Thinking Outside the HVAC Box: **Outdoor Air, DOAS and VRF**

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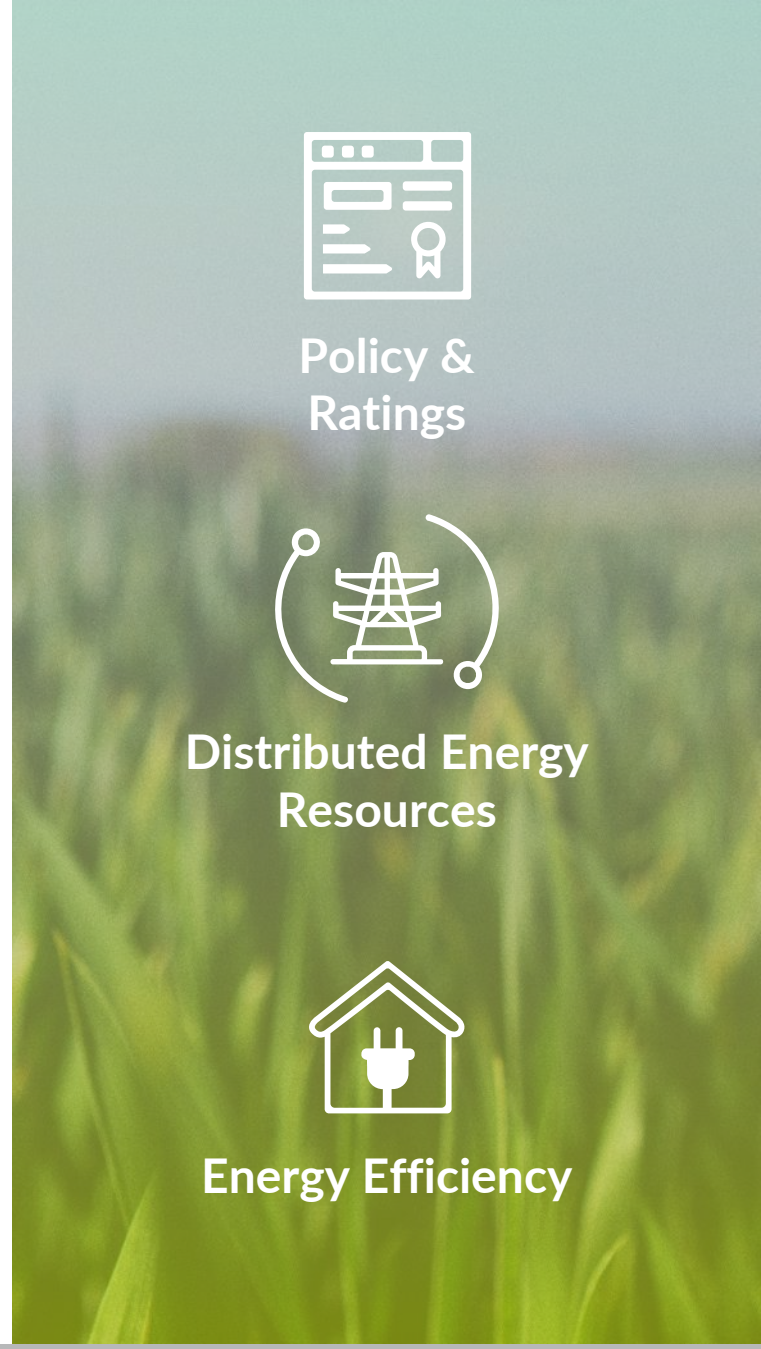
Energy Solutions

About Energy Solutions

Our Mission: Create **large-scale energy and environmental impacts** by leveraging **market-based solutions.**

- Founded in 1995
- Employee-owned
- 200+ employees
- Offices in CA, MA, MI, and NY



Agenda

1 **Outdoor Air: Why should you care?**

2 **Decoupled VRFs**

3 **Promoting Efficiency**

4 **Looking Forward**

What is the first thing that comes to mind when you think about efficiency for HVAC systems?

