



Model Green Division

(A joint initiative by TERI & BSES Yamuna Power Limited)



THE ENERGY AND RESOURCES INSTITUTE
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BSES
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List of *Abbreviations*

Term	Full Form
AC	Air Conditioner
DERC	Delhi Electricity Regulatory Commission
DISCOM	Distribution Company
DR	Demand Response
DSM	Demand Side Management
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CO ₂ e	Carbon Dioxide Equivalent
EEM	Energy Efficiency Measures
EESL	Energy Efficiency and Services Limited
EMI	Equated Monthly Instalments
EMS	Energy Management System
ESCO	Energy Service Company
EV	Electric Vehicle
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
HVAC	Heating, Ventilation and Air Conditioning
GNCTD	Government of National Capital Territory of Delhi
GRIHA	Green Rating for Integrated Habitat Assessment
GSS	Grid Sub Station
GWp	Gigawatt-peak
INR	Indian Rupees
IRR	Internal Rate of Return
kg	Kilograms
kL	Kilolitre
km	Kilometre
kW	Kilowatts



List of *Abbreviations*

kWh	Kilowatt-hours
kWp	Kilowatt-peak
L	Litre
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
Misc.	Miscellaneous
MNRE	Ministry of New and Renewable Energy
MT	Metric Tonnes
MU	Million Units
MW	Megawatts
MWp	Megawatt-peak
NEMMP	National Electric Mobility Mission Plan
NPV	Net Present Value
O&M	Operations and Management
OPEX	Operational Expenditure
p.a.	Per Annum
PV	Photovoltaic
RESCO	Renewable Energy Services Company
RPO	Renewable Purchase Obligation
Sq. ft.	Square Feet
TERI	The Energy and Resources Institute
W	Watts
WBS	Work Breakdown Structure
Yrs.	Years



Executive *Summary*

The report details out the Model Green Division Project to be undertaken in Mayur Vihar Phase – I & II Division. BSES Yamuna Power Limited (BYPL) in association with TERI has been actively working on conceptualizing and finding a way forward for the project. The Model Green Division Project will comprise conceptualization and development of a series of measures, both utility-level and customer-oriented, to BYPL for minimizing the impact on the environment. Under utility-level measures, BYPL buildings falling under the project area's jurisdiction would be in focus and will be upgraded to green buildings. To reduce energy dependence and effectively reduce the carbon footprint, certain initiatives, such as replacement of electrical appliances in offices, installation of rooftop solar systems, introduction of electric vehicles for operational duties, rainwater harvesting and minimizing paper usage, have been envisaged. Under customer-oriented measures, efforts would be made to engage with customers for creating awareness about energy efficiency and renewable energy measures, BYPL existing initiatives and programmes and as a means to execute BYPL's corporate social responsibility initiatives as a responsible organization. The document summarizes costs for the major elements of the Model Green Division Project. Further, a cost-benefit analysis has been detailed in the report. The overall project cost considering major elements is INR 3.61 crores considering contingencies, escalation, supervision, and taxes. Going ahead with this project would give BYPL an outstanding opportunity to showcase its commitment to environment and motivate our customers to adopt environment-friendly measures. The proposed measures can potentially reduce carbon footprint to the tune of 2100 tonnes of CO₂e per year. This initiative is going to create a green culture for customers and employees which, in turn, will be beneficial to the environment and society as a whole.

Background

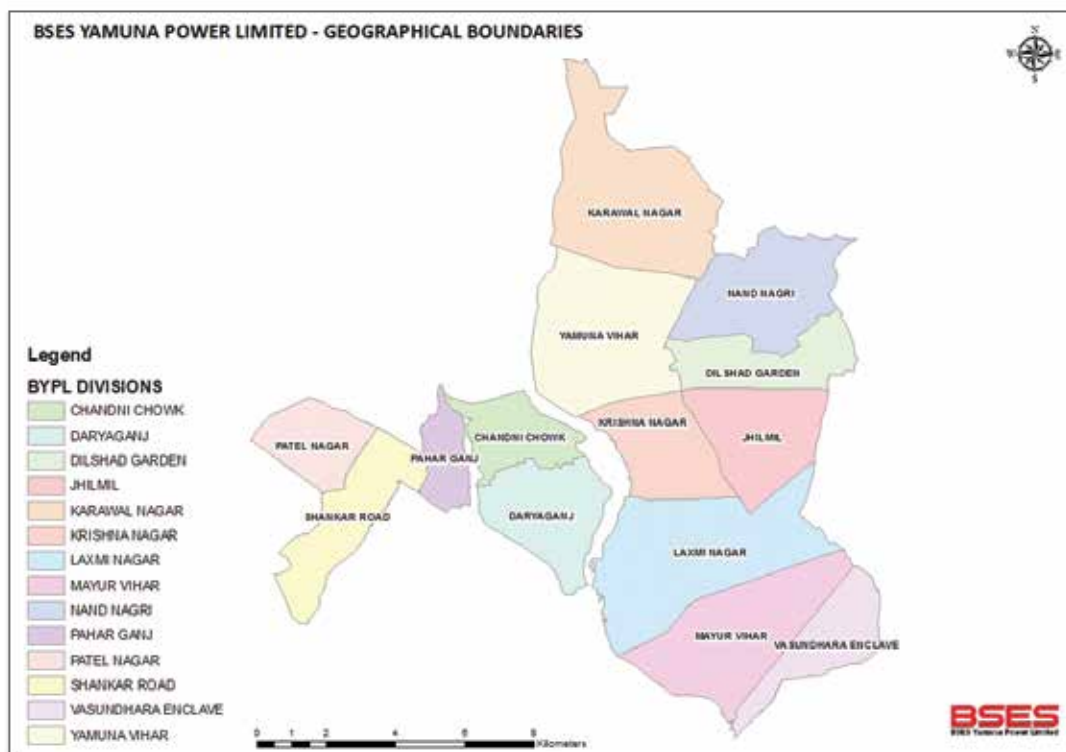


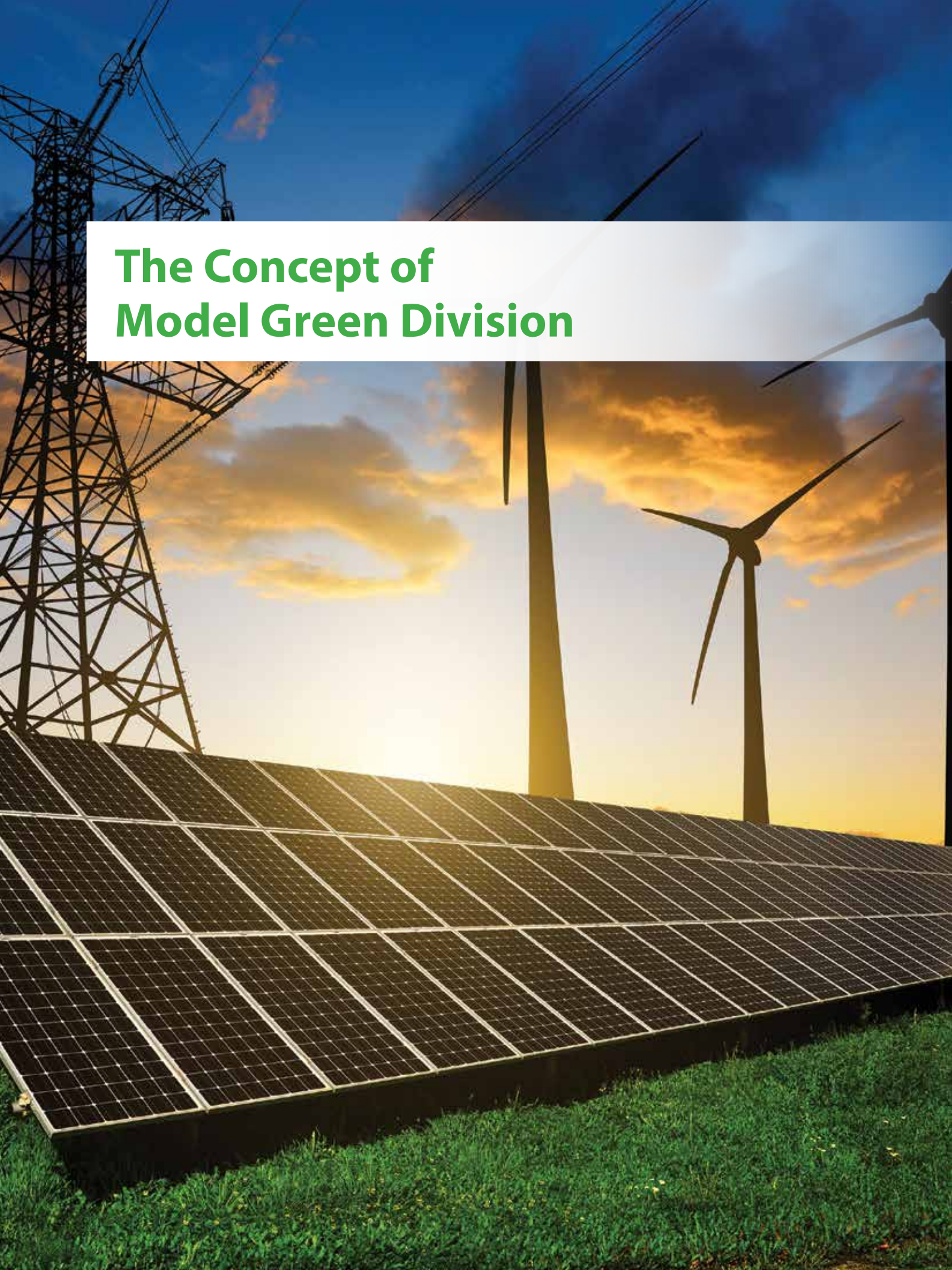
BSES Yamuna Power Limited (BYPL), a power distribution licensee, caters power to around 1.6 million customers in the central and eastern parts of Delhi. The company met the peak power load of 1459 MW and supplied around 7200 million units during 2017–18. For operational purposes, BYPL has divided its license area into 14 distinct geographical areas known as divisions, namely Chandni Chowk, Darya Ganj, Pahar Ganj, Shankar Road, Patel Nagar under Central circle, Jhilmil, Karawal Nagar, Laxmi Nagar, Mayur Vihar Phase I & II, Mayur Vihar – III under South East circle, and GT Road, Krishna Nagar, Nand Nagri, and Yamuna Vihar under the North East circle.

