Industrial Heat Pumps (IHPs) Intro

• Can be driven by:
  ➢ Electricity (motor-driven)
  ➢ Steam (steam ejector)
  ➢ Heat-activated (sorption)

• IHPs are those larger than 100kW that move heat up from a lower heat source temperature to a heat sink temperature of greater than 150°F (~65 °C)

• Opportunities to lower operating costs and carbon emissions under favorable conditions
Steam Boiler vs. IHP

**Fossil Fuel Driven Steam Boiler**
- Fossil fuel (natural gas) 120 units
- Flue gases 20 units
- Process heat 100 units @ 250 °F

**Electricity Driven Heat Pump**
- Electricity 25 units
- Industrial heat pump Coefficient of Performance (COP) = 4.0 = (100/25)
- Process heat 100 units @ 250 °F
- Waste heat 75 units @ 180° F

**Waste heat recovery**
- 75 units @ 180° F
Process Heat Accounts for Most (~70%) Industrial Energy Use

U.S. Manufacturing Sector Process Energy Flow in 2010

Significant Industrial Process Heat is at or Below 150 °C

Data Source: McMillan 2019
Many States have Favorable Cost Parity for IHPs

- Blue states indicate areas where operating an industrial heat pump is likely more affordable than running a natural gas-powered equipment.
- Based on electricity/natural gas ratios.
- Assumes a COP of 4.0.

*Propane and RNG make IHP use even more cost-favorable.*
IHP Research Phase 1: Opportunity Scouting

- Process heat: 51% of industrial on-site energy use. The large, early, cross-cutting GHG reduction opportunity

- Three industry groups - good early focus for IHPs, as they have high amount of process heat < 200°C
  - Food & Beverage
  - Pulp & Paper
  - Chemicals

- IHPs research shows combined potential impact of:
  - Net energy savings 26-32% (427-518 TBtus/year)
  - CO₂ savings 30-43 million tons/year
  - Simultaneous cooling needs met
  - 5 GW-hour/year electricity needed

- Simple paybacks can be under 2 years, depending on electricity/ natural gas price ratio

- Policy enablers can accelerate adoption

Report: https://www.aceee.org/research-report/ie2201
Website: https://www.aceee.org/industrial-heat-pumps
Market Transformation is Needed in both Supply and Stoking Demand

Where we are:

- End-users have process heat needs that can be met with available IHP tech
- There is **limited commercial availability** of IHPs in the U.S.
- The U.S. has fallen behind the EU and others in IHPs, industrial electrification at large
- New plants are looking to be fueled by 100% carbon-free electricity
- There is limited knowledge on the current potential of IHPs for end-users

Where we want to go:

- Robust domestic IHP market supported by capable workforce
- IHP implementation at scale in both new and retrofitted facilities
- Decarbonization of process heat, enabling of other solutions (I.E., thermal storage, on-site renewables)
- IHP manufacturing and implementation support equity, create jobs in underserved communities
- Full market awareness of IHP potential
Roles for federal government

• Support domestic supply (48C, DPA & LPO)
• Build knowledge & expertise in design & installation (USDA-NRCS, EPICx, IACs & TAPs)
• Develop market infrastructure (MESC, IEDO & LPO)
• Support IHP demonstrations (MESC & IEDO)
• Support implementation (MESC, IEDO, LPO & USDA)
Important Stakeholder Interconnections in the IHP Value Chain

IHP Suppliers and supply chain

Utilities & State Programs

Suppliers provide product availability, technical & maintenance support to end-users

Utilities help connect IHP suppliers with end-users, find candidate sites for demos. Possible future equipment incentives

Federal policies, programs & funding

Federal policies and programs supporting early IHP adoption. Federal funding (White House, DOE, Treasury) supports manufacturing, testing infrastructure, implementation, and design of IHP systems.

Industrial End-Users

Energy & Refrigeration Engineers

ACEEE & other NGOs

ACEEE & others convene, aggregate demand, connect players with each other & with funding opportunities

Third-party firms conduct thermal analysis, IHP design & installation

NEMA serves a convening role, gathering and representing IHP suppliers

NEMA

• 48C
• DPA funds
• LPO

Utilities

EPRI, NASEO & NARUC

Utilities & State Programs
Federal programs & Incentives to Support Domestic IHP Supply

- DPA co-funding
- 48C mfg. tax credits
- LPO financing of new manufacturing
- Funding infrastructure (e.g., testbed)
Market Assessment of IHP Potential

National study of:
- ID of key industries with opportunities
- Distribution of opportunity by temperature
- Geographic distribution of opportunities
IHP Market Support Programs

- On-shoring of IEA knowledge base
- National trainings
- Regional TAPs
- IAC involvement
IHP Demonstration Incentives

Utilities and Energy Governance Orgs.

