Indo-German Energy Forum

Applications intergrating Renewable Energy and Energy Efficiency

A Collection of Case Studies

Indo-German Energy Forum Support Office

Federal Ministry for Economic Affairs and Energy

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

Ministry of POWER Government of India

Ministry of New and Renewable Energy Government Of India

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EXECUTIVE SUMMARY

Energy is one of the most critical inputs for any industry or a country as a whole. Renewable energy is the cleanest energy source, while energy efficiency leads to energy savings. Both of them are being pursued in a large way all across the world, but the biggest issue is that very few attempts have been made to integrate the two – they are pursued separately in most cases. However there could be a large number of areas and applications where they can be integrated that could not only reduce the dependence on fossil fuels especially when they are imported, but also contribute to the energy security of any nation.

The biggest obstacle that one faces in understanding the synergies between renewable energy and energy efficiency technologies is that there are not many installations to showcase the technical and financial feasibility of such synergies. The installations that are there, need to be highlighted to all stakeholders in the energy sector for them to understand all the aspects of it. If one deeply analyses such installations, one would understand that such applications already have been installed in a variety of sectors including the banking, telecom, buildings etc. Almost all of the applications and the subsequent installations have been successful because of the private sector companies that are operating on their own to market their own products. There is, thus, a need for a sectoral approach to the whole thing to promote the idea of such synergies that are not just ideas, but also have techno-commercial feasibility.

In its continuous effort to promote such synergies as to well as increase the involvement of the private sector in its activities, the IGEF Support Office has come out with this publication that brings together several case studies from both India and Germany on such applications that integrate renewable energy and energy efficiency technologies. The techno-commercial feasibility of the applications have been proven by the fact that they have all been implemented in multiple locations across the two countries and in others as well. The aim of this publication is to reach out to all stakeholders in India and in Germany to not only familiarise them with the possible synergies, but also to encourage the adoption of these and similar other applications by the stakeholders.

Indo-German Energy Forum Support Office

CONTENTS

Executive Summary

Wheelabrator Shasta energy Comapny, Anderson, California (Photo by Warren Gretz / NREL No. 00071)

Indo-German Energy Forum Support Office

IN TECHNICAL PARTNERSHIP WITH

DÜRR

ORGANIC RANKINE CYCLE

Strategic investment in Energy-Efficient ORC System

Jochen Fink • Thomas Schumacher

The Stadtwerke Groß-Gerau Versorgungs - GmbH (GGV) municipal utility company has invested in an energy-efficient Organic Rankine Cycle (ORC) system from Dürr Cyplan, and thereby, increased the power to heat ratio of its cogeneration units (combined heat and power – CHP). Since the end of 2007, the biogas system of this municipal utility company has been converting biomass to biogas in order to fire two CHP units. The Dürr ORC system, integrated in November 2012, increases the efficiency of electricity generation and improves the heat utilization concept. So far, the two CHP units have produced 8.3 million kilowatt-hours of electricity per year, providing power to around 7,100 end-users. The heat produced in the process is used to heat the municipal utility company's buildings and those of neighboring companies. Additionally, the fermenter and post-fermenter are also heated. The temperatures are maintained at a constant level of 40 degrees Celsius (40°C) to ensure ideal living conditions for the microbes responsible for the fermentation and outgassing processes. During the summer, the heat is also used to dry herbs in a neighboring agricultural operation. "The concept thus corresponds to the fundamental idea of combined heat and power (CHP), according to which the energy is simultaneously converted to electrical power and heat and used," says GGV managing director Paul Weber.

DÜRR ORC TECHNOLOGY

The integration of the ORC system from Dürr, the system construction specialist, enhances comprehensive energy utilization. ORC stands for "Organic Rankine Cycle" – a procedure that uses waste heat to produce electricity with the aid of an evaporation process. In Groß-Gerau, the high-temperature flue gas waste heat from a CHP unit with an electrical output of 800 kWel, is used for this purpose. "This proven principle produces 60 kWel of additional power on average," explains Dürr project leader Timm Greschner. "No heat is lost in the process, no matter whether or not a concept for heat utilization exists. Up to 18% of the total heat in the flue gas is converted to electricity, and the remaining (approx. 82%) is provided at a temperature level of up to 90°C." A significant efficiency increase in power generation has therefore been realized in Groß-Gerau without restricting the existing heat utilization concept.

Figure-1 ORC system in Groß-Gerau

The ORC system is simple, robust and easily integrated into the overall system. Since there is no complex intermediate circuit and no separate turbine lubrication with lubricating oil, the system also operates very stably. The ORC system uses the flue-gas heat throughout the year and also produces full power in the summer thanks to the high condensation level.

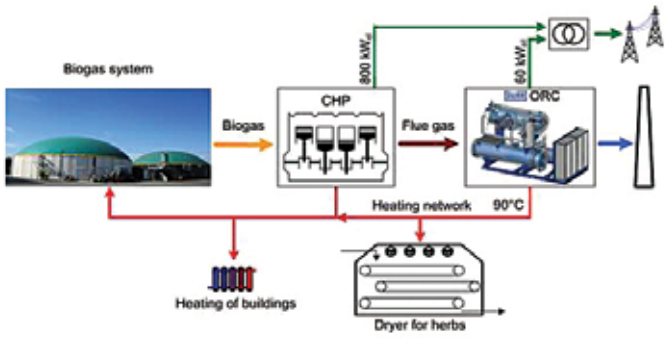

Figure-2 The flow chart schematically shows the system integration after the ORC expansion

ECONOMIC EFFICIENCY

This investment has been worthwhile for the Stadtwerke Groß-Gerau municipal utility company. The integration of the ORC system permitted the exhaust-air heat exchanger behind the CHP unit to be omitted. The total electrical power generated is increased from 8.3 to more than 8.7 million kWh. This allows electricity to be

provided to around 360 on more end-users. Despite the omission of the exhaust-air heat exchanger, the heat is fed into the heating network and is fully available for herb drying and for heating the administration building, the fermenter, and the post-fermenter.

The amortization period of such an ORC investment is five years with an electricity buyback price of 20.3 cents/kWh and 7,500 hours of full utilization. With a depreciation period of ten years, this corresponds to an internal rate of return of 15.6%.

The use of ORC technology perceptibly increases the CHP remuneration. According to the recommendation from the clearing office for the German Renewable Energy Law dated November 25th, 2010, "Systems with heat extraction (…) are to be considered as a unit for the purpose of determining the power to heat ratio if a device is used to convert the extracted heat into electricity by means of an additional generator." Consequently, the power to heat ratio of the overall system consisting of CHP unit and ORC improves according to the formula below :

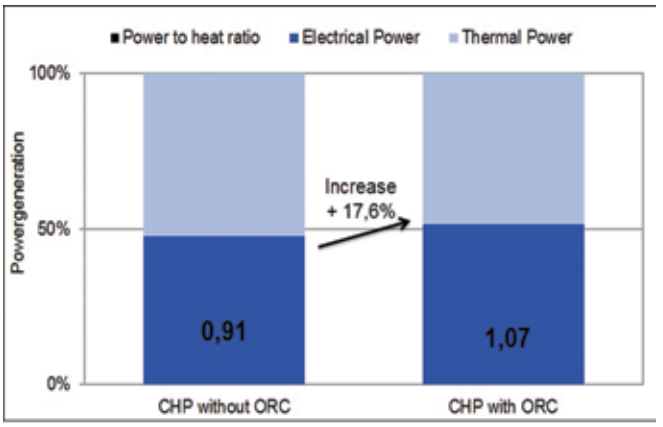

Fig. 3: Improvement of the power to heat ratio of a similar CHP unit with 834 kWel and 904 kWth

The CHP remuneration results from the sum of the externally used heat multiplied by the power to heat ratio and by the CHP bonus. This means that the remuneration automatically rises when the power to heat ratio is increased by the ORC system. With unchanging heat utilization, the CHP income increases by 17.6% with a retrofitted CHP unit. In the case of heat utilization with a dryer (e.g. a wood, digestate, or herb dryer) of 1.5 million kWh/a, the resulting additional CHP income is around € 7,100 per year.

OTHER APPLICATIONS

"Beyond the use in CHP concepts, ORC systems from Dürr are suitable for a broad range of applications. The energy-efficient technology from Dürr generally can be coupled with the most diverse combustion engines and waste-heat sources. Waste heat is one of the largest unused potential sources of energy in Germany," explains Frank Eckert, Managing Director of Dürr Cyplan. "Waste heat from industry, firing systems, and the use of geothermal heat sources are especially attractive application options for ORC technology, which assists in developing energy-efficiency potentials as well as attractive returns on capital.

Dürr is a mechanical and plant engineering group that holds leading positions in the world market in its areas of operation. It generates more than 80% of its sales in business with the automotive industry. It furthermore supplies the aircraft, machinery, chemical, and pharmaceutical industries with innovative production and environmental technology. The Dürr Group operates in the market with four divisions: Paint and Assembly Systems plans and builds paint shops and final assembly plants for the automotive and aviation industries. Application Technology provides the automatic application of paint, sealants and adhesives with its robot technologies. Machinery and systems from the Measuring and Process Systems division are used in balancing and cleaning, in engine and transmission manufacturing and in final vehicle assembly, among other areas. The fourth division, Clean Technology Systems, is focused on processes to improve energy efficiency and on exhaust air purification. Dürr employs approx. 7,300 people at over 50 locations in 23 countries worldwide. In the fiscal year 2011 Dürr achieved sales of around € 1.9 bn.

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(Photo by Thermax India)

Indo-German Energy Forum Support Office

IN TECHNICAL PARTNERSHIP WITH

THERMAX

SOLAR COOLING SYSTEM USING VAPOUR ABSORPTION MACHINE (VAM)

Solar Process & Comfort Cooling Solutions

A Sustainable Source of Energy For Cooling Solutions

Sameer Kulkarni

NEED FOR SOLAR COOLING

In a tropical country like India, the importance of air conditioning can hardly be over- emphasized. In modern day lifestyles, comfort cooling has almost become a necessity. But, like most modern conveniences, air conditioning has its down-sides. Conventional electricity driven cooling represents a large growing proportion of electricity consumption mainly during the daytime. It is estimated that almost 40-50% of the residential sector peak demand on hot summer days is attributable to air conditioners. This electricity-powered cooling load is a major contributor to the peak power deficit. Cooling is also required in cold storages for fruits and vegetables as well as for domestic refrigeration purposes. Some industries also require cooling for specific processes such as chilling and cold storage in food processing and dairy sectors, paint shop air-conditioning in the automobile sector, etc.

While total cooling load is estimated to currently be around 28.7% of the total power generation installed capacity nationally, of the yearly capacity addition planned, 40% to 50% of the electricity generation is projected for cooling. Extensive use of heating ventilation air conditioning (HVAC) systems increase the peak electric load, causing energy shortage which worsens during dry years because of the drop in the hydroelectric power stations output. Total energy demand increases by 3–4% per year, which corresponds to a yearly increase of electric energy consumption of around 1000 GWh and implies the installation of a new thermal power generation plants of which 300 MW every 18–24 months.

The energy consumed for heating and cooling of domestic premises accounts for just 7% of the country's total energy demand, but is responsible for 29% of the CO_2 emissions. Sales of mini split air conditioning units tripled during the period 1996-2000. Between 1970 and 1990, the CO_2 emissions of the country almost quadrupled. In India, ambient temperatures have a direct impact on the pattern of the nation's power demand. Most buildings whether commercial, Institutional or offices are cooled by electrically powered conventional, vapour compression systems which are high electricity consuming systems.

