

TEPLATOR:

BASIC ECONOMIC STUDY FOR THE CONSTRUCTION AND OPERATION

TEPLATOR CONCEPT

The TEPLATOR is an innovative concept for future district heat production. The TEPLATOR facility will use already spent fuel from commercial nuclear power plants. Consequently, this concept will produce heat without any emissions and with minimal fuel costs. The first TEPLATOR DEMO design with output power 50 MW of thermal energy will use 55 PWR (VVER) spent fuel assemblies. This fuel loading will be operated for two years.¹ The amount of produced heat for one heating season (9 months) will be sufficient for residential heating of a large city with 100 000 citizens (estimated using Czech Republic district heating systems data).

EU DISTRICT HEATING PRICES

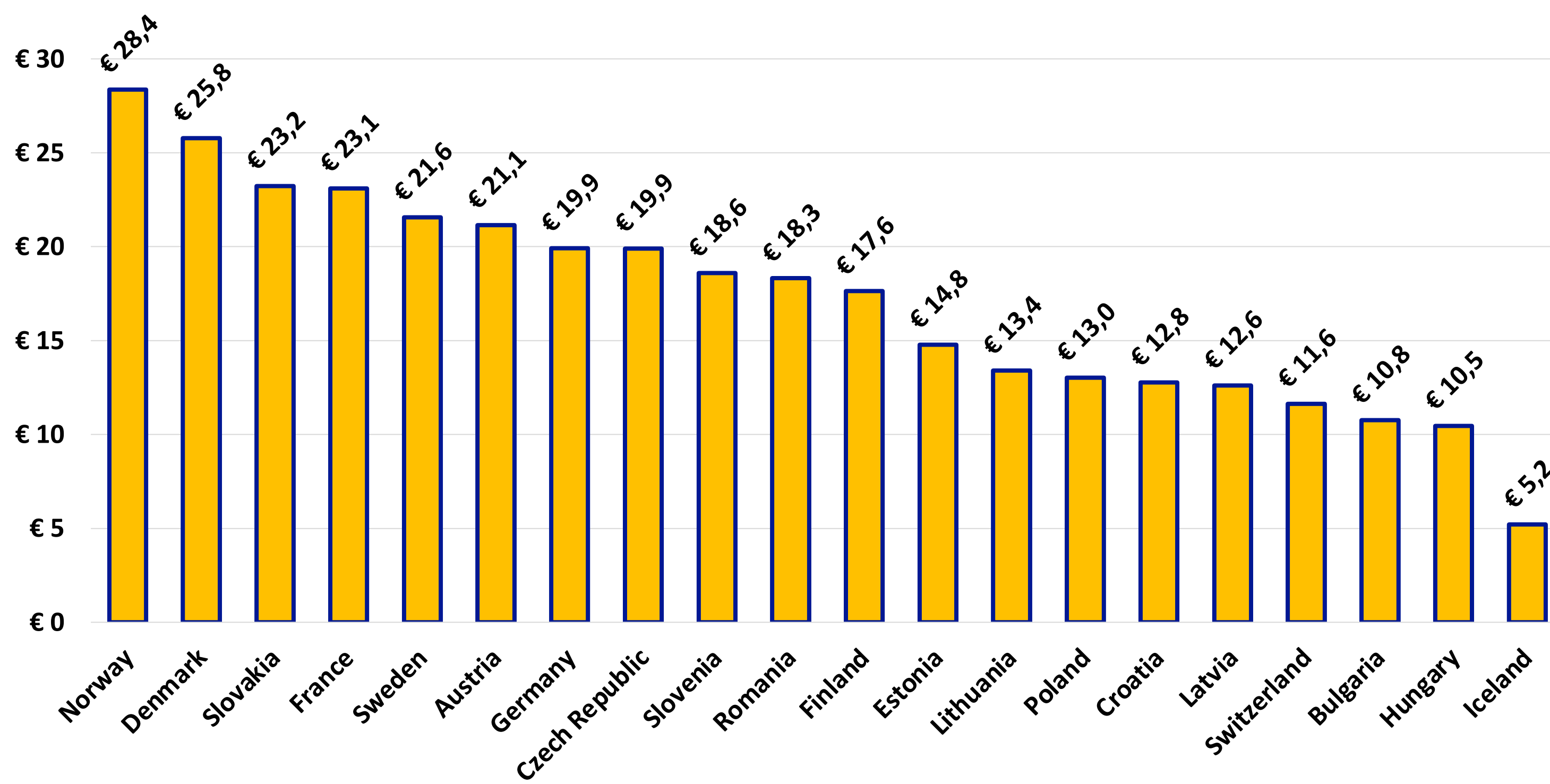


Fig. 2: Consumer heat energy prices in 2019 (EUR/GJ) ^{4, 5}

DISTRICT HEATING FINANCIAL ASPECTS

Each district heating price (see Fig. 2) consists of several parts - distribution costs, fuel and emissions costs, operation costs, fees and taxes. This study for the TEPLATOR competitiveness is primarily focused on the fuel and emissions costs of the conventional district heating plants. The average fuel expenses for all the coal-based heat plants in the Czech Republic are 19% of the consumer price without VAT, i.e. **3.78 EUR/GJ**. For the other kinds of fuel these expenses are 52% of the consumer price, i.e. **10.35 EUR/GJ**.⁷ The sticking point of conventional heating plants economy are emissions and the emission limits. Every ton of exhausted carbon dioxide (or equivalent amount of other greenhouse gases) by every facility operator must be covered with the emission allowances (credits). Some of them are allocated for free, but this number is decreasing every year, thus the heat plants must buy more credits on trading markets. Fig. 4 shows the number of free allowances and the real exhausted emissions (both for Europe region) and also the average price of one allowance for one ton of CO₂. The final number of produced emissions per GJ of heat energy is difficult to determine, because it is variable for fuel, technology, size and multiple other factors. The Czech Energy Regulatory Office regularly announces the maximal allowed costs directly proportional to the allowance price. For the 2019 allowance price average, these costs are **2.22 EUR/GJ** for coal and **0.79 EUR/GJ** for other fuels. This is the highest price, which may be accounted for the final consumer price.⁸

