'Powering Cities in the Global South: How Energy Access for All Benefits the Economy and the Environment'

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Venue: Kochi

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Summary

Increased pressure on urban areas requires “smart city” planning, assuring an integrated and holistic socio-environmental sustainable development in balance to the benefit of both the citizens and the environment. Energy is fundamental to economic productivity and livelihoods, and cities have a major role to play in how it is provided, distributed and consumed. Generation and utilization of energy and power is one of the important issues for development of smart cities, where access to space is a major constraining factor. The conference 'Powering Cities in the Global South: How Energy Access for All Benefits the Economy and the Environment' addressed during two days particularly three major topics (i) Green Energy and Sustainable City Planning, (ii) Smart Energy Systems for Urban Areas and (iii) Challenges for Renewable in India. The objective was to share and disseminate the knowledge and information based on renewable energy sector in India. Further, to explore possibilities for more collaboration in the future from the global south and within different smart cities across India.

The interesting talks sparked discussions around challenges and opportunities in green energy production and smart energy systems on both national and community levels. Some of the presentations threw light into the situation where Kerala stands with respect to renewable energy concept. More than 90 % of the present electricity supply in the State of Kerala comes from hydroelectric power, with Increased future supply of electricity envisaged through development of renewables – mainly solar, wind, green hydrogen etc. The European Initiative "Destination Earth," a suitable holistic framework with the goal of creating a very accurate digital model of the earth called a "Digital Twin" to track and predict environmental change and human effects in order to promote sustainable development was discussed. The CIAL highlighted about the initiatives to attain net zero carbon emission and sustainable activities which can be adopted for making sustainable cities. The New town Kolkata discussed how waste management can be incorporated with energy production, how green spacing, e-mobility can be included in sustainable city planning etc. The importance of star labelling accounting to Environmental Performance Index (EPI) has come out as a possible suggestion which comes hand in hand with green building concept. Scarcity of space is a major limitation in large cities world-wide and much more creative solutions like deployment solar panels along metro lines or covering waters bodies are needed to cater the electricity needs for the future. The introduction of floating solar panels was one of the advances to be encouraged with improved generation capacity. Use of solar energy on community basis for commercial purpose is also having added advantage. Distributable renewable energy for livelihood applications is a good

solution for energy management problems. The introduction of Solar Renewable Energy Certificates (SRECS) in power tariff will attract general public towards it. There were suggestions to try low ESCO model, MARIKAL model etc; that can have improved efficiency with no extra cost. The main challenges for sustainable energy are technology, policy and regulation, business models, and access to finance. Integration of power system through management of energy storage, systems transmissions, reinforcement, future energy storage etc. will provide system flexibility for renewable energy management. Some strategic interventions like engagement with NBFCs and HFCs, pipeline potential for the residential sector, virtual net metering RESCO model etc. were also suggested. Based on the presentations and discussions the workshop made the following recommendations for implementation towards smart city development in southern Asia and Kerala in particular:

- An integrated framework and guideline for adaption of sustainable energy practices by cities with large population.
- Mandate clean energy technologies in emerging applications viz Mobility, Green Hydrogen, Cooking, Cooling etc.
- Explore offshore wind power harness, along the lengthy coastline of Kerala.
- The unexplored biofuel generation from aquatic weeds has a large potential in the state. Specific studies need to be undertaken for assessment of its potential.
- Distributed Renewable Energy for livelihood applications needs to be examined in detail.
- Financial interventions to accelerate Renewable Energy uptake through co-operative banks and NBFCs.
- Regulatory framework for Virtual Net Metering for Renewable Energy

The workshop was organized by the Nansen Environmental Research Centre - India (NERCI) under the project 'URban Sustainability in Action Multidisciplinary Approach through Jointly Organized Research schools' (URSA MAJOR), coordinated by the Nansen Environmental and Remote Sensing Center (NERSC), and funded by the Research Council of Norway (grant #322317) Norway.

1.Introduction

"Smart City" is a concept that has been put forward to describe an interconnected urban environment that activates feedbacks of citizens. The project 'URban Sustainability in Action Multidisciplinary Approach through Jointly Organized Research schools' (URSA MAJOR), integrates interdisciplinary advances into a holistic socio-environmental programme for "Smart Cities". URSA MAJOR is coordinated by the Nansen Environmental and Remote Sensing Center (NERSC), Norway and funded by INTPART-2020 – International Partnerships for Excellent Education, Research and Innovation Project of the Research Council of Norway. The project has its focus on the regions of accelerated and amplified climate change where urban areas have urgent needs to improve their sustainability and resilience strategies, and where the cost of maladaptation is intolerably high and beyond precautionary actions. URSA MAJOR seeks a multidisciplinary approach to urban nature-based solutions with strengthening access to digital communication and remote sensing. Under the work package Road to the South activities in the project, two-day International conference on 'Powering Cities in the Global South: How Energy Access for All Benefits the Economy and the Environment' was organised by the Nansen Environmental Research Centre (India). The objective was to share and disseminate the knowledge and information based on Renewable Energy sector in India and to explore possibilities for more collaboration in the future from the global south and within different smart cities across India.

2. Focal theme

Energy is fundamental to economic productivity and livelihoods, and cities have a major role to play in how it is provided, distributed and consumed. Cities in the global south face three fundamental energy challenges: the urgent need to increase access to clean, affordable, and reliable energy; how to meet increasing electricity demand while addressing inadequate supply and system inefficiencies; and the imperative to chart a new model of development that slows the growth of carbon emissions and is not fossil fuel-intensive. The brain storming session on 'Powering Cities in the Global South: How Energy Access for All, Benefits the Economy and the Environment' was planned in such a manner that it includes sharing experiences by various stakeholders.

3. About the conference

Conference was primarily focussed on three major themes;

1. Green Energy and Sustainable City Planning,
2. Smart Energy Systems for Urban Areas and
3. Challenges for Renewable in India.

The conference had twelve speakers from diverse background and esteemed institutions like The Arctic University of Norway/Nansen Environmental and Remote Sensing Center, Jawaharlal Nehru University, Cochin International Airport ltd, West Bengal Housing Infrastructure Development Corporation Ltd, Energy Management Centre, Kerala, National Institute of Advanced Studies & Centre for Earth Research and Environmental Management, National Institute of Solar Energy, NTPC School of Business, Norwegian University of Science and Technology, SINTEF, Ernst & Young, Kerala State Electricity Board, World Resources Institute etc. Representatives from universities, research institutes, LSGD, private companies, smart cities, research scholars and students participated in the Conference. The Conference programme is given in Annex 1.

