CLEAN ENERGY FOR BRAZIL

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1. GENERALITIES

Brasil has the less polluting power generation system world-wide (more than 90% is hydropower). In the transport sector equally Brazil is the world leader as far as concern the biofuel production and utilisation. The yearly production is around 13 million m^3 feeding a fleet of about 4.5 million neat-ethanol cars and a park of 8 million ethanol blended cars. The production cost of hydrous ethanol is around 180 \$/m^3 with a dewatering cost of 30 ÷ 60 \$/m^3, depending on the system capacity and method.

Brazil will be confronted (in future) to three problems:

- Comply with the obligation derived by the ratification of the Kyoto-agreement for the reduction of the green-house emission;
- To satisfy the increasing demand of energy now 290 Twh/year;
- Fluttuating and shortage of stored water in dams due to the generalised more and more unstable climatic conditions.

For example the past year Brazil suffered severe shortage of power and was obliged to adopt stringent rationing plans (compulsory reduction – 20%) not only for domestic uses, but also for commercial and industrial utilisations, therefore with immediate negative economic effects (estimated about – 1.5% of the G.N.P.).

Power distributors were not allowed to expand new electric loads penalising possibility for new industrial/commercial activities.

2. MEASURES TO EXPAND THE POWER GENERATION AND DISTRIBUTION

It is expected that for sometimes new investments in Brazil will be at risk due to 1) the temporary electric power limitations; 2) incertitude in the electricity spot-market.

The last year crisis perhaps will be beneficial for eliminate the existing obstacles like: privatisation, artificial tariffs, etc….

Opportunities for power technology supply are emerging because it is estimated than Brazilian Industry can cover only about 60% of the needs. In particular good opportunities exist for:

- Power equipment and services;
- Cogeneration equipment and services;
- Energy efficient systems;
- Emergency equipment (back-up power generators, emergency generators).

3. POSSIBLE ACTION PLAN

Taking into account the country energy situation in particular:

- A pending risk of power deficit;
- A surplus of bioethanol of ~2 M.ton/year (2000);
- A reasonable production cost of bioethanol in Brazil: 180 \$/ton;
- A good infrastructure for bioethanol production, transport, supply;
- A good environmental characteristics of bioethanol (no CO_2 – no SO_2 – low particulate emission – production energy ratio $\frac{\text{Output}}{\text{Input}}$
- more than 200 smaller distilleries being closed down for economic reasons in recent years could be able perhaps to start again the low quality ETON production (at reasonable cost) providing many new jobs (~20 ton of ETON per one job) and to expand the bioethanol production reducing the pressure for the country balance of payment (\$).

The following power generating system could be proposed:

A cluster of macro – gas – turbine c.c. (100 MWe) generators together a cluster of smaller (10 MWe) Aereoderivative gas – turbine c.c. generators and a group of mobile (5 MWe) Aereoderivative gas – turbine generators all fuelled with low quality (92°) ETOH.

4. WHY GAS TURBINE GENERATORS FUELLED BY ETANOL?

The main reason are the following:

- bioethanol is a simple very good molecule for energy utilisation as can be seen in Appendix I.
- bioethanol (in Brazil) is competitive with gasoline/gasoil;
- the gas – turbine c.c. (large capacity) have very high efficiency: ~ 48%;
- the use of bioethanol in gas turbines is expected to increase the electrical efficiency of about +5% (similarly to what has been demonstrated using methanol as fuel) in comparison with natural gas and gas-oil;
- the investment cost of gas turbine is low (200-300 $/KWe) allowing the possibility of their amortisation also for a relative low number of operating hours per year (4,000 h/year);
- the utilisation of low-quality bioethanol (92°) in aereoderivative gas generators is expected to produce an effect similar to the "steam - injection" with consequent power (efficiency) increase for some superimposition of Bryton/Rankine cycles.

Assuming to have at disposal 2 million t of surplus bioethanol per year this amount could be sufficient to feed:

N° 7 generators of 100 MWe each consuming 1,37 Million **t** ETON/**y** - producing 4,9 Twhe/**y**

N° 20 generators of 10 MWe each consuming 0,39 Million **t** ETON/**y** - producing 1,4 Twhe/**y**

N° 20 generators of 5 Mwe each consuming 0,195 Million **t** ETON/**y** - producing 0,7 Twhe/**y**

For a total of 1,000 Mwe Consuming 2 Million **t** ETON/**y** ⟶ producing 7 Twhe/**y**

Furthermore now exist also the possibility to use microturbines (100 KWe) fueled with bioethanol.

The marginal cost for electricity production is:

- from Large Generators: ~ 0.054 $/Kwhe
- from Small Generators: ~ 0.0063 $/Kwhe

5. INVESTMENT

The total estimated investment is as follows:

● for the 7 x 100 MWegenerators	210 M.$
● for the 20 x 10 MWegenerators	60 M.$
● for the 20 x 5 MWegenerators	40 M.$
TOTAL ~	**310 M.$**

COOPERATION AND CO_2 TRADE-OFF FOR INVESTMENT

The total "CO_2 – Trade-off" volume involved in this potential action plan is ~ 4,0 million ton of CO_2/year. Assuming a value of CO_2 of 10 $/t the "trade-off":

ANNUAL VALUE ~ 12 M.$/year

To compare with the annual financial charges for investments cost and interest estimated (***i***=5% on 10 years life-time operation)

ANNUAL FINANCIAL COSTS = 0,12 x total investment = 38 M.$/year

CONCLUSION

Temporary power supply shortage in Brazil could be coped with the use of surpluses of bioethanol (now ~ 2 miot) in modern low-cost gas turbines, because their low-cost/high efficiency, combined with a reasonable cost of low-gradebioethanol (200 $/m^3) as fuel, can satisfy very well temporary shortage or ion.