




Combi Heat Pumps

Webinar- May 22, 2024



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Why Combi Heat Pumps?

In today's webinar we'll discuss:

- What are combi heat pumps?
- What is their use case?
- What have been barriers to their adoption?
- What is the current market for combi heat pumps?
- Where are combi heat pumps in use today?
- What advancements are needed to bring more combi heat pumps to market?
- What are some stories and lessons from the field?
- Example of one combi heat pump – Harvest Thermal



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Today's Panelists



Edward Louie
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Combi Heat Pump Product Market Overview & Deep Dive into One Example

May 22, 2024

Presented by:

Edward Louie

Building Energy Efficiency Research Engineer
Pacific Northwest National Laboratory

Pierre Delforge

Head of Product and Operations
Harvest Thermal

Monobloc Type



Outdoor Unit



Outdoor Unit

Indoor Unit



Split Type

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Overview

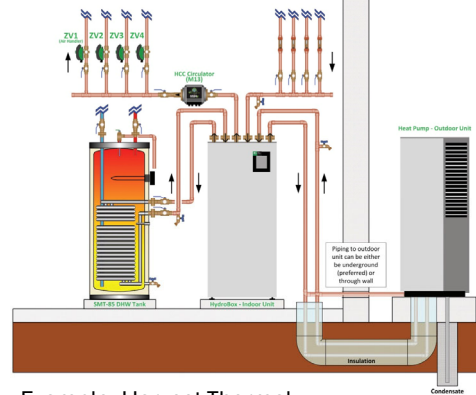
- Name/terminology – what are we talking about?
- History of combi heat pumps
- Why combi heat pumps?
- Types/categories of combi heat pump?
- Pros and cons of each type
- Market availability and readiness of products on the list
- Deep dive into the Harvest Thermal Heat Pump system
- Conclusions

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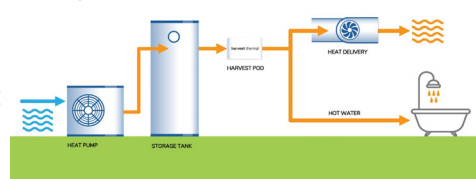
Name and Terminology

- A combi heat pump at minimum combines domestic hot water (DHW) and space heating and uses one outdoor unit to serve both functions
- Some combi heat pumps combine DHW with space heating *and* space cooling
- Some combi heat pumps combine DHW with space heating, space cooling, ventilation, and dehumidification
- Some combi heat pumps combine DHW with space heating and space cooling and thermal energy storage
- The industry and literature has a few different names for the same type of heat pump combination (combi) heat pumps, integrated heat pump, multipurpose heat pumps.
- All air-to-water heater pumps capable of outputting a high enough temperature water/glycol can be field configured into a combi heat pump setup, but getting the controls right is sometimes challenging

Example: Taco System M



Example: Harvest Thermal



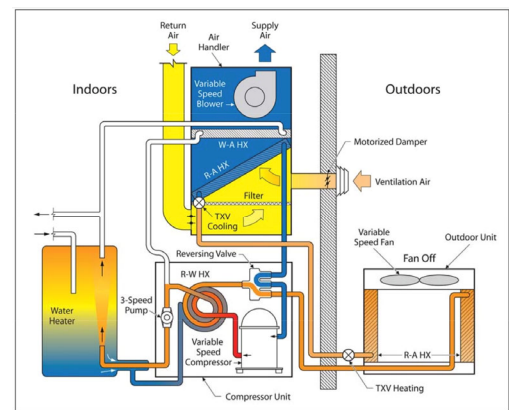
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History of Combi Heat Pumps

Combi heat pumps aren't a new thing; early combi heat pump efforts include the...

- Carrier/EPRI HydroTech 2000 – Commercial production began in 1989 available in 2 and 3-ton units.
- Nordyne/EPRI Powermiser - Commercial production began in 1992 available in 2, 3, and 4-ton units
- Lennox AquaPlus - Commercial production began in 1997

Modern technology and manufacturing capabilities, greater concern for climate change, and higher energy prices of today means we have the chance of combi heat pumps taking off this time around



Research air-source integrated heat pump by Murphy, R. W., Rice, C. K., Baxter, V. D., & Craddock, W. G. (2007). Air-source integrated heat pump for near-zero energy houses: Technology status report (No. ORNL/TM-2007/112). Oak Ridge National Lab.(ORNL), Oak Ridge, TN (United States). Building Technologies Research and Integration Center (BTRIC).

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Why combi heat pumps?

