Opportunities for utilisation of biomass residues in the renewable sector in Ukraine

Project outline

This project explored new opportunities for producing renewable energy from biomass residues in Ukraine. Its goal was to conduct a study to identify the optimal concepts for the supply, logistics and final utilisation of biomass for energy. The study was implemented by outlining the KPI[1] benchmarks of 8 case studies from Finland and Ukraine using various biomass types, such as agricultural crop and forestry residues, and livestock residues and industrial organic by-products. These case studies centred on converting wood residues into woodchips and pellet fuel as well as biodegradable feedstock into biogas and digestate, which can further be used as fertilizer. The findings of the project include a gap analysis of the biomass value chain from the initial feedstock supply and logistics to the final utilisation. This gap analysis has been used to prepare a roadmap for sector development which identifies technical and policy gaps, and proposes possibilities to boost the growth of the biomass-to-energy market in Ukraine.

Current situation

Official* projected distribution of fuel and energy resources from 2020 - 2035

Figure 1

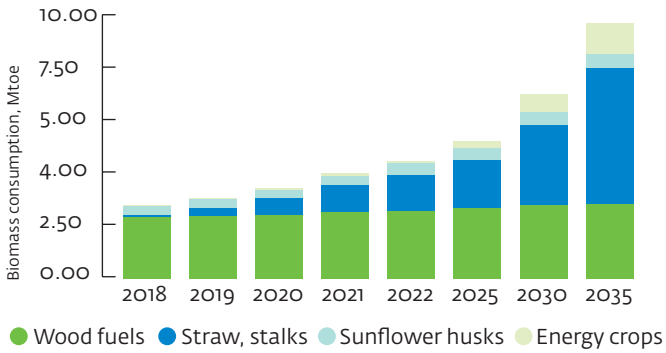
Consumption, Mtoe	2020	2025	2030	2035
Coal	18.00	14.00	13.00	12.00
Natural Gas	24.30	27.00	28.00	29.00
Oil Products	9.50	8.00	7.50	7.00
Nuclear Power	24.00	28.00	27.00	24.00
Biomass, biofuel, waste	4.00	6.00	8.00	11.00
Solar and wind energy	1.00	2.00	5.00	10.00
Hydro	1.00	1.00	1.00	1.00
Ambient power	0.50	1.00	1.50	2.00
Total	**82,30**	**87,00**	**91,00**	**96,00**

* approved by Cabinet of Ministers of Ukraine in 2017

The Energy Strategy of Ukraine until 2035, approved by the Cabinet of Ministers of Ukraine in 2017, projected that RES fuel sources will cover on average a 15% share of the total fuel balance, and RES bioenergy in 2020-2035 will cover on average 45% of consumption of energy resources as can be summarized from Figure 1. Thus, bioenergy will be the major contributor to the renewable energy targets.

Forecast of total consumption and structure of solid biomass in Ukraine from 2018 - 2035

Figure 2*



Biomass type	2018	2019	2020	2021	2022	2025	2030	2035
Wood fuels	2.35	2.40	2.45	2.55	2.60	2.70	2.80	2.85
Straw, stalks	0.10	0.40	0.70	1.10	1.45	1.89	3.12	5.26
Sunflower husks	0.34	0.38	0.40	0.43	0.49	0.54	0.58	0.59
Energy crops	0.01	0.04	0.05	0.10	0.11	0.27	0.70	1.20
Total	**2.80**	**3.22**	**3.60**	**4.18**	**4.65**	**5.40**	**7.20**	**9.90**

*This biomass covers only woody and agricutural solid biomass.
Source: SECB expert projections

The main constituents of the biomass potential in Ukraine are agricultural biomass, such as agro residues and by-products of crop production, as well as energy crops (e.g., willow and miscanthus), while the available resources of woody biomass for energy are rather limited and are not expected to increase as shown in Figure 2.

[1] Key Performance Indicators (process efficiency, load factor, specific energy consumption, energy losses, specific investment cost, specific operational and maintenance cost, etc.)

Key figures for woody and agricultural residue biomass market development in Ukraine from 2019–2035

9.9 Mtoe by 2035

The total demand for biomass in 2035 is expected to triple compared to the 2019 figures.

0.4 Mtoe/a to 2035

Predicted high growth in biomass demand for the upcoming years, on average 13 % p.a.

0.39 Mtoe/a

Significant growth in agricultural biomass, on average 47% p.a.

0.03 Mtoe/a or 1.2%

In comparison, woody biomass growth is severely limited at less than 1.2% p.a., mainly due to forest cleaning.

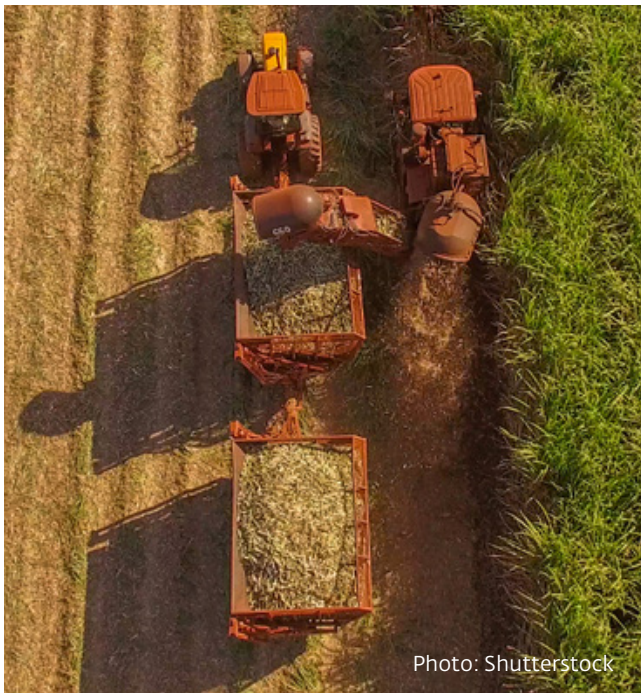


Photo: Shutterstock

Photo: SECB/Mykyta Sadyka

Project background

The project was financed by the Finland Ukraine Trust Fund, which provides grant financing to promote cooperation in the fields of energy efficiency, renewable energy and alternative types of energy sources in power and heat generation and district heating networks. The Fund is financed by the Ministry for Foreign Affairs of Finland and managed by NEFCO. The local coordinator is the State Agency on Energy Efficiency and Energy Saving of Ukraine (SAEE). For more information please visit www.nefco.org/finland-ukraine.

Project contribution to the Agenda 2030 and the Sustainable Development Goals

NEFCO contact info and link to additional materials

During the implementation of the project, a two-day seminar was organised in Kyiv in February 2020 for market stakeholders together with experience transfer between Ukrainian and Finnish companies in the bioenergy sector. The materials presented during the seminar can be found at www.nefco.org/finland-ukraine.

Identified key gaps and recommendations

Identified key technical gaps	Recommendations
Key gaps for overall solid biomass resources, and the supply and harvesting chain	
• Low quality control and lack of standardization for biomass fuels • Lack of available bioenergy feedstock from agriculture, industrial organic by-products and forestry residues • Lack of residue harvesting from logging sites (an important potential source for low quality wood fuel) • Complicated road access to logging residues • Absence of record keeping for the logging residues; absence of data on the amount of residues in felling areas	• **Introduction of a bioenergy exchange market for solid fuels and feedstock for biogas facilities** • **Introduction of a fuel and feedstock certification standard and confirmation procedures for the quality of raw materials** • Establishment of certified laboratories specialising in the quality of raw materials • Increasing the efficiency of lumbering activities and introducing modern technologies for logging • Dissemination of information on harvesting and the volume of harvesting residues; obligating the forestry industry to collect residues and set targets for their use
• Lack of special high-productivity equipment for chipping wood residues to provide large quantities of raw materials for energy utilities • Lack of specialised machinery for forestry operations, especially for accessing and harvesting wood fuel	• Increasing financing for state forest enterprises and facilitating the updating of their machinery and technical handling basis • Encouraging the creation of small and medium-size enterprises supplying specialised machinery, creating leasing programmes and credit systems for acquiring specialised machinery
• Lack of forest roads hampers access to forest resources	• Imposing an obligation on state forest enterprises to transport 80% of felling residues to the nearest roads to be gathered for solid biofuel production
Key gaps for biomass utilisation for energy	
• Lack and high cost of equipment capable of burning wet fuel, bark and wood waste	• Increasing the demand for and encouraging businesses to acquire boilers capable of burning high humidity fuel and promoting widespread development of technology and equipment
• Limited access to heat and power networks	• **Development of a competitive heating market in which independent producers can connect to the district heating network**
• Price of the heat from biogas facilities is not competitive with price of the heat from natural gas • Lack of support for biomethane production and use as a substitute for natural gas • Low-efficiency of energy conversion into power; thermal energy losses	• Establishment of strategic targets and a subsidy or support mechanism for biomethane production and use as a substitute for natural gas
• Lack of experience, in particular with lignocellulosic materials (straw); underdeveloped biofuel market	• Introduction of information and research campaigns • **Development of pilot demonstration projects for the production of biogas based on lignocellulosic raw materials**
• Lack of certification for organic fertiliser and farming • Lack of machinery for digestate handling	• **Development of a fertiliser market**
Key institutional, economic and commercial gaps	**Recommendations**
• The high price of solid biomass (wood chips, pellets and briquettes)	• Increasing fuel efficiency and reducing costs • **Development of incentives and benefits for biomass producers in the domestic market and considering export restrictions**
• The high price of wood chips from firewood resulting in the production of thermal energy that cannot be priced competitively against traditional fuels (natural gas)	• Prioritising low-quality and low-cost fuel, waste and industrial organic by-product use in medium and high capacity plants in district heating
• High transportation costs	• Optimisation of logistics; promoting biofuel logistics centres and depots
• Complicated procedure of project development in parallel with high degree of institutional challenges	• Preparation of well-thought-out projects based on a strong project team in order to ensure smooth project development and minimize institutional challenges and risks
• Practical problems and lack of experience using agricultural biomass as fuel or raw material	• Use of agricultural waste mainly for boiler plants with the application of modern specialised boilers; following fuel requirements and maintaining optimal operating modes
• Lack of dissemination of information about successful cases on energy production from agro-biomass	• Promoting successful cases of agro-biomass energy production, increasing the reach of information

Identified key policy and regulatory gaps and barriers for overall sector	Recommendations for Ukraine based on the European experience
• Underdeveloped biofuel/biomass market, short-term contracts for fuel/raw materials supply • Fuel quality assurance	• **Introduction of a biomass exchange similar to Baltpool in the Baltic states or Finbex in Finland and the introduction of biomass quality assurance** • Formation and implementation of state policy in the field of production and use of biomass
• Low attractiveness of biomass/biogas projects due to low green tariffs, high discount rates, limited third-party access to heat networks	• **Extension of feed-in tariff (FIT) for electricity produced from biomass/ biogas; implementation of a special tariff for small-scale projects and extending the FIT validity period; ensuring access to DH networks for biomass-to-heat producers**
• Difficulties raising funds for agricultural bioenergy projects	• **Introduction of targeted state support for harvesting/collection of certain types of agricultural biomass for energy**
• Difficulties arranging agricultural biomass collection supply chains	• Encouraging the application of the best international and national experience and practice in agricultural biomass collection supply chains
• Underdeveloped state policy on the use of agricultural biomass for energy	• **Development and promulgation of the state strategy for the use of agricultural biomass for energy**
• Lack of support for biomethane production and use as an alternative gas substitution • Low level of engagement of small/medium farms for biogas production • Lack of support for biomethane; lack of legislation for biomethane production and use in transportation and households	• **Adaptation of a legal framework for biomethane production and consumption support** • Establishment of strategic targets for biomethane production and use as engine fuels, i.e. a green vehicle premium, support for filling stations, investment grants or introduction of subsidies for biomethane transport infrastructure development • Green tariff differentiation; implementation of a special tariff for small-scale projects; extending the FIT validity period
• Underdeveloped organic farming and digestate applications • Low market demand for digestate-based fertiliser products	• **Development of legislative and regulatory policy to support the market of digestates and introduction of the certification and standardisation of their quality** • Awareness-raising of digestate products • **Development of the organic fertiliser market;** accelerated implementation of new law No. 2496-VIII 'On the basic principles and requirements for organic production, circulation and labelling of organic products'
• High level of state regulation of heat and electricity production and limited level of project profitability • Problems with grid connection; seasonal variation in thermal energy demand; lack of clear state policy and support for waste and renewable energy production	• Encouraging competition in heat and electricity production • Creation of simplified rules and incentives, especially for small-scale biogas and biomass projects

Photo: Shutterstock

Biomass market for thermal energy, electricity and motor fuels production in Ukraine. Opportunities and challenges

Yuri Matveev, Yevhen Oliinyk
SEC BIomass

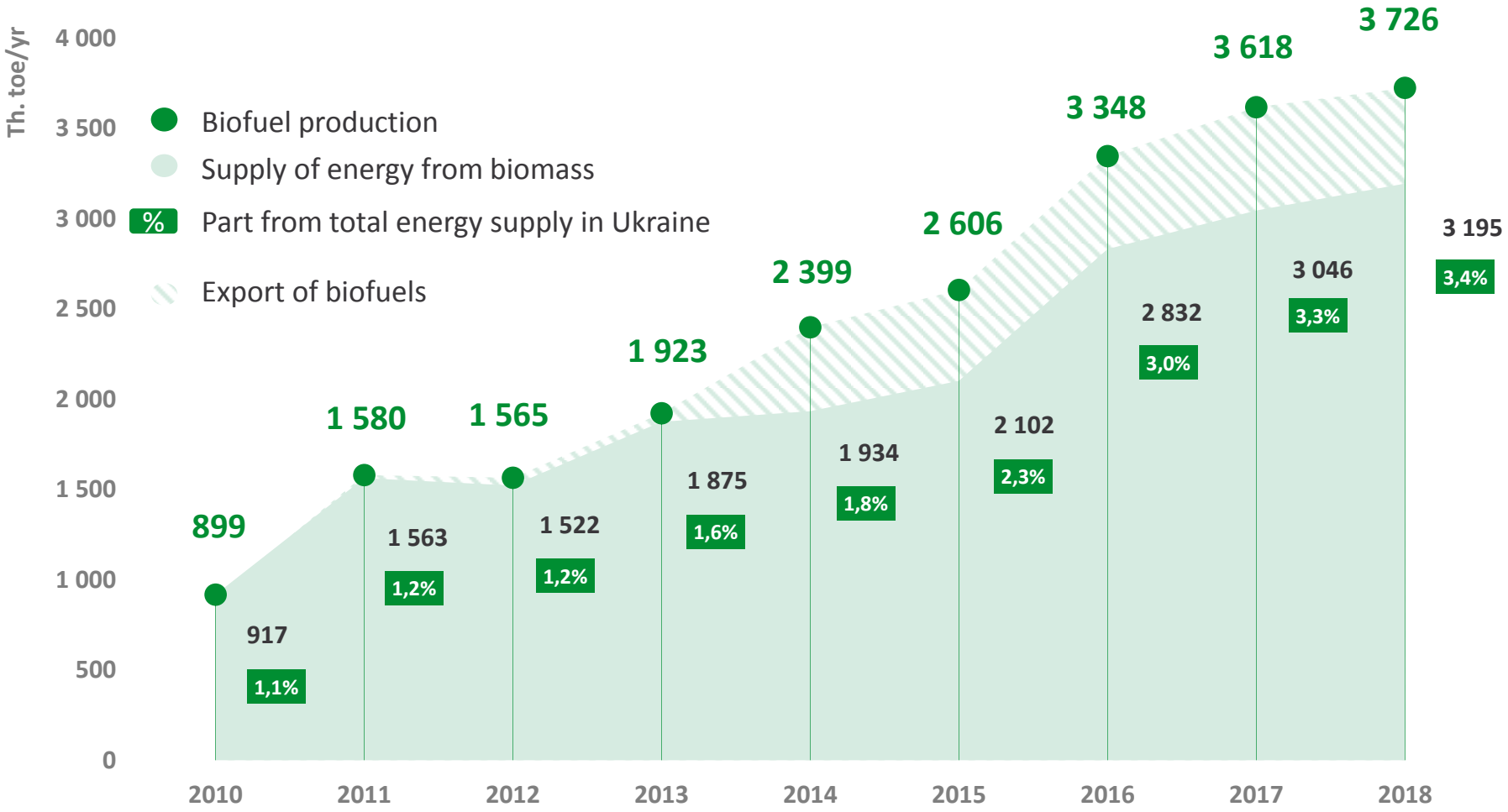
Seminar-presentation of project results/
Kyiv

06.02.2020

Bioenergy grouth in Ukraine

31%

per annum



Source: State Statistics Service of Ukraine

Forecast of Bioenergy Development in Ukraine – growth in more than 5 times (2015 – 2035)

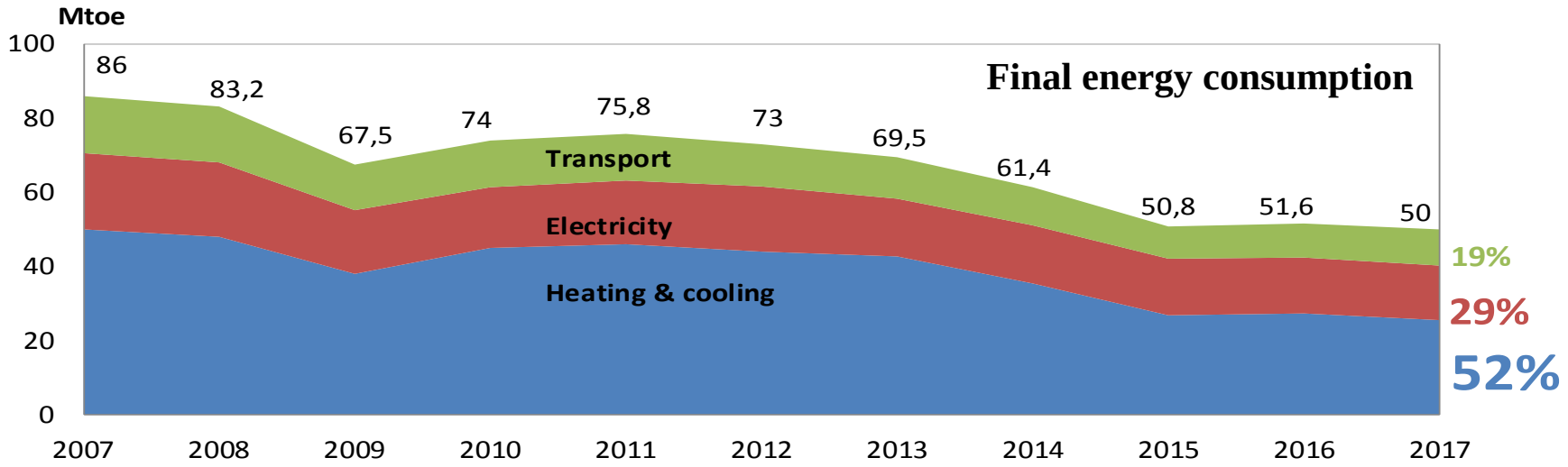
Structure of total primary energy supply according to the Energy Strategy of Ukraine until 2035

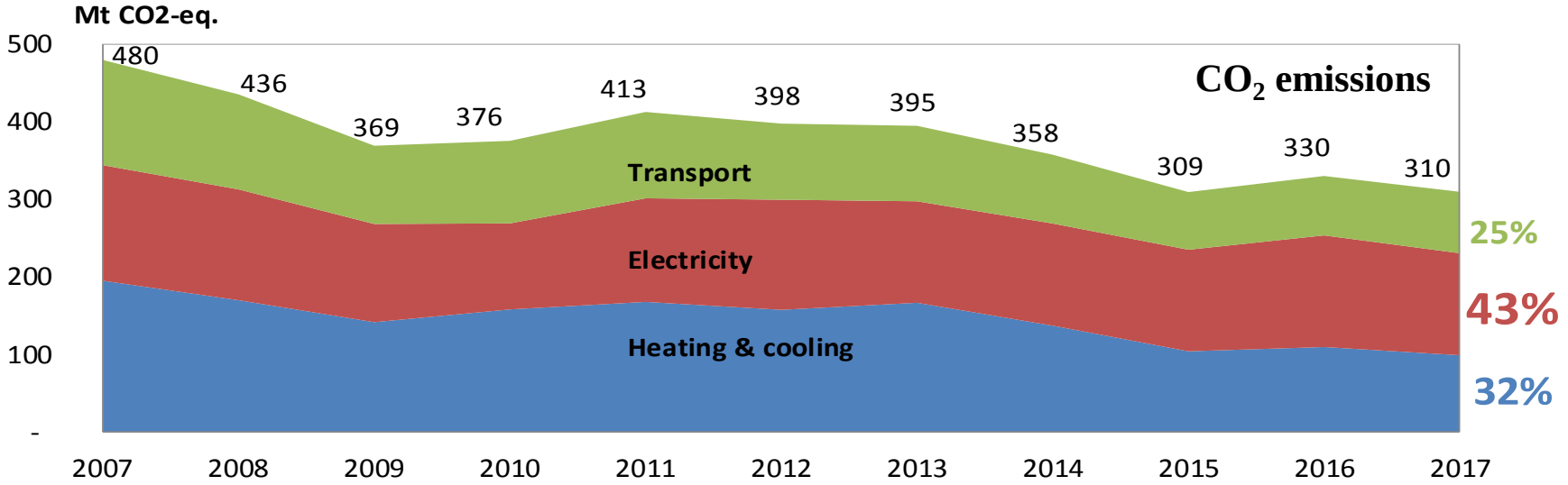
Type of energy source	2015 (fact)	2020 (forecast)	2025 (forecast)	2030 (forecast)	2035 (forecast)
Coal	27,3	18	14	13	12
Natural Gas	26,1	24,3	27	28	29
Oil Products	10,5	9,5	8	7,5	7
Nuclear Energy	23	24	28	27	24
Biomass, Biofuels and Wastes	2,1	4	6	8	11
Solar and Wind Energy	0,1	1	2	5	10
Hydro Energy	0,5	1	1	1	1
Thermal energy	0,5	0,5	1	1,5	2
TOTAL, Mtoe	90,1	82,3	87	91	96

Source:
http://mpe.kmu.gov.ua/minugol/control/uk/publish/article?art_id=245234085&cat_id=35109

«Energy» is not equal «Electric Energy»

