GOVERNMENT OF KERALA

THIRTEENTH FIVE-YEAR PLAN
(2017-2022)

WORKING GROUP ON

ENERGY SECTOR

REPORT

INDUSTRY AND INFRASTRUCTURE DIVISION
STATE PLANNING BOARD
THIRUVANANTHAPURAM
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PREFACE

In Kerala, the process of a Five-Year Plan is an exercise in people's participation. At the end of September 2016, the Kerala State Planning Board began an effort to conduct the widest possible consultations before formulating the Plan. The Planning Board formed 43 Working Groups, with a total of more than 700 members – scholars, administrators, social and political activists and other experts. Although the Reports do not represent the official position of the Government of Kerala, their content will help in the formulation of the Thirteenth Five-Year Plan document.

This document is the report of the Working Group on Energy Sector. The Chairpersons of the Working Group were Shri Paul Antony IAS and Shri Prabir Purkayastha. The Member of the Planning Board who coordinated the activities of the Working Group was Professor T Jayaraman. The concerned Chief of Division was Shri N R Joy.

Member Secretary

CONTENTS

LIST OF ABBREVIATIONS

1.	AAC	- All Aluminium Conductors
2.	ACSR	- Aluminium Conductor Steel Reinforced
3.	ANERT	- Agency for Non- conventional Energy and Rural Technology
4.	AT&C Losses	- Aggregate Technical & Commercial Losses
5.	BEE	- Bureau of Energy Efficiency
6.	BDPP	- Brahmapuram Diesel Power Project
7.	BSES	- Bombay Suburban Electricity Supply
8.	CEA	- Central Electricity Authority
9.	ECBC	- Energy Conservation Building Code
10.	EC	- Energy Conservation
11.	EHT	- Extra High Tension
12.	EHV	- Extra High Voltage
13.	ELCB	- Earth Leakage Circuit Breaker
14.	EPS	- Electrical Power Survey
15.	GAIL	- Gas Authority of India Limited
16.	G o K	- Government of Kerala
17.	HEP	- Hydro Electric Project
18.	HVDC	- High Voltage Direct Current
19.	HT	- High Tension
20.	ISTS	- Inter State Transmission System
21.	ITI	- Industrial Training Institutes
22.	KDPP	- Kozhikode Diesel Power Plants
23.	KSEBL	- Kerala State Electricity Board Limited
24.	KV	- Kilo Volt
25.	LA	- Land Acquisition
26.	LNG	- Liquefied Natural gas
27.	LPG	- Liquefied Petroleum Gas
28.	LSG	- Local Self Government
29.	LSHS	- Low Sulphur Heavy Stock
30.	LT	- Low Tension
31.	MNRE	- Ministry for New and Renewable Energy
32.	MU	- Million Unit
33.	MVA	- Mega Volt Amp
34.	MW	- Mega Watt
35.	NTPC	- National Thermal Power Corporation Limited
36.	PGCIL	- Power Grid Corporation of India limited
37.	PPA	- Power Purchase Agreement
38.	PV	- Photo Voltaic
39.	PSUs	- Public Sector Undertakings
40.	QCO	- Quality Control Order
41.	RE	- Renewable Energy
42.	RGCCPP	- Rajiv Gandhi Combined Cycle Power Project
43.	RLNG	- Re- Gasified Liquefied Natural Gas
44.	R o W	- Right of Way
45.	SAIDI	- System Average Interruption Duration Index
46.	SAIFI	- System Average Interruption Frequency Index
47.	SCADA	- Supervisory Control and Data Acquisition

48.	SECI	- Solar Energy Corporation of India
49.	T&D Losses	- Transmission & Distribution losses
50.	UG	- Under Ground
51.	UMPPS	- Ultra Mega Power Projects

FOREWORD

Energy plays a vital role in the socio-economic development and human welfare of a State. Apart from its contribution to economic development, it contributes significantly to revenue generation, employment, enhancing the quality of life and reducing poverty. For any developing country, therefore the strategy for energy development is an integral part of the overall economic strategy. Economically affordable and environmentally clean power to all is the Vision of Power Sector in Kerala.

For evolving suitable strategy and approach towards adequate power generation- renewable and non-renewable, energy conservation, electrical safety etc during the 13th Plan, the State Planning Board has constituted the Working Group on Energy with Sri Paul Antony IAS, (Additional Chief Secretary to Government, Department of Power) and Sri Prabir Purkayastha, (President Centre for Technology and Development, New Delhi/Chairperson Knowledge commons) as Co-Chair persons. The committee comprises eminent experts from various areas related to Energy.

The Committee met thrice and conducted a review of Twelfth Plan programme 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 13th Plan period.

We are grateful to all the members of the Committee and Sub-Committee whom contributed with valuable insights, specific suggestions and recommendations. Special thanks to Prof T Jayaraman, Member, State Planning Board for his support, co-ordination and constructive suggestions. We are sanguine that some of the issues and problems identified will help the State Agencies to work towards new solutions and ideas. We wish that the report will lead light to evolve appropriate proposals and schemes in the coming plans which can address many of the issues in the Power Sector.

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EXECUTIVE SUMMARY

Background: Kerala is one of the States which has decided to continue its Planning process for the next Five year plan (2012-17). As a first step, working groups on different sectors were re constituted and elaborate discussions were conducted on different sectors by incorporating the services of best subject experts in the country. Working Group on Energy was co-chaired by Sri. Prabir Purkayastha (President, Centre for Technology and Development, New Delhi and Chairperson, Knowledge Commons) with Sri. Paul Antony IAS (Additional Chief Secretary to Government, Department of Power). The working group met three times in Thiruvananthapuram and made elaborate discussions on Issues, Present Situation, Strategies and prospects of Energy sector of Kerala and submitted a scientific, concrete and realistic plan to be pursued in 13th Plan period. It is prepared on a background where the State presently met 70% of their energy needs from outside and they are once a surplus state in the country. The following are the major gist from the report.

Review of 12th Plan: In order to get a back ground of the Energy sector and a brief picture of the plan progress in the sector, the report start with a brief review of the 12th Plan targets and achievements. It is found that targets fixed for the 12th Plan period was ambitious but the achievements are comparatively meagre at least in capacity addition. In Hydro (Large, Medium and Small), the achievement was only 30.75 MW in the first four years compared to the aggregate combined target of 248 MW. So there is a difference of 217.25MW in targets and actual in Hydro Sources alone. Similarly there is a difference of 290.4 MW in Wind, 44.69 MW difference in Solar, 874 MW difference in additional UMPPS, 500 MW in Pet coke and 1000 MW in coal. The pet coke cost proposed by Kochi refinery meant a power generating cost of Rs.9-10 on the grid and found not viable. The Baitarani coal linkage did not materialise, so the proposed plant of NTPC in Ramagundam with Kerala coal allocation. Today, the installed capacity of the State is in the range of 30% only and the balance is met from Central Generating Stations and the Private sector.

During the 12th Plan period, 1 nos. of 220 KV substation,15 no's of 110KV sub stations,5 no's of 66 KV sub stations ,16 no's of 33 KV substations were constructed.7,292 Kms of HT transmission lines and 14,749 Kms of LT transmission lines was also commissioned. 16,22,122 no's of new connections were provided. AT&C losses reached down to 16.0% while Transmission losses were 4.3% during this period. The 400 KV transmission backbones could not be constructed due to forest and other environmental clearances.

Key points: The present working group report is prepared on the basis of taking in to account the following three key points in general. They are (1) what is the likely energy demand of the State at the end of 13th Plan? (2) How is this Demand going to be met-Sourcing from within Kerala and through Imports? And (3) what is the Energy mix including renewables for the 13th Plan?

Demand Forecast: The peak Demand for the previous year (2015-16) was 4004 MW and for the current year (2016-17), it is expected to be about 4200 MW. With respect to the Five year projections, the 18th EPS projected figure was 6092 MW which appears to be on the higher side. The figure of 5343 MW as projected in the 19th EPS seems to be more reasonable and is adopted as the basis for preparing the targets of 13th Plan.

Capacity addition: The difference in Existing peak (4200 MW) and Projected Demand (5400 MW) is 1200 MW which is to be met from the following additional sources (1) 300 MW from Hydro Sources (2) 600 MW Solar from Grid connected Solar Stations (3) 500 MW from Roof top solar schemes and (4) 100 MW from Wind Sources.

From Hydro sources, a modest target of 300 MW is fixed by finishing the existing hydro projects that have been sanctioned and under construction. Of this,140 MW is targeted from 4 ongoing Hydro projects. They are Pallivasal Extension Scheme, Thottiyar, Sengulam Augmentation and Mankulam. In the Small Hydro Projects segment, 174 MW is expecting from 20 SHPs which are now under execution level. In view of the significant increase in RE in the grid, an aggressive plan for building pumped storage is recommended to provide flexibility and enhance existing storage by 50-80 MW by using existing potential for storage or enhancing their capacity.

In the solar segment, two solar stations of 200 MW capacities are targeted to be completed during this plan period. Out of this, one station is already under construction. KSEBL is also proposing to procure solar power from Independent Power Producers from Kerala having capacity not less than 5MW through tariff based bidding to add another 200 MW. This will provide a total of 600 MW of grid connected large solar units in Kerala during the 13th Plan. Apart from this, it is proposed to add 500 MW from roof top solar Plants alone. Policies and institutional arrangements however to be designed to address how to induct large scale solar energy into the system or as stand-alone systems.

Although the scope for large wind farms are limited in the State due to locational disadvantages, a modest addition of 100 MW is targeted in the 13th Plan. It has been proposed that small wind turbines can be used and this can be a major source of energy.

Transmission and Distribution: It is estimated that an additional import capability of around 2000 MW by year 2018 and 4000MW by year 2022 will be required to meet Kerala's demand. In this context, it has to be noted that the intra state transmission system available at present will not be sufficient for catering to the additional transmission capacity required for dispersing the Inter State Transmission System (ISTS) power received from the planned ISTS nodes. In the 13th Plan, new sub stations and transmission lines proposed are (1) Three 400KV new sub stations at Neeleswaram, Mylatty, (2*500 MVA), Kottayam,Ettumanoor (2*315 MVA), Kollam,Kundara (2*315 MVA) to be done by KSEBL and (2) Capacity addition of transformer (1*315) in Kozhikode 400 KV substation, and HVDC 2000 MW Madakkathara by PGCIL.

In distribution sector, first target is to achieve 100% electrification. Apart from this, as part of revamping the network, it may require to reconstruct about 10,000Kms of old 11KV lines. New constructions of about 3000 Kms may be required to standardize the system with special optimizations. Also it may require to construct 5000 Kms of new 11KV lines as part of system widening. Hence there needs to be a target of 18,000 Kms of 11 KV lines during next 5 year plan, i.e. 3600 Km/year. Renovation, reconstruction and new constructions of LT lines are also required and a target of 10,000Kms of LT lines /year is targeted. Average addition of 11 KV lines to the system based on present plan period is 4,000 Kms/Year. During the present 5 year plan, the number of distribution transformers installed by KSEBL is 11,706 (as on 30/09/2016) with an average of about 2,700 Nos/year. Target for the next plan is fixed at 3500 numbers per year with a total of 17,500 numbers.

System Stability, Power Purchase Agreements and Economics of the System: Kerala needs to address the problem of how to schedule its power purchases, solar energy and its hydro plants. With significant ingression of decentralised solar power, the demand felt in the system during day time is likely to see a slump in sunny days too. This, along with the dwindling share of hydro power in the power basket, could pose technical and commercial challenges for the utility in the immediate future, in case the growing demand - supply gap is met entirely through long term contracts with thermal power plants. It is understood that major hydro power plants set up/being set up in Himalayan region (within and outside

the country) has entered the Indian power market seeking long term contracts. This option may be explored to match the daily load curve over different seasons in the coming years. An alternative is to seek contracts for peaking power, instead of long term round the clock power, while meeting base load requirements through long term contracts. However, this could expose the utility to market risks since appropriate risk mitigation products are yet to be developed by regulators. Given the uncertainties, it is best suited to have a mix of long and medium term contracts with thermal power to meet the base load requirements, along with a combination of long term hydro/ diurnal short term contracts for different time slots aligned with the anticipated load curves during different seasons. The utility shall gear up to maintain a least cost power procurement portfolio in view of the gradual fall in the share of own generation capacity in the power basket. For the above, the state will need to institutionalize and significantly strengthen the Power Purchase Planning and Procurement arrangements.

Since nearly 1200 MW is proposed to be generated through Renewable Energy such as Solar and Wind will have huge impact on KSEBL's revenue. Similarly, dismal record of paying dues in time by Government Departments and PSUs to KSEBL in time making it vulnerable to financial liquidity problems. Therefore KSEBL have to be finically assisted to compensate the loss of large domestic consumers and delayed payment from Govt. Departments and PSUs.

Fuel: Regarding fuel usage in Industry, efforts need to be made to switch from fuel oil to LNG as fuel since LNG is available from the Kochi LNG terminal. Where fuel is being used to heat water, e.g., hotels, laundry, etc., solar water heaters should be encouraged. In respect of fuel usage in Domestic sector, there is a growing shift in domestic sector to LPG. This should be encouraged.

Energy Conservation: The 13th Plan should focus on energy efficiency in equipment, government buildings, and water pumping activities in agricultural fields and energy awareness programmes. Energy awareness programs will be implemented in Education, Domestic, Industrial and Agriculture Sectors apart from LSGs and other Government offices to spread the importance of energy conservation awareness and practices.

Electrical Safety: Rate of electrical accidents has increased in recent years in the domestic sector. This is due to lack of knowledge and low safety consciousness among the users. It is proposed to take the following measures to bring down the number of accidents (1) Educating the public through various means(2) Using ELCB's at subsidised rate to families under BPL category (3) Training programme for Electrician/Wireman and Electricity workers (4) Strengthening of Electrical Accident Preventive Committee and Monitoring Centre in the state (5) Replacement of AAC (All Aluminium Conductors) with ACSR (Aluminium Conductor Steel Reinforced) conductors and similar such other policies.

Other Important points: AT&C Loss targeted for the period is 10%.The report also contains vital suggestions and observations regarding the issues of Kayamkulam and Kochi gas fired plants, Hydro potential and Environmental sensitivity, Self Sufficiency and Energy security aspects as well apart from examining various policies and strategies that build energy sector of the state to prosper and green in future.

Conclusion: Since the State does not have any coal or gas reserves and their energy mix mostly based on hydro sources which are almost used and the Demand Supply gap is widening in a complex regulatory circumstance, it is high time to consider alternative sources of energy without affecting the system stability or environmental sensitivity. The approach to be followed is to consider Hydro and Non-Conventional Sources of Energy as complementary sources and not as competitive sources.

CHAPTER 1
REVIEW OF THE 12TH PLAN

1. Kerala's capacity addition plan included ambitious targets for thermal, hydel and non-conventional sources during the 12th Plan. The Table below gives the targets and the actual achievements.

Table 1 *Plan Targets for Additional Capacity (12th Plan)*

Sl. No.	Source	Proposed	Actual	Difference
1	Large and Medium Hydro	100	0	100
2	Small Hydro	148	30.75	117.25
3	Wind	300	9.6	290.4
4	Solar	60	15.31	44.69
5	Additional UMPPS	874	0	874
6	Petcoke*	500	0	500
7	Coal* (Baitarni West, Orissa) at NTPC, Ramagundam	1000	0	1000

Note: * Did not materialise for reasons given below

Other Targets

2. Other major targets are:
   1. Renovation and modernisation of old hydel stations. Some work has been done during the 12th Plan, more needs to be taken up in the 13th Plan.
   2. Life extension and exploring conversion from liquid fuel to natural gas for BDPP and KDPP. The proposals to replace two of the damaged existing machines at BDPP with Gas engines for using LNGs was turned down by the Regulatory Commission due to the price of LNG. Therefore, this conversion also could not be done

Review of Generation Targets

3. *Thermal.* Clearly, the goal of self-sufficiency of energy generation for Kerala could not be met in the 12th Plan. The thermal projects – the 500 MW pet coke based or the 1,000 MW plant with NTPC in Ramagunadam with Baitarni coal, additional UMPP allocations – did not materialise. The pet coke cost proposed by Kochi refinery meant a power generating cost of Rs. 9-10 on the grid and was not viable. The Baitarni coal linkage did not materialise, so the proposed plant of NTPC's in Ramagundam with Kerala's coal allocation also did not materialise. Without these two plants, there is no way Kerala could have become self-sufficient in energy terms.

