GTEN™

Gas Turbines for Energy Network™

NEWSLETTER
2021

Chairman's Corner

Welcome to the 2021 issue of the Gas Turbine Energy Network newsletter. Since my taking over as chair of GTEN Committee we have faced some very challenging and unprecedented times around the world. Each of us have had to adapt to a new way of day to day life as well as a new way of working and communicating on a daily basis.

The GTEN Committee has had to adapt and shift our approach from in person Symposiums and Short Courses to holding virtual online technical training seminars and meetings. Our vision is to keep engaging the Power, Oil and Gas industries, Government bodies as well as the general public about the important role that Gas Turbine systems play in the Canadian Energy Market and the changes being implemented.

Over the past few years there has been ever increasing pressure and more ambitious goals made to try and reach Canada's net-zero emissions by 2050. This is to comply with the Paris Climate Agreement that was signed in December of 2015. In order to meet these goals our Gas Turbine industry has accepted the challenge and implemented significant advancements in system efficiency, reliability and the utilization and blending of alternate fuels from the Pipeline to Power and Heat Generation markets.

Over the past year and a half the GTEN has held very interesting and informative presentations during our Virtual seminars demonstrating very successful plant examples and beneficial results towards our nation's Goal of net-Zero Emissions.

Gas Turbine systems play a major role in our energy markets, including supporting renewable energy. We at GTEN want to keep the information flowing to all Canadians that our industry as a whole is taking measures to reduce emissions, making the environment a top priority in all decisions made.

To continue our role of providing information about the industry in Canada we have included some interesting and informative articles in this newsletter on recent as well as ongoing projects in Canada. Articles on Compressor Pipeline Trains, Canada's first of its kind Waste to heat Facility, Repowering Coal Plants to the Hydrogen Strategy in Canada.

I invite you to attend our Fall Virtual Symposium will be held Oct 18th and 19th 2021 (Powering Canada's Energy and Economic Future). Watch for the program notifications by email or you may go to our Website GTEN.ca to register.

In closing I would like to say that I am very grateful that we have such a diversified and knowledgeable group of industry leaders on the GTEN Committee that have stepped up in these difficult times to make the Virtual Webinars an informative success.

If you wish to become a member and participate, please reach out to one of our committee members.

See you in person for October 2023 in Banff.

David Flake
GTEN Chair

Virtual Training Webinars

The GTEN network is focused on technical training modules for government, industry and environmental sectors. Due to pandemic shutdowns, our 2020-21 programs have been applied to virtual meetings, including several training sessions as below. They have been focused on a transition to cleaner gas turbine energy systems with cogeneration, hydrogen, LNG exports, more efficient pipelines, increased electrification and linkages to renewables.

These short sessions were aimed at young employees and students for some exposed to basic design details and networking opportunities provided by experienced professionals. These set of sessions set up a more detailed GTEN virtual Symposium planned for **October 18-19, 2021.** **www.gten.ca**

GTEN Technical Webinars (2020-21)

Gas Turbine Basics
GT Air Filtration to Reduce Carbon Footprint

Hydrogen Blending, Combustion & Compression
H_2 Transition and the Role of Gas Turbines

NOx/GHG Emissions for LNG Project
GE LMS100 Gas Turbines
Cogeneration, Combined-Cycle Basics

Gas Turbine Coatings, Repairs of Components
Durability Improvements

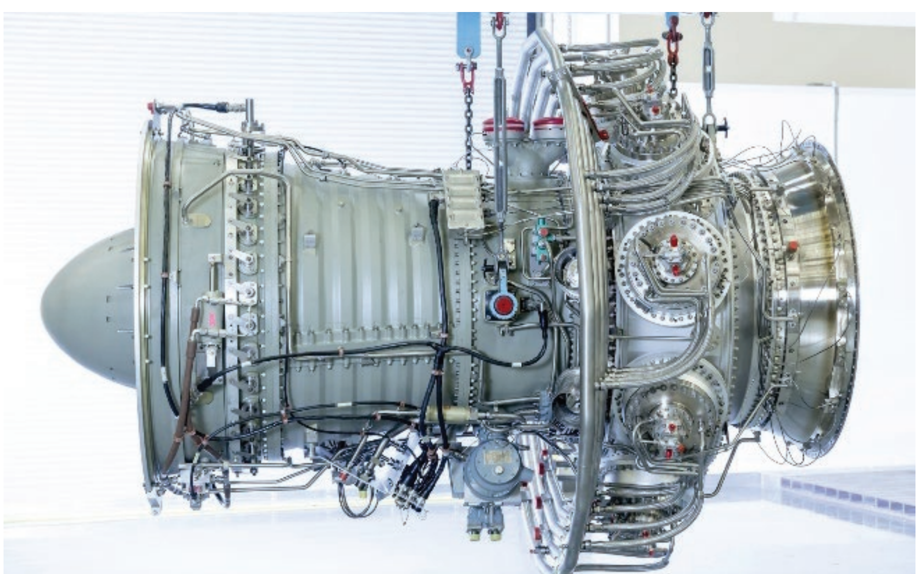
H_2 Mixtures in Centrifugal Compressors
Materials for Hydrogen Service

