Environmental and Climate Technologies
2021, vol. 25, no. 1, pp. 840–852
https://doi.org/10.2478/rtuect-2021-0063
https://content.sciendo.com

Analysis of the Heat Pump Market in Europe with a Special Regard to France, Spain, Poland and Lithuania

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***Abstract* – Becoming the world's first climate-neutral continent by 2050 is currently the most ambitious European goal. Heat pumps are the example of the key technology, which could help to achieve the aim by heating, cooling and domestic hot water (DHW) preparation in an ecological and energy-efficient way. This article characterized a heat pump market in Europe between 2009 and 2020 with a special regard to France, Spain, Poland and Lithuania, for which a more detailed study was presented. The analysis was performed primarily on the grounds of statistics data provided by the European Heat Pump Association (EHPA), which determined the number of heat pumps sold based on standard questionnaires from national heat pump associations, statistical offices and research institutes. The highest number of heat pump sold in analysed period of time was recorded in France, Italy, Sweden, Norway, Germany and Spain. Poland was in the middle of the list, while Lithuania was one of the last countries. Considering the number of heat pumps sold per 1000 households, Norway was the clear leader, followed by Estonia, Finland, Sweden and Denmark. Lithuania was placed 12th, while Poland was only 18th. In terms of the type of lower and upper heat source, air-to-water and air-to-air heat pumps were the most popular choices, while ground source heat pumps were the least popular. The development of the heat pump market has been influenced by social, environmental, economic and technological factors.**

***Keywords* – Cooling; domestic hot water; heat pumps; heating; renewable energy**

1. INTRODUCTION

Energy supply is an essential issue in people's daily lives. Ensuring energy security in Europe is essential for the proper functioning of households as well as schools, hospitals, companies, cinemas or theatres [1]. Becoming the world's first climate-neutral continent by 2050 is actually the most ambitious European goal. As it is known, the use of renewable energy sources could provide many economic, social and environmental benefits to the European countries. Implementation of clean technologies into the energy sector could minimize the dependence on the current fossil fuel market, as well as provide the diversification of energy supply industries and decrease of primary energy consumption. What is more, the application of 'green' policies ensures the reduction of the volatile

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pollutants, carbon dioxide and other greenhouse gases emissions to the atmosphere, as well as enables the creation of new jobs in the renewable energy branch [2]. According to the International Renewable Energy Agency (IRENA), carbon emissions should be reduced to 9.5 Gt by 2050, to restrain global warming to less than 2 ºC above preindustrial temperatures. To achieve this aim, it is necessary to expanse the renewable energy and improve energy efficiency [3].

Heating and cooling account for approximately 50 % of the total energy consumption in Europe [2]. According to 2019 data from Eurostat, about 75 % of cooling and heating is still generated from traditional fossil fuels, while only 22 % from renewable energy. To meet the European Union's (EU's) climate and energy goals, heating and cooling sector must significantly reduce its energy consumption and reduce the use of fossil fuels [4]. An example of the key technology, which could provide heating, cooling and domestic hot water preparation in an ecological, energy-efficient way are heat pumps. The operation principle of these devices is based on the extraction the renewable and naturally occurring in the environment heat and then upgrade it to a usable temperature (in with heating or cooling demand can be covered). Heat pumps offer many advantages compared to conventional heating solutions. First of all, they have a really efficient conversation rate of energy to heat. Heat pumps are also cheap to run and do not require specialized maintenance, so they could be a good replacement for either the boiler, furnace, air conditioner or central ventilation [5]. What is more, according to IEA (International Energy Agency) data, heat pumps could save 50 % of the CO_2 emissions of the building sector and 5 % of the industrial sector, what means that 1.8 billion tons of CO_2 per year could be saved [6].

In 2018, the global heat pump market size was estimated to be USD 58.6 billion. Due to extensive government support in the form of subsidies and other financial incentives, as well as the growing demand for renewable energy sources, the compound annual growth rate (CAGR) is expected to reach a value of 8.5 % during 2019–2025. The largest user of heat pump market is the residential sector and the most frequently chosen are reversible heat pumps up to 10 kW [7]. As it is presented on the European Heat Pump Association (EHPA) website, since 2009, increasingly heat pumps have been produced in Europe every year. For example, in 2009, only 3.7 million heat pumps were produced in 21 European countries, while in 2018 it was as much as 68 % more (11.6 million units) [8]. Due to the public's strong interest in ecology in the energy sector, the analysis of the renewable energy market, including heat pumps, has recently become an important issue all over the world.