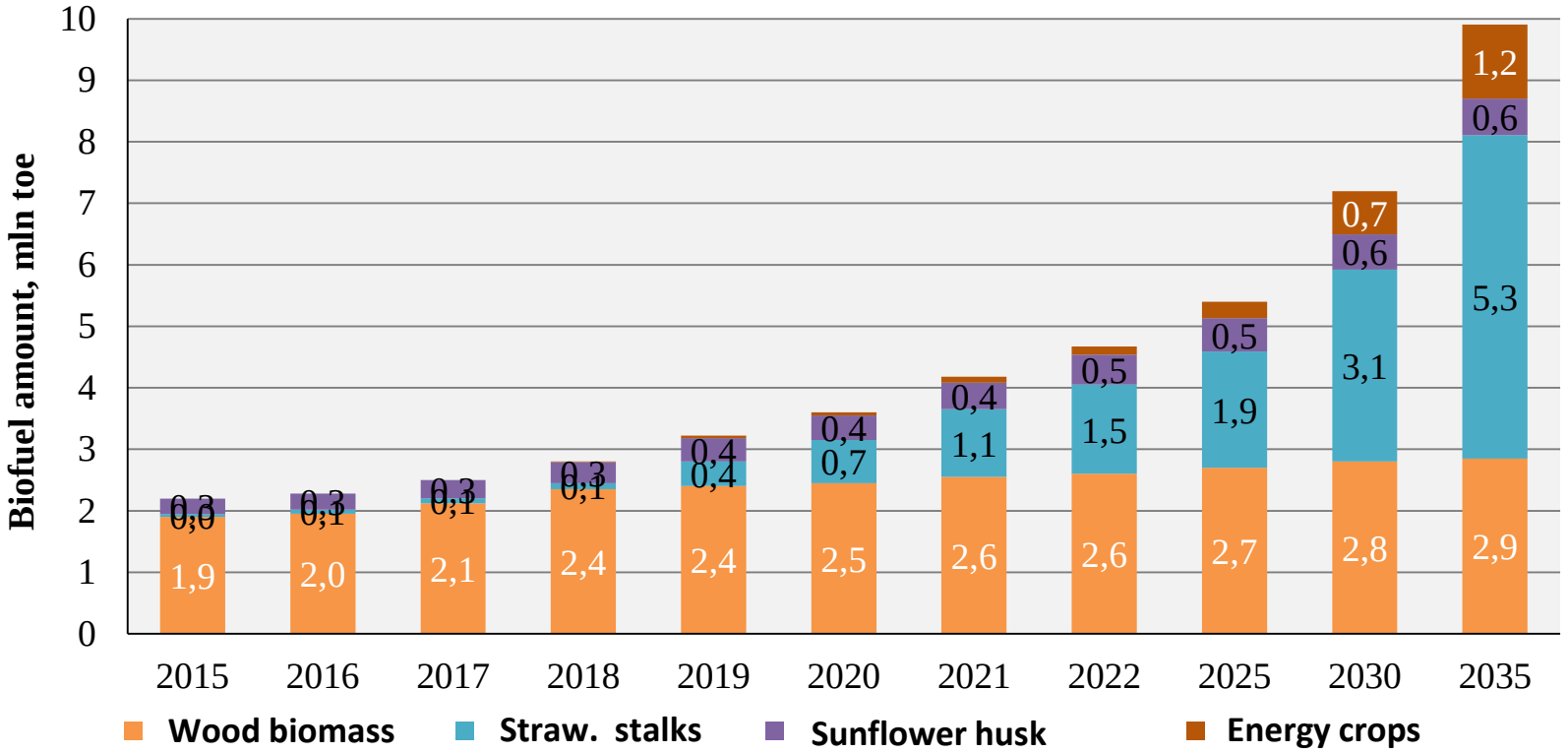
Structure of final energy consumption of Ukraine and CO_2 emissions, 2007-2017





Agrobiomass is a Future of Bioenergy in Ukraine

Forecast of total consumption and structure of solid biofuels in Ukraine (2015 – 2035)



Biomass type	2015	2016	2017	2018	2019	2020	2021	2022	2025	2030	2035
Wood fuels	1,90	1,95	2,12	2,35	2,40	2,45	2,55	2,60	2,70	2,80	2,85
Straw, stalks	0,05	0,07	0,08	0,10	0,40	0,70	1,10	1,45	1,89	3,12	5,26
Sunflower husk	0,25	0,26	0,30	0,34	0,38	0,40	0,43	0,49	0,54	0,58	0,59
Energy crops	0,00	0,00	0,00	0,01	0,04	0,05	0,10	0,13	0,27	0,70	1,20
TOTAL, Mtoe	**2,20**	**2,28**	**2,50**	**2,80**	**3,22**	**3,60**	**4,18**	**4,67**	**5,40**	**7,20**	**9,90**

Energy Potential of Biomass in Ukraine exceeds 25 bln m^3 of natural gas/year (2017)

Type of biomass	Theoretical potential, Mt	Potential available for energy		
		Share of theoretical potential, %	Mtoe	
Straw of grain crops	35,6	30	3,65	43%
Straw of rape	3,9	40	0,54	
By-products of grain corn production (stalks, cobs)	32,1	40	2,45	
By-products of sunflower production (stalks, heads)	23,2	40	1,33	
Secondary agricultural residues (sunflower husk)	2,4	100	0,99	
Wood biomass (firewood, felling residues, wood processing waste)	6,6	94	1,54	
Wood biomass (dead wood, wood from shelterbelt forests, pruning)	8,8	44	1,01	
Biodiesel (rapeseed)	-	-	0,31	
Bioethanol (corn and sugar beet)	-	-	0,59	
Biogas from waste and by-products of agricultural sector	1,6 bln m^3 CH_4	50	0,68	
Landfill gas	0,6 bln m^3 CH_4	34	0,18	
Sewage gas (industrial and municipal wastewater)	1,0 bln m^3 CH_4	23	0,19	
Energy crops:				
- willow, poplar, miscanthus (1 mln ha*)	11,5	100	4,88	36%
- corn for biogas (1 mln ha*)	3,0 bln m^3 CH_4	100	2,58	
TOTAL	-	-	20,92	

* *In case of growing on 1 mln ha of unused agricultural land.*

Roadmap for biomass-to-energy future market growth up to 2050

Objectives of the Roadmap:

- ✓ To suggest ways to tackle the identified technical and regulatory gaps, problems and bottlenecks in the sector.
- ✓ To define next steps required for the sector growth from technical, economical, legal and institutional perspective.

Integration and synergies of the Roadmap with other existing policies:

Bioenergy Roadmap until 2050 is closely interconnected and coherent with the existing and planned strategic documents in Ukraine's energy sector. Based on this:

- ✓ Materials of the Roadmap can be used for the development of new NREAP until 2030; revised Energy Strategy of Ukraine until 2050; Concept of state policy in energy and environmental protection.
- ✓ Roadmap will show how to achieve the existing bioenergy targets until 2035 fixed in the Energy Strategy of Ukraine until 2035.
- ✓ Roadmap will facilitate contribution of bioenergy to Ukraine's international commitments to reduce greenhouse gas emissions under the 2015 Paris Climate Agreement.
- ✓ Bioenergy Roadmap until 2050 is in line with key objectives and points of Ukraine Green Deal Concept until 2050.

Roadmap for biomass-to-energy future market growth up to 2050 (2)

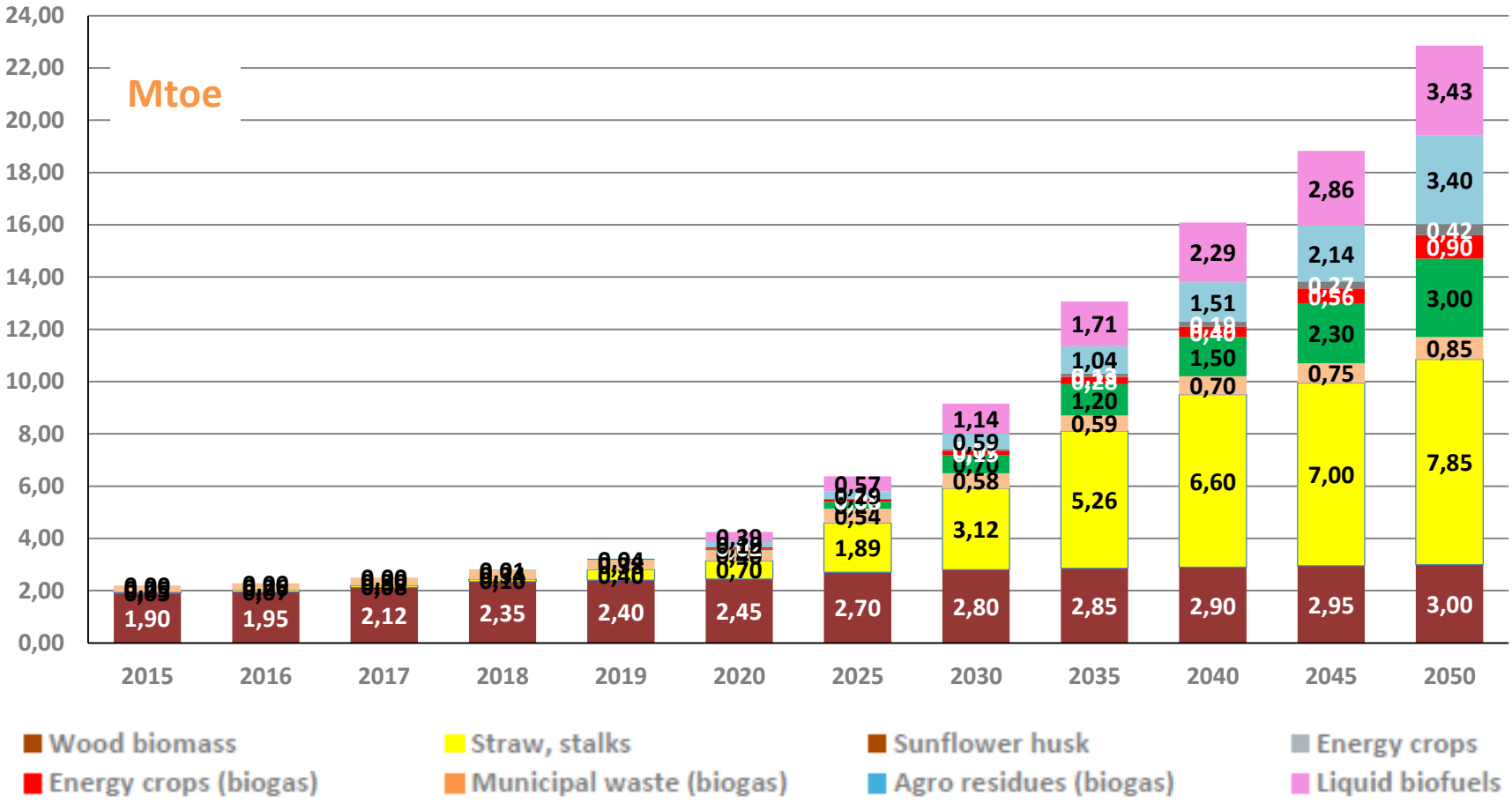
Basic approach and features:

- Starting point: 2020.
- Roadmap is in line with the scenario of up to **70% RES** in the energy balance in 2050 provided that TPES in 2050 will be 33% less than that in 2018 (~ 63 Mtoe in 2050) and the final energy consumption will increase by 8% (~ 55 Mtoe in 2050) .
- Total installed capacity of bioenergy equipment in 2050: **36** GWth and **3.5** GWel.
- Total consumption of biofuels in 2050: **23 Mtoe.**
- Utilisation of biomass potential of 2050 (~**43** Mtoe): up to **60%.** *Factors for*

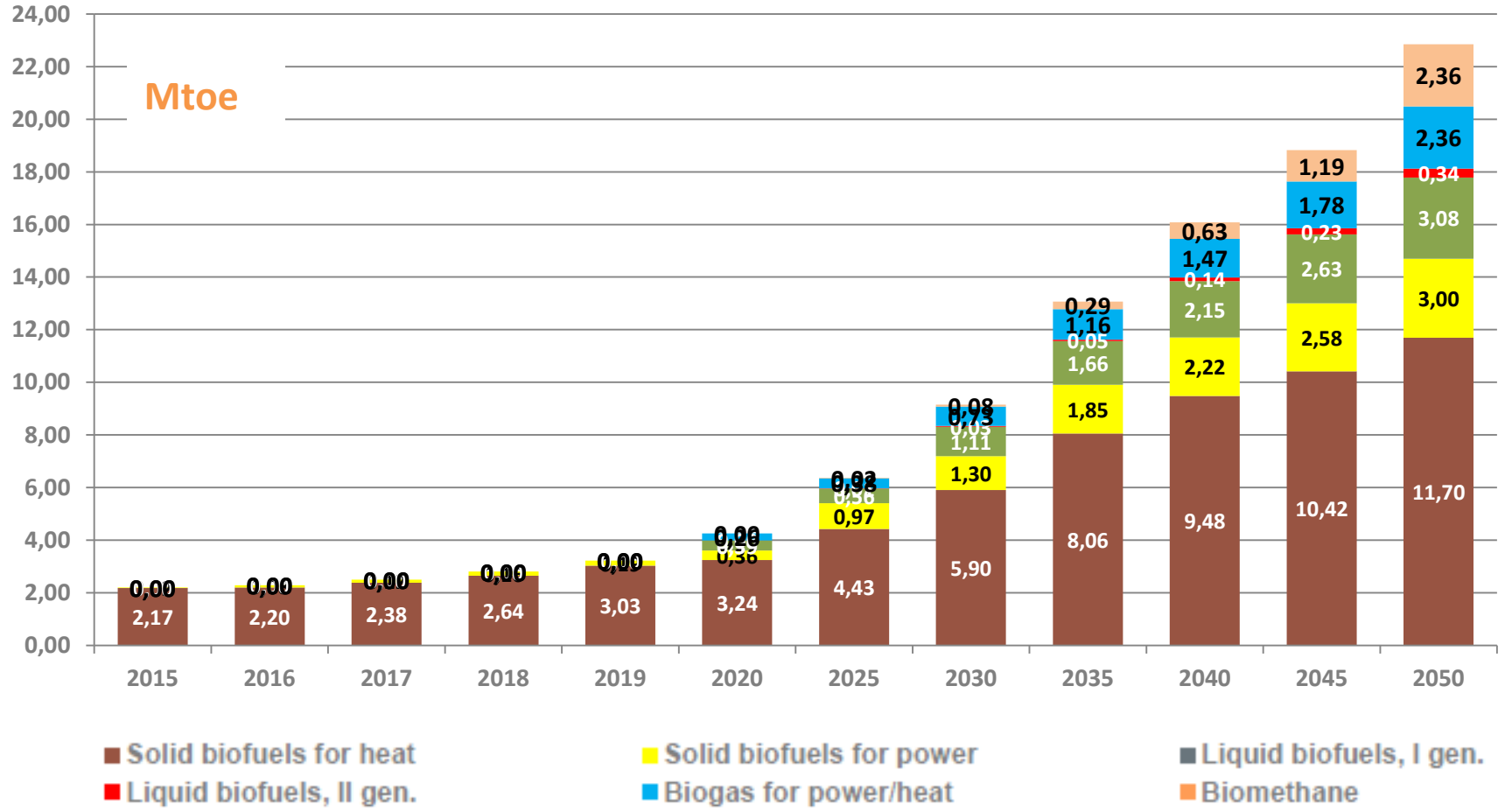
Factors for increased biomass potential in 2050:

- increasing yield of crops;
- increasing share of wood increment cutting in forests;
- rising economic potential of biogas from different types of feedstock;
- enlarging areas under energy crops and increasing yield of energy crops.

Roadmap: Suggested structure of biofuel consumption in Ukraine by type until 2050



Roadmap: Suggested structure of biofuel consumption in Ukraine by the type of energy carrier produced

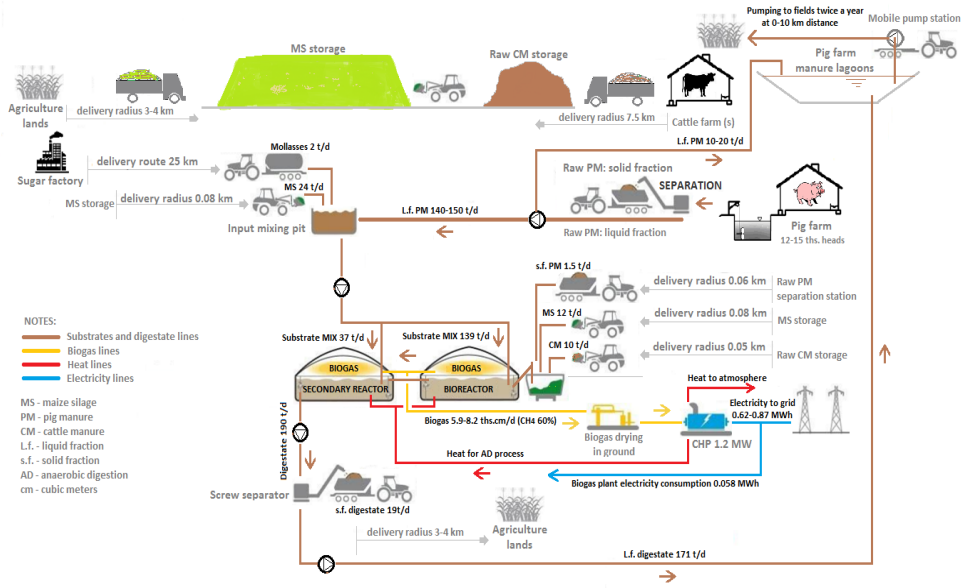


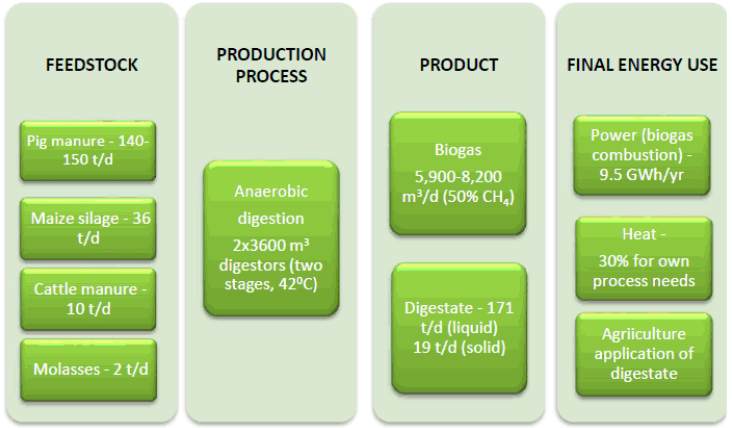
Roadmap for biomass-to-energy future market growth up to 2050 (3)

Key trends during 2020-2050:

- Increasing shares of agro-residues and energy crops in the structure of solid biofuels consumption: up to **60%** and **20**% of the total, respectively, by 2050.
- Minimal rise in the consumption of wood biofuels: **1.2** times by 2050 (against **8** times for agro-residues).
- Considerable increase in the production of **biogas** and **liquid biofuels**: up to 4.7 Mtoe/yr and 3.4 Mtoe/yr, respectively, by 2050.
- Launching and rising production of **biomethane** and **II generation** transportation fuels: up to 2.4 Mtoe/yr and 0.34 Mtoe/yr, respectively, by 2050.

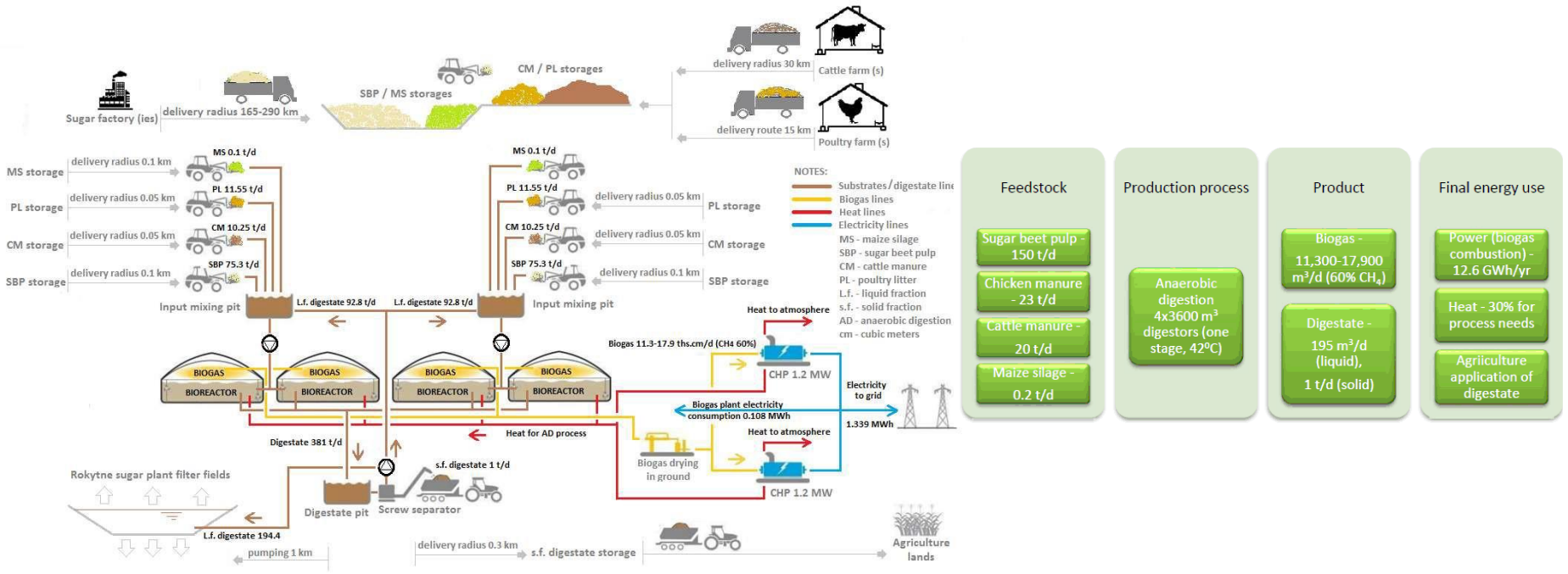
Case 3: Gals-Agro Biogas plant





Country	Ukraine
Project name	Gals-Agro Biogas plant
Ownership	Gals-Agro corporation
Feedstock	Own agricultural residuals and by-products (pig and cattle manure, molasses) and maize silage. No gate fee. Delivery within 7 km (manure), 30 km (molasses) by own transport
Technology	Standard wet process, raw biogas drying and desulfurization
Final energy use	Electricity generation in CHP unit for grid delivery and sell by FIT, heat for own process only, 1.2 MW_e

Case 4: Biogas plant at Rokytne sugar plant Ltd



Country	Ukraine
Project name	Biogas plant at Rokytne sugar plant Ltd.
Ownership	Silhospprodukt corporation
Feedstock	Purchased agricultural residuals and by-products (sugar beet pulp, cattle and chicken manure) and harvested for biogas maize silage. No gate fee
Technology	Standard wet process, raw biogas drying and desulfurization (4x3600m^3)
Final energy use	Electricity generation in CHP unit for grid delivery and sell by FIT, heat for own process only, 2x1.2 MW_e

The similarities, contrasts and differences in the practices used in Finland and Ukraine

Article	Ukraine	Finland
Main feedstocks	Predominant treatment of own raw materials, no gate fee. Purchasing if necessary.	Treatment of different raw materials including manure, centralized organic waste treatment based on gate fee
Feedstock quality and quality control	Lack of feedstock quality control, bad quality of purchased materials possible	Quality control. Suppliers of feedstock are often consumers of digestate
The average market price of feedstock, €/t	0-25 (10)	- (30-50) if gate fee applied
Priority of biogas utilization	Main driver - electricity production by green tariff (FIT), no heat utilisation	Priority of raw biogas for external heating, 2nd priority - biomethane, no power production (except CHP)
Biomethane use	No biogas upgrading to biomethane quality	Biomethane can be use as motor fuel (local feeling station) or delivered to industry consumers in mobile containers
Biomethane prospects	Legislation is needed	Lack of biomethane fuelling car and feeling stations, governmental goal for number of cars and fuelling station
Digestate application	Digestate field application is limited and technically underdeveloped	Digestate field application among local farmers based on no-cost approach
Governmental support	Green tariff (FIT) for power from biogas	Governmental investment support (25%), fixed price for biomethane (1.5€/kg). High price of NG
The level of biogas utilization for heating, %	20-30 (for process heating)	All available customers
Investor interest	Low interest of investors	Mid and high interest of investors

Project #1 Ukraine: Biomass CHP installation of public utility Miskteplovodenergia

- Biomass boiler heat capacity – 15 MW
- ORC unit power capacity – 1,6 MW
- Main fuel – wood chips
- Investment - 12,2 mill $
- Loan (WB) - 9.6 mill $
- Energy production:
  - heat - 44 706 MWh
  - power – 7 160 MWh
- Fuel consumption – 69 548 MW (23 kt)
- Energy efficiency of supply chain – 77%

Project #2 Ukraine: Biomass HOB installation of private company LLC Ukteplo

- Biomass boiler heat capacity –10,5 MW
- Main fuel – wood chips
- Investment - 4 mill $
- Energy production:
  - heat - 32 564 MWh
  - power – 0 MWh
- Fuel consumption –38 300 MW (15 kt)
- Energy efficiency of supply chain –81 %

Fuel supply chain costs and emissions

Fuel supply chain based on old garden comminution at garden

Volume: 2000 t
5560 MWh

RAW material	Felling	Chipping	Transportation	Total:
- €/MWh	5,33 €/MWh	3,64 €/MWh	1,212 €/MWh 4,85 EUR/MWh 100km	16,0 €/MWh
Motor fuels consumption and emissions CO2				
0 kg/MWh 0 kg CO_{2e}/MWh	0 kg/MWh 0 kg CO_{2e}/MWh	1,97 kg/MWh 6,5 kg CO_{2e}/MWh	0,86 kg/MWh 2,8 kg CO_{2e}/MWh	2,83 kg/MWh 9,4 kg CO_{2e}/MWh

Fuel supply chain from forest residues and firelogs based on comminution at forest

Volume: 23 017 t
63 988 MWh

3,2 €/MWh	5,3 €/MWh	3,6 €/MWh	0,823 €/MWh 1,267 EUR/MWh/100km	20,0 €/MWh
Motor fuels consumption and emissions CO2				Total:
0 kg/MWh 0 kg CO_{2e}/MWh	0 kg/MWh 0 kg CO_{2e}/MWh	2,0 kg/MWh 6,5 kg CO_{2e}/MWh	0,5 kg/MWh 1,8 kg CO_{2e}/MWh	2,5 kg/MWh 8,3 kg CO_{2e}/MWh

The value chain steps with most important gap impacts

- **Production process (Gap impact -20).** No special high productivity equipment for chipping wood residues to provide large quantities of raw materials for powerful energy objects.
- **Product (Gap impact -20).** High price of wood chips from firewood. Produced thermal energy can be not competitive with traditional fuels (gas).
- **Heat/Power generation and product (Gap impact -25).**. The lack and high cost of special equipment for burning of wet fuel and bark.
- **Final energy distribution (Gap impact -20).** High level of state regulation of heat and electric energy production and limited level of projects profitability.
- **Heat final use (Gap impact -20**). Problems with grid connection, seasonal consumption of thermal energy, lack of a clear state policy and support for waste and renewable energy consumption.

