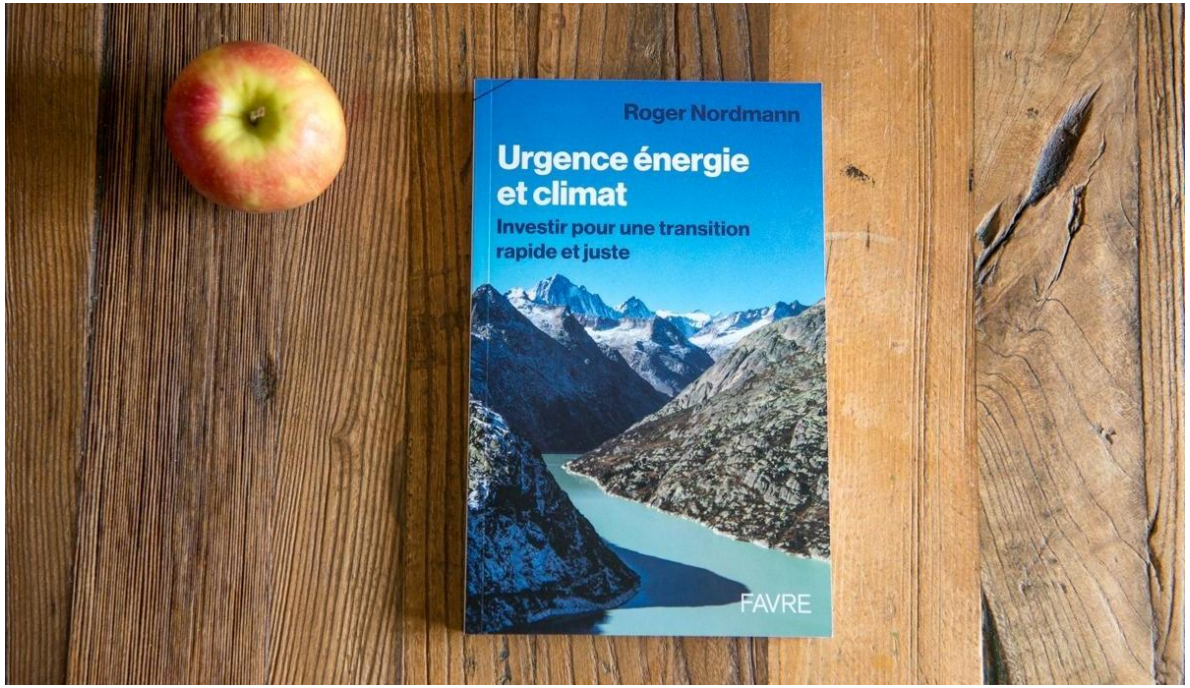
Energy supply, economics and transition course

The central role of electricity in decarbonisation

27 May 2025



Roger Nordmann, Consultant,
Chairman of the Board of Directors of Planair, member of the Board of Directors of Groupe E,
Chairman of Smartgrid-Switzerland,
former Chairman of the SP Group in the Federal Parliament

approche NORDMANN

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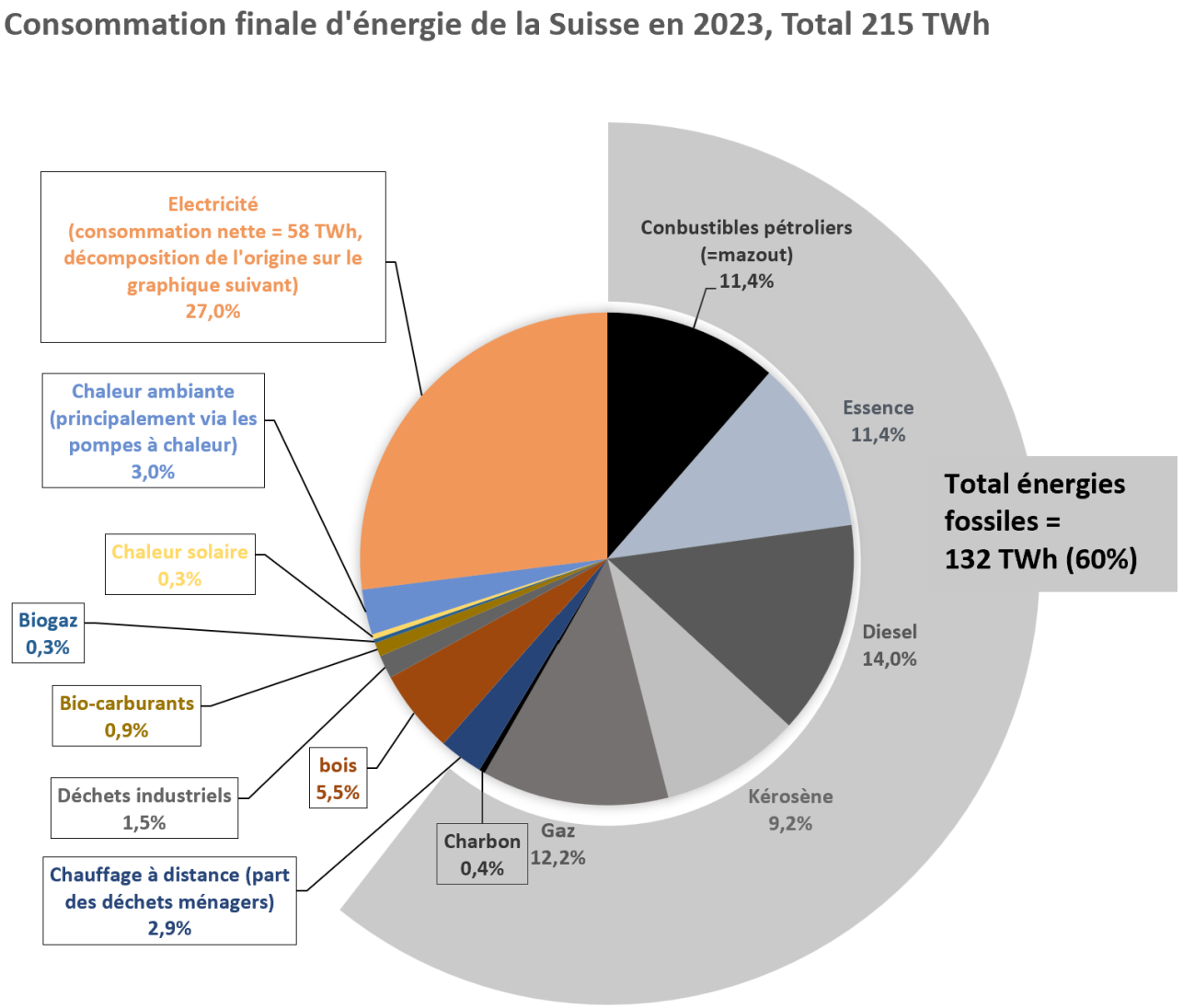
1) The starting situation



