Energetic and Environmentally Assessment of Sustainable Housing

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In future the main indicators for a building are the demand for *non-renewable energy carriers* and its *CO_2-emissions*. The "*Building of Tomorrow"* may be characterized by a high insulated building envelope with "passive building" standard and a low-temperature heating system with heat recovery. The remaining heat demand (below 15 kWh/(m^2, a)) has to be covered by *appropriate auxiliary heating system*.

The implementation of a seasonal thermal storage in buildings with a high-insulating standard is technically possible, but it has to be considered also under economical and environmentally aspects. Experience shows that economical-technology solutions with middle-term stores in combination with renewable energy technologies, which are reliable and easy to handle, are of more importance, at least for near-term applications and commercialisation. Proved technologies are solar combined heating systems with heat pumps, bioenergy technologies and heat recovery systems. Sufficient experience and operational data already exist to achieve the goals for solar advanced (sustainable) buildings and to ensure professionally designed as well as cost-effective solutions with an optimum of performance.

Favourites for auxiliary heating solar combined heating systems are:

- Heat recovery
- Heat pump technologies
- Advanced bioenergy technologies.

Heat recovery systems will cover the main part of the heat demand of passive housing. Nevertheless, about 15 kWh/(m², a) has to be shared by auxiliary heating. In low-energy housing without heat recovery about 40 kWh/(m², a) have to be covered by a "conventional" heating system. New developments combine the renewable energy sources heat recovery, solar thermal, solar electric and bioenergy.

The combination of heat recovery with renewable energy sources will reduce the requirements for passive housing: high building insulation (U-value ≤0,1 W/(m², K)), high insulated windows (U-value for glass and frame ≤0,7 W/(m², K)). Also natural air conditioning would be possible.

Both environmentally relevant CO_2-emissions and primary energy demand of heating systems are indicators for the quality of housing. The following Figures 1a to 1c show the annual system efficiency of heating systems (average of existing and proved technologies) and the Primary-Energy factors and the specific CO_2-emissions for fuels and electricity. The results of assessment for different heating systems in a single-family house in factor 4- and passive house standard are illustrated Figure 2a to 2e..