Priorities for improving normative and legal basis of bioenergy

Lobbying the **required level of state support quotas** for biomass / biogas projects.

Improvement of the stimulation mechanism for **biomethane** production and consumption.

Improvement of the of stimulation mechanism for power generating capacities on biomass, biogas and biomethane for operation in the **balancing capacities market**.

Introducing of the stimulating mechanism for **energy crops cultivation and use** in Ukraine.

Support for implementation of e-commerce system for solid biofuels.

Support the introduction of competition in district heating systems.

Support of the developed mechanism for stimulating the production and use of **liquid biofuels and biogas for transportation.**

Promoting the need to abolish the **tax on CO_2 emissions** from boiler houses, TPPs / CHPs on biomass and biogas.

We are making the green future

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Development for Opportunities for Utilisation of Biomass Residues in the Renewable Sector of Ukraine

Biomass to heat and Power - FIN/UA cases

Result Seminar, Kyiv, Feb 05th and 06th 2020

Mr Matti Virkkunen, VTT,
Mr Yevhen Oliinyk, SEC Biomass

Background

Wood-based bioenergy is a by-product of sustainable forestry

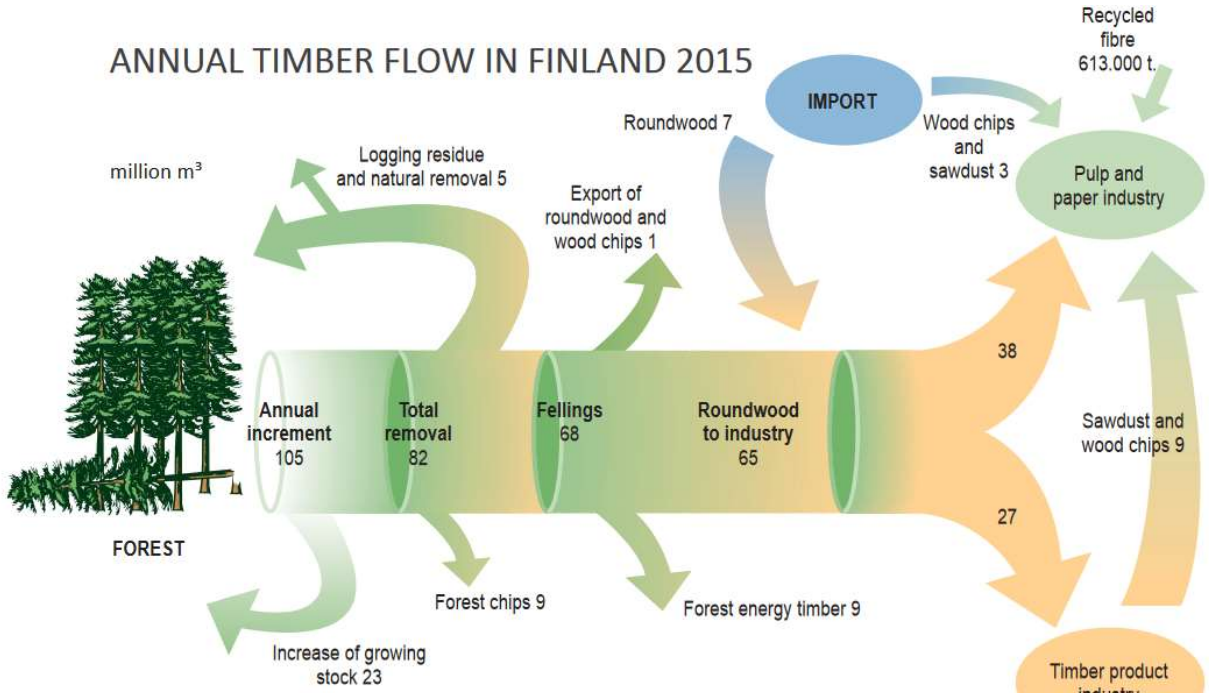
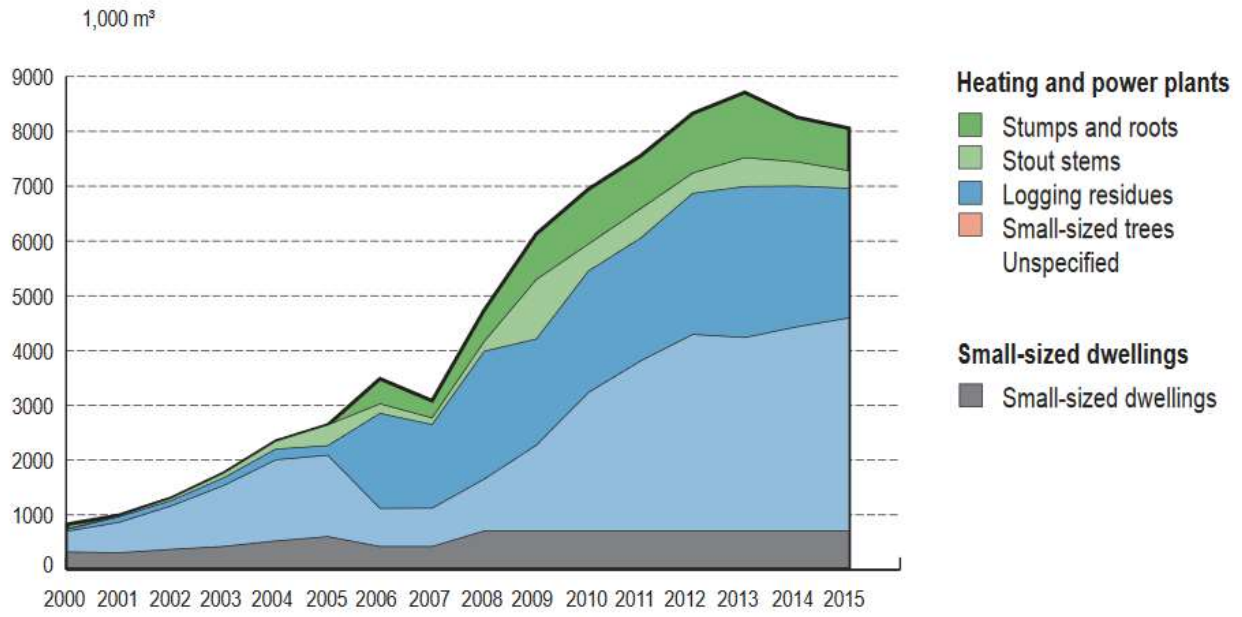


Image source: forest.fi

Forest based energy in Finland



- The use of forest chips has almost multiplied by ten during the 2000's. finland's goal is that in 2020 the annual use is 13.5 million cubic meters.
- Felled stout timber is made into forest chips, if it has such faults that it cannot be used as timber or pulp wood. Such a fault can be decay, for example.
- Source: Natural Resources Institute Finland (stat.luke.fi). Updated 19.4.2016.

Image source: forest.fi

Forest based energy in Finland

SOLID WOOD FUEL CONSUMPTION IN HEATING AND POWER PLANTS IN 2015

FUEL	Solid volume mill.m3	share, %	Energy content TWh	share, %	Users
FOREST CHIPS	**7.35**	**40.2**	**14.68**	**42.1**	**985**
FOREST INDUSTRY BY-PRODUCTS	**10.10**	**55.3**	**18.27**	**52.4**	-
industrial chips	1.02	5.6	2.06	5.9	200
sawdust	2.15	11.8	4.28	12.3	245
bark	6.92	37.9	11.90	34.1	190
other	0.02	0.1	0.03	0.1	3
WOOD PELLETS AND BRIQUETTES	**0.14**	**0.7**	**0.73**	**2.1**	**240**
RECYCLED WOOD	**0.69**	**3.8**	**1.19**	**3.4**	**105**
TOTAL	**18.27**	**100**	**34.87**	**100**	-

- The bulk density of 1,150 kg/m3 has been usen in converting pellets and briquettes into solid volume.
- Source: Natural Resources Institute Finland (stat.luke.fi). Updated 21.04.2017.

Image source: forest.fi

Agrobiomasses in Finland

(Sakari Alasuutari/Plugi)

- Current energy use of agrobiomasses 0.5 TWh/a, mainly straw
- Total potential 12 – 22 TWh/a
- Major part of the potential consists of agricultural side products (straw) 10% and dedicated energy crops 50% (Reed canary grass) (Mikkola 2012. peltoenergian tuotanto Suomessa)

FIN Cases:
#1 Imatran Lämpö Oy Virasoja

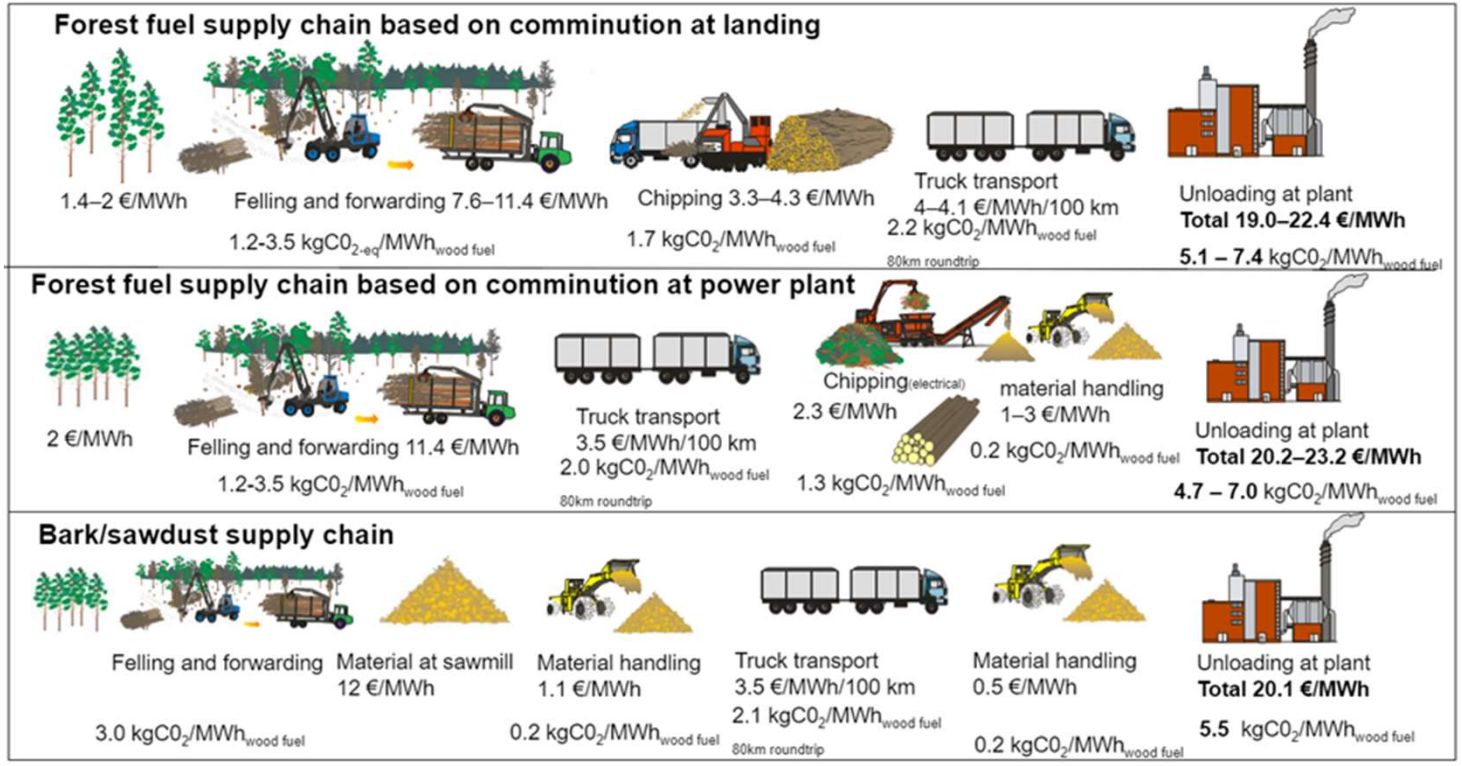
#2 Imatran Lämpö Oy Rajapatsas

Project #1 Finland: Imatran Lämpö Oy, Virasoja

- Biomass boiler heat capacity – 36 + 4 MW
- Main fuel – wood chips (from logging residues), bark
- Investment - 15.5 M€
- Energy production:
  - heat - 134495 MWh
  - power – N/A MWh
- Fuel consumption – 154 565 MWh
- Energy efficiency of supply chain including losses in the heat distribution network 83%*

*=heat produced/fuel consumption$_{fuel}$+fuel consumption $_{supply\ chain}$
=> approx 2-3ltr diesel fuel consumed for 1 Mwh$_{fuel}$
=> Energy consumption in the supply chain approx. 0,03MWh$_{diesel}$/Mwh$_{wood\ fuel}$

Project #1 Finland: Imatran Lämpö Oy, Virasoja

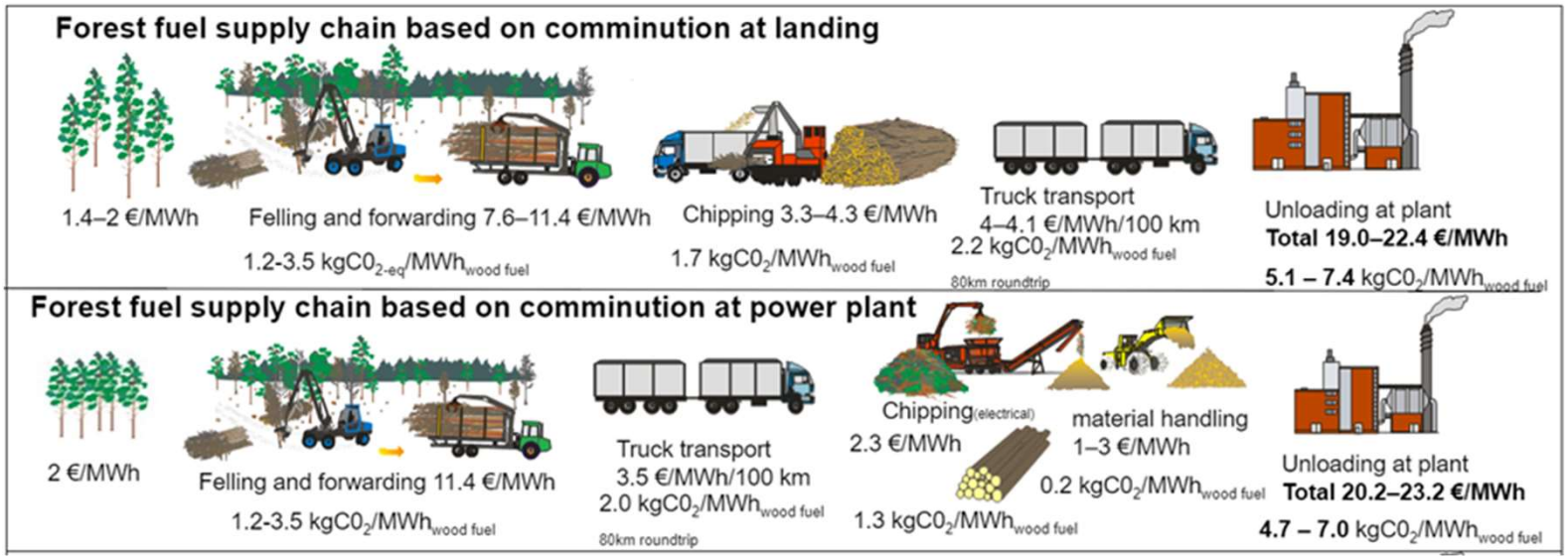


Project #2 Finland: Imatran Lämpö Oy, Rajapatsas

- Biomass boiler heat capacity – 4 MW
- Main fuel – wood chips
- Investment - 2.6 M€
- Energy production:
  - heat - 18 871 MWh
  - power – N/A MWh
- Fuel consumption – 22 894 MWh
- Energy efficiency of supply chain including losses in the heat distribution network 80 %
- A flue gas condenser investment will be made in the near future

*=heat produced/fuel consumption$_{fuel}$+fuel consumption $_{supply\ chain}$
=> approx 2-3ltr diesel fuel consumed for 1 Mwh$_{fuel}$
=> Energy consumption in the supply chain approx. 0,03MWh$_{diesel}$/Mwh$_{wood\ fuel}$

Fuel supply chain costs and emissions

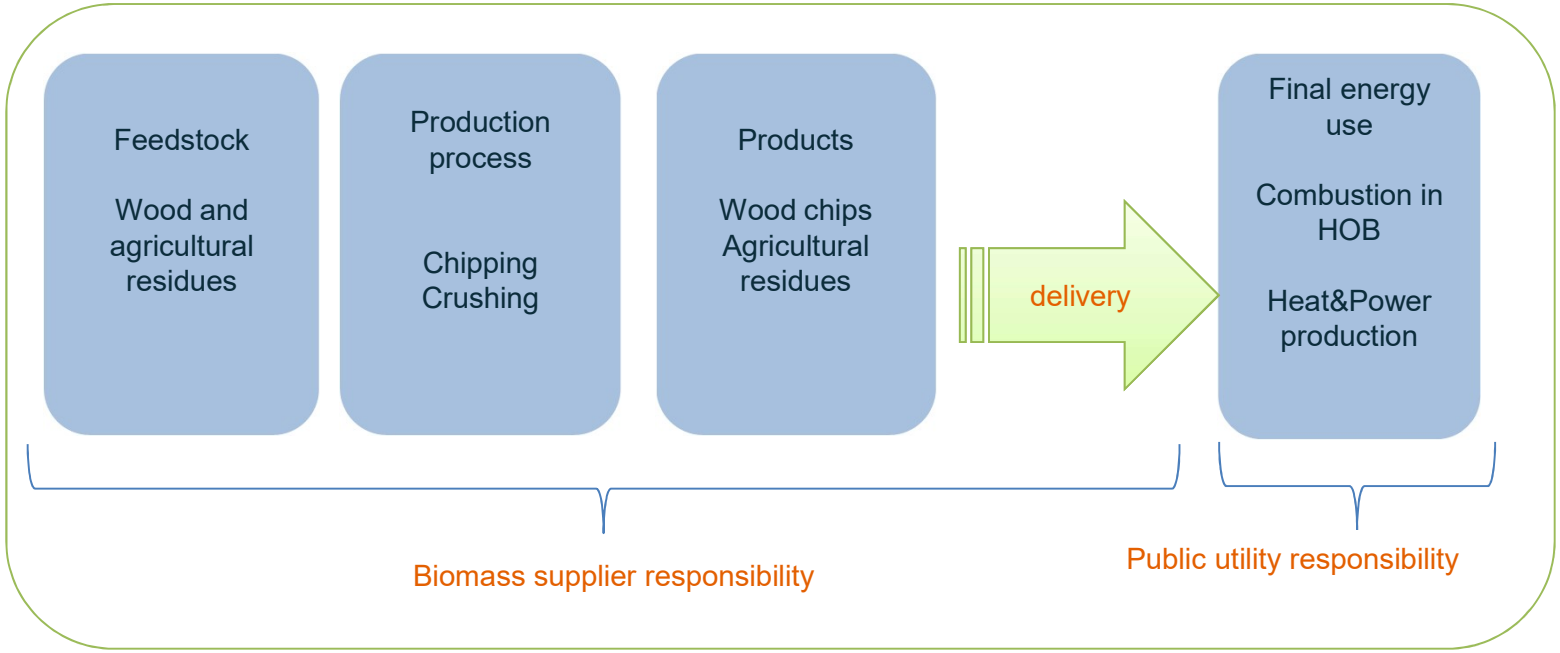


UA Cases:
#1 Biomass CHP installation of public utility Miskteplovodenergia
#2 Biomass HOB installation of private company LLC Ukteplo

Project #1 Ukraine: Biomass CHP installation of public utility Miskteplovodenergia

- Biomass boiler heat capacity – 15 MW
- ORC unit power capacity – 1,6 MW
- Main fuel – wood chips
- Investment - 12,2 mill $
- Loan (WB) - 9.6 mill $
- Energy production:
  - heat - 44 706 MWh
  - power – 7 160 MWh
- Fuel consumption – 69 548 MW (23 kt)
- Energy efficiency of supply chain – 77%

Fuel supply chain



Fuel supply chain costs and emissions

Fuel supply chain based on old garden comminution at garden

Volume: 2000 t
5560 MWh

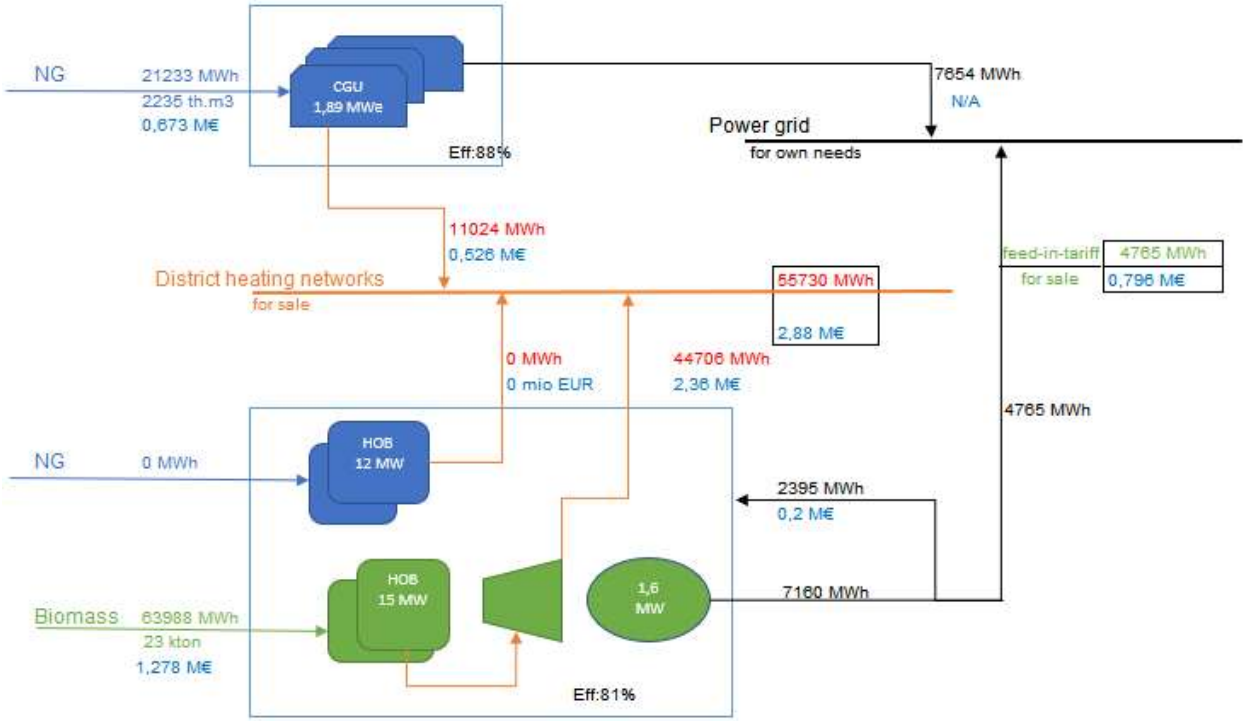
RAW material	Felling	Chipping	Transportation	Total:
- €/MWh	5,33 €/MWh	3,64 €/MWh	1,212 €/MWh 4,85 €/MWh 100km	16,0 €/MWh
Motor fuels consumption and emissions CO2				
0 kg/MWh	0 kg/MWh	1,97 kg/MWh	0,86 kg/MWh	2,83 kg/MWh
0 kg CO_{2e}/MWh	0 kg CO_{2e}/MWh	6,5 kg CO_{2e}/MWh	2,8 kg CO_{2e}/MWh	9,4 kg CO_{2e}/MWh

