SIMULATION OF ENERGY EFFICIENCY MEASURES IN SINGLE-FAMILY, ONE-FLOOR DETACHED HOUSES

1. PURPOSE

The purpose of this assignment is to test how a computer program can facilitate energy calculations in buildings, in this case, a detached house in Umeå. Suitable prior knowledge includes *U*-value calculations and an understanding of buildings' energy losses in general.

2. GENERAL

Detailed energy calculations, even for a house, can be quite extensive when carried out manually. Calculations are greatly facilitated by a computer. In the general energy calculation program PHPP, it is easy to enter different conditions and adjust them to investigate differences in energy use. Theoretically, it is easy to investigate the impact of additional insulation and test the significance of installing a heat pump.

The program includes a special module for *U*-value calculations, which allows the calculation of a building's various *U*-values.

3. IMPLEMENTATION

The technical specification for a single-storey house is shown below, along with a drawing.

Calculate the total annual energy requirement of the house according to the conditions given in section 5 below. This is the reference for comparing different energy saving measures, as set out in measures A to C in Section 6 below.

4. ACCOUNTING

Present the results in table or figure form with accompanying descriptive and explanatory text. You do not need to do the accounting in the form of a complete report.

5. TECHNICAL DATA

The conditions are as follows:

The house is home to a family consisting of two adults and two children. The house is located in Umeå, and the indoor temperature is generally 22ºC during the heating season.

HEATING SYSTEM:	Electric radiators
VENTILATION:	The building's ventilation system is an exhaust air system with a constant flow (day and night) of 0.8 exchanges per hour.
AIR LEAKAGE:	0.8 l/s, m^2 at 50 Pa.
CEILING:	145 mm mineral wool board (96 %), wooden beams (4%) Plastic foil, 20 mm wooden panel.
EXTERIOR WALLS:	From the outside: 22 mm wood panel with associated air gap 25 mm, mineral wool boards 150 mm between wooden studs (10%), plastic film, 13 mm plasterboard.
FLOOR:	Slab on ground: 200 mm concrete, 150 mm cellular plastic, silt non-drained sand and gravel, moraine.
WINDOWS:	2-glazed windows (clear glass), $U = 2.5$ W/m^2K
DOORS:	Practical U-value, $U = 1.4$ W/m^2K
MISCELLANEOUS:	Annual energy requirement for domestic hot water according to the standard (residential building) in webpage: https://www.energiberakning.se. Lighting, electrical appliances, and personal heating (i.e., internal heat sources) according to the standard values at https://www.energiberakning.se.

For area calculations and the house's orientation, see the attached drawing.
Assume reasonable kWh prices for electricity and district heating, respectively.

6. SIMULATION TASKS

The evaluation of each measure below refers to the overall savings, compared to the house's original annual energy needs, in kWh and SEK.

A. SIMPLE MEASURES

- Lowering the indoor temperature by 2ºC throughout the heating season.
- Local sealing measures to reduce air leakage by half.
- Reducing the ventilation air flow rate to 0.5 exchanges per hour
- Apply a combination of all of the above measures