Valanicius *et al.* [9] provided a review of different heat pump (HP) technologies in Lithuania, as an example of a cold climate case study. They also make an overview of the HP market trends in Lithuania within the European context. Moià-Pol *et al.* [10] analyzed the heat pump market in Russia also compared to the European market. What is more, they presented the prospects of application of combined heat pump systems for small buildings. Pieve and Trinchieri [11] presented the Italian HP market, considering the past 10 years. They also proposed a comparison between the economic performances of two heating and domestic hot water systems with an air-to-water heat pump and condensing boilers, based on several factors. The obtained results could be used for a comparative analysis with other European countries. Gaigalis *et al.* [12] provided a review on heat pump implementation in Lithuania in 2005 and 2013. They investigated the dissemination and manufacture of perspective HPs, as well as compared HP market shares by the company's brand name. Zimny *et al.* [13] presented the development of the heat pump market in Europe, with a focus on Poland in 2000–2013. They also provided a review of the support systems for heat pumps for selected countries. Kazjonovos *et al.* [14] analysed Seasonal Performance Factor values for air-to-water heat pump in Latvian climate and found that SPF for a tested equipment was between

2.45 and 2.62 in cold water months. Martinaitis and Siupsinskas [15] analysed the possibilities of integration of heat pumps for dwelling houses (DHS) to conclude that HP did not have advantages over DHS supplied by biomass in the context of environmental assessment based on CO_2. Marina *et al.* [16] provided an estimation of the European industrial heat pump market potential in terms of sizing, number of units and magnitude. The aim of the paper was to provide technology suppliers and manufacturers of heat pumps perspectives for the technology.

2. METHOD

This article characterizes the heat pump market during 2009–2020 in different European countries and presents a detailed analysis of the heat pump market for four selected countries – France, Spain, Poland and Lithuania. The analysis was performed primarily on statistics provided by the European Heat Pump Association [17]. The number of heat pumps sold was determined by EHPA based on standard questionnaires from national heat pump associations, statistical offices and research institutes. Moreover, data about number of installed heat pumps per 1000 households was collected.

3. RESULTS AND DISCUSSION

Among the 21 European countries analysed by EHPA, the following countries were characterized by the highest number of heat pumps sold between 2009 and 2018: France (1.9 million units), Italy (1.4 million units), Sweden (1.1 million units), Norway (764 000 units), Germany (746 000 units) and Spain (701 000 units). Poland was 12th with 167 000 heat pumps sold, while Lithuania ranked 18th place (only 29 000 units sold).

Taking into account the second part of the analysed decade, the highest sales of heat pumps were recorded in France, followed by Italy, Spain, Sweden, Norway and Germany. As can easily be seen, Spain is characterized by the significant sales growth in recent years. During the analysed period (2014–2018), the heat pump market in this country recorded an increase of as much as 130 000 units. Next was France (89 000 units), Italy (60 000 units), Germany (41 000 units) and Denmark (40 000 units). Poland took a really high 6th place with an increase of 31 000 units, while Lithuania was placed 13th. The summary of heat pump market growth in individual countries shows Fig. 1.

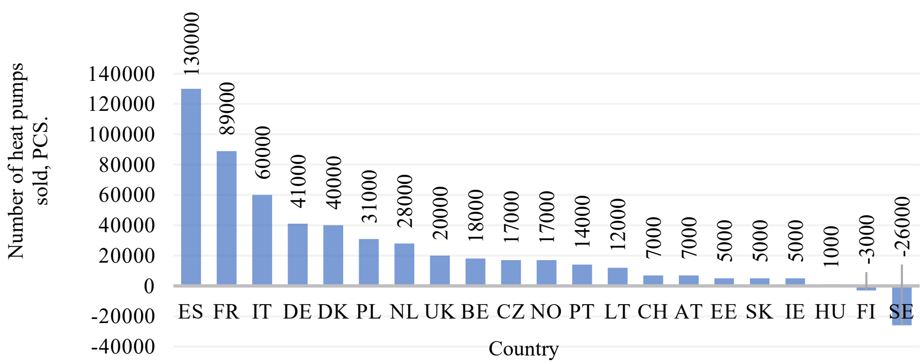

Fig. 1. Heat pump market growth in 2014–2018.

