Webinar on

Financing Geothermal in India

23rd May 2022

Proceedings

The EU - India Clean Energy and Climate Partnership (CECP)

Background

Geothermal energy is a type of renewable energy taken from the Earth's core. It is the heat derived within the sub-surface of the earth. Water and/or steam carry the geothermal energy to the Earth's surface. This energy is harnessed mainly through

i. **Geothermal power plants** - use heat from deep inside the Earth (temperature exceeding 1500C) to generate steam to generate electricity
ii. **Geothermal direct use** –direct use of hot water (temperature between 300C to 1500C) from the ground without the need for any specialized equipment
iii. **Geothermal heat pumps –** use heat close to the Earth's surface (temperature between 50C to 300C) to heat water or provide heating/cooling for buildings

Under the European Union (EU) – India Clean Energy and Climate Partnership (www.cecp-eu.in), which was agreed at the EU-India Summit in 2016 and confirmed in 2017, 2020 and 2021, the EU Delegation to India is developing the "EU-India Financing Investment in Clean Energy Platform (FICEP)". The objective of FICEP is to encourage investment in the field of energy efficiency and renewable energy systems in India and the EU. FICEP is expected to act as a catalyst for investments and is intended to inform and connect various actors in the energy sector, including initiators and innovators, project promoters and entrepreneurs, project developers and the European and Indian financing community.

One of the focus areas of FICEP (at initial stage) is energy efficiency in buildings and industries. Geothermal or Ground Source Heat Pump (GSHP) technology is selected as the technology of interest. GSHP is an efficient space cooling and heating technology for buildings. It uses a type of heat pump to transfer heat to or from the ground, taking advantage of the relative constancy of temperatures of the earth throughout the year. Thermal transfer fluid, a mixture of water and antifreeze, flows around a loop of pipe which is buried within the ground. The fluid absorbs from or releases in the ground the heat for heat exchange into the heat pump. This in turn lowers or raises the temperature of the water used to cool or heat the space.

The 'Best Practice Manual for Investment in Ground Source Heat Pumps', as part of the building energy efficiency intervention under FICEP, brings across the best practices that should be adopted by investors and borrowers for availing finances for ground source heat pumps (GSHPs) in India.

Inaugural session

- **Mr. Ram Joshi, Senior Associate, PwC India,** extended a warm welcome to all the participants and provided a brief introduction to the EU-India CECP and on the topic "Financing Geothermal in India".
- **Ms. Sneha Subudhi, Senior Associate, PwC India, shared her presentation on the topic 'Introduction to Geothermal energy and its applications' -**
    - Geothermal energy is the heat energy within the earth and the name comes from the Greek words geo (earth) and theme (heat)
    - Geothermal energy is a renewable energy source and the deeper it goes to the earth's surface the hotter is the temperature
    - **Applications of geothermal energy includes utilization of earth's temperature and can be categorized into the following:**
        - **Direct use:** Direct use of heated water from the ground, in the form of hot water from springs and reservoirs near the surface.
            - Temperature range of 50 to 150C

