Lesson 7. The Nano World

The Nanotechnology is perhaps the fastest growing world in the 21st century. Global competition among nations in nanotechnology research, development and marketing is on the rise. Advantages of nanotechnology towards improving the quality of life are many and are felt by humankind. Whether the nanoworld holds any solutions to problems faced by science education is a critical question which must be addressed in its entirety. However, disadvantages of nanotechnology especially related to human health and the environment are only beginning to surface raisin serious concerns. Systematic exploration, characterization, organization, and regulation of the nanoworld are warranted to make the best use of nanoscience and nanotechnology. The nanoworld will continue to influence science and technology. But before we engage in nanotechnology, we need to take into account the social, ethical, and environmental concerns of using nanomaterials.

Truly *revolutionary* nanotech products, materials and applications, such as nanorobotics, are years in the future (some say only a few years; some say many years). What qualifies as "nanotechnology" today is basic research and development that is happening in laboratories all over the world.

"Nanotech" products that are on the market today are mostly gradually improved products (using *evolutionary* nanotechnology) where some form of nano-enabled material (such as carbon nanotubes, nanocomposite structures or nanoparticles of a particular substance) or nanotech process (e.g. nanopatterning or quantum dots for medical imaging) is used in the manufacturing process.

Intended Learning Outcomes:

At the end of the lesson/ topics, the students are expected to:

1. Define and characterize nanotechnology;
2. Discuss the major impacts (both potential and realized) of nanotechnology on society;
3. Analyze the issue through the conceptual STS lenses; and
4. Critique the issue on its costs and benefits to society.

Discussion

7.1 Definition of Nanotechnology and Size of Nanoscale

The term was coined in 1974 by Norio Taniguichi of Tokyo Science University to describe semiconductor processes such as thin-film deposition that deal with control on the order of nanometers. His definition still stands as the basic statement today: "*Nano-technology mainly consists of the processing of separation, consolidation, and deformation of materials by one atom or one molecule*."

One of the problems facing this technology is the confusion about how to define nanotechnology. Most revolve around the study and control of phenomena and materials at length scales below 100 nm and quite often they make a comparison with a human hair, which is about 80,000 nm wide.

Some definitions include a reference to molecular nanotechnology systems and devices and 'purists' argue that any definition needs to include a reference to "functional systems". The inaugural issue of *Nature Nanotechnology* asked 13 researchers from different areas what nanotechnology means to them and the responses, from enthusiastic to skeptical, reflect a variety of perspectives.

It seems that a size limitation to the 1-100 nm range, the area where size-dependent quantum effects come to bear, would exclude numerous materials and devices, especially in the pharmaceutical area, and some experts caution against a rigid definition based on a sub-100 nm size.

Another important criteria for the definition is the requirement that the nano-structure is man-made, i.e. a synthetically produced nanoparticle or nanomaterial. Otherwise you would have to include every naturally formed biomolecule and material particle, in effect redefining much of chemistry and molecular biology as 'nanotech.
The most important requirement for the nanotechnology definition is that the nano-structure has special properties that are exclusively due to its nanoscale proportions. This definition is based on the number of dimensions of a material, which are outside the nanoscale (<100 nm) range.

The U.S. National Nanotechnology Initiative (NNI) provides the following definition:
... the understanding and control of matter at dimensions between approximately 1 and 100 nanometers, where unique phenomena enable novel nanotechnology applications. Encompassing nanoscale science, engineering, and technology, nanotechnology involves imaging, measuring, modeling, and manipulating matter at this length scale.
A nanometer is one-billionth of a meter. A sheet of paper is about 100,000 nanometers thick; a single gold atom is about a third of a nanometer in diameter. Dimensions between approximately 1 and 100 nanometers are known as the nanoscale. Unusual physical, chemical, and biological properties can emerge in materials at the nanoscale. These properties may differ in important ways from the properties of bulk materials and single atoms or molecules.

