Experience with high Energy Efficient Building in the Netherlands since 1982

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Abstract

It was 25 years ago (1979-1983) that the first Minimum Energy (ME) houses were devised. In 1982-'83 184 houses were built in the Netherlands with government assistance from PBE/TNO (ProjectBureauEnergy research), which is now called SENTER/NOVEM. The basic idea for this type of house arose in 1979. "How much energy can be saved if you are allowed to invest 10.000 NGL (€ 4.500) more into a standard house". Fundamental integral designing from the foundation to the highest point gave rise to a new building and installation technology which drastically changed the Dutch building market. First a non-centrally heated house was developed with a double-wall woodstove as heat source which burned clean at high temperatures. As fuel, all the newspaper issues collected in one year were used as well as hot tap water from an open kitchen boiler. However, this type of stove had a maximum allowed capacity of 5 kW. When financial government assistance became available and the accompanying official evaluation was completed, the ME house came into existence. An electronically ignited gas heater with a modulation burner as heat source and an advanced compact air heating system with heat recovery were the major improvements. In the book Integraal Ontwerpen/Vitale 36 pages illustrated in colour which are devoted to the design, detailing and construction of the ME houses in Woudhoek-Noord in Schiedam, the Netherlands. The black/white figures in this paper are selected from this book.

Key words : wood stove, centrally heated house, Minimum Energy House, airtight building innovation, new building materials, new compact heating and ventilation system, electronic gas heater ignition.

1. Investments versus savings

In connection with a Symposium in Spijkenisse, the Netherlands we were asked to make a standard house energy efficient at NGL 10.000,-- extra per house, according to the Dutch NEN 1068 '64 standards of construction and building science, (Fig. 1). The conclusion was that it became evident that besides more investments also savings arose. It became the beginning of the non-centrally heated house.

