ENGINEERING COMPANY OF CENTRAL AMERICA

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Special Issue: Energy Sector

One feature that characterizes a modern industrial society is the general and constant provision of the essential energies. The conversion of fossil, regenerative, and nuclear energy sources has been used to generate electricity centrally in power stations for around 110 years.

Considering that the United Nations is predicting world population growth from 6 billion to 7.5 billion by 2020, it is important to recognize that the demand for energy should increase at very similar rates over that period. Both population growth and increasing standards of living for many people in developing countries will cause strong growth in energy demand, which is expected to be over 2% per year, or 57% from 1997 to 2020.

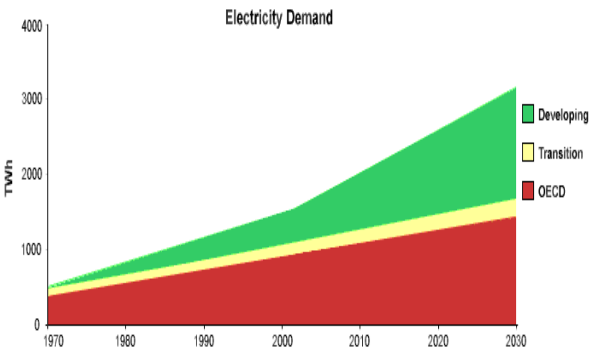
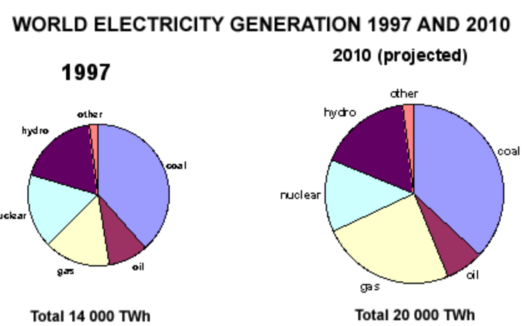


Fig. 1: Worldwide electricity demand development (Source: OECD/IEA *World Energy Outlook* 2004)



Graph 2: World electricity generation development and expected distribution of prime sources between 1997 and 2010 in TWh (Tera Watt hours) development (Source: OECD/IEA *World Energy Outlook* 2004)

Graph 2 shows development of electricity generation between 1997 (14 000 TWh) and the projections for 2010 (20 000 TWh). This graph also includes the contribution of the various prime sources to the total. Although the amount of electricity produced is expected to increase dramatically (>35%), changes in the relative contributions of the prime sources are expected to be considerably less. Interestingly, the contribution of prime sources base on sustainable sources, such as biological, aeolical, solar, and geothermal are expected to contribute less than 20% of the total electricity by 2010.

The growing importance of environmental issues such us greenhouse effects, political developments, and additional demands for electricity generated by an emerging hydrogen economy suggest that substantial investments in the energy sector are bound to continue.

The demand for electricity is increasing at a faster rate than the overall energy demand growth rate. Whereby it is projected to grow at a rate of 2.8% per year up to 2010, and substantially more up to 2020. Currently, some 2 billion people have limited or no access to electricity. Addressing this need is a high priority.

Since 1980 total world energy use grew by nearly 50%, with electricity growth even stronger. Increased demand was most dramatic in developing countries. Figure 1 illustrates this growth projection.

This growing demand scenario clearly indicates that electricity generation should experience similar growth rates in the upcoming years.

There are various technologies used for the generation of electricity. Individual solutions are strongly dependent on the prime sources used for such purposes. The following is an overview of this situation.

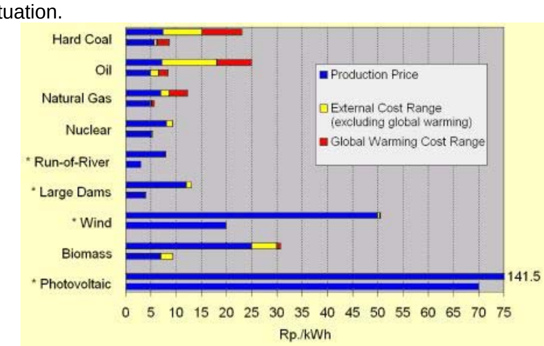


Fig.3: Internal and external (environmental) costs of electricity production. For each energy carrier two cases are shown - one representing the lower range of values and the other representing the upper range. (Source PSI, Switzerland)

A cost breakdown of each kWh of electricity produced, in dependence of the prime source, is depicted in Figure 3, including the investments in infrastructure, production price and externalities. Externalities are defined as the economic consequences of electricity production that pertain to society, but that are not explicitly accounted for in the decision making of participants.