We found another good definition that is practical and unconstrained by any arbitrary size limitations (source):

The design, characterization, production, and application of structures, devices, and systems by controlled manipulation of size and shape at the nanometer scale (atomic, molecular, and macromolecular scale) that produces structures, devices, and systems with at least one novel/superior characteristic or property.

A nanometer (nm) is one thousand millionth of a meter. For comparison, a red blood cell is approximately 7,000 nm wide and a water molecule is almost 0.3nm across.

To see where 'nano' fits on the scale of things, check out our metric prefix table with examples and an interactive tutorial: View the Milky Way at 10 million light years from the Earth. Then move through space towards the Earth in successive orders of magnitude until you reach a tall oak tree. After that, begin to move from the actual size of a leaf into a microscopic world that reveals leaf cell walls, the cell nucleus, chromatin, DNA and finally, into the subatomic universe of electrons and protons.

People are interested in the nanoscale – which we define to be from 100nm down to the size of atoms (approximately 0.2nm) – because it is at this scale that the properties of materials can be very different from those at a larger scale. We define nanoscience as the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale; and nanotechnologies as the design, characterization, production and application of structures, devices and systems by controlling shape and size at the nanometer scale.

For more understanding of the discussions above, you may open these url and watch the videos:

https://www.youtube.com/watch?v=PAAvuhYKNz0
https://www.youtube.com/watch?v=VdJ6jne6k7M

7.2 Viewing Nanomaterials

How do scientists see what's going on in the extremely small world of nanotechnology? The microscopes that are typically used in high school and college won't do the job. Nano scientists use high-powered microscopes that use unique methods to allow them to see the surface features on the atomic scale, effectively opening the door to modern nanotechnology.

Beginning as early as the 1930s, scientists were able to see at the nanoscale using instruments such as the scanning electron microscope, the transmission electron microscope, and the field ion microscope. The most recent and notable developments in microscopy are the scanning tunneling microscope and the atomic force microscope.

The electron microscope, first developed by German engineers Ernst Ruska and Max Knoll in the 1930s, uses a particle beam of electrons to illuminate a specimen and create a highly magnified image. Electron microscopes yield much greater resolution than the older light microscopes; they can obtain magnifications of up to 1 million times, while the best light microscopes can magnify an image only about 1,500 times.

The scanning tunneling microscope (STM) is among a number of instruments that allows scientists to view and manipulate nanoscale particles, atoms, and small molecules. Its development earned its inventors, Gerd Binig and Heinrich Rohrer, the Nobel Prize in Physics in 1986.

Atomic force microscopes (AFMs) gather information by "feeling" the surface with a mechanical probe. Gerd Binig, along with Calvin Quate and Christoph Gerber, developed the first AFM in 1986.

These microscopes make use of tiny but exact movements to enable precise mechanical scanning.

7. 3. Distinct Features/Properties of Nanoscale

The principal parameters of nanoparticles are their shape (including aspect ratios where appropriate), size, and the morphological sub-structure of the substance. Nanoparticles are presented as an aerosol (mostly solid or liquid phase in air), a suspension (mostly solid in liquids) or an emulsion (two liquid phases). In the presence of chemical agents (surfactants), the surface and interfacial properties may be modified. Indirectly such agents can stabilize against coagulation or aggregation by conserving particle charge and by modifying the outmost layer of the particle. Depending on the growth history and the lifetime of a nanoparticle, very complex compositions, possibly with complex mixtures of adsorbates, have to be expected. In the typical history of a combustion nanoparticle, for example, many different agents are prone to condensation on the particle while it cools down and is exposed to different ambient atmospheres. Complex surface chemical processes are to be expected and have been identified only for a small number of particulate model systems. At the nanoparticle - liquid interface, polyelectrolytes have been utilized to modify surface properties and the interactions between particles and their environment. They have been used in a wide range of technologies, including adhesion, lubrication, stabilization, and controlled flocculation of colloidal dispersions (Liufu et al 2004).

