FBC UTILISATION PROSPECTS IN DECENTRALISED COGENERATION UNITS IN CAUCASUS REGION COUNTRIES

by

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Great differences are encountered among Caucasus region countries with respect to energy resources reserves and economic conditions. Thermal power plants consist of obsolete and inefficient units, while the Soviet-type large heating systems in the area collapsed after 1992 and their reconstruction is considered uneconomic. Renovation needs of the power and heat sector, and the potential of fluidised bed combustion implementations in decentralised cogeneration units were investigated, since operating oil and gas power plants exhibit high fuel consumption, low efficiency and poor environmental performance. Results showed significant prospects of fluidised bed combustion utilisation in decentralised cogeneration units in the Caucausus region heat and power sector. Their introduction constitutes an economically attractive way to cover power and heat demands and promotes utilisation of domestic energy resources in all of three countries, provided that financial difficulties could be confronted.

Key words: FBC, cogeneration, fossil fuels, biomass, wastes, Caucasus

Introduction

In its Green Paper on European strategy for energy supply, the Commission highlighted European Union (EU) dependency on imported energy supplies and that EU countries green house gas emissions are rising, making difficult to meet Kyoto Protocol commitments [1]. Combined Heat and Power (CHP) implementations can offer improved fuel utilisation and reduced green house gas emissions. In order to exploit European CHP potential, the Commission set the target of doubling the share of CHP electricity generation from 9% in 1994 to 18% by 2010 [2]. Moreover, development of fluidised bed combustion (FBC) processes has been proposed due to their potential to overcome the disadvantages of conventional combustion systems, since it is evident that they are the most efficient and environmentally sound way for solid fuels utilisation. Significant progress in research and development was achieved; thus, FBC technology is adopted in major modernisation programs in Eastern European countries.

Caucasus region countries are still recovering from economic and energy crisis that followed the Soviet Union break-up, civil wars and territorial conflicts. Financial difficulties restrained implementation of renovation and environmental protection programs. The European Union, however, aims to attain financial and political stability as well as common environmental standards all over Europe. Therefore, EU promotes the rehabilitation of local industry and the establishment of a contemporary legislative framework.

Within the scope of this concept, renovation needs of the heat and power sector in Caucasus region countries and FBC utilisation in decentralised cogeneration units were investigated, in order to identify prospects of domestic energy resources utilisation in all countries. In this work, an assessment of the energy resources reserves, the technological status of the heat and power sector, the market needs, and the identification of FBC utilisation in decentralised CHP units in the Caucausus region countries was performed.

Energy resources reserves

Great differences are encountered among Caucausus region countries in respect of energy resources reserves, fig. 1. Apart from Azerbaijan the other two Caucasus region countries are poorly endowed with fossil fuel resources.

Armenia is an energy importer. It has neither domestic oil production nor refining industry. More than 60% of the energy produced derives from thermal power plants fed with imported natural gas. Thermal power plants cover more than 70% of the total

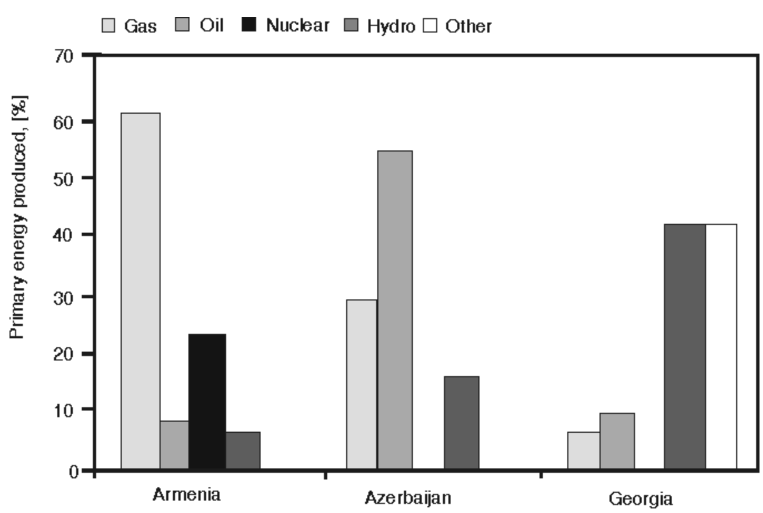

Figure 1. Produced energy balance of Caucasus region countries

energy produced. Since Armenia has not been explored systematically, estimates of oil potential that vary between 60 and 100 million tonnes are speculative. The only domestic energy resource is hydropower, contributing to merely 7% in energy balance 3 .