During the inaugural address Hon. Mayor, Kochi Municipal Corporation, Adv. M. Anilkumar, highlighted the renewable energy practices in Cochin, such as the power-neutral airport, metro, and electric autorickshaws. He discussed the effects of climate change, particularly the monsoon vagaries, city transformation, wetland conversion, sea level rise, and water logging and the importance of initiatives and efforts that could integrate climate change with the energy issues and energy conservation. He concluded that the two-day international conference on powering cities in the global south would be an excellent beginning to start off in city of Cochin to become a sustainable smart city on all aspects.

Dr. Igor Esau's, Professor, The Arctic University of Norway/Nansen Environmental and Remote Sensing Center, during his keynote address highlighted the European Initiative "Destination Earth," a suitable holistic framework with the goal of creating a very accurate digital model of the earth called "Digital Twin" (originally introduced in the manufacturing industry to reproduce constructions and processes) to track and predict environmental change and human effects in order to promote sustainable development. The concept "Destination Earth", was focusing on Climate Change, Energy Natural disasters & Risk management, Farming. He made the point that smart energy solutions are necessary for the urban climate.

He mentioned how societal and technological changes are both necessary for the switch to renewable energy. From his perspective, renewable energy increases the role of weather and climatic factors. Energy consumption across globe has only conventional sources of energy until 2010. However, by 2050, renewable energy will account for more than 50% of energy generation. He made the point that urban areas, which use 70% of all energy because they lack natural cooling influences like water and vegetation, are responsible for 75% of all carbon emissions worldwide. He emphasised that, according to the IPCC report, changes in land use patterns and the global climatic warming both contributes to increase warming in urban areas. He suggested that in order to create sustainable smart cities, we should integrate ICT (information and communication technology), common people's participation, networking, and feedback, as well as sustainability. As a solution, he proposed socio-environmental interactions. Co-production of ecosystem services, socioeconomic and sociocultural systems, human health and well-being, integrated environmental performance, biodiversity, potential for cross-cutting issues and solutions across geographic and temporal scales, cost-trade-offs, benefits and co-benefits for biodiversity, economy, and community are all advantages of nature-based smart energy and climate solutions for smart cities.

4. Session 1: Green Energy and Sustainable City Planning

Under the session Green Energy and Sustainable City Planning there were eight speakers from different institutions viz: Cochin International Airport Ltd (CIAL), West Bengal Housing Infrastructure Development Corporation Ltd, Energy Management Centre, Kerala, National Institute of Advanced Studies & Centre for Earth Research and Environmental Management, ADTECH System Ltd, Amrita Viswa Vidyapeetham University, National Institute of Solar Energy and College of Climate change and Environmental Science.

When discussing CIAL success story in renewable energy sector, Mr. Rajumon, As part of their energy strategy, CIAL decided in 2012 to develop, implement, and use their own renewable energy sources to achieve power self-sufficiency. He explained the initiatives by CIAL. For energy-efficient terminal design, LED lights are commonly used, which is a green technology. 95% of the entire terminal lighting is LED. There is a sewage treatment plant that is monitored by the pollution control board. Another CIAL success is the solar boat, which was

launched on February 15, 2021, as part of the Kovalam-Akkulam waterway's inauguration, and will use 13 panels mounted in the bottom to generate 5.1 KW(Fig.1). CIAL also installed hybrid wind-mill cum solar panels and solar floating panels at the CIAL golf club at Payyannur,

Fig. 1 CIAL's Solar Boat, Solar floating panels at CIAL golf club Payyannur

which are terrain-based solar plants, the first in south India. He has also elaborated on "Agrivoltics" for the harvesting of both food and energy together, reducing irrigation requirements, and protecting crops from adverse weather conditions. Another CIAL-monitored small hydro-electric project across the Iruvahhinji River at Arippara is also a success, generating 4.5 megawatts. CIAL plays a vital role in reducing our carbon footprint. By generating 48.13 megawatts of green energy in the years 2021–2022. All of their accomplishments earned them the title of United Nations Champions of the Earth for 2018.

Debashish Sen IAS, Chairman, New Town Kolkata Green Smart City Corp Ltd (NKGSCCL) and Managing Director, West Bengal Housing Infrastructure Development Corporation Ltd, discussed about the sustainability policy initiatives in New Town Kolkata and the Bagjola Solar Power Project. He emphasized the scarcity of space available in urban areas, and hence the significance of solar roof tops as well as the government's support in providing river canal tops and green spaces for solar panel installation. Urban local bodies in Kolkata made changes to

the structure-building rule to produce at least 2% of their power from solar energy. In the New Town Kolkata Project, they implemented a waste-to-energy program. Through 100% door-to-door collections, they segregate waste at the source for this programme and provide a Smart Home Tag for the households for better waste management activities. In the township, there is a bio-methanation plant with a daily capacity of 5 tonnes and 100 street lights that are powered by waste electricity.

Another unique experiment by the New Town Kolkata Project was "ZeroShop," which sells upcycled goods and is a livelihood option for women. Another pilot project is the plastic-free community market, which introduced plastic alternate carry bags at a subsidized rate and free of cost distribution of cloth bags to adjacent communities.

Another core area of sustainability in New Town Kolkata is the development of green spaces. Every year, 10000 trees are planted as part of the project in the New Town area. Another core area is the adoption of greenways, an initiative to involve community participation in plantations. Green open spaces, as well as the greening of metro pillars and vertical gardens, are available.

He brings insights to the initiatives of the E-Mobility sector in New Town Kolkata, which include electric vehicle charging stations, electric buses, barrier-free footpaths and cycle track, app-based cycle booking system, a LoRa WAN-based street lighting system, and a SCADA-based water supply system. Then there is also a weather monitoring system for real-time air quality information and warnings to the authorities and citizens.

Mr. Tomson Sebastian, Energy Technologist, Energy Management Centre, Kerala, addressed the "star labelling for residential and commercial buildings, which helps in identifying the buildings that have reduced usage of energy as well as water (Fig. 2). Star labelling is based on EPI (Energy Performance Index), where commercial and residential buildings have separate EPI ranges. Office buildings, hospitals, and shopping malls have different star rating programmes based on climate zones, such as warm and humid, composite, hot and dry.

