

National Electrical Safety Campaign

kVAh Billing -
Understanding Benefits
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- Back to Power Triangle Basics
- kVAh billing - The Why & What
- Load Types & their impacts on kVAh billing
- Getting familiar with the new Power Triangle
- kVAh Billing - Get on top to achieve maximum efficiency

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Reactive Power Fundamentals

- Reactive power is used to develop the electrical environment to make the active power work, but isn't directly utilized for work, hence called useless power

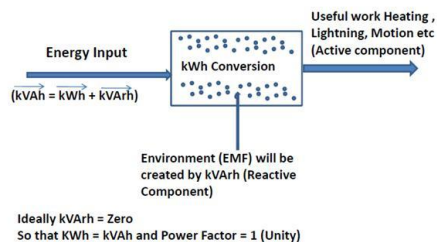
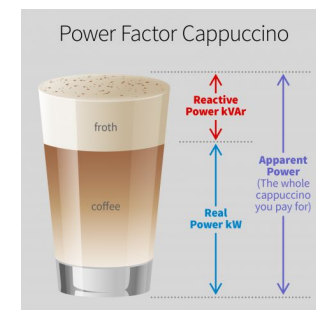
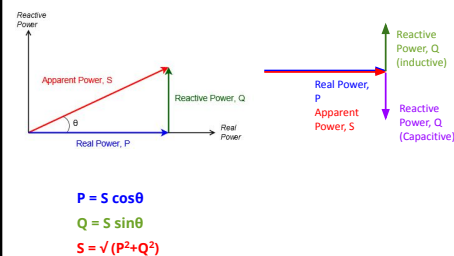