4. The central government has reduced the budgetary support for investments in the state government's generation programs. With this lessening of funds from the centre, the major investments in the last 20 years in generation have been from NTPC and the private sector. Today, the installed capacity of the states is in the range of 30% for states, the rest of their energy needs being met by central generating stations and the private sector. Given this scenario, for a state like Kerala that does not have any coal or gas reserves, it is not surprising that the state did not achieve self-sufficiency in energy.

5. *Hydel*. In the hydel program, there have been slippages in achieving the targets. Instead of the targeted 248 MW, only 30.75 MW have been added. The major reason for the delays has been forest and environmental clearances. However, the projects that have started in the 12th Plan are expected to be completed by the 13th Plan.

6. *Renewable*. For solar, though the target for the 12th Plan was not met, a 200 MW grid connected solar station is under construction in Kasragode and its first stage of 50 MW is under commissioning. For wind, 9.6 MW have been already commissioned. Kerala does not have the wind potential comparable to that of states such as Tamilnadu, and therefore wind has proved to be less attractive for private wind farms.

7. *Long-term supply contracts*. For achieving security of energy supply, Kerala State Electricity Board reached long-term contracts with various plants for supply of electricity. This is apart from its share of electricity from its share in central schemes such as Koodankulam. It is because of these long term contracts that Kerala has sufficient energy to meet its needs this year, in spite of a poor monsoon and therefore lower hydel supplies.

Table 2 *Transmission & Distribution Targets Met for the Twelfth Plan(Up to 4th Year of the Plan)*

Construction of numbers of sub stations
1. 400 KV-0 2. 220KV-1 3. 110KV-15 4. 66KV- 5 5. 33KV -16 6. 11KV-0
Construction of transmission lines
1. HT LINES: 7,292Kms 2. LT LINES: 14,749Kms
New Connections provided
1. 16,22,122 Numbers
AT&C losses
1. 16.0% for AT&C 2. 4.37% for Transmission losses
Others
1. 100% electrification plan on target, to be done by 2017

Other T&D Targets

8. Other T&D Targets are:

Table 3 *Other T&D Targets*

1. 400 KV transmission backbone across the state	This could not be constructed due to forest and other environmental clearances, but is planned now included in the proposed Trans grid 2 plan.
2. Implementation of SCADA in major cities and pilot implementation of smart grid	This will be taken up in the 13th Plan.

CHAPTER 2
13TH PLAN TARGETS AND PROGRAMMES

9. We need to address the following key questions in planning of the electricity sector for the13th Plan:
    1. What is the likely energy (electricity) demand of the State at the end of the 13th Plan?
    2. How is this demand going to be met – sourcing from within Kerala and through imports?
    3. What is the energy mix including renewables for the 13th Plan?

10. The transmission and distribution plan needs to follow the demand profile and its spatial distribution. However, understanding the future energy demand is the starting point of the planning process.

Demand Forecast for the Electricity Sector

11. Central Electricity Authority (CEA) conducts Electrical Power survey (EPS) covering every 5 year plan periods. Report on the 19th EPS which considers the period 2017-18 to2021-22.

12. The peak demand for the previous year (2015-2016) was 4,004 MW and for the current year (2016-2017) it is expected to be about 4,200 MW. With respect to the five year projections, as per the 18th EPS, the projected figure for the State for peak demand was 6,092 MW, which appears to be on the higher side. The figure of 5343MW as projected in the 19th EPS, seems to be a more reasonable figure and can be adopted as the basis for the 13th Plan.
    1. Existing Peak -4,200
    2. Projected Demand - 5,400 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

13. So altogether 1,200 MW can be derived from renewable sources. The breakup of 600 MW from grid connected solar stations includes two solar parks planned of 200 MW capacities and an additional solar stations, smaller MW scale solar units or a mix of both. Apart from this, 300 MW from Big, Small and Mini hydro schemes can also be targeted. Of this, 174 MW is reported from small hydro sources alone.

Thermal Generation

14. Coal-fired plant in Kerala or outside: It is clear that the demand of the state is going to be far in excess of its installed capacity. The increase in hydel is going to be still a small fraction of the total demand, and renewables, with its low plant load factor is not going to meet the shortfall. Neither is Kerala well-endowed with solar and wind energy. For solar, the additional problem that Kerala has is the constraint on land.

15. There have been arguments that for the purpose of energy security, Kerala needs to invest in a coal-fired 1,200/1,320 MW plant, located either within Kerala or at a pit head. For such a pit-head station, Kerala could negotiate with other state governments for investing in such a plant.

16. Kerala neither has any coal reserve, nor does it have any experience of coal fired plants. If coal is imported into Kerala, it would have to be imported coal. Importing coal from abroad means linking Kerala's electricity prices to international prices of coal. Linking electricity prices to fluctuating international prices of energy is a high risk option. We have already seen this in the case of Mundra and Sasan plants of Tata Power and Reliance, where the rise in coal prices made the original contract price of supplying electricity unviable. In any case, importing foreign coal may mean self-sufficiency in electricity but not in energy.

17. Instead of setting up a plant within Kerala with coal from an Indian mine, import of electricity from a pit head station is a cheaper and a simpler option. The economics of importing coal from a coal mine in India as against importing electricity, is in favour of importing electricity.

18. The answer to the question of self-sufficiency versus energy security, is therefore clearly against self-sufficiency. It does not make much sense to import coal into Kerala in order to set up a large coal based plant.

19. Import of electricity can be done in two ways. Once can be by investing in a pit-head coal fired plant in another state. The other is in long-term power purchase agreements with existing power producers; or such agreements with entities setting up such plants.

20. There are risks with both options. It is possible that even though there are long-term contracts, contracting parties may renege on such contracts. The risk on setting up a plant in another state is the construction may get delayed, the plant may not work well, the contracting state may also renege on the contract. Kerala will still be at the risk of losing its supplies.

21. Looking at both the options, there are two advantages to long term supply contracts from a number of parties. It reduces the risk by distributing such contracts to a number of generating stations. The second is that the state does not have to invest in a plant – it is revenue expenditure, not an investment.

22. Long-term supply contracts have risks but relatively lower risks to investing in a single plant outside Kerala. Instead of looking at them merely as supply contracts, long term contracts should be looked as buying a share of the output of the plants for the long term and therefore fundamentally not different from that of owning a share of the plants. Further, when we look at energy security, we have to look at the security of supplies on a regional basis, and not just on the basis of a state.

23. There have been arguments that having plants within Kerala will make the Kerala grid more stable. Once Kerala grid is connected to the southern grid, its stability depends on the stability of the southern grid. For stability of the Kerala grid, the critical question will be the basic robustness of the transmission network in Kerala, and not just plants located in Kerala.

24. In view of this, the most appropriate strategy of Kerala will be to reach a significant part of its future demand from long term supply contracts from generating stations outside the state. The implications of this strategy would also imply strengthening of the transmission networks, particularly for those corridors that require a large transmission of power for providing electricity to the major load centres in the state.

Gas-based Plants

25. Various proposals have been made for Gas-based plants in the state. The re-gasification terminal at Kochi is a favourable factor in this regard. The suitability of gas as an environmentally benign fuel also is not questionable.

26. However, LNG prices depend on the international price of oil and fluctuate widely. India took a decision in the 90's to go in for liquid fuel at a time that the LNG and oil prices (~ $15 barrel) were low. The Enron's Dabhol project was undertaken with this assumption, as also Kayamkulam and Kochi BSES projects. With higher price of oil, all of these are not viable today, and there is a need to address the stranded costs incurred by adopting the liquid fuel route. In the given circumstances of uncertainty in domestic gas availability and price volatility of Re-gasified LNG, an investment decision may be highly risky. Therefore it needs to be delayed for further period. If the price of RLNG becomes domestically stable, and available at reasonable prices, smaller plants at load centres may be considered at a future date.

27. Kayamkulam and Kochi Gas-fired Plants*:* Rajiv Gandhi Combined Cycle Power Project (RGCCPP) of NTPC at Kayamkulam is a cause of worry for the whole nation. The infrastructure, including land available at this station, is sufficient to generate a minimum of 2500 MW of power. First unit of 360 MW naphtha based power plant at this site was commissioned on 02.06.1998. The cost of naphtha has increased significantly ever since, and the plant has been grossly underutilized due to the high cost of generation. As per the original agreement, fuel of the plant is to be changed to gas and the installed capacity was to be increased as and when natural gas is made available. Soon after the commissioning of re-gasification terminal at Kochi, NTPC approached the participants in the southern grid for buying power from the expanded plant using RNLG. This was turned down due to high cost and uncertainty of RLNG prices. The conversion of naphtha based unit to natural gas and expansion of the plant being at stake, GoK proposed pooling of energy cost of existing RGCCPP unit, which has also not been accepted by NTPC.

28. This has led to a situation that the state has been paying fixed costs to NTPC, while drawing very little power for the same. As the existing Power Purchase Agreement expires in 2018, the state needs to examine how it should proceed with this agreement – whether it should not be renewed, if it is renewed, under what terms, etc.

29. The power from this plant has been drawn by KSEBL on sparingly because of the high cost of naphtha. Keeping it as a standby plant, involves payment of Rs 207 crore per year towards fixed charge by KSEBL. The annual fixed cost is set to increase further to approximately Rs 300 crores with the extension of the PPA for another 15 years.

30. Option I could be to convert the plant into LNG fired plant by replacing naphtha firing. But GAIL states that it will be economically viable for them to lay a pipeline from the LNG terminal to Kayamkulam only if the capacity of the plant is a minimum of 1,000 MW. This brings to the fore the issue whether Kerala can afford LNG-based power of such large quantum, given its high and uncertain cost.

31. Option II would be to scrap RGCCPP, considering the bleak chances of producing power at competitive rates and also given the availability of coal-based power from outside Kerala at cheaper rates; the land could instead be used for solar power installation, which NTPC themselves could fund. The advantage would be the avoidance of the annual drain from KSEBL, but on the other side

would be popular sentiment in allowing a Central Govt Institution to do down.

32. Option III would be to translocate RGCCPP (and convert it to LNG), to a place where the LNG pipeline already passes, like Bramhapuram in Kochi, or is expected to pass, like Cheemeni in Kasargod. Here again, a stand will have to be taken on the issue of whether Kerala can afford LNG-based power.

33. Similar issues come to the fore regarding the private sector LSHS fired 157 MW plant in Edayar in Kochi. Here again, KSEBL does not draw power because of the high cost but pays annual fixed charges of around Rs 71 crores. One option is to execute a PPA for conversion of the plant to LNG, as the LNG pipeline passes almost through the plant site. However, the petition of BSES to KSERC seeking approval for extension of the existing PPA for two more years, being the time required for the conversion of the fuel of the plant to natural gas was dismissed by the latter, citing that it is not maintainable as per the provisions of the Act and regulations.

34. As the PPA has expired in respect of this plant, KSEBL also has an option to take over this plant at its depreciated value and to position it as a standby plant as Kochi is a big load centre, but the high cost of conversion of this plant may be a deterrent, forcing KSEBL to tell the investor to dismantle the plant from the site rather than taking it over.

35. Which decision should be taken by the state would depend on the success of the negotiations with NTPC and BSES. Kerala should pursue such negotiations with NTPC and BSES to resolve the above issue, and if negotiations are not successful, withdraw from the PPA's with NTPC's Kayamkulam plant and BSES Kochi plant.

Hydro Generation

36. Against a total potential of 6,000 plus MW's in Kerala, the harnessed capacity in large capacity hydro plants is only about 1,300 MW. The Renewable Energy status is now being considered for all hydro plants without capacity considerations also provides an incentive for more hydro stations. However, this has to balanced against its environmental sensitivity.

37. The development of hydro-electricity in the state has serious concerns with regards to the flooding of evergreen forests that have rich biodiversity, and therefore causing ecological damage. There is therefore a case for re-assessing the hydro potential of the state taking into account its environmental sensitivity.

38. Hydro should therefore not be considered as the main energy source for Kerala, as it has been considered till now. Instead, it should be looked at for providing peaking power and to act as 'balancing power' to Renewable Energy (RE) sources, in view of the substantial capacity addition proposed in RE sector of the state.

39. Given this, the target for the 13th Plan is a modest one on finishing the existing hydro projects that have been sanctioned and under construction. Micro and mini hydel projects that have much less impact on the environment should be considered, in partnership with local bodies and under the leadership of the Kerala State Electricity Board. This will be dealt with separately as a part of the renewable energy section.

Table 4 *HEPs to be completed in 5 years (2016-2021)*

SL No	Projects	MW	MU	Status
1	Pallivasal Extension Scheme	60	153.9	74 % Completed. Work to be rearranged
2	Thottiyar	40	99	39 % Completed.
3	Sengulam Augmentation Scheme	-	85	60% Completed
4	Mankulam	40	82	LA Stage
	Total	140	419.9	

40. Hydro power not only helps to provide quick injection of power into the system – meeting peaking requirements – but also as a storage of energy. Increased share of renewable energy in the system means that there would always be uncertainty with respect to how much renewable energy will be available at a given time. With Kerala committing to long term contracts, storage becomes even more important as it may need to store the power bought under such contracts if renewable energy is available in that period. Therefore, the strategy for Kerala shall also include ways to enhance the hydro storage capacity, given the limited technological options for storing infirm RE. Therefore, hydro and non-conventional energy in Kerala should be seen as complementary and not as competitive sources.
41. It had been estimated earlier that pumped storage should be about 5-6% of the peak load in a system. With a large increase of renewable energy in the system, this should increase to about 10-12%. Pumped storage schemes should therefore be actively considered to enhance existing storage by about 50-80 MW in this period by using existing potential for storage or enhancing their capacity. Potential exists between Poringalkuth and Idamalayar reservoir, and between other similar reservoirs. In view of a significant increase in RE in the grid, an aggressive plan for building pumped storage should be taken up to provide the necessary flexibility for Kerala.

42. Kerala should also invest in enhancing the capacity of existing stations, in view of increasing the peaking capacity. Also the efficacy of existing reservoirs needs to be improved through bottom flushing and de-siltation. There is a need to refurbish old turbines and their associated systems. It is also necessary to improve the governing systems of the existing hydro turbines in order to be able to ramp up quickly for meeting peaking requirements and varying renewable power coming into the system.

Nuclear Energy

43. In the prevailing socio-political environment and the current development state of nuclear technology, nuclear energy is not an option to be considered in the present plan period for Kerala.

Renewable Energy

44. All renewable energy is not decentralised and distributed. It is possible to set up wind farms and solar stations that are analogous to large centralised stations. For the purpose of this energy plan, we have considered two 200 MW solar stations plus another 200 MW, adding 600 MW of solar energy to the plan. Apart from the two major solar plants, the rest of Kerala's renewable program has to come from small and distributed generation.

45. In the renewables, wind energy has already emerged as competitive with fossil fuel based plants. Wind velocities are not high in Kerala and therefore it is not suitable for putting up large wind farms.

46. Solar has higher capital costs, but per unit cost of energy has dropped significantly with large scale induction of PV panels all over the world. This trend is likely to continue. Nevertheless, renewables will have higher cost, both in terms of per unit cost and capital cost per MW than coal based units.