At some point between the Angstrom level and the micrometer scale, the simple picture of a nanoparticle as a ball or droplet changes. Both physical and chemical properties are derived from atomic and molecular origin in a complex way. For example, the electronic and optical properties and the chemical reactivity of small clusters are completely different from the better-known property of each component in the bulk or at extended surfaces. Complex quantum mechanical models are required to predict the evolution of such properties with particle size, and typically very well-defined conditions are needed to compare experiments and theoretical predictions.

Nanoparticles consist of three layers: the surface layer, the shell layer, and the core. The surface layer usually consists of a variety of molecules such as metal ion, surfactants, and polymers. Nanoparticles may contain a single material or maybe consist of a combination of several materials. Nanoparticles can exist as suspensions, colloids, or dispersed aerosols depending on their chemical and electromagnetic properties.

The properties of nanoparticles are dependent their size. For instance, copper nanoparticles than are smaller than 50 nm are super hard materials and do not exhibit the properties of malleability or ductility of bulk copper. Other changes that are dependent on the size of nanoparticles are super paramagnetism exhibited by magnetic materials, quantum confinement by semiconductor Q-particles, and surface plasmon resonance in some metal particles.

Research has also demonstrated that absorption of solar radiation in photovoltaic cells is much higher in nanoparticles than it is in thin films of continuous sheets of bulk material. This is because nanoparticles are smaller and can absorb greater amount of solar radiation.

Nanoparticles exhibit enhanced diffusion at elevated temperatures due to their high surface area to volume ratio. This property of nanoparticles allows sintering to take place at lower temperatures than in the case of larger particles. While this diffusion property exhibited by nanoparticles may not affect the density of the product, it can lead to agglomeration.

7.4 Applications of Nanotechnology

One of the most fascinating aspects of nanotechnology is the incredibly small scale at which nanoengineering and nanofabrication take place. Consider this example: The first working transistor, built by Bell Labs' John Bardeen, Walter Brattain, and William Shockley in 1947, measured roughly 1 centimeter across. Today, logic transistor density has surpassed a staggering 100 million transistors per square millimeter. That means that the same surface area of Bell Labs' original transistor can now contain more than 10 billion transistors.

Chemists and biologists have dealt with naturally occurring nanoparticles all along. Think molecules or viruses. Toxicologists have dealt with nanoparticles that are the result of modern human life such as carbon particles in combustion engine exhaust. Without being aware of it, tire manufacturers used nanoparticles (carbon black) to improve the performance of tires as early as the 1920s. Medieval artists used (unknowingly) gold nanoparticles to achieve the bright red colors in church windows. You might even say that we are surrounded by, and made of, nanomaterials – atoms and molecules are nanoscale objects after all. So why all the fuzz about "nano" now?

The ongoing quest for miniaturization has resulted in tools like the atomic force microscope and the scanning tunneling microscope. Combined with refined processes such as electron beam lithography, these instruments allow researchers to deliberately manipulate and manufacture nanostructures; something they couldn't do before.

Engineered nanomaterials, either by way of a top-down approach (a bulk material is reduced in size to nanoscale patterns) or a bottom-up approach (larger structures are built or grown atom by atom or molecule by molecule), go beyond just a further step in miniaturization. They have broken a size barrier below which quantization of energy for the electrons in solids becomes relevant.

The so-called quantum size effect describes the physics of electron properties in solids with great reductions in particle size. This effect does not come into play by going from macro to micro dimensions. However, it becomes dominant when the lower nanometer size range is reached. Materials reduced to the nanoscale can suddenly show very different properties compared to what they show on a macroscale. For instance, opaque substances become transparent (copper); inert materials become catalysts (platinum); stable materials turn combustible (aluminum); solids turn into liquids at room temperature (gold); insulators become conductors (silicon).

