futureme
North East Collaborative Outreach Programme

nustem

Nuclear Fuel

How it's used and its environmental impact

EDF Energy own and operate eight nuclear power plants around the UK, including one near Hartlepool. More than 500 work at the plant, and it can provide electricity to 2 million homes around the UK.

About a fifth of the electricity generated in the UK comes from nuclear power plants. These use nuclear fuel, such as uranium, and do not produce carbon dioxide when they are generating electricity. Nuclear fuels are not burned like fossil fuels. Instead, they undergo a process called *nuclear fission* which releases energy.

Image credit: courtesy Nuclear Regulatory Commision / USA.

Nuclear fuel pellets

Nuclear power stations are expensive to build and require strict safety and security measures to deal with the risks posed by using nuclear fuel. However, they have relatively low running costs once they are built, and last a long time. This makes them cost-effective. EDF and other companies are planning to build more nuclear power stations. This will help meet the future electricity needs of the country and keep carbon dioxide emissions low.

Know

1. What is nuclear **fission**?

2. Name an element, other than Uranium, that can be used as fuel for a nuclear reactor.

3. Describe what is meant by the phrase '**decommission** a nuclear power station.'

4. Write down **two advantages** and **two disadvantages** of generating electricity using nuclear power stations.

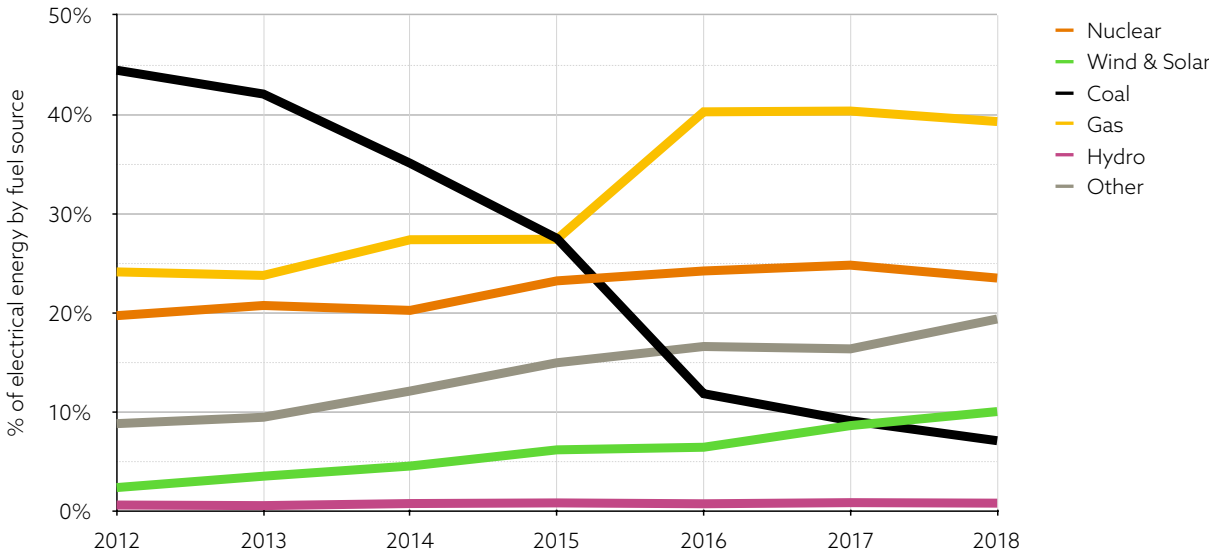
Apply

5. It takes nearly 15 000 kg of coal to generate the same amount of electricity that can be generated using 1 kg of uranium. State two or more benefits to the environment of using nuclear fuel instead of coal.

6. The graph on the next page shows how the percentage of electricity generated from a range of different sources has varied between 2012 and 2018. Use the graph to answer the following questions:

   (i.) Which **non-renewable** fuel has been used in decreasing amounts since 2012?
   (ii.) Which **renewable** energy source generates the most electricity?
   (iii.) Describe how the use of nuclear fuel varied between 2012 and 2018.

UK annual electricity mix 2012-18



(source: UK Government historical energy data,
https://www.gov.uk/government/statistical-data-sets/historical-electricity-data)