47. With the Paris Agreement on Climate Change, we have to acknowledge that in the future, cheaper coal based electricity generation will give away to relatively higher cost energy production. Renewables have higher costs, and have a daily cycle that is different from the load curve. The economics of the electricity sector will have to factor all this into its calculations. Kerala should take the lead in inducting renewables in the system, and putting in place, policies and institutional arrangements to achieve this goal.

Large Solar Plants

48. Kerala has relatively little relatively unpopulated land, unlike many other states. The insolation levels in the state are also lower than Rajasthan and Gujarat. Despite these constraints, it is proposed to have 600 MW of installed capacity through grid connected solar plants

49. A 200 MW solar park, is being jointly developed by Solar Energy Corporation of India (SECI) and state utility Kerala State Electricity Board, at Kasargod. The first phase is planned to have 100 MW, out of which 50 MW is being commissioned shortly. In the second phase of this project, another 100 MW is being added with MNRE support.

50. A second station of 200 MW is also being planned in the 13th Plan period, bringing the total installed capacity from large solar plants up to 400 MW. In addition, KSEBL is proposing to procure solar power from Independent Power Producers from Kerala having capacity not less than 5MW through tariff based bidding to add another 200 MW. This will provide a total of 600 MW of grid connected large solar units in Kerala during the 13th Plan.

Distributed and Decentralised Renewable Generation

51. It is important to realise that all small generating units – small/roof top solar, wind, micro hydro or biomass based units – need not be isolated from the grid. Connecting them to the grid involves additional expenses, but has the benefit of helping to conserve stored hydro power for peaking purposes, improves reactive power management, reduces losses and improves tail–end voltages.

52. The issue of providing small distributed generating units wherever such possibility exists should not be seen as one of providing power to isolated communities but also very much a part of the overall management of the grid. A number of small solar, wind, micro hydro and biomass units would then help in conserving peaking resource of the state – its stored hydro power.

Small Hydro Electric Projects

53. A list of hydro electric projects under execution and to be taken up by KSEBL during the period 2016-2022 is appended below.

Table 5 *Small Hydro Projects to be completed in 5 years (2016-2021)*

Sl. No.	Project	Installed Capacity MW	Expected Generation MU	Status
1	Perunthenaruvi	6	25.77	Work in progress
2	Bhoothathankettu	24	83.5	Work in progress
3	Poringalkuthu	24	45.02	Work in progress
4	Kakkayam	3	10.39	Work in progress
5	Chathankottunada	6	14.76	21 % Completed
6	Upper Kallar	2	5.14	Work Started
7	Peruvannamoozhy	6	24.7	Tendered
8	Vadakkepuzha Extension	0	0.7	To be tendered
9	Peechad	3	7.74	LA Stage
10	Western Kallar	5	17.41	LA Stage
11	Olikkal	5	10.26	LA Stage
12	Poovaranthodu	3	5.88	LA Stage
13	Ladrum	3.5	12.13	LA Stage
14	Marmala	7	23.02	LA Stage
15	Chempukadavu 3	7.5	17.72	LA Stage
16	Maripuzha	6	14.84	LA Stage
17	PazhassiSagar	7.5	25.16	LA Stage
18	Upper Sengulam	24	53.22	LA Stage
19	Chinnar	24	76.45	LA Stage
20	Valanthodu	7.5	15.29	Pre Const Survey
	Total	174	489.1	

54. In addition, generation of Electricity from Irrigation dams and canals using small hydro units should also be explored with the Irrigation Department of the state.

55. For small hydro generating units to be useful, we also need certain institutional arrangements in place. First, is the guarantee that whenever power is available from all such units, they would be able to supply to the grid. While the rates would need to be fixed by the regulatory commission, without this guarantee, it is very hard for small producers to be able to sell their power. The second institutional arrangements that needs to be worked out is the issue of standardising some basic designs which the small units can use without each project needing to work out its own designs and technical options. The third institutional mechanism is the partnership with KSEBL and Local Self Government bodies, for projects to be carried out, particularly for small hydro. ANERT and other such bodies may be associated with such exercises, but KSEBL's involvement is necessary for both technical reasons and providing grid connectivity.

Wind Energy

56. Kerala is estimated to have about 600-800 MW of wind energy, the majority of it is unfortunately concentrated in the areas that have difficult terrain not helpful to the transportation of large machine parts or are remote. If at all possible, this situation adds to the cost of installation as well as cost of transmission networks. Therefore, large wind farms may not be possible in Kerala.

57. The current wind energy capacity in Kerala is43.275 MW of which 2.025 MW is owned by the KSEB. Kerala's neighbours – Tamil Nadu and Karnataka – between them have an installed capacity of over 10,000 MW. Wind capacity can certainly grow, as wind is a relatively cheap source of energy. Potential investment in wind energy and the exploitation of good wind sites should be encouraged. In the 13th Plan, it is proposed to have a modest target of 100 MW in addition to the existing capacity.

58. It has been proposed that small wind turbines can be used and this can be a major source of energy for Kerala. The key problem is that if these sources are too small, they cannot be grid connected, and therefore have to be largely stand alone systems. While they may have a place in the overall energy plan, they cannot be a substitute for grid connected power.

59. Small wind turbines can be used on an experimental basis to test their feasibility and the possibility of connecting them to grids. If successful, this can be provide additional renewable capacity for the state.

Small and Roof-top Solar Plants

60. Small and roof-top solar Plants have a big role if the target of 1,000 MW of solar power is to be met as planned. It is proposed to have 500 MW to be met using largely roof top solar Plants. Though insolation levels are lower in Kerala, there is sufficient sunlight in the state round the year for solar panels to be an important source of future energy. Policies and institutional arrangements need to be designed to address how to induct large scale solar energy into the system or as stand-alone systems.

61. Currently, roof-top solar Plants are largely stand alone systems. This has the problem of additional cost for batteries. Further, these batteries need to be changed every two/three years, and is a high recurring cost. Instead, grid-connected solar systems should be the preferred mode of inducting solar panels in the state. KSEBL should provide the necessary institutional and technical support for this to happen.

62. In addition, all government buildings, including local body head quarters, schools and colleges, should be equipped with Roof Top Solar PV systems.

63. There are two issues that need to be addressed with induction of large scale solar energy into the system. One is the economics of KSEBL. KSEBL might lose a lot of its high-end consumers to such solar Plants. Secondly, is the stability of the grid.

64. The problem of the stability of the grid with increased proportion of fluctuating renewable energy is being addressed across the world. It means that the stations that were earlier thought to be base load – nuclear and coal – have also to work as peak/variable load stations. But this is not the problem of Kerala alone, but of the Indian grid. Kerala's demands are significant in the southern grid, and a higher proportion of solar energy will have much smaller impact on the national or the southern grid.

65. Kerala needs to address the problem of how to schedule its power purchases, solar energy and its hydro plants. This issue is being addressed in a subsequent section. It also needs to strengthen its connection to the southern grid and build a strong transmission backbone for the state. This is addressed in the Transmission and Distribution section of the plan.

Stand-alone Systems and Solar Heating

66. There is a potential for micro and pico hydro turbines, small stand alone solar panels, small wind turbine and solar heating potential that can be tapped. Details of such schemes are given in the Annexures, where the subcommittee reports have been appended.

System Stability, Power Purchase Agreements and Economics of the System

67. With more than 70% of Kerala's power coming from power purchase agreements and large scale induction of renewables, particularly solar, the energy department/KSEBL will need to plan how to schedule its plants and arrive at power purchase contracts.

68. The present load factor of Kerala system is about 68% and the daily load curve is characterized by two distinct peaks during morning and evening. The evening peak demand of 4004 MW recorded in 2016 summer is more than double the system demand during night off-peak hours during monsoon and winter months. With significant ingression of decentralised solar power, the demand felt in the system during day time is likely to see a slump in sunny days also. This, along with the dwindling share of hydro power in the power basket, could pose technical and commercial challenges for the utility in the immediate future, in case the growing demand - supply gap is met entirely through long term contracts with thermal power plants.

69. It is understood that major hydro power plants set up/being set up in Himalayan region (within and outside the country) has entered the Indian power market seeking long term contracts. This option may be explored to match the daily load curve over different seasons in the coming years. An alternative is to seek contracts for peaking power, instead of long term round the clock power, while meeting base load requirements through long term contracts. However, this could expose the utility to market risks since appropriate risk mitigation products are yet to be developed by regulators.

70. Given the uncertainties, it is best suited to have a mix of long and medium term contracts with thermal power to meet the base load requirements, along with a combination of long term hydro/ diurnal short term contracts for different time slots aligned with the anticipated load curves during different seasons. The utility shall gear up to maintain a least cost power procurement portfolio in view of the gradual fall in the share of own generation capacity in the power basket."

71. For the above, the state will need to institutionalize and significantly strengthen the Power Purchase Planning and Procurement arrangements. For Power Purchase Contracts, there is a generally a mix of short, medium and long term contracts. The simplest option might be to have stable long-term contracts, but has the risk of tying the state to pay fixed cost, if the demand in the state does not materialise. Further, contracts can be of varying amounts at various times of the day, and again there is a need to schedule the amount of purchase based on the load curve and the expectation from renewables. Finally, the peaking capacity of the hydro plans and the pumped storage can be used to balance the gap between the supply and demand, and if need be, even store power.

72. These demands to sets up skills within the Energy Department/KSEBL. One is to have simulation models that will predict future demand based on current demands, other data including weather. The second is to optimise its long term, medium term and short term contracts with a view to energy security and cost of electricity. This is a new requirement for which the state will have to gear up, considering that it is increasingly dependent on import of power through such agreements and dependent on uncertain and varying renewable power.

Financial Assistance to Kerala State Electricity Board Ltd. (KSEBL)

73. Notwithstanding the fact that the power sector has been playing a crucial role in the development of the State, the Plan assistance to KSEBL has been very low. Even as compared to the neighbouring States, Kerala has been receiving meagre amount as Plan Assistance. Now that about 1,200 MW is proposed to be generated through Renewable Energy such as Solar and Wind, the same will have huge impact on KSEBL's revenue. Commercial and large domestic consumers, who are under higher slabs in domestic tariff are encouraged to put up Roof Top Solar, and may also migrate out of the KSEBL's consumer list. It is these large consumers who are cross-subsidizing the low-income consumers.

74. Further, some of the Government Departments and Public Sector Undertakings have dismal record of paying dues in time to KSEBL making it vulnerable to financial liquidity problems.

75. These two factors will adversely affect the revenue of KSEBL and in the long run may erode financial viability of the organization. Therefore KSEBL will have to be financially assisted to compensate the loss of large domestic consumers, and delayed payment from Government Departments and PSUs. The Plan Assistance may therefore by specifically increased from the present level of Rs 50 crores to help the viability of KSEBL.

Transmission and Distribution

76. If the bulk of the supply of power to the state comes through imports, Kerala will have to strengthen its inter-state transmission capacity as well as its intra-state capacity. Currently, there are large bottlenecks for importing power from the grid. Kerala also needs to strengthen its internal transmission system, which is extremely weak.

77. While Kerala has made enormous strides in reducing its AT&C losses, the quality of supply to the consumers is still poor. There are a large number of interruptions and long outages. The 13th Plan needs to be focus on this aspect of distribution and become much more customer friendly.

Transmission

78. It is estimated that an additional import capability of around 2,000 MW by year 2018 and 4,000 MW by year 2022 will be required for meeting the demand forecast for the time frame under consideration. Taking the above facts into account, additional 400 KV Inter-State Corridors along with a high Power HVDC corridor has been sanctioned to the State for catering to the additional Interstate transmission capacity required as above.

79. In this context, it has to be noted that the intra-state transmission system available at present will not be sufficient for catering to the additional transmission capacity required for dispersing the Inter State Transmission System (ISTS) power received as above from the planned ISTS nodes. There is a need therefore to develop a robust and integrated power system that will complement the ISTS power that will flow into the state. The transmission system has to be planned such that it can meet demand at any part of the network without any overloading / constraints in a secure, reliable, efficient and economic manner, even under contingency conditions. The present day transmission system in Kerala is does not comply with these criteria, and is completely inadequate to meet the projected future demand.

80. Presently about 572 ckt. Km of 400 KV EHV transmission line and four (4) numbers of Grid sub-stations at 400/220 KV level with total transformation capacity of 3150 MVA are existing in the Inter-state Transmission system of PGCIL & KSEBL.

81. The new substations and transmission lines in the 13th Plan
    1. Three (3) 400 KV new substations at Neeleswaram, Mylaty, (2*500 MVA), Kottayam, Ettumanoor (2*315 MVA), Kollam, Kundara (2*315 MVA), to be done by KSEBL
    2. Capacity addition of transformer (1*315) in Kozhokode 400 KV substation, and HVDC 2000 MW Madakatara by PGCIL

82. The long term transmission plan for the State of Kerala is evolved based on the requirement of further dispersal of the interstate power drawn at various ISTS nodes under construction and additional development plans of the ISTS, including HVDC. This Transmission Plan has been christened as Trans Grid 2.0, the future grid of the State.

83. The present demand of around 3500 MW is currently evacuated with a backbone of 220 KV system. 400 KV backbone transmission network from Northern part of the State to its Southern part is proposed in the Trans Grid 2.0 plan with intermediate substations at 220 KV and 110 KV Voltage levels planned to cater the load requirement of various load centres. Considering the difficulties in obtaining new RoWs. It was also considered prudent to plan new 400/220 KV corridors utilizing the RoW of existing sub transmission lines using multi–circuit multi voltage towers. Further possibilities for utilizing the existing sub transmission corridors by up rating the lines using High Capacity conductors were also considered in the plan.

84. Transmission development inside the State has been affected by Right of Way issues, increasing litigations against land acquisitions and government regulations for protecting environmental / forest conservation concerns. Scarcity of land poses difficulties for constructing more transmission substations and lines. People protest drawing EHV line through their property, citing damages caused by the tower footings, destruction of trees and diminishing land value. A higher percentage of forest land in the state, than the national average, also limits the options in transmission line routes. Under these circumstances optimization of the available right of way should be the first priority while planning for any transmission network.

85. Adopting technology to tackle these problems is essential. Consequently, KSEBL needs to enhance its technical capabilities, develop alternative modes of construction methods and explore latest techniques while complying with the mandatory safety, environmental and regulatory norms. It is proposed to have optimal utilization of the existing corridors by alternate technologies like narrow based / Mono Pole towers, HVDC / hybrid models, UG cables, composite / covered conductors, HSIL technology etc.

Distribution

86. Consumer satisfaction in Electricity Distribution System mainly depend on following issues
    1. Quality of Electricity – Voltage, Frequency, Interruption
    2. Billing system and payment options
    3. Procedure for new connections
    4. Tariff
    5. Other related services

6. Costumer relations
7. Maintaining Electrical Safety
8. Achievement of social goal

87. In this, the quality of electricity depends on Generation and Transmission issues as well. Renovation and strengthening of network, organizational reforms and change in work culture are the key areas to be addressed.

88. Quality of Electricity can be measured in different ways. SAIDI and SAIFI are two basic measures for comparing the level of interruptions. In Kerala, we have no reliable statistics for these calculations. Still there are some assessments. For example, in Thiruvananthapuram city, SAIDI and SAIFI indices are 373 interruptions/consumer/Year and 595 minutes/consumer/Year in 2015. In the US for example, these figures are 1.3 Nos/consumer/Year and 2.4 minutes/consumer/Year only. This is just an indication of where we stand now.

89. For addressing the quality of supply, we need to have reliable measurements. This is the first step that needs to be taken if the quality of service is to be improved. To achieve this purpose, all meters need to be made fault free and a scheme for replacing all meters to smart meters needs to be chalked out. Automatic Metre Reading should be introduced to all industrial, commercial and all consumers having connected load above 10,000 KW in domestic tariff within the plan period. With smart meters at the consumer end, the measurement of quality of supply to consumers is not difficult to achieve.

