REPUBLIKA SLOVENIJA
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INFO-GEOTHERMAL

Podpiranje učinkovite kaskadne uporabe geotermalne energije z dostopom do uradnih in javnih informacij /

Supporting efficient cascade use of geothermal energy by unlocking official and public information

Delovni sklop T1 Zagotavljanje informacij o globoki geotermalni energiji

Aktivnost AT 1.1 Najsodobnejša analiza stanja

Dosežek: DT 1.1.3 Delavnica in ogled prenosljivih študij primerov o reinjekciji, tehnologiji kaskadne uporabe in binarnih geotermalnih elektrarn na Islandiji

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Verzija 1.0

Projekt INFO-GEOTHERMAL sofinancirajo Islandija, Lihtenštajn in Norveška s sredstvi Finančnega mehanizma EGP v višini 1.073.529,41 €. Namen projekta je podpiranje učinkovite kaskadne uporabe geotermalne energije z dostopom do uradnih in javnih informacij.

Vodilni partner / Lead partner: GeoZS

Avtorji / Authors: Nina Rman, Mateja Macut, Andrej Lapanje, Simona Adrinek, Luka Serianz

Pri pripravi gradiva so sodelovali / Materials were prepared with the help of:
Aleš Jeraj, Gregor Rome, Lara Šuman

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Kazalo vsebine

Kazalo slik

1 Povzetek

Islandija je relativno mlad otok vulkanskega nastanka. Najstarejše vulkanske kamnine so stare le 16 milijonov let, prevladuje bazalt. Ker se Islandija nahaja na območju razmikanja (rifta) dveh tektonskih plošč (Evrazijske in Severno-ameriške), se ozemlje vsako leto razmakne za približno 2 cm. Posledično je otok še vedno vulkansko aktiven in ima velik potencial za izkoriščanje geotermalne energije. Namreč, na območju riftne cone termalna voda dosega zelo visoke temperature (tudi več kot 250 °C), kar omogoča pridobivanje geotermalne energije tako za ogrevanje kot tudi električno energijo. Termalne vode večinoma še ne vračajo nazaj v vodonosnik, ampak jo nekoliko ohlajeno (s temperaturo 30-45 °C) spuščajo v okolico ali neposredno v morje.

V obdobju 25. – 28.10.2022 je v okviru projekta INFO-GEOTHERMAL na Islandiji potekala »DT 1.1.3 Delavnica in ogled prenosljivih študij primerov o reinjekciji, tehnologiji kaskadne uporabe in binarnih geotermalnih elektrarn na Islandiji«. Dogodek je potekal delno v prostorih Univerze v Reykjavíku in delno na različnih lokacijah na jugozahodu Islandije.

Prvi del izobraževanja (torek, 25.10.2022) je potekal v obliki kratkih predstavitev projektnih partnerjev, islandskih podjetij, raziskovalnih organizacij in drugih sodelujočih v projektu na področju geotermije, prav tako so se predstavili tudi udeleženci iz Slovenije. Od srede, 26.10., do petka, 28. 10. 2022, so bili organizirani ogledi več lokacij uporabnikov geotermalne energije, geotermalnih elektrarn in sistemov daljinskega ogrevanja ter ogrevanja rastlinjakov. Ogledali smo si: CO_2 postajo v kraju Hæðarendi, črpalno postajo daljinskega sistema v upravljanju podjetja Selfossveitur in polje vodnjakov v Ósbotnarju, rastlinjak Reykir Fakultete za kmetijstvo v Reykjamörku, geotermalno elektrarno Hellisheiði in geotermalno razstavo, geotermalno elektrarno Kópsvatn, rastlinjake v Friðheimarju, nadzorno sobo daljinskega ogrevanja Bæjarháls, geotermalno elektrarno Nesjavellir, distribucijski objekt Reynisvatnsheiði in črpalke od podjetja Veitur, ter črpalno postajo Bolholtsstöð in zbirni sistem vode nizkotemperaturnega polja Laugarnes.

Devetnajst udeležencev je spoznalo različne tehnologije rabe termalne vode, princip geotermalnih parkov, sheme zavarovanja tveganja pri razvoju projektov ter načine upravljanja s prostorom in naravnimi viri. Zaradi zelo hitre rasti mest in s tem potrebe po ogrevanju vlagajo v širjenje obstoječih in iskanje novih geotermalnih virov, pri čemer ni zanemarljivo, da je vrtanje cenejše kot v Sloveniji. Geotermalne elektrarne so večinoma v lasti javnih podjetij, ki največkrat sama financirajo širjenje črpališč. Ob tem imajo veliko podporo administrativnih teles in raziskovalnih inštitucij, uporabljajo pa tudi finančne mehanizme za zavarovanje tveganj in kredite. Velik izziv pri lociranju novih vrtin je umeščanje v prostor zaradi pridobivanja soglasij za posege na parcelah in zagotavljanja okoljske in družbene sprejemljivosti. Izpusti odpadne termalne vode v okolje zaradi večinoma neproblematične sestave vode in primernih prejemnikov, ki zagotavljajo ustrezno razredčenje, niso zelo problematični. Vseeno se zaradi preprečevanja termalnega in kemičnega onesnaženja in vzdrževanja tlaka v vodonosniku vse bolj poslužujejo tudi reinjekcije. Ta ni sistematično, a priori zahtevana, ampak se o načinu rabe in izpustu termalne vode presoja za vsak projekt posebej. V prihodnosti načrtujejo povečanje energetskega izkoristka v sistemu rabe (pri končnih uporabnikih in tudi z rabo toplotnih črpalk, ki jih zdaj skoraj ni) in večjo samozadostnost na področju pridelave hrane v rastlinjakih.

2 Abstract

Iceland is a relatively young volcanic island. The oldest volcanic rocks are only 16 Ma old, dominated by basalt. Since Iceland is located in the area of the rift zone between two tectonic plates (Eurasian and North American), the territory moves apart by approximately 1 cm a year. As a result, Iceland is still volcanically active and has a high potential for using the geothermal energy. Namely, the thermal water can reach up over 250 °C in the rift zone, which enables using it for the heating purposes, as well as the electricity production. Due to the surplus of thermal water it is mostly not reinjected yet, however, it is slightly cooled (30-45 °C) and released into the surroundings or the sea.

Between 25th and 29th October 2022 a »DT 1.1.3 Workshop and site-visit to transferrable case studies in reinjection, cascade use technology and binary geothermal power plants in Iceland« was held within the framework of the INFO-GEOTHERMAL project. The event took place partly in the premises of the Reykjavík University, partly in various locations in the south-west Iceland.

During the first part of the educational programme (Tuesday, 25th October) presentations of icelandic companies, organizations and other partners, who are being a part of the projects, were held. In addition, participants from Slovenia presented their work and companies as well. From Wednesday 26th to Friday 28th October many site-visits were organized – mainly icelandic companies, which work with geothermal energy and are supervising it, as well as smaller and bigger geothermal powerplants. We also visited two greenhouses. We visited: CO_2 plant at Hæðarendi, Selfossveitur pump station and well field in Ósbotnar, Agricultural University's Reykir Greenhouse in Reykjamörk, Hellisheiði power plant with Geothermal Exhibition, Kópsvatn power plant, Friðheimar greenhouse, Bæjarháls District heating control, Nesjavellir power plant, Veitur's Reynisvatnsheiði water distribution facility and pumps, as well as Bolholtsstöð pumping station and water gathering station of low temperature field Laugarnes.

Nineteen participants learned about different technologies in the field of thermal water utilization, principles of geothermal parks, schemes for risk insurance, project development and methods of managing space and natural resources. Due to a very rapid growth of cities and thus the need for heating, they are investing in the expansion of existing sources and searching for new ones. Moreover, there is a significant difference between drilling prices in Slovenia and Iceland, where it is much cheaper. Geothermal power plants are possesed by public companies, such as Reykjavík Energy. Currently, they have been working on drilling new boreholes, because they are facing a fast growth of new buildings (especially in Selfoss). Work is supported by administrative bodies and research institutions, as well as financial mechanisms for risk insurance and credits. The major challenge represents locating new wells, due to gaining approvals for spatial intervention and ensuring environmental and social acceptability. Releasing of waste thermal water into envirnment is often not problematic, as the water has a chemical composition similar to groundwater and flux of recipients is sufficient to ensure adequate dilution. However, in order to prevent thermal and chemical pollution and to maintain pressure in the aquifer, the use of reinjection is locally increasing. This is not yet required *a priori*, but the method of using and releasing waste thermal water is discussed for each project separately. In the future, more efficient utilization of the geothermal energy is planned, as well as drilling more reinjection boreholes. Moreover, a greater self-sufficiency in the field of the greenhouse food production is planned.

3 Uvod

Islandija je že vrsto let med vodilnimi na področju raziskav in rabe geotermalne energije, saj je ta lahko dostopna in omogoča visoko kvaliteto bivanja ter visok življenjski standard. 99,9 % njihove električne energije pridobijo iz obnovljivih virov, 95 % hiš je ogrevanih z geotermalno energijo, vse skupaj 85 % primarne energije pride iz obnovljivih virov (Internet 1).

Od 25. do 28. 10. 2022 je potekalo izobraževanje na temo prenosljivih študij primerov o reinjekciji, tehnologije kaskadne uporabe in binarnih geotermalnih elektrarn na Islandiji. Izobraževanja se je iz Slovenije skupaj udeležilo 19 ljudi, med katerimi je bilo 5 udeležencev iz GeoZS, 1 z Ministrstva za okolje in prostor, 1 z Ministrstva za infrastrukturo, 2 iz Skupnosti občin Slovenije, 5 iz občin (Beltinci, Benedikt, Dobrovnik, Piran in Podlehnik), 1 iz podjetja KRONOTERM d.o.o., 1 iz podjetja VELING-DEOL d.o.o. ter 2 iz podjetja GOLEA.

Izobraževanje je potekalo v dveh delih – v torek, 25. 10., je v prostorih Islandske šole za energijo potekala delavnica, kjer se je predstavilo več islandskih podjetij in organizacij, ki se ukvarjajo z geotermalno energijo, kot tudi partnerji in deležniki v sklopu projekta INFO-GEOTHERMAL: Orkustofnun (Agencija za energijo), GRÓ GTP, Iceland School of Energy (ISE), Reykjavík Energy (OR), Icelandic Centre for Research (RANNÍS), Geothermal Research Cluster (GEORG) in Baseload Power Iceland. Poleg tega so se predstavili tudi udeleženci iz Slovenije, Nina Rman (GeoZS) je predstavila projekt INFO-GEOTHERMAL ter Si-Geo-Electricity, Andrej Lapanje (GeoZS) pa geotermalni potencial in trenutno rabo geotermalne energije v Sloveniji. Predstavniki občin in podjetij so predstavili svoje strokovno delovanje in potrebe s področja geotermalne energije. Terenski del izobraževanja se je pričel v sredo, 26. 10., in trajal do vključno petka, 28. 10. Ogledali smo si: CO_2 postajo v kraju Hæðarendi, črpalno postajo daljinskega sistema v upravljanju podjetja Selfossveitur in polje vodnjakov v Ósbotnarju, rastlinjak Reykir Fakultete za kmetijstvo v Reykjamörku, geotermalno elektrarno Hellisheiði in geotermalno razstavo, geotermalno elektrarno Kópsvatn, rastlinjake v Friðheimarju, nadzorno sobo daljinskega ogrevanja Bæjarháls, geotermalno elektrarno Nesjavellir, distribucijski objekt Reynisvatnsheiðiwater in črpalke od podjetja Veitur, ter črpalno postajo Bolholtsstöð in zbirni sistem vode nizkotemperaturnega polja Laugarnes.

4 Delavnica – torek, 25. 10. 2022

4.1 Islandska podjetja in organizacije na področju geotermalne energije

4.1.1 Orkustofnun (National Energy Authority of Iceland)

Orkustofnun (Internet 1) je državni urad, ki deluje v okviru Ministrstva za okolje, energijo in podnebje. Njegovi glavni nameni so: svetovanje islandski vladi na področju energetike in sorodnih tematik, urejanje dovoljenj ter nadzorovanje razvoja in izkoriščanje energetskih virov in rudnih nahajališč, urejanje delovavnja prenosnega in distribucijskega sistema ter spodbujanje raziskav na področju energetike. Generalna direktorica Orkostofnuna je Halla Hrund Logadóttir, ki ga je tudi predstavila na delavnicah.

Na spletni strani so dostopni prostorski podatki, za katere so odgovorni v Orkustofnunu.

Trenutno so aktivne naslednje spletne strani:

1. Iceland Continental Shelf Portal (Landgrunnssjá) – ICSP (Internet 2)

ICSP omogoča prijavo, vzdrževanje in delitev podrobnih podatkov na območju islandskega kontinentalnega šelfa. S pomočjo ICSP lahko dostopamo do različnih podatkov, ki so vezani na kontinentalni šelf v okolici Islandije, vključno z dovoljenji, izdanimi s strani Orkustofnuna od leta 2008 naprej, področji raziskovanja, morskim dnom ter najdbami z odprav na območje Dreki in druge lokacije znotraj islandskega gospodarskega območja. Spletna stran je dostopna v angleščini (več informacij na povezavi Internet 3).

2. Orkustofnun - Geoportal (Internet 4)

Orkustofnun Geoportal je nov portal (delujoč od decembra 2016), ki temelji na natančnem zračnem posnetku celotne države, v merilu 1 : 25.000. Na portal so naloženi podatki o vrtinah iz OS Well Registry (identifikacijska številka, ime vrtine, ime lokacije, koordinate, lastnik, globina, največji in najmanjši premer, datum začetka vrtanja in podjetje, ki je vrtalo). Zaenkrat obstaja le različica v islandskem jeziku (več informacij na povezavi Internet 5).

3. OS Map Collection Portal (Internet 6)

OS Map Collection Portal je zbirka vseh kart, ki so nastale pod okriljem Orkustofnuna in drugih podjetij. Karte so nastale v okviru projektov, v katerih so sodelovali Orkustofnun, predhodna inštitucija Raforkumálaskrifstofan, Landsvirkjun in Rarik v obdobju 1958-1998. Karto energetskih virov (»Energy Resource Map«) in geološke karte (»Geological Maps«), ki pokrivajo geološke in hidrogeološke vire, so ustvarili v obdobju 1972-2003, in sicer Orkustofnun, ÍSOR in Vatnamælingar. Med leti 1986-2000 je Orkustofnun skupaj z National Land Survey of Iceland (Landmælingar Íslands), RALA (Agricultural Research Institute), Natural Science Institute in Landsvirkjun v okviru kartografskega projekta naredil geološke karte v merilu 1 : 25.000. Zaenkrat obstaja le različica v islandskem jeziku (več informacij na povezavi Internet 7).

4.1.2 Geothermal Training Programme (GRÓ GTP)

GRÓ GTP (Internet 8) je geotermalni izobraževalnih program (»Geothermal Training Programme«) na Islandiji, v okviru UNESCO-a, ki deluje od leta 1978 naprej. Program je organiziran znotraj organizacije GRÓ (International Centre for Capacity Development – Sustainable Use of Natural Resources and Societal Change) in traja šest mesecev, oziroma so na voljo tudi krajša izobraževanja. Sedež GRÓ GTP se nahaja v Iceland GeoSurvey (ISOR), ki je neprofitna inštitucija v lasti države, ustanovljena leta 2003. Z GRÓ GTP upravljajo strokovnjaki z ISOR, UI (University of Iceland) in RU (Reykjavík University) (Internet 8). Na delavnici ga je predstavil Guðni Axelsson. Predstavitev se nahaja v Prilogi 1.

4.1.3 Iceland School of Energy (ISE)

ISE (Internet 9) ponuja študij druge stopnje (120 ECTS) na temo geotermalne energije. Je del Inženirskega oddelka (»Department of Engineering) na Univerzi v Reykjavíku (»Reykjavík University«) in je podprt s strani Združenja pooblaščenih inženirjev Islandije (»Association of Chartered Engineers in Iceland«). Na delavnici jo je predstavila Juliet A. Newson. Predstavitev se nahaja v Prilogi 2.

4.1.4 Reykjavík Energy (OR)

Reykjavík Energy (Internet 10) je energetsko in komunalno podjetje v lasti treh občin. S štirimi hčerinskimi družbami na trajnosten in finančno ugoden način pridobivajo energijo za oskrbo stanovanjskih in poslovnih objekte. Pod okriljem OR delujejo: Veitur (komunalno podjetje), Ljósleiðarinn (telekomunikacijsko podjetje), ON (Orka Nattúrunnar – energetsko podjetje) in CARBFIX (akademsko-industrijsko partnerstvo, ki je razvilo nov pristop k zajemanju in shranjevanju CO_2). Na delavnici ga je predstavila Arna Pálsdóttir. Predstavitev se nahaja v Prilogi 3.

4.1.5 Icelandic Centre for Research (RANNÍS)

Islandski raziskovalni center RANNÍS (Internet 11) podpira raziskovanje, novosti, izobraževanje in kulturo na Islandiji. Sodeluje z Islandskim odborom za znanost in tehnologijo (»Icelandic Science and Technology Policy Council«) ter prispeva k pripravi in uporabi pravil na področju znanosti. Poleg tega sodeluje v evropskih programih, kot so: Horizon Europe, Erasmus+ in Creative Europe. Odločajo o financiranju raziskovanja in razvoja geotermije ter skrbijo za promocijo raziskav, novosti, izobraževanja in kulture na Islandiji na islandski, kot tudi mednarodni ravni. Na delavnici ga je predstavil Egill Þ. Níelsson. Predstavitev se nahaja v Prilogi 4.

4.1.6 Geothermal Research Cluster (GEORG)

Geothermal Research Cluster (GEORG) (Internet 12) je neprofitna organizacija, ki stremi k promociji raziskovanja in razvoja na področju geotermalnih virov in posledično zmanjšanju emisij CO_2. GEORG je ustanovljen leta 2009 s podporo RANNIS-a kot Center odličnosti v Geotermiji (Geothermal Centre of Excellence), od leta 2016 pa deluje kot neprofitna organizacija. Njegov namen je zmanjšati vrzeli med različnimi deležniki (privatni sektor, izobraževalne in raziskovalne organizacije) v geotermalnem sektorju in aktivno sodelujejo v trajnostnem razvoju po celem svetu. Na delavnici jo je predstavil generalni direktor Hjalti P. Ingólfsson. Predstavitev se nahaja v Prilogi 5.

4.1.7 Baseload Power Iceland

Baseload Power Iceland (Internet 13) se je razvil leta 2017 iz predhodnega tehnološkega podjetja Climeon, ki je razvil način, s katerim lahko učinkovito pridobivajo elektriko iz nizkotemperaturne termalne vode. Sprva so imeli stranke iz industrije jekla in ladjedelstva, kjer so izkoriščali odpadno toplo vodo. Po selitvi na Islandijo so leta 2018 začeli izkoriščati toplo vodo iz vrtin pod novim imenom Baseload Capital. Danes imajo elektrarne v štirih državah: na Japonskem, na Tajvanu, v ZDA ter na Islandiji. Uspelo jim je usposobiti več elektrarn, v načrtu jih je še več. Na delavnici sta podjetje predstavila Ragnar S. Ragnarsson in Paula F. Acosta.

4.2 Povzetek predstavitev slovenskih udeležencev

4.2.1 Geološki zavod Slovenije GeoZS

Nina Rman je predstavila projekt INFO-GEOTHERMAL z naslovom Podpiranje učinkovite kaskadne uporabe geotermalne energije z dostopom do uradnih in javnih informacij. Predstavitev se nahaja v Prilogi 6. Drugo predstavitev je imela na temo projekta Si-Geo-Electricity z naslovom Pilot Geothermal power plant on an existing gas well Pg-8. Predstavitev se nahaja v Prilogi 7.

Andrej Lapanje je predstavil možnosti uporabe geotermalne energije v predstavitvi z naslovom Geothermal potential and use of geothermal energy in Slovenia. Pojasnil je, kako trenutno uporabljamo geotermalno energijo v Sloveniji ter kakšni so izzivi in načrti v prihodnosti. Predstavitev se nahaja v Prilogi 8.

4.2.2 MZI in MOP

Gregor Rome je predstavil Ministrstvo za infrastrukturo RS (MZI), Aleš Jeraj pa Ministrstvo za okolje in prostor (MOP). Predstavila sta naloge ministrstva, s čim se trenutno ukvarjajo in kakšne cilje imajo za prihodnost na področju geotermalne energije. Predstavitvi se nahajata v Prilogi 9 (MZI) in Prilogi 10 (MOP).

4.2.3 Skupnost občin Slovenije (SOS)

Jasmina Vidmar je predstavila Skupnost občin Slovenije, kakšen je njihov namen, kaj organizirajo in znotraj katerih projektov sodelujejo. Predstavitev se nahaja v Prilogi 11.

4.2.4 Predstavitev slovenskih občin Benedikt, Dobrovnik, Piran in Podlehnik

Občine so predstavili: Igor Barton (Občina Benedikt), Daniel Bot (Občina Dobrovnik), Robert Smrekar (Občina Piran) in Sebastijan Toplak (Občina Podlehnik). Predstavitvi se nahajata v Prilogi 12 (Benedikt) in Prilogi 13 (Podlehnik).

5 Terenski del – sreda, 26.10. – petek, 28. 10. 2022

5.1 Teren, 1. dan (26. 10. 2022)

5.1.1 Točka 1: CO_2 postaja v kraju Hæðarendi, Burfellsvegur

Na postaji uporabljajo dve vrtini, iz katerih črpajo termalno vodo s temperaturo 103 °C na 700 m globine. Vodo morajo ohlajati, da preprečujejo obarjanje kalcita v vrtini, saj se topnost CO_2 z višanjem temperature zmanjšuje. Ohlajena voda, ki jo ohlajajo s pomočjo površinske vode na 70 °C, kroži v vertikalnem toplotnem izmenjevalcu do globine 330 m globoko, kjer jo reinjektirajo. Višja kot je temperatura na separatorju, več CO_2 izhaja. Preden vodo injektirajo v vrtino (približno polovico količine, zato da voda služi kot medij za prenos CO_2 na površje), ji dodajo inhibitorje (v tem primeru natrijeve in magnezijeve spojine), ki preprečujejo obarjanje. Višek tople vode odvajajo v okolico, en del pa se uporablja za ogrevanje bližnje kmetije in po rabi izteka v bližnji bazen s temperaturo 40 °C.

Pridobljen CO_2 utekočinijo in shranijo v rezervoarje. Količina pridobljenega CO_2 je odvisna od temperature na separatorju – višja kot je, več CO_2 lahko dobijo iz vode. CO_2 uporabljajo predvsem v poljedelstvu in pijačarstvu, vendar zaradi večjega povpraševanja Islandija dodatno uvaža CO_2.

Slika 1 CO2 postaja v kraju Hæðarendi, Burfellsvegur. Od leve proti desni: izpust CO2 pod tlakom (levo), vertikalni toplotni izmenjevalec (sredina) in črpalna vrtina, iz katere črpajo vodo s temperaturo 103 °C na 700 m globine (desno). Foto: Mateja Macut. Posneto 26. 10. 2022.

5.1.2 Točka 2: Črpalna postaja Selfossveitur in polje vodnjakov, Ósbotnar

Toplarna Selfossveitur se nahaja v naselju Selfoss. Trenutno se sooča z izzivom hitrega naraščanja števila na novo zgrajenih stanovanjskih objektov, podvojitev sledi na 20 let, kar povečuje potrebo po geotermalni energiji za ogrevanje. Tukaj so bili termalni izviri, vrtine so locirali glede na geofizikalne rezultate.

Na tem območju imajo tri hidravlično ločena geotermalna polja: najstarejše je iz leta 1948, sledijo vrtine iz leta 2001, najnovejše pa so iz leta 2020 in se nahajajo tik zraven glavne ceste v Selfossu ob mostu. Novejše vrtine so usmerjene. Ustja vrtin so urejena in zavarovana v zelenih hiškah. Starejše vrtine so bile globlje (okoli 1400 m) in izvrtane na toplejšem območju (temperatura do 118 °C). Globlje ležeče toplejše območje ima manjšo kapaciteto (le 5 l/s) od višjega območja, zato so novejše vrtine izvrtane v zgornji del vodonosnika. Najglobljа vrtina je 2,4 km.

V splošnem je temperatura termalne vode na tem območju okoli 70-90 °C, najvišja temperatura je 118 °C. Stara toplarna je imela kapaciteto 250 l/s, nova pa 750 l/s, oziroma 60 MWt, kar lahko oskrbuje do 30.000 prebivalcev. Daljinski sistemi so visokotemperaturni, 60-80 °C. S polno kapaciteto črpajo le pozimi, medtem ko poleti uporabljajo približno eno tretjino celotne količine. Na začetku so bile vrtine samoizlivne, s povečevanjem rabe pa se je tlak v vrtinah znižal. Trenutno oskrbujejo približno 10.000 prebivalcev Selfossa in še dveh naselij, v načrtu je vrtanje več novih vrtin in povečanje pridobivanja geotermalne energije, ker delajo pozimi na polni kapaciteti. Prav tako stremijo k temu, da bi imeli dovolj vrtin, da bi lahko nekatere vrtine izklopili. Zadnje čase tudi razmišljajo v smeri reinjektiranja uporabljene vode, ker jim nivoji padajo, a jo zaenkrat še izpuščajo v okolje. Kjer imajo težave z obarjanjem, uporabljajo raztopino H_2S, medtem ko s korozijo nimajo težav. Voda ima pH okoli 9,4 in je pitna.

Uporabniki plačujejo za količino prejete tople vode, npr. 1 m^3 tople vode je 0,19 € (različni predavatelji so nam podali nekoliko različne ocene cen, ker so odvisne od območij (Internet 14), ne glede na temperaturo, zato ne delajo na energetski učinkovitosti. Po državi ni enotnega plačila (m^3 ali energija), niti cene zanjo po regijah. Uporabnik se odloči sam, ali bo termalno vodo uporabljal neposredno za sanitarno vodo ali preko toplotnega izmenjevalca (HEX), kar povzroča manj težav z obarjanjem mineralov v ceveh. Termalna voda in hladna podzemna voda se v sistemu sicer ne mešata, ker se drugače oborijo magnezijevi silikati, kar predstavlja težavo.

Slika 2 Pred vhodom v črpalno postajo Selfossveitur (levo), ena izmed zelenih hišk z vrtino v bližini lokacije, kjer trenutno potekajo nova vrtalna dela (desno) Foto: Nina Rman (levo), Mateja Macut (desno). Posneto 26. 10. 2022.

5.1.3 Rastlinjaki Reykir Fakultete za kmetijstvo, Reykjamörk

Rastlinjak, ogrevan z geotermalno energijo, so zgradili leta 2005. Danes v njih delajo različne poskuse gojenja zelenjave (trenutno preizkušajo, kako različna vsebnost CO_2 v zraku (od normalne do 1200 ppm) vpliva na rast paradižnika - vplivi morebitnih bodočih podnebnih sprememb). Rezultate poskusov posredujejo kmetom, ki se odločajo sami, kako bodo gojili zelenjavo za namen prodaje. V rastlinjaku med drugim eksperimentirajo s spreminjanjem tipa, razporeditve in višine luči. Opraševanje rastlin opravijo čmrlji, ki jih uvažajo iz Belgije. V tropskem rastlinjaku gojijo bolj eksotične rastline, kot so banane, fige, kakavovec, kavovec, različne vrste kaktusov, ipd.

Izven rastlinjaka imajo manjši vrt, kjer preizkušajo, kako se rastline odzivajo na zunanje pogoje. Hkrati plitvo pod površje vgradijo cevi za geotermalno vodo in s tem ogrevajo zemljo in opazujejo, ali ugodno vpliva na rast rastlin v zunanjih pogojih (Internet 15).

Slika 3 Rastlinjak z bolj eksotičnimi rastlinami - bananami, figami, kakavovcem, kavovcem ter različnimi vrstami kaktusov, ipd. Foto: Mateja Macut. Posneto 26. 10. 2022.

5.2 Teren, 2. dan (27. 10. 2022)

5.2.1 Geotermalna elektrarna Hellisheiði in ogled geotermalne razstave, Hengill

To je geotermalna elektrarna, ki proizvaja elektriko in toploto in pokriva velik del ogrevanja Reykjavika. Je največja od desetih geotermalnih elektrarn na Islandiji, oz. osma največja na svetu, in prispeva približno 40 % geotermalne elektrike proizvedene na Islandiji. Le tri od teh so enakega tipa (combined H&P), ostale proizvajajo samo elektriko (Internet 16).

Glavni proizvod je toplota, sistema (toplota in elektrika) sta povsem neodvisna. Od 2006 proizvajajo tudi elektriko, uporabljajo 7 turbin, vsaka daje do 45 MWe, cca 2-3 MWe od tega se uporablja za obratovanje samega sistema (parazitska energija), ter eno nizkotlačno turbino. Skupna nazivna moč elektrarne je 303 MWe. Poleg tega imajo 3 linije HEX, ki proizvajajo toplo vodo za Reykjavík. Zraven uporabljajo še tri plinske separatorje, ki s pomočjo gravitacije ločujejo paro od vode. Imajo 60-70 vrtin, v uporabi jih je okoli 70%, globine 0,5-2 km. Večinoma gre za usmerjene vrtine, ki so globlje od 300 m, odklonjene za 30 stopinj od vertikale. Vse je vrtano v bazalt.

Ker se elektrarna nahaja na območju riftne cone, ima najtoplejša voda temperaturo 180 °C. S pridobivanjem elektrike to vodo ohlajajo na 120 °C. S to vodo nato ogrevajo hladno podzemno vodo preko HEX na na 85 °C in jo uporabljajo za daljinsko ogrevanje Reykjavika. Temperaturne izgube do mesta, 25 km stran so le 2 °C. Razlog za majhne izgube so veliki volumni vode (oz. cevi), velik pretok in naklon cevi. V to vodo zaradi preprečevanja korozije in obarjanja dodajajo manjše količine H_2S.

Leta 2011 so začeli reinjektirati vodo nazaj v rezervoar (predvsem zato, da bi vanj vračali H_2S in CO_2), vendar so se pričeli v začetku pojavljati potresi, od teh 2 kar zelo močna. Na hitro so oblikovali strokovno skupino, ki je preučila mehanizme pojavljanja potresov in sklenila, da gre za sproščanje napetosti ob prelomu in da se bo sčasoma sprostila vsa napetost ter se potresi ne bodo več pojavljali. Ob reinjekciji so v sosednjih vaseh zaznali potrese, saj je tekočina mazivo za premike ob prelomih, zato so spremenili pristop reinjekcije, niso pa je opustili. Tlak vtiskanja je 6-7 bar, enako kot v sistemu elektrarne. Dovoljenje imajo za 100 % vračanje, izpusti v okolje so le ob posamičnih testiranjih.

Pri daljinskem ogrevanju so imeli težave zaradi prisotnega magnezija (hladna voda) in kremenice (termalna), zato zdaj ne mešajo hladne podzemne vode s termalno in uporabljajo toplotne izmenjevalce, da segrevajo hladno podzemno vodo, ki jo črpajo iz vrtin, ter jo po cevovodih pošiljajo do Reykjavika.

Reinjekcijsko polje se nahaja ob tovarni, drugo reinjekcijsko polje čez magistralno cesto so spremenili v črpalno, saj so potrebovali več energije.

Hladna podzemna voda severozahodno od elektrarne je vir pitne vode za Reykjavík, zato so okoli elektrarne postavili »resource park«, z namenom, da bi zajeli vse tokove, ki prihajajo iz elektrarne (tudi CO_2) in spodbujali inovacije. Na ta način odpadna voda postane vir surovin: CO_2, H_2S, kremenica, ipd. V sklopu geotermalne elektrarne Hellisheiði se nahaja eden največjih sistemov vračanja CO_2 v tla. Razvili so ga v projektu CARBFIX, ker so morali znižati vsebnost CO_2 v zraku v Reykjaviku. Sedaj zajamejo okoli 30 % CO_2 in 80 % H_2S, ki je bolj topen, zato ga uspejo več ujeti. Raztopi se v kondenzatu iz separatorja in nato reinjecira. S tem so znižali izpuste CO_2

celotne elektrarne za cca 30%. Menda bodo dovažali utekočinjen CO_2 z ladjami, da ga bodo injicirali in to zaračunavali (Carbon storage). Utekočinjen CO_2 v vrtini reagira z minerali kamnine in se mineralizira.

Na isti lokaciji so v projektu SULFIX poskušali reinjecirati tudi čisti H_2S, a projekt ni bil tako uspešen, ker je po 10 h vse korodiralo, zato so prenehali ločevati plina in oboa vračajo hkrati. H_2S je namreč leta 2010 povzročil težave zaradi širjenja neprijetnih vonjav in kislega dežja proti Reykjavíku. To so sanirali z omejitvijo emisij H_2S v ozračje. Danes je H_2S pod 24-urnim monitoringom. H_2S dodajajo tudi v vodo v toplovodnih cevovodih, zato da izrine kisik in deluje kot antikorozivno sredstvo. Zato ima na izpustih v okolje odpadna termalna voda vonj po gnilih jajcih. Iztoki v morje so mogoči oziroma dovoljeni, ker so bili tudi prej v Reykjaviku in okolici topli izviri in se zaradi velikega volumna morja izpusti hitro razredčijo.

Imajo tudi elektrolizo za proizvodnjo H_2 kot pilotni primer sistema.

