



Geothermal direct use, with a focus on agriculture and agro-industry sectors.

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Uses of Geothermal Energy in Food and Agriculture

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Food and Agriculture
Organization of the
United Nations



**Uses of
geothermal
energy
in food and
agriculture**

**Opportunities
for developing
countries**

Locations of the main geothermal operations around the world



Iceland

Italy

United States of America

Mexico

Central America

Ethiopia

Kenya

China

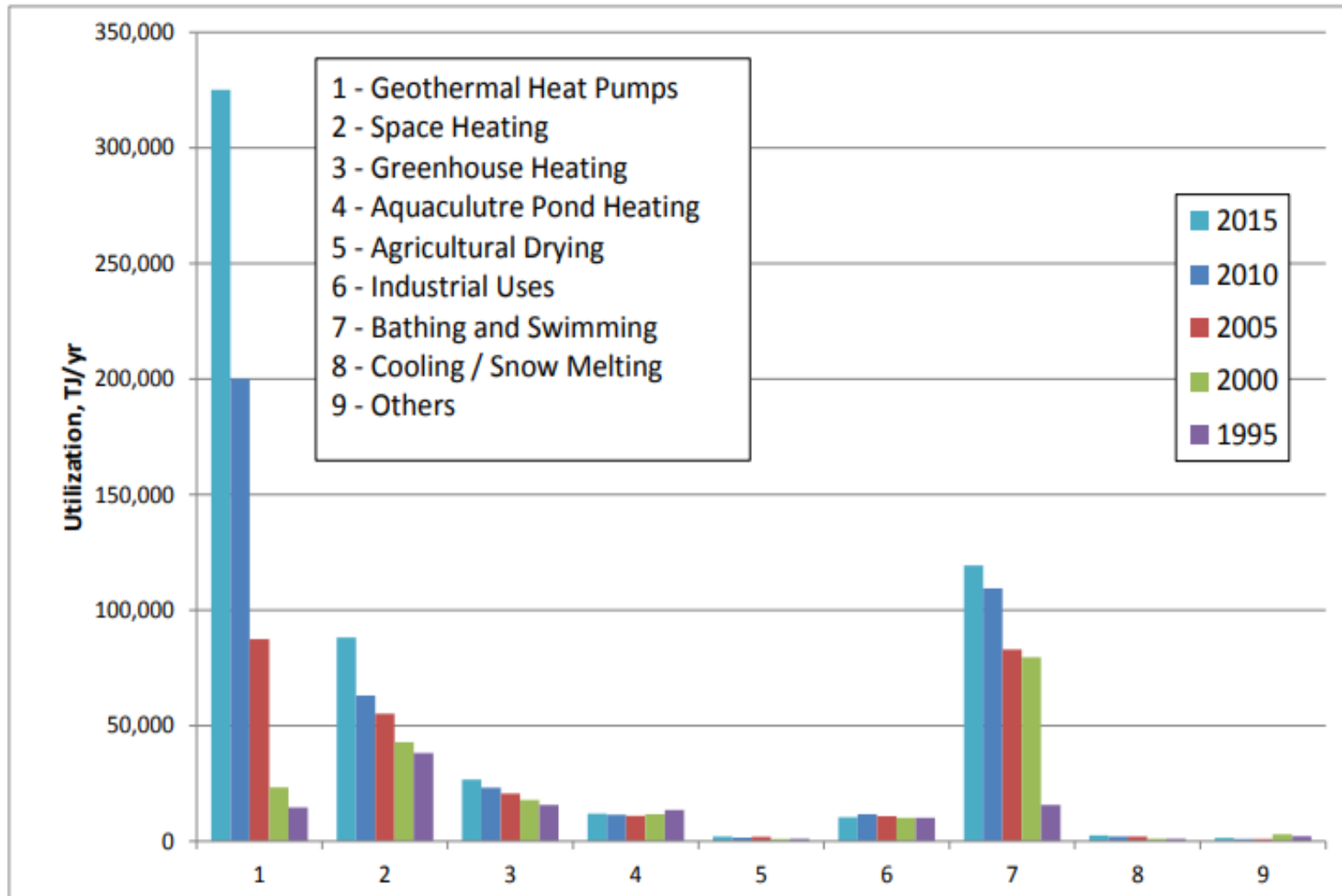
Japan

Philippines

Indonesia

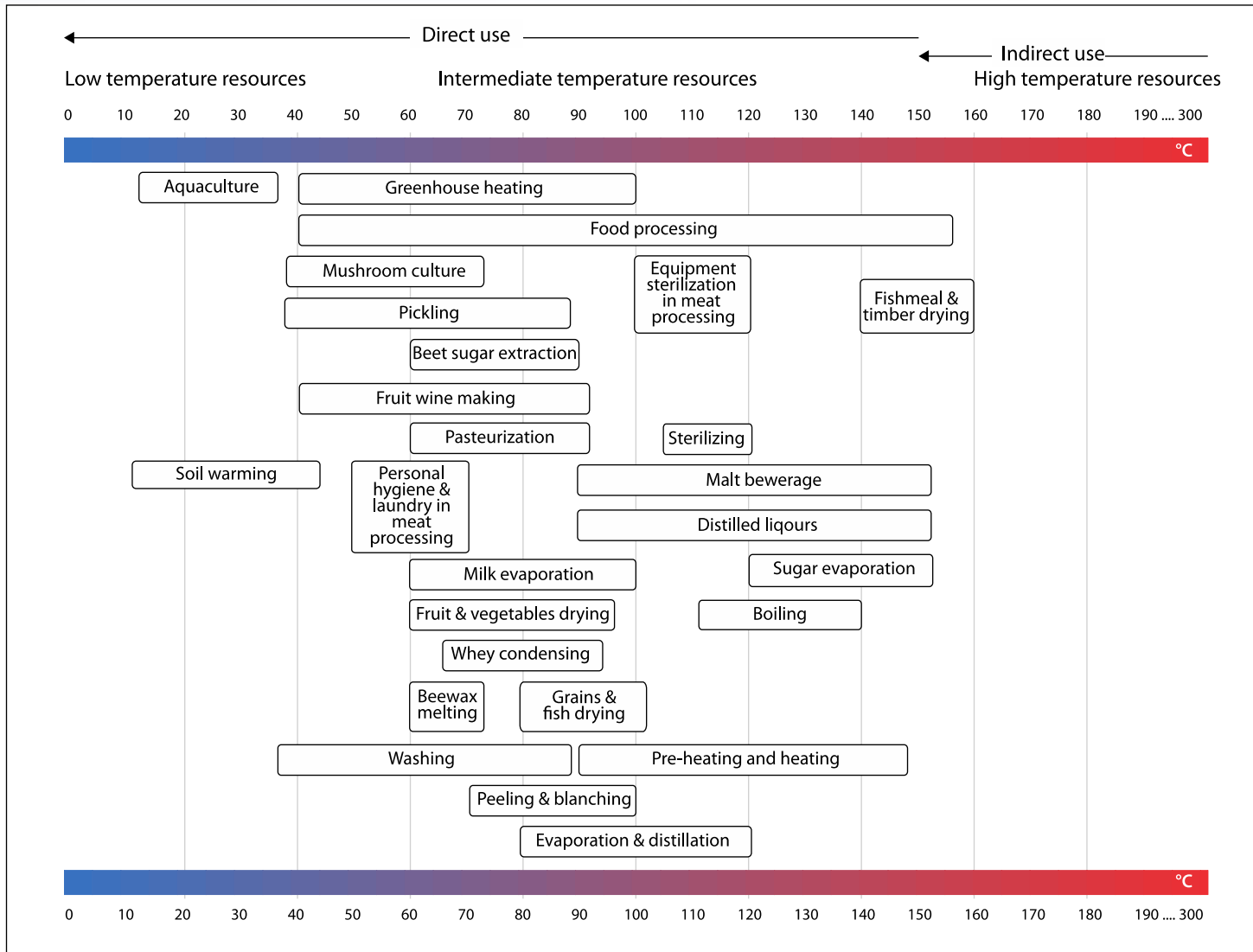
New Zealand

Comparison of worldwide direct-use of geothermal energy in TJ/yr

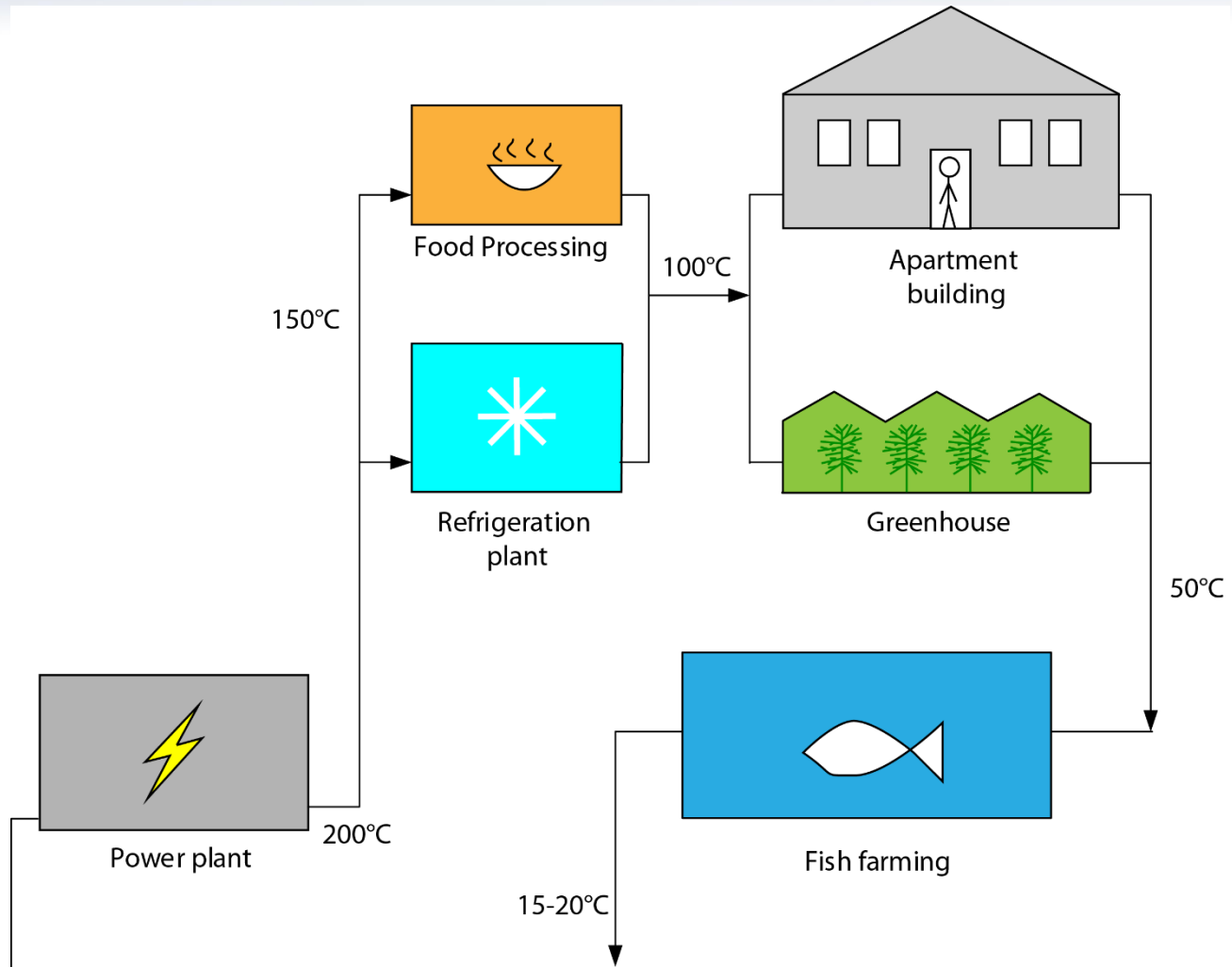


Examples of direct uses at different temperatures.





Cascading from a geothermal power plant



Tomatoes loaded on drying racks in Greece

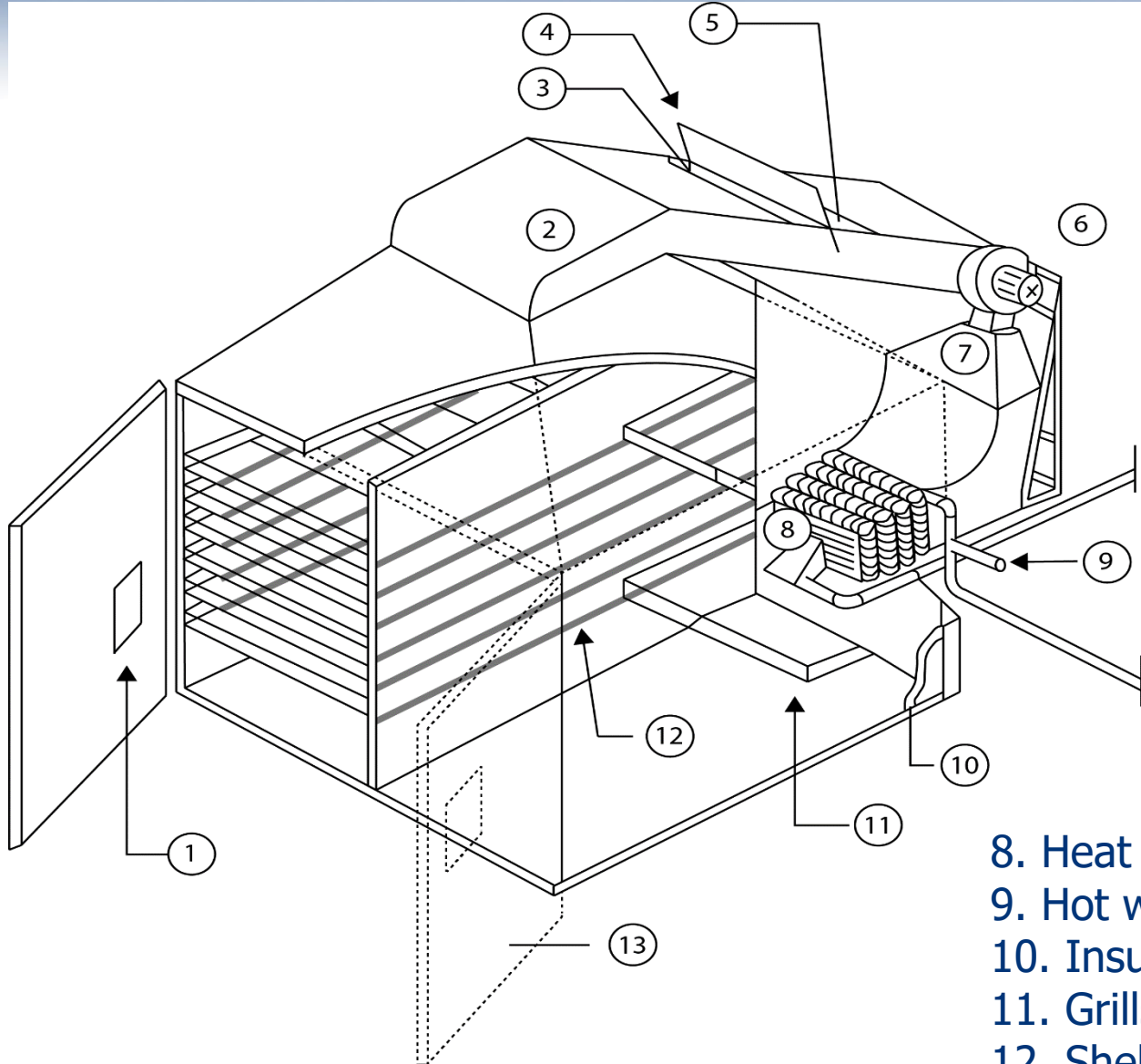


Pilot-scale cotton dryer using geothermal energy in Greece



© Nikos Andritsos

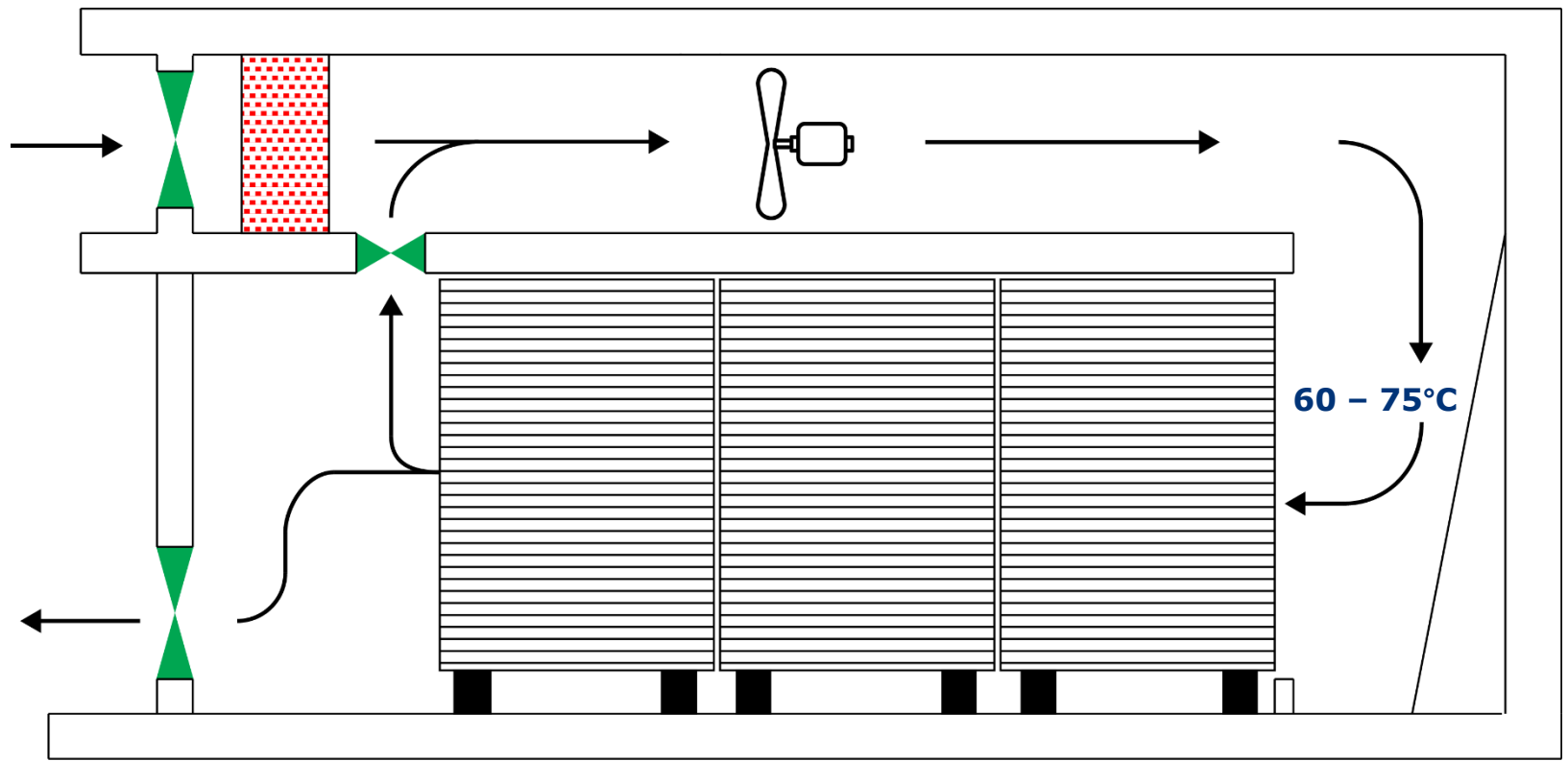
Cabinet dryer for drying chilies and garlic