Fig. 2 Star Labelling

He addressed the importance of "green building," which is the practice of creating structures and processes that are environment-friendly and resource-efficient throughout the life span of a building, right from the site

selection to design, construction, operation, maintenance, renovation, and deconstruction. Green building reduces the overall impact on human health and the natural environment by using energy and water resources. Some of the features of green buildings are maximum use of natural ventilation, minimum impact on the natural environment, reduced water consumption, renewable building materials, and reusable resources.

Dr. Jayasree Vaidyanathan, Scientist, National Institute of Advanced Studies & Centre for Earth Research and Environmental Management, addressed the fact that we can produce electricity mainly from organic, sustainable alternatives to divert waste from landfills, which can reduce carbon footprints. As problematic plants, she emphasised aquatic weeds (water hyacinth). Its sudden growth hampers aquatic system flora and fauna, hinders navigation, hinders tourism, and impacts livelihoods through high eradication costs, environmental degradation, health impacts, biodiversity loss, increased flooding, sedimentation, and water logging, as well as global warming, GHG emissions, and climate change. She also addressed the futility of controlling plant growth due to a lack of planning and an unscientific approach. She also pointed out that what we need is a microlevel approach, but the government has given us macrolevel solutions to the problem.

She pointed out that aquatic weeds can be used as a resource crop (fig. 3) and biofuel in all forms. This kind of electricity generation is simple, ecofriendly, and has zero carbon emissions, which has a higher efficiency compared to ordinary bio waste. And she explained the energy production process. She emphasised that Kerala pioneered hyacinth-based electricity production in the Kottayam vegetable market to power Thiruvalla. There will be a Kerala WET plant in Njeliyanparambu, Calicut, and the Bhramapuram

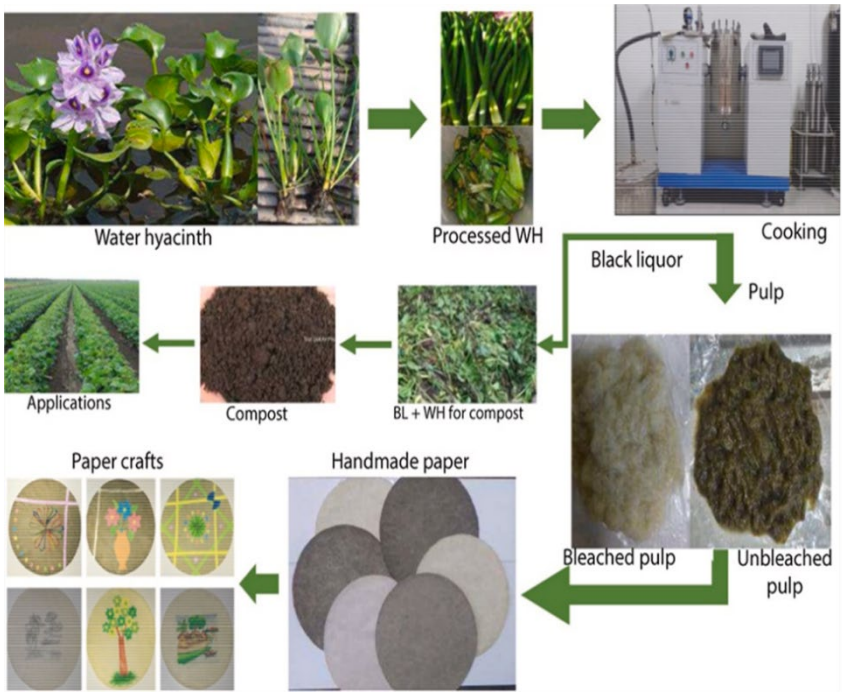

Fig. 3 Aquatic weeds as a Resource Crop

panchayat. She concluded that electricity generation from wastes mixed with biomass is the most feasible option for processing solid wastes, local development, and community empowerment.

Mr. Narayanan M R, Chairman, ADTECH System Ltd, suggested wind farms and floating solar panels as potential energy-generation options. According to him, there is a lot of potential for floating solar power in both India and abroad. He highlighted the advantages of Adtech System Limited's floating solar. Adtech Systems installed floating panels at the Banasurasagar dam as a proof-of-concept, producing 10 and 5000 kilowatt peak power output in their first and second projects, respectively. He made the point that a strong anchoring system is the key to a floating panel's ability to endure powerful landslides and floods. He highlighted two distinct technologies, namely HDPE technology (Fig.4) based on plastic and ferro-cement technology. Even though floating solar is much more expensive than land-based solar panels, it has many advantages over them, including the fact that no land is needed, that 7 percent more power can be produced, that water evaporation loss is minimized, that less dust collects on the panels, and that it requires less maintenance overall.

Fig. 4 HDPE technology based floating solar panels

Dr. Shashi, Retd. HOD, Amrita Viswa Vidyapeetham University, stated that as photovoltaic penetration grows, the ramp rate required in traditional power plants will increase. He emphasised the significance of industrial energy storage solutions such as Battery Energy Storage (BES) and Pumped Hydro-Energy Storage (PHES). On the basis of lithium ion and lead acid batteries, various PV with BES scenarios are discussed, both with and without capital subsidies. He came to the conclusion that lead-acid batteries are the best.

Similarly, different scenarios of solar hydro project possibilities for solar pumps were proposed. When compared to solar and photovoltaic projects, wind power output is taken into account without any form of energy storage. He came to the conclusion that solar PV is not a very appealing alternative, even with a 50% subsidy on the entire project capital cost and a feed-in price above Rs. 6 per unit of electricity. Whereas a modest hydropower project only generates a marginal profit with a 50% solar pumping subsidy and a 20% increase in the RTC tariff for peak-time generation. In order to increase power generation, he suggested that the government and the central electrical regulating body play a role.

Mr. Vikrant Yadav, Asst. Director (Technical), National Institute of Solar Energy, He brings an insight into the utility of solar power, mainly in the agricultural segment. He clearly explains the various technologies developed and adopted for hot air requirements, hot water requirements, solar water pumping electricity requirements, cold storage systems, solar dryer systems for processing different food products such as fruits, vegetables, milk, eggs, coffee, tea, etc. (Fig 5). They utilise solar energy systems to heat the space during the winter, too. He highlighted the advantages of solar dryers over conventional direct drying of different food products. The former is more hygienic, freer from pathogens, better quality, and takes less time to dry. He listed various solar project installations across India, and the first solar-powered vaccine storage facility at hospital levels is located in the government medical college in Calicut, Kerala.

