FORUM OF REGULATORS

FRAMEWORK TO DRAW UP A SCHEME AT NATIONAL LEVEL FOR FEEDER SEGREGATION OF RURAL AND AGRICULTURAL CONSUMERS AND SUGGEST MEASURES ON EFFECTIVE METERING

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1. Foreword:

1.1 Introduction

State Governments have been subsidising the cost of electricity consumption by agricultural consumers since the Green Revolution in the early 60's. Today a number of agriculture based states provide subsidized power to agricultural consumers either free or at a tariff significantly below the average cost of supply.

The Ministry of Power requested the Forum of Regulators (FOR) to give their considered views on "Power Supply Challenges and Way Forward." The FOR formed a Working Group to consider this matter. Considering the complexity of the issues, the working Group formed two sub groups on August 27, 2014 each of which would examine part of its mandate.

Subgroup II was required to make recommendation on '*A Framework to draw up a scheme at national level for feeder segregation of rural and agricultural consumers and suggest measures for effective metering*'

The Sub Group comprised of the following members

i. Chairperson, APERC: Chairperson
ii. Chairperson, GERC: Member
iii. Member (VS), PSERC: Member

The Sub Group (hereinafter SG) distilled from its Terms of Reference the following eight questions which would need to be addressed in its recommendations. The first four questions would refer to states which had already undertaken the feeder segregation program and the next four would be on the broader aspects applicable to all the states in the country subject to information availability.

1. What was the objective for undertaking feeder segregation program?
2. What was the structure and phasing of the implementation program?
3. How was the program funded and how was it managed?
4. What economic and social benefits were derived from the program?
5. What is the ideal framework for Government of India to roll out a national scheme for feeder segregation?
6. Is feeder segregation an end in itself? If not, what additional initiatives/ minimum requirements need to be simultaneously undertaken to leverage the desired benefits?

7. Are there any alternatives to the feeder segregation program?
8. What is the best framework for effective metering?

The SG met three times as under:

a. Ahmedabad, Gujarat (10^{th}-11^{th} September 2014)
b. Chandigarh, Punjab (18^{th}-19^{th} September 2014)
c. Hyderabad, Telangana (1^{st} – 2^{nd} October 2014)

Prior to the meetings, the SG worked out the modalities for its working. The SG decided to address the eight questions framed above using three different approaches as detailed below.

a) A review of the existing reports as well as literature on the experience of agriculture feeder separation and metering and culling out lessons to be drawn from previous work and analysis

b) A review of the experience in agricultural feeder separation and metering in the three states of Gujarat, Punjab and erstwhile Andhra Pradesh through an intensive interaction with officials of the transmission and distribution utilities in each of these three states.

c) Field visits in each of the three states to villages where feeder separation had been implemented to ascertain from both agricultural and non agricultural consumers the benefits derived from the separation.

The subgroup benefited from a review of the previous experience of feeder segregation in different Indian states as reported by different institutions/ organisations. These reports are listed in Annexure 1. During its visits to the three states, the SG interacted extensively with the respective Regulatory Commissions. It also reviewed the feeder segregation program with the senior management officials of the following utilities in Gujarat, Punjab, Telangana and Andhra Pradesh:

a. Uttar Gujarat Vij Company Limited (UGVCL)
b. Dakshin Gujarat Vij Company Limited (DGVCL)
c. Paschim Gujarat Vij Company Limited (PGVCL)
d. Madhya Gujarat Vij Company Limited (MGVCL)
e. Punjab State Power Corporation Limited (PSPCL)
f. Southern Power Distribution Company of Telangana State Limited (TSSPDCL)
g. Northern Power Distribution Company of Telangana State Limited (TSNPDCL)
h. Eastern Power Distribution Company of Andhra Pradesh Limited (APEPDCL)
i. Southern Power Distribution Company of Andhra Pradesh Limited (APSPDCL)

The sub-group has also collected detailed information about the feeder segregation projects undertaken in the above states. This data (presented in annexures 2, 3 and 4) has been analysed for obtaining insights on the feeder segregation projects.

The SG also benefited from its field visits to a number of villages in each of the three states where it interacted with farmers as well as non-agricultural consumers.

The SG recommends that subject to adequate power being available a national level program for segregation of feeders be implemented in a calibrated manner while allowing states to have the flexibility to design the project to suit their specific requirements. Feeder segregation may not be the first priority for certain utilities. Such utilities should be allowed to take up, what is in their view, more pressing projects aimed at stabilising rural supply such as HVDS.

1.2 Summary of key findings and recommendations:

The summary of key findings and recommendations is placed below. The main recommendations are in Chapter 7.

1.3 Key objectives for undertaking feeder segregation program

The key objectives envisaged for the rural power distribution systems in India by undertaking this program include:

a) Improved power supply to rural non-agricultural consumers (Ultimate aim is to provide 24x7 three phase supply to rural consumers). Consequent improvement in the quality of their lives and catalysis of rural industry.

b) Improved load management through a better ability to regulate supply to agricultural customers. Consequent transparency as well as capping of agricultural subsidies and thus stabilising financial position of the utilities

c) Reduction in line losses through better monitoring of consumption in the agricultural sector.

d) Improved management of environmental resources through husbanding ground water resources.

1.4 Structure and phasing of the implementation program

Various states have implemented the feeder segregation program with different features as tabulated below.

Table 1: Basic features of the schemes adopted by different states

Particular	Erstwhile Andhra Pradesh	Gujarat	Rajasthan	Haryana	Punjab
Program Planning	• Draft DPR prepared. • Administrative feeders selected at Mandal level and envisioned benefits not included in DPR	• DPR not prepared. • Cost of scheme was estimated sub division level and approved by respective Discom	• Feeder-wise DPR prepared. • Percent IRR: 22.7% • Initially scheme prioritized high loss feeders and balance later	• Sub division specific DPR. • Percent gross returns: 27.75 • Cost benefit analyzed through gross percent returns	• Feeder wise DPRs were prepared. • Cost benefit analysis of the schemes executed on turnkey basis prepared.
Procurement Strategy	• Partial turnkey for physical segregation • Discoms procure VCBs, DTs and HT and LT conductors • Balance by implementing contractor	• All material by former Gujarat Electricity Board	• Typically partial turnkey • Discoms procure VCBs, DTs and HT and XPLE conductors • Balance by contractor	• Turnkey contractor for turnkey works • In house management for labor contracts	• Work was carried out both departmentally and on turnkey basis
Institutional Framework	• Pilot managed through routine business operations • Framework for complete plan yet to be decided	• No scheme specific plan for execution	• Circle head as Project Managers • Junior engineers as managers of feeders	• Discoms planning and design cell for planning, awarding contract and project execution	• CE level officer responsible for monitoring, awarding & implementation
Project Owner	• Distribution Utility	• State Government	• Distribution Utility	• Distribution Utility	• Distribution Utility
Financing arrangements	• Pilot funded by Utilities • Full scale project funding not finalized	• Mainly funded by state government grant	• Financial institutions	• Financial institutions	• Contribution from village Panchayats, state government & financial institution.

The implementation framework for the feeder segregation program could be adopted, based on the objectives of the program and quantum of agricultural load in a particular geography, It is recommended that implementation criteria such as the program planning, procurement strategy, institutional framework and financing arrangements should be developed in a customized manner for each subcomponent of the program.

Implementation plan should be developed both at state as well as feeder level. States with a higher agricultural load could take up segregation in the first instance, based on the economic and technological environment as well as implementation capacity. For example, in the first phase, states where agricultural sale not less than 10% of the total energy sales could be selected for implementing the scheme. Within such a state, the feeders to be taken up could also be similarly prioritized. The implementation programme could include the following steps:

a) Defining objective- As stated in the previous sections, objectives for different states can be different for example: 24x7 supply to rural domestic feeders, load balancing, loss reduction, accurate assessment of agricultural pumpset (AP) consumption, energy audit etc. The strategic objectives selected would form the basis of the investment decision.

b) Selection of approach- There can be different viable options for each state depending upon the objective adopted for feeder separation. These could depend upon the geographical, political and socio economic environment in a state as well as the existing grid infrastructure.

c) Selection of geography- Geographical considerations based on the agricultural load could be the primary consideration. All feeders with agricultural load above a certain datum could be included in the segregation scheme.

d) Implementation: Implementation of the selected program can either be carried out in the whole area of the state in one go or it can be phased out, depending on the agriculture needs of various regions of the state and concentration of agriculture vis-a-vis non-agriculture rural loads. The main feeder segregation program may be supplemented by appropriate measures for loss reduction etc. by way of comprehensive metering infrastructure, if not for all the consumers shall at least metering at feeder and distribution transformer ends.

1.5 Cost incurred in feeder segregation by different states

Table below captures the capital cost incurred by different states for feeder segregation.

Table 2: Capital cost incurred by different states

	Erstwhile Andhra Pradesh	Gujarat	Rajasthan	Haryana
Number of Agricultural feeders	8,878	1,904	8,126	1,226
Total (Rs Crore)	3,014	1,290	4,485	573
Per feeder (Rs Lakh)	33.94	67.75	55.19	46.73

Source: World bank report: Lighting rural India - Experience of Rural Load Segregation Schemes in States (February 2014)

In the state of Punjab, one of the feeder segregation projects taken up departmentally required material costing nearly Rs 211.55 Crore for segregation of nearly 848 mixed feeders1. The cost of feeder segregation excluding the cost of manpower is nearly Rs 24.95 Lakh per feeder.

In Gujarat, though the World Bank Report mentions the per feeder cost of Rs. 67.75 lakhs, the GERC has assessed the per feeder cost of Rs. 37.5 lakhs based on total cost of Rs. 1290 Crore and 3439 number of new feeder created.

Project cost for different states cannot be directly compared due to significant differences in the project scope and the year of execution. Different states took different methods such as virtual segregation, physical segregation and integrating feeder segregation with rural development program and water resource management programs. Thus the costs incurred vary across states in Table 2 above.

1.6 Funding Mechanism envisaged for a national level programme

Central government financial support may be provided to implement the feeder segregation program at National level. Central assistance should recognize and reward performance on the lines of R-APDRP, Financial Restructuring Programme and Interest subsidy Scheme under National Electricity Fund.

Central funding may be provided in a manner similar to R-APDRP as detailed below. Higher funding is envisaged for projects that include 100% metering for the customers under the project area.

[1] Source: PSPCL

Loan by the central government would be converted to a grant on achievement of the objectives of the particular stage as verified and established by the monitoring committee.

Table 3: Proposed Loan from Central Government as % of the Project Cost.

For the projects proposing 100% metering for the cinsumers in the project area	**80 %**
For other projects	**50%**

Initially the central assistance would be provided as loan by the Government of India. Balance funding would be through internal resources/ Financial Institutions/ multilateral agencies. Subsequently, a specified part of the loan (may be even 100%) could be converted as grant based on achievement of the measurable outcome indicators.

1.7 Economic and social benefits from the program

The following are the reported benefits from feeder segregation projects in Indian discoms:

a. Improved load management (ability to regulate supply to agricultural customers)
b. Improved power supply to rural consumers
c. Improved socio economic conditions of rural consumers

The following benefits are observed in some of the feeder segregation projects:

a. Reduction in line losses
b. Improved financial condition of discoms
c. Improved transparency in subsidy distribution
d. Ground water resource management

Feeder segregation may be envisaged with one or more objectives and accordingly the project should be customized. Projects for feeder segregation should be taken up after conducting a cost benefit analysis.

For the purpose of Cost benefit analysis the following tests are recommended:

a. Total Resources Cost (TRC) Test
b. Ratepayer Impact Measure test (RIM) Test
c. Life-cycle Revenue Impact – RIM (LRIRIM) Test and
d. Societal Cost (SC)Test

Most discoms in India do not realize the average cost of supply through sale of power to domestic and agricultural categories even after including the subsidy received from the state government.

The most important parameters that influence the economic viability of feeder segregation projects are the following:

a. Reduction in the line losses. Feeder segregation projects may not be viable unless the reduction in the lines losses achieved after implementation of the program is more than five percentage points. Such a substantial reduction is possible only in cases where the base line losses in distribution system are significant (typically more than 15%).

b. Revenue realization (including subsidy) per unit from domestic and agricultural categories. Feeder segregation projects may not be viable unless the discom realizes at least 80% of the average cost of supply through tariff and subsidy. This is a pricing challenge that most discoms need to address consistent with the National Tariff Policy.

The threshold condition proposed is that the project pass the TRC test and the RIM test. Projects that do not pass the TRC and RIM tests may still be taken up if the following conditions are met:

a. Project passes the TRC and RIM tests under an assumption that about 80% of cost of supply is realized through tariff and subsidy received for the subsidized categories (domestic and agricultural categories)

b. Significant positive socioeconomic impact is expected in qualitative terms

c. Project passes the SC test and

d. Impact on the tariff as seen in the LRIRIM test is reasonable

1.8 Recommended framework for a rollout of a national level program

It needs to be underlined that there is no standard solution or method for feeder segregation and states should come with a feeder segregation plan based on their felt needs and specific requirements.

Discoms may select feeder segregation projects or an alternative project focusing on agricultural loads suitable for its environment. However, a necessary condition could be that the project should pass the cost benefit analysis test specified by the central government.

Because of the wide variation in the requirements of different regions in the country, it is recommended that the program should adopt a bottom-up approach rather than a top-down approach. While the Centre can put in place guidelines, each discom will have to come up with its individual approach. Further, it is recommended that the project implementation also should be decentralized and taken up by the discoms and not by a state level body.

It is also recommended that the following features should be made mandatory for projects assisted by the central government:

a. Conducting a base line study in all the feeders before implementation of the project to establish authentic base line data.

b. Project management units for effective supervision of the feeder segregation projects.

c. Establishment of an effective monitoring and evaluation framework

d. Participation of discom staff in every phase of the project to ensure knowledge transfer from the implementing agencies.

1.9 Prioritization and Phasing

A phased approach should be adopted at the national level to prioritize the agriculture intensive states.

Phase 1- High Priority States: The states with higher agricultural sale than a suitable norm (say 10% of total consumption) could be given higher priority as feeder segregation would result into more benefits in such states. Central government could formulate the norm for deciding on the Phase I states.

Phase 2 -Other States: The states with lower agricultural sales could also be considered for assistance if they so desire.

1.10 Collateral Programs required to achieve the desired benefits from feeder segregation

1. A minimum metering infrastructure is essential to assess and derive the desired benefits from feeder segregation as listed below:
    a. Metering at feeder level - Metering at feeder level would help the utility in effective energy audit thus identifying high loss feeders and LT lines
    b. Economical remote metering infrastructure for DTRs or External meters for all customers on the lines of pillar box metering done in Punjab for non-agricultural customers could be one of the prerequisite for feeder segregation to facilitate, identify and avoid any type of power pilferage in the system
2. For discoms to obtain financial benefits from feeder segregation, one or more collateral programs may have to be implemented in addition to the feeder segregation program. These collateral programs will help in reduction of commercial and/or technical losses. These are described separately.
3. There is no standard model for feeder segregation. Each discom has to design and implement a model to suit its specific requirements. The broad options available for feeder segregation are

a. Virtual segregation – Virtual segregation through switches limits duration of three phase supply to the feeders as most of the irrigation pumps run on three phase supply. For the remaining duration, only single or two phase supply is given on the feeders for supply to non agricultural rural feeders. While it does not requires massive infrastructure investments it has limitation such as (i) possibility of unauthorized conversion of two phase to three phase for usage of small pumps for irrigation, (ii) constraints on non agricultural consumers who need continuous three phase supply in the villages, including water supply schemes, cottage industry, heath clinics, schools etc (iii) poor power quality and safety

b. Physical segregation – Physical segregation of agricultural and non agricultural lines will require the laying of new lines. In effect, every village will have a pair of supply lines. It requires significantly higher infrastructure investments and separates agricultural consumers completely from the other rural consumers. However, there are important benefits such as better quality of supply, easier operation and better safety.

1.11 Alternatives for enhancing rural supply.

1. The following are the different options available to achieve better supply to the rural sector.

a. 100% metering of all customers – Ideally 100% metering to consumers of all categories would empower the utility to fully account for the energy supplied, and thus make subsidy payments more transparent. Further, paying consumers would regulate their consumption resulting in better load management and improved loss control. Due to challenges in implementing 100% metering and the consequent need for restricting supply hours to agricultural consumers, feeder segregation is seen as a pragmatic solution to separate supply to agricultural and non-agricultural consumers and ration supply to agricultural consumers.

b. High Voltage Distribution System - Is distribution of power at a higher voltage (11 kV) to the consumer, it uses smaller transformer of 40 kVA, 25 kVA and 15 kVA to supply power to one to three consumers. As line losses are lower and line theft is not easy in high voltage lines, it helps in reduction of losses

c. Advanced Metering Infrastructure (AMI) – Is based on smart meters which can collect time wise consumed units and also send the same data remotely. AMI ensures capturing consumption pattern and enhances the efficiency of the energy audit.

d. Solar pump sets for agricultural customers – Distributed generation such as solar pump sets can provide power to remote areas where costs of line laying and maintenance are significant and solar radiation is reasonably high. It will provide around 8 to 10 hours of

power supply in day time. Distributed generation would save the line losses and the need for distribution network. The benefits from solar pump sets are maximized in remote areas where laying distribution network would be very expensive.

e. Demand Side Management – Demand Side Management (DSM) initiatives such as installation of capacitors and usage of energy efficient pump sets, are difficult to implement as the consumer is not incentivised in a free power regime. However, it is essential that a sustainable solution to this program is implemented.

2. Scope of the Study

2.1 Scope of the study

The scope of the study undertaken by the Sub-Group (SG) is detailed below:

1. Review and learning from past experience, literature available, visits of the SG

1.1 Key learning from the past experience in different states based upon available literature reports / analysis from various organisations/ agencies

1.2 Analysis of the past experience in feeder segregation of selected states based upon the SGs review in the states of Punjab, Gujarat, Telangana and Andhra Pradesh. Learning from the visits of the SG to villages in the three states of Gujarat, Punjab and Telangana where the feeder segregation program has been implemented either wholly or on a pilot basis. The analysis was based on the following parameters:

(i) Objective for undertaking the feeder segregation program.

(ii) Implementation Structure and phasing of the program.

(iii) Program funding.

(iv) Economic and social benefits derived from the program.

2. Need for feeder segregation and evaluation of other options

2.1 Analysis of stated and unstated objectives of feeder segregation in India

2.2 Options beyond feeder segregation: Total metering and 24x7 power supply to all

2.3 Under what conditions should feeder separation be undertaken?

3. Cost benefits analysis of feeder segregation and implementation aspects

3.1 Quantification of costs and benefits.

3.2 Cost benefit analysis.

3.3 Implementation aspects: Options available.

4. Measures for effective metering

4.1 Need for effective and robust metering system in India 4.2 Measure for effective metering

5. Recommendations

5.1 Recommendations were based upon technical feasibility, economic analysis and pragmatic considerations.

2.2 Data, approach and methodology

The following data has been used by the subgroup in the analysis.

(i) Primary information from the states of Gujarat, Punjab, Andhra Pradesh and Telangana provided by the utilities to SG on feeder segregation and collected from the public domain sources.

(ii) Secondary sources in the public domain for other states. Though the other ERCs had been requested to provide relevant state data, no information was received from except from Sikkim ERC.

