



Photo Sigurður G. Kristinnsson

ÍSOR – ICELAND GEOSURVEY

Bjarni Richter

Head of Marketing and Business Development





Photo: Niels Girold

ÍSOR – ICELAND GEOSURVEY

- Owned by the Icelandic government.
- Provides specialized services to the Icelandic power industry, the Icelandic government and international companies.
- Operates on the free market on competitive basis.
- Profit goes exclusively into scientific research and to strengthen ÍSOR.

75 YEARS OF EXPERIENCE

- 1945 Established as a part of the State Electrical Authority.
- 1956 A Geothermal Division was formally established.
- 1967 National Energy Authority established.
- 1997 The GeoScience Division of the National Energy Authority of Iceland was established.
- 2003 Iceland GeoSurvey – ÍSOR.



Photo Guðmundur Palmason

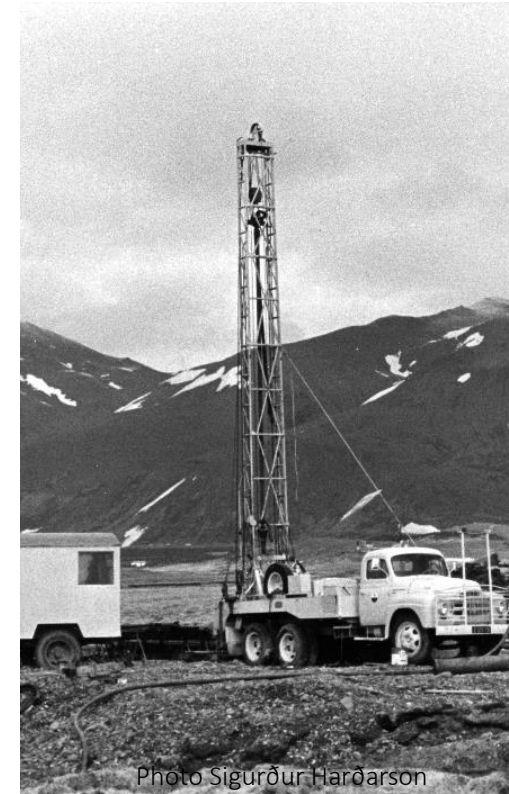


Photo Sigurður Harðarson



Photo Jón Ragnarsson



Photo Brynja Jónsdóttir

HUMAN RESOURCES

- Geologists
- Physicists & Geophysicists
- Engineers & Technologists
- Chemists & Geochemists
- Other Academic Education
- Other Education

60 Employees

SERVICES

- Geothermal exploration
- Drilling consultancy
- Well logging and mud logging
- Well testing and evaluation
- Resource assessment and management
- Due Diligence and Feasibility reports
- Geothermal training
- Groundwater and Environmental studies
- Engineering geology
- Offshore exploration
- Information technology



GEOLOGICAL EXPLORATION

- Geological mapping
- Structural mapping
- Stratigraphic mapping
- Mapping of soil temperatures
- Mapping of geothermal surface manifestations



GEOPHYSICAL EXPLORATION

- Resistivity surveys
- Seismic surveys
- Seismic monitoring
- Gravimetric measurements
- Magnetic measurements
- Surface GPS measurements



GEOCHEMICAL EXPLORATION

Sampling and analysis of

- Geothermal water, gas and steam
- Groundwater
- Cuttings/cores from wells
- Scaling and corrosion
- Rock samples



