MANCHESTER SCHOOL OF ARCHITECTURE

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MANCHESTER 1824 The University of Manchester

Manchester Metropolitan University

ecospheric

Rural Solutions

MSA LIVE 21

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Partners

Our partners for this project were Ecospheric in collaboration with Rural Solutions. Our collaboration began by assisting them in their planning application for Little Rissigton, a Paragraph 79 proposal located in the heart of the Cotswolds.

Ecospheric focus on pioneering eco developments that save carbon and drive technological change. The built environment sees new measures being introduced as we slowly approach the 2050 pledge for zero net buildings. The firms director Kit Knowles and his team aim to create valuable case studies to progress the field of sustainable construction.

Rural Solutions are a specialist consultancy group, national leaders in designing exceptional new and replacement country homes that sit harmoniously within pastoral landscapes.
For this project they have utilised their in house Architects, Landscape Architects and Paragraph 79 Planning Consultant Specialists in order to achieve the desired outcome for their client.

The new Arts and Crafts development set in the Cotswolds, which aims for Passivhaus Premium is an opportunity to set a precedent not only for Passive House standards but also future Paragraph 79 projects.

Agenda

ECOtswolds

The agenda for our project was to produce a presentation exploring the potential innovative technologies that our partners could use in not only the Little Rissington project, but for future paragraph 79 projects. Paragraph 79 is a specific planning requirement applicable to rural areas with historical/ conservational value. This meant that any technologies that we researched needed to be considered in the context of rural areas in order to be valuable to our partners.

We also wanted to focus on how this project could provide a wider social value, as this is something our partners admit they do not consider often during their projects. Therefore in our research we took particular interest in technologies that could involve local businesses to give something back to the communities that these high value projects are constructed in.

As well as the outputs for our partners, this project also brought together a group of highly motivated and inquisitive MA and BA students. Our BA's were what brought the project to life after careful MA student led planning and talks with the partners. In order to ensure the BA students got the most out of the project we kept activities varied. Our structure for the 2 week session took the form of a research based first week and a production based second week. First we divided into three topical subgroups: Energy generation, conservation and storage, to encourage more group working and easier dialogue between MA and BA students. For the first week we prepared talks from some key players in the sustainability and Passivhaus industries who came in to speak to our team about their work, and how they sit in the architectural process. In between these sessions we guided the BA's through research and had regular catch up meetings online to make sure everyone was on track. We also used this time to get to know each other and our skill sets and interests, so that by the second week, we were ready to create the visual representations of our research.

Our goal was to not only provide our partners with valuable research and exploration conducted by the team, but to enhance both the MA and BA student's interest in and knowledge of sustainability in architecture. It is our hope as a team that research of this kind will forward sustainable housing design in rural communities further, and encourage developers and architects to utilise more local businesses and resources in domestic projects.

Energy Conservation

CONSIDERING LOCAL COMMUNITY AND SUSTAINABILITY

This group looked at the sustainability process in the context of the local community the project site is in. Material uses are central, as these can have a high embodied carbon level, meaning that the project could already be a non sustainable even before it gets to site.

MAXIMISING BIODIVERSITY GAIN

-Aim for 600% biodiversity net gain through landscape enhancements.

-Natural swimming pool/pond.

-Increased Parkland tree density in order to offer livestock shelter and create an enhanced grazer-saprophyte relationship (improves grass production and soil carbon sequestration).

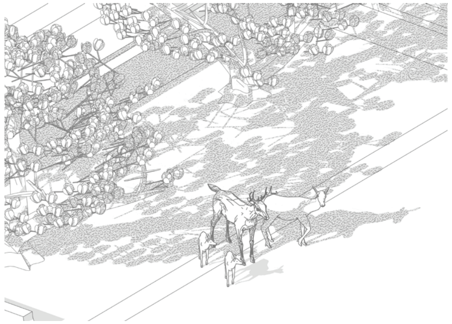
-Enhancement of onsite pannage, livestock feed enhancing elements and nut trees.

