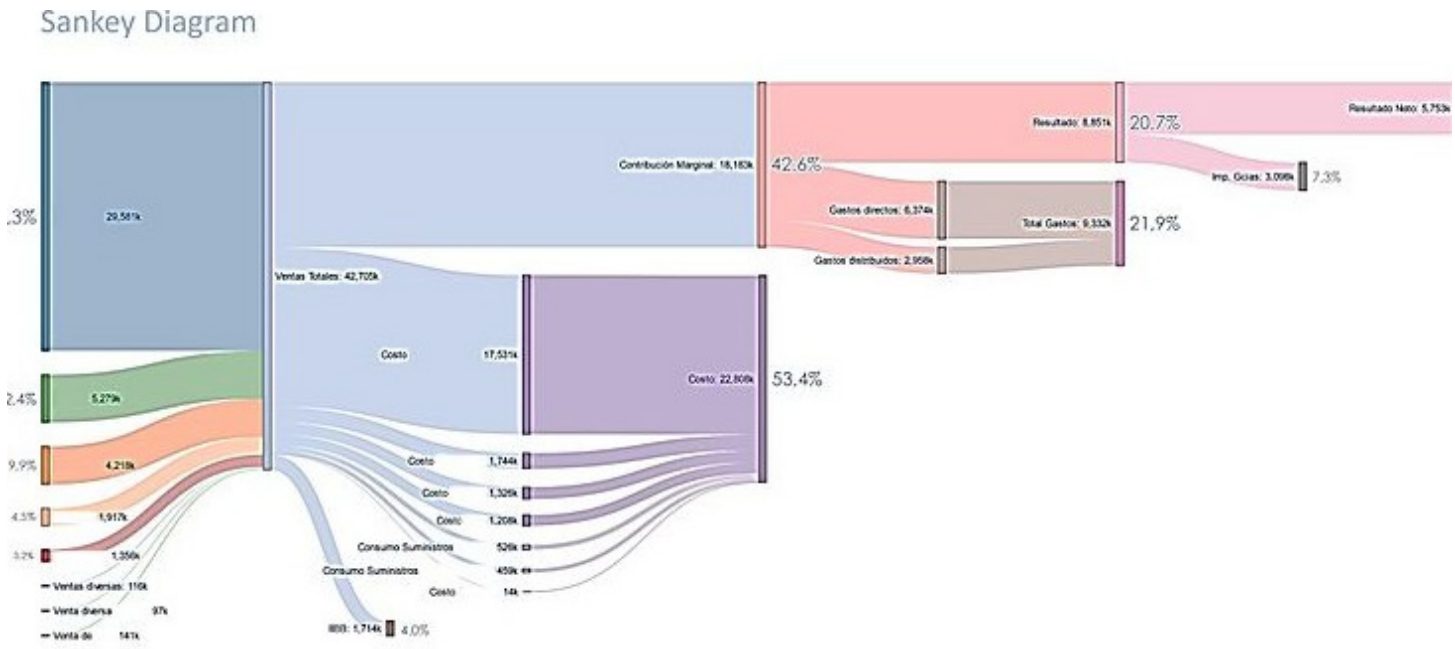
Exercise Level 3

Charts to Help Visualize Flows

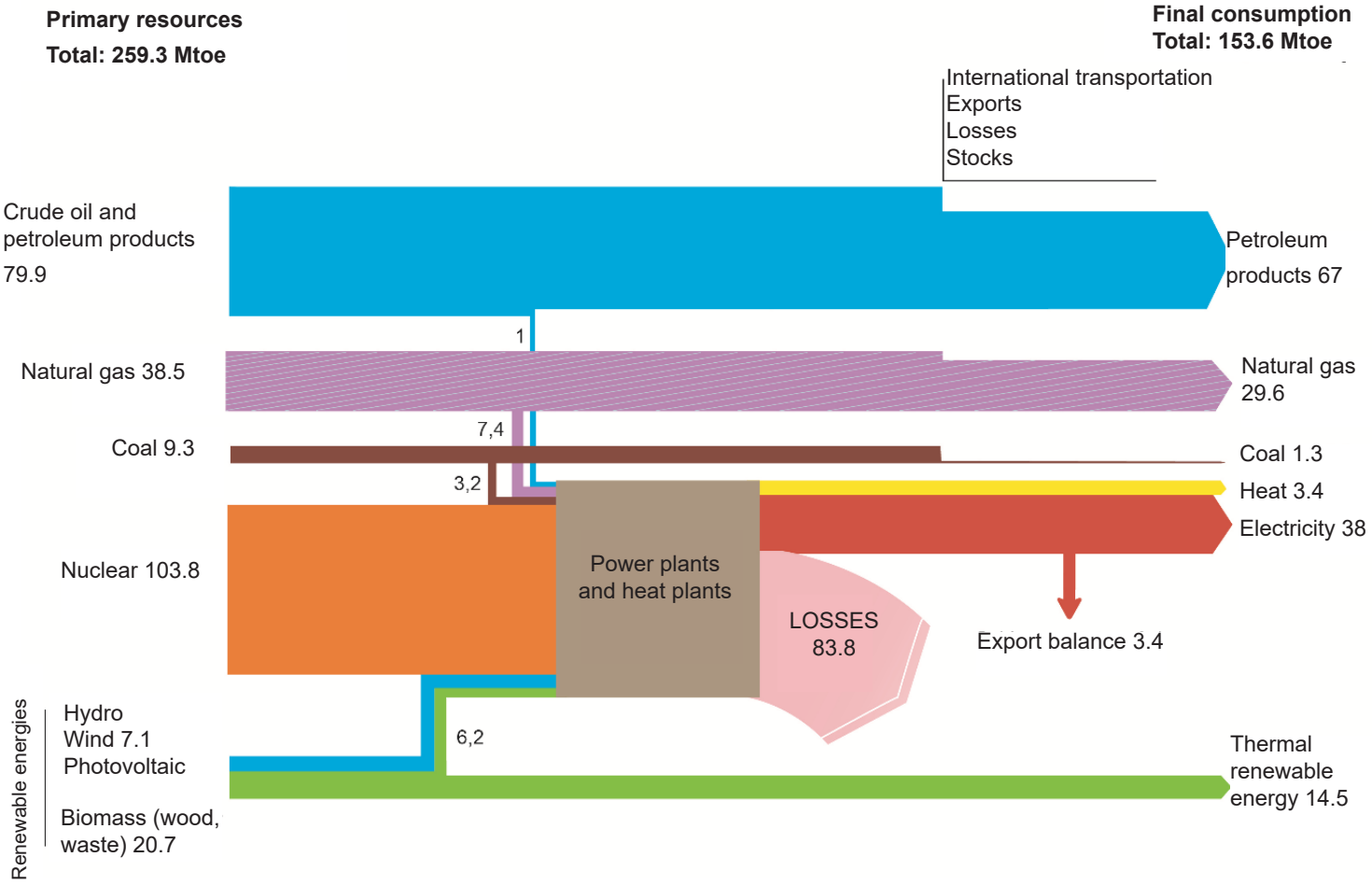
Sankey diagrams are charts that show flows from the beginning to the end of a process. They are often used in the fields of economics, political science and sociology. Flows are depicted by different colored arrows, whose widths are proportional to flow quantity. Below is a theoretical example of a Sankey diagram:



Sankey diagrams are useful tools in the energy sector as well. They can illustrate the flow and conversion of energy, from the production of primary sources to final consumption.

Here is a simplified illustration of France's energy performance in 2017[1].

[1] Taken from Chiffres clés de l'énergie, 2018 (in French) - https://www.statistiques.developpement-durable.gouv.fr/sites/default/files/2018-10/datalab-43-chiffres-cles-de-l-energie-edition-_2018-septembre2018.pdf



It's easier to understand than it looks!

- Look at the blue arrow representing oil. There was an original input of 79.9 Mtoe[2] of crude oil and refined product imports. Some of the resources were used for international transportation (ships and planes), some were stored or exported, and some were wasted as a result of efficiency losses, for example at refineries. A tiny portion (1 Mtoe) was used to generate electricity. At the end of the flow, 67 Mtoe were used as fuel for cars, home heating and industry.

- - The green arrow at the bottom of the chart represents renewable thermal energy sources such as wood, as well as waste. They were mainly used to provide heat for homes and industry. Some of the resources (6.2 Mtoe) were consumed by power plants and heat plants.

These plants are represented by a square in the middle of the chart. They produced electricity and a small amount of heat. The chart shows that they were chiefly powered by nuclear energy (103.8 Mtoe), but also by natural gas (7.4 Mtoe), coal (3.2 Mtoe) and, to a lesser extent, oil, wood and waste.

[2] Mtoe stands for million metric tons of oil equivalent. It's used to compare energy from different sources.

