HI-SMART

HI-SMART: HIGHER EDUCATION PACKAGE FOR NEARLY ZERO ENERGY AND SMART BUILDING DESIGN

MODULE #3

CHAPTER 4: ELECRTIC HEATING SYSTEM

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3.4.1 BASICS OF THEORY

Life without electricity is unthinkable for 21st century people. All of our appliances use electricity from some source, be it a phone, kitchen appliance, lighting, or whatever. Various electric heating solutions are gaining ground in buildings, and electric boilers are still very popular for domestic hot water. The use of electric heaters is highly dependent on the electricity tariffs in a given country, as well shown in the following tables and diagrams. Table 3.4.1 shows the distribution of energy sources used in buildings based on Eurosat data. For European Member States, natural gas and electricity use account for the largest share of the average price, followed by renewable energy. Outside the European Union, it can be seen that Norway uses an outstanding 78.1% of its electricity in its buildings. It is no accident the name: Norwegian heating.

	Electricity	Derived Heat	Gas	Solid fuels	Oil & petroleum products	Renewables and Wastes
EU-28	**24.4**	**7.8**	**36.9**	**3.3**	**11.6**	**15.9**
Belgium	19.9	0.0	42.1	0.9	29.2	7.9
Bulgaria	41.0	14.4	2.6	6.7	1.2	34.1
Czech Republic	18.6	15.3	28.8	10.8	0.6	25.9
Denmark	19.8	37.7	13.9	0.0	5.2	23.4
Germany	19.6	7.9	39.4	0.9	20.6	11.6
Estonia	17.7	33.5	6.2	0.2	1.1	41.2
Ireland	25.4	0.0	21.1	13.7	38.1	1.7
Greece	40.1	1.2	7.7	0.0	29.5	21.4
Spain	39.8	0.0	23.1	0.5	18.3	18.4
France	34.4	3.1	30.3	0.1	14.4	17.7
Croatia	22.0	5.0	19.5	0.1	6.0	47.5
Italy	17.2	2.9	53.1	0.0	7.1	19.6
Cyprus	41.8	0.0	0.0	0.0	37.0	21.2
Latvia	13.5	32.3	9.3	1.0	4.5	39.4
Lithuania	16.6	32.4	10.1	4.0	3.3	33.6
Luxembourg	15.4	0.0	45.2	0.1	33.8	5.6
Hungary	15.3	8.0	45.7	2.0	1.0	28.1
Malta	69.5	0.0	0.0 :		23.9	6.6
Netherlands	19.8	3.0	72.0	0.0	0.4	4.8
Austria	24.2	12.7	19.1	0.3	16.3	27.4
Poland	12.6	19.7	17.6	33.4	3.0	13.8
Portugal	42.9	0.0	9.6	0.0	16.3	31.1
Romania	14.0	10.8	30.9	0.8	3.4	40.2
Slovenia	24.4	7.1	10.0	0.0	12.5	45.9
Slovakia	21.6	22.1	52.6	1.5	0.4	1.8
Finland	36.6	31.8	0.5	0.1	6.4	24.6
Sweden	51.3	34.9	0.4	0.0	0.3	13.0
United Kingdom	24.4	0.1	63.3	1.5	6.3	4.4
Norway	78.1	2.7	0.1	0.0	7.6	11.6
Serbia	40.5	13.7	5.7	8.3	2.2	29.5
Albania	50.6	0.0	0.0	0.0	18.9	30.6
Kosovo*	33.1	1.6	0.0	1.6	2.3	61.4
Moldova	11.4	10.0	17.2	2.4	5.6	53.4

*This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence.

Table 3.4.1: Share of fuels in the residential sector (Eurostat-2016)

If we examine the individual energy carriers in more detail, the distributions shown in Figure 3.4.1 can be observed. We use a significant portion of our electricity for lighting and to operate our equipment. This is followed by use for heating and cooking. For other energy sources, there is no meaningful use for lighting purposes.