Application	Capacity range kWc	Indian market Requirement
MWc/ yr		
Space Cooling	100-1000	300
Industrial Process Cooling	100-7000	1500
Comfort Cooling	3.5-3500	2240
Industrial Refrigeration	15-500	120
Cold Storage – Fruits and Vegetables	15-500	80
Cold Storage – Deep Freezing	15-100	85
Domestic Refrigeration	1.5-7.0	40

The impacts of growth in cooling demand are summarized as under:

- A concomitant increase in greenhouse gas emissions
- Increasing peak electricity demand during the daytime
- Increase in electricity supply-demand gap
- Increasing dependence on conventional electricity

While continuing to making life more comfortable and supplying these cooling needs, the above impacts cannot and sustainable ignored, and hence the need for more alternative solutions was felt.

SOLAR COOLING

India being in the sunny regions of the world with most parts of the country receiving 4-7kwh (kilowatt-hour) of solar radiation per square meter per day for 250-300 sunny days in a year, solar energy indeed can be a solution. Being a tropical country where sunshine is available for longer hours per day in great intensity, solar energy has a huge potential as an energy source in India. Utilization of renewable energy source (viz. solar energy, wind power, bio-mass, etc.) for meeting energy demands of domestic as well as commercial/industrial establishments has also been one of the thrust

areas of the policies formulated by Govt. of India to offset the rising demands of energy generated by using fossil fuels like coal, diesel etc. and also for a cleaner environment.

TECHNOLOGY OVERVIEW

In keeping with its corporate philosophy of 'Conserving Energy and Preserving the Environment', Thermax has been the forerunner in developing unique solar cooling solutions to serve the various industrial and commercial processes and comfort cooling needs. Thermax offers solar based cooling solutions by integrating Vapor Absorption Machines with Thermax Solar Concentrators. The concentrators generate hot water by harnessing solar thermal energy. The hot water is supplied to a Vapor Absorption Machine (VAM). The VAM supplies chilled water which is circulated through cooling coils in the Air Handling Units (AHUs), over which air flows. The air, thus, cooled can be used for air-conditioning applications through solar cooling system hybridized with conventional cooling system. Balance cooling load, if any, can be met with the conventional cooling system, should solar generated cooling be insufficient. The in-built control logic allows the operation of the conventional cooling system only when there is a shortfall in the solar thermal energy.

This kind of system can be integrated with existing VAM in a way that solar can be used as a back-up with fossil fuel. This integrated system offers the advantage of optimizing the use of electricity and maximizing the use of clean, renewable, solar thermal energy, while meeting the cooling load. Cooling load is maximum when Solar radiation is high, and thus, solar energy availability and cooling demand closely follow, thereby making truly distributed power generation . The cooling demand is maximum during peak power demand, and if met by solar power, the peak demand tariff can be made more variable. Saving of power for cooling is virtual power generation in distributed manner.

Solar cooling finds applications in various industrial processes where cooling is required, commercial complexes, malls, large offices, hotels and hospitals. Solar concentrators hybridized with biomass gasifier can also be used to power cold storage facilities. This type of cold storage design will boost overall efficiency of the agricultural produce value chain by reducing wastage and by improving storage conditions for agricultural yield in a rural setup. In addition to the solar technology, there are various other sub-systems required in a solar cooling project including power block, water treatment, balance of plant, plant EPC, O&M, etc. Thermax has substantial experience and domain knowledge in these areas as well, thus enabling Thermax to serve customers in the best possible way.

100 KW SOLAR COOLING PROJECT AT SOLAR ENERGY CENTRE, GURGAON

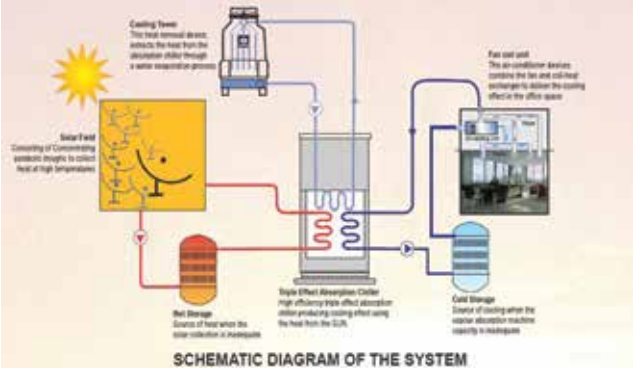
Globally first-of-a-kind solar cooling solution using Solar Parabolic Troughs with a Triple Effect Vapor Absorption Chiller Thermax has designed and commissioned a unique solar air conditioning system at the Solar Energy Centre in Gurgaon, Haryana. The 100 kW technology demonstration project was inaugurated by Dr. Farooq Abdullah, former Union Minister for New and Renewable Energy (MNRE), in the presence of Shri Sushil Kumar Shinde, Former Union Minister of Power.

In this innovative installation, for the first time in the world, Thermax has integrated a triple effect chiller and solar parabolic troughs, both indigenously developed by the company. While conventional solar systems take up a large area for limited cooling output, the Thermax project through in-house R&D has achieved a significant space reduction of nearly 30%, and a 20% increase in cooling efficiency. This has brought down cost and moved the project closer to commercialization.

The solar collectors in the Thermax system have been designed to harness sun's energy in an effective manner to provide temperatures from 140 °C to 210 °C. They are effectively integrated with a newly designed triple effect chiller. Offering the highest COP (coefficient of performance) in global markets today, the new chiller offers a technological breakthrough for solar applications. Thermax is working closely with Government of India to proliferate this solution across other installations and geographies; such efforts are being supported actively from Government and certain additional subsidies are being offered for similar cooling system projects which Thermax may put up for its clients.

PROJECT SALIENT FEATURES

Use of solar energy for cooling through vapor absorption technology	World's first project where a triple effect chiller is integrated with completely indigenously developed Parabolic Troughs	Highest efficiency cooling system delivering significant reductions in capital costs
Lowest foot print taking this technology a step closer to commercialization	Successfully completed within fifteen months with able support from the Ministry of New & Renewable Energy	Involvement & contribution from various national entities towards delivering a solution which is likely to set a global benchmark



SCHEMATIC DIAGRAM OF THE SYSTEM

SOLAR PROCESS COOLING - PAINT SHOP APPLICATION AT AUTO MAJOR MANUFACTURING FACILITY NEAR PUNE

Thermax installed one of India's largest solar process cooling systems, at an auto manufacturing facility located at Chakan near Pune. The 100 TR solar based cooling solution is provided by integrating Vapor Absorption Machines with SolPac™ D160 solar parabolic dishes.

The parabolic dishes generate hot water by harnessing solar thermal energy. The hot water is supplied to a Vapor Absorption Machine (VAM). The VAM supplies chilled water which is circulated through cooling coils in the Air Handling Units (AHUs), over which air flows. The air is, thus, cooled, and thus, the system is able to deliver 100TR of cooling which is used for paint shop application within the plant. This integrated system automatically switches between operating on solar energy during sunny hours and on gas during non-sunny hours, thus, offering the advantage of optimizing the use of conventional fuel and maximizing the use of clean, renewable, solar thermal energy, while meeting the cooling load. Through this system, savings of 158,400 units of electricity are achieved annually at the facility.

SOLAR BIOMASS HYBRID DECENTRALIZED COLD STORAGE PROJECT

India's existing food cold storage facilities can accommodate 21.7m tons of produce compared with a requirement for more than 31m tons which indicates a shortfall of 10m tons of cold storage facilities for agriculture produce. Also, available cold storage facilities are mostly for single commodity, such as potato, orange, apple, grapes, pomegranate and flowers etc. that result in poor capacity utilization. Without a strong and dependable cold chain, a vital sector such as food processing industry, that is based mostly on perishable products, cannot survive and grow.

Thermax's solar biomass hybrid cold storage demonstration project at the Solar Energy Centre can solve the problems of agricultural produce losses and ensure optimal return to the farmers at the bottom of the value chain, apart from creating a distributed power generation alternative.

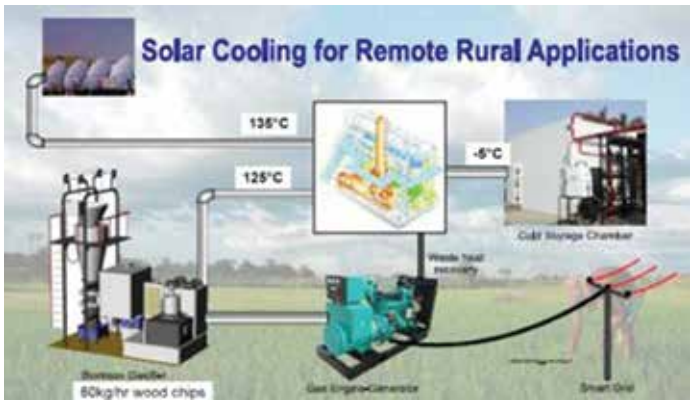
PROJECT SPECIFICATIONS

Cold Storage Capacity: 25MT	Cooling Capacity: 15 kW	Cold storage Temperature: 0 to 5°C
Gas Engine capacity: 50 kWe	Biomass consumption: 60 kg/hr	Heat source for VAM • During solar hours: Solar and producer gas engine exhaust • During non solar hours: Producer gas engine exhaust/ auxiliary firing

PROJECT SALIENT FEATURES

Solar Field	• Indigenous Parabolic Dish • Indigenous solar tracking system
Vapor Absorption Machine	• Ammonia vapor absorption system • Easy to operate - simple cycle • PLC based user friendly control panel
Biomass Gasifier & gas engine	• Biomass gasifier working on agro waste or wood chips • Gas engine working on 100% producer gas
Heat recovery unit	• Generates hot water from engine exhaust to drive ammonia chiller • Provision for auxiliary firing of producer gas in case exhaust heat and solar is not available
System Simulation	• The entire system has been simulated in Transys dynamic modeling

PROJECT SCHEMATIC



SOLAR COOLING FOR AUTO MAJOR, CHENNAI

Thermax installed a comfort cooling solution powered by solar thermal energy at an auto major facility located in Chennai. The 90 TR cooling system comprises of a total reflective area of a reflective area of 944 m^2 integrated with a vapor absorption machine (VAM). The solar fraction of the plant consists of SolPac™ D160 dishes mounted on the roof of the facility. The system is able to provide comfort cooling in the auto major office building, and thereby, achieve annual electricity savings of 142,560 units. The installation has also rendered a 'green' brand image to the user.

SOLAR COMFORT COOLING AT AUTO ANCILLARY FACILITY IN GURGAON

Thermax provided the client with a customized solution for comfort cooling purposes of its office building located at Manesar in Haryana, a major industrial hub in northern India that receive an abundance of solar radiation throughout the year. The solar cooling system is located on the roof top comprising a reflective area of 320 sq. m. with a cooling capacity of 30 TR.

The solar fraction, comprising of parabolic dishes, is seamlessly integrated with the electrical cooling system for continuous cooling purposes. The solar parabolic dishes generate hot water by harnessing solar thermal energy. The hot water is supplied to a Vapor Absorption Machine (VAM). The VAM supplies chilled water which is circulated through cooling coils in the Air Handling Units (AHUs), over which air flows. The air, thus, cooled is used for air-conditioning applications through solar cooling system hybridized with conventional electric cooling system. Balance cooling load, if any, is met with the conventional cooling system, should the solar generated cooling be insufficient. The in-built control logic allows the operation of the conventional cooling system only when there is a shortfall in the solar thermal energy. Through this system, significant savings of electrical energy are achieved.