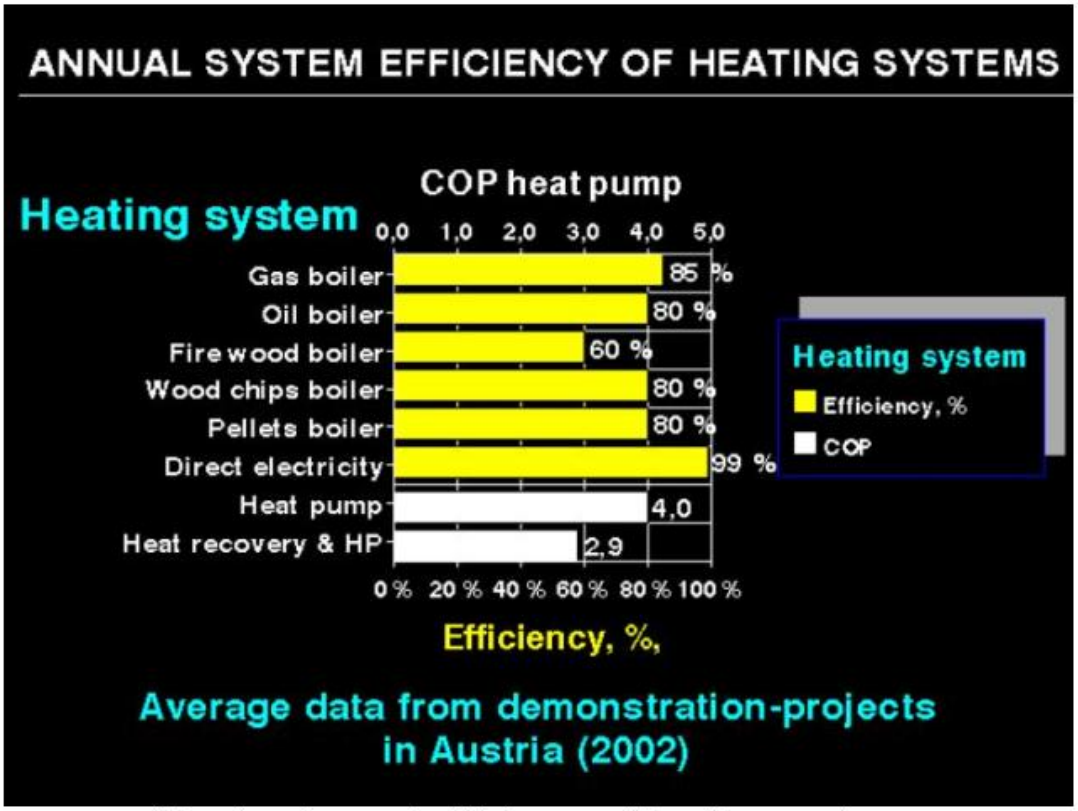

Fig. 1a: Annual efficiency of heating systems

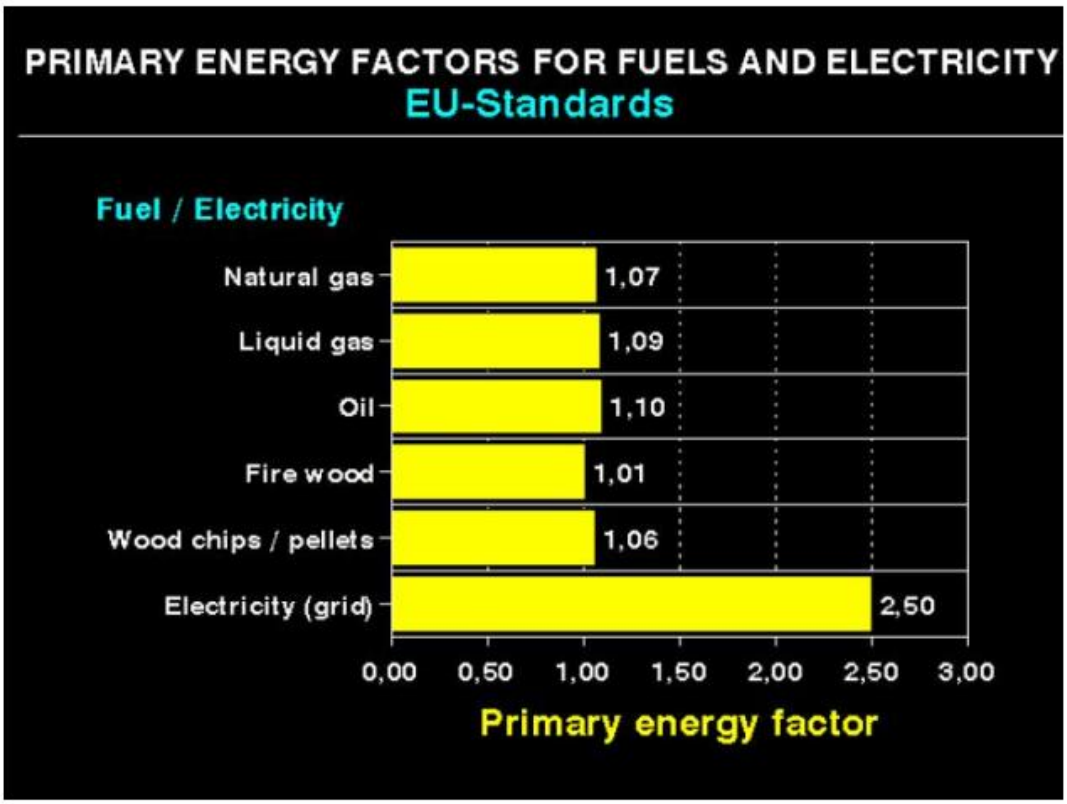

Fig. 1b: Primary energy factors for fuels and electricity