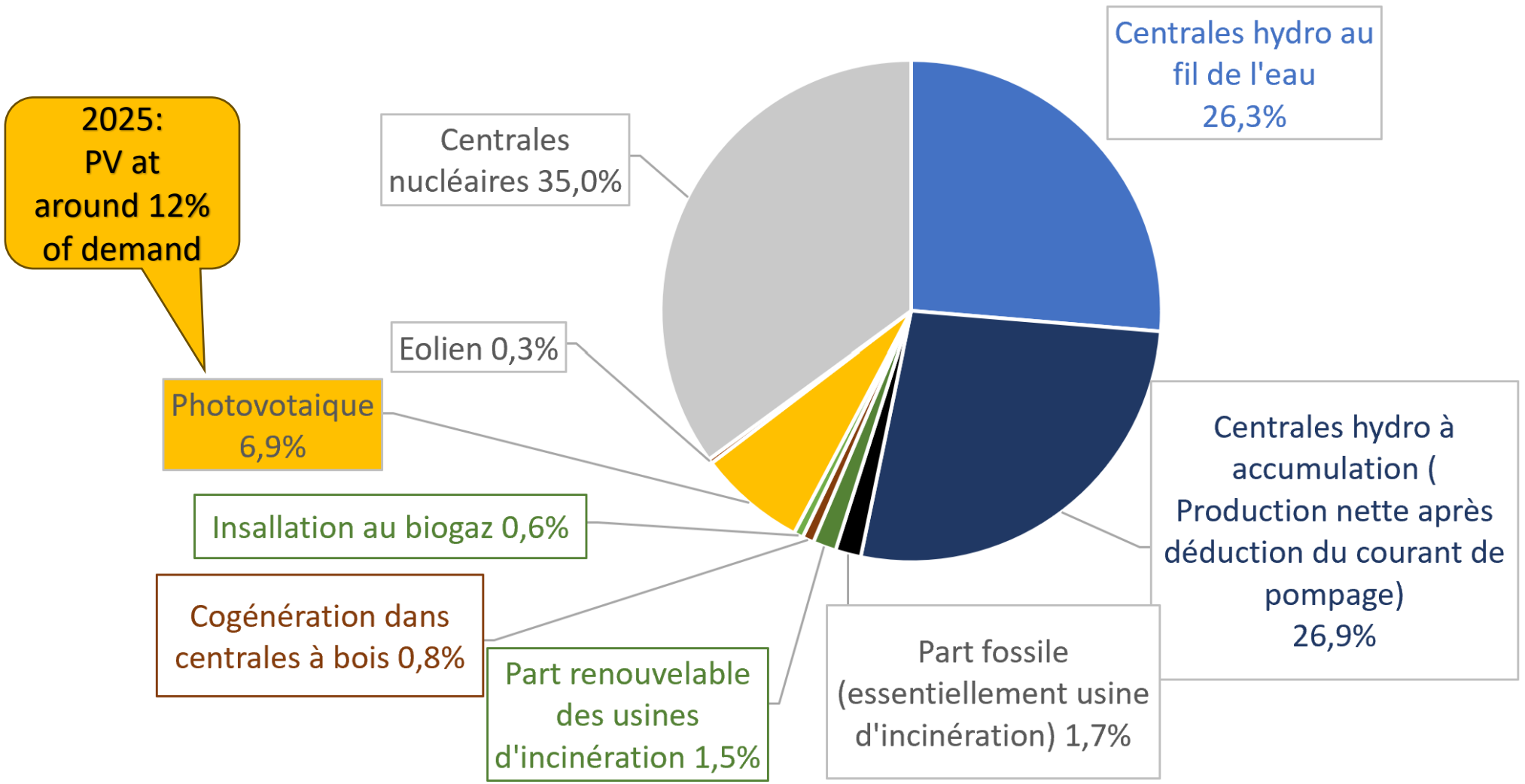
Historical maximum in 2010: 251 TWh

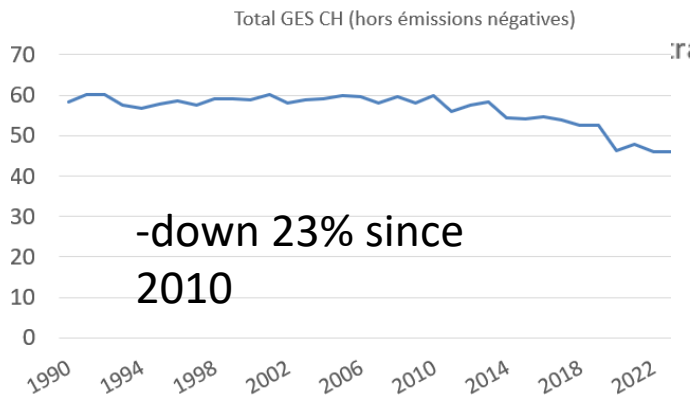
2023: 215 TWh

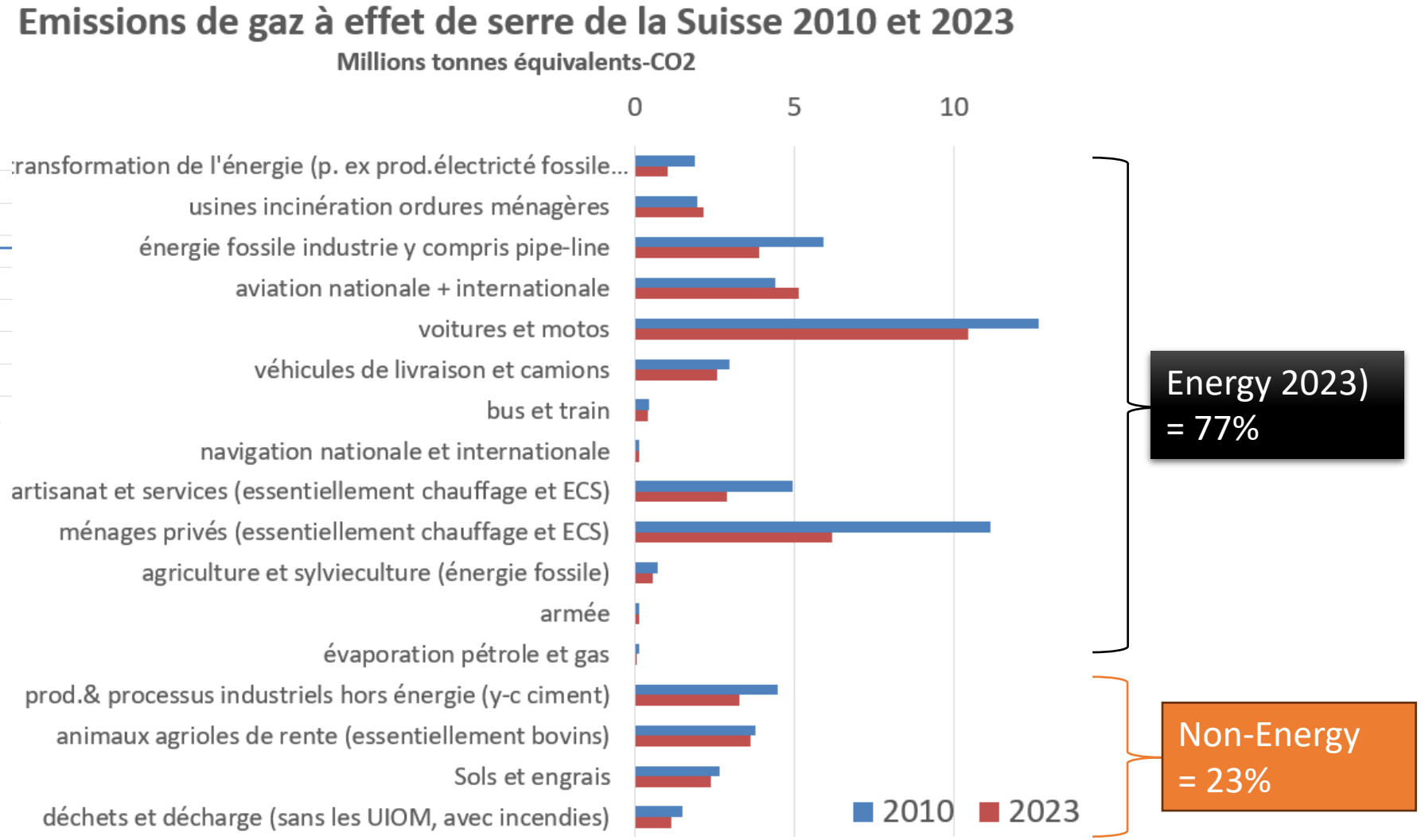
Down 14.4%.

Net electricity generation in 2023 = 66.5 TWh

(Higher than demand of 58.1 and grid losses of 4.2 TWh)



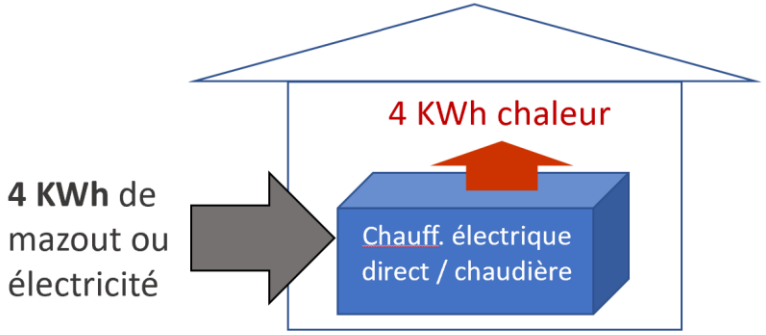

Total GES CH (hors émissions négatives)
70
60
50
40
30
20
10
0
1990
1994
1998
2002
2006
2010
2014
2018
2022
-down 23% since 2010


Emissions de gaz à effet de serre de la Suisse 2010 et 2023
Millions tonnes équivalents-CO2
0
5
10
ransformation de l'énergie (p. ex prod.électricté fossile...
usines incinération ordures ménagères
énergie fossile industrie y compris pipe-line
aviation nationale + internationale
voitures et motos
véhicules de livraison et camions
bus et train
navigation nationale et internationale
artisanat et services (essentiellement chauffage et ECS)
ménages privés (essentiellement chauffage et ECS)
agriculture et sylvieculture (énergie fossile)
armée
évaporation pétrole et gas
prod.& processus industriels hors énergie (y-c ciment)
animaux agrioles de rente (essentiellement bovins)
Sols et engrais
déchets et décharge (sans les UIOM, avec incendies)
2010
2023
Energy 2023) = 77%
Non-Energy = 23%

