

Engineering Challenges and Innovation in Power Engineering

Perspectives From My 2008/2009 Vocational Employment Experience

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ABSTRACT

Power Engineering is a field truly facing great challenges. The demands for economic, environmental and material sustainability are beginning to be felt on an international scale, and these pressures being applied on a global level are now filtering through to Australia's national and local power generators, and can be recognized by those working in the industry. When coupled with an impending shortage of qualified power engineers, it can be seen why power engineering is a field of which much will be asked in the coming years. As engineers however, we can now no longer depend on the solid theory of yesterday. Innovation in power engineering is now not only desirable, it is required just to face these complex challenges. As Einstein remarked, "we can't solve problems by using the same kind of thinking we used when we created them." Even now, the power industry is facing current challenges with unprecedented and ground-breaking measures. However the drive towards further innovation in engineering will be relentless. The challenges facing power engineering are by no means insurmountable, but it is innovation and originality in engineering that will be the vehicles to transport the power industry through all these current and future challenges.

The Power Industry: A Global Perspective

It is without a doubt that the global power industry is facing one of the most challenging periods in its history. The problems the industry is confronted with are numerous and complex in nature and the responses to these challenges will be vital in sustaining high performance critical infrastructure nationally and globally. The essential nature of the power industry ensures the widespread consequences of decisions made in today's climate.

The push for eco-friendly production has accelerated the perpetual drive for efficiency in all areas of power generation, as well as initiating interest in renewable power sources. The debate on the scientific evidence confirming human impact on climate change is not relevant here. Whether real or unreal, the effects of the debate on the power industry remain very real, and this is what must be understood in the engineering profession. Notwithstanding the environmental aspects, the current global economic conditions will begin to affect power engineering, as it is affecting all branches of engineering. There will be pressure to decrease spending in all areas of the industry and this would pose a significant challenge itself in isolation; when further coupled with the ever-increasing environmental challenges it will magnify and become a much more significant problem.

In a global environment, this is perhaps the largest challenge facing power engineers: the integration of environmental and economic concerns at the one point in time, for the first time in history. Consider firstly, the speed at which the economic situation has turned. The rapidity of its onset has called for a reduction in capital spending at a time when many significant projects were already planned or underway. As such, many power engineers are in difficult positions across the globe as the compromise between asset investment and capital spending begins to sharpen. Secondly, consider the momentum gathered in the push for environmentally friendly power generation. The European Union has implemented an emissions trading scheme, numerous countries have ratified the Kyoto Protocol, Australia plans to commence a trading scheme in 2010 and ten states in the Northwest United States have recently commenced the Regional Greenhouse Gas Initiative aimed specifically at emissions from the power generation sector. The key point to consider is that the results of this momentum towards environmental sustainability were, in many ways, hinging upon continual international economic growth, and subsequent movement to the contrary will significantly increase the difficulty with which these environmental targets can be reached.

The position of the global power industry in today's climate is indeed a complicated one and a challenging one. Although it is not the purpose of this essay to address the global outlook of the industry, the challenges facing the global power industry closely echo the challenges facing Australian power engineers, and understanding of the broader picture is conducive towards a thorough comprehension of the challenges I have been exposed to in my own employment experience.

The Power Industry: My Perspective

The challenges facing the global power industry can be seen clearly even in Queensland's own power stations. The key issues that revolve around economic and environmental sustainability and resource constraints are now impacting on operations and decisions in these plants.

Perhaps the primary challenge facing the industry in Australia is recognising that these key issues are interrelated, and that solution to any one problem will impact on other issues. The economic, environmental and resource aspects of power generation are interlinked, and the major change taking place is the focal transition from economic to environmental. However, it must be understood that *there will always be compromise in changing any of these factors*. In the past, the drive was always to produce economic justification, effectively marginalising environmental considerations. With the shift of balance towards "greener" production, the complex problem of drastically reducing the climatic impact of power generation while still maintaining fiscal responsibility is brought to the fore.

