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PHeasibility Report

For:	NicoBells Ltd. (Rochelle Ade & Joel Payne)
Project:	Living House
Project address:	119 First View Avenue Beachlands Auckland 2018 New Zealand
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Revision:	-

Executive Summary

The Living House is a proposed 2-storey rammed earth dwelling with attached double garage and family unit. The project is aiming for Living Building Challenge, HomeStar and Passive House Certification.

PHeasibility is a Passive House feasibility & modelling service to determine how the current design performs in terms of energy consumption and occupant comfort. It also looks at ways the design could be developed to meet the requirements of the international Passive House Standard.

The results of the modelling indicate that the current design has an annual heating demand of 12 kWh/(m²a). This means that a total of 2072 kWh of heating is needed per year to maintain internal temperatures at 20 C for the whole house, excluding the garage and family unit.

The results also indicate a heat load of 12 W/m². This means that the heating system needs to provide a maximum heat output of approximately 2.072 kW on the coldest days of the year to maintain internal temperatures at 20 C for the whole house, excluding the garage and family unit.

Passive House certification could be possible with the current design as the heating demand is below the certification requirement of 15 kWh/(m²a). Assumptions used in the current modelling would need to be verified or corrected and development of the construction details would need close attention. Some details are critical thermal bridges as currently indicated and would need developing to be acceptable. Construction quality would also need to be high enough to conform with Passive House requirements, particularly blower door testing to achieve an airtightness measure of 0.6 ach.

Contents

PHeasibility Scope

PHeasibility is a Passive House feasibility & modelling service undertaken at the concept / sketch design stage to determine how the proposed design performs in terms of energy consumption and occupant comfort. It is not a full Passive House design service and only includes a level of detail equivalent to concept / sketch design.

Included

- Expert visual assessment of drawings and information provided
- Passive House modelling of the current design using the Passive House Planning Package (PHPP V9.6a)
- Review and interpretation of the PHPP modelling results
- Sensible and conservative provision for thermal bridges in the PHPP model, based on the visual assessment of the information provided

Excluded

- Thermal bridge modelling. Thermal bridge modelling can be undertaken as a separate service if required. The fee is $300 +GST per detail / thermal bridge model.
- Modelling multiple ventilation units / systems. A single system is assumed.
- Primary Energy or Primary Energy Renewable calculations. These would only be undertaken when full Passive House Design services are provided
- Modelling of summer cross-ventilation through windows. Some preliminary commentary on this may be provided if the modelling indicates a summer overheating risk.
- The PHPP file. This is not released because it is both our intellectual property and highly technical. For an additional fee of $500 +GST a copy of the PHPP file can be provided. This may be desirable if the design is intended to be developed by a competent person to meet Passive House Certification requirements.

Note

- All calculations and results are in English and use Metric units.

Results

The main results of PHeasibility are the annual specific heating demand, the heat load and the risk of overheating.

Modelled with standard PHPP 3 occupancy values (3 adults) the results are:

Measure	Living House	Passive House requirement	Units
Heating Demand	12	15	kWh/(m².a)
Heating Load	12	10	W/m²
Overheating	5	10 (Best practice 2 %)	% time that internal temperature exceeds 25 C

Heating

Passive House certification requires that either the heating demand <u>or</u> the heating load are below the required limits. For the Living House, the Heating Demand of the current design as modelled complies with the Passive House requirement.

Multiplying the heating load (12 W/m²) by the treated floor area (172.7 m²) gives a total heating output required for the coldest days of approximately 2.072 kW. The heating system can be sized on this basis, provided the assumptions set out in the next section are correct and the built house matches the current design and modelling assumptions.