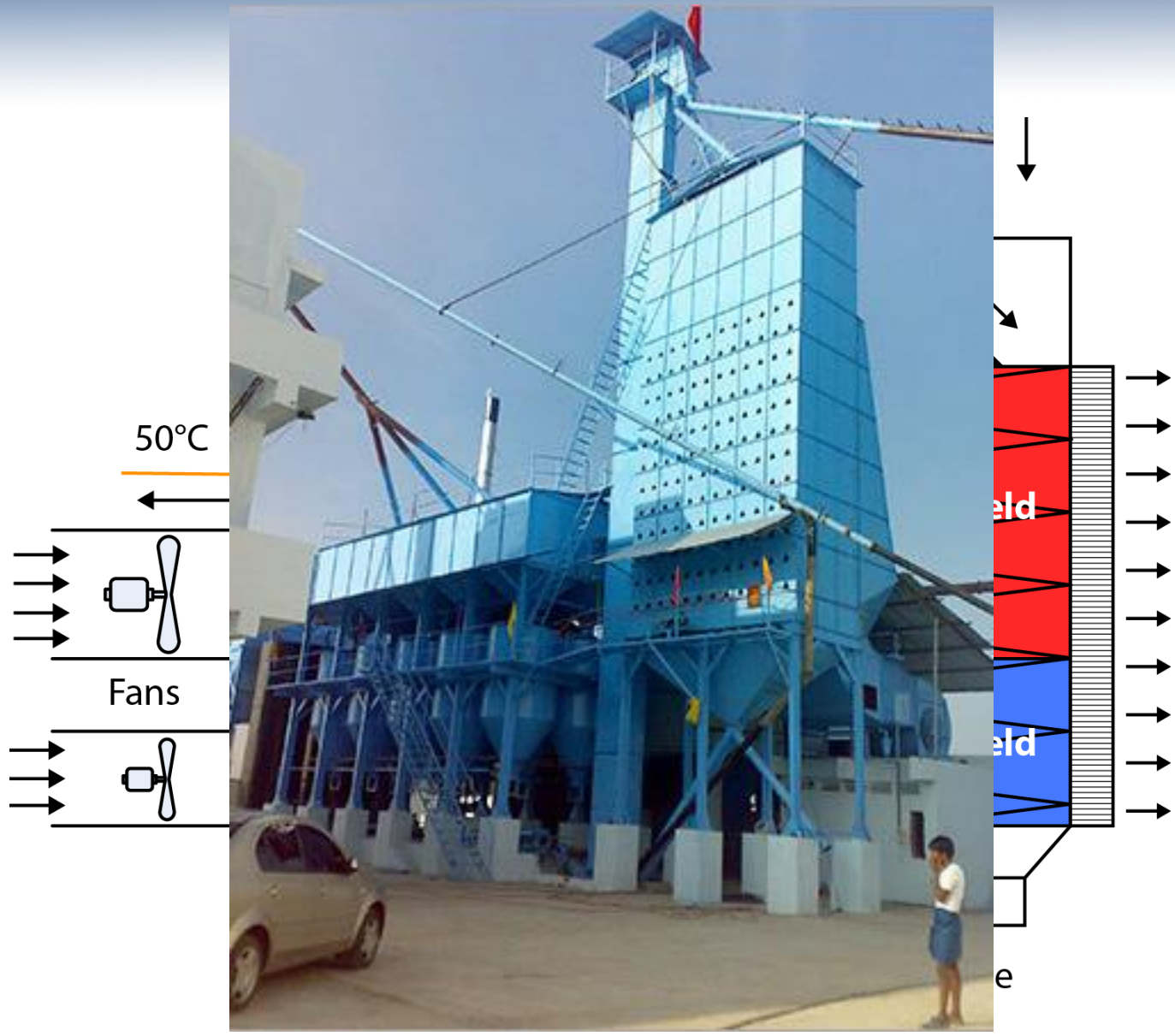
- 1. Window
- 2. Return air duct
- 3. Exhaust opening
- 4. Valve
- 5. Inlet
- 6. Centrifugal fan
- 7. Air duct

- 8. Heat exchanger using hot water
- 9. Hot water tap
- 10. Insulated walls
- 11. Grills
- 12. Shelf for putting grill
- 13. Door

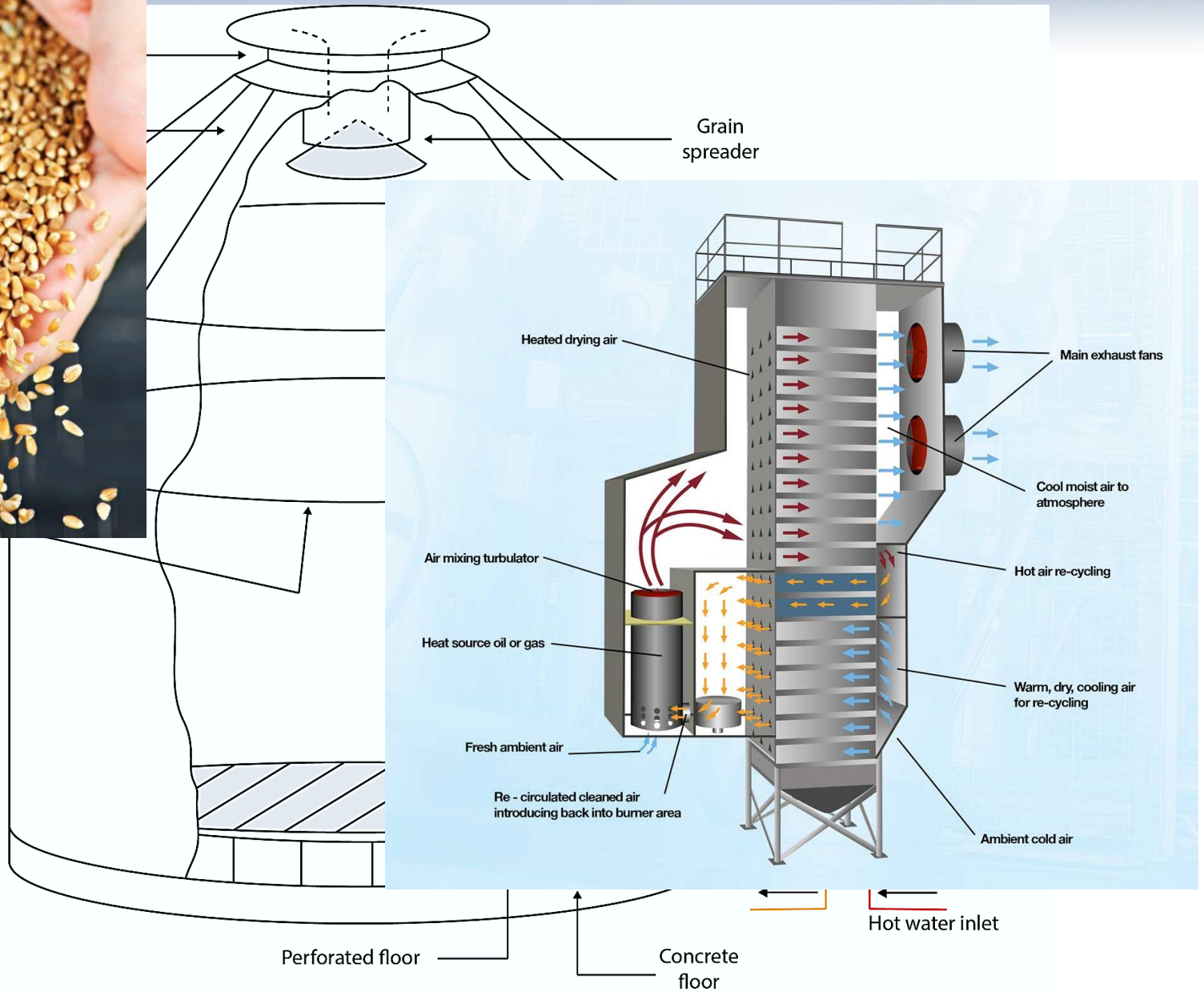
Fruit dryer using geothermal energy in Los Azufres, Mexico