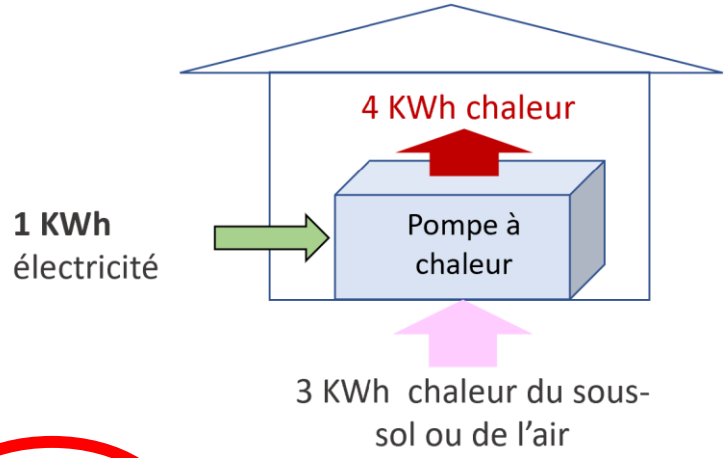
2. The classics: housing and mobility

Chauffage d'une maison

Conventionnel



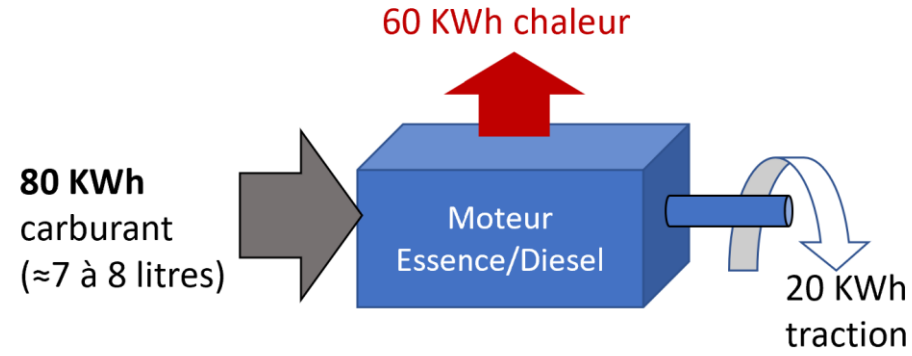
Pompe à chaleur



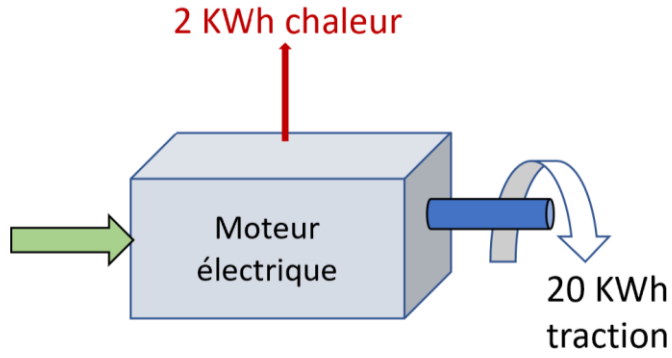
+ 6 TWh electricity consumption, mainly in winter (also insulation and non-electric heat)

100 Km en voiture

Avec une voiture fossile



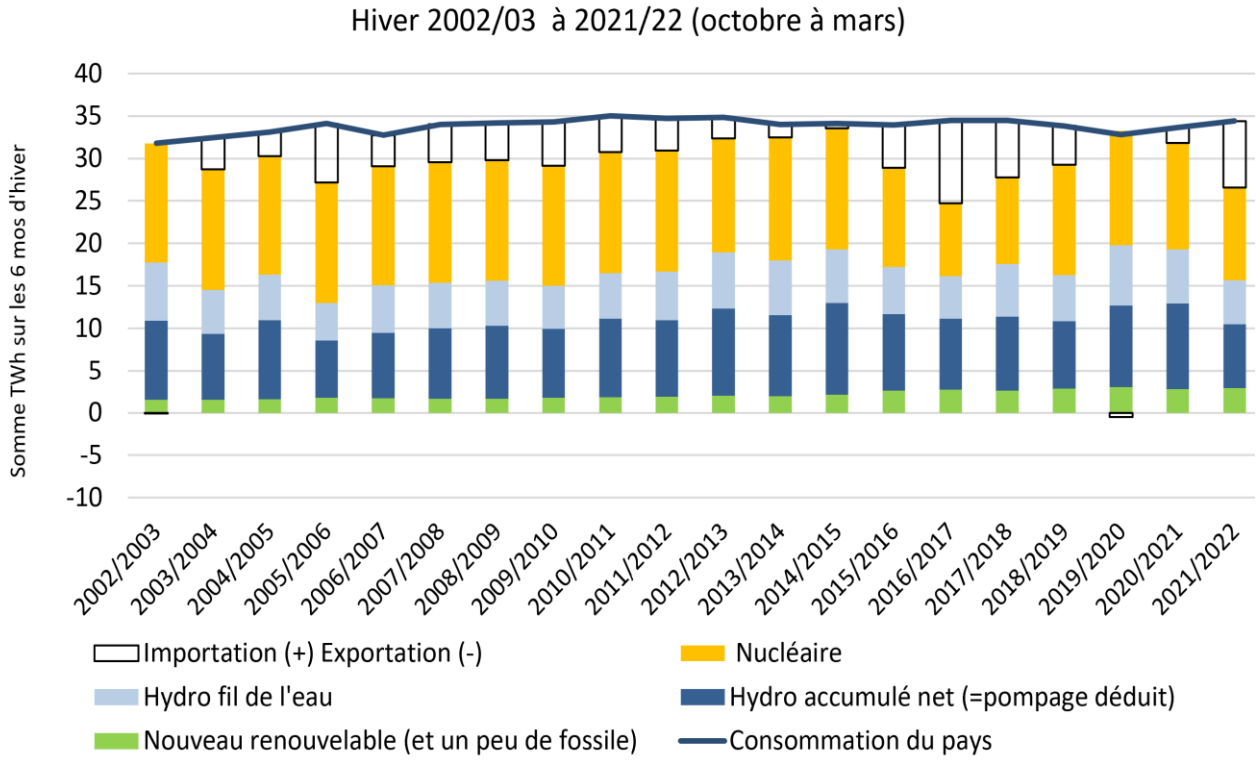
Avec une voiture électrique

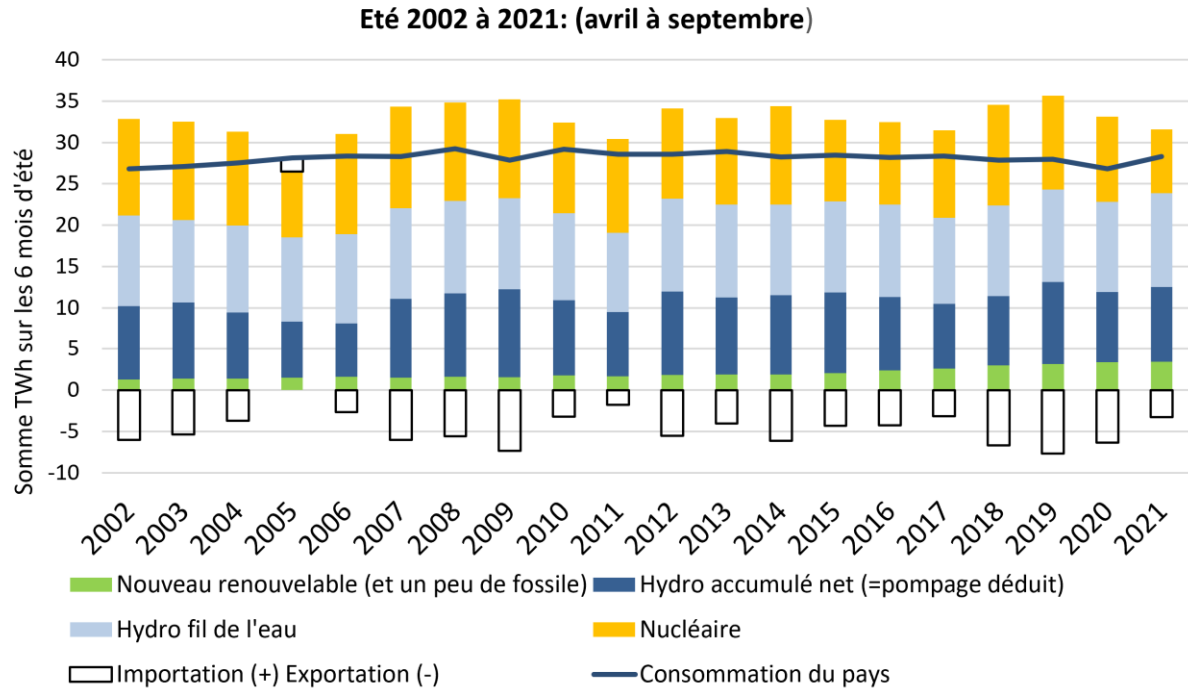


+ 17 TWh electricity consumption (evenly spread)