The differences between the upper and lower values given in Figure 3 show that uncertainties in the estimates are still large. However, at least the order of magnitude of most major damages and costs can be given. The dominant sources of uncertainties include global warming and health effects associated with small particles emitted by fossil fuels.

Selected electricity generation technologies and EC's activities therein

Hydroelectric Power Generation

Overview

Hydroelectric power, using the potential energy of rivers, now supplies 17.5% of world electricity (99% in Norway, 83% in Brazil, 58% in Canada, 55% in Switzerland, 46% in Sweden, 7% in USA). Aside from a few countries with an abundance of it, hydro capacity is normally applied to peak-load demand, because it is so readily stopped and started. It is not a major option for the future in the developed countries because most major sites in these countries having potential for harnessing gravity in this way are either being exploited already or are unavailable for other reasons (i.e. environmental considerations). Growth to 2030 is expected mostly in China and Latin America (see Figure 5).

Fig. 4: Raul Leoni (Guri), Venezuela. The world second largest power plant (after Itaipu, Brazil). With 10,055 MW it accounts for less than 0.1% of the total worldwide electricity production, or 2% of the worldwide hydropower generation.

The chief advantage of hydro systems is their capacity to handle seasonal (as well as daily) high peak loads. In practice, the utilisation of stored water is sometimes complicated by demands for irrigation, which may occur out of phase with peak electrical demands.

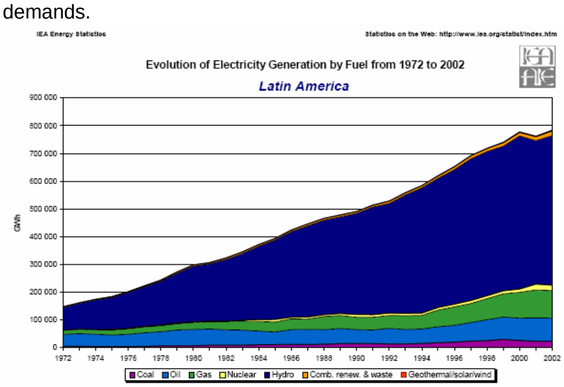


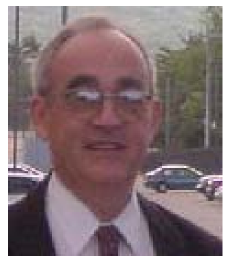
Fig. 5: Overview of the evolution of electricity generation by Fuel in Latin America. Note the considerable increase of the role of hydroelectric plants. Sources: United Nations, IAE.

EC Activities

Through the build-up and development of international partnerships, EC achieved years of experience in consulting, design, and supervision of hydro-electrical plants.

Team of experts

Our experts boast an accumulated experience of over 50 international hydroelectric power plant projects. They include hydraulic engineers, specialists in civil, geothechnical, and hydrological engineering, dam rupture analysis, specialists in dam security and norms, emergency plan elaboration, and others.



Professor Dr. Carlos Alberto Prato, PhD Civil Engineering, Massachusetts Institute of Technology, MIT, USA.
Expert in hydraulic structures, inspections and stability. Seismic evaluation of concrete dams and sub soils, determination of seismic design actions for hydroelectric plants, nuclear plants and other large edifications.

Dr. Phillippe Martin, PhD Civil Engineering, University of Berkley, USA.
Long year experience as project leader in large dam erection projects, and specialist soil mechanics and seismic engineering of dams.

EC's Offering for Hydroelectric Power Plants

- Topological survey
- Hydrological survey
- Soil studies and geotechnical investigations
- Detail engineering and stability analysis, taking into consideration weight, hydrostatic pressures, seismic events, filtrations and sediment pressures.
- Identification of rupture mechanisms
- Determination of water levels during peak events
- Elaboration of flooding maps
- Studies of downstream impact on facilities and settlements
- Action plans for emergency situations
- Operation rules

Short list of reference projects[1]:

- Tellico Plant, Tennessee, USA
- Blue Ridge Plant, Georgia, USA
- Gargar Plant Argelia
- Beni Haroun Dam, Argelia
- Anacua, Zaczreta, Argentina
- Alicura Hydro Project, Argentina
- Presa Rio Rejo, Mina Yanacochja, Peru
- Arab Potash Potash, Dead Sea, Jordania
- Presa El Guapo Plant, Venezuela
- Angostura Plant, Colca Peru
- Angostura hydroelectrical plant, Costa Rica

[1] Projects with major contributions by EC's experts.

