Progress in Development of Renewable Electricity in Northern Europe in the Context of the EU 2020 Renewables Target

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Abstract— **The 20% targets set for Renewables at EU level were translated into national level targets in the 2009 Directive on Renewable Energy Sources (2009/28/EC). In turn, Member States were obliged to provide a detailed plan of their proposed pathway to the targets in the form of "National Renewable Energy Action Plans", which were due to be submitted by end June 2010 (all plans finally received by early 2011). The plans contain detailed projections for renewable electricity, heating and cooling, and transport up to 2020. This article compares actual progress in the development of renewable electricity against the intentions set out in the plans for the years 2010 and 2011. The focus is upon EU Member States in the Northern European region - Sweden, Finland, Latvia, Lithuania and Estonia. Furthermore, consideration is given to some of the specific national policies and conditions determining the level of progress against the plans to date.**

Index Terms-- Hydroelectric power generation, Solar power generation, Wind power generation, Power generation planning

I. Introduction (Purpose of this paper)

The purpose of this paper is to evaluate the progress of Nordic and Baltic EU Member States in developing RES Electricity (RES-E) towards their 2020 renewables targets set under the 2009 RES Directive [1]. The directive, containing a 20% target for RES in the EU by 2020, was brought forward together with a 20% target for carbon reduction by 2020, as part of the EU "Climate and Energy Package" [2]. In this paper, we compare the plans for RES-E laid out in the Member State National Renewable Energy Action Plans (NREAPs) against actual progress in the Member States according to Eurostat data for 2010 and 2011. A key motivation for this work is that the Member States themselves are required only to report progress on a biannual basis, the next report being due by the end of 2013. Furthermore, these mandatory progress reports are not very detailed (see section II, part B). In addition, we have found an absence of academic literature concerning Member State progress against their targets, despite a significant body of literature of analysing the effect of the Renewables Directive as a part of the Climate and Energy Package [3], the debate on RES trading within the directive [4], and the effect of the resulting high share of renewables on electricity markets [5]. The choice of countries in this study has been defined geographically to the Nordic and Baltic region, in order to give a comparison between Member States with certain similarities in RES resources (principally, biomass, hydro and wind), but with relatively limited development of wind power thus far. These states either already share or plan to further power market integration; Nord pool spot operates in all countries except Latvia; Finland and Estonia now have two undersea interconnections; and the NordBalt cable from Sweden to Lithuania has recently received final approval [6]. Despite its Nordic location, Denmark has not been included given its rather different situation with very significant experience in wind power development, with wind power already accounting for 29% of total Danish domestic power production in 2011, compared to not more than 11% in the countries studied [7].

II. Introduction to RES target and RES directive

A. RES target & directive

The 2009 Renewables Directive (2009/28/EC) sets a new precedent for EU policy on renewable energy sources (RES), with the 20% target for RES in total energy consumption by 2020 representing more than doubling the 2005 level of around 8.5% [1]. The Directive presents Member States with a huge implementation challenge that cannot simply be met by an extension of existing promotional policies for renewables.

The 20% target for renewable energy is calculated as a percentage of total final energy consumption, including all energy use – electricity, heating & cooling and transport. There are no sectoral targets for electricity or heating/cooling, but a separate 10% target has been set for use of renewable energy in transport.

Within the Member States covered in this article, the individual targets have been set out in Table I. As can be seen from the table, the challenge varies significantly from one Member State to another. The fourth column (marg2020) expresses the marginal increase in the RES share required by each Member State. In the above table, France, Germany, Italy and the UK are included for comparative purposes only. Member States have been assigned to achieve different marginal increases in their national RES percentages, on the following principles:

- All Member States must achieve a marginal flat increase of 5,75%
- A further increase, based on national GDP per capita, is applied in addition to the flat 5.75%, such that the total of GDP-modulated targets in principle averages 5,75%
- Some account is taken of significant advances in RES-development already made by Member States such as Sweden and Finland (note comparison with Germany, France, Italy and UK, which have equal or lower GDP per capita but higher marginal targets)

TABLE I. NATIONAL EFFORT SHARING UNDER 2009 RENEWABLES DIRECTIVE [1]

