 Lessons learned and the way forward

In this Section, we set forth a set of policy guidelines both on the short (2020) and longer (2030) term. More specifically, Subsection 6.1 presents selected paragraphs from the Moniteur Belge, and argues that importing renewable energy via statistical transfers might be a likely option to compensate for the 2020 deficit. Subsection 6.2 produces a rough cost estimate for importing these statistical transfers. In Subsection 6.3, we provide some guidelines on how to reach the national 2030 renewable energy target more efficiently by advancing the use of cooperation mechanisms. Such mechanisms, however, are accompanied by an important caveat that must be taken into account. This will be elaborated upon in Subsection 6.4.

6.1 Coping with the 2020 RES deficit

Up till now, we made a clear distinction between the deficit resulting from (i) the inability of some of the regions to attain their renewable energy goals as defined in the Belgian burden sharing agreement and (ii) the under-estimation of Belgium's gross final energy consumption. This distinction propagates throughout this Subsection because the first effect is formally accounted for in the Moniteur Belge, whilst the second is not. The Moniteur Belge states that, if any region experiences a deficit compared to the burden sharing agreement, it must compensate this deficit by administratively importing renewable energy (i.e. via statistical transfers, see Section 2.1) [12]. Additionally, if some regions bear a deficit whilst others experience an excess which they are willing to sell, intra-Belgian compensation must supersede trade with other EU Member States. Put differently, the Walloon region must give priority to the federal level, Flemish region and also the Brussels region when selling their excess (and vice versa). As the

[14]This explains the 9.3 % value in 2017. The 2017 9.1 % share presented in Section 2.3 was calculated with respect to the 2017 consumption level.

Walloon excess is not able to fully cover the aggregate federal, Brussels' and Flemish deficit, this excess must be sold proportionally to the respective regions' deficits. The price of these transfers is set as the average of the Flemish and Walloon support for onshore wind energy, capped at 75 EUR/MWh. Furthermore, the Flemish, Walloon and Brussels regions enjoy an inter-regional[15] solidarity principle in which the transfer price also is decreased by a factor depending on the total amount of transfers (a 25 % reduction for the first 750 GWh tier, a 20 % reduction for the second 750 GWh tier, etc.). After the intra-Belgian compensation, any remaining regional deficit (compared to the burden sharing agreement) must be resolved by importing statistical transfers from other Member States.

The Moniteur Belge remains vague on how to handle the second type of deficit, i.e. the gap resulting from the under-estimation of Belgium's gross final energy consumption. The document only states that, if there is a Belgian deficit whilst all regions attain their RES goals as specified in the burden sharing agreement, this shall be submitted to the so-called consultation Committee after completion of the final evaluation regarding renewable energy targets. As such, we can only speculate on how the Belgian policy makers will cope with this deficit.

There are three options. The first one would be an accelerated role-out of renewable capacity to achieve the target domestically. As we will discuss below, this option will probably be relatively expensive (Subsection 6.2) and practically no longer realistic (Subsection 6.3). The second alternative would be to risk not achieving the mandatory 13 % RES target. If this was the case, the EU Commission could bring the matter—i.e. the failure to fulfill an obligation under the Treaties—before the EU Court of Justice. The latter then confirms the violation, and imposes a lump-sum (or periodic) penalty payment. The level of this penalty payment, however, is not known in advance and thus induces a significant level of risk-exposure. In fact, it not even is clear whether the Commission would submit this matter to the EU Court of Justice as such a decision will probably be driven by political considerations. Given the regional obligations to compensate any deficit via statistical transfers, however, the governments do not seem too keen on risking a potential penalty fee. Non-economic factors (i.e. national climate reputation, public opinion, etc.) of course play their part here as well.

The third option is importing statistical transfers to compensate for the deficit resulting from the under-estimation of Belgium's GFEC. Employing this cooperation mechanism would mitigate the non-compliance risk, but comes at a cost which will be discussed in depth in Subsection 6.2. If this second type of deficit also is compensated via statistical transfers, it remains open how much each region should contribute to compensate the gap. Depending on the allocation scheme, even the Walloon region might experience a deficit, making them unable to sell their original excess to the other regions. Either way, Belgium as a whole should be importing around 6.7 TWh of statistical transfers in order to fully compensate their deficit (Section 5).

