Sharkya Stem School

Grade: 11

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Portfolio 22-19-02

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Introduction

Through our faith in the soul of our Teamwork and working together as one hand. We are happy to introduce our portfolio to you. This portfolio represents our work, achievements, and results of the integration between learning outcomes in our study throughout our second year in STEM schools. It is a pleasure to exhibit our ideas in our portfolio; hoping that it will assist the nation to solve its problems and issues.

As known, the Egyptian nation faces challenges, and through our work, we will try to solve some of these challenges like increasing the industrial and agricultural bases of Egypt and Improvement the scientific and technological environment for all, in addition to, Improvement the use of clean energies. The previous challenges are barriers for our country; to reach the desired target, which is sustainable development goals (SDG) and the optimum for the nation so that, our project tries to assist our country in beating these problems. Hence, we will do our best to overcome the problem and we will make a new and creative design that satisfies our needs; using the engineering design process, scientific research, and innovation; achieving a helpful assist for the Egyptian nation. We hope that our work admires your pleasure.

Present and Justify a Problem and Solution Requirements

Egypt Grand Challenges

- **Improve the use of alternative energies.**
- **Recycle garbage and waste for economic and environmental purposes.**
- **Deal with urban congestion and its consequences.**
- **Work to eradicate public health issues/disease.**
- **Increase the industrial and agricultural bases of Egypt.**
- **Address and reduce pollution fouling our air, water and soil.**
- **Improve uses of arid areas.**
- **Manage and increase the sources of clean water.**
- **Deal with population growth and its consequences.**
- **Improve the scientific and technological environment for all.**
- **Reduce and adapt to the effect of climatic change.**

Increase the industrial and agricultural bases of Egypt

Industrialization is generally accompanied by: Social changes as increased urbanization and the spread of manufacturing towns and Economic changes such as a fall in birth rates and a rise in per capita income. In the 1950s, Egypt started an ambitious industrial strategy that helped achieve economic development, creating jobs and increasing national revenues. Unfortunately, this industrialization was hit hard by the policy of nationalization and Egypt's defeat in the 1967 war. In the early 1990s the government has promoted privatization as a way to eventually increase industrial output. In 2001 industry accounted for 30% of GDB (Gross domestic Product).

Major industrial products included:

1. **Textiles**
2. **Chemicals (including fertilizers, polymers and petrochemicals)**
3. **Pharmaceuticals**
4. **Food processing**
5. **Petroleum**
6. **Construction**
7. **Cement**
8. **Metals**
9. **Light consumer goods**

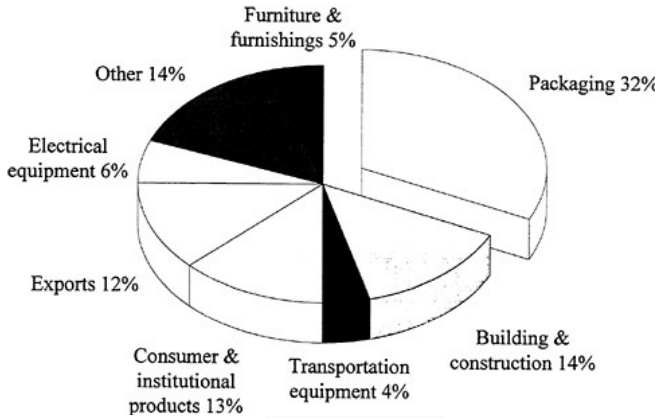


FIG. 1

Reasons of weaknesses of the industrial and agricultural bases:

1. **There are human resources, but the educational standards, whether in schools, universities or technical collages, are low. That's why there are low levels of productivity.**
2. **Low level of domestic saving in general and the reduction of foreign direct.**
3. **Investment (FDI), particularly after the 2011 Revolution.**
4. **The recent decline in energy supplies.**
5. **Egyptian industries at home and in international markets face heavy competition because Egyptian products are of a low quality and relatively high price.**
6. **Social instability and social Dissociation.**

Solutions to develop the industrial and environment base:

- **Establishing new industries, but also to deepen existing industries. Having political stability, predictability of policies, pressure for performance, public-private partnership, respect for property rights, and production capabilities of local firms in the value chain.**

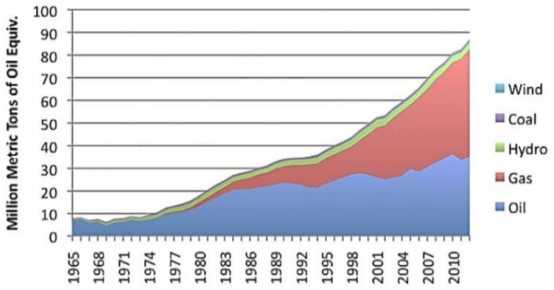


FIG. 2

- **Adjusting the public framework and make the domestic environment conducive to industrialization. Encouraging the private sector invest in energy production available modern investment laws that strike a balance between encouraging investment and maintaining national rights and interests using modern technology in education.**

- **For Egypt to be a modern industrial state it needs not only capital accumulation, but technical progress, new and efficient production techniques, and, most importantly, new energy sources.**

FIG. 3

Improve the use of alternative energies

Introduction:

Myriad types of energy affect our daily life but we are in danger of the ending of the sources of these energies. So, we need to find new sources that are clean and renewable to guarantee our existence.

