TURBLEX INC.
A Siemens Company

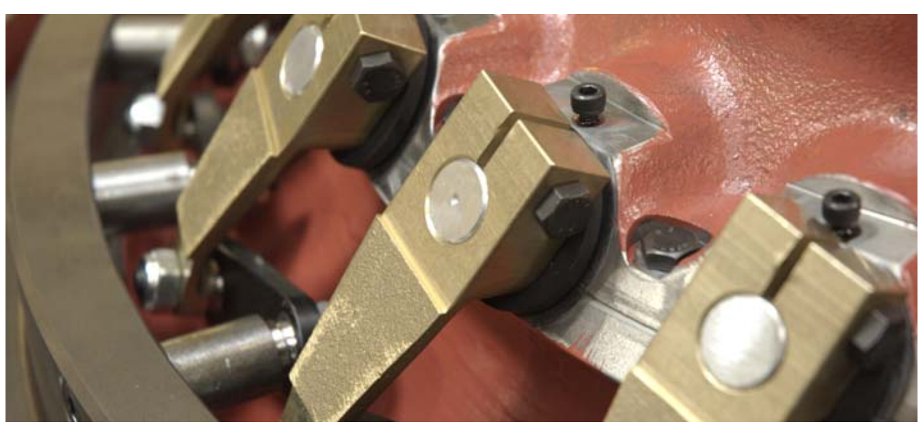
August 13, 2008

TURBLEX TECHNOLOGY REVIEW

Represented By: Bergren Associates, Inc.

the art of **Efficiency**

Intelligent Air by Turblex



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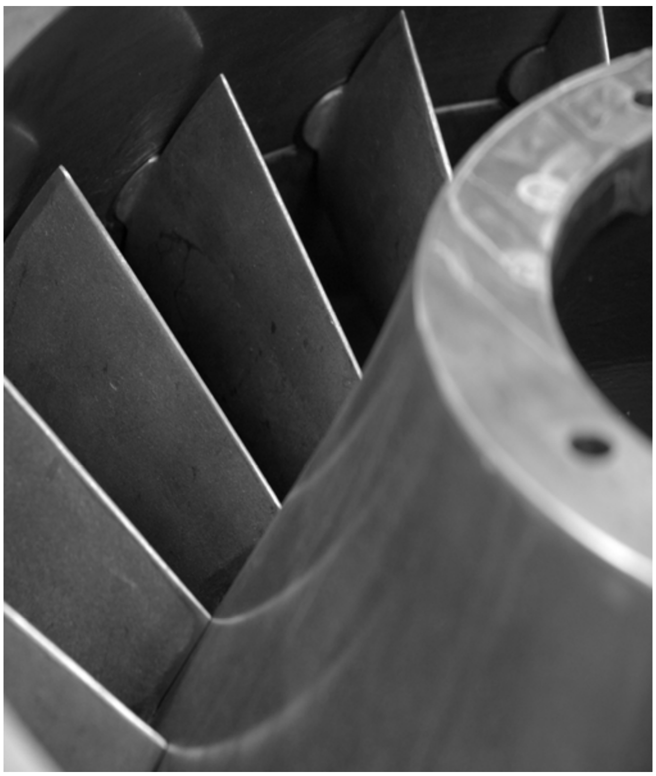

Introduction

The aeration process of a wastewater treatment plant consumes 50% to 70% of all the power used by the plant and represents the second largest operating cost after labor. Additionally, the treatment of wastewater accounts for approximately 35% of the energy consumed by a municipality, including street lights, heating and cooling, etc. It is not surprising that City Managers are willing, more now than ever before, to expend resources to make this process more efficient. When it comes to improving the efficiency of a wastewater aeration process, there are three primary technologies that have the greatest impact on the overall power consumption:

1. *Diffuser Technologies*
2. *Blower Technologies*
3. *Air Control Technologies*

The optimal process incorporates fine bubble diffusers, automated DO and pressure control, and dual point control single stage blowers. This combination has a proven track record of yielding the highest efficiency of any secondary treatment process. Plants which are without these high efficiency standards are penalized each and every month with a higher utility bill.