Challenges	Opportunities
Small/full electrical panel	Possibility of electrifying a home's DHW and space heating using one circuit for the outdoor unit using a combi heat pump
Water heater location not ideal for noise, cold air, and condensate	The DHW tank in a combi heat pump system doesn't generate any of these byproducts
High DHW usage household	Combi heat pumps can have high/strong hot water recovery rates
Expensive electricity at certain times of day	Combi heat pump can integrate with thermal energy storage to reduce energy usage during high electricity price periods
Home is in a climate the experiences extreme cold and/or extreme heat periods	Combi heat pump can integrate with thermal energy storage to store up heat/cold to improve efficiency and heating/cooling performance during times of extreme cold/heat.

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Residential Combi Heat Pumps – Types & Current Options

Air-to-Water Monobloc	Split Heat Pump	Split Heat Pump w Heat Recovery
Taco System M LG THERMA V Hydrosplit Daikin Altherma 3 M Harvest Thermal & SanCO2 Mitsubishi Ecodan Hydronic Aris Hydronics Arctic Heat Pump Chiltrix Multiaqua	LG THERMA V Split Daikin Altherma 3 R Samsung EHS Split Samsung EHS TDM Plus Mitsubishi Ecodan Split	LG Muti V S Heat Recovery SAMSUNG DVM S Eco Heat Recovery Panasonic Aquarea EcoFlex
Pro: Simpler Less costly Less chance of refrigerant leak Lower GWP refrigerants available Simultaneous DHW and space heating possible sometimes	Pro: No risk of freezing Efficiency of DX cooling Simultaneous DHW and space heating possible.	Pro: Simultaneous DHW and space cooling Heat recovery possible No risk of freezing Can use latent heat of ice as a heat source
Con: Freezing Glycol More HX efficiency losses DHW and space cooling NOT simultaneous	Con: Field made refrigerant connections DHW and space cooling NOT simultaneous	Con: Field made refrigerant connections 1 additional pipe Most expensive

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Air-to-water Monobloc Heat Pumps Pros & Cons

Pros:

- Low/Lower GWP refrigerants available (e.g. R600a isobutane). These refrigerants are flammable thus might not be approved to run indoors but are approved if kept outdoors.
- Less chance of refrigerant leak

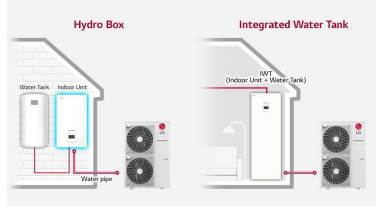
Cons:

- Additional heat exchanges impacts efficiency
- Freezing risk if glycol is not used
- Generally, DHW & space heating can't occur simultaneously, 3-way valve switches between DHW and space conditioning

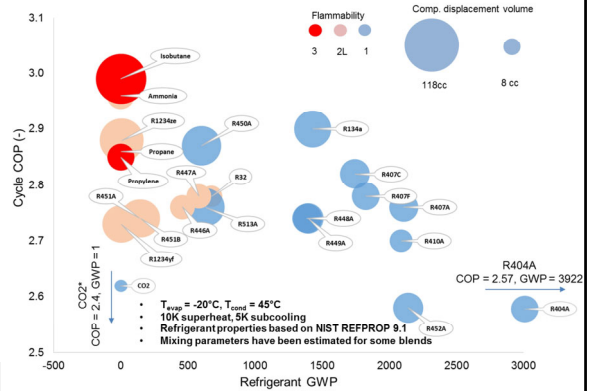
Example: Daikin Altherma 3 M



Example: LG Therma V Hydrosplit



Refrigerant Properties for Refrigeration



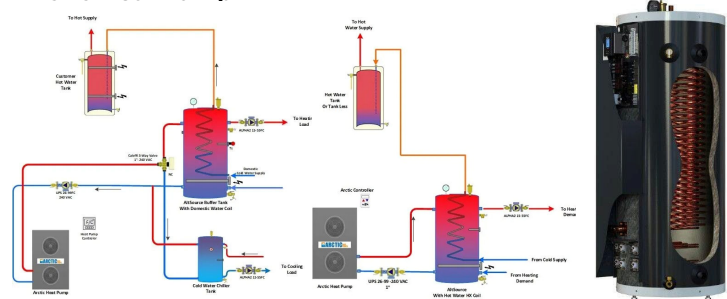
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Air-to-water Monobloc Heat Pumps More Examples