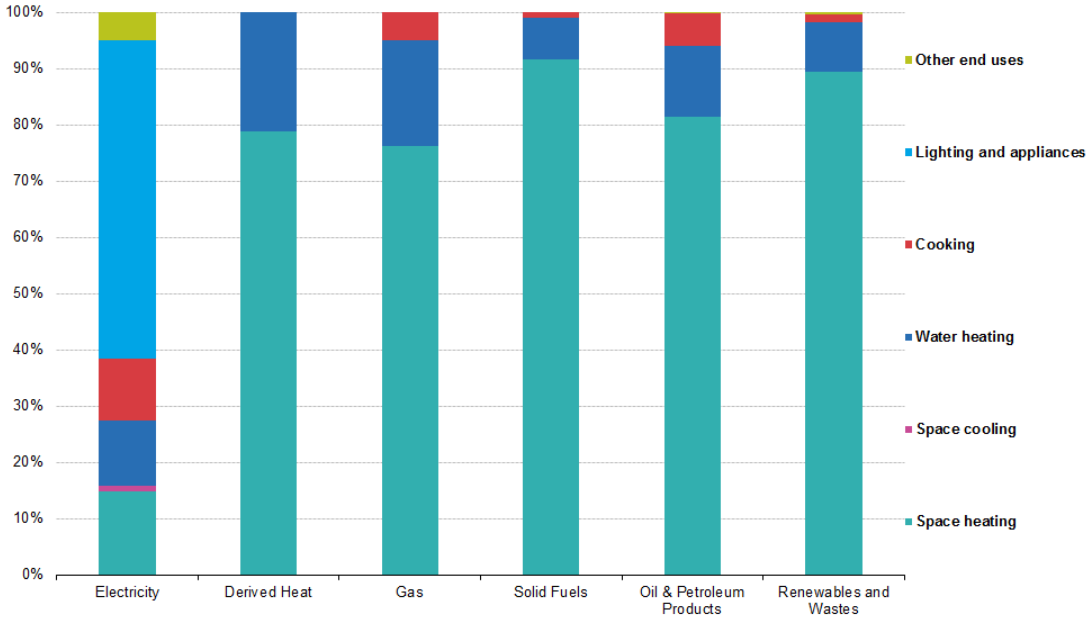


Figure 3.4.1: Share of fuels in the residential sector 2 (Eurostat-2016)

The Norwegian electricity price level is clearly higher than Serbian prices. Interestingly, however, the price of energy in France alone is more than three times the price of electricity in Norway. As a result, the amount to be paid per 1 kWh in France can still be barely cheaper than in Austria. Of course, production costs are not always reflected in consumer prices, so electricity in France may be sold at a significant premium. Overall, although the French heat only 16.2% of their homes (2016) with direct electricity, compared to Norway, which has a population of 5 million, this is almost 10 million people in the 67 million Western European country, which is more than 2. It reported the use of heating energy by 7 million families (4 people / family) in 2015.

3.4.2 TECHNOLOGY OVERVIEW

In the case of modern electric heaters, the basic technology has not changed compared to the old equipment. The heating energy is provided by an electric heating wire, which is controlled by a temperature switch.

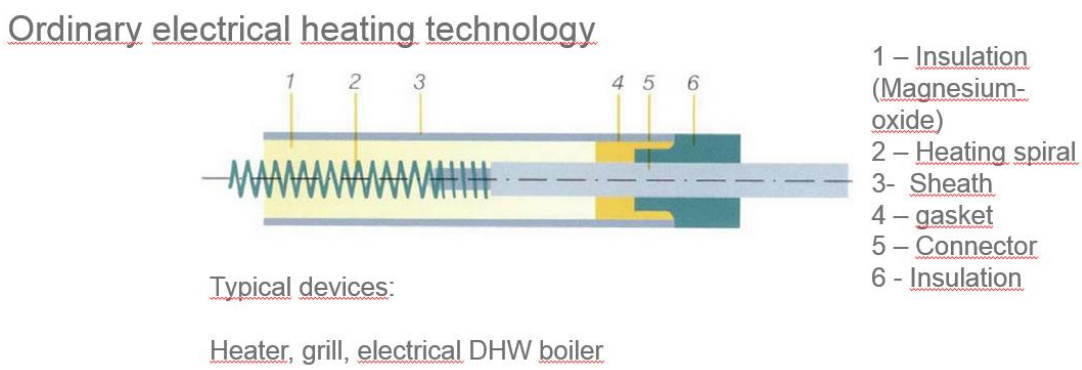


Figure 3.4.2: Ordinary electrical heating technology

In the case of modern equipment, the digital control and modulation capability appears, which makes the operation of the equipment more efficient. In electric heating, the losses are also converted into heat, which is also true here, so the efficiency of the equipment can be considered 100%. Typical electric heating solutions:

- Electric radiator,
- Infra heating,
- Electric surfacer heating,
- Electric boiler,
- Electric heat storage stove.