An important indicator of the European heat pump market development is also the number of heat pumps sold per 1000 households. In this case, in 2009–2018, Norway was definitely the leader (347 units), followed by Estonia (251 units), Finland (248 units), Sweden (229 units) and Denmark (129 units). Lithuania was on the 12th position, while Poland took a lowly – 18th place. A comparison of these results is shown in Fig. 2.

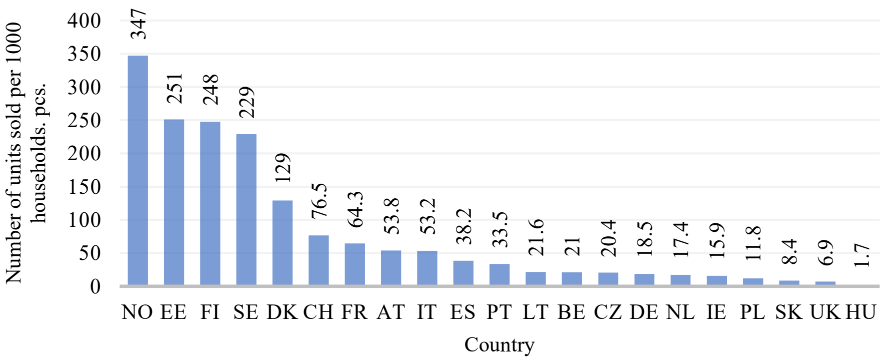

Fig. 2. The number of heat pumps sold per 1000 households.

As shown in Fig. 3, in the analysed decade, in all 21 countries altogether, the most popular types of heat pumps were in order: 'Reversible air-air w/heating', 'H-air/water', 'H-ground/water', 'Sanitary hot water' and 'Reversible other'. 'Exhaust air' and 'Hybrid HP' heat pump types were slightly less popular.

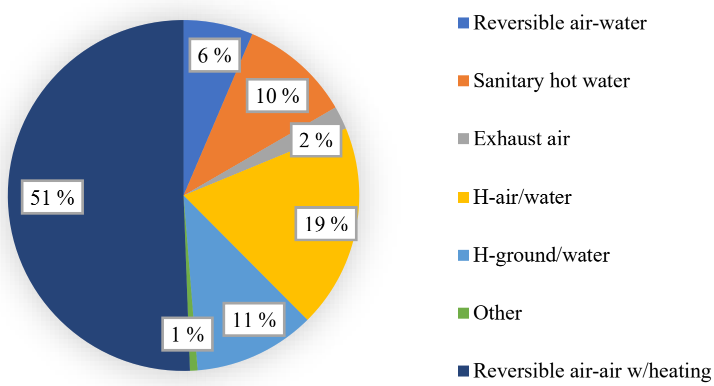

Fig. 3. The total number of heat pumps sold in 2009–2018 by type.

The summary of the most popular of heat pump types for the four analysed countries between 2009 and 2018 is presented in Fig. 4. In comparison with the previous years, the biggest growth was recorded in the: 'Reversible air-air w/heating', 'Sanitary hot water', 'Reversible other' and 'H-air/water' heat pump markets.

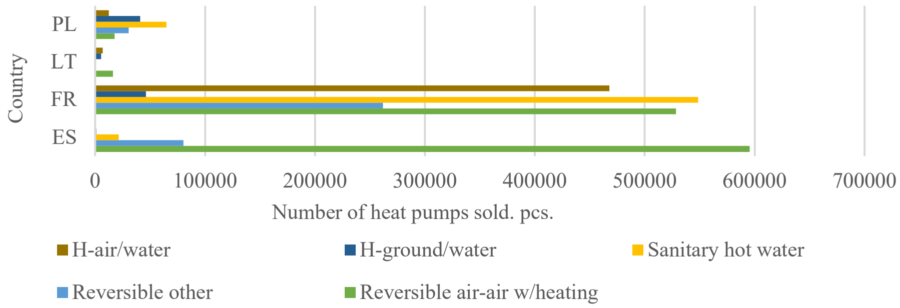

Fig. 4. The number of heat pump sold in 2009–2018 by type, for selected countries.

Across the four analysed countries altogether, the most popular heat pump type proved to be the 'reversible air-air w/heating' heat pump (1 157 939 units in total), while the least popular was the ground source heat pump (93 804 units).

