JUNE, 11TH 2024

ZLATIBOR

RENEWABLE ENERGY FOR DISTRICT HEATING IN SWITZERLAND TODAY

PERSONAL VIEWS

DR. PETER HEUSSER

AGENDA

Renewable Energy: The UN Framework

Relevance of Biomass in Switzerland

Technology

Legal Frame for Energy Wood in District Heating

Reasoning

Renewable Energy

United Nations

https://www.un.org/en/climatechange/what-is-renewable-energy

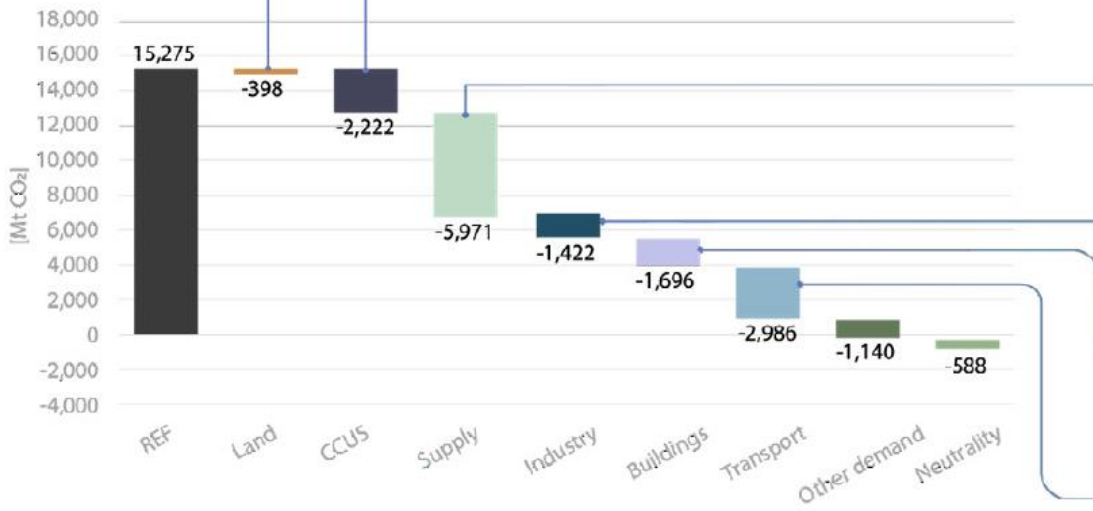
“Renewable energy is energy **derived from natural sources** that are replenished at a higher rate than they are consumed. **Sunlight and wind, for example**, are such sources that are constantly being replenished. Renewable energy sources are plentiful and all around us.”

CO_2 – UN Road map 2050

https://unece.org/sites/default/files/2022-09/Technology%20Interplay_final_2.pdf

How can different energy sectors be decarbonized?

All low- and zero-carbon technologies are needed across sectors



Carbon Dioxide mitigation [$MtCO_2/yr.$] in UNECE, Carbon Neutrality vs. Reference Scenarios

LAND

Enhanced land use enables natural carbon sinks to flourish.

CCUS

Scaled-up carbon capture and storage infrastructure for biomass, coal, and gas combustion and conversion.

SUPPLY

Transition to low-carbon supply chains with renewables, nuclear and demand changes accounting for most avoided emissions.

INDUSTRY

Accelerated substitution of traditional fossil fuels to low- and zero-carbon alternatives, including electricity, hydrogen, and district heat. Economic structural change results in low-energy intensity industrial production processes.