And replace around 20 TWh of aging nuclear power

3. Electricity: the current situation in winter and summer





The challenge of winter electricity supply

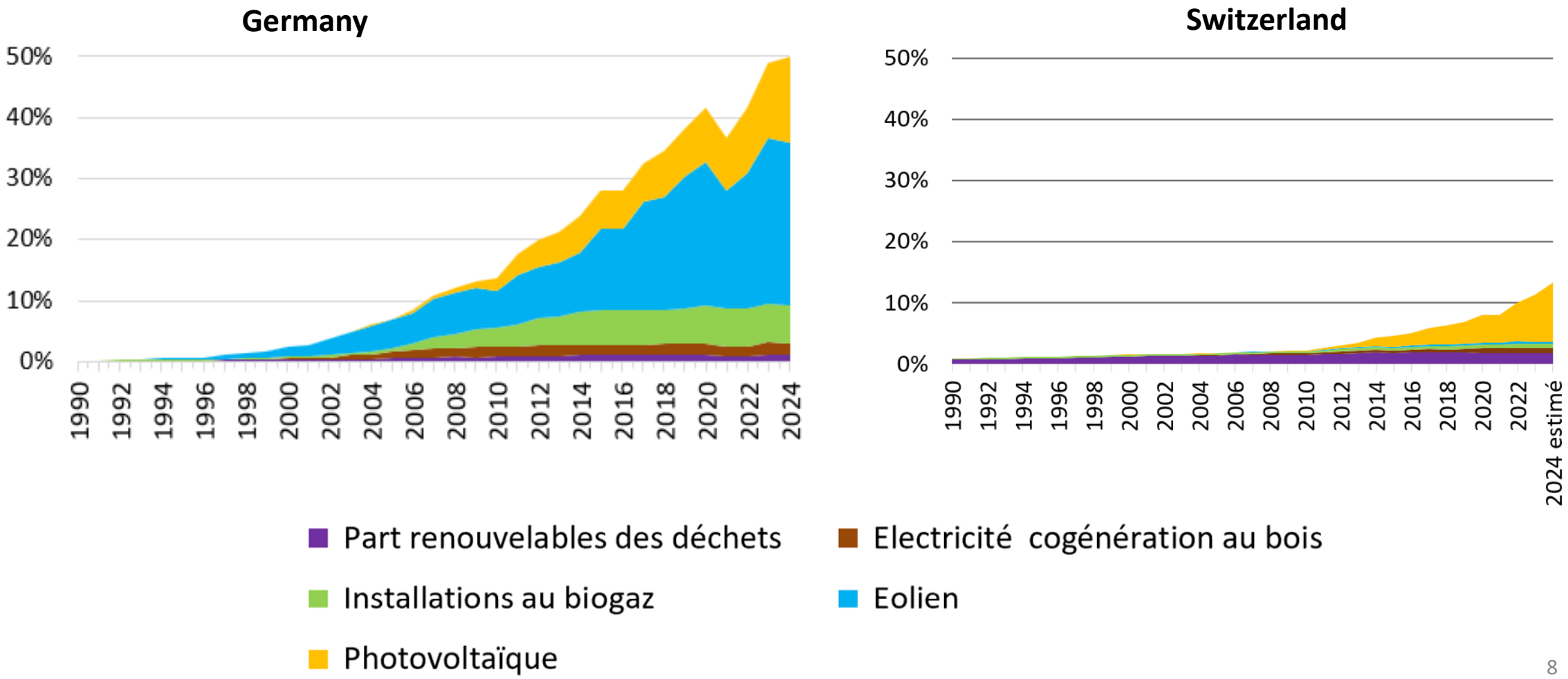
OK at present, but will become critical when the nuclear power stations are shut down due to age.

For climate neutrality (excluding aviation):

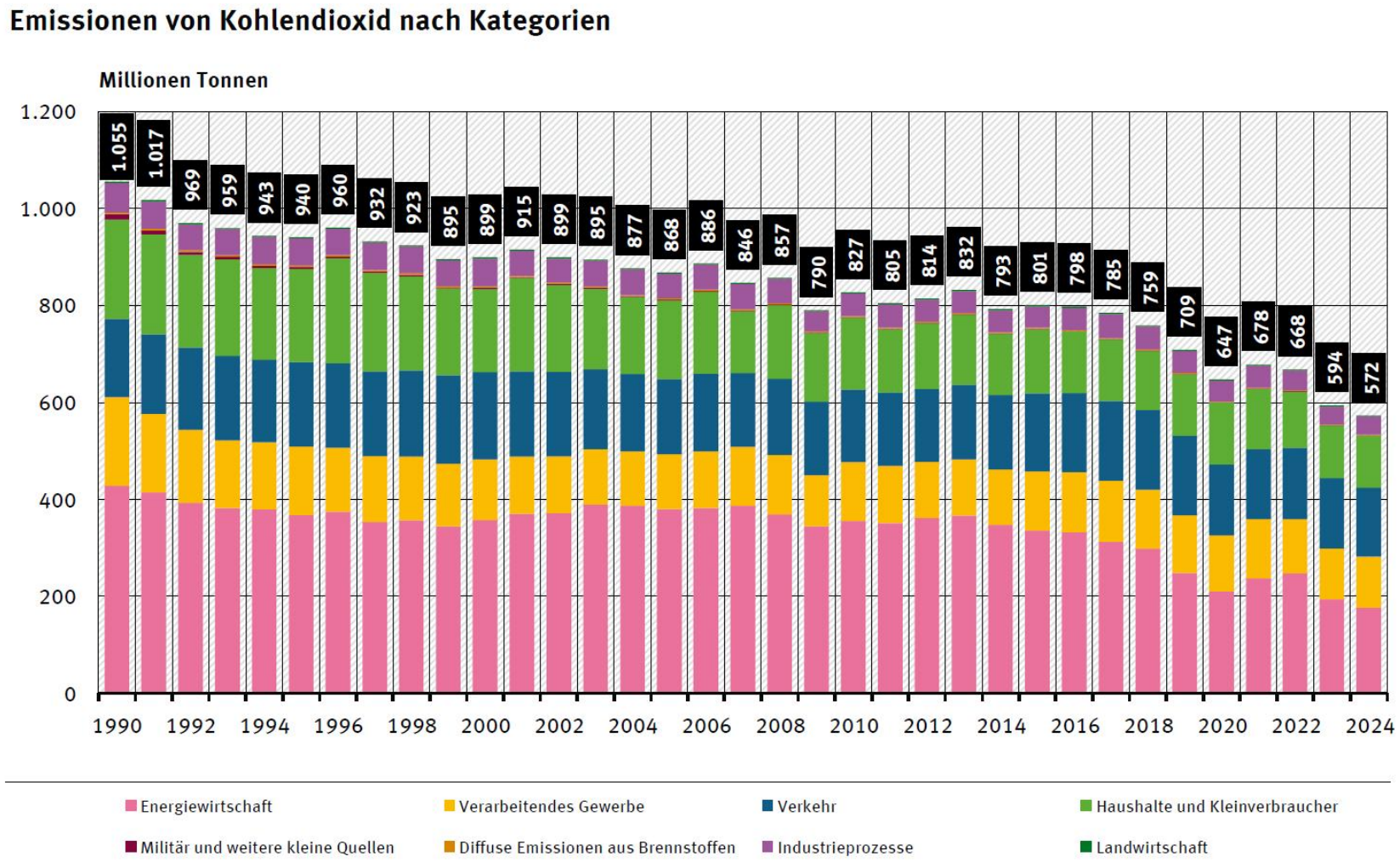
20 TWh to replace declining nuclear power
+ 6 TWh per year, mainly in winter, for heating.
+ 17 TWh per year for mobility (spread evenly)
+ Decarbonising industry
+ No use of fossil fuels in winter to generate electricity
= Huge challenge → invest massively

Development of electricity production from new renewable energies as a % of gross consumption

(hydro, also renewable, not included)



Excursus: Germany's CO2 emissions



All (excluding aviation)

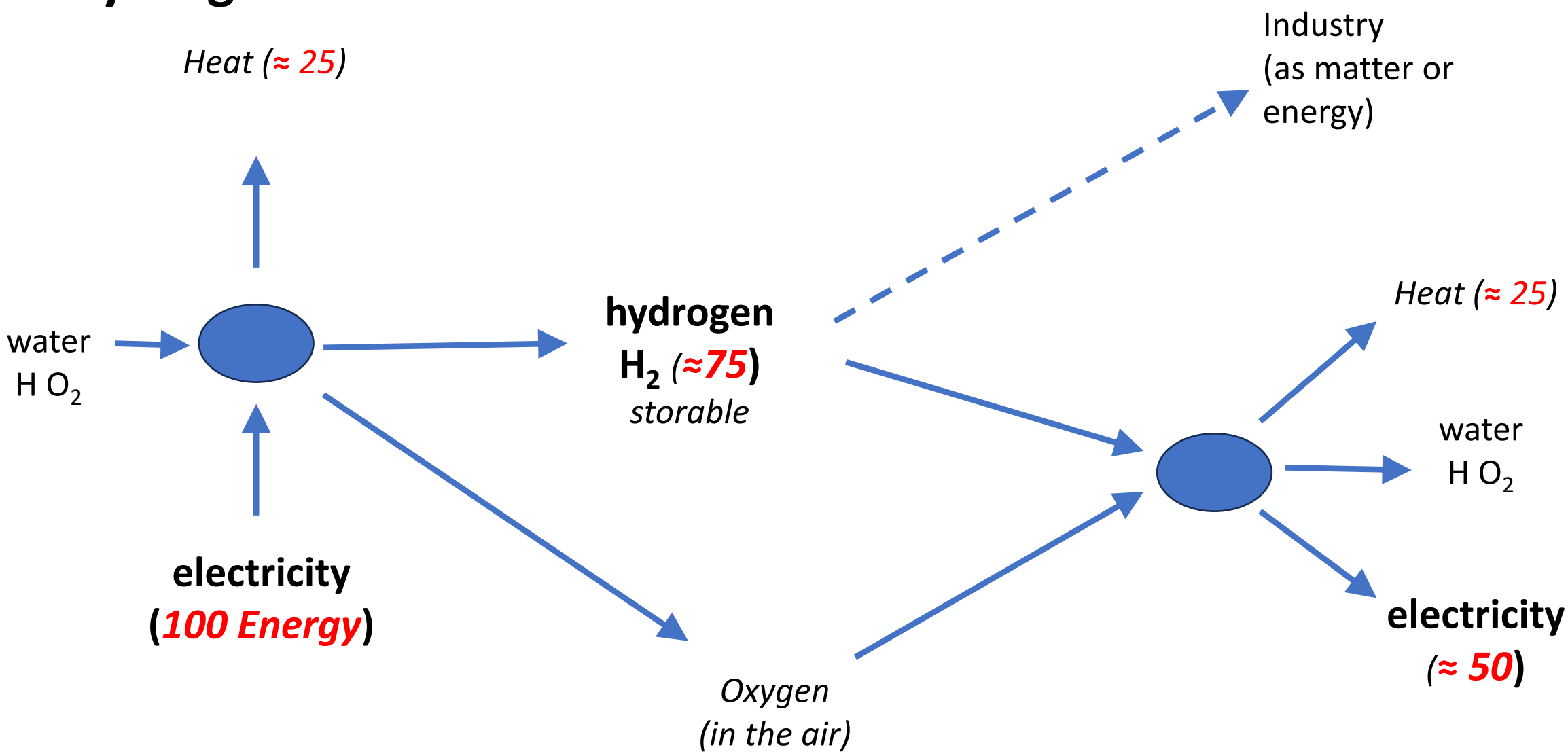
DE: -46% (1990-2024)
CH: -28% (1990-2022)