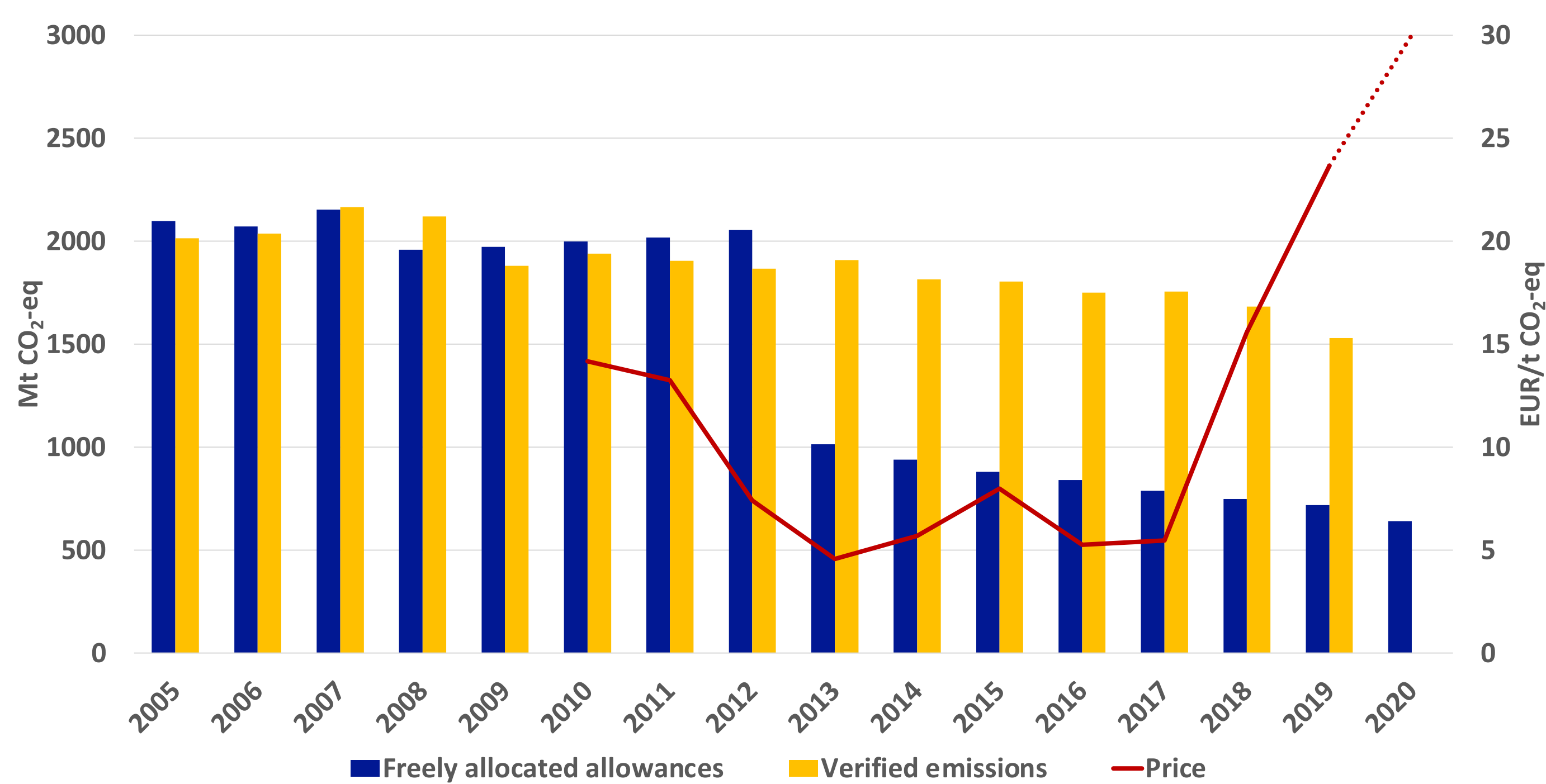


Fig. 4: CO₂ allowances EU data ^{9, 10, 11}

Final heat consumption in 2018

Germany	415 PJ
Italy	227 PJ
France	153 PJ
Finland	174 PJ
Czech Republic	89 PJ
Hungary	41 PJ
Bulgaria	28 PJ
Slovakia	25 PJ

Tab. 1: Potential EU countries for the first TEPLATOR application ²

TEPLATOR is a perspective way of future district heating with negligible costs for fuel. Great potential for the TEPLATOR application has been identified in a number of EU countries with high heat energy demand based on fossil fuels. The consumer prices of heat in the European union in 2019 range between 10 EUR and 26 EUR per GJ. The share of primary fuel in the total heat costs is 30% for the coal-based generation and for other fuels, it is significantly higher. This value includes fees for the carbon emissions allowances, which are becoming more expensive every year. Comparison with the price of the heat produced by TEPLATOR for 4 EUR/GJ clearly shows economic feasibility of the concept. Application of the TEPLATOR facility as replacement of the old conventional fossil fuels-based heat plants will also save significant amount of polluting emissions in accordance to EU climate policy.

REFERENCES

[1] ŠKODA, Radek et al. TEPLATOR: nuclear district heating solution. In: 29th International Conference Nuclear Energy for New Europe. Portorož, Slovenia, 7. – 10. 9. 2020.
[2] Eurostat. Supply, transformation and consumption of derived heat [Data file]. 2020.