Mitsubishi Ecodan Hydronic



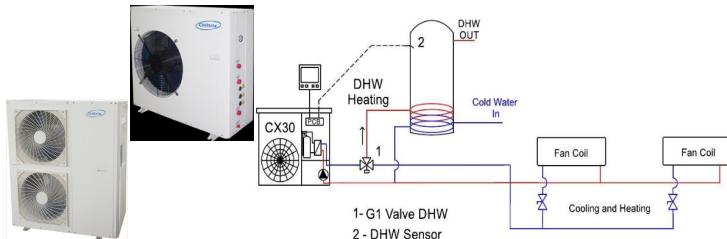
Arctic Heat Pump



Aris Hydronics



Chiltrix



Multiaqua



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Split Heat Pump Pros & Cons

Pros:

- Greater efficiency due to fewer heat exchanges and no intermediary heat transfer fluid
 - Outdoor Air ⇌ Refrigerant ⇌ Indoor Air
 - Outdoor Air ⇌ Refrigerant ⇌ DHW
- No risk of freezing

Cons:

- Field made refrigerant connections need quality installers
- Greater refrigerant charge
- Limited refrigerant choices A2Ls: R454B (GWP 466), R32 (GWP 675) unless stance on flammable refrigerants changes

Example: LG THERMA V Split



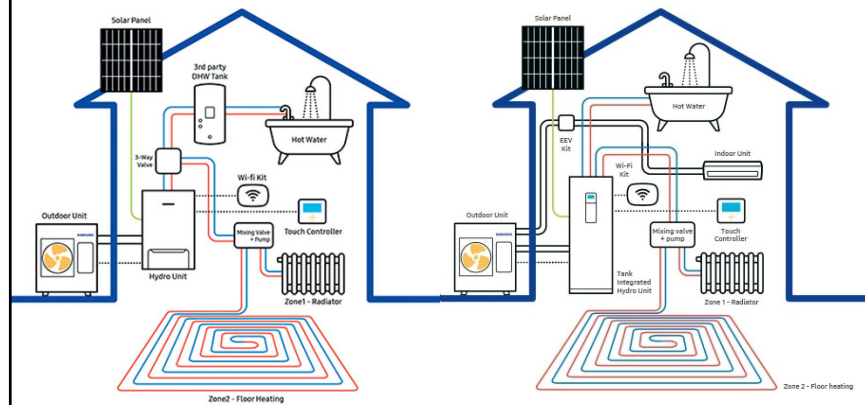
Example: Daikin Altherma 3 R



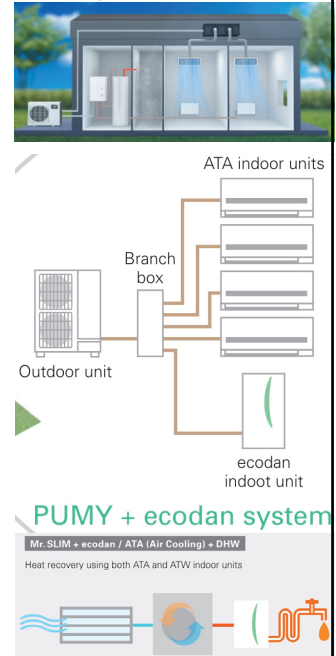
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Split Heat Pump More Examples

Samsung EHS Split
Samsung EHS TDM Plus



Mitsubishi Mr. Slim, PUMY, or PXZ paired with Ecodan



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Split Heat Pump with Heat Recovery Pros & Cons

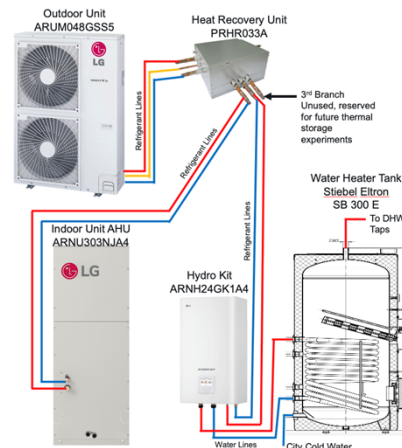
Pros:

- Simultaneous heat AND cooling is possible

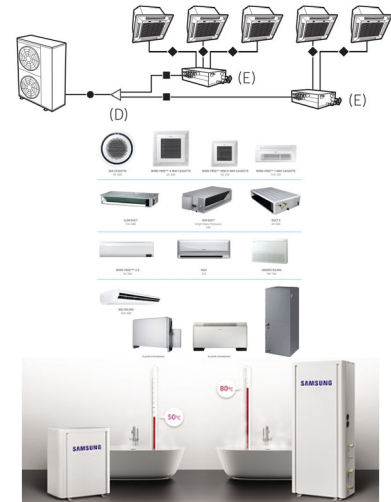
Cons:

- More expensive equipment, the additional heat recovery hardware isn't free
- Field made refrigerant connections require skilled labor
- Greater refrigerant charge
- Out of the box control logics aren't optimized for DHW + space cooling scenario

LG Multi V S Heat Recovery Example setup/configuration



Samsung DVM S Eco Heat Recovery Example setup/configuration



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Market Availability and Readiness of Different Combi Heat Pump Products

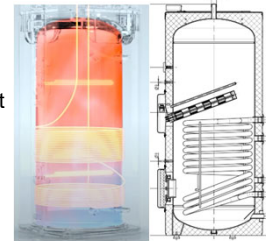
Market Availability:

- Almost all the combi products described are beginning to emerge or grow in the U.S. market
- Combi systems are more common in markets outside the U.S.

