E3T Energy Efficiency Emerging Technologies

Washington State University Extension Energy Program

# Commercial HVAC
# Emerging Technologies

## Emerging Technologies Showcase

## Commercial HVAC Webinar #1

**April 8, 2015**

Welcome. Today's webinar is being recorded and will be posted at:

- www.E3Tnw.org
- www.ConduitNW.org

Bonneville Power Administration

Energy Services

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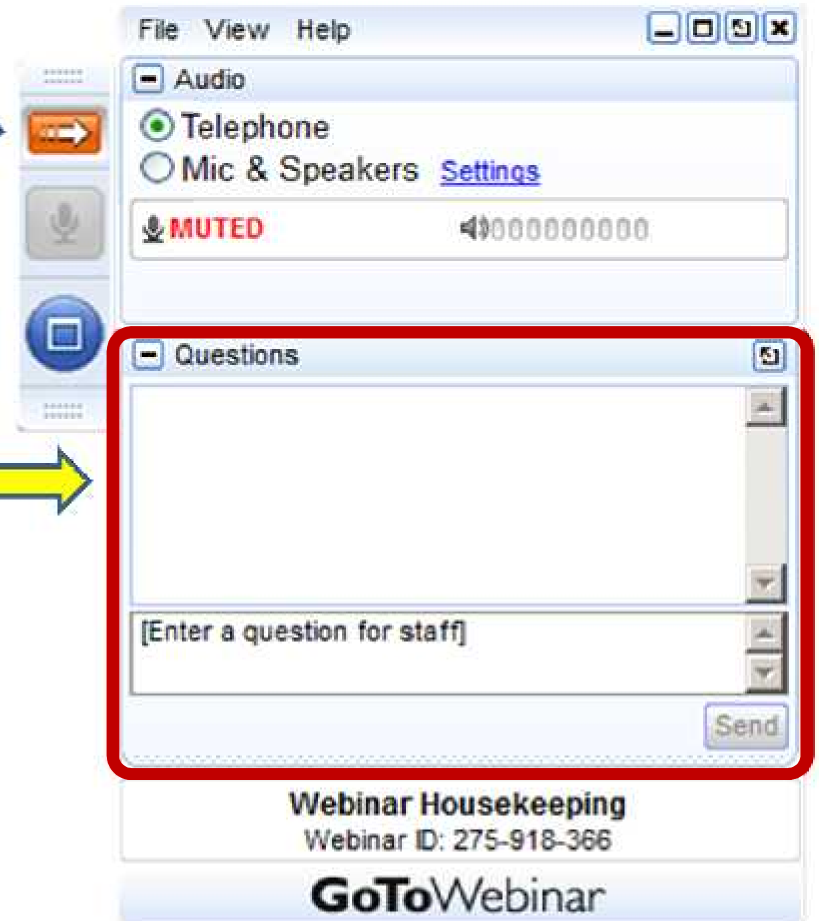


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E3T Energy Efficiency Emerging Technologies

WASHINGTON STATE UNIVERSITY EXTENSION ENERGY PROGRAM

# Commercial HVAC Emerging Technologies

- Electronically Commutated Permanent Magnet (ECPM) Motors for Single Phase HVAC Fan Applications
- Circulating Hot and Chilled Water Pumps with Variable Speed ECPM Motors
- High Volume, Low Speed Fan Technology
- Q-Sync Motors – "the Buzz"

**Mary Horsey – E Source**

April 8, 2015

E SOURCE

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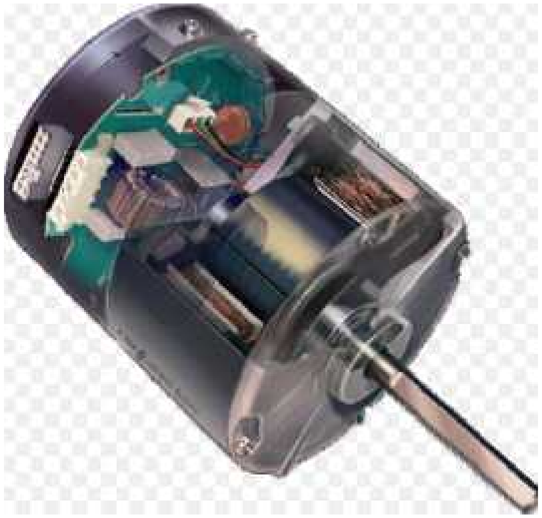
# ECPM Motors for Single Phase HVAC Fan Applications - Technology