[3] International energy agency. Data and statistics. Heat generation by source [Data file]. 2020.
[4] WERNER, Sven. European District Heating Price Series. Energiforsk, 2016. ISBN 978-91-7673-316-5.
[5] Eurostat. Harmonised index of consumer prices for Heat energy [Data file]. 2020.
[6] European commission. Mapping and analyses of the current and future (2020 – 2030) heating/cooling fuel deployment (fossil/renewables). Final report, 2016.

[7] Energetický regulační úřad. Vyhodnocení cen tepelné energie a jejich vývoj k 1. lednu 2019. Jihlava, 2020.
[8] Energetický regulační úřad. Energetický regulační věstník. Jihlava, 2018, Ročník 18. Částka 8/2018.
[9] Intercontinental Exchange. European Union Allowances (EUA) Futures. [Price data]. 2020.
[10] European Environment Agency. EU Emissions Trading System (ETS) [Data file]. 2020.
[11] Energetický regulační úřad. Průměrná cena emisní povolenky pro rok 2010 – 2019.

DISTRICT HEATING TODAY

Total heat energy consumption in the European union provided by the Eurostat data is 2179 PJ (for 2017).² Popularity of district heating varies across Europe. Fig. 3 shows the share of district heating in the total heating and cooling energy demand in EU countries. Primary fuels used for heat generation in Europe (2017) shows Fig. 1. Preferred TEPLATOR application is in countries with widely used district heating systems, where the old fossil fuel-based technologies need to be replaced and the heat distribution can be provided by existing systems.

