

ACBA6004 ADVANCED CONSTRUCTION AND CIVIL ENGINEERING

BUILDING SERVICES AND ENERGY - ACBA6004

Y CAMBRIA



(Flickr, 2015)

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INTRODUCTION

The following case study will be on Y Cambria building which is part of The Old College in Aberystwyth. The Cambria building is nestled on the beautiful coastline of Aberystwyth encompassing the rich cultural heritage of Wales. This case study will delve into the building's purpose, usage, architectural style as well as its economic and social values. The case study will look at the improvements that can be made with regard to energy use, cost of construction, operational cost, and embodied carbon.

Looking at the building's function, past and present. This building was chosen because of its age, its original use, the location of the building and evolution of the building through the ages and it is also a well-known building which is linked to the Old College Building in Aberystwyth.

LOCATION

The Cambria is in Aberystwyth in North-west Wales, on the seafront New Promenade opposite The Pier Hotel facing North (Bing Maps, 2023). Aberystwyth is a seaside university town in Ceredigion Wales and a community with a population of 15 935 (Wikipedia, 2015).

Aberystwyth is surrounded by the Irish Sea, with the North by cliffs of Constitution Hill and South by Pen Dinas Hill Fort (Smith, 2019).

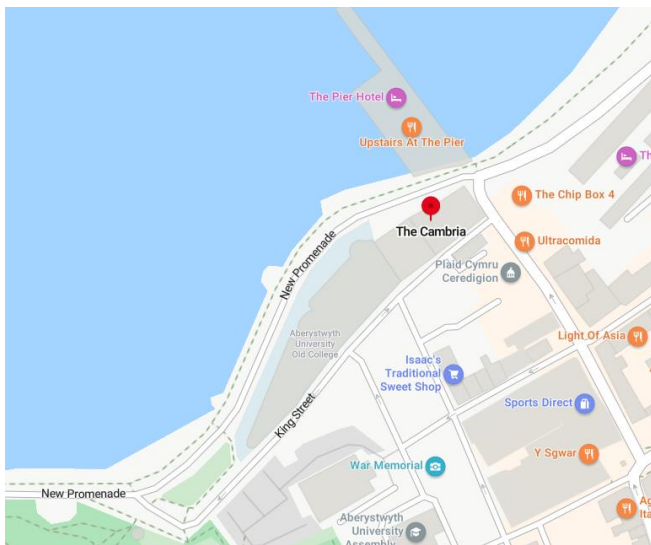


Image 1 The Cambria (Bing Maps, 2023)

HISTORY

The Hotel Cambria was an extension of The Old Customs House building on Pier Street this became the home of Dr Richard Gilbertson and family which also was the location of his surgery when he retired and moved in 1890. There was an announcement in *The Cambrian News* in November 1894 of the extension of the house to be opened as a hotel had commenced (Davies, 2023).

Hotel Cambria as it was known, was designed by George Croydon Marks, and opened in 31 July 1896 (Davies, 2023), the build was taken over by Aberystwyth Improvement Company (Pint of History Wales, 2023). The hotel was not a success even with innovations like a sea bath with water pumped directly into your bath with a turn of the tap and the hotel also had electric lighting (Davies, 2023). The Cambria Hotel was put on sale and bought by David Davies in 1906 to be used as a college for Calvinistic Methodists and used as a Red Cross Hospital during the World War I (Geograph, 2016). In 1992 it was combined with Bala College with a title change to United Theological College, and in 1999 it became the Cambria Restaurant (Coflein, 2023). The Cambria is now used for business community centre with serviced offices, hot desks, meeting rooms and therapy rooms for hire (The Cambria Facebook, 2019) and has recently been acquired

by the university and plans to upgrade the building are in place and have recently begun it will provide conference and meeting facilities including a 4* hotel for accommodation (Aberystwyth University, 2023).

It is a grade II listed building, designated on the 24th of November 1987 (Cadw, 2023).

ARCHITECTURAL STYLE & EXTERNAL FACADE

The Cambria is a three-storey building, with a basement and attics, it has a 5-bay symmetrical façade front and advanced end with and central bays (Cadw, 2023). Classified in the period as Post Medieval, Victorian with some Dutch Renaissance influences, it is built out of bull-nosed rubble and freestone dressings with gable parapets, the roof is slate with steep pitches to cross gables. The main roof is mansard therefor has four sides to the roof, it consists of flat roof dormers to the attics and has casement windows. The end and central sections have a steep Renaissance Dutch gable consisting of semi-circular pediments and volute scroll kneelers (Coflein, 2023).



