Advanced Water Heating Initiative Playbook and 2020 Progress

Webinar | February 11, 2021

AWHI Funders and Partners
Today’s Panel

Ralph DiNola  
CEO  
New Buildings Institute

Amruta Khanolkar  
Project Manager  
New Buildings Institute

Geoff Wickes  
Senior Product Manager  
Emerging Technologies  
Northwest Energy Efficiency Alliance

Keshmira McVey  
Emerging Technologies Program Manager  
Bonneville Power Administration

Owen Howlett  
Customer Experience Strategist  
Sacramento Municipal Utility District

Welcome Smita Gupta to NBI (and AWHI)

Smita Gupta  
Director of Building Innovation  
New Buildings Institute
HPWHs are a hot topic!

How Your Water Heater Can Be a Secret Weapon in the Climate Change Fight

California wants to replace millions of gas water heaters with high-tech electric ones to serve as “thermal batteries” for storing solar and wind energy.


Laying the Foundation for Market Transformation

Ralph DiNola
CEO
New Buildings Institute
Household Site Energy Consumption

In coldest areas natural gas is the most-consumed energy source

Source: U.S. Energy Information Administration (EIA), 2015 Residential Energy Consumption Survey

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Why is this Initiative Needed?

California Residential Water Heating Stock
(90% fossil fuel dominant)

U.S Homes Water Heating Stock
(54% fossil fuel dominant)

Source: NBI 2020 – based on data from RASS 2009 and 2015 RECS

Water heating with natural gas represents one of the largest GHG emissions end use in a typical residence in CA

GHG Reduction as the Grid gets Cleaner


Future GHG emissions from a Sacramento home built in the 1990’s under two Scenarios: 1. the “mixed fuel 2. all-electric appliances
HPWH: Controls and Operating Cost

Energy Burden
Electrify Everyone
Community Energy Project Low-Income Water Heater Replacement Program

Your tax-deductible donation goes a long way at CEP. A water heater may seem a small target to help low-income communities and address climate change, but it can have a big impact. Water heating is the second largest energy consumer in a home. Replacing an old, gas water heater with an electric heat pump water heater dramatically reduces household emissions and helps to save money on energy bills.

Replacing one gas water heater with an electric heat pump can:

- Avoid 2.5 tons of CO2 per year
- Save $180 or more per year in energy costs

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Agenda

• What is AWHI?
• Need for the Initiative
• Initiative Elements and Status
• 2020 Key Updates
• How You Can Support the AWHI?

What is AWHI?

AWHI is a Market Transformation Initiative to bring HPWHs into mainstream, led by NBI.

Funders and Partners:

Link: https://newbuildings.org/resource/advanced-water-heating-initiative/
Collaborative Membership

- Collaborative effort of over 50 organizations, 100+ active members
- Key stakeholders:
  - Manufacturers
  - Efficiency advocates
  - Utilities and Cities
  - Air Quality Management Districts

![COUNT OF ORGANIZATION TYPES](image)

AWHI Five Priorities

1. **TRANSFORM THE MARKET.**
   Advance from an increase in market penetration to market transformation. This includes simplifying and targeting policy and program levers.

2. **FOCUS FIRST ON NEW CONSTRUCTION.**
   Help establish universal program adoption and policy performance requirements that support HPWHs.

3. **BUILD DEMAND.**
   Build awareness through a coordinated marketing campaign customized for various audiences to provide inspiration, awareness, confidence, and education.

4. **CREATE UNIFORM PROGRAMS AND INCENTIVES.**
   Create a consistent statewide approach that results in uniform program design and incentive amounts that include direct-to-consumer rebates and incentives for distributors and retailers.

5. **ESTABLISH TRAINING AND TOOLS.**
   Provide training and tools to distributors, contractors, and installers.
AWHI Elements and Status

 workflows:
- Strategy, Planning & Coordination
- Technology Advancement & Validation
- Priming the Market

 elements:
- Planning & Coordination
- Partnerships
- Performance Testing
- Supporting Research
- Codes & Policy Advancement
- Program Design/Rollout
- Awareness & Trainings

 status:
- Pillars: Done
- Channels: In progress
- Ongoing
- Not Started

* National, Regional, Manufacturers, Builders

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Codes and Policies for HPWH

- 42 CA jurisdictions with Electrification Reach Codes
- 2021 IECC: §C406 Points options dedicated for HPWH
- ASHRAE: 89.1 §7.4.42 for high-capacity electric water heating
- IECC Decarb Overlay: Space, power and CTA 2045B
- Fixture Efficiency – regulated by Plumbing Code
- Emissions (NOx) CARB Resolution 20-32
- Refrigerants in CA: Mid-GWP January 2025
AWHI Playbook and 2020 Report