Fig. 5 Uses of Solar in food park/agro industries

Mr. Varghese K P, Master student, College of Climate change and Environmental Science, discusses the case study on implementing photovoltaic systems in the city district of Mollenberg, Norway. The case study was done based on a house-by-house survey and stakeholder analysis, including municipal, cultural, and policy-making environments, etc. The survey was based on a questionnaire regarding the implementation of renewable energy in Mollenberg and received 50 responses. Most of the people of Mollenberg responded positively, but around 8% were negative toward renewable energy because of a lack of information and concerns regarding the installation cost. Many solutions for this problem were also discussed, like the use of SRECS (Solar Renewable Energy Certificates) to lower consumer costs, the role of the people and the private sector, and the importance of financial models.

5. Session 2: Smart Energy Systems for Urban Areas

Under the session Smart Energy Systems for Urban Areas there were four speakers from World Resources Institute India, Jawaharlal Nehru university, Evergreen Energy Technologies Pvt Ltd, Norwegian University of Science and Technology and SINTEF.

Mr. Dhilon Subramanian, Manager, Energy program, World Resources Institute India, detailed global scenario of cities (fig. 6); only 2% of the world's cities contribute to its 2/3 rd of energy usage. He also mentions the fact that 90% of metropolitan areas are near coastlines and are therefore more vulnerable to the effects of climate change. He emphasised that the focus should be on urban areas because they frequently have greater relationships with businesses, citizens, and institutions of government. Also, they are directly affected by climate change. He highlighted the UN Sustainable City Program, Race to Zero, C40 Cities, and Building Efficiency Accelerator Program as examples of international programmes for sustainable city

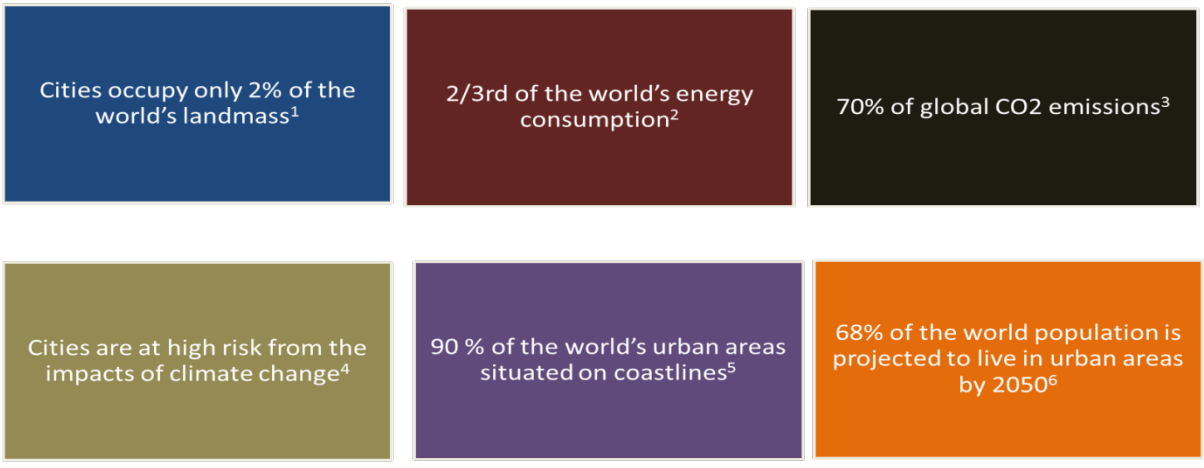

Fig. 6 Global scenario of cities. Source: 1,2,3,4,5- C40 Cities, 6-UN department of economics and social affairs

energy use. He mentioned that Kochi is one of the five cities in the building efficiency development programme. He explained his study Benchmarking the energy performances of offices in Kochi—the first of its kind in India (city-based)— They use the Building Performance Index (BPI) for comparisons of the energy efficiency of buildings. The study methodology includes both quantitative and qualitative analysis. He suggested the low- energy service companies (ESCO) model in the country.

Dr. Atul Kumar, Professor and Director, Energy Studies Programme, Jawaharlal Nehru University, discussed the Indian community's energy and related challenges, as well as global energy trade scenarios. He noticed that the air quality was deteriorating, and that by 2011/12, most cities in the country had already exceeded the ambient air quality, resulting in a 5.73 lakh mortality rate from PM2.5. He explained the importance of renewable energy and the modelling-based (MARKAL model) optimization of energy resources, which minimises energy system costs while incorporating elements of sustainable development. He also observed that aggressive efficiency will improve to the tune of 59% by 2051. and addresses the fact that biofuels and solar thermal technology need to play a key role by 2051. and concluded that we have to move toward algae fuel.

Mr. C M Varghese, CEO, Evergreen Energy Technologies Pvt Ltd and President, Kerala renewable Energy Entrepreneurs and Promoters Association, defined smart EV charging and its significance. He gives an insight into the EV penetration plan for India by 2030, which includes 30% private cars, 70% commercial cars, 40% buses, and 80% two- and three-wheelers. According to him, power system integration is essential for addressing power system flexibility from renewable energy sources. He explained the necessity of demand side management for charging stations, energy storage systems, transmission reinforcement, future energy storage, etc. There are 3 different kinds of smart charging: V1G (unidirectional controlled charging), V2G (vehicle to grid), and V2H/B (vehicle to home or building). Some advantages of the integration of smart charging with proper PCS in the grid are high yield, wireless charging, load leveling, capacity improvement, frequency regulation, and power quality. Smart charging enables the conversion of increasing amounts of heat to electricity, and the distribution of energy resources and electricity is becoming more digital. The two elements that will control smart charging infrastructure are the Internet of Things (IoT), artificial intelligence (AI), block chain, etc.

Prof. Sobah Abbas Petersen, Associate Professor, Norwegian University of Science and technology and Senior Research Scientist, SINTEF & Bjorn Rude Jacobsen, Research Scientist, SINTEF, jointly discussed Augmented and Virtual Reality technologies, including mobile augmented reality, mobile virtual reality, and Augmented and Virtual Reality with head-mounted displays. He also noted the usage of augmented reality apps for energy management. A video presentation also showed augmented reality wind farm simulations and IVR environment education on Greenland melting and pollinator parks (Fig.7).

