GLOBAL GEOTHERMAL ALLIANCE

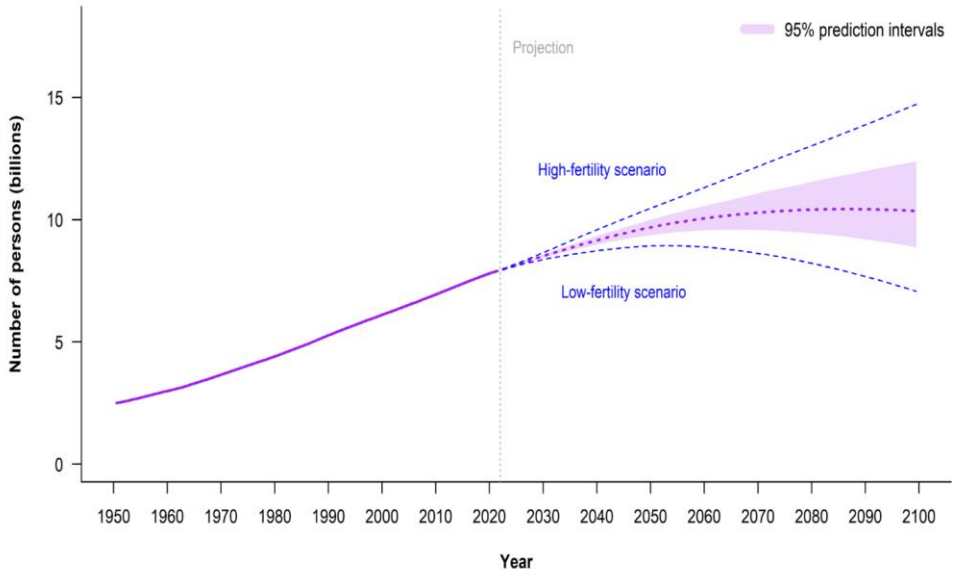
IRENA
International Renewable Energy Agency

