

**Large Power Plant
Project Engineering Management
Brief overview of the experience of Tech-wise
and
Consulting Services provided by Tech-wise**

1. Tech-wise's EXPERIENCE

1.1 Tech-wise

Tech-wise is a consulting engineering company with approx. 200 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 four new central power plants with a total capacity of approx 1600MWe have been added to our portfolio of projects. All the power plants are with the newest technology at the time of construction, and Tech-wise is proud to hold, together with the power plant owners, the world record in efficiency within conventional fossil-fuelled power plants.

Tech-wise has a leading role in the development of new technologies, in particular with conventional fossil-fuelled power plants with ultra critical steam data till 700°C.

Apart from the new central plants a number of rehabilitation, retrofit and optimization projects have been completed on the existing older power plants, municipal power plants, and international projects for other clients than ELSAM. Approx. 25% of our annual turnover comes from international activities and this share is expected to increase in the future.

1.2 New central combined heating and power plants

Tech-wise has achieved comprehensive knowledge of building new larger fossil-fuelled power plants.

The competence of Tech-wise includes:

- Coal, oil and natural gas fired power plants including DeSO_x and DeNO_x both as natural circulation plants and as once-through supercritical units
- Combined cycle units with a capacity up to 800 MW
- Extraction of heat for co-generation on such units

Within the last 10 years Tech-wise has been the owners engineer for construction of four new central power plants with state-of-the-art design, equipments and materials, and achieved several world records in the power production efficiency, with high reliability, low maintenance and reduced man-power requirements for operation. The size of the four power plants has been approximately 400 MWe and 470 MJ/s. The latter by production of district heating. The efficiency of the plants have increased from 43% electric and 90 % total, to 49% electric and 92 % total.

The projects involved prefeasibility study, feasibility study, basic engineering, detailed engineering, tender documents and specifications, tendering, bid evaluation, procurement, planning, cost control, fabrication inspection, site supervision, contracts completion, commissioning, test runs, and document completion, etc. for the complete power plant package.

All the Elsam power plants have been handled in accordance with the multi contract approach. However, also turnkey or DPC type contracts have been experienced.

The power plants included as a minimum:

- Complete boiler package with integrated equipment and appurtenances.
- Complete turbine package with district heat exchangers, feed water tanks, preheaters, integrated steam and condensate systems, equipment and appurtenances.
- High pressure steam and condensate piping interconnecting packages for steam and condensate generation, feed and extraction.
- Feed water pumps.
- Condensate cleaning and demineralised water generation plants.
- District heating systems.
- Auxiliary steam boilers.
- Emergency generators.
- Low pressure utility systems and equipments.
- All civil works including buildings, steel structures and coal silos.
- Sea water cooling systems, including screens pumps, canals or piping, filters and appurtenances.
- Coal cranes, conveying, crushing, storage, distributing, sampling for handling of row coal from ship, to storage, and to silos.
- DeNo_x plants.
- Blowers, induced draft fans, recirculation or booster fans.
- Flue gas ducting.
- Electrostatic precipitaters or bag filtrations.
- Flue gas desulphurisation plants, of various types: SNOX, Spray Dry Absorbtion, or Wet gypsum producing scrubber type.
- Stacks of various constructions, including all emission measurements.
- Waste water cleaning plant.
- Absorbent, by-product and fly ash silos. Gypsum storage and handling facility and all related equipments.
- All electrical systems, switch gears and controls within the power plant.

- All high and medium voltage transformer.
- Distributed control system, including all software systems.
- All other required facilities, systems or equipment for a complete and integrated power plant.

1.3 Advanced 700°C pulverized coal fired power plants

Tech-wise is closely involved in an international R&D project using ultra super critical steam data for power production.

The purpose of the project is to prepare, develop and demonstrate the next generation of pulverised coal-fired power plants featuring advanced steam data.

Newly developed nickel-based superalloys are to bring the live steam temperature up to 700°C compared with around 600 °C for the best plants currently commercially available. Hereby the efficiency is increased from 47% to 55% resulting in a reduced fuel consumption and CO₂ emission of almost 15%. The plant will have an output of 400-1000 MW.