3.1. France

The development of heat pump sales in France is shown in Fig. 5. It can be seen that the highest growth (27 %) was recorded at the turn of 2013 and 2014, while a decrease (as much as 31 %) was recorded in 2010 (compared to 2009). There was a total increase of 38 % between 2009 and 2018. Since 2010, heat pump sales in France have been growing steadily.

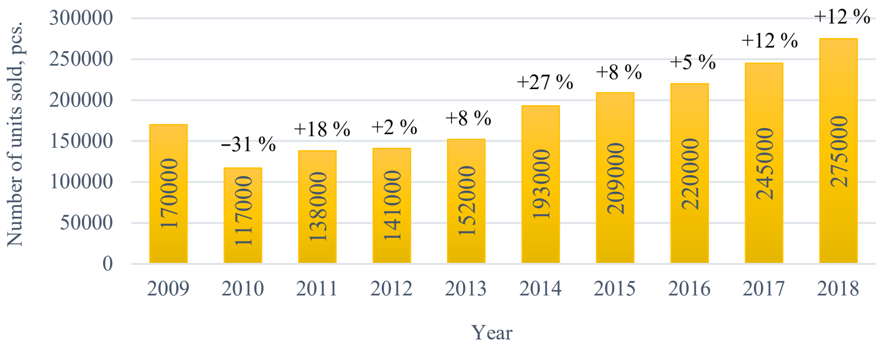

Fig. 5. The development of heat pump sales in France.

Considering the type of a lower and upper heat source of the heat pumps, regardless of the year, air-to-water heat pumps were the most popular in France. In 2018, 119 881 of them were sold, which was as much as 68 % more than in 2010 – when their sales were the lowest. Air-to-air heat pumps were also in high demand. The highest number of them was sold in 2018 (77 936 units), while the lowest number in 2009 (32 255 units) – 59 % less. Ground-source heat pumps were the least frequently chosen in the analysed period of time. They reached the peak of popularity in 2009 (14 349 units sold), while the lowest popularity was in 2017 (2489 units) – 83 % less. A summary of the number of different types of heat pumps sold, divided by years, is shown in Fig. 6.

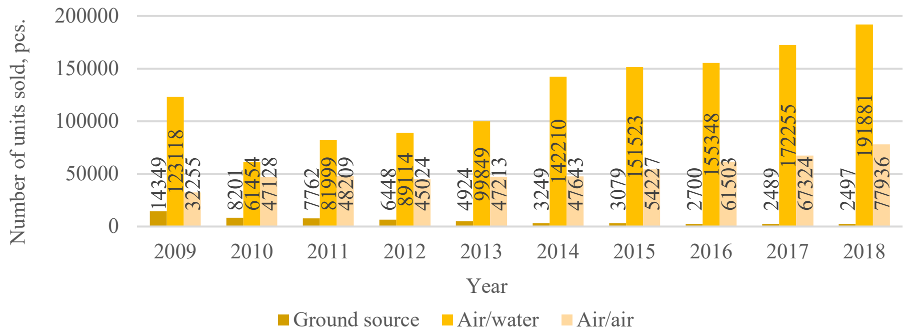

Fig. 6. The number of heat pumps sold in France by type.

The number of heat pumps sold in France between 2009 and 2018, divided into the individual types (considering both the type of lower and upper heat sources as well as their technical solutions) is summarized in Table 1.

TABLE 1. THE NUMBER OF HEAT PUMPS SOLD IN FRANCE – BY TYPE

Type	2009–2013 (first half of the decade)	2014–2018 (second half of the decade)	2009–2018
Sanitary hot water	126 150	422 312	548 462
Reversible air-air w/heating	219 829	308 632	528 462
H-air/water	224 299	243 586	467 885
Reversible other	109 983	151 962	261 945
H-ground/water	36 786	9371	46 157
Hybrid	–	5800	5800

3.2. Spain

The development of the heat pump sales in Spain is shown in Fig. 7. It can be seen that the highest growth (50 %) was recorded at the turn of 2014 and 2015, while a decrease (as much as 32 %) was recorded in 2012 (compared to 2011). There was a total increase of 42 % between 2010 and 2018. Since 2012, heat pump sales in Spain have been growing steadily.

