Case Studies: Small Particulate Blower Systems Energy Efficiency

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ABSTRACT

As part of an on-going program to acquire energy conservation savings by investing in industrial customers operations, Snohomish County Public Utility District partnered with the Northwest Energy Efficiency Alliance's 'Just Enough Air' project. The project focus is on improving efficiencies of blower operations using various strategies to generate significant and very cost-effective electrical energy savings.

This paper highlights fan speed reduction technologies ranging from very low cost sheave changes to adjustable speed drives. Returns on investment results have been especially positive with these approaches. The technology lends itself to use by a variety of secondary wood products and other material processing operations using small particulate low-pressure material collection systems.

Case studies of three Snohomish County Public Utility District (Snohomish) customers participating in Snohomish's Energy Efficiency Incentive Program are presented where fan speed reduction achieved significant energy savings. Descriptions of how each business met its specific needs address the crucial requirement of all industrial efficiency practices to align with customer's industrial process objectives. The case studies include firms manufacturing cabinets, office/sales displays and furniture edge-banding products.

The paper addresses approaches and lessons learned that are useful for both utilities and end-users in achieving low-pressure pneumatic blower systems efficiency improvements. The partnership between Snohomish, its industrial customers and the Just Enough Air project serves as an example of a successful approach to achieving low cost energy savings.

Introduction

Snohomish is the 12th largest public utility in the nation serving over 275,000 electric customers in western Washington State. The utility has been a regional leader in energy conservation for over two decades with its customers participating in incentive programs achieving savings of over 60 average megawatts since 1982. Snohomish offers energy conservation programs to residential, commercial and industrial customers for an array of energy efficiency retrofits including lighting, controls, HVAC, pumps and other technologies as part of their commitment to investing in sustainable economic development. For commercial and industrial customers Snohomish provides incentives of up to $0.14 per kWh for electricity savings realized in the first year after installation to a maximum of 70% of total project costs.

Snohomish is a public utility member of the Northwest Energy Efficiency Alliance (The Alliance), a non-profit group of investor-owned and public electric utilities, state governments, public interest groups and industry representatives committed to bringing affordable, energy-efficient products and services to the marketplace. In 1999 The Alliance began offering the Just Enough Air Project, with a focus on assisting secondary wood products manufacturers in the Northwest in improving the efficiency of their wood waste collection systems (Goddard, Shinn, Vranizan & Williams 2002). Early on Snohomish began promoting the Just Enough Air Project to its secondary wood products customers as an opportunity to generate energy savings.

In developing the Just Enough Air project, The Alliance acted on research conducted on energy usage in the Northwest wood products industry. According to 1992 U.S. census data, blower systems comprised approximately 12 percent of the overall wood product Northwest energy usage.

Comprehensive energy analyses of five Northwest secondary wood products firms determined that blower system energy usage ranged from 25 to 35 percent of the annual electricity used in those plants. Extrapolating those results to region-wide electricity costs for operating low-pressure blower systems in Northwest wood products plants resulted in an industry wide estimate of approximately $19 million per year. (Goddard, Shinn, Vranizan & Williams 2002). The potential cost-effective energy savings in blower systems spurred The Alliance to develop the Just Enough Air Project.

Snohomish Customers Experience with Just Enough Air Project

Snohomish's customers Canyon Creek Cabinet Company, Doelken-Woodtape, Inc. and Synsor Corporation participated in Just Enough Air's demonstration phase. All three firms realized significant savings from fan speed reductions as shown in Table 1.1.

