# Status of Cogeneration in Singapore

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## 1. Introduction

Cogeneration is well accepted by the government and industry as essential to achieving greater efficiencies and cost effectiveness to maintain Singapore's national competitiveness in the globalized market and economy. The development of industry clusters has made possible the implementation of a centralized cogeneration plant to provide customers in the cluster with power and steam. A number of established key players in the petroleum refining and/or petrochemical manufacturing industry also have cogeneration plants or are in the process of expanding/building cogeneration plants to serve their own energy needs with possible surplus electricity for supply to the grid. Two small biomass based cogeneration plants will be commissioned in 2004 as part of the Full Scale Demonstration Plants of the EC-ASEAN Cogen Programme. Yet, despite these many instances of cogeneration applications, further significant (in terms of MW) applications of cogeneration may face some limitations or hurdles in the near term.

## 2. Applications of Cogeneration in Singapore

In 2003 the total licensed capacity of generation companies in Singapore is 11,490MW (Table 1). The actual installed capacity at the end of 2002 was 8,124MW and the maximum demand was 5,027MW (or 61.9% of installed capacity). In addition, there are about another 250MW available from generators exempt from licensing. The installed generation capacity by plant type is shown in Fig.1. Cogeneration plants comprise 10.8% of all installed capacity.

**Table 1: Power Generators in Singapore**

| Company | Authorized Capacity (MW) |
|---|---|
| **Power Seraya** | 3,100 |
| **Senoko Power** | 3,300 |
| **Tuas Power** | 2,670 |
| **SembCorp Cogen** | 900 |
| **Island Power Company** | 800 |
| **Singapore Syngas Pte. Ltd.*** | 20 |
| **Exxon Mobil Asia Pacific Pte. Ltd.*** | 180 |
| **Keppel Merlimau Cogen** | 470 |
| **Elba Eastern (Pte) Ltd.*** | 50 |
| **National Environment Agency** | 250 |
| **TOTAL** | **11,740** |

