



**GOVERNMENT OF KERALA
KERALA STATE PLANNING BOARD**

**FOURTEENTH FIVE-YEAR PLAN
(2022-2027)**

**WORKING GROUP ON
ENERGY SECTOR**

REPORT

**INDUSTRY AND INFRASTRUCTURE DIVISION
STATE PLANNING BOARD
THIRUVANANTHAPURAM
March 2022**

FOREWORD

Kerala is the only State in India to formulate and implement Five-Year Plans. The Government of Kerala believes that the planning process is important for promoting economic growth and ensuring social justice in the State. A significant feature of the process of formulation of Plans in the State is its participatory and inclusive nature.

In September 2021, the State Planning Board initiated a programme of consultation and discussion for the formulation of the 14th Five-Year Plan. The State Planning Board constituted 44 Working Groups, with more than 1200 members in order to gain expert opinion on a range of socio-economic issues pertinent to this Plan. The members of the Working Groups represented a wide spectrum of society and include scholars, administrators, social and political activists and other experts. Members of the Working Groups contributed their specialized knowledge in different sectors, best practices in the fields, issues of concern, and future strategies required in these sectors. The Report of each Working Group reflects the collective views of the members of the Group and the content of each Report will contribute to the formulation of the 14th Five-Year Plan. Each Report has been finalised after several rounds of discussions and consultations held between September and December 2021.

This document is the Report of the Working Group on “Energy”. The Co-Chairpersons of Working Group were Dr Tejal Kanitkar, Associate Professor, National Institute of Advanced Studies and Shri Rajesh Kumar Sinha IAS, Principal Secretary, Department of Power. Dr Ravi Raman, Member of the State Planning Board co-ordinated the activities of the Working Group. Shri Joy N.R, Chief, Industry & Infrastructure Division was the Convenor of the Working Group and Smt.Lijamol M David, Assistant Director, Industry & Infrastructure Division was Co-Convenor. The terms of reference of Working Group and its members are in Appendix of the Report.

Member Secretary

PREFACE

As part of the formulation of Fourteenth Five Year Plan (2022-2027), the State Planning Board has constituted various working groups under the priority sectors. Accordingly the Working Group on Energy was constituted during September 2021 with the objective of fulfilling the tasks outlined in the Terms of Reference for the Group by taking into consideration the guidelines for the formulation of 14th Five Year Plan. The Committee met twice and made detailed deliberations on issues, present situation, strategies and prospects of Energy sector of Kerala and delivered thoughts for a scientific, concrete and realistic plan to be pursued in 14th Plan period. The Working Group was constituted with two Co-chairpersons and 14 members. The member of the State Planning Board who coordinated the activities of the working group was Dr Ravi Raman. The concerned Chief of Division was Shri Joy. N.R.

Dr. Tejal Kanitkar
Co-Chairperson

Shri. Rajesh Kumar Sinha IAS
Co-Chairperson

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ABBREVIATIONS

ANERT	Agency for Non-conventional Energy and Rural Technology
CAGR	Compounded Annual Growth Rate
CERC	Central Electricity Regulatory Commission
EV	Electric Vehicle
ECBC	The Energy Conservation Building Code
ELCB	Earth Leakage Circuit Breaker
EMC	Electro Magnetic Compatibility
ESS	Energy Storage System
ETI	Energy Transition Index
HEP	Hydro Electric Project
HVDC	High Voltage Direct Current
IPP	Independent Power Producer
ISTS	Inter State Transmission System
KSEBL	Kerala State Electricity Board Limited
KW	Kilo Watt
LED	Light Emitting Diode
MTSL	Meter Testing and Standards Laboratory
MW	Mega Watt
MWP	Mega Watt Peak
NIWE	National Institute of Wind Energy
PAT	Perform Achieve and Trade
RE	Renewable Energy
RES	Renewable Energy Sources
RPO	Renewable Purchase Obligation
VRE	Variable Renewable Energy
WISE	World Institute of Sustainable Energy

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EXECUTIVE SUMMARY

Kerala turned into a fully electrified State in 2017. To sustain this achievement, steps should be taken to supply reliable and affordable electricity to all. In order to ensure there are no power shortages by 2040, a long-term strategy is needed. During the fourteenth five year plan (2022-2027), the State Government's top most priority is to increase power generation to ensure availability of power to match the increasing demand. It is also necessary to enhance internal generation capacity during the 14th Plan Period through hydro, solar, wind and other means. At the same time, quality of power is also of equal importance. Key drivers of electricity demand continue to be GDP, Population, Price, seasonal weather etc. in the state.

The major agencies in the energy sector include KSEBL, ANERT, EMC and Department of Electrical Inspectorate.

The major challenges in the power sector to be addressed in the 14th five year plan include : (i) Resource constraints for promoting RE projects (ii) Lack of transparent policy on power procurement from RE sources (iii) Delay in commissioning of projects (iv) Desiltation of dams (v) Financing models based on energy saving/ productivity/ benchmarks in priority areas (vi) Commercial sector activities not mandated to follow energy efficiency in design/ construction stages (vii) Demand aggregation of existing inefficient appliances and their replacement (viii) High land costs and forest clearance issues in small Hydro Power Projects.

The major recommendations put forward by the working group include:

State Electricity Plan: A strategy should be developed for the management of energy sector in such a manner to promote rapid economic growth and sustainable development of the State guided by some well-defined policies in generation capacity addition including from renewable energy sources, transmission, distribution, grid operation, rural electrification, energy market operations etc. Power purchase agreements (short, medium & long term) need to be relooked based on revised demand projections factoring in the current & emerging energy efficient technologies and capacity addition through renewable power options.

Green Energy: During the 14th Five Year Plan period a major addition (3,000 MW) through renewable energy sources such as hydropower projects, solar energy and wind is proposed. By 2025, 40 per cent of Kerala's electricity demand will have to be met from renewable energy sources including hydro, wind, solar etc. Initiating Idukki HEP second stage, completing 156 MW hydro projects, rooftop solar projects in one lakh premises etc are the focus.

Floating Solar PV: Kerala has a large size of manmade water bodies. Out of total, 81 dams in Kerala, KSEB owns 59 dams which forms 45 reservoirs, Kerala irrigation department owns 20 dams which forms 20 reservoirs and Kerala Water Authority vests the control of 2 dams with 2 reservoirs. Installing medium size (100MW to 300MW) grid storage-based solar floating power plants in dam reservoirs and lakes in Kerala are proposed.

Energy Storage System: With the increasing penetration of the intermittent nature of RE into the grid, Energy storage systems (ESS) have the capability to balance the grid. Kerala has the potential to have pumped hydro systems. In this context, Kerala state should have storage projects that are properly sized and sited in the transmission network.

Energy Efficiency- Perform, Achieve and Trade (PAT) scheme under National Mission for Enhanced Energy Efficiency (NMEEE) needs to be implemented effectively to achieve energy efficiency and consequent improvement in air quality in energy intensive industries.

Power quality improvement - Poor power quality can cause unstable voltages, data loss, malfunctioning of PLC controls and protection relay equipment, erratic operation of precise control equipment. Hence, power quality improvement activities are also proposed in the energy policy of 14th Five Year Plan.

E- Mobility Ecosystem - In order to facilitate shifting from IC engine based vehicles to electric vehicles relies on strategic integration among EV & Accessories manufacturers, Charge station manufacturers, Charge Point Operators, E-Mobility service Providers, Grid Operators/ Distribution System Operators, Transmission System Operators, Power generation / Utility Suppliers, Regulating authorities etc. Well defined policy and regulations needs to be formulated on manufacturing/ purchase/use of electric vehicles, installation, accessibility, operation, maintenance & service of charging stations and incentives for e-vehicle charging. To speed up the process of installing charging infrastructure, a geographical spread across the State is required. The possibility of solar charging stations will also be explored.

Transmission and Distribution: A short term plan for the next five years and perspective plan for next 10 years need to be developed for the optimal utilisation of resources to ensure reliable and affordable energy. During 14th Five Year Plan, transmission and distribution network, especially high voltage transmission lines to be strengthened. To bring down T&D losses further, all Transmission and Distribution network needs to be made smart physically as well as technically through various innovative initiatives.

