Actions for sustainable energy development for Lithuania, until 2020

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This is an overview of activities to realise the first steps for a transition to sustainable energy in Lithuania, with main focus on the period until 2020. First are actions for increased use of renewable energy, then comes actions for energy efficiency. The authors welcome comments (see page 11).

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Windpower

It is proposed to install a total of 1200 MW of windpower until 2020 of which 200 MW off-shore. The windpower programme currently implemented will result in installation of 200 MW. We expect that this capacity will be installed until 2010. To realise the additonal capacity of 1000 MW, installations should continue with about 100 MW/year 2010 – 2020: 80 MW/year on land and . With this level of installation, it is possible to attract one windpower assembling or windpower equipment factory to Lithuania, making windpower a partly domestic production, and thereby leading to new employment in Lithuania.

Requirements:
-Political decision to continue installations
-Agreement for production of windpower equipment in Lithuania

Economy:
Installation of windpower will require an investment of 100 mill. €/year in the period 2010-2020 (100 MW/year, 1000 €/kW), in total 1000 mill. €

Energy Production: 2 TWh with 2000 full lead hours, in addition to the 0.4 Twh from windmils installed until 2010. It will replace other electricity production and imports
Operating and maintenance costs: expected 1 €-cent/kWh
Energy costs with 20 year lifetime and 6& interest rate equal to 0.19 Litas/KWh.

Even though the cost price of windpower without profit is 0.19 Lt/kWh, it is necessary to pay investors a higher price for the first years, both as a risk premium and because of the substantial burocratic obstacles that they have to overcome.

Biomass

Biomass is currently the most important form of renewable energy, and will remain so until 2020, and also beyond.
The current use of biomass is mainly wood used for room heating. 80% is used for domestic heating while 6.6% is for heating in the service sectors, 6.4% for district heating, and the rest for industry and agriculture (2000 figures, IEA Energy Statistics).

Improve existing Biomass Use

An importent first step is to introduce efficient use of biomass with clean and user-friendly combustion technologies, to ensure continued popularity of wood use for heating. This requires training of those currently involved in biomass use (wood-stove producers and installers, chimney cleaners etc.) and introduction of clean, efficient and user-friendly technology. Given the size of the residential market (21 PJ = 6 TWh/year for heating), there is scope for a high-quality, Lithuanian equipment industry, adopting best available technology. A good equipment production can also lead to exports, if the quality is sufficiently high.

Requirements:

-establish a centre of expertise of biomass use for heating (building on existing structures) with knowledge of Lithuanian and European biomass markets: supplies, equipments etc.
-Free information to users about technology available (efficiency, environmental parameters, user-friendly-ness, suppliers, etc.)
-training programme for current equipment manufacturers, installers, chimney cleaners etc.
-labelling system for equipment
-promotion of high-quality biomass heating.

Economy:

-an expertise centre also in charge of web-based information will require about 10 full time staff
-user information with outreach to biomass users including rural users will require 5-10 full time staff depending on level of ambitions
-training programmes will require 5-10 full time staff, and can be combined with above functions.
-Replacement of oil and gas with biomass for heating will save import of oil and gas. With replacement of about, 3.3 PJ of LPG use, 2.8 PJ (1/2 TWh) of coal use, 2.5 PJ of natural gas use and 0.7 PJ of oil use oil, the fuel swift will save money for fuel import, money that are used instead to create employment in Lithuania.
-Renewal of installations will increase efficiency from currently in the order of 50-70% efficiency to around 80% (annual average), increasing heat output with about 1/3. It is not known if this

improvements will actually lead to less wood consumption or rather be used for better heating comfort (assuming some of the rural houses that use wood today are not heated fully to a satisfactory level such as 20’C).
-Renewal of installations will also reduce emissions, including particulate emissions from installation, thereby contributing to lower environmental costs and to the EU strategy to reduce particulate emissions.