Being fully aware of the adverse impact of thermal power generation on the environment, the company has actively promoted energy-efficient equipment and solar power among its customers. During the past few years, it has been successful in selling 20 lakh Energy Efficiency Services Limited (EESL)-supplied energy efficient LED bulbs among its customers leading to sustainable reduction in power consumption year on year. The company has also encouraged its customers to install rooftop solar plants and avail net metering facility from the company. These efforts, undertaken at all 14

divisions of the company, have led to 230 net metering connections with a total installed capacity of around 15 MWp by September 2018.

Notwithstanding the initiatives described above, the company has witnessed an increase in the peak demand and annual consumption of power year after year. It was therefore felt that present interventions are not adequate to mitigate increasing consumption levels and energy intensity. Thereupon, the company undertook a series of activities in this direction, namely, brainstorming among the company executives, feedback from customers, interactions with the experts in renewable energy, environmental issues, etc. These interactions revealed that the company should view power consumption in the larger context of ecological sustenance while focussing on power consumption because electricity generation is one of the big contributors to generation of greenhouse gases (GHGs). Also, the interventions promoted towards ecological sustenance should address the issue at two levels—customer awareness and customer confidence. Subsequent deliberations on these issues led the company to come up with a concept of a 'Green Division'.





The Concept of Model Green Division

The concept of a Model Green Division is an extension of the concept of a green building. Conceptually, a 'green building' is the one which optimizes the use of water and energy, generates minimum waste, and maximizes comfort for the building occupants by consuming minimum resources. Extension of this concept of green building to a power distribution division (geographical area for the operational purpose of power distribution utility) implies optimum usage of water and energy, and minimum wastage of resources in all buildings located in the division. Envisaging that all buildings owned by thousands, if not lakhs of different owners, in a geographic area, as 'green', is a utopian concept.

In order to create a culture of uptaking green initiatives, there is a requirement of active participation of various stakeholders which can be achieved by creating awareness through various consumer awareness programmes and campaigns at the ground level. In order to achieve our environment objectives and for creation of a sustainable environment, it was conceptualized to convert a power distribution area into a 'Model Green Division' as a pilot case. Since being on the initial conceptual level, successful implementation on a smaller scale will help in determining any flaws in the current methodology adopted. Once successfully implemented on a smaller scale, it can then be expanded to other areas and thus help in creating mass awareness amongst sections of consumers to adopt

green and energy efficiency measures which would help in benefitting the society as a whole. Being committed towards environment preservation, it will help the utility to showcase the benefits of adopting similar measures to consumers and become a leading example in the consumer awareness programme

Based on the success and learnings, the initiative would be further replicated in other divisions of the utility. The project for a power distribution area into a Model Green Division will have two focus areas of implementation, namely—utility-level measures and customer-oriented measures. The utility dimension envisaged the 'Model Green Division' as the one in which all buildings owned by the utility in an area are 'green'. This dimension also envisaged usage of energy-efficient equipments and e-vehicles by the utility. On the customer dimension, the concept of 'Model Green Division' included Demand Side Management and customer awareness programmes. Thus, the scope of a 'Model Green Division' was restricted to those customer-oriented activities which are under the control of the utility but which may lead to wider participation of energy conservation. However, it is envisaged that 'green' buildings of the utility, besides reducing energy consumption and wastage among these buildings, will act as demonstration projects to instill confidence about the concept among the customers.



BYPL Model Green Division Project



Being a new concept, the company decided to convert one power distribution division out of its 14 divisions into a “Model Green Division” to start with. Implementation of the concept in one division will enable the company to focus its efforts on one division, identify flaws in the proposed model, iron out these flaws, spot challenges in execution, and address these challenges to ensure its success. Once successfully implemented on a smaller scale, the model will be standardized and replicated among all the remaining 13 divisions.

The company selected Mayur Vihar Phase – I & II division as the first “Model Green Division” after evaluation of all divisions on various parameters, such as loss level, customer demography, ease of implementation, number of company-owned buildings, and proximity to the head and circle offices. The project will have two implementation focus areas, namely, utility-level measures and customer-oriented measures that BYPL will execute as part of the project. Both parts will be executed simultaneously.

Project Description

Utility-level measures

A preliminary survey was carried out during June 2018 to estimate the scope pertaining to utility-level measures. Subsequently, discussions were held with the key division-level officials, namely to finalise the scope for the utility-level measures of the project. Once the scope was

detailed, the quantum of work was estimated through measurements on site.

The utility-level measures would be implemented for all the BYPL buildings, as detailed in Table 1, falling under the Mayur Vihar Phase – I & II Division.

The following utility-level measures have been identified after discussions at various levels in the company and with external experts:

- » Rooftop Solar PV system,
- » Replacement of old appliances with energy-efficient appliances,
- » Sun reflective coatings on rooftop,
- » Rain water harvesting,
- » Provision of e-vehicles for the field teams,
- » Waste management
- » Going ‘E’

A brief background on the above measures and their relevance to the project is as follows:

Rooftop solar PV systems

The importance of solar power in meeting the ever-growing national energy requirements needs no introduction. The governments at both the national and state levels have adopted policies to accelerate the growth of rooftop solar. The Ministry of New and Renewable Energy, Government of India, has launched various schemes for the promotion of rooftop solar at the national level to meet its target of 40 GWp installed

Table 1: List of offices Building falling under Mayur Vihar Phase – I & II Division

Building Name	Building Purpose/Operations
Business Division Office , Mayur Vihar, Phase – I	Division Office – Business
Pocket C , Sub Division office, Mayur Vihar phase – II	Sub-division - O&M
13 Block Sub Division office, Trilokpuri	Sub-division - O&M
Pandav Nagar/Anand Lok Sub division office	Sub-division - O&M
Chilla Village O&M Office Mayur Vihar, Phase - I ext.	Division Office – O&M
Block - 5 Trilokpuri (Dispensary)	Dispensary
Pocket E, Meter Store, Mayur Vihar phase – II	Store
Khichripur Grid Sub Station	Grid Sub Station
Chilla Grid Sub Station	Grid Sub Station
Noida More Grid Sub Station	Grid Sub Station



capacity by 2022. The Government of National Capital Territory of Delhi (GNCTD) has laid out the Delhi Solar Policy, 2016, which focuses on the importance of rooftop solar as one of the viable forms of energy generation. It has clearly set targets to be achieved in total solar capacity with the importance given to net-metering policy of Delhi Electricity Regulatory Commission (DERC). It has also made the role of DISCOMs more evident for implementation of rooftop solar projects by counting all solar energy generated at a net metered connection site towards that DISCOM's RPO target.

BYPL plans to install rooftops solar power plants at all the existing space available on its own buildings and feed generated power directly to the grid. Solar generation capacities on BYPL premises would showcase the commitment to this form of energy and motivate customers in adjoining areas to opt for solar roof top system.

Replacement of old appliances with energy-efficient appliances

Introduction of energy-efficient equipment into the market and for internal use is an important step to achieving energy efficiency. There are various programmes being implemented by EESL for promotion of appliances, such as LEDs, energy-efficient ACs, and fans (star-rated). Another important approach is the

star-labelling system on most of the appliances so that a consumer can choose energy-efficient appliances for use.

BYPL uses four different types of equipment namely—lighting systems, fans, air conditioning, and miscellaneous equipments, such as water coolers, refrigerators, water pumps, etc., in its offices. The company plans to replace energy-guzzling appliances in BYPL buildings with energy-efficient ones.

Sun reflective coating on rooftop

There are rules and codes set by various building certifications (such as LEED and TERI-GRIHA) for energy-efficient buildings. These codes focus on building envelope, mechanical systems and equipment including heating, pumping, ventilating, HVAC, lighting and electrical systems and renewable energy. Many of these aspects need to be incorporated at the building design stage itself. There are limitations to which energy efficiency can be enhanced in an existing building. Nevertheless, energy audits, usage of sun reflective coatings, etc., can help in increasing the energy efficiency of the existing building.

Going for sun reflective coating on identified BYPL buildings would reduce air conditioning load. Further, implementation of these measures (including replacement of appliances) would help BYPL gain green certifications (LEED and GRIHA).