(iii) Interaction with stakeholders in relevant states for validating some of the assumptions made.

Based on the above sources the SG analyzed the past experience of different states focusing on Gujarat, Punjab, erstwhile Andhra Pradesh, Rajasthan and Haryana. The aim was to leverage the lessons learnt in the past to while recommending an effective and efficient framework for a national level implementation of the feeder segregation. The need for feeder segregation was studied and the circumstances that may necessitate the segregation are identified. The SG evaluated the quantification of the costs and benefits done by distribution companies in the past and reviewed the economic analysis conducted by the distribution companies considering the key parameters such as payback period and IRR. The SG also evaluated alternatives such as total metering and 24x7 supply and discussed with relevant stakeholders for identifying the limitations and other relevant issues.

This report presents the findings and the recommendations of the sub-group based on technical requirements, economic analysis and pragmatic considerations.

3. Review and learning from past experience

3.1 Analysis of the past experience in feeder segregation of selected states (Punjab, Gujarat, erstwhile Andhra Pradesh, Rajasthan and Haryana)

Subsidization of the electricity consumption by agricultural customers by state governments started in the 60's with the Green Revolution. Today, almost all agriculture intensive states subsidize electricity to agricultural customers either fully or partially. The subsidy is required to be met completely by the state governments but often delayed and partial release of subsidy places an unplanned and unbudgeted burden on the utilities. This constraint often incentivizes utilities to restrict power to non-remunerative agricultural pump sets mostly to about 8 hours a day. Since in some of the states, same three phase line feeds both pump sets and rural households, an unintended consequence of such rationing is that non agricultural consumers in villages are also restricted to 8 hours of three phase supply a day. Some states provide single phase supply to villages when AP supply is switched off. Such limited power supply while constricting the provision of public services in the rural areas including health, education also inhibits the growth of cottage and tiny industries in the rural areas. The segregation of the AP & non-AP supply to villages provides an opportunity for the utilities to supply 24 hours 3 phase power to the rural sector while maintaining a limited supply to the feeder supplying pump sets. In this chapter, the experiences of key states that took up segregation of feeders is reviewed.

Gujarat opted for virtual segregation prior to 2003 and physical segregation through the Jyoti Gram Yogna scheme subsequently. In Punjab, the work of segregation of agricultural feeders was initiated in 1996-97 departmentally. Subsequently segregation projects were executed on turnkey basis in 2003-04. Erstwhile Andhra Pradesh initially adopted virtual segregation and later took up a pilot for physical segregation in 2010 to access the befit of physical segregation. Haryana and Rajasthan have chosen physical segregation and feeder renovation program (FRP) respectively.

Gujarat incorporated the feeder segregation program into its rural development program as improvement of the ground water level by inhibiting wasteful consumption of water was also seen as an objective of the feeder segregation program. The primary objective of feeder segregation in Haryana was to reduce the distribution losses, while for Rajasthan it was undertaken to improve the quality and hours of supply to consumers.

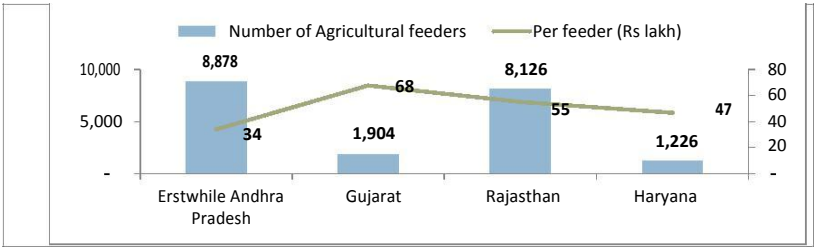
The World Bank report- Lighting Rural India (February 2014) has reviewed the investments in feeder segregation projects made by four states – Gujarat, Haryana, Rajasthan and erstwhile Andhra Pradesh. It was observed that total investment in the feeder segregation scheme was highest in Gujarat on per

feeder basis (Rs 68 Lakh per feeder) whereas Haryana incurred maximum amount on the basis of per kilometer length of distribution lines (Rs 3.3 Lakh per kilometer).

Project cost for different states cannot be directly compared due to significant differences in the project scope and the year of execution. Different states took different methods such as virtual segregation, physical segregation and integrating feeder segregation with rural development program and water resource management programs. Thus the costs incurred vary across states.

The graphic below captures the capital investment in these states.

Figure 1: Capital investment of feeder segregation in different states



Source: World bank report: Lighting rural India - Experience of Rural Load Segregation Schemes in States (February 2014).

In Punjab, one of the feeder segregation projects taken up departmentally required material costing nearly Rs 211.55 Crore for segregation of nearly 848 mixed feeders[2]. The cost of feeder segregation excluding the cost of manpower is nearly Rs 24.95 Crore per feeder.

The experiences of the four states – Gujarat, Punjab, Telangana and Andhra Pradesh is discussed in the following sections. The implementation details provided by the discoms in these states is presented in annexures 2,3 and 4.

3.2 Experience in Gujarat

Jyoti Gram Yojna (JGY) was initiated in 2003 covering all the 18,000 villages and 16,000 hamlets. Before implementation of JGY, mixed feeders were supplied three phase power supply for about 8 hours and two phase supply was provided in the remaining time. Reliability and quality of this supply was also questionable. Main objective of JGY programme was to provide 24x7 three phase quality power supply to non-agricultural rural consumers. JGY also aimed at optimized use and conservation of ground water resources by way of limited three phase power supply for a period of 8 hours through a roster system. To ensure the continuous single phase supply to people living in farmhouses away from the village site, specially designed transformers have been installed to tap power from the agricultural feeder.

[2] Source: PSPCL

Different studies have been conducted by organisations like Indian Institute of Management, Ahmadabad (IIM-A), Institute of Rural Management, Anand (IRMA) and Centre for Environmental Planning and Technology (CEPT). These studies have highlighted numerous social benefits the scheme has provided to non-agricultural rural consumers like better life style, improved education facilities, development in small industrial activities like polishing, furniture making, agro processing, social activities etc.

JGY program was implemented with a cost of Rs 1,290 Crore which was funded mostly by a grant of Rs 1,100 Crore given by the Government. The balance was sourced from institutions such as Asian Development Bank (ADB), the APDRP, MLA Grant, public participation and contributions through the allocation in the 11th/12th Finance Commission's grants . JGY was completed in 4 years and infrastructure erected during the program is as follows:

i. 56,308 KM of HT lines
ii. 22,146 KM of LT lines
iii. 18,724 new transformers
iv. 17, 28, 344 nos. of poles

3.3 Experience in Punjab

Agricultural pumpset (AP) consumers constitute a total of 11.95 Lakh out of a total consumer base of 78.85 Lakh in Punjab, who are catered through a 9,373 nos 11kV feeders, The AP consumers spread over 12,428 villages and are fed through 4,660 dedicated 11kV AP feeders and 295 mixed load 24 hrs feeders in sub-mountainous area. The share of AP consumption is 25.5% (9,296 MU) out of total power consumed in Punjab (36,383 MU).

3.3.1 Feeder Segregation Project in Punjab

Before 1996-97, the non-AP connections were being fed three phase supply through mixed rural feeders supplying power to both AP and non-AP consumers for 6 to 8 hours per day while single phase supply was provided for the remaining period to non-AP consumers. As the quality of supply on these feeders was very poor, segregation of these mixed feeders was taken up in the year 1996-97 with an objective of providing 24 hours supply to rural households, commercial establishments and industries besides measuring the pumped energy to AP sector through sub-stations end meters. Out of these, about 2,000 mixed load feeders were segregated into pure AP and non-AP feeders during the period 1996-97 to 2003-04. As a parallel experiment, work on 900 mixed load feeders was undertaken for virtual segregation by erecting 4th wire whereby after restricted 3 phase supply on these rural feeders 2 phase supply could be provided to non-AP loads through 4th wire. This experiment of virtual segregation did not prove successful and was abandoned due to high accident rate and failure to record pumped energy to AP sector. These 900, 3-phase 4 wire feeders were physically segregated during the period 2008-09

to 2013-14. As a result of physical segregation, now all non-AP loads in most of the villages of Punjab are provided power supply through UPS feeders (Urban Pattern Supply feeders). The only exception is Kandi (sub-mountainous) area which is being fed through 245 non segregated mixed load 24 hours supply feeders. DPRs to segregate the AP and non-AP load are under consideration of REC.

The main benefits of feeder segregation observed in Punjab were:

- Rural household, shops and industry are receiving 24x7 three phase quality power supply thereby improving the standard of living in the villages
- Greater flexibility in grid operation
- Correct assessment of AP consumption
- Facilitated identification of high T&D loss areas
- Growth of rural economy through agro based industry
- Helped in crop diversification by encouraging horticulture/floriculture & high tech farming
- Reduced no load losses on AP feeders

However, post segregation, it was found that UPS feeders had very high technical and commercial losses in the range of 50%-70%, primarily due to increased supply hours to UPS feeders and poor quality of distribution system. Besides, while the power supply hours increased from 6-8 hours to 20-24 hours, the quality and reliability of supply on the UPS feeders was not good. To address these issues, other projects had to be taken up.

3.3.2 Post Feeder Segregation Projects in Punjab

It was realised in Punjab that feeder segregation alone was not enough. After segregation the supply to non-AP loads increased thereby increasing the total line losses in energy terms (mu). This hit the discom financially and, therefore, loss reduction projects were taken up following the feeder segregation project. On AP feeders, HVDS/less LT project is under implementation while on non-AP feeders low cost T&D loss reduction program is being executed.

a) HVDS/less LT project for AP Feeders:

To reduce technical losses on AP feeders a project to convert all AP connections from LVDS to HVDS was launched in 2005 under a program sanctioned by REC. The aim was to convert the then existing 9 Lakh plus AP connections to HVDS with dedicated transformers for each AP consumer. REC had sanctioned a loan of Rs 4,500 Crore for this purpose. However, due to high cost and incidents of theft of small rating distribution transformers, the scheme has now been re-modelled after converting 2.21 Lakh AP connections (costing Rs. 1502 crore) from LVDS to HVDS (zero LT). PSPCL has now adopted less LT system (maximum LT 150 meters) instead of

zero LT system envisaged under the HVDS program. However, all the new AP connections are being released w.e.f. year 2008 with dedicated transformers with zero LT.

b) Low-cost T&D Loss Reduction Program for non-AP feeders in rural and sub-urban areas: To tackle the problem of high AT&C losses on the UPS feeders numbering 1256 and the sub-urban area feeders supplying 24x7 power to villages and suburbs, it was decided to take up a low cost T&D loss reduction program comprising:

- Shifting of meters outside consumer premises - pole mounted or pillar box
- Replacing bare LT conductor and main/sub mains in the villages with four core XLPE cable to prevent direct hooking of lines
- Upgrading/Replacing 11 kV conductor, adding distribution transformers, load balancing on all distribution transformers
- Providing robust earthing across the system

Benefits of the feeder segregation and post feeder segregation projects in better assessment of AP consumers:

Till 2000-01, AP consumption was assessed on the basis of AP factor worked out through recording of consumption of just 3,220 sample meters which was 0.38% of the then total AP connections. The sample size was increased to about 1 Lakh meters which was about 10% of AP connections by 2011-12 but the reading data was not reliable. Field staff were not taking actual readings of these meters and many meters were reported defective. The AP factor was not credible.

After segregation, all 11 kV AP feeders are being metered at sub-station end and thus the pumped energy data of all AP feeders recorded at grid sub-stations are being collected monthly at PSPCL headquarters through web based application. Same data is then transmitted to the Punjab State Electricity Regulatory Commission (PSERC) every month and agricultural consumption is worked out by deducting distribution losses by the Commission in the tariff order for relevant year, from pumped energy of AP feeders. The pumped energy data is also cross verified from AMR data of about 2,200 feeders available on real time basis. The project to cover AP feeders under AMR was started in 2008-09. About 3,500 AP feeders are covered under AMR project. AMR compatible meters have been installed on all AP feeders but due to some problems with communication hardware, data for about 2,200 AP feeders are available. All AP feeders would be covered under AMR project during the next one year. After assessment of AP consumption on pumped energy basis, the agriculture consumption has reduced by more than 13% resulting lowering of ARR by about Rs 400 to 500 Crore per annum.

Future initiatives required to be undertaken:

c. DSM measure of installation of 4-star pump motors for all new AP connections has been adopted since 2011-12. Besides a project to replace all old inefficient pump sets (average efficiency 33%) with5- star rated pump sets (average efficiency 56%) through ESCOs has been suggested for implementation by the state DISCOM.As per estimates of EESL, the cost of replacing old 10 lac pump sets across Punjab is likely to be Rs. 4,500 crore and the execution can be spread over 6 to 7 years. The recovery period of the project is 3 to 4 years. For payment security of the investor, an Agricultural DSM Revolving Fund (ADRF) under regulatory oversight is proposed to be created with a contribution of Rs. 120 crore from the Govt of Punjab (2.5% of annual subsidy of about Rs 5000 crore) thereby attracting a private investment of Rs. 600 crore enabling replacement of 1.5 lac pump sets annually.

d. The DISCOM has been directed to implement AMR project for all AP consumers along with LT capacitor on each motor through outsourcing. This AMR – cum – LT capacitor project to be executed by private parties may prove to be a zero cost solution to attain 100% metering and reading of AP consumers.

3.4 Experience in Telangana

Telangana State Southern Power Distribution Company Limited (TSSPDCL) has jurisdiction of 5 districts of Mahabubnagar, Nalgonda, Medak, Ranga Reddy & Hyderabad. Excluding Hyderabad, there are significant agricultural loads the remaining four districts. Before segregation, three 3 phase supply was provided to agricultural consumers for 7 hours and single phase supply was extended in night hours (from 6 pm to 6 am). Pilot scheme of segregation of agricultural loads from 11 kV rural feeders was planned in 5 Mandals.

This feeder segregation scheme was implemented with the following objectives. :

a. Increase in industrial activities in rural area by providing 24x7 three phase supply and thus decrease in labour migration which was endemic in some of these districts.

b. Improving the quality of life in rural areas by providing continuous supply to educational, health , public water supply institutions..

The results of the pilot programme were :

a. Increase in metered sales in between 1.2% to 3.17%

b. No significant growth in industrial connections.

c. Aggregate losses in these five mandals rose after feeder segregation was implemented from 8.07% to 10.10%

In its interaction with the SG, Northern Power Distribution Company of Telangana Limited (TSNPDCL) stated that in his view that, this scheme involves significant financial commitment which may not generate adequate financial returns. Presently it is able to provide 24x7 single phase supply to all non agricultural consumers and limited hours of three phase supply to its agricultural consumers. It provides 3 phase 24 hour supply to industry in rural areas based upon demand by laying a direct line from the substation. The utility has taken up feeder segregation program on a pilot basis for 48 feeders under its jurisdiction. No significant commercial or industrial growth has been noted in feeders where segregation has been implemented. Further TSNPDCL has also mentioned that it is not able to provide 24x7 three phase power to consumers due to supply constraints. According to TSNPDCL, the challenges faced in implementation of the feeder segregation program are listed below.

1. Huge investment is required for feeder segregation without adequate returns
2. There is a space constraint in the sub stations due to non availability of additional bays for the duplicated feeders
3. Laying of Duplicate feeders may face right of way objections
4. It is not possible to supply 24x7 three phase supply in a power constrained environment which Telangana presently faces.

TSNPDCL has suggested that a better alternative for feeder segregation is increasing the density of substations and implementing compact substations. Utility has listed the following benefits of compact substations (increased density of sub-stations) in its presentation to SG,

a. 33/11KV ratio increases reducing losses with increased 33KV line when compared to 11KV
b. Length of 11 KV line reduces
c. Improved Voltage profile
d. Farmers will get benefited with minimal failure of motors, better discharge of water
e. Reduction of breakdowns
f. Improved reliability
g. Right of way problem is avoided to the maximum as villagers welcome construction of substations in their villages with the perception of 24 hrs supply and better voltage profile
h. Any disturbance due to interruptions is confined to a small area only

For the above reasons, the Telengana discoms therefore felt that implementation of the feeder segregation was not a high priority initiative for them. They wish to take up other initiatives such as HVDS implementation, increasing density of sub-stations/Compact sub-stations in the place of feeder segregation.

3.5 Experience in Andhra Pradesh

In Eastern Power Distribution Corporation Limited (APEPDCL), all the urban consumers and HT services are provided 24 hours power supply. Agricultural consumers are given 7 hours three phase power supply in a day. Non-agricultural rural consumers are being supplied power for 17 hours in a day. Single phase virtual segregation is implemented for segregating agricultural and rural consumers. APEPDCL has also implemented pilot feeder segregation scheme for 48 feeders in 6 Mandals spread across 5 districts with a cost of Rs.15.51Crores. For scaling up the feeder segregation project across the discom spread across 5 districts, APEPDCL has prepared a tentative proposal to a tune of Rs.546.90 Crore.

Southern Power Distribution Corporation Limited (APSPDCL) has completed segregation of Rural and Agriculture loads in Eight (8) Mandals in each district of Krishna, Guntur, Prakasam, Nellore, Chittoor, Kadapa, Kurnool and Ananthapur during 2011 at a cost of Rs. 26.73 Crore for 53 numbers of feeders as a pilot project.

The following are the findings from the pilot study:

a. With the segregation of Agricultural feeders and erection of separate 11 KV lines for 24 hours three phase supply, the line losses have reduced

b. Due to availability of three phase 24 hours supply, there is a growth in the number of industrial services.

c. More number of consumers opted for three phase services.

d. The non agricultural rural feeders has seen a substantial growth in consumptions

With the erection of more feeders, right of way (RoW) problems are observed. RoW problems are identified as the key constraint in APEPDCL.

High Voltage Distribution System:

Both the discoms in Andhra Pradesh have implemented HVDS. In APEPDCL, Out of 1,99,274 agricultural consumers, approximately 1.60 Lakh agricultural consumers have been covered under HVDS implemented at a cost of Rs. 570 Crore. For the balance 0.40 Lakh agricultural services the tentative cost to implement HVDS is about Rs. 294 Crore. In APSPDCL, out of 11,55,237 agricultural services approximately 6 Lakh agricultural services Are already covered under HVDS implemented at a cost of Rs.2,000 Crore. For the balance 5.50 Lakh agricultural services the tentative cost to take up HVDS is Rs.2,600 Crore.

With the implementation of HVDS the following benefits are observed:

a. The LT line losses have been reduced and power supply is more reliable
b. Theft of Energy i.e. hooking to the LT lines has been avoided.
c. The DTR failure has been reduced to the minimum.
d. Satisfactory voltage levels are maintained and pumping efficiency has increased.
e. Due to increase in voltage levels burning of motors has been avoided. Energy audit conducted before and after HVDS shows that the losses after implementation of HVDS system is 3 - 10% and 10-14% in APEPDCL and APSPDCL respectively.

3.6 Review of available literature on feeder segregation

3.7 Objective of past feeder segregation projects

There are a number of objectives of feeder segregation. These include:

1. To provide continuous three phase supply to non agricultural consumers (domestic, agro business etc.) in the rural areas to ensure better quality of life as well as to catalyse rural industry and generate employment.
2. Reducing power pilferage, line losses with resultant technical and commercial benefits to the utilities.
3. Improving load management with better quality of supply to pump sets
4. Formally limiting the supply of power to the non-remunerative agricultural sector and thus limiting losses in states where subsidy is not fully disbursed or delayed.

