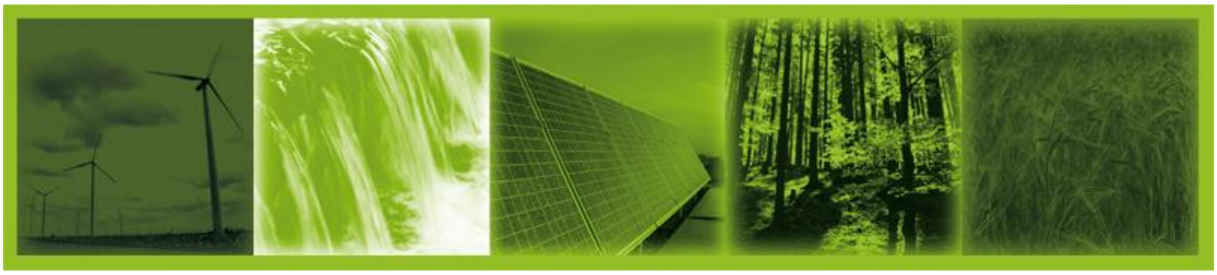
REPAP 2020

Renewable Energy Policy Action Paving the Way towards 2020



# *Renewable Energy Industry Roadmap for Lithuania*

-Draft -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Intelligent Energy Europe

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# 1 The case of Lithuania

## 1.1 Current situation of renewable energies

### 1.1.1 Background

Lithuania is a country highly dependent on energy imports. It has only very limited natural deposits of oil and gas, and imports most of its oil and gas from Russia. It is however, the only Baltic state to own a refinery, which makes it an exporter of petroleum products.[1]

Renewable energy sources (RES) are available to a larger extent. Good potential for wind energy exists along the shores and geothermal sources are located in the western part of the country. But the largest and still widely unused potential lies in biomass. The hydroelectric potential is rather low and already largely utilized. [2] [3]

The Lithuanian electricity sector was dominated by the nuclear power plant (NPP) of Ignalina. It consisted of two reactors, the first of which had been shut down in 2005 and the second one on 31st December of 2009. The closure of the Ignalina NPP was a precondition to the accession to the EU based on safety concerns. The NPP was responsible for 75-88% of Lithuania's electricity output. Its decommissioning will turn the country from an electricity exporter into an importer and make it even more dependent on Russian gas. Natural gas from Russia is expected to account for 75% of the domestic electricity generation while it is already used for 75% of the production of district heating. Furthermore, the foreseeable electricity imports will also mostly be of Russian origin, since there are no interconnections to the Western European electricity grid. To reduce this dependency, the construction of a new NPP is planned in a joint project with Estonia, Lithuania and Poland. It is planned to be located on the same site in Ignalina and be operational by 2016.[4] [5]

The target defined in Directive 2001/77/EC is RES-share of 7% in gross electricity consumption. Pursuant to the EU Directive 2003/30/EC, the share of biofuels in transport shall reach 5.75% until 2010.

The Directive 2009/28/EC announces a RES target for final energy consumption of 23% by 2020, with at least 10% renewable energy in the transport sector.

Further national commitments are included in the National Energy Strategy of 2007. The RES-share in the primary energy balance shall be increased by 1.5% per year until 2012 and reach 20% until 2025. Biofuel targets are set at 15% by 2020 and 20% by 2025.[6]

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[1] IEA (2009b)

[2] Coenraads, R et al. (2008), pag. 92

[3] Austrian Energy Agency (2009e)

[4] Coenraads, R et al. (2008), pag. 92

[5] EREC (2009g), pag.1

[6] EREC (2009g), pag. 3 and 4

Policy making institutions are the Ministry of the Environment and the Ministry of Energy. National energy strategies and other improvement programs are created by the State Enterprise Energy Agency, an organization incorporated in the Ministry of Energy. The National Control Commission for Prices and Energy regulates the electricity and gas sector including prices. The State Nuclear Safety Inspectorate and the Radioactive Waste Management Agency are important institutions within the field of nuclear energy.

Further market actors are national interest groups for district heating, hydro, biomass and wind power as well as the Lithuanian Energy Institute, a scientific institution engaged in various energy related fields.[7]

### 1.1.2 Current status of renewable energies

Renewable energy reached a share of 8.7% in total primary energy consumption in 2007.[8]

**Electricity:**

Renewable energy contributed a 5% share in the total electricity consumption in 2008. Hydro power is the domination technology of renewable electricity generation in Lithuania with a single large scale plant of 100,8 MW and 325 GWh in the city of Kaunas and around 84 small facilities adding up to 26 MW and 99 GWh in 2008). Additionally, there is a pumped storage hydroelectric plant in Kruonis. It has a capacity of 800 MW.[9] [10]

Utilization of wind power grew considerably in recent years and reached 47 MW in 2007. 106 GWh were generated during that year.

In 2008 the installed capacity of wind power plants reached 47MW, (68 MW in 2008, 91 MW in 2009) 28 MW for biomass and 2 MW for biogas (4MW in 2008).

Similar figures can be observed for biomass. 28 MW generated 48 GWh of electricity. Biogas use took place on a lower level reaching 2 MW and 5 GWh in 2007.

Despite an existing potential, geothermal energy has not been used for electricity generation so far. Solar sources were left unused until now.

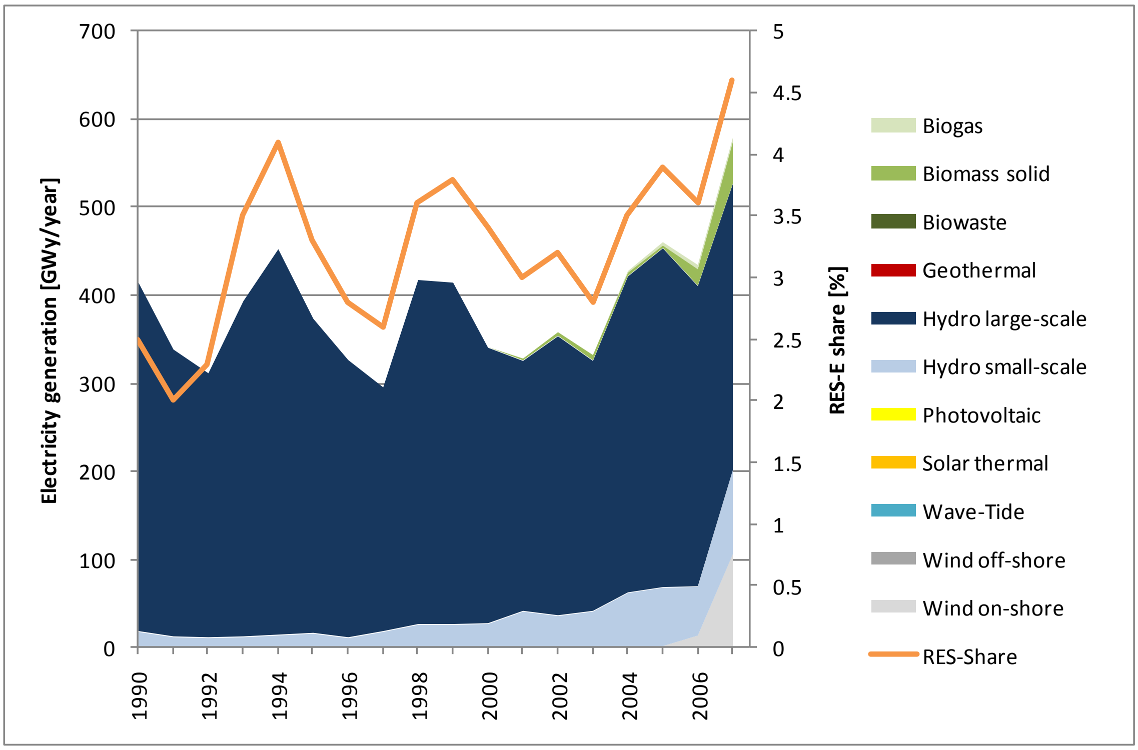
[7] Austrian Energy Agency (2009f)

[8] EREC (2009g), pag. 2

[9] Coenraads, R et al. (2008), pag. 92

[10] Eurostat (2009)

**Figure 1-1:** Development of RES-Electricity generation in Lithuania 1990 – 2007




**Source:** Eurostat (2009)

The following tables show the development and the compound annual growth rates (CAGR) of capacities and generation for all renewable technologies in greater detail:

**Table 1-1:** Development of RES-Electricity generation in Lithuania 1990 – 2007

| Technology | Electricity generation | | | CAGR | | |
|---|---|---|---|---|---|---|
| | 1990 [GWh] | 2000 [GWh] | 2007 [GWh] | 1990-2007 [%] | 1990-2000 [%] | 2000-2007 [%] |
| Biogas | 0 | 0 | 5 | : | : | : |
| Biomass solid | 0 | 0 | 48 | : | : | : |
| Biowaste | 0 | 0 | 0 | : | : | : |
| Geothermal power plants | 0 | 0 | 0 | : | : | : |
| Hydro large-scale | 396 | 313 | 325 | -1.2 | -2.3 | 0.5 |
| Hydro small-scale | 18 | 27 | 95 | 10.3 | 4.1 | 19.7 |
| Photovoltaic systems | 0 | 0 | 0 | : | : | : |
| Solar thermal | 0 | 0 | 0 | : | : | : |
| Tide & wave | 0 | 0 | 0 | : | : | : |
| Wind-turbines onshore | 0 | 0 | 106 | : | : | : |
| Wind-turbines offshore | 0 | 0 | 0 | : | : | : |
| RES-E total | 414 | 340 | 579 | 2.0 | -1.9 | 7.9 |

**Source:** Eurostat (2009)

**Table 1-2:** Development of RES-Electricity capacities in Lithuania1990 – 2007

| Technology | Capacity | | | CAGR | | |
|---|---|---|---|---|---|---|
| | 1990 [MW] | 2000 [MW] | 2007 [MW] | 1990-2007 [%] | 1990-2000 [%] | 2000-2007 [%] |
| Biogas | 0 | 0 | 2 | : | : | : |
| Biomass solid | 0 | 0 | 28 | : | : | : |
| Biowaste | 0 | 0 | 0 | : | : | : |
| Geothermal power plants | 0 | 0 | 0 | : | : | : |
| Hydro large-scale | 101 | 90 | 90 | -0.7 | -1.1 | 0.0 |
| Hydro small-scale | 6 | 13 | 25 | 8.8 | 8.0 | 9.8 |
| Photovoltaic systems | 0 | 0 | 0 | : | : | : |
| Solar thermal | 0 | 0 | 0 | : | : | : |
| Tide & wave | 0 | 0 | 0 | : | : | : |
| Wind-turbines onshore | 0 | 0 | 47 | : | : | : |
| Wind-turbines offshore | 0 | 0 | 0 | : | : | : |
| RES-E total | 107 | 103 | 192 | 3.5 | -0.4 | 9.3 |

**Source:** Eurostat (2009)

**Heat:**

Biomass has been traditionally used for heat production in private households where 529 ktoe worth of biomass were burnt in boilers of mostly low efficiency in 2007. A growing 135 ktoe worth of biomass were used during 2007 in district heating, a technology reaching 75% of all Lithuanian residential buildings.[11] [12] This amount grew up to 165 ktoe in 2008. A geothermal heat plant supplies the district heating grid of the city of Klaipeda. It produced 8.7 ktoe worth of heat in 2006.