- 2020 Exposition and Workshop at SMUD
- JA13 adopted: T24 HPWH Demand Management Standard
- 120Vs anticipated to be market ready by Q2-Q4 2021
- Collaboration with Local, Regional, State and Federal Entities
- Utility Programs: Midstream, Retailer Incentives
- 2020 AWHI Progress Report and 2021 planning in process

NBI 2021 Focus Areas

- AWHI continuation with West Coast group
- Launch National Initiative with Key Stakeholders
  - Expand Midwest AWHI
  - Engage priority regions: SE, NE/Mid-Atlantic, SW
- 120Vs field study NW & CA / commercialization
- Central packaged (skid) system adoption
- TECH, BUILD collaboration
- Training and awareness & building demand

Strategic planning session for 2021 scheduled
How are Heat Pump Water Heaters Different from Light Bulbs or Air Conditioners?

Why do we need a special market transformation effort for this product?

- May be more expensive, disruptive, and time-consuming to install than customers were planning a water heater replacement to be
- May require a panel changeout, additional wiring, and more than one trade to be on site
- Product is unfamiliar, performance and features may be confusing
- Requires supporting devices such as a thermostatic mixing valve and communication module
- May require more space to operate in, or adaptations for venting
- Has unfamiliar features such as cold air exhaust, different operating modes, and noise during operation.
- May produce insufficient hot water unless the temperature or mode are adjusted
- Requires different maintenance, such as filter cleaning and anode rod changes
Priming the Market for Unitary HPWH: Work to Date

- Oct 2018 Water Heater Summit, SF. Established need to work on both program models and technology
- Jan 2020 Water Heater Expo, Sacramento. 230 attendees, broad survey of market and tech needs
- Meeting topics:
  
<table>
<thead>
<tr>
<th>Value propositions</th>
<th>Equity in program design</th>
<th>Quantitative research methods for program development</th>
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</thead>
<tbody>
<tr>
<td>Best practice examples: Maine, Vermont &amp; NW</td>
<td>Engaging with residential developers</td>
<td>Expanding the breadth of customer participants</td>
</tr>
<tr>
<td>Expanding programs with strategic partnerships</td>
<td>Next steps for HPWH technology</td>
<td>Easy participation and emergency replacement</td>
</tr>
<tr>
<td>Market transformation logic model</td>
<td></td>
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</tbody>
</table>

Actionable Recommendations

The “Transforming the Market” report is intended to be directly actionable by utilities and their partners. Some examples:

- Program starting point for utilities
  - Based on best practices from VT, ME, NW
Actionable Recommendations

The “Transforming the Market” report is intended to be directly actionable by utilities and their partners. Some examples:

- Continuous course-correction for programs based on quantitative research on technologies and behaviors

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<thead>
<tr>
<th>New construction</th>
<th>MF</th>
<th>SF</th>
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<tr>
<td>PG&amp;E</td>
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<td>SMUD</td>
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<table>
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<th>MF</th>
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<th>gas/propane</th>
<th>electric</th>
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<td>PG&amp;E</td>
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<td>SMUD</td>
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</table>

<table>
<thead>
<tr>
<th>Total unitary water heaters/year</th>
<th>PG&amp;E</th>
<th>SCE</th>
<th>SDG&amp;E</th>
<th>LADWP</th>
<th>SMUD</th>
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<td>CA total</td>
<td>15.000</td>
<td>5.800</td>
<td>5.400</td>
<td>1.600</td>
<td>900</td>
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<td>200</td>
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<td>3.400</td>
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<td>700</td>
<td>200</td>
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<td>Total</td>
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<td>31.000</td>
<td>25.300</td>
<td>7.800</td>
<td>4.100</td>
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</table>

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Actionable Recommendations

The “Transforming the Market” report is intended to be directly actionable by utilities and their partners. Some examples:

- But that’s not all!
- Data sharing between utilities:
  - 120V field trial
  - Sharing ongoing data on costs, customer types, device performance, installation problems, etc.
- Use of strategic partnerships to promote programs
  - Quantifying and tracking these relationships
  - Working with ENERGY STAR
- Education and training
  - Identified by utility staff as essential
- Next steps for HPWH technology

Emerging Plug-in HPWHs and Market Readiness

Amruta Khanolkar
New Buildings Institute, Project Manager
Why Needed?

Heat Pump Water Heater Installer Flowchart
A Quick Guide of Considerations & Best Practices

EXISTING BUILDING pre 2020

Does panel have adequate Ampacity for future electrification?