Image Courtesy : MERC

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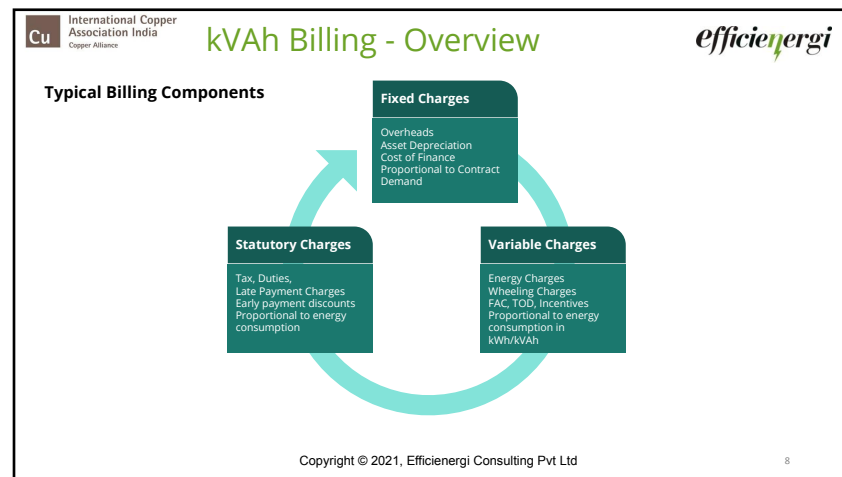
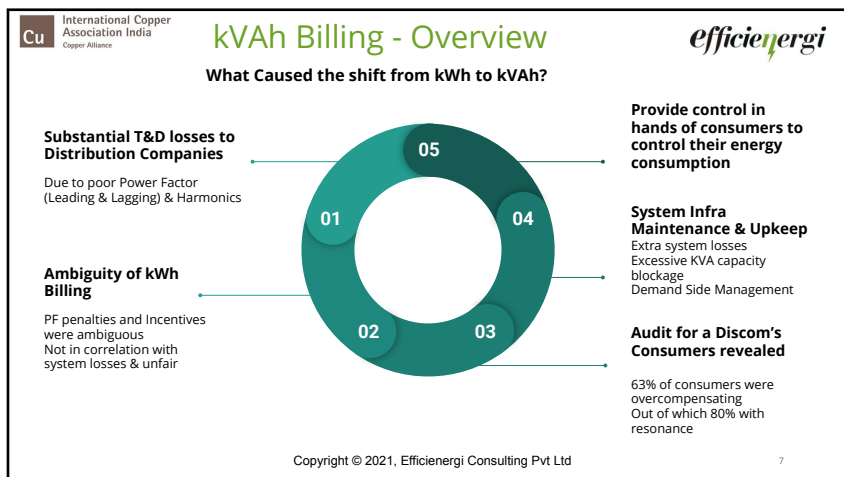
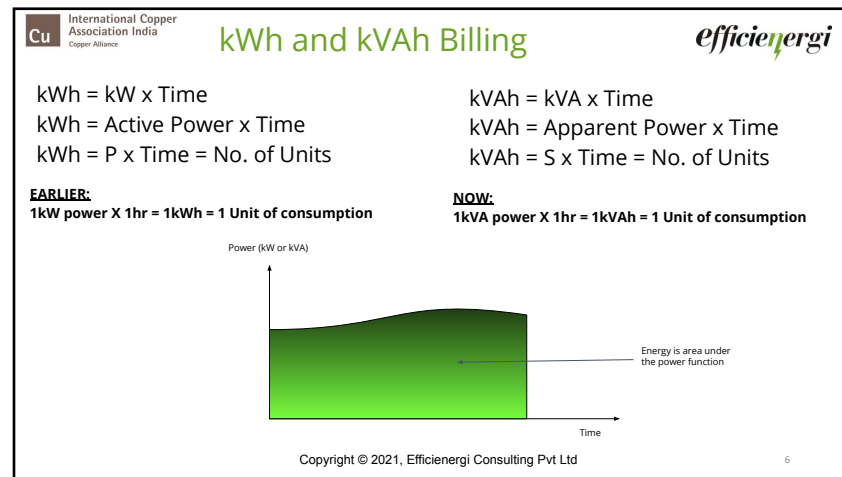
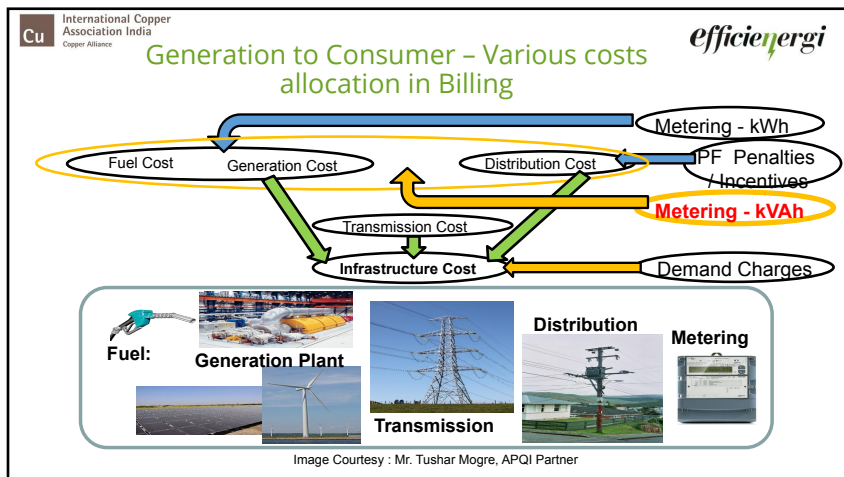
Reactive Power Fundamentals

- Types and Characteristics of electrical power can be best explained with a Power Triangle



$$\text{Power Factor} = \frac{\text{Real Power kW coffee}}{\text{Apparent Power (kW}^2 + \text{kVA}^2) \text{ coffee + froth}}$$

