

Appendix

Energy Flow, Energy Demand and CO₂ Emissions of the World's-Regions and of the G-20 Countries in 2011

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Description of Diagrams

The energy consumption of the world, for the individual regions of the world and for all G-20 countries is illustrated by 6 diagrams A1 ... A6, described below (data based on: Energy Statistics from the IEA, International Energy Agency [5]).

Figure A1: Energy Flow in the Energy Sector

Figure A1 describes the flow of energy in the energy sector from primary energy to gross energy (or gross inland consumption) and to final energy. Primary energy and gross energy are illustrated by the **energy carriers** used. Energy is expressed in Mtoe.

The **primary energy** is the sum of local production and, for regions, net imports minus net exports of energy carriers (for countries, effective imports/exports instead of net imports/net exports per energy carrier).

The **gross energy** follows from the primary energy after subtracting the non-energy use demand (e.g. for the chemical industry) and any stock changes. For the regions of the world, the amounts of energy for the international marine and aviation bunkers are also subtracted, since the corresponding CO₂ emissions are recorded only worldwide.

It is the task of the **energy sector** to provide consumers with energy in the form of **final energy**. In this diagram we distinguish 4 forms of final energy: **electricity**, **district heating**, **motor fuels** and **“heat”**. The latter consists mainly of non-electric heating and process heat (from fossil and renewable energies) and without district heating. Stationary work, of non-electrical origin, can also be included (e.g. stationary gas, petrol or diesel engines and pumps); at least in developed countries, this share is minimal. With the conversion of gross energy into final energy, losses occur, which we refer to as **losses of the energy sector**.

These losses consist of **thermal losses** in power stations (thermodynamic reasons) as well as in combined heat and power plants and heating plants, and

additionally **electrical losses** in the transmission and distribution network, including the energy sector's own energy requirement and, finally, of the **remaining losses** in the energy sector (refining, liquefaction and gasification plants, heat transfer losses, in-house use of heat, etc.).

The diagram also shows the **CO₂ emissions in Mt** associated with the final energy consumption and the losses of the energy sector (together corresponding to the gross inland consumption). Most of the losses of the energy sector are normally associated with the electricity and district heat production, which is why the CO₂ emissions of these three factors are combined. Separation can be done using Figure A4.

Figure A2: Shares of Energy Carriers

Figure A2 shows the shares of energy carriers, in percentage of total final energy demand, required for obtaining the 4 final energy types, and for covering the losses of the energy sector.

This diagram thus complements diagram A1, with respect to the energy carrier distribution in the final energy area. The energy-carriers-colors are shown in the legend, and also apply to the energy flow diagram A1.

Figure A3: Losses of the Energy Sector

The losses of the energy sector represent a significant part of gross energy demand. Worldwide, in 2011, they were about 54 % and in some countries they even exceed 100 % of final energy demand. For the CO₂ emissions they are therefore of primary importance.

Figure A3 shows the percentage composition of these losses and the resulting CO₂ emissions. A characteristic parameter and index of the CO₂-efficiency of the energy sector in the world region or country is the ratio Mt CO₂ relative to Mtoe losses.

Figure A4: Energy Flow of Final Energy to the Final Users

The chart shows the breakdown of the 4 types of final energy over the three end-user categories. Similarly, the CO₂ emissions are allocated to these consumer groups.

The end users are (according to IEA statistics)

- industry,
- residential, services, agriculture, etc.,
- transport.

To obtain the total emissions, the CO₂ emissions of the energy sector (i.e. of the corresponding losses) have to be added to this.

Figure A5: CO₂ Emissions and Originating End-Energy Carriers

The figure gives the total CO₂ emissions in Mt, the emissions per capita and its distribution over the consumer groups, detailed per end-energy carrier.

In addition, the indicator of CO₂ sustainability of the country or region is stated.

The causes of the CO₂ emissions of the end energy carriers electricity and district heat can be taken from the diagrams A2 and A6.

Figure A6: Electricity Production and Consumption

The large, often decisive importance of electricity consumption and of its generation for the amount of CO₂ emissions is clear from the flow charts A1 and A4, and also from A5. The share of the losses of the energy sector (mostly coupled with the electricity production) is also to be taken into account.

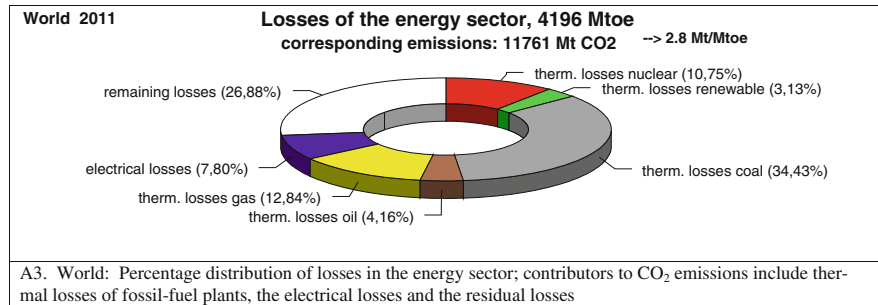
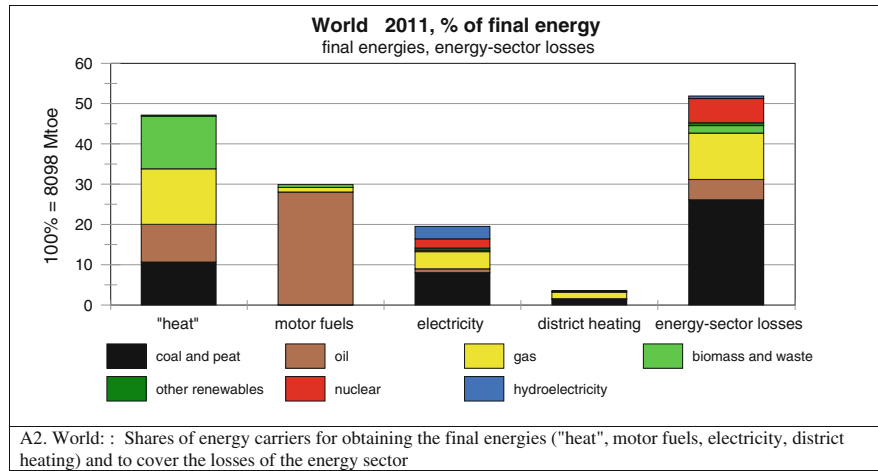
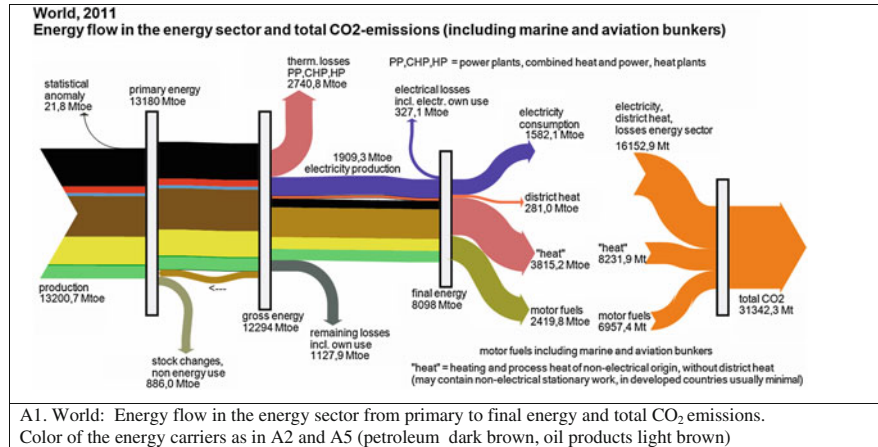
Diagram A6 shows in detail the percentage composition of the energy sources used for the production of electricity.

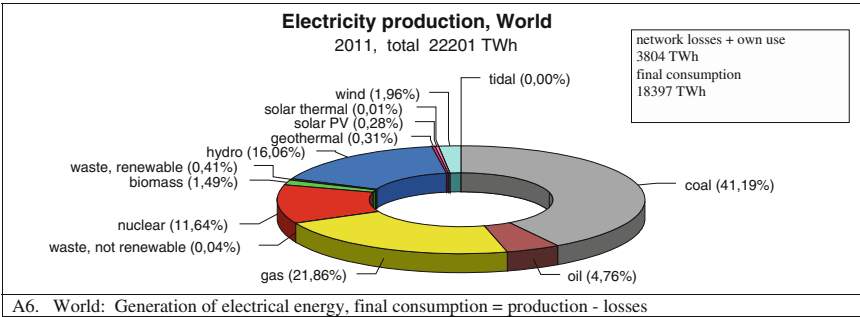
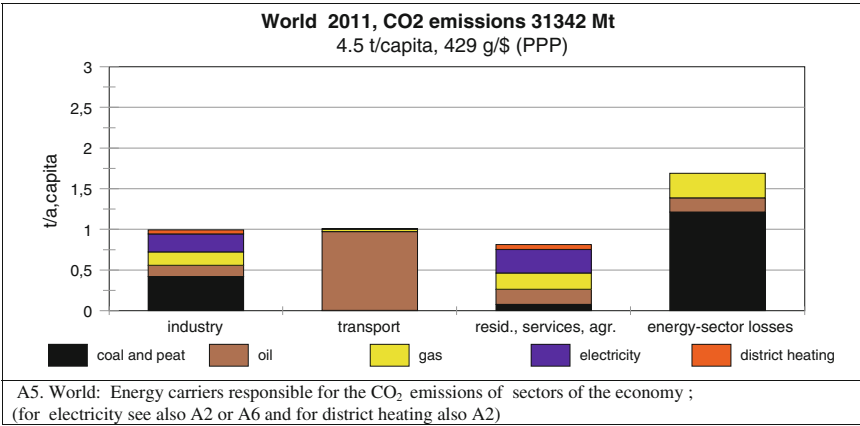
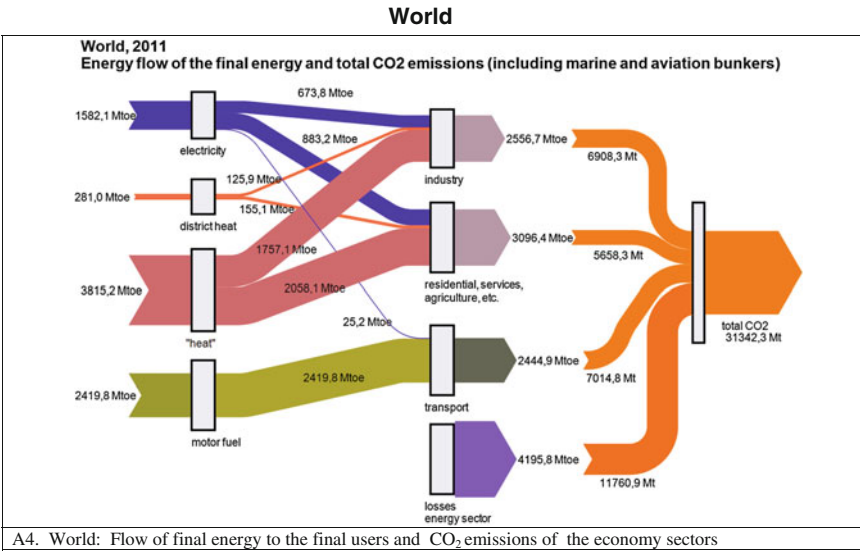
Similarly, imports and exports are given in percentage of final consumption.

The final consumption follows after deduction of losses (network losses and the energy sector's own use).

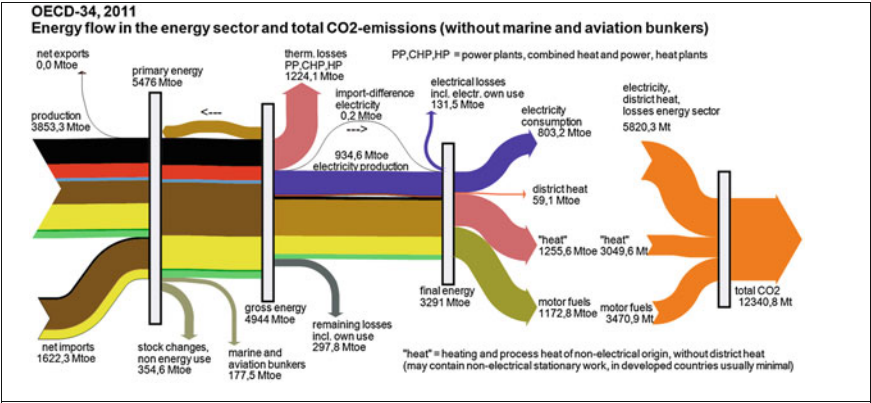
Regions of the World

World

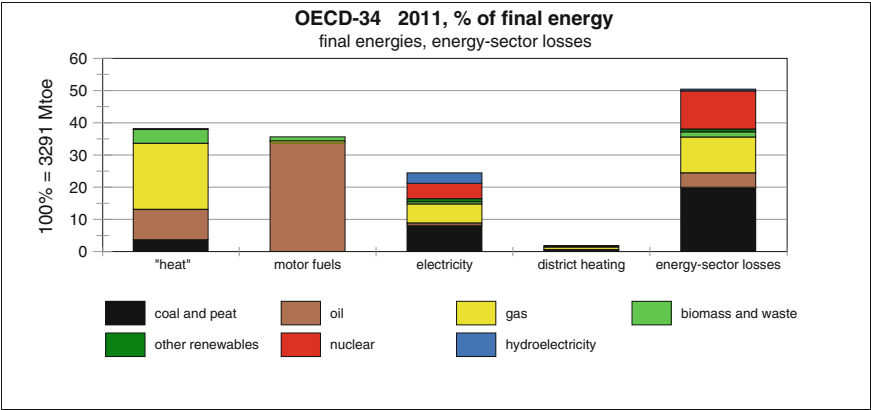




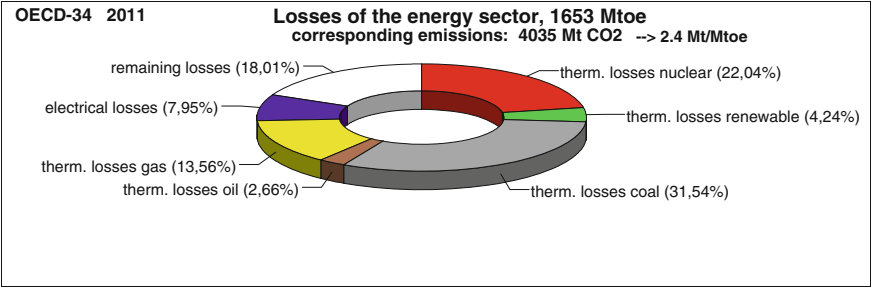
OECD-34



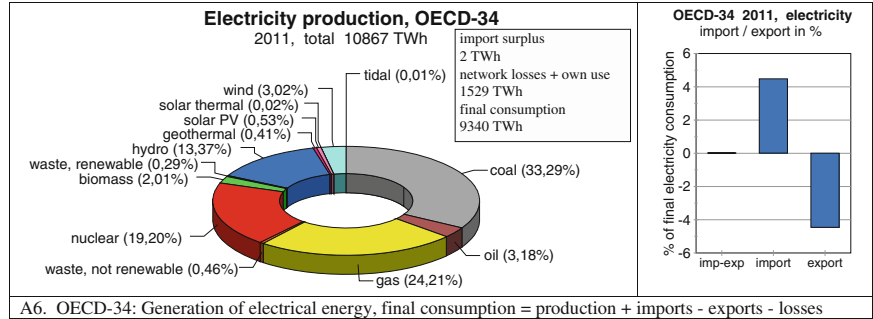
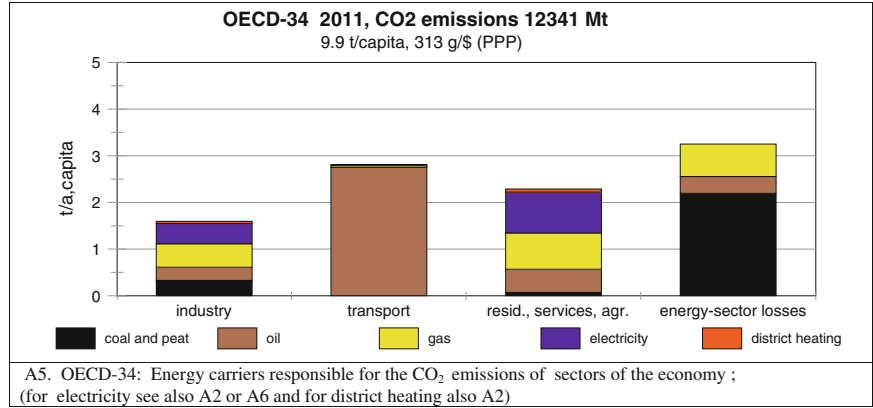
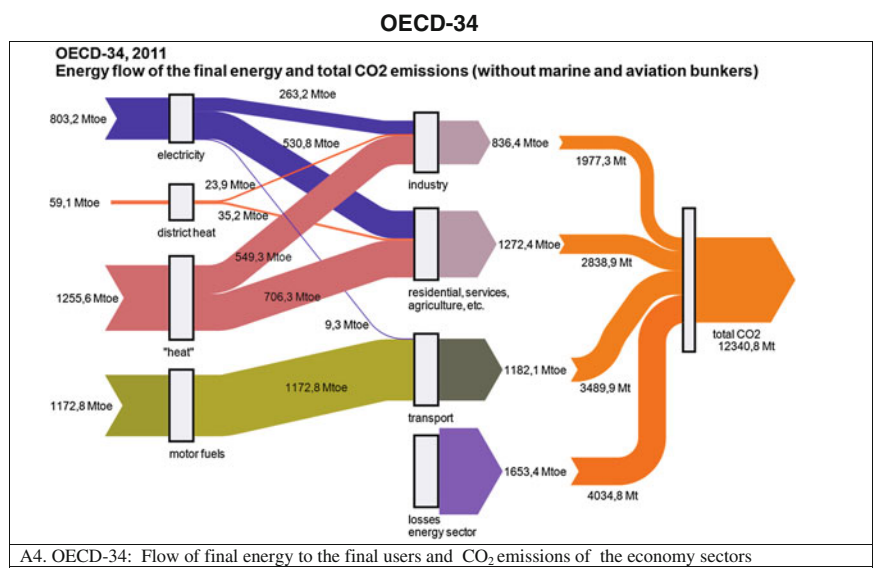
A1. OECD-34: Energy flow in the energy sector from primary to final energy and total CO₂ emissions. Color of the energy carriers as in A2 and A5 (petroleum dark brown, oil products light brown)



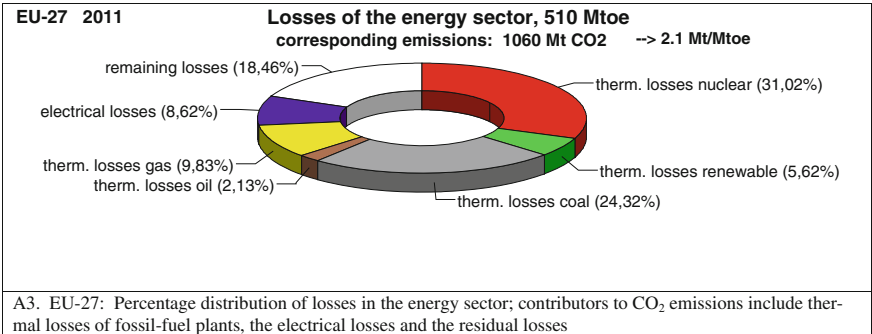
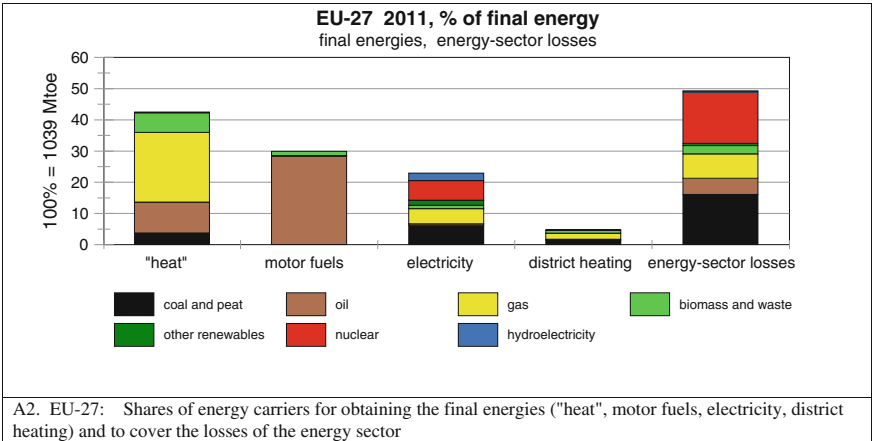
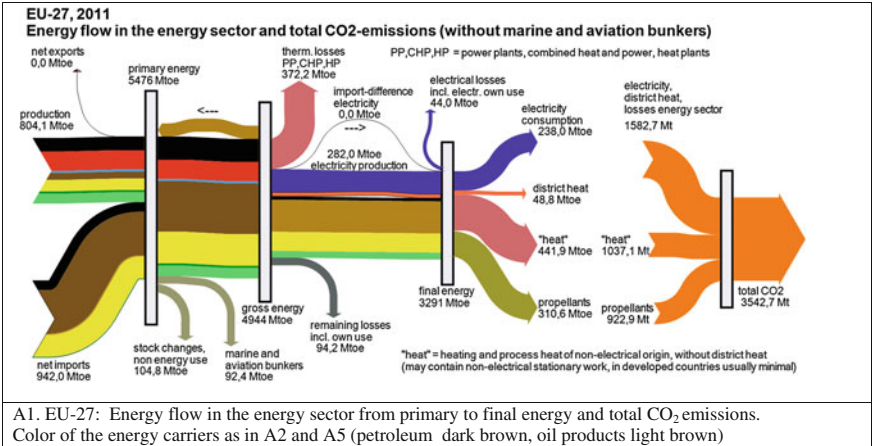
A2. OECD-34: Shares of energy carriers for obtaining the final energies ("heat", motor fuels, electricity, district heating) and to cover the losses of the energy sector



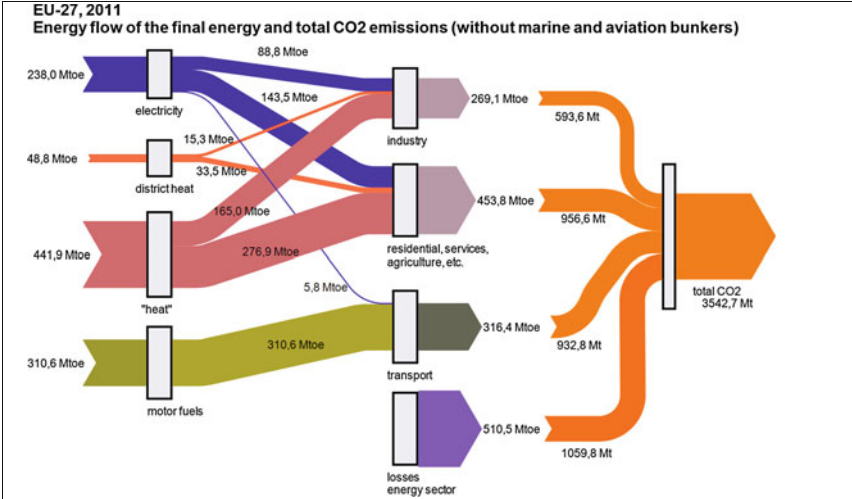
A3. OECD-34: Percentage distribution of losses in the energy sector; contributors to CO₂ emissions include thermal losses of fossil-fuel plants, the electrical losses and the residual losses



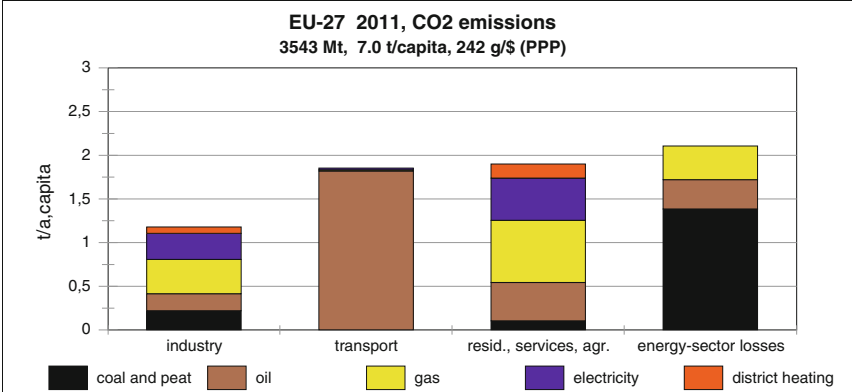
EU-27



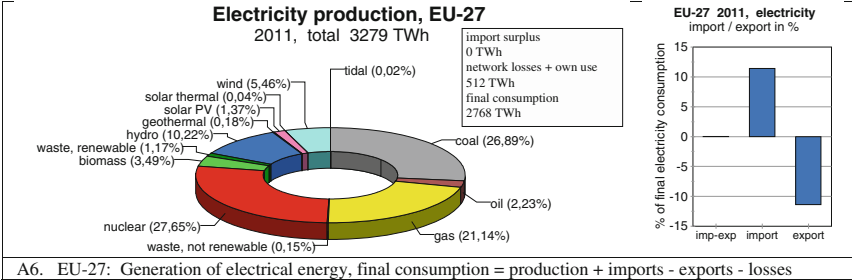
EU-27



A4. EU-27: Flow of final energy to the final users and CO₂ emissions of the economy sectors

