

PROJECT CLOSING REPORT

Natural Gas Centre of Excellence Project

NARRATIVE

March 20, 2005

Introduction

The Gas Technology Centre of Excellence TTF project was officially approved in May 2000 with the signing of agreements between CIDA and Agência Brasileira de Cooperação (ABC). This project will assist the Centro de Tecnologias do Gás (CTGÁS) to have significant impact over the next few years on the increased use of natural gas in Brazil. There is a federal mandate to increase the proportion of natural gas from 6% to over 12% in the energy matrix over the next few years. This will be accomplished by increasing the availability of natural gas in Brazil. CTGÁS has, and will continue, to play a strategic role by providing support to business and industry in the conversion to, and the expanded use of, natural gas. They will do this through linkages with other centres in other states of Brazil. Currently there are 17 such centres in 16 states of Brazil. Four more centres are expected to join in 2004/5. The training, consultancies and transfer of technology from Canada will be directed from CTGÁS throughout Brazil.

The concept for this centre is about 8 years old. In November 1996, Petrobras and the Government of Rio Grande do Norte finalized an agreement to analyze support of the regional industry Polo Gas-Sal. It was agreed that a centre was needed to provide courses on natural gas in Natal. In March 1998 an interim agreement between Petrobras and CNI/SENAI was signed to support such a centre. By this time ideas for its functions had changed. It was to be more than just a centre for courses on Natural Gas. It was to be a comprehensive Centre of Excellence to serve the natural gas sector in Brazil. In April 1999, Centro de Tecnologias do Gás commenced operations in Natal. In May 1999 there was a final agreement between Petrobras and CNI/SENAI for joint operation of the centre on 40% – 60% basis.

The official Inauguration of the Centre was in March 2002. Attending the event by special invitation were over 300 representatives from all segments of the gas sector, as well as from the local and political communities. Canada's ambassador to Brazil Jean-Pierre Juneau was present and received a medal for Canada's support.

A 10-year agreement between Petrobras and CNI/SENAI to support CTGÁS on an equal basis was signed in April 2002. This agreement provides for support on equal (50 – 50) basis between CNI/SENAI and Petrobras. It also has an optional 10 year extension. This should ensure the stability of CTGÁS for the next 20 years

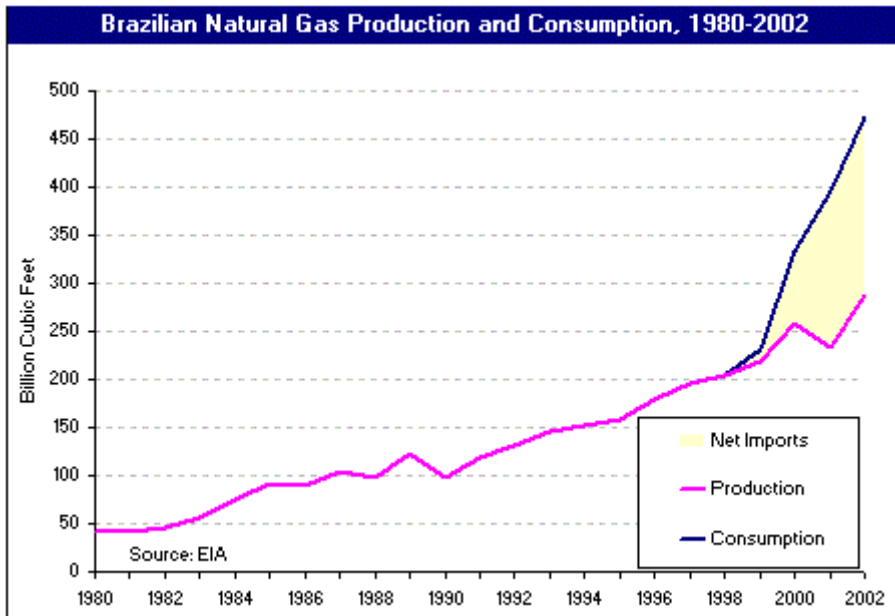
CTGÁS is a unique centre of excellence for SENAI since it is a joint venture with a private partner, Petrobras, Brazil's national oil and gas company. The centre will use Canadian management models to become self-sustaining. In fact it is expected to generate significant revenue within the next few years. This management model should transfer to other existing SENAI centers.