$1000-$3000
Panel Upsize

Up Size Panel and Service line

Use 120 V < 900W Plug-in HPWH

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Retrofit-Ready 120V HPWHs

• Plug into existing electrical circuit
• Possible Techniques:
  o Higher temperature storage with mixing valves
  o Larger tank sizes or enhanced tank stratification

<table>
<thead>
<tr>
<th>Circuit Breaker</th>
<th>Wire Size (gauge)</th>
<th>Circuit Type</th>
<th>Maximum Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>15A</td>
<td>14</td>
<td>shared</td>
<td>900W</td>
</tr>
<tr>
<td>15A</td>
<td>14</td>
<td>dedicated</td>
<td>1440W</td>
</tr>
<tr>
<td>20A</td>
<td>12</td>
<td>shared</td>
<td>1200W</td>
</tr>
<tr>
<td>20A</td>
<td>12</td>
<td>dedicated</td>
<td>1920W</td>
</tr>
</tbody>
</table>

derived from California Electrical Code

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Technology Status

**Technology Status**

### GE Appliance @ SMUD HPWH Expo, Jan 2020

- 120V (Shared Circuit) plug-in
- Integrated Electronic Mixing Valve
- Tank Size: 40, 50, 65, 80 Gallons
- CTA-2045 module that complies to JA-13
- Built-in WIFI module to connect to cloud services

### Technology Status

<table>
<thead>
<tr>
<th>Electrical Constraints</th>
<th>Unit shall be able to operate on a shared 120 Volt / 15 Amp circuit.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Connections</td>
<td>That shall have a cord allowing plug-in to a standard 120V receptacle.</td>
</tr>
<tr>
<td>Space Constraints</td>
<td>To qualify as a “space-constrained” product, the unit shall</td>
</tr>
<tr>
<td></td>
<td>o fit within a space of 24” x 26” 72” inclusive of drain pan and all</td>
</tr>
<tr>
<td></td>
<td>plumbing connections, and</td>
</tr>
<tr>
<td></td>
<td>o be able to fit through an opening of minimum size as specified by</td>
</tr>
<tr>
<td></td>
<td>the manufacturer and listed on the Qualified Products List.</td>
</tr>
<tr>
<td></td>
<td>If larger than these dimensions, the product will be listed without the</td>
</tr>
<tr>
<td></td>
<td>space-constrained mark.</td>
</tr>
<tr>
<td>Energy Performance</td>
<td><img src="image_url" alt="Image" /></td>
</tr>
<tr>
<td>Sound Level</td>
<td>dB(A) &lt; 55</td>
</tr>
<tr>
<td>Warranty</td>
<td>10 years parts, 5 year labor</td>
</tr>
<tr>
<td>Demand Response</td>
<td>CTA-2045, or equivalent, and complying with the proposed California</td>
</tr>
<tr>
<td>Connectivity (Optional)</td>
<td>2019 Title 24 requirements, JA-13, for electric water heater demand</td>
</tr>
<tr>
<td></td>
<td>management. To be revisited on next specification revision (likely 2021).</td>
</tr>
<tr>
<td>Documentation</td>
<td>Installation manual shall contain necessary references to NEC, UPC, and</td>
</tr>
<tr>
<td></td>
<td>describe a list of approved installation locations and electrical</td>
</tr>
<tr>
<td></td>
<td>connection scenarios.</td>
</tr>
<tr>
<td></td>
<td>It is strongly recommended that manufacturers create technical</td>
</tr>
<tr>
<td></td>
<td>bulletin, or similar, to assist with installations in various installation</td>
</tr>
<tr>
<td></td>
<td>locations and housing stock.</td>
</tr>
</tbody>
</table>

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**NEEA AWHS Version 7.0,**

*Appendix A: Plug-In Heat Pump Water Heater Specification*

Source: Jeff Maguire

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Rheem

- 120V (Dedicated Circuit) plug-in
- Tank Size: 40, 50 Gallons
- Integrated WIFI control board

**Technology Status**

**ProTerra Plugin (Dedicated Circuit)** is the most efficient water heater available

- **Efficiency**
  - UL 634-13 listed operating
  - ENERGY STAR® qualified
- **Performance**
  - Ambient operating range: -20°F to 120°F (-29°C to 49°C)
  - EnerGuide ratings: 1 (Excellent) - 5 (Average)
- **Easy Installation**
  - Factory-assembled plug-in
- **Integration**
  - UL Listed with built-in water sensor