DRILLING CONSULTANCY

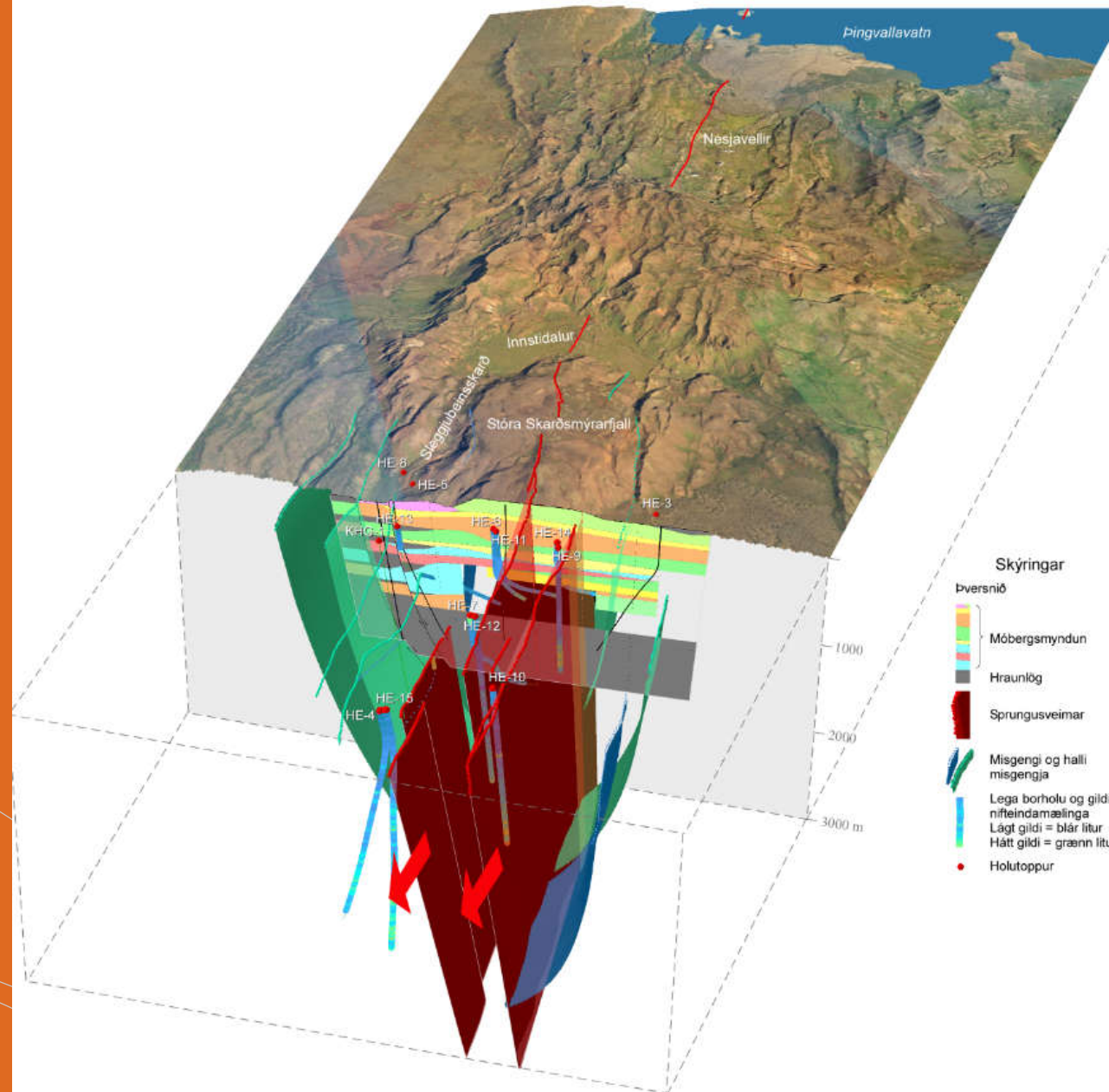
- Well siting
- Well design
- Drilling supervision
- Mud logging services
- Well logging services
- Well testing services
- On site geological consultancy
- Environmental monitoring during drilling



Photo Tobias B. Weisenberger

RESOURCE ASSESSMENT AND MANAGEMENT

- Conceptual models
- Volumetric assessment
- Geothermal system modeling
- Estimate the effects of reinjection
- Evaluation of the production
- Optimization of field development
- Reinjection research and planning
- Environmental monitoring
- Sustainability assessments



