BIOFIT

Bioenergy Retrofits for Europe's Industry

MEDIUM-SCALE HEAT AND CHP SECTOR

SECTORAL RECOMMENDATION PAPER

Retrofitting in terms of the BIOFIT project means the adaption or replacement of a plant characteristic (e.g. equipment, feedstock or auxiliary) to foster the use of bioenergy instead of fossil energy or to improve the overall sustainability of the process. The retrofit measures can result in using (additional) biomass as an input to the production plant or producing additional output from biomass at the production plant.

SECTOR STATUS-QUO

Electricity from fuels is produced either in power plants, which only generate electricity, or in combined heat and power, CHP, plants which, in addition to electricity, also produce heat for, for example, a district heating network. The simultaneous production of electricity and heat in combined heat and power plants uses significantly more of the fuel's total energy content compared to a power plant. Efficiency, calculated as utilized energy in relation to fuel used, is between 70 and 90 percent in cogeneration plants.

A wide range of feedstocks are possible for CHPs, e.g. coal and different types of biomass, where the most common is woody biomass. In order to decarbonise the power and heating sector, actions for retrofitting the fossil fired CHPs are important and policies at different levels are striving for conversion of the feedstock. There are different options for feedstock conversions, in addition to full biomass repowering, some options for co-firing are possible. Complete conversion is of course desirable from a decarbonisation point of view, however some aspects have to be taken into account, e.g. availability of the feedstock and plant-specific conditions for the retrofit.

2018	Solid fossil fuels and peat	Oil and oil products	Natural gas	Renewables	Other fuels
Belgium[3]	1,4%	1,0%	66,6%	18,7%	12,4%
Bulgaria	27,9%	1,1%	38,5%	18,6%	14,0%
Czech Rep.	60,6%	0,9%	12,5%	23,7%	2,4%
Denmark	20,7%	2,2%	13,9%	53,1%	10,2%
Germany	24,2%	2,0%	48,0%	14,3%	11,5%
Estonia[2]	21,4%	13,3%	0,0%	64,3%	0,9%
Ireland[3]	2,5%	0,0%	94,1%	3,2%	0,2%
Greece[2]	11,9%	31,3%	46,4%	0,6%	9,8%
Spain	2,2%	7,2%	81,0%	8,9%	0,7%
France	4,1%	4,4%	51,2%	30,1%	10,1%
Croatia	1,6%	7,9%	75,0%	15,5%	0,0%
Italy	1,8%	8,7%	66,0%	16,1%	7,4%
Cyprus	0,0%	7,9%	0,0%	92,1%	0,0%
Latvia	0,5%	0,0%	55,8%	43,7%	0,0%
Lithuania	0,0%	14,9%	21,4%	52,0%	11,6%
Luxembourg	0,0%	0,0%	47,9%	52,0%	0,1%
Hungary[3]	8,4%	0,0%	69,9%	14,5%	7,2%
Malta	0,0%	0,0%	93,8%	5,2%	1,0%
Netherlands	2,9%	4,0%	80,6%	8,8%	3,8%
Austria	7,7%	7,4%	38,7%	41,1%	5,2%
Poland	66,4%	7,0%	12,3%	12,9%	1,4%
Portugal[3]	0,0%	7,1%	46,1%	46,3%	0,5%
Romania	23,5%	3,0%	67,6%	5,7%	0,3%
Slovenia[3]	48,1%	0,3%	29,7%	19,5%	2,3%
Slovakia	21,3%	14,1%	27,6%	31,2%	5,9%
Finland	23,0%	0,5%	9,8%	62,9%	3,8%
Sweden	10,3%	0,5%	4,3%	58,4%	26,5%
United Kingd.	2,2%	11,2%	73,1%	9,8%	3,8%

2 open validation issues

3 contains negative PES figures

Mix of fuels for Combined Heat and Power generation (Source: Eurostat)

Various technologies are possible for bioenergy conversion independently on the final product, which may be e.g. heat-only or steam for power production or CHPs. A selection of options are presented in this paper on page 3. Additional options are presented in the recommendation paper for retrofitting options at larger scale power/ heat production facilities.

MEDIUM-SCALE HEAT AND CHP SECTOR FRAMEWORK CONDITIONS FOR RETROFITTING

Political Conditions

Political targets and various national legislative frameworks, e.g. carbon tax, have a decisive impact on the development of the CHP sector.

The political frame on EU level is mainly set by the Renewable Energy Directive (2018/2001, RED II) and the Energy Efficiency Directive (2018/2002).

Cogeneration can significantly help improve energy efficiency as efficiency gains can be achieved in a technologically neutral way, particularly by making use of waste heat and cold from waste incineration, power generation and industry, as well as district heat and cold transmission installations with low losses.

In line with the Energy Efficiency Directive, the Commission may require EU countries to carry out a comprehensive assessment of the potential for efficient heating and cooling, including the assessment of the potential for cogeneration.

With the Energy Efficiency Directive, EU countries are required to ensure that the origin of electricity produced from high-efficiency cogeneration can be proved with guarantees of origin.