90. In the 13th Plan, we need to have a target for improving the figures for SAIDI and SAIFI. A target of half of the present value (to be measured) in the first 2 years, and half of that value with in last 3 years of plan period is proposed.

91. By March 2017 Kerala will achieve 100% house hold Electrified state status. The system should be able to add new connections without delay.

92. In Kerala, Billing computerization is almost complete. On-line and any where payment option has been made available, though there some connectivity issues. Online registration for new connections is under piloting stage. Other services are also proposed to be put online within a short time. It will then be easier to extend costumer care facilities.

93. Currently, there are network constraints for providing connection to large industrial and commercial consumers. A thorough revamping of network is required to address this.

94. As on 30/09/2016 there are 1,18,32,180 Service connections attached to KSEBL. There are 58,014 Kms of HT Lines, 2,87,283 Kms of LT Lines and 74,299 Nos of Distribution Transformers under KSEBL Network. As part of Revamping of network, it may require to reconstruct about 10,000 Kms of old 11 KV lines. New constructions of about 3,000 Kms may be required to standardize the system with spacial optimization. Also it may require to construct 5,000 Kms of New 11 KV lines also as part of system widening. Hence there needs to be a target of 18,000 Kms of 11 KV Lines during next 5 year plan, *i.e.*, 3,600 Km/year. Average addition of 11KV lines to the system based on present plan period is 1,500 Kms/Year. But during 2006-2011 period it was 3,100Kms/Year. Hence 3,600 Km/Year is an achievable target.

95. Renovation, reconstruction and new constructions of LT lines are also required. A target of 10,000

Kms of LT lines/Year may be sufficient. Average addition of 11 KV lines to the system based on present plan period is 4,000 Kms/Year. But during 2006-2011 period it was 9,600Kms/Year. Hence 10,000 Km/Year is an achievable target. During present 5 year plan the number of distribution transformers installed by KSEBL is 11,716 (as on 30/09/16) with an average of about 2,700 Nos/Year. Target for the next plan can be fixed at 3,500 Numbers per year with a total of 17,500 Numbers.

96. With the revamping scheme already discussed above, it is possible to limit the bulk of the 11KV feeders to a length of 5-10 Kms. There may be some exceptions, and these can be managed on a case by case basis. All 33 KV substations have to be transferred to distribution wing. 33 KV distribution system should be introduced. DC micro grid and High Voltage DC Distribution system have to be introduced. Considering the integration of distributed generation including solar, efforts have to be made to introduce smart grids.

97. Kerala has already achieved low Transmission Distribution losses and will meet its target of the 12th Plan of reducing its AT&C losses to below 15%. For the 13th Plan, there should be a target 10% for AT&C losses.

Fuel, Energy Conservation and Electrical Safety

98. The 13th Plan also needs to consider other issues, apart from generation, transmission and distribution of electricity. These are addressed below.

Fuel

99. Fuel is required for the following:
    1. Industrial needs
    2. Domestic needs
    3. Transport

100. As the transport sector is being dealt with separately, we have not included the fuel needs of the transport sector here.

101. For the industry, the following fuels are in use:
    1. Furnace Oil is used in oil Fired Boilers/Furnaces/ Heaters
    2. Wood fired boilers and heaters
    3. LNG/ Natural Gas

102. Given that LNG would be available in Kerala from the Kochi LNG terminal, and effort needs to be made to switch from fuel oil to LNG as fuel. Energy efficiency of fuel being used in the industry should also be a priority through modifications to the systems, multi-fuel options, and better education and training of the people involved.

103. Where fuel is being used to heat water, e.g., hotels, laundry, etc., solar water heaters should be encouraged.

104. For domestic purposes, the following fuels are in use:
    1. LPG
    2. Biofuels such as wood and coconut shells, etc

3. Biogas

105. There is a growing shift in domestic sector to LPG. This should be encouraged. While we should encourage long term shift to LPG as a clean and an easy fuel for handling, in the short term, all fuels will continue to be used. Smokeless chulhas, biogas plants, etc., should also be encouraged to provide more efficient combustion and therefore less damage to the health of the people, particularly women.

Energy Conservation

106. The 13th Plan should focus on energy efficiency in equipment, government buildings, and water pumping activities in agricultural fields and energy awareness programmes.
    1. Education Sector: Energy education in Schools, Colleges, Energy conservation modules in ITI, Polytechnics, Energy Smart schools etc.
    2. Domestic Sector: Energy conservation awareness programmes for domestic house wives, Programmes in association with NGOs, residential associations etc.
    3. Industrial Sector: Impose energy audits in all HT/EHT consumer premises, Cluster based DSM programme for energy efficiency adoption etc.
    4. Municipalities/LSG: Encourage model energy efficient panchayat, and introduce energy efficient street lighting etc.
    5. Agriculture sector: Capacity building of farmers regarding water efficient crop planning, water conservation Development Programmes etc.
    6. Government buildings: Implement ECBC and EC practices
    7. Commercial Building: Introduce ECBC, Awareness on BEE Star labelled appliances, promote building star rating system

Electrical Safety

107. Rate of electrical accidents has increased in recent years in the domestic sector. This is due to lack of knowledge and low safety consciousness among the users. Common accidents are due to electric shock from domestic electrical appliances and metallic rods used to pluck coconuts from trees coming into contact with live overhead wire.

108. It is proposed to take the following measures to bring down the number of accidents:
    1. Educating the public through various means.
    2. Using ELCB's at subsidised rate to families under BPL category
    3. Training programme for Electrician/Wireman and Electricity workers
    4. Strengthening of Electrical Accident Preventive Committee and Monitoring Centre in the state
    5. Replacement of AAC (All Aluminium Conductors) with ACSR (Aluminium Conductor Steel Reinforced)conductors
    6. Supply of personal protective equipment to employees of Supplier/Utility
    7. Strengthening the Quality Control Order and use of IS marked electrical appliances and accessories

CHAPTER 3
EXCERPTS OF THE RECOMMENDATIONS OF THE WORKING GROUP ON ENERGY -13TH PLAN

109. Major recommendations of the working group report on Energy constituted for the 13th Five year plan are summarised below.
    1. Generation: The peak demand for the previous year (2015-2016) was 4,004 MW and for the current year (2016-2017) is expected to be about 4,200 MW. The figure of 5343 MW as projected in the 19th EPS, seems to be a more reasonable figure and can be adopted as the basis for the 13th Plan.
        1. Existing Peak -4,200 MW
        2. Projected Demand -5400 MW

110. To meet this, the additional sources targeted are the following
        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

111. Under Generation, the other recommendations include;
    1. Coal-fired plant in Kerala or outside: It is clear that the demand of the state is going to be far in excess of its installed capacity .In view of this, the most appropriate strategy of Kerala will be to reach a significant part of its future demand from long term supply contracts from generating stations outside the state. The implications of this strategy would also imply strengthening of the transmission networks, particularly for those corridors that require a large transmission of power for providing electricity to the major load centres in the state.
    2. Kayamkulam and Kochi Gas-fired Plants: For this, the following options are suggested. Which decision should be taken by the state would depend on the success of the negotiations with NTPC and BSES.
        1. Option I could be to convert the plant into LNG fired plant by replacing naphtha firing.
        2. Option II would be to scrap RGCCPP, considering the bleak chances of producing power at competitive rates and also given the availability of coal-based power from outside Kerala at cheaper rates; the land could instead be used for solar power installation, which NTPC themselves could fund.
        3. Option III would be to translocate RGCCPP (and convert it to LNG), to a place where the LNG pipeline already passes, like Bramhapuram in Kochi, or is expected to pass, like Cheemeni in Kasargod.

112. Kerala should pursue such negotiations with NTPC and BSES to resolve the above issue, and if negotiations are not successful, withdraw from the PPA's with NTPC's Kayamkulam plant and BSES Kochi plant.

Nuclear Energy

113. In the prevailing socio-political environment and the current development state of nuclear technology, nuclear energy is not an option to be considered in the 13th Plan period for Kerala.

Wind Energy

114. Small wind turbines can be used on an experimental basis to test their feasibility and the possibility

of connecting them to grids. If successful, this can be provide additional renewable capacity for the state.

Small and Roof-top Solar Plants

115. Though insolation levels are lower in Kerala, there is sufficient sunlight in the state round the year for solar panels to be an important source of future energy. Policies and institutional arrangements need to be designed to address how to induct large scale solar energy into the system or as stand-alone systems.

116. Instead, grid-connected solar systems should be the preferred mode of inducting solar panels in the state. KSEBL should provide the necessary institutional and technical support for this to happen. In addition, all government buildings, including local body head quarters, schools and colleges, should be equipped with Roof Top Solar PV systems.

Pumped Storage Scheme

117. It had been estimated earlier that pumped storage should be about 5-6% of the peak load in a system. With a large increase of renewable energy in the system, this should increase to about 10-12%. Pumped storage schemes should therefore be actively considered to enhance existing storage by about 50-80 MW in this period by using existing potential for storage or enhancing their capacity. Potential exists between Poringalkuth and Idamalayar reservoir, and between other similar reservoirs. In view of a significant increase in RE in the grid, an aggressive plan for building pumped storage should be taken up to provide the necessary flexibility for Kerala.

Financial Assistance to Kerala State Electricity Board Ltd. (KSEBL)

118. Notwithstanding the fact that the power sector has been playing a crucial role in the development of the State, the Plan assistance to KSEBL has been very low. Since 1,200 MW is proposed to be generated through Renewable Energy such as Solar and Wind, the same will have huge impact on KSEBL's revenue. Moreover, some of the Government Departments and Public Sector Undertakings have dismal record of paying dues in time to KSEBL making it vulnerable to financial liquidity problems.

119. These two factors will adversely affect the revenue of KSEBL and in the long run may erode financial viability of the organization. Therefore KSEBL will have to be financially assisted to compensate the loss of large domestic consumers, and delayed payment from Government Departments and PSUs.

120. *Transmission.* It is estimated that an additional import capability of around 2,000 MW by year 2018 and 4,000 MW by year 2022 will be required for meeting the demand forecast for the time frame under consideration. The new substations and transmission lines proposed in the 13th Plan are:
    1. Three (3) 400 KV new substations at Neeleswaram, Mylaty, (2*500 MVA), Kottayam, Ettumanoor (2*315 MVA), Kollam, Kundara (2*315 MVA), to be done by KSEBL
    2. Capacity addition of transformer (1*315) in Kozhokode 400 KV substation, and HVDC 2000 MW Madakatara by PGCIL

121. The long term transmission plan for the State of Kerala is evolved based on the requirement of further dispersal of the interstate power drawn at various ISTS nodes under construction and

additional development plans of the ISTS, including HVDC. This Transmission Plan has been christened as Trans Grid 2.0, the future grid of the State.

122. *Distribution.* By March 2017 Kerala will achieve 100% house hold Electrified state status. The system should be able to add new connections without delay.

123. As part of Revamping of network, it may require to reconstruct about 10,000Kms of old 11 KV lines. New constructions of about 3,000 Kms may be required to standardize the system with spacial optimization. Also it may require to construct 5,000 Kms of New 11 KV lines also as part of system widening. Hence there needs to be a target of 18,000 Kms of 11 KV Lines during next 5 year plan, *i.e.*, 3,600 Km/year. Average addition of 11KV lines to the system based on present plan period is 1,500 Kms/Year. But during 2006-2011 period it was 3,100 Kms/Year. Hence 3,600 Km/Year is an achievable target.

124. For the 13th Plan, there should be a target 10% for AT&C losses.

125. *Fuel.* Where fuel is being used to heat water, e.g., hotels, laundry, etc., solar water heaters should be encouraged. For domestic purposes, there is a growing shift in domestic sector to LPG. This should be encouraged. While we should encourage long term shift to LPG as a clean and an easy fuel for handling, in the short term, all fuels will continue to be used. Smokeless chulhas, biogas plants, etc., should also be encouraged to provide more efficient combustion and therefore less damage to the health of the people, particularly women.

126. *Energy Conservation.* The 13thPlan should focus on energy efficiency in equipment, government buildings, and water pumping activities in agricultural fields and energy awareness programmes.

127. *Electrical Safety.* It is proposed to take the following measures to bring down the number of accidents (1)Educating the public through various means (2) Using ELCB's at subsidised rate to families under BPL category (3) Training programme for Electrician/Wireman and Electricity workers (4) Strengthening of Electrical Accident Preventive Committee and Monitoring Centre in the state (5) Replacement of AAC (All Aluminium Conductors) with ACSR (Aluminium Conductor Steel Reinforced)conductors (6)Supply of personal protective equipment to employees of Supplier/Utility (7) Strengthening the Quality Control Order and use of IS marked electrical appliances and accessories.

ANNEXURE 1
NOTES PREPARED BY VARIOUS SUB -GROUPS

1. Distribution Sector

Consumer satisfaction in Electricity Distribution mainly depend on following issues

1. Quality of Electricity – Voltage, Frequency, Interruption
2. Billing system and payment options
3. Procedure for new connections
4. Tariff
5. Other related services
6. Costumer relations
7. Achievement of social goal
8. Electrical Safety

In this the quality of electricity depends on Generation and Transmission issues as well. Renovation and Strengthening of network, organizational reforms and change in work culture are key areas to be addressed.

Quality of Electricity got different measures for comparison. SAIDI and SAIFI are two basic measures for comparing the level of interruptions. In Kerala, we have no reliable statistics for these calculations. Still there are some assessments. For example in Thiruvananthapuram city, SAIDI and SAIFI indices are 373 Nos/consumer/Year and 595 minutes/consumer/Year in 2015-16. (In America these figures were 1.3 Nos/consumer/Year and 2.4 minutes/consumer/Year only) This is just an indication of where we stand now. Any how we should have a target for these figures. A target of half the present value (to be measured) by first 2 years and half of that value with in last 3 years of plan period is suggested.

In Kerala, Billing computerization is almost complete. On line and anywhere payment option is available. Still there are some connectivity issues. Online registration for new connections is under piloting. Other services also will go online with in short time. Then it will be easier to extent costumer care facilities even without section offices. The demand for new section offices will die out with these reforms.

By March 2017 Kerala will achieve 100% house hold Electrified state status. Still there will be applications for new connections and it will be catered without delay. Still industrial, commercial and other connections require relatively large loads will face issues of feasibility due to network constraints. A thorough revamping of network is required to address this.

As on 30/09/2016 there are 11832180 Service connections attached to KSEBL. There are 58014 Kms of HT Line, 287283 Kms of LT Lines and 74299 Nos of Distribution Transformers under KSEBL Network.

As part of Revamping of network it may require to reconstruct about 10,000Kms of old 11 KV lines. New constructions of about 3000 Kms may be required to standardize the system with spacial optimization. Also it may require to construct 5000 Kms of New 11 KV lines also as part of system widening. Hence there can be a target of 18000 Kms of 11 KV Lines during next 5 year plan, *i.e.* 3600 Km/year. Average addition of 11 KV lines to the system based on present plan period is 1500 Kms/Year. But during 2006-2011 period it was 3100Kms/Year. Hence 3600 Km/Year is an

achievable target.

Renovation, reconstruction and new constructions of LT lines are also required. A target of 10000 Kms of LT lines/Year may be sufficient. Average addition of 11 KV lines to the system based on present plan period is 4000 Kms/Year. But during 2006-2011 period it was 9600 Kms/Year. Hence 10000 Km/Year is an achievable target.

During present 5 year plan the number of distribution transformers installed by KSEBL is 11716 (as on 30/09/16) with an average of about 2700 Nos/Year. Target for the next plan can be fixed at 3500 Numbers per year with a total of 17500 Numbers.

