

Lozen Passivhaus 2012 - 'LPH2012'

The prime concept in Passivhaus design is the building envelope. To reduce the wall area to volume ratio, a simple box form was initially created. The box form was manipulated by carving out a front porch and a balcony above. At the rear of the house, a deck was added to provide shade for windows during summer and cover from the rain and snow during the winter months. To ensure consistent building envelope barrier, the walls at ground floor and upper floor line up and balconies are thermally-broken from the wall assembly to reduce thermal conduction.

Building construction :

The house is built without a basement to reduce site soil disruption. A perimeter footing system is employed for ease of construction by local tradespeople. Footings are insulated around exterior with 2" [51mm] expanded polystyrene (EPS) rigid insulation. The ground floor concrete slab is insulated below grade with 12" [305mm] of EPS rigid insulation. A 4" concrete slab is poured over and a 1" gap between the foundation wall and slab is filled with rigid insulation and finished with a bead of flexible sealant. This provides a continuous thermal break. Walls are built by local craftspeople using traditional brick-laying methods. Once the walls are built, exterior rigid insulation is installed around the entire envelope. The upper floor and roof concrete slabs are then completed. Windows and doors are installed and additional rigid insulation at the perimeter of the openings is installed. An air-tightness blower door test is conducted to ensure proper air sealing and to eliminate any draft spots prior to finishing the interior. Exterior walls are strapped with wood strips to ensure a vapour diffusion cavity behind the exterior finish. Commonly used in Bulgaria is stucco for exterior finish, as well as, on the LPH2012. The exterior finish at the north elevation is tongue & groove wood siding. The roof has a minimum of 9" of rigid insulation sloped towards the roof drains, which collect water for use in the house and for landscape irrigation. Durable 2-ply Styrene-Butadiene-Styrene (SBS) modified-bitumen waterproof membrane is the finished material for the roof. High albedo (high reflectance) of the membrane ensures that the heat island effect is minimized. As an option, the roof may be finished as an extensive green roof to further reduce water run-off and heat island effect. The interior of the house is built out with 2x6 wood studs and any mechanical, electrical and ventilation conduits are placed in these chase walls. The walls and ceiling at roof are tightly insulated with rockwool and enclosed with drywall. A final blower door test is performed once all wall penetrations, such as light boxes, light fixtures and plumbing pipes are sealed. Interior finishing is completed and plumbing fixtures, cabinetry, appliances are installed.

Building envelope :

The ground floor concrete slab is insulated by 12" EPS insulation and is thermally-broken along the perimeter by 1" of rigid insulation. The exterior walls are built with traditional massive stone construction. To ensure a thermal barrier, 2" of rigid rockwool insulation is provided around entire thermal envelope (walls) above grade. 2" of EPS rigid insulation is provided at the foundation walls below grade. The balconies are discontinuous from the floor slabs maintaining the thermal break. A $\frac{3}{4}$ " vapour diffusion cavity is provided between the exterior insulation and backside of stucco cladding, which also acts as a capillary break. Roof insulation is sloped towards the roof drains and is finished with decking and 2-ply SBS waterproof membrane. The roofing membrane is extended up the parapet walls to ensure water tightness.

Site layout :

The site is clearly defined by five zones. The zones are semi-public entry zone, house and side yard zone, back deck zone, open back yard zone and the edible garden zone.

- The semi-public entry zone consists of the area south of the property line at the street and the front of the house, and encourages social interaction with pedestrians and neighbours. The main driveway entry and outdoor parking area is located to the east side of the house. Main pedestrian walkway built of stone slabs surrounded by permeable gravel is at the west side of the property. The front porch is covered by a balcony above creating weather protection for homeowners and visitors alike.
- The house is wrapped by two side yards. On the eastern side yard is open lawn space for the homeowner's children to play, as well as, enjoy the morning sun. A stone wall flanks the yard along the north to provide protection from the driveway and visual privacy from the street. The western, narrow side yard is intended to be a flower garden and for spending time in during the afternoon.
- The back deck is located directly off the main living space of the house. Generous hard surface deck can be used throughout the year and provides space to enjoy the sun on a hot summer day. From this location, line-of-sight of most of the property is possible.
- The enclosed backyard provides a safe place for children to play, while a large living room and second floor deck allow for observation.
- Along the eastern side of the back yard are two raised planters for a vegetable and herb garden, to provide a sustainable food system and food independence for the homeowners. A compost box is also allocated in this area to reduce waste.

Interior layout :

The interior of the house is principally an open concept with only partitions to the bedrooms and a den/office space. Entry, powder room and a den are located on the north side of the house to allow for daytime used spaces (dining, living room) to be located on the southern sunlit side. Circulation was carefully considered and minimized. A central staircase separates the living space from the dining/kitchen space on the ground floor and separates the master bedroom/ensuite area from the children's bedroom/bathroom area.

Ecological considerations :

All interior finishes are specified to contain no harmful chemicals to the inhabitants, such as no-VOC paints, formaldehyde-free cabinetry and Greenseal-certified natural wool carpets with jute backing. Spray foam is avoided and all wood framing including any OSB sheathing is formaldehyde-free. All wood used in the construction of the house is either FSC certified, beetle-kill pine or recycled lumber (that has been previously harvested) to ensure sustainable forestry practice. Wood framing is spaced at 24" on centre to reduce quantity. Exterior driveway is paved with open grass-crete surfacing to allow for drainage.

Lighting :

In order to reduce the need for artificial lighting, the focus was set on ensuring all rooms have natural light. The use of clerestory windows allows natural light during the entire day to enter the house. A central skylight and opening in the second floor at the stairs allows for sunlight to illuminate the central areas of the house naturally. For artificial light, LEDs are specified throughout circulation areas as they produce no heat and use miniscule amounts of energy. Occupancy sensors reduce waste energy.

Heating and cooling :

A small air-to-air heat pump will provide all the necessary heat required. The heat pump can also function as an air conditioning unit if the need arises during the summer months. Due to the sun shading provided by the roof overhang and deck at the south elevation, overheating is minimized. Window glazing on the south elevation of the house is specified with high solar heat gain coefficient and low emissivity to trap warm air indoors during the low-angled winter months of the year. A deciduous tree planted at the south-east corner of the house will additionally block any summer sunrays to the house, and during winter months, when the branches are bare of leaves, will allow for sunlight to penetrate.

Ventilation :

During the summer months, the windows and doors can be kept open to provide natural cross-ventilation. A highly efficient heat recovery ventilator (HRV) will provide fresh air when doors and windows are closed. A humidity sensor in the kitchen and bathrooms will adjust the speed of the HRV to balance the humidity in the house. The skylight is outfitted with a sensor for wind and rain and will close when activated. To reduce the need for HRV to operate when conditions outside are favorable, the skylight will open to allow for stale warm air to be released.

Water / plumbing :

Rainwater collection is integrated into the roof with containers located underground in the yard. Rainwater collection will be used for the clothes washing machine, toilet flushing and watering the gardens. Drying clothes will be done on a clothes line in the backyard, weather permitting. Hot water heating will be provided by solar hot water panels and when extra heating is required, a small on-demand gas water heater is supplied. Toilets will be low-flow, dual-flush type. Kitchen faucet, bath faucets and shower head will be low-flow to reduce water consumption. An additional exterior water barrel is located in the yard for watering plants and garden plots.