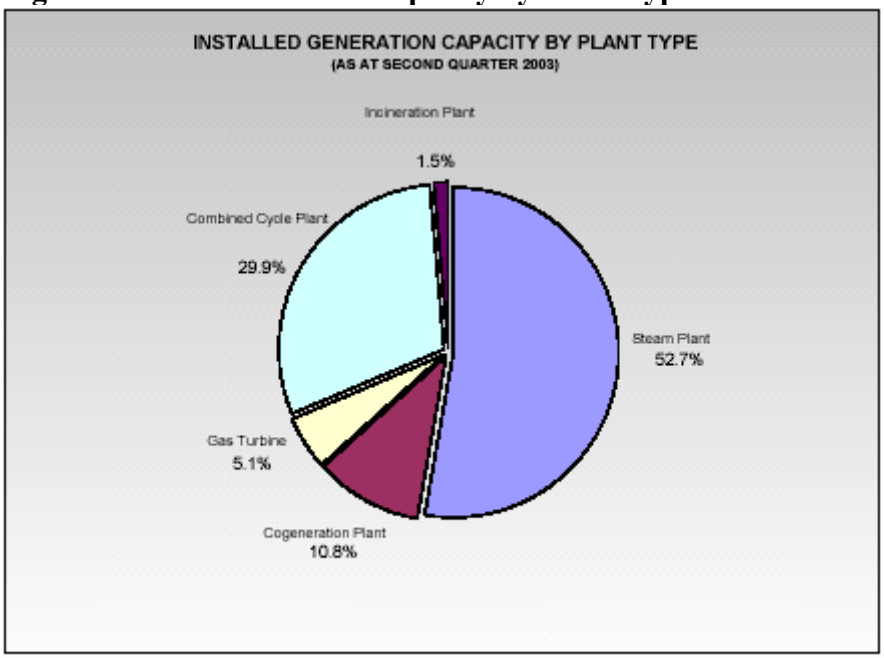
* exempt from New Energy Market rules

With the development of the petrochemical and chemical industry cluster on newly reclaimed Jurong Island the opportunity came to provide a centralized power and steam cogeneration plant to serve the nearby chemical and petrochemical plants. This resulted in the setting up of SembCorp Cogen as the first IPP (independent power producer) to provide 815MW of electricity and 700 tonnes/h of steam from natural gas imported by the SembCorp Group from the Indonesian sector of the Natunas gas field. The merger of Exxon and Mobil resulted in the integration of the energy needs of the two previously separate plants and in the merged ExxonMobil developing their own 155MW cogen plant to serve their own electricity and steam needs. Both Island Power Company Pte Ltd and Keppel Merimau Cogen Pte Ltd are also licensed to generate power (800MW and 470MW respectively) and steam for their own use as well as to supply electricity to the grid. Island Power is partially owned by Shell which operates a number of petroleum refineries on Bukom Island and has a stake in some petrochemical plants on Jurong Island, all requiring electricity and steam for their operations. Keppel Merimau is associated with Singapore Refining Company on Jurong Island. Another cogenerator is Syngas Singapore, a manufacturer of reformer and other specialty gases.

The National Environment Agency's (NEA) four incineration plants generate 250MW of electricity and recover much of the waste heat to reduce the moisture content of the 7,200 tonnes/day of solid waste sent to the incinerators.

Two FSDP's (full scale demonstration plants) under the EC-ASEAN Cogen Programme will join the list of cogeneration plants in 2004. The smaller plant of 0.5MW will burn unrecyclable wood from industrial/commercial wastes and use the electricity and steam for other waste recovery and cleaning operations. The other 1MW cogeneration plant will burn wastes remaining from tree pruning and other horticultural wastes after usable wood has been recovered for making charcoal briquettes. Each year Singapore's Garden City Programme of growing trees and plants provides about 230,000 tonnes of such wastes. The electricity and steam generated will be utilized in the wood chip briquetting and other waste recycling and cleaning operations.

**Fig.1 Installed Generation Capacity by Plant Type**




Note: Incineration plant refers to generation of electricity from refuse incineration by the National Environment Agency (NEA).

## 3. Prospects for further cogeneration applications

The question often arising with these substantial cogeneration applications existing already is the potential prospects for more cogeneration applications in Singapore. There is wide recognition of the economic benefits of cogeneration in the public and private sectors. Industry leaders see cogeneration as one of the means to reduce costs in order to stay competitive. Environment authorities promote the use of natural gas for cogeneration as being clean and efficient.

Facing the worst recession in 2001 the GDP shrank by 2.4%. Since its independence Singapore formed the Economic Review Commission (ERC) to review the situation and recommend actions to maintain its competitive advantage. Under the ERC are sub-committees covering areas ranging from retail to manufacturing and the financial sectors. Each sub-committee is made up of industry leaders, professionals, academics, government and other experts.

The sub-committee on manufacturing, in its review of costs affecting the sector, called for utilities costs, among other costs, to be reduced for Singapore to regain its competitive advantage. It highlighted ***utilities cost "as consistently expensive** in Singapore (source: World Competitiveness Yearbook infrastructure ranking)" and stated that "power supply costs should be reviewed with a focus on competitive rates, and not merely on ROTA (return on total assets) or (sic) production and distribution." It recommended that "**regulations around co-generation and transmission and distribution charges should be reviewed**." and that "…in the event that local suppliers do not provide power at competitive rates, then alternative sources of power should be evaluated, including the opening of the market to suppliers from outside of Singapore."

The sub-committee identified four key industries that "will form the nuclei of value manufacturing clusters". Under the Electronics Industry Cluster it identified 7 Key Initiatives, one of which is "**Centralised co-generation facilities for wafer-fab parks that could generate 25% cost savings…**".

Similarly, for the Chemicals cluster it listed 2 of 11 recommended Key Initiatives as:

— **Review regulations to encourage more efficient methods of power generation including co-generation**

— **Ensure cost competitiveness of power, including reviewing transmission and distribution charges**".

The sub-committee in its Recommendations/Action Plan specifically called for the government to "**Review regulations to encourage co-generation**. The chemical industry, in particular polymer processing facilities are large consumers of electricity, while many petrochemical processes utilize large amount of steam, making the industry ideal for the use of **highly efficient methods of power generation such as co-generation**, where steam and electricity are co-produced."

It correctly identified the New Energy Market rule requiring co-generators to put their generators to the Energy Market Authority for despatch would put them at risk of disrupting steam production and called on the government to "review its regulations to **encourage more efficient methods of power generation such as co-generation**".

Although, in its review of the Biomedical Sciences Cluster it was more concerned with other issues concerning this new and fast growing sector it nevertheless, recommended that "JTC (the government board responsible for industrial land planning and development) to identify specific opportunities for providing **common utilities and services**. ..".