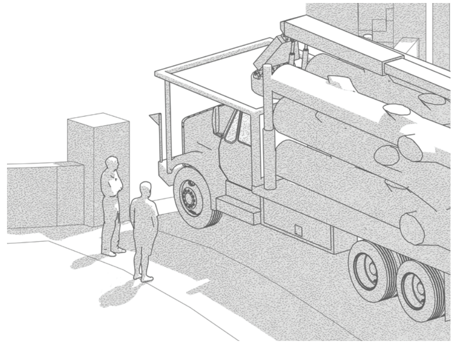
UTILISING LOCAL MATERIALS

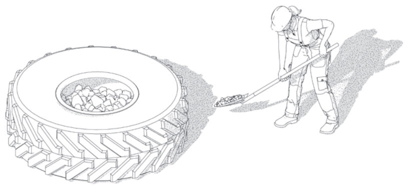
Methods of construction and material choices are to be carefully and locally selected. This ensures that the embodied energy of the chosen materials is kept to a minimum due to lower transportation miles. Cotswold stone uses no chemicals in the production and processing, and therefore has a low amount of chemical waste. It is also easily modified on site.

VERNACULAR ARCHITECTURE

A simple and local material palette generates the opportunity for social engagement with local craftsmen. The innovative nature of the Little Rissington project also affords the opportunity for the building to inform an educational live project. It could include local school-children in the process by informing them of the importance of locally sourced material and trade, establishing a sense of local pride for the Little Rissington project.







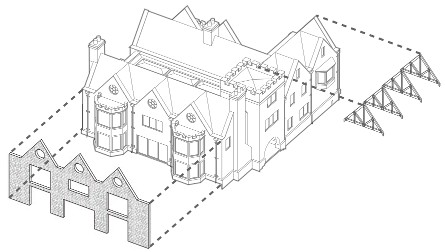


Image Top (Left):
Maximum Biodiversity

Image Middle (Left):
Utilising Local Materials

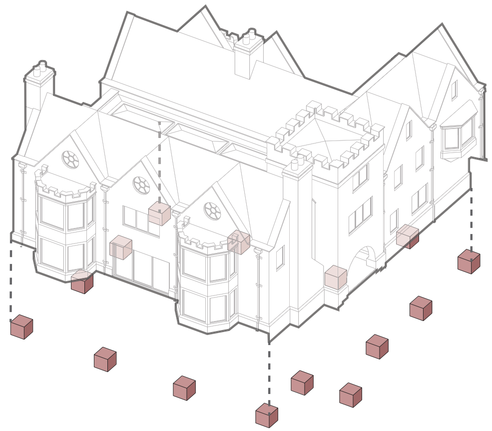
Image Top (Right):
Utilising Local Materials

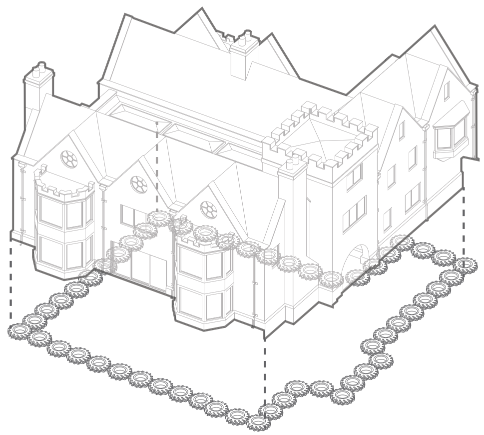
Image Middle (Right):
Vernacular Architecture

Image Bottom:
Natural Insulation

MINIMISING CONCRETE

Throughout our research for alternatives to concrete, which in its traditional form, has a high carbon footprint, we found the tyre foundation. This particular type of foundation is ideal since it is a low-tech solution, composed only of scrap tyres filled with compressed gravel. Both components are easily accessible as the site has several farms nearby. The gravel used encourages drainage and allows for water expansion while avoiding some major ground instability caused by frost. It can then be compressed easily with a hammer. For better stability, a metal plate and threaded rods can be used to connect the tyre foundation to columns and beams. The foundation also offers the possibility for the farmers' community to get involved in the construction process, from providing the spare tyres to filling them with gravel. To prove the viability of this technology, we included a map of potential tyre sources below.