Member State	Share of energy from RES in gross final energy consumption (FEC) in 2005 (s2005)	Target for share of energy from RES in gross FEC in 2020 (s2020)	Marginal increase in share of RES required to 2020 (marg2020)
Estonia	18,0%	25,0%	7,0%
Latvia	32,6%	40,0%	7,4%
Lithuania	15,0%	23,0%	8,0%
Finland	28,5%	38,0%	9,5%
Sweden	39,8%	49,0%	9,2%
For comparison only:			
France	10,3%	23,0%	12,7%
Germany	5,8%	18,0%	12,2%
Italy	5,2%	17,0%	11,8%
UK	1,3%	15,0%	13,7%
EU-27	8,5%	20,0%	11,5%

B. *National RES Action Plans, interim targets and progress report*

The Directive requires that each Member State should submit a National Renewable Energy Action Plan (NREAP) by 30 June 2010, setting out how it plans to achieve its 2020 target. The European Commission issued a strict template for this plan which Member States must adhere to, setting out in detail how they plan to reach their overall RES target through development in the three RES energy sectors – electricity, heating and cooling and transport [8]. The plans contain a total of 16 tables; in the case of RES Electricity the tables require the Member States to provide year by year projections for both generation and capacity of different types of RES electricity. It is also notable that because the target is based on a percentage of final energy consumption, efforts to improve energy efficiency are also relevant and indeed Member States are required to set out in the plans energy consumption according to business as usual and with enhanced energy efficiency scenarios (the latter scenario is used for the target compliance calculations in the plans).

The Member States are also required to fulfil interim targets under the directive. These interim targets are expressed as a percentage of the total growth in renewables needed between the 2005 baseline percentage and the 2020 target percentage. The interim targets are based on an average of the percentage of renewable energy in final energy consumption taken over a two year period. The interim targets, found in part B of Annex I of the Renewables Directive, are as follows:

- 20% average over the years 2011 and 2012
- 30% average over the years 2013 and 2014
- 45% average over the years 2015 and 2016
- 65% average over the years 2017 and 2018

To clarify these interim targets, the example of Finland is explained as follows:

2005 RES percentage in final energy consumption (FEC) = 28,5%
2020 RES target percentage of FEC: 38%

2011-2012 interim target percentage:
28,5% + 0,20(38%-28,5%)
= 30,4%

The performance against the interim target is to be reported as part of biannual progress reports, the first of which is due by the end of 2011, then end of 2013, 2015, etc. In this report, the Member State is only required to report on the share of RES in the different sectors (electricity, heating and cooling, transport) in the preceding two calendar years. Notably, Member States are not required to report on their progress in individual technologies so these progress reports are rather limited in scope. This implies that the report due at the end of 2013 is the first in which Member States report on compliance with an interim target – in this case, that for the period 2011 to 2012. A key motivation for this paper is to report on Member State performance well in advance of the progress reports, and to consider progress in individual RES-Electricity technologies so as to provide a greater insight into the detail of RES development and prospects for continued growth.

Member States are subject to one further requirement; if a progress report indicates that a Member State is not in line with the interim target trajectory, it is then required to submit a revised national plan within the following six months, indicating how it intends to re-align with the trajectory.

C. *Using RES-Electricity production data as proxy for compliance with the overall RES target*

As discussed above, reaching the overall Renewables target relies on Member States making sufficient progress in the development of Renewables in the three energy sectors – electricity, heating & cooling, and transport. This paper only considers the progress of Member States in reaching their objectives in their national plans for the development of RES-Electricity, and in effect, takes their progress in this sector as something of proxy for their progress in reaching the overall target. There are several arguments in favour of using progress in RES-Electricity as a proxy in this regard:

- Of the three energy sectors – electricity, heating & cooling and transport, RES-Electricity makes the second largest contribution to reaching the target for the five countries concerned (RES Heating and Cooling makes the largest contribution). Estonia is an exception, where RES-Electricity makes the highest contribution (see Table III)
- In case of Nordic and Baltic countries, performance in RES-Electricity development is tied to RES-Heating as Biomass CHP plays a significant role in foreseen RES development

Furthermore, Member States are required to report on the sectoral share of renewable electricity as part of the progress reports mentioned above. Whilst Member State performance against the interim target will only be monitored on the basis of their overall share of renewable electricity, underperformance on renewable electricity will make it difficult to reach the overall target. Even if the Member State reaches its overall target while underperforming on renewable electricity, it will raise questions about the Member State's general performance in renewables development and the sustainability of their approach for reaching the overall target.