Vzdrževanje geotermalne elektrarne poteka na tedenski, letni in štiriletni ravni. Tedensko izmerijo gladine v opazovalnih vrtinah, vizualno pregledajo ustja in vseh stikov. Vse točke izpustov (manjše cevi) zaprejo s ploščico, ki jim omogoči opazovanje morebitnega puščanja skozi odprtino ali v cevovodu pri večanju tlaka. Poleg tega vsak četrtek obiščejo vse vrtine, ročno izmerijo tlak na ustju vrtine in pogledajo opremo ter aktivnost vrtin in delovanje kontrolnega ventila. Vsako leto sledi pregled tesnil in lubrikacija stikov, odprejo in zaprejo glavni ventil, pregledajo merilno mesto za pretok (V-profil). Torej vsaj enkrat leto zaprejo vsak delujoč objekt. Pregled traja manj kot en dan. Na štiri leta testirajo cevovod pod tlakom do dušilca zvoka, da bi preprečili pokanje cevi, ko je vrtina v uporabi.

Slika 5 Glavna stavba geotermalne elektrarne Hellisheiði (levo), del geotermalne razstave (desno). Foto: Mateja Macut (levo), Nina Rman (desno). Posneto 27. 10. 2022.

Slika 4 Trije plinski separatorji zraven glavnega objekta (levo), eno izmed dveh reinjekcijskih polj (pod hribom) (desno). Foto: Nina Rman (levo), Mateja Macut (desno). Posneto 27. 10. 2022.

5.2.2 Geotermalna elektrarna Kópsvatn, Hrunamannavegur 30, Flúðir

Geotermalna elektrarna Varmaorka's (Internet 17), s katero upravlja podjetje Baseload Power Iceland, deluje na Climeon module (Švedska), ki delajo na Rankinov cikel. Poleg elektrike proizvaja tudi toploto. Geotermalno toplarno, ki zagotavlja ogrevanje za 5 km oddaljeno naselje Flúðir, podnevi upravljata dva delavca, sicer jo nadzorujejo na daljavo. Leta 2008 so izvrtali 1,5 km globoko vrtino, v kateri je bila voda pretopla za daljinsko ogrevanje. Sistem bodo še širili oz. priključili na daljinski sistem v bližini. Lociranje je na območju nekdanjih izvirov v bližini, nato so kartirali prelom (s plitvimi termometričnimi vrtinami) in ga ciljali. Pri vrtanju so ugotovili pritok toplejše vode iz drugega sistema, zaradi česar se na določeni globini temperatura vode nenadoma zviša na 150-160 °C. V načrtu imajo vrtanje novih vrtin na območju toplejšega sistema.

Leta 2008 so izvrtali 1,5 km globoko vrtino, v kateri je bila voda pretopla za daljinsko ogrevanje. Zato so leta 2017 začeli z odvajanjem odvečne toplote s pomočjo švedske tehnologije – pridobivajo 30 l/s vode s temperaturo 110 °C. Enote so povezane zaporedno. V vrtini je vedno 10 bar. Temperatura vode po odvzemu toplote znaša 75 °C. Kapaciteta štirih modulov skupaj je 600 kW oz z vsemi delujočimi deli menda do 1,2 MW (ampak ne delajo vsi moduli, niso zadovoljni z opremo, naslednjič gredo na Turboden). Izčrpane vode ne injektirajo nazaj v sistem, ampak nekoliko ohlajena voda prosto teče v okolico. Voda ni mineralizirana, sestava je podobna hladni podzemni vodi. Na tej lokaciji ne uporabljajo inhibitorjev, saj je fizikalno-kemijska sestava vode podobna sestavi pitne vode. Poleg tega voda vsebuje zmerne količine dušika in CO_2, zato ni težav med rabo ali z izpusti.

Ker se je pokvarila sonda za gladino, privezana na črpalko, jo do menjave merijo ročno, približno enkrat mesečno, tako da v vrtino potisnejo plinski dušik in izmerijo, koliko ga porabijo. Ker je nestisljiv, iz porabljenega volumna določijo globino do gladine, ki je ves čas okoli 100 m. V večini geotermalnih vrtinah z vgrajeno potopno črpalko merijo na Islandiji gladino vode z dušikom.

Slika 6 1,5 km globoka vrtina (2008) (levo), pogled na celoten kompleks geotermalne elektrarne Varmaorka's z bližnjega hriba. Foto: Nina Rman (levo), ? (desno). Posneto 27. 10. 2022.

Slika 7 V bližini geotermalne elektrarne izpuščajo odpadno termalno vodo (levo), master valve (desno). Foto: Mateja Macut. Posneto 27. 10. 2022.

5.2.3 Friðheimar rastlinjaki, Friðheimar

Kmetija Friðheimar (Internet 18) v rastlinjaku vzgaja štiri različne vrste paradižnikov in so eni izmed največjih pridelovalcev paradižnikov na Islandiji (proizvedejo 40% paradižnikov za islandski trg). Skupna površina rastlinjaka je 1,174 m². Za opraševanje uporabljajo belgijske čmrlje, v sklopu samega rastlinjaka pa se nahaja tudi restavracija, kjer ponujajo različne jedi s pridelanim paradižnikom, in paradižnikovo pivo.

Vrtina s termalno vodo je oddaljena približno 200 m od rastlinjakov. Voda ima okrog 95 °C. Zato, da pride do rastlin čim več svetlobe, imajo rastlinjaki le 4 mm debelo steklo, kar pomeni da so toplotne izgube večje in posledično porabijo več termalne vode. Približno 100.000 m^3 na leto. Zaradi boljše fotosinteze v rastlinjake dodajajo ogljikov dioksid, pridobljen iz njihove geotermalne vrtine.

Slika 8 Geotermalni sistem na tleh v rastlinjaku (levo), ena izmed škatel s čmrljevo družino, ki pomagajo pri opraševanju rastlin, ter izdelki. Foto: Nina Rman. Posneto 27. 10. 2022.


Slika 9 Osvetljava v rastlinjaku (levo), restavracija v sklopu rastlinjaka, kjer strežejo paradižnikovo juho (desno). Foto: Nina Rman. Posneto 27. 10. 2022.

5.3 Teren, 3. dan (28. 10. 2022)

5.3.1 Bæjarháls kontrolna soba daljinskega ogrevanja, Reykjavík

Bæjarháls District Heating Control (Internet 19) deluje v sklopu sedeža islandskega komunalnega podjetja Veitur. Nadzorna soba vsebuje 30 računalniških zaslonov, na katerih stalno spremljajo dogajanje v sistemu. Delavci so prisotni od 8.00 do 16.00 vsak delavnik, izven delovnih ur pa pridejo v primeru prižiga alarma in imajo omogočen dostop do sistema od doma.

Skupaj imajo na območju Reykjavika 60-70 vrtin, s črpalno količino 40 l/s na vsako vrtino, ki poleg toplovoda iz geotermalnih elektrarn Hellisheiði in Nesjavellir, ogreva tudi urbano aglomeracijo Reykjavika. Skupen dotok vode v sistemu je okoli 4500 l/s. Nadzorujejo nivo vode v zbiralnikih, iz česar dobijo podatek, koliko smejo črpati. Kapaciteta zbiralnikov je 23.000 m^3, vendar vode ne shranjujejo, temveč gre ohlajena na 20-40 °C direktno v morje. Del odpadne vode, ki gre od uporabnikov, ponovno zajemajo, da jo mešajo z vodo iz vrtin, ki ima previsoko temperaturo, tako da ima voda, ki jo pošiljajo v toplovod, temperaturo 85 °C. Pozimi zaradi večje potrebe po toploti v hišah nekoliko zvišajo temperaturo vode. Višek je januarja, ko dosežejo kapaciteto 1 GWt.

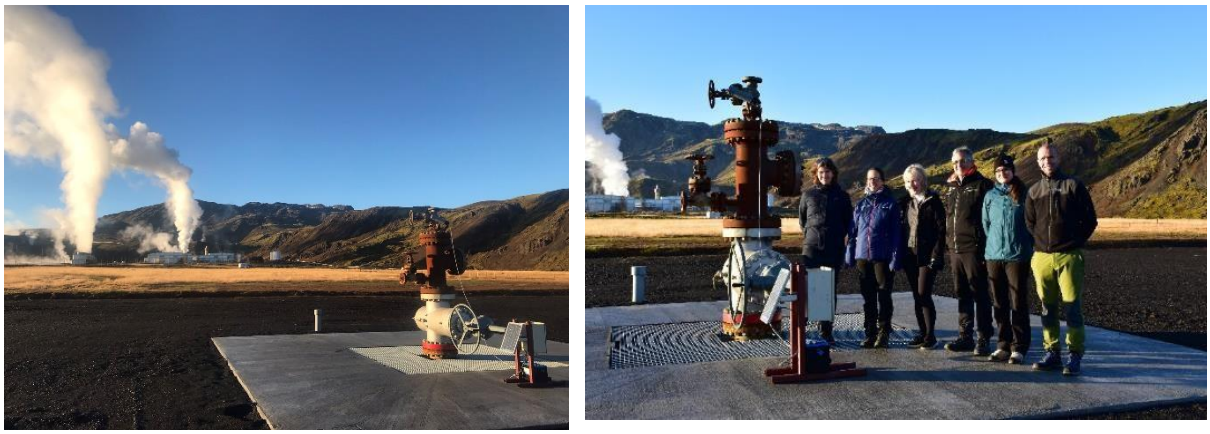
Zaradi podnebnih sprememb imajo vse več težav s strelami, ki povzročajo motnje v delovanju toplarne zaradi električnih udarov in okvar opreme, poleg tega se zaradi širjenja mesta soočajo z vse večjo porabo vode – vsako leto potrebujejo dodatnih 160 l/s termalne vode.


Slika 10 Nadzorna soba s 30 računalniškimi zasloni (levo), celoten kompleks Bæjarháls. Foto: Nina Rman (levo), Mateja Macut (desno). Posneto 28. 10. 2022.

5.3.2 Geotermalna elektrarna Nesjavellir, v bližini Hengilla

Geotermalna elektrarna Nesjavellir (Internet 20) deluje od leta 1990 in je v lasti Reykjavik Energy. Trenutna kapaciteta je 120 MW elektrike in 400 MW geotermalne energije za ogrevanje hiš. Črpajo 1600 l/s s temperaturo 192 °C. Pri tem gre odpadna voda v topel potok v bližini. Pred elektrarno se nahaja prva reinjekcijska vrtina, ki zaenkrat služi kot opazovalna vrtina. Izvrtali so jo marca 2022, globoka pa je 2 km.

Mešanica pare in geotermalne vode se transportira iz vrtin v centralno separatorsko postajo pri 192 °C in 12 barih. Primarni namen elektrarne je bil zagotavljanje tople vode za 27 km oddaljeno območje Reykjavíka. Prvih osem let je elektrarna zagotavljala le toplo vodo za Reykjavik, kjer so hladno podzemno vodo ogrevali s paro in geotermalno vodo preko toplotnih izmenjevalcev. Od leta 1998 proizvajajo tudi elektriko. Toplo vodo črpajo iz elektrarne, ki je na nadmorski višini 160 m, v večji zalogovnik na nadmorski višini 400 m, od koder gravitacijsko teče v zalogovnike na obrobju Reykjavika, preden jo distribuirajo naprej.



Slika 11 Geotermalna elektrarna Nesjavellir (levo), udeleženci z GeoZS in Juliet A. Newson ob reinjekcijski vrtini (desno). Foto: Mateja Macut (levo), ? (desno). Posneto 28. 10. 2022.

5.3.3 Distribucijski objekt Reynisvatnsheiði in črpalke, Reynisvatnsheiði

Termalno vodo iz tega objekta (Internet 21), ki ga nadzoruje Veitur, distribuirajo v dve smeri: proti severu in jugu. Gre za enega izmed večjih distributivnih obratov s tremi booster črpalkami, vsaka ima moč 1 MWe, oziroma maksimalen odvzem 2000 l/s. Ne mešajo nizko-(hladna podzemna voda z HEX iz geotermalne vode) in visokotemperaturne vode (geotermalna voda iz vrtin v okolici Reykjavika) zaradi problemov z obarjanjem mineralov.

V Reykjavíku sta dva distribucijska sistema, ki se med seboj ne povezujeta neposredno; v enem je voda iz vrtin v okolici Reykjavika, druga pa iz geotermalnih elektrarn Nesjavellir in Hellisheiði.

Slika 12 Distribucijski objekt Reynisvatnsheiðiwater (levo), notranjost objekta s tremi booster črpalkami (desno). Foto: Nina Rman (levo), Mateja Macut (desno). Posneto 28. 10. 2022.

5.3.4 Črpalna postaja Bolholtsstöð in zbirni sistem vode, Reykjavík

Gre za nizkotemperaturni geotermalni sistem (Internet 22) s skupnim številom 10 vrtin, izvrtanih med letoma 1967 in 2020. Najnovejša vrtina iz leta 2020 je globoka 1000 m. Vrtine so izvrtane na območju istega vodonosnika, kar se tudi odraža v spremembah nivoja podzemne vode v nekaterih vrtinah, medtem ko druge ne kažejo odziva na črpanje. Črpajo s črpalno količino 40 l/s, oziroma maksimalno 50 l/s. Globina produkcijske vrtine znaša 2000 m, črpalka je vgrajena na 40 m. S črpanjem iz te vrtine oskrbujejo z ogrevanjem okoli 4500 ljudi.

Črpajo vodo s temperaturo 80 °C in jo nato ohlajajo z dodajanjem hladne podzemne oziroma povratne termalne vode na 60 °C. Veliko odpadne vode s temperaturo okoli 30 °C izpustijo v morje.

Slika 13 Pred črpalno postajo Bolholtsstöð (levo), najnovejša vrtina iz leta 2020, globine 1000 m (desno). Foto: Nina Rman. Posneto 28. 10. 2022.

6 Zaključek

Uporaba geotermalne energije na Islandiji je v porastu od 40-ih let prejšnjega stoletja naprej, z izrazitim skokom v zadnjih 20 letih. V tem obdobju so razvili zelo učinkovito tehnologijo, zmanjšali emisije CO_2 in izboljšali kakovost življenja v islandskih mestih. Postali so neodvisni od tržnih cen, danes minimalno uvažajo in ohranjajo stabilno ekonomijo. Čeprav so naravne danosti Islandije povsem drugačne od Slovenije, bo možno v prihodnosti uporabiti veliko njihovega znanja, ugotovitev iz prakse in se naučiti iz njihovih napak.

Ogledali smo si več geotermalnih elektrarn in podjetij, ki se ukvarjajo z geotermijo, oz. nadzorujejo elektrarne. Na Islandiji plačujejo za ogrevanje večinsko po količini dobavljene termalne vode (v m^3), redkeje in predvsem v novih sistemih pa prehajajo na plačilo za prejeto toploto. Cene vode se razlikujejo glede na območja in se gibljejo do nekaj manj kot 20 evro centov za m^3. Posledično to ne spodbuja energetske učinkovitosti, česar se vse bolj zavedajo šele sedaj, ko jo črpalna polja pogosto na robu trenutnih zmogljivosti. Pogosto so sistemi rabe celo takšni, da je termalna voda »pretopla« za direktno uporabo za ogrevanje hiš, zaradi česar jo morajo najprej ohlajati. Včasih to dosežejo z dodatnimi enotami za proizvodnjo elektrike, včasih pa jo kar mešajo s hladnejšo vodo. Zavedajo se, da so na tem področju možne številne izboljšave, prav tako stremijo k njim zaradi zmanjševanja okoljskega odtisa in zniževanja izpustov odpadne vode v okolje in v morje.

Islandija je zaenkrat samozadostna na področju energije, ne pa pri proizvodnji hrane, zato načrtujejo povečanje pridelave hrane v geotermalnih rastlinjakih. Poleg tega se soočajo z vse večjim izzivom povečanja števila novih hiš zaradi večanja števila prebivalcev. Cilj je, da bi v prihodnosti imeli dovolj vrtin, da bi lahko hkrati obratovalo do 70 % sistema.

Mednarodno izobraževanje, ki smo se ga udeležili na Islandiji, nam je prineslo mnogo uporabnega znanja in novih poznanstev, ki nam bodo pomagali pri uresničevanju ciljev projekta INFO-GEOTHERMAL.

7 Literatura

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GRÓ Geothermal Training Programme (GTP)

Under the auspices of UNESCO

Gudni Axelsson

Director
GRÓ GTP

United Nations Educational, Scientific and Cultural Organization · GRÓ GTP Geothermal Training Programme Under the auspices of UNESCO

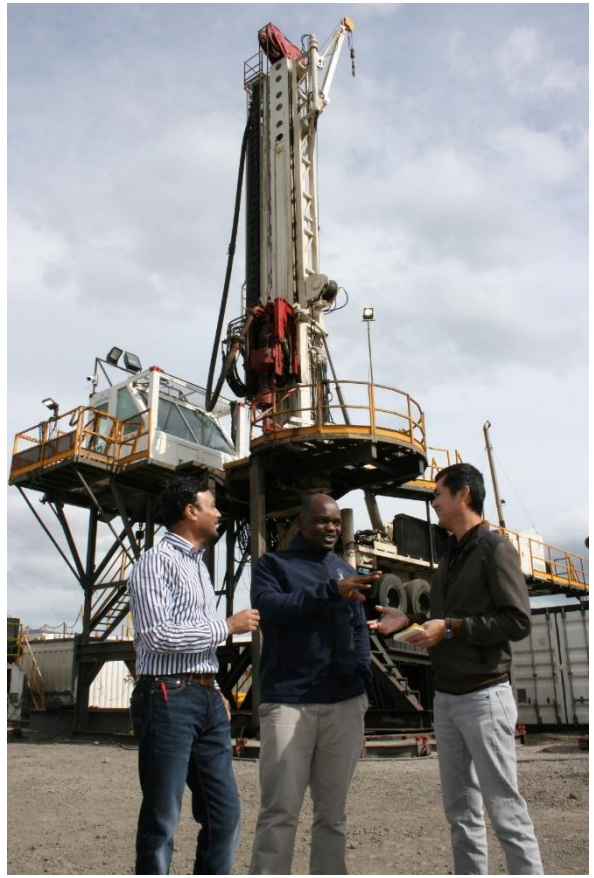
GTP

Purpose and Organization

- To assist **developing nations** with geothermal potential to build expertise through intensive training in different fields of specialization
- Operated at **Iceland GeoSurvey (ÍSOR)** – mainly based on funding by the Government of Iceland
- **Four – five** full time staff members
- Academic activities governed by an **8 member Studies Board**
- Annually, about **80-90 lecturers and support staff** are hired from Iceland‘s leading geothermal institutes, universities, engineering companies or energy companies in line with the needs of the programme and its trainees at any given time

Services Offered Today

- **Six-month training** of appr. 25 fellows yearly
- **Fellowships for MSc- and PhD-studies** at University of Iceland and Reykjavík University
- **Short courses** in support of the United Nations Sustainability Development Goals (SDG's)
- Support for Diploma Course in El Salvador, Training Centre in Kenya and new Training Program in China
- **Other training activity**, including customer designed courses and individual training

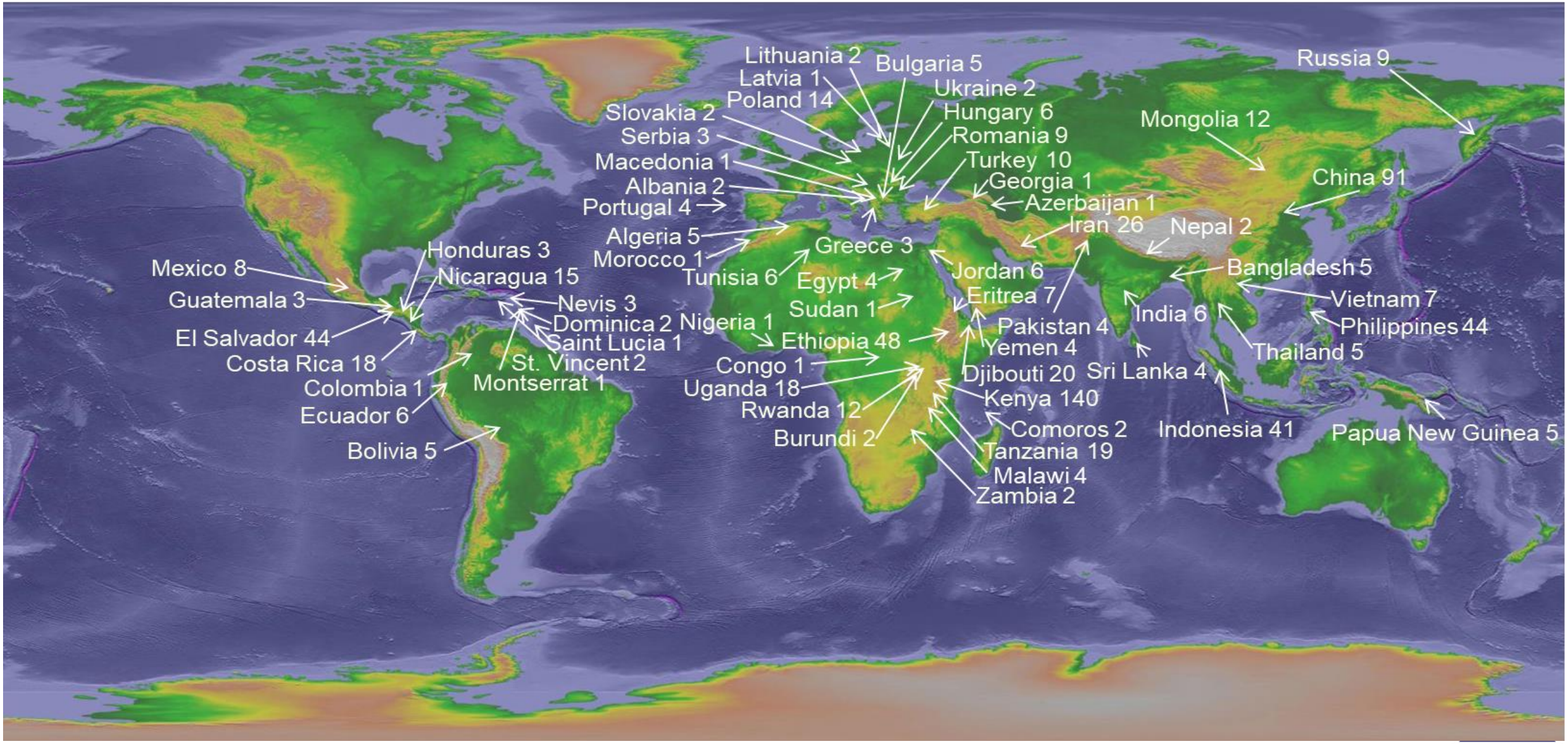


United Nations Educational, Scientific and Cultural Organization

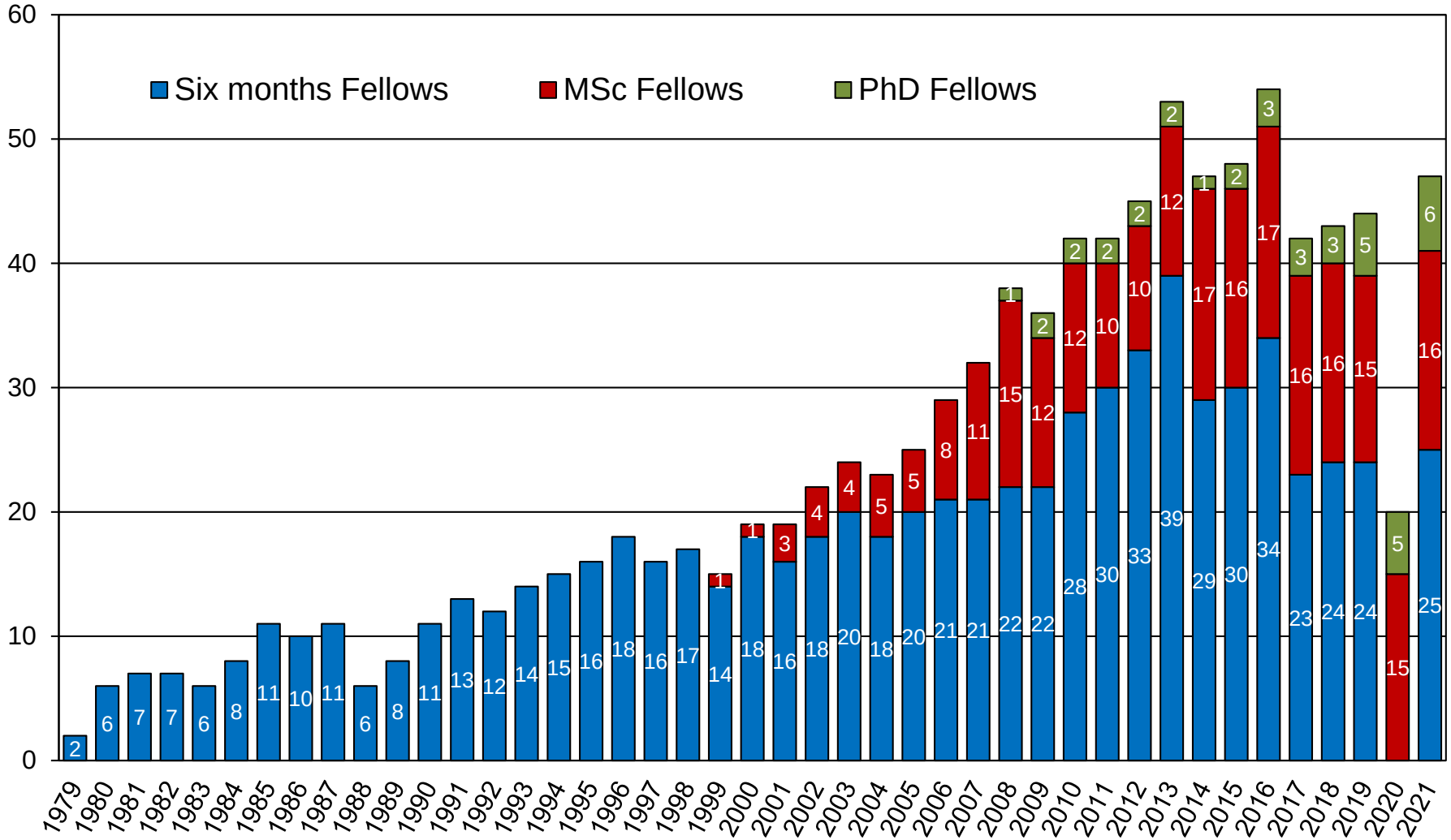
GRO GTP Geothermal Training Programme Under the auspices of UNESCO

GTP

Home Countries (64) of 1979 – 2021 GTP Fellows



Number of Fellows in Iceland 1979-2019

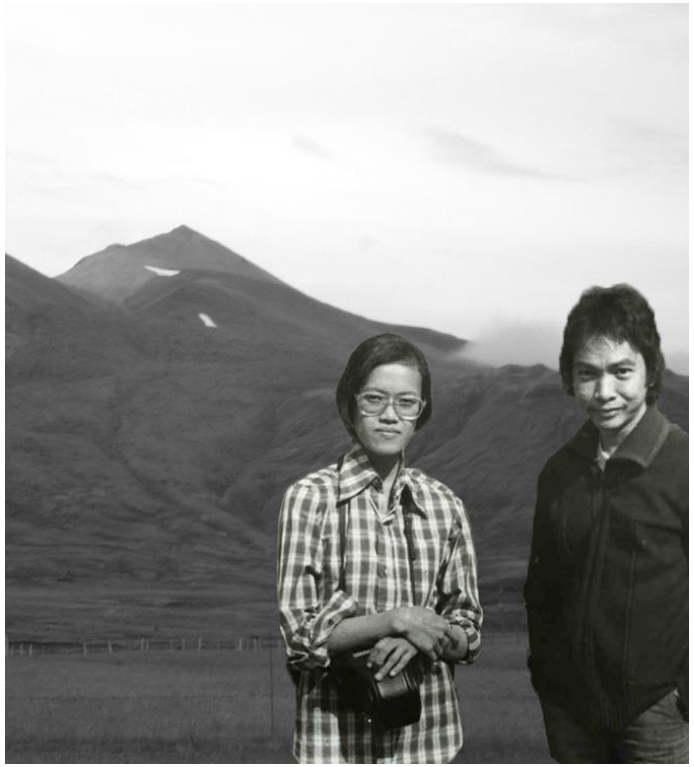


Gudni Axelsson Oct. 2022

United Nations Educational, Scientific and Cultural Organization

GRO GTP Geothermal Training Programme Under the auspices of UNESCO

GTP



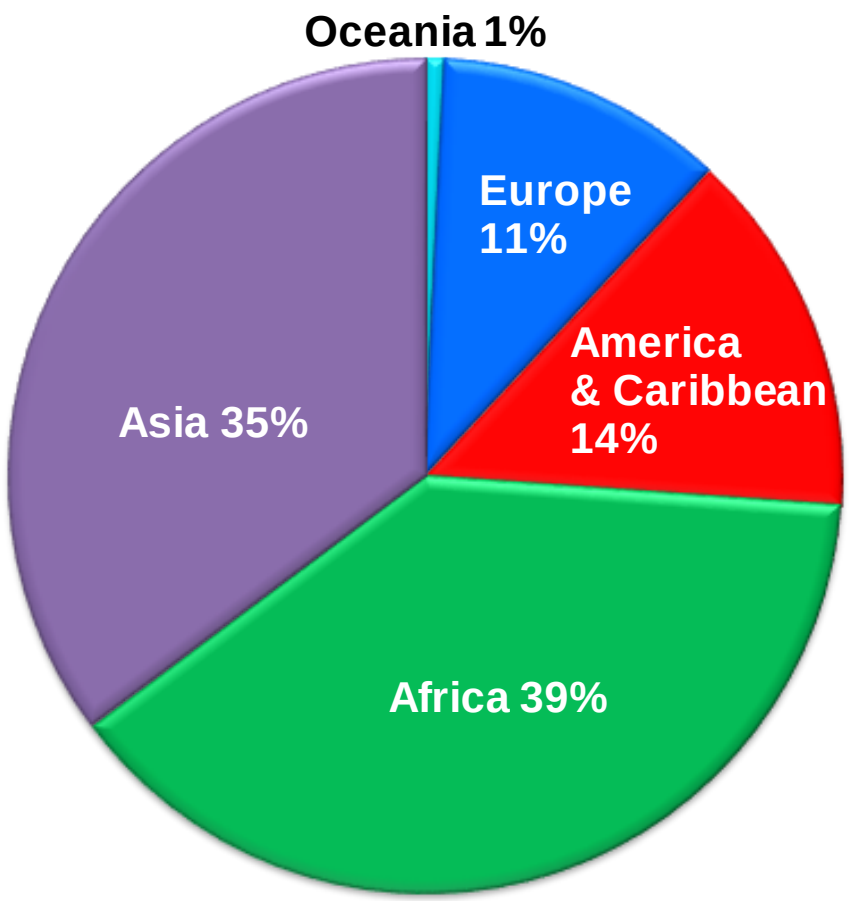
GTP 6-month fellows
1979 vs. 2021

United Nations
Educational, Scientific and
Cultural Organization

GRO
GTP

Geothermal Training
Programme
Under the auspices
of UNESCO

GTP Participation in Iceland 1979 – 2022



- **766** scientists and engineers from 65 countries have completed the 6-month specialized training
- MSc programme – **80 graduates** – 10 presently enrolled
- PhD programme at UI since 2008 – **PhD theses defended in 2013, 2016, 2019, 2021 and 2022** – seven are currently pursuing their studies
- >**1500 SDG short course** participants
- Female participation in 6-month training about 25%, almost 50% in 2021

United Nations Educational, Scientific and Cultural Organization · GRO GTP Geothermal Training Programme Under the auspices of UNESCO

Gudni Axelsson Oct. 2022

GTP

Future of GRÓ GTP is bright!

