Spring 2014

Derelect Churchbells Ring in New Technology

Lauren Sloan

DERELECT CHURCHBELLS RING IN NEW TECHNOLOGY

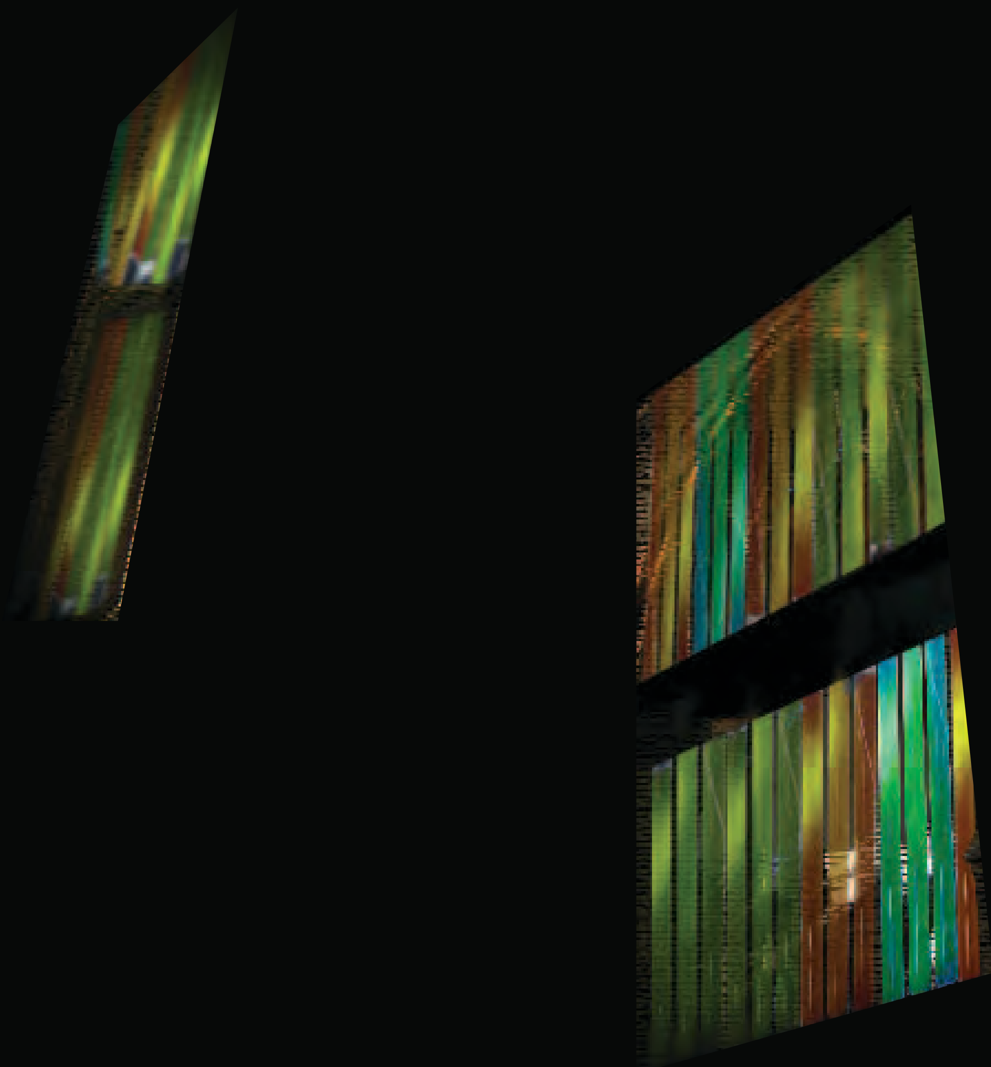

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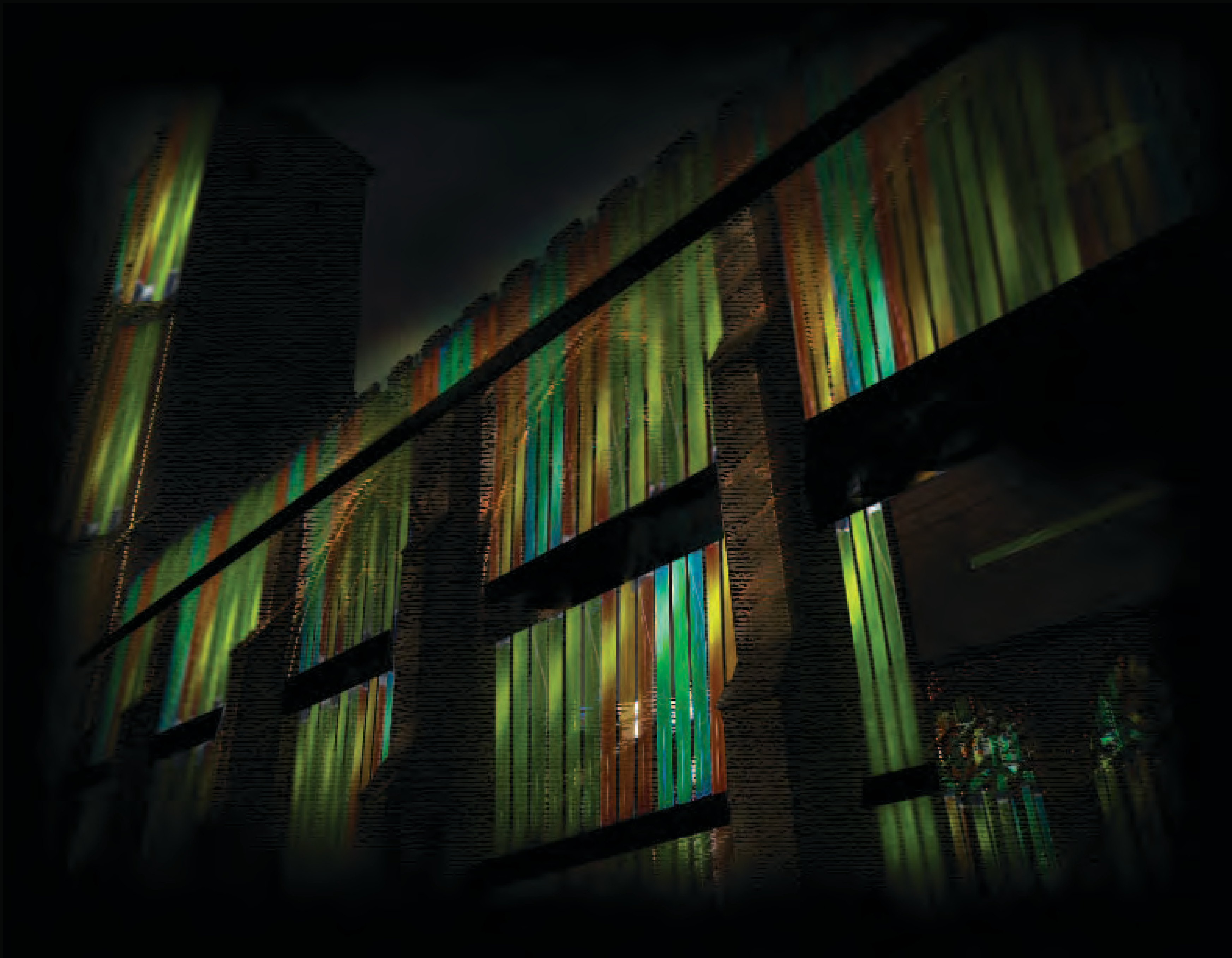
Figure 1 . Temple Church, Bristol UK >

Source: "Flickr." Last modified December 11, 2011. http://www.flickr.com/photos/eltpics/6555549933/.



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INTRODUCTION

INTRODUCTION

Intro: Algae biofuel research sheds a promising light on the way towards a more sustainable future for our cities. Not only is it the only biofuel to grow off of waste water, it is also the highest yield, grows just about anywhere with sun, and actually absorbs carbondioxide in its growth. It is inevitable that in the future we will not have a surplus of land and algae will have to grow on building facades.

Abstract: In order to accommodate this, we should first test algae facades on pre-existing building shells. I have a specific interest in derelect churches in because they are plenitful and although not on historic lists, they can still be preserved through the revitalization process. All buildings cannot be saved for preservation sake, so these buildings can accomodate new programs for specific city and site needs. Injecting these new technologies into the buildings will produce a contradiction that emphasizes both the new and old architecture. The deeper meaning of this thesis embodies what the visual chroma effects of algae are on the built enviornment. This includes their presence at night as a sustainable broadcaster through the RGB colors of algae and their daylit interiors encompassing a mixture of reflected colored light.

Application: Testbed projects like this will only be possible by by changing the BREEAM innovation credits. The innovation credits currently applaud one to three points to specific categories executed superbly, however a mass accumulation of points in one category is not allowed. This thesis will propose that one category can collect all the innovation points.

Preface: This thesis is broken up into three different categories architecturally: adaptive reuse of churches, an algae biofuel skin, and the experiential effects of color. Hence there is a word on each one of them and a combination of concluding remarks at the end.

Contention: The destruction of monuments and buildings can be traced back as early as human beings existed. The Romans famously used spolia in their own architecture by removing columns for new buildings. However, the preservation movement is relatively new and can be traced back to 17th century Britain when civil wars destroyed important churches and ancient Roman walls for stone and people began to wonder if these buildings should be saved for reasons of nationalism.[1] The first preservation movements took place in Britain with medieval churches and in Scotland on Baronial Castles, with a 'laissez faire' tactic of individuals and private organizations.[2] In the 19th century, preservationists often saved what they liked, covering over historic facades that were 'out of style.'[3] In response, the Anti-Scrape movement uncovered all of these facades and prevented this from ever happening again. Pugin's take on this was to highly differentiate the old and new to ensure authenticity, however Ruskin reacted against any new industrial fabric infiltrating the old as any restoration was 'active destruction'.[4]

Figure 2 . Pugin's Contrasts, medieval and modern British city retain history, but progress architecture.

In the early 1900's, the public objected to the destroying nineteen Wren churches while post war struggled what to do with bombed ruins, but ended up thinking they were a strategy for modern architecture.[5]

Figure 3 . Coventry Cathedral, bombed out shell left as public space, modern cathedral connected.

Coventry Cathedral in London was one of these bombed out churches rebuilt modernly and another example includes Carlos Scarpa's Castelvecchio in which a castle was transformed into a museum using steel and glass to contrast the old. If the site is high in tourism, the building should be preserved as its first agenda, and addition of amenities for the tourists. However, if an insignificant building is sitting dormant and waiting to rott, it would be to its benefit to add a new function for the people who would object to having it torn down and a new structure built there. Preservation is really for the people and future generations, not because it is the most efficient and cost-effective.

Figure 4 . 13th c. church in Holland converted into a multi-story library after it sat empty for awhile.

The Churches Conservation Trust in the UK rescues churches in need and rents them out for filming, concerts, services, wedding, ect. and encourages tourism to these destinations. There are 340 churches saved by the organization, but the UK as a whole has 51,000 churches total and church attendance is dropping in every religion.[6] The methodists have seen the biggest decrease, with 41% decrease in the UK since the 1980's.[7] These churches will close for what they think will be temporary, but never gain enough support to reopen and there church sits and decays. The embodied energy of these churches is enormous and could host new programs that simply need a roof over their head.

Algae biomass growth could be one of these programs, as photobioreactors (PBR) just need a base to sit on. Where people used to come hear the word of the Lord and feel his presence through diffused even light and RGB stained glass depicting biblical scenes for those who could not read, people could now look at readatpive algae churches as sustainable fitness centers through RGB PBRs reflective light and night time imagery.

Algae biomass is grown primarily outdoors in bulk and is disconnected from research facilities due to lack of room for

1 Miles Glendinning, The Conservation Movement: A History of Architectural Preservation, (New York, NY: Routeledge, 2013).
2 Ibid.
3 Ibid.
4 Ibid.
5 Ibid.
6 "Church attendance on the rise in the UK?." http://thisfragiletent.com/2009/02/13/church-attendance-on-the-rise-in-the-uk/.
7 Ibid.

expansion or lack of direct sunlight. Most of the progress is in the United States due to EPA funding and oil major funding coming from the US and the UK. In fact, five out of six oil majors give primary funding to the United States because we have built up the research base for algae and simply use the most oil of any country.[8]

As stated before, algae can harbor a symbiotic relationship with buildings due to its growth and cleaning of waste water. It also would be beneficial to be located near factories that produce carbon dioxide, which the algae will absorb during photosynthesis. Other benefits include an excellent insulator due to water's high specific heat coating a building like a blanket. Churches in particular are mostly all oriented east-west, so they are already set up for algae panels.

A similar analogy of the advancement of algae panels is the emergence of photovoltaic cells. Although they were first developed on the ground, they were eventually commercialized for public roofs and then integrated into vernacular tiles, and eventually tested in architecture at the Solar Decathalon.
The Algae Building by Arup Associates is the first of its kind and uses customized PBRs to grow algae on a new apartment complex. The image of the building is rather fake because in rednerings the algae panels are green, however in real imagery the panels look black or clear depending on the light. This architecture relies on the presence of green paint to convey the message of a living skin and 'caution toxic' tape providing a message of a living experiement and living shade.

Figure 5 . Algae Building real imagery shows the algae as a clear panel, green only from the paint.

There are no images of the algae building at night due to the fact that the architects did not plan for the building as a beacon, but rather the first stab at a functional algae skin. This thesis looks to the future and says that eventually algae will be a viable facade feature just like photovoltaics and we should get a head start and begin designing the possibilities of what algae architecture could be. There is little research on the area, however looking at the algae building and the visual possibilities we can speculate it will have the same progression as PVCs: technology will get smaller, more integrated, need less direct sun, and more of an envelope than a tack on component.

The visual color of the algae panels will provide an experiential interior space during the say and exterior mass on the exterior at night. Just like stained glass glowing outward at night to notify members the church was in service, algae panels can attempt to do the same thing for sustainability. Complex patterns can be ever changing based on the three algae colors and their changing harvest transparencies. At some points one may be able to see the silouette of the building behind, but other times the colors may be bold and opaque. The may form different patterns depending on the harvesting, and some even emptied for cleaning. Just as the Computing Faculty at TU Dresden by Code Unique Architek uses foggy white light and strands of algae colored green light to illuminate and provide a silouette of the building itself at night, the algae building can take this a step further and animate the facade with a variety of changing colors by night.

Figure 6 .TU Dresden Faculty Building uses tinted green glass combined with opaque white panels to create a subtle beacon.

The lighting effects expected on the inside will grant the harmony and relaxation of green, which has been placed in the past in places of tension or instability such as pre-stage rooms or in doctor's offices.[9] The reflected green light will react with the materials inside weather they be absorbing, reflective, or shiny. Materiality placed nearest the skin will have the greatest impact on the visual effect and spread or absorption of the reflective green. The Idea Store in London by David Adjay uses green tinted glass paired with interior soft metal fins in order to amplify the brilliant green cast shadows in a modern bookstore and sidewalk canopy.

Figure 7 . The Idea Store has a combination of clear and varied color glass panels that cast green shadows on metal fins and the floor.

There is no better a time to have derelect churches ring in new technology, that of algae biomass growth in order to promote sustainability of the new and old, reunited and symbiotic in each other's glory to promote sustainable lifestyle program's in Bristol, UK.

8 Thurmond, William. Emerging Markets Online, "Top 11 Algae Investment and Market Trends to 2020." Last modified 2011. http://www.emerging-markets.com/algae/Top_11 Algae_Investment_Trends_ from_ Algae_ 2020_ Study.pdf.
9 Contemporary Color Design, (Cologne: Daab, 2007).

BREEAM INNOVATION POINTS

BREEAM was launched in 1990 in the UK, preceding the LEED system in the United States by almot ten years. It was launched to help designers realize and be recogized for acheiving sustainable design. There have been many new versions that have come out for specialty building, including domestic adatpive reuse, but not non-domestic adaptive reuse-yet (this is suppose to come out in 2014.)

One of the major problems with BREEAM is it does not always allow designers to invest in innovation.[10] They are adhering to strict guidelines and once the list is checked off, there is no more use for unique sustainable deisgn. This is a problem because if innovation is never pushed or tested in the field, it will never progress and become more efficient.

Innovation credits currently work in a way that allows designers up to 10% more points in the innovation category, which is exceptional work in the categories of energy, health/well-being, materials, management, waste, and water. Not only does this skip the categories of land use/ecology, pollution, and transport. it only allows 1-3% PER category. If a designer had an innovative idea that would push just one of these categories, they may claim it a waste of time and money if it will not

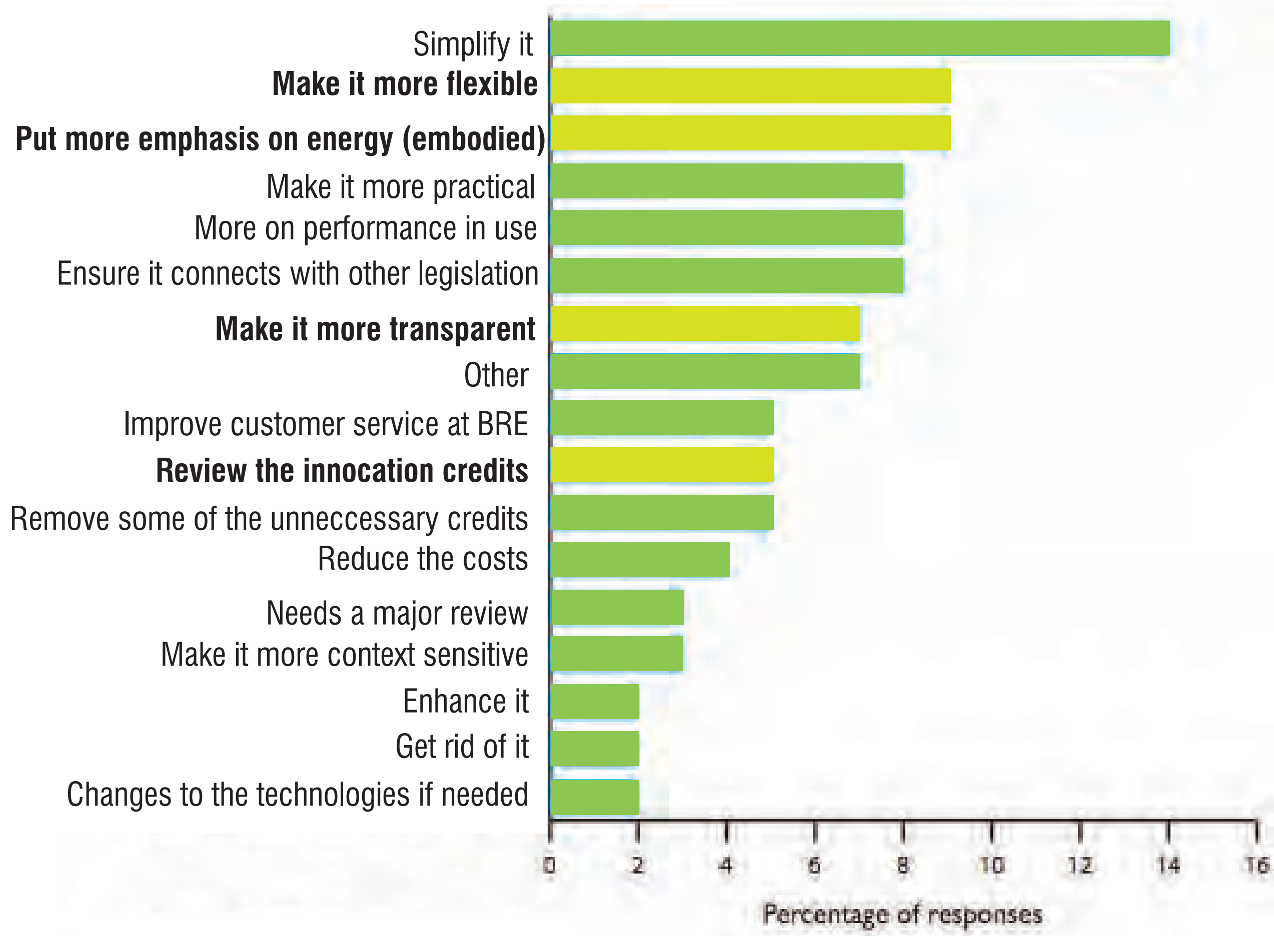


Figure 8 . Changes needed to BREEAM according to clients

Source: Image adapted from BRSIA Report, James Parker, 2012.

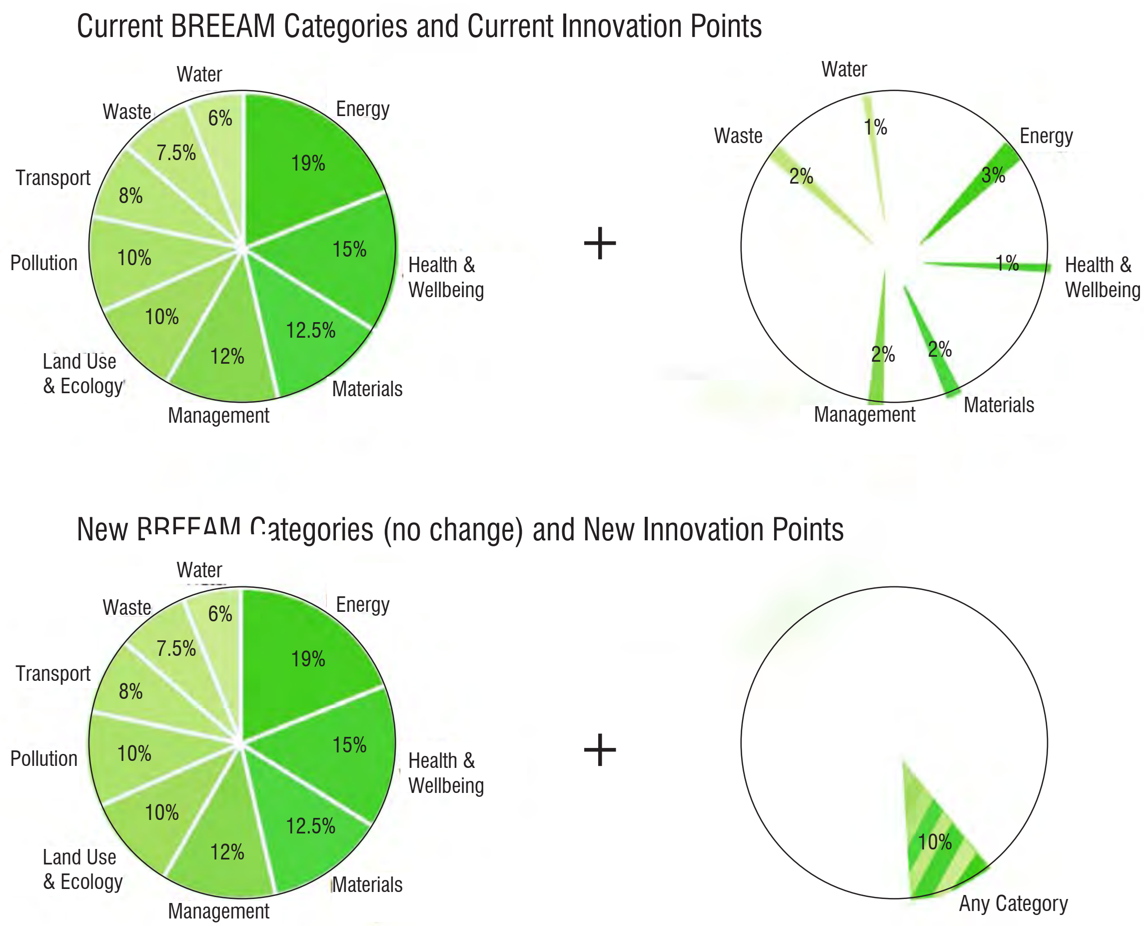


Figure 9 . Current and new BREEAM categories plus innovation points

Source: Image adapted from BRSIA Report, James Parker, 2012.

help their client get the BREEAM rating they desire, which is already a costly endeavor.

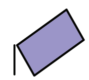
This thesis will propose that the innovation credits will be avaliable lumped in any of the categories, hence major new innovations are invited monopolize one category. These buildings may lack in some categories, but the overall sucess should be evident in the new ideas the new BREEAM will offer the field. The credits still could be divided up amongst all the categories or grouped in just two or three.

This organization of innovation credits will allow for the regulation of guidelines BREEAM strives for, yet allow that factor of flexibility and transparency desired by designers and clients. In BRSIA research, a client survey asked how often BREEAM'drives people to invest in innovation. Three quarters of respondents said occaissionaly, but what was noteworthy is one tenth of respondents said never and one percent said always.[11] As designers in architecture, we would like innovation always or we are just building from a manual of BREEAM strategies and all of the buildings will be alike in their sustainable atributes.

10 BRSIA Report, James Parker, 2012.
11 Ibid.

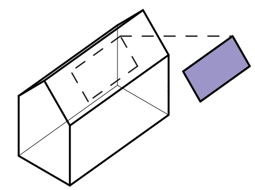
2

WHY ALGAE



1954

PVC field



1950's

PVC tacked onto roof

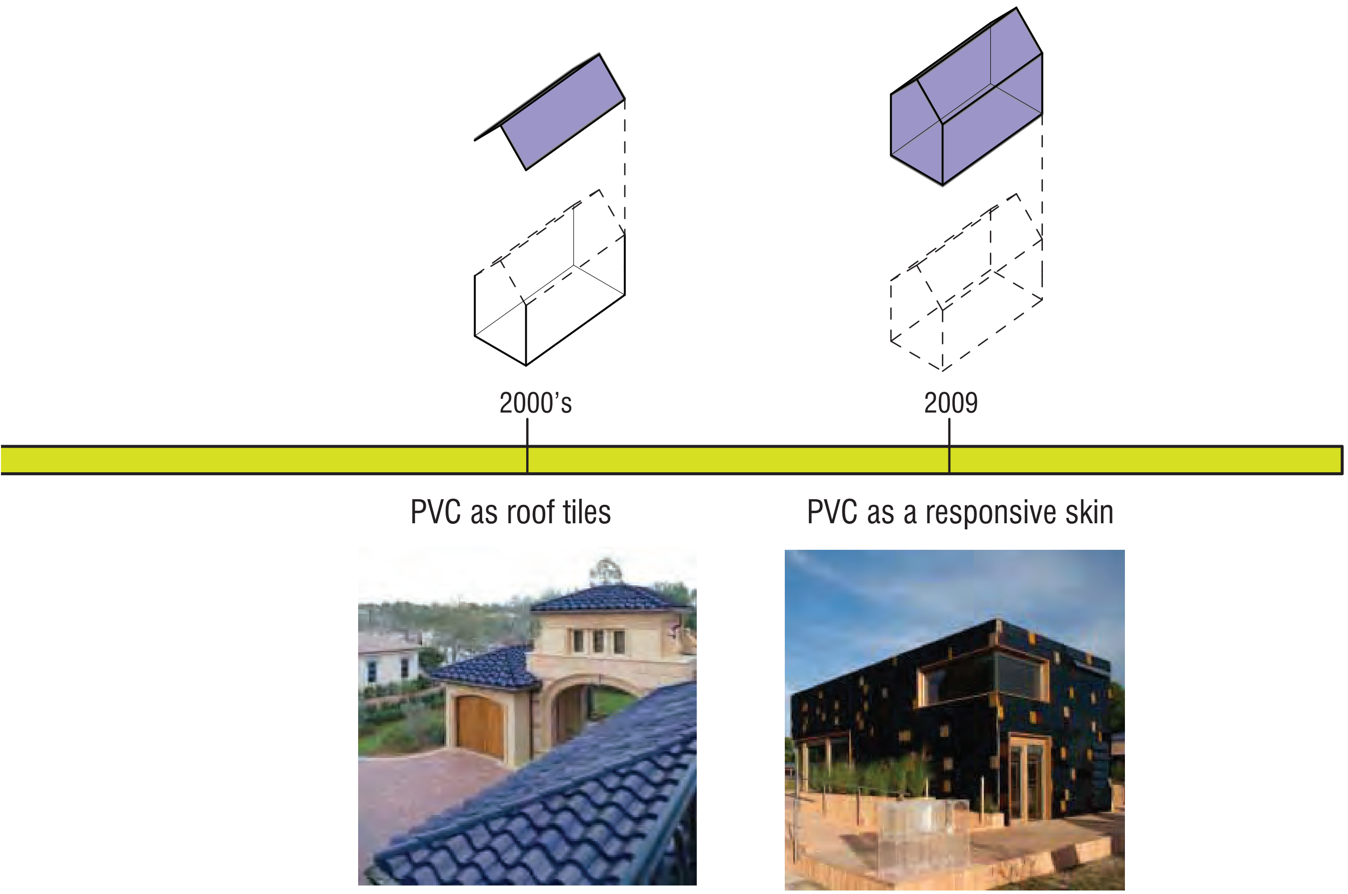


Figure 10 . Short History Diagram of PVC's impact on architecture

Sources: 'PVC Field' from Buzzle, "How Solar Panels are Made." http://www.buzzle.com/articles/how-solar-panels-are-made.html.
'PVC Tacked onto Roof' from Cazeault, "What Are the Solar Roof Tiles Prices." http://cazeaultsolar.com/tag/solar-tiles/.
'PVC as Roof Tiles' from Gizmag, "Stafier's solar roof tiles appear wafier thin." http://www.gizmag.com/stafier-solar-roof-tiles/28177/.
'PVC as a Responsive Skin' from U.S. Department of Energy, "Team Germany: Starting a Solar Revolution." http://www.solardecathlon.gov/past/2009/where_is_germany_now.html.

PVC ANALOGY

PVC (Photo-voltaic cells) technology started in the mid 1950's as a new technology capable of transfering solar energy into electricity. As the technology was refined, fields of panels were tested to ensure it captured enough energy to market to wealthy homeowners. Originally panels were just tacked onto existing homes with southern sun exposure, high up on the roof where it would capture the most sunlight. Newer vernacular roof tiles have hit the market in the 2000's, translating a specific architectural style tile into a PVC, so much you cannot tell it is not your ordinary roof tile.

In the solar decathalon 2009, twenty teams were asked to design solar powered homes with excellence in the categories of design, efficiency, consumer appeal, and affordability.[12] Team Germany designed a home as a responsive skin entirely of PVC panels of varied size. The wrapper is a small outlook on where PVC design is headed into integrating with architecture.

12 U.S. Department of Energy, "Solar Decathlon 2009 Team Germany." Last modified March 23, 2010. http://www.solardecathlon.gov/past/2009/team_germany.html.

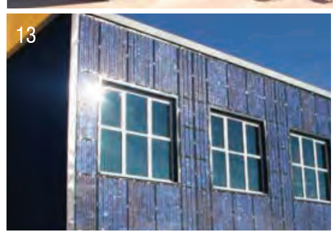
It was only after the solar decathalon 2009 that truely BIPV (Building Integrated Photovoltaics) began to take off. After Germany won the competition, the next year in Spain, the Spanish team integrated their envelope with a grid on PVC, however theirs was only on the southern facades and roof. In Germany, there was a spark in the solar technology sector. New products by Soltecture came out and are avaliable in the colors black or blue. They have still not really caught on in the market because their architectural aesthetic is so dark and different than a traditional home, however they are more successful for commercial buildings.

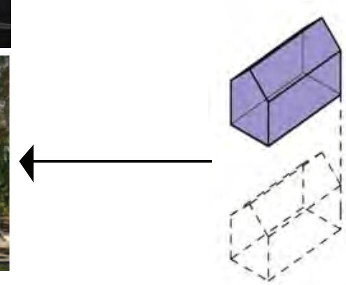
If comparing Figures 12 and 14 with Figure 11 (Germany's Solar Decathalon home), it is very obvious they have looked at the model and took away its orange-yellow accent hue. Figure 12 also took away wood framing and dark tinted windows. This cross-breeding is no accident as the competition winner's strategy tries to make it into the market.

Around the same time, the church community in the US and the UK began to question the use of using PVC on their roofs in order to save money on heating and electricity.

One example of this is St. James Church in Piccadilly.The church is registered as a Grade I Building, so it could not show any

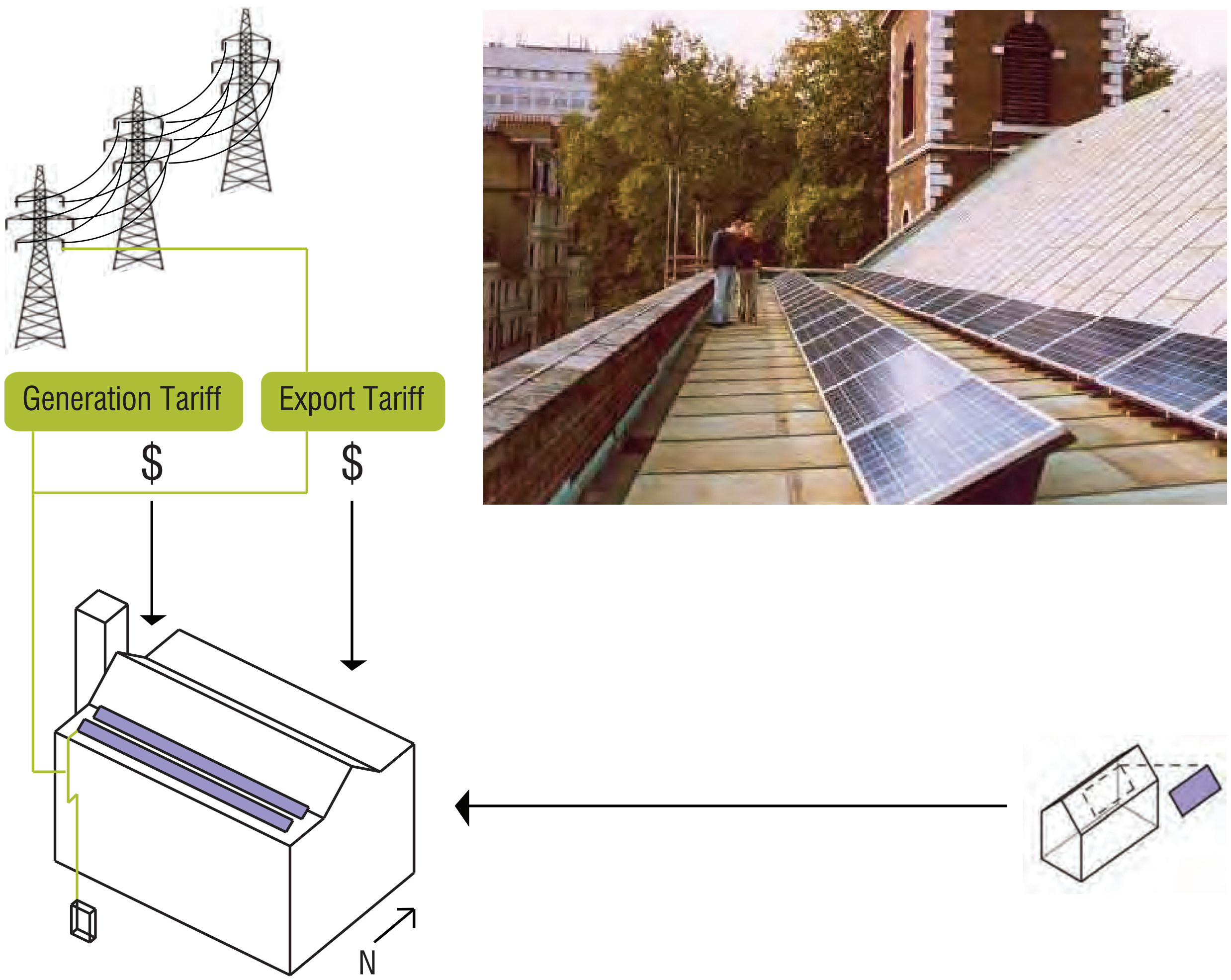
11 Solar Decathalon 2009, Team Germany
12 Solar Decathalon 2010, Team Spain
13 Solar facade, Spain, 2013
14 Soltecture Module, Germany, 2012
15 Soltecture Module, Germany, 2012
16 Soltecture Module, Germany, 2012





Figures 11-16 . Architecture became more BIPV (Building Integrated PV) post solar decathalon 2009

Source for Figure 11 U.S. Department of Energy, "Team Germany: Starting a Solar Revolution." http://www.solardecathlon.gov/past/2009/where_is_germany_now.html.
Source for Figure 12 Peter, Leah. Inhabitat, "Team Valencia's Solar Decathlon SML System House Adapts to a Growing Famil'ys Needs Read more: Team Valencia's Solar Decathlon SML System House Adapts to a Growing Famil'ys Needs | Inhabitat - Sustainable Design Innovation, Eco Architecture, Green Building."
Source for Figure 13 Gomez, Paco. Nosoloingenieria, "Ciudad de Hielo: Harbin, China." Last modified May 24, 2013. http://nosoloingenieria.com/page/3/.
Source for Figure 14 Style Park, "Soltecture Standard module." http://www.stylepark.com/en/soltecture/standard-module-scg-hv-f-integrated?ref=over_products_navig.
Source for Figure 15 Style Park, "Soltecture Standard module." http://www.stylepark.com/en/soltecture/standard-module-scg-hv-f-integrated?ref=over_products_navig.
Source for Figure 16 Style Park, "Soltecture Standard module." http://www.stylepark.com/en/soltecture/standard-module-scg-hv-f-integrated?ref=over_products_navig.



Figures 17 . St. James Church in London put up solar panels and receives tariffs for feeding back to the grid.

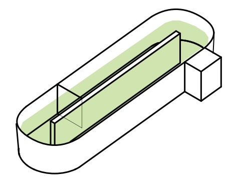
Source from St. James Piccadilly Church, "Photovoltaic Systems at St James's Church, Piccadilly." http://www.simondawson.com/sjpenv/sjppv1.htm.

evidence of PVC from the ground. The panels were applied in a tacked on fashion on the flat part of the roof so they would be unseen. Although not the most architecturally interesting advancement, they set out to prove a historic grade building could apply PVC unnoticeably. The building adhered minimal damages to route electric wires to the church's power supply.

Just as church's face E-W for lighting purposes, the PVC and algae facades find this an already perfect envionrment. If they were more integrated into the building that was not Grade I rated on the English Heritage, the aesthetic of new and old would be harmonic.

The UK church's are so interested in this investment because they have access to two tariff's as of April 2010: the generation tariff and the export tariff. The generation tariff pays the church for what they produce, no matter if it feeds into the grid or not. The export tariff pays the church for power they introduce back onto the grid, usually 50%.[13] Over 25 more church sites in London have installed PVC onto their roofs, and more are to follow with savings of million collectively.

13 Baird, Nicola, and Vicki Felgate. Friends of the Earth, "Feed-in tariffs and the renewable heat incentive." Last modified September 2011. Accessed November 26, 2013. http://www.foe.co.uk/sites/default/files/downloads/feed_in_tariffs.pdf .

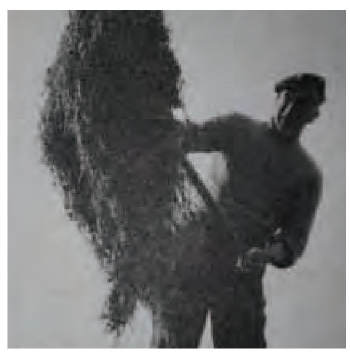


Nomadic tribes

1960’s

1980’s

Traditional European harvest



Algae raceway

PBR for regulated production

BENEFITS OF ALGAE

There is not one place in the world where algae ceases to exist. Even in Antarctica, algae has been found growing under the ice. In an age where we live with increasing oil and food prices, algae seems to offer relatively cheap solutions.

Vernacular countries have been harvesting algae and microalgae from lakes, ponds, or the oceans for centuries.[14] First experiements on mass production of algae were done in algae raceways, but production was low and risk of pollution was uncontrollable. In the 1980's Algae PBR (Photobioreactors) made headway. They are made of glass or plastic and connected to a harvesting mechanism which allows for control of the production. Recently in 2013, the first Algae Building was built in Hamburg, Germany and has flat PBR on the south facing facades to harvest algae as a nutrition supplement. This building is so new that testing is not complete on it, however just like PVC panels, a shell was wrapped around the building of the technology. The next challenge architects will face is how to make the algae technology into an integrated language that is not just tacked on, but an integral part of the design without compromising functionality.

14 Robert Henrikson, and Mark Edwards, Imagine Our Algae Future, (Richmond, CA: Ronroe Enterprises, 2012).

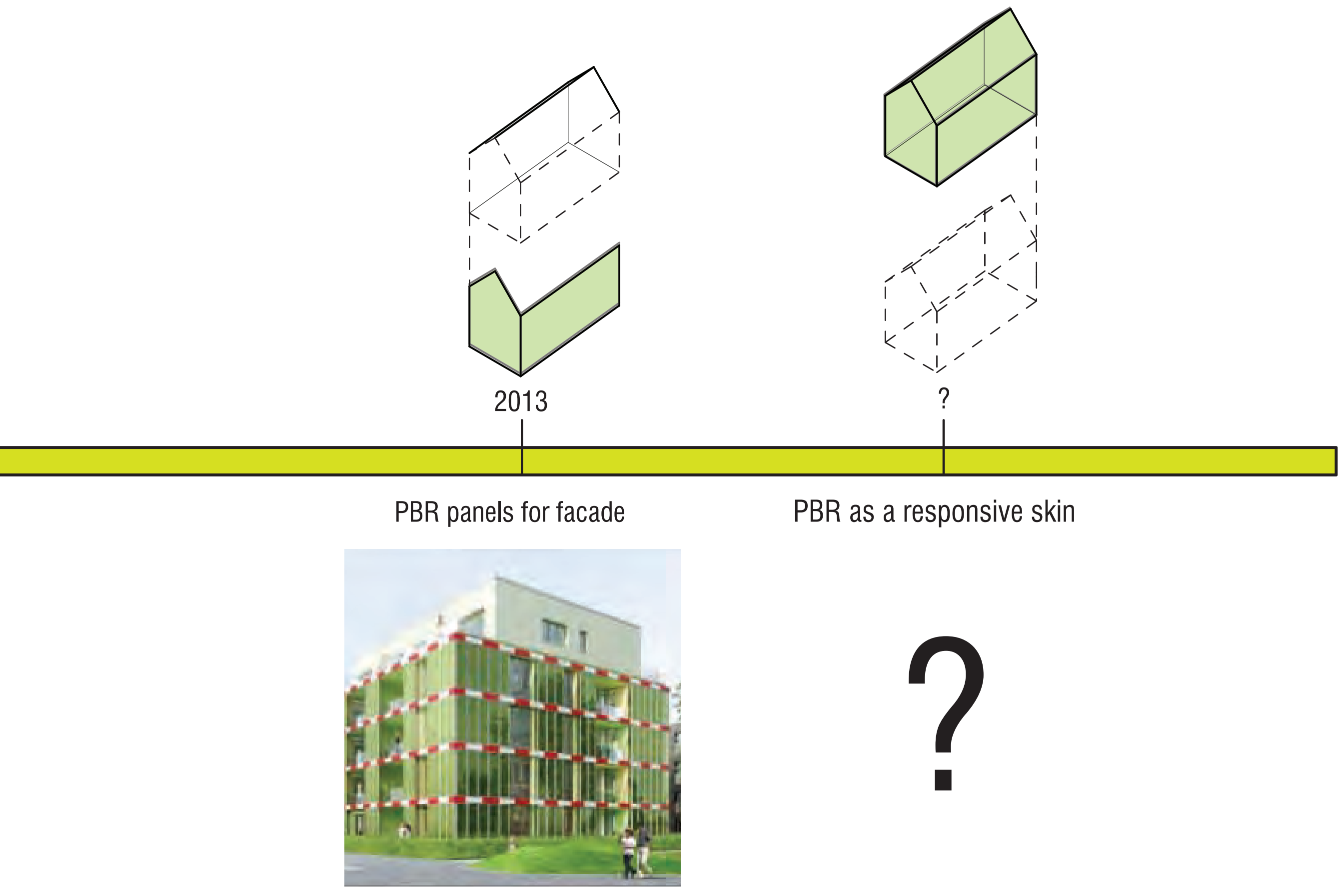


Figure 18 . Short History Diagram of PBR's impact on architecture
Sources: 'Algae Raceway' from Early, W. Blaine. Enviornmental Law News, "Kentucky Research on Algal Fuel Production." Last modified November 22, 2012. http://www.environmentallawnews.com/kentucky_research_on_algal_fuel_production/.
'PBR for Regulated Production' from NanoVoltaics, "Algae." Last modified December 30, 2012. http://www.nanovoltaics.com/portfolio/algae.
'PBR Panels for Facade' from Architects' Journal, "Toda'ys Green News." Last modified March 8, 2013. http://www.architectsjournal.co.uk/sustainability/footprintwire-080313/8643941.article.
'PBR as a Responsive Skin' from Henrikson, Robert, and Mark Edwards. Visionary Algae Architecture and Landscape Design. Richmond,

There are four main categories where algae has proven to be effective in production: food, fuel, products, and cleaning the envriorn ment.[15]

Early human nomads harvested seaweed from the ocean and drank microalgae in their water as a nutritious substance that has more protein than soybeans or corn. Today, algae production for food seems promising because unlike corn and soybeans, it can be grown in brackish and greywater rather than fresh. Up to four times less water is needed than normal[16] agriculture as well. Algae is commonly used to feed aquaculture as a cheap source of nutrients, but this is expanding to land animals as well.

Algae is also great for a variety of products. It is found in over 90% of cosmetics today, and can be added to soil as a natural fertilizer to save on chemicals entering runoff. Algae would be great for faminine relief due to the fact bioreactors could be quickly imported and start growing algae on site for people in need.

One of the major goals is to make algae into biofuel. Algae takes in CO2 during production and the right strains grown under the right conditions produce algae 40% or more of oil. Algae is so effective in the

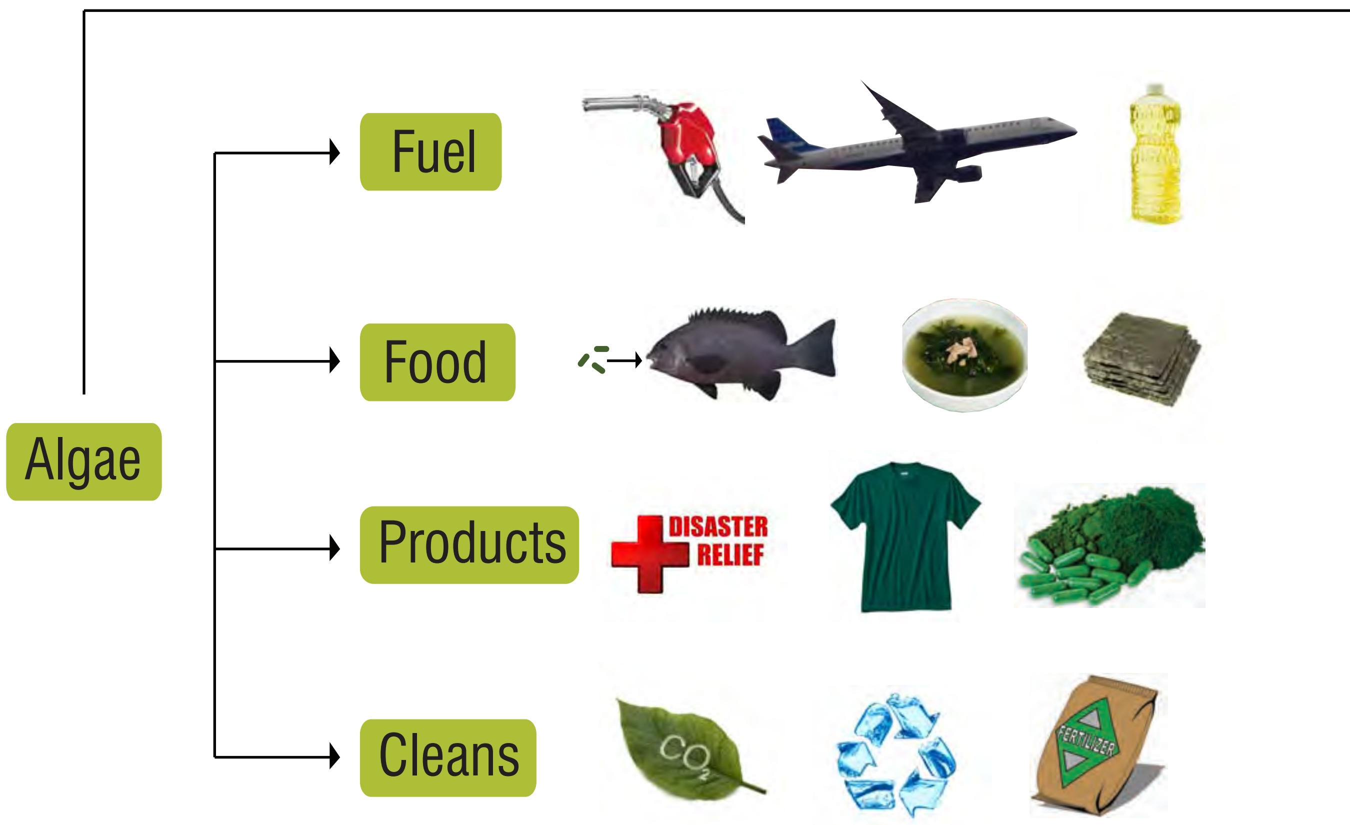


Figure 19 . Categories of algae production.