Fuel supply chain from forest residues and firelogs based on comminution at forest

Volume: 23 017 t
63 988 MWh

RAW material	Felling	Chipping	Transportation	Total:
3,2 €/MWh	5,3 €/MWh	3,6 €/MWh	0,823 €/MWh 1,267 €/MWh/100km	20,0 €/MWh
Motor fuels consumption and emissions CO2				Total:
0 kg/MWh	0 kg/MWh	2,0 kg/MWh	0,5 kg/MWh	2,5 kg/MWh
0 kg CO_{2e}/MWh	0 kg CO_{2e}/MWh	6,5 kg CO_{2e}/MWh	1,8 kg CO_{2e}/MWh	8,3 kg CO_{2e}/MWh

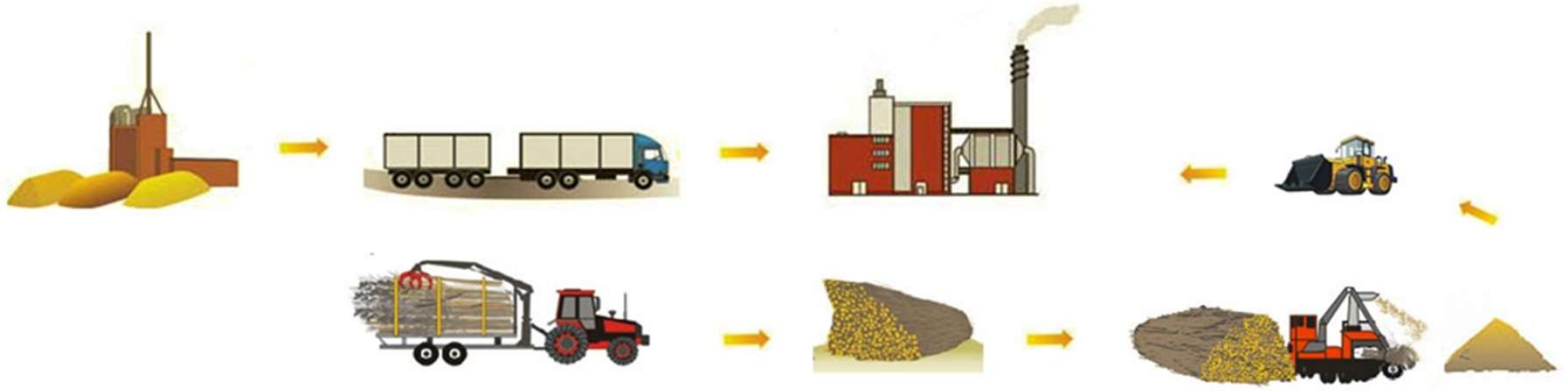
Flow chart for energy production



Project #2 Ukraine: Biomass HOB installation of private company LLC Ukteplo

- Biomass boiler heat capacity –10,5 MW
- Main fuel – wood chips
- Investment - 4 mill $
- Energy production:
  - heat - 32 564 MWh
  - power – 0 MWh
- Fuel consumption –38 300 MW (15 kt)
- Energy efficiency of supply chain –81 %

Fuel supply chain



Fuel supply chain costs and emissions

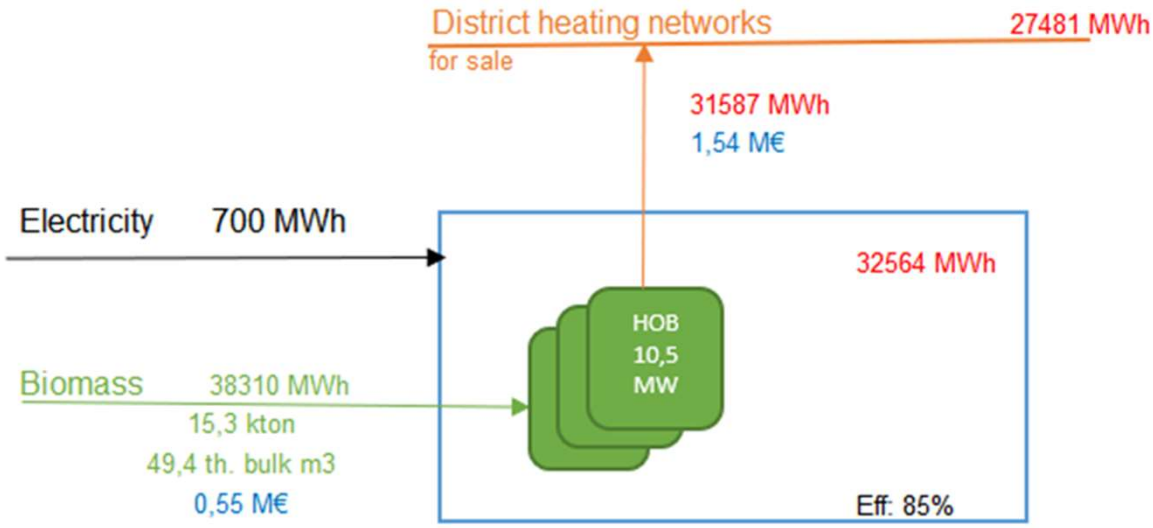
Fuel supply chain from sawmill residues based on chipping at HOB site

Volume: 15 321 t
38 304 MWh




RAW material	Felling and forwarding	Sawmill residues transportation	Chipping	Handling	Total
0 €/MWh	0,0 €/MWh	6,3 €/MWh	1,741 €/MWh	4,34 €/MWh	12,4 €/MWh
Motor fuels consumption and emissions CO2					
0 kg/MWh	0 kg/MWh	0 kg/MWh	0,4 kg/MWh	1,6 kg/MWh	2,00 kg/MWh
0 kg CO_{2e}/MWh	0 kg CO_{2e}/MWh	0 kg CO_{2e}/MWh	1,2 kg CO_{2e}/MWh	5,4 kg CO_{2e}/MWh	6,6 kg CO2e/MWh
Electricity consumption and emission CO2					
0 kWh.e/MWh	0 kWh.e/MWh	0 kWh.e/MWh	0,0 kWh.e/MWh	18,3 kWh.e/MWh	18,3 kWh.e/MWh
0 kg CO_{2e}/MWh	0 kg CO_{2e}/MWh	0 kg CO2e/MWh	0,0 kg CO_{2e}/MWh	20,1 kg CO_{2e}/MWh	20,1 kg CO2e/MWh

Flow chart for energy production



Biomass to heat and power, Cases #1 and #2: Observed similarities, differences and suggestions for development

Case #1 Energy balance of fuel supply chain

Name	Virasoja	MTVE	Units
Install capacity	36 +4	15	MW
Total volume of biomass	67 476	23 017	t
	154 565	69 548	MWh
Diesel consumption		205	t
		2432	MWh
Total energy production	148 973	51 866	MWh
heat	148 973	44 706	MWh
power	-	7 160	MWh
Power for own consumption	3475	2 395	MWh
Useful energy balance	145 473	48 958,1	MWh
% of primery energy	94,1%	77%	-

Case #1 CAPEX and OPEX

Name	Virasoja	MTVE	Units
Install capacity	36+4	15	MW
heat production	148 973	44 706	MWh
power production	-	7 160	MWh
Biomass CHP CAPEX, incl. VAT	15,5	12,2	Mio €
OPEX, excl. VAT:			
Biomass	2,632	1,278	Mio €
Maintenance costs	0,115	0,003	Mio €
Repairing costs	0,089	0,017	Mio €
Personnel costs	0,300	0,176	Mio €
Own cost of:			
- electricity	-	0,083	€/kWh
- heat	22,6	42,8	€/MWh
Revenue, excl.VAT	7,3	2,6	Mio €

Case #1 Technical Key Performance Indicator

Name	Virasoja	MTVE	Units
Raw materials consumption	67 476	23 017	t/year
Raw materials consumption	154565	63 988	MWh/year
Losses	5595	-	MWh/year
Power produced	-	7 160	MWh/year
Heat produced	148 973	44 706	MWh/year
Internal power consumption	3 475	2 395	MWh/year
Boiler Efficiency	96,4%	85%	%
CO_2 emissions		17 279	$t.CO_{2e}$ /year

Case #2 Energy balance of fuel supply chain

Name	Rajapatsas	LLC Ukteplo	Units
Install capacity	4	10,5	MW
Total volume of biomass	8 562	15 321	t
	22 894	38 304	MWh
Diesel consumption		76,7	t
		910	MWh
Total energy production	18 871	32 564	MWh
heat	18 871	32 564	MWh
power	-	-	MWh
Power for own consumption	352	700	MWh
Useful energy balance	18 852	30 953	MWh
% of primery energy	82,3%	81%	-

Case #2 CAPEX and OPEX

Name	Rajapatsas	LLC Ukteplo	Units
Install capacity	4	10,5	MW
heat production	18 871	32 564	MWh
power production	-	-	MWh
Biomass CAPEX, incl. VAT	2,6	3,556	Mio €
OPEX, excl. VAT:			
Biomass	0,465	0,466	Mio €
Maintenance costs	0,018	0,073	Mio €
Repairing costs	0,006	0,019	Mio €
Personnel costs	0,050	0,053	Mio €
Own cost of:			
- electricity	-	-	€/kWh
- heat	20,31	20,832	€/MWh
Revenue, excl.VAT	1,022	1,286	Mio €

Case #2 Technical Key Performance Indicators

Name	Rajapatsas	LLC Ukteplo	Units
Raw materials consumption	8562	15 321	t/year
Raw materials consumption	22894	38 304	MWh/year
Heat production	18871	32 564	MWh/year
Internal power consumption	352		MWh/year
Boiler Efficiency	82,3 %	85%	%
CO_2 emissions	Not available	6 417	$t.CO_{2e}$ /year

The similarities, contrasts and differences in the practices used in Finland and Ukraine

Article	Ukraine	Finland
Share of forest (Woodiness)	16,5%	74%
Forest area	10,6 mil ha	23 mil ha
Felling area	445 th. ha/a	1 850 th. ha/a
Volume of timber harvesting	20 mil m^3	70 mil m^3
Number of forestry owners	Private – 0 State -543	Private forestry – 600 000 State forestry – 25% of land area
Main wood fuel feedstocks	Wood waste and fuel wood	Logging residue, delimbed small diameter stems, Non-commercial stem wood, bark, sawdust
Methods of harvesting wood residue	manual	Mechanized, minor share manual in special sites with sensitive soil or other special conditions
Main place of waste/chips processing/production	At the woodworking enterprises, at the CHP / boiler room	Roadside storages near cutting sites for logging residue. For delimbed stem and other stemwood also grinding at CHP/terminal is a feasible option

The similarities, contrasts and differences in the practices used in Finland and Ukraine

Article	Ukraine	Finland
Main residue/waste grinding technology	Stationary wood chippers and low-productivity mobile chippers	High productivity truck mounted mobile chipper
Typical moisture content	35-45%	45- 60%
Typical net weight load capacity - cargo weight	Lightweight (up to 10t) or mediumweight (up to 25t)	up to 30km small scale tractor - up to 25 t net load) and heavy > 30km distance (35-45 t net load)
Methods of quality control controlling the volume of delivery and quality of wood fuel and fuel raw materials	Weight control, Moisture control	Weight control for each delivered load, quality control - sampling of each load, quality certificates,
The average wood chips market price, EUR/MWh incl. VAT: - Feedstock - Felling - Chipping - Transportation Total	 0-3,2 5,3-7 3,6 0,82-2 **12-22**	 1,4-2 7,6-11 3,3-4,3 3-5 **20-25**
Diesel fuel price	0,9-1 EUR/lt	1,45 EUR/lt

Benchmark analysis of case studies between BAT and Ukrainian practices

Estimate Gap Impact = likelihood*impact

Impact	Neglible 1	Minor 2	Moderate 3	Significant 4	Severe 5
Very likely/common 5					
Likely/rather common 4					
Possible 3					
Unlikely 2					
Very unlikely 1					

	Solid biomass
	Production process (Gap impact = 20). No special high productivity equipment for chipping wood residues to provide large quantities of raw materials for powerful energy objects.
	Product (Gap impact = 20). High price of wood chips from firewood. Produced thermal energy can be not competitive with traditional fuels (gas).
	Heat/Power generation and product (Gap impact = 25). The lack and high cost of special equipment for burning of wet fuel and bark.
	Final energy distribution (Gap impact = 20). High level of state regulation of heat and electric energy production and limited level of projects profitability.
	Heat final use (Gap impact = 12). Problems with grid connection, seasonal consumption of thermal energy, lack of a clear state policy and support for waste and renewable energy consumption.

Benchmark analysis of case studies between BAT and Ukrainian practices

Value chain step	Feedstock	Production process	product	Transport	Heat/Power generation	Final energy distribution
BAT in FIN	Residue collected from spruce dominated final felling areas	Chipping at roadside with heavy duty truck mounted chippers	Even particle size, moisture content/impurities/market value/Standards for quality	Transport of chips with a trucks with 45 ton load capacity	Receiving/feed to process/combustion	Power grid/DH grid
UA practice	Not common	On-site shredding with small shredders, mobile shredding services, waste disposal at lower timber landing	High moisture and ash content, deferent particle size	Transportation by trucks - 6-10 t net load capacity	Direct combustion, steam cycle	Power grid/DH grid

Benchmark analysis of case studies between BAT and Ukrainian practices

Value chain step	Feedstock	Production process	product	Transport	Heat/Power generation	Final energy distribution
Gaps/bottlenecks	Lack of information, lack of technology, high manual labor costs, low productivity, limited access	No special equipment for chipping	Low quality as fuel	No wood roads, need for off-road transport	No special equipment for combustion of moist fuel, Lack of a large number of powerful consumers	Tariffs and profitability state regulation, high competition with traditional fuels (gas), grid connections
Gap impact*	16 (4x4)	20 (4x5)	25 (5x5)	12 (4x3)	25 (5x5)	20 (5x4)
Recommendation	Publish information on harvesting and volume of harvesting waste, oblige forestry to collect waste, set targets for the use of forestry waste	Increase forestry financing to upgrade the technical status and production of new products or increase production	Quality must meet consumer requirements and equipment available	Need to construct forest roads, to use trailers with a net loading of more than 20 tons	Installation of new equipment for wet fuel combustion, use of heat energy utilizers	set national and regional targets for the share of RES in heat and electricity, introduce incentives for the use of wood and agriculture residues, grid connection

The value chain steps with most important gap impacts

- **Production process (Gap impact -20).** No special high productivity equipment for chipping wood residues to provide large quantities of raw materials for powerful energy objects.
- **Product (Gap impact -20).** High price of wood chips from firewood. Produced thermal energy can be not competitive with traditional fuels (gas).
- **Heat/Power generation and product (Gap impact -25).**. The lack and high cost of special equipment for burning of wet fuel and bark.
- **Final energy distribution (Gap impact -20).** High level of state regulation of heat and electric energy production and limited level of projects profitability.
- **Heat final use (Gap impact -20**). Problems with grid connection, seasonal consumption of thermal energy, lack of a clear state policy and support for waste and renewable energy consumption.

Conclusions

- Biomass transport efficiency is a key challenge, load sizes are two times larger in Finland
- Mechanized forestry and high-efficiency technology is a key to cost-effective forest fuel supply
- Long (wood) biomass transport distances are a challenge in K-Podilsky
- Short heating season is a big challenge in UA
- Relatively low gas prices are an economic challenge for new investments

Conclusions

- Low heat tariff and weak state support for heat production in UA
- High price for feedstock is a big challenge in UA (High price of wood chips from firewood)
- Lack of a large number of powerful consumers
- No special equipment for moist fuel combustion
- Problems with grid connection
- High level of state regulation of heat and electric energy production and limited level of projects profitability

Conclusions

- The direct comparison of a case against another does not reveal all bottlenecks.
- In Finland bioenergy – especially wood based heat and power – is a result of a determined and multi-dimensional long term development covering sustainability in social, environmental and economical level.
- Also it has been a matter of political will – certain forestry practises that aim at wood fuel production have received subsidies and a support mechanism has been available for wood fuel use in heat and power production
- For the future the key question is how CO_2 emissions from biomass will regarded. Is BIO-CO_2 equivivalent to the CO_2 that is formed when fossil fuels are burned?

VTT

beyond

the obvious

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20/03/2020

Biomass to transport fuel and power, case study installations in Finland and Ukraine. Similarities, differences and suggestions for development.

Presentation of the project: Development for Opportunities for Utilisation of Biomass Residues in the Renewable Sector of Ukraine

Pekka Sulamaa, SCL ltd
Yuri Matveev, SEC Biomass

5.2.2020 **VTT – beyond the obvious**

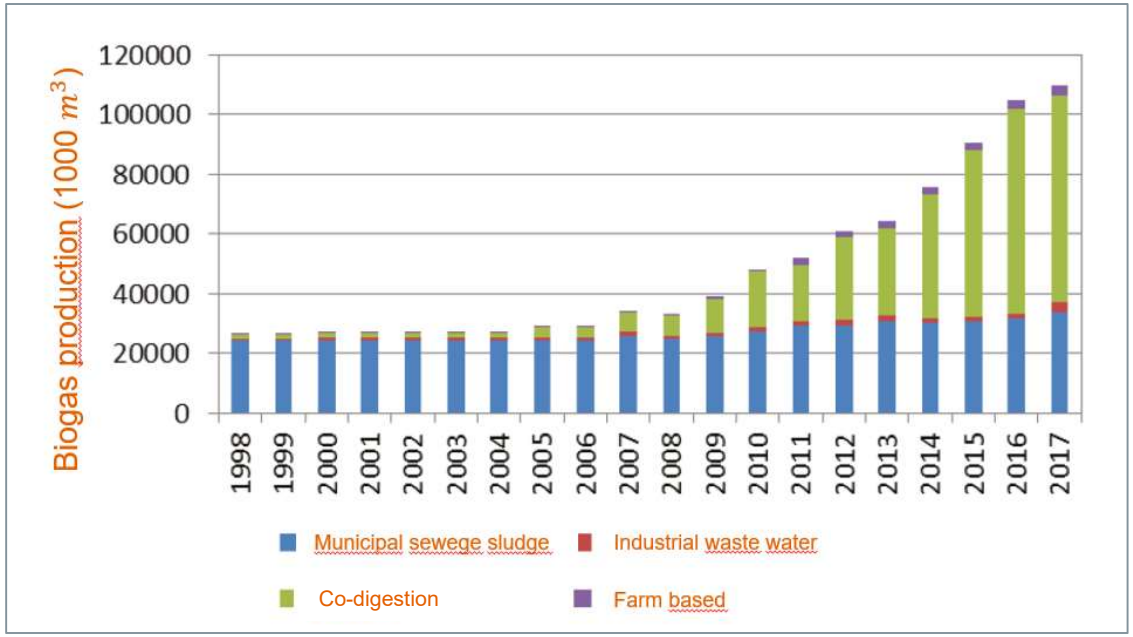
Background

Biogas sector in Finland

By the end of 2017 there were 43 integrated and 21 farm-based biogas plants operating in Finland. The integrated installations can further sub-divided into: waste water or sewage sludge installations by municipal (16) and industrial (5) basis. The rest are co-digestion facilities (22). In addition to these there are landfill sites for collecting biogas.

The energy produced with biogas in 2017 (0.7 TWh) corresponded to only about 0.5% of all renewable energy in Finland.

There is, however, potential for biogas production to be much larger (10 TWh).

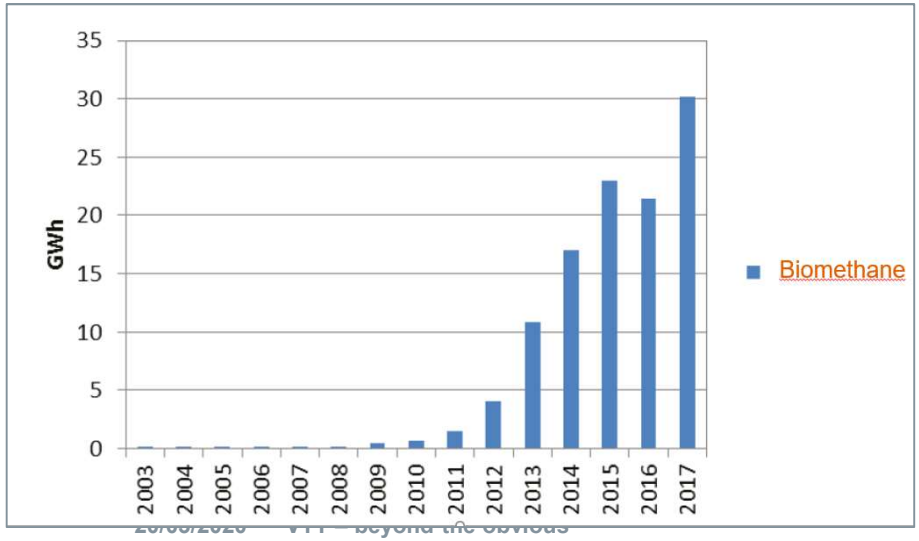


Biogas sector in Finland

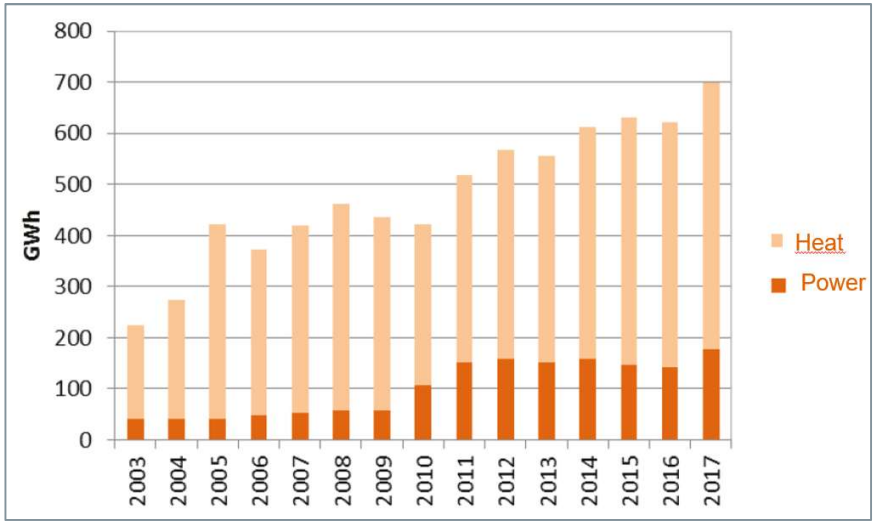
Biogas in transport use has increased especially in heavy transport sector as a result of political decisions. Biogas has been introduced as fuel for city buses and garbage trucks.

At the end of 2016 public gas filling stations there were 24 and at the end of 2017 the number increased to 34.

