DESIGN AND CONSTRUCTION OF HIGH-PERFORMANCE HOMES

Building Envelopes, Renewable Energies and Integrated Practice

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ROUTLEDGE

for preheating before traveling to the heat exchanger. The housing complex included an unconditioned north-facing glass atrium that performed as a thermal buffer. Once completed, extensive monitoring began with results confirming the merit of the idea and the attainability of its goals. As published by the Institut, the inaugural *Passivhaus* uses 88 percent less energy than a typical German home.[18]

By 1998, the Passive Housing Planning Package (PHPP) was developed to guide certified practitioners in designing to Passivhaus standards. The 2007 version of the PHPP is a sophisticated software package available for both residential and non-residential buildings, for new construction and renovations. Validated against 300 projects, the tool facilitates calculation of thermal conductivity values, internal heat gains, energy balance, ventilation rates, total energy demands, and electricity demands from fans and other plug-in loads. It can be used during the design process to parametrically model the effect of external walls, windows, ventilation rates, solar absorption of external materials, and internal loads on energy use.[19]

Tens of thousands of buildings have already been built using the standard, mostly in Central Europe where the climate is optimal. Yet many of its tenets are just as effective in cooling dominated environments that depend on air conditioning for thermal comfort. Highly insulated building skins, minimized thermal bridging, air tightness and energy recovery ventilators are necessary for minimizing the consumption of energy in hot and humid climates. And where abundant solar radiation can be found, the Institut promotes the use of low-tech solar hot water collectors to further offset energy consumption. The worldwide popularity of Passivhaus has resulted in the founding of international chapters including the Passive House Institute US (PHIUS) and Passivhaus UK managed by the Building Research Establishment (BRE).[20] They offer access to a wide array of services including certification of consultants and buildings, thermal modeling, and the testing and monitoring of homes and equipment. The certification process endorses designer/consultants and building inspector/certifiers involved in the delivery of buildings, as well as actual building components tested for performance, including wall and construction systems, glazing, doors, and curtain-wall systems. Certified designers can be found in over 35 different countries including Latvia, United Arab Emirates and Bulgaria. In the United States, nearly 200 PHIUS consultants help with the decision-making process during the early design phase of a project, during construction as well as during post-construction monitoring. Consultants verify homes to ensure they are built air tight and without thermal bridging; details necessary for achieving the Passive House Building Energy Standard and for securing official certification.

Hundreds of successful *Passivhaus* homes have been built, including the first *Passivhaus* certified in London, UK by bere:architects. (Figure 1.1.3) Located in Camden, the two-bedroom, two-storey home is 118 square meters and, in keeping with Passivhaus standards, built using a heavily insulated exterior envelope made of 3-meter-tall retaining walls and prefabricated timber frames. It features glazed openings to the south for maximizing winter solar heat gains. It is cool in the summer and warm in the winter. The PHPP was employed in siting the house and in establishing the amount and location of fenestration. Triple-