        - Cooking, bathing, industrial application (milk pasteurization etc), warm single building / whole districts.
    - **Electricity Generation**: Geothermal power plants use hydrothermal resources (water & heat) to produce electricity. We can use these resources by drilling wells into the earth and piping steam or hot water to the surface.
        - Required temp range of 150 to 400 °C
        - Geothermal wells are one or two miles deep
        - Three types of geothermal power plants:
        - **Dry steam plants:** Uses steam piped directly from a geothermal reservoir to turn the generator turbines.
        - **Flash steam plants:** Takes high-pressure hot water from deep inside the earth and convert it to steam to drive the generator turbines
        - **Binary power plants:** Transfers the heat from geothermal hot water to another liquid. The heat causes the second liquid to turn to steam which is used to drive a generator turbine.
    - **Geothermal Heat Pumps / Ground Source Heat Pumps:** Heat pump to transfer heat to or from the ground
  - The temperature above the ground changes and varies frequently depending on the season or the time of day whereas the temperature within 20-30 feet of the Earth's surface remains nearly constant at about 10-15 C
  - GSHP use the Earth's constant temperatures to heat and cool buildings. They transfer heat from the ground (or water) into buildings in winter and reverse the process in the summer.
  - A GSHP system is made up of a heat exchanger (a loop of pipes buried in the ground) and a pump.
  - The heat exchanger transfers heat energy between the ground and air at the surface by means of a fluid that circulates through the pipes; the fluid used is often water or a combination of water and antifreeze
  - Very efficient, using 25–50 percent less electricity than comparable conventional heating and cooling systems
  - During winters, the ambient air is at a cooler temperature than the underground Earth's temperature, so the GSHP system utilizes the underground heat to heat inside the building
  - During summers, the ambient air temperature is high compared to the underground Earth's surface, so the hot fluid is cooled down in the pipes buried below the surface and is extracted to cool down the building's temperature
  - **The common two types of GHPs in use are:**
    - **Earth-couple (closed loop) system** that uses sealed pipes/tubes-placed vertically or horizontally, through water or a mixer of water and antifreeze circulates transferring heat to and from the earth
    - **Water source (open loop) system** where water from the underground aquifer pumps water to the heat exchanger
  - In the EU region the GSHP is a mature heating and cooling technology, but this technology is at a nascent stage in the Indian market
- **Mr. Thomas Garabetian, Senior Policy Advisor, European Geothermal Energy Council, shared his presentation on the topic 'Introduction to status of geothermal technologies in Europe, market trends, recent advances, and the policy environment' –**
  - The overview of the EU market includes key figures such as having 140 geothermal electricity plants with sustained deployment driven by the Turkish Market, the EU having passed the 2 GWth

threshold for geothermal heating systems, and having more than 2 million geothermal heat pumps in Europe

- The locations of the installed geothermal heating and cooling capacity (in MWth) is scattered across Europe and the number of geothermal district heating and cooling projects in development across Europe is a large number which indicates a very strong interest for such projects
- In terms of sales and number of geothermal heat pumps sold in 2020 across Europe, the market is dominated by 2 countries, namely Sweden and Germany
- Some other important markets include the Netherlands, Finland, and Switzerland
- The heat pumps can become a mainstream technology in the market if backed by a favourable regulatory framework
- The penetration rates of geothermal heat pumps show the assessment of its usage and Sweden (12%) and Finland (6%) have high penetration rates of the technology
- The penetration rate in Germany, although just 1% overall represents a significant amount given the size of the German economy
- **The European geothermal market is driven by these factors:**
    - Demand and planning
    - Availability of infrastructure
    - Policies and regulations
    - Knowledge of resources
    - Financing schemes
    - Innovation
- **The main components of the European Energy policy for geothermal includes:**
    - **Green Deal:** Pushing towards decarbonization of the European economy by 2050
    - **Fit for 55% :** Pushing for reducing emissions by 55% compared to 1990 Levels
    - **REPowerEU :** Calls for contribution of geothermal in the European Energy mix to triple within the next ten years
    - **Ecodesign :** It makes sure that the equipments are corresponding to different standards for efficiency and Energy performance
    - **Internal Energy Market :** It favors the development of other types of schemes from small scale to large scale equipments
    - **Building Regulation**
    - **RED – EED**
    - **COVID Recovery**
- The penetration rate in Germany, although just 1% overall represents a significant amount given the size of the German economy
- Cooling has become an increasingly important topic in Southern Europe where heatwaves are frequent
- A lot of the costs associated with a geothermal project lies in the drilling, for instance, for a 50 kWth geothermal heat pump installation, almost €35-60,000 is needed for drilling of borewells, €60-80,000 is required for installation of the geothermal heat pump system, €25-30,000 is required for heat pump manufacturing and installation and €1-5,000 is required for the system design
- **Cost reductions in geothermal are driven by:**
    - Uncertainty reduction, better knowledge of resource
    - Learning by doing – reduction of drilling costs
    - Economies of scale
    - Innovation reaching market maturity