Spacial optimization of distribution network requires re-organization of office structure. A feeder starting from one substation should be under the control of a single office. At present feeders are passing through different sections. These sections may be under different subdivisions, Divisions and even in different Circles. It is possible to identify feeder managers in charge of maintenance of such feeders if present division of geographic sections are reorganized based on substations. With the revamping scheme already discussed above it is possible to limit 11KV feeder length within in 5-10 Kms. There may some exceptions and can be managed case by case. All 33 KV substations have to be transferred to distribution wing.

33 KV distribution system should be introduced.

All meters are to be made fault free. A scheme for replacing all meters to smart meters have to be chalked out. AMR should be introduced to all industrial, commercial and all consumers having connected load above 10,000 KW in domestic tariff within plan period.

DC micro grid and High Voltage DC Distribution system have to be introduced. How to fix a target?

Promotion of Electric vehicles has to be taken up on a priority basis. Charging kiosks for Electric vehicles to be introduced.

Considering wide integration of distributed generation including solar there should be good efforts to introduce smart grid system.

Transmission Distribution loss target 10% by the plan period.

2. Long Term Transmission Plan

Although Kerala is bestowed with huge hydro potential, the State is devoid of any fossil fuel reserves. Out of the estimated hydel potential of about 6000 MW in the State, Kerala could harness only about 2040 MW so far, leaving a huge gap between the potential and the harnessed capacity. Considering the peculiar ecological and demographical nature of the State, with its high percentage of biodiversity and population density vis-à-vis other states, setting up of large scale power plants in the State has become extremely difficult. All the proposed hydel projects in Kerala can come up only in the Western Ghats, which is declared as a biodiversity hotspot by IUCN (International Union for Conservation of Nature). The forest cover of Kerala is only 29% of its geographical area whereas the State accounts for 28% of the total biodiversity in the country. No hydro projects with storage sufficient to provide peak support during summer is possible due to environmental concerns. Hence to meet the demand, the only option for the State is to import power from outside.

It is estimated that an additional import capability of around 2000 MW by year 2018 and 4000 MW by year 2022 will become quite essential for meeting the forecasted demand of about 5000 MW and 6100 MW respectively (as per 18th EPS) for the time frame under consideration. Taking the above facts into cognizance, additional 400 KV Inter-State Corridors along with a high Power HVDC corridor has been sanctioned to the State for catering to the additional transmission capacity required as above.

In this context it has to be noted that the intra-state transmission system available at present will not be sufficient for catering to the additional transmission capacity required for dispersing the ISTS power received as above from the upcoming ISTS nodes. The National Electricity policy and the Electricity Act 2003 have put emphasis on the development of transmission sector through adequate and timely investments by preparing an efficient and coordinated action plan to develop a robust and integrated power system. The transmission system is expected to be capable of meeting the demand at any part of the network without any overloading / constraints in a secure, reliable, efficient and economic manner even under contingency conditions. But the present day transmission system in KSEBL is found to be not complying with these criteria and is analysed to be extremely inadequate to meet the projected future demand. Further with the evolution of Open Access in transmission and competitive power markets, the role of transmission has changed from a mere infrastructure provider to an enabler in operation of a competitive power market.

However, transmission development inside the State has been affected by Right of Way issues, increasing litigations against land acquisitions and government regulations for protecting environmental / forest conservation concerns. Till recently there was no master plan with a strategic and long term perspective for transmission development activities in the State; transmission additions were mainly carried out to meet the requirements of the immediate horizon period. In this case also scarcity of land often poses difficulties for constructing more transmission substations and lines. People naturally protest to drawing EHV line through their property citing damages owing to occupation of land by the tower footings, destruction of trees and diminishing land value. A higher percentage of forest land in the state, than the national average, also limits the options in line routes. Under these circumstances optimization of the available right of way should be the first priority while planning for any transmission network.

Adopting technology to tackle these problems is essential to stay ahead of the curve which calls for significant technology expertise in power transmission and grid technology. Consequently to satisfy growing needs, it is high time for ***KSEBL to enhance its technical capabilities, work on innovative business models and develop alternative sources of construction methods and explore latest techniques*** complying with the mandatory safety, environmental and regulatory norms for building up

additional corridors. Further considering the difficulties encountered in the construction of new transmission corridors, considerable efforts needs to be maintained for optimal utilization of the existing corridors and concentrate on developing alternate technologies like narrow based / Mono Pole towers, HVDC / hybrid models, UG cables, composite / Covered conductors, HSIL technology etc and deployment of the same by considering different approaches for the creation of new corridors and seamless integration of the same with the existing ones.

Considering the above facts, a Long Term Transmission Plan up to 2023 horizon year was prepared to streamline the investment and activities of KSE Board and the same was approved by the Board and AS was issued . In consideration to the planning philosophy adopted to embrace the latest technological innovations including innovative business models and alternative construction methods available in the sector with a mission to enhance system reliability and security with minimum disturbance to environment and public at large and a green vision for better energy management through reduction in system losses, this Transmission Plan was christened as **Trans Grid 2.0,** the future grid of the State.

The long term transmission plan for the State of Kerala is evolved based on the requirement of further dispersal of the interstate power drawn at various ISTS nodes under construction and additional development plans of the ISTS, including HVDC, in Kerala. The present demand of around 3500MW is currently evacuated with a backbone of 220 KV system. 400 KV backbone transmission network from Northern part of the State to its Southern part is proposed for Kerala system in the Trans Grid 2.0 plan with intermediate substations at 220 KV and 110 KV Voltage levels planned to cater the load requirement of various load centres. Considering the difficulties in obtaining new RoWs it was also considered prudent to plan new 400/220 KV corridors utilizing the RoW of existing sub transmission lines using multi–circuit multi voltage towers. Further possibilities for utilizing the existing sub transmission corridors by uprating the lines using High Capacity conductors were also considered in the plan.

3. Renewable Energy - Hydro Electric Projects to be taken up by KSEBL

A list of hydro electric projects under execution and to be taken up by KSEBL during the period 2016-2022 is appended below.

Small Hydro Projects to be completed in 5 years (2016-2021)				
Sl. No.	**Project**	**Installed Capacity MW**	**Expected Generation MU**	**Status**
1	Perunthenaruvi	6	25.77	Work in progress
2	Bhoothathankettu	24	83.5	Work in progress
3	Poringalkuthu	24	45.02	Work in progress
4	Kakkayam	3	10.39	Work in progress
5	Chathankottunada	6	14.76	21 % Completed.Work to be rearranged
6	Upper Kallar	2	5.14	Work Started
7	Peruvannamoozhy	6	24.7	Tendered
8	Vadakkepuzha Extension	0	0.7	To be tendered
9	Peechad	3	7.74	LA Stage
10	Western Kallar	5	17.41	LA Stage
11	Olikkal	5	10.26	LA Stage
12	Poovaranthodu	3	5.88	LA Stage
13	Ladrum	3.5	12.13	LA Stage
14	Marmala	7	23.02	LA Stage
15	Chempukadavu 3	7.5	17.72	LA Stage
16	Maripuzha	6	14.84	LA Stage
17	PazhassiSagar	7.5	25.16	LA Stage
18	Upper Sengulam	24	53.22	LA Stage
19	Chinnar	24	76.45	LA Stage
20	Valanthodu	7.5	15.29	Pre Const Survey
	Total	**174**	**489.1**	
	HEPs to be completed in 5 years (2016-2021)			
1	Pallivasal Extension Scheme	60	153.9	74 % Completed.Work to be rearranged
2	Thottiyar	40	99	39 % Completed.Work to be rearranged
3	Sengulam Augmentation	0	85	60% Completed
4	Mankulam	40	82	LA Stage
	Total	**140**	**419.9**	
	Grand Total	**314 MW**	**909 MU**	

Athirappally HEP (163 MW- 252 MU) has been given all clearances and is considered for implementation in addition to above.

Points for discussion

1. Difficulties in completing Land Acquisition:-After the introduction of RFCTLARR Act 2013 the procedures for land acquisition have increased. The only practical option now possible is Negotiated

Purchase. All acquisition of land needs support and aid of the Revenue Department who are usually pre occupied with their own work and have little time to spare for other Departments. Land acquisition for infrastructure projects need a special priority or are to be treated on Fast Track Mode.

2. Scarcity of good Contractors for KSEBL works:- Many are evading tenders due to low rates and one sided conditions in contracts. Only those who use machinery intensive methods succeed these days. Nowadays the practice is to award the work to the lowest. They often turn to be unworkable at a later stage and delay projects.
3. Deviations after awarding contracts due to Excess quantities/ Extra items leads to non payment affecting cash flow of contractors:-Hydro projects are located over a vast area with significant differences in geological features. Investigations for hydro projects have several limitations due to wide variations in subsurface strata over these locations. Actual conditions can be properly identified only on completion of excavation. Geological surprises and consequent revisions in design and deviations were part of many of the hydro electric projects completed. But many of them are delayed now due to indecisions on fear of executing excesses over estimate.
4. Sustainable planning of projects to be done:-Entails making provisions for one's requirement after duly taking care of any adverse environmental, social and economic impacts. Even after addressing all of the above many of the projects turn controversial. Projects which have obtained all clearances could not be implemented due interests of a few.
5. Developmental works of Hydro projects (eg: - Roads and Bridges) coming up as a part of project as well as other Social costs (eg:- labour generation)may be apportioned and not loaded only on power component.
6. With the increasing injection of unstable power in to the grid, hydro power has become a technical compulsion for providing 24 X 7 interruption free quality power.
7. Treating all hydro power as renewable energy rather than Small Hydro Electric Power only as is now. It is the cleanest form of energy which is the most beneficial non consumptive use of water.
8. Providing budgetary support for all hydro projects considering its vital role in sustainable development.
9. Requirement of a pumped storage scheme (PSS) to provide peaking power as well to utilize unstable power coming in to the grid considering its contribution to grid stability.
10. Efficacy of existing reservoirs to be improved through bottom flushing and desiltation to ensure live storage capacity.
11. Refurbishing of the ageing power plants to be taken up urgently to ensure hindrance free operation.
12. Settlement of interstate issues that hinder development of some of the projects.
13. Dam monitoring is to be modernized with instrumentation for all major dams. Camera security surveillance is to be implemented at all dams.

4. Economizing the Fuel Consumptions

While adequate emphasis is given on Electrical and Renewable energies, two equally important areas to be suitably addressed to are:-

1. Thermal Energy consisting of Fuel Oil, Biomass, LPG & Natural Gas
2. Transport Sector

On the basis of Energy Audits/ Visits to variety of Industries across Kerala, potential avenues on optimizing energy consumptions are listed below.

1 Thermal Energy

1. *Furnace Oil / Thermic Fluid Fired Boilers/Furnaces/ Heaters*:
    1. Barring few large units (approximately 10% of the total Units), operator controlled firing systems are adopted. Adequate scope exists for efficiency improvement by way of controlling firing temperatures, air/water pre heating, condensate recovery, blower controls etc.
    2. Wood being cheap at many places, over feeding is widely seen, causing large CO emissions. Eventual cutting down of trees is another menace.
    3. Practice of wet wood feeding is common
    4. Insulation losses are widely prevalent
    5. Modifications to suit new fuels like LPG/Natural gas not done: While an FO fired system may require a stack temperature of 180 deg C, the same for LPG/NG fired one shall require only 100 deg C, throwing adequate potential for recovery.

How to redress? : EMC is coordinating a study on the above through PCRA. Individual Unit owners of every Industry parks have to be educated on the above and monitoring of implementations to be done.

2 *Ice Factories*

1. Heat escape through chiller tanks are very common
2. Poor maintenance of Heat Exchangers

How to redress? : On cluster basis, the above to be implemented and monitored

2 Transport Sector

For a mid-income family, the energy expenditure on petrol/ diesel is more than his monthly electricity bill in terms of units spent. PCRA is training almost 100% drivers of KSRTC & Oil Companies. From last year we started training new recruits of Police Dept at KPA, Trichur. This apart, in coordination with RTO's, trainings for driving school instructors are being carried out. In fact, Niti Ayog has accepted implementation of Eco Driving for Govt Depts and Mail Motor service trained their drivers recently.

The average improvement we observe during field trainings is 20-25 %. Even if half of it is retained, the contribution shall be tremendous.

How to redress? Departments having large number of vehicles should coordinate field trainings for their drivers and KMPL improvements are to be monitored.

5. Electrical Safety

Sophisticated lifestyle, population explosion, increased agricultural and industrial activities etc. have accelerated the growth of electrical network. As a result, the electrical installations are becoming more complex, rate of electrical accident is also increasing day by day. It is found that number of electrical accidents increases when the last ten years data is analysed. Around 494 electrical accidents were reported during the financial year 2015-2016, 287 lives were lost in these accidents and 153 victims were seriously injured.

Majority of accident are happening in domestic premises and supplier premises. In the Industrial sector the numbers of accidents are comparatively less. This is because of the periodical inspections conducted by the Electrical Inspectorate and subsequent remedial measures taken in these installations. Number of accidents in generating stations and substations are also very less. Main reason is that the persons engaged are qualified and work under the direct supervision of well qualified person. The cause of accidents in supplier premises is due to lack of supervision, inadequate safety precaution, poor quality of materials and equipments, improper workmanship, lack of training etc. In the previous year around 51 electrical accidents (both human and animal) reported due to snapping of conductors. To prevent such accidents following remedial measures are to be adopted ACSR conductors shall be used instead of the old Aluminium conductor. All old and deteriorated distributed system shall be replaced, clearing of tree touching and regular inspection and maintenance shall be carried out periodically.

About 50 persons met with electrical accident while using metallic ladder /rod near overhead line while trying to pluck the fruits or nuts from nearby trees. These type of accidents happen mainly because of lack of awareness. This can be reduced by conducting massive public awareness campaign.

The number of electrical accidents in domestic premises is found increasing day by day. The reason for these accidents is lack of awareness, non-standard wiring, poor quality electrical components, carelessness, etc. 80% of domestic electrical accidents are fatal. If ELCB is made mandatory for all domestic premises, the number of fatality can be reduced. But as per Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations, 2010 Regulation 42, ELCB is made compulsory for installation only having connected load above 2 KW. But if we examine the data the most of the accident in domestic premises occur in house hold premises where the connected load is less than 2 KW. So ELCB at subsidised rate shall be provided for the public under BPL category, thereby the number of electrical accidents can be reduced to a greater extend. Another reason for electrical accidents are usage of poor quality equipment, by strengthening the quality control inspection we can avoid the poor quality electrical commodities being sold in market. Quality of wiring has an important role in ensuring electrical Safety in domestic premises. To achieve this goal periodical training for licensed wireman and supervisors is to be conducted. One of the major reasons for both domestic accidents is lack of awareness. Creating public awareness is the only solution to reduce the electrical accidents.

The following projects are proposed to reduce the number of accidents.

1. To create awareness among the public, through advertisement by telecasting through visual media and FM radio.
2. By arranging interactive classes by trained personnel for the members of residential association, NGO's and such organisation.
3. By designing and employing better mobile application for the electrical safety awareness programmes.

4. Arrange programmes to educate the Ward level Asha workers or, Kudumbashree, workers in all panchayath by giving incentives to propagate the message of electrical safety to all households.
5. Subsequent to the initial awareness programme a survey questionnaire is to be prepared and a random survey to be conducted.
6. Preparation of printed guidelines, brochures and safety procedures.
7. To provide ELCB at subsidised rate to families under BPL category.
8. Strengthening the functions of Electrical Accident Prevention and Monitoring Centre.
9. Replacement of All Aluminium conductors in overhead line by ACSR.
10. Strengthening the activities of Quality Control Order.
11. To provide Personal Protective Equipment (PPE) to all workers engaged in power sector.
12. To conduct Electrical Safety audit and Power Quality Audit.
13. Strengthening of independent safety wing of Supplier/Utility.
14. To formulate a safety policy.