Biomethane production in Finland



Biogas heat and power production in Finland



Biogas cases : case 3 and 4

	Case 1 UA/FIN	Case 2 UA/FIN	Case 3 UA/FIN	Case 4 UA/FIN
Biomass source	Biomass from forestry and other industries (e.g. forestry residues, saw)	Biomass from forestry and other industries (e.g. forestry residues, saw)	Biomass from agriculture and agro industries (e.g. crop residues, straw, manure)	Biomass from agriculture and agro industries (e.g. crop residues, straw, manure)
Installation capacity	< 30MW	10MW to 30MW	1 -3 MW	3 -5 MW
Process type	Chipping wood/agri residues	Traditional pellet mill	Dry fermentation / biogas installation	Wet fermentation / biogas installation
Installation type	UA=CHP, FIN=HOB,	UA=HOB, FIN=HOB	UA=Biogas CHP FIN=biogas + HOB	UA=Biogas CHP FIN=biogas + HOB
Energy outputs	Heat and power, heat	Heat	UA=Heat and power, FIN= heat and transport fuel	UA=Heat and power FIN=heat and transport fuel
Installation (name/location) in Ukraine	*Biomass CHP installation of public utility Miskteplovodenergia in Kamyanets-Podilskyi City, Khmelnitsky region. 15MWth Biomass based CHP*	*Slavutych Boiler installation in Kiyv oblast, 10MW HOB based on wood chips*	*Gals-Agro company, Varvinsk raayon, Chernihiv region 1.2 MWe Pig manure, maize silage*	*Biogas installation of Rokytne sugar plant Ltd. in Rokytne town, Kyiv region. 2.4 MWe. Subtrates: sugar beet pulp, poultry litter cattle dung poultry litter*
Installation (name/location) in Finland	*Imatran Lämpö Virasoja heating installation , 30 MW + 5MW Biomass based HOB*	*Imatran Lämpö Rajapatsas, 4MW Biomass based HOB*	Palopuron Biokaasu Ltd ,*Nivos Energia Oy Biogas installation / Metener/ Grass and mixed manure / Dry fermentation/(2500 MWh transport fuel/a)*	*Jepuan Biokaasu Oy biogas installation /Doranova / Pig and mixed manure & crop residues/ heat output 3-4 MWth (~ 5000 MWh transport fuel/a)*

Two large and two small biogas cases under comparison

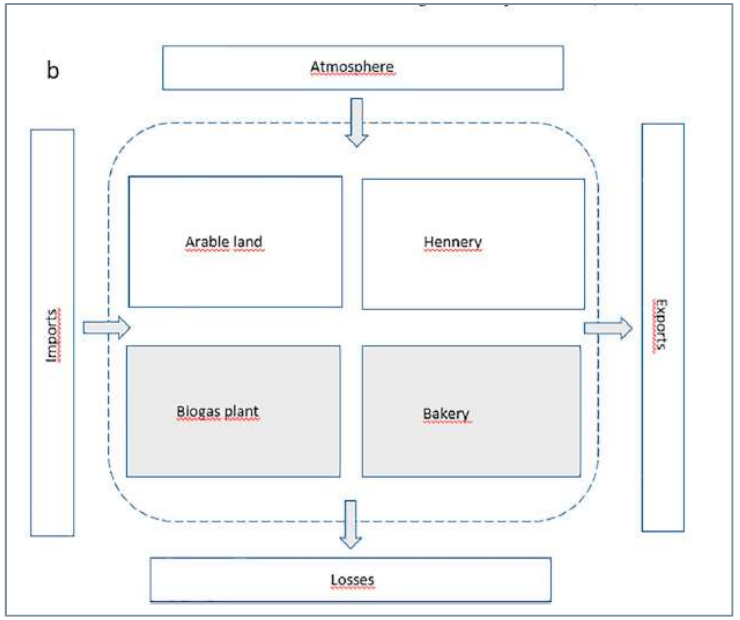
FIN Cases:

#3 Palopuro biogas plant
#4 Jepua biogas plant

Case 3 Palopuro

- Biogas production - 2500 MWh/y
- Heat generation - 310 MWh/y (own use)
- Main fuels - grass silage 2 300,0 tn/y; horse manure 1 000,0 tn/y; Chicken manure 80,0 tn/y
- Investment – 1,1 M€
- Gas upgrading to biomethane - 1628 MWh/y
- Raw material consumption – 2470 MWh/y
- Energy efficiency of supply chain- 86 %

Part of organic farming system: Agro-ecological Symbiosis



Case 3 Palopuro

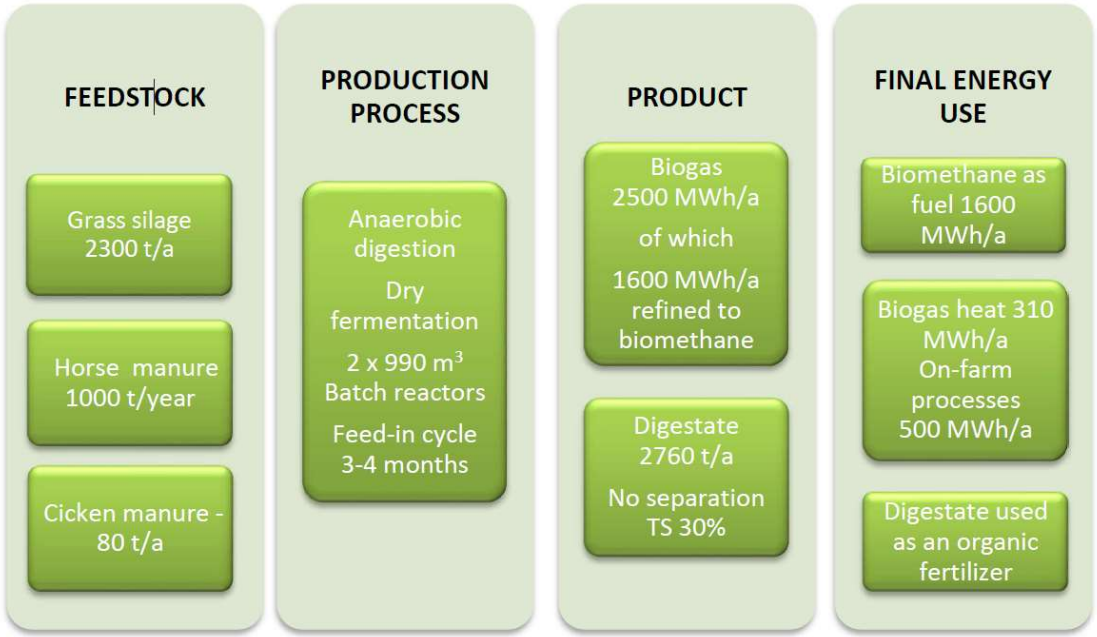
The feedstock is converted to biogas in two 800 m^3 dry fermentation batch reactors.

Feedstock owners: Knehtilän tila, local animal farmers/ horse stables. The silage is the most important feedstock with roughly 70 % share. For horse manure there is gate payments (amount of the payment not disclosed). The chicken manure is also collected from local operator.

Item	Units	Value
Raw materials input	t/year	3380
Raw materials input	MWh/year	2470
Biomethane production	MWh/year	1628
Power produced	MWh/year	0
Vehicle gas sold	MWh/year	1528
Heat produced own use	MWh/year	310
Raw materials use efficiency	%	86%

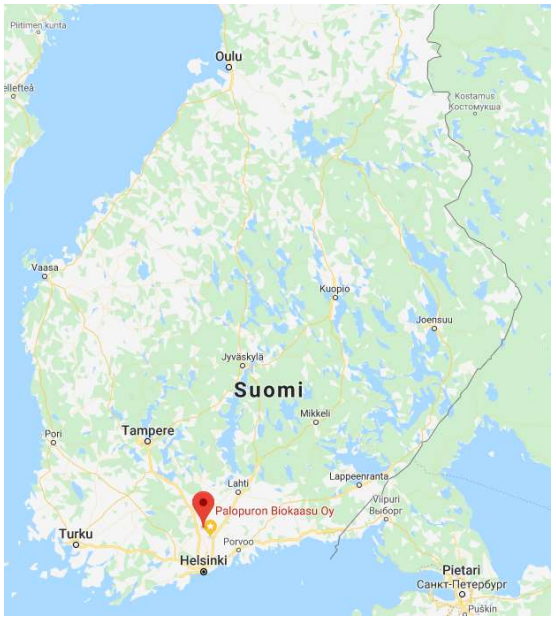
Country	Finland
Project name	Palopuro Biogas plant
Ownership	Main owner Nivos Energia Ltd (energy company)
Feedstock	Grass silage within crop rotation system. Chicken and horse manure.
Technology	Dry fermentation in batch reactors with biogas upgrade (water washing) to biomethane quality
Final energy use	The use of raw biogas for own plant heating, no electricity generation, the rest of biogas is upgraded to biomethane and used mostly as motor fuel

Palopuro Value chain



Palopuro biomethane production and sales

Own gas station for biogas close to the biogas plant



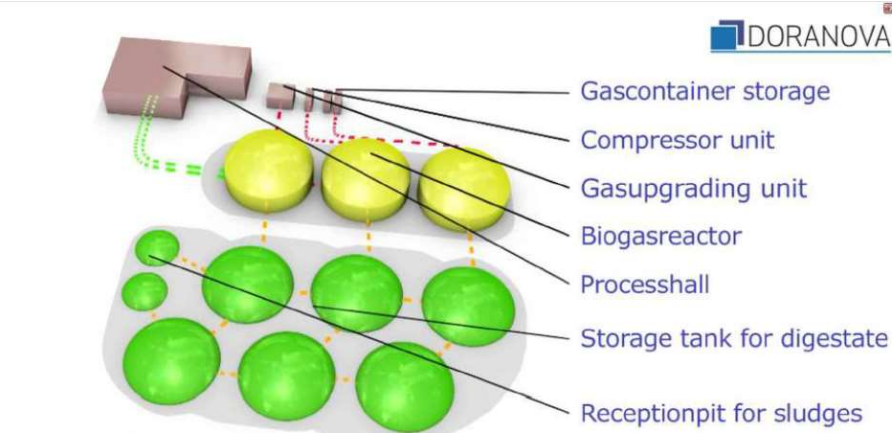
Case 4 Jepua

JEPUA

- Biogas production capacity – 3,5 MW
- Heat generation – 2,6 GWh/y (plant heating)
- Main fuels -
  - Pig and slaughter house manure 70 000-80 000 tn/y
  - Biowaste from food and animal food industry (vegetable waste, fish residues, etc.) 25 000 - 30 000 tn/y
  - Grass and old ensilage 2 000 - 5 000 tn/y
  - Other organic waste material 3500 tn/y
- Investment – 12,5 M€
- Gas upgrading to biomethane - 30 GWh/y
- Raw material consumption – 31 000 MWh/y
- Energy efficiency of supply chain - 91 %

Largest Biogas plant in Finland

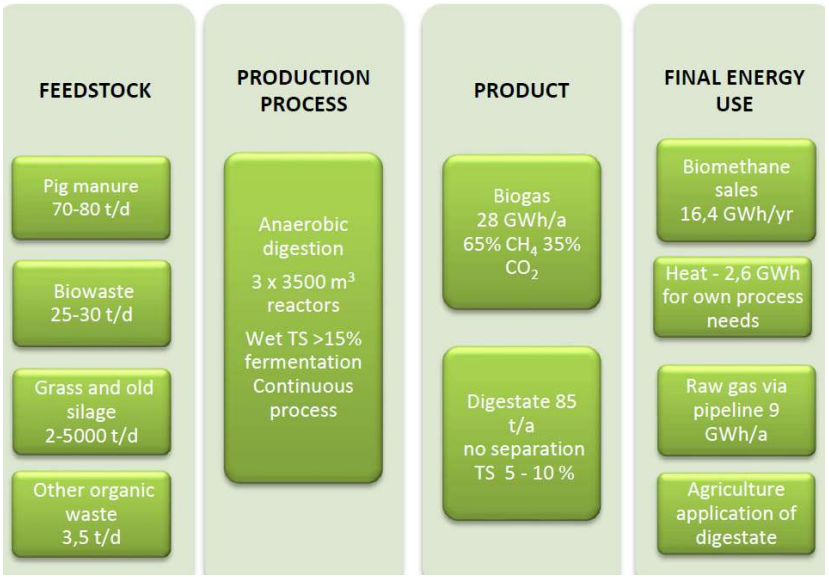
Located in West coast of Finland. The biogas plant, designed and delivered by Finnish company Doranova Ltd. in co-operation with the German Weltec Biopower GmbH was commissioned in fall 2013.



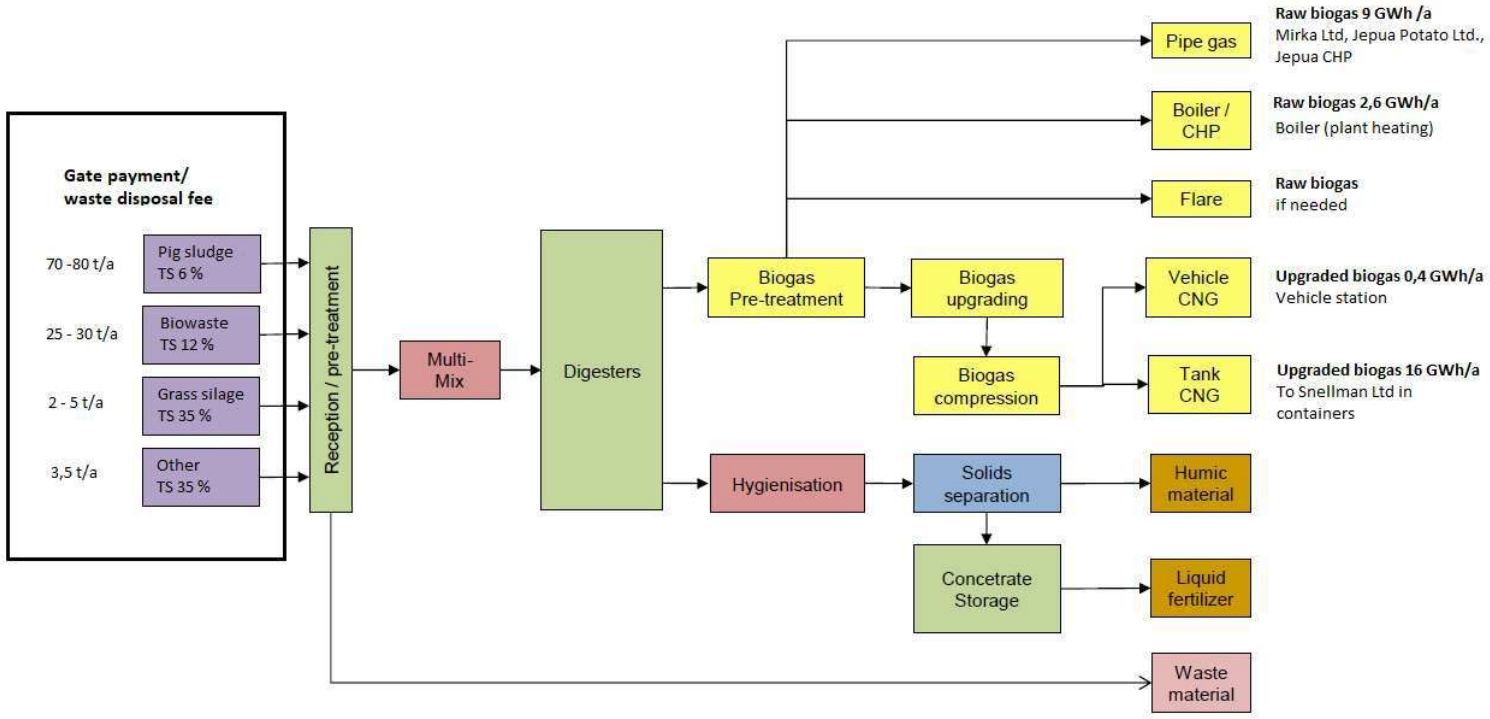
Jepua plant

The biogas plant consists of three 3500 m^3 digesters with a total of 4800 m^3 gas buffer capacity. Fourth reactor is being build. The biogas plant operates both in thermophilic (56 - 60°C) and mesophilic (30 - 45°C) temperature range.
Hydraulic retention time for feedstock is 12 - 40 days depending on process temperature and raw material. Process is continuous and stirring follows specific program automatically.

Parameter	Unit	Value
Vehicle gas sold	MWh/y	400
Heat producd (if any)	MWh/y	2600
Raw material use efficiency	%	91

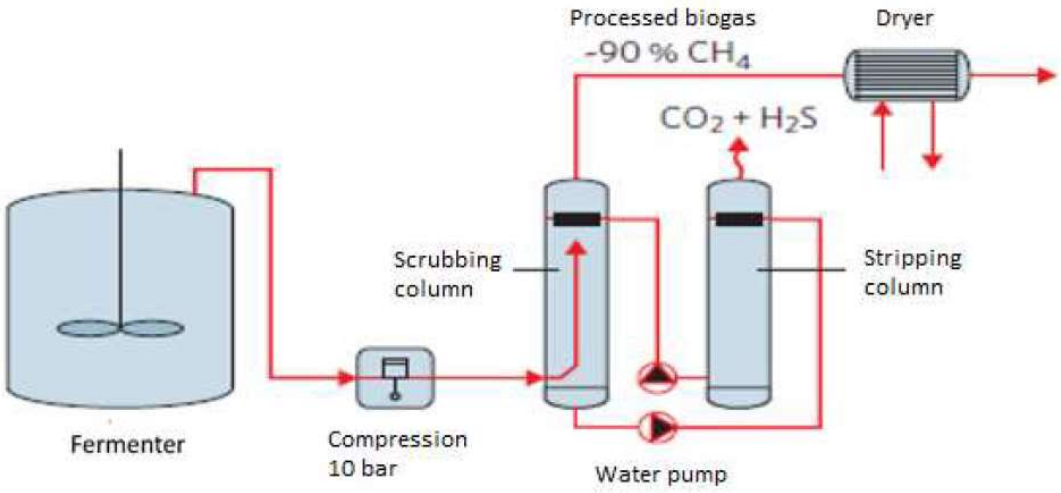


Value chain: Jepua plant



Biomethane processing: Jepua plant

For use as a transport fuel, biogas needs to be converted into biomethane, which means that most of the carbon dioxide, hydrogen sulphide, moisture and any low-level impurities must be removed. Carbon dioxide is removed because it lowers the calorific value of the gas. The simplest and most common method of converting biogas into transport fuel is water washing. In a water scrubber, carbon dioxide and hydrogen sulfide are soluble in water, but methane is insoluble in water



Biomethane processing: Jepua plant

The cost of biomethane fuel washer investment depends on the size of the washer. In Jepua it is 1,5 M€.
In addition to the washer a compressor station (200 k€) and possibly containers are needed (150 k€) if there is no gas network.

Digesters, upgrading unit and compressor unit

Biomethane processing: Jepua plant

Jepua has own vehicle fuel distribution station for biomethane. Station includes double-sided dispenser for compressed biogas. The station is located besides the biogas plant.

Currently the price is: 1,40 – 1,50 €/kg, which is equivalent to 6 €/100 km. The station is open 24/7.

Summary of the Finnish cases

Two very different kind of plants from Finland - **lessons from these plants**

1. Large biogas plant with Biomethane upgrading JEPUA

- Modern technology connected to industrial food production residue utilization (Snellmann Ltd.)
- Biomethane upgrading which is transported in containers and sold from own station
- Biogas distribution to local school and industry
- Pipelines to transport slurry feed-in to the plant
- Jepua is currently setting up new dry fermentation unit which gives interesting information

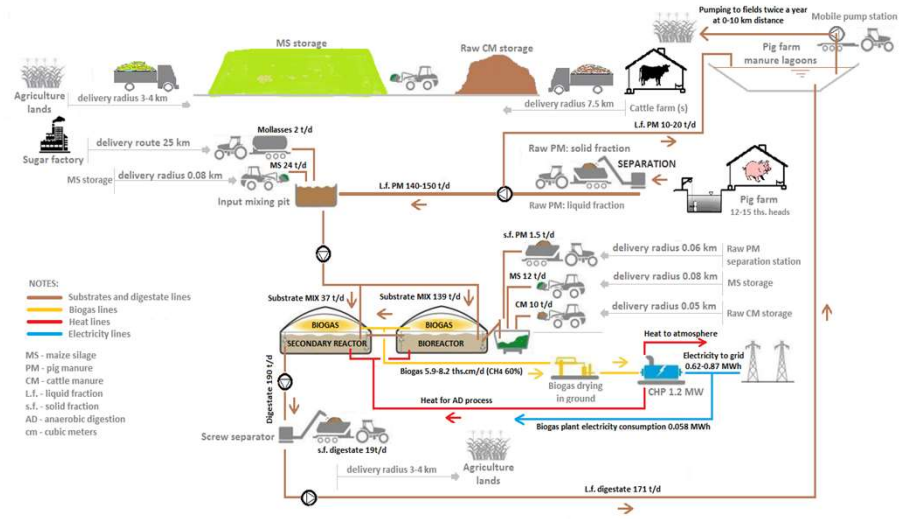
2. Small farm-based biogas plant with biomethane upgrading PALOPURO

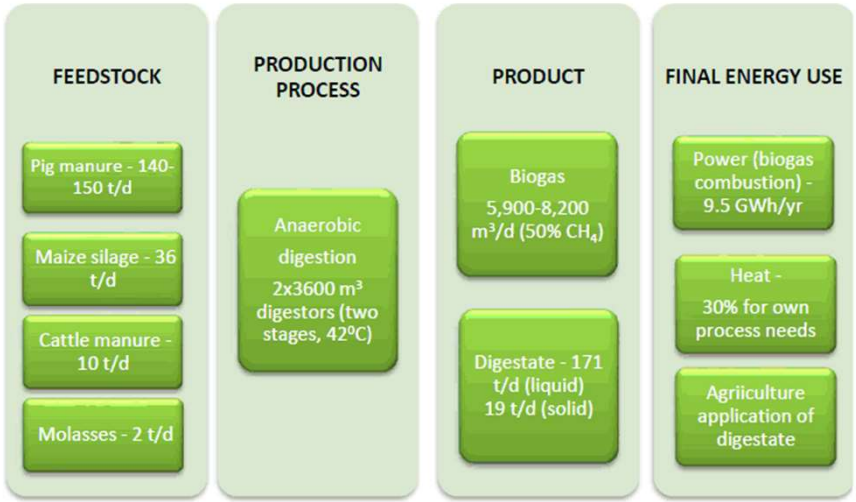
- Integrated farm-based plant with local food industry closely interacting with the Agroecological Symbiosis
- Biomethane distribution station
- Dry fermentation with batch reactors
- Interaction with organic farming
- Could be scaled-up to larger units in Ukraine

UA Cases:

#1 Gals-Agro Biogas plant
#2 Rokytne sugar plant

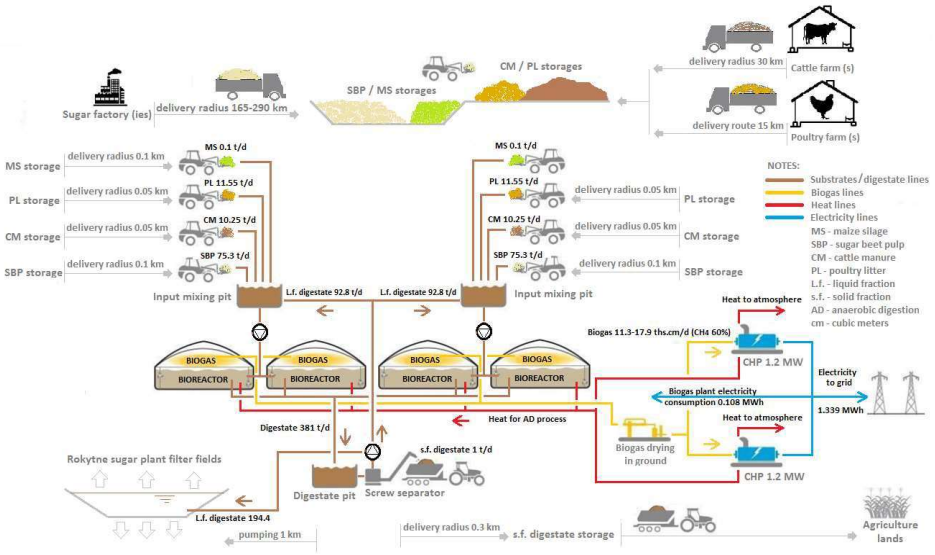
Case 3: Gals-Agro Biogas plant

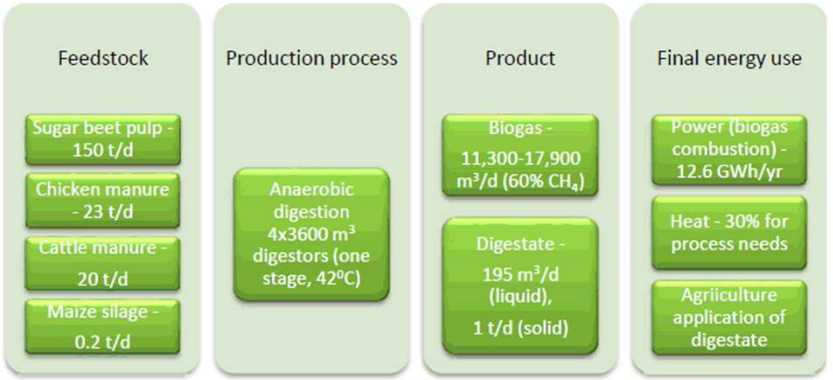




Country	Ukraine
Project name	Gals-Agro Biogas plant
Ownership	Gals-Agro corporation
Feedstock	Own agricultural residuals and by-products (pig and cattle manure, molasses) and maize silage. No gate fee. Delivery within 7 km (manure), 30 km (molasses) by own transport
Technology	Standard wet process, raw biogas drying and desulfurization
Final energy use	Electricity generation in CHP unit for grid delivery and sell by FIT, heat for own process only, 1.2 MW_e