6.2 The cost of importing statistical transfers

At this point, it is interesting to provide an estimate of the cost related to importing statistical transfers. As mentioned above, Luxembourg already made arrangements to import renewable energy from both Estonia and Lithuania in 2020. According to the Estonian State Gazette, the agreement between Estonia and Luxembourg is based on a transfer price of 15 EUR/MWh [26]. Unofficial sources declare a similar price for the agreement between Lithuania and Luxembourg. For comparison, onshore wind turbines installed in Flanders currently are eligible to a minimum support of 44 EUR/MWh[16]. At a transfer price of 15 EUR/MWh, supporting renewable capacity abroad would thus be about three times less costly for Flanders than subsidizing domestic wind energy. Returning to the question at hand, Belgium as a whole would spend around 100 million euros for fully compensating its 2020 deficit (6.7 TWh) if the transfer price remains 15 EUR/MWh.

Another interesting comparison arises by considering Flanders' yearly renewable electricity

[15]The Federal level is excluded from this principle.

[16]Based on the Flemish minimum green certificate price of 93 EUR/certificate, and the banding factor of 0.474 certificate/MWh applied as of 2019 [27].

support. In 2017, this amounted to a total of 1.06 billion[17] euros, whilst total renewable electricity generation was 7.9 TWh [17]. PV certificate support (689 million euros for 2.4 TWh during 2017 [17, 28]) should be omitted from this comparison because (i) support was overly generous and thus a significant share of this amount actually represents a transfer rather than a real underlying economic cost, and (ii) it avoids having to take into account indirect subsidies via net-metering. Excluding PV, renewable electricity generation during 2017 amounted to 5.5 TWh and enjoyed a total certificate support of 371 million euros. Again, Belgium would be paying 100 million euros for 6.7 TWh RES generation if the transfer price remains 15 EUR/MWh. This comparison is not fair as it is based on different technologies (further explained in Section 6.4), geographical areas (Belgium and Flanders), historical technology costs and policies, etc. Nevertheless, it does hint that supporting renewable energy abroad (or compensating the 2020 deficit by importing statistical transfers) can be cost-effective. We will present a more fair illustration on the cost-savings resulting from renewable cooperation in Section 6.3.

The main uncertainty, of course, is whether Belgium will be able to secure a statistical transfer price as low as 15 EUR/MWh. The future transfer price will strongly depend on whether the EU as a whole will attain the 20 % RES target. First, we have to note that all Member States which have exceeded their national target should be willing to sell their excess at pretty much any price (as the RES capacity investments have already been made and should be considered as a sunk cost). If the EU as a whole would overachieve its target, there will be an excess of statistical transfers. In such a game-theoretic setting, Member States that should import statistical transfers have the strongest bargaining position and one can image a situation in which the statistical transfer price is extremely low, possibly even zero (i.e. a Bertrand game). If, however, the EU as a whole does not attain the 20 % renewable share, supply for statistical transfers will become tight, naturally accompanied by a price increase. As mentioned in Section 2.3, there are several countries (i.a. the Netherlands, France, Ireland and the UK) that will be bearing a large deficit and likely are looking into the use of statistical transfers as well. If, for instance, the Netherlands and France started importing statistical transfers before Belgium, the potential tightness of the future market would be revealed to all potentially exporting countries, thereby weakening the bargaining position for all Member States still planning to import statistical transfers. A transfer price increase of, say, 15 EUR/MWh would imply an additional cost of 100 million euros for Belgium during 2020. In reality, the price increase might be more significant, up to the expected value of the penalty payment. Given that the EU currently has attained 17.5 % in 2017, with an average annual growth of 0.4 pp during 2016-2017 (Section 2.3), this last situation certainly is not excluded. Moreover, the potential price increase is significantly higher than the potential price decrease.

Finally, we note that the cost for importing statistical transfers may carry on over multiple years. The new EU governance regulation declares that from 2021 onwards, a Member State's renewable energy share shall not be lower than its 2020 mandatory national target [11]. Member States will thus be forced to import statistical transfers (or to make use of other cooperation mechanisms) as long as their domestic means are insufficient to meet the their 2020 target. As such, Member States cannot simply pay off their obligations during the target year (2020), and withhold any efforts thereafter[18]. Belgium's cost for importing statistical transfers may consequently recur for multiple years. Note, however, that this does not nullify the fact that importing statistical transfers can still be the most cost-effective option (as domestic renewable capacity also provokes a recurrent cost).

[17]In 2017, an amount of 6.1 million certificates were handed out to renewable electricity generators. Part of these (3.3 million) were sold to the transmission and distribution system operators at the minimum price and costed a total of 811 million euros. The other part (2.8 million) were sold bilateral. Given that the average bilateral price was 89.03 euro per certificate, the support for this latter stream amounts to 249 million euros. Both steams thus total to 1.06 billion euros. All numbers were taken from [28].

[18]The governance regulation also imposes intermediate renewable energy targets in 2022, 2025 and 2027 for which the same logic applies.

