Q1: Explain what is meant by 'sustainable energy management'. Include in your explanation examples of renewable energy sources. (1.1) Sustainable energy management involves looking at sources of energy and efficient use of energy. It is an ongoing process that aims to reduce use, manage use, reduce wastage of energy and limit negative impacts on the environment. Businesses and organisations should develop a sustainable management system, overseen by a designated member of staff or team of staff, that monitors use of energy and develops an action plan which has clear goals. The process should involve planning, controlling and monitoring energy related processes to help conserve energy, minimising costs and protecting the environment.

Organisations must take into account both primary and secondary energy; primary being that produced through the earths resources, coal, oil, gas, biomass, geothermal, nuclear and secondary whereas the primary sources are converted into other forms such as electricity, petrol and diesel. Electricity is a key secondary source as it can be created by burning fossil fuels or, as we increasingly try to introduce, through renewables, particularly with microgeneration and energy for transport and heating. The system must consider supply, consumption and conservation, reducing waste where possible, and looking at transport and heating as well as electricity use. This will need the organisation to combine technology, management and sustainable practices, consider new lighting, heating and appliance technology, and educate employees to help change their habits and behaviours.

As well as looking at sustainable energy management in relation to businesses and organisations, I feel it is important to view the issue on a national scale, the national energy mix. National governments, when attempting to manage energy sustainability, must consider primary and secondary energy production and consumption. It is too easy to just consider electricity, but in a country such as the UK only around 20% of total energy is used to produce electricity, most energy is used fuelling transport or heating.

When we look at energy in the UK the picture looks quite rosy when we only consider electricity, however, when we look at total energy sources the picture is quite different (assets.publishing.service.gov.uk). The data for 2023 shows that renewable sources at around 37% are most important for electricity production and fossil fuels produce only 33%, but when we look at total energy the vast majority at 77% still comes from burning fossil fuels, with only 17% from renewables.

It is very important in a national sense, as well as with businesses and organisations, to consider the energy used in transportation and heating and move away from oil and gas. The UK government addresses this by encouraging the change to electric vehicles, research in new vehicle technologies, and the move away from gas boilers. The government also offers grants and incentives to enable households and businesses to insulate effectively to prevent heat loss and conserve energy.

Renewable sources of energy must be the focus for the UK if it is to address the bold government target of producing 95% of its electricity from low carbon sources by 2030. Wind farms, both onshore and particularly offshore, at present produce around 30% of our electricity, smaller amounts come from solar and hydro. Wave or tidal power stations may be used in the future and biomass can be considered renewable if the biomass fuel is from sustainable sources. Because of its tectonic position the UK is not in a great position to produce geothermal energy, the hot rocks are far below the surface, but heating schemes are possible. Nuclear power stations use uranium which is an unsustainable resource, but the introduction of fast-breeder reactors that can produce new fuel may mean that the earth has enough nuclear resources to last a few billion years, since that is longer than the length of time the earth will be able to sustain life it is theoretically a sustainable sources of energy.

Nuclear power stations produce radioactive waste that is difficult to deal with and this, along with spills and accidents, has slowed down their spread. It must be remembered, however, that all sustainable sources have some environmental impact, offshore wind farms can destroy sea and ocean habitats, onshore wind farms are considered by some an eyesore, kill birds and may affect health, and even hydro-electric power stations involve flooding large areas to create storage reservoirs.

Q2: Identify legislation and agreements which relate to sustainable energy management at: (1.2)

a) An international level a) International level

It is difficult to get consensus on an international level regarding energy issues because of varying political and vested interests. Some areas of the world seek to protect their domination of fossil fuel exploitation, sale and wealth creation, particularly the Middle East and Russia, and the relevant trans-national corporations, which works against sealing and maintaining satisfactory sustainable energy management agreements. The position of the USA, a major player in both energy production and use, is very dependent on the political complexion of the government. The Democrats have recently embraced sustainable sources of energy, but Republicans are now stressing the need to exploit home reserves of fossil fuels, particularly oil and gas, in order to offer more energy security.