Private households – non-district heating sector takes the largest share of biomass used for heat generation (~400 ktoe in 2008).

Renewable heat satisfied 26.1% of the total Lithuanian heat demand in 2007 and 27,4% in 2008.

[11] Ibid.

[12] EREC (2009g), pag.2

**Table 1-3:** Development of RES-Heat generation in Lithuania 1990 – 2007

| Technology | Generation | | | CAGR | | |
|---|---|---|---|---|---|---|
| | 1990 [ktoe] | 2000 [ktoe] | 2007 [ktoe] | 1990-2007 [%] | 1990-2000 [%] | 2000-2007 [%] |
| Biogas (grid) | 0.0 | 0.0 | 1.0 | : | : | : |
| Solid biomass (grid) | 10.0 | 29.0 | 135.0 | 17.7 | 11.2 | 29.2 |
| Biowaste (grid) | 0.0 | 0.0 | 0.0 | : | : | : |
| Geothermal heat (grid) | - | - | 8.7 | : | : | : |
| Solid biomass (non-grid) | 272.0 | 579.0 | 529.0 | 4.2 | 7.8 | -1.5 |
| Solar thermal heating and hot water | 0.0 | 0.0 | 0.0 | : | : | : |
| Heat pumps | - | - | - | : | : | : |
| RES-H total | 282.0 | 608.0 | 673.7 | 5.6 | 8.0 | 1.7 |

**Source:** Eurostat (2009)

**Transport:**

In 2007, a share of 2.9% of biofuels in the total domestic consumption of transport fuels was reached. The following table shows the consumed quantities from 2005 until 2007[13]:

The share of biofuel consumption of petrol and diesel used for transport reached 4.3% in 2008. Nowadays, 4 biofuel plants and 2 bioethanol plants operate in Lithuania.

**Table 1-4:** Development of RES-Transport fuel consumption in Lithuania

| Technology | Unit | 2005 | 2006 | 2007 |
|---|---|---|---|---|
| Biodiesel | ktoe | 3 | 14 | 42 |
| Bioethanol | ktoe | 1 | 5 | 11 |
| Biofuels, total | ktoe | 3 | 19 | 53 |
| Share Biofuels | % | 0.2 | 1.3 | 2.9 |

**Source:** Eurostat (2009)

### 1.1.3 Current renewable energy support policies

**Electricity:**

Since 2002, Lithuania has a feed-in tariff that has been revised owing to the influence of inflation and other factors in 2007 and 2009. The levels of the tariffs are depicted in the following table.

[13] Eurostat (2009)

**Table 1-5:** Feed-in tariff level in Lithuania since 1st January 2009

| RES technology | Support level | | Duration |
|---|---|---|---|
| | LTL/MWh | €/MWh | years |
| Hydro | 260 | 75.3 | 10 |
| Wind | 300 | 86.9 | |
| Biomass | 300 | 86.9 | |
| PV (up to 100 kW)* | 1630 | 472.1 | |
| PV (from 100 kW to 1 MW)* | 1560 | 451.8 | |
| PV (from 1 MW)* | 1510 | 437.3 | |
| * Feed-in tariff for electricity produced at PV installations will be introduced from 1st January 2010 | | | |

**Source:** RES-Legal (2009)

The plants are connected to the electricity grid in accordance with the principle of non-discrimination. The plant operator has to carry 60%[14] of the charges of connection. The grid operator has to bear the rest of the connection cost, but can include them into his price calculation for the following year. The cost of the feed-in tariff is also borne by the consumer through apportionment on the electricity price. Furthermore, if the grid capacity is limited, electricity from RES has a priority of transportation.

According to the order of approval of legal acts necessary for implementation of the Law on Electricity, the Ministry of Energy is responsible for the monitoring of electricity generated from RES (RES-E) production and purchase.Lithuania has introduced an annual maximum quota of RES-E to be purchased at the guaranteed price for period 2004-2010[15], differentiated according to RES technologies. The maximum quota of RES-E to be purchased with feed-in tariffs for 2009 and 2010, and the related installed capacities of RES are presented in the following table.

**Table 1-6:** Maximum quota of RES-E to be purchased with feed-in tariffs for 2009 and 2010

| RES technology | 2009 | | 2010 | |
|---|---|---|---|---|
| | Installed capacity, MW | A maximum quota, GWh | Installed capacity, MW | A maximum quota, GWh |
| Wind | 173 | 259.6 | 203.5 | 320.4 |
| Hydro | 30 | 118 | 31 | 122 |
| Biomass | 30.8 | 103.1 | 32.8 | 127.1 |
| Solar and geothermal | 0.6 | 1.4 | 1.6 | 3.2 |
| Total | 234.4 | 482.1 | 268.4 | 572.7 |

[14] With respect to wind energy, discounts of connection charges are not applicable. Moreover, the wind parks development licenses have been issued based on tenders where winning bids were from 70% to 7,000% of the connection cost, thereby the above mentioned discount is not implemented in practice (Tadas Navickas, 4 energia, JSC).

[15] Unfortunately, most support mechanisms cannot be predicted in the long-term, i.e. assigning one or another tariff is not related to the project payback and future prospects, in relation to validity term of tariff and unclear tariff validation and value after the term. This situation causes uncertainty for investment projects within the sector. (Valdas Lukosevicius, Lithuanian Energy Consultants Association).

**Source:** Order No. 1474 on approval of legal acts necessary for implementation of the Law on Electricity and its amendments.[16]

As direct financial support, the Lithuanian Environmental Investment Fund (LAAIF) offers subsidies and loans to operators of RES power plants. Additionally, electricity generated from RES will be exempt of excise duty from 2010.[17] [18]

200 MW of permits for wind farms have been granted based on tenders within the support scheme (mostly in 2004-2006). The projects with the permits granted during the above-mentioned tendering rounds are being implemented with different success, but within 5 years only 40-50% of the permitted capacities have been installed. This illustrates the difficulties which developers are facing in spatial planning, Environmental Impact Assessments and other administrative procedures.[19]

No support scheme exists for wind energy projects outside the tendered capacity hence further investment into the sector are not possible at the time.[20]

**Heat:**

District heating companies buying heat from independent providers are obliged to purchase heat according to the following order, if the offered prices are alike:

1. From CHP plants using renewable energy sources
2. Heat produced from renewable and geothermal energy sources
3. Industrial waste heat
4. From efficient CHP plants
5. From fossil fuel biomass boilers[21]

There is a mixed ownership/management structure in the Lithuanian DH sector. The DH companies mainly belong to municipalities, bus some of them are rented on the long term to private companies. The Combined Heat and Power plants themselves can also be owned by the DH company or private business. Lack of investment capital is the main obstacle for the growth of RES share in the DH field.

However there are no clear and transparent procedures for private capital to enter the DH field.

[16] Order No. 1474 on approval of legal acts necessary for implementation of the Law on Electricity and its amendments: http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=342973

[17] German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009b)

[18] EREC (2009g), pag. 4 and 5

[19] Tadas Navickas (4 energia, JSC)

[20] Tadas Navickas (4 energia, JSC)

[21] EREC (2009g), pag.5

The EU cohesion fund provides approximately 37 million Euros between 2007 and 2013 for the modernisation of existing boiler houses and CHP plants, as well as for the construction and connection of new ones.

Support of structural funds for the conversion of energy sources from fossil fuel to biomass in Lithuania was insufficient – only a few projects were implemented. The support has already been used up and is not expected until 2013.[22]

If pollution from a stationary source is reduced by a minimum of 5% through implementing environmental measures, the tax burden for pollution is reduced by the amount associated with the mitigated pollution. This is for 3 years after the implementation of the measure. Exempt from tax are also emissions arisen from burning renewable fuels.[23]

**Transport:**

The main target is 10% for energy from RES-T by 2020 (5.75% by 2010). There is no specific yearly target on RES-T technologies.

Bioethanol, biodiesel and bio-ETBE are subject to reduced excise tax rates.[24] If the biofuel is not pure, the tax rate is reduced according to the share of contained biofuel. Emission taxes are waived for biofuels and share of biofuel contained in fuel blends.

Direct subsidies to farmers selling cereal or rapeseed grains to biofuel producers are granted. 114 LTL per tonne of cereal grains and 160 LTL per tonne of rapeseed grains. Additional 45 Euros are granted per hectare for energy crop cultivation by the European Union.[25]

## 1.2 Targets & trajectories

### 1.2.1 Overall renewable energy targets and trajectories

In 2005, Lithuania had an RES share of 15% in its gross final energy consumption. This share has to be increased to 23% until the year 2020 according to the Directive 2009/28/EC.

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[22] Remigijus Lapinskas, Lithuanian Biomass Energy Association (LITBIOMA)

[23] EREC (2009g), pag.5 and 6

[24] Unfortunately, during the period when factories were being built and investments were being made in the biofuel sector, the excise duty of fuel produced from biodegradable materials was reversed. As a consequence, investments in bioethanol plants became unprofitable, because biofuel prices have risen and the promotion of the biofuel consumption reduced. It means that Lithuania does not have a long-term strategy and it is very difficult to plan projects and evaluate the risk of investments (Juozas Savickas ,Lithuanian Energy Institute).

[25] EREC (2009g), pag.6

**Table 1-7:** Overall renewable energy targets and trajectories – Lithuania

| 2005 | Average 2011 - 2012 | Average 2013 - 2014 | Average 2015 - 2016 | Average 2017 - 2018 | 2020 |
|---|---|---|---|---|---|
| 15.00% | 16.60% | 17.40% | 18.60% | 20.20% | 23.00% |

**Source:** Directive 2009/28/EC

### 1.2.2 Sector targets and trajectories

Possible future developments of the renewable energy sector in Lithuania until 2020 have been assessed based on two scenarios using the Green-X model, the NAT and ACT scenarios (defined in Appendix 1) and considering a moderate energy demand (based on PRIMES 20% case scenario).[26]

Lithuania's RES target for 2020 will be met under both scenarios as **Table 1-8** and

**Table 1-9** depict. Under the NAT scenario, the target is exceeded by 1.8 base points. A plus of 4.8 base points is predicted under the ACT scenario.

The heating sector will be the dominating contributor, providing around three fourths of all renewable energy in the scenarios. As scenarios become more ambitious, the renewable electricity output will grow stronger than that of the renewable heat sector. It will hence be responsible for most of the additional output in the more ambitious scenarios.

