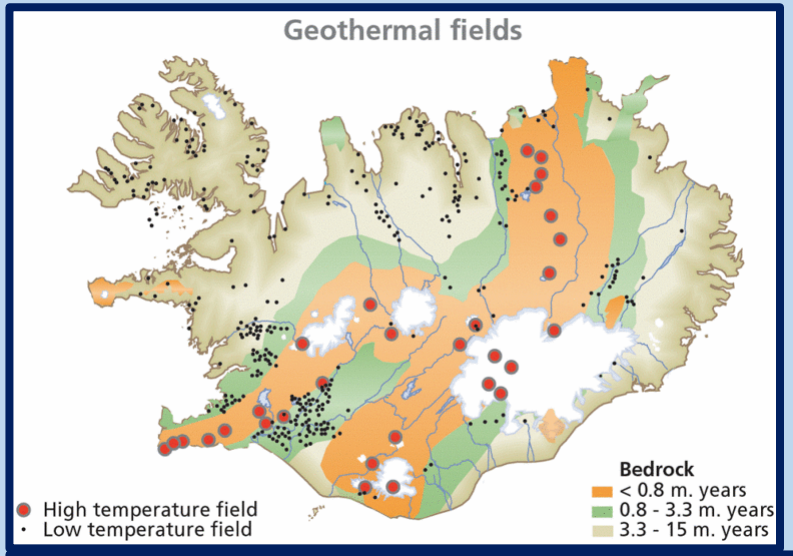
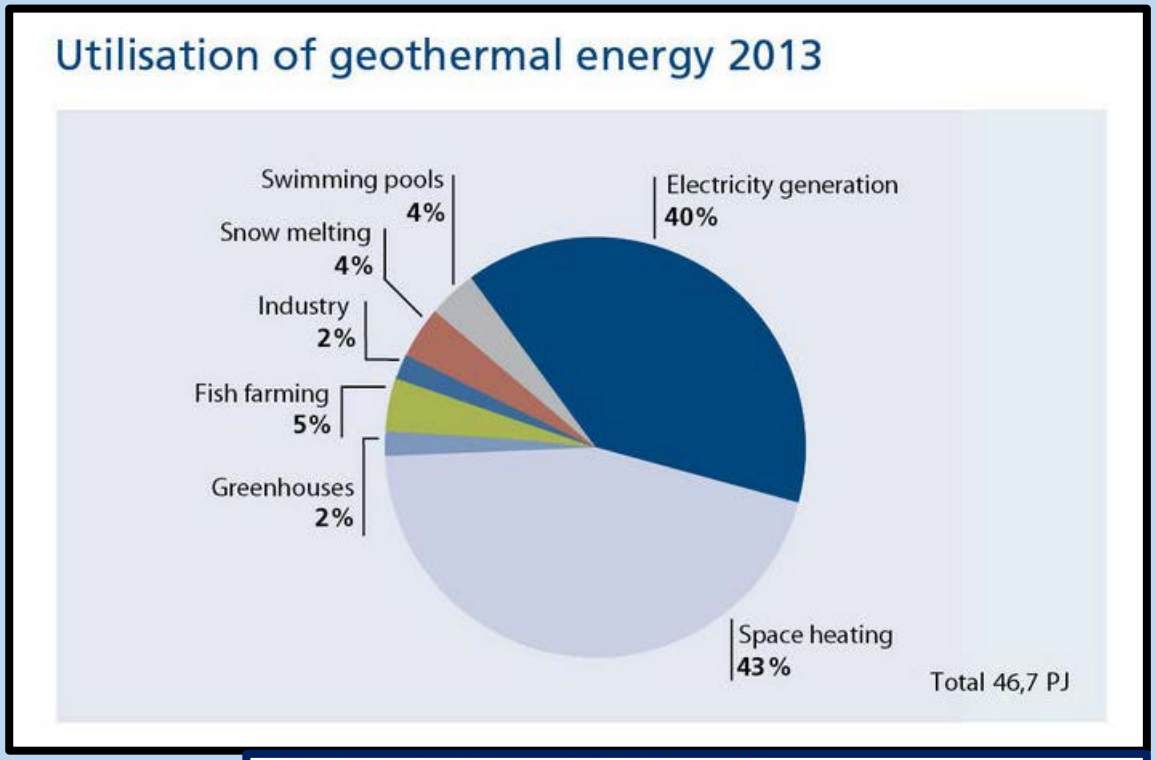
Geothermal in Iceland