Source: Image adapted from Henrikson, Robert, and Mark Edwards. Visionary Algae Architecture and Landscape Design. Richmond, CA: Ronore Enterprises, Inc, 2012.

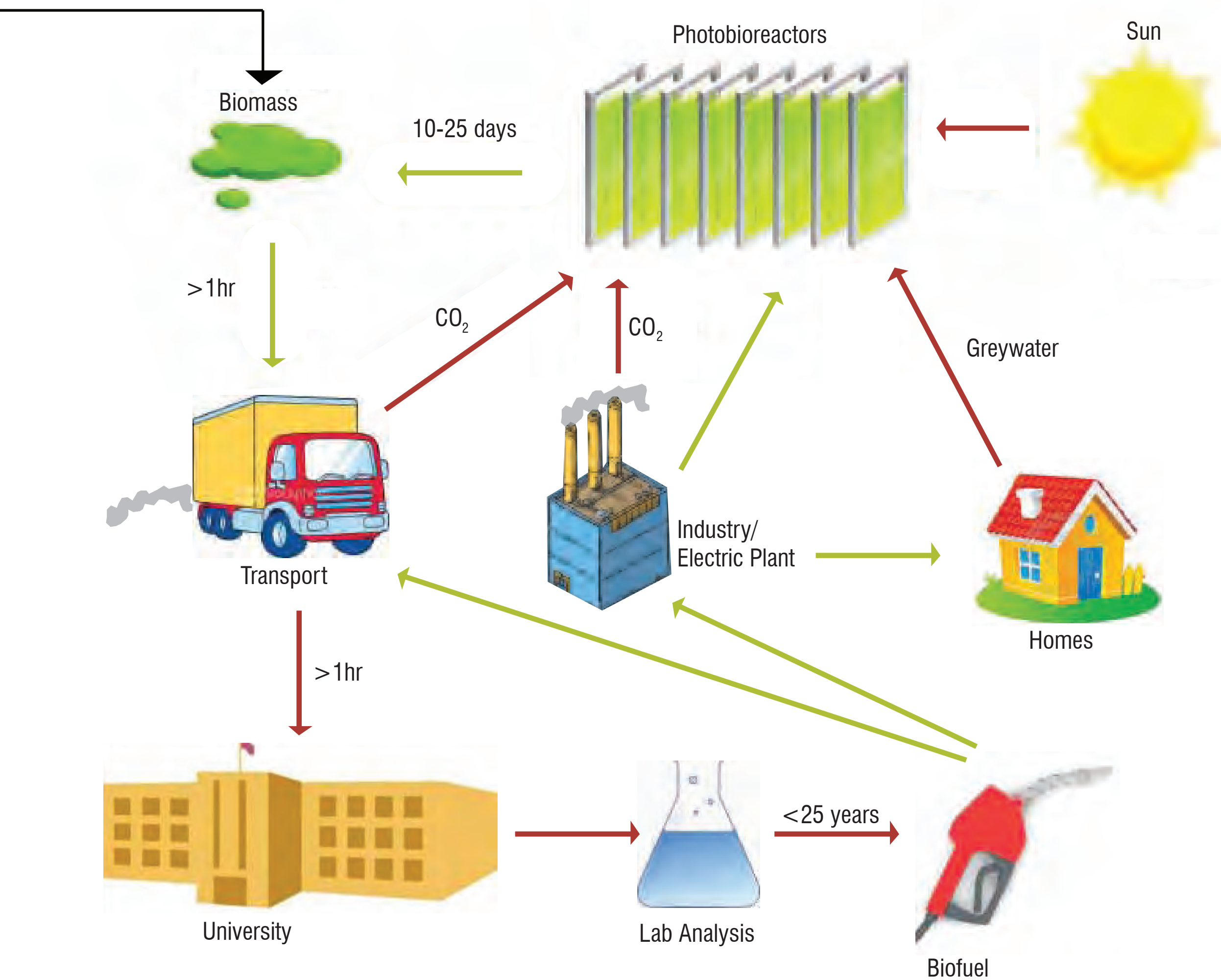


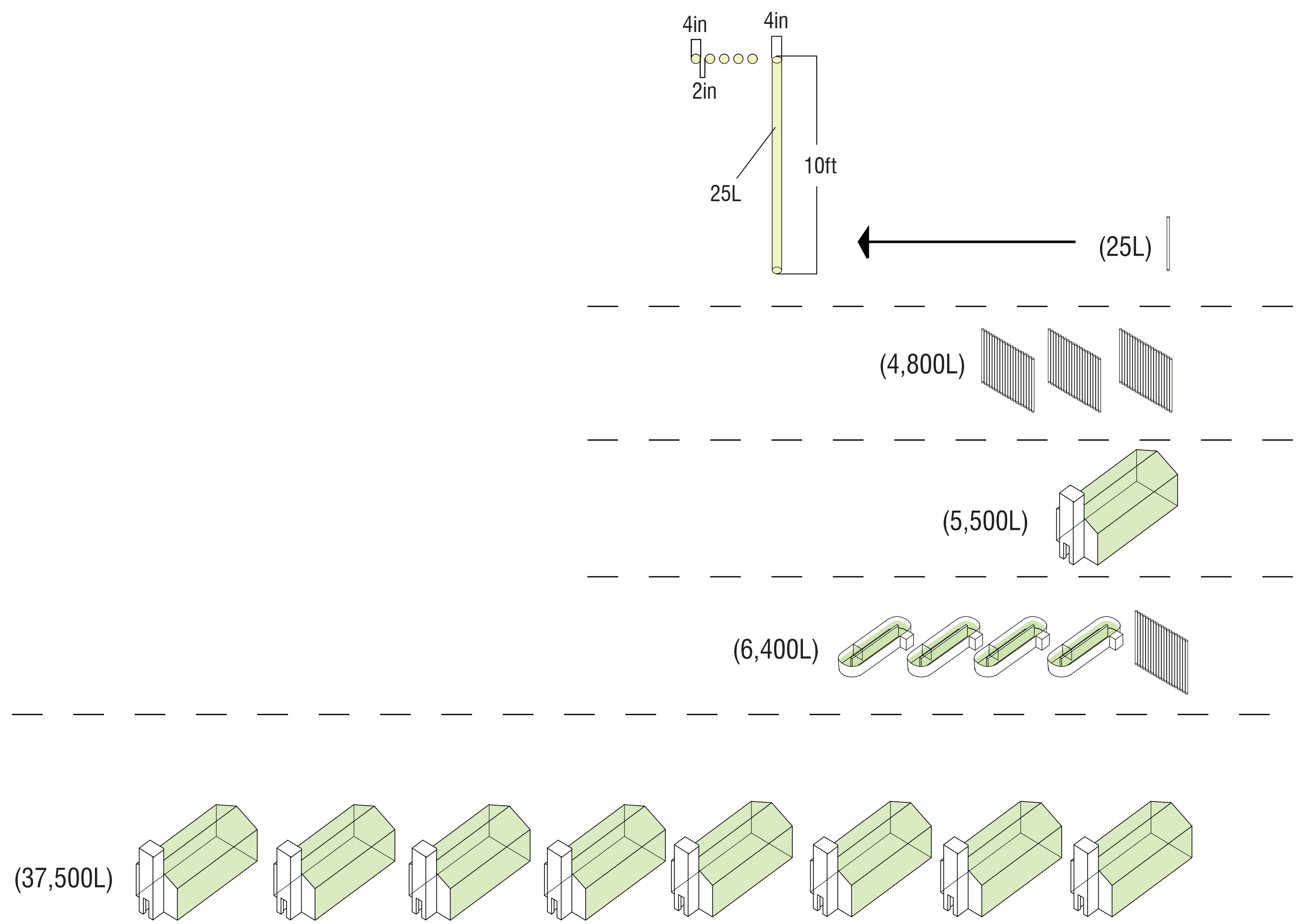
Figure 20 . Algae inputs and outputs

biofuel industry because it is a single cell, void of leaves or stalks that consume energy to make but cannot be turned into fuel. It also can be grown on non-arable land, so it does not take up land needed for farming.

The process of growing algae is an interconnected cycle. The sun is the main ingredient for photobioreactors or raceway ponds to grow a stock of algae. Photobioreactors should be placed near universities for research at this infant stage, and near industrial centers due to their need for CO2. Once a biomass matures in 10-25 days, it is transported to a factory for processing or university for study, particularly biofuel which is predicted to be a reality in 25 years or greater. Algae also needs some of the nutrients that greywater provides, otherwise they must be added to the watersource indepedently.

Large amounts of land or surface area are needed in algae production. In 2009,[15] the United States utilized approximately 150 million acres of land for soybean and corn later turned into biofuel.[16] The United States has desert landscapes which are otherwise unusable, so they can grow algae there, however countries where land is scarce or dense may find a better option on or built into architecture.

15 Robert Henrikson, and Mark Edwards, Imagine Our Algae Future, (Richmond, CA: Ronroe Enterprises, 2012).
16 Ibid.


4in
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Square Footage/Liters Required by Algae for Biomass Research

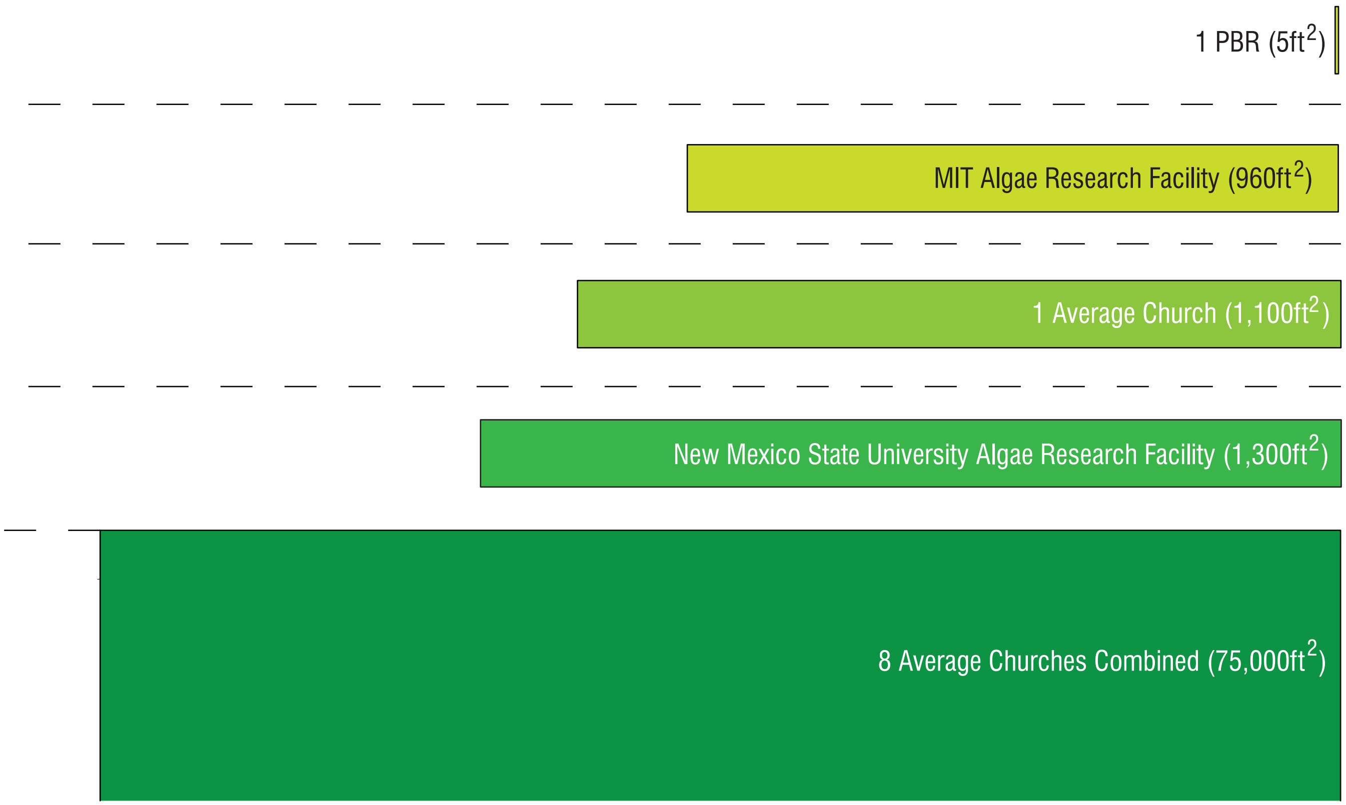


Figure 21 . Square Footage/Liters Required by Algae for Biomass Research

Source for New Mexico State University from New Mexico State University, "Algae Cultivation Testbed." http://www.research.nmsu.edu/erl/algalbiofuels/testbed/.
MIT, "MIT Algae Photobioreactior." Last modified May 11, 2007. http://www.youtube.com/watch?v=EnOSnJJSP5c.

ALGAE BIOMASS RESEARCH

The amount of square footage to grow algae for biomass is the amount universities need for research experiments. The standard PBR is 4inches diameter and a maximum of 10ft long. The tubes must be seperated by a minimum of 2 inches. If we determine the overall area needed for one tube to be 5ft squared (25L per tube), we can calculate how much square footage is needed on a church.

By comparing the amount of square footage of exisiting facilities, we can see that facilities such as New Mexico State Algae Research Facility which needs 6,400L of algae, it can be determined that just using one church is not enough. One Bristol church, on average would yield 33L of space for algae. If we use all of the Bristol churches (8), the total exceeds the New Mexico Research Facility about six times more. Looking at the Algae Productivity World Map, New Mexico falls within the orange range, so we can determine that having this much area is needed in a less warm climate in order to produce a significant yield of algae.

CHROMA ARCHITECTURE

Cities have always embodied a unique palette of colors in their architectue and cultures. The nature of the specific colors of a place relies on three factors:

1. Geography
2. Geology
3. Light

The geography of a place will explain what kind of colors the vernacular encompasses because a predictable angle of sun is present at the same latitudes. It is exactly 90 degrees at the equator and maximum reflectivity is reached. The climate of an area will also tell of the quality of light in an area. Brighter light typically looks best on bright brilliant colors while dull cloudy light will make these colors look dull, so duller colors are commonly used. The geology of an area's vernacular will include the stone or other material colors that were used historically in the city because that it what they had.[17a] For example, the Caracalla pure white marble found near Italy is prevalent in the sculptures there.

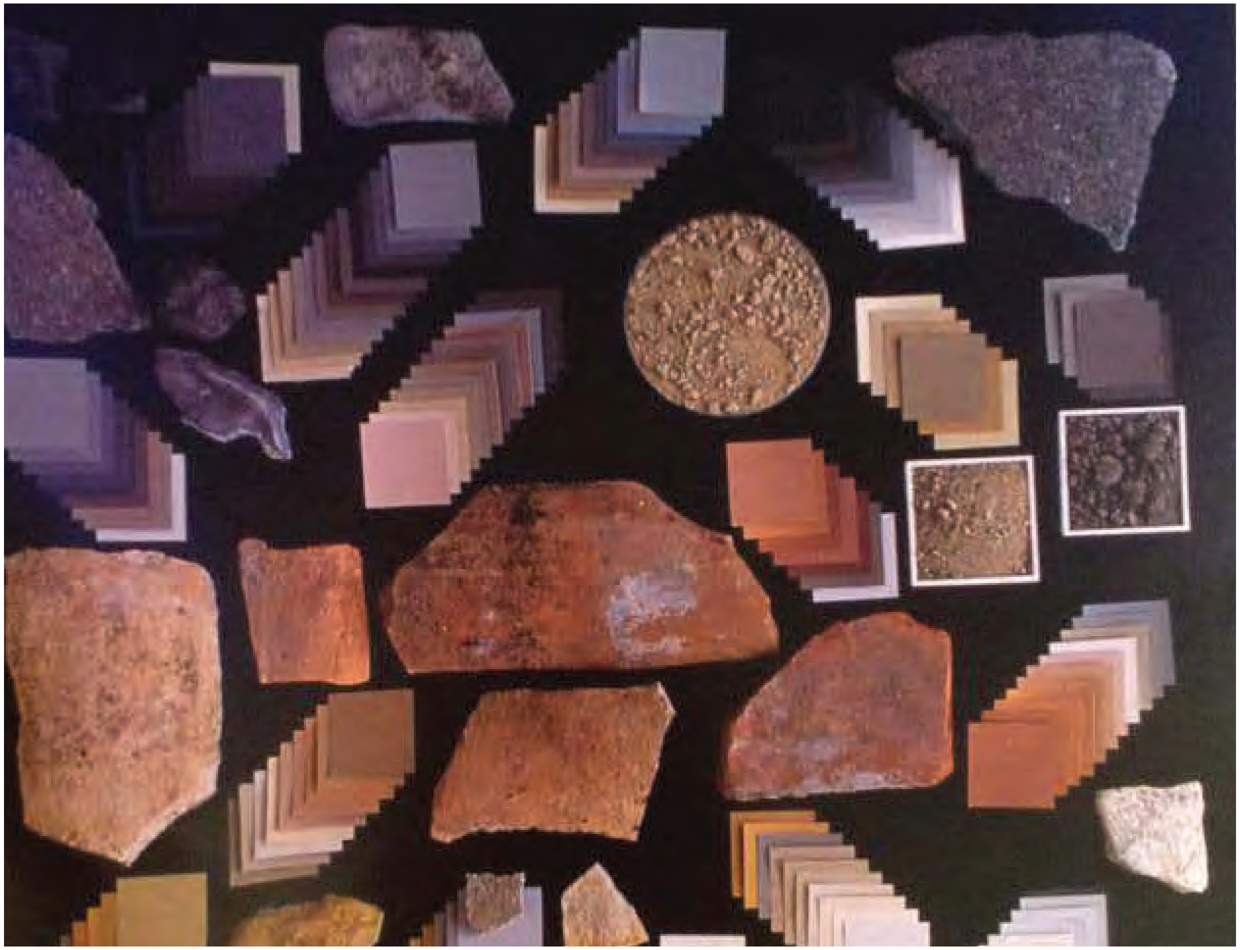


Figure 21B . The architectural spectrum of Lenclos tells the color of a place through photos, materials, and textures
Source from Poter, Tom, and Byron Mikellides. Colour for Architecture Today. New York, NY: Replika Press Pvt. Ltd., 2009.

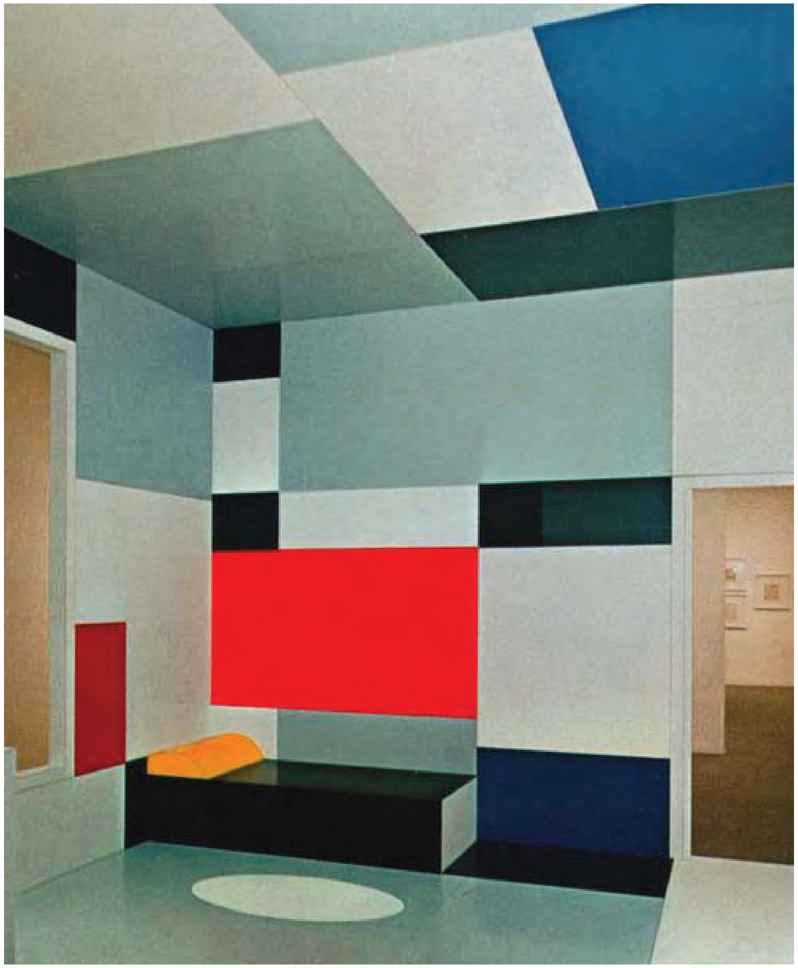


Figure 21C . Piet Mondrian's painted room shows that depth perception plays a large role in color. Toole, Bill. Blogspot, http://billtoole.blogspot.com/2009/07/piet-mondrian_3126.html.

Although we do not atribute color as a key proponent of form through light and dark perceptions, form would not exist without color gradiation. "We experience space through our interaction with surfaces. Light may be reflected off these surfaces and we may touch or even deform them. A particular geometric configurationmay appear very different when it is color, its context, or the color of the light used for observation is varied."[17b]

It seems that color is often an after throught for deisgners, and is hell if left to interior designers, but what if the design problem was about color from the start. Lois Swirnoff's study of color, "investigates color reflectivity, spatial configuration of depth, the interaction of colored planes in the field, angular relationships, and curved surfaces with relationship to light, shadow, and color."[17c]

De Stijl painters discovered the underlying principles of receding and advancing colors first in their 2D paintings and gradually in 3D space. In Figure 21C, red seems to pop forward.

17a Poter, Tom, and Byron Mikellides. Colour for Architecture Today. New York, NY: Replika Press Pvt. Ltd., 2009.
17b Ibid.
17c Ibid.

PRECEDENTS: BIQ BUILDING

The Algae Builidng is only spoken about in terms of its scientific advancement of technology inserted into the building to save on heating costs, however the architects had a very important concpetual agenda.

The building has been described by architectural critics as a green Mondiran painting and a living terrarium.[17] From its conception, the main design firm, Splitterwerk, was concerned with the chromatic effects of algae's green hue and were able to bring the idea of color into the interior living of the building from the exterior by using other bold bright colors.

The facade was thought of as a series of layers and filters that would overlap each other to form different shades of green and hazardous/ experimental spandrels of red and white to contrast the green.

This overlapping of greens from the balconies, the algae panels, and the gren painted building would hide and enhance the color of the algae when it has just been harvest and the water is almost completely clear. This is a lie because one cannot track the progress of the harvesting of algae if the paint is behind it.

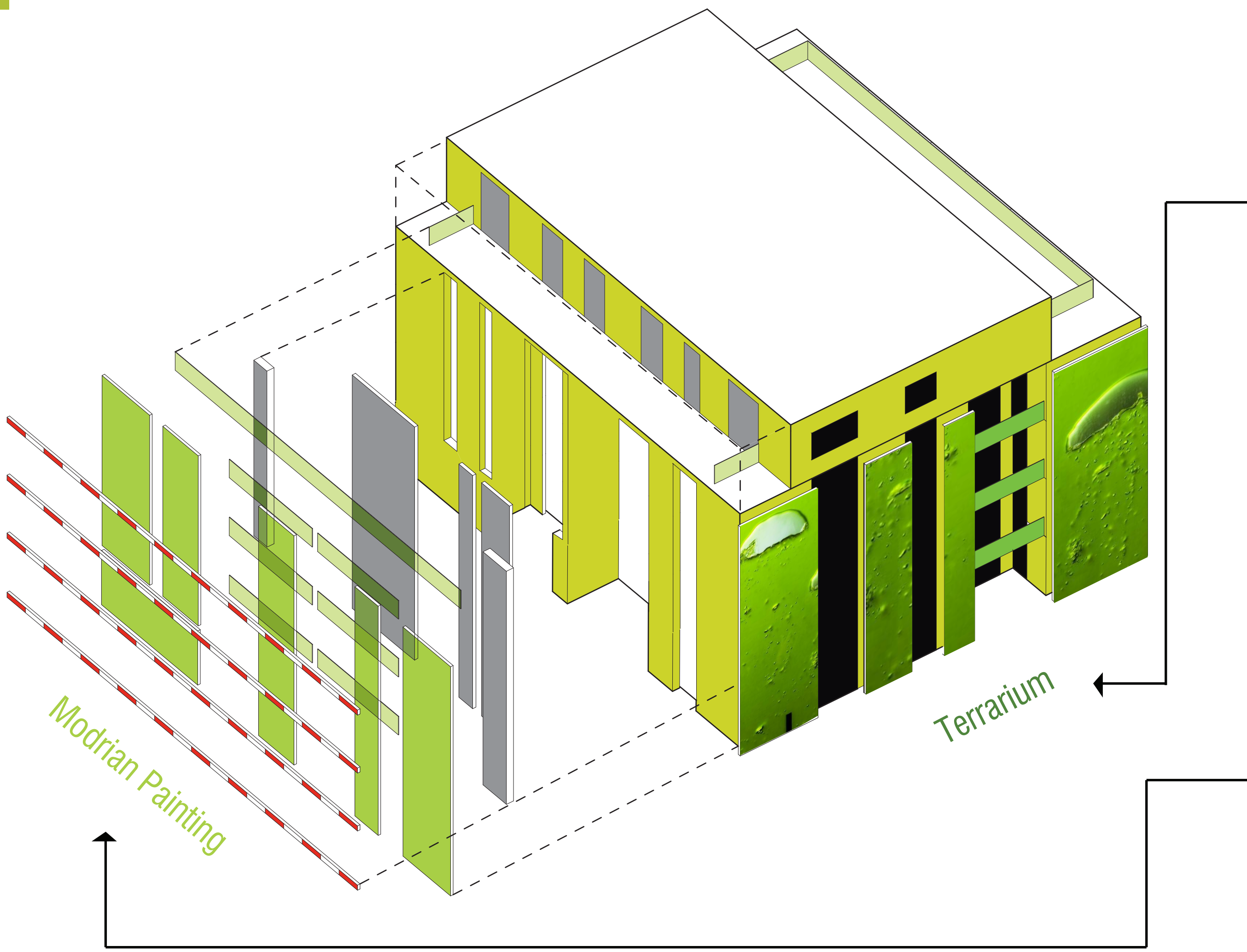
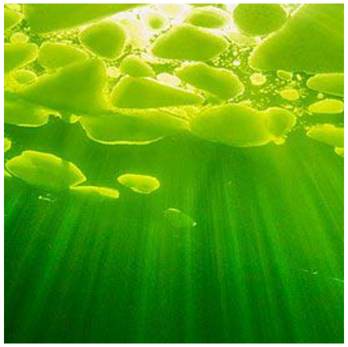


Figure 22 . Algae Building Case Study: Green Modrian Painting and Terrarium
Source of 'Terrarium' from "Centsational Girl." Last modified June 23, 2011. http://www.centsationalgirl.com/2011/06/secrets-of-a-successful-terrarium/.
Source of 'Green light and shadows' from Lyagushkin, Victor. AirPano.com, "The first "under ice" panorama in the world." http://www.airpano.com/360Degree-VirtualTour.php?3D=White-Sea-Russia.
Source 'Living Ecosystem' from McDermott, Mat. Tree Hugger, "New Algae Biofuel from Sapphire Energy "Chemically Identical to Gasoline"." Last modified August 1, 2008. http://www.treehugger.com/renewable-energy/new-algae-biofuel-from-sapphire-energy-chemically-identical-to-gasoline.html.

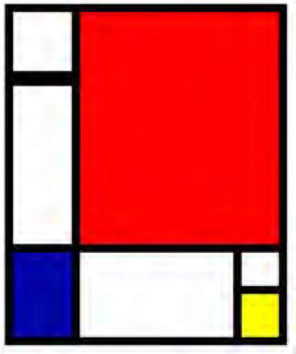
Terrarium



Green light and shadows

Living ecosystem

Mondrian Painting



Hazard Tape

Green Background

Source of 'Modrian Painting' from Piet, Mondrian. "A dream I had 'bout Mondrian."
Source of 'Hazard Tape from ScrewFix, http://www.screwfix.com/p/no-nonsense-hazard-tape-red-white-50mm-x-33m/88844.
Source of 'Green Background' from McCracken Paints, http://www.mccrackenpainting.com/about.php.

There are many chromatic oppurtunities for architecture that algae has to offer including: green light of various shades depending on thr harvest times, RGB color spectrum, living bubbles that travel through the panels, and an architecture that at night would be a beacon of hope and sustainability.

Interestingly enough, the BIQ (Bio-IQ) building is so new that there are no night shots of the building. Just as a church glows from the inside to the exterior through lit up stained glass, an algae skin could glow and be seen very far in the distance as a chromatic spectacle. The algae building killed this oppurtunity when they painted the whole building green, so it would always glow falsely even if it did have a presence at night. If various non-green paint colors were used in tangent with the real algae green, there could be a chromatic archtiectural spectacle. The same could apply for the interior, where green light would shine through from the exterior and be combined with other colors and materials to carry the light.

17 Wallis, David. New York Times, "When Algae on the Exterior Is a Good Thing." Last modified April 24, 2013. http://www.nytimes.com/2013/04/25/business/energy-environment/german-building-uses-algae-for-heating-and-cooling.html?_r=0.

The layers of the algae building are suppose to work together as one piece of artwork. When the transparent layers overlap, there is a new hue created, just as when the algae is harvested, new hues arise. The problem with the algae building is unlike the dynamic color changing process of harvesting the living algae, there are too many static colors that prevent the reading of the algae. The spandrels always remain white and red, the balcony glass is barely visible, the windows the same black, and the whole building was painted a striking green because the architect was afraid the algae would not be green enough most of the time and they were completely correct.

The diagrams on page 22 show that the intention was to have the panels stand out as the only green living thing, however the built result is the algae panels appear gray most of the time from the exterior while the main green comes from the painted concrete facade behing the panels. In all of the published pictures, the algae has not grown in at all because they harvest it every single day. This defeats the purpose of appearing a green hue.

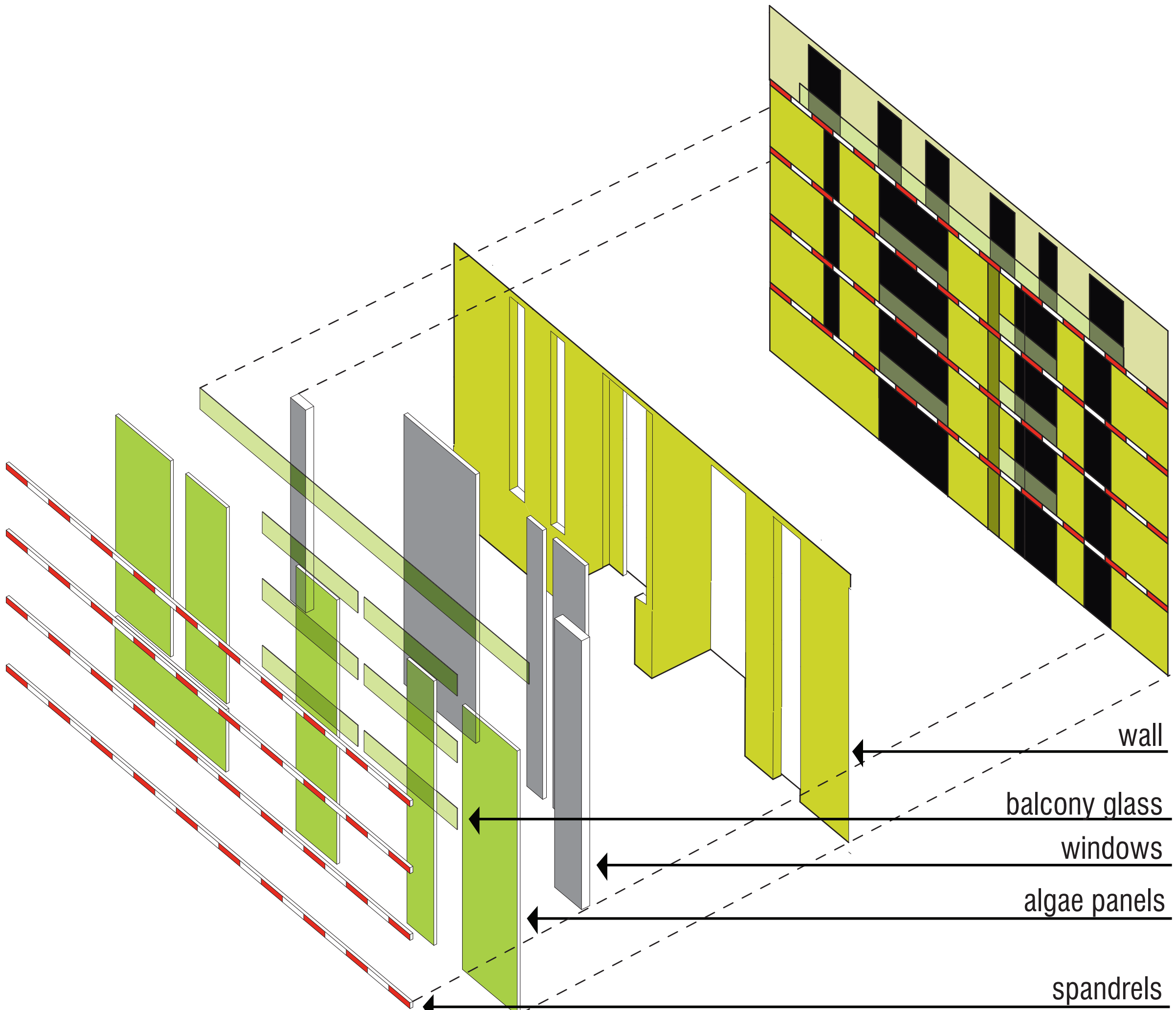


Figure 23 . Chromatic layers of the Algae Building

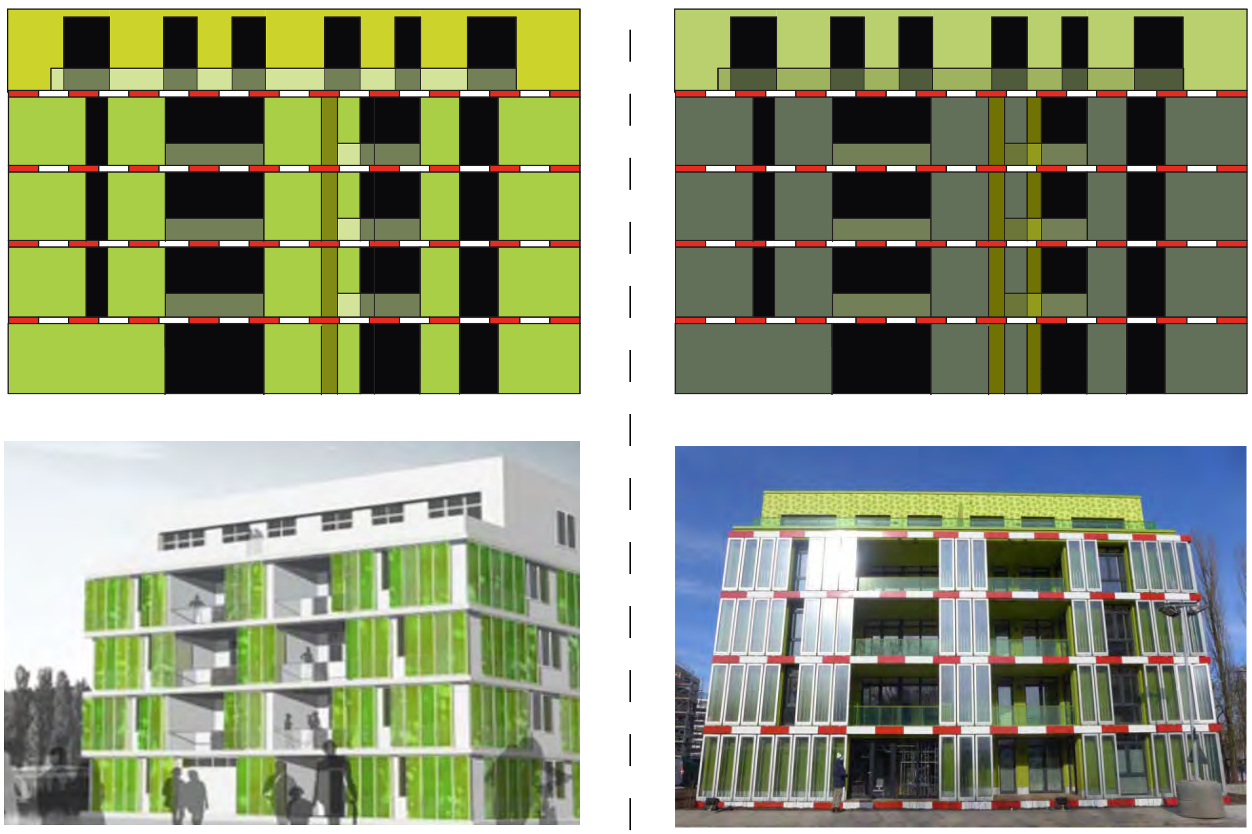


Figure 24 . Rendered vs Built facade of the algae building.
Source of rendered image from Kenntronn, . The Volt Report, "Algae Energy x Apartment Building." Last modified March 10, 2013. http://www.thevoltreport.com/algae-energy-x-apartment-building/.
Source of built image from Yirka, Bob. Phys.org, "First algae powered building goes up in Hamburg." Last modified April 12, 2013. http://phys.org/news/2013-04-algae-powered-hamburg.html.

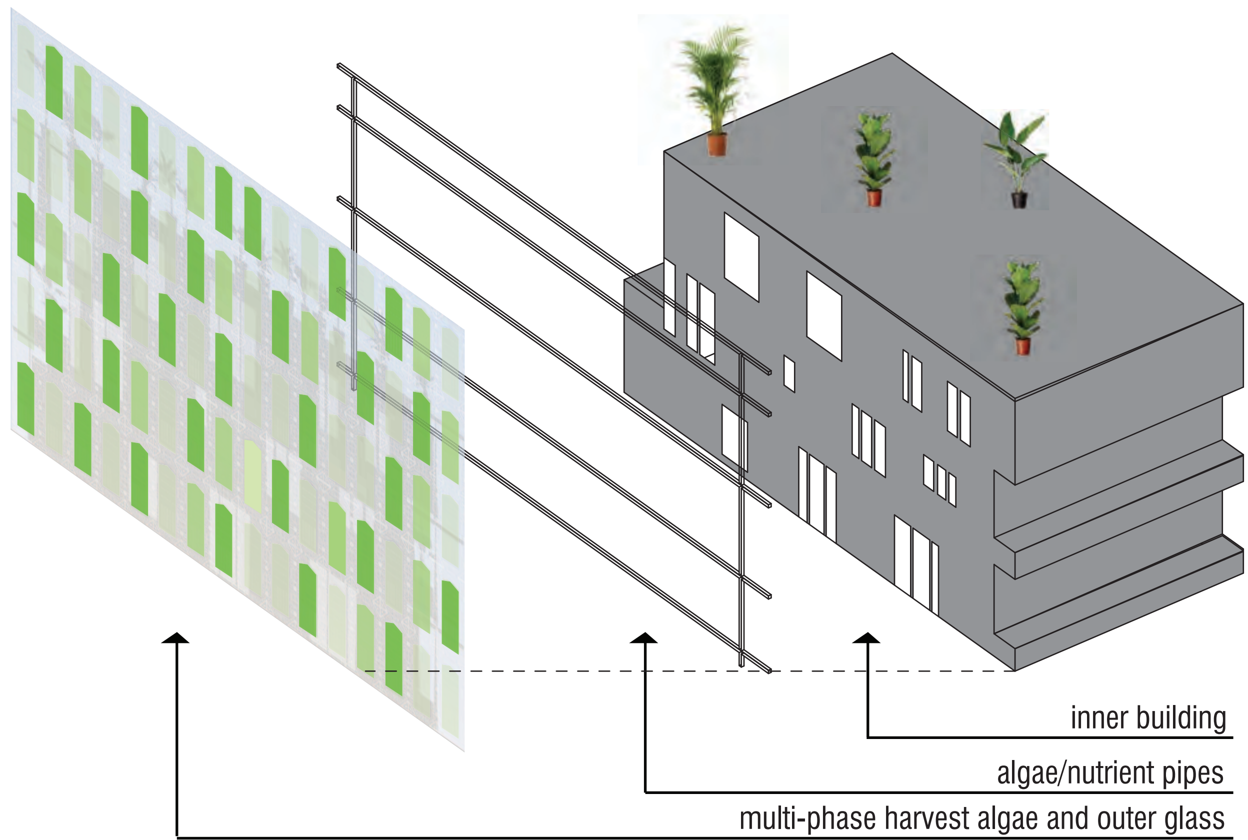


Figure 25 . Conceptual First Phase of the competition, ‘House within a house’.

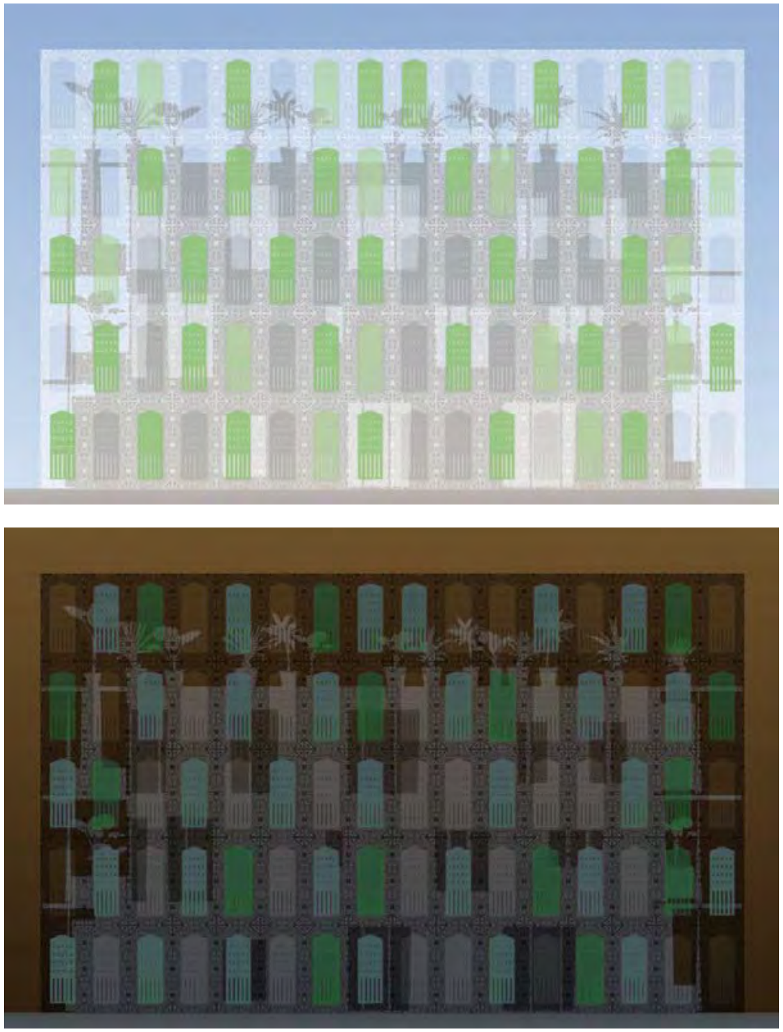


Figure 26 . Rendered conceptual design ‘House within a house’
Source from Roedel, Christian, and Petersen Jens-Phillip. "Smart Material House BIQ." IBA Hamburg, July 2013.

By looking at the conceptual facade rendering of the BIQ building, we can gain some knowledge that originally the architects thought about using the algae aesthetically. There are multiple harvest phases represented in the rendering, the lightest ones being the most translucent. The outer glass facade is semi-transparent itself and the piping for the algae and the inner house are ghosted through the alge, as well as potted plants on the roof. One can imagine the ghost of a church behing this facade rather than the ghost of an inner home.

This also gives us insight that the architects did indeed want the algae to be the main part of the design aesthetically in terms of color, however they were unable to pull this off due to the fact that the algae panels appear black in the daylight.

If one looks at the inverse image of Figure 26, one can see immediately that the algae has better potential to expose the inner building shadow at night because it will be lit up opossed to the panel reflecting daylight and looking black.

Although in the conceptual facade we saw a clear distinction between the outer facade and th inner building, in the built building, there are few algae panels that are left exposed. Most of the panels are against the concrete exterior wall which leaves many of the residents disconnected from the algae and its chromatic effects. Where the algae panels are left exposed, we can see how beautiful their green color is once they are backlit by sunlight. Unfortunately, we cannot be sure if any green light is bounced into the apartment because the whole balcony is painted bold bright green. Some of the apartments only have panels against the wall and do not get to exprience the terrarium bubbles, green light, or gradation of greens.

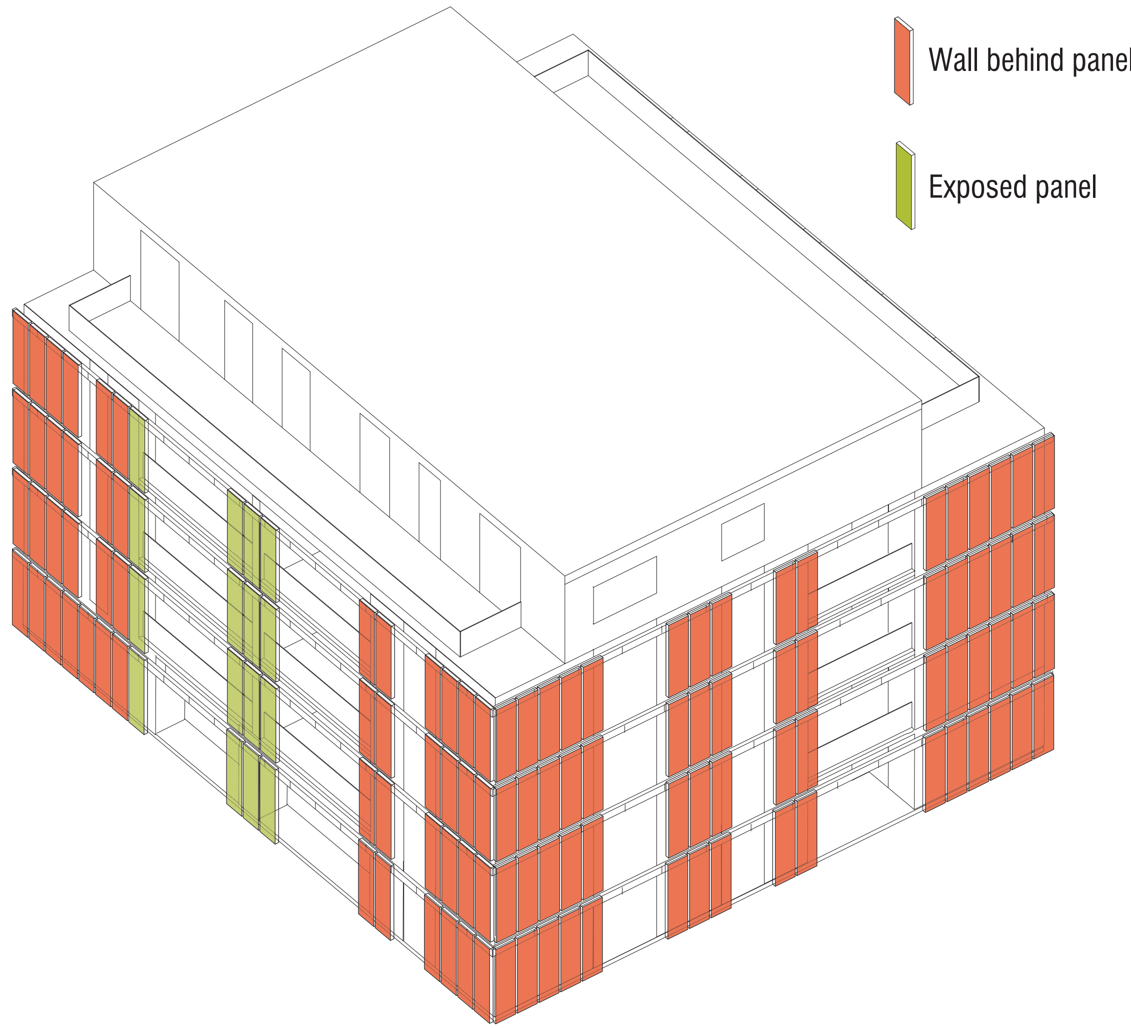


Figure 27 . Algae panels that are given the chance of being viewed and green light are highlighted in green.