**Table 1-8:** Sectoral targets and trajectories – NAT scenario Lithuania

**Source:** Green-X Model (2009)

**Table 1-9:** Sectoral targets and trajectories – ACT scenario Lithuania

| Lithuania | | ACT (proactive support - realisable deployment) | | | | | |
|---|---|---|---|---|---|---|---|
| Indicator | Unit | 2005 | Average 2011 - 2012 | Average 2013 - 2014 | Average 2015 - 2016 | Average 2017 - 2018 | 2020 Targets |
| Expected Gross Final energy consumption | Ktoe | 4,941 | 5,718 | 5,971 | 6,220 | 6,431 | 6,714 |
| Total share of RES in final energy consumption | % | 14.8% | 19.1% | 21.0% | 23.2% | 25.5% | 27.8% |
| Gross Final Consumption of RES-E | Ktoe | 35 | 102 | 151 | 213 | 276 | 330 |
| Share of RES-E in gross final electricity consumption | % | 3.6% | 9.6% | 13.5% | 18.0% | 21.6% | 23.5% |
| Gross final energy consumption RES-H | Ktoe | 695 | 926 | 1,014 | 1,126 | 1,243 | 1,383 |
| Share of RES-H in final Heating and Cooling consumption | % | 27.3% | 31.8% | 33.6% | 36.0% | 38.7% | 41.4% |
| Final energy from renewable sources consumed in transport | Ktoe | 3 | 61 | 87 | 101 | 118 | 156 |
| Share of RES in gross final transport energy consumption | % | 0.4% | 4.4% | 6.0% | 6.7% | 7.7% | 10.0% |

[26] Results and figures for a low energy demand scenario (based on PRIMES high energy efficiency case scenario) are shown in Appendix 2.

**Source:** Green-X Model (2009)

### 1.2.3 Contribution of renewables to electricity consumption

Since Lithuania produced comparably little renewable energy in the electricity sector so far, many RES-E technologies will experience substantial growth until 2020. As depicted in **Table 1-10** for the NAT scenario, small-scale hydropower will grow by 78% and large-scale hydropower will grow by 21% reaching together an overall share of 21% in the RES-E sector. It will be overtaken by onshore wind energy by the middle of the next decade, which will become the dominating technology with a share of 50% of the RES-E generation in 2020.

Biogas will play an important role contributing about 17% in 2020 with a strong increase at the end of the next decade. Electricity generation from solid biomass will reach a share of 10% in 2020. Offshore wind and photovoltaics will be installed on a rather low level.

**Table 1-10:** Contribution of renewables to electricity consumption – NAT scenario Lithuania

| Lithuania | NAT (National target fulfillment) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Technology | 2005 | | Average 2011 - 2012 | | Average 2013 - 2014 | | Average 2015 - 2016 | | Average 2017 - 2018 | | 2020 Targets | |
| | MW | GWh | MW | GWh | MW | GWh | MW | GWh | MW | GWh | MW | GWh |
| Biomass | 5.0 | 7 | 46.6 | 297 | 54.9 | 350 | 68.0 | 433 | 84.7 | 537 | 116.8 | 732 |
| Solid | 2.0 | 3 | 34.4 | 219 | 34.4 | 219 | 36.1 | 229 | 36.1 | 229 | 39.5 | 249 |
| Biogas | 3.0 | 4 | 7.8 | 49 | 13.6 | 86 | 23.3 | 148 | 39.2 | 247 | 67.9 | 422 |
| MSW | 0.0 | 0 | 4.4 | 29 | 6.9 | 45 | 8.6 | 56 | 9.4 | 61 | 9.3 | 61 |
| Liquid | : | : | : | : | : | : | : | : | : | : | : | : |
| Concentrated Solar Power | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| Geothermal | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| Hydro, total | 119.3 | 398 | 136.6 | 463 | 146.1 | 489 | 152.8 | 510 | 155.8 | 520 | 155.8 | 520 |
| >10MW | 92.3 | 331 | 98.7 | 367 | 102.2 | 379 | 105.4 | 391 | 108.0 | 400 | 108.0 | 400 |
| <10MW | 27.0 | 67 | 37.9 | 96 | 43.9 | 110 | 47.4 | 119 | 47.8 | 119 | 47.8 | 119 |
| Of which pumping | : | : | : | : | : | : | : | : | : | : | : | : |
| Photovoltaic | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| Ocean | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| Wind | 6.4 | 3 | 130.0 | 323 | 234.2 | 573 | 349.0 | 840 | 469.0 | 1,110 | 521.5 | 1,231 |
| Onshore | 6.4 | 3 | 129.3 | 321 | 230.8 | 563 | 343.3 | 822 | 460.6 | 1,082 | 509.9 | 1,192 |
| Offshore | 0.0 | 0 | 0.8 | 2 | 3.3 | 10 | 5.7 | 18 | 8.3 | 27 | 11.7 | 39 |
| Gross Final Consumption of electricity from RES | 130.7 | 407 | 313.2 | 1,083 | 435.1 | 1,412 | 569.8 | 1,783 | 709.4 | 2,167 | 794.1 | 2,482 |

**Source:** Green-X Model (2009)

When the ACT scenario is assumed, a strong increase in renewable electricity production will occur, reaching 55% more output compared to the NAT scenario.

The utilization of solid biomass will be especially intensified. It will see strong, steady growth until the electricity output will be quadrupled compared to the NAT scenario until 2020 and a 27% share in the total renewable electricity output is reached. Onshore wind however, will still become the dominant technology, due to its strong growth in the middle of the next decade leading to an output increased by 40% compared to the NAT scenario and reach a share of 44% in the RES-E sector until 2020.

In relation to the figures depicted in the NAT and ACT scenarios for electricity generation through biomass: the mentioned forecast could be achievable in case there is an efficient legislation that allows the access to adequate sources of necessary sources of capital for the sector.[27]The development of hydropower, biogas and offshore wind is comparably similar to the NAT scenario and occurs on a lower level. Due to the increased production through other technologies the corresponding shares in the total renewable electricity output however decrease to 14% for hydropower, 11% for biogas and 1% for offshore wind. Photovoltaic power plants will be installed but their total electricity generation will stay very low.

**Table 1-11:** Contribution of renewables to electricity consumption – ACT scenario Lithuania

| Lithuania | ACT (proactive support - realisable deployment) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Technology | 2005 | | Average 2011 - 2012 | | Average 2013 - 2014 | | Average 2015 - 2016 | | Average 2017 - 2018 | | 2020 | |
| | MW | GWh | MW | GWh | MW | GWh | MW | GWh | MW | GWh | MW | GWh |
| Biomass | 5.0 | 7 | 66.5 | 388 | 112.4 | 632 | 166.1 | 925 | 220.9 | 1,224 | 280.5 | 1,529 |
| Solid | 2.0 | 3 | 54.1 | 310 | 91.7 | 500 | 133.7 | 718 | 171.5 | 912 | 201.5 | 1,038 |
| Biogas | 3.0 | 4 | 8.0 | 50 | 13.8 | 87 | 23.8 | 151 | 40.0 | 251 | 69.6 | 431 |
| MSW | 0.0 | 0 | 4.4 | 29 | 6.9 | 45 | 8.6 | 56 | 9.4 | 61 | 9.3 | 61 |
| Liquid | : | : | : | : | : | : | : | : | : | : | : | : |
| Concentrated Solar Power | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| Geothermal | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.2 | 1 | 1.1 | 6 | 2.7 | 16 |
| Hydro, total | 119.3 | 398 | 136.6 | 463 | 146.1 | 489 | 153.3 | 511 | 158.8 | 527 | 161.0 | 533 |
| >10MW | 92.3 | 331 | 98.7 | 367 | 102.2 | 379 | 105.4 | 391 | 108.0 | 400 | 108.0 | 400 |
| <10MW | 27.0 | 67 | 37.9 | 96 | 43.9 | 110 | 47.9 | 120 | 50.8 | 127 | 53.0 | 132 |
| Of which pumping | : | : | : | : | : | : | : | : | : | : | : | : |
| Photovoltaic | 0.0 | 0 | 4.0 | 3 | 9.2 | 7 | 16.0 | 13 | 27.5 | 22 | 53.2 | 42 |
| Ocean | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| Wind | 6.4 | 3 | 131.5 | 328 | 256.0 | 624 | 437.7 | 1,033 | 624.0 | 1,430 | 764.6 | 1,716 |
| Onshore | 6.4 | 3 | 129.3 | 321 | 250.9 | 608 | 429.8 | 1,008 | 613.5 | 1,395 | 750.7 | 1,670 |
| Offshore | 0.0 | 0 | 2.3 | 7 | 5.1 | 16 | 7.8 | 26 | 10.5 | 35 | 13.9 | 47 |
| Gross Final Consumption of electricity from RES | 130.7 | 407 | 338.5 | 1,182 | 523.8 | 1,753 | 773.2 | 2,483 | 1,032.2 | 3,209 | 1,262.0 | 3,837 |

**Source:** Green-X Model (2009)

The business representatives states that based on their assumptions the amount of electricity energy, generated by offshore wind power plants is expected to reach 200-600 MW by 2020.[28]

## 1.2.4 Contribution of renewables to heating & cooling consumption

The development of the RES-H sector is fairly similar in both scenarios as **Table 1-** and **Table 1-6** show. Heat from non-grid-connected solid biomass, will see steady growth and stay the dominant technology in the renewable heating sector with a share of around 66% in total renewable heat output in 2020. Grid-connected solid biomass will also see a steady but far stronger growth, as it more than triples until 2020, reaching a share of around a third in the RES-H sector. Heat generation from biowaste, biogas, geothermal and solar thermal energy will increase strongly, but on such a low level that these technologies will remain of

[27] Tadas Navickas (4 energia, JSC)).

[28] Tadas Navickas (4 energia, JSC), Dainius Jurenas, (New Energy Group, JSC)

minor importance. In the ACT scenario the contribution of solar thermal heat generation is significantly higher than in the NAT scenario.

The differences between the scenarios lies in the magnitude of the various growth rates, i.e. in the different amounts of heat produced during the given time frame. When the NAT scenario is assumed, total renewable heat production rises by 87% until 2020 compared to 2005, whereas a plus of 99% when the ACT scenario is assumed.