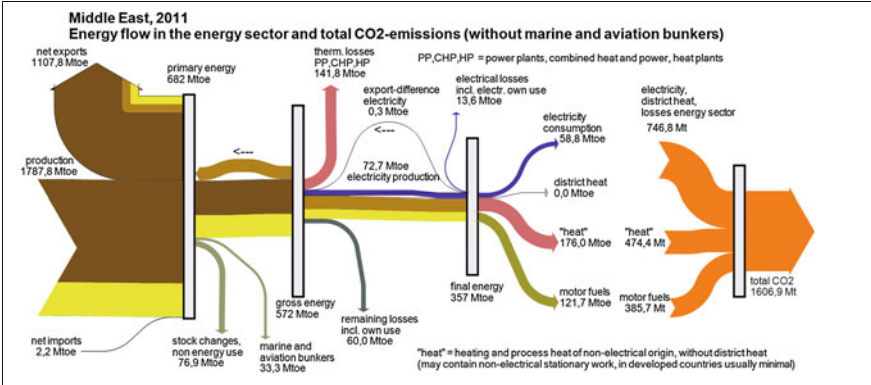


A5. EU-27: Energy carriers responsible for the CO₂ emissions of sectors of the economy ;
(for electricity see also A2 or A6 and for district heating also A2)

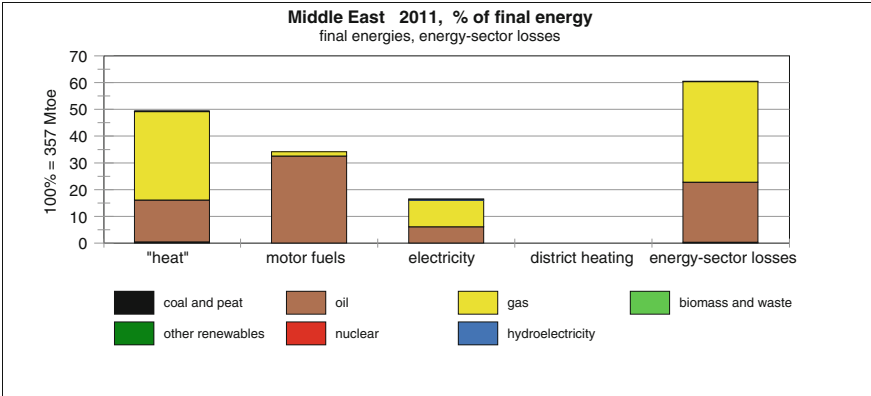


A6. EU-27: Generation of electrical energy, final consumption = production + imports - exports - losses

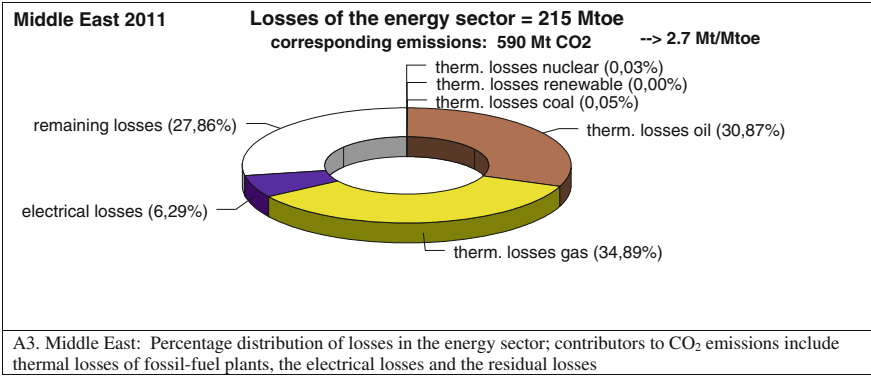
Middle East



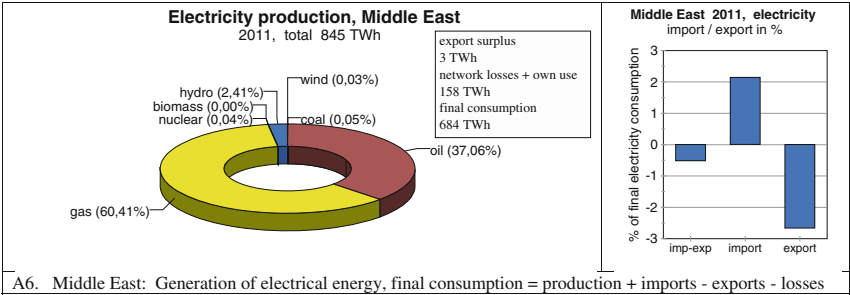
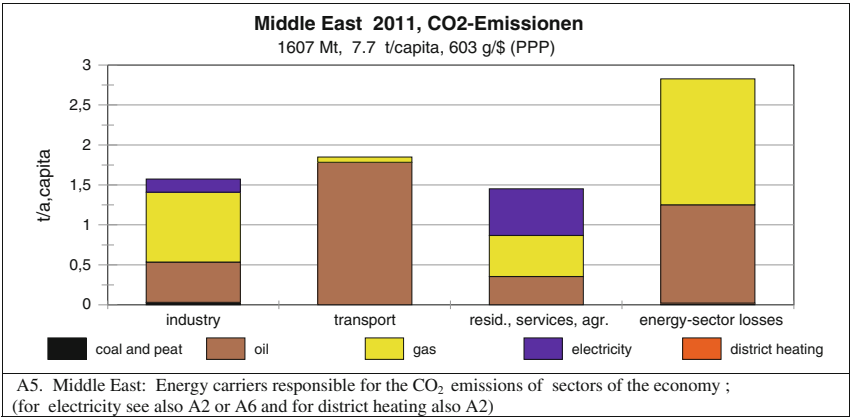
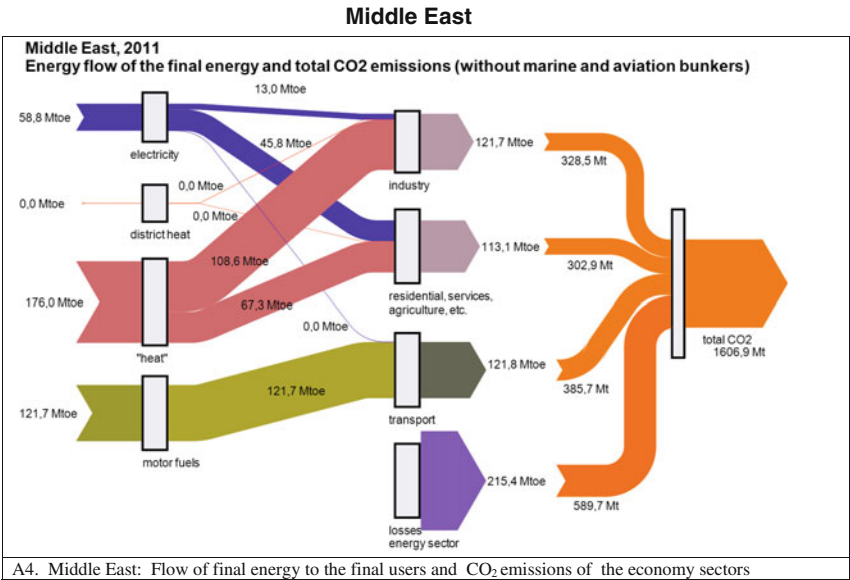
A1. Middle East: Energy flow in the energy sector from primary to final energy and total CO₂ emissions. Color of the energy carriers as in A2 and A5 (petroleum dark brown, oil products light brown)



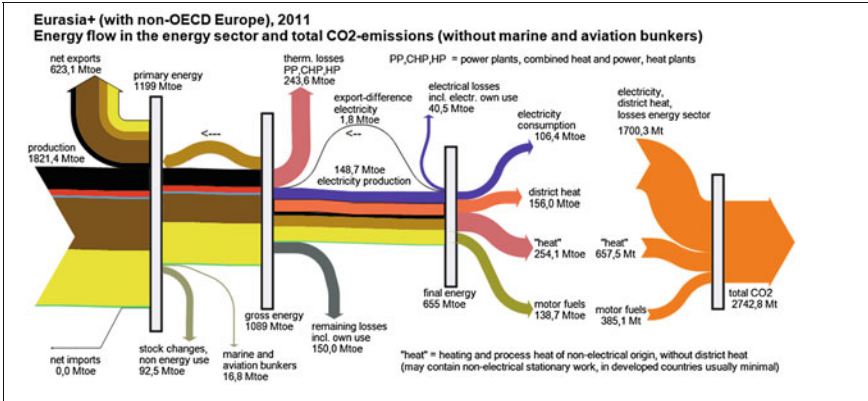
A2. Middle East: Shares of energy carriers for obtaining the final energies ("heat", motor fuels, electricity, district heating) and to cover the losses of the energy sector



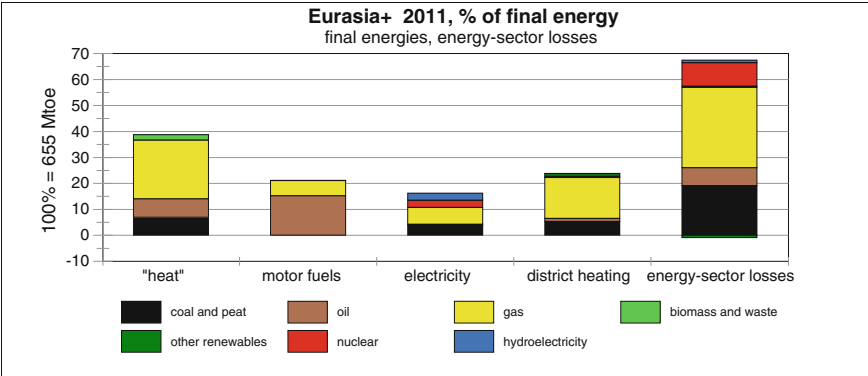
A3. Middle East: Percentage distribution of losses in the energy sector; contributors to CO₂ emissions include thermal losses of fossil-fuel plants, the electrical losses and the residual losses



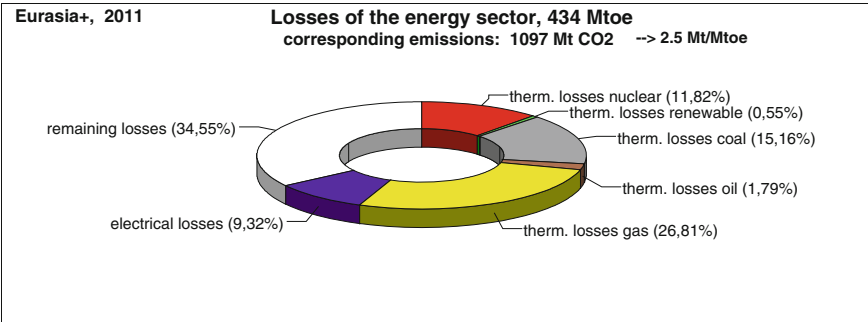
Eurasia+



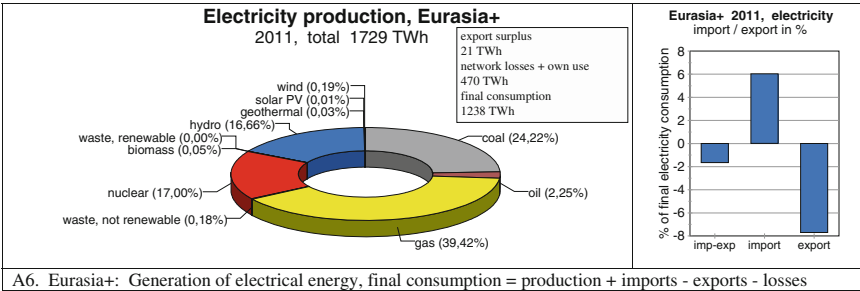
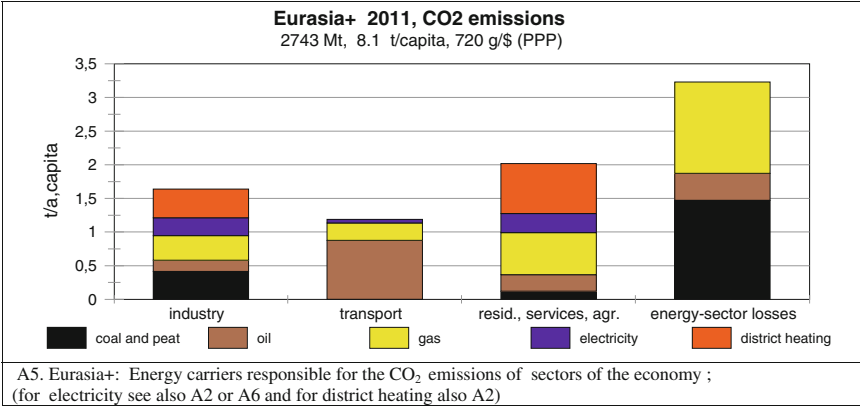
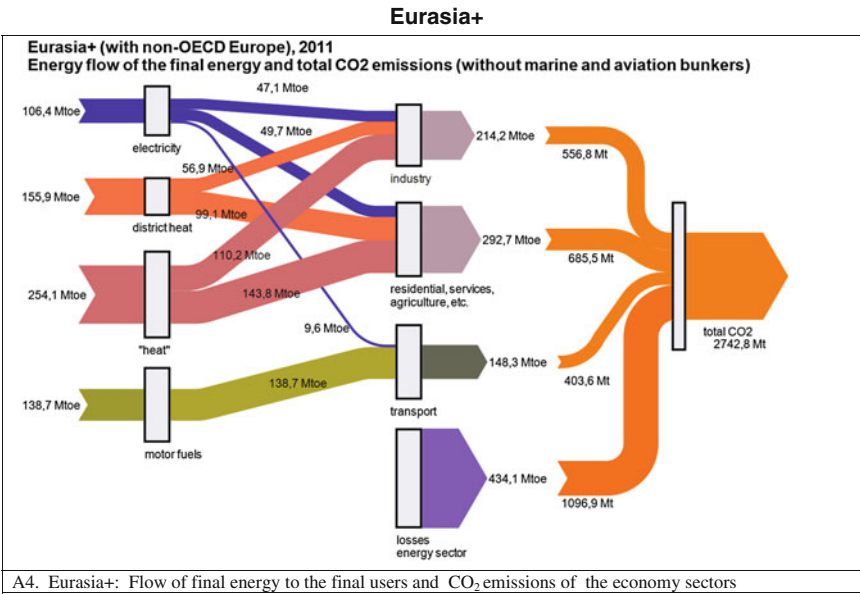
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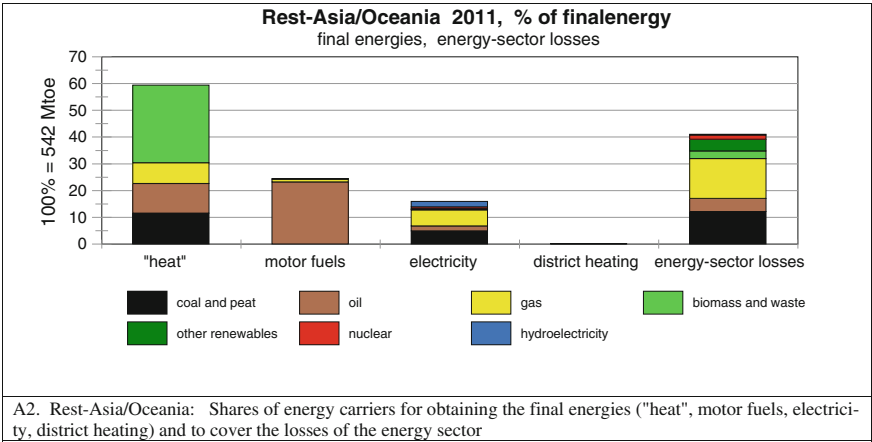
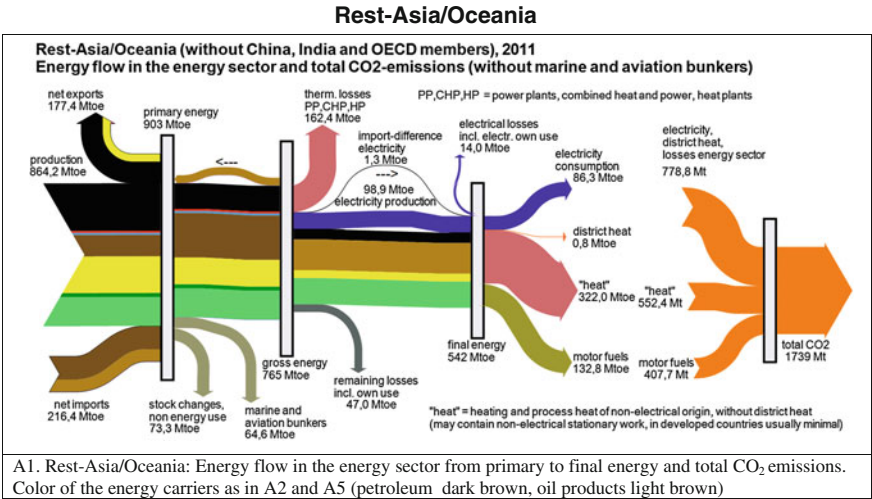


A2. Eurasia+: Shares of energy carriers for obtaining the final energies ("heat", motor fuels, electricity, district heating) and to cover the losses of the energy sector

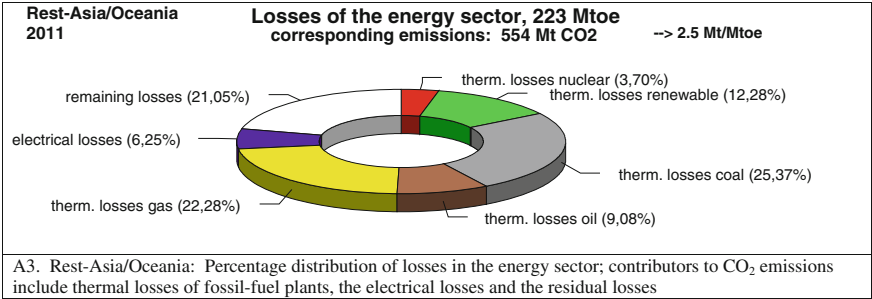


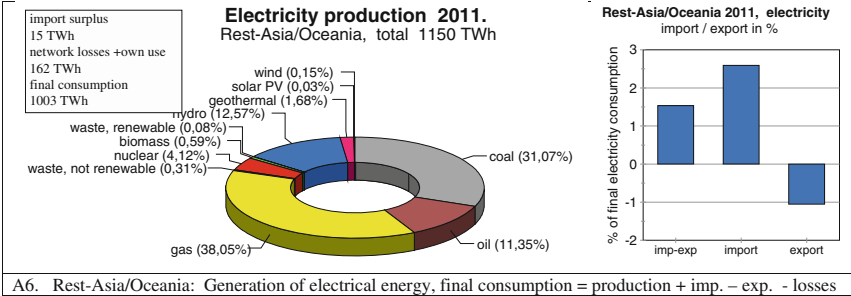
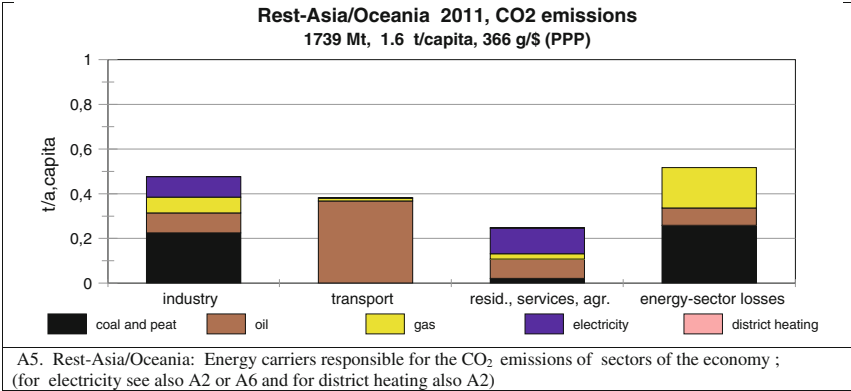
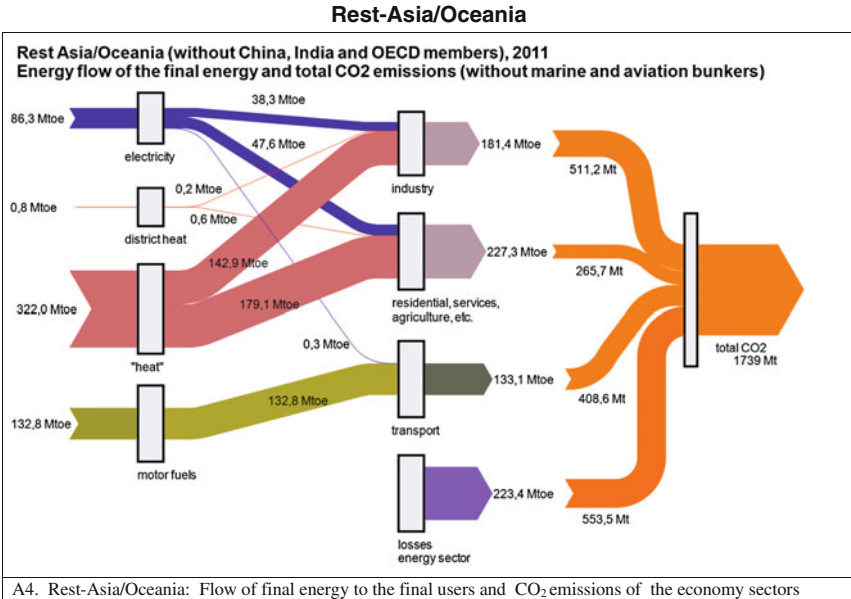
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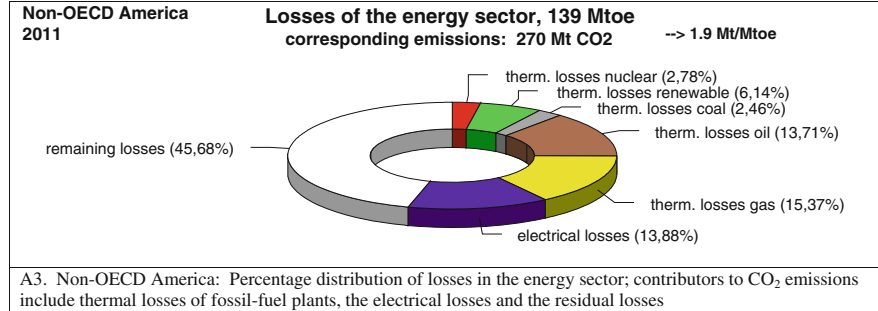
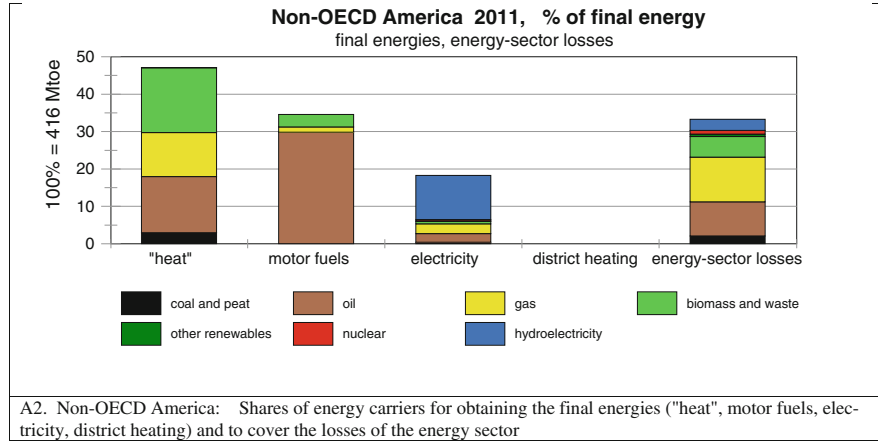
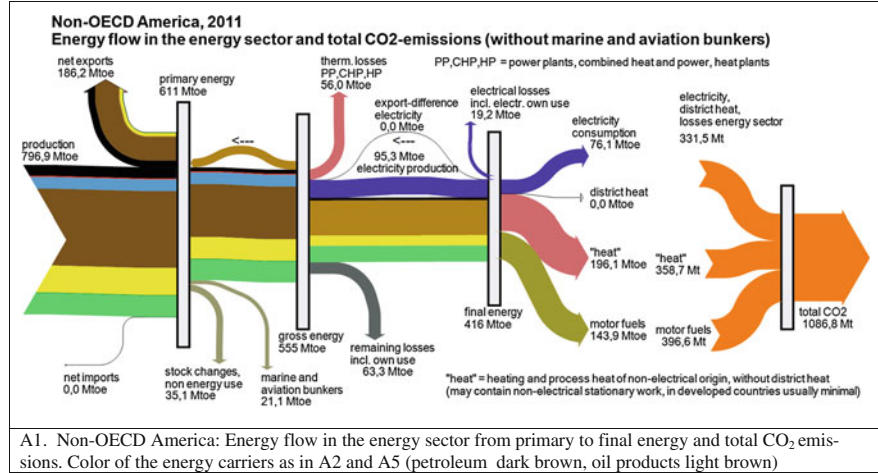