Overview of the Brazil Natural Gas Sector

In the 1990s, the Brazilian government introduced new laws which partly privatized state-owned oil company Petrobras and state-owned utility Eletrobrás. New agencies were established, such as the Agência Nacional do Petróleo (ANP) to regulate the petroleum industry and the National Council for Energy Policy (CNPE) to set energy policy. For the first time, private and foreign companies were allowed to participate in Brazil's energy sector.

Brazil's energy sector is still hampered by problems. Energy privatization has stalled, and Petrobras' presence in the oil and natural gas sectors remains pervasive, possibly slowing the development of competitive markets and the attraction of foreign investment. In addition, Brazil is still recovering from the 2001 energy crisis, which forced the government to implement a power rationing program. The crisis highlighted Brazil's dependence on hydropower and its need to diversify the country's fuel mix. Since then, the da Silva administration has introduced new legislation for electricity and natural gas that would help avert a future energy crisis, but it remains unclear whether the new regulations will guarantee supply. Analysts are also skeptical about Brazil's attempt to become oil self-sufficient, questioning how long the country would be able to maintain this status once reached, particularly with a burgeoning population and a recovering economy. With oil consumption likely to increase significantly in coming years, the question remains whether increased domestic oil output will simply offset domestic demand.

Brazil's natural gas reserves stood at 8.5 trillion cubic feet (Tcf), as of January 2004. The Campos and Santos basins hold the largest Brazilian natural gas fields. Other natural gas basins include Foz do Amazonas, Ceara e Potiguar, Pernambuco e Paraíba, Sergipe/Alagoos, Espírito Santo and Amazonas (onshore). Recent discoveries in Blocks BS-400 and BS-500 in the Santos Basin will likely increase Brazil's natural gas reserves considerably in coming years. In September 2003, Petrobras reported that these discoveries could hold up to 14.8 Tcf of natural gas, up from a previous estimate of 2.46 Tcf. It will likely take several years, however, for these fields to be thoroughly evaluated and commercialized.



Overall, natural gas plays a small role in Brazil's energy mix. In 2002, gas accounted for only 5.7% of Brazil's total primary energy consumption. In contrast, natural gas in Argentina accounted for approximately 45% of the country's total primary energy consumption in 2002. Natural gas consumption in

Brazil, however, has been steadily increasing, and in 1999, the country began importing natural gas from Bolivia. Since then, Brazilian natural gas consumption has grown at a much faster rate than production. In 2002, Brazil consumed 472 Bcf, an increase of 19.4% year-on-year, while producing only 287 Bcf. Nonetheless, Brazil's demand for natural gas is still not high enough to consume the contracted volumes the country imports from Bolivia (more information below).

Petrobras is the largest producer of natural gas in Brazil, as well as the largest supplier to local distributors. Under Brazilian law, each state has the monopoly right to distribute natural gas in its jurisdiction. In recent years, the states have sold stakes in their distribution companies. Petrobras reportedly has minority stakes in 17 natural gas distribution companies in Brazil. The largest distributor is CEG in Rio de Janeiro, controlled by Spain's Gas Natural.

