Case Study: EA-254

Energy Audit of Railway Traction Distribution System

About The Installation:

Traction Sub-station (TSS) is the substation feeding power to traction lines. The traction substation draws electricity at 132 KV or 220 KV and supplies at 25 KV to the traction lines. Locomotives are the major loads in the traction distribution whereas contribution of other loads (signaling & other single phase loads) is negligibly small (less than 1%).

The substations in Indian Railways generally have two transformers of capacity 21.6 MVA or 12.5 MVA. One transformer is kept as standby (hot/cold) in order to have more reliability. There are many auxiliary transformers of 10 KVA each, which are feeding signaling and other point loads etc. Capacitors along with series reactors are installed at 25 KV bus bar to improve the power factor. This Detail Energy Audit has been carried out at one of the TSS of Indian Railways. Contract Demand for this substation is 15.5 MVA. This TSS feeds 4 sections. Annual energy consumption is 57.63 million KWH.

About the Assignment:

Scope of work for this Detail Energy Audit has been:

1. Qualitative and quantitative study of all components of energy payable i.e. KW, KWh, KVAR, MD, PF and harmonics etc.
2. Study of system network, rating/capacities, operational pattern and energy metering systems
3. Study voltage profiles over 25 KV lines, variations in the system and optimal voltage pressure for utilization with least specific energy consumption, energy flow and identification of wastages
4. Capacitor Banks:
   - 4.1 Energy dissipation in series reactor and capacitor banks and measures to minimize losses.
   - 4.2 Switched capacitor banks
   - 4.3 Scope of using series capacitor banks and/or capacitor banks at sectioning-cum Paralleling posts (far end)
5. Review of auxiliary transformer installed in the traction system, rating, utilization and losses.
6. Study of Loco consumption profile for Passenger train, Express train and Goods train etc.
7. Suggestion/measures to reduce transmission losses for energy conservation

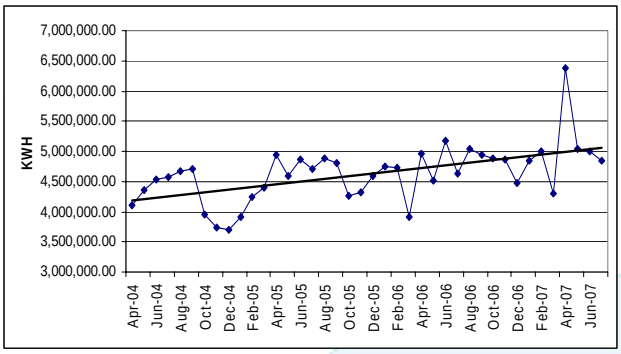
How did we Approach?

Energy Audit for traction is comparatively more recent than Energy Audit in manufacturing sector. The issues are also different: like working with moving load which is also highly un-steady, single phase nature of operation (traction motors), HT load causing limitations for measurements, longer transmission lines & others. The areas identified for energy conservation to be done are as follows:

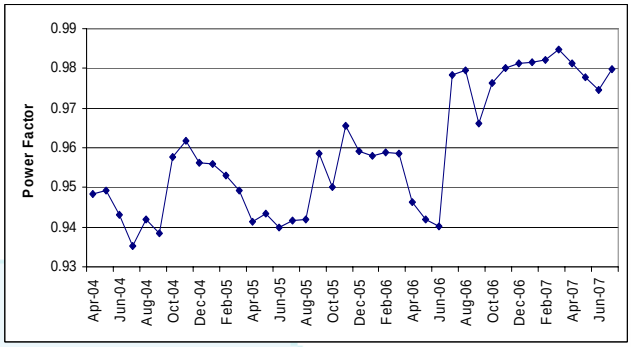
1. Transmission line losses in HT lines from metering point of SEB to the Traction Substation
2. Main transformers at Traction Substation
3. Series Reactors & Capacitor Bank
4. Traction line
5. Locomotive
6. Auxiliary transformers

Overall focus has been on measurements & quantification of losses in energy transmission and analysis thereupon. The study has finally evolved measures to improve energy efficiency.

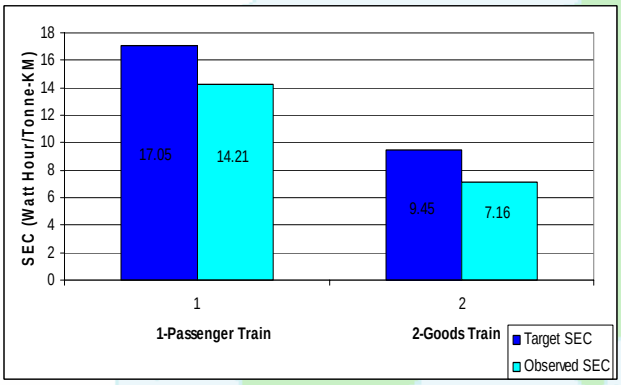
Observations: Variations in V, I, KWH consumption, PF and harmonics are observed & studied:



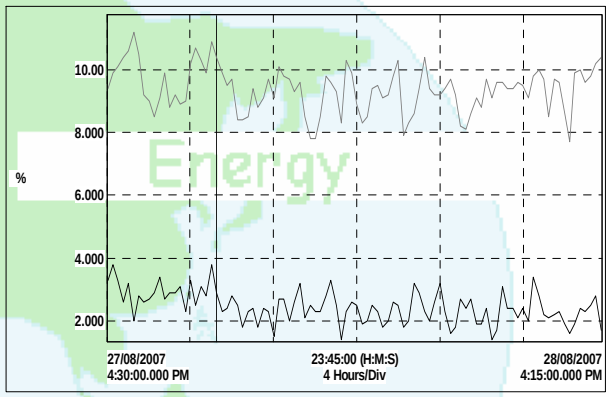
Monthly KWH for Last 3 Years



Power Factor Variation for Last 3 Years



Targeted & Observed SEC



Harmonics in Voltage & Current

Findings & Recommendations:

1. At present the metering point TSS is 1.2 Km away from Traction Substation causing additional transmission losses. It is recommended to shift the metering point to the TSS.
2. It has been found that one 21.6 MVA transformer is kept hot standby. It is recommended to keep it cold standby resulting in 33% loss reduction in total losses in the transformer.
3. While studying load profile in locos, it is observed that PF in locos is in the range of 0.7 to 0.85. It is recommended that dynamic capacitors should be provided in loco itself considering that capacitors should always be provided nearest to the load end. This will result in significant reduction in line losses in the 25 KV line.
4. Wherever possible the load on the auxiliary transformers should be shifted only on one transformer & the surplus transformers should be removed considering the cable length criterion. This will also increase loading of the transformers and thereby improve efficiency.
5. Coasting Boards should be provided so that the drivers will be aware of the coasting period. This kind of practices will help to minimize the specific energy consumption of locomotives.
6. Microprocessor based Energy Meters should be provided in the all Electric Locomotives to monitor the energy consumption. Specific energy consumption (SEC) of the locomotive should be calculated & compared with the benchmark values to take corrective measures.
7. Due to the increasing energy tariffs, installing biomass captive Power Plants and investing in Wind Mills are also good measures, which will provide CDM benefits also.

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