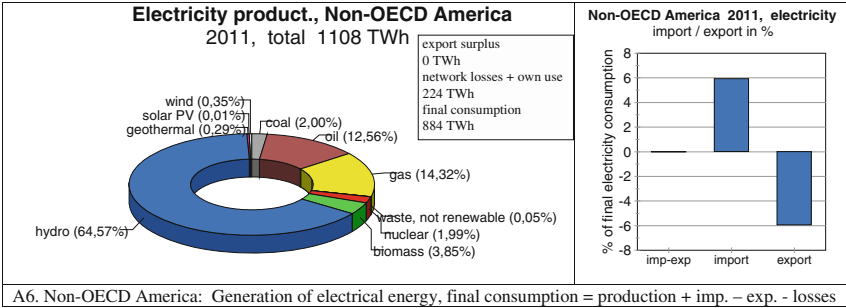
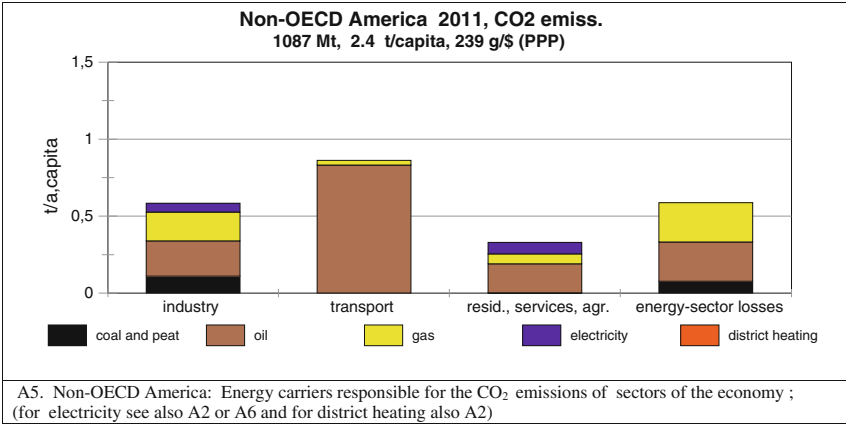
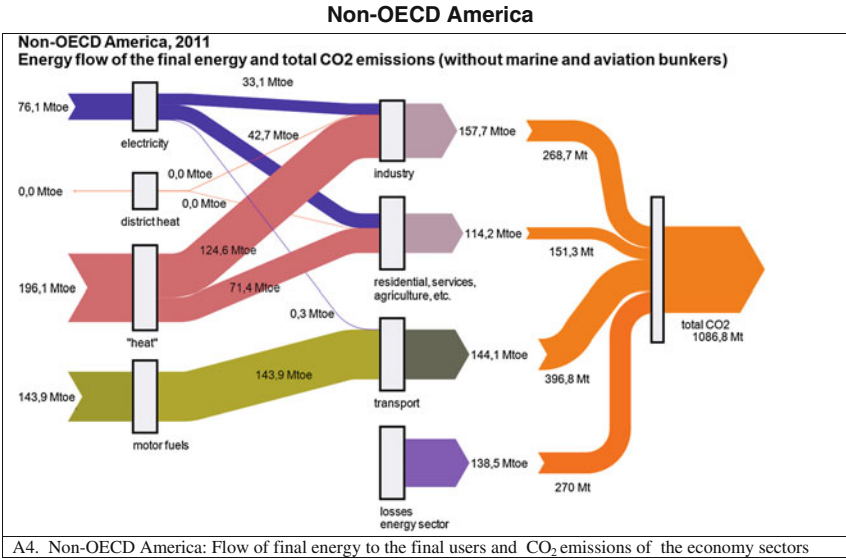
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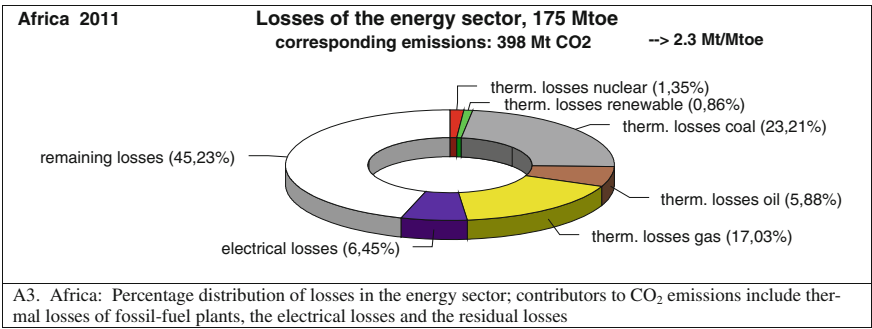
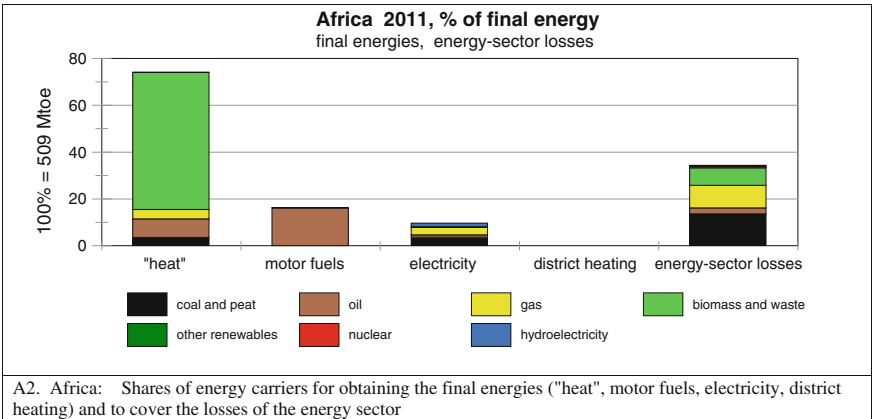
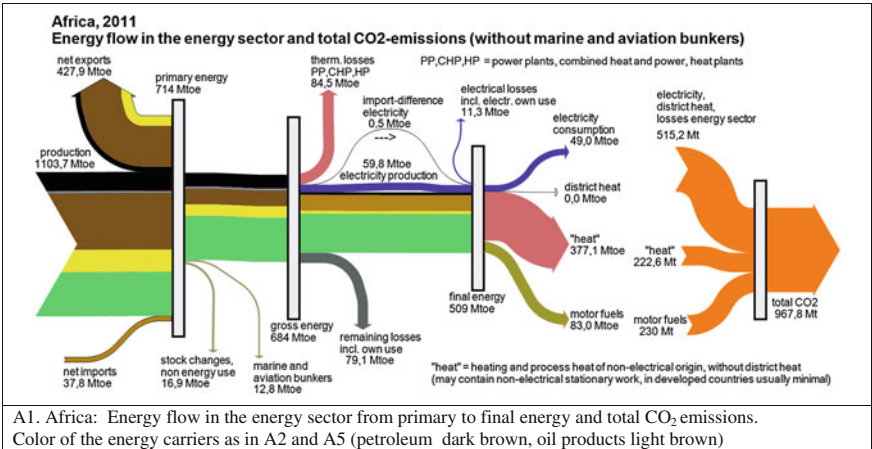


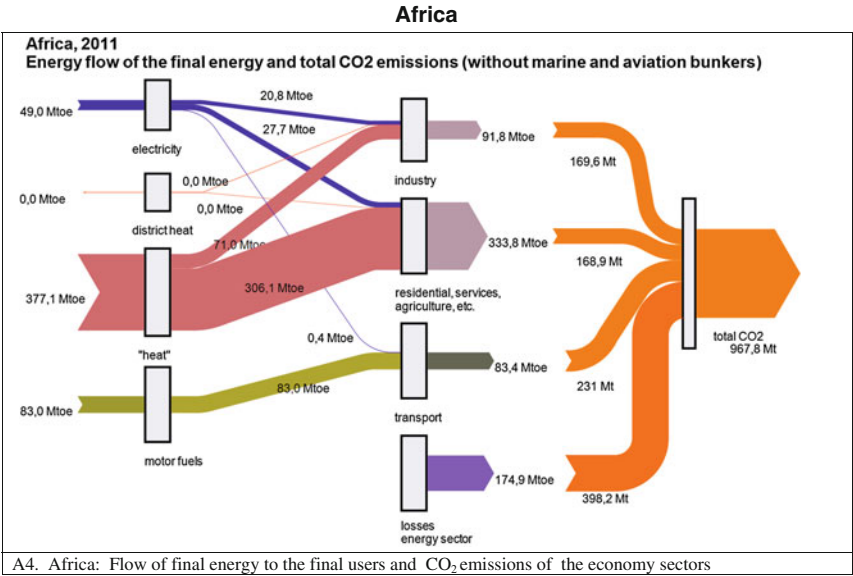
Non-OECD America



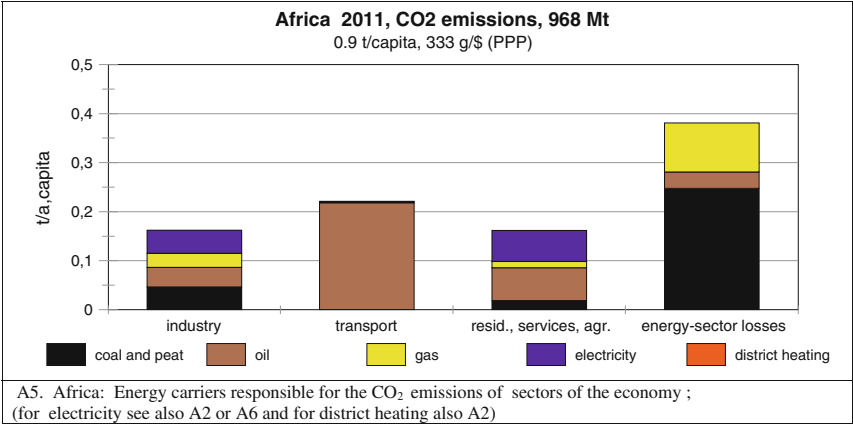


Africa

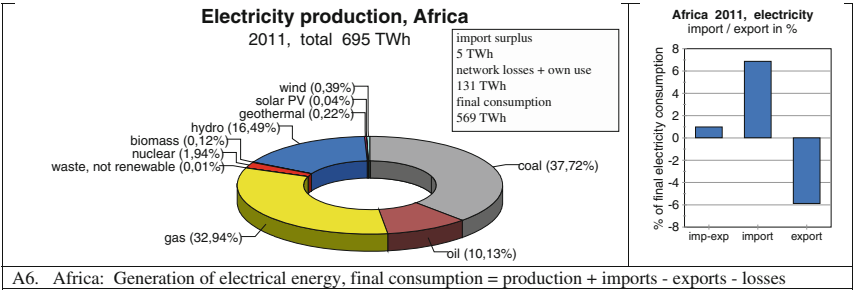




A4. Africa: Flow of final energy to the final users and CO₂ emissions of the economy sectors



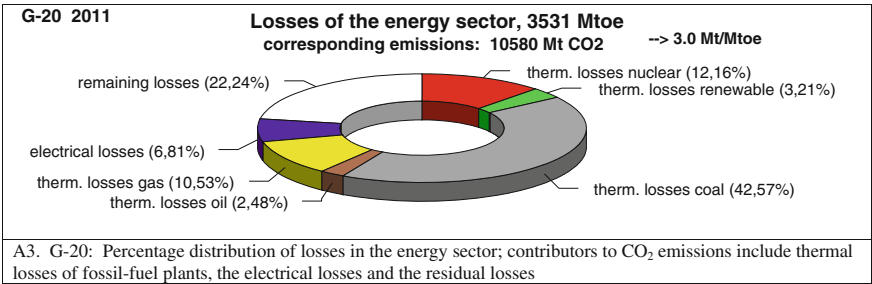
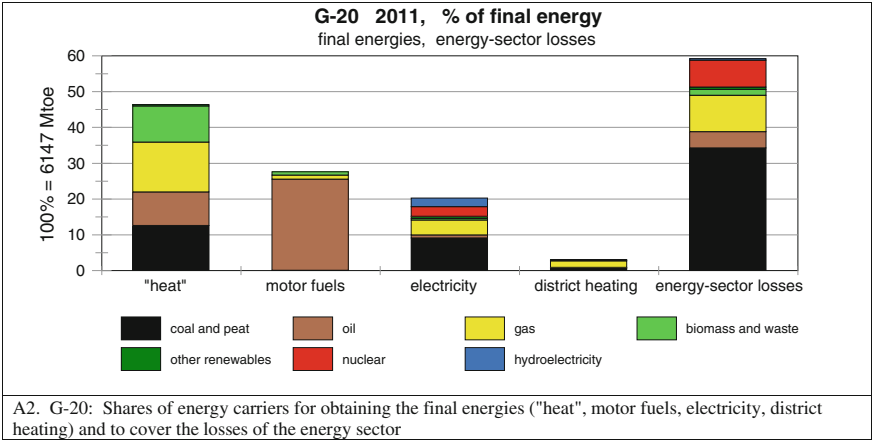
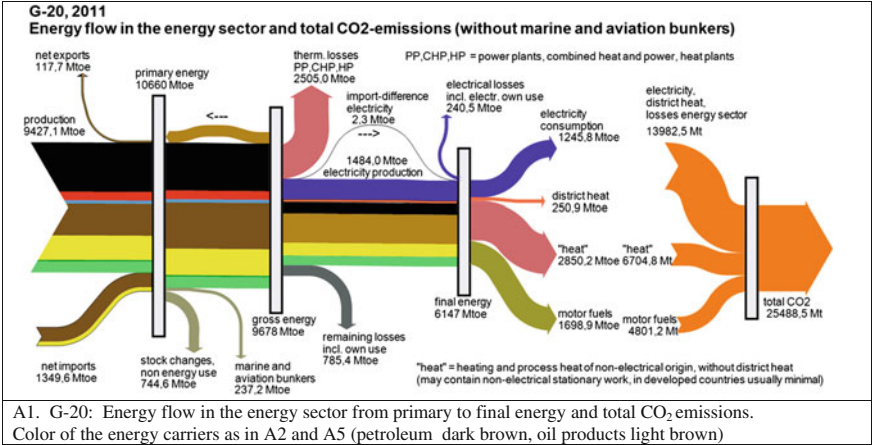
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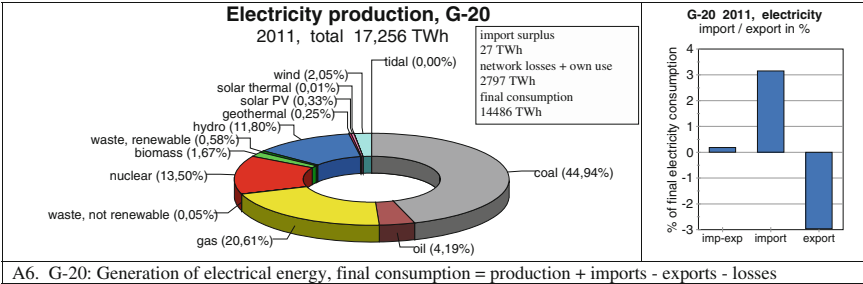
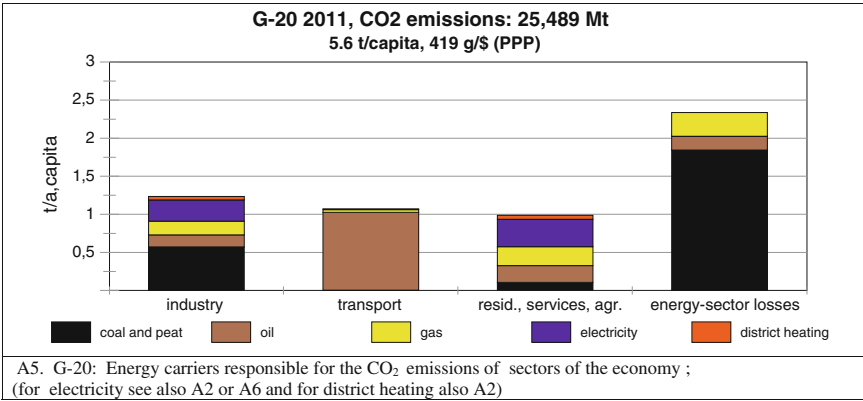
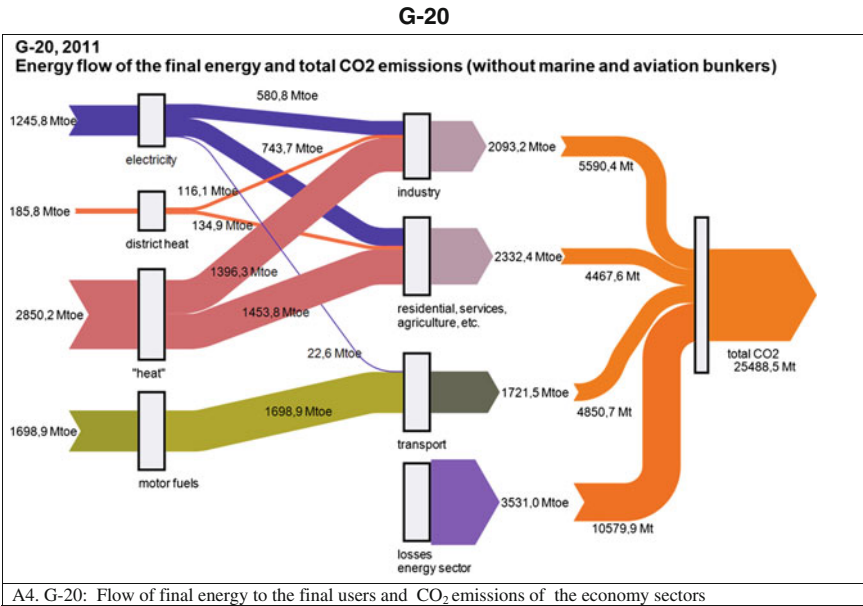


A6. Africa: Generation of electrical energy, final consumption = production + imports - exports - losses

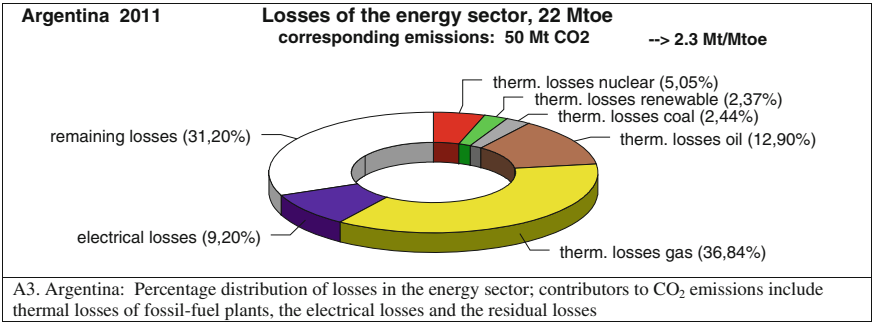
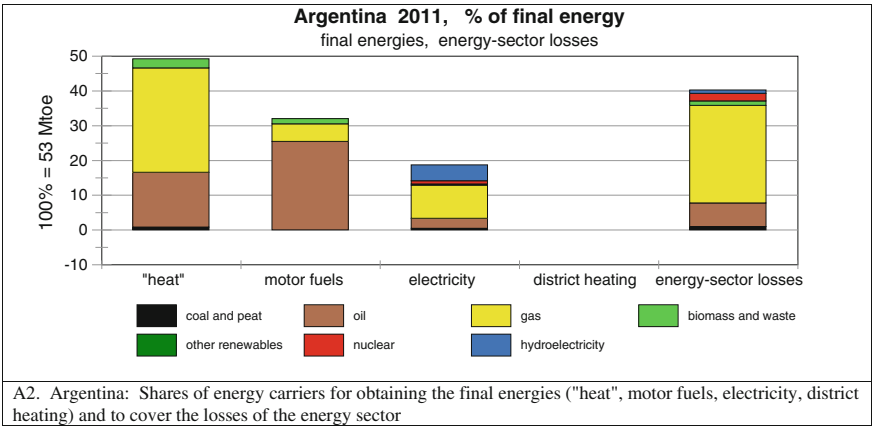
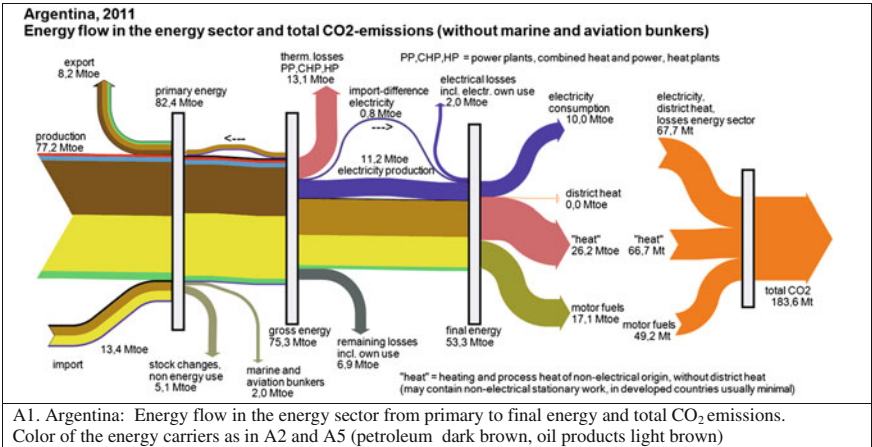
G-20 Countries

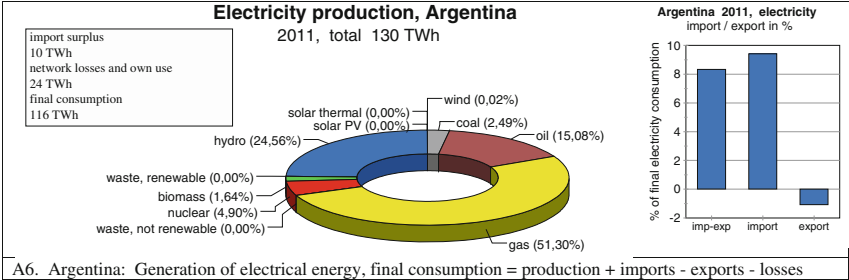
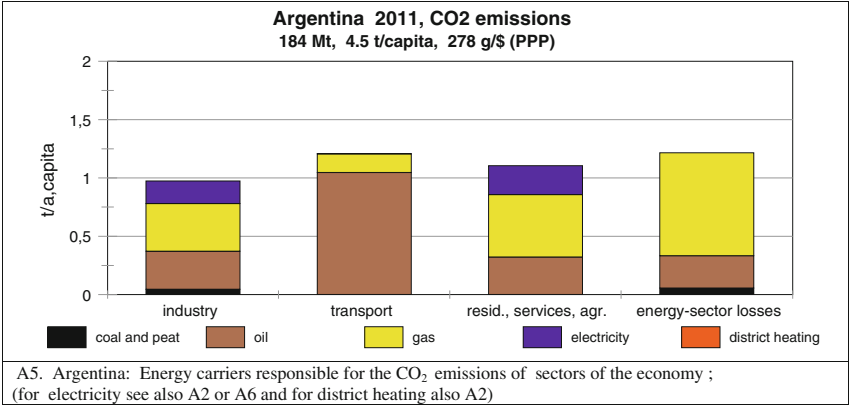
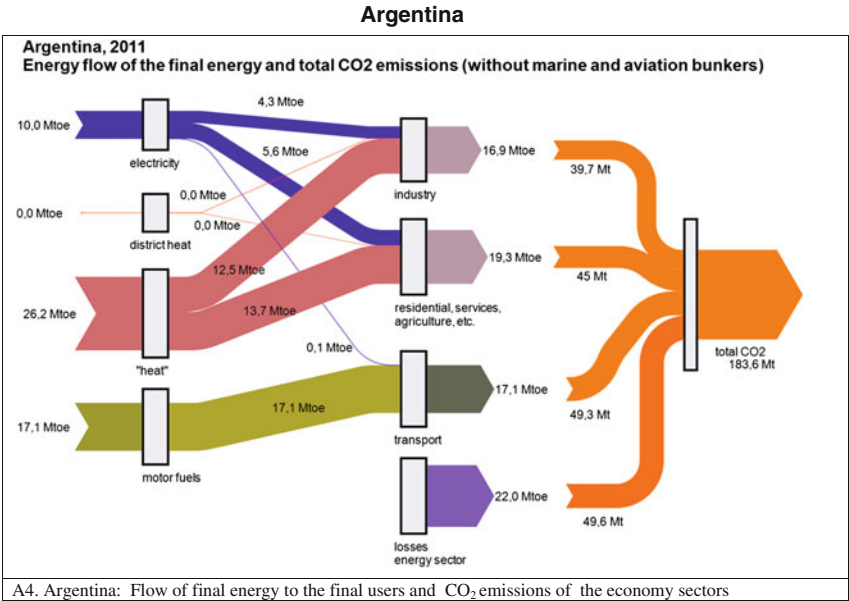
G-20