Smart Metering: The smart metering system needs to be introduced in the State, which is mandated by GoI to reduce theft, commercial losses & improve efficiency and governance of KSEB.

Environmental Issues: To mitigate the environmental impacts of the construction and operation of power plants, strategies need to be developed for the judicious usage of land and water, and the management of electronic waste. More over special effort needs to be taken to promote more storage/pondage based hydro generation through pumped storage and desilting of dams.

Grid Ancillary Services: Central Electricity Regulatory Commission (CERC) has issued a draft regulation to provide for a regulatory mechanism for ancillary services in the interest of reliability, safety and security of the grid. Once issued, this regulation requires grid operators to provide stability through active power injection or withdrawal as the case may be. Kerala Transmission System Operator (TSO) shall be obligated to provide these services

at Grid stations. A blue print and adequate funds shall be incorporated in the energy sector for the 14th Five Year Plan period towards this new activity.

Testing laboratory for fire accident enquiry-Last five year data shows an average of 250 fire accidents per year in our state. Fire accidents are the result of both electrical and non-electrical causes. Identification of the cause of such accidents is an onerous task. There are no testing laboratories as part of investigation of electrical fire accidents in the state. Hence it is highly essential to include Power Quality study and scientific investigation of fire accidents in the research and development of energy sector and establish testing laboratories.

Research and Development: During 14th Five Year Plan special efforts should be made for promoting research activities involving improvement of efficiency/ effectiveness of various techniques, procedures, processes, in manufacturing electrical equipment, developing new technologies for various type of power generation, especially from renewable sources, transmission and distribution.

In addition harnessing non-conventional energy sources and implementation of the projects in a time bound manner will help development of state energy sources from state energy security point of view. The high demand for electricity from the MSME sector needs to be addressed via improvement in MSME capacities to improve efficiency and undertake fuel substitution if and when possible. We need one time solution to address electricity supply gap to marginalised sectors and those in inaccessible areas through innovative RE solutions. Climate resilience involves ensuring the safety and stability of power supply with increasing weather variability and extreme events due to climate change.

Strategies are suggested for the management of Energy Sector to boost rapid economic growth and sustainable development of State addressing challenges in generation, transmission, distribution, energy markets and other key functional areas for meeting the projected targets.

CHAPTER 1 INTRODUCTION

India is the world's third largest producer and third largest consumer of electricity. The Central Government lays special emphasis on reduction in Transmission and Distribution (T&D) losses and Demand Side Management (DSM) to optimise resource utilisation. Concerted efforts are going on to make power available to all in a sustainable manner, through policy initiatives, such as the development of power projects through tariff based bidding, private sector participation in transmission sector, the National Mission on Enhanced Energy Efficiency, focus on development of Renewable Energy Sources (RES) and flexible use of coal for generating power from India's cheapest source of generation. Renewable energy, mainly solar and wind power generation, now occupies centre-stage in the development of power generation. Renewable power plants, which also include large hydroelectric plants, constitute 37 per cent of India's total installed capacity. According to World Economic Forum (WEF) report, India has been ranked at the 87th position among 115 countries in the Energy Transition Index (ETI), which measures performance of energy systems of countries across three dimensions: economic development and growth, environmental sustainability, and energy security and access indicators and readiness to transition to secure, sustainable, affordable, and inclusive energy systems.

A unique aspect of the power sector in the State is that it is fully embracing the technological advances that have taken place in the country in the past two decades, and that the State's strategy in the sector is taking advantage of these advances. It is also leveraging a number of new innovative ideas and initiatives to maintain its growth in the new era of sustainability. The State should consider and evaluate newer forms of renewable energy beyond solar and wind in the era of renewable energy. The interaction between State's science and technology as well as the technological higher education institutions are major activities. The State has also embarked upon a mission to build a state-of-the-art transmission network by constructing new lines, substations and modernizing existing systems, to be ready for taking in the projected boom in e-mobility.

The Government's top most priority is to increase power generation to ensure availability of power to match the increasing demand. At the same time, quality of power is also of equal importance. The state has kicked off the ambitious 'Oorjja Kerala Mission' which is a bouquet of five inter-related projects namely, 'Dyuthi 2021', 'Soura' 'Filament free Kerala' 'Transgrid 2.0' and 'e-safe', woven together as a combination of priorities set by the above aspects. The underlying spirit of all the projects envisaged in the power sector of the State is to contain the challenges of climate change and to reduce the carbon footprint of the power sector. Having achieved universal electrification, the State is now concentrating on the modernisation of the grid to meet the ever increasing customer aspirations with respect to reliability, to attain the lowest level of system losses, to meet the requirements thrown up by decentralised renewable generation and to ensure safety of installations. In addition to all these, the State has also embarked upon a mission to build a state of the art transmission

network by constructing new lines, substations and modernising existing systems, to be ready for taking in the projected boom in e-mobility.

The non-conventional sources of energy need to be utilised to the maximum extent possible in meeting our energy requirements. Electricity generation from wind, solar photovoltaic, small and medium hydro projects should be tapped to its full potential. Regarding energy efficiency, policies, protocols, rules and regulations on energy efficiency, management and version updation, financing energy efficiency projects highlighting benchmarks, persistence and compliance through energy audits, linking outcomes, evolving right balance between standard and skilled manpower, regulators initiatives and appliance's market approaches may be considered. For the healthy growth of the power sector and to formulate agreed policies and programmes, there should be close and constant interaction and better coordination among different organisations of power industry. Better synergy between the power sector agencies like KSEBL, ANERT, EMC and Electrical Inspectorate through comprehensive plan like Urja Kerala Mission will develop the energy sector in the State to truly global standards.

CHAPTER 2 REVIEW OF 13TH FIVE YEAR PLAN

The 13th Five Year Plan approach was development of domestic capacity for power generation through hydro, solar and wind projects, strengthening of transmission and distribution network, especially high voltage transmission lines, providing electricity to all households, substantial expansion of large scale solar power generation, a paradigm shift from stand-alone to grid connected systems regarding small scale generating capacity and providing assistance to households that still depend on cooking stoves and fuel with substantial emissions to move to clean fuels.

The Mission of 13th FYP were capacity addition through renewable and non-renewable energy sources, building up transmission and distribution systems for reliable power, enhancing customer satisfaction through user-friendly systems, acquire, develop and demonstrate suitable renewable energy technologies, enhancing energy efficiency by energy conservation and management efforts and minimise electrical accidents.

The Strategies were Generate Clean Energy to increase internal generation through Small Hydro Electric Projects, Solar, Wind and gas, procure power from other State through tenders and by strengthening interstate corridors, improving quality of power by strengthening both transmission and distribution, manage demand through energy conservation activities and by using efficient equipment, ECBC, LED lights, star labelled products etc. better customer satisfaction through user-friendly systems and by adopting IT oriented services, Improving Safety by implementing ELCBs, safer equipment etc.

Thrust areas during the 13th Five Year Plan period were i) Sustain complete electrification ii) Strengthening of transmission & distribution network iii) Enhancement of internal generation capacity iv) Promote renewable energy generation and energy conservation v) Electrical safety and Effective implementation of Quality Control Order vi) and Further reduce AT & C losses vii) Energy Conservation activities.

With a vision of developing Kerala as a more energy-efficient economy and evolving an energy efficiency conscious society, the energy conservation activities were proposed to be carried out focusing on three key areas: Energy Conservation and Energy efficiency interventions, energy Storage System and Power generation projects (SHP & RE projects).

The Projected Demand for 13th Five-Year Plan was 5,400 MW and 5343 MW as projected in the 19th EPS, was adopted as a basis for the plan period. The additional sources for capacity addition identified were to realise 1200 MW from Variable Renewable Energy sources and 300 MW from Hydro sources. Of this, 174 MW is reported from small and mini hydro sources alone.

It was expected that the Transgrid 2.0 project takes care of the requirement for a robust backbone for the intrastate transmission network. In anticipation of 4000 MW by year 2022, additional transmission capacity required for dispersing the Inter State Transmission System (ISTS) power received from the planned ISTS nodes were planned. Three 400 kV

new substations, and capacity addition of 1 No 315 MVA at 400 kV were envisaged. 2000 MW of HVDC Madakkathara was also planned for the period.

