When Benjamin Franklin flew a kite in a storm with a key attached to its string, he discovered a force that became one of the greatest forms of power—electricity. Since that time, Westinghouse has cast that key in many molds to unlock new sources of energy and more efficient, effective ways of producing power.

Our combustion turbines have generated electricity for utility and industrial applications for more than 30 years, often as part of cogeneration systems. And they are once again opening the door to cogeneration and its benefits. Beyond this door lie energy and cost savings—backed by the Westinghouse tradition of excellence in power generation systems and equipment.

Let us help you unlock your profits with Westinghouse combustion turbines: the key to cogeneration.
COGENERATION

Electricity Comes of Age
Page 4

Perfect Timing
Page 6

Westinghouse Sets the Pace
Page 10

Complete Service Program Saves Time
Page 16

Fuel For Thought
Page 18

No Time Like the Present
Page 21

©Copyright 1983
by Westinghouse Electric Corporation
All Rights Reserved
Electricity has been a part of our lives for a long time. But as important as Franklin’s discovery was, it took another 100 years to put this new energy source to work. The breakthrough came when George Westinghouse developed the means for the practical distribution and use of electricity near the turn of the century. Since then, Westinghouse has continued to develop and improve the means for generating electricity and making its benefits readily available.

Westinghouse equipment was there at the dawn of industrial electrification. In those days, before the era of low cost utility-supplied power, the co-production of electricity and heat—now known as cogeneration—was a way of life. In the production and processing of chemicals, wood products, textiles, petroleum, metals and food products, cogeneration was the only practical way to meet the need for power
and process heat. The turbine generator became an integral part of most industrial energy systems, and Westinghouse was there, establishing a tradition of reliability and quality in power generation equipment.

A Tradition Evolves

The Westinghouse tradition of excellence in industrial power equipment includes more than three decades of experience with combustion turbine-based systems. Our first design combined the best features of our long-proven steam turbines with those of the early jet engines—another development in which Westinghouse played a key role. The result was an 1800 hp unit, which went into service in 1949 for the Mississippi River Fuel Corporation. It was the first combustion turbine used commercially in the United States, the first used for pipeline compressor drive, and the first in the world to operate for over 100,000 hours.

Since then, Westinghouse has continued to lead the way in the development and application of combustion turbine-based power systems for industry. Our first unit with heat recovery for process steam was installed nearly 30 years ago. We set the pace in the development of cogeneration and combined cycle power plants for industrial and utility installations, with well over 4,000,000 kilowatts of capacity in place. Today, Westinghouse offers the most efficient heavy duty combustion turbines available, as well as the largest single unit for 60 Hz power generation, the 100 MW W501D.

About 1200 Westinghouse-designed combustion turbines—installed for utility and industrial service worldwide—support our reputation for reliability and customer satisfaction.
PERFECT TIMING

Throughout the years, Westinghouse has built its reputation by finding better ways to meet the energy needs of its customers. Today, we are continuing this tradition through combustion turbine cogeneration.

Cogeneration is not a new idea. It has many names—in-plant generation, by-product power, total energy, dual energy utilization—and has met industrial needs for years. The pendulum is swinging back because cogeneration makes sense today for most energy intensive industries. The reason is simple—cogeneration means lower overall energy costs because it produces electricity and process steam from the same fuel source. The savings translate directly into lower production costs, providing an important competitive edge.

Producing power on site makes an industry more energy self-sufficient. And, if more power is produced than is needed, the excess can be sold to a local utility for added revenue—further improving profitability.

Cogeneration is also an opportunity for a utility to participate in energy planning with its industrial customers. Joint ownership of a cogeneration facility can open the door to substantial savings for both parties. And cogeneration is a way for a utility to delay construction of costly new generating capacity. Westinghouse can make these possibilities happen—from the project planning stage through installation, startup, and development of a continuing service program over the life of the cogeneration plant.
If the Key Fits

Is cogeneration for you? Does it fit your plant requirements? Does it make economic sense?

There are no easy answers. An optimum system is both plant and site specific, and the key economic factors that influence your decision—fuel and power costs—will depend largely on plant location.

The decision to add a cogeneration system will mean a major capital investment. And although similar project opportunities may exist, the Westinghouse option is one that you just can’t afford to ignore—considering the high returns it can bring.