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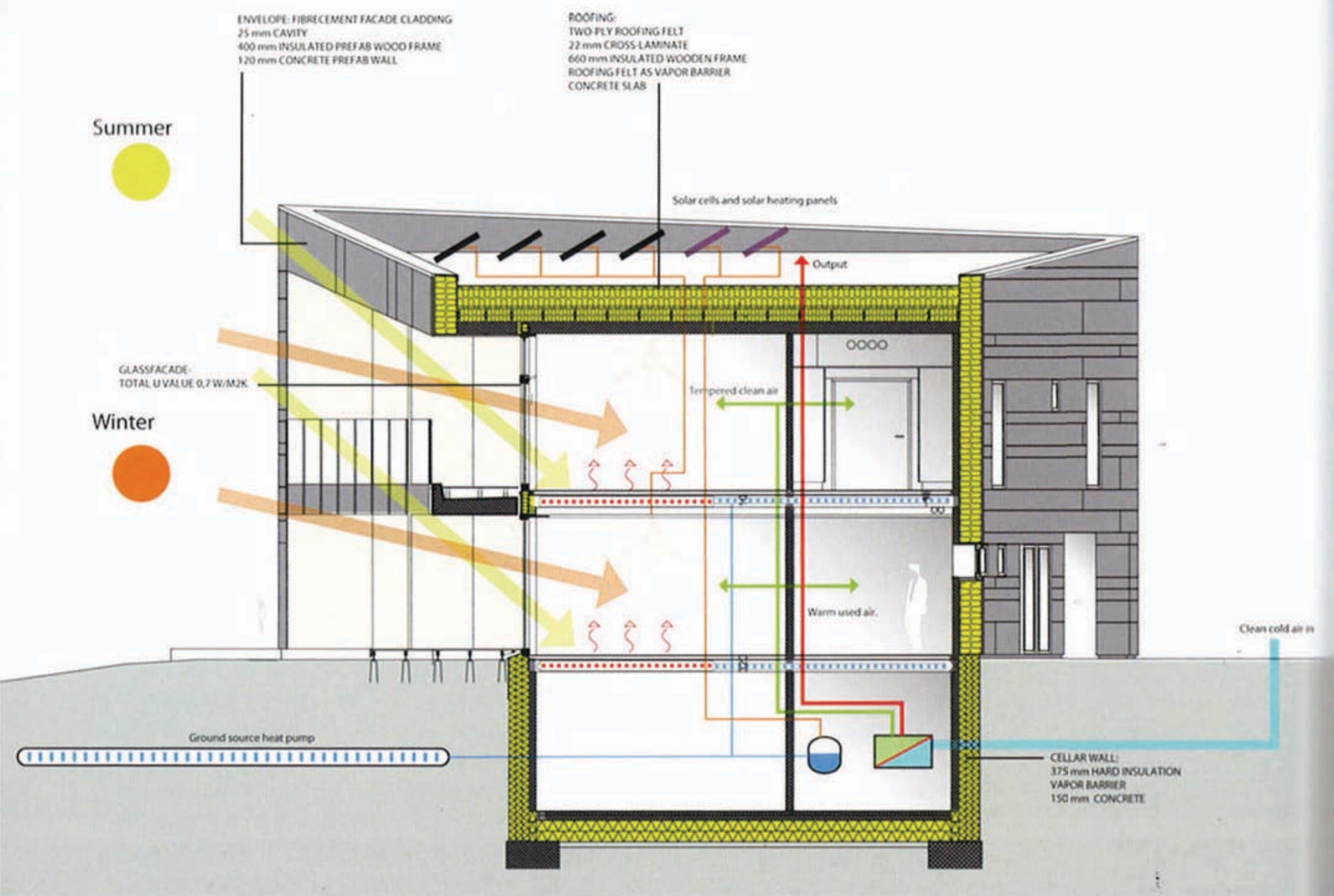
1.1.3 (facing)
Certified *Passivhaus*,
bere:architects, Camden,
London

1.1.4 (top)
Certified *Passivhaus*,
KEY ARCHITECTS, Kamakura,
Japan

glazed windows were used alongside automatic retractable shades for protecting against summer solar exposure. It employs a highly efficient energy recovery ventilator (ERV) that contributes directly to the home's 90 percent reduction in energy consumption over a typical London residence. In desiring to implement larger ecological strategies, rainwater is harvested and a solar thermal panel is used for supplying the house's domestic hot water needs. Urban landscaping strategies include a green roof and south-facing green wall. And as noted by bere:architects, the project surpasses the minimum standards of the UK Building Regulations Part L 2006 by 70 percent as well as being compliant with the UK 2016 definition for zero-carbon homes. The firm's commitment to the Passivhaus program continues, having just completed a *6-Month Post-Construction and Initial Occupation Study* and initiating a *24-Month In-Use Performance and Post-Occupancy Evaluation*, both of which were funded by the UK's Technology Strategy Board.

In autumn 2009, the very first Japanese certified *Passivhaus* was built in Kamakura city, Kanagawa prefecture, Japan, by KEY ARCHITECTS. (Figure 1.1.4) The two-storey home was designed to integrate within its setting as well as to promote the tenets of energy-efficient design. To this end, it was clad with locally sourced cedar, detailed with an abundance of insulation, glazed with triple-pane windows from Germany and built according to the best practices for achieving air tightness. Light wood-frame techniques were used for the house's main structure and wood fibers were used for insulation. Its particular invention lay in updating Passivhaus standards for the Japanese climate, being a great deal more humid than the temperate climate of Europe. Unconventionally, this house used a vapor barrier/retarder that allows the air moisture to travel in both directions across the wall, avoiding the very real possibility of condensation in the building envelope. In so doing, this *Passivhaus* demonstrates the program's capacity to accommodate to local conditions.


ENVELOPE: FIBRECEMENT FACADE CLADDING
25 mm CAVITY
400 mm INSULATED PREFAB WOOD FRAME
120 mm CONCRETE PREFAB WALL
ROOFING:
TWO-PLY ROOFING FELT
22 mm CROSS-LAMINATE
660 mm INSULATED WOODEN FRAME
ROOFING FELT AS VAPOR BARRIER
CONCRETE SLAB
Summer
Solar cells and solar heating panels
Output
GLASSFACADE-
TOTAL U VALUE 0,7 W/M2K
Tempered clean air
Winter
Warm used air.
Clean cold air in
Ground source heat pump
CELLAR WALL:
375 mm HARD INSULATION
VAPOR BARRIER
150 mm CONCRETE