Technology # 101 in the E3TNW.org database

http://e3tnw.org/ItemDetail.aspx?id=291



# ECPM Motors for Single Phase HVAC Fan Applications - Technology

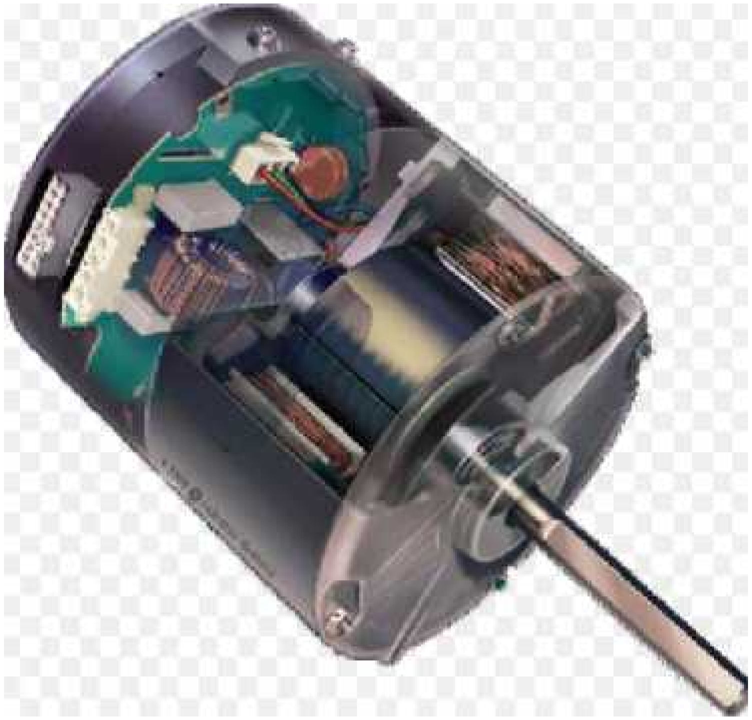
## What is it?

- Electronically commutated permanent magnet motor
- ~ 80% efficiency across operating range
- Inherent variable speed capacity
- Typical sizes 1/15, 1/10, 1/5, 1/3, ½, ¾, and 1 horsepower motors
- Standard frame sizes
- Typical applications: package terminal air conditioners, room air conditioners, unitary condenser fans and blowers, and exhaust fans

# ECPM Motors for Single Phase HVAC Fan Applications - Technology

## How does it work?

- Three phase synchronous motor
- Permanent magnet rotor
- Integral microprocessor control