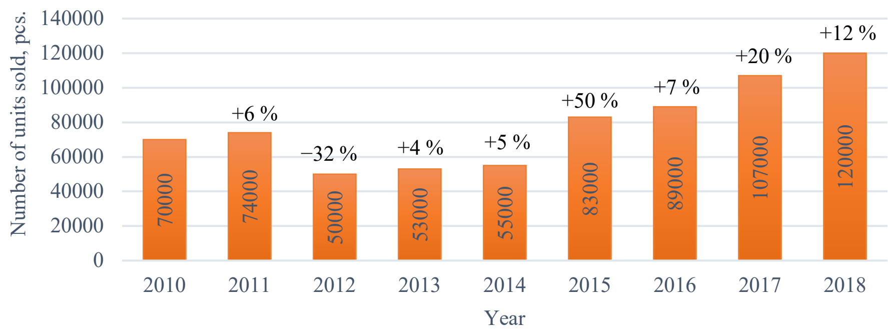

Fig. 7. The development of heat pump sales in Spain.

Considering the type of a lower and upper heat source of the heat pumps, regardless of the year, air-to-air heat pumps were definitely the most popular in Spain. In 2018, 87 104 of them were sold, which was as much as 45 % more than in 2014 – when their sales were the lowest. Air-to-water heat pumps were also very popular. The highest number of them was sold in Spain in 2018 (32 561 units), while the lowest number was sold in 2012 (1656 units) – 95 % less. Ground-source heat pumps were the least frequently chosen in the analysed period of time. They reached their peak of popularity in 2012, but it was only 511 units sold. In 2009, EHPA recorded no sales of heat pumps in Spain or the researches were not included in the report, so this year was not taken into account in the analysis of sales by type. A summary of the number of different types of heat pumps sold, divided by year is shown in Fig. 8.

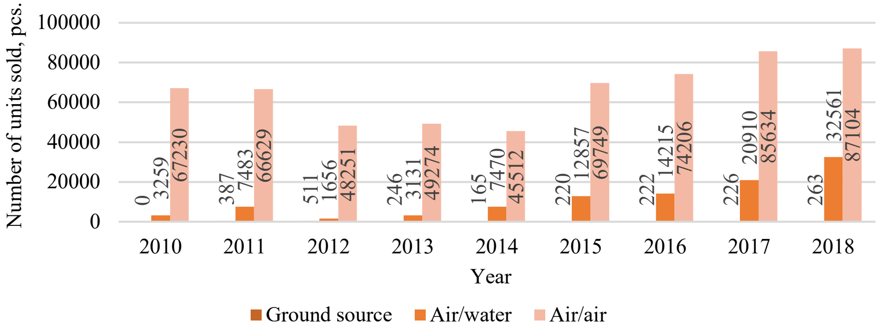

Fig. 8. The number of heat pumps sold in Spain by type.

The number of heat pumps sold in Spain between 2009 and 2018, divided into the individual types (considering both the type of lower and upper heat sources as well as their technical solutions) is summarized in Table 2.

TABLE 2. THE NUMBER OF HEAT PUMPS SOLD IN SPAIN – BY TYPE

Type	2009–2013 (first half of the decade)	2014–2018 (second half of the decade)	2009–2018
Reversible air-air w/heating	231 384	364 204	595 588
Reversible other	12 233	68 172	80 405
Sanitary hot water	1206	20 158	21 364
H-air/water	2090	–	2090
H-ground/water	1144	–	1144
Industrial heat pumps	–	779	779

3.3. Poland

The development of the heat pump sales in Poland is shown in Fig. 9. It can be seen that the highest growth (25 %) was recorded at the turn of 2013 and 2014. There was a total increase of 74 % between 2010 and 2018. Since 2010, there has been no decrease in sales of heat pumps in Poland.

Fig. 9. The development of heat pump sales in Poland.

Considering the type of a lower and upper heat source of the heat pumps, regardless of the year, air-to-water heat pumps were definitely the most popular in Poland. Since 2010, their sales have steadily increased. In 2018, 20,480 of them were sold, which was as much as 83 % more than in 2010 – when their sales were the lowest. Ground source heat pumps were also popular. The highest number of them was sold in Poland in 2018 (5831 units), while the lowest number was sold in 2010 (4590 units) – 21 % less. Air-to-air heat pumps were the least frequently chosen in the analysed period of time. They reached their peak of popularity in 2018, while they were the least purchased until 2013. In 2009, EHPA recorded no sales of heat pumps in Poland or the researches were not included in the report, so this year was not taken into account in the analysis of sales by type. A summary of the number of different types of heat pumps sold, divided by year, is shown in Fig. 10.

