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Small-scale polygeneration market uptake: the Slovenian case

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Climate change and security of energy supply are becoming one of the greatest challenges in the beginning of the 21st century (Prentice et al, 2001). Although there are many measures foreseen to deal with those challenges, the small scale polygeneration based on renewable energy sources and natural gas could have an important contribution in our striving to increase the security of electricity supply in many European countries. While the CHP Directive (2004/8/EC) encourages the implementation of micro and small scale cogeneration (and polygeneration), the individual supporting mechanisms are left to the Member states to decide upon. However, it may turn out, that new regulatory framework in Member States still does not answer all the needs for the establishment of favourable conditions for high-efficiency (small and micro) cogeneration. Therefore the progress of cogeneration in each particular Member State should be monitored and analyzed regularly and improvements of regulatory framework have to be made if necessary. For Slovenia, the polygeneration could be one of the most important progressing priorities of sustainable development due to several reasons: the electricity generation from natural gas is negligible (2%), fast increase of electricity demand (4% increase on annual basis) results in 20% electricity imports and already serious shortages of generation capacities. At the same time the specific CO_2 emissions from thermal power plants are the highest in European Union (approximately 1,2 $kgCO_2/kWh_{el}$). Existing market environment enabled the introductionary phase of polygeneration units with first (pilot) installations. On going reform of supporting scheme and recent huge increase of electricity prices are increasing the market potential for polygeneration in Slovenia and are the main driving forces fur further technology deployments. Hedging of risk of high natural gas prices is becoming a new establishing instrument for setting the appropriate economic conditions for implementation of ongoing and future projects.

1. Introduction

Polygeneration technologies (in particular cogeneration) are known in Slovenia, especially within industry and district heating sectors. On the other hand, the share in commercial and domestic sector is quite insignificant. In the past there was a lack of clear legal framework and this was stopping many of new projects. Nevertheless, high gas prices and uncertainties regarding electrical market liberalisation in recent years were not making any positive impact on CHP (combined heat and power) development. Despite this, some individual investors have performed a series of feasibility studies in the period after 1990. The range of sectors in which the feasibility studies were undertaken includes industry, district heating, and public sector (hotel, schools, hospitals, etc.). Micro-scale CHP was so far very rarely

used in Slovenia, but there some initiatives that micro-scale could be interesting (especially for households and smaller companies); first installations started with operation in 2006. Recent development of polygeneration (CHP) units in Slovenia is shown in Figure 1. It reflects the limited supporting policy (feed-in tariff system) established in 2002. Appropriate level of support for district heating units and biogas plants has resulted in installation of many generation capacities (some 40 MW_{el} or approximately 80% of all new installations after year 2000). Except 7% market share for steam engines and turbines, (natural) gas engines are prevalent technology (where mainly 50% of all installed units have capacity of less than 1 MW_{el}).

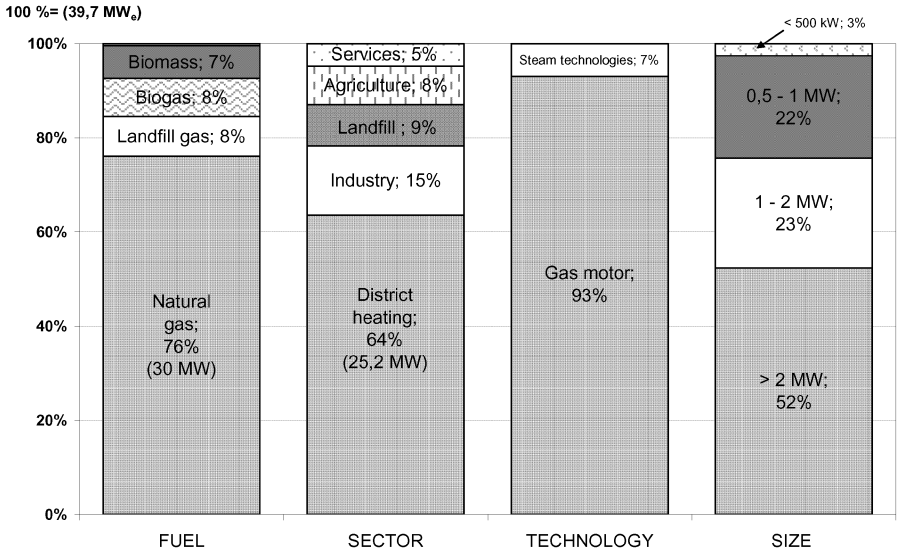

Figure 1. New polygeneration (CHP) capacity structure in Slovenia (2000–2006)