Table 1.1. Summary of Case Studies: Blower System Energy Efficiency Projects

	Canyon Creek Cabinet Company	**Doelken-Woodtape, Inc.**	**Synsor Corporation**
Location	Monroe, WA	Everett, WA	Everett, WA
Plant Size	Medium	Medium	Medium
Energy efficiency measures	Permanent VFD, used for fan speed reduction	Sheave change, fan speed reduction	Sheave change, fan speed reduction
kWh/yr savings	312,468	217,525	243,000
$/year savings	$21,505	$9,133	$16,225
Blower system % savings	38%	38%	36%
Total project cost*	$18,537	$4,607	$2,340
Project costs paid by Alliance**	$680	$3,560	$1,180
Utility conservation incentive	$12,277	$733	$812
Net project cost to site	$5,580	$314	$348
Simple payback based on total project cost (years)	0.9	0.5	0.1
Simple payback based on net project cost (years)	0.3	0.03	0.03
Products produced	Wood cabinets	Furniture edge banding woodtape	Office & sales display partitions

*Total project cost includes engineering funded by Just Enough Air project sponsored by The Alliance.
**The Alliance contributed engineering services and rental of ASDs.

Source: Just Enough Air Project, Case Studies, Northwest Energy Efficiency Alliance, 2002.

Evaluating Low-Pressure Pneumatic Blower Systems

Just Enough Air Project's consulting engineer delivered evaluation services in each of the case studies described below. As part of the Just Enough Air technology transfer the consulting engineer also provided classroom and field training on evaluating dust collection systems for interested regional consulting engineers, utilities and blower system contractors. Snohomish's utility engineer completed that training and worked collaboratively with the consulting engineer in evaluating the dust collection systems of the customers profiled here. This training enables Snohomish's engineer to evaluate other customer systems and potentially identify equally significant savings opportunities.

We are presenting a brief overview of the evaluation process in this paper. A more detailed discussion is available in the *2002 Best Practices Guide: Low Pressure Blower Systems* (Goddard, Shinn, Vranizan & Williams 2002). *Industrial Ventilation: A Manual of Recommended Practice* covers design components of ventilation systems in greater detail.

Design standards. For dust collection systems, maintaining a minimum suction static pressure at all pick-up points and a minimum conveying velocity in all ductwork is necessary for effective operation. Table 1.5 lists the requirements for various materials. New collection systems should be commissioned after full operation to ensure efficient operation.

The Just Enough Air approach is based on the "affinity laws" or "fan laws". These laws specify the relationship between air volume, system static pressure, and power required to drive the fan. With CFM, RPM, SP, and BHP representing air volume (cubic feet per minute), fan speed, static pressure, and brake horsepower respectively, the laws are stated:

a. CFM varies as the RPM: $CFM_2/CFM_1 = RPM_2/RPM_1$
b. SP varies as the RPM^2: $SP_2/SP_1 = (RPM_2/RPM_1)^2$
c. BHP varies as the RPM^3 $BHP_2/BHP_1 = (RPM_2/RPM_1)^3$

Small changes in speed result in large changes in power required to drive the fan. Using the fan laws as outlined above, we can see that a 15% reduction in air volume (fan speed) will result in about 40% reduction in power consumption ($(.85)^3 = .61$). Even a slightly over built collection system creates significant energy waste.

Measurements and analysis. The focus of the measurement protocol and analysis is to determine potential for cost-effective energy savings. Measuring the static pressure at the blower/dust collection system's pick-up points is necessary to identify the point at which the static pressure is lowest as it becomes the critical leg around which many of the potential energy saving measures are developed. Velocity pressure is also needed for several points in the system to calculate the volume and velocity of the air inside the ducts at different points. A fan curve may be created based on the type of fan, fan speed, and static pressure across the fan and fan volume (see Figure 1.2 for example). For baghouse systems it's important to assess the reduced flow that can be expected with dirty bags as they cause system resistance to increase and the fan develops less volume.

The second step of the analysis is to redraw the system showing the velocities in the major ducts and the pressure at the pick-up points and, when dealing with baghouse systems, the flows associated with dirty bags. If there is a positive determination of savings potential a further assessment step is scheduled.

Unique Just Enough Air assessment of operating blower systems. When the collection system evaluation process determines that there is potential for savings, Just Enough Air uses a unique approach they developed to find the amount of speed reduction that can be implemented. An adjustable speed drive is installed temporarily in place of the existing fan motor starter. The adjustable speed drive is used as a tuning tool to manipulate fan speeds to operate the system at a variety of lower speeds. The plant operators select the lowest acceptable speed that ensures that the system is performing adequately.