BUILDINGS

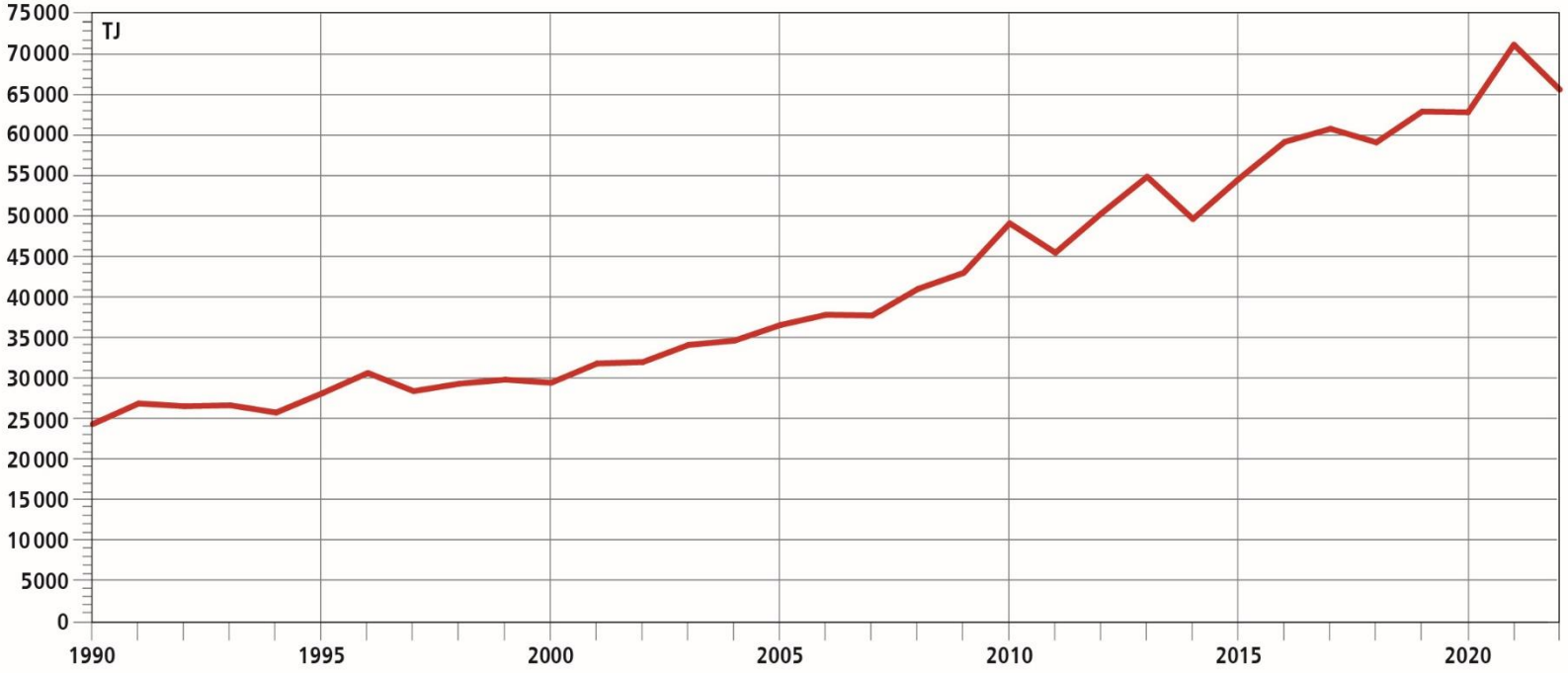
Refurbishment and replacement of existing housing stock with low-energy buildings. Replacement of oil and gas heating systems with heat pumps, biofuels, district heat and solar thermal systems reduces fossil energy use to less than 10% by 2050.

TRANSPORT

A massive replacement of oil-fuelled internal combustion engines by electric vehicles and energy demand reductions via lifestyle changes and efficiency improvements.

