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Bioenergy Retrofits for Europe's Industry

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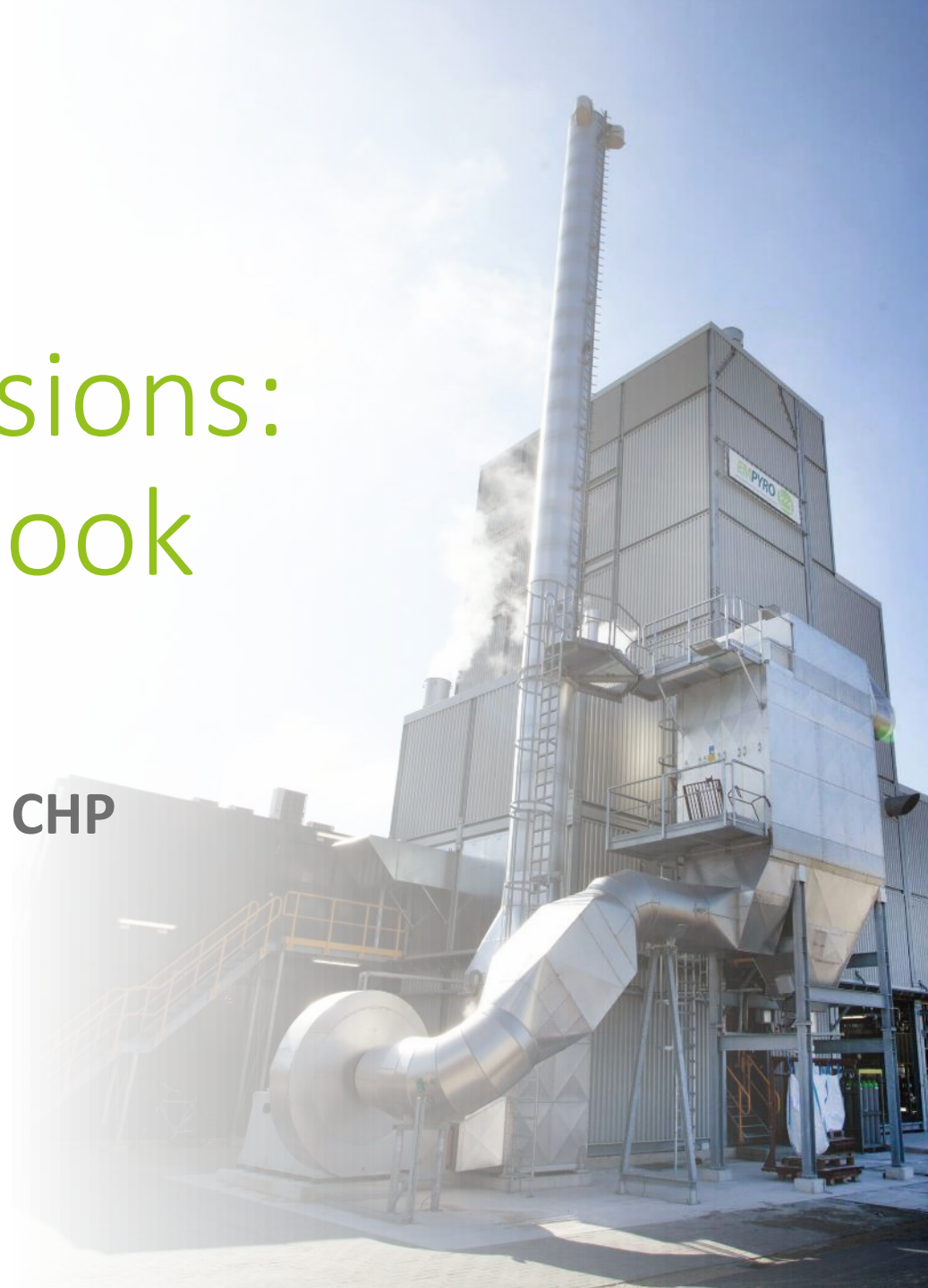
# Coal to biomass conversions: status and future outlook



**BIOFIT Final Policy Conference**

**Industry session: Fossil firing power and CHP**

18 January 2022

Manolis Karampinis, CERTH, Greece

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# Coal to biomass conversions

# Why biomass conversions and not co-firing?

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## Political will to phase-out