Electric Generator Basics
Historical Power Perspective

A summary of recent developments in the Canadian gas turbine industry

Siemens Energy to Supply Compressor Trains for Western Canada

Siemens Energy is supplying seven gas turbine-driven compressor trains to support the natural gas transmission pipeline in Western Canada. Each compressor train includes an RFBB36 pipeline compressor driven by Siemens aeroderivative SGT-A35 gas turbine (Industrial RB211) with Dry Low Emissions (DLE) technology, and associated auxiliary systems. This proven solution provides an especially efficient, cost effective, and environmentally friendly option for safely transporting natural gas to markets and consumers.

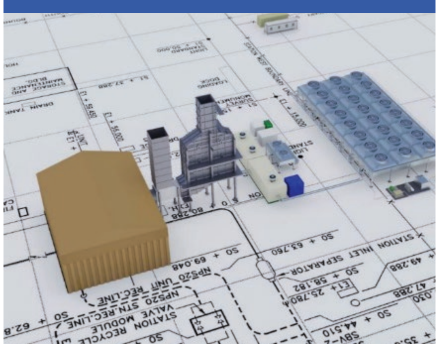


The SGT-A35 DLE Gas Turbine (Siemens Energy)

Siemens Energy to Build First-of-its-kind Waste Heat-to-Power Facility in Canada

Siemens Energy has signed an agreement with TC Energy Corporation to commission a novel waste heat-to-power pilot installation in Alberta. The facility will capture waste heat from a gas-fired turbine operating at a pipeline compression station and convert it into emissions-free power. The electricity produced will be put back into the grid– resulting in estimated greenhouse gas reductions of 44,000 tons per year, equivalent to taking more than 9,000 vehicles off the road.

Waste heat recovery from pipeline compression station using sCO_2 system (Siemens Energy)



At the heart of the facility will be an innovative heat recovery process designed by Siemens Energy. The patented technology, licensed under Echogen® Intellectual Property, is based on an advanced Rankine Cycle and uses supercritical carbon dioxide (sCO_2) as the working fluid to convert waste heat into power without the need for a secondary thermal loop, typically required in traditional waste heat recovery systems. This results in 25% – 40% smaller footprint than steam-based systems, while the waste heat conversion provides a 10% increase in overall energy efficiency for the compressor station.

Siemens Energy Commissions Low-emissions Compressor Trains for Canadian Gas Plant

Siemens Energy recently completed the commissioning of one feed and sales gas train and one refrigeration compression train for the Pipestone Processing Facility in Grand Prairie, Alberta, Canada. The Pipestone Processing Facility is owned by Keyera Partnership, a subsidiary of Keyera Corp. The feed and sales gas train features two high-efficiency DATUM centrifugal compressors and gearbox, driven by a 40 MW SGT-750 industrial gas turbine. The project is the first application of this generation of gas turbine for a gas processing plant in North America.

The dry-low emissions (DLE) combustion system of the SGT-750 turbine offers world-class NOx emission performance and fuel flexibility over a wide load range. The compression train also includes a waste heat recovery unit, which will enhance processing efficiency and further contribute to reducing the plant's carbon footprint.

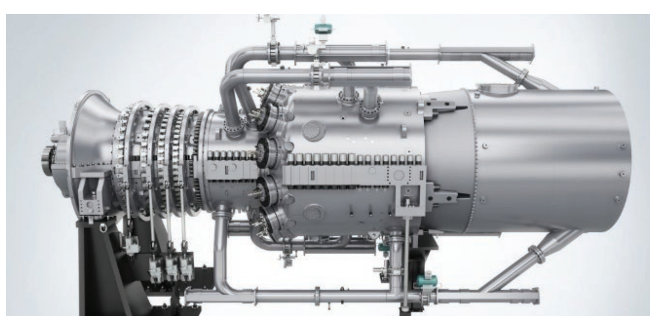
Refrigeration compression train for Pipestone Processing in Grand Prairie, AB (Siemens Energy)

Siemens Energy and Kineticor Advance Canada's Decarbonization Efforts

Siemens Energy has been selected to provide its highly efficient gas turbine technology and long-term services to the planned 900 MW Cascade Power Plant in Alberta, Canada. The project supports the decarbonization of Alberta's power supply by switching from coal to efficient natural gas power systems.