IHP Manufactures & Suppliers

Value chain

Industrial End-Users

Energy Engineers

- MESC & IEDO grants & incentives
- LPO demonstration fund
IHP Implementation Incentives

- Utilities and Energy Governance Orgs.
- Value chain
- Industrial End-Users
- Energy Engineers
- IHP Manufactures & Suppliers

- 48C customer tax credits
- MESC grants & incentives
- Farm Bill Title IX REAP
Federal Programs & Incentives to Support Domestic IHP Supply

- DPA co-funding
- 48C mfg. tax credits
- LPO financing of new manufacturing
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IHP Manufacturers & Suppliers

Utilities and Energy Governance Orgs.

Value chain

Industrial End-Users

Energy Engineers

National study of:
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On-shoring of IEA knowledge base
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MESC & IEDO grants & incentives
- LPO demonstration fund

48C customer tax credits
- MESC grants & incentives
- Farm Bill Title IX REAP

DPA co-funding
- 48C mfg. tax credits
- LPO financing of new manufacturing
- Funding infrastructure (e.g., testbed)
IHP Connected Programs:
- State leadership grants and programs
- ($3.2m) IAC expansions

Relevant Funding:
- BIL 40523 IAC Expansions
- BIL 40521 IAC Impl. Grants
- BIL 40534 State Manufacturing Leadership
- IRA 50161 Advanced Industrial Facilities Deployment

Manufacturing and Energy Supply Chain (MESC)
- Director
- Principal Deputy Director

- MESC-10 Facility and Workforce Assistance
- MESC-20 Battery and Critical Materials
- MESC-30 Energy Sector Industrial Base Technical Assistance
- MESC-40 Business Operations

Relevant Funding:
- BIL 40555 Rebate Program
- IRA 50143 Manufacturing Conversion Grants (+OCED)
- DPA (IRA)
- 48c + 45x Tax Credits

IHP Connected Programs:
- ($250m) DPA awards for IHP manufacturing*
- ($10b) 48 C for manufacturers & end-users

Source: https://usea.org/sites/default/files/event/Dr.%20Zach%20Valdez.pdf
### Overview of 48C Round 1 (2023)

**What is the Qualifying Advanced Energy Project 48C Credit?**

- Competitively-awarded Investment Tax Credit (ITC) established in 2009 and functions very similar to FOA
- Expanded by IRA with **$10B** for (1) clean energy manufacturing & recycling, (2) critical materials, and (3) industrial GHG emissions reduction projects
- Projects receive 30% ITC (or 6% if prevailing wage and apprenticeship requirements not met)
- DOE will accept a first round of applications in 2023 to allocate up to $4B, with additional competitive application rounds in future years
- Approximately 40% of credits ($1.6B) will be allocated to projects in coal communities (if sufficient meritorious applications are received)

**Timeline and Review**

- **Notice Released:** May 31
- **Concept Papers Due:** July 31
- **Full Applications Due:** Fall 2023

DOE will evaluate proposals against technical review criteria reflecting four major priority measures, and pass recommendations to Treasury:

1. Commercial Viability
2. Greenhouse Gas Emissions Impacts
4. Workforce and Community Engagement

With merit review scores plus program policy factors DOE will rank all meritorious projects into a final list for up to $4 billion in allocations for IRS

**Allocation Decisions:** No later than March 31, 2024

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**Legend**

- **Scope defined by ARRA in 2009**
- **Scope added by IRA**

**Clean Energy Manufacturing and Recycling**

- Re-equip, expand, or establish industrial or manufacturing facility for **production or recycling of clean energy and energy efficiency technologies**

**Critical Materials Processing, Refining, and Recycling**

- Re-equip, expand, or establish an industrial facility to **process, refine, or recycle critical materials** (50 USGS minerals + DOE critical materials)

**Industrial GHG Emissions Reductions**

- Re-equip industrial or manufacturing facility to **reduce greenhouse gas emissions by at least 20%**
IHP Connected Programs:
- ($23m) TAPs program (awarded)
- ($70m) ASU EPIXC Institute