- Electric GSHPs are competitive as compared to other technologies such as a pellet boiler or a gas condenser, based on the average annual operating cost range for certain selected space and water heating technologies and regions in the EU
- **The challenges of investing in geothermal are the following:**
  - Lack of relevant heating and cooling infrastructure
  - Lack of awareness and knowledge about geothermal technologies – including in relevant planning and decision making circles
  - High barriers due to path dependency in the heating and cooling sector
  - Unclear regulatory framework makes market uptake more difficult
  - Access to exploration is costly
  - Geothermal resource risk
- The risk mitigation schemes for geothermal can go from giving grants to public insurance and private risk insurance schemes based on the market maturity
- When de-risking is available, several public support models have proven successful such as :
  - **Feed in tariff for heat :** the case of the Greenhouse developers in the Netherlands
  - **Investment aid :** Fonds Chaleur in France
  - **Public-private partnership to develop new resources** : Janssen & Janssen in Flanders
- **The three elements of a Heat Purchase Agreement are :**
  - **Renewable heat resource**
  - **Infrastructure** – either a direct link for self-consumption or multiple consumer consumption
  - **Consumers** – either a single entity or multiple entities dependent on infrastructure
- The HPA de-risks investment in the first two elements. It encourages project developers to expand the pool of consumers linked to the resource to increase the economic performance of the project. Consumers sometimes market the use of renewable energy in their product offering
- **Economic benefits of geothermal project include:**
  - Stable operating cost of Energy
  - Reduced uncertainty on energy availability, availability of flexibility incomes
  - Localisation of the value of geothermal projects
  - Local economic development (e.g., cascading use plants)
  - Higher job intensity than fossil fuels

- **Mr. Jagdeep Singh, Director, Rosemex Ecotech, shared his presentation on the topic 'Overview of geothermal energy in India, technologies in focus and their status' –**
  - India currently faces an acute water shortage and a heat island crisis as cities such as Delhi have seen temperatures soar to record highs of 49C temperature
  - One building which has a 1000-ton cooling equipment installed acts as a 4MW heater
  - Bulk of energy production is based on conventional sources such as coal, which is harmful for the environment
  - There is need to look at technologies in heating and ventilation that can save water, use technologies that utilize less energy
  - Geothermal gives the option of generating environmentally clean energy, free heating, lower energy in HVAC and reduces need of water for HVAC
  - **The Organic Rankine Cycle (ORC) uses hot water present in the ground. The advantages are:**
    - Clean Renewable Power Generation
    - 170 F to 600 F Heat Source Input Range
    - Modular and Scalable to Larger Plants Year-Round 24/7/365 Operation

        - Robust and Reliable Components
        - 20-year Design Life
        - 2 to 4 Year Payback
        - Low-Quality Sources
        - Biomass
        - Geo-Thermal
        - Industrial Process
        - Stack Exhaust
    - The HVAC is USD 10 billion industry in India with over 12 million Tonnage of cooling annually and 2 Million KW of heating added annually
    - With 10% geothermal use it would save almost 52 Billion litres of water and 0.5 Billion units of electricity annually
    - Retrofit offers a 10-time saving potential
    - A heat pumps picks up heat from a body with lower temperature and put it in a building which is at a higher temperature
    - The difference in temperatures decides the size of the compressor which in turn decides the energy consumption of the system
    - Geothermal utilizes temperatures which are higher than the outer atmospheric temperatures
    - Geothermal system reduces the energy consumption for both cooling and heating applications by about 15-45% depending on the location/terrain
    - Indian government is looking to harness about 10GW of geothermal power by 2030, and a big chunk of saving in the geothermal lies in the HVAC systems
    - There are cases where some building areas require space heating, while others require Cooling in air conditioning or other process requirements
    - Centralized HVAC systems in large buildings normally have separate heating and cooling equipment; for example, high-rise buildings often have both a chiller and a boiler
    - Use a common system where cooling needs are met by evaporator side and heating needs are met by condenser side and whatever be the surplus send to geothermal
    - One ton of cooling is equal to 3.5 KW of heat, so this heat should be reused for other applications as the building will use another source of energy to produce the same amount of heat
    - Some buildings such as an automobile factory requires simultaneous heating and cooling requirements, and a geothermal system can be used in such applications which reduces the energy requirements by almost 60% in a project application
    - Other buildings requiring simultaneous heating and cooling requirements include Hotels, Hospitals, Restaurants, Pharma, Food, Dairy etc
    - **There are different types of geothermal systems such as:**
        - Open loop – well system
        - Closed loop – horizontal
        - Closed loop – lake or pond
        - Closed loop – vertical
    - An aquifer is an underground lake which can be used to release water from one lake to another lake using a heat pump and a heat exchanger
    - Heat exchanger applications can be used in rivers and geothermal systems for buildings can be setup which are next to river systems using heat exchangers
    - The sewage generated can be used for heating and cooling of buildings using sewage energy recovery filter units

