IRENA
International Renewable Energy Agency

UN environment programme

GLOBAL GEOTHERMAL ALLIANCE

POWERING AGRI-FOOD VALUE CHAINS WITH GEOTHERMAL HEAT

GEOTHERMAL HEAT TARIFFS

CAPACITY BUILDING EVENT – AFRICA WEBINAR

JULY 19, 2022

GreenMax Capital Advisors

Establishing a Geothermal Heat Tariff

Key Factors In Establishing Heat Tariff

- ✓ Cost recovery for the energy supplier
- ✓ Temperature and flow rate of the fluid
- ✓ Distance to the application location
- ✓ Seasonal nature of produce

Key Elements Of A Heat Purchase Agreement

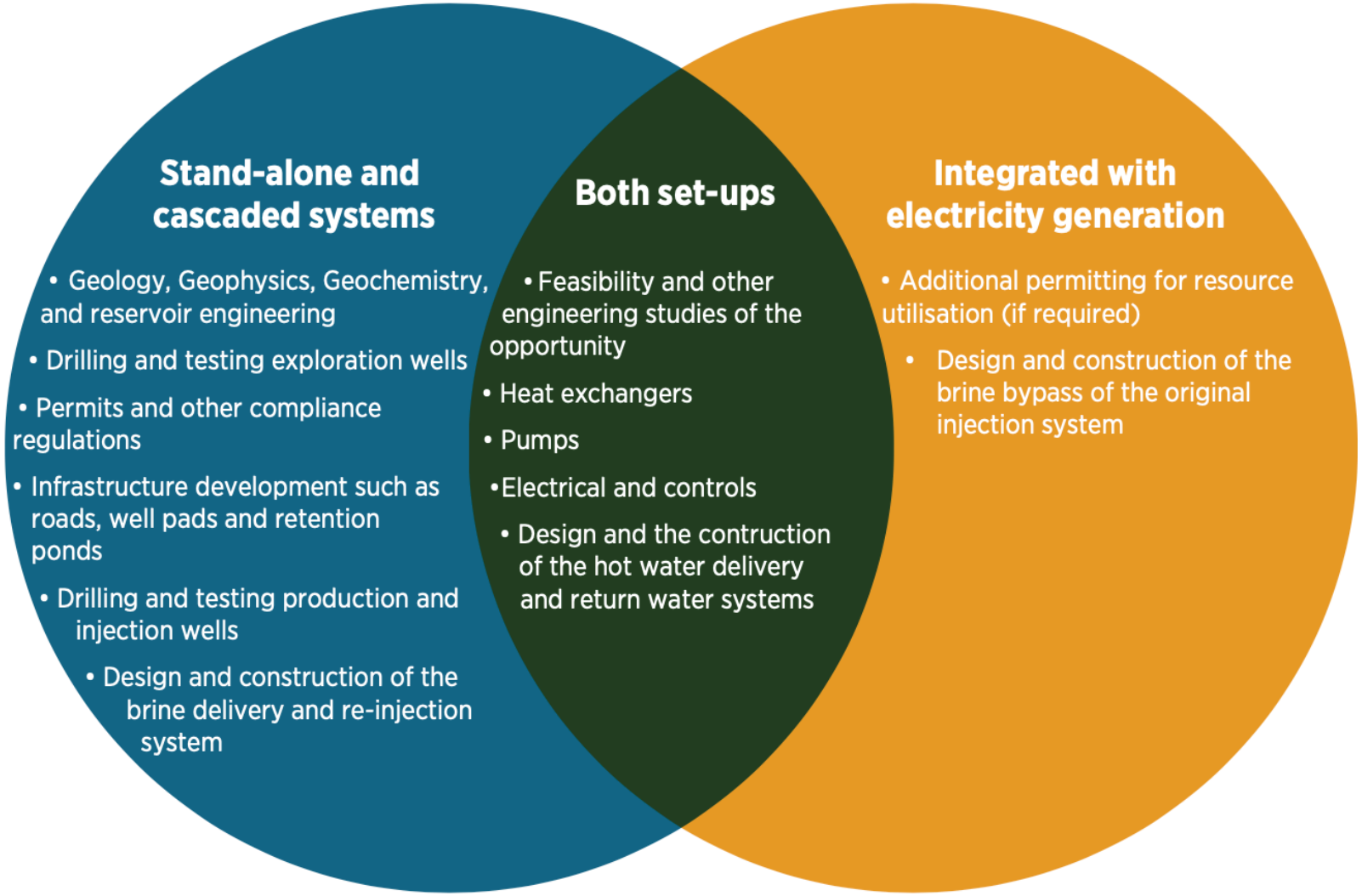
- ✓ Parties and duration
- ✓ Price for a unit of energy and how to measure it
- ✓ Tariff structure
- ✓ Minimum and maximum temperatures and amounts
- ✓ Obligations of the parties
- ✓ Mechanisms to deal with underperformance
- ✓ Dispute resolution mechanisms
- ✓ Other terms and conditions