A second important aspect of the nanoscale is that the smaller a nanoparticle gets, the larger its relative surface area becomes. Its electronic structure changes dramatically. Both effects lead to greatly improved catalytic activity but can also lead to aggressive chemical reactivity.

The fascinating prospects that nanotechnology offers engineers and researchers stems from these unique quantum and surface phenomena that matter exhibits at the nanoscale, making possible novel materials and revolutionary applications.

It is quite amazing how much of nanotechnology-related research is inspired by nature's designs. As a matter of fact, nature is full of examples of sophisticated nanoscopic architectural feats. Whether it is structural colors; adhesion; porous strength; or bacterial navigation and locomotion—they underpin the essential functions of a variety of life forms, from bacteria to berries, wasps to whales.

7.5 Social and Ethical issues of Nanotechnology

Nanotechnology will have very broad applications across all fields of engineering, so it will be an amplifier of the social effects of other technologies. There is an especially great potential for it to combine with three other powerful trends – biotechnology, information technology, and cognitive science – based on the material unity of nature at the nanoscale and on technology integration from that scale. Technological convergence highlights such existing issues as the treatment of the disabled, communication breakdowns, economic stagnation, and threats to national security. Nanotechnology itself may possibly raise distinctive ethical and social issues in the future, but much of the public discussion to this point has been misdirected and misinformed, lacking a firm social scientific basis. Thus it will be important to integrate social and ethical studies into nanotechnology developments from their very beginning.

Social scientific and economic research can help manufacturers and governments make the right decisions when deploying a new technology, maximizing its benefit for human beings. In addition, technically competent research on the societal implications of nanotechnology will help give policymakers and the general public a realistic picture free of unreasonable hopes or fears. The costs of premature or excessive regulation would be extremely high, harming the very people it was intended to protect, and failure to develop beneficial nanotechnology applications would be unethical.

The significance of nanotechnology depends largely on how its development relates to wider trends going on in the world such as the impending population declines of most advanced industrial nations, the apparent diminishing returns to increased medical research and health care investment, and the threatened deceleration of progress in microelectronics. Well established social-scientific explanations for unethical behavior – such as learning, strain, control, and subculture theories – could help us understand possible future cases in nanotechnology industries. Ethics and social implications are largely matters of social perception, and the public conception of nanotechnology is still in the early stages of developing. Social science can now begin to examine its unfolding impacts in all sectors of the economy, in most spheres of life, and both short-term and long-term time scales.

Assessment

Task 1. Name at least five (5) areas/fields of development where nanotechnology has been applied to. Classify your answers using the matrix and example below. Perfect score for this output is 50 points.

Area/Field of Development	Name of Product/Device/nano material	Function/s
Example: manufacturing	CermaClad	a nanocomposite coating for pipes in the oil industry to provide resistance to corrosion. The coating can be applied at a lower temperature and faster speed than conventional methods, leading to reduced cost and cheaper pipes.
1.		
2.		
3.		
4.		
5.		

Task 2. List down two (2) major concerns that may affect humans and society in the manufacture and use of nanotechnology. Describe your concerns. Perfect score for this output is 10 points for each item.

Task 3. Perfect score for this output is 25 points for each item.

A. https://www.sciencedaily.com/terms/nanoparticle.htm

Go and open the url given above. You will find a news article entitled, "Nanoparticle" posted on September 2, 2020. Read the article and make a reaction (composed of not less than 200 words, excluding articles such as: "of, in, and, or, if, as, to, by" and the likes..)

B. https://www.youtube.com/watch?time_continue=12&v=yxyCLoYfexo&feature=emb_logo

Go and open the url given above. Watch the video. Your task is to find and watch another but similar video that also demonstrates or at least illustrates a product that is manufactured with the application of nanotechnology. Make a reaction (composed of not less than 200 words, excluding articles such as: "of, in, and, or, if, as, to, by" and the likes..). At the bottom of the reaction, copy paste the url of your chosen video to provide link and reference to your instructor. First come first served basis, which means: a particular video that has been watched by five (5) students already cannot be anymore watched by one or more students and any student in excess of five per video will have to look for another video of similar content.