Powering Agri-food Value Chains with Geothermal Heat

A Guidebook for Policy Maker

18 October 2022

Introduction

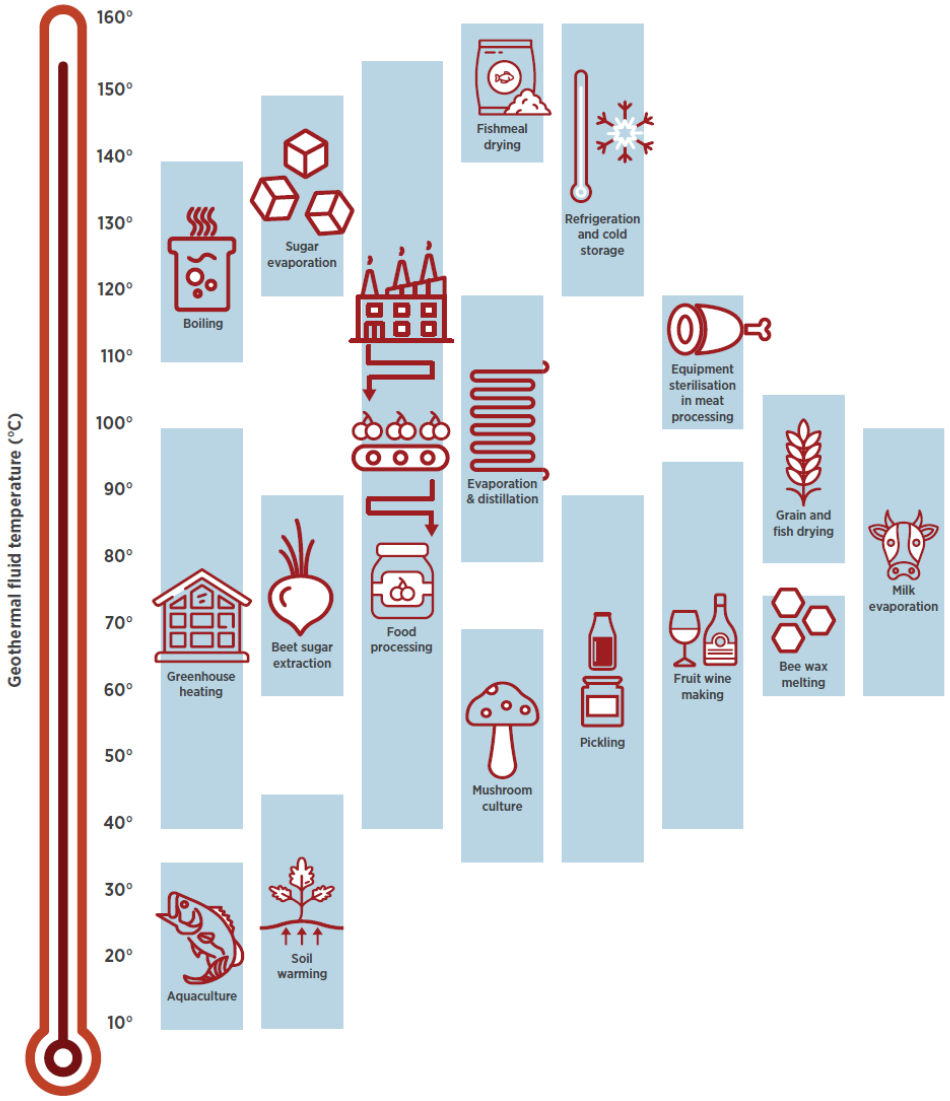


- The population of the world expected to reach around 10 billion in 2050
- Demand for food and expected to grow by at least 50%
- 30% emissions from food systems as a result of fossil fuel usage

RE as an enabler of sustainable food systems

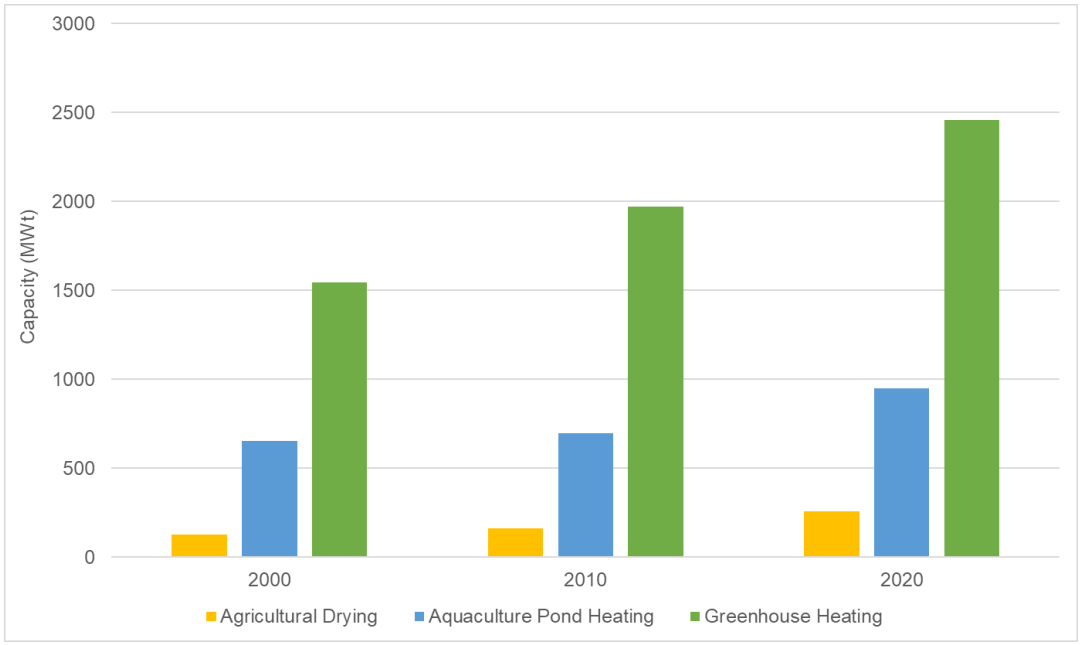
- Food production
- Food processing
- Food preservation: Drying, dehydration and cold storage