Image 2 Front Survey of Y Cambria (Theological College) Aberystwyth (Survey Base, 2023)

These elements are supported by palister strips, complemented a simple cornice. The flanking bays showcase a balustraded parapet. The first-floor windows boast French windows. The central entrance is arched and surrounded by Gibbs ornamentation and foliage, with a featured dragon-carved spandrels, the entrance has panelled double doors.



Image 3 Dragon Carved Spandrels at Entrance (Coflein Government, 1967)

The gross internal floor area is 1,883 square meters excluding the basement (Davies, 2023). Total useful floor area is 2694 square meters (Find Energy Certificate Service, 2020).

Aberystwyth was a "bustling thriving town" in 1874, with gas works, railway links, foundry chimneys and magnificent hotels, there were businesses thriving like shipbuilding yards, saw mills, and slate works a lot of the local jobs in the area were service industries like education and administration (Aberystwyth Government, 2023). Therefore the slate roof of the Y Cambria building would have been acquired from local sources like the slate works nearby.



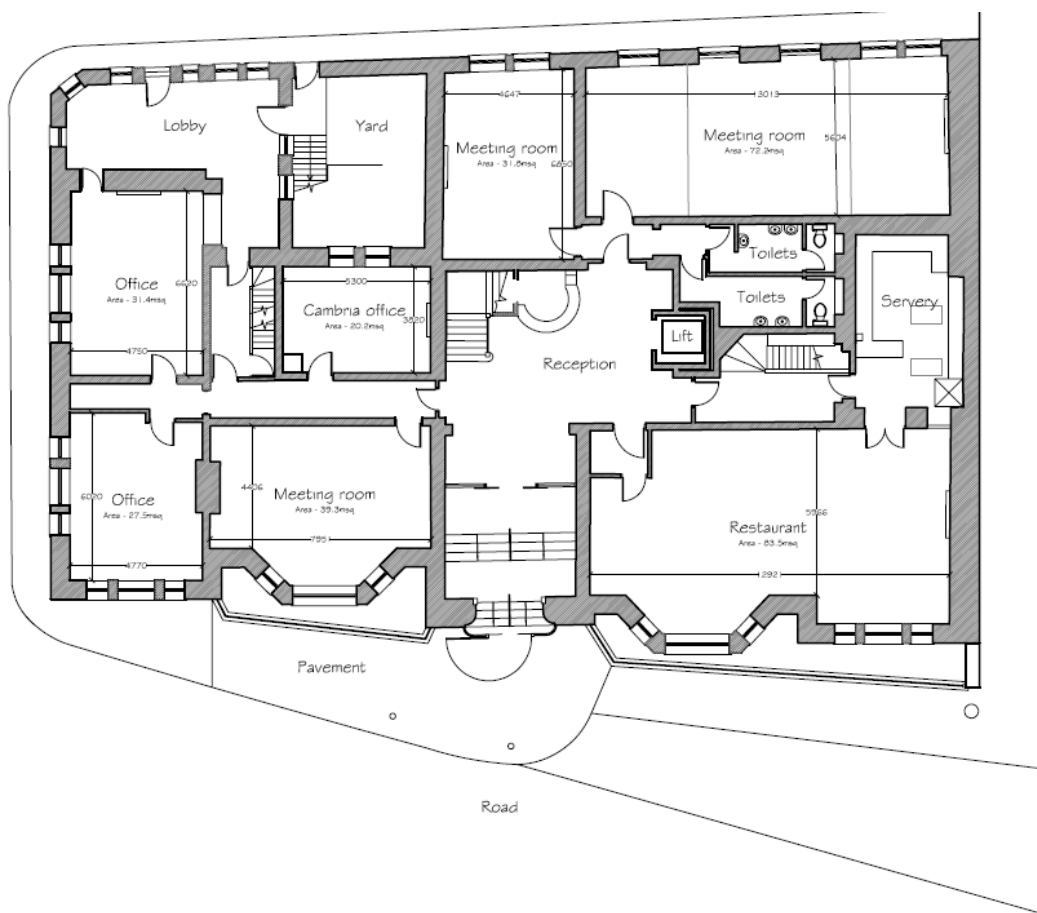
Image 4 Pen & ink architectural drawing of the 2nd, 3rd and attic floors former Cambria Hotel and Theological College c.1906 (Dickens-Lewis, c.1906)

The building methods would have been mostly from that era, which was the later Victorian era, the Victorian era refers to the era when Queen Victoria reigned 1837 – 1901 (Wikipedia, 2023). Steel was introduced into construction shortly after the cast iron and wrought iron was used previously in the 1790's to 1890's Steel became dominant by c1900 after being introduced in c1885 (Bussel, 2011).