Once operational, the power plant is expected to supply over eight percent of the province's average electricity demand, and reduce Alberta's carbon emissions from energy production by up to five percent.

For this project Siemens Energy will provide two SGT6-8000H gas turbines in single shaft combined cycle configuration, steam turbines and heat recovery steam generators as well as long-term services. The plant is expected to begin operating in 2023.



The SGT6-8000H Gas Turbine (Courtesy of Siemens Energy)

Siemens Achieves First Commercial Operation for SGT-A45 Mobile Unit

In November 2019, the Bayat Power Phase 1 project has entered commercial operation at the Sheberghan site in northern Afghanistan. This gas-fired power plant utilizes Siemens' SGT-A45 mobile gas turbine. It now provides up to 41 MW of clean and reliable electricity for approximately 200,000 homes in the province of Jowzjan. As the first new gas-fired power plant project in Afghanistan since the 1970s, Bayat Power Phase 1 is a critical first step towards energy independence for the country.

SGT-A45 mobile Gas Turbine unit (Siemens Energy)

Repowering TransAlta Sundance-5 Power Plant

TransAlta Utilities is proceeding to repower the Sundance coal-fired unit 5 in Alberta with the goal of full commercial operation by the end of 2023. Next steps include authorizing Siemens to procure major equipment such as two Nooter Erickson heat recovery steam generators, boiler feed pumps, combustion turbine auxiliaries, and selective catalytic reduction equipment. These activities are in addition to the equipment TransAlta acquired in 2019 with its purchase of two Siemens SGT6-5000F4(6) gas turbine generators and ancillary equipment.

Sundance 5 repowering will cost approximately $825 million and will bring it from a mothballed state to a fully functioning combined-cycle generator capable of generating 730 MWe. Re-purposing the existing steam turbine generator and most of the existing plant equipment and infrastructure will limit the capital investment required. The original 45-year old boiler and associated equipment will not be used and will be left in place.

Sundance coal-fired plant in Alberta

Repowering the HR Milner Coal Plant

In 2020 Maxim Power installed a new simple cycle gas turbine, a 204 MWe GE Frame 7F.05, at the HR Milner in power plant in northwestern Alberta near Grand Cache. 'Milner 2' replaces some of the generation of the existing 150 MWe coal unit installed in 1970, which is now dual-fueled. There are plans to convert to the gas turbine to combined cycle by installing a heat recovery unit and steam turbine. When complete, the Milner 2 unit will generate about 300 MWe of efficient natural gas-fired generation, complete with DLE combustion and a low carbon footprint to assist in decarbonization and support for renewable energy.

204 MW simple cycle GE Fr 7F.05 gas turbine, at HR Milner Plant, AB

Atura Purchase of TC Energy Combined Cycle Plants

Last year a new subsidiary of Ontario Power Generation, Atura Power, acquired three large combined-cycle plants previously been owned by TC Energy;

- 900 MWe Napanee Station near Kingston (2 x MHPS 501GAC units, 2018)
- 683 MWe Halton Hills Station (2 x Siemens SGT5000F units, 2010)
- remaining ownership of 550 MWe Portlands Energy Centre, Toronto (2 x GE Fr7FA units, 2008)

Atura had also acquired the remaining interest in the ATCO 560 MWe Brighton Beach Station near Windsor (2 x GE Frame 7FA units, 2004). Since being built over the last two decades, these four plants as well as several smaller industrial cogeneration units, have been essential in supporting Ontario's coal phaseout and the increase in renewable power.

GT Combined Cycle Plants in Ontario Acquired by Atura in 2019/20

Halton Hills | Napanee | Brighton Beach | Portlands

Cogeneration Facilities Near Edmonton

Imperial Oil has a new cogeneration unit for the 190 000 bbl/day Strathcona refinery near Edmonton. The 43 MW GE Frame 6B gas turbine generator will enable Imperial to supply its own electrical power and will produce approximately 80% of the 53 MW electricity requirement of the refinery and up to 280,000 lb/hr or about 50% of the required steam. The unit also reduces province-wide GHG emissions by about 112,000 tpy, would allow the refinery to retire one of its four existing boilers.

Another project in the Edmonton area is the a 96 MWe cogeneration plant by ATCO Power Canada for the Strathcona Cogeneration Plant in Fort Saskatchewan. This will support the operation of Williams Canada Propylene ULC propane dehydrogenation facility and a polypropylene facility. The cogen plant consists of two 48 MWe Siemens SGT-800 gas turbines each with a heat recovery steam generator. The electricity that is generated in excess of the project's requirements would be exported to the Alberta grid.