There are two types of sources of energy which are: Renewable and Non-renewable sources. Most non-renewable energy sources are fossil fuels like coal, petroleum, and natural gas. Carbon is the leading element in fossil fuels which is from the reasons of global warming.

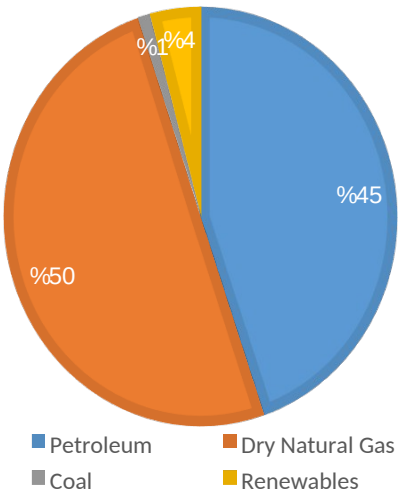


Chart.1

Sources of renewable energy:

FIG. 4

1- ***Solar energy*: The cleanest and most plentiful renewable energy source available, this form of energy depend on the nuclear fusion power from the core of the Sun. This energy can be collected and converted in a few different ways such as solar cells.**

2- ***Wind power*: The movement of the atmosphere is driven by differences of temperature at the Earth's surface; due to changeable temperatures of the Earth's surface when lit by sunlight. It needs wide areal coverage to produce significant quantities of energy.**

FIG. 5

3- ***Water "Hydroelectric"*: This form uses the gravitational potential of raised up water that was elevated from the oceans by sunlight. At present, most of the available locations for hydroelectric dams are already used in the developed world.**

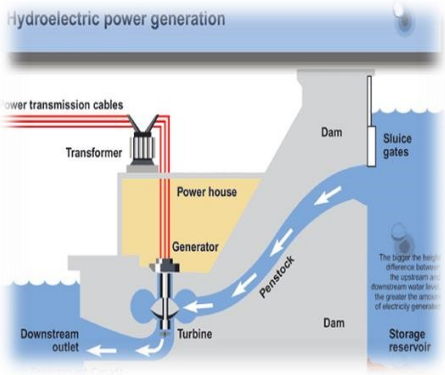


FIG. 6

4- *Biomass*: is the term for energy production from plants. Energy in this form is very commonly used all over the world. Unluckily, the most popular is the burning of trees for cooking and heat. This process releases abundant amounts of carbon dioxide gas into the atmosphere and is a major contributor to harmful air in many areas.

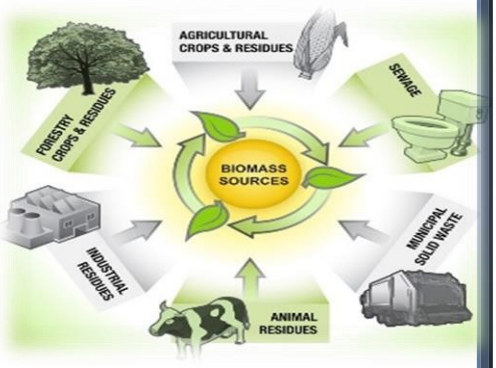


FIG. 7

5- *Geothermal energy*: is the use of the Earth's internal heat to boil water for heating buildings or generating electricity. Geothermal power is about extracting energy from the ground around us.


geothermal power station in philippines

FIG. 8

6- *Nuclear energy*: utilizes nuclear fission to release energy stored in the atomic bonds of heavy elements as uranium to form energy.

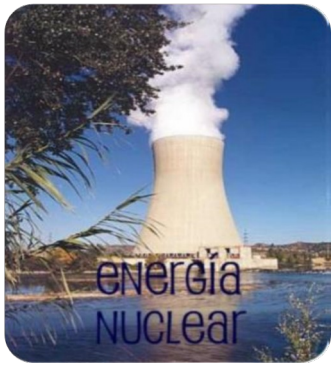
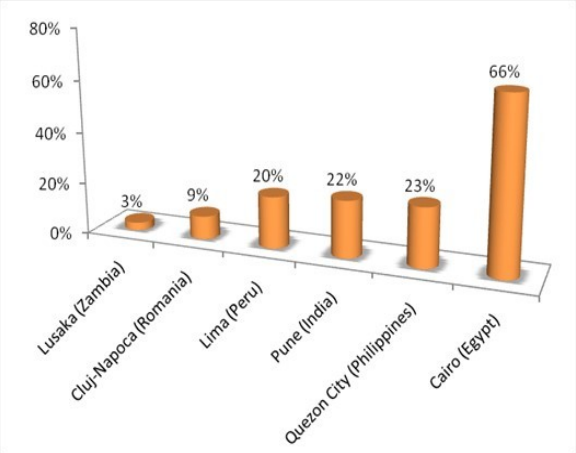


FIG. 9

Recycle garbage and waste for economic and environmental purposes

Introduction:

Not least of Egypt's problems are those created by and related to solid wastes, both hazardous and nonhazardous. Recycling is a process of converting waste materials into usable materials and objects. In 2012, Egypt generated 89.03 million tons of solid waste. So, we need to improve the recycling of wastes and garbage as it affects the public health, and if we improved the process of recycling this will increase the resources.