Forum of Regulators (FOR) presentation on 'Feeder segregation and Agricultural Loads' (August 2014) also recognises the fact that, different states may have different objectives for feeder segregation. The objectives of different states are listed in the table below:

Table 4: Objectives of different states for undertaking feeder segregation

States	Erstwhile Andhra Pradesh	Gujarat	Rajasthan	Haryana	Punjab
Objectives of different states for adoption of feeder segregation	24 hours 3 phase supply to rural consumers to bring socio-economic benefits	24x7 three phase supply to non agricultural rural consumers	Providing increased supply to rural consumers and curtail losses	Regulate supply to agricultural consumers, ensuring power supply to rural domestic consumers, improving distribution voltage and stabilizing distribution system	24x7 supply to non agricultural rural consumers Correct assessment of Agricultural consumers Flexibility in grid operations Growthof rural economy

3.8 Approach of different states towards feeder segregation

The approach followed by different states as described in various reports published on feeder segregation is explained in this section.

World Bank Report.

World Bank in its report on 'Lighting Rural India: Load Segregation Experience in Selected States' (February 2014) notes that at present most agricultural consumers are paying less than one –tenth of the average cost of supply of power. The report further indicates that agricultural subsidy is higher than the expenditure on health and rural development for some of the states. To limit the subsidy and avoid wastage of precious ground water, states resorted to limiting the power supply to feeders supplying to agricultural feeders. Such curtailment of power has adversely impacted the rural population connected to such feeders, limiting their social and domestic development. This report notes that rural feeder segregation is proposed as a practical solution for this problem so that non agricultural rural consumers are provided better access to electricity.

The approaches adopted by the different states are summarized in the table as follows:

Table 5: Approaches adopted by the different states

States	Erstwhile Andhra Pradesh	Gujarat	Rajasthan	Haryana
Approach adopted by different states for adoption of feeder segregation	Virtual segregation (2001-05) Pilot for physical (2010-ongoing)	Virtual segregation (existed till 2003) Physical segregation through JGY (2003-06)	Virtual segregation on all rural mixed feeders (2005-ongoing) Supply by existing feeders is restricted through roster switch to provide 3 phase to agricultural consumers during supply hours and single phase for the balance hours	Physical segregation (2006-10)
Technical system architecture	Stand-alone	Stand-alone	FRP was integrated with other system strengthening techniques like HVDS, DT metering etc	Stand-alone

This report has analyzed effect of feeder segregation in erstwhile Andhra Pradesh, Rajasthan and Gujarat. Several findings on the approach of different states from the reports are discussed below,

1. Each of the state has taken a different approach for the feeder segregation. While Rajasthan undertook virtual segregation, Gujarat incorporated the program into with its rural development program simultaneously and addressing issues relating to the depletion of the water table.
2. Project cost in different states cannot be directly compared due to significant differences in the project scope. As explained earlier different states took different methods such as virtual segregation, physical segregation and integrating feeder segregation with rural development program and water resource management programs. Thus the costs incurred vary across states.
3. Except for Rajasthan no separate framework was developed and feeder segregation was done in a part of routine business. Rajasthan has developed a framework, treating feeder segregation as exclusive task where as other states has integrated it with their larger programs of infrastructure strengthening.
4. Gujarat and Rajasthan did a pilot project before going for a statewide project. Haryana implemented it state wide in the first instance. Andhra Pradesh and Telangana have taken up pilot projects but are yet to scale up the project to the state level.
5. None of the states has included remote metering or advance metering as a part of project.
6. Evaluation and monitoring of project execution and impact evaluation has not been undertaken in a consistent and comprehensive manner in any state. Baseline data studies were not conducted prior to load segregation in any state, and development of an MIS tool to measure and monitor agricultural consumption in rural areas had not been envisaged as part of the schemes.
7. Segregation helped significantly in reduction of losses and improved quality of supply. The survey of customers in Gujarat has showed hours of power supply has improved and low voltage problems have decreased.
8. The economic and financial effect of feeder segregation is not positive in all of the states for which study has been under taken. For example Gujarat has managed to control the subsidy and financial losses, while overall financial losses and subsidy in Rajasthan continue to increase even after feeder segregation.
9. The study was unable to establish impact of feeder segregation on subsidy transparency due to lack of data at feeder level.
10. The study established significant improvement in socioeconomic parameters front as a result of feeder segregation.
11. Feeder segregation is not a onetime investment and further investments in consumer indexing; remote metering and automated data analysis are required to leverage the benefits.

Apart from above major findings, study emphasized on the fact that there are no standard solutions for feeder segregation and a state has to analyze its specific needs and requirement before implementing feeder segregation.

Madhya Pradesh

Feeder segregation projects have been undertaken by the Madhya Pradesh discoms. As nor primary information was available, the websites of the relevant discoms were consulted which provide a brief of the objectives, key factors and the key benefits of feeder segregation. Some of the key benefits include reduction in AT&C losses and DT failures, improved voltage profile, control on power supply to irrigation pump sets.

The Project Management Consultant (PMC) managing the feeder separation project for Madhya Pradesh Madhya Kshetra Vidyut Vitaran Company Ltd. (MPMKVVCL) in the write-up on 'Rural Feeder Segregation –Overview', advocates the strengthening of power distribution sector through feeder segregation calling it last mile of the sector.

The discom supplies power to 16 districts of Madhya Pradesh. Currently, all agricultural pump-sets and all other users in the rural areas of discoms' jurisdiction are being served through mixed 11 KV feeders. The paper recognizes the effect of limited and poor supply on different growth indices such as health care, education and income sources. Details of the Asian Development Bank (ADB) funded program for parallel feeder segregation in its area to provide reliable supply to the domestic and other nonagricultural consumers in the state have been provided in the note.

Bihar

Bihar State Electricity Board (BSEB) has recognized various benefit of feeder segregation and provided a brief roadmap for feeder segregation in the state in its paper 'Dedicated feeder for agricultural – A Flagship Program under Krishi Road Map (Rainbow revolution)'. The paper recognizes that the share of agriculture in the electricity consumption (5.83%) is very low in the state. The state's per capita power consumption (778.71units) is well below the national average. The paper outlines the state's program for rural feeder segregation to enable agricultural feeders to be provided with quality supply for limited hours and non agricultural feeders can be provided reliable power for a longer period. According to the paper, the objective of the segregation is to measure and control power supply for irrigation purpose and to provide reliable power to rural households and agro based industries. The salient features of the schemes are provided below,

1. Separation of feeders
2. Deployment of distribution transformers close to agricultural pumps

3. Asset mapping, GPS survey and strengthening of distribution network

The program envisages installation of about 1,000 dedicated feeders supplying power to more than 19 Lakh agricultural consumers. The key benefits of the scheme as stated in paper are uninterrupted electric supply to non agricultural rural consumers, better energy accounting and load curve flattening.

3.9 Program design and implementation aspects of past projects

The feeder segregation projects in various states were designed based on the local conditions and defined objectives. The implementation of past project had significant differences. The design and implementation aspects in various states are discussed below.

FOR report on ' Loss Reduction strategies '

Forum of regulators (FoR) in its report titled 'Loss Reduction Strategies (September, 2008)' has recommended segregation of feeder for agriculture supply, especially in states where the proportion of supply to agriculture sector is substantial, as a remedy for the high AT&C losses.

This report discusses different feeder segregation programs carried out in different states under system stranding exercise. Some of the schemes discussed in details in the report are detailed below,

1. Example of virtual segregation: Feeder Renovation Program (FRP) of Rajasthan

Prime objectives of the program were,

i. Reduction of distribution losses on 11 kV feeders to a level below 15%
ii. Better operating cycle of DTs
iii. Improvement in quality of power supply and make it interruption free
iv. Availability of 24 hours domestic and non domestic single phase supply in rural areas
v. Investment in technical interventions for preventing theft of electricity and reduction in commercial losses

vi. Segregation of domestic and agricultural supply system

The report notes the following steps which were taken in Rajasthan as part of the feeder segregation program

i. Segregation of urban and industrial feeders from rural feeders
ii. Installation of small DTs for supplying agricultural consumers
iii. Segregation of Single Phase Domestic & Non Domestic Connections from Three Phase Agricultural & Industrial Connection by installation of Single Phase Transformers.
iv. Identification of high loss feeders.

2. Example of physical segregation:

The FOR Report also provides a brief about 'Jyoti Gram Yojna' of Gujarat, which has been detailed earlier.

The report also incorporates Central Electric Authority (CEA) presentation on 'Innovative methods of Power supply to rural consumers'. This presentation has noted various techniques adopted by different states for supplying reliable quality power to the rural consumers in states like s like Gujarat, Rajasthan, erstwhile Andhra Pradesh, Karnataka, Punjab and Haryana. Some of the these steps include:

i. Implementation of feeder segregation
ii. Programmable logic Controllers (PLC) used to control supply power to irrigation pumps in Karnataka.

FOR's working group on metering issues has also emphasized need of segregation of agricultural feeder in its (August, 2009) report.

The brief summary of basic features of the schemes followed by different states is provide in the table below. The summary is prepared based on the World Bank report titled 'Lighting Rural India: Load Segregation Experience in Selected States' (February 2014) and information provided by PSERC /PSPCL. It is to be noted that there are several differences in the implementation and design aspects in various states mainly because of the differences in local conditions.

Table 6: Basic features of the schemes adopted by different states (Next Page)

Particular	Erstwhile Andhra Pradesh	Gujarat	Rajasthan	Haryana	Punjab
Program Planning	• Draft DPR prepared. • Administrative feeders selected at Mandal level and envisioned benefits not included in DPR	• DPR not prepared. • Cost of scheme was estimated sub division level and approved by respective Discom	• Feeder-wise DPR prepared. • Percent IRR: 22.7% • Initially scheme prioritized high loss feeders and later implemented on all rural feeders	• Sub division specific DPR. • Percent gross returns: 27.75 • Cost benefit analyzed through gross percent returns	• Feeder wise/Circle wise DPRs were prepared. • Cost benefit analysis of the schemes executed on turnkey basis was prepared. • The feeder segregation project was followed by HVDS/Less LT and Low Cost T&D Loss Reduction programs
Procurement Strategy	• Partial turnkey for physical segregation • Discoms procure VCBs, DTs and HT and LT conductors • Balance by contractor	• All material by former Gujarat Electricity Board	• Typically partial turnkey • Discoms procure VCBs, DTs and HT and XPLE conductors • Balance by contractor	• Turnkey contractor for turnkey works • In house management for labor contracts	• Work was carried out both departmentally & on turnkey basis
Institutional Framework	• Pilot managed through routine business perations	• No scheme specific plan for execution	• Circle head as Project Managers	• Discoms planning and design cell for planning, awarding	• CE level officer was responsible for monitoring,

Particular	Erstwhile Andhra Pradesh	Gujarat	Rajasthan	Haryana	Punjab
	• Framework for complete plan yet to be decided		• Junior engineers as managers of feeders	contract and project execution	awarding/ implementation of the project
Project Owner	• Distribution Utility	• State Government	• Distribution Utility	• Distribution Utility	• Distribution Utility
Financing arrangements	Pilot funded by Utilities Full scale project funding not finalized	Initially government local body but mainly funded by state government grant	Financial institutions	Financial institutions	• Contribution from village Panchayats, state government, REC & financial institution.

3.10 Achievements and limitations of past projects

Results achieved:

The IIM/IRMA/World Bank reports have established that socio economic development has occurred in the rural areas consequent to load segregation. Further, the reports also recognize that load segregation has also resulted in improvement in the power supply to rural customers by providing reliable power supply.

Planning Commission in its approach paper for 12th plan titled – 'Faster, Sustainable and More Inclusive Growth' has noted feeder segregation as a way to implement water resource management in an effective way. The approach paper states that agriculture accounts for 80% of water needs and there is an opportunity to use control on the power supply as a measure of control on the vicious cycle between free energy and excess use of groundwater.

The approach paper also states that by putting in place dedicated feeders it would be easy to evaluate the load and efficiency of irrigation pumps. Thus it would help in implementing energy efficiency measures in the irrigation sector. The approach paper recognizes the importance of 24x7 supply for improving the lifestyle of rural population which can be achieved through feeder segregation

Limitations:

Feeder segregation cannot be an alternative for effective metering. The Forum of Regulators (FOR) presentation on 'Feeder segregation and Agricultural Loads' (August 2014) notes the following points in this context:

1. Feeder segregation alone cannot help gain the benefits of advanced metering infrastructure such as:
    - Remote monitoring and operation
    - Real time (or near real time) operation of distribution network
    - Implementation of TOD schedules
    - Remote metering of agriculture loads

2. Additional supply of electricity to the agricultural consumers who are willing to pay for additional electricity requirement is not possible with feeder segregation
3. Feeder segregation alone cannot ensure improvement in the quality of supply of power to rural areas since most Indian states are facing a significant gap between demand and supply. The deficiencies in the generation capacity should be addressed in order to provide reliable supply to the consumers.

The presentation on ‘Segregation of Rural Feeders into agricultural and non agricultural loads - A case study of Punjab’ provided by Punjab State Electricity Regulatory Commission (PSERC) notes the issues and opportunities for feeder segregation program. After segregation, it was found that non agricultural rural feeders had very high technical and commercial losses in the range of 50%-70%, primarily due to increased supply hours to UPS feeders and poor quality of distribution system. Besides, while the power supply hours increased from 6-8 hours to 20-24 hours, the quality and reliability of supply on the UPS feeders was not good. To address these issues, other projects were undertaken as detailed earlier. .

4. Findings of the Sub Group

4.1 Work done by the Sub Group

Subgroup was required to make recommendation on 'A Framework to draw up a scheme at national level for feeder segregation of rural and agricultural consumers and suggest measures for effective metering'.SG has collected data from the utilities of states of Gujarat, Punjab, Andhra Pradesh and Telengana for feeders where segregation happened. All of the segregated feeders have shown an increased supply to the non-agricultural rural consumers in respective states. Pilot feeders in Andhra Pradesh which were getting 18 hours supply before segregation are now reported to having been receiving 24 hours three phase supply after segregation. In Gujarat, agricultural consumers who were earlier receiving 8 hours of three phase supply and 12 hours of single phase supply are now restricted to 8 hours three phase supply where as non agricultural rural consumers are receiving 24 hours three phase supply in state. Further, the Gujarat utilities are providing 24 hours single phase supply to the families residing in farms from the agriculture feeders through special design transformers. In Punjab, supply to non-agricultural rural consumers has increased from 22 hours to 24 hours , supply to agricultural consumers has also increased from 6 hours to 8 hours. There is a clear reduction in agricultural sales (9%) in Punjab due to better assessment of agricultural pumpset (AP) consumption on the basis of pumped energy recorded at sub-stations end. Non-agricultural rural sales has seen a 35% increase in the state which is expected to result in improved socio-economic conditions. All of the utilities of Gujarat have seen a decrease in over all losses and increase in agricultural sales in the state. Discoms from Telangana however were not enthusiastic about feeder segregation. As mentioned earlier, they preferred to implement alternative projects such as increasing the density of sub-stations/compact sub-stations and HVDS.

4.2 Analysis of objectives of feeder segregation in India

Feeder segregation can serve as a means for better power supply to rural customers. It can also help in improving transparency in the estimation of subsidies and improvement in financial health of the Discoms.

The main objective of the Feeder Segregation Programme in Gujarat was to provide 24x7 three phase quality power supply to the people living in the rural areas. Based on the successful implementation of the JGY scheme, the main objectives of the Feeder Separation Programme are suggested as:

(i) To provide reliable and quality power supply for the socio-economic development of the rural areas and improve the quality of life for them across India.

(ii) Due to bifurcation of the mixed feeders which supply power to both the agricultural consumers as well as non-agricultural consumer, the agricultural load is to be so managed so as to ensure optimization and conservation of ground water resources

Some of the key benefits that are envisaged from the feeder segregation exercise are as follows:

4.3 Improved power supply to rural consumers

Feeder separation can help in providing reliable and better quality power to the rural customers. Following the experience in selected states, one important objective of the JGY scheme was to provide 24x7 three phase power supplies to rural area, which would help in better social and financial status of rural India. Further, feeder separation programme is a mechanism to facilitate load management by regulating and improving the quality of power supply for agricultural consumers and 24x7 three phase supply for other consumers by way of bifurcation of load into two separate feeders viz., rural (village) feeders getting 24 hours continuous three phase power supply catering to all the categories of consumers in the village such as residential, commercial and industrial consumers and separate agricultural feeder catering to the need of the agricultural consumers. It is expected to help in providing better supply not only to rural domestic customers but also to cottage industries, agro industries and to rural commercial establishments. Some of the key benefits anticipated from the feeder segregation are,

1. Improved quality and reliable power supply to non agricultural rural consumers
2. Better energy accounting and reduction in distribution losses
3. Improved distribution infrastructure and reduced DT failures
4. Supply of subsidised power to entitled agricultural consumers

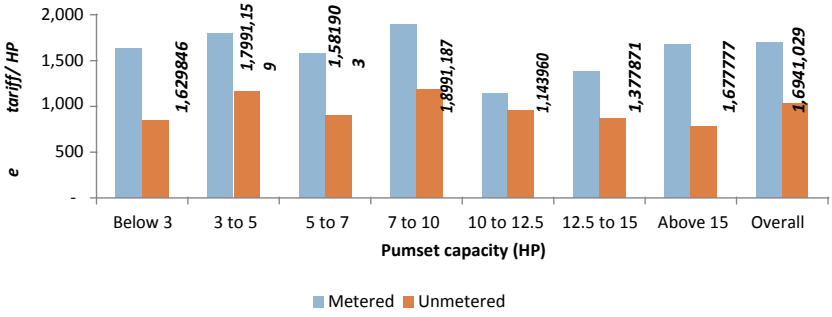
Regular power supply to villages not only enhances its socio economic environment but also rectifies the present bias in supply in favour of urban areas.

4.4 Transparency in subsidy distribution

One of the main concerns in the power sector related to agricultural consumption is the fair allocation of subsidy. The agricultural consumers are allocated subsidized power. However because of mixed feeders it has become difficult to ensure the transparency in providing subsidies to agricultural consumers. Feeder segregation can be one of the possible options to attain clarity and transparency in subsidy distribution. Separate accounting of agricultural feeders is required in order to attain the fair allocation of agricultural subsidy. Among the agricultural consumers, metered consumers should be given better subsidy incentive in order to promote metering among the agricultural consumers. Gujarat Electricity Regulatory Commission (GERC)[3] has observed that the average tariff paid by the metered consumers (monthly/ bimonthly bills) per unit of their pump capacity is more than the fixed annual charges paid by the unmetered consumers. This has been shown in the graph as follows:

[3] http://www.gercin.org/newspdf/en_1402056066.pdf

Figure 2: Average tariff paid by metered & unmetered farmers per unit of pump Capacity (Gujarat)

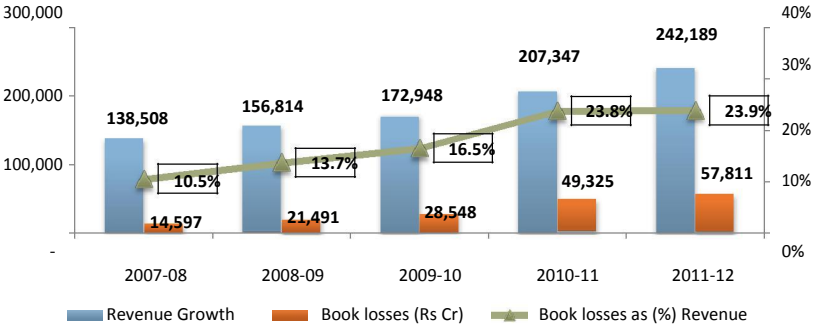


Source: Primary survey undertaken by GERC's consultant in November 2013

4.5 Improved financial condition of Discoms

The most critical function in the power sector – the distribution function has now become the weakest link in the value chain. The declining financial health of the distribution utilities is probably the most critical problem faced by the power sector. Financial distress of these utilities is impacting the quality of the supply to consumers as well as the finances of the generating companies. The revenues of the state power utilities increased at a CAGR of around 15% in the period 2007-08 to 2011-12. However in the same period the book losses have grown by a CAGR of 41%. Figure below shows the year on year book losses and revenue by distribution utilities in period 2007-08 to 2011-12.