Pink: CO emissions$_2$ energy sector
= **Mainly electricity, gas and coal production**

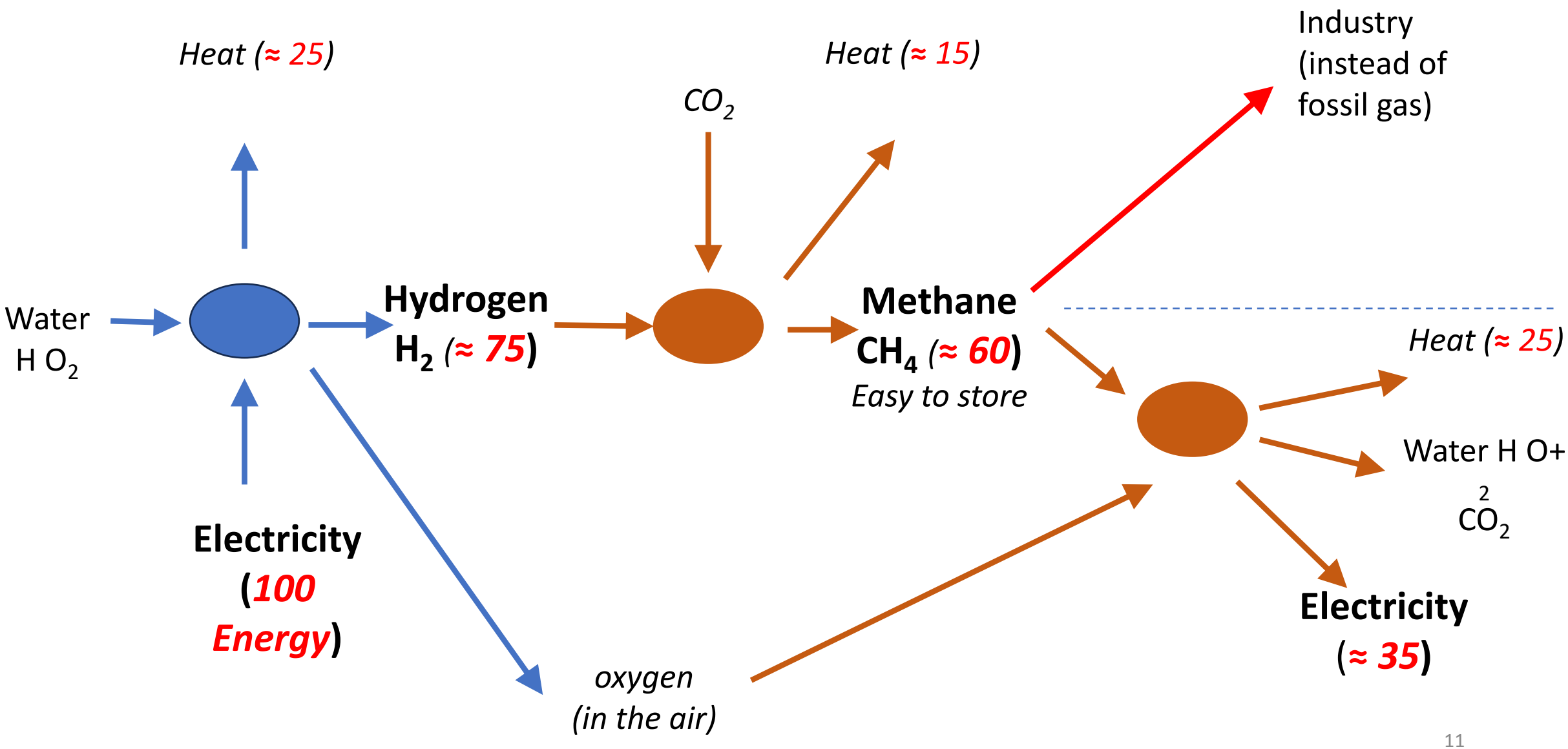
Source: https://www.umweltbundesamt.de/daten/klima/treibhausgas-emissionen-in-deutschland/kohlendioxid-emissionen#herkunft-und-minderung-von-kohlendioxid-emissionen

4 Excursus: hydrogen and synthetic methane

Hydrogen



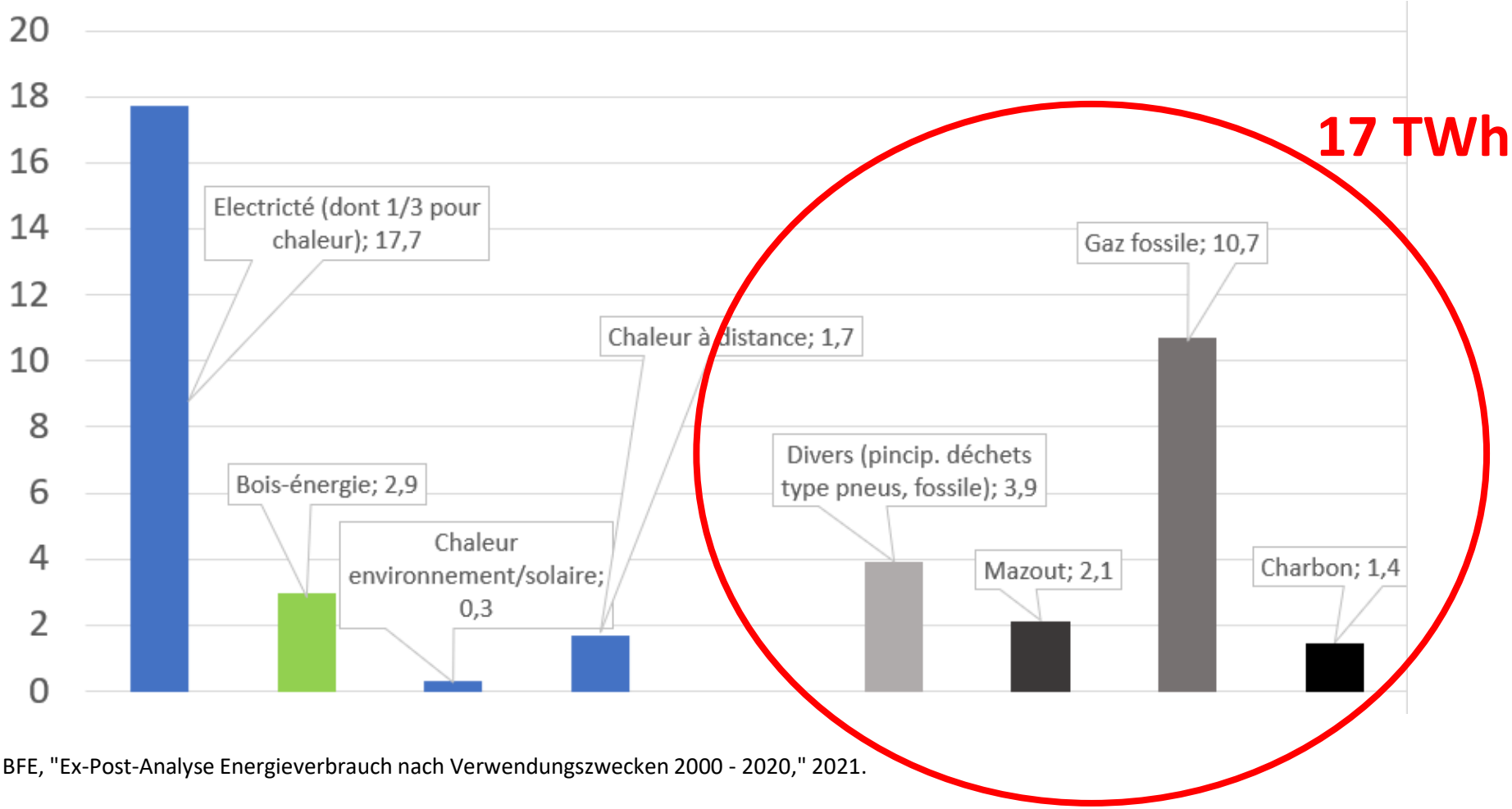
Synthetic methane (chemically equivalent to "natural" fossil gas)



5. Synergy between industry and winter electricity supply

Energy use in Swiss industry in 2019

(excluding fuels, which are included in transport).