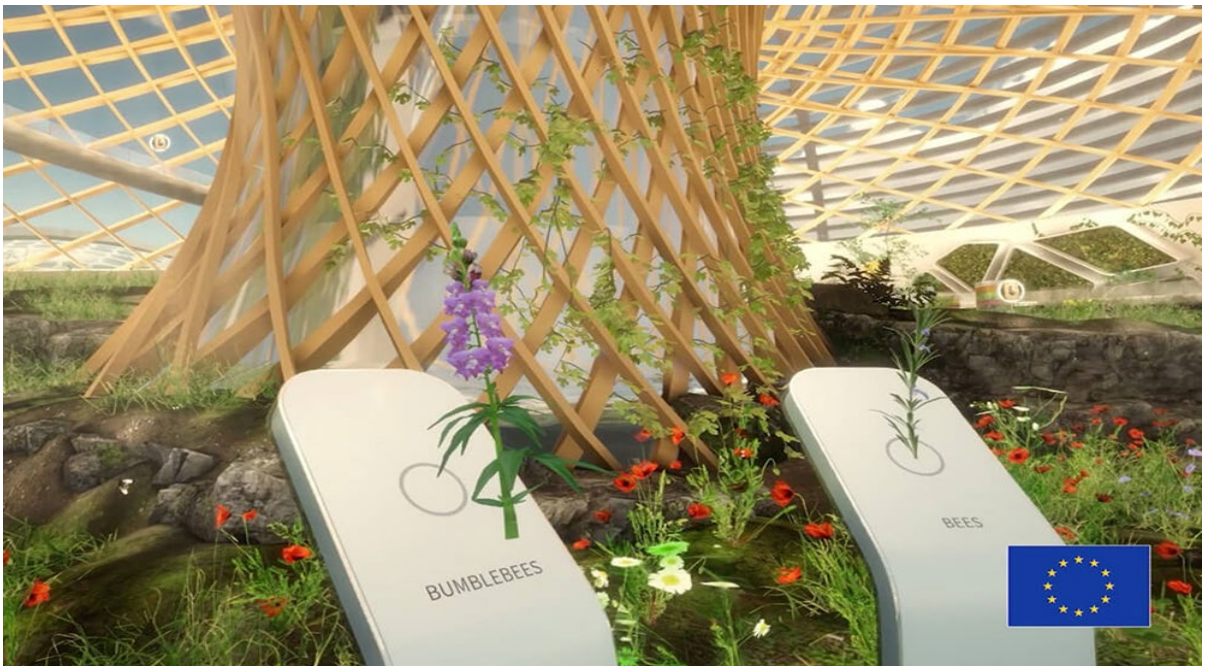

Fig. 7 Illustration of IVR based environment education on pollinator parks

6. Session 3: Challenges for Renewable in India

Under the session Challenges for Renewable in India there were four speakers from NTPC School of Business, Ernst & Young and Kerala State Electricity Board.

Dr. Debajit Palit, Professor, NTPC School of Business, brings some insight into the power sector of India, especially the updated NDC-Panchamrit. According to the growth trajectory of renewable energy use in India, the last 5 years have given a production of 10 GW per year (Fig.8). Here, Tamil Nadu comes in first place, followed by Gujarat, mainly in terms of solar and wind energy. Solar and wind energy are the cheapest energy sources in India. Tariffs are increased quite a lot during and after this period, and battery storage costs are also reduced. By 2050, RE will be very cost-competitive. In 2020, coal demand will be significantly lower. According to him, now is the time to develop some models for reviving India's RE policies. He

pointed out the challenges of RE variability and the challenges of achieving 500 GW by 2030. According to him, whenever it is visible and wherever possible, we can install solar power plants to achieve the goals. He suggests some innovative ideas for "energy islands" in both urban and rural areas. And we should build deeper understanding and take collective action on impacts, risks, and opportunities. Provide equal importance and develop enabling policies, a regulating framework, and financing schemes for DRE/DES and enable RE use for livelihood applications.

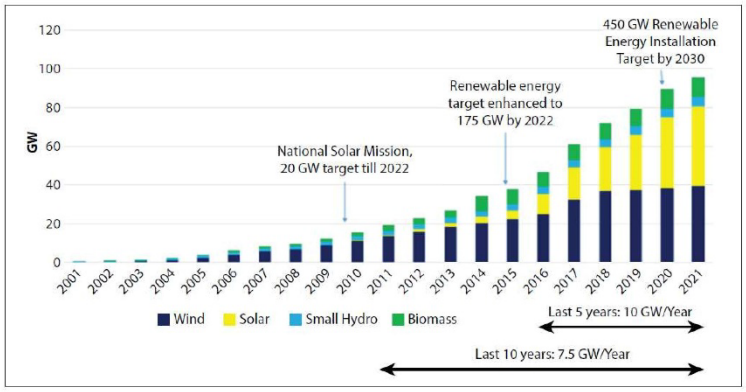

Fig.8 Growth trajectory of renewables in India

Mr. Shivaramakrishnan G, Consultant, Green Energy, addressed the vision of PANCHAMRIT at COP 26 (fig.9), especially the reduction of carbon intensity, energy requirements, net zero emissions, and the financial requirements to meet them. He pointed out that the main challenges for sustainable energy are technology, policy and regulation, business models, and access to finance. Some of the technological avenues explained by him are reducing emissions by 2050 by raising the energy level, using hydrogen, and using fossil fuel-based carbon dioxide storage. He explained the major policy interventions to promote in renewable purchase obligations, offshore wind, green energy open access, energy storage, wind and solar hybrid parks, etc.