Some of the 17 UN sustainability goals developed as part of the 2030 Agenda are designed to address sustainable energy management. These goals, however, are really just aspirational targets that all countries should strive to achieve, they are not mandatory or legally binding and action depends on individual nations. Goal 7, addresses affordable and clean energy, and pushes countries to sustainably manage their energy, improve energy efficiency and promote research and development into clean energy technology. Others goals also touch on sustainable energy management, 11, concerning sustainable cities and communities addresses the environment, air quality and sustainable transport systems, 12, which looks at responsible

consumption and production, asks for sustainable use of resources and encourages companies to adopt sustainable practices, and finally goal 13 on climate action necessarily relates to the move towards 'clean' renewable energy sources.
The backdrop to current global attempts at sustainable energy management is the Paris Agreement of 2015/16. This followed the Kyoto protocol of the late '90's and early 2000's to produce a legally binding document signed by 196 countries. The main aim of the Paris Agreement is to reduce the greenhouse gas emissions, especially carbon dioxide, in an attempt to limit global temperatures to 1.5C above pre-industrial levels by the end of the century. While the agreement is not confined to energy management power and transport are major areas of concern.
Individual nations are responsible for developing and implementing policies to hit their targets and help reach global ones, but some countries have made more progress than others. Progress is monitored and tracked in a 5 year cycle against a National Determined Contribution for each nation and a global stocktake was commissioned in 2023. Contributions to global warming are not equally spread around the world. The top 5 greenhouse gas emitters in order are China, USA, India, EU and Russia, and much of this is caused by a continuing over-dependence on fossil fuels, and the UK Meteorological Office has predicted that the target may be breached as early as this year (2024), although climate data is usually calculated over a 30 year period so there still may be a chance to hit the target.
The Energy Charter Treaty is an older document but it has been revised in the light of the Paris agreement. A recent version has taken into account that Paris did not agree on a rigid path to renewable energy sources and make this more of a target. The EU and the UK have, however, withdrawn from the treaty as it was not pushing the move away from fossil fuels to renewables as fast as was seen necessary and was not signed by oil rich nations such as the USA, Russia and Saudi Arabia, at present the USA and Russia produce only around 20% of their electricity from renewables and the figure is as low as 0.2% for Saudi Arabia!
On a less global scale blocs of countries like the EU have introduced their own initiatives. The EU Renewable Energy Directive is a framework for developing clean, renewable energy sources and aims to raise EU renewables from 23% in 2022 to 42.5% by 2030. The EU Energy Efficiency Directive is stressing renewables and also helping member states reduce energy consumption, especially in the public sector, introduce Energy Management Systems and decarbonise heating and cooling.

b) A national level b) National level

The national approach to sustainable energy management is the most important. International initiatives like the Kyoto Protocol, the Paris Agreement and various UN Climate Change Conferences (COP's) may set the scene, but it is only at national level implementing policies and legislation, and using carrot and stick approaches that change can be made and national targets hit, or missed. The latest COP29 summit, which took place in Baku (un.org), stressed the need for developed nations, like the UK, to invest $300 billion per year ito developing nations since this is where it is thought most progress can be made. The UK will have to seriously consider its commitment to this target in the coming years.
UK policies and legislation include :-
- Climate Act 2008. (legislation.gov.uk) One of the first attempts by any country to address international concerns, it set up legally binding procedures for reducing carbon emissions, aiming to reduce them by 80% below 1990 levels by 2050. This act introduced the Climate Change Committee (theccc.org.uk) which reports to the government on the progress being made on reducing emissions, adapting to climate change, and advises it on Carbon Budget targets.
- Energy Act 2013. (legislation.gov.uk) This was designed to oversee and implement de-carbonisation targets by introducing carbon capture technologies, administering and tracking reductions in energy use and low carbon heating schemes.
- Feed-in tariffs. (ofgem.gov.uk) The aim is to promote renewable, low carbon electricity generation, funding is available for renewable initiatives, especially on a small, local scale.
- Carbon Budgets. (assets.publishing.service.gov.uk) These delivery plans aim to limit UK emissions over 5 year cycles and enable the UK to hit its National Determined Contribution (NDC) to global reductions. The plans are comprehensive and cover all aspects of society including industry, power supply, fuel, transport, and heat and buildings.
- Off-setting. If an organisation or company cannot reduce carbon emissions in one area of its operations, it may offset the carbon produce in this area by investing in projects elsewhere that reduce carbon emissions.