III. Overview of Countries and Comparison of National RES Plans

A. *Overview of countries*

As commented in the introduction, the countries studied in this paper have certain similarities in availability of RES resources and existing or prospective market integration. However, in terms of current power generation (see Table II), the states may be divided between Sweden and Finland, who have a significant share of nuclear in their generation mix – and the Baltic countries, who are more reliant on fossil thermal power but with a significant role for hydropower in Latvia and Lithuania. However, a major historical change is notable; Lithuania was over 75% reliant on nuclear until 2009[7], and was hard hit by the closure of the Ignalina nuclear power plant (unit 1 stopped end 2004, unit 2 stopped end 2009; this plant had to shut down as condition of Lithuania's accession to the EU). This plant was also important in exporting power to Latvia. As can be seen in Table II, Lithuania now has net imports amounting to over 50% more power than its total domestic generation. In this respect its 11% share of wind in domestic production is rather less impressive than at first glance. The importance of net imports is notable in terms of the 2020 RES target - as the target is based on a percentage of domestic final energy consumption, large net imports of non-RES electricity will need to be compensated by a high share of domestic RES-E generation (according to the national RES plans, none of the Baltic States intend to use the limited possibilities for RES-E import from other Member States allowed under the Renewables directive [9],[10],[11]).

Given that hydropower shows only limited potential for increase, the most relevant experience for future RES-E development is that in biomass and wind power. Sweden and Finland show particular experience in biomass (with Estonia having had rapid recent development), whilst Sweden has the longest experience of the states in wind power development (putting aside the somewhat misleading Lithuanian example). In the case of Estonia, one should note that the high share of oil shale, which accounts for almost all fossil thermal generation; this fuel is domestically produced but gives Estonia the highest specific CO_2 emission factor from electricity in the EU, of 990gCO_2/kWh [12]. Finally, it is notable that in all of the states studied, a high percentage of thermal generation is based on combined heat and power plants – this share is just over 75% in Finland in 2011 [7].

TABLE II. Power generation mix by country (% of total domestic generation) and electricity import/export balance [7]

Generation type	Estonia	Latvia	Lithuania	Finland	Sweden
Fossil thermal	90 %	46 %	58 %	34%	3%
Biomass thermal	7%	4%	2%	16%	8%
Nuclear				32%	40%
Hydro		49 %	23 %	17%	45%
Wind	3 %	1 %	11 %	1%	4%
Other			6 %		
*Net import/ export balance**	*31%*	*-21%*	*-152%*	*-20%*	*5%*

*expressed as % of total domestic generation, thus minus % = net import)

B. *Presentation of National Renewable Energy Action Plans*

The first table on the following page, Table III, presents a sectoral analysis of the national plans, indicating for each country what part of the target they plan to reach through RES-electricity, heating & cooling or transport. For all Member States except Estonia, RES Heating and Cooling is foreseen to make the largest contribution to RES growth towards the 2020 target, with a typical share of over 50% of the additional RES to be developed between 2005 and 2020. As indicated, the share of electricity is typically around 30%, but is almost 45% for Estonia. The second set of tables show the data from the National Plans for RES-Electricity, with actual data for 2005 and then projected data for 2010, 2011,

2015 and 2020 (data from tables 10a/10b of National Renewables Energy Action plan, [9]-[11],[13],[14]).

C. *Discussion on differences in approach between plans for RES-Electricity development*

Tables IV-VII, looking at intentions for RES-Electricity development in each of the national plans, show significant variations in approach between the different countries. In all states, little or no growth is foreseen in hydropower (Estonia does foresee a 50% increase from 2005 to 2020, but the absolute numbers are very small). Likewise, solar photovoltaic plays an insignificant role. Wind energy plays a major role in all Member States, starting from a rather low base in all countries except for Sweden. This lack of experience in wind development can be seen as a risk in reaching the high objectives set for wind. This contrasts with biomass electricity, where a large growth is foreseen, but as previously mentioned, both Finland and Sweden have a high experience level. However, the Baltic States have rather mixed experience – Estonia having some basis in solid biomass and Latvia in biogas, but Lithuania having had almost no experience in any type of biomass electricity generation. Whether these low levels of experience imply difficulties in reaching objectives for the development of wind and biomass electricity is considered in the following section.