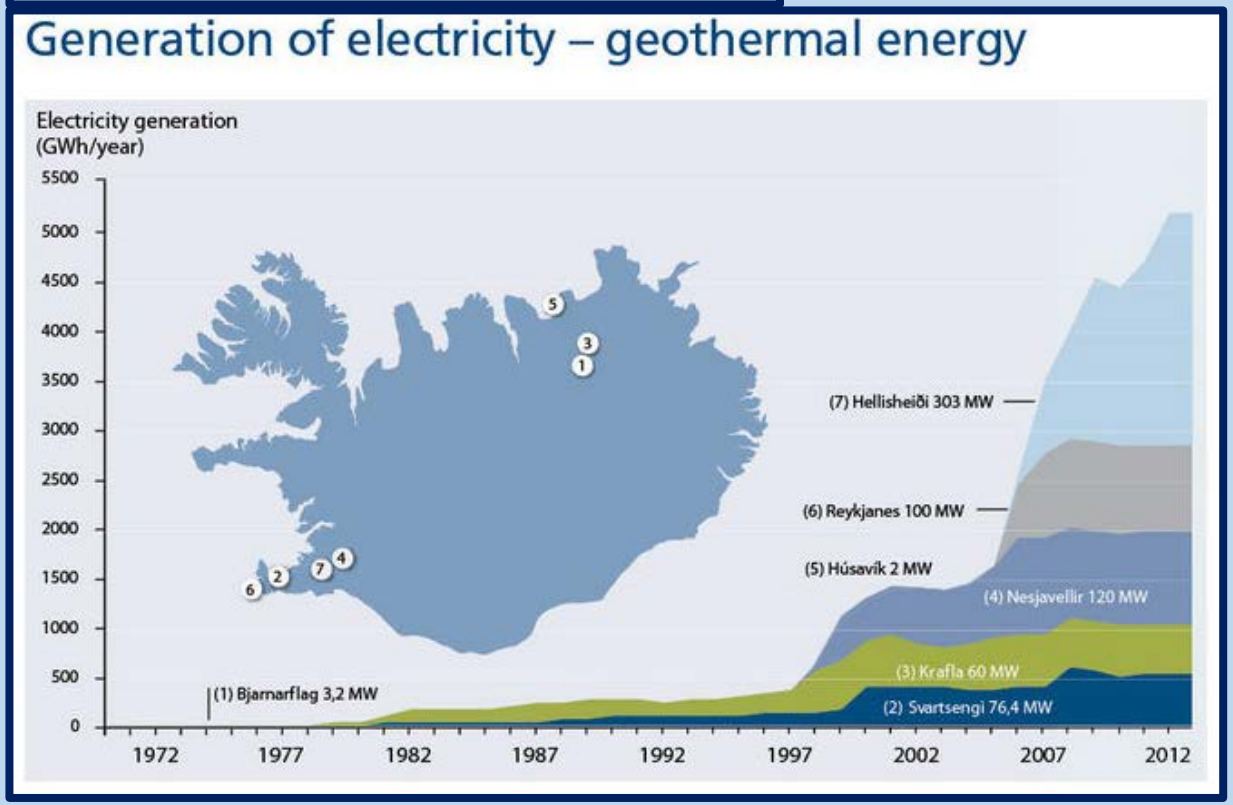
By

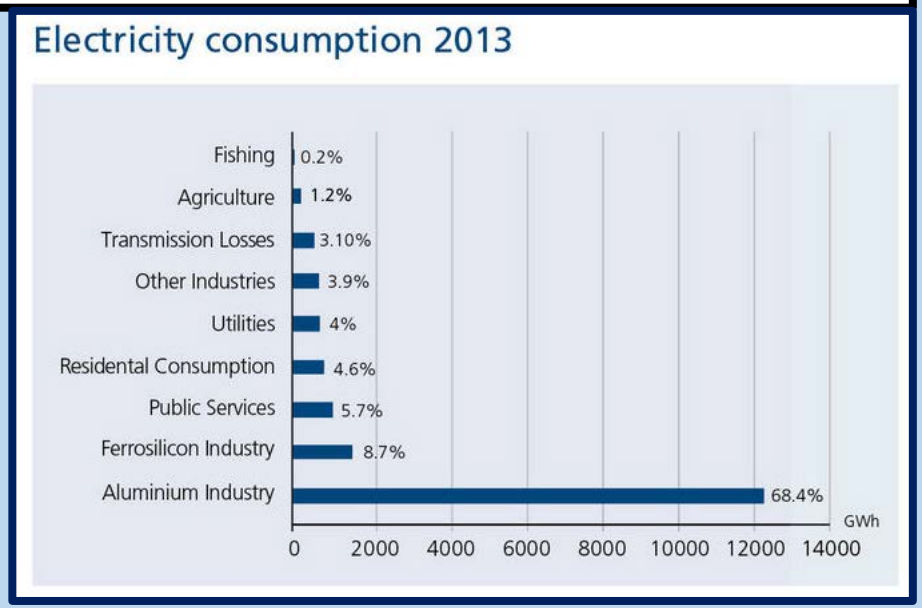
S. Amelia Kajiyama

Overview of Iceland Geothermal Uses



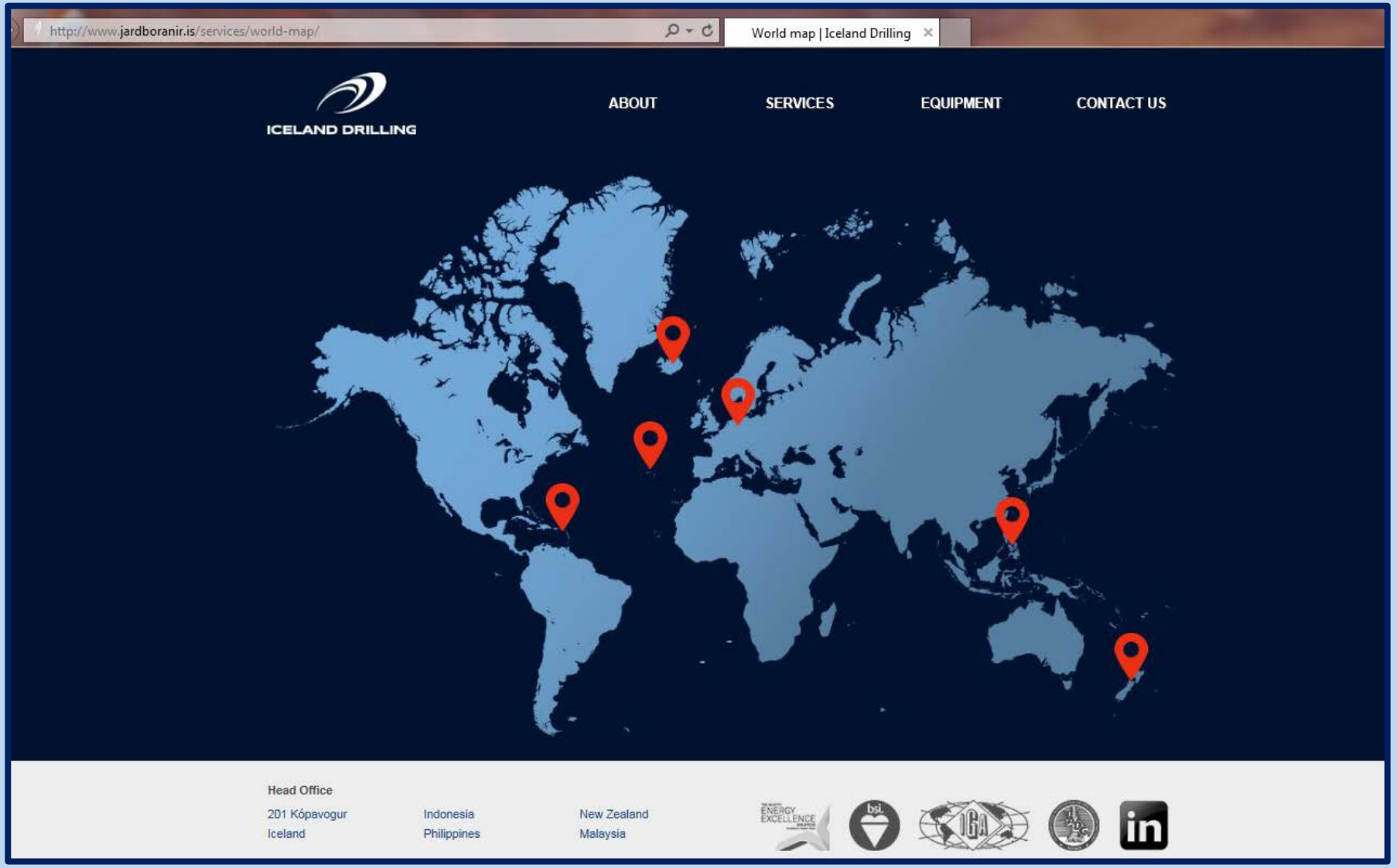






Iceland Geothermal Safety Record

Iceland Drilling, the main private geothermal drilling company in Iceland is the world leader in deep high temperature geothermal & low temperature geothermal with over 1000 successfully developed wells worldwide. They have offices in New Zealand, Indonesia, Philippines, Azores, Dominica, and Malaysia and have multiple projects worldwide.

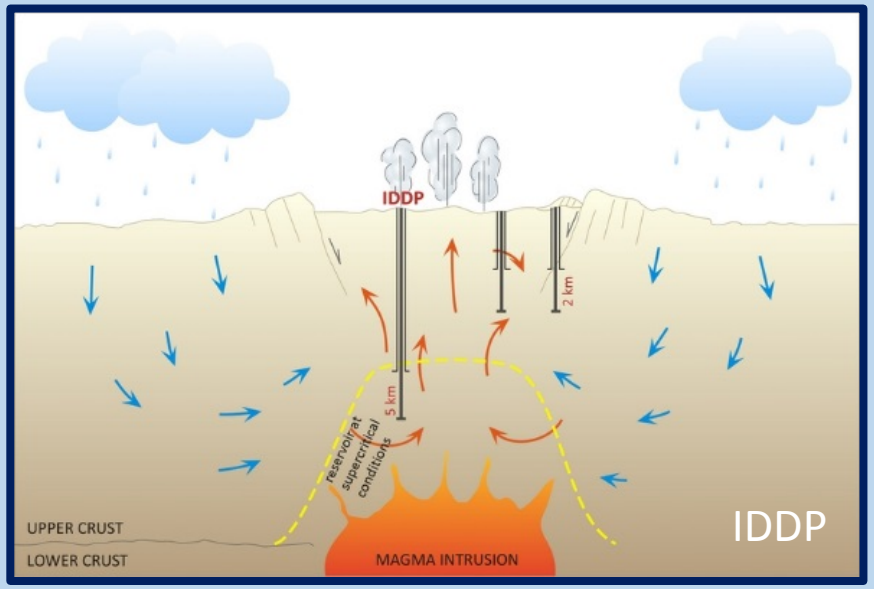


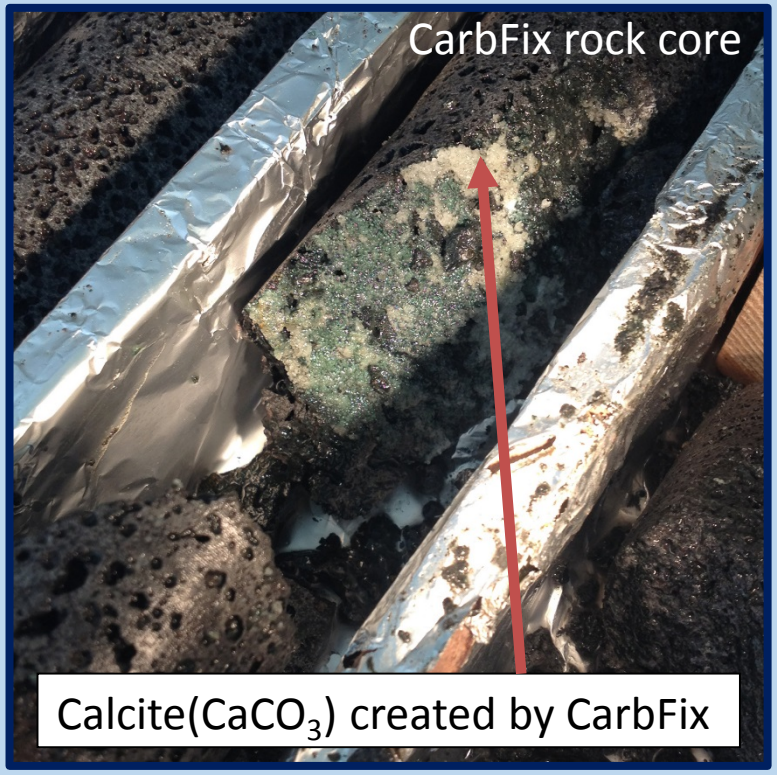
Iceland Geothermal Research

- Iceland Deep Drilling Project (IDDP)-reached magma at ~6890 ft and successfully harness its power in 2009, the first time this has been accomplished in the world.

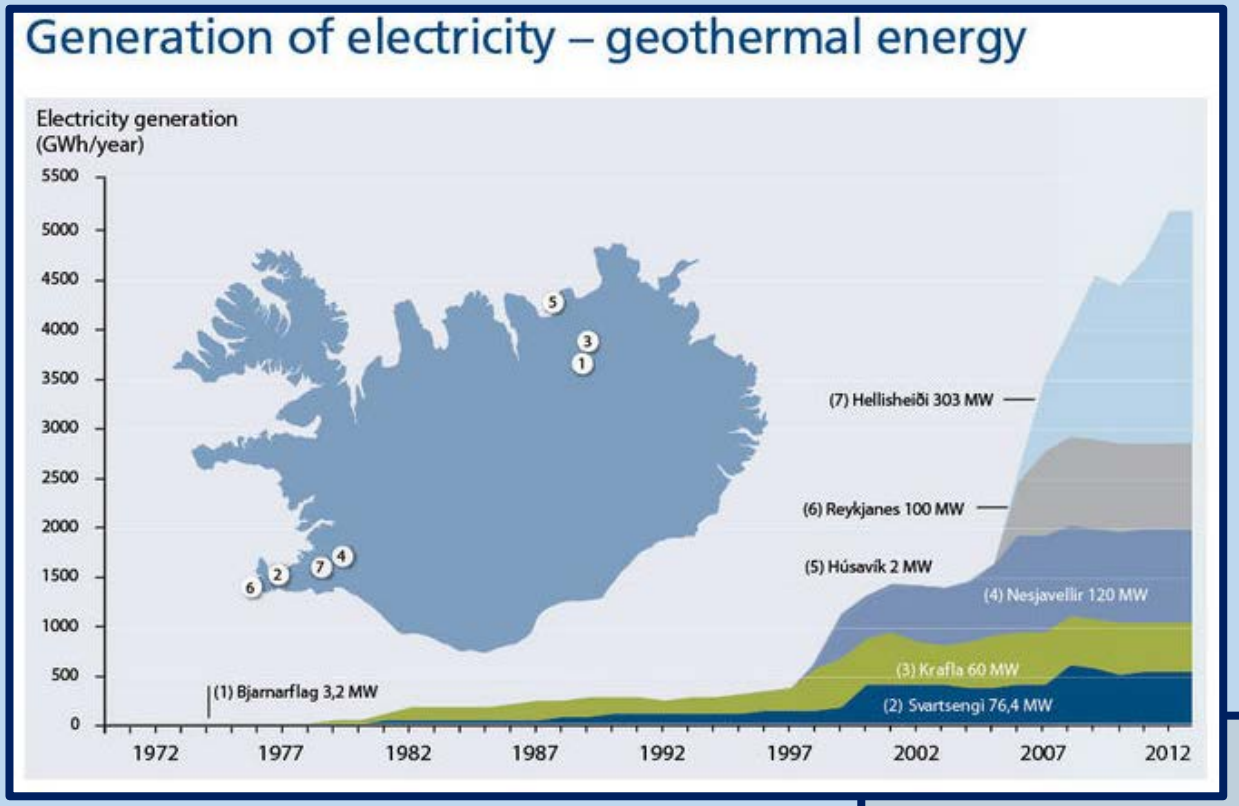
- CarbFix, Hellisheidi Power Plant with University of Iceland & Columbia University research project, successfully injected CO_2 with water into basalt formation and found that 95% of the CO_2 injected mineralized into Calcite ($CaCO_3$) in the basalt rock in less than 2yrs.