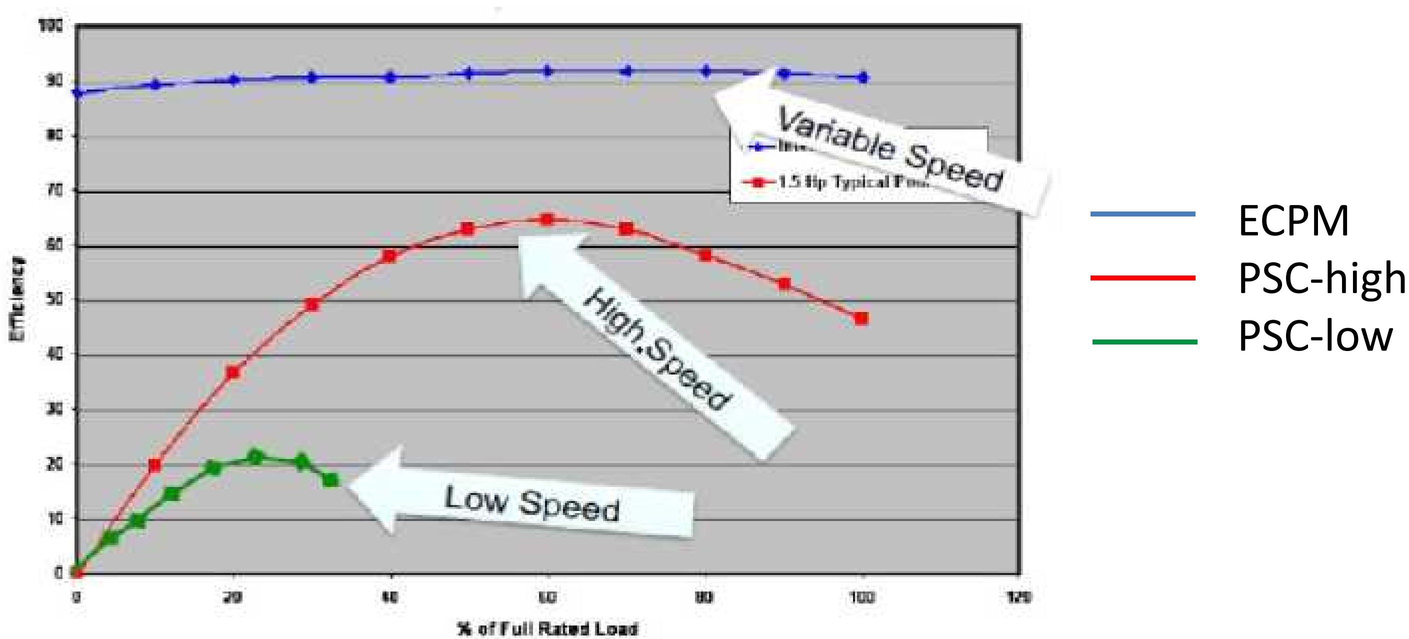


# ECPM Motors for Single Phase HVAC Fan Applications -Technology

## What problem does it solve?

Incumbent technology: Permanent Split Capacitor motors (PSC)

- Low full-load efficiency (around 60%)
- Efficiency degrades in part-load operations




Pentair_2013 Resnet Conference

# ECPM Motors for Single Phase HVAC Fan Applications - Technology

## Estimated Energy Savings

- 20% to 80% percent
  - Variations due to
    - Applications
    - Load Profiles
    - Manufacturer controller designs and programming

# ECPM Motors for Single Phase HVAC Fan Applications - Technology

## Additional Considerations for Optimal Performance

- In retrofit applications
  - The motor speed or system airflow of existing unit is input into the new ECPM
    - Required information for optimal ECPM performance
  - Important to minimize airflow restrictions (dirty filters)
    - ECPM increases speed to maintain airflow
- ECPM motors typically have low power factor (40% to 60%)

# ECPM Motors for Single Phase HVAC Fan Applications -Technology

## Non-Energy Benefits

- Substantial peak demand reductions
- Decrease cooling loads - reduced thermal losses
- Programming functionality:
  - "On-delays" to allow heat exchanger to heat up or cool down prior to fan start-up.
  - "Off delays" keep the fan running to use the stored energy in a heat exchanger.
- Variable speed operation:
  - Improves occupant comfort
  - Extends equipment life
  - Provides soft-start to help some with demand reduction (power outages)

# Questions

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# Circulating Hot and Chilled Water Pumps with Variable Speed ECPM Motors

Technology # 291 in the E3TNW.org database

http://e3tnw.org/ItemDetail.aspx?id=291


Courtesy Wilo

# Circulating Hot and Chilled Water Pumps with Variable Speed ECPM Motors

## What is it?

- Speed and pressure controlled, circulating pump with ECPM motor for commercial hydronic heating and chilled water systems
- Motors from ¼ to 7.5 HP

Courtesy Grunfos

## What problem does it solve?

- Nearly all circulator pumps are OVERSIZED
- Majority are constant speed

# Circulating Hot and Chilled Water Pumps with Variable Speed ECPM Motors

## How does it work?

- Onboard variable speed control + proportional pressure control delivers only as much water as needed
- Self-calibration (push button)
- Bus communication: GENIBus and LONWorks
- Pump speed varies in response to changing flow demands
- Offers part-load operation

Courtesy Grundfos

# Circulating Hot and Chilled Water Pumps with Variable Speed ECPM Motors

## Energy Savings

- Up to 70% to 90% pump and motor energy savings can be realized. (Manufacturer case studies, data from Europe)
- Increased boiler efficiency: reduced flow rates = lower return water temperatures (condensing boilers)
- Improved heat transfer rates


Courtesy Wilo

# Circulating Hot and Chilled Water Pumps with Variable Speed ECPM Motors

## Non-energy advantages

- **Problem**: No pump performance data available
- **Solution**: Press auto-adapt button
  - Pump self-calibrates
  - Installer can set it and walk away
  - Selling point for trade allies


- Standard flange-to-flange connections for ease of installation

# Circulating Hot and Chilled Water Pumps with Variable Speed ECPM Motors

**Estimated Costs – compared to standard circulators from same manufacturer**

- Grundfos Magna: ~50% more
- Wilo Stratus & Stratus Eco: ~ 200% to 250% more
- Simple payback period – 8 months to 3 years
  - Hours of operation
  - Pump load profile
  - How oversized was original pump

# Questions

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# High-Volume, Low-Speed Fan Technology

Technology # 620 in the E3TNW.org database

http://e3tnw.org/ItemDetail.aspx?id=620

# High-Volume, Low-Speed Fan Technology

## What is it?

- Highly efficient, variable speed blade fan, 6 to 24 feet in diameter
- Provides
  - High volume of airflow at low speeds
  - Convective cooling via increased air flow.
  - Heating via destratification