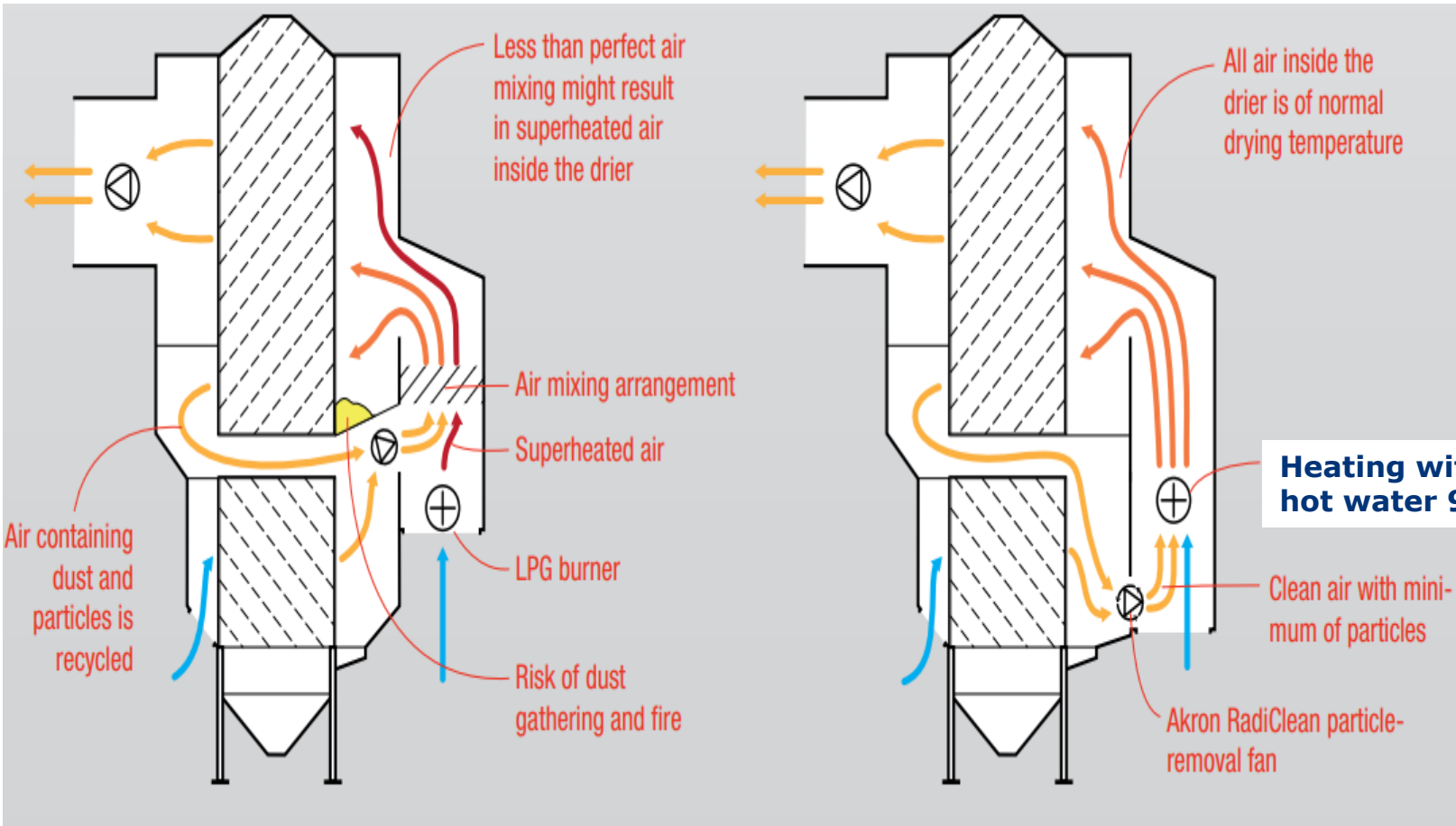
Convective geothermal rice dryer



Batch grain dryer using geothermal energy



Changing from fossil fuel to geothermal energy

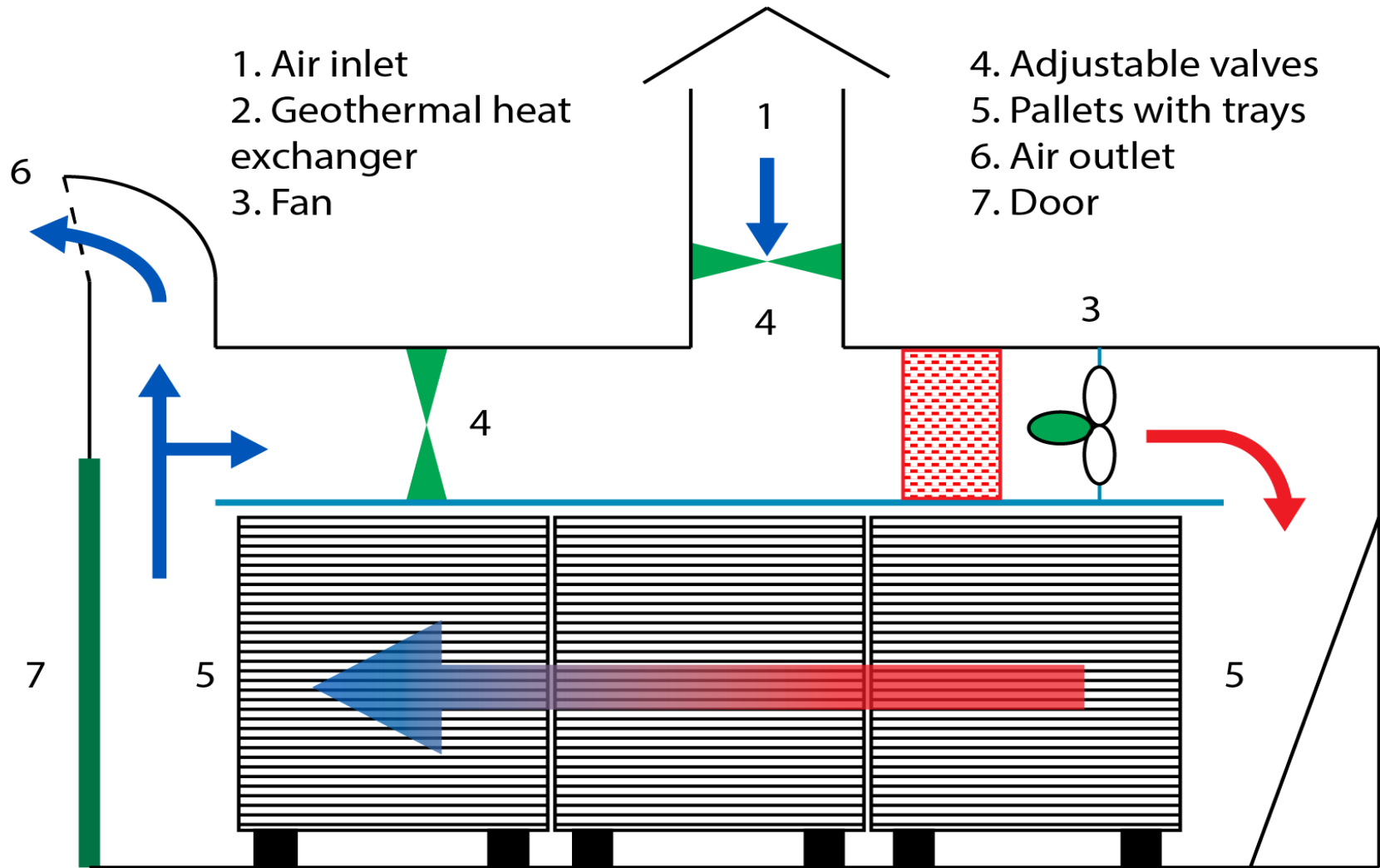


The developing indoor drying of fish in Iceland

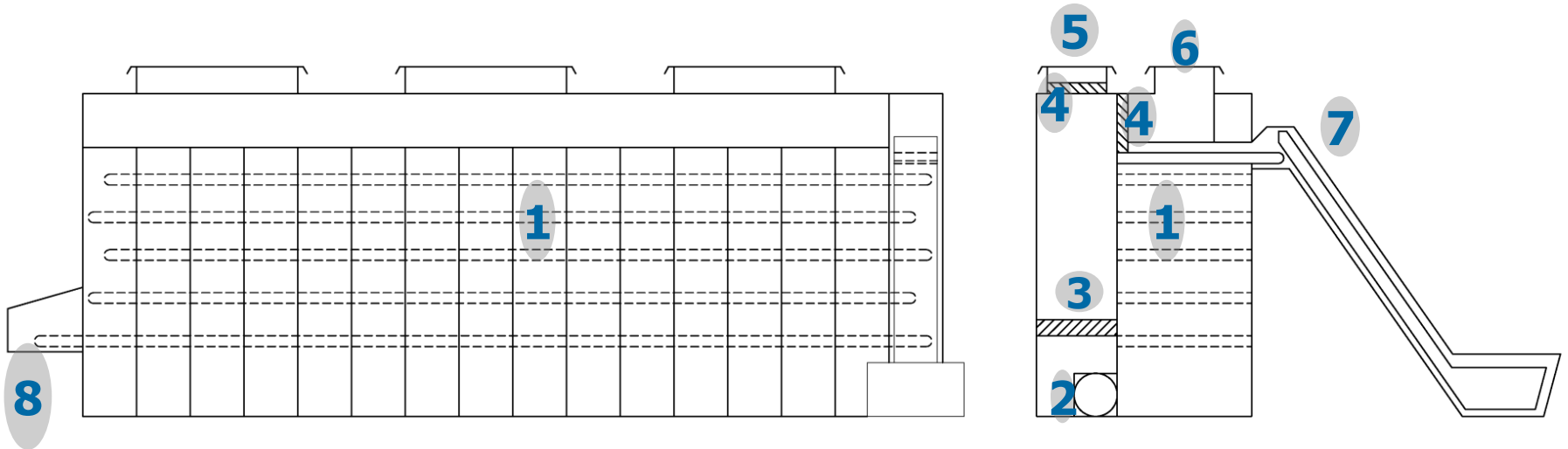


- **The first companies in this field were founded 40 years ago and now there are twelve companies with around 100 big dryers.**
- **In the fishing industry, geothermal energy has mainly been applied to indoor drying of cod heads, small fish, stock fish, salted fish, seaweed and other products.**