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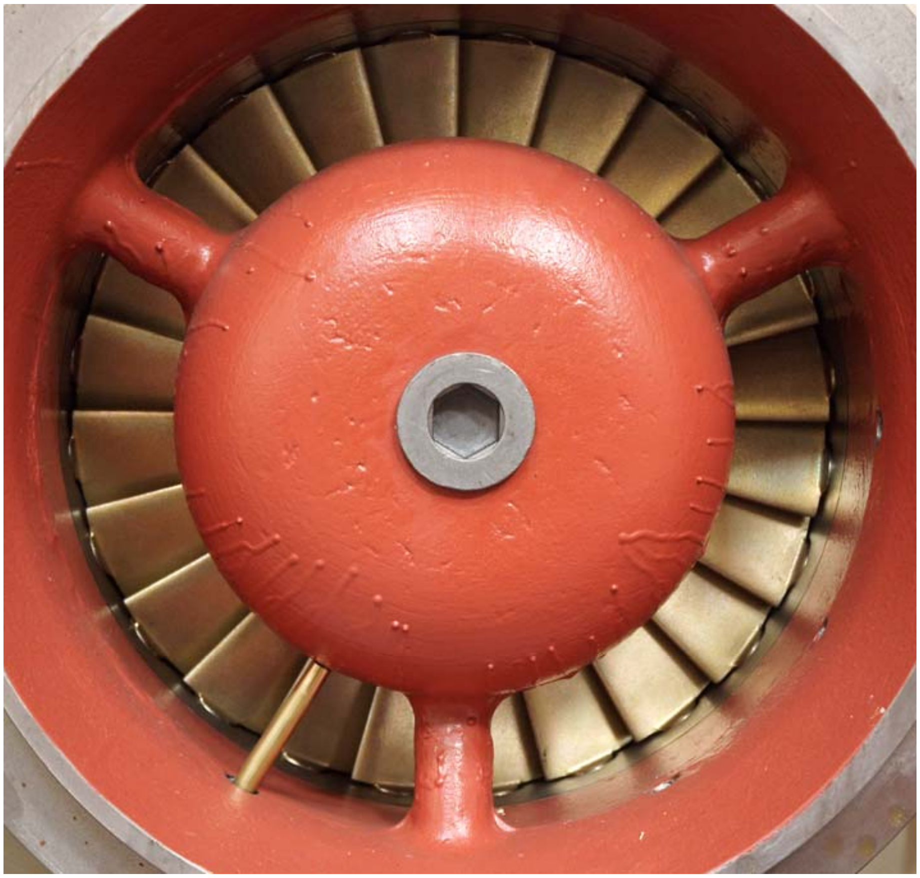
Diffuser Technologies

Fine bubble disc diffusers are considered the most efficient technology available for oxygen transfer in wastewater treatment applications. Typically, power costs can be reduced by up to 50% when compared to other aeration processes such as mechanical or course bubble diffusion. Fine bubbles provide larger total surface area, create more friction and rise slower than coarse bubbles. The combination of more transfer area and a greater contact time enhances transfer efficiency.



Blower Technologies

Wastewater blower applications typically utilize one of three blower designs;

- *Positive Displacement*
- *Multi-stage Centrifugal*
- *Single-stage Centrifugal*

Operational efficiency differences are a result of both the blower technology utilized, as well as the control methodology selected.

Positive Displacement Blowers are the least efficient of the three types of blower technologies typically implemented in a wastewater aeration process, with a peak isentropic efficiency in the lower 60 percentile range. Multi-stage centrifugal blowers have a peak isentropic efficiency between 68%-76%, while higher speed single-stage centrifugal blowers range from 78% (for units utilizing standard impeller designs), to as high as 85%, for designs utilizing advanced impeller and case aerodynamics.

Control Methodologies

From this base efficiency at a blower's maximum design condition, (i.e., maximum flow, temperature and pressure) careful consideration must be given to control methodologies when applying these technologies to a relatively constant pressure and variable temperature/flow application such as the wastewater aeration process.