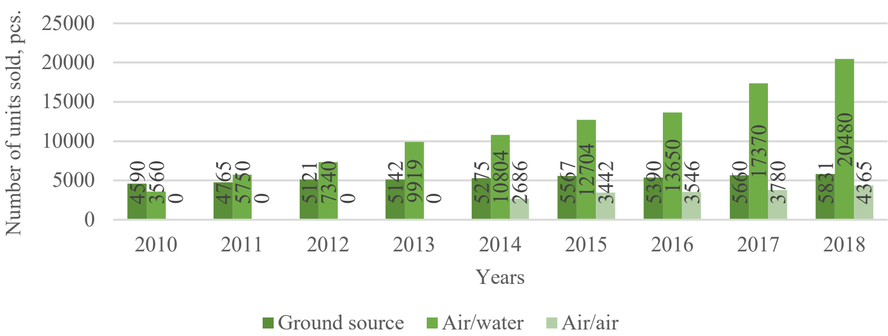

Fig. 10. The number of heat pumps sold in Poland by type.

The number of heat pumps sold in Poland between 2009 and 2018, divided into the individual types (considering both the type of lower and upper heat sources as well as their technical solutions) is summarized in the Table 3.

TABLE 3. THE NUMBER OF HEAT PUMPS SOLD IN POLAND – BY TYPE

Type	2009–2013 (first half of the decade)	2014–2018 (second half of the decade)	2009–2018
Sanitary hot water	19 960	44 845	64 805
H-ground/water	17 619	23 333	40 952
Reversible other	3413	27 032	30 445
Reversible air-air w/heating	–	17 818	17 818
H-air/water	5125	7348	12 473
Exhaust air	355	173	528
Other	42	–	42

3.4. Lithuania

The development of heat pump sales in Lithuania is shown in Fig. 11. It can be seen that the highest growth (456 %) was recorded at the turn of 2016 and 2017, while a decrease (by 7 %) was recorded in 2010 (compared to 2009). There was a total increase of 95 % between 2009 and 2018. Since 2010, heat pump sales in Lithuania have been growing steadily.

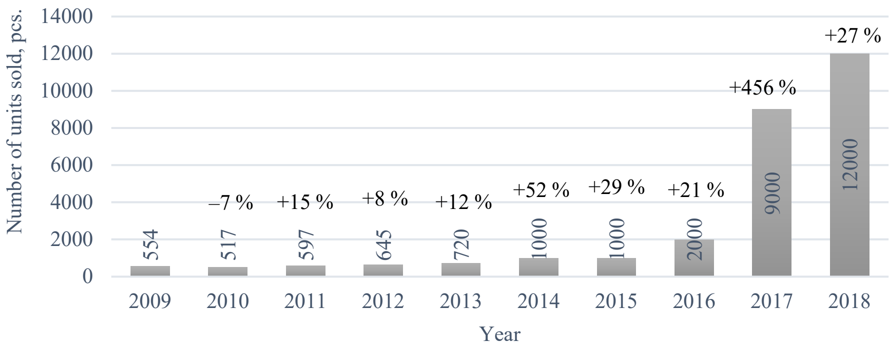

Fig. 11. The development of heat pump sales in Lithuania.

Considering the type of lower and upper heat source of the heat pumps, the most popular in Lithuania between 2009 and 2015, were ground source heat pumps. In 2014, their sales peaked at 835 units. In 2016, air-to-water heat pumps were the most frequently chosen, while since 2017, air-to-air heat pumps have led the way. In 2018, 8 750 of the air-to-air heat pumps were sold, which was 16 % more than in 2017. Summing up the total sales of heat pumps between 2009 and 2018 in Lithuania, air-to-air heat pumps were sold the most (16 095 units), air-to-water heat pumps were sold slightly lower, while ground source heat pumps sold the least. A summary of the number of different types of heat pumps sold, divided by year, is shown in Fig. 12.