Azerbaijan has based its economy in oil and gas exports. The country changed from a net energy importer back in 1990 to a net energy exporter by 1997. Oil overtook gas as the prime fuel since 1993. Energy from thermal power plants account for about 85% of the total primary energy produced. Petroleum oil proven reserves are estimated at about 920 million tonnes, while natural gas reserves are considered to be more than 1500 billion m^3 3, 4 . The entry of foreign operators increased both oil and gas production since 1999. Officials predict that gas production will be increased up to about 20 billion m^3 by the year 2010.

Hydropower is Georgia's main domestic energy source, accounting for 42.3% of total primary energy production. Although hydropower plants need extensive rehabilitation, Georgia has enough hydropower potential to become a net electricity exporter. However, less than 20% of the country's hydropower potential is exploited today. Georgian oil fields are located at Western and Eastern country's regions. Official estimates for both oil and gas reserves should be considered as highly inflated figures by taking into account the up to-date cumulative production. Proven commercial oil reserves are about 12 million tonnes. Moreover, biomass potential, especially wood fuel, appropriate exploitation is considered favourable, along with wind power utilisation 3, 5 .

Generally, coal is considered as marginal fuel, while biomass potential has not met systematic, full exploitation.

Solid fuel reserves and characteristics

Total coal potential in Caucasus region is estimated at approximately 465 million tonnes, while lignite and peat reserves are about 735 million tonnes. However, exploitable industrial coal reserves vary between 50 and 75 million tonnes, depending upon technical evaluation criteria 6 . About 96% of them are located in Georgian coal deposits, while the rest are located in Armenia. Although about 80% of Georgian coal potential is concentrated in Tbilisi and Shaori deposits, coal is mined in about 10 underground mines. Armenian exploitable coal reserves are estimated at about 5 million tonnes. Most of them are located at Idjevan and Djadjur deposits. There are 12 depots out of total 22 that are operating.

Caucasus subbituminous coal reserves exhibit low heating value, 17,570 kJ/kg on average, and high ash content, about 28%, compared to similar underground exploitations 6, 7 . It is considered that such quality fuel can best be exploited as burning fuel. However, industrial underground coal mining is considered uneconomic due to the geographic spread and the geological conditions of the deposits. On the other hand, existing mines can support up to 200 MW_e power generation and the cost of coal can be easily predicted 6 . At present, production is used in residential heating in neighbouring areas of the mines.

There is significant potential of biomass utilisation in Caucasus region countries, especially by exploiting wood, wood wastes and municipal wastes. The risk is that improper forest management and lack of environmental concern will substantially damage these resources. In recent years, economic difficulties and disruptions in energy supply have increased the use of renewable energy, particularly in rural areas.

In Georgia biomass and wastes constitute about 140 MW_e of potentially installed capacity. Georgian total wood bark reserves are estimated at around 434 Mm^3 green 8, 9 . Wood bark production has been increased by almost 5.5 times in the period of 1980 to 1995, reaching a maximum of 525 thousand tonnes of oil equivalent (ktoe). Today it is estimated at less than 500 ktoe, aiming at the rational annual consumption of 350 ktoe by the year 2005, in order to avoid environmental damage. Moreover, vineyard and grapes processing residues seem to increase today, although declined during the 1990-2000 period. It is estimated that about 250 dry tonnes of vineyard residues and 40 dry tonnes of grapes process residues will be available for utilisation by the year 2005, summing to 52.2 ktoe.

Municipal wastes are estimated at about 5-6 Mm^3 annually in the South Caucasus region, corresponding to approximately 500 ktoe (at 30% humidity). In Azerbaijan only, household wastes sum to a total of more than 850,000 tonnes per year, providing the potential utilisation of about 170 ktoe of solid fuel 8 .

Although biomass utilisation in these countries seems to be attractive, detailed information concerning biomass resources is required, especially for Armenia and Azerbaijan.

