

Cost Effective options for the upgrade of existing dwellings to NZEB standards.

Ciaran Farrell K00276842



Aim of the Project

The Aim of the project is to see if a dwelling constructed in 1993 would comply with modern regulations of NZEB standards and if the dwelling did not comply with those standards see what new systems had to be added to the dwelling to be able to comply.

Background

Energy usage of dwellings is one of the highest contributing factors of climate change. One way to be able to reduce this major impact that dwellings have on climate change is to find ways to be able to reduce the amount of energy being used and this is why the Energy Performance of Buildings Directives were set up. The EPBD sets out the guidelines that new dwellings will have to comply with for the energy usage and carbon emissions of the dwelling. These guidelines are called Near Zero Energy Buildings and the aim is to get dwellings to use zero carbon emissions when heating or cooling the dwelling. To be able to find out if the dwelling had complied with modern regulations the Building Energy Rating (BER) of the dwelling had to be found for the dwelling. When all the information related to the dwelling has been put in the software will calculate the Energy Usage and the Carbon Emissions for the dwelling and will also give a Building Energy Rating. To be able to comply with the current NZEB standards the BER of the dwelling will have to be A2 or above if not, the dwelling does not comply with the standards.

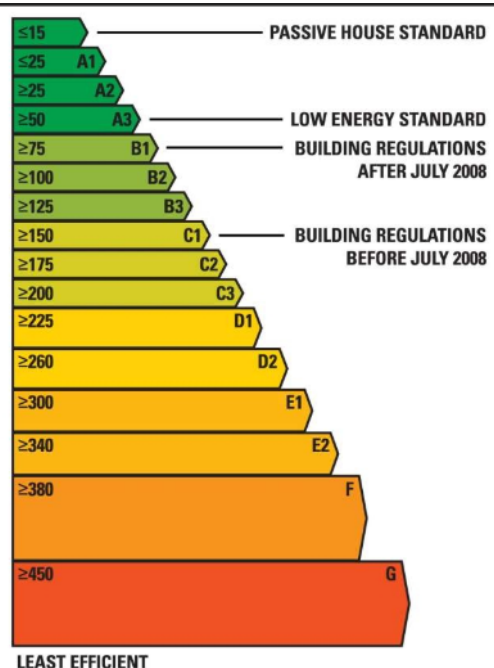


Figure 1: Building Energy Ratings.

Modelling and DEAP software

The first step to doing this dissertation was to use Revit to create a model of the dwelling. The Revit model was used to show a visual of the dwelling and to be able to show any of the improvements that were made to the dwelling but also to be able to get information from the model that was needed for the DEAP software such as the areas of the walls, roof, windows, and external door in the dwelling.



Figure 2: Revit model of the dwelling.

Then with the Revit model made the next step was to get the Building Energy Rating of the dwelling with the existing systems. After filling out all the relevant information about the dwelling that was being reviewed into the DEAP software it calculated that the dwelling had a Building Energy Rating of a C3, the Energy Usage of the dwelling was 201.18 kWh/m²/yr , and a Carbon Emissions 49.57 kgCO₂/m²/yr.

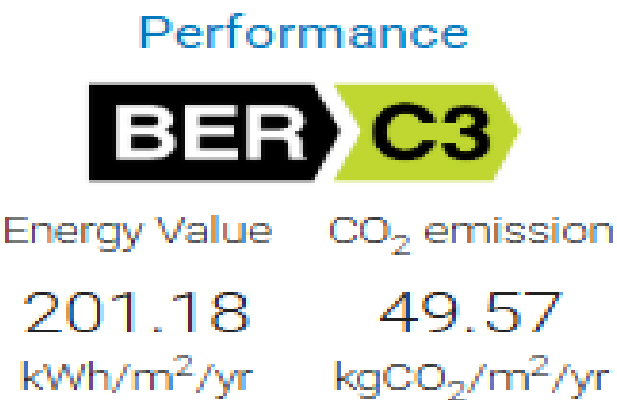


Figure 3: The BER of the existing dwelling.

The systems that were looked at to be able to improve the BER of the dwelling were a Heat Pump, PV panels, Mechanical Ventilation with Heat Recovery, and the improvement of the controls of the boiler.