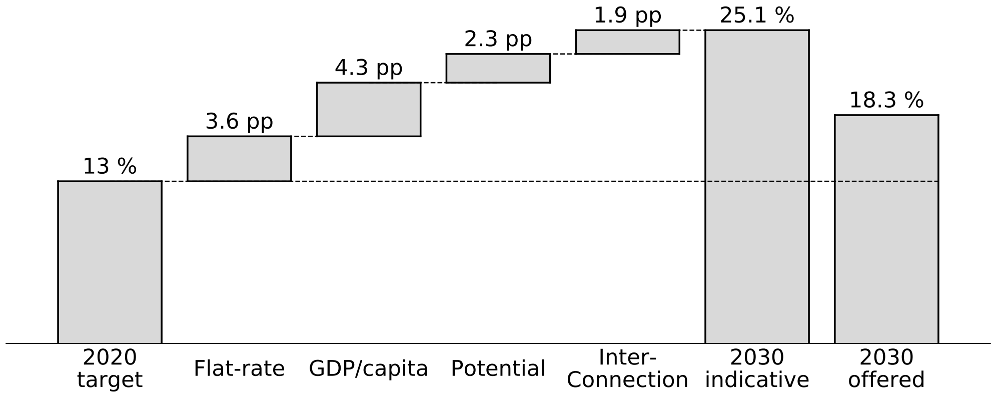

Figure 10: The Belgian renewable energy targets (pp stands for percentage points).

6.3 Moving towards a more cost-effective approach by 2030

As stated in Section 2.2, the 2030 national contributions will be set based on a bargaining procedure under the new governance mechanism. By the end of 2018, each Member State was obliged to submit a draft national integrated energy and climate plan that covers the five dimensions of the energy union for the period 2021-2030 [11]. Regarding renewable energy, Belgium proposed to aim for a share of 18.3 % in 2030 [29], an increase of 5.3 pp with respect to its 2020 target. Compared to the EU-wide increase of 12 pp, the contribution seems modest[19]. The Commission in fact included a key for calculating indicative national targets on which they assess whether a Member State's contribution is deemed sufficient [11]. This calculation key determines the additional EU-wide RES generation required to attain the 2030 target, and allocates this amount to the Member states based on a flat-rate component, a GDP-per-capita component, a RES-potential component and a component taking into account the level of interconnection with neighboring countries. We estimate that Belgium's indicative RES quota would be somewhere around 25 %, reflecting an increase of 12 pp relative to their 2020 targets[20]. Figure 10 presents the indicative 2030 target, decomposed into the four previously-mentioned elements, along with Belgium's offer. The reason for the discrepancy is that Belgium uses a bottom-up approach. The resulting 18.3 % is the combination of all stated contributions from the different regions and thus relates to Belgium's renewable potential which admittedly could be relatively limited. The philosophy behind EU's indicative targets is fundamentally different and states national contributions that are fair, whilst expecting the use of cooperation mechanisms to adjust for varying RES potentials across Member States (see Section 2.2). As such, it is almost certain that the Commission will recommend Belgium to increase its level of ambition.

Regardless of the final Belgian RES contribution by 2030, we issue two recommendations to achieve the target more cost-effectively. First of all, the Belgian governments should refrain from imposing regional targets as has been done in the burden sharing agreement. As stated in Section 2.1, the EU administratively partitioned the additional RES generation required to attain the 2020 target towards its Member States. Such an approach can only be made efficient with the effective usage of cooperation mechanisms. As these cooperation mechanisms currently remain underused, the EU's approach has been heavily criticized (see e.g. [3]). Belgium has duplicated this approach, and administratively partitioned its total quota towards the four regions. Hereby, the country did not even incorporate the possibility of intra-Belgian cooperation mechanisms, besides perhaps an offset to balance the regional deficits and excesses in 2020. Belgium's burden sharing agreement thus created regional targets based on a political bargaining procedure without the option to tap into regional cooperation. Such an approach

[19] Note that there are economically-sound rationales for not promoting renewable energy via a fixed quota (see e.g. [30] for an overview). In this paper, however, we'll take on the EU's 2020/2030 renewable energy goal as a premise.

[20] The final Belgian 2030 target will probably be a few percentage points lower because of additional efforts of more ambitious Member States.

is inefficient by definition. Furthermore, the approach is inflexible as well. Once the burden sharing agreement was defined, every single region became focused on achieving their regional target without considering the larger picture, and without questioning whether the gross final energy consumption set forth in the burden sharing agreement would be achieved. As stated, the projected GFEC will not be reached and the burden sharing agreement should thus be amended. The four ministers of energy and/or environment, however, took six years to create the original burden sharing agreement. One may thus expect that amending this agreement to include the higher-than-anticipated GFEC will take some time as well. Given the time of writing, such time-consuming processes limit Belgium's options and pretty much narrow them down to importing statistical transfers or risking the EU penalty fine.