TABLE III. SECTORAL ANALYSIS OF NATIONAL PLANS [9]-[11],[13],[14]

ALL DATA IS KTOE (EXCEPT PERCENTAGES)	Estonia			Latvia			Lithuania			Finland			Sweden		
	2005	*2020*	*% of total RES growth 2005-2020**	*2005*	*2020*	*% of total RES growth 2005-2020**	*2005*	*2020*	*% of total RES growth 2005-2020**	*2005*	*2020*	*% of total RES growth 2005-2020**	*2005*	*2020*	*% of total RES growth 2005-2020**
RES Heating and Cooling	505	607	29,3 %	1114	1395	51,9 %	688	1051	48,8 %	5530	7270	55,4 %	7084	10543	57,5 %
RES Electricity	9	165	44,8 %	261	446	34,2 %	38	254	29,0 %	2030	2870	26,8 %	6605	8356	29,1 %
RES Transport	0	92	26,4 %	7	83	14,0 %	3,7	169	22,2 %	0	560	17,8 %	288	1008	12,0 %
Gross RES Final Energy Consumption	515	863		1377	1918		730	1474		7560	10700		13689	19709	
Gross total Final Energy Consumption	3098	3451		4241	4796		4907	6084		26260	28170		34519	39231	

Explanation: 2005 figures are actual data for 2005, the baseline year for the National plans. 2020 figures are projections from national plans, for the additional energy efficiency scenario, the key scenario by which Member States intend to reach their 2020 RES targets)

* "% of total RES growth 2005-2020" represents the share of growth in the particular sector (RES electricity, heating and cooling, transport) as a percentage of total RES Energy growth foreseen in the Member State from 2005 to 2020

TABLE IV. ESTONIA: RES-ELECTRICITY DEVELOPMENT IN NATIONAL PLAN (GWH) [9]

Generation type	2005	2010	2011	2015	2020
Hydro	20	26	30	30	30
Solar PV	0	0	0	0	0
Wind	54	337	355	981	1537
Solid biomass	33	241	307	346	346
Biogas	0	0	0	0	0
Bioliquids	0	0	0	0	0
Total	**107**	**604**	**692**	**1357**	**1913**

TABLE V. LATVIA: RES ELECTRICITY DEVELOPMENT IN NATIONAL PLAN (GWH) [11]

Generation type	2005	2010	2011	2015	2020
Hydro	2942	2906	2985	2965	3051
Solar PV	0	0	0	1	4
Wind	47	58	73	228	910
Solid biomass	5	8	24	271	642
Biogas	36	64	130	393	584
Bioliquids	0	0	0	0	0
Total	**3030**	**3036**	**3212**	**3858**	**5191**

TABLE VI. LITHUANIA: ELECTRICITY DEVELOPMENT IN NATIONAL PLAN (GWH) [10]

Generation type	2005	2010	2011	2015	2020
Hydro	451	432	432	446	470
Solar PV	0	0	2	13	15
Wind	2	297	473	924	1250
Solid biomass	3	98	115	533	810
Biogas	4	50	87	228	413
Bioliquids	0	0	0	0	0
Total	**460**	**877**	**1109**	**2144**	**2958**

TABLE VII. FINLAND: RES ELECTRICITY DEVELOPMENT IN NATIONAL PLAN (GWH) [14]

Generation type	2005	2010	2011	2015	2020
Hydro	13910	14220	14220	14220	14420
Solar PV	0	0	0	0	0
Wind	150	360	590	1520	6000
Solid biomass	9640	3930	4520	5300	7860
Biogas	20	40	40	50	270
Bioliquids	0	4120	4350	4530	4780
Total	**23720**	**22670**	**23720**	**25620**	**33330**

TABLE VIII. SWEDEN: RES ELECTRICITY DEVELOPMENT IN NATIONAL PLAN (GWH) [13]

Generation type	2005	2010	2011	2015	2020
Hydro	68420	68280	68252	68140	68000
Solar PV	0	1	2	3	4
Wind	939	4793	5563	8646	12500
Solid biomass	7452	10513	11126	13574	16635
Biogas	53	53	53	53	53
Bioliquids	65	65	65	65	65
Total	**76929**	**83705**	**85061**	**90481**	**97257**

IV. DIFFERENCES BETWEEN EUROSTAT ACTUAL DATA AND NREAP PROJECTIONS

A. Illustration of differences for 2010 and 2011

Tables IX and X below show the differences between the national plan projections for RES-Electricity and the actual Eurostat data for 2010 and 2011. The differences are indicated in two ways, absolute and relative, explained as follows:

- **Absolute:** This shows the difference in GWh between the NREAP and the Eurostat data for the concerned year. Therefore a positive number indicates that the Member State is in surplus compared to their NREAP objective.
- **Relative:** This percentage indicates in relative terms how much the absolute difference is above or below the NREAP target. Therefore, a relative difference of -10% indicates that the Member State is 10% below its target for the year (e.g. NREAP target 100GWh, Eurostat 90 GWh, difference 10GWh, -10% relative performance)

It is notable that the Eurostat data for hydro and wind in 2010 and 2011 has been normalised according to the formulae set out in the Renewable Directive [1]. This normalisation is necessary due to annual variations in rainfall and wind conditions that would otherwise make raw annual production data unrepresentative. The formulae imply the hydro plant output is averaged according to average capacity factors for the past 15 years of the Member State in question; for wind, the production data is adjusted according to the average capacity factor of the previous four years, or less if capacity and production data is available for fewer years i.e. the Member State has shorter experience in the use of wind power.

Normalising the data can imply that there are major differences compared to the actual data provided by Eurostat. For example, the actual amount of hydro power generation in Estonia is 34 % higher than the normalized production in 2011 and in the same year the actual hydro power is 12 % less than the normalized generation in Finland. Taking the example of wind power, in 2011 the actual wind power generation on Finland is 16 % higher than the normalized production and 14 % higher in Lithuania. Solar Photovoltaic is not included in Tables IX and X, since the intentions for its development in the national plans are minimal (see Tables IV-VII).

TABLE IX. DIFFERENCE BETWEEN EUROSTAT (NORMALIZED) AND NREAPS FOR 2010 [7],[9]-[11],[13]-[15]

	Estonia		Latvia		Lithuania		Finland		Sweden	
	Absolute [GWh]	***Relative [%]***	***Absolute [GWh]***	***Relative [%]***	***Absolute [GWh]***	***Relative [%]***	***Absolute [GWh]***	***Relative [%]***	***Absolute [GWh]***	***Relative [%]***
Hydro	-3,7	-14 %	125,2	4 %	505,0	117 %	-288,5	-2 %	188,0	0 %
Geothermal	0,0	0 %	0,0	0 %	0,0	0 %	5,0	0 %	7,6	543 %
Wind	-90,1	-27 %	-2,7	-5 %	-50,8	-17 %	-36,6	-10 %	-992,7	-21 %
Solid biomass, bioliquids	489,0	203 %	1,0	13 %	18,0	18 %	2818,0	35 %	1578,0	15 %
Biogas	10,0	0 %	-7,0	-11 %	-19,0	-38 %	49,0	123 %	-17,0	-32 %
Total	**405,2**	**67 %**	**116,6**	**4 %**	**453,2**	**52 %**	**2546,9**	**11 %**	**763,8**	**1 %**

TABLE X. DIFFERENCE BETWEEN EUROSTAT (NORMALIZED) AND NREAPS FOR 2011 [7],[9]-[11],[13]-[15]

	Estonia		Latvia		Lithuania		Finland		Sweden	
	Absolute [GWh]	***Relative [%]***	***Absolute [GWh]***	***Relative [%]***	***Absolute [GWh]***	***Relative [%]***	***Absolute [GWh]***	***Relative [%]***	***Absolute [GWh]***	***Relative [%]***
Hydro	-10,1	-34 %	110,1	4 %	498,7	115 %	-350,4	-2 %	103,4	0 %
Geothermal	0,0	0 %	0,0	0 %	0,0	0 %	5,0	0 %	9,3	547 %
Wind	-10,3	-3 %	-8,4	-11 %	-64,4	-14 %	-188,1	-32 %	27,6	0 %
Biomass	474,0	154 %	-34,0	-22 %	-44,0	-22 %	2309,0	26 %	292,0	3 %
Solid biomass, bioliquids	459,0	150 %	-10,0	-42 %	6,0	5 %	2216,0	25 %	312,0	3 %
Biogas	15,0	0 %	-24,0	-18 %	-50,0	-57 %	93,0	233 %	-20,0	-38 %
Total	**453,6**	**66 %**	**67,7**	**2 %**	**390,3**	**35 %**	**1775,5**	**7 %**	**432,3**	**1 %**