- SEER
- EER
- IEER
- Compressor Energy
- Fan Energy
- Economizers
- Energy Recovery
- VFDs
- Demand Control Ventilation
- **Outdoor Air?**

Outdoor Air Basics

Heating and cooling basics:

- Heating and cooling is used to counteract solar and internal loads heat and to cool outdoor air
- Outdoor air requirements are determined by building occupancy and other factors
- Almost all commercial building require forced air (mechanically powered) ventilation to bring in outdoor air

Outdoor air effects on duct sizing:

- Air volume required for cooling > air volume required for outdoor air

Primary Outside Air Options:

Outside air provided as part of the space conditioning system (coupled): Unitary HVAC (RTUs), traditional chilled water systems

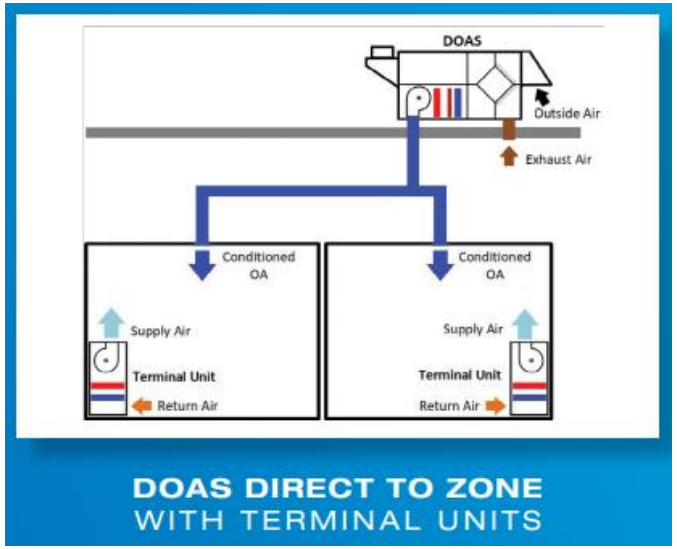
Outside air provided separately from the space conditioning system, usually through a DOAS (decoupled):

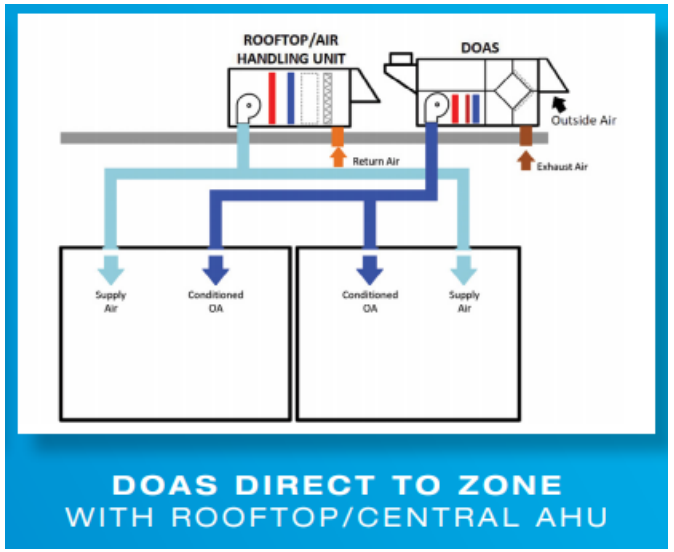
- Water Source Heat Pumps
- VRFs
- Fan coil units
- Radiant Heating

