MODULE 2

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- Differentiate between potential uses for natural gas in vehicular propulsion.
- Determine the factors that led to the use of natural gas as a shipping fuel.
- Recognize the differences between biogas and biomethane as well as their production processes.

NATURAL GAS IN VEHICULAR PROPULSION.

Vehicular Propulsion

This is a means of creating force leading to movement in vehicles. There will be a focus on how natural gas can be used as fuel in vehicular propulsion.
Not just for cooking, heating, and producing electricity, natural gas is essential. It can also be used to fill automobiles. Compared to petroleum goods, natural gas is a far more cost-effective and ecologically friendly fuel for vehicles.

What kind of fuel is used to fill Vehicles?

Different types of liquefied gas, including methane (natural gas), propane, butane, and their mixes, are used to fuel modern cars (so-called hydrocarbon gases). Methane may also be utilised in its compressed form. This article focuses only on using natural gas as a car fuel.

Why natural gas is viewed as an environmentally friendly fuel?

The "blue fuel" car's emissions are five times less toxic than those of a car with a gasoline engine. Since cars are the primary source of air pollution, especially in major cities, this is a significant benefit of natural gas. Cleaner air and better environmental conditions can result from the conversion of autos and buses to natural gas.

Methane Vehicle fuelling reduces costs

Methane currently costs roughly NGN 79.44 per cubic metre, which is equivalent to one litre of gasoline. Compared to gasoline, this is three times less expensive and uses less energy. It is significantly more advantageous to use NGV fuel in public transportation, which frequently travels vast distances. For instance, the price difference allows you to save roughly NGN 225.07 Million annually if you switch 100 buses from conventional fuel to methane.

Methane also doesn't contain any contaminants, so when it burns, it doesn't leave behind any silt in the fuel system. An engine powered by gas runs longer and more effectively.

Clean gas

Of all the fuels on the market today, natural gas is the safest. Methane doesn't build up in depressions during an accident and doesn't form a combustible vapour-air mixture. Gas leaks are not dangerous since they instantly dissipate because gas is lighter than air.

Engines powered by natural gas

Nowadays, practically all major auto manufacturers make vehicles that run on methane. The top manufacturers in the world today offer series cars with CNG engines, including Volvo, Audi, Chevrolet, Daimler-Benz, Iveco, MAN, Opel, Peugeot, Citroen, Scania, Fiat, Volkswagen, Ford, Honda, and Toyota. These cars are quite well-liked by car owners and are in no way inferior to their gasoline-powered equivalents. Today, there are more than 17 million methane-powered vehicles on the road, and that figure is rising.

It has been suggested that it be used more frequently as fuel for on-road vehicles, especially for light-duty cars. This could refer to running an internal combustion engine on natural gas. Similar to those found in the majority of natural gas, gasoline, and diesel-powered automobiles on today's route. However, natural gas can also be used as hydrogen or plug-in electric vehicle fuel. Automobiles are powered by fuel cells. Some effectiveness and environmental evaluations of three potential natural gas-powered light-duty vehicle choices.

NATURAL GAS AS A SHIPPING FUEL.

As the shipping industry searches for new fuels that will significantly reduce the carbon footprint of the sector, it is undergoing its most significant transition since switching from coal to heavy oil more than a century ago. Commercial pressure on ship owners to take action to safeguard the environment is growing.

Because research into new propulsion systems is still in its early stages and there is no agreement on what kind of fuel would propel oceangoing vessels into a new, cleaner future, many shipowners and industry observers doubt whether the industry can meet the carbon-cutting deadline.

Many shipowners predict that in the years to come, natural gas will be used to power an increasing number of oceangoing vessels. Even though it is yet unclear how far LNG can help ship operators transition to a carbon-free future, they are investing heavily in the technology.

According to estimates, using LNG lowers CO2 emissions by about 20% overall.

The primary component of natural gas is methane, and when natural gas doesn't burn completely, part of that substance is discharged into the atmosphere. The Natural Resources Defense Council claims that methane is "much more potent as a greenhouse gas than CO2" and that it is "80 times more effective at trapping heat than carbon dioxide." The economics of fuel are crucial for ship owners.

Building LNG-powered ships costs around 15% more than building ships burning conventional heavy oil, but fuelling them costs about 20% less, and if natural gas output rises, they may become even more cost-effective.