Rainwater harvesting

Rainwater harvesting provides a solution to our problem of depleting underground water. Under the Water Policy of Delhi 2016, it is mandatory for new buildings to install rainwater harvesting in certain notified areas.

During the survey of our building, it was observed that the selected buildings have a huge internal water consumption which needs to be controlled and managed. Also, there is a good scope of rainwater harvesting which can replace municipal water requirements and would lead to significant savings.

Provision of e-vehicles for the field teams

Hybrid and EVs provide a solution to our dependency on oil and gas as fuel for transportation. There is no policy and infrastructure support for the growth of EVs in the present market. EESL, on its part, is however making efforts to overcome these hurdles. But the main push towards the growth for this market is coming from the National Electric Mobility Mission Plan (NEMMP) 2020 launched by the Government of India in 2013. NEMMP aims to promote hybrid and electric vehicles in India by providing monetary support. Increased usage of e-vehicles will help in reduction of carbon footprint.

BYPL has taken a commitment as a member of EV-100 (Climate Group) to work towards the following goals by 2030:

- » EV integration in the present utility fleet (owned/ leased)
- » Supporting EV uptake by staff (charging and information / incentives)
- » Supporting EV uptake by customers (charging and information/incentives)

In order to meet these goals and gain technical expertise in operation and maintenance of e-vehicles by controlled introduction of such vehicles for its field operations, the operation of a small fleet of vehicles will help BYPL understand issues relating to charging of e-vehicles and its impact on the electrical grid network. In addition, high visibility of BYPL e-vehicles among customers will enhance their confidence in the viability of this technology and may increase the chances of customers adopting this technology faster.

Waste management

It is really important to reduce, segregate, and dispose the waste generated daily. Under this project, causes of waste generation in selected offices will be analysed and measures will be taken to reduce its generation. Measures will also be undertaken to ensure proper disposal of waste.

Going 'E'

Going 'electronic' or going 'E' in short, is a powerful way for reducing paper usage. BYPL prints 2-page electricity





bills for all its 1.6 million plus customers every month leading to colossal consumption of paper. BYPL is currently working on engaging more consumers to go for the option of e-billing by registering on their website and plans to promote acceptance of 'e-bills' among all its customers. These bills will be made available through 'one-window app' for consumer interaction.

Customer-oriented measures

Active participation of various other stakeholders, such as the end-customers, can only be achieved by creating awareness of the issue and the solution in hand. Various environment-oriented programmes focused

on the energy aspect must be implemented in order to accomplish this. Providing incentives provides a boost to the participation in the process. The awareness must begin from the school level in order to change the way of thinking of the next generation. Without any active stakeholder participation, there would not be any 'model green division'.

As a part of the awareness programmes and campaigns, BYPL is working on various fronts to introduce awareness among people about energy efficiency.

The themes for these activities along with targeted customer-oriented measures are summarized in Table 2.

Table 2: Proposed themes for customer-oriented measures

S. No	Themes	Proposed Measures
1	Energy Efficiency & Renewable Energy	a) Awareness Camps i. Solar Roof top ii. Energy Efficiency and Conservation iii. School level seminars iv. New Schemes from BYPL on energy efficient appliances v. E-bill adoption b) Engaging customers on opting for Demand response program c) Schemes for energy efficient appliances d) Promotion of rooftop solar systems e) DSM awareness
2	Paper conservation and waste management	a) Plantations b) Paper recycling c) Waste segregation d) Rain water harvesting

Project Analysis



Utility-level Measures

The project cost for various utility-level measures in all 10 identified buildings is discussed in the following sections.

Replacement of old appliances with energy-efficient appliances

Old appliances installed in the selected buildings were identified for replacement and are summarized in Annexure-II. Table 3 summarizes building-wise cost for replacement of appliances.

Cost Benefit Analysis

With the help of various new and energy-efficient equipments used for replacement, we were able to project a reduction in the connected load for each type and for each of the buildings as highlighted in Figure 1.

The total connected load and reduction in the connected load is estimated by calculating load of all the appliances present in the building appliances, apart from the ones considered for replacement, such as desktop, printers, etc., are also considered in total connected load calculations. This connected load and its reduction have been plotted

Table 3: Investment required for replacement of old appliances in different buildings

S. No	Building Name	Investment Required (INR)
1	Khichripur Grid, Grid Sub St. , Near LBS Hospital	2,64,920
2	Chilla Village Grid Sub Station	2,55,350
3	Noida More Grid Sub Station	2,42,520
4	Chilla Village O&M, Mayur Vihar, Phase - I ext.	3,21,610
5	Business Division Office, Mayur Vihar, Phase – I	3,91,640
6	Block - 5 Trilokpuri (Dispensary)	2,05,090
7	13 Block Sub Division office, Trilokpuri	62,930
8	Pocket – C, Sub Division Office, Mayur Vihar Phase – II (Addl. VP office)	1,85,770
9	Pocket - E, Meter Store, Mayur Vihar Phase - II	13,070
10	Pandav Nagar/Anand Lok Sub division office	1,07,960
	Grand Total	20,50,860

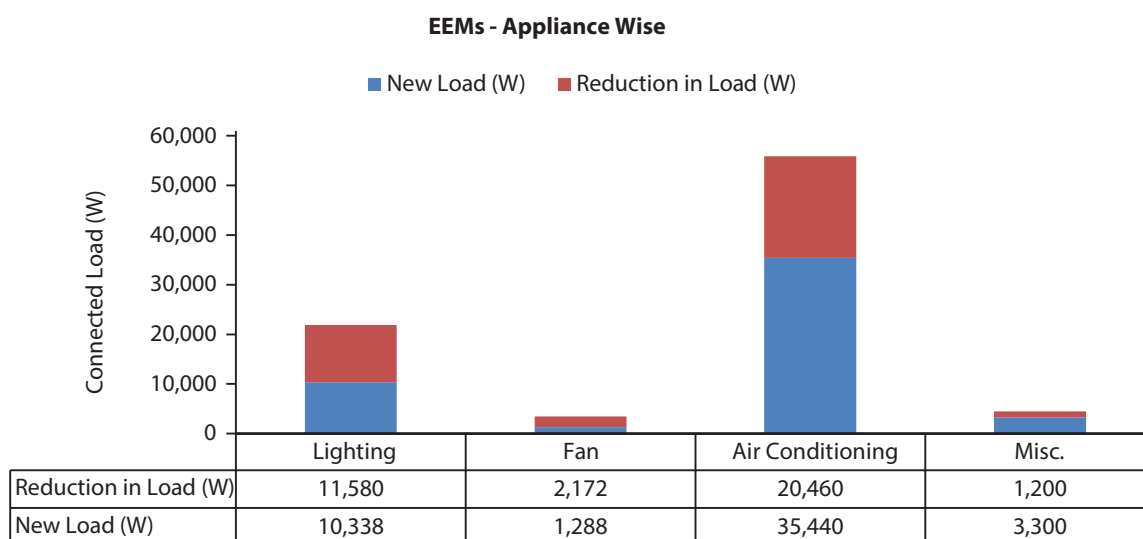


Figure 1: Appliances Wise Reduction in Connected Load

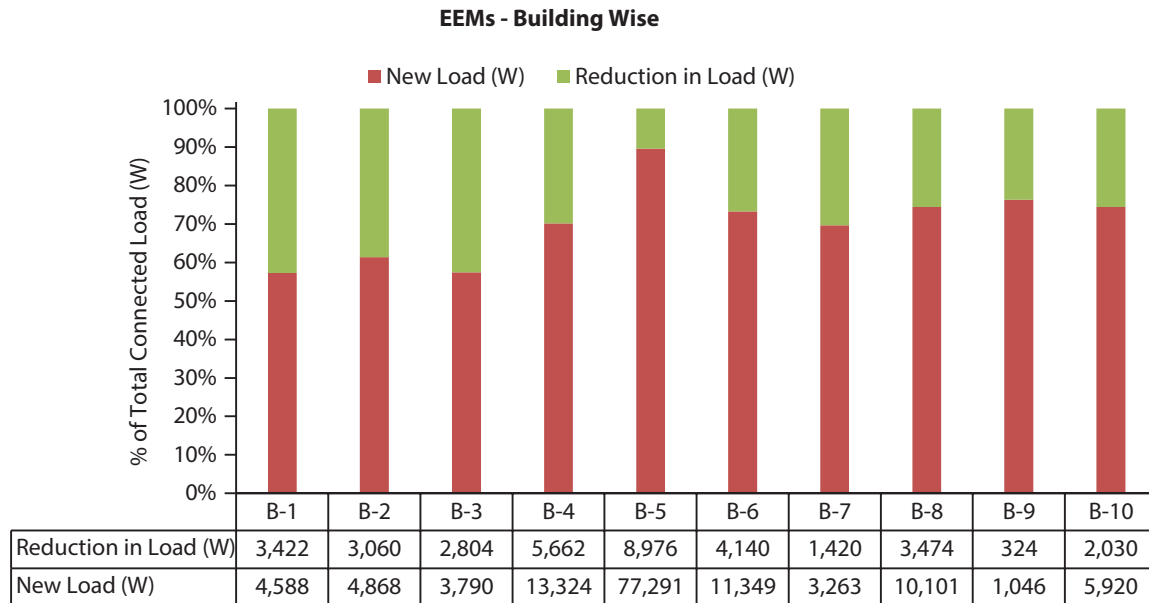


Figure 2: Building Wise Reduction in Total Connected Load

for each building (refer Figure 2) to demonstrate the percentage reduction as a result of EEMs.