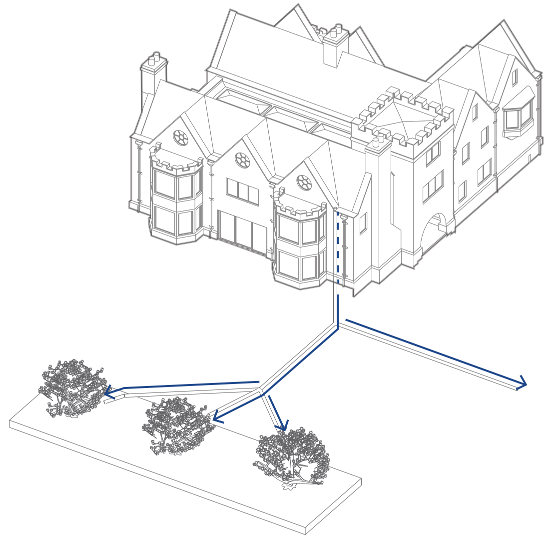


The map shows the farms in proximity to the site that could provide the tyres necessary for the foundation. There are 18 farms, with the furthest one being 26 minutes from the site. As several farms have tractor tyres that they no longer use, they could provide the necessary materials. Being locally sourced, they minimize the carbon emission that would have resulted from the transport. Additionally, this type of foundation will not require lots of heavy machinery, as the construction is simple and provides the opportunity for community involvement. Consequently, the pavilion's embodied energy is relatively low.

GREYWATER FILTRATION

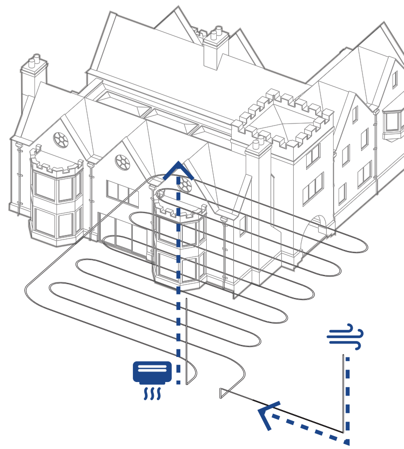
Greywater is used water from your bathroom sinks, showers, tubs, and washing machines. It is not water that has come into contact with faeces, either from the toilet or from washing diapers. Therefore it is safe to use for irrigation and toilet flushing for example.

Greywater is a system that could be viable in the Little Rissington project, due to the large amounts of outdoor space on the site, as well as a large roof area which can feed into multiple water collection points.



GROUND TO AIR HEAT EXCHANGER

A Ground to Air Heat Exchanger (GAHX) device is used to change the temperature of fluids by passing them through tubes that enter another medium. The process of transferring heat from one medium to another is called heat exchange. And the device in which the process takes place is called a heat exchanger. For example, an air conditioner is a heat exchanger that changes the room temperature by passing air through tubes carrying cold refrigerant gas (Freon). Uncoated liquid collectors are commonly used to heat water in swimming pools and thus makes it a potentially appropriate technology for use in Little Rissington.



Energy Generation

The Energy Generation group focused on the harnessing and generation of energy using solar, wind and water systems. We focused on technologies that minimised or completely negated the need for mains electricity to be used, with an aim to make it viable that the project could be completely self sufficient.

STAINED GLASS

The Arts and crafts movement is such a central part to the Cotswolds area's history, and therefore our students felt the use of stained glass could pay homage to this movement, especially considering the traditional design of the house itself. To achieve this without compromising on the sustainability aspect of the design, PET stained glass panels were examined as an option. Stained glass panels are made of light absorbing organic dyes, covering tiny particles of titanium dioxide nano material. Made from PET, they generate electricity and let in tinted light through the openings. It can be applied like a sticker to translucent surfaces to create solar powered façades.