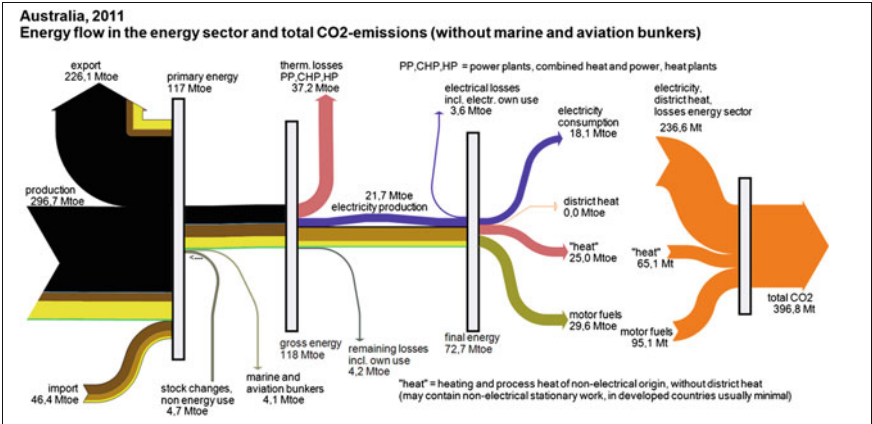


Argentina

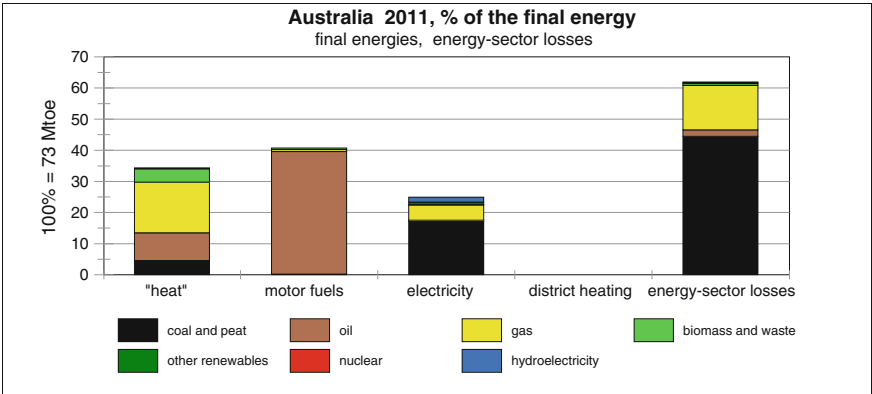




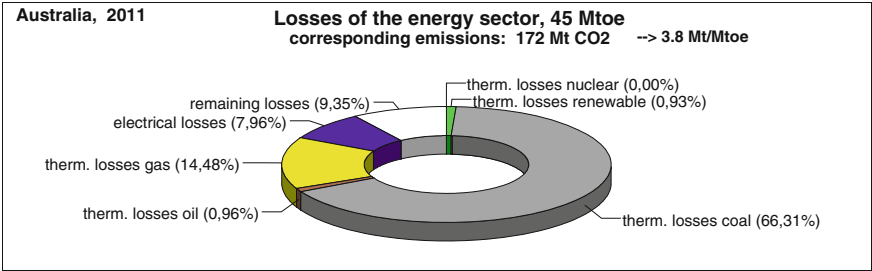
Australia



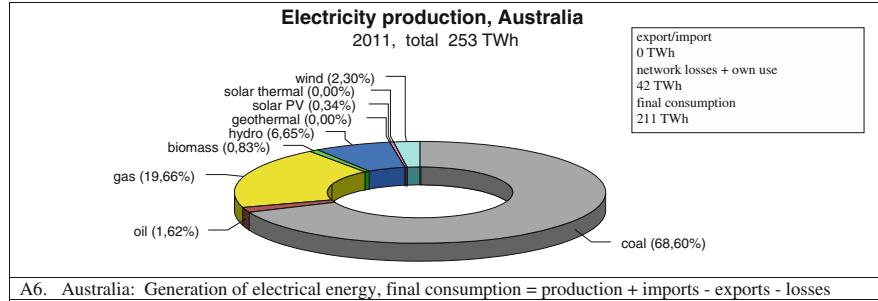
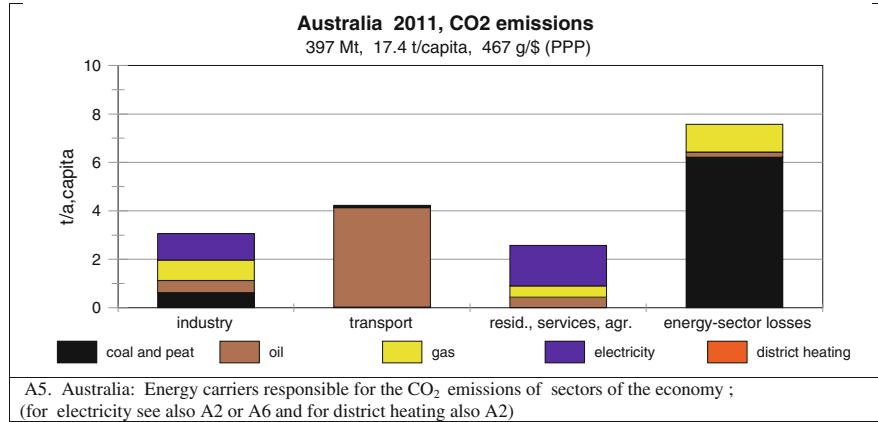
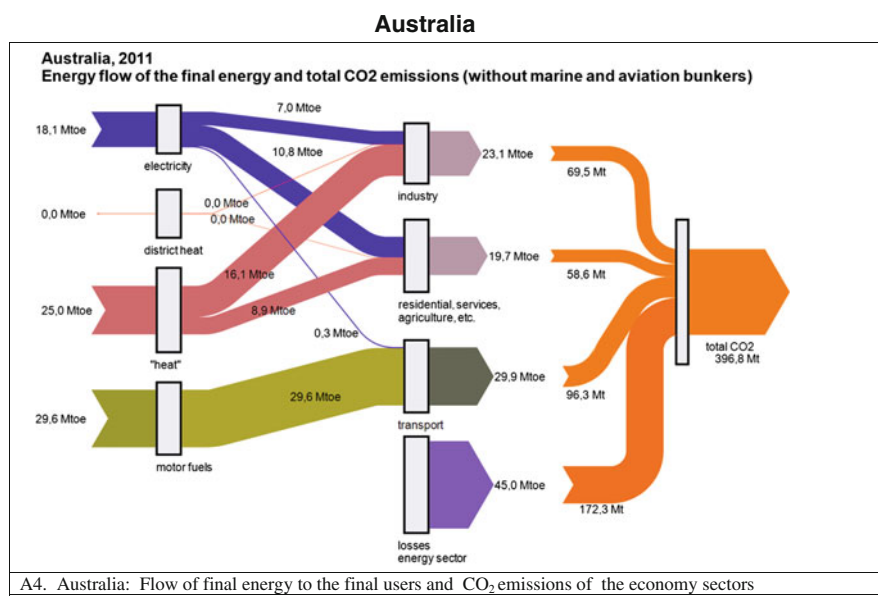
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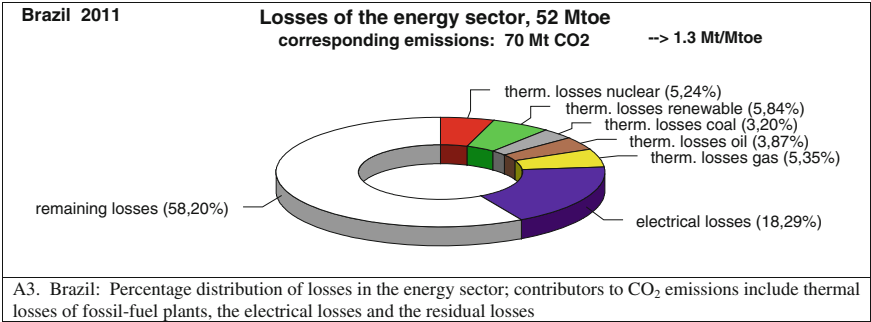
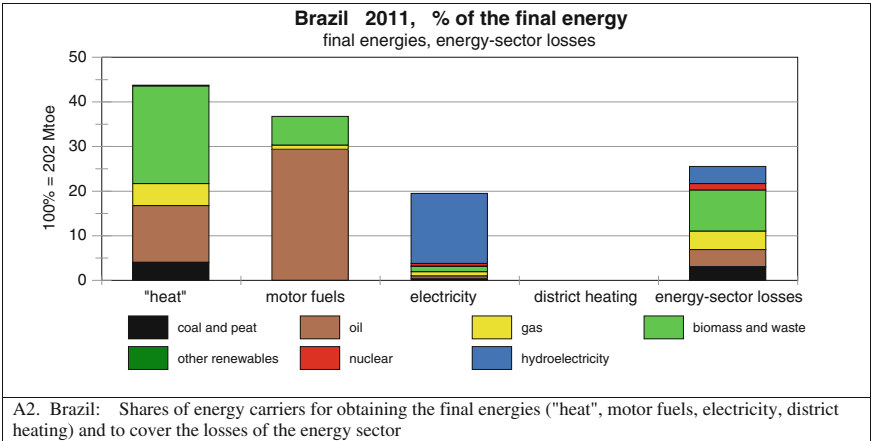
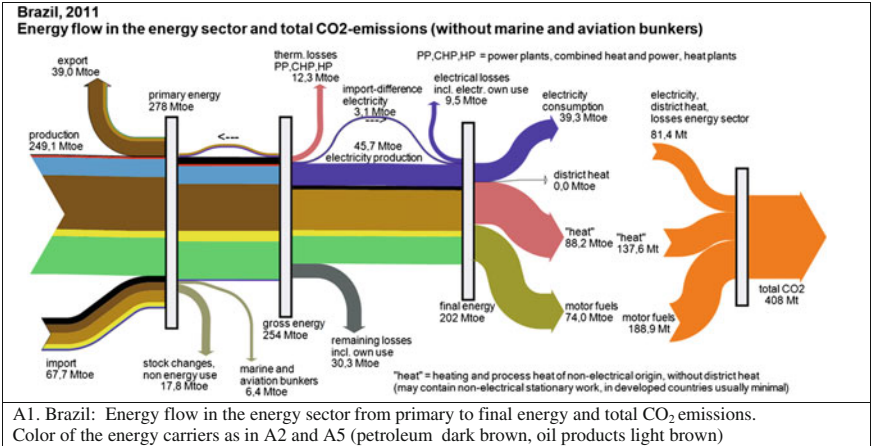
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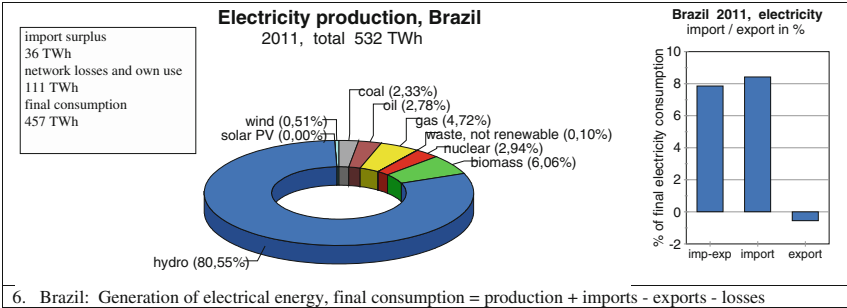
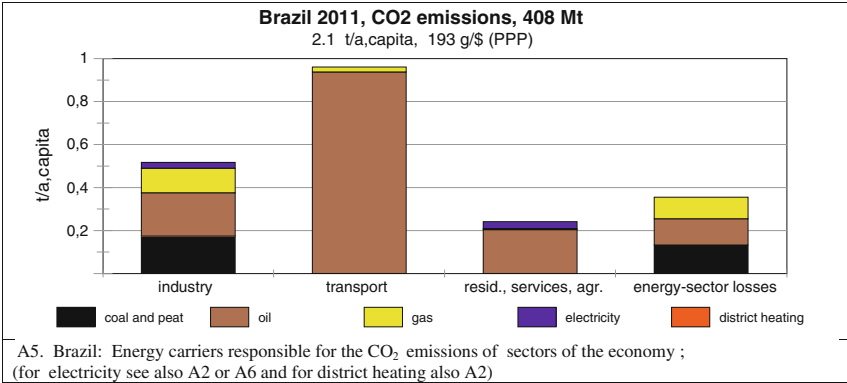
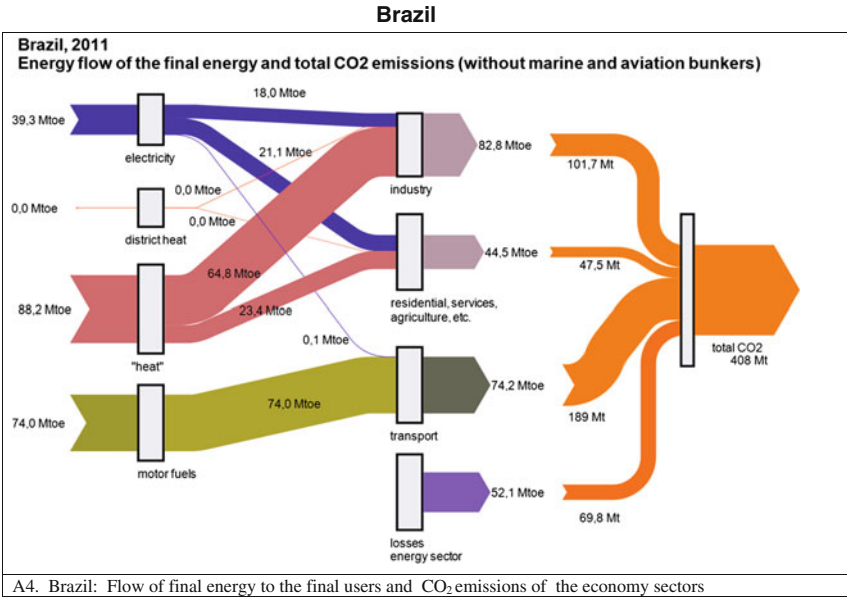


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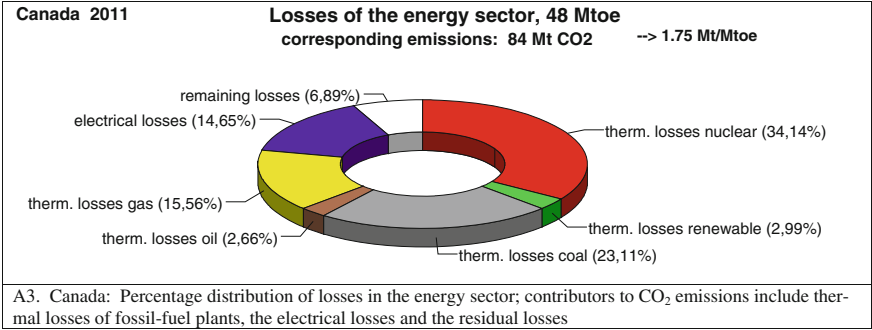
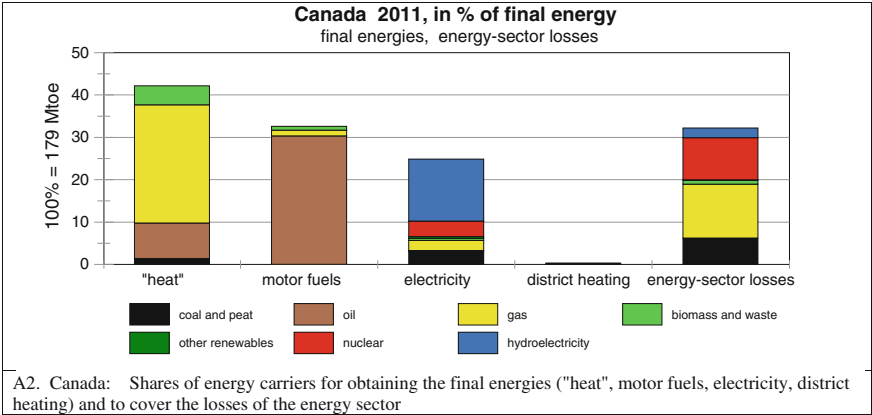
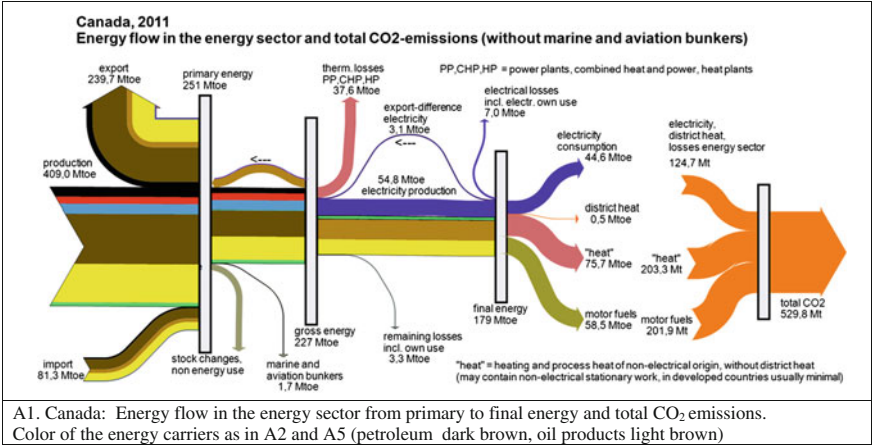


Brazil

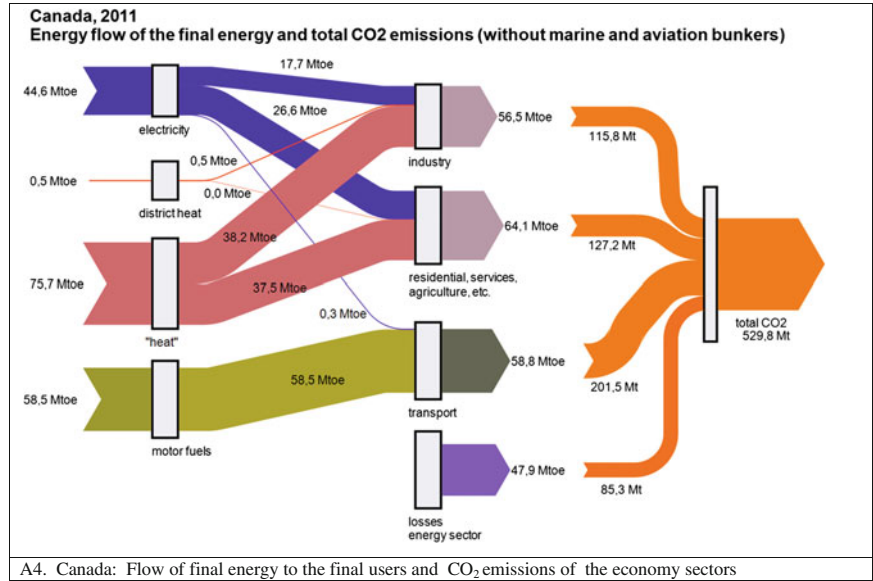




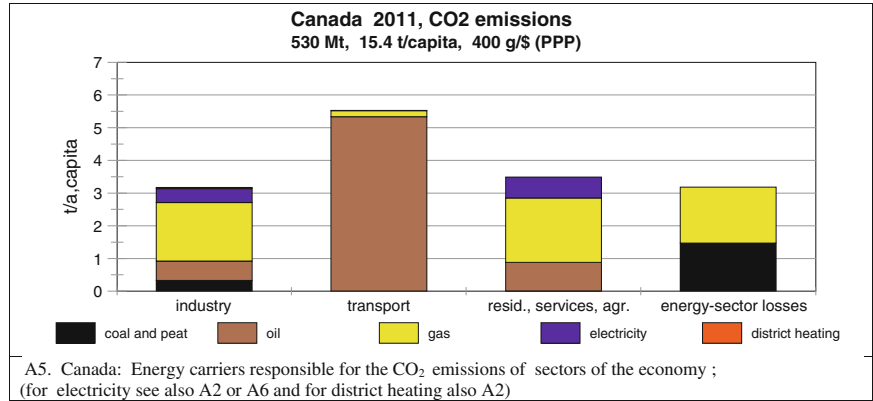
Canada



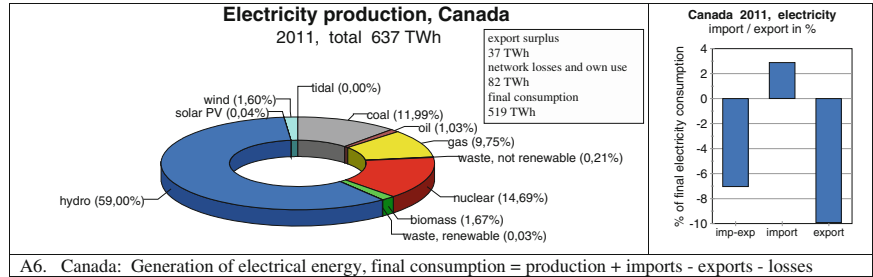
Canada



A4. Canada: Flow of final energy to the final users and CO₂ emissions of the economy sectors

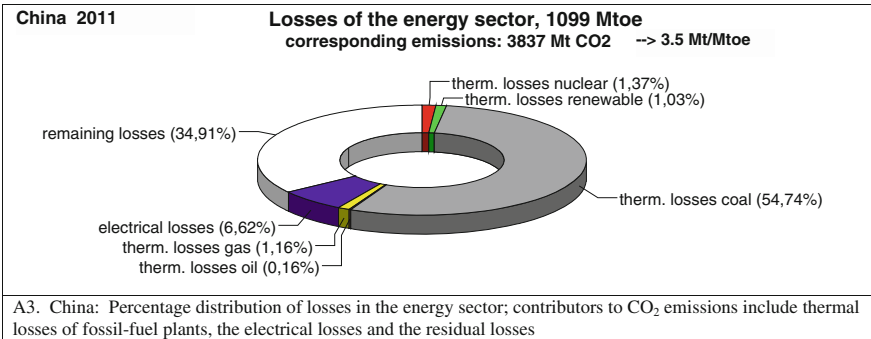
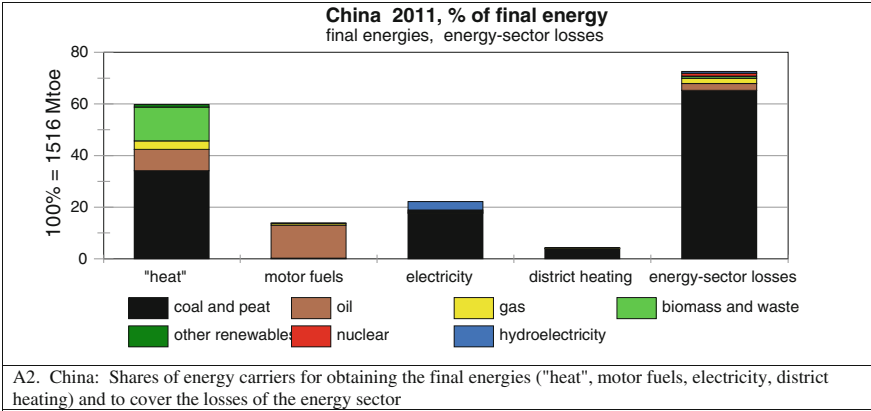
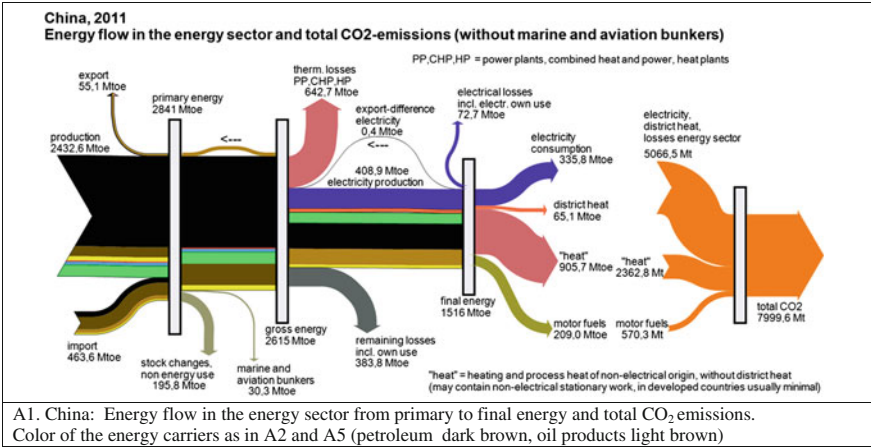