Increase Biomass Availability with Energy Plantations and Straw Use
To make biomass available for the proposed increases, straw and energy plantations should be used. For straw is estimated an annual use of 900,000 tons/year in 2020, equivalent to 35% of total straw production. This can in practice be done by making the straw into large bales of 300 – 500 kg that is stored on the fields near roads and covered with strong plastic. Then they are sent by truck or eventually by train to CHP and heating stations during the heating season. This is normal practice in Denmark and other countries.

For energy plantations (energy crops) is proposed that 2500 km2 (250,000 ha), equal to 50% of unused land and agricultural land with low producticyty, is planted with energy crops such as willow for coppice until 2030. It is assumed that the yield will reach 9 ton of dry matter per hectare. The plantation and cutting can be done with machines, while there can be need for manual weeding the first year. The requirement for fertilisers is substantial less than for grain and most other crops; but there can be needs for fertiliser on poor soils. Waste-water sludge can be used as fertilizer, if the sludge has low contents of heavy metals and persistent organic pollutants (POPs). Heavy metals and POPs can pollutes the soil, which can be a problem for future use of the land for food production. If fertiliser requirements become substantial (because of poor soil), more permanent forests can be an alternative to short rotation crops. Usually pesticides are not needed for energy plantations. Sweden and other countries have substantial experience with willow as an energy crop.
By 2020 the energy yield is expected to reach 32 PJ annually and 40 PJ in 2030.

<u>Requirements:</u>
-expertise must be built on energy crops and straw for energy use. Beside expertise on the technologies, experts should also evaluate how energy plantations are best integrated in Lithuanian agriculture: change of larger areas, or smaller fields among existing farmlands.
-demonstration plants must be built, demonstrating energy plantation and straw use for district heating for one or two towns, engaging farmers and the municipality in the process
-political decisions for the development should ensure a market so farmers can invest in machines and in conversion into energy plantations.
-loans for farmers for transition is needed because there is no income the first 2-3 years with coppice.
-market – building with standard contracts and agreed price levels, to ensure the economy for farmers as well for the energy installations.
-use of EU Common Agricultural Policies and EU structural funds to support energy plantations and infrastructure as possible. (regarding agricultural policy, see: http://ec.europa.eu/agriculture/markets/sfp/index_en.htm)

Economy:
-investment in straw balers and machines to plant and cut willow and other energy crops
-investment in energy plantations (work, time without income)
-annual work to bale the straw and cover it, to harvest energy plantation, and to transport to heating stations.

A Danish evaluation of costs of willow plantation is that it will production costs can be 3.7 Eur/GJ equal to 10 €/Mwh with an interest rate of 6% and a yield of 10 tons dry matter pr. ha pr. year and regional transport of the produced wood-chips. To this should be added land rent and profit margin. It is likely that costs will be the same in Lithuania for smaller scale production; but due to lower wages the costs can be lower with larger scale production.

Increased use of biomass for CHP and district heating, partly with energy plantations
With the plan is proposed to increase biomass use. The main increases until 2020 are in district heating stations and in CHP plants.

For CHP stations is proposed an increase in use of solid biomass from 0.01 PJ in 2000 to 39 PJ in 2020, effectively creating a new power sector that provides 65% of the power from CHP plants (remaining 20% from gas, and from oil and biogas), resulting in power production of 17 PJ (4.6 TWh). With a capacity factor of 5500 hours/year (mainly base load) there is a need for construction of about 850 MW-electric of CHP plants. Based on current heat loads in Lithuanian district heating systems, the capacities could be installed for the following cities:

Site	Heat load 2005 (GWh)	CHP nominel heat capacity** (MW-heat)	Electric efficiency	Electricity /heat ratio ****	CHP nominel electric capacity (MW-electric)
Vilnius*	2,982	364	48%	1.60	580
Kaunas	1,631	199	45%	1.36	270
Mazeikiei	403	49	40%	1.05	50
Lithuanian PP	171	21	39%	1.00	21
Other towns	5,452	op til 650***	38%	0.95	200-400
Total	10,639				1100 – 1300