Assessment of the Caucausus region thermal power plants

Technological status of thermal power plants

The total installed capacity of thermal power plants in the Caucasus region is about 8.1 GW_e. However, less than 70% of total capacity is operational at present. Caucasus region operating thermal power plants consist of obsolete and low efficiency units, suffering from lack of maintenance and often experiencing fuel shortage. These result in high fuel consumption, low thermal efficiency and high level of emissions. Indicatively, there are thermal power plants in Georgia operating at thermal efficiencies less than 20%, while in Azerbaijan electricity production losses account for about 85% of output, due to chronic lack of maintenance of the ageing plants and modernisation delay of the majority of power stations and networks 3 .

The main reasons for inefficiency of the existing thermal plants are that (a) in the power grid and heating networks there is no interest in taking measures in order to achieve energy savings and higher efficiency, (b) there are no modern process control devices and instrumentation, and (c) specifically for Armenia, there is actually absence of an accounting system based on the measurement of heat energy consumption; therefore, energy consumption regulation is not possible on consumer level, while the relationship between energy producer and consumer is not based on "heat-commodity" principles 10 .

Armenian total installed capacity of thermal power plants is about 1.8 GW_e. The smallest plant, Vanadzor, is not operational. The other two plants, Razdan and Yerevan, with 1100 and 550 MW_e installed capacities, respectively, are designed as CHP plants. However, only about 50 MW_t are produced from these two operating plants. Moreover, the construction of a new 300 MW_e unit at Razdan Thermal Power Plant (TPP), initiated at about 1993, has been suspended due to lack of funds and mismanagement 3, 11 .

There are 6 thermal power plants in Azerbaijan with total installed capacity of about 4200 MW_e. However, total operational capacity of all six stations sums up to less than 3000 MW_e. From a total of 29 installed thermal units 24 are operational. Eith of them are 10 to 20 years old, 5 are 20 to 30 years of age, and 11 of them are overaged. About 2 GW_e installed capacity has been in operation for more than 30 years.

Today operating installed capacity in Georgia is just 650 MW_e, although the total installed capacity is more then 2100 MW_e. Among the three major power plants, the Tkvarcheli TPP is now in the territory of Abkhazia and is not operational at present. There is only one operating power plant today, the Gardabani TPP. Five of its units, with installed capacity of 150 MW_e each, are not operational due to technical problems. Among its operational units, two 600 MW_e total capacity units are private-owned by the AES-Mtkvari, while another three 150 MW_e each units are state-owned, managed by the Tbilisi TPP. Apart from the Tbilisi CHP plant, no other CHP plant is operational today in Georgia. Kutaisi and Rustavi CHP plants, and Batumi oil-refinery CHP plant do not operate due to the collapse of big industrial enterprises and of the central heating system. The Tbilisi CHP plant used to supply heat to President's Administration, the Parliament and its library, and part of Tbilisi residence. Since the price of produced electricity became higher than the price of imported electricity, the Tbilisi CHP plant has not been in operation for the last couple of years.

Environmental performance of TPP

During the last two decades, increased environmental concern of the European governments is reflected in national legislation and international conventions signed by them. Unfortunately, in many countries, among them the Caucasus region ones, economical difficulties and political instability restrained efforts in retrofitting or repowering the power sector.

CO_2 emissions of the Caucasus oil and gas-fired power plants are even comparable with those of the Balkan countries coal-fired power plants and should be also considered high with respect to the ones of the Western European coal-fired units, fig. 2 11, 12 . Emissions in Armenia are much lower due to the fact that thermal power production is largely based upon natural gas.

In Azerbaijan, annual SO_2 emissions per plant amount 3310 tonnes 3 . The respective value for the Armenian power sector is estimated at 2300 tonnes SO_2, while