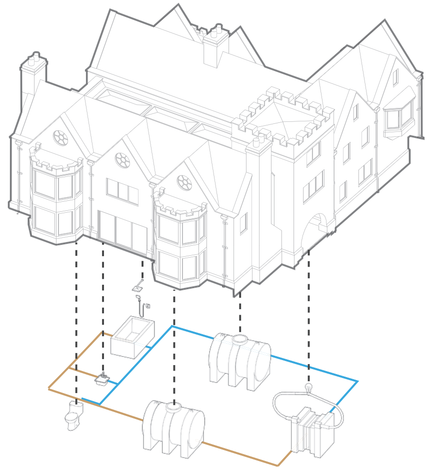
The process used by stained glass panels are inspired by the process of photosynthesis of plants where light is converted to energy. The different colours of the panels harness the light to convert it into energy, different colours produce different wavelengths resulting in different energy levels. This image on the top left is a our suggestion for a design, a depiction of the Cotswolds landscape made with PET glass.

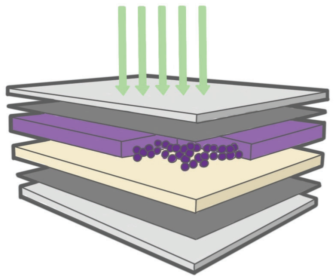
WATER TANK

Wastewater treatment system which recovers electricity and filters water. Biogas is the primary source of energy we can recover from wastewater; the other is bioelectricity. Through combining

RIDGE WIND TURBINE

The RidgeBlade® turbines use the pitched roof surface to focus prevailing wind towards the ridge, accelerating the wind through the turbines by up to 3 times. The RidgeBlade® system is well-integrated, unobtrusive and can be hybridised with solar panels at no cost to turbine performance, effectively allowing the majority of the roof surface to generate energy.





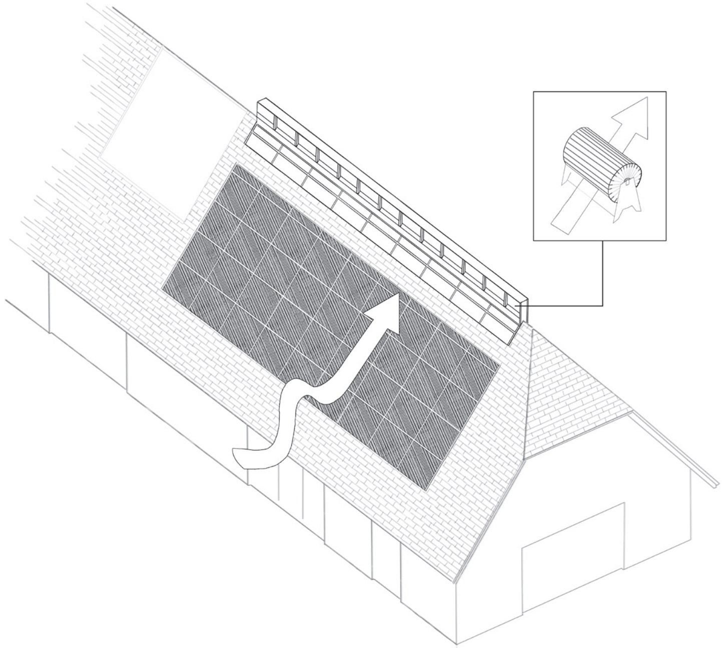


Image Top (Left):
Stained Glass Illustration

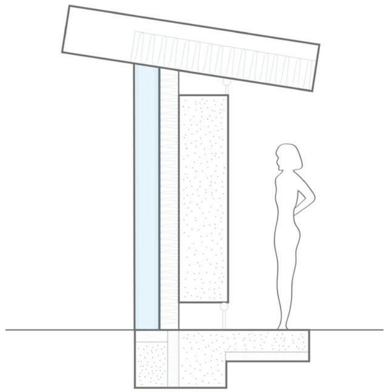
Image Middle (Left):
Stained Glass Composition