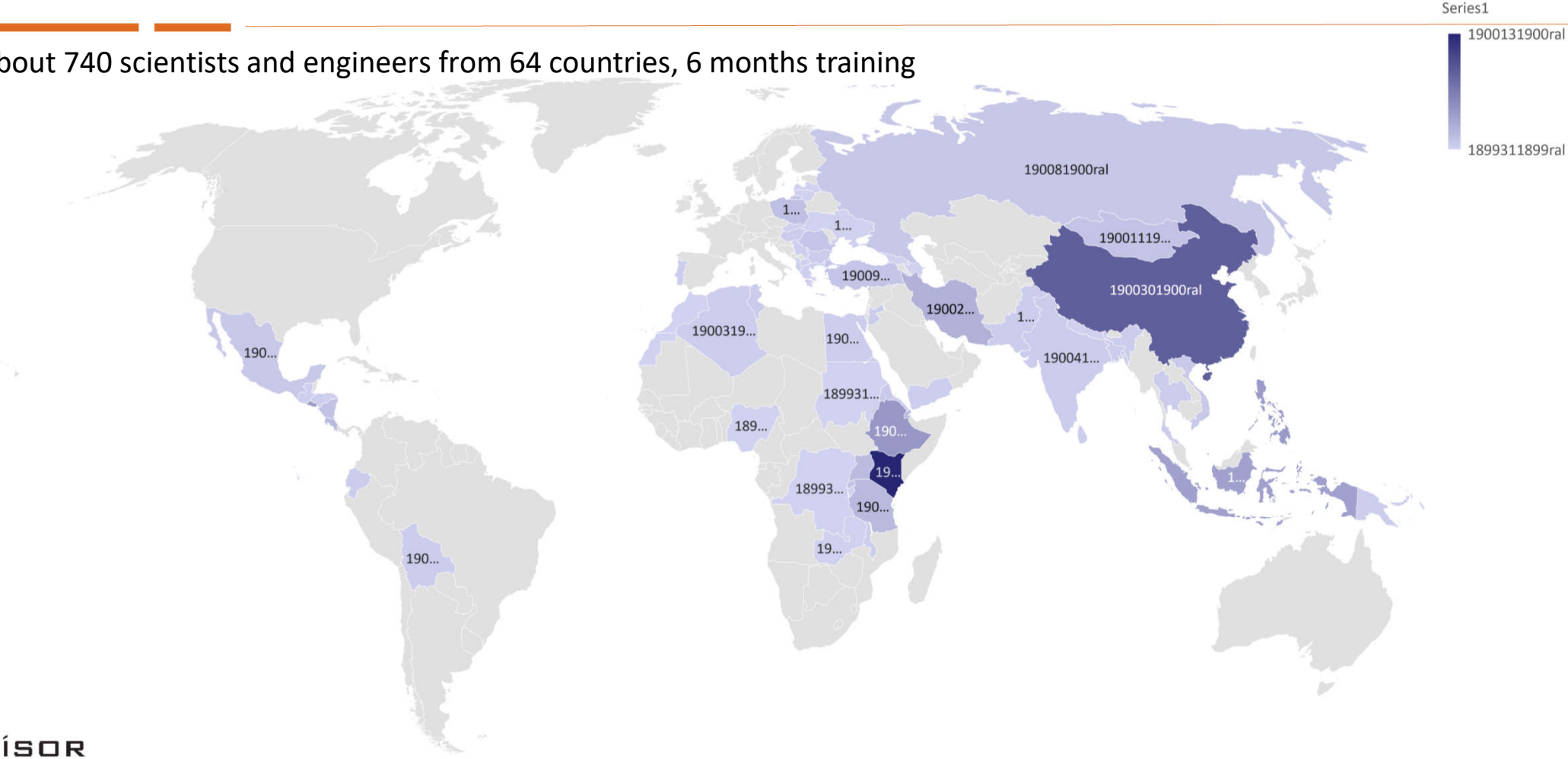
GEOHERMAL TRAINING

- United Nations University Geothermal Training Programme
- University of Iceland
- University of Reykjavík
- Iceland School of Energy (ISE)
- Keilir
- Icelandic International Development Agency (ICEIDA)



TRANSFER OF GEOTHERMAL KNOWLEDGE 1979-2021 THROUGH GRÓ-GEOTHERMAL TRAINING PROGRAM, HOSTED BY ÍSOR.

About 740 scientists and engineers from 64 countries, 6 months training



GEOTHERMAL TRAINING

Focused short courses, mainly through UNU-GTP (now UNESCO) Geothermal Training Program





GEOHERMAL DEVELOPMENT

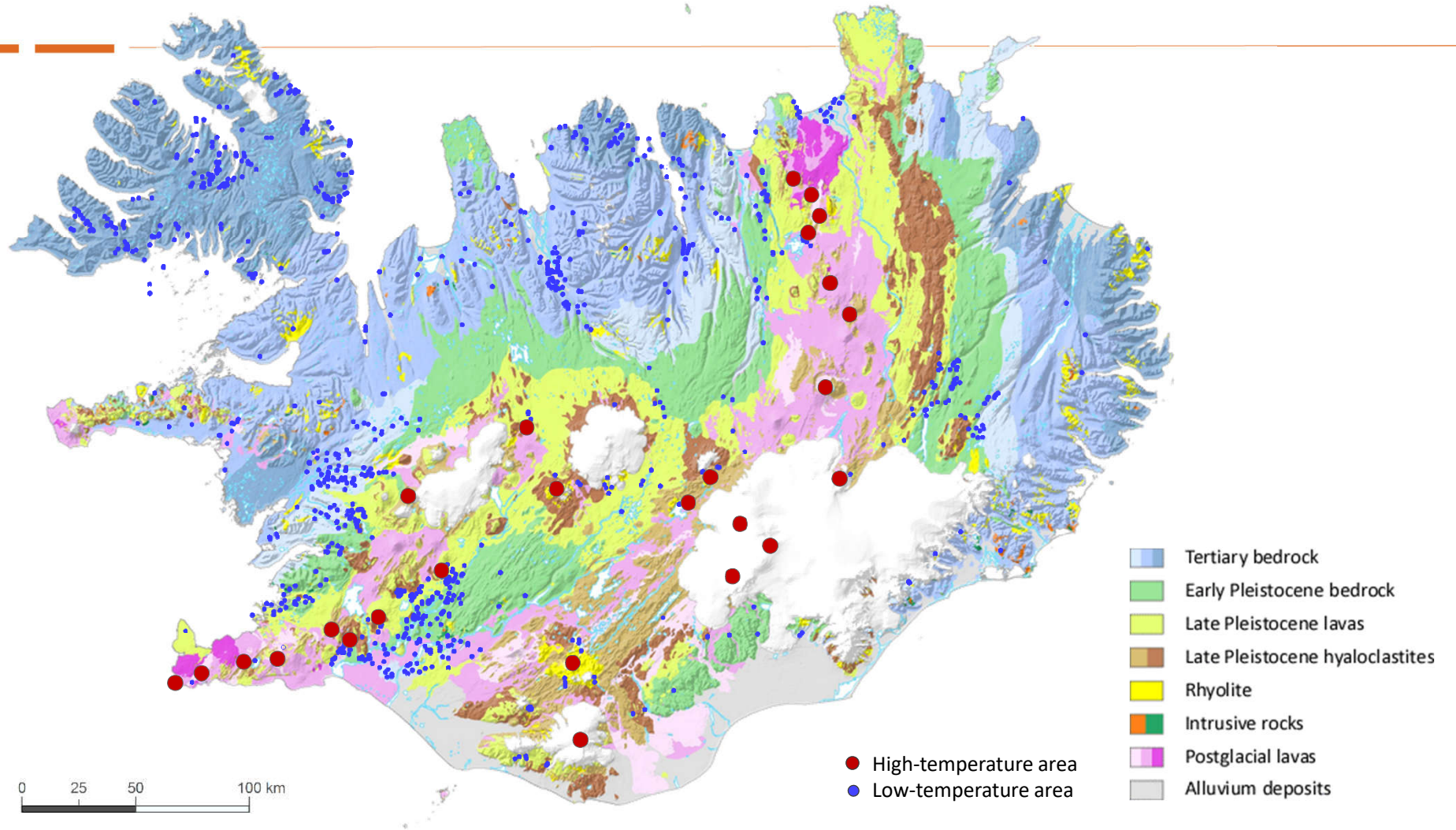
- Gathering and evaluation of existing data.
- Surface exploration and exploration drilling, Pre-feasibility report.
- Drilling and testing of add. exploration/confirmation wells.
- Concept design, EIA assessment, feasibility study.
- Detailed design, construction, drilling, supervision.
- Testing, commissioning, training.
- Operation and resource management and after considerable time, abandonment.