Strathcona refinery, Edmonton, Alta. (Courtesy Imperial Oil Ltd)

Hydrogen in Canada with Solar Turbines

At the end of 2020 Canada's Minister of Natural Resources announced the launch of the Hydrogen Strategy for Canada. The strategy outlines a plan to create 350,000 jobs and to become net-zero by 2050 (Government of Canada, 2021). The plan would see Canada as a 'world-leading producer, user and exporter of clean hydrogen'. The Alberta Industrial Heartland, with the support of Indigenous groups and all three levels of government, are planning to be Canada's first Hydrogen Node (Bennett Jones, 2020). Canada is planning to be one of the world's leading producers .

Given the activity and attention that hydrogen is being given, upstream, midstream and pipeline companies in Canada are looking at how hydrogen can be used as part of their Environmental, Social and Governance strategy. While the source of the hydrogen is still yet to be determined, feasibility studies are underway to look at a wide range of hydrogen applications, from large pipeline projects flowing pure hydrogen or hydrogen – natural gas mixtures, facilities producing blue hydrogen with carbon capture utilization and storage, to low percentages of hydrogen being used to lower the carbon intensity of the natural gas.

Solar Turbines has many years of experience with high-hydrogen content as a fuel gas in gas turbine generators. Currently Solar has 46 gas turbines running in China on 52-66% hydrogen fuel gas. The first of these units was installed in 2005 and the fleet is approaching two million cumulative operating hours.

Experience shows that hydrogen is not without its challenges. Transporting hydrogen in a pipeline, even when mixed into natural gas, increases the power demand, and may reduce the pipeline capacity. Compressors have to run faster, or need restages to compress hydrogen-natural gas mixtures. Even a relatively small percentage of hydrogen in natural gas can have a large increase in the required horsepower. Alternatively, transport capacity of the pipeline is reduced.

However, hydrogen can be an important contributor to ultimately reach a carbon free future, and turbomachinery equipment manufacturers such as Solar Turbines, in close cooperation with the end users, are working on making the wider use of hydrogen a reality, in Canada and in the rest of the world.

Support for Naval Applications

Liburdi Turbine Services, for over 30 years, has been supporting LM2500 fleet owners with its value added proprietary & advanced repairs in extending life of capital parts such as blades and vanes. In 2016, a US Navy program was initiated to evaluate the reparability of previously rejected hot section parts declared unrepairable by conventional vendors using conventional processes. Lack of repair technology deployment by the conventional vendor had resulted in a high scrap rate of HP turbine parts resulting in higher replacement costs, poorer durability and more frequent outages.

The Liburdi effort looked at more advanced repair methodologies with proven track records of success to increase repair yields and thereby mitigate the high costs of retiring valuable assets in turbine blades and vanes. The project review established new turbine hot section inspection limits to repair HPT components. Using this advanced repair methodology enabled Liburdi to repair previously condemned HPT turbine components. These parts have been returned to service with the full expectation they would achieve additional service time beyond the conventional life limit. Interim inspections have found no discrepancies in the performance or durability compared to new parts.

Statistically, Liburdi was able to repair more than 65% of the components that had previously been declared scrap by the conventional repair vendor. The operator has concluded that HPT components repaired by Liburdi are fully restored at a fraction of the cost of new replacement parts, and at significantly higher yields, to maintain and improve component integrity while creating significant savings for the LM2500 operators.

LM2500 Vane as received and cleaned | After LPM Layer | Finished repair with new shower head cooling, ready for assembly

Courtesy Liburdi and US Navy

MDS and Rolls-Royce Complete the World's Largest Aero Engine Testbed

Rolls-Royce has officially opened the world's largest and smartest indoor gas turbine aero engine testbed. This research and development test facility has been designed and built by MDS Aero based in Canada. Testbed 80 offers up cutting-edge technology to match the development of the next generation UltraFan engine program, and current generation engines like the Trent XWB and Trent 1000.

Test Bed 80 (MDS)

Some of the headline features of the test facility are:

- MDS's next generation nxDAS data acquisition system which has been designed to the new iDDS communication standard;
- Precision thrust measurement system rated to 150,000 lb_f;
- X-ray capability - to enable this novel imaging technique, the entire building is encased in thick radiation shielding concrete;
- Automated rapid handling and hydraulic docking;
- Enabled for performing a variety of special engine tests such as fan blade off, bird strike, core water injection and others.

In the future, Rolls-Royce indicates that it will run an UltraFan demonstrator with 100% sustainable aviation fuel as early as next year. The facility is also poised to test hybrid or all-electric flight systems.