Counting 40 parties from 11 European countries, the project is heavily industry-oriented, as 27 of the participating companies are developers and suppliers of power plant equipment such as turbines, boilers, pipes and materials. Utilities and institutes for materials testing constitute the remaining participants. The future perspective is that the coming coal-based expansion of generating capacity in Europe and overseas (China, Indonesia, etc.) can be supported by offering a well known technology with a hitherto unseen efficiency.

The EC-contract covers the first 6 years of a total project duration of 17 years including a two-year demonstration period. It is estimated that the actual construction of the plant somewhere in Europe could start around 2008.

Tech-wise is involved in the project with four key positions: One position as chairman in the steering committee, one position as project management coordination, one metallurgist for boiler materials, and one position for the process engineering.

1.4 Retrofit, rehabilitation and optimisation projects on existing plants

Basically all the old existing plants have been through some kind of rehabilitation, retrofit and optimization projects.

Among the retrofit projects can be mentioned:

- Retrofit or addition of either electro static precipitators or bag type filter.
- Retrofit of DeNO_x system.
- Retrofit of Low-NO_x burners.

- Addition of flue gas desulphurisation.
- Retrofit of steam turbine driven feed water pump.
- Boiler of turbine retrofit.
- Retrofit of district heating systems.

Among the rehabilitation and optimization projects can be mentioned as examples:

- Conversion of fuel type from oil to coal and/or gas.
- Modifications on boiler or turbines to enhance the overall efficiency.
- Remnant lifetime extension on existing boilers by replacement of tubes or tube bundles, after a thorough remnant lifetime analysis.
- Change of materials in order to increase efficiency, increase the lifetime by reduction of high temperature creep, reduction of erosion or corrosion in boiler heating surfaces.
- Optimisation of electro static precipitators by addition or relocation of pulse generators, voltage, frequency of hammering, or control system.
- Optimisation of desulphurisation plants by change in absorbent in order to increase reaction or reduce effect of various inhibiting impurities, and use of different or addition of new materials in order to reduce corrosion.

As integrated assistance in the daily operation and maintenance teams, many big and small improvement tasks have been completed, which has strengthened the comprehensive knowledge of various ways to solve the technical problems experienced on a conventional power plant.

1.5 International Experience

Tech-wise has been involved in the engineering, construction, rehabilitation or retrofit of various plants or part of plants international. Our involvements internationally have been ranging from project management of larger projects, to engineering or inspection of minor modifications on existing power plants. Our experiences as the owners engineer during many years have been valued by the international costumers due to our insight in the daily operation and maintenance problems. This have resulted in that Tech-wise can offer the services over the full spectrum from prefeasibility study, via the entire engineering, including commissioning, operation and maintenance.

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

2.1 General Remarks

The consultancy services which we are able to provide cover a complete range of services from feasibility and environmental studies to commissioning and operation, and Tech-wise is capable of handling all phases of a total project. However, to provide as much value to the project as possible, the extent of services has to be defined

according to the specific project and the owner's/developer's organisation and experience. A situation frequently encountered is a project owner/developer having contracted with a local engineering company with limited specific knowledge to the type of plant. In such cases our engineering services can be related to specialist fields, such as fuel handling, combustion systems, steam and condensate systems, heat and mass balances, or other specialist fields which requires specialist know how. A specialist know how could be Project Engineering Management, as assistance to the client's Project Director. By joining forces with the owner's staff and/or a local engineering company it is ensured that a strong combination of local knowledge and the practical capabilities of Tech-wise A/S on specific issues related to power plants is made available to the project.

In cases where Tech-wise is not acting as an owner's engineer handling the complete plant engineering, we can provide selected services in accordance with the project needs. Below, some examples of selected services from Tech-wise in relation to power plant projects are briefly outlined.

The examples are as follows:

- Feasibility studies;
- Third-party assessment of feasibility studies;
- Basic plant description & preliminary design;
- Call for tender specification;
- Call for tendering;
- Evaluation of tenders;
- Fuel contract specification;
- Project coordination after signing of contract;
- Commissioning;
- Operation and maintenance.

In the following, we have commented on each of the above examples.