Table 1- 13th Five Year Plan – Demand Forecast

13th Five Year Plan – Demand Forecast 5400 MW		
Additional Sources		
1	Hydro Sources (including small and mini hydro)	300 MW
2	Solar from the Grid Connected Solar stations	600 MW
3	Roof Top Solar Schemes	500 MW
4	Wind Sources	100 MW
Grand Total		1500 MW

Reconstruction of 10,000 KM of old 11 KV lines, new construction of about 3000 KM 11 KV lines, additional 5,000 KM lines of 11 KV as part of system widening etc. were planned. Thus the plan target was kept as 18,000 KM of 11 KV lines.

HVDC Pugalur- Madakkathara Pole I and II and 400 kV Kozhikode-Madakkathara double circuits were commissioned during the plan period.

Regarding Power Purchase Agreements nearly 1200 MW of generation was planned from renewable during the 13th plan period. However, what could be achieved was much smaller in numbers.

Performance of Energy Sector Agencies

Power development activities in the State are carried out mainly through four agencies, namely, Kerala State Electricity Board Limited (KSEBL), Agency for Non-conventional Energy and Rural Technology (ANERT), Department of Electrical Inspectorate, and Energy Management Centre (EMC). During the 13th Five Year Plan, an amount of Rs.8073.84 crore was provided as budgeted outlay for the power sector and Rs.7008.28 crore was incurred as expenditure (87%) as on 15th March 2022.

During the 13th Five Year Plan period, the “Oorja Kerala Mission” was launched in focusing integrated development of electricity sector in the State. It aims at implementing five important projects – Saura, Filament free Kerala, Dyuthi 2021, Transgrid 2.0, and e-safe. A three year programme for improving distribution network and for improving quality and reliability of power to consumers was initiated, Wiremen Institute and skill Development Centre for Electricians was set up. Introduced the Earth Leakage Circuit Breaker (ELCBs) in homes and Power Quality Study (T&D losses, effect of harmonics) in different licensees were conducted and E – mobility initiatives were also implemented.

Kerala State Electricity Board Limited is a (power utility) company incorporated under Companies Act 1956 (Central Act 1 of 1956). It is fully owned by Government of Kerala, under provisions of section 131 of the Electricity Act 2003 by re-vesting (under sub section (2) of section 131 and 133 of the Act) the functions, properties, interest, rights, liabilities, proceedings and personnel vested in State Government from erstwhile Kerala

State Electricity Board. Re-vesting was done on October 31, 2013. KSEBL is a single holding company with Distribution, Transmission and Generation as strategic business units with separate accounting. The company was incorporated on January 14, 2011 and it started operation as independent company with effect from November 1, 2013. KSEBL has been responsible for the generation, transmission and distribution of electricity in the State, with particular mandate to provide electricity at affordable cost for domestic as well as agricultural purposes.

Agency for Non-conventional Energy and Rural Technology (ANERT) is an autonomous body under the Power Department, GoK. It is the independent agency for the implementation and propagation of non-conventional sources of energy in the State. It is also the nodal agency for the Ministry of New and Renewable Energy Sources (MNRE), GoI, to carry out the Central Government programmes in Kerala.

Energy Management Centre (EMC) is the State designated agency of Bureau of Energy Efficiency, MoP, and GoI for promoting energy conservation, energy efficiency and enforcing Energy Conservation Act, 2001 in the State. EMC also promotes small/mini/micro hydel schemes. SHP Cell constituted by GoK under Power Department is also attached in EMC to give impetus for development of SHPs through private participation.

The Electrical Inspectorate is functioning under the Department of Power, GoK. Safety inspections are carried out and sanction for energisation for all HT/EHT and other medium voltage installation in the State are issued by this inspectorate. The motto of Meter Testing and Standards Laboratory (MTSL) is to provide testing and calibration of various types of electrical equipment. At present, calibration facilities is available for voltage, current, resistance, frequency, power, power factor and energy. The testing facilities include pre-commissioning tests for protection relays and instrument transformers. Also, pre-commissioning tests are conducted for power transformers, cables and circuit breakers. All calibrations and tests are conducted as per national and international standards. Enquiry into all electrical accidents occurring in the State, forwarding the reports to the State Government and taking actions against responsible person/authority are also done by Electrical Inspectorate.

Major Physical Achievements of the Agencies

‘Urja Kerala Mission’

Government of Kerala has launched ‘Oorjja a Kerala Mission’ on June 14, 2018, aimed at the integrated development of electricity sector in the state. It aims at implementing five important projects: i) Sour- Project aimed to achieve a cumulative capacity of 1000 MW to its renewable content through Solar Projects 50per cent of which is expected from Roof Tops (RTS). Another 150 MW each is expected from solar parks and floating solar projects. Remaining 200 MW is planned to be procured through reverse e-bidding, from solar projects commissioned in the country. Demand aggregation for first phase of RTS is already completed. For the first phase of 200 MW, 42,500 premises were selected from 2.78 lakh consumers who expressed interest in associating with the project. ii) Filament-free Kerala - Through this project, all the existing CFL and filament bulbs in domestic and

street lighting sector in the State will be replaced with energy efficient and long-lasting LED lamps targeting reduction in peak demand, global warming and Mercury (Hg) pollution. More than 13 Lakh consumers have already registered for LED lamps in the 1st phase in which domestic sector was targeted. iii) Dyuthi 2021 - The projects included in the Oorjja Kerala Mission, are in progress with a mission to up lift the distribution grid of KSEBL to international level. iv) Trans grid 2.0 – 2nd Generation Transmission network - This project aims at strengthening of transmission network to meet the future energy requirement of the State and is scheduled to be implemented in two phases. The 1st phase of the project is scheduled for execution during 2017-2022 and 2nd phase for 2019-2024. The works included in the 1st phase of the project are grouped into 13 packages and comprises construction of 12 substations and 2084 Circuit kilometre of EHT lines. Out of these 12 substations, 4 are Air Insulated Substations (AIS) and the remaining 8 are Gas Insulated Substations (GIS). 12 sub-stations (AIS - 3 Nos. and GIS - 9 Nos.) are included in Phase II of the project which is grouped into 12 packages. Implementation of the projects in Phase I are underway and are progressing. v) eSafe - The e-safe project jointly mooted by Electrical Inspectorate and KSEB aims at zero electrical accidents in the State. Conduct of safety awareness programmes, rewiring tribal households at Agali, Sholayur and Pudur Panchayat Pilot implementation of safety system preventing accidents from snapping of overhead lines and electric fence energiser test set up are envisaged under the project.

I. Kerala State Electricity Board Limited (KSEBL)

- Kerala became a fully electrified State. Kerala was declared a fully electrified State on May 29, 2017 by providing connections to over 1.5 lakh applicants under the “Total Electrification Scheme.” The State also did away with power cuts and load shedding.
- The power disruptions that occurred during Floods 2019 was restored and normalized within a short span of days through Mission Reconnect 2019.
- Provided uninterrupted power and maintained all essential services during Covid-19 lockdown and subsequent unlocks through its dedicated staff, maintaining strict Covid-19 protocol.
- The 400kV Tirunelveli-Kochi-Madakkathara-Udumalpet Power highway becomes a reality. Six e-Vehicle charging stations were set up with state funds in short span of time.
- Mission reconnect 2018- This was launched by KSEBL during the floods of 2018. 16,158 distribution transformers were repaired, 1735 distribution transformer stations were reconstructed, 25.60 lakh service connections were restored, 5275.80 km distribution lines including one lakh damaged poles were reconstructed, three lakh single phase energy meters and fifty thousand three phase energy meter were replaced, and restored 720 single-point connections where existing installation were damaged in the floods. This work was completed in 21 days.
- Commissioned Kanchikode solar plant 1 MW and solar projects of total capacity 5.90 MWp.
- Commissioned Vilangad Hydro Electric Project (HEP) (7.5 MW), Barapole HEP (15 MW), and Adyanpara HEP (15 MW) , Vellathooval SHEP (3.6 MW) ,

Perumthenaruvu Project (6 MW, 25.77 MU), and Kakkayam Project (3 MW, 10.39 MU)

- Completed construction work of Tirunelveli-Idaman-Kochi-Madakkathara 400 kV line from Idaman to Kochi on September 25, 2019 with the objective of strengthening the power transmission network of Kerala and facilitating the supply of power to the State from Kudankulam Nuclear Power Station. As a result, the power import capacity of the State has increased by 500 MW. In addition, there has been a significant increase in voltage levels.
- Commissioned HVDC Pugalur- Madakkathara Pole I and II and 400 kV Kozhikode-Madakkathara double circuits.