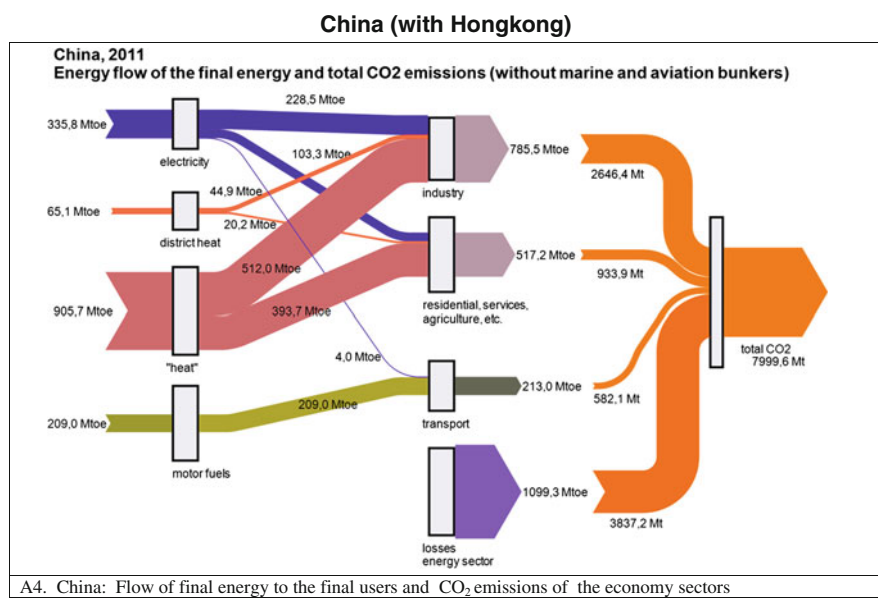
A5. Canada: Energy carriers responsible for the CO₂ emissions of sectors of the economy ; (for electricity see also A2 or A6 and for district heating also A2)



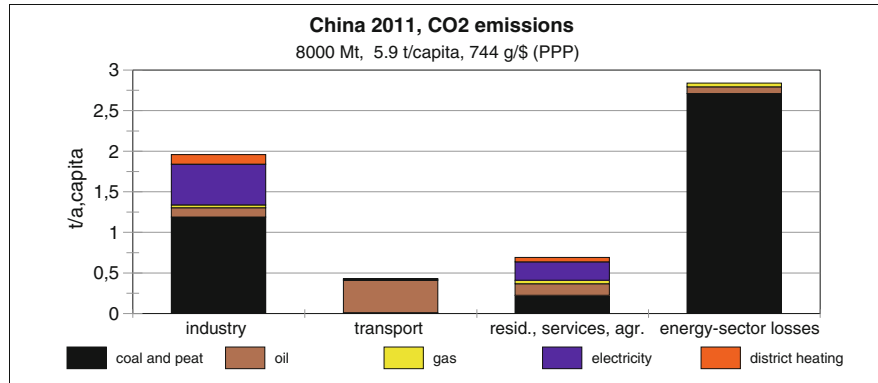
A6. Canada: Generation of electrical energy, final consumption = production + imports - exports - losses

China (with Hongkong)

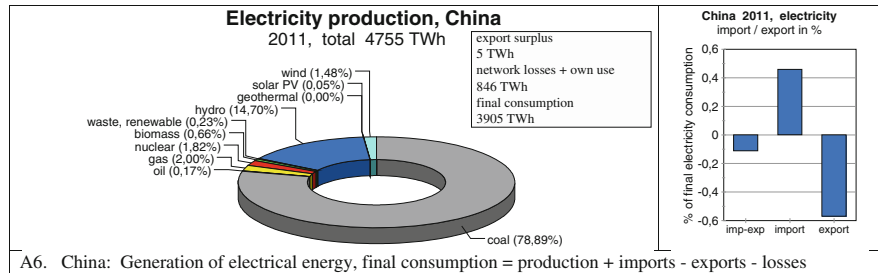




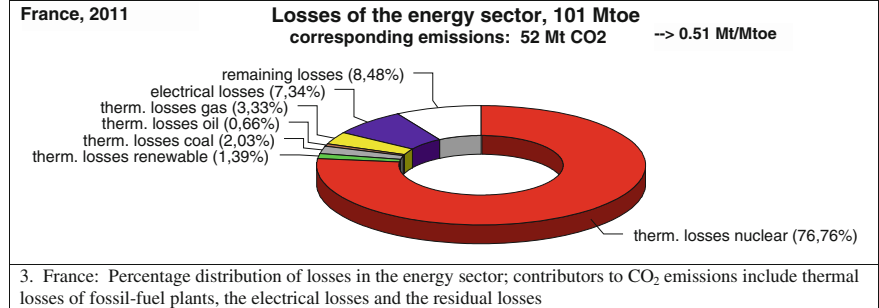
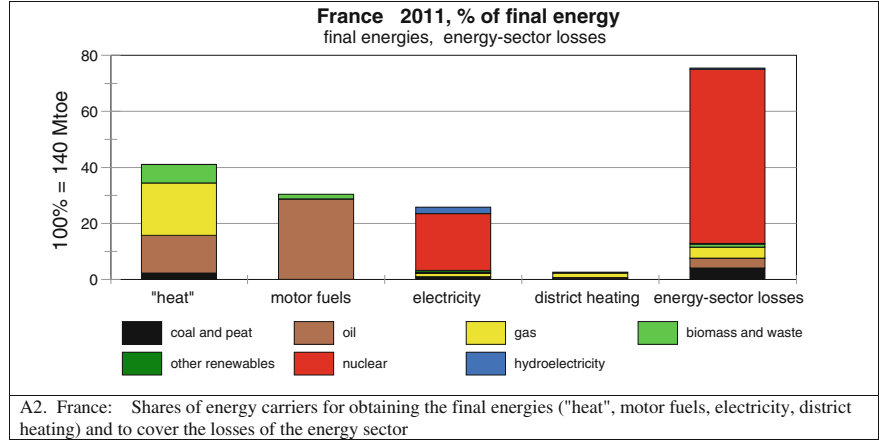
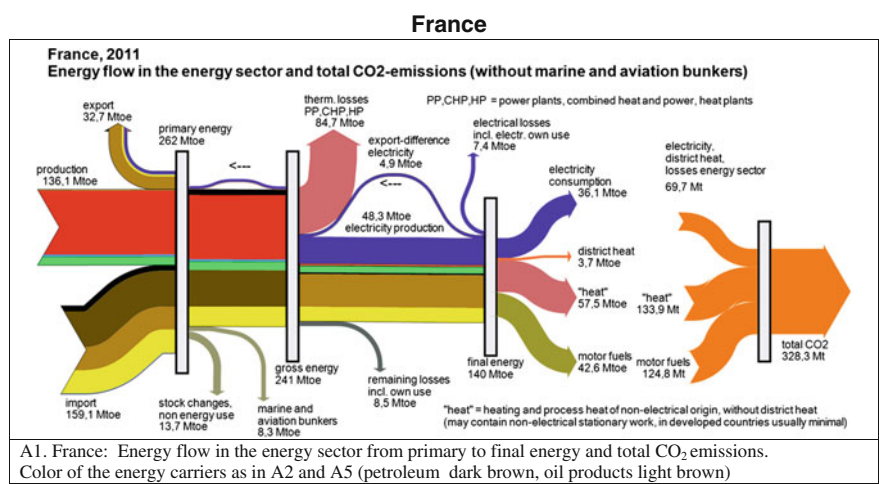
A4. China: Flow of final energy to the final users and CO₂ emissions of the economy sectors



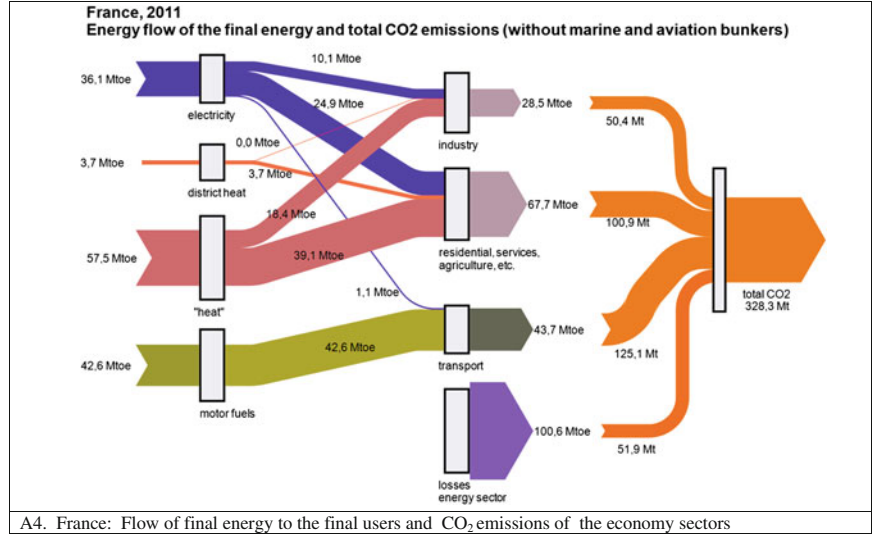
A5. China: Energy carriers responsible for the CO₂ emissions of sectors of the economy ;
(for electricity see also A2 or A6 and for district heating also A2)



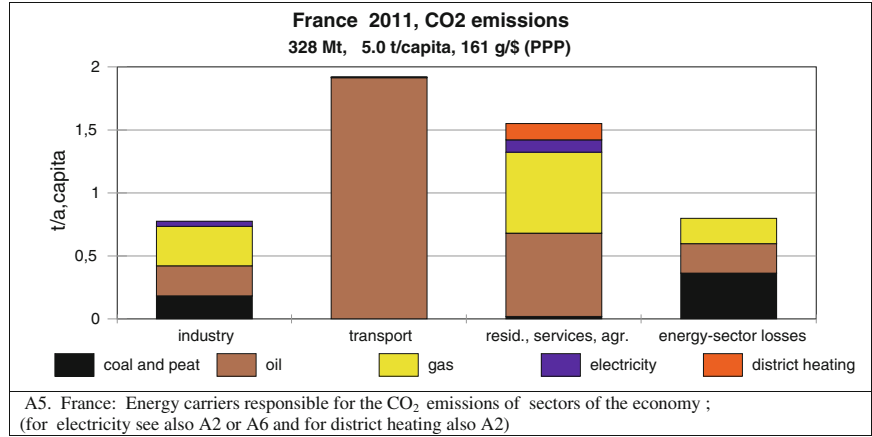
A6. China: Generation of electrical energy, final consumption = production + imports - exports - losses



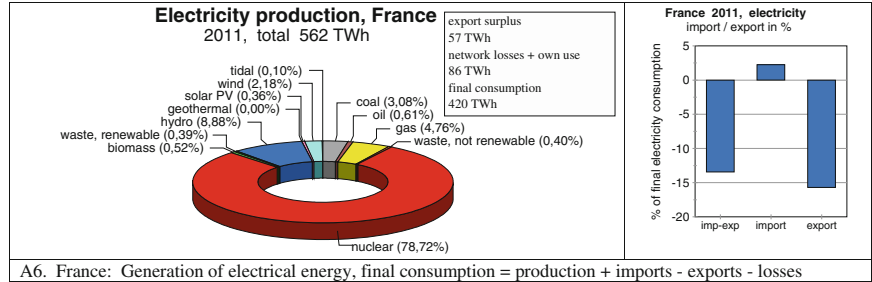
France



A4. France: Flow of final energy to the final users and CO₂ emissions of the economy sectors

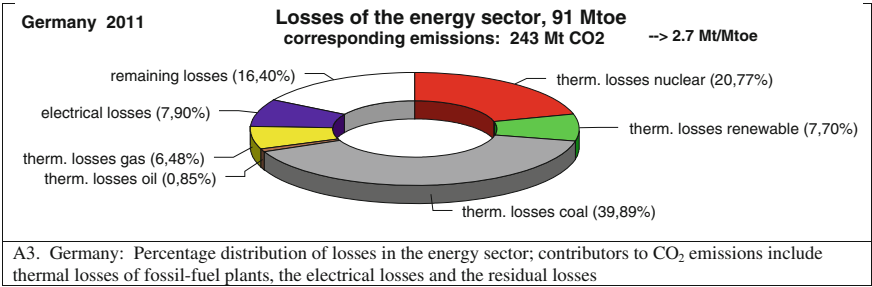
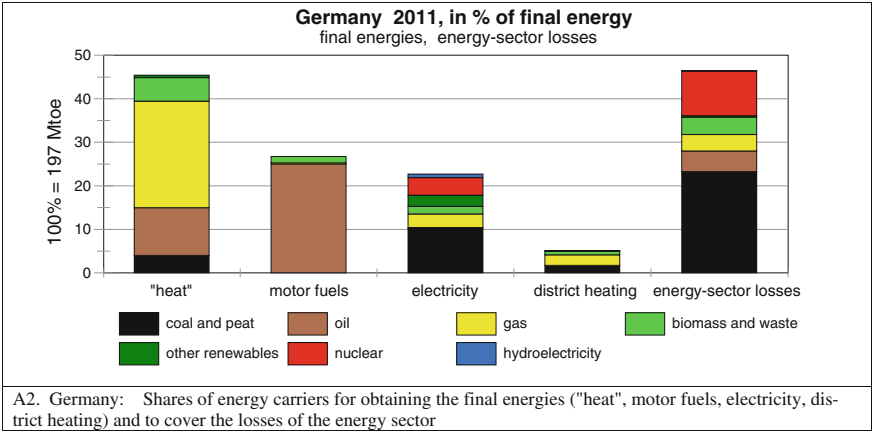
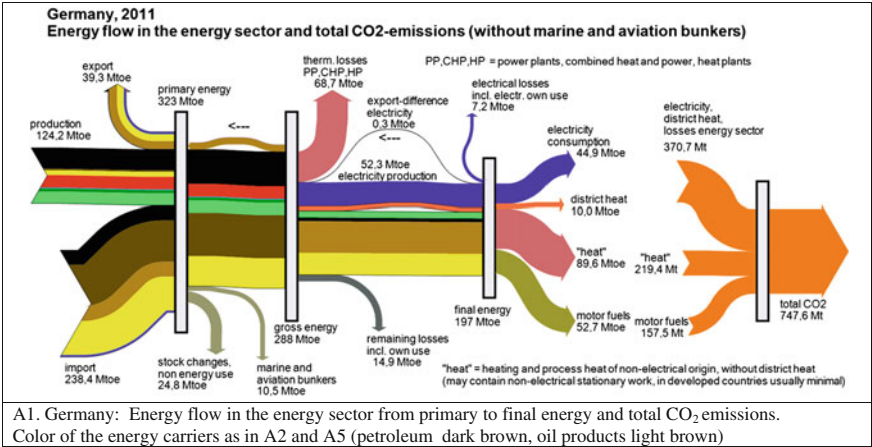


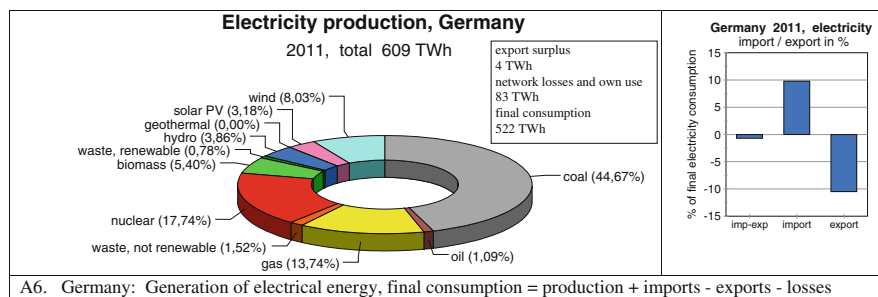
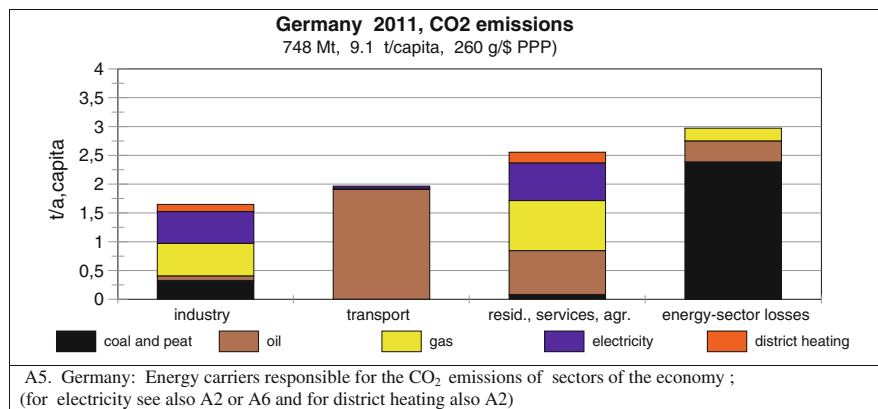
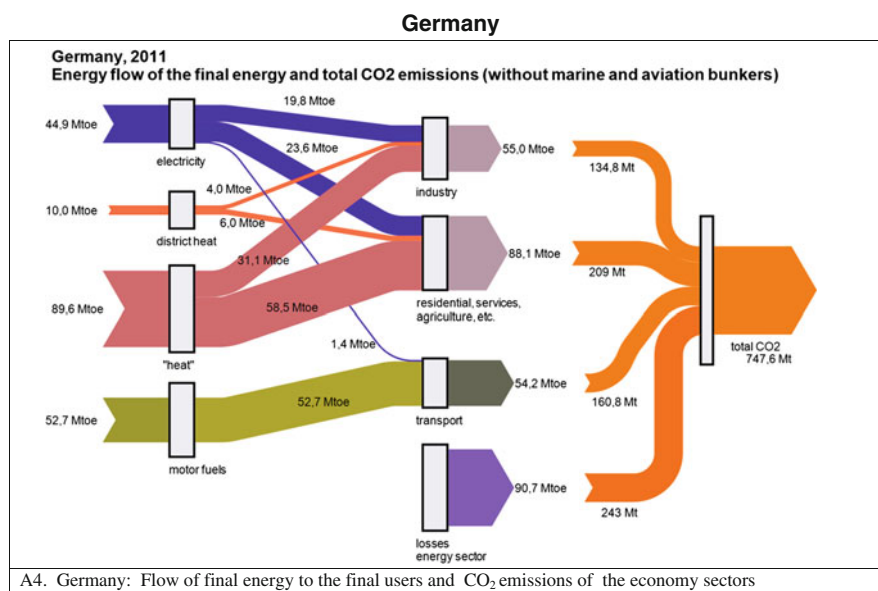
A5. France: Energy carriers responsible for the CO₂ emissions of sectors of the economy ;
(for electricity see also A2 or A6 and for district heating also A2)



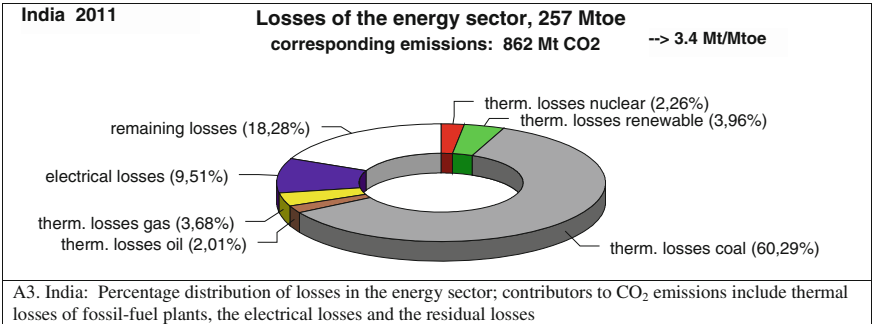
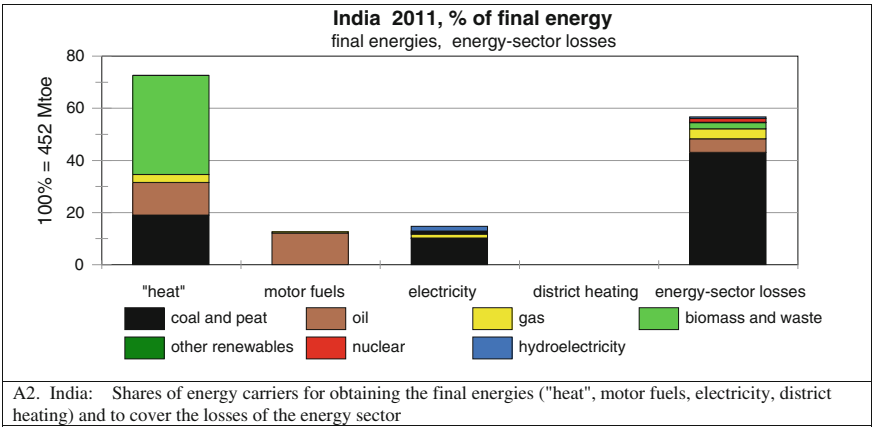
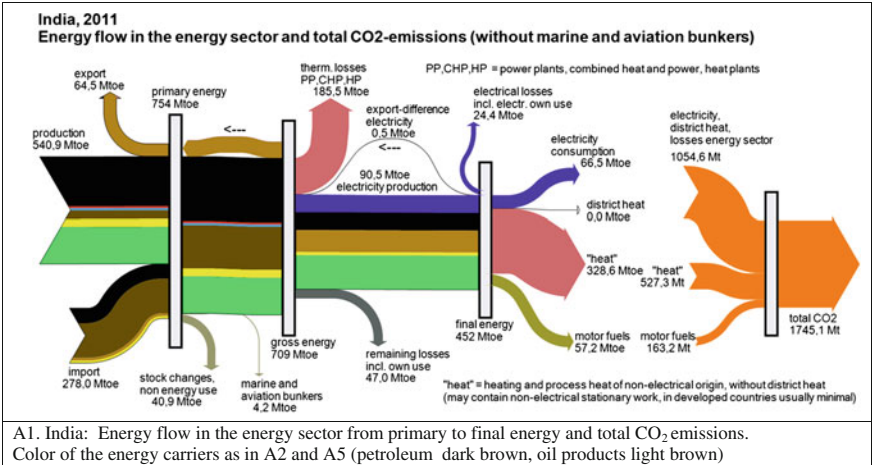
A6. France: Generation of electrical energy, final consumption = production + imports - exports - losses

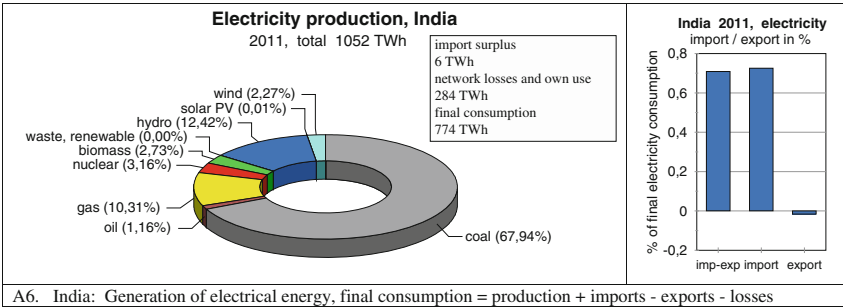
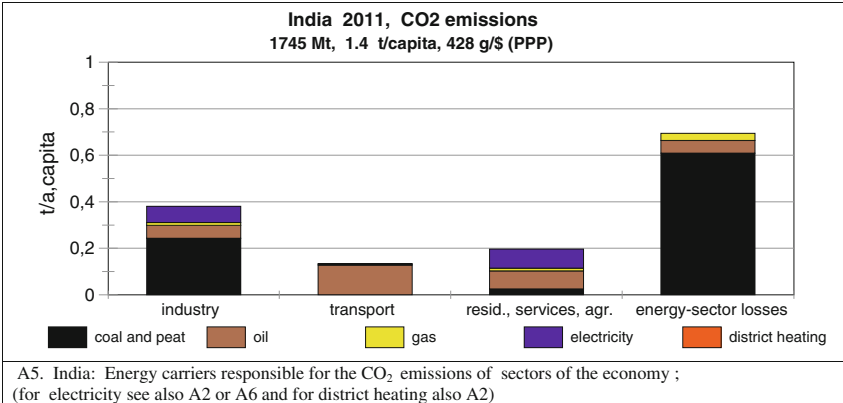
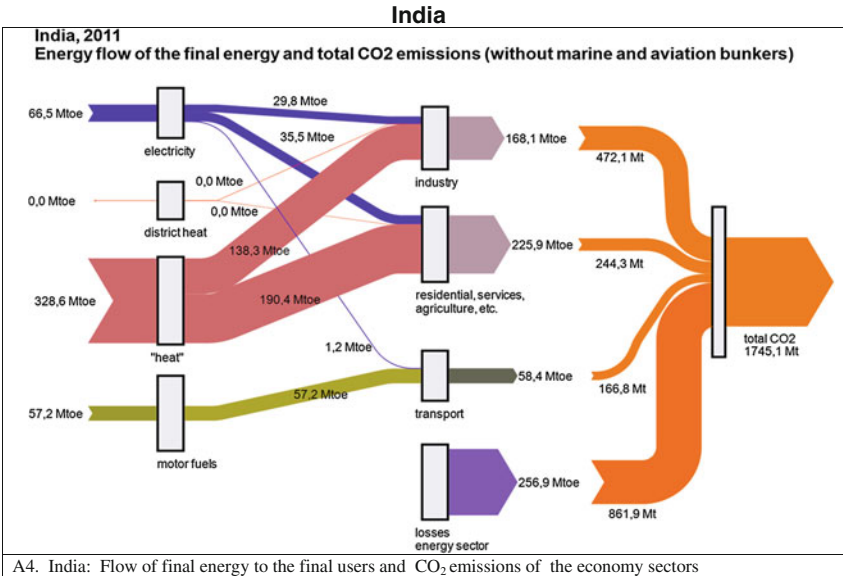
Germany