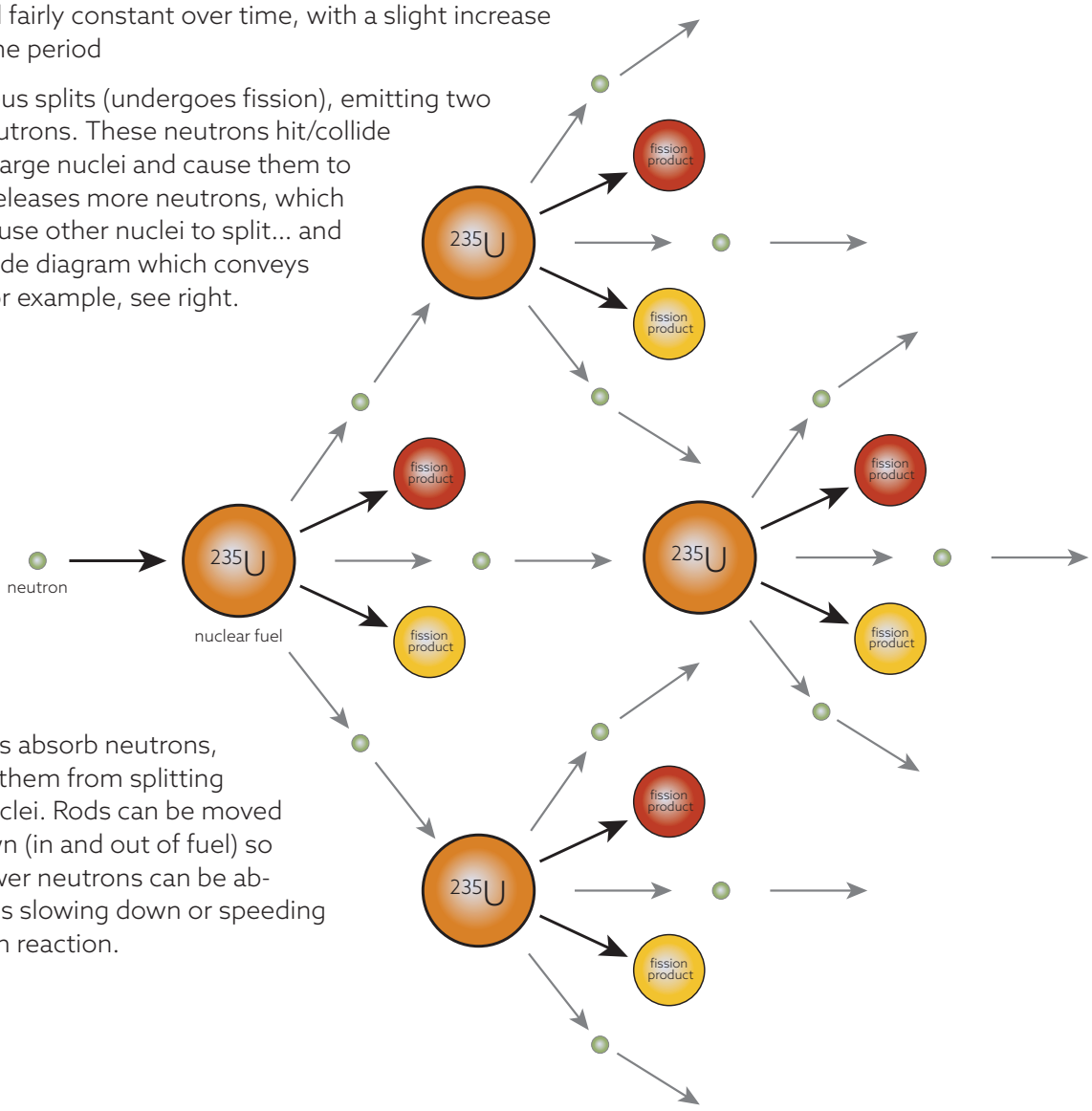
Extend

7. Describe how a nuclear chain reaction happens in a nuclear reactor. You should draw a diagram as part of your answer.

8. Explain the purpose of control rods in a nuclear reactor and describe how they are used.

Mark Scheme: Nuclear Fuel

1. Answer including the idea of a **large, unstable nucleus** splitting.
2. Plutonium or Thorium.
3. **Dismantle** and (safely) **remove** (and dispose of) radioactive waste / materials / fuels, *not* simply "knock down".
4. Advantages include: lower running cost of power station ("cheaper"), low carbon footprint / no production of carbon dioxide from electricity generation, more reliable than non-renewable sources such as wind, less pollution from fuel transportation because fuel is "concentrated."
   Disadvantages include: non-renewable (fuel will run out), high start-up/building costs, produces radioactive waste which is difficult to store safely/dispose of (and so a potential danger to humans and the environment).
5. Burning coal produces more CO_2 and pollutants other than CO_2, e.g. nitrogen oxides, sulfur dioxide, and particulate matter.
6.
   (i.) Coal
   (ii.) Wind
   (iii.) Stayed fairly constant over time, with a slight increase over the period
7. Large nucleus splits (undergoes fission), emitting two or more neutrons. These neutrons hit/collide with other large nuclei and cause them to split. This releases more neutrons, which go on to cause other nuclei to split... and so on. Include diagram which conveys this idea: for example, see right.



8. Control rods absorb neutrons, preventing them from splitting uranium nuclei. Rods can be moved up and down (in and out of fuel) so more or fewer neutrons can be absorbed, thus slowing down or speeding up the chain reaction.