ENERGY & GREEN AUDIT REPORT

Academic Year – 2020 – 2021
Date of Audit – March 2021

Institute Name –
Shri Vitthal Education and Research Institute,
Gopalpur-Ranjani Road, P.B. No.54, Gopalpur
Pandharpur-413 304,
Dist-Solapur, Maharashtra, India.

Auditing Agency –
Papillon Industrial Electricals
Office No-11, Shreeram Udyog Bhavan,
Near Yamaha Showroom, Baramati, Dist- Pune-413 102.
Energy Auditor's Certificate No- 9811/19

Acknowledgement

We express our sincere thanks to the management of Shri Vitthal Education and Research Institute for giving us the assignment of carrying out the detailed energy audit and green audit of their Institute premises. We sincerely appreciate the effort and support provided by the management team of Institute during our working period at the Institute.

We would like to applaud the good practises that are carried out in theInstitute premises. Such practises are really laudable and can help the Institute run better.

We hope this report is as per your satisfaction and should be able to help you manage your energy better and obtain the said benefits.

Yours Sincerely
Energy Audit team

Institute s Under Shree Vitthal Education Research Institute, Pandharpur

I) College of Engineering, Pandharpur
II) College of Engineering (Polytechnic), Pandharpur
III) College of Pharmacy, Pandharpur
IV) College of Pharmacy(Polytechnic), Pandharpur

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Executive Summary

Sr.No.	Parameter	Energy Savings (kWh)	Cost saving (Rs.)	Investment (Rs.)	Payback period (Months)
1.	Replacement of 70 W Fan to 28 W BLDC Fan	1,83,759	17,42,029	57,33,335	39
Total		1,83,759	17,42,029	57,33,335	39

Lighting –

Some of Existing lighting for classes and offices are of non-efficient T5 of 40 W and they are degraded by the period of usage. So, we can replace that efficient LED lights. Energy and cost Savings can be achieved through installation of tube lights.

BLDC Fans –

Institute can install BLDC Fans instead of conventional fan that can be save energy and subsequent effects of comfort cooling's can be achieved through this measure.

Green Audit -

Carbon dioxide generation of campus due to usage electricity and other modes like transport as very much catered by following means like usage of 405 kWp solar PV plant in the campus, usage of solar water heater for hostel premises for water heating, usage of small amount of rain water harvesting and Sewage treatment plant in the campus. Also, there are multiple number of trees in the Institute campus which are planted by Institute or naturally cultivated. So, there is very less chance of CO_2 emission in Institute facility.

Abbreviations

Eff	-	Efficiency
Hr	-	Hour
K Cal	-	Kilo Calories
kWh	-	Kilo Watt Hour
MT	-	Metric Ton
Kg	-	Kilogram
H P	-	High Pressure
L P	-	Low Pressure
T_2	-	Temperature Final
T_1	-	Ambient Temperature
MW	-	Mega watt
TPH	-	Tones per hour
ΔT	-	Temperature Difference
MD	-	Maximum Demand
CD	-	Contract Demand
AMD	-	Actual maximum Demand
PC	-	Powder Coating
PT	-	Pre-Treatment Line
TOD	-	Time of Day tariff
VSD	-	Variable Speed Drive
DBT	-	Dry Bulb Temperature
WBT	-	Wet Bulb temperature
RH	-	Relative Humidity
TR	-	Tons of refrigeration
KW	-	Kilo Watts
KVA	-	Kilo Volt Ampere
KVAr	-	Kilo Volt Ampere Reactive
PF	-	Power Factor

Chapter I
Electricity Bill Analysis

Shree Vitthal Education & Research Institute has the following details for contract with MSEDCL.

Consumer no – 337019052100

Meter no – 055- XB452203

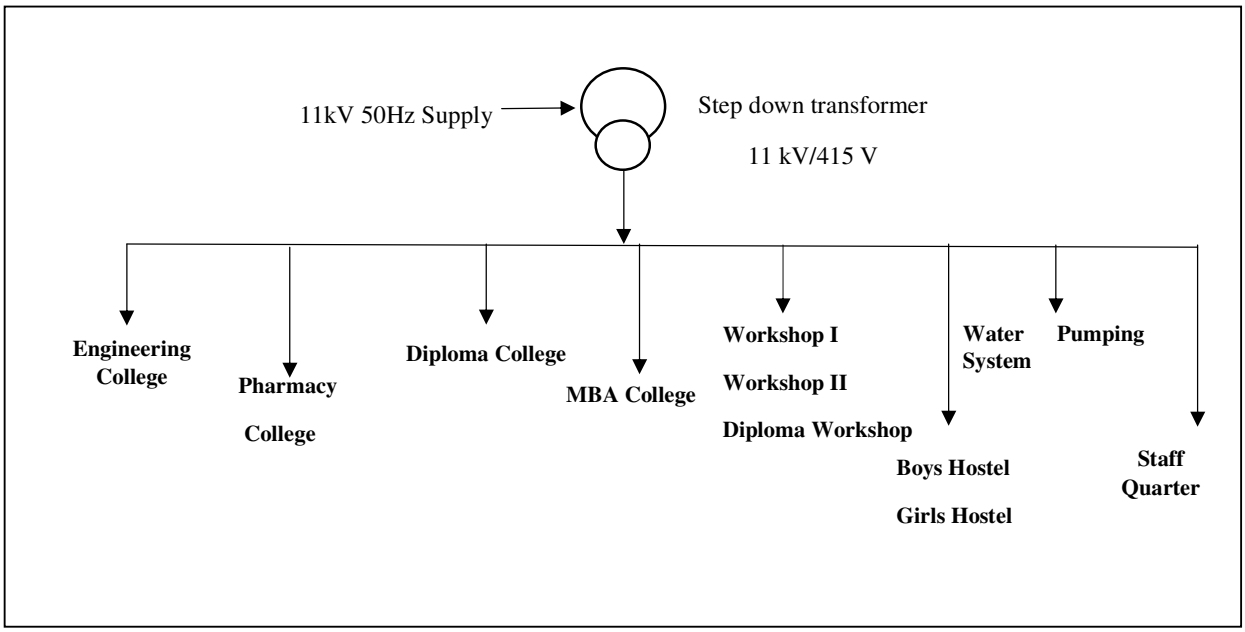
Connected Load – 460 kW

Connected Solar plant – 400kW.

Contract demand – 408 kVA

Unit Rate – 9.48 Inr/kVAh

Tariff – 146– HT VIII – B



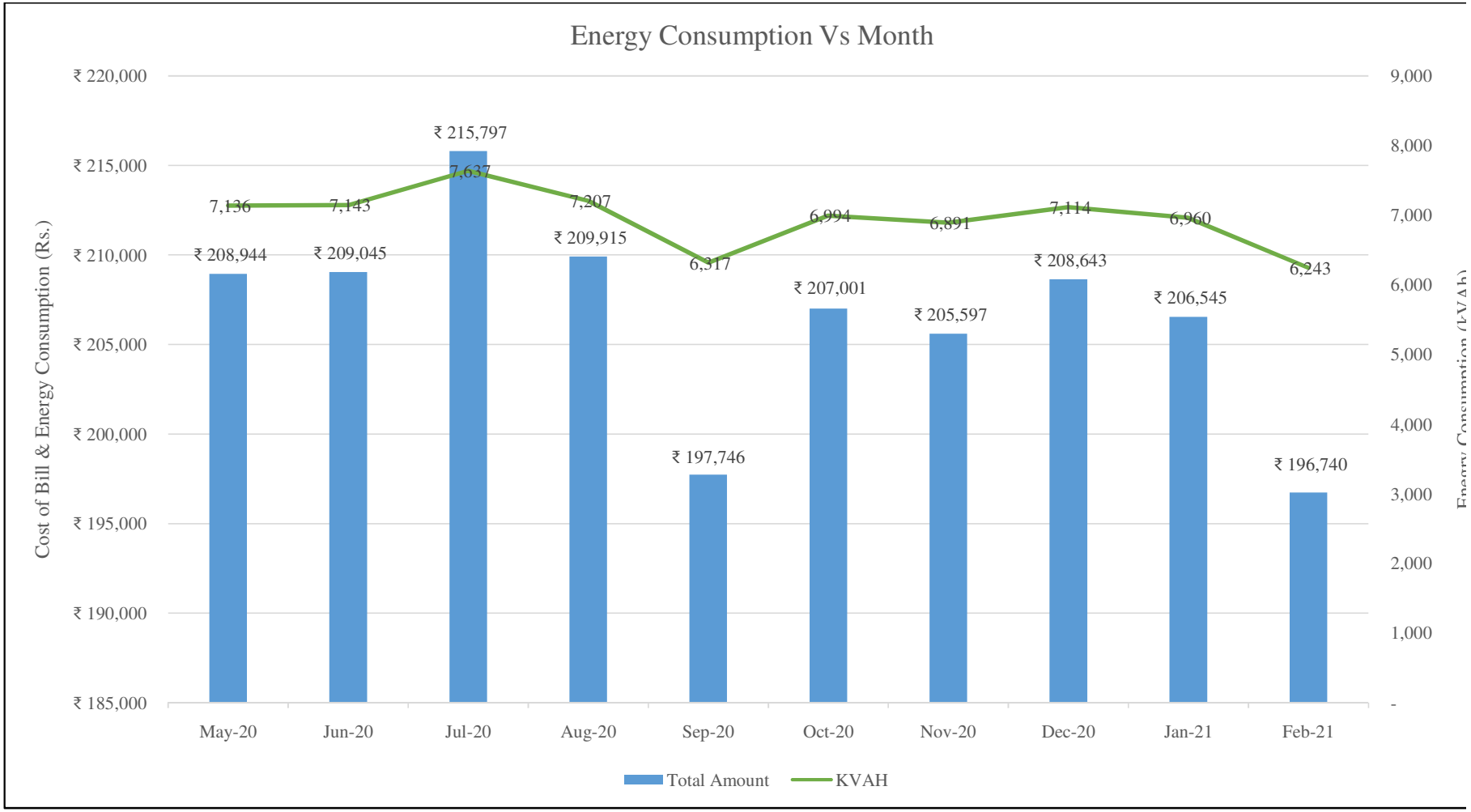
We have Studied you MSEDCL bills from April 2020 – Feb 2021, during this, following has been the trend of bills for the imported energy from MSEDCL: -