Photo Auður Agla Óladóttir

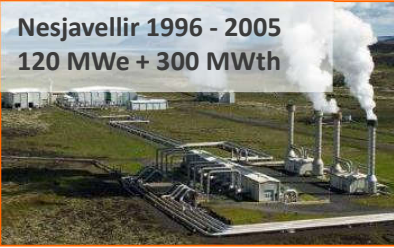
GEOHERMAL UTILIZATION IN ICELAND

GEOHERMAL MAP OF ICELAND



GEOHERMAL POWER STATIONS IN ICELAND

Nesjavellir 1996 - 2005
120 MWe + 300 MWth



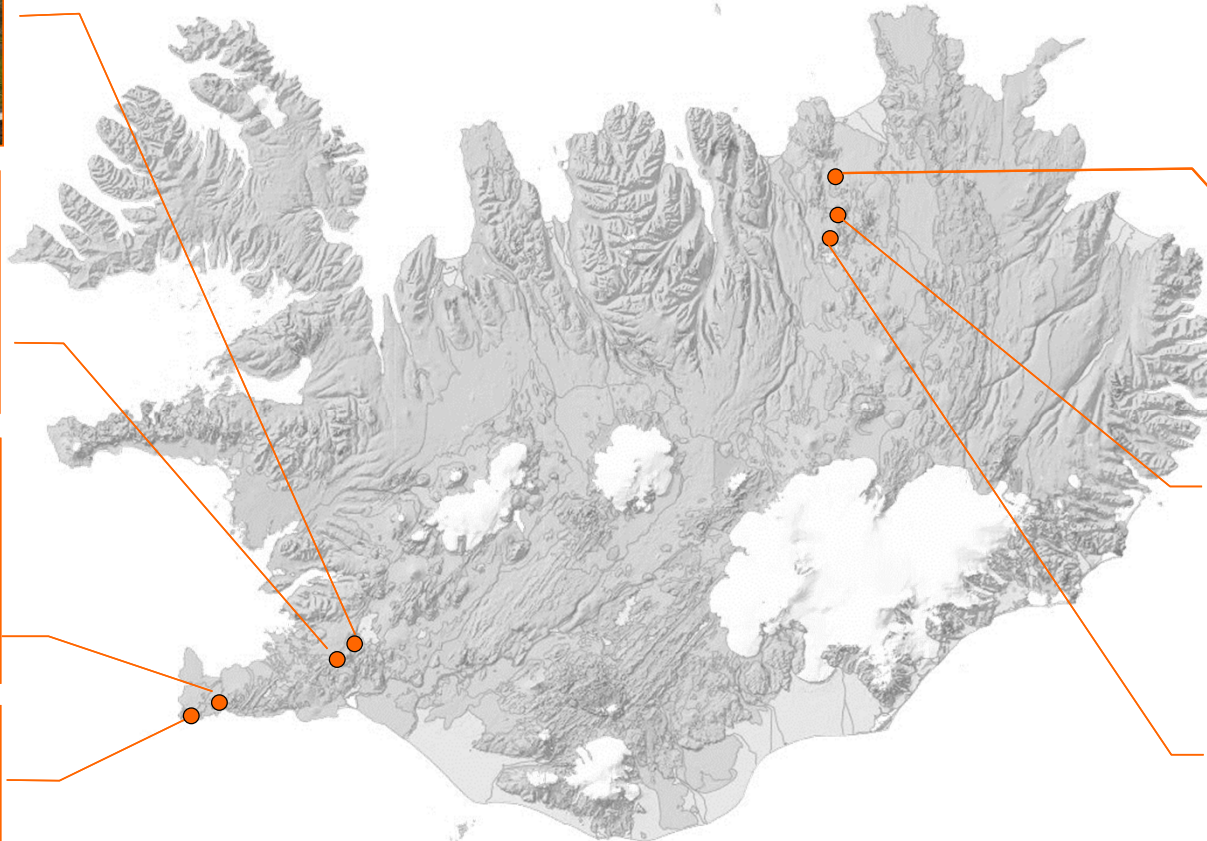
Hellisheiði 2006 - 2011
303 MWe + 133 MWth