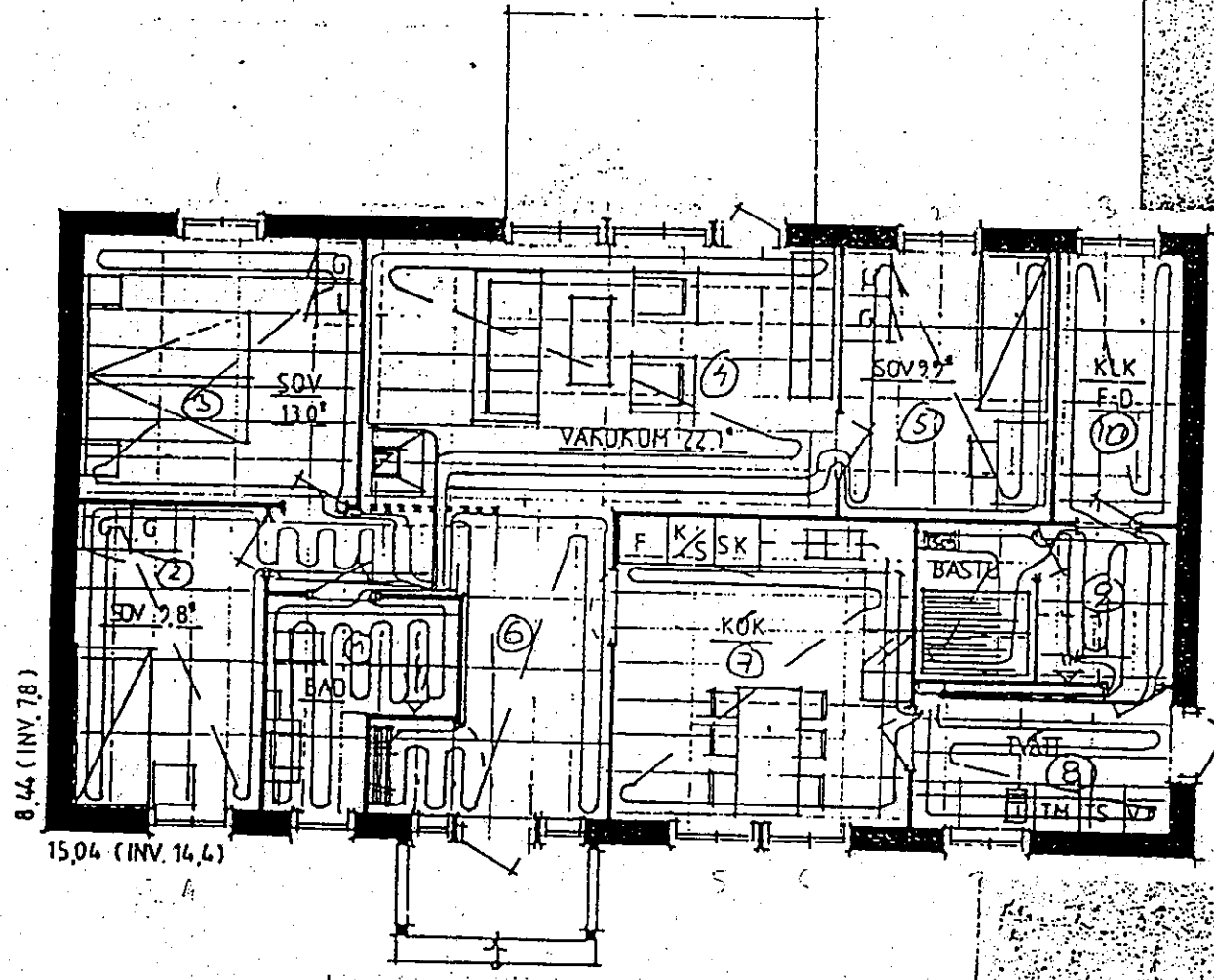
B. MORE EXTENSIVE MEASURES

- Internal additional insulation of the outer wall with 50 mm mineral wool board.
- Additional insulation of attic floors (ceiling) with 300 mm mineral wool (loose wool).
- Both additional insulation of the exterior wall and attic floors (ceiling), as above.
- Replacement to 3-glazed windows (clear glass), $U = 1.2$ W/m^{2}K.
- Switching to 3-glazed windows with selective coating and argon filling between the panes, .$U = 0.8$ W/m^{2}K

C. VERY EXTENSIVE MEASURES

- Modification of the ventilation system to a fan-controlled supply and exhaust air system (CAV) with heat recovery, but without a comfort cooling system. Assume the heat recovery efficiency is equal to 80 %.
- Conversion of heating system from direct electric to ground source heat pump (including domestic hot water preparation), otherwise original conditions.
- How is the energy cost affected if the house is connected to district heating for heating and domestic hot water preparation?
- Combine and simulate your own action package, e.g. combinations of B and C actions. Is it possible to meet passive house requirements?

