Tech-wise
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Combined Heat and Power (CHP)
Brief overview of the experience of Tech-wise and Consulting Services provided by Tech-wise

1. Tech-wise's CHP Experience

1.1 Tech-wise

Tech-wise is a consulting engineering company with approx. 220 employees. We are a subsidiary of the ELSAM utility group, which operates about 5000 MW_e of power plants of which the majority are Combined Heat and Power (CHP) plants. We have engineered power plants from 2 to 600 MW_e, fired mainly with coal, oil and natural gas. During the last decade, biomass and waste have been added to our portfolio of projects. Approx. 25% of our annual turnover comes from international activities and this share is expected to increase in the future.

1.2 General Experience in CHP

The combined production of heat and power has been utilised in Denmark for more than 30 years leading to a steadily increasing, total efficiency of the Danish heat and power sector. In the beginning the large central power stations were the only CHP operators but in the 1990's small decentralised CHP plants have been built in large numbers and now, 80% of all the heat consumption in district heating systems is produced in CHP plants.

Tech-wise has been actively engaged in this development and has thereby achieved extensive experience with CHP plants ranging in size from a few MWe to over 400 MWe. In addition, Tech-wise has been engaged in industrial co-generation plants.

The experience covers a wide range of technologies and fuels, i.a.:

- Large coal-fired CHP plants
- Large gas-fired plants utilising gas turbines in Combined Cycle CHP's
- Large gas-fired plants utilising a conventional steam cycle
- Small gas-fired engine plants
- CHP plants utilising fuels such as municipal waste and biomass
- CHP plants using natural gas such gas engines, open gas turbine and combined gas turbine cycles with a capacity from 5 MW up to 250 MW

The Elsam group operates a large number of the CHP plants established in Denmark and for years we have positively utilised the feedback from the operation of all types of

plants and we continuously incorporate the operating experience in our services to reach better solutions for future projects.
The combination of Tech-wise's long-term involvement in the engineering of CHP projects and the operating experience available within the Elsam utility group therefore provides a solid basis for the engineering of future plants, and Tech-wise is able to provide consultancy services which cover the complete project lifetime from the project idea to the operation and maintenance of the completed plant.

For easy reference we would like to highlight the following plants as examples:

- The central CHP plants Studstrupværket, Fynsværket, Vestkraft, Skærbækværket and Nordjyllandsværket. All plants are in the range of 350 to 400 MWe
- The 105 MWe combined cycle plant Silkeborg Kraftvarmeværk which has 50% electric efficiency even though it is a cogeneration plant
- The 18 MWe Circulating Fluid Bed plant in Grenaa utilising coal and straw
- Måbjerg cogeneration plant, a multifuel plant burning municipal solid waste, wood, straw and natural gas
- The 9 MWe natural gas fired engine plant at Bjerringbro

A number of other plants and consulting services assignments related to CHP are presented in reference lists.

1.3 Experience in CHP and District Heating Systems

Tech-wise has built up a comprehensive knowledge in district heating systems, especially with respect to evaluation of heat demand, defining peak and reserve load capacity, evaluation of heat tariffs and optimisation of the complete system. Such an optimisation encompasses i.a. CHP plant configuration and size as well as transmission/distribution system design, and the optimisation takes all important aspects into consideration such as present and future heat demand, power tariffs, taxes, fuel costs, cost of alternative heat supplies, peak and reserve capacity requirements, district heating temperature requirements as well as the possibility of cooling of excess heat. The experience of Tech-wise also covers design of district heating transmission/distribution systems including large and specialised pieces of equipment like heat storage tanks.

1.4 Experience in Industrial Co-generation Systems

Besides the heat supply to domestic heating systems, Tech-wise has also been involved in co-generation plants supplying heat and/or process steam to industrial facilities. Such applications put stringent requirements on steam supply reliability, hence detailed design of the complete plant including peak and reserve load systems is essential for the success of the co-generation plant.

Tech-wise's involvement in industrial co-generation projects includes the engineering of the complete plants and associated steam and heat distribution systems and as part of the engineering, e.g. we have designed a 1.5 km DN 500 pipeline for 8 bar steam. Tech-wise has performed dynamic simulations of steam system performance during various operating scenarios including trips of the co-generation plant. Such simulations can provide essential information on technical solutions aiming at improving reliability of the steam or heat supply, and are also providing vital information to be used in defining control strategies and in connection with training of operators.