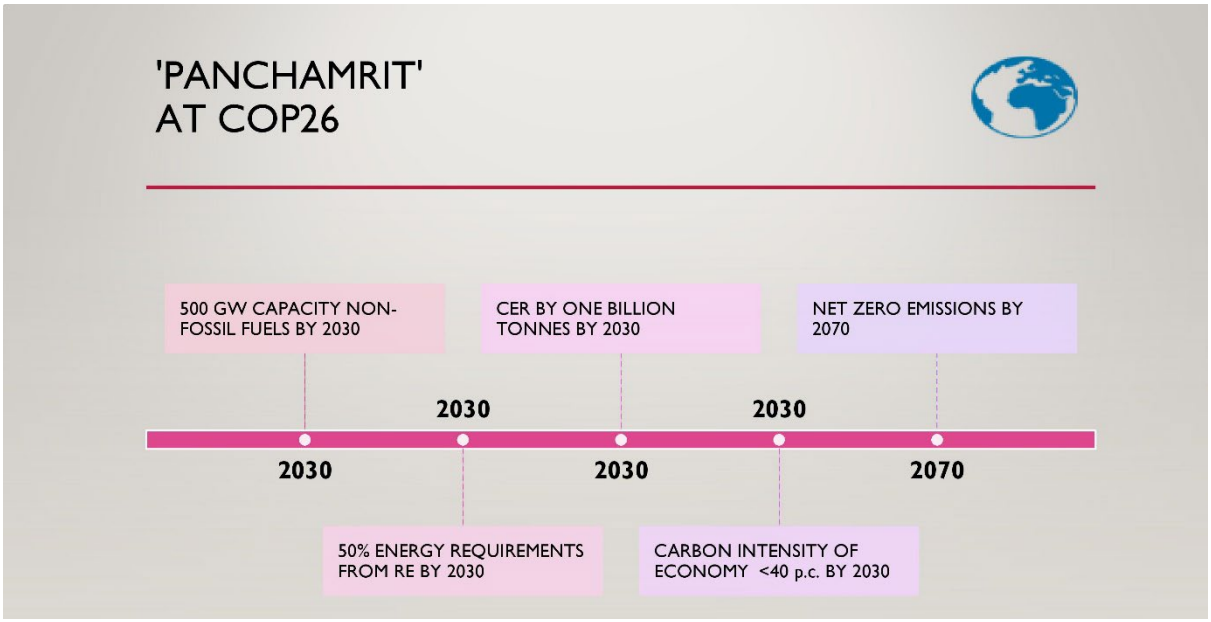

Fig. 9 Panchamrit at COP26

Distributable renewable energy for livelihood applications like cold storage, rice milling, horticulture, irrigation, textiles, and aquaculture is well explained. Along with smart cities, smart villages are also essential. A list of scores and rankings of larger states for clean energy initiatives, energy efficiency, and energy sustainability is explained.

Mr. Yuvaraj Dinesh Babu, Exe Director, Ernst & Young, addresses the fact that India has witnessed significant growth in renewable energy capacity through coal. The main barriers to scaled-up RE procurement are policy and regulations, technology options, financial constraints, and capacity building. The SUPRABHA rooftop solar TA programme by EY in different states of India and its beneficial sides were discussed. The current installation status of rooftop solar panels in India is shown, and it is mentioned that rooftop solar growth will slow down in 2022 due to many challenges like discouraging government policies, supply chain issues, weak consumer credit profiles, and other technical issues. Key interventions to accelerate RTS uptake and the methodology for product design and dissemination were discussed. Some strategic interventions were proposed, like engagement with NBFCs and HFCs, pipeline potential for the residential sector, etc. He concluded with the virtual net metering RESCO model.

Mr. S. Noushad, Asst. Exe. Engineer, Kerala State Electricity Board, expressed the Kerala State Electricity Board's concern and interest in the renewable energy sector, and he listed KSEB solar projects (Banasura Sagar, India's first floating solar project, and Canal Top projects). He explains REES (renewable energy and energy services). KSEB has a clear plan for the next five years. A total of 630 MW of electricity capacity exists now. But it was only 247 MW for the last 15 years, and it increased to 630 MW in the last 15 months alone. And he explains the SAURA flagship program, the EKIRAN portal for consumers, developers, and KSEB officials. He pointed out that 412 public charging stations are complete, and a total of 1165 are planned. And they conducted an awareness programme on renewable energy and gave subsidies to developers.

7. Concluding remarks

The interesting talks sparked discussions around challenges and opportunities in green energy production and smart energy systems on both national and community levels. Some of the presentations threw light into the situation where Kerala stands with respect to renewable energy concept. More than 90 % of the present electricity supply in the State of Kerala comes from hydroelectric power, with presently some minor contributions from other renewable

sources such as thermal, solar and wind. During the dry monsoon years there are periodically shortages in the hydropower supply. Increased future supply of electricity is envisaged through development of renewables – mainly solar, wind, green hydrogen etc.

Prof. Igor Esau (University of Tromsø and Nansen Center), who initiated URSA MAJOR, underlined the need to think untraditionally and "out of the box" to identify regionally adaptable solutions for cities being both consumers and suppliers of energy. He made the point that smart energy solutions are necessary for the urban climate. He mentioned how societal and technological changes are both necessary for the switch to renewable energy. He suggested that in order to create sustainable smart cities, we should integrate ICT (information and communication technology), common people's participation, networking, and feedback, as well as sustainability. As a solution, he proposed socio-environmental interactions viz. Co-production of ecosystem services, socioeconomic and sociocultural systems, human health and well-being. Integrated environmental performance, biodiversity, potential for cross-cutting issues and solutions across geographic and temporal scales, cost-trade-offs, benefits and co-benefits for biodiversity, economy, and community are all advantages of nature-based smart energy and climate solutions for smart cities. He highlighted the European Initiative "Destination Earth," a suitable holistic framework with the goal of creating a very accurate digital model of the earth called a "Digital Twin" to track and predict environmental change and human effects in order to promote sustainable development.

The CIAL targeted goal wrt. reneables and their success story tells about the initiatives to attain net zero carbon emission and sustainable activities which can be adopted for making sustainable cities. The New town Kolkata tells a different story with more solutions other than energy management. It shows how waste management can be incorporated with energy production, how green spacing, e-mobility can be included in sustainable city planning etc. The importance of star labeling accounting to Environmental Performance Index (EPI) has come out as a possible suggestion which comes hand in hand with green building concept. Scarcity of space is a major limitation in large cities world-wide and much more creative solutions like deployment solar panels along metro lines or covering waters bodies are needed to cater the electricity needs for the future. The introduction of floating solar panels was one of the advances to be encouraged with improved generation capacity. Another source of reducing carbon footprint and energy production that come out is from waste mixed with biomass, eg. water hyacinth, is a feasible option The processing requires micro-level approach which needs government support. Another area of power generation is wind energy which has great potential along Kerala coast. This also requires financial support in the initial stage. Use of

solar energy on community basis for commercial purpose is also having added advantage. The introduction of Solar Renewable Energy Certificates (SRECS) in power tariff will attract general public towards it. BPI was introduced for the first time in India in Kochi, which was a huge success. There were suggestions to try low ESCO model, MARIKAL model etc; that can have improved efficiency with no extra cost. Integration of power system through management of energy storage, systems transmissions, reinforcement, future energy storage etc. will provide system flexibility for renewable energy management.