Both multi-stage and single-stage centrifugal designs offer single point control through inlet valve guide vane or variable speed control. This single point control methodology has

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significant limitations in the wastewater application. The inlet valve or guide vanes only control common on many centrifugal applications, allows for good overall capacity control, but dramatically reduces system efficiency. This reduction in the machine efficiency is due to the inlet losses associated with throttling. While single point speed control offers a method for capacity reduction with fewer losses than inlet throttling (frequency converter and motor losses must still be factored in), the turndown range of the centrifugal unit is compromised in a relatively constant pressure wastewater application. The pressure capability of a centrifugal impeller is relative to the square of the tip speed of the wheel. The significant loss of pressure, due to speed reduction, quickly moves below the process's system resistance curve. The only solutions for this shortcoming is to drastically oversize the blower, which reduces the base efficiency, or provide significantly more units to cover the range of flows. **Figure 1** (below) shows a comparison of various blower technologies with different control methodologies. This averaged comparison illustrates the differences in base, average and minimum isentropic efficiencies utilizing different blower types and their associated control methods. Also represented are average expected stable operational turndown capabilities for each scenario.

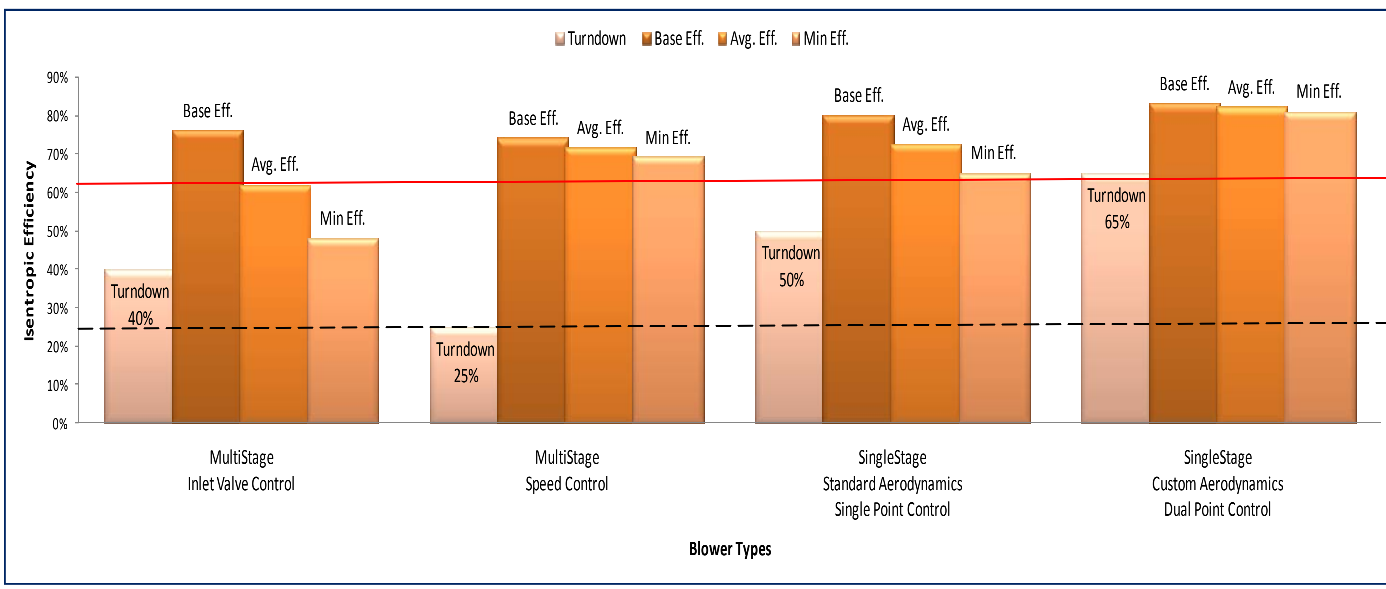


Figure 1 - Differences in efficiency between available blower technologies.