Parameter	Feb-21	Jan-21	Dec-20	Nov-20	Oct-20	Sep-20	Aug-20	Jul-20	Jun-20	May-20	Apr-20
Contract Demand	408	408	408	408	408	408	408	408	408	408	408
Billed Demand	224	224	224	224	224	224	224	224	224	224	224
Maximum Demand	90	88	86	74	75	76	81	92	91	82	90
Billed PF	0.992	0.995	0.988	0.99	0.988	0.987	0.99	0.993	0.994	0.99	0.997
Energy Consumed kWh	20,928	24,023	23,080	22,448	24,670	21,008	25,303	27,240	25,243	23,693	23,630
Adjustment Solar Units kWh	14,735	17,098	16,051	15,626	17,760	14,730	18,168	19,565	18,143	16,628	16,454
Total Consumption kWh	6,193	6,925	7,029	6,822	6,910	6,235	7,135	7,675	7,100	7,065	7,176
kVAh	6,243	6,960	7,114	6,891	6,994	6,317	7,207	7,637	7,143	7,136	7,198
kVArh lag	338	598	575	320	458	243	223	508	908	808	905
kVArh lead	2,313	1,753	3,048	2,950	3,365	3,178	3,373	2,745	1,970	2,523	2,365
Demand Charges	₹ 92,064	₹ 92,064	₹ 92,064	₹ 92,064	₹ 92,064	₹ 92,064	₹ 92,064	₹ 92,064	₹ 92,064	₹ 92,064	₹ 92,064
Wheeling Charges	₹ 3,559	₹ 3,967	₹ 4,055	₹ 3,928	₹ 3,987	₹ 3,601	₹ 4,108	₹ 4,353	₹ 4,072	₹ 4,068	₹ 4,103
Energy charges	₹ 59,184	₹ 65,981	₹ 67,441	₹ 65,327	₹ 66,303	₹ 59,885	₹ 68,322	₹ 72,399	₹ 67,716	₹ 67,649	₹ 68,237
TOD EC	₹ 6,867	₹ 7,656	₹ 7,827	₹ 7,581	₹ 7,693	₹ 6,949	₹ 7,928	₹ 8,401	₹ 7,857	₹ 7,850	₹ 7,920
FAC	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -
Duty	₹ 33,951	₹ 35,630	₹ 35,991	₹ 35,469	₹ 35,710	₹ 34,125	₹ 36,209	₹ 37,215	₹ 36,059	₹ 36,042	₹ 36,188
Bulk Consumption Rebate	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -
Incremental Consumption Rebate	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -
Tax	₹ 1,115	₹ 1,247	₹ 1,265	₹ 1,228	₹ 1,244	₹ 1,122	₹ 1,284	₹ 1,365	₹ 1,278	₹ 1,272	₹ 1,292
Total Amount	₹ 1,96,740	₹ 2,06,545	₹ 2,08,643	₹ 2,05,597	₹ 2,07,001	₹ 1,97,746	₹ 2,09,915	₹ 2,15,797	₹ 2,09,045	₹ 2,08,944	₹ 2,09,804

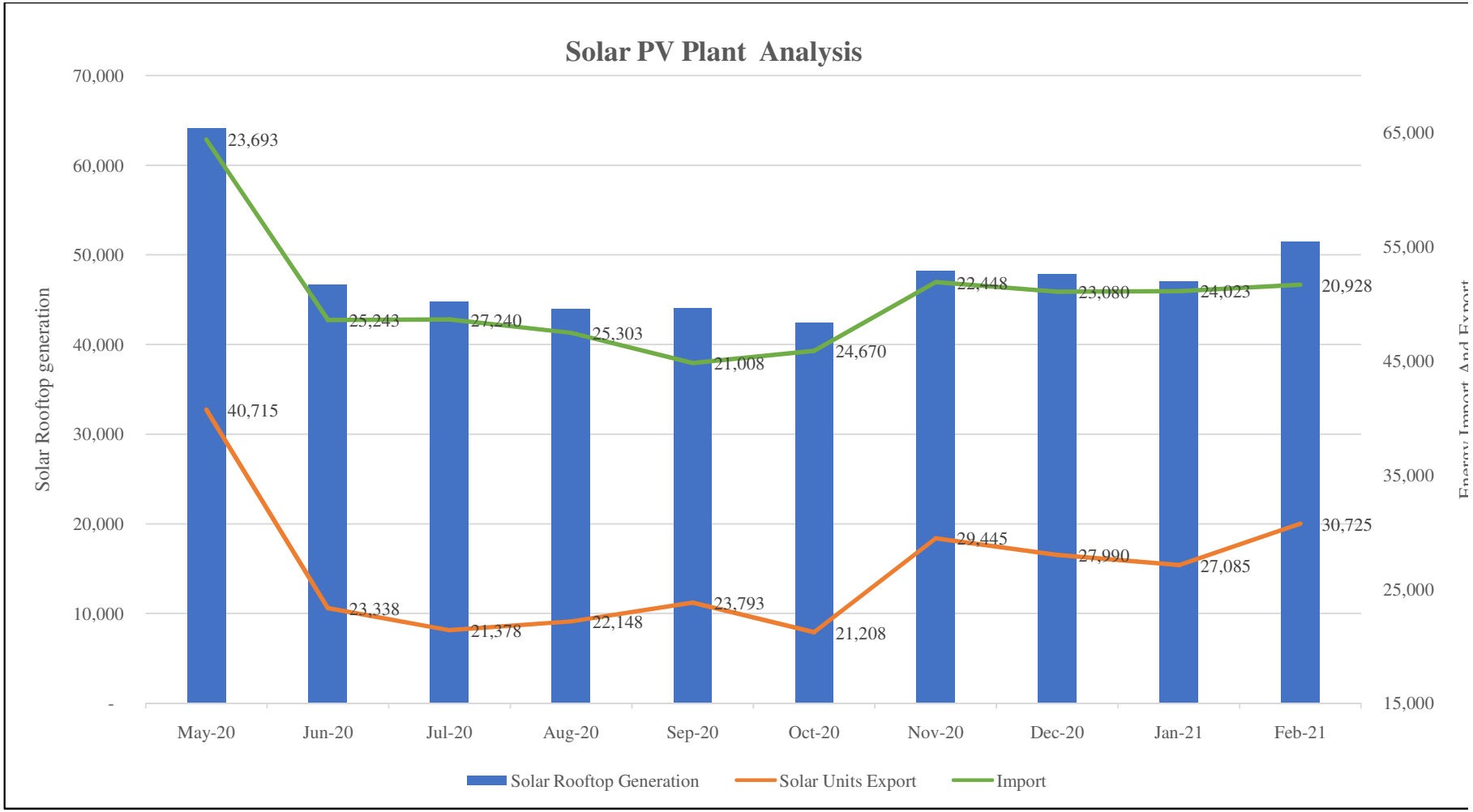
Billing System – Jan 2020 – Mar 2020

Parameter	Unit	Mar-20	Feb-20	Jan-20
Contract Demand	kVA	408	408	408
Billed Demand	kVA	204	204	204
Billed PF		0.997	0.995	0.994
Billed MD	KVA	204	194	192
Energy Consumed	kWh	45985	57862	58335
Solar Units	kWh	26618	0	12590
Adjusted Units	kWh	19367	57862	45745
KVAH	kVAh	46070	57942	58453
kVArh lag	kVArh	1215	1182	1755
kVArh lead	kVArh	2180	4802	4880
Demand Charges	₹	79,764	79,764	79,764
Wheeling	₹	14,719	33,155	34,766
Energy Charges	₹	1,87,860	5,61,261	4,43,727
TOD EC	₹	5,965	-12,273	-10,386
FAC	₹	23434.07	68055	61755.75
Electricity duty	₹	65,465	1,24,291	1,28,021
Tax	₹	3,486	7,852	8,234
Pf incentive	₹	-10910	-20715	-15240
Total Bill	₹	3,69,782	7,03,292	7,30,641

Electricity Bill analysis –



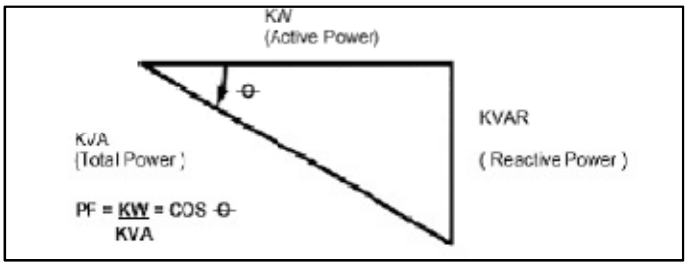
Solar Rooftop Plant Analysis -



Observation & comments –

I) **Power factor Basics**

In all industrial electrical distribution systems, the major loads are resistive and inductive. Resistive loads are incandescent lighting and resistance heating. In case of pure resistive loads, the voltage (V), current (I), resistance (R) relations are linearly related, i.e., = I × R and Power (kW) = V × I. Typical inductive loads are A.C. Motors, induction furnaces, transformers and ballast-type lighting. Inductive loads require two kinds of power: a) active (or working) power to perform the work and b) reactive power to create and maintain electro-magnetic fields. Active power is measured in kW (Kilo Watts). Reactive power is measured in kVAr (Kilo Volt-Amperes Reactive).



Monthly Power Factor –

Month	Power Factor
Feb-21	0.992
Jan-21	0.995
Dec-20	0.988
Nov-20	0.99
Oct-20	0.988
Sep-20	0.987
Aug-20	0.99
Jul-20	0.993
Jun-20	0.994
May-20	0.99
Apr-20	0.997

Power factor is maintained to unity in respective month.

II) Energy Consumption –

Institute has following energy consumption pattern –

Month	Feb-21	Jan-21	Dec-20	Nov-20	Oct-20	Sep-20	Aug-20	Jul-20	Jun-20	May-20
Solar Rooftop Generation (kWh)	51,446	47,090	47,908	48,247	42,446	44,046	43,928	44,769	46,651	64,148
Solar Units Export (kWh)	30,725	27,085	27,990	29,445	21,208	23,793	22,148	21,378	23,338	40,715
Import (kWh)	20,928	24,023	23,080	22,448	24,670	21,008	25,303	27,240	25,243	23,693
Adjusted (kWh)	14,735	17,098	16,051	15,626	17,760	14,773	18,168	19,656	18,143	16,628
Bank (kWh)	1,22,917	1,06,927	96,939	85,000	71,181	67,733	58,713	54,733	53,010	47,815
Total Energy Consumption (kWh)	**41,649**	**44,028**	**42,998**	**41,250**	**45,908**	**41,261**	**47,083**	**50,631**	**48,556**	**47,126**
Energy consumption per day (kWh)	**1,487**	**1,420**	**1,387**	**1,375**	**1,481**	**1,375**	**1,519**	**1,633**	**1,619**	**1,520**

Chapter II
Study of Power Quality

We shall be discussing each parameter one by one for the meter.

1. Voltage

The voltage has been recorded for all intervals; the voltage can be represented as follows:-

	Vrms ph-n RN	Vrms ph-n YN	Vrms ph-n BN	Vrms ph-n NG	Vrms ph-ph RY	Vrms ph-ph YB	Vrms ph-ph RB
Maximum	253.8	257.6	256.9	6	442.4	446.28	441.7
Minimum	0.14	0.04	0.2	0.06	0.12	0.2	0.08
Average	240.75	243.62	243.30	3.98	419.36	422.92	418.09

Observations and Remarks –
Voltage is seen to be normal in all the phases. The mean voltage is set at 243.62 V or 419.36 V Neutral to Ground voltage is 3.98 V for average value
Standards Referred – EN50160 – Voltage Fluctuation within 10% is allowed.

2. Current

Current has been recorded in all the phases including neutral Current. It can be shown as per the table and graph below.

		Current R Avg.	Current Y Avg.	Current B Avg.	Current N Avg.
Maximum	A	307	292	280	50
Minimum	A	1	1	0	0
Average	A	121.91	103.718	100.98	33.02

Observations and Comments -
- Current is driven by the load. This parameter has no limit and is based upon the requirement of the Institute.

- ***Neutral Current is in limit.***   *The rule states that allowable limit of neutral current of 10% of load current. The present demand does not comply with this standard*
Reference Standards –   Neutral Load Current allowable less than 10% of load current.

