



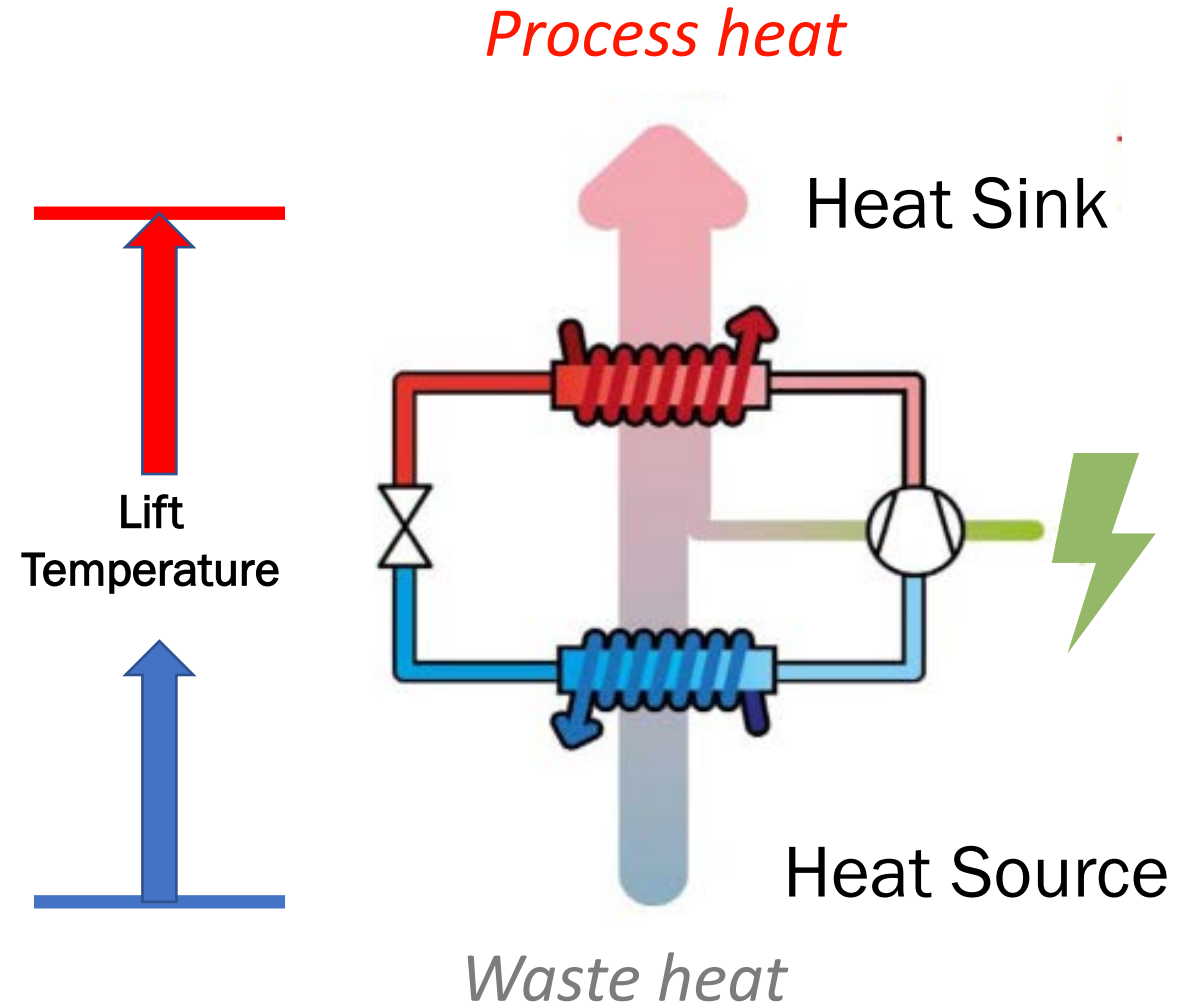
Industrial Heat Pump Market Transformation –

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Neal Elliott
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2023