Renewable Energy for DH in CH

Heatproduction from renewable energy (total heat used, incl. wood and renewable share of waste)



BFE, Schweizerische Gesamtenergiestatistik 2022 (Fig. 8)
OFEN, Statistique globale suisse de l'énergie 2022 (fig. 8)

Biomas for District Heating in Switzerland

Renewables as part of total energ

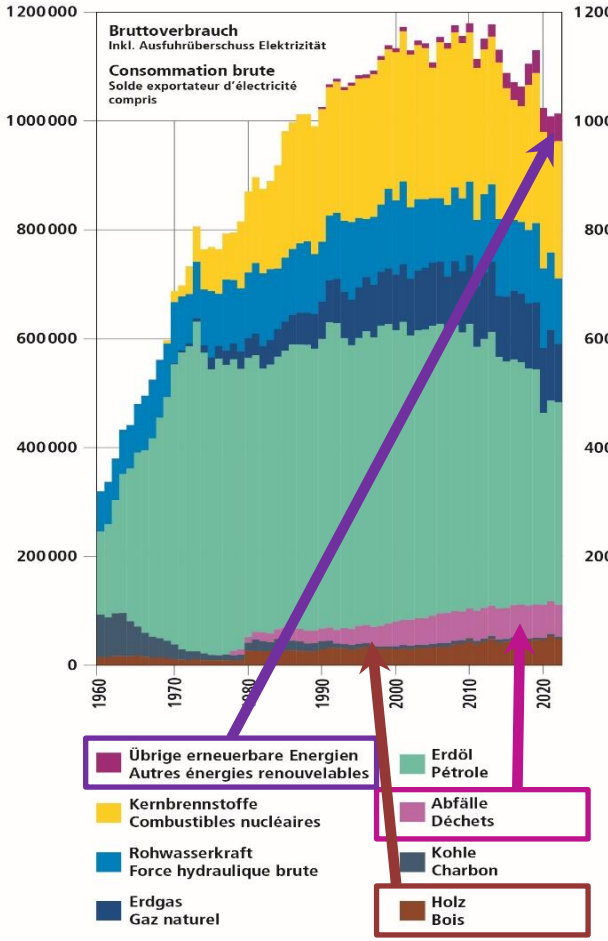
- Wood (brown)
  Waste (pink)
  Other renewable (purple)

Final consumption

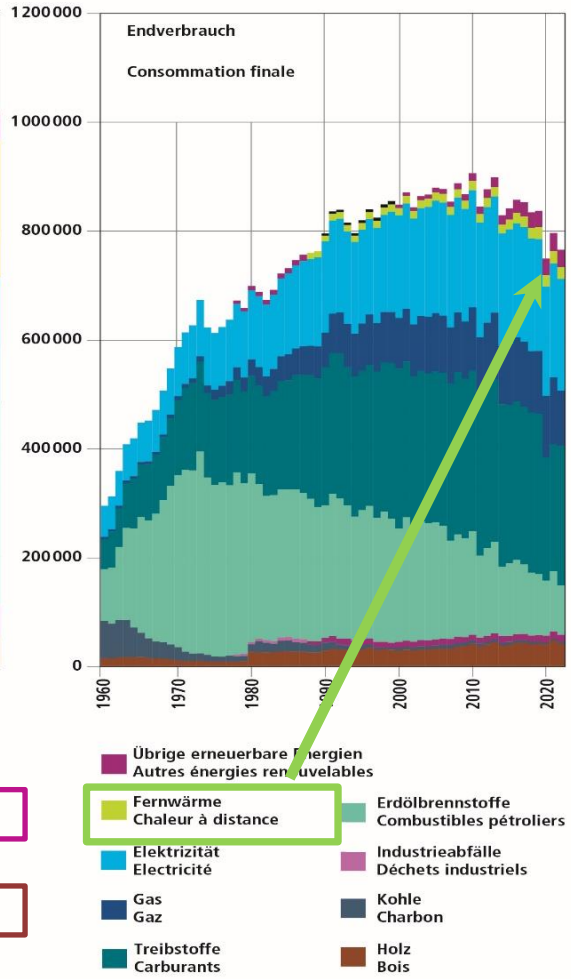
- DH (green)