In 2020 a number expected in the district heating sector (DHS) is around 400 ktoe. The same figure remains in the non-district heating sector as well. There has not been assessed any decreasing trend in the number of residents in the rural areas and no trend of modernization or more economical use of heating installations. If the same level of biomass for heating houses which are not connected to the district heating system is maintained, a substantially higher amount of biomass could be allocated to the district heating system and in this way 70% of heat in the district heating system could be produced from biomass in 2020.[29]

**Table 1-12:** Contribution of renewables to heating and cooling consumption – NAT scenario Lithuania

| Lithuania | NAT (National target fulfillment) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Technology | 2005 | | Average 2011 - 2012 | | Average 2013 - 2014 | | Average 2015 - 2016 | | Average 2017 - 2018 | | 2020 | |
| | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe |
| Biomass | 0 | 686 | 5,119 | 908 | 5,386 | 975 | 5,825 | 1,067 | 6,264 | 1,157 | 6,817 | 1,266 |
| Solid | 0 | 685 | 5,091 | 901 | 5,343 | 964 | 5,769 | 1,054 | 6,196 | 1,142 | 6,729 | 1,249 |
| Biogas | : | 1 | 8 | 2 | 11 | 2 | 16 | 3 | 26 | 4 | 45 | 6 |
| Biowaste | : | 0 | 20 | 5 | 32 | 8 | 39 | 10 | 43 | 11 | 43 | 11 |
| Geothermal | : | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Solar Thermal | : | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 1 | 0 | 93 | 3 |
| Heat pumps | : | 0 | 42 | 7 | 70 | 11 | 98 | 15 | 126 | 20 | 176 | 27 |
| Gross final energy consumption from RES in heating and cooling | 0 | 695 | 5,163 | 915 | 5,458 | 986 | 5,925 | 1,083 | 6,392 | 1,177 | 7,086 | 1,296 |

**Source:** Green-X Model (2009)

**Table 1-63:** Contribution of renewables to heating and cooling consumption – ACT scenario Lithuania

| Lithuania | ACT (proactive support - realisable deployment) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Technology | 2005 | | Average 2011 - 2012 | | Average 2013 - 2014 | | Average 2015 - 2016 | | Average 2017 - 2018 | | 2020 | |
| | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe |
| Biomass | 0 | 686 | 5,119 | 915 | 5,387 | 994 | 5,826 | 1,098 | 6,266 | 1,205 | 6,819 | 1,328 |
| Solid | 0 | 685 | 5,091 | 907 | 5,343 | 984 | 5,769 | 1,084 | 6,196 | 1,190 | 6,729 | 1,311 |
| Biogas | : | 1 | 8 | 2 | 11 | 2 | 17 | 3 | 27 | 4 | 47 | 6 |
| Biowaste | : | 0 | 20 | 5 | 32 | 8 | 39 | 10 | 43 | 11 | 43 | 11 |
| Geothermal | : | 9 | 1 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 2 | 0 |
| Solar Thermal | : | 0 | 70 | 3 | 162 | 6 | 253 | 10 | 353 | 13 | 524 | 20 |
| Heat pumps | : | 0 | 58 | 9 | 88 | 14 | 119 | 18 | 158 | 24 | 222 | 34 |
| Gross final energy consumption from RES in heating and cooling | 0 | 695 | 5,248 | 926 | 5,637 | 1,014 | 6,199 | 1,126 | 6,779 | 1,243 | 7,566 | 1,383 |

[29] Remigijus Lapinskas, Lithuanian Biomass Energy Association (LITBIOMA)

**Source:** Green-X Model (2009)

Referring to **Table 1-12** and **Table 1-13** scenarios' contribution of geothermal energy to heating and cooling consumption is assessed in very low vales and opposing the real numbers. In 2004 there was 35 MW th of geothermal energy in Klaipeda district heating and other direct uses, in 2007-2008 the power plant was for overhaul and in 2009 it started with 11 MW th of producing power. Thereafter the growth is foreseeable in few years period to re-establish 35 MW th and there are a plans to open a new plant on Vydmantai-1 borehole which can produce 5 MW th from geothermal.[30]

In 2020, according to the European Geothermal Energy Council, there should be 50Mw th representing 19 ktoe mainly with new geothermal district heating.

### 1.2.5 Contribution of renewables to transport fuel consumption

The utilization of biofuels in the Lithuanian transport sector will increase considerably under both scenarios until 2020 as **Table 1-7** shows. Bioethanol will make up 68% of the domestic biofuel production, while biofuels of the second generation will contribute around a quarter to the renewable transport fuel market. With around 9% of biofuel production in 2020, biodiesel will stay of minor importance. Lithuania will vastly export its biofuels with 42 ktoe in 2020.

**Table 1-74:** Contribution of renewables to transport consumption – all scenarios Lithuania

| Lithuania | | NAT | | | ACT | | |
|---|---|---|---|---|---|---|---|
| Technology | Unit | 2005 | Average 2011 - 2012 | Average 2013 - 2014 | Average 2015 - 2016 | Average 2017 - 2018 | 2020 |
| Bioethanol | ktoe | 1.0 | 78.8 | 94.5 | 106.9 | 119.3 | 134.8 |
| Of which imported | ktoe | : | : | : | : | : | : |
| Biodiesel | ktoe | 3.0 | 11.4 | 17.3 | 6.4 | 0.0 | 17.3 |
| Of which imported | ktoe | : | : | : | : | : | : |
| Biofuels from wastes, residues, non-food cellulosic material, and ligno-cellulosic material | ktoe | : | 0.0 | 0.0 | 15.5 | 15.5 | 46.5 |
| Of which imported | ktoe | : | : | : | : | : | : |
| Hydrogen from RES | ktoe | : | : | : | : | : | : |
| Renewable electricity | ktoe | : | : | : | : | : | : |
| Biofuel import | ktoe | : | -28.7 | -25.1 | -27.8 | -16.8 | -42.3 |
| Final energy from renewable sources consumed in transport | ktoe | 4.0 | 61.5 | 86.8 | 101.0 | 118.0 | 156.3 |

**Source:** Green-X Model (2009)

## 1.3 Measures for achieving the targets

### 1.3.1 Policy measures

Table 1-6 gives the impression that Lithuania has economical regulation mechanisms, i.e. the volume of support is set and this support is provided to the plant operators. However,

[30] Geoterma, JSC

since 2006, the volume has been clearly limited by administrative boundaries.[31] It is necessary to remove administrative barriers for the development of the RES in Lithuanian. Moreover, the Government, before submitting its National Renewable Energy Action Plan to the European Commission, should organize a public consultation.[32]

The support has to be differentiated for different fields, taking into account the possibilities of different technologies.[33]**.** It is appropriate to organize the manufacture of wind power elements and solar cells in Lithuania which will allow for job creation and lead to the decrease in prices of equipment.[34] Furthermore, the purchase and use of electric and hybrid automobiles should be promoted in Lithuania on a national level as it is being done in other countries**.**[35]

Since 2010 Lithuania participates in the EU electricity market, and - from mid 2010 onwards - other Baltic countries will join the system. There is a declaration of the Prime Ministers of the Baltic countries encouraging the electricity trade including that produced from RES. This means that Lithuania could export the electricity surplus that it does not consume domestically. It should be kept in mind that a deficit of generating capacities is creating in the Baltic States and Lithuania has a unique opportunity to fill this gap with RES. It is necessary to regulate the possibility of building offshore wind farms as this technology has the largest potential with minimal environmental and social use impact.[36]

**Measures on administrative procedures, regulations and codes:**

- **Should authorization procedure take into account the specificities of different renewable energy technologies? If yes, how?**

Certainly the specifics of different RES sources should be considered for the design of authorization procedures.

- **Should the renewable energy potential be taken into account in spatial planning?**

Generally RES, and their respective potential, are insufficiently taken into account in spatial planning. In many countries and regions future development of RES projects is not taken into account at the moment of drawing up spatial planning programs. This means that spatial planning programs have to be adopted in order to allow for the implementation of a RES

[31] Tadas Navickas (4 energia, JSC)

[32] Arturas Skardzius (LAIEA)

[33] Valdas Lukosevicius (Lithuanian Energy Consultants Association)

[34] Juozas Savickas (Lithuanian Energy Institute)

[35] Dainius Jurenas (New Energy Group, JSC)

[36] Tadas Navickas (4 energia, JSC)

project in a specific area (e.g. RES-E), especially when there is a high RES potential involved in that particular area. This process can take a very long time. Often the acquirement of permits related to spatial planning is the longest trajectory of the overall period needed for development of the project. This is especially the case for projects in the field of wind and biomass. Responsible authorities should be stimulated to anticipate the development of future RES projects in their region, by allocating suitable areas.

Surveys show that spatial planning, construction permits and EIA (environmental impact assessment) procedures are key problems for regulators. In the RES-E sector to obtain the necessary permits can take years in countries where the authorities take into account the opinion of many stakeholders that are hard to harmonize. Since RES-E development is not taken into consideration in the special planning, every project and project variants have to be evaluated on an individual basis.

The number of the often long lasting appeal procedures could be effectively decreased by including RES-E development plans in local and regional spatial planning. In Germany for example these problems have been solved to a large extent. In the case of onshore wind projects the administrative barriers regarding spatial planning are low thanks to the Building Code (1996), which made states designate areas for onshore wind parks. Thanks to this, a wind farm can be established within 1 year. A similar approach is being followed for offshore wind parks. The federal states and the Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency) are responsible for designating areas and issuing permits for offshore wind installations.

The procedures of territorial planning (general plans, detailed plans) and the entire legal regulation of territorial planning are currently absolutely unadapted to the development of renewable energy projects. No priority zones are planned only general procedures are applied, which involve extensive lead times. When the new law on territorial planning will be prepared by the Ministry of Environment, the Ministry should look for and apply best practice from other EU Member States - especially Germany - to achieve an improvement of the procedures. Handling of general plans is also an issue of the future.[37]

The Lithuanian spatial planners are considering the idea of creating a special wind and solar energy plan. It would stop the development of this sector between 3 and 5 years. If the plan indicates the areas in which development is not allowed, which would mean that the rest of the areas are available, we would achieve better results.[38]

4 energia suggest that the German case could be used as an example for RES spatial planning: the territories for RES exploitation are identified, where construction is allowed, where it is forbidden, and where a detailed spatial planning is necessary.[39]

- **Should timetables for processing applications be communicated in advance?**

[37] Arturas Skardzius (LAIEA)

[38] Vitas Maciulis (Lithuanian Business Employer's Confederation)

[39] Tadas Navickas (4 energia, JSC)

Usually long lead times are needed to obtain necessary permits. Time needed to obtain all necessary permits for the construction of a RES plant can take many years (e.g. RES-E). Also it can be unclear what the exact length of a procedure will be. Clear guidelines for authorization procedures are highly recommended together with obligatory response periods for authorities involved in such procedures.

In Lithuania the period between the start of obtaining authorizations and the start of construction is very long. Now it takes about 5 years to implement a wind onshore project.[40]

- **How many steps should be needed to obtain the final authorization? Should there be a one-stop shop for coordinating all the steps?**

Generally, a high number of authorities are involved to obtain the final authorization. Often many authorities are involved in both permitting as well as support related procedures for renewable energy projects. Responsible authorities usually comprise several administrative bodies at national, regional and local level. An important improvement would be to reduce the number of local, regional and national administrations involved in the authorization processes for permits and financial support. Project developers are much more positive in situations where a single administrative body has been made responsible for co-ordination of several administrative procedures, such as the Bundesamt for off-shore wind in Germany.

