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Tree Removal Supplementary Information for 18 Raeburn Ave

1 Passive House

The Passive House is the world's leading standard in energy efficient design. It started out as a construction concept for residential buildings in Central Europe. Today, the Passive House Standard can be implemented in all types of buildings almost anywhere in the world. Passive House is a building standard that is truly energy efficient, comfortable and affordable at the same time.

Passive House certification is a rigorous quality assurance process that determines whether a building meets all of the requirements of the Passive House standard. More importantly, it confirms that the building has been designed to achieve high levels of occupant comfort and health and energy performance.

Main Criteria for Passive House Certification

For a building to be certified as a Passive House, it must meet the following main criteria:

		Criteria	Alternative Criteria
Space Heating	Heating Demand	≤ 15 kWh/m2a	
	Heating Load		≤ 10 W/m2
Space Cooling	Cooling & Dehumidification Demand	≤ 15 kWh/m2a	
	Cooling Load		≤ 10 W/m2
Airtightness	Pressurization Test Result @ 50 Pa	≤ 0.6 ACH	
Total Primary Energy Renewable Demand		≤ 60 kWh/m2a	

All of the above criteria are achieved through intelligent design and implementation of the 5 Passive House principles:

1. Super insulated thermal envelope
2. Airtight construction
3. High-performance glazing that allows for solar heat gain in the winter months
4. Thermal bridge free design
5. Ventilation with heat recovery

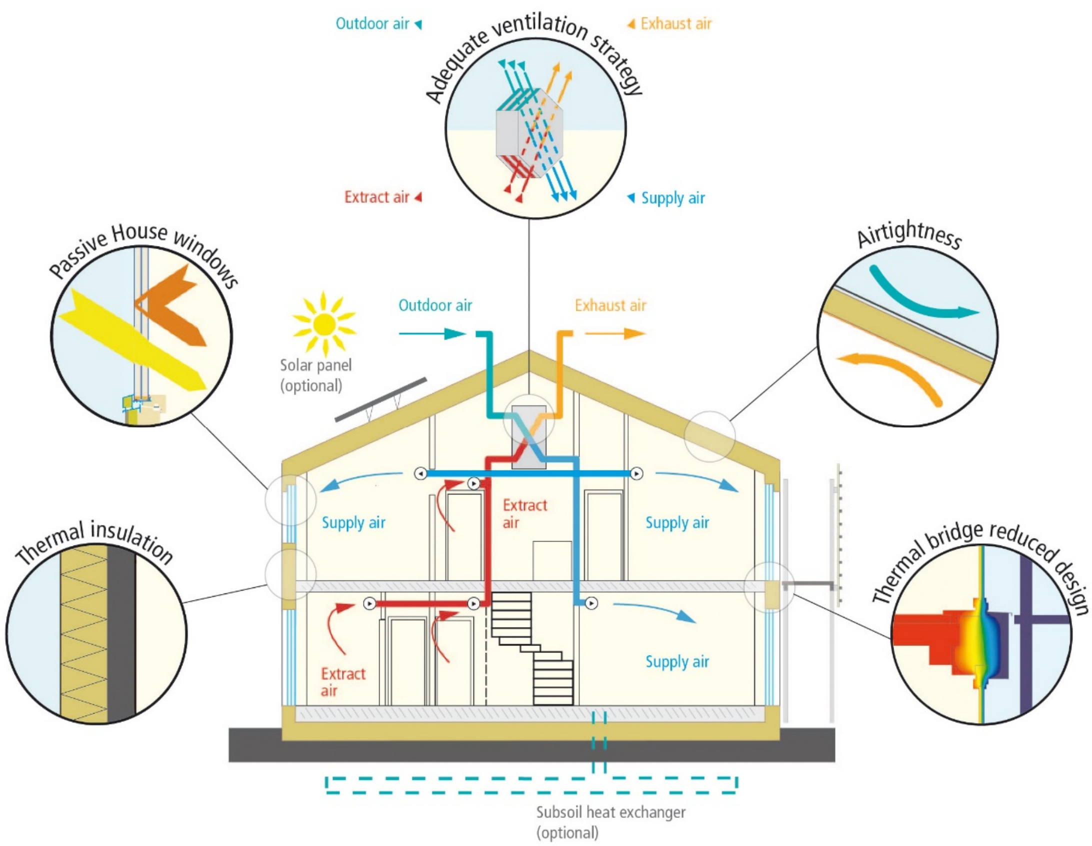

Figure 1: Passive House design principles

2 PHPP

The Passive House Planning Package (PHPP) is the energy modelling software used for Passive House certification. The software uses steady state calculations and was developed with the aid of dynamic simulation tools. The software has been validated for low energy buildings through comparison with actual measured energy consumption data. An article demonstrating this validation can be found here:
https://passipedia.org/planning/calculating_energy_efficiency/phpp_-_the_passive_house_planning_package/phpp_-_validated_and_proven_in_practice

The software calculates the annual heating demand, heating load, cooling demand, cooling load, overall energy use of the building, among other outputs. The modelling in PHPP involves accurate modelling of the building envelope including thermal bridging, windows, solar gains through the glazing, airtightness, HVAC system, DHW system and additional electrical energy such as appliances and small electronics.