As a result of reduction in load, it is estimated that there would be a reduction in the energy (or units of electricity) consumed for the operation of each of the building. It is based on estimate of the duration of operation of each equipment.

For the energy savings calculations, we have only considered the consumption and the savings for the appliance which are being replaced by more energy-efficient appliances.

Alongside the technical analysis, the financial analysis was also performed for these EEMs to understand what the cost incurred and monetary savings for implementation of such measures.

Energy Savings (kWh per day) -Appliance Wise

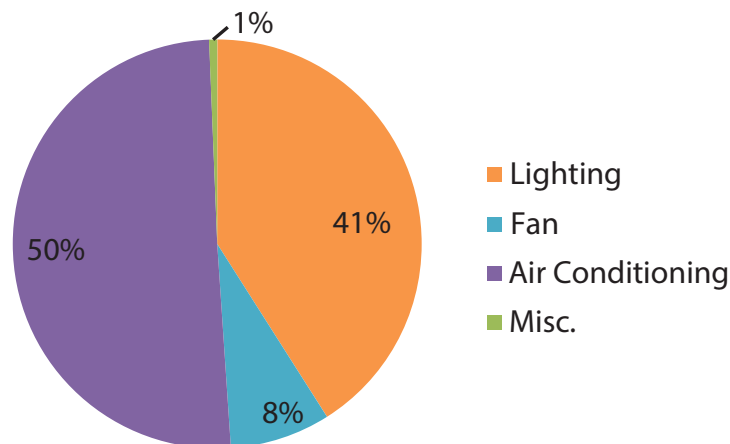


Figure 3: Reduction in Energy Savings for Appliance Replaced

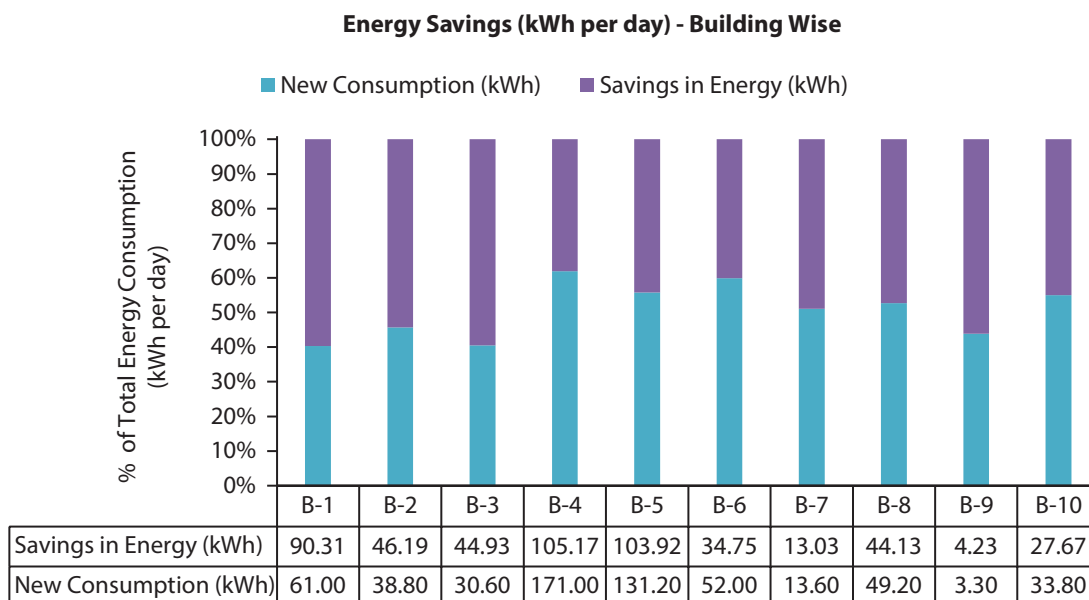


Figure 4: Building-wise Reduction in Energy Savings for Appliances Replaced

Energy-efficiency measures were evaluated as a part of the utility-level scenario for conceptualizing a model green division. With an aim of reducing the connected load of each of the building and thereby reducing the

electricity consumption for each of the buildings, the implementation was targeted at replacing the old and less efficient equipment with new and energy-efficient equipment.

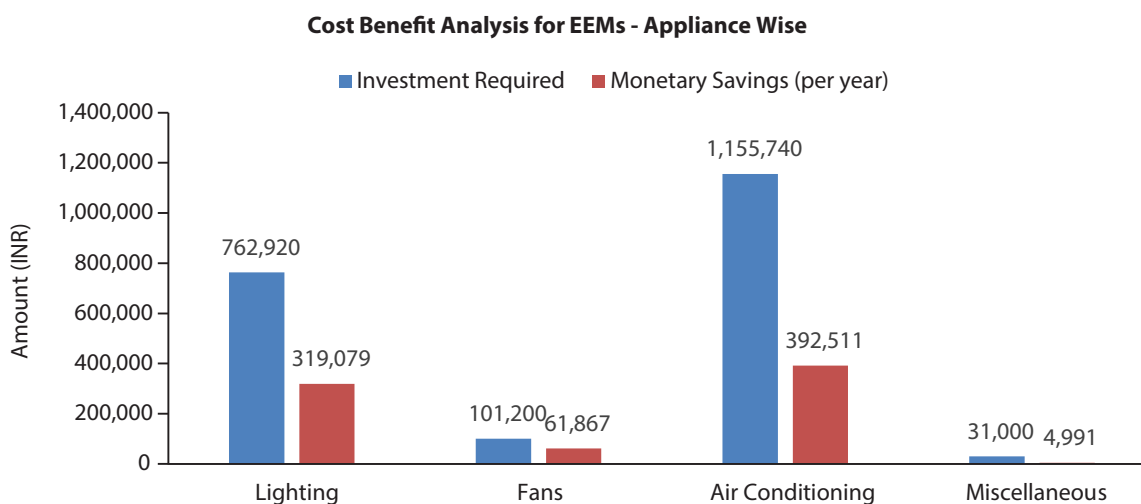


Figure 5: Appliance-wise Cost Benefit Analysis for Energy Efficiency Measures¹

¹ For monetary savings, we have used the value of electricity tariff for the utility (BYPL) as INR 4.14 with CAGR at 3%.

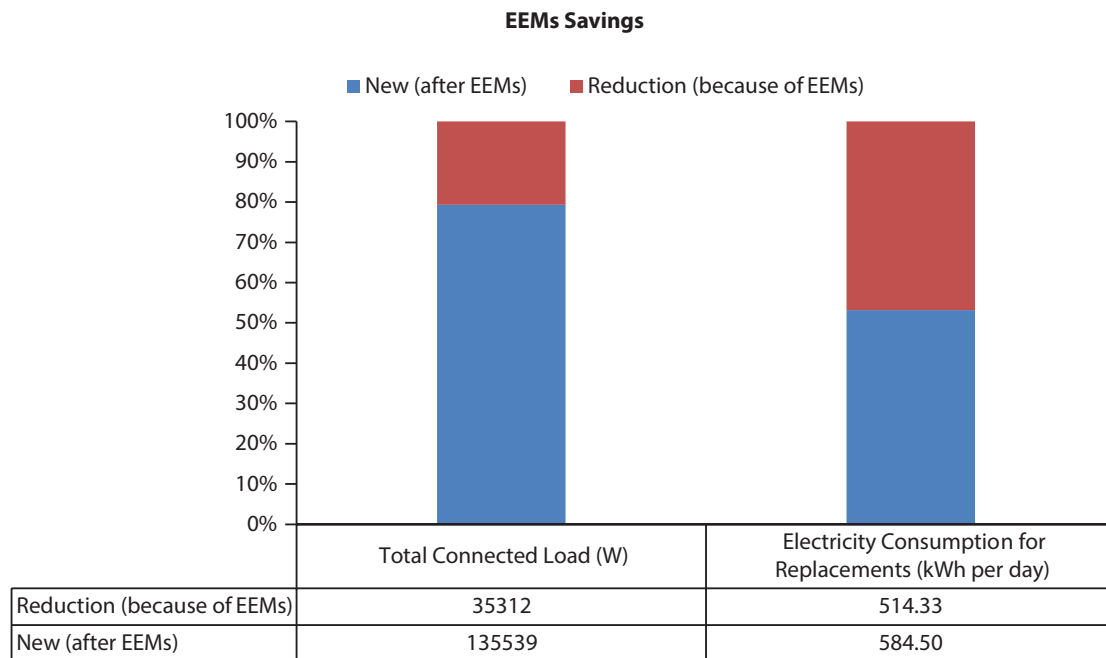


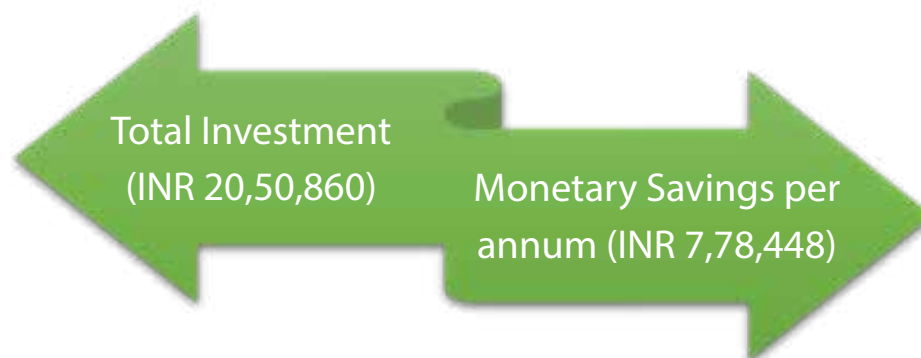
Figure 6: Total Energy Savings for Energy Efficiency Measures

It has been observed that, with standard replacement of appliances, it is expected that there is approximately 20% reduction in the total connected load of all the utility buildings. The standard replacement would lead to 45% reduction in electricity consumption for the various appliances replacement. With a more detailed analysis of the connected load and replacement of equipment, a further reduction in connected load may be achieved along with the same in electricity consumption.