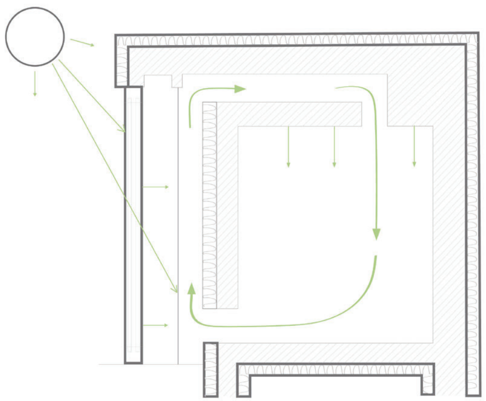
Image Top (Right):
Water Tank Diagram

Image Bottom:
Ridge Turbine Illustration

BARRA CONSTANTINI/ TROMBE WALL

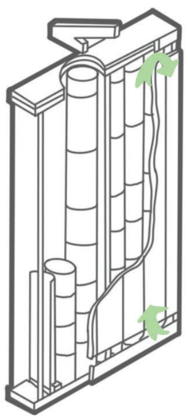
Solar walls store solar energy, allowing it to be slowly radiated into the interior of the building. This method consists of a south facing window, in which sunlight enters the building. Behind this is the absorber, which can be any insulation material that absorbs heat, and the last element is the thermal mass. The combination of these elements provides constant heating to a structure harnessing the energy from the sun sustainably, rather than conventional methods that require the usage of electricity. Both these options are viable for our partners, in specifically the pool building.





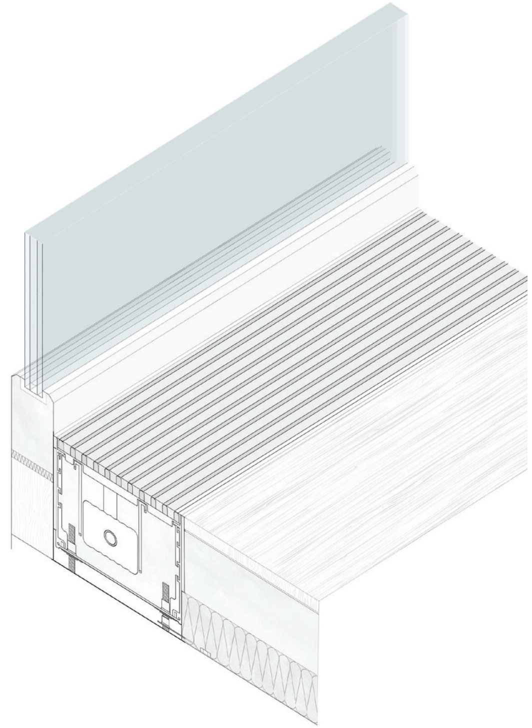
WATER WALL

Water walls provide thermal mass at a lower cost than concrete. The can be installed easily and economically. In areas with colder nights, they are more effective than masonry for heating and cooling. Water walls can be embedded into the walls of the structure and can be disguised do they are not visible. Water walls are effective because they provide thermal mass and quicker heat exchange than concrete or masonry. They are said to have a 10 to 20 percent advantage over slightly larger masonry walls in moderate climates. In addition, energy savings in heating and cooling can be expected in the 70 to 90 percent range.



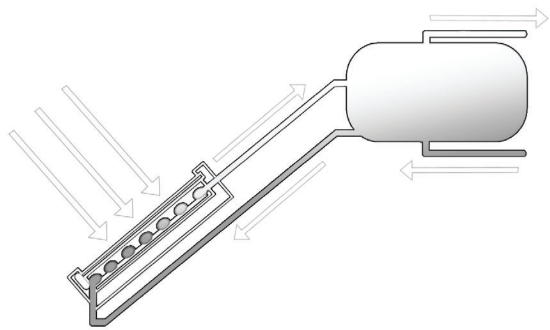
THERMAL TRENCH

A thermal trench has been deemed appropriate fir this project, as the nature of the technology means it could be incorporated into the building design quite seamlessly. The design of the building would not need to change significantly to accommodate this, and the appearance of exterior of the building would not be affected at all.



ISOLATED GAIN

This method of energy generation and storage could be used in conjunction with a thermosiphon. The Thermosiphon system doesn’t require pump or controller, and instead relies on hot air rising and cool air sinking. To keep this a purely renewable energy water heating system, a wind turbine can be used. When it is windy the water will be heated by wind power, and when it is still and sunny the water will be heated by solar power. Mains could also be connected in order to maintain hot water supply in all types of weather. The whole system shown in the diagram is an example of a passive isolated gain system, where thermosiphonage is the mechanism for the movement of heat energy.