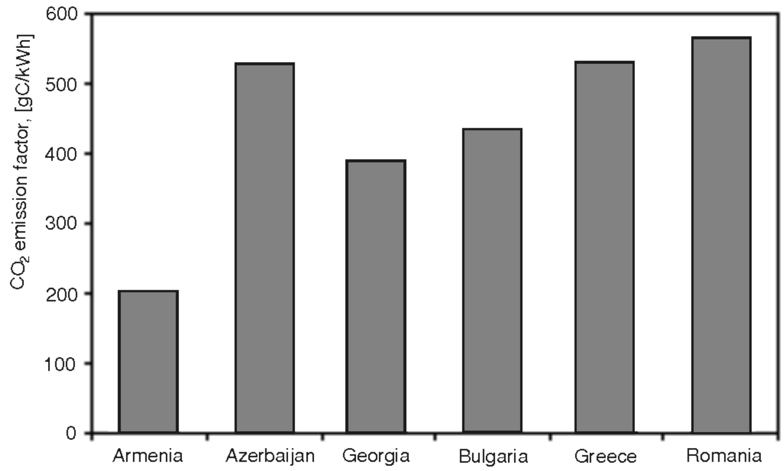

Figure 2. Specific CO_2 emissions per kWh produced

NO_x emissions are about 5100 tonnes 11 . Annual NO_x emissions by Georgian power plants are about 2810 tonnes. SO_2 and NO_x emissions should be considered high, as well, with respect to the ones of the Western European coal-fired units 12 . Specifically for Azerbaijan, high SO_2 emissions may be attributed to the great dependency on petroleum oil products in country's electricity production.

Identification of heat and power needs

Energy and economic crisis, caused by the Soviet Union break-up and regional conflicts that followed, is reflected in power and heat production in all countries. Apart from Azerbaijan, where heat production has been partially restored, heat demand cannot be covered at present 3, 4 . Just 12% of the heat produced back in 1990 is generated today in Armenia 10 . There is no operational cogeneration unit in Georgia today. Moreover, large district heating systems collapsed after 1992 and reconstruction of them is considered not to be economically feasible.

Electricity generation in Armenia dropped from 10.3 TWh in 1990 to 5.6 TWh in 1994. Electricity consumption in the industrial sector declined from 4.6 TWh in 1988 to less than 600 GWh in 1993 due to industrial production collapse 13 . Based on electricity demand and supply projections presented by the Armenian Ministry of Energy, net electricity generation would increase from about 6 TWh in 1998 to 9.4 TWh in 2005 and 11.8 TWh in 2010, while electricity consumption would increase from 4.7 TWh in 1998 to 7.4 TWh in 2005 and 9.5 TWh in 2010.

Heat production has sharply declined during the 1990-1993 period. Moderate increment has been observed since, fig. 3. The extended district heating network is unlikely to be restored, due to the high rehabilitation costs and the climatic conditions that

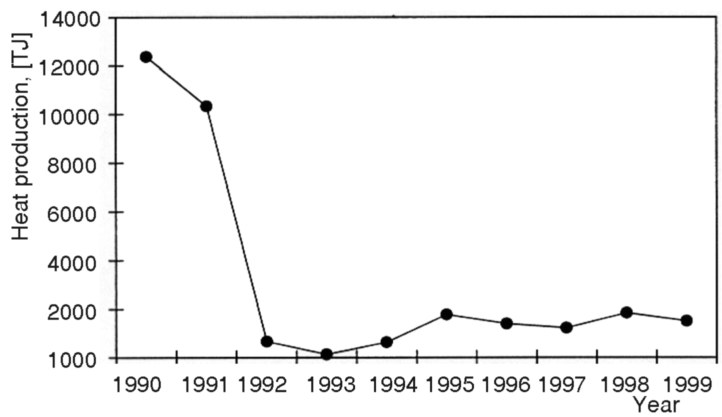

Figure 3. Heat production in Armenia in the period 1990-1999

make large DH systems less economically attractive. Today, just the Yerevan region heating network has been restored to an acceptable level, although heating needs remain high 10 .

Azerbaijan's economy relies on indigenous oil and gas. Energy crisis observed during early 1990's has been reversed since late 1996, fig. 4. Power generation peaked in 1988 at 23.45 TWh, while energy consumption was 21.45 TWh. Both energy production and consumption are expected to be increased to more than 20 TWh by the year 2005 3, 4 .

Heat production has been also restored. About 12,000 and 9960 GJ have been produced in 1999 and 2000, respectively. District heating systems, however, have to com-