3. **Frequency –**

Frequency of the network is being monitored in this logging session. The summary can be shared as follows

		Frequency Avg
Maximum	Hz	50.16
Minimum	Hz	49.83
Average	Hz	50.01

Observations and Remarks -
- Frequency is normal and is within tolerance of +-2%
Standards Referred –   EN 50160- Mean Value of fundamental measured over 10s +/- 2% for 99.5%

4. Power-

In this section we shall discuss the power drawn by the load. Active reactive and apparent power has been recorded and summarised as below:-

Active Power During Solar Plant is producing electricity: (Time: 07:52:00 AM to 05:02:00PM)

			R Phase	Y Phase	B Phase	Total
Active Power	Maximum	kW	74.50	72.5	68.5	214.5
	Minimum	kW	0.5	0.5	0.5	1.5
	Average	kW	44.84	41.32	41.77	127.803

Active Power During Solar Plant is not producing electricity: (Time:05:03:00PM to07:51:00 AM)

			R Phase	Y Phase	B Phase	Total
Active Power	Maximum	kW	23.5	28.5	26.5	78
	Minimum	kW	18.64	15.13	13.03	46.82

	Average	kW	18.69	15.15	13.11	46.91

Observations and Remarks -
- As mentioned previously in the current Section, the power drawn by the load is as per the requirement of the load.

5. Energy –

As seen in the power section, the energy that has been consumed over 24 hours can be stated as follows.

No Load Condition: (11/03/2021)

Energy consumption During Solar Plant is off:(Time: 05:03:00PM to 07:51:00 AM)

	Forward			
	R Phase	Y Phase	B Phase	Total
Kwh	261.485	214.370	185.85	661.525

Energy consumption During Solar Plant ison:(Time: 07:52:00 AM to 05:02:00PM)

	Reverse			
	R Phase	Y Phase	B Phase	Total
Kwh	398.660	362.860	364.355	1125.69

Observations and Remarks -
The energy consumed by the plant is normal as per the requirement.

6. Harmonics: -

The harmonics are being monitored and recorded in this instrument. The summary can be as given below.

		Voltage R Phase	Voltage Y Phase	Voltage B Phase	Voltage NG	Current R Phase	Current Y Phase	Current B Phase	Current N Phase
Max	%	56.19	128.73	170.31	327.67	258.61	131.82	233.55	327.67
Min	%	0.75	0.62	0.88	43.07	5.17	3.41	7.25	42.8
Avg.	%	1.36	1.53	1.93	140.05	16.19	12.34	23.29	122.02

Observations and Remarks -
Voltage Harmonics – - Voltage Harmonics are within tolerable limits of 5%, Individual Harmonic distortion is within 3 %. - Neutral voltage harmonics are 140.05 %, this is due to the presence of non-linear loads & lack of earthing. Current Harmonics – - Current Harmonics are not within tolerable limits of 3rd& 5th harmonics 5% - The individual harmonic distortions are not within the tolerance of 7% as given by the standards. - Neutral Harmonics are high with average of 140.05%. and maximum is 327.67%
Recommendation – **To reduce the effects of harmonics on the system by harmonic filters are recommended.**
Standard Referred – IEEE 519

Summary of Observations

The Summary of the observations made in this chapter can be shared as per the individual parameters are as follows -

- Voltage –

Voltage is seen to be normal and within specified limits however Neutral to Ground voltage is 2 V for average value.

- Current –

Load current is subject to requirements of the plant and will fluctuate as per the load.

- Power –

Power is similar to current as the required power is drawn by the load.

- Frequency –

Frequency is seen to be normal.

- Voltage Harmonics –

Voltage Harmonics are not within tolerable limits of 5%, Individual Harmonic distortion is within 3 %.Neutral voltage harmonics are 140.05 %, and this is due to the presence of non-linear loads & lack of earthing.

- Current Harmonics –

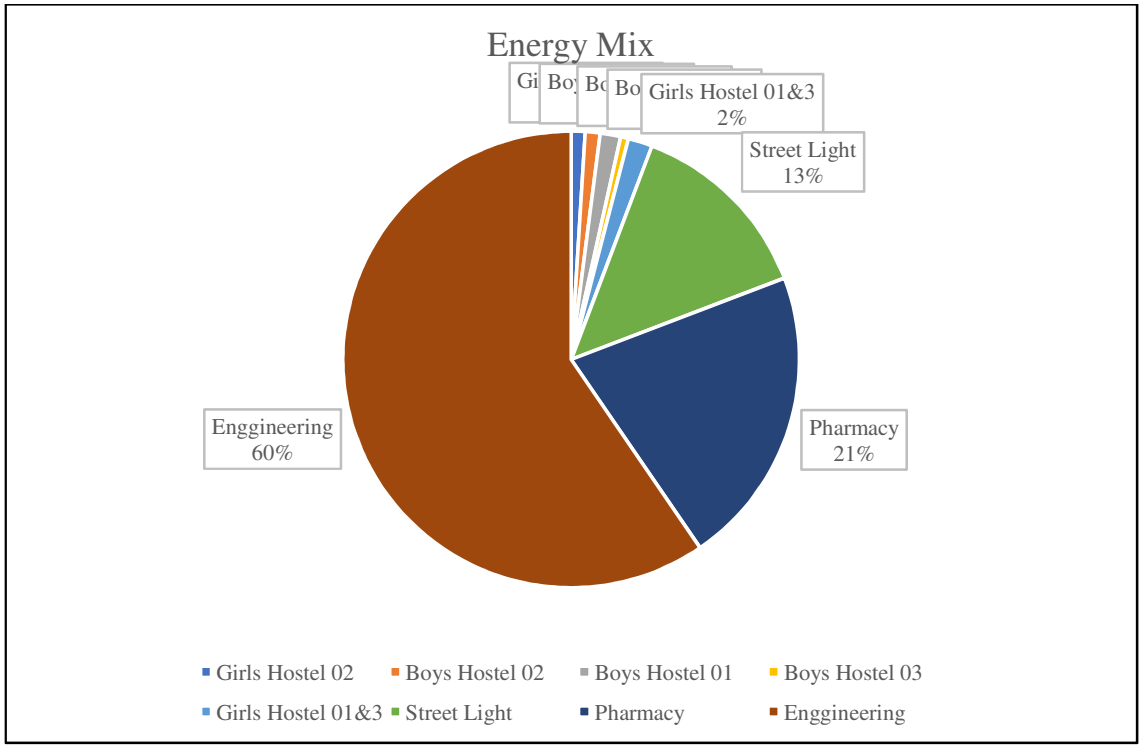
  Current Harmonics are not within tolerable limits of 3rd& 5th harmonics 5%. The individual harmonic distortions are not within the tolerance of 7% as given by the standards. Neutral Harmonics are high with average of 140.05%. and maximum is 327.67%

Chapter III
Connected Load

Energy Mix –

Feeder wise energy distribution in the institute campus is as follows –

Sr.No.	Feeder	Power (kW)	Voltage (V)	Current (A)	Power Factor
1	Girls Hostel 02	1.5	406	2.03	0.9
2	Boys Hostel 02	1.62	406	2.36	0.9
3	Boys Hostel 01	2.22	425	3.38	0.9
4	Boys Hostel 03	0.81	422	1.89	0.9
5	Girls Hostel 01&3	2.64	421	3.77	0.9
6	Street Light	20.52	423	28.18	0.9
7	Pharmacy	32.43	423	48	0.94
8	Engineering	90.9	420	134	0.95



Pumps –

Pump name	Power (kW)	Voltage (V)	Current (A)	Power Factor
Waste Water Motor 01	3.39	422	4.53	0.9
Waste Water Motor 02	1.65	422	3.5	0.9
Borewell 1	9.345	411	15.47	0.84
Borewell 2	9.052	410	15	0.85
Municipal Well Pump	10.8	410	28.47	0.851
Boys Hostel	2.25	417	5.94	0.994
Water Supply Engg Institute	3.42	410	8.52	0.719
Girls Hostel	6.03	418	10.38	0.78
Pharmacy Institute	5.19	418	9.58	0.767
R.O.Mineral Pump	3.69	409	6.7	0.791
STP Air Blower	4.22	409	12.6	0.812
STP Submersible Pump	0.63	404	1.37	0.99
STP Scrubber Pump	1.32	402	3.91	0.85

Energy Savings –

Replacement of existing fans to efficient brushless Direct current fans

ProposedFan:BLDC 28 W fan
Description:

Finish	Metallic
Sweep (mm)	1200
Power (W)	28
RPM	360
Air Delivery CMM (m^3/min)	240
Power factor	0.99
Service value (CMM/W)	8.6
MRP	3145

Savings Calculation:

I) Institute fans –

- Operational hours of 8 during working and 300 days of operation is considered for the Institute.

No of Existing Fans	Wattage of Fan (W)	Total Operating (Hr)	No of Days	Energy Consumption (kWh)	BLDC Fan (W)	Energy Consumption (kWh)	Savings (kWh)	Cost Savings (Rs)	Investment (Rs)	Payback Period (Months)

1262	70	8	300	2,12,016	28	84,806	1,27,210	12,05,947	39,68,990	39

II) Hostel fans –

- Operational hours of 12 during non-working and 330 days of occupancy is considered for the Institute.

No of Existing Fans	Wattage of Fan (W)	Total Operating (Hr)	No of Days	Energy Consumption (kWh)	BLDC Fan (W)	Energy Consumption (kWh)	Savings (kWh)	Cost Savings (Rs)	Investment (Rs)	Payback Period (Months)
561	70	12	330	94,248	28	37,699	56,549	5,36,082	17,64,345	39

Saving Summary:

Sr.No.	Parameter	Energy Savings (kWh)	Cost saving (Rs.)	Investment (Rs.)	Payback period (Months)
1.	Replacement of 100W Fan to 28 W BLDC Fan	1,83,759	17,42,029	57,33,335	39

Chapter IV
Carbon Foot printing

A Carbon Foot printis defined as the Total Greenhouse Gas emissions, emitted due to various activities. In this we compute the emissions of Carbon-Di-Oxide, by usage of the various forms of Energy used by the Institute for performing its day-to-day activities. The Institute uses electrical energy for operating various electrical gadgets. We herewith furnish the details of electrical Energy consumption consumer number wise as under –

4.1 Basis for computation of CO2 Emissions:

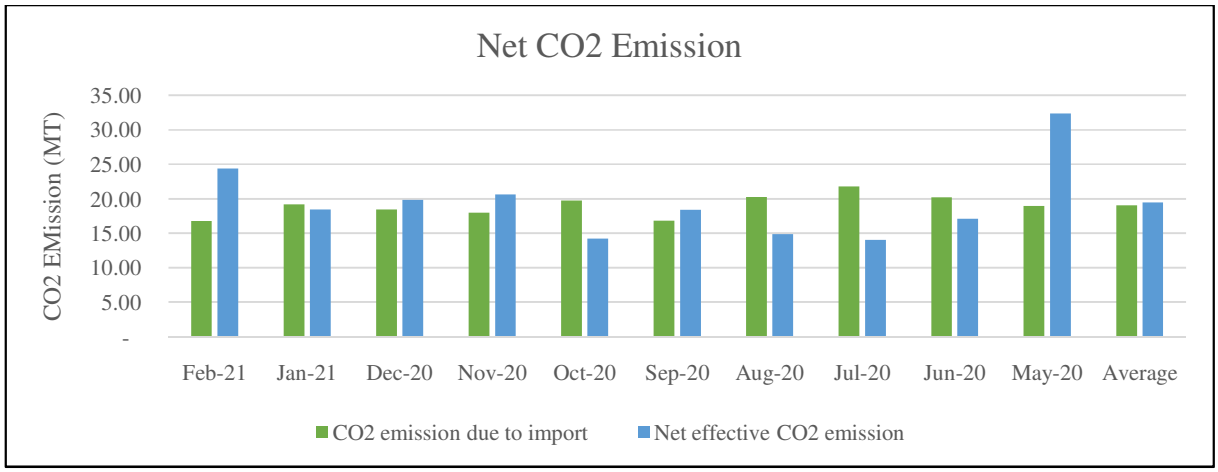
The basis of Calculation for CO2 emissions due to Electrical Energy are as under –
1 Unit (kWh) of Electrical Energy releases **0.8 Kg of CO2** into atmosphere

Based on the above Data we compute the CO2 emissions which are being released in to the atmosphere by the Institute due to its Day-to-Day operations.