Furthermore, there is a lack of co-ordination between different authorities. In many cases project developers need to submit similar information multiple times to different authorities. A suggestion to reduce the administrative burden for RES development would be to standardize procedures, such as standardized administrative requirements and application forms between different authorities.

The procedure of examining applications should be improved. The examination of applications should be public. There has not been such publicity so far for doing this. The laws which are governing such procedures, legal framework, and terms are being breached. It is necessary to return to legal regulation and make the institutions which are performing those functions comply with it.[41]

In **Figure 1-2** we present the perception of administrative barriers per renewable energy source, as identified by the stakeholder consultation.[42]

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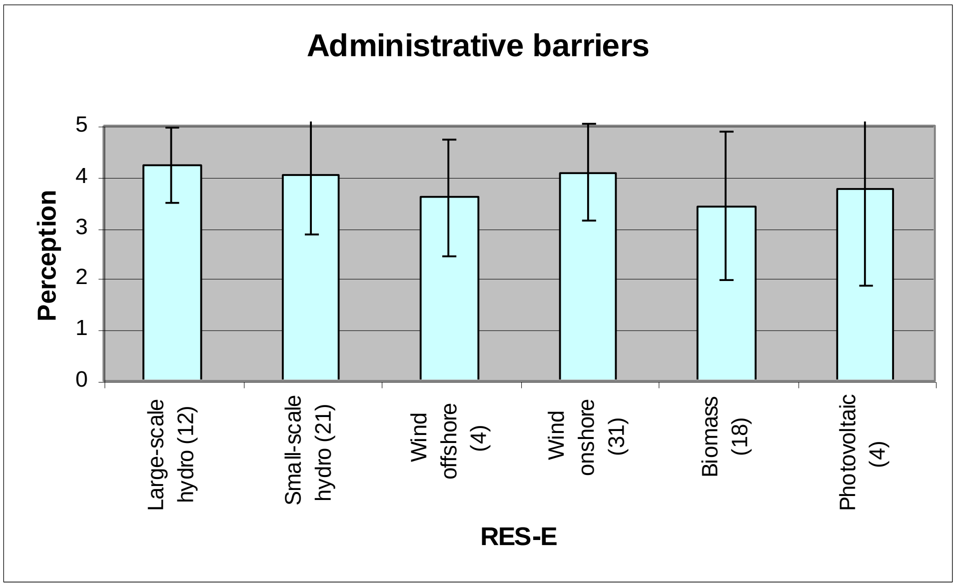
[40] Tadas Navickas (4 energia, JSC)

[41] Arturas Skardzius (LAIEA)

[42] OPTRES (2007)

**Figure 1-2:** Perception of administrative barriers




**Source:** OPTRES (2007)

Perception from 0 (no perceived barrier) to 5 (high perceived barrier). Number of received answers per source is provided in brackets, while standard deviation is marked by bars. Only those RES-E types with at least 4 answers have been depicted.

**Figure 1-2** shows that the respondents of the stakeholder consultation perceived the administrative problems to be highest for hydropower projects and on-shore wind. However, also for the other renewable energy sources the administrative barriers are perceived an important obstacle in the development of renewable energy projects.

**Main barriers in the Lithuanian RES sector::**

1. Complicated procedures of spatial planning.
2. It takes a lot of time/procedures to receive permits for expansion of generating capacities.
3. There are a lot of institutions that regulate RES development. Their actions are not coordinated.
4. Municipal institutions are not interested in promoting and implementing RES development projects.
5. Legal regulations do not differentiate RES projects according to their volume and technology.
6. Building of offshore wind parks is not legally regulated.
7. Inadequate legal regulation for installing biogas plants and connecting them to the end-grids.
8. Inadequate legal regulation and organizational measures for using municipal waste to produce energy.
9. If a fixed purchase feed-in tariff support scheme is applied for producing energy from

RES, there is no transparent and long-term mechanism.
10. Inadequate legal regulation for combining central heating and individually produced heat from RES.
11. A lack of public awareness regarding RES technologies and benefits.

A key problem for the development of renewable energy sources in Lithuania is unsuccessful communication with grid operator entities. It would be appropriate to establish a tripartite energy council. For example, in the field of electricity, a council could be established consisting of representatives of electricial grid operators, producers, as well as representatives from the Ministry of Energy.[43]

There is huge demand and huge potential for the biomass sector to invest both in heating and electricity production, but there is no a transparent and clear mechanism of how private business and private capital could come to the heat consumers or municipalities and build a plant or transform the existing cogeneration plant. There are dozens of bureaucratic obstacles and lots of protectionism. A clear, simple and transparent procedure should be created.[44]

**Measures concerning Buildings:**

- **What measures should be introduced into the building codes to ensure the share of renewable energy used in the building sector will increase?**

Policy instruments should be introduced that provide incentives for integrating a RES-H/C device into the heating/cooling system. But since RES-H/C applications operate only effectively if they are fitted to the overall system design, the chosen policy instrument should create incentives for a good overall system performance. Hence, it should also support the reduction of a building’s energy consumption (e.g. by improving its insulation) and motivate for an efficient use of the RES-H/C equipment.

As far a possible the policy instrument should motivate the utilization of high efficiency equipment, e.g. through linking the financial incentives to quality standards of a determined minimum rate of efficiency.

The new legal framework for new buildings should introduce an obligatory amount of RES energy which must be consumed by the building. Additionally, there should also be a certain state support in introducing these measures.[45] The concept of green houses should be promoted by providing possibilities to use geothermal, wind, and solar energy combining efficient energy use and house insulation. This field should be supported at national level by

[43] Vitas Maciulis (Lithuanian Business Employer’s Confederation)

[44] Tadas Navickas (4 energia, JSC)

[45] Arturas Skardzius (LAIEA)

providing a partial subsidy for the purchase of RES equipment and installations for each building.[46]

- **How should an obligation for minimum levels of renewable energy in new and newly refurbished buildings be drafted to best ensure renewable energy integration in buildings? At what levels should it be set?**

The obligation should take the different target groups and their different needs into account and might be different for each of these groups. The target groups are private homeowners living in their own home, homeowners renting to others as well as private, municipal and social housing organizations. As such companies often own and manage a large number of buildings they can become a key driver (but also key barrier) for switching buildings to RES-H/C.

Whereas housing companies often have sufficient technical skills to handle even innovative RES-H/C technologies they generally base their economic calculation on shorter pay back times e.g. private building owners in the domestic sector. In addition, the level of willingness to pay might generally be lower than with small scale investors. These circumstances should be considered in the setting of minimum levels for RES and in the corresponding support schemes.

From the perspective of the building owner (investor) apart from the level of support one of the main indicators is the share of the investment costs he can and/or legally is allowed to allocate to the tenants (by increasing the rent). From the perspective of tenants the crucial question concerns the relationship between the financial burden that might derive from an allocation of the investment costs on the rent and potentially reduced costs for heating/cooling due to the reduced use of conventional fuel.

The chosen obligation should ensure that investment is still effectively motivated. Costs for building owners and tenants shall not be too high to discourage investments (e.g. by postponing the reconstruction of heating systems as long as possible).

- **What is the projected increase of renewable energy use in the building sector until 2020?**

The Lithuanian Biomass Energy Association (LITBIOMA) has calculated that in order to reach 70% of heat from RES within the building sector currently, it is necessary to change 1,5 thousand MW installations, and it would require approximately 1,1 billion Lt. Only the increase in gas prices created conditions for the pay-off and conversion. The introduction of excise duty on the imported fossil energy resources, such as gas, fuel oil, coal, and imported electric energy would provide a relevant source of funding. Neighboring countries Estonia

[46] Tadas Navickas (4 energia, JSC)

and Latvia have already implemented similar measures. Lithuania is one of the few EU countries which do not have such excise duty.[47]

**Measures on information:**

- **How should specific information be targeted at different groups, as end consumers, builders, property managers, property agents, installers, architects, farmers, suppliers of equipment using renewable energy sources, public administration?**

The question is basically about information sharing to all stakeholders. General information for example about subsidies for renewable technologies needs to be broadcasted to all stakeholders. As the internet offers 24 hours access to information and can be updated easily, a base for general information would be a web page. A best practice examples is given in Luxembourg, where Subsidies for heat in households are communicated with the information paper “Förderprogramm zur Energieeinsparung und Nutzung erneuerbarer Energien im Wohnbereich” of the Ministère de l'Environnement of Luxembourg in an easy manner. Thereby, the paper targets not only public administration, but also especially end consumers, property managers and agents, installers and architects and is kept in an understandable and clear style.

End users can be informed by customer information brochures about the possibility to make use of support for renewables. The information brochures can be shared among installers, property managers and suppliers of equipment to hand them over to the end consumers.

Furthermore, there could be a subsidy for consultancy on renewable energy and energy efficiency related tops for end consumers. This would give the advantage, that consumers would choose the most appropriate efficiency and renewable energy option according to an energy expert.

Renewable energy and energy efficiency exhibitions are a great possibility to get to know information physically and are therefore for energy experts as well as for technology end consumers adequate. With expositions, it is possible to share specific information as well. For instance, the SOLTEC exhibition in Germany is mainly focusing in solar technologies and through this focus, information can be shared in more detail.[48]

Workshops and speeches provide the possibility to share specific information only of major interest for a small target group. Workshops and speeches can be integrated to exhibitions as well.

Experts and public administration members need the most up to date information having a higher degree of details than the ones for example for end users. Regularly reports published by the responsible administrative bodies keep the legal framework up-to-date. A best

[47] Remigijus Lapinskas, Lithuanian Biomass Energy Association (LITBIOMA)

[48] Information about the exhibition is given on the web page: http://www.soltec.de/s

practice example is the German "Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit", which published a brochure of the environment policy from 2005 to 2009 in July 2009 being detailed and giving an overview of the topic as well.49 With published articles in RES journals, the dynamics of the market can be analyzed in detail.

Specific information for a smaller target group can be shared via internet as well. It would be possible to establish a work group in a small field of work being responsible for specific field publishing news on their own internet platform.

- **How should guidance for planners and architects be provided to help them consider the optimal combination of renewable energy sources, high efficiency technologies and district heating and cooling when planning, designing, building and renovating industrial or residential areas?**

Planners and architects should be provided with an internet platform that holds information on possible options of including renewable energy, high efficiency technologies and districts heating and cooling into new or existing buildings. It should not only contain up-to-date information on technology, how it can be installed and how profitable such investments are on the long run. It should also include detailed information on successfully completed exemplary projects, legislation and events related to the topic. Local information on the applicability of solar technology and the availability of district heating and cooling is desirable. Furthermore it should be possible to order printed copies of the contained information as well as publications explaining the various concerns in greater detail. Contact information to all relevant professional associations and their local members would complete the web page's content.

The information should be gathered in consultation with experts in energy, technology, construction and installation and be updated continuously to secure a high level of relevance and actuality. The web page should be supervised with the help of the chambers of architects as well as planners associations respectively consumers advice centers to secure that the target groups are addressed properly. These organizations could also contact their members and customers to raise the web page's awareness level within the target groups.

