Liverpool Everyman theatre - our plan to become zero carbon

1 - Building the Everyman Theatre

Between 2011-13 the Liverpool Everyman Theatre was demolished and rebuilt. Designed by Haworth Tompkins, the new Everyman Theatre includes a technically advanced and adaptable 400 seat theatre with a metal 'brise soleil' façade featuring 105 full length cut out figures on photographs of Liverpudlians. In 2014, the theatre was awarded the RIBA Stirling Prize, RIBA National Award, RIBA North West Building of the Year and in 2016 the CIBSE Building Performance Awards 2016 Building Performance Champion.

Dr Stephen Finnegan (University of Liverpool) and Mark Da Vanzo (Chief Executive of the Everyman and Playhouse Theatre) are working in collaboration to (a) measure the **whole life carbon impact** of the theatre and (b) develop a plan to **reduce this impact to zero**. The work includes an assessment of the "embodied carbon" due to construction and the "operational carbon" due to operation.

How and why did we undertake the study and what did we find?

Method

The Everyman Theatre (the cultural heart of Liverpool) is exploring how it can reduce its carbon impact and lead the way in pioneering a strategy for others to follow. **No theatre in the UK has (to date) been able to reduce its whole life carbon impact to zero, without demolition of course!** There are direct and indirect carbon impacts as a result of using energy for power, heating, cooling, lighting and other fuels for transportation, waste, water, catering, maintenance etc.

In order to undertake an assessment of this type, we start with defining the *scope of the project* and considering the areas of the theatre that we can and cannot directly measure and control. There is a standardised process for undertaking an assessment of this type using the globally accepted Greenhouse Gas (GHG) protocol. Within the protocol there are 3 stages to consider. Scope 1 (Direct emissions such from boilers), Scope 2 (Indirect emissions from purchased electricity) and Scope 3 (All other indirect emission). In this analysis (and at this stage) we are covering the buildings Scopes 1 and 2 only as these are the emissions in our direct control. Scope 3 emissions can be influenced but are in the control of other 3rd parties. For example, the Everyman cannot control which mode of transport a visitor will use; however they can influence which contractors they use. It is the intention to consider Scope 3 emissions at a later date.

We then consider the *time period* for assessment (in this case 60 years). The Everyman closed in September 2011 and over the next two years the new Everyman was constructed. Practical completion occurred in December 2013. To simplify the analysis we consider the time period of 2010-2070 and discount energy use from 2012 and 2013. Following this we calculate the operational and embodied energy use, from which it is possible to determine the carbon impact.

The **operational energy use** was calculated by obtaining the average gas and electricity consumption figures (kWh) for the theatre on an annual basis, with exclusion of energy consumption from 2012 to 2013* and estimates for the future (we assume the energy use will obviously vary through the years but will remain relatively consistent). Secondly we convert kWh into carbon, for each year, using the UK Government Department for Business, Energy and Industrial Strategy (BEIS) Green Book. Finally it was necessary to consider the changes in carbon intensity due to decarbonisation of the grid from 2010 to 2070 (with 2012 and 2013 excluded). If the theatre used similar amounts of energy each year, the carbon emissions would fall as the UK grid kgCO2 per kWh of energy used is reducing year on year due to the national introduction of renewables.

For the **embodied energy use**, we started by obtaining a full and comprehensive Stage 4 cost plan (consisting of over 1,000 components), provided by Charcoalblue and created by the Quantity Surveyor (Gardiner and Theobald). This is a comprehensive list of all the new and reclaimed items (from the previous theatre) used in the construction of the theatre (including Foundations, Frame and Floors, Internal Planning, External Walls, Engineering Services and the Roof). Next, it was necessary to generate *emissions factors* for every listed component to discover the embodied carbon impact. All emission factors collated are EN15804 verified and standardised Environmental Product Declarations (EPDs) given some confidence in the results. The list of components used in the study has independently been checked by the Architect (Haworth Tompkins), the Structural Engineers (Alan Baxter & Associates) and the Services Engineers (Waterman Group). ** From November 2011 to December 2013 the new Everyman was being constructed and commissioned. Clearly onsite power was needed for construction/commissioning etc however this is excluded from the assessment as the contribution was deemed minimal by the author. Carbon emissions from site activites were measured under BREEAM Man 3.*

2 - The Greenhouse Gas (GHG) Protocol

Carbon Impact

Our analysis has shown that the **embodied carbon** impact of the theatre was approximately 4,845 tonnes of CO_2 (carbon)*. If we assume the value is a reasonable estimate, we have discovered that 26% of the carbon impact was due to the foundations and 25% from engineering services. We have a full and comprehensive list of all of the carbon impacts for each of the 1,000+ components from a Stage 4 cost plan. If the theatre had used UK standard grid connection power for electricity and gas from 2010 (with no power used between November 2011 to December 2013) then the 60 year **operational carbon** footprint would equal approximately 5,758 tonnes of carbon. A combined total of approximately **10,603**

tonnes of carbon (see the chart below). In this scenario, approximately *46% of the buildings life cycle* would be embodied.