II. Agency for Non-conventional Energy and Rural Technology (ANERT)

- Rolled out 140 Akshaya Urja Service centres across the State
- Grid connected 2 MW solar power plant at Kuzhalmannam, Palakkad fed 49 lakh units of electricity to KSEBL grid. This is the first grid connected solar photo voltaic (PV) plant in the State under Independent Power Producer (IPP) mode. Off-grid solar roof top power plant of cumulative capacity 1941 kW installed.
- Completed empanelment of agencies for the installation of solar water heating systems, solar lanterns, solar home lighting systems and solar LED street lighting. Empanelment process for manufacturers of batteries and invertors is initiated. Empanelment process for biogas and improved chulah was completed.
- Three grids connected solar power plants with aggregate capacity of 470 kW and five off grid solar power plants with aggregate capacity 35 kW installed.
- Installed 2199 biogas plants (capacity 0.75 and 1 cubic metre per day), 2827 improved chulah, and solar water heating system in 7926 sq. metre.
- Installed 4195 kW grid interactive solar photo voltage (SPV) power plants of 2 kW to 100 kW to individuals/ institutions and 3279 kW off-grid rooftop solar PV power plants of capacity 1kW to 5 kW.
- Under Total Electrification Programme, 1625 houses and public buildings in Idukki District, 681 houses and public buildings in Palakkad District and 16 houses and public buildings in Wayanad District were electrified
- Established integrated renewable energy complexes in all the 14 districts and procured one Battery Operated Mobile Exhibition Unit.
- Under Innovative RE projects, 3 solar power coir ratt installed on pilot basis and 1000 solar lanterns have been distributed under “Jyothi” – solar power pack for street vendors.
- Launched e-Market place in 2018, incentivising users for utilising the electronic market place (www.buymysun.com).
- Mobile apps were developed for the use of public and various field activities of ANERT and empanelled vendors. The features of the apps include interaction with individuals and institutions to express their interest to partner with ANERT, checking feasibility on installing renewable energy systems, online installation reports by vendors for renewable energy systems, and online verification of installation by ANERT officials.

- ANERT installed a solar cold storage system at Subicsha Coconut Producer Company Ltd, Kozhikode as a pilot project to support farmers. The system consists of a 5 hp compressor motor and solar panels with 6 kW capacities, and can hold up to 5 tonnes of products. In the event of a power outage the cold storage can maintain its cold temperature for up to 30 hour
- Installation of Solar Radiation Resource Assessment Stations: ANERT had installed two Solar Radiation Resource Assessment Stations at Kuzhalmannam (Palakkad) and Ramakkalmedu (Idukki) in association with National Institute of Wind Energy (NIWE) (Government of India).
- Solar cooking system: A parabolic-trough concentrator based steam cooking system was installed by ANERT in the pre-matric hostel, Neriya Mangalam, Ernakulam in 2019. The community solar steam cooking system is designed for cooking food for 100 inmates. It is the first solar community steam cooking system installed in Kerala.
- Accreditation of Solar Power Plant Installers (Technicians). Considering the increased interest in renewable energy sector and to ensure quality of installations ANERT has started accrediting installers of solar power plants and 150 installers were trained in 5 batches.
- Installed 1 kW power plant solar wind storage hybrid at Ramakkalmedu.
- Commissioned Solar Water ATM – 3000 LPD water purification system with 3 kW solar at Alappuzha and Kannur
- Commissioned Solar Power Plants in Government buildings with capacity of 619 kW and 1350 kW
- Four projects of academic institutions were funded by ANERT
- Solar Agro farming: Installed 25 kW solar in farm lands without affecting the crops at Chittoor, Palakkad.

III. Energy Management Centre (EMC)

- Inaugurated Pathamkayam SHP (8 MW), 4 kW Pico Hydel project at Echampetty tribal colony, installed 20 kW Vortex Micro hydroelectric project at Kaduvetti bridge, and 2 kW at Murikkassery police station.
- Initiated model energy efficient panchayat project.
- Made Pelicode panchayat in Kasaragod, the first incandescent lamp free panchayat in India Retrofitting of energy efficient equipment in 10 primary health Centres (327 LED tubes, 145 Ceiling fans, 240 LED bulbs).
- EMC's Green Building, recognised by UNEP in its Global Status Report-2017 on zero emission, efficient, and resilient building, and received IGBC-Lead Gold Rating.
- NITI Aayog with the support of BEE prepared the first State Energy Efficiency Preparedness index and Kerala topped the index with 77 points.
- Energy Meter Calibration Laboratory of EMC has been granted with NABL Accreditation in accordance with IS/ISO/IEC 17025:2017 for the discipline of Electro-Technical Calibration.
- Conducted Energy audit at various parts of the State.

IV. Electrical Inspectorate

- Successfully launched online software “SURAKSHA”
- Retained “SEVOTHAM CERTIFICATION” (Service Quality Management System Certification) as per IS.15700:2005 from the Bureau of Indian Standards.
- To resume electric supply and equipment in the flood affected areas, department has launched an ENERGY safety programme named Operation Suraksha and its objective is to standardise and ensure safety.
- SKOCH-Electrical Inspectorate online software Suraksha was awarded SKOCH order of Merit award in e-governance category.
- Retained National Board for Testing and Calibration Laboratories (NABL) certification for electro technical calibration in Meter Testing and Standards Laboratory, Thiruvananthapuram. NABL accreditation has also been obtained for Regional Meter Testing Laboratories in various districts.
- Procured Power System Analysis Software ETAP and Compact LED testing equipment in MTSL.
- Banned substandard ELCB
- Procured three fully automatic transformer test set for conducting pre- commissioning test as per Quality Control Order.
- Procured Power System Analysis Software ETAP
- Rewiring and Standardization work for 600 Houses in Agali, Puthur and Sholayur in Palakkad district have been completed
- Established New Regional testing laboratory at Alappuzha
- Purchased 2 lakhs quantity of Poly carbonate tamper proof energy meter seals for Meter testing and Standards laboratories
- Kerala State Electricity Licensing Board Rules have been revised.
- Conducted training programme for Service quality as per IS 15700:2018
- During flood, as a part of Operation Suraksha, the team from our department inspected more than 10,000 houses in the flood affected area and we have fixed the issues and ensured the electrical safety in these houses before reconnection of the supply with the help of KELCON, Wiremen Association, Government Contractors Association, Students from ITI, Polytechnic and Engineering colleges in co-ordination with Electrical Inspectors of respective district.
- Procured Compact LED testing equipment in MTSL.

Challenges of the sector to be addressed during 14th Five Year Plan

The major challenges in the sector need to be addressed in the next five year include:

- (i) Resource constraints for promoting Renewable Energy Projects.
- (ii) Lack of transparent policy on power procurement from Renewable Energy Sources.
- (iii) Delay in commissioning of projects.
- (iv) Desiltation of dams.
- (v) Financing models based on energy saving/ productivity/ benchmarks in priority areas
- (vi) Commercial sector activities not mandated to follow energy efficiency in design/ construction stages.

- (vii) Demand aggregation of existing inefficient appliances and their replacement.
- (viii) High land costs and forest clearance issues in small Hydro Power Projects.
- (ix) Enhance internal generation capacity to meet the anticipated energy requirement and peak demand in addition to exploring options for supplementing power requirements through contracts with other power generation companies outside State.