ELECTRIC RADIATOR

In the case of electric radiators, the installation of the heating system can be solved with a simple installation. Each radiator can be controlled by a separate, programmable thermostat, but can also be connected to a central control unit. Temperature control is also available with precise SMART function. During their installation, care must be taken to build up the appropriate electrical network and to ensure sufficient ampere coverage. They are characterized by low space and elegant appearance. They are also available for bathroom use.

Figure 3.4.3: Electric radiator (www.nobo.hu)

Heating capacity [W]	Size [cm]	Amperage [A]
250	40*43	1,1
500	40*53	2,2
750	40*63	3,3
1000	40*73	4,3
1250	40*93	5,4
1500	40*103	6,5
2000	40*133	8,7

Table 3.4.2: Network requirements

Table 3.4.2 shows the network capacity requirements for electric radiators. Typical sizes are listed with their corresponding size and electric current requirements. Because heating needs occur simultaneously in an apartment or house, these ampere needs occur simultaneously. In the case of a family house, the desired ampere demand is 3x25 or 3x 32 A.

INFRA HEATER

In the case of infrared heating, the feeling of heat characteristic of radiant heaters occurs. We sense the radiator in the radiation zone, but when it leaves, the feeling of heat changes, it becomes uncomfortable. In terms of installation and operation, it is characterized by the paper parameters mentioned in the case of electric radiators. Typical installation locations

are high-ceilinged spaces (production hall, swimming pool, church, shopping center). Some products have a low installation, so they can even be used in residential buildings.

Figure 3.4.4: Infra heater

ELECTRIC SURFACE HEATING

Even in the case of electric underfloor heating, the basic technical parameters mentioned for radiators are typical. Of course, there is a significant difference in the place of installation. The surface heating system is placed directly under the cover. Installation is much easier than with a classic floor heating system. Systems with suitable touch protection design can also be used in bathrooms and swimming pools. When installing the premises, special care must be taken to allow free airflow between the floor surface and the furniture. In the absence of free air flow, the heating filaments can burn in and malfunction. Their subsequent repair is complicated or rather impossible.

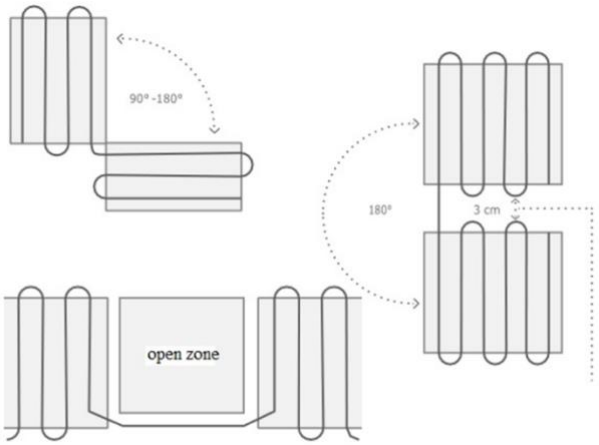


Figure 3.4.1: Surface heater installation

ELECTRIC BOILER

In the case of electric boilers, the design of the heating system is exactly the same as the classic, e.g. with a gas boiler system. On the heat generation side, the only difference is in the installation conditions. Due to the electric heating, the installation is simpler, there is no need to build a chimney or install a gas network. However, it is characterized by a high demand for electrical capacity, as we have seen above. They can be precisely controlled, but are not the best solution due to their relatively high cost and operating costs. However, it is the best solution for easy and quick replacement of broken boilers. These devices are also suitable for heating and DHW production.