- Continued emphasis on six-month training, need not diminishing
- New countries, non volcanic resources and direct use
- MSc- and PhD-scholarships provide valuable additional support
- Increased emphasis on short courses on location
- Increased support for regional training centres
- Online training activity has tremendous potential
- Increased emphasis on using former fellows as lecturers/advisors

Thank you

REPUBLIKA SLOVENIJA
SLUŽBA VLADE REPUBLIKE SLOVENIJE ZA RAZVOJ
IN EVROPSKO KOHEZIJSKO POLITIKO

Iceland Liechtenstein Norway grants

Iceland Geothermal & Iceland School of Energy

Dr Juliet Newson, Director, Iceland School of Energy

ÍSOR
ÍSLENSKAR ORKURANNSÓKNIR

OR
Reykjavík Energy

GeoZS Geološki zavod Slovenije

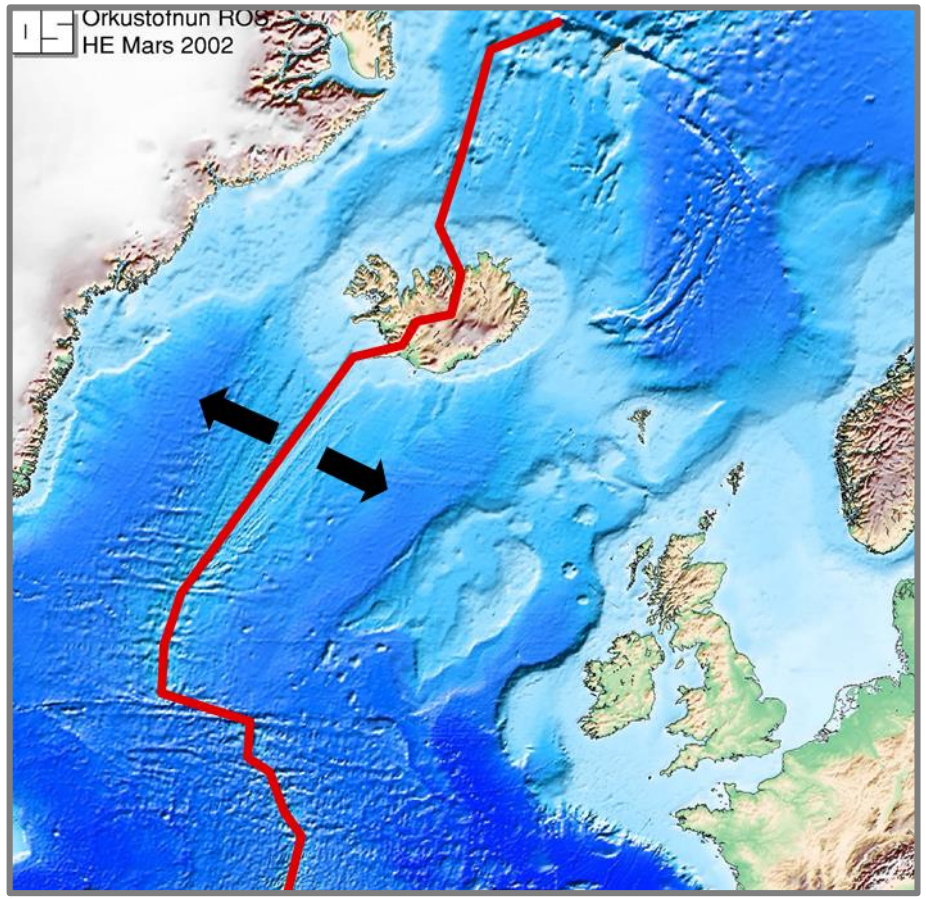
REPUBLIKA SLOVENIJA
MINISTRSTVO ZA INFRASTRUKTURO

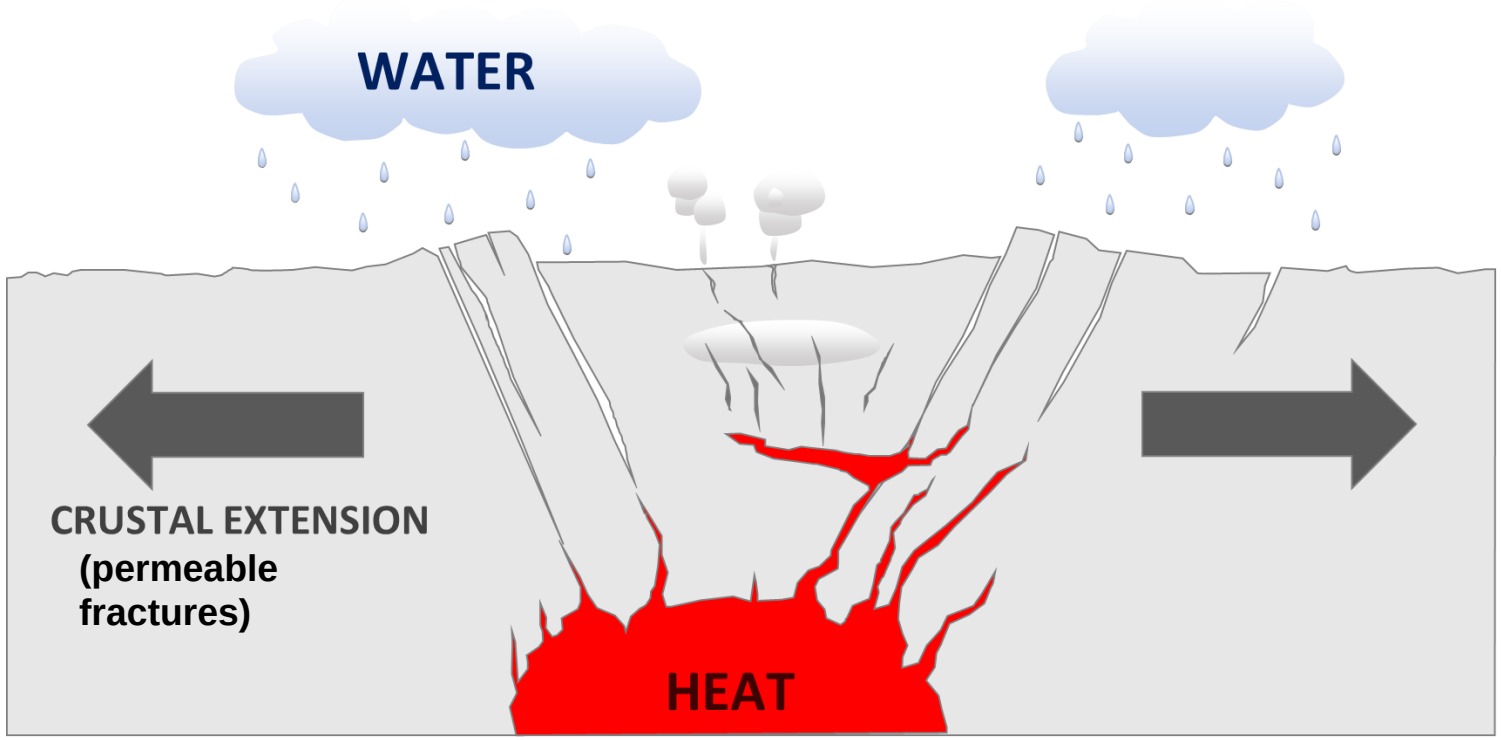
REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR

Skupnost občin Slovenije
Association of Municipalities and Towns of Slovenia

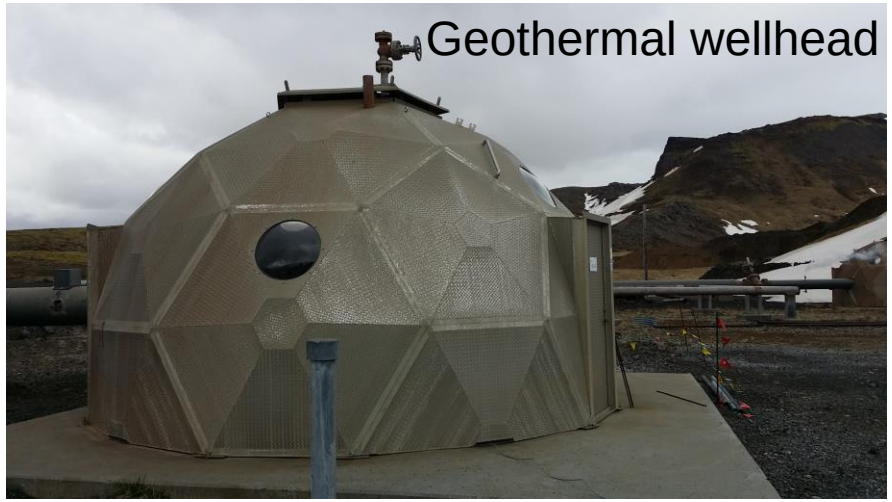
HÁSKÓLINN Í REYKJAVÍK
REYKJAVIK UNIVERSITY

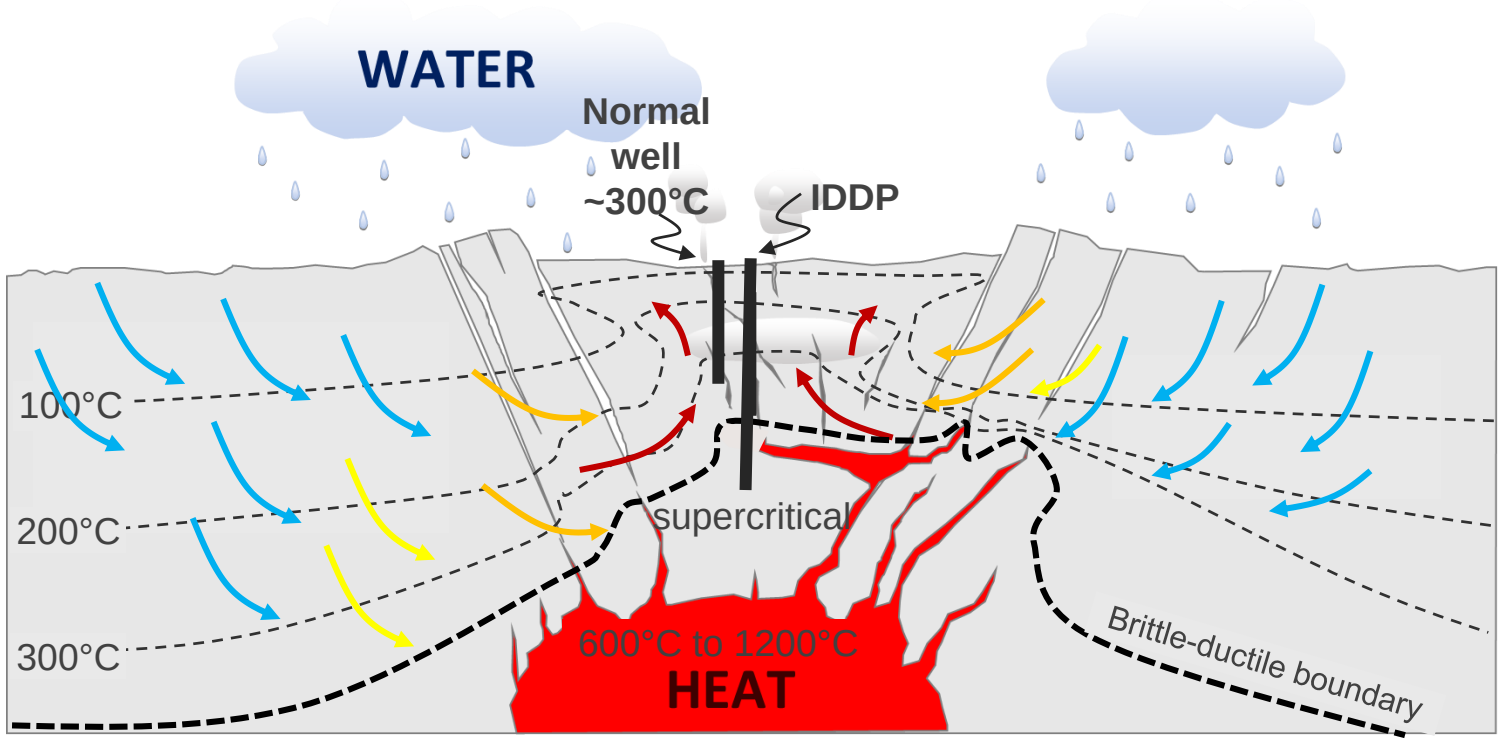
Iceland tectonic context





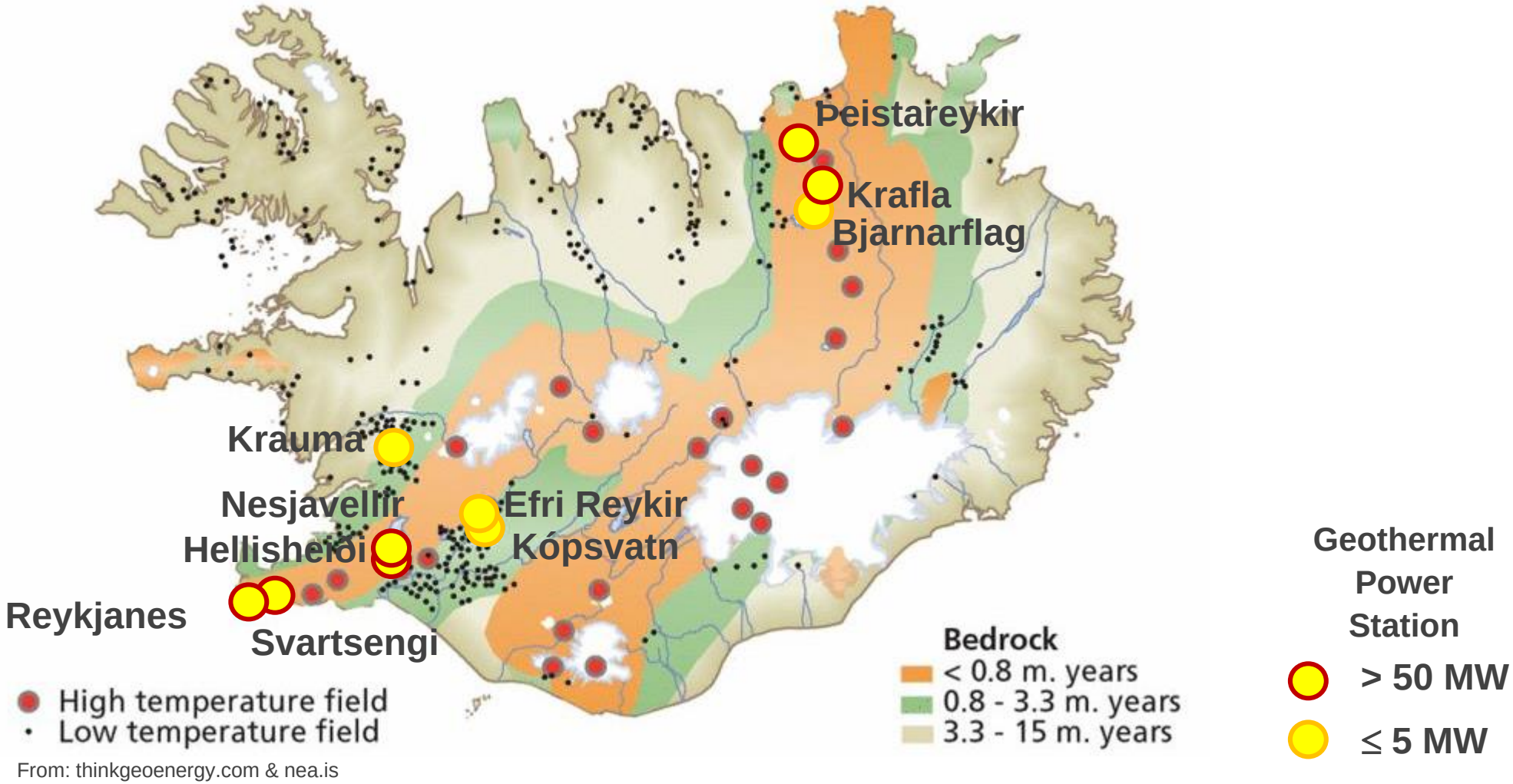
Internal structure of a typical Iceland high-temperature geothermal system





Iceland Geothermal systems

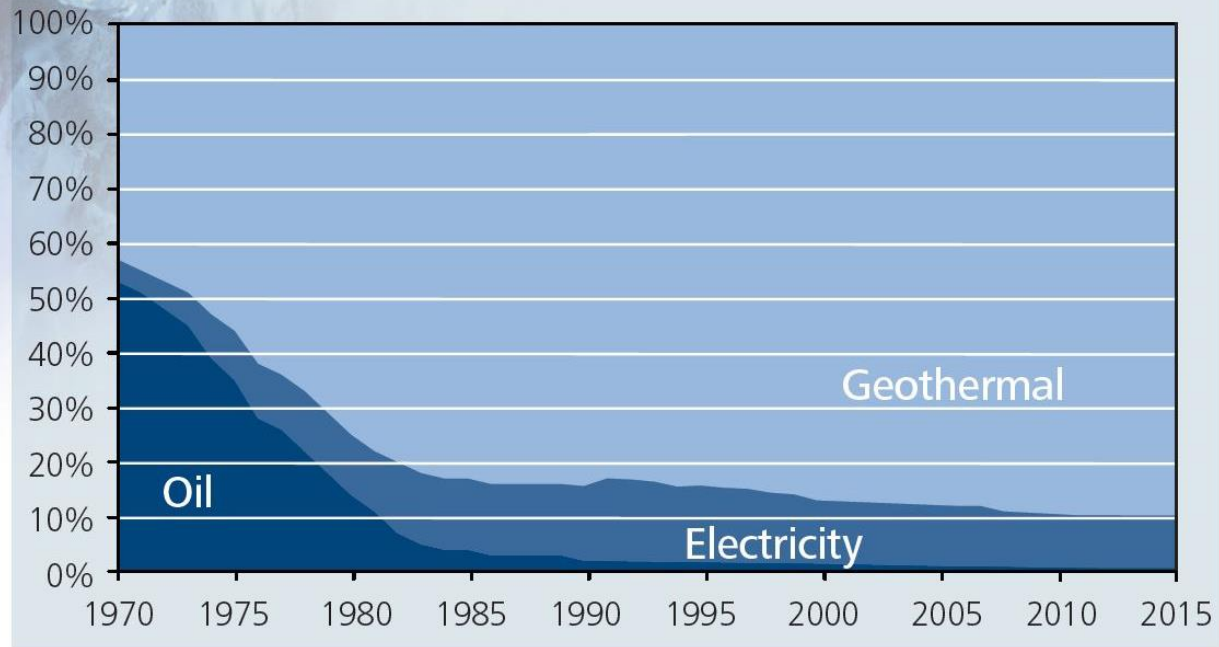
Total installed capacity 755.1 MW; total potential 7 GW



From: thinkgeoenergy.com & nea.is

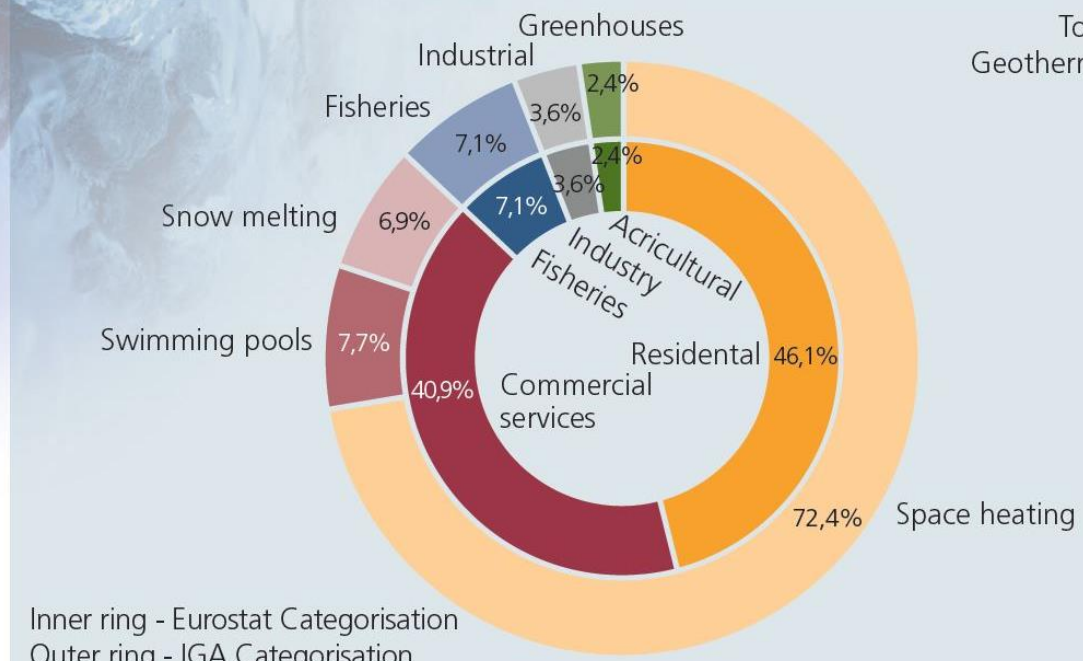
Geothermal heat use

Space heating 1970–2015



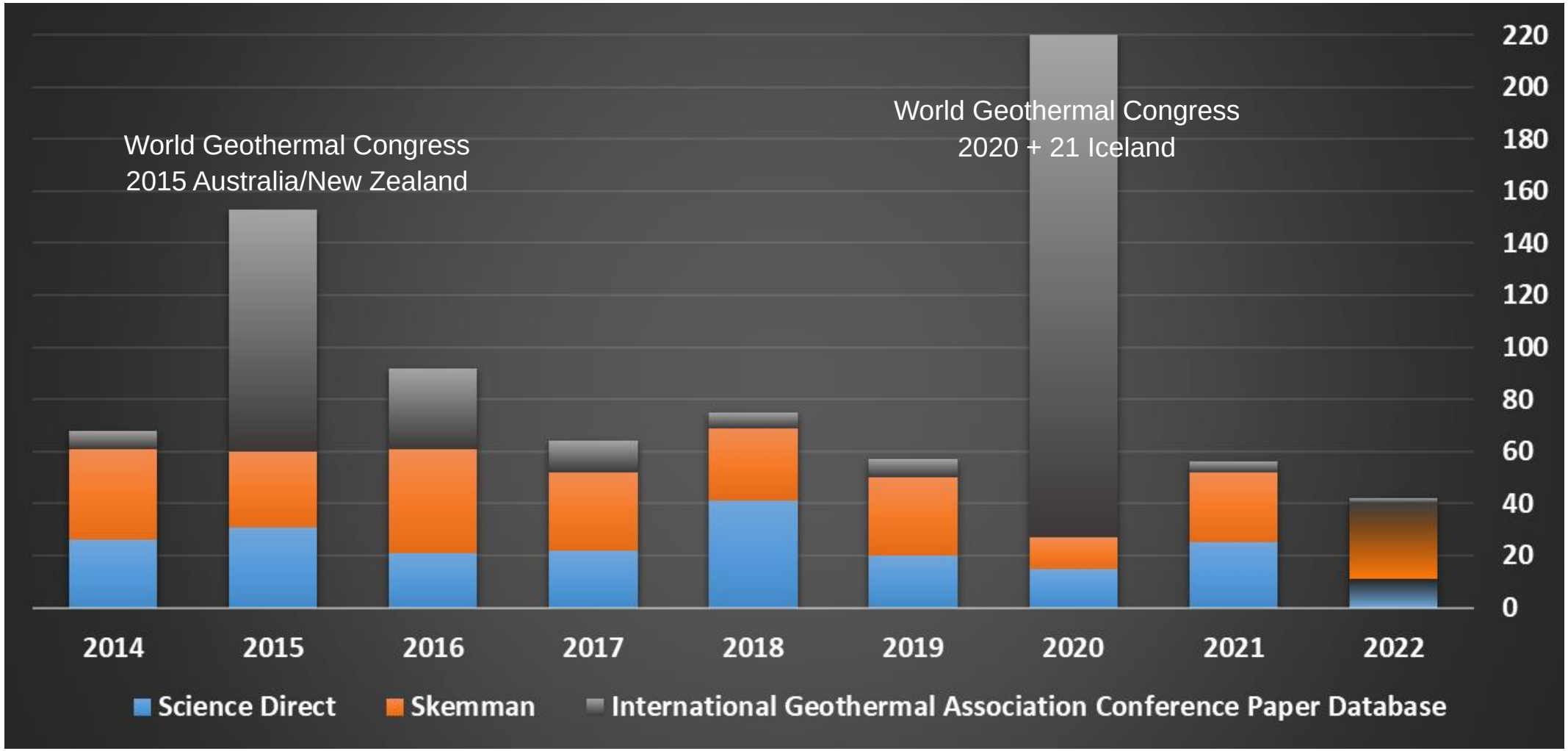
Source: Orkustofnun

Final heat use 2015



Source: Orkustofnun Data Repository OS-2016-T004-01

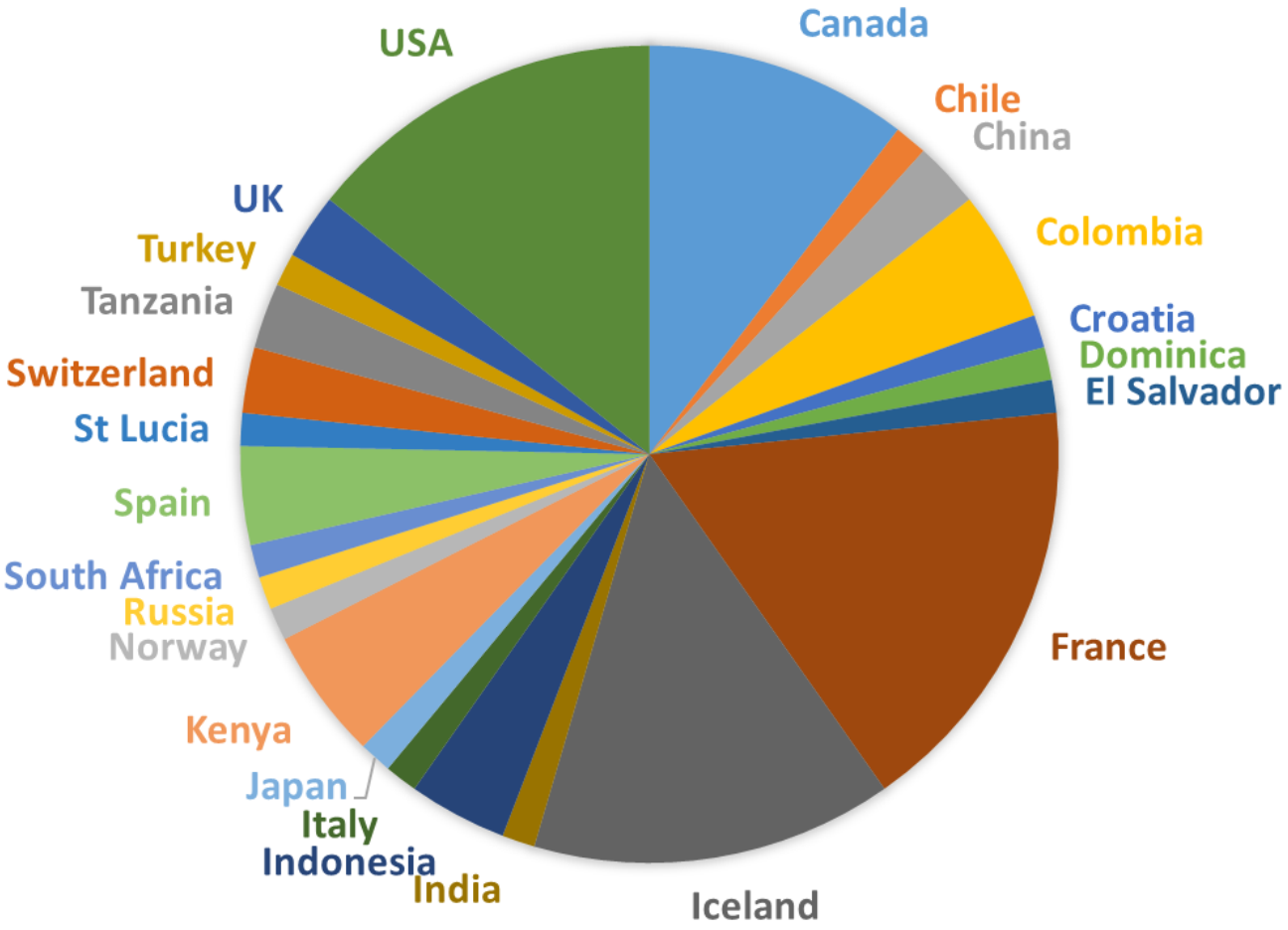
A sample of Iceland geothermal publications



Iceland School of Energy

Student origin

Graduate school hosted by Dept of Engineering

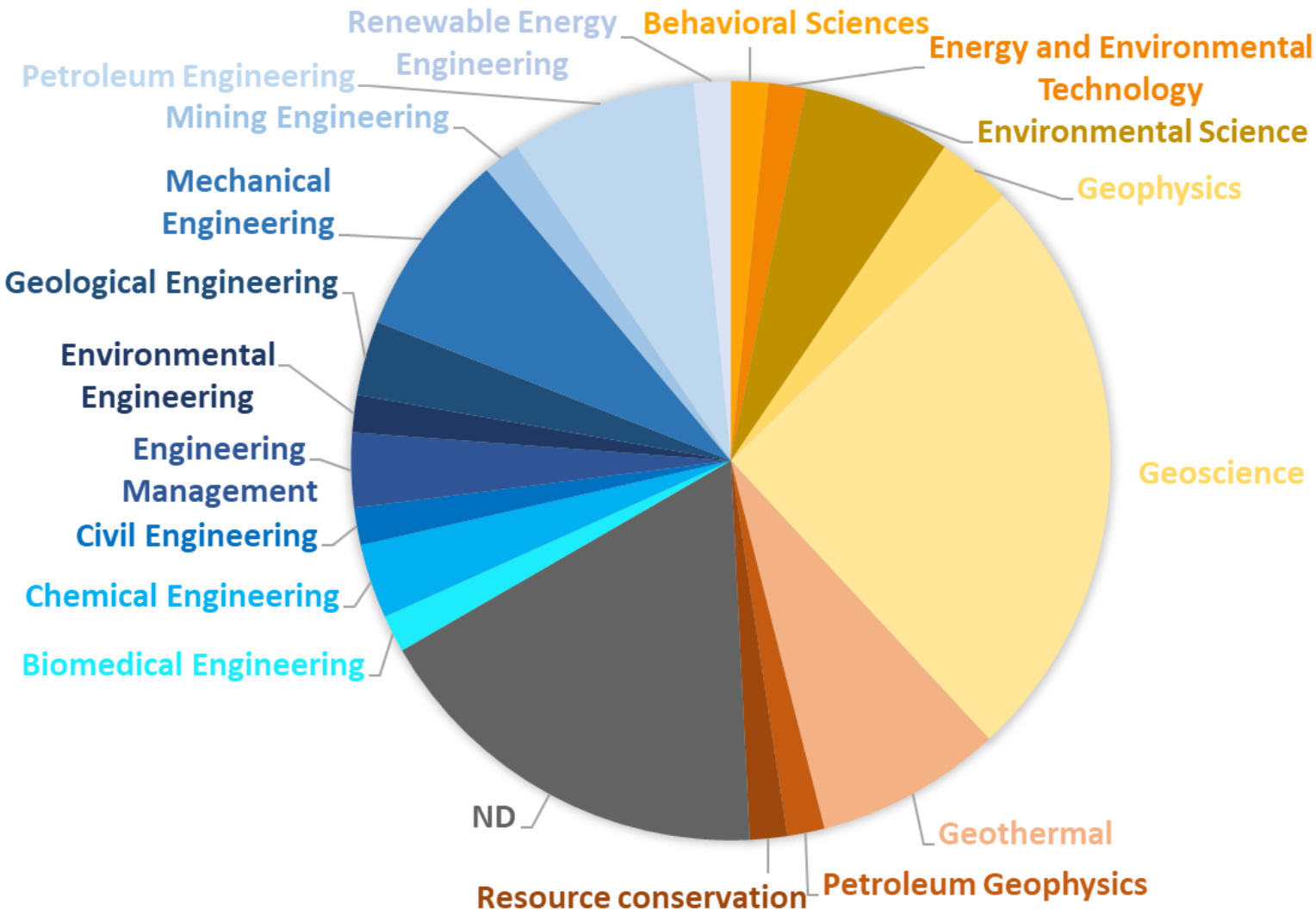


<u>Iceland School of Energy –</u>

- Grants 2-year Masters degree
- 1 semester of general energy topics
- 1 semester of Geothermal classes (there are other specializations)
- 1 year thesis with geothermal topic
- 85.7% International students

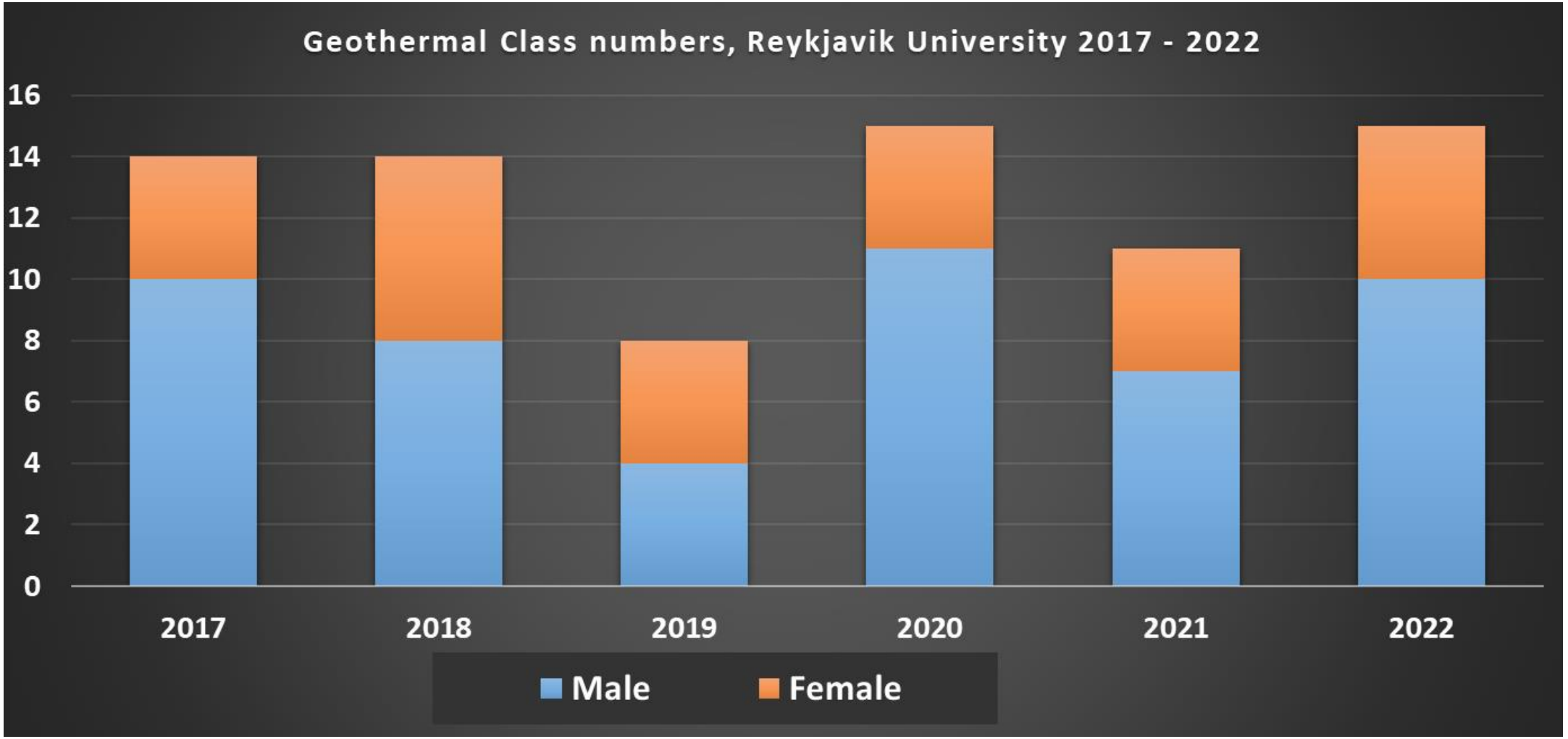
Iceland School of Energy

Geothermal Student background



- Geothermal is multidisciplinary
- Majority of the course is scientific & engineering aspects
- Wider coverage in thesis topics

77 Geothermal students 2017 – 2022
(including Erasmus exchange students)



Nataly Castillo-Ruiz, Geothermal Reservoir Engineer

Hjörleifur Þór Steingrimsson, Engineer

VARMAORKA

Ragna Björk Bragadóttir, Innovation Project Manager

Carbfix

Lily Suherlina, PhD candidate

ETH zürich

Esteban Gomez, PhD candidate

RWTH AACHEN UNIVERSITY

Ben Smith, Geologist-modeller
Tegwell Tech AS, Norway

Andres Laverde, Geologist

ARCTICGREEN ENERGY CORPORATION

Chelsea Cervantes, Geothermal Geologist

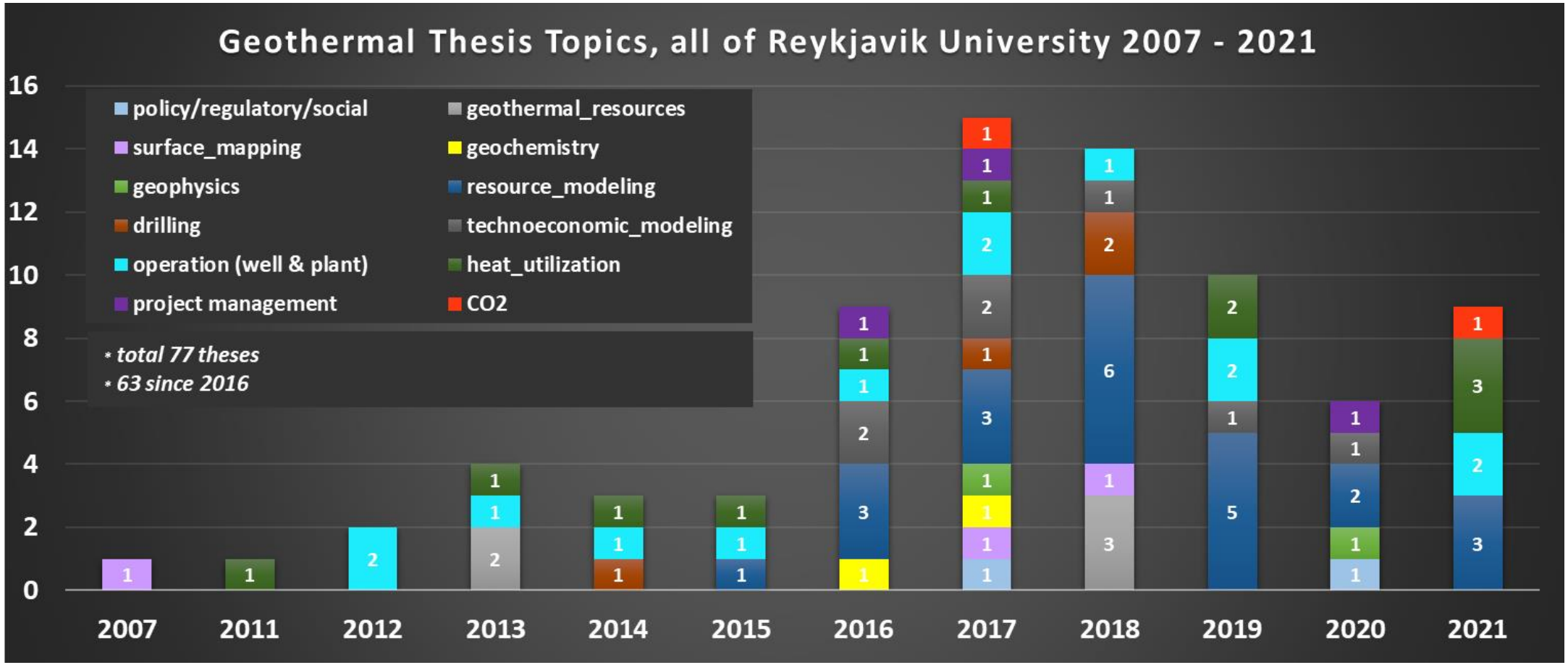
RG Reykjavík Geothermal

Arthie Bellot, PhD candidate

ÍSOR ICELAND GEOSURVEY

HÁSKÓLINN Í REYKJAVÍK UNIVERSITY

Thank you!