Task 4. Answer the following questions as comprehensively and personalized as you can. Perfect score for this output is 10 points for each item.

1. Shouldn't we concentrate on current problems like poverty, pollution, or solving international conflicts and crisis such as this covid-19 pandemic, instead of putting effort into far future technologies such as nanotech? Why or why not?
2. Simplify this quotation from a scientist: "Incurable diseases will eventually force mankind to justify disruptive nanotech and genetic engineering." ― Toba Beta

Learning Resources:

1. Module
2. Schoology
3. Moodle
4. Google Classroom

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Lesson 8. Climate Change

Climate change is a worldwide issue that we have to face. Climate change is referred to as statistically significant climate variation persisting for a period of time. The continuous climate change could bring drastic effects to living and nonliving forms on Earth.

Climate change is brought by several factors like natural processes and persistent human activities. Global warming is one of the major effects of climate change. Global warming threatens all life forms on Earth. It has drastic effects on water availability, food source, health issues, land use and ecosystem.

Intended Learning Outcomes

At the end of the lesson/topics, the students are expected to:

1. Identify the causes of climate change;
2. Assess the various impacts of climate change including economic, geopolitical, biological, meteorological, etc.;
3. Apply STS concepts to the issue of climate change;
4. correlate the use of alternative sources of energy to mitigation to climate change impacts; and
5. Suggest ways in helping minimize the effects of climate change and reduce the risk of disasters.

Discussion

8.1 Definition, Causes and Effects of Climate Change

Climate change, periodic modification of Earth's climate brought about as a result of changes in the atmosphere as well as interactions between the atmosphere and various other geologic, chemical, biological, and geographic factors within the Earth system.

The atmosphere is a dynamic fluid that is continually in motion. Both its physical properties and its rate and direction of motion are influenced by a variety of factors, including solar radiation, the geographic position of continents, ocean currents, the location and orientation of mountain ranges, atmospheric chemistry, and vegetation growing on the land surface. All these factors change through time. Some factors, such as the distribution of heat within the oceans, atmospheric chemistry, and surface vegetation, change at very short timescales. Others, such as the position of continents and the location and height of mountain ranges, change over very long timescales. Therefore, climate, which results from the physical properties and motion of the atmosphere, varies at every conceivable timescale.

Climate is often defined loosely as the average weather at a particular place, incorporating such features as temperature, precipitation, humidity, and windiness. A more specific definition would state that climate is the mean state and variability of these features over some extended time period. Both definitions acknowledge that the weather is always changing, owing to instabilities in the atmosphere. And as weather varies from day to day, so too does climate vary, from daily day-and-night cycles up to periods of geologic time hundreds of millions of years long. In a very real sense, *climate variation* is a redundant expression—climate is always varying. No two years are exactly alike, nor are any two decades, any two centuries, or any two millennia.

Causes

- The brightness of the Sun continues to increase as the star ages and it passes on an increasing amount of this energy to Earth's atmosphere over time.
- Fossil-fuel combustion, deforestation, rice cultivation, livestock ranching, industrial production, and other human activities have increased since the development of agriculture and especially since the start of the Industrial Revolution.
- Greenhouse gases (GHGs) in the atmosphere, such as carbon dioxide, methane, and water vapor, absorb infrared radiation emitted from Earth's surface and reradiate it back, thus contributing to the greenhouse effect.
- Ice sheets, sea ice, terrestrial vegetation, ocean temperatures, weathering rates, ocean circulation, and GHG concentrations are influenced either directly or indirectly by the atmosphere; however, they also all feed back into the atmosphere and influence it in important ways.
- Periodic changes in Earth's orbit and axial tilt with respect to the Sun (which occur over tens of thousands to hundreds of thousands of years) affect how solar radiation is distributed on Earth's surface.
- Tectonic movements, which change the shape, size, position, and elevation of the continental masses and the bathymetry of the oceans, have had strong effects on the circulation of both the atmosphere and the oceans.