During this era local stone was dominant as a building material, with slates in uniform sizes as common roofing materials and sash windows were generally used, solid concrete were often used for floors finished in clay tiles if they had suspended timber floors it would usually rest on stone piers. Floorboards were usually irregular hand cut wide elm or oak planks. The doors and windows were a critical feature to help identify the period it was built in, the size of glass increased in this era as new methods of manufacturing were developed for glass. Chimneys would be constructed of many different types of materials from basic stone to brick (Cadw and Historic England, 2019) as shown in the image 5 below of the Y Cambria chimney.



Image 5 Y Cambria chimney (Peoples Collection, n.d)



Ground floor plan 1:200

Image 6 Y Cambria Aberystwyth Ground Floor Plan (Gareth Lewis Architect, 2010)

As seen in the image above the walls are thick, they were generally masonry walls built out of brick or stone with lime or clay mortar (Cadw and Historic England, 2019) see image 7 below the thick exposed stone basement level walls (Aberystwyth University 3D, 2023). It is assumed that the lower basement levels have solid flooring and the upper levels suspended wooden flooring.



Image 7 3D scan of the solid basement level walls Y Cambria (Theological College) (Aberystwyth University 3D, 2023)



Image 8 3D scan of the front section of Y Cambria (Theological College) (Aberystwyth University 3D, 2023)

STRUCTURAL APPROACH

In 1875, the Public Health Act was introduced, this ensured that local urban authorities made provisions for bylaws for new streets and to ensure structural stability for houses, prevent fires and incorporate drainage for building's (University of West England, 2023).

The image 8 below represents the typical types of foundations at the end of the 1800's, with the depths varying considerably according to circumstances and much shallower than modern building's (University of West England, 2023).

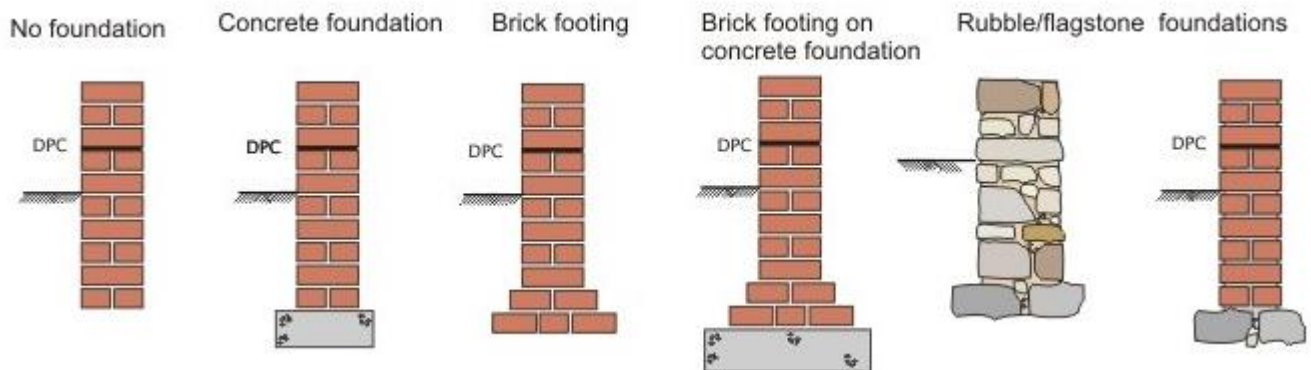


Image 8 Foundations at the end of the 1800's (University of West England, 2023).

Due to the era of the construction of the building, it will mainly consist of load bearing masonry, with stone and brickwork on outer skins. The internal walls of the building are generally made of brickwork with most of the walls being of the original construction internally, the basement would consist of the main loadbearing floor with suspended timber flooring throughout the floors.

INTERIOR



Image 8.1 3D scan of the entrance foyer of Y Cambria (Theological College) (Aberystwyth University, 2023)



Image 8.2 3D scan of the entrance foyer of Y Cambria (Theological College) (Aberystwyth University, 2023)



Image 8.3 3D scan of the entrance foyer of Y Cambria (Theological College) (Aberystwyth University, 2023)

As you enter the front entrance on the Ground Floor level 1, you will enter through double arched wooden doors, there are 4 concrete stairs that leads to glass sliding entrance doors and a blue patterned carpet. To the right on the landing before you enter the glass doors are entrances to other rooms there is a carpeted stairway ahead behind a large reception desk, there are retrofitted lifts to the right facing the stair way. The internal rooms all consist of wooden suspended flooring some bare and some carpeted. There is a stairway from the hall to the right leading to the basement floor and rooms, which has terracotta tiles this area and the room above were kitchen areas. The stairway leads to the next floors which consists of various rooms. The sixth floor is accessible via separate stairway through a door and via another room.