It was mentioned that rooftop solar growth will slow down in 2022 due to many challenges like discouraging government policies, supply chain issues, weak consumer credit profiles, and other technical issues. Some strategic interventions were proposed, like engagement with NBFCs and HFCs, pipeline potential for the residential sector, virtual net metering RESCO model etc. Some of the KSEB activities for the next five years include SAURA flagship program, the EKIRAN portal for consumers, developers, awareness programme on renewable energy and subsidies to developers. There are 412 public charging stations already completed and a total of 1165 are planned. The main barriers to RE procurement are policy and regulations, technology options, financial constraints, and capacity building. Government should provide equal importance and develop enabling policies, a regulating framework, and financing schemes for DRE/DES and enable RE use for livelihood applications. The main challenges for sustainable energy are technology, policy and regulation, business models, and access to finance. Distributable renewable energy for livelihood applications is a good solution for energy management problems.

Several talks discussed the possibility for India to fulfill its pledges of becoming carbon neutral in 2070, and that this will depend on Europe, US and China reaching their goals for 2050 or 2060. India will then have 10-20 years to capitalize on technology and solutions implemented in other countries, making the Indian goals doable.

The Hon. Minister for Law, Industries and Coir Shri P. Rajeeve from the Government of Kerala concluded the conference, by stating:

“Kerala is a progressive and foreword looking state willing to invest in responsible solutions in our energy supply. We want to strengthen the tie up with Norway in the fields of energy solutions and invites Norwegian industry to take part in this development.”

8. The conference recommends below action plan based on the expert suggestions:

- An integrated framework and guideline for adaption of sustainable energy practices by cities with large population.
- Mandate clean energy technologies in emerging applications viz Mobility, Green Hydrogen, Cooking, Cooling etc.
- Explore offshore wind power harness, along the lengthy coastline of Kerala.
- The unexplored biofuel generation from aquatic weeds has a large potential in the state. Specific studies need to be undertaken for assessment of its potential.
- Distributed Renewable Energy for livelihood applications needs to be examined in detail.
- Financial interventions to accelerate Renewable Energy uptake through co-operative banks and NBFCs.
- Regulatory framework for Virtual Net Metering for Renewable Energy

9. Contributors

Session 1

1. Mr. Rajumon, Cochin International Airport Ltd (CIAL)
2. Debashish Sen IAS, Chairman, New Town Kolkata Green Smart City Corp Ltd (NKGSCCL) and Managing Director, West Bengal Housing Infrastructure Development Corporation Ltd
3. Mr. Tomson Sebastian, Energy Technologist, Energy Management Centre
4. Dr. Jayasree Vaidyanathan, Scientist, National Institute of Advanced Studies & Centre for Earth Research and Environmental Management
5. Mr. Narayanan M R, Chairman, ADTECH System Ltd
6. Dr. Shashi, Retd. HOD, Amrita Viswa Vidyapeetham University
7. Mr. Vikrant Yadav, Asst. Director (Technical), National Institute of Solar Energy
8. Mr. Varghese K P, Master student, College of Climate change and Environmental Science

Session 2

1. Mr. Dhilon Subramanian, Manager, Energy program, World Resources Institute India
2. Dr. Atul Kumar, Professor and Director, Energy Studies Programme, Jawaharlal Nehru University
3. Mr. C M Varghese, CEO, Evergreen Energy Technologies Pvt Ltd and President, Kerala renewable Energy Entrepreneurs and Promoters Association
4. Prof. Sobah Abbas Petersen, Associate Professor, Norwegian University of Science and technology
5. Senior Research Scientist, SINTEF & Bjorn Rude Jacobsen, Research Scientist, SINTEF

Session 3

1. Dr. Debajit Palit, Professor, NTPC School of Business
2. Mr. Shivaramakrishnan G, Consultant, Green Energy
3. Mr. Yuvaraj Dinesh Babu, Exe Director, Ernst & Young
4. Mr. S. Noushad, Asst. Exe. Engineer, Kerala State Electricity Board

Annex 1

PROGRAMME SCHEDULE

INAUGURAL SESSION
Powering Cities in the Global South
31 October 2022 | 09:15 AM | Crowne Plaza, Kochi
PROGRAMME

Welcome	**Dr. Ajith Joseph K** (Exe. Director, Nansen Environmental Research Centre(India)NERCI)	09:15 - 09:20
Introduction to Workshop	**Lasse H. Pettersson** (Chairman, NERCI, Research Coordinator/Senior Researcher, Nansen Environmental and Remote Sensing Center, Norway)	09:20 - 09:25
Presidential Address	**Prof. K. Riji John** (Hon. VC, Kerala University of Fisheries and Ocean Studies)	09:25 - 09:30
Inaugural Address	**Adv. M. Anilkumar** (Hon. Mayor, Kochi Municipal Corporation)	09:30 - 09:55
Felicitations	**Dr. Tore Furevik** (Director, Nansen Environmental and Remote Sensing Center, Norway)	09:55 - 10:00
	Shri. Dinesh Kumar (Director, Cochin International Airport Ltd.)	10:00 - 10:05
	Dr. B. Manoj Kumar (Registrar, Kerala University of Fisheries and Ocean Studies)	10:05 - 10:10
Vote of Thanks	**Dr. Bindu G** (Principal Scientist, Nansen Environmental Research Centre India)	10:10 - 10:15
	Tea Break	10:15 - 10:50
Key Note address	**Dr. Igor Esau** (Professor, UiT, The Arctic University of Norway)	10:50 - 11:20 (Online)

Technical Sessions will be commenced at 11:30 am

Session 1
Day 1
31 October 2022 | 11:30 AM | Crowne Plaza, Kochi
Green Energy and Sustainable City Planning
Session Chairs: **Dr. Nikhil** (Asst. Director, National Institute of Solar Energy) | **Dr. Santhosh Kumar R**, Asst. Director, National Academy of Customs Indirect Taxes and Narcotics