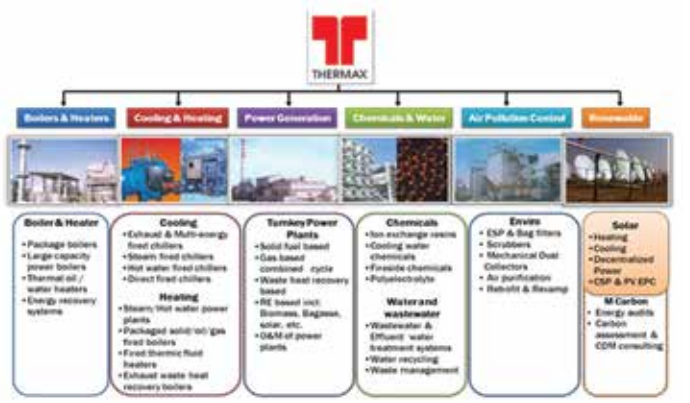
CONCLUSION

Solar energy will play a dominant role in the coming years and decades given the energy crisis and increasing cost of fossil fuels and climate change. Solar cooling solutions have the potential to mitigate this energy crisis as well as greenhouse gas emissions produced by its electricity powered counterpart. Successful completion of customized cooling projects as outlined in the previous section of this report has helped lay the foundation for large scale commercialization of solar powered cooling.

The industrial and commercial sectors being major cooling energy consumers in the country, the deployment of solar energy in these segments can play a major role in guaranteeing energy security for the country. In this context, it is important to understand that the continuity of industrial and commercial processes is critical and directly affects the performance of business. Seamless integration of solar systems to existing processes therefore becomes vital. Appropriate solar technology identification, accurate application engineering, efficient system design and effective integration of the solar system are Thermax's strengths due to its strong engineering and management capabilities. With more than half a decade of strong solar thermal engineering experience and numerous first-of-a-kind projects to its credit, Thermax is regarded as a forerunner in solar industrial and commercial applications. Thermax has been able to create a niche for itself in industrial and commercial sector by packaging the right technological expertise, in-depth understanding of industrial processes and vast experience in system design and integration. This puts the company in an extremely strong position to pioneer the solar cooling solutions domain in the country.

THERMAX INTRODUCTION

Thermax Group is a technology driven company offering sustainable solutions in the energy and environment space with revenues of around USD 1.31 billion for FY 11-12. Thermax has established itself as a reputed manufacturer and supplier with a product portfolio



comprising of solar thermal and photovoltaic technologies, boilers, heat recovery units, vapor absorption machines, steam accessories, air pollution control equipment, water and waste management plants, specialty chemicals & resins and other related equipment.

Thermax also provides turnkey solutions for power plants, operation & maintenance of thermal plants, energy & water audits, plant performance enhancement, augmentation, revamp & retrofit for existing boilers and heaters and water & waste water treatment and steam on hire. Through technology partnerships and strategic alliances, Thermax provides superior value to help industries perform efficiently and profitably across the globe. Thermax has a strong team of over 3000 well qualified, committed employees of which around 2000 are qualified and certified engineers.

With a dedicated sales & service network spread across South East Asia, Middle East, Africa, Russia, Europe and America in addition to SAARC, Thermax ensures innovative solutions and reliable support for over 22,000 clients worldwide. Thermax services over 75 countries with solutions to conserve energy and preserve the environment.

Thermax has a well-knit domestic and distribution network of four regional offices, seven area offices and numerous channel partners all over India to serve its domestic clients. Thermax's manufacturing facilities are spread over 14 plants measuring an area of 400,000 square meters, at various locations. The main manufacturing facilities are in the Pimpri- Chinchwad industrial belt near Pune and others are in Paudh in Maharashtra, Savli near Vadodara, port assembly facility at Mundra, boiler manufacturing facilities at Denmark and Germany and Vapour Absorption Chiller manufacturing unit in Jiaxing, China. Three additional manufacturing facilities are under construction at Shirwal and Solapur in Maharashtra and Jhagadhia in Gujarat.

THERMAX IN SOLAR ENERGY

In keeping with its corporate philosophy of 'Conserving Energy and Preserving the Environment', Thermax forayed into the sustainable solutions domain with solar thermal technologies five years ago. With over four decades of experience in thermal engineering and application development, Thermax has emerged as a key player in

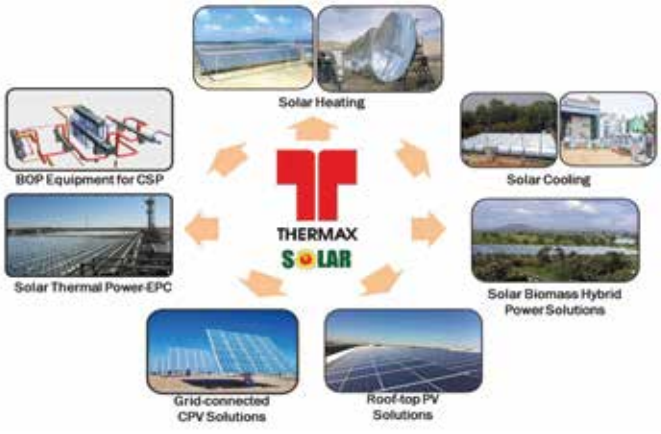
the solar domain in the country, with the largest number of operating installations in India.

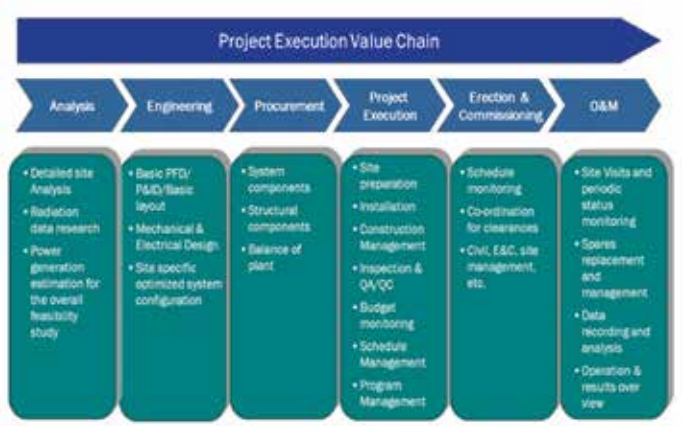
Thermax Solar Thermal Product Portfolio comprises of Non-Imaging Collector, Parabolic Dish and Parabolic Trough technologies. These solar concentrators are capable of delivering solutions across a wide temperature spectrum (70-210°C) and can also be integrated with steam boilers, hot water generators, absorption cooling machines, etc. so that solar energy can complement systems using fossil fuels or electricity providing heating and process or comfort cooling solutions. Thermax also provides solutions for community cooking needs through its parabolic dish based system for large cooking requirements and small parabolic dish cooker for smaller segments.

In the power segment, Thermax's portfolio comprises about 60 (completed and under execution) power/co-generation projects totaling to approximately 2000 MW on turnkey (EPC) basis for its clients. This turnkey methodology coupled with an in-depth understanding of over 100 different fuels, enables it to commission fast-track power plants with wide fuel flexibility and assured performance standards. Thermax provides EPC and O&M services for solar thermal power projects and solar photovoltaic off-grid and grid connected power projects. Leveraging its alliance for technology with reputed global players, for off-grid and grid-connected photovoltaic projects; Thermax ensures optimal value delivered across the project value chain.

Thermax has the largest number of working installations in the country today encompassing heating, cooking and cooling applications across various industrial sectors, commercial segments and educational institutions and has emerged at the forefront of the industry in a short time horizon. Every day Thermax helps save thousands of units of energy through its solar installations providing solar thermal and power solutions to several esteemed clients.

MNRE has accredited Thermax as a Channel Partner for off-grid and decentralized solar thermal and photovoltaic applications under Jawaharlal Nehru National Solar Mission based on CRISIL and





ICRA solar rating of SP1A indicating highest performance capability and high financial strength of the channel partner as a "Solar Thermal and Photovoltaic - System Integrator" to undertake "Off Grid and Decentralized Solar Thermal and Photovoltaic Applications".

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June 7, 2011 - Concentrating Solar at the Englewood Federal Detention Center in Englewood, CO. is used for heating hot water. (Photo by Dennis Schroeder / NREL)

Indo-German Energy Forum Support Office

IN TECHNICAL PARTNERSHIP WITH invensor making life cooler

SOLAR HEATING SYSTEMS AND COOLING BASED ON AN ADSORPTION CHILLER

Bibione Yacht Harbor relies on solar heating systems and cooling based on an adsorption chiller manufactured in Germany

Sophie Schieler

Solar water heating systems are extremely popular, particularly in the sun-drenched regions of Southern Europe. Heating raw water at campgrounds is a good opportunity to combine ecology and efficiency at tourist locations such as these. A tourism complex on the banks of the Adriatic Sea is now also taking advantage of this prestigious solar technology: solar-powered air conditioning with an adsorption chiller. Powered by vacuum tubes from the company Thermics Energie Srl, which is based in the region, an InvenSor adsorption chiller has been air-conditioning office spaces in the Portobaseleghe administrative buildings since the middle of 2013. The large, private harbor and camping complex forms the center of Bibione Mare near Venice.

The Bibione Mare harbor building

The vacuum tube collectors feature a capacity of 22 kW and are installed on the roof of a hall in the marina, 20 more moorings. They provide enough thermal energy for air conditioning in the summer (solar cooling) and heating in the winter. With a cooling capacity of 10 kW, the InvenSor LTC 10 plus chiller was installed in 2013, replacing an inoperable absorber from another manufacturer, and, like the previously installed chiller, is powered by heat instead of electricity. The InvenSor adsorbers use pure water as an eco-friendly refrigerant and therefore offer another major benefit for the environment, compared to conventional electrical chillers. In Portobaseleghe, the offices are air-conditioned using a cold-water distribution system. The InvenSor chillers in Germany are used in much the same way, but are usually driven by combined cooling, heat and power (CHP) or cogeneration units. Systems like this are also popular options for cooling server rooms and are gaining ground in industrial applications and thermal management.

In Bibione, a large, 2,000-liter hot-water buffer tank stores the heat generated by the solar collectors until it is fed into the building heating system or used to power the adsorption chiller. A smaller, 750-liter buffer tank is also supplied for cooling, providing reserve capacity when more cooling is required. The system's heat exchanger was installed in a shaded passageway through the harbor building, which is why the system can withstand Venice's warm climate with dry heat exchange.

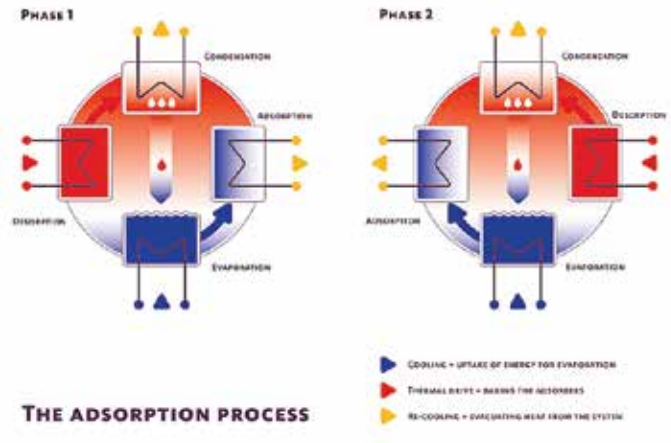
In Bibione, the combination of solar heating and air-conditioning was planned and implemented by the Italian company Thermics Energie Srl in 2008. To air-condition the rooms, an absorption chiller was initially installed by a supplier that is no longer in the market. It was replaced by an InvenSor chiller in the middle of 2013 to make the entire system operable again and it has been running reliably ever since, to the utmost satisfaction of the system planner and operator.