However, since 2010, the Everyman Theatre has purchased 100% renewable electricity from a [REGO]() supplier (a utility company that guarantees that electricity purchased is from 100% renewable sources off-site). This is significant as it means that the electricity used within the everyman is effectively zero carbon in operation.

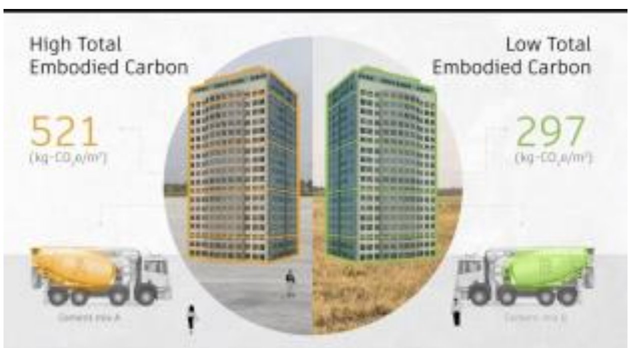
The [UK Green Building Council (UKGBC)]() framework definition of Net Zero Carbon (NZC) in operation is:

"When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset"

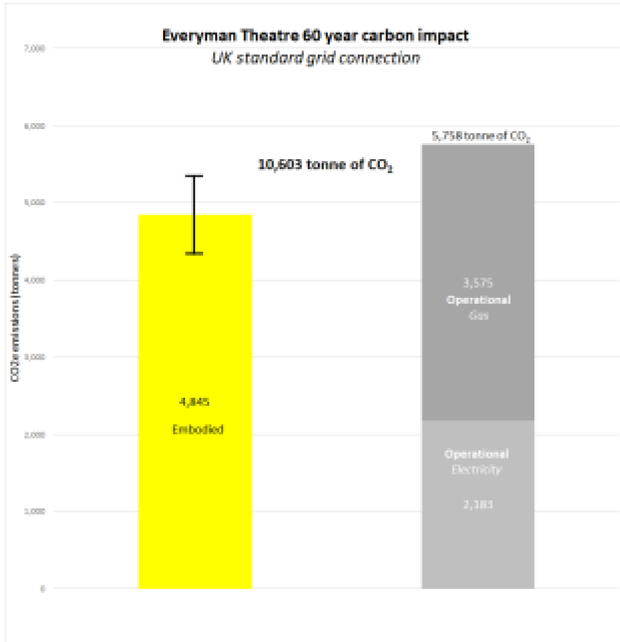
Since 2010, the Everyman has secured all of its electricity (100% renewable) and gas from the the UK national grid. In additional a a micro Combined Heat and Power (CHP) plant** has also been used to provide onsite heat and power. If the Everyman continues to purchase electrcity in this way upto 2070, their operational carbon footprint from electricity can be considered as zero. Their 60 year whole carbon footprint would then reduce from 10,603 tonnes to approximately **8,420 tonnes** (see below). In this scenario, approximately *57% of the buildings life cycle* would be embodied.

**It should be noted that this value should not be considered as a fixed value and is an estimated with a degree of uncertainty. The author estimates this inaccuracy to be 10% .*

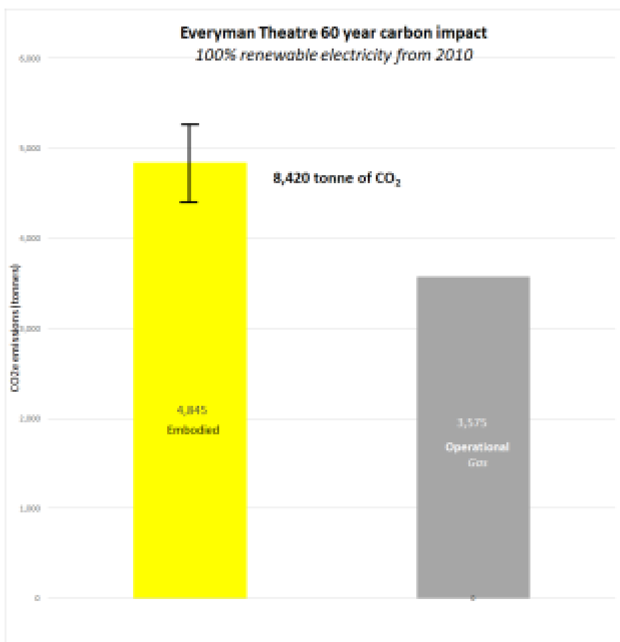
*** The micro CHP has been out of commission for the past two years and is planned to be reintroduced*