Opportunities



Primary production	Post-harvest and storage	Transport and distribution	Processing	Retail preparation and cooking
• Water for irrigation • Heating of greenhouses and soil warming • Aquaculture heating • Sterilisation of soil, irrigation water and substrate for mushroom culture • Enhancing photosynthesis through CO_2 from geothermal sources • Fertiliser manufacture from sulphur • Running of water pumps using geothermal electricity	• Drying and dehydration of grains, fruits, vegetables, meat and fish, etc. • Cold storage and refrigeration (electric and thermal driven)	• Ice generated using geothermal energy • Electric vehicles charged using geothermal energy	• Process heating applications • Pasteurisation, *e.g.* milk • Sterilisation, *e.g.* food canning • Fermentation and distillation, *e.g.* beer, wines and spirits • Evaporation, *e.g.* milk powder • Powering of processing equipment using geothermal electricity	• Pre-cooking, *e.g.* food canning • Baking

Recent trends



Geothermal heating applications in agri-food grew by 63% between 2010 – 2020

- Greenhouse heating – 25%
- Aquaculture heating – 36%
- Agricultural drying – 60%

Aquaculture heating, Kenya

Fruit dehydration, Mexico

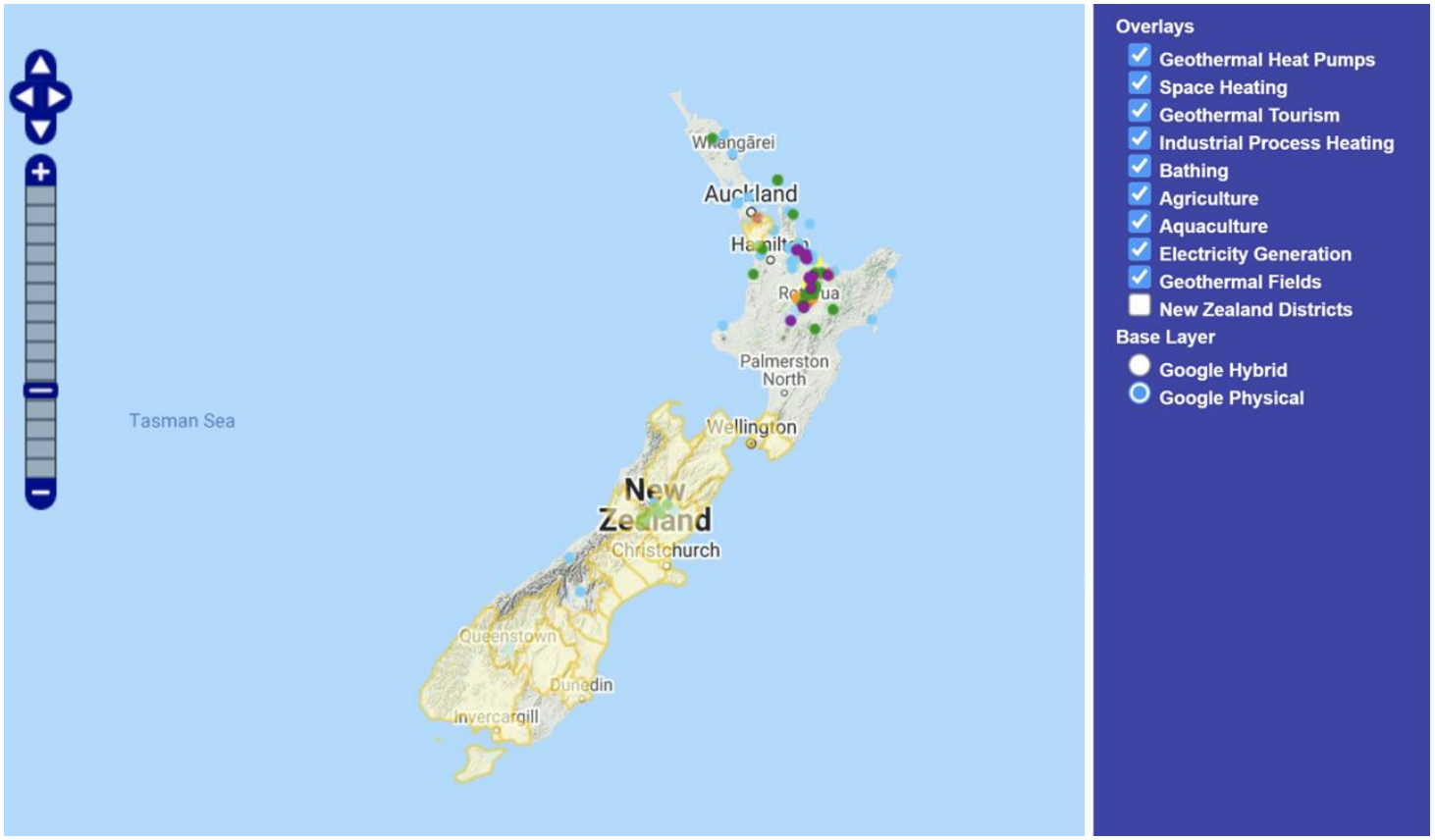
Honey Processing, El Salvador

Greenhouse heating, Turkiye

Milk processing, New Zealand

Guidelines to scale up Deployment

Resource and Demand Mapping



Resource mapping