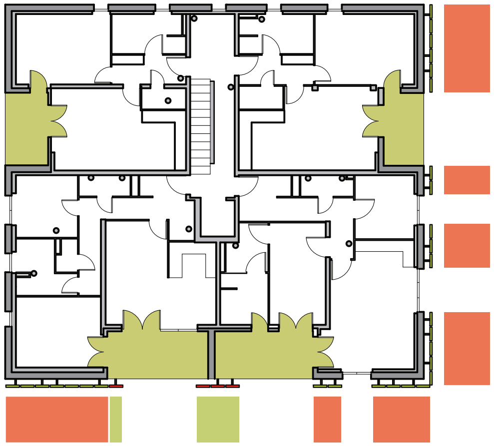


Figure 28 . Second floor plan corresponds to exposed and wall panels and interior porches are painted green.
Source top left photo from Youtube, "Algae Powered Building." Last modified October 3, 2013. http://www.youtube.com/watch?v=nJwNT2iDyxA.
Source top right from Otto Wulff, "BIQ Das Algenhaus." http://www.biq-wilhelmsburg.de/wohnungen/hamburger-mailaender-wohnung.html.
Plan traced from Roedel, Christian, and Petersen Jens-Phillip. "Smart Material House BIQ." IBA Hamburg, July 2013.

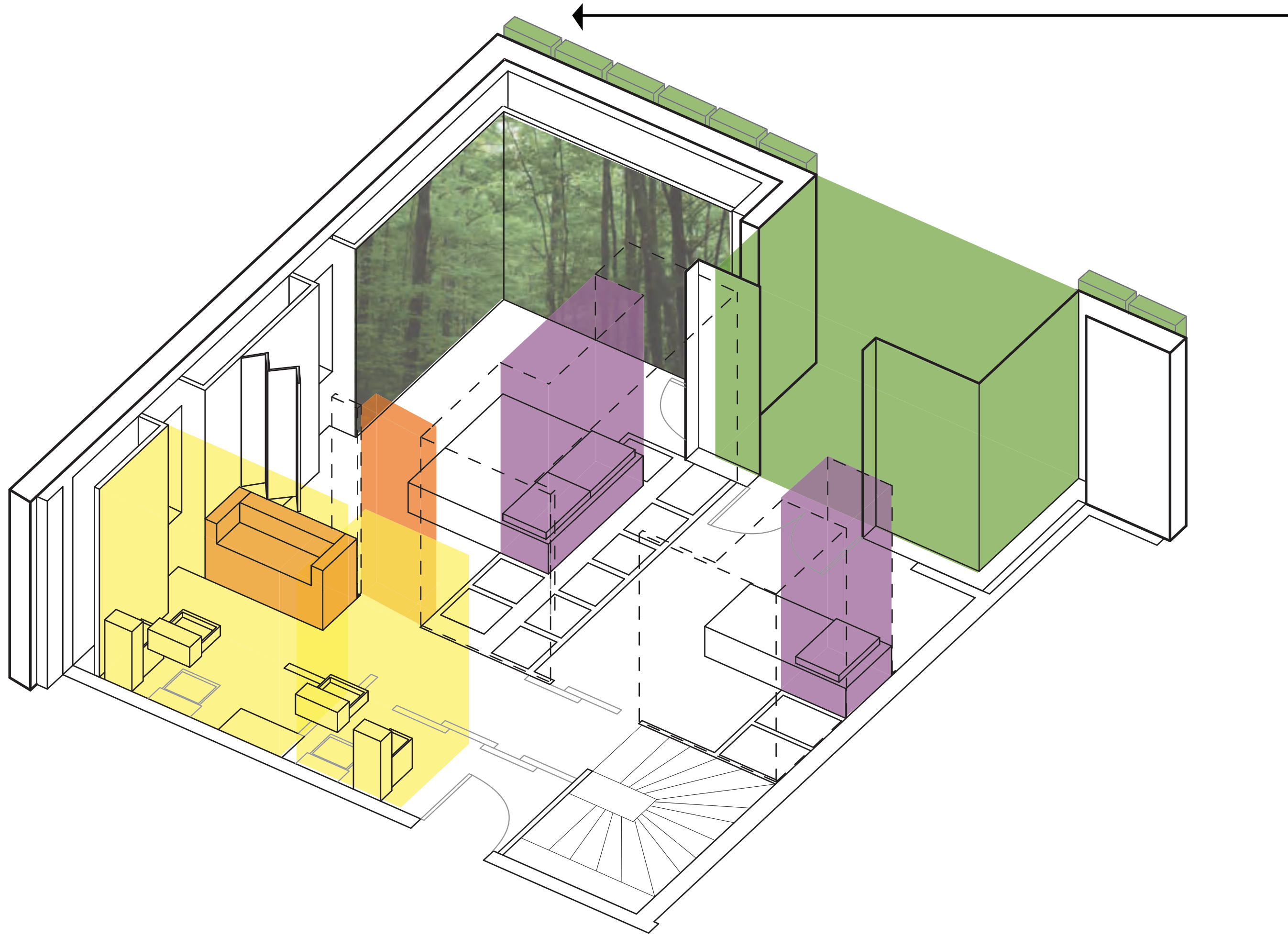


Figure 29 . This axon of one floor of a duplex shows the chroma of the interior, inspired by the algae.

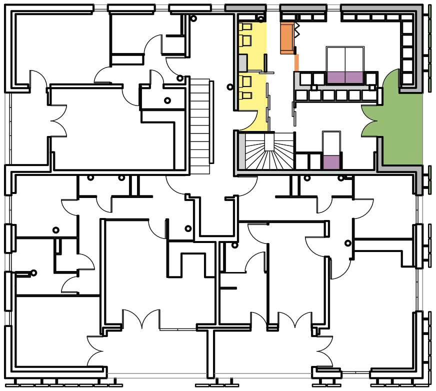


Figure 30 . Third floor plan corresponds to color block axon and bedroom image.
Source top right from Otto Wulff, "BIQ Das Algenhaus." http://www.biq-wilhelmsburg.de/wohnungen/hamburger-mailaender-wohnung.html.
Plan traced from Roedel, Christian, and Petersen Jens-Phillip. "Smart Material House BIQ." IBA Hamburg, July 2013.

Once we venture inside of the BIQ Building, we find fourteen apartments. Two of the apartments are special, including this duplex shown here on the third floor. The architects have taken the chroma idea of bright green algae and painted not only the porch, but used other colors to designate various functions. For example, purple is for sleeping, yellow is for bathroom or kitchen, and orange is for sitting. Some of the interiors have natural forest wallpaper while the rest are muted grey tones that allow the color blocks to cast reflective shadows of their color back onto other surfaces. The muted areas seem most sucecessful at doing this.

The algae again, is barely added to the mix because its panels are blocked by the wall all the time. The painted porch is meant to carry the thought of algae onto the interior. The architects painted artificial colors, but did not allow the actual living algae color to be utilized. They were probably afraid it could be too translucent andwould block too much daylight depending on the day of harvest. This differs greatly from the initial concept.

Idea Store (Whitechapel)

The Idea Store by Adjaye Associates in Whitechapel, UK 2006 is inspired by green and white striped tarp of the nearby ground vendors. It most noticeably has an all glass exterior that is pulled away from the main massing of the building. The glass is raised a whole story off the ground and an escalator covered by the building, but exposed to the exterior invites people into the public library.

Just like algae panels, the varied tones of this building could be imagined as how algae would behave under sunlight. Because this building is in the UK, it is credible to the same lighting condtions for the proposed UK site.

The six tones of green/blue are repeated in sequence randomly across the building, seperated by wider clear glass panels. The onyl interuption in the system is a black lookout rectangle which myst be the executive suite or a public viewpoint. The facade is the same materiality on all four sides except when it rears up to an adjacent facade. It is only pulled away as a double skin on the southwest and southeast, allowing sunlight to play with the glass like stained glass would and lite the inside in a kaleidoscope manner.

Figure 30 . Idea Store facade in Whitechapel is tinted green glass, but could be thought of as various shades of algae

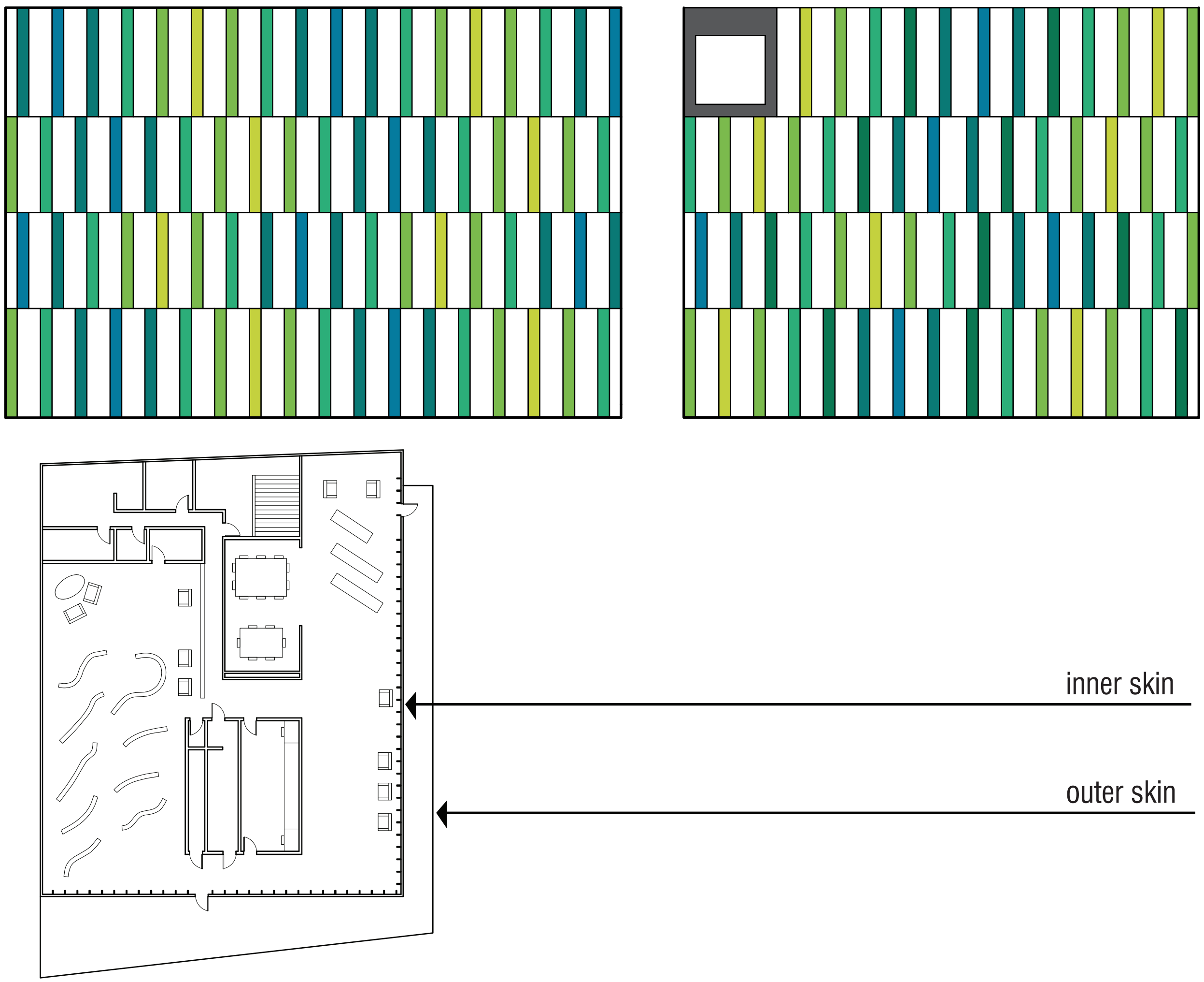
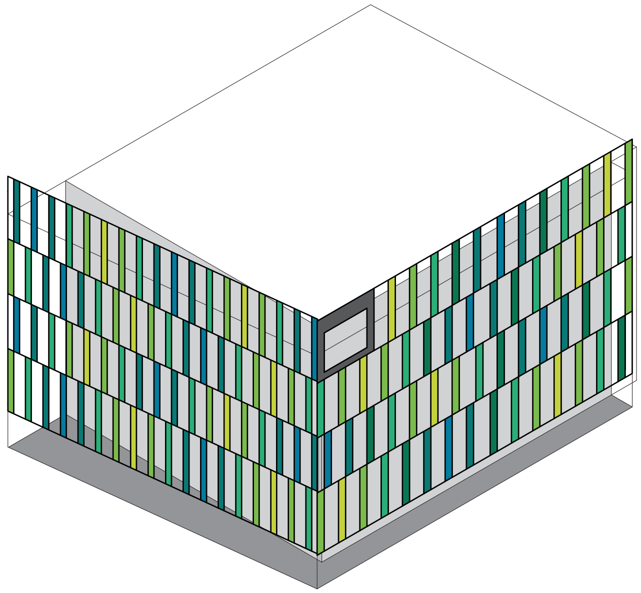


Figure 32 . The facades of the Idea Store feature six different tones of green/blue glass spaced with clear planes of glass and in plan the double facade is easily identifiable.



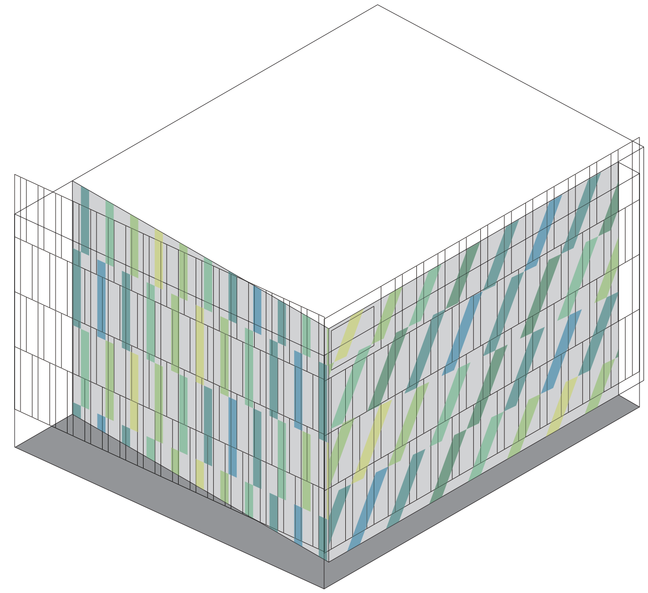


Figure 33 . Idea Store diagram of exterior facade on right and on left diagram of interior second skin illuminated by reflection of outer skin.
Source bottom left image from White Mercury, "LEADING LIGHT OF BRITISH ARCHITECTURE." http://www.whitemercury.com/art/leading-light-of-british-architecture.html.
Source bottom right image from Flickr, Last modified May 27, 2008. http://www.flickr.com/photos/22968900@N07/2541101013/.

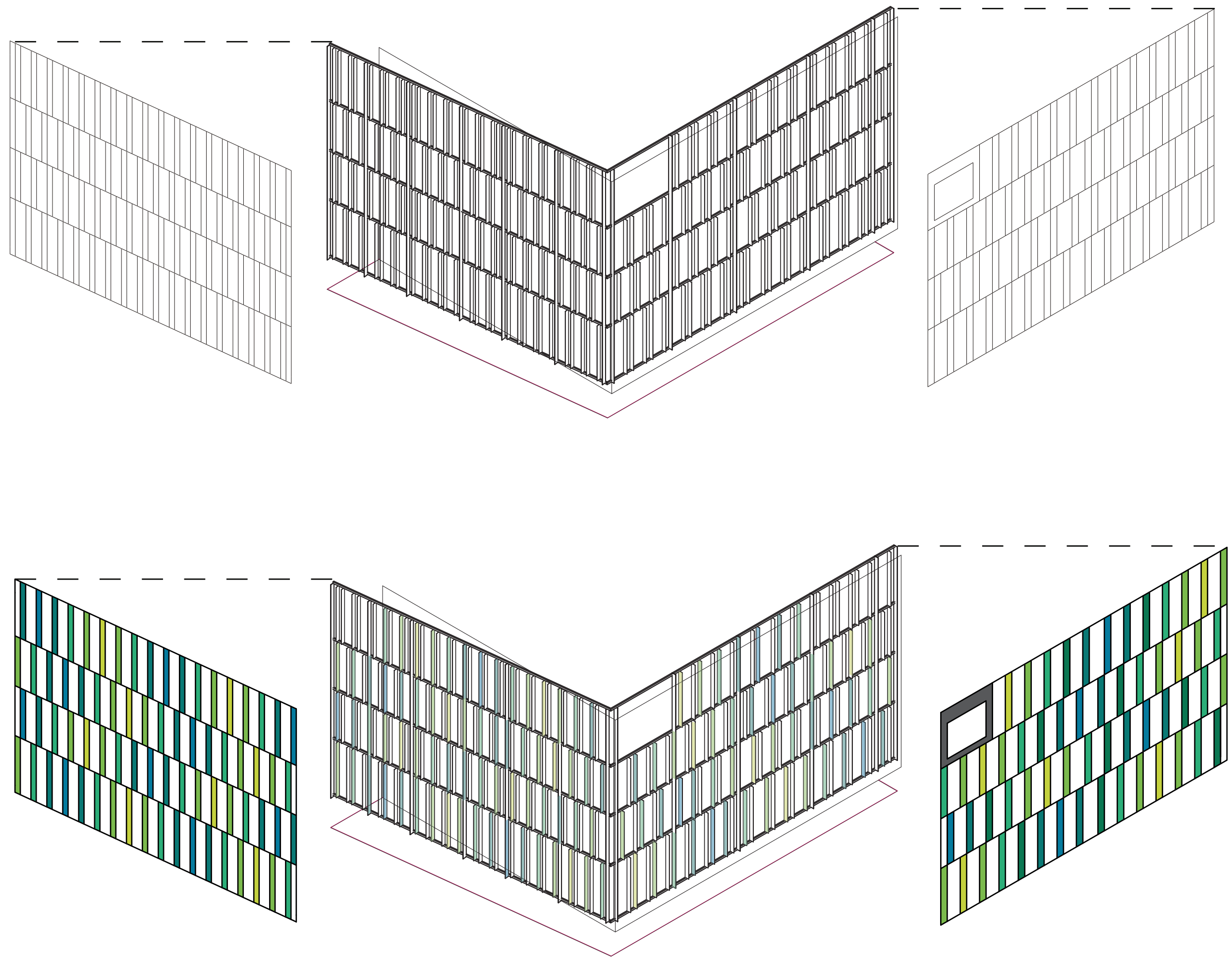
Figure 34 . Image between the interior and exterior skins is a space of reflective light from the tinted panels.
Source from Burns, Andrew. ArchitectureAU, "A Detail of Architecture." Last modified June 5, 2012. http://architectureau.com/articles/a-detail-of-architecture/.

During the day, between the interior and exterior skins on the southern facades, the tinted glass really comes to life. Light streams through and creates colored shadows on the interior facade and all objects entering this space as it hovers over a busy sidewalk. They naturally change throughout the day as the sun moves and depending on the intensity of the sun. The surfaces that capture the reflection best are those that are lighter as opposed to darker, however some of these surfaces are glass so one can look out and see the phenomenon from inside the building.

Interior floor surfaces without the double skin will also inherit this quality. The shiny red floors of the reading areas manage to reflect green light, even if the day is not so sunny. It is noteworthy that this building chooses to use red floor because it contrasts and complements the green tones. Just as the BIQ Building used red on its spandrels, this building has used red as an accent color on most of the floors.

Another chroma phenomena this building experiences is reflective light is bounced off of supporting wood braces. The wood lines each and every vertical mullion and is visible on the outside as well as the inside. When one looks down the inside rows of them, one side is completely illuminated a tone of green and its pair is a natural wood which is absorbing natural light. Unlike the shiny surfaces, the wood absorbs most of the color itself and does not radiate it back at anything.

The horizontal braces are part of the beam structure, but they are held steady by the wooden panels. Algae would probably have this same phenomena on wood, but the panels may not allow as much light through if they are heavy with algae ready to be harvested. The space therefore may be darker and may want to use a more reflective material to bring the light further into the space rather than absorbing it.

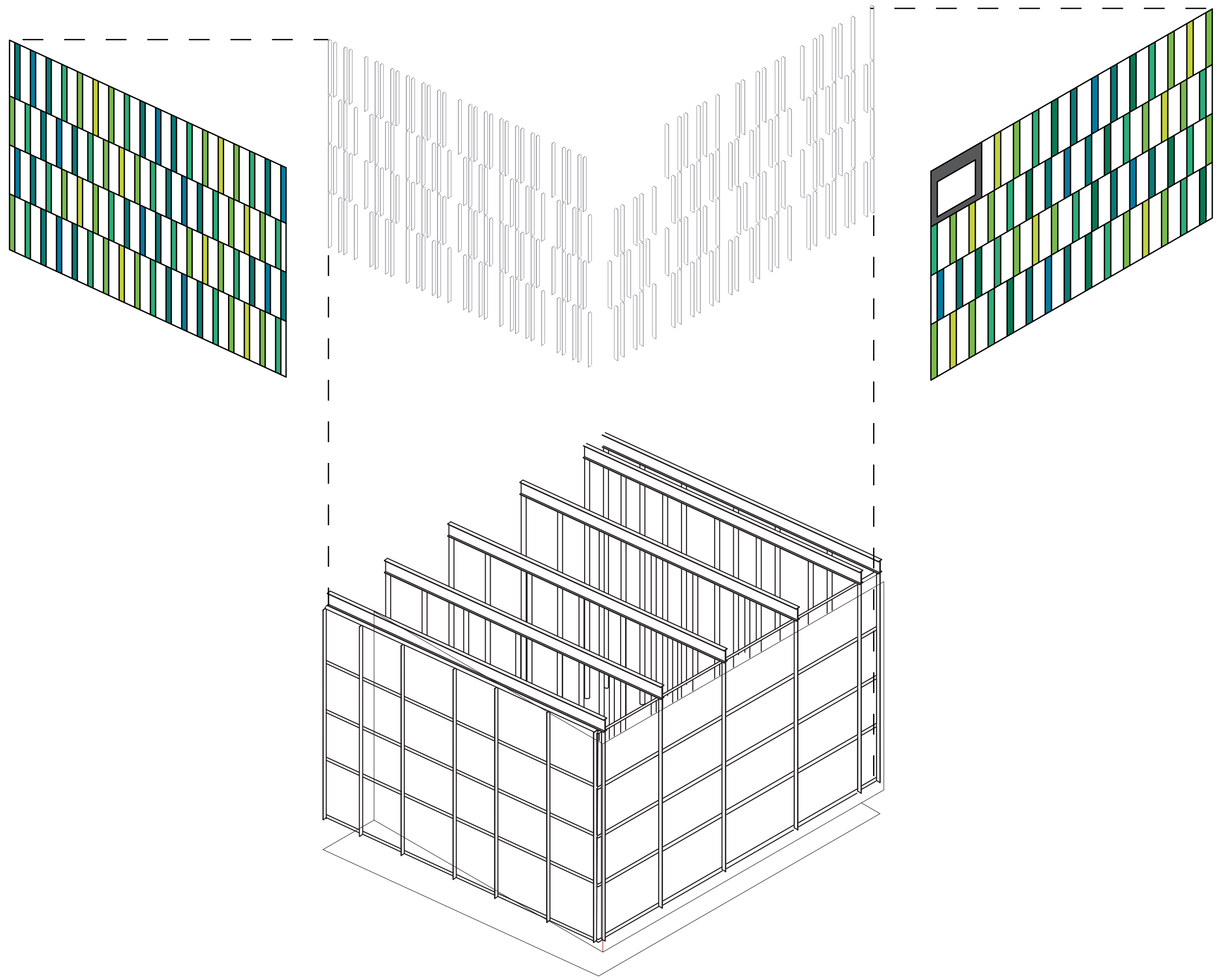


Figures 35 . Architecture became more BIPV (Building Integrated PV) post solar decathalon 2009

Figures 36 . St. James Church in London put up solar panels and receives tariffs for feeding back to the grid.
Source from Flickr, Last modified May 14, 2009. http://www.flickr.com/photos/pallrokk/3565675960/.

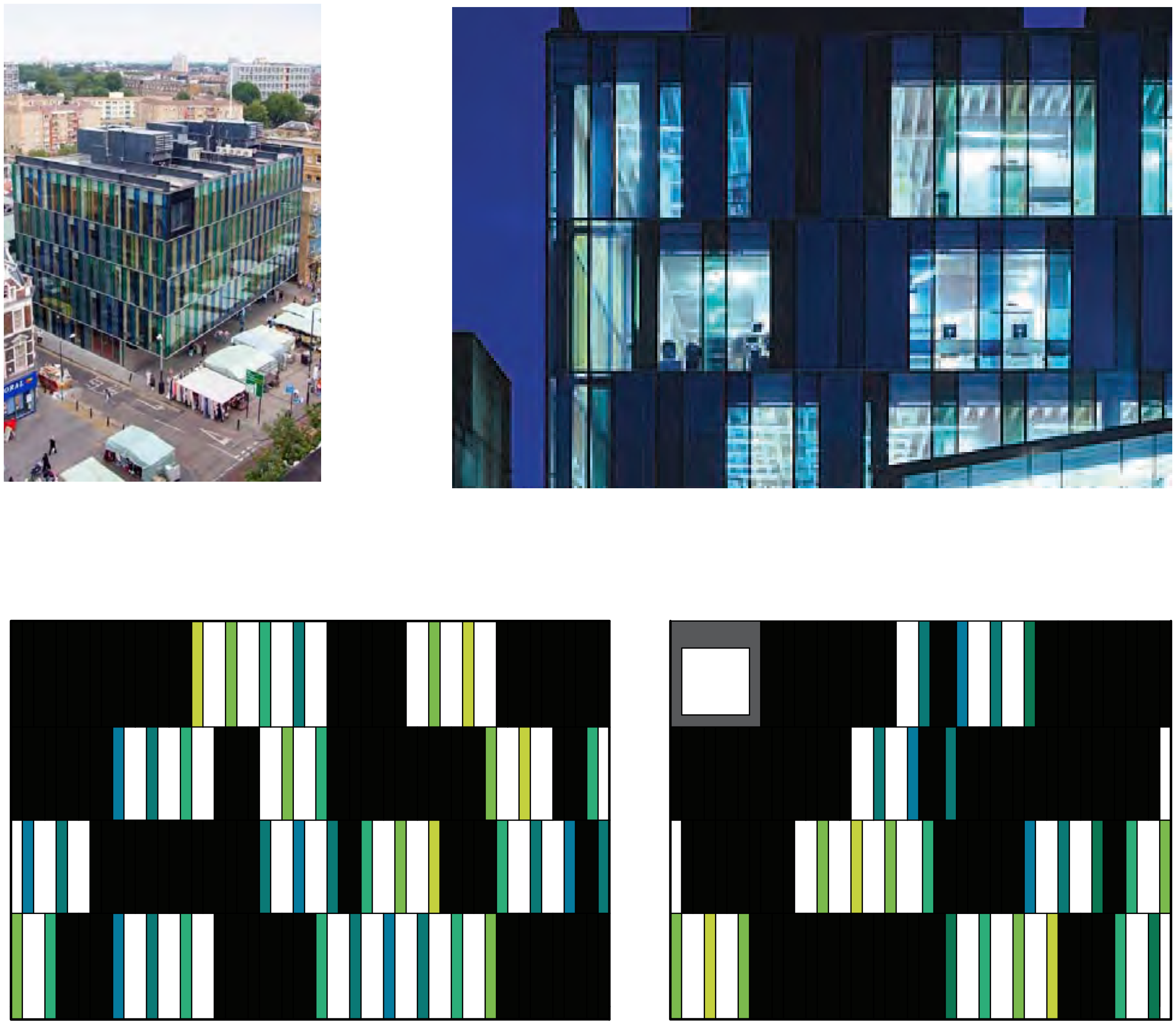
The double cantilevered skin of this building is structurally and chromatically witht the same elements. Deep roof I-beams hang the whole facade, carrying their loads down through internal columns. The roof beams hang secondary structure that hold the outer facade together. The vertical hung sturcture act as the wooden panels do, often blending into the chromatic effect without much effort. The horizontal elements of the outer facade are hidden strategically behind horizontal mullions. The also supposrt and are braced by the chromatic wood panels. This harmony between color and structure shows that although algae may be functional up until this point, it should be investigated as an architectural aesthetic in terms of its chromatic potential.

Another interesting feature of the Idea Store is at night, we can see that the exterior skin is not a true representation of the interior. For the insulation purposes of a cold climate, the secondary interior skin is not all glass and has some insulation value. This means the architecture is not a glowing box at night, but a spiratic array of individual spaces. Thus just like the Algae Building there is a hope



Figures 37 . The Idea Building is hung off of beams on the roof that bring their loads down through columns to create the overhang of the outer facade.

for getting some insulation, but this building fully utilizes color through glass while the Algae Building only begins an investigation in certain parts. It is still a mystery what the Algae Building looks like at night, but unless the Algae Panels are backlit, the only light will come from the apartments which are not going to illuminate many of the panels, if any at all.



Figures 38 . The Idea Building illuminates the street with its greenish=blueish hues at night from various rooms on the inside.
Source top left from Architectural Record, "Idea Store- Whitechapel: Building Types." http://archrecord.construction.com//subscription/LoginSubscribe.aspx?cid=/projects/bts/archives/libraries/08_Whitechapel/default.asp.
Source top right from ize, "Idea Store." Accessed December 2, 2013. http://www.ize.info/projects/public/idea-store.html.

ALGAE TRANSPARENCIES

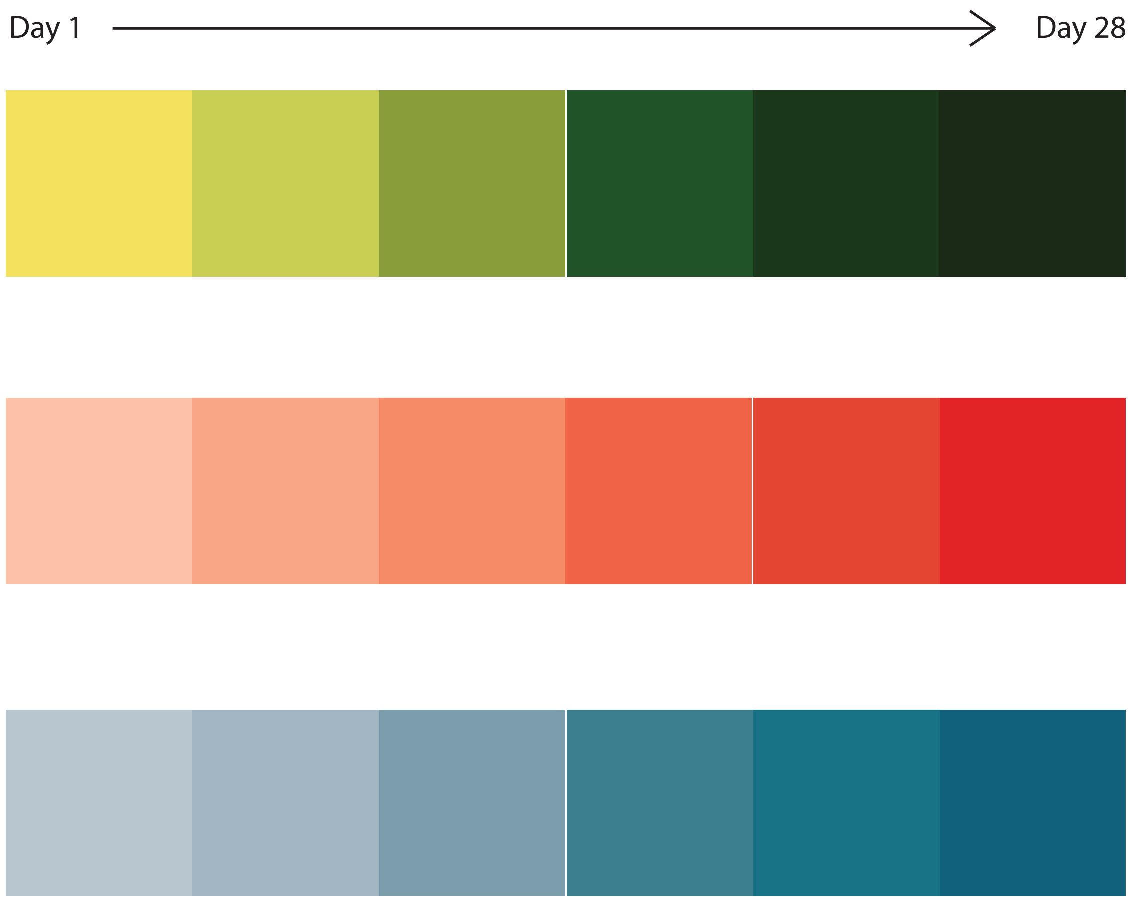


Figure 22 . Shades of algae in the growth cycle.

Although it may appear that algae changes color over its growth cycle, what we are actually seeing as color change is due to increased density of organisms. When combined with water, different transparencies can be produced. So if algae was harvested in week 1 vs week 28, it would look the same out of the water.

ALGAE TRANSPARENCIES

Because the algae is a living organism and living things grow and change, the cycle of algae growth provides varied transparencies that can be utilized in design intentions. When the cyle of growth begins for green algae, its color is a transparent chartreuse. (Note: the containers on the right are opaque plastic). By the first week, it has turned more of a clear lime green. By the second week, the algae is halfway through its growth cycle and is more of a semi-transparent emerald green. At the end of the 4 week cycle, the algae is almost completely opaque and as seen on the right, almost blocks the LED lighting that is helping it grow.

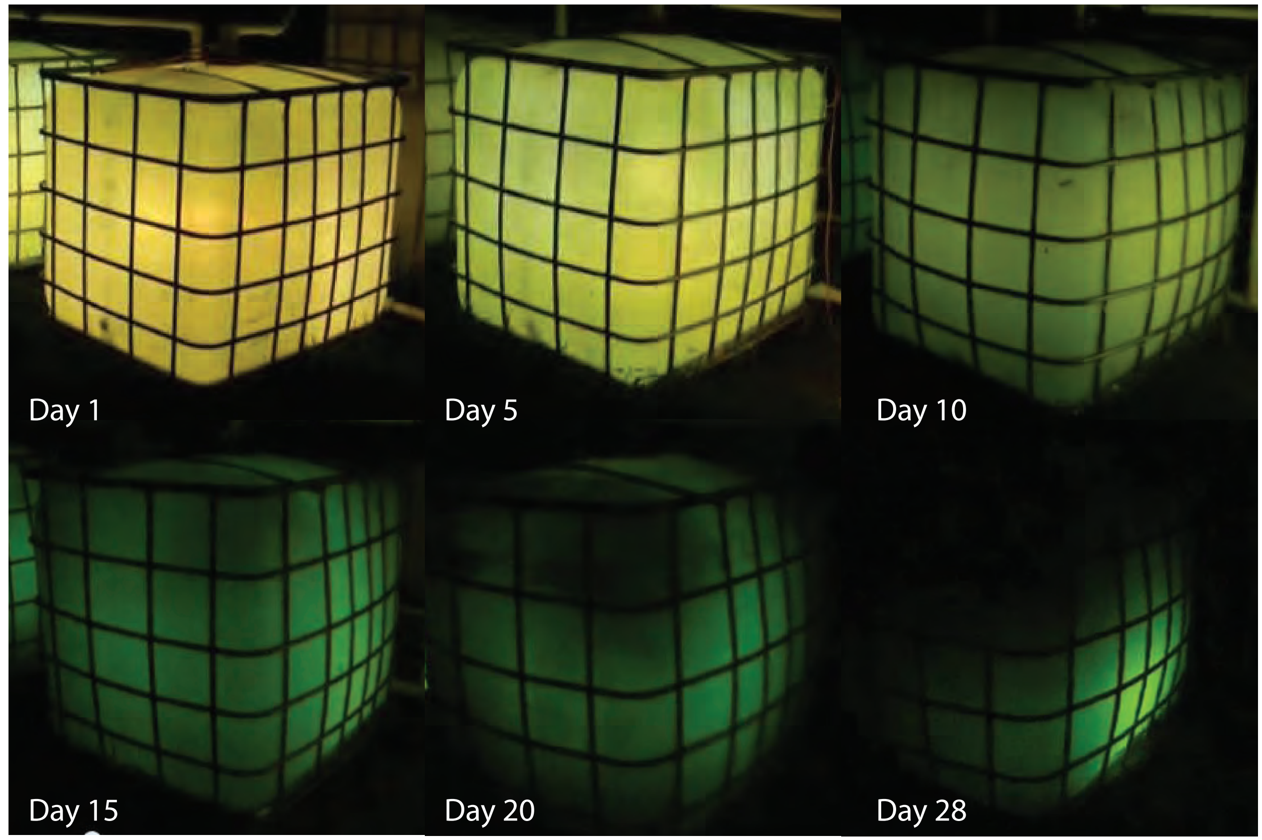


Figure 21. Real photographs of algae growth over 4 weeks.
Source: Gerads. (Producer) (2008). Algae bioreactor at night [Web]. Retrieved from http://www.youtube.com/watch?v=oCXTzpVyVM0

Computing Faculty

The Computing Faculty of TU Dresden by Code Unique Architects in 2006 truely reflects the science and engineering o ces and classrooms it cradles. The large facility has a chromatic palate of *only* electric green and tones of grey to reflect the nature of scienti c research. Why this building is interesting to study is because it uses green surfaces at a minimum level compared to the compltely painted green BIQ Builing.

The main areas in the Computing Facility that are green are interior corridors, the floors of both courtyards, green tinted glass below certain windows, and parts of doors. Yet, the color is portrayed stronger than ever, maybe even more than the Algae Building. Layers are used in order to exentuate the green colors, which are often seperate colored panels that read aesthetically as one because of the detailing and repetition. The being light coming from the inside also helps light up the night shot of the building.

The different tones created on the ground floor are due t o the glass wrapper on this floor which exposes the most public functions and various depths of painted walls, but they are all the same green.

Figure 39 . Computing Facility at night showing its scientific green modestly.
Source from Kuffner, "Faculty of Computer Sciences, TU Dresden." http://www.kueffner.de/en/references/aluminium-frames/faculty-of-computer-sciences-tu-dresden.html.

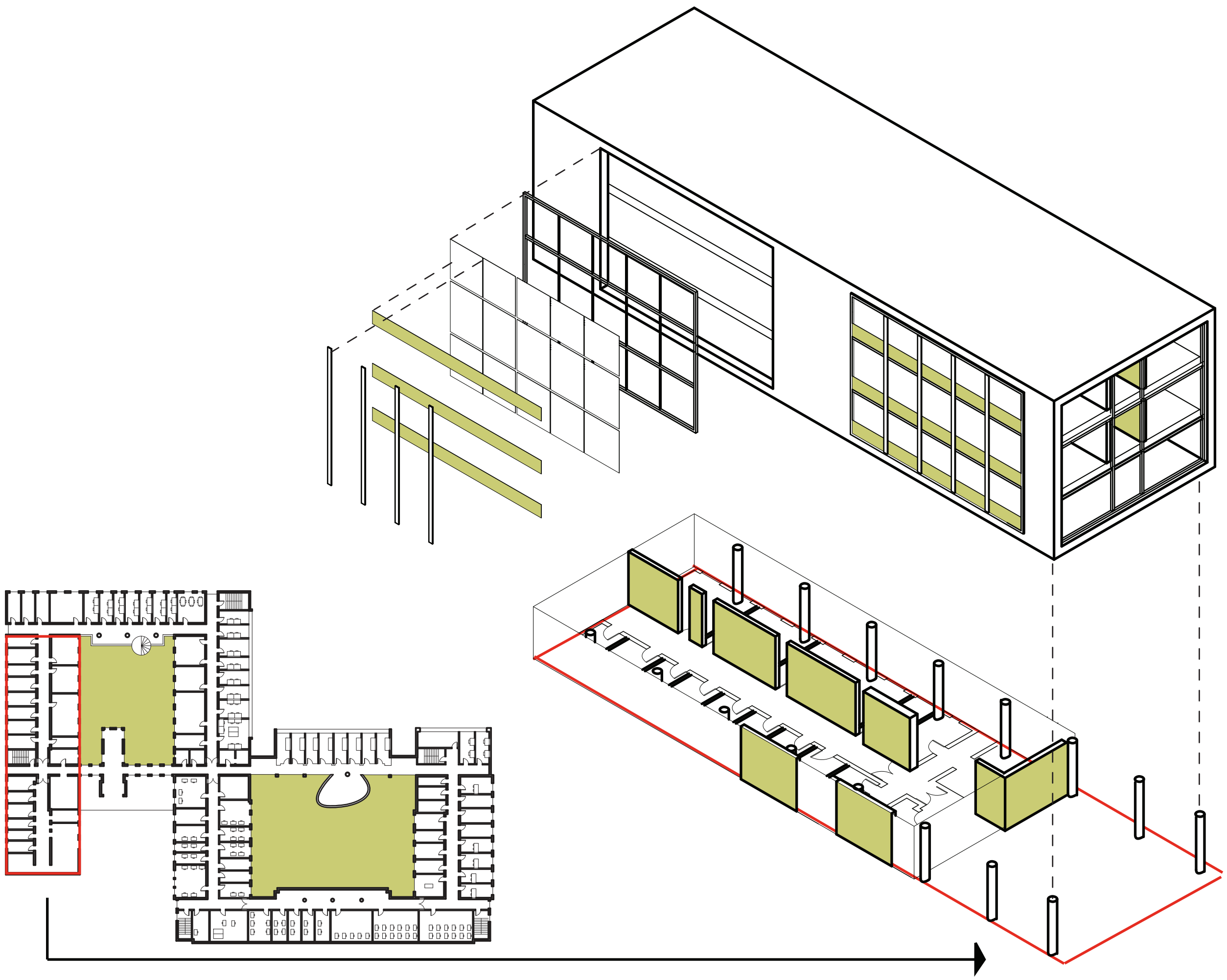


Figure 40 . Diagram of green surfaces in a block of the Computing Faculty.

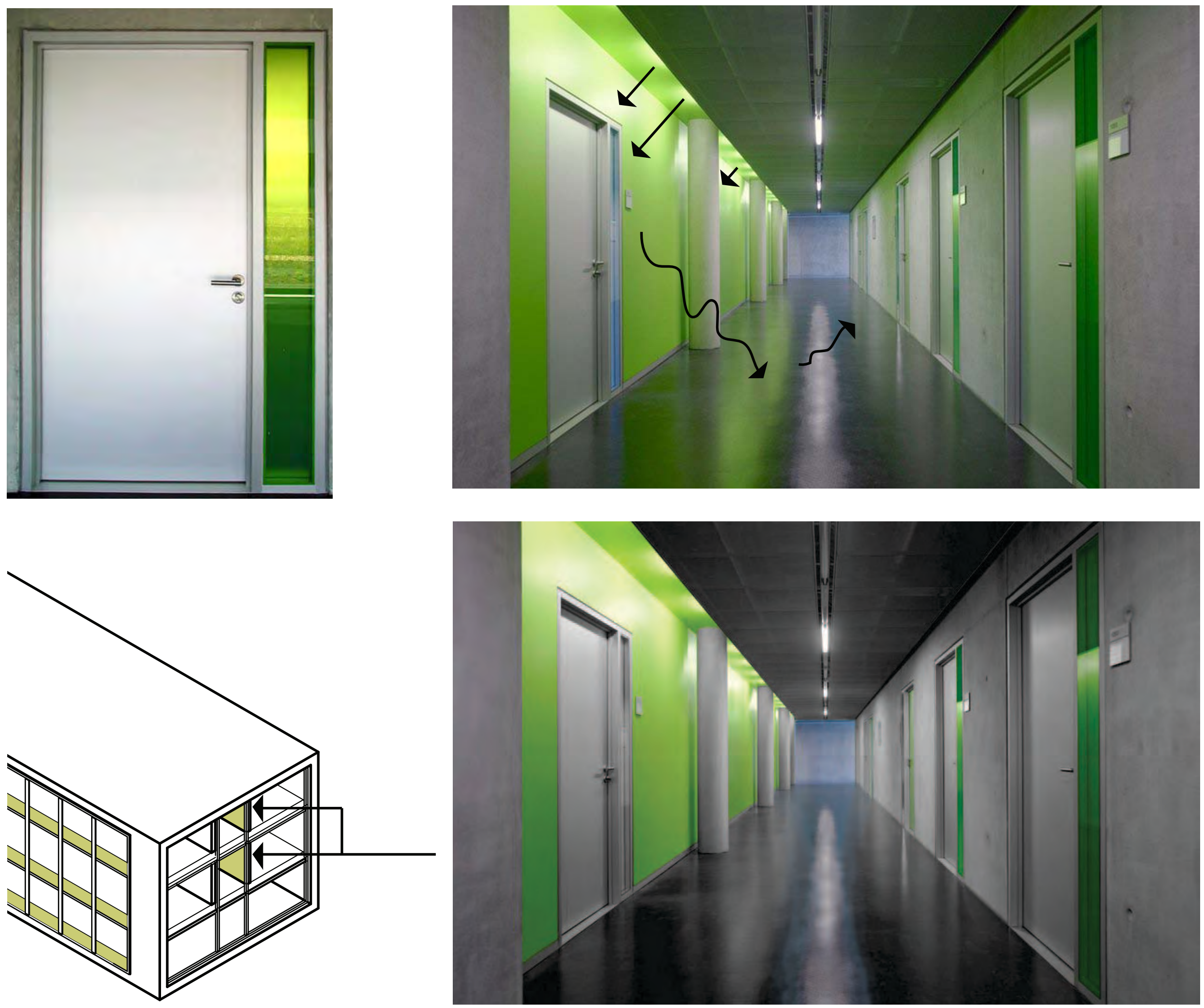


Figure 40 . Computing Facility corridors; top left is the real life image and bottom left is showing the true materiality.
Source of top left from Kuffner, "Faculty of Computer Sciences, TU Dresden." http://www.kueffner.de/en/references/aluminium-frames/faculty-of-computer-sciences-tu-dresden.html.
Source of top right from Kuffner, "Faculty of Computer Sciences, TU Dresden." http://www.kueffner.de/en/references/aluminium-frames/faculty-of-computer-sciences-tu-dresden.html.

Figure 41 . Chromatic facade comparison of Computing Faculty (top) and BIQ Building (bottom).
Source top from Kuffner, "Faculty of Computer Sciences, TU Dresden." http://www.kueffner.de/en/references/aluminium-frames/faculty-of-computer-sciences-tu-dresden.html.
Source bottom from Nidhi, . Industry Tap Into News, "Algae-Powered Building Redefines Going Green." Last modified October 10, 2013. http://www.industrytap.com/algae-powered-building-redefines-going-green/14226.

The interior corridors that are painted are the most concentrated areas of green in the whole building. Figure 41 on the top right is the real photograph of the corridor while the one below it has been edited in photoshop to show the material's real colors. This demonstrates that due to the direct hidden lighting in the ceiling which illuminates the green wall speci cially, the colors are reflected with the light onto the very reflective floor and onto the absorbing concrete. The lighting could have been done many different ways in this corridor, but the architect studied the chromatic properites of the materials and found this worked best.

In terms of illumination from the outside, the green in front of the windows becomes enhanced at night rather than fade to the background. The backlighting controls this effect, which is not overbearingly green, as shown in Figure 42 on the top. The bottom image on this page is of the BIQ Building in comparison and how although it is painted green all over, it is not lit correctly to illuminate the algae in the glare, but could look like the Computing Faculty at night if the architect's had thought of its night presence.