**Measures on electricity infrastructure development:**

- **Should there be priority connection rights or reserved connection capacities provided for new installations producing electricity from renewable energy sources?**

In general and according to stakeholder consultation, the legally guaranteed access to the grid for RES-E sources and priority transmission and distribution is not considered as a key barrier in countries where this guarantee is currently not applied.

[49] Document available on http://www.bmu.de/ministerium/aufgaben/aufgaben/doc/44214.php

Introduction of positive discrimination of RES-E as regards the guarantee of grid access or transmission and distribution of RES-E, however, may become an additional motivating factor for reasons of investment security, low transaction costs and the acknowledgement of RES-E system benefits.

Currently there is a will to limit the development of wind to 500 MW of total installed capacity. The number rests on the ideas that balancing cost would be higher and at certain moments the electricity produced in Lithuania could not be consumed in Lithuania. However studies in several EU countries show, that cost related to the balancing of wind energy are very small until wind takes up to 20% of total energy consumption. Moreover, Lithuania has an 800 MW pumped hydropower station in Kruonis which is ideal for the balancing of wind energy and other RES variations. Normally much higher cost in the integration of wind capacities into the system is related to the expansion of the electrical grid. However, studies done in Lithuania show that over 1,700 MW of wind could be connected in coast areas without further investments in grid expansion.[50]

**Priority/Guaranteed Access to the grid:**

- **Should priority or guaranteed access be ensured? Explain.**

Priority grid access is an essential condition for the rapid expansion of renewable energies. In Member States in which it is applied it has enabled new entrants to the market in particular to supply and sell the power they have generated under clear-cut conditions and at foreseeable costs. Priority grid connection prevents the existing oligopolies from squeezing out renewable energy producers, especially in markets where networks and generation capacity are largely in the hands of similarly-sized companies.

According to 4 Energia there should be a priority access, as in other European Member States. Certainly, transparent and mandatory procedures should exist. Another important task for the grid energy system operator is to adjust the grid to accept renewable energy beforehand and proactively. Energetikos projektai claims that currently there are three institutions: electrical grid, transmission grid and distribution grid but there is no coordination between these three institutions. Therefore, Ministry of Energy should improve its role within this process - coordination is necessary by assigning clearly defined functions for each operator and allocating concrete period to submit the conclusions to applicants states Mr. Arturas Skardzius (LAIEA).

- **How should it be ensured that transmission system operators, when dispatching electricity generating installations give priority to those using renewable energy sources?**

Clear statutory regulations and consistent enforcement are required.

[50] Tadas Navickas (4 energia, JSC)

- **How should the transmission and distribution of electricity from renewable energy sources be guaranteed by the transmission and distribution system operators?**

### 1.3.2 Financial support

**Table 1-15** gives an indication on the necessary financial support by illustrating the weighted average (2011 to 2020) levelised (to a period of 15 years) total remuneration per MWh of RES generation for new installations in the investigated cases (NAT and ACT). This shows the gross support requirements as besides the financial premium offered by a RES support scheme also default revenues from the selling of the produced energy on the related energy market are included.[51] Gross figures were selected here as net expenditures largely depend on the future development of energy and carbon prices at European as well as at global scale.[52]

A comparison of the technology- or sector-specific figures by scenario shows significant differences between both cases. This illustrates the need to increase support levels if an ambitious and accelerated RES deployment is targeted. However, the figures of the ACT case represent the upper limit of such support requirements, where a fine tuning of the EU-wide equally conditioned technology-specific support levels to the circumstances in Lithuania offers a significant potential for cost reduction.[53]

Consequently, if Lithuania follows the NAT policy track the support requirements would decrease significantly. An important precondition for that is however that the implemented RES policy needs to be classified as stable and the investor's risk is reduced to a low level (e.g. by offering a guaranteed duration of support (incl. support levels)).

**Table 1-15:** Weighted average (2011 to 2020) total remuneration for yearly new RES installation in Lithuania – NAT and ACT scenario[54]

51 For the case of small-scale RES heating systems this shall mean the price of heat supply based on a typical conventional reference technology.

52 Obviously, also gross figures are not independent from the future development of energy prices. As the price development for energy related equipment in the years before the financial crisis (2008) has shown, prices (and largely also cost) for most types of power plants coincided to a large extent with rising energy and raw material prices.

The overall impact of energy prices on support cost is however seen larger on net compared to gross figures.

53 Compare e.g. total remuneration for RES in the heat sector: Although support is significantly higher in the ACT case differences in terms of resulting RES deployment are comparatively small.

54 Table 1-15 shows figures that correspond to weighted average total remuneration for yearly new RES installations for the timeframe 2011 to 2020. Therefore, these figures should not be considered for current RES level of support but only as references from the Green-X simulation process.

| *RES policy indicator (i.e. required total remuneration)* | Weighted average (2011 to 2020) total remuneration for yearly new RES installations [€/MWh$_{RES}$] | |
|---|---|---|
| | NAT (National target fulfillment) | ACT (proactive support - realisable deployment) |
| Biogas | 77.3 | 133.8 |
| (Solid) Biomass | 81.2 | 139.7 |
| Biowaste | 74.0 | 109.7 |
| Geothermal electricity | 0.0 | 151.5 |
| Hydro large-scale | 74.1 | 121.7 |
| Hydro small-scale | 73.9 | 125.6 |
| Photovoltaics | 0.0 | 371.1 |
| Solar thermal electricity | 0.0 | 0.0 |
| Tide & Wave | 0.0 | 0.0 |
| Wind onshore | 74.2 | 102.9 |
| Wind offshore | 77.7 | 119.1 |
| RES-E (average) | 75.3 | 122.7 |
| RES heat (district heat) | 49.2 | 79.8 |
| RES heat (decentral) | 77.4 | 118.1 |
| Biofuel (average) | 102.9 | 102.9 |

**Source:** Green-X Model (2009)

The developers have to be sure that the level of support will not change i.e. the price for electricity produced by wind energy which is set until 2020. In order to have sustained development and possibilities for investment, some long-term financial guarantees should be present.[55]

The Lithuanian Confederation of Industry would like to highlight that a larger part of the EU agriculture funds could be allocated to bioenergy products and thus facilitate the situation of both the growers and the consumers.

Today, the key barrier for efficient development of the heat sector is the lack of funding and subsidies to switch from traditional fuel to renewable energy sources.  A good incentive could be a special governmental programme, which would accumulate funds (e.g. introducing the excise tax for imported fossil energy sources and imported electric energy) and provide subsidies or co-funding for such projects. Such support schemes/good practices are applied among neighbouring countries and within the EU and should be replicated in Lithuania.[56]

[55] Tadas Navickas (4 energia, JSC)

[56] Remigijus Lapinskas (Lithuanian Biomass Energy Association (LITBIOMA))

### 1.3.3 Increasing biomass availability

The use of biomass in terms of primary energy will be between 1,467 and 1,577 ktoe in 2015 dependant on the respective scenario, as shown in **Table 1-6 and Table 1-87**. Until 2020, this amount will grow to 1,893 ktoe in the NAT and to 2,147 ktoe under the ACT scenario. The latter hence projects a considerable plus of 13% compared to the national scenario. Imports will only play a minor role under both scenarios.

**Table 1-16:** Availability of biomass in Lithuania – NAT scenario

| Lithuania | | NAT (National target fulfillment) | | | |
|---|---|---|---|---|---|
| Feedstock category | Unit | Total 2015 | Imports 2015 | Total 2020 | Imports 2020 |
| Agricultural products | [ktoe] | 235 | 13 | 334 | 27 |
| Agricultural residues | [ktoe] | 137 | : | 276 | : |
| Forestry products | [ktoe] | 726 | : | 865 | : |
| Forestry residues | [ktoe] | 305 | 4 | 313 | 9 |
| Biowaste | [ktoe] | 47 | : | 68 | : |
| Total biomass availibility | [ktoe] | 1,467 | | 1,893 | |

**Source:** Green-X Model (2009)

**Table 1-87:** Availability of biomass in Lithuania – ACT scenario

| Lithuania | | ACT (proactive support - realisable deployment) | | | |
|---|---|---|---|---|---|
| Feedstock category | Unit | Total 2015 | Imports 2015 | Total 2020 | Imports 2020 |
| Agricultural products | [ktoe] | 262 | 13 | 475 | 27 |
| Agricultural residues | [ktoe] | 216 | : | 339 | : |
| Forestry products | [ktoe] | 729 | : | 913 | : |
| Forestry residues | [ktoe] | 305 | 6 | 313 | 9 |
| Biowaste | [ktoe] | 48 | : | 71 | : |
| Total biomass availibility | [ktoe] | 1,577 | | 2,147 | |

**Source:** Green-X Model (2009)

An important aspect is to increase the use of biomass through conversion of plants to biogas. The second point is that Lithuania, just like other states surrounding the Baltic Sea, has learned to use wood, but agro-biomass (e.g. straw) is hardly used. Furthermore, and due to various reasons, Lithuania, Latvia and Estonia do not use municipal waste as a source of biomass. The Lithuanian Biomass Energy Association (LITBIOMA) suggests investing at national level in order to create technologies that could exploit unused material such as straw. Currently, the straw is used in the simplest way and at very low levels. The third point is related to the increase of biomass availability. In Lithuania the creating and developing of energy plantations should be supported by the state. There is currently some support, but it is still not enough.[57]

### 1.3.4 Flexibility/Joint projects/European perspective

**Table 1-18** depicts that under an EU scenario (defined in Annex 1), renewable energy production in Lithuania will be higher during the whole period than the indicative trajectory. The excess will reach 199 ktoe in 2020.

**Table 1-18:** Excess and deficit production of renewables compared to the indicative trajectory in Lithuania – EU scenario

| Lithuania | | EU (European perspercitve) vs.Indicative trajectory | | | | |
|---|---|---|---|---|---|---|
| Sector | Unit | Average 2011 - 2012 | Average 2013 - 2014 | Average 2015 - 2016 | Average 2017 - 2018 | 2020 |
| Excess | [ktoe] | 133 | 192 | 245 | 267 | 199 |
| Deficit | [ktoe] | : | : | : | : | : |

**Source:** Green-X Model (2009)

## 1.4 Estimated costs & benefits of RES policy support measures[58]

### Expected renewable energy use

The use of renewable energy is expected to more than double until 2020 under all considered scenarios. 1,666 ktoe will be produced in 2020 under the NAT scenario. That is a plus of 127% compared to the 733 ktoe produced in 2005. Under the ACT scenario, 1,869 ktoe of renewable energy are expected to be produced in 2020. That is a plus of 155% compared to the situation of 2005.

The main contribution will come from the heating sector, which will however become relatively smaller with the more ambitious scenario. It will provide between 78 (NAT) and 74% (ACT) of all renewable energy. The share of the electricity sector will grow from 13% under the NAT scenario to 18% under the ACT scenario. The biofuel sector will contribute with a mostly stable share of 8 to 9%.

