Article 33

Power Sector Small Talk

Albrecht Kaupp, Manager
Indo-German Energy Programme, IGEN

Whenever I philosophy over the system energy efficiency and performance in the power sector, several things come into my mind.

1. Are power plant owners and managers really aware about the relation between the annual salary of equipment operators and the annual energy costs for the equipment they operate? Equipment operators who may earn between Rs 6 and 12 lakhs a year are in charge of operating 210 MW power units that consume coal costing 150 Crore Rs a year. In other words – a little bit more concern about Human Resource Development, as well as incentives and appreciation for operators work would by far be the most economic investment to reduce specific coal consumption. Internal rates of return in the range of 50,000 % are common in HRD investments. Why being satisfied with IRRs of only 14 % for investments in modernization of equipment?

2. In the old and very old days the eyes, ears and nose of an operator where the most common sensors to roughly adjust the boiler and turbine performance. Today most sophisticated instrumentation control backed by intelligent software does the trick and enables operators to take appropriate action to reduce specific coal consumption or to identify an operational problem. The argument that sophisticated instrumentation control and analytical software is fine for modern plants only does not hold water. The older plants would benefit even more.

3. There is a hypothesis that operating a power plant day in and day out will help to understand power plants. I disagree. It helps in knowing how to fix problems and how to get MWh of electricity out of the plant but not much more. My understanding of knowing how a power plant performs is different. I may give you the most important 180 performance parameters of a unit, ask you to change one parameter by 10%, and then tell me what happens to the other 179 parameters that may be affected. Neither I nor you will be able to give a satisfying answer without consulting sophisticated simulation software, and even this analytical tool may be sometimes wrong due to a complicated interdependence of parameters. Unfortunately conventional power plant training does not emphasize in depth this aspect of power plant operation. Let us change this. It will certainly save coal costs.

4. A buzz word in any national statistics is “power plant efficiency”. Comparison between countries and power plants becomes difficult if we take into account that there are four different definitions used worldwide and most publishers do not even bother to explain which one of the four definitions applies.

$$eff(1) = \frac{\text{Net kWh output}}{\text{Energy input as GCV}}$$ Gives the lowest efficiency figure

$$eff(2) = \frac{\text{Net kWh output}}{\text{Energy input as NCV}}$$ It always holds eff(2) > eff(1)

$$eff(3) = \frac{\text{Gross kWh output}}{\text{Energy input as GCV}}$$ eff(3) > eff(2) most likely

$$eff(4) = \frac{\text{Gross kWh output}}{\text{Energy input as NCV}}$$ It always holds eff(4) > eff(3)

Let us use a precise language and scientific comparison instead of comparing apples with oranges!

5. Most of us learned in our engineering studies about the principle of the “most economical insulation thickness”. It says that for a given outside surface temperature of a steam pipe, and given four other parameters such as insulation costs, energy costs, technical life of the insulation and IRR one wants to earn on the investment, there is exactly one insulation thickness. A thinner insulation as well as a thicker insulation will let you loose money. The same applies to the system efficiency of a thermal power plant. There is a most economical system efficiency jump from an old power generation technology to a new power generation technology for any given data set of coal costs in Rs/kcal, PLF, technical life and expected IRR. An example is given:

How large could be the investment cost difference in Rs/MW between a 500 MW supercritical and 500 MW subcritical if system efficiency improves from 0.38% to 0.42%. Assume coal cost of 600 Rs per MWh of coal energy, n = 25 years and q = 1.16.

$$I_{max} = \frac{(1.16^{25} - 1) \bullet 8760 \bullet 0.85 \bullet 600 \bullet (0.42 - 0.38)}{1.16^{25} \bullet 0.16 \bullet 0.42 \bullet 0.38} = 6.83 \text{ Million Rs./ MW}$$

You may argue that the Indian power sector would be better off if all power plants are supercritical. Use the equation and explore the issue how much more money could you invest in a power plant technology that has a system efficiency of say 40% (supercritical) instead of 37% (subcritical). You will then appreciate that in some countries the share of supercritical power plants is very high because coal energy costs in Rs/kcal are very high, while in others the share is very low because coal costs in Rs/kcal is low. This phenomenon has little to do whether a country has access to supercritical technology, or may or may not be able to manage the technology. A second look at the equation will also show you that the decision which level of efficiency jump is the most economical in a given project scenario does not depend on the power tariff because this variable does not enter the equation. In other words in a competitive power sector market with low coal energy costs, highly efficient power plants require most likely subsidies. Therefore decision makers have major choices. Either they opt for a subsidy free competitive power tariff market in a low coal energy cost scenario such as India, taking the risk that the country is loosing it’s competitive technology edge; or they decide to subsidize State- of -the Art or even Cutting –Edge- Technology; or they increase coal energy costs; or they give a directive that all bidders need to propose supercritical power technology at a certain pressure and temperature combination. In fact in the latter case it is best to “map” the proposed plant configuration with software to recalculate the system efficiency. It will be very interesting to see whether large coal mine mouth based power plants can offer competitive tariffs at supercritical parameters.

There is a historic parallel. We may wonder why in general sugar mills in the old days and some even up today had always captive power plants with a very low efficiency although much better power plant equipment had been available. The reason is that a sugar mill generates its own fuel (bagasse) for the power plant and there is usually plenty of bagasse available for the power and process heat requirement of a mill. Some even had a heavily smoking furnace on their premises to burn excess bagasse. Only in recent times secondary markets for electrical power and bagasse had been emerging worldwide and that’s why sugar mills all of sudden also go “high efficiency”.

You may pick holes in this rather totalitarian assessment which I may appreciate, because I have never learned anything from a man who agrees with me.