Graph.1

Harms of garbage:

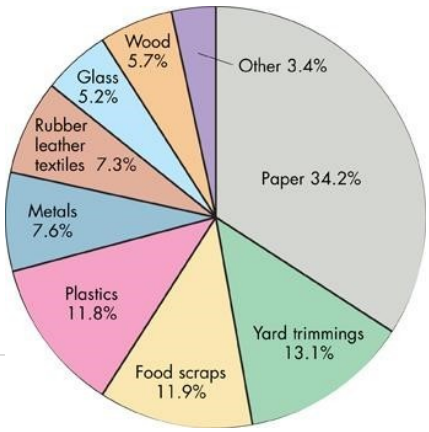
1- It poses dangerous risks to our land water, and air.

2- Landfills overfilling with garbage destroy profitable land and take many years to regain nutrients.

3- Some waste will eventually rot, but not all, and in the process, it may smell or generate methane gas, which is explosive and contributes to the greenhouse effect.

Industries help in producing wastes:

1. **Fertilizers**
2. **Inks**
3. **Oil**
4. **Plastic**



5. **Vehicles**

Importance of recycling:

Chart.2

1. **Solving the problem of garbage by recycling them instead of throwing them in water or street.**
2. **It increases the number of materials that we can use in Egypt instead of importing new materials.**
3. **Huge amounts of energy are used when making products from raw materials. Recycling requires much less energy and therefore helps to preserve natural resources.**

FIG. 10

Ways ease recycling of materials:

Putting recycle baskets in the streets with a label that identifies the type of the material that will be put in.

Improve the scientific and technological environment

Introduction:

FIG. 11

In a world moving rapidly towards the economics of 21th century which depends on knowledge and capacity building in science and technology is an urgent need everywhere, and surely in Egypt, in addition the accumulation of knowledge and its applications are accelerating dramatically, but our beloved Egypt faces many problems that preventing it from doing.

The integration between science and technology:

Technology implicates both machines (hard technology) and scientific thinking (soft technology) used to solve problems and consolidate progress. Particularly in Egypt, the scientific and technological environment is slightly unsatisfying as it is slightly arrear.

Importance of development for technology and environment:

1. **New developments.**
2. **Helping the developing world.**
3. **Creation of motivated scientific environment.**

Reasons of weaknesses of the scientific and technological environment:

1. **Weakness of education in Egypt.**
2. **Lack of training on the new equipment.**
3. **Lack of technological tools.**
4. **Lack of scientific labs.**
5. **Weakness of communication means in Egypt.**
6. **Lack of job opportunities for scientists.**

Overcome:

Encouraging young people to work in scientific fields as they don't like this because there aren't job opportunities in this field and the improvement of outsourcing communication means in Egypt and with experts in this field. Beside this solution Egypt will go forward toward progress and will be developed country that has many scientists that will help in development of it, the economy of Egypt will be better.

FIG. 12

Problem to be solved

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We have to admit that all people benefit from the growing industry in our country, be it advances in media production, business opportunities, power plants, or even just a new mall that has just been built. Industry plays an important role in everyone's life and it is one that we cannot live in one day without using a device or purchasing something manufactured by a large corporate industry. Although the industry seems to have a positive relationship with our daily life, there is a very negative impact of the growing industry on the environment.

To start with, one of the most known epidemics occurring today is air pollution. Air pollution is one of the major factors causing global warming, and it is due to the growing factories and industry in America that cause such pollution. The use of factories has released pollutants into the air, such as nitrogen oxides and organic solvents. Most of this air pollution results from the burning of fossil fuels, such as coal, oil, natural gas, and gasoline to produce electricity and run our cars. These pollutants not only harm public health but also harm the environment, and lead to climate change, global warming impact, and the ozone hole. Pollution is not only confined to factories, but also results from daily activities such as driving cars and trucks. Most cars have a typical combustion engine that burns fuel for energy, which results in the production of a variety of harmful chemicals such as carbon dioxide, volatile organic compounds, and particles. Additionally, it requires many fluids that are toxic to people, animals, and plants to function.

Not only do factories harm the environment because they cause tons of daily air pollution, but they also pollute the earth. The simplest way in which these factories can pollute the ground is simply by construction. Large acres of good land have been destroyed in order to build either a mall, a factory, or some other high-end buildings. These factories that sometimes have hazardous materials inside have leaks in which the fuel and energy stored in the factories seep into the ground under the building, causing ground pollution. Going

back to my first Civic Issues blog, one of the opponents of the pipelines Trump wants to revive to transport oil was the fact that these pipelines caused large amounts of ground pollution to the places they were running below. These pipes not only harm the surrounding environment but also harm the communities created above ground. If one of the pipelines bursts, the ground will be completely contaminated with harmful oil, which will lead to soil pollution. Soil pollution results from direct exposure to pollutants, toxic gases leakage into buildings, and groundwater pollution. Exposure to these toxic liquids may make the soil or the ground unsuitable for use due to industrial waste which will subsequently begin to slow down on the surface of the earth.

Causes for the industrial impacts on the environment:

1. Lack of Policies to Control Pollution:

Lack of efficacious policies and miserable enforcement drive allowed many industries to bypass laws made by the pollution control board that resulted in mass-scale pollution that affected the lives of numerous people.

FIG. 13

2. Unplanned Industrial Growth:

In most industrial townships, unplanned growth took place wherein those companies flouted rules and polluted the environment with air, soil and water pollution.