Figure 3: Revenue growth vs. book losses of distribution utilities (Rs Cr)



Source: PFC report on performance of state power utilities for FY 2012 and FY 2011

Feeder segregation would be helpful to the utilities in demonstrating transparency in estimation of subsidies and also in better energy management ultimately resulting in positive financial impact. It would also help in reduction of high energy losses.

4.6 Ground water management

Feeder segregation would lead to a better control to power supply to irrigation pumps. Agriculture accounts for 80% of ground water consumption and an unchecked and heavily subsidised power supply leads to unnecessary use of ground water. By feeder segregation such excessive exploitation can be controlled. Together with water conversation options, feeder segregation has led to an increase ground water table in states such as Gujarat. The World Bank report titled Lighting Rural India: Load Segregation Experience in Selected States' (February 2014)[4] observes that there is a 5% marginal increase in the depletion of ground water depleted blocks in Madhya Pradesh.

Reduction in diesel consumption is also a benefit of the feeder segregation. Restricted power supply was forcing certain consumers to use diesel based generators. Increase in supply hours of power would resulting reduction of the usage of DG as alternative source. This would not only result in saving in costly fossil fuels but also reduce pollution.

4.7 Overview of physical segregation of feeders and various alternatives

Physical segregation of feeders and other initiatives are discussed in the following sections.

4.8 Physical segregation

This has been adequately discussed in the earlier chapters .

4.9 Virtual segregation

Virtual segregation is enabled by limiting the three phase supply to feeders for the agricultural hours to limit the usage of pump sets for a specific duration. Feeder is supplied single or two phase supply for rest of the period for usage by non-agricultural customers. Both two phase and single phase virtual segregation requires AB switches to be installed at substation power transformer/DTRs to restrict three phase supply for limited time period. Virtual segregation does not require heavy infrastructure investment but has certain limitations. The major attributes of the virtual feeder segregation are,

1. Feeder is energized in 3 phase mode for limited hours per day and in single phase or two phase mode during rest of the day.

[4] 'Lighting Rural India: Load Segregation Experience in Selected States' (February 2014), World Bank

2. Single phase transformer need to be erected to cater to non agricultural consumers during single phase supply.
3. Additional transformers are not required for two phase supply. Two phase power can be supplied through three phase transformers and thus it does not require additional single phase transformers. But two phase supply can be converted to the 3 phase supply using phase converters and thus it is not very efficient in controlling agricultural consumption.
4. Virtual segregation does not provide 24x7 three (3) phase supply to the villages which is required for good quality of power supply to the villages. Cottage and agro industries in villages may require 3 phase supply.

4.10 Metering for all

In the present circumstances, 100% metering for all consumer categories is an ideal solution to address most of the issues faced in the power distribution sector in India. Implementation of 100% metering specially in the subsidized category is constrained by socio economic and political challenges. Feeder segregation is the second best solution in such a scenario if it ensures limiting agricultural power consumption while providing better quality of power supply to other rural consumers. In such a case, metering should be implemented as under

1. Given the wide geographical dispersal of agricultural pump sets and their respective DTRs, meters with remote data transmitting facility should be adopted.
2. Ideally, metering should be implemented at feeder level, DTR level and consumer level for effective energy auditing. Metering should be supplemented with measures such as taking meters outside consumer premises, Advance Meter Reading (AMR) etc.
3. Energy audit measures such as Advance metering accompanied by limiting the subsidy element to each farmer as per a preannounced norm along with demand side management (DSM) measures such as time of day metering can possibly provide similar results as feeder segregation.

4.11 Implementation of HVDS

The common distribution system in India is Low Voltage Distribution System (LVDS). LVDS employs 3 phase 11 kV feeders which are used with 3 phase spur lines and 3 phase DTRs. This system transforms 11 kV voltage level to 400 Volt. This system includes long low tension lines which lead to high technical and commercial losses. This affects the voltage profile and also performance of the Distribution System. LVDS for agricultural loads results in higher losses because of high load of the pump sets. Both the conductor and transformer are overloaded. The high losses also arise from lengthy lines in the distribution network. Such losses can be improved by strengthening of the distribution system. LVDS can be converted to High Voltage Distribution System (HVDS). In HVDS, power is

distributed through high tension lines and it is converted to LT level at consumer end using smaller transformers. Overloading and mismanagement of load can be restricted.

HVDS would be helpful in providing transparent power supply to registered consumers, since theft at high tension lines is difficult thus hooking, theft and illegal consumption can be significantly reduced.

Improved voltage profile leads to efficient motor usage and lesser motor failures. Quality and reliability of power improves by not only improvement in the voltage but also because only a limited number of consumers are affected in case of any breakdown in LT line. For the implementation of HVDS, phased approach should be followed where a sample of consumers from the high loss or high theft areas should be focused upon and irregular consumers should be regularized.

The key benefit of HVDS is the reduction of technical and commercial losses. Due to the socio-political challenges in various Indian states, feeder segregation programs may not result in loss reduction unless accompanies by HVDS. High capital expenditure is the key limitation of HVDS.

4.12 Solar pump sets for agriculture

Installation of solar pump sets is a relevant solution for supplying reliable and affordable power to the agricultural consumers located at remote locations where either lines have not been laid or where supply is erratic. Agricultural pump sets can be supported with solar panels and battery to utilize solar energy for power generation. Apart from the environmental benefits, solar pump sets generate a coincidence of wants providing continuous supply to the agricultural consumers during the daytime. Supply during the day time may incentivise farmers to grow less water incentive crops. Further, in a scarcely populated and geographically distant area, a solar power plant of appropriate capacity can be installed for supplying power to the agricultural consumers to run their pump sets. Instead of maintaining separate individual distributed solar panels, it would be an advantage to operate plant at single point and distribute power to nearby pump sets.

4.13 Remote metering at DTR level

100% metering at consumer level is a very challenging task in most Indian states. Lack of metering at customers constraints initiatives such as energy audit. DTR metering can address this problem to some extent. By installing remote meters at DTR level, the utility can identify DTRs with high losses and implement possible anti theft measures. DTR metering can be implemented with or without feeder segregation for controlling losses.

4.14 DSM Measures

DSM measures include mandatory installation of energy efficient pump sets for all new AP connections and taking up projects for replacement of old inefficient pump sets with star rated pump sets through

ESCOs. EESL (Energy Efficiency Services Limited), a Government of India (GoI) undertaking has assessed that 170 billion units of energy can be saved if this project is implemented across India..

4.15 Under what conditions should a utility opt for feeder separation

Different states have different objectives to be achieved through feeder segregation. Conditions and situations of particular utility need to be taken under consideration for feeder segregation without treating it as an inevitable solution. Different objectives proposed for the feeder segregation may vary from state to state. These are as follows:

a. ***24x7 supply to non agricultural consumers***- One of the primary objective for feeder segregation is providing 24x7 three phase supply to the non agricultural consumers. With separate feeder for non-agricultural rural consumer, it would be possible for utility to supply 24x7 (subject to the availability of power) electricity to such consumers.

Alternative: Segregation can be selected as one of the options only if metering cannot be adopted as a feasible option. Feeder segregation may not completely address the issues like estimation of losses. In a favorable political and social environment, initiative such as implementation of 100% metering and Advanced Metering Infrastructure (AMI) should be preferred over segregation of feeders. Metered irrigation pumps can be provided subsidized power on the basis of minimum power required for irrigation purpose. Time of day metering can incentivize agricultural consumers to draw power at off peak period.

b. ***Loss reduction***-. The segregation of agricultural and non agricultural load can potentially help in reducing AT&C losses by better estimation of agricultural consumption and relatively better energy audit. However, in practice, several discoms could not achieve loss reduction unless feeder segregation is combined with other measures such as HVDS and improved metering system. For example, feeder segregation implemented alone did not help discoms in Telangana to reduce the losses. However, segregation of feeders with measures like advance metering, taking meter outside and HVDS helped Punjab to curb losses.

Alternative: There are **other** alternatives for loss reduction such as implementation of better energy accounting. Accurate metering at feeder level, DTR level and for non-agricultural customers would help in better energy accounting. HVDS and strengthening of the distribution network would also help in reduction of losses. Schemes on the lines of Restructured Accelerated Power Development and Reforms Programme (R-APDRP) could be adopted for loss reduction. Northern Distribution Company of Telangana State Limited (TSNPDCL) feels that that increasing in density of sub-station/compact sub-station in rural areas would be a more effective way for loss reduction due to increased 33 kV network.

c. ***Rationing of subsidy to agricultural consumers***- In some of the states the objective could be to ration the amount of power supplied to agricultural consumers and hence limit subsidy outgo. By bifurcating the dedicated feeders to agricultural and rural domestic, the subsidy can be rationalized effectively by limiting power supply to agricultural feeders. Currently, due to the supply of power through mixed feeders to agricultural and non agricultural consumers, distribution of subsidy is not transparent.

Alternative: 100% metering to all consumers categories with measures such as taking meter outside consumers premises, AMI and direct disbursement of subsidy to agricultural consumers can be a better and effective alternative even though it does not appear to be a pragmatic solution in the present environment of free power.

d. ***Load balancing***- The segregation of agricultural feeders from the non agricultural feeders would be helpful in load balancing. By optimizing power supply in different time slots to agricultural consumers of different areas, load balancing and load curve flattening can be achieved.

Alternative: 100% metering (with preventive measures) and DSM initiative can help in significant reduction of the load from the demand side.

Discoms supplies major share of power to the farmers during the night (off peak time) due to which farmers keep their pumps running throughout the night. Such practice prevents farmers to grow dry crops during rabi season when the ground water supply is short. Dry crops like groundnuts, jowar etc cannot tolerate stagnant water and because of night water supply farmers would not be able to prevent water puddles. Unmetered and unchecked energy flow during supply hours discourages farmers from growing less water intensive crops and running their pumps for lesser time.

e. ***Energy audit***- Feeder segregation along with consumer indexing and feeder/DTR level metering can contribute to better energy auditing of agricultural consumers and non-agricultural rural consumers.

Alternative: Energy audit can be achieved through better alternatives such as 100% metering and other mechanisms like the system envisaged under R-APDRP scheme. Accurate metering at feeder level, DTR level and for non-agricultural customers would help in better energy accounting.

4.16 Implementation aspects for feeder segregation

Different objectives for the implementation of feeder segregation have been stated in the previous sections. The proportion of agricultural load differs across the rural feeders. Based on the agricultural load in a particular geography, framework for the feeder segregation implementation could be adopted.

It is recommended that implementation criteria be developed both at state as well as feeder level. Based on the economic and technological environment as well as keeping in mind capacity considerations, states with a higher agricultural load could take up segregation in the first instance. For example, in the first phase, states where agricultural sale is not less than 10% of the total sales could implement the scheme. Within the state, feeders could also be similarly prioritized based on their agricultural load. Thus for a particular state, pilot could be located based upon the feeder with maximum consumption and if and when the project is scaled up, only feeders where agricultural consumption is more than say 15% could be considered for segregation.

The implementation scheme should include the following steps:

a. Defining objective - As stated in the previous sections, objectives for different states can be different for example: load balancing, 24x7 three phase supply to non agricultural rural feeders, loss reduction etc

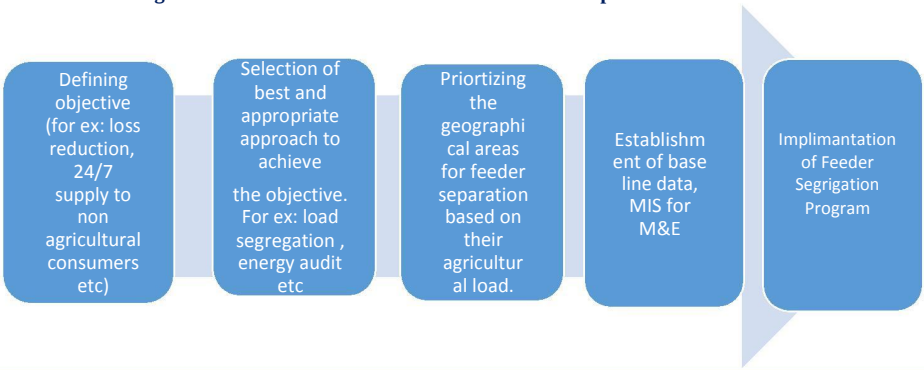
b. Selection of approach - There can be different viable options for each state depending upon the objective adopted for feeder separation. These could depend upon the geographical, political and socio economic environment in a state as well as the existing distribution infrastructure.

c. Selection of geography - Geographical considerations should be based on the agricultural load. All feeders with agricultural load above a certain datum could be included in the segregation scheme.

d. Implementation - Implementation of the selected program can either be carried out in the whole area of the state in one go or it can be phased out, depending on the agriculture needs of various regions of the state and concentration of agriculture vis-a-vis non-agriculture rural loads. The main feeder segregation program may be supplemented by appropriate measures for loss reduction etc. by way of comprehensive metering infrastructure, if not for all the consumers shall at least metering at feeder and distribution transformer ends

The schematic for the implementation of the programme is shown below:

Figure 4: Schematic for activities before full scale implementation



4.17 Key learning from the past experience in different states

In Gujarat, JGY has proved to be helpful not only in providing better power supply to rural areas and the resultant improvement in socio-economic conditions but also in bringing transparency in agricultural consumption and thus accurately estimating distribution losses. It was observed that there is a reduction in the monthly power demand which translates to effective reduction in power purchase cost.

Gujarat has utilized uniquely designed transformers referred to as Special Design Transformers (SDT) to supply power to non agricultural load in farms. As on date 4615 SDTs have been installed across the entire state. The following are the important features of SDTs:

- SDT has only single phase HT winding and no LT winding
- The HT winding is solidly earthed at the sub-station itself and is capable to charge the line at 11 kV and charge all the transformers installed on the feeders.
- Unique design of windings in the Special Design Transformer (SDT) provides; full voltage on one phase i.e.230 volt and very low voltage on other two phase.
- Only one full phase voltage and two very low phase voltages makes the use of TETA (phase converters) difficult.

In Rajasthan, FRP scheme has led to reduction in losses. On the other hand, there is an increased pressure on the state's finances because the increased sales to agricultural consumers has called for increased subsidy payments. FRP scheme has also shown an increase in monthly household expenditure on electricity in Rajasthan.

Haryana has experienced a delay in the feeder segregation program due to lack of effective monitoring which is essential to implement the load segregation program.

Punjab has faced challenges of high losses and poor quality of power supply on rural non-agricultural feeders (termed post segregation as Urban Pattern Supply (UPS) feeders). Although feeder segregation has contributed in increasing supply hours to non-agricultural consumers and better load management of AP feeders but AT&C losses for the state did not show any improvement and continued to be 25%. It was only after Punjab conducted a successful Low Cost T&D Loss Reduction Program from 2007-08 onward, the state could bring down its T&D losses to 18.85% as approved by PSERC for 2013-14.

The most important learning based on the review of past experience is that there is no one size fits all approach for load segregation. Unless Monitoring and Evaluation (M&E) process were put in place appropriately before and after post segregation, benefits cannot be evaluated successfully. The Punjab

experience confirms that segregation alone is not enough and that it has to be followed by T&D loss reduction program, 100% metering, making the meters non accessible to the consumers etc.

4.18 Way forward for implementation of future programs

Since one size fits all approach cannot be adopted, each discom has to formulate a customized feeder segregation programme based on the analysis of its specific needs and requirements.

All the alternate options that have benefits over load segregation for the particular state should be evaluated. Considering the different objective requirements of different states, the best fit option should be adopted for each state. It is also to be taken into consideration that apart from the hardware requirements like additional institutional and infrastructure set up, software needs should be effectively engaged. This may include the accountability systems and use of Information Technology (IT). All the data collected automatically from the feeder meters should be monitored and analyzed. This may require active Data Monitoring System (DMS) to manage the information. Further, regular monitoring, field visits and inspections are must for the effective working of the system.

5. Cost benefits analysis of feeder segregation

5.1 Quantification of cost

24x7 three phase supply to non agricultural rural consumers can be achieved by physical segregation, virtual segregation (single phase or two phase supply), 100% consumer metering and implementation of load breaking switches. Important costs incurred for the all of the above options are discussed below,

1. **Capital Cost:** Capital required for initial infrastructure investment is one of the major costs.
2. **Operational Cost:** Operation and maintenance of additional infrastructure erected would be an ongoing cost for utility. It will include the cost of the repairs, maintenance, manpower and administrative cost for the corresponding network.
3. **Increased sale to subsidized category:** Most of the utilities are not recovering the full cost of service from subsidized category such as agricultural and domestic. Increased power supply to such category would results into increased sales and thus utilities would end up selling increased quantum of subsidized energy. Discoms such as TSSPDCL feel that increased sale to subsidized categories would result in additional costs to them.

The section would present investment in infrastructure by different utilities in the past using the metrics based on number of feeders and and circuit kilometers.

5.2 Cost incurred in feeder segregation by different states

Table below captures the capital cost incurred by different states for feeder segregation.

Table 7: Capital cost incurred by different states

	Erstwhile Andhra Pradesh	Gujarat	Rajasthan	Haryana
Number of Agricultural feeders	8,878	1,904	8,126	1,226
Total (Rs Crore)	3,014	1,290	4,485	573
Per feeder (Rs Lakh)	33.94	67.75	55.19	46.73

Source: World bank report: Lighting rural India - Experience of Rural Load Segregation Schemes in States (February 2014)

In the state of Punjab, one of the feeder segregation projects taken up departmentally required material costing nearly Rs 211.55 Crore for segregation of nearly 848 mixed feeders[5]. The cost of feeder segregation excluding the cost of manpower is nearly Rs 24.95 Crore per feeder.

[5] Source: PSPCL

In Gujarat, though the World Bank Report mentions the per feeder cost of Rs. 67.75 lakhs, the GERC has assessed the per feeder cost of Rs. 37.5 lakhs based on total cost of Rs. 1290 Crore and 3439 number of new feeder created. Project cost for different states cannot be directly compared due to significant differences in the project scope and the year of execution. Different states took different methods such as virtual segregation, physical segregation and integrating feeder segregation with rural development program and water resource management programs. Thus the costs incurred vary across states.