The Bibione Mare vacation resort was established in 1959 and welcomes thousands of visitors every year. It now has a harbor, three large campgrounds and four beaches. Because environmental protection and the use of renewable energy sources have always played a key role for the owners of Bibione Mare, most of the buildings on the extensive grounds have photovoltaic or solar water heating systems. The resort is setting new benchmarks with the solar cooling system.

The installed solar heat system

The installed LTC (Low Temperature Chiller) 10 plus adsorption chiller

For Stefano Bertolini, Sales Manager at Thermics Energie Srl, the solar cooling system is a great example of a well-running system: "Since it was installed, the new chiller has been working seamlessly. The owner and we are extremely satisfied with the savings achieved so far. The InvenSor machine has greatly decreased the number of maintenance sessions, which has also meant even more savings for the owner. The entire system is now exceptionally reliable. Similar systems are currently in our pipeline."



Cooling System:	InvenSor Adsorption chiller LTC 10 plus with a nominal capacity of 10 kW, 750 liter cold water buffer, Dry recooling, Cold water system used for air-conditioning
Heating System:	Thermics vacuum tube collectors with a nominal capacity of 22 kW, 2,000 liter warm water buffer.
Installation:	Replaced absorber from 2008, InvenSor Adsorption chiller June 2013

The InvenSor adsorption units are some of the most user-friendly ones in the market. For example, the target temperatures for cold water and the recirculation back into the driving cycle are extremely easy to set using the multilingual color-touch display. In addition, the unit is already set up for use in heat pump mode that can be activated on the device. Using the hydraulic system already integrated into the unit, specialists and planners can implement special solutions, such as the use of free cooling on cold days, without increasing the entire system's complexity and risk of malfunctions. The easy-to-operate start-up mode, automatic operating optimization, and the internet interface that is the included standard combine to make devices from InvenSor into plug-and-play chillers that are easy to use even without significant prior knowledge

INVENSOR - PIONEER IN USER - FRIENDLY ADSORPTION COOLING

Based in Wittenberg and Berlin, InvenSor GmbH is one of the world's leading companies in the development and production of adsorption chillers in the power range from 5 kW to 100 kW. Chillers from InvenSor produce cold water using heat instead of electricity to drive the system. Typical heat sources include combined heat and power units, solar power systems, and industrial processes. The possible applications for cooling are diverse, ranging from data centers, offices, and stores to the cooling of industrial processes. The company's engineers succeeded in making extremely effective use of zeolites in the adsorption units. Water serves as an environmentally friendly refrigerant. The company, which received the Kältepreis ("cooling award") from the German Federal Ministry for the Environment in 2009 and 2012 and the Intersolar Award in 2010, offers high-tech engineering "made in Germany."

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Alamosa Solar, CPV solar plant (Photo by Dennis Schroeder / NREL)

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CONCENTRATED PHOTOVOLTAIC SYSTEM

Forbes Marshall Case Study on Concentrated PV Systems

Rajesh Nair

For over half a century, Forbes Marshall has been building steam engineering and control instrumentation solutions that work for process industry. Forbes Marshall's goal is to provide solutions in Energy, Efficiency and Process Automation, using the best technology the world has to offer. 50 years ago we started out with steam generation solutions. Today we are comprised of twelve business divisions; most of them partnering with the world technology leaders in respective fields, manufacturing products that cover the entire spectrum of energy generation, energy efficiency, control and instrumentation for the process and power industry.

In the last five decades, Forbes Marshall has grown to a multi-divisional, ISO 9001 certified global company manufacturing advanced engineering products for process and power industries across the World. Forbes Marshall is probably the only company in the world to have extensive expertise in both steam and control instrumentation. The dual expertise has allowed us to engineer industry specific systems that focus on energy efficiency and utilities management for sectors as diverse as textiles, food processing, paper, power and chemicals etc.

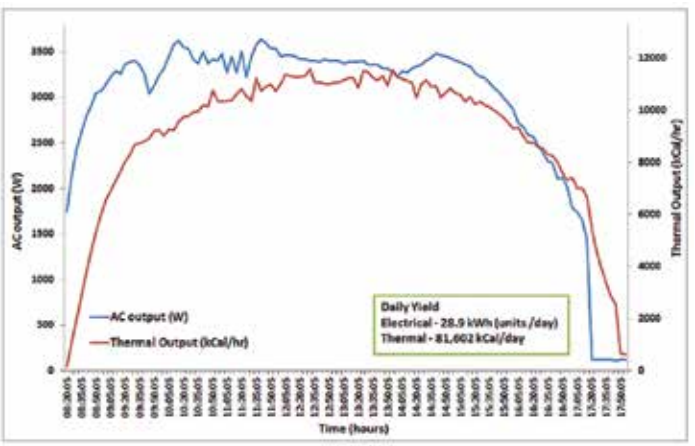
Forbes Marshall has always played a part in reduction of thousands of tons of greenhouse gas (GHC) emissions. Forbes Solar, our newest joint venture with Azur Earth GmbH, Germany, a company with 40 years of experience in space flight heritage, aims at taking the vast, untapped solar energy to the industry in a climate friendly way.

FORBES SOLAR has installed the Unique Combined Solar Heat and Power system at a manufacturing facility Close to Pune. It's a unique solution wherein both electrical as well as thermal outputs are generated from a single solar collector. Solar co-generation systems comprises of a solar concentrating collector system that includes a parabolic dishes each of size 16 m^2 and 2 dishes per system along with a thermo-photovoltaic receiver. The parabolic dishes are mounted on a common two axes tracking system. The thermo-photovoltaic receiver consists of very high efficiency (35%) Triple Junction GaAs Solar Cells that are actively cooled by water, thereby generating hot water as well. The system generates 7.5 kWp (DC) electrical and around 3.9 m^3/day of hot water at 55°C (peak values – actual generation may vary according to location).

This system is, thus, a fine example of integration of renewable energy and energy efficiency. In this system, the high efficiency solar cells give more power output over a much smaller area compared to conventional solar cells. The hot water generation is an additional output that captures the residual portion of the solar power captured by the cells that couldn't be converted into electricity, and makes it available for thermal applications.

The system has been giving outstanding results (please refer below chart for details). Primarily the electricity generated from the system is connected to one phase in the already existing electrical supply line of the factory with an energy meter fitted giving the outputs from the solar system. The additional hot water got from the solar system is fed to the boiler feed water tank. The system has been performing satisfactorily for more than 6 months.

Another similar system has been installed at a Pharma facility located 80 km from Pune. This too is a combined heat and power system where electricity is being used to add on to the power requirement of their Engineering department, while the hot water from the solar



system is fed into the feed water tank of boiler for the plant. Plant performance data from both plants are given below.

It is a unique solution wherein both electrical as well as thermal outputs are generated from a single solar collector, without loweirng the power generated from solar cells, rather increases the overall

system efficiency by making available for any thermal application, the part of the solar energy that could not be converted into electricity. Solar co-generation systems comprises of a solar concentrating collector system which includes a parabolic dish of 16 m^2 and a thermo-photovoltaic receiver. It consists of two parabolic dishes mounted on a common two axes tracking system thereby reducing the costs. A single module consists of two dish mounted on a two axis tracking system which has $\pm 0.2^{\circ}$ of accuracy in both the axes.

TECHNOLOGY & SALIENT FEATURES

- It is a thermo-photovoltaic receiver that consists of multi-junction Ga-As PV cells and a heat exchanger to cool that cells and take away the heat that may damage the cells and/or other system components
- PV cells generate around 7.5 kW (DC) of electrical output which can be directly used by DC loads or by AC loads thru a DC to AC converter. It can be also used to charge the batteries to use the solar electricity during non-solar hours.
- Hot water is generated as by-product of PV cells cooling. Up to 70°C of hot water can be generated through this system. It can be used as boiler feed water heating or directly used in any other thermal application.
- This co-generation system is ideally suitable for Indian conditions where installation space is always a constraint.
- Specially protected glass reflectors for very long trouble-free life without significant loss of reflectivity.
- Two – axis close loop precision tracking mechanism with minimum backlash.
- Designed for 20 years of service.
- Completely automatic operation requiring minimum operator intervention and maintenance.

Specifications

No of dishes per module	2
Aperture area (for two dishes)	32 m^2
Tracking	2-axis-fully automatic tracking system
Hot water	3.9 m^3/day
Maximum thermal output	17.4 kWth
Maximum electrical output	7.5 kW (DC)
Operating voltage	160 Volts (DC)
Operating wind speed	40 KMPH
Permissible wind speed	160 KMPH
Minimal shadow free area required	90 m^2

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Indo-German Energy Forum Support Office

GREEN TELECOM REVOLUTION – INDIA VS REST OF THE WORLD

Overview of the Indian Mobile Industry

Ankan Datta

The mobile telecom industry in India has been one of the biggest success stories in the world, serving one of the largest subscriber bases in the world with unimaginable tariffs as low as 0.000125 Euros per second or lower. The sector has seen unprecedented growth in the number of subscribers over the years of more than 50% within the last five years. Some of the mobile companies have offered free calls to any number only within their own networks at prices as low as 5 to 6 Euros a month, and 3G data plans of around 2 Euros a month for 1 GB.

YEAR	NUMBER OF MOBILE SUBSCRIBERS IN INDIA[1]
2010	621 million
2011	846 million
2012	951 million
2013	1048 million or 1.048 billion

Currently the industry serves more than a billion subscribers with more than 585,000 mobile towers[2] and 750,000 BTS (Base Transceiver Stations). Now comparing this with the United Kingdom that has 26,000 towers, one can really imagine the enormity of the sector in India. As the country progresses, and with the ongoing 3G and 4G expansions, the subscriber base would expand further, while the tariffs are not expected to increase that much. It must be noted here that only 70% of the Indian population has access to telecom infrastructure, and thus there is enormous scope for further expansion.

In India, the business model of the industry has been the delineation of the tower ownership and operation from the mobile service provider to keep the latter's costs down. The towers are then owned and operated by the telecom tower companies who bundle the networks for multiple service providers onto one tower to serve an area.

ENERGY CONSUMPTION IN THE INDIAN MOBILE INDUSTRY

The real reasons for keeping the tariffs so low include not only competition, but also some of the following innovative measures by the companies to reduce costs.

- Passive infrastructure sharing
- Replacement of old BTSs with the new more energy efficient and technologically advanced ones including the deployment of outdoor BTSs
- Optimised cooling solutions
- Deployment of Intelligent Transceivers (TRXs)
- Deployment of batteries to store power during hours of grid availability to be supplied during times of grid failures (cost of power from grid is mostly cheaper than from diesel generators)

The idea was to reduce the costs to as low as possible by intervening in every possible way ignore including increase of energy efficiency. The reduction of the energy consumption for the operations has stemmed also from the need to reduce the carbon footprints of the operations of these companies.