The adjustable speed drive is often left in place for a trial period of a week or more to assure plant personnel that adequate dust collection is occurring. Once plant personnel approve that reduced fan speed, the drive is removed and the fan speed is made permanent through the use of different sheaves on the fan, or motor or in some cases both. Just Enough Air has four adjustable speed drives for tuning collection systems available for use by cooperating consulting engineers, contractors or utilities.

Evaluation and analysis example. The following discussion provides a general example of the evaluation process. "Consider a 150 horsepower system loaded to 100 kilowatts. The system is pulling air from a saw and blowing it into a cyclone. The system has a minimum velocity of 4,500 feet per minute and suction pressure of 8 inches. These values exceed generally accepted performance criteria of 3,500 feet per minute and 2.5 inches suction pressure for dry sawdust/light shavings and indicate that fan speeds can be reduced.

A ten percent speed reduction will result in velocity of just over 4,000 feet per minute and suction pressure of 6.5 inches. These values are closer to generally accepted performance criteria and reduce power consumption to 72.9 kilowatts or a 27.1 kilowatt savings. Over the course of a 4,000-hour year, the energy savings will be 108,400 (29 percent reduction in kilowatt hours consumed). At $0.04/kilowatt-hour and $4/kilowatt/month, that results in annual energy savings of $5,637." (Goddard, Shinn, Vranizan & Williams 2002).

Table 1.2. Example of Evaluation Analysis Details

Metric	Original Conditions	After Speed Change	Savings
Flow ft/min	4,500	4,000	N/A
Suction pressure	8"	6.5"	N/A
kW	100	72.9	27%
KWh/yr	400,000	291,600	108,400
Cost/yr	$20,800	$15,163	$5,637

Source: Just Enough Air Project, 2002 Best Practices Guide: Low Pressure Blower Systems, 2002.

Potential Low Pressure Blower System Energy Conservation Measures

Although the focus of this paper is on the over-capacity status, that is excess system velocity and high suction pressure, of the customers we profile, other potential inefficiencies in collection systems should be evaluated. The following list contains some of the system inefficiencies that can exist and a brief general description of a solution(s) to the problems.

1. *Excess system velocity and high suction pressure.* In some cases suction pressure and duct velocities exceed normal levels thus fan speed adjustment can potentially reduce power needs.
2. *Excess system velocity with normal suction pressure.* This is potentially caused by excess resistance in undersized ducts resulting in energy loss.
3. *Large differences in velocity and suction pressure from one end of the system to the other.* System balancing and possibly fan speed adjustment are potentially able to reduce energy usage.
4. *Entire branches of dust collection system that can be used fewer hours than other segments of the system.* Temporarily blocking off unused parts of the system while maintaining sufficient velocity in the ducts that are being used may create energy savings.
5. *Excess pressure on the discharge side of the fan.* If a material-handling fan is used, there may be an opportunity to replace it with a more efficient system. Excess pressure on the discharge side of the fan can also be due to ducting problems.
6. *Excess pressure drop through the baghouse caused by dirty bags or excess air volume.* It's important not to exceed manufacturer's recommended air to cloth ratio as performance would be impacted. Adjustable speed drive controls or inlet guide vanes can conserve energy by reducing flow when the bags are clean. When the bags are dirty the fan will operate at full speed.
7. *Fan operating significantly more hours than necessary.* Reducing speed or turning off fans when not needed may produce substantial energy savings.
8. *Return air systems.* Equipping systems with air filtering at the baghouse so that warmed air can be returned to the interior in colder weather can reduce heating costs significantly.