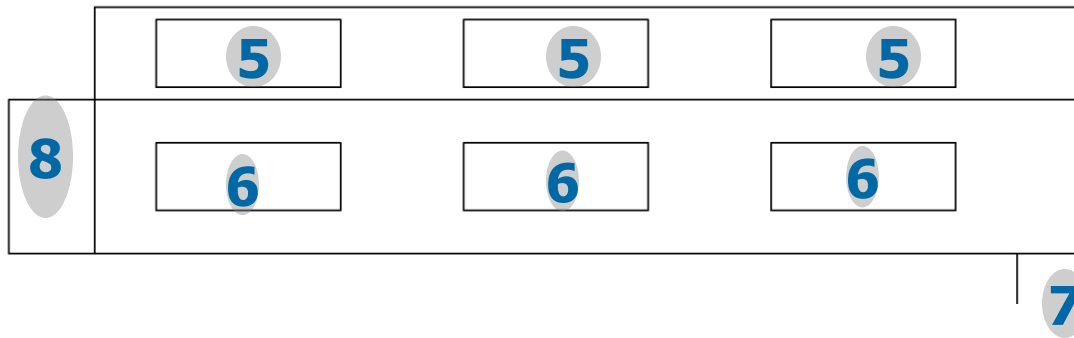
Tunnel dryer using geothermal energy for fish drying



Continues conveyor dryer for primary drying of fish cuts



4



- 1 Conveyor**
- 2 Blower**
- 3 Heater**
- 4. Adjustable valves**
- 5. Air inlet**
- 6. Air outlet**
- 7. Feeding conveyor**
- 8. Product**







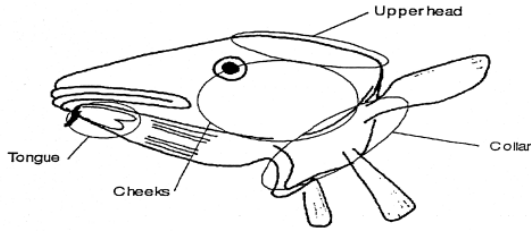
29/06/2012



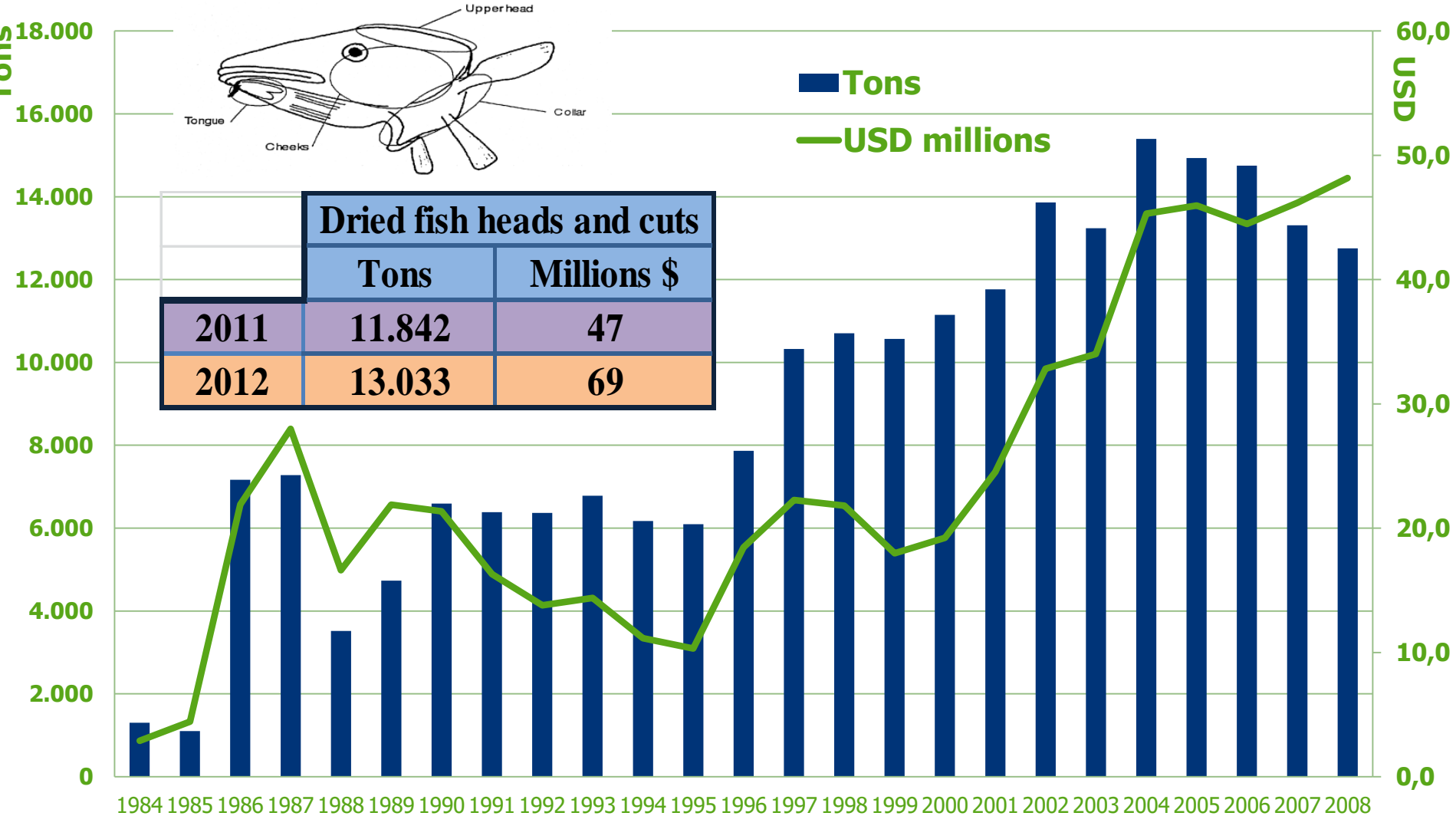


Dried fish byproducts

Export of dried fish byproducts from Iceland 1984-2008



Dried fish heads and cuts		
	Tons	Millions \$
2011	11.842	47
2012	13.033	69



Source: Hagstofa Íslands

Tomato cultivation in a greenhouse in Iceland



Cucumber cultivation in a greenhouse in Iceland



ORF Genetics Ltd. is a global leader in the manufacturing of plant-made recombinant proteins in Greenhouse.



Endotoxin-free Growth Factor – Paradigm Shift



ORF Genetics offer stem cell research high-grade, animal free and endotoxin free growth factors under the ISOkin[™] brand.

BIOEFFECT[®] is Icelandic skin care brand, based on 10 years of biotechnology research by ORF Genetics.



Raceway pond for cultivation of spirulina using geothermal energy in Nigrita, Greece