4.2. Month wise Consumption of Electrical Energy

Electricity bill analysis data – May 2020 to February 2021

Month	Energy Consumption	Solar Generation	Import	CO_2 emission savings due to solar	CO_2 emission due to import	Net effective CO2 emission
Feb-21	41,649	51,446	20,928	41	16.74	24.41
Jan-21	44,028	47,090	24,023	38	19.22	18.45
Dec-20	42,998	47,908	23,080	38	18.46	19.86
Nov-20	41,250	48,247	22,448	39	17.96	20.64
Oct-20	45,908	42,446	24,670	34	19.74	14.22
Sep-20	41,261	44,046	21,008	35	16.81	18.43
Aug-20	47,083	43,928	25,303	35	20.24	14.90
Jul-20	50,631	44,769	27,240	36	21.79	14.02
Jun-20	48,556	46,651	25,243	37	20.19	17.13
May-20	47,126	64,148	23,693	51	18.95	32.36
Average	45,049	48,068	23,764	38	19.01	19.44
Total	4,50,490	4,80,679	2,37,636	385	190.11	194.43


Net CO2 Emission
CO2 EMission (MT)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
-
Feb-21
Jan-21
Dec-20
Nov-20
Oct-20
Sep-20
Aug-20
Jul-20
Jun-20
May-20
Average
CO2 emission due to import
Net effective CO2 emission

4.3 Benchmarking:

Now we compute the CO2 emissions per Sq ft basis as under:

Electricity bill analysis data – May 2020 to February 2021

No	Parameter	Value	Unit
1	CO2 emissionsdue to import of electricity from grid	190.11	MT
2	CO2 emission savings due to Solar PV plant	385	MT
3	Net CO2 emissions	-194.43	MT
2	Institute area	56,656	Sqm
3	**CO2 emissions**	-3.43	**Kg of CO2/sqm/month**

Chapter – V

GREEN AUDIT for the AY-2020-21

Shri Vitthal Education and research institute (SVERI) is one the leading higher education Institutes in Pandharpur, Solapur district. Ithas been providing quality education to the rural students of Solapur and premises. The Institute is spread over of 10 acres campus. It is also anInstitute of highly greenery Maintenance Institute inPandharpur, Dist. Solapur. We have prepared a green audit report after visiting the Institute campus by our team. This green audit report is based on the following major points.

1. Plantation in the campus
2. Energy audit and power savings
3. Carbon accounting
4. Use of Renewable energy options for saving the environment
5. Water audit
6. Waste disposal

1. Plantation in the campus

Plantation is playing very important role in the green audit and helping to save environment from damage. The campus plantation is very diverse and well maintained. After a daylong survey and records about the plantation in the campus is prepared which is per following table.There are roughly around 11,000 trees comprising of bigger trees, bushes and smaller trees. This is watered with the help of recycled waste water with the help of Sewage treatment plant.

Sample Trees and their dimensions –

Sr. no	Name of Tree	Scientific name	Average Count	Average Periphery of Tree in cm	Average Height in ft
1	Kadunimb	Azadirachta indica	100	30	20
2	Karanja	Millettia pinnata	70	12	20
3	Umbar	Ficus racemosa	4	20	20
4	Amba	Mangifera indica	50	30	15
5	Chikku	Manilkara zapota	25	8	10
6	Badam	Prunus dulcis	25	20	22
7	Padas Pimple	Ficus religiosa	25	12	15
8	Vad	Ficus benghalensis	2	35	20
9	Chinch	Tamarindus indica	30	30	20
10	Bel	Aegle marmelos		10	12
11	Khair	Senegalia catechu		10	10
12	Kanher	Nerium oleander	10	10	12
13	Areka Pam	Dypsis lutescens	30	20	15
14	All Vitamin				3
15	Palas	Butea monosperma		15	12
16	Avala	Phyllanthus emblica		10	10
17	Hadaga	Sesbania grandiflora		10	10
18	Shevaga	Moringa oleifera		15	15

19	Adulsa	Justicia adhatoda			
20	Kapur ulas	Hedychium spicatum			2.5
21	Morchud				
22	Pailas				
23	Korfad	Aloe Vera			
24	Panfuti	Bryophyllum pinnatum			
25	Ashwagandha	Withania somnifera			

1.1 CALCULATION OF AMOUNT OF CO2 SEQUESTERED IN TREES PER YEAR

The carbon sequestration potential of the plant species present in green belt has been estimated and suitable plant with maximum sequestration of CO2 was recommended. Carbon sequestration is nothing but capturing atmospheric carbon dioxide or anthropogenic CO2 from large scale stationary sources like cement industry before it is released to the atmosphere. Once captured, the CO2 gas is put into long term storage. CO2 sequestration in plants has the potential to significantly reduce the level of carbon that occurs in the atmosphere. Terrestrial or biologic sequestration means using plants to capture CO2 from the atmosphere and then storing it as carbon in the stems and roots of the plants as well as in the soil. The green belts in industrial area acts as sink for capturing and storing carbon dioxide released from the industries.

Assessment of carbon sequestration ability of trees for adopting in greenbelt of cement industries

The carbon dioxide sequestered in plant species are determined based on following method:

1. Determine the total (green) weight of the tree
2. Determine the dry weight of the tree
3. Determine the weight of carbon in the tree
4. Determine the weight of carbon dioxide sequestered in the tree
5. Determine the weight of CO2 sequestered in the tree per year

1.2 Determination of Total (Green) Weight of the Tree

The algorithm to calculate the weight of a tree is:

For trees with D < 11: W = 0.25D2H

For trees with D >= 11: W = 0.15D2H

Where, W = Above-ground weight of the tree in pounds

D = Diameter of the trunk in inches

H = Height of the tree in feet

Depending on the species, the coefficient (e.g., 0.25) could change and the variables D2 and H could be raised to exponents just above or below 1. However, these two equations could be seen as an ―average‖ of all the species' equations. The root system weighs about 20% as much as the above-ground weight of the tree. Therefore, to determine the total green weight of the tree, multiply the above-ground weight of the tree by 120%.

1.3 Determination of Dry Weight of the Tree

Taking all species in into account, the average tree is 72.5% dry matter and 27.5% moisture. Therefore, to determine the dry weight of the tree, multiply the weight of the tree by 72.5%.

1.4 Determine the weight of carbon in the tree

The average carbon content is generally 50% of the tree's total volume. Therefore, to determine the weight of carbon in the tree, multiply the dry weight of the tree by 50%.

Assessment of carbon sequestration ability of trees for adopting in greenbelt of cement industries

Determine the weight of carbon dioxide sequestered in the tree –

CO2 is composed of one molecule of Carbon and 2 molecules of Oxygen.
The atomic weight of Carbon is 12.001115.
The atomic weight of Oxygen is 15.9994.
The weight of CO2 is C+2*O=43.999915

The ratio of CO2 to C is 43.999915/12.001115=3.6663.
Therefore, to determine the weight of carbon dioxide sequestered in the tree, multiply the weight of carbon in the tree by 3.6663. Determine the weight of CO2 sequestered in the tree per year.
Divided the weight of carbon dioxide sequestered in the tree by the age of the tree.

Sample Measurements –

Sr.No.	Name of tree	Circumference	Diameter (inch)	Height (Feet)	Weight of tree	Dry weight of tree	Carbon content	CO2 Sequestration
1	Chinch 1	840	11	49	819	614.1	307	1125
2	Chinch 2	1080	14	49	1354	1015.2	508	1859
3	Chinch 3	1250	16	49	1813	1359.9	680	2491
4	Kadunimb	840	11	49	819	614.1	307	1125
5	Nilgiri	1050	13	49	1279	959.6	480	1757
6	Kadunimb	1140	14	49	1508	1131.1	566	2072
7	Sagwan	800	10	49	743	557.0	279	1020
8	Chinch	1150	14	49	1535	1151.1	576	2108
9	Kadunimb	1200	15	49	1671	1253.3	627	2295
10	Limb	900	11	49	940	705.0	352	1291
							Total	17144

Chapter VI

Water layout

Institute has multiple buildings and tanks for water usage. Staff, students and other persons in the campus are roughly 4000 nos. during normal operation. Currently 500 staff present in the Institute premises and 30 staff quarters are there in premises. This in total varies with considering current condition. Institute has multiple raw water sources which are as follows –

Sr. No.	Name of Supply	Capacity (in Litres)	Frequency in day	Remarks
1	Asabe Institute well	1,00,000	once	Night Time
2	Kasegaon Water supply	2,00,000		Due to current situation no water supply
3	Ingale well supply	2,00,000		Water is supplied if problem in Asabe or Kasegaon supply
4	Gopalpur Gram panchayat well	1,00,000	once	
5	Anteshwar Mandir Institute well	1,25,000	once	
6	Pharmacy Borewell	1,00,000		Operated during water shortage
7	Boy's hostel borewell 1,3	1,00,000		Operated during normal operation

Water flow –

Total incoming water supply is collected in main tank which is of 3 lac capacity and this is being separated for domestic purposes and drinking purpose. Drinking water is passed through main RO plant which is situated near to the storage tank. This RO plant is of 5000 litres capacity. Also, for domestic purpose there are multiple tanks which are situated at different location in the campus. This is pumped through the different lines and passed at desired location.

Various tanks in Institute premises –

Sr. No.	Name of Dept.	Capacity (in Liters)	No. of Tanks	Capacity	Particulars
1	Engineering Buildings	12000	3	36000	For Common Use
		2000	1	2000	For Drinking Purpose
		1000	2	2000	For Drinking Purpose
2	Library Buildings	2000	2	4000	For Common Use
		1000	1	1000	For Drinking Purpose

3	Principal Office, Board Room and President Room	1000	3	3000	For Drinking Purpose
4	MBA	2000	1	2000	For Common Use
		250	1	250	For Drinking Purpose
5	Pharmacy (Pharm&B. Pharm)	12000	1	12000	For Common Use
		1000	1	1000	For Drinking Purpose
6	Ladies Hostel	12000	4	48000	For Common Use
		1000	6	6000	For Drinking Purpose
7	Boys Hostel	12000	3	36000	For Common Use
		1000	1	1000	For Drinking Purpose
		2000	2	4000	For Drinking Purpose
Total			**32**	**1,58,250**	

- Current water situation is handled by operating pumps for 4 hours daily for pumping water from storage tank to different location.

Energy for Pumping station –
Total power required for pumping water from storage tank to various tanks-

Voltage (V)	Current (A)	Power factor	Power (kW)
390	42	0.84	21.63

RO Plant –
Power required to run the central RO plant which handles hostels, pharmacy Institute, indoor sports complex and solar PV module cleaning.

Voltage (V)	Current (A)	Power factor	Power (kW)
394	20.61	0.9	12.78

Observations –
- Current water usage considering only staff present in campus should be minimal but there is no accounting of water flows.
- Also, many tanks getting over flow during pumping operation that should be avoided.
- RO water is being used for solar PV module cleaning; this should be verified with solar PV supplier.