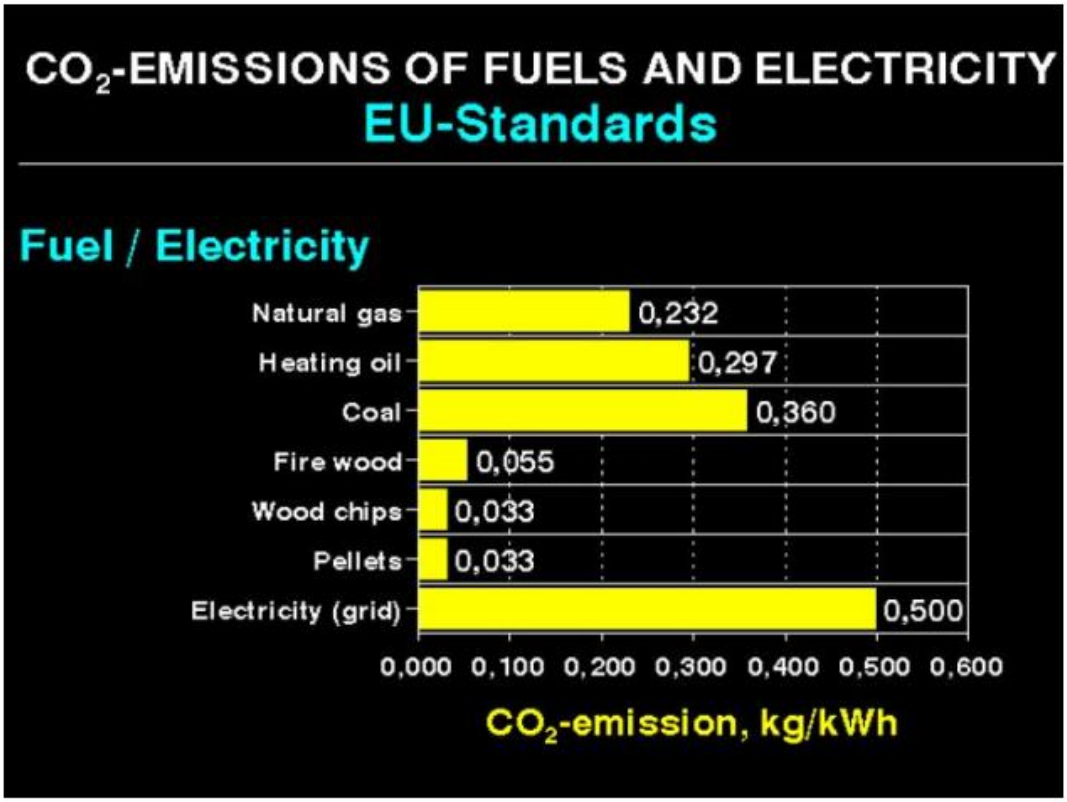

Fig. 1c: CO_2-emissions for fuels and electricity

ENERGETIC AND ENVIRONMENTALLY ASSESSMENT

Heat demand, heat energy demand, fuel/electricity demand and primary energy demand