Case 4: Biogas plant at Rokytne sugar plant Ltd





Country	Ukraine
Project name	Biogas plant at Rokytne sugar plant Ltd.
Ownership	Silhospprodukt corporation
Feedstock	Purchased agricultural residuals and by-products (sugar beet pulp, cattle and chicken manure) and harvested for biogas maize silage. No gate fee
Technology	Standard wet process, raw biogas drying and desulfurization (4x3600m^3)
Final energy use	Electricity generation in CHP unit for grid delivery and sell by FIT, heat for own process only, 2x1.2 MW$_e$

Biomass to heat and power (biogas), Cases #3 and 4

Observed similarities, differences and suggestions for development

The similarities, contrasts and differences in the practices used in Finland and Ukraine (1)

Article	Finland (3)	Ukraine (3)	Finland (4)	Ukraine (4)
Commissioning	January 2019	January 2019	2013, biomethane – August 2014	2015
Equipment supplier	Metener Ltd, Finland	Zorg Biogas, Ukraine	Doranova Ltd., Finland	Zorg Biogas, Ukraine
Raw material input, tn/y	3 380	72 800 (54 750 - pig manure)	115 000 – 120 000	71 000
Raw material input, (MWh)	2470	18 400	31 000	35 730
Biogas production, MWh/y	2 479	17 000	28 000	30 500
Raw materials use efficiency, %	86	92.5	91	85
Power/heat production, MWh	0 / 810	7 048 / 0	0 / 2 600	12 900 / 0
Biomethane, MWh	1670	0	16 400	0
Power consumption, MWh	165 (BG upgrade)	510	3 000	940
Investment, M€ (€/MWh/y)	1.1 (440)	3.0 – 3.5 (195)	12.5 (450)	10.5 (350)
OPEX, €/y (%)	81 050 (7.4%)	86 200 (2.6%)	1 926 304 (15.4%)	968 000 (9.2%)
Raw material consumption, €/y	47 000	523 300	-2 875 000	730 500
Power sale, €/y	0	1 137 600	0	2 000 000
Biogas/Biomethane sale, €/y	190 780	0	1 000 000/1 700 000	0
Total income, €/y	199 750	1 137 600	2 700 000	2 000 000
Waste gate fee, €/tn	30-50	0	30	0

The similarities, contrasts and differences in the practices used in Finland and Ukraine (2)

Article	Ukraine	Finland
Main feedstocks	Predominant treatment of own raw materials, no gate fee. Purchasing if necessary.	Treatment of different raw materials including manure, centralized organic waste treatment based on gate fee
Typical transportation distance	Lack of raw materials may result in purchasing and long distance delivery (up to 300 km) usually by car	0-40 km (cars, piping)
Feedstock quality and quality control	Lack of feedstock quality control, bad quality of purchased materials possible	Quality control. Suppliers of feedstock are often consumers of digestate
Maize silage application	Maize silage harvesting for own biogas production	Not used
The average market price of feedstock, €/t	0-25 (10)	- (30-50) if gate fee applied
The market of services in transportation	Developed, no special vehicles	Developed, piping systems, special car with pressurised containers for biomethane
Priority of biogas utilization	Main driver - electricity production by green tariff (FIT), no heat utilisation	Priority of raw biogas for external heating, 2nd priority - biomethane, no power production (except CHP)

The similarities, contrasts and differences in the practices used in Finland and Ukraine (3)

Article	Ukraine	Finland
Biomethane use	No biogas upgrading to biomethane quality	Biomethane can be use as motor fuel (local feeling station) or delivered to industry consumers in mobile containers
Service of equipment, spare part availability, suppliers guaranty	Insufficient service of equipment and spare part supplier, lack of suppliers guaranty	Automatic operation, good service of equipment and spare part supplier, supplier's guaranty. Experienced local equipment suppliers
Digestate application	Digestate field application is limited and technically underdeveloped	Digestate field application among local farmers based on no-cost approach
Governmental support	Green tariff (FIT) for power from biogas	Governmental investment support (25%), fixed price for biomethane (1.5€/kg). High price of NG
Biomass electricity tariffs, €/kWh w/o VAT	0.1239	0.830
The level of biogas utilization for heating, %	20-30 (for process heating)	All available customers
Biomethane prospects	Legislation is needed	Lack of biomethane fuelling car and feeling stations, governmental goal for number of cars and fuelling station
Investor interest	Low interest of investors	Mid and high interest of investors

The value chain steps with most important gap impacts for biogas cases

- **Heat final use**. Problems with DH connection, heat from biogas is no competitive with heat from natural gas
- **Biogas/biomethane as energy product**. Low efficiency of energy conversion for power, heat losses. Lack of conditions for biomethane
- **Final use of motor fuel from biomethane.** Lack of legislation for biomethane, lack of governmental support, biomethane based motor fuel no competitive with natural gas price
- **Production.** Lack of supplier guaranties. Complicated procedure of project development (problems with connection to power greed)
- **Final use of digestate.** Lack of certification for organic fertilizer and farming, no machinery for digestate application
- **Feedstock from plant residuals.** Lack of experience in particular with lignocellulosic materials (straw), underdeveloped biofuel market

General recommendation for gap/ barriers removal in Ukraine

- Development of biomass market
- Extension of FIT Scheme for electricity produced from biomass/biogas/biomethane
- Provision of non-discriminatory third-party access to heat networks
- Update (raise) of stimulating tariff on heat energy from biomass/biogas
- General increasing of investment attractiveness of the bioenergy sector
- Resolving of practical problems and lack of experience to use agribiomass as fuel or raw materials
- Development of organic farming and digestate application
- Development of legal and regulatory framework for biomethane production and use

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20/03/2020

Development for Opportunities for Utilisation of Biomass Residues in the Renewable Sector of Ukraine – Gap Analysis and Recommendations. Bioenergy Roadmap

Seminar-presentation of the project results/Kyiv/05.02.2020

Mrs Tetiana Zheliezna, Ms Anna Pastukh

20/03/2020 VTT – beyond the obvious

Task III: Roadmap for biomass-to-energy future market growth

Objectives of the Roadmap:

- ✓ To suggest ways to tackle the identified technical and regulatory gaps, problems and bottlenecks in the sector.
- ✓ To define next steps required for the sector growth from technical, economical, legal and institutional perspective.

Integration and synergies of the Roadmap with other existing policies:

Bioenergy Roadmap until 2050 is closely interconnected and coherent with the existing and planned strategic documents in Ukraine's energy sector. Based on this:

- Materials of the Roadmap can be used for the development of new NREAP until 2030; revised Energy Strategy of Ukraine until 2050; Concept of state policy in energy and environmental protection.
- Roadmap will show how to achieve the existing bioenergy targets until 2035 fixed in the Energy Strategy of Ukraine until 2035.
- Roadmap will facilitate contribution of bioenergy to Ukraine's international commitments to reduce greenhouse gas emissions under the 2015 Paris Climate Agreement.
- Bioenergy Roadmap until 2050 is in line with key objectives and points of Ukraine Green Deal Concept until 2050.

Task III: Roadmap for biomass-to-energy future market growth (2)

Basic approach and features:

- Starting point: 2020.
- Roadmap is in line with the scenario of up to **70% RES** in the energy balance in 2050 provided that TPES in 2050 will be 33% less than that in 2018 (~ 63 Mtoe in 2050) and the final energy consumption will increase by 8% (~ 55 Mtoe in 2050) .
- Total installed capacity of bioenergy equipment in 2050: **36** GW_{th} and **3.5** GW_{el}.
- Total consumption of biofuels in 2050: **23 Mtoe.**
- Utilisation of biomass potential of 2050 (~**43** Mtoe): up to **60%.**

Factors for increased biomass potential in 2050:

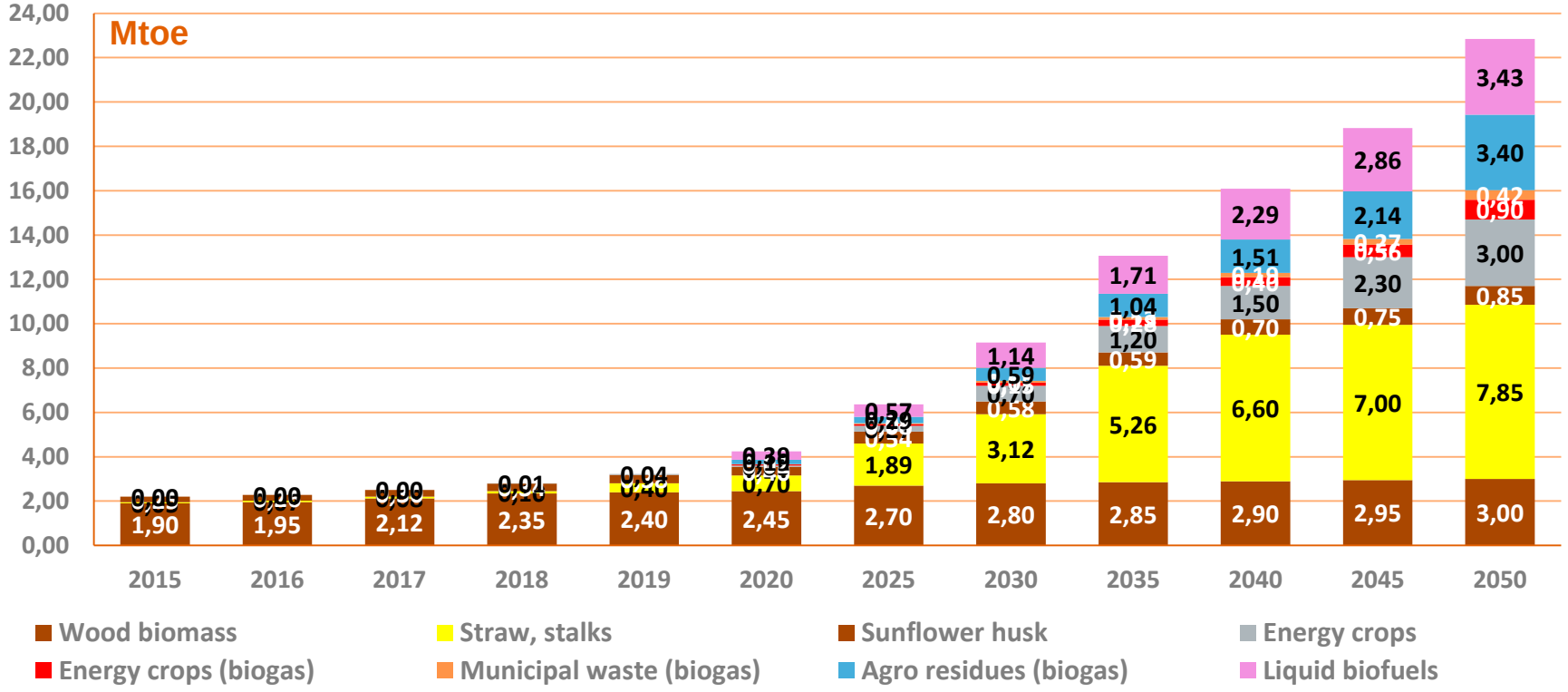
- increasing yield of crops;
- increasing share of wood increment cutting in forests;
- rising economic potential of biogas from different types of feedstock;
- enlarging areas under energy crops and increasing yield of energy crops.

Task III: Roadmap for biomass-to-energy future market growth (3)

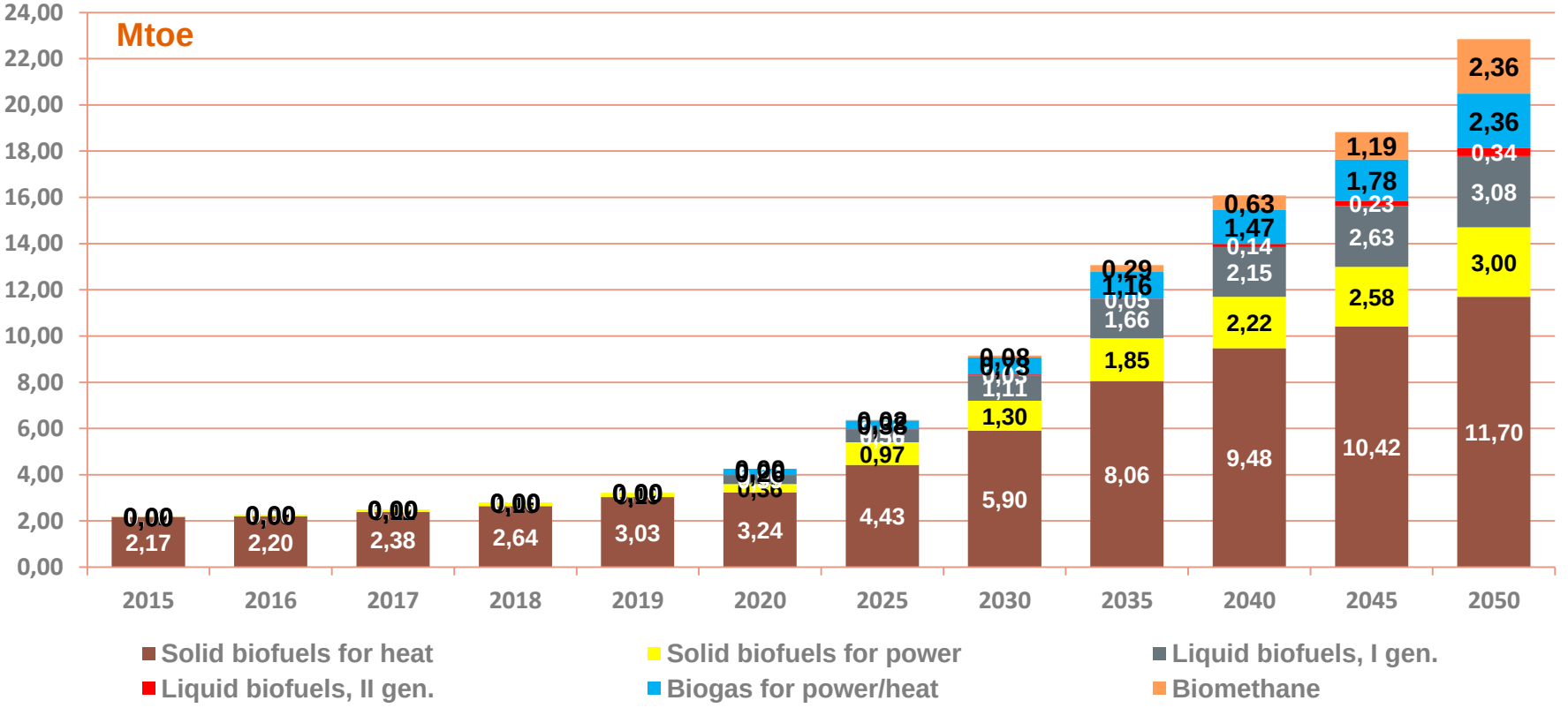
Key trends during 2020-2050:

- Increasing shares of agro-residues and energy crops in the structure of solid biofuels consumption: up to **60%** and **20**% of the total, respectively, by 2050.
- Minimal rise in the consumption of wood biofuels:
  1.2 times by 2050 (against **8** times for agro-residues).
- Considerable increase in the production of **biogas** and **liquid biofuels**:
  up to 4.7 Mtoe/yr and 3.4 Mtoe/yr, respectively, by 2050.
- Launching and rising production of **biomethane** and **II generation** transportation fuels:
  up to 2.4 Mtoe/yr and 0.34 Mtoe/yr, respectively, by 2050.

Roadmap: Suggested structure of biofuel consumption in Ukraine by type until 2050



Roadmap: Suggested structure of biofuel consumption in Ukraine by the type of energy carrier produced



Assessment of budget and resources for implementing Roadmap until 2050

Implementation of Bioenergy Roadmap until 2050 requires investments in the range of **37.5 – 132.5** billion EUR depending on individual specific capital costs of equipment to be installed.

Division of investments between different types of bioenergy equipment/technologies is:

- Biomass boiler plants: 4 – 24 billion EUR.
- Biomass CHP plants: 8 – 29 billion EUR.
- Biogas CHP plants (agro-residues and MSW): 10 – 35 billion EUR.
- Biogas to biomethane: 11 – 38 billion EUR.
- Production of liquid biofuels of I generation: 2.5 – 5 billion EUR.
- Production of liquid biofuels of II generation: 1.0 – 1.5 billion EUR.

Envisaged sources of financing include:

- funds of private players (network operators, private investors);
- loans and grants from Ukrainian and international banks, other financial establishments and programs such as Ukrgasbank, EBRD, GEF, IFC, USAID, GIZ, NEFCO, UNDP and others;
- state funds within some relevant support mechanisms and programs.

Task II: Gap analysis and recommendations

Ukrainian and Finnish policies and institutional framework

Item	Ukraine	Finland
Biofuel market	Poorly developed	Some development
FIT for electricity from biomass/biogas	123.9 EUR/kWh without VAT	83 EUR/MWh
Heat prices	90% of the tariff for the supplier of heat from NG	50% premium for heat
Investment support	No support	20-30 % for biogas investment
Biomethane support	No support	Investment support, 1.5 EUR/kg CH_4 as motor fuel
Investor interest	Low level	Medium/high
DH systems status	Old style monopoly, bad technical condition	Local monopoly, loosing market for geothermal
Agribiomass «collection-supply» chains	Logistic chain should be developed	Gate payment for biowaste
Machinery to collect crop by-products	Lack of specialized equipment	Farm machinery good
Access to forest for private companies	Limited	High
Organic fertilizer application	Limited	Still low

Task II: Gap analysis and recommendations

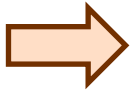
Ukraine: Key policy gaps and barriers to bioenergy development	Recommendations for Ukraine based on European experience
1. Underdeveloped biofuel/biomass market. **(Gap impact = 25)***	Introduction of **biomass exchange** similar to Lithuanian Baltpool.
2. Low market attractiveness of biomass/biogas projects **(Gap impact = 20)**	**Extension of FIT** for electricity produced from biomass/ biogas. Implementation of **special tariff** for small-scale projects and extending the FIT validity period. To ensure non-discriminatory access to DH networks for biomass-to-heat producers.
3. Complicated procedure of project development in parallel with high degree of non-transparency. **(Gap impact = 20)**	Preparation of well thought out projects based on the strong project team in order to ensure smooth project development and minimize institutional challenges risks.
4. Complicated access to biomass of forest origin (felling residues). **(Gap impact = 16)**	Development, introduction and optimization of operations for **felling residues collection** with the use of effective specialized equipment.
5. Practical problems and lack of experience to use agribiomass as fuel or raw materials. **(Gap impact = 12)**	To use straw mainly for boiler plants with the application of modern specialized boilers. To follow fuel characteristics requirements and keep optimal operating modes.
6. Underdeveloped organic farming and digestate application. **(Gap impact = 12)**	Development of **organic fertilizer market**. Accelerated implementation of new law No. 2496-VIII "On the basic principles and requirements for organic production, circulation and labelling of organic products".
7. Lack of support for biomethane production and use. **(Gap impact = 16)**	Establishment of **strategic targets** for biomethane production. Adaptation of legal framework for biomethane production and consumption **support**.

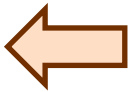
* Approach to the estimation of Gap Impact is the same as in *Benchmark analysis of case studies between BAT and Ukrainian practices.*

Proposals to legislation for biomass-to-energy future market growth

Barriers to bioenergy development	Proposals
1. Underdeveloped biofuel/biomass market.	❖ Draft Concept of State Policy in the Fields of Energy and Environmental Protection. The program of activity of the Cabinet of Ministers of Ukraine envisages the creation of a transparent and **competitive market for solid biofuels** by 30.06.2020. ❖ In addition to amending the laws, a number of by-laws are required: ✓ **The Rules for the electronic trading with solid biofuels.** ✓ **The Procedure for the operator competitive selection.** ✓ **The quality requirements for solid biofuels.** ✓ **The methodology for operator's services threshold price formation.** ✓ **The Procedure for the consideration of operator's and participants reports and approval of its forms.**
There is no specific legislation	
Amendments to the Law of Ukraine "On alternative fuel types" and other laws	

Proposals to legislation for biomass-to-energy future market growth





- ✓ Optional trading for all biomass producers;
- ✓ Obligatory trading for state and municipal enterprises that produce biofuels.

- ✓ Optional trading for all biomass buyers;
- ✓ Business entities with «green» tariff granted;
- ✓ Business entities that received a stimulating tariff for heat energy from RES in accordance with the Law of Ukraine “On Heat Supply”

An annual increase of the mandatory percentage for trading via ETS (from 20% to 100%).

Possibility for buyers not to use ETS in some cases.

SAEE

Enterprises annually report on compliance with mandatory percentages.

Proposals to legislation for biomass-to-energy future market growth

Barriers to bioenergy development	Proposals
2. Low market attractiveness of biomass/biogas	
Amendments to the Law of Ukraine “On alternative energy sources”,	❖ Extension of FIT for electricity produced from biomass/ biogas. ❖ Implementation of special tariff for small-scale projects and extending the FIT validity period.
Amendments to the Law of Ukraine "On Heat Supply". Heat energy market creation	❖ Draft Concept of State Policy in the Fields of Energy and Environmental Protection. Program of activities of the Cabinet of Ministers of Ukraine. Introduction of market mechanism and modern instruments of regulation of heat supply market. Adoption of the Law of Ukraine "On Amendments to Certain Laws of Ukraine Concerning the Introduction of Competition in District Heating Systems" – by 31.12.2021. ❖ Competitive heat energy market with “single-buyer model”. ❖ Clear mechanism and non-discrimination rules for IHP connection to heat networks. ❖ Competition at the stage of heat energy production. ❖ **The Procedures of bidding for heat energy purchase and form of a model heat energy purchase contract in the competitive heating systems.** ❖ **The Methodology of operator’s heat energy production threshold tariff formation.** ❖ **The Procedure for balancing, dispatching control, reserving of heat generating installations and the reservation fee calculation in the competitive heating systems**.

