Embodied energy of thermal insulation – What is that exactly?

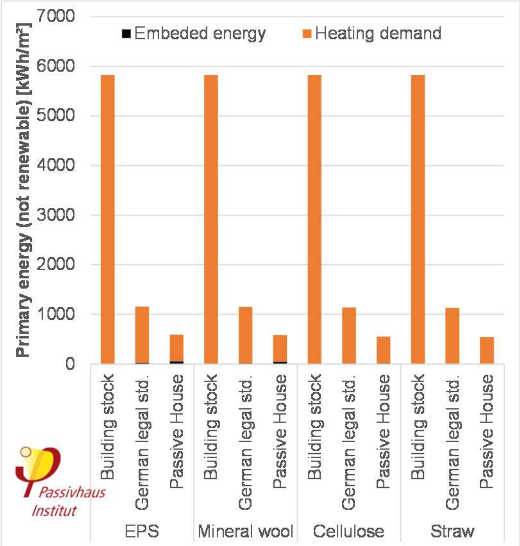
The correct U-value is essential!
For future-proof buildings, the U-value of exterior walls and roofs in cool, temperate climates must be between 0.10 and 0.15 W/(m²K). The type of insulation material used and the kind of construction system selected is not relevant for the heat loss. It is the U-value that matters. This also applies if embodied energy (which includes the non-renewable primary energy that is required for the manufacturing process, as well as that stored in the material) of the insulation material is also taken into account. Here is an example to illustrate this:

The heat loss from an exterior wall of an existing building with a U-value of 1.4 W/(m²K) amounts to 120 kWh/m² of exterior wall per year. Assuming an oil-fired heating system with a performance factor of 1.1 and a PE factor of 1.1 for heating oil, this corresponds with a primary energy demand of 146 kWh/(m²a).
A compound insulation system consisting of polystyrene is applied to the exterior wall. 8.5 cm of thermal insulation are required for refurbishment to the German legal standard with a U-value of 0.3 W/(m²K). In this case, the saved heating energy is 97 kWh/(m²a) of exterior wall per year; in comparison to the primary energy saving of 117 kWh/(m²a), a one-time primary energy expended for the insulation is 24 kWh/m². Thus, in the first year, the primary energy saving due to the insulation is 93 kWh/(m²a), the calculated amortisation period for the insulation is 0.2 years. If a useful life of just 40 is assumed for the insulation, this results in a primary energy saving of 4700 kWh/m² for the German standard variant over this period.

If the refurbishment is carried out to the Passive House Standard instead, the PE saving is actually 132 kWh/(m²a) compared with the existing building stock. This is achieved with an insulation thickness of 19 cm, for which 55 kWh/m² of embodied energy will have to be invested. Although this will increase the energy-relevant amortisation period to 0.4 years, this is irrelevant as it will now be possible to save over 5200 kWh/m² of primary energy over the useful life of 40 years.

This example calculation shows that with reference to the energy-relevant amortisation period, the investment of energy in insulation is extremely worthwhile and makes sense. There are hardly any other measures in the energy sector that are this meaningful. It is much more sensible to invest crude oil in insulation than to use it as a fuel for heating. Added to this is the fact that after using it as insulation, the material can be further utilised through recycling. In contrast, if oil is burned, it cannot be recycled.

Polystyrene, which is assumed as an insulation material in the example here, has a comparatively high primary energy content. The primary energy balance of embodied energy and operating energy over the useful life will be even better if other insulation materials such as mineral wool, cellulose or even straw are used. However, on account of the already extremely low share of embodied energy, the choice of the insulation material plays a less significant role, as the graph below shows.



The primacy of thermal quality follows from this. If this is ensured, the construction and the material for insulation can be optimised. This fact provides ample scope for personal preferences and additional individual criteria such as fire safety, structural characteristics, biological construction considerations, diffusion and sorption characteristics or costs.

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Further information and sources

http://www.passipedia.de/grundlagen/energiewirtschaft_und_oekologie/graue_energie_und_passivhaus-standard
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