The design of aero engine test beds requires a multitude of disciplines. The biggest challenge is managing aerodynamic and acoustic performance to ensure optimal conditions for the engine. Indoor test beds for aero gas turbines strive to mimic the aerodynamic conditions of a free field environment, minimize infrasound, and to accurately measure thrust and acquire other important engine performance parameters.

Free field aerodynamic conditions require the minimization of pressure and temperature distortion at the engine inlet, using both upstream aerodynamic flow conditioning, as well as a carefully designed ejector and exhaust system. Typically, the larger the engine, the larger the test cell cross section. Careful consideration must be given to the design of these aerodynamic elements of the test cell, as there is an artful balance between aerodynamic performance criteria, and the management of noise levels emitted from the facility.

To this end, special expertise is required in the field of aero-acoustics to reduce infrasound which is an important hazard that needs to be mitigated by design.

Inside Test Bed 80 (Rolls Royce)

Aircraft drivetrains are undergoing an important evolutionary phase to meet the ambitious Paris climate agreement goals. These technological leaps bring alongside it the need for R&D test facility design to tackle new challenges beyond the ones presented above. It could be an opportunity to upgrade and add to Canada's extensive collection of active aero bed test facilities in Thompson MB, Montreal, Ottawa and other locations.

Status of Activities for ISO TC/192 Standards on Gas Turbines

In Canada, the Gas Turbine Mirror Committee for the International Standards Organization (ISO) has been active in monitoring the activity of the ISO/TC 192 at the international level. Three of our members are also part of standard development there. A working group has also been initiated on education and fields of study to ensure that we have an understanding of how we can collectively promote national gas turbine knowledge, as well as contributions to clean energy systems.

The revision of ISO 21789 on Safety is currently in its Draft International Standard stage (40.99). In this stage, the text is approved if a two-thirds majority of the Participating members of the committee is in favor and not more than one-quarter of the total number of votes cast are negative. This draft stage is expected to be completed and published as revision 2 by end of 2021.

	Description
ISO 21789:2009	Gas Turbine Safety
ISO 3977	Gas Turbine Procurement
ISO 19859:2016	Requirements for power generation
ISO 21905:2020	Gas Turbine exhaust systems with or without waste heat recovery

A complete list is available at : **https://www.iso.org/committee/54432/x/catalogue/p/1/u/0/w/0/d/0**

The revision has clarified quite a few points on risk assessment, explosive atmosphere protection and fire protection. In addition to the standards changes proposed in this revision, an effort is made to align this activity with the EU Gas Turbine group to harmonize the standard to the Machinery Directive 2006/42/EC.

ISO 3977 is a series of Procurement standards in eight parts. The standard parts have exceeded the scheduled revision interval for a significant time and are overdue for revision. Two of these parts have been withdrawn as their content was deemed not sufficiently relevant; Part 5 on the application for petroleum and natural gas industries. and Part 7 on technical information.

The remainder of the ISO 3977 standard is being revised.

- Part 2 on standard reference conditions and ratings is being balloted for Draft International Standard as very minor changes were required (the addition of hydrogen usage being one).
- Part 9 on Reliability, Availability, Maintainability and Safety has entered the initial Working Draft Stage and is scheduled to be revised in about 3 years.
- Future activities will include the revision of many other standards, including ISO11042:1996 on emissions and ISO 11086:1996 on definitions.

Gas Turbine Applications in Canada - A Historical Review

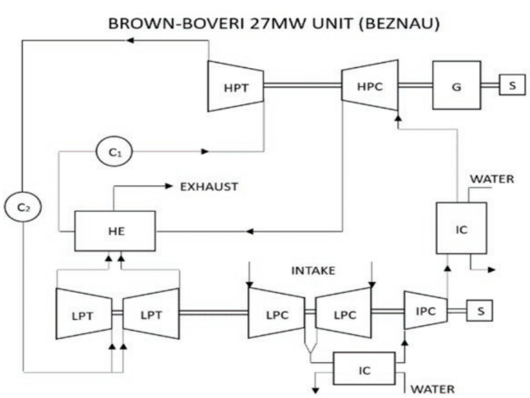
Part 1 - Early Developments in Canada *(by Herb Saravanamuttoo)*