Fossil fuel power generation

Overview

The combustion of fossil fuels, such as coal, gas, and oil for electricity generation accounts for roughly two-thirds of the world-wide electric power generation. Of the 10 490 TWh (Tera Watt hours) produced in 2002 with these three prime sources, 60% were produced with coal, 11% with oil and 29% with gas.

Fig. 6: Choloma III Diesel Power Plant, Honduras. Configuration: 15 X 18.6-MW 18V48/60 MAN B&W engines Fuel: heavy Oil Operation: 2004/2005.

The relative amounts of electricity produced with each type of fossil fuel, have changed considerably over the past years, as shown in fig. 7. Whereas the relative amount of electricity produced with coal has remained relatively steady between 1973 and 2002, the relative use of gas a prime source has increased, whilst the percentage of electricity produced with oil has dropped dramatically.

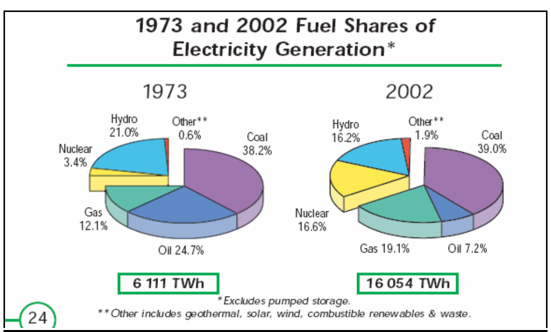


Fig. 7: Development of the fuel shares of electricity production between 1973 and 2002. Today, the amount of yearly amount electricity produced triples the TWh produced in 1972.

EC Activities

EC has over 12 years of experience in the design of thermal power plants, predominantly in the Central American and Caribbean regions. In this type of projects, EC acts as a subcontractor to the general contractor, who has been appointed by the end client or project owner to deliver a turnkey fuel power plant.

EC's participation in fuel plant projects takes place in the following three project phases.

Phase 1 is the Project Planning Phase. In this phase, EC elaborates and provides site-sensitive information to its Customer, based on an agreed existing concept for a particular project. Such information enables to study and produce different variants of the concept and concluding in the "best variant", which represents the most feasible and economic solution.

The selected variant is then quantified, reconciled, and updated with respect to structural, technical and functional requirements. Further close interaction between the Customer and EC leads to a detailed definition of the project. The quality of this project definition is of key importance, since it provides assurance to the client, of what the final product will be.

Phase 2 is the Detailed Engineering Phase, during which the actual carrying of the design takes place. The customer Project Management Team will provide EC with finalized information that has been reconciled with all specialties and the client. EC will then prepare, as requested by customer, the complete description of the works in terms of:

- Definition of physical areas (indoor and outdoor),
- Civil and Structural Engineering
- Construction Drawings
- Electrical and Mechanical interconnection engineering
- Integration design and operating documents for instrumentation, automation & control
- Technical Specifications
- Bill of Quantities.

These works include practically all areas of the power plant in question, including power house, substations, urbanization works, hydraulic systems, tank farms, pump houses, pipe racks and bridges, stacks and boilers, radiators, fuel unloading stations, administration buildings, workshop, laboratory and spare part storage buildings, firefighting house, rainwater and sewage systems and others.

Phase 3, which is the Execution Phase, normally starts after the design is completed. EC's task is to ensure, under customer's Project Management Organization, that the works are executed as agreed with the client and in accordance with the project plans. The scope of works to be provided by EC can be summarized as site management assistance for coordination and documentation, and on-site technical supervision (QA/QC)

EC Fuel Plant Reference Projects

PROJECT	**LOCATION**
124MW POWER BARGE	PUERTO QUETZAL, GUATEMALA
90MW POWER STATION	LA VEGA, DOMINICAN REPUBLIC
PLANT EXPANSION	ACAJUTLA, EL SALVADOR
245 MW POWER STATION	CHOLOMA, HONDURAS
PLANT EXPANSION	LOWMANS BAY, ST VINCENT
PLANT EXPANSION	PUERTO QUETZAL, GUATEMALA
18 MW POWER STATION	EL RONCO, EL SALVADOR
18-33 MW PLANT EXTENSION	EL RONCO, EL SALVADOR
150 MW POWER BARGE	MANZANILLO, DOMINICAN REP.

