ENERGY to care

Greater efficiency supports patient care.

# Install variable frequency drives on pumps and motors

*All ECM content was independently developed and reviewed to be vendor-, product-, and service provider-neutral.*

## Description

Install variable frequency drives (VFDs), also called variable speed drives, (VSDs), on HVAC system fans, pumps and other motors to enable speed to vary in response to system demand resulting in energy savings and reduced equipment wear and tear.

### Project Talking Points

- Fan affinity laws show the energy required to run a fan or pump varies with the cube of its motor speed, resulting in large energy and cost savings when the motor speed modulates in response to demand. For example, a reduction in motor speed from 100% to 90% will result in a 27% energy savings.
- The life of building system equipment can be extended by gradually ramping up pumps and motors when increased capacity is required and by reducing the percentage of time pumps and motors work at full capacity.
- A slower fan or pump is quieter, potentially improving occupant satisfaction.

### Triple Bottom Line Benefits

- **Cost benefits:** Energy savings and increased equipment life reduce utility and maintenance costs significantly.
- **Environmental benefits:** Reducing energy consumption decreases carbon emissions and environmental impact. (see Benefits Calculator page).
- **Social benefits:** Installing VFDs can allow for improvements in thermal comfort and a reduction in sound, enhancing patient and staff experience.

### Purchasing Considerations

- Ensure a proper enclosure is provided with the VFD depending on the installation environment. Most indoor applications will require a NEMA (National Electrical Manufacturers Association) 1 enclosure, while outdoor applications will require a NEMA 3R enclosure.

- Check with your local electric utility as rebates may be available for installing VFD.

**How-To**

1. Assemble a team of stakeholders including the building engineer, MEP engineer, HVAC maintenance personnel, and building automation system (BAS) manager.

2. Consult with any users who will be affected by the installation and/or will need to understand and approve procedures to override the system. This may include the manager or director of the area affected by the change, infection control staff, safety officer, and/or chief operating officer.

3. Review energy usage data generated by the facility's BAS to calculate the variability of the facility's load profile and establish baseline energy use. VFDs generate the highest efficiency benefits in variable load conditions.

4. Catalog which fan and pump motors could have VFDs installed. Consider the following equipment, as suggested in ASHRAE Standard 90.1: *Energy Standard for Buildings Except Low-Rise Residential Buildings*:
    - Supply and return fans
    - Booster fans
    - Fan coil units
    - Exhaust fans
    - Cooling tower fans
    - Liquid coolers
    - Condenser fans
    - Secondary chilled water pumps
    - Domestic and hot water pumps

5. Analyze which fan and pump motors are appropriate for retrofitting a VFD. Analysis should consider the ability of the system design to perform properly under variable flow. For example, where fan systems require minimum flow rates and room to room pressure differentials, these must be maintained. In general, VFDs function best when installed on high efficiency equipment.

6. Either remove inlet guide vanes (or other mechanical flow modulating device) or remove the actuator and open the guide vanes to avoid counteracting the VFD's modulation of airflow.

7. Use a harmonics calculator to identify whether harmonic filters should be installed.

8. Ensure power quality to the VFD is consistent as fluctuations can cause the VFD to trip, negating any benefit.

9. Install and program VFDs to avoid operating equipment in the critical speed range. Consult the pump/motor manufacturer for information about optimal speed, vibration, and resonance.

10. Establish new control sequences to optimize energy reduction while maintaining proper system performance. For example, sequence control of the VFDs to either run the maximum or minimum number of motors consistent with loads and energy savings. Alternately, upgrade controls to modulate fan capacity according to the position of zone dampers.

11. Incorporate VFDs in the facility's commissioning program

**Tools**

- Efficiency Maine Variable Frequency Drive Retrofit Worksheet
- U.S. Environmental Protection Agency (EPA), ENERGY STAR Tools:
    - Buildings & Plants, 8. Air Distribution Systems, 8.4 Best Opportunities, Install Variable-Speed Drives

- VFD Energy-Savings Tools
    - VFDs.org Calculator
    - Specific VFD vendors will have their own calculators, as well
- Harmonics Calculators
    - CSG Network
    - Specific Harmonics companies will have their own calculators, as well

- Database of State Incentives for Renewables & Efficiency (DSIRE). Search "Select a Technology" for "Motor VFDs."

**Regulations, Codes and Standards, Policies**

- American Society for Heating, Refrigerating and Air-Conditioning Engineers

    - Standard 90.1: *Energy Standard for Buildings Except Low-Rise Residential Buildings*
    - Standard 170: *Ventilation of Healthcare Facilities*

- Air-Conditioning, Heating, and Refrigeration Institute

    - Standards 1210 (I-P)-2011 & 1211 (SI)-2011: *Performance Rating of Variable Frequency Drives*

## ECM Synergies

- Retrocommission HVAC controls.
- Practice preventive maintenance of major HVAC equipment.
- Set thermostats to balance efficiency and comfort.
- Evaluate setback of temperature and airflow settings at night.
- Perform economizer maintenance.
- Reevaluate HVAC equipment scheduling.

## Educational Resources

- Energy University Courses https://energent.link/EU

  The American Society for Healthcare Engineering (ASHE) has approved the courses below for continuing education credits. ASHE issues credits in quarter-hour increments, and a total of 10 contact hours equals 1 continuing education credit.

  - Active Energy Efficiency Using Speed Control

  - Efficient Motor Control With Power Drives Systems

## Other Resources

- American Society for Healthcare Engineering
  - Healthcare Energy Guidebook
  - Monographs

- U.S. Department of Energy, Energy Efficiency & Renewable Energy Building Technologies Program Tools:
  - Hospitals Benefit By Improving Inefficient Chiller System https://energent.link/y96
  - Hospitals Save Energy and Money by Optimizing HVAC Performance https://energent.link/c347a

- U.S. Environmental Protection Agency (EPA), ENERGY STAR Tools:
  - Building Upgrade Manual https://energent.link/overview

- American Society for Heating, Refrigerating and Air-Conditioning Engineers
  - *ASHRAE GreenGuide: The Design, Construction, and Operation of Sustainable Buildings* https://energent.link/gol, 3rd ed. (2010)

- Centre for Energy Advancement through Technological Innovation (CEATI) International

    - Variable Frequency Drives: Energy Efficiency Reference Guide https://energent.link/e20c2

- Portland Energy Conservation, Inc.
    - Retrocommissioning Handbook for Facility Managers (2001)

- U.S. Department of Defense, Strategic Environmental Research and Development Program
    - Strategic Conservation and Energy Factsheet EW-201152: Converting Constant Volume, Multizone Air Handling Systems to Energy-Efficient Variable Air Volume Multizone Systems https://energent.link/aee22

## ECM Descriptors

### Energy

Category List:
- Building and Maintenance
- Controls
- HVAC

ECM Attributes:
- Basic Device Upgrades
- System Upgrades

Improvement Type:
- Retrofit/Renovations
- New Buildings
- Operations and Maintenance

Department:
- Engineering/Facilities Management