The Ministry of the Environment and its National Environment Agency in 2002 put forth their Singapore Green Plan 2012, recognizing the contribution of cogeneration and combined cycle power plants running on clean natural gas in reducing pollution and improving energy efficiencies. The plan cited, as examples of clean and efficient use of energy,

- SembCorp Cogen's 900MW capacity cogeneration plant achieving fuel efficiency of 70-75 percent, and
- ExxonMobil's 155MW on-site cogeneration plant as being "twice as efficient(ly) as separate conventional power generation units, and reduces carbon emissions".

Under the Singapore Green Plan 2012 the growth of refuse from residential and industrial/commercial waste is to be slowed down. To encourage recycling and waste minimisization the disposal fee paid by waste collector to the incineration plants has been allowed to increase. Although this increase was deferred during the 2002/2003 period of recession and slow economic growth it will eventually rise to SGD87 per tonne, possibly in 2004 or soon after. The planned privatization of the incineration plant later may also mean the disposal fee will be fixed by the market system. This

development, while posing some threats to the smaller waste collectors, may also spell opportunity for others, especially those involved with the collection of biomass and other wood waste. Such combustible wastes could provide cogeneration plants such as the FSDPs mentioned earlier biomass fuel at a negative cost of minus SGD50 - 70 per tonne (the incinerator's disposal fee minus the transportation cost). Currently, under the Singapore Garden City Programme, tree pruning and other horticultural activities require disposal of woody or green biomass of about 250,000 tonnes per year. If most of this biomass is available for cogeneration a few more plants similar to the FSDPs could result.

The Energy Market Authority, in recognizing the trend towards more demands for on-site cogeneration prepared an information paper on its Policy on Direct Supply of Electricity by Generating Sets to On-site Loads. However, this merely restricts the use of the power generated (but no mention of steam or other form of heat) to users within the fences of the on-site cogenerator.

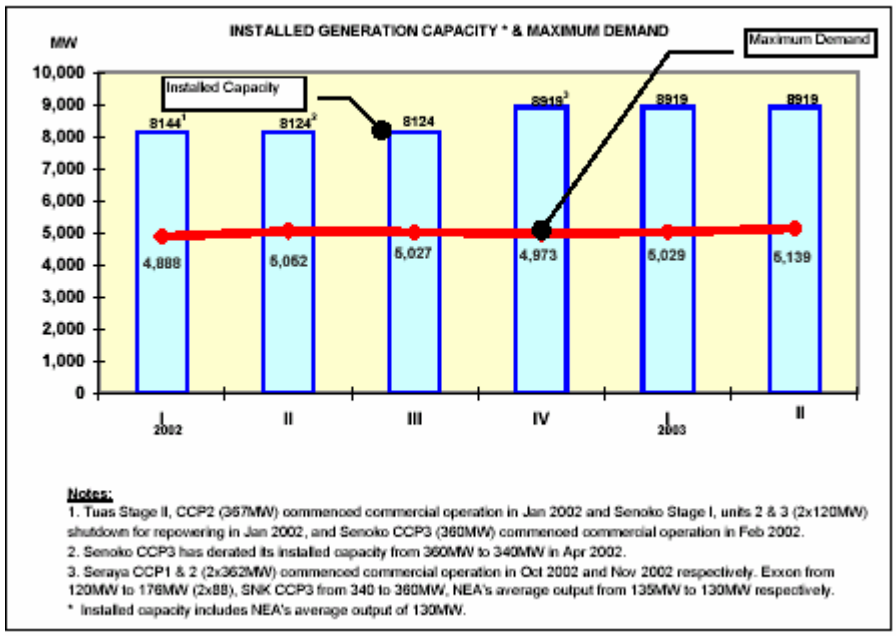
## 4. Barriers /Limitations to Further Development of Cogeneration Applications

Despite the substantial examples of cogeneration technology and the benefits provided and the very positive signals from the government a number of critical factors exist as hurdles to limit further substantial developments at least in the near term.

