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Working Committee 6

Utilization of Gases for Domestic, Commercial and Transportation Sectors

Study Group 6.3: Gas as a Transportation Fuel for Today & Tomorrow

Part 5: “From local business to a developed market in Sweden”

Comité de Travail 6

Utilisation des Gaz pour les Secteurs Domestique, Commercial et du Transport

Groupe d’Etude 6.3 : Gaz pour Transport Aujourd’hui et Demain

Partie 5 : «D’un commerce locale au marché développé du GNL en Suède»

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ABSTRACT

This report is part of the work undertaken by Study Group 6.3 during the triennium 2000–2003. The result of the work is based on the knowledge of the members and on the experience of four worldwide selected successful business cases in delivering Compressed Natural Gas for Vehicles. The result is a guideline for gas-companies how to start CNG-business in a profitable way.

The subjects relating to starting CNG-business are:

- Driving forces and Stakeholders
- Station Technology and Exploitation
- Marketing activities
- Calculation model
- Market Characteristics

Surveys are also conducted on this subject and the result is an identification of four profitable business cases in different markets, notably:

- Egypt - part 2
- Colombia - part 3
- Japan - part 4
- Sweden - part 5

This report details on the Sweden case. The four cases will be presented during the same session June 5th, 2003, at the IANGV/WOC 6 NGV-2 session.

RESUME

Ce rapport reflète une partie du travail réalisé par le SG 6.3 durant le triennium 2000-2003. Le résultat de ce travail est basé sur les connaissances des membres du groupe. Quatre pays ont été sélectionnés pour illustrer des exemples de réussites pour la technologie des véhicules au gaz naturel. Le résultat du travail est un guide à l'usage des compagnies gazières qui souhaitent introduire cette technologie de manière profitable.

Les paramètres traités sont les suivants:

- acteurs et actionnaires
- technologie et exploitation
- activités de marketing
- modèle de calcul
- caractéristiques du marché

L'enquête réalisée permet d'identifier un certain nombre de cas de réussite et notamment pour les marchés des pays suivants:

- Egypte
- Colombie
- Japon
- Suède

Le rapport traite en détail de ce dernier pays. Les quatre cas seront présentés le 5 juin 2003 (IANGV/WOC6 NVG, Session2).

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1. NATURAL GAS IN SWEDEN

Natural gas was introduced in Sweden in 1985. A pipeline from the North Sea was constructed and a local grid was built in southwest part of Sweden between the cities of Malmö and Gothenburg. Danish natural gas was sold to the Swedish market. The strongest market driver was environmental concern, and the need to replace oil.

After a few years of successful expansion of the grid and with a 10-20 % share of the local energy market, the political support was weakened and the search for renewable energy was given priority. The lack of political support in combination with long distances and relatively low density of population made the natural gas companies stop the expansion of the main grid. After 1990 only local expansion of the distribution system has been made. The market situation for natural gas in a country or a region will affect the strategy in introducing natural gas as vehicle fuel.

The most important characteristics on the Swedish gas market are:

The gas grid is only covering a minor part of the country.

Introduction of new applications of natural gas must be local instead of national. This creates special problems with legislation and standards. Stockholm is one of few capitals without natural gas.

Natural gas is a newcomer on the Swedish market.

There is no tradition of gas use among the public or in the industry. Safety is a big issue that sometimes overshadows the product quality.

High transportation cost.

Due to the geography and the small market (1 B m³/year 2002) natural gas is not an obvious low-price alternative.

The CO₂-issue.

There is political doubt about expanding the grid since natural gas is a fossil fuel and will in the end be substituted by renewable energy. On the other hand, natural gas is well recognized to submit lesser CO₂ than oil when used.

2. NATURAL GAS ON THE ROAD

The interest for vehicles with improved environmental performance is increasing rapidly. The gas industry has a great opportunity to create a market for vehicles fuelled by compressed natural gas (CNG). Money can be made and the environment can be saved.