1.5 Fuel Supply

The fuel specifications and fuel contracts are of utmost importance to the economic feasibility of a CHP plant. As an example of Tech-wises work on gas supply systems, a study on liquid formation and transportation in natural gas pipeline systems could be mentioned. Such condensates are very harmful to the gas turbines or engines utilising the gas and based on the investigations performed, Tech-wise prepared recommendation as to how to design gas systems to avoid these problems.

When it comes to biomass-fired plants, Tech-wise has extensive knowledge covering the whole chain from the fuel source to the utilisation in the plant. Of special importance is to make sure that the risk of shortage in main fuel to the power plant is investigated and for this purpose, an evaluation of long-term fuel resources and the availability of alternative fuels is often necessary. Tech-wise has worked extensively on the logistic side including intermediate and long-term storage of biomass and the transportation and handling of biomass. An important aspect of fuel resources is to make sure that the plant is designed to handle a wide range of fuels to avoid shortage and price escalations of one fuel. Designing for fuel flexibility has been an important feature of many plants engineered by Tech-wise.

1.6 Specialist Issues

1.6.1 Grid Connections

Tech-wise has been involved in designing a large number of grid connections up to 400 kV, and also for small power production units is the grid connection an important aspect. Besides the engineering of such grid connections the specialised knowledge of Tech-wise has been used in clarifying failure causes. Examples of these services are some CHP engine installations where transients in the grid to which the CHP supplies the power have not been properly taken into account during the design phase. Using the in-house software SETPOS, Tech-wise evaluated the mechanical loads on the engine/generator set, and in subsequent mechanical Finite Element Method calculations causes for failure were confirmed and possible remedy advised.

1.6.2 Chemistry and Metallurgy

Within Tech-wise and the Elsam utilities group, a Specialist Group called "Fælles-kemikerne" has been formed including specialists within the following areas relevant to CHP technology:

- Metallurgy, e.g. the metallurgy of hot parts in gas turbines
- Corrosion, e.g. corrosion occurring in biomass boilers or in waste to energy plants
- Lubricants for gas turbines, steam turbines and engines
- Fuel composition analysis and prediction of consequences of using the fuel in different types of energy conversion plants
- Water chemistry and corrosion in water and steam systems, e.g. district heating systems
- Flue gas cleaning systems
- Residues handling and waste water treatment systems

The knowledge of these specialists is integrated in the engineering work performed by Tech-wise, when necessary as integrated members of the engineering teams working on a specific project. In addition, these specialists are often involved in clarifying causes for equipment failures.

2. Tech-wise's Services related to CHP Plants

In the initial stages of the project - feasibility study or technical/economic review - Tech-wise's plant cost and performance programme is used to achieve initial cost and performance data including environmental data. In particular, our experience and know-how includes the important aspects of analysing the present and future heat demand and performing an optimisation of technology, size and configuration of the CHP plant. In the subsequent project phases Tech-wise can perform environmental impact studies and advise on fuel, heat and power purchase agreements. In addition, we can cover the plant tendering and contracting tasks and engineering/supervision tasks during construction and commissioning. Finally, we can assist in various ways in the operating phase of plant life.

Since the experience of Tech-wise covers all disciplines in all phases of a project we can handle the complete engineering of any CHP plant. However, the role of Tech-wise can also be limited to specific disciplines or specific tasks of a project and in the following, some typical roles of Tech-wise are briefly outlined.

2.1 Projects as Owner's Engineer

Tech-wise has undertaken a large number of major power plant projects as Owner's Engineer. In general our services include responsibility for project management, detailed engineering, preparation of tender specifications, tender evaluation, supervision

during construction and commissioning as well as assistance during final acceptance tests.

2.2 Projects for Banks or Financing Institutions

Tech-wise has served a number of national and international banks, investors and donor organisations worldwide. Such projects include Due Diligence analysis, project evaluation, appraisal missions, third-party opinions, technical and environmental assessments and feasibility studies as well as consulting services during construction and commissioning.

2.3 Projects in Co-operation with other Companies

Tech-wise has been involved in projects where the owner or the appointed owner's engineer already possessed expertise covering many but not all aspects of plant engineering. In these cases, Tech-wise provides the services and knowledge needed to supplement the capabilities already present in the project, thus ensuring the owner/investor that his project is handled by a engineering team possessing all the expertise needed for a successful completion of the plant.