Energy consumption 1960 – 2022 in TJ

Gross consumption



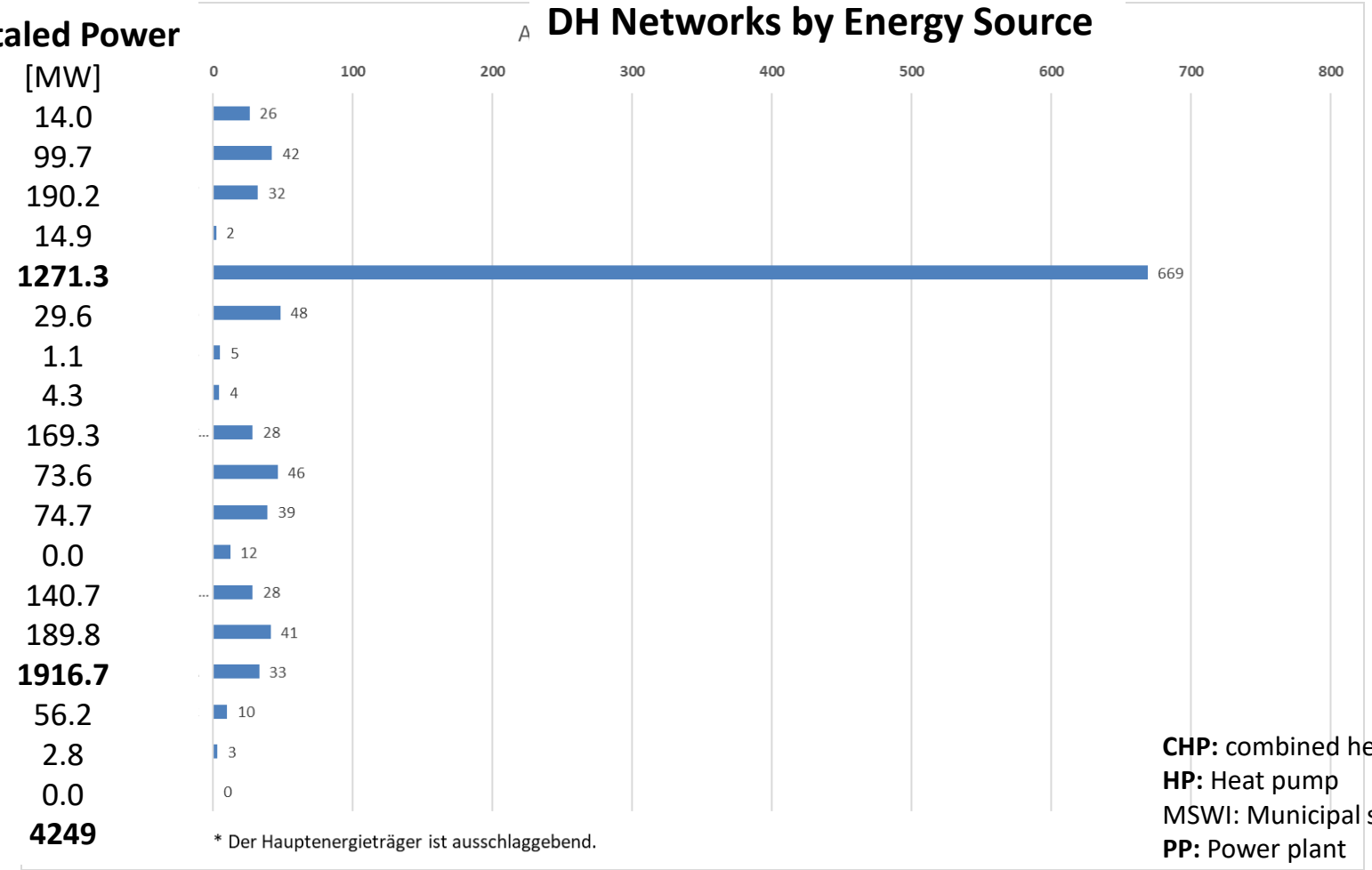
End use



BFE, Schweizerische Gesamtenergiestatistik 2022 (Fig. 4)
OFEN, Statistique globale suisse de l'énergie 2022 (fig. 4)