*Eventually two units of 300 MW each or one unit of 400 MW
** Nominel capacities are derived from heat loads as average loads + 7%. This comes from the criteria that the CHP plants should be able to operate on minimum heat loads, from the assumptions that minimal heat load is 40% of average load and that minimum capacity of the CHP plants is 33% of nominel capacity.
***With this vision we only propose that about half the potential CHP capacity of smaller towns is installed.
**** On the assumption of a total efficiency of 78%.
See sources for power plant data at A vision for Lithuania based on INFORSE's Vision2050, -Background note, Version December 17, 2008

The electric capacities of the proposed power plants are considerably larger than the capacity of the existing gas-fired CHP stations. This is possible because of the higher electric efficiency of the new, state-of-the-art power plants and therefore a much higher electricity/heat ratio[1]. State-of-the-art power plants similar to those proposed here are currently working in Denmark and Finland with the data described.

In addition to the CHP plants should be constructed heat storages in the form of hot water tanks to allow flexibility in heat delivery independent of power production, 6-12 hours of storage capacity should be adequate.

For heating stations for district heating is proposed an increase in use of solid biomass from 1.65 PJ in 2000 to 6.1 PJ in 2020, and that the efficiency is increased from 77% to 87%. Some of this increase has already taken place. The increase of biomass consumption for heating with 4.55 PJ will require installation of heating plants with of capacity of 300 MW-heat under the assumption of average use of 4000 hours/year. The use of 4000 hours/year (46% capacity factor) is an average for a few boilers used as main source in smaller district heating systems and boilers used as medium load together with biomass CHP plants and gas-fired boilers as peak plants (the CHP plants will need heat supplement in about 4800 hours/year in the examples described above).

The larger biomass power plants require an infrastructure to bring the biomass to the plants; preferably with train and barges rather than lorries. Trains are already regularly carrying biomass in Lithuania, and it is possible to draw on the experience of the Scandinavian countries, where several towns are heated with biomass.

Requirements:
-feasibility studies for individual installations in existing district heating grids, also studying opportunities to combine existing heat loads from district heating, industry, etc.
-financing packages for installations
-political decisions

Economy:

The investment of biomass CHP varies between 1.66 mill. €/MW-electric for large plants (i.e. 400 MW-electric) to 3.2 mill €/MW for smaller plants (10 MW-electric). It is proposed that there will be 670 MW-electric of large plants with an investment of 1120 mill. € and 180 MW of small plants with an investment of 580 mill. € (3.2 mill. €/MW), total investments about 1700 mill. €.

In the table on the next page is an overview of possible biomass power plants with indicative costs and technical parameters. The source for technical and economic parameters are "*Technology Data for Electricity and Heat Generating Plants*"2. and investment costs are added 27% from price base 2002 to price base 2008. Capacities are derived from heat demands and electricity/heat ratios of the proposed plants, Operating hours are estimated from coverage of typical heat loads with 40%

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[1] According to IEA statistics (IEA Energy Balances for non-OECD countries 2000-2001, published in Paris) the realised electric efficiency of the Lithuanian gas-fired CHP plants was 19% in 2000 and the electricity/heat ratio 0.38. With this electricity/heat ratio the electric capacity of a CHP plant for Vilnius should be just 138 MW.

[2] Report published by the Danish Energy Authority et.al. March 2005, ISBN: 87-7844-503-5 (available from www.ens.dk), data for solid biomass fired power plants, of 10 MW and 400 MW. Data for Kaunas and Mazeikei are found with interpolation

minimum load and verified with hourly modelling with EnergyPlan[3] Biomass fuel costs are assumed from market conditions, and they should be further evaluated.