3. Use of Outdated Technologies:

Most industries still rely on old technologies to produce products that generate a large amount of waste. To avert high cost and expenditure, many companies still make use of traditional technologies to produce high-end products.

FIG. 14

4. Presence of a Large Number of Small-Scale Industries:

Many small-scale industries and factories that don't have sufficient capital and rely on government grants to run their day-to-day businesses often escape environment regulations and release a large number of toxic gases in the atmosphere as Carbon Dioxide.

5. Inefficient Waste Disposal:

Water pollution and soil pollution are often caused directly due to inefficiency in the disposal of waste. Long term exposure to polluted air and water causes chronic health problems, making the issue of industrial pollution into a severe one. It also lowers the air quality in surrounding areas, which causes many respiratory disorders.

6. Leaching of Resources from Our Natural World

Industries do require a large amount of raw material to make them into finished products. This requires the extraction of minerals from beneath the earth.

The extracted minerals can cause soil pollution when spilled on the earth. Leaks from vessels can cause oil spills that harm to marine life.

FIG. 15

7. Natural Resource Use:

Raw material is a need for industries, which often wants them even pulling out underground elements. One of the most common forms of leaching from natural resources is fracking for oil. When industries extract minerals, the process causes soil pollution and also causes oil leaks and spills that are harmful and even deadly to the life.

Effects for the industrial impacts on the environment:

1. Water Pollution:

The effects of industrial pollution are far-reaching and liable to affect the ecosystem for many years to come. Most industries require large amounts of water for their work. When involved in a series of processes, the water comes into contact with heavy metals, harmful chemicals, radioactive waste, and even organic sludge. These are either dumped into open oceans or rivers. As a result, many of our water sources have a high amount of industrial waste in them, which seriously impacts the health of our ecosystem. The same water is then used by farmers for irrigation purposes, which affects the quality of food that is produced.

FIG. 16

2. Soil Pollution:

Soil pollution is creating problems in agriculture and destroying local vegetation. It also causes chronic health issues to the people that come in contact with such soil on a daily basis.

3. Air Pollution:

Air pollution has led to a steep increase in various illnesses, and it continues to affect us on a daily basis. With so many small, mid and large-scale industries coming up, air pollution has taken a toll on the health of the people and the environment.

4. Wildlife Extinction:

By and large, the issue of industrial pollution shows us that it causes natural rhythms and patterns to fail, meaning that the wildlife is getting affected in a severe manner. Habitats are being lost, species are becoming extinct, and it is harder for the environment to recover from each natural disaster.

Major industrial accidents like oil spills, fires, the leakage of radioactive materials and damage to property are harder to clean-up as they have a higher impact in a shorter timeframe.

5. Global Warming:

With the rise in industrial pollution, global warming has been increasing at a steady pace. Smoke and greenhouse gases are being released by industries into the air, which causes an increase in global warming. Melting of glaciers, extinction of polar bears, floods, tsunamis, hurricanes are few of the effects of global warming due to the green house gases' effect.

FIG. 17

6. Biodiversity Loss:

Industrial pollution continues to cause significant damage to the earth and all of its inhabitants due to chemical wastes, pesticides, radioactive materials etc.

It affects wildlife and ecosystems and disrupts natural habitats. Animals are becoming extinct, and habitats are being destroyed.

The increasing liquid, solid and hazardous wastes undermine ecosystem health and impact on food, water and health security. Industrial pollution disasters, including oil spills and radioactive leakage, take years to decades to clean up.

7. Atmospheric Deposition:

Cadmium enrichment of soil can also be associated with industrial pollution. Top soils contaminated by mine spoil showed a wide range of Cadmium concentrations. Industrial effluents are commonly discharged to surface water drainage systems after clarification in tailing ponds. Recent investigations have disclosed very high concentrations of Cd in the overbank and bottom sediments of the rivers.

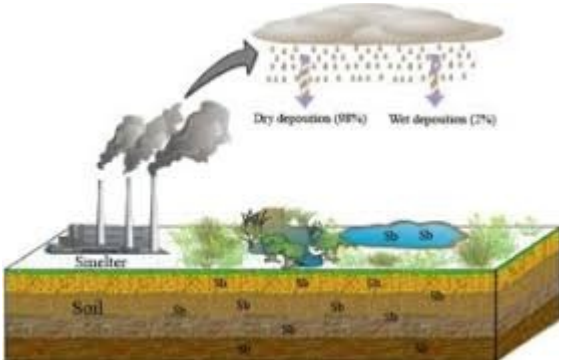


FIG. 18

Effects of energy industry:

Negative environmental impacts of hydropower industry:

- **Damage to wildlife habitats and migratory paths:**

Constructing large storage or pumped storage hydropower plants involves blocking, diverting, or changing the natural course of river systems.

One issue that arises with blocking a river's natural flow is the simultaneous blocking of important migration routes for fish. Many species of fish depend on inland rivers for reproduction; by blocking a river's flow with dams, fish cannot reach their breeding grounds. Over time, dammed rivers lead to drastically reduced fish populations, which has negative implications for the health of river ecosystems as well as for human food stocks. Some hydropower facilities use fish ladders to help fish populations traverse dammed rivers, but these devices are rarely large enough to support massive migrations.

Additionally, damming rivers also often reduces water and sediment flow to dangerous levels, which impacts downstream wildlife populations. Low water flow downstream, as well as low nutrient flow, can lead to loss of habitat and healthy water for animals.