Interested? Let Westinghouse help you develop your cogeneration profile. If it looks good, we’ll work with you to plan your system, starting with the key—a Westinghouse combustion turbine.
Combustion Turbine Cogeneration—
What Makes It Tick

The key to cogeneration is the energy that's saved by producing electricity and useful thermal energy at the same time. When power and process heat are produced separately, only about half the fuel used goes to useful output. The rest is lost, mostly as heat rejected through cooling systems and exhaust stacks.

Cogeneration greatly reduces these losses. By combining power and steam generation, it makes use of the rejected heat from one process to “power” the other. So overall energy efficiency and costs are substantially improved.

These benefits are readily available with a Westinghouse combustion turbine cogeneration system. In a typical application, fuel is burned to produce power, and the heat in the turbine exhaust is recovered by a boiler, producing steam for process heat. The result is a combined output of about 200 kilowatts per 1000 lb/hr of steam—at a combined efficiency of over 75 percent. This means a fuel savings of greater than 30 percent compared to separate generation!

An equally beneficial approach is to use a Westinghouse combustion turbine in a combined cycle configuration. The steam is produced at high pressure and expanded through a steam turbine generator before going to process, with a typical result of 250 kilowatts per 1000 lb/hr of steam.

The key feature in any combustion turbine cogeneration system is its high power-to-steam ratio—more kilowatts per pound of steam means less power to purchase, or more power to sell.

Cogeneration produces power and steam from the same fuel source by recovering the turbine exhaust heat in a boiler, which produces steam for process.
In separate generation, only about half the fuel input goes to useful output.

53%  
Power and Process Heat

47%  
Stack and Condenser Losses

Combustion turbine cogeneration offers a combined efficiency of over 75%, which means a fuel savings of more than 30%.

76%  
Power and Process Heat

24%  
Stack Losses
At the heart of a Westinghouse cogeneration system is the best there is in heavy duty combustion turbines. Our state-of-the-art W251B and W501D systems are nominally rated at 40,000 and 100,000 kilowatts. These machines are what our customers have grown to expect from a leader in the industry—units with the efficiency and reliability required for industrial applications, supplying the power and steam that's needed when it's needed.

The key to supplying the best equipment is the Westinghouse commitment to quality at every step along the way—from devel-
opment engineering and system design, through delivery, installation, and continuing service programs.

Today’s W251B and W501D units are the results of more than 30 years of Westinghouse combustion turbine experience. When introduced in the late 1960s, both frames incorporated the major design features of their field-proven predecessors. New technology, especially in component materials and cooling techniques, was carefully evolved and integrated, moving the units forward in power generating capacity and efficiency without losing sight of the Westinghouse design-for-reliability philosophy.

As technology developed in the critical turbine section, steady improvements were made in the design and performance of the compressor and combustion sections. Advanced analytical and test techniques were introduced to keep pace with the ever-increasing intricacies of design. The result—totally integrated and optimized state-of-the-art systems, with high efficiency, delivering simple cycle heat rates below 11,000 Btu/kWh, and emission levels low enough to meet environmental requirements.
Flexible Systems Fit Today and Tomorrow

Westinghouse knows that cogeneration applications in particular demand maximum flexibility. System requirements vary from site to site, and from one industrial process to another. And we have always designed and built our combustion turbines to adapt to these needs and provide continuous, reliable service.

Over the years, our systems have been successfully integrated into a broad spectrum of industrial facilities—chemical and petrochemical plants, petroleum refineries, pulp and paper mills, and metal ore processing plants. Our success is based on two important facts:

- Combustion turbine systems are inherently flexible, so they can be arranged to fit nearly any cogeneration configuration.

- We work closely with process plant designers and operators to ensure that the system we install matches specific plant requirements.

To Westinghouse, flexible combustion turbine cogeneration includes all aspects of an installation.

Inlet systems can be fitted with silencing and filtration equipment to meet specific site requirements, and we offer supercharging and inlet air cooling to boost power and efficiency.

Flexible cogeneration also means an adaptable waste heat recovery system. Low pressure process steam may be produced in simple, unfired heat recovery steam generators (HRSG). Or, more complex systems can be used to produce multiple pressure levels. By adding the ability to fire the HRSG, steam production can be varied over a wide range, allowing the system to follow fluctuating process steam requirements while power production is held at full load.