* A small number of these are from RU students not associated with ISE

Large Scale Deployment of Geothermal Energy

Arna Pálsdóttir
Research Project Manager, Ph.D.
Reykjavík Energy

VEITUR

OR Reykjavík Energy

- Geothermal power plants
  Hellisheiði: 200 MW_{th} and 300 MW_e
  Nesjavellir: 340 MW_{th} and 120 MW_e
- District heating
  13 separate systems
  ~10,000 km of pipes
  Reykjavik – 4700 l/s @84°C ~ **1 GW_{th}**
- Water distribution system
- Electricity distribution system
- Sewage system

Reykjavík Energy

- Public company owned by three municipalities
- Services ~70% of the population of Iceland in some shape or form

VEITUR

Reykjavik Energy Group

VEITUR

District Heating System

Reykjavík

Century of developing geothermal utilization

In the early 19th century, the main use for geothermal hot water was bathing and laundry

Today, geothermal water is used for many purposes which support our living standard and quality of life

VEITUR

Coal smog over Reykjavík in the 1930's

Reykjavik‘s council member:
“... I don‘t think I‘ve ever approved such a completely ludicrous idea as to think that water can be brought all the way to town, and that it will still be hot enough when it arrives to heat up entire buildings. You will never get me to believe that this is feasible, no matter what you can calculate.“

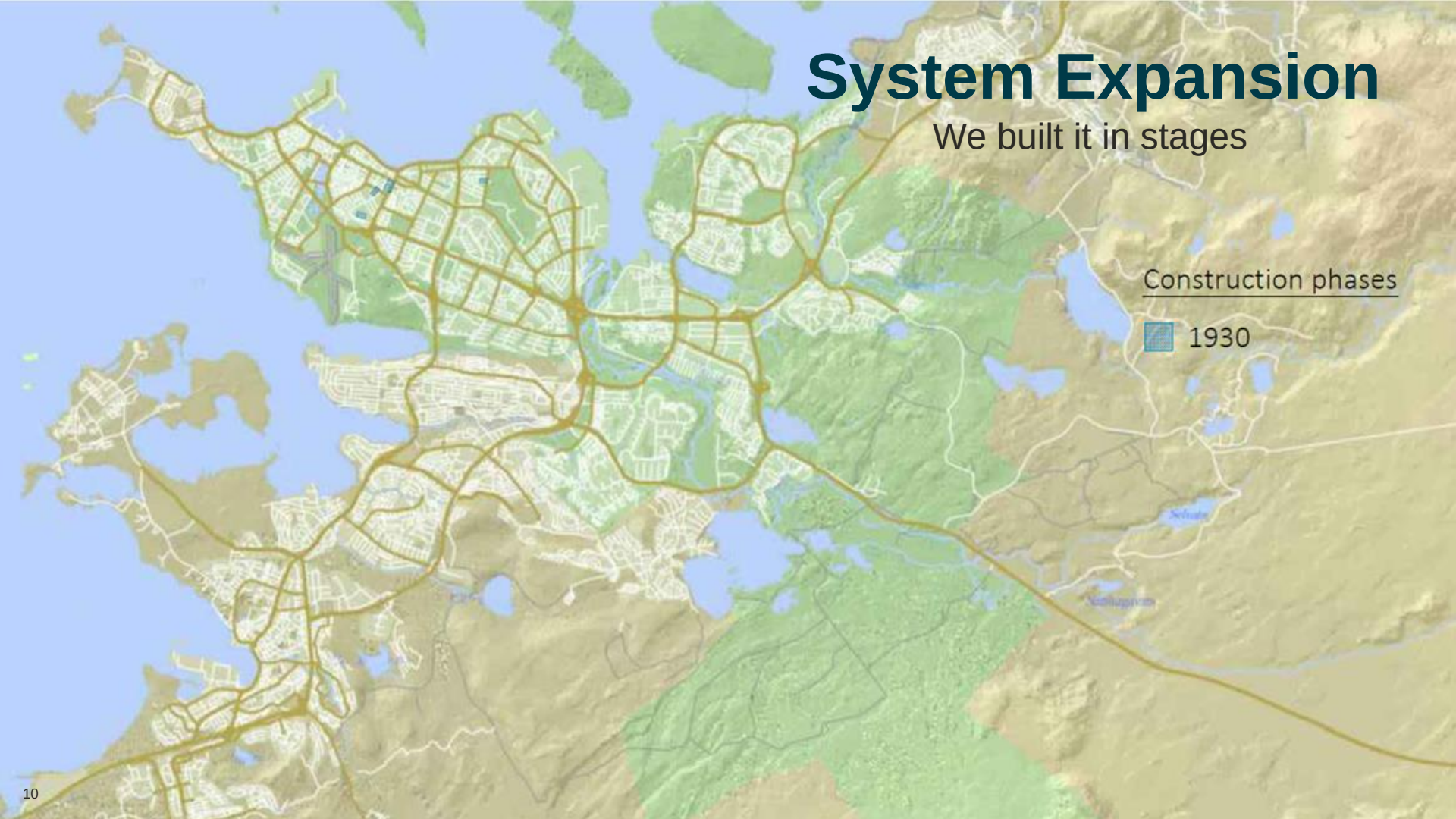
How did the system develop?

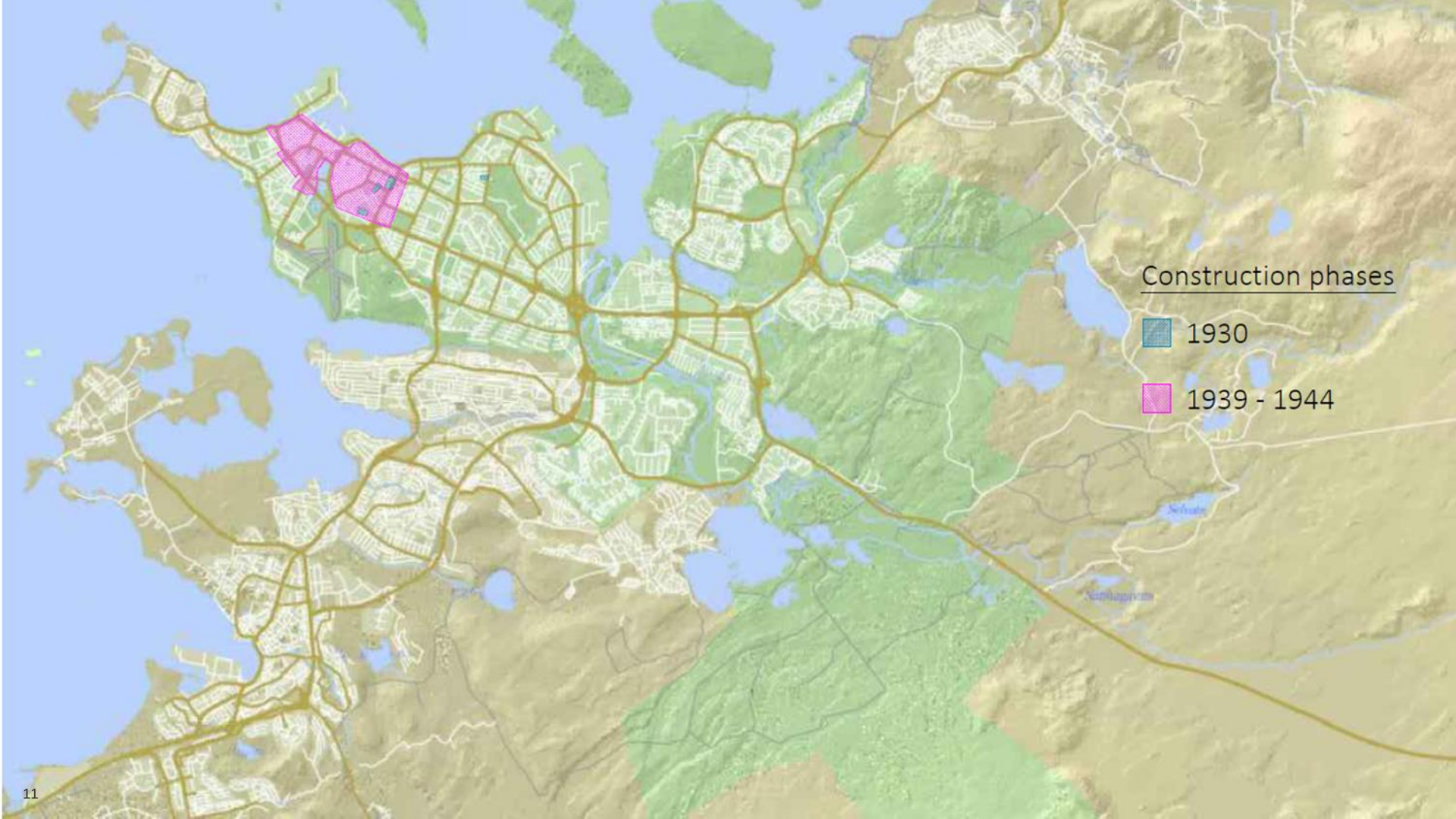
- Constructed in stages
- Expansion based on:
  - The available resources
  - Growing population
  - Regulations
  - External factors – e.g. oil crisis and World War II

VEITUR

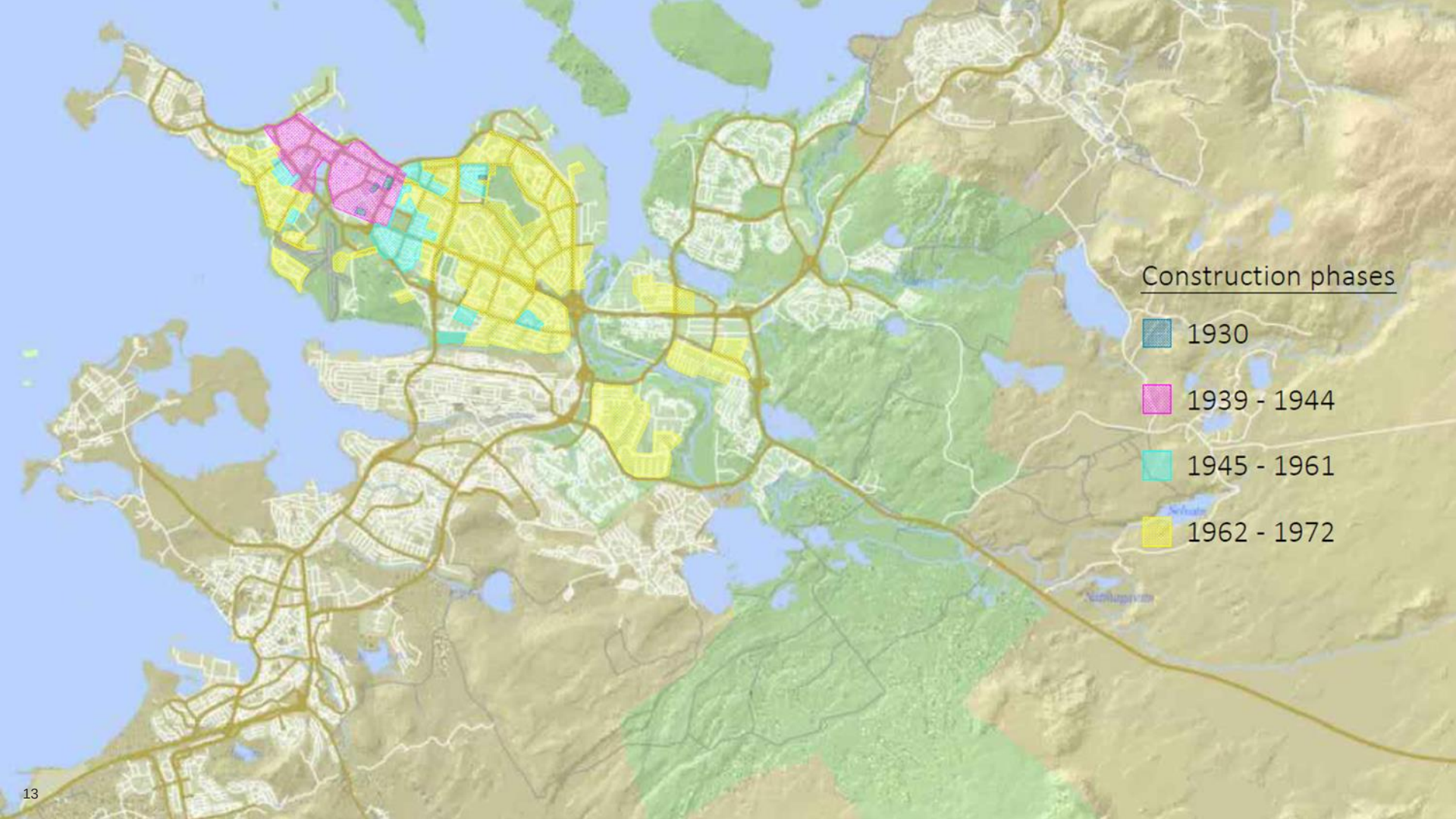
System Expansion

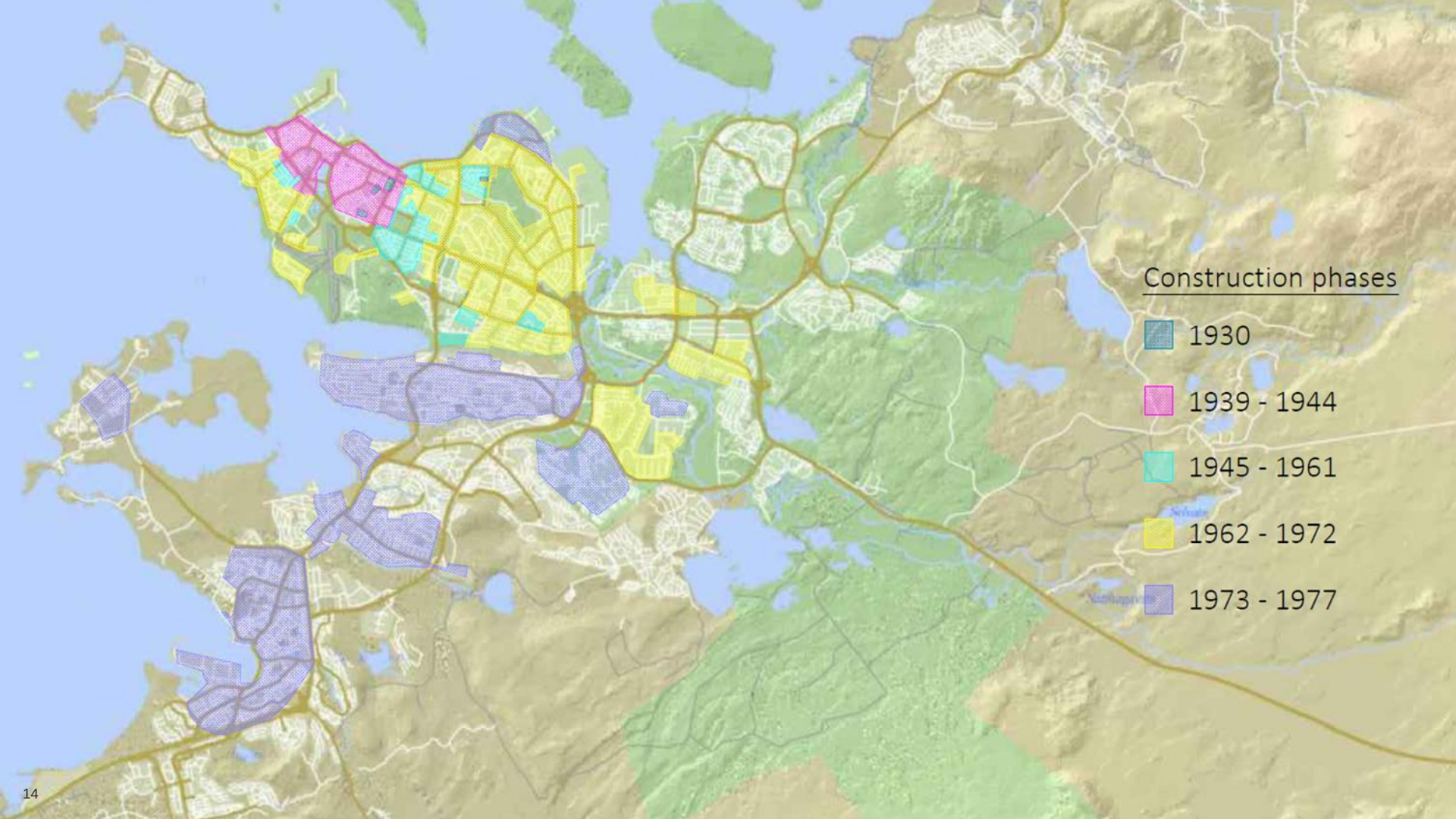
We built it in stages

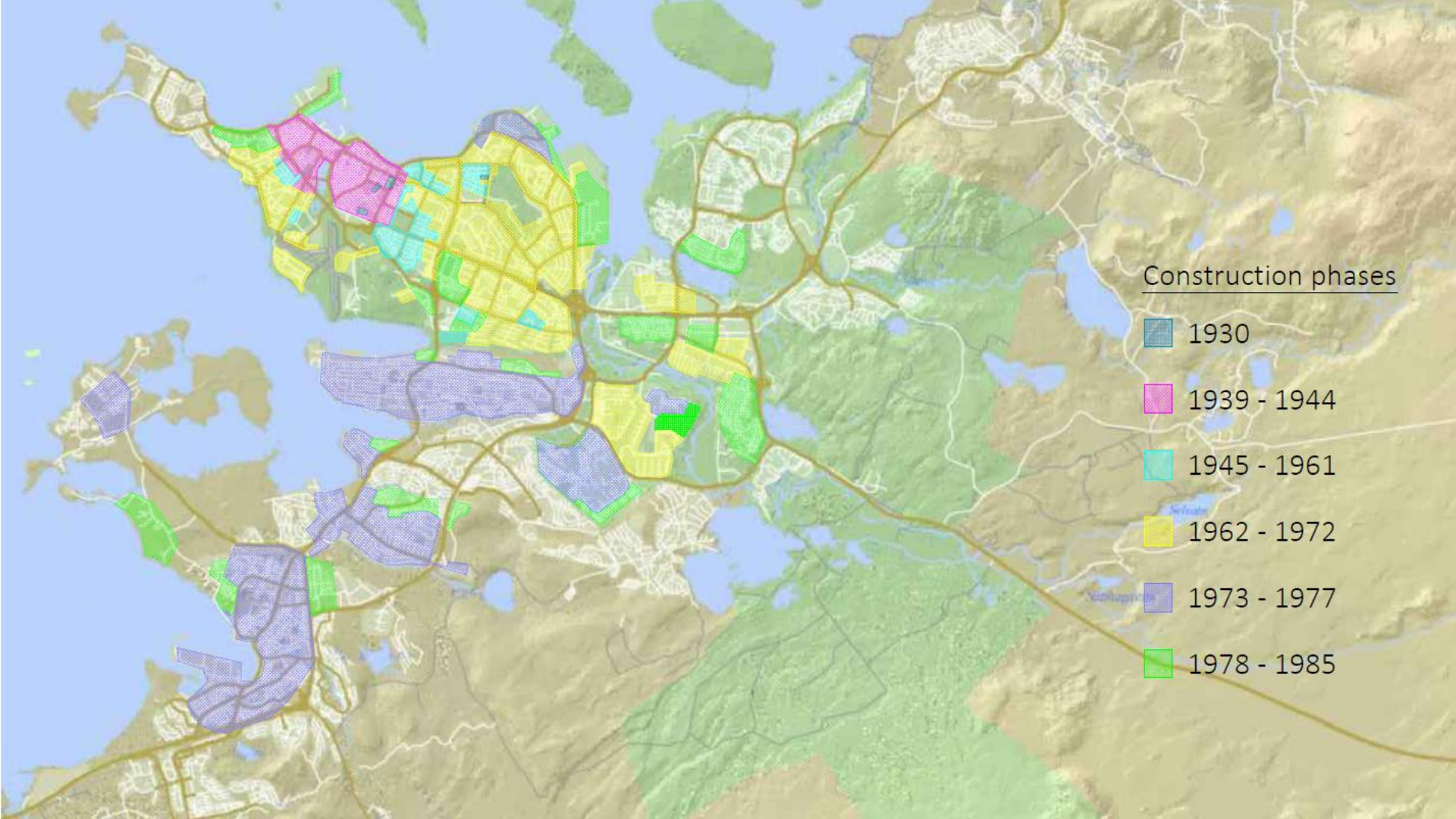


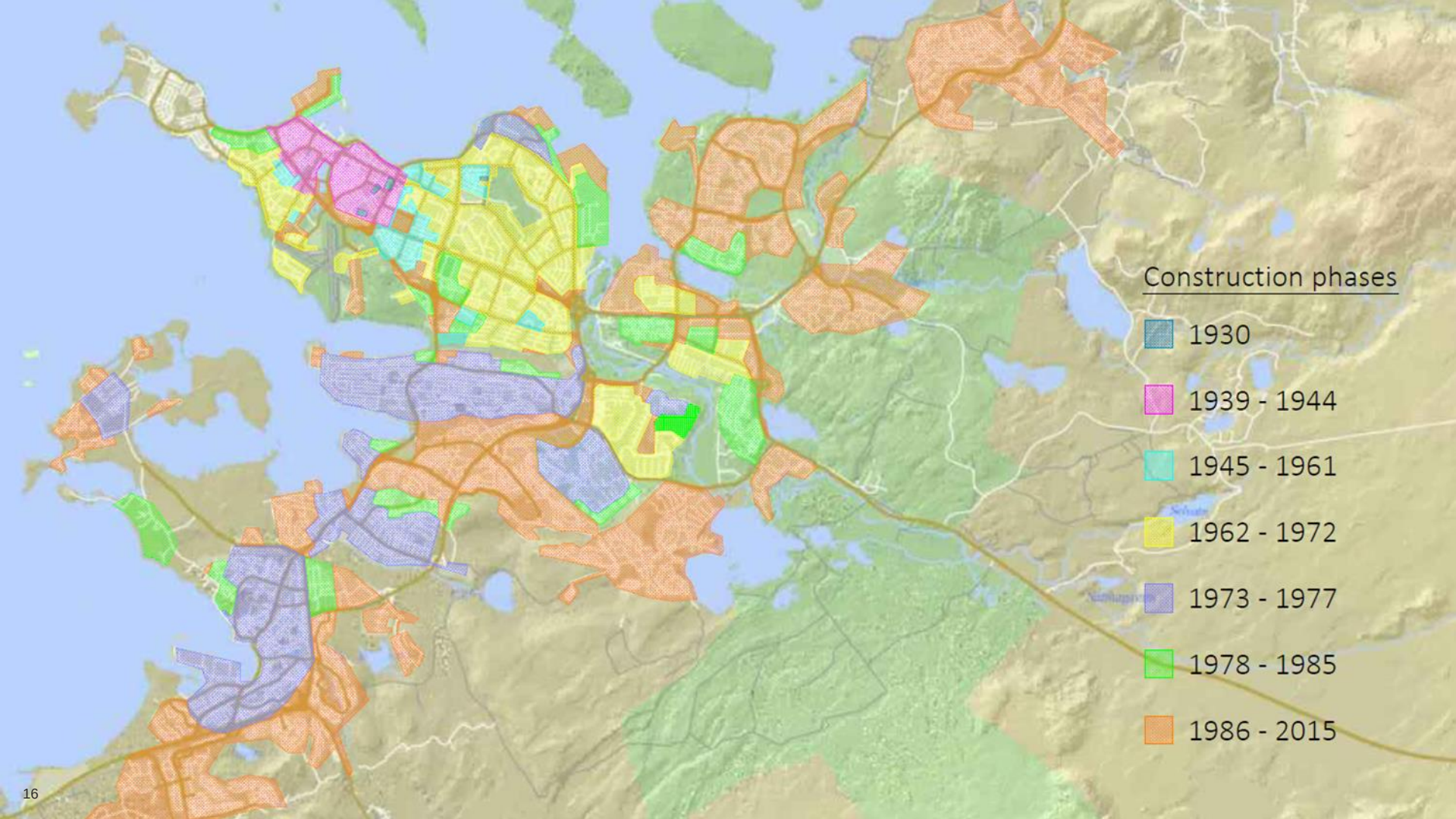

Construction phases
1930
1939 - 1944


Construction phases
1930
1939 - 1944
1945 - 1961


Construction phases
1930
1939 - 1944
1945 - 1961
1962 - 1972


Construction phases
1930
1939 - 1944
1945 - 1961
1962 - 1972
1973 - 1977


Construction phases
1930
1939 - 1944
1945 - 1961
1962 - 1972
1973 - 1977
1978 - 1985


Construction phases
1930
1939 - 1944
1945 - 1961
1962 - 1972
1973 - 1977
1978 - 1985
1986 - 2015

The Geothermal Resources

VEITUR

Low Temperature Sources

- 54 boreholes in the capital region, four locations
- Heat 70° - 130°C
- Approximately 40% of the total production for the capital area in 2022

Laugarnes

VEITUR

High Temperature Fields

Nesjavellir Geothermal Power Plant

340 MW thermal / 120 MW electricity

Hellisheiði Geothermal Power Plant

200 MW thermal / 303 MW electricity

VEITUR

Geothermal Success

Today, Iceland’s geothermal energy provides for

- 90% of space heating
- 30% of electricity production

Electricity and heat production account for 5% of the total CO_2 emissions in Iceland

VEITUR

Thank you !

The Icelandic Centre for Research - Rannís

date

Rannís - The Icelandic Centre for Research

- Supports research, innovation, education and culture in Iceland.
- Administers competitive funds in the fields of research, innovation, education and culture, as well as strategic research programmes.
- Coordinates and promotes Icelandic participation in European programmes such, as Horizon Europe, Erasmus+ and Creative Europe.
- Monitors resources and performance in R&D and promotes public awareness of research and innovation, education and culture in Iceland.
- Cooperates closely with the Icelandic Science and Technology Policy Council and provides professional assistance in the preparation and implementation of the national science and technology policy.