6. Note to WG on Energy by Prof. R.V.G Menon

Detailed notes had been prepared for the last FY Plan which are relevant even today, since the target of 500 MW by Renewables have not yet been realized.

All government buildings, including Local Body HQs and schools and Colleges should be equipped with Roof Top Solar PV systems. All UPS systems for supporting computers should be solar powered.

The ANERT plan for propagating Stand - alone Solar Roof Top systems should be replaced with Grid - Connected Solar PV sytems. KSEB should agree to convert the present Roof Top Stand Alone PV systems to Grid - Connected PV systems, with no harassment to the house owners. Even though there is a lot of enthusiasm at the top level in KSEB, the approach at the lower levels is not encouraging enough. The inspection personnel from the Electrical Inspectorate also need to be motivated.

There exists considerable reservation among the engineer ranks in the KSEB about the feasibility of connecting large number of household Roof Top PV systems to the grid. Technical reservations regarding system stability have been advanced. These should be examined by a competent technical group and solutions if needed should be arrived at. Qualified experts from the engineering Colleges in the state should be invited to participate in this effort. If necessary, Research Projects should be allotted to them.

An important limitation is the need for storage at the KSEB level, in order to overcome the problem of variability. Pumped Storage could be an appropriate solution in Kerala. Some preliminary studies have been done by KSEB in this regard. The following two findings are significant. An 80 MW potential exists between Poringalkuttu reservoir and Idamalayar reservoir. . The potential between Sholayar and Idamalayar is found to be 900 MW. However, no follow up work has been done on these prospects. This should be urgently pursued since the findings could be of international significance: a significant credit for KSEB

7. ANERT – Renewable Energy- 13thFive-Year Plan- Summary Points

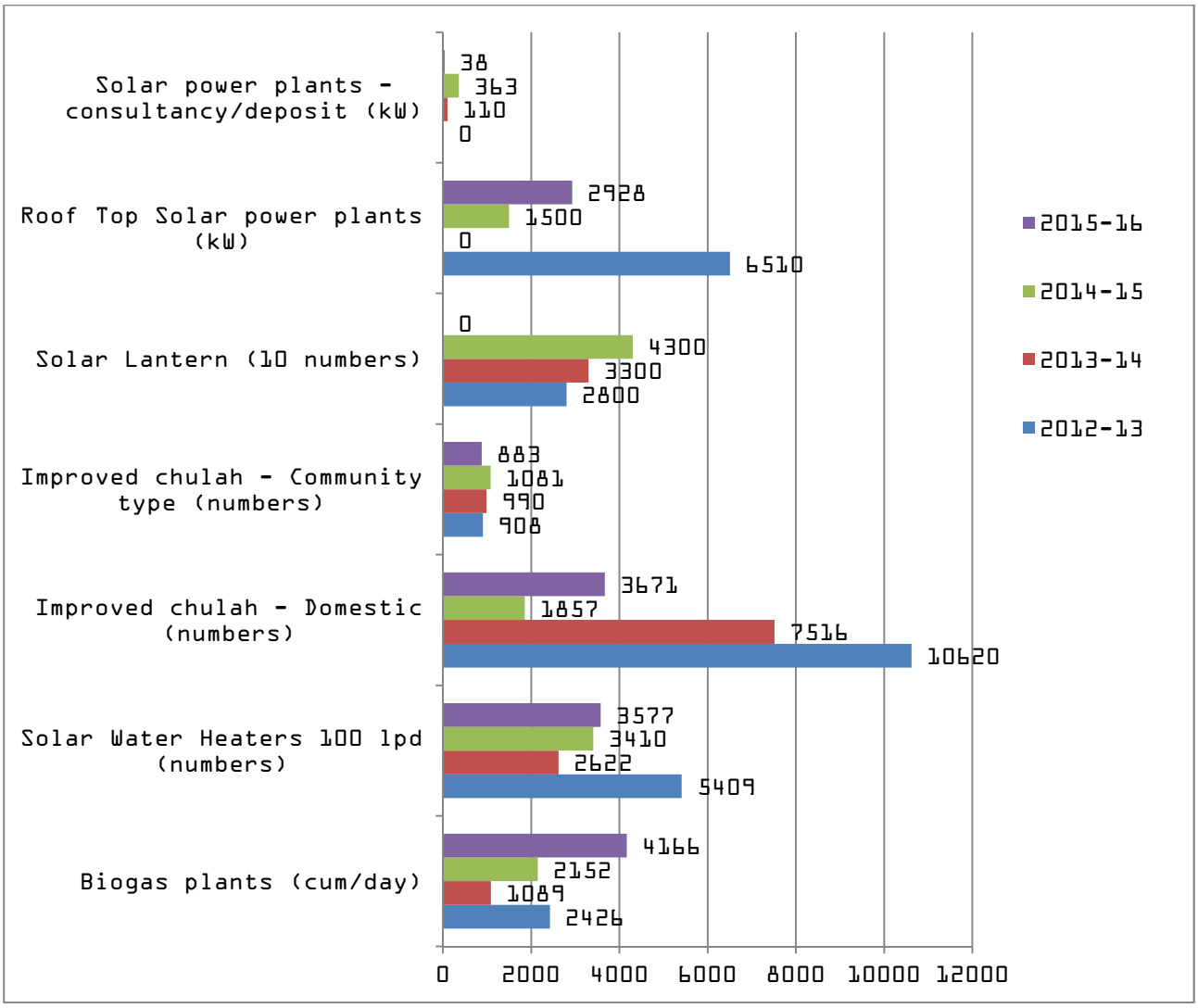
Financial achievement - 12th Plan

Year	Administrative Sanction received (Rs lakhs)	Financial achievement(Rs lakhs)
2012-13	4726	1700.69
2013-14	3980	2864.34
2014-15	4203	1978.18
2015-16	4268	1803.25
Total	17177	8346.46
% utilisation	**49**	

Administrative set-up – ANERT

Sanctioned strength	105
Permanent employees	41
Deputation	10
Vacant	54

Physical achievement – 12th Plan



30 years of subsidy driven programs – both by the Central & State governments, though could create certain installations scattered across this State, failed to establish a credible, authoritative institutional mechanism which could increase the intellectual capital in this domain and advance the business case for RE. The nodal agency need to be adequately strengthened with fresh permanent intake to fill up the vacant posts in a phased manner; giving emphasis to the district set-up and filling up technical posts in phase 1.

Tinkering with the present system would not suffice to fetch expected results, rather, a professional turn-around of its policies and programs are to be attempted with strategic partnerships with other Govt departments / agencies/ PSUs, etc., addressing their needs/ issues and harnessing the potential of all its stakeholders. Repeating the same programs with minor changes in subsidy levels and delivery pattern cannot yield different but desirable results.

With a mix of following facilitation/support services from ANERT and a mix of different drivers like state/LSG subsidy, CFA, incentives, soft loan, interest free loan, recognising social/green commitment of RE consumers, etc., targets for 13th Plan period is fixed as given below; to be implemented in mass campaign mode.

1. Renewable Energy (RE) Facilitation Centres in all Districts
2. Trained/certified Renewable Energy Technicians/ integrators
3. RE Branding / Award, to recognise excellence, commitment & document/disseminate best practises
4. Empanelment of RE systems/vendors, Incentives for intermediaries, RE systems census, RE Insurance for different systems/ empanelled technicians & dedicated RE Fund to promote business in RE in Kerala
5. RE Research & Studies; installing demo projects, giving thrust towards different types of storage systems (hydrogen/battery), micro grids, battery integrated SPV systems to mitigate the variability nature, etc.; resource assessment – wind micro-sitting, biomass potential, etc.
6. RE public engagement, with toll-free numbers, dedicated web portal, mobile apps, literature, short films, mobile exhibition units, etc; to support innovations & RE integration with Rural Technology
7. RE Club/Forum for stakeholder consultations
8. RE Consulting & Project Management Cell – to take up more turn-key/consultancy works to gain/strengthen the field experience, with due motivation to the team

Targets:

1. 10 lakh cu.m/day capacity biogas plants
2. 10 lakh numbers of improved chulha
3. 10 lakh solar street lights, pumps, small wind/wind-hybrid systems
4. 10 lakh roof top solar systems/ 500 MW from Solar energy
5. 100 lakh lpd equivalent solar water heating systems
6. 100 MW from Wind Energy projects

in Target sectors like: - Households, Industries, Hotels, Hospitals including PHC/CHC, Govt buildings (all departments including revenue, police, health, etc.), educational institutions, LSGIs, etc.

7. Note on Solar and Wind Power for the Power Sector in Kerala

Introduction

The prospects of renewable energy deployment – especially solar and wind energy projects - in Kerala have to be studied very carefully. While on the one hand, many reports claim high potential and benefits in terms of increasing energy security for the state, it is also true that this would require high amounts of investments. In addition to this, if the industrial demand for power in the state increases, then there would be a greater requirement of base load power, so the decision about where to target investments in the power sector, have to be made carefully.

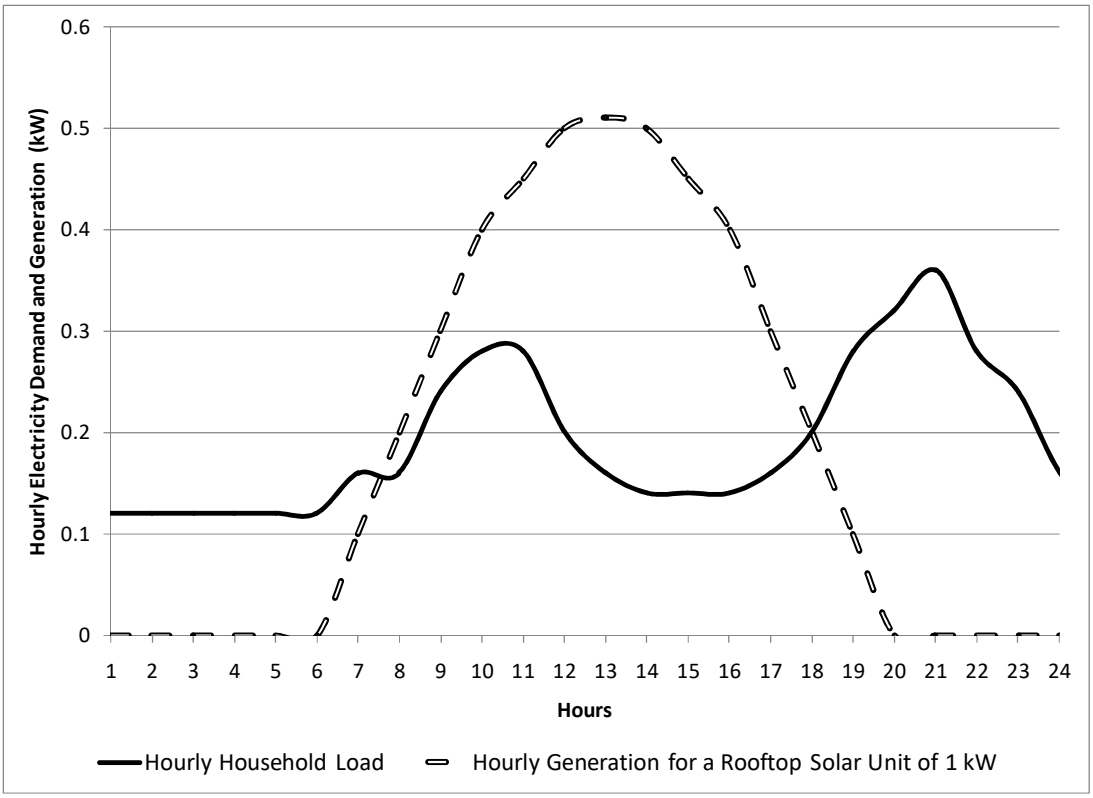
Energy Situation in Kerala and Implications for Renewable Energy

Kerala has a unique power consumption pattern. Almost 50% of the total electricity consumed in the state is for domestic use (as against the national figure of about 22%). Agricultural and industrial consumption is low. On the one hand, this pattern of consumption can be conducive for renewable energy deployment of the decentralized variety – rooftop solar in particular, though high costs would inhibit large scale uptake of this technology. However, on the other hand, the lack of industrial consumers who can pay slightly higher costs of electricity and act as cross-subsidizers would act as an obstacle in large scale deployment of grid connected renewable energy systems.

The overall electricity consumption in the state however is much lower than the all India average; per capita electricity consumption in year 2014-15 was 686 KWh/year in Kerala as opposed to the national average of 1010 KWh/year. This is mainly due to low consumption by the industrial and agricultural sectors in the state. Relatively low demand from the agricultural sector also leads to a fairly uniform consumption across all months of the year. States where the relative demand from agriculture is higher tend to experience more seasonal variation in electricity demand. This feature of seasonally uniform demand makes the use of wind energy fairly conducive. The availability of wind energy is usually highest in the months of July, August and September, *i.e.* the monsoon. Due to low agriculture demand for electricity during these months, states do not usually need to purchase power from traders in the market and the obligation to purchase relatively expensive wind energy is often seen as an unnecessary increase in the burden on distribution utilities. However, in Kerala, the lack of seasonal variation in demand, can work in favour of wind energy where it may be able to replace other expensive power bought from traders, provided it is cheaper.

Rooftop Solar Photovoltaic

Per capita consumption of electricity in Kerala is about 336 KWh per year, which is much higher than the national average of 222 KWh per year. This translates to about 4.6 KWh/household/day for an average household with 5 members. This load is not evenly distributed throughout the 24 hours. Peak consumption occurs in the evening with a lower morning peak. A sample load curve for an average household is shown in Figure 1. This is not an actual load curve as each household would have varying consumption patterns, but a sample load curve based on typical patterns of consumption adding to about 4.6 KWh of energy consumption per day. The figure also shows a typical daily generation pattern of a 1 KW solar unit operating at an average capacity factor of about 18%.



It can be seen that most of the generation from the rooftop solar unit happens during the afternoon when demand is less. Therefore such a unit will require storage which increases cost. Or such units can be connected to the grid in order to export electricity to the grid during low demand hours and to import additional electricity from the grid during peak demand hours. The minimum size for eligibility for connecting to the grid is 1 KW according to the "Off-Grid and Decentralised Solar Applications" scheme of the MNRE. However, connecting a large number of such small units to the grid may create problems of grid reliability.

Cost Breakup of 1 KW roof top solar panel

Component	Rs	% of total cost
PV modules (Crystalline)	52,000	52%
Inverters	23,000	23%
Balance of System (cables, etc.)	17,000	17%
Installation	8,000	8%
Total	1,00,000	

A battery backup will add about Rs 25000/- to the above system.

The above prices are for components from Tier 1 manufacturers with 5-year manufacturer's warranty. In addition the PV modules have output warranty of 90% of rated capacity for the first 10 years and 80% of rated capacity for the next 15 years.

There are Central Government schemes providing subsidy for units of various sizes. Without availing these subsidies, the cost of electricity from such a rooftop system would be approximately Rs 5/KWh not considering maintenance and repair. With subsidies, the costs may reduce to about Rs 3.5/KWh. This

makes it fairly competitive with grid electricity in other states, although in Kerala with high amounts of hydro power, grid electricity may still be cheaper.

A WWF report released in 2013 titled 'The Energy Report- Kerala' indicates that the total exploitable potential for decentralized solar PV power packs for household sector is about 13,079 MW, while that for institutional/commercial sector is about 18,066 MW. The aggregate potential for decentralized solar PV power packs is assessed at 31,145 MW. This calculation is based on the total roof tops available for solar installations. 50 per cent of all concrete roof tops of commercial and institutional buildings and 30 per cent area of all concrete roof tops of households are taken into consideration for calculating the potential. This is therefore a highly optimistic assessment. Without experience in terms of actual costs and other factors that may influence decision making by different households (such as lack of time to maintain units, major setback in terms of regular income flows that may affect repairs, and other such reasons), it will not be possible to work with such an exaggerated estimate and realistically plan for what is possible on the ground.