Market Readiness:

- For systems capable of heating and cooling (basically all systems except for CO₂ based systems)
 - DHW is NOT the same as hydronic radiant floor or panel radiators, systems optimized to do the latter may not be optimized to do DHW
 - ✓ Heat exchangers and tanks optimized for the hydronic radiant floor are generally not optimized to do DHW
 - ✓ Heat exchangers and tanks optimized for solar thermal, or fossil fuel boilers are generally not optimized for heat pump systems. Return temperatures matter a lot to heat pump system efficiency.
 - Pay attention to the switching efficiency/energy between heating mode and cooling mode (especially for glycol-based systems)
- For CO₂ based systems
 - Take protection measures where power outage during freezing weather is a concerned
 - Pay attention to the return fluid temperature and system design/configurations that could impact it
 - Currently no CO₂ based system is optimized for space cooling
- For the systems integrating thermal energy storage
 - Rapidly maturing technology, mostly software control logic optimization at this point
 - Pay attention to how long you want the stored energy to last
 - Pay attention to the physical footprint, shipping and installed weight of the thermal energy storage device

Heat pump refrigerant optimized tank heat exchanger versus tank optimized for solar thermal and fossil fuel boilers.



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Harvest Thermal Heat Pump System

A deep dive into Harvest Thermal's system and thermal energy storage



Pierre Delforge
Co-founder and Head of Product
pierre@harvest-thermal.com


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The slide features the Harvest logo in the top left corner. The background is a chalkboard with a hand-drawn smiley face. A hand is placed on the chalkboard, with the fingers pointing towards the smiley face. The text is overlaid on the left side of the chalkboard.

Harvest

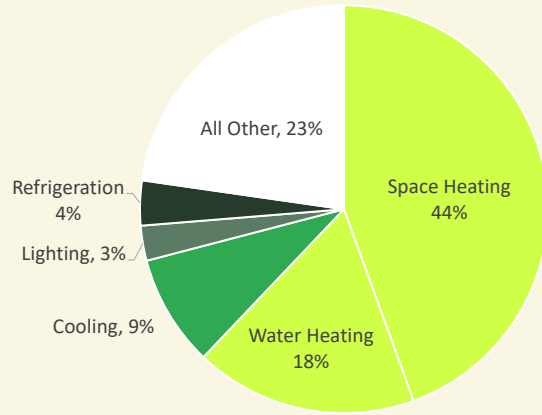
Combi Heat Pump Thermal Battery

For Transformative Home Decarbonization

 Pierre Delforge, Co-founder and Head of Product
pierre@harvest-thermal.com
May 22, 2024

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2/3 of home energy use = heating and hot water



EIA End Use Energy Consumption 2020

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Did you know?