Effects

- Human societies have changed adaptively in response to climate variations, although evidence abounds that certain societies and civilizations have collapsed in the face of rapid and severe climatic changes.
- The complex feedbacks between climate components can produce "tipping points" in the climate system, where small, gradual changes in one component of the system can lead to abrupt climate changes.
- The history of life has been strongly influenced by changes in climate, some of which radically altered the course of evolution.
- The most familiar and predictable phenomena are the seasonal cycles, to which people adjust their clothing, outdoor activities, thermostats, and agricultural practices.

8.2 Effects of Climate Change on Society

Climate change is not only hitting close to home – it's knocking on our front door and demanding to come in. But we're not going to let that happen. When we talk about who climate change affects, we are guessing your first thought isn't *me*. Or your friends and family today. You are not alone. If you're like most people, you maybe imagine your grandchildren or even great-grandchildren having to deal with record heatwaves. Or people far away struggling in the face of rising seas.

But the (rather inconvenient) truth is that the climate crisis is already affecting most of us right here and right now. From the second we wake up in the morning, to the minute we doze off at night. And we have to do something about it. We all know that global temperatures are rising – and we know why.

For centuries, humans have been burning fossil fuels to power their lives. This process releases additional greenhouse gases into the atmosphere, trapping heat that would escape into space otherwise. We have known for decades about the damage all that extra heat is doing to the Earth. Now, a recent UN-backed report on climate change highlights just how dangerous that process has been. The planet has already warmed 1 degree Celsius and temperatures could rise even more – significantly changing life as we know it.

We are already seeing the first impacts of this crisis. But here's the good news – *we still have time to turn things around*.

Here are three ways that climate change is already affecting people's lives:

1. Health

Climate action is just what the doctor ordered. And we mean that quite literally. Medical professionals have increasingly been sounding the alarm about the risks and consequences of continually burning fossil fuels. Here is the problem. The same dirty fossil fuel emissions that contribute to the greenhouse effect can lead to respiratory diseases – such as asthma – in children and adults. And they can be quite dangerous. Air pollution kills an estimated 7 million people worldwide every year, according to the World Health Organization.

By trapping heat into our planet, carbon emissions also damage the human body and mind in other ways. We've all heard about the risks of heat strokes. But did you know that warmer temperatures are linked to a 2 percent increase in mental health issues such as stress, anxiety, and even PTSD?

2. Home

There's really no place like home. But for many living in coastal communities, sea-level rise could lead to an unwanted (and sudden) move. As our globe warms, glaciers melt and ocean water expands, leading seas to rise about **7 to 8 inches on average since 1900** – about 3 inches of that since 1993. The added volume of water creeping up coastlines slowly swallows land and homes and fuels more flooding inland (to name just a few impacts). For example, in the United States, from 2005 to 2015, the median annual number of flood days more than doubled on the East Coast between Florida and North Carolina, thanks in part to rising sea levels.

3. Food

No two people in this world are exactly the same. But there is something that we all do, regardless of our culture, language, or personality. We all eat. So it is hard to ignore the impacts of climate change on food. The same CO2 accumulating in our atmosphere thanks to fossil fuels is actually changing the composition of fruits and vegetables that we eat, making them less nutritious. Extra CO2 is speeding up photosynthesis and causing plants to grow with more sugar and less calcium, protein, zinc, and important vitamins.

According to Harvard researchers, if we don't reduce carbon emissions right now, this could spell big problem for our diets. By the middle of the century about 175 million more people could develop a zinc deficiency and 122 million people could become protein deficient as a result of these changes to plant physiology.