3 18 Raeburn Ave

18 Raeburn Avenue is designed to the Passive House standard and aiming for Passive House certification. The house was modelling using the Passive House Planning Package (PHPP) to demonstrate that the design meets the Passive House criteria.

Our current design has been optimized and represents a high performance home which includes:

- Triple pane windows R-8
- Compact design
- Heat Recovery Ventilation (83% efficiency)
- High Performance Thermal Envelope
  - Above grade walls R-68
  - Below grade walls R-58
  - Roof R-83
  - Floor R-58
- Thermal Bridge Free Design
- Continuous air barrier

The following two bar graphs shows the energy balance in the winter of the house with and without the two coniferous trees at the front of the house**. With a deciduous tree replacing the two coniferous trees the solar heat gains increase by 12%. This increased solar heat gain reduces the need for mechanical heating by 17%**, from 15.5kWh/m^{2}a to 12.9kWh/m^{2}a, and allows for the design to meet the space heating demand target for Passive House certification.

Other options to reduce the space heating demand to meet the Passive House target were investigated. The insulation and ventilation heat recovery efficiency have already been optimized so there is little room for improvement with these measures**. For example, with above grade walls with a thickness of 21" and overall R-value of R-69, adding an extra 2" of insulation would only reduce the mechanical heating by 4%.** Similarly, the chosen Zehnder ComfoAir Q450 is a certified ERV with heat recovery efficiency of 83%. This unit is one of the highest efficiency ERVs available in the North American market. Therefore, the measures we looked at improving were the windows and airtightness. **Using EnerSign windows instead of the Vetta Puro Passive windows improves the overall average U-value of the windows from 0.75W/m^{2}K to 0.70W/m^{2}K and subsequently** **reduce the mechanical heating by 7%,** from 15.5kWh/m^{2}a to 14.5kWh/m^{2}a. Another option would be to aim for a **reduced airtightness target of 0.4ACH at 50Pa which would also reduce the mechanical heating by 7%**, from 15.5kWh/m^{2}a to 14.3kWh/m^{2}a. The Passive House criteria is an airtightness of 0.6ACH at 50Pa. While these options are below the Passive House criteria of 15kWh/m^{2}a**, we generally recommend aiming for 13 kWh/m^{2}a at the design stage so that there is room for any construction changes that are inevitable.** Furthermore, the airtightness target of 0.6ACH at 50Pa is already a challenging target to meet and while we can design the details to ensure a continuous air barrier, the actual performance highly depends on the construction quality and requires collaboration by all sub trades. It is our recommendation to replace the coniferous trees with deciduous trees in order to have the best chance of meeting the criteria for Passive House certification.