Biomass for District Heating in Switzerland

	Instaled Power [MW]
Oil	14.0
Gas boiler	99.7
Gas CHP	190.2
Wood	14.9
Wood chips	**1271.3**
Pellets	29.6
Biogas boiler	1.1
Biogas CHP	4.3
Surface water (HP)	169.3
Ground water (HP)	73.6
Geothermal (HP)	74.7
Air (HP)	0.0
Industrial heat (HP)	140.7
Waste water (HP)	189.8
MSWI	**1916.7**
Waste heat Nuclear PP	56.2
Waste Heat Tunnel	2.8
Solar thermal	0.0
Total	**4249**



CHP: combined heat & power, engine
HP: Heat pump
MSWI: Municipal solid waste incineration
PP: Power plant

Experiences with Cogeneration in Switzerland

Energetic optimisation

- Economic optimisation
- Efficiency increase in part-load operation

- High-pressure condensing Turbine → larger plants > 10MW_{th} (> 2MW_{el})
- ORC → for smaller plants < 10 MW_{th} (ca. 1MW_{el})
- Back-pressure turbines → larger plants with industrial heat

Legal Frame (Emission Control)

Specific Needs for Biomass

All thermal processes lead to the release of a stream of exhaust gases, which is contaminated with air pollutants, which is why the stationary systems for thermal conversion of energy wood are subject to the Swiss Clean Air Ordinance (LRV).

Basic physics but consider…

Clean Air Ordinance

Fuel Heat Capacity		up to 70 kW	over 70 kW up to 500 kW	over 500 kW up to 1 MW	over 1 MW up to 10 MW	over 10 MW
Reference oxygen content	% vol	13	13	13	11	11
for central heating and single stoves as well as commercially used baking ovens:						
- Total solids	mg/m3	100	50	–	–	–
- Carbon monoxide (CO)	mg/m3	4000	4000	–	–	–
for individual room heaters (1) and manually fed boilers:						
- Total solids	mg/m3	100	50	–	–	–
- Carbon monoxide (CO)	mg/m3	2500	500	–	–	–
for automatically fed heating and steam boilers:						
- Total solids	mg/m3	50	50	20	20	10
- Carbon monoxide (CO)	mg/m3	1000	500	500	250	150
- Nitrogen oxides (NOx), indicated as nitrogen dioxide (NO_2)	mg/m3	with a mass flow of 2500 g/h or more 250 mg/m3				150
- Gaseous organic substances, indicated as total carbon	mg/m3	–	–	–	–	50

Relevant also for smallest plants!

Notes:

(1) For stationary stoves according to SN EN 15544 (stationary tiled stoves/clay stoves - design), regardless of their fuel heat capacity, the emission limits for solids and CO up to 70 kW apply.

Legal: Wood and Solid Waste

Thermal use of wood results in
→ Bottom Ash
→ Filter Ash

In Switzerland Ash from Wood has to be collected with the house hold waste (<35l) or dumped in controled dump site (Typ D or E)!

Generally underestimated costs!

Cost and Benefit:
Careful assessment and planning

Investment

- Sizing
- Subvention
- Ownership cost

Management and Operation

- Fuel (biomass) → availability
- Waste (ash)
- Staff
- Maintenance -> just in time and predicted
- Energy sales
- CO_2-Compensation
- Quality increase (Emission / Redundancy ...)
- Risk assessment