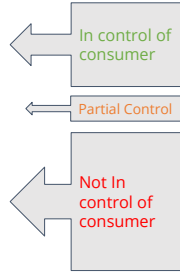
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kVAh Billing - Overview

kVAh Billing Details - Example - MSEDCL

- Demand Charges
- Energy Charges
- PF Incentives/Penalties (Not applicable for kVAh billing)
- Early Payment Discounts
- TOD charges
- Wheeling Charges
- Electricity Duty
- FAC - Fuel Charge Adjustment
- Bulk Discount
- Incremental Discount
- Duties and Taxes



kVAh Billing - Load Types & Impacts

Highly inductive or Capacitive Loads – The loads that have poor Power Factor (Leading or Lagging)

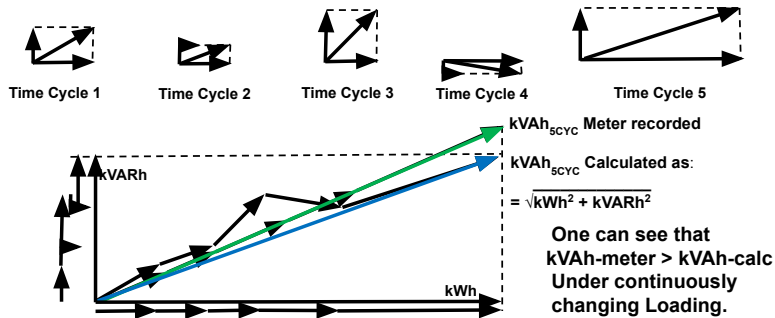
- ⇒ **Continuously Variable Load** – The electrical loading that is continuously variable in nature. More abrupt the load changes, adverse is the effect on kVAh billing
- ⇒ **Unbalanced Loading** – The loads that are Unbalanced in nature. It even affects, if the unbalance phenomenon is continuously changing
- ⇒ **Harmonics Prone Load** – The loads with higher level of Harmonic currents and / or Harmonic voltages

Any of the above load types in your plant will necessitate action to optimise kVAh billing