Although the new Labour government has only recently gained power in the UK it has made a promising start in the energy field and made progressive and far reaching commitments in its manifesto (labour.org.uk). It aims to make the UK a clean energy superpower by setting up Great British Energy a publicly funded but privately run organisation that is responsible to the government to introduce tough regulations to reform the energy system and make it more efficient. It will increase energy efficiency in British homes, introduce a Warmer Homes Plan, increase national energy security and accelerate the move to net-zero, all while protecting the environment.
Impressive ambitions, but the Energy Secretary has recently announced record funding of £1.5 billion for clean energy projects (climateaction.org). The plans look at the provision of green infrastructure projects where offshore wind will still be the backbone of renewable energy generation, but restrictions will be lifted on onshore wind developments and the Energy Auction process will be re-organised to make the competitive bidding for funding more straightforward.

Q3: Summarise energy conservation techniques that apply to both homes and businesses. Support your answer with examples. (1.3) Energy conservation techniques that can be applied to homes and businesses are best considered by looking at 4 broad areas. 1 Preventing heat loss. 2 Generating energy. 3 Reducing energy use. 4 New build techniques and technologies. Before embarking on a programme of energy conservation any homeowner or business owner should conduct a thorough energy audit to assess the current energy situation, identify areas where improvements can be made, to help them produce a plan of action to reduce energy consumption and wastage.

1. Preventing heat loss
- If heat loss can be controlled or prevented from homes and businesses less energy will need to be expended keeping the property warm. Insulation is a must, loft insulation to prevent the largest heat loss, but also floor and cavity wall insulation. Buildings without cavity walls can have insulating materials added to the inside or outside of walls. Government grants and incentives can be sought to help with the cost.
- Heat loss through windows can be reduced by installing double or even triple glazed window systems or by retro-fitting existing single glazed windows.
- Buildings should have smaller window to cut down on heat loss, but this may be a delicate balance between that and losing daylight which will increase lighting costs.
- Stopping and sealing leaks and constructing airtight buildings will also cut down on heat loss.
2. Generating electricity
- Microgeneration schemes can be added to homes and businesses and costs may be cut by government assistance to stimulate this trend, many homes and businesses in the UK are now having solar panels fitted to roofs.
- Photo-voltaic cells that generate electricity form sunlight are being added to many south facing roofs.
- Small wind turbines are built on roofs and other exposed position to generate 'free' renewable electricity.
- These sources may be intermittent, but will reduce the use of national grid electricity and will therefore also cur costs. Some of the electricity produced by these renewable means can now be stored using new and improved technology.
3. Reducing energy use
- Homes and businesses can set their thermostats to a lower temperature to use less energy and install programmable meters to help the process.
- Low energy light bulbs are more expensive than traditional ones but use significantly less energy for similar light output.
- Presence detecting light systems will shut off lights and save energy if no-one is in the room.
- Energy saving appliances with star ratings should be bought and used.
- Education of staff and/or family members to change their behaviours to help save energy, overseen by a specific member of staff or head of household, will make them more aware of their responsibilities to help reduce energy use. Installation of smart meters may make people more aware of how and when they can save energy, such as switching off and unplugging appliances and office equipment when they are not in use.
4. New built techniques and technologies
- This is particularly important with new build homes and business premises, but for older building retro-fitting new approaches can be a great aid to energy conservation.
- Super-insulation and airtight buildings are especially important in reducing heat loss and cutting costs significantly.
- Some building are now being constructed with high concrete mass to absorb and retain heat.
- Windows on south facing walls (northern, hemisphere) will allow more solar radiation to be absorbed inside the building.
- Ground sources heat systems or geothermal energy systems can be incorporated into build if conditions are right, as well as ground storage of heat.
- Passive building standards are becoming the norm with enlightened resident and businesses, these may have a home energy management system and take into account natural heat sources and the local microclimate.