For the implementation of the EEMs, a business model can be worked out with the vendors and the bank wherein

the annual monetary savings made by the utility can be used to as EMI for the repayment of the total investment required for implementing energy efficiency measures.

This business model would work around the payback period, which would depend on the monetary savings and the investment required. It may be organized in two ways—appliance wise or building wise. The payback period and thus the EMI period would vary in each case.



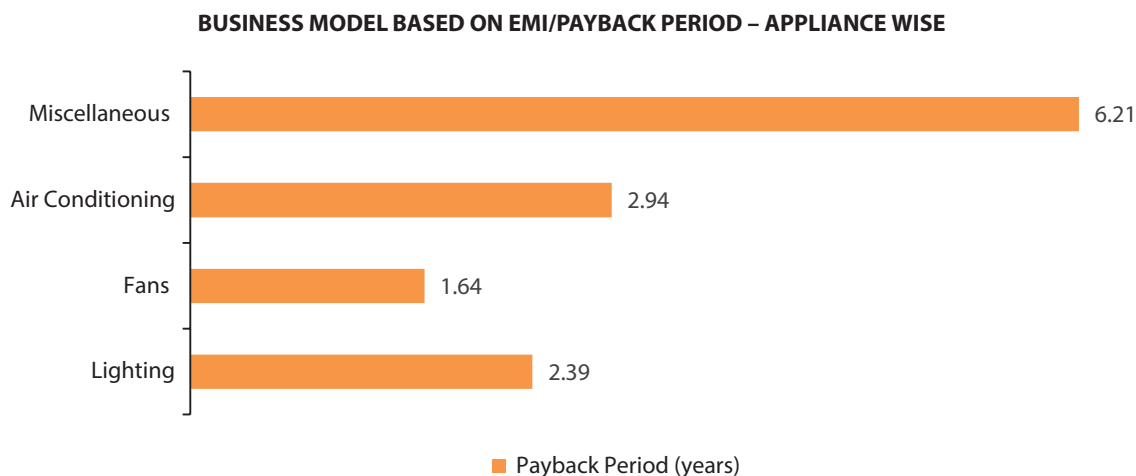


Figure 7: Business Model Based on Payback Period for Appliance Wise Scenario

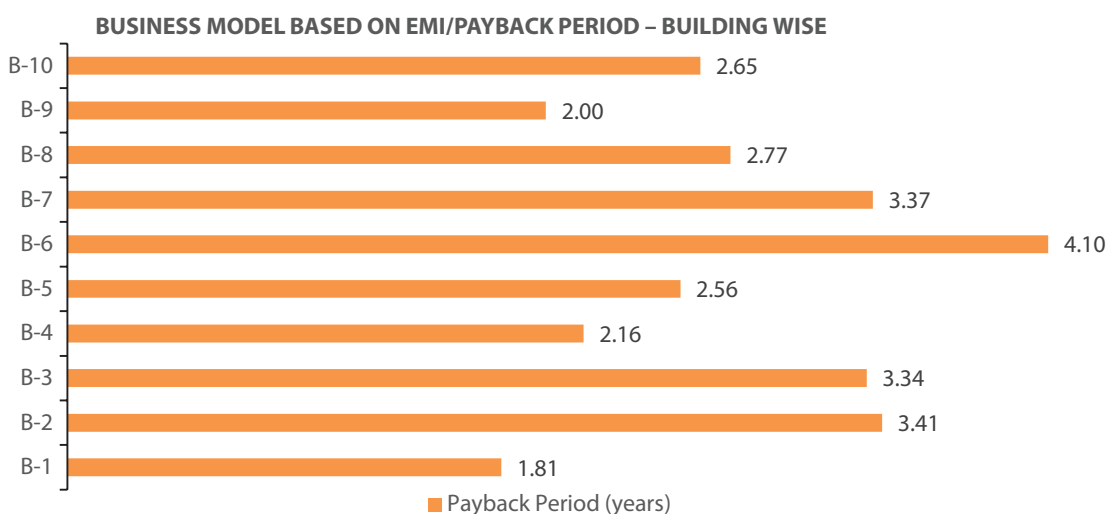


Figure 8: Business Model Based on Payback Period for Building Wise Scenario

Installation of Rooftop Solar Systems

It is envisaged to install rooftop solar systems on the BYPL office buildings. With the installation of rooftop solar, one intent is to make building as a net positive building in terms of energy. Further, the adoption of solar roof top generation will provide leverage for making a case for distributed generation and help BYPL in managing peak load effectively in the future. Table 4 summarizes building-wise estimated potential capacity for installation.

The cost associated with installation of roof top solar power plants on BYPL office buildings is summarized in Table 5.

Cost Benefit Analysis

Two models have been proposed for installation of solar capacity, namely, 1) CAPEX and 2) RESCO. The cost benefit analysis results, for both the models taken into consideration, are summarized in Tables 6 and 7.



Table 4: Building-wise estimated potential rooftop solar capacity

S.No.	Building Name	Estimated Potential (kWp)
1	Mayur Vihar - Business Division Office	13.8
2	Pocket C, Mayur Vihar, Phase II - Sub Division Office	13.2
3	13 Block Sub Division office, Trilokpuri ²	-
4	Pandav Nagar/Anand Lok - Sub Division Office	2.24
5	Chilla Village - O&M Office	5.61
6	Trilokpuri - Dispensary	9.57
7	Pocket E, Mayur Vihar, Phase II - Meter Store	1.98
8	Khirchipur - Grid Sub Station	26.1
9	Chilla - Grid Sub Station	31.7
10	Noida More - Grid Sub Station	31.7
	TOTAL	135.9

Table 5: Estimated installation cost of rooftop solar systems for each utility building

S.No.	Building Name	Estimated Potential (kWp)	Project Installation Cost(INR)
1	Mayur Vihar - Business Division Office	13.8	7,07,250
2	Pocket C, Mayur Vihar, Phase II - Sub Division Office	13.2	6,76,500
3	13 Block Sub Division office, Trilokpuri ²	-	-
4	Pandav Nagar/Anand Lok - Sub Division Office	2.24	1,14,800
5	Chilla Village - O&M Office	5.61	2,87,512
6	Trilokpuri – Dispensary	9.57	4,90,462
7	Pocket E, Mayur Vihar, Phase II - Meter Store	1.98	1,01,475
8	Khirchipur - Grid Sub Station	26.1	13,37,625
9	Chilla - Grid Sub Station	31.7	16,24,625
10	Noida More - Grid Sub Station	31.7	16,24,625
	TOTAL	135.9	69,64,875

² Rooftop Solar PV System is not feasible at this location

Table 6: Cost benefit analysis for CAPEX Model

RTS Capacity Size (kWp)	135.9
Own Consumption (MU)	0.44
Yearly Growth	3%
RPO (INR/kWh)	2
Escalation in RPO (%)	3%
IRR (%)	22%
NPV @11% (INR Lacs)	47
Payback Period (yrs.)	6

Table 7: Cost benefit analysis for RESCO Model

RTS Capacity Size (kWp)	135.9
Efficiency	18%
First Year Annual Generation (MU)	0.2142871
Generation Reduction (% p.a.)	1.00%
Benchmark Cost (INR/kWp)	51250
O&M Cost (INR/kW)	1100
Escalation in O&M Cost (% p.a.)	5.00%
Electricity Tariff Structure (INR/kWh)	4.14
Electricity Tariff CAGR (% p.a.)	4.00%
Solar Tariff (INR/kWh)	3.50
Solar Tariff CAGR (% p.a.)	0.00%
Discount Rate (% p.a.)	11.00%
Own Consumption (MU)	0.44
Yearly Growth	3%
RPO (INR/kWh)	2
Escalation in RPO (%)	3%
NPV @ 11% (INR Lacs)	76

As can be seen from the above analysis, the rooftop solar systems are viable in both CAPEX and RESCO models.



E-Vehicles for operational duties

It is proposed to replace existing vehicles deployed for operational duties. The vehicles would be replaced by e-vehicles to minimize their impact on the environment. Table 8 presents a summary of the vehicles which need to be replaced.

Table 9 summarizes the cost associated with replacement by e-vehicles.

Cost Benefit Analysis

There are inherent benefits for adopting e-vehicles due to cost savings in running and maintenance. Figure 9 shows a comparison of running cost considering CAPEX and OPEX (for an average running of 40 km per day) among two wheelers of various types.