Energy Storage

The generation of renewable electricity is often dependent on the weather (Solar, Wind, Hydro) and can yield intermittent flows in resources. This could potentially disrupt the balance between supply and demand. As renewable energies increase their share of total energy production, storing this energy becomes increasingly important. In this way, the ability to store also allows energy to be bought from the grid during low carbon density periods and for a lower cost. The potential drawbacks of energy storage are that often we see it at a large scale, e.g., Hydro (Dams), and it can be hard to replicate the same results at a smaller scale. There is also an inherent upfront cost that must be balanced with the lifetime savings intelligent management can deliver.

BATTERY ENERGY SYSTEM

Excess solar energy must be stored and one of the most efficient ways is to use a battery. The energy is mainly stored throughout the day when the production is at its peak, so when it comes to the evening, this stored energy can be utilised. The table to the right shows the differences between two market leaders– the Tesla Powerwall and the Sonnen. The diagrams show how they connect to the solar panel, inverter, main panel and grid. The Sonnen must be stored indoors as it can only operate at 5°C to 45°C, whereas the Tesla can operate at -20°C to 50°C– so it can be kept outdoors.

GRAVITATIONAL ENERGY SYSTEM

The battery consists of the well, weight, cable, and coil. When the weight has elevated, the battery is charged. The equation to work out the energy stored in the battery is E=mgh, where E is gravitational potential energy, m is the mass of the weight, g is gravity (9.81 m/s2), and h is the height the weight is raised from the bottom plane. Energy is used from the grid or renewable sources to raise the weight – or charge the battery. When energy is needed, the weight is dropped, which spins the coil and starts the generator. The whole process is managed by a computer (CPU) that keeps track of energy production, demand, and the batteries' charge level. By using a series of gears, the batteries' energy levels can be managed from low to high output or input. The research shows the prototype can be used to light up homes during power cuts and serve in rural areas replacing the expensive batteries used with solar panels, making it viable for Little Rissington.

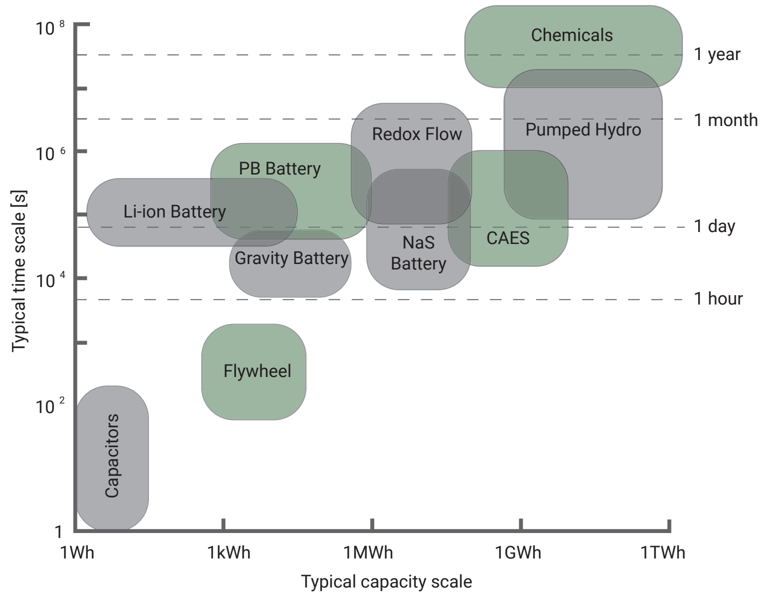
Diagram
r. radius of well
h. height of drop
m. mass attached to the system
E = mg h