2.2 Feasibility Studies or Third-party Assessment of Feasibility Study

In principle, the most optimal situation occurs when Tech-wise is involved in the very early stages of the project and prepares or contributes to the feasibility study. In many cases the initial investigations or feasibility studies have been prepared by others, however, a third-party assessment of the feasibility of the project is often requested by the owner or by financing institutions. Such an assessment must uncover potential technical risks and the impact of these risks on plant economy. The extent of a third party assessment will vary from case to case but typically, the following issues are dealt with:

- Check of the heat and mass balance for the main process cycle;
- Physical/chemical properties of fuels in relation to the technology suggested;

- Assessment of plant technology and plant design with emphasis on issues with large impact on plant economy such as plant cost, efficiency, availability, O&M;
- Assessment of environmental issues.

2.3 Basic Plant Description

These services may include the whole plant but the following task descriptions are concentrated on boiler, fuel handling equipment, main process circuit and turbine generator selection and the essential interaction for fulfillment of overall performance requirements. The objective is to ensure that all relevant experience is included in the tender specifications for potential suppliers.

Tech-wise can review the proposed thermal cycle and design parameters and suggest alternative thermal design parameters.

The proposed plant process concepts can be described, including design data and requirements for special concept or considerations.

Based on Tech-wise's experience with operation and maintenance of large power plants, we find that exact definition and description of the equipment planned to be included in the power plant in order to leave the turn-key or multi contract supplier(s) with sufficient information to perform a proper design and provide the right plant equipment, thereby avoiding disputes between owner and contractor at a later stage in the project. Tech-wise can analyse and specify fuels and the fuel characteristics, or the required steam and condensate circuit in order to ensure the correct equipment selection by the tenderers and ensure that the tender specifications are fulfilled.

The requirements for boiler, turbine and flue gas cleaning systems can be described, including emission reducing measures, ash handling equipment, or any other required facilities.

The staff requirements for operation and maintenance of the plant can be described, and Tech-wise can assist in all phases of the plant commissioning, daily operation and maintenance.

2.4 Tender Specification

This service comprises either the complete preparation of a tender specification or a review of an existing call for tenders prepared by others.

The specification could either be on functional level or a detailed level including specific design requirements.

In case a tender specification is already available, it should be reviewed to ensure that all relevant experience is included in the specification. Systems and plant components to receive special attention are:

- Overall performance of the power plant;
- Fuel handling and storage systems;
- Fuel specification/material selection;
- Boiler specification and combustion systems;
- Flue gas particle precipitation and flue gas cleaning;
- Materials handling of all by-products, absorbents or catalysts.

2.5 Evaluation of Tender

Tech-wise can perform the complete technical and economic tender evaluation, alternatively contribute with evaluation of specific plant parts or evaluation of how suppliers have addressed specific problems.

2.6 Services during Engineering, Manufacturing and Erection

After a contractor has been appointed, Tech-wise can assist the owner's organisation either as an overall project coordinator or as a supplement to the owner's project organisation. Examples of such supplementary services in this phase could be conducting design reviews to ensure that the supplier fulfils the contractual obligations, especially for issues related to fuel handling, boiler design, boiler auxiliaries, turbine systems, flue gas cleaning and materials handling.

2.7 Commissioning

Tech-wise considers test of concurrence of guarantee obligations, commissioning and staff training to be extremely important for the success of a plant, and according to our experience, power plants need special consideration in this phase. A typical service of Tech-wise is to provide an experienced engineer for the planning and supervision of the plant commissioning and to assist in the training of the future staff. In this way, the project benefits from lessons learned in other projects and, in addition, the requirement for an increased staff level in the beginning of the operating period can be overcome by the temporary employment of an experienced engineer.

2.8 Operation and Maintenance

"Operation and Maintenance Services" is a joint business area for the Elsam Group. The business area is led by Tech-wise and is addressed to owners and suppliers of power plants and energy producing units in Denmark and abroad.

The services we offer are based on the theoretical and practical know-how of the Elsam Group gained from more than 50 years of experience within engineering, procurement, construction, operation and maintenance of the following plant types:

- Large coal or gas-fired power stations;
- A large number of local gas, biomass or waste-fired combined heat and power plants fully or partly owned;
- Wind turbines and wind farms.

We offer to assume operation and maintenance responsibility, in whole or in part, of the operation for a set period, but we can also offer our assistance on a consultancy basis, issues such as defining an efficient O&M organisation, initial operation, various interim solutions such as ad-hoc repair assistance, training/supplementary training of operation and maintenance personnel on site or at Danish power plants.