- Carbon Recycling International Inc. uses CO_2 produced from Svartsengi Power Plant, (which amounts to 8% of what oil plant produces) and converts it into methanol and uses power generated from geothermal and/or hydropower power plants in the area to make the fuel that can be used for cars.

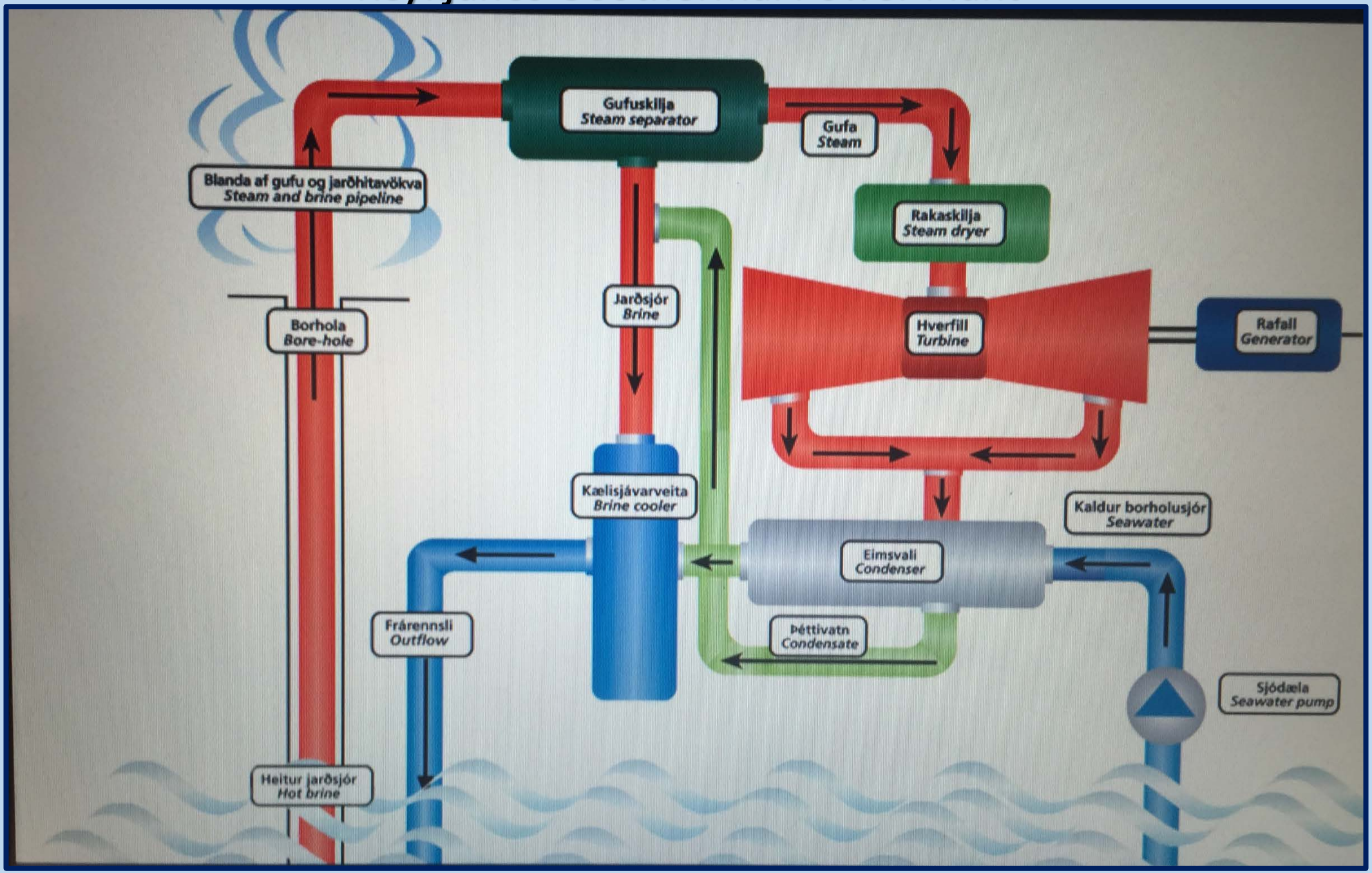




Reykjanes Geothermal Power Plant



Reykjanes Geothermal Power Plant



Reykjanes Geothermal Power Plant

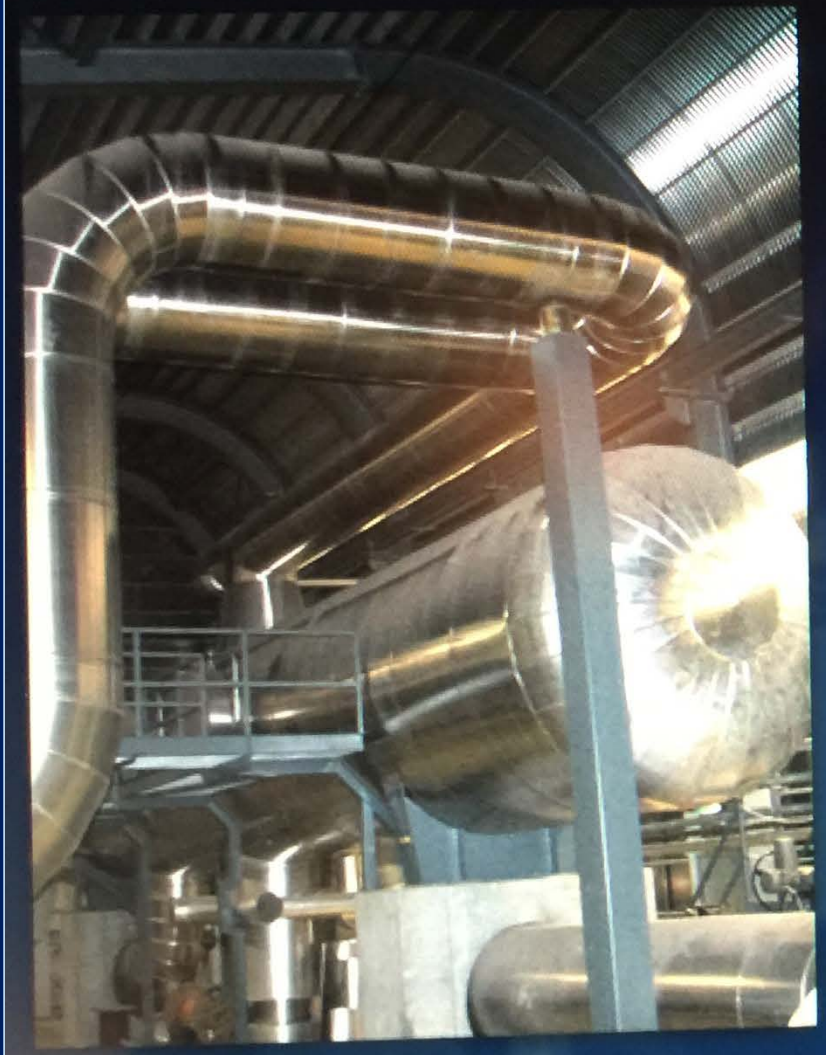
Operating Hole

Hot brine (300°C) and steam come from an operating hole about 2700m deep.

300°C ~ 572°F 2700m ~ 8860ft

Reykjanes Geothermal Power Plant

Steam Separator



The hot brine and steam mixture is piped into a steam separator which separates the steam from the liquid.

Reykjanes Geothermal Power Plant

Turbine

From the separator, the pressurized steam passes through the steam dryer to the turbine units, each producing 50MW of electricity.

1MW can power ~ 1000 to 650 homes

Reykjanes Geothermal Power Plant

Condenser

The steam passes through a condenser where it is cooled with seawater (8°C). The steam condenses into liquid on the cold pipes.

8°C ~ 46°F

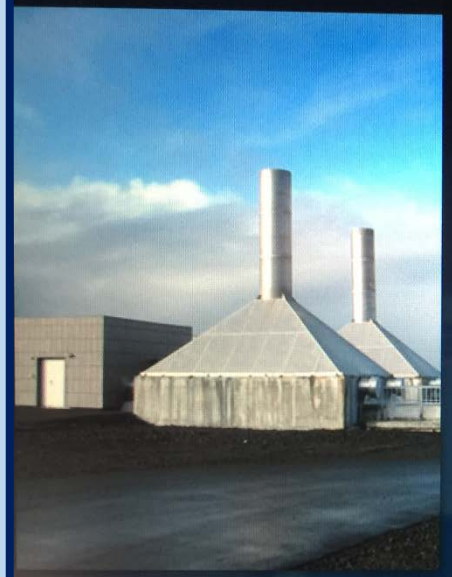
Exhaust

When the exhausted steam comes from the turbine, it has been cooled to 46°C.

46°C ~ 115°F

Reykjanes Geothermal Power Plant

Brine Cooler



The brine is cooled, thinned with condensate and at a temperature of 190°C is piped to the brine cooler.