Further, it was also seen that running cost for a four wheeler is less than that of a regular petrol vehicle. As

Table 8: Summary of all utility vehicles

S. No	Operational Duty	No of Vehicles
1 Business Office		
	a) Meter Reader/ Bill Distributor– Two Wheeler	45
	b) Recovery– Four Wheeler	1
	c) Recovery – Two Wheeler	8
2 O&M		
	a) O&M – Four Wheelers	4
	b) O&M – Two Wheelers	54
	Total	112

Table 9: E-vehicles Implementation – Cost Analysis

S. No	Operational Duty	No. of Vehicles	Per vehicle cost (INR)	Total Cost (INR)
1. Business Office				
a)	Meter Reader/ Bill Distributor– Two Wheeler	45	34,568	15,55,560
b)	Recovery– Four Wheeler	1	7,25,000	7,25,000
c)	Recovery – Two Wheeler	8	34,568	2,76,544
2. O&M				
a)	O&M – Four Wheelers	4	7,25,000	29,00,000
b)	O&M – Two Wheelers	54	34,568	18,66,672
	Total	112		73,23,776

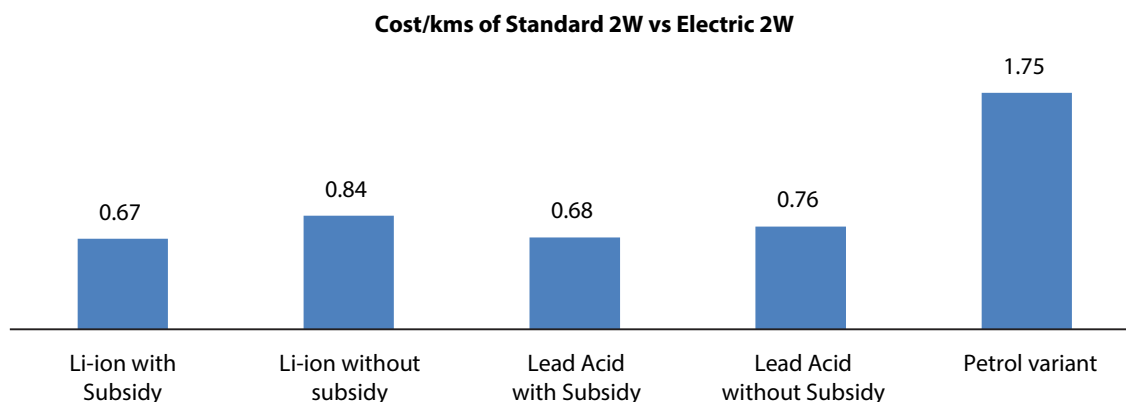


Figure 9: Analysis for e-vehicles under various scenarios

per the proposal, a total of 107 two wheelers are to be purchased, out of which 54 will be used to replace the existing bicycles. This would help in greater mobility of lineman staff and better operational efficiency. While justifying, this comparison has been made between replacing with regular petrol bikes and electric two wheelers. It was found that cost of purchasing and operating electric two wheelers would cost INR 110 lakhs less than that of petrol two wheeler option. Similarly replacement of four wheelers for operational duties would help in saving of INR 22 lakhs over the lifecycle. The detailed cost benefit analysis and the running cost comparison for the above is shown in Annexure – II.

Reflective Coatings on office buildings and rooftops

To calculate area for putting in place sun reflective coating on the walls, 60% of floor area has been considered.

The building wise roof area, wall area is summarized in Table 10.

Table 11 summarizes cost associated with reflective coatings for office locations.

It is envisaged that this measure would be able to save 10% of internal consumption leading to annual saving of INR 2.09 lakhs and a payback period of 2.5 years.

Table 10: Area for sun reflective coating measures for all utility buildings

S.NO	Building Name	Building Area (sq. ft.)	Floor Area @ 80% Of Building Area (sq. ft.)	Roof Area For Painting @ 60% (sq. ft.)	Wall Area @ 60 % Of Floor Area (sq. ft.)	Total Area For Coating (sq. ft.)
1	Mayur Vihar - Business Division Office	6,348	5,078	3,047	3,047	6,094
2	Pocket C, Mayur Vihar, Phase II - Sub Division Office	4,080	3,264	1,958	1,958	3,917
3	13 Block Sub Division office, Trilokpuri	770	616	370	370	739



Table 10: Area for sun reflective coating measures for all utility buildings

S.NO	Building Name	Building Area (sq. ft.)	Floor Area @ 80% Of Building Area (sq. ft.)	Roof Area For Painting @ 60% (sq. ft.)	Wall Area @ 60 % Of Floor Area (sq. ft.)	Total Area For Coating (sq. ft.)
4	Pandav Nagar/Anand Lok - Sub Division Office	1,026	821	492	492	985
5	Chilla Village - O&M Office	3,168	2,534	1,521	1,521	3,041
6	Trilokpuri – Dispensary	2,352	1,882	1,129	1,129	2,258
7	Pocket E, Mayur Vihar, Phase II - Meter Store	1,558	1,246	748	748	1,496
8	Khirchipur - Grid Sub Station	5,100	4,080	2,448	2,448	4,896
9	Chilla - Grid Sub Station	4,920	3,936	2,362	2,362	4,723
10	Noida More - Grid Sub Station	5,040	4,032	2,419	2,419	4,838
	Total	34,362	27,489	16,494	16,494	32,987

Table 11: Reflective Coatings Implementation - Cost Analysis

S.NO	Building Name	Building Area (sq. ft.)	Floor Area @ 80% Of Building Area (sq. ft.)	Roof Area For Painting @ 60% (sq. ft.)	Wall Area@ 60 % Of Floor Area (sq. ft.)	Total Area For Coating (sq. ft.)	Cost (INR)
1	Mayur Vihar - Business Division Office	6,348	5,078	3,047	3,047	6,094	97,504
2	Pocket C, Mayur Vihar, Phase II - Sub Division Office	4,080	3,264	1,958	1,958	3,917	62,672
3	13 Block Sub Division office, Trilokpuri	770	616	370	370	739	11,824

Table 11: Reflective Coatings Implementation - Cost Analysis

S.NO	Building Name	Building Area (sq. ft.)	Floor Area @ 80% Of Building Area (sq. ft.)	Roof Area For Painting @ 60% (sq. ft.)	Wall Area@ 60 % Of Floor Area (sq. ft.)	Total Area For Coating (sq. ft.)	Cost (INR)
4	Pandav Nagar/ Anand Lok - Sub Division Office	1,026	821	492	492	985	15,760
5	Chilla Village - O&M Office	3,168	2,534	1,521	1,521	3,041	48,656
6	Trilokpuri - Dispensary	2,352	1,882	1,129	1,129	2,258	36,128
7	Pocket E, Mayur Vihar, Phase II - Meter Store	1,558	1,246	748	748	1,496	23,936
8	Khirchipur - Grid Sub Station	5,100	4,080	2,448	2,448	4,896	78,336
9	Chilla - Grid Sub Station	4,920	3,936	2,362	2,362	4,723	75,568
10	Noida More - Grid Sub Station	5,040	4,032	2,419	2,419	4,838	77,408
	Total	34,362	27,489	16494	16,494	32,987	5,27,792



Rainwater Harvesting for Internal Use

Table 12 summarizes roof area, catchment area, total area available at the sites:

Table 13 summarizes cost associated with building necessary rainwater harvesting infrastructure at green division office locations.

Table 12: Total area for rainwater harvesting for all utility buildings

S. No	Building Name	Roof Area (sq. ft.)	Catchment Area (sq. ft.)	Total Area (sq. ft.)
1	Mayur Vihar - Business Division Office	6,348	1,270	7,618
2	Pocket C, Mayur Vihar, Phase II - Sub Division Office	4,080	816	4,896
3	13 Block Sub Division office, Trilokpuri	770	154	924
4	Pandav Nagar/Anand Lok - Sub Division Office	1,026	205	1,231
5	Chilla Village - O&M Office	3,168	634	3,802
6	Trilokpuri- Dispensary	2,352	470	2,822
7	Pocket E, Mayur Vihar, Phase II - Meter Store	1,558	312	1,870
8	Khirchipur - Grid Sub Station	5,100	2,040	7,140
9	Chilla - Grid Sub Station	4,920	1,968	6,888
10	Noida More - Grid Sub Station	5,040	2,016	7,056

Table 13: Rainwater Harvesting Implementation - Cost Analysis

S. No	Building Name	Roof Area (sq. ft.)	Catchment Area (sq. ft.)	Total Area (sq. ft.)	Rate (INR/sq. ft.)	Total Cost (INR)
1	Business Division Office , Mayur Vihar, Phase – I	6,348	1,269	7,618	100	7,61,760
2	Pocket C , Sub Division office, Mayur Vihar, Phase – II	4,080	8,16	4,896	100	4,89,600
3	13 Block Sub Division office, Trilokpuri	770	154	924	100	92,400
4	Pandav Nagar/Anand Lok Sub division office	1,026	205	1,231	100	1,23,120

Table 13: Rainwater Harvesting Implementation - Cost Analysis

S. No	Building Name	Roof Area (sq. ft.)	Catchment Area (sq. ft.)	Total Area (sq. ft.)	Rate (INR/sq. ft.)	Total Cost (INR)
5	Chilla Village O&M Office, Mayur Vihar, Phase - I ext.	3,168	633	3,802	100	3,80,160
6	Block - 5 Trilokpuri (Dispensary)	2,352	470	2,822	100	2,82,240
7	Pocket E, Meter Store, Mayur Vihar, Phase - II	1,558	311	1,870	100	1,86,960
8	Khichripur Grid Sub Station	5,100	2,040	7,140	100	7,14,000
9	Chilla Grid Sub Station	4,920	1,968	6,888	100	6,88,800
10	Noida More Grid Sub Station	5,040	2,016	7,056	100	7,05,600
					Total	44,24,640



Table 14 highlights cost benefit analysis through implementation of rainwater harvesting measures.