Water flow and temperature

Power Station HS ORKA

Installed capacity of 100 MW



HS ORKA	
T (°C)	55
Flow (l/s)	3200

Hot water outflow - lost energy



Cooling water 35°C



PIPE TO SSF	
T (°C)	35
Flow (l/s)	2000

Cold water wells



SSF WELLS	
T _a (°C)	9
Flow (l/s)	2000

SSF MIX	
T (°C)	22
Flow (l/s)	4000

Senegalese sole

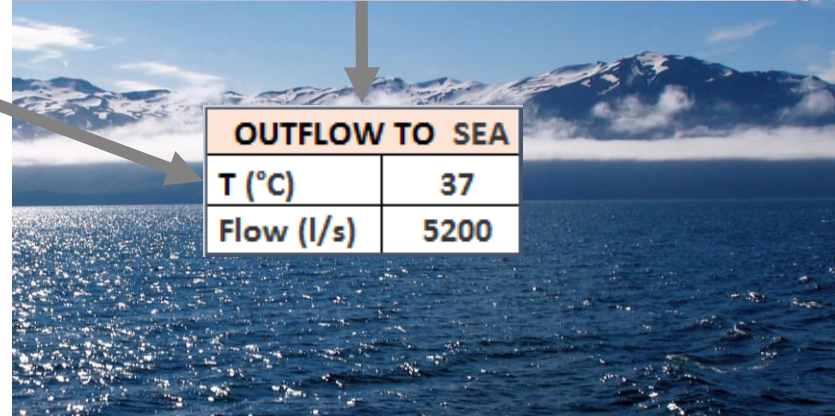


Natural distribution of Senegalese sole

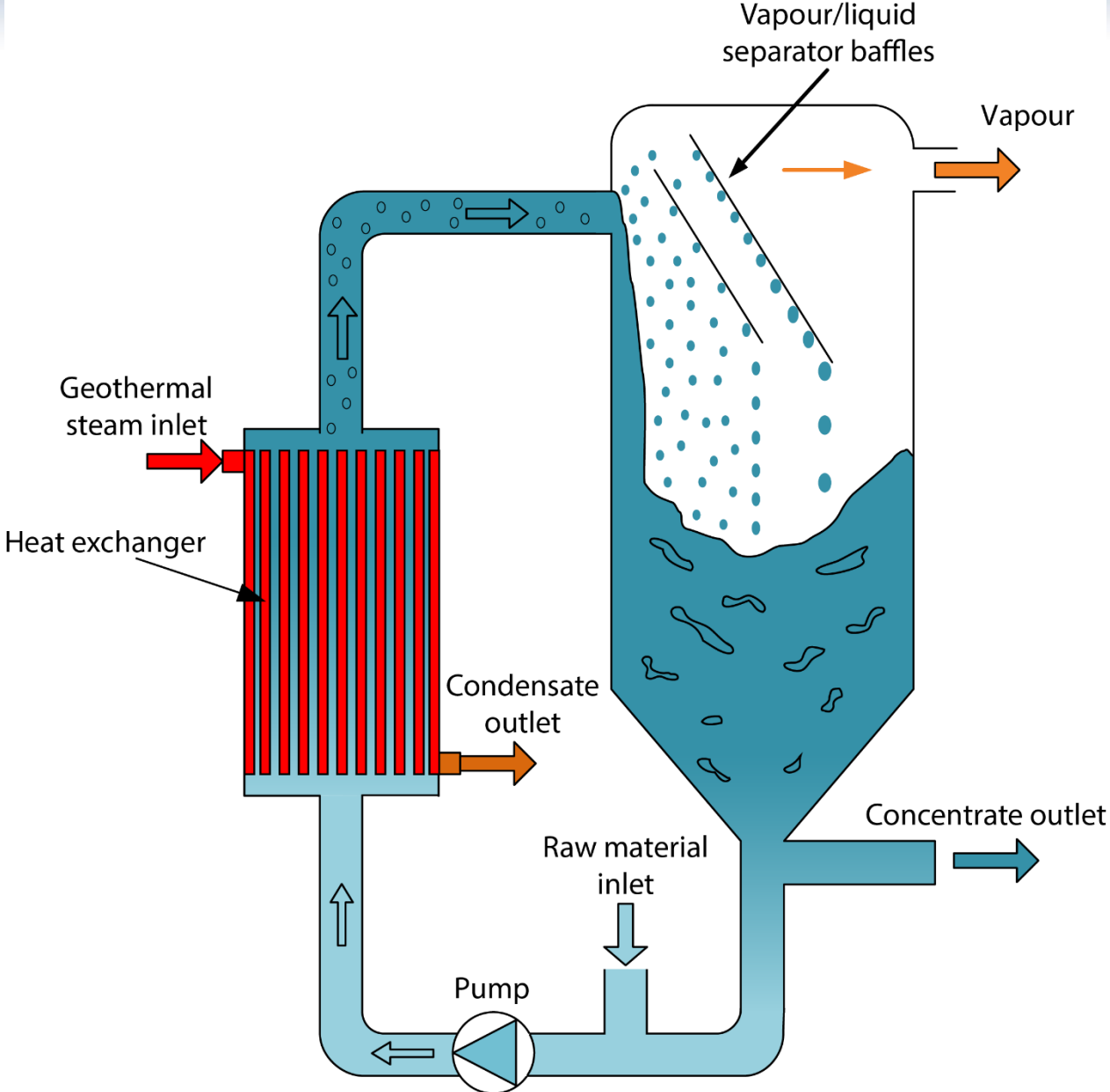


SSF=Stolt Sea Farm

OUTFLOW TO SEA	
T (°C)	37
Flow (l/s)	5200



Evaporator

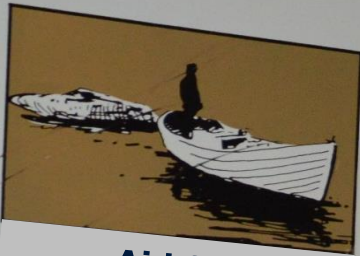


Thorverk Iceland





Seaweed harvest



Aid for seaweed harvest



Transport of seaweed



Landing



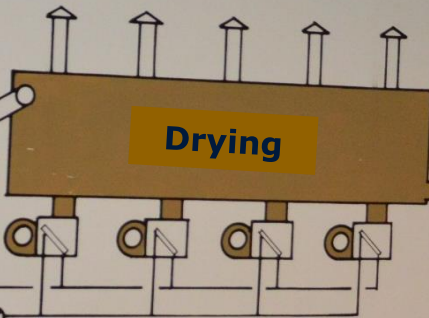
Transport to the factory



Feeding in process



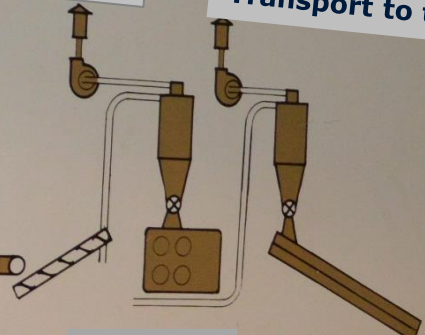
Chopping



Drying

Geothermal energy

112°C.



Milling

Sieving



Storage tank



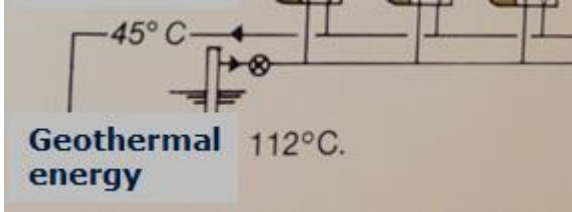
Weighing, packaging



Storage



Export



Waste energy (45-65°C)



Evaporation



Crystallization Washing



Harvesting



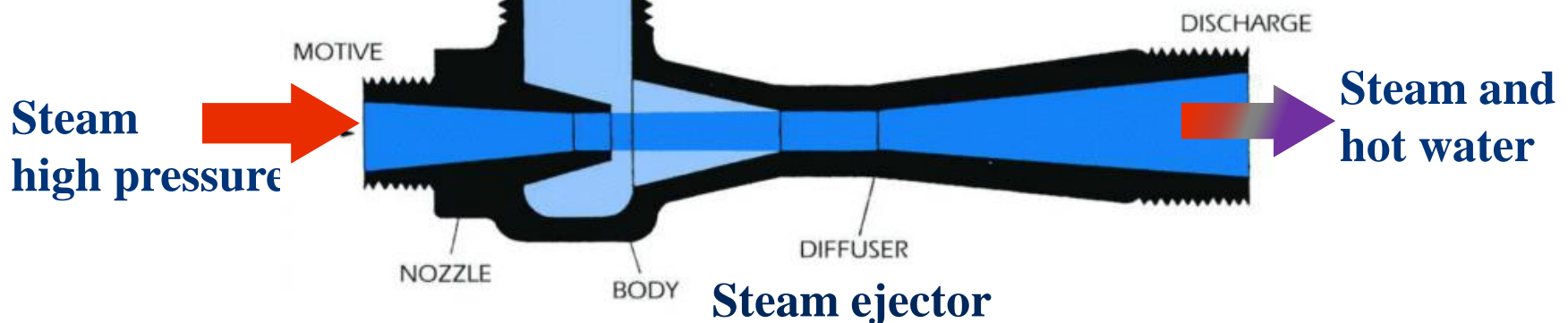
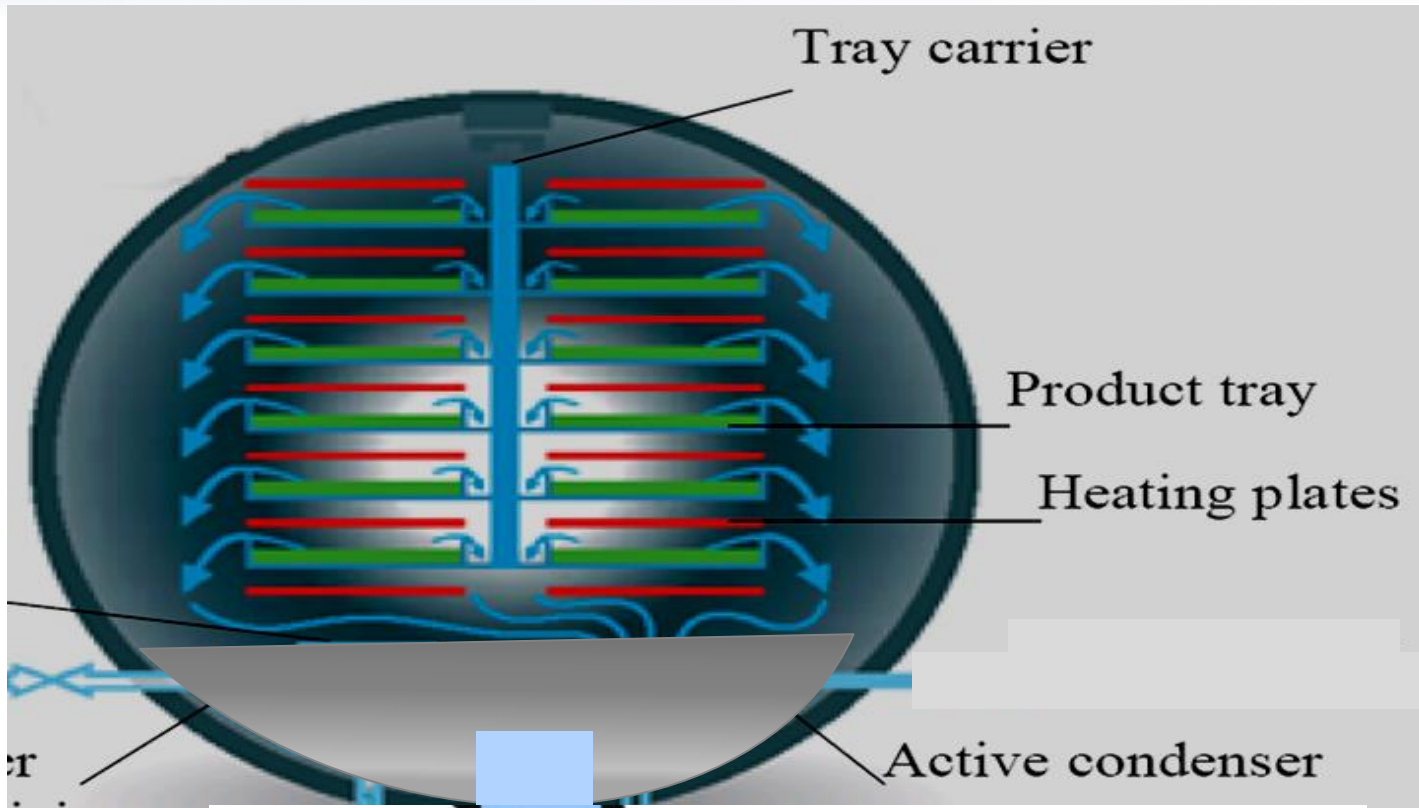
Quality evaluation