HEATING AND LIGHTING STRATEGIES

The Y Cambria building was built in the late 1800's but was also one of the first to have electric lighting.

Hotel Cambria as it was known, was designed by George Croydon Marks, and opened in 31 July 1896 (Davies, 2023), the build was taken over by Aberystwyth Improvement Company (Pint of History Wales, 2023). The hotel was not a success even with innovations like a sea bath with water pumped directly into your bath with a turn of the tap and the hotel also had electric lighting (Davies, 2023). Due to the age of the building, it would not have been built with any environmental or energy efficiency regulations or considerations. The size, type, and age of the building creating an immense amount of energy required to heat and light the building. Although the building has been through many transformations, it has not been completely upgraded to current regulations and standards, the lack of care and maintenance of the building would contribute to this as well. You can see many upgrades in the building over time, but this was

mainly focused on communal areas. Where they had installed automatic motion sensor lighting is used in the entrance which will save on energy consumption, but at a very small percentage compared to the size and number of rooms in the building. See image 9 below. There should be consideration to installing solar panels on the roof.



Image 9 3D scan of the entrance foyer of Y Cambria showing the motion sensor lights at the entrance (Theological College) (Aberystwyth University, 2023)

The heating system in the Y Cambria would need to survey and upgraded to ensure efficiency is achieved. There has been upgrades to the heating system over the years but with the building changing uses and very little maintenance completed the age and building envelope would make the building extremely inefficient and a huge amount of cost and heat loss is expected mainly through the windows and walls. See image 10 of the upgrades to heating systems in the basement level of the building. The radiators present in most rooms are large to try and compensate for the heat loss some radiators are undersized this combination will not be very effective. There are also some radiators that are not placed in the correct place in the rooms to be efficient in heating the space see image 11 below. Considerations to a different type of heating strategy would be advantageous. An air source heat pump or a Monobloc heat pump if there is issues accessing areas for the ground works, should be considered. The building has a lot of damp that can be due to not having an efficient heating and ventilation system as well as the building remaining vacant for a period.



Image 10 A 3D scan of the boiler room of Y Cambria showing the upgrades and equipment (Theological College) (Aberystwyth University, 2023)

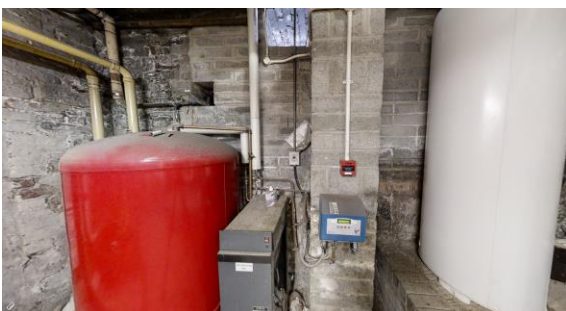


Image 10 B 3D scan of the boiler room of Y Cambria showing the upgrades and equipment including hot water cylinders (Theological College) (Aberystwyth University, 2023)

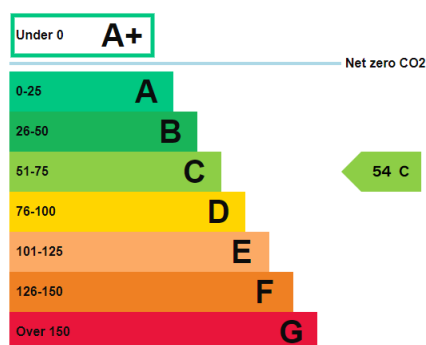


Image 11 3D scan of a semi communal type of room in Y Cambria (Theological College) (Aberystwyth University, 2023)

The Cambria currently has an EPC rating of 54C which is a fair score considering the age of the building as well as the many uses it has had over the years.

Energy rating and score

This property's energy rating is C.



Properties get a rating from A+ (best) to G (worst) and a score.

The better the rating and score, the lower your property's carbon emissions are likely to be.

Breakdown of this property's energy performance

Main heating fuel	Natural Gas
Building environment	Heating and Natural Ventilation
Assessment level	3
Building emission rate (kgCO2/m2 per year)	53.03
Primary energy use (kWh/m2 per year)	306

(Find Energy Certificate Service, 2020)

ECONOMIC AND SOCIAL VALUE

Y Cambria (formally the Theological College as it was known) has the grad II listed designation on the 24/11/1987 with the reason being "Group Value" (Cadw, 2023). This is due to the fact it is part of the Old College buildings of Aberystwyth University (Aberystwyth University 4, 2023). The group value listing indicates architectural or historic unity or are excellent examples of planning such as model villages and squares (CADW, 2023)

According to CADW "Grade II (two) — buildings of special interest which justify every effort being made to preserve them. These make up approximately 91 per cent of the total number of listed buildings in Wales."