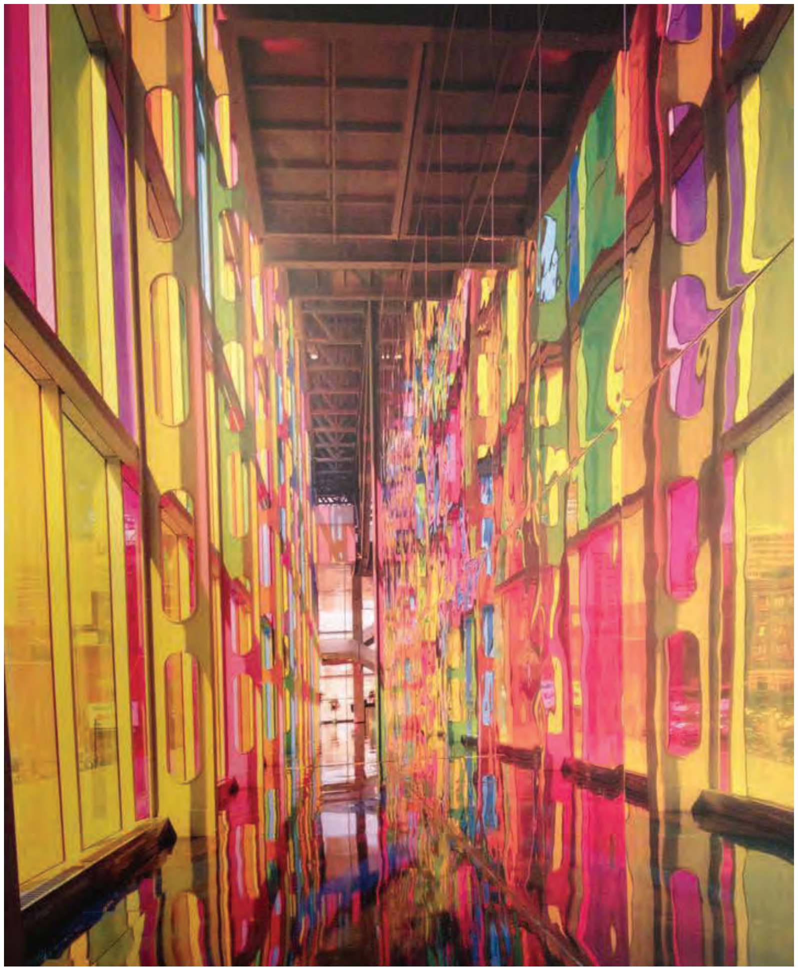
OTHER CHROMA PRECEDENTS

The Parts House by Johnsen Schmaling Architects is a small colored glass installation with huge impacts. The site rests on top of a 1920's industrial building in Milwauke. The installation consists of colored panels of glass on a track and steel infrastructure. The panels create a bright colorful atmosphere and their colors mix to form new transmitted[17] colors onto the facade of the existing building.

The panels respond to flexibility the client asked for, and[10] strategically respect views to the city, and protection from western sun and winds.

The key to the working of this project is the lighting, a common theme through chroma projects. The panels are back lit angling towards to existing facade. They are spaced randomly here, but have a similar effect demonstrated in the Idea Store where the colors were reflected onto a surface with daylight.

Figure 42 . The Parts House consists of backlit colored panels that reflect onto an existing surface.
Source of top left from Johnsen Schmaling Architects, "Parts House Pavilion." http://www.johnsenschmaling.com/parts-house-pavilion/.
Source of bottom left from Johnsen Schmaling Architects, "Parts House Pavilion." http://www.johnsenschmaling.com/parts-house-pavilion/.
Source of right from Johnsen Schmaling Architects, "Parts House Pavilion." http://www.johnsenschmaling.com/parts-house-pavilion/.



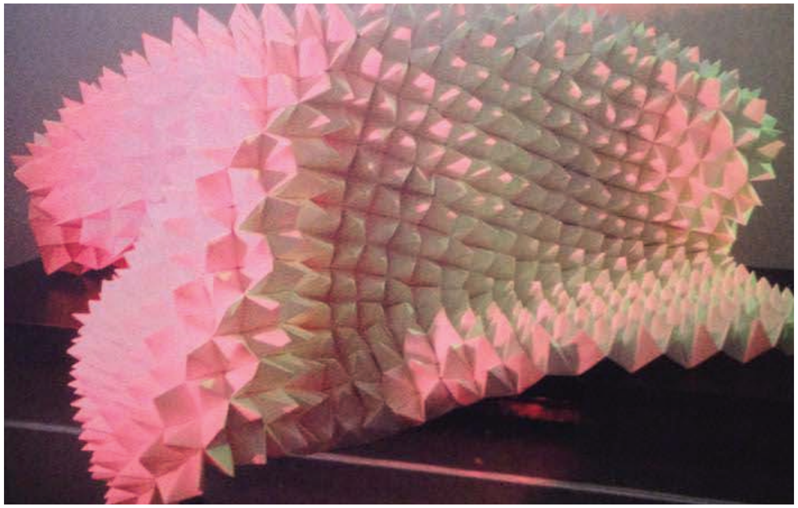
The Montreal Convention Center Expansion by Saia Barbarese Architects aims to create a vibrant public, inviting community center. The outer facade is colored glass. Behind this facade there is a walkway and then either a mirrored wall or concrete wall which give different effects. The mirrored wall almost blurs the colored structure and lighting together to look like a melting painting. The concrete takes on the color of the transmitted glass

Figure 43 . The Montreal Convetnion Center is all about reflective materiality.
Source of left from Flickr, http://www.flickriver.com/photos/spencerslife/3426663171/.
Source of top right from Dreamstime, http://www.dreamstime.com/royalty-free-stock-images-convention-center-palais-des-congrs-de-montral-located-quartier-international-de-montral-north-end-image32688559.
Source of bottom right from Chennibus, "Montréal Convention Center (Palais des congrès de Montréal)." http://chennibus.com/montreal-convention-center-palais-des-congres-de-montreal/.

What is interesting when we add more 3D elements into color theory, light plays a major role in surface recognition. Using very similar colors that are almost the same tone as 'shadowed colors,' one can flasely perceive a surface. For example figures x and z are the same model, but shown with light at different angles of incidence. If one changed the angle of incidence on a 2D painting, it would not respond as it does to 3D forms, which is why architecture can really take advantage of this.

Imagine an algae skin that through its formal aesthetic could transform in the changing day and seasonal lighting. It would also reflect below onto a pallete of colors that would react daily to the color reflectivity. The skin would not only be architecturally interesting, but it would also be producing the tons of biofuel the labs need to do research.

Figure 44 . This object is painted with hues that are deceptive under certain lighting conditions.
Source top from Poter, Tom, and Byron Mikellides. Colour for Architecture Today. New York, NY: Replika Press Pvt. Ltd., 2009.
Source bottom from Poter, Tom, and Byron Mikellides. Colour for Architecture Today. New York, NY: Replika Press Pvt. Ltd., 2009.

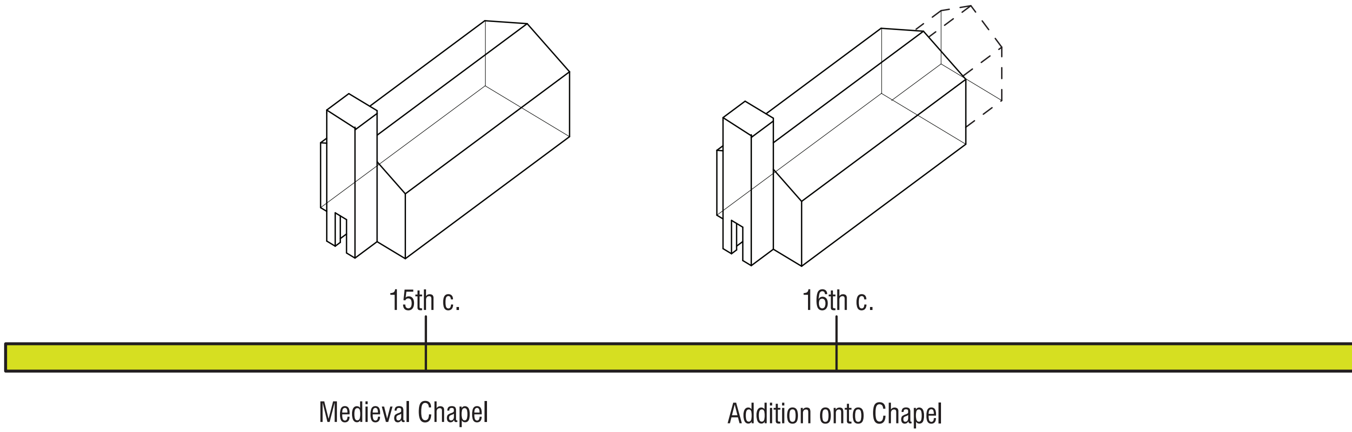


These images are not so much about the form, but about how the different surfaces are receiving light from two separate angles of incidence. We can call the pink light the 'shadow' and the green light the direct light. We can see that in the deep crevases, the color actually multiplies and becomes red, illuminating the otherwise white surface. This lesson is important in understanding the chromatic shadow of algae onto an interior which may reflect another color on the same object and the effect it may have.

Figure 45 . A repetitive paper modell is illuminated by two colors from different angles to get this effect.
Source left from Poter, Tom, and Byron Mikellides. Colour for Architecture Today. New York, NY: Replika Press Pvt. Ltd., 2009.
Source right from Poter, Tom, and Byron Mikellides. Colour for Architecture Today. New York, NY: Replika Press Pvt. Ltd., 2009.

3

WHY REDUNDANT CHURCHES


15th c.
16th c.
Medieval Chapel
Addition onto Chapel

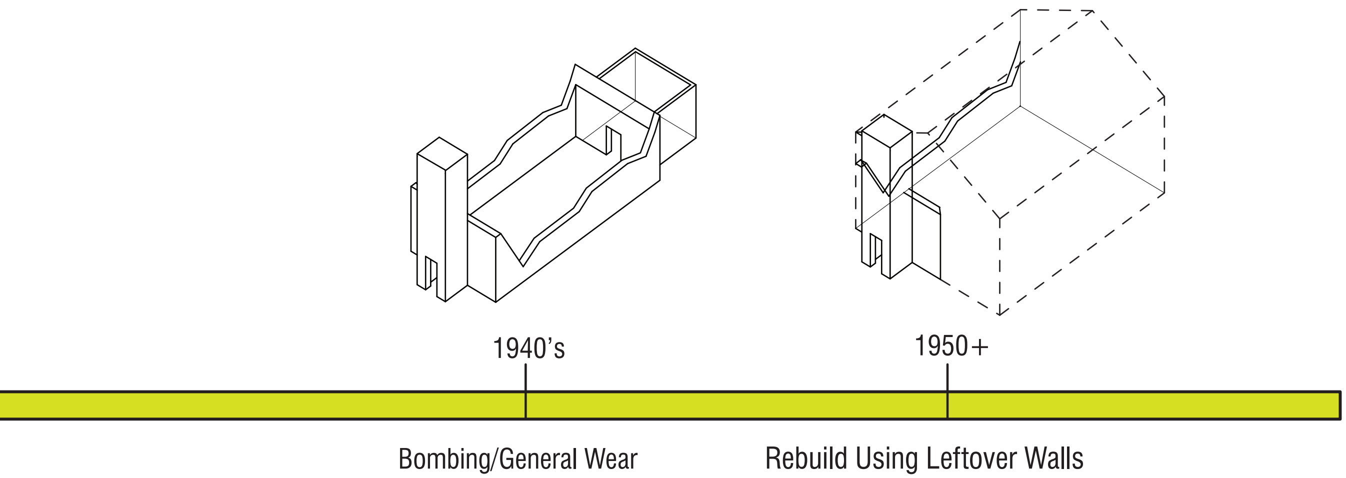


Figure 46 . Historic Rebuilding Diagram of a church in the UK

HISTORIC REBUILDING

Churches have been the subject of preservation for all cultures due to their massive scale and sacred place in the public's mind. If one thinks for a moment about the places they have visited and the most massive structures they remember are churches: Sagrada Familia of Barcelona, Saint Paul's Cathedral of London, San Marco of Venice, Hagia Sophia of Istanbul, the Duomo of Florence, Notre Dame of Paris, and the list continues. These buildings usually have a rich history and connection to the beginnings of a place.

As stated in the introduction, historic rebuilding has been going on since human existence, noteably with the Roman's spolia. In fact, San Marco Bascilica in Vencice has a scultpure called the 'Portrait of the Four Tetrarchs' on its corner which was stolen from Rome which was originally Egiptian porphry stone.

Churches and other large structures are easily susceptible to damage because of their massive size. They can be seen from the air, which meant that during war, the enermy could identify an easy target in the center of town, but they also have long lifespans and endure natural wear and tear.

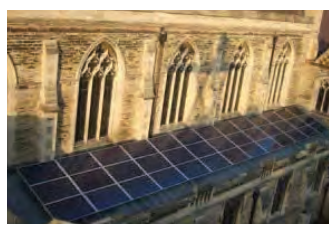
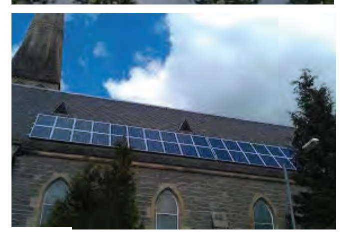
Modern rebuilding of churches includes applying solar panels on their roofs. Yes, even the green movement has caught on with these historic stone dinosaurs. “When churches install solar panels, it’s never simply a practical exercise designed to reduce energy bills. It’s more like a religious conversion, a shift from Christianity to the new all-powerful religion of environmentalism.”[18]

It is well known in the UK that churches collectively and Sainsbury’s give off similar CO_2 emissions, just because the organizations are both so large’.

Churches all over the UK are installing the panels on the southern side of their buildings, sometime using some humor and putting them in the shape of a cross. They are kind of an eyesore if done incorrectly. What if they could be better integrated into the design of the building? They could be visible, but they could become part of the aesthetic rather than a foreign object. Just as PVC architecture could act as an encompassing skin around a church, so could algae. If we could use the incentive of the church should encompass the religion of sustainability, we can convince the biblical commuity that algae is the next thing churches can help with.





Figures 47 . Various images of churches that apply solar panels to the southern facade of their building, often in an awkward fashion.
Source top left from Havill, Chris. HAV Main Blog, "Torquay PV Solar Installer – MCS Accredited." Last modified November 23, 2011. http://www.havmain.co.uk/blog/electrical-services-and-electricians/torquay-pv-solar-installer-mcs-accredited/.
Source top right from Nichols, Wil. Business Green Plus, "How the Church of England is spreading the energy efficiency gospel." Last modified May 14, 2013. Accessed December 3, 2013. http://www.businessgreen.com/bg/feature/2265817/how-the-church-of-england-is-spreading-the-energy-efficiency-gospel.
Source middle left from This is Cornwall, "The sun shines on righteous at church." Last modified April 19, 2012. http://www.thisiscornwall.co.uk/sun-shines-righteous-church/story-15858433-detail/story.html
Source middle right from Imgur, "The church down the street from me got new solar panels." http://imgur.com/TxNkb2k.
Source bottom left from St John's Wood Church, "Greening Our Church." http://www.stjohnswoodchurch.org.uk/about-the-building/greening-our-church.
Source middle bottom from The Church of England, "Solar Panels." http://www.stjohnsfarsley.org.uk/solar-panels.php.
Source bottom right from Gary, Hartley. Energy Saving Trust, "Church v checkout in the renewables rush." Last modified June 17, 2013. http://www.energysavingtrust.org.uk/blog/2013/06/17/church-v-commerce-in-the-rush-to-cut-carbon/.

Figures 48 . Churches on the left are for sale in Las Angeles and Curches on the right are derilect in Australia
Source top left from Havill, Chris. HAV Main Blog, "Torquay PV Solar Installer – MCS Accredited." Last modified November 23, 2011. http://www.havmain.co.uk/blog/electrical-services-and-electricians/torquay-pv-solar-installer-mcs-accredited/.
Source top right from Nichols, Wil. Business Green Plus, "How the Church of England is spreading the energy efficiency gospel." Last modified May 14, 2013. Accessed December 3, 2013. http://www.businessgreen.com/bg/feature/2265817/how-the-church-of-england-is-spreading-the-energy-efficiency-gospel.
Source middle left from This is Cornwall, "The sun shines on righteous at church." Last modified April 19, 2012. http://www.thisiscornwall.co.uk/sun-shines-righteous-church/story-15858433-detail/story.html
Source middle right from Imgur, "The church down the street from me got new solar panels." http://imgur.com/TxNkb2k.
Source bottom left from St John's Wood Church, "Greening Our Church." http://www.stjohnswoodchurch.org.uk/about-the-building/greening-our-church.
Source middle bottom from The Church of England, "Solar Panels." http://www.stjohnsfarsley.org.uk/solar-panels.php.
Source bottom right from Gary, Hartley. Energy Saving Trust, "Church v checkout in the renewables rush." Last modified June 17, 2013. http://www.energysavingtrust.org.uk/blog/2013/06/17/church-v-commerce-in-the-rush-to-cut-carbon/.

It is an undeniable fact that algae grows best in warm, sunny climates, but that fact is also true for the longer established PCV's, yet they are only significantly making headway in the UK.

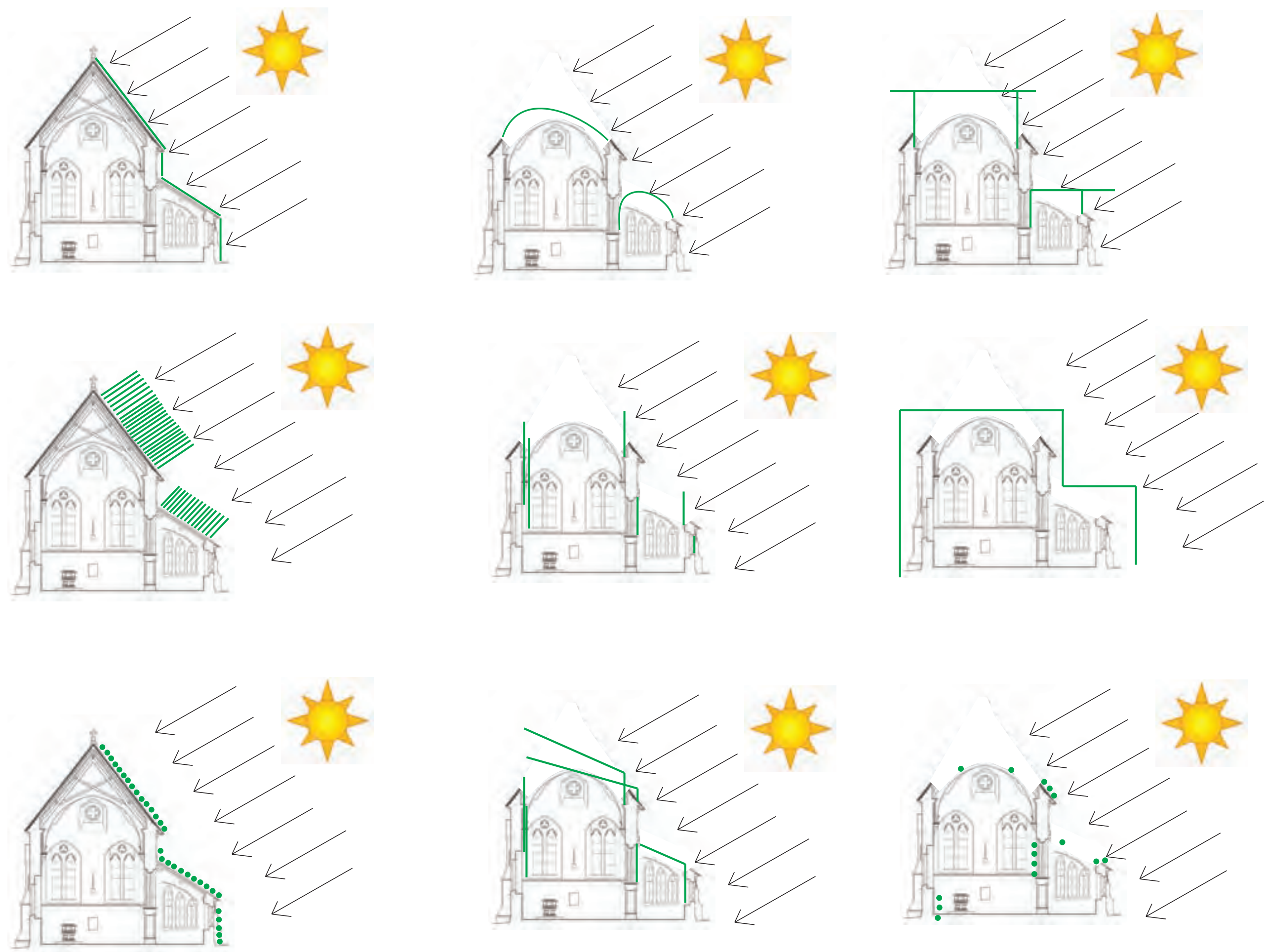
For comparison, the church images on this page are either from Las Vegas or Australia. These churches are not the same caliber as churches in the UK. For one, the churches that are redudant are not all architectecturally significant because only four of them are listed in Australia. There are significant churches however they are not for sale. There is no redundant church website in Australia, nor are churches there installing photovoltaics on their roofs. This is because Australia is not short on land. Most of Australia is undeveloped due to desert condtions, making space for growing algae plentiful. Land in the UK is in high demand, and therefore it makes more sense to reuse buildings for algae, rather than take up farmland. Desert land is where the US grows their algae reserves, such as outside of Las Angeles. The UK does not have this land luxury.

BENEFITS OF ALGAE CHURCH READAPTATION

Just as stained glass was an invention for the church to tell the stories of the bible pictorally and beautifully in color through an architectural element, chromo algae glass will be an abstract story of why algae is beautiful enough to save our future as a candidate for biofuel. The effective reflective colored light from the algae can play with the rennovated architecture as well as make up an interesting pattern of architectural skin on the exterior, and interior lighting conditions against the rough textures and soft textures of new and old architecture.

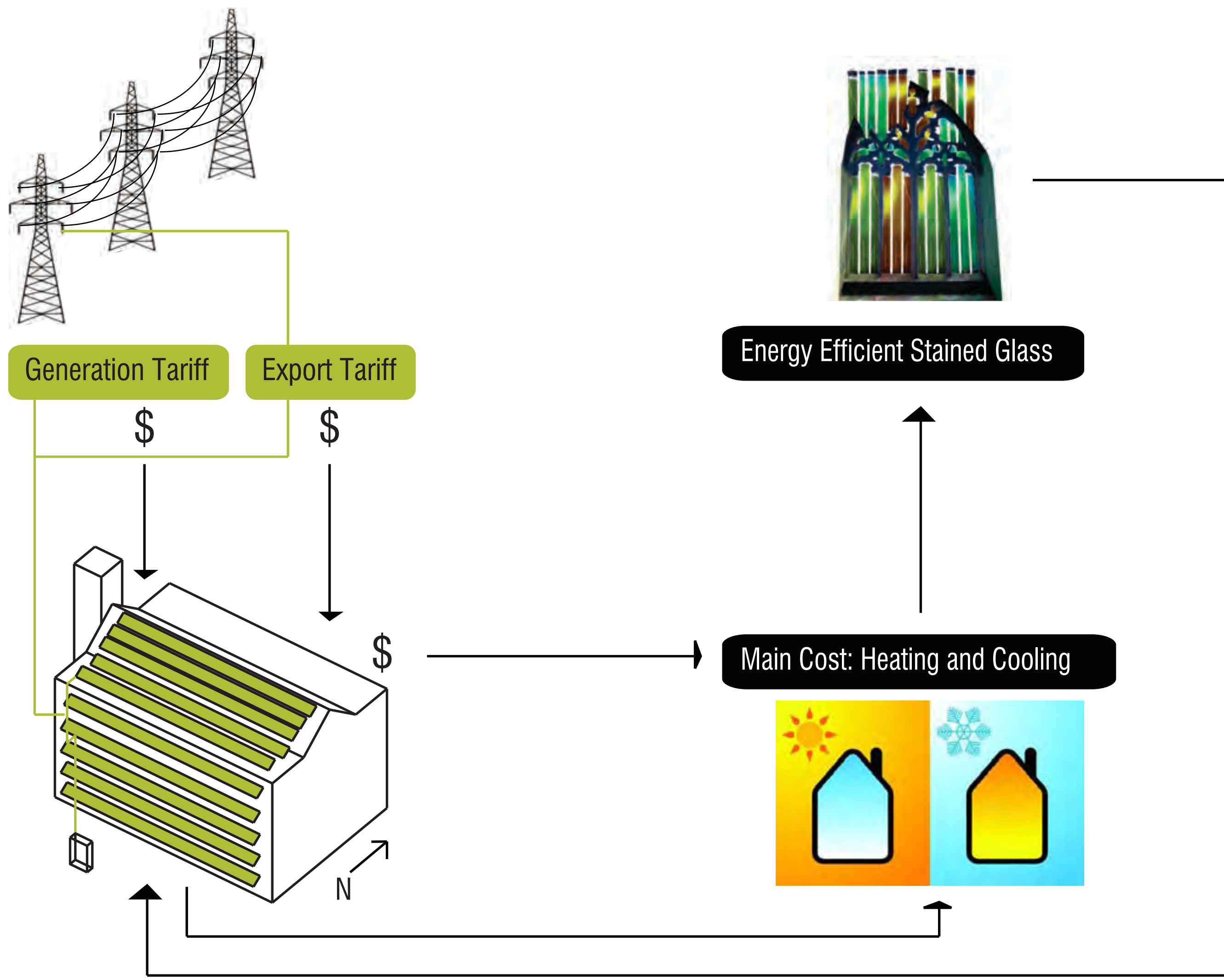
Churches that have lost their stained glass, those that have lost their roofs, or those that wish to insulate their buildings with the insulation algae tubes provide are ideal candidates for chroma algae skins.

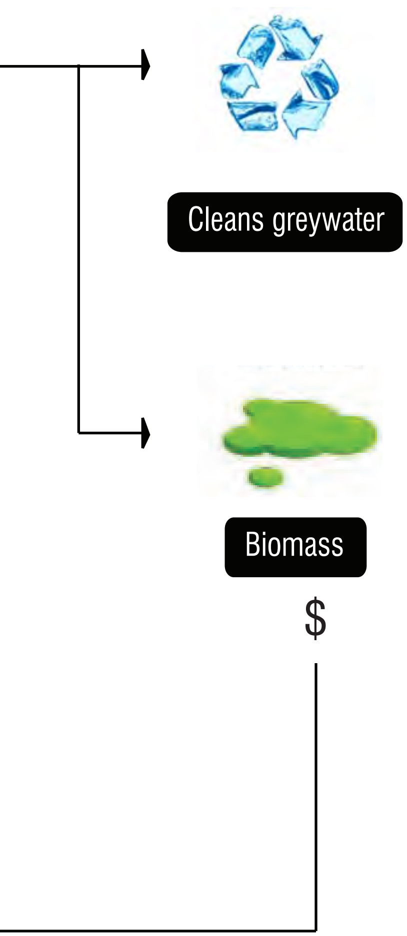
Figures 49 . The RGB of traditional stained glass can be modernized by the RGB of chroma algae tubes.



Figures 50 . Experimentation of vrious ways algae tubes could rest on a church.

Just as churches have been installing PVC's in order to save on energy costs and boast their green ways, churches could be marketed to to install algae panels as a way to save money for whatever program will be in the church. Thus the first energy efficient stained glass is born which works with the building's greywater system to recycle water for algae growth.



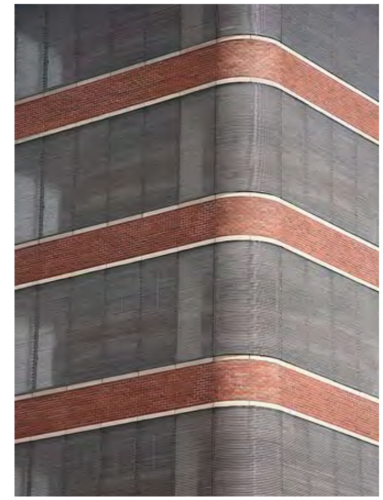


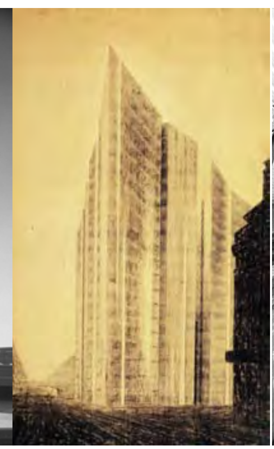
Figures 50b . Experimentation of vrious ways algae tubes could rest on a church.

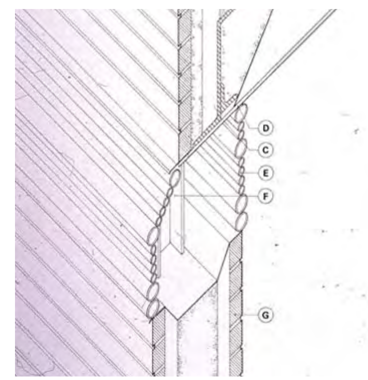
GLASS TUBE PRECEDENTS

FLW: The Johnson Wax Building by Frank Llloyd Wright in 1936 sought to use the new technology of glass tubes, taken from scientists and apply it experiementally to a building. Wright enjoyed thequality of light the tubes produced, which was equally distributed daylight. It also acted as a filter, allowing shapes to be seen as blurs, but not as objects.

He formally cemented them together in a variety of patterns as clestory lighting, interior partitions, and on the roof. The tubes varied in sizes for aesthetic reasons. Although not stated, the tubes are a great insulator of heat and in the climate of Wisconsin this would have been ideal. Figure 50c reminds one of Mies' friedrichstrasse skyscraper of 1919. Wright made the Johnson Wax Museum look eerily transluscent like the way Mies treated his glass and floors in hs sketch. Wright worked a lot in stained glass so his pattern making in glass tubes does not seem out of the ordimary for him. Surprisingly tube architecture has not taken off, but glass tubes are used to heat water or for their insulating properties as seen in Figure 50d and in



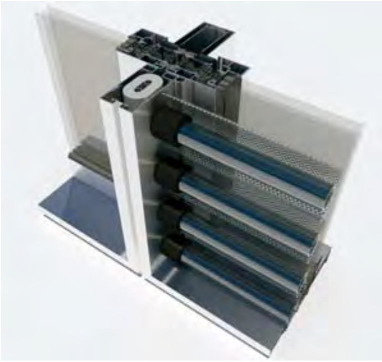




Figures 50c . The Johnson Wax Building experimented with glass tube technology and its filtering effects for light and people.
Source top left from youtube, "Johnson Wax Building." Last modified August 28, 2008. http://www.youtube.com/watch?v=z1MXuBAxcdM.
Source top right from Zimbio, "Cool Johnson Wax images." Last modified February 4, 2007. http://www.zimbio.com/Organic architecture/articles/Hm fA0tLbnD6/Cool Johnson Wax images.
Source bottom left from Ceborski, Jaroslaw. Rethinking Architecture, "Ezra Stoller photography exhibition." Last modified January 5, 2011. http://www.rethinking-architecture.com/ezra-stoller-photography-exhibition,447/.
Source middle left from Mies, . "Friedrichstrasse ." Last modified 1919.
Souce middle right from ARCHDOC, "AD Classics: S.C. Johnson and Son Administration Building / Frank Lloyd Wright | ArchDoc." Accessed December 4, 2013. http://archdoc.mr926.com/ad-classics-s-c-johnson-and-son-administration-building-frank-lloyd-wright-archdoc/4545/.
Source bottom right from Colombia, "http://www.columbia.edu/cu/gsapp/BT/EEI/CLADDING/cladding1.html." http://www.columbia.edu/cu/gsapp /BT/EEI/CLADDING/cladding1.html.

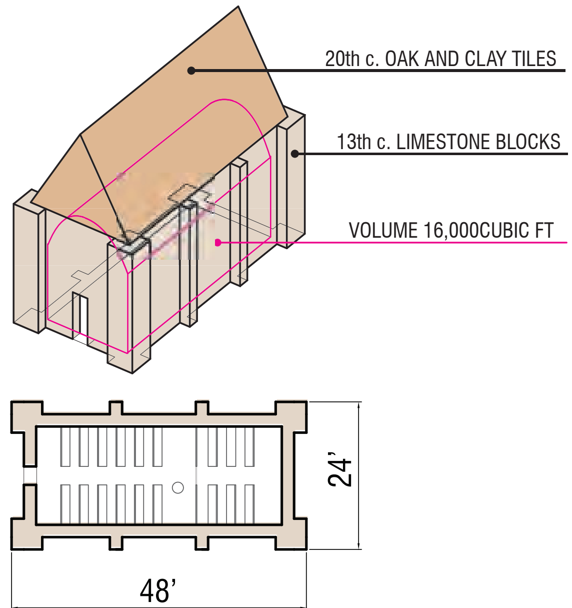
many of the solar decathalon houses.

There is a new product on the market that is just what Wright was getting at in his Johnson Wax Building. The product is a series of glass tubes which are advertised to generate a high temperature in the tubes from solar heat and at the same time provide semi-transparent light. "For architectural, geometric, technical and visual reasons," the tubes are placed horizontally." [20]

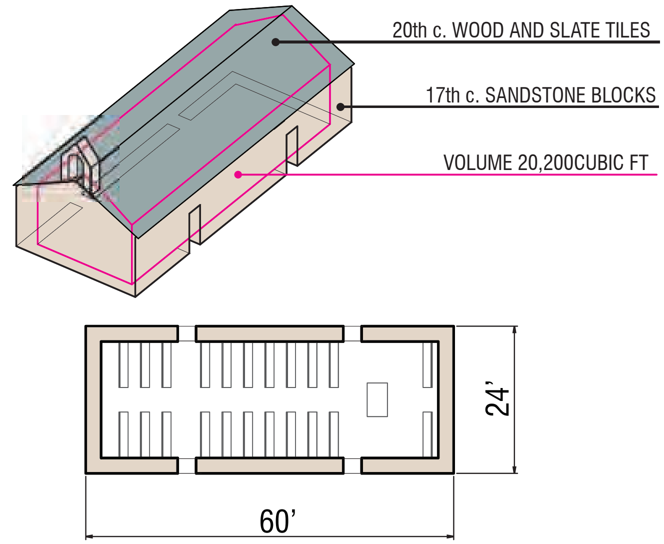


Figures 50d . A newly developed tube technology acts as a solar heater and cooler, plus eliminate direct light.
Source top from BINE, "Facade Collectors with Perspecitve." http://www.bine.info/fileadmin/content/Publikationen/Projekt-Infos/2013/Projekt_07-2013/ProjektInfo_0713_engl_internetx.pdf.
Source left bottom from BINE, "Facade Collectors with Perspecitve." http://www.bine.info/fileadmin/content/Publikationen/Projekt-Infos/2013/Projekt_07-2013/ProjektInfo_0713_engl_internetx.pdf.
Source right bottom from BINE, "Facade Collectors with Perspecitve." http://www.bine.info/fileadmin/content/Publikationen/Projekt-Infos/2013/Projekt_07-2013/ProjektInfo_0713_engl_internetx.pdf.

20 BINE, "Facade Collectors with Perspecitve." http://www.bine.info/fileadmin/content/Publikationen/Projekt-Infos/2013/Projekt_07-2013/ProjektInfo_0713_engl_internetx.pdf.



13th c.



17th c.

RE-ADAPTATION USE: SMALL COMMUNITY FUNCTION

Early Meeting House

Puritain Chapel

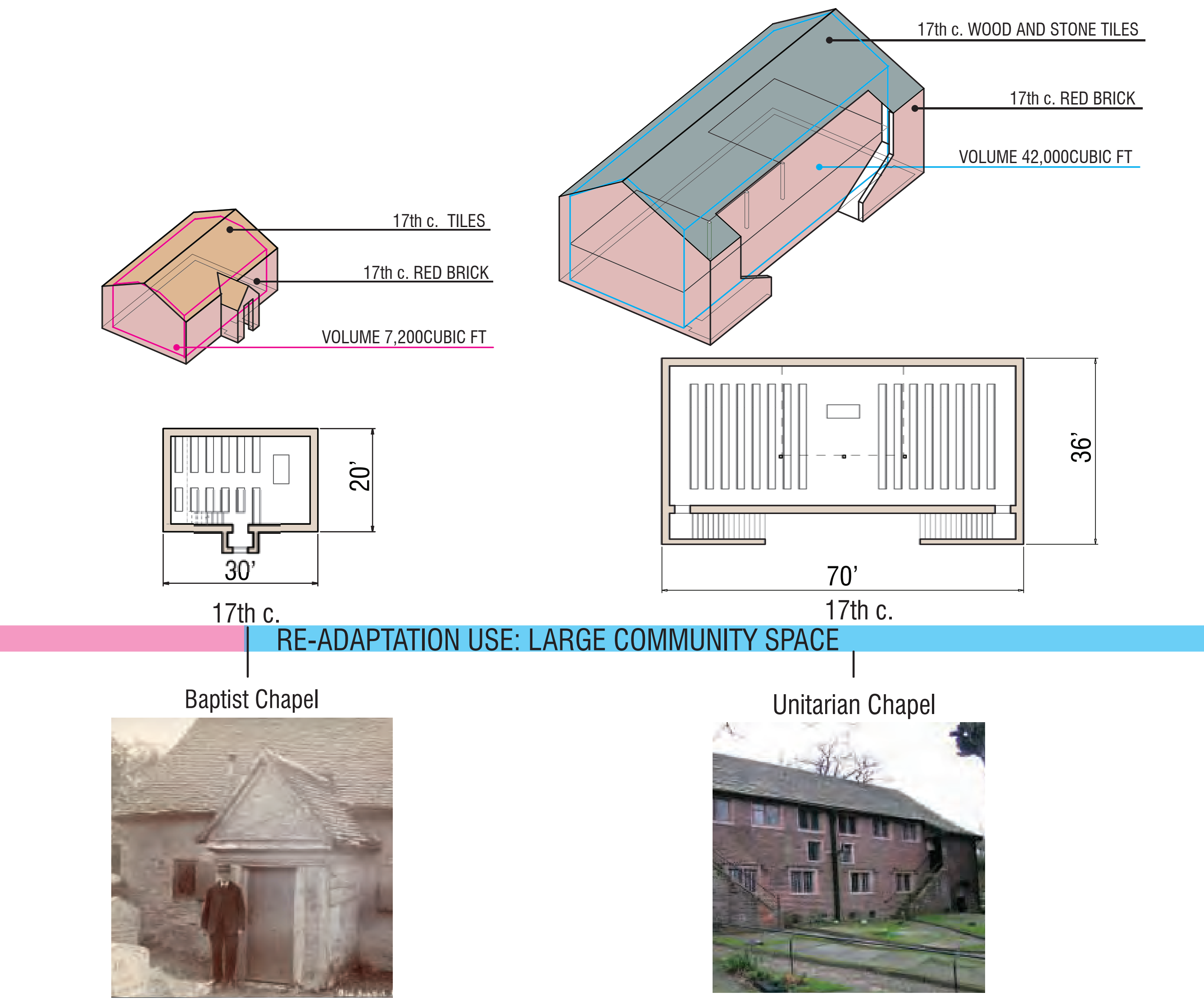


Figure 51 . Timeline of church adatpive reuse typologies.
Source far left from Genuki, "Kirkstead." http://www.genuki.org.uk/big/eng/LIN/Kirkstead/.
Souce mid left from Genuki, "The Puritan Chapel, Bramhope." Last modified August 1, 2013. http://www.genuki.org.uk/big/eng/YKS/PhotoFrames/WRY/BramhopePuritanChapel.html.
Source mid right from Winslow History, "Keach's Meeting House." http://www.winslow-history.org.uk/winslow_chapels-keach.shtm.
Source far right from Genuki, "Knutsford - Unitarian." Last modified October 26, 2011. http://www.genuki.eu/CHS/Church1109.htm.

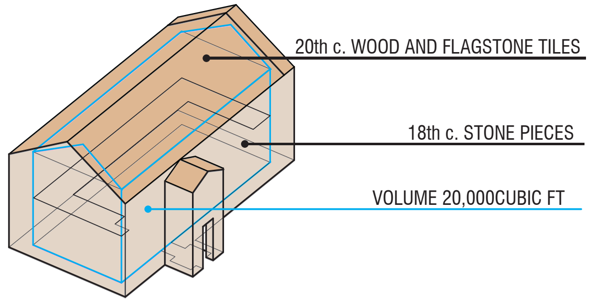
CHURCH READAPTATION TYPOLOGIES

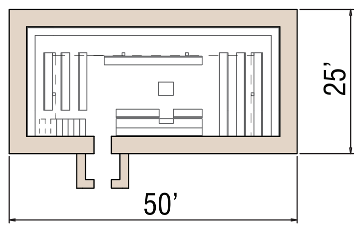
Specific church typologies have characteristics that make them better or worse for different adaptive reuse functions. Through this timeline, it is explained the volume, materiality, and dates of various repairs common to the typology. This way, depending upon the church sites settled upon, they can quickly be analyzed for a program that will suit the site as well as the historic church.

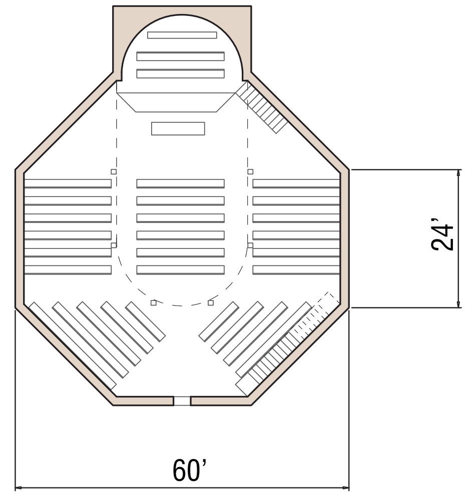
Older churches from the 13th c. and early typically have had their roofs replaced, but their thick stone walls are in good shape. The roof is usualy replaced with a similar product to the original, which is often clay or slate tiles. These early chapels are generally small in volume, often less than 25,000 cubic feet. The best programs for these chapels are small scale community functions. Programs that just need a roof over their head are great for these chapels, as they are usually one story, so one could not build multiple stories on the interior without punching through the roof.   These churches would not have a large surface area to grow algae on.

By the 17th century, churches have moved away from chapels and are commonly greater than 25,000 cubic feet to meet population demands. The churches often have more than one storey, but leave the congregation space a double storey open space. This helps with acoustics, but mainly more people can gather. The roofs from this period are also not original and have been replaced in the 20th century. The plans are still central with a great emphasis on a center than the chapels. These larger volume spaces are great for large scale community spaces.

When it comes to the Methodist chapels, there is nothing better for acoustics. The plan of these is typically octangular for the purposes of sound and central gathering. These make great theater and orchestra adaptive reuse spaces. Most of them are quite large in diameter to accomodate for these kind of events.







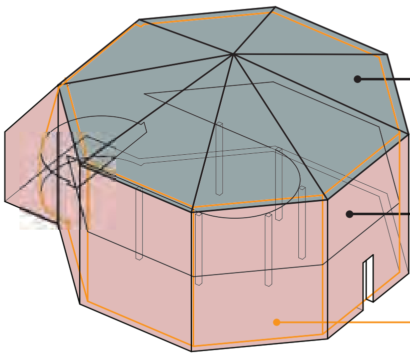
18th c.

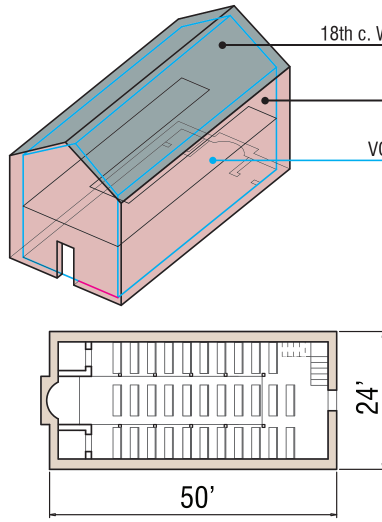
18th c.

RE-ADAPTATION USE: LARGE COMMUNITY SPACE

Quaker Chapel

Methodist Chapel





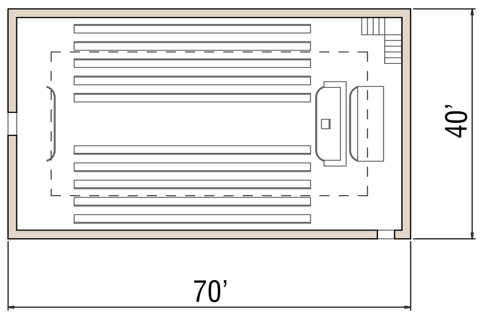
18th c.

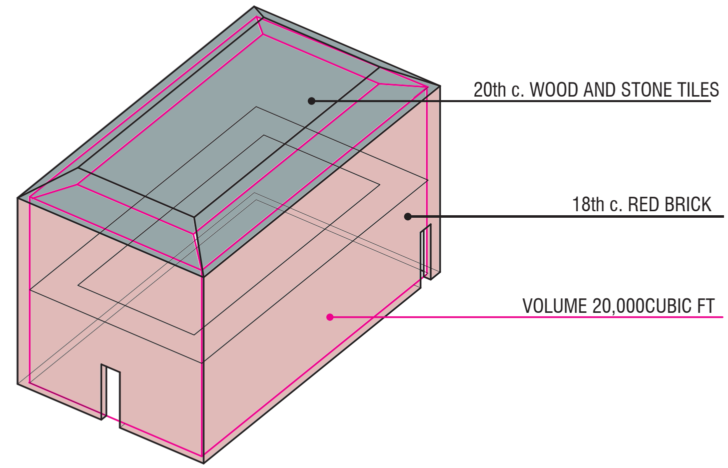
PHENOMENAL ACOUSTICS: THEATER, ORCHESTRA

Roman Catholic Church

Figure 52 . Timeline of church adatpive reuse typologies.
Source far left from Lake District 1652 Quaker History Tour, "Travel Ministry Blog." Last modified May 3, 2007. http://travelministry.blogspot.com/2007/07/lake-district-1652-quaker-history-tour.html.
Souce mid left from A, Scott. English Heritage, Last modified August 29, 1999. http://www.heritage-explorer.co.uk/web/he/searchdetail.aspx?id=6459&crit=&cid=69.
Source right from Portsmouth Diocese, "Catholic Diocese of Portsmouth." Last modified June 6, 2010. http://www.portsmouthdiocese.org.uk/churches/default2.php.

Lastly, synogogues are relatively new construction exterior and roofs in the UK. They are often two stories and have soaring ceiling heights, just like the Roman Catholic Churches. The difference of these two churches is in plan The Roman Catholic centers on an alter to one side of the building while the synagogue is relatively central. The synagogue may be dificult for adaptive reuse because so much of it is ornate detailwork that one would not want to cover. Otherwise, they have large windows for a lot of daylight and interior stories could be built.





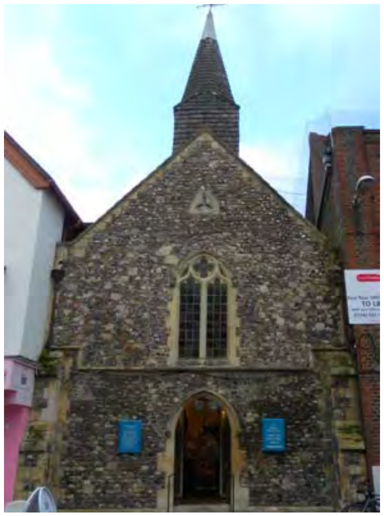
18th c.

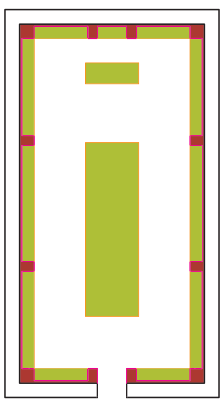
RE-ADAPTATION USE: LARGE COMMUNITY SPACE

Synagogue

Figure 53 . Timeline of church adatpive reuse typologies.
Source bottom image from Wikipedia, "Litsa delle Sinagoghe d-Europa." http://it.wikipedia.org/wiki/Lista_delle_sinagoghe_d'Europa.

COMMON CHURCH ADAPTIVE REUSE PROGRAMS





New walls

New furniture

Existing church

The next set of diagrams analyzes various adaptive reuses of churches. Although not inclusive of all functions, they include some of the most common reuses and what has to be done to the church in terms of new infrastructure and furniture. A comparison can also be made between the volume and type of church and the program, building off the last set of knowledge.

Bookshops: Bookshops are common community program that simply just needs a roof overhead. Figure 54 shows analysis of St Olave Bookshop in the UK. The chapel is relatively small in floor area and because the building is sandwiched between two others, there is no risk that the bookshelves lining the interior wll block windows and daylight.

Figure 54 . St. Olave Bookshop in the UK does not disrupt the existing chapel to insert its new program.
Source of left from Wikipedia, "Former St Olave's Church, East Street, Chichester ." http://commons.wikimedia.org/wiki/File:Former_St_Olave's_Church,_East_Street,_Chichester_(NHLE_Code_1026724).JPG.
Source of top left from Smith, Bradley. Christian Bookshops, "St Olav Christian Bookshop." http://www.christianbookshops.org.uk/stolavchichester.htm.

Library: Libraries are similar to bookshops, but need a larger colume church due to their increased useage. Figure 55 of St Edmund Hall was once a bascilica, but converted into a church after it was derelect and proved to be an ideal location on the campus for a new library. The reuse is really quite simple, adding a few book cases and bookshelves for this size of a church, and keeping it one storey. The interior feels very spacious and prestigious for one to study in. None of the original church was damaged. The library will need large windows for lighting and a lot of supplemental lighting plus an open plan works best.