In India, the practice of bundling the networks for multiple service providers onto one tower to serve an area, has contributed to the installation of lesser than a fraction of 'the number of ' the towers that are needed to be deployed in case the towers were owned by the service companies unlike elsewhere in the world that necessitates the need for every company to deploy its own tower. The latter case not only increases the energy consumption, but also puts a pressure on the tariffs for the subscribers. Thus, in a large way, the Indian mobile telecom industry has a much lower carbon footprint compared to any its global counterparts.

More than anything, the fact that diesel costs to operate towers in areas of high grid failures or non-availability of the grids can sometimes be more than 50% of the total operations expenses. Around 20% of the towers are located in off-grid areas. With nearly 70% of the mobile towers located in the areas with grid failures of around 8 hours on an average, the total requirement of the diesel for the industry to ensure proper network connectivity that is vital to the nation's development, is well beyond 5.12 billion litres per annum[3]. Considering an emission factor of 2.78, this diesel consumption accounts for more than 14 million metric of CO_2 that is definitely a huge drawback of this industry.

[1] http://www.coai.com/Statistics/Telecom-Statistics/National
[2] http://www.energynext.in/at-least-50000-mobile-towers-should-switch-to-solar-mnre/

With increasing urbanisation and the ever increasing data requirements of the subscribers, some of whom even have dual SIM card (Subscriber Identity Modules) phones, these horrifying figures of the diesel consumption and the corresponding carbon emissions needed to be checked. If one extends the above table to include the corresponding prices of diesel in that period one may find an increase of the diesel prices by a half – the situation is that there has been a 50% growth in both subscriber base as well fuel costs.

Telecoms Tower https://www.flickr.com photos/yewenyi/474860427

YEAR	NUMBER OF SUBSCRIBERS IN INDIA (IN MILLIONS)[4]	DIESEL PRICES IN DELHI (IN INR PER LITRE)[5]
2010	62	38.10 (as on 01/04/2010)
2011	846	41.12 (as on 01/06/2011)
2012	951	41.28 (as on 01/06/2012)
2013	1048 (or 1.048 billion)	48.63 (as on 01/01/2013)
2014	NA	57.84 (as on 01/07/2014)

INDIA – WORLD'S 3RD LARGEST RENEWABLE POWERED MOBILE INDUSTRY

India being one of the largest importers of fossil fuels, is very vulnerable to global oil prices that has put a lot of pressure on the mobile tower operators who also find it difficult to arrange for the diesel supply for the towers located in the remote areas. With the deregulation of the diesel prices in India, coupled with the increase of 0.5 INR per month in diesel prices to curb the losses arising out of the increasing global oil prices, the diesel prices can go well beyond 65 INR per litre. At the current diesel prices, energy bills account for about 70% of the operating costs of the towers in the rural areas and for about 15 to 30% in the urban areas[6]. At 65 INR per litre or higher, fuel costs could account for 90% or more of the operating costs if every other cost is constant.

Thus, coupled with a huge number of measures to reduce energy consumption as mentioned before, the industry has now started to look into the new and renewable sources of energy to meet its energy needs such as bio-fuel, fuel cells, wind mills and solar power. This then serves several purposes as mentioned below, and also ensures the "green" growth of the industry.

- Reduction of energy bills
- Less dependence on the supply chain systems to ensure diesel supply to the towers
- Less dependence on the grid for supply of power
- Cushion against any increases of energy costs in future to minimise the need of tariff increases
- Expansion of the telecom infrastructure to off-grid and remote locations to increase the subscriber base further
- Reduction of carbon emissions to make the industry more competitive

Compared to other countries[7], one can see that India happily occupies the 3rd position in the world for the deployment of the renewable energy based telecom towers preceded by China and Indonesia while being followed by France and Cambodia. Rest all other countries have 1000 or lesser numbers – especially notable are the most developed economies, such as Germany and USA that have only 2 and 1 respectively. Also notable from the following data is that France is the only developed country to have installed such mobile towers among the top 10 countries in the world to do so. This highlights the fact that the ever increasing need for and the corresponding shortages of fuel in the developing countries have forced the companies to reduce their dependence on fossil fuels as well as power supply from grid and to move to the renewable sources. Adopting the latter is extremely beneficial when one looks at the long term sustainability of the industry as well as providing attractive tariffs to the consumers.

[3] http://www.energynext.in/at-least-50000-mobile-towers-should-switch-to-solar-mnre/
[4] http://www.coai.com/Statistics/Telecom-Statistics/National
[5] http://www.mypetrolprice.com/2/Diesel-price-in-Delhi?FuelType=1&LocationId=2
[6] Adoption of Green Technology and Safety of Wireless Network by Milan Jain (Sr. Research Eng. – Converged Network, TRAI)

COUNTRY	NUMBER OF MOBILE TOWERS POWERED BY RENEWABLE SOURCES[8]	WORLD RANKING IN ADOPTION OF RENEWABLES BY MOBILE INDUSTRY (AS ON 10TH JULY 2014)	WORLD RANKING IN SIZE OF ECONOMIES IN 2013[9]
CHINA	22,763	1	2
INDONESIA	4590	2	16
INDIA	3413	3	10
FRANCE	2310	4	5
CAMBODIA	1626	5	118
NIGERIA	795	6	23
PAKISTAN	609	7	43
BANGLADESH	523	8	57
SAUDI ARABIA	500	9	19
EGYPT	456	10	40
UNITED STATES	1	-	1
JAPAN	300	-	3
GERMANY	2	-	4

INDIAN PRIVATE SECTOR INITIATIVES TO ADOPT RENEWABLES

The cost of installation of solar power systems for a mobile tower is well beyond 200,000 INR. Currently the three major renewable sources that are deployed for the mobile towers are biofuels, fuel cells and the solar photovoltaic (PV) modules. The following table shows the detailed deployment of the renewable energy sources in hybrid mode for the towers by the major telecom tower companies in India.

TELECOM TOWER COMPANY	BIO FUEL	FUEL CELLS	SOLAR PV	TOTAL
Bharti Infratel	4	5	1650	1659
GTL	0	0	80	80
Idea Cellular	1	35	590	626
Indus Towers	8	0	650	658
Vodafone Essar	0	0	390	390
NATIONAL TOTALS	13	40	3360	3413[10]

In all, 3413 towers are getting powered from the renewable sources in which the major share is still by solar energy, while the other two suffer from uncertainties in fuel supply – biomass for biofuels and hydrogen for fuel cells.

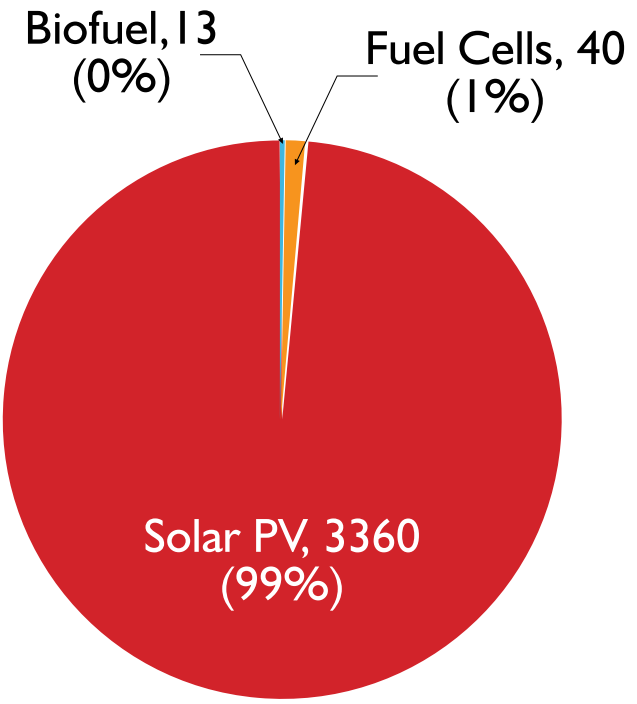

Chart showing the share of various renewable energy sources in the Indian mobile industry[11]

The Tower and Infrastructure Provider's Association (TAIPA) has engaged with the Renewable Energy Service Companies (RESCOs) so that the latter installs the renewable energy systems at their own costs, while the mobile tower company pays for the power used as well as the savings achieved from non-usage of the diesel. This is an unprecedented example that has been the resultant of the industry practice of bundling the networks onto a single tower. This model is not only cost effective when run on diesel power, but also equally effective to hive-off the large capital investment needed to install such renewable energy systems without affecting the mobile tariffs much.

INDIAN GOVERNMENT INITIATIVES TO PROMOTE RENEWABLES IN THE MOBILE INDUSTRY

While the Indian mobile industry is combating the power supply scenario for its mobile towers by adopting the renewable sources, the Indian government has also initiated several measures to complement such activities to make the industry more sustainable given the extreme importance of a highly efficient and a comfortably priced communication systems in the overall development of the nation.

In fact, India, in response to its growing energy demands, was the first country in the world to have established a separate ministry to promote renewables, namely the Ministry of New and Renewable Energy (MNRE). In conjunction to that, the Telecom Regulatory Authority of India (TRAI) has also come out with its own regulations to promote the adoption of the renewables to run the mobile towers, especially eyeing the rural off-grid remote locations.

The following major initiatives from the Indian government have, thus, been presented here:-

NATIONAL SOLAR MISSION

- This is the flagship programme of the Indian MNRE to promote solar energy in the country that envisages the installation of 200 MW of off-grid solar applications by 2013, totalling to 2200 MW of net installations by 2022. Under this scheme, several incentives and subsidies have been rolled out which have seen very good reception in the market. Particularly important for the mobile industry are the financial incentives for the solar installations of capacities less than 100 kWp.

- The MNRE announced its support for 400 mobile towers in particular under the National Solar mission. The incentive from the MNRE included 81 INR per Wp towards the capital costs of the project. This resulted in the major private companies in Indian adopting the solar PV powered mobile towers such as Airtel putting up 100 towers in the state of Bihar while both Indus and GTL Infrastructure doing the same numbers in the states of Andhra Pradesh and Uttar Pradesh respectively. The state owned telecom company, Bharat Sanchar Nigam Limited (BSNL), had also established around 100 towers in across 12 Indian states.

GREEN TELECOM MANDATE

- MNRE – The MNRE in 2013 mandated the installation of solar PV systems for 50,000 mobile towers in response to the extremely high quantities of diesel putting a strain on the forex reserves of the country

- TRAI – The TRAI has also mandated the Indian mobile telecom companies to adopt renewable energy sources for the mobile towers in the following way

YEAR	PERCENTAGE OF THE TOWERS TO RUN ON RENEWABLES	
	URBAN AREAS	RURAL AREAS
2015	20	50
2020	75	33

[7] http://www.gsma.com/mobilefordevelopment/programmes green-power-for-mobile/tracker as on 15.07.2014
[8] http://www.gsma.com/mobilefordevelopment/programmes/green-power-for-mobile/tracker as on 15.07.2014
[9] http://data.worldbank.org/indicator/NY.GDP.MKTP.CD as on 15.07.2014
[10] http://www.gsma.com/mobilefordevelopment/programmesgreenpower-for-mobile/tracker as on 15.07.2014
[11] http://www.gsma.com/mobilefordevelopment/programmes/green-power-for-mobile/tracker as on 15.07.2014

https://www.flickr.com/photos/osde-info/2790088900

Indo-German Energy Forum Support Office

IN TECHNICAL PARTNERSHIP WITH taipa

Tower and Infrastructure Providers Association

GREEN TELECOM IN INDIA

Brief note on TAIPA Initiative on Green Telecom

taipa
Tower and Infrastructure Providers Association

Bhaskar Banerjee • Tilar Raj Dua

INTRODUCTION

The increasing emission of Green House Gases (GHG) is a legitimate concern as it threatens the health and quality of life of citizens across the world. It is difficult to justify use of harmful fuels when cleaner and affordable options exist or, if the use of such fuel is for non-essential purposes such as e.g., air-conditioning and lighting at a late-night party or power for an advertising billboard. On the other hand, it is clear that services like trains, telephone, hospitals, movement of food, security etc. are absolutely essential and must be available 24x7 without interruption or deterioration of quality.