Rannís in a nutshell 2021

29
national
funds

8
international
programmes

> 7.000
applications

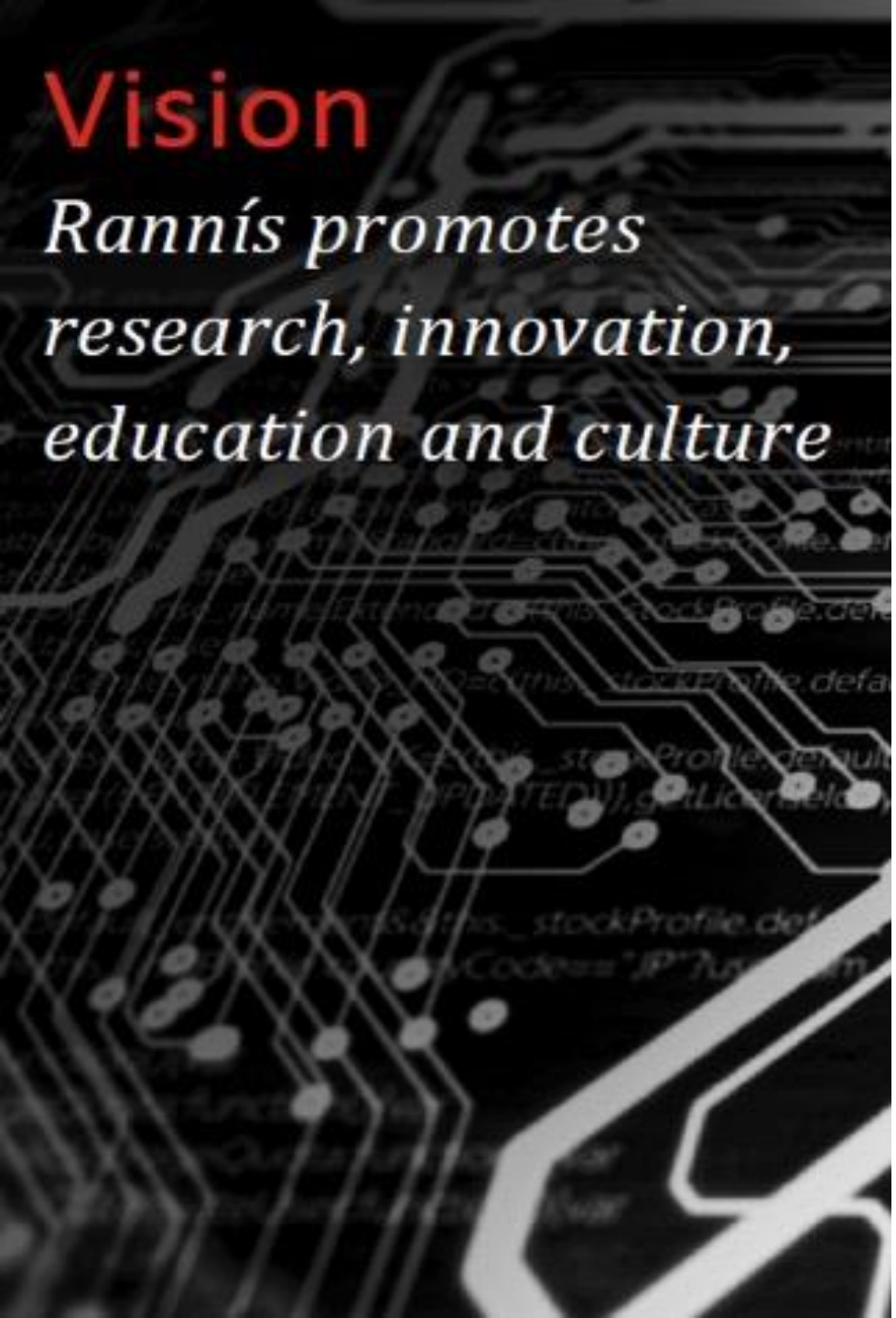
3.400
project grants

>15.000
individuals who
benefit directly

22 BISK
>150 M€
National support

Active information
provision
and policy support

61
employees in
four divisions



Rannís : one-stop-shop for international cooperation

- The rational
  - Everyone knows where to turn to for information about opportunities for all international cooperation (important to maximize participation)
  - Efficient programme management with synergies between programmes and overview of demand and engagement
  - Distribution at national level of information about outcomes and impact of participation in international cooperation (important for political commitment)
- European, Nordic and Arctic cooperation
  - For a long time: Horizon Europe – Erasmus+ – Creative Europe – EEA and Norway Grants
  - New programmes: Life – Digital Europe – Space
  - Nordic research and education cooperation
  - International Arctic Science Committee secretariat in Akureyri
- Rannís is big in Iceland – but small in Europe

Rannis – EEA and Norway Grants services and activities outside Iceland

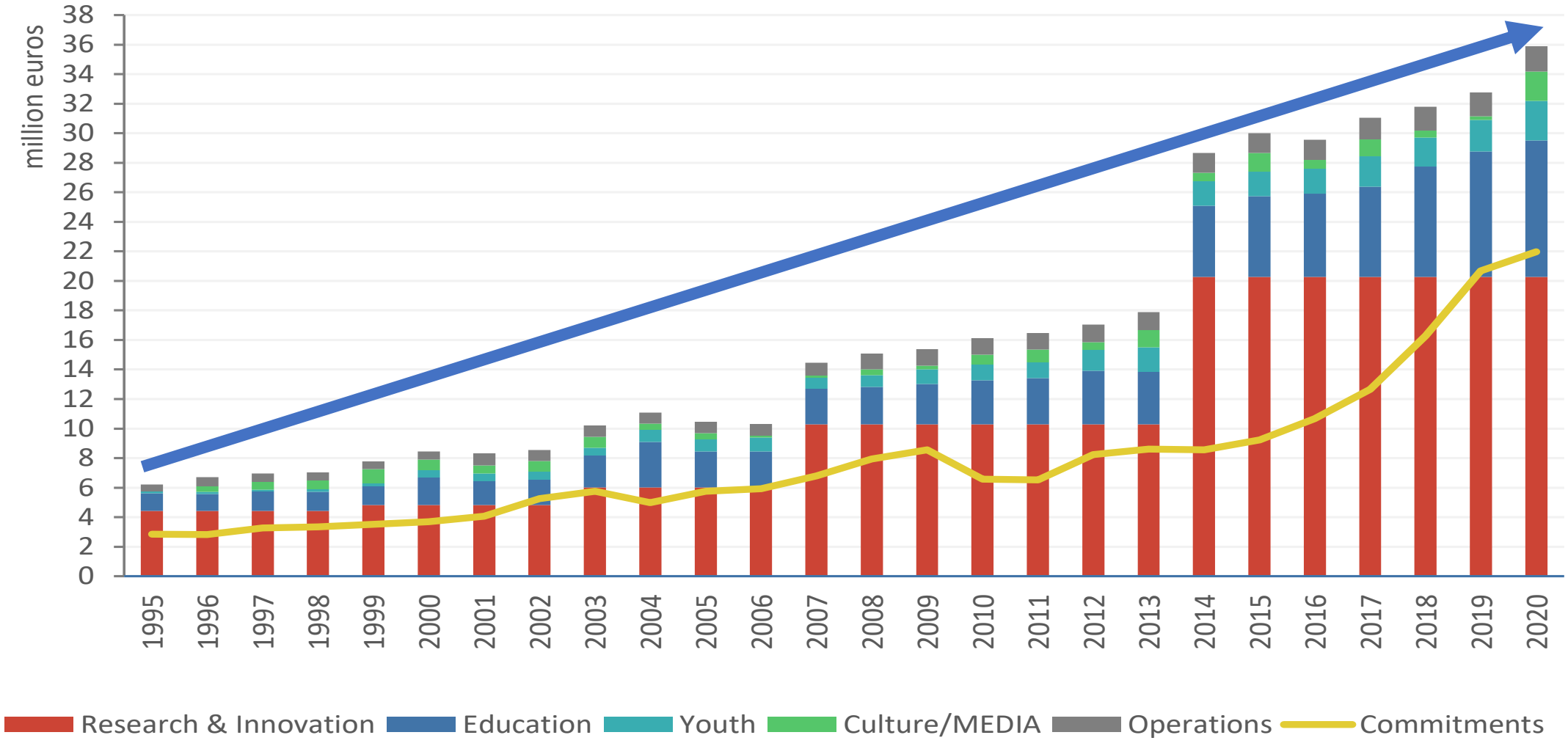
- **Rannis has the role of Donor Programme Partner (DPP)** in several countries/ programmes providing expert advice on programme creation and implementation.
  - Portugal (Innovation – Blue Growth)
  - Romania (Research)
  - Poland (Education)
  - Czech Republic (Culture)

- **Facilitates cooperation -** Rannis is an access point helping applicants from all countries receiving EEA-grants get into contact with Icelandic entities
- **Presents Icelandic systems and structures abroad** increasing their visibility and attractiveness in terms of cooperation.

- **Partners in Iceland- EEA and Norway Grants**
- **National Energy Authority (Iceland)**
  - Is a government agency under the Ministry of the Environment, Energy and Climate. DPP for Environment, Energy, Climate Change and Low Carbon Economy Programmes.
- **Business Iceland**
  - Business Iceland is a public-private partnership established to improve the competitiveness of Icelandic companies in foreign markets and to stimulate economic growth through increased export.

Government of Iceland | Partnership opportunities in Iceland

European cooperation from 1994



Horizon Europe & service provided at Rannís

rannís

enterprise europe network

Business Support on Your Doorstep

Life

European Commission

HORIZON EUROPE

EURATOM

SPECIFIC PROGRAMME: EUROPEAN DEFENCE FUND

Exclusive focus on defence research & development

- Research actions
- Development actions

SPECIFIC PROGRAMME IMPLEMENTING HORIZON EUROPE & EIT*

Exclusive focus on civil applications

Pillar I
EXCELLENT SCIENCE

- European Research Council
- Marie Skłodowska-Curie
- Research Infrastructures

Pillar II
GLOBAL CHALLENGES & EUROPEAN INDUSTRIAL COMPETITIVENESS

Clusters

- Health
- Culture, Creativity & Inclusive Society
- Civil Security for Society
- Digital, Industry & Space
- Climate, Energy & Mobility
- Food, Bioeconomy, Natural Resources, Agriculture & Environment

- Joint Research Centre

Pillar III
INNOVATIVE EUROPE

- European Innovation Council
- European Innovation Ecosystems
- European Institute of Innovation & Technology*

WIDENING PARTICIPATION AND STRENGTHENING THE EUROPEAN RESEARCH AREA

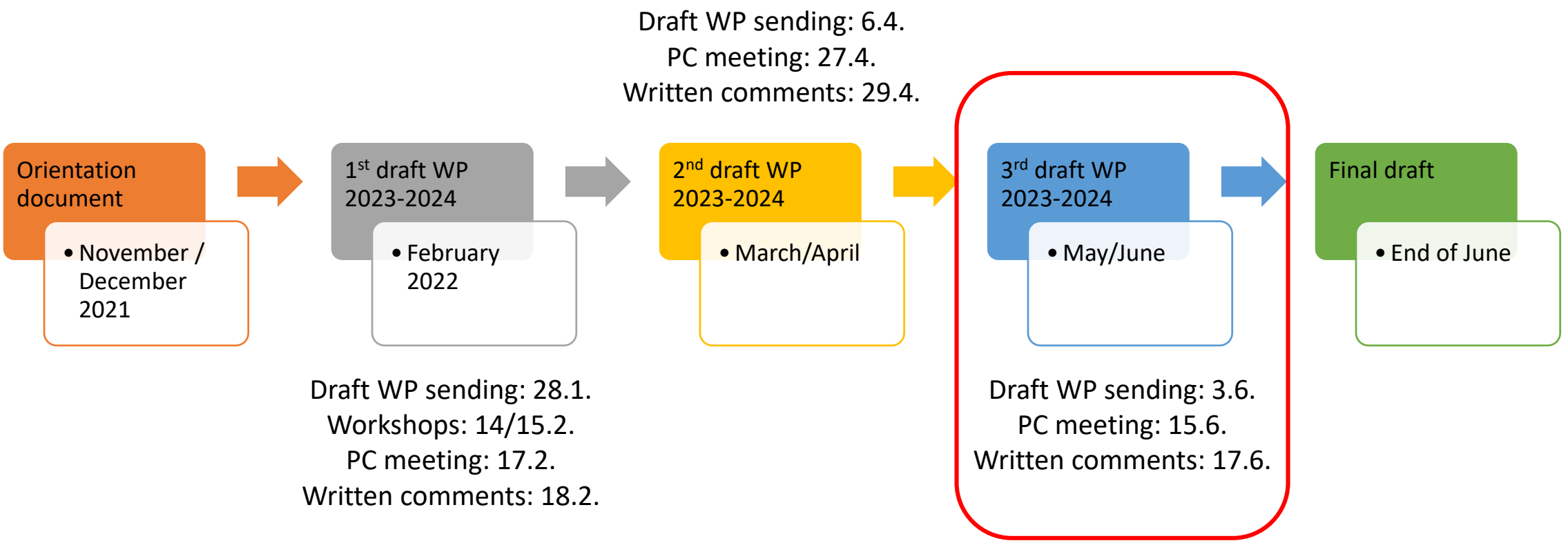
- Widening participation & spreading excellence
- Reforming & Enhancing the European R&I system

EURATOM

- Fusion
- Fission
- Joint Research Center

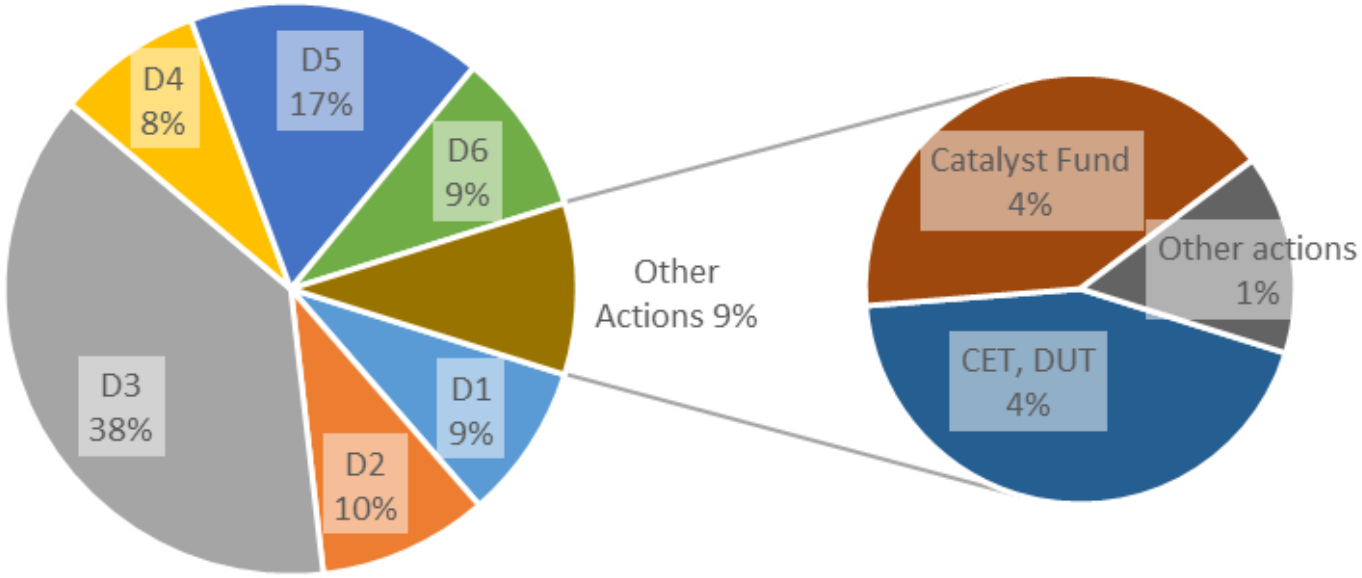
European Commission

Drafting process



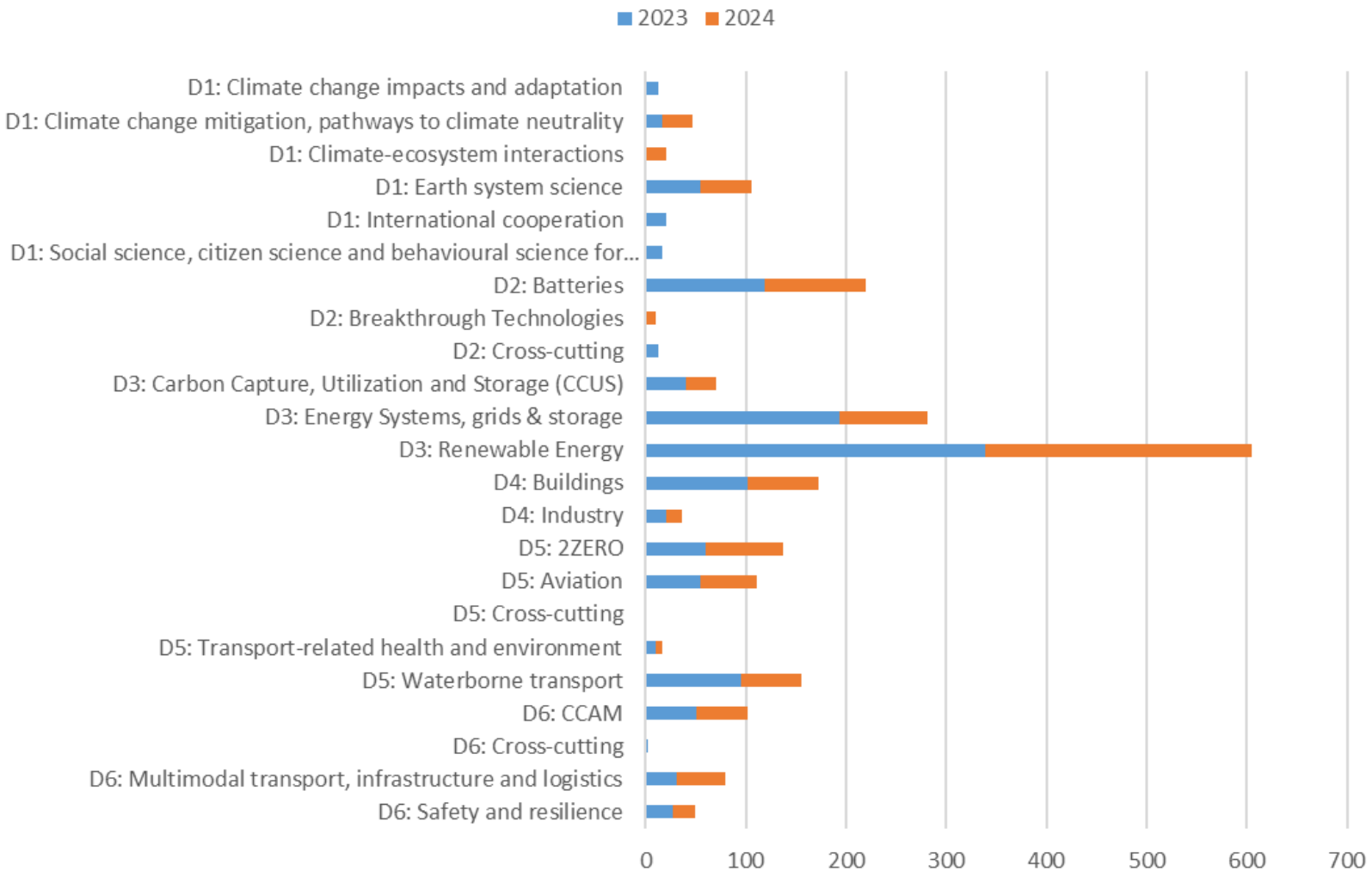
Budget allocation (Destinations, Other Actions)

Total budget: **2,522.6 M€** (1,395.0 M€ in 2023 and 1,127.6 M€ in 2024)

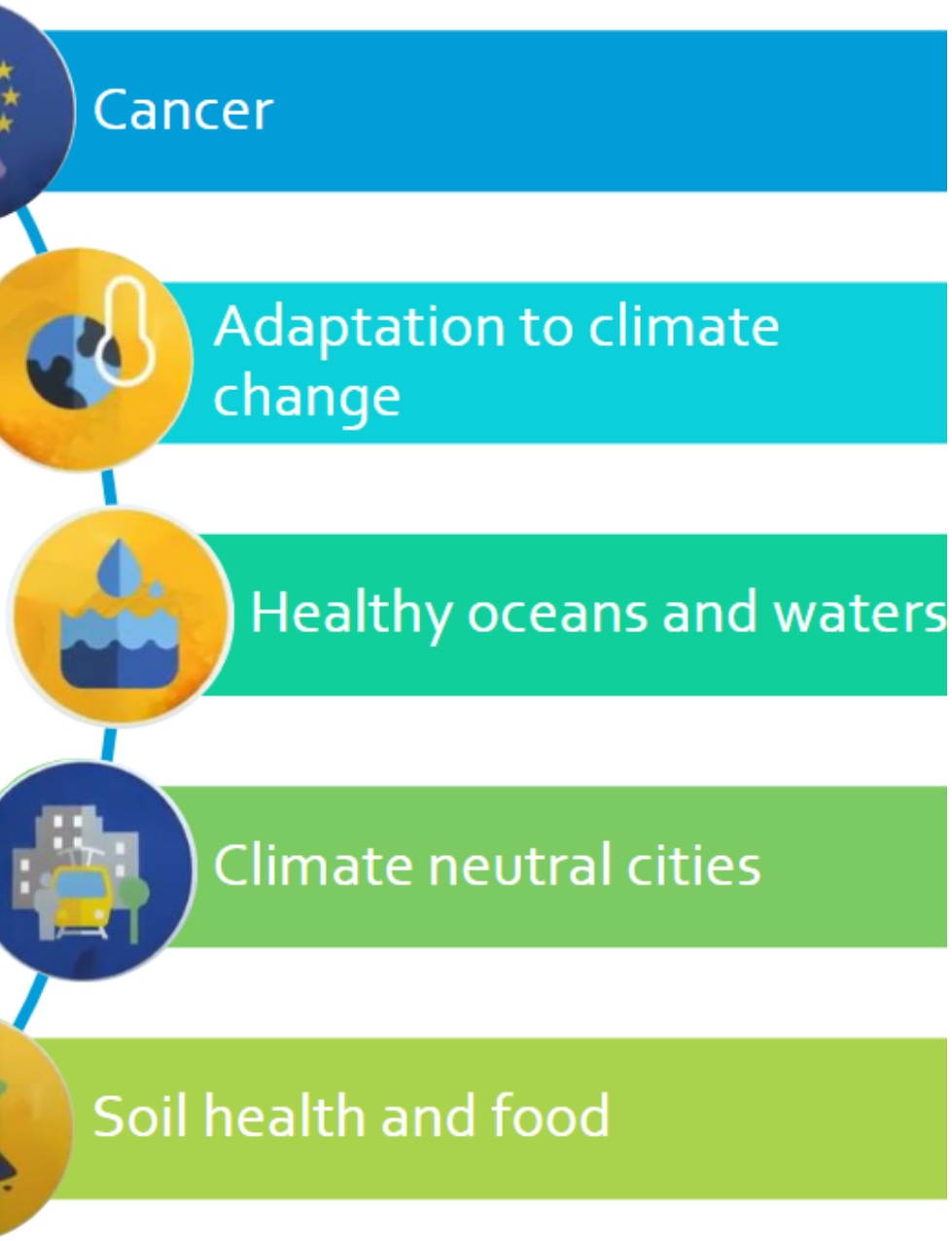


European Commission

Budget allocation (thematic areas)



European Commission



Missions

A mission is a portfolio of actions across disciplines intended to achieve a **bold and inspirational and measurable goal** within a set timeframe, with **impact** for society and policy making as well as relevance for a significant part of the European population and wide range of European citizens.

European Commission

Overview of 49 candidate European Partnerships

HORIZON EUROPE PILLAR II - Global challenges & European industrial competitiveness

CLUSTER 1: Health

- Innovative Health Initiative
- Global Health Partnership
- Transformation of health systems
- Chemicals risk assessment
- ERA for Health
- Rare diseases*
- One-Health Anti Microbial Resistance*
- Personalised Medicine*
- Pandemic Preparedness*

Co-funded or co-programmed

CLUSTER 4: Digital, Industry & Space

- Key Digital Technologies
- Smart Networks & Services
- High Performance Computing
- European Metrology (Art. 185)
- AI-Data-Robotics
- Photonics
- Made in Europe
- Clean steel – low-carbon steelmaking
- Processes4Planet
- Global competitive space systems**

CLUSTER 5: Climate, Energy & Mobility

- Clean Hydrogen
- Clean Aviation
- Single European Sky ATM Research 3
- Europe's Rail
- Connected and Automated Mobility (CCAM)
- Batteries
- Zero-emission waterborne transport
- Zero-emission road transport
- Built4People
- Clean Energy Transition
- Driving Urban Transitions

CLUSTER 6: Food, Bioeconomy, Agriculture, …

- Circular Bio-based Europe
- Rescuing Biodiversity to Safeguard Life on Earth
- Climate Neutral, Sustainable & Productive Blue Economy
- Water4All
- Animal Health & Welfare*
- Accelerating Farming Systems Transitions*
- Agriculture of Data*
- Safe & Sustainable Food System*

PILLAR III - Innovative Europe

EIT (KNOWLEDGE & INNOVATION COMMUNITIES)

- InnoEnergy
- Climate
- Digital
- Food
- Health
- Raw Materials
- Manufacturing
- Urban Mobility
- Cultural and Creative Industries

SUPPORT TO INNOVATION ECOSYSTEMS

- Innovative SMEs

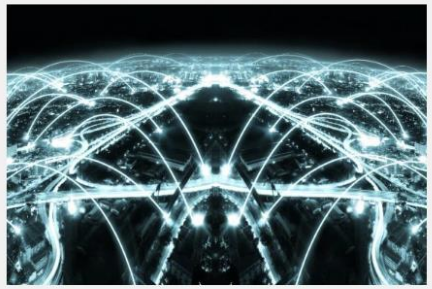
CROSS-PILLARS II & III

- European Open Science Cloud

European Commission

CETP Partnership – Single stage – OPEN NOW

Transition Initiatives (TRIs)



TRI 1: Integrated Net-zero-emissions Energy System

TRI 2: Enhanced zero emission Power Technologies

TRI 3: Enabling Climate Neutrality with Storage Technologies, Renewable Fuels and CCU/CCS

TRI 4: Efficient zero emission Heating and Cooling Solutions

TRI 5: Integrated Regional Energy Systems

TRI 6: Integrated Industrial Energy Systems

TRI 7: Integration in the Built Environment

European Commission

DUT Driving Urban Transitions

Driving Urban Transitions to a sustainable future

The DUT Partnership steps up the game to tackle urban challenges. Through research and innovation and capacity building, we enable local authorities and municipalities, service and infrastructure providers, and citizens to translate global strategies into local action.

We develop the skills and tools to make urban change happen and boost the urgently needed urban transformations towards a sustainable future with enhanced quality of life in cities.

DUT Activation Folder

LEARN MORE GET IN TOUCH

European Commission

Driving Urban Transitions

DUT Call 2022

CALL OPENING: 21 September 2022

The first joint call of the DUT Partnership – the DUT Call 2022 – opens on 21 September and offers opportunities for transnational and transdisciplinary cooperation along and across the three DUT Transition Pathways. In addition, a portfolio of measures is offered to strengthen the community and build capacities in all stakeholder groups, networking and learning across countries, sectors and disciplines. Activities include furthermore provision of scientific evidence and recommendations to policy making on all levels as well as valorisation of research results to allow urban dwellers to experience how a future neighbourhood may look and feel.

European Commission

The future is green

The future is *Life*

5 500+
LIFE projects
since 1992

1 100
projects
in action

€5.4
billion
in funding
for 2021 - 2027

€598
million
in funding
for 2022

#LIFEprogramme

European Commission

The **objectives** of LIFE are

To contribute to the shift to a circular, energy-efficient, renewable energy based- and climate resilient economy.

To protect and improve the quality of the environment

To halt and reverse biodiversity loss

Projects should aim to:

Develop and demonstrate eco-innovative techniques and approaches

Promote best practices and behavioural changes

Help to implement and enforce plans and strategies, in compliance with EU legislation

Catalyse the large-scale deployment of successful solutions.

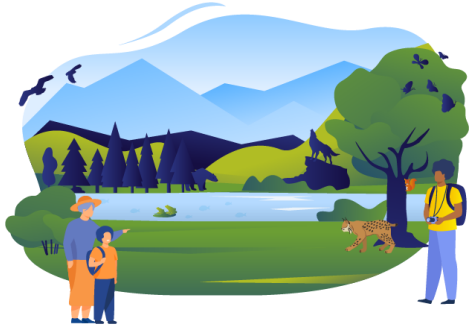
budget for LIFE is 5.4 billion Euros

#LIFEprogramme

European Commission

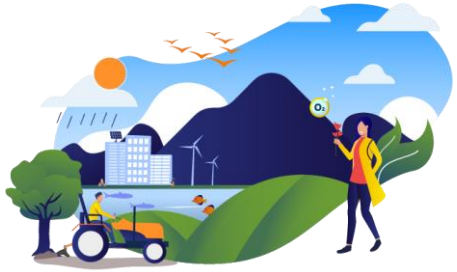
LIFE has 4 sub-programmes

Nature and biodiversity



Circular economy and quality of life

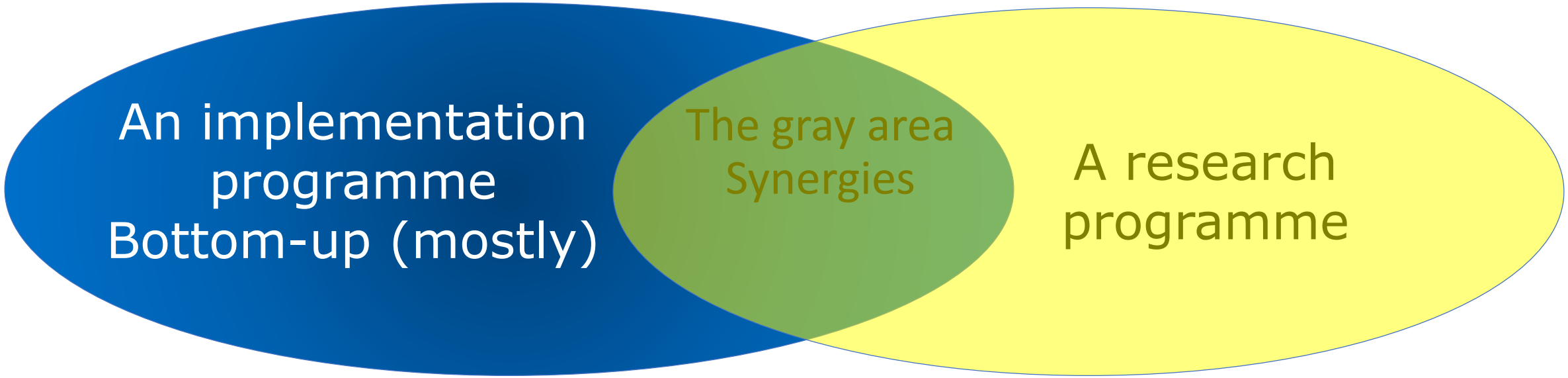
Climate change mitigation and adaptation



Clean energy transition

LIFE is

LIFE **is not**



#LIFEprogramme

Integration of low-grade renewable energy or waste heat in high temperature district heating	6 000 000
National Finance Roundtables for sustainable energy investments	4 000 000
Energy performance and Smart Readiness of buildings – making the instruments work	7 000 000
Supporting the clean energy transition of the business sector	6 000 000
Developing support mechanisms for energy communities	6 500 000
Accelerating deployment and affordability of heat pumps through collective purchase actions and procurement	6 000 000
Integrated Home Renovation Services	8 000 000
Innovative financing schemes for sustainable energy investments	4 000 000
Technical support to clean energy transition plans and strategies in municipalities and regions	7 000 000
Towards an effective implementation of key legislation in the field of sustainable energy	2 000 000
Addressing building related interventions in vulnerable districts	6 000 000

Feel free to contact us anytime

Egill Þór Níelsson
Senior Adviser, Rannís
egill.t.nielsson@rannis.is

Gyða Einarsdóttir
Senior Adviser, Rannís
Gyda.einarsdottir@rannis.is

Kolbrún Bjargmundsdóttir
Senior Adviser, Rannís
Kolbrun.bjargmundsdottir@rannis.is

Moving forward

- Potential applicants are invited to read the call documentation on the topic page in **the Funding & Tenders Portal** and **the work programmes**, carefully

- Note down the topic calls that interest you. Visualize your contribution to the project (research methods/instrument, citizen engagement, monitoring schemes).

- Participate in **brokerage events**: The main objective of international brokerage events is to gather all the relevant stakeholders intending to apply for funding in the Horizon. These events will help you build your consortium for the upcoming calls.

- You can contact Rannís every step of the way, from idea phase and through the whole proposal stage

Proper advice

- Work as an expert. They assist in the evaluation of grant applications, projects and tenders.
- Take part in a COST project. Short application form, always open, potentially great gains, career wise and for future Horizon applications.
- Take a look at previously funded projects on Cordis .
- If you hand in an application you can apply for Preparatory Grants at Rannís.
- Read General Annexes set out the general conditions applicable to calls and topics.
- The Enterprise Europe Network (EEN) in Iceland assists small and medium-sized companies, as well as universities and public bodies, through the world's largest business network. The Enterprise Europe Network employs around 3,000 specialists in over 600 locations in more than 60 countries and on every continent.
- If you are new to Horizon, do not try to coordinate projects. Best way to start is as a partner.

Why participate?

- Big grants, some 100% funded.
- Access to outstanding research, publication, technology, infrastructure and scientist.
- Visibility within Europe and globally.
- Build your research network, increase your access to international markets, companies, researchers
- Take part in solving big, urgent challenges through research and innovation
- Make an impact on standards and research pathways

But . . .

Competition in tough☹

Rannís services

- Rannís has regular webinars (soon hopefully on site as well), trainings on specific matters, such as budget estimation, dissemination & exploitation.
- Rannís offers tailor made services for each customer.
- We recommend talking to Rannís employees on the first stages of an idea.
  - Does my company/research idea fit within the Horizon programme strucure?
- Rannís offers consultancy regarding partner search, such as where to look.
- Rannís reads over proposals.
- Follow-up & questions during funding period.

Next steps

Identify:

- Synergies
- Possible consortium members
- Relevant topic calls **with assistance of you NCP**

GEOTHERMAL

innovations and opportunities

Hjalti Páll Ingólfsson
GEORG – Research Cluster Iceland

Vision

Impartial collaboration platform that builds bridges between Research, Industry, and Public Authorities, for the benefit of society

GEORG

GEORG aims to

reduce GHG emissions worldwide by contributing to a significant increase in sustainable energy production/utilization from geothermal sources.

make **Iceland a case study for a nearly energy** independent and **carbon neutral society**.