Svartsengi 1977 - 2007
75 MWe + 190 MWth



Reykjanes 2006
100 MW

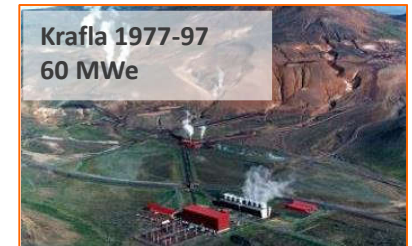


Total 753 MWe

Beistareykir 2017
90 MWe



Krafla 1977-97
60 MWe



Bjarnarflag 1969
5 MWe



ÍSOR has been a key actor in all development of geothermal power production in Iceland.

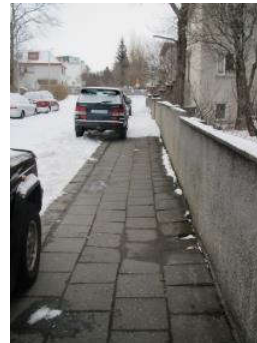


GEOHERMAL DISTRICT HEATING

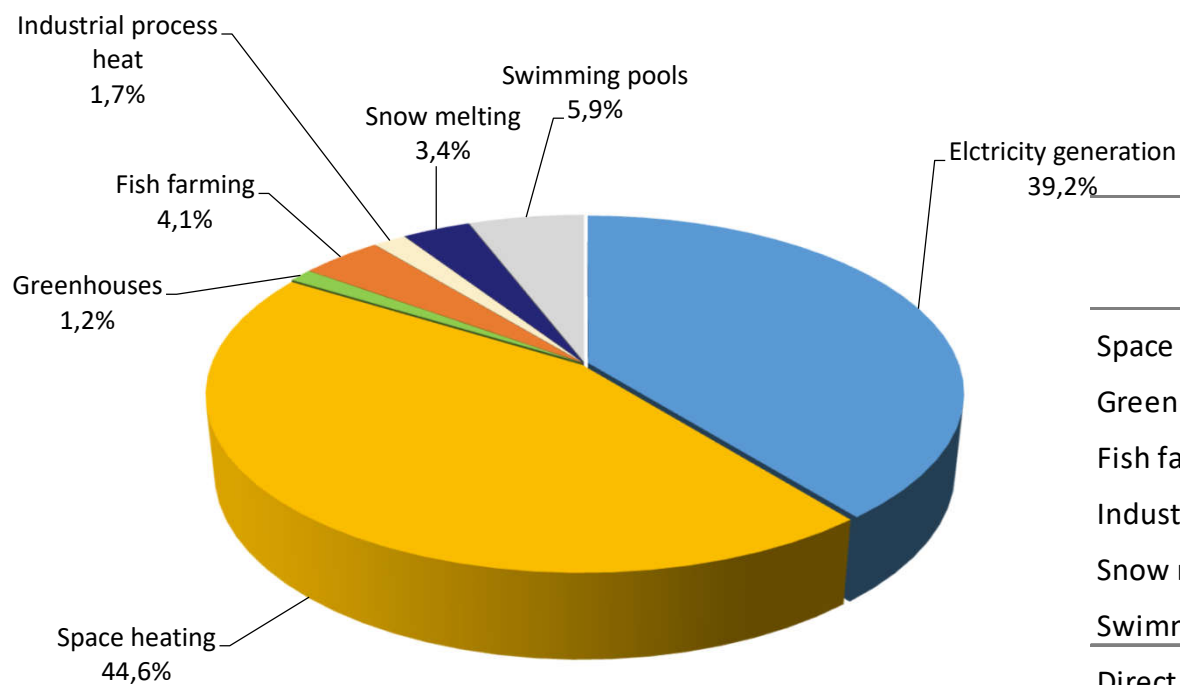
- Iceland GeoSurvey has been a key actor in all developments of district heating in Iceland.
- A few key figures for geothermal district heating systems in Iceland:
 - Reykjavik Energy: 1000 MWth
 - Húsavík: 40 MWth
 - HS Orka: 150 MWth
 - Hveragerði: 65 MWth
 - Akureyri: 80 MWth

SOME DIRECT UTILIZATION OF GEOTHERMAL ENERGY IN ICELAND

- DISTRICT HEATING – ABOUT 90% OF ALL HOUSES IN ICELAND ARE HEATED WITH GEOTHERMAL
- BATHING AND SWIMMING – SPAS AND PUBLIC SWIMMING POOLS
- AQUACULTURE, SUCH AS FISHFARMING IN REYKJANES PENINSULA
- DRYING OF FISH PRODUCTS, AND OTHER TYPES OF FOOD PROCESSING
- SALT PRODUCTION FROM SEAWATER – NORDURSALT AND SALTVERK
- SEAWEED PROCESSING PLANT AT REYKHÓLAR BY ÞÓRVERK
- AGRICULTURE, GREENHOUSE GROWING
- PRODUCTION OF METHANOL IN SVARTSENGI
- CO₂ PRODUCTION, HÆÐARENDI
- DIATOMITE PLANT AT MYVATN
- SNOW MELTING / DE-ICING