- Use of sewage reduces the need for water, it reduces the heat island effect by reducing the heat rejected outside the building and it also reduces the energy consumption by 50% as compared to an air-cooled system and by 20% as compared to a standard water system
- As the purchasing power increases, the demand for air cooling technologies will rise and geothermal can help to reduce coal consumption
- Many countries are utilizing sea water source heat pumps, but India is using this technology not at present
- Metro Bhawan in Nagpur is a geothermal project undertaken in India which uses soil vertical bore holes
- Geothermal systems can be used in metro tunnels as most of the costs associated with drilling has been saved
- The geothermal air-conditioning cooling project was awarded as the most innovative and the most useful project award by the CII in 2019
- AIIMS Srinagar is coming up with a large geothermal installation with both horizontal and vertical soil heat exchange systems
- Nalanda University is utilizing horizontal geothermal heat exchangers
- Radiant cooling and heating technology in consonance with geothermal systems becomes a very good application
- Closed circuit cooling towers are a good fit for the balancing act
- A composite energy system utilizing all these technologies saves up to 50-60% of energy use
- **The way forward are the following steps:**
    - Government Investment in Geothermal Tech for own projects
    - Low-cost funds availability to Private Sector
    - Investment in Local production for Geothermal equipment and materials
    - Energy Saving Companies
    - Subsidy for Geothermal Industry
    - Training of Designers and Specifiers
    - Legislation for Induction of Geothermal Tech
    - Co-ordination between International Agencies
    - ACTION
- Closed circuit cooling towers are a good fit for the balancing act

- **Mr. Rushikesh Bhadra, Senior Manager, PwC India, shared his presentation on the topic 'Best Practices manual on GSHP'–**
    - The purpose of the manual is to facilitate investments in GSHP, and the manual is focused on the financing aspect as compared to other topics spoken in the seminar
    - **The manual is divided into these 7 sections:**
        - **Market overview:** This section talks about the market outlay, what types of investments have been done in India and the potential of GSHP in the Indian context
        - **Business models:** This section outlines the business models available in India and the EU as well as in other developed economies and the way forwards
        - **Barriers and Challenges:** The key barriers and challenges have been identified based on varied consultations which have caused low penetration in India and what needs to be done in future
        - **Financing options in India:** This section outlines the financing options available for a developer who is interested in GSHP technologies

- **Debt financing process:** This section outlines the steps involved in availing a loan finance, and additionally the requirements from an Indian lender perspective, and it helps to make a market-ready proposal and from a techno-commercial perspective for lenders
- **Availing equity finance:** Most of financing on equity side has been carried out through internal accruals or promoter funding, and this section outlines how to approach a financing or an equity funding agency, the parameters, and challenges to look at during the due-diligence phase
- **Potential collaboration with Europe:** This section outlines the learning areas and in what aspects can collaboration be done between India and the EU

- GSHP uses relatively constant temperature of earth between 16 C - 24 C at depth of ~6m to provide heating, cooling, and hot water solutions
- The Earth's surface can act as heat source – heating application or act as heat sink for cooling applications
- In India, the current cooling mix is hydrofluorocarbon (HFC) in refrigerant-based cooling
- HFC is a major GHG contributor
- To overcome this, India has launched the India Cooling Action Plan (ICAP) to reduce the cooling related emission
- Estimated (annual) HVAC market in India is around ~EUR 11.25 bn ($ 12 bn) and ~EUR 2.81 ($ 3 bn) for cooling and process, respectively
- GSHPs share is estimated at 20% in cooling and 60% in processes respectively
- Space cooling in building to increase 11 times by 2037-38 and Green building market is projected to reach EUR 37.5 bn ($40 bn) by 2025
- **The different kinds of business models in Green Source Heat Pumps (GSHP) are the following:**
    - **Upfront investment:**
        - Project developer is the owner and pay entire amount upfront
        - No periodical charges except maintenance
        - More beneficial to large developer
        - Allow user to utilize system on need basis
    - **Pay-as-you-save/Energy Service Company (ESCO):**
        - Project developers make initial down payment and rest in instalment and take help of ESCO to install
        - Instalment is generated from cost saving
        - Beneficial to small developer
        - Help to reduce financial burden and off-taker risk
    - **Cooling-as-a-service:**
        - GHSP is installed at large scale and project developer connect to cooling network develop by project developer
        - Service providers provide cooling to developer on a pay per unit basis
        - Highly flexible and convenience to developer to save upfront investment
        - Yet to adopt in India and has limited adoption in EU
- Most of the projects in India are of the Upfront investment type
- **There are many factors which helped in the penetration of GSHP technologies in the EU and the manual has identified these 5 key factors:**
    - **Regulation & Policy:** EU has many regulatory interventions like the Fit for 55 strategy, Renovation Wave, European Performance of Buildings Directive (EPBD),