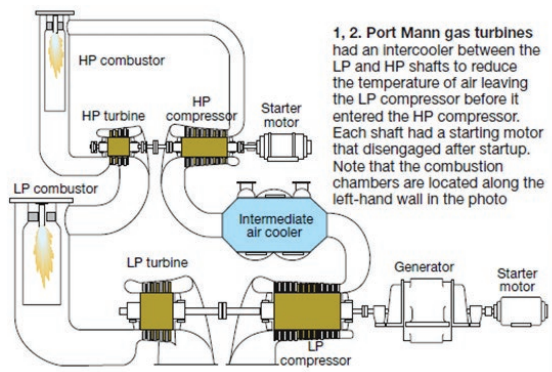
I arrived in Canada in 1955 with a job offer from Orenda, who were a well established presence in the jet engine field. Toronto had just completed the shift from coal burning to oil burning furnaces and natural gas was just starting to appear. Ontario Hydro had recently introduced the first thermal (coal burning) power plant, the Richard L Hearn, in the Toronto harbour area and it was producing 400 MW with eventual growth to 1,200 MW. Toronto was in the final stages of converting from 25 to 60 Hz and it was interesting to move from the flickering 25 Hz lighting to 60 Hz, sometimes just by crossing the road.

Orenda already had about 4,000 engines in service, powering both the CF100 and the F86 Sabre, and the Orenda was fully competitive with the British Avon and the US GE J47. All engineering at Orenda was focussed on development of the Iroquois for the Avro Arrow, with the exception of in-service support of existing engines. The Iroquois was a very advanced engine, pioneering the use of titanium and was significantly lighter than competitors such as the Olympus or J75. The jet engine and industrial gas turbines had virtually nothing in common and there was no industrial gas turbine development in Canada.

It was fully understood that to get a high efficiency gas turbine it required both a high pressure ratio and a high turbine inlet temperature, but these were limited to 4-5 and 1100ºK for military jet engines and 900ºK for industrial engines based on current developments in aerodynamics, metallurgy and manufacturing. This required complex cycles to achieve high efficiency.

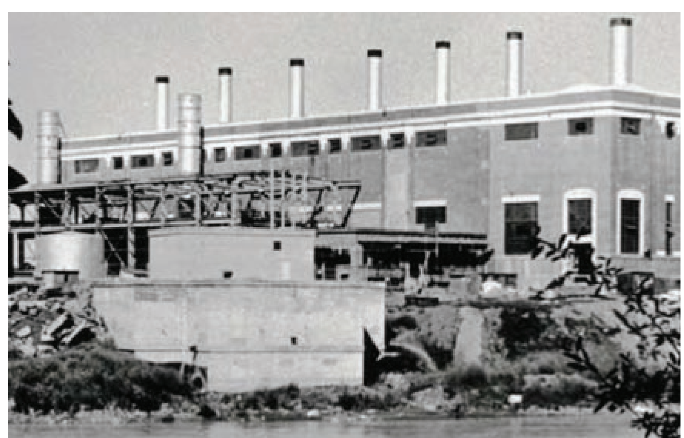
Brown Boveri was one of the pioneers in this field and developed the world's largest gas turbine with a mighty output of 27 MW and a maximum cycle temperature of 900ºK. This achieved a thermal efficiency of 30% but required 3 compressors, 2 turbines, 2 intercoolers, 2 combustors and two shaft lines each with their own starter. It is interesting to consider the difficulty of starting a complex unit like this in the days before computers and electronics!





(Brown Boveri) (from Sep van der Linden, Combined Cycle Journal, 2012)

It is obvious that the basic simplicity of the gas turbine is lost. Four of these were installed at the Port Mann station of BC Hydro in 1957, at that time the largest GT station in the world. Another was installed at Edmonton Power, where they discovered a mysterious brown cloud in cold weather operations; so the first problems with NOx came at 900ºK TIT! These were both peaking plants and were not repeated.



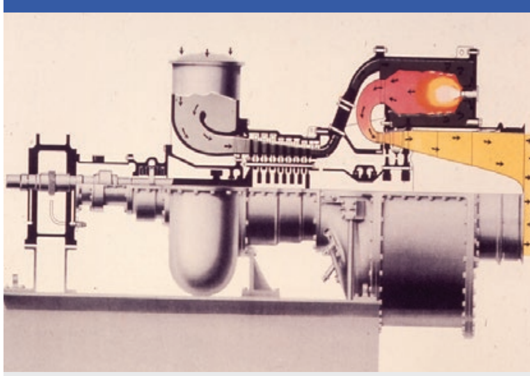
Two 30 MW BBC GT units in foreground, Rossdale Edmonton, 1957

In 1955 the proposed natural gas pipeline across Canada was being proposed and there was heated discussion between the Liberal government under St.Laurent and the Conservative opposition led by Diefenbaker and resulted in the fall of the government. The early gas turbines on TCPL were mostly Clark (later Dresser-Clark) and Westinghouse of around 5,000 HP. The Westinghouse units (WR62 and WR92RM) were often two shaft regenerative units, with heat exchangers needed to give a reasonable thermal efficiency.