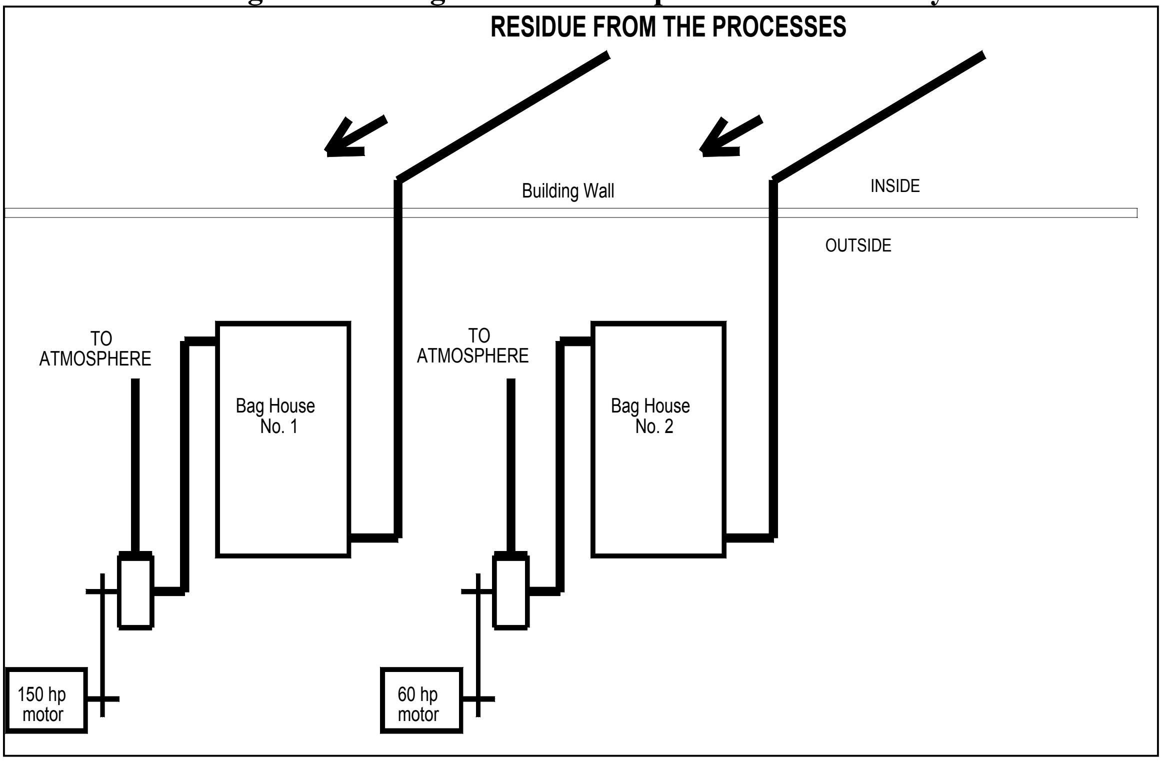
The Just Enough Air Project completed nine customer demonstration projects in the Northwest. The recommendations to these customers included a number of the conservation measures described above (Goddard, Shinn, Vranizan & Williams 2002). The three customers profiled here had systems displaying excessive pressure and velocity, corrected to flows related to dirty bags in the baghouses, thus all were candidates for fan speed reduction. For two customers an adjustable speed drive was temporally installed in their systems and the correct fan speed was determined by slowing the fan and observing the system. The lowered fan speed was then replicated by changing the sheaves. The third customer opted to install a permanent adjustable speed drive to reduce fan speed for energy savings.

Case Studies

Doelken-Woodtape, Inc.

At the time of the Just Enough Air demonstration, Woodtape was a subsidiary of American Profiles though the Doelken Group has since purchased them. Woodtape currently operates their specialty wood products plant in Everett, Washington in a facility completed in 1995. Their product line focuses on wood tape sliced from wood veneers to which adhesive backing is attached so that the tape can be glued to the edges of doors, furniture, moldings and other manufactured wood products. Their production process involves extensive cutting and sanding with sanding dust being the largest portion of the waste material handled by the two low-pressure pneumatic conveying systems. (Vranizan, *Case Study: Woodtape* 2000)

Figure 1.1. Diagram of Woodtape Dust Collection System



Source: Just Enough Air Project, Woodtape Case Study, 2001.