Promotion of Natural Gas

Since the early 1990s, the Brazilian government has been trying to promote the use of natural gas in order to diversify its energy mix, in particular to reduce its dependence on hydropower and on imported oil. The most significant development in reaching that goal was the construction of the nearly 2,000-mile Bolivia-to-Brazil pipeline, known as Gasbol. Construction of Gasbol began in July 1997 and was completed in 1999. Gasbol was the result of a 1996 gas supply agreement (GSA) for the purchase of natural gas between the Bolivian state oil company, Yacimientos Petrolíferos Fiscales Bolivianos (YPFB), and Petrobras. The GSA requires Petrobras to purchase from YPFB, on a take-or-pay basis, specified volumes of natural gas transported through Gasbol over a 20-year term. At the original signing of the contract, the supply volume was tied to Brazil building 16 natural-gas-fired power plants.

In following years, neither the projected demand for natural gas nor the completion of the many power plants have materialized. One of the reasons was an economic recession in 1999, which devalued the Brazilian *real*, making dollar-denominated natural gas imports from Bolivia more expensive. While power producers in Brazil paid for their natural gas in dollars, they were required to sell their power to distributors in *reais*. Currency exchange losses only compounded the fiscal stress placed on power producers, many of which faced difficulty in servicing other dollar-denominated liabilities.

The energy crisis in 2000-2001, brought on by prolonged droughts, provided the Brazilian government an opportunity to diversify its power supply and to lessen its dependence on hydropower. In February 2000, the Cardoso administration launched a \$5 billion program (the Emergency Thermal Power Project -PPT) that called for the construction of 49 new gas-fired power plants, increasing Brazil's installed capacity by 17 gigawatts (GW) by 2003. When the rains returned however, the already-amortized hydropower plants again supplied cheap electricity, putting the construction of new natural gas-fired plants on hold indefinitely, as companies reconsidered their investments in Brazil. A final blow to the PPT program came in late 2002, when newly-elected President da Silva indicated that his administration supported the expansion of hydropower projects, in spite of the recent power crisis.

With natural gas demand low, Brazil was unable to absorb contracted volumes from Bolivia, but was still required to pay for the full volume it had agreed to buy from its neighbor. Brazil consequently sought to revise its take-or-pay contract with Bolivia. During 2003, government delegations from both countries met repeatedly in an attempt to renegotiate the GSA contract. Brazil wanted to import less and pay a lower price for natural gas from Bolivia. Bolivia indicated that it would not change the contract unless Brazil would guarantee that exports would increase in the future. When former Bolivian President Sanchez de Lozada was forced to flee the country in October 2003, President da Silva indefinitely abandoned contract talks to show support for newly-appointed Bolivian President Carlos Mesa.

Turning the Corner

It remains unclear how Brazil's natural gas sector will develop in coming years. However, recent actions undertaken by the da Silva administration and Petrobras appear to have revitalized the importance of natural gas in Brazil's energy mix. **In December 2003, the da Silva administration reversed its policy towards natural gas when the MME announced its intentions to develop a plan to boost natural gas consumption.** Petrobras has also been keen on increasing the use of natural gas in Brazil, particularly since its investments have been severely impacted by the drop in demand for natural gas. In December 2003, for example, Petrobras offered discounts to local distributors in the states of São Paulo, Minas Gerais, Paraná, Santa Catarina, Rio Grande do Sul, and Mato Grosso do Sul, which it supplies, if they sold more natural gas than they were originally contracted for. The company hopes that the program will stimulate demand for natural gas and ultimately reduce the financial exposure from their take-or-pay commitments it has with Bolivia.

Other recent Brazilian gas developments include the revitalization of once-dormant natural gas infrastructure projects. In the case of Petrobras, the company has been proceeding on a number of domestic pipeline expansion projects. The first project, known as the Networks Project, involves the expansion of natural gas distribution networks in southeastern and northeastern regions of Brazil, with completion expected in mid-2005. A second phase of this project involves constructing a 750-mile pipeline (Gasene), interconnecting the southeastern and northeastern regional distribution units. A similar project, dubbed Gas Unificacao or Gasun, will link the southwest of Brazil with the northeast. The 1,412-mile pipeline will begin in the state of Mato Grosso do Sul, which borders both Bolivia and Paraguay. From there, the pipeline will traverse in a northeastern direction the following states: Goiás; Tocantins; and Maranhao (terminus). These pipeline projects fulfill an objective the Brazilian government announced in June 2003 to expand the country's natural gas pipeline network.