During my vocational employment experience at Tarong Power Station, I was exposed to a problem that clearly shows the challenge facing power engineers. With environmental considerations in mind, increased efficiency in power generation is quite obviously highly desirable, resulting in less atmospheric pollution per unit power. There are multiple ways of increasing efficiency in a coal-fired steam power station; however increasing steam parameters in the power cycle is a large factor of increasing overall thermal efficiency. That is, increasing main steam and reheater steam pressures and temperatures. However, the magnitude of the increase in these parameters is limited by the mechanical attributes of materials within the boiler. At Tarong Power Station, planning is underway for replacement of reheater tubes in the boiler, a high-cost but necessary exercise. Creep and oxidation degradation in the metals have greatly decreased life expectancy, and with massive lost production costs for tube failures as an alternative, the plant engineers have no choice but

scheduled replacement. Therefore, even with the current steam pressure and temperature, the materials used in the boiler are in need of replacement. Hypothetically, what would result with increased steam parameters? Firstly, an increase in overall efficiency would occur. Secondly, increased strain on the tube material's mechanical limitations would cause less time to material failure and the subsequent required multi-million dollar replacement, and hence decreased plant life. The solution is, by necessity, a tradeoff between increased efficiency and increased plant life. Moreover, developments in materials technology have led to improved material properties; should these newer materials be used to facilitate greater plant life? Again, there is no simple answer. Increased material properties are unfortunately generally coupled with increased material prices, and thus again a tradeoff must occur between increased plant life and decreased costs.

So in this relatively small example of a challenge in a Queensland power station, the primary challenge facing the modern power engineer can be seen in the interrelationship between economy, environment and resources, and the difficulty inherent in considering all three systemically. The complexity of the global challenges becomes even more evident, and the multi-faceted process that is power generation becomes more complicated in its improvement.

However, using this same example, what are some innovations that can be implemented or are already being used to help solving this challenge? I believe an increased knowledge base is fundamental to engineering a solution, and although there are currently organisations that help provide a variety of technical knowledge to power engineers, considerable progress can be made to harnessing the combined capabilities of all the different local and national power generators. Greater integration of research and development documentation within the *industry* is necessary to maximising engineering innovation and development. Publishing trials, sharing experiences, distribution of root cause analysis reports, industry discussion of new equipment testing, non-destructive evaluation and life assessment methods will all increase the industry pool of knowledge and talent from which innovation and solutions can grow.

Consider, for example, another major challenge currently facing power engineers – the very shortage of power engineers themselves in conjunction with the lack of academic research and development in professional research institutions. From discussion with co-workers and senior engineers, this is a problem at the forefront of their minds. This issue has been met with an unprecedented, collaborative effort from the power industry in encouraging and facilitating increasing quality and numbers of power engineers, an effort

that was truly innovative in the true sense of the word. This challenge is being faced head on by the Australian Power Institute's Bursary schemes, introduction of integrated postgraduate courses in power engineering and through vacation work such as my own experience. In this instance, it was recognized that a segmental, divided approach would not provide a holistic solution to the challenge faced, and hence the industry acted together to provide an extensive solution for the benefit of everyone.

Further innovation must continue in this way in the more technical fields within the power industry. Although the National Electricity Market is a highly competitive market, there is the opportunity for all companies involved to make a difference for the benefit of everyone. Intrinsic to this opportunity is the *recognition* that only a truly collaborative effort will face these challenges head-on. It is perhaps not as simple as Alexander Graham Bell's sentiment that "*great discoveries and improvements invariably involve the cooperation of many minds,*" but it must surely be seen that collaboration on the part of the entire industry is needed to foster the innovation and technological advancements we desperately need to face the challenges of today.