- Identify the geothermal resources (depth, temperature)
- Sources of heat:
  - From power generations: separated from power plant, excess steam, sub-commercial wells, distant wells,
  - From direct heat

Demand mapping

- Resource push
- Industry pull

ThermoGIS

Netherlands

Danube region geothermal information platform

Central Europe

National Renewable Energy Laboratory Geothermal Prospector

NREL; United States

Geologic database of Switzerland

Switzerland

Enabling Policy and regulatory frameworks

Competitive Heat Tariff
- Acceptable to both the enterprises and the geothermal developer
- Used to enhance the bankability of the energy supply business and support the developers to obtain financing

Tax Incentives
- Exemptions on the purchase of equipment
- Lower system costs for operators
- Support the sustainable operation of agri-food businesses

Subsidy Scheme
- Compensate operators of heat plants for the difference between the cost of generating renewable heat and the prevailing market price of heat

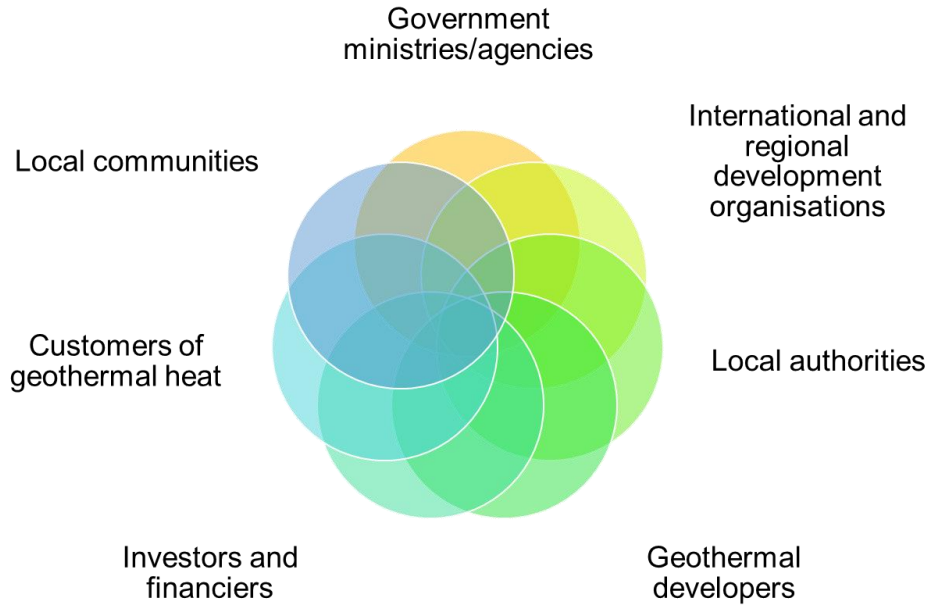
Risk Mitigation and Insurance
- Grant-based schemes more suitable for nascent markets
- Insurance-based schemes more suitable for mature markets

Regulatory frameworks
- Clear licensing procedure
  - Simplified

Cross-sectoral alignment and coordination

Coordination of multiple stakeholders

- Multiple stakeholders with diverse interest
- Provide a structure for engagement