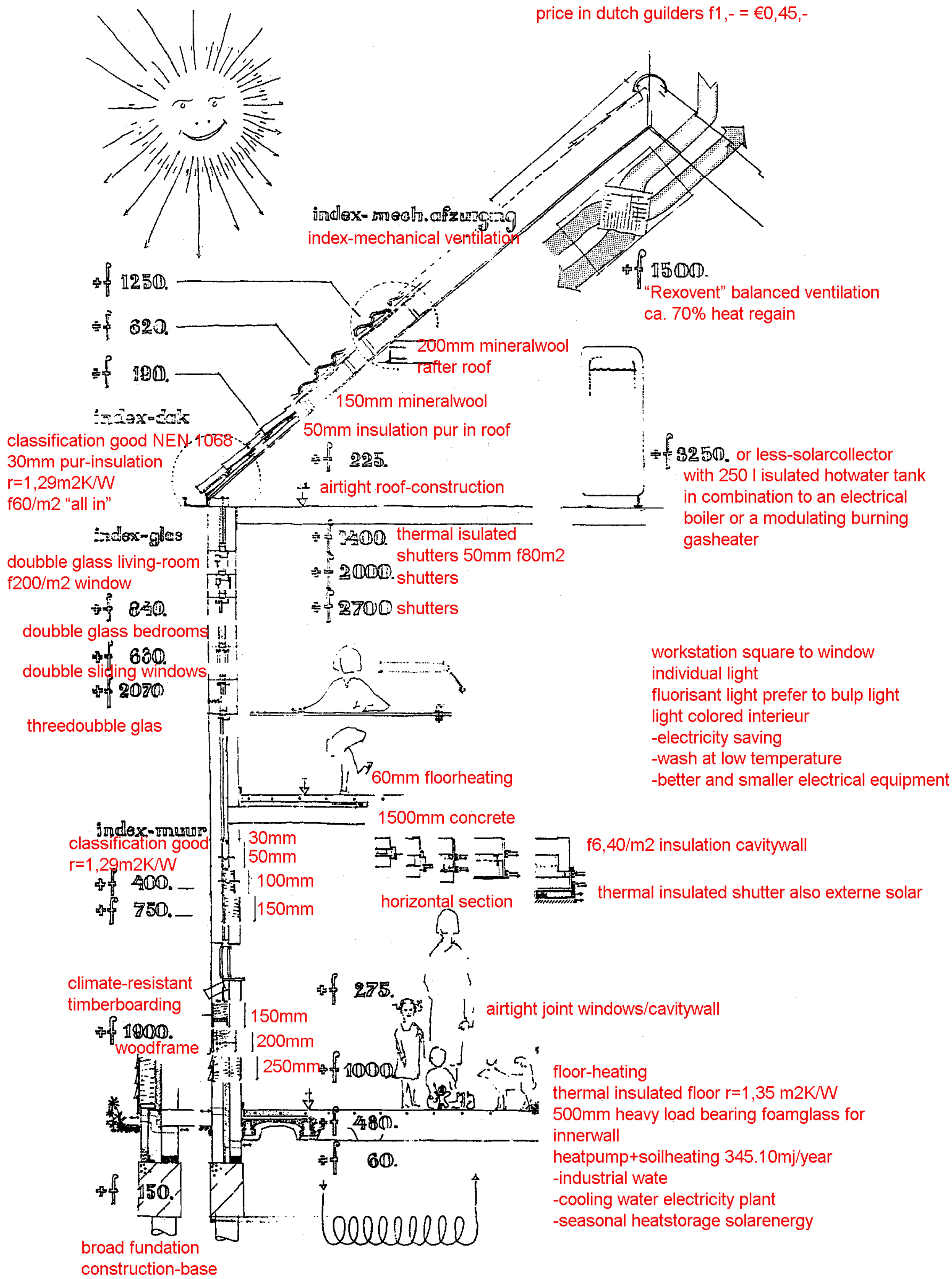

Fig. 1: Cross-section of a standard council house according to the NEN 1068 '64 building programme 1980 with insulation and installation measures indicated in Dutch guilders.

According to the Housing Act Index which was used as a reference, a Council house has a volume of 330 m³ and consumes annually 74.000 MJ of heating (without hot tap water), which corresponds to 2.460 m³ natural gas (NG), using a High-Performance boiler with 90% efficiency.
With an extra investment of € 3.900,-- excl. VAT in thermal insulation a 42% reduction of transmission losses is reached as well as the highest investment efficiency.
A clear criterion in the price-conscious house-building industry is to calculate in building investments, that is in euros per m3 natural gas savings per year. In 1980 a domestic user paid about € 0,14/m³ natural gas a year.
The smallest investment in an insulated floor at an insulation thickness of 40 mm is € 0.67/m³ NG/a year. When the insulation thickness of the roof increases from 30 mm to 150 mm, the investment will be € 0,95 m³ NG/year. Besides these thermal insulation measures other measures will be profitable as well. Thus € 1,32/m³ NG/year is attributed to heat recovery of ventilation air, and € 1,70/m³ NG/year to extra crack coverage. Later it appeared that the supposed investment in heat recovery of ventilation air had not been reached. Still more confusing is that the heat of the ventilator is added to the efficiency of the heat exchanger. This mistake is still being made and nett/gross efficiency is being mixed up. A ventilation system with a high resistance and a ventilator with a high capacity will thus result in a high energetic output. The application of a "season-dependent outer wall" with thermally insulating shutters and blinds on the outside besides is favourable in relation to double glazing, but is compared to triple glazing, which at this stage of development is relatively expensive: € 4,55/m³ NG/year. The conclusion of this symposium: by building energy-saving houses at an extra investment of € 3.900,-- (excl. VAT) heating requirements can be reduced from 74.000 MJ to 12.000 MJ per year/house and traditional central heating will be superfluous. Instead of 2.460 m³ NG/year per house 410 m³ NG/year will be the calculated heating requirement, a highly promising perspective.

2. First draft of a non-centrally heated house

The integral design of the non-centrally heated house, which would later become the Minimum Energy house, is based on the scientific design of various cross-sections and abandoning many general designing principles. (Fig. 2+3+4+5)

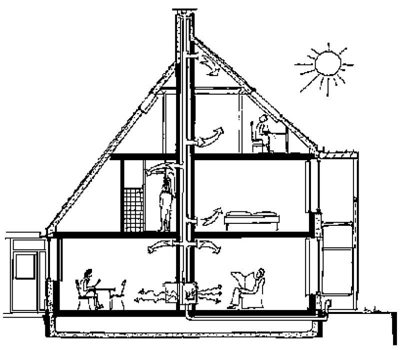

Fig 2: Non-centrally heated house
Insulated on all sides, heat is kept inside,
Extra heating with hot air by means
of a double fume-extracting pipe
in the central shaft.