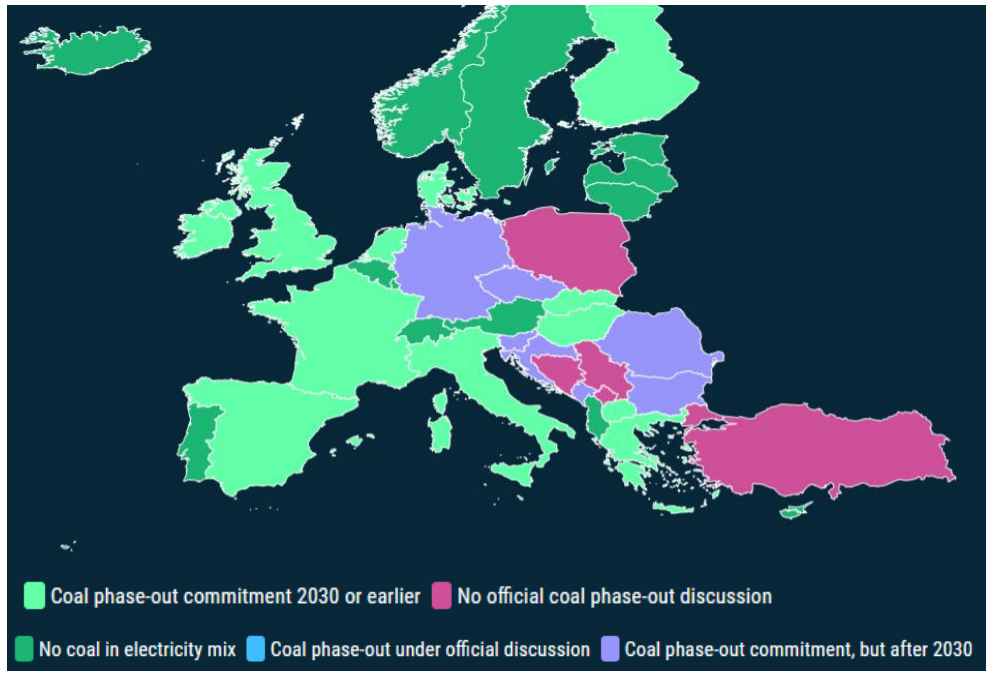


Image Source: https://beyond-coal.eu/coal-exit-tracker/

## Directive (EU) 2018/2001 / Article 29: Sustainability and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass

21.12.2018 EN Official Journal of the European Union L 328/133

11. Electricity from biomass fuels shall be taken into account for the purposes referred to in points (a), (b) and (c) of the first subparagraph of paragraph 1 only if it meets one or more of the following requirements:

(a) it is produced in installations with a total rated thermal input below 50 MW;

(b) for installations with a total rated thermal input from 50 to 100 MW, it is produced applying high-efficiency cogeneration technology, or, for electricity-only installations, meeting an energy efficiency level associated with the best available techniques (BAT-AEELs) as defined in Commission Implementing Decision (EU) 2017/1442 (1);

(c) for installations with a total rated thermal input above 100 MW, it is produced applying high-efficiency cogeneration technology, or, for electricity-only installations, achieving an net-electrical efficiency of at least 36 %;

(d) it is produced applying Biomass $CO_2$ Capture and Storage.

For the purposes of points (a), (b) and (c) of the first subparagraph of paragraph 1 of this Article, electricity-only-installations shall be taken into account only if they do not use fossil fuels as a main fuel and only if there is no cost-effective potential for the application of high-efficiency cogeneration technology according to the assessment in accordance with Article 14 of Directive 2012/27/EU.

# Coal to biomass conversion benefits

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**For utilities:**

- Utilization of otherwise stranded assets
- Generation of renewable electricity
- Financial motivation (feed-in premiums, no $CO_2$ cost,…)

**For grid operators:**

- Dispatchable thermal power generation at large-scale

**For society:**

- Supporting local economies, especially in transition regions

# Coal to biomass conversion options

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| Conversion aspect | Conversion retaining pulverized fuel combustion | Thermally treated biomass | Conversion into Bubbling Fluidized Bed (BFB) combustion |
|---|---|---|---|
| **Boiler fuel input** | Up to 1,000 MW or more | Up to 1,000 MW or more | Up to 300 MW |
| **Main modifications required** | Milling system<br>Burner system (possibly)<br>Biomass handling & storage | Limited | Replacement of lower furnace with fluidized bed and others |
| **Fuel** | Primarily wood pellets (due to large-scale supply issues) | Thermally treated wood pellets | Wide range of "standard' biomass feedstocks + limited co-firing of agrobiomass / waste |
| **References** | Several | 1 & several demonstrations | Several |

# Factors to consider in a conversion

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- On-site infrastructure: boiler & turbine design, space availability, fuel handling infrastructure, minimum efficiency requirements, emissions control
- Fuel sourcing: white pellet as standard option for large utility scale; alternative options (e.g. agropellets) as part of the fuel mixture or in post-subsidy future; local fuels for smaller conversion projects; waste derived fuels?
- Logistics infrastructure: port access and biomass handling capacity, land transport mode (if required)
- Health and safety aspects: dust control, fire prevention measures
- Support scheme: feed-in premium, green certificates, etc.
- Future: BECCS?