Skala 1:100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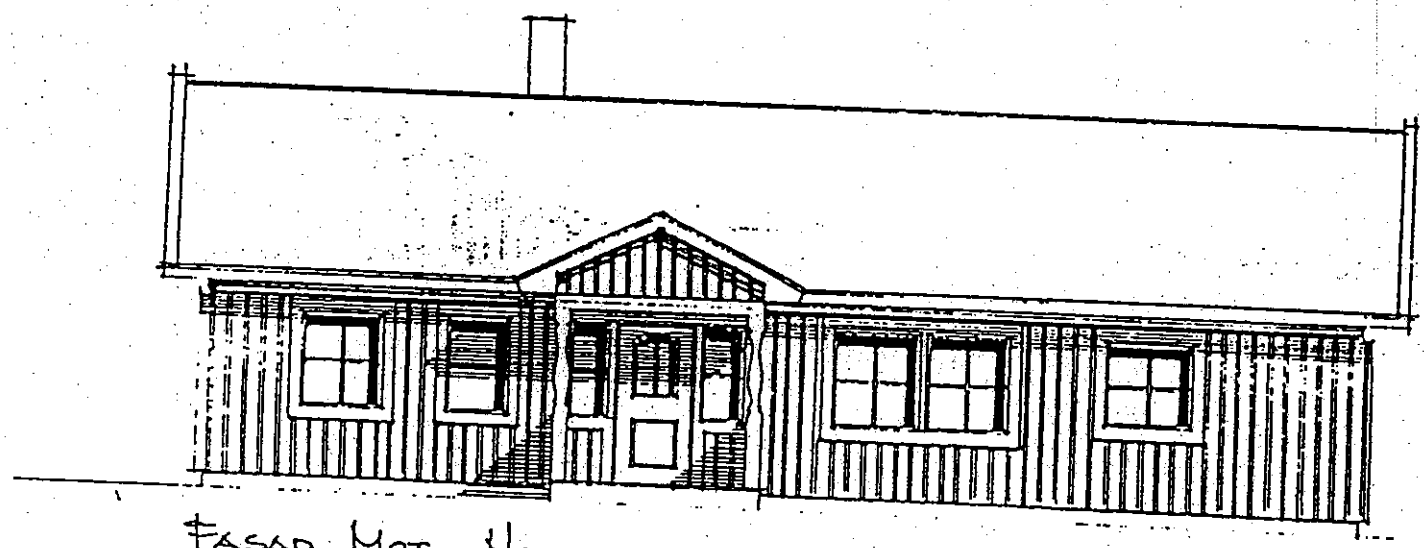

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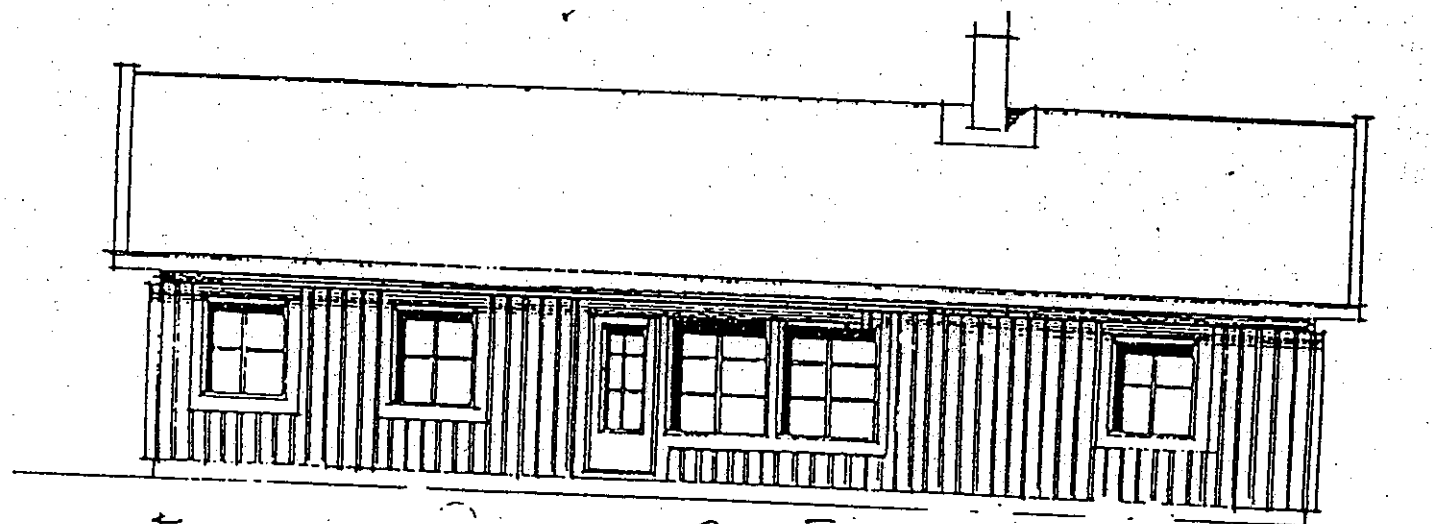