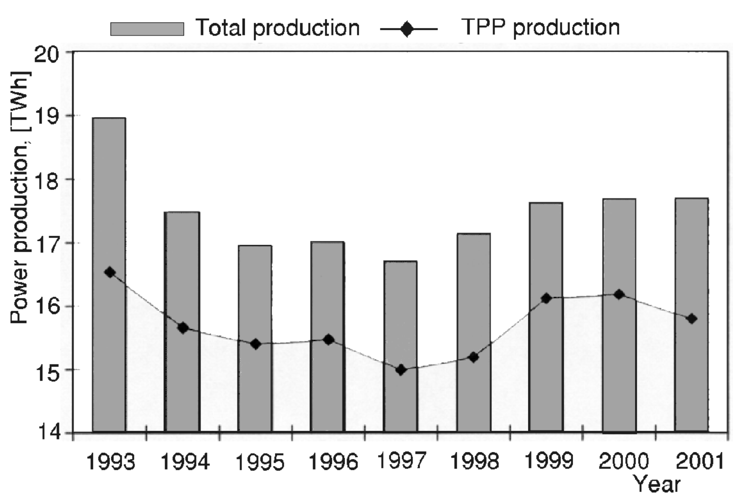

Figure 4. Power production in Azerbaijan during the period 1993-2001

pete with electricity prices. Electricity consumption for households is still subsidised, while non-payment by domestic and industrial consumers remains as a problem, holding back rehabilitation efforts.

Electricity production in Georgia reached maximum of 15.8 TWh in 1989, declined to about 7 TWh in 1994-1995, and presented slight improvement in the recent years, fig. 5. Similarly, electricity demand dropped to more than half of the 10.5 TWh in 1990, to a minimum of about 3.5 TWh in 1995. Tacis EEC produced a moderate forecast for the year 2010, estimating electricity production up to 10 TWh and electricity demand to about 12 TWh 5 .

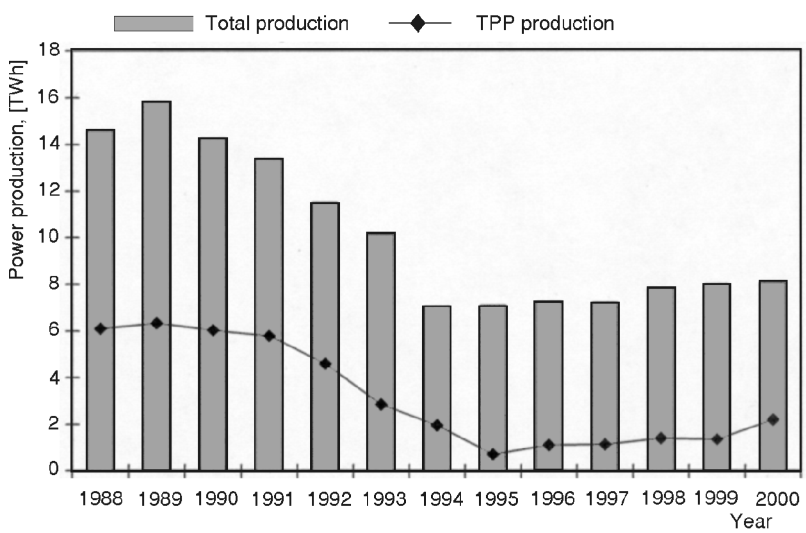

Figure 5. Electricity production in Georgia in the period 1988-2000

Georgian district heating networks are out of use today. The only operational CHP plant is the Tbilisi plant, which has n`ot been in operation for the last two years. Experts believe that the renovation of district heating network is not cost-effective, *i. e.* Tbilisi CHP plant renovation is estimated to cost about 5.000.000 $. High repair costs and the relatively mild Georgian climate do not justify the reconstruction of a large scale, Soviet-type, district heating system.

Identification of FBC utilisation in decentralised CHP in the Caucausus region

Decentralised CHP summarises the grid-connected or stand-alone production of electricity and heat using small, modular technologies close to the point of consumption. Decentralised CHP units operate at small to medium capacities and they are located nearby end-users within an industrial area, or even inside a building, and in this sense they differ fundamentally from the traditional model of centralised power and heat production and delivery. Decentralised CHP combines the advantages of both decentralised generation and cogeneration technologies over separate power and heat productions. Decentralised CHP units present increased overall plant efficiency, and improved fuel utilisation through the waste heat exploitation from power generation that results in (a) reduced fuel consumption, (b) reduced emissions, and (c) reduction of imported fuel cost. They provide environmental benefits and flexibility to increase generation capacity. Moreover, autonomy of plant energy needs is achieved, covering electricity, heat and cooling demands. Conventional power generating plants operate at efficiencies ranging between 30-45%, while CHP units' efficiency is up to 80-85%. Decentralised CHP is also emerging due to vigorous technology development. Among CHP technologies that are being developed, trigeneration, which is the production of electricity, heating and cooling, in the tertiary sector is a fine example. Micro-CHP for use in individual dwellings is another [14]. In the next 20 years decentralised CHP is expected to play an increasingly important role in the European electricity infrastructure and market. Since decentralised CHP technologies have the potential to significantly contribute to savings in CO_2 emissions and energy consumption, they are expected to play a key role in strategies needed in order to meet each country's Kyoto target for greenhouse gas emissions reduction and increased share of power production from domestic energy sources.