190°C ~ 374°F

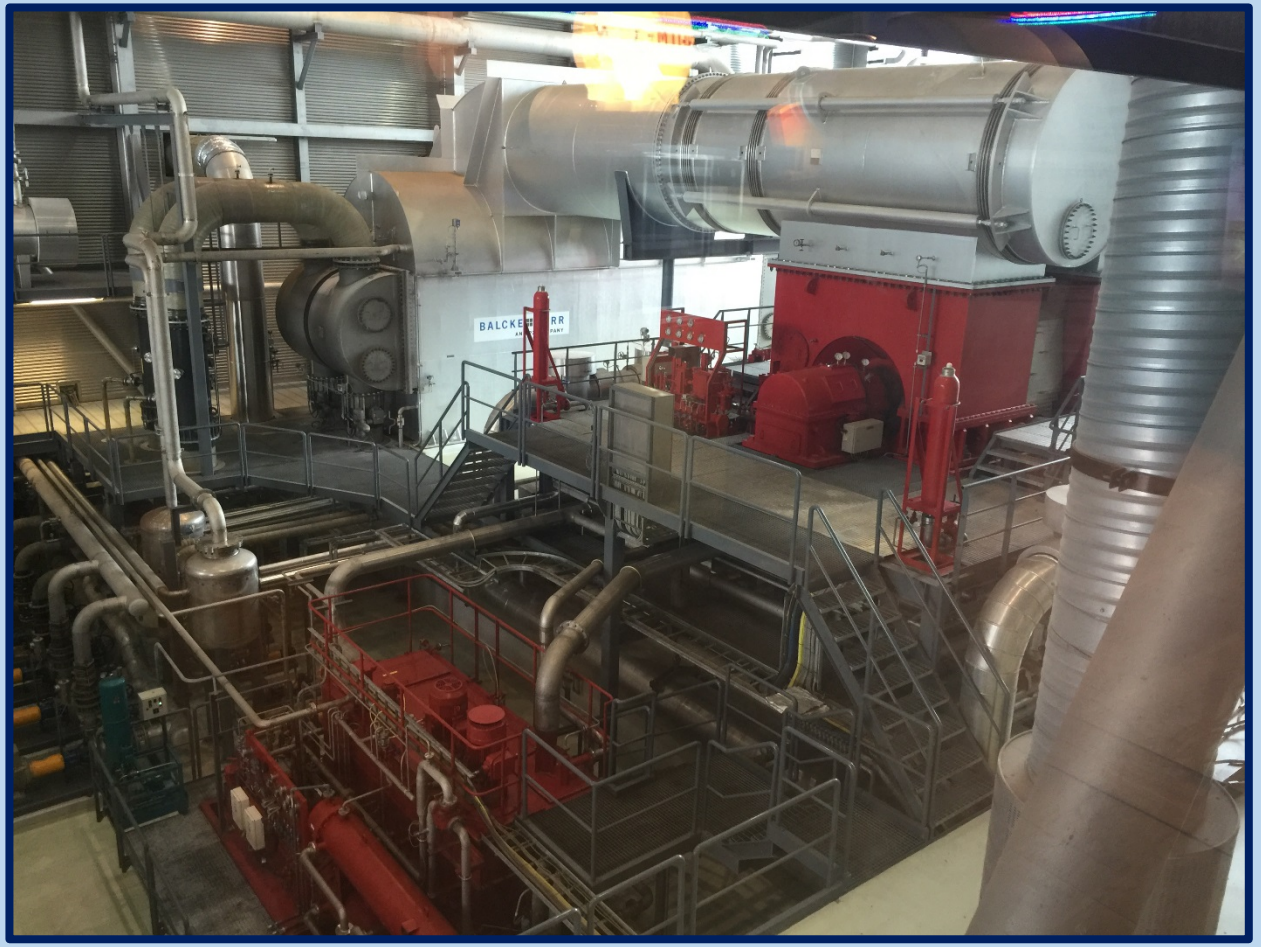
Outflow

Note: Not all Icelandic Geothermal power plants disposed outflow water into ocean, others (like Hellisheidi) inject outflow water back into the ground to allow magma heated rock to reheat outflow water so it can be reused. Blue Lagoon and Myvtan Natural Baths water is outflow water from nearby geothermal power plants.

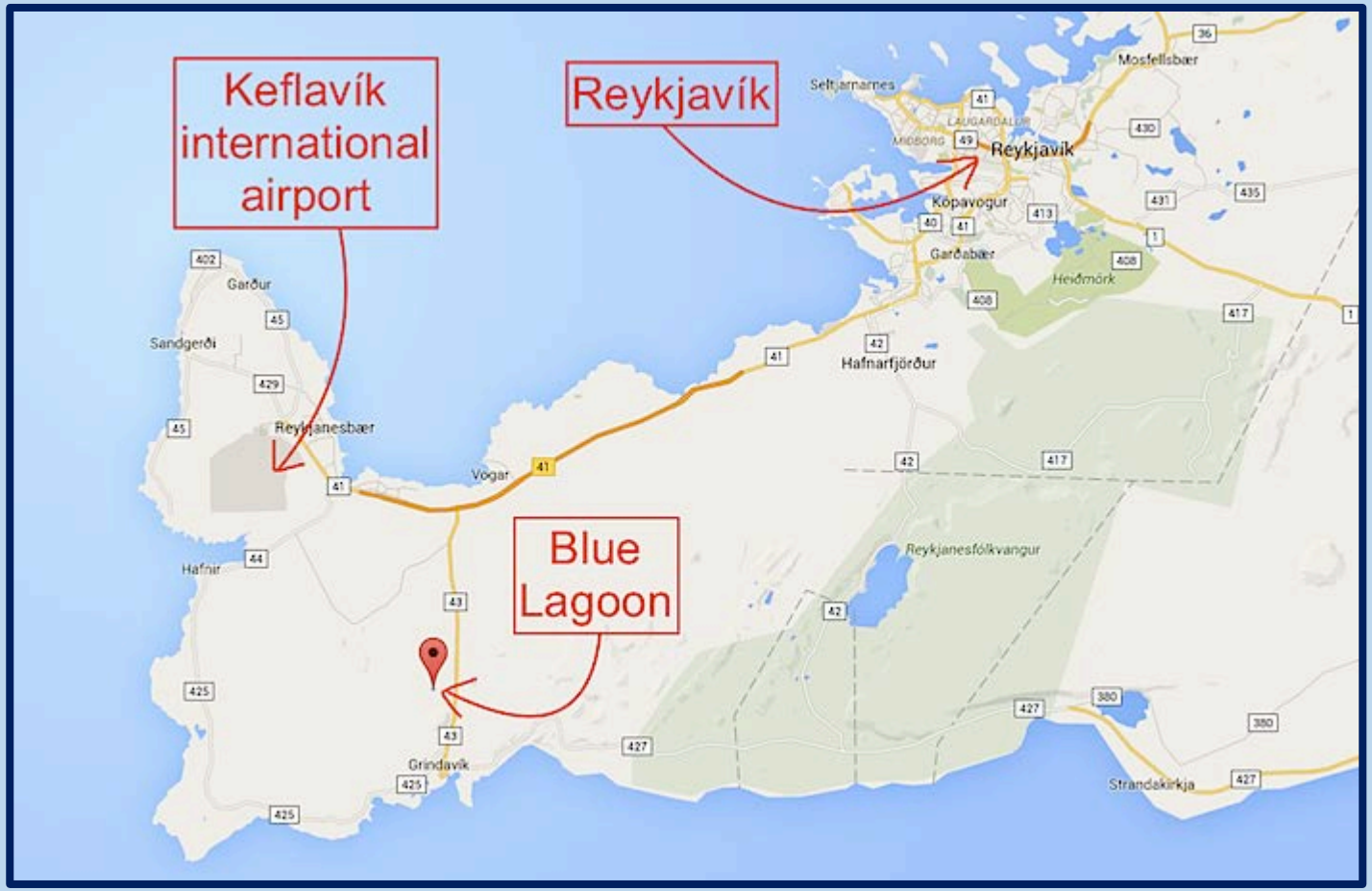
Condensate, seawater and waste brine are mixed together and channeled back into the sea at a temperature of 57°C.