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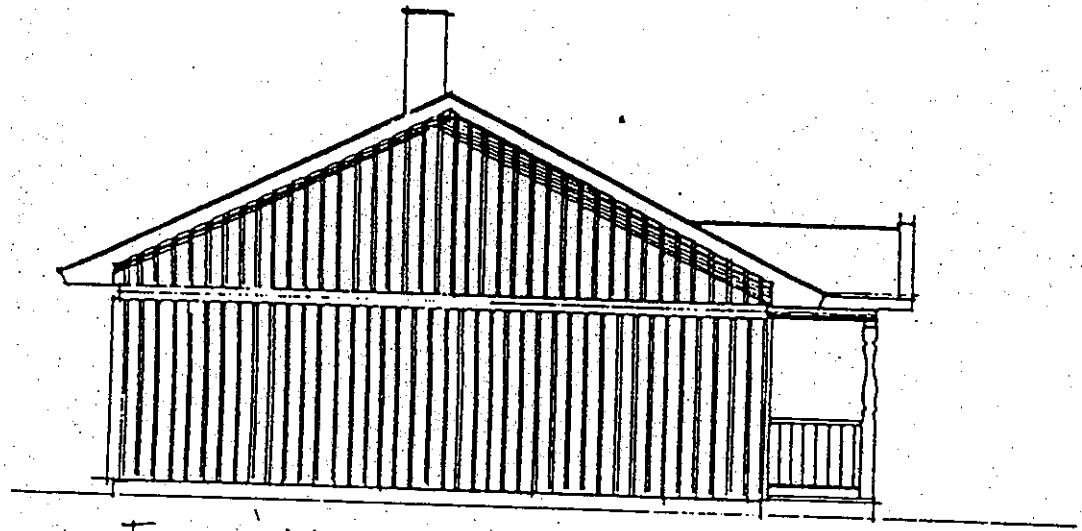

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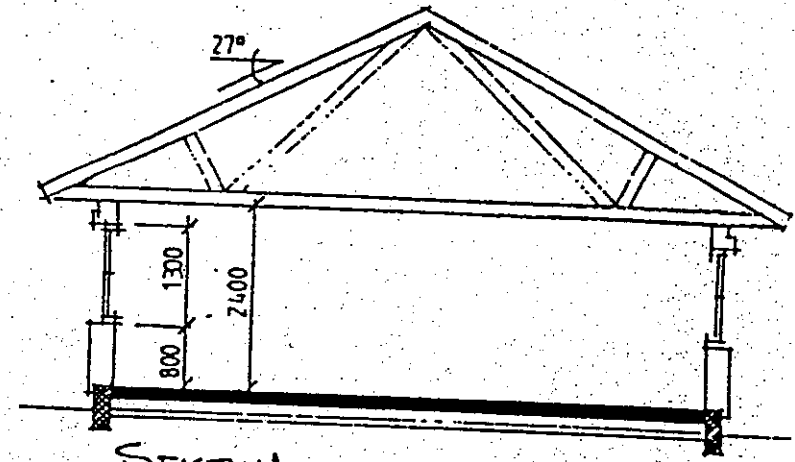

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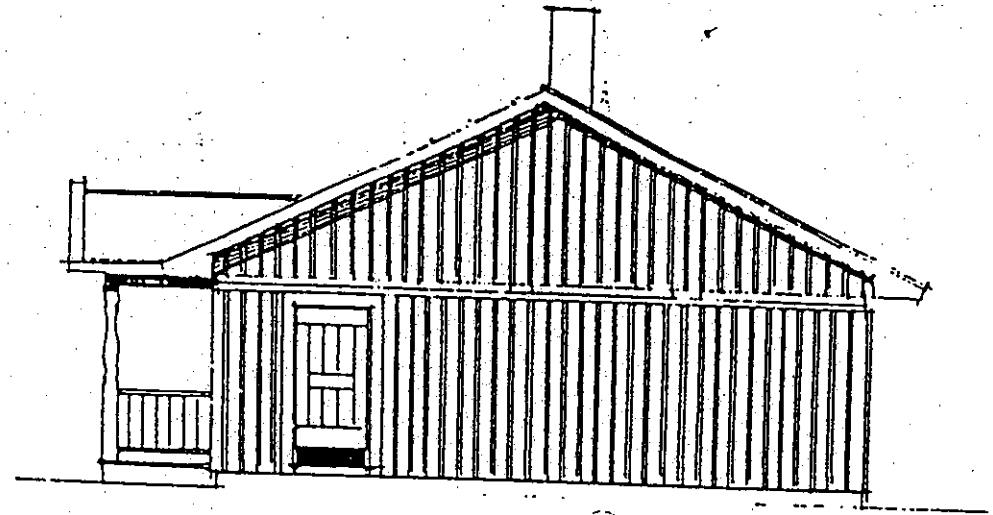

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