Table 14: Rain water harvesting Implementation - Cost and Savings - Cost Benefit Analysis

S. No	Building Name	Roof Area (sq. ft.)	Catchment Area (sq. ft.)	Total Area	Rate (INR/ sq. ft.)	Total Cost (INR)	Water Collection (L)	Consumption (L)	Saving	Monthly Saving	Tariff (INR/ kL)	Saving (kL)	Saving (INR)
1	Mayur Vihar - Business Division Office	6,348	1,270	7,618	100	7,61,760	5,56,109	2,90,000	2,90,000	24,167	35	290	1,22,287
2	Pocket C, Mayur Vihar, Phase II - Sub Division Office	4,080	816	4,896	100	4,89,600	3,57,423	3,20,000	3,20,000	26,667	88	320	3,37,344
3	13 Block Sub Division office, Trilokpuri	770	154	924	100	92,400	67,455	2,50,000	67,455	5,621	26	67	21,046
4	Pandav Nagar/ Anand Lok - Sub Division Office	1,026	205	1,231	100	1,23,120	89,881	3,10,000	89,881	7,490	26	90	28,421
5	Chilla Village - O&M Office	3,168	634	3,802	100	3,80,160	2,77,529	3,10,000	2,77,529	23,127	35	278	1,17,028
6	Trilokpuri - Dispensary	2,352	470	2,822	100	2,82,240	2,06,044	2,80,000	2,06,044	17,170	35	206	86,885



Table 14: Rain water harvesting Implementation - Cost and Savings - Cost Benefit Analysis

S. No	Building Name	Roof Area (sq. ft.)	Catchment Area (sq. ft.)	Total Area	Rate (INR/ sq. ft.)	Total Cost (INR)	Water Collection (L)	Consumption (L)	Saving	Monthly Saving	Tariff (INR/ kL)	Saving (kL)	Saving (INR)
7	Pocket E, Mayur Vihar, Phase II - Meter Store	1,558	312	1,870	100	1,86,960	1,36,487	1,00,000	1,00,000	8,333	26	100	31,620
8	Khirchipur - Grid Sub Station	5,100	2,040	7,140	100	7,14,000	5,21,242	2,00,000	2,00,000	16,667	35	200	84,336
9	Chilla - Grid Sub Station	4,920	1,968	6,888	100	6,88,800	5,02,846	2,00,000	2,00,000	16,667	35	200	84,336
10	Noida More - Grid Sub Station	5,040	2,016	7,056	100	7,05,600	5,15,110	1,80,000	1,80,000	15,000	35	180	75,902
						Total Cost						Total Savings	9,89,205

For the above investment, there would be an annual savings of INR 9.89 lakhs leading to a payback period of 4.5 years.



Consumer-oriented Measures & DSM

With reference to 'Green Initiatives', BYPL has been running many programmes for the benefits of the consumer and for the society as a whole to ensure

participation in climate change measures. Till date, BYPL has achieved some of the success through continuous awareness programmes and are sure to augment such measures effectively to benefit the society as a whole. Proposed locations and tentative schedule for carrying out customer-oriented measures are detailed in Table 15.

Table 15: List of proposed locations to carry out customer-oriented measures

S. No	Location
Apartments/Society	
1	Bhagyan Apartments
2	Fine Home Apartments
3	Akash Darshan Apartments
4	Una Apartments
5	Gyandeep Apartments
6	Mavila Apartments
7	Mannu Apartments
8	Maitri Apartments
9	Navbharat Apartments
10	Kalavihar Apartments
11	Parwana Apartments
12	Manas Apartments
13	Nirman Apartments
14	Dronacharya Apartments
DDA Housing Society	
1	Pocket- II Mayur Vihar-1
Schools	
1	Govt. Boys Sr. Sec School
2	Govt. Girls Sr. Sec School
3	Mother Mary School
4	Alcon International school
5	ASN Public school

The awareness activity would be carried out by the identified agency sequentially in the above mentioned locations. The agency would arrange camps on the identified locations for early adoption of energy-efficiency measures. As a result of this measures, potential reduction in electricity consumption leads to reduction in CO₂e emissions as detailed in Annexure – III.

Demand Side Management (DSM)

Demand Side Management (DSM) refers to initiatives that encourage consumers to optimize their energy use. Consumers can reduce their electricity bill by adjusting time and amount of electricity to be used and energy systems becomes more stable as the load demand becomes more uniform—these are the two main benefits of DSM. Active participation from the consumers as well as the DISCOMs is required for successful implementation of DSM.

- » Demand response: BYPL has already carried out demand response (DR) programme in the last two years. It is envisaged to involve consumers in the green division in a greater way.
- » Consumer behaviour studies: Consumer behaviour studies will be carried out in some of group housing societies to assess response and devise information and fiscal instruments. Further, incentives may be offered to the consumers to go for energy-efficient appliances in addition to the already running BYPL schemes.
- » Focused campaigns for promotion of energy-efficient appliances: BYPL, in association with ESCOs, had carried out a workshop to bring together ESCOs and

consumers for better understanding and adoption of energy efficiency. It is proposed to carry out focused interactions with RWAs.

- » Setting up of e-marketplace for energy efficient appliances: It is proposed to set up an e-marketplace focusing on customers of the green division by involving interested parties.
- » Smart meters and smart grid: Both the smart meters and the smart grid, combined together, will help in managing electricity distribution by providing real time data on the consumption pattern. With the advent of Time of Day tariff and further plans to introduce dynamic tariffs, smart metering arrangement will help in enhanced customer participation.
- » Energy management systems (EMS): EMS for homes, buildings, factories, and communities would help in managing and reducing the energy consumption pattern in-house by integration of smart meters with our EMS. Shifting of loads to non-peak hours helps in smoothening out the load curve.
- » Storage appliances and captive power generation: They provide a solution to reduce the peak demand. Renewable power, although variable in power generation, can also be integrated easily with the help of automation and data collection into the smart grid. It is envisaged to carry out some pilot projects in Mayur Vihar – Phase I and II division which would enable energy storage for grid stabilization.

All these initiatives, which are a part of DSM, would help in smoothening the load curve and reduce the peak demand.

Project Plan



These are some of the few initiatives which BYPL can undertake to target creation of a 'model green division'. Successful execution of these initiatives along with others in the future depends on four different aspects—technical, social, financial, and policy support.

It is expected that the utility-level measures would be carried out in 36 weeks from the date of commencement. A broad schedule is detailed in Table 16. Detailed activity wise schedule is shown in Annexure- I.

Project Organization Structure

This project is proposed to be executed by awarding the work to agencies specializing in respective project themes. The organizational structure is highlighted in the following figure:

Table 16: Broad schedule of utility-level measures

S. No	Measure	Phase	Timeline from date of commencement
1	Rooftop Solar installation	Phase – I	7 Months
2	Replacement of old appliances	Phase – I	4 Months
3	Reflective coatings	Phase – I	4 Months
4	Minimizing paper usage	Phase – I	4 Months
5	E-Vehicles	Phase – II ³	4 Months
6	Rainwater harvesting	Phase – II ³	9 Months
7	Waste management for proper disposal of waste	Phase – II ³	3 Months

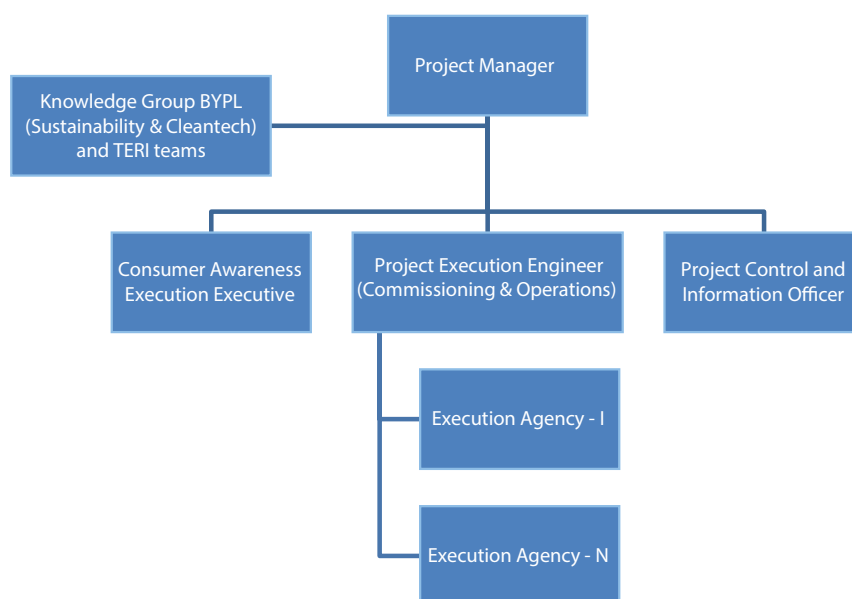


Figure 10: Project Organization Structure for Model Green Division

³ Phase – II shall commence after completion of phase – I i.e., after seven months of start date of the project.