Air pollution and the emission of carbon dioxide, which contributes to the greenhouse effect, mean that the automotive industry has been working for many years to develop vehicles with cleaner and more efficient engines and better environmental profiles. Much effort and money have been put into research in the last few years. Today there are several types of vehicle using different technologies that run on a variety of alternative fuels. Alternative fuels in Sweden include electricity, natural gas, biogas and ethanol. The extent of development varies depending on the technology but natural gas is the most promising option. Buses and lorries that use natural gas have been in operation for about a decade and several carmakers, including Volvo, have models that run on gas. Natural gas has a great potential to be a major alternative, fuel but there are some obstacles.

Advantages

- Local environment
- Pipeline delivery
- World reserves
- Existing local market
- OEM's on the market

Obstacles

- Not renewable/CO₂ emissions
- Profitability
- No national grid
- Public knowledge

3. BIOGAS - A SUSTAINABLE MARKET WINNER

To get a mass market we had to get around the problems and one of the solutions was the introduction of biogas (renewable methane) on the market.

Biogas - a renewable resource

Biogas, like natural gas, can replace petrol and diesel for running all kinds of vehicles. The energy-rich component in natural gas and biogas is methane (CH₄). Biogas is formed when organic material- manure, domestic waste, crops, industrial waste and sludge from waste water treatments plants - are broken down by methane-producing bacteria in the absence of air. The composition of biogas varies depending of the type of the raw material. All kinds, except landfill gas, can be used as vehicle fuel after separating carbon dioxide from methane. The upgraded methane fuel contains 97 % methane. In this form it can be used in exactly the same way as natural gas. The two gases can also be mixed. In Sweden a national standard for biogas as vehicle fuel has been established. The yearly consumption of natural gas in Sweden is 1Bm³. In the future the same quantity of biogas can easily be produced from organic waste. The plants for producing biogas are usually located close to wastewater treatment plants, food-factories and farms where there is a good supply of raw materials. The conversion of organic waste to biogas also yields a useful residual product that can be used as a fertilizer.

4. NATURAL GAS AND BIOGAS HAVE MUCH IN COMMON

The use of methane from organic waste was tested in some cities in the nineties but until now it has been looked upon as a competing fuel on the market. The idea of marketing natural gas and biogas together as vehicle fuel has been the key element for taking a step towards a coherent market for methane fuel in Sweden. This means that the CNG - market in Sweden consists of 50 % natural gas and 50 % biogas.

This approach is a way of solving the obstacles on the market:

The CO₂ issue and the demand for renewable fuels

The production and use of biogas in all kinds of vehicles reduces the CO₂ exhausts with 90-95 % compared to diesel or petrol. The reduction when using natural gas is 15-25 %. Biogas is renewable and is sometimes produced from organic material that otherwise would have been wasted. In combination they create a solution for this very important issue.

No national grid

The marketing of an alternative fuel for transportation is a difficult thing to do. If the fuel has a limited geographical market it is almost impossible since the idea of transportation is getting from one place to another without any restrictions. The local production and upgrading biogas is an important supplement to the grid. The expansion of the grid can bring even more biogas to the market.

Public knowledge

The joint venture between natural gas and biogas has made methane known not only as better fuel but also as a local and a renewable fuel. The political support is increasing and since the CNG technology already is available the market development from local projects to mass market has started.

Taxes

Biogas is tax free in Sweden. The tax rate for natural gas in vehicles is 0.10 \$/m³. The tax rate is depending on the CO₂ emissions. The tax difference is necessary to compensate for the expensive process of upgrading the biogas.

5. NATURAL GAS AND BIOGAS FILLING SYSTEMS

Piping natural gas and biogas together

To bring biogas to the customer Sydkraft Gas uses the natural gas grid. The biogas is produced in a production plant in a farming area. The carbon dioxide is separated from the gas and the methane content reaches 97 %. The appropriate heating value is achieved by adding a suitable amount of propane. The gas is then mixed into a 4 - bar distribution system. The filling station is placed in the city, where the customers are. 1M m³ was put into grid in this way in the city of Laholm 2002. This concept will be of great importance for the development of the CNG - market in Sweden.

Biogas with natural gas back - up

A biogas filling station is dependent on a constant production of biogas. To secure the deliverance from a biogas filling station we connect the natural gas grid to the station. If the production goes down the compressor will feed from the natural gas grid. This back - up system is essential to get a market from dedicated vehicles that only can run on natural gas or biogas.