Fig. 2a: Reference Building

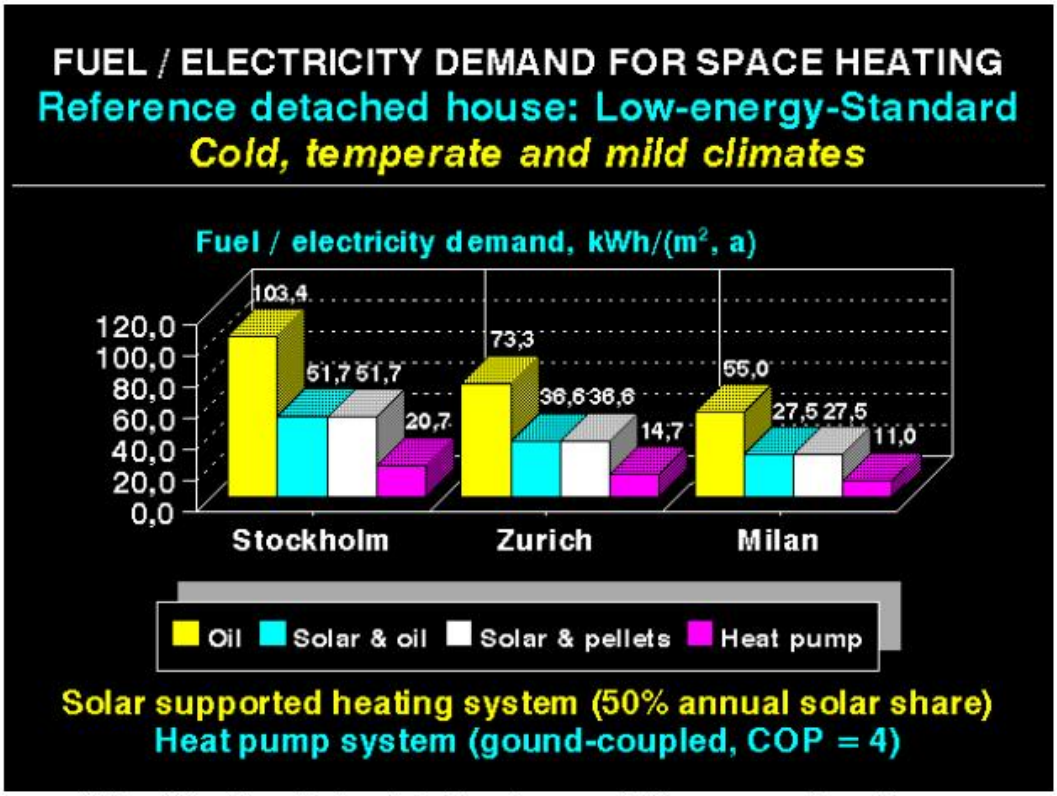

Fig. 2b: Fuel/electricity demand for space heating

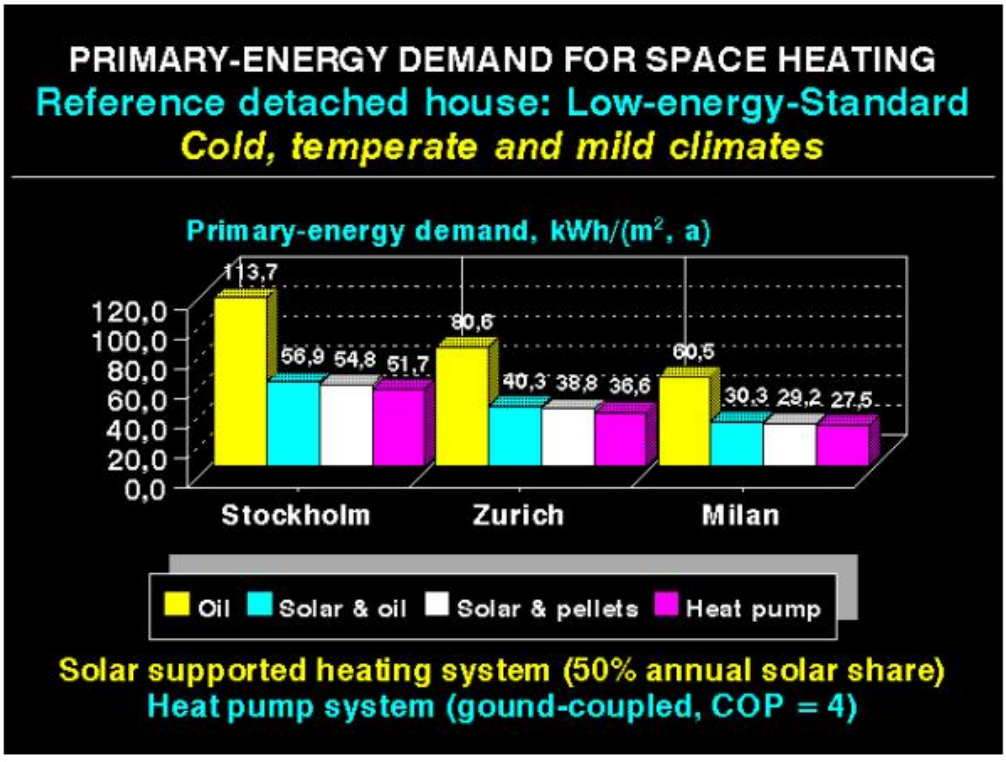

Fig. 2c: Primary energy demand for space heating