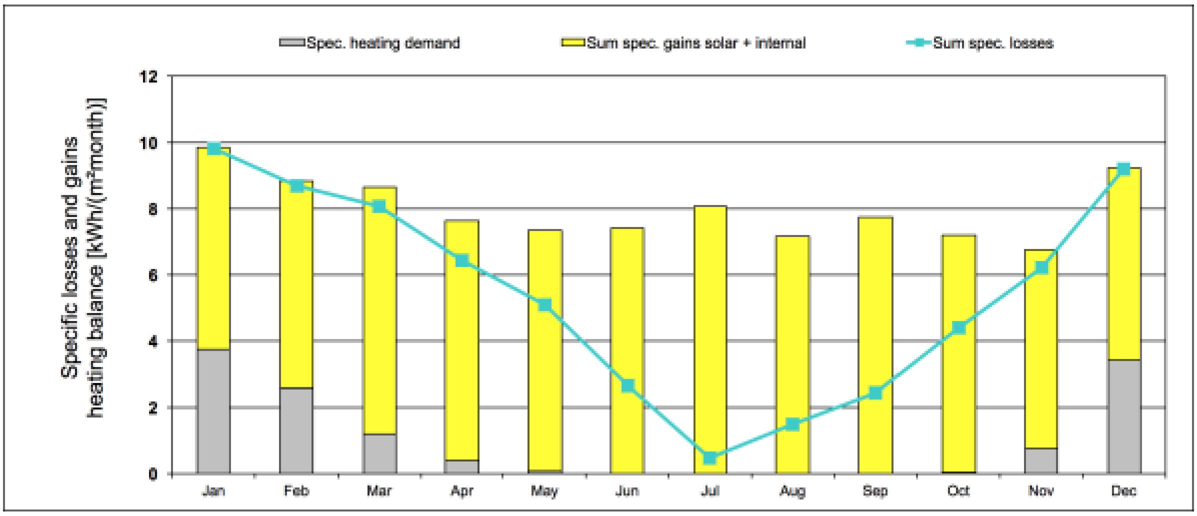
However, at this stage it would be better to add a sensible margin to account for the assumptions in the PHPP model and design development, construction etc. EG size it for 15 W/m² maximum (2.591 kW total) although you may never need that much unless you want to keep your house warmer than 20 C.

The heat capacity of air means a maximum of only 10 W/m² heating can be provided through the ventilation system, if you were considering this. Therefore, the heating could be provided partially in the ventilation air and partially through other means, or entirely through other means. If you do wish to provide some heating through the ventilation all the fresh air supply ducts need to be suitably insulated.

If there is a poor match between what gets built and the current design and modelling, there will be a ‘performance gap’ between what is predicted and the actual requirements.

Overheating

Overheating is not a major issue at only 5% of the year, which complies with Passive House requirements. This is equivalent to 438 hours or 18.25 full days. However, in reality, overheating tends to happen late afternoon and early evening before outdoor temperatures start to fall again. Therefore 438 hours is likely to be spread over something like 73 afternoons – evenings (6 hours / day above 25 C) or even 110 afternoon-evenings (4 hours / day above 25 C). The PHPP indicates the overheating would occur mainly from November to April. You can see this in the following chart where the yellow bars exceed the blue line. Note the labelling of the months is for the Northern Hemisphere and what is labelled “Jun” is in fact December in New Zealand.



It should be noted, however, that the thermal bridging of the concrete ring beams at first floor and eaves level are currently keeping the overheating this low. If these thermal bridges are reduced to a sensible amount, which would be required for Passive House certification, the overheating increases to 19% which is catastrophic. There are other measures that need to follow on from reducing these thermal bridges to still meet Passive House requirements. Some suggestions follow in the next section of the report.

Also, external or internal blinds have not been included in the PHPP model or the cooling effects of any ventilation through opening windows. Some of the overheating might be mitigated with sensible use of blinds and opening windows in the morning and evening when the outdoor air is cool. More detailed PHPP modelling (beyond the scope of this service) can check this.

Design Data and Assumptions

If any of the following is incorrect I am happy to make corrections / changes once, on receipt of suitable evidence, and provide an updated report.

