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

- Water for irrigation
- Heating of greenhouses and soil warming
- Aquaculture heating
- Sterilisation of soil, irrigation water and substrate for mushroom culture
- Enhancing photosynthesis through CO₂ 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%

Fruit dehydration, Mexico
Honey Processing, El Salvador
Greenhouse heating, Turkiye
Milk processing, New Zealand

Aquaculture heating, Kenya
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
gеothermal information platform
Central Europe

National Renewable Energy Laboratory
Geothermal Prospector
NREL; United States

Geologic database of Switzerland
Switzerland
### Enabling Policy and regulatory frameworks

<table>
<thead>
<tr>
<th>Competitive Heat Tariff</th>
<th>Tax Incentives</th>
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<td>• Acceptable to both the enterprises and the geothermal developer</td>
<td>• Exemptions on the purchase of equipment</td>
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<td>• Used to enhance the bankability of the energy supply business and support the developers to obtain financing</td>
<td>• Lower system costs for operators</td>
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<td>• Support the sustainable operation of agri-food businesses</td>
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<tr>
<th>Subsidy Scheme</th>
<th>Risk Mitigation and Insurance</th>
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<tr>
<td>• Compensate operators of heat plants for the difference between the cost of generating renewable heat and the prevailing market price of heat</td>
<td>• Grant-based schemes more suitable for nascent markets</td>
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<tr>
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<td>• Insurance-based schemes more suitable for mature markets</td>
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### 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

**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

**Ownership models**
- Full ownership
- Heat purchase agreement
- Partnership
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.
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

Two approaches

Cost-based approach

- Geology, Geophysics, Geochemistry, and reservoir engineering
- Drilling and testing exploration wells
- Permits and other compliance regulations
- Infrastructure development such as roads, well pads and retention ponds
- Drilling and testing production and injection wells
- Design and construction of the brine delivery and re-injection system

Market-based approach

- Feasibility and other engineering studies of the opportunity
- Heat exchangers
- Pumps
- Electrical and controls
- Design and the construction of the hot water delivery and return water systems

Integrated with electricity generation

- Additional permitting for resource utilisation (if required)
- Design and construction of the brine bypass of the original injection system

Stand-alone and cascaded systems
Assessing Socio-economic impacts

Economic indicators
- Income generation
- Diversification
- Savings
- Costs
- Employment opportunities
- Water and food security
- Market access
- Food import reduction
- Energy security
- Fossil fuel reduction

Social, health and well-being indicators
- Education
- Health
- Inclusivity and gender equality
- Standard of living and quality of life

Environmental indicators
- Greenhouse gas emission reductions

Transfer Payments
- Taxes
- Subsidies