5.3 Quantification of benefits

5.4 Benefit to utility

The power distribution utilities can benefit from feeder segregation. The major benefits to a utility are listed below,

1. **Saving in peak load:** By limiting supply to specific areas over a specified periods, feeder segregation helps the utility in flattening of load curve by distributing agricultural load over off peak time period also. Loss reduction also contributes to reduction in peak load. This results in saving of costly peak power procurement by the utility. For example, the cost of the marginal 10% of power procured in erstwhile Andhra Pradesh for FY 2013-14 as per the projections in the tariff order was Rs 6.67/kWh. This is more than 200% of average projected power procurement cost (RS 3.28/kWh) for the remaining 90% cost.

2. **Loss reduction:** It is expected that feeder segregation initiatives would help in reduction of losses due to the various reasons as discussed in the earlier chapters. Loss reduction also reduces power procurement from the costliest sources thus generating benefits to the utility.

3. **Reduction in transmission charges:** Saving in peak load would result in a reduction of the demand on the transmission system. Hence transmission charges are expected to be reduced.

4. **Additional sales to subsidizing categories:** Supply of 24x7 power not only results into higher power consumption by existing subsidizing consumers (e.g. commercial, industrial etc.) but also provides a conducive environment for setting up of new commercial and industrial entities resulting in additional customers in these categories. Regular power supply also incentivizes

setting up of energy intensive activities in rural area with concomitant benefits. Discoms such as TSSPDCL view additional sales to industrial and commercial categories as the main benefit envisaged from pilot projects of feeder segregation.

5. **Salvage value:** In the feeder segregation projects, some equipment is replaced because of the following reasons:
    a. Need for using equipment with a different rating such as transformers
    b. Need for replacing old or obsolete equipment

The residual value of such replaced equipment is a considered as a benefit.

5.5 Benefit to Consumers

As the consumer would be the ultimate beneficiary of the feeder segregation, different quantitative benefits which will accrue to him are summarized below.

1. **Benefit sharing by utility:** Any financial benefit to utility would be shared by the discoms with the consumer by way of reduction in tariff or reduction in increase in tariff especially to the subsidizing categories.
2. **Reduction in cross subsidy:** Rational and transparent distribution of subsidized power will result in reduction in cross subsidy of consumers.
3. **Increased commercial activities and improvement of living standards** Associated socio-economic benefits of 24x7 power supply are clear but not easily quantifiable in financial terms.

5.6 Societal benefits

Such benefits which are applied to society as whole are discussed here, these benefits are,

1. **Saving in peak load:** Saving in peak load in terms of society is higher because in an environment of power shortage, the peak power saved can be transferred to a customer presently sourcing a higher cost source for e.g. liquid fuel or diesel . Considering cost of diesel power around Rs 13 to 14 per unit, a potential saving of about Rs 6 to 7 per unit is possible in such case.
2. **Reduction in intra state transmission charges:** Transmission charges are reduced due to reduced peak demand of the utility.

5.7 Tests suggested for Cost Benefit Analysis

The following tests developed by the California Energy Commission and California Public Utility Commission were customized for evaluating the cost benefit analysis of the feeder separation program.

5.8 Total Resources Cost Test

The Total Resource Cost Test measures the net costs of the feeder segregation program including both the utility's as well as the participants' costs.

This test could be adopted as the main hurdle test, i.e. programs that do not clear this test need not be considered for further evaluation of cost-benefit analysis. This test is carried out individually for each proposed feeder segregation program by calculating the following parameters:

- Net Present Value (NPV) of benefits such as reduction in losses
- NPV of costs such as capital expenditure (Capital expenditure) and additional operational expenditure (Operational Expenditure)
- NPV of benefits minus the NPV of costs

Net Present Value (NPV) of benefits

The following parameters are computed:

- ***Avoided purchase of power by licensee (APPt) (MU)***
  This is defined as

$$APPt = \frac{dSt}{[(1 - TLt) * (1 - DLt)]} \qquad APPt = \frac{dSt}{[(1 - TLt) * (1 - DLt)]}$$

  Where,

  dSt = Energy savings at the point of use

  TLt = Transmission l osses i n the system

  DLt = Di stri buti on l osses i n the system

- ***Rate of power purchase (Rt) (Rs/kWh)***
  The rate of power purchase in the first year of implementation of the program is assumed as the weighted average of highest marginal cost of power purchase related to the top 10% of the energy use stack. Suitable escalation is applied for future years.

- ***Avoided power purchase cost (APPCt) (Rs Crore)***
  The avoided power purchase cost, APPCt, is determined as APPt * Rt in each year.

  Benefits (Rs Crore)

The benefits are equal to the avoided power purchase cost

- ***Discounted Benefits***

  The discounted benefits in each year are calculated by using a specified discount rate as follows:

$$\text{Discounted benefits} = \frac{\text{Benefits}}{(1 + \text{discount rate})\text{^}(number\ of\ years - 1)}$$

  - ***NPV of Benefits***

    The NPV of benefits is determined as the sum of the discounted benefits over the period of evaluation of the energy efficient initiative.

Net Present Value (NPV) of costs

The cost elements being considered while calculating the NPV of costs for any program, are as follows:

- Capital Expenditure
- Operational Expenditure
- Salvage value if any

The NPV of costs is thus determined using the above cost parameters.

5.9 Ratepayer Impact Measure Test (RIM Test)

Programs that clear the main hurdle test, i.e. the Total Resource Cost Test could be considered for further evaluation by using the Ratepayer Impact Measure test. This test is carried out individually for each proposed Feeder segregation program that clears the Total Resource Cost Test. In this test too, benefits and costs are both calculated over the period of evaluation of the energy feeder separation program. The NPV of benefits and costs for each program are further discounted over the expected period of evaluation of the program under consideration in that particular program.

The Ratepayer Impact Measure test is similar to the Total Resources Cost test except for the following additional costs which are relevant in the context of Indian discoms.

- Cost corresponding to a "increase in sales to subsidised categories due to the Feeder segregation program"
- Benefit corresponding to a "increase in sales to subsidizing categories due to the Feeder segregation program"

5.10 Life-cycle Revenue Impact (LRI Test)

The LRI test is to be conducted using the same data used for calculating the results of the RIM test. The difference between the NPV of Costs and the NPV of Benefits is then to be divided by the total energy sales under the feeders considered to determine the rate impact on the customers.

Feeder segregation programs that do not show positive number for the RIM test may be considered if the LRIRIM test is reasonable.

5.11 Societal Cost Test (SCT)

Societal Cost Test (SCT) is required to provide understanding net economic benefit to the society gained from the Feeder segregation programs under consideration.

The Societal Cost Test is similar to the Total resources Cost test, except for the following parameters:

Table 8: Differences between SCT and TRC test

Parameter	Total Resources Cost test	Societal Cost Test
Rate of power purchase in first year of implementation of a Feeder segregation program (Rs/kWh)	Weighted Average of Highest Marginal Cost of Power Purchase related to top 10% of energy use stack.	Cost of Diesel generation (about Rs 12.74/kWh)
Cost elements (Rs.)	Cost elements to be considered including taxes	Cost elements to be considered excluding taxes

5.12 Qualitative benefits

Financial benefits to utility are easily quantifiable where as it is not easy to quantify socio-economic benefits to consumers arising from the implementation of the feeder segregation program. This section will review the qualitative benefits of the feeder segregation,

5.13 Benefit to Utility

Apart from above discussed quantitative benefits to utility, segregation would enable the utility to adopt better energy audit and energy accounting practices. It will help the utility to strengthen its network and utility can integrate its future expansion plan with this program. Efficient management and utilization of network reduces DTR failures and other network related issues. Better supply to consumers, results into satisfied consumers and improved relation between utility and consumer.

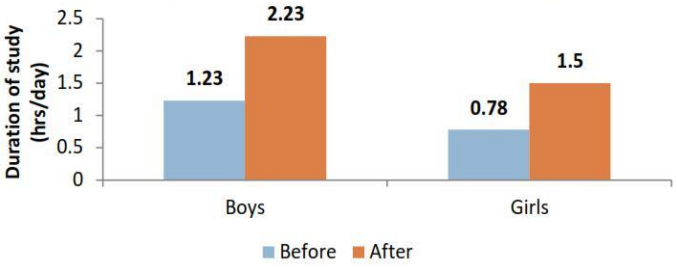
5.14 Societal benefits

Consumers will get a better quality and reliable power supply. This will be helpful in improvement of quality of life and improvement in the standard of living as households will be able to gain control over their time of usage of electricity. Public Health Centers can function more efficiently with 24 hour supply. Cold storages can be set up to store perishable agricultural product. Households can use appliances more flexibly at any time of the day. Schools will be benefitted because of extended hours of study because of 24x7 power supply. Other benefits like better storage of food items, overall safety, recreation etc will help in improving the life of consumers.

Institute of Rural Management, Anand (IRMA) has carried out a study to access the socio economic impact of Jyoti Gram Yogna in Gujarat[6]. A survey was carried out as the part of the study in which two districts were selected from each of the four Discoms. Within each district five (5) villages were selected and twenty household were chosen within each village. The key objectives of this study were to examine the key features of the scheme, access the social and economic impact and identify the key issues that need to be addressed to improve the effectiveness of the scheme.

The survey finds that the attention and the willingness to study has increased from 8.3% to 65.5%. The improvement in the duration of the study is shown in the graphic given below.

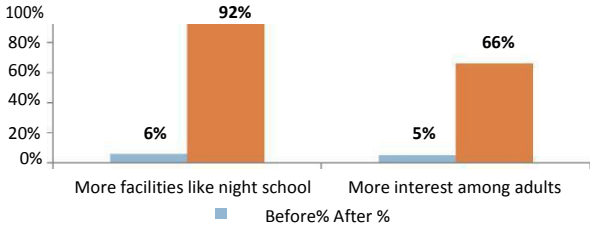
Figure 5: Impact on duration of the study



A positive impact on the adult education has also been observed. More adults are interested in education and facilities such as night school have shown an increased trend. This is shown as follows:

[6] Impact Assessment of Jyoti Gram Yojna in Gujarat

Figure 6: Impact on adult education



One of the important impacts of the Jyoti Gram Yojna was on Women Empowerment. Due to the better and continuous supply of electricity women have shown more socialization i.e. involvement in the societal activities. This in turn helps in rising of standards of the society. The impact on mobility of women at night and participation in social functions is shown in below:

Figure 7: Impact on mobility of women at night

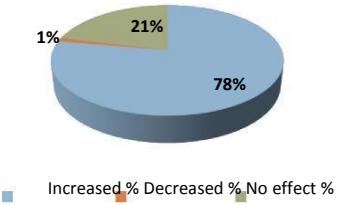
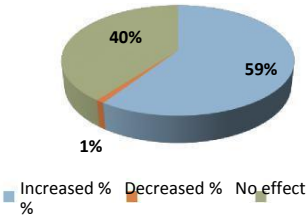
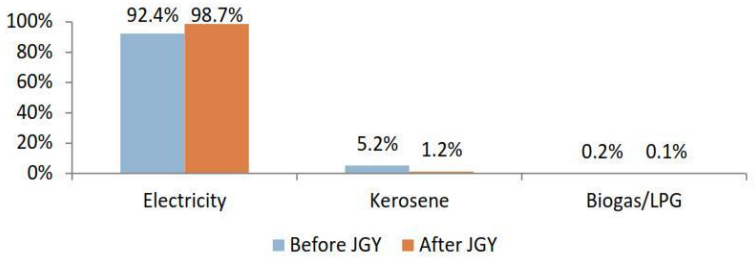


Figure 8: Impact on participation of women in social functions



Another study was carried out by Indian Institute of Management, Ahmadabad on impact assessment of the JGY of the Government of Gujarat. It focuses on the socio economic impact of the scheme. One of the findings is that there was change in the main fuel consumption after implementation of Jyoti Gram Yojna. It was observed that consumption of electricity as a fuel for lighting has increased, shown in the figure below:

Figure 9: Change in the consumption pattern of fuel for lighting



Other societal benefits include more yield from animals, gains in dairy business, initiation of home based activities, availability of 24 hours health services etc helps in improvement of socio economic conditions in the rural areas.

6. Measures for effective metering

6.1 Need for effective and robust metering system in India

The metering infrastructure and related process is inadequate in most Indian discoms due to the following reasons:

i. Most of the agricultural consumers and some non agricultural domestic consumers are unmetered which leads to non accountability of the power supplied to agriculture resulting in diffused measurement of losses

ii. Inadequate metering process such as regular testing, calibration, reading and recording of meter readings.

iii. Inadequate process for updating consumer indexing (leading to inaccurate energy audit or loss estimation)

iv. Energy audit not being taken up on a regular basis.

Hence it is difficult to detect meter tampering and pilferage. Thus the deficiencies in existing metering mechanism in India are resulting in high losses.

The table below shows the enhancements in metering system required in the Indian discoms at various levels:

Table 9: Enhancements in metering systems required

SN	Level	What type of meter is required	Whether meters exist	Whether meters are adequate	Is there an effective metering process
1	Customer	Electronic/High accuracy	Customers are not metered. e.g. Agricultural, BPL (in some cases)	Some discoms require to replace the electromechanical /Low Accuracy meters	Some discoms do not have an effective process
2	Distribution Transformer	Remotely readable	Most discoms do not have metering infrastructure at this level.	Need to upgrade the conventional meters installed in some discoms	Most discoms where meters are installed do not have an effective process

SN	Level	What type of meter required	Whether meters is exist	Whether meters are adequate	Is there an effective metering process
3	Feeder	Connected to online data acquisition system	Most discoms have metering at this level.	Most discoms need to upgrade the meters	Most discoms do not have an effective process

Metering is an important aspect not only to bring down the losses but also to achieve the transparency in the power distribution system. The Forum of Regulators WG set up to address metering issues recommended as under.

1. CEA standards and specification to be followed for meter installation by utilities
2. CEA to develop a methodology for remote meter reading in rural areas.
3. Completion of consumer indexing on a time bound basis by utilities
4. Provisional meter reading shall be discouraged and actual meter reading should be incentivized by SERC by regulation on distribution Standard of Performance.
5. SERCs should encourage metered supply via lower tariff rates to metered supply in comparison to flat rate supply.
6. SERCs may adopt longer billing cycle for the rural areas wherever monthly or bi monthly reading is not practical.
7. DTR based group metering should be adopted till the time individual metering is not possible. Consumers can be charged on a pro-rata basis based on their pump sets ratings
8. Procedure for meter installation and sealing should be put in place to allocate responsibility of line officer or consumer for any malpractice
9. Electro-mechanical metering should be replaced with by static meters in a phased, time bound manner. .Consumer confidence building measures should be taken up for new metering system
10. Continuous research and innovation is required for tackling new ways of power theft
11. Third party meter testing should be done through accredited institution and organization
12. Distribution transformer metering should be made compulsory
13. Use of pre-paid meters should be encouraged
14. KVAh metering should be promoted for keeping check on power factor

Agricultural consumers are not sufficiently metered in any of the states. The Working group on metering issues has realized the need for 100% metering for agricultural consumers. It was suggested that research and development (R&D) project should be taken up to develop the robust metering system. It is recognized that the shortfall in achieving 100% metering is due to practical difficulties in metering agricultural consumers. Such difficulties include the geophysical constraints and socio-economic factors. Hence the Working Group has not suggested any immediate time frame to achieve metering of agricultural consumers.

6.2 Deficiencies in current system

Several issues are associated with the present system of metering in India, although these issues may vary from state to state. Some of the existing deficiencies are listed below:

a) Inefficiency in the system- In the existing system, the metering is not found to be effective and efficient. Presently , thefts and lack of an effective MIS in utilities hinder efficient metering. This results in high distribution losses. As per the working group report on metering issues (August 2009) [7], it has been observed that regular readings are not taken every billing cycle and provisional billings are recorded.

b) Existing Infrastructure- For the effective metering and development of the advanced metering technologies, the existing infrastructure is not sufficient. Technology (IT) system connected to metering is not adequate. For achieving an effective metering mechanism, putting in place remote meter readings ensuring transparency and accuracy is critical.

c) Poor maintenance- Meters which have been installed at the consumer premises are not well maintained. The meters are made defective intentionally in some cases and in other cases the defective meters are not timely replaced by the utility. Meters are not found to be of desired accuracy class and not tested.

6.3 . Measures for effective metering

The following measures are recommended by FOR Working Group on 'metering issues' and FOR Working Group on 'Loss Reduction Strategies' for effective metering and loss reduction:

a) Consumer indexing - Consumer indexing the first step for any energy auditing plan. The report of the Working states – 'Compilation of baseline data should be the starting point for energy accounting and auditing'. Identifying and linking of consumers to DTRs and feeders is a necessary activity for establishing loss levels.

[7] http://www.forumofregulators.gov.in/Data/Reports/Report-Metering-Issues%2520august%25202009.pdf http://www.forumofregulators.gov.in/Data/Reports/Report-Metering-Issues%20august%202009.pdf

b) Enabling legal and other provisions for metering- The consumers should be bound to comply with the provisions made in the Electricity Act 2003 and other state regulations. Consumers need to meet the specified standards and provisions for effective metering, accounting, under the acts, laws and regulations. Wherever the existing provisions are not applicable, state shall make their own recommendations for the consumers to adhere to and the recommendation for default shall also be stated.

c) Regular review of status of metering in each Discom- Discoms of each state should undertake the responsibility of regular review of the status of metering and suggest the measures to overcome the shortfalls. Results achieved should be compared with the time set targets. SERCs can recommend tariff incentive for the metered consumers. The state government shall also analyze the required subsidy and should specify the limit/cap for the subsidy.

d) Installation of meters- SERCs can specify the guidelines regarding installation of meters. The responsibility for installation of meters should lie with the Discoms. The installed meters should meet the required standards. It is the responsibility of the Discom to make the consumers aware about the mechanism of installation of meters. Further, new technology should be adopted and existing electro mechanical meters needs to be replaced. As per the recommendation made by the Working Group on metering issues, if the meter which is installed is showing a variation of more than 30% in the readings when compared to the readings of the old meter, then special checking of the wiring of the premises of the consumer is required.

e) Regular testing of meters- The meters installed at consumer's end should be tested at regular intervals by the third party independent audit agency. Utility shall be responsible for testing of meters if meters have been supplied and installed by the utility. However, in cases where consumer feels that there is some error in the meter and he wants utility to check the meter, cost for such process should be borne by the consumer.

f) Regular check of defective meters and their replacements- If utility finds that any of the meters is defective (running fast or slow), not working or burnt utility should replace the old meter with the new one within the stipulated time frame. SERCs suggest the mechanism of billing for the period when meter remains defective. Such billing mechanism should be effectively followed but in order to avoid the losses in the revenues. Discoms should report the number of defective meters replaced to the SERCs every quarter. This would help to track the progress over a period of time.

g) Efficient billing mechanism and meter readings- The most crucial part of the entire metering mechanism is the reading of meters and billing based on the actual consumption. The objective of the metering gets defeated if the reading and billing are not performed correctly in an effective and transparent manner. Most important component for the metering is consumer indexing. Discoms should focus on consumer indexing in areas with high loss levels. UERC

has adopted the approach of reading agricultural consumers every 6 months and thus the same can be adopted by other states based on their other local conditions.

h) Metering of DTs- Metering of DTs is important since it helps to measure the losses on the transformers, energy accounting, supply monitoring and the reliability. AMR along with the DTR metering is an additional advantage.

i) Suitable metering technologies- The most relevant technology for the metering of agricultural consumers needs to be adopted. The selection of such technology may differ from state to state depending on geographical, political and socio-economic issues. Achieving a long term effective metering solution like Automatic Meter Reading (AMR) or Meter Data Management (MDM) will take time. Such metering technologies provide real time or near real time information. Till the time such metering mechanisms are implemented, group metering system could be implemented.