3 - Embodied Carbon in Buildings



4 - Carbon footprint using UK standard grid connected gas and electricity from 2010



5 - Carbon footprint using 100% REGO electricity from 2010

Zero Carbon Roadmap

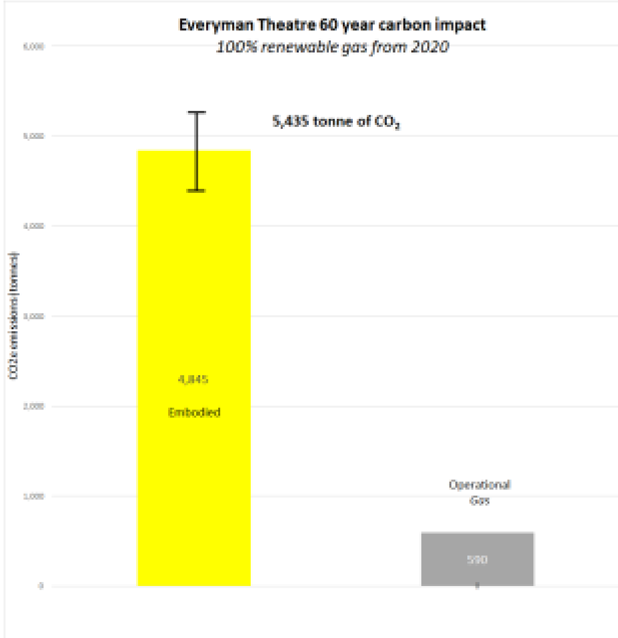
The next steps for the Everyman is to design a **Zero Carbon Roadmap** and consider the level of ambition, scale and associated costs. Should they just follow UK Government guidance which will require them to achieve Net Zero Carbon (NZC) in operation by 2050? To achieve this would be relatively straightforward as they have 30 years to either (a) not use gas by 2050, (b) procure 100% renewable green gas that year or (c) look to offset their gas use from 2050. Could they move to a 100% electricity operated theatre? Could they "offset" their carbon contribution from gas using an approved gold standard Verified Emissions Reduction (VER) carbon offsetting scheme? Both would satisfy the UK Government requirements at the moment. Mark Da Vanzo and his team are looking at the options and carefully considered the next steps. For example they are currently considering a switch to 100% Green Gas from 2020 (30 years from when they will be mandated to do so). If this happened, they would save approximately 2,985 tonnes of carbon resulting in a new whole life carbon footprint of **5,435 tonnes** (with the gas related emission from 2010 to 2020 remaining). In this scenario, approximately *90% of the buildings life cycle* would be embodied.

6 - What is a zero carbon building?

If the Everyman wishes to take a bolder step and consider **whole life Net Zero Carbon (NZC) status** then there is a need to reduce **5,435 tonnes of carbon** over the next 50 years, continue to purchase 100% REGO electricity and switch to 100% green gas from 2020. But how economically viable is this? COVID-19 hasn't helped of course and with temporary closure comes revenue loss.

We are working on a long term plan to achieve this and it will involve more detailed discussions and a working group to:

- Estimate the costs associated with achieving Whole Life NZC;
- Obtain more accurate disaggregated data through Automated Meter Readings (AMRs) and sub meters;
- Identifiying the key Energy Intensity Units (EIUs) and acting upon them;
- Comparing the use of energy over time with half hourly and seasonal data;
- Internally invest in better energy management;
- Reduce annual operational energy use by seeking ia range of short and longer term improvements;
- Reintroduce the micro CHP;
- Plan for electrification as part of future procurement strategies;
- Consider the retrofit of energy saving technology either on or offsite;
- Continue to procure 100% REGO energy,
- Finally (and as a last resort) consider the potential for carbon offsetting. For example, offsetting 5,435 tonnes of carbon over a 50 year period is 109 tonne per year. At £10 per tonne that's £1,087 per year.



7 - Theoretical Carbon Footprint with 100% REGO Electricity and Gas Supply

Project Partners and Collaborators

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