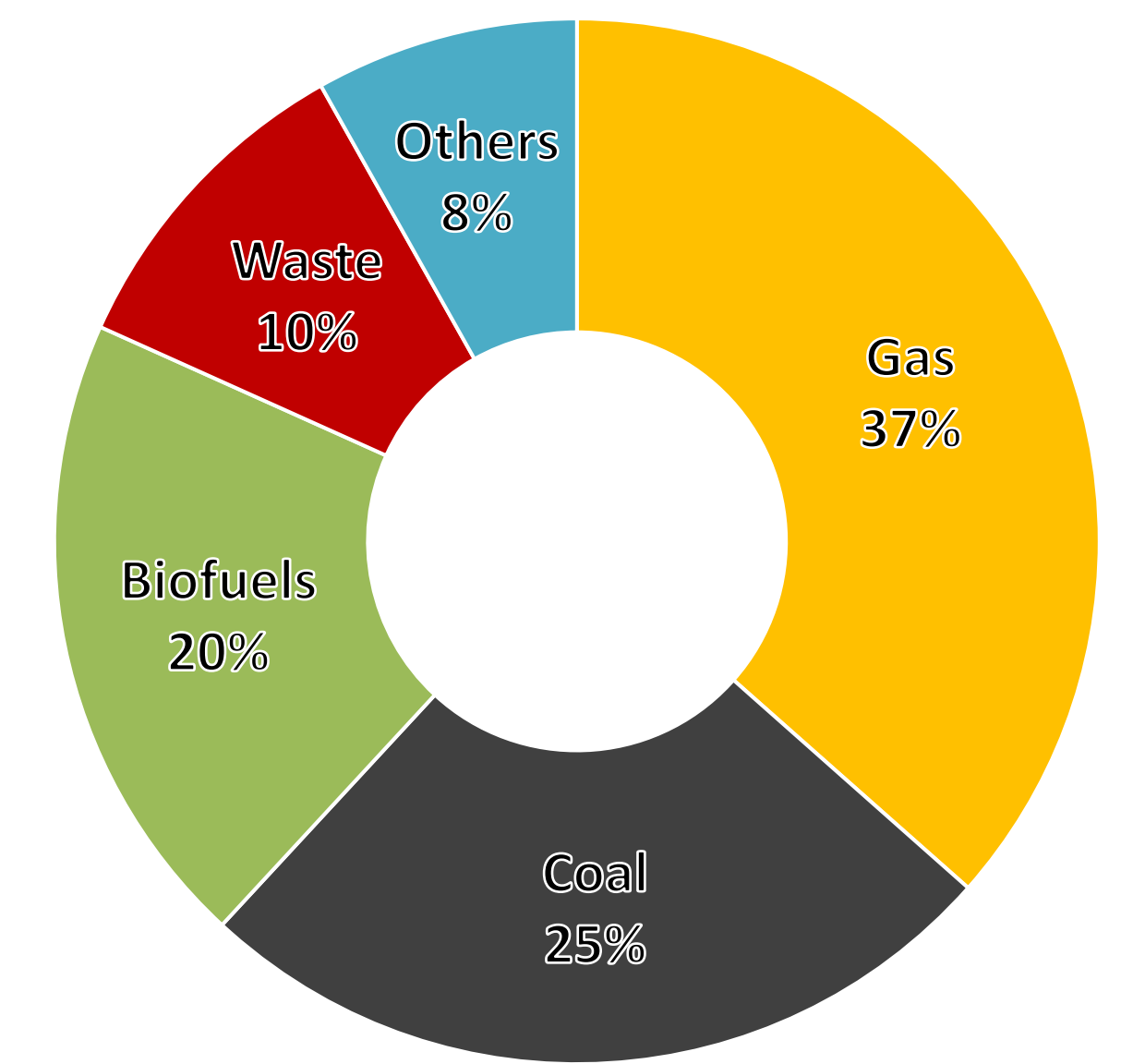


Fig. 1: EU heat generation by source ³

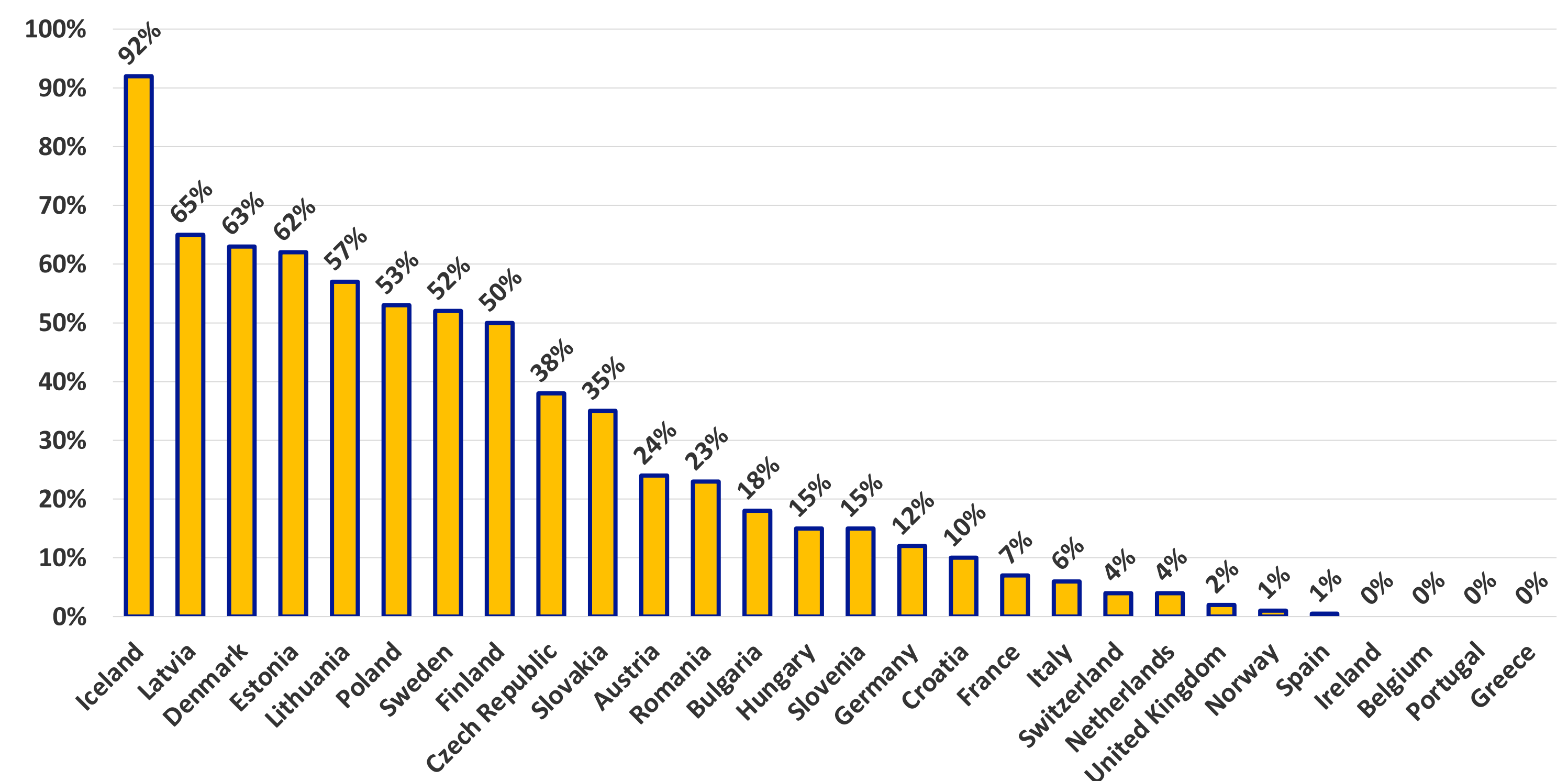


Fig. 3: Share of district heating in total heating and cooling energy demand ⁶

TEPLATOR COMPETITIVENESS

The preliminary economics study for the TEPLATOR construction and operation has been carried out. The calculated investments costs for the first TEPLATOR DEMO 50 MWt facility is **30 M EUR**. Then the final price of produced heat is **4 EUR/GJ**.¹ Overview of district heating share in the total heat demand shows the preliminary potential of TEPLATOR application in many European countries. However, a number of further factors have to be considered. The most promising countries for TEPLATOR application (see Tab. 1) should have the higher total heat demand, that is based mainly on fossil fuels, and also possess the reserves of PWR spent fuel assemblies. As the final consumer price of district heating in EU countries is above 10 EUR/GJ, the heat produced by TEPLATOR for 4 EUR/GJ is fully competitive for all EU countries. Comparison of the calculated price for TEPLATOR with the obtained data for the conventional heat plans shows evident financial advantage of TEPLATOR. The final calculated price of the heat energy 4 EUR/GJ is lower than standard costs of the fuel and emissions allowances 6 EUR/GJ for the coal-based heat plants and likewise for other fuels plants with significantly higher fuel costs.

CONCLUSIONS