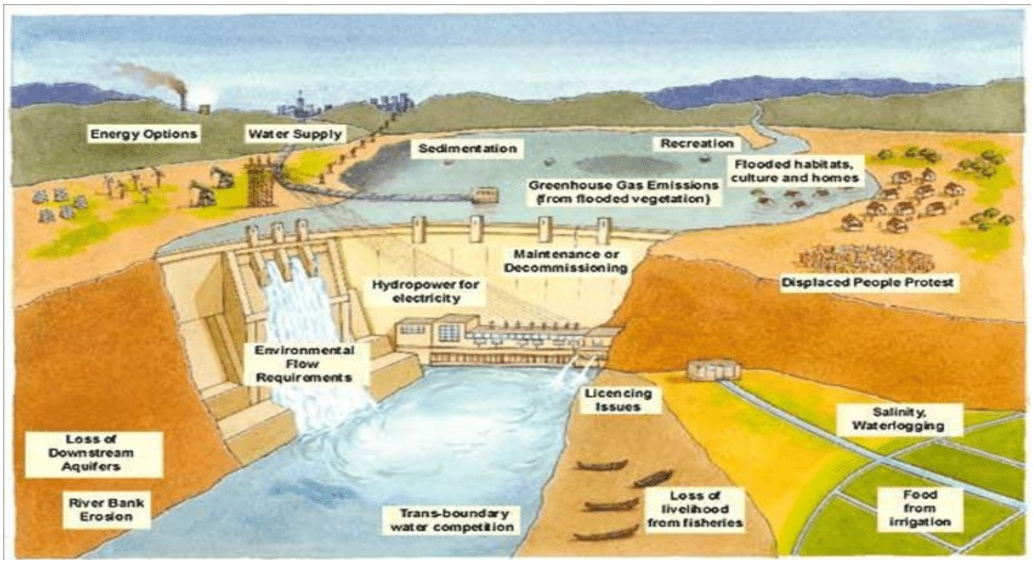


FIG. 19

- **Greenhouse gas emissions from reservoirs:**

While generating power by spinning turbines with water doesn't directly use any fossil fuels or emit any greenhouse gases, several recent studies have shown that reservoirs created by damming rivers contribute significantly to atmospheric greenhouse gases. This is because organic material trapped in the reservoirs, such as dead plants, breaks down and releases gases like carbon dioxide and methane into the reservoir water.

Negative environmental impacts of natural gas industry:

- **Global warming emissions:**

  Natural gas is a fossil fuel, although the global warming emissions from its combustion are much lower than those from coal or oil.

- **The drilling and extraction of natural gas from wells and its transportation in pipelines results in the leakage of methane, which is the primary component of natural gas that is 34 times stronger than CO2 at trapping heat over a 100-year period and 86 times stronger over 20 years. Studies and field measurements show that these methane emissions range from 1 to 9 percent of total life cycle emissions.**

- **Air pollution:**

  Burning natural gas does produce nitrogen oxides (NOx), which are precursors to smog, but at lower levels than gasoline and diesel used for motor vehicles. Reductions in these emissions affects public health positively, as these pollutants have been linked with problems such as asthma, bronchitis, lung cancer, and heart disease.

Research

We searched on many topics to know more about the problem, the scientific concepts, the prior solution, the design requirements that are the characteristics that should be in our solution and the mechanisms that we would use to construct our prototype.

First: Topics related to the problem:

- Introduction on energy industry and its impact on the environment.

- Causes of energy industry impact on the environment.

- Effects on the environment due to energy industry.

- Prior solutions of reducing greenhouse gases emissions and the effect of industry on the environment.

Second: Topics related to the solution:

- Conversion of solar energy to electricity using thermoelectric cooler.

- Usage of Freon gas in producing electric energy from solar energy.

- How the Freon gas can be reused or replaced with a less effect gas on the environment?

-

Other solutions already tried

1) Carbon capture and storage (CCS):

Carbon capture, utilization and storage (CCUS), also referred to as carbon capture, utilization and sequestration, is a process that captures carbon dioxide emissions from sources like coal-fired power plants and either reuses or stores it so it will not enter the atmosphere. Carbon dioxide storage in geologic formations includes oil and gas reservoirs, unamendable coal seams and deep saline reservoirs and structures that have stored crude oil, natural gas, brine and carbon dioxide over millions of years. The Energy Department supports research and development of tools to assess the environmental fitness and safety and proposed geologic storage sites. We're also developing models that simulate the flow of stored carbon dioxide, to help understand and predict chemical changes and effects of increased pressure that may occur.

FIG. 20

Mechanisms:

1- In post-combustion carbon capture, the carbon dioxide is captured after the fossil fuel is burned. Carbon dioxide is separated from the flue gas, having carbon dioxide, water vapor, Sulphur dioxides, and Nitrogen oxides, by bubbling the gas through an absorber column packed with liquid solvents, such as ammonia. In the most widely used system, once the chemicals in the absorber column become saturated, a stream of superheated steam at around 120 C passed through it. This releases the trapped CO_2, which can then be transported for storage elsewhere.