Time	Speaker	Topic
11:30 - 11:55	**Mr. Rajumon**, DGM (Cochin International Airport Ltd.)	CIAL Success story in renewable energy sector
11:55 - 12:20 (Online)	**Debashish Sen IAS** (Chairman, NKGSCCL, MD, West Bengal Housing Infrastructure Development Corporation Ltd.)	Challenges and opportunities for applying sustainability concept in the social context
12:20 - 12:45	**Mr. Tomson Sebastian** (Energy Technologist, Energy Management Centre)	Green & energy star rating of buildings
12:45 - 02:00	Lunch Break	
02:00 - 02:25 (Online)	**Prof. Alenka Temeljotov Salaj** (Vice-dean for Innovation, Faculty of Engineering, Norwegian University of Science and Technology)	Challenges and opportunities for applying sustainability concept in the social context
02:25 - 02:50	**Dr. Jayasree Vaidyanathan** (Scientist, Centre for Earth Research and Environmental Management)	Wastes to Energy As a pathway to Socio-Economical and Environmental sustainability
02:50 - 03:15	**Mr. Naryanan M R** (Chairman, ADTECH Systems Ltd.)	Floating solar panels
03:15 - 03:40	**Dr. Rajan Chedambath**(Director, Centre for Heritage, Environment and Development)	Challenges and opportunities for applying sustainability concept in the social context
03:40 - 04:10	Tea Break	
04:10- 04:35	**Mr. Vikrant Yadav** (Asst. Director (Technical), National Institute of Solar Energy)	Decentralized RE applications and Energy Access
04:35- 05:00	**Mr. Varghese K.P** (Masters Student, College of Climate Change and Environmental)	URSA MAJOR

Session 2
Day 2
01 November 2022 | 09:30 AM | Crowne Plaza, Kochi
Smart Energy Systems for Urban Areas
Session Chairs: **Dr. Debajit Palit** (Professor, NTPC School of Business) | **Mr. Sivaramakrishnan. G** (Consultant, Green Energy)

Time	Speaker	Topic
09:30 - 09:55	**Mr. Dhilon Subramanian** (Manager, Energy Program, World Resources Institute India)	Significance of building energy efficiency in the context of the urban energy transition
09:55 - 10:20	**Dr. Atul Kumar** (Professor & Director, Energy Studies Programme, Jawaharlal Nehru University)	100% Renewable Energy by 2050: Challenges and Opportunities for India

Time	Speaker	Topic
10:20 - 10:40	Tea Break	
10:40 - 11:05	**Mr. C M Varghese** (CEO, Evergreen Energy Technologies Pvt Ltd, President, Kerala Renewable Energy Entrepreneurs & Promoters Association)	Smart EV charging
11:05 - 11:30 (Online)	**Prof. Sobah Abbas Petersen** (Associate Professor, Norwegian University of Science and Technology, Senior Research Scientist, SINTEF) & **Dr. Bjørn Rude Jacobsen** (Research Scientist, SINTEF)	Informing and engaging citizens towards smart energy systems using Augmented and Virtual Reality Technologies
11:30 - 11:55	**Dr. Shashi** (Retd. HOD, Amrith Viswa Vidyapeetham University)	Peak time power supply from Renewables – An investigation on the scope of ToD framework for FiT

Session 3
01 November 2022 | 11:55 AM | Crowne Plaza, Kochi
Challenges for Renewable in India
Session Chairs: **Dr. Atul Kumar** (Professor & Director, Energy Studies Programme, Jawaharlal Nehru University) |
Mr. Sivaramakrishnan. G (Consultant, Green Energy)

11:55 - 12:20	**Dr. Debajit Palit** (Professor, NTPC School of Business)	Renewable Energy Transition in India: Opportunities and Challenges
12:20 - 12:45	**Mr. Sivaramakrishnan. G** (Consultant, Green Energy)	Challenges for transition towards Sustainable Energy in Urban India
12:45 - 02:00	Lunch Break	
02:00 - 02:25	**Dr. Subin K Jose** (Asst. Prof, Christ college)	Role of Enforcement Agencies in Protecting Green Initiatives in India
02:25 - 02:50	**Mr. Aneesh S Prasad** (Chief Technical Manager, Agency for Non-conventional Energy and Rural Technology)	Green Energy for the marginalised community
02:50 - 03:15	**Mr. Yuvraj Dinesh Babu** (Exe. Director, Ernst & Young)	Renewable energy and challenges
03:15 - 03:30	Tea Break	

VALEDICTORY SESSION
Powering Cities in the Global South
01 November 2022 | 03:30 PM | Crowne Plaza, Kochi

PROGRAMME

Welcome Address	**Lasse H. Pettersson** (Chairman, NERCI, Research Coordinator/Senior Researcher, Nansen Environmental and Remote Sensing Center, Norway)	03:30 - 03:35
Presidential Address	**Prof. K. Riji John** (Hon. VC, Kerala University of Fisheries and Ocean Studies)	03:35 - 03:40
Special Address	**Dr. Tore Furevik** (Director, Nansen Environmental and Remote Sensing Center, Norway)	03:40 - 03:45
A Brief summary of the themes discussed during two days	**Dr. Bindu G** (Principal Scientist, Nansen Environmental Research Centre India)	03:45 - 03:55
Address by Chief Guest	**Shri. P Rajeeve** (Hon. Minister for Industries, Law and Coir, Government of Kerala)	03:55 - 04:25
Vote of Thanks	**Dr. Ajith Joseph K** (Exe. Director, Nansen Environmental Research Centre India)	04:25 - 04:30

Annex 2

Abbreviations

HDPE	High Density Polyethylene
BES	Battery Energy Storage
PHES	Pumped Hydro-Energy Storage
SRECS	Solar Renewable Energy Certificates
BPI	Building Performance Index
ESCO	Energy Service Companies
PCS	Power Conversion System
NTPC	National Thermal Power Corporation Ltd
RE	Renewable Energy
DRE	Decentralised Rural Electrification
KSEB	Kerala State Electricity Board
RTS	Rooftop Solar
NBFC	Non-Banking Financial Company
HFC	Housing Finance Company
RESCO	Renewable Energy Service Company
REES	Renewable Energy and Energy Services
ICT	Information and Communication Technology
CIAL	Cochin International Airport Limited
EPI	Environmental Performance Index
SRECS	Solar Renewable Energy Certificates
NERSC	Nansen Environmental and Remote Sensing Center, Norway
NERCI	Nansen Environmental Research Centre(India)
URSA MAJOR	Urban Sustainability in Action Multidisciplinary Approach through Jointly Organized Research Schools
INTPART	International Partnerships for Excellent Education, Research and Innovation

LSGD	Local Self-Government Department
IPCC	Intergovernmental Panel on Climate Change
NKGSCCL	New Town Kolkata Green Smart City Corp Ltd
WAN	Wide Area Network
SCADA	Supervisory Control and Data Acquisition