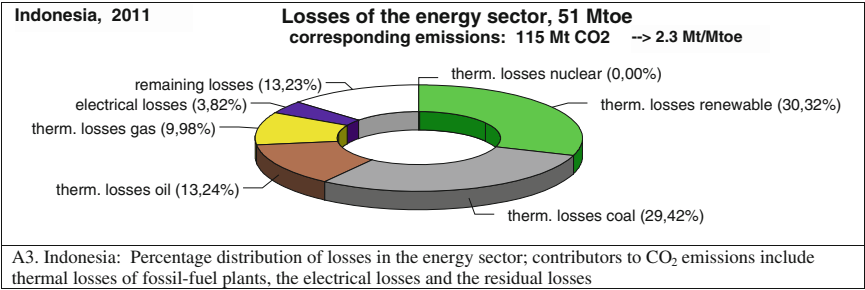
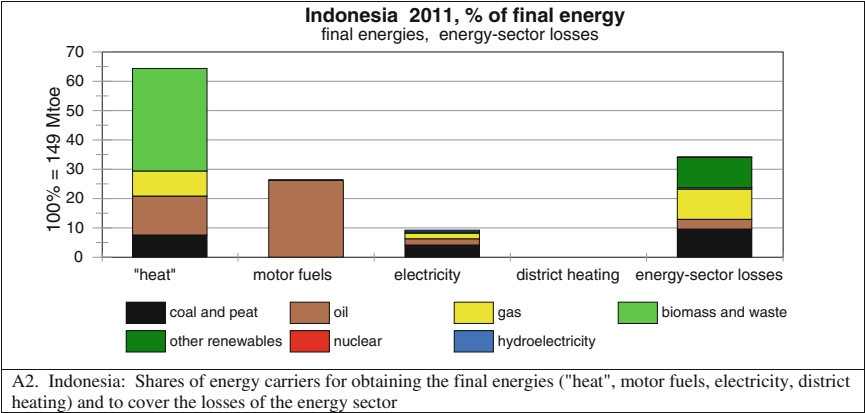
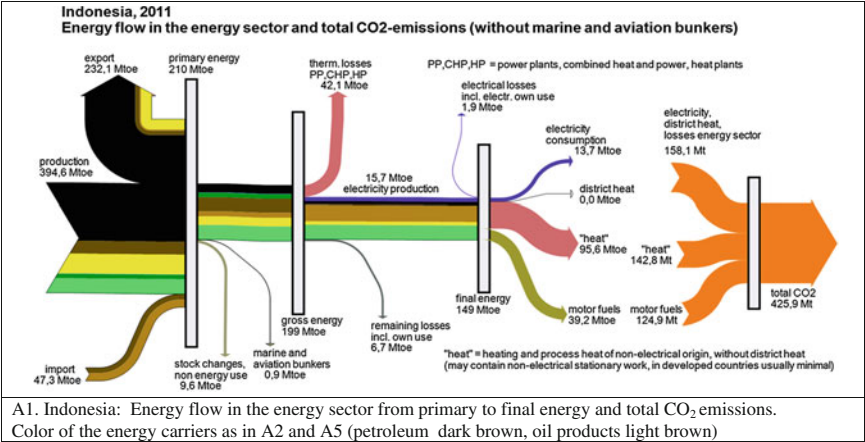


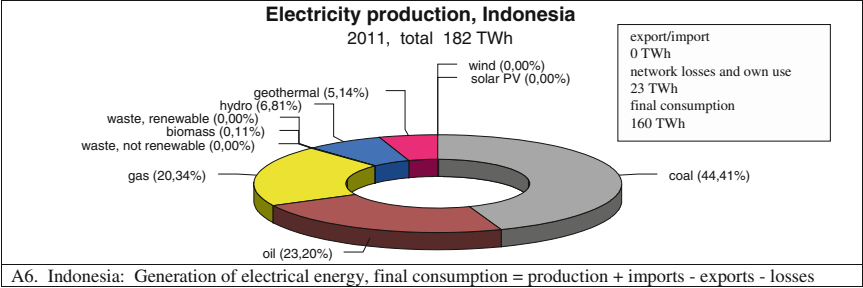
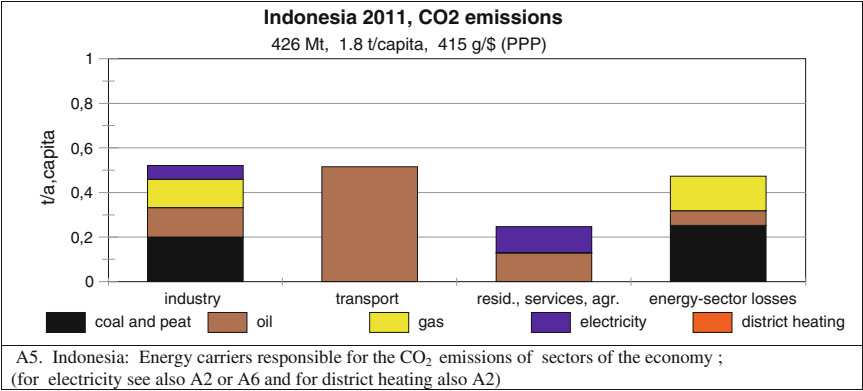
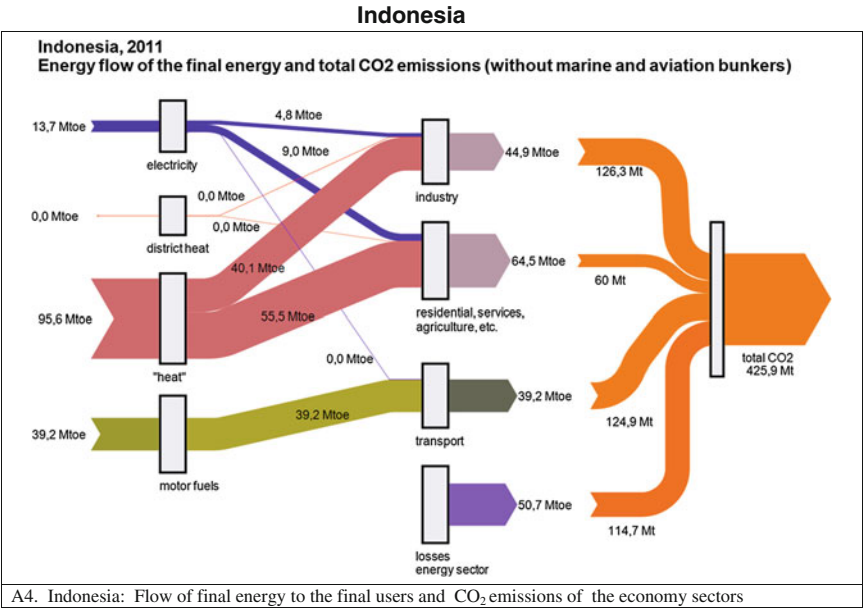
India



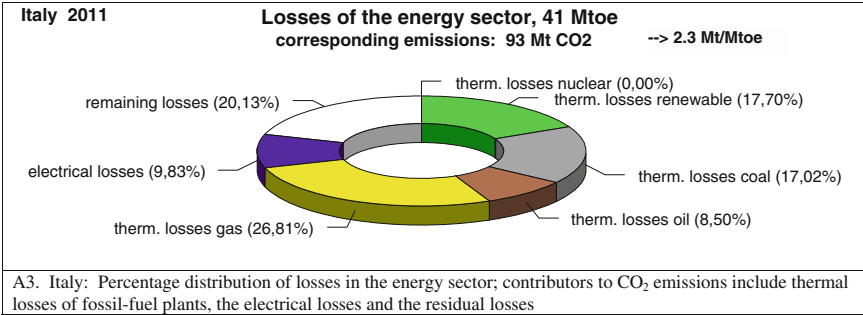
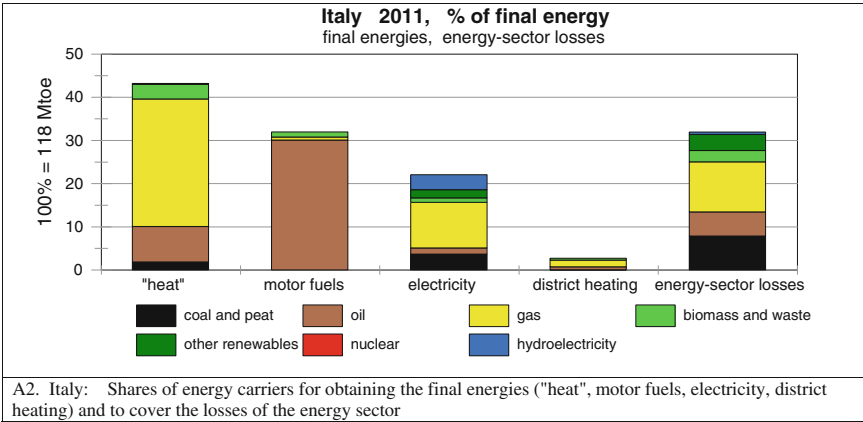
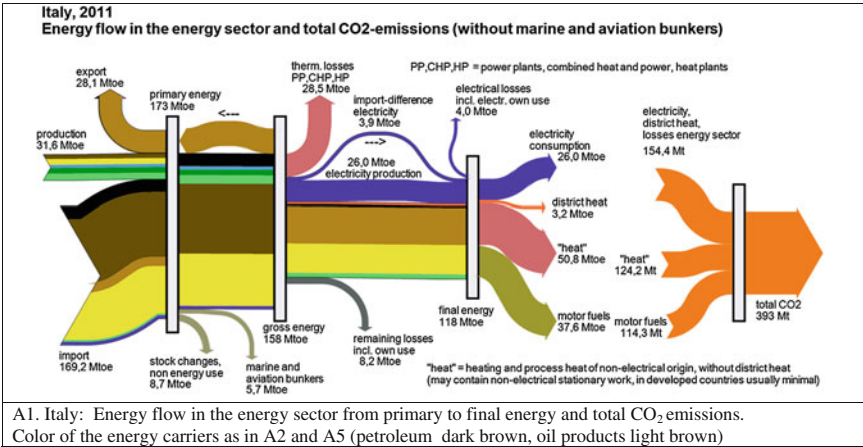


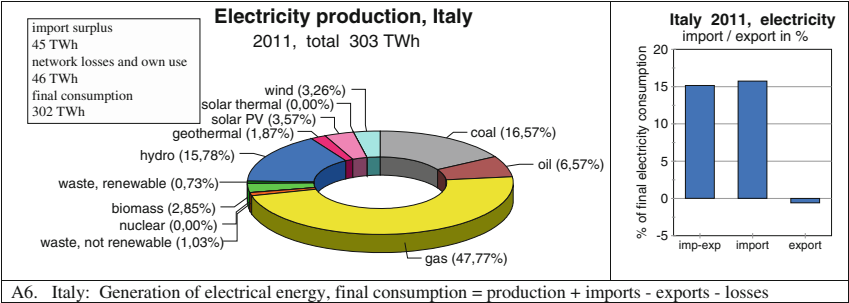
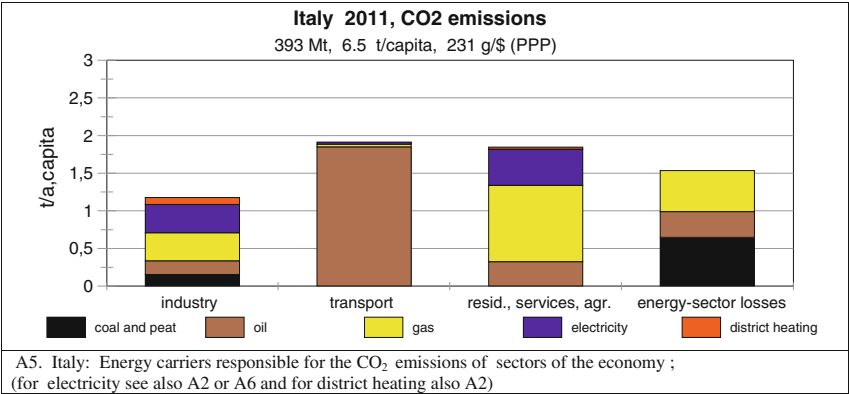
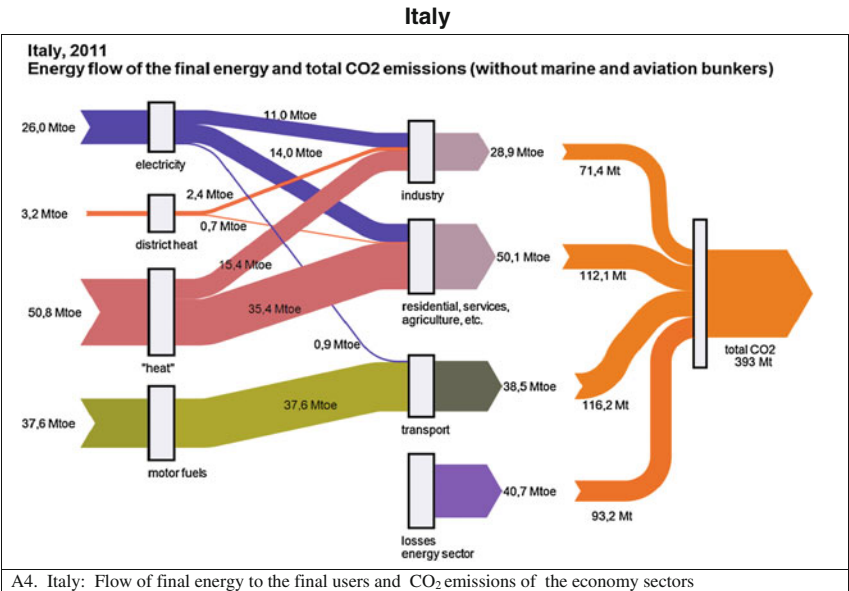
Indonesia



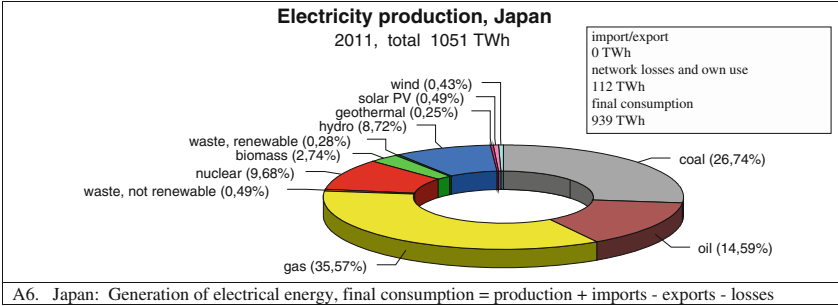
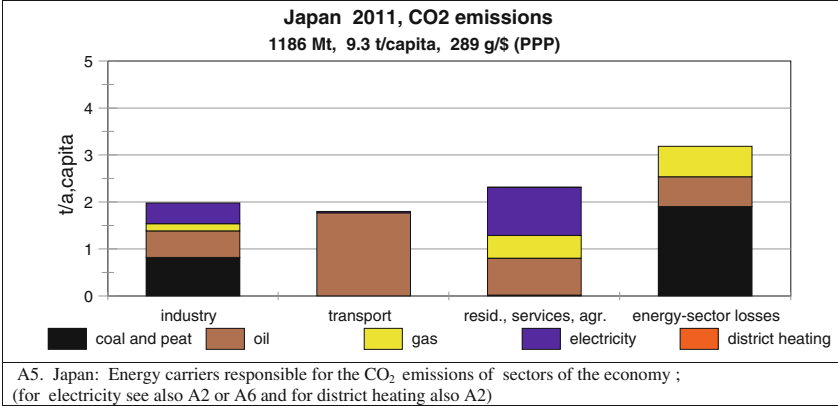
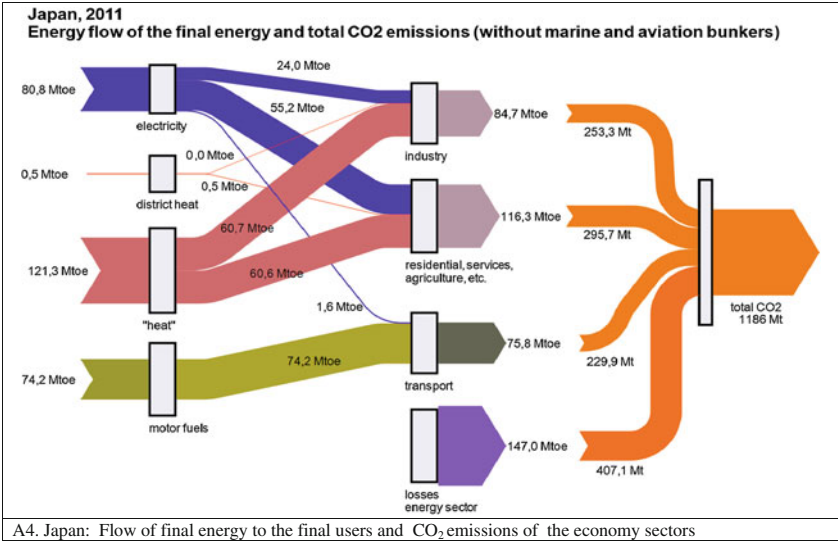


Italy

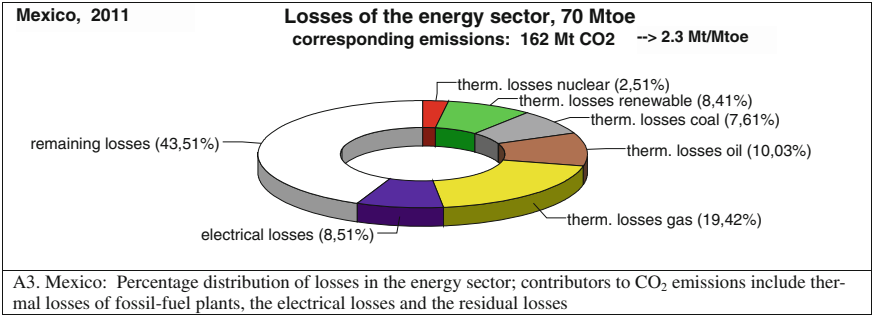
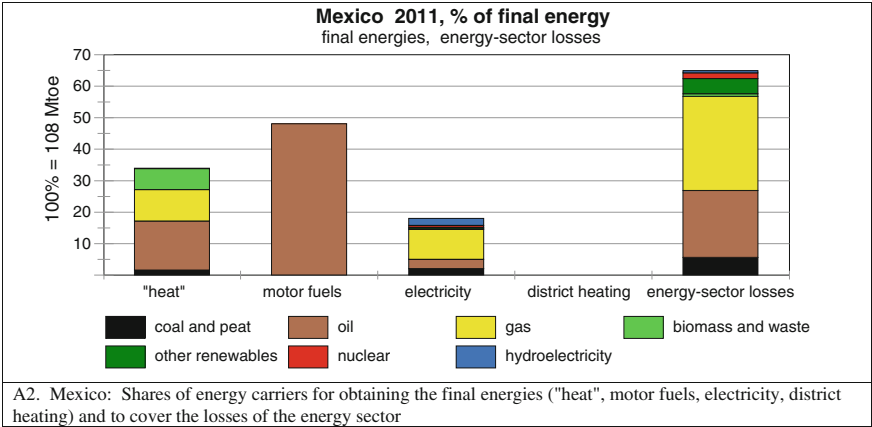
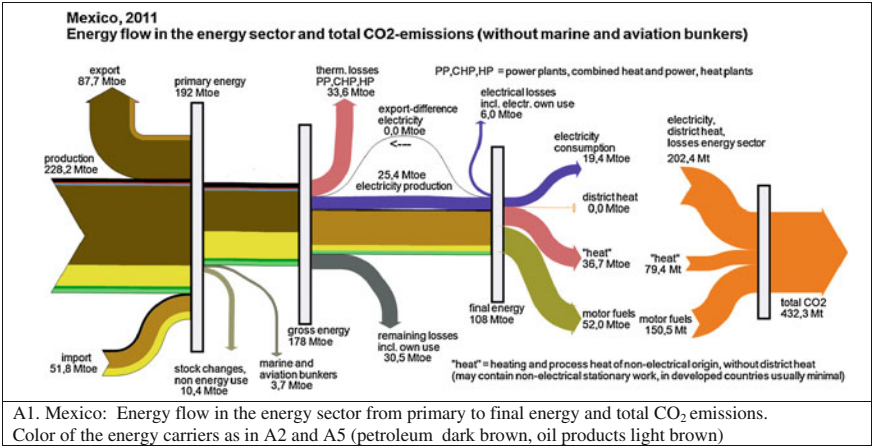


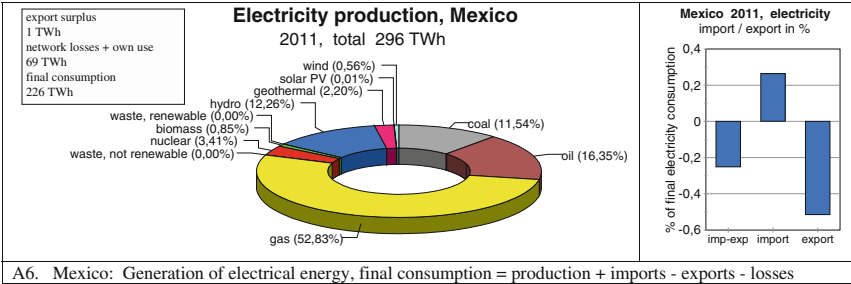
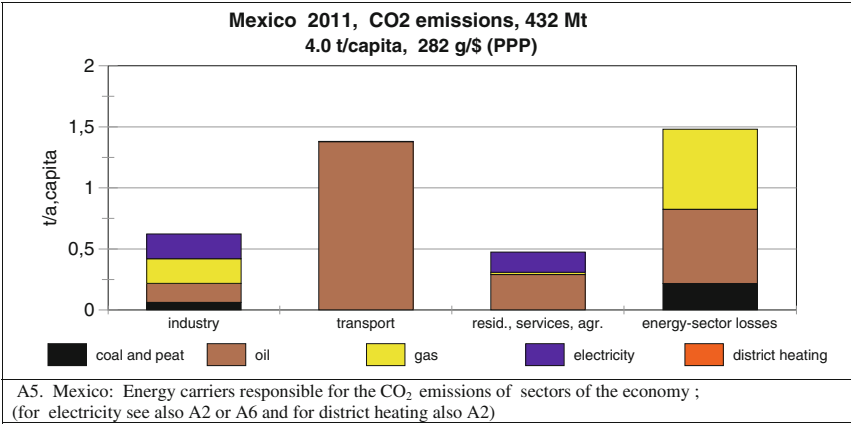
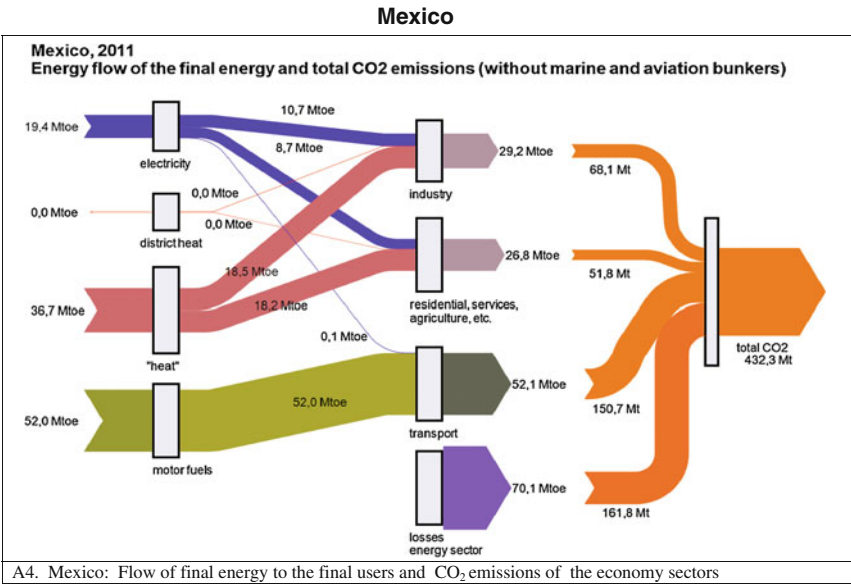