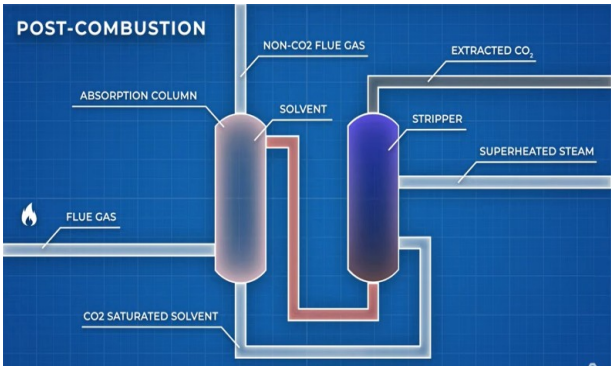
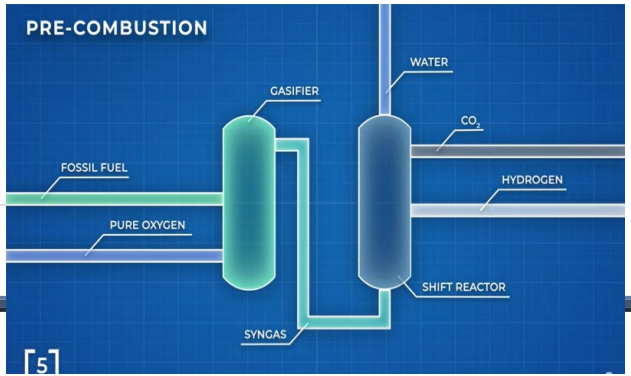


FIG. 21

2-In pre-combustion carbon capture, CO_2 is trapped before it's diluted by other flue gases. The fossil fuel is heated in pure oxygen, resulting in a mix of carbon



monoxide and hydrogen. The carbon monoxide is reacted with water to produce carbon dioxide, which is captured, along with hydrogen. The hydrogen can be used to produce electricity, and the carbon dioxide is stored. Pre- and post-combustion carbon capture can prevent 80 to 90 percent of a power plant's carbon emissions from entering the atmosphere.

3- This is a big deal. The IPCC estimates that carbon capture and storage have the potential to make up between 10% and 55% of the total carbon mitigation effort until year 2100. However, this carbon has to be stored somewhere. It is most often stored underground in a process called geological sequestration, which involves injecting CO_2 into underground rock formations. It is stored as a supercritical fluid, meaning it has properties between those of a gas and a liquid. When carbon dioxide is injected at depth, it will remain in the supercritical condition as long as it stays in excess of 31.1°C and at a pressure in excess of 72.9 atm. The carbon dioxide is injected into a reservoir which previously trapped oil and gas, since those areas have natural rock formations that help to contain the carbon dioxide.

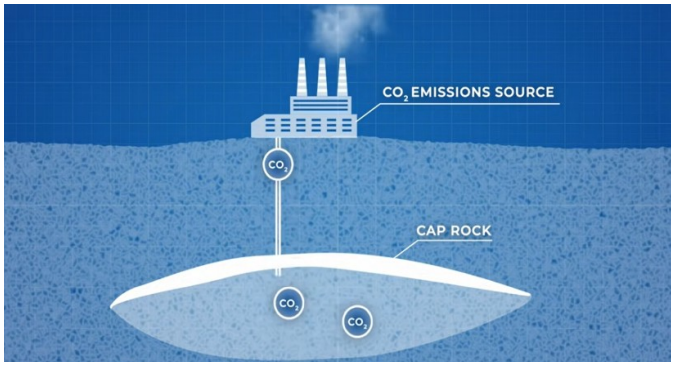


FIG. 23

4- Other methods of storing carbon include sinking it deep below the ocean, at depths under 3500 meters, where it turns into a slushy material that will sink to the ocean floor under that amount of pressure. But this method is largely untested, and again, there are concerns about what this could mean for marine life, and uncertainty on whether or not the CO_2 could eventually make its way back into the environment.

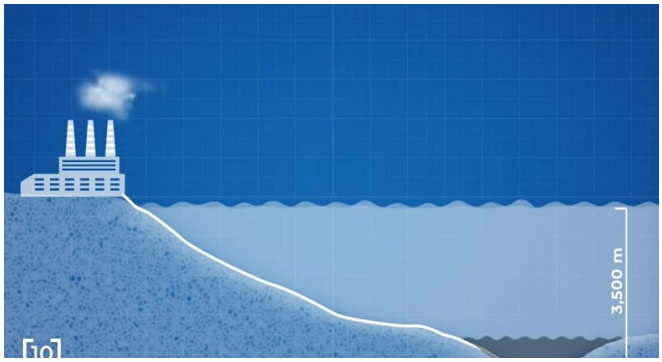


FIG. 24

Advantages:

1- High efficiency

2- Mineralization of carbon dioxide into minerals

3- Inexpensive

Disadvantages:

1. **May damage soil**
2. **Hazard the aquatic life**
3. **Earthquakes or human-induced incidents might result in CO2 leakage from underground and reservoir storages.**

2) Carbon nanotubes:

In 1993 by Lijima and Ichihashi and Bethune et al discovered independently carbon nanotubes. They can be used in highly-end electronics, also in the improvement of the carbon composite materials that used in air craft or spacecraft. Scientists from George Washington University invented a valuable technology; to restrict the carbon emissions located in the atmospheric air; decreasing the global worming effect by a making a solar power low energy system that can convert atmospheric carbon dioxide into