Possible Biomass Power Plants		Vilnius BPP	Kaunas BPP	Mazeikei BPP	Other towns
Specific invest-ment costs	mill. € / MW-e	1,66	2,0	2,8	3,2 @ 10 MW-e
Capacity installed	MW-e	400	270	50	130
Total investment	mill. €	660	549	138	413
Lifetime	years	30	30	30	30****
LFCC@6%*	€/MW-e	119943	147623	200852	230660
O&M-1	€/MW-e/year	25000	40000	65385	70000
O&M-2	€/MWh-e	2,7	6,7	13,6	15
Eq.full load	hours/year	5700	5700	5700	5700
O&M costs	mill €/year	35,9	21,1	7,2	38,9
Eff-el	%	48	45	39	38
Eff-total	%	78	78	78	78
Fuel costs	€/MWh	10	10	8	6
Energy costs, average	€/MWh - total energy	33	38	43	43
Heat selling costs**	€/MWh - heat	21	21	19	17
	Litas/kWh	0,11	0,11	0,10	0,09
Electricity costs**	€/MWh-el	40	51	67	71
	Litas/kWh	0,14	0,17	0,23	0,24

* LFCC = Levelised fixed cost charge, the annual payment to pay back a loan with fixed annual payment. In this case it is a loan with 6% interest rate to be paid over 30 years.
** Electricity and heat costs on the assumption that the heat heat selling price is the production price for heat from biomass heating with the same fuel cost as the one for the CHP plant. It is estimated that these costs will allow distribution via heat networks to consumers at a cost below the household tariff for natural gas (estimated at about 40 €/MWh = 0.14 Litas/kWh = 1.5 Litas/m3) The prices are "gate prices" and do not include distribution losses and distribution costs

The smaller CHP plants will be more expensive to run than the larger ones; but we expect that they can have cheaper fuel because they are closer to the biomass resources and because of lower

[3] EnergyPlan model, developed by Aalborg University, Institute, prof. Henrik Lund et.al.; modelling with 1000 MW windpower and estimated energy demands for Lithuania for 2020.

network costs because of smaller networks, the heat "gate price" can be higher. Even with the cheaper fuel assumed in the calculations, they will produce more expensive energy.

The cost of biomass boiler plants can be estimated to 250,000 €/MW-heat for plants above 2 MW, wood-fired and 20% more for straw-fired plants.[4] Installation of 270 MW, half wood-chip fired, half straw-fired will be 75 mill. €. Operating and maintenance is estimated to be 15,000 – 25,000 €/MW annually in Denmark. In Lithuania wages are lower and O&M costs are therefore estimated to be 10,000 €/MW, leading to total O&M costs of 2.7 mill. €/year. Some of this investment has already taken place and is found to be cost-effective with wood residues as fuel. With the increasing gas and oil prices, also straw-fired heating stations are expected to be cost-effective today, even though they are 20% more expensive in investment than wood-fired stations.

Biogas

The estimated gas production from biogas plants is 1.37 PJ in 2020 and later, divided in 1.01 PJ in agriculture and wastewater plus 0.36 PJ from landfill gas plants. We propose that the plants are to be constructed in the period 2010 – 2020.
For agriculture and wastewater plants, the net production of 1.01 PJ (280 GWh) of energy as gas can fuel 16 MW-electric of CHP plants, with the assumptions of 8000 operating hours/year, 39% electric efficiency, and own consumption of 18% of heat from CHP (for process heat).
There a few working biogas plants in Lithuania; but the technology is not well known among potential users.

<u>Requirements:</u>
Based on the working plants there should be built capacity to operate and maintain biogas plants in Lithuania. This could be with a small knowledge center that also can train coming users of biogas plants and that can be a focal point for biogas activities in Lithuania.
A political decision to use landfill gas should be part of the Lithuanian climate plan.
Support for construction of biogas plants should be introduced, including preferential loans.