Packaging

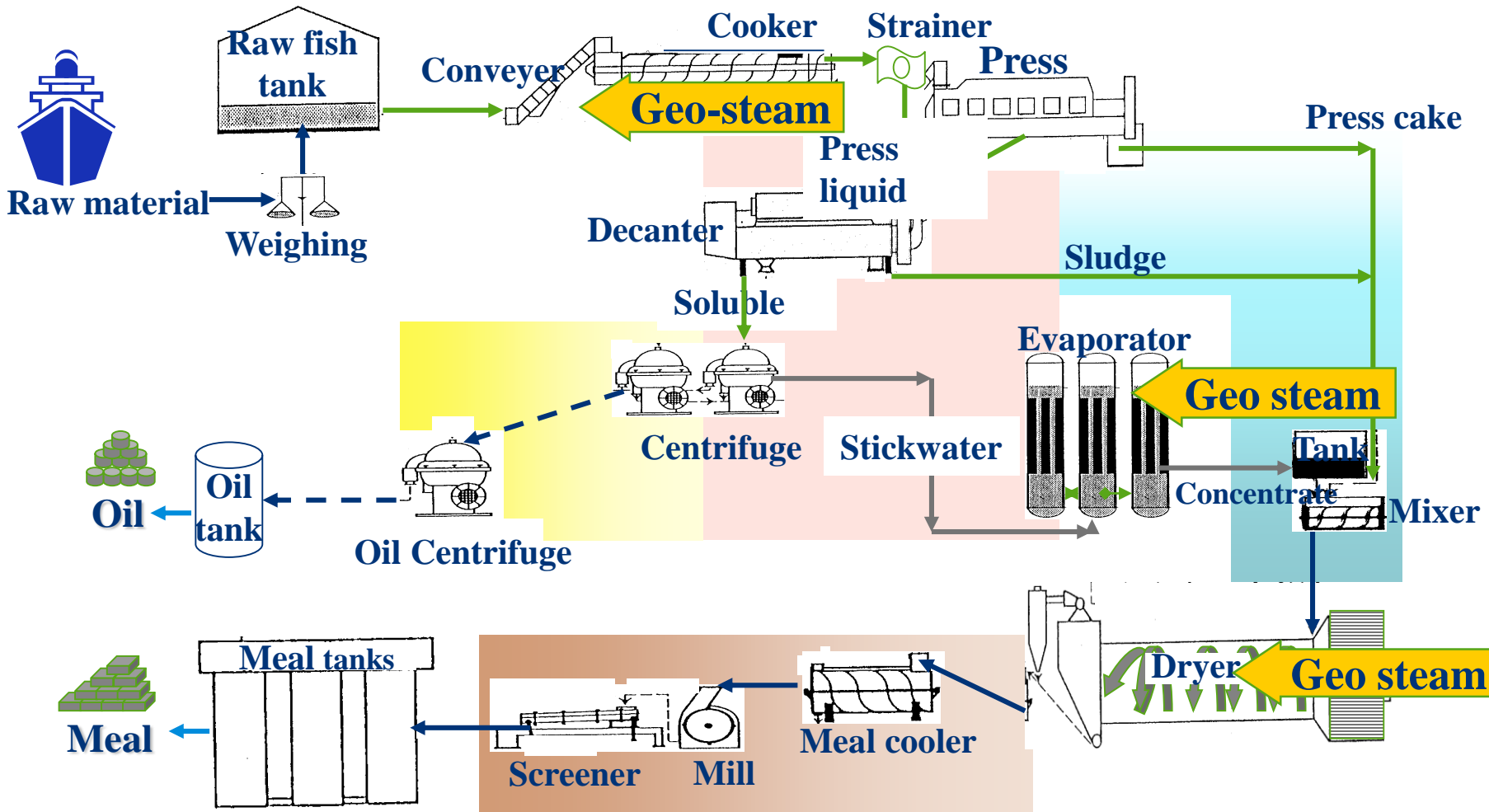


A geothermal freeze-drying system, no vacuum pump and ice-trap.