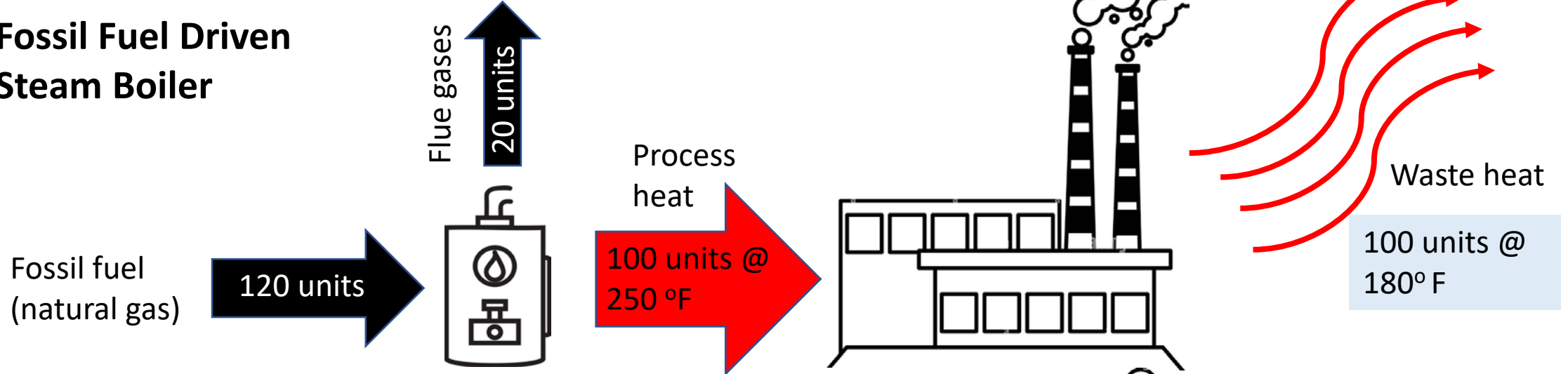
Industrial Heat Pumps (IHPs) Intro

- 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

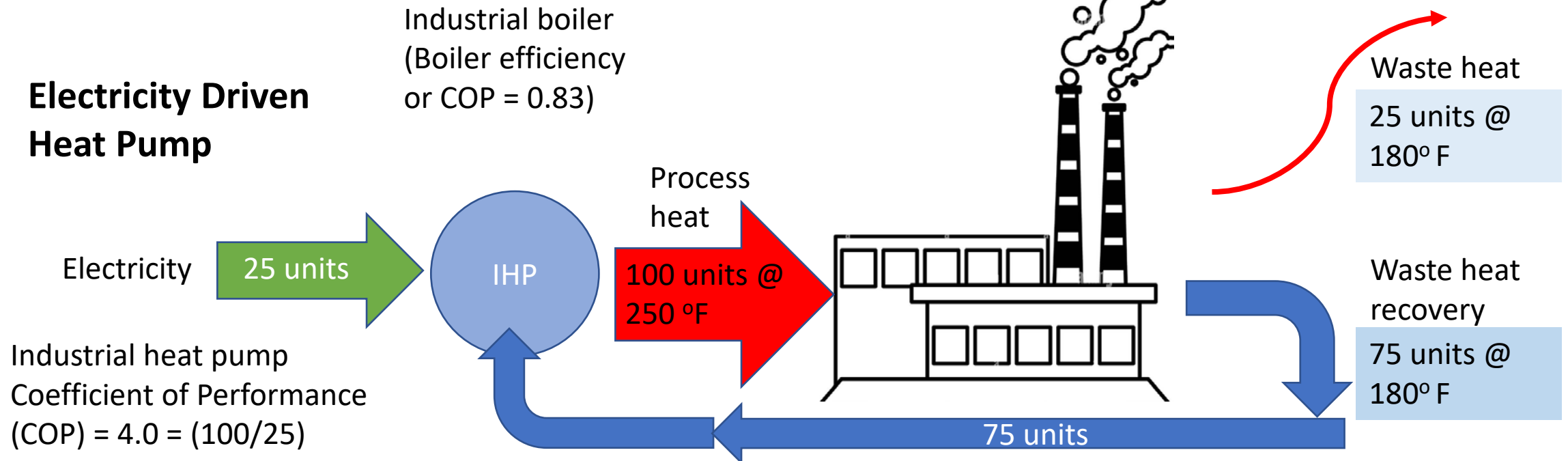


Steam Boiler vs. IHP

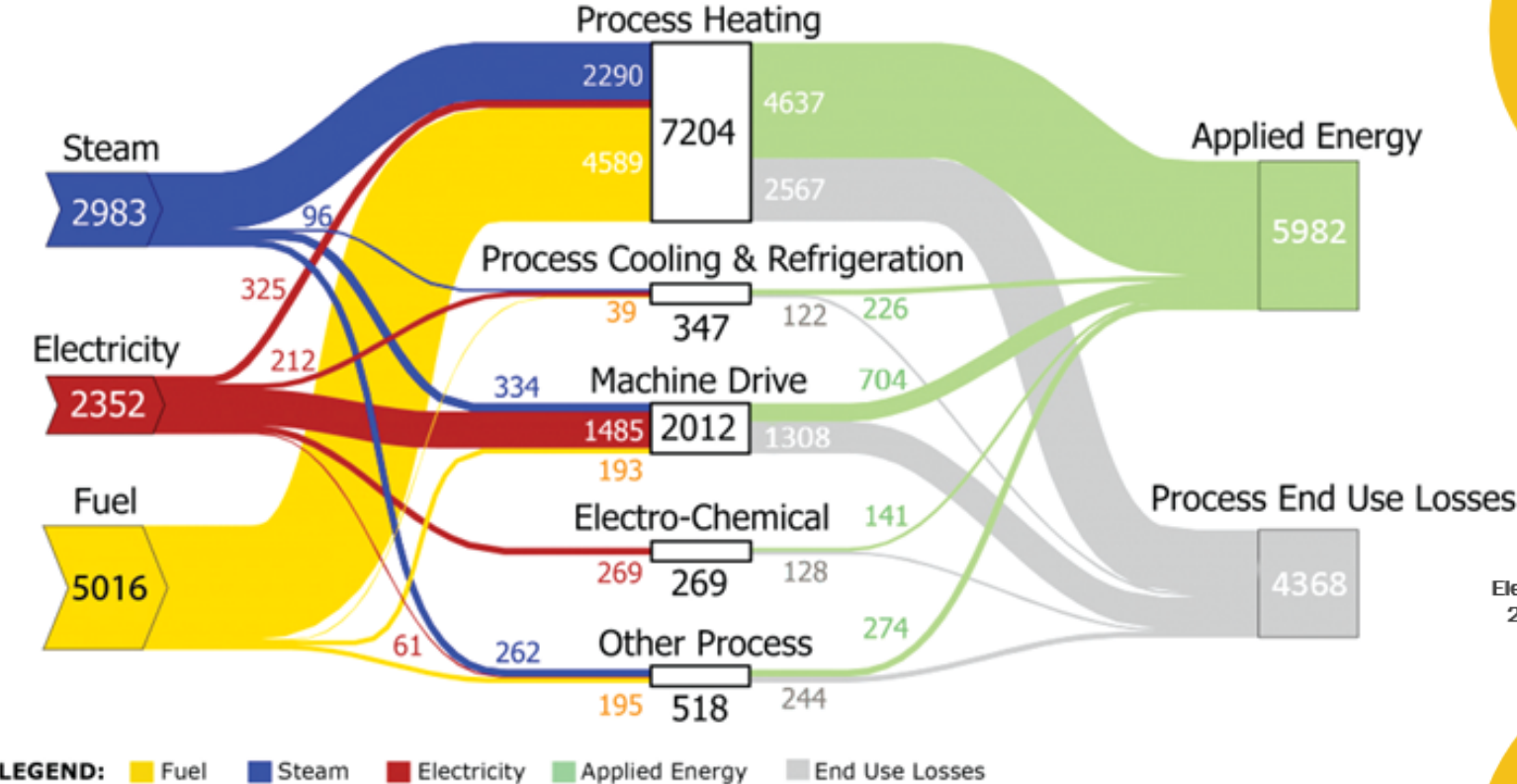
Fossil Fuel Driven Steam Boiler