Geothermal utilization in Iceland 2019



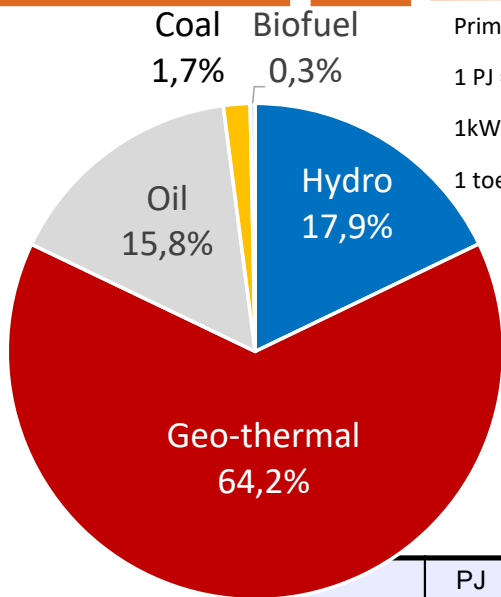
| | Energy consumption | |
|-------------------------------------|--------------------|---------------|
| | TJ/year | GWh/year |
| Space heating | 24,603 | 6,834 |
| Greenhouses | 668 | 186 |
| Fish farming | 2,264 | 629 |
| Industrial process heat | 922 | 256 |
| Snow melting | 1,889 | 525 |
| Swimming pools | 3,232 | 898 |
| Direct uses total | 33,579 | 9,328 |
| Electricity generation | 21,636 | 6,010 |
| Geothermal utilization total | 55,215 | 15,338 |

| | Installed power | |
|-------------------------------------|-----------------|--|
| | MW | |
| Space heating | 1,650 | |
| Greenhouses | 57 | |
| Fish farming | 110 | |
| Industrial process heat | 80 | |
| Snow melting | 260 | |
| Swimming pools | 210 | |
| Direct uses total | 2,367 | |
| Electricity generation | 755 | |
| Geothermal utilization total | 3,122 | |

Source: Orkustofnun

Primary energy consumption in Iceland 2019

Primary energy consumption in Iceland 1940-2019



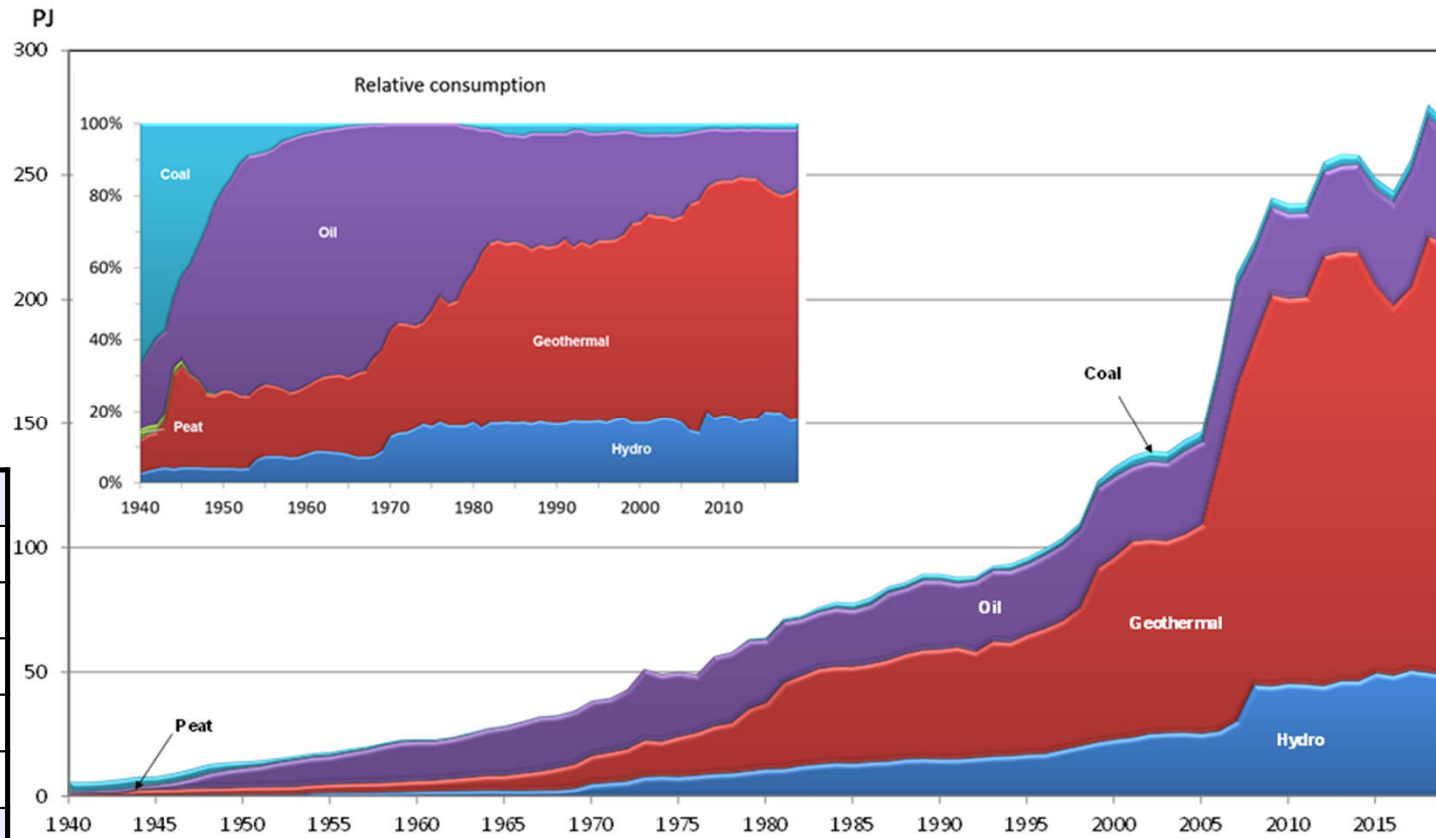
Primary energy consumption 745 GJ/capita

