On Efficacy of Power Engineering Education

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Abstract: Transformations of power engineering structures in the developed countries follow the urgency of an efficient action regarding the growing disproportion between the natural resources and consumption of energy, as well as the imperative for making the power generation friendly to the environment. Sometimes it is difficult to conclude what is more important – the balance of energy resources or ecologically sound power generation. Nevertheless this problem of priority is not that important after all. A principle is breaking through to the effect of a necessity to use all available resources of energy and in such a manner that would oblige all current exigencies. Such necessity may have originated in the need of power generation industry or environment protection, or it may have been motivated by an effort for economic growth. Usually all these three stakeholders are involved. The efficiency is of primary concern. The efficiency puts the consumption down and prolongs the resource lifetime. It represents the easiest way for reducing negative impact on the environment and is a kind of catalyst for lateral thinking. Such concept of power engineering regards energy resources and creates a kind of a backgr ound for development of related technologies and their employment. It is this concept, which deserves the intellectual support represented by university education and training.

Currently it is not common to make a programme for a course of study that would implicate complex problems of power engineering and put forward their key aspects – efficiency, competitiveness, and ecological adequacy. But it is only such orientation in education which can be of real use as regards the future imperative of sustainable development. The importance of this development is defined by the position of power engineering that maintains: Security of energy supply is the cornerstone of the current society existence. Only efficiency can ensure availability of secure supply. Assessment of energy efficiency asks for defining its limits. A narrow limit implies assessment of technological level. A wider limit scope takes more socially important aspect into consideration – environment, community, economy. All these aspects have their specific weight and none of them can be neglected or marginalized. The wider limit we have the more complex, difficult, and useful decisions are implied. Technical university education, which offers profound study of all aspects of the modern power engineering systems, is by its very definition also more effective. The next century will be the century of effectiveness.

Keywords: energy, efficiency, resources, system.

1. Introduction

It is about 85% of energy consumption in the world that is being generated by burning fossil fuels. While the energy consumption increases exponentially, fossil fuel resources are final and as such subject to ultimate depletion. Taking into account current trends of consumption, the calculation of these resources life cycle poses no serious problem, and it is pointless to discuss the exactness of such calculations. There is no doubt to the effect that effective exploitation of all energy resources available represents a remedying action for the predicament. Regarding the increasing and just interest in the quality of the environment, all this exploitation must be environmentally friendly – all unavoidably negative aspects of energy generation and exploitation must be minimised.

Taking into account energy resources, we are thinking not only about fossil fuels but also about the often overestimated, nevertheless important, renewable resources, and – reluctantly - about nuclear energy. What more, there is a must to realise that finding the right balance between the ever-increasing energy consumption and its limited generation should be oriented by increasing the efficiency of energy resources, energy systems, and by putting down specific energy consumption. There are no practical technical difficulties that would hinder the implementation of these efficiency measures. They are difficult to put into action, as they ask both for capital investment and substantial change of current paradigm. Present experience represents an explicit proof to the assertion that the most favourable condition for changing an energy system is facilitated by liberalisation and competition.

2. Current trend of development

Making an effort to increase efficiency of energy systems, which has been instigated by the obvious disproportion between resources and consumption, is characterised by two facts. First of all such a solution is unacceptable that is of declining effect on the current standard of living – albeit its level – and secondly it should be regarded that the energy transformed is subject to no storage. It represents commodity of instant spending. All the experience available points to the route of looking for systems which would ensure high efficiency. Such systems are of rather limited scale and by their very nature decentralised. Only within such limited scale systems, it is possible to effectively harmonise energy generation with its consumption. But the effect attained is substantial. In comparison to the traditional way of power plant electricity generation, at which we can expect the overall efficiency slightly exceeding 30%, the co-generation of electricity and heat would be at least twice that figure. There is nothing new to it - it represents the basics of thermomechanics – and, after all, the first commercial power plant in the US – Thomas Edison's Pearl Street Station, built in 1882 – was also the first CHP plant (combined heat and power), as it made and distributed both electricity and thermal energy. It just asks for a constant take-off (and consumption), which is realistic only for limited scale systems. As such decentralisation is the most prominent feature of the present change in energy engineering.

"The pace of change in the energy arena is without precedent. Today, we are at the unique point in the history of energy generation. The convergence of competition in the electric power and natural gas industries and the arrival of environmentally friendly advanced industrial turbines, microturbines, reciprocating engines, fuel cells, photovoltaics and small wind turbines have sparked tremendous interest in on-site generation. This convergence of policy and technology could radically transform the electric power system as we know it today: a transformation that, like the revolution that took us from mainframe computers to PCs, could take as from central station generation to personal power plants" [1].

As exciting as the opportunities are, there are many barriers to their realization in the market place. These include interconnection with the grid, utility pricing practices and tariff structures and current business models and practices. It is difficult to contemplate a world without energy networks. Nevertheless their role, gravity, and management will be different. Decentralised energy network securing reliable delivery of energy will necessarily influence energy prices.

As the law of ever increasing entropy is undisputed, so the never formulated law of ever-increasing energy price is. In an effort to use energy resources effectively, to manage energy consumption rationally, the price factor represents a positive aspect, of which the development is determined by liberalised energy market, and resource diversification. Competitiveness is the principal demand for energy systems and price of energy represents a supreme competitive criterion. This price is the outcome of the overall system efficiency. The EU Council of Ministers established broader relationships in July 1996. It welcomed the white paper, An Energy Policy for the European Union. "It is as a useful basis for further work in that it endorses the necessity of reconciling the objectives of competitiveness, security of supply and protection of the environment taking into account the principle of subsidiarity and economic and social cohesion" [2].