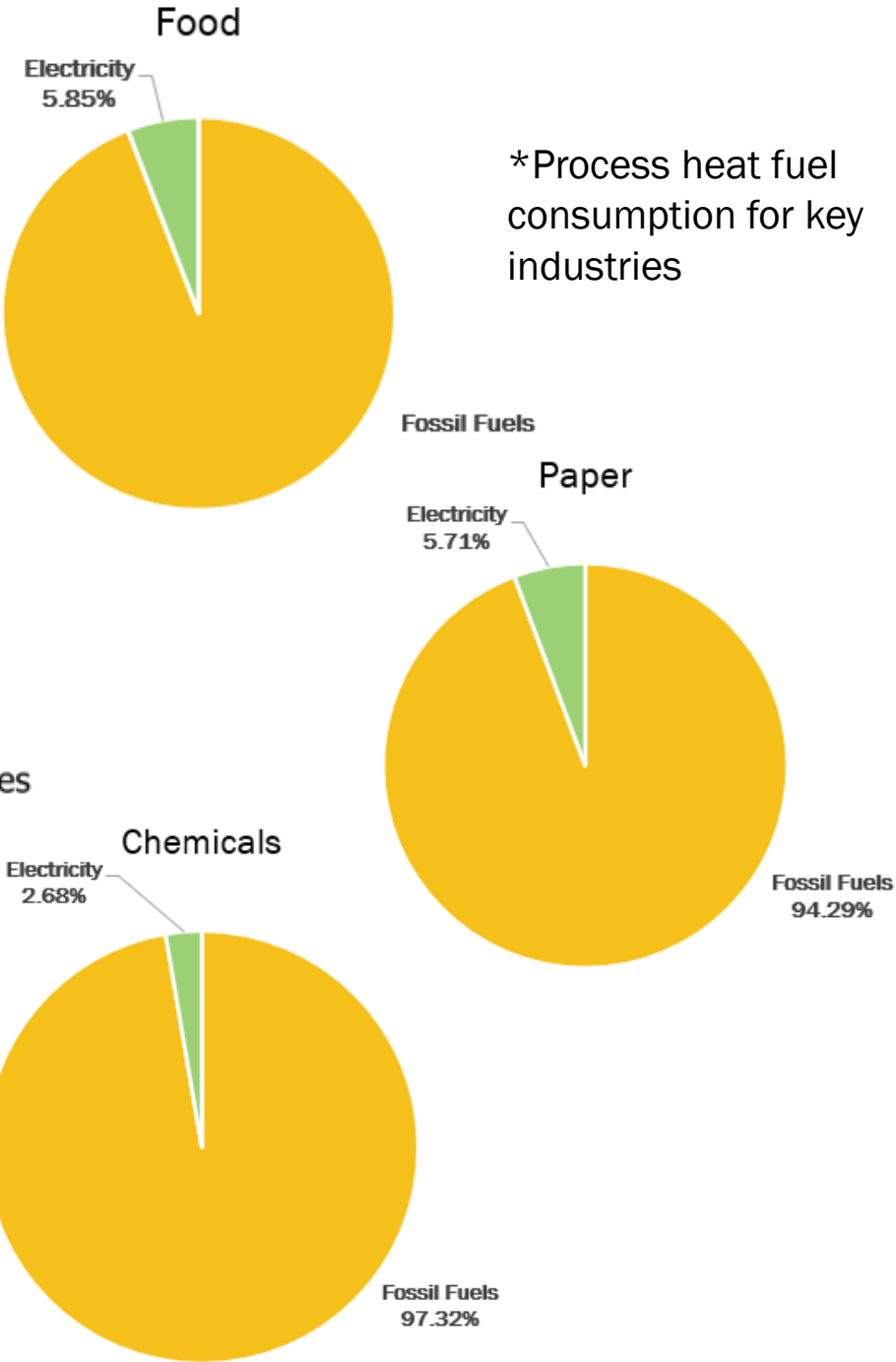
Electricity Driven Heat Pump



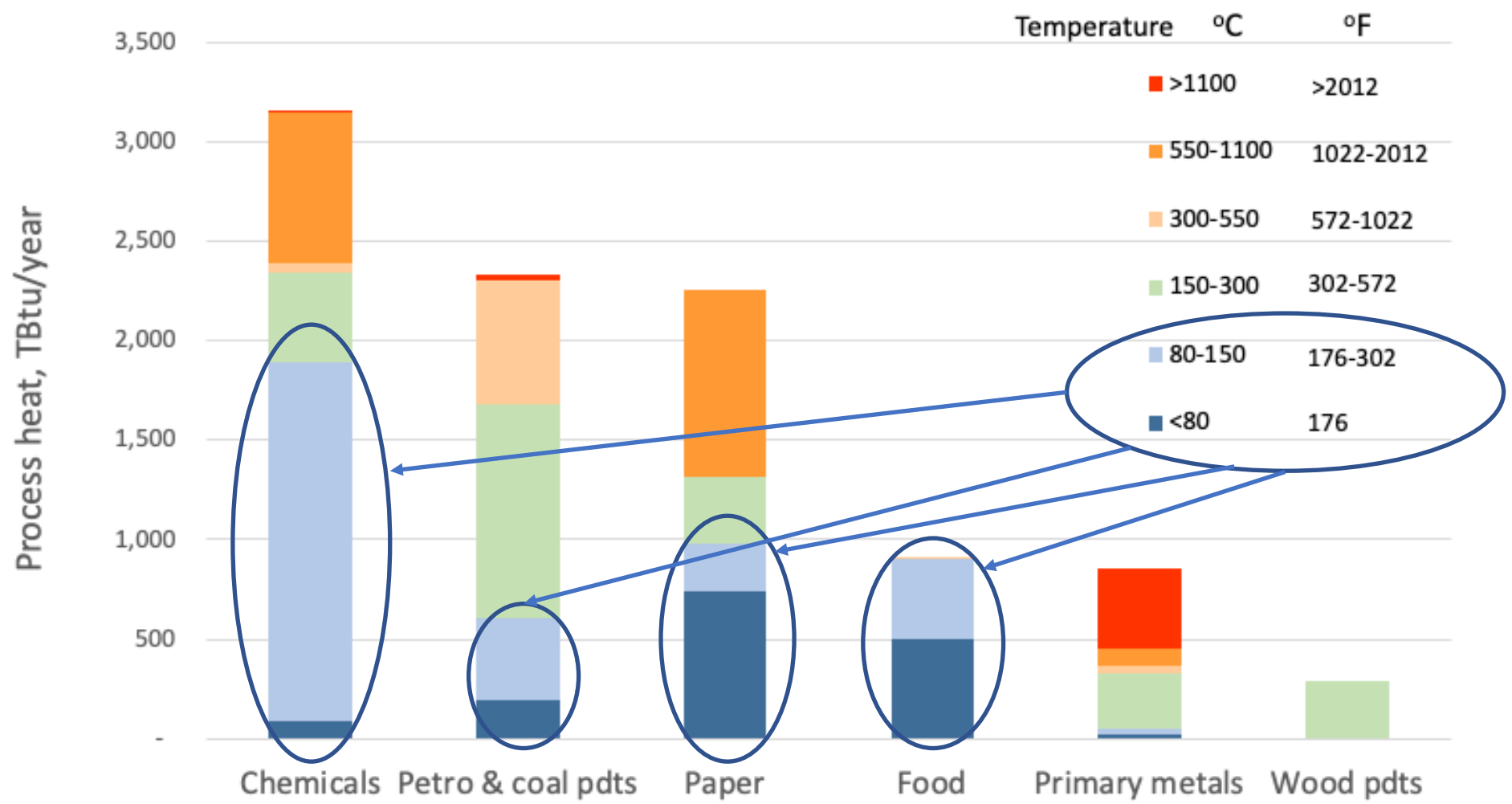
Process Heat Accounts for Most (~70%) Industrial Energy Use



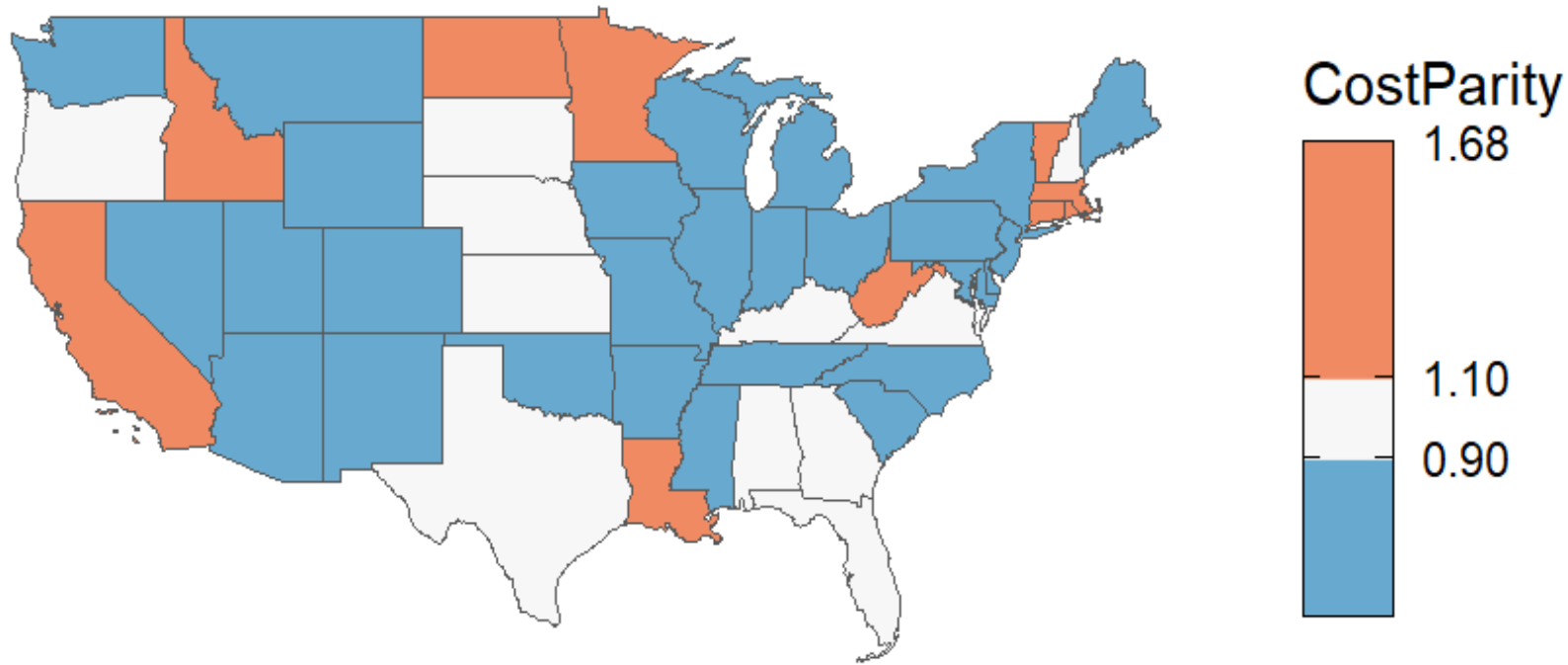
U.S. Manufacturing Sector Process Energy Flow in 2010