Japan

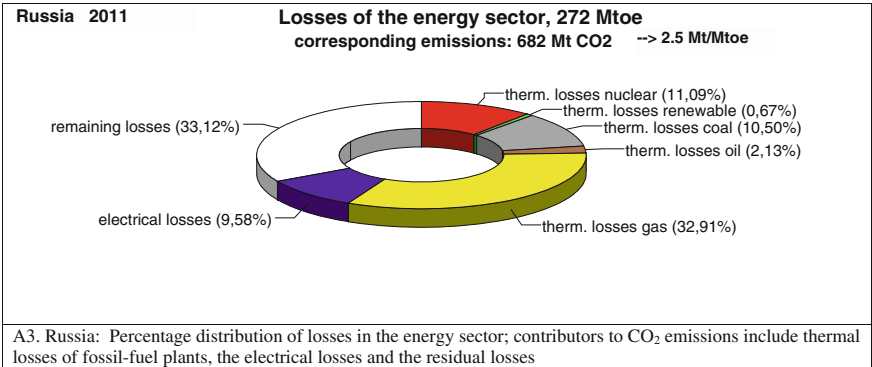
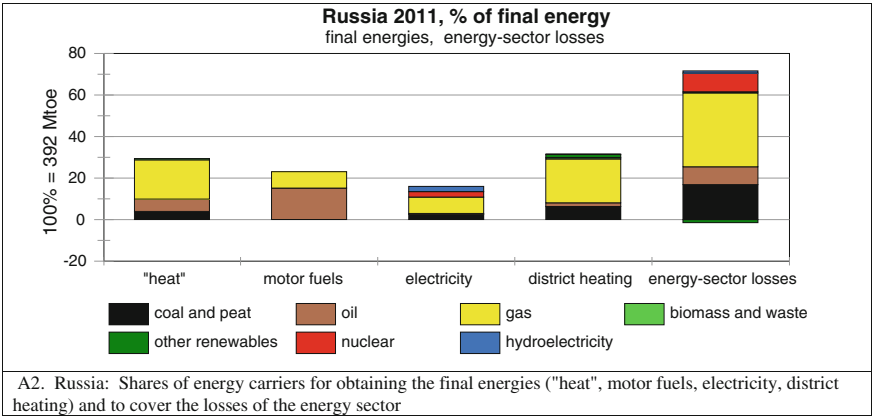
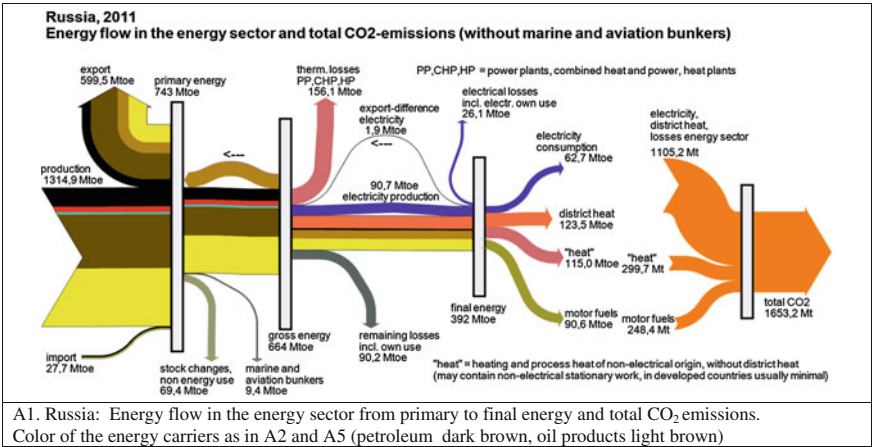


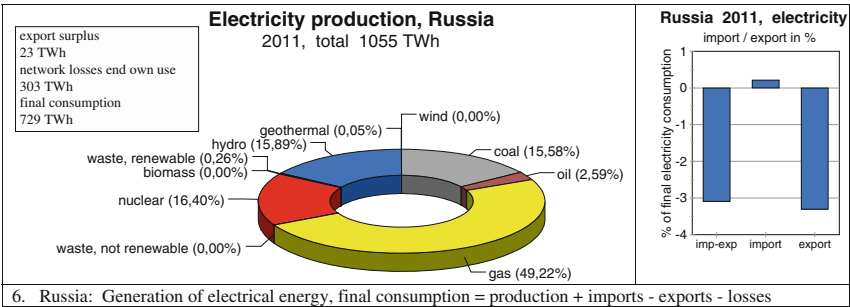
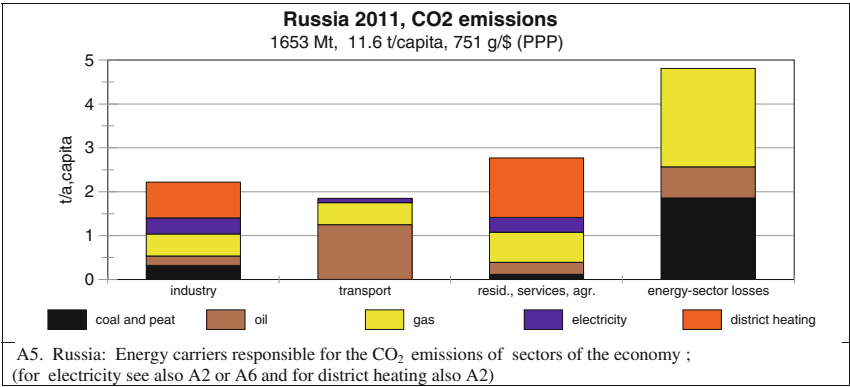
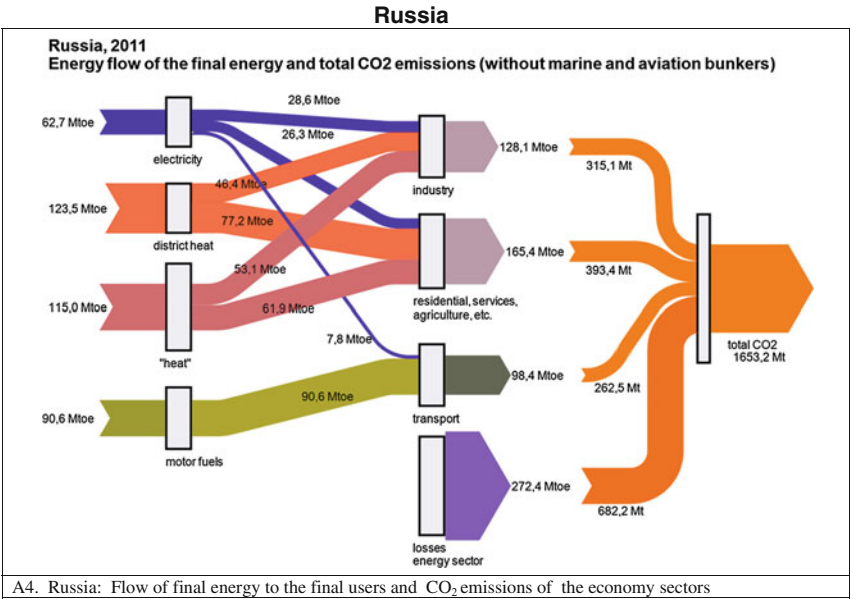
Mexico



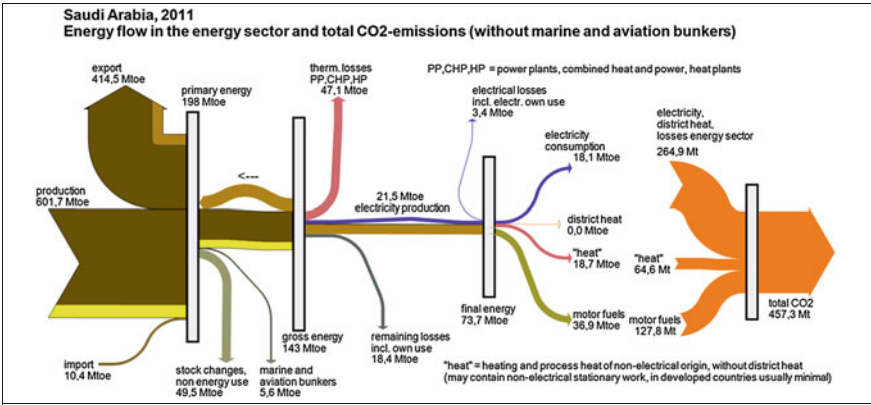


Russia

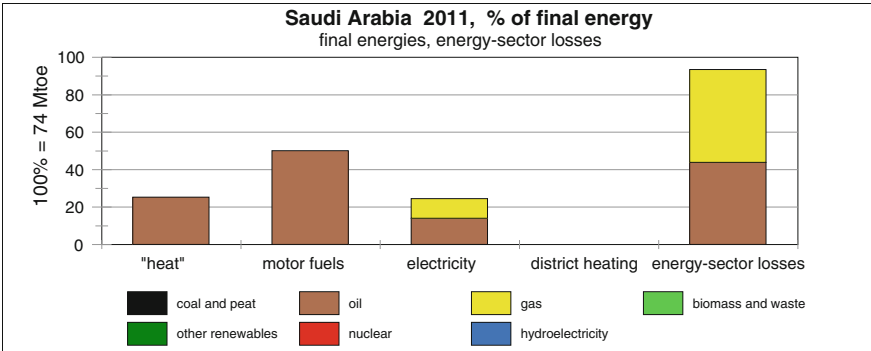




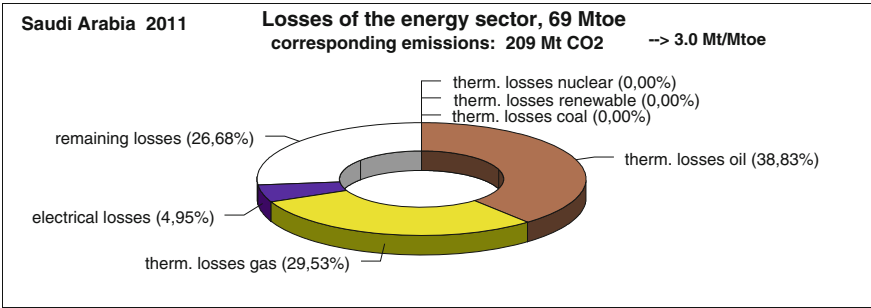
Saudi Arabia



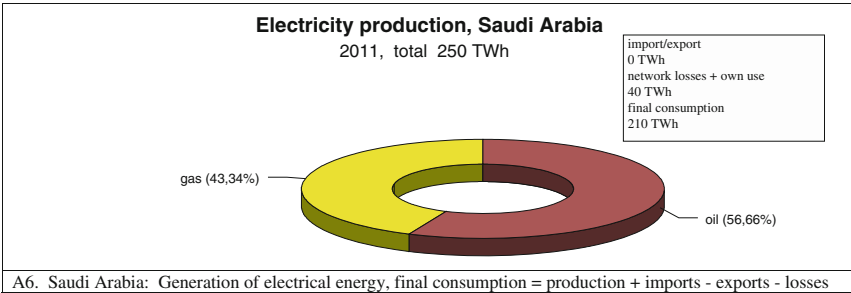
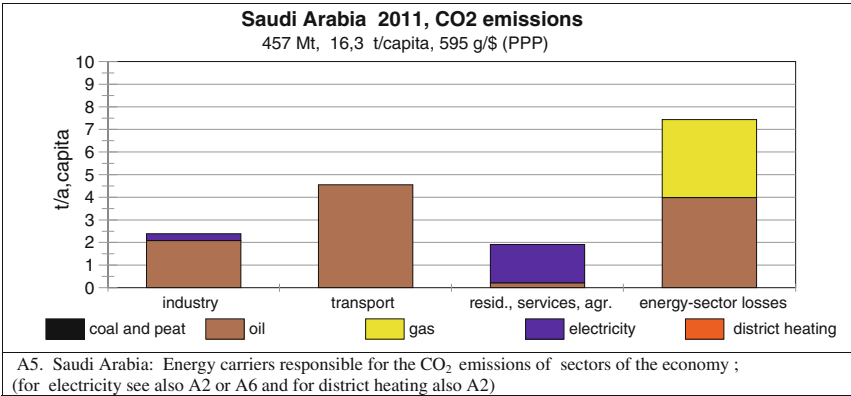
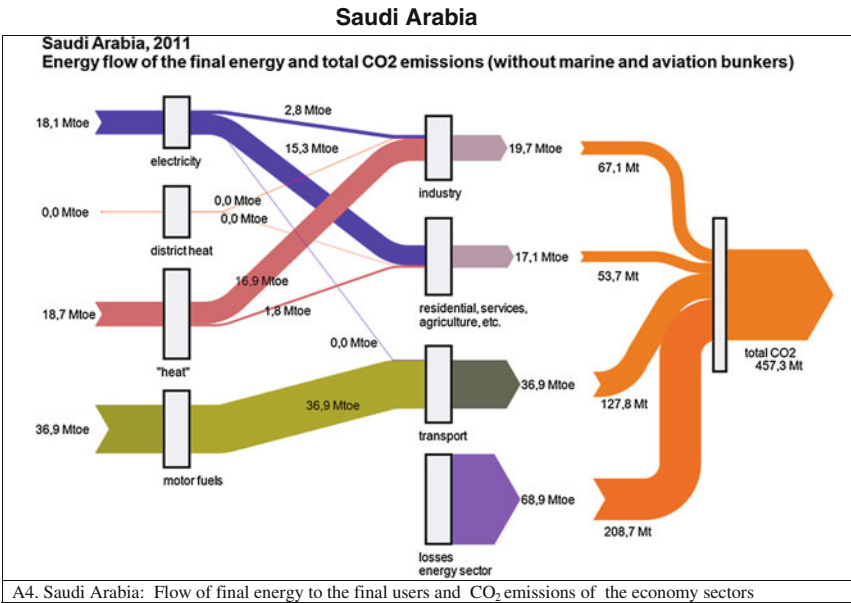
A1. Saudi Arabia: Energy flow in the energy sector from primary to final energy and total CO₂ emissions. Color of the energy carriers as in A2 and A5 (petroleum dark brown, oil products light brown)



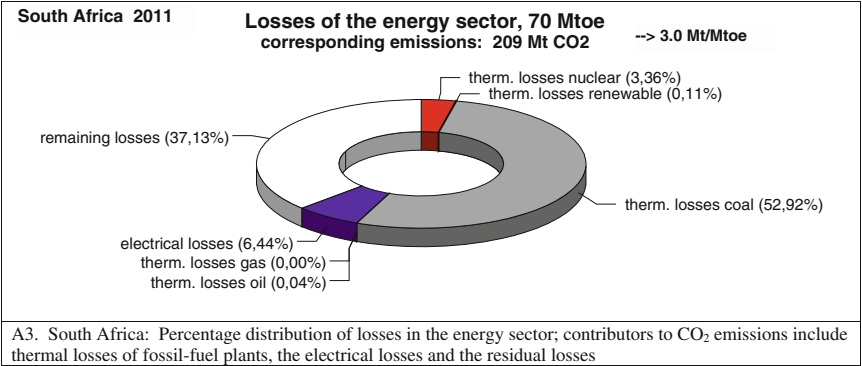
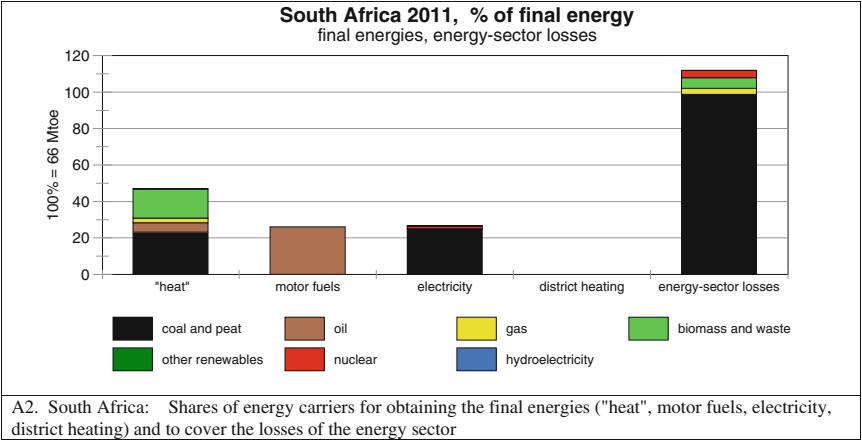
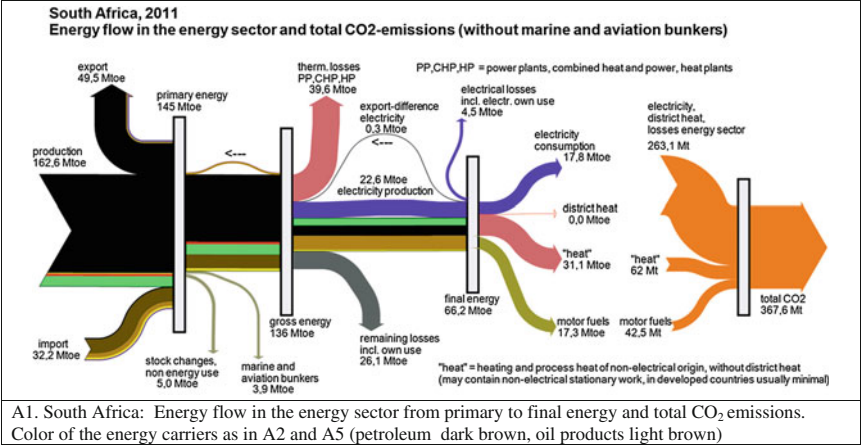
A2. Saudi Arabia: Shares of energy carriers for obtaining the final energies ("heat", motor fuels, electricity, district heating) and to cover the losses of the energy sector

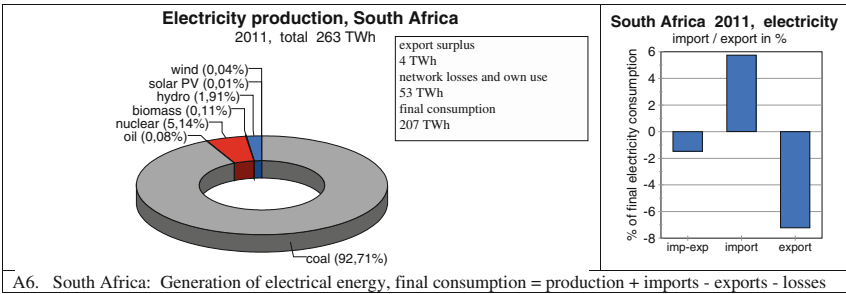
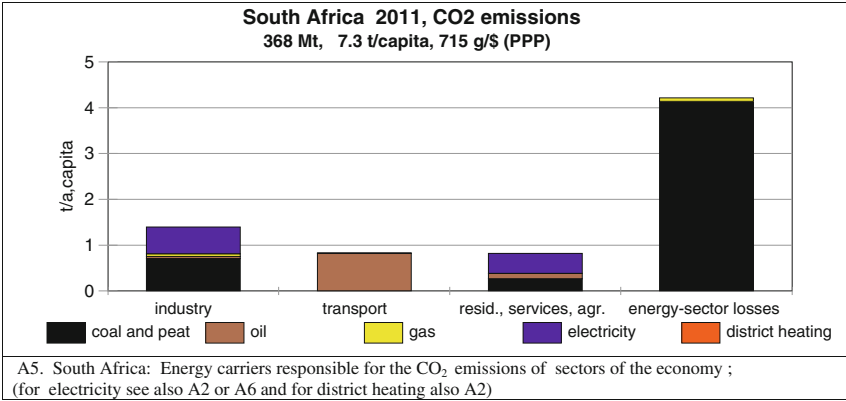
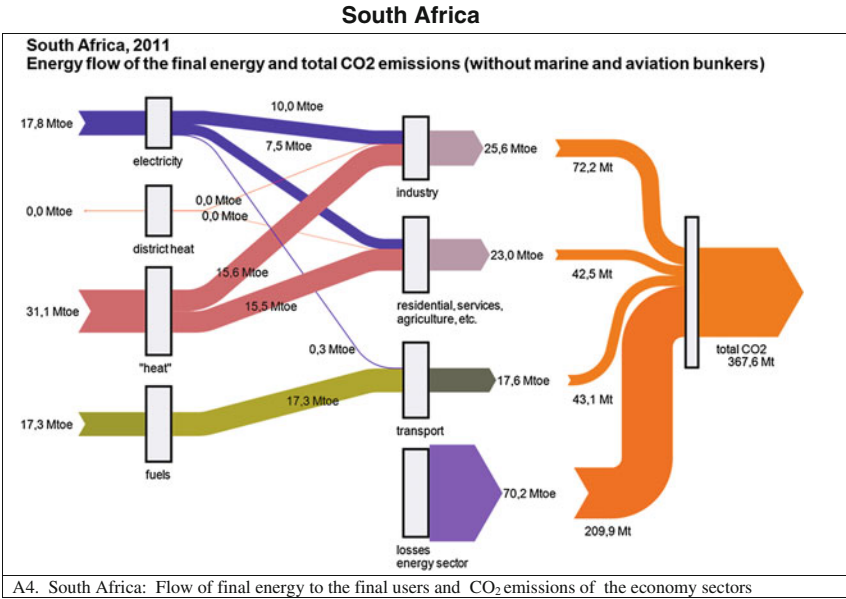


A3. Saudi Arabia: Percentage distribution of losses in the energy sector; contributors to CO₂ emissions include thermal losses of fossil-fuel plants, the electrical losses and the residual losses

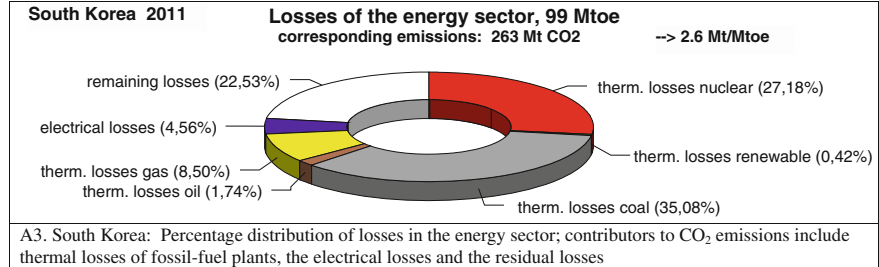
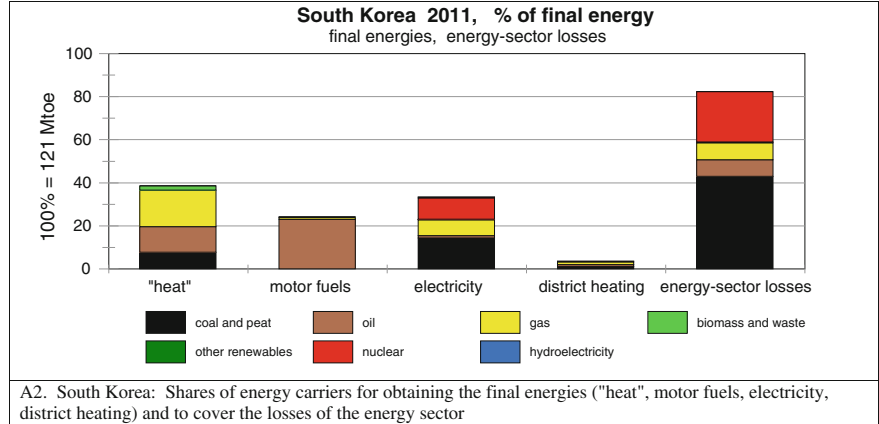
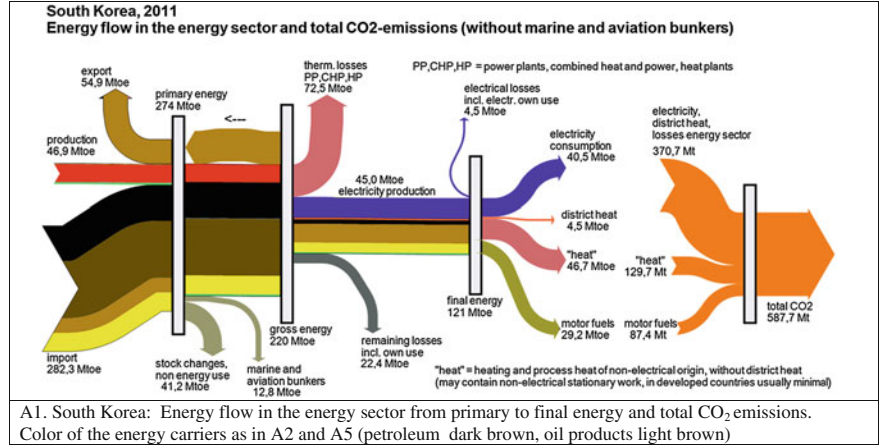