EU Emissions Trading Scheme (EU ETS), fossil fuel phaseout targets, carbon tax etc

- **Technology & Business Model:** Technology well promoted through regulatory, finance and market-based interventions. All the type of models like upfront invest, ESCO model and heat-as-a-service are present in the EU countries
- **Market:** There are a total of 2.1 million installations with a capacity of 27 GWth. 350 geothermal district heating systems are in operation and 232 plants are under development. The GSHP market is expected to grow at 15-20% by 2030
- **Incentives:** Providing subsidy scheme like tax incentives, capital subsidy, interest subsidy etc. to the projects. Germany, Poland, Spain etc. have capital subsidy of a certain percent on the incurred cost. Sweden has tax incentives on the cost of work & Hungary has interest subsidy based on the rating
- **Access to Finance:** Concessional line of credit to Bank/FIs to provide low-cost finance for energy efficiency. Finance is provided as a combination of energy efficiency solution not for a standalone GSHP project. Finance to large business is based on the balance sheet and for the small business/others, it is based on the credit worthiness

- **The market trends in GSHP from an Indian perspective are the following:**
  - The GSHP technology is still at a nascent stage of penetration in the cooling market
  - The technology is being adopted in the industrial, commercial, residential sectors
  - here are limited providers and installers of this technology and the majority falls under SMEs
  - An Upfront investment model is widely accepted in India
  - The ticket size of a GSHP project depends on the size, ground and sub-ground conditions, the type of installation etc.
  - There are different benchmarks for horizontal & vertical installations
- **Key financial barriers to GSHP adoption:**
  - **High Investment cost:** GSHP solutions require at least 30-40 per cent additional investment per TR over the conventional systems
  - **Need for incentives**: The European GSHP market has seen a massive development based on financial interventions. Similar instruments are also needed to be introduced in India
  - **Limited access to finance:** Since GSHP projects involves major risks like payment security, small ticket size, lack of past references, etc., most financial institutions do not want to fund such standalone projects
  - **Need for funding for SMEs:** The unavailability of easy finance to SMEs is considered a significant barrier. The manufacturing and integration of these technologies is a capital-intensive process
  - **Lack of innovative financing mechanism:** The use of financial instruments, such as crowdfunding, can facilitate access to capital for GSHP projects when traditional financing is not available or is too costly
- **Other barriers to adoption of GSHP:**
  - **Need for continuous R&D:** The GSHP technology and its components used in the European and other heating-dominated regions may not be directly applicable in the tropical climate of India

- **Lack of sufficient success stories:** Although the GSHP technology is present in the Indian market for the last decade, there are only a handful of projects which can demonstrate its successful installation and operation
- **Need for conducive regulatory environment:** Design and execution of GSHP projects is a site-intensive exercise and requires clearances from multiple government agencies
- **Need for awareness and capacity building across the value chain:** It is necessary to determine gaps across the value chain of GSHP technology, including the public sector, financing institutions, private sector, and standardization agencies
- **Lack of Quality and Standards:** Lack of technical standards for components of GSHP application coupled with underdeveloped monitoring mechanism poses a serious threat on quality of the equipment used and eventually the project economics
- **Lack of Certifications for GSHPs**: At present, there are no clearly defined technical standards and certificates for GSHPs