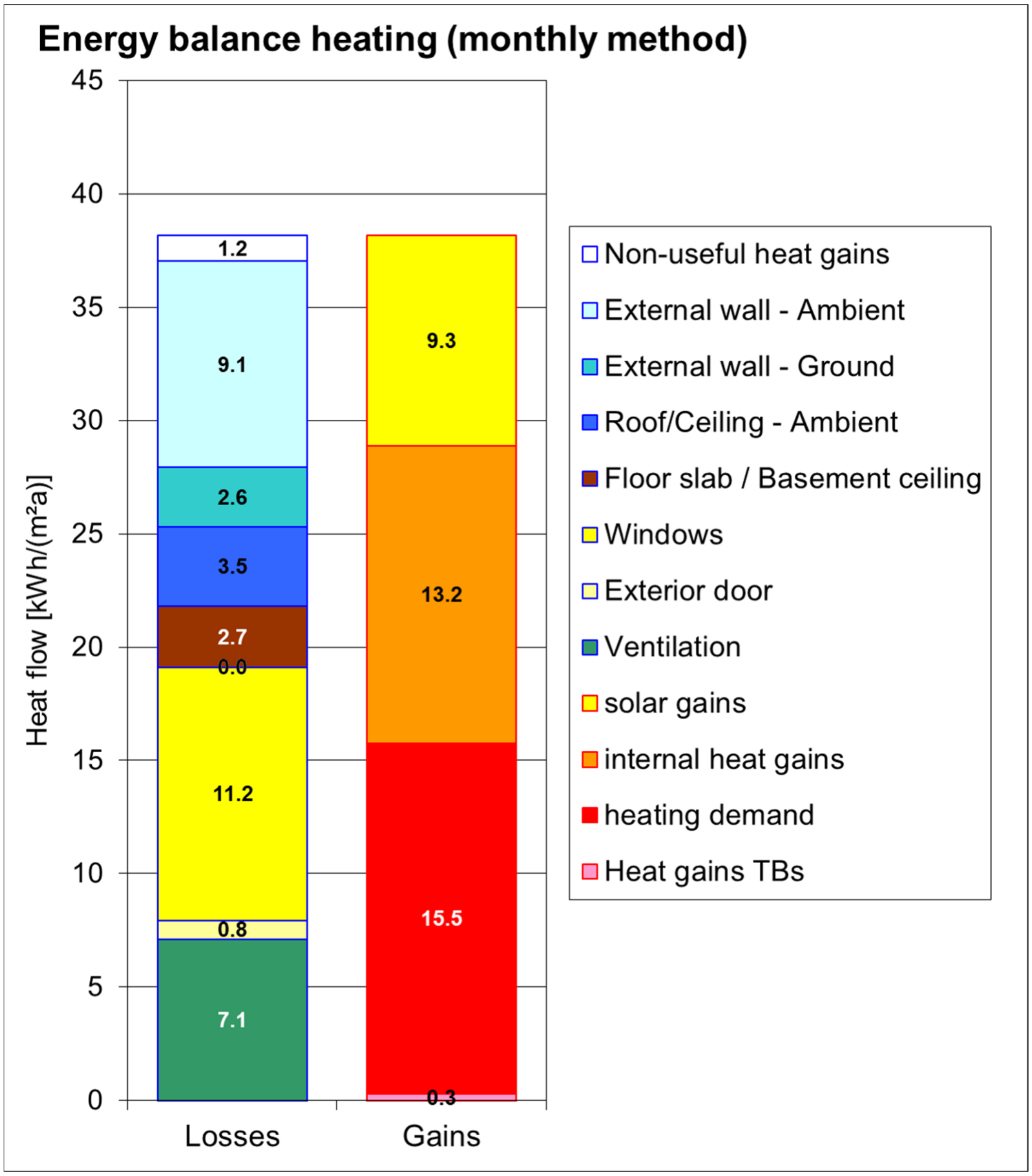

Figure 2: Energy balance with the two coniferous city trees in front of the house