# Major active wood pellet conversions in Europe

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| Power plant / Unit | Country | Retrofit year | Electrical Capacity (MWe) | Thermal Capacity (MWth) | Main fuels used |
|---|---|---|---|---|---|
| **Västhamnsverket (Öresundskraft)** | Sweden | 2006 | 69 | 138 | Wood pellets |
| **Rodenhuize 4 (ENGIE)** | Belgium | 2011 | 180 | - | Wood pellets |
| **Drax 1** | United Kingdom | 2013 | 660 | - | Wood pellets |
| **Avedøre 2 (Ørsted)** | Denmark | 2014 | 394 | 497 | Wood pellets, Straw (direct co-firing) |
| **Drax 2** | United Kingdom | 2014 | 645 | - | Wood pellets |
| **Drax 3** | United Kingdom | 2015 | 645 | - | Wood pellets |
| **Avedøre 1 (Ørsted)** | Denmark | 2016 | 254 | 359 | Wood pellets |
| **Studstrup 3 (Ørsted)** | Denmark | 2016 | 362 | 513 | Wood pellets, Straw (parallel co-firing) |
| **Drax 4** | United Kingdom | 2018 | 645 | - | Wood pellets |
| **Lynemouth (EPH)** | United Kingdom | 2018 | 407 | - | Wood pellets |
| **Amer 9 (RWE)** | Netherlands | 2019 | 600 | 300 | 80 % wood pellets, 20 % hard coal (mass basis) |
| **Eemshaven (RWE)** | Netherlands | 2019 | 1,560 | - | Hard coal, 15 % wood pellets |
| **Maasvlakte 3 (Uniper)** | Netherlands | 2019 | 1,110 | - | 69 % hard coal, 27 % wood pellets, 4 % other biomass (mass) |

Source: BIOFIT Handbook: Technical options for retrofitting industries with bioenergy (2nd edition, upcoming)

- More than 81.8 GWe of coal plants to be decommissioned by 2030 according to the draft NECP – probably even more now
- Conversion projects were also considered in Italy, Ireland, Greece, Spain (see BIOFIT Industry Forum: Repowering coal power plants with biomass)
- → Almost nothing happened since then – why?

# Controversies

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## The controversy of wood pellets as a green energy source

By Christine Ro
Business of Technology reporter

7 days ago

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## How 'Green' Are Wood Pellets as a Fuel Source?

Europe is betting big on wood to replace coal, but the industry is taking heat for stoking carbon emissions and air pollution.

PHOTOGRAPH: DAN KITWOOD/GETTY IMAGES


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## How the EU's Renewable Energy Directive risks destroying Europe's forests

**DISCLAIMER:** All opinions in this column reflect the views of the author(s), not of EURACTIV Media network.

By Dominic Scott, Jan Rosenow and Samuel Thomas | RAP

Jun 22, 2021

To meet their 2020 renewable energy targets, EU countries nearly doubled the amount of solid biomass used in Europe, the majority of which comes from forests, write Samuel Thomas, Dominic Scott and Dr Jan Rosenow. [Rokas Tenys / Shutterstock]

# Cost factors in conversion projects

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**Conversion CAPEX:**

- ~ 13 €/kWe → conversion of Thunder Bay 3 to black pellets
- ~ 54 €/kWe → conversion of Drax 4 (re-use of redundant co-firing equipment)
- ~ 416 €/kWe → conversion of Drax 1-3 + supply chain infrastructure
- ~ 125 - 833 €/kWe → range for some other conversion projects

→ Compare with new biomass power plants: 2,500 – 4,500 USD/kWe

→ Compare with new NG CCGT: ~ 390 €/kWe

**Fuel / Electricity cost:**

- Spot pellet prices from around 120 EUR/t (Jul 20) to 224.5 EUR/t (Dec 21), CIF NWE (Source: Argus Biomass Markets)
- Electricity production around 63.5 – 118.9 €/MWh-e (assuming 40 % net efficiency)

→ Compare with current electricity prices!

- Drax: from around 75 £/MWh-e to → 50 £/MWh-e by 2027 through fuel supply restructuring (increased self-supply, wider fuel envelope)

# BIOFIT coal to biomass conversion case studies

# BIOFIT Coal to biomass case studies

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- Elektropriveda BiH / Tuzla 6 (223 MWe)
  - Up to 30 % (mass basis) co-firing (various local biomass fuels)
- Elektropriveda BiH / Kanakj 5 (118 MWe)
  - 100 % biomass conversion (various local biomass fuels)
- EP Produzione / Fiume Santo 4 (320 MWe)
  - 100 % biomass conversion (wood pellets, up to 5 % local wood chips)

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# Thank you for your attention!


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