Significant Industrial Process Heat is at or Below 150 °C



Many States have Favorable Cost Parity for IHPs



*Propane and RNG make IHP use even more cost-favorable

- 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

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



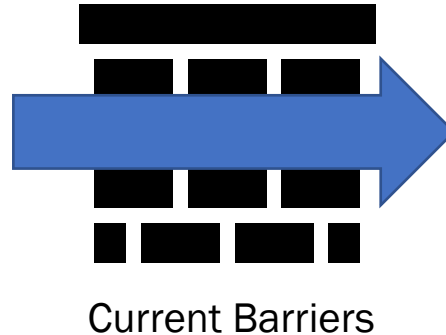
Report: <https://www.aceee.org/research-report/ie2201>

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



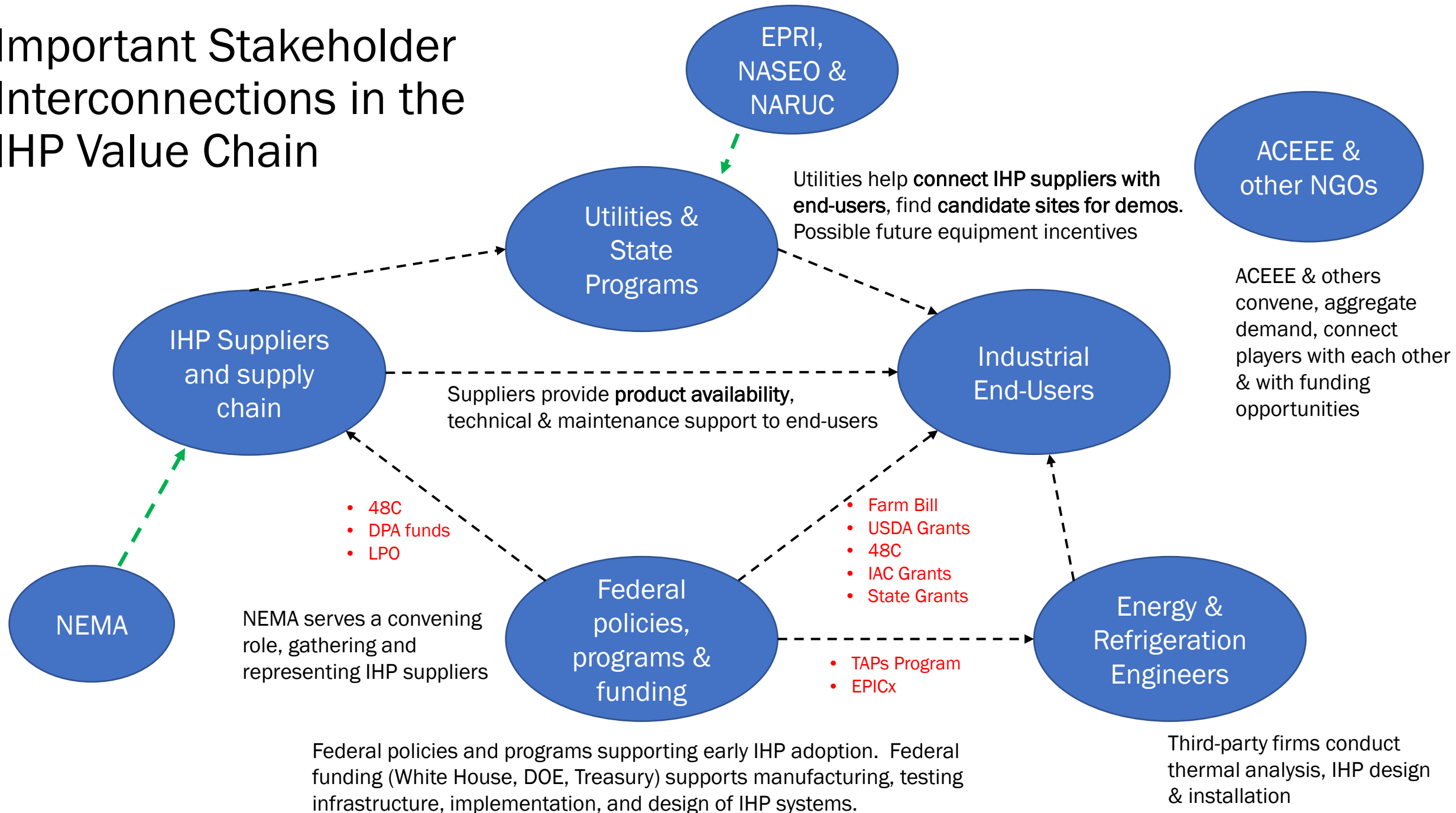
Where we want to go:

- 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

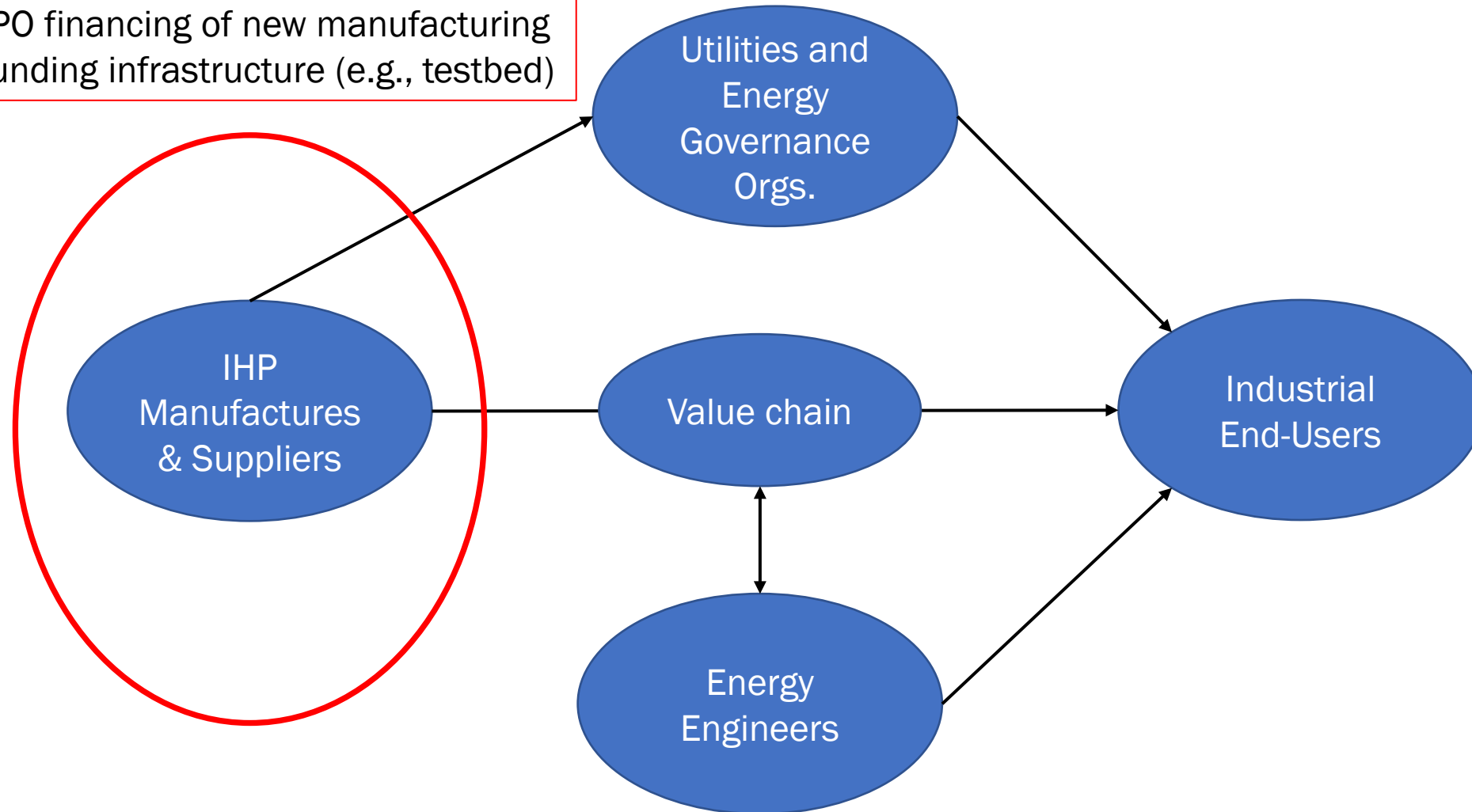
- Support domestic supply (48C, DPA & LPO)
- Build knowledge & expertise in design& installation (USDA-NRCS, EPICx, IACs & TAPs)
- Develop market infrastructure (MESC, IEDO & LPO)
- Support IHP demonstrations (MESC & IEDO)
- Support implementation (MESC, IEDO, LPO & USDA)