Since ships this year began using new fuel mixes based on oil that emits less sulphur and costs around 50% more than conventional heavy oil, the price gap has widened.

According to data from Vessels Value, there are only 746 LNG-powered ships now in operation and another 243 are on order among a total global fleet of around 60,000 oceangoing vessels. However, due to a lack of substitute fuels, hundreds more LNG-powered ships may be constructed in the upcoming years.

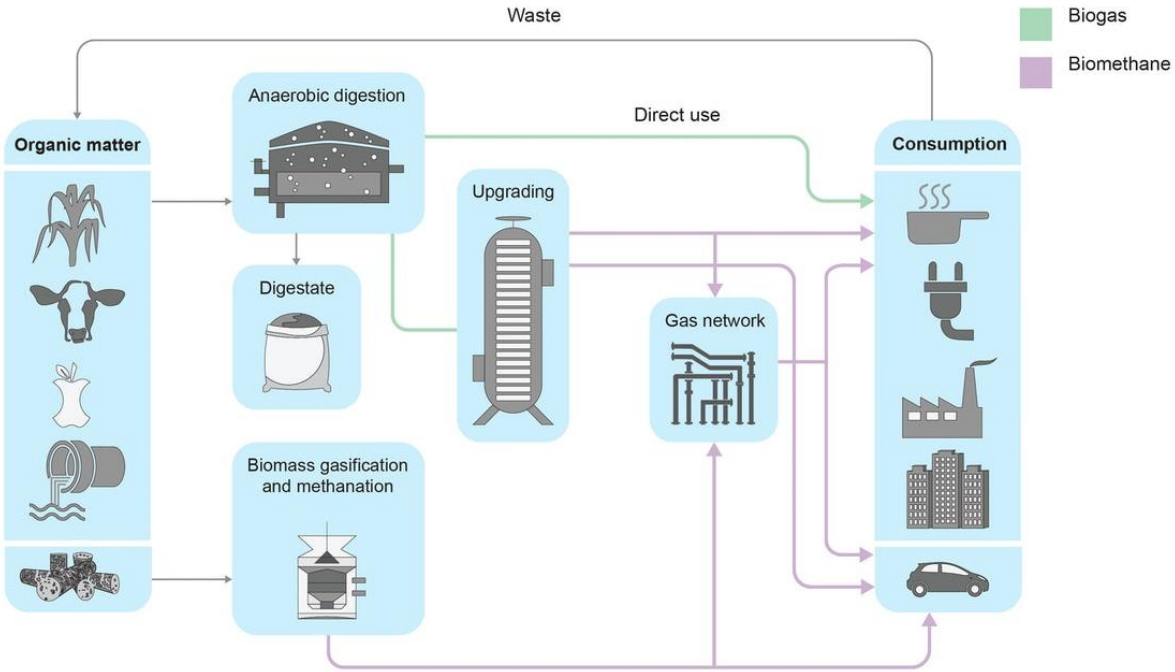
According to some owners, LNG may soon replace other fuels as the market hunts for greener substitutes. In comparison to fuel oil, LNG used as ship fuel emits much fewer sulphur oxides and particulate matter, and it also helps lower nitrogen oxide emissions. Even while LNG won't get ship operators to their target, it is a necessary stop along the long road to decarbonization.

In summary;

- Comparing natural gas to conventional marine fuels, natural gas minimises local air pollution.

- The first maritime application of Technology Warming Potential (TWP).
- When compared to other fossil fuels, LNG may have a lower TWP in some situations.
- A well-crafted energy strategy can support improved local low-GHG LNG infrastructure.

DIFFERENCES BETWEEN BIOGAS AND BIOMETHANE



How biogas and biomethane are produced.

BIOGAS

Biogas is a renewable fuel or non-fossil fuel created when organic material like food scraps and animal manure decomposes. Learn how biogas is created and how it may be used to generate energy, heat houses, and fuel automobiles.

Exactly how is biogas made?

An eco-friendly, renewable energy source is biogas. It is created during a process known as anaerobic digestion, in which microbes break down organic matter, such as food or animal manure, without the presence of oxygen. The waste material must be contained in an environment with no oxygen for this to happen.
Biogas can be produced artificially or organically as part of industrial processes for fuel.