Decentralised CHP appears to be suitable for Caucasus countries that are facing the challenge of power and heat sector rehabilitation, while utilising domestic resources and reducing imported fuel cost, facts that are evident in each country's energy sector planning. Thus, strategic priorities set by Caucausus countries governments include the rehabilitation of existing power plants in order to compensate for low efficiencies, high emissions and large production losses, the construction of new ones in order to increase operating capacity, improvement of tariff policy and regulatory mechanisms, and harmonisation to world standards. Georgian and Armenian governments aim at reduction of imported fuel dependence, fuel availability, and reliability improvement of the power sector. Both governments are interested in establishing a healthy free market in the power industry and an effective investment infrastructure 3, 15, 16 . Georgia's strategic priorities also include the creation of a strategic coal reserve and coal utilisation, especially in relatively remote areas. Moreover, Armenia's energy plans contain the construction of a coal-fired plant at Razdan, preferably by employing FBC technology, while wastes utilisation in a 50 MW_e plant in Yerevan was planning 11 . It is also considered that there is significant potential of biomass utilisation in Caucasus region countries, especially by wood, wood wastes, and municipal wastes exploitation 8, 9 . Therefore, in order to exploit domestic solid fuels, Caucasus countries should adopt combustion technologies that exhibit high efficiency and improved environmental performance when employed in poor quality fuels utilisation, such as biomass and wastes, while providing fuel flexibility and being mature for full-scale implementations. FBC fulfils such requirements, among other technologies.

Development of FBC processes has been proposed due to their potential to overcome the disadvantages of conventional combustion systems, since it is evident that they are the most efficient and environmentally sound way for solid fuels utilisation. Within the frame of EU funded projects, significant progress in research and development was achieved; thus, FBC technology is adopted in major modernisation programs in East European countries. FBC technologies offer a number of advantages over conventional combustion systems, regarding efficiency and environmental performance of the thermal units, as well as reduced operating and maintenance costs. FBC units exhibit significant improvement of combustion efficiency due to increased particle residence time and mixing rate, and increased fuel flexibility because the fluidised bed has a substantial thermal capacity that allows a variety of fuels to be burnt, including poor quality domestic fossil fuels, biomass and fuel mixtures. As the intense particle – air mixing that occurs results in a uniform temperature profile of the bed, better bed temperature control is feasible, while increased heat transfer rates, due to the continuous contact of the particles and the immersed water tubes, lead to smaller heat exchange surface per unit of heat energy. The relatively low bed temperatures result in appreciably reduced NO_x formation, and subsequently FBC systems do not usually require any additional denitrification equipment, while more than 90% of SO_2 formed during combustion can be retained as a sulphate by inserting an absorbent in the furnace, such as limestone, lime or dolomite. Moreover, reduced CO_2 emissions can be achieved as a result of the increased overall efficiency. In FBC boilers slag formation problems, such as those usually encountered in pulverised fuel boilers, do not exist, because the average bed temperature remains below the ash melting point. FBC implementations require decreased fuel pre-treatment cost, as relatively large particles (up to 10^{-2} m) can be sufficiently burnt and a simple crushing device can replace the usually encountered milling process. Adaptable boiler designs to all operating modes are also feasible; between 40% of the nominal load and full load in the course of the day. Finally, FBC is a proven technology with high commercial availability. Successful FBC operations have been achieved in European countries, Japan, and the USA, rising up to output capacities of 250 MW_e, while many new CFBC units are being built in Germany, Japan, China, and USA 17 .

Introduction of decentralised cogeneration units, utilising FBC technologies, looks promising, constituting an economically viable way to cover power and heat demands of industrial utilities, agricultural and residential sector, even at relatively remote areas of the Caucasus countries. They can also be considered as an appropriate option to cover heat demands in countries with diverse climatic conditions, such as the Caucasus countries, where there are some areas with mild subtropical climate and others with alpine type one. Hence, there are areas that the heating period lasts just 70 days and others that it lasts about 220, or even up to 380 days 18 . Moreover, in some remote areas with long heating periods, coal and biomass utilisation for heat production is the only option 5, 9 .