This brings high importance to the building in a social and economic way as it is linked to one of the oldest University buildings in Wales, it was first intended as grand railway hotel. The building was bought by the University in 1864 for £10,000 (Aberystwyth University history, 2023). The communal Value is considerable due to the fact it is linked to an educational institution that is over 150 years this is based on the social relationships with the townsfolk (Smith, 2019). The Public Services Social Value Act 2012 was brought into force in 2013 ensuring that all public sector organisations do not only look at the financial contract but also how the services they provide will improve the social and economic value of a building (Local Government Association, 2024).

Even due to the decline in education activity in recent history the group of buildings continued to serve the community in various new ways. The value of the buildings show the meaning of a place and the people that relate to it (Smith, 2019).

Y Cambria, has had various changes of use in the past from The Od Custom House to the home of Dr Richard Gilbertson and his family, who then extended the building to open a hotel that was short lived before it became the Theological College up until 2003 (Davies, 2023), thereafter it was used as an office space and conference centre, when the University of Wales purchased the building to convert it to 24 4* Bedrooms, restaurants, meeting and activity rooms (Abersytwyth University Plans, 2023) which is currently in the early development stages (Davies, 2023). This is going to bring major economic value to the community as it becomes a part of a landmark building being the first University College of Wales, it will be among the transformation of iconic buildings into a cultural and creative centre for Wales and the diverse communities will be able to engage (Aberystwyth University future plans, 2023).

The major changes throughout history represents the importance of the building in a social value aspect, the community has needed the various transformations to adapt to the social and economic changes throughout the history of the building and the history of the area as times have changed both within a community as well as economic from the industrial era through to modern day times. This is represented in how the building had to change its use to ensure it adds constant economic value to the community.

ENVIRONMENTAL IMPACT

The environmental impact of the Y Cambria (Theological College) the entire life cycle of the building would need to be taken into consideration, the materials used and would they have been locally sourced, the extraction of these building materials, the energy efficiency of the building from that era, looking at waste generation and would recycling and reduction in waste practices have taken place. Other factors to consider would be the lifestyle of those workers from that era as well as asbestos and lead based paints used, also considering transportation methods for building materials and maintenance factors.

Hotel Cambria as it was known, was designed by George Croydon Marks, and opened on 31 July 1896 (Davies, 2023) the building is approximately 127 years old, which indicates it has a long-life cycle.

The industrial revolution was powered by burning coal and large industrial cities pumped vast amounts of pollution into the atmosphere, workers had poor living conditions and nutrition, dangerous workplaces, and environmental harm (History, 2023). Local stone as well as brick and terracotta were widely used during the Victorian and Edwardian construction times 18:30 – 1910's (Cadw and Historic England, 2019).

The fact that old buildings exist demonstrates their sustainability, but they are not always energy efficient (SPAB, 2024). In 1965 was the first-time building regulations had an impact on energy efficiency, and limited the amount of energy that could be lost through fabric elements of the building. Most buildings the wall area represents the biggest volume of the thermal envelope, making the walls more efficient, will in return create the biggest impact on reducing energy consumption and lowering the energy demand (The Green Age, 2015).

In conclusion building in the 1890's would be resource intensive with the extraction and transportation of materials having a big environmental impact. The energy efficiency of Victorian buildings would have been less energy efficient due to limited features and insulation not common practice of those times. Waste generation was not a priority in the Victorian times, air quality would have been low due to the types of materials used in construction for example lead based paints, the transportation of materials would have an impact not necessarily due to the fact the materials come from far but more due to the lack of transportation or accessing materials from remote locations.

ADVANCED CONSTRUCTION GUIDANCE

OPERATIONAL ENERGY USE

There can be various construction phases to buildings, therefore it is important to note that this can alter the performance of the building in terms of energy efficiency, moisture, and extreme weather conditions. The degree of maintenance and repair can have an impact on the building's efficiency (Cadw and Historic England, 2019).

For a building to reduce their impact on the planet, you need to meet the operational energy targets of a building, energy performance is calculated as represented in the below image 12 and measured as kWh/m²/year (RIBA Journal , 2022).

The calculation is:

Annual Energy Consumption (kWh)

Gross Internal Floor Area (m²)

or as expressed below

(A) + (B)

(C)

By way of explanation:

(A) = Annual consumption of imported (grid) energy

KWh energy consumption figures (A) can be taken directly from gas and electricity utility bills or BMS reports or as the difference between manual meter readings taken one year apart (or monthly over a year).

