

Title: Natural Gas Reserves

Topic: Students explore through various interdisciplinary activities the mathematics and science topics involved in using natural gas.	Time: 4 x 45 min lessons	Age: Grade 6-9, 12-15 year olds
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Differentiation***Lower level***

The basic outcome of pupils is to develop an understanding of the advantages and disadvantages of using Natural Gas as an energy source, and a simple calculation model of natural gas consumption.

Higher level

Students can develop complex models of natural gas consumption and fit their models to real world data. Students can also provide concrete ideas/solutions for improving the use of natural gas.

Guidelines, ICT support etc.

- Problem / Key question: How the disadvantages of using Natural Gas can be minimized, as to improve its use and when are the natural gas reserves going to be exhausted?
- Students work in groups to answer the key questions and provide the manager of a company with useful information on the key questions.
- Two videos can be used to introduce students in the uses and the formation of natural gas.
<https://www.youtube.com/watch?v=Xb9EF6NsloU>
https://www.youtube.com/watch?v=PDOD_FEnNk
- Pupils work in groups of 3-4.
- Students can use spreadsheet software in developing their models.

<p>Equipment needed for this activity</p> <ul style="list-style-type: none">• worksheets for students• computers with internet connection• computers equipped with spreadsheet software (Excel, Google Sheets, or any other spreadsheet software) <p>Required knowledge:</p> <ul style="list-style-type: none">• elementary arithmetic operations <p>Health and Safety: No special requirements</p>	<p>Learning outcomes for this activity</p> <p><u>All:</u></p> <p>All students are expected to understand the situation of the energy consumption, and the current situation of the natural gas use. It is also expected that all students will be able to develop a simple model for calculating when the reserves will be exhausted.</p> <p><u>Most:</u></p> <p>Most students are expected to understand the major advantages and disadvantages of using natural gas (also compared to other sources of energy).</p> <p>Students are also expected to develop quite complex models for calculating when the reserves will be exhausted.</p> <p><u>Some:</u></p> <p>Some students are expected to be able to provide concrete suggestions on how specific disadvantages of natural gas can be minimized (e.g., odorless).</p> <p>Some students are also expected to develop sophisticated models on estimating when the natural gas reserves will be exhausted, by also taking into consideration other factors, like for instance the discovery of new reserves.</p>
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Lesson descriptionStarter Activity

During the first part of the activity students can work individually to read the provided introductory text and answer the readiness questions (Worksheet 1). The purpose of this starter activity is to introduce students to the context of the situation, and to familiarize themselves with the various energy sources, the concepts of renewable and non-renewable energy, and the increase on the use of natural gas.

Main Activity

Students form groups of three to four. During the main activities (Worksheets 2, 3) students work in their groups to solve the problem. However, each student is provided with his/her own worksheets. Each group works on the problem under the supervision of the mathematics and science teacher. Appropriate feedback and support (to overcome difficulties) is provided when needed.

In the second activity (Worksheet 2) students work in developing an understanding of the various advantages and disadvantages of the natural gas uses. It is also expected from students (at least some of them) to provide suggestions on minimizing some of the disadvantages of the natural gas, as to improve its uses.

In activity 3 (Worksheet 3) students are encouraged to develop various models (as to provide answers to the three tasks), in answering the question: “When are the natural gas reserves going to be exhausted?”

During the last part of the activity (Worksheet 4) students prepare their letter, on an individual basis, addressing the main key-findings of their work.

Plenary

A whole class discussion takes place. Each group presents their results for discussion and reflection. The teacher orchestrates a discussion that focuses on the core concepts (e.g., improving the use of natural gas, calculation model on reserves) used in solving the problem, and provides guidelines for further improving the students’ solutions.

Energy Consumption in the World

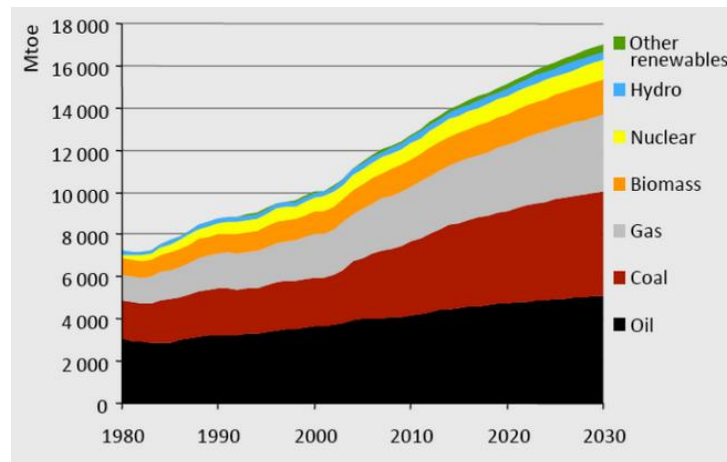
Work sheet 1

Energy sustainability is about finding the balance between a growing economy, the need for environmental protection and social responsibilities in order to provide an improved quality of life for current and future generations.