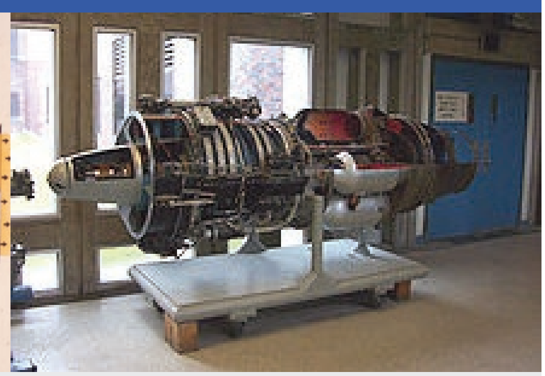
In mid-1958 Orenda decided to enter the market, using the existing jet engine as a starting point. One idea was to refurbish aero engines and replace the final nozzle with a separate power turbine and another was to keep the aerodynamics of the jet engine in a heavy frame, resulting in the OT-3 and OT-2. A market survey showed 3:1 in favour of the heavy frame, but in the long run the aero derivative outsold the heavy frame by 3:1. The OT-2 was actually quite a good engine but was blown out of the water by the RR Avon and the eventual domination of the Canadian pipeline market by the aeroderivatives.

Orenda also built the OT-5, a 1.5 MWe generator drive based on a scaled down Orenda jet engine compressor. This was used in the early 60s for the first major cogeneration system in Canada , providing all power and heat on the Pinetree Line. This system was part of the radar early warning system during the Cold War and ran approximately along the 50th parallel. The OT-5s produced all the power for the radar scanner and station utilities , with exhaust heating used for station heating and absorption refrigeration. Because of the remote locations natural gas was supplied on an interruptible basis, and the OT-5s were capable of switching to standby oil fuel automatically on full load. I believe this was the first time this was done. They were installed on 19 stations and operated successfully until the Pinetree Line closed in 1991, with 14 of the stations operating up to 1988. It is unfortunate that nothing appears to have been published on this major achievement.

Canada's First GT Cogen Plants, Northern Pinetree Line



1.5 MW Orenda OT5 (1962)



Orenda aero display at Carleton University

Old HRSG Boilers at Pinetree station

Portable Orenda OT2100 compressor unit,
TCPL Kapuskasing ON, 1975

Part 2 - Later Developments *By Manfred Klein*

After taking Herb's 4th year Gas Turbine course at Carleton U. in 1980, I learned about the importance of high pressure airflow that powers gas turbines and their energy systems. Soon after joining the National Energy Board, early exposure to the Canadian gas pipeline industry found me visiting compressor stations and later with Environment Canada, many other application sites as below.

The Rolls Royce Avon was first used on gas pipelines in 1964 at TransCanada's Stn 13 in Saskatchewan, and with GE LM1500 units with Westcoast Energy in BC. This began the more widespread application of high-flow centrifugal gas compression with aeroderivative GT units across these systems. This was followed by the GE LM2500 units with Westcoast and NOVA Alberta in 1972-74. More efficient twin-spool units began with TCPL - the first 20 MW RB211 unit at Burstall in 1976, and 12 MW Spey unit near Winnipeg in 1981. The trend continued with Union Gas facilities in Ontario using mostly Rolls Royce (now Siemens) units, with the Dawn storage facility later becoming the largest compressor station in Canada. Several new GHG emission solutions were developed during this period, including recip engine retirements, dry gas seals, gas transfer compressors and methane leakage monitoring. In 1990 a series of fifteen innovative pipeline waste heat combined cycle plants were built, some using OTSGs and steam turbines, and more recently with Organic Rankine cycle expanders.

At the same time over this period, about fifty aero-derived Orenda, RR Avon, Olympus and Pratt & Whitney FT4 units were installed as electric utility peaking plants and nuclear standby units, most in response to the 1965 major power outages in the Northeast. In 1971 the Canadian navy launched the world's first all-gas turbine frigates (four Tribal class ships) with Pratt&Whitney FT4 and FT12 units. The combination of these systems led Canada to be a leader in the application of aeroderivative GT units with over 400 units in simple cycle applications, which also resulted in the new Industrial Applications of Gas Turbines (IAGT, now GTEN) committee events, initiated in 1974 by Herb Saravanamuttoo, Carleton University and the National Research Council.