An Excel spreadsheet to enter the monthly consumption is an easy way to track this. Air/ground source heat pumps are included here as these technologies use grid electricity efficiently, but do not generate it themselves.

(B) = Annual consumption of on-site renewable energy

If on-site renewables (such as PV panels) are present, the renewable energy in kWh (B) that is used directly on site, ie not sold back to the grid, must be calculated.

This is the total generated renewable energy minus the energy exported back to the grid. For PVs, the inverter will show the total on-site generated electricity and a smart export meter will show the amount sent back to the grid.

If no smart export meter is present, it can be assumed that 50 per cent of the generated energy is used on site and 50 per cent is sold back to the grid (as assumed by the Feed-In Tariff Scheme).

The sum of (A) and (B) will provide the annual operational energy consumption of the property.

Lastly, the building's gross internal floor area (GIA) needs to be obtained in square metres. This can be taken from building plans. All floor levels must be included (C).

Image 12 Energy performance calculation (RIBA Journal , 2022)

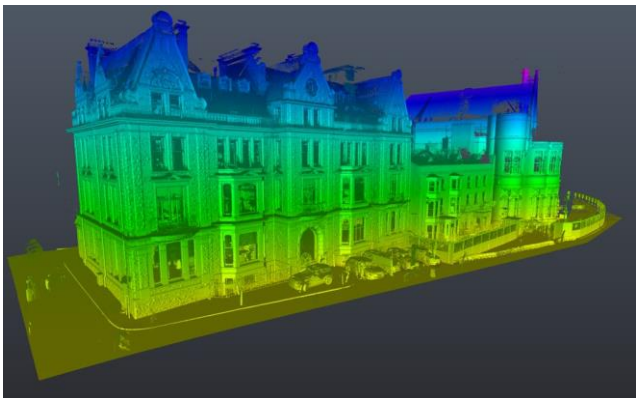


Image 30 Surveybase point cloud scan y Cambria

EMBODIED ENERGY/CARBON

It is safe to assume that due to the age of the building the location and the materials used, the Y Cambria has a low embodied carbon footprint, most of the materials would have been locally sourced nearby therefore there is no long-haul transportation requirements for the materials thus bringing down the embodied carbon. The manufacturing of the materials would have been basic factories nearby. It had easy railway links very close by, gas works sawmills and nearby slate works, it was also just prior to when the use of steel became popular and common practice. The age of the building means that it has more than likely paid back its carbon footprint, and after upgrading the building to current building regulations and standards, it can be assumed to reach net zero targets. The embodied carbon of the same building being built now would be high, due to the manufacturing and transportation of materials and types of materials that would be used. However, reaching a net zero would be achieved over a less years due to the current building regulations and energy efficiency requirements that would need to be met, it would ensure the building is extremely efficient.

The Building Regulations 2010 Approved Document Part L Volume 2 buildings other than dwellings sets out the regulations for Wales and the conservation of fuel and power.

Embodied carbon of bricks is substantially less than that of concrete, bricks are net absorbers of Co2 due to the continuous carbonation over their lifetime and 100% recyclable (Marshalls, 2020).

COST OF CONSTRUCTION

Due to the type of construction methods that have changed over the years, the regulations now in force, sourcing, and manufacturing of materials as well as materials not always necessarily coming from local areas, inflation and labour costs including all the studies, desktop reports required prior to any construction project the cost of building a building of this size would be significantly higher than when it was constructed.

COST OF OPERATIONS MAINTENANCE

The cost of maintenance and operations will end up paying for themselves over the years. Preventative maintenance is important in older buildings to prevent decay, this can also ensure that there is no loss to the original fabric and in return be cost effective (SPAB, 2024). A full maintenance plan or programme will need to be created. The cost of setting up the maintenance programme will initially be a set up cost but overtime it will also repay itself due to reducing the overall cost of any major repairs required and keeping the building in a good state. Ensuring the heating and lighting strategies are optimised as well as carrying out internal wall insulation in areas that require it will ensure that the building is kept dry and reduce damp while keeping costs low regarding carbon emissions and maintenance work. There has been some windows pointed out having high U-values therefore secondary glazing is required.

END OF LIFE REUSE/RECYCLE

To try reach carbon targets like 2050 net zero, it is important to first consider use and reuse first (Historic England, 2020). Due to the age and they type of construction the Cambria has a long-life span this in return reduces its embodied carbon footprint, along with maintenance plans this can increase the lifespan of the building as well. However, should the Cambria need to be demolished almost all its structural components are almost 100% recyclable. The previous uses of the building over the years demonstrates that it is a building that can be easily adapted for various uses.