CHAPTER 3

SUGGESTIONS & RECOMMENDATIONS OF THE WORKING GROUP

The Working Group put forward the following suggestions and recommendations for sustainable development of state's energy sector during 14th Five Year Plan.

I. GENERATION

As of September 2021, the state's total generation capacity is 3,165 MW, with hydro accounting for the lion's share (58 %). The State has a target of 1870 MW set by the Government of India for 2022. For the combined Commercial, Industrial and Domestic energy consumptions, total energy handled by Kerala Grid for last five years can be summarized as follows:

Table 2 - Total Energy handled by Kerala for last five years

Year	Energy in M.U.	% Change
2016-17	23,726	-
2017-18	24,388	↑ 2.79
2018-19	24,842	↑ 1.86
2019-20	26,010	↑ 4.70
2020-21	25,145	↓ 3.32

The Compounded Annual Growth Rate (CAGR) of electricity consumption for the above period 2016-17 to 2020-21, is 1.17 per cent. The decrease in consumption during 2020-21 is due to the Covid -19 pandemic.

Currently, the installed capacity of Renewable Energy (RE) in Kerala stands at 568 MW (273 MW of Solar Power, 230 MW of SHP, 63 MW of Wind Power and 2 MW of Bio power). This is amongst the installed capacity of 3496 MW and Maximum Demand of 3,102 MW. This suggests a state RE penetration of 16.25% of the state grid, against the corresponding national RE penetration of 25.64% (as on Aug 2021) of the national grid.

Kerala requires more energy in the near future to meet the changing development scenario and bring in more industries. Additional load on the electric power will come as the State switch to more electric vehicles. However, Kerala being a small state with large part of it falling under the Ecologically Sensitive Zone, generation of electricity has its own limitations. Therefore, Kerala should not only follow the traditional route of energy generation with the time-tested methods, but also look for large number of small generating systems with the many possible resources available in Kerala. Hence, Kerala needs to move to an extensive research and development effort to identify and harness whatever energy sources available in the state with innovative ideas. The goal that has to be taken into account while framing the plan programmes include:

State Trajectory:

- 40 per cent of power to be sourced from renewable by 2025.
- Sourcing 3000 MW power from renewable sources including hydro, wind, solar etc; which includes initiating Idukki HEP second stage
- Completing 156 MW hydro projects
- Rooftop solar projects in one lakh premises

Kerala's growth in Energy has been a biological one (Business As Usual – BAU – mode). More over the state is currently in an energy transition mode with electrical energy adoption accelerating in the mobility sector. The heat energy requirements are also to be met through green sources. The skewed load pattern as well as higher amounts of variable RE penetration necessitates bulk storage in the grid such as pumped-hydro. As per Central Electricity Authority (CEA), pumped-hydro storage potential for the state is 4400 MW. Since, Kerala has predominantly hydro-based generation; it is feasible to associate some of the existing plants with pumped-hydro. The state has identified three such schemes as Sholayar-I (810 MW), Sholayar-II (390 MW) and Poringalkuthu (80 MW). In view of expected 0.5 Million EV's in the state by 2030, the sources for additional energy requirement needs to be captured with clear numbers.

Green Energy Mission

A mission-mode approach needs to be pursued to promote renewable, solar, hydro and wind energy by conducting energy potential surveys/feasibility studies. During the 14th Five Year Plan period a major addition (3,000 MW) through from renewable energy sources such as hydropower projects, solar energy and wind is proposed as a vision.

Review the growth and achievement of the renewable energy targets, particularly as part of the K-GEM initiative, and propose a plan to achieve the targets. Currently renewable energy generation (other than small/mini/micro hydro) in Kerala is just above 370 MW, out of which 300MW from solar grid connected PV plants including utility-scale and roof-tops and 70 MW from wind energy.

K-GEM shall be mandated with climate goals, among other objectives. Further, K-GEM may give an impetus to the Green Energy movement, by designating it as the nodal agency to National Green Hydrogen Mission. An institutional framework is clearly the need of hour for Green Hydrogen adoption and this shall be discussed among all stake holders (KSEB Ltd/ANERT/ EMC) including experts before its finalisation and implementation in different phases.

- **Solar Energy-Floating Solar PV** Kerala has a large size of manmade water bodies. Out of total, 81 dams in Kerala, KSEB owns 59 dams which forms 45 reservoirs, Kerala irrigation department owns 20 dams which forms 20 reservoirs and Kerala Water Authority vests the control of 2 dams with 2 reservoirs. Installing medium size (100MW to 300MW) grid storage-based solar floating power plants in dam reservoirs and lakes in Kerala are proposed.

- **Wind Energy**

National Institute of Wind Energy (NIWE), Govt. of India has predicted a total of 1700MW wind energy potential in the State based on Meso-Micro scale mapping and based on the available ground based data. 200MW can be generated from wind energy as a first phase, especially from the potential areas in Palakkad and Idukki District. The wind farm potential near Chengotta in Kollam and Ponmudi in Thiruvananthapuram District are also to be explored.

- **Waste to Energy:**

The increasing industrialization, urbanization and changes in the pattern of life give rise to generation of increasing quantities of wastes leading to increased threats to the environment. In recent years, technologies have been developed that not only help in generating substantial quantity of decentralized energy but also in reducing the quantity of waste for its safe disposal. The Ministry of India is promoting all the technology options available for setting up projects for recovery of energy in the form of Biogas/BioCNG/Electricity from agricultural, Industrial and urban wastes of renewable nature such as municipal solid wastes, vegetable and other market wastes, slaughterhouse waste, agricultural residues and industrial/STP wastes & effluents.

Therefore, the Working Group suggests scaling up Green Energy from the Biomass and Waste to Energy. Plans for Municipal Solid Waste (MSW) to Energy should be incorporated as integral part of energy security and mitigation of environmental considerations in consultation with LSGI's.

II. Transmission

- Kerala has clear RE targets; however, do not have a carbon goal to pursue. The Working Group recommends formulating plan for reduction in carbon emission with clear cut targets.
- Kerala is the most backward state in terms of Variable Renewable Energy (VRE) share for energy mix. Alongside sun and wind, water is also an inconsistent source of energy. Therefore consider seasonal storage. Variable Renewable Energy coupled with large storage shall become dispatchable source of electrical power.
- Utility should accommodate frequently changing business models and rapid technological changes in RE sector.
- **Energy Storage:** The solar generation target for the State by 2022 is 1,870 MW as per the state Renewable Energy (RE) target imposed by the Ministry of New and Renewable Energy (MNRE) , however, the state is able to achieve 312 MW of solar installation by September 2021. Further, in order to achieve the ambitious RE target of 500 GW set for India by 2030, additional RE targets will be imposed at the state level in the coming years. With the increasing penetration of the intermittent nature of RE into the grid, one of the major challenges faced by utility operators is balancing the grid. Energy Storage Systems (ESS) has the capability to balance the grid by allowing seamless integration of renewables into the grid. Hence, it is important to assess the energy storage requirements at the grid level and assess the suitable grid integration point for the storage projects to smoothen the

intermittent RE generation. In this regard, Kerala state should have storage projects that are properly sized and sited in the transmission network.