For more understanding of the preceding discussions, it is recommended that you watch the video using the link below:

https://www.facebook.com/watch/?v=1547603985326654&t=39

8. 3. Alternative Sources of Energy

For several decades there has been quite a bit of discussion about the damage caused to the environment by littering and pumping harmful gases into the atmosphere. Many ideas on how to protect the environment have been put into place, either by social consciousness or by law, to help clean up the earth and reduce future pollution. These ideas range from recycling, to picking up trash, to using alternative energy sources. We are going to focus on the benefits, possibilities, and barriers that come with the use of alternative energy.

Alternative energy is best defined as the use of energy sources other than traditional fossil fuels, which are considered environmentally harmful and are in short supply. Fossil fuels consist of natural gas, coal, and oil. Currently, fossil fuels are the most used energy source to heat our homes and power our cars. To use these fuels as energy they must be burned, and burning of these fuels releases harmful gases into the atmosphere, causing pollution. Another problem associated with fossil fuels is their supply: it is unclear how long oil and coal reserves will last with our current rate of consumption or if new reserves will be found before current reserves run out. Estimates on how long current reserves will last run anywhere from 20 years to 400 years. Because of these concerns with fossil fuels, more people are beginning to use alternative energy sources. Some popular alternative energy sources are wind power, hydroelectricity (water power), solar power, biofuels, and hydrogen. These fuels all have two things in common: their small environmental impact on the earth and their sustainability (never ending supply) as an energy source.

So, if alternative energy sources are supposed to fix our environmental and supply problems, why have we not switched to using alternative energy sources solely? Well, the simple answer is that alternative energy sources also tend to have common barriers to their use as widespread energy sources. These barriers include location, storage, high cost to produce and use, and inconsistent energy supply.

When you boil it down there are only two types of energy: brown and green. Brown energy refers to electricity generated through the burning of traditional fossil fuels, such as coal or oil. This type of energy is associated with pollution because it emits a number of greenhouse gasses attributed to climate change. Green energy is the exact opposite. It's made of alternative energy sources that are infinite and pollution-free, such as wind, hydroelectric or solar power.

Types of alternative energy sources

When it comes to alternative energy sources, you're likely talking about the following renewable energy generation processes.

- **Wind energy.** Wind energy is one of the most abundant alternative energy sources in the United States, at times generating more than 6 percent of the nation's electricity, according to the Natural Resources Defense Council. Today, wind energy is typically generated through a **wind turbine.** These structures, which can stand more than 400 feet tall, resemble large pinwheels. As wind blows, the turbine blades spin, producing kinetic energy. That energy can then be converted into usable electricity for your home.

- Solar energy. The sun is so powerful that just one hour of sunlight could power the planet for an entire year. In order to harness its energy, solar panels, or photovoltaic cells, use semiconductors to capture the powerful rays. The semiconductor, typically silicon, absorbs sunlight and knocks its electrons loose, creating solar energy that can be harnessed and transported to the power grid.

- **Geothermal energy**. There are geological hot spots, such as volcanoes or hot springs, all over the world that are teeming with energy opportunity. These areas radiate extreme temperatures that, if harnessed, can be converted into renewable energy. To capture this energy, geothermal power plants are set up around hot spots where they drill into the Earth's core. The steam or scalding water that comes up in the process pushes a turbine to create electricity.

- **Hydroelectric power**. Water is another free resource that makes a great alternative energy source. And it's one of the nation's oldest renewable energy resources. In the 1920s, hydroelectric power supplied as much as 40 percent of the nation's electricity needs. Though the resource supplies significantly less today, it's still a valuable energy source. Hydroelectric power plants typically include a dam that helps control water levels and movement. To generate energy, the plant forces water through a turbine, causing it to spin. The movement is then captured by an attached generator that transforms the waters energy into electricity.

- Biomass. Instead of letting plant waste decompose on its own, the energy stored in the plants can be converted into renewable energy. Because plants store energy from the sun, they are full of usable energy that just needs to be harnessed. The process of creating energy involves burning plant material to create heat and then converting the heat into renewable electricity. Common biomass materials include forest residue, corn stalks or husks, sawdust and switch grass.