As serious players in the telecommunications sector and as responsible citizens, we recognize the need for steps to reduce this carbon footprint. Such steps, however, must recognize the concern for telecommunications that touch virtually all aspects of the economy and citizens.

India's telecom operators provide excellent mobile services at some of the lowest prices in the world and earn the lowest revenues per user. They are agents of development and hardly the ruthless commercial players pursuing profits at the cost of the environment, as is being positioned by vested interests.

Nationally, electricity grid currently meets barely 33% of Telecom Infrastructure energy needs and therefore, they are forced to address the deficit by other energy sources available to them. Majority of off-grid energy sources in use today are non-renewable and polluting.

FACTS ABOUT DIESEL USE AND TELECOM MOBILE INFRASTRUCTURE

The attempts to restrict or penalize telecom towers because they use large amounts of diesel miss the important point that this use is for a critical infrastructure and service. It is frequently forgotten that Mobile Infrastructure Companies use diesel as an option of last resort - Diesel is an expensive fuel, with high costs for movement as well as storage, that brings with it issues of safety and misuse. Besides the obvious concern for pollution, it would make eminent commercial sense for companies to use a cleaner or safer alternative if it existed. The experience with thousands of standalone solar solution deployments confirms that the assumptions about the life cycle of solar PV systems and batteries are overly optimistic. The extremely high upfront costs and the accompanying technology risk have deterred roll-outs on a large scale.

The recent All India Study conducted by M/s Nielsen (India) Pvt. Ltd. for 'Petroleum Planning and Analysis Cell' (PPAC) of Ministry of Petroleum and Natural Gas has re-affirmed the fact that Telecom Infrastructure Providers are only the miniscule users of Diesel compared to other sectors like Transportation, Railways, Agriculture, etc. As per the report, 70% of diesel and 99.6% petrol is consumed in the transport sector alone whereas Mobile Towers consumes only 1.54% of the total diesel consumption.

KEY CONCERN AREAS WHICH ARE FREQUENTLY FORGOTTEN

i. Telecom Infra Companies use diesel as an option of last resort

ii. Telecom Companies cannot meet their License Obligations/ Quality of Service

iii. It is untenable to single out Telecom Infra Companies as threats to environment

iv. Telecom Infra Companies provide connectivity that mitigates other infrastructure gaps

v. Telecom Infra Companies deserve higher priority than several currently authorized users of Generators e.g. hotels, Group Housing Societies, etc

vi. Telecom Infra Companies prefer rechargeable batteries to Generators

vii. Telecom Infra Companies comply with existing regulation relating to emissions

Telecom Infra Companies recognise that renewable energy is important for their long term success. They have worked closely and constructively with MNRE to facilitate movement to cleaner power including solar, wind and other sources. They are participating in several efforts to improve the viability of renewable energy. Their position paper supports MNRE's endeavors to see Renewable

Energy Service Companies (RESCOs) have viable business models. The Mobile Infrastructure Companies are willing to be Anchor clients for RESCOs distributed model.

Therefore, any intervention in the telecom sector requires careful analysis of costs and benefits. In addition, such steps must also be effective and sustainable.

GREEN TELECOM DIRECTIVES

The DOT guidelines issued vide its letter dated 23 January 2012 mandates the Telecom Service Providers, whereby it was required that :-

a. At least 50% of all rural towers and 20% of the urban towers are to be powered by hybrid power (Renewable Energy Technologies (RET) + Grid power) by 2015;
b. Further 75% of rural towers and 33% of urban towers are to be powered by hybrid power by 2020.

Experience with RET of Telecom Industry

KEY OBSERVATIONS FROM ABOVE RET INSTALLATIONS ARE:

- RET installations installed at only Ground based telecom towers, predominantly in rural areas
- Space for solar installation not available at majority of the sites (as per BSNL experience on 100+ sites pilot, space not available at 80% sites)
- RET installations are widely scattered due to Telecom towers being distributed and further very less sites are feasible
- Periodic PV panel cleaning is a challenge due to non-availability of water at site, adversely effecting solar output.
- This results in considerable maintenance expenses to maintain Solar set up.
- Output from solar set ups at telecom towers are considerably low, as compared to MW scale solar power plants:

S. No.	Sector Average	Solar Power Generation, kWH/kWp/day
1	Telecom sites	3.5
2	Grid connected MW scale plants	4.5-4.8

This clearly indicates 30% of incremental capex per MW as against conventional MW scale solar farms.

Without considering the technical and operational challenges, the capital investment required for these many installations alone stands out to be gigantic Rs. 66,000 Crores by 2020 to meet the targets.

The said target is clearly unachievable as it amounts to 100+ RET deployment per day, every day till 2015. For the period 2012 to 2015 this amounts to the following: -

i) Total number of towers 440,000
ii) 70% in rural areas 308,000, 50% of this is 15,4000
iii) 30% in urban areas 132,000, 20% of this is 26,400
iv) Total towers to be powered by hybrid power (Renewable Energy Technologies (RET) + Grid power) by 2015 is 154,000+26,400 = 180,400
v) Time available for achieving target from 2012 Feb (11 months) to Jan 2013 - Dec 2015 (36 months) = 47 months
vi) Monthly target to be met 180,400/47 = 3838 towers per month.

FINANCIAL IMPACT

- 3 Lakh Towers powered by RET by 2020 (~3 GW)
  – This is Twenty three times the current installed off-grid / captive solar power in India
- Current off grid / captive solar (>1 KW) installed capacity is 0.13 GW (as on 30.6.2013)
  – Double the current installed solar power in India
- Current solar installed capacity is app. 1.5 GW
  – 1.5 times country's off-grid solar application target for 2022
- 2 GW is cumulative off-grid solar application target under JNNSM (2010 - 2022)
  – 15% of MNRE's target of grid interactive RET power for 2011-17
- MNRE target for Grid RET = 21.7 GW
- Monthly run rate to achieve target of 2 Lakh towers powered by RET by 2015 (~2 GW) (in 33 months, April 2013 to Dec 2015)
  – 6000 RET installations (60 MW) per month
  ≈ 1200 Cr per month

CHALLENGES TO MEET GREEN TELECOM DIRECTIVES

Despite significant challenges, various RET options have been tried by the industry at multiple locations with telecom operators having installed Solar solutions at almost 4000 locations. Having considered other options as well, no other RET could get scaled up. Further, it has been experienced that even in case of solar deployments; there are serious technical and practical challenges at the eligible telecom tower sites as stated below:

i) A major constraint is the availability of minimal essential area to place the solar panels - due to which Roof Top Towers (RTP) sites have to be ruled out for eligibility for solar installations.
ii) Solar solutions due to very limited power output (Approx. 15% of installed capacity) are hardly capable to power outdoor, non-shared / very low load shared GBT sites.
iii) In our opinion, the goal is to reduce dependence on diesel and the distinction between Rural and Urban is unhelpful. Therefore, in Urban areas we should be limiting ourselves to batteries as a clean source of energy.
iv) We do not have enough number of Vendors and solutions in Solar & Bio-mass – two technologies available & being

implemented currently to deploy as-many number as envisaged in DOT notification.

v) Further, due to space and other techno-economic constraints, the typical capacity of a Solar Power System is about 2-3 KW, which is suitable only for the sites with single tenancy. Hence, these sites would NOT be capable of being shared with other operators.

Industry has already requested DOT to re-look/ review at these targets taking technical feasibility into account.

INDUSTRY INITIATIVES – REDUCTION OF CARBON FOOTPRINT

Some of the key initiatives taken by telecom infrastructure companies to reduce diesel usage along with reduction in overall energy consumption thereby reducing carbon footprint are listed below. It is pertinent to mention that all such efforts have been undertaken not because of any guidelines by the government but as a measure of our intent towards a cleaner society.

- While building new sites the industry is focusing on Outdoor site (by doing this, Air-conditioners are eliminated reducing the DG/Diesel consumption)
- The batteries are drained upto the maximum extent possible. Though this reduces battery life but also considerably reduces DG/Diesel usage at sites.
- All new sites are now provided with FCU (Free Cooling Unit) inbuilt with Aircons sites which uses ambient air for cooling to cool the shelter.
- New sites are also being put with Inverters to delay/minimize DG run to operate Aircons on battery during the power cut.
- We are doing trials on Fast charging batteries/ other new technology batteries which can handle intermittent power cuts & gives backup. Please note that these are quite costly batteries as compared to current VRLA batteries but helps in reducing DG/Diesel usage.

Additionally, we must highlight that due to the increase in tenancy ratio, the DG/ Diesel consumption has considerably reduced. This has been possible only through the innovative concept of 'Sharing of Towers'. Some of the key benefits of Tower sharing are :

- Economics : More efficient Use of Capital for creating national assets,
- Aesthetics : Reduce Tower Proliferation and improved Aesthetics
- Service Access : Faster Rollout,
- Safety : players have incentive to follow prescribed norms
- Protects Environment & Energy savings
- Quality of Service : Better coverage quality
- Standardization : by using IIT/TEC designs for Towers

Moreover, we would like to highlight that towers are already operational on Renewable Energy technology (Hybrid model) at various telecom tower sites presently and the industry is keen to scale up the deployment of Green technologies in the near future.

As a concerted effort to try and comply with the DoT directive, the tower infrastructure industry floated the RESCO RFP, to attract RET companies and related experts to collaborate with the telecom industry for faster and practical implementation. More than 70 RESCOs were interacted with, and finally 2 RESCOs (CMES Pune and Mahindra & Mahindra) were engaged for potential deployment of RETs at 1100 sites. This also exhibited very slow progress in implementation on ground due to challenges with regard to scalability and unviable business model.

DoT constituted a committee and collated the data / experience of RET installations in telecom across the country. The Committee has decided the following:

a) To engage with Planning Commission, Department of Economic Affairs, Ministry of Finance, etc.

b) To repare Detailed Project Report (DPR) to develop the accelerated road map of RET deployment in Telecom sector by a third party Consultant to evaluate suitable technology and required VGF quantum & soft funding from various sources.

The report of the independent third party consultant is expected soon.

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Indo-German Energy Forum Support Office

IN TECHNICAL PARTNERSHIP WITH

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Helping banks reach out

SOLAR POWERED ENERGY EFFICIENT ATMS

ATM Machines

C. Rajasekar • Ankan Datta

ATM machines not only help a bank become more competent and cost effective, but also help the consumers access some or most of the facilities that a bank's branches would offer at any time of the day and at any place. This is why when opening a branch at a remote geographical location becomes not profitable, most banks start an ATM there and advertise it boldly, a move that helps the bank get more customers as well. These and many such advantages that the 'ATM Revolution' has brought, have led to unprecedented increase in the number of ATMs all over the world making banking services available to more and more people in the world. The story has also been the same in India where the increase in the number of ATM installations has been at a CAGR of nearly 30 percent from 2005 to 2011 and would continue to do so in the next 5 years from 2012 to 2016[1]. Moreover it must be noted that out of the 1.2 billion people in the country, nearly 40 percent or 480 million people are yet to receive banking services, a fact acknowledged by all. In fact, India has an ATM penetration of about 0.04 per 1000 people.