**Field Study & Research Plan**

**Goal**: Independent field verification to advance market commercialization and program promotion.

- User satisfaction
- Energy performance
- Installer experience

**Demonstration Diversity**:

- Application: single family, multifamily in-unit, manufactured homes
- Install Location: garage, closet, basement etc.
- Climate: California sites in the South Coast, Bay Area and Central Valley; NW sites E, W of the cascades

- To date agreed participants are AO Smith, GE & Rheem
- Project Manager - NBI
Field Study: Research Method

- **Metering and analysis:**
  - Hot water runout events
  - Energy performance
  - Potential to load shift
  - Operating cost scenarios

- **Survey:**
  - Customers
  - Installers
  - Manufacturers

- Monitoring start date 2nd quarter 2021

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Commercialization & Building Demand

- Support Workpaper/ TRM Process
- Bulk purchase Order
- Awareness & Training Development
Thank you!

Amruta Khanolkar
amruta@newbuildings.org

Central Heat Pump Water Heating Systems

Keshmira McVey
Emerging Technologies Program Manager
Bonneville Power Administration
CONTEXT

- Central Heat Pump Water Heater (CHPWH) are emerging technologies
- 10+ years of demonstration experience in PNW
  [http://www.bpa.gov/goto/e3t](http://www.bpa.gov/goto/e3t)

- Lessons learned
  - Performance
  - Persistence
  - Commissioning

- Goal develop plug and play fully packaged HPWH systems

VISION

By 2026, CHPWHs are the product of choice in 90% of new multifamily construction
STRATEGY

• Focus on multifamily new construction in major markets
  • Beachhead market one of the largest growing sectors across the country
  • Gain a stronghold market share
  • Prove performance, efficiency and customer satisfaction
• Leverage positive outcomes of acquired customers as a launchpad to new adjacent market segments

APPROACH

• How do we reach that goal?
• What is the best way to influence the market and drive change?
• What levers can we use to achieve rapid adoption?
• What outcomes do we seek?
• Whose help do we need?
PRICE

- Multiple proven CHPWH systems are available in local markets at competitive prices
- Sticks: Codes mandate
  - Federal, state and municipal
- Carrots: Incentives (upstream, midstream or downstream)
  - Combination of both

2021

- Advanced water heater spec 8.0
- Qualified products list
- Model incentive program requirements

PRODUCT

- CHPWH are fully packaged plug and play* systems
  - Systems include the compressor, mixing valves, temperature maintenance and storage
  - System COP 3
  - Load shift capability – CTA 2045
  - Low global warming potential refrigerants
- Multiple proven products available in local markets
- Known, quantifiable and persistent energy savings
- Partner with manufacturers and bring new products through the development pipeline
  - Design guidelines, performance maps, system metrics
PRODUCT

Seven potential low GWP products in the Technology Innovation Model (TIM)

Five fully developed products with design guidelines

Three research projects on temperature maintenance, thermal storage optimization and load shifting

One Ecosim energy modeling tool

https://ecosizer.ecotope.com/sizer/

CUSTOMER

• Everyone knows and wants the product
  • Market actors know how to acquire, install, commission and optimize and CHPWH systems

• Market research and change management move markets

• Simultaneous and continuous development
  • Developing programs offerings
  • Conducting product demonstrations and continually improving the products
  • Continuous stakeholder engagement
CUSTOMER

- Curriculum maps technology, economics, policy and case studies
- Market research study identify barriers and additional training
Join Us!

- Keshmira McVey
- Program Manager, Emerging Technologies
- Bonneville Power Administration
- krmcvey@bpa.gov
- 503.929.6036

Connected Water Heaters are Ready for Prime Time

Geoff Wickes
Senior Product Manager Emerging Technologies
Northwest Energy Efficiency Alliance
**Connected Water Heaters are Ready for Prime Time**

- Why should the water heater be grid connected?
- Hot water storage (battery) & grid integration:
- What we have and need for load shifting of the unitary and central technologies
- Policies related to connectivity and controls

*If all water heaters the US were connected, we could disconnect 30-40 coal fired power plants.*

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**So What Problem are we Solving**

- Older and more carbon intensive base load plants are going offline
- More renewables are coming online – the grid needs more flexibility
- Peaker plants are expensive and carbon intensive
- Change won’t happen absence of intentional direction
- People don’t care about their water heaters
- Substantial barriers at the OEMs
  - Water heaters are a commodity item
  - NRE and incremental cost
  - No uniform standard
- Utilities need to be ready and start taking action
- General awareness campaign~ We need to care about our water heaters
What does Water Heating have to with the Grid?