<u>Economy:</u>
The investment in biogas can be estimated to about 6.2 mill. €/MW-electric, or a total investment of 100 mill. € for wastewater and landfill gas plants. This is for agricultural plants of capacity of 1 MW electric (medium-large plants). Other plant sizes will have different prices. e.g. a plant with a capacity of 3 MW- will have an investment cost of 3 mill. €/MW. Landfill gas plants have lower investment per MW than biogas plants.
With investment of 6.2 mill. €/MW-electric, 20 years lifetime, 8000 operating hours/year, 6% interest rate, pperating and maintenance costs are estimated to 30 €/MWh-electric equal to 15 €/MWh total energy (based on Danish experience) total costs can then be estimated to 50 €/MWh (0.17 Lt/kWh) of total energy delivered; but can be lower for Lithuania, and will depend on plant size. An assumption for this is that manure and waste is delivered for free at the biogas plant, and the produced sludge is taken away for free by farmers that can use it as fertiliser. Half of the production is electricity and half heat. If the heat cannot be sold, the electricity costs will be 100

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4 Based on REKA plant, 1.7 MW, wood-chip fired, hot-water or low pressure steam, including building and inlet/storage of wood-chips.

€/MWh; but if the heat can be sold for a price similar to heat prioduced from solid biomass (19 €/MWh) the electricity price is about 80 €/MWh (about 0.27 Litas/kWh).
The costs are without risk payment and profit, so it is not certain that the feed-in tariff of 0.30 Litas/kWh will be sufficient to attract investors. On the other hand the co-benefits of biogas in the form of treatment of often difficult organic waste and the production of fertiliser is not included in the economy.

Geothermal energy

The use of geothermal energy is proposed to increase from 0.8 PJ in 2000 to 2.9 PJ in 2020, then covering close to 9% of total district heating consumption (as CHP will be the major source of district heating). It is proposed that this capacity is built 2010-2020.
The increase of geothermal energy use with 2.1 PJ will require construction of geothermal heating plants with a combined capacity of 120 MW, assuming 5000 working hours/year.

Requirements:
-geothermal feasibility studies should be started for district heating systems in the Central and Western parts of Lithuania, where the prospects for geothermal energy are best
- test-drilling for the most promising sites.
-based on results of the feasibility studies, plans and investment packages should be made for the most prospective sites.
-Political decisions to start constructions is the next step.

Economy:
The economy of geothermal energy plants depends very much on the site, in particular the geothermal source available and the heat demand.
Investment costs for a geothermal heating plant with a gas-fired heat pump and using geothermal water of 45’C in Denmark is estimated to 800,000 € / MW; but with higher temperature of the geothermal water, the costs will be lower.
Energy production costs for geothermal heating plants with heat pump is estimated to be 20 – 40 €/Mwh (0.07-0.14 Lt/kWh) heat in Denmark; but will be lower if better geothermal reservoirs are found in Lithuania.

The results of the Klaipeda geothermal heating station have not been promising, partly due to lack of planning and disputes with the district heat supplier. The lessons from this station is that geothermal heating must be planned well, and that the heat distributors must be included in planning and operation.

Hydropower

The expansion of hydropower use from 1.5 PJ to 2.7 PJ will be a combination of improving existing plant and construction of new, small hydropower plants. If 2/3 of the incease will be from new plants with an average capacity factor of 0.75 (6500 full load hours per year), it will require construction of 64 MW of small hydropower.
In order to realise this, investors in the hydropower plants should have a guaranteed tariff for 20 years, or a similar support scheme. Substantial construction has already taken place; but the full potential is not used yet.

Solar Energy

There is no market for solar energy installations in Lithuania for the moment. This is expected to change after 2010; with the development of solar heating expected to start and result in average installations of 10,000 m2/year 2010 - 2020 (total 100,000 m^2 installed in 2020).

Requirements:
-Demonstration program for solar energy
-Support scheme for solar heating in selected applications

Economy:
-Installation of solar heating will require an investments of (2 mill. €/year (200 Eur/m2))
-Energy Production: 40 GWh/year in 2020, replacing heat from gas with an efficiency of 80%, leading to gas consumption reduction of 50 GWh/year.
In general solar heating will have a good economy for larger users that use expensive energy for water heating such as electricity or eventually gas. Also self-build systems will be cost-effective if they are built with high enough quality to last 20 years.