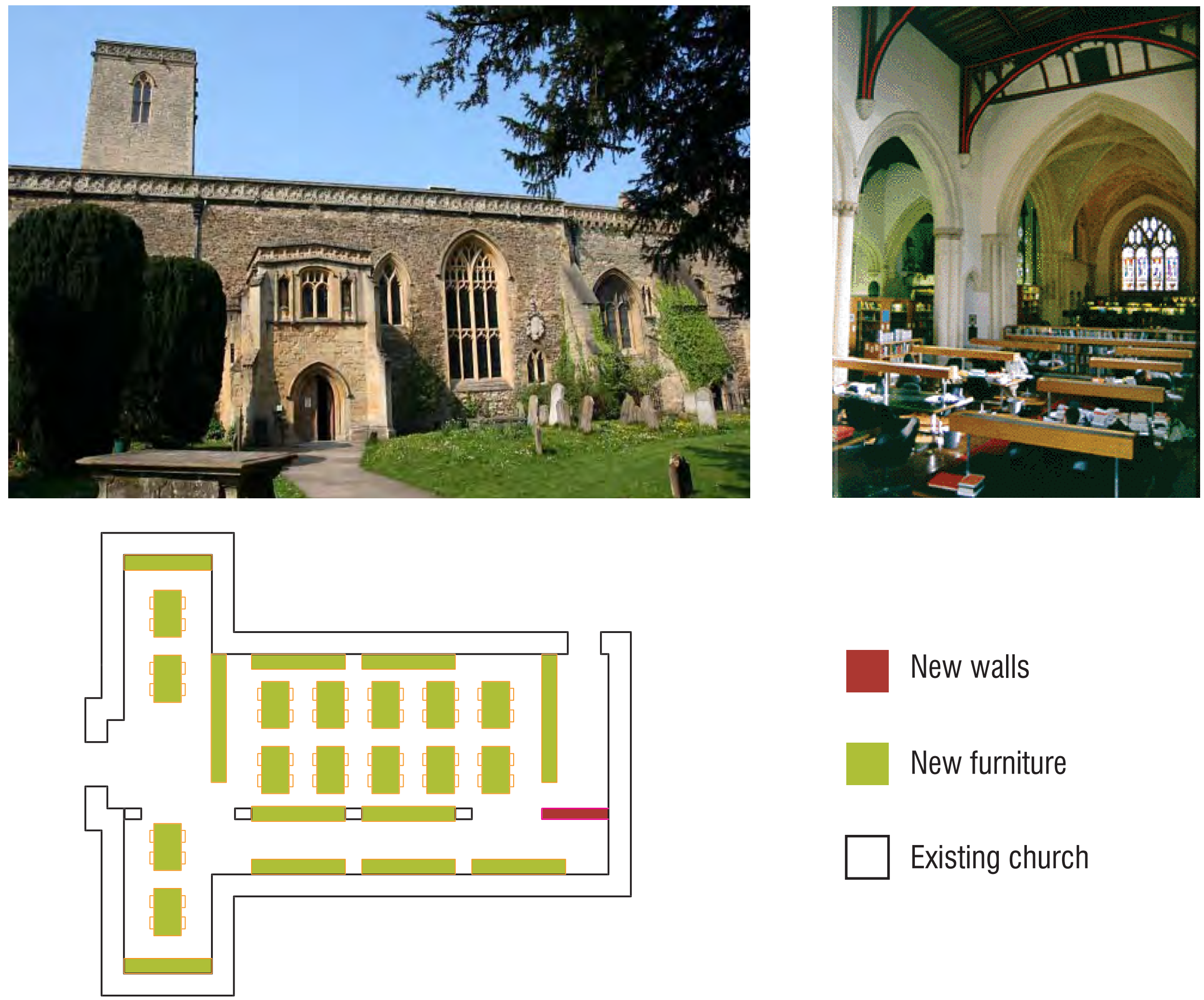
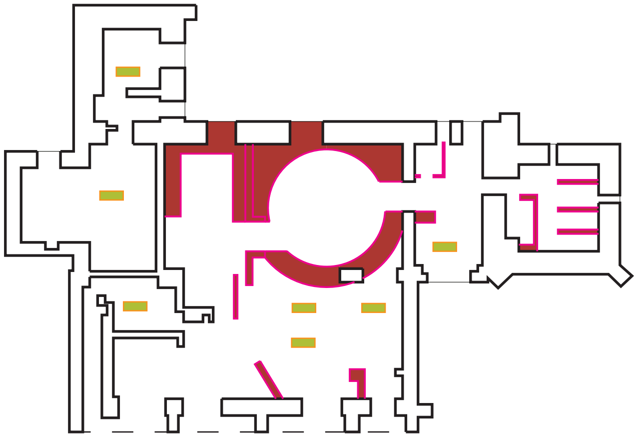


Figure 55 . St. Edmund Library in Oxford, UK was originally a church, but made into a library after disuse and is in an ideal location.
Source top right from Go Historic, "Church of St Peter-In-The-East (St Edmund Hall Library), Oxford." http://gohistoric.com/places/church-st-peter-east-edmund-hall-library-oxford.
Source top left from Academics: Holy Cross, "ST. EDMUND HALL, OXFORD UNIVERSITY." http://academics.holycross.edu/studyabroad/programs/sites/england/edmund.



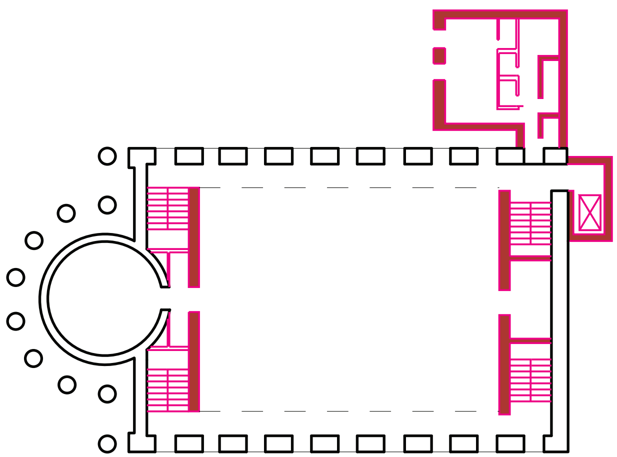
Museum: Museums readatped in churches are a relatively old typology. Church museums featuring church paraphernalia are over done and most of them do not exist anymore because of the lack of interest. Museums like the Green Howards Museum in Figure 56 exist because they put the Green Howards infantry regiment of the British Army on display inside.

Museums best fit into quirky churches such as the medieval churches because it provides for a unique layout and display possibiltites. The partial plan of the museum shows that many new walls were added to make room for display of objects in an interesting layout. Museums like this can be quite disruptive to the spacial layout of the church, especially when multiple stories cover up the nave. Monumental churches work best for large museums, so they have space to display what they need to show.

Figure 56 . The museum typology usually works best in medieval quirky churches, making for a unique museum experience.
Source left top from Wallis, Toby. The Green Howards, "Welcome to the Green Howards Museum." Last modified 2013. http://www.greenhowards.org.uk/index.php.
Source top right from Facebook, "AboutGreen Howards Regimental Museum." https://www.facebook.com/pages/Green-Howards-Regimental-Museum/107931219235677.

Orchestra/Theater: Going back to our church readaptation typologies, we can see that Methodist churches are circular domes and have the best acoustic qualities. Therefore, it was a smart choice for this Baptist church in Leichester to be readapted into an orchestra theater. The only changes made were removing some of the lower seating in order to incorporate seating around the orchestra pit. Depending on the size of the church, the second tier of seating is already in good condition for seeing the pit as well. Most of the original church was not disrupted.

Figure 57 . The Leichester Baptist church is now the Hamson Hall theater with amazing acoustics.
Source top right from Hamson Hall, "Hansom Hall - Leicester City Centre Venue Hire." http://www.hansomhall.co.uk/.
Source top left from Crosby Heritage, "Pork Pie Chapel (Leicester)." http://www.crosbyheritage.co.uk/location/leicester/pork-pie-chapel/.



Performing Arts: A performing arts center is ideal for a church with high ceilings and a large uninterrupted nave. Mainly new walls and floors will be added to make the building functional as a perfomring arts space. This is an ideal large community event space for all kinds of events. The Black-E Theater in London is a perfect example of a performing arts center. They frequently open shows to the public, but other times allow actors to practice in the space. The amount of walls may disrupt the original walls, however the integrity of the large space is maintained.

Figure 58 . The Black-E Theater in London is a large space for perfoming arts.
Source top left from The Black-E, "Welcome." Last modified 2013. http://www.theblack-e.co.uk/.
Source top right from The Black-E, "Welcome." Last modified 2013. http://www.theblack-e.co.uk/.

Education Center/Retreat: An education center retreat is perfect for churches that are in the middle of the country. Usually there is not much around the churches and they are surrounded by foliage, the perfect place for contemplation. These centers need added facilities for visitors to stay overnight and large spaces for lectures and small workspaces. Collaboration is key so the open plan of the church is adventageous. The volume of the churches does not have to be very large. This is a program that really just needs a roof over it head, so mainly new furniture is added and a few walls for private programs.

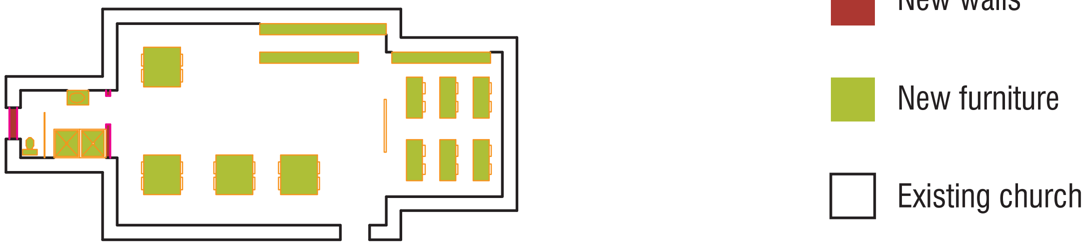
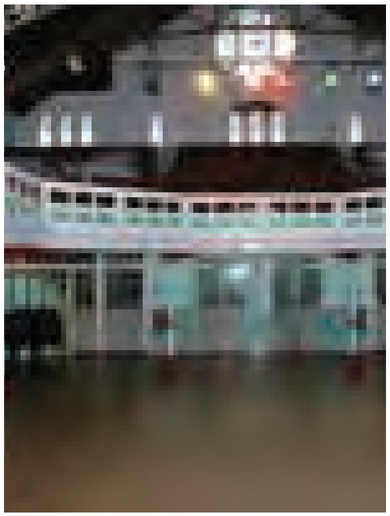


Figure 59 . The Newton Fied Center in the UK used a derelect church for an education retreat.
Source top right from Newton Field Center, "WELCOME TO NEWTON FIELD CENTRE." http://www.newtonfieldcentre.org.uk/.
Source top left from Newton Field Center, "WELCOME TO NEWTON FIELD CENTRE." http://www.newtonfieldcentre.org.uk/.



Community Center: A community center is ideal for a church which already centers around the community. The best case scenario would be a church that has a large nave for public events, and the aisles can be outfitted with offices. This adaptive reuse typology tends to divide the church spatially by adding a lot of walls for offices and conference rooms. Multiple floors may be added for the offices, which would further divide up the space.

The Belgrave Neighborhood Center hosts monthly activities in their church for children.

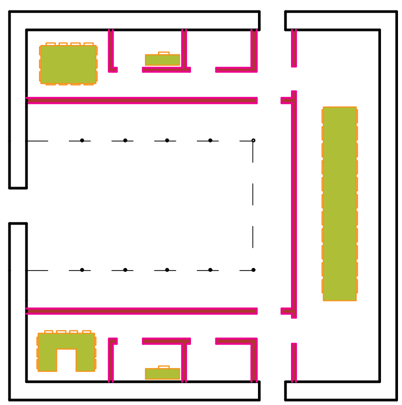


Figure 60 . The Belgrave Neighborhood Center in the UK divides up the church into an event space and offices.
Source top left Wikimapia, "Belgrave Neighbourhood Centre (Leicester)." http://wikimapia.org/7987478/Belgrave-Neighbourhood-Centre.
Source top right from Wikimapia, "Belgrave Neighbourhood Centre (Leicester)." http://wikimapia.org/7987478/Belgrave-Neighbourhood-Centre.

Private Homes: If a church is made into a home, not only does this take the function from public to private, but the home will also add many walls to the church and destroy its integrity. Often multiple stories will ruin the interior and the only thing reminding one they live in a church is the stained glass windows. Private homes are not the best choice for the churches because they damage the church and often will remain a home forever. The St. Nichola residence in London does just that, dividing up the space until it is unrecognizable.

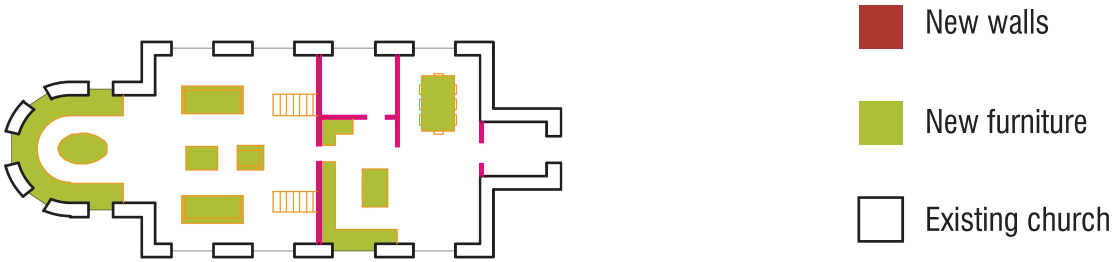


Figure 61 . The St Nicholas residence adds floors and walls to the church.
Source top right from Web Urbanist, "Religious Conversions: 15 Houses of Worship Turned Secular." http://weburbanist.com/2013/09/09/religious-conversions-15-houses-of-worship-turned-secular/2/.
Source top left from Web Urbanist, "Religious Conversions: 15 Houses of Worship Turned Secular." http://weburbanist.com/2013/09/09/religious-conversions-15-houses-of-worship-turned-secular/2/.

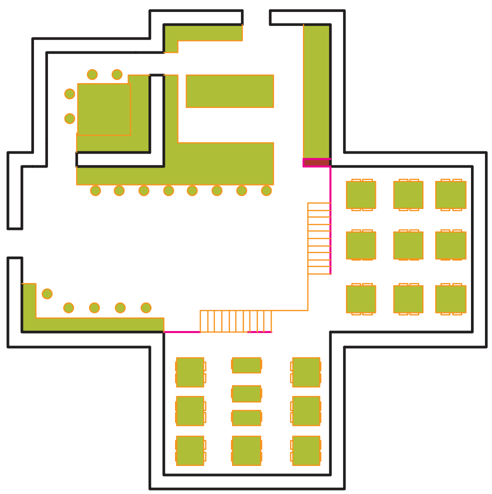


Figure 62 . Oneil's Restaurant in the UK used the central plan to its benefit.
Source top left from The Black-E, "Welcome." Last modified 2013. http://www.theblack-e.co.uk/.
Source top right from The Black-E, "Welcome." Last modified 2013. http://www.theblack-e.co.uk/.

Restaurant: **Restaurant:** A restaurant is an excellent idea for readaptation because it is a public function for community enjoyment. Although the kitchen equipment installation may damage the church, the rest of the readaptation is only furniture. Multiple stories were added in Oneil's Restaurant shown in Figure 62. Large uninterrupted spaces are best for restaurants, but booths can fill in the nooks just as well. The unexpected medieval elements make for great large party tables.

In conclusion, church readaptation programs are not limited to the ones here, but this gives a breadth of what is being done and what types of programs work the best.

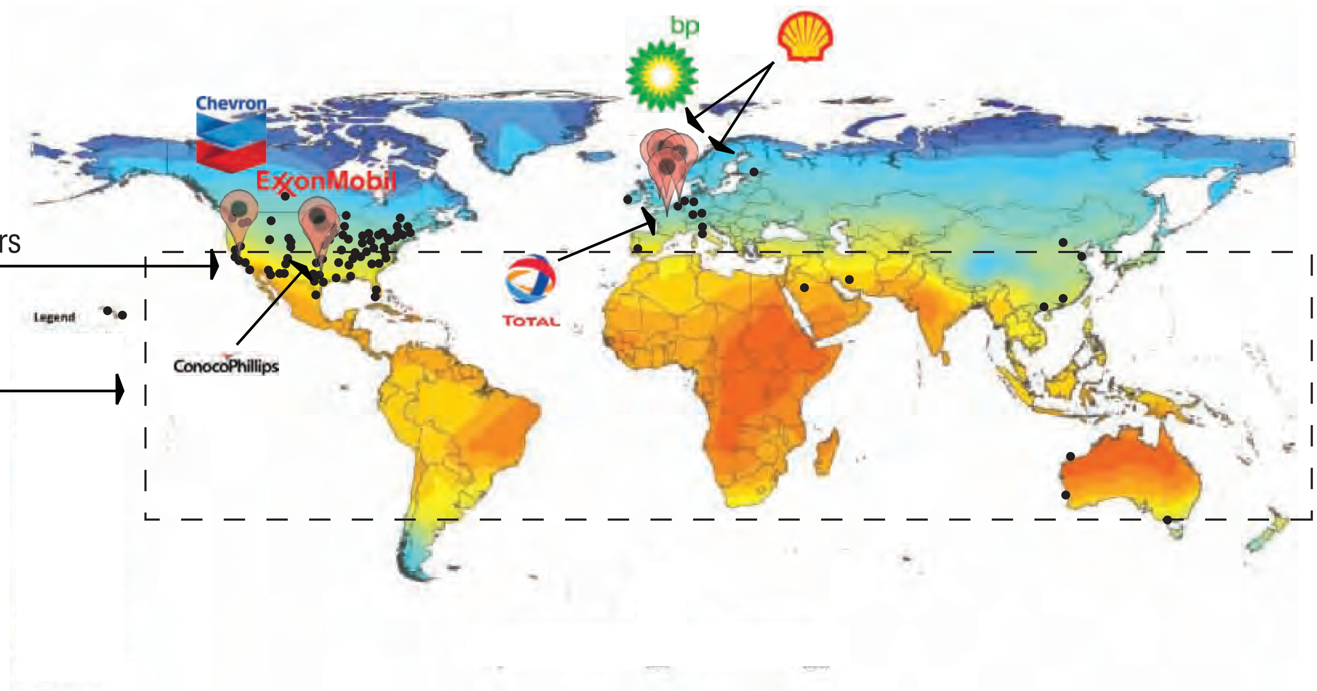
4

SITE

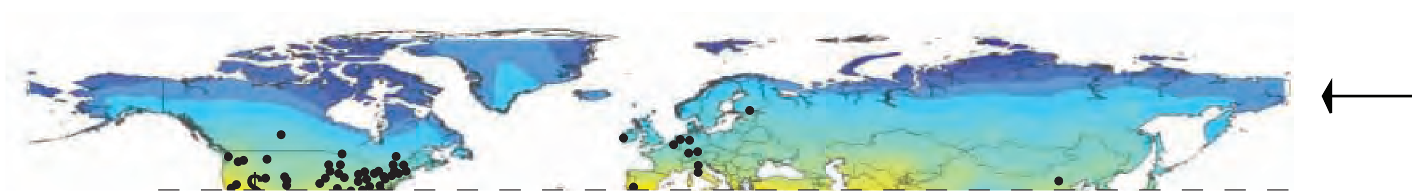
Location of Oil Majors Headquarters

- One ABO (Algae Biomass Organization) : members, algae production projects, and others

Band of most efficient algae growth



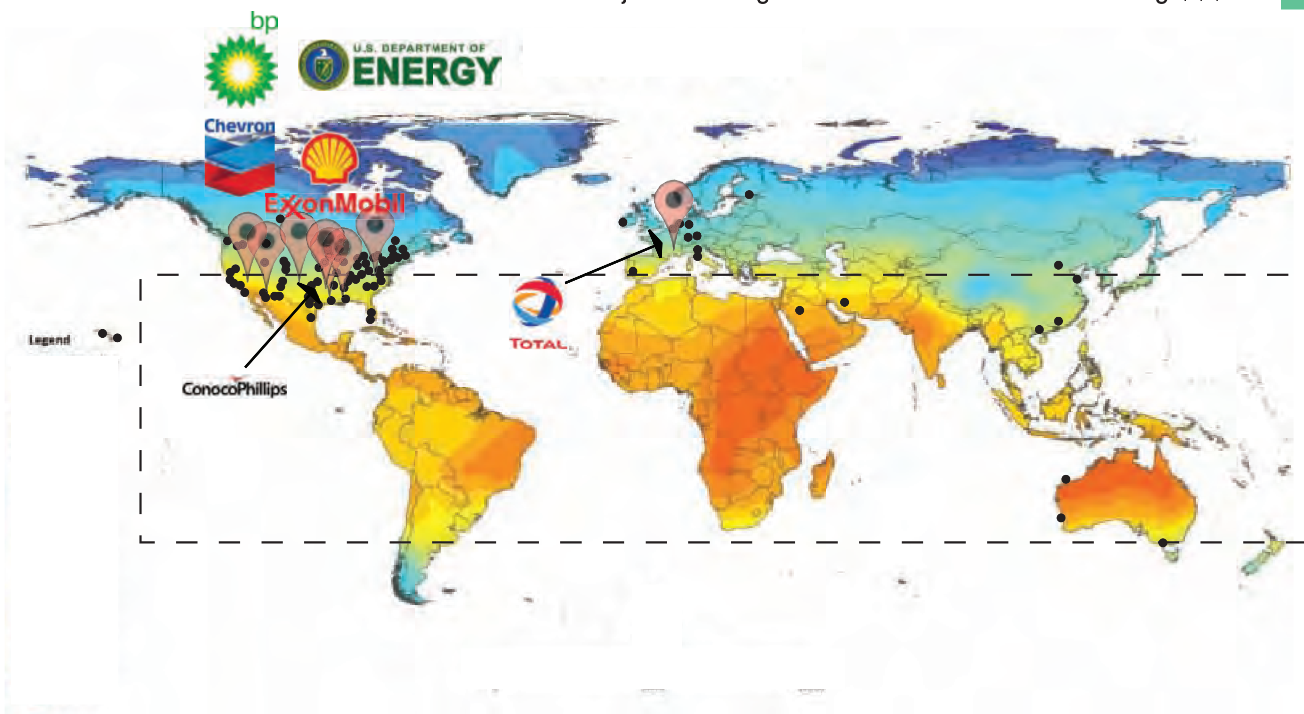
ABO Outside of the Most Efficient Algae Growth Band



Lowest algae growth

Highest algae growth

Location of Oil Majors Funding Efforts and Government Funding $$$



Half of USA ABO are not in the most efficient algae growth band, they are near universities

(list not inclusive)

Figure 63 . Mapping of algae production, universities outside the ideal zone for algae growth, oil majors headquarters, and oil majors funding efforts. Source: Image adapted from Katie, Fehrenbacher. Gigaom, "This is How Much and Where Algae Could be Grown on the Planet." Last modified October 10, 2013. http://gigaom.com/2013/10/10/this-is-how-much-and-where-algae-fuel-could-be-grown-on-the-planet/ and Biomass Magazine, "ABO launches map of algae research, company and project locations." Last modified April 17, 2013 . http://biomassmagazine.com/articles/8883/abo-launches-map-of-algae-research-company-and-project-locations.

SITE SELECTION CRITERIA

Algae: Although algae may grow best in many third world countries, it is expected that algae research is occuring in developed nations. The United States is leader in research and development in algae production due to these factors:

1. The US uses the most oil out of any country in the world, and feels obligated to research alternative fuel.

2. Funding avaliable from a variety of sources, including from the Department of Energy and from 5/6 world oil majors. Chevron Corporation (US), ExxonMobil (US), BP (UK), and Royal Dutch Shell (UK and Netherlands) all fund algae biofuel research in the US rather than the UK funding their own research due to the lack of organized facilities for research.
(The last Oil Major is Total SA (France)).

3. Organization among universities and companies allows for shared knowledge and innovation.

Other countries invloved in research include Europe, Saudi Arabia, Australia, and Asia. Many countries have research in a cold climate but have facilities in a sunny climate to test their findings. The site must be located in the US or the UK because this is where the oil majors are located for funding. It would make sense for the UK to start funcing research on its home turf.

Although the United States has a strong base of research and development on algae production for biofuel, more countries need to establish research centers. If a natural disaster somehow devestated the algae stock in the United States, the base would be wiped out for a few years. Having mutliple bases if the best option for a successful future in algae research.

Due to the fact that 3/6 oil majors of the world are in the US, it would only make sense to choose the country with the second most oil majors which is the UK with 2/6. The oil majors in the UK currently contribute tons of money to US research; $500 million coming from BP in 2009 towards algae research. This is due to the fact that there is no research organization in the UK, so they must export their funding. Nationalism runs high in the UK and they should have a strong desire to fund their own research.

However, up until the mid 1980's, the UK was a world leader in algae research and still contains one of the key algae and protezoa collections. According to the BBSRC (Biotechnology and Biological Sciences Research Council in the UK) as of July 2011 in their 'Algae Research in the UK' publication, the UK has no reason it should

Research area	Researcher	Organisation	Early publications
Ecological, taxonomic, classificatory, morphological and evolutionary aspects of phycology	Felix E Fritsch	Queen Mary, University of London (Founding Father of Freshwater Biological Association)	Fritsch 1903
Seasonal cycles, eutrophication, long term changes, culture studies (notably bioassay), whole or part lake experiments and taxonomy of algae	John WG Lund FRS	University of Sheffield, later Freshwater Biological Association	Lund 1942
First electron micrographs of algae	Irene Manton	Leeds	Manton and Clarke 1950
Algal photosynthesis	CP Whittingham	Cambridge and Queen Mary	Whittingham 1952
Diatom ecology and taxonomy	Frank E Round	Bristol	Round 1953
Mapping of seaweed in Scotland	FT Walker	Institute of Scottish Seaweed Research	Walker 1954
Algal cell walls	Donald H Northcote FRS	Cambridge	Northcote *et al.* 1958
The ecology of algae and cyanobacteria	Brian A Whitton	Durham	Whitton 1965
Gas vesicles and buoyancy; cyanobacterial heterocycsts	Tony (AE) Walsby, Peter Fay	London (Westfield) / Bristol	Fay and Walsby 1966
Algal photosynthesis	John Raven	Dundee	Raven 1967
Dinoflagellates	Barry Leadbeater	Birmingham	Leadbeater and Dodge 1967
Metabolism and molecular biology of cyanobacteria	NG Carr	Liverpool and Warwick	Hood and Carr 1969
Fundamental physiology, photosynthesis , eco-physiology	John F (Jack) Talling	Freshwater Biological Association	Talling 1970
Biofouling	Len V Evans, AO Christie	Leeds	Evans and Christie 1970
Evolution of photosynthesis; metallo-proteins; bioenergy; PBRs	David O Hall, KK Rao	King's College London	Hall *et al.* 1971; Rao *et al.* 1971
Carbon metabolism	A J Smith	Aberystwyth	Smith 1973
Cyanobacterial toxins	GA Codd	Dundee	Codd and Stewart 1973
Photosynthetic electron transfer	Mike Evans, Jonathan Nugent	University College London	Evans *et al.* 1976; Nugent *et al.* 1981
Cyanobacteria: cell division, gliding motility, cellular differentiation and plant symbiosis	Dave Adams	Liverpool and Leeds	Adams and Carr 1981
Algal lipids	John R Sargent	Stirling	Sargent *et al.*

Figure 64 . From the 1900's to the 1980's the UK was world class in algal research and still is, just not established ABO's. Source: Image from "Algal Research in the UK." BBSRC. (2011).

Figure 65 . Forty UK Universities are involved in algae research, ten historically always were (none are established ABO).
Source: Data mapped from "Algal Research in the UK." BBSRC. (2011).

not be capitalizing on algae research. The UK has through out history shown biological and ecology research to be their strong suit. Some universities in the UK have began algae based research, however their efforts are small and disconnected. The two main reasons the UK has not utilized their brain

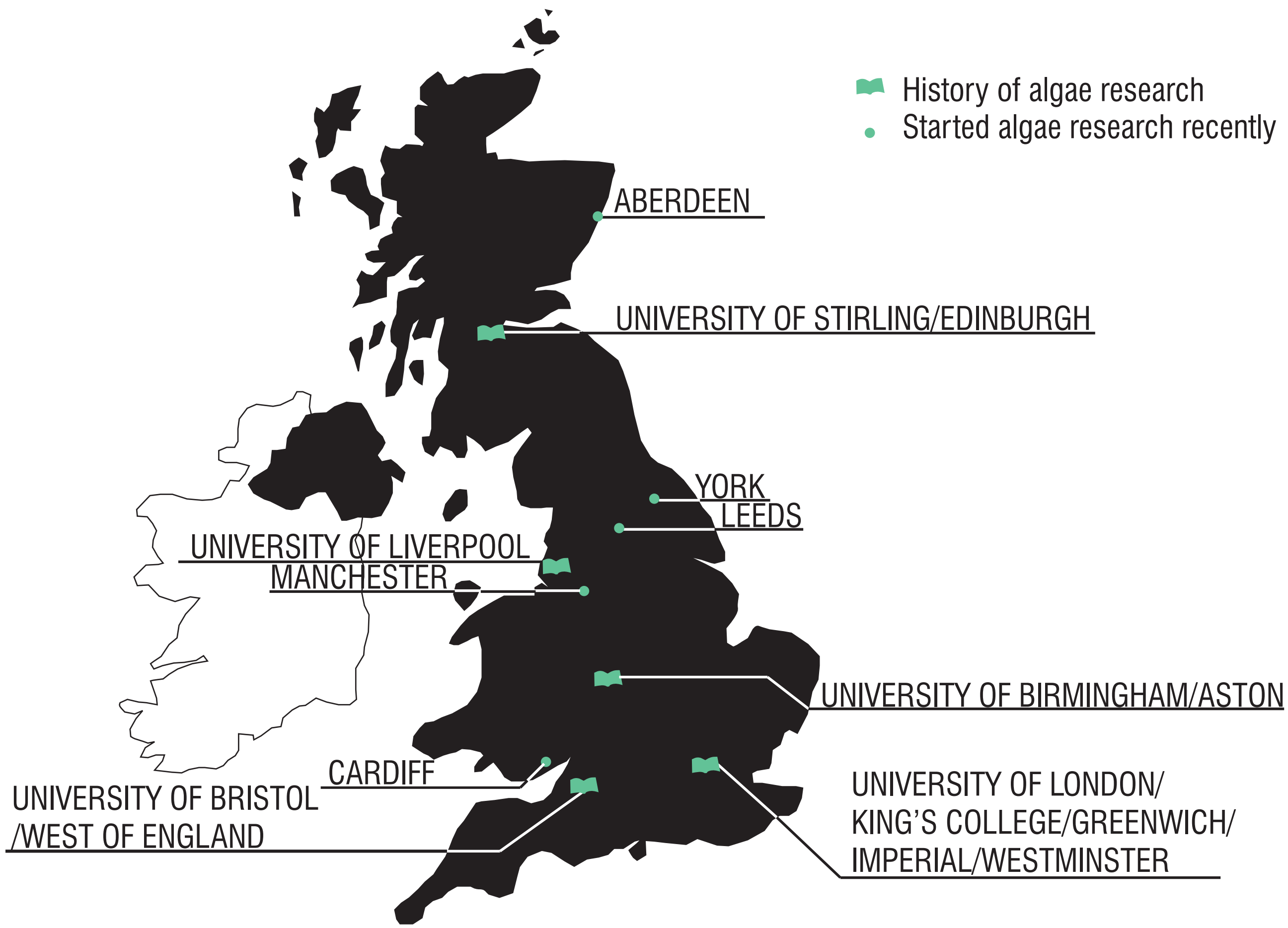
1. there is a lack of integration and collaboration between disciplines across the

2. There is a severe lack of funding, especially due to the fact that the government is not contributing and the two oil majors of the UK are sending their funding abroad to the states due to lack of a biotechnology platform

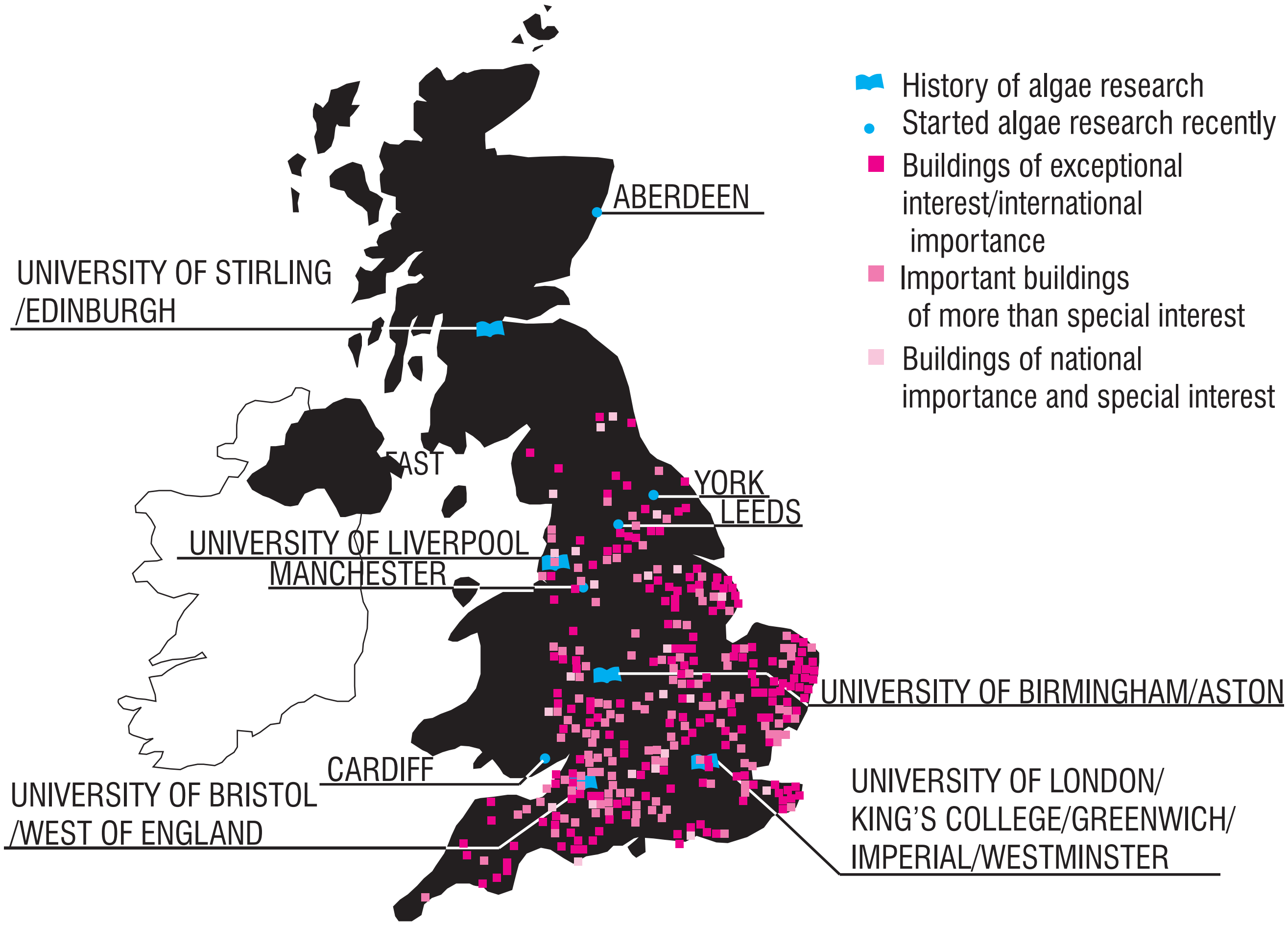
3. There is lack of commercialization for the current research at universities. They are not gaining enough profit back from their research to continue and many of them are

If the UK does not do something about this soon, they will be sending funding for research and development and experiencing a brain drain on the topic elsewhere.

The UK is also fits the criteria for an industrial source for CO2 the algae needs. There are many universities that were founded very close to the industry, which makes a perfect pairing for the algae. In these dense city centers, it will be necessary to grow the algae on top of buildings or included in architecture. Because the UK is small compared to the US, most of the land has already been developed at one time, and farmland should not be taken over by algae farming.



Figures 66 . Universities also located near heavy industry for carbon dioxide to feed algae.



Churches: Due to the fact, we already argued for algae facades on churches because just like PVC's, it is economically viable for the churches to get tax breaks, chromatic effects are an insulated stained glass, and the church can save on heating and cooling, the largest expense of churches. Figure 67 identifies derelect churches based on the Churches Conservation Trust, which are churches that did not make it to the National Heritage level of saving, but are still noteworthy pieces of architecture.

The churches at this level are rated in three categories: churches of exceptional interest/international importance, churches of more than special interest, and churches of national importance/special interest. With church populations continuously decreasing, there are bound to be more churches up on the market than we know what to do with. An ideal site to add an algae skin to the churches would be near one of the universities that has a history of algae research and is located near heavy industry.

Figures 67 . Mapping of Churches Conservation Trust Maintained Churches and University Research Centers near heavy industry.

This leaves us with four potential cities that meet this criteria near churches: Liverpool, Manchester, Bristol, and London. By mapping the proximity of the churches from the universities, we can narrow down the site further by keeping in mind sites closer to the university/industry will mean less transportation and more easily accessible sites for the public. Both the churches of Bristol and Manchester are highly condensed near the city center while Liverpool and London the churches are much farther from the university. This means we can eliminate University of London and University of Liverpool due to the inconvenient locations of their spread apart churches.

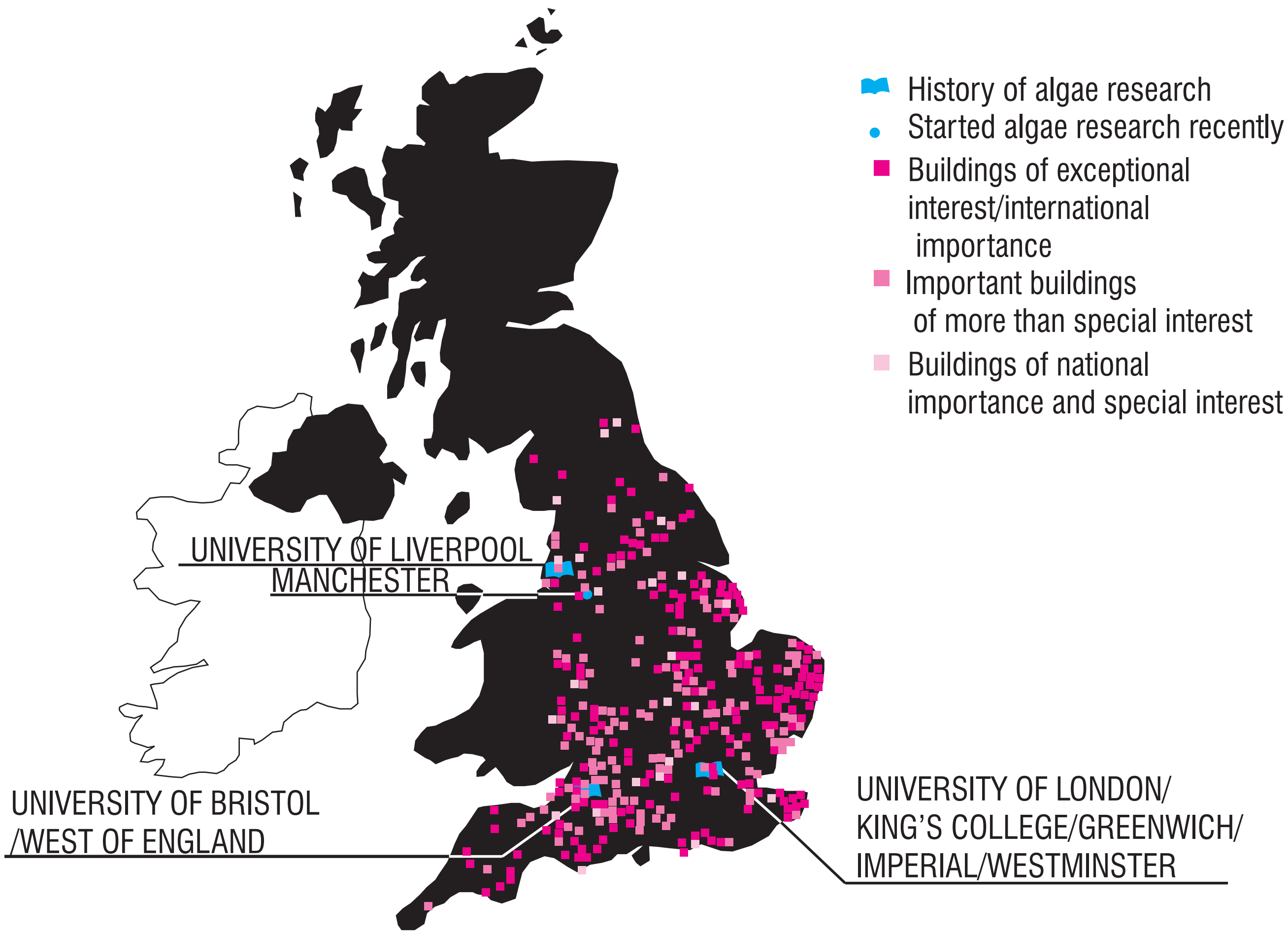
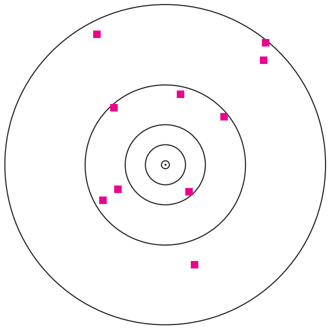
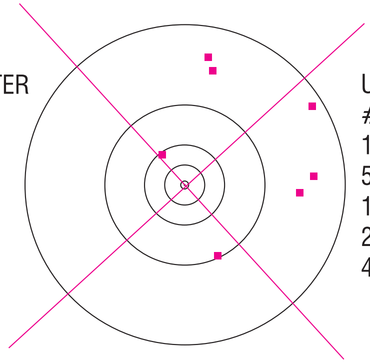


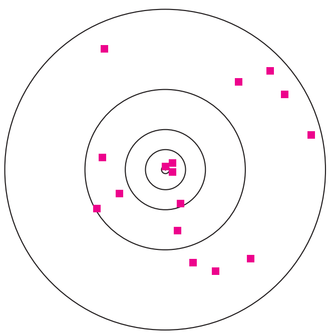
Figure 68 . Four potential cities are left as potential sites near churches and heavy industry.



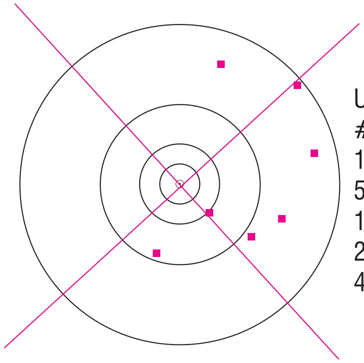
UNIVERSITY OF MANCHESTER
# of Churches within:
1km: 0
5km: 0
10km: 1
20km: 6
40km: 10



UNIVERSITY OF LIVERPOOL
# of Churches within:
1km: 0
5km: 0
10km: 1
20km: 2
40km: 7

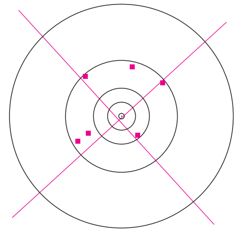


UNIVERSITY OF BRISTOL
# of Churches within:
1km: 1
5km: 3
10km: 4
20km: 8
40km: 16

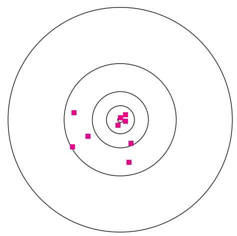


UNIVERSITY OF LONDON
# of Churches within:
1km: 0
5km: 0
10km: 0
20km: 2
40km: 7

UNIVERSITY OF MANCHESTER



UNIVERSITY OF BRISTOL



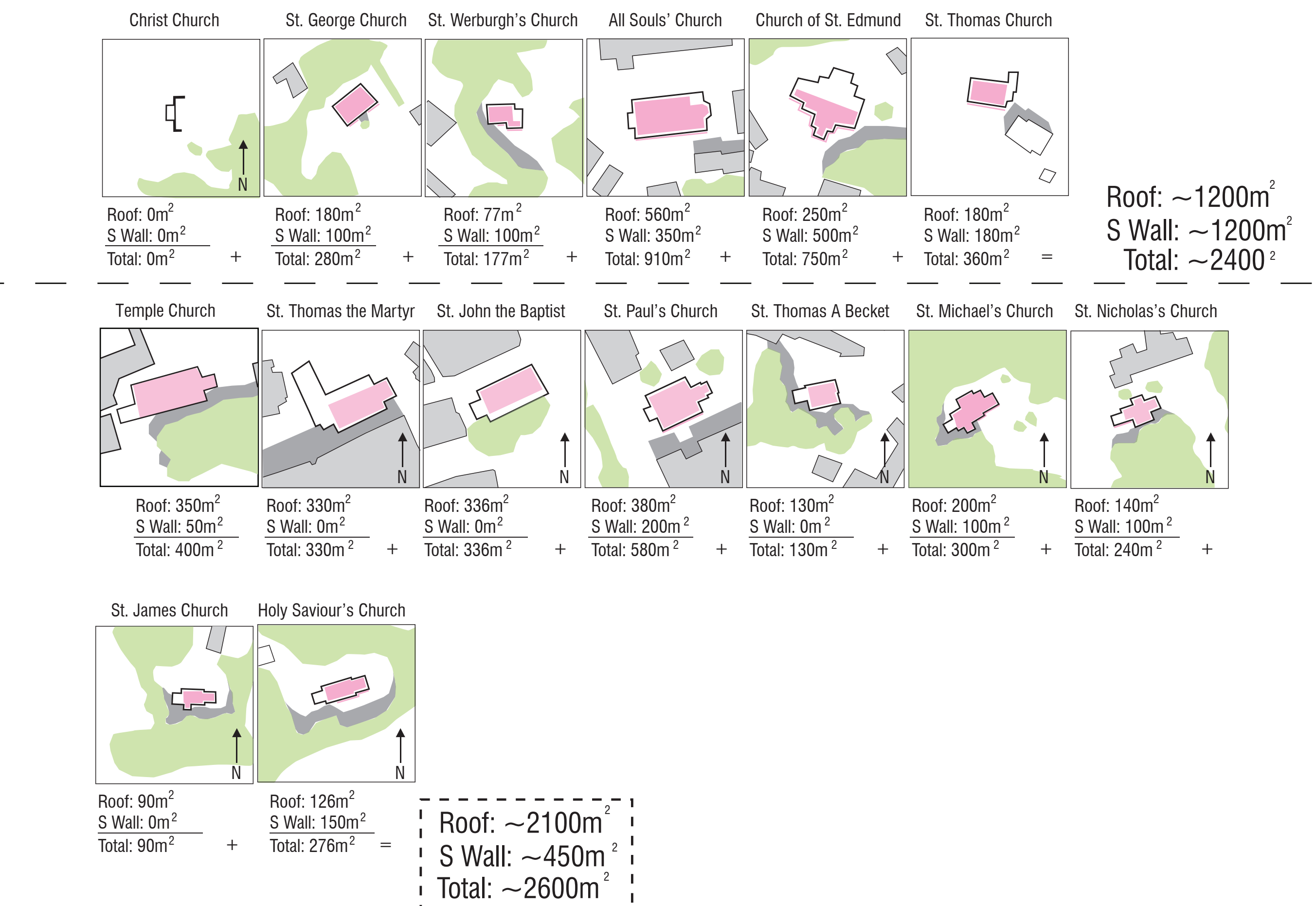


Figure 69 . Churches in each of the citiies are analyzed for their proximity and square footage for an algae skin.

Final site selection is determined by the sqare footage of the walls and roofs of the churches combined in each city. The total dquare footage of each city's churches is relatively equal, around 2,500 meters squared each. As we calculated previously, this is more than enough area to produce the necessary biomass for the university's research needs. Only one church would actually need to be used to produce biomass for research, however we would like to propose doing this to up to five churches so that the public can experience the other benefits of algae.

Looking at the closest five churches, university of Bristol actually has five within 10km. After further site inspection, there is a National Heritage bombed out church right in the city center that is sitting derelect and can be included in our data. Manchester only has one church within 10km of its campus. Thus Bristol looks more desirable in terms of proximity.

If we add up the total square footage of the five closest churches, we find out that both Bristol and Manchester have apprximately 2,000 meters squared which makes them even in terms of square footage. Because we need carbon dioxide and to harvest the algae as close to the university as possible, Bristol is the city that was chosen.

SITE SPECIFIC PROGRAM

Large community event space:
Temple Church is actually on the National Heritage List, however it is a bombed out Bascilica and is derelect. Its location in in prime Bristol land and it is time people let go of the past and rebuilt it. Only the tower and the walls remain. Due to its central location, an events space would be a public function that would just need a roof overhead. There are interior dividing walls, so the spaces would be seperate to rent out and encourage mingling. It could be for weddings, recptions, graduations, or any kind of classy party that would enjoy antique architecture with a modern colorful twist.