B. Discussion and investigation of key differences

It is notable that all Member States reached their objective for the RES-Electricity sector overall in 2011, with Sweden over-performing by the smallest relative margin (1%). However, many Member States show a lack of consistency in their performance across different RES-Electricity technologies, which is explored in the following sub-sections:

1) Sweden

Of the countries studied, Sweden is most consistently in line with its target objectives, despite only being slightly over its overall RES-Electricity objective in 2011. In 2010, Sweden had significant underperformance against its wind objective, but quickly recovered in 2011 to be on target. Only on biogas does Sweden show an underperformance in 2011 – of -38%, although this is a percentage of a relatively small number, with the absolute underperformance being only -20GWh. This good performance is likely due to good experience of RES development in Sweden, with a well-functioning, technology neutral, renewables certificate based support system, in existence in 2003.

2) Finland

Finland shows a deepening trend of underperformance in wind power, combined with an over-performance for biomass generation. The overall result is a significant 7% over-performance in total for RES-Electricity in 2011. The success in developing biomass-based electricity can be attributed to the strong experience in this sector, combined with new subsidies put in place for biogas in 2010 and coming into force in 2011 (perhaps accounting for the 233% over performance of biogas, with an almost doubling in capacity from 2010 to 2011). For wind power, the situation is less positive, with the 10% underperformance in 2010 worsening to a 32% underperformance in 2011. This is despite a revised feed-in tariff for wind power coming into force in 2011, guaranteeing 83,5 €/MWh for 12 years, with a higher tariff for quick starters of 105 €/MWh until 2015. A lot of wind power developments in Finland have been held up by planning problems and it remains to be seen whether the improved subsidies will have any success in overcoming these problems.

3) Estonia

Estonia shows good performance against its objectives for renewable electricity development, with an overall 66% over-performance against its RES Electricity objective in 2011. This is particularly significant given Estonia's strong reliance on the RES-Electricity sector for reaching its overall target, as shown in Table II. For wind power, there is only a small underperformance of 3% in 2011. The installed capacity of wind power in Estonia has steadily increased from 31 MW in the year 2005 to 108 MW in 2010 and, by the end of 2012, there was already 269 MW wind power installed, indicating that Estonia is likely to exceed its objective for that year too. Connection proposals have been given for total over 3 000 MW wind power plants, potentially indicating a strong forward development. The future development of wind power depends primarily on the subsidy system, which is currently in the amendment process. Currently, for wind power there is an annual electricity generation limit of 600 GWh, after which subsidy is not paid, which will become a limiting factor in the next years, given the objective to reach 981 GWh of wind power generation in 2015. The Ministry of Economic Affairs and Communications has proposed a variable feed-in premium-based support scheme, by which the subsidy would be calculated by subtracting the monthly weighted average electricity market price from a set feed-in tariff, with the 600GWh limit remaining in place. Whether this proposal is put in place and, given the 600GWh limit, it remains to be seen if the required additional increases in the next years can be delivered.

The slight underperformance for hydro power in Estonia is not particularly significant, given the very small size of this sector and limited plan for expansion, with a production capacity of only about 5 MW. For biomass, the significant over-performance (150% for solid biomass) can be accounted to the building of three new CHP plants with a total electrical capacity of 65 MW. But the significant growth has also come from co-firing of wood chips with oil shale (local fossil fuel) in large power plants. This trend may diminish, since as of 1st July 2010, support is only given to biomass combustion in cogeneration plants. However, the new RES support proposal suggests that support is again given to biomass combustion in condensing plants.

4) Latvia

Latvia shows an interesting situation, in which a significant absolute over-performance in its hydropower sector (110GWh) – only 4% in relative terms compensates for its less satisfactory performance in wind and biomass, respectively 11% and 22% below its objective in 2011. The background to this is a continuing discussion on the need to change the current Renewables support scheme in Latvia over the past few years. The situation on Renewables support to date has been extremely unstable, with four legislative changes on price setting made in the period between 2007 and 2012. In the biomass sector, a number of biomass CHP plants had qualified for support but have not yet been built; the construction of these plants had been foreseen when the National Plan was drafted. The Latvian Energy Strategy 2030 [16] foresees introduction of market principles in the support design, but does not specify how this is to be achieved. The Ministry of Economy has recently announced that the current framework has been neither effective nor efficient and that some action has to be taken. This appears to have been partly motivated by concerns that the electricity tariff would need to increase to provide the RES support. There is understood to

be a lack of knowledge on price setting in the ministry and so external experts have been relied on so far, but this has not necessarily delivered an economically efficient policy. Thus it is clear that Latvia needs significant changes in its RES support schemes to a stable, sufficient system that delivers the technology objectives in the National Plan. However, competing concerns over electricity tariff increases in an economically constrained environment further complicate the situation.