Energy sustainability can inspire technical innovation with an environmentally conscious mindset. Renewable resources such as sunlight, wind and biomass provide a source of sustainable energy.

This includes biofuels like ethanol, which is created from crops like corn or sugarcane.

Regulations designed to reduce air, water and waste emissions from energy-related activities such as coal mining and electricity generation also help with energy sustainability, as do people who conserve energy.



Source: EIA, World Energy Outlook 2008

Meeting energy demands also require using what we do produce much more efficiently. How can we use less energy to power everything from our computers to cars? The answer will require both new technologies and new cultural habits.

More than 85% of the world's current energy needs are met through fossil fuels such as coal, oil and natural gas. While there is enough fossil fuels supply for several more decades, what will happen when it starts running low? There are ways to reduce waste and use existing technologies to keep the air cleaner by reducing fossil fuels emissions. Expansion of all economic energy sources will be required: coal, nuclear, biomass, other renewables, unconventional oil and natural gas. Options like these are part of a concept called energy sustainability.

Oil and natural gas together make petroleum. Petroleum, which is Latin for "rock oil," is a fossil fuel, meaning it was made naturally from decaying prehistoric plant and animal remains. It is a mixture of hundreds of different hydrocarbons molecules containing hydrogen and carbon that exist sometimes as a liquid (crude oil) and sometimes as a vapor (natural gas).

Natural-gas use is growing across all economic sectors. Natural gas burns cleaner than oil or coal, and this environmental benefit has encouraged its use. Most natural gas is distributed by pipelines, which is a limiting factor for remote resources that are not near the major consuming markets. But there is considerable development of technology to convert natural gas to liquids to enable more widespread transportation.

Answer the following questions

a. List three renewable and three non-renewable energy sources.

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b. Which categories of energy sources (renewable or non-renewable) are mostly used?

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c. Which factors have an impact on the use of natural gas?

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Natural Gas: Advantages and Disadvantages

Work sheet 2

Natural Gas exists in a gaseous state and is composed mainly of methane (CH₄), and a small percentage of other hydrocarbons. Natural gas is produced along with coal and oil beds. Natural gas can be used in the form of compressed natural gas (CNG) or liquefied petroleum gas (LPG).

Some advantages of using Natural Gas are:

1. Less Harmful than Coal or Oil, as it causes less damage to the environment. Its use produces 30% less carbon emissions than oil.
2. Easy Storage and Transport, as it is easier to preserve than other fuels.
3. Residential Use: Natural gas can be piped (or using tanks) into houses for heating and cooking purposes and running a variety of appliances. It is the best fuel to power kitchens because of its control, reliability and precision. It is also an economic and instant fuel for heating water and large areas as well as cooking.
4. Vehicle Fuel: Natural gas can be used as a fuel for vehicles (cars, trucks, jet engines). It is a cleaner, cheaper fuel than diesel or gasoline.
5. Industrial use: Natural gas is used for producing hydrogen, ammonia for fertilizers and some paints and plastics.
6. Safer: It is lighter than air and tends to dissipate when there is a leakage unlike Propane, which being heavier than air, collects into explosive pockets.

Some disadvantages of using Natural Gas are:

1. Toxic and Flammable: Leaks of natural gas are tremendously dangerous, as they may cause explosions or fire. When inhaled, the gas is highly toxic. The main danger is that it is odorless.
2. Damage to Environment: Burning of natural gas also releases carbon dioxide, carbon monoxide and other carbon compounds which are greenhouse gases that cause global warming and climate change
3. Non-Renewable: Like all fossil fuels, natural gas though found in abundance is non-renewable and hence likely to be exhausted at some point of time. It is not a long term solution to our energy problems.
4. Inefficiency in Transportation: Natural gas when used as a fuel in vehicles provides less mileage than gasoline.

(Edited version of the text provided at <http://www.fueleconomy.gov/feg/bifueltech.shtml>)

Task 1: Read the following article and answer the questions.

List the two (2) advantages of using Natural gas that you find the most important.
Explain why.

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List the two (2) disadvantages of using Natural gas that you find the most important.
Explain why.

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Do you have any suggestions in improving the way Natural Gas is used, and in minimizing the disadvantages of using Natural gas?

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Natural Gas Reserves

Work sheet 3

Task 1:

The world natural gas reserves at the end of 1993 stood at 141.8 trillion cubic meters. Since then, and until 2013, on an average 2.5 trillion cubic meters are used annually.

- Use the provided information to find an estimate on when the reserves of the natural gas will be exhausted.
- Use different assumptions, and make explicit how each assumption impacts your solution / model.



Task 2:

The world's natural gas reserves at the end of 2013 stood at 185.7 trillion cubic meters.

Use this information to adapt/refine the model you have developed in Task 1.

Task 3:

According to the BP, one of the world leading energy companies, the reserves of the natural gas at the end of 2013 (185.7 trillion cubic meters) are sufficient to meet 55.1 years of global production.

How close is your estimation to the one provided by BP? Assuming that their model/estimation is correct, how could you change/refine your model, in order to end up with the same results?

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