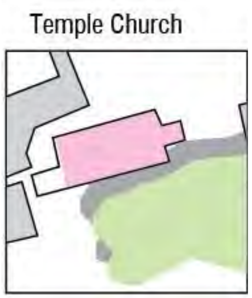
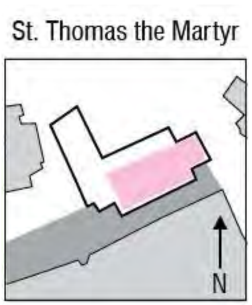


Figure 70 . Temple Church is a series of bombed out walls just waiting for a roof to enclose a community center.
Source top left from Bristol Reads, "Areas." http://www.bristolreads.com/areas.htm.
Source top right from bing maps.



Restaurant: Due to this church's medium size and relatively intact interior, it would be a great reuse as a restaurant. The pews could be repurposed as seating without harming the church, and the space could remain relatively undisturbed, minus using part of it for a kitchen. The downtown location is perfect for the program.

The algae skin will produce the biomass for the building to use in its own cooking; yes a vegetarian algae restaurant to teach people about the algae and its benefits. The clestory lighting has long ago lost its original stained glass, so these windows are great for showing the new chroma algae stained glass, and will reflect great on the white interior.

Figure 71 . St Thomas the Martyr has the perfect volume and shape for a restuarant plus it does not have clestory stained glass anymore.
Source top left from The Churches Conservation Trust, "An Elegant Georgian Survivor." http://www.visitchurches.org.uk/Ourchurches/Completelistofchurches/Church-of-St-Thomas-the-Martyr-Bristol-Bristol/.
Source top right from SketchUp, "St Thomas the Martyr, Bristol." http://sketchup.google.com/3dwarehouse/details?mid=bdc6e21c8c1aacbcf22ba74da7a4ddf7.

Library: St John the Baptist is located very close to central downtown and the University of Bristol. The university is always expanding, but due to the dense urban fabric this is never the easiest of tasks. This church fits an ideal library shape because it is relatively narrow and has large windows for plenty of lighting. The pews could be reused for seating easily, and the integrity of the building would be saved. This building's algae skin would go on the roof only because it already has stained glass on its windows and chromatic lighting is not ideal for libraries.

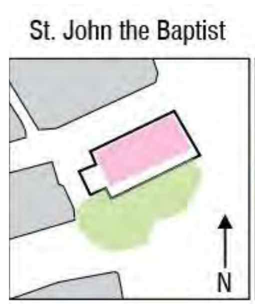


Figure 72 . St John the Baptist is relatively narrow and has large windows with translucent stained glass, great for a library.
Source top left from The Churches Conservation Trust, "A Church Rising out of Bristol's North Gate." http://www.visitchurches.org.uk/Ourchurches/Completelistofchurches/Church-of-St-John-the-Baptist-Bristol-Bristol/.
Source top right from The Churches Conservation Trust, "A Church Rising out of Bristol's North Gate." http://www.visitchurches.org.uk/Ourchurches/Completelistofchurches/Church-of-St-John-the-Baptist-Bristol-Bristol/.

Circus: St. Paul's Church already has been readapted into a world famous circus performance space. The interior has a flying trapeeze rig that is only possible due to the large heights of the space. The building is a grade I listed church, so the church was not divided spacially by walls, but kept quite intact. This is the perfect candidate for an algae roof skin because the circus often uses chromatic lighting in its performances, and the external lighting at night would call people to the circus, rather than calling them to a redundant church exterior.

Figure 73 . St. Paul's Church has already been readapted to a circus program.
Source top left from The Churches Conservation Trust, "A Circus School? Surely Not." http://www.visitchurches.org.uk/Aboutus/Regeneratingcommunities/Projectsexamplesofourregenerationwork/AcircusschoolBristol/.
Source top right from The Churches Conservation Trust, "A Circus School? Surely Not." http://www.visitchurches.org.uk/Aboutus/Regeneratingcommunities/Projectsexamplesofourregenerationwork/AcircusschoolBristol/.

Children's Retreat Center: St. Thomas a Becket is the furthest out of the city center of all of Bristol's churches, therefore its function must be more natural. The building is relatively small in volume and thus it would make a great learning facility for children.The colorful algae roof will symbolize a playground of colors for the children's space to be welcoming, however inside of the building, the lighting will be mostly normal besides a few areas to remind the inhabitants of the algae roof. The retreat center is not to learn about algae, but about nature and place away from the city.

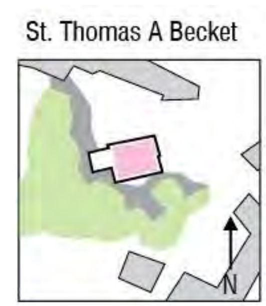
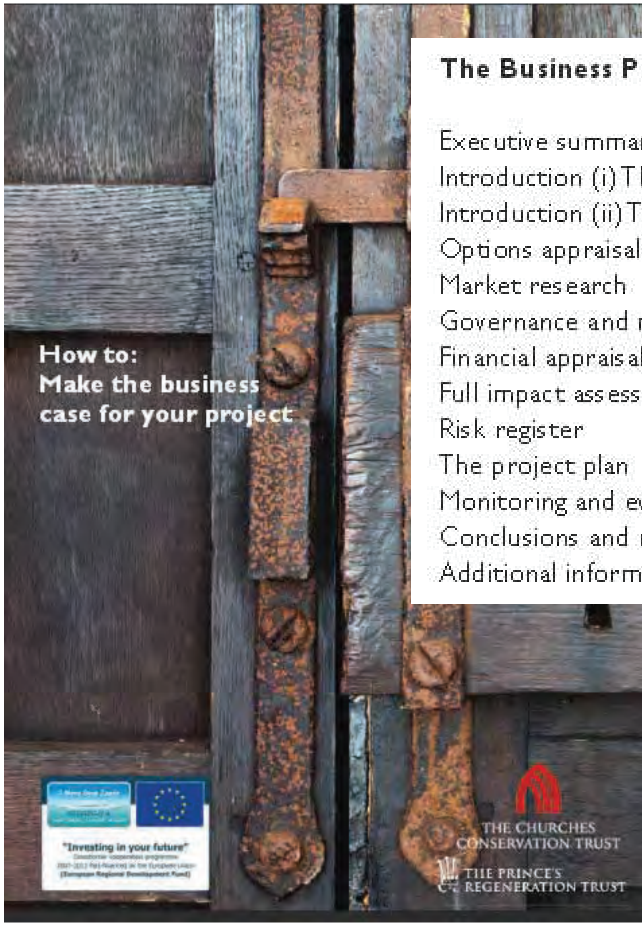


Figure 74 . St Thomas A Beckett is relatively small and remote, perfect for a retreat center.
Source top left from The Churches Conservation Trust, "A Thomas Beckett Connection." http://www.visitchurches.org.uk/Ourchurches/Completelistofchurches/Church-of-St-ThomasBecket-Capel-Kent/.
Source top right from The Churches Conservation Trust, "A Thomas Beckett Connection." http://www.visitchurches.org.uk/Ourchurches/Completelistofchurches/Church-of-St-ThomasBecket-Capel-Kent/.



The Business Plan – what to cover

Executive summary
Introduction (i) The project
Introduction (ii) The organisation
Options appraisal summary
Market research
Governance and management structure
Financial appraisal
Full impact assessment
Risk register
The project plan
Monitoring and evaluation
Conclusions and recommendations
Additional information – appendices and supporting documents

Figure 75 . Churches Conservation Trust 'How to Make the business case for your project will be a key guide in architectural development of the program.
Source from The Churches Conservation Trust, "How to: Make the Business Case for Your Project."

5

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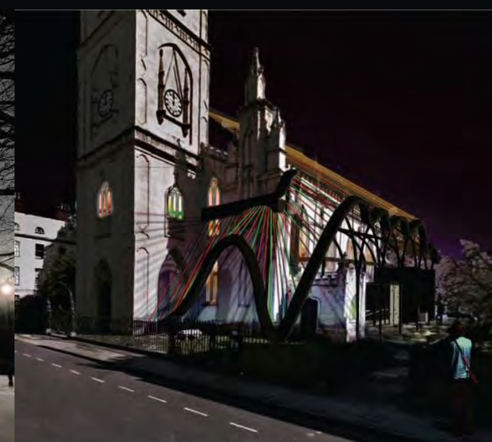
Stained Glass
BIOMASS

DERELICT CHURCHBELLS RING A NEW TECHNOLOGY

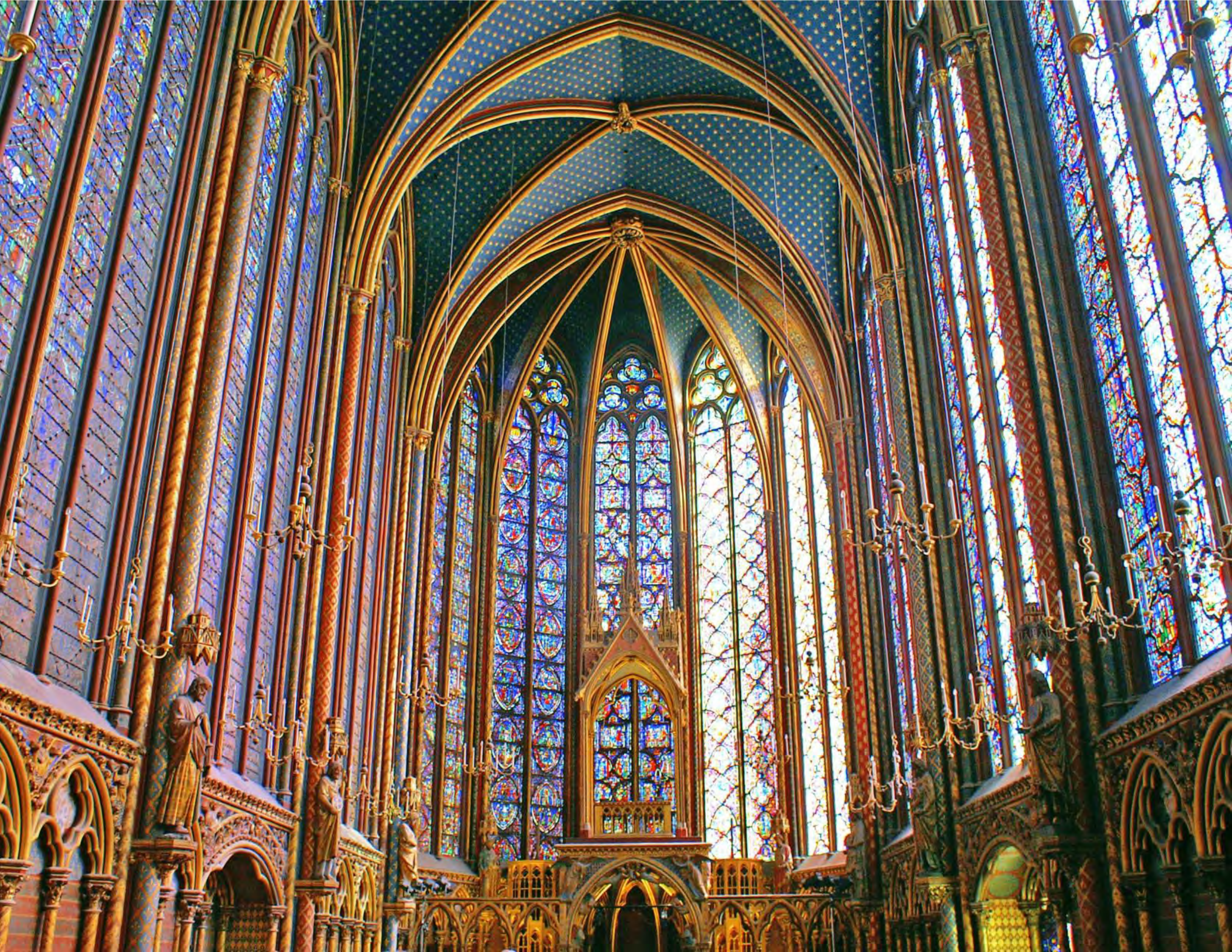
LAUREN SLOAN
THESIS SPRING 2014
ROBERT SVETZ
JULIA CZERNIAK

Stained Glass
BIOMASS




Stained Glass
BIOMASS

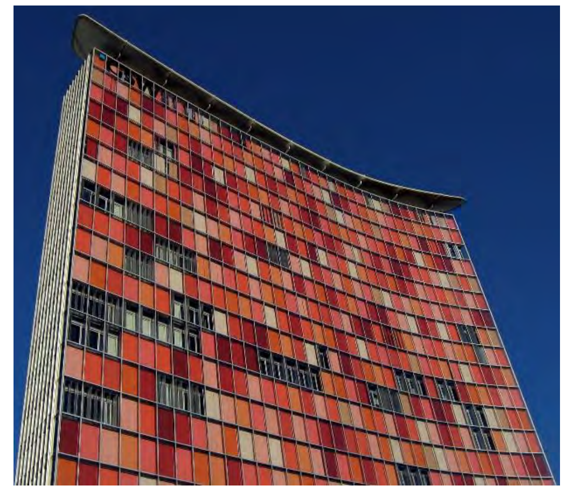



7 Different Bottles of Light
in a Stone box
2 Blessed Sacrament
3 Choir
4 Altar
6 Gathering
Chapel of

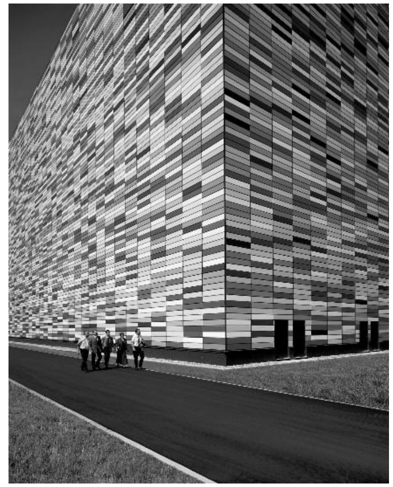

7 Different Bottles of Light
in a Stone box
2 Blessed Sacrament
3 Choir
4 Altar
6 Gathering
Chapel of

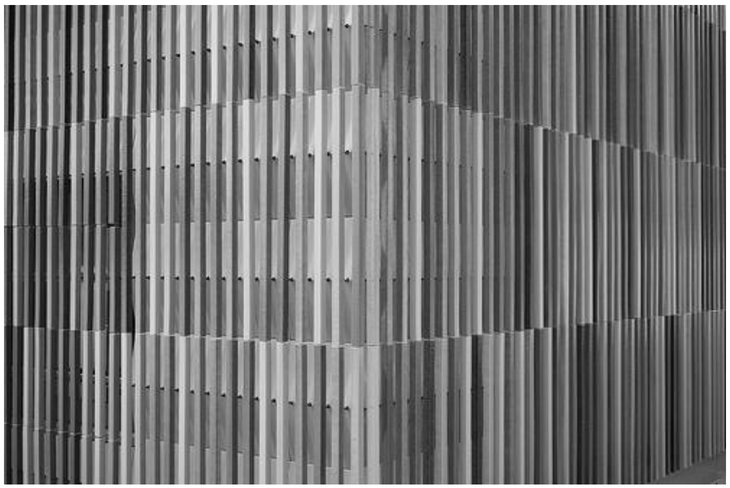










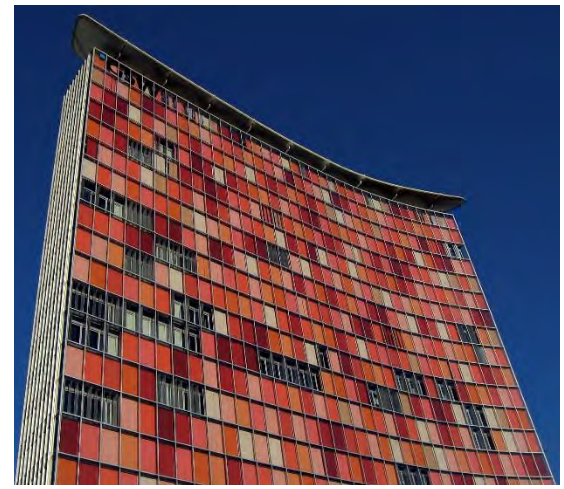




Checkpoint Energie

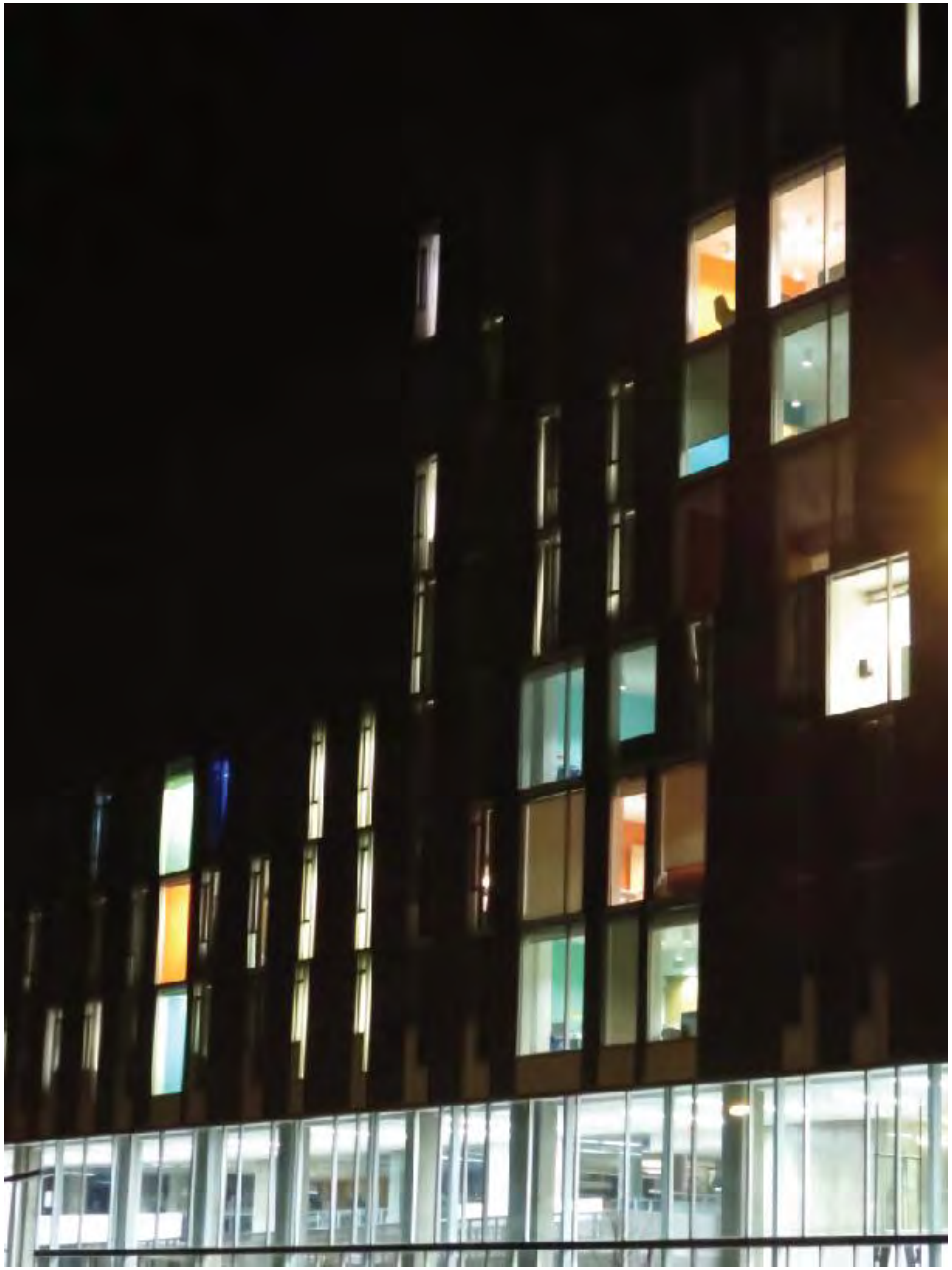


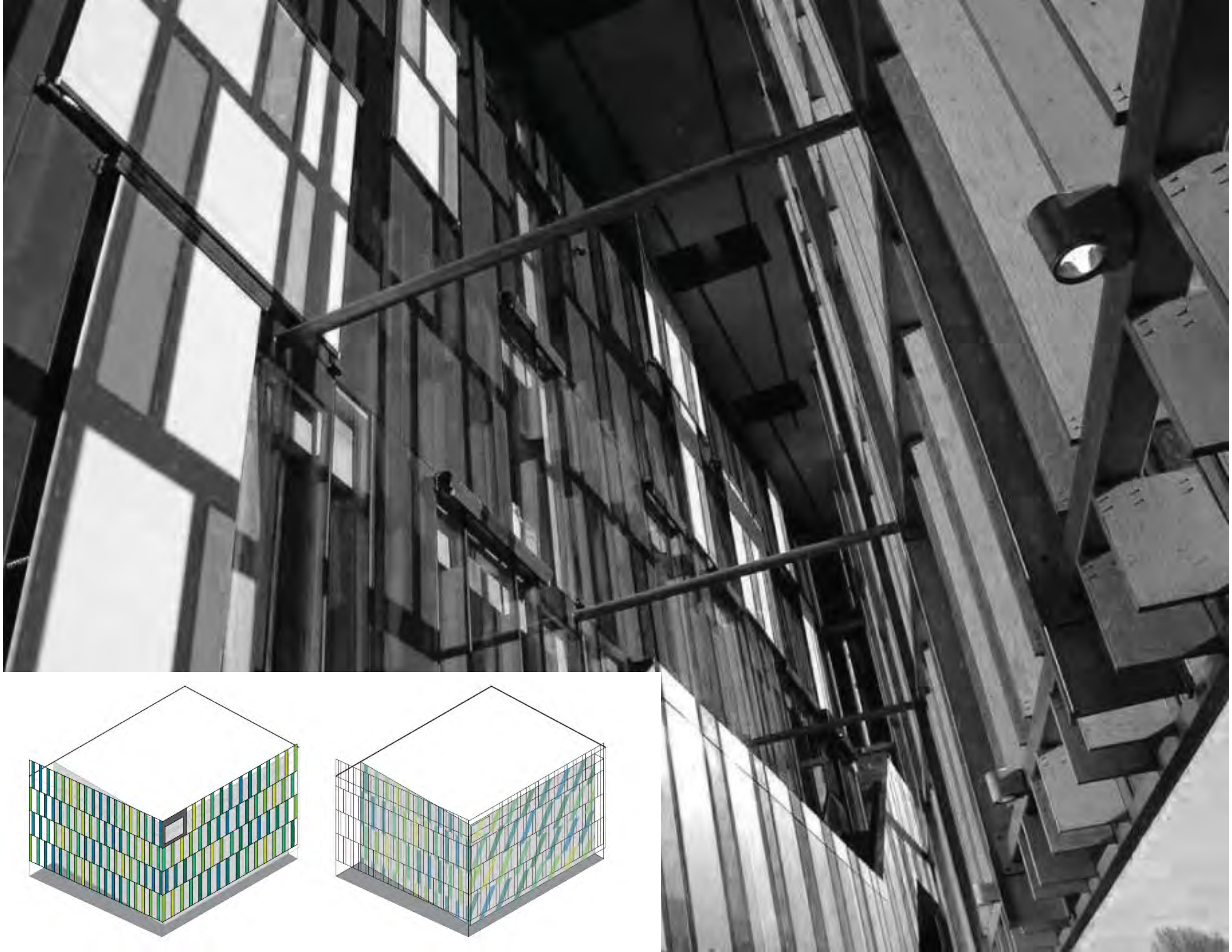




Checkpoint Energie

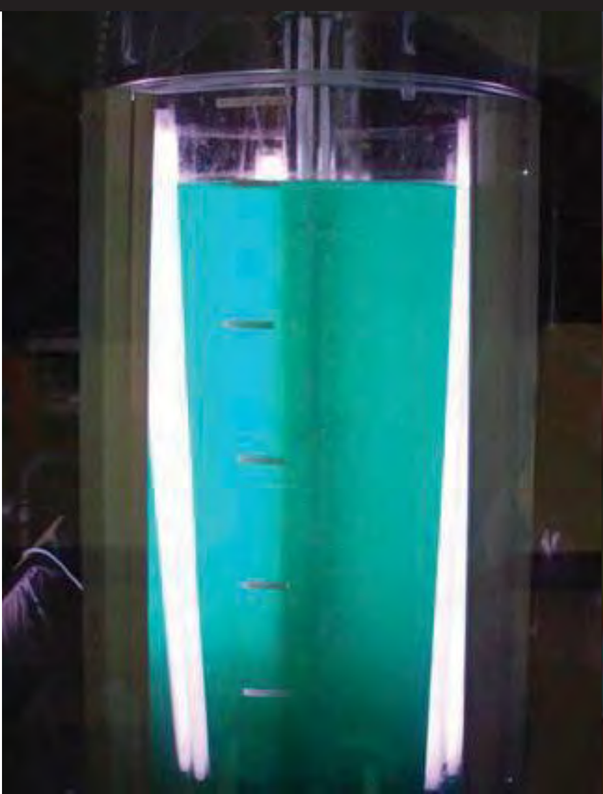




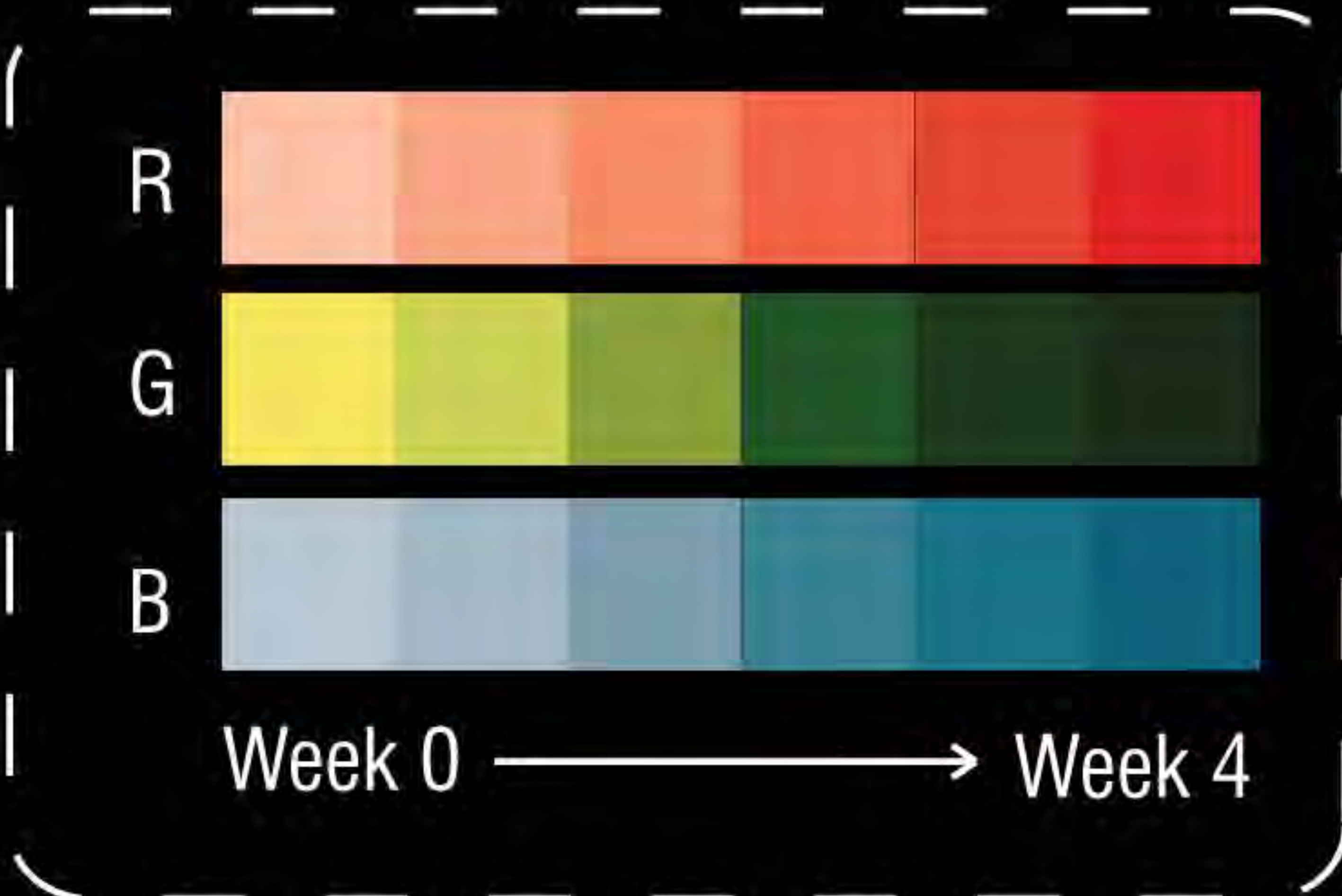


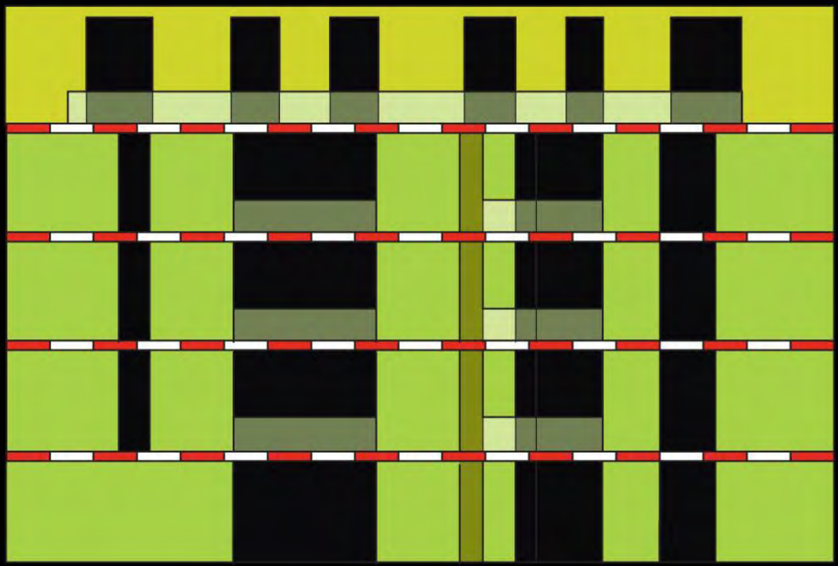
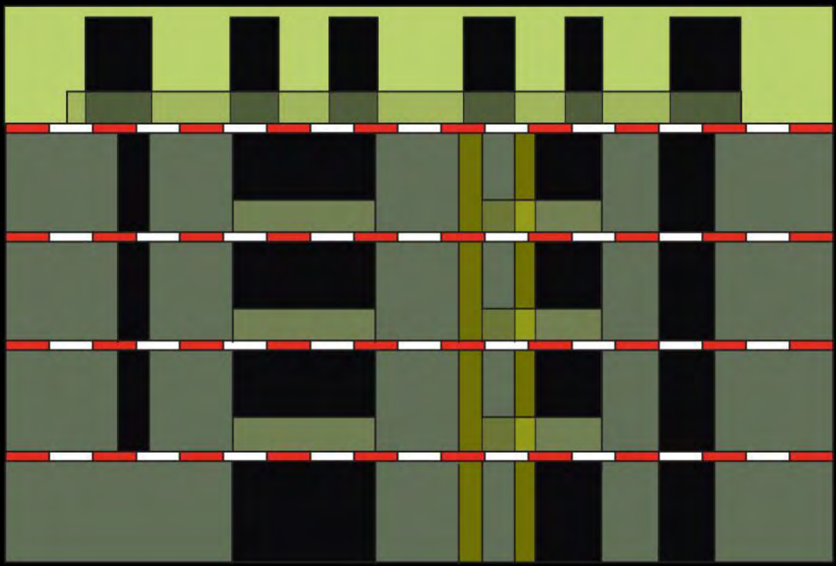
algae photobioreactors

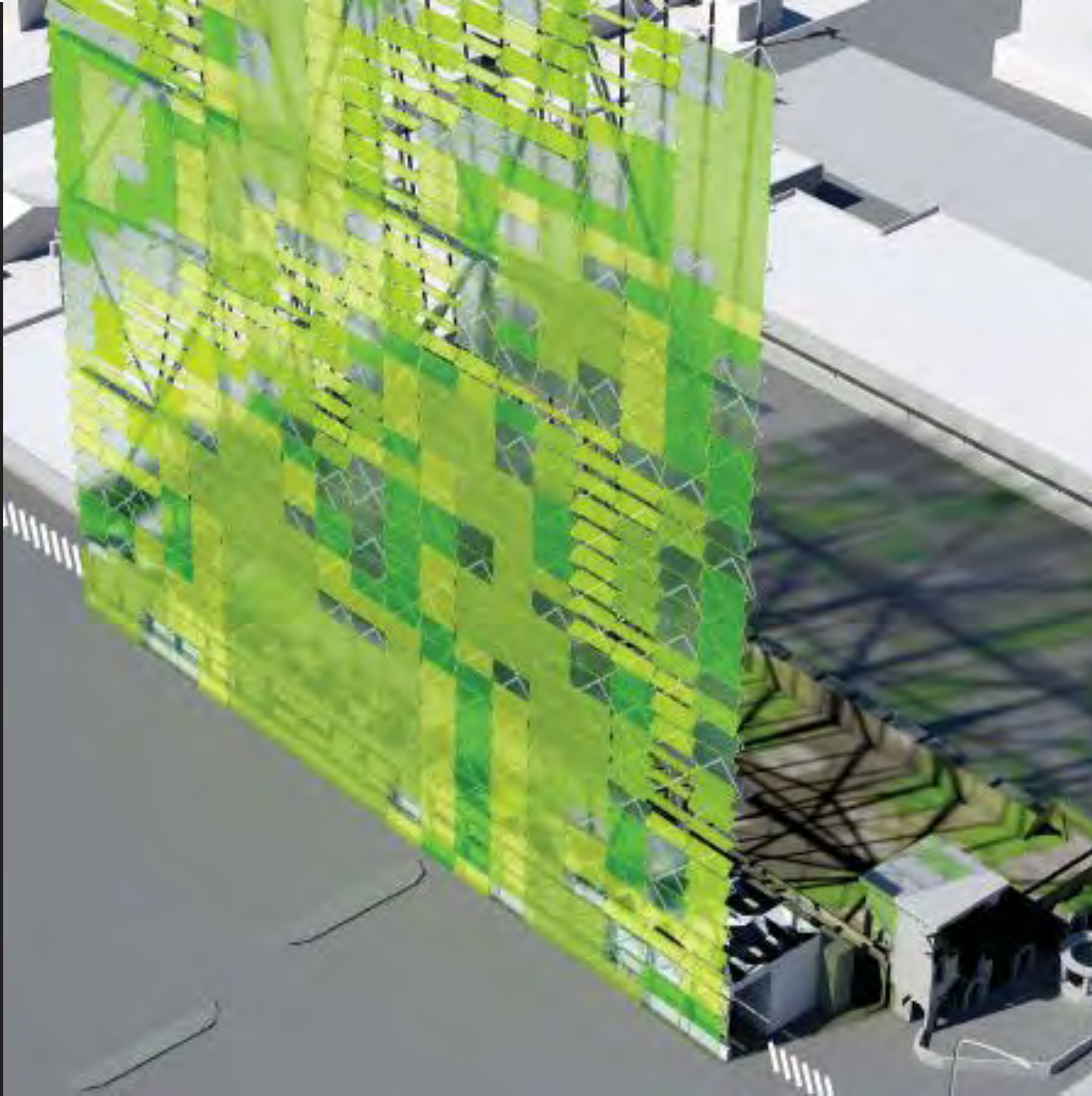


algae photobioreactors

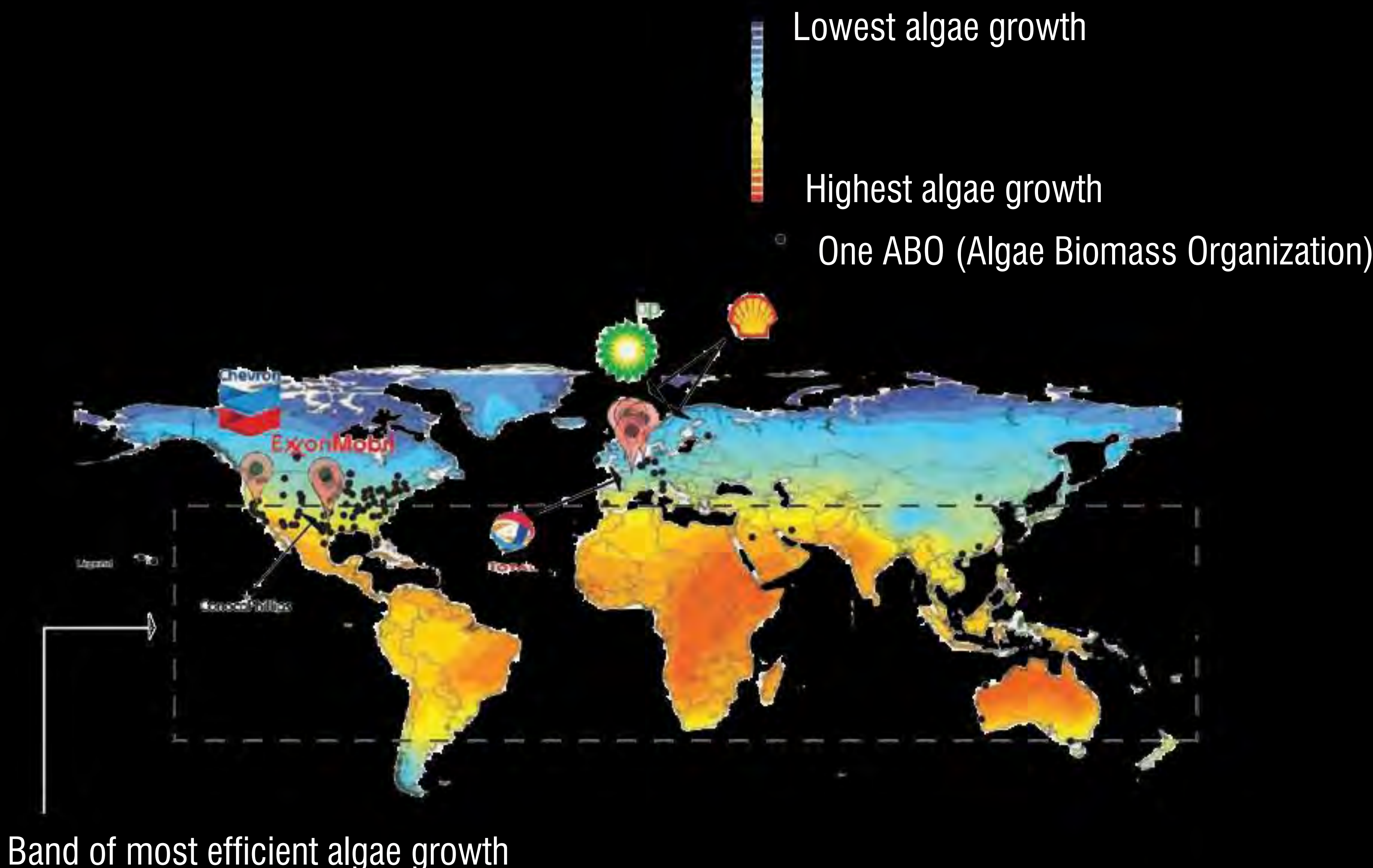

R
G
B
Week 0
Week 4



CONTENTION

When architecture can move us both sustainably and aesthetically, it resonates deeper than technology or beauty independently.

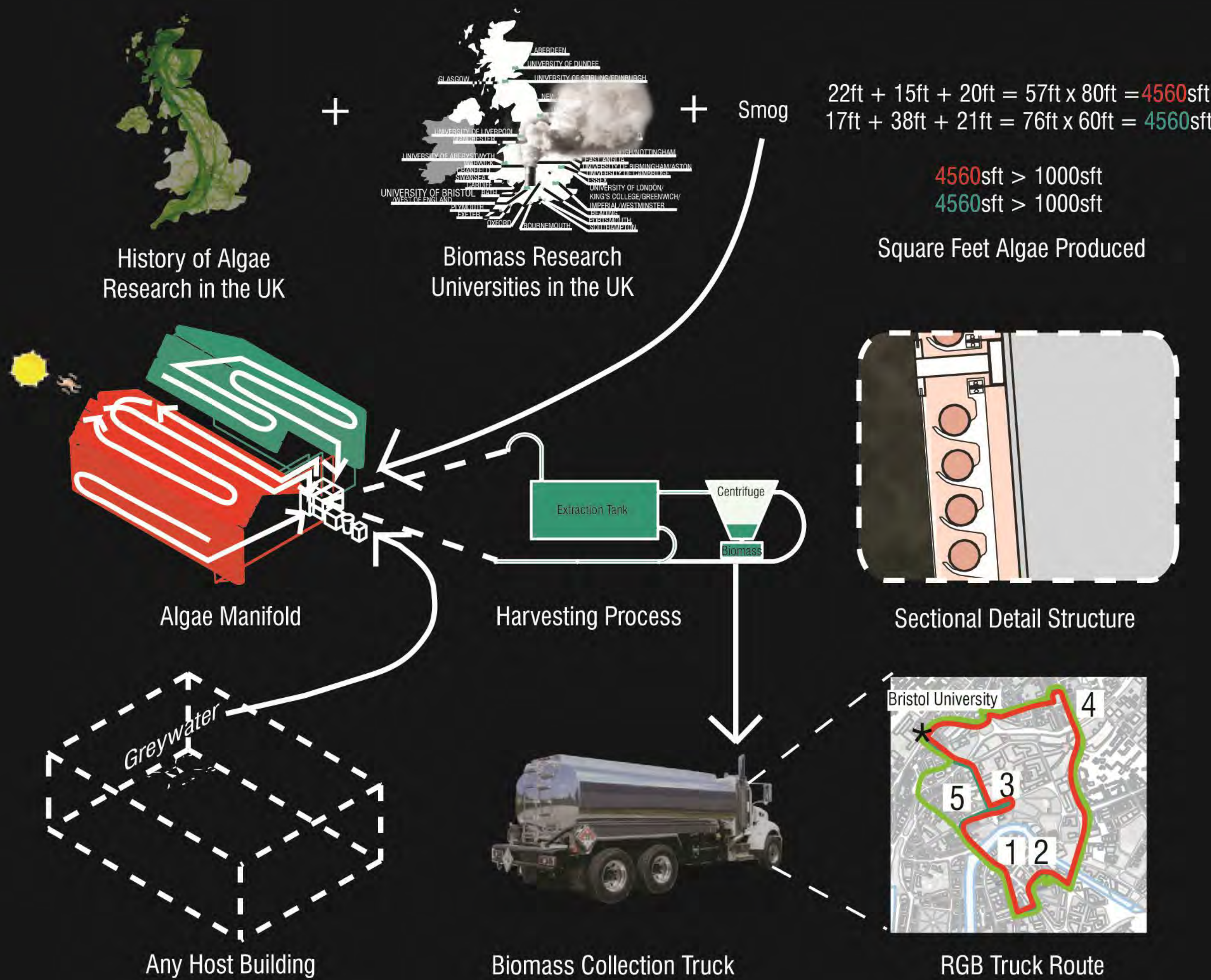


Location of Oil Majors Headquarters Compared to Optimal Algae Growth

Half of ABO are not in the most efficient algae growth band, they are near universities

Algae Research Faclities

Algae Research Facilities Near Major CO2 Industry


ABERDEEN
UNIVERSITY OF DUNDEE
GLASGOW
UNIVERSITY OF STIRLING/EDINBURGH
UNIVERSITY OF LIVERPOOL
MANCHESTER
UNIVERSITY OF ABERYSTWYTH
WARWICK
SWANSEA
CARDIFF
UNIVERSITY OF BRISTOL
/WEST OF ENGLAND
BATH
PLYMOUTH
EXETER
OXFORD
BOURNEMOUTH
EAST ANGLIA
UNIVERSITY OF BIRMINGHAM/ASTON
UNIVERSITY OF CAMBRIDGE
ESSEX
UNIVERSITY OF LONDON/
KING'S COLLEGE/GREENWICH/
IMPERIAL/WESTMINSTER
READING
PORTSMOUTH
SOUTHAMPTON
History of Algae Research in the UK
+
Biomass Research Universities in the UK
+
Smog
22ft + 15ft + 20ft = 57ft x 80ft = 4560sft
17ft + 38ft + 21ft = 76ft x 60ft = 4560sft
4560sft > 1000sft
4560sft > 1000sft
Square Feet Algae Produced
Extraction Tank
Centrifuge
Biomass
Algae Manifold
Harvesting Process
Sectional Detail Structure
Greywater
Bristol University
4
3
5
1
2
Any Host Building
Biomass Collection Truck
RGB Truck Route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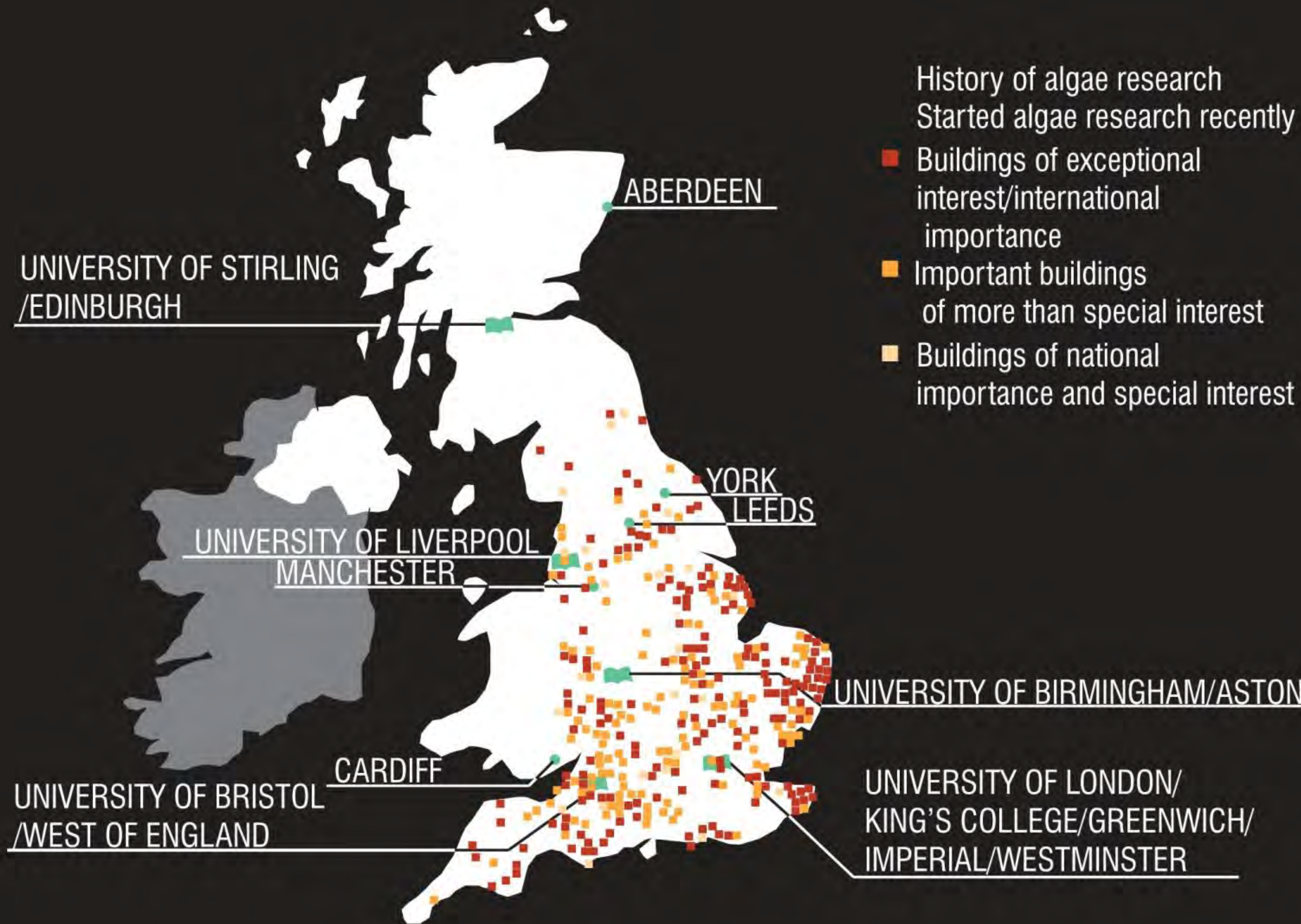
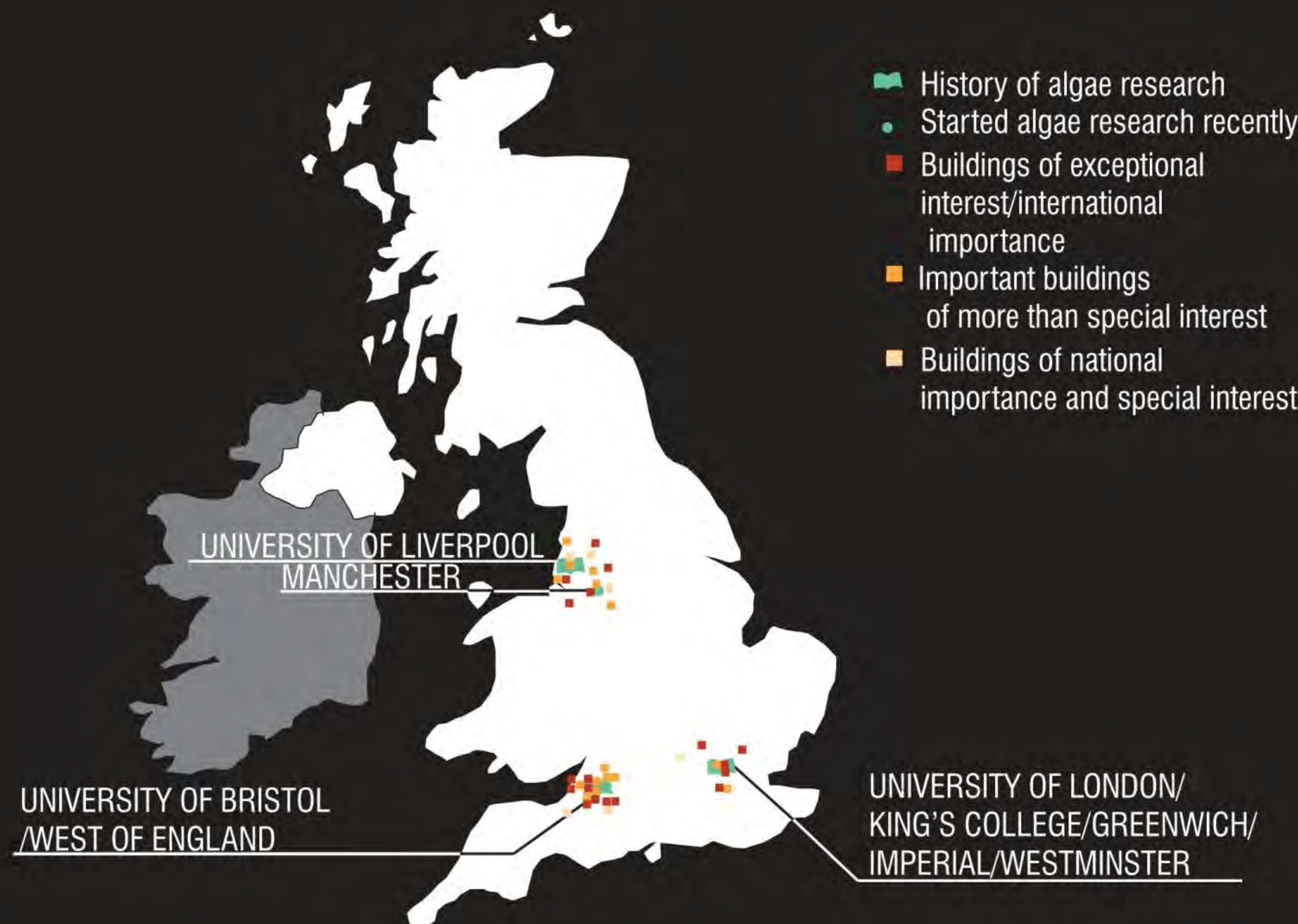
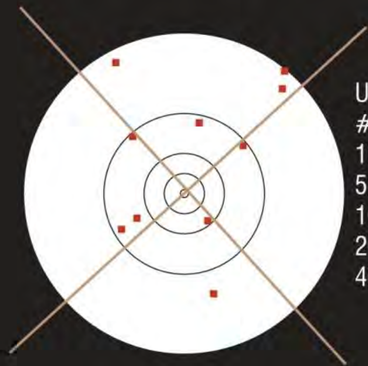
THE CHURCHES CONSERVATION TRUST
The national charity saving historic churches at risk
Search our site
Days out
Our churches
What's on
About us
How to help
Shop
Donate
champing
Bored with Glamping? Champing is the latest trend in camping chic.
→ A 2 day package
→ Picturesque Aldwincle, Northamptonshire
→ Canoeing and candlelight
Champing
Camping in churches
Bristol lecture
The next bus to Imber
Inspiring days out
Visit a church this spring
Churches of WW1
Share your photos and stories
Find a church
You can find our churches in one of three ways - search via interactive map, type in a postcode or location, view our churches in a list.
Search by map
Our interactive map allows you to easily locate all our churches together with other nearby attractions.
Search by postcode, place or name of church
Type in any postcode or location to find churches nearby.
Search by location
Crafts skills for the future
The regeneration of All Souls Bolton is well underway. This short film by the Media Trust tells the story of six bursary placements given expert training in traditional craft skills.