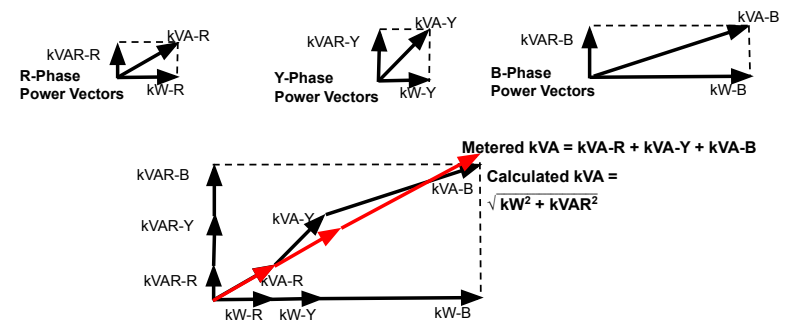
Factors Affecting the kVAh

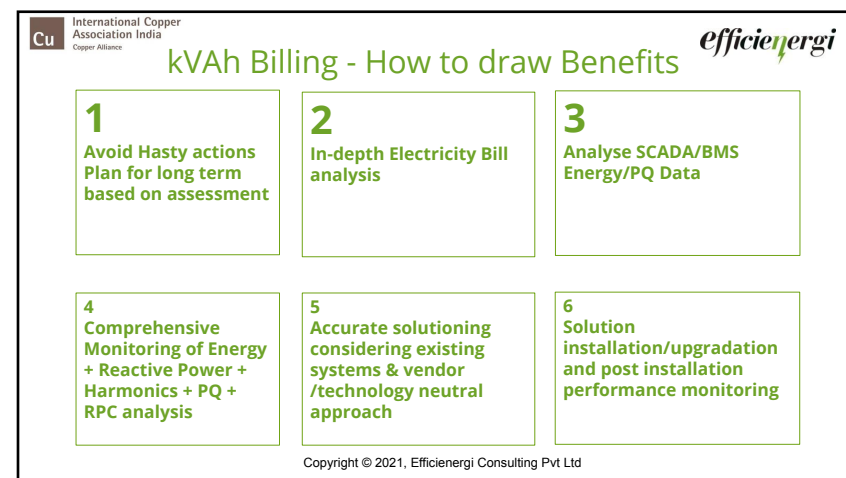
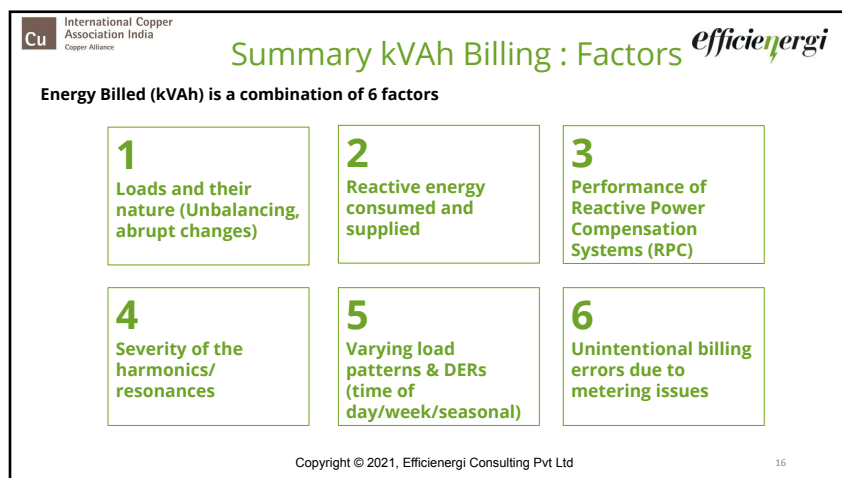
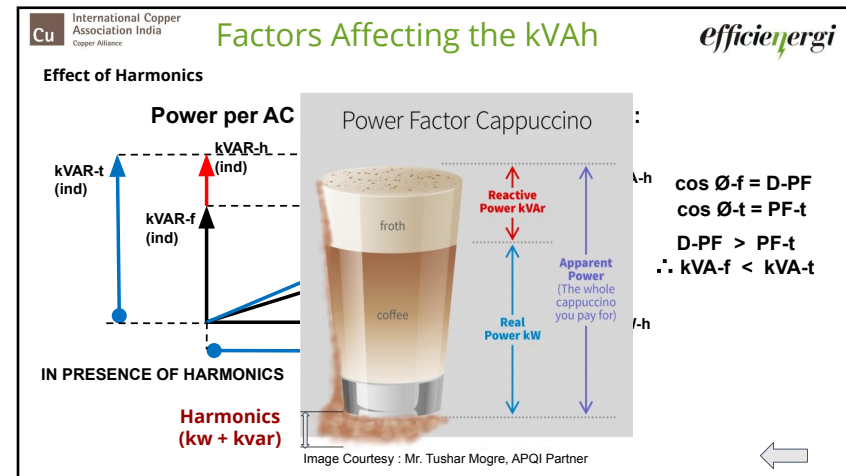
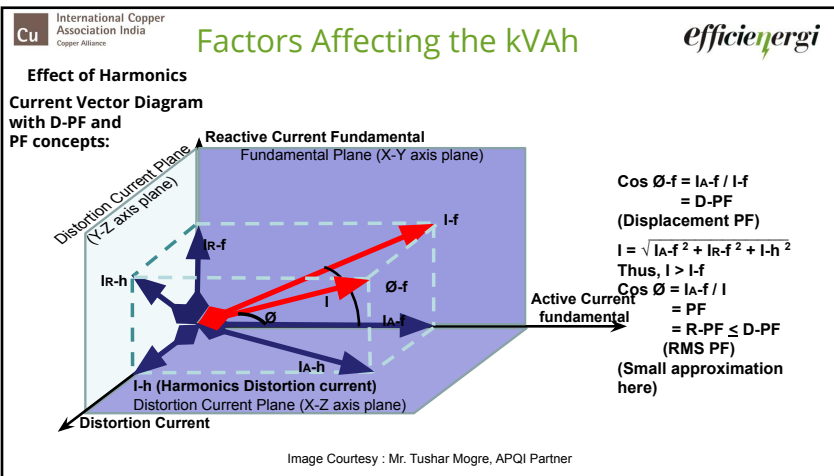
Effect of Load Variation