So what other steps is Tarong Energy Corporation taking to face these challenges and promote innovation? From my perspective as a vacation student, I could see there was significant emphasis on a universal effort to maximize plant efficiency and face these challenges. There was an online database for all employees to record energy saving ideas. There were also efforts to increase environmental sustainability with weekly updates on environmental projects and any developments. An important ongoing project involved contracting a consultant specializing in innovation in the power industry, and developing a list of 25 feasible options for increasing Tarong Power Station plant efficiency. Perhaps one of the most interesting options explores the possibility of integrating bio-fuels – in the form of torrefied wood - with the traditional coal-burning process. The combining of these fuel types would be analogous, in principle, to the ethanol blended fuels becoming popular in the automobile industry. Simply put, the torrefaction process involves a pre-treatment of biomass (in this case wood) at temperatures of 200-300°C. This dries out the wood, increases its grindability, and generally approaches the properties of coal. Although obviously still in its infancy, a project of this nature would be a substantial yet exciting prospect. Specific fuel plantations would have to be developed on or near the station site. Moreover, the infrastructure required for the torrefaction process and logistics would be considerable. Nonetheless, torrefaction has the potential of being an economically feasible environmentally sustainable additive (or even eventually perhaps substitute) for coal.

Integrating the process with the existing plant infrastructure would indeed require innovation in all parts of engineering. Again however, the challenges facing power engineers currently and potentially necessitate the pioneering of new ideas.

Another innovative proposal is that of intelligent soot-blowing. Intelligent soot-blowing deviates from the traditional method of either manual or fixed scheduled soot-blowing by integrating advanced control systems into the procedure and through this, optimizing of the process. Slagging and fouling are the terms used to describe the deposition of post-combustion ash in the furnace, and are detrimental to plant efficiency as they decrease heat flux across the boiler tubes. Soot-blowing is used to clear this deposition and maximize plant performance. Essentially, intelligent soot-blowing relies on heat flux sensors providing information on the level of slagging or fouling on the boiler tubes, which is used to diagnose and subsequently activate the soot-blowers via the optimization control loop. The system would provide greater flexibility to the soot-blowing process and would allow a greater number of factors to be accounted for. While essentially building on a pre-existing process, such an initiative challenges traditional processes and integrates the very latest digital controls with the existing method. Apart from the immediate benefits, such a project would encourage plant engineers to scrutinize other aspects of the plant for improvement, perhaps processes not previously considered in the search for efficiency.

Perhaps the most important impact of such innovations is the development of an alternative thinking methodology within the power engineering profession. Particularly given the number of aging power stations nationally and indeed globally, it may not be just the revolutionary ground-breaking discoveries that make the difference. Instead, recognizing the opportunities that exist in current stations and developing methodologies to act on these opportunities may well be the innovative thinking required. The number of ways to make a difference in our current plants should serve as encouragement for the advancements already made, and the potential differences that can be made by using existing technology in innovative ways.

Conclusion

There are indeed great challenges ahead for the power engineering profession. The industry must consistently engineer original and innovative solutions on a global scale to be able to meet these challenges. Despite the added pressures placed on power engineers, perhaps overall the presence of these challenges can be a positive thing. It will force engineers to glean every bit of plant efficiency possible, minimizing waste, and optimizing the entire process. Greater still, I believe, it will compel the entire power industry to work together for the benefit of all, working collaboratively to achieve the best results possible. That could yet be the biggest innovation to come out of these problems – the possibility of harmony as an industry for engineering solutions, while sustaining a competitive market. Tarong Energy Corporation is the face of these challenges for me. The research I have done, and the knowledge I have gained allow me to recognise the challenges through this corporation, and recognise the manifestations of innovation in industry. It may be through an idea, or it may be through a new methodology, but this drive for innovation will ultimately allow power engineers to exceed themselves, and carry the power industry to new levels.

As a final thought, consider this remark I encountered in my readings.

“We need to engage in and elevate the global debate, to talk less about the problems and challenges we face, and more about how we can, by working together, find solutions that benefit everyone.”

(Robert C Hart, *The Global Power Industry and Globalization: Challenge and Opportunity*)