**Good Electric Resistance Water heater control features**
- 4.5kW instantaneous load
- 20-30 minutes to heat full tank
- Up to 8-10 hours of storage before quick recharge
- Cold water event protection

**Best Heat Pump Water heater control features**
- 0.5 kW instantaneous load
- 2-4 hours to heat full tank
- Up to 8-10 hours of storage before quick recharge
- Cold water event protection
- Smart Grid Devices On-device schedule storage

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Goals the AWHI Connectivity Group

- All unitary electric water heaters (standard electric and heat pump) over 40 gallons shipped have a grid ready open-source communication interface (CTA-2045)
- All Central Systems HPs are demand response and time of use ready
- ENERGY STAR and the DOE recognize and promote ANSI/CTA-2045 as a minimum requirement
- Aggregators leverage DR capabilities of CTA 2045
- Utilities leverage DR capabilities sooner rather than later

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Opportunities

• HPWHs already have sophisticated controls
• Customers have increased interest in “smart” appliances and “green” energy integration
• Digital control is a differentiator for the market
• Codes and Standards
• National engagement, DOE and regional power managers are interested
• Customers are interested in helping with the greater good

What is happening with policy

<table>
<thead>
<tr>
<th>Geography</th>
<th>Regulation</th>
<th>Date of Implementation</th>
<th>Details</th>
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</thead>
<tbody>
<tr>
<td>Washington</td>
<td>SB 5115</td>
<td>January 1, 2021</td>
<td>All new electric water heaters CTA (Heat pump 1/21, Electric resistance 1/22)</td>
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<tr>
<td></td>
<td>HB 1444</td>
<td></td>
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</tr>
<tr>
<td>Oregon</td>
<td>EO 2020-04</td>
<td>January 1, 2022</td>
<td>All new electric water heaters requires CTA 2045 similar to WA (Heat pump &amp; Electric resistance 1/22)</td>
</tr>
<tr>
<td>National for HVAC</td>
<td>AHRI 1380</td>
<td>2019</td>
<td>DR-ready Variable Capacity HVAC systems rated to 65,000 Btu/hr. or less shall have CTA-2045-A or OpenADR 2.0 or both.</td>
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<tr>
<td>CA</td>
<td>Title 24, JA13</td>
<td>July 8, 2020</td>
<td>Requires NEEA Tier 3 v2, which requires a CTA-2045 port (New Construction)</td>
</tr>
<tr>
<td>National for Water Heating</td>
<td>AHRI 1430</td>
<td>In Progress Currently</td>
<td>Proposing CTA 2045 B with optional OEM path customer via (WiFi, Bluetooth or others). Good alignment at this point</td>
</tr>
<tr>
<td>NEEA</td>
<td>Version 7</td>
<td>July 1st, 2020</td>
<td>Requires Tier 3 and higher HPWHs have CTA 2045</td>
</tr>
<tr>
<td>AWHI</td>
<td>Current Recommendation</td>
<td>December 1st, 2020</td>
<td>Requires CTA 2045 for Unitary with an optional vendor path and TOU loading for California market</td>
</tr>
</tbody>
</table>
**What should you remember?**

- CTA 2045 B Port should be required on all water Heaters
- For CA JA 13 in New Construction
- Washington State, Oregon and soon California will require port
- Port required on Unitary, Split and Central Units
- All the manufactures are on board

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**Questions and or input**

- Geoff Wickes
- Senior Product Manager, Emerging Technology
- Northwest Energy Efficiency Alliance
  - gwickes@neea.org
  - 503.329.0523
The Building Electrification Technology Roadmap (BETR) is a guide for utilities and other organizations developing, implementing, and supporting electrification technology programs as a way to advance high efficiency technologies, reduce GHG emissions, and improve public health.

https://newbuildings.org/resource/building-electrification-technology-roadmap/

Save the Date!

GETTING TO zero FORUM 2021
October 27-29, 2021
New York City

Join building and energy industry leaders at the premier global event dedicated to defining a low-energy, low-carbon future for the built environment.
Access case studies, research, guidance, models and more

The Getting to Zero Resource Hub is an open-source collection of over 300 zero energy and zero carbon resources across six different topic areas:

- Design & Development
- Embodied Carbon
- Codes & Policy
- Local Governments Toolkit
- Residential
- Schools

The Getting to Zero Resource Hub was developed and delivered by New Buildings Institute with ongoing support from our sponsors and partners.

How You Can Support the AWHI

- Become a Partner in the National Initiative
- Support Regional Implementation
- Provide Technical Analysis and Resources
- Connect us with Utilities and Foundations

Contact:
Amruta Khanolkar, AWHI Manager NBI, at amruta@newbuildings.org
Smita Gupta, Director of Building Innovation, at smita@newbuildings.org

NBI AWHI website
Thank you!

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