Figure 1.1 represents the layout of Woodtape's dust collection system. Inside the plant individual machine stations are served by collector ducts and vertical risers that feed the waste into the main ducts as the conveying systems move the wood waste from the production area to baghouse. Pull-through centrifugal New York Blower fans serve each baghouse, the larger system has a 150 horsepower fan motor while the smaller system is powered by a 60 horsepower fan motor. Depending on outside air temperature, the air stream can be routed back into the plant for supplemental heating, or discharged to the atmosphere if the heat isn't needed. Both systems were performing without issues before the Just Enough Air Project.

The evaluation of Woodtape's system followed the protocol outlined earlier in this paper. Table 1.3 highlights the specific savings benefits of this project. The Woodtape Just Enough Air Project, as the first for Snohomish, served as a demonstration of how to meet the project's goals and serve Woodtape's production and business needs at the same time. Woodtape's primary goal was reducing operating energy costs while not adversely affecting their production process either in product quality issues or maintenance problems from waste products not being picked up as a result of lower suction pressure.

Table 1.3. Woodtape Just Enough Air Project Details

Components of Usage & Cost Metrics	60 HP System	150 HP System	Totals
Original Fan Speed (rpm)	1,454	1,098	N/A
Fan Speed After Sheave Change (rpms)	1,345	863	N/A
% Speed Reduction	7.5%	21%	
Original Motor Load (kW)	44.4	97.0	141.4
Motor Load Post-Upgrade (kW)	35.6	51.4	87.0
Demand Savings (kW)	8.6	45.6	54.4
Original Annual Energy Use (kWh/yr)	177,600	388,000	565,600
Annual Energy Usage Post-Upgrade (kWh/yr)	142,440	205,635	348,076
Annual Energy Savings (kWh/yr)	35,160	182,365	217,525
Original Annual Energy Costs ($/year)*	$7,456	$16,290	
Annual Energy Costs Post-Upgrade ($/yr)*	$5,980	48,633	
Annual Energy Cost Savings ($/yr)*	$1,476	$7,657	$9,133
Total Direct Costs (Labor & Materials) to Woodtape			$1,407
Snohomish County PUD Energy Incentive			$ 733
Net Cost to Woodtape			$ 314
Project Costs Paid by Alliance – Rental of ASD's			$ 500
Project Costs Paid by Alliance – Engineering			$3,060
Total Woodtape & Alliance Costs			$4,607
Woodtape Actual Payback In Months			0.5
Similar Project w/o Alliance or PUD Incentive Funding Expected Payback In Months			6
Non-Energy Benefits: In addition to energy savings, the project reduced noise levels in the production area near the fans. With less air being pulled from the baghouse in winter to be re-circulated into the production area for heating, less dust carry-over is expected.			
*Energy Charge at $0.0323/kWh; Demand Charge at $3.23/kW.			

Source: Just Enough Air Case Study, Northwest Energy Efficiency Alliance, 2000.

An additional success factor in this early project was that the Woodtape process engineer had extensive energy efficiency engineering experience from prior work positions and had previously worked with Snohomish on energy conservation projects. This prior working relationship was key to the success of the project as the parties were able to quickly develop a base level of understanding of each others goals.