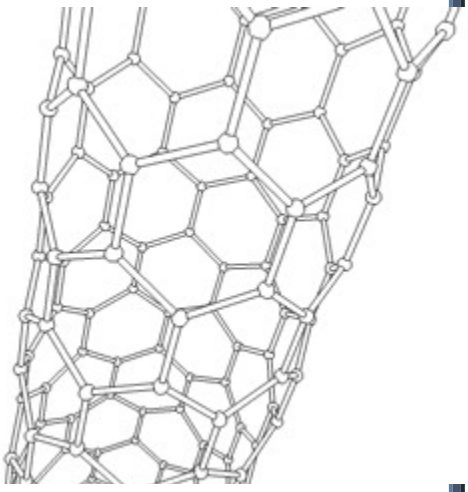


FIG. 25

valuable carbon nanofibers. This manner is used later as a clue to reduce the environmental impact of energy industry.

Mechanism:

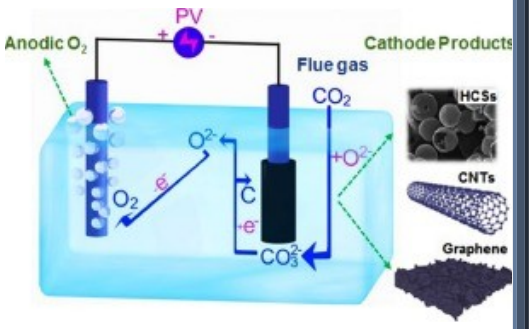


FIG. 26

A bath of molten carbonate is used and electrodes were dropped into the bath. Then passing an electric current through the salt. Through the chemical reaction, a black, sooty residue began to form around the electrodes. This back staff is the carbon nanofibers. Thus, the system alters the carbon dioxide from the atmosphere (by cars, fuel fuels, and industries) into a carbon residue at rate of 10 gram per hour.

Advantages:

1. **Smaller Inside**
2. **Low Cost per Computing**
3. **High Energy Efficient**
4. **Graphics Intensive**
5. **Free of energy leakage**
6. **Enable Multitasking**

Disadvantages:

1. **Not Portable**
2. **Lower rate conversion to carbon nanofibers**
3. **Large number of molten salts required for the reaction**

3) Solar Power industry:

Solar power plants using III-V / silicon cells have yet to be installed, as they are still in the early research and development stage. "We looked at potential environmental impacts at each stage of the life cycle of these advanced cells," Blanco explains. In this way, the researchers found that the biggest environmental impact of III-V / silicon cells comes from having to manufacture them with electricity from power plants. Especially when these power plants still depend on burning coal. "Not only does this affect the climate through carbon dioxide emissions, but the toxic fumes from burning coal also affect ecosystems in various other ways."

Solution:

Guest Frank Demroth of Fraunhofer ISE: “This impact can be overcome by developing more energy-efficient manufacturing processes and of course by moving to more sustainable electricity. It is surprising to note that the environmental impact of new solar cell technology depends on the way in which we produce electricity. Today from fossil fuels. "

The researchers were also able to confirm that - thanks to the new cells' high conversion efficiencies - ultimately fewer materials are needed per unit of electricity generated. Blanco: "This indicates that continuous innovation in solar cell technology and more energy-saving technologies can reduce the environmental impacts of solar cells.

Blanco and his colleagues relied on several models that consider many possible industrialization scenarios—more innovative or conservative. "This careful framing along with an unprecedented level of detail in the models allowed us to give very specific guidance for technology developers and policymakers. We found a few things that matter, but we also found many things that did not matter as much as initially thought. For example, the use of gallium and arsenic did not pose a major environmental concern in terms of toxicity or resource depletion as only very small quantities of these elements are consumed and they are strongly bound into the crystal structure."

4) Hydro Power industry:

Firstly, hydropower is a clean source for renewable electricity. No fossil fuels are needed to be burnt to generate hydroelectricity, and the water cycle is constantly running naturally, meaning that hydropower won't run out. Hydroelectric generation isn’t limitless, however, as there is a finite amount of water on Earth available to be harnessed (especially considering how many rivers have already been dammed).

While hydropower is clean and renewable, there are unique environmental side effects to the technology. The environmental impact of hydroelectric generation is complicated and necessitates examining the lifecycle of a hydropower plant. As new and improved hydropower technologies continue to be developed, hydroelectricity has the chance to become an even cleaner source of power.

FIG. 27

Solutions:

Fortunately, there are ways to improve hydropower systems to be more environmentally friendly. One such strategy is to better plan land use around river basins upstream of dams. By protecting the natural environment in a river's watershed, erosion can be better contained, which can then help lessen greenhouse gas pollution into the air from reservoirs, as there will be less decaying organic material in the water.

There is also progress being made to reduce hydropower's impact on fish habitats and migrations. Some hydroelectric facilities use trap-and-haul programs to collect fish, transport them past a dam, and release them. The Department of Energy (DOE) has recently even sponsored research and development of "salmon cannons", which launch migrating fish over a dam. A more sustainable long-term solution for many locations is more careful planning of dam placement so that the most important migration paths aren't disturbed. In some cases, removing old dams and letting river flow return closer to its natural state leads to habitat restoration for fish species.