Geothermal Heat Tariffs

Two approaches

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

Capex elements for different direct use set-up options



Geothermal Heat Tariffs

Key components

✓ **Cost-plus approach**

Capital Costs (CAPEX)

- ✓ Exploration studies
- ✓ Feasibility studies
- ✓ Permits
- ✓ Drilling
- ✓ Energy delivery systems and associated infrastructure

Operating Costs (OPEX)

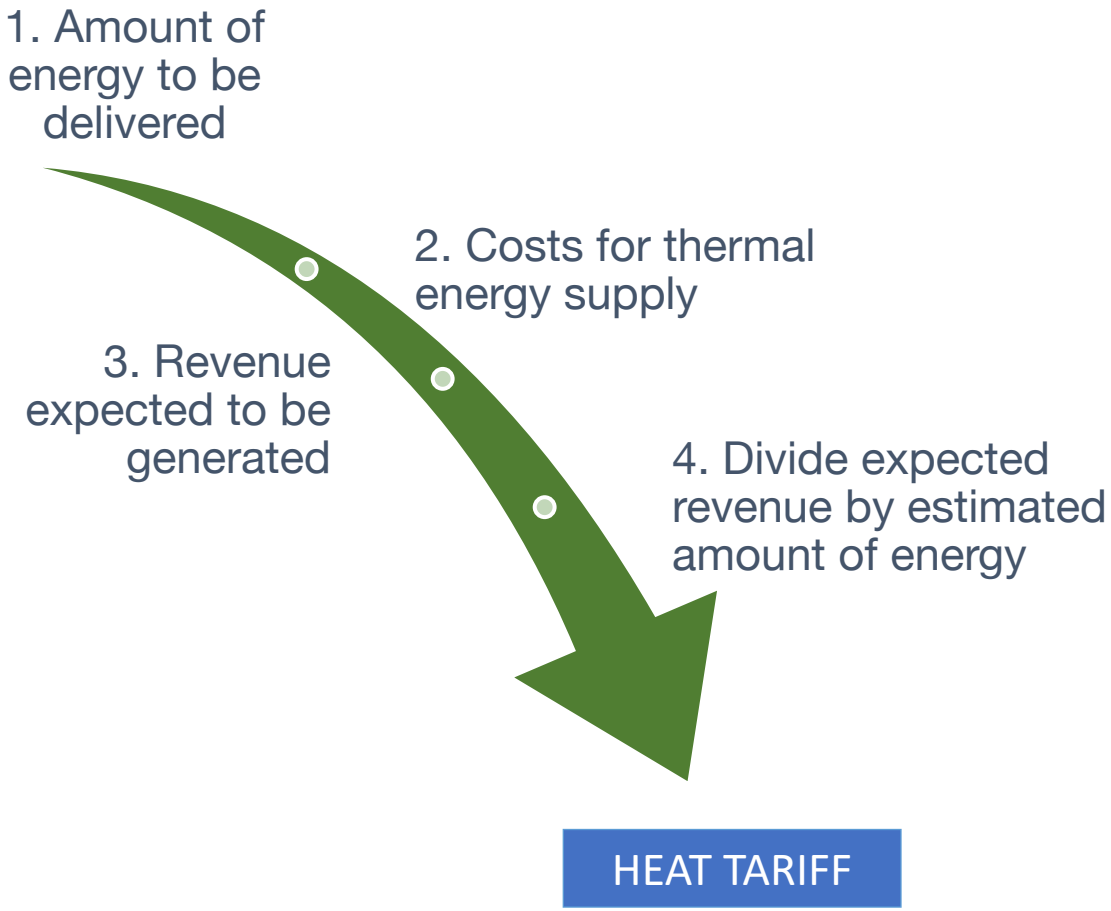
- ✓ Salaries/wages
- ✓ Electricity usage for operations
- ✓ Equipment maintenance
- ✓ Interest/bank fees
- ✓ Depreciation of assets