Current installed capacity far exceeds current demand due to slower economic and power consumption growth (Fig.2), The gap is even greater if all licensed capacity is taken into account. In Q2 2003, the maximum demand was 5139MW or 7.6% of installed capacity. The average growth rate in electricity net demand was 4.78% in the past 5 years from 1998 (see Fig. 3). Even with a projected annual increase of 5% in the maximum demand the current installed capacity will be adequate (with a reserve capacity of 25%) till 2008. With more capacity coming on line in the next few years and with the lowered expectation for the GDP growth rates over the next 10 years it is likely that the maximum demand will stay below 75% of installed capacity well past 2010.

**Fig.2**

Installed Capacity & Maximum Demand

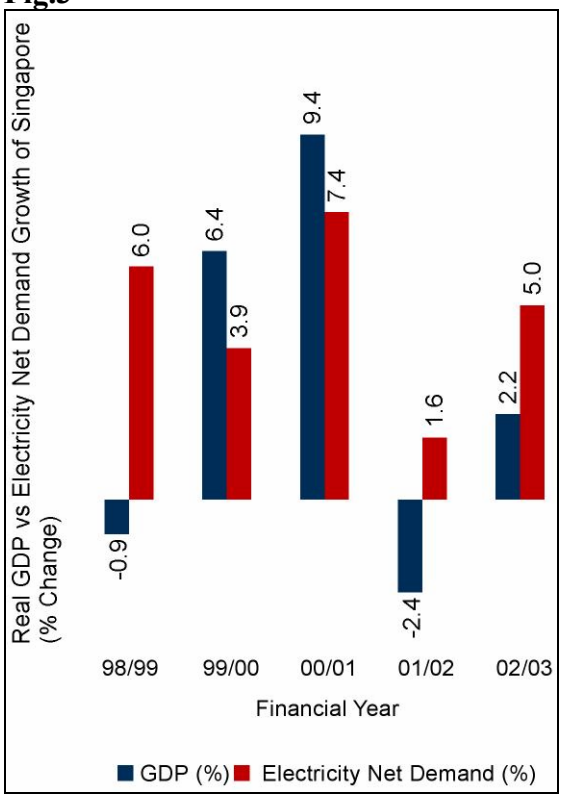



Source: Energy Market Authority

EMA's New Energy Market (NEM) rules require all generating units over 10MW to be included in the NEM, i.e. all such generators will have to be made available for despatch by EMA and the generators will have to post their generated power on the market. All licensed generators between 1MW and 10MW are required to be registered with the EMA's Energy Market Company's (EMC) as market participants either for dispatch or as a generation settlement facility. As pointed out by the ERC's sub-committee on the Manufacturing Industry this has the effect of putting the cogenerator in the risk of losing their steam power. Although the recommendations have generally been accepted by the government and it is believed that EMA is looking into this issue, changes in policy have not been announced. In the meantime, EMA has exempted some cogenerators which had been in operation prior to the introduction of NEM.

Cost of imported natural gas for smaller users who have to buy it from the two major gas importers who are currently government-owned or government-linked and incidentally affiliated to some of the major power producers are or may be pegged too high relative to the wholesale price of electricity to make cogeneration by natural gas generally economically feasible.

**Fig.3**




Source: Singapore Power Annual Report 2003

The government effort to limit the growth of solid wastes and the limited land for tree planting and horticulture would put a limit to the availability of combustible wastes for cogeneration plants similar to the 2 wood burning FSDPs already mentioned. Although a few more such plants may materialize in the next few years the question foremost in the mind of any potential user of cogeneration would be whether, in an open waste collection market, and user's access to the woody wastes would be assured for the life of the cogeneration plant.

The growth of the biomedical industry sector cluster (for pharma and biologics production) and the semiconductor industry sector will provide some demand for cogeneration provided EMA regulations on licensing of cogeneration units exceeding 1MW are changed. But this demand would also depend on the eventual growth of these sectors.

## 5. Conclusions

— Due to the surplus power generating capacity the number of or size of major cogeneration plants, not already planned, will be limited until this excess capacity is taken up.

— While smaller manufacturing plants such as those in the wafer fab, food, pharma and biotech clusters would like to achieve better energy efficiency and security by cogeneration for themselves, the price of gas will be a key factor in deciding whether on-site cogeneration will be economically feasible. The two major gas

importers are currently linked to major power producers. These importers may not be particularly keen to supply small cogenerators at prices encouraging on-site cogeneration and reduce power purchase from these government-linked power generators. However, as the government recognizes the need to maintain global competitiveness it may set a cap on the price of gas by these importers.