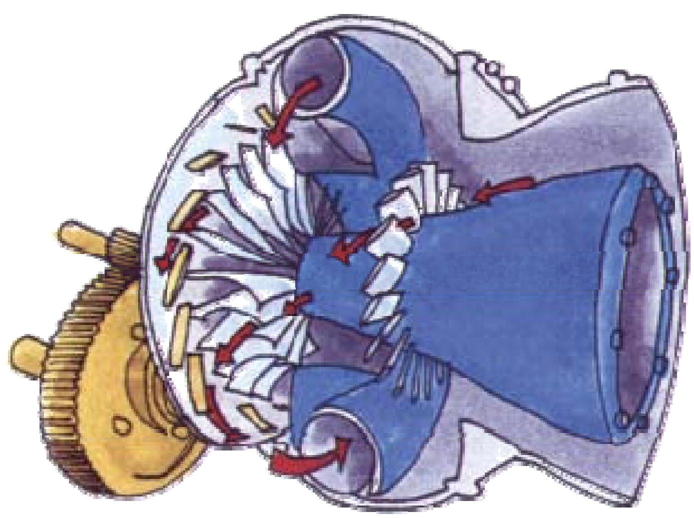
DUAL POINT CONTROL

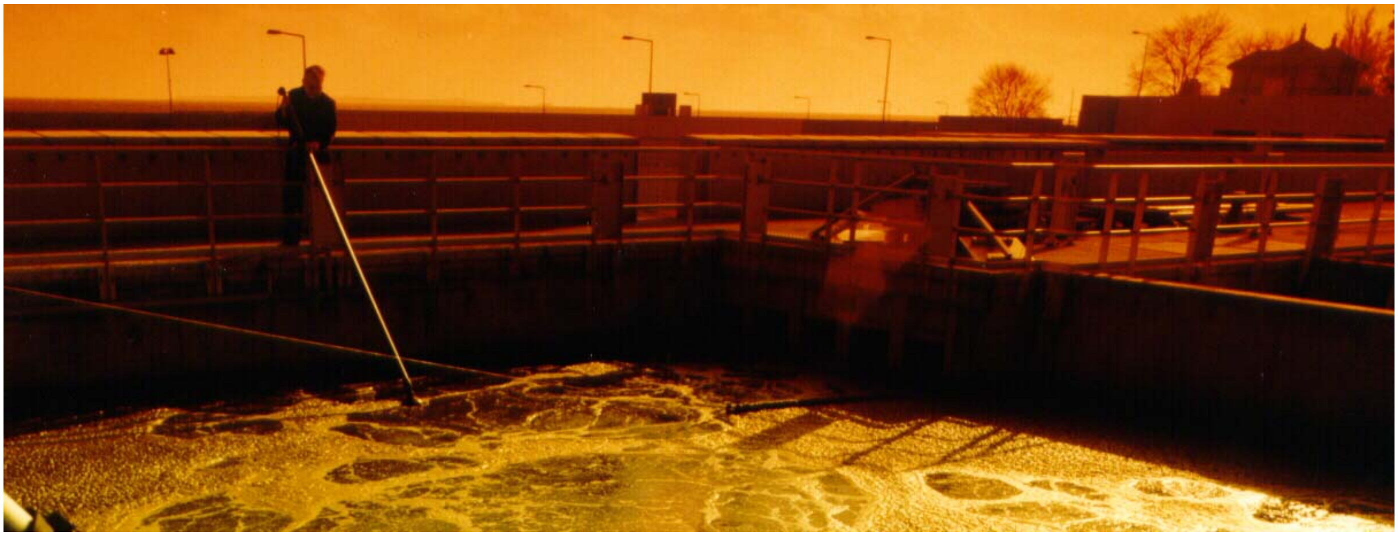
"Over the last 30 years, the standard in high efficiency aeration blowers has shifted from multi or single-stage centrifugal blowers with single point inlet throttling or speed control to highly aerodynamic single-stage blowers incorporating dual inlet and discharge vane control.

This unique control process allows for management of the flow and head functions independently."