Reforms, which have been initiated by the effort to increase efficiency of power generation and relieve the discrepancy between resources and consumption, are pacing fast ahead. Costly measures are imperative and the intensive technical development and power engineering are becoming very dynamic species. According to PHB Hagler Baily [3] is projected worldwide power sector investment activity for next 10 years:

- New utility plants - 280 GW, i.e. $ 175 billion,
- New IPPs - 440 GW, i.e. $ 270 billion,
- Generation - 540 GW, i.e. $ 175 billion,
- Distribution - 355 GW, i.e. $ 80 billion.

Deregulation is now affecting nearly 80 percent of the global power market. This means that the fraction of the global power market that is fully competitive will increase tenfold during the coming decade: from an estimated $ 250 billion worth of annual revenues in 1999 to more than $ 2,5 trillion in 2009.

The organisation, structures, and curricula of engineering education should correspond to these realities. So far it has not been the case.

3. Efficiency assessment

The principal objective of this dynamically developing subject is the efficiency increase, and the corresponding savings for traditional energy resources – fossil fuels. The key to the resolution of the problem is the systems efficiency increase. In this regard, the efficiency assessment is of vital importance. Establishment of boundaries for the system assessed is decisive. The wider system, the more complicated assessment, and more valuable results are there. The system definition establishes whether the assessment concentrates only on fuel combustion or if it is of wider implications from the point of view of power generation, economy or society.

Taking the efficiency of combustion into account, we try to assess the completeness of burning inflammable matter of the fuel. It is a typical task from the province of combustion engineering. Its importance is represented by the ability to characterise the process initiating the subsequent transformation chain.

The assessment of boiler efficiency is a very closely assiciated problem. Again the assessment of technical excellence would be in play but, thanks to boundary extension, the assessment would be more demanding, results more general, and as such valuable. On the other hand, boilers are part of the wider system, of which the efficiency is decisive. As such the boiler efficiency increase does not always imply increased efficiency of the whole system.

If we extend assessment boundaries to the whole power station block, we may compare the amount of electricity produced with the amount of energy in the fuel itself. All losses of energy transformation, including the losses of one's own, are inclusive here. Such net efficiency characterises perfectly the technical level of the block. Thanks to unequivocally defined system boundaries, actual bench marking is facilitated. Thanks to the concentration on the final product of energy transformation, also the economy evaluation is possible. Only these assessments, which account for such important factors like fuel cost, capacity factor, or overall costs, indicate to the actual efficiency of the energy resource, and would decide about its competitiveness.

We may further consider extending boundaries of assessment to those of the State and compare yearly consumption of primary energy resources with GDP. We get a generic parameter that estimates both energy efficiency and the efficiency of national economy – energy intensity.

The energy system efficiency is always the outcome of congregated efficiencies of constituent parts. It is extremely useful to make a detailed account for this aggregate. The transformation chain weaknesses are highlighted in the process and as such also the most efficient resolution leading to the overall efficiency increase. Defining the system boundaries is essential. It is surprising how low the energy efficiency is, when we assess the system from its very, verbatim underground, roots to the final utilisation in the form of electricity. Thanks to the deposit low extractability, demanding transport, energy transformation and grid distribution losses, and efficiency of the final employment, the overall efficiency would amount to single figure percentage.

4. Energy engineering education

Readily available energy is a cornerstone of modern society. Energy is, indeed, imperative for life. The current world of global economy and communication, of which major resources of energy are estimated in scale of decades, and where intelligence and wit represent the only actual potential for energy efficiency increase – both in generation and spending – asks for education and training of state-of-the-art professionals and specialists. Development of appropriate condition and finding the most effectual mode to that effect is needed. Such subjects should stand for fundamentals of power engineering education that are concentrated on energy resources, their utilisation, energy technical and economic management, and power generation environmental aspects. In such a manner it is possible to ensure that students are aware of wider social impact and major objectives of development. The further study should include subjects regarding technical means for energy transformation, both on the side of generation and consumption. The wide extent of this curriculum would ask for specialisation but a minimum of division is desirable.

The final and most demanding stage of energy engineering education should facilitate specialised knowledge and tailor-made know-how in that it would create favourable condition for inter-disciplinary studies. It may concerns subject that are relatively closely affiliated, for example geology, energy raw material deposit extraction, chemistry of combustion processes, electrical engineering, control instrumentation, energy networks, heating for buildings or air-conditioning. But it could involve also such subjects, like agriculture, biology, social or law sciences. Concluding stages would be always characterised by individual specialised studies.

Updating the concept of power engineering education is in no way easy. It means making major inroads into well-established routines, which - quite understandably - implies resistance. Final specialisations will always regard local condition and need. Some advantage represents the obviousness of need for change that may result in civic society support. Observing the given principles and systematically abiding by current requirements, the education may succeed in training specialists fit for the future competitive labour market.

5. Conclusions

Presently it is not a common practice to understand energy engineering as an individual subject for study. I personally have not experienced a single university faculty of this kind. The discussion and facts given above substantiate the idea and the assumed development of power engineering might make it worth of trying.

6. References

[1] D. Reicher: "Opportunities, Barriers and Partnerships", Cogeneration and On-site Power Production, issue 2, pp. 21-24, April 2000.

[2] P. K. Lyons: Energy Policies Towards the 21st Century:, A Business Intelligence Report, EC Inform, June 1998.

[3] J. L. Poirier: "A Y2K Global Power Market Forecast", Independent Energy, Vol. 30, pp. 7 – 11, February 2000.