2. Existing framework for polygeneration

Insufficient support for CHP installations in industrial and service sector resulted in some new projects, but this is almost negligible compared to the potential. In addition, market turbulence since year 2000 (Figure 2) with unpredictable electricity prices and high variations of natural gas as prices (especially the huge increase after the year 2004) is the reason that affected decisions of many potential investors. Nevertheless, lack of incentives for market penetration enabled only the introductory phase of polygeneration units in Slovenia, with first (pilot) installations and several feasibility studies. The first (year 2001) market based project that has been successfully carried was trigeneration system (CHP and cooling (Kranjcevic et al, 2004); two 500 kW_e gas engine units and 892 kW_c absorption cooling system) for business-trade and warehouse Centre (including 8 cinemas) with total surface of 30,000 m^2. The system consists of several sub-systems including cooling system

for cold-storage chamber, cooling system for air-conditioning and use of waste heat from gas motors (out of absorption cooling system).

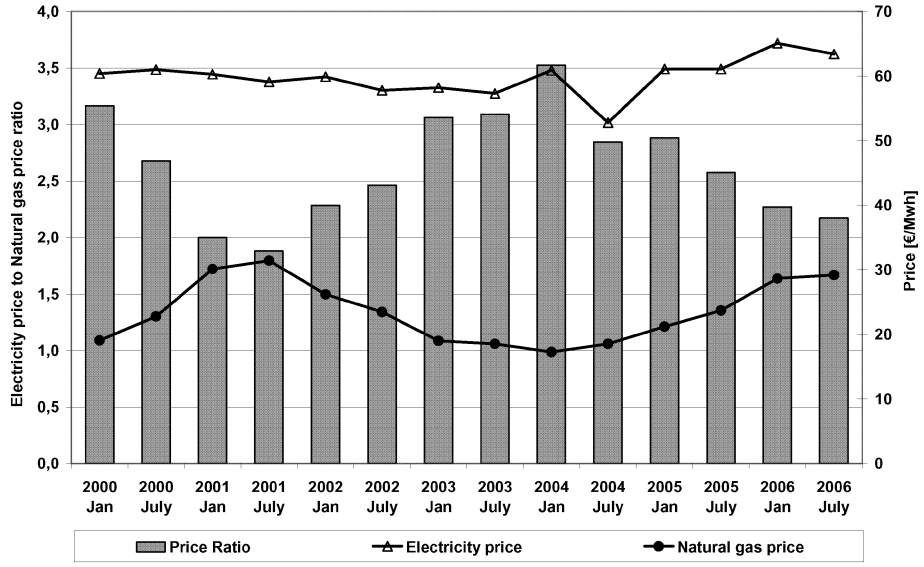

Figure 2. Electricity and natural gas prices development (Eurostat standard consumer prices: I_e - electricty and I_{3-1} - natural gas) and ratio for industry since 2000

Another feasibility study of trigeneration ($2MW_e$ and $1MW_c$) was made for the largest Clinical centre of Ljubljana (Pegan et al, 2004), which demonstrated attractive potential for trigeneration in hospital sector. Main barriers for implementation were lack of investment founds and existing heat supply from central district hearing network (of Ljubljana city).

3. New support framework

The slow progress in construction of new power capacities in the country has caused severe deterioration of security of supply and significant increase in electricity import; in year 2008 more than 30% is expected (Slovenia report…, 2005). Taking into account the Directive 2005/89/EC, renewable sources and cogeneration could play significant role in the future improvements (of current situation). In addition to the lack of new power capacities, Slovenia has to carry out CO_2 reduction measures according to its Kyoto targets (-8% from 1986 levels to 2008-2012 annual average). In practice, the CO_2 constraint will probably introduce only minor (but not negligible) modifications to the choice of technologies for the plants to be built (Operational plan…, 2006). What causes a serious concern at present stage is that existing thermal power plants in Slovenia are using obsolete technology and are as such extremely inefficient with average specific carbon emission (for electricity production) over 1 kg CO_2/kWh_{el}. Therefore it is indispensably to start with the conversion of the

present stage of technology, also in the way of integrating new gas-fired capacities, where cogeneration and trigeneration could play an important role (Merse et al, 2003). At present stage, natural gas represents only 2% of total national (electricity) power balance, which is rather insignificant share. Unfortunately, due to high natural gas prices in last few years, especially when compared to other alternatives such as coal, hydro and nuclear, investment into natural gas based technologies were not attractive for investors. Nevertheless, the transposition of the Directive 2004/8/EC in to the Slovenian legal framework and necessary fulfilment of requirements of the European Commission regarding current support scheme are now additional driving forces for enabling new Slovenian framework for cogeneration and electricity generation from renewable energy sources (RES). Activities for preparation of new scheme started in the late stage of 2006 should finished by the end of 2007, while new legal framework is expected to step into force in 2008. This new scheme also intends to include relevant criteria for reduction of specific CO_2 emissions of (new) CHP units compared to (existing) thermal power plants. A criterion is expresses as percentage (%) of "CO_2-free electricity", and is also used for setting the intensity of the new support. Considering share of "CO_2-free electricity" for different technologies (e.g. type of fuel used) the CHP units are sorted into 4 classes, with decreasing intensity of support (Figure 3):