Q4: Explain the contribution of renewable energy sources to sustainable energy management. (1.4) In order to explain the contribution of sustainable energy sources to sustainable energy management (SEM) I feel it is useful to revisit the idea of SEM and define exactly what it means. A basic definition is 'a framework that uses technology, management and sustainable practices to improve businesses energy performance.' A more comprehensive definition (Bilge, 2015. Energy systems and management) states that 'approaches to energy management strategies are concerned with the planning, controlling, and monitoring energy related processes, to conserve energy resources, protect the climate and save energy costs.' Finally the Foresight report, Powering Our Lives (assets.publishing.service.gov.uk) mentions related forces including 'climate change and the environment,' 'technology and materials,' and 'the political framework.'
By looking carefully at the definitions we can identify the areas where renewable energy sources are likely to have most impact and greater contribution to SEM. Conserving energy resources is obviously a key area as the use of finite fossil fuels for energy and heat is unsustainable in the long term and renewables by definition use the earths natural resources that will continue to be available. The final definition I quote widens the idea of protecting the climate to include the whole of the environment, and renewables do not release greenhouse gases such as carbon dioxide, and also do far less damage to the wider environment of ecosystems, habitats, flora and fauna. Introducing renewables also involves technology and technological advances that can be beneficial to society. Saving energy costs is a more difficult area to consider, certainly businesses that install microgeneration schemes, be it solar panels or wind turbines, will quite quickly begin to save money, on a larger scale however, while it is clear that the resources are free, the technology and construction costs are often very high. Finally, a full definition considers all 'energy related processes,' which means heating as well as the use of electricity, and it is also clear that the political systems and parties running a country will have a great impact on the directions taken on the renewable energy issue.
An area of the world where sustainable energy sources are making a significant impact is the state of California in the USA. Physically California is well endowed with the natural resources needed to exploit sustainable energy. Solar energy, the most important source of renewable energy in California, is exploited in the sunny mediterranean/semi-arid climate of the south, where large solar power stations have been built in the Mojave desert area. These large schemes involve mirrors that concentrate the heat on a central tower where fluids are heated to turn turbines to generate electricity. The California Solar Initiative also offers grants to organisations, businesses and individuals to install photo-voltaic cells on roofs to generate