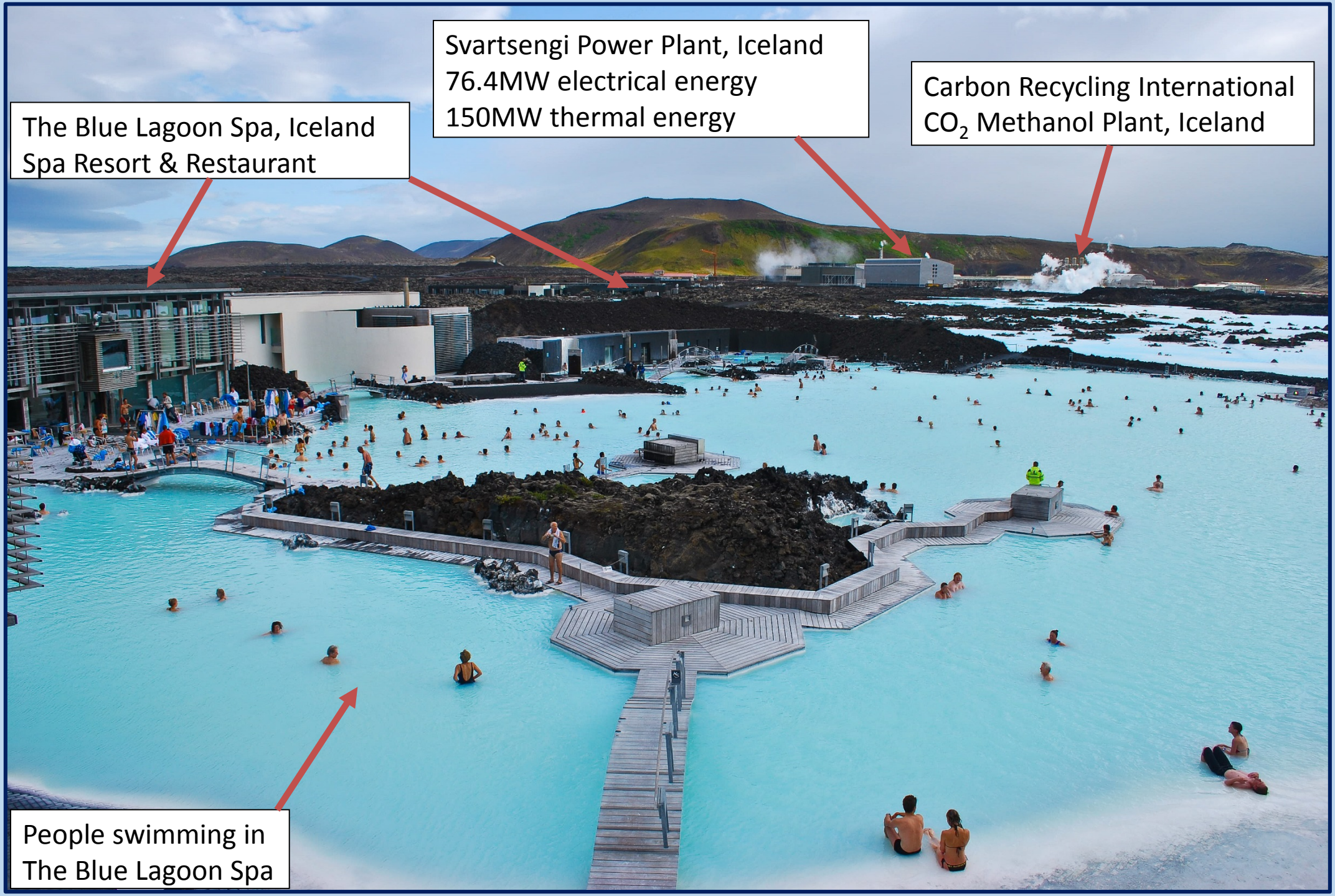
57°C ~ 135°F

Pictures inside the Reykjanes Geothermal Power Plant



Blue Lagoon Iceland

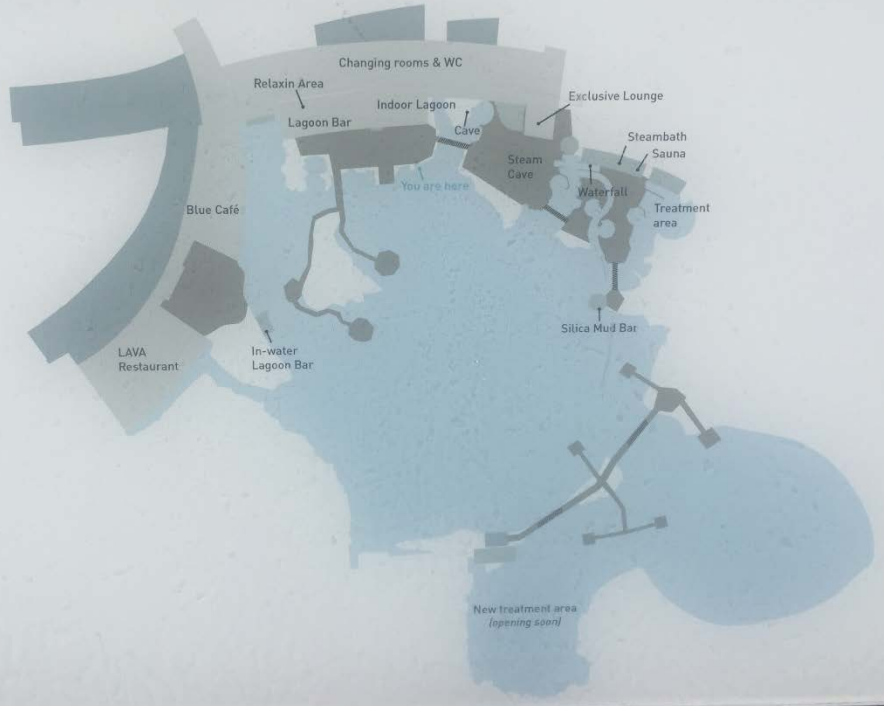



The Blue Lagoon Spa, Iceland
Spa Resort & Restaurant
Svartsengi Power Plant, Iceland
76.4MW electrical energy
150MW thermal energy
Carbon Recycling International
CO_2 Methanol Plant, Iceland
People swimming in
The Blue Lagoon Spa

Me swimming in Blue Lagoon

Have ~ 1/2 million visitor per year; therefore, pre booking is required

BLUE LAGOON OVERVIEW



BLUE LAGOON FACTS

9 MILLION LITERS
The amount of geothermal seawater in the Blue Lagoon

40 HOURS
The time it takes for all the Blue Lagoon's water to naturally renew itself

6,500 FEET / 1,981 METERS
The distance below the surface to the origin of the geothermal seawater

800 YEARS
The age of the lava field surrounding the Blue Lagoon

100°F / 38°C
The average temperature of the Blue Lagoon

BLUE LAGOON ACTIVE INGREDIENTS:

ALGAE

Research shows that Blue Lagoon coccoid algae reduces UV-induced degradation of collagen in the skin, and Blue Lagoon filamentus algae stimulates the skin's natural collagen production.

SILICA

Research shows that Blue Lagoon silica strengthens the skin's barrier function which is one of the key elements in maintaining healthy and radiant skin.

MINERALS

Blue Lagoon geothermal seawater contains a unique combination of pure minerals which are an important part of Blue Lagoon skin care formulas for their revitalizing effects.

Iceland straddles the Mid-Atlantic Ridge, where the North American and Eurasian tectonic plates are pulling apart. Upwelling magma built the island and heats its vast reservoirs of water, creating a geothermal paradise. First among the country's many simmering geothermal pools is the Blue Lagoon, a turqoise vision in a black basaltic moonscape. The geothermal spa is fed by seawater 6,500 feet (1,981 m) beneath the surface, where it reaches a searing 464°F (240°C). Capturing silica and other minerals on its way to the surface, it emerges from the ground at a balmy 100°F (38°C), just right for pampering visitors.

(2011) Blue Lagoon. National Geographic, Wonders of the world, p.125.