Dual Point Control Technology

Over the last 30 years, the standard in high efficiency aeration blowers has shifted from multi or single-stage centrifugal blowers with single point inlet throttling or speed control to highly aerodynamic single-stage blowers incorporating dual inlet and discharge vane control. This unique control process allows for management of the flow and head functions independently via a multi-variable control process. Typically, the flow function of the blower is managed through discharge control vanes, while the head function is managed via inlet guide vanes. This divided control strategy allows for the base efficiency to be maintained at or near the maximum across an extremely wide range of flow and temperature conditions (**see Figure 1**). An added benefit to this type of control process is significantly increased blower stability, allowing for turndown ranges in excess of 60% (almost double that of a multi-stage blower utilizing inlet throttling control). This wide control range with high isentropic efficiencies across the entire operational envelope is ideally suited for the widely varying conditions experienced by most activated sludge wastewater treatment facilities. Because wastewater aeration blowers predominately operate at average conditions of flow and temperature, single-stage blowers (implementing the latest in aerodynamic designs and dual point control) can easily reduce overall aeration system operating cost by 30% to 50% when compared to other blower technologies incorporating single point throttling or VFD control. A detail analysis examining several (maximum, average and minimum) operating points should always be considered when evaluating blower technologies.





Process Air Control Technologies

Most activated sludge aeration processes can benefit significantly from an automated Closed Loop Dissolved Oxygen (DO) and Variable Header Pressure (VHP) control system. Automated DO and pressure control, using VHP technology, can dramatically lower a plant's energy bill. Target DO's at many treatment plants are inflated due to a manual or ineffective automated control process. **Table 1** illustrates the percent of air consumption reduction that can be achieved through lowering the average DO.

	To mg/l			
From mg/l	4 mg/l	3 mg/l	2 mg/l	1 mg/l
5 mg/l	18%	37%	55%	73%
4 mg/l	-	16%	31%	47%
3 mg/l	-	-	13%	27%
2 mg/l	-	-	-	12%

Table 1 - % AIR FLOW REDUCTION VERSUS DO REDUCTION

Additional energy savings are available through the proper management of an aeration system's operating pressure. Many plants do not practice system pressure management. Plants that do implement pressure management through manual practices or fixed pressure set point automation typically operate between 0.4 and 0.7 psig higher than necessary. **Table 2** illustrates the Energy Difference when header pressure set point is lowered by only 0.5 psig in the main air header through VHP control.

Discharge Pressure	System Pressure Reduction	% Power Reduction
10.5 - 9.6 psig	0.5 psig	5%
9.5 - 8.8 psig	0.5 psig	5.5%
8.7 - 8.1 psig	0.5 psig	6%
8.0 - 7.5 psig	0.5 psig	6.5%
7.4 - 7.0 psig	0.5 psig	7%
6.9 - 6.5 psig	0.5 psig	8%

Table 2 - % POWER REDUCTION VERSUS SYSTEM PRESSURE REDUCTION

Products

Single-Stage Blowers

Turblex blower products cover a wide range of low pressure (0-30 psig) high flow (500 - 300,000 cfm) applications. Table 3 (below) lists the eight most common blower models utilized in the US wastewater market. In conjunction with the single-stage blower products offered, Turblex also provides hybrid blower systems in which various blower technologies (single-stage, multi-stage and PD blowers) are combined to meet the specific demands of the application. Central to these unique hybrid solutions are specialized blower control systems for the management and optimization of the various blower configurations.

Model	KA2	KA5	KA10	KA22
Flow (cfm)	500 - 2150	1800 - 6000	4500 - 9000	8000 - 14000
Pressure (psig)	4 - 22	4 - 28	4 - 25	4 - 23
HP	50 - 200	100 - 600	150 - 1000	200 - 1500
Model	KA44	KA66	KA80	KA100
Flow (cfm)	13000 - 21000	18000 - 33000	22000 - 44000	30000 - 70000
Pressure (psig)	4 - 23	4 - 23	4 - 20	4 - 17
HP	300 - 2000	450 - 3000	600 - 4000	800 - 5000

Table 3

Blower Instrumentation and Accessories

Where most blower manufactures end, Turblex begins. Along with a complete line of basic blower systems Turblex offers a wide variety of specialized blower instrumentation, control, safety, protection, maintenance and convenience accessories. This complete line of accessories provides a wide variety of product configuration and customization capabilities.