Important Stakeholder Interconnections in the IHP Value Chain

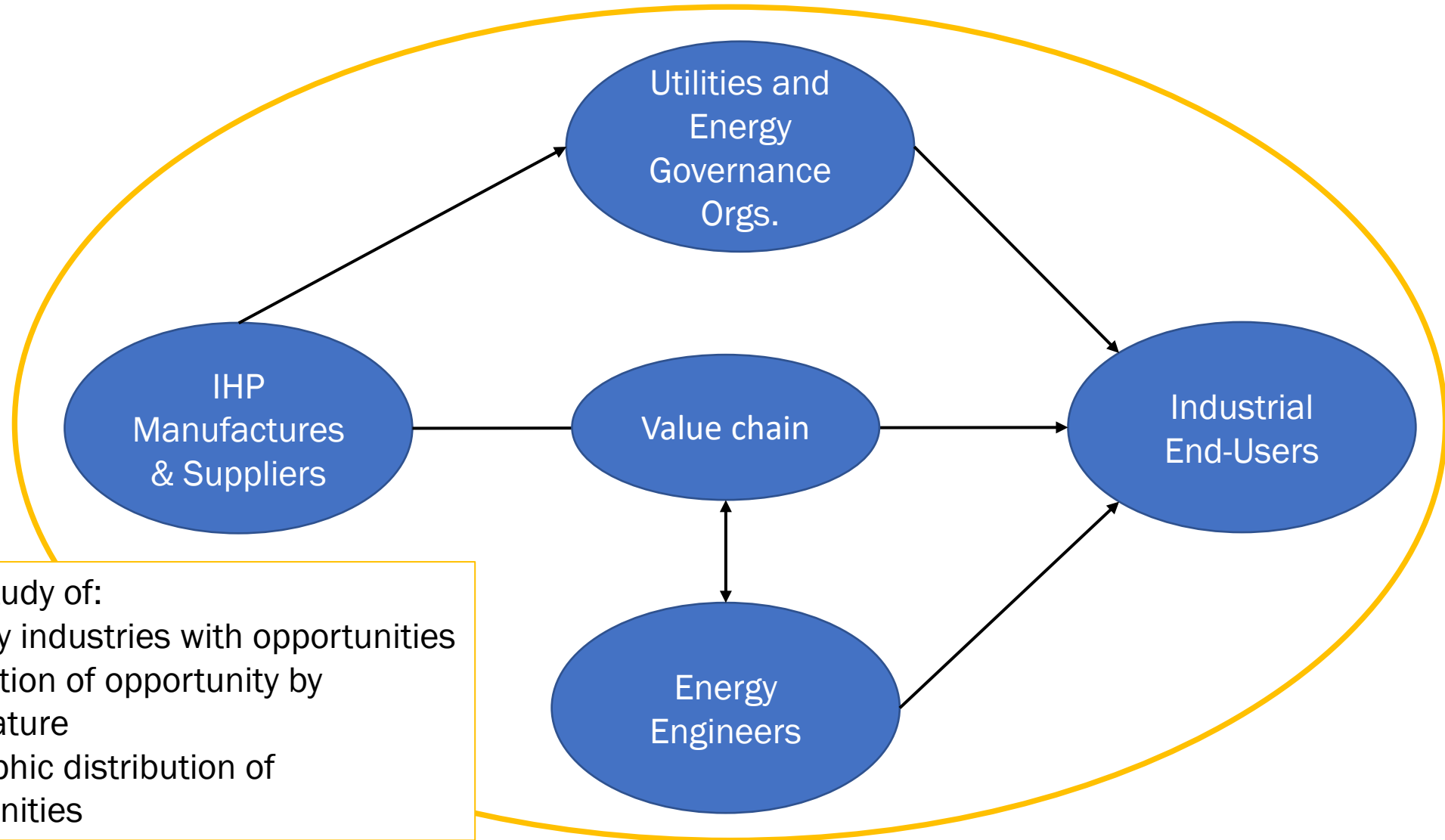


Federal programs & Incentives to Support Domestic IHP Supply

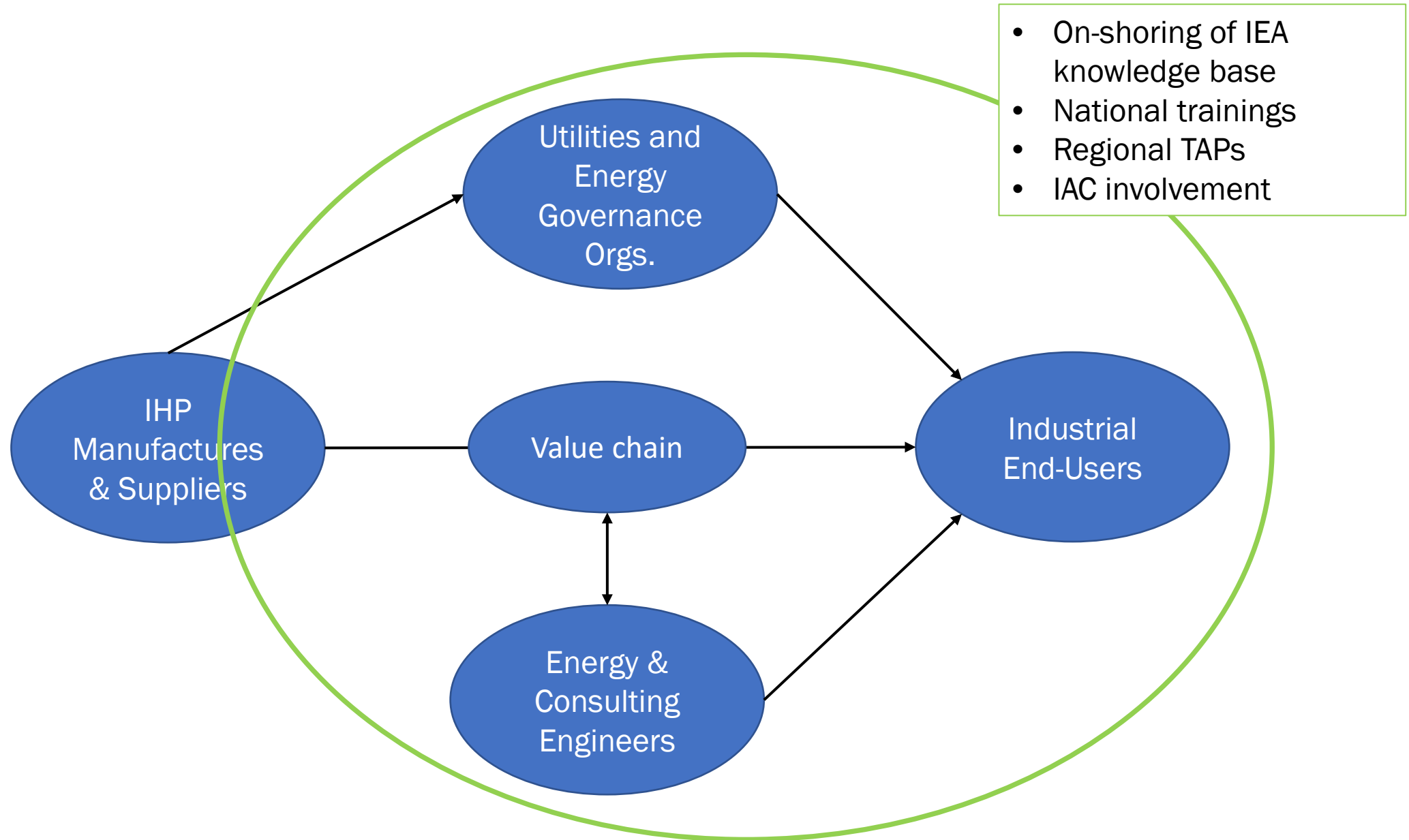
- DPA co-funding
- 48C mfg. tax credits
- LPO financing of new manufacturing
- Funding infrastructure (e.g., testbed)