Another important infrastructure project, located in Coari (state of Amazonas), began in June 2004. The project involves the construction of a natural gas processing plant to boost gas production in Coari from the current 211 Mmcfd to 353 Mmcfd. From Coari, Petrobras is building two pipelines: a 342-mile line to Manaus, the capital of Amazonas State; and a 261-mile to Porto Velho, the capital of Rondônia State. The pipelines are expected to eliminate the two cities' need for fuel oil to generate electricity.

Despite these positive signs, Brazil's natural gas market still faces some major hurdles, the largest of which is domestic demand. Petrobras is still importing only about half of the volumes prescribed in its take-or-pay contract with Bolivia. Without demand, it will likely be difficult to attract foreign investment to develop newly found natural gas reserves. Petrobras' dominance of Brazil's natural gas sector might also discourage foreign investment, which is needed to help develop the country's natural gas infrastructure.

Brazil has two existing international pipeline connections. The first pipeline was the Bolivia-to-Brazil pipeline (Gasbol), tapping Bolivia's Rio Grande sources. Gasbol covers almost 2,000 miles, with a terminus in Porto Alegre. Brazil's second operational international natural gas pipeline links Argentina to Brazil. The pipeline, operated by Transportadora de Gas del Mercosur, is 270 miles long. The pipeline supplies natural gas to a \$350 million, 600-MW power plant in Uruguaiana. In January 2004, the Brazilian and Argentine governments agreed to proceed with a 384-mile pipeline extension, the Transportadora Sulbrasileira de Gas (TSB), which would connect Uruguaiana to Porto Alegre. The project will likely revitalize a project to build two new natural gas-fired power plants in Porto Alegre.

[Ref – Energy Information Administration, US]

Project Partners

In Canada a flexible network of partners was developed called the Canadian Natural Gas Consortium (CNGC). Every effort was made to ensure the Canadian trainers and consultants were the best available and had specialized expertise in the latest Canadian

technology. All had many years in the Canadian natural gas industry and training institutions. Also shown is a list of Canadian sites hosting Brazilian missions. There were a variety of sites and partners from British Columbia to Québec.

The list of Canadian partners is:

- ◆ Lambton College, Sarnia ON (project leader)
- Advanced Controls & Engineering (ON)
- ◆ BC Gas (now Terasen) (BC)
- ◆ British Columbia Institute of Technology (BC)
- ◆ Canadian Standards Association (ON)
- ◆ Centre de Recherche Industrielle du Québec (QC)
- ◆ Centre des Technologies du Gaz Naturel (QC)
- ◆ Dalmar Consulting (ON)
- ◆ Elenchus Research Associates (ON)
- ◆ Entec Solutions (ON)
- ◆ Environment Canada (ON)
- ◆ Marathon Technical Services (ON)
- ◆ Southern Alberta Institute of Technology(AB)
- ◆ T. Geddes Consultants (ON)
- ◆ TG Engineering (AB)
- ◆ The Syndicon Group
- ◆ TransCanada Calibrations Ltd. (MB)
- ◆ Union Gas (ON)
- ◆ Universal Burners & Controls (ON)

Canadian sites hosting Brazilian missions included:

- ◆ Alberta Research Council (AB)
- ◆ BC Gas (now Terasen Gas) (BC)
- ◆ British Columbia Institute of Technology (BC)
- ◆ Canadian Energy Research Institute (AB)
- ◆ Canadian Gas Association (ON)
- ◆ Canadian Standards Association (ON)
- ◆ CANMET Energy Technology Centre (ON,QC)
- ◆ Centre de Recherche Industrielle du Québec (QC)
- ◆ ECO Fuel Systems (BC)
- ◆ École Polytechnique (QC)
- ◆ Enbridge Inc (Consumers Gas) (AB,ON)
- ◆ Fuel Maker Inc (ON)
- ◆ Fueling Technologies Inc (ON)
- ◆ General Motors Alternate Fuels Group (ON)
- ◆ GFI Control Systems (ON)
- ◆ Lambton College (ON)
- ◆ Marathon Technical Services Inc (ON)
- ◆ Measurement Canada (ON)
- ◆ Ministry of the Environment of Ontario Drive Clean (ON)
- ◆ Oxford Technical Training Centre (ON)

- ◆ Petroleum Technology Alliance Canada (AB)
- ◆ Southern Alberta Institute of Technology (AB)
- ◆ The Syndicon Group (ON)
- ◆ Toronto Transit Commission (ON)
- ◆ TransCanada Calibrations (MA)
- ◆ Union Gas (now Duke Energy) (ON)
- ◆ Universal Burners and Controls (ON)
- ◆ University of Calgary (AB)
- ◆ University of Waterloo (ON)
- ◆ Westport Innovations Inc (BC)
- ◆ Yugo-Tech (ON)

Results – Outcomes and Impacts

The project **met or exceeded** all stated outcomes and outputs with the exception of the very few activities which were cancelled due to the refinement of priorities by CTGÁS. The most **significant** result was the transfer of technology from Canada to CTGÁS to 17 centres in 16 states of Brazil. While no statistics are available it is estimated that the actual results for the project (business services, training activities, staff trained) could be multiplied by 5 – 10 those provided at CTGÁS.

1 – Outcomes

- CTGÁS established with high credibility in energy sector
- centres established in 16 states to deliver training and services in natural gas
- 21 instructors trained in Canadian curriculum design and delivery
- 20 staff and supervisors trained in Canadian organizational and business marketing
- 70 staff trained in Canadian technology
- 8 staff trained in Canadian information and intelligence systems
- 22 staff trained in Canadian equity principles and processes
- 254 staff training units were completed, of which 61 involved women (24%)
- 32 conversions to natural gas (bakeries, ceramics)
- 7 new programs and 21 courses offered
- cumulative enrolment to date of 23,400 full and part time students
- equity training to 22 staff; equity workshop to all senior managers
- 4 labs certified by INMETRO
- website with English version with more than 2M hits to date
- regular newsletter from CTGÁS to almost 2800 business, institutional and individual clients
- gas standards from Canada transferred and modified for Brazil
- almost \$500, 000 in Canadian equipment purchased by CTGÁS

- new technology transferred from Canada in information and intelligence, natural gas vehicles, burner conversion, gas measurement, management models, fire and safety facilities and procedures, compression, and gas distribution networks
- the project accelerated the development of gas courses for industry by SENAI
- Canadian marketing strategies for natural gas transferred
- Canadian business models studied
- culture of marketing established at CTGÁS
- project publication “Path to Excellence” produced and distributed to Brazilian business, industry and institutions on the scope and success of the project and available at the Rio Gas and Oil conference in Rio, October 2004
- new model for project development using Centre for Intercultural Learning

2 – Impacts

- Canadian technology transferred to 16 other states by REGÁS, the network of centres coordinated by CTGÁS
- improves environment with increased use of natural gas
- less deforestation with increased use of natural gas
- increased use of natural gas requires more education which leads to increased employment, reducing poverty and stabilizing families
- better understanding of Canada and Brazil – long term relationships and increased partnerships
- safer use of natural gas means less accidents and improves confidence in the use of gas
- Canadian curriculum models will be transferred throughout Latin America by Brazil
- Canadian model of industry in partnership with education will spread to other sectors in Brazil
- use of gas in ceramics, bakeries, hotels institutions, industry will lower emissions,
- produce more quality with less wastage and strengthen small business
- then presence of CTGÁS in the northeast will help attract more industry to the region and improve employment of men and women
- seeds of equity sown which will empower women to greater participation in education and the energy sector
- more accurate gas measurement will lead to more accurate and fairer billing
- informal network of sustainable Canadian resources in the gas industry
- improved technical knowledge of NGV will increase use of car buses and trucks using natural gas with improved performance
- improved standards and testing based on Canadian regulations will lead to better and safer product design for gas appliances