Source: BFE, "Ex-Post-Analyse Energieverbrauch nach Verwendungszwecken 2000 - 2020," 2021.

Figure 23. Utilisation d'énergie pour la production de chaleur dans l'industrie selon le niveau de température (procédés et bâtiments)

Tous usages, sources renouvelables et non renouvelables	TWh	Part
Chauffage, eau chaude et chaleur des procédés jusqu'à 100°	9,0	31,0 %
100-200 °C	3,3	11,4 %
200-400 °C	1,6	5,5 %
400-800 °C	8,9	30,5 %
800-1200 °C	4,4	15,3 %
>1 200 °C	1,8	6,3 %
Total	29,2	100,0 %

Source des données du calcul : [45]

Hydrogen enables synergy between industry and winter electricity supply

If we treat the problems separately

Industry:

To replace 17 TWh Fossil → 17 TWh Syngas produced in summer → 34 TWh electricity *(because of 50% conversion losses during syngas production).*

Winter electricity shortfall:
(with decarbonised land transport and buildings, 50 GW PV):

Shortfall = 10 TWh → 20 TWh Syngas produced in summer *(due to new 50% conversion losses Syngas → electricity)*
→ 40 TWh electricity

Total = 74 TWh electricity in summer to produce syngas+ and storage of 37 TWh Syngas.

= monstrous quantity! Unrealistic

By exploiting synergies and efficiency

Winter electricity: harvest enough electricity directly in winter to rarely need to use syngas for power generation

Syngas

Summer production for winter:

Mainly for industry, to avoid conversion losses into electricity

Rest of summer electricity surplus:

Direct consumption in industry + just-in-time syngas for industry

What is the strategy for replacing the 17 TWh of fossil fuels used by industry (including tyres)?

Maximum efficiency strategy.

All year	**Heat in industry for heating, processes up to 100°: 5 TWh**, half of which for processes (constant over the year) and the other half for heating (mainly in winter)	High-temperature heat pumps, mainly in winter. Heat pumps consume **2.5 TWh** →Davantage electricity, 2/3 of which in winter
Sum-mer half-year	**1ère Half of the heat > 100° of fossil origin in industry**, summer half-year **3 TWh**	Direct use of electricity to produce heat > 100° : **3 TWh** (hybrid electric & gas installation! No efficiency gains because no heat pump!) →Davantage electricity during the summer
	2nd half of heat > 100° of fossil origin in industry, summer half-year: 3 TWh (Where electricity is not feasible)	Use of 3 TWh of syngas, which requires **5 TWh** of electricity to produce it, no seasonal storage. →Davantage electricity during the summer
Winter Half year	**Replacement of 6 TWh of industrial heat > 100° during the winter half-year.**	Use of 6 TWh of renewable syngas to be produced during the summer and stored for the winter. Requires **12 TWh** during the summer →Davantage electricity during the summer

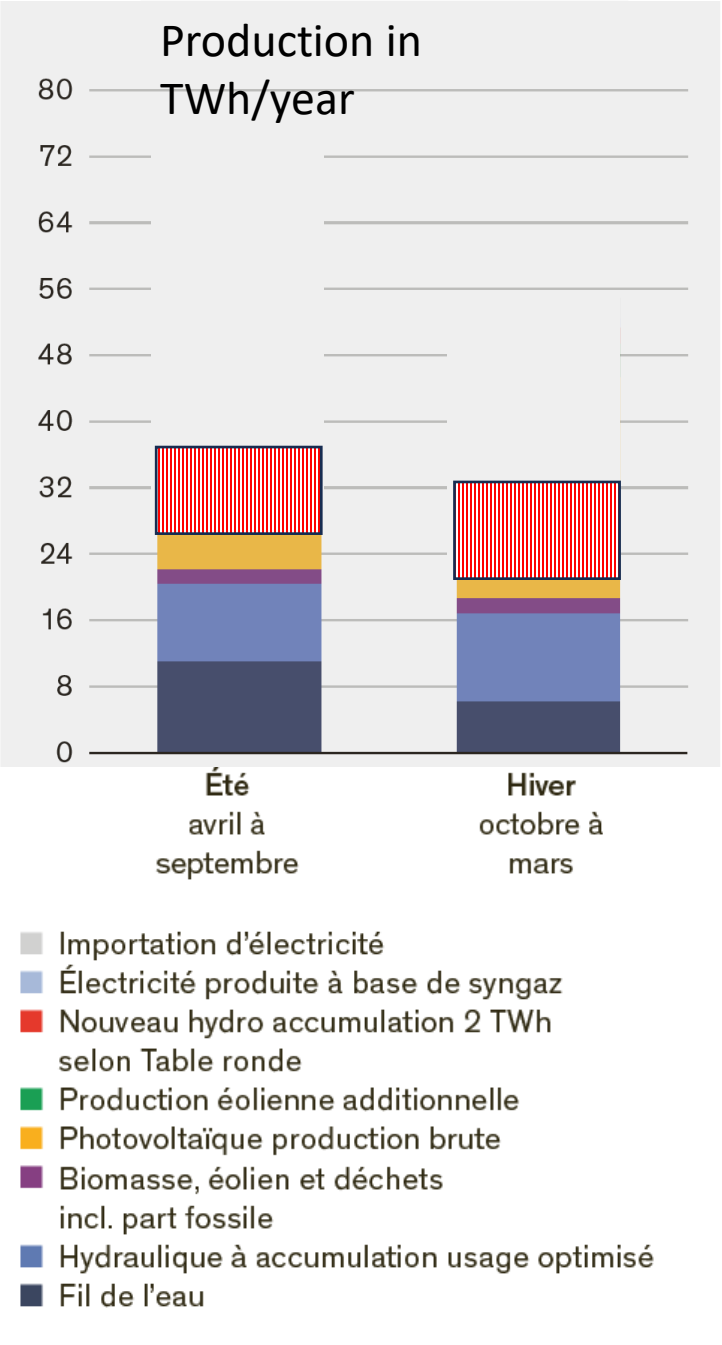
Sum= 22 TWh, uppermostly in summer half year

6. The electricity generation mix we need

- Existing hydropower
- Existing biomass
- 4 GW wind power (1000 machines) → 6 TWh, including 4 in winter
- 15 "Round Table" projects: 2 TWh of additional hydro storage
- A total of 72 GW Photovoltaic → 76 TWh (9 x more than today).

  - Currently: **9 % of roof potential is used for PV, for around 8** GW
    (source: https://www.uvek-gis.admin.ch/BFE/storymaps/DO_Energiereporter/)