1 PJ = 1000 TJ = 1,000,000 GJ

1kWh = 3,600 kJ

1 toe = 41.868 GJ

| | PJ | Ktoe | % |
|--------------|--------------|--------------|------------|
| Hydropower | 48.5 | 1,158 | 17.9 |
| Geothermal | 174.5 | 4,168 | 64.2 |
| Oil | 43.0 | 1,027 | 15.8 |
| Coal | 4.7 | 112 | 1.7 |
| Biofuels | 0.9 | 21 | 0.3 |
| Total | 271.6 | 6,486 | 100 |



Source: Orkustofnun

WHY GEOTHERMAL?

- Offers Base Load Power and Heat. Will produce no matter the weather or time of day
- In almost all cases considerably more environmentally friendly than coal, oil and gas
- Direct use applications (from low temperature resources) are numerous.
For example: Green house growing, drying of food, fish farming, bathing, cooling, desalinations etc.
- House heating, with geothermal resources, is most advantageous in the northern countries
- Cascaded use of power and direct use makes sense in most cases
- Resources can be managed in a sustainable way for decades or centuries
- Due to its baseload qualities, it works well in combination with other clean, renewable energy sources

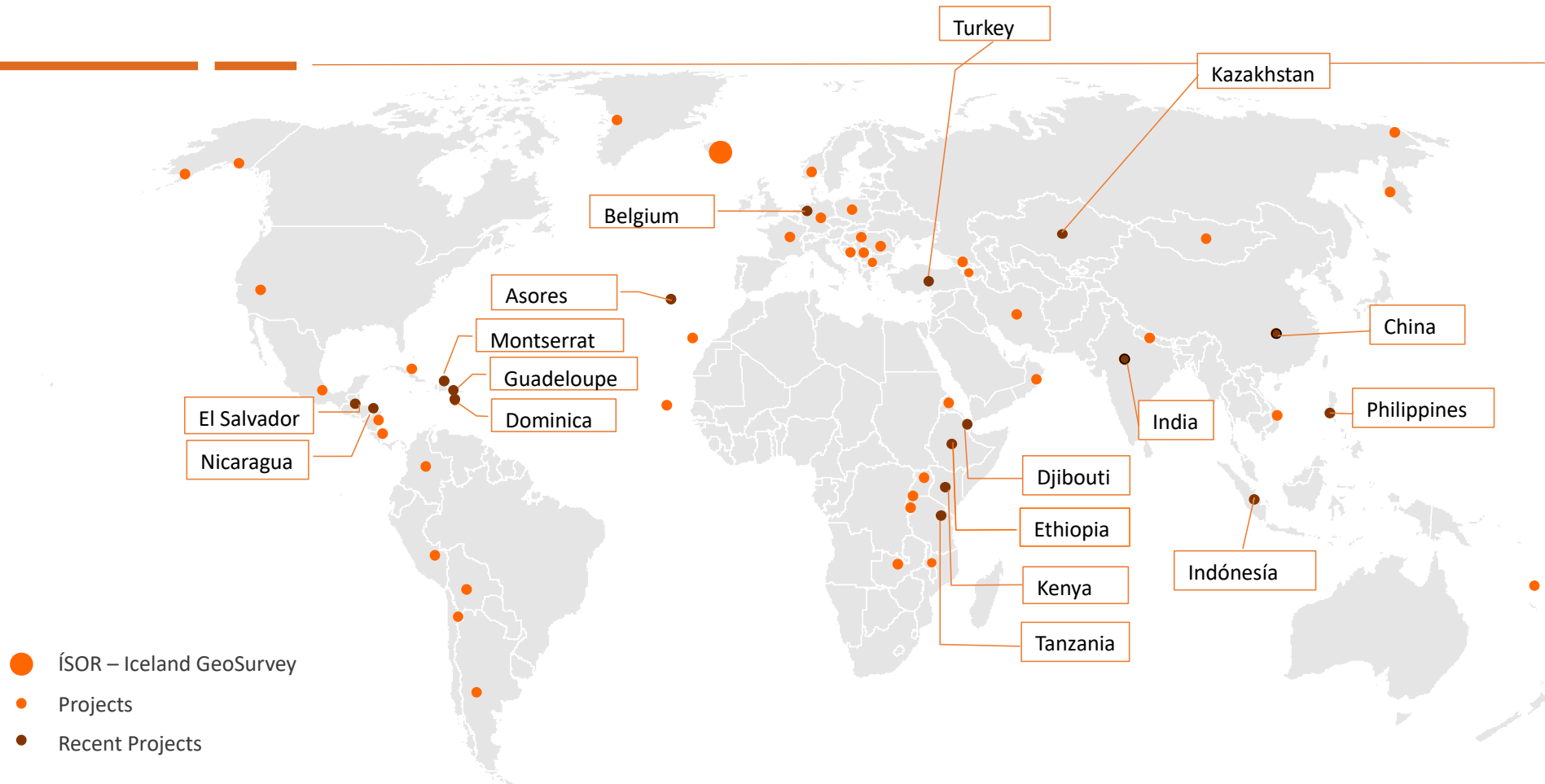


Photo Gylfi Páll Hersir

INTERNATIONAL ACTIVITIES

Geothermal experience

ÍSOR PROJECTS AROUND THE WORLD



SOME ÍSOR PROJECTS IN EUROPE

Often in co-operation with other Icelandic companies

Sao Miguel and Terceira, Azores Islands (Portugal)

- Flow testing of wells and recommendations for further development
- Conceptual modelling
- Siting and design of wells
- Power plant consultation
- Geothermal training

Holland, Belgium

- Well logging and reservoir consultation

Germany

- Well siting
- Consultation on geothermal development and resource assessment in Molasse
- Due Diligence

France

Rheingraben and Guadeloupe

- Monitoring of flow test, evaluation of flow data, Tracer Flow Measurements (TFT), Stimulation
- Monitoring of temperature and pressure changes in the reservoir Study of well integrity (calcite scaling and/or casing problems)

Turkey

- Consultation for World Bank in promoting exploration drilling
- Consultation for Turkish Developing Bank on exploration drilling
- Flow testing and interference testing
- Exploration consultation in several areas
- Consultation on development and resources
- Due diligence and feasibility studies