# High-Volume, Low-Speed Fan Technology

## What problem does it solve?

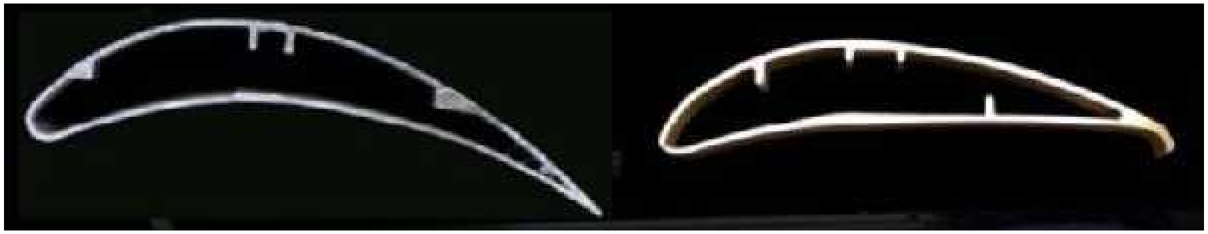
- High-speed circulating fans are very energy intensive
- 1 HVLS fan can provide the same airflow as ten or more high-speed fans
- Provides energy efficient supplemental cooling in summer and heating in winter
- Improves animal comfort and health in Ag applications

Courtesy Macroair

# High-Volume, Low-Speed Fan Technology

## How does it work?

- Long, lightweight blades slowly circulate large amounts of air
- Airfoil blade design (not flat)
  - Maximizes airflow at all fan speeds
  - Minimizes power consumption and noise
- Reversed airflow required for heating season
  - Changing fan direction and/or
  - Adjusting blade pitch (angle)
- Adjustable blade pitch – can vary airflow

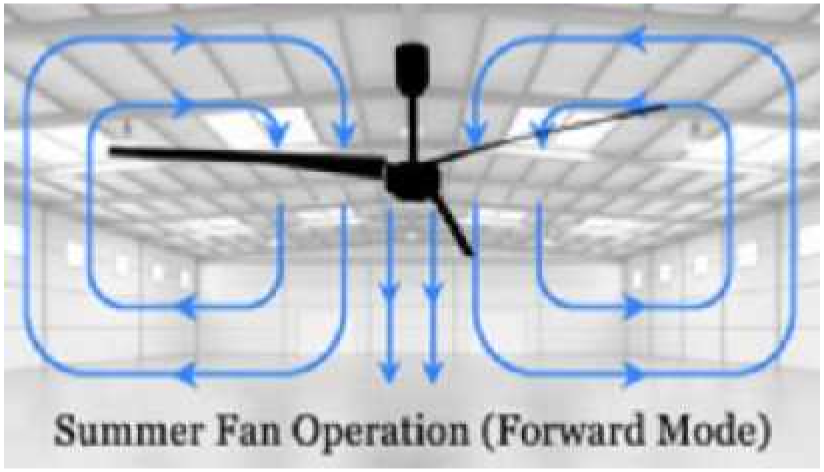


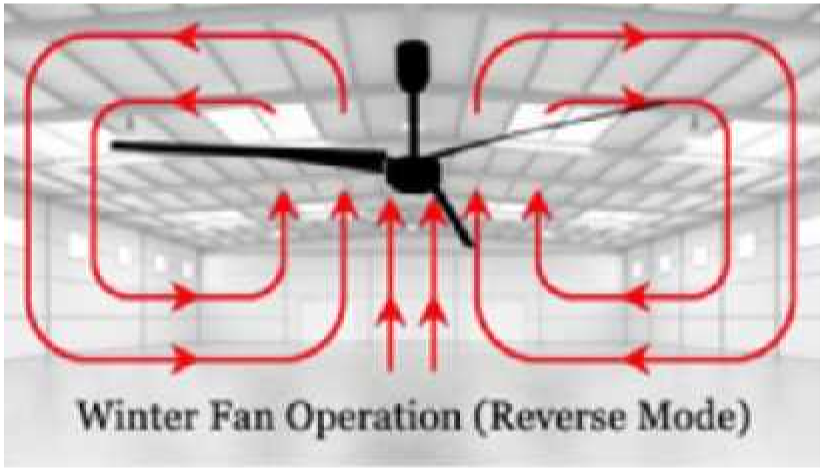
# High-Volume, Low-Speed Fan Technology

## How does it work, cont'd

- Summer: More airflow at floor level increases evaporative cooling. Cooling setpoints can be raised.

- Winter: Destratifies by pushing warm air ceiling air down, increasing ambient temperature at floor level – reduces heating equipment runtime (gas and electric savings).