It may be possible to target up to 5% of the entire rooftop area of commercial and institutional buildings together in the next three years. This can still amount to approximately 100-300 MW depending on the size of each unit and may provide important lessons through which the program can be subsequently up-scaled to include more commercial buildings as well as some households. There can be systematic efforts to facilitate the provision of subsidies already available through central schemes and the provision of standby power by KSEB in the short term to gauge the performance of such units and their usefulness in demand-side management.

Grid-Connected Solar PV

The MNRE estimates the total potential for grid connected solar in Kerala to be approximately 6110 MW. This is however a very rough estimate assuming that 10% of all 'waste land' would be available for installing solar panels. The WWF study quoted earlier estimates the total potential for grid connected solar PV to be about 6816 MW. This study uses a GIS based Multi Criteria Analysis to arrive at this estimate. It juxtaposes a terrain map of the state with a map of solar irradiation in the state and uses the following assumptions – Minimum GHI (Global Horizontal Irradiance) – 1600 KWh/m2; Minimum contiguous land – 5 acres (0.02 Km^2) for a minimum size of 1 MW. The study estimates that about 85.46 Km^2 of waste land and 50.87 Km^2 of grass land would be required for generation of 6816 MW of solar energy. However, the report is not at all clear about the status of the so called 'waste land' or 'grass land', in terms of ownership, current use and value. The assumption of minimum contiguous land availability of 5 acres for a 1 MW plant, leads to an implicit recommendation in the WWF report to effectively build 6800, 1 MW plants, connecting which to the grid will involve significant additional costs, not to mention balancing problems for the grid. The advantage in Kerala however, is large hydro capacity which has good ramping speeds. The existence of so many hydro plants can aid in the smooth integration of solar energy in the grid, also in terms of merit order dispatch.

There is no reliable cost estimate available for development of renewable energy in Kerala. In general it is estimated that the cost of PV module is Rs 30-50 per watt of power generation. It doesn't include the infrastructure and land acquisition costs. A 590 MW solar power plant in Gujarat required an area of 22 Km^2 and a capital investment of 4500 Crores. This implies an energy cost of about Rs 3/KWh without considering operation and maintenance costs. However, Kerala has lower GHI levels than Gujarat and therefore with lower capacity utilization factors, the cost of energy from solar would be higher. Also, the value of land is higher in Kerala, and it would add to the total investment required.

It should also be remembered, that solar plants will not provide base load power that may be needed to encourage investments in manufacturing in the state, unless they have storage capacities or are connected to pumped storage units. This however, will add significantly to costs. If there is to be some effort in increasing the thermal capacity in the state or investment in transmission infrastructure to import the energy needed from outside the state, then there would be a tradeoff in terms of where Government investment should be focused. It may be possible to attract private companies to develop and deploy solar plants in the state, but this would mean that sufficient incentive needs to be provided in terms of a strong RPO (Renewable Purchase Obligation), which may put additional burden on KSEB. Currently Kerala's RPO is weak and neighboring states of Tamil Nadu and Karnataka already generate surplus renewable energy at cheaper rates, so for KSEB it would make sense to source renewable energy from these states to meet its RPOs. However, as the RPOs in each state become more stringent, it would be more difficult to import this power and the Government should plan for this eventuality.

Using a similar methodology of identifying suitable terrain, with a minimum level of GHI and reasonably acquirable land, the next three years can focus on trying to install a few 1 – 10 MW grid-connected solar systems in Kerala. It may be possible to target a modest 10-20 MW in the short term to assess the possible implications of this energy option and also to allow more time for the reduction in prices and for suitably understanding how best to leverage the hydro power capacity already present in the state to extract maximum gains from solar plants. Caution should be exercised in proceeding with haste with this technology. Conventional options should be explored to the maximum and given priority for investments at this stage.

Wind Energy

The following table gives the estimates given by various agencies for the total wind potential in the state.

Agency Name	Wind Potential (MW)
MNRE (Ministry of New and Renewable Energy)	837
WWF (World Wildlife Fund)	7353
ANERT (Agency for Non-Conventional Energy and Rural Technology - Kerala)	605
GENI (Global Energy Network Institute)	1026
Report of the Expert Committee on Energy 2015	700

The
assumptions in the WWF report for wind energy are responsible for the very high estimate of 7353 MW. They have assumed that non-irrigated farmland, as well as all other land where wind power density is greater than 150 W/m2 can be utilized. In all other reports however, there is fairly consistent estimate of about 600-800 MW. The main problem with wind energy potential is that a majority of it is concentrated in the areas that have difficult terrain or are remote. This would increase costs of installation as well as cost of under-utilized transmission networks.

The current wind energy capacity in Kerala is 33 MW of which 2 MW is owned by the KSEB. Kerala's neighbors – Tamil Nadu and Karnataka – between them have an installed capacity of over 10,000 MW. Wind capacity can certainly grow and as mentioned earlier, the presence of so much hydropower in the state allows more flexibility in grid operations. Potential investment in wind energy and the exploitation of good wind sites should be encouraged as this is also a relatively less expensive source of energy. In the short term a target of increasing the installed capacity from 33 MW to 70 MW can be set which would require attracting an investment of about Rs. 200 crore.

Role of Renewable Energy

Kerala already has a high amount of renewable hydro power. What is lacking in the state is availability of thermal power than can supply base load. Almost all of the thermal power is being imported currently from central generation units or traders. Increasing industrial production in the state would require a focus on increasing the availability of electricity in the state and especially the deployment of units that can supply base load. Attracting investments in this area therefore along with investing in strengthening transmission infrastructure to facilitate efficient import should be the focus at this point. However, there eventually will be increasing pressure on the state to make the RPOs more stringent and contribute towards meeting the national renewable energy targets. Also, notwithstanding this, both solar and wind technologies can play a moderate but important role in reducing the state's dependence on imported power. A steady and measured increase in the capacity of these two renewable energy technologies can provide the state with expertise and experience that will be useful in transitioning eventually to a low carbon pathway when the time for such a transition is right. The push for renewable energy technologies should be seen in this context and strategies for the future must be planned accordingly.

9. Demand Forecast and Generation of Electricity other than from Renewable Sources

This short report on Demand forecast and Generation of Electricity is in compliance to the decision on the first working group meeting on 13th five year plan held on 13.10.2016.

1. Demand forecast

1. Understanding of future energy demand is the starting block to the planning process on the same. The discussion here is limited to the forecast of electricity demand and not on all forms of energy.
2. Central Electricity Authority (CEA) conducts Electrical Power survey (EPS) covering every 5 year plan periods. Report on the 19th EPS which considers the period 2017-18 to 2021-22, is being finalised.
3. The only attempt by the State in the past to make its own forecast of electrical energy was that done as part of preparation of 'Perspective Plan 2030', the document of which was published in October 2014.
4. 'PP-2030' forecast provides a much larger figure for electricity demand than the 18Th EPS projection for the period from 2016-17 to 2021-22.
5. It should be viewed in the backdrop of the fact that, the projections as per EPS were always on the higher side, though there are justifications for the same.
6. The projections of 18th EPS with respect to the actual in the case of energy requirement for the years 12-13, 13-14, 14-15 and 15-16 were 5.2%, 7.04%, 8.43% and 9.58% respectively, on the higher side. In the case of Maximum demand the variation was higher by 11.25%, 8.06%, 12.935% and 11.99% in the respective years.
7. Though the reality was not so close to the estimates, the scientific approach, methodology and adherence to accepted statistical tools in EPS are to be appreciated.
8. It is to be deliberated whether the state can match, if not exceed, the wisdom and capability of CEA in the matter of Electricity forecast, in making its own projection.
   Perusal of the 19th EPS data indicates that the same is much more moderated and can be expected to be reliable at least for the medium term.
9. In the absence of a better alternative, it is advisable to move ahead with the 19th EPS data, the ultimate risk of it being a variation of 10% which is of less relevance.

2. Generation

1. Sufficiency Vs Security
    1. States dependence on the sources located in other parts of the country is on the increase. If the trend continues the domestic content in the energy portfolio shall become insignificant in the coming years. What sort of issues this situation raises?
    2. In cases other than CGSs, ownership of other state plants are in private hands or with the respective state government, for whom the interest of the buying state shall only be secondary. It raises the question whether energy sourced from such plants is cent per cent 'secured' in the long run?
    3. On the other hand is it advisable for the state to fulfil all of its energy need by having more and more generating stations within its geographic limits in proportion to its demand growth, such that the state shall be not only secure but 'Self-sufficient' also in energy matters.
    4. Little strength the state may have is in the RE sector. Given the variability and uncertainty of renewable energy, it is not prudent to make an energy plan to meet the future demand depending solely on RE sources.
    5. At the same time, is it possible to find the resources to have more number of large capacity conventional energy plants in state which is acutely stressed on land availability, ecologically tender and devoid of fossil fuels? The answer is on the negative. Self sufficiency – having sufficient source plants within the state boundary – cannot be set as goal under this plan period.
    6. Given the limitations, the goal could be to achieve energy security through strategic investments.
2. *Hydro Generation*
    1. Against a total potential of 6000 plus MWs the harnessed capacity in large capacity hydro is only about 1300MW.
    2. The RE status now being bestowed on hydro plants without capacity consideration shall be supportive to the idea of more hydro stations.
    3. But development of Hydro electricity in the state has more serious issues linked with flooding of evergreen forests and biodiversity. There is an urgent case to re-assess the hydro potential in consideration of its environmental sensitivity.
    4. The large-Hydro development strategy shall be basically focused on its capability to act as 'balancing power' to RE sources, in view of the substantial capacity addition proposed in RE sector of the state.
    5. The strategy may include capacity enhancement of existing stations, necessary improvements in the existing stations to increase its ramping up response, RMU, and pumped storage plants based on financial viability.
    6. The strategy shall also include ways to enhance the hydro storage capacity, given the limited technological options for storing infirm RE.
3. *Thermal Generation*
    1. Manifesto of LDF on thermal plants reads as follows "By making ecological security we should make interference to start a thermal power plant which had a capacity of 1200 to 1320 MW. Parallel to this we should do the socio-industrial development programs in the plant area. If it is not possible in Kerala we will establish it near the mining area."
    2. A pit-head power plant, in which Kerala has ownership control, is the next to an ideal option on an energy security point of view. But the chance of success for such an

endeavor is to be re-ascertained based on our current experiences and if not favourable the proposal to have a plant within Kerala is to be re-considered.

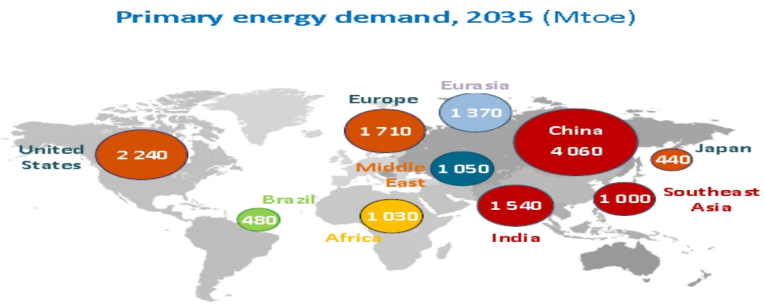
3. Various proposals have been made for Gas based plants in the state. The re-gasification terminal at Kochi is a favourable factor in this regard. The suitability of gas as an environmentally benign fuel also is not questionable.
4. But in the given circumstances of uncertainty in domestic gas availability and price volatility of RLNG, an investment decision may be highly risky and need to be delayed for further period.
5. In the prevailing socio-political environment and the current development state of nuclear technology, Nuclear energy is not an option to be considered in the present plan period.

10. Energy Efficiency and Conservation

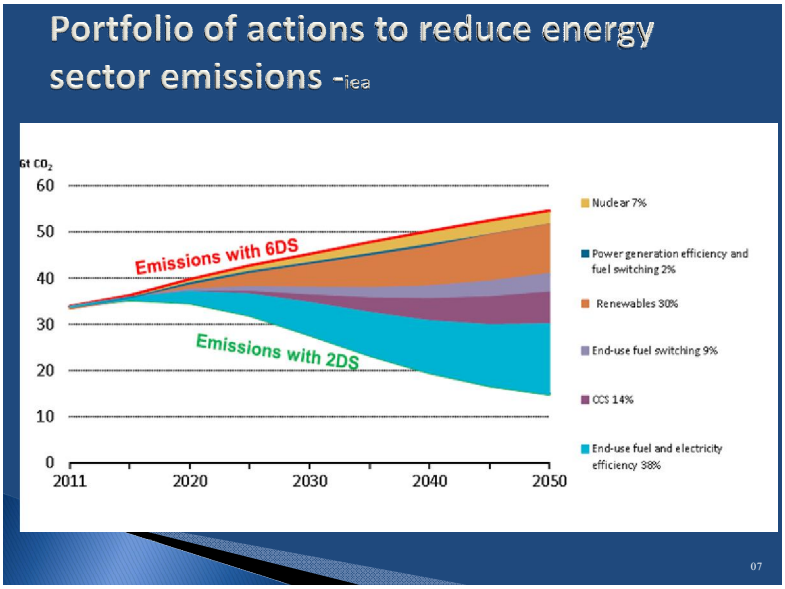
Energy efficiency has gained attention as a key resource for economic and social development across all economies. According to BharathRatna Dr. A. P. J. Abdul Kalam, energy efficiency is the fifth fuel after wood, oil, nuclear, and green sources. Energy efficiency (EE) & Renewable Energy (RE) must be developed faster to stabilize and to reduce GHG emissions. Efficiency brings down energy demand growth; rising clean energy supplies can reduce fossil fuel use.

The Energy demand growth in Asian countries is increasing rapidly led by China this decade, but shifts towards India and, to a lesser extent, Southeast Asia after 2025. The Middle East emerges as a major energy consumer, with its gas demand growing by more than the entire gas demand of the OECD: the Middle East is the second-largest gas consumer by 2020 and third-largest oil consumer by 2030, redefining its role in energy markets. Improved energy efficiency and a boom in unconventional oil and gas production help the United States to move steadily towards meeting almost all of its energy needs (in energy equivalent terms) from domestic resources by 2035.

The world is concerned about the primary energy demand in future, because of two countries, China and India. The chart exhibited gives a picture of the same in 2035.



Further the entire world is concerned about the climate change and the global warming issues. According to IEA reports, in the energy sector emissions, energy efficiency plays a crucial role in bringing down the global temperature



The scope for energy efficiency is very high to bring down the energy demand, specific energy consumption in Industries, energy performance index in buildings and green house gas emissions. Based on this, the following activities can be carried out during the next 5 years.

Energy conservation awareness is the first and foremost step.