Heating efficiency

It is proposed that a 22% reduction of specific heat use in residential buildings will be implemented until 2020 and a similar 8-9% reduction in service sector buildings (realisations of proposals from National Energy Savings Program). This will require investment in a number of heat conversation measures such as improvements of building envelops (roofs, windows, floors, walls) and of heating systems (insulation and renovation of heat pipes). The National Energy Savings Program has described the measures in details. The measures are economic beneficial according to the National Energy Savings Program. With the increasing fuel prices, even more measures can be expected to be cost-effective.
In addition to realising the economic potential identified by the National Energy Savings Program, is proposed a long-term effort leading to reductions in specific heat demand of 2-3%/year after 2020. This will require further improvements of building codes, continued information on energy efficiency, and in general an ambitious implementation of the EU “buildings directive” on energy efficiency in buildings.

Energy efficiency in Electricity

For energy efficiency in electricity use is proposed an increase of 1-4%/year. To realise that is proposed:
-a levy of 2% on the electricity price to be used to improve electricity efficiency with information and subsidies.
-information campaigns on the savings possible with energy efficiency in electricity use for all sectors including the residential sector. As part of that should be specific campaigns for the different industry and service sectors. The campaigns should use existing EU labelling schemes, but also include equipment that is not yet covered by labelling.
-targeted subsidies for purchase of the most efficient equipment, for avoiding inefficient equipment, and for replacing electric heating with other forms of heating.

The proposed measures are expected to be cost-effective, including the payment of the 2% levy. Regular evaluations should monitor the cost-effectiveness of the schemes to ensure the maximum benefits for the users and for the environment.

Energy efficiency in Industry and Private Service

While private sectors are covered by above-mentioned activities for space heating and electricity, there is a need for additional actions to improve energy efficiency in the commercial sectors. The above-mentioned sector specific information campaigns for electric efficiency can be expanded to cover all types of energy. In addition can be introduced energy taxes, voluntary agreements of implementation of all cost-effective measures, special financing etc.

Energy Efficiency in Public Service

The public sectors are covered by above-mentioned activities for space-heating and electricity; but also for the public sectors special additional actions will be beneficial. Public institutions should carry out all energy efficiency measures with simple pay-back periods below 6-10 years. To enable this, funding must be available for the investments. As an incentive, public institutions should be able to keep a part of the economic savings from energy efficiency measures for the first years after the investment.

Further, institutions should always purchase equipment with the highest efficiency, or at least the highest cost-effective efficiency. If the energy efficiency equipment is more expensive, the investment budgets must be increased with the cost-effective part of the extra cost.

Energy efficiency in Transport

Energy eficiency in transport in an important part of the vision. It can be increased in a number of ways:

-taxation for car use and for car registration/import shall be graduated according to energy consumption.

-public transport companies shall have incentives to increase energy efficiency, e.g. by a levy of their fuel use that is recycled to energy efficiency improvements in public transport. It is important that such a levy is set on a level where it will not harm public transport compared with individual transport.

-tax incentives to use public transport to and from work, and to use by-cycling.

-eventually tax penalties for long-distance commuting.

-campaigns on real cost of buying inefficient cars, such as old, imported cars.

In addition, urban and national planning should minimise transport needs and favour rail transport and by-cycling over motorised road transport, in particular personal cars.

About this note

This note was developed by Gunnar Boye Olesen, INFORSE-Europe in cooperation with Saulius Piksrys, Bendrija Atgaja for the Vision2050 for Lithuanuia.

When no other **sources** are given, the following sources are used:

-use of renewable energy and increase of energy efficiency in Lithiania “Vision for a sustainable energy development for EU – 25, 2000 – 2050 - A vision for Lithuania based on INFORSE's Vision2050. Background note, INFORSE-Europe.

-costs and efficiencies “Technology Data for Electricity and Heat Generating Plants” by Danish Energy Agency and others, March 2005. Available from www.ens.dk

Read more about the vision for other countries at www.inforse.org/europe. Please send comments to ove@inforse.org and/or saulius@atgaja.lt.

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