The average situation during the summer and winter semesters



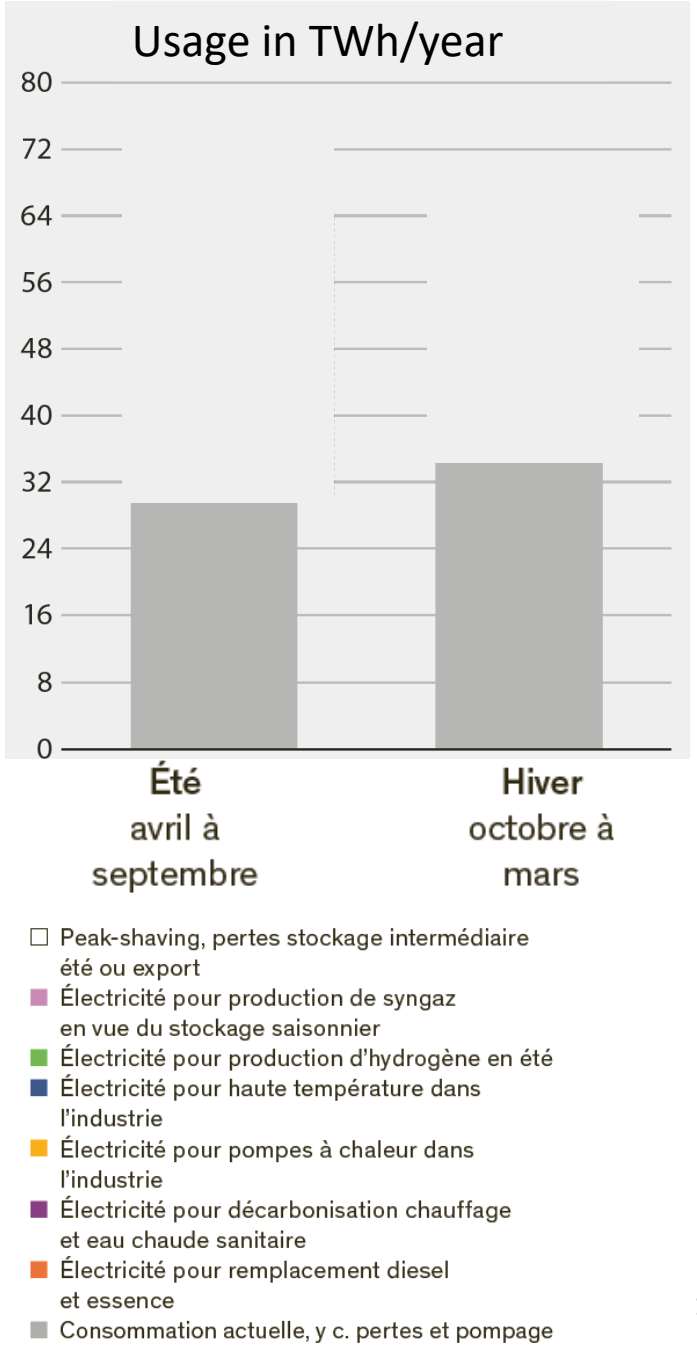
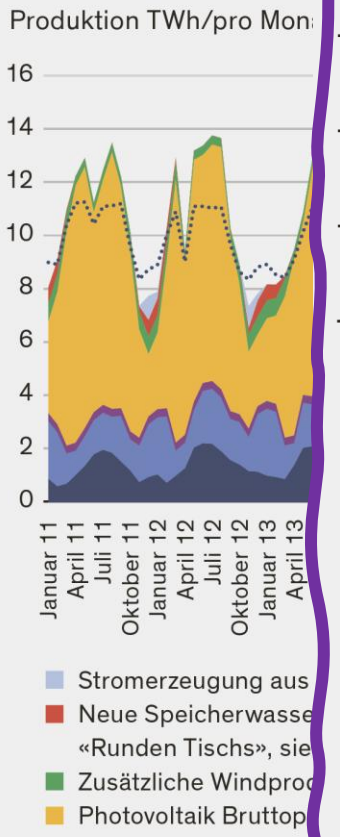
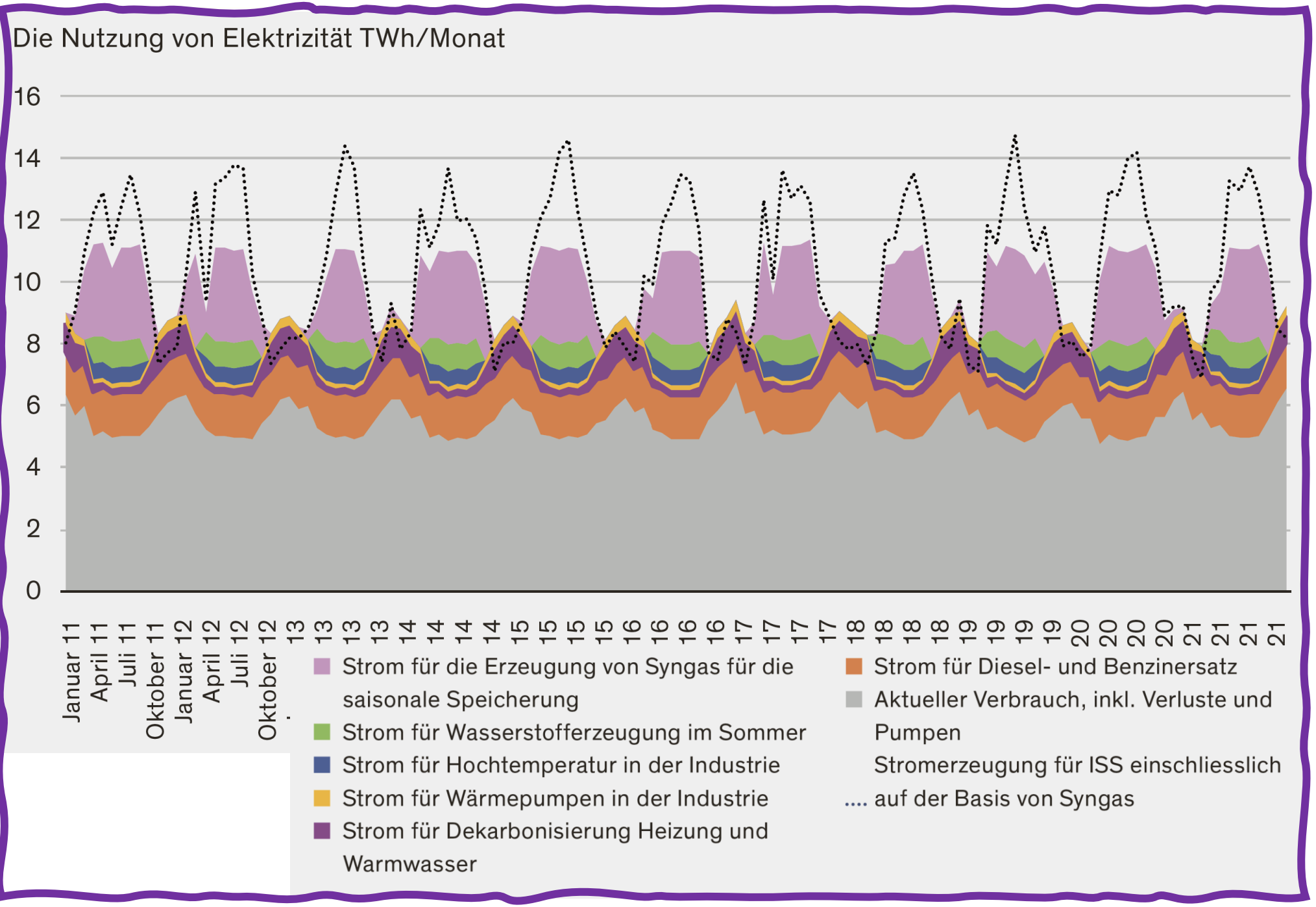
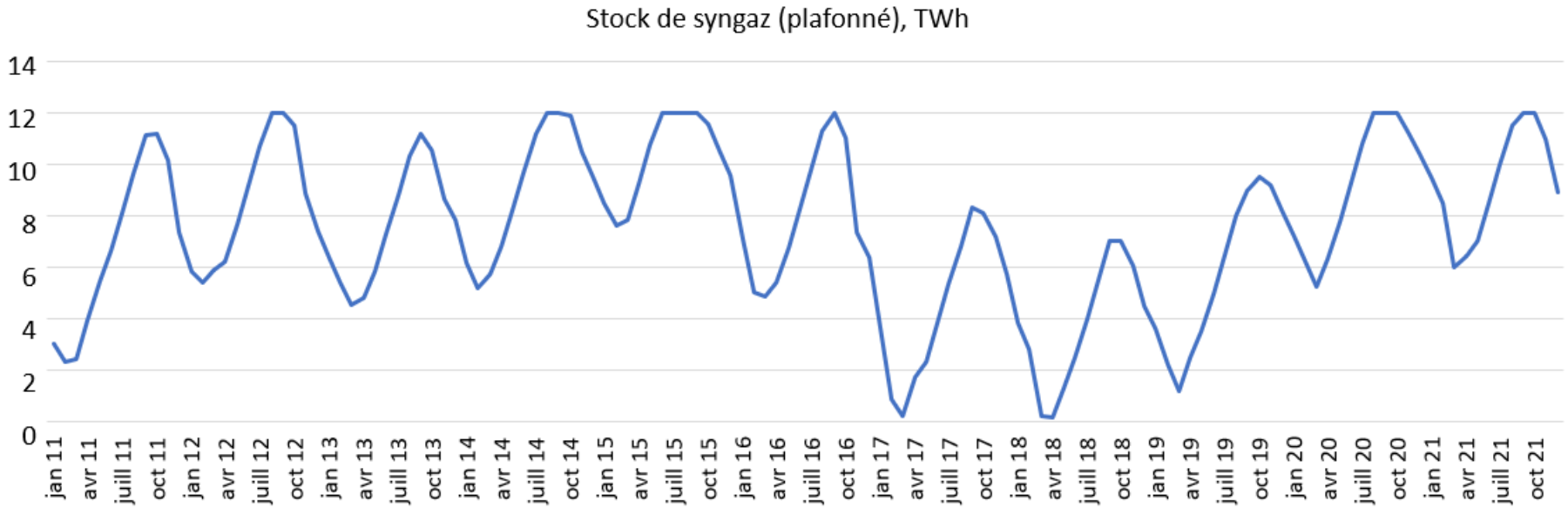