- The best practices for availing the Debt financing side are the following:
  - GSHP can be installed for greenfield and brownfield projects
  - Lender's preference in India is corporate lending for both type of projects. Since lenders are interested in financing entire project instead of GSHP technology segment.
- **A set of guidelines are available for project proponents to avail debt financing. The it is divided into 5 stages:**
  - **Application:** Borrower to provide company operational details and project details
  - **Appraisal:** FIs/Bank to access key parameters like application details, implementation plan, risk factor
  - **Loan Sanction:** Sanction based on the board resolution of company & guarantor, IT 281 certificate, Loan agreement etc
  - **Loan Disbursement:** Disburse loan in tranches, depend on physical progress, inspection, proper end-use & contribution
  - **Loan Monitoring:** Evaluate GHSP application at ground level for performance & risk can be track & recorded
- The best practices for availing Equity financing side are the following:
  - Equity financing has not been observed as a funding source for GSHP technology in India. However, as awareness towards this application grows, it could generate valuable interest from equity investors
- **The equity financing stage could differ across firms and type of instruments proposed, however broadly there are following 5 stages:**
  - **Preparatory:** Prepare list to cover info on applicant & project details, market assessment, prospect to invest etc.
  - **Due Diligence:** To carry various due diligence related to company, legal, finance, HR, debt, ECG, IPR, assets etc.
  - **Partnership Agreement:** Discuss contours of investment like amount, tranches, form, tenure, expected ROE, exit plan etc.
  - **Equity Approval:** Investment plan, signing of docs & other strategic info etc taken through board approval

        - **Investment:** Investor will invest post board approval. Inform authorities on investment part. Track progress
    - **The key learnings from Europe are that a knowledge exchange forum can be convened which would bring together the key GSHP stakeholders from both the sides and discuss these 5 major areas:**
        - **Policy interventions**
        - **Technology transfers**
        - **Research & development**
        - **Innovative business model**
        - **Financing**

Stakeholder consultation

Question by Mr. Ram Joshi – What are the top two critical elements which are essential for funding new clean technologies and what are your experiences in this domain as a European lender?

Response from Ms. Nina Fenton

As an EU lender, the Bank of EU at the European Investment Bank, and the stakeholders being the EU Member States and the European Commission, the first thing to look at would be the eligibility of a new project with the lending program, based on whether the project contributes to the policy objectives. The projects need to make a strong contribution towards climate action, energy efficiency and economic and social benefits. One good example would be the heat island crisis in Delhi as Mr. Singh talked about and if the project can mitigate such climate risks.

At EIB the lending duration is long term with at least 5 years or up to 2030. Another area to look at is the ticket size and for the EIB to consider a project for direct lending, it generally needs to cost at least €50-100 million, which implies a total project cost of about €100-200 million. For smaller projects the total cost must be around €25 million, implying a total project cost of about €50 million. The individual projects should be grouped or aggregated in some way for it to be considered for lending by the EIB. There are 3 ways to do this, the first is to be a component of a larger investment project, and the EIB has funded 6 metro projects in India so far and EIB can intervene and invest in a heat pump component as part of a larger project. The second way is the intermediated lending, and the EIB works with organizations such as the IREDA and SBI where the EIB supports smaller projects and the organizations implement the funding, so in this way the EIB can fund SMEs or micro-finance smaller projects. The third way is to use framework loans for the Public sector, so that if a total size of a project is €100 million, the projects underlying it can be smaller.

The EIB can come in several ways but the key question is how to create scale in the market so that these kinds of investments can make sense. There are 2 things that can help in this aspect. One is providing subsidies which help create the market and it needs to have clear rules and easy access and it needs to be well publicized. The second aspect is the tried and tested Quality and Technical standards. This process is well established in Europe, but it needs to gain ground in India, and it needs to be properly certified with proper processes in place as these would be important for lenders as the due diligence cost would be higher for such projects. And these processes would make it easier for the lenders and project promoters to add new kinds of components to a larger investment project. For an EU lender there are also ESG considerations.

The manual would be a good contribution to start this process and to help make some of these investments feasible.

Question by Mr. Ram Joshi – How can the manual be further improved or refined so that it can help propagate innovative practices in this domain and make it attractive for lenders and investors?

Response from Mr. Mandar Kaprekar:

The manual is already helping stakeholder in terms of sharing perspectives and it is a good starting point. The manual provides an unbiased reference for investors and entrepreneurs. For this industry to grow, it needs more investors to come in and more importantly, right-fit investors. Regulatory help is also needed in this domain. The manual will boost confidence in the investor community as the information available in it is reliable and dependable. The manual details both the challenges and opportunities that the investors can refer to and make informed decisions which is important for right-fit investors as there are may be instances where investors invest without any prior knowledge about this newly emerging space which causes a misfit which is certainly not good for the industry.