Proposals to legislation for biomass-to-energy future market growth

Barriers to bioenergy development	Proposals
2. Low market attractiveness of biomass/biogas	❖ Introduction the legal definition of "energy crops". ❖ Lease of unproductive and degraded agricultural land of state and communal property for the purpose the cultivation of energy crops - without auctions. ❖ The term of lease of state and communal agricultural land for the purpose of the cultivation of energy crops may not be less than 20 years. ❖ Implementation of state support for the cultivation of energy crops (per 1 ha). ❖ **The amount of compensation** (25 thousand UAH / ha, payable in 2 stages). ❖ **Frequency of compensation** (in the 1st and 3rd year of plantation establishment). ❖ **Compensation conditions** (area not less than 100 hectares, not less than 85% and height of energy plants not less than 1 m in the first year, not less than 80% and height of energy plants not less than 2 m in the third year of plantation existence). ❖ **Control** - formal verification of submitted documents and field checks.
Amendments to the Law of Ukraine "On Alternative Energy Sources". Introducing of state support for the cultivation of energy crops	

Proposals to legislation for biomass-to-energy future market growth

Barriers to bioenergy development	Proposals
3. Complicated procedure of project development in parallel with high degree of non-transparency. **Changes to the Rules of connection to heat networks.**	❖ Procedure for providing the technical terms for the connection. Set of minimum requirements to technical terms of connection. ❖ Exceptional instances when rejection of connection to heat network can take place. ❖ Procedure for publishing information on the main characteristics of the heat supply system, associated heat load, potential points of connection to heat networks, structure and actual volumes of heat energy production and consumption and other information required for connection.
4.Complicated access to biomass of forest origin (felling residues). **Amendments to the Forest Code of Ukraine**	❖ Obligation for forest owners and permanent forest users to transport 80% of logging residues to the nearest roads with the purpose of solid biofuels production.
7. Lack of support for biomethane production and use. **Amendments to the Law of Ukraine "On Alternative Energy Sources"**	❖ Introduction of the concept of biomethane, guarantee of origin of biomethane, green tariff for biomethane. ❖ Development and adoption of the Order of functioning of the register of production and consumption of biomethane. ❖ Introduction of FIT for electricity produced from biomethane at least at 0.123 Euro/kWh without VAT.

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20/03/2020

Short review of the biomass market in Ukraine. Recent development and future outlook

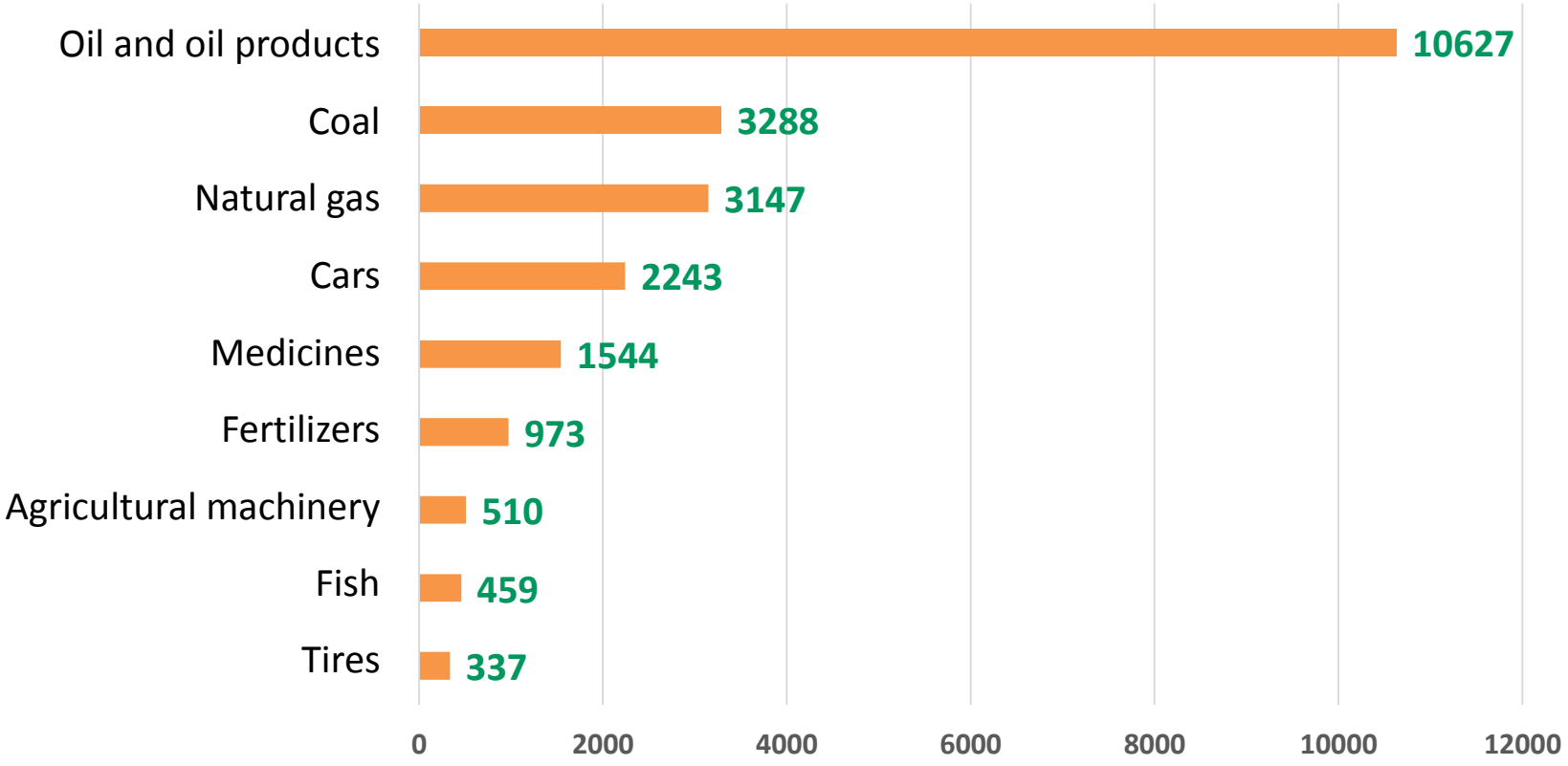
Georgiy Geletukha
SEC Biomass, Director

Seminar-presentation of project results/
Kyiv/05.02.2020

MINISTRY FOR FOREIGN AFFAIRS OF FINLAND

Ukraine imports $ 17 billion of energy curriers in 2018, up 27% of total value

Structure of Ukrainian import in 2018. Main components

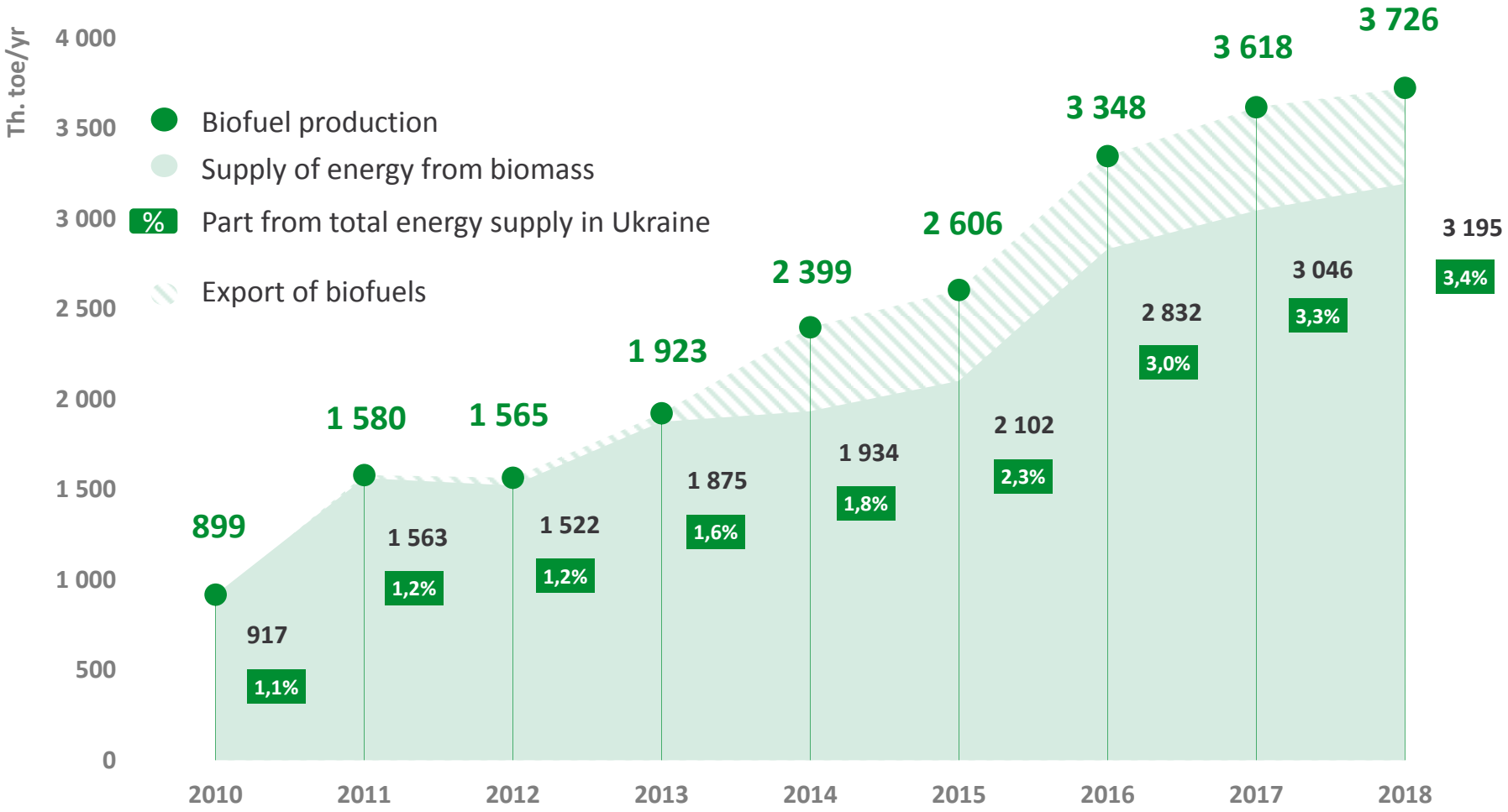


Source: State Statistics Service of Ukraine

Bioenergy grouth in Ukraine

31%

per annum



Source: State Statistics Service of Ukraine

Forecast of Bioenergy Development in Ukraine – growth in more than 5 times (2015 – 2035)

Structure of total primary energy supply according to the Energy Strategy of Ukraine until 2035

Type of energy source	2015 (fact)	2020 (forecast)	2025 (forecast)	2030 (forecast)	2035 (forecast)
Coal	27,3	18	14	13	12
Natural Gas	26,1	24,3	27	28	29
Oil Products	10,5	9,5	8	7,5	7
Nuclear Energy	23	24	28	27	24
Biomass, Biofuels and Wastes	2,1	4	6	8	11
Solar and Wind Energy	0,1	1	2	5	10
Hydro Energy	0,5	1	1	1	1
Thermal energy	0,5	0,5	1	1,5	2
TOTAL, Mtoe	90,1	82,3	87	91	96

Source:
http://mpe.kmu.gov.ua/minugol/control/uk/publish/article?art_id=245234085&cat_id=35109

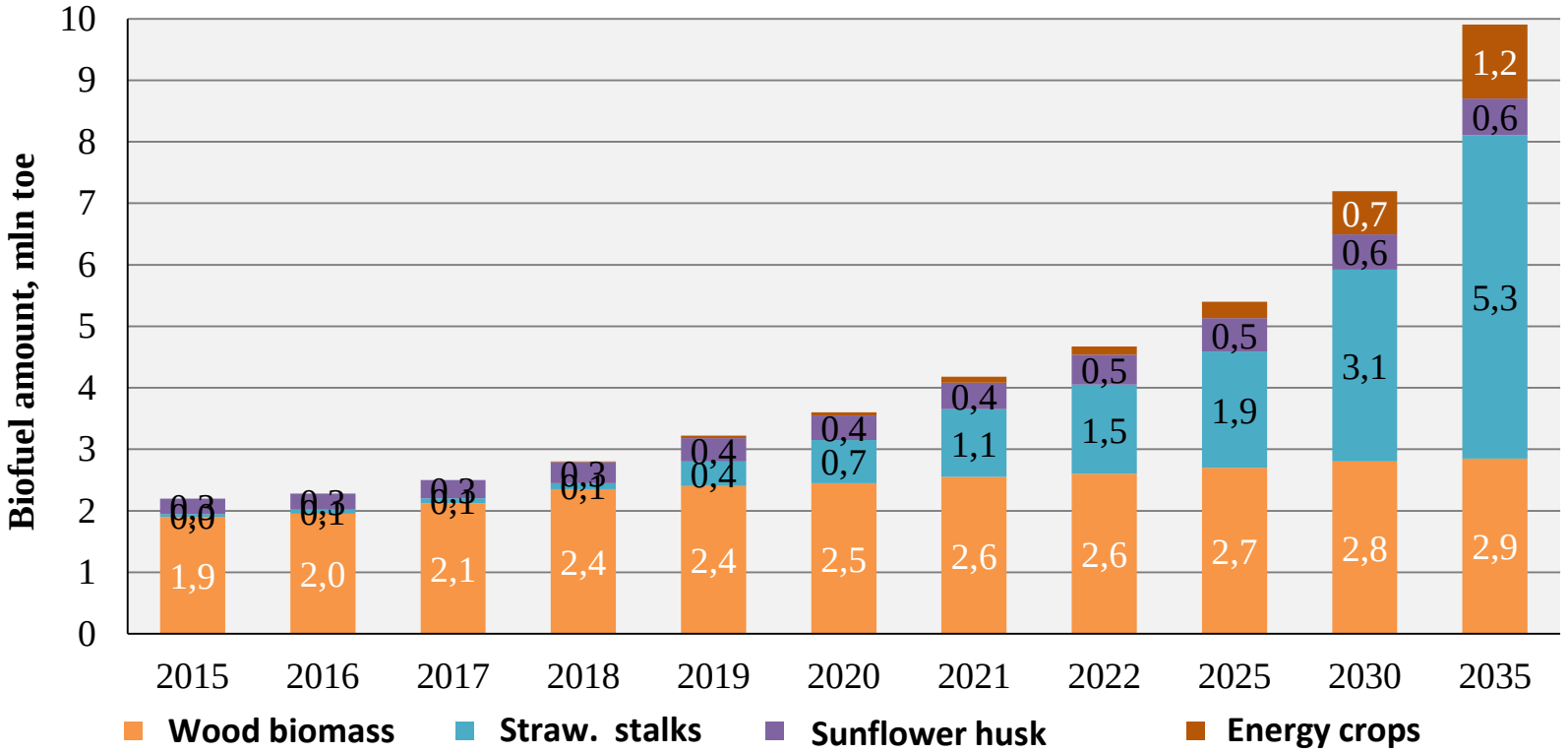
Energy Potential of Biomass in Ukraine exceeds 25 bln m^3 of natural gas/year (2017)

Type of biomass	Theoretical potential, Mt	Potential available for energy		
		Share of theoretical potential, %	Mtoe	
Straw of grain crops	35,6	30	3,65	43%
Straw of rape	3,9	40	0,54	
By-products of grain corn production (stalks, cobs)	32,1	40	2,45	
By-products of sunflower production (stalks, heads)	23,2	40	1,33	
Secondary agricultural residues (sunflower husk)	2,4	100	0,99	
Wood biomass (firewood, felling residues, wood processing waste)	6,6	94	1,54	
Wood biomass (dead wood, wood from shelterbelt forests, pruning)	8,8	44	1,01	
Biodiesel (rapeseed)	-	-	0,31	
Bioethanol (corn and sugar beet)	-	-	0,59	
Biogas from waste and by-products of agricultural sector	1,6 bln m^3 CH_4	50	0,68	
Landfill gas	0,6 bln m^3 CH_4	34	0,18	
Sewage gas (industrial and municipal wastewater)	1,0 bln m^3 CH_4	23	0,19	
Energy crops:				
- willow, poplar, miscanthus (1 mln ha*)	11,5	100	4,88	36%
- corn for biogas (1 mln ha*)	3,0 bln m^3 CH_4	100	2,58	
TOTAL	-	-	20,92	

* *In case of growing on 1 mln ha of unused agricultural land.*

Agrobiomass is a Future of Bioenergy in Ukraine

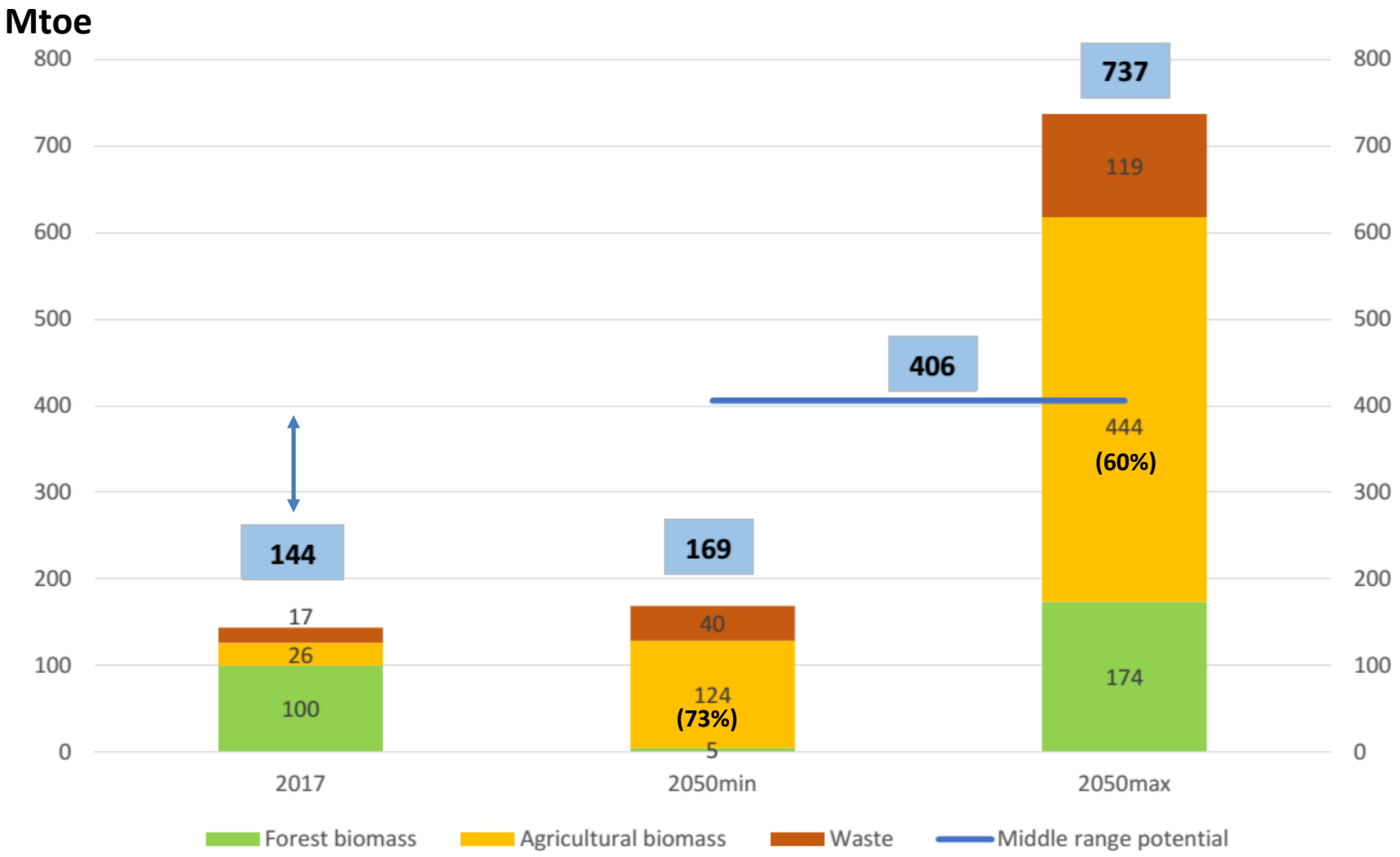
Forecast of total consumption and structure of solid biofuels in Ukraine (2015 – 2035)



Biomass type	2015	2016	2017	2018	2019	2020	2021	2022	2025	2030	2035
Wood fuels	1,90	1,95	2,12	2,35	2,40	2,45	2,55	2,60	2,70	2,80	2,85
Straw, stalks	0,05	0,07	0,08	0,10	0,40	0,70	1,10	1,45	1,89	3,12	5,26
Sunflower husk	0,25	0,26	0,30	0,34	0,38	0,40	0,43	0,49	0,54	0,58	0,59
Energy crops	0,00	0,00	0,00	0,01	0,04	0,05	0,10	0,13	0,27	0,70	1,20
TOTAL, Mtoe	**2,20**	**2,28**	**2,50**	**2,80**	**3,22**	**3,60**	**4,18**	**4,67**	**5,40**	**7,20**	**9,90**

Agrobiomass is a Future of Bioenergy in Ukraine

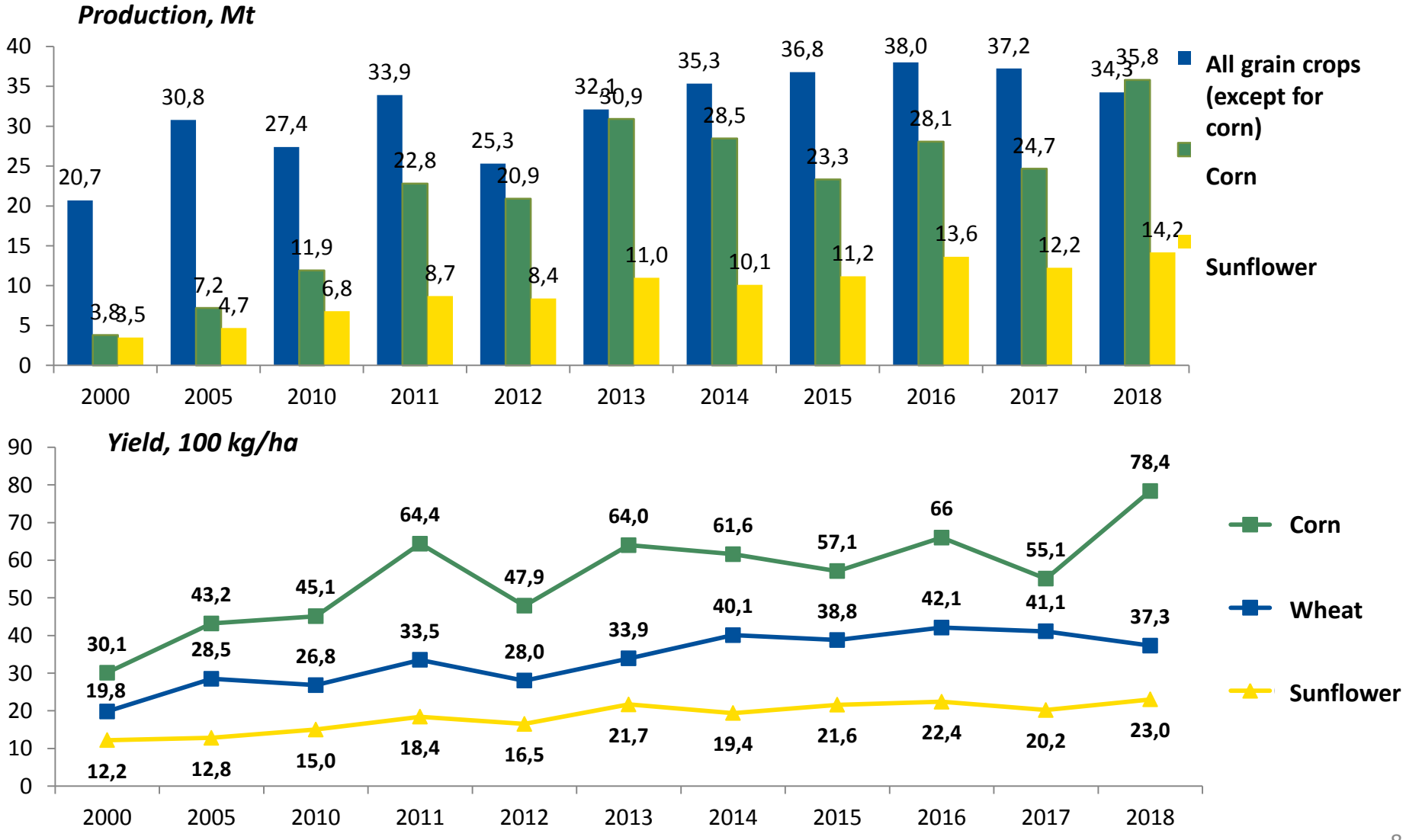
Gross inland energy consumption of biomass in 2017 and potential in 2050 for the EU-28



Source: Statistical Report. Biomass supply, Bioenergy Europe, 2019
https://bioenergyeurope.org/statistical-report-2019/

Corn is a bioenergy perspective for Ukraine

Dynamics of production of main agricultural crops in Ukraine



Corn is a bioenergy perspective for Ukraine

Chemical composition and properties of different types of biomass

Parameters	Yellow straw	Grey straw	Straw of winter wheat	Corn stalks*	Sunflower stalks*	Wood chips
Moisture, %	10-20	10-20	11.2	45-60 (after harvesting) 15-18 (air dried)	60-70% (after harvesting) ~20 (air dried)	40
Lower heating value, MJ/kg	14.4	15	14.96	16.7 (c.p.) 5-8 (W 45-60%) 15-17 (W 15-18%)	16 (W<16%)	10.4
Volatile components, %	>70	>70	80.2	67	73	>70
Ash, %	4	3	6.59	6-9	10-12	0.6-1.5
Elementary composition, %:						
carbon	42	43	45.64	45.5	44,1	50
hydrogen	5	5.2	5.97	5.5	5.0	6
oxygen	37	38	41.36	41.5	39.4	43
chlorine	0.75	0.2	0.392	0.2	0.7-0.8	0.02
potassium (alkali metal)	1.18	0.22	–	cobs: 6.1 mg/kg d.m.	5.0	0.13-0.35
nitrogen	0.35	0.41	0.37	0.69; 0.3	0.7	0.3
sulphur	0.16	0.13	0.08	0.04	0.1	0.05
Ash melting temperature, °C	800-1000	950-1100	1150	1050-1200	800-1270	1000-1400

d.m. – dry matter; W – moisture.