Roof – the thermal envelope is at ceiling level and comprises 300 x 100mm timber rafters @600mm centres with 300mm glass wool insulation between, 19mm ply sheathing. Internal and external finishes are ignored. U-value 0.168 W/(m²K)

Walls – Cement stabilised rammed earth comprising 140mm rammed earth, 70mm XPS insulation, 140mm rammed earth. U-value 0.418 W/(m²K)

A thermal conductivity of 1.25 W/mK has been used for the rammed earth. For certification, the value to use would need to be agreed with the Passive House certifier to account for the cement / sand / earth mix, compaction and steel reinforcing in the earth and passing through the insulation.

Ground floor slab – 100mm rammed earth on 150mm compacted gravel on 30mm XPS insulation. U-value 0.224 W/(m²K)

A thermal conductivity of 1.25 W/mK has been used for the rammed earth and 1.5 W/mK for the gravel. As per the note above, this would need agreeing with the Passive House certifier.

Glazing – assumed to be Dopfner as supplied by Ecowindows: double pane Climaplus Ultra XN with warm edge spacers. U-value 1.1 W/(m²K), g-value 0.65.

Window frames – assumed to be Dopfner as supplied by Ecowindows: dimensions based on Dopfner brochure images, thermal performance based on Passive House certified component "Carpinteria Llodiana S.A. - VENTACLIM SUPER-CONFORT - CHROMATECH ultra F" as a near match for the Dopfner Wood/Aluminium system with accurate data available. U-value 0.98 W/(m²K) on sides and top, 1.01 W/(m²K) on the bottom.

Door frames - based on the same information as the windows. If the doors have different frame widths then U-values may be poorer. Dopfner may not be able to supply all the doors currently indicated in the design also and this should be checked as early as practical with Ecowindows.

Thermal Bridges - the following thermal bridges have been measured and assigned assumed values in the PHPP model:

- Repeating thermal bridges – included within assembly U-value calculations
- Window and door installation – included as 0.040 W/mK (good thermal installation) within the window calculations
- Ground slab perimeter (geometry / detail) – 0.333 W/mK
- First Floor concrete beam – 1.0 W/mK
- Eaves concrete beam – 1.0 W/mK

Ventilation - The number of bathrooms / en suites / kitchens etc in the house, requires a maximum of 168 m^3/hr extract according to the Passive House mythology of sizing ventilation systems.

The PHPP model includes a Zehnder ComfoAir 350 to provide balanced ventilation for the whole house. It is best located inside the thermal envelope and adjacent an external wall. The ducts with outside air coming and going from the unit need to be as short as possible and well insulated with vapour impermeable insulation. It would be possible to locate it in the garage, if this is preferable, although it may reduce the efficiency slightly. It could be possible to use a larger MVHR unit to provide ventilation to the family unit also. However, depending on occupancy, it might be better served with a small independent ventilation system.

- Zehnder systems are used in PHeasibility as the only Passive House certified ventilation system currently on the market in NZ. Other systems are available from Australia or Europe.

- Fantech, who supply Zehnder in NZ, should be able to provide you with a ventilation design if you wish to use a Zehnder ventilation system.

- Alternatively, VIA architecture can design the ventilation system (using Zehnder or a different system) or carry out an independent check of the design by Fantech or any other supplier.

Airtightness - a blower door test result of 0.6 ach is assumed. A higher result (more leakage) will make a noticeable increase in the heating load (and how big the heating system needs to be) and may affect the overheating. It will also increase the risk of uncomfortable draughts, condensation and mould. Similarly, a lower result will reduce the heating load.

Treated Floor Area (TFA) – this has been measured as 172.7 m^2.

Heat Loss Area – this has been measured as 396.3 m^2. This results in a heat loss form factor of 2.3 indicating that the design is inherently efficient.

Orientation - the orientation of the elevation labelled as “North” has been measured as 15 degrees west of north.