Factors Affecting the kVAh

Effect of Unbalanced Loading







kVAh Billing - How to draw Benefits

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Avoid haste, avoid band-aids, Plan for long term

- Variables affecting plant operations
- Stock of existing systems affecting kVAh optimisation
- Stock of existing processes for monitoring/controlling
- Arrive at the impact that you currently foresee

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kVAh Billing - How to draw Benefits

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Analysis of past 12 months of Electricity Bills

- Goldmine of data exists in your bills
- Energy consumption/PF/Actual Demand/Billed Demand patterns
- Potential Losses and/or realistic savings estimates
- Focus on other factors affecting billing
- Estimate of investment vs. ROI

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kVAh Billing - Overview

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Electricity Bill Analysis - Case 1

CURRENT CONSUMPTION DETAILS									
Reading Date	KWH	KVAh	KVAh (LAD)	KVAh (LEAD)	KW (MD)	KVA (MD)			
Current 30/05/2021	93298.552	12669.100	36937.100	24.400	16.600	21.100			
Previous 31/05/2021	96071.300	12708.800	36970.900	24.400	16.600	21.100			
Difference	5162.352	5100.350	3028.200	0.000	0.000	0.000			
Multiplying Factor	0.000	0.000	0.000	0.000	0.000	0.000			
Consumption	2641.752	30007.200	15131.000	0.000	0.000	0.000			
L.T. Metering	0.000	0.000	0.000	0.000	0.000	0.000			
Adjustment	0.000	0.000	0.000	0.000	0.000	0.000			
Assessed Consumption	2641.752	30007.200	15131.000	0.000	0.000	0.000			
Total Consumption	2641.752	30007.200	15131.000	0.000	0.000	0.000			

BILLING DETAILS									
Billed Demand (KVA)	169	Rate	Amount Rs.	Surcharge @ 6.56 Rs/KW	11,084.00				
Assessed P.F.	0.846	L.F.	0.846	Energy Charge @	3,41,611.00				
Billed P.F.	0.846	Rate	0.846	100% Demand	3,41,611.00				
Consumption Type	0.000	Rate	0.000	FAC @ 8.88	0.00				
Industrial	0	11.20	0.00	Electricity Duty	0.00				
Residential	0	5.70	0.00	Bulk Consumption Rebate	0.00				
Commercial	0	11.20	0.00	Tax on Sale @ 12.5%	4,913.00				
G.D. (Rs.)	16,500	Rate	0.00	Incremental Consumption Rebate	0.00				
4,39,943.00	21.00	Rate	0.00	Charges For Excess Demand	0.00				
TOD Zone	Rate	Units	Demand	Charges Rs.	0.00				
10:00 hrs to 24:00 hrs	1.50	7,024	89.00	-10236.00	0.00				
24:00 hrs to 10:00 hrs	0.00	12,981	108.00	0.00	0.00				
					TOTAL CURRENT BILLS				
					5,37,244.18				

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kVAh Billing - How to draw Benefits

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Electricity Bill Analysis - Case 1