Create a **platform for entrepreneurship** and export of geothermal energy resources, technology and education, both for partners in the group and in the ensuing creative environment established through its national and international operations.

contribute to the **Sustainable Development Goals**

THE TEAM

Hjalti Páll Ingólfsson

Alicja Wiktoria Stokłosa

Amel Barich

Steinar Örn Jónsson

Tomasz Urban

Björn Þór Guðmundsson

Sigurður Tómas Björgvinsson

SENIOR ADVISORS

John Ludden

Sigurður Bogason

Geothermal for Society

GGW GEORG GEOTHERMAL WORKSHOP 2018

WORLD GEOTHERMAL CONGRESS 2020 REYKJAVIK

Strong Project Leadership
Research Dissemination
Policy and Strategy

GEORG plays a leading role in

KMT, DEEPEGS, GEOTHERMICA, GECO, and SU-DG-IWG

Partnering in CROWDTHERMAL & GEOENVI

Focusing on long term geothermal policy and strategy support

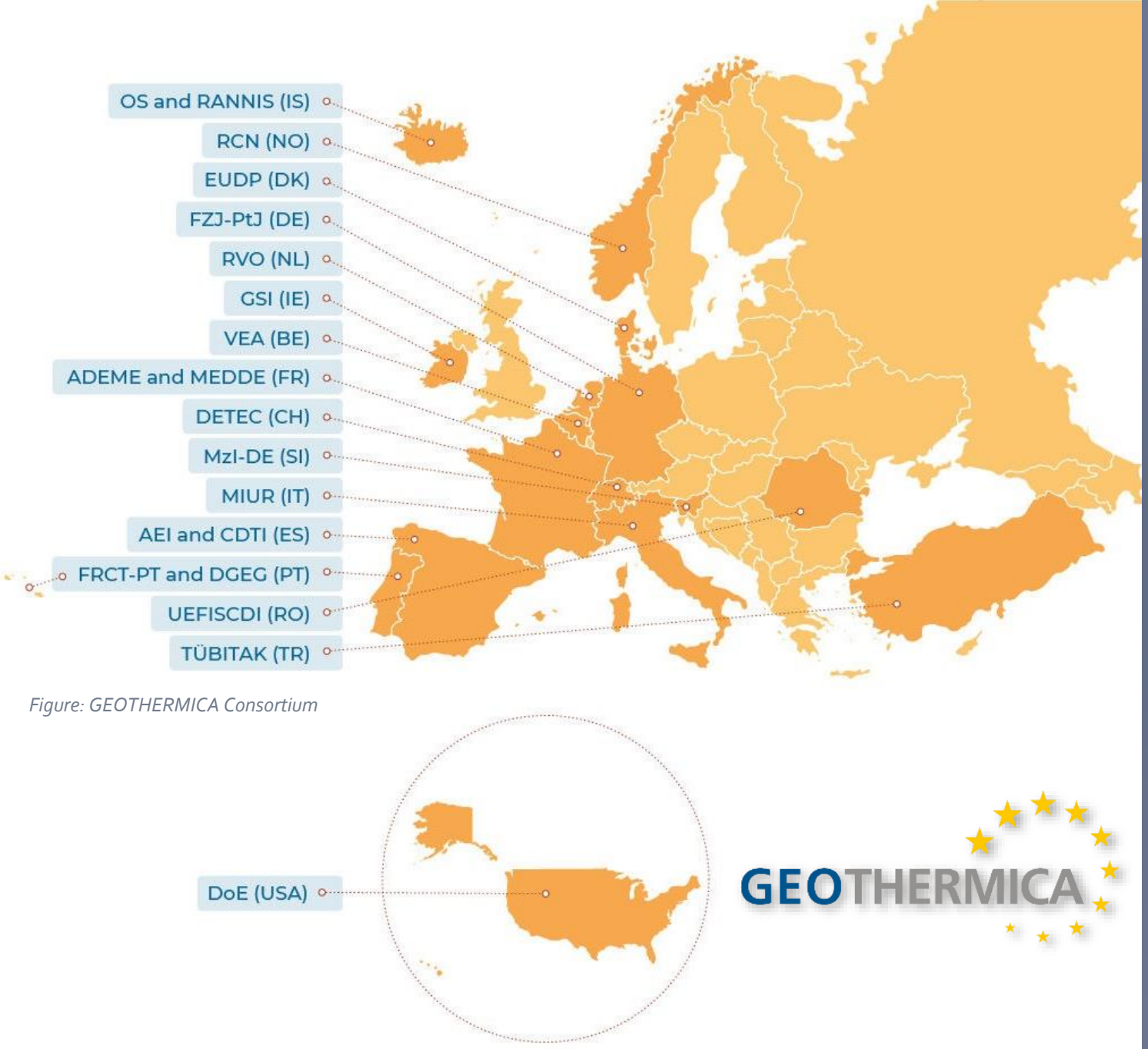


Figure: GEOTHERMICA Consortium

GEOTHERMICA

- Initiated as Geothermal ERA-NET 2012-2016 by Iceland, Netherlands, Germany, Italy & Switzerland
- Pooling national and EC funds for research and innovation
- Focusing on accelerating geothermal development
- Establishing a long-lasting strategic collaboration
- Influence the development of geothermal energy worldwide

Towards stronger European geothermal sector

- The European Members States and Regions play a crucial role
- Lateral cooperation
  - value chain approach
- Advancing on different levels
  - policy
  - regulatory
  - decision making

Deep GEOTHERMAL IWG SUPPORT UNIT

GEOTHERM-FORA

GEOTHERMICA

CETPartnership

TRIs

TRI 4: Efficient zero emission Heating and Cooling Solutions

The Transition Initiative Heating & Cooling (TRI4H&C) will contribute to Challenge 4 "Efficient zero-emission Heating and Cooling Solutions", formulated in the SRIA of the CETP. The overarching goals of this initiative are the **provision of enhanced and improved heating and cooling technologies and systems** for all major parts of Europe by 2030 and to enable 100% climate-neutral heating and cooling by 2050.

TRI 4 Lead
Gerdi Breembroek (RVO, NL)
info@georg.cluster.is

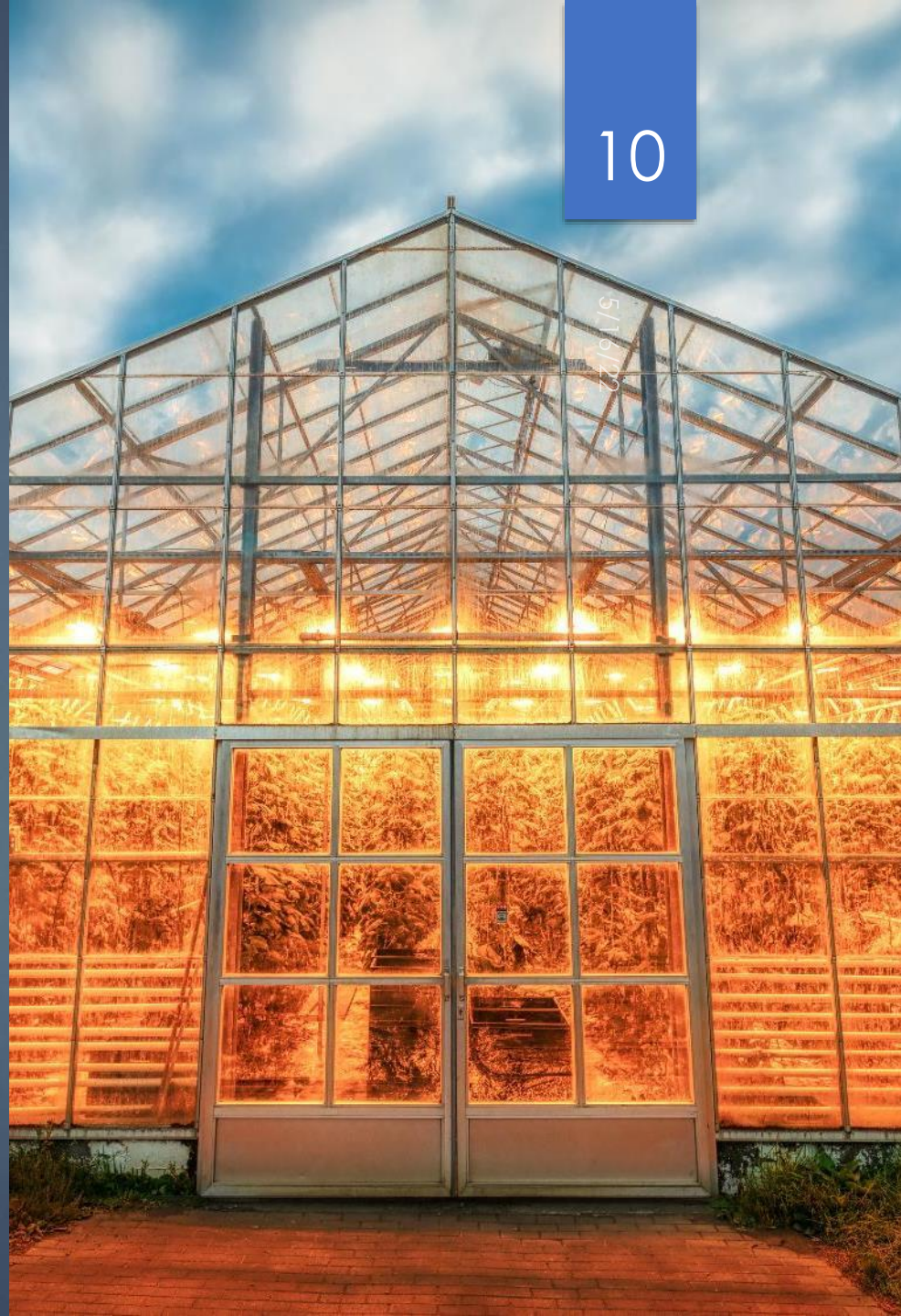
TRI 4 Office
Alicja Wiktoria Stokłosa
TRI4@CETPartnership.eu

Co-funded by the European Union
European Partnership

Front edge research and innovation fields in geothermal

FOOD – ENERGY - WATER

- Use local heat energy in controlled environment for food production / geothermal resources ideal with low CO_2 footprint
  - Not only in Iceland but Europe wide, NL good example
- Circular economy ideology
- Innovation needed to increase use of automation
- Increase food security and diversity



Closed loop, zero emission, total usage

- Society without waste, utilising all value streams out of geothermal resource
- **Lower emissions** from geothermal power generation **by capturing them** for either **reuse or storage**
- Invention developed in the geothermal sector, by **Carbfix**, applicable for other industrial sectors.

JARÐHITAGARÐUR
ORKA NÁTTÚRUNNAR

RESOURCE PARK

carbfix

GECCO

GOING HOTTER AND DEEPER

- Further the understanding of relation between magma and geothermal fluids
- Develop new equipment to withstand the challenging properties of superhot fluids
- Engineer solutions to deal with up to **10 times** more powerful wells

Thank you

Hjalti Pall Ingólfsson

Managing Director

HPI@GEORG.CLUSTER.IS

HTTP://WWW.GEORG.CLUSTER.IS

REPUBLIKA SLOVENIJA
SLUŽBA VLADE REPUBLIKE SLOVENIJE ZA RAZVOJ
IN EVROPSKO KOHEZIJSKO POLITIKO

Iceland Liechtenstein Norway grants

INFO-GEOTHERMAL

Podpiranje učinkovite kaskadne uporabe geotermalne energije z dostopom do uradnih in javnih informacij /

Supporting efficient cascade use of geothermal energy by unlocking official and public information

dr. Nina Rman, Geological Survey of Slovenia

Reykyavik, 25. 10. 2022

GeoZS Geološki zavod Slovenije

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA INFRASTRUKTURO

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR

Skupnost občin Slovenije
Association of Municipalities and Towns of Slovenia

HÁSKÓLINN Í REYKJAVÍK
REYKJAVIK UNIVERSITY

Geological Survey of Slovenia (GeoZS)

- Public research institute founded in 1946
  - Ministry of Education, Science and Sport
  - Ministry of the Environment and Spatial Planning
  - Ministry of Infrastructure
- Approximately 120 employees
- Annual turnover of app. 6 M€
  - 5 research programmes
  - 9 research projects
  - 37 EU projects
  - Numerous applicative projects

ISO 9001
BUREAU VERITAS
Certification
SL21537Q

e-datasets:
- e-Geologija
- e-Vrtine
- e-Teren
- Geohazard
- Rudarska knjiga

REPUBLIKA SLOVENIJA
SLUŽBA VLADE REPUBLIKE SLOVENIJE ZA RAZVOJ
IN EVROPSKO KOHEZIJSKO POLITIKO

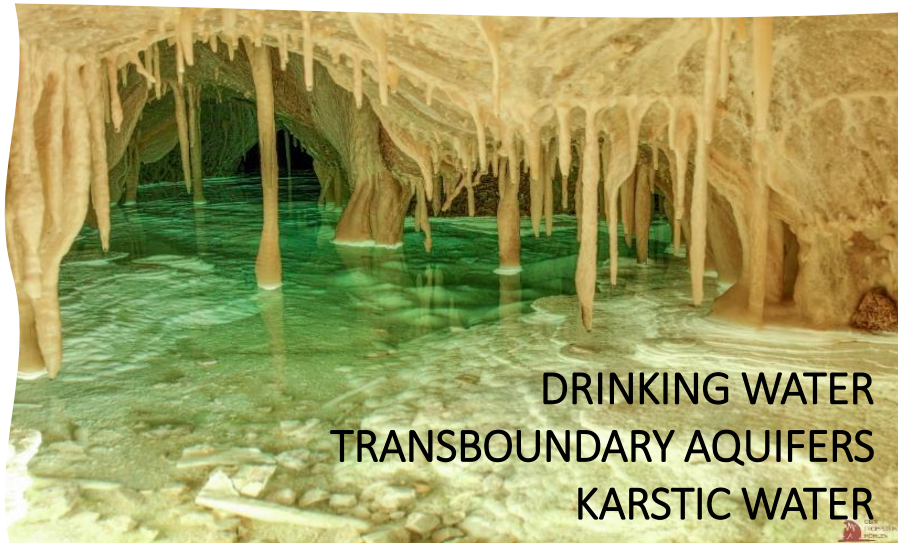
Iceland Liechtenstein Norway grants

Department Groundwaters - Hydrogeology

- Drinking water resources (exploration, exploitation, risk assessment, protection zones)
- Groundwater bodies and their management (WFD)
- Ecosystems, related to groundwater-surface water interaction
- Mineral and thermal waters (exploration, water rights, monitoring, trends)
- Shallow geothermal energy (potential, utilization, benchmark, legislation)

GeoZS
Geološki zavod Slovenije

https://www.geo-zs.si/



Research group Geoenergy

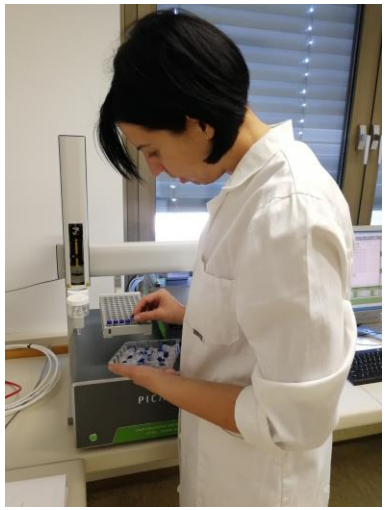
Field and laboratory measurements of geothermal parameters of soils and rocks (TCS, KD2 Pro)

Thermal Response Test in geoprobes

Sampling and interpretation of chemical and isotopic composition of water and gas (Picarro L2130-i)

Analytical and numerical modelling of flow and heat transport (EED, FeFLOW)

Evaluation of geothermal potential and guidelines for sustainable water/heat use



INFO-GEOTHERMAL in brief

Programme

Climate Change Mitigation and Adaptation

Predefined project

Output

B.1.1: Improved capacity to develop less established renewable energy sources

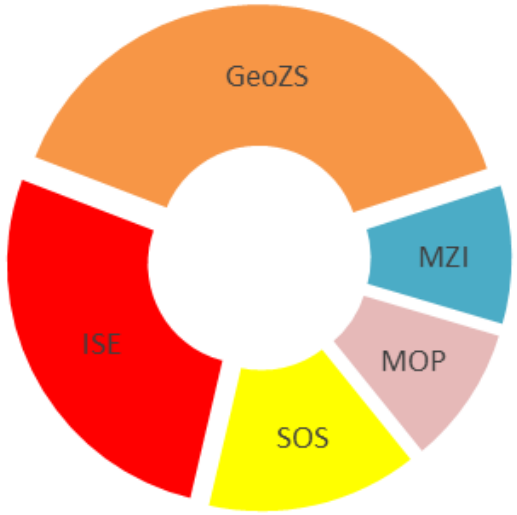
Duration

20 months

Sept 2022 – April 2024

EEA grants

1,073,529,41 EUR



5 partners

GeoZS (LP)
MZI
MOP
SOS
ISE

Keywords

Thermal water
Direct use
Electricity
Efficiency
Databases
Guidelines
Trainings

INFO-GEOTHERMAL - Supporting efficient cascade use of geothermal energy by unlocking official and public information

We aim to prepare 2 amendments of legislation to establish a business-supportive environment :

geological risk insurance schemes, and for reinjection, cascade use and electricity

We will improve availability of information on subsurface by:

Mapping technical potential of deep GTE: (3D model of NE Slovenia, digital data of 2 pilots)

We will improve know-how by:

Workshop with field trips and trainings in Iceland (25.10.-2.11.2022)

Visit of Icelandic experts at geothermal summer school (3.-8.7.) and workshop (10.-12.7.2023)

Establishment of a Slovenian national geothermal network (2024)

Towards a future one-stop-shop and geothermal competence centre in Slovenia

Where is participation of stakeholders foreseen?

Kick-off and closing conference in Slovenia (nov. 2022, 2024)

Analysis of typical Q&A of municipalities and potential investors (nov. 2022)

Video on geothermal potential and investment possibilities in Slovenia (2023)

Workshop in Slovenia on overcoming technological, legislative and financial barriers (10.-12.7.23)

Info boards on efficient and cascade use of geothermal energy (2024)

Workshops on using the guidelines (2024)

Establishment of a national geothermal network (2024)

Most documents will have English summaries to be usable also for foreign investors

Acknowledgement

The project INFO-GEOTHERMAL benefits from a 1,073,529.41 € grant from Iceland, Liechtenstein and Norway through the EEA Grants. The aim of the project INFO-GEOTHERMAL is to support efficient cascade use of geothermal energy by unlocking official and public information.

https://www.geo-zs.si/index.php/en/?option=com_content&view=article&id=1120

www.eeagrants.org

www.norwaygrants.org

»Working together for a green, competitive and inclusive Europe«

REPUBLIC OF SLOVENIA
GOVERNMENT OFFICE FOR DEVELOPMENT
AND EUROPEAN COHESION POLICY

Iceland Liechtenstein Norway grants

SI-Geo-Electricity

Pilot geothermal power plant on an existing gas well Pg-8, pilot project

Nina Rman, PhD

Geological Survey of Slovenia

Working together for a green Europe

dem Dravske elektrarne Maribor

PETROL Petrol Geo, proizvodnja ogljikovodikov d.o.o. Milnska ulica 5D 9220 Lendava, Slovenija

Univerza v Mariboru

GeoZS Geološki zavod Slovenije

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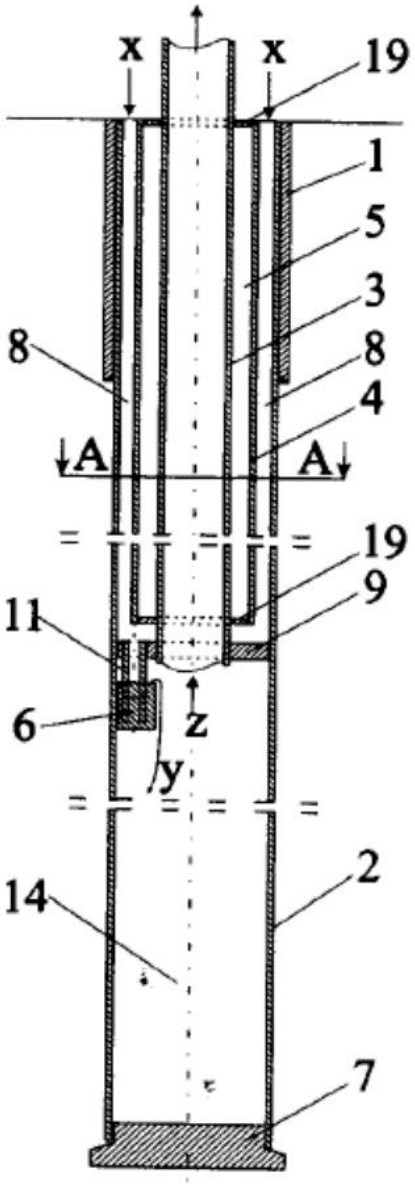
AND EUROPEAN COHESION POLICY

Iceland Liechtenstein Norway grants

SI-Geo-Electricity

- Demo electricity production by using a geothermal gravity heat pipe (Slovenian patent SI 23618 A) with adapted Kalina cycle
- Using a dry abandoned HC well Pg-8 with 155 °C at 3,012 m
- Estimated capacity 50 kW_e and production 400 MWh_e annually
- **Aim: valorize abandoned hydrocarbon boreholes in Slovenia**



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Univerza v Mariboru

GeoZS Geološki zavod Slovenije

SI-Geo-Electricity

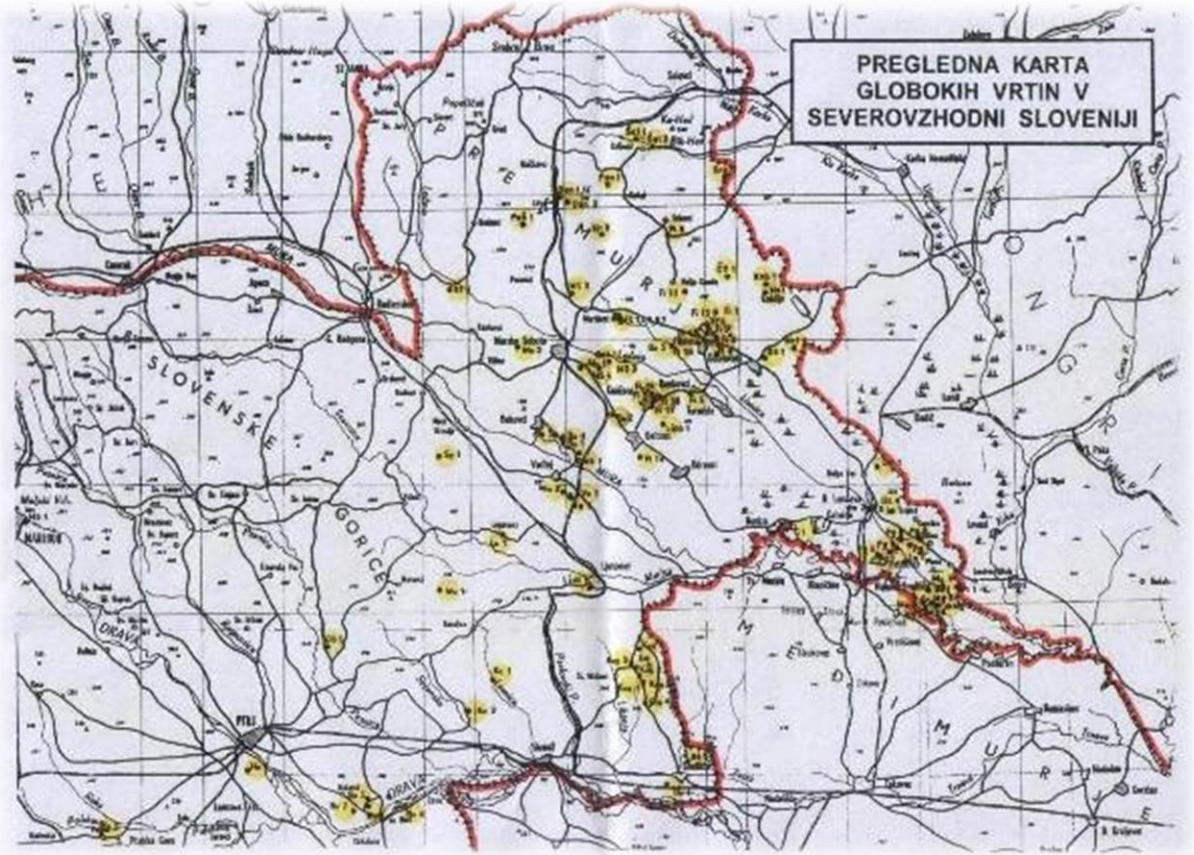
- 210 drillings prior-1945 to 1981-on

  (UJMA, 13, 1999)

- Remediation of 205 boreholes in 1999-2011

  (www.energetika-portal.si)

  - Cca 10% re-worked into geothermal



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GeoZS Geološki zavod Slovenije

REPUBLIC OF SLOVENIA
GOVERNMENT OFFICE FOR DEVELOPMENT
AND EUROPEAN COHESION POLICY

Iceland Liechtenstein Norway grants

SI-Geo-Electricity

- Duration: May 2022 – April 2024
- Partners:
  - Dravske elektrarne Maribor, d. o. o. (project leader)
  - Faculty of Chemistry and Chemical Technology, University of Maribor
  - Petrol Geo, production of hydrocarbons, Ltd.
  - Geological Survey of Slovenia
- Estimated costs: 900.210,98 €, 81% co-financing

Working together for a green Europe

dem Dravske elektrarne Maribor

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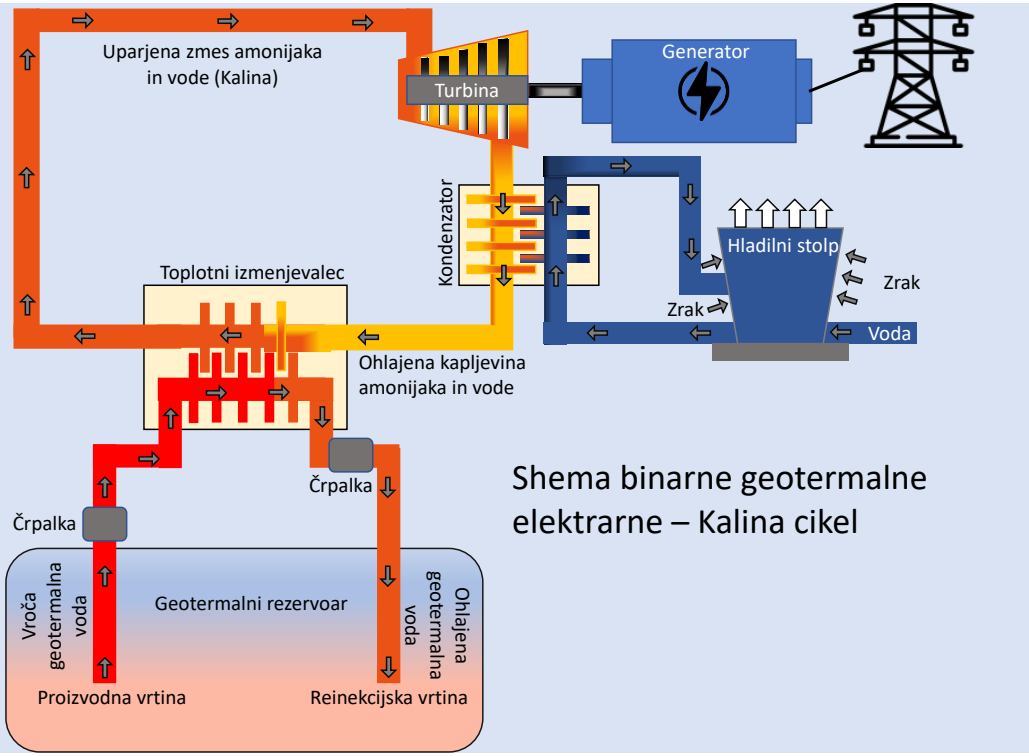
Univerza v Mariboru

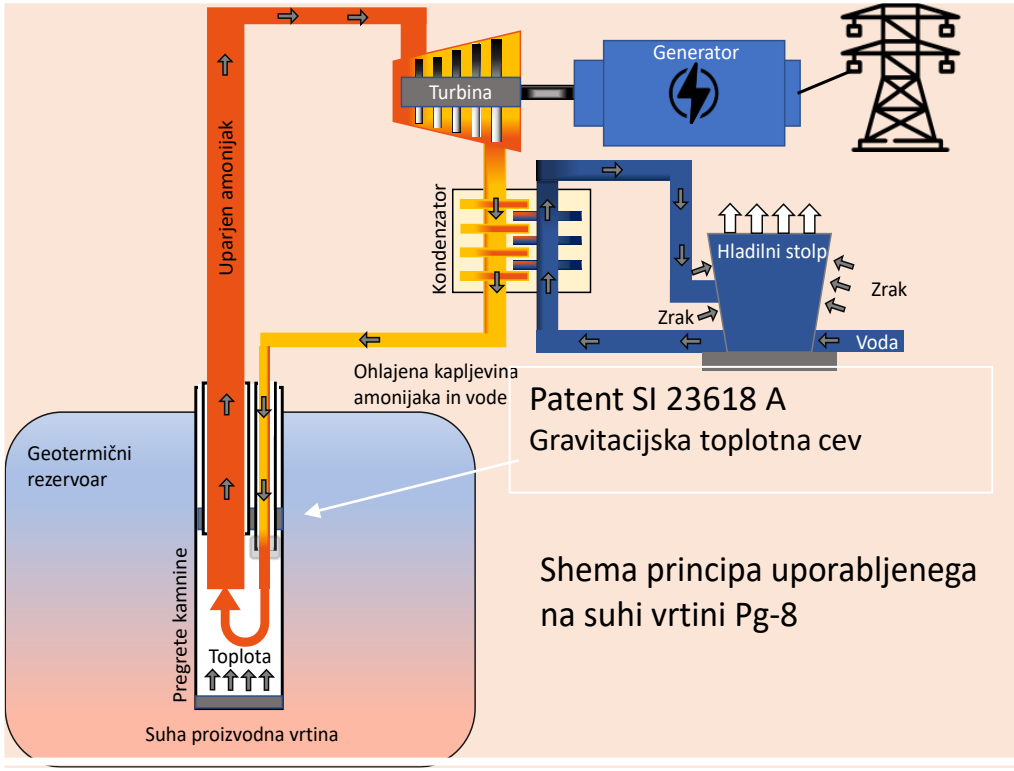
GeoZS Geološki zavod Slovenije

SI-Geo-Electricity



Shema binarne geotermalne elektrarne – Kalina cikel

Innovative approach



Patent SI 23618 A
Gravitacijska toplotna cev

Shema principa uporabljenega na suhi vrtini Pg-8

Working together for a green Europe

dem Dravske elektrarne Maribor

PETROL Petrol Geo, proizvodnja ogljikovodikov d.o.o. Milnska ulica 5D 9220 Lendava, Slovenija

Univerza v Mariboru

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REPUBLIC OF SLOVENIA
GOVERNMENT OFFICE FOR DEVELOPMENT
AND EUROPEAN COHESION POLICY

Iceland Liechtenstein Norway grants

SI-Geo-Electricity

Reworking of Pg-8 and installment of surface system (2022)

Heat flow measurement & Simulations in 3D (2023)

Trial operation plant & Connection to the grid (2024)

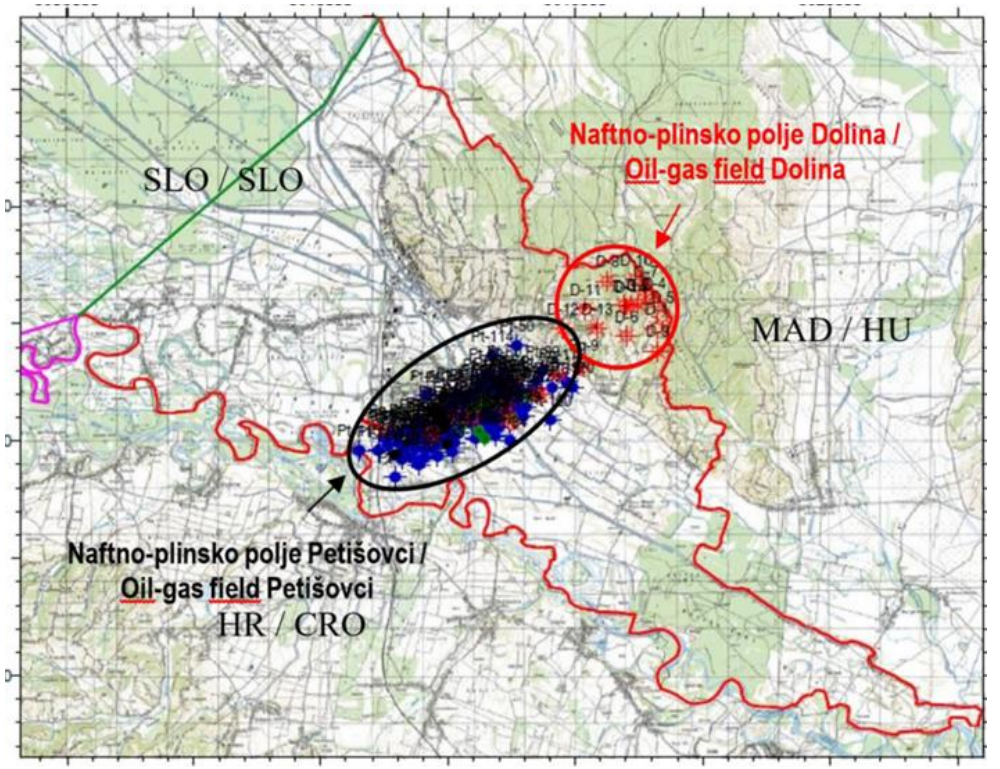
Local geological and geothermal models of Petišovci (2023)

Mapping of technical potential of abandoned HC wells (2024)

Guidelines to develop such geothermal power plants (2024)

Scientific publications & Two public workshops (2024)

– partly linked to INFO-GEOTHERMAL (→fluids)



https://doi.org/10.5474/geologija.2018.011

Working together for a green Europe

dem Dravske elektrarne Maribor

PETROL Petrol Geo, proizvodnja ogljikovodikov d.o.o. Miinska ulica 5D 9220 Lendava, Slovenija

Univerza v Mariboru

GeoZS Geološki zavod Slovenije

REPUBLIC OF SLOVENIA
GOVERNMENT OFFICE FOR DEVELOPMENT
AND EUROPEAN COHESION POLICY

Iceland Liechtenstein Norway grants

Acknowledgment

Project "SI-Geo-Electricity - Pilot geothermal power plant on the existing gas well Pg-8, pilot project" is co-financed by Iceland, Liechtenstein and Norway with the EGP Financial Mechanism resources in the amount of € 622.600,00 and the corresponding Slovenian participation in the amount of € 109.800,00. The purpose of the project is to increase renewable electricity by building the first pilot geothermal power plant in Slovenia.

Working together for a green Europe

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REPUBLIKA SLOVENIJA
SLUŽBA VLADE REPUBLIKE SLOVENIJE ZA RAZVOJ
IN EVROPSKO KOHEZIJSKO POLITIKO

Iceland Liechtenstein Norway grants

INFO-GEOTHERMAL

Geothermal potential and use of geothermal energy in Slovenia

mag. Andrej Lapanje, Geological Survey of Slovenia

Prepared by Lapanje, A., Rman, N., Rajver, D., Adrinek, S.