** Volatile components, ash, and elementary composition are given as d.m. mass %.*

Technological schemes for corn stover harvesting

- **Combine + tractor with stalk-chopping windrower + tractor with baler**



SC1 (20-35 t/hour)

SC2 (8-10 t/hour)

- **Forage harvester system: combine +tractor with stalk-chopping windrower + forage harvester + tractor with trailer.**




SC3 (20-40 t/hour)

Forage loader wagon system: combine + tractor with stalk-chopping windrower + tractor with forage loader wagon.



SC4 (10-20 t/hour)

Potential of energy crops is equivalent to 8.9 billion m^3 of natural gas per year (for 2 million ha)

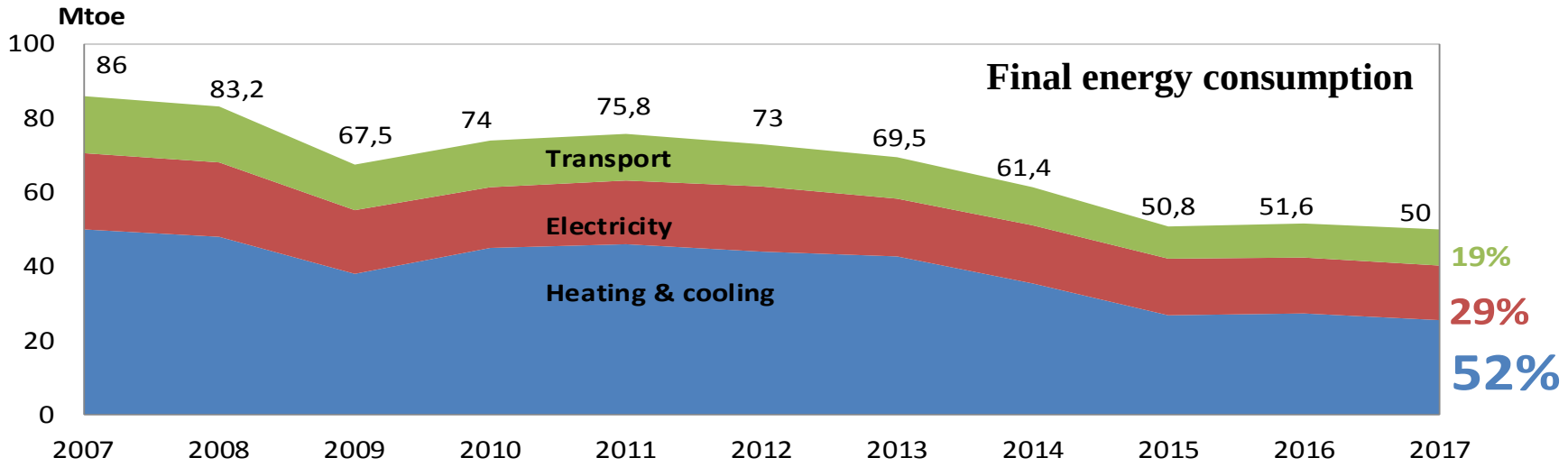
Type of biomass	Theoretical potential, Mt	Potential available for energy, Mtoe
Willow, poplar, miscanthus (for 1 Mha)	11.5	4.88
Corn for biogas (for 1 Mha)	3.0 bln m^3 CH_4	2.58
TOTAL		7.46

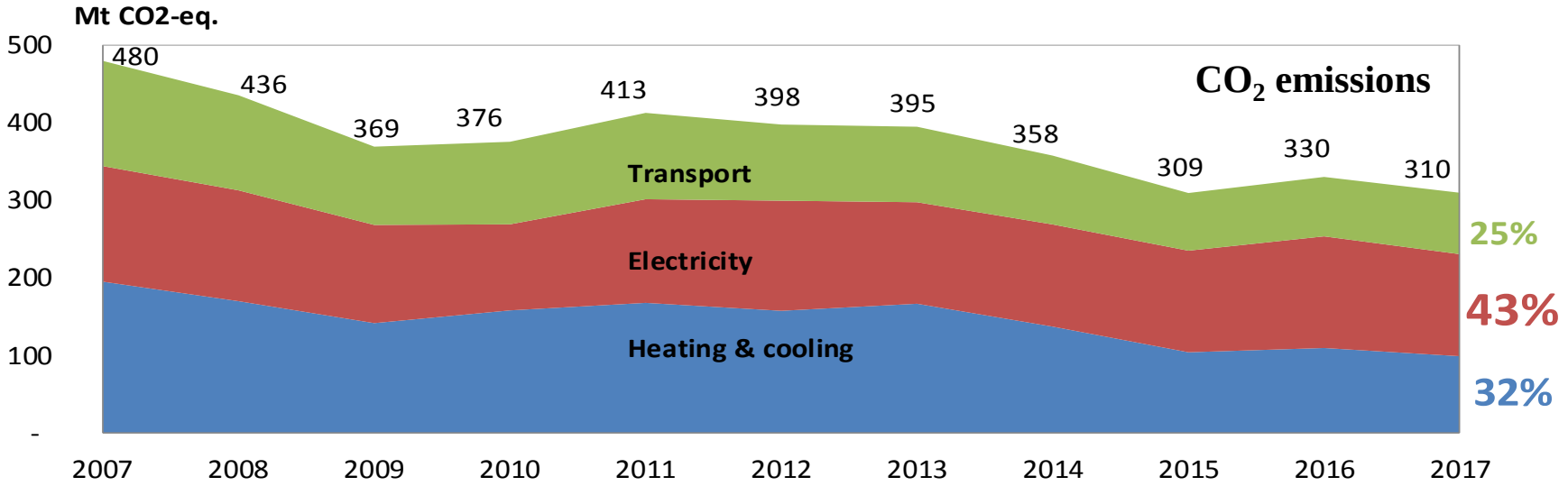
Economic indexes for energy crop production

Name	Unit	Poplar		Willow		Miscanthus	
		No subsidy	Subsidy: 20 000 UAH (649 EUR)	No subsidy	Subsidy: 21 000 UAH (681 EUR)	No subsidy	Subsidy: 24 000 UAH (778 EUR)
Capital costs	EUR/ha	1192	541	1282	599	4021	3240
Subsidy as a share of capital costs	%		55		53		19
Operating costs	EUR/ha	176	176	45	45	45	45
Profit	EUR/ha	396	396	310	310	854	854
Credit share (8 years; 8%/yr)	%	60	60	60	60	60	60
NPV	EUR	557	1085	715	1250	3684	4334
IRR	%	11.3	21.7	11,9	21.4	17.0	21.5
Simple payback period	EUR	8.4	5.0	8.2	5.3	6.0	4.7

«Energy» is not equal «Electric Energy»

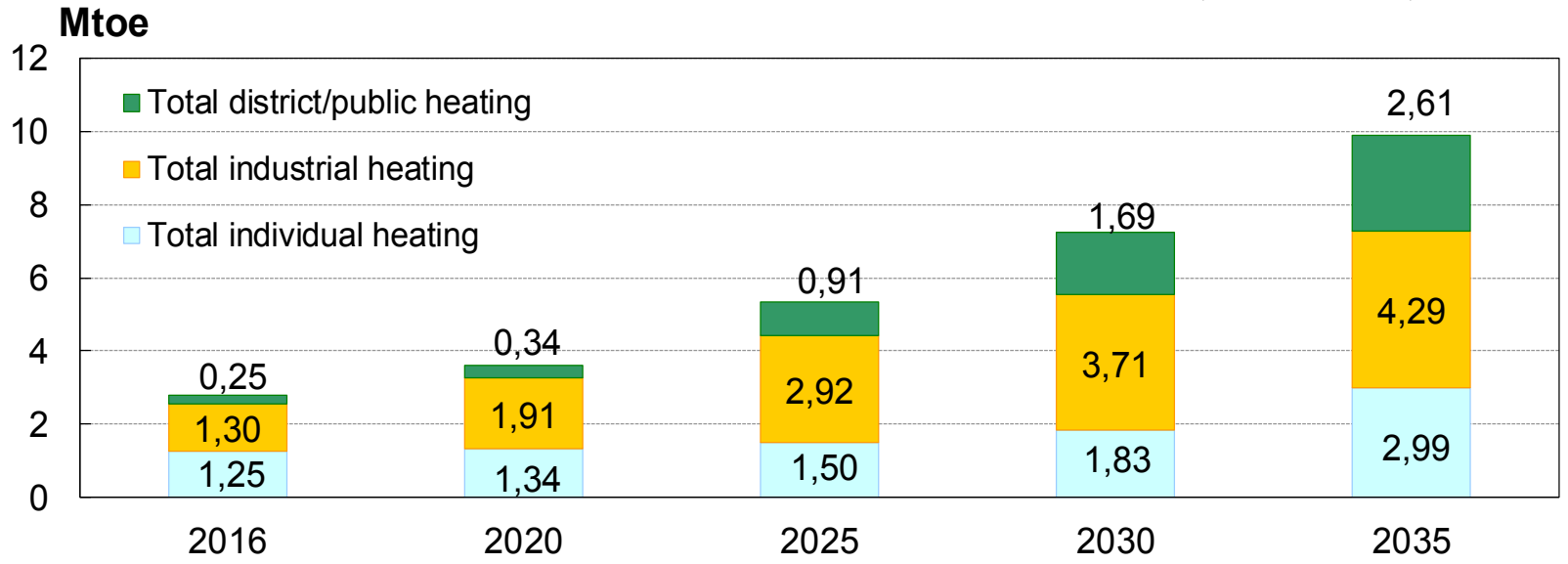
Structure of final energy consumption of Ukraine and CO_2 emissions, 2007-2017



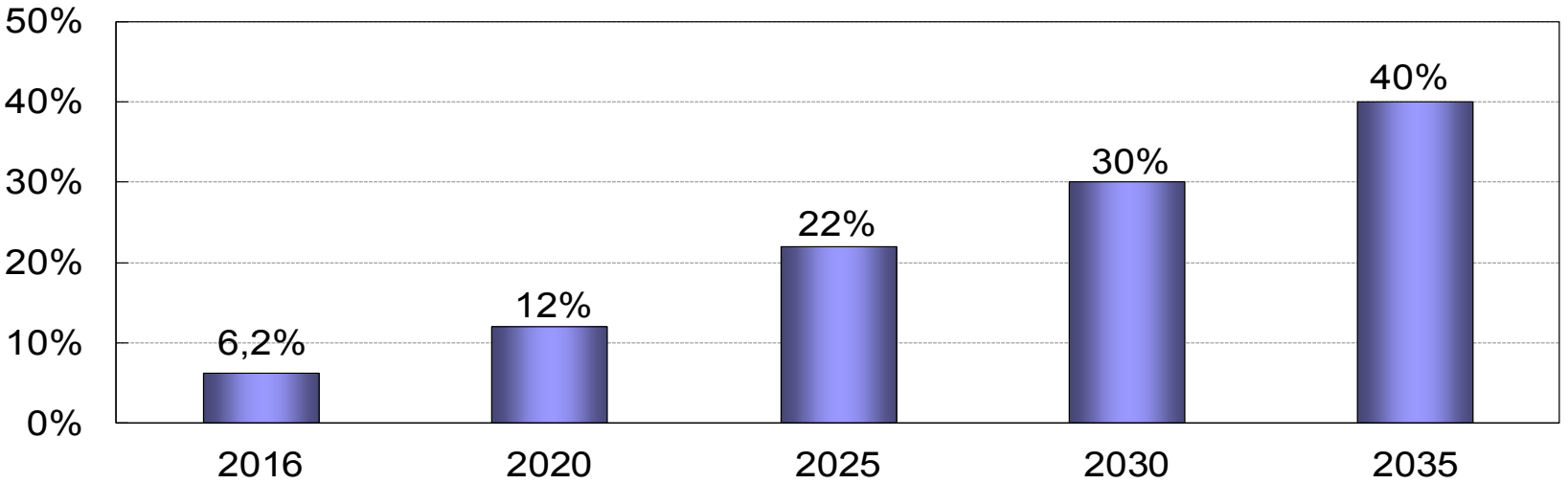


Moving to 40% of Renewable Heat in Ukraine

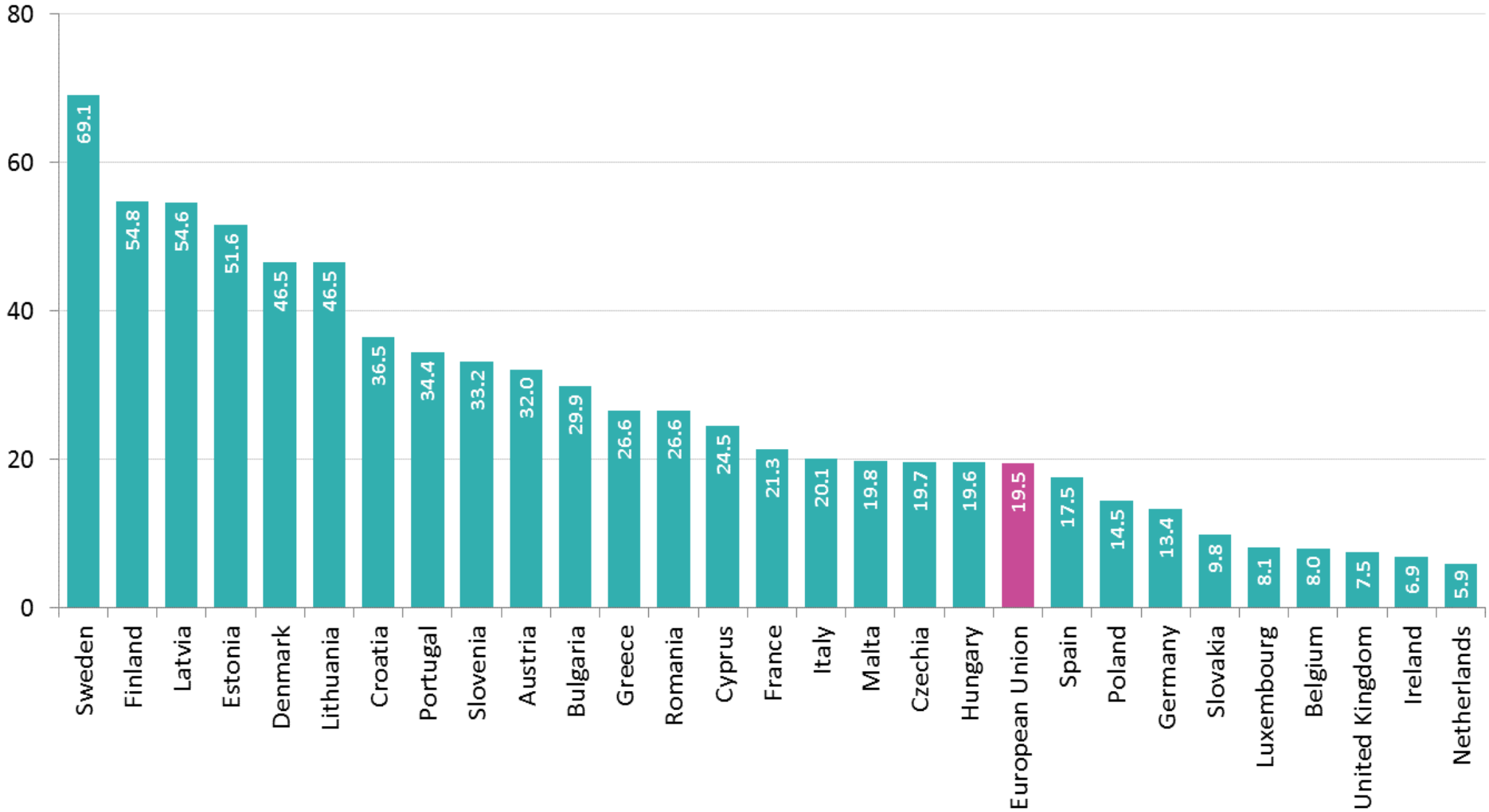
Forecast of Renewable Heat Production in Ukraine (2016-2035)



Forecast of RES share in heat production (2016-2035), %



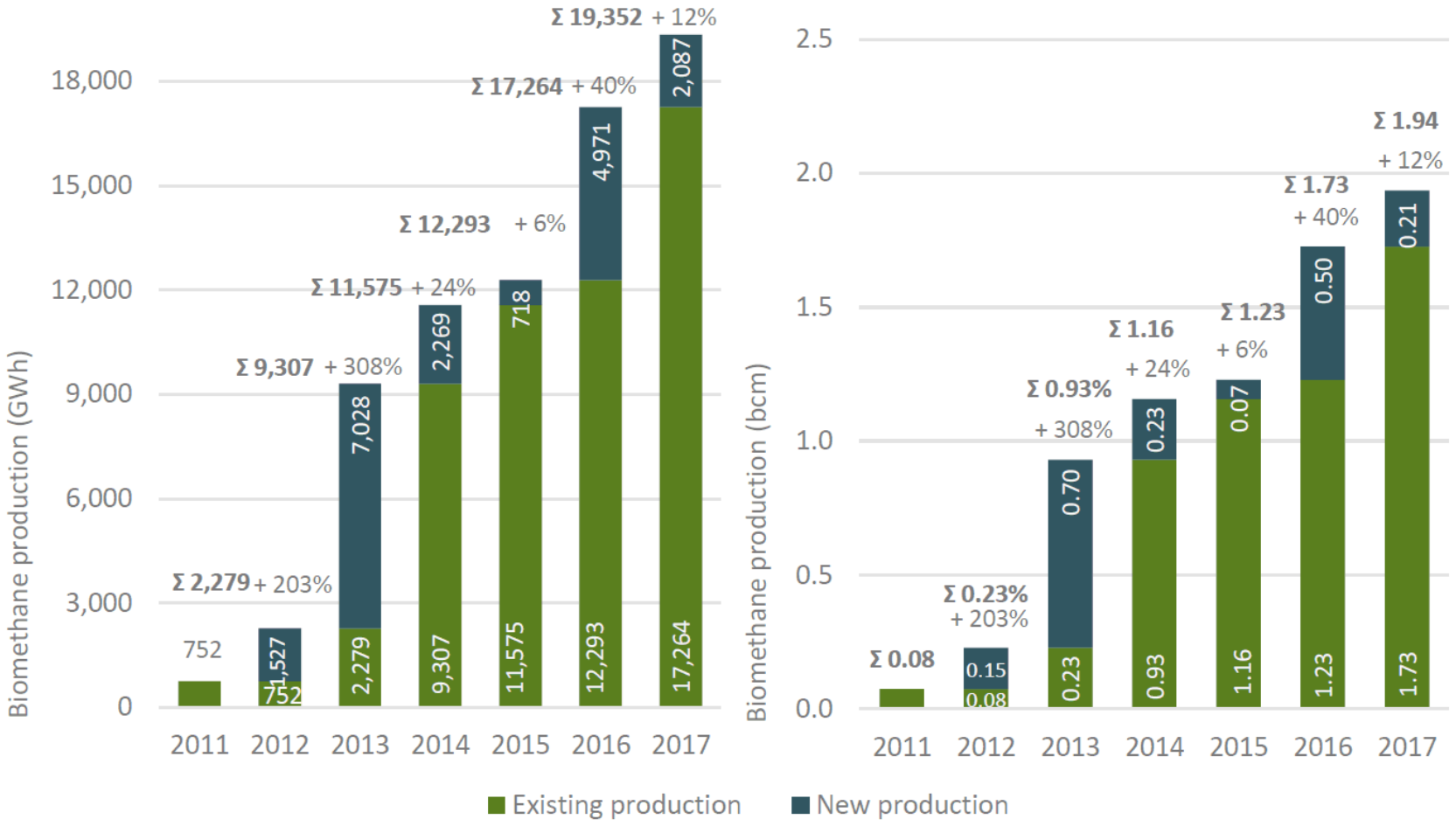
RES share in heat and cold production in the EU in 2017 (%)



Source: ec.europa.eu/eurostat

Biomethane – Future of Biogas

Biomethane production in European countries (2011-2017)

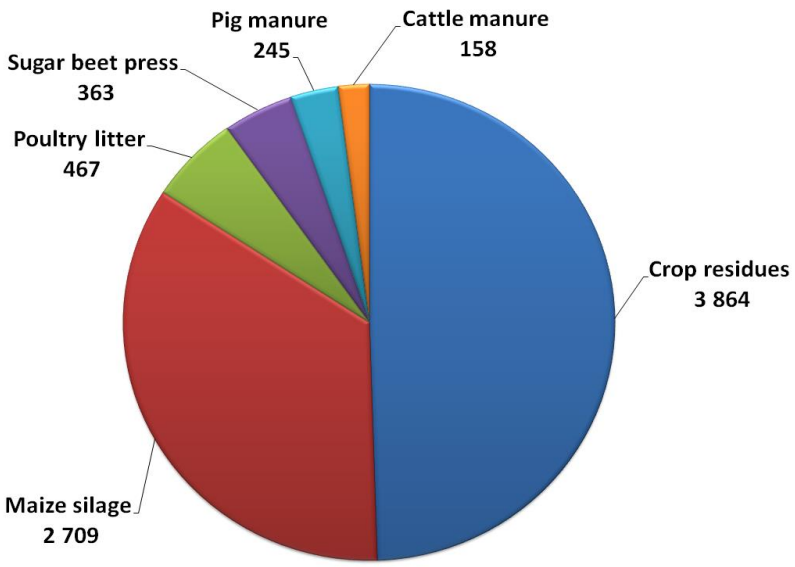


GWh

bcm (billions m^3 of CH_4)

Source: EBA Statistical Report 2018

Biomethane – Future of Biogas



Biomethane potential in Ukraine in 1000 $_{N}m^3$ -
7.8 bln m^3 CH_4 or
25% of NG consumption (2018)

Necessary amendments to the Law of Ukraine "On alternative energy sources"

Energy unit category	«Green» tariff, EUR/kWh w/o VAT
Electricity from biomethane	0,123

Priorities for improving normative and legal basis of bioenergy

Lobbying the **required level of state support quotas** for biomass / biogas projects.

Improvement of the stimulation mechanism for **biomethane** production and consumption.

Improvement of the of stimulation mechanism for power generating capacities on biomass, biogas and biomethane for operation in the **balancing capacities market**.

Introducing of the stimulating mechanism for **energy crops cultivation and use** in Ukraine.

Support for implementation of e-commerce system for solid biofuels.

Support the introduction of competition in district heating systems.

Support of the developed mechanism for stimulating the production and use of **liquid biofuels and biogas for transportation.**

Promoting the need to abolish the **tax on CO_2 emissions** from boiler houses, TPPs / CHPs on biomass and biogas.

We are making the green future

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