7. Recommendations on the national level framework for feeder segregation

The task of implementing agricultural feeder segregation programs (hereinafter FSP) is a challenging one and requires deployment of significant resources. Any replication of the Gujarat model or the Punjab model or the erstwhile Andhra Pradesh model, across India would require careful prior planning and strategization. This would also require adoption of a project/mission mode with an appropriate mechanism for implementation, monitoring and evaluation.

The sub-group recommends implementation of a national level program for segregation of agricultural feeders in a graded and calibrated manner while allowing states to have flexibility to adapt the design of the project consistent with their respective felt needs and priorities. The Sub-group suggests the following roadmap for implementation of the programme.

7.1 ROADMAP FOR IMPLEMENTATION OF FEEDER SEGREGATION & RELATED PROJECTS

7.1.1 Feeder Segregation

The feeder segregation provides a platform on which various blocks of modern day electrical network can be built by the utilities in different states across India. For any composite development of the rural areas to happen, 24x7 supply is must which not only becomes a harbinger of overall development of rural India by lifting the standard of living for the rural masses but also helps to tackle the menace of high AT&C losses. It promotes small scale agro industry & setting up of quality educational/vocational institutes due to availability of three phase power. It facilitates identification of high loss areas due to better assessment of agriculture consumption and greater flexibility of grid operation.

The general experience is that due to longer hours of power availability after feeder segregation, the AT&C losses shall increase. Feeder segregation is therefore not an end itself but requires further inputs to make such a huge investment an economical viable proposition & also to improve the quality of service in rural areas.

(a) Input for pure agriculture feeders:

To tackle AT&C losses on pure agriculture feeders, less LT HVDS is a lower cost solution in comparison to 100% HVDS constituting independent DT for each agriculture consumer. A transformer may feed 2 to 3 motors with maximum LT length of Aerial Bunched Conductor

restricted to 150/200 meters. It controls the unauthorised running of motors and also reduces technical losses resulting into reduction in AT&C losses on agriculture feeders.

(b) Input for non- agriculture feeders.

The rural sector is prone to high AT&C losses and more power to non- agriculture sector in the rural areas will increase the AT&C losses of the utility. It has been experienced that states having fully segregated feeders have recorded 40% to 70% AT&C losses on non- agriculture feeders. It is therefore essential to take steps to tackle high losses on non- agriculture feeders. One of the cheapest methods is to shift meters outside consumer premises in pillar boxes and re-lay the LT Distribution system by removing bare conductor with cables and ensure 100% metering of all non- agriculture consumers (cost per consumer: Rs. 5000). Punjab has witnessed a reduction of about 6% in overall AT&C losses (from 2007-08 to 2013-14) on project implementation for about 40% consumers. The payback period in high loss feeders is even less than one year whereas overall simple payback period of this project is around 3 years.

It is therefore suggested that feeder segregation should accompanied by shifting of meters outside consumer premises in pillar boxes and adoption of less LT HVDS for AGRICULTURE loads. The total cost of the project constituting feeder segregation, Less LT HVDS for AP consumers & shifting of meters outside the premises of non-AP consumers is Rs. 1,72,619 Cr (Annexure.-5). The saving accruing on account of execution of these projects on Pan-India basis comes to be 52003 MU annually at the consumer end (equivalent to generation from 9650 MW installed capacity) resulting in a saving of capital investment worth more than Rs. 57900 crore at a capital cost of Rs.6 crore/MW. These projects can be funded over a period of 3 to 5 years and completed in 5 years from the date of their initiation. The recovery of the investment is likely to be in a period of 5 to 6 years.

7.1.2 Agriculture DSM

In addition, each utility may implement Agriculture DSM by replacing in-efficient pumpsets with energy efficient pumpsets. The fact that electricity prices for agriculture power consumed are low or non-existent, there is a complete absence of incentives for the farmers to invest in efficiency. However, well designed and targeted DSM programs have proven to be the models that could be replicated on a large scale. The burden of paying for agricultural energy rests largely with the state governments. As analysed by EESL, efficiency improvements between 25-37% are possible by replacing inefficient pump-sets with BEE STAR labelled ones. The estimated energy saving potential in India is estimated to be around 23 billon units. A key enabling factor for stimulating private investment is to establish a financial mechanism that ensures recovery of capital investment as well as provide a robust payment security mechanism. To enable the two, creation of an Agriculture DSM Revolving Fund (ADRF) under Regulatory oversight is suggested. Each State Regulatory Commission could mandate that a small %age (say 3%) of annual subsidy given by the

state will be used to fund ADRF. In Punjab, where annual agriculture subsidy is around Rs. 5000 crore, an ADRF of Rs. 150 crore could potentially attract investment of Rs. 600 crore annually by covering upto 20% of the investor capital every year to replace about 1.5 lac pumpsets.

7.1.3 Metering of agriculture consumers

The 100% metering is the mandate of the Act but most of the utilities have yet to achieve this target mainly due to the non-metering of agriculture motors. Moreover, by simply installing meters on the agriculture motors does not solve the problem as meter reading of agriculture motors spread over the length & breadth of the country is a costly affair without matching returns on investment. It is an established fact that hardly any farmer maintains LT capacitors on his motor resulting in very low power factor on agricultural feeders. Reactive compensation at the consumer end or at a point nearest to the consumer will not only reduce technical losses on the lines but will also spare a lot of capacity on the lines resulting in tremendous saving to the utility. It is recommended that AMR meters on each less LT HVDS distribution transformer along with LT capacitors may be installed on the secondary side of the DT and this AMR meter-cum-LT capacitors project may be executed either by the utility or got implemented as turnkey project on lease-rental basis. In case it is got implemented on lease-rental basis, then it shall be the responsibility of the project implementer to install, operate and maintain the meters as well as capacitors. Although this may not fully meet the mandate of the Act but is the practical solution to the problem of agriculture metering & commercial viability of such project .

7.2 Other Related Issues:

7.2.1 Need for Customization and Bottom-up Approach

Each state will have to prioritise the objectives it seeks to attain by implementing the FSP, following which the FSP could be designed to focus on achieving these objectives. Some of the objectives around which the FSP could be designed are listed below.

a. Improved power supply to rural non-agricultural consumers. Consequent improvement in the quality of their lives and catalysis of rural industry. Subject to adequate availability of power.

b. Improved load management through a better ability to regulate supply to agricultural customers. Consequent transparency as well as capping of agricultural subsidies and thus stabilising financial position of the utilities

c. Reduction in line losses through better monitoring of consumption in the agricultural sector.

d. Improved management of environmental resources through husbanding ground water resources.

While attaining all these objectives is desirable, each may require differentiated approaches. It needs to be underlined that there is no one size fits all approach for implementing FSPs. States should prepare FSPs according to their individual felt needs and requirements.

Thus to achieve the objectives outlined above, utilities may adopt a number of approaches according to their individual priorities. Some of the possible approaches are listed below. While finalizing the approach to be adopted, the outcome of the cost benefit analysis tests described earlier would need to be taken into account.

a. Segregation of feeders supplying agricultural and rural non-agricultural loads through either virtual segregation or physical segregation.

b. Increasing the density of sub-stations/compact sub-stations.

c. Implementing HVDS with load break switches for agricultural feeders.

d. Implementing 100% metering of all customers including initiatives such as taking meters outside consumer premises and AMR–cum- LT capacitor model through outsourcing for agricultural pumpset (AP) consumers.

e. Implementing Demand Side Management initiatives to improve efficiency of agricultural pumpsets in a subsidy environment

f. Installing Solar pump sets at remote or difficult locations

The SG notes that the feeder segregation will stimulate consumption in the non agricultural rural sector. While such an increased supply to subsidised consumers will improve the quality of their life, there will also be a concomitant reduction in AT & C losses. To address this issue, it may be desirable to parallely implement a program aimed at reducing AT & C losses. The SG notes that in most states agricultural consumption is not effectively metered. What cannot be measured cannot be managed. It is essential that agricultural consumption is metered if not at the consumer level then at least at the DTR level so that losses can be managed more effectively. Some of the initiatives that could be adopted in this direction include the following:

a. Implementing the High Voltage Distribution System (HVDS)/Less LT HVDS

b. Putting in place Advanced Metering Infrastructure (AMI)

c. Reducing theft and increasing metering efficiency by installing electronic meters outside the premises of the consumers through Pillar box meters or otherwise.

Each state scheme should adopt a bottom-up approach rather than a top-down approach in designing such a scheme. While the Centre can put in place broad guidelines, each state and possibly each utility may come up with its individual approach. Further, it is recommended that the project implementation also should be decentralized and taken up by each utility rather than by a state level body. This would help not only in better implementation of the project but also in ensuring that the utility takes full ownership of the project.

It is recommended that the following features should be made mandatory for projects assisted by the central government:

a. Conducting a base line study in all the feeders taken up for segregation before implementation of the project to establish authentic pre program base line data. The base line data should include (i) Comprehensive network diagram under the selected feeders based on network survey including consumer indexing and asset mapping and (ii) Estimation of AT&C losses based on a methodology approved by Ministry of Power.

b. Putting in place project management units for effective supervision of the FSP.

c. Establishment of an effective monitoring and evaluation framework which should incorporate an effective MIS.

d. Involvement of utility staff in every phase of the project to ensure effective and sustainable knowledge transfer from the implementing agencies.

7.2.2 Prioritization and Phasing

A phased approach could be adopted at the national level to prioritize the agriculture intensive states.

Group 1- High Priority States: The states with higher agricultural consumption beyond a norm (say 10% of total consumption) could be given a higher priority in FSP as feeder segregation could lead to greater and immediate benefits to such states. GoI could decide the norm to be adopted.

Group 2 -Other States: The states with agricultural consumption lower than the norm could also be considered for support if they so desire.

Within the selected state there can be further prioritization based not only on administrative and geographical contours but also the project imperatives. Areas having a greater number of feeders with high agricultural loads could be selected on priority for segregation. Here again, the State government as part of its FSP should fix this norm (for example, at least 25% of total load on the feeder should be

agricultural for the feeder to be included in the FSP in the first phase). Where the State's priority as defined in Para 7.1 is improved supply to non agricultural rural consumers, this norm may be modified depending upon factors like availability of power and other resources , industrial potential etc. It is suggested that the Government of India's FSP could be implemented in the following manner:

(i) Preparation of a DPR which would incorporate the state's priority objectives, the specific initiatives which will be taken up and the approximate costing and phasing.

(ii) Implementation of the pilot program. The phasing could be over a period of five years, with the first year committed for pilot implementation and project preparation. The funding of the program will depend upon the contours of the central support offered.

(iii) Implementation of the feeder segregation/creation of new feeders in each phase to cover the area targeted by the FSP .

(iv) Creation of transmission facilities wherever required.

(v) Implementation of the associate programs to reduce AT & C losses including comprehensive metering.

Based on the learning from R-APDRP projects, it may be desirable for utilities in states which have not taken up FSP earlier to take up pilot projects before taking up large full scale projects for the following reasons:

a. To validate the design and implementation aspects.

b. To validate the estimated economic benefits

c. To develop in-house capabilities for project management

The Sub-group further considered the issue that whether implementation of the programme should be undertaken directly on full scale, or should each utility initially take up pilot projects in selected areas ? The Sub-group noted that many states have already taken up the pilot projects and some of them have also completed the full scale projects. Moreover, the pilot projects may delay the implementation of the programme by at least one year or more. As such, in view of the established benefits of the programme and experience already gained by some of the states, Sub-group felt that there is no need to take up the pilot projects. However, alongwith the main feeder segregation programme, the utilities may also adopt other measures like Distribution transformer metering, HVDS and efficient metering systems for rural non-agriculture consumers.

7.2.3 Cost Benefit Analysis

As mentioned earlier, there is scope of increased financial losses when FSP is implemented. Already, utilities in India do not realize the average cost of supply through sale of power to domestic and agricultural categories even after accounting for the subsidy received from the state government. Important parameters which can influence the project implementation decision for the FSP could include economic viability of feeder segregation projects are the following:

a. Reduction in the line losses. Feeder segregation projects may not be financially viable unless there is concomitant and significant reduction in the lines losses say more than five percentage points. Such reduction may be possible only in cases where the base line losses are significant say more than 15%.

b. Revenue realization (including subsidy) per unit from domestic and agricultural categories may need to be above a threshold for FSPs to be financially viable. FSPs may not be financially viable unless the utility realizes at least about 80% of the average cost of supply through tariff and subsidy.

c. Social benefits provided to the non agricultural rural consumer through 24X7 three phase supply as well as potential for growth in rural industry could set off the losses in (a) and (b) above

The SG therefore recommends that the DPRs prepared for the scaled up project include a cost benefit analysis for the proposed projects. For this purpose, the following tests are recommended:

a. Total Resource Cost Test (TRC Test)
b. Ratepayer Impact Measure Test (RIM Test)
c. Life-cycle Revenue Impact Test (LRI Test) and
d. Societal Cost (SC)Test

The threshold condition could be that the project pass the TRC test and the RIM test. Projects that do not pass the TRC and RIM tests may still be taken up if the following conditions are met:

a. Project passes the TRC and RIM tests under an assumption that about 80% of cost of supply is realized through tariff and subsidy received for the subsidizing categories (domestic and agricultural categories)
b. Significant positive socioeconomic impact is expected in qualitative terms
c. Project passes the SC test and
d. Impact on the tariff as seen in the LRI test is reasonable

7.2.4 Funding Mechanism

Support from the Government of India may be provided on the lines of R-APDRP. The Feeder Segregation Programme project could be submitted for approval to an agency nominated by the Ministry of Power. This agency would appraise the State Government's DPR and monitor allocation of funds with suitable phasing as envisaged under the scheme.

The SG recommends that as part of the scheme contours, performance should be rewarded on the lines of R-APDRP and Financial Restructuring Programmes.

The funding of the proposed scheme could comprise of three components. Central assistance can support two components of funding, while utilities may approach financial institutions/ promotional agencies / multilaterals for the balance requirement,

1. **Investment Component:** Under this part central government would provide financial support by way of a grant to the state utility for fully funding the infrastructure component of the pilot project. The Utility would provide the results of the pilot program along with the DPR for the FSP to the designated agency. The DPR should include an outcome projection based upon measurable parameters which will define the success of the project. Additionally, the DPR should integrate the recommendations of the state ground water policy. It should also examine issues of sustainability after the completion of the project. Upon approval of the DPR by the agency, the Central Government shall provide part funding for the infrastructure requirement as per the scheme contours.
2. **Incentive Component:** After the loan has been granted to the state for feeder segregation, a state and central level review mechanism would monitor the progress of scheme based upon achievement of the outcome indicators mentioned in the DPR within one year of the completion of each phase. On the basis of the level of achievement of the outcome indicators read with respect to the pre defined outcome indicators, the GoI will convert a part of the loan into grant. Higher incentive may be provided to projects which include implementation of 100% metering at customer level.

3. **Internal Resources/ Loans from financial institution:** Based upon the scheme contours, the balance part of the part of the investment required after accounting for the GoI support could be funded through internal resources of the utilities / loans from financial institutions/ multilateral agencies.

The central funding may be provided in a manner similar to R-APDRP as detailed below.

Higher support could be provided for projects which include a 100% metering component covering all customers under project area. The GOI grant would be converted to a grant on achievement of the pre-determined outcome indicating as verified and established by the monitoring committee.

Table 10: Suggested Central Government Support as % of the Project Cost

For the projects proposing 100% metering for the cinsumers in the project area	**80 %**
For other projects	**50 %**

7.3 Monitoring Mechanism

Putting in place an effective monitoring mechanism is critical to the success of the FSP. A proposed monitoring mechanism is suggested in Para 8.1 and 8.2 below. Figure 10 below suggests possible measurable outcome indicators, some or all of which could be adopted by states as part of their respective FRP.

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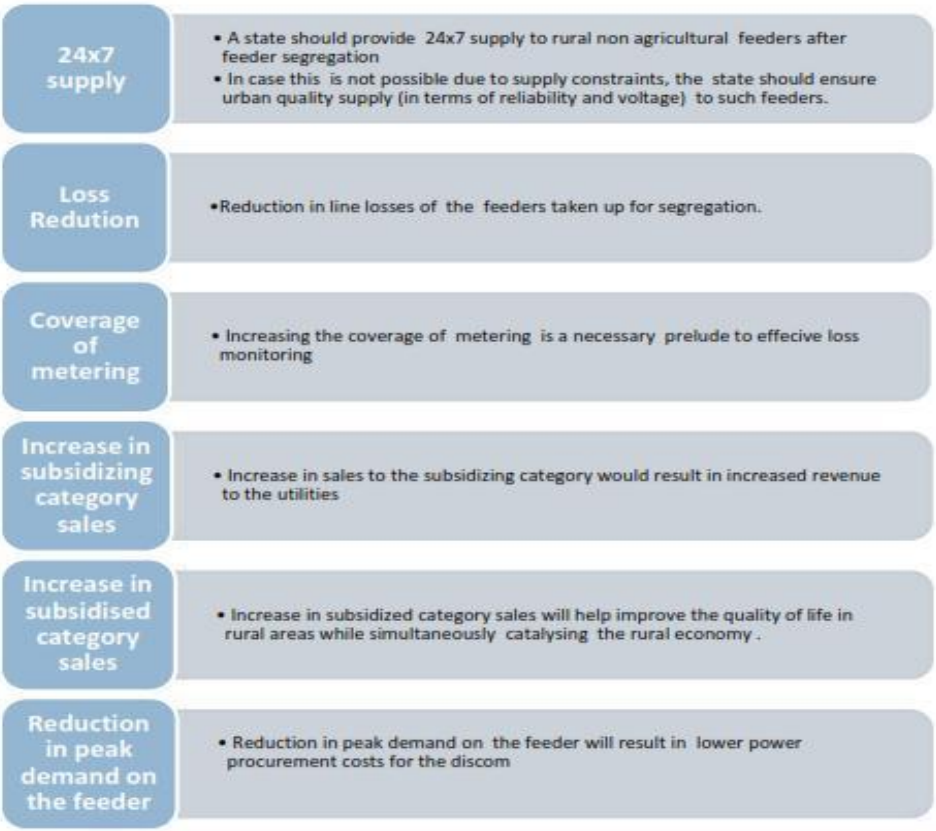
Figure 10: List of desirable achievements of feeder segregation projects



7.4 Central level steering committee

A Central level steering committee chaired by Secretary (Power) could be constituted for monitoring the program implementation at national level. The Committee could comprise of representatives of from Ministry of Finance, Ministry of New and Renewable Energy, Ministry of Agriculture, Ministry of Rural Development, Central Electricity Authority (CEA), Power Finance Corporation, Rural Electrification Corporation and participating state governments. The Central Government Committee

and the agency appointed by the Central Government could inter alia undertake the following functions.