5) Lithuania

Lithuania shows a somewhat similar situation to Latvia, in which over-reaching its objective in hydropower compensates for underperformance for wind and biomass. In Lithuania's case, the hydro performance is quite remarkable, 498 GWh over its objective, representing 115% in relative terms. However, this is from production already evident in the 2010 data and does not indicate the development of significant new plant from 2010 to 2011. The over performance appears to be due to the renovation of the large Kaunas hydropower plant completed in 2009. Therefore, as for Latvia, the significant underperformance in wind and biomass is concerning considering the strong objective to develop these sectors (see Table VI) over the next years.

V. CONCLUSIONS

Overall, this initial analysis of the progress of Nordic and Baltic States in reaching their objectives for RES-Electricity development shows rather positive progress, given that all Member States reached their overall RES-Electricity sectoral objectives in 2011. However, all Member States under-perform in some forms of RES-Electricity generation, raising questions about their overall strategy and the sustainability of them continuing to reach their RES-Electricity sectoral objective in future years. Indeed, where Member States have reached their overall RES-Electricity objective by substituting under-performance in one form of RES-Electricity generation with over-performance in another, it can be argued that the state has exploited the "lowest hanging fruit" first and faces a greater challenge in developing the other technologies in future years. To reach their overall 2020 target, Member States will need to utilize all the forms of RES-Electricity identified in their National Plans. Whilst there is room for some substitution between different forms, development of e.g. biomass electricity will be significantly restrained at a certain point by resource constraints and rising costs. A number of specific observations can be made about the progress of the Nordic and Baltic States in their development of RES Electricity thus far:

- The underperformance in wind power in all Member States, except for Sweden and Estonia, is particularly concerning given the central role of wind power in all of the National Plans. Thus far, the slow development of wind power has been due to planning problems and insufficient/unstable support schemes. Although consideration is being given to these issues in some of the Member States, there seems little evidence of a radical step change in wind development in the underperforming states.
- The Member States typically over-perform in sectors in which they have previous experience, e.g. biomass in Finland and hydro in Lithuania. In order to reach their overall 2020 objectives, Member States must also achieve development of RES-Electricity technologies in which they have little experience (e.g. as per the previous point, wind power, in which only Sweden has significant experience, but also biogas for many of the states represents a new technology). Lack of capacity building in these sectors at this stage will lead to problems with the more ambitious annual growth projects for these technologies in the later period e.g. 2015-2020.
- A significant part of existing biomass electricity in the Baltic States appears to be from co-firing. The use of significant co-firing, especially when it involves rather low proportions of biomass combusted with fossil fuels, can be argued to be somewhat against the spirit of the Renewables Directive, in that it can imply the continued operation of high carbon emitting plant (co-firing subsidies can indeed extend the economic sustainability of such plant). Furthermore, co-firing in electricity only plants can be seen as an inefficient use of the limited biomass resource – possibly bringing forward resource constraint issues – and denying the use of the biomass in cogeneration plant which could produce more RES final energy for the same resource.
- Despite over-performance in the overall RES-Electricity sector, the Baltic States show the most unbalanced approach, with over-performance in some RES-E technologies apparently caused by a single or small number of large plant investments or renovations. As these initial possibilities are exhausted, and as overall volumes grow, the potential to ensure compliance with the overall RES-Electricity sectoral objective through such means will diminish. The performance of these states against their objectives should be particularly closely followed in future years.

This short analysis gives rise to a number of ideas for further research, as follows:

- Modelling of the states against their interim target trajectory, based on their progress so far, and consideration of whether the Member State can achieve the steepening annual objectives for the next years.
- Analysis of whether the capacity factors for RES plant assumed in the national plans have been achieved in reality.

- Consideration of whether the continuation of over-performance in biomass could prompt supply problems.
- More in-depth analysis of national RES promotional policies in the Member States covered and their relative success; for example taking forward the extensive findings from the EC-backed RE-Shaping project on developing and efficient and effective Renewable Energy Market [17].

The authors intend to take up these issues in a future publication.

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