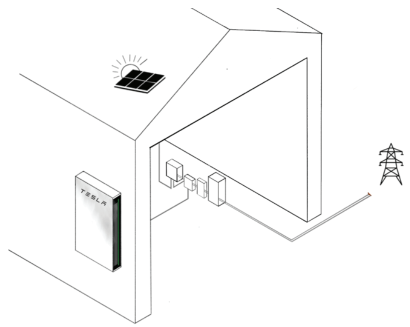
Image Top:
Energy Storage Graph

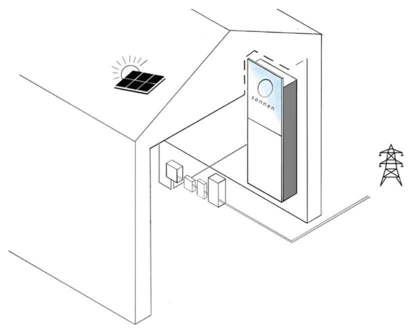
Image Middle (Left):
Tesla Battery System

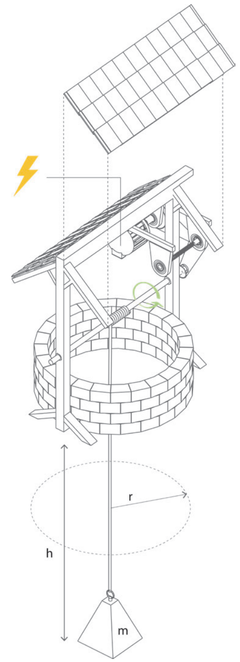
Image Bottom (Left):
Sonnen Battery System

Image Bottom (Right):
Gravitational Battery System



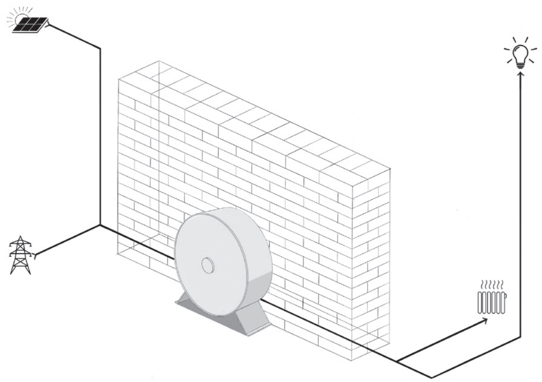






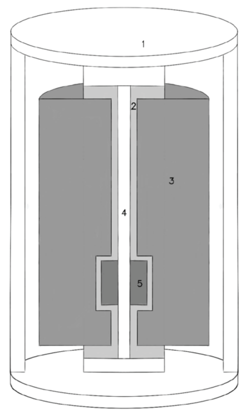
FLYWHEEL ENERGY SYSTEM

FESS is a mechanical electrical energy storage device that stores energy by accelerating the spin of the flywheel from its motor and generating kinetic energy. Once its rotational velocity threshold is reached, it disengages with the motor and engages with the generator, and so as long as the flywheel continues to spin, energy is ready to be discharged and utilised.



Benefits & Drawbacks:
+Fast response to frequency change
+Full charge in few milliseconds
+ Long lifespan (≈ 20 years)
+High efficiency (≈95%)
+ High energy density (≈200Wh/Kg)
-High installation cost
-Great safety risk when overloaded with energy
-Accumulation of mechanical stress and fatigue over time

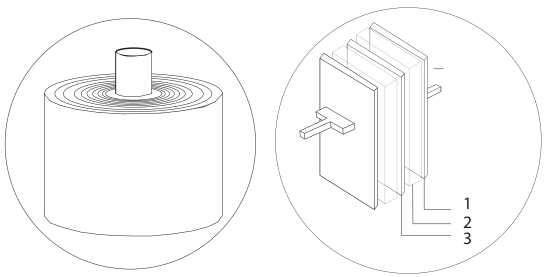
Diagram:
1. Protective Case
2. Magnetic bearing
3. Flywheel
4. Shaft
5. Motor/Generator



SUPERCAPACITOR ENERGY SYSTEM

A supercapacitor is a high-capacity capacitor. It bridges the gap between electrolytic capacitors and rechargeable batteries. Supercapacitors can be charged or discharged at a higher rate than the batteries. A capacitor stores energy by means of a static charge as opposed to an electrochemical reaction.