### Expected GHG reduction

The reduction of GHG emissions will be substantial under both scenarios. They will cumulate to 26 Mt$CO_2$ under the NAT scenario. When the ACT scenario is assumed, savings will cumulate to 30 Mt$CO_2$ until 2020.

[57] Remigijus Lapinskas, Lithuanian Biomass Energy Association (LITBIOMA)

[58] Chapter 1.4 provides the results obtained by simulation

Around 60% of these savings will be due to RES use in the heating sector, around 30% will come from the electricity sector and around 10% from the biofuel sector in the NAT scenario. This ratio shifts in favor of the electricity sector in a more ambitious scenario, due to then relatively greater efforts.

### Expected job creation

The effects on the job market are based on the study EmployRES published by Fraunhofer ISI, EEG, Rütter + Partner, LEI and SEURECO. In this study, the total gross employees due to the renewable energy field are analyzed in three scenarios. The first scenario is a business as usual scenario (BAU scenario) assuming the current renewable energy policy will be retained. The second scenario assumes a stronger RES policy (advanced policy scenario) and is comparable to the EU scenario of Green-X. The third scenario is a hypothetical scenario assuming that no further support for renewables is given after 2006.

The efforts to achieve the target to produce 23% of Lithuania's energy from renewable sources will add in the BAU and advanced policy scenario the following total gross jobs figures:

**Table 1-19:** Additional employees in the renewable energy sector of Luxembourg

| Indicator | Unit | 2010 | 2015 | 2020 |
|---|---|---|---|---|
| **BAU scenario** | **1000 employees** | 47.7 | 65.9 | 88.6 |
| **Advanced policy scenario** | **1000 employees** | 48.9 | 81.4 | 85.5 |

**Source:** Fraunhofer ISI; EEG; Rütter + Partner; LEI; SEURECO (2009)

### Avoided fossil fuel imports

The avoidance of fossil fuel imports will be similar under both scenarios and will cumulate to 10,263 ktoe, which relates to 4,239 M€ in monetary terms until 2020 under the NAT scenario. When the ACT scenario is assumed, avoidance of fossil fuel imports will rise to 11,994 ktoe, which relates to 4,963 M€ in monetary terms.

56% of the total avoidance of imports of oil, gas and coal until 2020 will be generated through making efforts in the renewable heating sector, while the electricity sector will be responsible for around one third. In the more ambitious scenario, the electricity sector will contribute a greater and the heating sector a smaller share to the avoidance of imports. The biofuel sector will make up about 10% of all import avoidance in the scenarios.

### Expected capital expenditures

Capital expenditures, i.e. the investments in RES related technology, is expected to cumulate to 3,332 M€ until 2020 under the NAT scenario. They will sum up to 4,354 M€ under the ACT scenario until 2020. Generally, investments in the heating sector will be the highest, followed by the electricity sector and the biofuel sector. Between 52 and 59% of all investments will be made in the heating sector, between 34 and 43% in the electricity sector and the remaining 5 to 7% will be made in the biofuel sector. Although investments grow for all technologies in the more ambitious scenarios, the shares decline for the heating and rise for the electricity sector, because here, investments will be especially intensified.

### Expected costs of achieving 2020 target

*Policy cost:*

Policy costs, i.e. consumer expenditures due to RES support, will be the main cost type. They cumulate to 319 M€ under the NAT scenario and to 3,897 M€ under the ACT scenario. The origins of the policy costs vary vastly among the scenarios. Under the NAT scenario, the biofuel sector will generate 85% of all policy costs, while expenditures stay similarly low in the other sectors. Under the ACT scenario, the heating sector becomes more dominating producing 73% of all policy related consumer expenditures, while the electricity sector will be responsible for 20 and the biofuel sector for 7%.

*Additional generation costs:*

Additional generation costs, i.e. the operating costs of the newly built plants will cumulate to 115 M€ under the NAT and to 334 M€ under the ACT scenario.

### Avoided external costs

If the avoided $CO_2$ emissions are expressed in monetary terms, the avoided external costs are received. They are 791 M€ in the NAT and 853 M€ in the ACT scenario cumulatively seen from 2006 to 2020.

## 1.5 References

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# Appendix 1 - Overview on investigated cases

Within this project we have calculated three different scenarios of the future renewable energy development up to 2020. These scenarios are meant to form a basis for establishing the 27 national energy roadmaps. The following gives an overview of the three aims of the scenarios. Generally, in all scenarios it is preconditioned to pursue the overall 20% RES by 2020 on EU scale. All results of the scenario calculations are depicted in terms of RES deployment as well as the associated costs and benefits.

NAT – National target fulfillment:

Within the NAT scenario each Member States tries to fulfil its national RES target by its own. The use of cooperation mechanisms as agreed in the RES Directive is reduced to necessary minimum: For the exceptional case that a member state would not possess sufficient RES potentials, cooperation mechanisms would serve as a complementary option. Additionally, if a member state possesses barely sufficient RES potentials, but their exploitation would cause significantly higher consumer expenditures compared to the EU average, cooperation would serve as complementary tool to assure target achievement. As a consequence of above, the required RES support will differ comparatively large among the countries.

EU – European perspective:

In contrast to the NAT case, within the EU scenario the use of cooperation mechanisms does not represent the exceptional case: If a member state would not possess sufficient potentials that can be economically exploited, cooperation mechanisms as defined in the RES directive would serve as a complementary option. Consequently, the prior aim of the EU scenario is to fulfil the 20% RES target on EU level, rather than fulfilling each national RES target purely domestically. Generally, it reflects a “least cost” strategy in terms of consumer expenditures (due to RES support). In contrast to simple short-term least cost policy approaches, the applied technology-specification of RES support does however still allow an EU-wide well balanced RES portfolio.

ACT – proactive support – realizable deployment:

Finally, the ACT scenario depicts an optimistic future with respect to RES exploitation. The assumption is taken that all EU member states apply proactive RES support whereby EU-wide equal incentives are preconditioned for individual RES technologies (e.g. by applying a harmonised but technology-specific premium feed-in system to support RES-E). With EU-wide effective and efficient RES support this scenario ends up with a higher RES exploitation as foreseen in the RES directive.

# Appendix 2 - Results and figures for a low energy demand

Based on PRIMES high energy efficiency case scenario

Sectoral targets and trajectories – NAT scenario Lithuania

| Lithuania | | NAT (National target fulfillment) | | | | | |
|---|---|---|---|---|---|---|---|
| Indicator | Unit | 2005 | Average 2011 - 2012 | Average 2013 - 2014 | Average 2015 - 2016 | Average 2017 - 2018 | 2020 Targets |
| Expected Gross Final energy consumption | Ktoe | 4,941 | 5,526 | 5,536 | 5,564 | 5,641 | 5,745 |
| Total share of RES in final energy consumption | % | 14.8% | 19.3% | 21.5% | 23.8% | 25.9% | 28.5% |
| Gross Final Consumption of RES-E | Ktoe | 35 | 91 | 119 | 150 | 174 | 206 |
| Share of RES-E in gross final electricity consumption | % | 3.6% | 8.5% | 10.9% | 13.4% | 14.7% | 16.3% |
| Gross final energy consumption RES-H | Ktoe | 695 | 915 | 987 | 1,081 | 1,179 | 1,296 |
| Share of RES-H in final Heating and Cooling consumption | % | 27.3% | 33.3% | 36.4% | 40.2% | 42.9% | 46.1% |
| Final energy from renewable sources consumed in transport | Ktoe | 3 | 60 | 83 | 93 | 106 | 135 |
| Share of RES in gross final transport energy consumption | % | 0.4% | 4.4% | 6.0% | 6.7% | 7.7% | 10.0% |

**Source:** Green-X Model (2009)

Sectoral targets and trajectories – ACT scenario Lithuania

| Lithuania | | ACT (proactive support - realisable deployment) | | | | | |
|---|---|---|---|---|---|---|---|
| Indicator | Unit | 2005 | Average 2011 - 2012 | Average 2013 - 2014 | Average 2015 - 2016 | Average 2017 - 2018 | 2020 Targets |
| Expected Gross Final energy consumption | Ktoe | 4,941 | 5,526 | 5,536 | 5,564 | 5,641 | 5,745 |
| Total share of RES in final energy consumption | % | 14.8% | 19.7% | 22.5% | 25.7% | 28.8% | 32.2% |
| Gross Final Consumption of RES-E | Ktoe | 35 | 102 | 151 | 213 | 276 | 330 |
| Share of RES-E in gross final electricity consumption | % | 3.6% | 9.5% | 13.8% | 19.0% | 23.4% | 26.1% |
| Gross final energy consumption RES-H | Ktoe | 695 | 926 | 1,014 | 1,126 | 1,243 | 1,383 |
| Share of RES-H in final Heating and Cooling consumption | % | 27.3% | 33.7% | 37.4% | 41.8% | 45.3% | 49.2% |
| Final energy from renewable sources consumed in transport | Ktoe | 3 | 60 | 83 | 93 | 106 | 135 |
| Share of RES in gross final transport energy consumption | % | 0.4% | 4.4% | 6.0% | 6.7% | 7.7% | 10.0% |

**Source:** Green-X Model (2009)

## Contribution of renewables to electricity consumption – NAT scenario Lithuania

| Lithuania | NAT (National target fulfillment) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Technology | 2005 | | Average 2011 - 2012 | | Average 2013 - 2014 | | Average 2015 - 2016 | | Average 2017 - 2018 | | 2020 Targets | |
| | MW | GWh | MW | GWh | MW | GWh | MW | GWh | MW | GWh | MW | GWh |
| Biomass | 5.0 | 7 | 43.6 | 277 | 51.9 | 330 | 65.0 | 413 | 81.7 | 518 | 108.7 | 682 |
| Solid | 2.0 | 3 | 31.4 | 199 | 31.4 | 199 | 33.1 | 210 | 33.1 | 210 | 36.5 | 230 |
| Biogas | 3.0 | 4 | 7.8 | 49 | 13.6 | 86 | 23.3 | 148 | 39.2 | 247 | 62.9 | 391 |
| MSW | 0.0 | 0 | 4.4 | 29 | 6.9 | 45 | 8.6 | 56 | 9.4 | 61 | 9.3 | 61 |
| Liquid | : | : | : | : | : | : | : | : | : | : | : | : |
| Concentrated Solar Power | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| Geothermal | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| Hydro, total | 119.3 | 398 | 136.6 | 463 | 146.1 | 489 | 152.8 | 510 | 155.8 | 520 | 155.8 | 520 |
| >10MW | 92.3 | 331 | 98.7 | 367 | 102.2 | 379 | 105.4 | 391 | 108.0 | 400 | 108.0 | 400 |
| <10MW | 27.0 | 67 | 37.9 | 96 | 43.9 | 110 | 47.4 | 119 | 47.8 | 119 | 47.8 | 119 |
| Of which pumping | : | : | : | : | : | : | : | : | : | : | : | : |
| Photovoltaic | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| Ocean | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| Wind | 6.4 | 3 | 129.3 | 321 | 230.8 | 563 | 343.3 | 822 | 416.3 | 987 | 506.7 | 1,190 |
| Onshore | 6.4 | 3 | 129.3 | 321 | 230.8 | 563 | 343.3 | 822 | 415.6 | 985 | 502.4 | 1,176 |
| Offshore | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.7 | 2 | 4.3 | 14 |
| Gross Final Consumption of electricity from RES | 130.7 | 407 | 309.5 | 1,061 | 428.8 | 1,382 | 561.1 | 1,745 | 653.8 | 2,025 | 771.2 | 2,392 |