Till September, 2013, the country had 114,000 ATMs[2] that were functional – now one can imagine the situation when all these 480 million people start receiving banking services. One study by Celent has predicted that the number of ATMs in the country could double up to 200,000 or more by 2016[3]. There is yet another study by the World Bank's International Finance Corporation (IFC) that predicts the growth in the number of ATMs to be three-fold by 2015[4]. This really shows that the country is prospering and its citizens are receiving the fruits of the development. But there is something that one has totally ignored while feeling good about the development, is Newton's 3rd Law – Every action has an equal and opposite reaction.

One would wonder, why this thing is being talked about here. Well, when one is standing in a standard ATM booth in India and looks around, what is it that he or she sees – the ATM machine (of course), an air-conditioner, two or more tube lights – just summed up the power consumption equipment in the booth. All these things cannot run on their own and, thus, consume electricity from the grid, and thanks to fact that these equipment run 24 hours and 365 days is a cause of concern. A brief calculation of the power consumption in an ATM booth is shown below, along with a possible cost of the electricity consumption.

TABLE1: POWER CONSUMPTION AND COSTS IN A CONVENTIONAL ATM BOOTH

Equipment	Power Load/Costs	Assumptions
ATM machine	400 watts	Normal power consumption of an ATM
Air-conditioning	1500 watts	1.5 to 2 TR ACs are normally used
Lights	40 watts	At least 1 tube light per booth is used
Total Connected Load	1840 watts	
Total Connected Load	1.84 kilo-watts	
Hours of operation per day	24 hours	
Daily energy consumption	44.16 kWh	
Annual energy consumption	16,118.4 kWh	
Cost of electricity	₹ 8.00/kWh	Considering an average of the electricity prices that vary from 7 to 9 for domestic consumption.[5]
Annual Expenditure on electricity	₹ 128,947.20	

[1] Edelweiss (2012). Indian Payment Industry in 2012. Available at http://tsi.swishdesign.com.au/wp-content/uploads/2011/08/Indian-Payment-Industry-2012.pdf
[2] http://www.kenresearch.com/banking-financial-services--insurance-bfsi-/banking/india-atm-industry-research-report/394-93.html
[3] http://www.celent.com/reports/indian-atm-industry
[4] http://www.ifc.org/wps/wcm/connect/49a11580407b921190f790cdd0ee9c33/India+Scoping+report+063013+for+publication.pdf?MOD=AJPERES
[5] Commercial consumption rates have not been considered here. If those rates are considered, then the savings indicated in the article would be even higher.

Well some of the points and figures that have been mentioned above need further analysis to see what is the connected load of all ATMs in the country and how that would look in the near future.

TABLE 2: POWER LOAD OF ATMs IN INDIA

Electricity load per ATM booth	1.84 kW
Number of ATMs by September 2013	114,000
Total connected load as on September 2013	209.76 MW
Number of ATMs by December 2016 as per CELENT	200,000
Total connected load as on December 2016	368 MW
Number of ATMs by December 2016 as per IFC	300,000
Total connected load as on December 2016	552 MW

This simple calculation done above shows the gravity of the situation in terms of the connected load on the electricity grids in India doubling up with the doubling of the number of ATMs, when the country has been gripped badly by the energy crisis. Please note that predictions have not been made till 2030, but guess that would be really scary. One may also imagine the associated carbon emissions and the long term climate impact of this aspect of development. The answer to this whole issue is to reduce the energy consumption and shift the power supply to ATM booth from the grid to the renewables.

It is at this critical juncture that a solution has been developed by an Indian company, Vortex Engineering Private Limited. The company has developed an ATM machine that not only consumes 60 watts compared to the normal machines that consume 400 watts, but also does not need any air-conditioning at all. In fact, the company has tested them to perfectly functional within a temperature range of 0° to 50° Celsius.

This was achieved by a patented dispenser mechanism that consumes very less power and reduces cash jams. This technological breakthrough, having made this ATM the world's lowest power consuming one – on an average consumes 60 watts of power – has enabled it to be run on solar power completely, thus been branded "ECOTELLER ATM".

Vortex ATMs operate at a temperature range of 0° to 50° Celsius, whereas the conventional ATMs are designed to work at a temperature range of 0° to 40° Celsius. The Ecoteller consists of a beltless design, and at any point of time, requires only 2 motors to run, thereby dissipating very less amount of heat – a feature that eliminates the need for any air-conditioning.

All public and private banks and many cooperative banks use Vortex ATMs. Vortex ATMs are chosen over the other systems because the conventional ATMs consume very high power, require air-conditioners for smooth functioning and have higher operating cost whereas the initial usage of ATMs are normally low because of which the time taken to reach the commercial breakeven is very long for a machine. The Conventional type of ATMs that the MNCs provide does not suit the conditions existing in many parts of India. For example the rural and the semi urban area do not have continuous supply of power. This means power backup capacity needs to be high, no air-conditioning for long durations and also, many a times no support from the renewable sources.

As far as the product features are concerned, Vortex ATMs are at par with any other ATMs in terms of the product features and capabilities. In addition, vortex ATMs come with biometric security system (finger print scanner) that enables the illiterate people anywhere to use either this biometric identification or the Personal Identification Number (PIN) to use their ATM or credit cards. In addition, they have a multi-lingual support and a 10 inch LCD screen and an up-grade to 4 cassettes at no cost for the hardware change.

Vortex Engineering is an ISO 9001:2008 certified company across design, manufacturing and services. From a climate impact point of view, per 1000 transactions through one of this ATMs reduces at least 18,500 kg carbon dioxide equivalent emissions provided the solar option is there with the concerned machine, while as per the Reserve Bank of India, around 191 ATM transactions are conducted every second in India. Now coming to the market acceptance, the machine has a high degree of security with a UL291 L1-certified CHASSIS. In terms of the size of the machine, the machine is smaller in size compared to conventional ATMs, and thus, saves money by requiring a smaller ATM booth in turn reducing the commercial rent pay-out for the space.

Some of the customers of Vortex Engineering include – but not limited to – State Bank of India, Bank of India, Bank of Maharashtra, Dena Bank, Indian Bank, Central Bank of India, Union Bank Of India, Federal Bank Limited and Andhra Bank. These ATMs have been deployed across 17 states in India, with a client base that is now extending well into Africa and the rest of Asia. In all about a thousand ATMs from Vortex are running successfully without any issues.

Having seen the technical feasibility of these machines and wide acceptance, let us now move into the commercials of the systems. Given below is a calculation that shows how 90% of the electricity cost is saved if the Ecoteller is NEITHER run on solar power NOR with the power back-up.

TABLE 3: POWER CONSUMPTION AND COSTS IN AN ECOTELLER ATM BOOTH		
Equipment	Power Load/Costs	Assumptions
ATM machine	60 Watts	
Air-conditioning (1.5-2 TR)	-	No AC required for Ecoteller
Lights	40 Watts	
Ceiling/Table Fan	100 Watts	One ceiling fan added for the comfort of the security guard for the Ecoteller
Total Connected Load	200 Watts	
Total Connected Load	0.2kW	
Hours of operation per day	24	
Daily energy consumption	4.8 kWh	
Annual energy consumption	1752 kWh	
Cost of electricity	₹ 8.00/kWh	Considering an average of the electricity prices that vary from 7 to 9 for domestic consumption.[1]
Annual Expenditure on electricity	₹14,016.00	

TABLE 4: ANNUAL ELECTRICITY SAVINGS BY ECOTELLER ATMs	
Annual Expenditure on electricity for an conventional ATM	₹ 128,947.20
Annual Expenditure on electricity for an Ecoteller ATM	₹ 14,016.00
Savings on electricity consumption	₹ 114,931.20
Percentage of energy cost savings	89.1 %

One can imagine that if the solar panels and the power back-up options are now used, the net expenses on the electricity would actually be nothing other than 0 (Zero) leaving a 100 per cent savings on cost of electricity.

The other important thing is that the price of this Ecoteller ATMs is about 20 to 30 per cent lower compared to the conventional ATMs – that again brings into light the fact that the bank that purchases would enjoy the following benefits that would make the Ecoteller the best of all:-

- 20 to 30 percent lower capex
- Lower commercial rents for lesser space needed by the compact systems
- Up to 90 per cent savings on electricity without the solar and the power back-up options and up to 100 per cent if they are used
- Massive reductions in carbon footprint of bank operations through solar options that make the system operation independent of the electric grid

SOLAR OPTION:

Because of the ultra-low power consumption, it is also possible to power these ATMs with compact solar panels. In case, there acute power shortage and there is need to use alternate power, solar energy can opted for since it is available everywhere in the country abundantly. To enable this, Vortex also offers Solar UPS from a qualified vendor as an option.

Vortex offers 375 watt peak solar panel where the panel size is less than 50 sq. ft (that requires a roof area of less than 60 sq. ft.) with 800 VA hybrid UPS and 120 AH battery. It provides a backup for at least 8 hours. Typically 5 hours of sunlight is enough to charge the batteries of this size for 8 hours back up. With a higher battery capacity and accordingly sized solar panels, the machine operation would become totally grid independent – the company offers solutions for 12 hours power back-up. The operation of the Ecoteller ATM is such that during the day time, the solar panels not only provides enough power to run the machine and to charge the battery, but also provides excess power to the grid.

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Helping banks reach out

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[6] Commercial consumption rates have not been considered here. If those rates are considered, then the savings indicated in the article would be even higher.

SkyFuel ReflecTech advanced parabolic trough solar collector mirror
(Photo by David Hicks / NREL, NREL No. 18553)

Indo-German Energy Forum Support Office

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

SOLAR HEATING AND ENERGY STORAGE SYSTEM

Solar air heating in Ladakh

Anant Shukla

THE CHALLENGE

Living conditions for around 270,000 residents in the arid spans of the Ladakh region is tough with extremely cold and more than seven month long winters and low precipitation. The region witness scant irregular rainfall and therefore the availability of biomass is limited. Dried cow dung and sporadically available shrubs are the only energy sources in the area. Fossil fuels, such as coal, petroleum products or liquefied petroleum gas (LPG) are very expensive in this region due to higher transportation cost from low lying areas and only two approach roads Ladakh region is accessible for only 6 month in a year.

The altitude of Ladakh is 3000 meters above the sea level with very low oxygen content in the atmosphere (NIC Leh n.d.); at this altitude the efficiency of combustion is low, and results in higher fuel consumption to meet the demand.

ENERGY SITUATION IN LADAKH

The demand for electricity in Leh, is growing at a rate of 7% annually (Thirumurthy, et al. 2012). The power generation is done mostly through diesel generators (65%) and hydro, and remaining from renewable energy sources. During the winter season when the region faces sub-zero temperatures (Figure 1) (Mueller 2013) traditional and conventional methods are used for heating indoors. The government buildings that consist of mainly offices and hospitals, are the mostly heated buildings. The residents use crude heating devices such as Bukharis (wood burning stove), kerosene/wood stoves and sometimes LPG to heat the homes during harsh winter, when temperatures goes as low as -28°C (www.weatherbase.com n.d.). The demand and consumption of energy for heating in buildings is increasing significantly every year with new construction sites and growing hotel industry. The demand surges further because of the increasing number of tourists that incidentally is the main source of income for the local residents.