BIL, IRA Industrial Demonstrations Program

BIL 40521 IAC Implementation Grants (i.e., TAPs expansion)

Industrial Efficiency & Decarbonization Office

Energy- and Emissions-Intensive Industries

Cross-Sector Technologies

Technical Assistance & Workforce

IHP Connected Programs:
- ($104m) Industrial Efficiency & Decarbonization FOA (ongoing)
- ($156m) FY23 Multi-topic FOA (Industrial Heat Shot)

Source:
https://www.energy.gov/sites/default/files/styles/full_article_width/public/2022-10/IE DO.png?itok=KxBMa0JJ
Highlighted Barriers

**Supply Side:**
- Workforce gaps
- Intellectual property constraints on IHP components
- Large manufacturers not operating domestically at scale
- Codes and regulatory constraints
- Perceived risk from suppliers, implementers w/out demonstrations/market assessment

**Demand Side:**
- Limited domestic IHP product availability
- Lack of demonstrated energy/GHG and **cost** savings
- Lack of knowledge of opportunity
- Limited current vendor support for international product
- Need engineering to support implementation and integration at end-user facilities
- Resource adequacy - supply of electricity
- Economic constraints for end-users, large capex investment
- Fuel switching
Ongoing ACEEE Work to Help Overcome Barriers

Supply Side:
- ACEEE and partners are engaging with DOE, White House, Treasury, and other possible sources of federal funding to:
  - outline the most significant barriers IHP manufacturers face in increasing domestic production, and possible enablers
  - connect players with funding opportunities (FOAs) as we gain understanding
- Identifying contacts with IHP suppliers for further collaboration, NEMA
- ACEEE response to RFI on DPA co-funding for heat pumps

Demand Side:
- ACEEE is engaging with utility sponsors, creating IHP pilot projects for end-users in their service territories
- ACEEE is engaging with the Renewable Thermal Collaborative and their network of end-users

*Pilots give proof of concept & build knowledge base in the marketplace for both suppliers and end-users*
Use of DOE’s IACs and TAPs program for implementation assistance and maintenance

Alleviating codes constraints for IHP components and refrigerants

Creation of a national industrial heat pump test facility

Co-funding opportunities for demonstrations

Utility programming in support of IHP implementation

National trainings on opportunities for engineers, others

*Combination of policy action & connection of key supply chain actors
IHP Alliance

- Assistance with utility program design
- How to leverage state policy
- Utility based pilot projects

Utilities and Energy Governance Orgs.

*in addition to advocating, communicating policy action

Buyers Group
- Evaluation of needs, barriers
- ACEEE training(s) on IHP use

Industrial End-Users

- Thermal analysis; what are thermal needs of each system? Re-engineering of thermal systems in retrofitting
  - Armstrong International

IHP Manufactures & Suppliers

- Suppliers Group
- Evaluation of needs, barriers

- Connection to implementers and integrators (Cascade, FlexTech, Armstrong etc.)
- Connection to technical assistance measures (IACs, TAPs)

Energy Engineers

Value chain
Next Steps

Understanding of barriers, coalition, alignment on consistent messaging
- ACEEE, NEMA, RTC IHP Alliance
- IHP Workshops at ACEEE Summer Study & EER
- Collaboration with TAPs, EPIXC Institute

Communicating priorities, identifying best pathways for mitigating barriers
- Convening of stakeholders from across IHP value chain
- Public event for stakeholders to commit to accelerating US IHP market

Affecting action, demonstrations, funding
- Congressional briefing/hearing on IHPs
- Advancing installed IHP capacity and pilots, designated demonstration site for key applications

Key Outcomes
- Collaboration with TAPs, EPIXC Institute
Upcoming Events and Resources

• ACEEE IHP report: [https://www.aceee.org/research-report/ie2201](https://www.aceee.org/research-report/ie2201)
• ACEEE IHP website landing page: [https://www.aceee.org/industrial-heat-pumps](https://www.aceee.org/industrial-heat-pumps)
• RTC industrial electrification report: [https://www.renewablethermal.org/electrifying-us-industry/](https://www.renewablethermal.org/electrifying-us-industry/)
• Australian Alliance for Energy Productivity’s online heat pump estimator: [http://www.heatpumpestimator.com/](http://www.heatpumpestimator.com/)
• Next IHP workshop at ACEEE’s Energy Efficiency as a Resource Conference in October [https://www.aceee.org/energy-efficiency-resource](https://www.aceee.org/energy-efficiency-resource)