Home heating and hot water account for

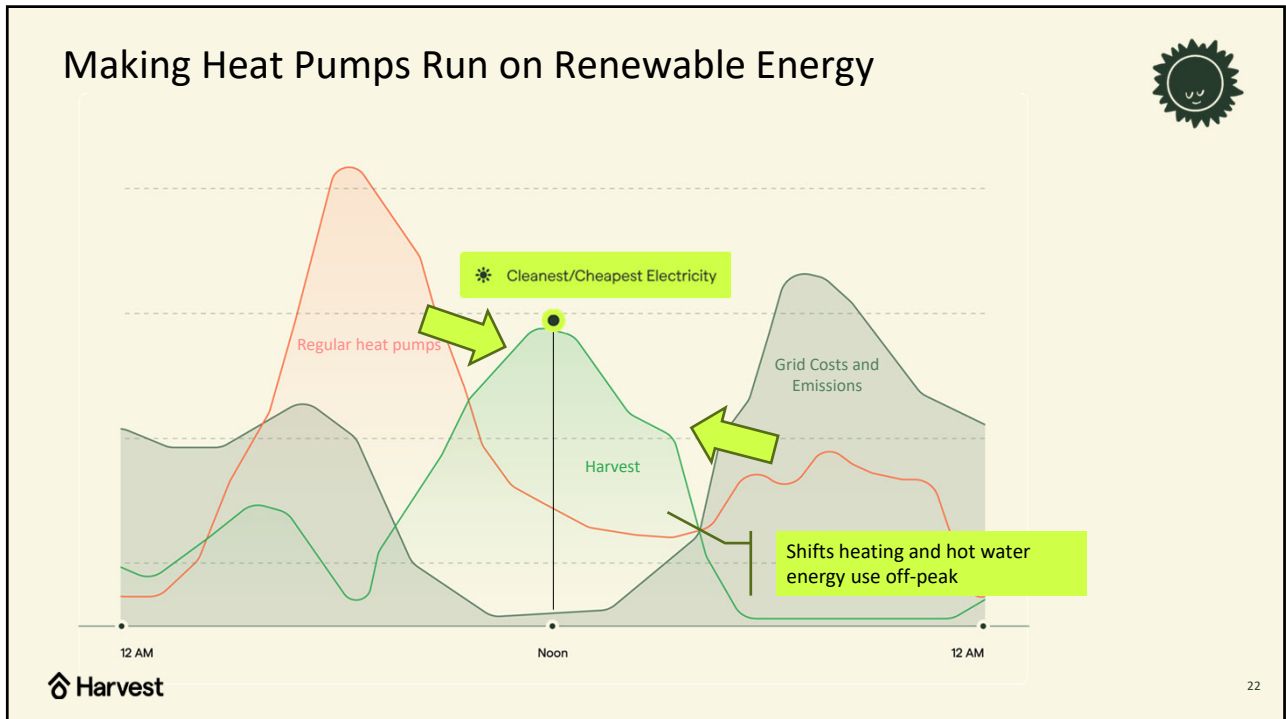
10%

of America's emissions problem

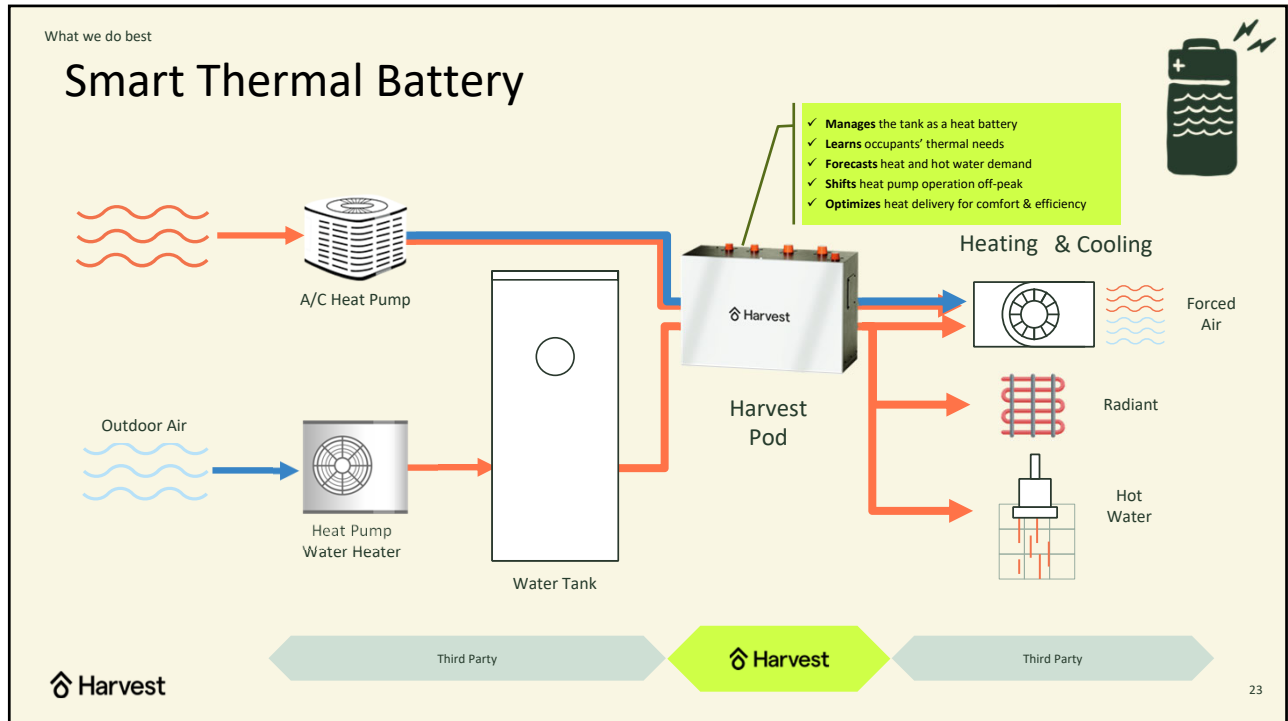