Alignment of policies across different sectors

- Energy vs agri-food and industrial sectors
- Alignment of national and local priorities
- Geothermal heat master plan/ sector roadmap to provide direction
  - Targets
  - Opportunities and challenges
  - Policy and financing measures

Ownership, business models & Financing

Stand-alone systems
- Individual projects
- Naturally occurring/shallow well/existing well
- Lower cost/risks/time

Cascaded systems
- 2 or more projects utilizing same stream
- Medium to high temperature
- Usually drilling required
- Shared costs
- Potential lower tariffs
- Efficiency in utilistion
- Socio-economic impact
- Potentially higher costs
- Complex agreements

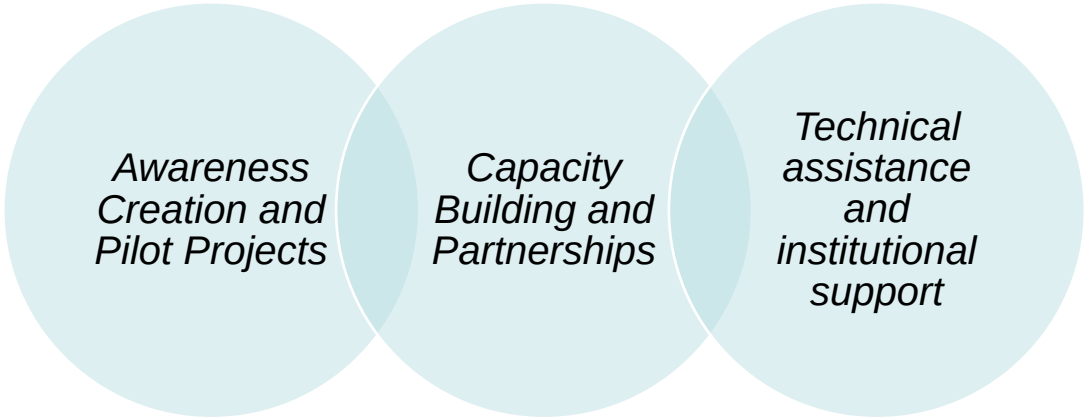
Integrated with electricity
- Stand-alone or cascaded alongside power generation
- medium to high temp
- Resource risks and costs avoided
- Captive power with lower tariff
- Circular economy
- More revenue streams
- Complex agreements

Ownership models
- Full ownership
- Heat purchase agreement
- Partnership

Shared objectives
- Project identification and prioritisation

Financing
- Risk mitigation and sharing costs
  - Co-location of power and direct use
- Feasibility studies
  - Include socio-economic impacts
- Partnership with local commercial banks

Addressing Knowledge Gaps



- ✓ **Awareness creation** to demonstrate the benefits and opportunities of agri-food applications for policymakers, entrepreneurs and communities; raise awareness at the local level given that geothermal heat is used locally; **pilot projects** help demonstrate the technical viability and can provide indications for the commercial viability of direct-use heating technologies

- ✓ **Capacity building** through academia and/or technical capacity building programmes; **partnerships** with international, regional and local institutions are important to provide training and certification programmes for technical experts, service providers and the downstream workforce to operate and maintain projects

- ✓ In new markets build institutional support and establish enabling frameworks: Tools and methodologies, technical assistance.

Geothermal Institute: University of Auckland, New Zealand

Fraunhofer Institute for Energy Infrastructures and Geothermal Energy, Germany

Think-tank

iiDEA Group, UNAM, Mexico

Research group

Geothermal Training Programme in Iceland

Technical Assistance Programme in Central America

Leverage Tech, Sustainability and Innovation

Eco-Industrial Parks

- ✓ Model for utilising geothermal resources through innovative practices to generate revenue streams and reduce waste
- ✓ Incubation centres for innovation in the energy-food nexus
- ✓ Driving sustainability and new innovative technology

Circular Food Production

- ✓ Advantages of circular food production: optimization of energy and nutrient use, water treatment, and waste recovery processes when geothermal heat applications are implemented in agribusiness

San Michkael Mini-Industrial Park
Guatemala

Demonstration pilot project produces hot water and steam from shallow wells, which is used to dehydrate food, grains, fruits and vegetables, to produce handmade candles, and other industrial uses in cascade.