Process Instrumentation and Controls

Turblex leads the industry in the development of effective and reliable air process instrumentation and control packages. For the wastewater market, Turblex offers SMART closed loop dissolved oxygen control processes. This technology can be combined with other air control processes to provide combined air flow control to digesters, WAS and other holding tanks applications. This approach can often significantly reduce the number of blowers and related infrastructure required for multiple process applications.

Energy Funding

Project Financing Opportunities

Finding funding for wastewater projects is often one of the main hurdles to overcome when looking at implementing plant improvements or new equipment. Today, however, as energy conservation grows more important, there are an increasing number of innovative funding opportunities available. These are based on energy efficiency and the use of renewable energy resources. Beyond the traditional financing method of borrowing money, several alternative options for financing wastewater projects exist.

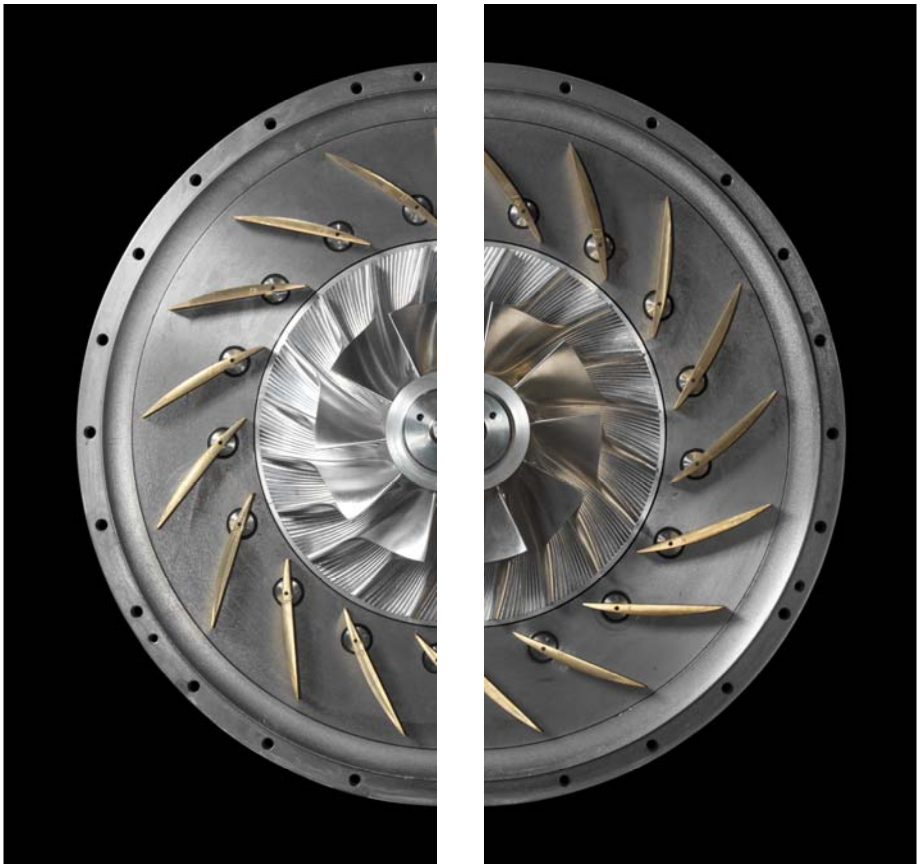
The following will discuss several innovative financing programs available today through means of energy efficiency improvements and/or use of renewable energy. It should be noted that the following is only a brief synopsis of each program. Each individual state and utility's programs and program requirements may differ.

Renewable Energy Programs

Several programs offer a financial incentive for projects developing and/or increasing the use of renewable energy resources. Projects that fall under this category use renewable energy resources in innovative ways resulting in the decrease in pollution, diversification of a state's energy portfolio, or creating economic benefits for the state's communities. Renewable energy is defined as energy that is provided from a renewable resource (i.e., solar power, wind power, biomass energy, fuel cells, etc). The amount of funding available is usually based on the size of the system and/or the amount of energy produced. Renewable energy has come into the spotlight of late due to the focus on conservation of resources and energy and environmental concerns. There are a variety of these programs available.