BLUE LAGOON IS ONE OF THE 25 WONDERS OF THE WORLD

- National Geographic -

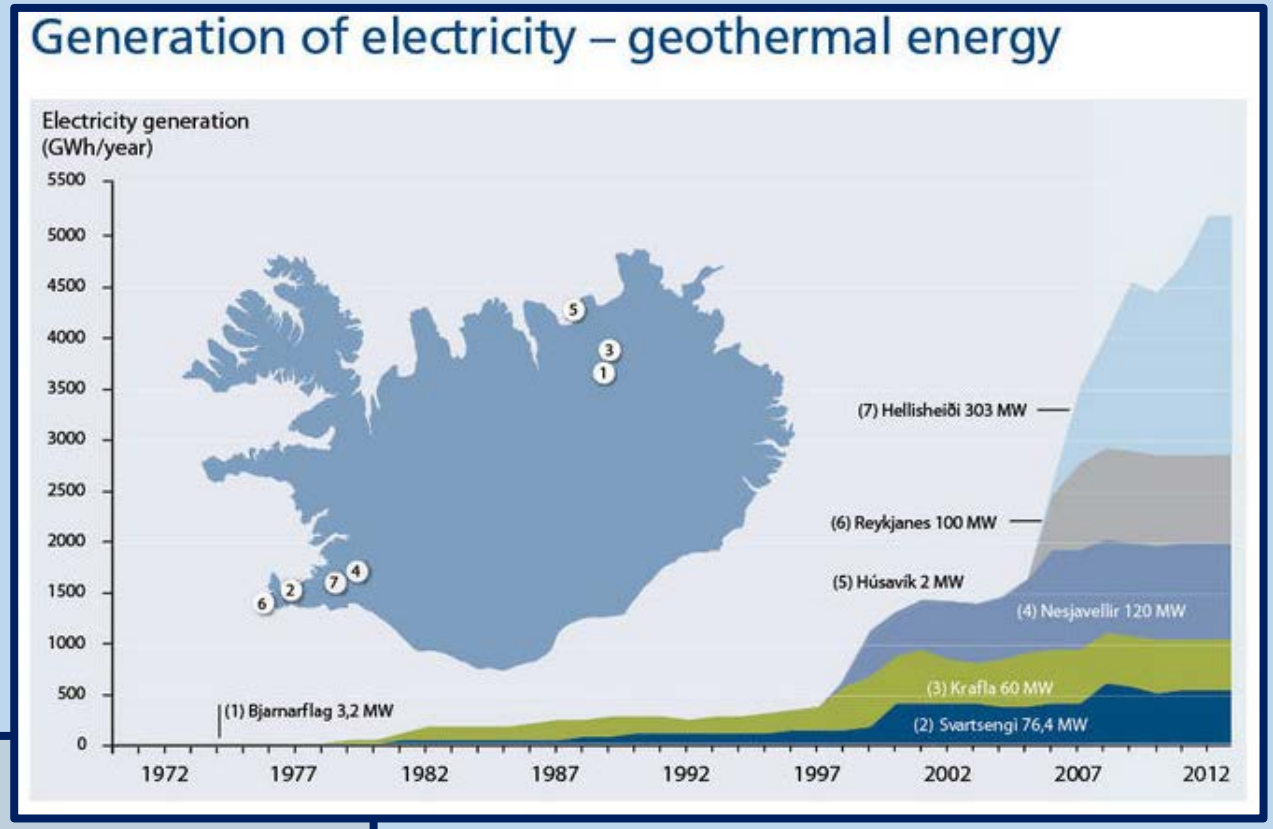
Selfoss Geothermal Public Heated Pool

Myvtan Natural Baths

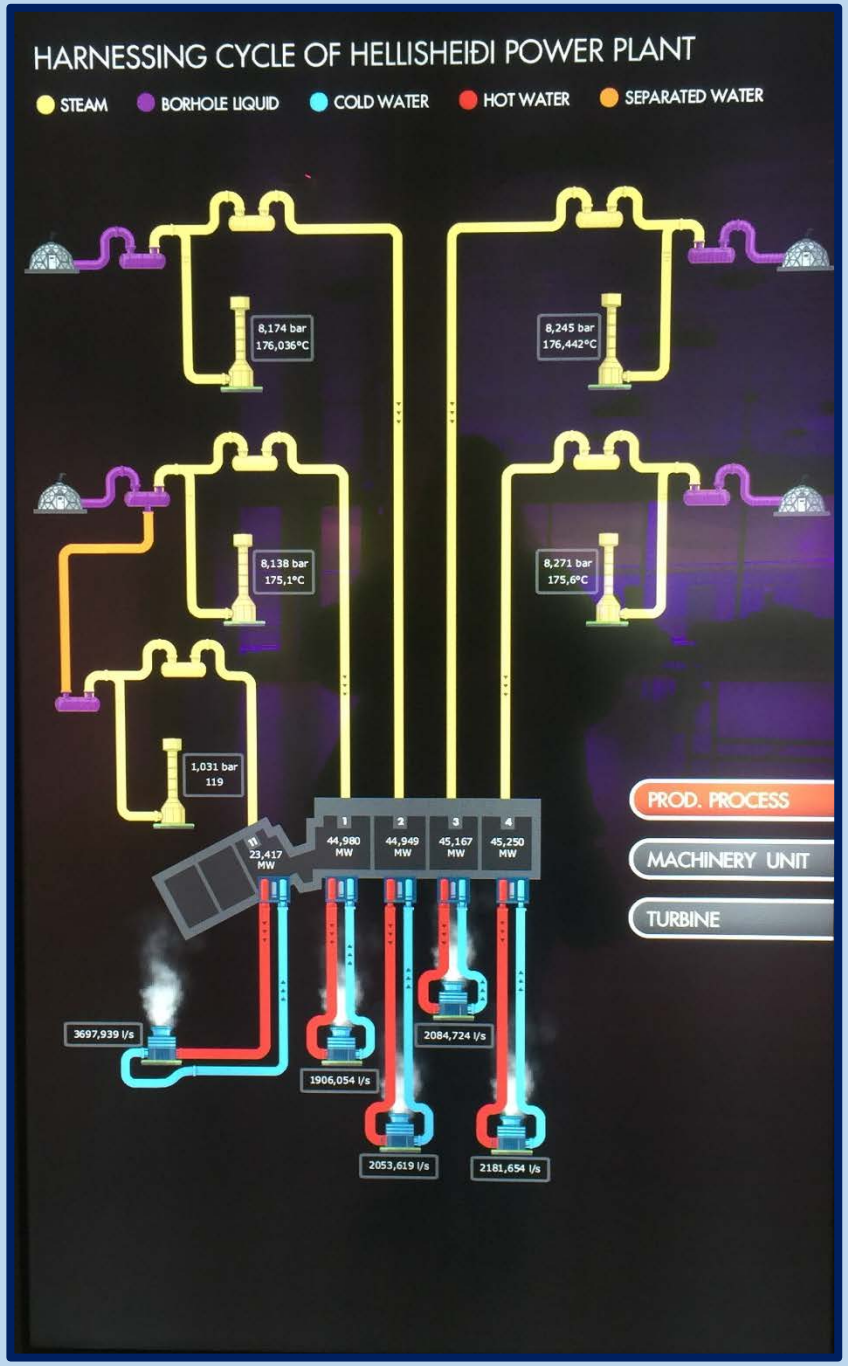
Myvtan Natural Baths

The water supplies for the lagoon run straight from the National Power Company´s bore hole in Bjarnarflag. The water has a temperature of about 266°F when it arrives to the huge basin beside the lagoon itself forming an impressive, man-made hot spring. Altogether, the lagoon and the basin contain around 1 million gallons of water with a temperature of 97 – 104°F.