Therefore, FBC implementations in decentralised CHP units in the Caucasus region countries will modernise the heat and power sector and will introduce the utilisation of renewable energy sources and the employment of more efficient and environmentally friendly combustion technologies. Their impact on energy systems will offer increased efficiency, better environmental performance of energy production units, and the opportunity to utilise domestic solid fuels. Their construction and operation will increase employment opportunities, will contribute to regional economic development, and will improve power supply reliability in Caucasus countries [14, 19]. Their penetration should be targeted in the power sector, industrial utilities, especially in the case of energy intensive industries, the commercial – residential sector, usually by constituting part of district heating or cooling systems, and the agricultural sector, *i. e*. supplying heat in greenhouses. However, as in most decentralised generation cases, such implementations are often highly location specific and depend on issues such as the technical implementation possibilities, fuel availability, environmental regulations, social acceptance of the projects, local market legislation and infrastructures. Thus, the prerequisites for FBC utilisation in decentralised CHP units in the Caucasus region are discussed next.

Prerequisites for FBC utilisation in decentralised cogeneration units

In order to penetrate the heat and power sector of the Caucasus region countries, FBC technologies have to compete price and availability of other than solid fuels and to overcome barriers such as the lack of large-scale projects in Caucasus countries, the state-own monopoly of the power sector, and any opposition to coal-fired technologies. Moreover, substantial funding should be attained in order to compensate for the present limited investments 20, 21 .

Fuel availability

Due to increased combustion efficiencies achieved, FBC systems can effectively utilise poor quality fuels, thus offering flexibility in fuel feed. Virtually, all available solid fuels could be burnt. Moreover, multi-fuel operation is possible and in some cases may contribute to either improved efficiency or improved environmental performance. Among possible fuels that can be supplied to FBC boilers are low-grade coal (peat, *etc*.), municipal wastes, sewage sludge, biomass, waste wood, and used tires.

Competitive cost

Investment costs of FBC boiler systems are generally higher than these of pulverised coal-fired (PF) boilers. However, in order to meet SO_2 emission limits, a desulphurisation unit (FGD) is usually required. FGD installation cost is then added to the PF boiler cost. In such cases, FBC boilers become a more attractive solution compared to PF boilers 22 . Moreover, as previously discussed, FBC systems do not usually require any denitrification equipment. Reduced demand in emissions control equipment is a major FBC advantage over PF units. Capital cost is the main contributor in produced electricity cost holding a 52% share, while fuel (29%), and fixed operation and maintenance (19%) are the remainder 23 .

Moreover, based upon data of 1998 EU Tacis programme concerning coal resources exploitation in Georgia, fluidised bed technology is competitive with electricity produced by natural gas. Although natural gas prices continue to be low, small difference in electricity production costs justifies the development of mines and power generation from coal, especially if the coal price is kept below $30 per tonne, fig. 6. The size of such power units was estimated at around 150 to 200 MW_e 6 .

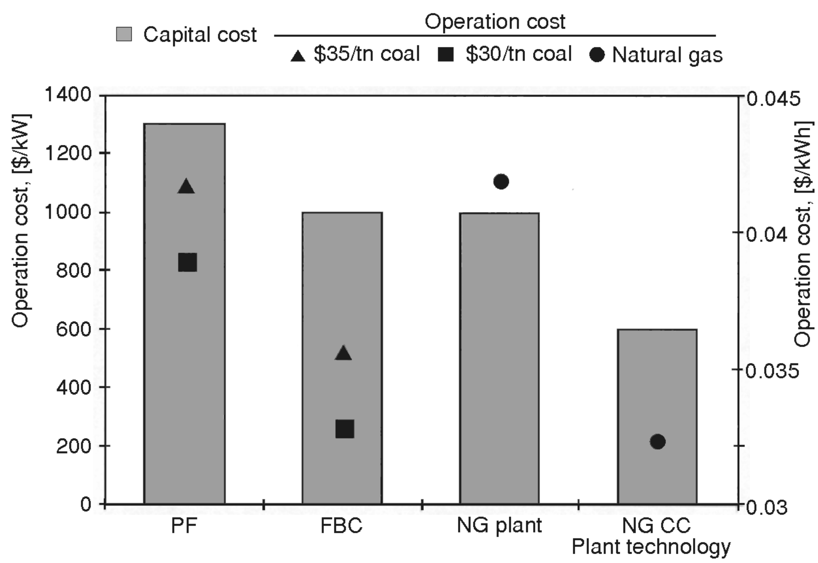

Figure 6. Various configuration cost data for the Georgian power sector
PF – pulverised coal-fired, FBC – fluidised bed combustion, NG – natural gas, NGCC – natural gas combined cycle