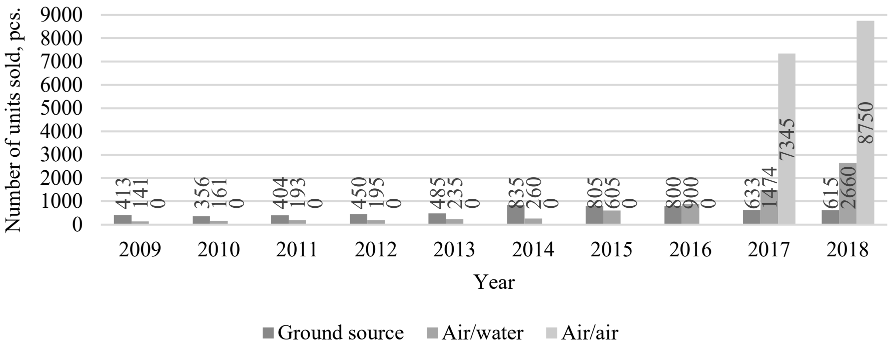

Fig. 12. The number of heat pumps sold in Lithuania by type.

The number of heat pumps sold in Lithuania between 2009 and 2018, divided into the individual types (considering both the type of lower and upper heat sources as well as their technical solutions) is summarized in Table 4.

TABLE 4. THE NUMBER OF HEAT PUMPS SOLD – BY TYPE

Type	2009–2013 (first half of the decade)	2014–2018 (second half of the decade)	2009–2018
Reversible air-air w/heating	–	16 071	16 071
H-air/water	920	5854	6774
H-ground/water	2093	3458	5551
Reversible other	–	195	195
Industrial heat pumps	20	80	100
Exhaust air	–	24	24

3.5. Environmental Benefits

EHPA [18] estimates that heat pumps installed in the 21 analysed European countries produced a total of 1000 TWh of renewable energy from 2011 to 2020. The highest amount of energy was produced in France (301 TWh), followed by Sweden (145 TWh), Germany (118 TWh) and Italy (117 TWh). In Poland, 14.4 TWh of energy was produced, which let this country take the 15th place. In Lithuania, it was produced only 2.1 TWh, so ranked 20th place. Furthermore, the use of heat pumps in the above 21 countries reduced carbon dioxide (CO_2) emissions by 266 Mt from 2011 to 2020. The amount of CO_2 saved was directly proportional to the amount of renewable energy produced from heat pumps in each country, so the ranking order was the same. The use of heat pumps in the countries analysed also saved a total of 1000 TWh of final energy and provided 2000 TWh of usable energy between 2011 and 2020.

3.6. Heat Pump Market in 2019 and 2020

In 2019, among 21 European countries analysed by EHPA, France (397 000 units), Italy (176 000 units), Spain (128 000 units), Sweden (108 000 units), Norway (105 000 units) and Germany (102 000 units) had the highest number of heat pumps sold. Poland was 9th with 42 000 heat pumps sold, while Lithuania ranked the 18th position (only 12 000 units sold).

The total number of heat pumps sold in 21 European countries in 2019 was 1.5 million units – 13 % more than in 2018.

‘Reversible air-air w/heating’ heat pumps were the most frequently chosen, followed by ‘H-air/water’, ‘Reversible other’ and ‘Sanitary hot water’ types. ‘H-ground/water’, ‘Exhaust air’ and ‘Hybrid HP’ types were chosen slightly less often.

In France, the most popular in 2019 was ‘Sanitary hot water’ heat pump type. Next was ‘Reversible air-air w/heating’, then ‘H-air/water’ and ‘Reversible other’. The last place took ‘H-ground/water’. In Spain, the most frequently chosen in 2019 was ‘Reversible air-air w/heating’ heat pump type, followed by ‘Reversible other’ and ‘Sanitary hot water’. In Poland, the heat pump type sold the most in 2019 was ‘Reversible other’. This type was followed by ‘Sanitary hot water’, ‘H-air/water’, ‘Reversible air-air w/heating’ and ‘H-ground/water’. In Lithuania, the most popular in 2019 was ‘Reversible air-air w/heating’ heat pump type. Next were ‘H-air/water’ and ‘H-ground/water’.

Considering the number of installed heat pumps per 1000 households in 2019, Norway was definitely the leader (47.8 units), followed by Finland (37.5 units), Estonia (29.3 units), Denmark (25.4 units) and Sweden (23.4 units). France was on the 6th place (13.7 units), while Lithuania was on the 8th position and Poland took lowly – 16th place.

According to the latest data (respecting 2020), the heat pump stock of 14.6 million units contributed to the reduction of CO_2 emissions by 40.6 Mt, consumption of 159 TWh of renewable energy, creation of 88 000 new jobs and increase the amount of stored energy by 514 GW.