CONCLUSION

While older buildings seem to stand the test of time and pay back their embodied carbon over a longer period, as well as the locally resourced materials bring this figure down again. With newer builds more regulations are in place to achieve these targets at a faster pace, even though most modern buildings

don't have as long-life cycle as older buildings do. The emphasis is on recycling and sustainability protecting the depletion of our natural resources. Offsite manufacturing has assisted to combat construction times and carbon footprint with transportation of many materials where 1 transportation link would be needed for the completed system to be installed. Approved document L2A July 2014 requires that new non-domestic buildings need to achieve a better energy consumption rate stated in regulation 26A 20% carbon dioxide savings across the new nondomestic build mix relative to Part L 2010. If this building had to be built in the modern day, the envelope would be constructed very differently and cavity walls would have been a requirement with sufficient insulation, with either a concrete, or steel frame. According to Section 6 Criteria 4 in Part L2A document insulation would be continuous over the entire building enveloped to limit thermal bridging (Welsh Government, n.d.).

REFERENCES

- Aberystwyth University Plans, 2023. *Aberystwyth University*. [Online]
Available at: <https://www.aber.ac.uk/en/oldcollege/future-plans/imagesandplans/>
[Accessed 29 November 2023].
- Aberystwyth Government, 2023. *Aberystwyth*. [Online]
Available at: <https://www.aberystwyth.gov.uk/en/council/history-of-the-borough/modern-history>
[Accessed 29 November 2023].
- Aberystwyth University 3D, 2023. *Aberystwyth University*. [Online]
Available at: <https://my.matterport.com/show/?m=nHbN3nb6cSX>
[Accessed 29 November 2023].
- Aberystwyth University 4, 2023. *Aberystwyth University*. [Online]
Available at: <https://www.aber.ac.uk/cy/oldcollege/future-plans/>
[Accessed 29 November 2023].
- Aberystwyth University future plans, 2023. *Aberystwyth University*. [Online]
Available at: <https://www.aber.ac.uk/en/oldcollege/future-plans/>
[Accessed 29 November 2023].
- Aberystwyth University history, 2023. *Aberystwyth University*. [Online]
Available at: <https://www.aber.ac.uk/en/oldcollege/history/>
[Accessed 29 November 2023].
- Aberystwyth University, 2023. *Aber*. [Online]
Available at: <https://www.aber.ac.uk/en/news/archive/2023/06/title-264120-en.html>
[Accessed 5 January 2024].
- Aberystwyth University, 2023. *Aberystwyth University*. [Online]
Available at: <https://my.matterport.com/show/?m=nHbN3nb6cSX>
[Accessed 29 November 2023].
- Bing Maps, 2023. *Bing Maps*. [Online]
Available at: <https://www.bing.com/maps?cp=52.414815%7E-4.087484&lvl=17.7>
[Accessed 15 November 2023].
- British Listed Buildings, 2023. *The United Theological College*. [Online]
Available at: <https://britishlistedbuildings.co.uk/300010308-the-united-theological-college-aberystwyth>
[Accessed 29 November 2023].
- Bussel, M., 2011. *Building Conservation*. [Online]
Available at: <https://www.buildingconservation.com/articles/structural-ironwork/structural-ironwork.htm>
[Accessed 29 November 2023].
- Cadw and Historic England, 2019. *Understanding Traditional (pre-1919) and Historic Buildings for Construction and Built Environment Courses*, s.l.: Crown copyright (2019).
- Cadw, 2023. *Cadw*. [Online]
Available at: <https://cadwpublic-api.azurewebsites.net/reports/listedbuilding/FullReport?lang=&id=10308>
[Accessed 15 November 2023].
- CADW, 2023. *Understanding listing*. [Online]
Available at: <https://cadw.gov.wales/advice-support/historic-assets/listed-buildings/understanding->

[listing#section-how-are-buildings-chosen-for-listing](#)
[Accessed 29 November 2023].

Coflein Government, 1967. *Coflein*. [Online]
Available at: <https://coflein.gov.uk/en/archive/6542119/>
[Accessed 29 November 2023].

Coflein, 2023. *United Theological College, Aberystwyth*. [Online]
Available at: <https://coflein.gov.uk/en/site/23302>
[Accessed 15 November 2023].

Davies, E. P., 2023. *The Cambria*, Aberystwyth: Aberystwyth University.

Davies, N., 2023. *Nia Davies Aberystwyth University Staff*. Aberystwyth University : s.n.

Dickens-Lewis, G., c.1906. *Coflein*. [Online]
Available at: <https://coflein.gov.uk/cy/archif/6156013>
[Accessed 29 November 2023].