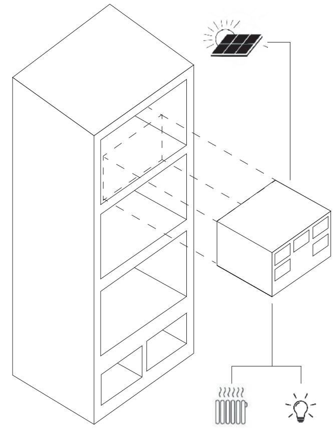
Diagram:
1. Outer Casing
2. Electrolyte
3. Separator Membrane



KILOWATT LABS

Energy Capacity: 7100 WH
Max charge rate: 296 A
Max discharge rate: 296 A
Weight: 135 KG

Suitable for project due to minimal interference with design needed.



COMPRESSED AIR ENERGY SYSTEM

Compressed Air Energy Systems (CAES) are normally found in rural areas as they require a great amount of land and large underground vessel tanks. In recent years the efficiency of these systems has been questioned and experimental solutions have been proposed for Small Scale CAES. These systems are connected to the renewable energy source of the project (PV, Wind turbine or other) and store the surplus energy in the form of compressed air. The compression and expansion of the air in the tank, stores and releases the energy when it's required.

Benefits and Drawbacks

+ More efficient than large scale

+ Longer lifespan than batteries

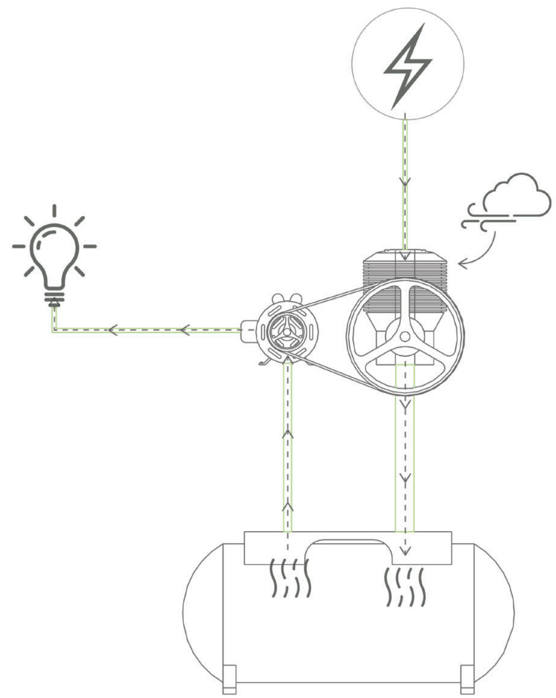
+ No high tech needed. Manufactured, installed, and maintained by local businesses

+ High tolerance

+ Almost infinite number of charge and discharge cycles

- Experimental small-scale options

- Higher initial cost than batteries



ABOUT
Each year the MSA Live (formerly Events) programme unites M Arch. year 01 with B Arch. year 01 and 02 and M Land. Arch 01 in mixed-year teams to undertake live projects with external partners to create social impact.

LIVE PROJECTS
All MSA Live projects are live. A live project is where an educational organisation and an external partner develop a brief, timescale, and outcome for their mutual benefit.

SOCIAL IMPACT
All MSA Live projects have social impact. Social impact is the effect an organization's actions have on the well-being of a community. Our agendas are set by our external collaborators.

EXTERNAL PARTNERS
MSA LIVE projects work with many organisations: charities, community groups, social enterprises, community interest companies, researchers, practitioners and educators.

STUDENT-LED
Our MSA masters students take the lead in the project conception, brief development, delivery and co-ordination of a small project. Other cohorts join for an eventful 2 weeks of activities at the end of the academic year.

KNOWLEDGE TRANSFER
Working in teams within and across year groups and courses; MSA students participate in peer to peer learning. In addition, collaborators, participants and students engage in the transfer of tangible and intellectual property, expertise, learning and skills.

LARGE SCALE
This year approximately 600 students from 4 cohorts in MSA will work on 42 projects with partners.

QUESTIONS
For questions about MSA Live 21 contact MSA Live Lead:
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BLOG
live.msa.ac.uk/2021

SOCIAL
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