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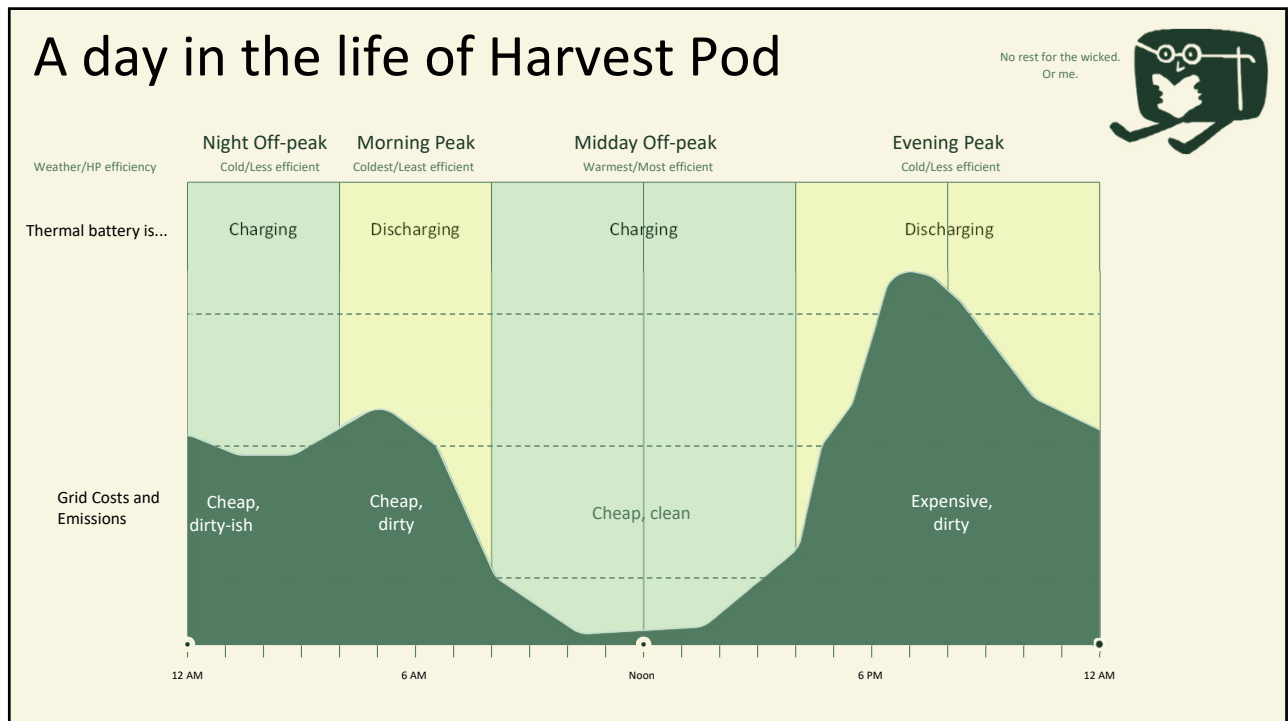
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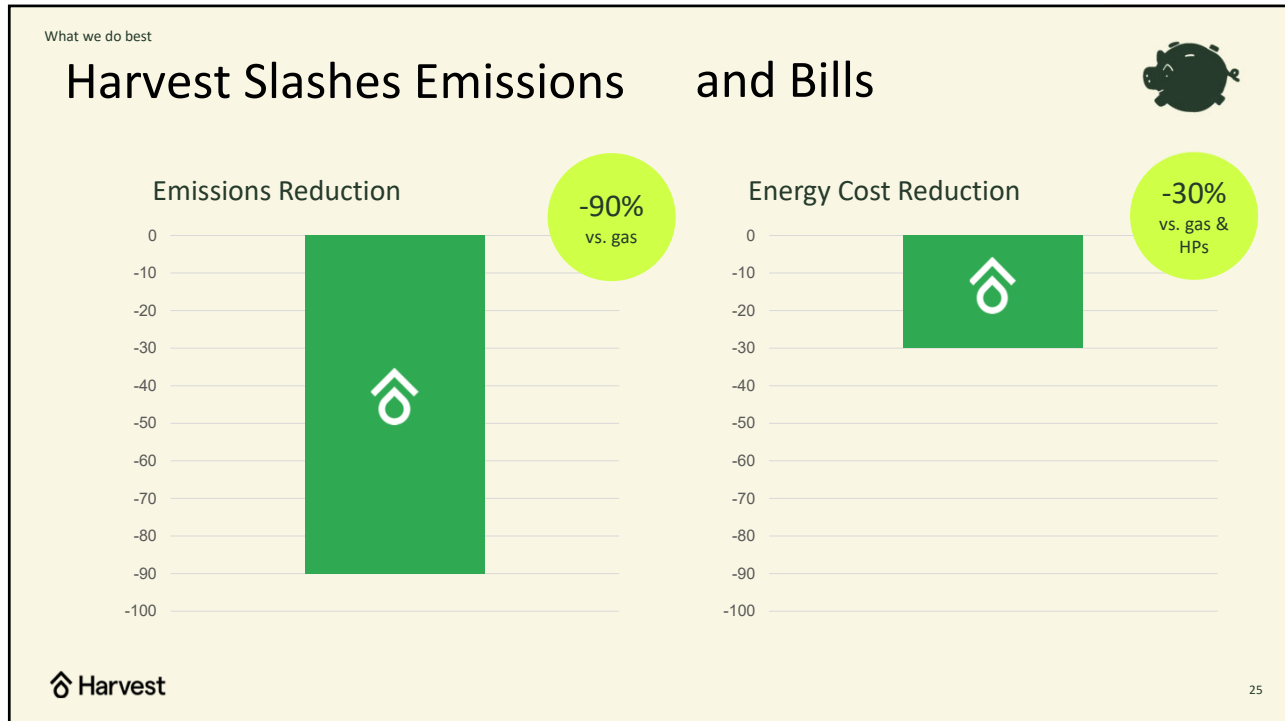