Synsor Corporation

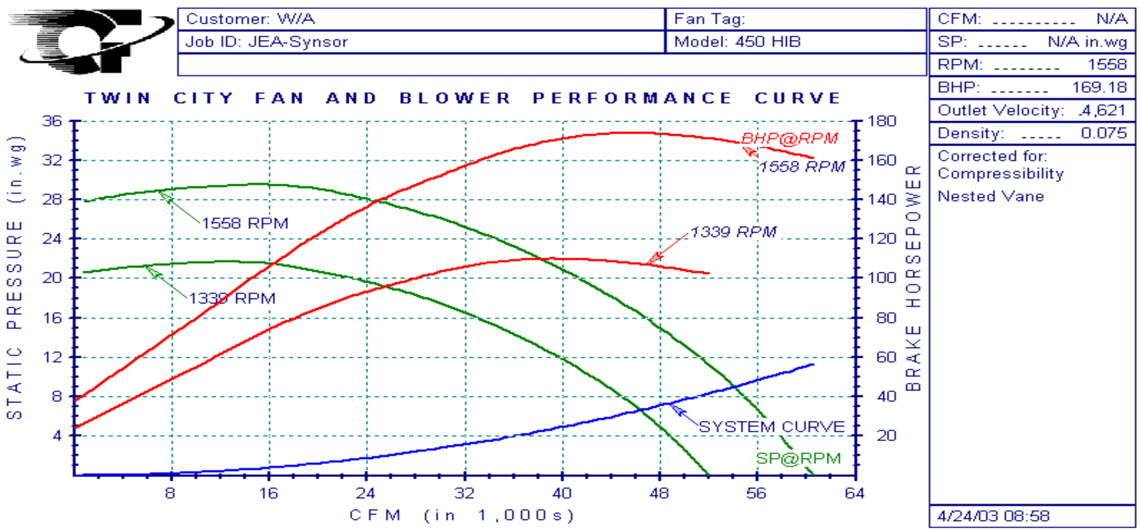
Synsor manufactures office and sales room display partitions for a nationwide market. Particleboard is the base component of their products made at their Everett, WA. plant where other wood and plastic components are also processed. Sophisticated saws, routers and edgers are used to transform the raw materials into finished partitions. The particulate generated in these processes are conveyed by a two-year-old system that includes a 200 horsepower Baldor motor driving a Twin Cities model 450 fan via a 40-inch diameter main duct to a filtering baghouse. The fan's inlet guide vanes were always left open. The cleaned air is returned to the plant in colder weather and vented to the atmosphere in warm weather. (Vranizan, *Case Study: Synsor* 2002)

While the dust collection system was generally performing without issues before the Just Enough Air Project, it was noted during on-site evaluation that some ducts had missing closure caps and the system control capability of the inlet guide vanes was underused. The evaluation of Synsor's system followed the protocol outlined earlier in this paper. Table 1.4 highlights the specific savings benefits of this project.

Synsor's primary motivation was reducing operating energy costs while not adversely affecting their production process. The maintenance supervisor's goal was to achieve energy cost reduction with a minimum capital investment and a simple and easily maintained solution. Fan speed reduction through changing sheaves fit that criterion. An additional success factor in this project was that Snohomish and Synsor teamed on a previous compressed air project that resulted in significant energy savings without negative impact on their production or maintenance.

In the Just Enough Air approach the temporary use of variable speed drive controls makes the improvement process empirical. This approach minimizes the need for theoretical analysis as the customer site can try a new fan speed with a minimal amount of effort. Development of schematics and fan curve analyses are useful for engineering analysis though they require levels of effort that are beyond the minimal needs using the tuning approach and they would increase the cost of the engineering. As the focus is on delivering low cost engineering analyses Just Enough Air does not typically create fan curves unless the customer requests it and is willing to pay for that service. For this paper we have presented a fan curve showing before and after performances of the Synsor system in Figure 1.2.

Figure 1.2. Synsor Fan Curve



Source: Just Enough Air Engineering Analysis for Synsor. Chen, 2003.

Canyon Creek Cabinet Company

Canyon Creek Cabinet Company (Canyon Creek) produces cabinets with more than 4,500 door style and finish combinations for residential and commercial markets. The company's 196,000 square-foot plant opened in 1997 in Monroe, WA and typically operates two shifts a total of 18 hours per day, five days a week. Using computerized woodworking machinery and a state of the art finishing system Canyon Creek processes plywood, particleboard and hardwood lumber through numerous stations for machining, edge-banding and sanding. (Vranizan, *Case Study: Cabinet Creek Cabinet Company* 2002)

The plant uses one large system to collect the coarse particulate to fine sanding dust waste from their processes. Their system features a baghouse and a high efficiency industrial backward-inclined Twin Cities Model 660 HIB fan. A 300 horsepower Baldor motor drives the fan capable of delivering 75,000 cubic feet per minute when driven at 1,000 rpm against a 13 inch static pressure. The cleaned air is directed back into the plant during colder weather and vented to the atmosphere during warm weather.