Project Cost Summary (Payback Period)

In view of the above, the total cost involved for converting 10 BYPL office buildings falling under Mayur Vihar – Phase

I & II division into green buildings is summarized in Table 17.

The overall project cost considering internal and customer-oriented measures is summarized in Table 18.

Table 17: Total Project Cost for Utility-level scenario implementation under Mayur Vihar Division

S. No	Intervention	Cost(INR)	Benefit/Payback Period (yrs.)
1	Rooftop Solar Installation	69,64,875	6
2	Replacement of Old Appliances	20,50,860	2.7
3	Reflective Coatings	5,27,792	2.5
4	E-Vehicles	73,23,776	NPV of 111 Lacs and 22 lacs for 2 wheelers and 4 wheelers respectively over a life of 10 yrs. at 8% discount factor.
5	Rainwater Harvesting	44,24,640	4.5
6	Minimising Paper Usage	10,40,000	One time cost
7	Ensuring Proper Disposal Of Waste	10,40,000	One time cost

Table 18: Overall Project Cost of Model Green Division Concept for Mayur Vihar Division

S.No.	Particulars	Cost (INR Lacs)
1	Rooftop Solar Installation	70
2	Replacement of Old Appliances	21
3	Reflective Coatings	5
4	E-Vehicles	73
5	Rainwater Harvesting	44
6	Minimizing Paper Usage	10
7	Ensuring Proper Disposal of Waste	10
8	Total (A)	234
9	Consumer Awareness & EV Charging Facilitation (B)	10
10	Total Cost (C = [A+B])	244
11	Escalation @10% of C	24
12	Supervision & Project Management Cost @10% of C	24
13	Project Contingency Expenses @10% of C	24
14	Taxes @18% of C	44
	Overall Project Cost (C + Taxes + Escalation +Contingency+ Supervision & Project Management)	361

Carbon Saving



The project themes highlighted in the report are going to further help in attaining environmental objectives. Table 19 summarizes the annual potential reduction in tonnes of CO₂e.

Table 19: Tentative carbon savings for green division project

S.No.	Interventions	CO2 equivalent saved (tonnes of CO ₂ e/year)	Remarks
1	Energy Efficiency Measures	140	Based on potential energy saving of 169227 units of electricity
2	Rooftop Solar PV Systems	174	Based on annual energy generation of 0.21 MUs
3	Awareness Programmes	1750	Calculations detailed in Annexure - III
4	EV - 2 Wheelers & 4 Wheelers	24	Based on difference of CO ₂ emission factors of Petrol and Electricity. 2.2 Kg per liter of petrol and 0.83 Kg of CO ₂ per unit of electricity
5	Paper Usage	1	Calculations detailed in Annexure - III
6	Sun Reflective Coatings	42	Based on annual energy saving of 50557 units of electricity as detailed in Annexure - III
	Total	2133	

*Note: Conversion factor for electricity used is 0.83 kg of CO₂ per unit of electricity
Detailed calculations are summarized in Annexure-IV.*



Annexure I: Energy Efficiency Measures

Appliance wise Summary and Savings

SL. NO	TYPE OF LOAD	TYPE OF OLD APPLIANCE	RATED CONS. (W)	TOTAL INVENTORY	RECOMMENDED NEW APPLIANCE	RATED CONSUMPTION (W)
1	Lighting	Tube Light	36-40	260	LED	18
		Halogen Street Light	150	70	LED	60
		LED and CFL	18-36	81	LED	18
2	Fans	Wall Fans	60-80	46	Gorilla Wall Fans	28
3	Air Conditioning	Desert Coolers	400	26	Symphony Air Coolers	200
		Window and Split ACs	1700-2200	24	Bluestar 5-star split inverter AC	1260
4	Miscellaneous	Coil Heater	2000	2	Induction Cooktop	1500
		Fridge	250	2	EE Fridge	150
		TOTAL		511		

Building-wise Cost Benefit Analysis for Energy Efficiency Measures

Building Name	Investment Required (INR)	Monetary Savings (INR per year)
Khichripur Grid, Grid Sub St. , Near LBS Hospital	2,64,920	1,46,028
Chilla Village Grid Sub Station	2,55,350	74,975
Noida More Grid Sub Station	2,42,520	72,576
Chilla Village O&M, Mayur Vihar, Phase - I ext.	3,21,610	1,49,007
Business Division Office, Mayur Vihar, Phase – I	3,91,640	1,52,806
Block - 5 Trilokpuri (Dispensary)	2,05,090	50,021
13 Block Sub Division office, Trilokpuri	62,930	18,687
Pocket – C, Sub Division Office, Mayur Vihar Phase – II (Addl. VP office)	1,85,770	67,012
Pocket - E, Meter Store, Mayur Vihar Phase - II	13,070	6,533
Pandav Nagar/Anand Lok Sub division office	1,07,960	40,801
Grand Total	20,50,860	7,78,446

Annexure II: Running Cost of Two Wheeler E-Vehicles

Running per day (km)	Li-ion with subsidy	Li-ion without subsidy	Lead-Acid with Subsidy	Lead-Acid without subsidy	Petrol
30	0.87	1.09	0.84	0.95	1.93
35	0.76	0.95	0.75	0.84	1.83
40	0.67	0.84	0.68	0.76	1.75
45	0.61	0.76	0.63	0.69	1.69
50	0.56	0.69	0.58	0.64	1.65
55	0.51	0.64	0.55	0.6	1.61
60	0.48	0.59	0.52	0.57	1.57

Li-ion with Subsidy	0.67
Li-ion without subsidy	0.84
Lead Acid with Subsidy	0.68
Lead Acid without Subsidy	0.76
Petrol variant	1.75

NPV @8% Discount Factor and lifetime of	2 Wheelers	4 Wheelers
10 yrs. (INR)	1,10,96,031	21,96,657



Annexure III: CO₂e Reduction

CO₂e Reduction from Consumer Awareness

S. No.	Location	No. of Consumers	Average consumption per consumer per year (Units)	Total Annual Consumption (Units)	Savings Units (@10%)	CO ₂ e reduction (kg)	CO ₂ e reduction (tonnes)
1	CGHS APARTMENTS	2,361	6,000	1,41,66,000	14,16,600	11,75,778	1,176
2	DDA HOUSING SOCIETIES	1,000	6,000	60,00,000	6,00,000	4,98,000	498
3	SCHOOLS	5	1,84,800	9,24,000	92,400	76,692	77
	Total			2,10,90,000	21,09,000	17,50,470	1,750

CO₂e Savings from Reduced Paper Consumption

S. No	Office Name	Paper Savings (reams)	Paper Savings (kg)	CO ₂ e savings from recycling and reduced usage
1	Khichripur Grid	24	54	35
2	Chilla Grid	12	27	17
3	Noida More	12	27	17
4	O&M Office	120	270	173
5	Business Office, Mayur Vihar	420	945	605
6	Trilokpuri Dispensary	15	33.75	22
7	13 Block Sub Division Office, Trilokpuri	60	135	86
8	Pocket C , Sub Division Office, Mayur Vihar Phase - II	120	270	173
9	Pocket E, Meter Store, Mayur Vihar Phase – II	0	0	0
10	Pandav Nagar/Anand Lok Sub Division Office	60	135	86
	Total Saving (MT)			1.21

CO₂e Savings from E-Vehicles

S.No	Vehicle Type	No. of Vehicles	Annual Fuel Consumption	CO ₂ e reductions(kg)
1	2 Wheeler – Petrol	107	7,300	16,970
2	4 Wheeler – Petrol	5	13,819	31,785
			Total	48,575
1	2 Wheeler – EV	107	16,379	13,594
2	4 Wheeler – EV	5	12,978	10,772
			Total	24,366
CO2e Savings in Tons				24

Electricity & CO₂e Savings from Reflective Coatings

S. No.	Office Name	Total	Annual Savings	CO ₂ e Savings
		kWh	kWh	MT
1	Khirchipur - Grid Sub Station	21,364	2,436	2.02
2	Chilla - Grid Sub Station	95,137	10,846	9.00
3	Noida More - Grid Sub Station	68,049	7,758	6.44
4	Chilla Village - O&M Office	69,714	7,947	6.60
5	Mayur Vihar - Business Division Office	1,28,434	14,642	12.15
6	Trilokpuri- Dispensary	10,231	1,166	0.97
7	Pocket C, Mayur Vihar Phase II - Sub Division Office	27,895	3,180	2.64
8	13 Block Sub Division office, Trilokpuri	5,665	646	0.54
9	Pocket E, Mayur Vihar Phase II - Meter Store	2,710	309	0.26
10	Pandav Nagar/Anand Lok - Sub Division Office	14,280	1,628	1.35
Total		4,43,480	50,557	42

A large, stylized green leaf graphic that curves from the left side of the page towards the right, with a smaller leaf-like shape positioned above it. The graphic is composed of several overlapping, curved segments in varying shades of light green.

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