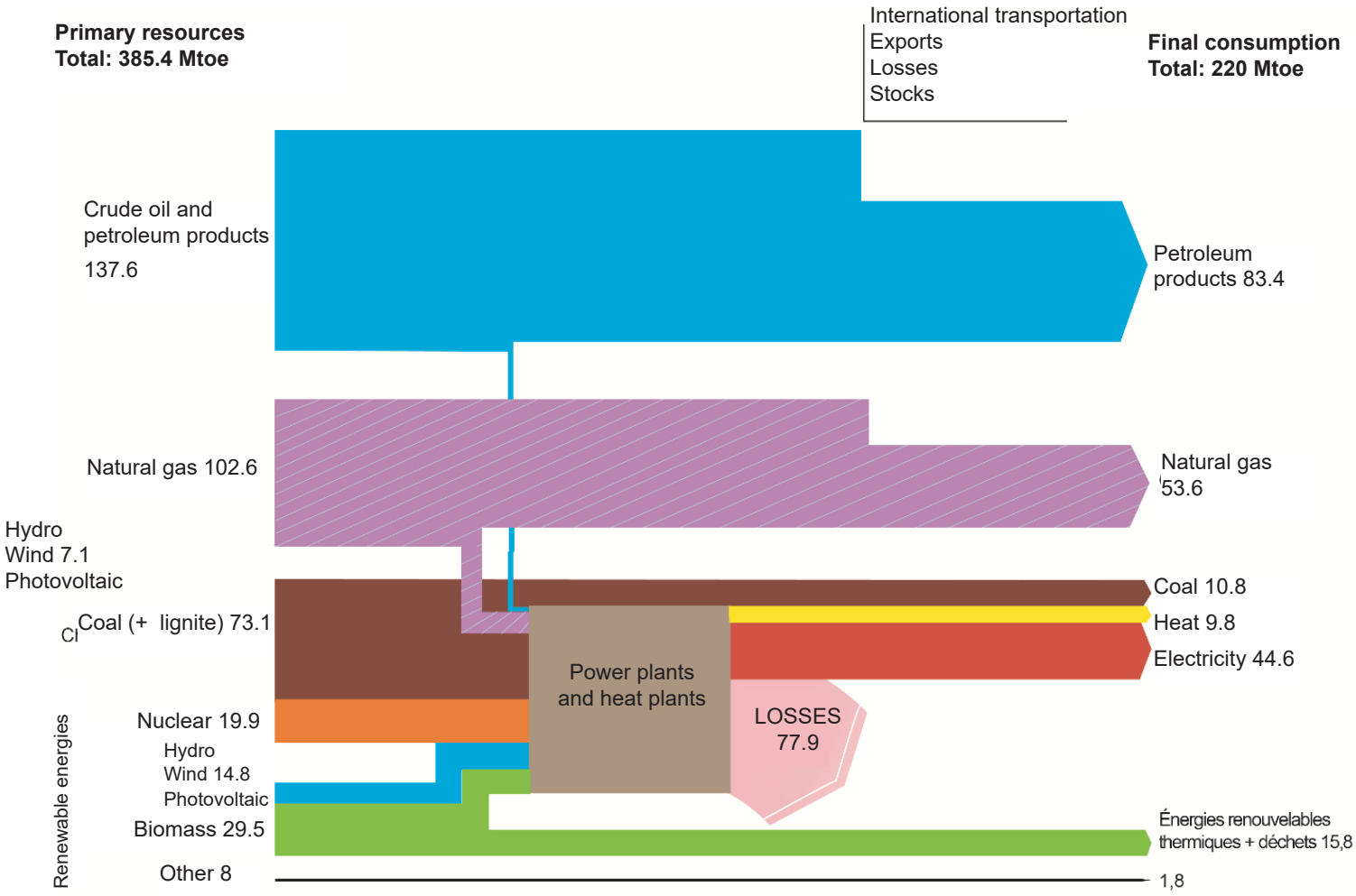
The plants burn fuel inside boilers that are connected to turbo generators and are called thermal power plants. In all, 121.6 Mtoe from various sources provided energy to the thermal power plants

Electricity was also generated from hydro (dams), wind and solar photovoltaic facilities (7.1 Mtoe), which are directly connected to the power grids.

As can be seen by the chart, the power plants had considerable energy losses (83.8 Mtoe). Thermal power plants, including nuclear facilities, are known to have low efficiency. According to the second law of thermodynamics first formulated by Carnot, only a portion of thermal energy can be converted to mechanical work (and then to electricity). The rest is lost to the environment via large cooling towers.

Find out more!

For the sake of comparison, here is a chart of Germany's energy flows[3].



The following observations can be made:

- Oil and gas consumption is much higher in Germany owing to the strength of its industry.
- Germany generates a significant amount of its electricity from coal, whereas in France nuclear energy is the dominant source of power.
- Solar thermal and photovoltaic technology is more popular in Germany, but hydro is less developed than in France.
- Germany is more advanced in heat recovery, especially district heating, which helps to lower its thermal power plant losses.

Test yourself!

Question level 3 :

How big are thermal power plant losses in France?

☐ 68.9 %

☐ 51.2 %

☐ 72.4 %

Answer

68.9% (losses equivalent to 83.8 Mtoe, compared with 121.6 Mtoe of energy supplied). Over two-thirds of the fuel energy is lost. That's because the recovery process is technically complex and not very cost effective.