While the dust collection system was generally performing without issues before this project, it was noted during on-site evaluation that the fan's inlet vane dampers were left partially closed at all times. The evaluation of Cabinet Creek's system followed the protocol outlined earlier in this paper though the final steps were deferred due to a planned expansion. During the expansion Canyon Creek installed a new 300 horsepower variable-frequency drive for the fan motor to simplify fan-speed changes to correspond to changing production needs. Table 1.4 below highlights the specific savings benefits of this project.

Table 1.4. Synsor & Canyon Creek Cabinet's Just Enough Air Project Details

Components of Usage & Cost Metrics	**Synsor Totals**	**Canyon Creek Totals**
Original Annual Energy Use (kWh/yr)	678,000	837,000
Annual Energy Use Post-Upgrade (kWh/yr)	435,000	524,732
Annual Energy Use Savings (kWh/yr)	243,000	312,468
Original Annual Energy Costs ($/year)*	$45,270	$56,881
Annual Energy Costs Post-Upgrade ($/yr)*	$29,045	$35,377
Annual Energy Cost Savings ($/yr)*	$16,225	$21,505
Original System Demand (kW)	113	161
Post-Upgrade System Demand (kW)	72.5	94.9
Demand Savings (kW)	40.5	66.1
Total Direct Costs (Labor & Materials) to Each Customer	$1,160	$18,537
Snohomish County PUD Energy Incentive	$ 812	$12,227
Project Costs Paid by Alliance – Rental of ASD's	$ 500	$ 0
Project Costs Paid by Alliance – Engineering	$ 680	$ 680
Total Customer & Alliance Costs	$2,340	$12,957
Net Cost to Customer	$ 348	$ 5,580
Customer Actual Payback on Net Costs In Months	0.25	3
Similar Project w/o Alliance or PUD Incentive Funding Expected Payback In Months	less than 2	10
Non-Energy Benefits: In addition to energy cost savings, this retrofit enabled both Synsor and Canyon Creek to better match airflow requirements to production needs.		
*Energy Charges: $0.059/kWh; Demand Charges: $3.81/kW		

Source: Just Enough Air Case Study, Northwest Energy Efficiency Alliance, 2002.

Cabinet Creek's primary goal in evaluating their dust collection system was reducing operating costs in a way that did not adversely affect their production process. The plant managers also focused on maintaining flexibility in the chosen solution to ensure that when production changes, they can easily modify the collection system operation if needed. The installation of the adjustable speed drive on the fan motor accomplished this goal as they can easily match airflow in the dust collection system to meet changing production requirements.

With the adjustable speed drive controlling the fan, it is also possible to use a programmable logic controller (PLC) to control the fan speed to maximize the energy savings when production fluctuates through time.

Contributing to the success of this collaborative project was the ongoing exploration between Snohomish and Canyon Creek in finding ways to reduce energy cost. The dust collection system was being evaluated when the Just Enough Air Project opportunity came along which speeded up the process of achieving this cost saving solution.

Application of Just Enough Air Approach to Other Industries

Any industrial firm that utilizes existing low pressure pneumatic conveying as a means for moving or collecting particulate matter is a candidate site for the safe and simple Just Enough Air technique. A portable adjustable speed drive can be wired into the power circuit in about a half-hour. New speeds can be tested immediately. If the system continues to perform adequately at a lower fan speed the user can be assured of energy savings for so long as the system operates. The speed change is made permanent with sheave changes. If a slower speed is found to be unacceptable, the adjustable speed drive can be removed and the system will be returned to the original state. The only risk on the part of the user is the time required for installing and removing the adjustable speed drive.

In applying this approach to other industries, the requirements for static pressure and conveying velocity are key factors. We've listed those requirements for some industries in Table 1.5.