Reykjavik, 25. 10. 2022

GeoZS Geološki zavod Slovenije

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA INFRASTRUKTURO

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR

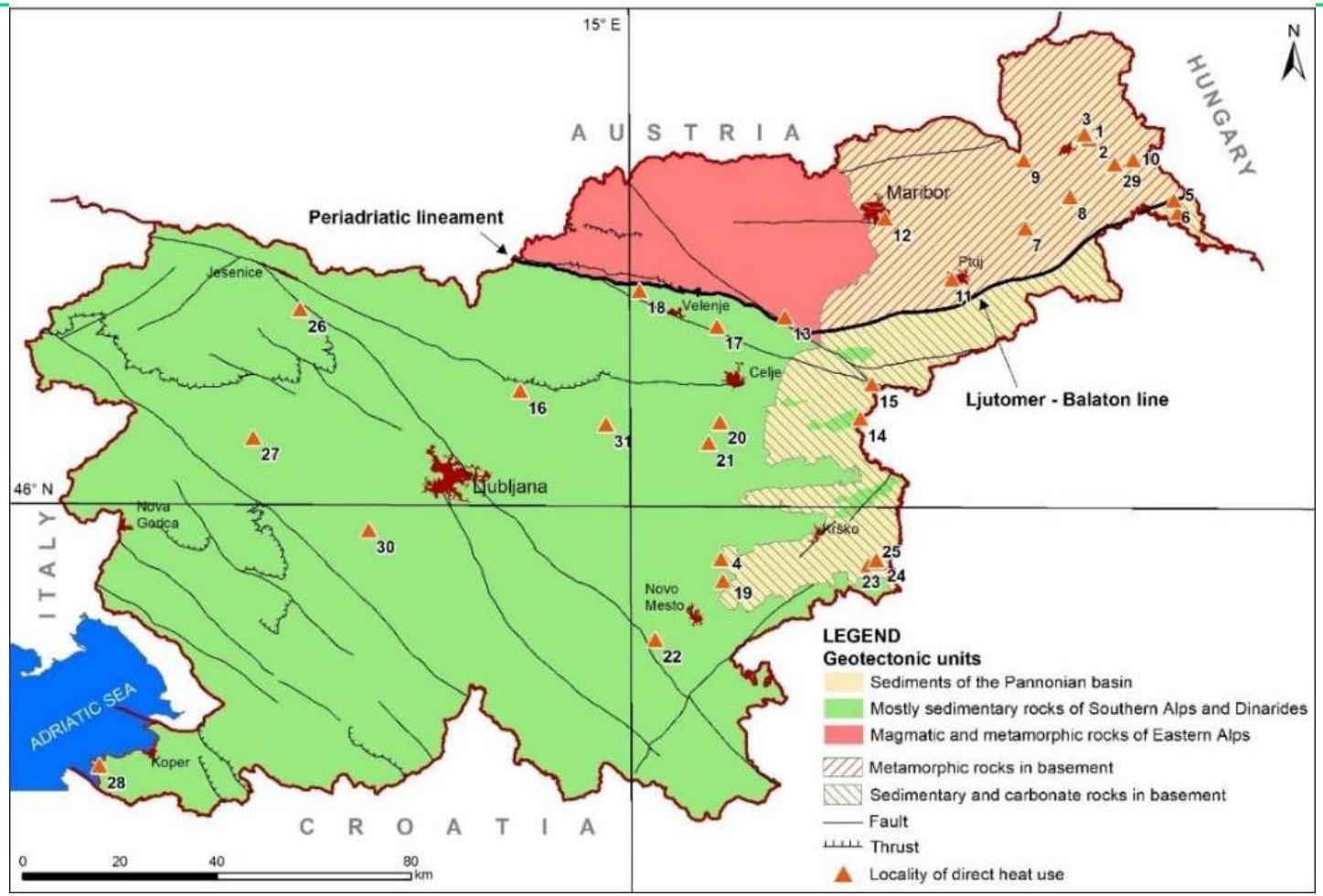
Skupnost občin Slovenije
Association of Municipalities and Towns of Slovenia

HÁSKÓLINN Í REYKJAVÍK
REYKJAVIK UNIVERSITY

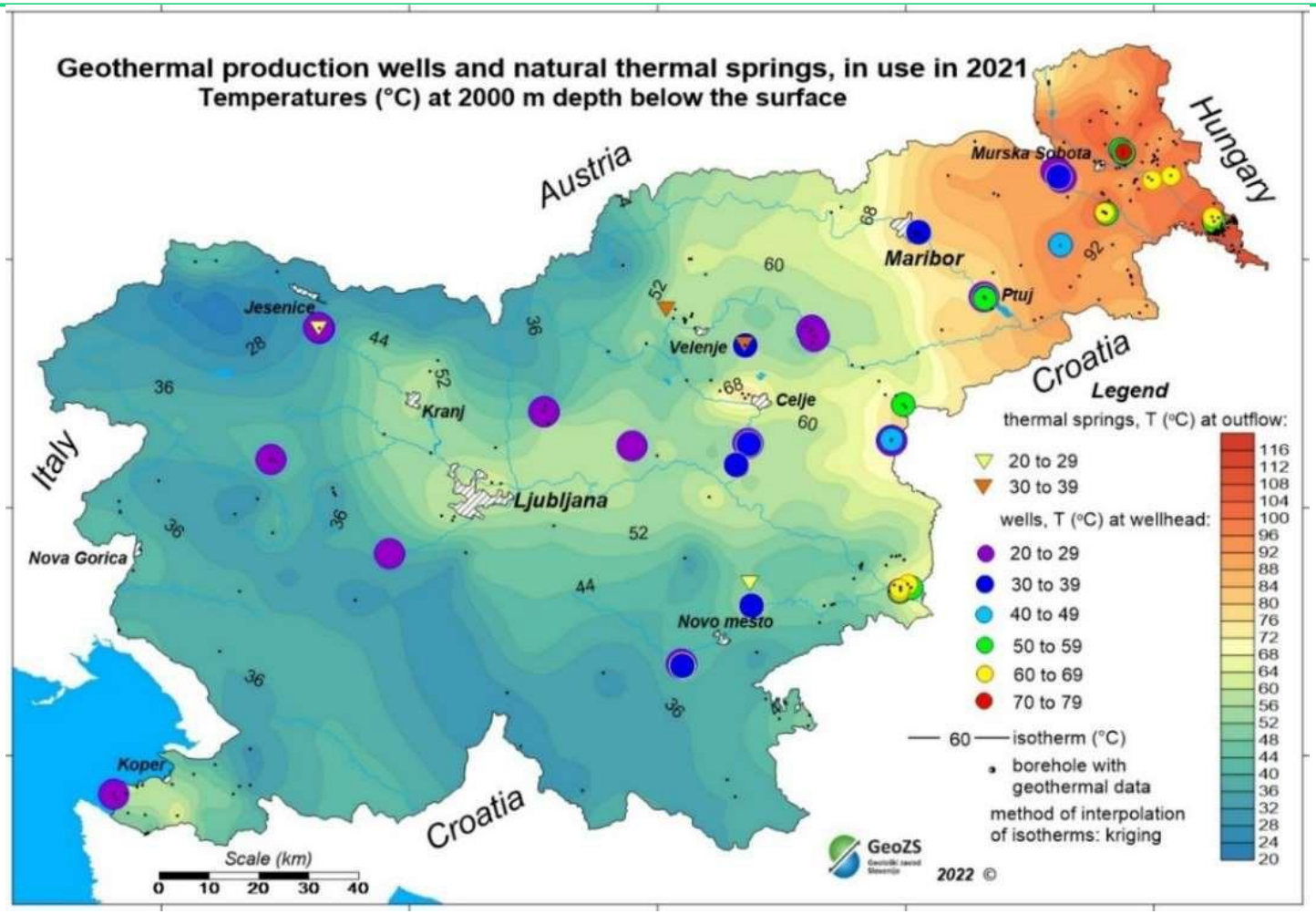
Slovenia vs. Iceland

	Slovenia	Iceland
Area (km^2)	20,271	103,125
Population	2,107,180	366,425
Population Density (/km^2)	103,9	3,6
Real GDP per capita (2021) EUR	21,310	36,860
Average montly wages (2021) brutto EUR	1,969	5,200
Geology	Sedimentary prevail	Volcanic
Heat Flow density	Low to average for continents (elevated in NE)	High to very high

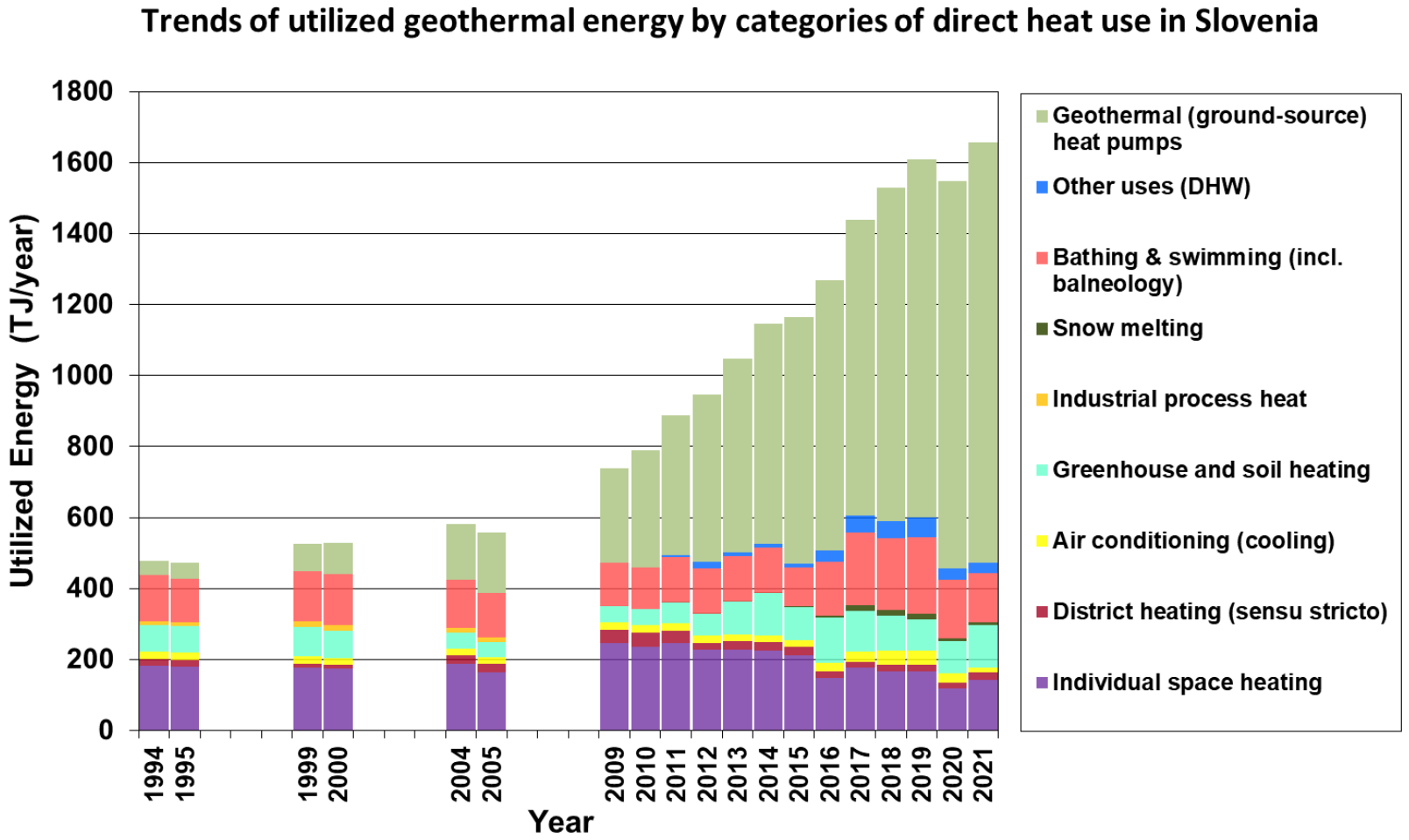
Geothermal potential of Slovenia is determined by its geological buildup 1



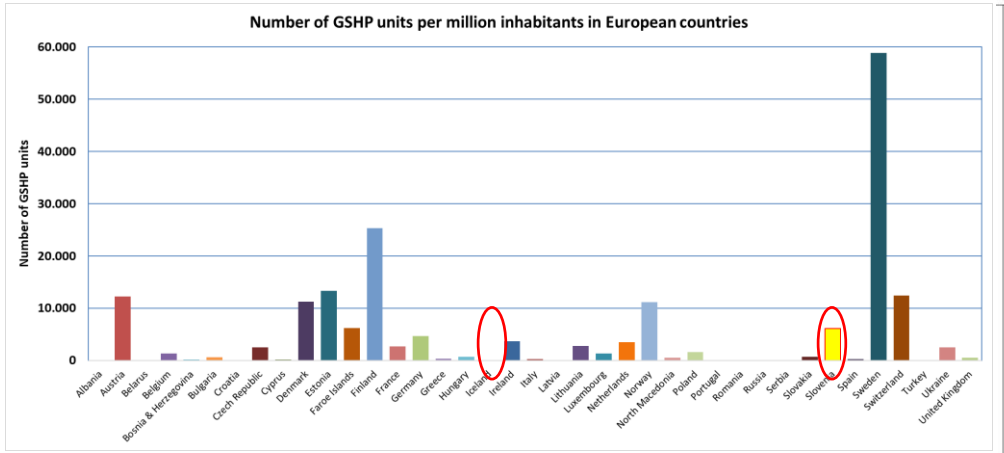
Geothermal potential of Slovenia is determined by its geological buildup 2



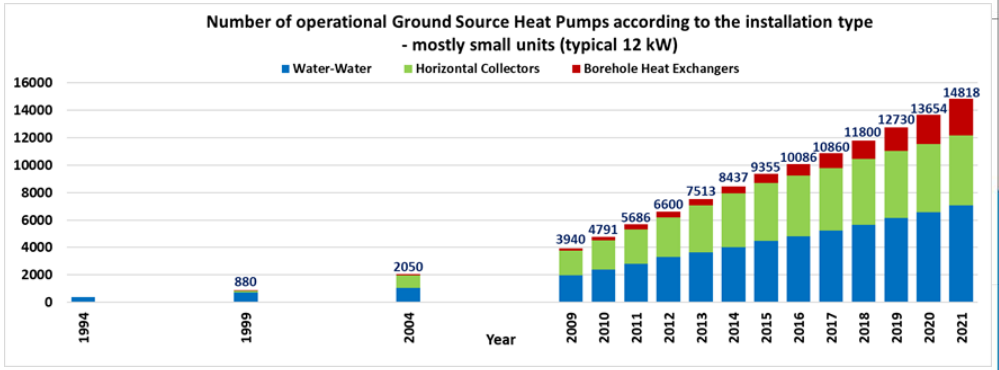
Geothermal heat use in Slovenia



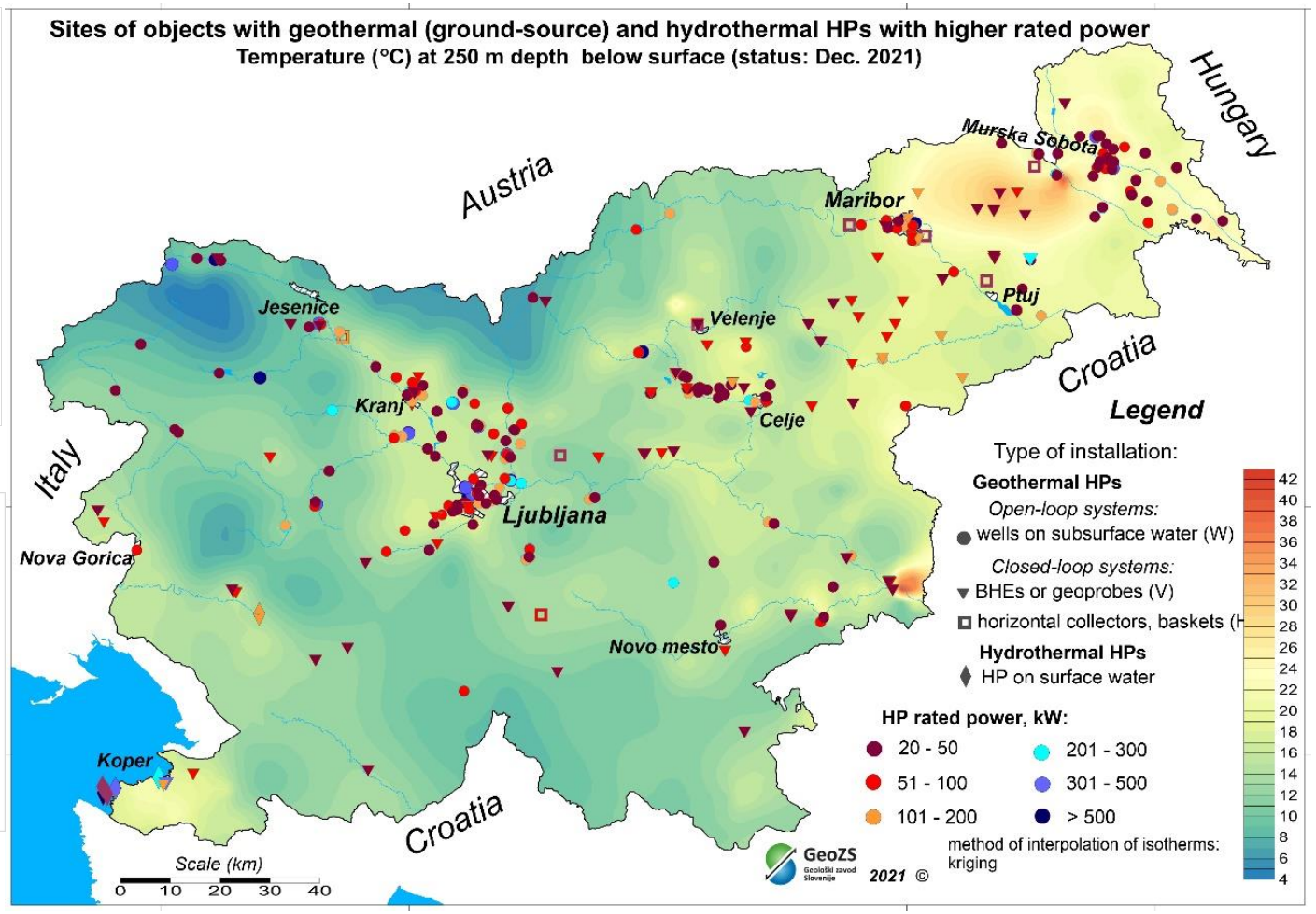
Shallow geothermal



Source: Rajver et al., 2021: Mineral Resources in year 2020, Bulletin.



Source: Rajver et al., 2022: Geothermal country update report for Slovenia, WGC 2023



Shallow geothermal - challenges

Craftsman world:

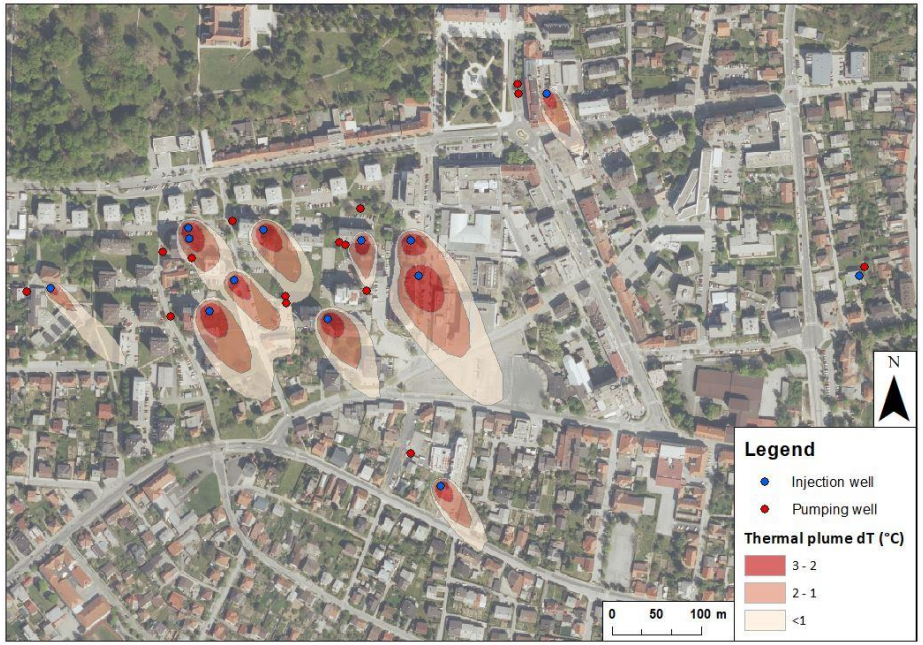
- Lack of application of standards for GSHP instalations (usually drillers design the GSHP)
- Possible mutual interference of open loop systems
- no TRT, no longterm simulations of closed loop systems

Week cooperation
State intervention needed

Research world:

- Shallow geotermal potential mapping of Ljubljana City (GeoPlasma-CE project) and Cerkno area (GRETA)
- pilot monitoring site in Murska Sobota for evaluation of interference in shallow aquifer

More challenges:
Missing state inventory of GSHP instatations (long term effects)
Iron in GWHP open loop systems (poor performance - bad publicity)

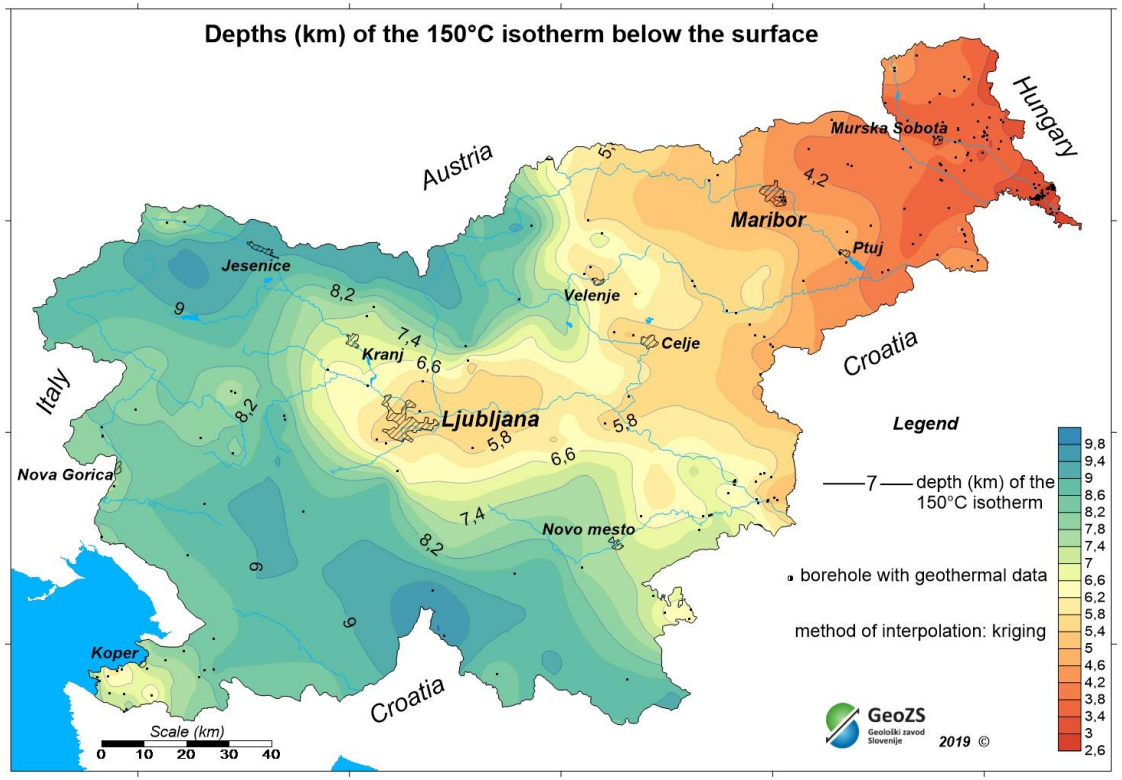


Deep geothermal

- Only direct use of geothermal water (heat exchangers and heat pumps with up to 2 MW_t are used additionally)
- Geothermal water is used mostly in spas
- No geothermal electricity power plant

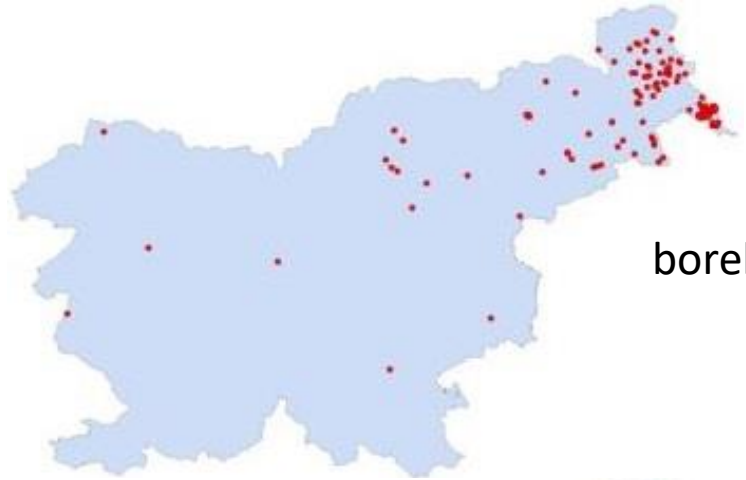
To do things:

- reinjection in loose sands – very slow
- use of dry HC wells (Si-Geo-Electricity),
- Exploration in existent HC prospection borehole Mg-6,
- pilot deep drillings bellow cities (Ljubljana, Kranj, Brežice…),
- Professional education of skilled personnel (for drilling, geophysics, deep logging, surface processes engineering)

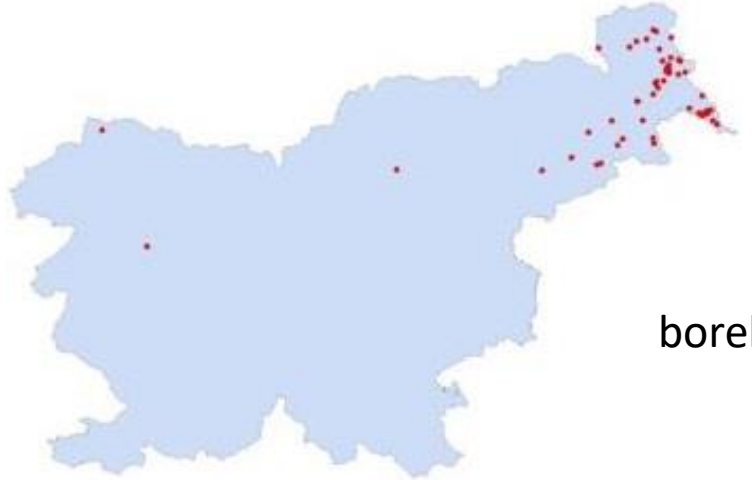


Deep geothermal - challenges

- No data available (lack of geophysical surveys, deep drillings) except for NE Slovenia
- Lack of knowledge throughout the geothermal chain from drilling to surface installations
- Poorly regulated administrative environment (clear environmental and spatial conditions for geothermal exploration and exploitation)
- Lack of stimulative business environment (geological insurances, feed-in tariffs for heat, etc…)
- Lack of national RTDI geothermal funds which would serve as a funding agencies in international geothermal programmes (e.g. CETpartnership 2022-2027 – Slovenia didn‘t join the call 2022)
- At the moment we don‘t see investors in deep geothermal sector in Slovenia.



boreholes deeper than 1000 m



boreholes deeper than 2000 m

Deep geothermal - oportunities

The project INFO-GEOTHERMAL is an opportunity to turn things on.

We came here not to take your natural features back with us, but to see how you handle geothermal energy from an administrative, management, research, technological and environmental point of view.

We will try to get the best out of it and try to prepare the geothermal friendly business and administrative environment in Slovenia.

And then we will see…

REPUBLIC OF SLOVENIA
MINISTRY OF INFRASTRUCTURE

Iceland Liechtenstein Norway grants

INFO-GEOTHERMAL

Supporting efficient cascade use of geothermal energy by unlocking official and public information

Podpiranje učinkovite kaskadne uporabe geotermalne energije z dostopom do uradnih in javnih informacij /

Gregor Rome

Reykjavik, October 2022

GeoZS Geološki zavod Slovenije
REPUBLIKA SLOVENIJA MINISTRSTVO ZA INFRASTRUKTURO
REPUBLIKA SLOVENIJA MINISTRSTVO ZA OKOLJE IN PROSTOR
Skupnost občin Slovenije
HÁSKÓLINN Í REYKJAVÍK

Team members from Directorate for energy:

Department for energy use, Gregor Rome

Department for renewabel energy sources: Mira Žnidarič

Department fo mining: (open)

Ministry for infrastructure field of work:

- Energy related policies and legislation (energy use, renevable energy sources…)
- Mining related policies and legislation (mineral and energy sources, water excluded)

Main objectives of the project:

- Increase use of geothermal energy for heat and electricity production in sustainable way.
- Public availability of reliable information on the deep subsurface to reduce geological risk.
- Build-up of technology and know - how transfer by development of guidelines and standards for project design and operation, good examples of high energy efficiency, cascade systems, and reinjection well design and management to reduce technological risk.
- Permanent interdepartmental cooperation of agencies and ministries to develop optimal permitting procedures.
- Development of risk insurance schemes.
- Dapacity building and education of all groups of stakeholders.

Project aims specific to to ministry‘s field of work:

- Report on national procedures, regulations, restrictions, permits and monitoring with suggestions for improvement•
- Report on the necessary adaptation of the legislation for the establishment of geological risk insurance schemes•
- Report on the necessary adaptation of the legislation for support schemes for re-injection, cascading and production of electricity from geothermal energy

The listed topics also coincide with the tasks for which the interministerial group is responsible for dealing with the long-term sustainable development of geothermal systems and the cascading use of geothermal energy in the Republic of Slovenia.

Hot topics:

- One-stop-shop for investor for new RES instalation (spatial plannig/placement, building permits, environmental impact assesmet, supports, schemes, financing) as envisioned in EU RES directives and RePower EU plan.
- Financing of wells vs. surface instalations.
- Aproach to potential investors, use of tenders for exploration and expoloitation of geothermal sources.
- 20 mio EUR is allocated for a tender for geothermal power plant in RRF in 2023.

INFO-GEOTHERMAL

Podpiranje učinkovite kaskadne uporabe geotermalne energije z dostopom do uradnih in javnih informacij

Supporting efficient cascade use of geothermal energy by unlocking official and public information

GeoZS Geološki zavod Slovenije
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REPUBLIKA SLOVENIJA MINISTRSTVO ZA OKOLJE IN PROSTOR
Skupnost občin Slovenije Association of Municipalities and Towns of Slovenia
HÁSKÓLINN Í REYKJAVÍK REYKJAVIK UNIVERSITY

Ministry of the environment and Spatial planing

Environment Directorate
Spatial Planning, Construction and Housing Directorate
Water and Investments Directorate

Bodies within the Ministry:

Slovenian Environment Agency
Slovenian Water Agency
Inspectorate for the Environment and Spatial Planning

WATER ACT

Permiting of water use:

- recording
- water permit
- concession

Charges for water use (water permit / concession)

- payment for permission to use
- payment due to pollution

USE OF THERMAL WATER

- baths, heating, and the like, if mineral, thermo-mineral or thermal water is needesd – concession
- concession act (regulation) and a concession contract

CHALLENGES:

- cascade use of thermal water
- reinjection sistems
- development of legislative frameworks
- lack of information
- new innovative uses

This project adresses them

Skupnost občin Slovenije

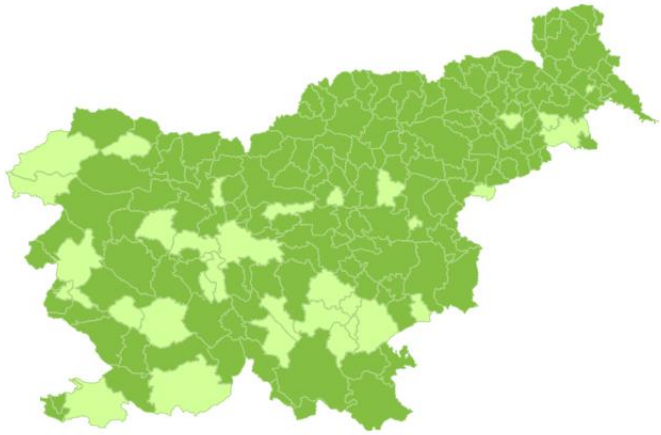
Association of Municipalities and Towns of Slovenia

- We connect municipalities, exercise their needs, we are their strong voice.

General about SOS

- We are the biggest representative association of municipalities in Slovenia,
- We are the biggest representative association of municipalities in Slovenia with 179 members municipalities (out of 2012),
- the post of chairman rotates between the representatives of three groups of municipalities - urban, medium and small.