- **Sizing of ESS:** With the integration of large renewables into the grid and the associated intermittency, it is important to analyse storage requirements to balance power in the grid. The optimal sizing of grid-scale storage for Kerala can be obtained from a simplified production-cost simulation, by taking into account the inter-state transmission that flows in and out of Kerala. This analysis will be further enhanced by modelling the state network into different areas/zones, taking into consideration the major intra-state transmission network to check the storage requirement at different areas/zones.
- **Siting of ESS: Transmission Planning-** Based on the capacity of storage required to balance the grid through production cost analysis, the transmission grid integration for the storage projects may be carried out by modelling Kerala's entire transmission network of 110 kV and above voltage levels in power simulation software. Various scenarios of load-flow analyses (peak load, off-peak load, peak solar,) to be carried out to identify the transmission network availability (both substations/transmission lines) to integrate the storage project. This will include estimating the requirement of new transmission infrastructure, along with the augmentation of the existing infrastructure. For the purpose the Working Group proposes to conduct transmission planning study. The study will be carried out for the targeted year. It will help the State to identify feasible energy storage sites in the network.
- **ESS: Benefit Quantification (Techno-economics of storage in the transmission grid):** The overall analysis of sizing and siting the storage in the grid helps us understand the value proposition offered by energy storage devices such as frequency regulation, voltage support, transmission congestion relief, reduce curtailment of renewables, energy time-shift, black start (restoring a power station to its operational capacity without external power), correction of forecasting inaccuracy, and whole-sale market arbitrage.
- **Decentralized Energy Generation and Energy Storage-Evaluate and establish DISCOM anchored Solar and Battery Storage Platform for addressing energy security, resilient grid and climate change:**
- evaluate the potential benefits to the C&I sector from PV and battery storage system and in parallel the techno-commercial impact on electricity distribution network from the wide scale use of distributed PV generation with and without battery storage using electrical power system analysis software, analyse and assess the scope for managing the power system to avail benefits from peak shaving, time-of-day (Todd) tariff management and energy arbitrage through open access market when solar and battery energy storage system (BESS) is integrated to the system.
- assess the potential of integration of solar and BESS for C&I consumers.
- assess independent BESS or rooftop solar system and combination of both based on the suitability for adopting such system based on their current load, critical loads, energy consumption pattern and available space in the premises.
- analyse revenue streams and direct benefits and propose various ownership structures

and possible financial options (different project financing options such as benefit share, different PPA structure, Open and Capex model of procurement can be discussed for standalone BESS or PV-BESS combined situation)

- analyse and evaluate use of distributed PV and battery storage for implementation of virtual power plant (VPP) concept
- Standards and Regulations related to electricity

III. Distribution

The Covid19 scenario undermines urgency in:

- a) Implementation of Smart meters soon
- b) Faster introduction of DBT mechanism in the sector.
- c) Modernising grids to smart grids to reduce distribution losses

IV. E- Safety

a. Power Quality Management

The use of electronic equipment in electrical system is increasing drastically, which in turn pollute the power system by generating harmonics. LED lamps, Solar PV installations, Inverters, EV chargers, UPS, computers are few examples. Presence of harmonics in power systems which are included by the mentioned equipment will seriously affect the performance of transformers. Moreover, poor power quality can cause unstable voltages, data loss, malfunctioning of PLC controls and protection relaying equipment and erratic operation at precise control equipment. Furthermore, an installation which is a source of hazardous order of harmonics can cause nuisance tripping not only in our installation but sometimes in nearby consumer's installation. And also there is also a risk of occurrence of fire accident. As per the electricity regulation to maintain harmonies, the consumer has to maintain the harmonics within the specified limits and testing of harmonics is mandatory for certain category of installations. The Working Group recommends power quality improvement projects/programmes are to be included in the energy policy of 14th Five Year Plan.

b. Testing laboratory for fire accident investigation

Electricity is one of the most widely used forms of energy and its safe use is also an important one. A properly designed, constructed, operated and maintained electrical network rarely leads to accidents. The electrical installations in the state often do not get the attention from consumers and it is not uncommon for the safety relying entirely on the regulations enforced by the state. This is reflected in the accident statistics. Last five year data shows an average of 250 fire accidents per year in our state. Fire accidents are the result of both electrical and non-electrical causes. Identification of the cause of such accidents is an onerous task. There are no testing laboratories as part of investigation of electrical fire accidents in the State. Hence it is highly essential to include Power Quality study and scientific investigation of fire accidents in the research and development of energy sector and establish testing laboratories.

V. Research and Development:

During 14th Five Year Plan special efforts should be made for promoting research activities

involving improvement of efficiency/ effectiveness of various techniques, procedures, processes, in manufacturing electrical equipment, developing new technologies for various type of power generation, especially from renewable sources, transmission and distribution.

VI. Project Management

- Implementation of the projects in a timely manner is as important as the planning itself. Even though the 14th Five-Year Plan (FYP) (energy) brings out the energy requirements of the state for the next five years, looking at the past two five-year plan period (12th and 13th FYP), what could be seen is a delay in the implementation of the projects. Covid-19 has caused a delay in the project implementations during the 13th FYP period, but no such situations existed in the 12th FYP period, still quite a delay in the implementations. So, it is necessary to strengthen the implementation efforts of the present and future projects.
- Project and its progress must be judged based on the deliverables in a timely manner. Every project should have deliverables written down clearly. Evaluation of the project must be based on these deliverables. One should also note that the project delivery is not a one step process at the end of the project period, rather it is a continuous process with its progress clearly known and evaluated. Thus, every project should be broken down with deliverables at definite time period, say at every six months. There will be a number of deliverables at each of these periods and they should be evaluated at the end of each of these time periods. All money disbursements should be tied to these deliverables. Necessary corrections and plan of actions should be implemented at each of these stages, so that there are no surprises coming out at the end of the project period. Authorities must move from regulatory to consultative mode in areas of state resources development

VII. Other Recommendations

- The MSME sector has consistently been registering higher growth rates compared to other sub sectors in the industrial sector. With over more than 55,000 manufacturing units (as on 31-03-2019) registered, the MSME sector in the industrial segment has far better scope and demand for products and implementation of new technologies than large industries. However, they are unable to achieve this due to their limited access to funds, lack of entrepreneurial spirit, and inability to take technology developments risks. With the right guidance, relevant policy push, and financial aid, the opportunity for optimizing their energy needs are substantial. Moreover, the Working Group suggests formulating plan for producing energy efficient power sector equipment/products in MSME sector for renewable energy generation/storage/distribution as part of Make in India/Kerala as well as other core products in Power Sector.
- The State of Kerala is facing the gravity of climate change for the last several years. The real threat started after the cyclone Ockhi devastated the Southern Kerala Coast in 2017. The worst flood happened in Kerala in 2018 and its repetition in the later years made a very bad impact on Kerala's electricity system. The importance of a resilient power system is particularly important in the context of the climate change. The power

system should be capable of facing such challenges. The Working Group suggests formulating an effective disaster management plan to build a resilient power system keeping in view of the enhanced risks of natural disasters due to Climate Change.

- Ensure permanent solutions to the problems of electricity supply to all people of the Scheduled Tribes and persons living in remote places, Scheduled Castes, fish workers, and other groups living in areas that are remote or vulnerable to natural disaster.
- A special study in typical areas on the needs (aspirations as well), their time of use etc. should be undertaken. For each area, the total requirement of all forms should be worked out. Then, the implementation schedule should be worked out.
- Electrification should not be the only way.
- Local youth should be involved during construction and minor maintenance tips should be given to them.
- There should be a plan for post implementation, “hand holding” visits by govt. officials.
- ICT Centres should necessarily be set up in such areas and elders made to make use of them. Local school can be the fulcrum.
- Productive application of energy should be specially designed and made part of energy plans for such areas.
- Community Common RE set up, use in sustainable development projects, community management should also be tried.
- Linking Engineering College students through IEEE or directly should be made a pattern, so that hand holding will be smooth, fast and effective.
- Renewable Energy based stand-alone power generation is the best solution for remote village electrification and for meeting the power needs of vulnerable communities who are facing the threat of climate change.
- Providing conventional electricity supply with a solar based backup solutions can be a permanent solution to solve the energy needs of all people of the Scheduled Tribes and persons living in remote places, Scheduled Castes, fish workers, and other groups living in areas that are remote or vulnerable to natural disaster. The best solution will be a solar hybrid PV power plant with intentional islanding systems where there is conventional grid connection though it is intermittent.
- There are proven solutions for remote areas where there is no conventional electricity connection. Stand-alone/off-grid plants, especially utilising solar PV with Battery Energy Storage Systems (BESS) are the best solutions for powering these areas. These systems will be always off-grid systems with defined autonomy for battery. Small Wind-Solar Hybrid Systems can be also utilised in areas where wind energy is available. Battery replacement after its life period shall be ensured to ensure the sustainability of these decentralised systems. The solutions suggested are listed below:
 - Solar PV Micro grids/Pico Grids
 - Solar – Wind Hybrid Systems
 - Solar PV Power packs for emergency systems
 - Implementation of Renewable Purchase Obligation (RPO) for captive consumers: In Kerala, the current level of RPO for 2021-22 is 6.75% and 10.25% from Solar

and Non-Solar (total 17%) energy sources. The compliance mechanism for Open Access consumers and other captive consumers needs to be strengthened through the designated compliance auditor.