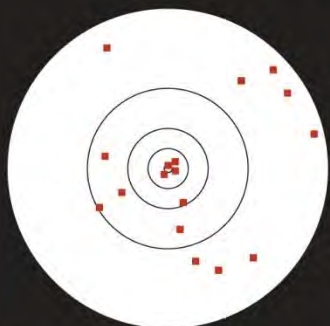
Algae Research Faclities And CCT Churches



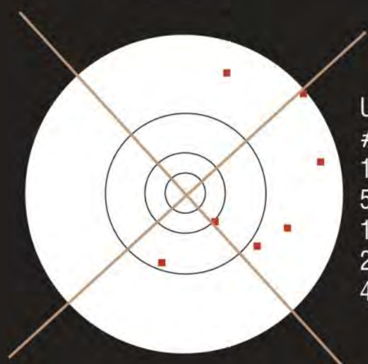
Four Potential Sites Near CCT Churches



UNIVERSITY OF MANCHEST
# of Churches within:
1km: 0
5km: 0
10km: 1
20km: 6
40km: 10



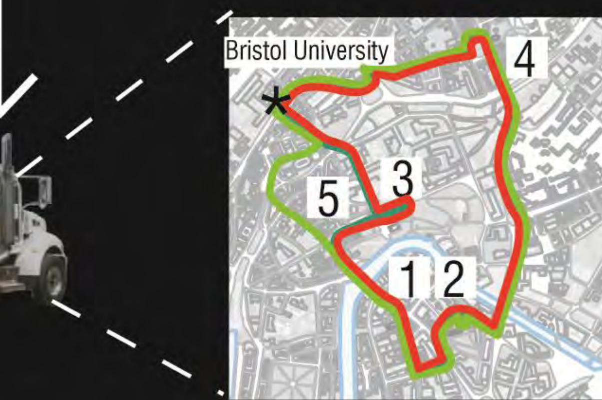
UNIVERSITY OF BRISTOL
# of Churches within:
1km: 1
5km: 4
10km: 5
20km: 9
40km: 17



UNIVERSITY OF LONDON
# of Churches within:
1km: 0
5km: 0
10km: 0
20km: 2
40km: 7

UNIVERSITY OF LIVERPOOL
# of Churches within:
1km: 0
5km: 0
10km: 1
20km: 2
40km: 7

Biomass Collection Truck

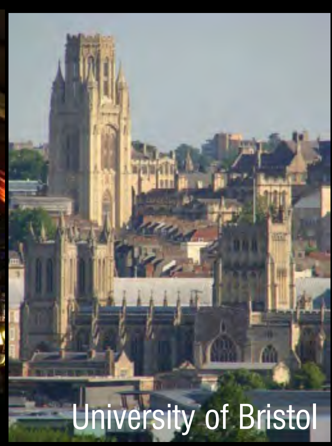


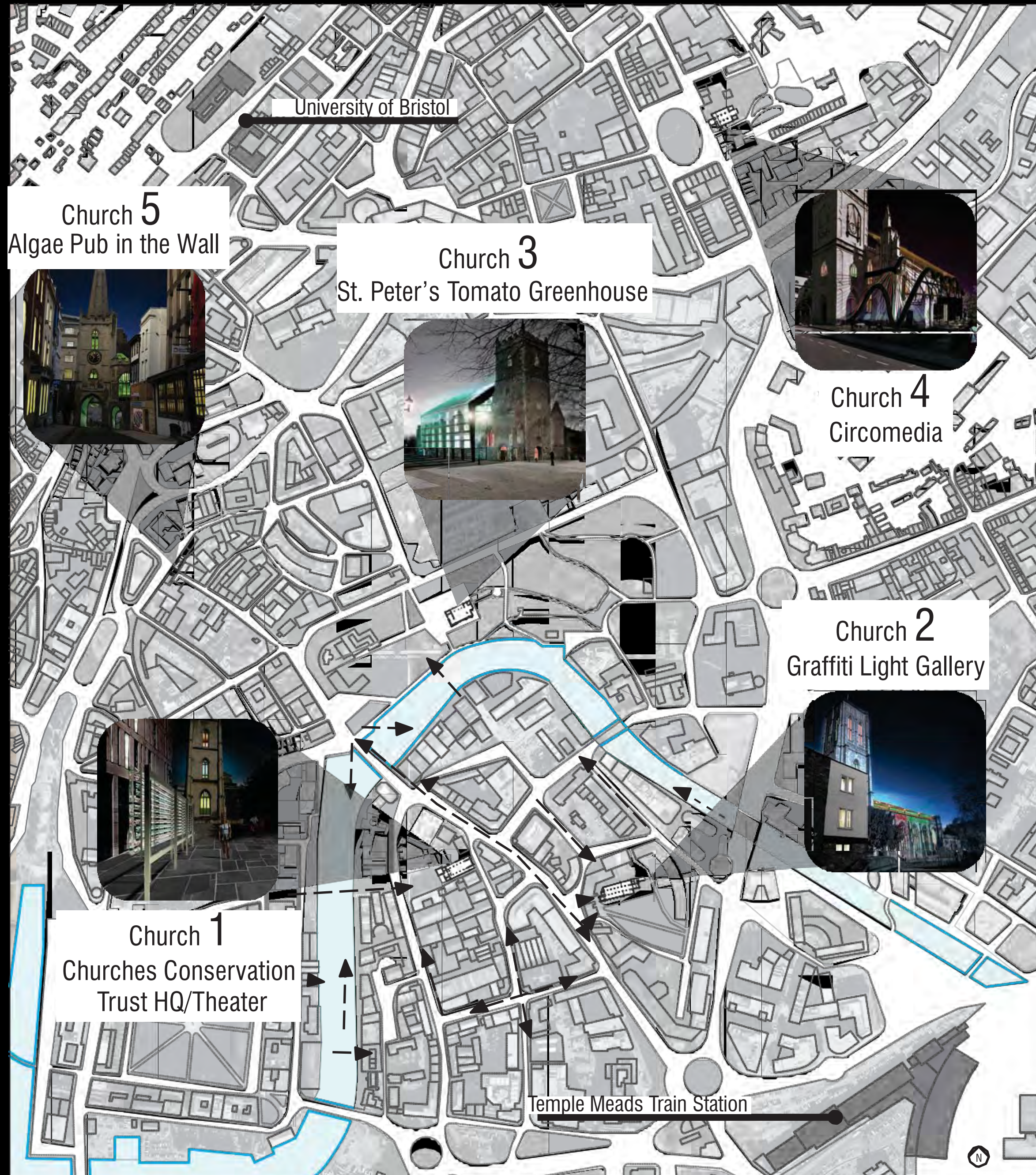
RGB Truck Route


Idea Store Beacon at Night London, UK


Revitalized Post-Industrial Waterfront Bristol, UK


Church as Pub London, UK

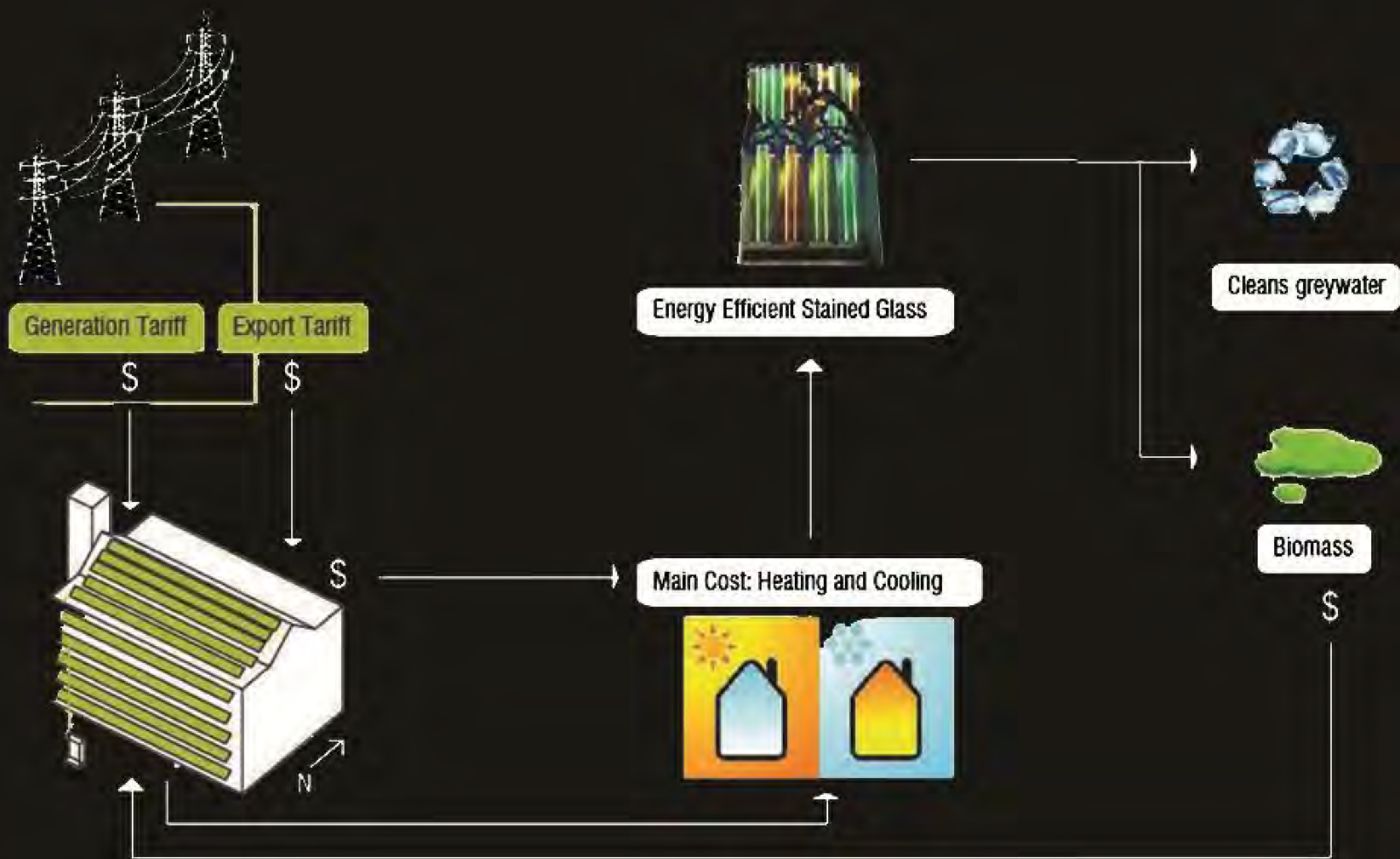

University of Bristol

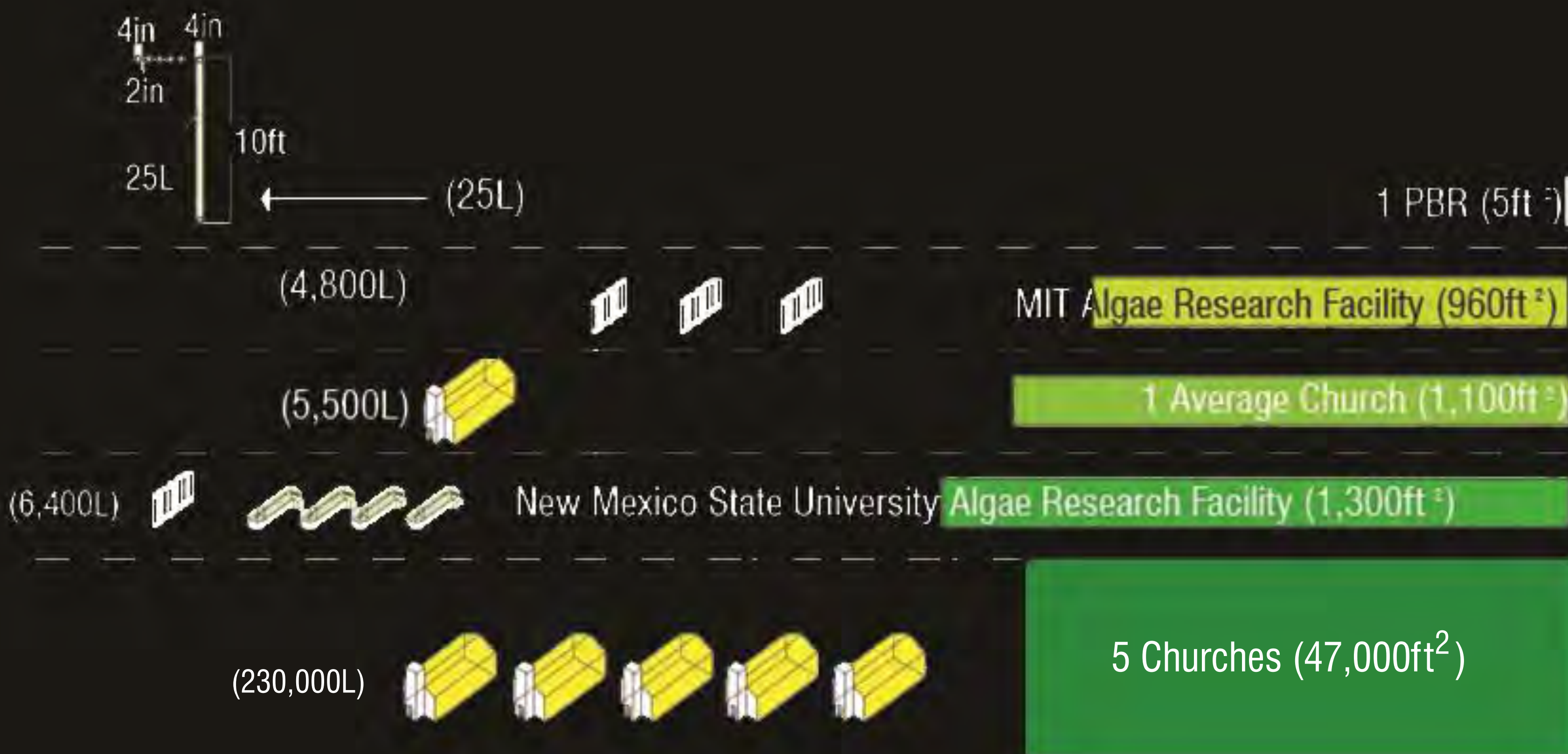


1" = 200' Site Map

Historic View Corridors Downtown

5 Church Sites as Beasons Bristol, UK


Generation Tariff
Export Tariff
$
$
$
N
Energy Efficient Stained Glass
Main Cost: Heating and Cooling
Cleans greywater
Biomass
$

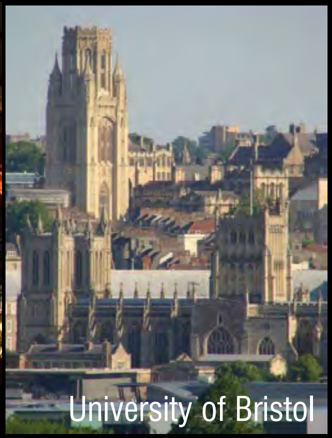


4in
4in
2in
10ft
25L
(25L)
1 PBR (5ft²)
(4,800L)
MIT Algae Research Facility (960ft²)
(5,500L)
1 Average Church (1,100ft²)
(6,400L)
New Mexico State University Algae Research Facility (1,300ft²)
(230,000L)
5 Churches (47,000ft²)

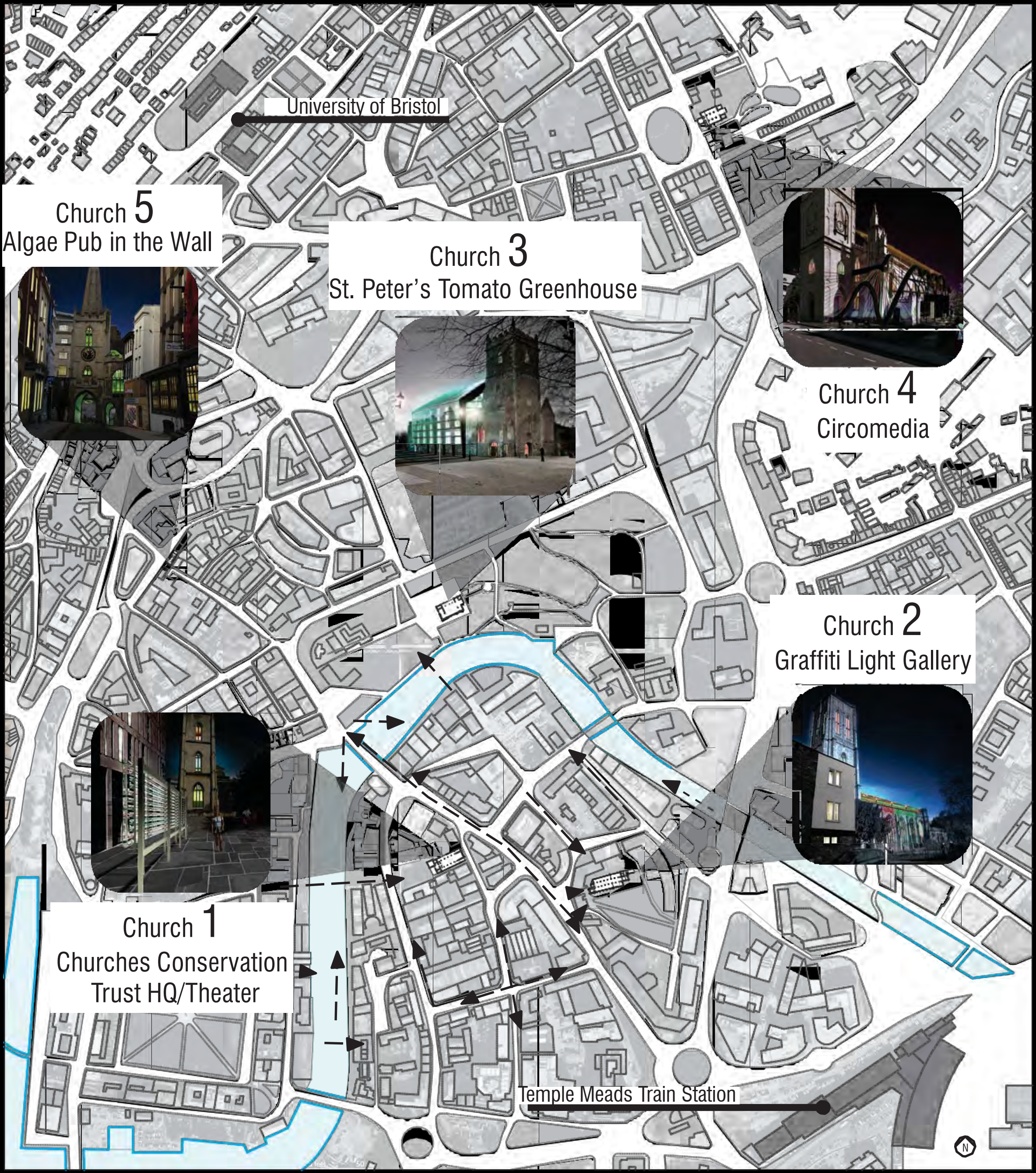
Idea Store Beacon at Night London, UK

Revitalized Post-Industrial Waterfront Bristol, UK

Church as Pub London, UK



University of Bristol

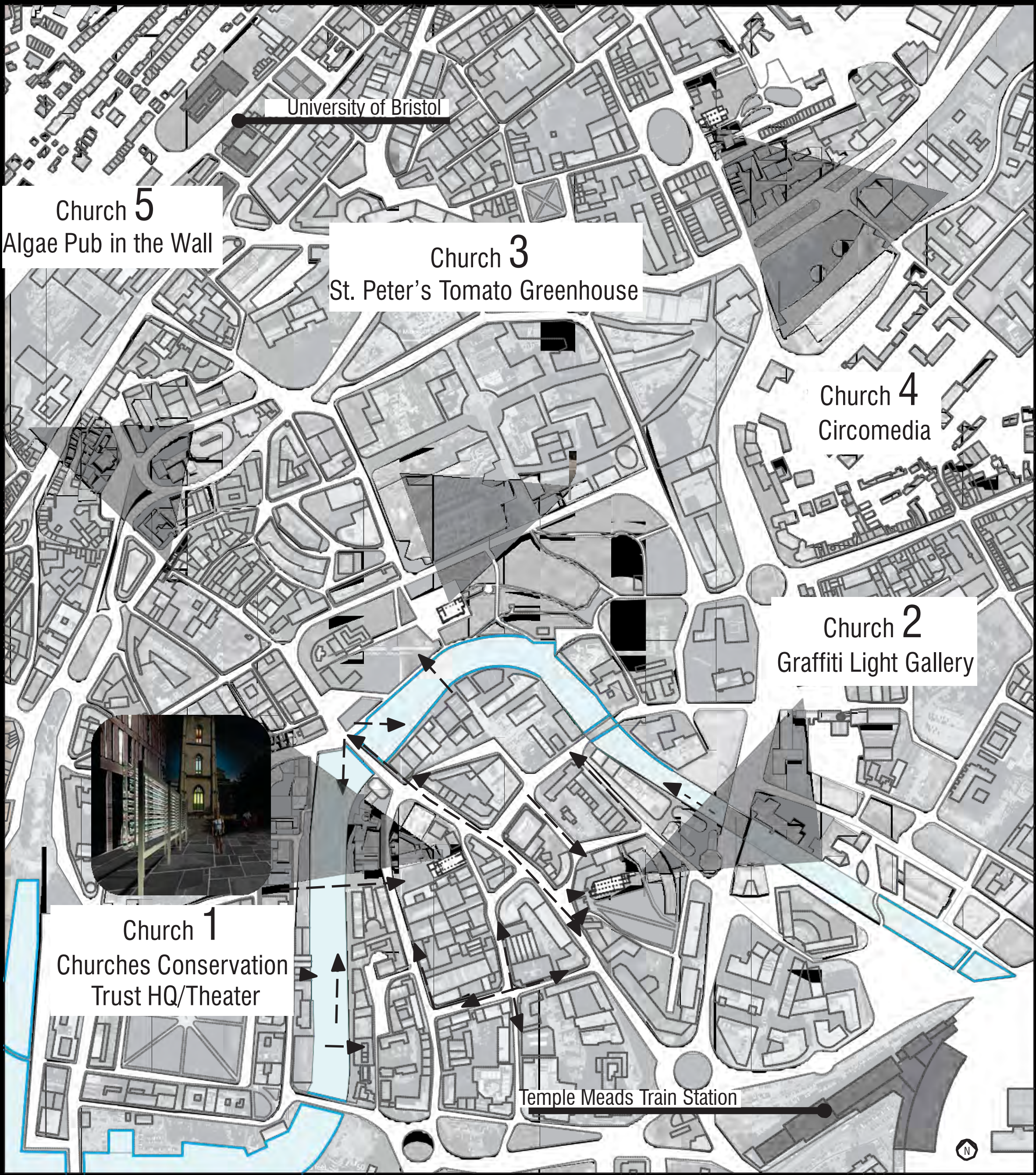


1" = 200' Site Map

Historic View Corridors Downtown

5 Church Sites as Beasons Bristol, UK

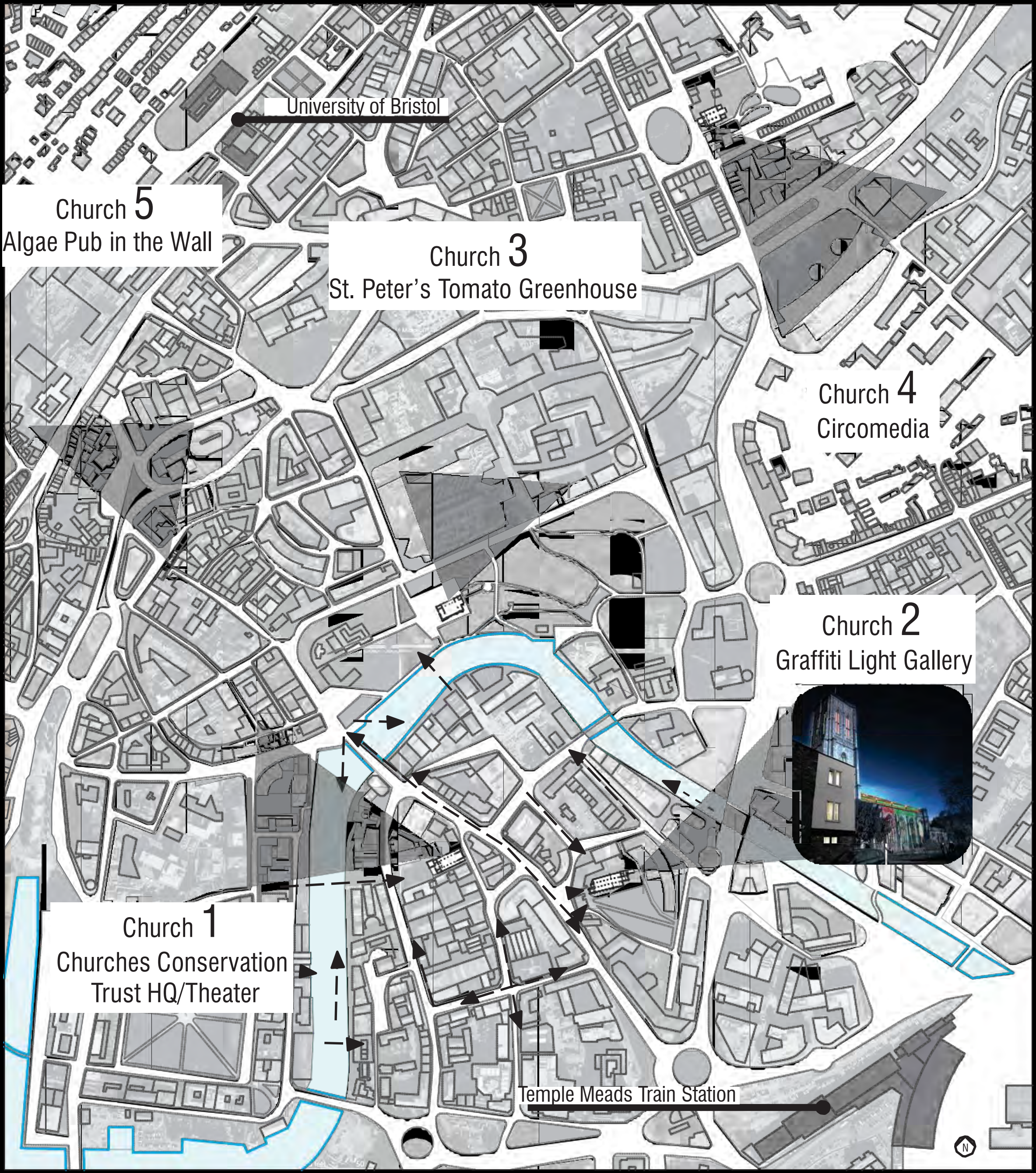
Church 1
Churches Conservation Trust HQ



1" = 200' Site Map

Historic View Corridors Downtown

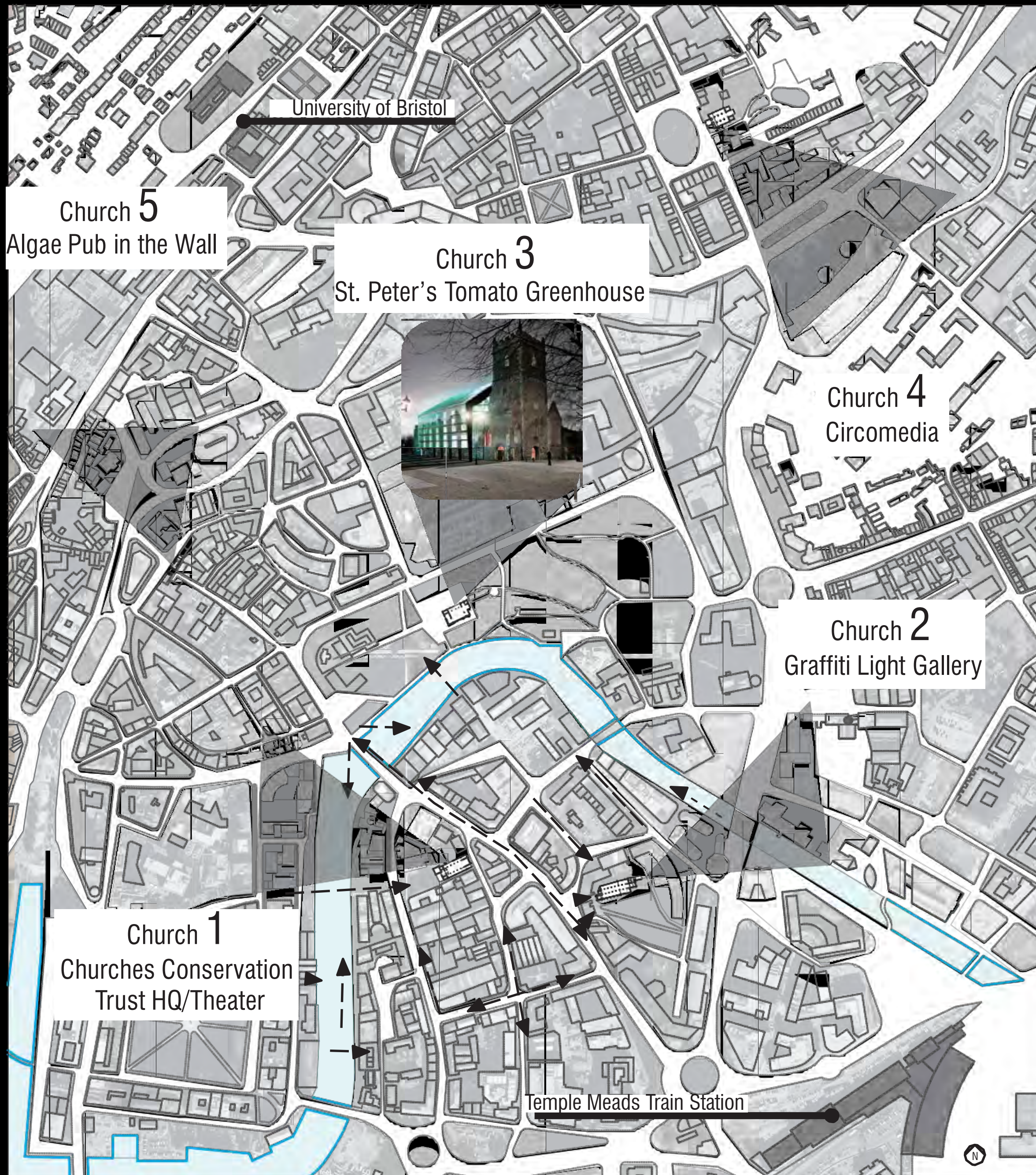
Church 2
Graffiti Light Gallery



1" = 200' Site Map

Historic View Corridors Downtown

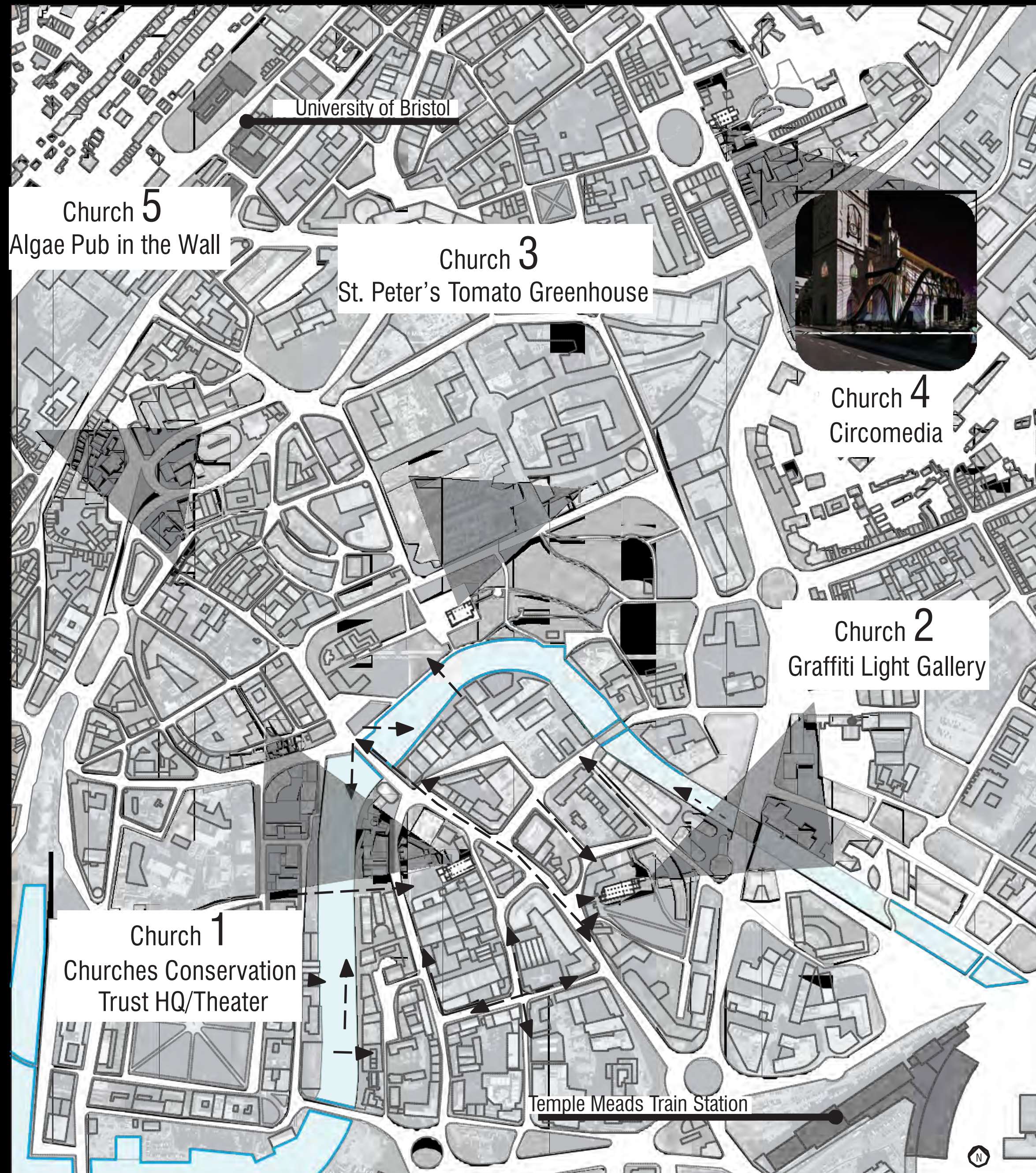
Church 3
St. Pete's Tomato Greenhouse



1" = 200' Site Map

Historic View Corridors Downtown

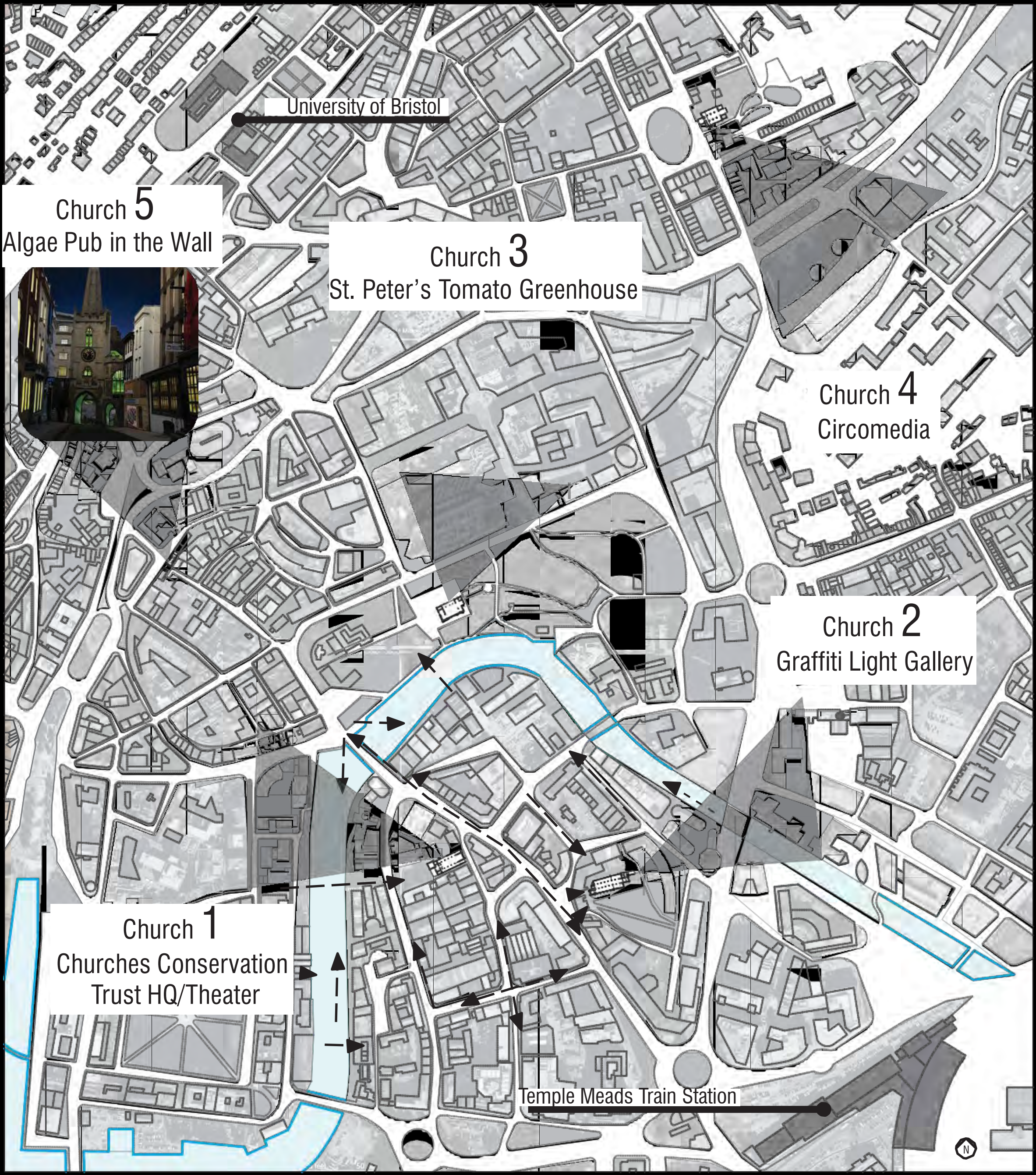
Church 4
Circomedia



1" = 200' Site Map

Historic View Corridors Downtown

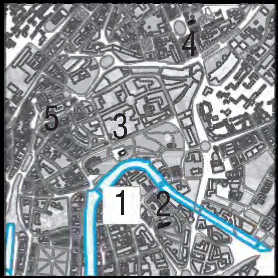
Church 5
Algae Pub
"In the Wall"

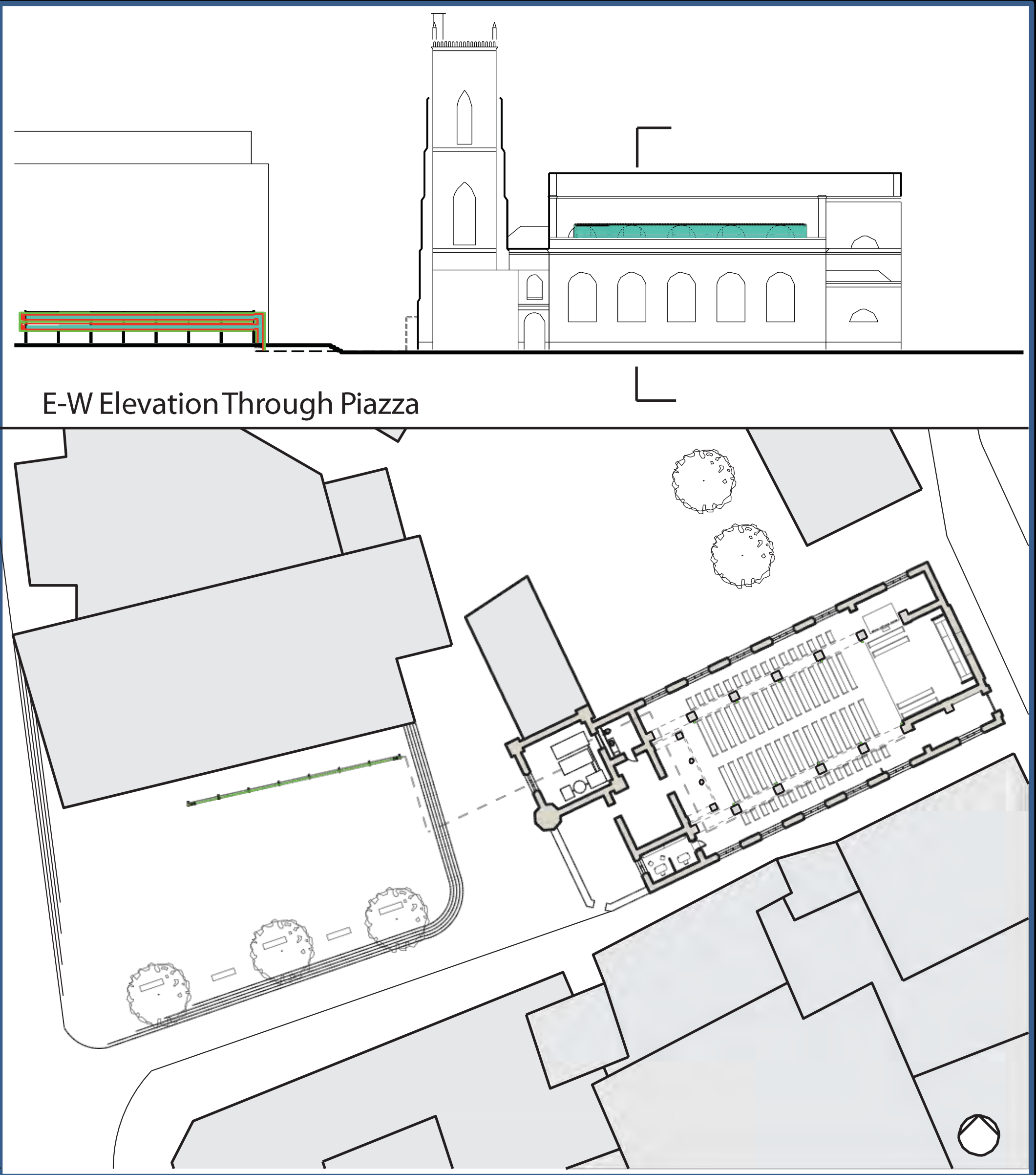


1" = 200' Site Map

Historic View Corridors Downtown

Church 1
Churches Conservation Trust HQ



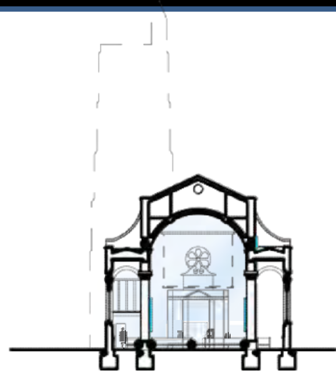


E-W Elevation Through Piazza

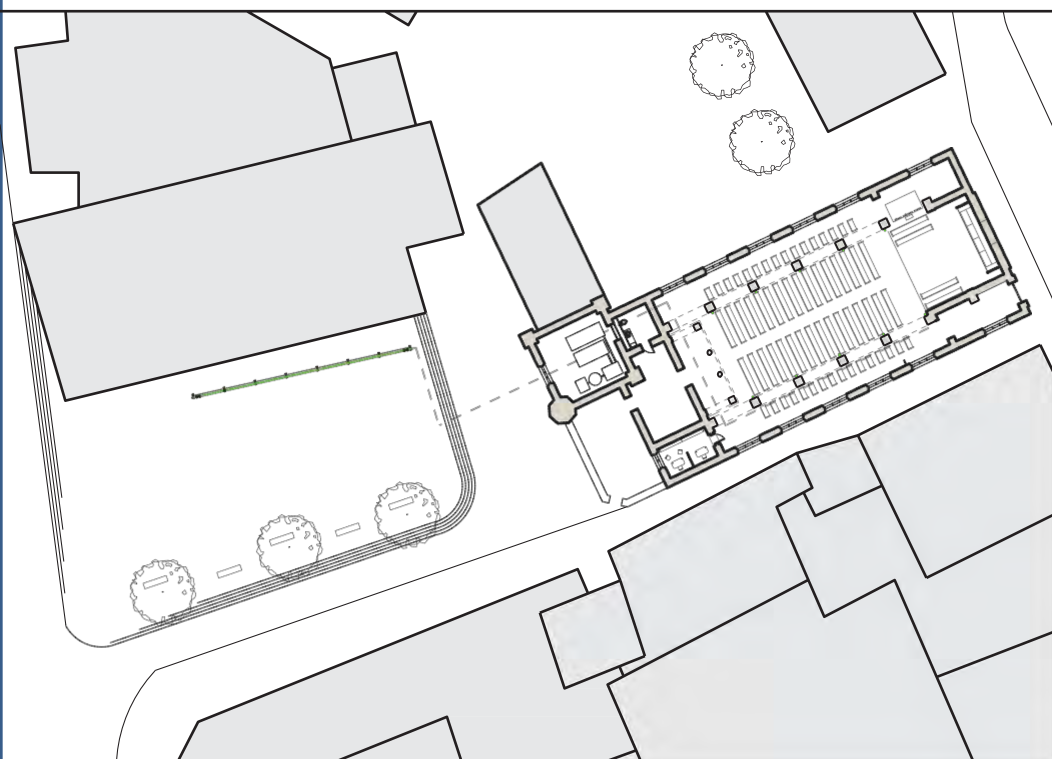
Site Ground Floor Plan

Nave Perspective Looking West

Church 1
Churches Conservation Trust HQ



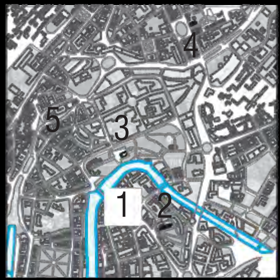
N-S Section of Algae Mimicking Northern Blue Light