Abbildung 44: Die Stromer





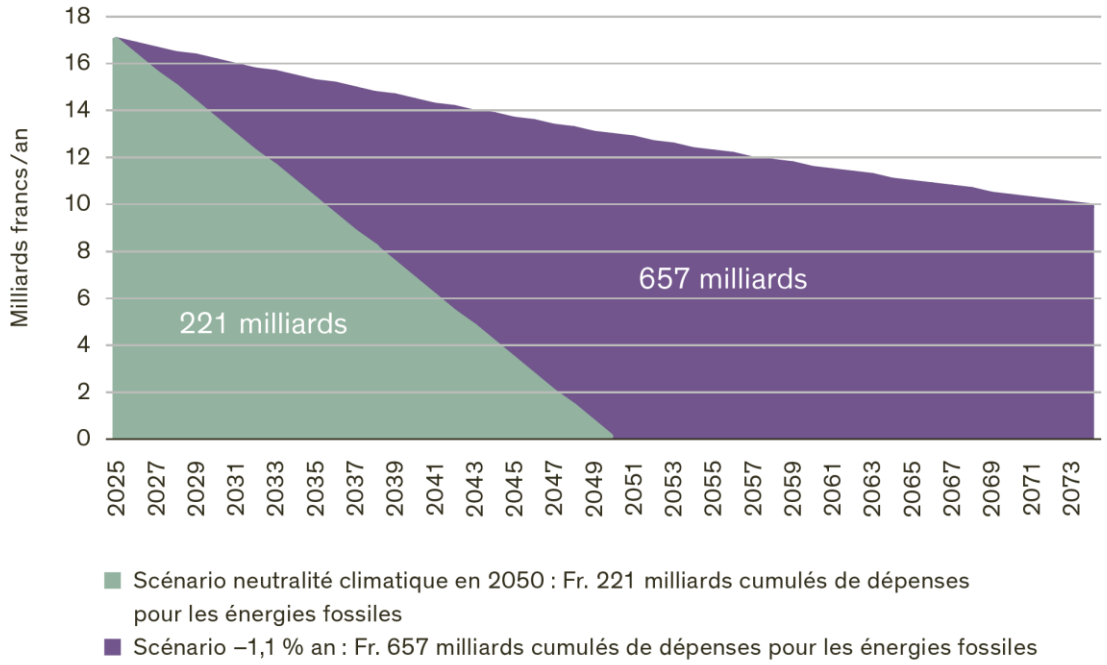


TWh	Currently	Everything decarbonised except aviation
Petrol, diesel, fossil gas, heating oil	121	0
Electricity (gross consumption)	67	118
Total	**188**	**118**
(kerosene)	(20)	(20)

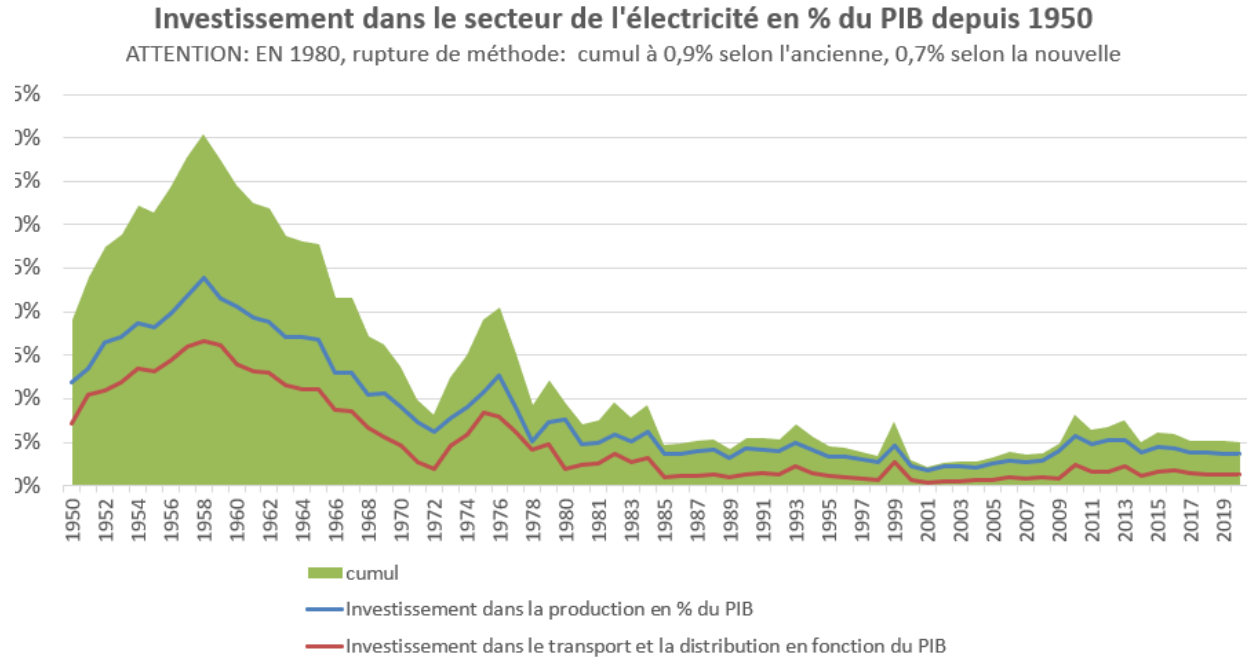
7. Investment requirements

430 billions of investment over 25 years to achieve climate neutrality (energy sector + other emissions)

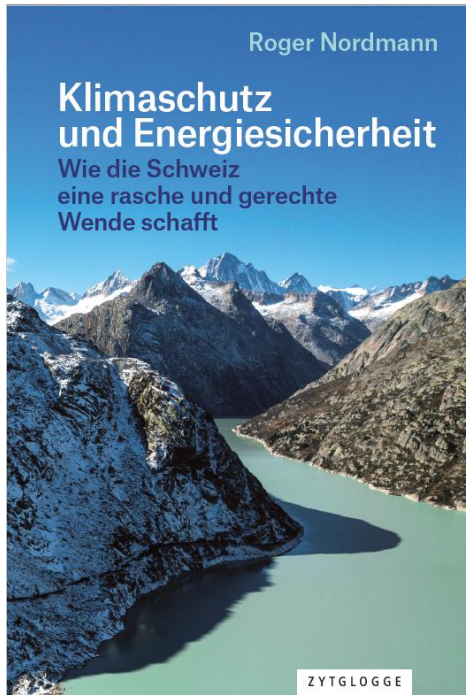
Figure 36. Représentation schématique des dépenses d'énergies fossiles des utilisateurs finaux (francs constants 2021)

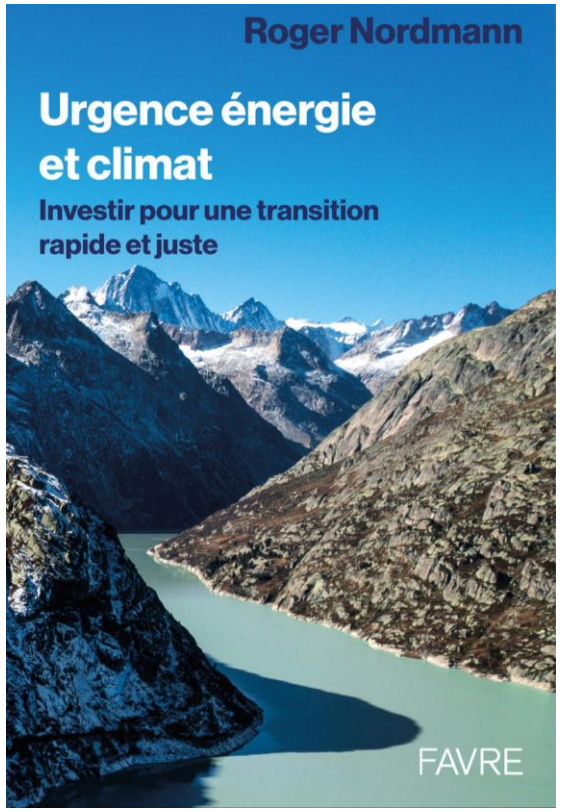


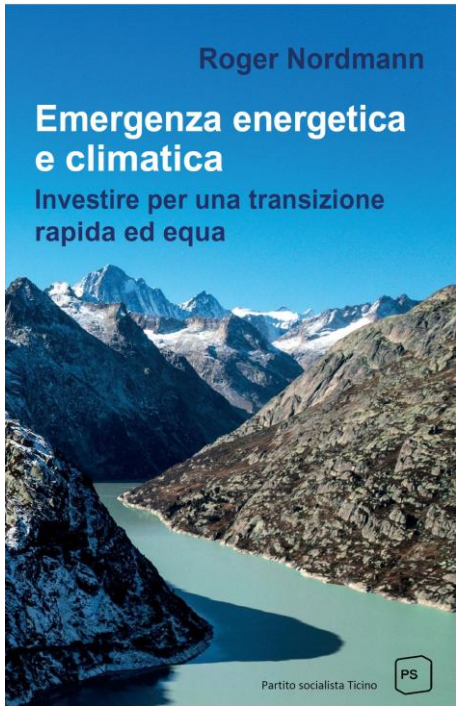
430 bn over 25 years = 17 bn/year = 2.2% of GDP



The need for a public investment fund







The message of the book:
Between denial and despair, there is a rational path

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