What kind of trash is suitable for making biogas?

Biogas is produced when a range of waste materials, such as animal manure, sewage, plant material, and municipal trash or garbage, decompose.

Which gases are present in biogas?

Methane and CO2 make up the majority of biogas. Additionally, it might contain a little moisture, siloxanes, and hydrogen sulphide. Depending on the kind of waste used to create the final biogas, these relative quantities change.

What can be done with biogas?

If compressed, biogas can be utilised as a fuel for motor vehicles.
If biogas is purified and brought up to par with natural gas requirements, it is then known as biomethane and can be utilised similarly to methane, such as for cooking and heating.

BIOMETHANE

Through biogas upgrading, biomethane or renewable natural gas (RNG) is created. In gas engines, it can also be utilised as a renewable fuel.

Production of Biomethane

Biogas upgraders, which take the CO2 out of biogas, turn it into biomethane, a sustainable fuel. Biomethane is made from biogas, which is created from organic elements like sewage, food waste, food waste from distilleries, and agricultural products. Biogas and biomethane are regarded as renewable fuels since the carbon in these substances was recently removed from the atmosphere and is a component of the short-term carbon cycle.

To transform biogas into pure biomethane, it is cleaned, dried, and contaminants are removed. Peaking stations can also employ biomethane. As a renewable fuel, biomethane can be used to offer a 100% renewable power supply by balancing intermittent renewable generation.

COMPARISON OF BIOGAS AND BIOMETHANE

The energy that is Affordable, Sustainable, and Secure

Renewable gases like biogas and biomethane assist reduce emissions along the entire value chain. If we want to expedite the reduction of GHG emissions in a variety of sectors, such as buildings, industry, transport, and agriculture, their utilisation is crucial.

It is not necessary to spend extra money on building new infrastructure to use biomethane to replace fossil fuels. The current gas infrastructure is prepared for biomethane. This is essential for accelerating the decarbonization process and giving customers access to affordable renewable energy.

Additionally, biomethane can be readily stored and produced continuously, which helps balance the energy supply from sporadic renewable energy sources like solar and wind.

If we take into account all the positive externalities produced by the generation of these renewable gases, biogas and biomethane are already available and cost-competitive. As the world's largest producer of biogas and biomethane, Europe will need to increase output to fulfil the need for renewable energy by 2030 and to reach the 2050 climate goals.

Reducing Emissions of GHG

With a threefold reduction in emissions, biogas and biomethane prevent emissions throughout the whole value chain. First off, they prevent emissions that would otherwise happen naturally. Organic leftovers are transported to controlled environments like biogas facilities, where they are converted into a gas without releasing any emissions into the atmosphere. Second, the energy sources that are replaced by the produced biogas and biomethane are fossil fuels. Thirdly, using the digestate from the biogas production process as fertiliser minimises the need for carbon-intensive mining and production of mineral fertilisers by reintroducing organic carbon to the soil.

Energy from Renewable Sources

In Europe, combining heat and power (CHP) engines are a typical method for valorising biogas. The concept behind CHP is that producing electrical and thermal energy simultaneously is more efficient than doing so separately. Depending on how the biogas plants are built, some of the heat from the CHP may be used to help the fermentation process. For instance, if the biogas reactors need heat to maintain the right temperature, this may be the case. The majority of the electricity generated is routed into the electrical grid, and any excess heat is used for local heating uses.

Tidy Transportation

According to the most recent studies, biomethane can reduce GHG emissions from transportation, which account for 25% of all emissions in the EU.

Biomethane is utilised as a biofuel in the form of a bio-CNG or bio-LNG alternative. If we take into account the entire carbon footprint of the cars, biomethane in transportation is a top performer in terms of the reduction of GHG emissions (Well-to-Wheel). Biomethane can even have negative emissions, which means that CO2 is eliminated from the atmosphere, depending on the feedstock utilised. For instance, liquefied biomethane can be employed in the maritime industry and heavy-duty road transportation, both of which are challenging to electrify.