Site Ground Floor Plan

Nave Perspective Looking West

Church 1
Churches Conservation Trust HQ

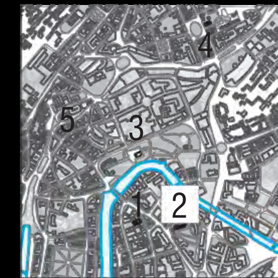


Introductory Algae Sculpture on northside of courtyard pre-harvest

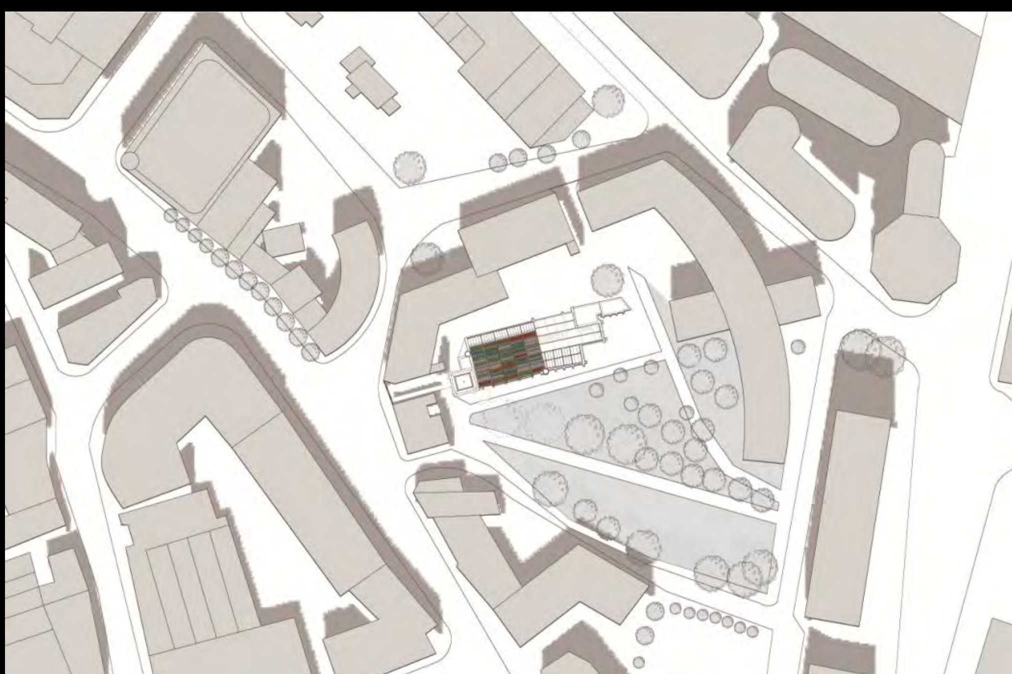
Introductory Algae Sculpture on northside of courtyard post-harvest

Church 2
Graffiti Light Gallery

Entry Perspective Looking East

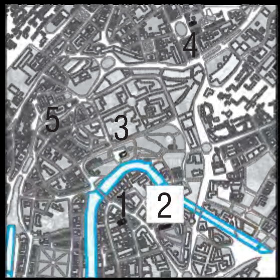


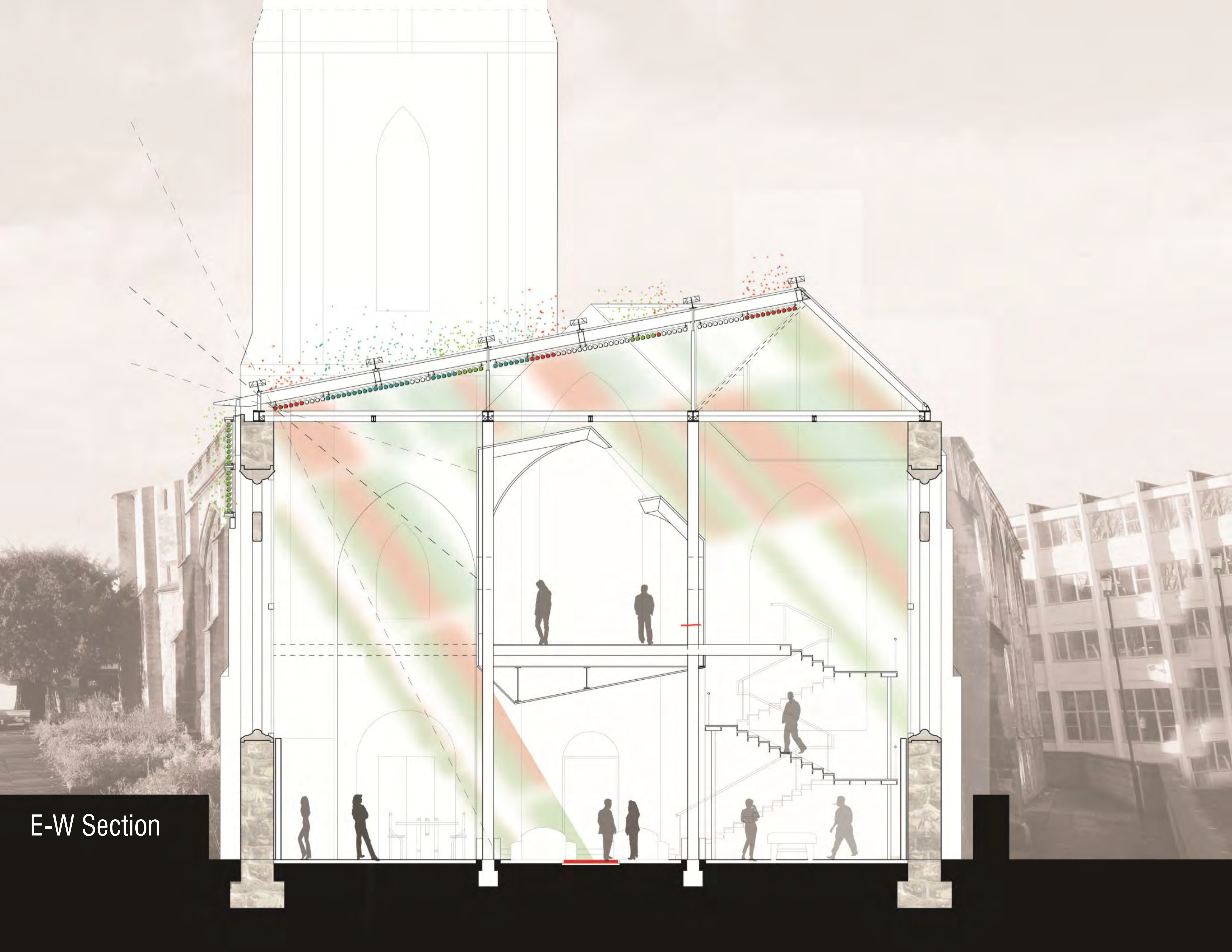
Temple Cathedral Crusader Stained Glass



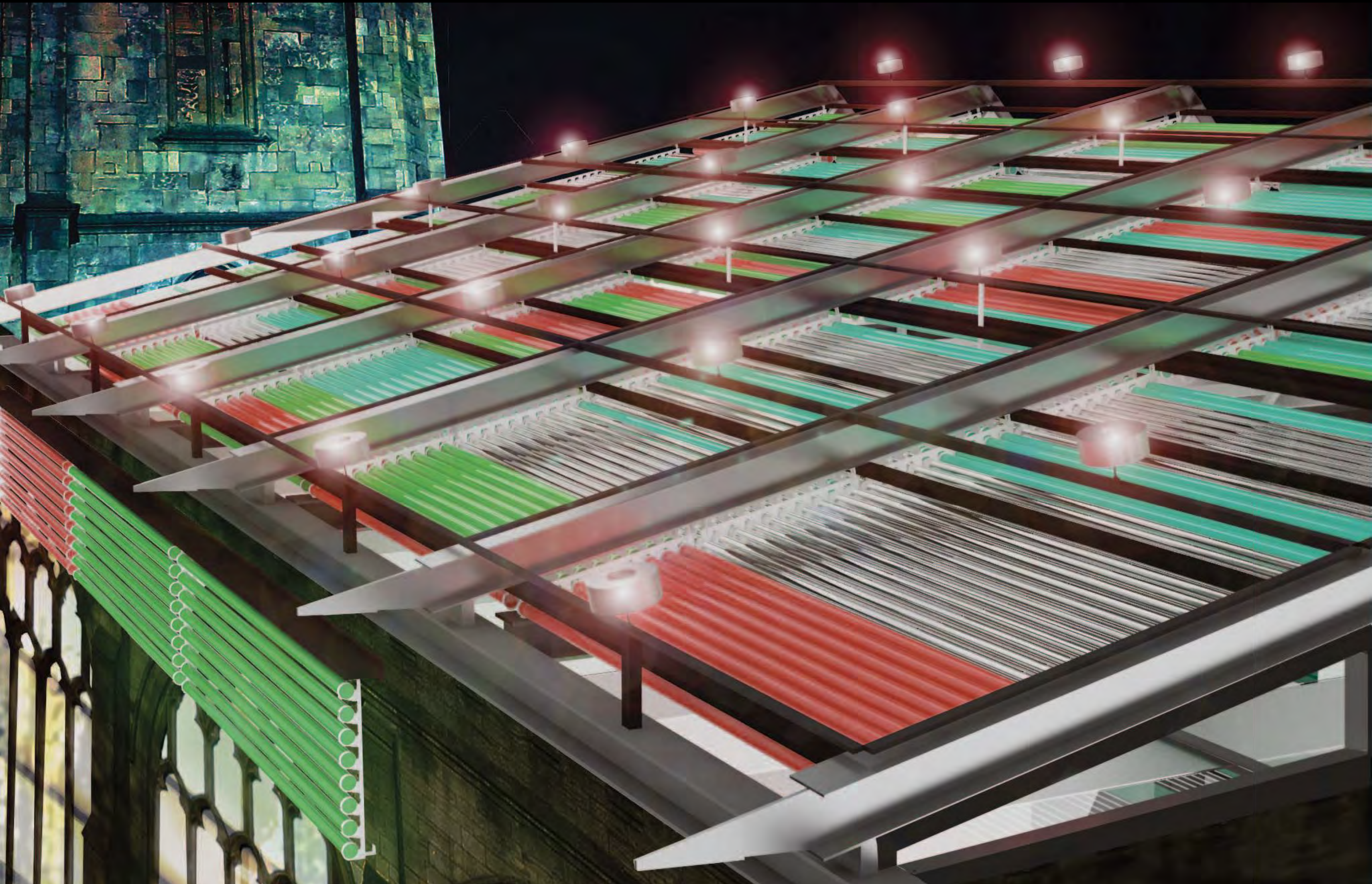
Site Roof Plan

Church 2
Graffiti Light Gallery



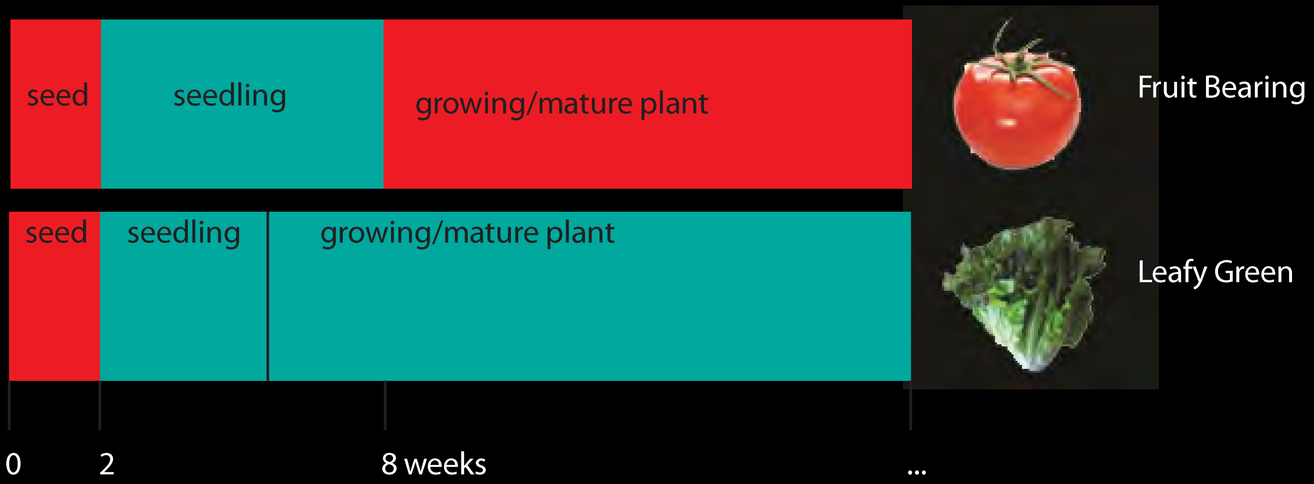


E-W Section

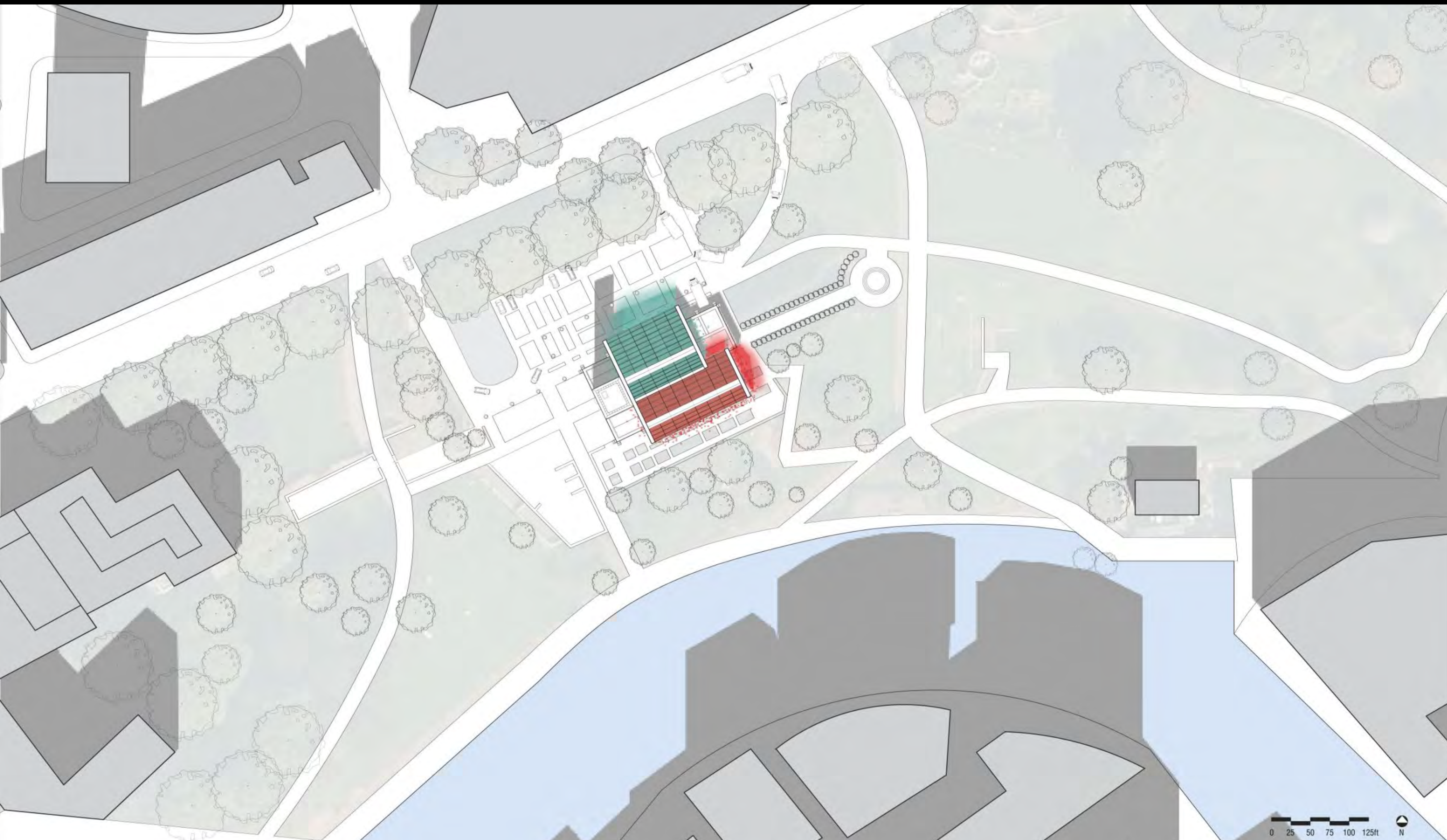


Church 3
Tomato Greenhouse

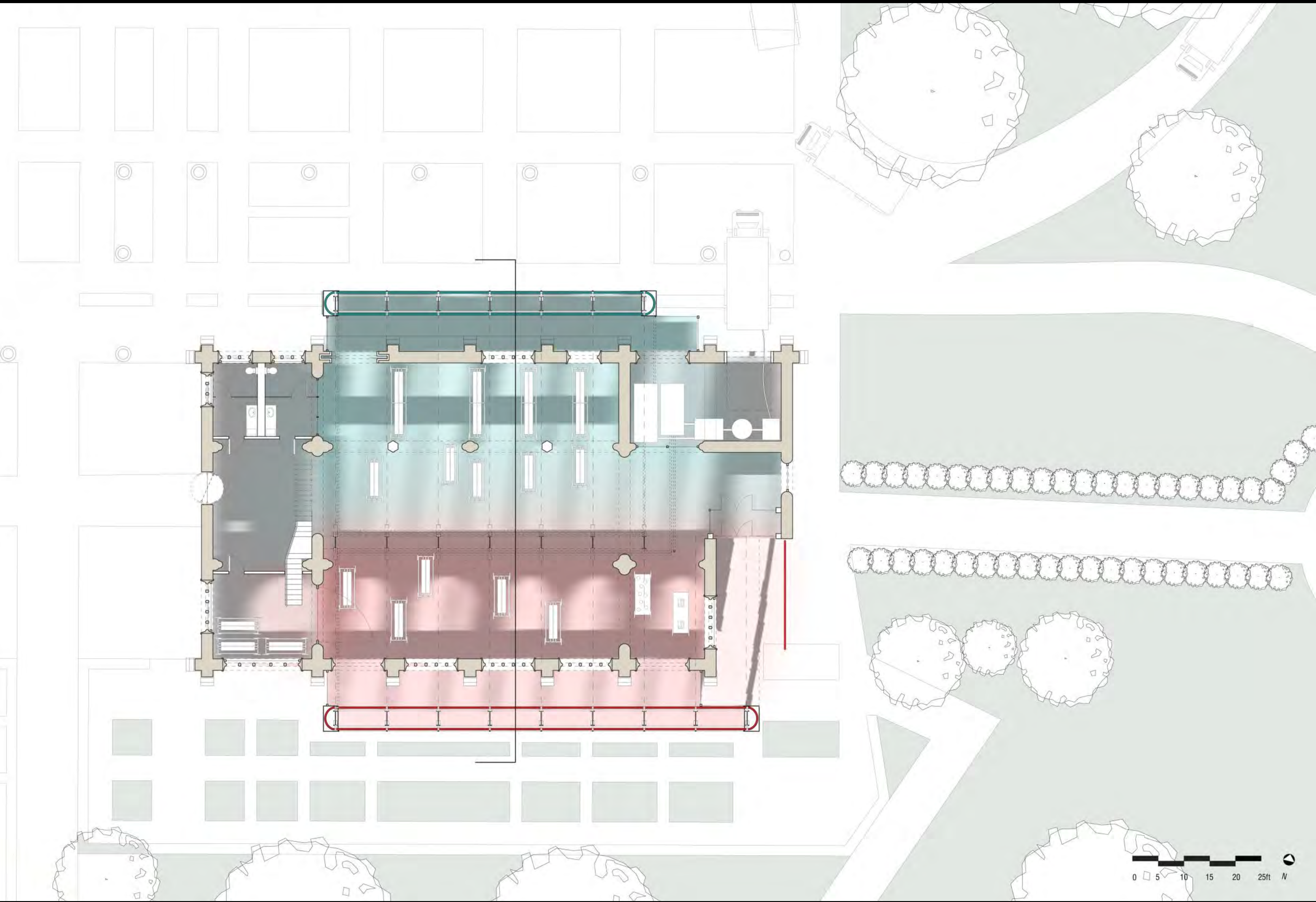
Lifecycle of 2 Types of Produce



Church 3
Tomato Greenhouse



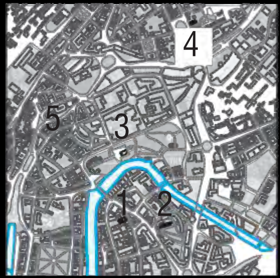
Site Roof Plan



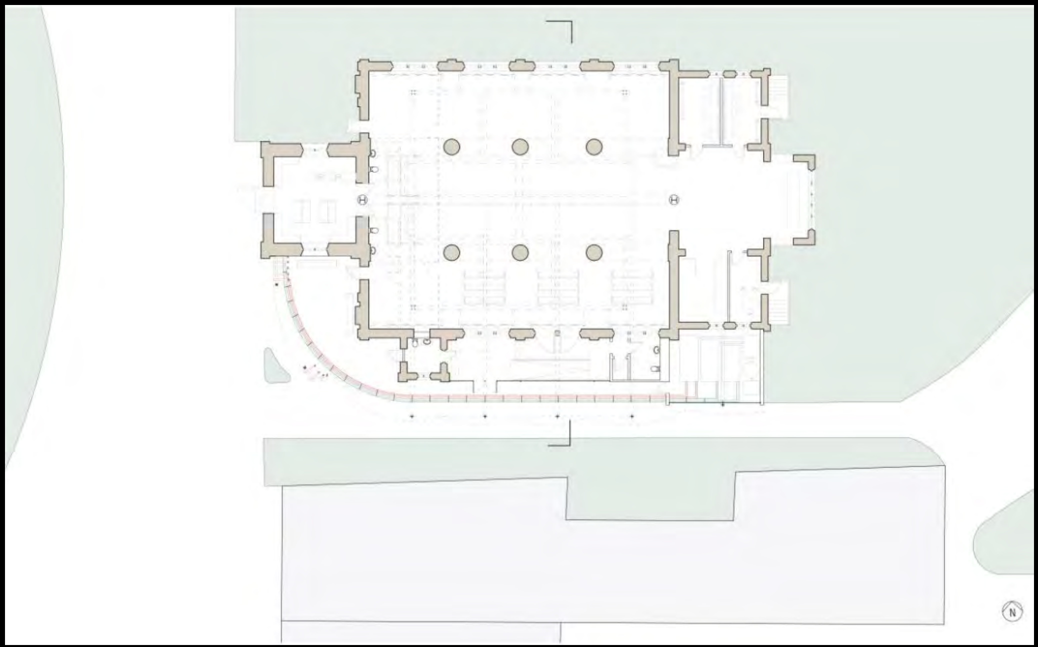
Ground Floor Plan

E-W Section

Church 4
Circomedia



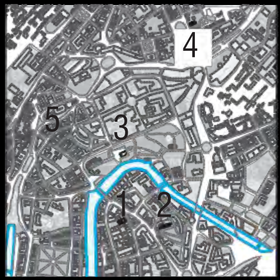
Red + White Circus Tent Inspiration

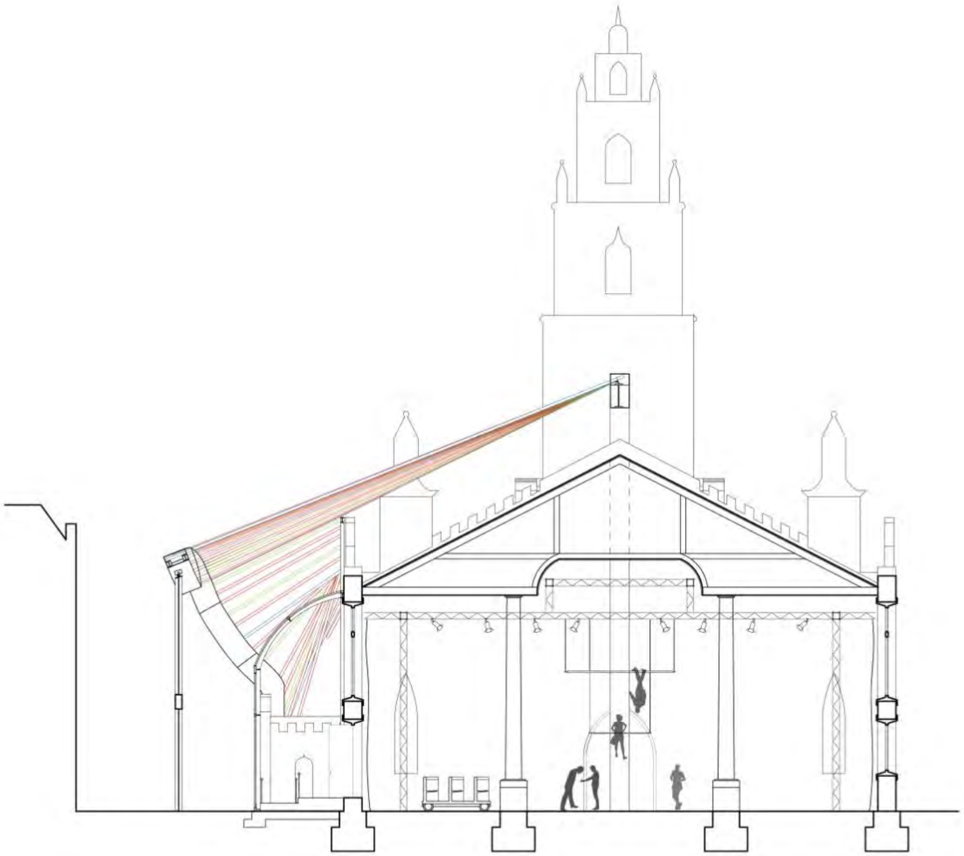


Ground Floor Plan

Nave Perspective Looking East

Church 4
Circomedia

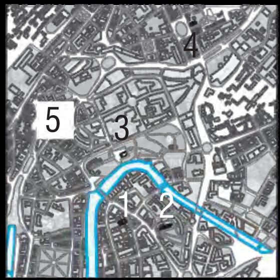




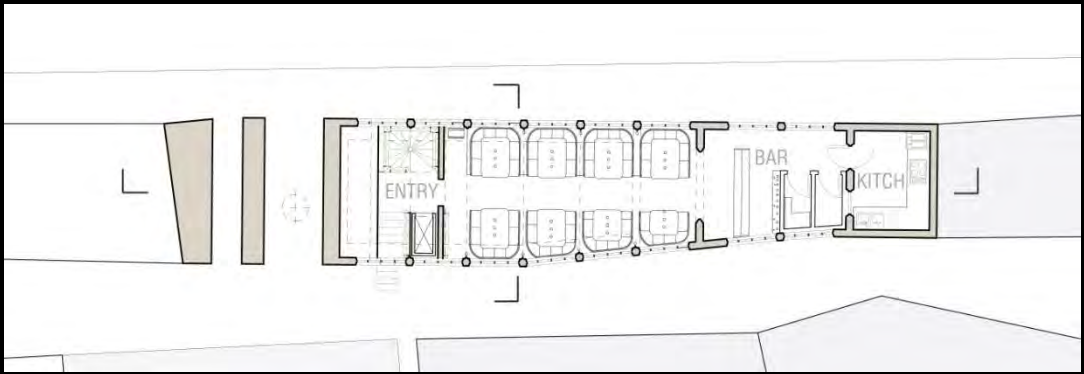
N-S Section through Algae Canopy

South Elevation of Algae Canopy

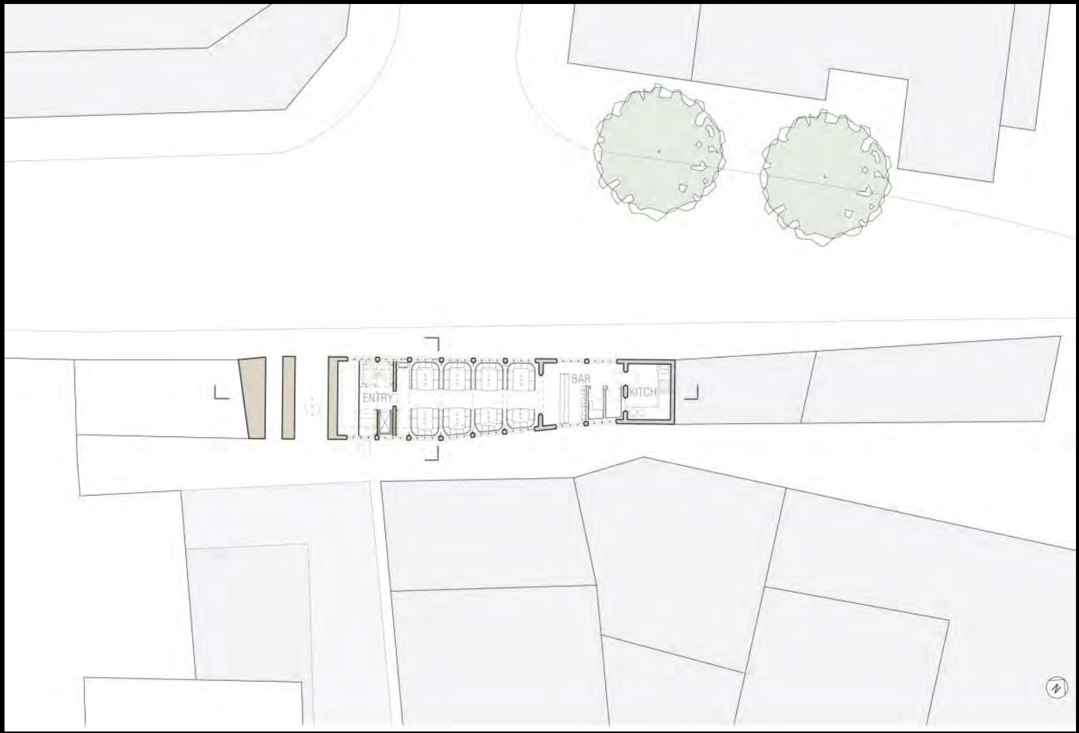
Church 5
Algae Pub 'In the Wall'



Nave Perspective Looking East



Ground Floor Plan Close-up



Ground Floor Plan

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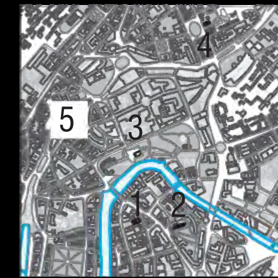
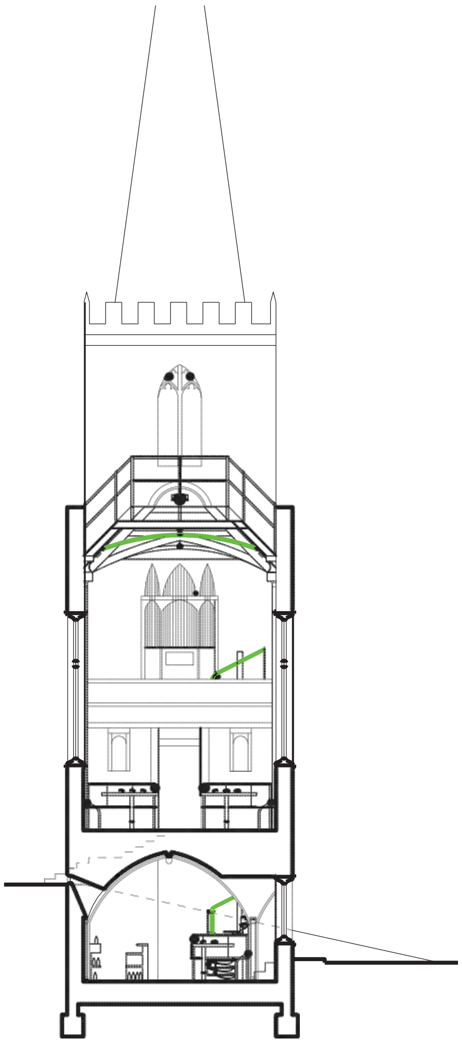
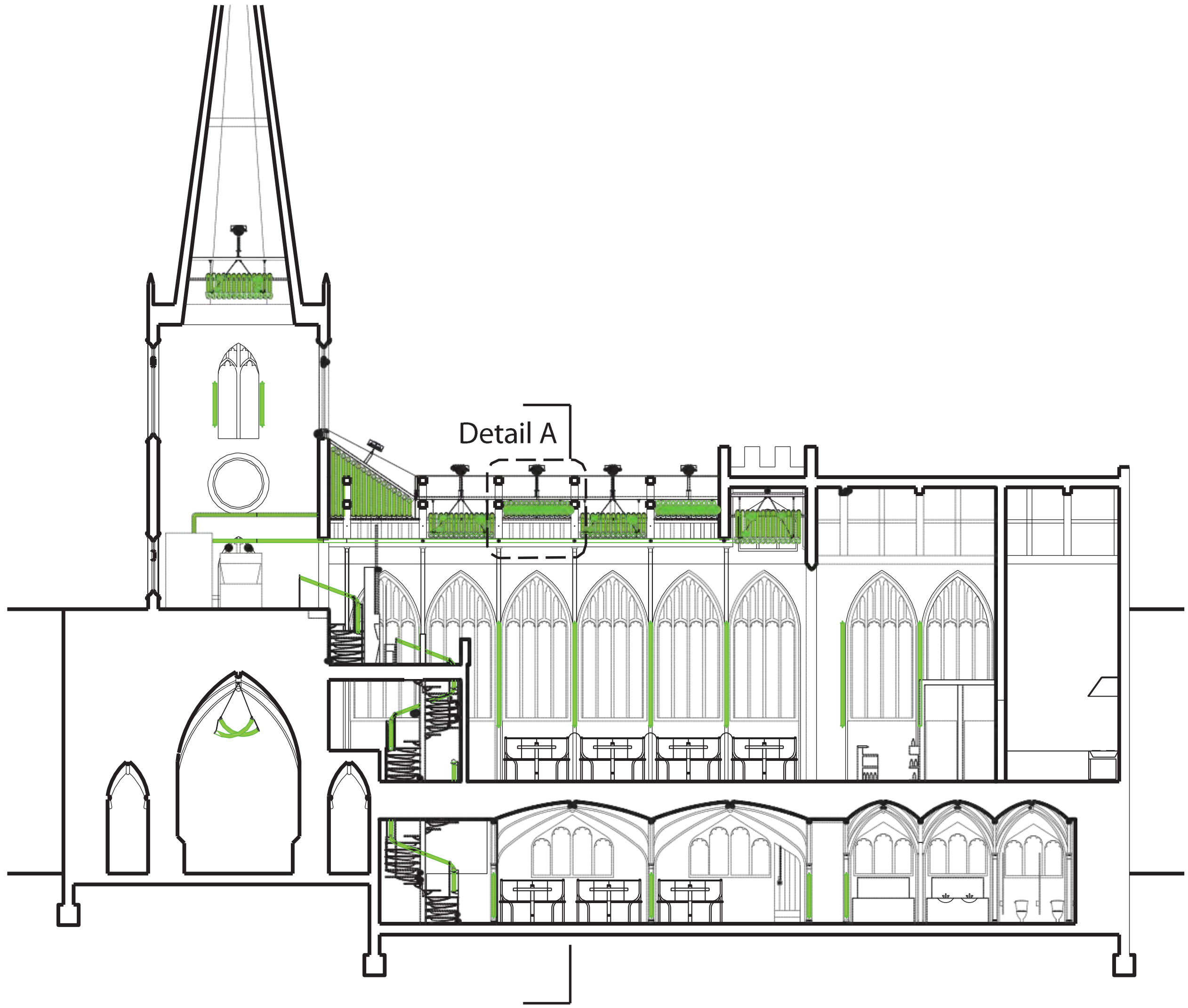
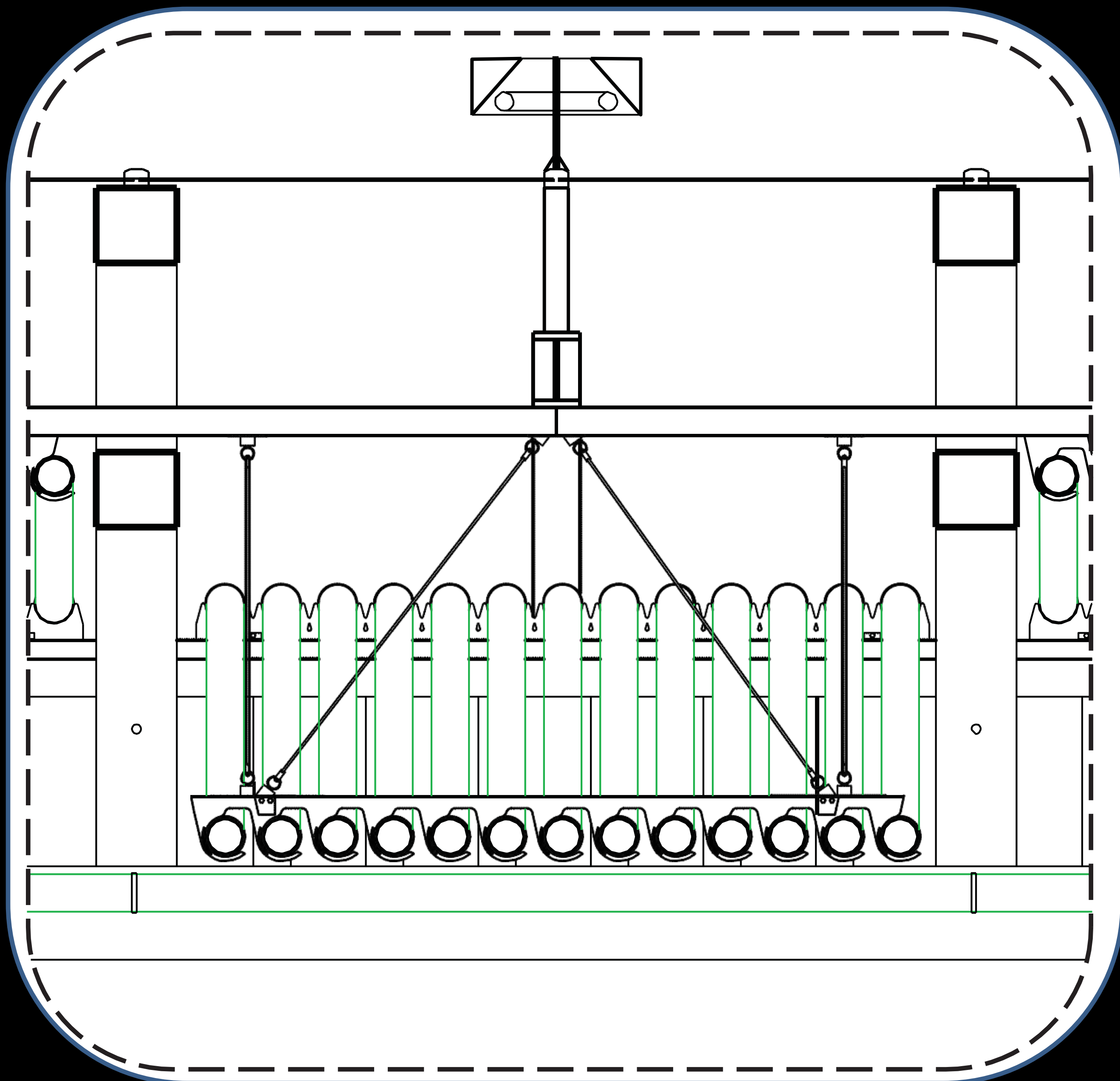






N-S Section

E-W Section Through Nave and Crypt of Algae Pub



Detail A

arc
FOR SALE
Group

Stained Glass Biomass

5 Churches Site Map . Dontown Bristol, UK

Universities throughout the United States receive funding from oil majors for algae biomass research, however, the same cannot be said for algae's aesthetic potential. In the future when mass production of algae is necessary as a source of renewable energy, algae technologies will need to integrate within existing cities, preventing infringement upon open land. While solar panels struggled to attractively manifest as architecture for decades following feasibility of the technology, even the Solar Decathlon has produced few aesthetic winners. To ensure a seamless transition to building skins for algae photo bioreactors, this technology needs to be studied architecturally in terms of chromatic and luminous effects.

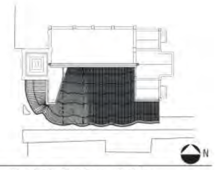
When architecture can move us both sustainably and aesthetically, it resonates deeper than technology or beauty independently.

This thesis looks at creating a new base for algae research in the United Kingdom, a country that is historically familiar with algae. Three of the world's five oil majors are based in the UK, and are perfectly situated to fund British universities if a solid research base existed.

Another criterion for site selection was looking at building shells that could act as a test bed for chromatic algae skins.

Derelict churches' history of stained glass, symbolically paired with the RGB potential of algae push them to the top of potential sites as well as their central locations as beacons, and receptiveness installing solar panels. Five churches in Bristol, UK were chosen for aesthetic algae skin re-adaptations to experiment with changing chromatic interior spaces and exterior glow.

Church #5 . Algae Roofscape for Circus Program . South Elevation

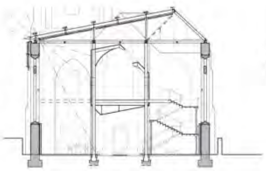


Church #5 . Algae Canopy Roof Plan

Church #3 . Tomato Greenhouse with RB Algae Skin . N-S Section

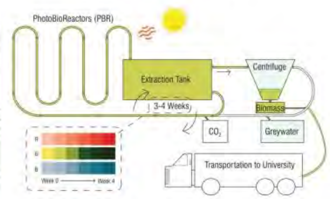
U.K.
Algae Research
History
+
University
Biomass
Research
+
Urban
Smog
(CO_2)
+
Host Building
=

RGB Algae Arranged by Design



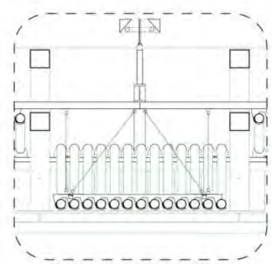
Church #1 . Algae Graffiti Gallery Reflective Pod . N-S Section

Church #1 . Algae Graffiti Gallery . Abstract Historic Stained Glass . Roof Plan



Harvesting Diagram

Church #4 . Algae Pub with Algae Roof . N-S Small Section . E-W Large Section



Church #4 . Algae Pub Roof Hanging Detail

Church #4 . Algae Pub from downtown

Church #4 . Algae Pub nave

Church #2 . Algae Headquarters Theater with different blue north/algae south lighting

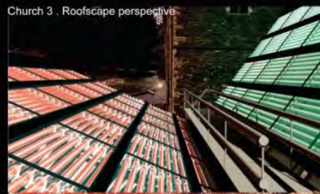
Student Biography

As a fifth year undergraduate student at Syracuse University School of Architecture, the prior abstract is derived from a year long architectural thesis from Fall 2013-Spring 2014 under the advisement of Professor Robert Svetz. I have always been interested in critiquing sustainable architecture in terms of how buildings can functionally integrate with technology, but also present an academic contention that goes beyond performance. How can the aesthetic of the technology move away from explicit 'green washing' imagery, in order to produce a greater architectural agenda? To advance this question, I was fortunate enough to receive the Walker Travel Prize from Syracuse University to visit the first algae skin 'BIQ Building' completed in 2013, by Splitterwerk Architects in Hamburg, Germany, which is devoid of aesthetics. I also traveled to Bristol, UK, to visit Bristol University, the five chosen derelict church sites, and their proprietor, the Churches Conservation Trust.

points.

Site Selection . Bristol, UK was chosen due to its algae research history, avaliable funding from oil majors, and smog for CO2 and church density.

Church 3 . Roofscape perspective



Church 3 . Interior aisle perspective looking west along exterior of church

Church 3 . Exterior perspective along street showing luminous chromatic glow revitalizes the surrounding park by night

Church 3 . E-W Section showing movement of vegetation between sheds for various stages of growth

Church 3 Tomato Greenhouse . Two new algae sheds shelter a WWII bombed out church without a roof, based off plant growth

5 Church Sites in Bristol, UK . The network of algae churches are colored beacons in a bleak cityscape

Church 4 . Exterior perspective of pre-existing church and algae canopy addition located on the south.

Church 4 Circomedia . As the only permanent occupant of 340 CCT churches, the pre-existing circus re-adaptation sets the standard. The circus was lacking storage space, hence the addition

Church 5 . Street perspective

Church 5 . Interior nave perspective looking west

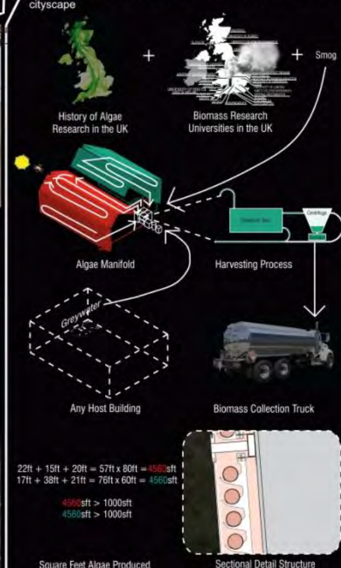
Church 5 Algae Pub 'In the Wall' . 14th c. built into the city wall fabric with a decaying wooden roof replaced by arced algae

Church 2 . Roof Perspective

Church 1 . Interior nave perspective looking west, of clestory natural northern blue light and abnormal blue algae/tinted glass south

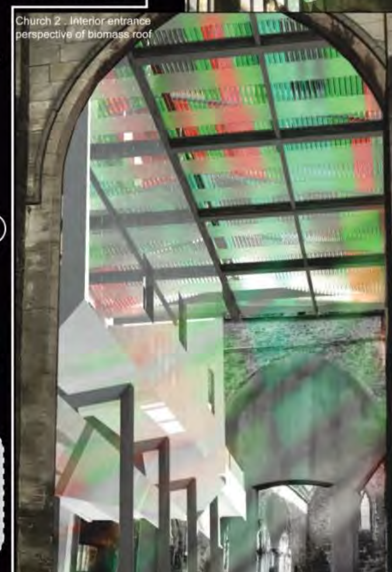
Church 1 . Algae sculptural intervention on north side of exterior courtyard

Church 1 Churches Conservation Trust HQ/Theater . A pristine condition church which intorduces concept of algae interventions



Algae Harvesting Mechanics . Three of five oil majors are located in the UK, but all biomass funding goes to the USA. It is time for a new research base.

Church 2 . Interior entrance perspective of biomass roof



Church 1 . E-W Section showing protected pod

Church 2 . Exterior perspective along park pathway

Church 2 Graffiti As Light Gallery . As a WWII bombed out church in need of a roof, a biomass 'stained glass' pattern was abstracted from the patron saint of the church and applied as a new roof bearing on the existing structure. The gallery exhibits the unigue