electricity on a smaller scale or develop solar water heating schemes.
Hydro-electric power (HEP) is also important, particularly in the wetter north and the Sierra Nevada mountains to the east, where water is stored in large reservoirs as at the Shasta dam. These are multi-purpose schemes providing HEP, but also supplying water to cities such as San Francisco and for irrigated farming in the fertile Central Valley, while also helping prevent floods. Smaller HEP plants are increasingly being seen as a possible answer to energy supply problems in California caused by droughts, made more common because of global warming. This includes pumped-storage schemes where off-peak electricity is used to replenish stores of water in municipal reservoirs.
Smaller amounts of renewable energy come from biomass and wind power. Biomass is a source of renewable energy if it uses sustainable sources of fuel such as municipal solid waste, rubbish, alcohol fuel and landfill gas. The generation of electricity by burning biomass does emit greenhouse gases but it is less than that produced by burning fossil fuels, although the transport of the biomass, often large distances, also causes emissions. Large wind farms have been built as at Palm Springs in the south of California, taking advantage of the strong, reliable winds.
California is well placed for geothermal energy as it lies near a plate boundary and hot rocks are near the surface. The hot rocks are exploited by pumping water underground which flashes to steam and is used in the conventional way to turn turbines and generate electricity. Geothermal water heating can also be used as space heating for organisations such as schools and hospitals.
California has set targets for the growth of renewable electricity production (energy.ca.gov/data), but hitting these targets may get more difficult as climate change and global warming make the incidence of extreme weather events like droughts and floods more common. The target for 2020 was 33% from renewable sources and it was hit ahead of time, the target for 2030 is 60% which seems quite possible, but the target of 100% from renewables by 2045 seems optimistic.
The picture for 2023 (eia.gov/state/analysis) showed that renewable sources produced 54% of the total electricity generated in the state of California. This included 28% from solar, 14% from hydro, 6% from wind, 4% from geothermal and 2% from biomass. In the same year, however, 39% of the total electricity produced was from gas fired power stations and it will be hard to reduce this to zero by 2045.

Q5: Explain how energy saving can be Monitored. (2.1) Before planning, targeting energy savings and delivering a management strategy for a home or business it is important to monitor the current situation in order to gain the information required to make improvements.
a. Assessing present usage
Bills and meters can be used to monitor present usage. This should be done regularly and frequently, monthly, weekly and perhaps even more frequently to look for periods or times of most and least energy use. Some systems can now show usage second by second so that you can assess the impact of certain activities or appliances, to allow users to discover the causes of both high and low usage of energy.
b. Methods of assessing usage
Smart meters have been introduced for households and small businesses and may have a wireless, remote display unit showing the immediate impact of an activity, so that present use can be monitored and family members or work colleagues made more aware of the situation. These meters can show the cost of use in terms of money, kilowatt hours or even in terms of carbon emissions. Sub-meters sited in various places around a household or business can indicate which locations most energy is being used in.
c. Energy audit
Energy use in a home or business should be carefully audited and this may include regular walk rounds undertaken by family members or staff assigned responsibility in organisations. This should include :-
1. Looking carefully at temperatures around the home or premises, taking note of the heating methods and controls, thermostats and timers.
2. Looking for draughts and air leaks that may waste energy, noting where windows are left open or are closed, and the controls and timing for extractor fans.
3. Noting down the lighting situation in all rooms, type of lights, fittings and bulbs to assess where improvements such a low energy bulbs can be introduced or where more use can be made of natural light.
4. Making a careful inventory of household appliances and/or office equipment to see if it is left on or on stand by when not in use and whether its energy rating shows it be be efficient. Businesses may involve energy consultants to help them monitor present usage and wastage, and perhaps even calculate the carbon footprint. Home and business owners can visit the relevant Ofgem energy advice sites to get a fuller picture of how to monitor their energy use and how to plan energy savings.

d. The process outlined above should highlight improvements that can bring about energy savings, however, the process should be repeated to monitor the impact of any changes implemented. This should then become an ongoing process that is built into the longer term procedures of households or businesses.

Q6: Describe ways to manage energy use. (2.2) Energy management is a step by step process. (nibusinessinfo.co.uk). This organisation suggests 6 steps. but I think we can consolidate this into 5 main stages.
1. Engage a member of staff, perhaps as leader of a team, to be responsible for the whole process from planning to auditing to setting targets and policies to addressing those targets, and establishing the degree of success. This member of staff or team will then:-
2. Conduct an energy audit using all available sources including bills, metering and walk throughs to assess the current position.

3. Use this information to set up specific targets and plan the specific actions and policies that need to be implemented to hit those targets.
4. Involve all levels of the organisations staff and stakeholders, and take advice from outside bodies that may have more in-depth professional knowledge and understanding.
5. Control the actions, monitor the actions taken and their impacts towards the targets, report back to all involved and make any necessary reassessments.