Results

After carrying out the Building Energy Rating for the existing systems in the dwelling each of the new systems was added to the DEAP software to see the impact that the new system would have on the Energy Usage and the Carbon Emissions on the dwelling. By doing this a percentage improvement would be able to be applied to each system to be able to compare them against each other.

Improvements	Energy Value (kWh/m²/yr)	Energy Performance Coefficient	Percentage Improvement
Original	201.18	-	-
Heat Pump	108.34	0.736	46.1477284
MVHR	192.7	1.31	4.215130729
PV	161.05	1.095	19.94731087
Controls	180.56	1.227	10.24952779

Table 1 : Improvements made to the Energy Usage of the dwelling.

When comparing the systems on their impact on the Energy Usage of the dwelling it is clear to see that the Heat Pump had the biggest effect with an 46% improvement on the original value. The system with the least impact on the Energy Usage was the MVHR which only improved it by 4%.

Improvements	CO2 Emissions (kg CO2/m²/yr)	Carbon Performance Coefficient	Percentage Improvement
Original	49.57	-	-
Heat Pump	17.68	0.585	64.33326609
MVHR	45.47	1.506	8.271131733
PV	47.29	1.466	4.599556183
Controls	44.35	1.468	10.53056284

Table 2: Improvements made to the Carbon Usage of the dwelling.

Then the improvements for the Carbon Emissions were that the Heat Pump was again the best with a 64% improvement on the dwelling. The system with the least improvement on the original value for the Carbon Emissions for the dwelling was the PV panels with a improvement of only 4%.

Conclusion

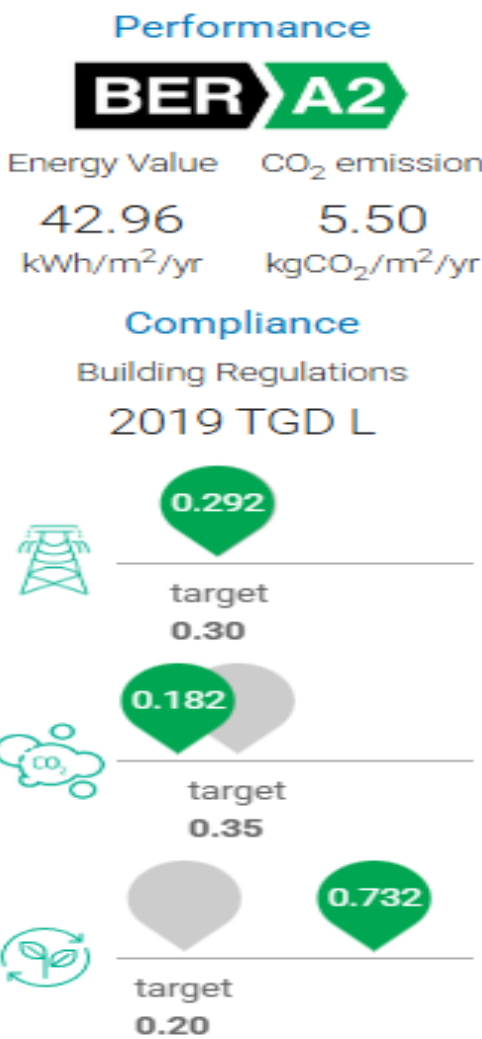


Figure 3: Improvements made to the BER by the Heat Pump and PV's

After gathering and analysis all the results next was to see which system would make the dwelling comply with the NZEB standards. With the heat pump being the best system that could be added to the dwelling it was paired with the PV panels to see what difference it would make to the. The DEAP software calculated that with these two systems the BER of the dwelling went to a A2. The system also had a 78% improvement on the Energy Usage and a 88% improvement on the Carbon Emission of the dwelling.

Improvements	Cost
Orgional	-
Heat Pump	€15,000.00
MVHR	€10,000.00
PV	€7,400.00
Controls	€1,200.00

Table 3 : Cost of implementing the different systems.

Then when comparing these two systems to see which one is more cost effective for homeowners to be able to implement in their dwelling it is quit clear to see that it is more viable for homeowners to be able to place PV panels onto their roofs than replace their boiler with a heat pump.

Acknowledgements

I would like to thank my supervisor Bosco Clarke for his support and guidance with this dissertation and Clodagh Moore for all her help with the report, presentations, and delivering the dissertation lectures.