In sum, Belgium should clearly keep the actual burden sharing (i.e. financial resources that each region contributes) and renewable share (i.e. RES generation that each region contributes) decoupled. Preferably, there will be no regional targets, but instead a harmonized support scheme across all regions. The political reality within Belgium, however, again points towards the use of regional targets. In that case, the governments should at least implement and employ a set of well-designed intra-Belgian cooperation possibilities. For instance, Flanders and Wallonia currently employ two different support schemes for onshore wind, which makes little sense. Besides the straight-forward solution (i.e. harmonizing both support schemes), both regions could draw upon the German-Danish cooperation scheme in which auctions for PV capacity were open to investors in both Germany and Denmark [8]. Wallonia could, for example, support wind turbines located in Flanders if this proved to be more efficient. The renewable generation from these wind turbines will then be statistically attributed towards the region that supports the project, which in this case would be Wallonia. Belgium could also set up a renewable energy financing platform (such as the European variant, see Section 2.2), which collects financial contributions from the different regions. A centralized institution could use these resources to support renewable energy projects wherever most efficient and not constrained by regional borders. The RES generation from installations financed by this mechanism will then again be statistically attributed towards the regions, proportional to their relative payments. The Brussels region already declared interest in such cooperation possibilities with the other regions [24]. Finally, to avoid the underestimation of Belgium's GFEC in 2030, regional targets (if deemed to be necessary) should be expressed in percentages (following the EU method).

Our second recommendation is to make use of cooperation mechanisms involving other Member States. As stated earlier, Belgium might be importing statistical transfers to compensate its 2020 deficit, but the use of cooperation mechanisms should extend beyond simply settling the books. An illustration of the potential cost savings is warranted here. For reasons explained in the following Subsection, we confine the example to the electricity sector, and more specifically, to onshore wind. It was already stated that Flemish onshore wind capacity is eligible to a minimum support of 44 EUR/MWh, on top of the electricity price. Denmark recently hosted onshore wind tenders in which the average successful bid secured a premium of only 2.88 EUR/MWh, again on top of the electricity price [31]. Assuming that both support premiums reflect the actual cost-recovery levels, and that these Danish wind farms actually materialize, promoting 1 MWh of onshore wind in Denmark instead of Flanders would thus saves approximately 41 euros[21]. Similarly, 1 TWh of Danish wind generation would cost 41 million euros less than 1 TWh of Flemish wind generation. Unteutsch et al. [4] already have concluded that significant gains up to 2030 are possible, by solely focusing on the electricity sector. It simply is not efficient to produce all renewable energy within the territorial borders of Belgium whilst other countries are better suited. Given that the external benefits of renewable energy remain the same regardless of the country of installation, economic theory stipulates

[21] In previous work, we showed that efficiency gains are based on the premiums on top of the electricity price, not on the levelized cost of electricity [5]. Furthermore, we state that this is a coarse approximation, with many underlying subtleties and potential distortions. The interested reader is referred to [5, 32]. For completion, both the Flemish and the Danish support presented in the body are guaranteed for 20 years.

that RES capacity should be placed wherever most efficient[22]. Consequently, making use of cooperation mechanisms reduces the cost to achieve the RES quotas, also for Belgium. The EU clearly recognized this and extended the possibilities to cooperate with other Member Sates.

6.4 A caveat of renewable cooperation

Different sources of renewable energy yield varying external benefits and by extension, various reasons to promote them. The typical (and valid) rationale for promoting wind turbines and PV panels is the ongoing decrease in their technology costs via learning effects and spillovers. Given the current lack of a proper global climate agreement, a sufficiently large climate coalition could promote currently more expensive renewable technologies with the aim of reducing their costs, thereby increasing the likelihood that third countries (not in the climate coalition) would adopt these clean technologies as well. This argument of course fails for mature/debatable technologies such as the burning of wood products[23]. Unfortunately, the EU does not make a distinction between varying renewable energy sources. For example, 1 GWh of electricity production from wind turbines contributes equally to the national RES statistics as 1 GWh of heat production from burning of biomass (often wood). Individual Member States are not incentivized to make a distinction between the various renewable technologies, which clearly is a missed opportunity and inefficient. Consequently, wood products accounted for 45 % of the EU's gross inland energy consumption of renewables in 2016 [33]. Estonia and Lithuania—the countries that will be exporting statistical transfers towards Luxembourg—are front-runners and obtain 93 % and 82 % from their renewable energy from wood-products, respectively [33].