Electricity Generation with Renewable Energies: Geothermal Energy and Biomass

Overview

Where hot underground steam can be tapped and brought to the surface it may be used to generate electricity. Such geothermal sources have potential in certain parts of the world such as New Zealand, USA, Philippines, and Italy. Some 6000 MWe of capacity is currently operating. In Japan 500 MWe of capacity produces 0.3% of the country's electricity. In New Zealand 420 MWe produces over 7% of the electricity, and Iceland gets most of its electricity from 200 MWe of geothermal plant. Geothermal electric output is expected to triple by 2030. In El Salvador, EC's home base country, around 20% of the country's electricity demand is fullfilled with geothermal energy today.

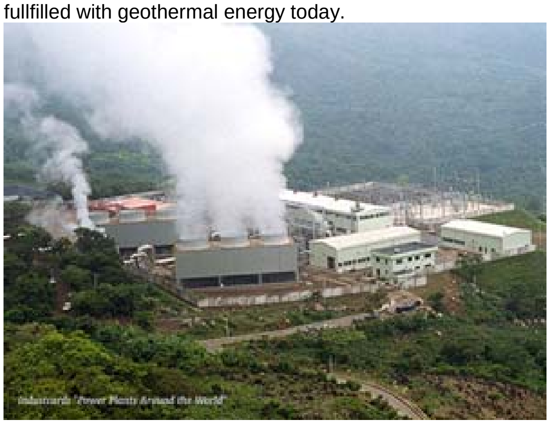


Fig. 8: Geothermal Plant of Berlin, El Salvador. Configuration: 2 X 30 MW, 1 X 35 MW.

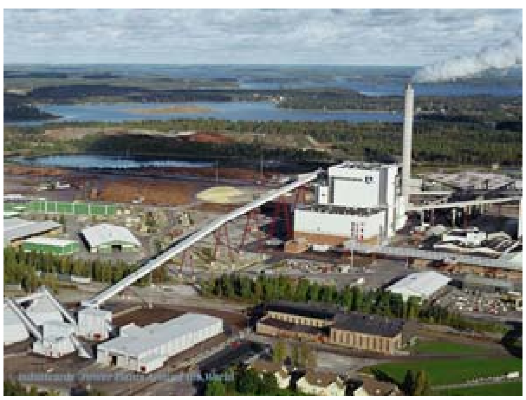


Fig. 9: Jakobstad Biomass Plant, Finland. Configuration: 1 X 240 MW, based on wood, peat and coal. In operation since 2001.

Growing supply of scrap wood or other materials that may be burned as fuel for generating electricity has won some appeal over the usual means of utilising solar energy for power. However, the logistics usually defeat it, in that a lot of energy is required to harvest and move the crops to the power station and for long-term sustainability, the ash containing mineral nutrients needs to be returned to the land. In Australia and Latin America sugar cane pulp is burned as a valuable energy source, but since this is a by-product of the sugar industry, it is in many cases, already used to satisfy the energy needs of this particular industry itself. However, by 2030 biomass-fuelled electricity production is projected to triple and provide 2% of world total, 4% in OECD Europe, as a result of government policies to promote renewable energy sources.

Activities of EC

Based on its experience the planning, design, and construction of conventional power conversion plants, EC can offer today a wide range of services for geothermal energy and biomass power plants.

For the case of geothermal energy conversion plants, EC is uniquely positioned through its base in El Salvador, a country with a relatively high geothermal energy contribution (20%). Such positioning permits EC to assess and apply all new developments in this particular sector.

Today, EC offers the following range of services for geothermal power conversion plants:

- Civil engineering in general
- Geo technical engineering
- Structural/ Seismic engineering
- Hydraulic and sanitary engineering
- Mechanical engineering (piping and HVAC))
- Electrical engineering (LV and MV, Substations)
- Automation and control
- Supervision, verification, and retrofit design of structures
- 3-D seismic analysis of structures
- Non destructive testing (concrete structures)
- On site vibration analysis of soils and structuresTender process assistance
- Coordination of multidisciplinary subcontractors
- Multidisciplinary detail engineering
- On-site project supervision and site management assistance
- Provision of web-based progressive project monitoring

Biomass Energy Conversion Plants

For the case of biomass energy conversion projects, EC is also actively collaborating in the development of such alternative energy sources.

Recently, EC joined an international research and development project with Florida International University (FIU), USA, with the aim of planning, designing and constructing the nations first biomass reactor.

Team of Experts

A typical project team employed by EC would include experienced professionals covering a wide array of engineering field specialties.