# High-Volume, Low-Speed Fan Technology

## Energy Savings - Fan

- Metric = airflow per watt of fan installed [CFM/W]
- Typical fan efficacy values

| Fan Type | HP | Efficacy [CFM/W] |
|---|---|---|
| 48” High-Speed Fan | 1 | 40 |
| 20’ HVLS Fan | 1 | 194 |

# High-Volume, Low-Speed Fan Technology

## Energy Savings – Convective Cooling Effect

- Occupants perceive ambient temperature reduction of 4-8°F - increase cooling setpoints
- Reduced mechanical equipment runtime

Courtesy ConstructionBlog

# High-Volume, Low-Speed Fan Technology

## Energy Savings – Heating from Destratification

- High ceiling applications
  - 30 deg Δ T between floor level and ceiling
  - Temperature at occupant level increases 6 – 8 deg
  - Less forced air heating run-time


Courtesy Rite-Hite

# High-Volume, Low-Speed Fan Technology

## Applications

- Retail Showrooms
- Grocery Stores
- Shopping Malls
- Museums
- Restaurant, Bar and Hospitality
- Sporting Facilities, Gyms, Fitness Centers, Water Parks, Pools
- Cafeterias
- Indoor Pools
- Office Buildings
- Lobby Areas
- Fire Stations
- Worship
- Airport Terminals
- Aircraft Hangars
- Automotive Maintenance Facilities
- Warehouses and Distribution Centers

# High-Volume, Low-Speed Fan Technology

## Perceived End User Drawbacks

- Obstruction with other building components
  - Lighting - strobing effects
  - Fire suppression sprinklers and piping
  - Structural members, beams and trusses
- Additional support needed for HVLS fan installation
  - Electrical – additional conductors, conduits, etc.
  - Structural – additional strength to support size and weight
- Additional maintenance and inspections may require a lift
  - Structures and support "guy wires"
  - Regular cleaning of blades

# High-Volume, Low-Speed Fan Technology

## Design considerations

- Avoid obstructions
  - Locate fans away from lighting and sprinklers
  - Reducing fan diameter size
    - Install more units (adjustable pitch)
  - Select fans with (efficient) lighting built into the hub

## Non-energy advantages

- Increased comfort to occupants and improved indoor air quality
  - Continuous mixing of incoming fresh air
  - Reduction of condensation
  - Reduction of mildew damage

# High-Volume, Low-Speed Fan Technology

## Costs – compared to standard fans

- Retrofit cost is 25% to 30% more for HVLS over conventional
- Incremental cost can range from $1,100 - $1,500
- 20-foot diameter HVLS from MacroAir cost $5,600 with an additional $900 for structural, electrical and installation

## Simple payback period

- Depends on cost savings from electricity reduction, demand charges, and thermal savings

# Questions

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# Q-Sync Motors

## What is it?

- Constant speed evaporator fan
- Permanent magnet motor
- New control circuit design
- Synchronous motor
- 1800 RPM
- Size: 9 to 12 W (< 1/50 HP)
- Current applications
  - Refrigerated cases
  - Vending and ice machines

Courtesy QM Power

Courtesy N-Lange.de

# Q-Sync Motors

## Energy and Cost Savings

| Motor type | Efficiency (%) | Annual energy use (kWh) | Annual savings ($) |
|---|---|---|---|
| Shaded pole | 18 | 876 | 80 |
| PSC | 35 | 451 | 29 |
| ECM | 63 | 250 | 5 |
| Q-Sync | 75 | 210 | – |

Note: kWh = kilowatt-hours.



- Annual savings accounts for refrigeration heat load savings
- DOE funded demonstration – report out next year

# Thank you!

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*Thank you to Gil McCoy and Tony Simon with the WSU Energy Program*

# Next Webinar

**Tuesday, April 14 at 12:00 PM Pacific Time**

## Commercial HVAC Emerging Technologies #2

- *Variable Refrigerant Flow Heat Pumps*
- *Variable-Speed Split System Heat Pumps*

*Register at www.e3tnw.org/webinars*

More information about emerging technologies:

E3T database: www.e3tnw.org

E3T Program: www.bpa.gov/energy/n/emerging_technology/

Conduit: www.ConduitNW.org

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# Criteria

1) How significant and reliable are the energy savings per unit?
2) How great are the non-energy advantages for the end user for adopting this technology?
3) How ready are the products(s) and providers to scale up for widespread use in the Pacific Northwest?
4) How easy is it for the end user to change to the proposed technology?
5) Considering all costs and all benefits, how good of a buy is this technology for the owner?