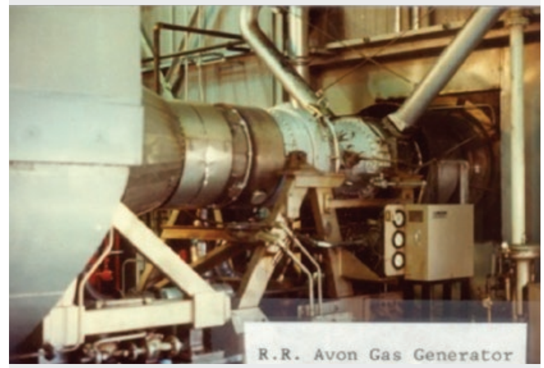
As modern pipeline operations needed flexible lightweight power in the 20-30 MW range, the smaller compressor market became dominated by Solar Turbines with 1 MW Saturn and 3-6 MW Centaur/Taurus units, and their larger 10 MW Mars and 15 MW Titan series applications across Canada. These units had the first Canadian dry low-NOx combustion systems in 1993, and subsequently DLN/DLE soon became the standard for most new pipeline additions and many retrofits of Rolls Royce and GE aeroderivative units, and notably;

- First major replacement of recip compressors, at Crowsnest BC with an 8 MW Solar Mars unit (1981)
- The first DLE LM1600 unit on the TCPL/ANG pipeline in southeast BC (2003)

Utility coal plants began seeing competition from the natural gas industry, with the first large industrial cogeneration repowering of the DOW Sarnia Chemical complex in 1971 with the first GE Frame 7B units, and a Westinghouse CW251 combined cycle repowering of gas boilers at Medicine Hat in 1980.

Gas Pipeline
Compression Innovations

First Rolls Royce aeroderivative
GT units in pipeline service, 1964
at TransCanada in Saskatchewan



Two 10 MW Avons at Stn 17, Regina Sask.

Waste heat combined cycle with RB211 and LM2500
at Nipigon ON, 1991

Methane Blowdown minimization
3 MW ASE40 with Norwalk TC40 Gas transfer
compressor

Early Repowering Projects

2 x GE Fr7B, Cogen/CC
DOW Sarnia, ON, 1971

2 x CW251, Medicine Hat AB
1980

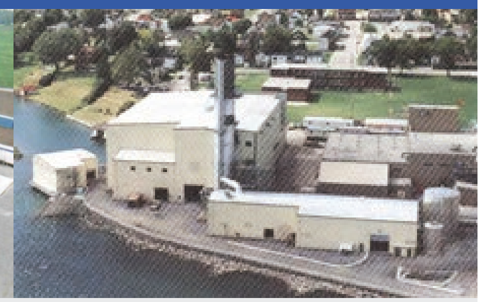
1st Major Greenfield GTCC

W501F, ENMAX Calgary
2003

Innovative Ontario Cogeneration Projects

First GE LM6000, 1991
TransAlta OHSC, Ottawa

First Rolls Royce Trent, 1997
Whitby Cogen



1st Large DLE Combustion
W501D at Cardinal, 1994

Cogeneration and district energy has become an important clean energy solution, using both gas and steam turbines, and recip engines. Another series of gas turbine 'firsts' can be seen in the growth of seventy industrial and municipal GT cogen facilities in Canada;

- World's first unique GE LM6000 gas turbine installed by TransAlta in Ottawa in late 1991, followed closely by the second in Toronto a few months later
- First 4 MW EGT Typhoon (now Siemens SGT100) at the National Research Council in Ottawa, 1993
- First DLE LM6000 at the Windsor Chrysler cogen, 1996
- The first large Canadian DLN application on the Cardinal Power W501D cogen unit, 1994
- First Rolls Royce Trent engine at the Whitby cogen plant (with DLE combustion, 1997)
- First 70 MWe GE Frame 6FA unit at the Kingston cogen plant for Celanese, 1997

The clean energy market has also grown with the steady phaseout of coal plant operations, that generation being replaced by about 15 repowering combined cycle plants, as well as a mixture of the above cogeneration and simple cycle facilities across Canada. The first large new greenfield utility combined cycle was the 250 MWe Calpine Calgary Energy center in 2003, based on a Siemens Westinghouse W501F unit. This was followed by a string of other GTCC facilities across Canada totalling about 11000 MWe.

The combination of small and large GT cogeneration, simple and combined cycles have contributed to Canada's cleaner and reliable energy production, in part by supporting a large increase in intermittent renewable wind and solar operations. Future innovations around advanced cycles, hydrogen integration, district energy, electrification and carbon capture should continue these trends, as new flexible gas turbine systems are developed to meet climate change and other environmental objectives.

GTEN™

Gas Turbines for Energy Network™

Our Function

Educational Training for the Energy Market

Providing Resource Awareness

Create Community, Government & Network Forums

Our Focus

Gas Turbine Systems in:

Pipeline Compression

Power Generation

Energy for Buildings

Industrial Solutions

Environmental Solutions

GTEN.ca

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