8 ANNEXURES

Months	Bill Cycle (No. of Days)	Billed PF	Contract Demand (kVA)	Actual Recorded Max Demand (kVA)	Billed Demand (kVA)	Recorded kWh	Recorded kVAh	Demand Charges	Energy (kWh/kVA h) Charges	Early Payment Discounts	Total Bill Amount
October -20	31	0.898	315	86	173	21275	23668	71103	271471.96	5378.7	430290
Novemb er-20	30	0.886	315	87	173	21230	23949	71103	274695.03	5440.48	435240
Decemb er-20	31	0.874	315	97	173	23040	26334	71103	302050.98	5891.31	471310
January- 21	31	0.864	315	116	173	25340	29310	71103	336185.7	6450.09	516010
Februar y-21	28	0.866	315	105	173	22269	25700	71103	294779	5787.97	463040
March- 21	31	0.87	315	117	173	26483	30415	71103	348860.05	6655.23	532420
April-21	30	0.872	315	102	189	25547	29264	81648	327756.8	6470.71	478890
May-21	31	0.858	315	106	189	27097	31561	81648	353483.2	6908.78	552700
June-21	30	0.846	315	108	189	25812	30501	81648	341611.2	6715.55	537240

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Electricity Bill Analysis - Case 1

3 EXECUTIVE SUMMARY

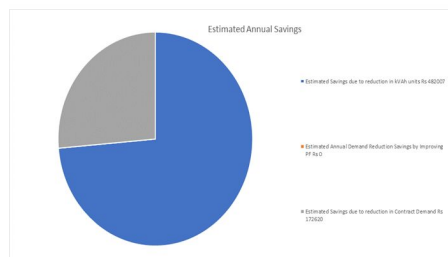
3.01 KEY SUMMARY POINTS

Text Name	Priority
Electricity Bill Analysis	High

Note:
The following Assumptions are made for the calculations of the estimated savings.
3.85 11.47 Per Unit Energy Charges are considered for savings calculation.
2.85 41.1 Per Unit Demand Charges (kVAh) are considered for savings calculation.
3.0.995 as Target Power Factor (PF) is used for calculating the savings.

Description	Values
Estimated Annual Monetary Savings in INR	654627
Estimated Savings due to reduction in Contract Demand in INR	172620
Return on Investment (ROI) in Months	1
Estimated Annual Demand Reduction Savings in INR	0
Estimated Savings due to reduction in kVAh units in INR	482007
Projected Capital Cost of the Reactive Compensation Solution (Assumed price as 1200 INR/kVAh)	66000
Total Estimated kVAh Requirement	55

4 DETAILED REPORT SUMMARY



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Evaluate existing EMS/SCADA data

- Completeness of parameters
- Accuracy of the measurements being undertaken
- Historic data availability
- Locations of data being collected
- Decide on further study necessary or not

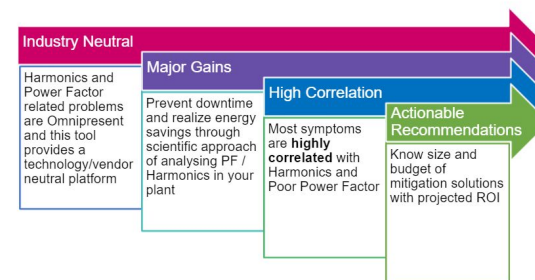
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Our Own Solution - A Cloud Based Engine

Jointly Created by APQI and Efficienergi, To propagate a common platform to monitor, measure and ensure PF & Harmonic compliance assurance

Introducing - secqlite® - India's First Online Harmonics & PF Assessment Tool

More than 50 industries have already utilised the tool for their benefit
Conservative Estimates across India - 4.5 Lac Tons of CO₂ savings Possible



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4 Comprehensive Energy + Harmonics + Reactive Power + PQ + RPC monitoring

- Solve 5 problems with one action
- Number of Locations / Duration / Simultaneous measurements
- Type and configuration of analysers to be deployed (Inhouse/Remote??)
- Beware - Switching off RPC's may do more harm
- Finalise right monitoring strategy - Short and Continual Basis

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- The increase in your billing amount could be because of one or more factors.
- The solutions required could also be one or more.
- Most importantly, solution can be decided only after a thorough understanding of the factors that affect your system and increase the billing amount.
- A product/technology neutral approach will be valuable.