5) Catalytic convertor:

The automobile energy depends on the fuel decomposition reaction. This reaction is considered as endothermic reaction, which produces heat. The concluded heat is converted to mechanical energy that makes the car move. Through the decomposition reaction, several types of gases are escalated. The exhausted gases, containing compounds such as nitric oxide, carbon containing compounds such as nitric oxide, carbon , cause dangerous impacts on the environment. These gases harms the atmosphere and contribute to increase the ozone-hole.

Catalytic converters is treatment system that is added to the end of the exhaust system. Catalytic converters are used to decrease the hazard of the exhausted gases as it convert them to less active gasses.

Types of catalytic converters:

1) Two-way catalytic converters (Oxidation) - used in diesel- fueled vehicles can reduce CO emission by
80% and a large portion of HC present in particulate matter emissions.
2) Three-way Catalytic Converters (Oxidation–Reduction)- installed on gasoline fueled vehicles can
reduce CO and HC emissions by about 90% and NO emission by 70% from uncontrolled levels.
3) Lean nitrogen-oxide Catalyst- is a modern type of catalytic converter which lessens NO emissions in lean conditions where a three-way catalyst is ineffective.

Mechanism:

The catalyst converts carbon monoxide to carbon dioxide, hydrocarbons to carbon dioxide and water, and nitric oxide to nitrogen gas to reduce the environmental impact of the exhaust gases.

6) Natural gas industry:

Technological advances have greatly increased natural gas production, keeping prices historically low and spurring many electric utilities and industrial companies to switch from coal to natural gas. To a lesser extent, policies have also played a role in the shift to natural gas. Because burning natural gas yields fewer carbon dioxide emissions than burning coal (one-half) or petroleum (one-third less), the transition to natural gas has accounted for much of the decrease in greenhouse gas emissions. Renewable electricity policies have also contributed to emission reductions.

Solutions:

- **Blending hydrogen with natural gas pipes:**

  Blending hydrogen into the existing natural gas infrastructure has high benefits for energy storage, resiliency, and emissions reductions. Hydrogen produced from renewable, nuclear, or other resources can be injected into natural gas pipelines, and the blend can then be used by conventional end users of natural gas to generate power and heat.

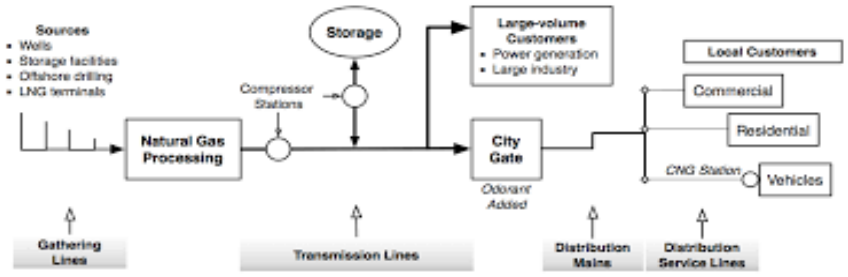


FIG. 28

- **Producing blue hydrogen from natural gas using steam methane reforming and carbon capture technology, which is consistent with 2050 climate goals.**

- **Capture the emissions of carbon dioxide when natural gas is burned. Carbon capture technologies could significantly reduce emissions at natural gas- and coal-fired power plants. These technologies are already in use in the industrial sector, but are just entering the power sector.**

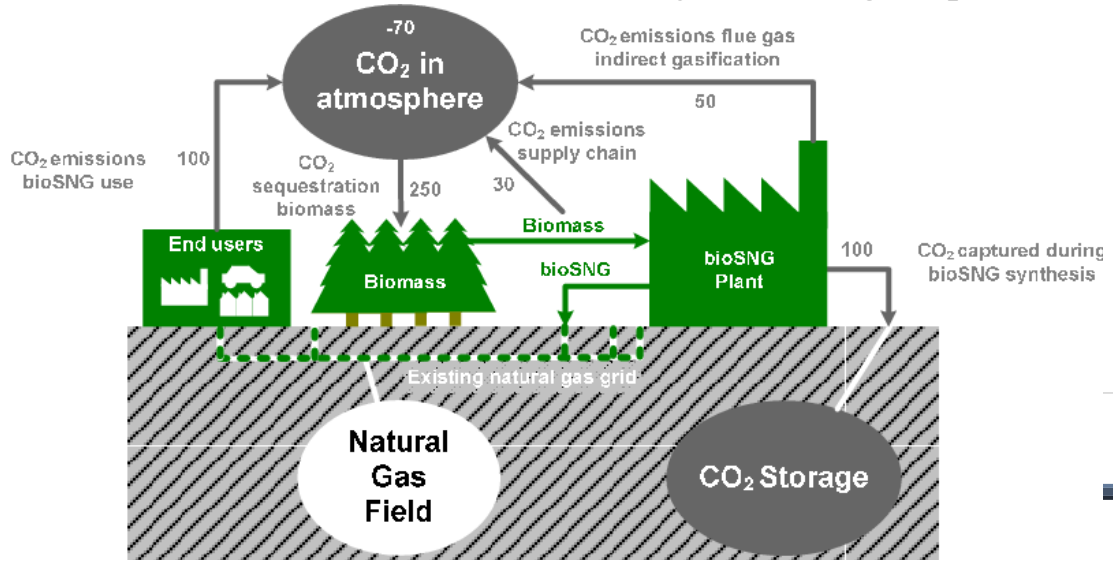


FIG. 29