- **Green Power:** Ministry of Power, Government of India has issued Draft Electricity (Promoting RE through Green Energy Open Access) Rules 2021 in August 2021. This rule shall be applicable for purchase and consumption of green energy. Consumers who have contracted demand / sanctioned load of 100 kW and above shall be eligible to take power through green energy open access. Consumers can request their DISCOM itself to supply Green Power. The Kerala Green Energy Mission shall need to plan for this generation.
- **Grid Ancillary Services:** Central Electricity Regulatory Commission (CERC) has issued a draft regulation to provide for a regulatory mechanism for ancillary services in the interest of reliability, safety and security of the grid. Central Electricity Regulatory Commission (Ancillary Services) Regulations 2021 is a significant step in maintaining grid frequency within the allowable band through market based mechanisms. Once issued, this regulation requires grid operators to provide stability through active power injection or withdrawal as the case may be. Kerala Transmission System Operator (TSO) shall be obligated to provide these services at Grid stations.
- A blue print and adequate funds shall be incorporated in the energy sector working, for the plan period 2022-27 towards this new activity.
- **Energy Efficiency:** The working Grope proposes to scale up the programmes for energy conservation by promoting energy conservation awareness programmes, use of energy efficient electrical equipment/products and to formulate State Energy Efficiency Action Plan for 14th Five Year Plan.
- It is also proposed to revise Energy Reduction Targets for the State by 2030.

CHAPTER 4

PERSPECTIVE & ROAD MAP FOR 14TH FIVE YEAR PLAN

State Electricity Plan: Energy is considered an important input for achieving sustainable development, including alleviation of poverty. Hence a strategy should be developed for the management of energy sector in such a manner to promote rapid economic growth and sustainable development of the state. State energy authorities need to be guided by some well-defined policies in discharging their functions in many areas such as generation capacity addition including from renewable energy sources, transmission and distribution, grid operation, rural electrification, energy market operations etc. Power purchase agreements (short, medium & long term) need to be relooked based on revised demand projections factoring in the current & emerging energy efficient technologies and capacity addition through renewable power options. Special emphasis needs to be given for supporting the rural households and promoting the value addition of rural/ agrarian products by providing affordable electricity.

GENERATION

Looking at the various energy sources like hydroelectric, solar, wind and other forms, each having its own non-uniform generating patterns, an energy mix will be ideal to compensate each other giving a more uniform power output. Such electricity generation capabilities also need to spread across Kerala for spatial compensations. There has to be a reference to the amount of non-availability of power during the 14th FYP on account of retirement of thermal plants which contributes under state's electricity purchase. Strategy on how this shortfall would be overcome needs to be clear by the energy planners.

Green Energy: During the 14th Five Year Plan period a major addition (3,000 MW) through from renewable energy sources such as hydropower projects, solar energy and wind is proposed as a vision. Emphasis needs to be given to roof top solar, solar based pumps for farmers for irrigation, floating solar etc. Other renewable schemes such as promotion of biogas, improved chulha, solar thermal and wind may also be promoted in the renewable energy programs. Waste to energy plants, which help to free up the landfilling / dumping grounds and avoiding pollution, needs to be promoted. Compliance to RPO and Green Power protocols to facilitate Green Energy Open access.

Green Energy Mission - A mission-mode approach needs to be pursued to promote renewable, solar, hydro and wind energy by conducting energy potential surveys/feasibility studies. K- GEM may give an impetus to the Green Energy movement, by designating it as the nodal agency to National Green Hydrogen Mission.

ESS - Energy storage systems (ESS) have the capability to balance the grid by allowing seamless integration of renewables into the grid. Hence, it is important to assess the energy storage requirements at the grid level and assess the suitable grid integration point for the storage projects to smoothen the intermittent RE generation. In this regard, Kerala state should have storage projects that are properly sized and sited in the transmission network covering battery, pumped and other innovative storage solutions. Evaluate and establish

DISCOM anchored ESS for addressing decentralised energy generation, energy security, resilient grid and climatic changes.

Solar Energy - Installing medium size (100MW to 300MW) grid storage-based solar floating power plants in dam reservoirs and lakes in Kerala totalling to a capacity of 500MW. Li-ion based Grid Storage systems are now very popular worldwide as storage solutions along with solar PV generation for pumping the power back to the grid whenever demand comes. In the case of our State, Grid Storage solutions along with Floating Solar helps to reserve water in the hydroelectric dam reservoirs for meeting the peak load in the evening. Also targets on Roof top Solar Plants to be fulfilled.

Wind Energy –(a) National Institute of Wind Energy (NIWE), Govt. of India has predicted a total of 1700MW wind energy potential in the State based on Meso-Micro scale mapping and based on the available ground based data. 200MW can be generated from wind energy as a first phase, especially from the potential areas in Palakkad and Idukki District. The wind farm potential near Chengotta in Kollam and Ponmudi in Thiruvananthapuram District are also to be explored.(b) NIWE’s predicted 1700 MW potential, State may target 200 MW generation from wind as 1st phase.

Waste to Energy - The Ministry of India is promoting all the technology options available for setting up projects for recovery of energy in the form of Biogas/BioCNG/Electricity from agricultural, Industrial and urban wastes of renewable nature such as municipal solid wastes, vegetable and other market wastes, slaughterhouse waste, agricultural residues and industrial/STP wastes & effluents. Green Energy from the Biomass and Waste to Energy will be promoted. Plans for Municipal Solid Waste (MSW) to Energy should be incorporated as integral part of energy security and mitigation of environmental considerations in consultation with LSGI’s.

Energy Conservation and Management: The campaign to promote energy conservation in the State has shown significant impact. It requires continues efforts in this field by converting all lights (including street lights) to LED as part of Filament Free Kerala programme, promoting energy efficient equipment and appliances and making energy audit mandatory in institutions. Energy labelling, rating the performance on a scale of 1 to 5 stars, is one of the most cost effective policy tools for improving energy efficiency. Minimum energy standard needs to be set for commercial buildings through Energy Conservation Building Code. ECO- NIWAS Portal has been developed by Government of India to promote energy efficiency in residential building sector. Perform, Achieve and Trade (PAT) scheme under National Mission for Enhanced Energy Efficiency (NMEEE) needs to be implemented effectively to achieve emission reduction in energy intensive industries. A State Energy Efficiency & Management Plan with Road Map needs to be developed and implemented focussing reduction on carbon emission and carbon intensity.

E- Mobility Ecosystem: The increased greenhouse gas emission to the atmosphere is causing serious changes in the planet that can affect lives of the people. As motor vehicles are identified as one of the primary sources of air pollutants, shifting from fossil fuel vehicles to electric vehicles will help to make a considerable reduction in harmful air pollution

from exhaust emissions of the sector. Success of electric mobility system relies on strategic integration between each of the stakeholders of the system including EV & Accessories manufacturers, Charge station manufacturers, Charge Point Operators, E-Mobility service Providers, Grid Operators/ Distribution System Operators, Transmission System Operators, Power generation / Utility Suppliers, Regulating authorities etc. Well defined policy needs to be formulated on manufacturing/ purchase/use of electric vehicles, installation, accessibility, operation, maintenance & service of charging stations and incentives for e-vehicle charging. Regulations need to be set for responsibilities for each of the stakeholders and industry initiatives of E- Mobility Ecosystem. To facilitate the process of shifting to electric vehicles, charging infrastructure needs a geographical spread across the State. The possibility of solar charging stations and State's own Electric cars hire project (E-Mobility) needs to be strengthened.

Transmission and Distribution: A short term plan for the next five years and perspective plan for next 10 years need to be developed for the optimal utilisation of resources to ensure reliable and affordable energy. Government is committed to improve the quality of life of its citizens by providing 24x7 power supplies to all households. Investment should be made in rural electrification infrastructure for improving the quality of electricity and the duration of which is made available. During 14th Five Year Plan, transmission and distribution network, especially high voltage transmission lines to be strengthened. To bring down T&D losses further, all Transmission and Distribution network needs to be made smart physically as well as technically through various innovative initiatives.