Twin W251 power generating systems in heat recovery application.
W251B
Power: 41,420 kW
Heat Rate (LHV): 10,825 Btu/kWh
Exhaust Flow: 1,263,300 lb/hr
Exhaust Temp: 940°F

Expected Steam Flow 1000 lb/hr

Dry & Saturated Steam

Expected Steam Flow 1000 lb/hr

Superheated Steam

W501D
Power: 104,400 kW
Heat Rate (LHV): 10,290 Btu/kWh
Exhaust Flow: 2,909,530 lb/hr
Exhaust Temp: 970°F

Expected Steam Flow 1000 lb/hr

Dry & Saturated Steam

Expected Steam Flow 1000 lb/hr

Superheated Steam

Westinghouse combustion turbine cogeneration system steam generating capacity.
Unfired HRSG, Sea Level-59°F Ambient, Natural Gas Fuel.
Flexibility also means operating on a variety of fuels—natural gas and liquid fuels, from light distillates to residual oil. Most units are installed with multi-fuel capability to respond to changes in costs, availability, and environmental restrictions.

We are working in the laboratory and in the field to develop designs that can readily adapt to tomorrow’s fuels—including gases and liquids produced from coal, shale, and biomass. And we are developing combustion turbine cogeneration systems that directly use plentiful, low-cost solid fuels such as coal.

For the flexibility required in cogeneration today, and for the changes that tomorrow brings, combustion turbine systems are the logical choice—and experience makes Westinghouse the logical choice for combustion turbines.

A W501 combined cycle cogeneration application meets today’s industrial needs with flexibility to fit tomorrow.
Availability to Go the Distance

The best equipment for cogeneration means high availability as well as flexibility. An unscheduled outage means a costly loss in production, so Westinghouse designs and builds its combustion turbines with an emphasis on reliability. To maintain it, we offer total service—from installation and startup, through user-integrated service programs over the life of the equipment.

Wistinghouse keeps the availability of its combustion turbines high by designing-in easy maintenance. This shortens scheduled outage time and keeps production time high. Key features that mean high maintainability for the W251B and W501D include:

- Horizontally split casing for easy access to internal parts
- Individually removable compressor and turbine blading
- Removable combustors, transitions, and first-stage vanes with cover in place
- Highly accessible journal and thrust bearings
- Borescope inspections for the compressor and turbine
- Compressor-end generator drive

The combination of tailored service programs and built-in reliability and maintainability has made our combustion turbines extremely successful—achieving availability levels well above 90 percent. This kind of performance makes a good technology even better.
COMPLETE SERVICE PROGRAM SAVES TIME

Westinghouse cogeneration plants are designed and manufactured with built-in quality and reliability. But getting the most from a cogeneration investment requires a complete service program designed to maintain the plant’s efficiency and reliability for years. That’s why Westinghouse has a worldwide service organization, backed by Availability Assurance specialists.

Our goals are simple: To keep your cogeneration plant running efficiently. To keep outages short. To offer new ways to improve plant performance and availability. And to maximize the value of every dollar you invest.

Westinghouse offers total service for the life of your equipment. We also offer full installation and start-up services so that each new plant runs effectively from the start. Once your cogeneration plant is in full operation, Westinghouse will help design a preventive maintenance program aimed at high availability and low downtime. We can help plan and supervise a scheduled outage. We can direct craft labor. We can supply parts, tools and materials. And, we offer complete training programs to keep operating crews up-to-date.
Outage Management: Without proper management, outages can take longer and cost more than necessary. Westinghouse has a dedicated team of specialists who can develop an outage plan that will get your cogeneration system back on line quickly. Using a critical path analysis model, we can determine the best time to perform each phase of the service, and implement recommended product improvements.

Parts Availability: Availability of high-quality, state-of-the-art replacement parts is a key to our total service program. We can recommend and plan on-site inventory. Replacement parts from Westinghouse are ready for quick shipment through our computerized ordering network.

Full-Service Repairs: Sometimes it may be more economical to repair rather than replace major parts or components. Westinghouse will work with you to make the right decision, and we offer total repair capabilities at our shop facilities worldwide.