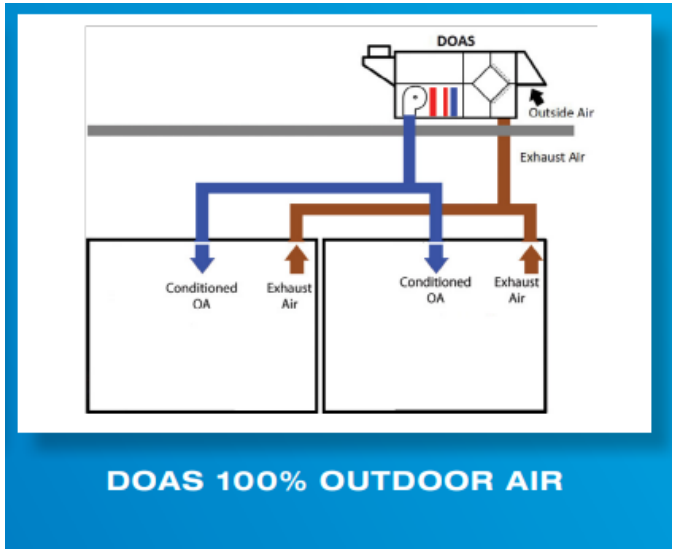
Introduction to DOAS

DOAS = Dedicated Outdoor Air System

- Cools, dehumidifies, and heats outdoor air
- Often used in conjunction with VRF or other decoupled HVAC systems to satisfy outdoor air requirements
- Often have Direct Exchange (DX) system to provide needed heating and cooling
- Interest in ventilation/DOAS has risen sharply since the pandemic
- Heat pump and energy recovery options are available on the market