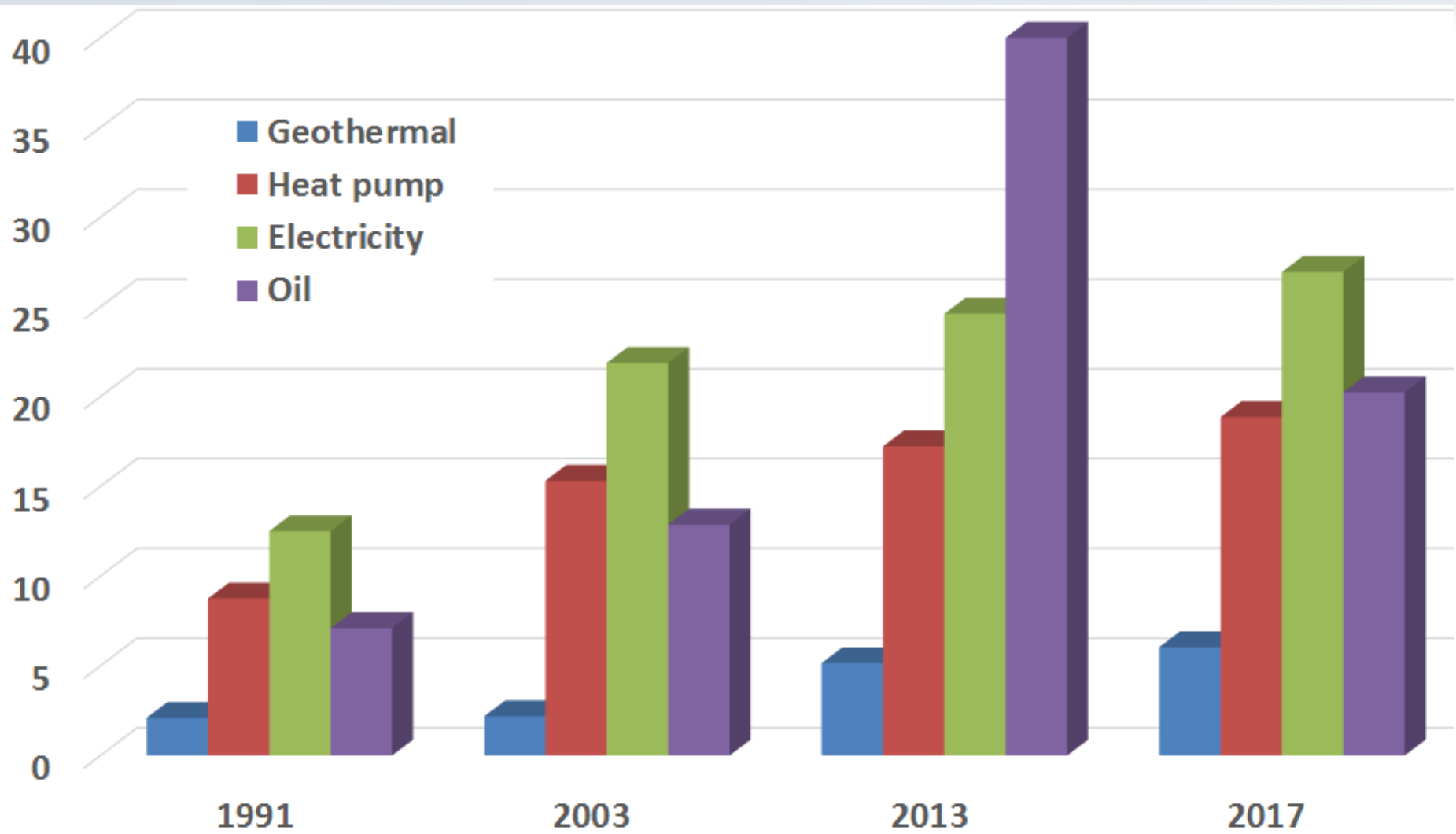




Process flow of fish meal process

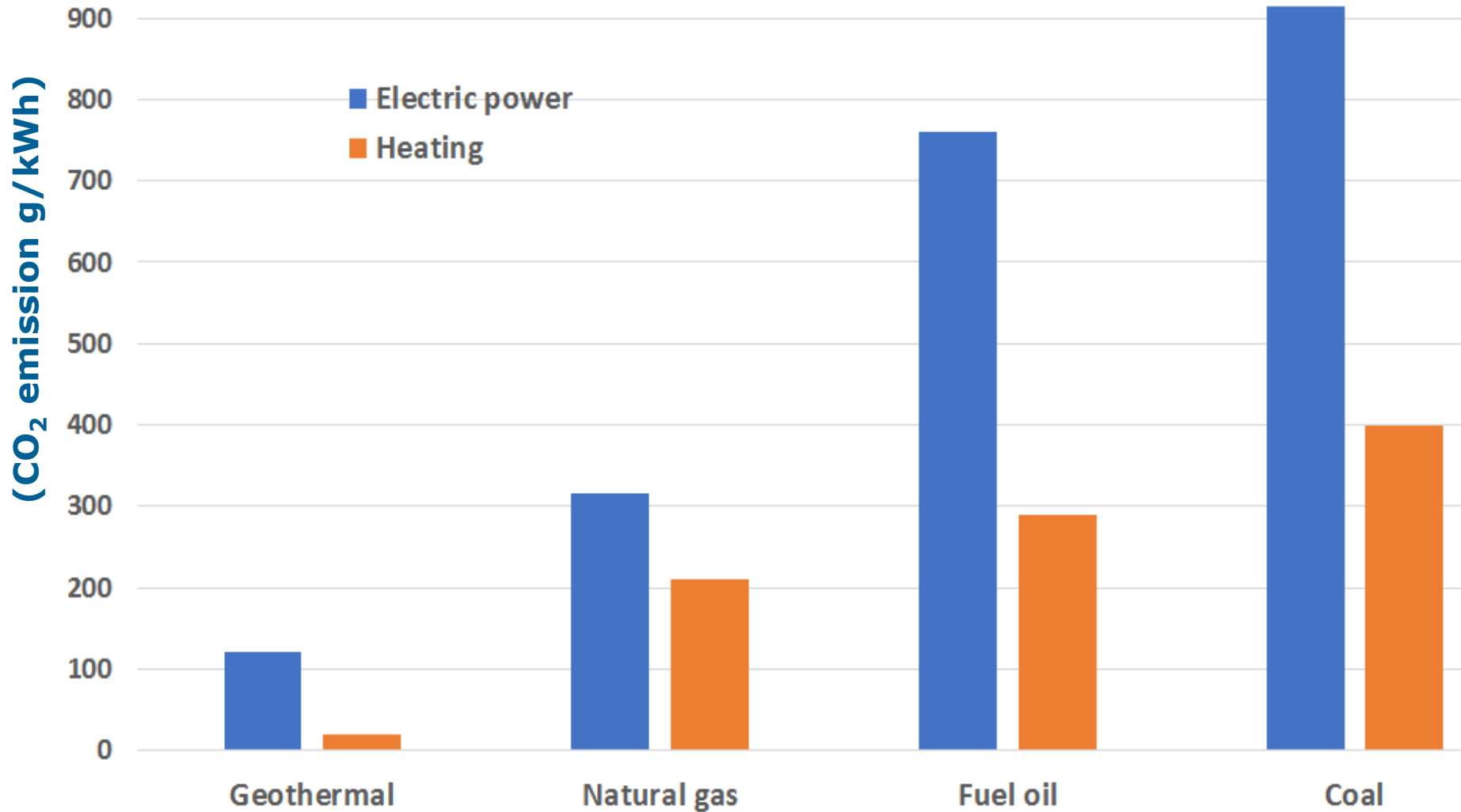


Prices for different types of energy for heating, ISK for drying one kilogram of dried cod head

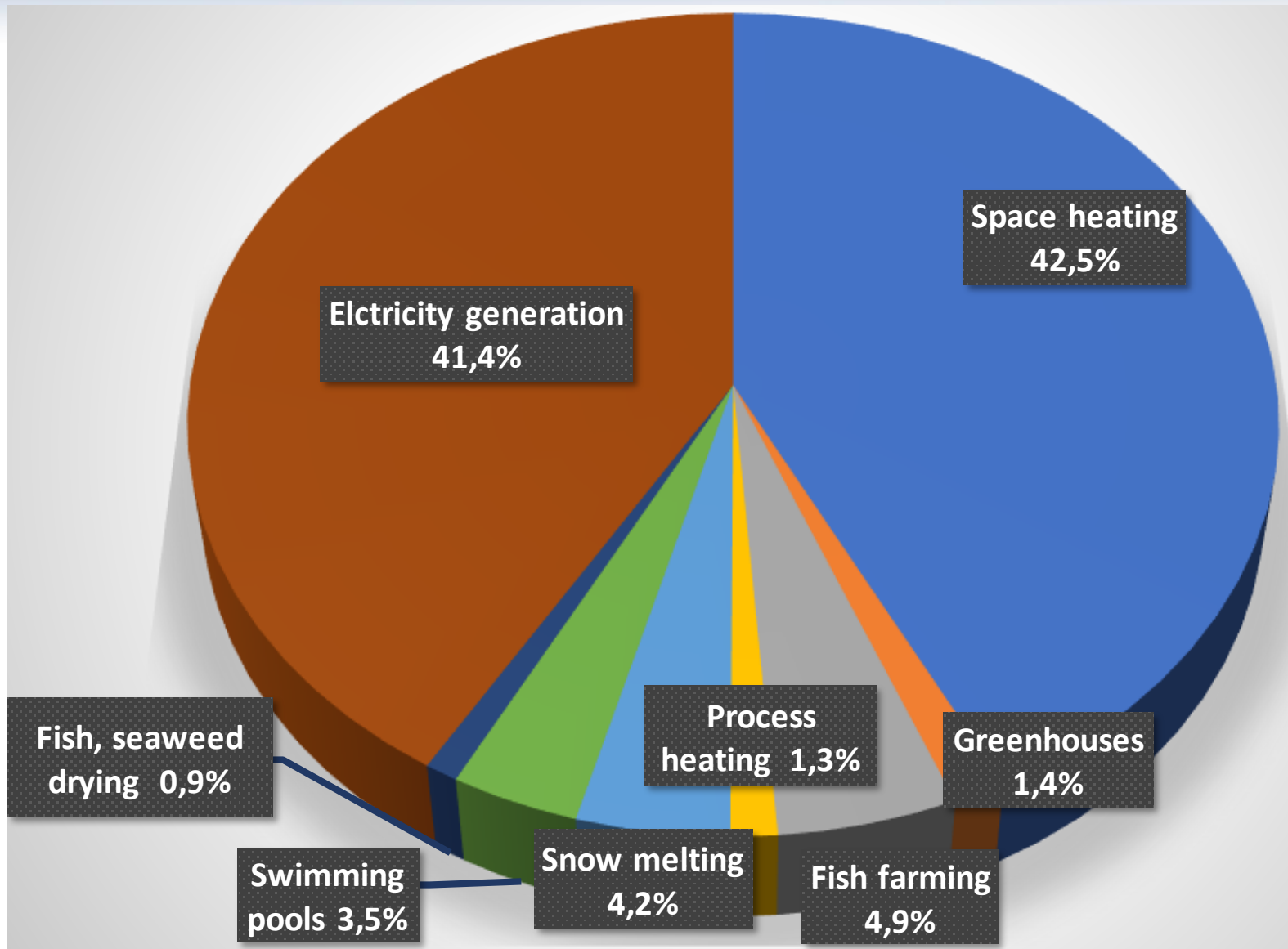


Based on 1 USD = 108 ISK, 2017

CO₂ emissions from electric and heating power plants, from different energy sources.



Geothermal utilization in Iceland 2014.



(Ragnarsson, 2015)

Conclusions

- ✓ **Increasing interest in “green” and “renewable” energy sources**
- ✓ **Geothermal direct-use is in main cases replacing fossil fuels and thus reducing greenhouse gas emissions**
- ✓ **Geothermal can make a major contribution to the world energy needs**
- ✓ **Geothermal heat pumps are the fastest growing direct use of geothermal energy –available anywhere for heating and cooling**
- ✓ **Low temperature combined heat and power plants using the binary cycle for power and cascading for space heating is gaining popularity**
- ✓ **However, “geothermal” is not well known and the benefits generally unknown –it needs to be promoted better**

Fact of Global food system

The value Chain



Present

- market pull
- long term
- chain oriented

Keyword: Collaboration!

- Collaboration between research institutes, seafood industry, service industry and universities
- Multidisciplinary projects
- Tradition for M.Sc. Projects
Ph.D projects becoming common
- The industry sees benefits in collaborative research



- **Matís is a research and science community based on strong research infrastructure and collaboration, to maximize impact of investment in research and innovation**
- **We provide our partners with support for increased value creation, food safety and public health.**
- **We play a leading role in holistic approach to sustainable use of the bioeconomy, specifically the blue-bioeconomy and have participated in policy making for the Icelandic government and foreign constituents.**



Our specialists work with:

**Food processing plants, fishing plants, fishing companies, slaughterhouses,
dairies, farmers, regulatory agencies, research institutions, universities**

all over the country and all around the world



A few of Matís' business partners





Thank you
Takk fyrir