Reasoning DH

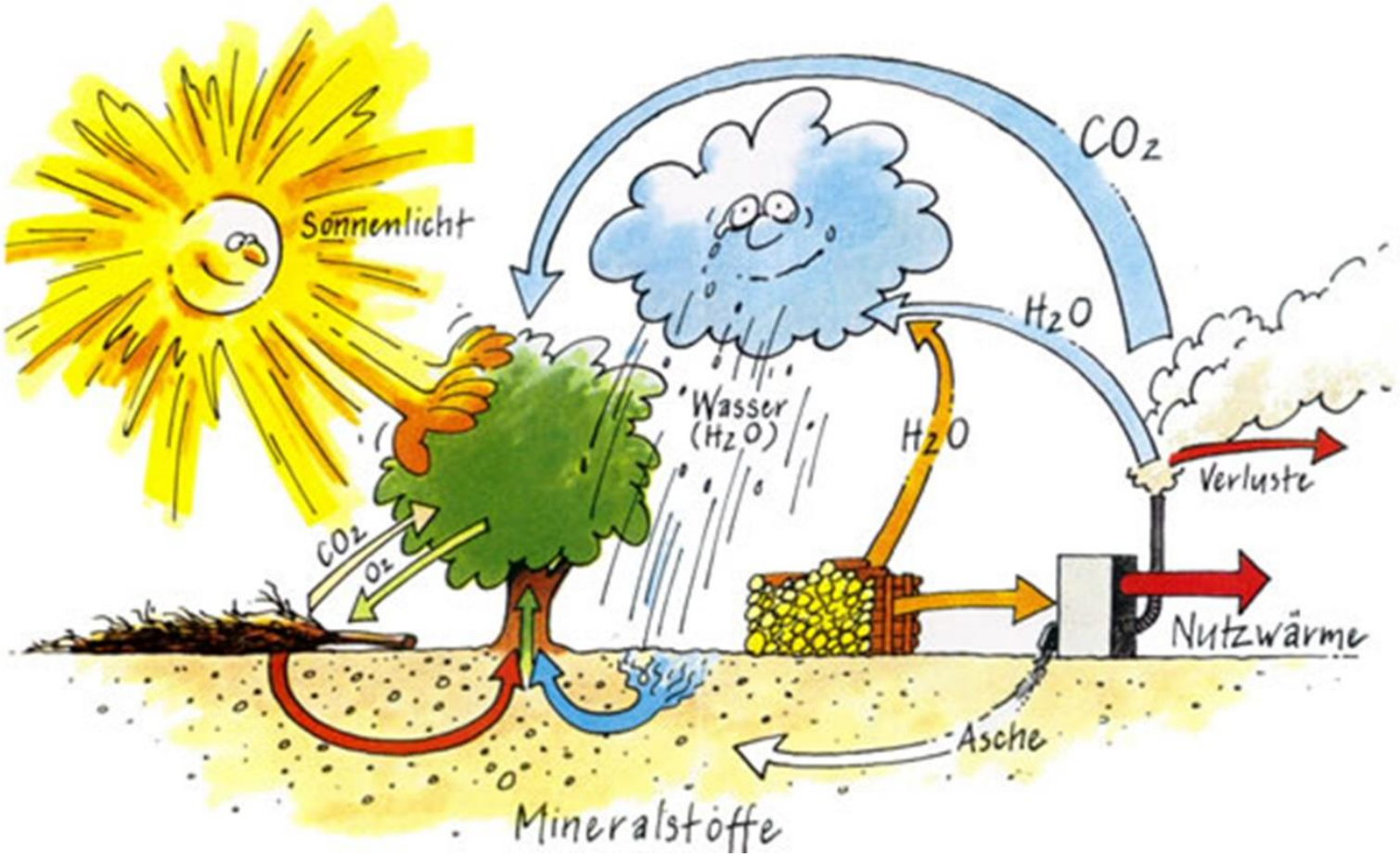
Biomass in DH for Carbon Free Future

- Centralised thermal plant shows higher efficiency
- Cogeneration (heat – electricity) increases flexibility and independence
- Centralised thermal plant has significant lower emission

Transformation of DH in Serbia

- Biomass is significant (wood) to reach UN 2050
- High temperature network is possible
- To be considered: cost-benefit, legal frame, …

Thank you



Peter Heusser
Dr. sc. techn. ETH
Doldertal 32
8032 Zürich

www.svut.ch
peter.heusser@svut.ch