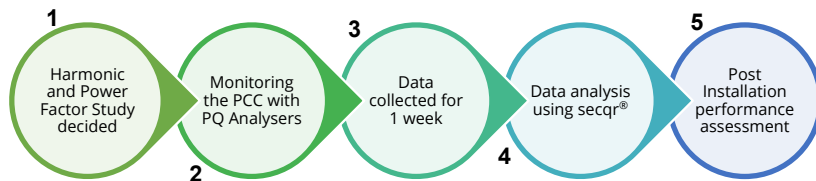
Actual Case Study done with Product/Vendor Neutral Approach

Approach	Time of Study	Cost of the Study	Cost of Filters/Solution (suggested)
OEM Study & Solution	1 Day	INR 10,000/-	INR 80 Lacs
Neutral Study & Solution	5 Days	INR 100,000/-	INR 8 Lacs (90% savings)

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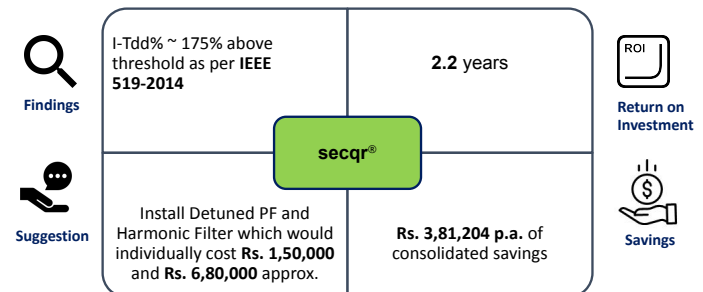
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Advanced Harmonic cum PF cum Power Quality Study



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Advanced PF cum Harmonic cum PQ Study - Case 2



5 Optimum solution prioritising considering existing systems

- Solutions lie within your facility a lot of times
- Evaluate collective effectiveness of existing solution, problems and new if any to be considered
- Focus on overall solutions, specifications, best ROI & future service support
- Side-effects of using the solution - Buy to solve the problem, not perpetuate it
- Have a technology/vendor neutral mindset at this stage.

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Some options available to choose from depending on end use application

For Inductive or Capacitive Reactive Load

Usage of Fixed Inductors or Capacitors: For constant continuous Load without variation
Manually Switched Inductors or Capacitors: For Very slow Load variation

Loss -
~0.5W/kvar

For Reactive Power Load Variation:

Automatic Power Factor Correction (APFC) system: For slow variation in Load
Real Time Power Factor Correction (RTPFC) system: For fast variation in Load
Solid state Reactive Power compensator (STATCON): For abrupt variation in Load

Loss -
~30W/kvar

For Harmonic Prone Loads:

Harmonic Filters. (Active or Passive - selected dependent on merits / demerits)
Usage of Detuned Reactors in APFC / RTPFC system if used for Load variation

For Unbalanced Loads:

Passive Unbalance Compensator: For Fixed Unbalanced condition
Solid state Unbalanced compensator (STATCOM): For Variable Unbalanced Loading

Loss -
~10W/kvar

For Combination of Above type of Loads:

Hybrid systems: APFC / RTPFC / STATCOM combination.

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6 Solution installation & post performance verification

- Ensure complete ownership of the solution and performance
- Plan for minimal downtime for integration of the solution
- Integrate post installation, performance monitoring strategy
- Use power of technology - Ensure 24/7 compliance, don't settle for anything else

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Key PQ Parameters

Power Factor
Harmonics

Current
Focus

Short
Term fix

Penalties charged for
poor PQ

Higher Bills

Steady State
Phenomenon
Power Disturbances
Transients
High Freq. Noise
Earthing and
Grounding issues
Power Quality Load
Suitability and
Compliance

The Required PQ
Focus to achieve
good Energy
Quality

Long
Term
Strategic fix

Improved life-cycle and
Optimised energy utilization with
continuous and comprehensive
PQ monitoring

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Thanks for your attention

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Questions?

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