Energy Efficiency Programs

Funding also exists for projects that are based on improving energy efficiency by the implementation of more efficient equipment or through other means of reducing site energy usage. Currently not as many efficiency programs exist as for renewable energy resources. The amount of funding available for energy efficiency projects is also usually based on the size of the project and the reduction in energy used. The following offers a general discussion of these programs.



Grants

There are a variety of grants available both on the state and federal level, for energy efficiency and renewable resource projects. These grants offer financial assistance to projects that encourage the use and development of renewable resources, or promote the use of improved energy efficiency. Most of these grant programs offer assistance to a broad range of renewable energy resources and technologies, while some are more focused on one type. The amount of assistance offered also varies from state to state.

Typically, grants are awarded based on an evaluated process. Grants usually involve submitting an application and other required information. This evaluation is based on need and how well the application meets the grant criteria.

Loan Programs

States offer low interest and/or zero interest loans to assist in the financing of renewable energy and energy efficiency projects. A broad range of renewable energy technologies and energy efficiency equipment generally qualify for these loans. These loans offer wide range of repayment schedules, determined on an individual project basis.

Rebate Programs

A variety of rebate programs are available at the state, local, and utility level to help promote the use of renewable energy equipment. Rebate programs are primarily available from state agencies and municipally-owned utilities. The rebate programs are sometimes combined with low interest loan programs.

Energy Performance Contracting (EPC) and Energy Service Contracting (ESC)

Energy Performance Contracting also know as Energy Service Contracting is an innovative arrangement for designing, installing, and financing energy improvement projects, where the savings achieved by the project are guaranteed to cover the cost of the project over the term of the agreement. Typically under this program, an energy service company such as Siemens Building Technologies, finances project improvements, and recovers their cost through the money saved by the use of energy efficiency or renewable energy technologies. The Performance Contractor will invest a combination of money and/or equipment into the customer's project. The customer then agrees to pay the investment back with some preset profit from the savings resulting from the improved energy efficiency. A performance contract can be undertaken with no up-front cost to the owner, and is paid for out of energy savings.

Utility Service Contracts (USC)

This program is very similar to EPC, only funding is provided for efficiency and renewable energy projects by their electric utility provider. The utility is then repaid through the cost savings incurred from the project.

Performance Contracting

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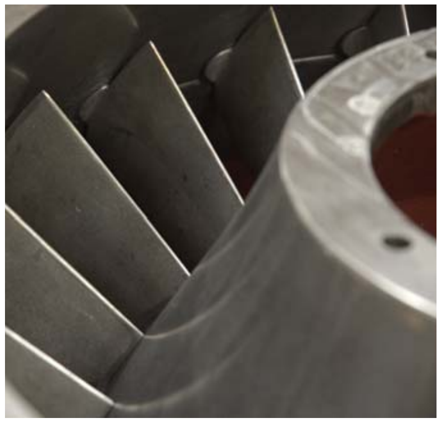

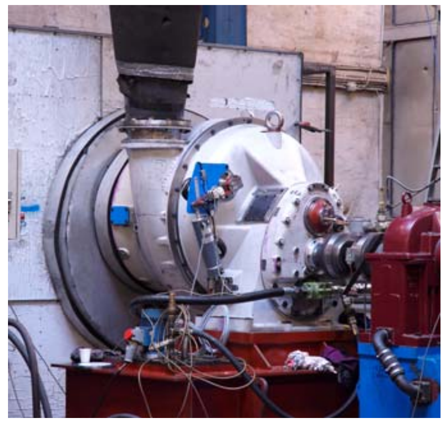

Support

Sales and Front End Engineering

Turblex Sales Team includes sixteen (16) engineering and support positions for direct sales support, project evaluation, study generation, sizing and technical services, bidding, proposal generation and contract review. Each region of North America has a Strategic Business Unit responsible for business development in their specific geographic area. Key Contact information for Turblex's Midwest Business Unit is:

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