**Source:** Green-X Model (2009)

## Contribution of renewables to electricity consumption – ACT scenario Lithuania

| Lithuania | ACT (proactive support - realisable deployment) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Technology | 2005 | | Average 2011 - 2012 | | Average 2013 - 2014 | | Average 2015 - 2016 | | Average 2017 - 2018 | | 2020 | |
| | MW | GWh | MW | GWh | MW | GWh | MW | GWh | MW | GWh | MW | GWh |
| Biomass | 5.0 | 7 | 66.5 | 388 | 112.4 | 632 | 166.1 | 925 | 220.9 | 1,224 | 280.5 | 1,529 |
| Solid | 2.0 | 3 | 54.1 | 310 | 91.7 | 500 | 133.7 | 718 | 171.5 | 912 | 201.5 | 1,038 |
| Biogas | 3.0 | 4 | 8.0 | 50 | 13.8 | 87 | 23.8 | 151 | 40.0 | 251 | 69.6 | 431 |
| MSW | 0.0 | 0 | 4.4 | 29 | 6.9 | 45 | 8.6 | 56 | 9.4 | 61 | 9.3 | 61 |
| Liquid | : | : | : | : | : | : | : | : | : | : | : | : |
| Concentrated Solar Power | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| Geothermal | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.2 | 1 | 1.1 | 6 | 2.7 | 16 |
| Hydro, total | 119.3 | 398 | 136.6 | 463 | 146.1 | 489 | 153.3 | 511 | 158.8 | 527 | 161.0 | 533 |
| >10MW | 92.3 | 331 | 98.7 | 367 | 102.2 | 379 | 105.4 | 391 | 108.0 | 400 | 108.0 | 400 |
| <10MW | 27.0 | 67 | 37.9 | 96 | 43.9 | 110 | 47.9 | 120 | 50.8 | 127 | 53.0 | 132 |
| Of which pumping | : | : | : | : | : | : | : | : | : | : | : | : |
| Photovoltaic | 0.0 | 0 | 4.0 | 3 | 9.2 | 7 | 16.0 | 13 | 27.5 | 22 | 53.2 | 42 |
| Ocean | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| Wind | 6.4 | 3 | 131.5 | 328 | 256.0 | 624 | 437.7 | 1,033 | 624.0 | 1,430 | 764.6 | 1,716 |
| Onshore | 6.4 | 3 | 129.3 | 321 | 250.9 | 608 | 429.8 | 1,008 | 613.5 | 1,395 | 750.7 | 1,670 |
| Offshore | 0.0 | 0 | 2.3 | 7 | 5.1 | 16 | 7.8 | 26 | 10.5 | 35 | 13.9 | 47 |
| Gross Final Consumption of electricity from RES | 130.7 | 407 | 338.5 | 1,182 | 523.8 | 1,753 | 773.2 | 2,483 | 1,032.2 | 3,209 | 1,262.0 | 3,837 |

**Source:** Green-X Model (2009)

## Contribution of renewables to heating and cooling consumption – NAT scenario Lithuania

| Lithuania | NAT (National target fulfillment) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Technology | 2005 | | Average 2011 - 2012 | | Average 2013 - 2014 | | Average 2015 - 2016 | | Average 2017 - 2018 | | 2020 | |
| | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe |
| Biomass | 0 | 686 | 5,121 | 908 | 5,394 | 976 | 5,816 | 1,066 | 6,278 | 1,159 | 6,818 | 1,265 |
| Solid | 0 | 685 | 5,093 | 901 | 5,351 | 965 | 5,761 | 1,053 | 6,209 | 1,144 | 6,740 | 1,250 |
| Biogas | : | 1 | 8 | 2 | 11 | 2 | 16 | 3 | 26 | 4 | 35 | 5 |
| Biowaste | : | 0 | 20 | 5 | 32 | 8 | 39 | 10 | 43 | 11 | 43 | 11 |
| Geothermal | : | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Solar Thermal | : | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 1 | 0 | 93 | 3 |
| Heat pumps | : | 0 | 42 | 7 | 70 | 11 | 98 | 15 | 126 | 20 | 176 | 27 |
| Gross final energy consumption from RES in heating and cooling | 0 | 695 | 5,164 | 915 | 5,466 | 987 | 5,916 | 1,081 | 6,405 | 1,179 | 7,087 | 1,296 |

**Source:** Green-X Model (2009)

Contribution of renewables to heating and cooling consumption – ACT scenario Lithuania

| Lithuania | ACT (proactive support - realisable deployment) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Technology | 2005 | | Average 2011 - 2012 | | Average 2013 - 2014 | | Average 2015 - 2016 | | Average 2017 - 2018 | | 2020 | |
| | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe | MWth | Ktoe |
| Biomass | 0 | 686 | 5,178 | 915 | 5,552 | 994 | 6,087 | 1,098 | 6,600 | 1,205 | 7,201 | 1,328 |
| Solid | 0 | 685 | 5,149 | 907 | 5,509 | 984 | 6,031 | 1,084 | 6,530 | 1,190 | 7,112 | 1,311 |
| Biogas | : | 1 | 8 | 2 | 11 | 2 | 17 | 3 | 27 | 4 | 47 | 6 |
| Biowaste | : | 0 | 20 | 5 | 32 | 8 | 39 | 10 | 43 | 11 | 43 | 11 |
| Geothermal | : | 9 | 1 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 2 | 0 |
| Solar Thermal | : | 0 | 70 | 3 | 162 | 6 | 253 | 10 | 353 | 13 | 524 | 20 |
| Heat pumps | : | 0 | 58 | 9 | 88 | 14 | 119 | 18 | 158 | 24 | 222 | 34 |
| Gross final energy consumption from RES in heating and cooling | 0 | 695 | 5,307 | 926 | 5,802 | 1,014 | 6,460 | 1,126 | 7,113 | 1,243 | 7,949 | 1,383 |

**Source:** Green-X Model (2009)

Contribution of renewables to transport consumption – all scenarios Lithuania

| Lithuania | | NAT | | | ACT | | |
|---|---|---|---|---|---|---|---|
| Technology | Unit | 2005 | Average 2011 - 2012 | Average 2013 - 2014 | Average 2015 - 2016 | Average 2017 - 2018 | 2020 |
| Bioethanol | ktoe | 1.0 | 78.8 | 94.5 | 106.9 | 119.3 | 134.8 |
| Of which imported | ktoe | : | : | : | : | : | : |
| Biodiesel | ktoe | 3.0 | 11.4 | 17.3 | 5.5 | 0.0 | 11.1 |
| Of which imported | ktoe | : | : | : | : | : | : |
| Biofuels from wastes, residues, non-food cellulosic material, and ligno-cellulosic material | ktoe | : | 0.0 | 0.0 | 15.5 | 15.5 | 46.5 |
| Of which imported | ktoe | : | : | : | : | : | : |
| Hydrogen from RES | ktoe | : | : | : | : | : | : |
| Renewable electricity | ktoe | : | : | : | : | : | : |
| Biofuel import | ktoe | : | -30.3 | -29.2 | -34.6 | -29.0 | -57.4 |
| Final energy from renewable sources consumed in transport | ktoe | 4.0 | 59.9 | 82.7 | 93.3 | 105.7 | 135.0 |

**Source:** Green-X Model (2009)

## Appendix 3 - Short characterization of the Green-X model

As in previous projects such as FORRES 2020, OPTRES or PROGRESS the ***Green-X*** model was applied to again perform a detailed quantitative assessment of the future deployment of renewable energies on country-, sectoral- as well as technology level. The core strength of this tool lies on the detailed RES resource and technology representation accompanied by a thorough energy policy description, which allows assessing various policy options with respect to resulting costs and benefits. A short characterisation of the model is given below, whilst for a detailed description we refer to www.green-x.at.

*Short characterisation of the* ***Green-X*** *model*

*The model* ***Green-X*** *has been developed by the Energy Economics Group (EEG) at Vienna University of Technology in the research project "Green-X – Deriving optimal promotion strategies for increasing the share of RES-E in a dynamic European electricity market", a joint European research project funded within the 5th framework program of the European Commission, DG Research (Contract No. ENG2-CT-2002-00607). Initially focussed on the electricity sector, this tool and its database on RES potentials and costs have been extended within follow-up activities to incorporate renewable energy technologies within all energy sectors.*

***Green-X*** *covers geographically the EU-27, and can easily be extended to other countries such as Turkey, Croatia or Norway. It allows to investigate the future deployment of RES as well as accompanying cost – comprising capital expenditures, additional generation cost (of RES compared to conventional options), consumer expenditures due to applied supporting policies, etc. – and benefits – i.e. contribution to supply security (avoidance of fossil fuels) and corresponding carbon emission avoidance. Thereby, results are derived at country- and technology-level on a yearly basis. The time-horizon allows for in-depth assessments up to 2020, accompanied by concise out-looks for the period beyond 2020 (up to 2030).*

*Within the model, the most important RES-Electricity (i.e. biogas, biomass, biowaste, wind on- & offshore, hydropower large- & small-scale, solar thermal electricity, photovoltaics, tidal stream & wave power, geothermal electricity), RES-Heat technologies (i.e. biomass – subdivided into log wood, wood chips, pellets, grid-connected heat -, geothermal (grid-connected) heat, heat pumps and solar thermal heat) and RES-Transport options (e.g. first generation biofuels (biodiesel and bioethanol), second generation biofuels (lignocellulotic bioethanol, BtL) as well as the impact of biofuel imports) are described for each investigated country by means of dynamic cost-resource curves. This allows besides the formal description of potentials and costs a detailed representation of dynamic aspects such as technological learning and technology diffusion.*

*Besides the detailed RES technology representation the core strength of the model is the in-depth energy policy representation. Green-X is fully suitable to investigate the impact of applying (combinations of) different energy policy instruments (e.g. quota obligations based on tradable green certificates / guarantees of origin, (premium) feed-in tariffs, tax incentives, investment incentives, impact of emission trading on reference energy prices) at country- or at European level in a dynamic framework. Sensitivity investigations on key input parameters such as non-economic barriers (influencing the technology diffusion), conventional energy prices, energy demand developments or technological progress (technological learning) typically complement a policy assessment.*