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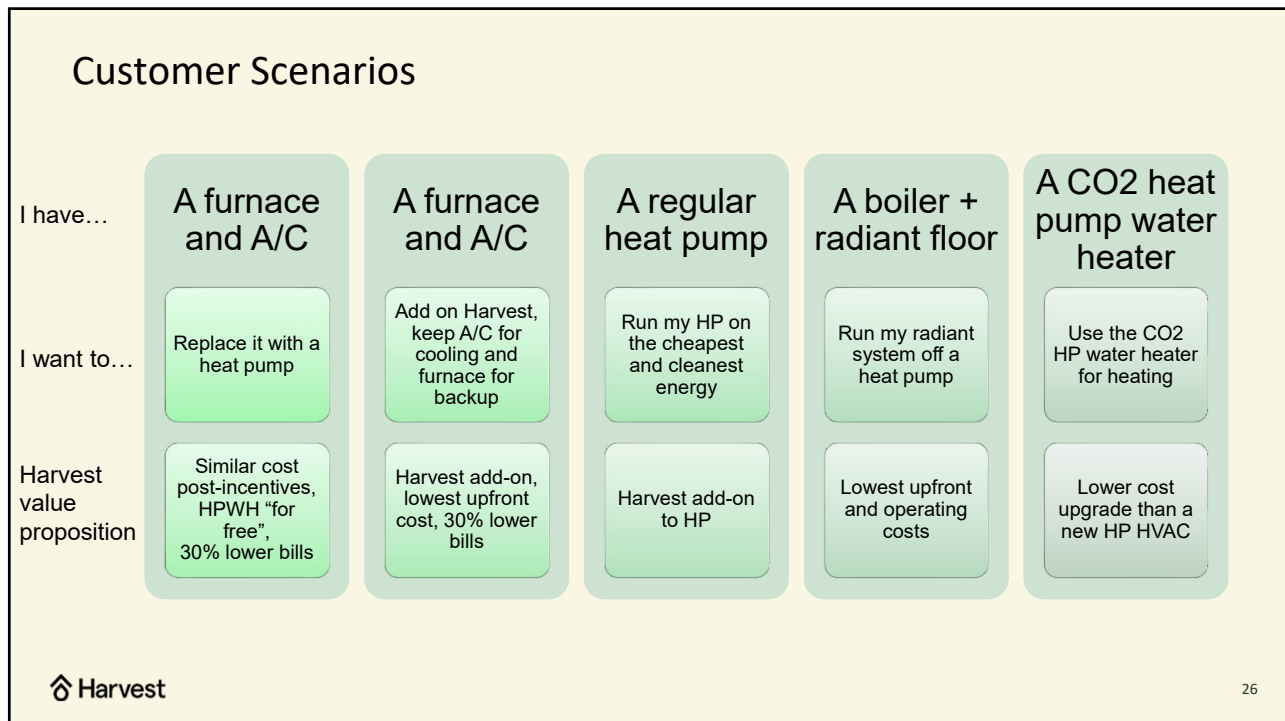
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Harvest Systems in the Field