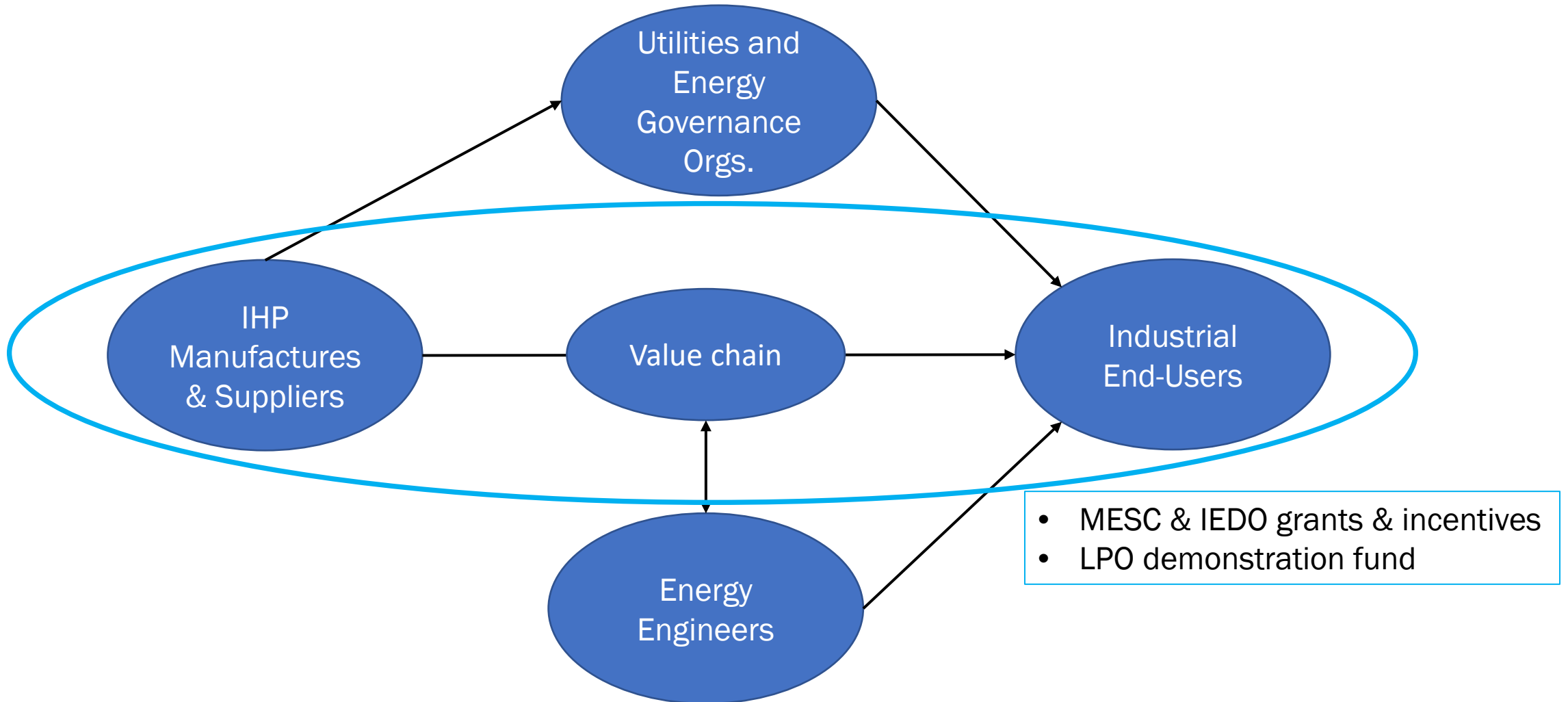
Market Assessment of IHP Potential



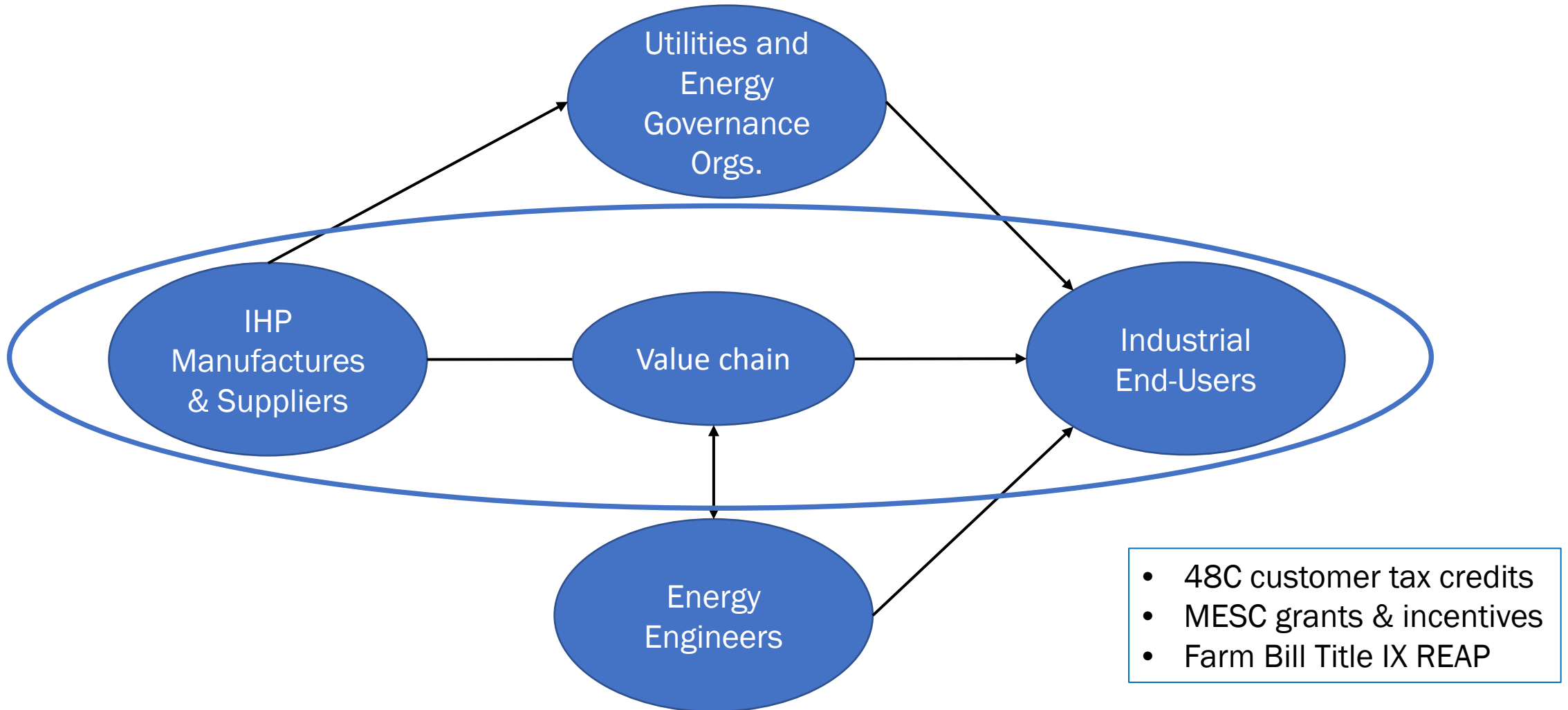
IHP Market Support Programs



IHP Demonstration Incentives



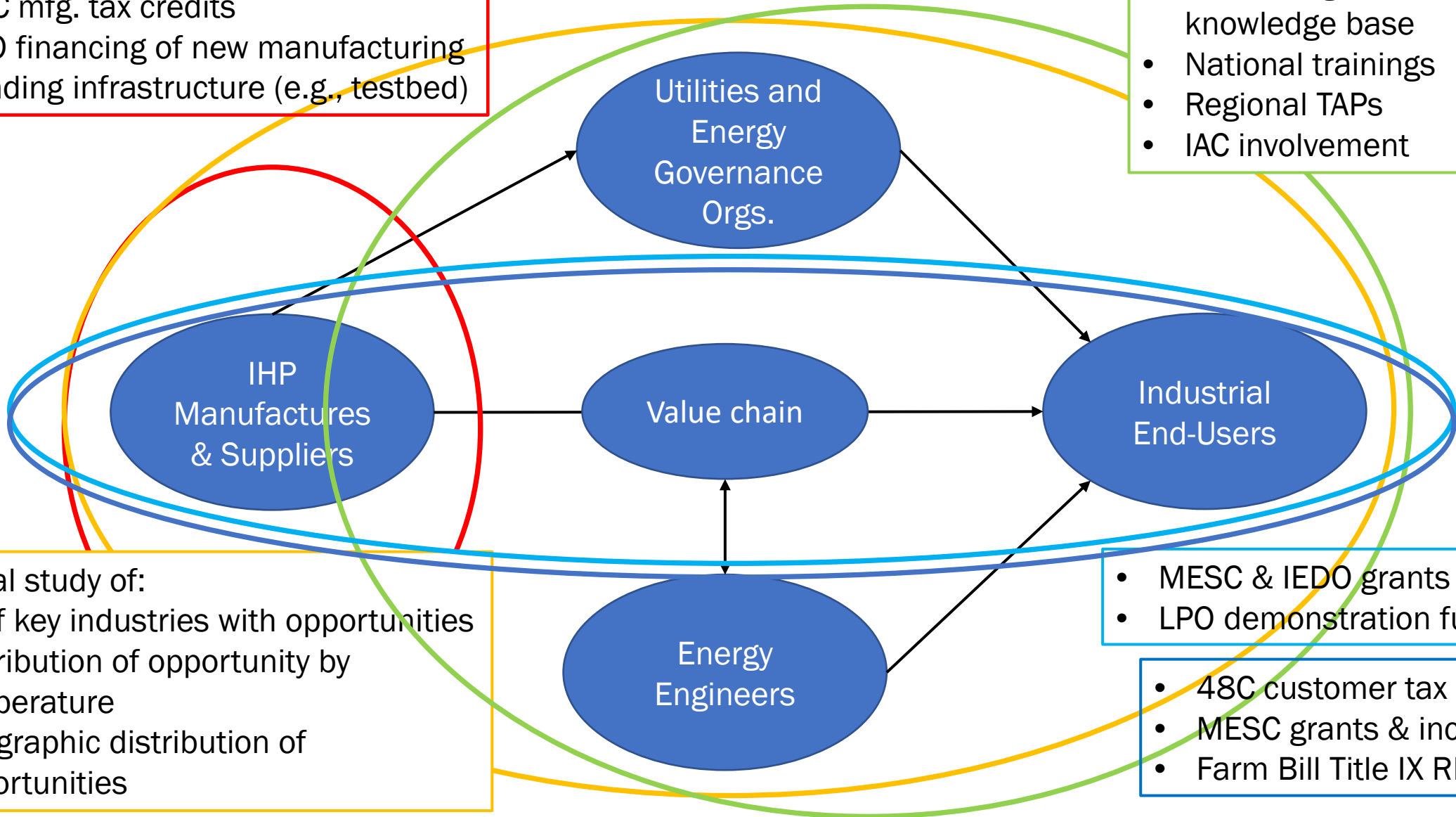
IHP Implementation Incentives



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)

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



National study of:

- ID of key industries with opportunities
- Distribution of opportunity by temperature
- Geographic distribution of opportunities