Reference - All design information used in the PHeasibility is based on telephone conversations / emails and drawings provided by the client. Measurements are taken from the following drawings: A1 - 5 and 7 – 9, all revision B draft

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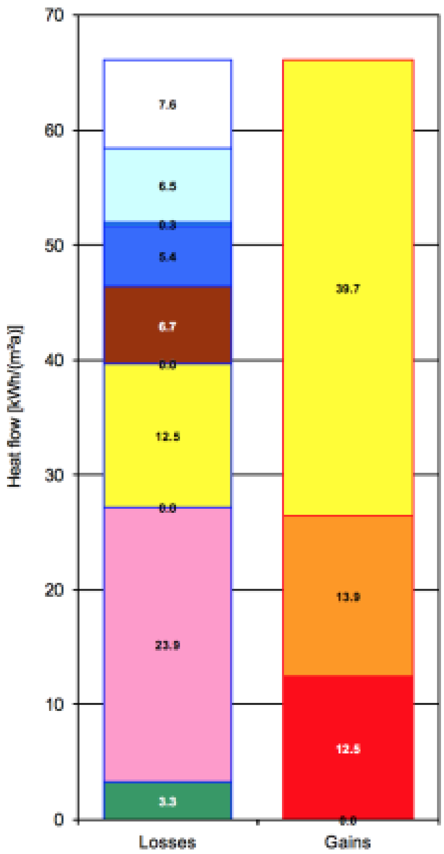
Improvement strategies

The following graph is taken from the PHeasibility PHPP modelling and indicates the heat balance calculated using the monthly method.



Key things this graph illustrates:

- Thermal bridging losses are extremely high and need to be reduced, ideally eliminated. Aside from significant heat loss, there is very high risk of condensation and associated problems. This is largely due to the concrete ring beams.

- Heat loss through the windows and doors could be the next target for improvement as they are the next largest heat losses. Construction detailing would need to ensure that an installation thermal bridge PSI-value of 0.04 W/(m.K) is achieved. Or the detail modelled and an accurate value used.

- Solar heat gain is high at three times greater than internal heat gains. In a well-balanced high-performance home, solar heat gain, internal heat gains and heating requirements should be in the same order of magnitude. The solar gain is offsetting heat losses but also contributing to the overheating. The thermal bridging is effectively masking the true effects of the overheating. If the thermal bridging is reduced or eliminated the overheating rises to 19 % which is catastrophic. To mitigate this, the glass can be changed to Dopfner Cool-lite

SKN174 double glazing with a U-value of 1.1 W/(m^2K) and a g-value of 0.41. This reduces the overheating to only 3 %, the heating demand to 8 kWh/(m^2.a) and the heat load to 8 Wm^2 – all giving good margins to work on developing the project for passive House certification.

- Solar heat gain could also be reduced by increasing shading (mainly by overhangs and/or external blinds) or by reducing the amount of glazing.

Next Steps

Passive House certification could be achieved with careful development and construction of the current design. Improvements in the previous section, or other measures with similar results, would need to be implemented. Assumptions in the current PHPP model would need to be verified or corrected and various details would need to be developed with close attention to keeping the insulation continuous and the construction airtight.

If you wished to pursue Passive House Certification*, a more detailed PHPP model would need to be created once the design has been developed in more detail. Consent and construction drawings, details and specification would need to be reviewed. Blower door tests would need to be undertaken during construction and there are specific information requirements for the construction process.

As well as working with a Passive House Designer, it would be best to appoint a Passive House Building Certifier early so that they could advise on specific certification requirements. For example, they would confirm which junctions, if any, would need thermal bridge modelling. The Passive House Building Certifier must be independent of the Passive House Designer to safeguard the quality assurance process of Passive House certification.

Or, if you do not wish to pursue Passive House Certification, you may still find value in an updated PHPP model once the design has progressed. Similarly, an independent expert Passive House review of the drawings and details could be of value.

- ➢ If you would like me to assist or guide you with any of the above, please get in touch.

Best wishes for a smooth process and a successful outcome: a comfortable and energy efficient home you are happy with.