Recommendations –
- Installation of water flowmeter should be done for all supply and consumption points.
- Main consumption meter should be installed on priority basis as there is no accounting of water and energy in the pumping station.
- Domestic water consumption can be reduced with the help of usage of recycled water for flushing in hostel and Institute campus

Chapter VII

Hot Water System

Hot water system –

Institute campus has 6 number of hostels comprising gents' hostel and women's hostel that means there is requirement of hot water and that is sufficed by the solar water heater. Approximately hostel has occupancy of 3,000 resident students. Requirement of 90,000 litre hot water is sufficed by the solar hot water in built with backup electrical heater. Also, there is hot water boiler for peak demand present in the campus. Hot water requirement of is sufficed by this solar water heater system.

Observations –

- All hot water system were kept shut due to no occupancy in the hostels from past one year.
- This system is equipped with the inbuilt heaters, if the set temperature is not achieved there will be unnecessary load on the electrical system.
- Also, for peak demand there is wood fired boiler in the hostel premises, so that needs to be catered and eliminated.

Calculations –

Sample Carbon emission savings per annum for quantity of 1000 litres/day is given as there was no load on solar water heater for evaluation -

Quantity of water – 1000 Litres/ day

Electrical equivalent = $\frac{Mass\ of\ water\ X\ Cp\ of\ water\ X\ Temeprature\ difference}{860}$

$$= \frac{1000\ X\ 1\ X\ 20}{860}$$

Electrical equivalent = 23.25 kWh/day

Carbon emission savings per day = 18.6 Kg/day

Carbon emission per annum = 6.78 MT/annum

Cost savings per annum = 59,400 Rs/Annum

Flat plate collector

Storage tanks

Recommendations –

- Due to covid and arose situation solar water heater system is completely shut from past one year so it should be audited and maintained prior to usage.
- If the proper maintenance of system will be done there will not be unnecessary burden on electrical load and boiler load.
- Preventive maintenance and repair work of system will help in long term benefit of institute.

Chapter VIII

Rooftop Solar PV Analysis

Institute has installed solar rooftop capacity of kWp on roof top on different Buildings. This supply has been given to main supply with the help of net metering connection as per the MSEDCL. Carbon emission is saved due to the rooftop generation. This is additional savings of carbon emission for Institute campus.

Plant No.	Place	Inverter Capacity (kW)	Inverter No.	Inverter total capacity in (kW)	Connected Solar Panels
1.	Engineering Polytechnic	25	02	50	157
2.	Engineering Polytechnic	27.6	03	82.8	272
3.	Engineering	25	03	75	258
4.	Engineering	25	03	75	251
5.	B. Pharmacy	25	02	50	174
6.	D.Pharmacy	27.6 & 17	02 & 01	72.2	198
	Total			405	1310

Detailed calculation of rooftop –

Installed capacity – 405 kW_p

Daily Average generation – 1600 kWh/ day

Carbon emission savings – 1280 Kg/day

Carbon emission savings per annum – 467 MT/annum

Cost savings per annum – Rs. 55.6 lacs/ Annum

Month wise Solar energy production –

Month	Solar Generation (kWh)	Carbon dioxide emission savings (MT)
Feb-21	51,446	41.16
Jan-21	47,090	37.67
Dec-20	47,908	38.33
Nov-20	48,247	38.60
Oct-20	42,446	33.96
Sep-20	44,046	35.24
Aug-20	43,928	35.14
Jul-20	44,769	35.82
Jun-20	46,651	37.32

May-20	64,148	51.32
Average	48,068	38.45

Installation –

Roof top Solar PV

Maintenance of Solar PV System –

Cleaning:

- To remove a layer of dust, panels are simply washed with soft water. If the module has thick dirt or grime and bird droppings, which are harder to remove, cold water is used, and the panel surface is cleaned with a sponge. Sometimes, soft detergents are also used along with water for easier cleaning. Metal brushes should be avoided to prevent wearing of the panel surface.

Defect Checking:

- A visual inspection of the modules is done periodically to look for possible defects such as cracks, chips, de-lamination, fogged glazing, water leaks and discoloration. If any obvious defects are found, their location is noted down in the system logbook so that they can be monitored for generation output. If the damage causes the modules to perform lower than the rated value, they should be replaced.

Recommendations –

- Institute needs to do preventive maintenance as a periodic activity for maximum solar generation.
- Regular cleaning and inspection should be done by Institute.

Chapter IX

Rain Water Harvesting

The system of rain water harvesting is an integral part of any educational institution. This system helps to conserve the rain water and also to use during the time of its desirable. This system helps the students to understand the basic concepts of rainwater harvesting system and their effective use in the real life.
It is seen that there is a natural slope at the Institute campus, such natural slope can be used to take the water through some specific path and absorb under the ground. There is one emptybore well in the Institute campus, such empty bore well can be charged with the use of rainwater harvesting system. In addition to this some ring wells can be prepared and rainwater, Gray waste water from all the building can be taken through some specific path in these ring wells and used to charge under the ground to maintain the ground level water.

Advantages of rain water harvesting –

(a) Promotes adequacy of underground water
(b) Mitigates the effect of drought
(c) Reduces soil erosion as surface run-off is reduced
(d) Decreases load on storm water disposal system
(e) Reduces flood hazards
(f) Improves ground water quality / decreases salinity(by dilution)
(g) Prevents ingress of sea water in subsurface aquifersin coastal areas
(h) Improves ground water table, thus saving energy (to lift water)
(i) The cost of recharging subsurface aquifer is lower than surface reservoirs
(j) The subsurface aquifer also serves as storage and distribution system
(k) No land is wasted for storage purpose and no population displacement is involved
(l) Storing water underground is environment friendly

Rain water harvesting potential –

- The total amount of water that is received in the form of rainfall over an area is called the rain water endowment of that area. Out of this, the amount that can be effectively harvested is called rain water harvesting potential.
- All the water which is falling over an area cannot be effectively harvested, due to various losses on account of evaporation, spillage etc. Because of these factors the quantity of rain water which can effectively be harvested is always less than the rain water endowment. The collection efficiency is mainly dependent on factors like runoff coefficient and first flush wastage etc. Runoff is the term applied to the water that flows away from catchments after falling on its surface in the form of rain.
- Runoff depends upon the area and type of catchment over which it falls as well as surface features. Runoff can be generated from both paved and unpaved catchment areas. Paved surfaces have a greater capacity of retaining water on the surface and runoff from unpaved surface is less in comparison to paved surface. In all calculations for runoff estimation, runoff coefficient is used to account for losses due to spillage, leakage, infiltrations catchment surface wetting and evaporation, which will ultimately result into reduced runoff. Runoff coefficient for any catchment is the ratio

of the volume of water that run off a surface to the total volume of rainfall on the surface.

- The runoff coefficient for various surfaces is given in following table –

Sr. No.	Type of catchment	Coefficient
1.	Roof Catchment	
	Tiles	0.8 – 0.9
	Corrugated metal sheets	0.7 – 0.
2.	Ground Surface Coverings	
	Concrete	0.6 – 0.8
	Brick Surface	0.5 – 0.6
3.	Untreated ground catchments	
	Soil on slope less than10 %	0.0 – 0.3
	Rocky natural catchments	0.2 – 0.5

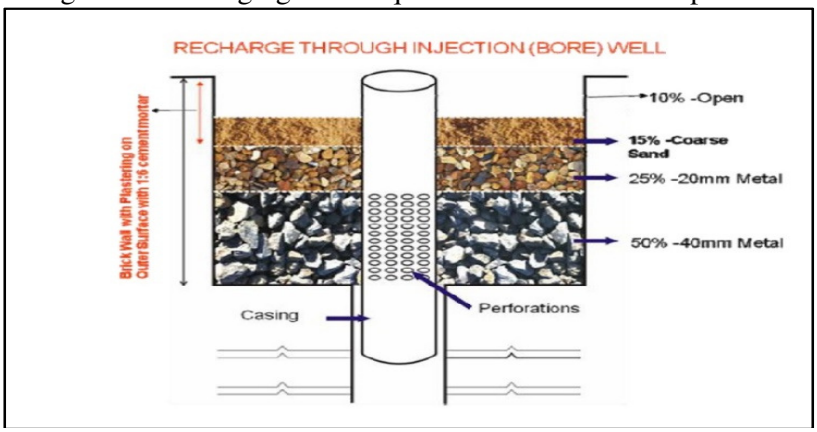
Based on the above factors, the water harvesting potential of site could be estimated using the following equation:
Rain Water harvesting potential = Amount of Rainfall x area of catchment x Runoff coefficient
Institute has area of roof top is – and untreated ground catchment is ---. As per the survey untreated ground catchment area is the soil on slopes more than 10%, so much rainfall from this area will not be available. If only the roof top area considered for calculation of rain water harvesting potential then

Rain water harvesting methods –

(a) Storing rain water for direct use
(b) Recharging ground water aquifers, from roof top run off
(c) Recharging ground water aquifers with runoff from ground area

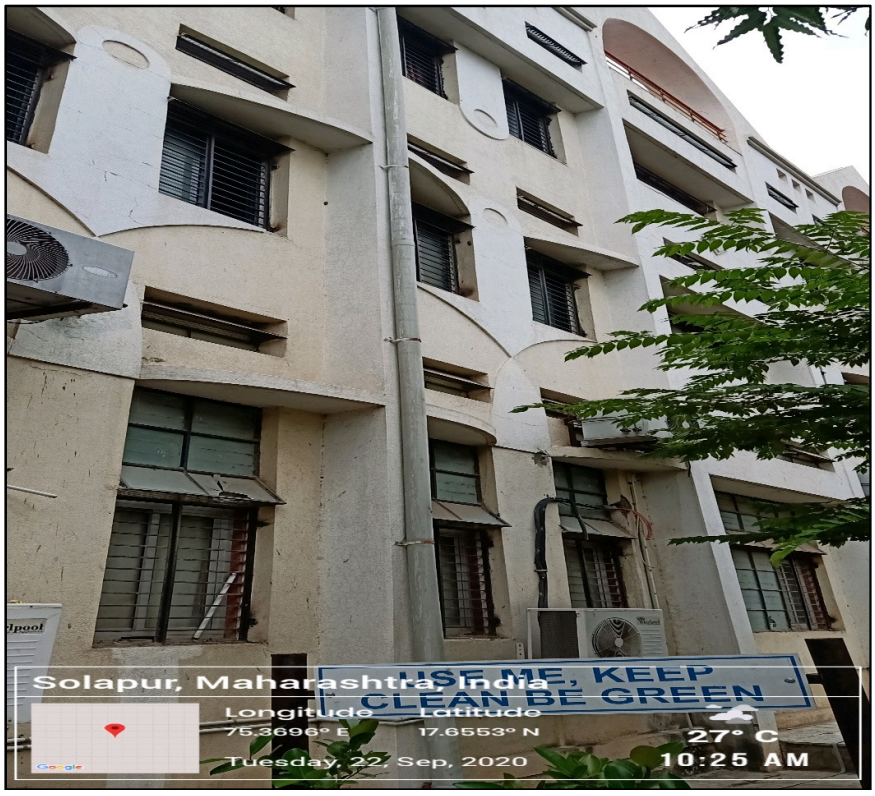
According to the site of Institute the method of recharging ground water aquifers from roof top run off may be suitable.Recharging ground water aquifers from roof top run off. Rain water that is collected on the roof top of the building may be diverted by drain pipes to a filtration tank (for bore well, through settlement tank) from which it flows intothe recharge well, as shown in following Figure. The recharge well should preferably be shallower than the water table. This method of rain water harvesting is preferable in the areas where the rainfall occurs only for a short period in a year and water table is at a shallow depth.