- MESC & IEDO grants & incentives
- LPO demonstration fund

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

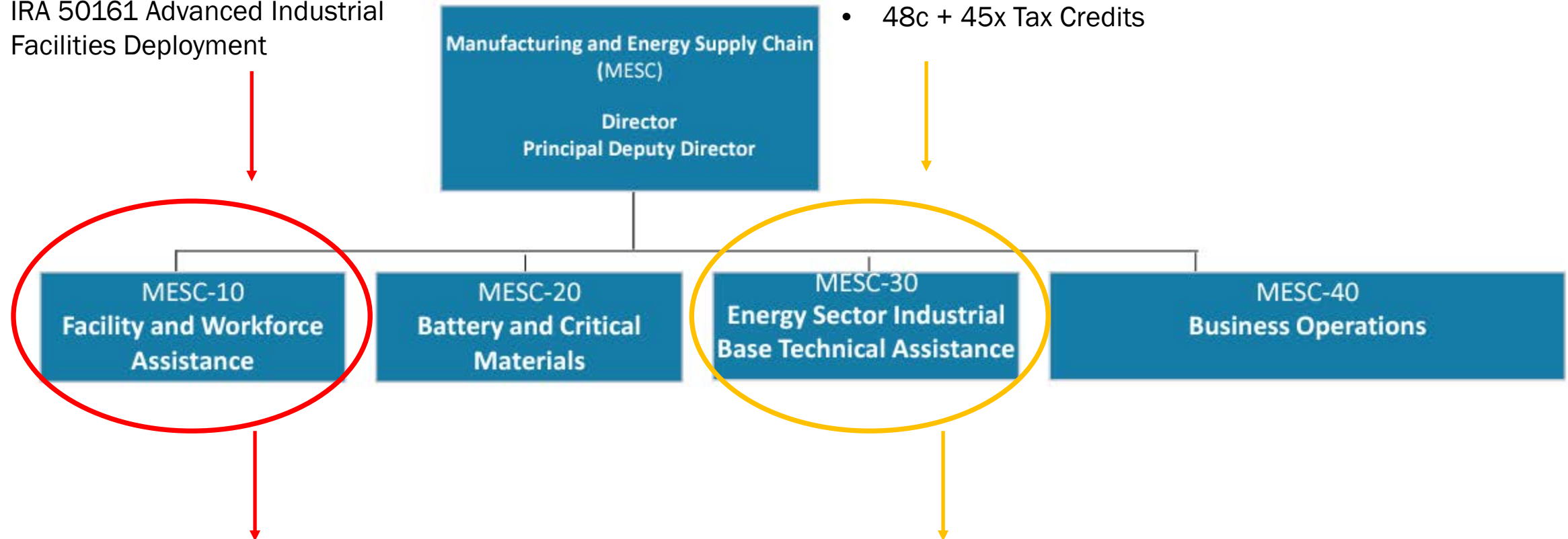
Relevant Funding:

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



Relevant Funding:

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



IHP Connected Programs:

- State leadership grants and programs
- (\$3.2m) IAC expansions

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
3. Strengthening U.S. Supply Chains and Domestic Manufacturing for a Net-Zero Economy
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

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-equips industrial or manufacturing facility to reduce greenhouse gas emissions by at least 20%

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)

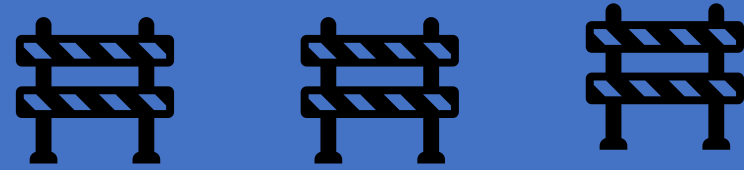
IHP Connected Programs:

- (\$23m) TAPs program (awarded)
- (\$70m) ASU EPIXC Institute

Source:

https://www.energy.gov/sites/default/files/stylles/full_article_width/public/2022-10/IEDO.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

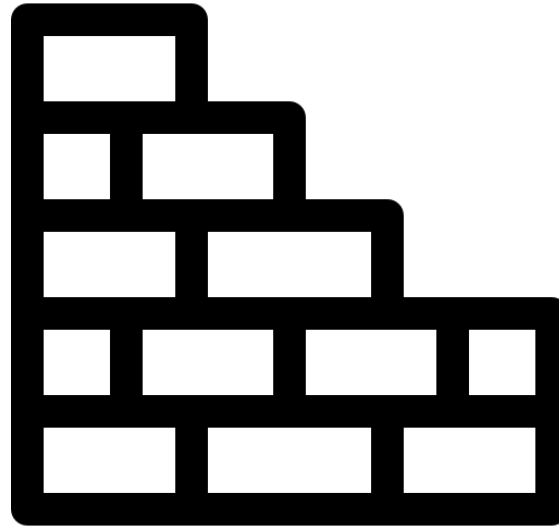
Demand Side:

- 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

Where we are

Where we want to go



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

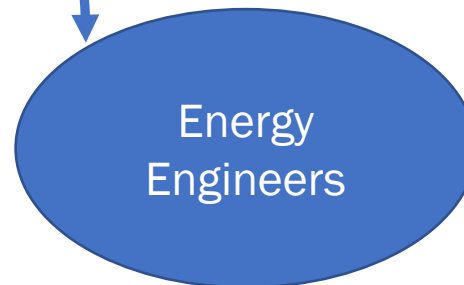
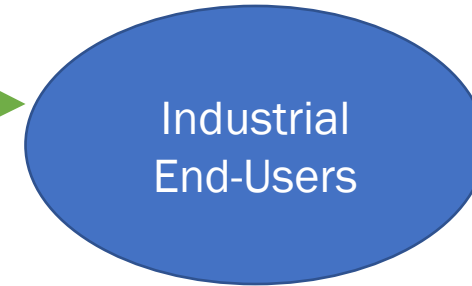
- Assistance with utility program design
- How to leverage state policy
- Utility based pilot projects

*in addition to
advocating,
communicating policy
action

- Suppliers Group
- Evaluation of needs, barriers



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

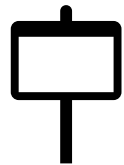


- Connection to implementers and integrators (Cascade, FlexTech, Armstrong etc.)
- Connection to technical assistance measures (IACs, TAPs)

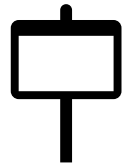
- Thermal analysis; what are thermal needs of each system? Re-engineering of thermal systems in retrofitting
 - Armstrong International

Next Steps

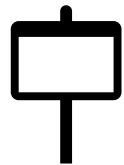
Understanding of barriers, coalition, alignment on consistent messaging



ACEEE, NEMA, RTC IHP Alliance

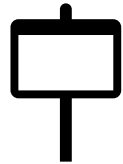


IHP Workshops at ACEEE Summer Study & EER

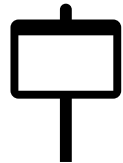


Collaboration with TAPs, EPIXC Institute

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

Upcoming Events and Resources

- ACEEE IHP report: <https://www.aceee.org/research-report/ie2201>
- ACEEE IHP website landing page: <https://www.aceee.org/industrial-heat-pumps>
- RTC industrial electrification report: <https://www.renewablethermal.org/electrifying-us-industry/>
- RTC suite of three Heat Pump Decision Support Tools: <https://www.renewablethermal.org/heat-pump-decision-support-tools/>
- Australian Alliance for Energy Productivity's online heat pump estimator: <http://www.heatpumpestimators.com/>
- LBNL Electrification of U.S. Manufacturing With Industrial Heat Pumps report: https://eta-publications.lbl.gov/sites/default/files/us_industrial_heat_pump-final.pdf
- Next IHP workshop at ACEEE's Energy Efficiency as a Resource Conference in October <https://www.aceee.org/energy-efficiency-resource>