Major DOAS Manufacturers

AAON

ADDISON
DEDICATED OUTDOOR AIR SPECIALISTS

CAPTIVEAIRE

Carrier

DAIKIN

DESERT AIRE

GREENHECK

PremiSys

RenewAire
Energy Recovery Ventilation

TRANE

valent

VENTACITYSYSTEMS
Making Buildings Healthy – Efficient – Smarter

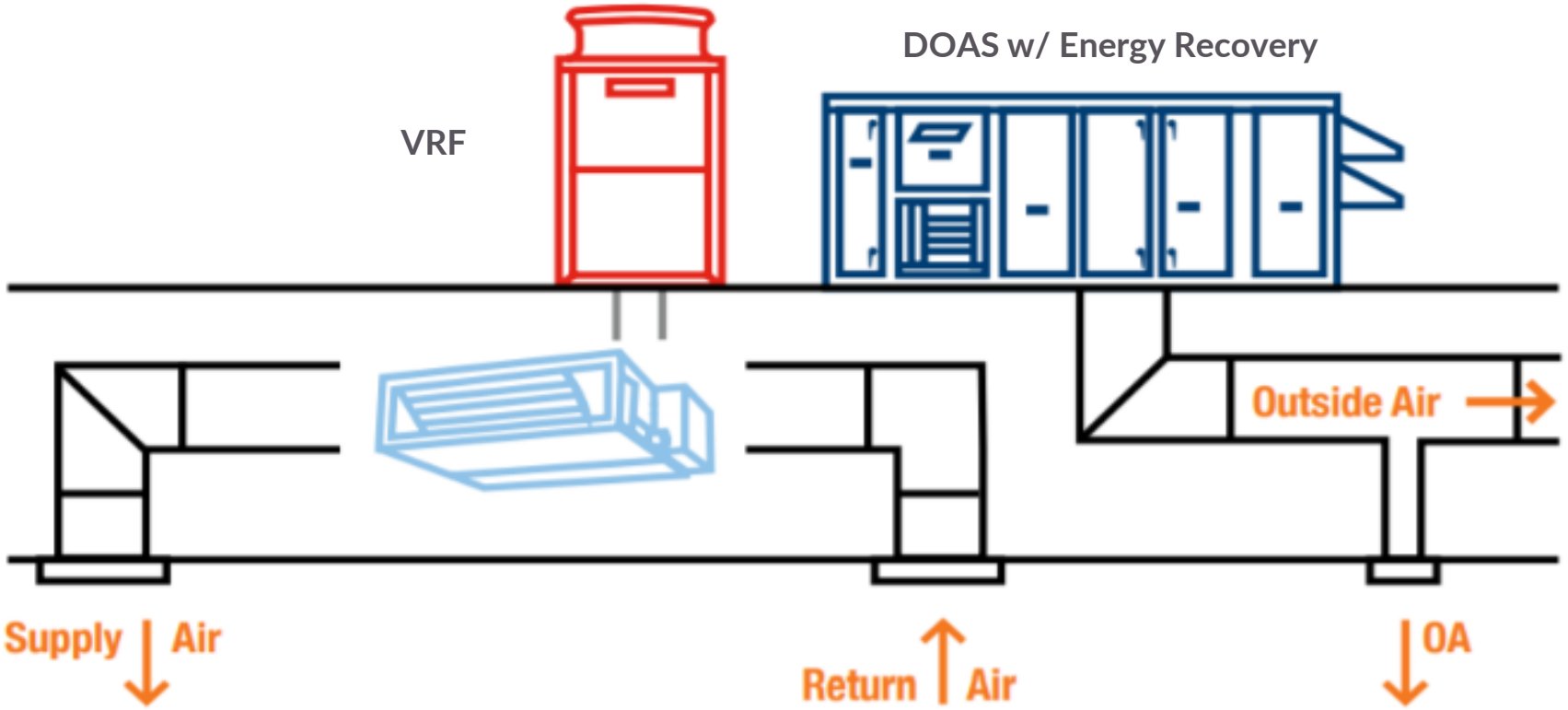
Outdoor Air Takeaways

Outdoor Air and Cooling do not have to be done by the same system and have different needs

Separate outdoor air systems allow for:

1) Optimizing of systems for latent vs sensible loads.
2) Optimized balance of airflow to fit outdoor air and cooling needs separately
3) Reduced amount of cooling necessary in a building due to lower outdoor air needs

Decoupled System



Efficiency gained from optimizing systems latent and sensible cooling needs separately for outside air and thermal loads.

VRF System Overview

Variable Refrigerant Flow

- A type of multi-split heat pump—greater than one indoor unit for each outdoor unit
- Refrigerant flow rate between indoor and outdoor units is modulated to match demand
- High efficiency systems with variable speed compressors and fans.
- Available with air-cooled or water-cooled condensers
- Models designed for cold climate operation are available

Efficiency gained from variable speed equipment

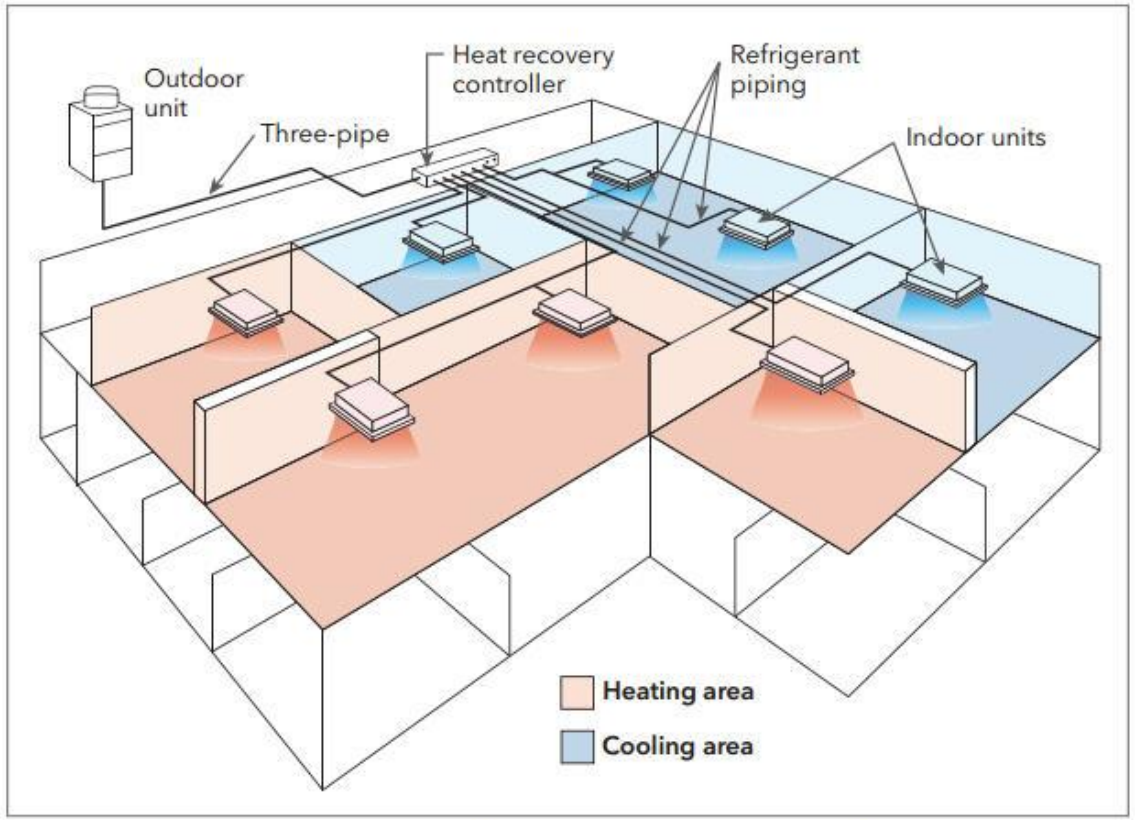
VRF Advanced Features

Heat Recovery:

- Hot refrigerant moves to zones that require heat, cold refrigerant to zones that require cooling
- Allows for simultaneous heating and cooling of a building

Load/Demand Limiting:

- Controls enable capping compressor energy usage



Variable refrigerant flow systems can deliver cooling to some zones and heating to others, with no reheat needed (an air-source system is shown here).

VRF and DOAS Interactions

VRF systems are **not capable of ventilation —**

- Requires DOAS or similar system to meet ventilation requirements
- DX-DOAS systems can provide dehumidification, reducing the required size of the VRF system
- DOAS with ERV can also be used to meet code requirements for energy recovery

Interactions

- Choosing a DOAS with energy recovery can remove the need for heat recovery VRF
- Design possibilities and efficiencies can get complicated and vary by region

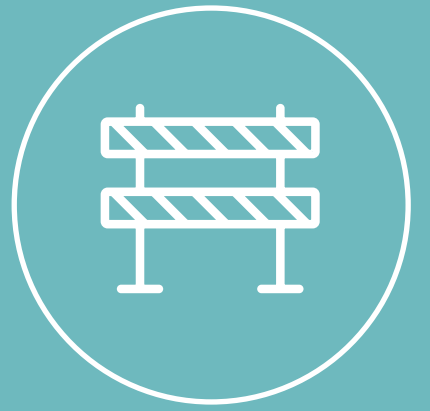
High Efficiency DOAS Features

- Inverter compressors
- Variable speed fans
- High effectiveness ERV

Rebates for DOAS?

Challenges to DOAS Promotion

- Standard definitions around DOAS and DX-DOAS
- DX-DOAS currently not regulated under federal code
- Efficiency metric for dehumidifying DX-DOAS is ISMRE(2)
- Equipment is not yet certified to AHRI standards
- Complicated assumptions if variable amount of loads or multiple systems interacting
- Need to have rules in place to promote optimal designs (e.g. Heat Recovery) by region



How Can We Promote These Designs?

- Work towards clearer federal codes and AHRI listing
- Encourage manufacturers to produce standardized IEERs
- Ensure adequate rules that vary by climate zones around system Interactions
- Create more standardized TRM and savings entries for DOAS Provide reliable incentives that can be computed my distributors, design engineers, and others during design phase to prevent value engineering

To the Future

- Facilitate more reliable HVAC savings:
  - Need to think beyond compressor efficiency and how to incentivize systems that reduce loads and look at components and other design issues
  - Make process easy to capture and estimate savings without creating burdensome designs
- Ensure that federal ratings allow for easy design and regulation of equipment (ISMRE2)
- Continue to look beyond just new HVAC systems, but the equipment that supports them.
- Look at pilots to expand and document savings opportunities with supporting technologies

Thank You!

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IEER vs ISMRE2

IEER is a measure of the **cooling capacity** in BTUH per power input unit.

ISMRE(2) is a measure of the **moisture removal capacity** in lbs/hr per power input unit.

- IEER suited for sensible only DX-DOAS, ISMRE2 suited for dehumidifying DX-DOAS.
- Many manufacturers rate to IEER, some existing programs have been treating IEER rated DOAS like RTUs.

Many manufacturers are not rating systems using ISMRE2 due to testing issues with the 2015 standard and uncertainty with upcoming changes in the test procedure.

- Many manufacturers rate their DOAS systems using IEER, essentially treating them like RTUs capable of 100% outdoor air.
- AHRI estimates that they will not have any ISMRE2 listed models until late 2022/early 2023 at the earliest.
- May require program changes as adoption of ISMRE2 increases.