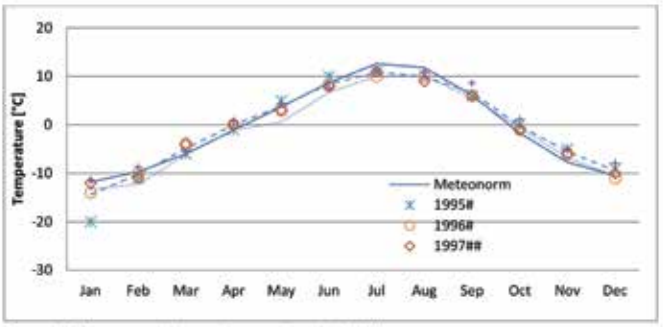

Figure 1. Average minimum temperature in Ladakh

Solar thermal systems offer a high saving potential of fossil fuels that has been hardly used so far in this region for space heating. Solar radiation in Ladakh is among the highest in the country. Average daily global solar radiation in Ladakh (Figure 2), (LEDEG and Jacobson, Renewable energy resource data collection in Ladakh, India - A summary of data collected in 1997 1998), (LEDEG and Jacobson, Renewable energy resource data collection in Ladakh, India - A summary of data collected in 1998 1999)) is as high as 24.6 MJ/m^2 (www.weatherbase.com n.d.). The availability of simple, efficient, cheaper solar thermal system manufactured with locally available materials has not only competitive advantage, but also reduces dependency on conventional fuels for heating. The reliability of the solar air heating system is further increased by a thermal energy storage system and insulation of the houses.

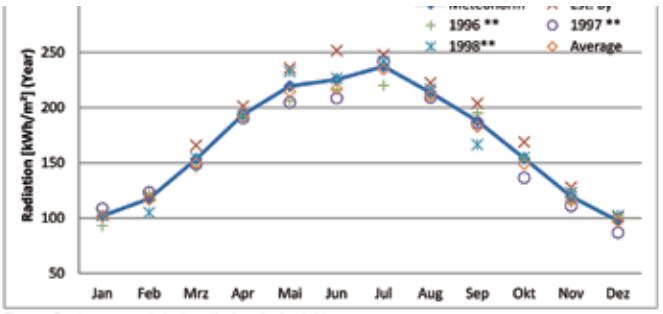

Figure 2. Average global radiation in Ladakh

OBJECTIVES

The main purpose of the project is to adapt and disseminate the solar heating concepts for buildings with thermal energy storage technology for the high altitude region of Ladakh through pilot

projects. This will help in offering sustainable solutions for energy demand in Ladakh and similar cold climatic regions.

INSTITUTIONAL ARRANGEMENT

Since there is limited know-how and experience in Ladakh on the solar air heating with thermal storage, a project is jointly being implemented by the Ministry of New and Renewable Energy (MNRE) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). The project is being implemented with active cooperation with state nodal agencies viz. Ladakh Renewable Energy Development Agency (LREDA) and Kargil Renewable Energy Development Agency (KREDA). International and national experts are engaged for specific tasks, in addition to developing working arrangements with local NGOs particularly Ladakh Ecological Development Group (LEDeG) that has significant local experience in implementing solar projects in the past. The project is funded by the German Ministry of Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

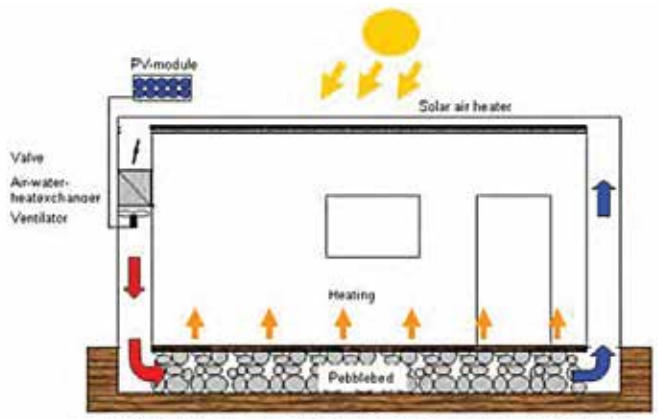

Figure 3. A concept view of the typical solar air heating system with storage

SOLAR AIR HEATING SYSTEM: DEMONSTRATION PROJECT IN LADAKH

The demonstration project in Ladakh is the first light house project of its kind in the Asian continent. Based on technologies for solar heating of buildings (Figure 3), a system was developed by the Solar Institute Jülich (SIJ), Juelich (Germany) for the Altiplano mountain region in Argentina. The knowledge gained during the last 15 years (Mueller and Schwarzer, The Use of Solar Energy for Improving the Living Conditions in Altiplano, Argentina 2004) is being utilized for developing a reliable, economical and locally manufactured solar air heating systems in Ladakh.

Two houses were identified for the first phase of the project. One of the houses was a guest house called Kurja guest house. The collector system was designed to cover the total heating demand during the whole year. In the system installed, the heat needed to warm up the buildings is collected by a solar warm air unit (or solar air collector, Figure 4), on the roof of the guest house.

The system heats up air during sunshine hours; the heated air is circulated inside the building through highly efficient fans powered by solar photovoltaic panel of 60 W. The hot air circulated is used to heat up pebble bed thermal energy storage (figure 5), beneath the floor of the building. This serves not only as a heat storage system, but also as an underfloor heating system that heats the room directly. Once the thermal storage is heated up, the heat is transferred to the indoors throughout the day. During extreme cold season the heated air can directly be circulated through the indoor giving an instantaneous heating effect. To save the energy generated from the sun, the house was protected from external weather through insulation. The insulation has helped reduced the heat demand to less than half of the original demand without heat protection.

During the winter upto 80 -100 % of the total heat demand in Kurja house can be covered through these solar collectors. The system can cover up to 97 % of the average yearly heating demand at a room temperature of 15°C, when the indoor temperatures are maintained at 18°C, the system can cover up to 92 % (Figure 6). The total heat demand of Kurja house is 5296 kWh per annum at a room temperature of 18°C and 4150 kWh per annum at 15°C, 22 % less than at when maintained at 18°C.

Figure 4: A demonstration solar air heating system installed on the roof of a house in Leh

Figure 5. Pebble bed thermal energy storage at Kurja guest house in Leh

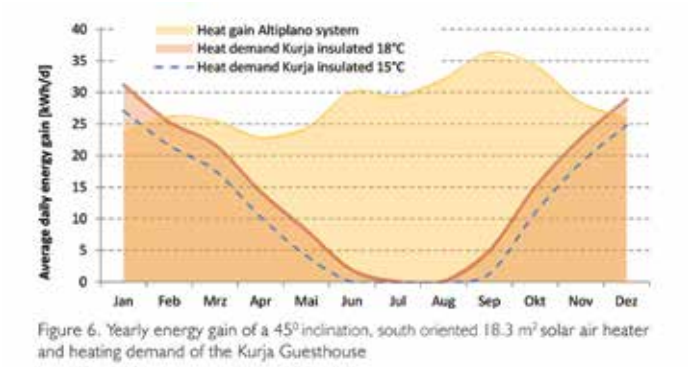

Figure 6. Yearly energy gain of a 45° inclination, south oriented 18.3 m² solar air heater and heating demand of the Kurja Guesthouse

Solar air heating system in Ladakh has several advantages over a liquid based system especially in extreme winters. As air is used as the heat transfer medium, the low thermal capacity of air enables the system to have low response time so that the heating effect is ready for use soon after sunrise. A small air/water heat exchanger can also be easily integrated to prepare hot water for sanitary use. The flexibility of the design allows adaptation to nearly all existing houses.

The system can not only be used during winters for heating purpose but can also be used during summer for drying purposes. The system is affordable and has a simple thermal energy storage (pebble bed) included in solar heating system in order to keep the room heated for 24 hours a day and on cloudy days. Compared to water based system, solar air heating system has no freezing issues as air is used as heat transfer medium, durable because wear and tear through air is very limited, low maintenance required during the whole year (technically very simple system, no complex mechanical parts, no fluids used, no heat exchangers, sensors, differential thermostats, etc.).

Through the demonstration project, training of local people on the manufacturing, operation and maintenance of such system during the project tenure will build the local manufacturing and employment generation. The adoption of the technology will increase value creation in local people through setting up manufacturing units, collector assembly, installation, building insulation and civil works. This will further reduce the money outflow from the region and payment for expensive fuel, increassing local income generation for planners, engineers, workshops, masons and material vendors. The impact on health due to smoke from Bukharis is avoided completely.

CONCLUSION

The installation of solar air heating systems with thermal energy storage, will reduce the consumption of costly fuel and combustion of traditional fuels in the region. Almost 80 % fuel savings are estimated from such a system in Ladakh region. According to an estimate savings of more than Rs. 20,000 per household per year is expected that will allow sustainable investments. The utilization of the system during summer season for drying purposes will further result in increased productivity, revenue generation, and maximum utilization of energy from sun. The GHG savings are estimated to be around 2 tonnes of CO_2 reduction per annum per house due to

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ABOUT
THE INDO-GERMAN ENERGY FORUM (IGEF)

Indo-German Energy Forum

Background and Objectives

To enhance and deepen the cooperation between India and Germany in the energy sector, the German Chancellor Dr. Angela Merkel and the Indian Prime Minister Dr. Manmohan Singh established the Indo-German Energy Forum (IGEF) at the Hannover Fair in April 2006.

The main objectives of the IGEF are

- to rehabilitate and modernise thermal power plants
- to encourage the use of clean energy sources
- to disseminate climate-friendly technologies on the energy supply and demand side.

The dialogue focuses on exchanging knowledge, promoting private sector activities and putting in place an enabling environment to further develop the markets for efficient thermal power plant technologies, energy efficiency and renewable energies in India and Germany.

Partners, Institutional Structure and Projects

The high level steering committee of the IGEF, also called the "Forum", takes place annually and provides a platform for high-level policy makers and representatives from industry, associations, financial institutions and research organizations from both India and Germany. On a working level, thematic sub groups have been created which convene meetings on a regular basis:

- Efficiency Enhancement in Fossil Fuel Based Power Plants
- Renewable Energies
- Demand-Side Energy Efficiency and Low Carbon Growth Strategies.

Within the sub groups, several task forces have been set up to devise and implement specific cooperation projects, such as the harmonisation of tender documents for the rehabilitation and modernization of thermal power plant, the Excellence Enhancement Centre for the Indian power sector or the development of an energy performance assessment tool for residential buildings. Additional task forces concerning further topics may be created at the initiative of representatives of the relevant government agencies, private sector and other experts. The Indo-German Energy Symposium provides energy experts from India and Germany a platform for technical exchange and has given further momentum to the bilateral dialogue. The Symposium takes place on a biannual basis and covers aspects of financing, project development, best practices as well as innovative technologies and policy issues.

Federal Ministry for Economic Affairs and Energy

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

Federal Ministry for Economic Cooperation and Development

KFW

Ministry of POWER Government of India

Ministry of New and Renewable Energy

ENERGY IS LIFE BEE CONSERVE IT

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Energy Forum
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