Natural gas and biogas side by side

In the city of Helsingborg there is one public filling station for biogas and one for natural gas. The customers can choose between the two stations.

Biogas on its own

In some cities in the part of Sweden where there is no natural gas grid Sydkraft Gas and other companies have developed market, mostly consisting of city-buses running on biogas. Separate production plants have been connected to the filling stations by new piping. To get more production capacity we are looking for more organic waste.

Natural gas on its own

Along the natural gas grid we can supply our customers with a cheap and environmental friendly vehicle fuel. The potential customers are many, and we are in Sweden opening 5-6 CNG - filling stations every year in the south.

Yearly sale of compressed natural gas and biogas to vehicles in Sweden

Starting 1995 we have reached a volume of 20 M m³ in 2002. Approximately 50 % of the volume is biogas. The number of vehicles will be 3000 by the end of 2003.

6. CHARACTERISTICS AND ECONOMY IN THE EMERGING MARKET

The Sydkraft Gas CNG Market

Sydkraft Gas has been very successful in bringing natural gas and biogas to the market as vehicle fuel. The business development phase has taken 10 years.

This is a summary of our market situation:

- 7 natural gas public filling stations
- 2 biogas public filling stations
- 3 natural gas slow fill stations at bus depots
- 1 biogas slow fill station at bus depot
- The total number of compressors is 15

In 2002 some 9 M m³ of Natural Gas en biogas was used by 600 vehicles.

We will open 3 public stations and one bus depot in 2003. The investment will be 2.5 M\$.

Most of our compressors are Nuovo Pignone, but the newest public filling stations are equipped with Idro Meccanica.

To be successful in getting CNG, including biogas, to the market, you must identify the market drivers and the technical demands and design the filling infrastructure after the various demands. In this task some typical cases can be recognized.

Type 1 Demonstration project - the first step

A fleet operator makes a field test with some of the vehicles running on natural gas. In many cases the project is funded with public means and the system is designed for a future enlarged market. In most cases the economy will be depending on subsidies. The investments will be high compared to the market.

Example: The first 3 buses in Malmö in 1990

System	Slow -fill natural gas
Compressor	1 Nuovo Pignone 850 m3/h
Yearly sales	100.000 m3
Investment	500 000 US \$

Income and cost for one m3 in US \$

Income	0.40
Price of gas	-0.15
Tax	-0.10
Electricity	-0.06
Other running costs	-0.10
Capital cost	<u>-0.65</u>
Loss	-0.66

A successful test project is a key factor for getting into the bus market.

Type 2 Pilot public filling station

Small station as a first step in a new area.

Example: Bo 01 Malmö

System	Public station
Compressor	1 Bauer 12 m3/h (bank system)
Yearly sales	50.000 m3
Investment	200 000 US \$

Income and cost for one m3 in US \$

Income	0.60
Price of gas	-0.15
Tax	-0.10
Electricity	-0.07
Other running costs	-0.09
Capital cost	<u>-0.52</u>
Loss	-0.33

This is an effective way of marketing the advantages of a gaseous fuel.

Public filling station - medium size

After 2-3 year a new public filling station is planned to reach 75 % of its potential market.

Example: Biogas Kristianstad

System	Public station
Compressor	Nuovo Pignone 200 m3/h (bank system)
Yearly sales	300.000 m3
Investment	350.000 US \$

Income and cost for one m3 in US \$

Income	0.50
Price of gas	-0.25
Tax	-0.00
Electricity	-0.03
Other running costs	-0.07
Capital cost	<u>-0.15</u>
Profit/loss	-0.00

When the sales are higher than 300.000 m³ /year this station will be profitable. The more expensive biogas is compensated by zero taxation.

Type 4 Integrated slow-fill and public quick-fill with high capacity

The more you can use the compressor capacity the better will your economy get.

example: Malmo Nobelvägen 66 One the largest filling station in Europe

System	Public station
	Slow-fill for 100 buses
Compressor	3 Nuovo Pignone 3 x850 m ³ /h
Yearly sales	4.1 M m ³
Investment	2.7 M US \$

Income and cost for one m³ in US \$

Income	0.45	
Price of gas	-0.15	
Tax	-0.10	
Electricity	-0.02	
Other running costs	-0.02	
Capital cost	<u>-0.09</u>	
Profit	0.05	200.000 \$/year

This station is the economic base for the CNG market expansion for Sydkraft Gas.