Disaster Resilient Approach: The world is increasingly reliant on secure, sustainable and affordable energy supply. Taking steps to improve and maintain power grids and address the causes of disruptions represents a key concern for businesses and society. It requires constant vigilance, planning and increased investment in energy infrastructure. We have to formulate a guideline for safe and resilient (especially from the flood) construction of power infrastructure. The possibility of underground power supply channels may also be explored. Measures need to be incorporated for reduction of disaster risk into planning, design, construction and operational aspects of power sector projects. Authorities should review the Standards of Construction and other Technical Standards and carry out changes, wherever necessary to minimise disaster risks. All the licensees and generating units must comply with the provisions of Disaster and Crisis Management Plan prepared by the Central Electricity Authority.

Smart Metering: Adoption of new technology helps to make possible sharing of end-to-end real-time information in various sectors. It enables accurate cost calculation and transparency in usage. Installation of smart meter helps to record information such as consumption of electric energy, voltage levels, current, and power factor. Smart meters communicate the information to the consumer for greater clarity of consumption behaviour, and electricity suppliers for system monitoring and customer billing. The smart metering system needs to be introduced in the State, which is mandated by GoI to reduce theft, commercial losses & improve efficiency and governance of KSEB.

Make in India/Kerala: The MSME sector has consistently been registering higher growth rates compared to other sub sectors in the industrial sector. With higher employment and income generation, the MSME with its 6000+ products from traditional to high-tech items holds a significant share of the overall industry output.

The Government of India is mandated to promote domestic production, create jobs, develop skills, facilitate investment, foster innovation, protect intellectual property, and build a best in class manufacturing infrastructure in the power sector. This would also apply to Kerala. Moreover, formulate a plan for producing energy efficient power sector equipment/products in MSME sector for renewable energy generation/storage/distribution as part of Make in India/Kerala. When domestic equipment/parts are not available, goods shall be produced through transfer of technologies by inviting foreign manufactures and creating manufacturing zones. Standards need to be developed and upgraded for ensuring the quality of equipment. Testing facilities needs to be developed to ensure the quality of indigenous products and security of imported products.

Research and Development: Special efforts should be made for promoting research activities involving improvement of efficiency and effectiveness of various techniques, procedures, processes, in manufacturing electrical equipment, developing new technologies for various type of power generation, especially from renewable sources, transmission and distribution. Efficient communication system and reliable analytics techniques need to be developed for the processing and analysis of data. Cyber security needs to be ensured and to minimise the possibility of cyber-attacks, cyber security standards should be specifically designed for the power systems. Specialised institutions engaged in research and development in the electricity sector should be further augmented and power companies should set aside a portion of their profits for research and development. Sector specific applied research , development and commercialisation through Industry- Academia linkage and collaborations need to be encouraged.

E-Safety: Generation, Transmission and Distribution systems of the power sector still encounter many hazards. New programs and policies with technology backups aimed at eliminating accidents needs to be developed and implemented. The state would take the initiative to prevent accidents with complete training, detailed pre-job planning, and maintenance of safety equipment.

Skill Building and Human Resource Development: It is important that the persons employed in the power sector have the required skills to enable them to adopt good operating practices so as to improve the efficiency of operation of power plants, transmission and distribution system, power procurement etc. Training infrastructure especially in the field of electricity distribution, regulation trading and power markets needs to be strengthened. Adequate human resources need to be provided by the power utilities as per the job requirements in order to ensure the SERC's in-house capacity augmentation. Joint initiatives by KSEBL, ANERT, EMC, Electrical Inspectorate and other research institutions needs to be developed and rolled out.

Environmental Issues: To mitigate the environmental impacts of the construction and operation of power plants, strategies need to be developed for the judicious usage of land and water and the management of electronic waste. Power sector projects, especially hydroelectric projects involve substantial land usage. Special effort needs to be taken to promote more storage/pondage based hydro generation through pumped storage and desilting of dams. In a land scarce state like Kerala, in view of increasing difficulty in getting land, innovative ideas /technologies addressing land constraints in Generation, Transmission and Distribution and waste disposal are to be explored.

New business opportunities: The vast water reservoirs, surrounded by mountains and lush green landscape, associated with the Hydel projects are unique attractions that make Kerala high on the list of tourist destinations in India. In order to tap the socio-economic benefits including generating employment and income for the people of remote areas, new tourism sector initiatives will be explored. Additionally, the power sector agencies under the Government of Kerala with their core strength of qualified and experienced professionals can offer a wide range of consultancy services in this sector. There can be opportunities to venture into consulting services for the civil, electrical, electronic, and information technology sectors within and outside the state and abroad.

Project Management - It is necessary to strengthen the implementation efforts of the present and future projects. In this respect one should adapt the industry best practices in project implementations. Project and its progress must be judged based on the deliverables in a timely manner. Evaluation of the project must be based on deliverables. Necessary corrections and plan of actions should be implemented at each stage, so that there are no surprises coming out at the end of the project period. Authorities must move from regulatory to consultative mode in areas of state resources development for project management. ERP solutions covering project management modules needs to be developed and rolled out.

Access to power in remote and vulnerable areas - Stand-alone/off-grid plants, especially utilising solar PV with Battery Energy Storage Systems (BESS) are the best solutions for powering remote areas. These systems will be always off-grid systems with defined autonomy for battery. Small Wind -Solar Hybrid Systems can be also utilised in areas where wind energy is available. Solar PV Micro grids/Pico Grids, Solar – Wind Hybrid Systems and Solar PV Power packs for emergency systems are some solutions.

Kerala needs to identify and harness whatever energy sources available in the state with innovative ideas and it is required to build a resilient power system that is capable of facing challenges in the State.

Appendix

PROCEEDINGS OF THE MEMBER SECRETARY STATE PLANNING BOARD

(Present: Sri Teeka Ram Meena IAS)

Sub:- Formulation of Fourteenth Five Year Plan (2022-27) – Constitution of Working Group on **Energy**- reg.

Read: -1. Note No.297/2021/PCD/SPB dated: 27/08/2021

2. Guidelines on Working Groups

ORDER No. 951/2021/ I&I/ SPB(AD1)/ WG - 1 Dated :10/09/2021

As part of the formulation of Fourteenth Five Year Plan, it has been decided to constitute various Working Groups under the priority sectors. Accordingly, the Working Group on **Energy** is hereby constituted with the following members. The Working Group shall also take into consideration the guidelines read 2nd above in fulfilling the tasks outlined in the ToR for the Group.

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Terms of Reference

1. Assess the demand-supply gaps for the 14th Five-Year Plans period and propose a plan for capacity additions in generation, transmission and distribution to meet the energy security needs of Kerala.
2. Propose measures required to build a resilient power system keeping in view the enhanced risks of natural disasters due to Climate Change.
3. Review the growth and achievement of the renewable energy targets, particularly as part of the K-GEM initiative, and propose a plan to achieve the targets.
4. Ensure permanent solutions to the problems of electricity supply to all people of the Scheduled Tribes and persons living in remote places, Scheduled Castes, fish workers, and other groups living areas that are remote or vulnerable to natural disaster.

Terms of Reference (General)

1. The non-official members (and invitees) of the Working Group will be entitled to travelling allowances as per existing government norms. The Class I Officers of GoI will be entitled to travelling allowance as per rules if reimbursement is not allowed from Departments.
2. The expenditure towards TA, DA and Honorarium will be met from the following Head of account of the State Planning Board '3451-00-101-93'- Preparation of Plans and Conduct of Surveys and Studies.

(Sd/-)

Member Secretary

To

The Members concerned

Copy to

PS to VC
PA to MS
CA to Member (Dr.K Ravi Raman)
Sr. A.O, SPB
The Accountant General, Kerala
Finance Officer, SPB
Sub Treasury, Vellayambalam
Accounts Section
File/Stock File

Forwarded By Order

Sd/-

Chief (Industry and Infrastructure Division)