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Chemistry 2, Lesson 12: Analyzing Energy Investments

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Identify and Define the Need or Problem

Bitumen Oil Sands

- reuters.com

  Northern Alberta's oil sands account for roughly two thirds of crude output from Canada, which is the world's fourth-largest oil producer.

- yaleclimateconnections.org

  Oil sands make up 97% of Canada's proven oil reserves, and they have been a major economic driver for Canada. But the oil is expensive to extract and process, and it has a lower market value compared to U.S. crude oil.

Natural Gas

- energyunderstood.com

  The full cost to produce electricity from a new natural gas plant is 6.5 cents per kilowatt hour, about 25 percent cheaper than the current cost of coal plants. The costs are lower than nuclear, clean coal, and available renewable technologies. Natural gas plants have more energy efficiency and lower pollution, so they are also a better choice for our nation. In addition, they will continue to meet our energy needs for decades to come.

Nuclear Energy

- nrl.mit.edu

  When a U-235 nucleus absorbs an extra neutron, it quickly breaks into two parts. This process is known as fission (see diagram below). Each time a U-235 nucleus splits, it releases two or three neutrons. Hence, the possibility exists for creating a chain reaction.

- world-nuclear.org

  Nuclear power is cost competitive with other forms of electricity generation, except where there is direct access to low-cost fossil fuels.

• large.stanford.edu

> Capital cost - the cost of constructing and engineering the plant - represents a large percentage of the cost of nuclear energy. The US Energy Information Administration estimated that for new nuclear plants to go into service in 2019, capital costs will make up 74% of the cost of electricity; higher than the capital percentages for fossil-fuel power plants - 63% for coal and 22% for natural gas, but lower than the capital percentages for other renewable sources - 80% for wind and 88% for solar PV.

I have chosen Option 3, Nuclear Energy.

• e360.yale.edu

> Nuclear waste disposal, although a continuing political problem in the U.S., is not any longer a technological problem. Most U.S. spent fuel, more than 90 percent of which could be recycled to extend nuclear power production by hundreds of years, is stored at present safely in impenetrable concrete-and-steel dry casks on the grounds of operating reactors, its radiation slowly declining.

a. What is the process of obtaining energy from nuclear fission?

> As published by the Massachusetts Institute of Technology Nuclear Reactor Laboratory: 'When a U-235 nucleus absorbs an extra neutron, it quickly breaks into two parts. This process is known as fission (see diagram below). Each time a U-235 nucleus splits, it releases two or three neutrons. Hence, the possibility exists for creating a chain reaction.'

• scientificamerican.com

> Paired with 48 stone or concrete 105-ton markers, etched with warnings in seven languages ranging from English to Navajo as well as human faces contorted into expressions of horror, the massive installation is meant to stand for at least 10,000 years—twice as long as the Egyptian pyramids have survived. But the plutonium ensconced in the salt mine at the center of this installation will be lethal to humans for at least 25 times that long—even once the salt walls ooze inward to entomb the legacy of American atomic weapons.

b. What products are produced by nuclear fission?

Energy is generally the intentional product, with whatever elements the plutonium and uranium split into being considered waste material.

c. What are the waste products produced by nuclear fission, and how are they managed?

A large variety of elements may be produced by the reaction of uranium to a collision with plutonium. Whatever does result may be expected to exhibit radioactive decay. According to Yale Environment 360: 'Most U.S. spent fuel, more than 90 percent of which could be recycled to extend nuclear power production by hundreds of years, is stored at present safely in impenetrable concrete-and-steel dry casks on the grounds of operating reactors, its radiation slowly declining.'

d. What is the impact to natural systems by nuclear fission? (Consider a well-operated plant and a reactor meltdown.)

Nuclear fission generally has negligible impacts on surrounding environments, for plutonium and uranium are not common elements in organic environments, and nuclear energy production generally gives off little radioactivity when all goes well. In case of an accident, the area surrounding need be evacuated for the sake of evasion of radiation poisoning. In the worst nuclear power plant accident to occur yet, at Chernobyl, some thousands of cases of thyroid cancer and 15 deaths have been attributed to radiation poisoning. As published by Yale Environment 360: 'The statistics of Chernobyl irradiations cited here are so low that they must seem intentionally minimized to those who followed the extensive media coverage of the accident and its aftermath. Yet they are the peer-reviewed products of extensive investigation by an international scientific agency of the United Nations. They indicate that even the worst possible accident at a nuclear power plant – the complete meltdown and burnup of its radioactive fuel – was yet far less destructive than other major industrial accidents across the past century.'

e. What are the environmental costs of extracting, refining, transporting, and using the products from nuclear fission?

Plutonium must be recovered from previous fissions and otherwise generated, for according to word-nuclear.org, 'Plutonium has occurred naturally, but except for trace quantities it is not now found in the Earth's crust.' Nuclear fission leaves behind material that may be radioactive for thousands of years. The following is an excerpt of a Scientific American article. 'Paired with 48 stone or concrete 105-ton markers, etched with warnings in seven languages ranging from English to Navajo as well as human faces contorted into expressions of horror, the massive installation is meant to stand for at least 10,000 years – twice as long as the Egyptian pyramids have survived. But the plutonium ensconced in the salt mine at the center of this installation will be lethal to humans for at least 25 times that long – even once the salt walls ooze inward to entomb the legacy of American atomic weapons.'

f. In general, are the benefits from nuclear fission worth the costs (monetary and environmental)?

Any answer to this question is a matter of opinion, as is the one that follows. As long as we continue to grow our energy usage, and until our understanding of the world we inhabit grows enough to enable otherwise, nuclear energy production is among our few practical options.

1. How will you quantify the environmental costs of your chosen energy source?

I will quantify the environmental costs of nuclear energy production as small, though lasting.

2. How will you evaluate the benefits versus costs of your chosen energy source?

I will evaluate nuclear energy production as greatly beneficial with manageable downsides.

Research, Brainstorm, and Develop

- Nuclear energy may often be produced from otherwise waste generated by previous nuclear fission.
- If we eventually run out of space to place nuclear waste, we may carefully eject it into outer space.
- There is a large initial cost to building or restoring a power plant, however there is a ceaseless market for the product.

Nuclear energy production should continue to be pursued, and should gradually replace existing methods of energy production. The current and growing needs for energy need to be met. Nuclear energy production is one of few methods that practically scales, and among those is least environmentally destructive. The waste produced is compact, and when stored properly, is a non-issue. During usual operation, nuclear power plants give off less radiation than any other popular energy generation method, coal burning especially.

Execute, Evaluate, and Share

My presentation is attached as *12-presentation.pdf*.