7. CONCLUSIONS

The best way to do it:

- ◆ Analyse the market drivers and the national fuel situation
- ◆ Use local opportunities to get started
- ◆ Design the technical system to optimise compressor capacity - save your money
- ◆ Avoid a scattered geographical market
- ◆ Be sure to be seen

APPENDIX 1

List of abbreviations

NGV =	Natural Gas Vehicle
CNG =	Compressed Natural Gas
OEM =	Original Equipment Manufacturer
M m ³ =	Million cubic metres
Quick-fill =	refuelling in same timeframe as gasoline and diesel.
Slow fill =	over several hours i.e. at night; capacity might vary from small home appliances for private cars to huge compressors serving complete bus-fleets overnight.

APPENDIX 2

Members of IGU SG 6.3

Alain Tridon	Gaz de France
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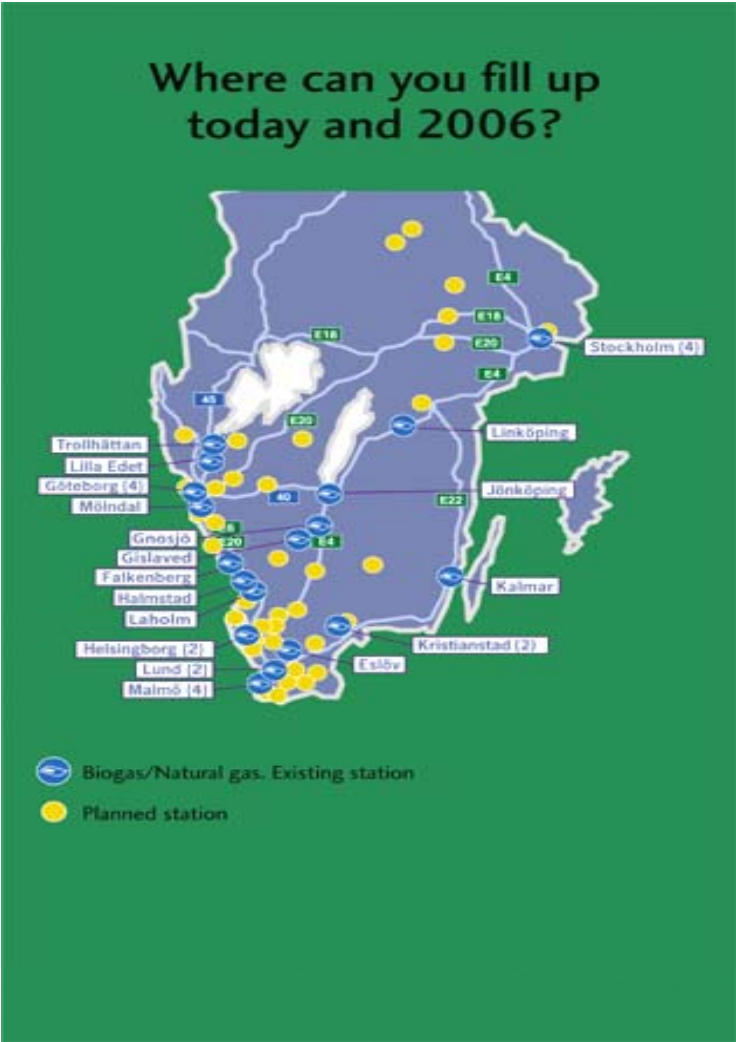
Meetings of SG6.3:

Amsterdam	November 20 th 2000
Malmö	May 4 th 2001
Milan	September 25 th 2001
Copenhagen	November 19 th 2001
Nice	May 30 th 2002
Bratislava	November 5 th 2002
Amsterdam	April 4 th 2003

APPENDIX 3

Illustrations

1. Public filling stations in Sweden 2006



2. Buses on a slow-fill ramp



3. A public filling station

