In a study undertaken by Ernest Orlando Lawrence, Berkeley National Laboratory, USA, on Energy-Efficiency Improvement Opportunities for the Textile Industry, the following observations are made with specific reference to Energy-efficiency improvement opportunities in *fan* systems.

This section is excerpted from Worrell et al. (2010).

Motor driven systems are one of the major end-use energy consumers in the textile industry. In the U.S. textile industry material processing has the highest share of the energy used by motor driven systems (31%) followed by pumps, compressed air, and fan systems (19%, 15%, and 14% respectively). These percentages in other countries will highly depend on the structure of the textile industry in those countries. For instance, if the weaving industry in a country has a significantly higher share of air-jet weaving machines (which consume high amounts of compressed air) than in the U.S., the share of total motor driven system energy consumed by compressed air energy systems would probably be higher

Efficiencies of fan systems vary considerably across impeller types. The average energy saving potential in these systems in the U.S. Manufacturing industry is estimated at 6% (Xenergy, 1998). For optimal savings and performance, it is recommended that a systems approach is used. In the following, energy saving opportunities for fan systems are presented.

***Minimizing pressure**

Pressure offers greater opportunities to reduce energy costs. A system with good airflow characteristics (duct velocities and sizes optimized), matched with the proper control device, pressure monitors, and variable-frequency drives, can help manage system pressure. Most baghouses or other collection devices will have varying pressure drops over the life of the system. Bags are generally more efficient at higher pressure drops, but then use more energy. A good pressure monitoring system that controls system volumetric flow rate can save thousands of dollars every year on the operation of even medium-sized systems. As ASDs become less expensive they are now being found on many installations. Be mindful of duct inefficiencies and fan system effects (elbows at inlets and outlets, etc. These shortcuts increase static pressure and operating costs for the life of the system (Lanham, 2007).

The key to any design is proper fan selection. The design of the fan and its blade type can affect efficiency and power requirements significantly. Laboratory-measured peak fan efficiency may not be the most stable point of operation. If peak efficiency coincides with the peak of the pressure curve then there may be operational problems as volumetric flow rates vary with small changes in system pressure. The designer must consider both curves when selecting the best fan and operating point to optimize reliability and power usage. Fan type may dictate proper selection. Airfoil wheels, while more efficient, may not be a good choice when handling particulate laden air. (Lanham, 2007).

***Proper fan sizing**

Most of the fans are oversized for the particular application, which can result in efficiency losses of 1-5% (Xenergy, 1998). However, it may be more cost-effective to control the speed than to replace the fan system.
Significant energy savings can be achieved by installing adjustable speed drives on fans. Savings may vary between 14 and 49% of fan system energy use when retrofitting fans with ASDs (Xenergy, 1998).

***Installation of variable frequency drives for blowers supplying combustion air to steam boilers**

A variable frequency drive can be installed to increase the efficiency of the blower supplying combustion air to the plant's steam boiler. Irregular demand for steam may result in excess oxygen in the combustion chamber. Inlet vane control is usually used, which means that the fan motor continues to operate at near-rated capacity under lower loads. Variable frequency drives can replace vane controls, permitting optimum operation under all loads and eliminating smoke problems. The installation of this measure in a textile plant in Canada resulted in electricity savings of 65 MWh/year (CADDET, 1993).

***Installation of turbo ventilators that rotate using wind blowing over roofs**
Some areas in the textile plant need to have a well-maintained standard temperature and humidity, for which HVAC systems are used. However, this is not the case for the whole plant. There are areas in many textile plants that do not need HVAC systems, such as most of the wet-processing plants and non-production areas. In these areas, usually, fans are used just to ventilate the air. Instead of using fans, turbo ventilators that rotate using natural wind can be installed on roofs. The potential implementation of this measure depends on the geographical location of the plant and also there might be seasonal changes in wind speed and direction. Several textile plants in India have installed turbo ventilators on their roof and have reported electricity savings of 23 – 91 MWh/year. The reported investment cost varies between US$6100 and US$9100. Energy savings and cost depend on the number of ventilators installed and the number of fans replaced (EMT, 2008k; EMT, 2008l).

***Installation of VFD on humidification system fan motors for flow control**
Temperature and humidity levels must be closely monitored and maintained for textile processes (especially spinning and weaving) so that yarns will run smoothly through the processing machines; a well functioning ventilation system is imperative to the plant's successful operation. Ventilation systems use supply fans (SFs) and return fans (RFs) to circulate high humidity air to maintain proper ambient conditions, cool process machinery, and control suspended particulate and airborne fibers. Initially, the mixture of return air and fresh air is cleaned, cooled, and humidified by four air washers. This air is then supplied to the facility by the SFs and distributed to the plant through ceiling mounted ducts and diffusers, producing required temperatures and relative humidity levels. The RFs then pull air through the processing machines into a network of underground tunnels that filter out suspended particles and fibers, usually through rotary drum filters on the inlet of each RF.

While the psychometric qualities and volumes of air supplied and returned from each area remain relatively constant in the system, seasonal variations occasionally cause minor changes in ventilation rates. In addition, different products result in changing heat loads in the plant due to a varying number of running motors and/or loads on the motor. Factors that influence the pressure, volume, or resistance of the system directly impact the fan energy requirements. Therefore, air density, changes to damper positions, system pressure and air filter pressure drops, supply and return air system interaction, and parallel fan operation all affect how much energy the fans require and must be monitored to ensure the efficient functioning of the system. Variable inlet guide vanes (VIVs) and outlet dampers usually initially control the system's air flow, and these are highly inefficient. Setting these devices is imprecise, resetting the openings can be done manually or automatically, and the VIVs and dampers can experience corrosion problems due to the high humidity in the air.

VFDs can be installed on flow controls; these devices control fan speed instead of changing the dampers' position. Thus, damper control is no longer necessary, so in the use of VFDs fan control dampers are opened 100 percent, thereby save electricity use by the fans. The average electricity saving reported for this retrofit in a plant in the U.S. is 105 MWh/year/fan with the cost of US$8660 (US DOE, 2005), whereas an Indian textile plant has reported the average energy saving of 18 MWh/year/fan with the cost of US$1900. The saving and cost of the measure depend on various factors such as the size of the fan, the operating conditions, the climate, the type of VFD used, etc. (EMT, 2004a).

***Energy-efficient control systems for humidification systems**
On average, the humidification plants in textile plants consume about 15% to 25% of the total energy of the plant. Energy-efficient control systems have been developed for humidification plants in textile plants. The control system consists of variable speed drives for supply air fans, exhaust air fans and pumps in addition to control actuators for fresh air, recirculation and exhaust dampers. Energy savings in the range of 25% to 60% is possible by incorporating such control systems in the plants depending on the outside climate. These measures can be easily retrofitted in the existing humidification plants (both in automatic and manually-operated humidification plants) and the entire system can be controlled through a central computer.