SOME ÍSOR PROJECTS IN AFRICA

Often in co-operation with other Icelandic companies

Kenya

- Several training workshops, including fieldwork
- Update on Olkaria resource estimate
- Assisting GDC on Geothermal Center of Excellence, through ICEIDA
- Surface exploration and processing of data
- Exploration management
- Well siting and design
- General geothermal consulting
- Project review work
- Geothermal training
- Due diligence and feasibility

Ethiopia

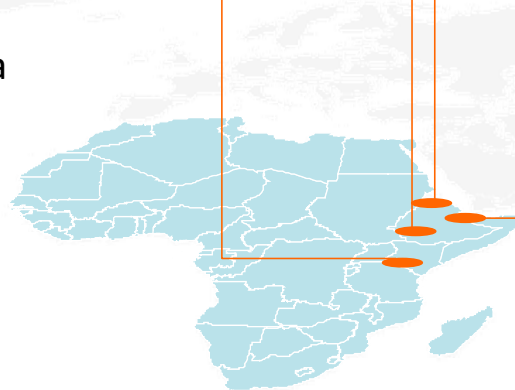
- Assisting local government in tendering out concessions
- Surface exploration, conceptual modelling and resource assessment
- Developing geothermal areas
- Due diligence

Eritrea

- Surface exploration in the Alid area

Djibouti

- Surface exploration
- Assisting local government in development through ICEIDA
- Geothermal consultation
- Project review work
- Geothermal training



SOME ÍSOR PROJECTS IN LATIN AMERICA AND ASIA

Often in co-operation with other Icelandic companies

Chile

- Reconnaissance work in several areas
- Surface exploration
- Assistance in setting up PM system
- Assisting in acquiring concessions and planning for exploration and drilling
- Targeting of exploration well, well design, drilling program and drilling supervision
- Training of experts for public and private sector

Dominica

- Well design, drilling program
- Mudlogging, well logging and geological consultation
- Testing of wells and assessment
- Environmental monitoring during drilling
- Training of experts for public and private sector
- Due diligence

China

- District heating
- Reservoir assessment
- Training of experts for public and private sector

Philippines


- Surface exploration and well siting
- Drilling consultation
- Development of geothermal areas
- Project review work
- Geothermal training

Indonesia

- Development of geothermal areas
- Project review work
- Well siting
- Geothermal training

THE ENVIRONMENTAL BENEFIT

**Before geothermal space heating:
Reykjavik in 1933 covered with smoke from
coal heating.**



**With geothermal space heating:
Reykjavik in 2008, almost same view
but without visible air pollution.**



Photo Sigurður G. Kristinsson

THANK YOU



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