Shared Costs

- ✓ Direct use project integrated with electricity generation

Markup

Determining the Heating Tariff



Case Study – Cost based: Fish Drying in Uganda

1. Capital Investment Costs (CAPEX)

2. Operation and Maintenance Costs (OPEX)

Cost estimation for fish drying

Items	Specification	Quantity	Price per unit($)	Total price($)
Heat exchanger		1	20000	20000
Pumps	Cast iron	1	3500	3500
Well drilling		30m	100	3000
Fans	Centrifugal fans	2	1500	3000
Pipes	Carbon steel	150m	300	45000
Construction of drying station		1	150000	150000
Drying cabinet		1	2000	2000
Total initial cost				**226500**
Depreciation at 1% of initial cost				2265
Operation and maintenance at 15% of initial cost				33975
Total cost				262740

Fish drying initiated fixed investment and annual expenditures = USD 262,740

Case Study – Cost based: Fish Drying in Uganda

3. Payback Period

$$\text{Simple payback period} = \frac{\text{Initial fixed investment of the project}}{\text{cash inflow from the project}}$$

$$\text{Simple payback period} = \frac{\$262740}{\$116712} = \mathbf{2.25\ years}$$

Fish drying cash inflow

Items	Specification	Quantity kg/month	cost in $/kg	Total cost in $
cost of fresh fish	Fresh	25000	1.5	37500
cost of dry fish	Dry	5556	8.5	47226
cash inflow in $/month				9726
Cash inflow/year				**116712**

→ Annual cash inflow = USD 116,712

VIABLE PROJECT!

Case Study – Market Based: Fish farming and production

- ✓ Mi : the initial moisture content is estimated at 80%, i.e., 0.8
- ✓ Mf : the final moisture content is estimated to be 10%, i.e., 0.1

Amount of moisture to be removed from 25000 kg of fresh fish is:

$$m_w = \frac{25000*(0.8-0.1)*100}{100-100*0.1} = 19444.44\ kg$$

Quantity of heat (energy) required to evaporate 19444.44 kg of water:

$$Q = m_w * h_{fg}$$

- ✓ Water evaporation assumption occurs at 20 o C during the drying process

$h_{fg} = 4.187*(597-0.56*20) = 2452.7$ kJ/kg

Q = 19444.44 kg/month * 2452.7 kJ/kg = 47692256 kJ per month

Q = 18.4 kJ/s

Case Study – Market Based: Fish farming and production

- ✓ Converting KJ to kWh. 1 kWh=0.0002778*KJ
- ✓ Monthly kWh consumed – 13,250
- ✓ Year kWh consumption – 159,000
- ✓ Assume 1 kWh cost 20 US cents
- ✓ Annual cost of using electric power to dry 25,000 kg of fish - $31,800. (on par with annual O&M costs using the cost-based method)
- ✓ Alterative cost calculation – cost of geo water:
- ✓ Assume flowrate of geo- water – 0.006 cm^3/sec or 189,000 cm^3/year.
- ✓ Price of one cubic meter of geothermal water – 16 US cents

Recommendations

Market-based approach

- ✓ When the cost of the alternative fuels increases considerably → potential for the supplier to make higher returns
- ✓ When the demand and prices for alternative fuels subsides → geothermal heat prices dropping, and the energy supplier may incur losses

Cost-based approach

- ✓ The cost of energy varies mainly with the costs associated with developing and operating the energy supply system.
- ✓ Key benefit is that the supplier can establish long-term contracts for heat supply with customers and use them as a basis for obtaining financing.

THANK YOU!