The schematic diagram of recharging water aquifers from solar roof top run off is as follows -



Existing Situation –

Institute has multiple high-rise buildings of 2 – 3 storeys each. These buildings are equipped with the rain water harvesting and water is being collected in the catchments. This collected water is being passed through the borewell present in the campus.



Rain water Harvesting

Catchment area

Chapter X

Waste Disposal and Vermi- Composting

Vermiculture Composting Culture –

Vermicomposting is basically a managed process of worms digesting organic matter to transform the material into a beneficial soil amendment. The institute has been started Vermi culture composting culture in house on 30 Sq. meter land. The main purpose of this is to reduce disposable waste in the Institute campus and after complete process of Vermi composting it is used as manure for plantation and greenery in the campus. It is also used for the demonstration and awareness in farmers to implement organic farming and its importance.

The main benefits of the process are to reduce the waste in the environment and utilized for some useful purpose and also it is cost savings process.

The earthworms being voracious eaters consume the biodegradable matter and give out a part of the matter as excreta or Vermi-castings. The Vermi-casting containing nutrients is a rich manure for the plants. Vermicompost, apart from supplying nutrients and growth enhancing hormones to plants, improves the soil structure leading to increase in water and nutrient holding capacities of soil. Fruits, flowers and vegetables and other plant products grown using vermicompost are reported to have better keeping quality. A growing number of individuals and institutions are taking interest in the production.

Process:

The process of composting crop residues / Agri wastes using earthworms comprise spreading the agricultural wastes and cow dung in gradually built-up shallow layers. The pits are kept

shallow to avoid heat built-up that could kill earthworms. To enable earthworms to transform the material relatively faster a temperature of around 300C is maintained. The final product generated by this process is called vermicompost which essentially consist of the casts made byearthworms eating the raw organic materials. The process consists of constructing brick lined beds generally of 0.9 to 1.5 m width and 0.25 to 0.3 m height are constructed inside a shed open from all sides. For commercial production, the beds can be prepared with 15 m length, 1.5 m width and 0.6 m height spread equally below and above the ground. While the length of the beds can be made as per convenience, the width and height cannot be increased as an increased width affects the ease of operation and an increased height on conversion rate due toheat built up.Cow dung and farm waste can be placed in layers to make a heap of about 0.6 to 0.9 m height. Earthworms are introduced in between the layers @ 350 worms per m3 of bed volume that weighs nearly 1 Kg. The beds are maintained at about 40-50% moisture content and a temperature of 20–300 C by sprinkling water over the beds. When the commercial scale production is aimed at, in addition to the cost of production, considerable amount has to be invested initially on capital items. The capital cost may work out to about Rs. 5000 to 6000 for every tonne of vermicompost production capacity. The high unit capital cost is due to the fact that large units require considerable expenditure on preparation of Vermi beds, shed to provide shelter to these beds and machinery. However, these expenditures are incurred only once.Under the operational cost, transportation of raw materials as also the finished product are the key activities. When the source organic wastes and dung are away from the production facility and the finished product requires transportation to far off places before being marketed, the operational cost would increase. However, in most of the cases, the activity is viable and bankable. Following are the items required to be considered while setting up a unit for production of Vermi-compost.

Components of a Commercial Unit –

Commercial units have to be developed based on availability of cow dung locally. If some big dairy is functioning then such unit will be an associated activity.

Commercial units must not be designed based on imported cow dung.

1. Sheds

For a Vermi-composting unit, whether small or big, this is an essential item and is required for securing the Vermi beds. They could be of attached roof supported by bamboo rafters or steel trusses. Locally available roofing materials or HDPE sheet may also be used in roofing to keep the capital investment at reasonably lower level. If the size is so chosen as to prevent wetting of beds due to rain on a windy day, they could be open sheds. While designing the sheds adequate room/pathways has to be left around the beds for easy movement of the labourers attending to the filling and harvesting the beds.

2. Vermi-beds

Normally the beds have 0.3 to 0.6 m height depending on the provision for drainage of excess water. Care should be taken to make the bed with uniform height over the entire width to avoid low production owing to low bed volumes. The bed width should not be more that 1.5 m to allow
easy access to the centre of the bed.

3. **Fencing and Roads/Paths**

The site area needs development for construction of structures and development of roads and pathways for easy movement of hand-drawn trolleys/wheel barrows for conveying the raw material and

the finished products to and from the Vermi sheds. The entire area has to be fenced to prevent trespass by animals and other unwanted elements. These could be estimated based on the length of the periphery of the farm and the length and type of roads/paths required. The costs on fencing and formation of roads should be kept low as these investments are essential for a production unit, yet would not lead to increase in production.

4**. Water Supply System**

As the beds have to be kept moist always with about 50% moisture content, there is a need to plan for a water source, lifting mechanism and a system of conveying and applying the water to the Vermi-beds. Drippers with round the clock flow arrangement would be quite handy for continuous supply and saving on water. Such a water supply system requires considerable initial investment. However, it reduces the operational cost on hand watering and proves economical in the long run. The cost of these items would depend on the capacity of the unit and the type of water supply chosen.

5. Transportation

For any Vermi-composting unit transport arrangement is a must. When the source of raw material is away from the production unit, an off-site transport becomes major item of investment. A large sized unit with about 1000 tonnes per annum capacity may require a three-tonne capacity mini-truck. With small units particularly with the availability of raw material near the site, expending on transport facility may become infructuous. On-site transport facilities like manually drawn trolleys to convey raw material and finished products between the storage point and the Vermi-compost sheds could also be included in the project cost.

Recommendations –

- Institute should install a small Vermi composting pit for their waste disposal, waste like leaves, bushes and decomposable waste collected in campus.
- Treated vermicompost can be used as the fertilizer for the gardening in Institute campus.
- Currently all this waste is being dumped and burnt in premises or this is being carried away with the wind.

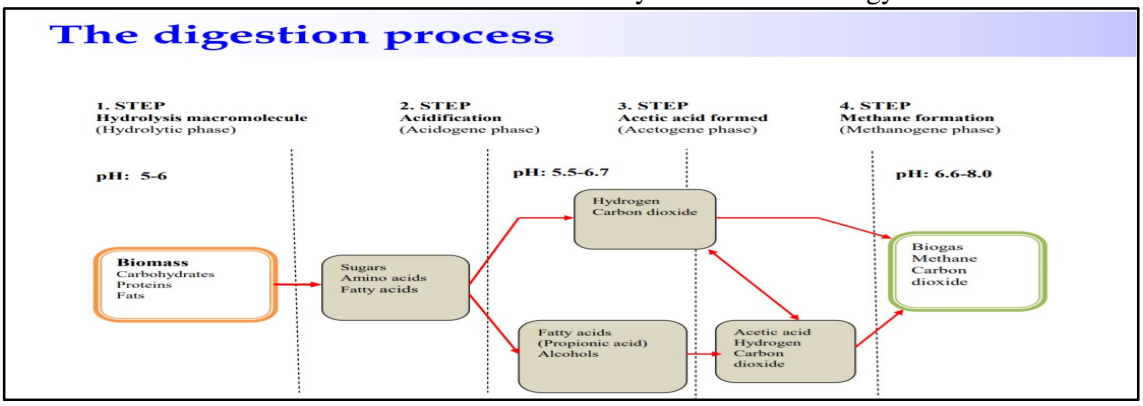
Chapter XI

Biogas system

Biogas system -

One of the main environmental problems of today's society is the continuously increasing production of organic wastes. In many countries, sustainable waste management as well as waste prevention and reduction have become major political priorities, representing an important share of the common efforts to reduce pollution and greenhouse gas emissions and to mitigate global climate changes. Uncontrolled waste dumping is no longer acceptable today and even controlled landfill disposal and incineration of organic wastes are not considered optimal practices, as environmental standards hereof are increasingly stricter and energy recovery and recycling of nutrients and organic matter is aimed.

Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. Biogas is a renewable energy source and, in many cases, exerts a very small carbon footprint. Biogas can be produced by anaerobic digestion with anaerobic organisms, which digest material inside a closed system, or fermentation of biodegradable materials. A wide range of micro-organisms are involved in the anaerobic process which has two main end products: biogas and digestate. Biogas is primarily methane and carbon dioxide and may have small amounts of hydrogen sulphide, moisture and siloxanes. The gases methane, hydrogen, and carbon monoxide can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel; it can be used for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat. Biogas can be compressed, the same way natural gas is compressed to CNG, and used to power motor vehicles. In the UK, for example, biogas is estimated to have the potential to replace around 17% of vehicle fuel. It qualifies for renewable energy subsidies in some parts of the world. Biogas can be cleaned and upgraded to natural gas standards, when it becomes bio-methane. Biogas is considered to be a renewable resource because its production-and-use cycle is continuous, it generates no net carbon dioxide. Organic material grows, is converted and used and then regrows in a continually repeating cycle. From a carbon perspective, as much carbon dioxide is absorbed from the atmosphere in the growth of the primary bio-resource as is released when the material is ultimately converted to energy.



Current Situation -

- Institute has 20 m^3 biogas plant installed at hostel campus but currently it is not working due to the unavailability waste manure collected from the canteens.

- Due to current condition of student unavailability in Institute campus the biogas plant is completely stopped.

- This biogas plant is equipped with 250 LPD solar water heater for performance enhancement.

- Produced biogas is directly used in the canteen for cooking purpose.

Existing Biogas plant

Recommendation -

- Institute need to install a gas flowmeter for evaluation of daily generated gas., so they can avail the full benefit of produced gas and can count that for LPG replacement.
- The plant needs to maintained as during the load condition the waste manure was scattered on biogas plant and adjacent room.
- Maintenance of plant is necessary during working conditions.

Chapter XII

Sewage Treatment Plant (Waste water Recycling)

Sewage Treatment Plant -

It includes physical, biological and sometimes chemical processes to remove pollutants. Its aim is to produce an environmentally safe sewage water, called effluent, and a solid waste, called sludge or biosolids, suitable for disposal or reuse. Reuse is often for agricultural purposes, but more recently, sludge is being used as a fuel source.

Water from the mains, used by manufacturing, farming, houses (toilets, baths, showers, kitchens, sinks), hospitals, commercial and industrial sites, is reduced in quality as a result of the introduction of contaminating constituents. Organic wastes, suspended solids, bacteria, nitrates, and phosphates are pollutants that must be removed.The features of wastewater treatment systems are determined by:

The nature of the municipal and industrial wastes that are conveyed to them by the sewers. The amount of treatment required to keep the quality of the receiving streams and rivers. Discharges from treatment plants are usually diluted in rivers, lakes, or estuaries. They also may, after sterilisation, be used for certain types of irrigation (such as golf courses), transported to lagoons where they are evaporated, or discharged through underground outfalls into the sea. However, sewage water outflows from treatment works must meet effluent standards set by the Environment Agency to avoid polluting the waters that receive them.In this process, aerobic bacteria digest the pollutants. To establish an aerobic bacterial colony, you must provide air for the bacteria to breathe. In a sewage treatment plant, air is continuously supplied to the Biozone either by direct Surface Aeration using Impellers propelled by pumps which whisk the surface of the liquid with air, or by Submerged Diffused Aeration using blowers for air supply through bubble diffusers at the bottom of the tank. (The most modern aerobic sewage systems use natural air currents and do not require electricity, though these are only used for small scale sewage systems at the moment. Once again, the general public leads the way!) Aerobic conditions lead to an aerobic bacterial colony being established. These achieve almost complete oxidation and digestion of organic matter and organic pollutants to Carbon Dioxide, Water and Nitrogen, thus eliminating the odour and pollution problem above. The effluent produced by this process is non-polluting and can be discharged to a watercourse

Conventional sewage water treatment involves either two or three stages, called primary, secondary and tertiary treatment. Before these treatments, preliminary removal of rags, cloths, sanitary items, etc. is also carried out at municipal sewage works.