Find Energy Certificate Service, 2020. *Energy performance certificate (EPC)*. [Online]
Available at: <https://find-energy-certificate.service.gov.uk/energy-certificate/0827-0534-6930-2700-3003>
[Accessed 10 January 2024].

Flickr, 2015. *Flickr*. [Online]
Available at: <https://www.flickr.com/photos/bara-koukoug/19584997695>
[Accessed 15 November 2023].

Gareth Lewis Architect, 2010. *The Cambria Ground Floor Plan*. s.l.:s.n.

Geograph, 2016. *Geograph*. [Online]
Available at: <https://www.geograph.org.uk/snippet/12919>
[Accessed 15 November 2023].

Historic England, 2020. *There's No Place Like Old Homes Re-use and Recycle to Reduce Carbon*, s.l.: Historic England.

History, 2023. *7 Negative Effects of the Industrial Revolution*. [Online]
Available at: <https://www.history.com/news/industrial-revolution-negative-effects>
[Accessed 29 November 2023].

Local Government Association, 2024. *Social value – achieving community benefits*. [Online]
Available at: [https://www.local.gov.uk/our-support/financial-resilience-and-economic-growth/procurement/social-value-achieving-community#:~:text=and%20the%20environment,-,Social%20Value%20is%20defined%20through%20the%20Public%20Services%20\(Social%20Value,procure%20migh](https://www.local.gov.uk/our-support/financial-resilience-and-economic-growth/procurement/social-value-achieving-community#:~:text=and%20the%20environment,-,Social%20Value%20is%20defined%20through%20the%20Public%20Services%20(Social%20Value,procure%20migh)
[Accessed 5 January 2024].

Marshalls, 2020. *Rising to the Low-Carbon Challenge One Brick at a Time*. [Online]
Available at: <https://www.marshalls.co.uk/commercial/blog/the-low-carbon-challenge#:~:text=Above%20and%20beyond%20that%2C%20concrete,%2F6%2F7%2F8>
[Accessed 7 January 2024].

Peoples Collection, n.d. *Peoples Collection*. [Online]
Available at:
<https://www.peoplescollection.wales/sites/default/files/images/2020/May/Photoscoot2020GroomTheologic>

[alCollege.jpg?itok=iQPqgXI9](#)

[Accessed 29 November 2023].

Pint of History Wales, 2023. *Exploring The History of Ceredigion's Pubs*. [Online]

Available at: <https://pint-of-history.wales/explore.php?func=showpub&id=33>

[Accessed 15 November 2023].

RIBA Journal , 2022. *Design in the Making*. [Online]

Available at: <https://www.ribaj.com/intelligence/how-to-calculate-operational-energy-of-a-building>

[Accessed 5 January 2024].

Smith, A., 2019. *Old College and Marine Villas (1 & 2New Promenade), Aberystwyth Heritage Impact Assessment*, s.l.: Austin-Smith:Lord LLP.

SPAB, 2024. *Briefing Energy Efficiency in Old Buildings*, s.l.: SPAB.

SPAB, 2024. *Preventative Maintenance*. [Online]

Available at: <https://www.spab.org.uk/advice/preventative-maintenance>

[Accessed 10 January 2024].

Survey Base, 2023. *3D REVIT MEASURED BUILDING SURVEY – THE CAMBRIA, ABERYSTWYTH, WALES*. [Online]

Available at: <https://www.surveybase.co.uk/project/measured-building-survey-the-cambria-aberystwyth-wales/>

[Accessed 29 November 2023].

The Cambria Facebook, 2019. *Facebook*. [Online]

Available at: <https://www.facebook.com/cambria.aberystwyth/>

[Accessed 15 November 2023].

The Green Age, 2015. *How Building Regulations Have Changed Over Time*. [Online]

Available at: <https://www.thegreenage.co.uk/building-regulations-changed-time/>

[Accessed 5 January 2024].

University of West England, 2023. *Evolution of Building Elements*. [Online]

Available at: https://fet.uwe.ac.uk/conweb/house_ages/elements/print.htm

[Accessed 5 January 2024].

Welsh Government, n.d. *The Building Regulations 2010 Conservation of fuel and power*, s.l.: 2010.

Wikipedia, 2015. *Wikipedia Aberystwyth*. [Online]

Available at: <https://en.wikipedia.org/wiki/Aberystwyth#References>

[Accessed 15 November 2023].

Wikipedia, 2023. *Victorian architecture*. [Online]

Available at: https://en.wikipedia.org/wiki/Victorian_architecture

[Accessed 29 November 2023].