There are lots of learning from the European experience but the learnings for Indian market could be more in the financing and regulatory fronts. In terms of technology, there needs to be a lot of indigenous thinking as the European and Indian climatic conditions are very different. The manual would also help stakeholders such as regulatory bodies, installers and drillers, other ecosystem players to understand this domain in a better way.

Question by Mr. Ram Joshi – From your experience of working in the European policy landscape, is there a scope for further refining the manual so that the policymakers are the most benefitted from this document?

Response from Mr. Thomas Garabetian:

The manual contains a lot of factually correct information overall for policymakers. It is very important to have the right level of dissemination so that it reaches the right people. There is a lack of understanding from the stakeholders that are directly related to the topic at hand. It is important that the correct information be circulated widely and properly and to highlight the best practices, especially in having the right financial schemes.

Question by Mr. Ram Joshi – From your experience as a Clean tech VC incubator, how do you see the manual in accessing the bankability of projects and what are your views in making the manual more impactful?

Response from Mr. Ajinkya Waradpande:

GSHP is an area that has not been fully explored in India, especially compared to developed countries such as USA or the EU Member States. The sector is fragmented, and the work is being done in bits and pieces. The manual will be the first step in achieving a level of uniformity that needs to be brought in. The manual makes several key points. The manual covers different funding models, the challenges faced by stakeholders in accessing various financing instruments and one area of improvement would be to provide a landscaping of different projects with innovative models that have already been successful in these areas. Things such as success stories or details about projects that have been successfully executed with innovation would provide a fillip to the manual.

The cost would always be an issue in terms of capex as by seeing large-scale solar installations that have been done over the years, the solar rooftop technology has not panned out well in India, and it might be due to

poor adoption and the high upfront costs. The high upfront costs in the GSHP technology area are a mitigating factor which creates an impediment towards large-scale adoption of this solution. In India, start-ups, entrepreneurs, and decentralized community models in urban areas can be investigated where the costs can be shared. Also, some innovative financial model can also come up in this domain. These areas can be further explored.

The problem being addressed is the heat and air cooling, as there is a lot of demand for such systems in India due to rapid urbanization, and there are a couple of innovative solutions being seen in this sector. One is the dew-point cooling for ACs and the other is refrigeration and cooling using biomass. Geothermal energy has a high potential and is a completely different sector. Options such as retrofitting and adoption patters across the EU can be utilized to access what kinds of models can be implemented in India. There are very few start-ups in the geothermal space as it is a complete system. Showcasing success stories would provide a boost to the contents of the manual.

Question by Mr. Raghav – What is the typical temperature gradient between the ground temperature and temperature below the earth's surface where the GSHP operates?

Response from Mr. Jagdeep Singh:

By going 3-4 meters below the soil, the temperature is nearly constant till the next 150 meters which is called the mean equilibrium temperature of the city. As there are 8760 hours in a year, then add the temperature of each hour, take a mean of those temperatures, and divide it by 8760 and this is the approximate temperature that would be shown. In a city of Srinagar, the soil temperature is about 14C. In the city of Nagpur, the soil temperature recorded was 27.8C and in Nalanda it was 27.3C. This temperature is constant for the next 100-150 meters and it is called the mean equilibrium temperature of the city.

Question by Mr. Ravi Theja – Despite having high saving potential using GSHP technology, why is it under-explored?

Response from Mr. Rushikesh Bhadra:

There are multiple reasons for this. Despite having various upsides, some of the reasons are as follows. The policy landscape generally does not support GSHP technologies as compared to other RE technologies in the mainstream. Secondly, the financing aspect is a challenge. The upfront capital financing costs are high, and people find it difficult to get financing at a standalone basis, so a lot of collateral or balance sheet financing is required which is a kind of a blocker. The third reason is that the technological maturity and awareness is required, both at the policymaker and the design end and the end-users. The moment the end-user starts asking for such technologies where the savings are guaranteed and upfront, a lot of things can change for the better. In the next 5-6 years, a lot will change in this aspect.