Primary Treatment

This is usually Anaerobic. First, the solids are separated from the sewage. They settle out at the base of a primary settlement tank. The sludge is continuously being reduced in volume by the anaerobic process, resulting in a vastly reduced total mass when compared to the original volume entering the system.

The primary settlement tank has the sludge removed when it is about 30% of the tank volume.

Secondary Treatment

This is Aerobic. The liquid from the Primary treatment contains dissolved and particulate biological matter. This is progressively converted into clean water by using indigenous, water-borne aerobic micro-organisms and bacteria which digest the pollutants. In most cases, this effluent is clean enough for discharge directly to rivers.

Tertiary Treatment

In some cases, the effluent resulting from secondary treatment is not clean enough for discharge. This may be because the stream it is being discharged into is very sensitive, has rare plants and animals or is already polluted by someone's septic tank. The Environment Agency may then require a very high standard of treatment with a view to the new discharge being CLEANER than the water in the stream and to, in effect, 'Clean it up a bit'. It is usually either Phosphorous or Ammoniacal Nitrogen or both that the E.A. want reduced. Tertiary treatment involves this process. If Phosphorous is the culprit, then a continuous dosing system to remove it is the tertiary treatment. If Ammoniacal Nitrogen is the problem, then the sewage treatment plant process must involve a nitrifying and then de-nitrification stage to convert the ammoniacal nitrogen to Nitrogen gas that harmlessly enters the atmosphere.

Current Situation -

- Institute has installed 300 CMD sewage treatment plant for waste water recycling. This plant is being located near to the polytechnic workshops and sports ground.
- This recycled water is being stored in the tank and then used for gardening purpose with the help of recycle pump.
- Waste water from the hostel and hostel canteen is stored near to the electrical room, and then transferred to the sewage treatment plant.

Existing STP plant

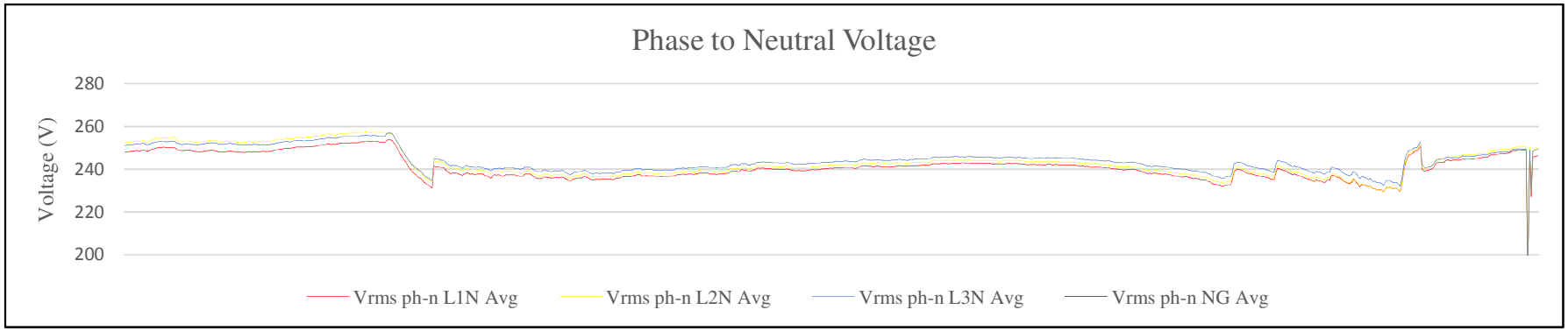
Recommendation -

- Institute need to install a water flowmeter for evaluation of daily recycled water so they can evaluate the performance of STP plant.
- Institute can also use the recycled water for flushing purpose in the hostels andInstitute campus.
- As the capacity of plant is 300 m3 per day and gardening does not required this much amount of water. This will save the fresh water which is already being transported form various sources and pumped for usage.
- Usage of recycled water will also, significantly impact on energy consumption for pumping station.

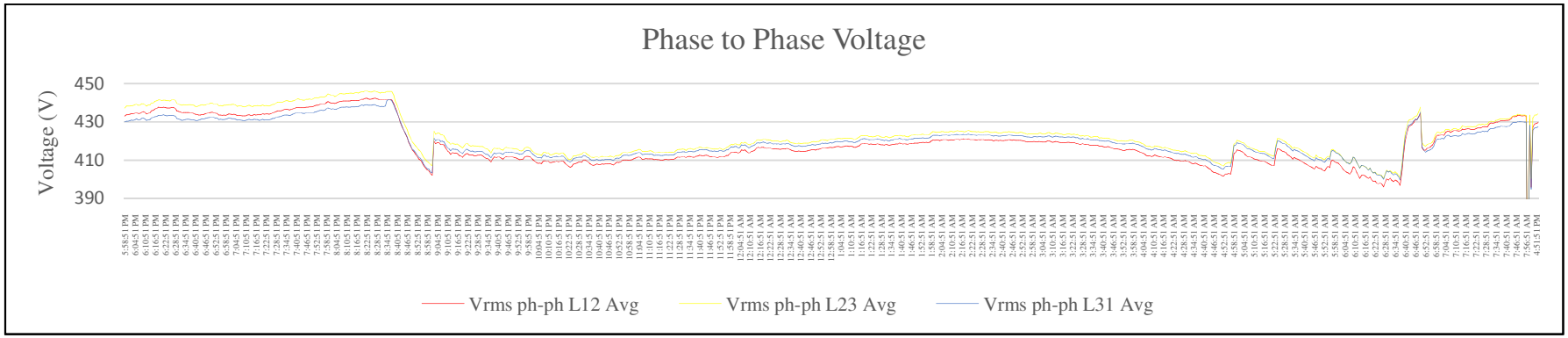
Annexure I – Power Quality Graphs

I) Voltage

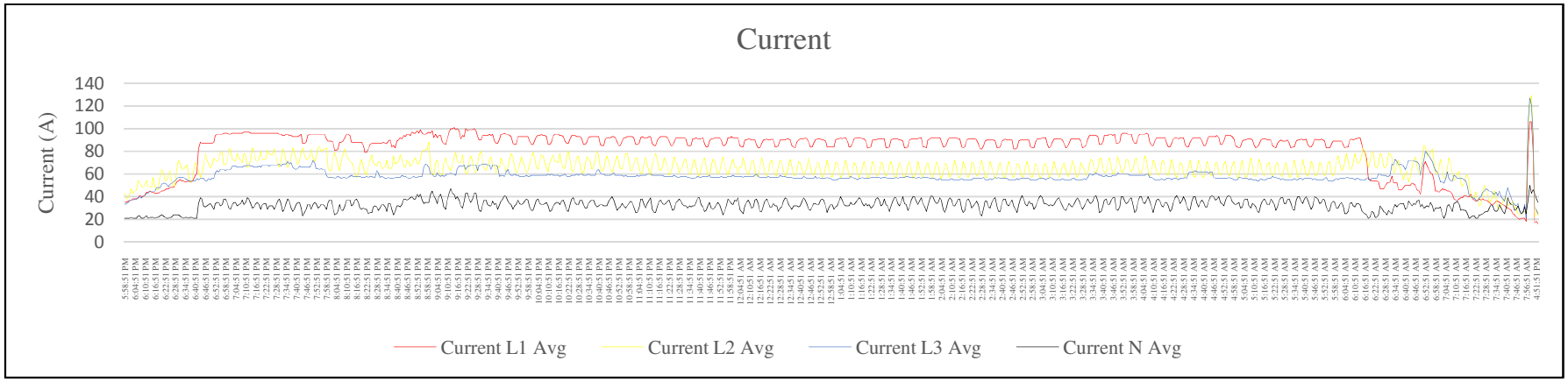
Phase to neutral voltage (V)



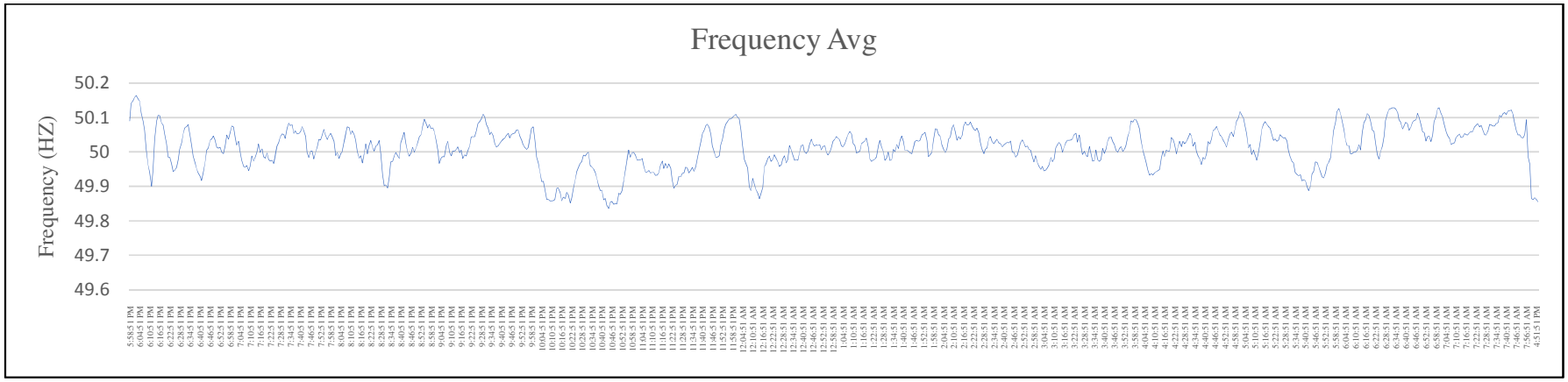
Line Voltage (V)