- Renewable energy sources (RES) more than 100%,
- Natural gas & LPG 70-90%,
- Fuels oils 20 – 70%, and
- Solid fuels (coal) up to 20%.

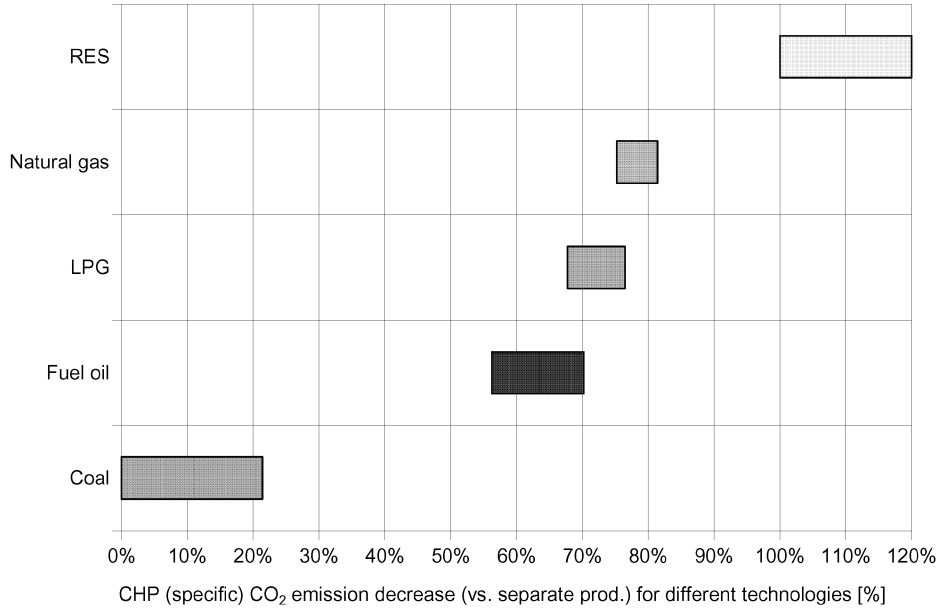

Figure 3. Potential of "CO_2-free" electricity for different technologies

Proposed support scheme is made of two main mechanisms:

- Capacity payment (€/kW_{el}/year) – 60%,
- Energy premium (€/MWh) – 40%.

The first analysis based on situation of current energy prices has proved, that the level of new support for typical gas engine unit of 500 kW_e and specific investment cost of 1000 €/kW_e should reach up to:

- 100 €/kW_{el}/year, and
- 10 € /MWh_{el}.

The supporting period of ten years should establish favourable conditions for new investments, also for trigeneration, which was again affected by new rapid increase (in range between 30 to 50%) of electricity prices (not including charge for use of network) in 2007. Another problem that is associated with potential investments comes along with the emission trading scheme (EU ETS), which is at the moment not delivering any clear policy signal for operators and investors (Kranjcevic, 2006). However, Slovenian government is now presenting a very positive signal with NAP2 (the national allocation plan for period 2008-2012), where free-allowances will be assured for any new high-efficient CHP installation, which will start to operate during the second trading period. Anyway, dealing with the climate change issues should be a long-term obligation, i.e. for the next 20-30 years. Specifically, we still do not have clear enough picture for the period after 2012. Consequently, the operators are in position where they could not take any additional risks, e.g. to invest in environmentally friendly but relatively expensive technologies such as renewable energy sources and other new promising technologies (Kranjcevic, 2007).

4. Conclusions

When we look at small-scale CHP sector, we can find out that Slovenia is a country where conventional concept of heating and electric power generation is prevalent. Despite that, there are some successful small-scale CHP installations initiated by individual end-users, which shows us the direction of polygeneration development in the future. This is the way to solve problems regarding expensive power production (heat and electricity) and necessity for further reduction of greenhouse gas emissions. Nevertheless, prospect (in general) for polygeneration will improve with new legal framework and prospect should be very good, since both the awareness and the interest on the technology is high.

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