Equity

At the beginning of the project there were few opportunities for women in the gas sector due to lack of educational opportunities, lack of role models and the perception that these careers were the domain of men. CTGÁS now ensures that there are photos of participation of women in all of its publications and promotional material. Average enrolment of women in programs and courses has increased from almost 0 to about 25% which is continuing to increase. Marketing strategies have been developed to specifically recruit women in to training opportunities.

Several training sessions were held as part of this project to develop a core group of women as trainers of equity issues, policy development and procedures. Senior managers participated in sessions designed to heighten their sensitivity to these issues. Policies impacting human resources, hiring practices and attitude adjustment were drafted. To date these have not yet been approved or put into practice. Awareness was raised at SENAI DN and RN. Further consideration of these issues by them is ongoing.

More emphasis on the safe use of natural gas at a consumer level is encouraging more homemakers to use gas. Training by CTGÁS in safe practices is enhancing the security for domestic application. Increased use of natural gas vehicles at increasing lower costs enables more families to access personal cars.

The conversion to natural gas by bakeries in poor neighbourhoods not only improves the environment but produces a more consistent product at more affordable cost. With more business and industry locating in the northeast, employment opportunities are expanding.

Project Management

The project team from both sides for the most part remained intact for the duration of the project. This contributed significantly to the success of the project.

A major concern was the political relationship between Canada and Brazil. Trade issues created political tensions between the countries. The project schedule was impacted at times because of this.

This project was well supported by Petrobras, SENAI and its parent Confederação Nacional da Indústria (CNI) with the local Federação das Indústrias do Estado do Rio Grande do Norte (FIERN). In general the relationship functioned well, though occasionally politics rears its head. This co-operation helped to ensure the success of the centre. Since was a developing relationship there was some risk at the beginning.

Stability of the management team at CTGÁS was a concern. Over the past few years there has been a new Executive Director, on an average, once per year. There have been

transfers in and out from Petrobras of senior staff. This resulted in the rescheduling of a number of activities and contributed to extensions for the project.

CNGC under the leadership of Lambton College continued to be challenged to deliver the training with current rates established by CIDA. Every effort was made to deliver the training and technology transfer in an effective manner to meet the needs from CTGÁS.

The difficult economic situation in Canada impacted on the willingness of the private sector to participate in the project as fully as planned.

In Natal there was a lack of willingness by the distribution company to develop the distribution networks as quickly as planned in the beginning of the project. This inhibited business and industry in their ability and willingness to increase or introduce gas as an energy source. This was particularly noticeable in the hotel district.

A key innovation was used as a project management tool to great advantage. A service in intercultural training was offered by DFAIT's (now morphed to DFA) Centre for Intercultural Learning (CIL). For the first time they agreed to offer this service to the project outside of Canada. The first workshop (2 ½ days) was helpful midway through the project. Details of the program and the specific outcomes are available. Sessions were conducted in Portuguese and English. Suffice to say that better understanding of each side's cultural and work values were achieved. This, with some operational changes, ensured the success of the project. The same team from CIL conducted a lessons learned workshop with much of the same project team at the end of the project. This 2 day workshop was held in Brazil to ensure a maximum participation by CTGÁS staff. The results will follow in another section.