Member Municipalities of SOS



In 2022 we celebrated the 30th anniversary of our work

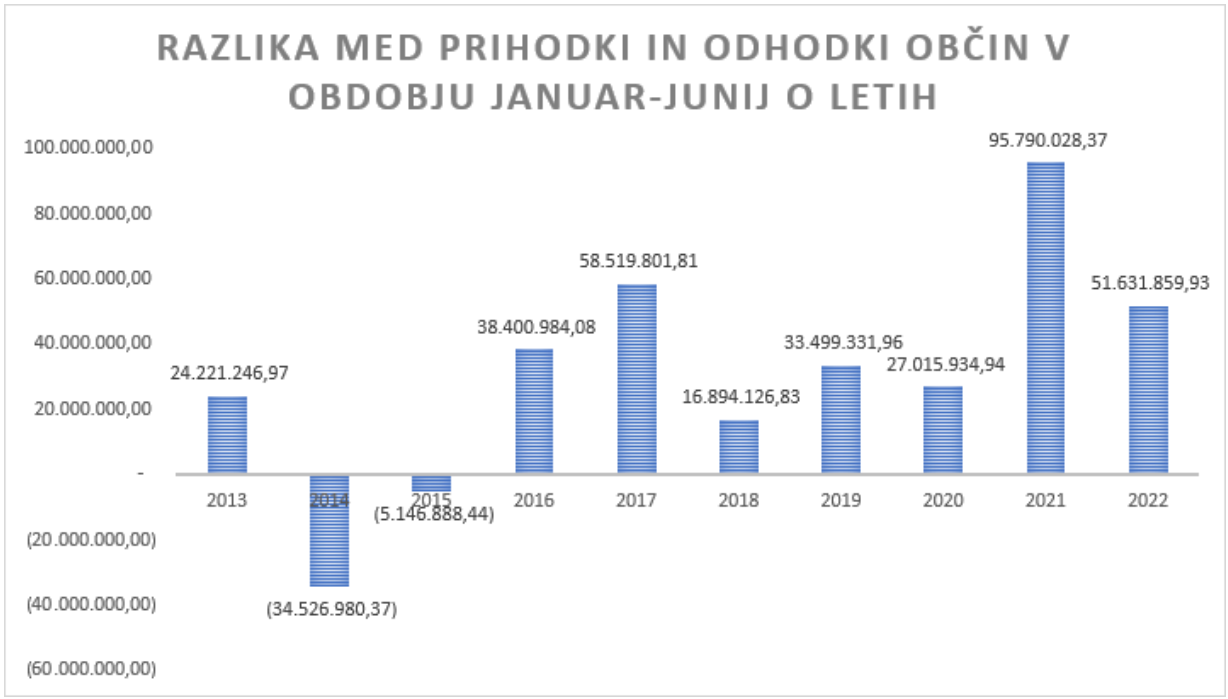
We received a special recognition from the President of the Republic for our work

Tasks of SOS

- We represent municipalities in relation to the Government of the Republic of Slovenia and other state institutions
- Negotiate the municipal finances for every xear

- Consider draft laws related to municipalities, and provide initiatives to the Government, the National Assembly and the National Council.
- We support and promote good practices of municipalities from Slovenia and abroad

- Organize seminars, workshops, educational events and advise to the municipalities



We collect various data that enable better municipal planning

- Cooperate with Slovene and foreign organisations of local and regional authorities
- Design joint development projects

Funded by the European Union
بتمويل من الاتحاد الأوروبي

Main project outcomes – Basra Business Incubator

Launched on December 22nd ,2021

Basra Business Incubator
For A Better Future

STRITIH
Sustainable Development

zavita

University of Ljubljana
Faculty of Electrical Engineering

Additional Services

- service of internal audit
- alignment with General Data Protection Regulation and role of Data protection officer
- support in preparation of public procurement
- joint public procurement
- support in e-Tourism system
- development of common development projects
- preparation of professional materials for members
- additional information and education in developmental areas such as digitization and circular economy

Informing Municipalities

For better information of member municipalities about the Association's work and topics important for good municipal government the Association issues **three web services**:

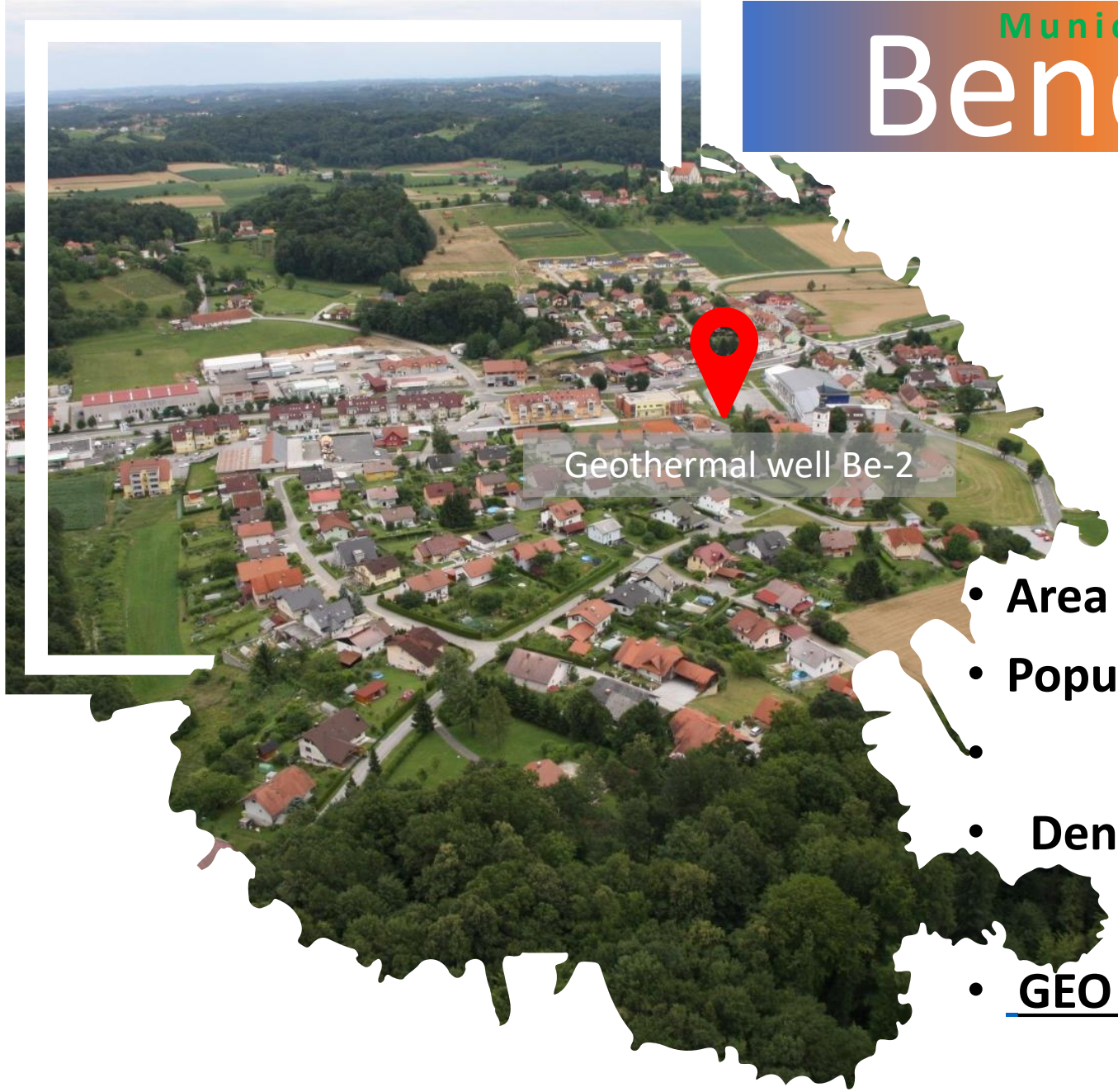
- »**Weekly news**« - online news, informs municipalities weekly about current development on national and local level, informs about suggestions and proposals of SOS to the national level, minister's answers on questions asked by the Association, clarifications and invitations for cooperation.
- **Web page -** www.skupnostobcin.si, for daily information of members about current affairs in the field of local government.
- **Facebook** - to inform about less formal content, which, however, extend the horizons of civil servants in developmental areas

- Thank you for your attention.

OBČINA BENEDIKT

Municipality

Benedikt



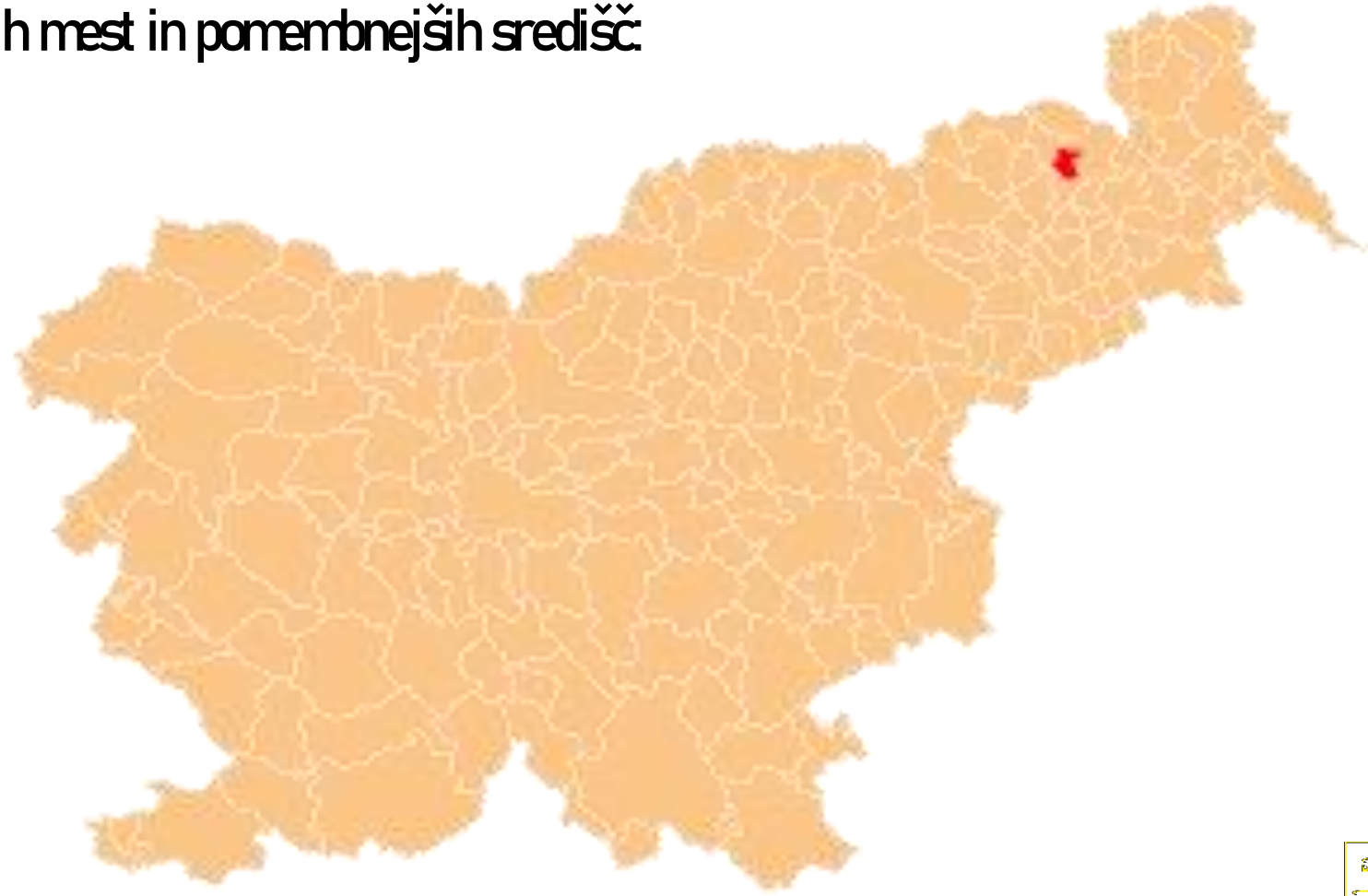
- **Area Total 24.1 km2**
- **Population 2012 2022**
- **Total 2.432 2.845**
- **Density 100/km2 (260/sq m)**

- **GEO Cordinates - 46°36’19”N 15°53’30”E**

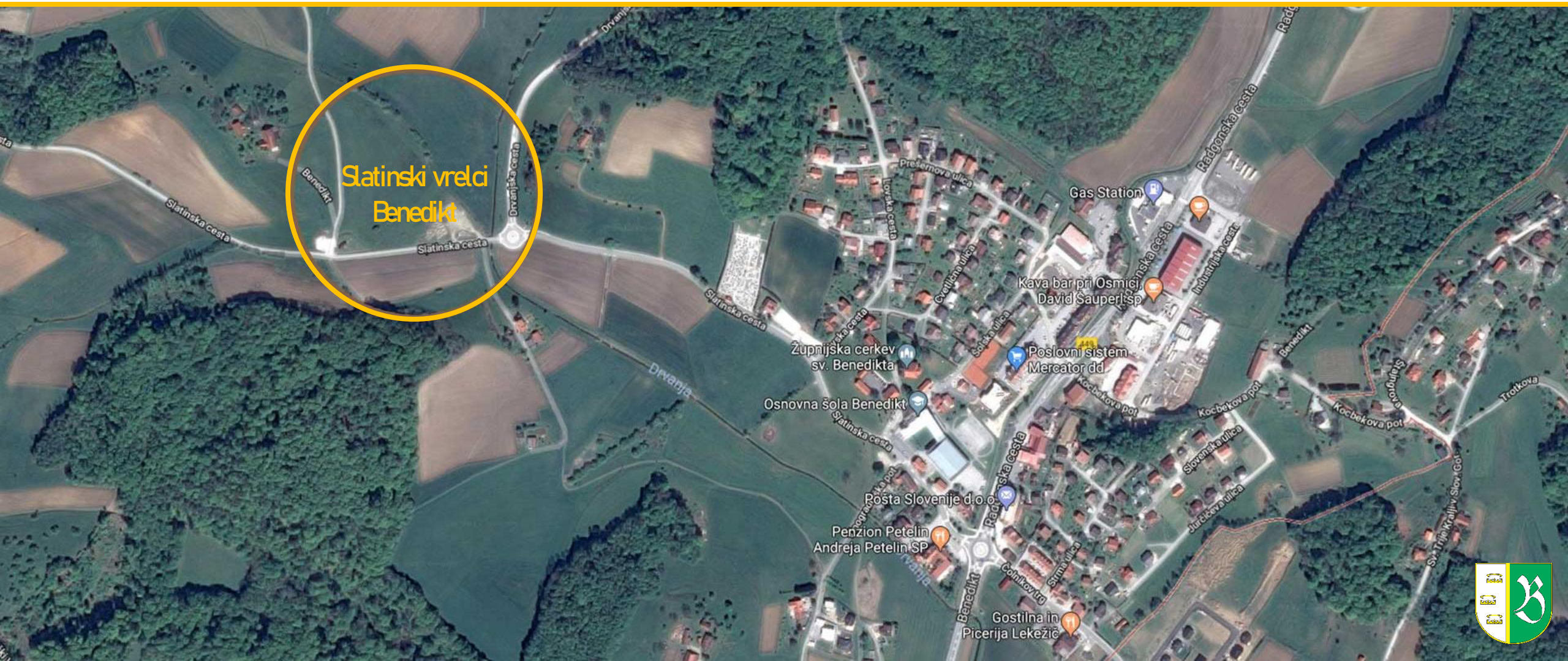
Lokacija

Cestne razdalje od Benedikta do bližnjih mest in pomembnejših središč:

- Maribor 7 km
- Ptuj 27 km
- Spielfeld 32 km
- Bad Radkersburg 13 km
- Dunaj 227 km
- Ljubljana 150 km
- Celje 80 km
- Gradec 85 km
- Hrvaška meja 40 km
- Zagreb 118 km
- Benetke 390 km



View form TOP



Geotermalna energija v Sloveniji

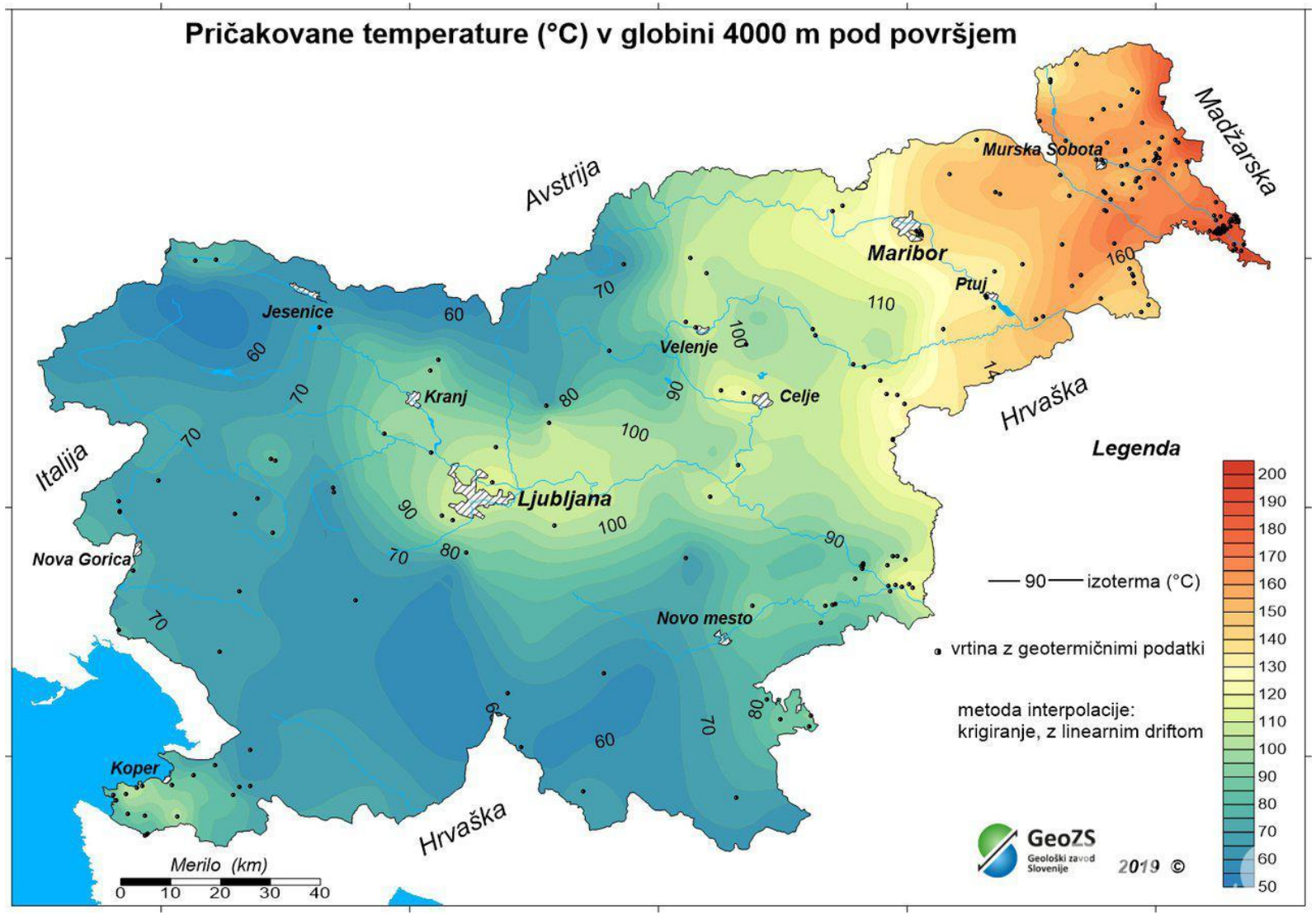


Foto: GeoZS

Geotermalna vrtina Be–2

- Lastnosti:
  - površinska temperatura: 72° C
  - pretok: 15,0 l/sekundo
  - globina 1.875 m
  - pH vrednost: 7,4 (kristalno čista)
  - ekološko neoporečna, sterilna

- Predvidena uporaba:
  - balneološki kopalni nameni (veliko pozitivnih terapevtsko rehabilitacijskih vplivov)
  - inhalacijska uporaba
  - dermatološki nameni
  - peroralna uporaba – kura
  - ogrevanje
  - agrikultura v povezavi z Apiterapijo

Foto: Aktivacija vrtine (2007) – Arhiv Občine Benedikt

Geotermalna vrtina Be-2 2007

Slatinski vrelci

Slatinski vrelec

- Lastnosti:
  - Globina vrtine: 102 m
  - pitna mineralna voda
  - pretok: 0,5 l/sekundo

- Predvidena uporaba:
  - pitje v pivnici
  - stekleničenje v 0,5 l steklenice za dodatno ponudbo
  - zdravilni učinki pri pitju

Benedikt danes

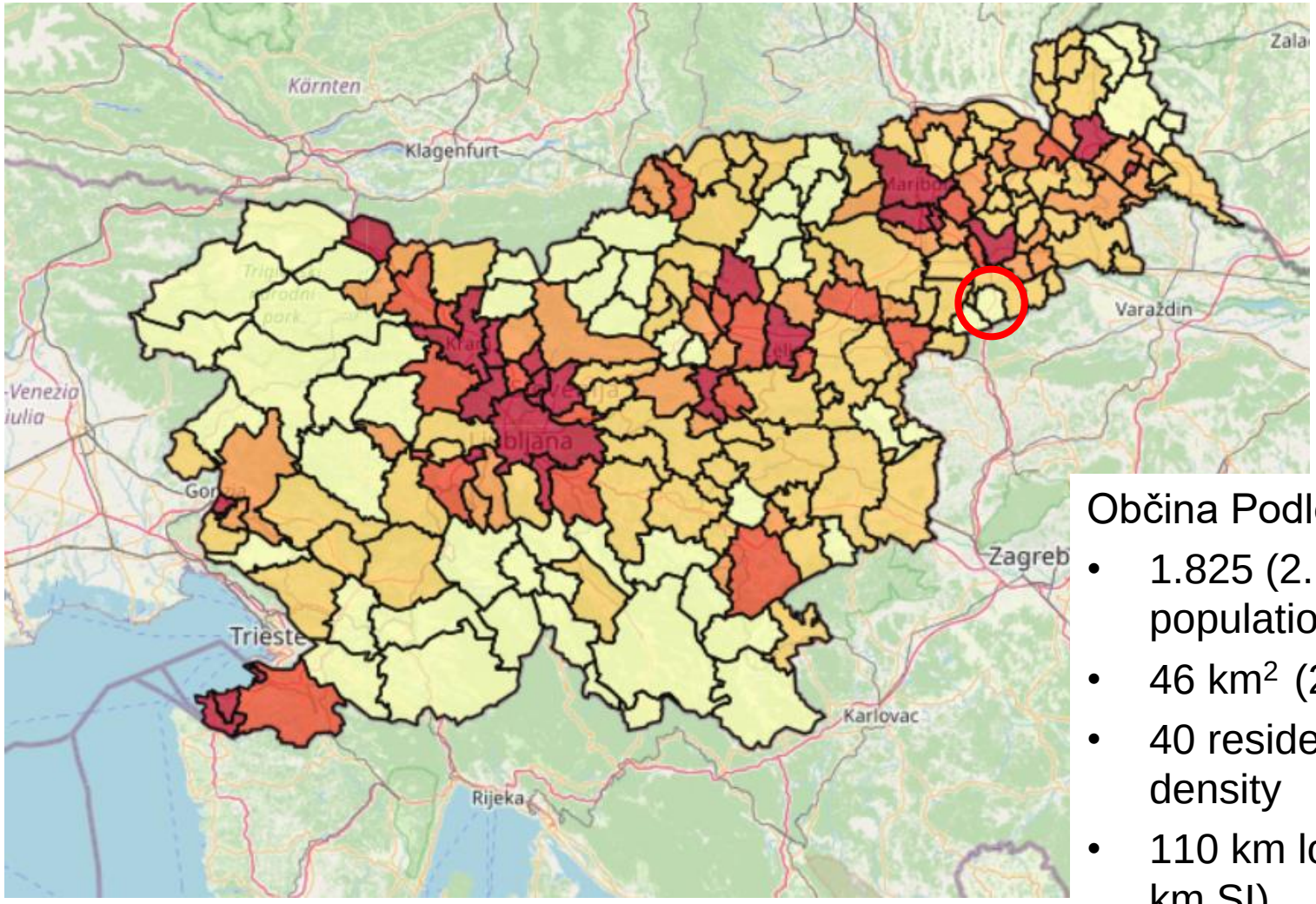
MUNICILALITY OF PODLEHNIK

Project INFO-GEOTHERMAL
Municipality of Podlehnik - Slovenia

Sebastian Toplak, Mayor

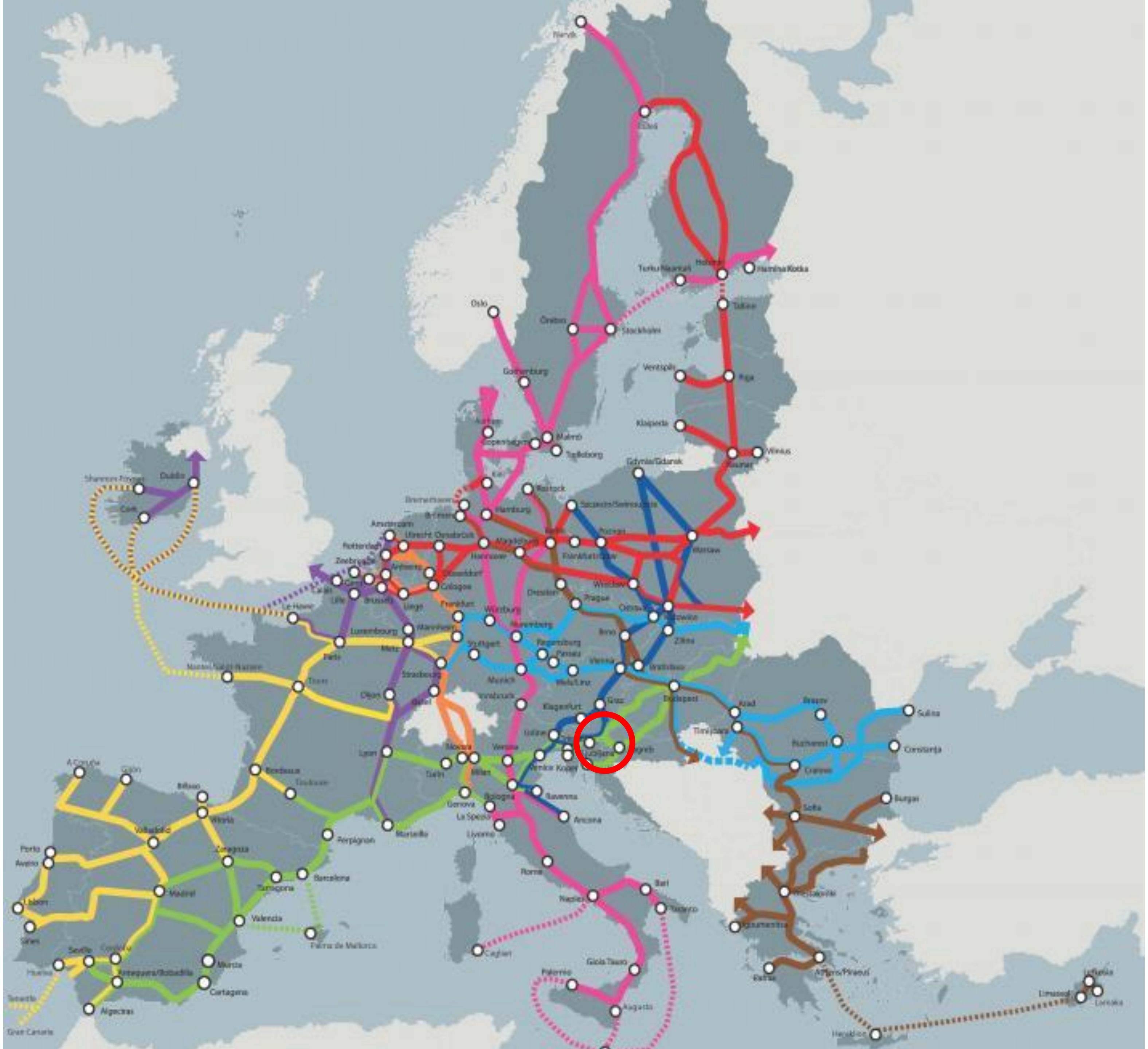
Rejkjavik, 25.10.2022

Občina Podlehnik



Občina Podlehnik:

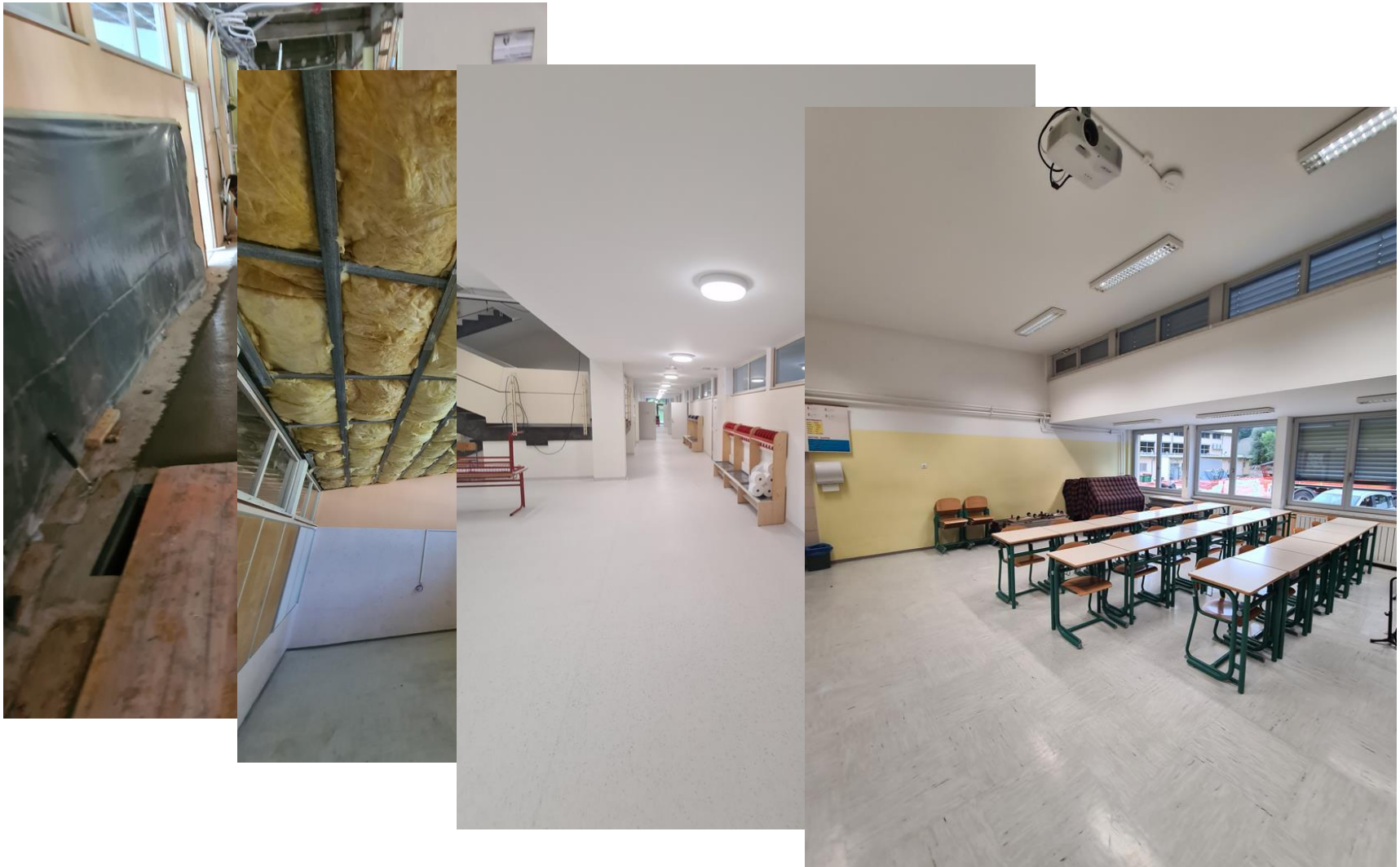
- 1.825 (2.100.126) population
- 46 km^2 (20.271) area
- 40 resident/km^2 population density
- 110 km local roads (6.541 km SI)



Narvik
Luleå
Helsinki
Hamina/Kotka
Turku/Naantali
Tallinn
Oslo
Örebro
Stockholm
Ventspils
Riga
Gothenburg
Klaipeda
Malmö
Trelleborg
Vilnius
Kaunas
Gdynia/Gdansk
Rostock
Hamburg
Bremen
Amsterdam
Rotterdam
Utrecht
Osnabrück
Hannover
Berlin
Poznan
Warsaw
Antwerp
Düsseldorf
Cologne
Brussels
Lille
Calais
Le Havre
Frankfurt
Wroclaw
Dresden
Prague
Ostrava
Katowice
Würzburg
Nuremberg
Luxembourg
Mannheim
Metz
Paris
Stuttgart
Regensburg
Brno
Zilina
Strasbourg
Munich
Vienna
Bratislava
Dijon
Basel
Nantes Saint-Nazaire
Tours
Innsbruck
Graz
Budapest
Klagenfurt
Arad
Brasov
Sulina
Udine
Ljubljana
Zagreb
Timisoara
Bucharest
Constanta
Lyon
Novara
Milan
Verona
Trieste
Koper
Craiova
Bordeaux
Toulouse
Genova
Bologna
Ravenna
Ancona
La Spezia
Livorno
Burgas
Sofia
A Coruña
Gijón
Bilbao
Vitoria
Valladolid
Zaragoza
Perpignan
Marseille
Porto
Aveiro
Barcelona
Tarragona
Rome
Bari
Thessaloniki
Madrid
Lisbon
Valencia
Naples
Taranto
Igoumenitsa
Sines
Palma de Mallorca
Cagliari
Sevilla
Murcia
Cartagena
Algeciras
Palermo
Gioia Tauro
Augusta
Patras
Athens/Piraeus
Heraklion
Limassol
Dublin
Cork
Shannon Foynes


TRANZIT
TRANSIT
EMKA

Energy reconstruction school & kindergarten (Public Private Partnership)



Replacement of the heating energy – from oil to heating pump (soil-water)

Project »Energy reconstruction«:

- Budget 0,5 mio EUR
- Private partner 51%
- Public partner 49% (Municipality – Ministry of Infrastructure)
- 15-year contract for the return of the private investment through energy savings
- Heating system (pump):
- 15 x geosounds 125 m depth
- 15°C watter temperature
- Power: 140 kW
- Space heating and sanitary water heating


Thank you for your attention !