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Conclusions

- Combination (combi) heat pumps, integrated heat pump, multipurpose heat pumps have a lot to offer and can solve a lot of problems

Challenges	Opportunities
Small/full electrical panel	Possibility of electrifying a home's DHW and space heating using one circuit for the outdoor unit using a combi heat pump
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Proven High Efficiency

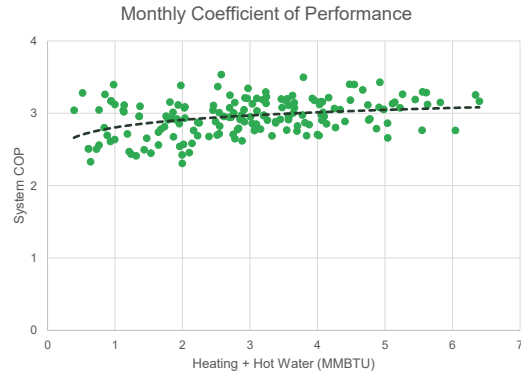


Field measured Efficiency:

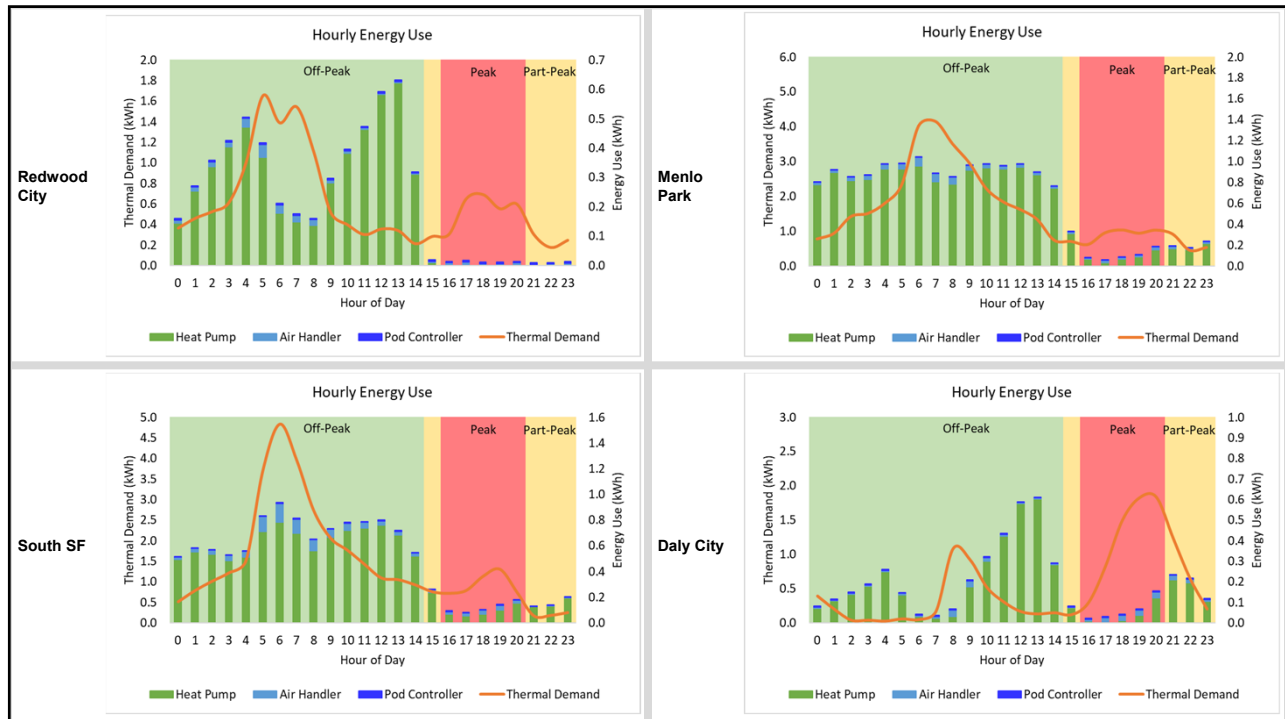
- 370%: annual **heat pump** performance
- 300%: annual **whole system** performance

This in-field efficiency is comparable with the most efficient heat pumps on the market.

On top of that, Harvest delivers the cost and emissions benefits of load shifting.



Why it matters: Efficiency + load shifting → Lowest operating costs



Summary



- ✓ 3-in-1: HVAC, hot water, thermal battery
- ✓ 30% energy costs reduction
- ✓ 90% climate pollution reduction
- ✓ Grid-friendly



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Thank you.

Heat your , not your home .

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