The leaders of the heat pump market in 2020 continue to be France, Italy and Spain, which are responsible for more than 50 % of the annual heat pump sales in Europe.

3.7. Forecast

Fig. 13 shows the growth forecast of the heat pump market development until 2025, considering the gross domestic product of the 21 European countries.

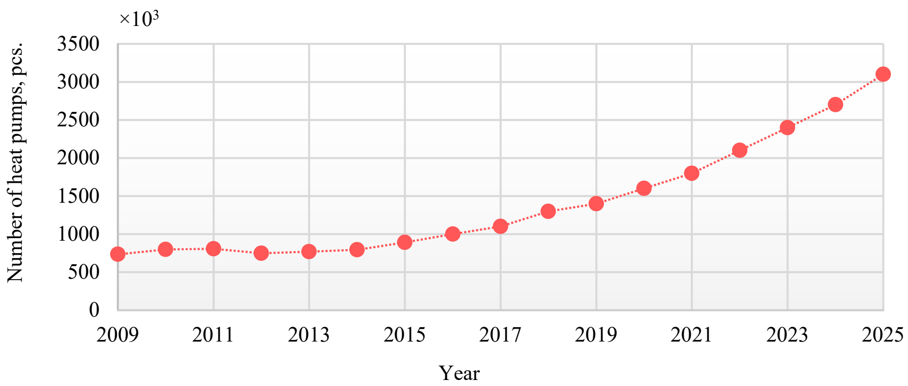

Fig. 13. Forecast of the heat pump market development until 2025.

As can be noticed, according to EHPA predictions, from 2019 to 2025, the heat pump market in Europe will witness a continuous, dynamic growth. It is forecast to reach a number of over 3 million heat pumps sold in 2025. This proves that heat pump technology is constantly developing and improving, and that these devices are the solution of the future.

4. Conclusions

After analysing the heat pump market in Europe, with a special regard to France, Spain, Poland and Lithuania, the highest number of heat pump sold between 2009 and 2019 was recorded in France, Italy, Sweden, Norway, Germany and Spain – the leading heat pump markets in Europe. In the second part of the analysed decade, Spain recorded the highest increase in the number of units sold. Poland was in the middle of the list, while Lithuania was one of the last countries. Considering the number of heat pumps sold per 1000 households, the situation is slightly different – Norway was the clear leader, followed by Estonia, Finland, Sweden and Denmark. Lithuania was placed 12th, while Poland was only 18th. In terms of heat pump type, Europeans were most likely to choose 'Reversible air-air w/heating', 'H-air/water', 'H-ground/water', 'Sanitary hot water' and 'Reversible other' heat pump types.

The heat pump market in France has been growing since 2010. In terms of the type of lower and upper heat source, air-to-water heat pumps were the most common, the next were air-to-air heat pumps and the least common were ground source heat pumps. In Spain, the heat pump sold has been increasing since 2012. Between 2009–2020 air-to-air heat pumps were definitely the most popular, air-to-water heat pumps were less common, while ground source heat pumps were by far the least sold. In Poland, the heat pump market has been developing since 2010. Air-to-water heat pumps were by far the most popular, followed by ground source heat pumps. Air-to-air heat pumps were definitely the least sold. They have only gained popularity since 2014. The heat pump market in Lithuania has been growing since 2010. However, these devices became more popular since 2017. Air-to-air heat pumps were by far the most popular choice, even though they have only been sold since 2017. Air-to-water heat pumps were less frequently chosen, while ground source heat pumps were definitely the least frequently chosen.

The main factors influencing the growth of the HP market in Europe are: increasingly wider range of temperatures at which heat pumps can operate in a highly efficient manner, financial subsides for renewable energy, restrictive legislation and building standards for heat demand, as well as using self-produced electricity, which ensures low operation cost of the heat pump installation [19]. In future, the demand for HPs in the commercial sector is expected to be driven by the growth in the residential building sector and increase in the revenue of the service and trading sectors due to the rising consumerism in the society [8].

Acknowledgement

This publication was financed within the project BUT InterAcademic Partnerships (PPI/APM/2018/1/00033/U/001). Additionally it was conducted within the scientific cooperation 'The possibility of the renewable energy sources usage in the context of improving energy efficiency and air quality in buildings and civil constructions' between BUT and UCO and the science research funds at Bialystok University of Technology WZ/WB-IIS/9/2019.

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