1. Setting up the guidelines for operationalization of the scheme
2. Approving proposals for funding the pilot projects
3. Sanctioning DPRs submitted by state governments after reviewing results of the pilot program of state.
4. Periodically monitoring and reviewing the implementation of the feeder segregation scheme
5. Appointing third party agencies for verification and validation of the outcome indicators.
6. Approval of the conversion of loan into grant upon fulfilment of the necessary conditions

7.5 Monitoring committee at the state level

State level monitoring committee could be chaired by the concerned Energy Secretary of the state. Committee could include representatives from utilities implementing the project, agriculture department, rural development department and panchayat raj departments. The committee could undertake as part of its functions, the following activities.

(i) Recommending pilot projects for approval by the Central Committee, monitoring and reviewing the implementation of the pilot projects and recommending DPRs for approval of the Central Committee.

(ii) Periodically monitoring the implementation of the FRP with reference to the achievement of milestones and outcome indicators under the Scheme.

The following model adopted successfully in Punjab for feeder segregation could be considered by state governments for adoption as part of their implementation plan.

(i) Subsequent to or in parallel with the implementation of the Feeder Separation Programme, the last linkage to the consumers could be through covered cables connected to consumer meters which could be taken outside their premises and placed in pillar boxes or small pole mounted boxes. This has resulted in control of theft and substantial reduction in distribution losses in Punjab.

(ii) A special cell, called 'Feeder Separation Programme Cell' was created at the headquarters of the distribution companies to exclusively monitor the Feeder Separation Programme implementation.

(iii) Regular and effective monitoring by the central agency was done to ensure that the project is on track all the time.

(iv) Metering arrangements on the agricultural feeders was mandatory an based upon the meter outputs, the bifurcated feeder was subjected to close monitoring . The recovery of losses was suitably but promptly addressed, depending upon the other priorities of the utilities and the government.

Annexure 1: List of documents referred

S. No.	Name of the report/presentation	Name of the publishing/presenting organization	Date
1	Presentation on Feeder Segregation of Rural and Agricultural Loads	FOR Secretariat	Aug-14
2	Faster, Sustainable and More Inclusive Growth –An approach to the Twelfth Five year Plan(2012-17	Planning Commission of India	Oct-11
3	Dedicated Feeder for Agricultural – A flagship scheme under Krishi Road Map (Rainbow Revolution)	Bihar State Electricity Board	
4	Lighting Rural India-Experience of Rural Load Segregation Schemes in States,	Energy Sector Unit South Asia Sustainable Development(ESMAP),	Aug-12
5	Report on 'Loss Reduction Strategy'	FOR	Sep-08
6	Report on 'Metering Issues'	FOR	Aug-09
7	Lighting Rural India-Load Segregation Experience in Selected States	World Bank	Feb-14
8	More Power to India-The Challenge of Electricity Distribution	World Bank	2014
9	Presentation on – "Segregation of Rural Feeders into agricultural and non agricultural loads - A case study of Punjab"	PSERC	
10	Details of the Feeder Separation Project	Madhya Pradesh Madhya Kshetra Vidyut Vitaran Company Ltd. (MPMKVVCL).	
11	Presentation on implementation of Jyoti Gram Yojna in Gujarat	MD, DGVCL	
12	Report on study of 24 hour 3 phase Supply to all villages in Gujarat State	CMD, TSSPDCL	

S. No.	Name of the report/presentation	Name of the publishing/presenting organization	Date
13	Jyoti Gram Yojna, 'Power ring Rural Gujarat'	Centre for Environmental Planning and Technology (CEPT)	Dec-04
14	Impact Assessment of the Jyoti Gram Program of the government of Gujarat	IIM Ahemdabad	Dec-10
15	Impact Assessment of Jyoti Gram Yojna in Gujarat	Institute of Rural Management Anand (IRMA)	
16	Note on scaling up Agricultural DSM in Punjab	Energy Efficiency Services Limited	
17	Minutes of the 41st meeting of Forum of Regulators (FOR)	PSERC	Jul-14
18	Document regarding site visit at 66 kV Grid sub-station, Gharaun (Punjab)	PSPCL	
19	Study on the segregation of 11kV Mouli Mixed Feeder (3ph 4 wire) into 11kV Mouli Urban Pattern Supply (UPS) and 11kV Chilla AP (3 ph 3 wire) feeder	PSPCL	
20	Presentation on feeder segregation to the SG	TSSPDCL	Oct 2014
21	Presentation on feeder segregation to the SG	TSSPDCL	Oct 2014
22	Presentation on feeder segregation to the SG	APEPDCL	Oct 2014
23	Presentation on feeder segregation to the SG	APSPDCL	Oct 2014

Annexure 2: Statistics of feeder segregation in Gujarat, Punjab and erstwhile Andhra Pradesh

Statistics of feeder segregation in APEPDCL

Sl. No.	Details	Units	Before segregation	After segregation (Envisaged)	Current Status
1	No. of Mixed Feeders	Nos.	72	42	42
2	No. of Agriculture Feeders	Nos.	11	49	50
3	No. of non Agriculture Feeders	Nos.	36	52	53
4	Total No. of Feeders	Nos.	110	135	137
5	No. of Agriculture Customers	Nos.	11,761	12,559	13,011
6	No. of Other Customers	Nos.	103,990	114,232	122,033
7	No. of 11 KV Bay with VCB	Nos.	113	137	139
8	Length of 11 KV Lines	ckm	1,642	1,811	2,059
9	No. of DTRs	Nos.	7,903	8,439	9,367
10	Length of LT Overhead	ckm	3,940	4,044	4,399
11	Length of LT AB Cable	ckm	600	667	758
12	No. of Energy Meters at DTRs	Nos.	336	349	376
13	No. of Energy Meters at Feeders	Nos.	110	136	154
14	No. of Energy Meters at Customer Level	Nos.	108,016	118,579	143,221
15	Length of LT lines converted to HT lines	ckm	396	405	398
19	Agl. Consumption (Sales)/Month	MU	10	10	15
20	Non Agl. Consumption (Sales)/Month	MU	29	26	35
25	Connected Load Agl. Consumption	MW	78	83	85
26	Connected Load Non Agl. Consumption	MW	101	106	120
27	Hrs. of Power Supply to Agl. Consumers	Hrs.	7 Hrs	7 Hrs	7 Hrs
28	Hrs. of Power Supply to Non Agl. Consumers	Hrs.	18 Hrs	24 Hrs	24 Hrs

Statistics of feeder segregation in APSPDCL

S. No	Details	Units	Before Segregation	After Segregation (Envisaged)	Current Status
1	No. of mixed feeders	Nos.	68	0	0
2	No. of Agl. Feeders	Nos.	1	53	53
3	No. of non-agl. Feeders	Nos.	25	80	84

S. No	Details	Units	Before Segregation	After Segregation (Envisaged)	Current Status
4	Total No. of feeders	Nos.	94	133	137
5	No. of agricultural customers	Nos.	13108	13391	14132
6	No. of other customers	Nos.	109739	115030	124591
7	No. of 11KV Bay with VCB	Nos.	89	102	105
8	Length of 11KV lines	CKM	1293.329	1649.749	1681.495
9	No. of DTRs	Nos.	5575	5965	6656
10	Length of LT overhead	CKM	4055.02	4177.02	4432.92
11	Length of LT AB Cable	CKM	702.34	869.227	903.45
12	No. of energy meters at DTRs	Nos.	531	547	558
13	No. of energy meters at feeders	Nos.	89	123	126
14	No. of energy meters at customer level	Nos.	110261	115599	125140
15	Length of LT lines converted to HT lines	CKM	820.1735	820.1735	964.91
19	Agricultural consumption (Sales)	MU	78.42	69.07	72.36
20	Non-Agricultural consumption (Sales)	MU	69.36	77.25	85.83
25	Connected load - Agl.	MW	52.218662	53.35002832	56.2930876
26	Connected load - Non-Agl.	MW	188.75108	197.84664	214.29652
27	Hours of power supply agl.	Hrs.	7	7	7
28	Hours of power supply non-agl.	Hrs.	18	18	24

Statistics of feeder segregation in Gujarat

S. No	Details	Units	Before Segregation	After Segregation	Current Status
1	No of mixed feeders	Nos	3639	0	0
2	No of agricultural feeders	Nos	0	3895	5842
3	No of non-agricultural feeders	Nos	2521	3706	5790
4	Total number of feeders	Nos	6160	7601	11632
5	No of agricultural customers	Nos	684102	725628	1075471
6	No of other customers	Nos	7581930	8108148	11637965
7	Number of 11 kV bay with VCB	Nos	6160	7601	11632

S. No	Details	Units	Before Segregation	After Segregation	Current Status
8	Length of 11 kV lines	ckm	170090	196805	304939
9	Number of DTRs	Nos	253264	282312	755162
10	DT Capacity	MVA	18476	20459	33342
11	Power Transformer Capacity	MVA	3090	3585	5355
12	Length of LT Overhead	ckm	223665	235925	304375
13	Length of LT AB cable	ckm	0	0	20510
14	No of Energy meters at DTRs	Nos	0	23093	476614
15	No of Energy meters at Feeders	Nos	5920	7477	11632
16	No of Energy meters at customer level	Nos	7773770	8328937	12227752
17	Length of LT lines converted to HT lines	ckm	-	0	5617
18	Agri Consumption (Sales) Metered	Mus	1240	1453	3817
19	Agri Consumption (Sales) Unmetered	MUs	8646	9585	11307
20	Total Agri consumption (sales) (A+B)	MU	9886	11038	15124
21	Non Agri consumption (sales)	MU	23807	21224	42988
22	Connected load agri consumption	MW	5687	6071	9481
23	Connected load non agri consumption	MW	11851	14369	23676
24	Hours of power supply agri consumer	Hrs	8 Hrs	8 Hrs	8 Hrs
25	Hours of power supply non agri consumer	Hrs	20 Hrs to Rural Consumers (24 Hrs to other Consumers)	24 Hrs	24 Hrs

Statistics of feeder segregation in Punjab

Sr. No.	Details (Number)	Units	Before Segregation	After Segregation (Envisaged)	Current Status
1	No. of mixed feeders (including Kandi area feeders)	Nos.	1,064	243	216
2	No. of agricultural feeders	Nos.	2,253	4,000	4,662
3	No. of Non-agricultural feeders	Nos.	1,850	3,167	3,057
	No. Of Urban Pattern Supply (UPS)feeders	Nos.	-	1,204	1,259
	Other than UPS & AP feeders	Nos.	1,850	1,963	1,798
4	Total number of feeders	Nos.	5,166	7,411	7,935
5	No. of agricultural customers	Nos.	899,613	1,049,408	1,162,220
6	no. of other customers	Nos.	4,464,984	5,644,738	5,976,857
7	Number of 11 KV bay with VCB	Nos.	4,895	7,335	7,427
8	Length of 11 KV lines	Nos.	127,379	176,554	198,867
9	Number of DTRs	Nos.	335,144	520,483	657,771
10	Length of LT overhead	ckm	136,162	136,257	135,422
11	Length of LT AB cable	ckm	1	50	4,268
12	No. of Energy meters at DTRs	Nos.	5,515	25,763	21,223
13	No. of Energy meters at Feeders	Nos.	5,166	7,411	7,935
14	No. of Energy meters at customers level*	Nos.	4,241,618	5,385,404	5,946,884
15	Length of LT lines converted to HT lines	ckm	2,385	11,432	11,355
16	Losses in Agri. Feeders	%	16.32	16.30	11.67
17	Losses in Non-Agri. Feeders	%	30.151	29.348	28.076
18	Total AT&C Losses of the Discom	%	23.819	19.838	21.287

Sr. No.	Details (Number)	Units	Before Segregation	After Segregation (Envisaged)	Current Status
19	Agri consumption (sales)	MU	12,344	14,043	11,173
20	Non-Agri consumption (sales)	MU	19,476	34,278	26,272
25	Connected load Agri. Consumption	MW	179,672	230,504	220,116
26	Connected load Non-Agri. Consumption	MW	375,714	1,727,951	461,650
27	Hours of power supply agri. Consumer***	Hrs.	6	6 to 7	6 to 8
28	Hours of power supply Non-agri. Consumer	Hrs.	22	22-23	23-24

Annexure 3: Additional details on feeder segregation experience in Punjab

Pilot Projects: Under the program for feeder segregation carried out in Punjab, before rolling it out across Punjab, pilot project on 4 feeders was executed and the results were audited for over a year. The results of the pilot project executed during 2007-08 were very encouraging as briefed below

1) ***Urban Area:*** **11KV Hospital feeder (work completed during Jan. 2008)**

Total material cost: ₹ 05 Lakh
Saving in Losses: 22 LU
Annual Saving @ 4/kWh : ₹ 88 Lakh
PAY BACK PERIOD: Less than month

Pilot project- 11KV Hospital feeder

Sr. No.	Description	Before Implementation (Jan 07 to Dec. 07)	After Implementation (Jan 08 to Dec. 08)
1	No. of consumers	970	970
2	Energy input(LU)	111.81	93.09
3	Billed energy(LU)	79.97	84.97
4	Losses %	28.43	8.72
5	No. of D.T. installed	21	21
6	Damage rate of T/Fs	-	Nil
7	No. of Complaints	substantial	Minimal
8	Max. Demand in Amp.	145	130

2) ***Urban Basti Area:*** **11KV Badungar Feeder Patiala (Work completed Sept. 2008)**

Total material cost: ₹ 25 Lakh
Saving in Losses: 02.06 LU
Annual Saving @ 4/kWh : ₹ 08.24 Lakh
PAY BACK PERIOD: 3 years

Pilot project- 11KV Badungar Feeder Patiala

Sr. No.	Description	Before Implementation (Nov. 07to Dec. 07)	After Implementation
1	No. of consumers	1058	1102
2	Energy input (LU)	4.44	2.63
3	Billed energy(LU)	2.01	2.41
4	Losses %	54.72	8.36
5	No. of DI installed	8	7.7.1

Sr. No.	Description	Before Implementation (Nov. 07to Dec. 07)	After Implementation
6	Damaged rate of T/Fs	25%	Nil
7	No. of Complaints	Substantial	Minimal
8	No. of new connections applied	-	44
9	Max. Demand in Amp.	35	20

3) Rural Area:

a) <u>11KV Ablowal UPS Feeder, Patiala</u> (work completed during April 2008)

This feeder supplies electricity to 10 villages of DS/NRS category besides few Atta Chakkis.

Total material cost: ₹ 50 Lakh
Saving in Losses: 15.43 LU
Annual Saving @ 4/kWh : ₹ 61.72 Lakh
PAY BACK PERIOD: Less than one years

Pilot project- 11KV Ablowal UPS Feeder, Patiala

Sr. No.	Description	Before Implementation (July 07 to Feb.08)	After Implementation (July 08 to Feb.09)
1	No. of consumers	2241	2389
2	Energy input (LU)	48.31	37.26
3	Billed energy(LU)	24.16	30.53
4	Losses %	49.98	18.06
5	No. of T/F's installed	31	39
6	Damage rate of T/Fs	15.3%	Nil
7	No. of Complaints	substantial	Minimal
8	No. of new connections applied	-	148
9	Max. Demand in Amp.	110	80

b) <u>11KV Dakala UPS feeder, Patiala(Work completed during October, 2008)</u>

This feeder supplies electricity to single village of Dakala comprising around 850 DS/NRS consumers.

Total material cost: ₹ 18 Lakh
Saving in Losses: 05.85 LU

Annual Saving @ 4/kWh : ₹ 23.40 Lakh
PAY BACK PERIOD: Less than one years

Pilot project- 11KV Dakala UPS feeder, Patiala

Sr. No.	Description	Before Implementation (Nov. 07 to Dec. 07)	After Implementation
1	No. of consumers	812	857
2	Energy input(LU)	10.41	4.41
3	Billed energy(LU)	2.48	3.53
4	Losses %	76.17	19.95
5	No. of DT installed	12	12
6	Damaged rate of T/Fs	40%	Nil
7	Complaints	substantial	Minimal
8	No. of new connections applied	-	45
9	Max. Demand in Amp.	85	40

PILOT STUDIES SUMMARY: REDUCTION OF LOSSES DUE TO SHIFTING OF METERS (2007-08)

Pilot Studies Summary

S. No.	Name of Feeder	Before (in %)	After (LT is minimised) (in %)
1	11 KV Hospital Feeder	28.43	8.72
2	11 KV Badungar Feeder	54.72	8.36
3	11 KV Ablowal UPS Feeder	49.98	18.06
4	11 KV Dakala UPS Feeder	76.17	19.95

After attaining success in the pilot project, the low cost T&D loss reduction program was rolled out across Punjab from 2009 onwards. Out of about 38 Lakh meters in rural and sub-urban areas, under Phase-I of the scheme, 20.57 Lakh meters have been shifted out at a cost of around 700 Crore on turnkey basis. The impact of the feeders covered under Phase-I of this project is summarized in the table below:

Impact Analysis

S.N.	Circle	Division	Name of 11 KV feeder	Benefits (%)					
				Reduction in Load/Max. demand (A)	Reduction in pumped in energy	Increase in Revenue Collection	Reduction in losses	Reduction in DT's damage rate	Reduction in no supply consumer complaint
1	Ferozepur	City Ferozepur	Mana Singh Wala	(-) 2.17	(-) 0.87	(+) 56.31	(-) 54.48	(-) 66.00	(-) 80
2	Ferozepur	City Ferozepur	Sodhe Wala	(-) 8.82	(-) 26.02	(+) 12.13	(-) 48.81	(-) 75.00	(-) 79
3	Ferozepur	Jalalabad	Mohar Singh Wala UPS	(-) 21.53	(-) 16.36	(+) 15.96	(-) 52.00	(-) 75.00	(-) 72
4	Ferozepur	Jalalabad	Sunderpura UPS	(-) 10.34	(-) 15.55	(+) 9.40	(-) 48.60	(-) 66.00	(-) 78
5	Ferozepur	Zira	UPS-2	(-) 16.67	(-) 6.06	(+) 56.60	(-) 60.00	(-) 66.67	(-) 59
6	Ferozepur	Zira	UPS Meshari + Lalle	(- 27.27)	(-) 12.04	(+) 44.01	(-) 54.00	(-) 75.00	(-) 61
7	Ferozepur	Zira	UPS Dhanna Sahib	(-) 25.00	(-) 8.57	(+) 116.75	(-) 34.15	(-) 66.67	(-) 69
8	Ferozepur	S/U Ferozepur	UPS Madhre	(-) 14.70	(-) 34.95	(+) 21.04	(-) 163.93	(-) 50.00	(-) 237
9	Gurdaspur	S/U Batala	Qilla Lal Singh	(-) 9.33	(-) 19.73	(+) 12.64	(-) 10.00	(-) 100.00	(-) 95
10	Gurdaspur	Gurdaspur	Babehali	(-) 37.5	(-) 35.60	(+) 61.87	(-) 45.83	(-) 66.66	(-) 82
11	Hoshiarpur	Dasuya	Panwa	(-) 30.46	(-) 20.91	(+) 19.13	(-) 24.47	(-) 0.00	(-) 47
12	S/U Amritsar	Jandiala Guru	Mula Chack	(-) 4.90	(-) 11.47	(+) 46.04	(-) 19.18	(-) 66.66	(-) 77
13	S/U Amritsar	Jandiala Guru	Chati Wind	(-) 20.79	(-) 14.88	(+) 118.63	(-) 24.17	(-) 0.00	(-) 59
14	Kapurthala	S/UKapurthala	Model Town	(-) 22.42	(-) 30.93	(+) 13.54	(-) 25.95	(-) 0.00	(-) 22
15	Kapurthala	Kartarpur	Hamira	(-) 26.31	(-) 9.60	(+) 21.10	(-) 30.70	(-) 66.67	(-) 42