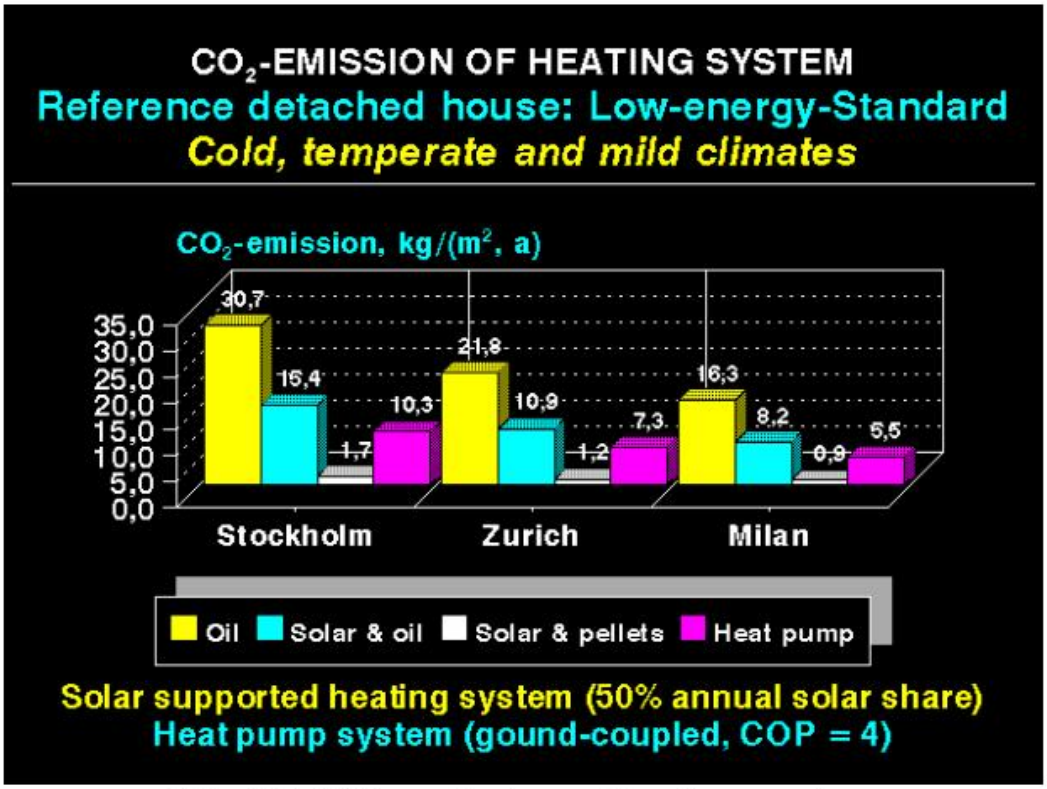

Fig. 2d: CO_2-emissions of heating systems

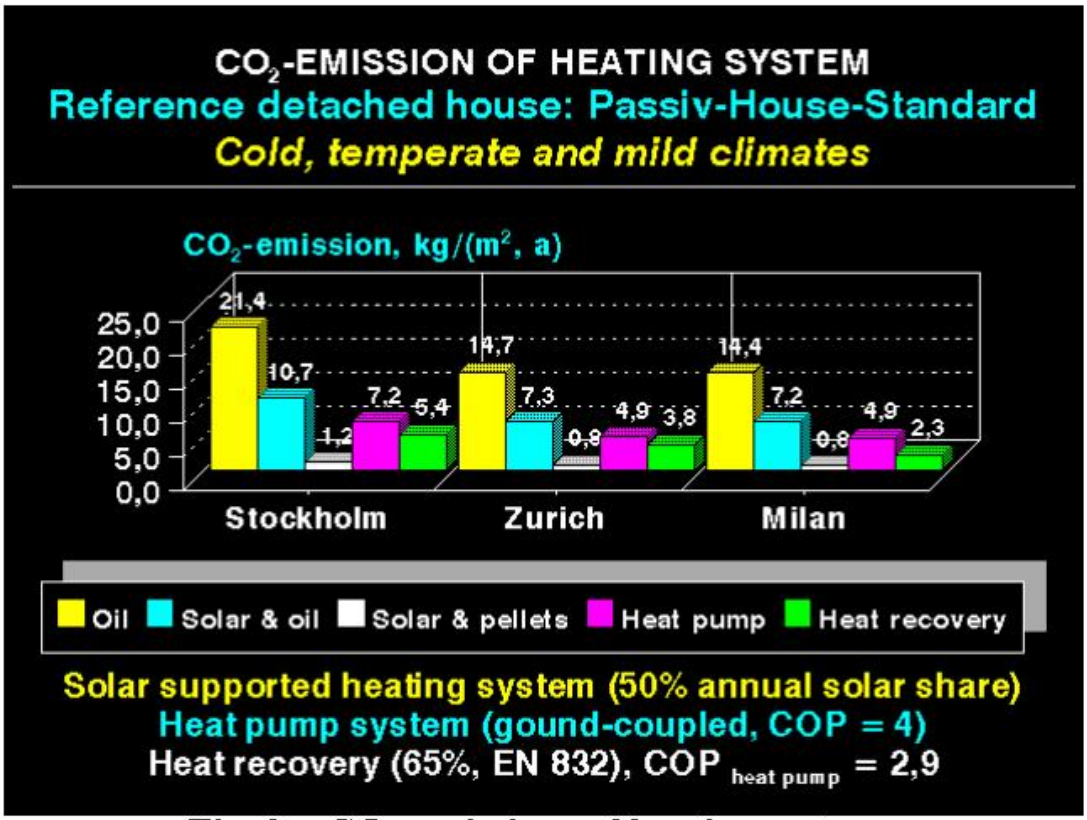

Fig. 2e: CO_2-emissions of heating systems