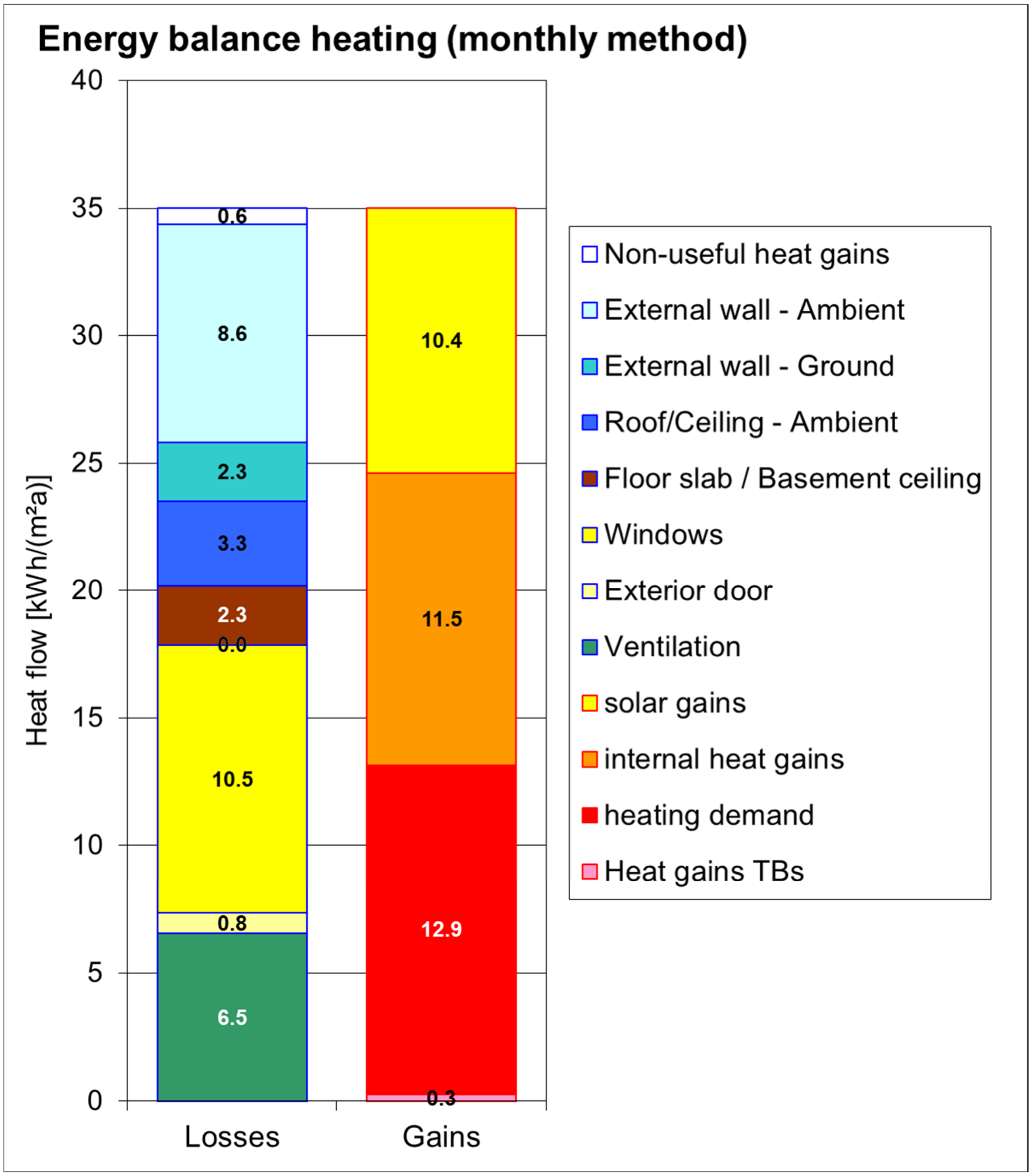

Figure 3: Energy balance without the two coniferous city trees in front of the house

4 CARBON EMISSIONS

A carbon emission analysis was completed by comparing existing gas and electricity bills with predicted energy usage for the Passive House design. The results are shown in the figure below.

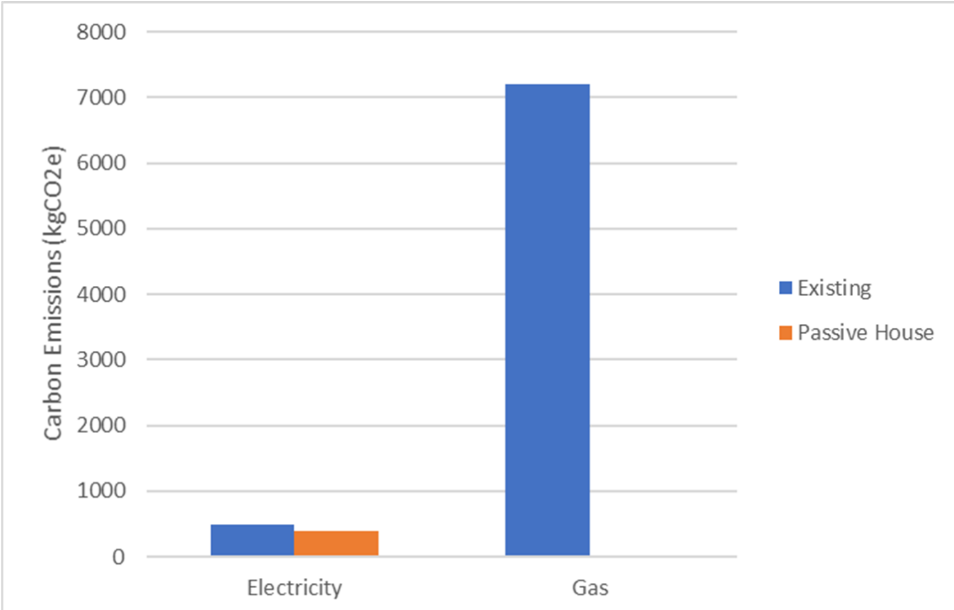

Figure 4: Carbon emissions for electricity and gas consumption for the existing house vs the Passive House

The analysis showed an annual savings of 7,299 kgCO2e with the new Passive House design or a 95% savings in carbon emissions. As a comparison a tree is estimated to sequester 22kgCO2e per year so two trees would sequester approximately 44kg CO2e.

PEEL PASSIVE HOUSE