Svartsengi Resource Park
Reykjanes peninsula, Iceland

Combined geothermal heat and power plant opened operations including Blue Lagoon spa and a dermatology clinic, algae production and methanol manufacturing facility.

GEOFOOD Project
Netherlands

Partnership between Iceland, the Netherlands and Slovenia which integrates horticulture and aquaculture into a net zero waste production system heated using geothermal energy

Geothermal Heat Tariffs

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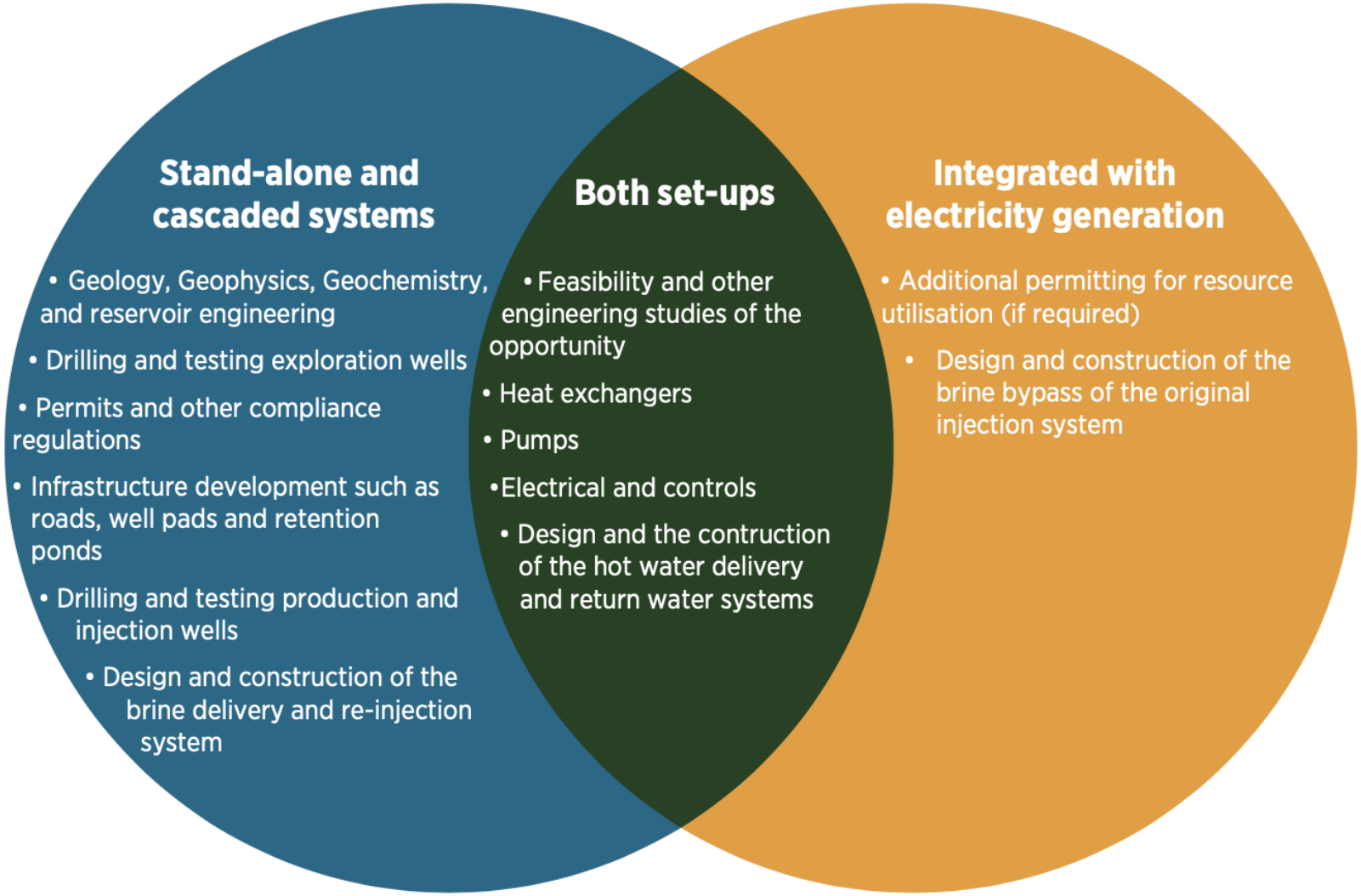
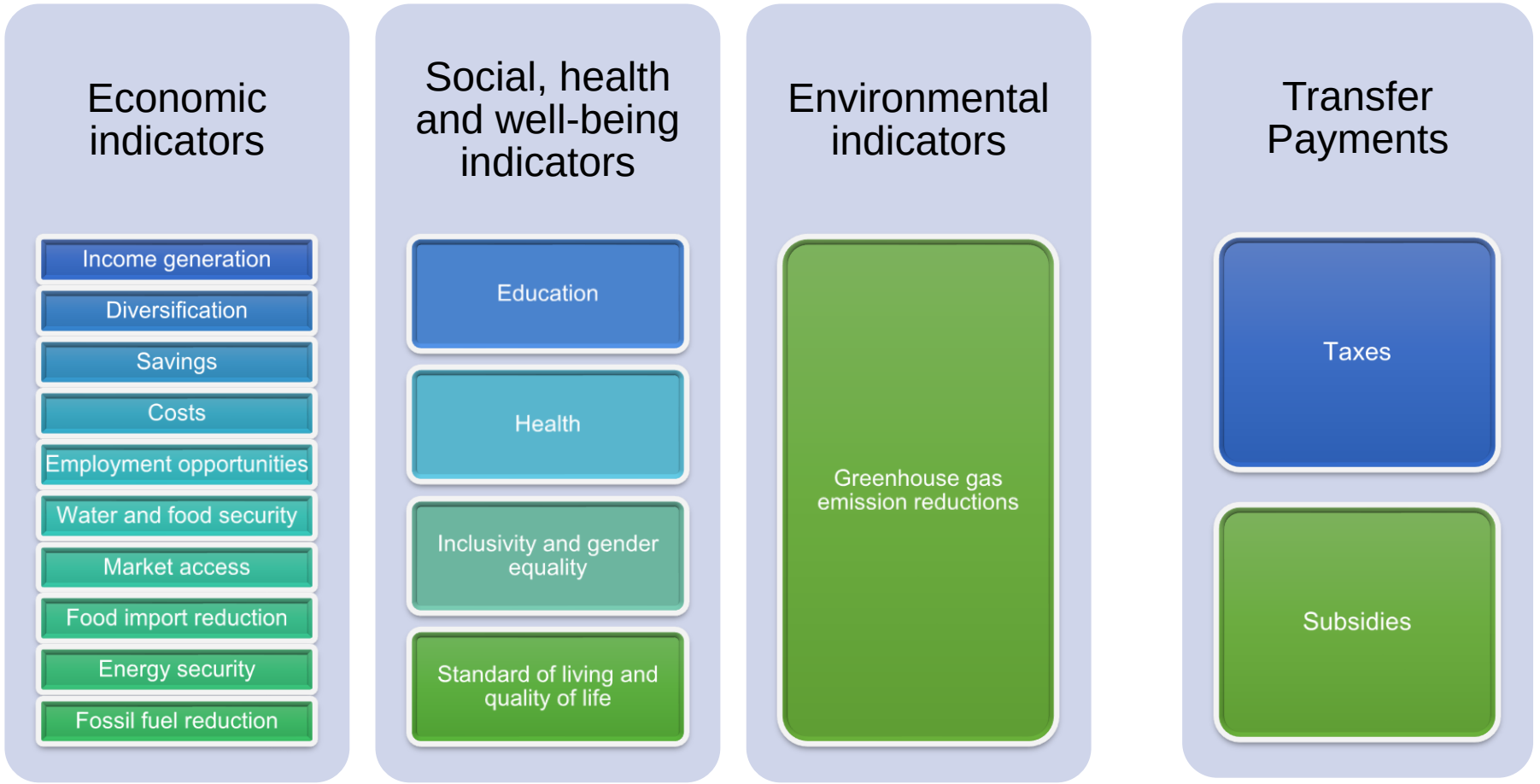
Two approaches

- *Cost-based approach*
- *Market-based approach*



Assessing Socio-economic impacts



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14