S.N.	Circle	Division	Name of 11 KV feeder	Benefits (%)					
				Reduction in Load/Max. demand (A)	Reduction in in pumped energy	Increase in Revenue Collection	Reduction in losses	Reduction in DT's damage rate	Reduction in no supply consumer complain
16	Kapurthala	Kartarpur	Pattar Kalan	(-) 20.80	(-) 11.90	(+) 21.99	(-) 17.70	(-) 66.66	(-) 56
17	Kapurthala	Kartarpur	Ibrahimwal	(-) 20.57	(-) 29.95	(+) 29.86	(-) 84.50	-	(-) 20
18	Faridkot	City Moga	Bughipur	(-) 45.00	(-) 33.00	(+) 6.92	(-) 72.42	(-) 100	(-) 81
19	Faridkot	Suburban Moga	Kokri Vehniwal	(-) 11.11	(-) 16.67	(+) 15.42	(-) 53.42	-	(-) 79
20	Amritsar	East Amritsar	Gumtala	(-) 13.80	(-) 10.28	(+) 67.98	(-) 51.62	(-) 14.54	(-) 36

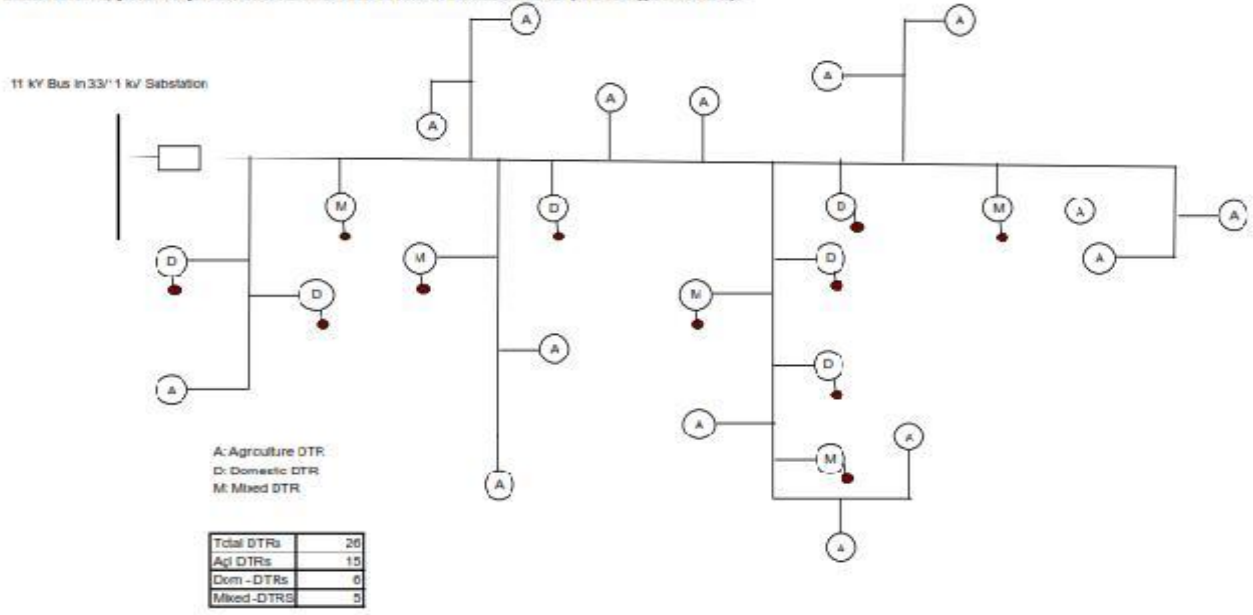
The Phase-II of the scheme at a cost of around ₹ 1000 Cr is under implementation and 0.44 lac meters have been shifted out till date. Total investment in low cost maintenance project under non RAPDRP scheme is likely to be ₹ 1700 cr. which will cover 38 lac consumers at an average cost of about ₹ 4500 per consumer. Payback period is thus 3 to 4 years. The average loss on UPS and sub-urban feeders is likely to reduce from 50-70% to 18-20%. The added advantage of the low cost T&D loss reduction project is that the 100% correct metering of non-AP consumers is attained, possibility of theft of power is reduced to minimum as the bare LT conductor is replaced by XLPE cables and the meters of these consumers become inaccessible to them

Photographs showing the Pillar Box arrangement – The Game Changer for Punjab


DANGER

Annexure 4: Exhibits representing feeder segregation schematics in erstwhile Andhra Pradesh

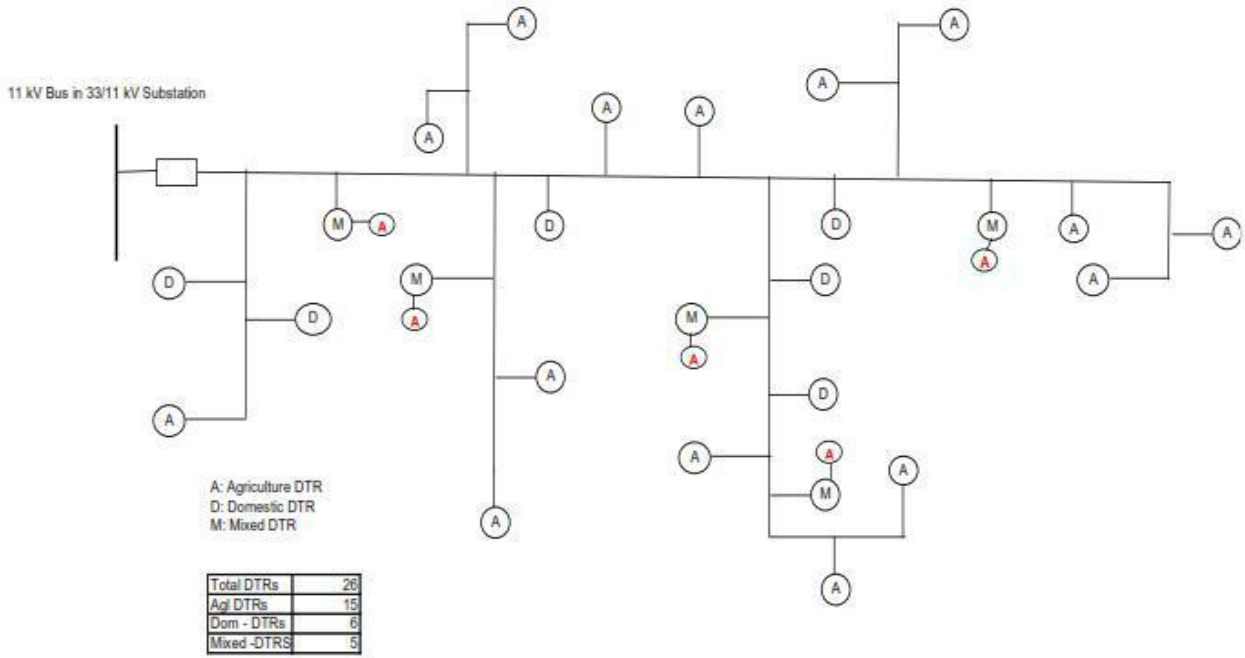
Exhibit I- Typical Representation of a 11 kV Rural Feeder in AP (Existing situation):



Notes:

- Feeder is energized in 3p mode for 7 hours per day and in 1p mode in 17 hours per day.
- At the locations of D type & M type DTRs, additional 1p Transformers are also erected to cater to the loads in 1p during 17 hours per day, since 3p DTR is inactive during that time period.

Exhibit II- Agriculture Load Segregation at DTR end (one of the solutions suggested for segregation)

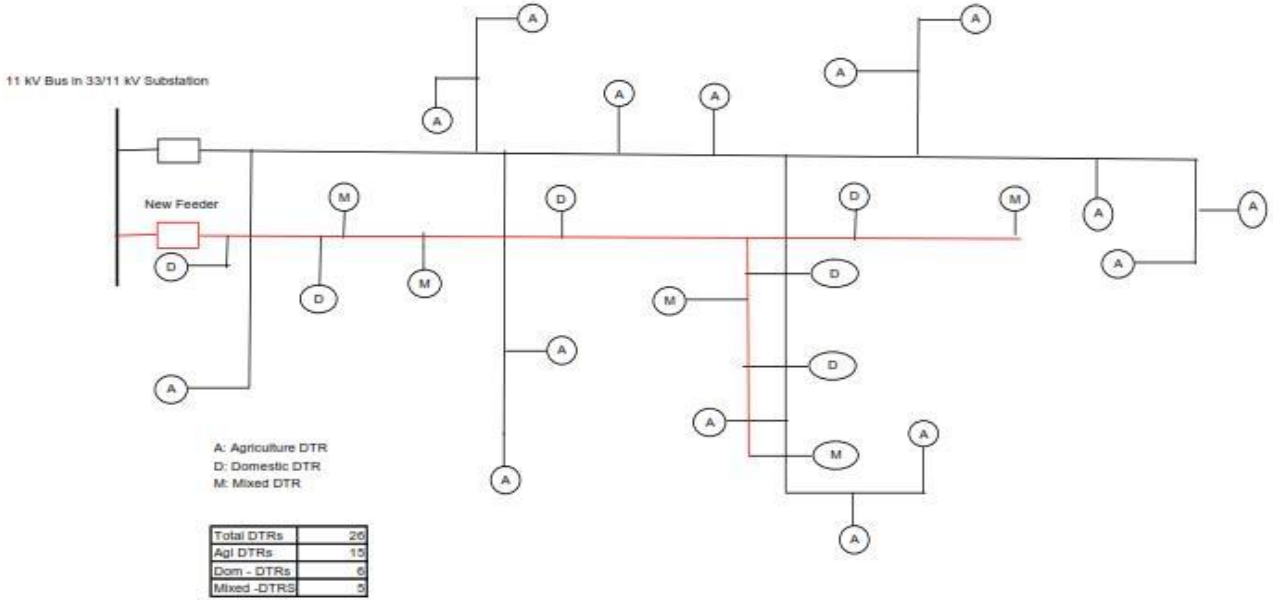


Total DTRs	26
Agl DTRs	15
Dom - DTRs	6
Mixed -DTRS	5

Notes:

- All the Agriculture DTRs to be fixed with electronic timer switches, so that supply will be fed during stipulated time and DTR automatically shuts off.
- If Timer switches are located outside the DTR, they might be tampered by farmers for getting continuous supply. So they have to be fixed internally.
- Apart from new Agl DTRs erected a mixed locations , existing DTRs also to be erected with these Timer Switches.

Exhibit III: Schematic showing physical segregation of 11 kV feeders

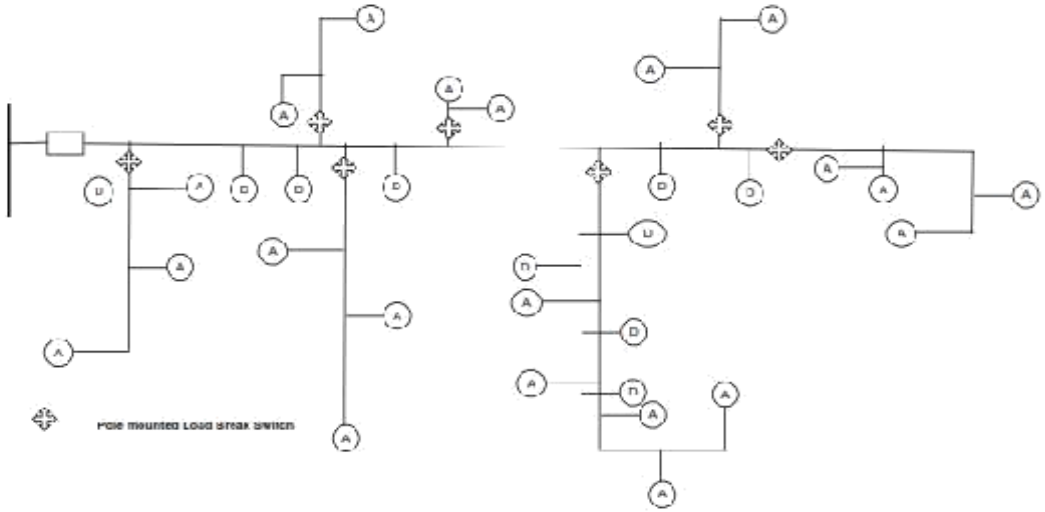


Total DTRs	26
Agl DTRs	15
Dom - DTRs	6
Mixed -DTRS	5

Exhibit IV- Revamped virtual segregation (one of the suggested solutions for segregation)

In the **revamped virtual segregation** loads are segregated at DTR level and all AGL loads are tagged to separate laterals / spur lines as shown in the following diagram and pole mounted load break switches can be erected on the first pole of each sub-branch / spur line as shown in the schematic.

The Load break switch would be able to Switch On and Switch Off in a particular time pattern of the day as per the pre-programme, otherwise it could be controlled from the Substation. In this way, all rural consumers can get 3 phase supply for 24 hours and agriculture consumers can get 8 hours or 10 hours per day supply as per the policy.


Pole mounted Load break switch

Estimation of cost of feeder segregation on Ckt. KM basis

Sr.No	Particulars	Units	Value	Source	Period
1	Total length of 11 kV line	Ckt.KM	2676229	CEA-All India Electricity Statistics	2010-11
2	Estimated length of 11 kV line	Ckt.KM	3777715	Estimated with annual growth of 9%	2014-15
3	Estimated length of rural feeders	Ckt.KM	2266629	Estimated with 60% factor	2014-15
4	Cost of segregation of feeder per KM	Rs.Crore	0.033	per KM cost of Haryana	2014-15
5	Total Estimated cost of segregation	Rs. Crore	74799	Estimated	2014-15
6	Already completed in various states	%	10%	Assumption	
7	Estimated cost of FSP alone for remaining feeders	Rs. crore	**67319**	Computed	2014-15
SHIFTING OF METERS OUTSIDE PREMISES OF NON-AP CONSUMERS IN NON-URBAN AREAS					
8	Total Domestic Consumers in India	crore	18.35	CEA-All India Electricity Statistics	2010-11
9	Estimated Domestic consumers in India	crore	22.3	Estimated with annual growth of 5%	2014-15

10	Estimated Non-Urban Domestic Consumers	crore	13.38	Estimated with 60% factor	2014-15
11	Cost of shifting of meter per consumer	Rs.	5000	Punjab report (including inflation)	2014-15
12	Total cost of shifting non-urban DS consumers	Rs. Crore	**66900**	Computed	2014-15
IMPLEMENTATION OF LESS L.T HVDS ON PURE AP FEEDERS					
13	Cost of HVDS per pumpset	Rs./ Pumpset	40,000	Assumption (Andhra report)	
14	Total number of pumpsets in India	Crore No.	1.92	CEA-Pumpset energisation report (july 2014)	2014-15
15	Cost of HVDS for 50% pumpsets	Rs. crore	**38400**	Computed	2014-15
ESTIMATED COST OF FEEDER SEGREGATION PROJECT INCLUDING METER SHIFTING OF NON-AP CONSUMERS &LESS LT HVDS OF AP FEEDERS					
16	FSP Cost (Grand Total) (col. 7+12+15)	Rs. crore	**172619**		2014-15
COST BENEFIT ANALYSIS					
17	Total Consumption of DS consumers	MU	155301	CEA-All India Electricity Statistics	2010-11
18	Estimated consumption of DS consumers	MU	203567	Estimated with annual growth of 7%	2014-15
19	Estimated consumption of non-urban consumers	MU	122140	Estimated with 60% factor	2014-15
20	Estimated saving in energy due to meter shifting	MU	**36642**	Estimated with 30% saving (Punjab Experience)	2014-15

21	Total AP consumption	MU	126378	CEA-All India Electricity Statistics	2010-11
22	Estimated AP consumption	MU	153613	Estimated with 5% annual growth	2014-15
23	Estimated AP consumption of 50% pumpsets (replaceable)	MU	76807	Computed	
24	Estimated Saving in energy due to HVDS	MU	**15361**	Estimated with 20% saving as per PSPCL experience	
25	Total expected energy saving from FSP	MU	52003		
26	Cost of Power per unit	Rs.	6.0		
27	Total Saving from FSP	Rs. Crore	**31202**		
28	Simple Pay back period	years	5.5		
29	Proportion of pilot project in the total project	%	3%	Assumption	
30	Total cost of pilot project (Stage 1)	Rs. Crore	5179	Computation	2014-15
31	GoI funding for pilot projects (Stage 1)	%	100%	Proposed	
32	GoI funding for pilot projects	Rs. Crore	4914	Estimated	2014-15
33	Total cost of full scale projects (Stage 2)	Rs. Crore	167705	Computation	2014-15
34	GoI funding for Full scale projects without 100% metering	%	50%	Proposed	

35	GoI funding for Full scale projects with 100% metering	%	75%	Proposed	
36	GoI funding for stage-2 (lower end)	Rs. Crore	83852	Assuming no projects are considered with 100% metering	2014-15
37	GoI funding for stage-2 (higher end)	Rs. Crore	125779	Assuming all projects are considered with 100% metering	2014-15
38	Total GoI funding at lower end: Total of stage 1 & 2 at lower end		**88766**	Assuming no projects are considered with 100% metering	2014-15
39	Total GoI funding at higher end: Total of stage 1 & 2 at higher end		**130693**	Assuming all projects are considered with 100% metering	2014-15

Estimation of cost of pump replacement with Energy Efficient Pumpsets				
Particulars	**Units**	**Value**	**Source**	**Period**
Estimated pumpsets in India	lac	192	Estimated with annual growth of 4%	2014-15
cost of pump replacement	Rs.	40000	Assumption	
Total cost of 50% pump replacement	Rs. Crore	38400	Computed	2014-15
Total AP consumption	MU	126378	CEA-All India Electricity Statistics	2010-11
Estimated AP consumption	MU	153613	Estimated with 5% annual growth	2014-15
Estimated AP consumption of 50% pumpsets (replaceable)	MU	76807	Computed	
Estimated Saving in consumption	MU	**23042**	Estimated with 30% saving as per EESL report	
Cost of Power per unit	Rs.	6	Assumption	2014-15
Total saving	Rs. crore	13825	Computed	
Simple pay back period	years	2.78	Computed	

Estimation of cost of AMR metering & LT Capacitor				
Particulars	**Units**	**Value**	**Source**	**Period**
total number of pumpsets in India	crore no.	1.92	CEA-All India Electricity Statistics	2014-15
cost of AMR metering per pumpset	Rs./pumpset	4500	Estimated	2014-15
cost of LT capacitor (average)	Rs./pumpset	1000	Estimated	2014-15
Total cost of 100% DT metering and LT capacitor for two AP motors per DT	Rs. Crore	5280	Computed	2014-15
Total AP consumption	MU	126378	CEA-All India Electricity Statistics	2010-11
Estimated AP consumption	MU	153613	Estimated with 5% annual growth	2014-15
Estimated AP consumption of 50% pumpsets (replaceable)	MU	76807	Computed	2014-15
Estimated Saving in energy due to LT capacitors	MU	**7680**	Estimated with 10% saving as per PSPCL experience	2014-15
Cost of Power	Rs./kWh	6	Estimated	
Saving	Rs. Crore	4608		
Simple Pay back period	Years	1.15		

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