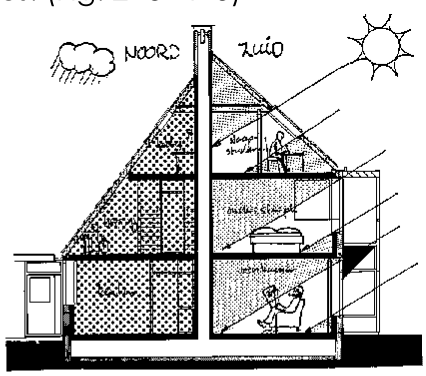

Fig. 3: Solar energy
Zoning and passive solar energy,
living area on the south side –blinds on the
outside, inbuilt bathroom situated near the
heated core of the house

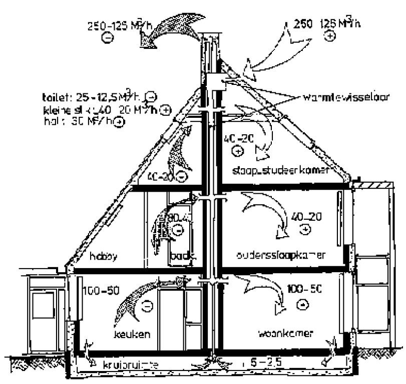

Fig. 4: Heat recovery
Permanently balanced ventilation in airtight houses is a must, 125 to 250 m²/h respectively

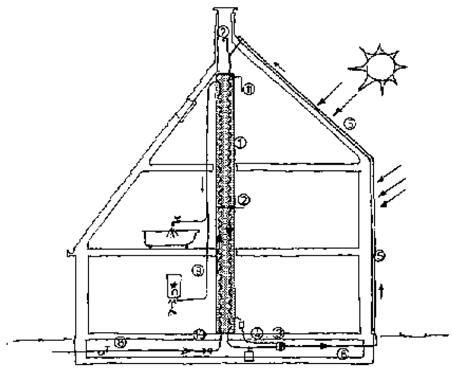

Fig. 5: "Low profile" solar collector of cheap solar boiler with slow-running protection and a high, narrow storage vessel with stratified temperature development of hot water.

a new list of design data arises
- town planning with south orientation and shade studies
- outer wall and roof insulation of 180 mm mineral wool, protected by impact-resistant plaster coating
- ground-level floor insulation with R=5 m2k/W of non-hygroscopic material
- foundation beams insulation as lost formwork
- large windows in the south walls, small windows in the north walls
- windows equipped with insulation shutters, to be controlled from inside
- zoning of the living areas on the south side. To make a heat buffer; kitchen, storage and hobby areas on the north side.
- bathroom in the 'hot' centre of the house
- extra crack coverage(draught-proof) by an entrance portal on the front
- draught-proof detailing of roofs, window/door connections and moving parts
- balanced ventilation with heat recovery
- air-extraction takes place in kitchen, bathroom and toilets
- cheap installations in pipe shaft which are easy to maintain

3. Design of minimum energy house

The construction of the non-centrally heated house undergoes a change in the transition to the Minimum energy concept. The house must be smaller and cheaper. Therefore the attic disappears and multi-layered building is also desirable to reach urban housing density. There are some additional problems, because draught-proof outer walls, roof windows and doors do not exist in Dutch house-building. The most important thing is that within a short time a completely new, small and compact ventilation, heating and heat recovery system must be developed. A switch is made from a wood/paper stove to clean natural gas as fuel. The traditional pilot flames in

the gas boiler and the boiler in the attic appear to be accountable for approximately half the gas consumption in a Minimum Energy house.
After an inquiry it appears that the Dutch market is not interested in investing in a small heating and ventilation unit.
This impasse is broken by Koos Slootweg, a young, skilled electrical installation engineer in our place of residence, Deventer, who takes up the challenge to develop and produce a new ventilation and heating concept. And so the new compact heating system is introduced; balanced ventilation with heat recovery, exhaust hood and disturbance detector, installed over the cooker in the kitchen next to the also new electronically ignited gas heater with modulation burner (Fig. 6)