Hellisheidi Power Plant



Hellisheidi Power Plant & Visitor Center



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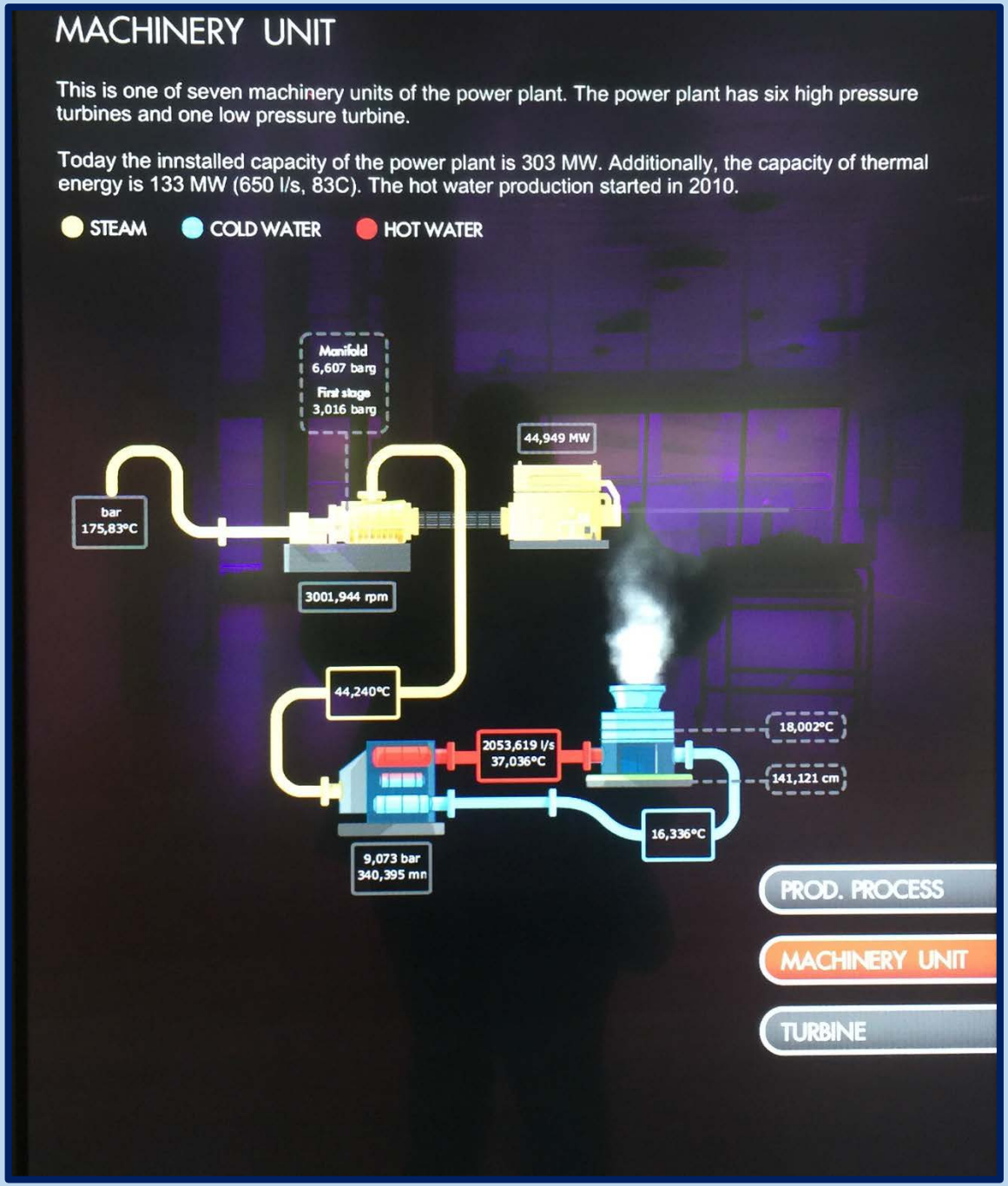
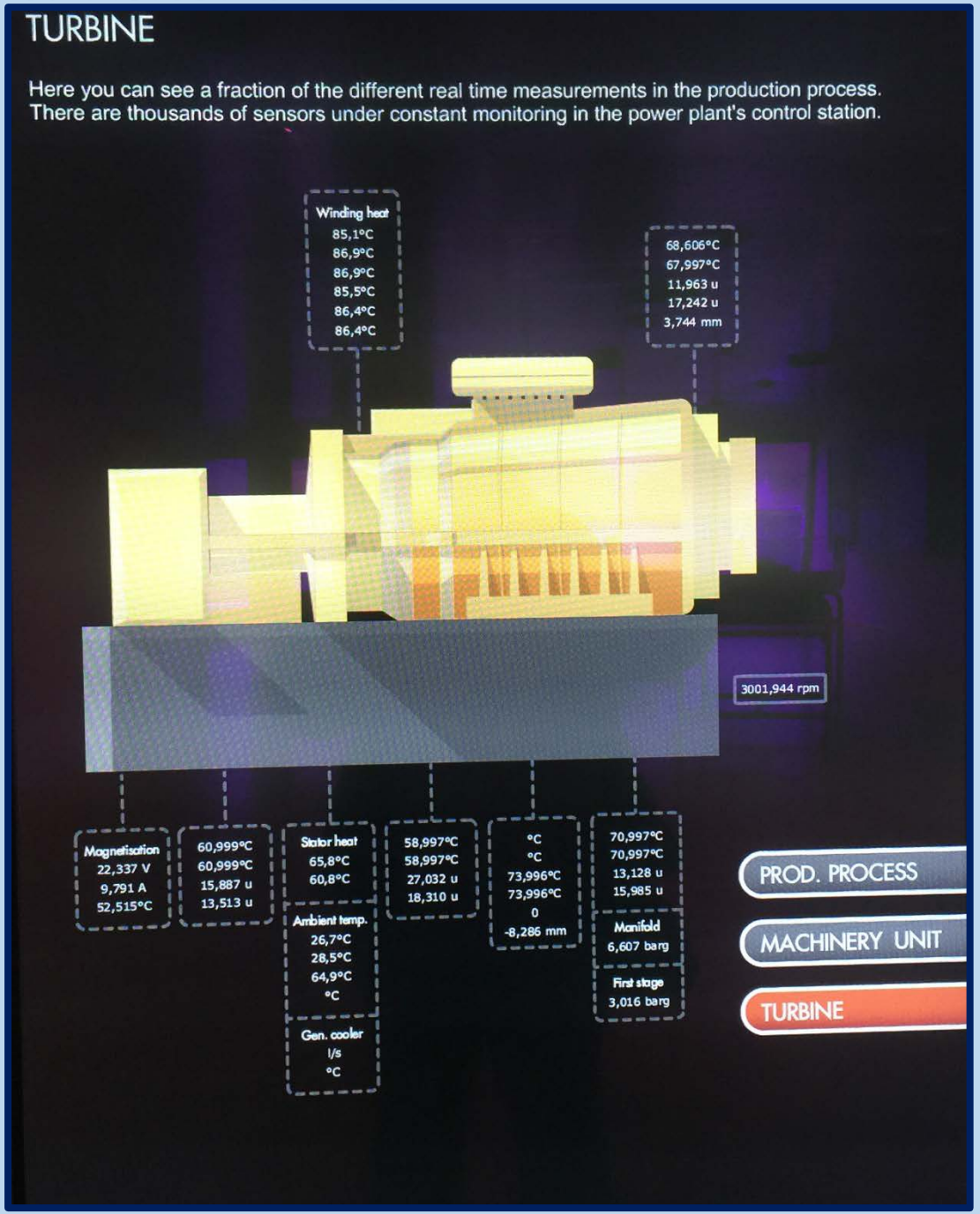
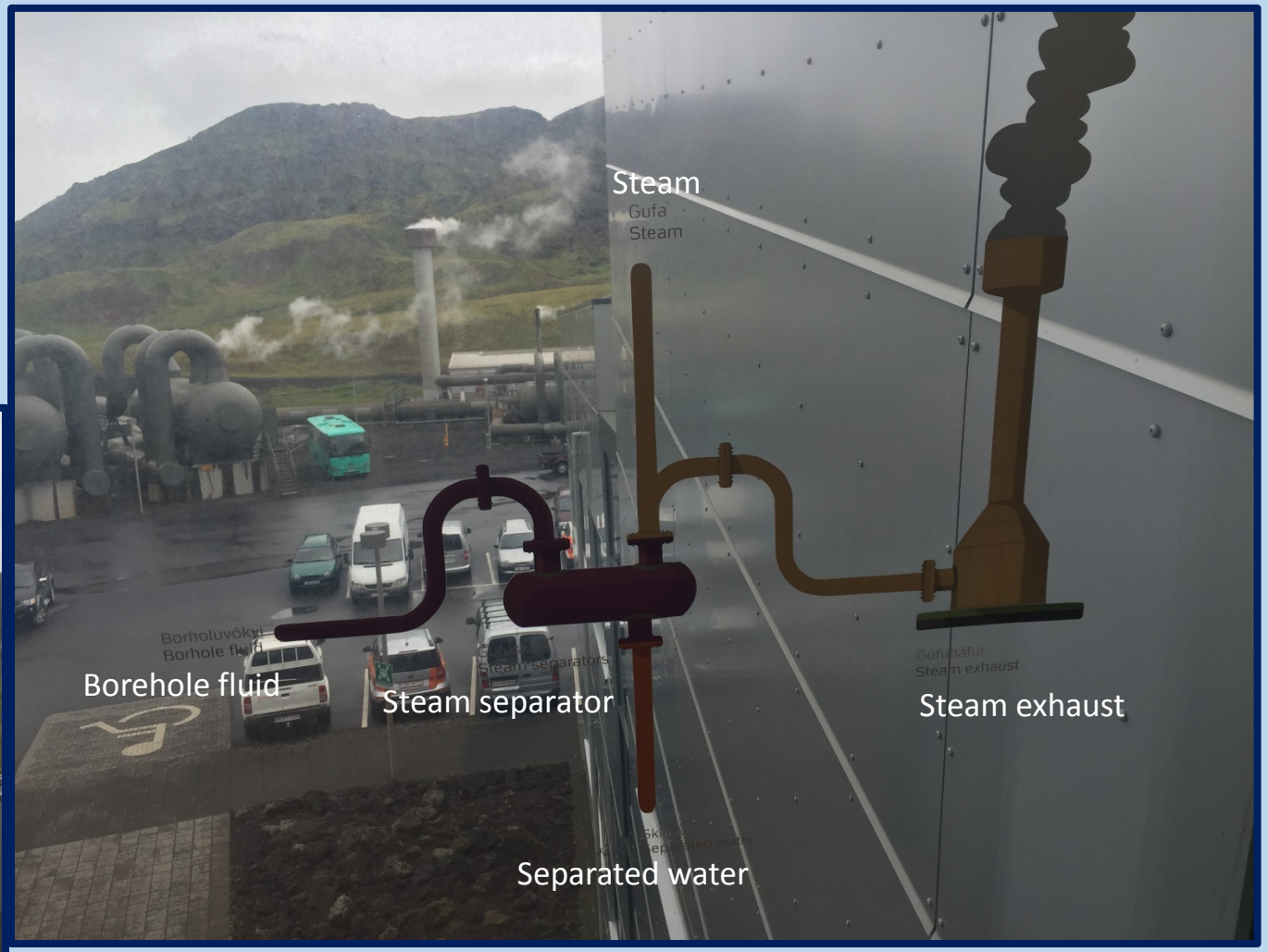
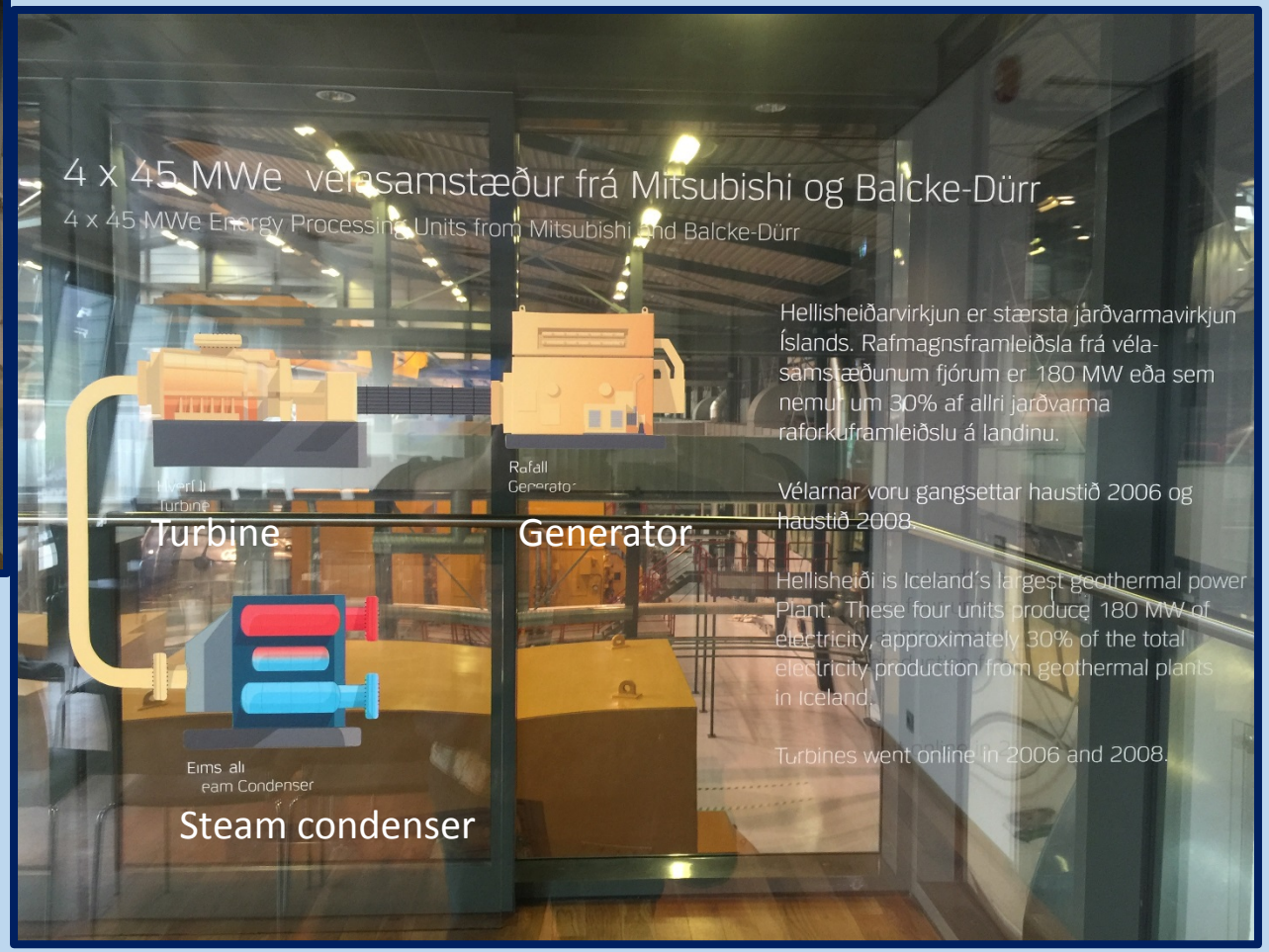




Pictures inside the Hellisheidi Power Plant



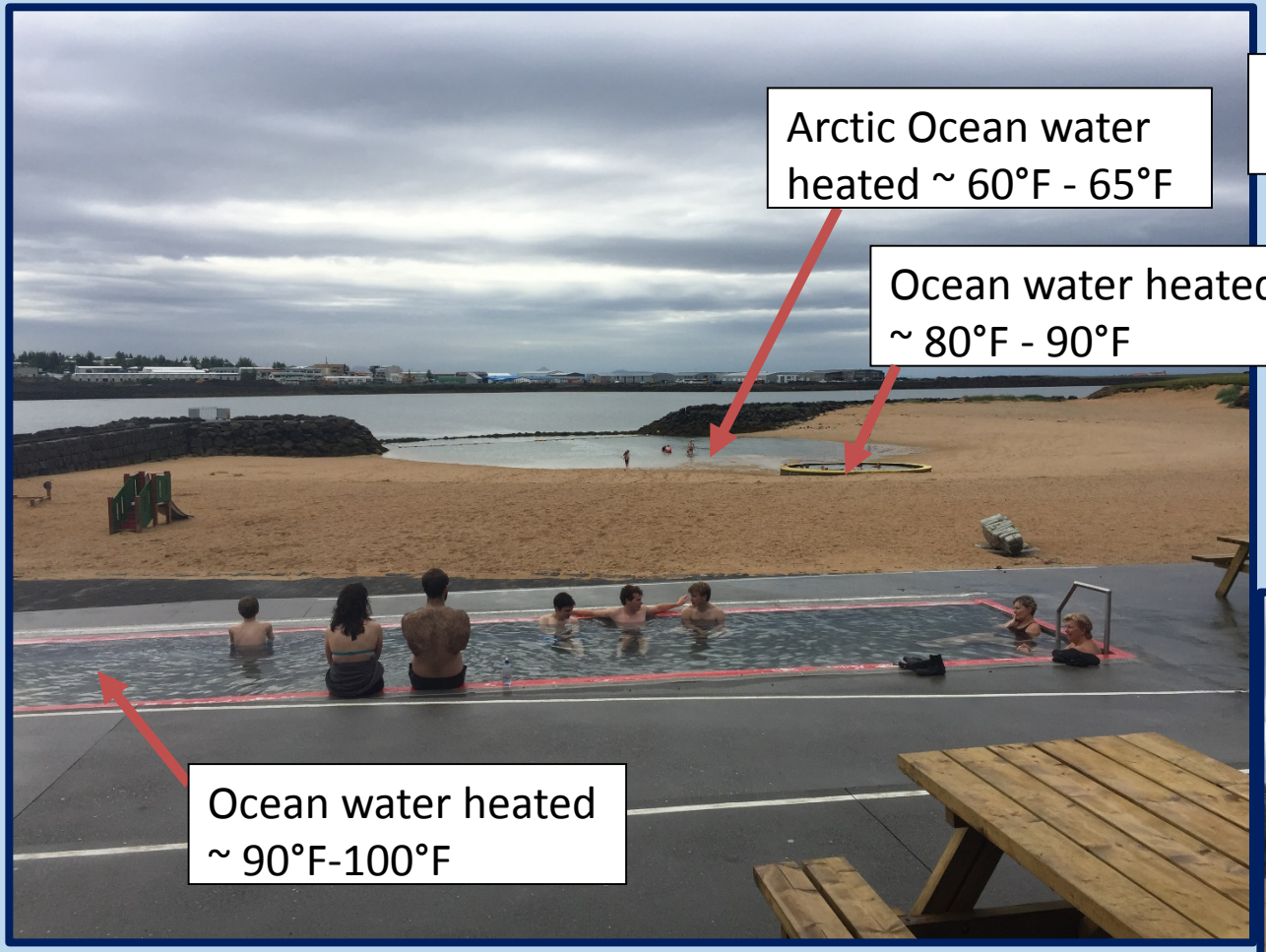
Pictures inside the Hellisheidi Power Plant