II) Current (A) –

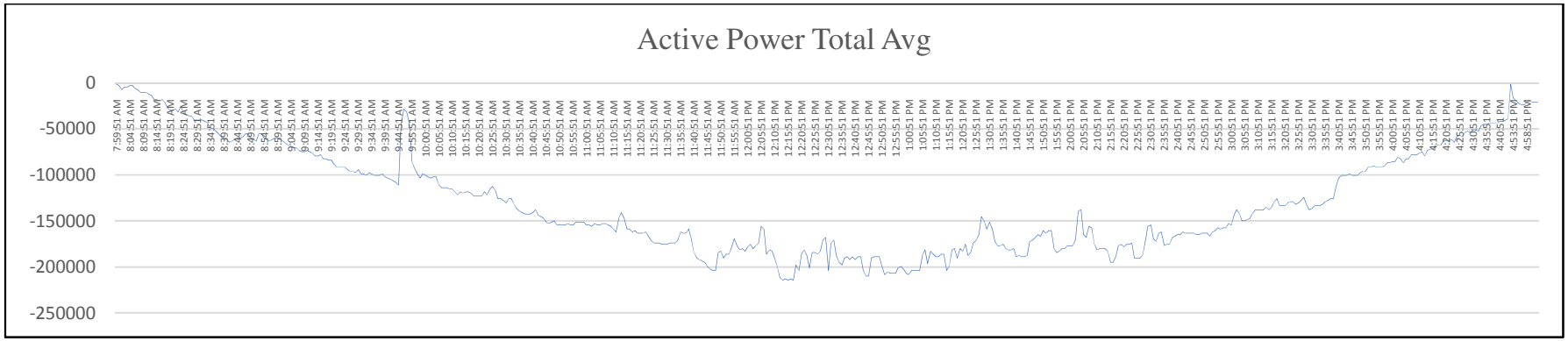


III) Frequency (Hz)–



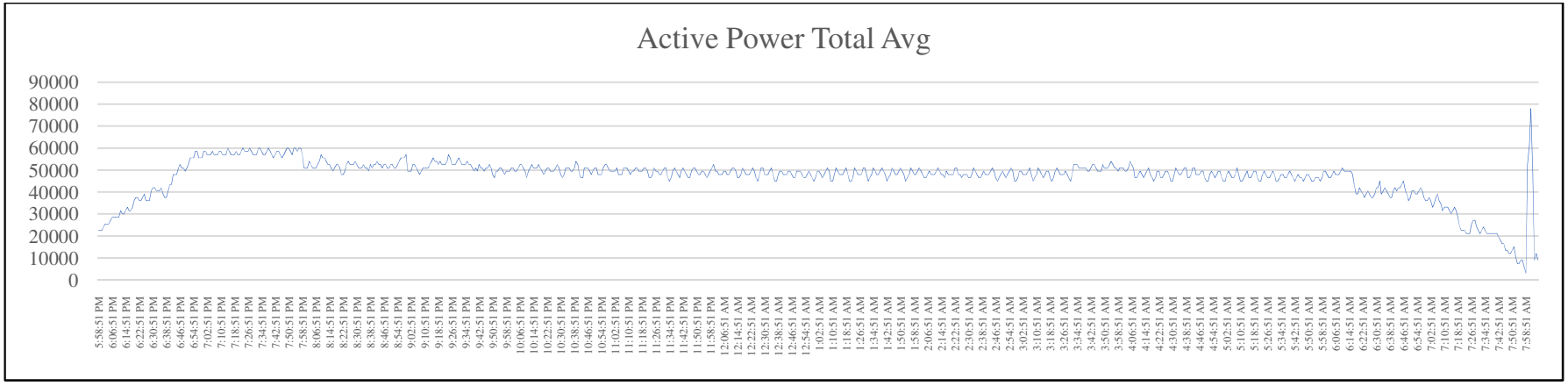
IV) Active Power (W) –

During Solar Plant is ON: (Time:07:52:00 AM to 05:02:00PM)

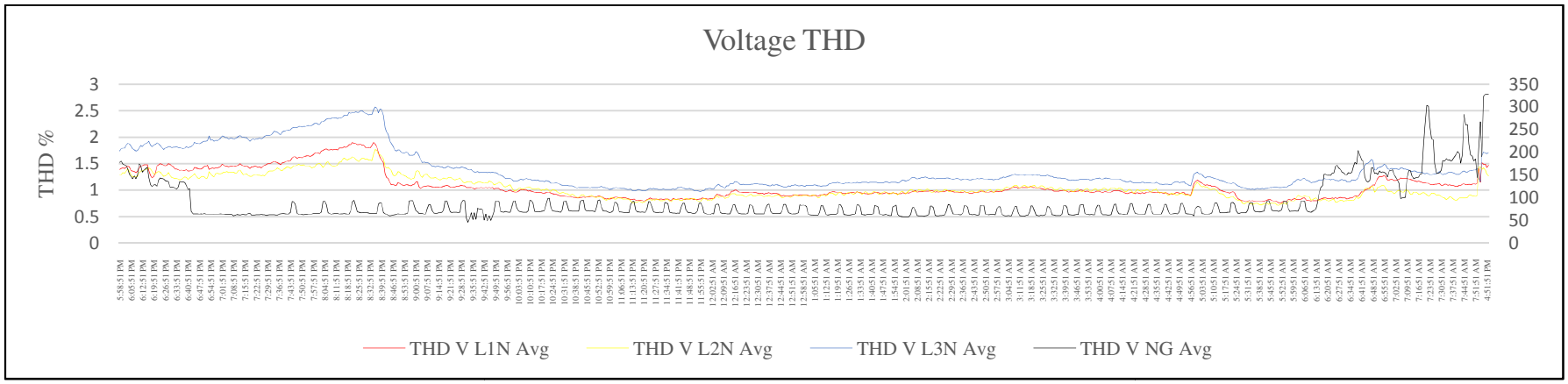


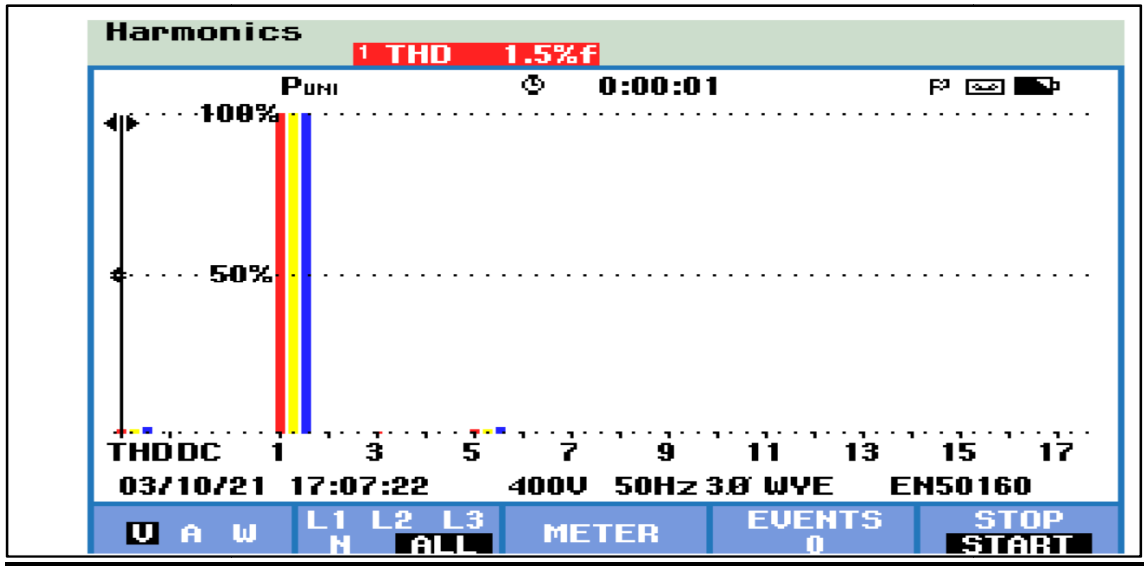
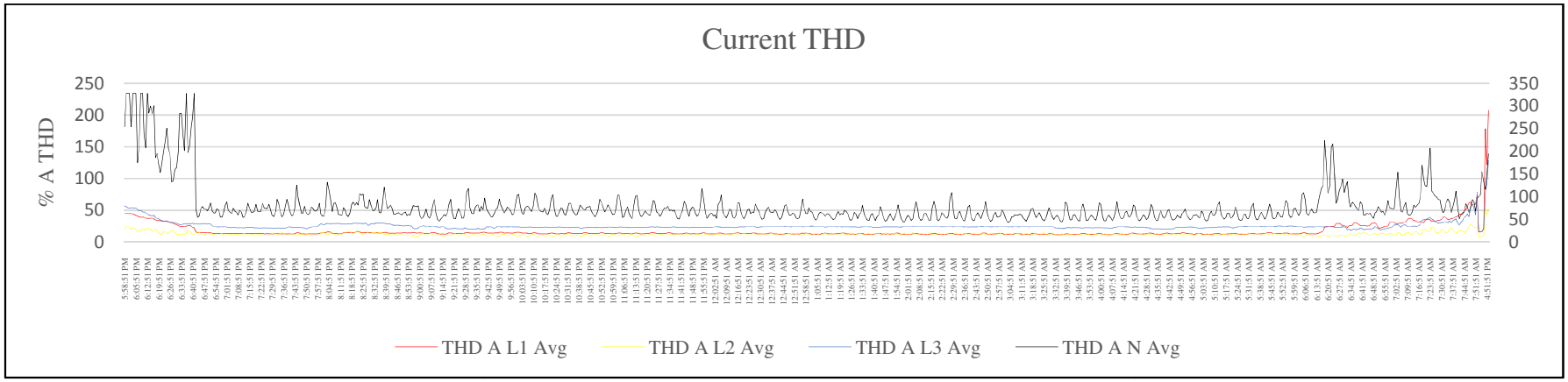
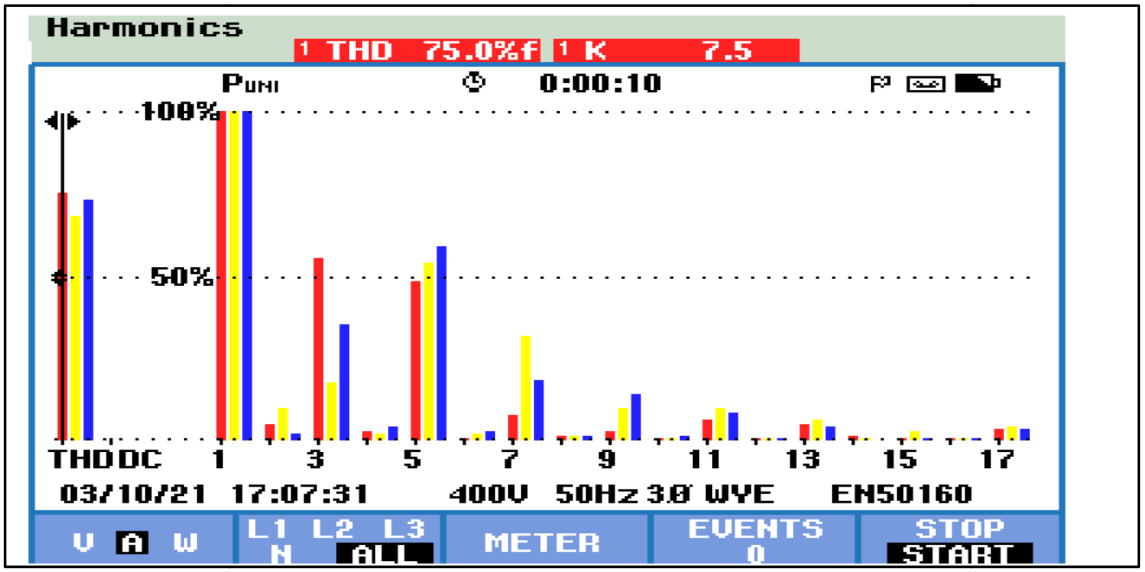
Active Power (W) –

Active Power During Solar Plant is: (Time:05:03:00PM to07:51:00 AM)



V) Harmonic Distortion- Voltage–


Voltage THD
THD %
3
2.5
2
1.5
1
0.5
0
350
300
250
200
150
100
50
0
THD V L1N Avg
THD V L2N Avg
THD V L3N Avg
THD V NG Avg


Harmonics
1 THD 1.5%f
PUMI
0:00:01
100%
50%
THDDC 1 3 5 7 9 11 13 15 17
03/10/21 17:07:22 400V 50Hz 3Ø WYE EN50160
U A W
L1 L2 L3
N ALL
METER
EVENTS
0
STOP
START

VI) Harmonic Distortion- Current –