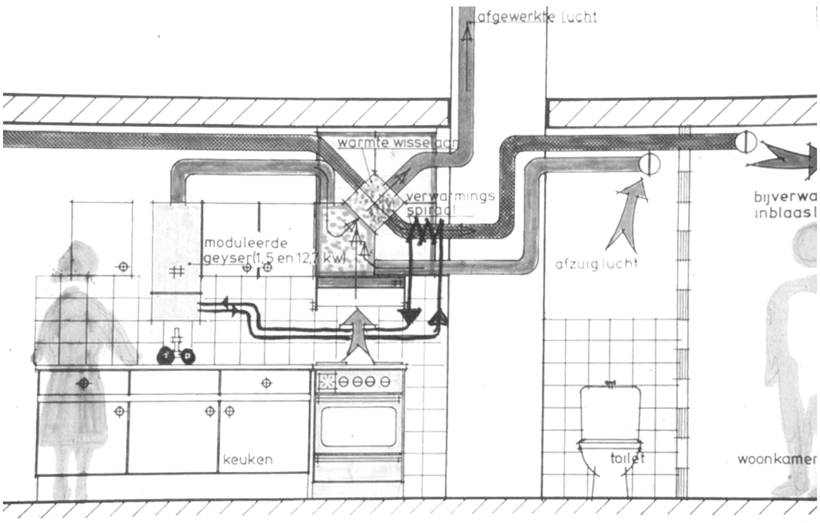

Fig. 6: Compact central air system with cross heat exchanger over the cooker in the kitchen of a unit in an apartment building with horizontal air inlet.

Boiler factory Fasto in Nieuw-Buinen, the Netherlands appears to be ready to develop an electronically ignited gas heater with a modulation burner. The energy balance is carefully adjusted by computer at Fläkt Company in Sweden. The internal big thermal mass of concrete in the apartment settles the air and radiation temperature fluctuations. When the inhabited apartment has the required temperature, 1,5 kW additional heating is sufficient, but via PO Box 51 the Dutch authorities dictate energy saving by temperature reduction during the night. We assume 5 kW in order to heat the apartment in the morning with air of 55˚C. Another problem arises when for the bath-tub and shower 1,5 litre/min. of 60˚C tap water or 12,5 kW is required. The control system and burner become more complicated. Conclusion: a minimum energy house is only possible on the basis of an optimal design and installation system. Through integral designing of all the aspects a great success could be scored. A 20 year-leap forward is too big, however. The against freezing convertible ventilators in the heat exchanger have not been forgotten. However, the weakest link determines the strength of the chain. In practice, 40% of the one-year TNO-tested electronically ignited renovated heater has one or more failures, probably caused by the induction current which has an effect on the advanced control. The initial problems with the electronically ignited boiler have a dramatic effect on the inhabited project. The authorities withdraw financially, the bank withdraws and other building societies lack technical insight and vision of the future and do not give follow-up commissions. The gas price goes down – end of story and bankruptcy for the electrical installation engineer/producer.

4. Looking back

We can state that most constructional innovations in ME-housing projects have practically straightaway found access to the building market. Polystyrene foundation insulation material is a standard product, applied as lost formwork. The firm of De Hoop in Sas van Gent, the Netherlands which made R=5 m^2 K/W ground-level floors, has become big business. Outer wall insulation with "non-impact proof" plaster is allowed in all municipalities. Rockwool is "still going strong", also in hard compressed mineral-wool slabs. Prefab airtight roof elements with insulation applied as trussed rafter roof have become a standard product. The Velux supplier of draught-proof dormer windows has a worldwide return of € 1,5 billion, although they do not meet the Dutch ventilation regulations. Myresjö in Sweden supplies draught-proof triple glazed wooden frames and windows. By now various Dutch joinery works can make double-glazed draught-proof windows. The insulating shutters as "variable elevation" make no headway, however, because the insulation value of windowpanes advances by leaps and bounds and the control of shutters is vulnerable. The EPC (Energy Performance Coefficient) = 0,53 of the ME houses from 1983 is satisfactory when in 2006 we venture to switch from 0.1 to 0.8 as the norm. The gas installations also turned out well finally. The, by initial problems plagued, disturbance-sensitive electronically ignited gas-heater of Fasto has been further developed into a perfect high-tech product, and, together with parent company Nefit, sold to Buderus and later to the German Bosch concern. The above-mentioned inventor and producer of the compact heating and ventilation unit, Koos Slootweg, has been technical director with Nefit in Deventer for some years.

5. Final conclusion:

The development of the Minimum Energy house was a fascinating innovative period. The political leading figure behind the ME houses, ir. Chris Zijdeveld, alderman in Schiedam, has won his spurs as a far-sighted principal.

The compact heating and ventilation unit over the cooker in the centre of the house did not make it. This is a pity, because in all renovation projects the kitchen is the first area to be tackled and there is always room in the house around the exhaust hood.
Time may have caught up with the "Slootweg-unit" by now. Owing to new high-tech decentralized ventilation on the outer wall (for example the 'breathing window') air ducts are superfluous and floor heating has generally replaced convectors. What remains is to find the right air treatment around the kitchen and the in-built wet areas in old and new buildings. This may be the greatest challenge in the development of the Passive House.

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