Ready Assistance: The Westinghouse service approach is based on scheduled, preventive maintenance as an alternative to forced outages. But in an emergency, we can offer qualified on-site assistance within hours. The Special Westinghouse Assistance Team (SWAT) is trained to handle tough problems quickly, and get your units back on-line at minimum cost.

Awareness: Westinghouse believes in keeping its customers aware of new methods to maintain and improve the efficiency, reliability and availability of their combustion turbine plants. Our Availability Assurance Engineering technical communications offer important service advice on inspection, repairs, and upgrading your equipment.

Configuration Visibility: The Westinghouse Configuration Visibility System is a central data base containing more than ten years of detailed operating, usage and maintenance records on our combustion turbine plants at utility and industrial sites worldwide. The system is an important tool for developing effective outage management plans and other maintenance programs that enhance availability.

Both the user and the manufacturer play key roles in and benefit from high combustion turbine availability in a cogeneration system. At Westinghouse, we are doing our part through reliable design and quality manufacturing, and we're also helping through service programs—such as Configuration Visibility—to reach even higher availability levels.
No other power system has all the advantages of combustion turbine cogeneration—high efficiency and high power-to-steam ratio, low first cost and low emissions, siting versatility, and flexibility for fuels and applications. Westinghouse is working to expand these benefits by developing technologies that use coal—our most abundant and secure energy resource. Two of the most promising approaches are gasification and atmospheric fluid bed (AFB) combustion systems. Both are clean ways to combine the benefits of combustion turbine cogeneration with low cost, available fuel resources.
Coal gasification offers an efficient way to use available fuel resources in combustion turbine cogeneration.

Gasification: Step-by-Step to Savings

This process makes a medium or low Btu fuel gas that can be burned in today's combustion turbines. The gas is produced by reacting coal or other solid fuel with steam and oxygen in a gasifier. The gas is then cleaned and fed to the combustion turbine for cogeneration of power and steam.

The advantages of this system include high efficiency and low emissions. And it offers a low cost way to convert to coal—because a gasifier can be retrofitted to our combustion turbines at any time. Adding parts in sequence means that the initial capital outlay is low since it is only for the cogeneration equipment. Plus, the return on this investment comes early because a Westinghouse combustion turbine cogeneration system is quickly on line and running, earning profits that can help finance the next step—installing the gasification system.

The result? A total savings that comes from combustion turbines, cogeneration, and low cost fuel.
AFB: A Step Ahead of the Times

Atmospheric fluid bed combustion has made its point in the minds of many industrial users as an economical, efficient, clean way to use solid fuels. It can be applied in combustion turbine cogeneration through an indirectly heated cycle—energy released during combustion is transferred through heat exchangers to power the turbine. Since the working fluid in the cycle is air, the system is called the air turbine cycle for cogeneration.

Steam for process is also produced as the turbine exhaust heat is recovered by a boiler.

Since the air in the tubes is heated indirectly, it is still clean when it reaches the turbine and the boiler. This avoids the problems usually caused by dirty fuels. And the clean air can also be used for drying or other industrial processes.

Even low emissions are built into the AFB combustion process. Low burning temperatures keep NOx levels down, and limestone in the bed absorbs sulfur. Particulates in the AFB exhaust are effectively controlled by a baghouse filter.

For a clean cogeneration system that meets even more process needs, an AFB air turbine is the answer. And Westinghouse is working to make these designs available in a range of sizes to meet your needs.
NO TIME LIKE
THE PRESENT!

The pendulum has made a powerful swing forward since the days of Ben Franklin. Side by side with hundreds of new advances, yesterday's idea of cogeneration has emerged as the logical choice for industrial power today and tomorrow. Westinghouse holds the key to cogeneration. Use it to unlock your profits.
For information on the W251B:

Customer Information
Turbine and Generator Division
Westinghouse Canada Inc.
P.O. Box 610
Hamilton, Ontario, Canada L8N 3K2

Phone: (416) 528-8811
Telex: 061-8532

For information on the W501D:

Marketing Manager
Westinghouse Electric Corporation
Combustion Turbine Systems Division
P.O. Box 251
Concordville, PA 19331 USA

Phone: (215) 358-4980
Telex: 834212