Education Sector

1. Energy Education in Schools, Colleges
2. Students Energy Congress in the name of BharathRatna Dr. A. P. J. Abdul Kalam - Energy conservation competition among students – Reorganization and grade marks can be considered for extraordinary works
3. Energy Smart schools
4. Support for projects on Energy conservation and energy efficiency
5. 'Maker spaces' for energy efficiency for supporting Make in India programme
6. Energy conservation modules with a practical bias in technical education covering ITI, Polytechnics, and Engineering Colleges

Domestic sector

1. Energy Conservation awareness programme for domestic house-wives
2. Course for Home Energy Auditors
3. Programmes for general public in association with NGO's, residential association etc.
4. Popularizing "Urjakiran" programme with the support of NGO's and Libraries

Industrial Sector

1. Facilitate and support for conducting energy audit in all HT/EHT consumer premises
2. Capacity Building training program for Industrial Energy consumers including SMEs
3. Cluster based DSM programme for energy efficiency adoption
4. Promoting demo projects among leading cluster units to encourage multiplier effect
5. Suitable financing scheme for implementing energy efficiency programme in Industries with the support of KFC

Agriculture Sector

1. Suitably designed DSM programme including for agro machineries

2. Promoting water conservation opportunities like rain water harvesting, water conservation development programme
3. Capacity building of farmers regarding practices of water efficient crop planning

Municipalities/LSG

1. Capacity building on energy efficiency, energy audit and good practices in street lighting, public water works and sewage pumping
2. Promoting Municipal DSM programme
3. Promoting demo projects for energy efficiency in street lighting, public water works and sewage pumping
4. Model Energy Efficient Panchayat

Government Buildings

1. To introduce and implement ECBC and EC practices in all the government building and best practices will be published.
2. To support PWD to make 10% of the Government Building as Net Zero Building by 2020.
3. Developing energy efficiency procurement policy

Commercial Building

1. ECBC
2. Programme for awareness building on BEE star labelled appliances
3. Promotion of building star rating system

Utility

Standardisation of transformer station, allied controlling devices, electric lines are very essential. DSM/DR activity should be strengthened. In order to absorb RE sources, energy efficiency improvement and smart grid are essential.

Transport sector

Since transport sector is a major energy consuming sector, more emphasis to be given for manufacturing energy efficient vehicles, energy efficient driving practices, etc

Monitoring

In order to monitor the energy conservation/ energy efficiency programmes, a monitoring system should be in place, with the following pattern

1. District level Co-ordination team for EC
2. State Level
3. National Level

Publicity

A mass awareness campaign has to be launched to create awareness on efficient use of energy and its important role in preserving environment. As a CSR activity each electronic media can allot 10 minutes time and space by the print media, exclusively for awareness building.

Financial support to Energy Efficiency programmes

Most energy efficiency projects require capital investment and are financed by financial institutions. The economic attractiveness of the project is therefore influenced by the interest rate. The economics of the EE project can therefore be improved if the financing can be made available at a low interest rate.

There is significant potential for energy savings in the domestic sector. Since energy efficient appliances are more expensive, consumers are often not willing to invest their own funds to achieve the energy savings that will provide costs savings. A financing mechanism should be created to facilitate the purchase of efficient products by providing zero interest loans.

HRD Programmes

With the globalisation of energy markets, the relevance of training programmes to update the knowledge and skills of the energy professionals, especially in the capacity building of professionals involved in the EE activities is highly necessary.

Energy Management Institute

As part of the energy management institute activity, EMC is planning following activities during the five year plan period.

1. Hands on training in Energy efficient technologies
2. Small Grant R&D Programmes:
3. Seed fund for commercialisation / Demonstration projects:
4. Scholarship for research fellows:
5. Research based Chairs of excellence
6. Certificate course for Energy Clinic Animators
7. Certificate course for Home Energy Auditors
8. Capacity Building training program for Industrial/ Commercial Energy consumers
9. Technical training programs

Low head and ultra low head micro/picohydel project development

Kerala State is falling behind hugely on self-sufficiency in power generation depending on 65% of its power usage from outside state; development of renewable energy has proven as the best source for generation in the State, especially small mini micro and picohydel projects.

There is a huge potential for Low head & Ultra Low Head (1.5 to 20m head) projects in Kerala. A preliminary run of the mill assessment projects a potential of about 300-500 such pico and micro hydel projects in Kerala. Till recent days availability of efficient low head turbo machinery was not available in India mainly attributed to high cost involved in such projects.

This plan year EMC propose to push forward the harnessing of Low/ultra low head hydel projects. If the actual viability of harnessing Low head & Ultra Low Head Projects has to be assessed, few pilot projects have to executed and commissioned on a trial and error basis. EMC is also planning river basin study to explore the possibility of all type of Small Hydro Projects on district basis.

Expected outcome

1. Develop the next generation of leaders in the energy sector
2. The course shall address global energy issues, sustainable energy technologies, and their interactions with economics, the environment and policy in State and national perspective
3. Inter connecting the academics, industry, society and government in energy related issues
4. Developing energy efficient technologies and system
5. Forecasting of energy demands and resource planning
6. Developing inter disciplinary experts in the field of energy
7. Attract the best minds from industry & train them in the area of energy management, infrastructure finance, leadership role etc. to fulfil the needs of energy sector

8. Industry & government participation at highest level to keep track of the changes in Energy & Power Sector
9. To help develop turnaround capabilities in public sector energy companies and state electricity boards
10. Lessons learnt from advanced energy markets
11. Carry out Action-oriented Research in emerging fields of Energy Management with active industry participation

ANNEXURE 2

PROCEEDINGS OF THE MEMBER SECRETARY
STATE PLANNING BOARD
(Present: Sri V S Senthil IAS)

Sub: Formulation of XIII Five Year Plan (2017-2022) – Constitution of Working Group –**Energy Sector** - reg.

Ref: Note No. 260/2016/PCD/SPB dated 06.09.2016 of the Chief (i/c), PCD, SPB

ORDER NO.SPB/295/2016/I&I (WG-1) Dated: 20.09.2016

As part of formulation of XIII Five Year Plan, the State Planning Board has decided to constitute Working Groups to formulate draft proposals in the various major development sectors and sub sectors. Resource persons including Professionals, Administrators and experts connected with the sectors were identified as members of the Working Groups. Accordingly, the **Working Group on Energy Sector** is hereby constituted with the following members.

Co-Chairperson

Sri Paul Antony IAS, Additional Chief Secretary to Government, Department of Power & CMD, KSEBL, VydhuthiBhavan, Pattom, Thiruvananthapuram

Co-Chairperson

Sri Prabir Purkayastha, President, Centre for Technology and Development, New Delhi and Chairperson, Knowledge Commons

Members

1. Sri KM DharesanUnnithan, Director, Energy management Center (EMC), Sreekrishna Nagar, Sreekaryam. P.O., Thiruvananthapuram
2. Dr R Harikumar, Director, ANERT, Law College Road, VikasBhavan P.O., Thiruvananthapuram
3. Sri Anil Kumar VC, ChiefElectrical Inspector, Electrical Inspectorate, Santhi Nagar, Thampanoor, Thiruvananthapuram
4. Ms Tejal Kanitkar, Energy Specialist (TISS, Mumbai)
5. Sri V Namasivayam,Deloitte, Bengaluru
6. Sri Rakesh Kumar, Retd GM, NTPC
7. Sri Arun George, CEO, Wind Power – Avant Garde Innovations
8. Sri R V G Menon, Haritha, Mudavanmugal, Poojappura, Thiruvananthapuram
9. Sri B Pradeep, President, KSEB Officers Association
10. Sri MG Sureshkumar General Secretary, KSEB Officers Association
11. Sri KO Habeeb, President, Electricity EmployeesFederation of India

Convener

Sri Joy N R, Chief, Industry & Infrastructure Division, State Planning Board, Pattom, Thiruvananthapuram

Co-Convener

Assistant Director, Power Sector, Industry & Infrastructure Division, State Planning Board

Terms of Reference - Energy /Power Sector

1. To review the development of energy/power sector with emphasis as to progress, achievements, present status and problems under its jurisdiction during the 11th and 12th Five Year Plan periods. More detailed terms in this regard will be communicated in the first meeting.
2. To evaluate achievements with regard to the plan projects launched in the power sector, both by the State Government and by the Central Government in the State during these plan periods.

3. To list the different sources of data in regard to the power sector and provide a critical evaluation of these data sources, including measures for improvement.
4. To identify and formulate a set of output and outcome indicators (preferably measurable) for the power sector and base the analysis of the previous plans on these indicators.
5. To suggest, in particular, a set of projects which can be undertaken during the 13th Plan period in the power sector.

Terms of Reference (General)

1. The Chairperson is authorised to modify Terms of Reference with the approval of State Planning Board. The Chairperson is authorised to invite, on behalf of the Working Group, experts to advice the Group on its subject matter. These invitees are eligible for TA and DA as appropriate.
2. The Working Group will submit its draft report by 1st December 2016 to the State Planning Board
3. The non- official members 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 allowances as per rules if reimbursement is not allowed from Departments.

(Sd/-)
MEMBER SECRETARY

To

The Members concerned

Copy to:-

The Accountant General, Kerala (A&E) with C/L
The Sub Treasury Officer, Vellayambalam.
The PS to the Hon. Vice Chairman, State Planning Board
PA to Member Secretary
CA to Member (TJ)
All Divisions, State Planning Board
The Sr. Administrative Officer, State Planning Board
Stock File

Forwarded by Order
(Sd/-)
Chief (Industry & Infrastructure Division)

PROCEEDINGS OF THE MEMBER SECRETARY
STATE PLANNING BOARD
(Present: Sri V S Senthil IAS)

Sub: Formulation of XIII Five Year Plan (2017-2022) –Working Group on **Energy Sector** –Re-constituted – Orders issued - reg.

Read: This Office Order of even number dated 20.09.2016

ORDER NO.SPB/295/2016/I&I (WG-1) Dated:23.09.2016

As part of formulation of XIII Five Year Plan, the Working Group on Energy Sector has been constituted vide paper read above. The Working Group on Energy Sector is hereby re-constituted by including one new member viz. Chief Engineer, PWD (buildings).

Co-Chairpersons

1. Sri Paul Antony IAS, Additional Chief Secretary to Government, Department of Power & CMD, KSEBL, VydhuthiBhavan, Pattom, Thiruvananthapuram.
2. Sri Prabir Purkayastha, President, Centre for Technology and Development, New Delhi and Chairperson, Knowledge Commons

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2. Dr R Harikumar, Director, ANERT, Law College Road, VikasBhavan P.O., Thiruvananthapuram
3. Sri Anil Kumar VC, ChiefElectrical Inspector, Electrical Inspectorate, Santhi Nagar,Thampanoor, Thiruvananthapuram
4. Ms Tejal Kanitkar, Energy Specialist (TISS, Mumbai)
5. Sri V Namasivayam, (Deloitte, Bengaluru)
6. Sri Rakesh Kumar, (Retd GM, NTPC)
7. Sri Arun George, CEO, Wind Power – Avant Garde Innovations
8. Sri R V G Menon, Haritha, Mudavanmugal, Poojappura, Thiruvananthapuram
9. Sri B Pradeep, President, KSEB Officers Association
10. Sri MG Sureshkumar, General Secretary, KSEB Officers Association
11. Sri KO Habeeb, President, Electricity EmployeesFederation of India
12. Smt Pennamma M., Chief Engineer, Public Works Department (Buildings) Thiruvananthapuram

Convener

Sri Joy NR, Chief (Industry & Infrastructure Division), State Planning Board, Pattom, Thiruvananthapuram

Co-convener

Assistant Director (Power Sector), Industry & Infrastructure Division, State Planning Board

Terms of Reference- Energy /Power Sector

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(Sd/-)
MEMBER SECRETARY

To

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All Divisions, State Planning Board.
The Sr. Administrative Officer, State Planning Board.
Stock File

Forwarded by Order
(Sd/-)
Chief (Industry & Infrastructure Division)

PROCEEDINGS OF THE MEMBER SECRETARY
STATE PLANNING BOARD
(Present: Sri V S Senthil IAS)

Sub: - Formulation of XIII Five Year Plan (2017-2022) –Working Group on **Energy Sector** –Re-constituted – Orders issued - reg.

Read: -1) This Office Order of even number dated 20.09.2016 and 23.09.2016

2) Decision taken in the 1st sitting of the Working Group Meeting on Energy Sector held on 03/10/16.

ORDER NO.SPB/295/2016/I&I (WG-1) DATED:17.10.2016

As part of formulation of XIII Five Year Plan, the **Working Group on Energy Sector** has been constituted vide order 1st read above. As per the paper 2ndread above, decision has been taken to re-constitute the Working Group on Energy Sector by including three new members viz; 1) Sri Venugopal N, Director (Distribution & Generation -Electrical), KSEBL2) Smt. Vijayakumari P, Director (Transmission), KSEBL and 3) Sri Suresh Kumar M, Additional Director, Petroleum Conservation Research Association (PCRA), Kochi.

In this context, the Working Group on Energy Sector is hereby re-constituted by including three new members as per the terms of reference cited in the order read as 1st above.

Member

1. Sri Venugopal N, Director (Distribution & Generation - Electrical),Kerala State Electricity Board Limited (KSEBL) VydhuthiBahvanam, Pattom, Thiruvananthapuram
2. Smt Vijayakumari P, Director (Transmission), Kerala State Electricity Board Limited(KSEBL) VydhuthiBahvanam, Pattom, Thiruvananthapuram
3. Sri Suresh Kumar M, Additional Director, Petroleum Conservation Research Association (PCRA), Kochi

(sd/-)
MEMBER SECRETARY

To
The Members concerned
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PA to Member Secretary
CA to Member (TJ)
All Divisions, State Planning Board.
The Sr. Administrative Officer, State Planning Board.
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Chief (Industry & Infrastructure Division)

ANNEXURE 3

List of Persons associated with the Working Group on Energy

Member

1. Prof T Jayaraman, Professor, School of Habitat Studies, Tata Institute of Social Sciences, Mumbai.

Chairpersons

2. Sri Paul Antony, IAS, Additional Chief Secretary, Power Department
3. Sri Prabir Purkayastha, President, Centre for Technology & Development and New Delhi & Chairperson, Knowledge Commons

Working Group Members

4. Sri K M DharesanUnnithan, Director, Energy Management Center (EMC) Sreekrishna Nagar, Sreekaryam.P.O, Thiruvananthapuram
5. Dr R Harikumar, Director, ANERT,Law college road, VikasBhavan P.O, Thiruvananthapuram
6. Sri Anil Kumar VC, Chief Electrical Inspector,Electrical Inspectorate, Santhi Nagar, Thampanoor, Thiruvanthapuram
7. Ms Tejal Kanitkar, Energy Specialist(TISS Mumbai)
8. Sri V Namasivayam, (Deloitte, Bangaluru)
9. Sri Rakesh Kumar, (Retd. GM, NTPC)
10. Sri Arun George, CEO, Wind Power-Avant Grade Innovations
11. Sri RVG Menon, Haritha, MudhavanMugal, Poojappura, Thiruvananthapuram
12. Sri B Pradeep, KSEB Officer's House, T.C 25/2969, Vanchiyoor, Malloor Road, Thiruvananthapuram -695035
13. Sri MG Suresh Kumar,General Secretary, KSEB Officers Association, KSEB Officer's House, T.C 25/2969,Vanchiyoor, Malloor Road, Thiruvananthapuram
14. Sri K.O Habeeb, President, Electricity Employees Federation of India, Shahina, Kodunganoor PO, TVM
15. Smt Pennamma M, Chief Engineer, PWD (Bldgs), Thiruvananthapuram
16. Smt Vijayakumari P, Director Transmission (KSEBL), VydhuthiBhavan, Pattom ,Thiruvananthapuram
17. Sri Venugopal N, Director Distribution (KSEBL), VydhuthiBhavan, Pattom, Thiruvananthapuram
18. Sri Suresh Kumar M, Additional Director, Petroleum Conservation Research Association (PCRA), Kochi

Special Invitee

19. Dr K Ellangovan IAS, Chairman & Managing Director, KSEBL, VydhuthiBhavan, Pattom, Thiruvananthapuram

Sub Committee Members

20. Sri Joji George, Executive Engineer , KSEBL
21. Sri Padmakumar G, EE, KSEBL, VydhuthiBhavan, Pattom, Thiruvananthapuram

Convener

22. Sri Joy N R, Chief, Industry & Infrastructure Division, State Planning Board, Thiruvananthapuram

Co - Convener

23. Sri Joseph A D, Assistant Director, Industry & Infrastructure Division, State Planning Board, Thiruvananthapuram assisted by Smt Dhanya Chandrasekhar, Research Assistant.