* Please note, a building cannot be referred to as, or claimed to be, a “Passive House” unless it is certified by a Passive House Building Certifier authorised by the Passive House Institute.

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Passive House Glossary

<u>The international Passive House (Passivhaus) Standard</u>
The world's fastest growing energy efficiency standard for buildings. The standard is based on achieving the optimum indoor conditions for human comfort and well-being (based in part on BS EN ISO 7730), whilst only requiring a minimal amount of energy. It is a performance standard with clearly defined metrics and a rigorous design and performance modelling methodology. The standard is administered by the Passive House Institute in Germany. For more information, see: What is the Passive House Standard?

<u>Passive House Classes</u>
There are 4 levels of Passive House for new buildings:

1. Low Energy House – as Passive House below but slightly relaxed targets

2. Passive House 'Classic' – well insulated, draught-free, good solar design, ventilation system with heat recovery, high performance windows and doors. This is typically what is meant by "Passive House".

3. Passive House Plus – as 'Classic' above with renewable energy generation accounted for based on the building footprint

4. Passive House Premium – as 'Plus' above with surplus energy generation

<u>Passive House Retrofit: EnerPHit</u>
EnerPHit – as Passive House 'Classic' above but with slightly less stringent requirements due to the nature and complexity of retrofit. EnerPHit can be achieved by meeting energy demand requirements or alternatively by following the 'component method' using Passive House certified components.

<u>Thermal Envelope</u>
This refers to the parts of a building that thermally separate the inside from the outside. It includes walls, floors, roofs (or ceilings, depending on where the insulation is located), windows and doors. It must be continuous and unbroken for Passive House. For more information, see: What is the Passive House Building Envelope?

<u>Heat Loss Area</u>
The total surface area that forms the thermal envelope of a building and therefore may lose heat. It includes ground floor, walls, roof, soffits etc. Areas are measured in total without subtracting windows, doors, rooflights, etc.

<u>Treated Floor Area</u>
The convention for measuring usable floor area within the thermal envelope. Rooms are measured from the internal finish of the walls, ignoring fitted furniture etc. Stairs and lifts are excluded, full landings, store rooms, bathrooms etc are included.

Heat Loss Form Factor
The ratio of heat loss area to treated floor area. Generally, 3 and below is efficient. For more information, see: [What is the Heat Loss Form Factor?]

Heating Demand
The total amount of annual heating energy required per square metre of treated floor area to maintain a Passive House building at the design temperature. Passive House requirement: 15 kWh/(m^2.a)

Heating Load
The maximum amount of power required per square metre of treated floor area to maintain a Passive House building at the design temperature. Passive House requirement: 10 W/m^2

Design temperature
Passive House uses 20 °C (68 °F) as a design temperature by convention. This is within the healthy range of temperatures for human occupation at 50% Relative Humidity (RH). Occupants may, of course, choose what temperature to maintain their house at regardless of the design temperature. Energy consumption will vary accordingly.

Primary Energy (PE) or Primary Energy Renewable (PER)
The total amount of source energy from fossil fuels (Primary Energy) or from a mixture of fossil fuel and renewable energy (Primary Energy Renewable)

Thermal Bridge
A thermal bridge is where something that conducts heat passes through ('bridges') the insulation. For example, steel, concrete or timber. Heat transfer follows the path of least resistance therefore thermal bridges can contribute significate unwanted heat loss. Thermal bridges also increase the risk of localised condensation, mould and moisture related issues. For these reasons, Passive House aims to eliminate thermal bridges. For more information, see: What is Thermal Bridge Free Construction?

PHPP
The Passive House Planning Package – the building performance modelling tool that must be used in Passive House design and certification. For more information, see: What is the PHPP?

ach
"Air changes per hour" the units used when measuring how airtight a Passive House building is. A blower door test (V50) is used to measure how often the enclosed visible air volume (ceiling voids, partition cavities etc are excluded) would be changed by infiltration through the building fabric at 50 pascals air pressure.