Reykjavik's Nautholsvik Geothermal Heated Beach

Nautholsvik Geothermal Heated Beach

Reykjavik's Nautholsvik Geothermal Heated Beach



Me, swimming in the Arctic Ocean!

Summary of Geothermal in Iceland

Geology

•Geologic hot spot with shield volcanos and composed of basalt and also sits upon the mid-Atlantic ridge. Also, has high rainfall range of 100-150 inches per year. Note: Iceland is the one of the few other places in the word most geologically similar to Hawaii.

Geothermal Usage History

•Icelanders started using geothermal heated pools for heating homes and washing over 1000 years ago. Icelandic power plants started using geothermal resources at a large scale in the 1970's to get Iceland off of fossil fuels. When Iceland switched from fossil fuels to renewable geothermal and hydropower they went from being the poorest country in Europe to now having one of the highest standards of living in the world.

•They now use 100% renewable energy resources for power (80% geothermal / 20% hydropower) only using fossil fuels for vehicles and fishing fleet and intend to switch all vehicles and their fishing fleet in the country to a renewable fuel source in the future. Iceland's energy use per capita is among the highest in the world and has one of the lowest electrical costs per capita.

•All Icelandic geothermal companies are partially or fully government owned. They have an open door policy and anybody can come and tour their geothermal power plants. Several of the geothermal power plants have visitor centers and museums.

Icelandic geothermal accidents

•Svartsengi Power Plant had a outflow pipe leak in the 1970's and the outflow water flowed onto a nearby pahoehoe lava field and the Blue Lagoon was created. Now, it's the top tourist destination in Iceland and named by National Geographic as one of the top 25 wonders of the world.

•Iceland Deep Drilling Project in 2009 accidently drilled into a magma chamber. There were able to repair the well and then harness geothermal power directly from the magma chamber, which is the first time that has ever been done in the world.

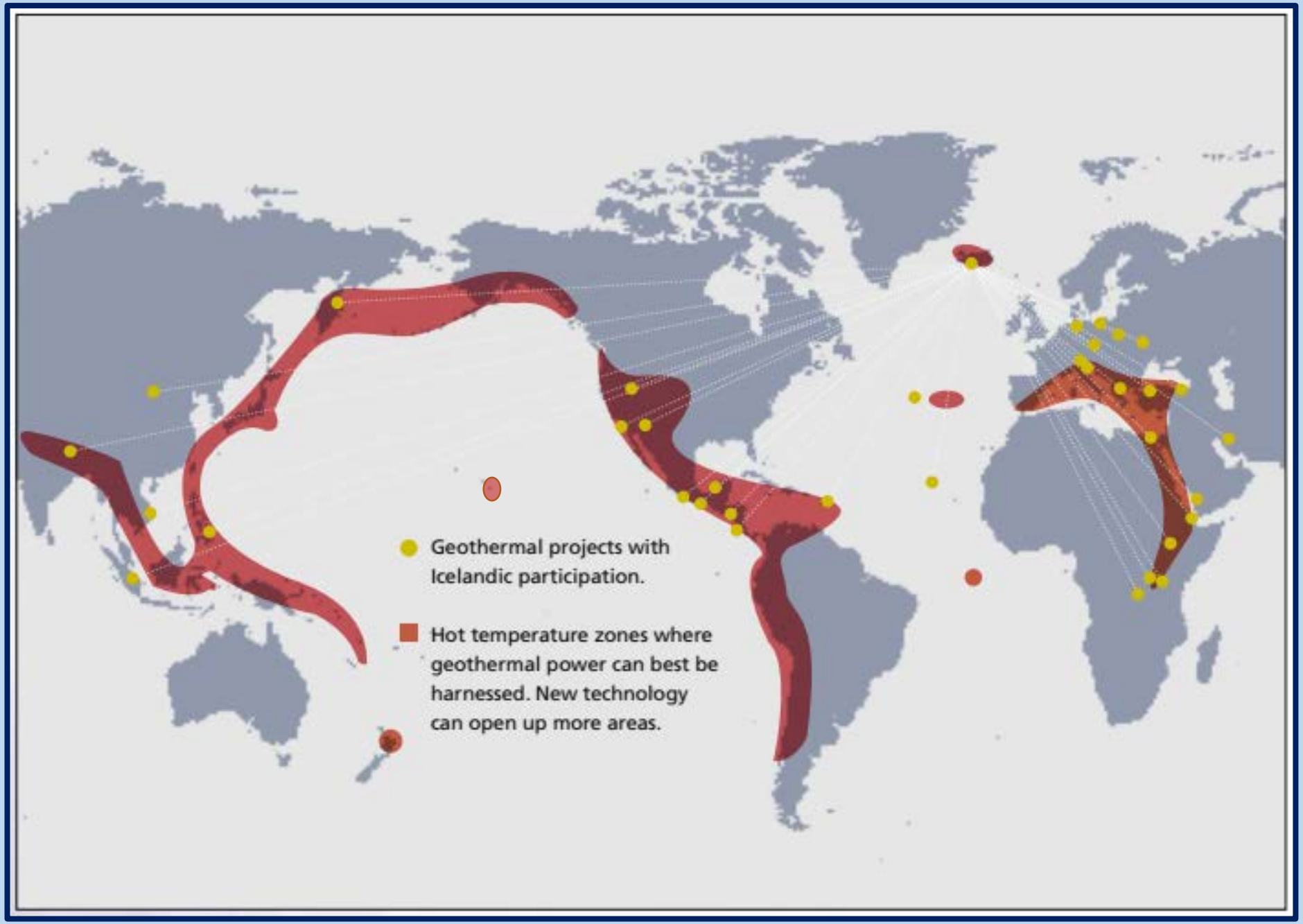
•The Iceland National Energy Authority has Borehole Directory for all 13,500 borehole wells drilled in Iceland since 1904 that is available on their website.

Export Know-How

•Iceland universities in conjunction with Icelandic geothermal power companies and the United Nations have college and post-graduate programs for students and leaders in power utility industry to learn how to develop geothermal power throughout the world.

•Many Icelandic consulting firms, Iceland Drilling company, and Icelandic geothermal power companies make it their business to export geothermal know-how and experience worldwide. There are now projects in Nevada, Nicaragua, New Zealand, China, Indonesia, Philippines, Germany, Hungary, Kenya, Azores to name a few.

Summary of Current Geothermal Projects with Icelandic Participation



Summary of Geothermal in Hawaii

Geology

•Geologic hot spot with shield volcanos and composed of basalt. Hawaii has a varied rainfall range depending upon ecosystem from rainforest (80”+) to desert(10”-20”).

•Note: Iceland is the one of the few other places in the word most geologically similar to Hawaii. Also, has high rainfall range of 100-150 inches per year.

Geothermal Usage History

•Puna Geothermal Venture in Pohoiki was started in 1982 by State of Hawaii, Halliburton & Ormat. It is now operated by Ormat and Halliburton assists in well drilling and maintenance. Halliburton is mainly an oil and gas company. Ormat is an Israeli based geothermal company.

•Supplies approximately 30% Hawaii Islands electrical needs.

Hawaii geothermal accidents

•Puna Geothermal Venture has had 38 documented leaks from 1982 to 1999.

•Puna Geothermal Venture had a borehole well blowout accident in March 1991.
It lasted for a week and forced many residents to leave their homes and many suffered from excessive H_2S exposure health related issues.

•Puna Geothermal Venture accidently drilling into magma in 2009 and closed the well.

•A Hawaii County Civil Defense issued an evacuate alert on August 20, 2014 during Hurricane Iselle due to the uncontrolled release of H_2S at the Puna Geothermal Venture.

Questions?

References

www.asherworldturns.com: a travel photo blog by Erica Meyers
www.bluelagoon.com: Blue Lagoon
www.bigislandvideonews.com: Big Island Video News
http://carbonrecycling.is: Carbon Recycling International, Inc.
www.hawaiibusiness.com: a Hawaii Business Magazine
www.hsorka.is/English: Alterra Power Corp owns Svartsengi Power Plant & Reykjanes Power Plant
www.icelandmonitor.mbi.is: an English language Iceland news website
www.jardboranir.is: Iceland Drilling Co.
www.myvatnnaturebaths.is: Myvtan Nature Baths
www.mappery.com: an online map lovers collection website
www.nea.is: Iceland National Energy Authority
www.or.is/en/about: Reykjavik Energy
www.travel.nationalgeographic.com: National Geographic Travel Magazine
www.viewportmagazine.com: a Design, Travel, & Architecture newsmagazine
Pipkin, Bernard. 1994. Geology and the Environment. Ch.5

My own photos from my vacation visiting Iceland