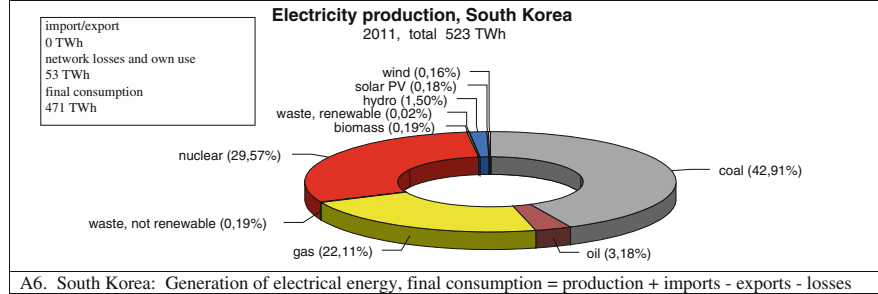
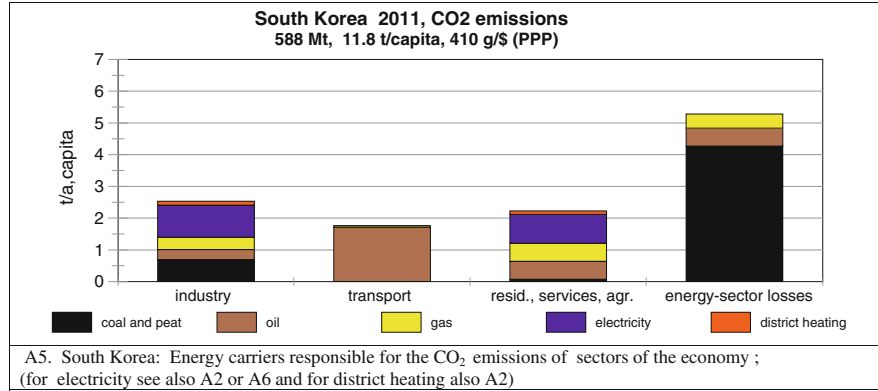
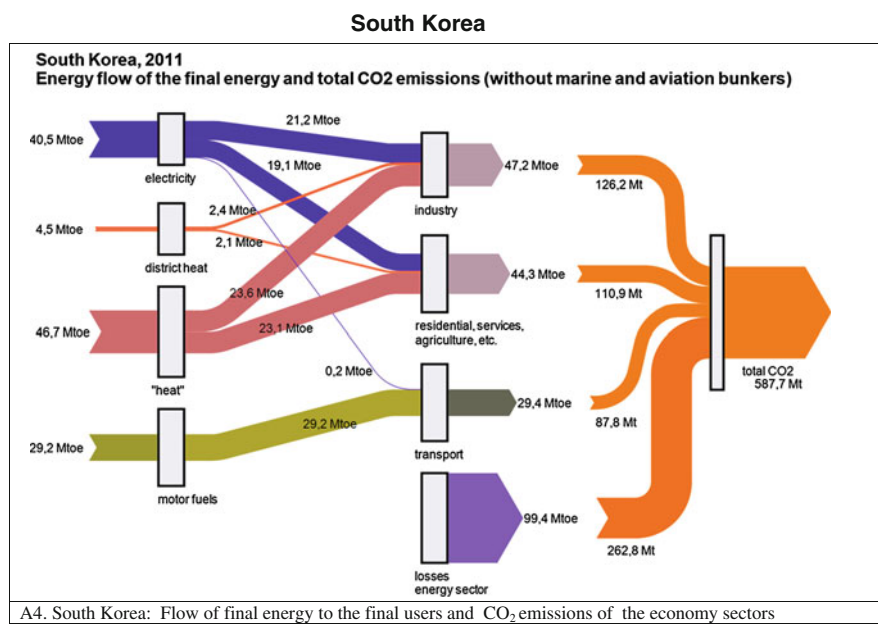
South Africa



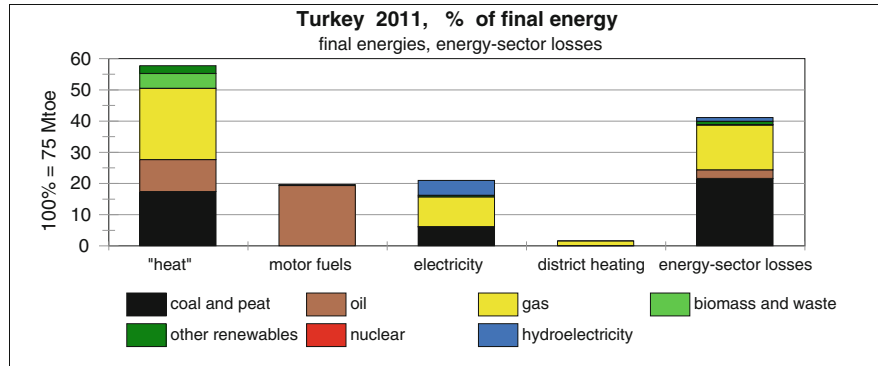
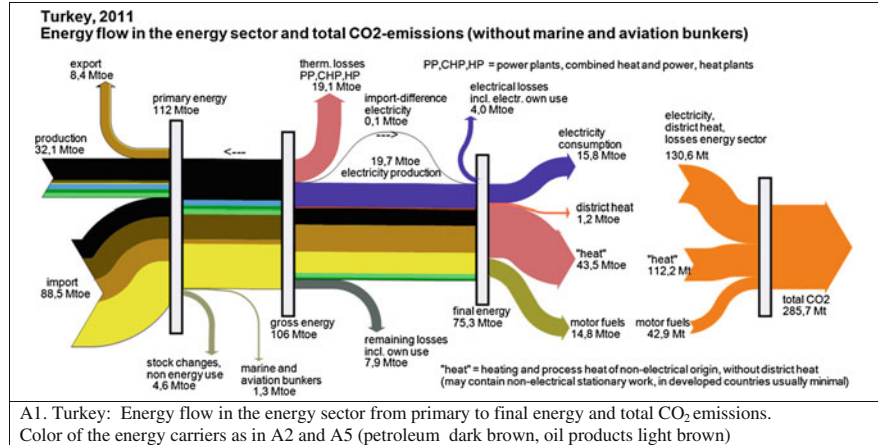


South Korea

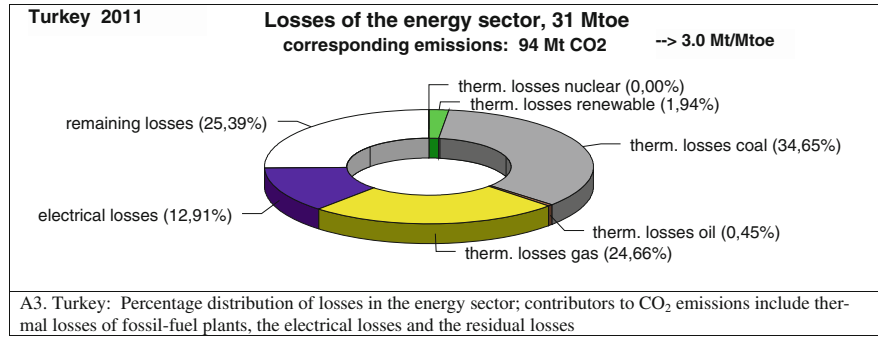


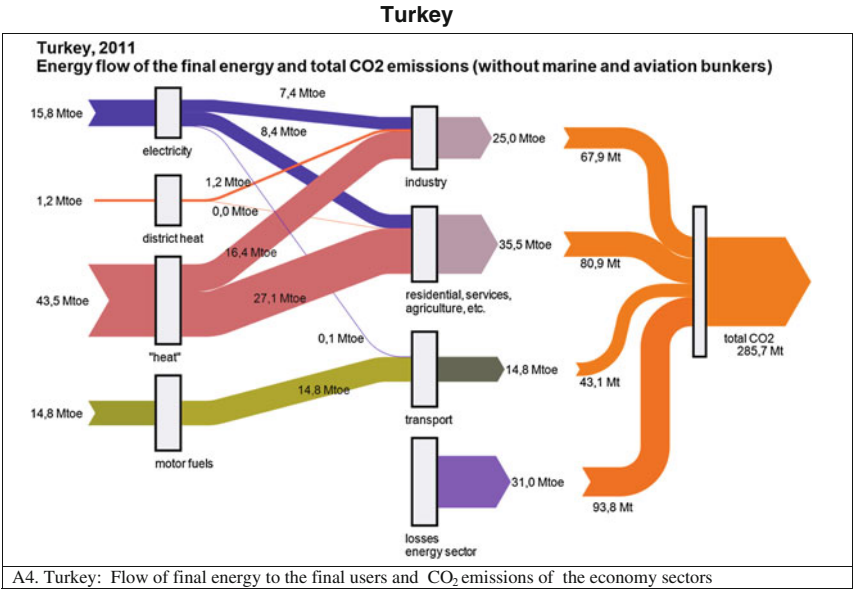


Turkey

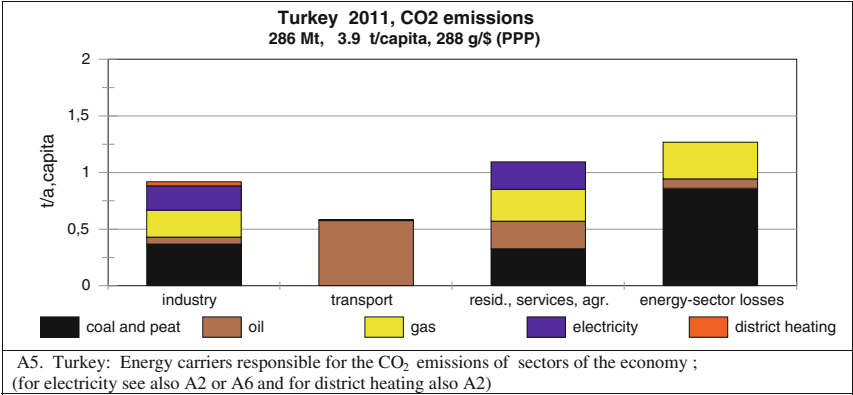


A2. Turkey: Shares of energy carriers for obtaining the final energies ("heat", motor fuels, electricity, district heating) and to cover the losses of the energy sector

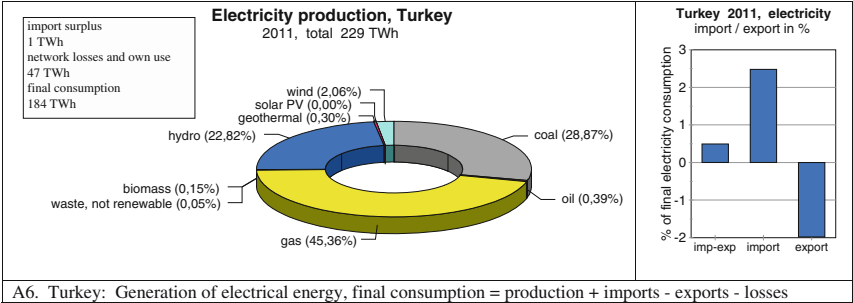




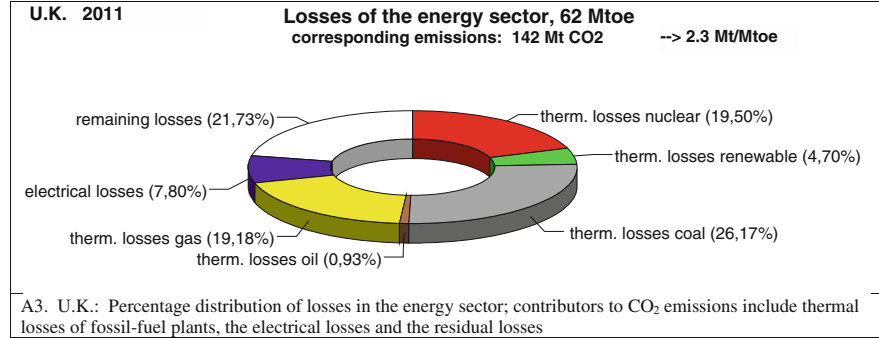
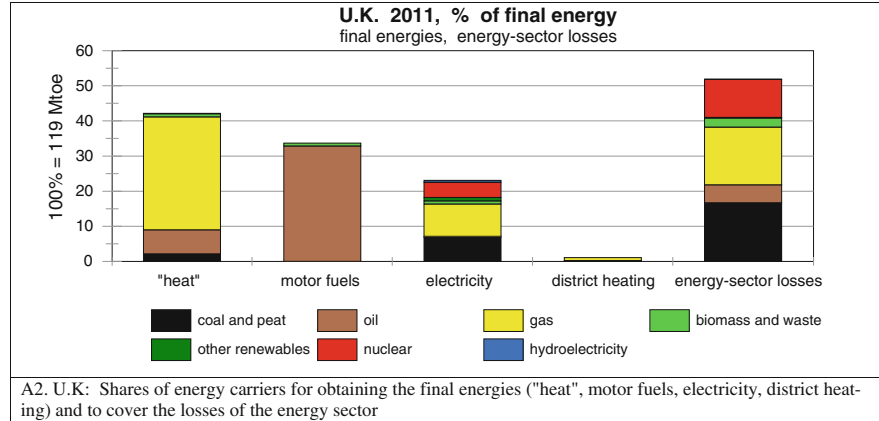
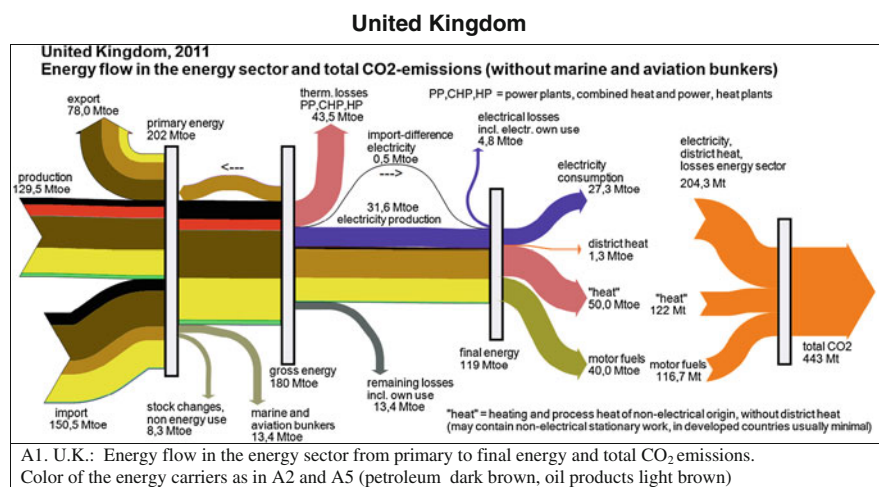
A4. Turkey: Flow of final energy to the final users and CO₂ emissions of the economy sectors

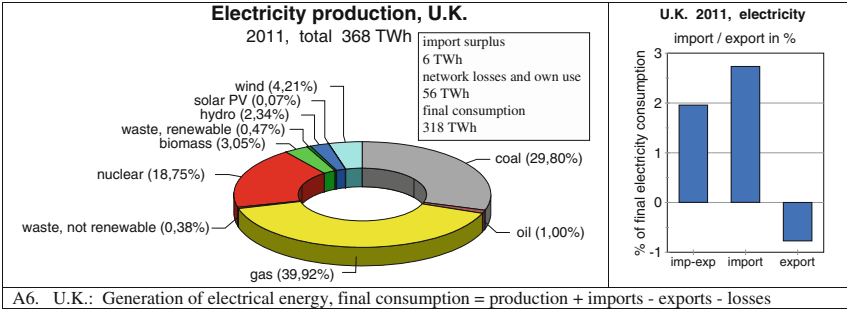
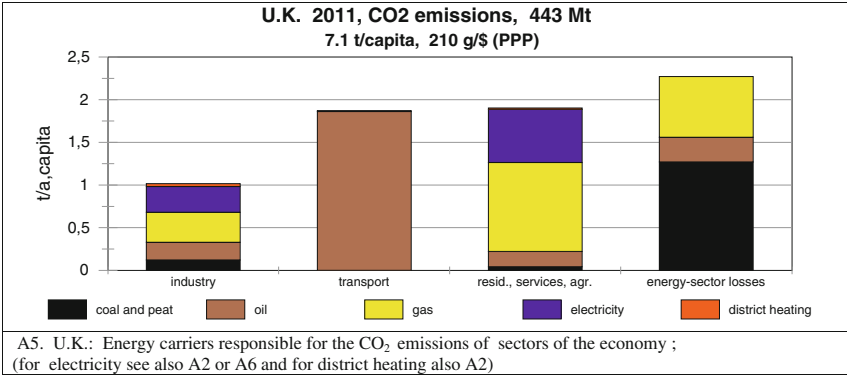
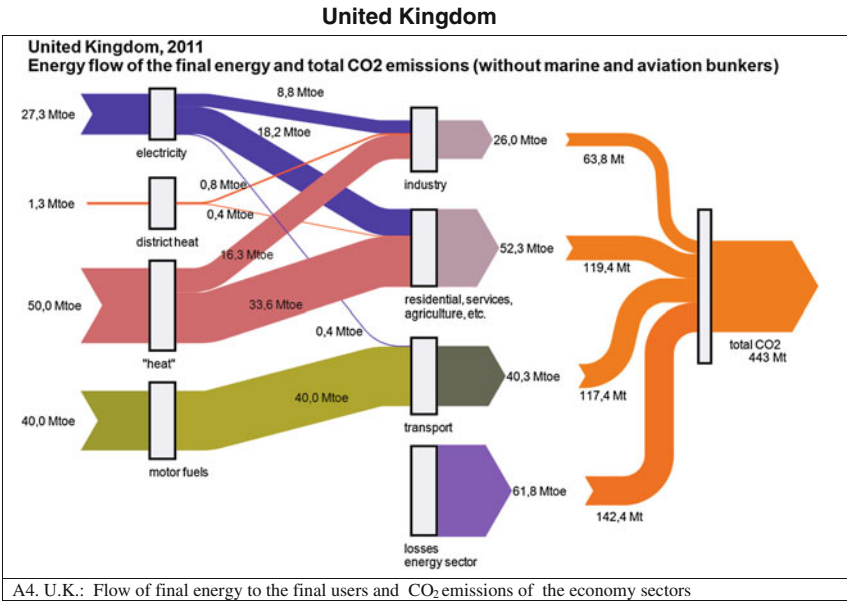


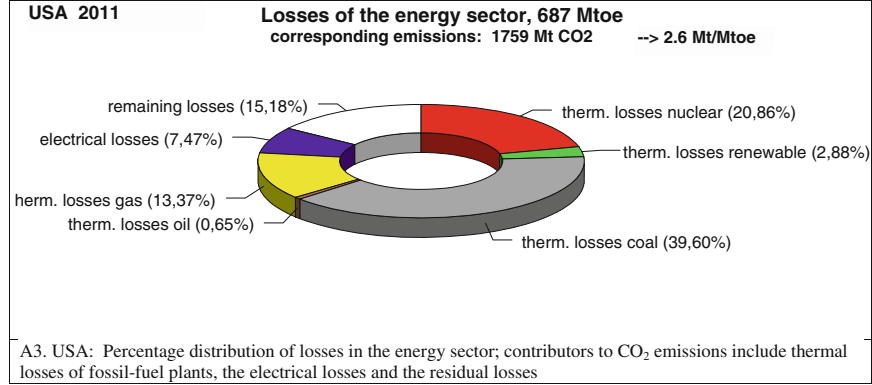
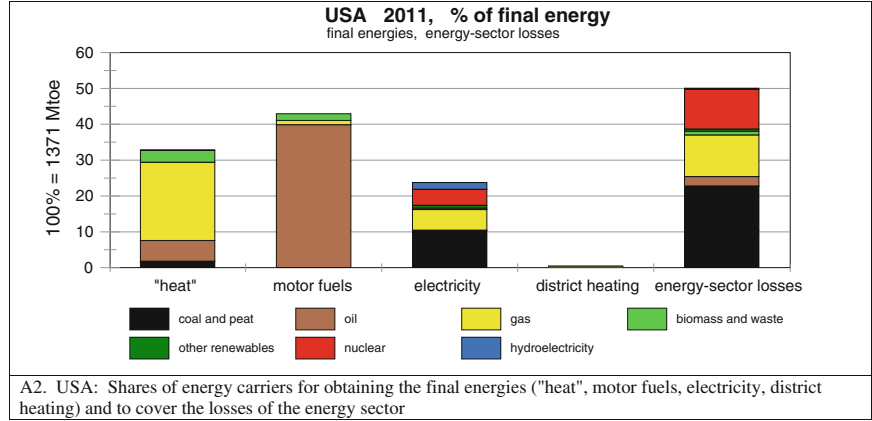
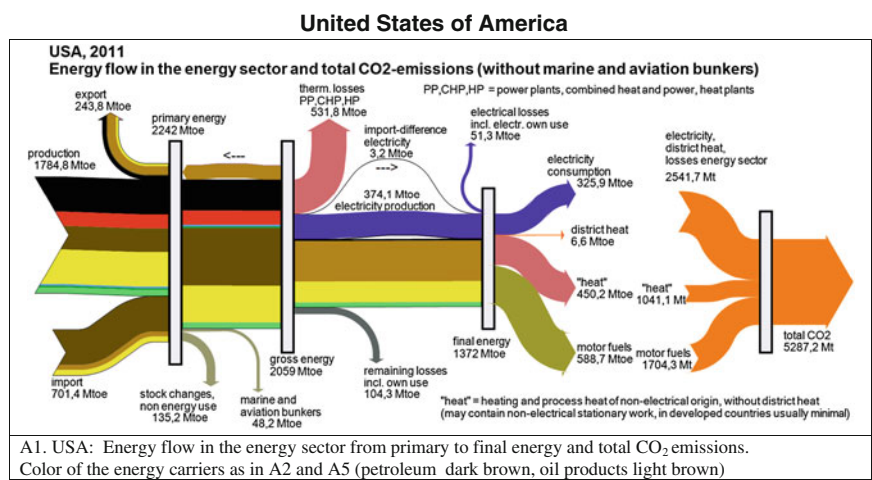
A5. Turkey: Energy carriers responsible for the CO₂ emissions of sectors of the economy ;
(for electricity see also A2 or A6 and for district heating also A2)

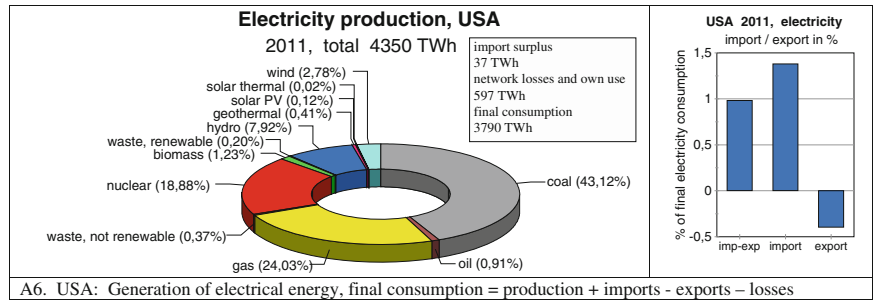
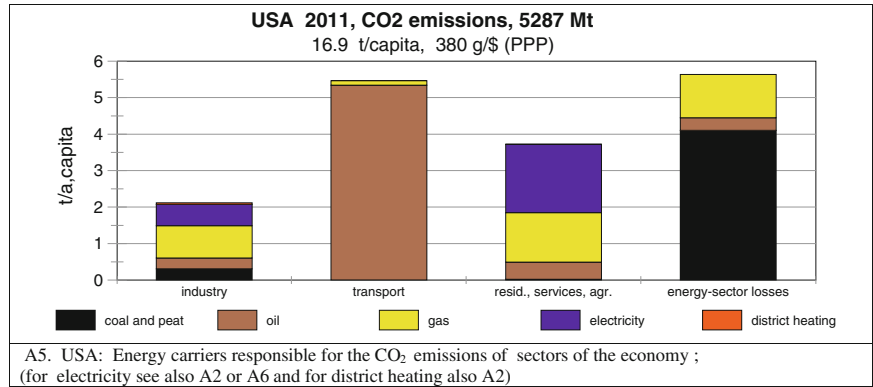
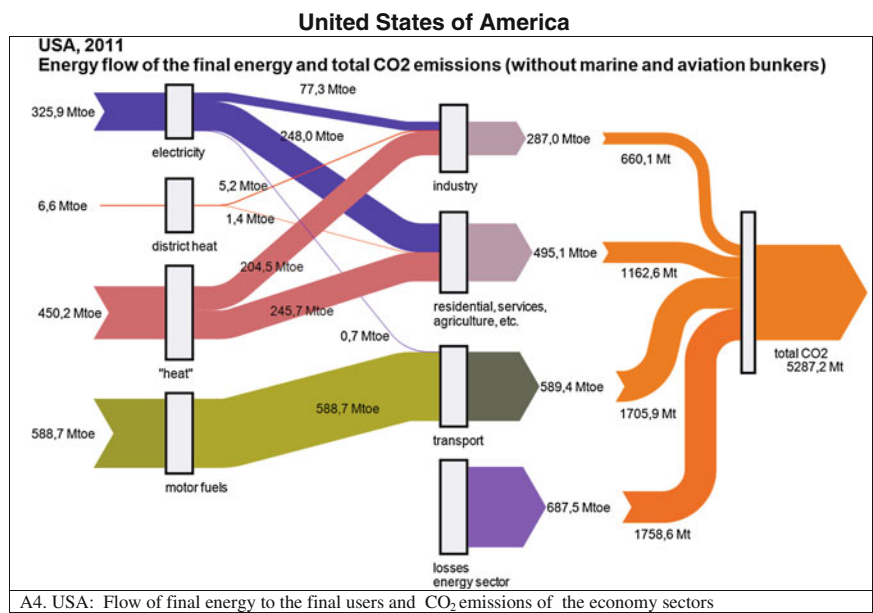


A6. Turkey: Generation of electrical energy, final consumption = production + imports - exports - losses









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