- Biogas. Biogas energy is generated by converting animal manure into electricity. As bacteria works to decompose the manure, special machinery is used to depress oxygen and convert the animal waste into methane gas. The methane can be used to heat water or create electricity for your home, while any leftover manure becomes fertilizer. But there's little-to-no biogas available on the grid today. Most biogas plants reside on large farms, where farmers use the energy source to power their own operations.

8.4 Disaster Risk Reduction Management

There is no such thing as a 'natural' disaster, only natural hazards.

Disaster Risk Reduction (DRR) aims to reduce the damage caused by natural hazards like earthquakes, floods, droughts and cyclones, through an ethic of prevention.

Disasters often follow natural hazards. A disaster's severity depends on how much impact a hazard has on society and the environment. The scale of the impact in turn depends on the choices we make for our lives and for our environment. These choices relate to how we grow our food, where and how we build our homes, what kind of government we have, how our financial system works and even what we teach in schools. Each decision and action makes us more vulnerable to disasters - or more resilient to them.

Disaster risk reduction is the concept and practice of reducing disaster risks through systematic efforts to analyse and reduce the causal factors of disasters. Reducing exposure to hazards, lessening vulnerability of people and property, wise management of land and the environment, and improving preparedness for adverse events are all examples of disaster risk reduction.

Disaster risk reduction includes disciplines like disaster management, disaster mitigation and disaster preparedness, but DRR is also part of sustainable development. In order for development activities to be sustainable they must also reduce disaster risk. On the other hand, unsound development policies will increase disaster risk - and disaster losses. Thus, DRR involves every part of society, every part of government, and every part of the professional and private sector.

Assessment

Task 1. Summarize the discussion on causes and effects of climate change by listing down at least five (5) major causes and effects of climate change. Suggest ways in minimizing the effects. Write your answers in the matrix below. Perfect score for this output is 25 points.

Causes	Effects	Suggestion/s on how to minimize the effects
1.		
2.		
3.		
4.		
5.		

Task 2. List down as least five (5) alternative sources of energy. One in the list should not be found or mentioned in the discussion, which means it is taken from your own research. Give their advantages and disadvantages to humans and environment. Write your answers in a matrix below.

Alternative Source of Energy	Advantages	Disadvantages
1.		
2.		
3.		
4.		
5. (not found in the discussion)		

Task 3. https://www.ndrrmc.gov.ph/attachments/article/41/NDRRM_Plan_2011-2028.pdf

Using the url above, open and read the complete copy the National Disaster Risk Management Council (NDRRMC) plans and programs for our country. Make a simple summary of the agency's plans and programs by filling out the matrix below. Perfect score for this output is 15 points.

Thematic Area (at least 4)	Function/Responsibility	Agency Responsible	Goal

Task 4. List down at least three (3) most common disasters in the Philippines. Describe their causes and effects. Give also suggestions on how can you reduce the risks according to the specific disasters in your list. Write your answers in a matrix below. Perfect score for this output is 25 points.

Name of disaster	Cause/s	Effect/s	Suggestion/s on reducing its risks
1.			
2.			
3.			

Task 5. Answer the following questions as comprehensively and personalized as you can. Perfect score for this output is 10 points for each item.

1. True or False: Environmental education is better than environmental laws. Defend your choice.
2. Explain these slogans:
   a. Disaster reduction is everyone's business.
   b. Think globally, Act locally.
3. What is the importance of using and looking for more alternative sources of energy?

4. https://www.facebook.com/watch/?v=907867819702932&extid=9uad9FVMzIzS5Y1b

   Using the link above, watch the video entitled, Storm Inside. Answer the following questions:
   a. What does the title mean to you?
   b. What part of the video caught your attention the most? Why?

Learning Resources:

5. Module
6. Schoology
7. Moodle
8. Google Classroom

References

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