Figure 3.4.6: Interior of an electric boiler (Bosch)

ELECTRIC BOILER FOR DOMESTIC HOT WATER

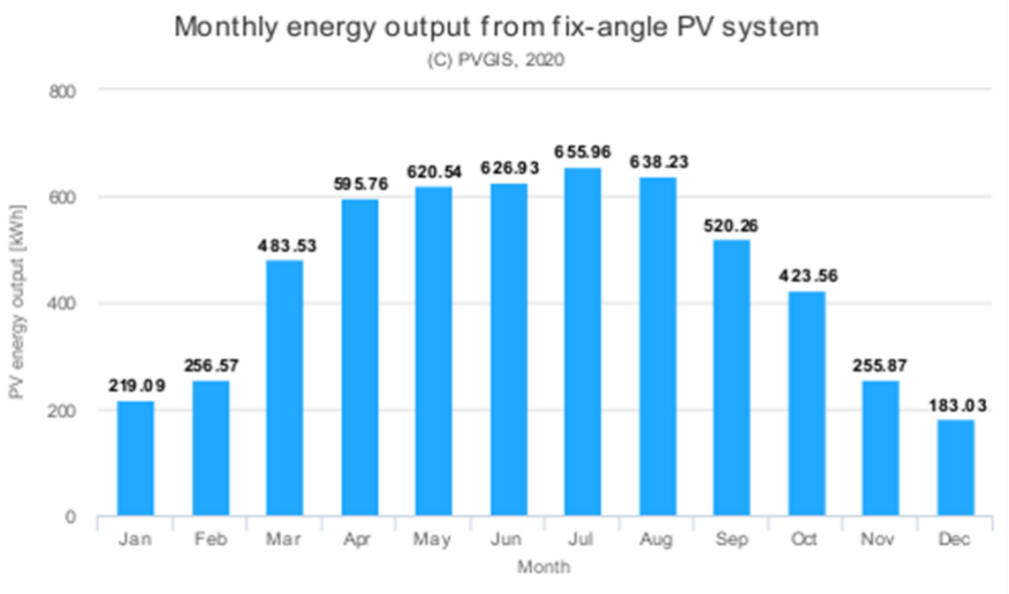
If a non-central heat generator is used, we must also provide hot water. The simplest equipment for this is the use of electric boilers. For conventional beds, a simple heating wire provides heating for the tank, which maintains a preset temperature in the system. For more modern equipment, there are two tanks in the equipment. Thanks to the smart function, it learns the user's habits and adapts the heating of the tanks accordingly. It uses the smaller tank for hand washing and small dishes during the day, while adjusting the heating of the large tank to the learned schedule due to user habits.

Figure 3.4.7 : Electric boiler (www.ariston.com)

3.4.3 PV SYSTEM EXAMPLE

Due to the high electrical demands, it is advisable and mandatory to install a solar system in buildings using electric heating. In the example below, we examined a modern family home. The heating demand of the building is 5.8 kW. The building will have electric radiators and electric underfloor heating. Domestic hot water is produced by an electric boiler. We did not calculate cooling needs. As a result, the electricity demand for heating and DHW production is 10.94 MWh / year. We examined 15 panels from a 300 Wp solar system. The annual yield of the installed 4.5 kW peak power solar system is 5479 kWH / year. This can reduce the building's electricity consumption by almost half.

This ratio is also reflected in the annual cost of heating and domestic hot water production. The annual operating cost without a solar cell is about 1.140 EUR, with a solar cell 570 EUR. The installed solar system results in an investment cost of the order of EUR 4,300, which means a payback period of almost 8 years. Of course, less of a more powerful solar cell is sufficient, thus reducing the required roof area.



3.4.4 CONCLUSIONS

From an energy point of view, electric heating is not considered to be the most efficient solution, but it has a number of advantages that make this technology competitive. In countries with low electricity costs, it is one of the best solutions and the fastest to install a heating system that is well worth operating. The centrally generated electricity is realized in a controlled, environmentally conscious way. Using a solar system can make these systems even more efficient. With high electricity prices, the ratio of low cost but high operating costs needs to be examined. In many cases, for example, the use of electric radiators can also be used in buildings where the main heating system is not built in some subordinate rooms. For fan coil systems, VRF systems, this is a standard solution for this purpose.

One of their main advantages is that they are easy to install, operate with smart features, but require thoughtful design due to their high power consumption.

BIBLIOGRAPHY

[1] EUROSTAT (ec.europa.eu/eurostat/web/main/data/database)

[2] NOBO electric heating products

[3] Ariston electric heating products

[4] Bosch electric heating products

[5] PHOTOVOLTAIC GEOGRAPHICAL INFORMATION SYSTEM (re.jrc.ec.europa.eu/pvg_tools/en/#PVP)

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