Legislation

The legislative framework regarding decentralised CHP implementations and FBC technology exploitation includes all national legislation and international conventions that determine environmental restrictions and regulate heat and electricity production issues. Armenian government passed the Law on Privatisation in 1997 and according to national energy policy non-strategic power facilities are to be privatised. At present electricity imports, exports and production are controlled by state Regulatory Commission 3 . In order to attract foreign investments, Azerbaijan republic adopted laws such as the Law on Protection of Foreign Investments and foreign investments in Azerbaijan enjoy fair protection under national law and international treaties 4 . The

Georgian Law on Monopolistic Activity and Competition that was enacted in 1996 and the Law on Privatisation of State Property constitute the legislative basis for open market development and for privatisation of state property. However, strategic enterprises are excluded 3 . In general, the legislative basis for regulating the development of the Caucasus countries' energy sector under market principles has not been completed yet.

Moreover, association with EU in the medium term requires compliance with EU environmental legislation, which in turn will probably promote the investigation of cogeneration and clean coal technologies applications, such as the FBC technology applications, in the Caucasus region countries and finance such projects. The European Council has introduced Directives relevant to the heat and power industry, concerning the environmental performance of combustion plants 17 .

Funding

Excluding Azerbaijan, investments in the Caucasus power sector are limited today. Generally, there are great funding needs in all Caucasus countries in order to rehabilitate the heat and power sector, gas and oil transmission pipelines, and the distribution network. The challenge in countries such as Armenia and Georgia is to develop the necessary conditions for increased foreign investment opportunities, in order to attain the necessary funds. Advancing privatisation of the power utilities and open-market heat and power sector development may lead towards this direction. The main barriers for Caucasus countries in attaining funds are probably social and economic conditions instability, mismanagement, and insufficient tariff policy and regulatory mechanisms. These reflect on more than strict financing conditions met in the past, such as very short payback time 5 .

Dominant financiers are the World Bank Group, including organisations such as the International Development Association, the European Bank for Reconstruction and Development, the European Investment Bank, bilateral aid agencies, and private-sector investment financiers. The contribution to the overall budget may vary from about 25 to 50%. Candidate beneficiaries are all Caucasus region countries, while Azerbaijan is also financed by the Islamic Development Bank. In general, strict financing conditions are expected to be met, while return on investment is considered attractive 24 .

Conclusions

There are significant prospects of FBC utilisation in decentralised cogeneration units in the Caucausus region heat and power sector, due to the obsolete and low efficiency units. Such implementations will modernise the heat and power sector and will introduce the utilisation of renewable energy sources and the employment of more efficient and environmentally friendly combustion technologies. Moreover, their adoption will promote the utilisation of domestic energy resources that were considered as marginal fuel or have not been fully exploited, such as coal and biomass.

The introduction of decentralised CHP units constitutes an economically attractive way to cover power and heat demands of industrial utilities, the agricultural and the residential sector, regardless of geographical location, while contributing to heat and power supply reliability. Construction and operation of decentralised CHP units increase employment opportunities and contributes to regional economic development. Their impact on energy systems will offer increased output efficiency, better fuel utilisation, and reduction of imported fuel cost.

In order to exploit solid fuels, Caucasus countries should adopt high efficiency combustion technologies that present improved environmental performance, such as FBC technologies. They present attractive possibilities for the utilisation of solid fuels of extremely poor quality or similar "problematic" fuels (biomass, wastes, industrial by-products). The adoption of FBC systems offers increased efficiency, fuel flexibility and availability, along with reduced operating and maintenance costs, while environmental standards could be met.

In general, there are fair funding possibilities for large-scale project implementations from international organisations and the EU, especially if barriers such as economic instability, mismanagement, and insufficient tariff policy and regulatory mechanisms are overcome. Advancing privatisation and energy market liberalisation, along will harmonisation with EU legislation, will further enhance possibilities.

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