The Energy Efficiency Directive requires EU countries must to ensure that a cost-benefit analysis is conducted of the potential of using cogeneration when they plan to build or substantially refurbish. [1]

Entrepreneurial Conditions

Retrofitting compared to new CHP plants entails reduced CAPEX. However sustainable sourcing of large volume of biomass for a large-scale retrofitting case can be challenging.

Several technologies for retrofitting of cogeneration facilities are identified, some of them for co-firing and other for complete conversion. The specific prerequisites for the current plant have to be considered. The chances of retrofit implementation are affected by e.g. availability of the biomass; policy framework; the national decarbonisation targets and the company strategies.

Some important drivers are strategies for mitigation of greenhouse gas emissions for the EU which includes targets for decarbonizing the sector and the EU ETS which penalizes use of fossil fuels but not bioenergy. An important barrier in parts of the EU are existing interests in local, regional, and national bodies on CHP which can hinder the phase out fossil heat and power generation. This is accompanied by lobbyism against the phasing-out of coal use.

MEDIUM-SCALE HEAT AND CHP SECTOR TECHNICAL OPTIONS FOR RETROFITTING

Option I – Biomass powder burners

Arctic Paper Grycksbo, a paper mill, located in central Sweden, is a producer of high-quality graphic paper. An existing oil-fired steam boiler was retrofitted into a CO_2 neutral steam boiler.

Besides the fuel (wood pellet) preparation, four 14 MW burners were installed on the existing steam boiler. The main fuel is wood powder, the secondary fuel is a process residue, the high corrosive pine tar. It took only 9 days stop of the existing boiler to accomplish the boiler retrofit. The wood powder/ pine tar fired steam boiler has an uptime of more than 8500 h and availability of 99 %.

Retrofit to wood powder/pine tar fired steam boiler (Source: Arctic Paper)

Fossil oil conversion to wood powder (Source: Söderhamn Nära)

Söderhamn Nära is a municipality owned company providing heat to the community. Back in the nineties Söderhamn Nära choose to convert the oil-fired hot water boilers to a wood powder fired solution in order to reach CO_2 neutrality. 25 years later, Söderhamn Nära upgraded their installation. PetroBio provided a new dosing and pneumatic transport system, a new highly efficient powder burner and an ESP flue gas treatment.

Option II – Fuel switch to bio-oil

Another option, relatively uncomplex, is to convert from fossil oil to light or heavy bio-oil. Sölvesborg Energi is providing heat to the community of Sölvesborg in south Sweden. Primarly waste heat from a nearby pulp mill is used. The feed-stock conversion concerns the boilers used to secure the heat deliveries in case of interruptions in waste heat deliveries. Heavy bio-oils require constant heating, which include additional investment costs, but they are cheaper, compared to light bio-oils.

Fossil oil conversion to bio-oil (Source: Energikontor Sydost)

CHP SECTOR BIOMASS RETROFITTING IS AN IMPORTANT CONTRIBUTION TO THE PHASE-OUT OF COAL AND TO MEET NATIONAL AND EU TARGETS FOR DECARBONIZATION.

CONCLUSIONS

Combined Heat and Power plants produce both heat and electricity at the same time, thereby reaching higher total efficiencies and exhibiting a better use of energy resources compared to heat-only or electricity-only installations due to primary energy savings. Integrating biomass in existing power or CHP plants effectively means substituting partly ("co-firing") or fully ("repowering") the thermal energy provided by the combustion of a fossil fuel, most commonly coal, with biomass.

Technologies for feedstock conversion is available, however plant-specific prerequisites have to be taken into consideration. The availability of the new feedstock has to be secured. A challenge in this sector, in case the installations are fueled with coal, is related to the phase-out of coal and its social challenges for the coal regions in transition. For these regions, co-firing retrofitting can be a supporting measure for the short-term.

REFERENCES

[1] https://ec.europa.eu/energy/topics/energy-efficiency/cogeneration-heat-and-power_en (20210326)

Related literature: Rutz, D.; Janssen, R.; Reumerman, P.; Spekreijse, J.; Matschegg, D.; Bacovsky, D.; Gröngröft, A.; Hauschild, S.; Dögnitz, N.; Karampinis, E.; Kourkoumpas, D.; Grammelis, P.; Melin, K.; Saastamoinen, H.; Susmozas Torres, A.; Iglesias, R.; Ballesteros, M.; Gustavsson, G.; Johansson, D.; Kazagić, A.; Merzić, A.; Trešnjo, D.; Dagevos, H.; Sijtsema, S.; Reinders, M.; Meeusen, M. (2020): Technical options for retrofitting industries with bioenergy - a handbook, 1st edition, Munich, WIP Renewable Energies, ISBN: 978-3-936338-51-5

THE BIOFIT PROJECT

This sectoral recommendation factsheet was prepared within the BIOFIT project. The project aims to facilitate the introduction of bioenergy retrofitting in Europe's industry. Target industries are first-generation biofuels, pulp and paper, fossil refineries, fossil firing power and combined Heat and power (CHP).

BIOFIT
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Disclaimer: The sole responsibility for the content of this factsheet lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the INEA nor the European Commission are responsible for any use that may be made of the information contained therein. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817999