Recycling of Waste

The basic idea of a successful circular economy is the production of biogas and biomethane from various kinds of organic leftovers, turning trash into a useful resource. A local bio-economy can be developed by recovering food waste or wastewater from our towns and using it to generate sustainable energy. In rural areas, agricultural biomass or livestock waste can be processed and turned into energy, and digestate can be utilised as an organic fertiliser. This expands the economic models available in the agricultural industry, increases its cost-effectiveness, and encourages sustainable farming.

Agricultural Ecological Change

Agriculture is frequently one of the key economic sectors in rural communities. Another important factor in the creation of renewable energy, such as biogas, is agriculture. Combining farming with the production of renewable energy through biogas has several advantages: it helps farmers manage their waste and residues effectively, it lowers agricultural emissions, and it enhances the soil quality and biodiversity in farmlands.

In these healthy ecosystems, plants act as carbon sinks, absorbing carbon dioxide from the atmosphere. Digestate is used as an organic fertiliser, returning nutrients to the soil. Methane emissions from livestock are taken into a biogas plant's-controlled environment rather than being released into the atmosphere. By making agriculture more efficient and cost-competitive, the promotion of sustainable and efficient agricultural techniques is a key factor in rural development.

Completing the Carbon Cycle

The conversion of biogas to biomethane produces carbon dioxide as a by-product. The food sector can make use of the carbon dioxide stream, and greenhouses can utilise it to their fullest capacity for photosynthesis. The so-called "short carbon cycle," which begins with the use of the carbon present in organic waste to make biogas, which is partially made up of carbon molecules, concludes with this phase. The carbon in the digestate is reused, and the "short carbon cycle" is continued by applying the digestate as organic fertiliser to the soil. The removal of carbon from

the atmosphere is guaranteed by completing the entire carbon cycle and valorising the carbon dioxide produced after manufacturing biomethane.

However, biogas and biomethane have a significant potential role in changing the global energy system.

Currently, 10% of the world's primary energy demand is met by bioenergy. It can be eaten in solid, liquid, or gaseous form, however solid biomass is now the most often used type of bioenergy (around 90%).
Solid biomass is often used for "traditional" or "modern" purposes, and the demand is currently split nearly equally between the two. Modern biomass is dependent on increasingly sophisticated technology, mostly in industrial applications and electricity generation that employ improved fuels like woodchips and pellets. Traditional use refers to the employment of simple technologies like three-stone fireplaces to burn solid biomass for cooking or heating, such as wood, charcoal, agricultural waste, and animal dung.
Many developing economies are attempting to shift consumption away from conventional use due to low conversion efficiency and severe negative health effects from indoor air pollution.

Liquid and gaseous bioenergy cannot be classified as either traditional or modern because they are both produced with cutting-edge technologies. Currently, the demand for liquid biofuels is about 7% of the entire demand for bioenergy. The primary renewable energy source used directly in the transportation industry is biofuels, which in 2018 consumed roughly 2 million barrels of oil equivalent, every day. Bioethanol, which is typically combined with gasoline, accounts for around 70% of the biofuels used today; biodiesel makes up the majority of the remaining portion.

Currently, the demand for biogas and biomethane is less than 3% of the overall bioenergy demand and accounts for only 0.3% of all primary energy. However, there are reasons to think that these low-carbon gases might establish themselves more firmly in the future.

- They can deliver natural gas system advantages—storage, flexibility, and high-temperature heat—without producing net carbon emissions. This becomes an essential quality as economies decarbonize.

- In addition to serving as a beneficial cooking fuel for poor nations, biogas offers a steady supply of heat and power that can benefit communities looking for local, decentralised energy sources.

- Methane, a strong greenhouse gas, that would otherwise be released into the environment as a result of the decomposition of organic waste and by-products, is processed and used instead, which increases the effect of GHG reduction.

- The management of waste can benefit from the use of biogas and biomethane, increasing total resource efficiency.

- Biogas and biomethane also contribute to energy security where they replace long-distance imported or transported gas.

- Additional non-energy factors include nutrient recycling, the establishment of rural jobs, and a reduction in the amount of time spent gathering firewood in low-income areas. The energy and agricultural sectors can collaborate to produce biogas and biomethane on a large scale. Biogas and biomethane are excellent examples of circular economy products since they convert a variety of organic wastes into higher-value goods.

Policies can help to unlock these advantages, but much will rely on how much and how expensive biogas and biomethane are now offered. The following section responds to these queries.