I suggested 4 areas for an audit/walk-though to consider : Temperatures; lighting; appliances/equipment and draughts, here I would like to add a 5th transport. These are the areas that all organisations must consider when trying to manage energy use.
The Management Maturity Model (MMM) which has 5 maturity levels has been suggested as a way that companies can organise their response to energy issues (V Introna et al. Journal of cleaner products. Nov. 2014). The 5 stages being: Initial-the company starts, Repeatable-some success, Defined-roles and tasks are clear, Managed-growth phase and Optimising-all goals being met. This paper takes the step by step approach of the MMM that can be applied to many corporate areas, gathering information, planning and implementing to reach goals. It is suggested that a new Energy Management Maturity Model (EMMM) should be established to enable organisations to manage their energy use effectively and efficiently. Organisations will work towards a final 'mature' stage where energy management and sustainability are embedded at all levels, all goals are met and the energy management system continues successfully.
Tesco (tescopic.com), a large retail company can be considered to illustrate how a company can manage energy use effectively. Tesco works closely with energy experts and suppliers EON (eonenergy.com) and has made significant progress in its many stores and depots. Together the partnership has developed strategies for carbon neutrality and reduced energy use and wastage by introducing energy monitoring, a data led approach and an energy management system. The initial target was to hit net-zero by 2050 but policies have been so successful this was reassessed in 2019 to 2035.
With the help of EON Tesco have introduced energy dashboards which can produce data down to the level of departments, identify wastage, energy efficiency and inform action that can be taken. This data driven approach has led to large savings, the introduction of LED lighting in all stores in 2021 led to an 8% reduction in electricity costs.
On-site renewables have been introduced, wind turbines have been set up at 4 depots and solar panels at 62 stores which has enabled Tesco to target that all their electricity will be produce by renewables by 2030. All staff have been involved, store workers, depot staff, delivery drivers, maintenance staff and office staff, for example, distribution has been revolutionised by the F Plan, fuller pallets, fuller trailers, fewer miles and fuel economy, and Tesco have been introducing electric vehicles into its home delivery fleet since 2020.

Q7: Explain how to set targets for energy saving. (2.3) When a company or organisation has decided to introduce energy saving policies and after monitoring the current situation regarding energy use and wastage, the next steps involve setting out the overall aim or goal, the longer term vision for energy use. To reach this goal, however, it is useful to develop a series of targets needed to achieve the goal. These targets should be SMART. Specific, Measurable, Achievable, Relevant and Time-bound. (nibusiness.info.co.uk)

1. Specific

Specific targets are clearly defined, focused on particular issues or areas and make it clear what is expected to be accomplished. It is important to set out what is intended, where it will happen and how it will be done.

2. Measurable

This means that data can be collected on the progress towards the target and if and when the target is achieved. By tracking the progress towards the target, policies and procedures can be adjusted if required, and having a clearly measurable end target allows evaluation of the degree of success and reassessment if needed.

3. Achievable

The target must be realistic, one that can be reached, as this will encourage staff and help with motivation. In setting up achievable targets it is important to consider the type of organisation, its resources, including staff and possible problems that may be encountered.

4. Relevant

The targets mush fit with the overall aims and ethos of the company or organisation, its place in society, its role in society and its relationship with all stakeholders, bearing in mind the need to enhance reputation where possible.

5. Time-bound

Unless the target indicates when it is proposed that it will be achieved it will lack precision and people within the organisation may feel less motivated to help reach the target. By having a date and perhaps interim dates the organisation can set out the steps needed to attain the target.

Targets must be clear and well publicised with clear avenues for communication within the company and with outside agencies
A specific member of staff or team of staff should be responsible for setting and evaluating the targets, reporting to senior management but also in close communication and hold meetings with staff at all levels and with all relevant stakeholders. Such a wide involvement will help motivate staff towards helping achieve the goals and targets and make them more likely to engage enthusiastically with any education or training schemes.