During the project there were significant changes in the world, in both countries and in the Brazilian gas industry, which had some impact on the project. Examples of these are:

- (a) world
 - travel was more difficult after 911
 - price of natural gas has increased
 - markets more sensitive to world events

- (b) Brazil and Canada
 - new president and prime minister
 - new CIDA priorities
 - more focus on social programs in Brazil
 - changing foreign policy in Brazil
- (c) gas industry
 - increased pressure for energy self-sufficiency due to war in Iraq
 - NGV has flourished in Brazil & struggled in Canada
 - deregulation of gas industry in Brazil
 - less commitment to natural gas in Brazil than previous government
 - new discoveries of gas in Brazil
 - political and economic issues between Brazil and Bolivia on price of gas
 - slower development of pipelines in Brazil
 - change in vision for Petrobras as an energy company, gas is a new focus
- (d) institutional
 - downsizing at ABC
 - turnover and downsizing at SENAI DN
 - changes in senior management at CTGÁS
 - CIDA Brazil program changing
 - some private sector members of CNGC reorganized and taken over
 - organizational changes at BCIT and Lambton

The Canadian network remains committed to continuing the relationship with CTGÁS after CIDA funding ends. This will ensure sustainability. Personal relationships as well as professional relationships will endure. CTGÁS will continue to strengthen and expand the network of centres in other states. Brazilian and Canadian business partnerships have formed and will continue to develop. Brazilians have a better knowledge of what expertise is available in the Canadian gas industry.

Lessons Learned

- ◆ project management was enhanced by having 3rd party intervention in cultural training and evaluation
- ◆ interventions should occur at the beginning of the project, midway and evaluation at the end of the project
- ◆ communications with all project team is critical
- ◆ minimal staffing changes can usually be beneficial to project success
- ◆ Canadians should help Brazilians articulate activity objectives and outcomes
- ◆ language training on both sides would improve communications
- ◆ jointly commit to activity evaluation process
- ◆ intercultural workshops for participants from both sides before each activity occurs
- ◆ Brazilians and Canadians work well together

Other Results/Unexpected Outcomes

- new project management model using third party intervention
- purchase of Canadian equipment by CTGÁS (\$400,000)
- creation of affiliated centres in 16 other states
- professional stimulation of Canadians by technical developments in Brazil
- business links established and contracts under consideration with CRIQ, Dynetek Industries Ltd, Fuelmaker, and the Environmental Technology Centre of Environment Canada

Success Stories and Comments

Students in mechanical classes constructed, as a class project, metal bed frames that were then donated to public hospitals in Natal. Students also worked on ideas to create designs for better access for the disabled. (there is a law requiring this in Brazil but little enforcement is done and few facilities meet requirements). A student from CTGÁS won the Technical Refrigeration category at the World Skills Competition in Switzerland. While no statistics exist, there is anecdotal evidence to substantiate the success of graduates from the Technical Course at CTGÁS in the workplace. The lives of many of these graduates have been changed due to higher paying and, in some cases, first jobs.

CTGÁS has helped three small companies (including a motel and a company which makes a natural medicine from honey) to optimize the natural gas processes to reduce costs by R\$1,500 per month.

One small bakery in a neighbourhood converted to natural gas and found that the quality of the product improved with a resulting improvement of sales. The neighbours were happy since there was no ash from burning wood as the previous fuel. The baker was happy since he had more storage for supplies and could increase his sales. His process was more cost effective.



CTGÁS offers a tuition-free basic education program to those who could otherwise not afford it. This program leads to employment so poor families become self-sufficient.

In 1999 Wertson Resende became a student at CTGÁS after completing the electricity program he received an invitation to represent CTGÁS at the Olympic Games of Knowledge and to train in a different field. He completed the civil construction program in 8 months. “I represented Brazil at the International competitions held in Switzerland. I believe that everyone was proud when I returned with the gold medal.” Wertson is now an instructor at CTGÁS.



“The natural gas technology centre (CTGÁS) is important to the development on the natural gas industry because of its human resource training function. Qualified people are central to our ability to achieve the natural gas industrialization objectives in the state”



Pedro Holanda Filho, President of Potigás