**Teacher´s Guide**

**Something about the excess of CO2 and the consiquences-increase in peoples awareness´and sense of responsibility leading to solutions.**

You can do so many things to mitigate (Causes) climate change. By reducing the impact of our actions on the environment and enhancing the conditions that help reducing the carbon dioxide in the atmosphere. This means that we have to change our habits to meet our needs. We can all make right choices and every little thing counts!

As climate change is already happening, we need to be prepared to respond/adapt (effects) to changes that will affect people and the environment in many ways. The greater the degree of preparatory adaptation, the less may be the impacts associated with any given degree of climate change.

In general the more mitigation there is, the less will be the impacts to which we will have to adjust, and the less the risks for which we will have to try and prepare. Conversely, the greater the degree of preparatory adaptation, the less may be the impacts associated with any given degree of climate

Reykjavik Energy´s experience running a geothermal heating utility dates back to the 1940s. [The Hellisheiði Geothermal Plant](http://www.or.is/en/projects/hellisheidi-geothermal-plant) is a CH-plant (combined heat and power) in the Hengill geothermal field, located 20 miles outside of Reykjavík. The Hellisheiði Plant currently produces 213 MW of electricity. A complete plant will produce 303 MW of electricity and 400 MW of thermal energy (hot water). [The Nesjavellir Geothermal Plant](http://www.or.is/en/projects/nesjavellir-geothermal-plant) generates electricity and hot water by utilizing geothermal water and steam.

OR participates in the [Carb-Fix](http://www.or.is/en/Projects/CarbFix/) project which purpose is to develop methods to safely store CO2 as solid calcium carbonate in basaltic rock.

Attention. When we talk about producing energy we are referring to the production form the power plant that provide electricity, hot water etc. The source can be different but the outcome is the same- useable energy for consumers. We are not explaining it by means of physics.

The CarbFix project is designed to optimize industrial methods for storing CO2 in basaltic rocks through a combined program consisting of, field scale injection of CO2 charged waters into basaltic rocks, laboratory based experiments, study of natural analogues and state of the art geochemical modeling. A second and equally important goal of this research project is to generate the human capital and expertise to apply the advances made in this project in the future.

The reduction of industrial CO2 emissions is considered one of the main challenges of this century. To address this challenge, the CarbFix project is designed to optimize industrial methods for storing CO2 in basaltic rocks through a combined program consisting of, field scale injection of CO2 charged waters into basaltic rocks, laboratory based experiments, large scale plug-flow experiments, study of natural CO2 waters as natural analogue and state of the art geochemical modelling. A second and equally important goal of this research project is to generate the human capital and expertise to apply the advances made in this project in the future.

This research program includes:

1. Field scale injection of CO2 charged waters into basaltic rocks at the Hellisheidi natural laboratory. The Hellisheidi natural laboratory, situated in the Hengill area, SW Iceland, comprises ideal conditions for studying the feasibility of permanent CO2 storage as minerals in basaltic rocks due to availability of CO2 and water, the presence of fresh basalts, suitable geological structures, and an extensive infrastructure.

**Educational Material**

The purpose of this web site is to educate Students, 10 – 12 years old, on the environmental threat/problem, the causes of it and the consequences.

Education towards sustainability should prepare students to address subjects

CarbFix is introduced as one solution to this problem but and to support them to find solutions.

**The Game**

The main characters are Carry and Fix: they could be siblings- or friends but Fix is the younger one and therefore more curious and asks Carry the questions. Their names are based on the word CarbFix, but also the fact that Reykjavik Energy carries out that project and that word is related to caring. Their outfit comes from the safety uniform you need to wear when you visit the Hellisheiði power plant.

Other characters include the gases involve in the game and the videos. Their looks are based on models of atoms and molecules often found in classrooms. The exception is found in the creation of the carbonic acid character. As it is made by mixing water and carbon we wanted it to have obvious characteristics from both of those. We also considered the blue drop more visually connected to water than a red circle, giving more possibilities to the look of the carbonic acid.

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| E:\CarbFix\C(carbon).jpgCarbon - C | Hydrogen Sulphur - H2S | Hydrogen - H2 | Carbon dioxide - CO2 | Water - H2O | Carbonic acid - H2CO3 |

**Minerals**

They type of mineral forming in the CarbFix depend on the ions the carbonic acid dissolves from the basalt. According to models and calculations the crystals most likely to form are calcite, formed when the carbonic acid meets calcium, magnesite (from magnesium), siderite (from iron) and dolomite (from calcite and magnesium).

As magnesite is not found in Iceland we decided to only show pictures of the other three minerals oufnd in the Icelandic nature.

**Learning outcome**

After going throught the contents of the web site, both videos, student assignment oand the computer game, the student should be able to:

* **Understand and discuss the CarbFix process and its purpose**
* **Understood and explain what carbon is and where it can be found**
* **Communicate / express the causes and consiqences of the climate change**
* **Search for and find some solutions to the issues related to climate change**