Table 1.5. Nature of Materials Conveyed by Blower Systems

Material	Lb/Ft3	Conveying Velocity Ft/Min	Suction to Pick Up In H2O
Ashes, coal	30	5,500	3.0
Beans	28	6,000	4.0
Cement	100	7,000	5.0
Grinding Dust	30	4,500	2.0
Sawdust, Dry	12	3,500	2.5
Shavings, Light	24	4,000	3.0
Shavings, Heavy	46	6,000	4.0
Wool, Dry	5	3,500	2.0

Source: Just Enough Air, Service Provider Training Manual. 2000.

Lessons Learned in Working with Just Enough Air Project Customers

These three customers had relatively new dust collection systems with significant excess capacity beyond what was needed to meet their current plant requirements. This unused system capacity created significant energy use along with corresponding higher costs that could be avoided without negatively impacting waste removal or creating product quality control problems. This experience with the case study customers is supported by Just Enough Air Project work with other customers. This finding suggests that designing for maximum loading continues to result in material collection systems operating under capacity resulting in higher than necessary electrical usage and cost. Recent electric rate increases in the Northwest suggest customer benefits will increase over time if electric rates stay at their current high levels.

The Just Enough Air approach offered flexibility in both the evaluation and measure implementation project stages that allowed unique customer requirements to be addressed. Canyon Creek's planned plant expansion led plant operators to bypass use of the adjustable speed drive tuning stage used in other customer facilities. Based on an initial analysis of significant cost savings, the customer completed their expansion then installed a permanent adjustable speed drive on the collection system fan motor. This approach achieved the predicted savings while providing flexibility should their production needs change significantly in the future.

The use of adjustable speed drives in tuning plant dust collection systems offers a valuable "hands-on" tool to address plant personnel concerns that recommended system changes to improve energy efficiency not result in negative machine operation or quality control problems. The installation of the tuning adjustable speed drive for a week or more served as an effective proof of concept for two of the customers. The resulting buy-in from plant personnel helps ensure that upgrades are installed correctly, commissioned thoroughly and maintained well; all essential components of achieving the potential savings.

Opportunities to Expand Just Enough Air Benefits to Additional Snohomish Customers

Secondary wood product manufacturing plants are the primary targets for energy savings for the Just Enough Air approach. Material collection systems encounter dry waste in the secondary industry and this is the area where low pressure pneumatic conveying is used most frequently. With the many sawmills in Snohomish's service territory, there may be opportunities to apply this approach to reducing energy usage in sawmill low-pressure pneumatic conveying systems. The operating characteristics of local sawmills require addressing issues that are not part of secondary wood products manufacture. These issues include variability in both moisture content and material size impacted by weather, season, type of wood and/or stage of the production process.

In addition to the customer successes and mutual benefits to both the customer and Snohomish in achieving energy savings, Snohomish engineering resources were enhanced through the training provided by the Just Enough Air project. The documentation provided by the project in the "Best Practices Guide" and associated evaluation tools enable Snohomish and other users to readily transfer the project benefits to other customers.

Summary: Successful Collaboration

Snohomish acquired extremely cost-effective conservation resources in this initiative. The Just Enough Air projects profiled in this paper achieved annual energy savings of 772,993 kWh at an incentive investment cost to Snohomish of $0.017 per kWh. These savings represent the equivalent of 630,292 pounds of reduced carbon dioxide emissions. The energy efficient upgrades to these three customers' material collection systems contributed to Snohomish's overall sustainable environmental practice goals. In 2001 and 2002 Snohomish provided conservation incentives to residential, commercial and industrial customers that delivered 197,540 MWh of savings and 52,532 tons of reduced carbon dioxide emissions.

Alliance programs are intended to transform the way markets work as they accomplish the objective of promoting electrical energy efficiency. This is a particularly difficult challenge in the Pacific Northwest industrial community because the cost of electricity is often a minor manufacturing cost compared to all other costs. The Just Enough Air Project, with a big assist from Snohomish, has begun to impact market transformation in one segment of the industrial community – secondary wood products. While we've jointly only begun to transform the market for energy efficient, small particulate, low-pressure blower systems on a regional basis, the experience in Snohomish's service territory creates a foundation for acquisition of conservation resources well into the future.

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