The first-best solution would be for the EU to recognize the varying external benefits from different renewable technologies, and to translate this into the renewable energy policy. This, however, did not happen, also not towards 2030. The choice of which technologies to promote is left to the individual Member States, as long as these achieve their national target. A country can thus opt for low-cost technologies with lower external benefits (e.g. wood-burning), or for higher-cost technologies with higher external benefits (e.g. wind turbines). Probably, the former is optimal from the country-level perspective whilst the latter is optimal from the global perspective (i.e. EU legislation introduces a free-riding problem that distorts technological development).

Besides the decision on which technologies to promote domestically, this issue also concerns cooperation mechanisms. Importing statistical transfers towards 2030 (not 2020, see below) implies supporting the renewable energy portfolio of the cooperating Member State. Other cooperation mechanisms (e.g. joint projects and joint support schemes) allow for more control in the technology selection process. Either way, this is an important nuance that should be taken into account. Given that renewable technology choice is left at the individual Member State's discretion, it is warranted that any Member State planning to be involved in cooperation mechanisms considers the technologies that will actually be promoted. Subsidizing wood burning in the Baltic states, for instance, will probably introduce some public acceptance concerns.

These issues are largely invalid up to 2020 as statistical transfers will solely be used to level out national excesses and deficits. As such, this form of cooperation will not induce additional renewable capacity, and thus, it does not matter from which Member State statistical transfers are being imported from. Belgium can simply select the most inexpensive option—if possible. If Belgium plans to cooperate beyond 2020, this will in fact influence renewable deployment. Belgian policy makers should thus reflect on which type of technologies they want to promote,

[22] This statement deserves a justification. We are fully aware that renewable energy is accompanied by external benefits beyond simply fulfilling the national RES quota obligation. These primarily include carbon mitigation in the heat/cooling and transport sectors, and learning effects. Additional benefits such as security of supply and green job creation are disputable, but suppose that these do exist. The value of all these external benefits will be captured by depressing the price of statistical transfers (or by an analogous effect for the other cooperation mechanisms). The point here is that these external benefits remain roughly the same, regardless of the country of installation. Even if this were not the case, a small extension of this argumentation would again point towards efficiency gains. In sum, it is difficult to deny the arbitrage possibilities and moreover, country-level external benefits of renewable capacity are not a valid argument for not engaging in renewable cooperation.

[23] One could argue that the burning of wood for heat purposes has a higher effect on carbon emission mitigation than promoting biomass fueled and other renewable electricity (due to the ETS system). The point here, however, is that external benefits differ per technology.

and by extension, which countries to cooperate with. Note that this issue only arises due to an imperfect regulatory framework on the EU-level. As we have shown in Subsection 6.3, there is ample opportunity for cooperation in the renewable electricity sector alone.

7 Conclusion

This paper's main contribution was to show that Belgium will probably not attain its 13 % share for renewables in gross final energy consumption in 2020 by deploying domestic means. We made a distinction between two effects. First, the intra-Belgian burden sharing agreement underestimates Belgium's gross final energy consumption in 2020, which yields a yearly RES generation deficit of about 5.0 TWh. Second, some of the regions will not attain their renewable energy targets as defined by the burden sharing agreement. We expect a Flemish deficit of 1.7 TWh, a federal deficit of 1.7 TWh, a Brussels' deficit of 0.3 TWh and a Walloon excess of 2.0 TWh, totaling to an additional yearly deficit of 1.7 TWh. The sum of both effects (6.7 TWh) implies that Belgium will attain a RES share around 11.4 %, 1.6 percentage points below the national binding target. We again stress that these estimates are subject to a significant level of uncertainty, but nevertheless, achieving the national RES target remains unlikely.

Furthermore, we focused on importing renewable energy (via statistical transfers) as an option to compensate for the Belgian RES gap. We highlighted the trade-off between making proper arrangements as soon as possible, and waiting until the EU 2020 RES statistics are refined. Finally, two recommendations were brought forward in order to attain the 2030 RES target more cost effectively. First, Belgium should refrain from imposing regional targets as has been done in the burden agreement, or as second-best option, should implement and employ a set of intra-Belgian cooperation possibilities. Second, Belgium could make use of the renewed EU-framework and cooperate with other Member States. These European cooperation mechanisms need to take better into account the ultimate goal of renewable energy and this is technological development. An appropriate implementation of both suggestions will lead to significant target compliance cost reductions.

Acknowledgments

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