

# Echo Solar: Creating Low Energy Healthy Homes

Building America Spring Meeting  
3/16/2011



## Main sections

Section 1: About Echo

Section 2: Why Echo wins with Homeowners

Section 3: Echo & Building Energy Use

Section 4: Driving Building Efficiency – Water Heating

Section 5: Driving Building Efficiency – Heating and Cooling

Section 6: Healthy Home – ASHRAE 62.2 Compliant Ventilation

Section 7: System Monitoring and Automated Fleet Management

# Section 1

## About Echo

# What is Echo

Echo contains PV, but is not just generation

Echo is an integrated energy supply system designed to optimize operation of residential building systems

Echo increases solar energy capture density from 15% to 50%

Echo is designed to overcome limited roof space available in most residential construction

Echo is designed to work with both existing and new homes

It incorporates aesthetics with performance

Echo was developed from 2003-2007 with funding from DoE Solar Thermal Technologies Program, as part of the pathway to Zero Energy

# Echo Is A High Efficiency Building technology

Echo captures both electrical and thermal energy from the solar PV panel.



Electricity



Water Heating

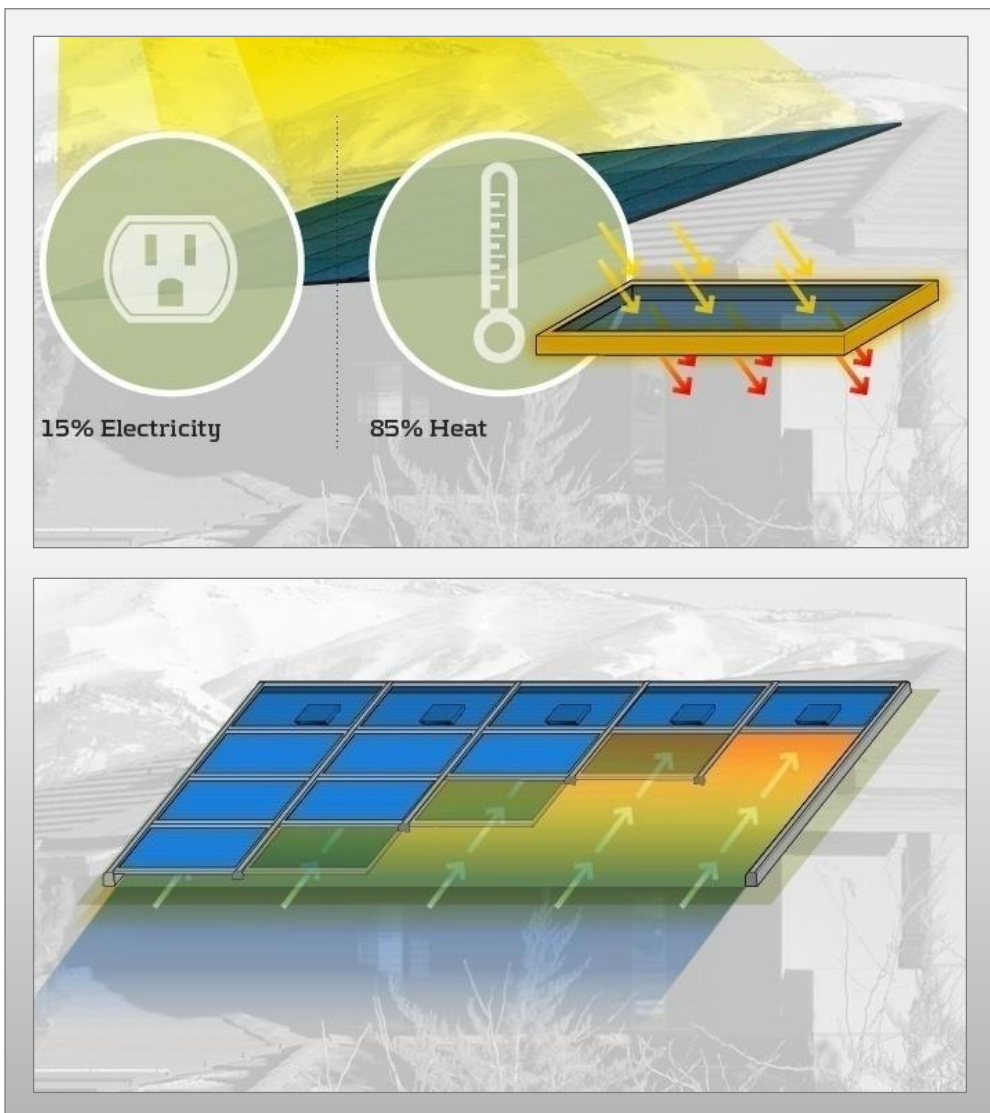


Home Heating



Home Cooling

# Echo Captures The Energy A Basic Solar Electric System Wastes



## Basic solar electric (PV):

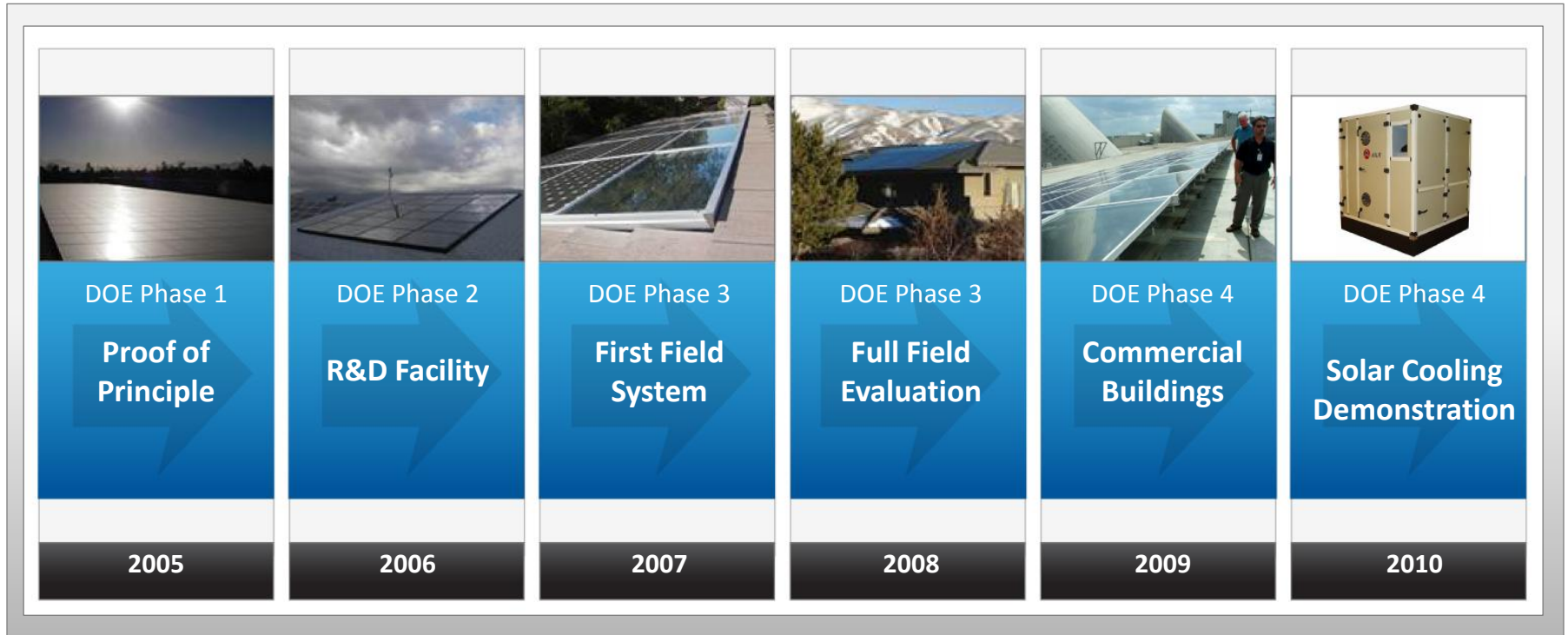
- 85% of the sun's energy is wasted – absorbed as heat by the PV panels

## Echo solar system:

- Fan draws air under panels
- Air is heated by panels
- Hot air used to heat the home and the water

*A simple, air-based approach*

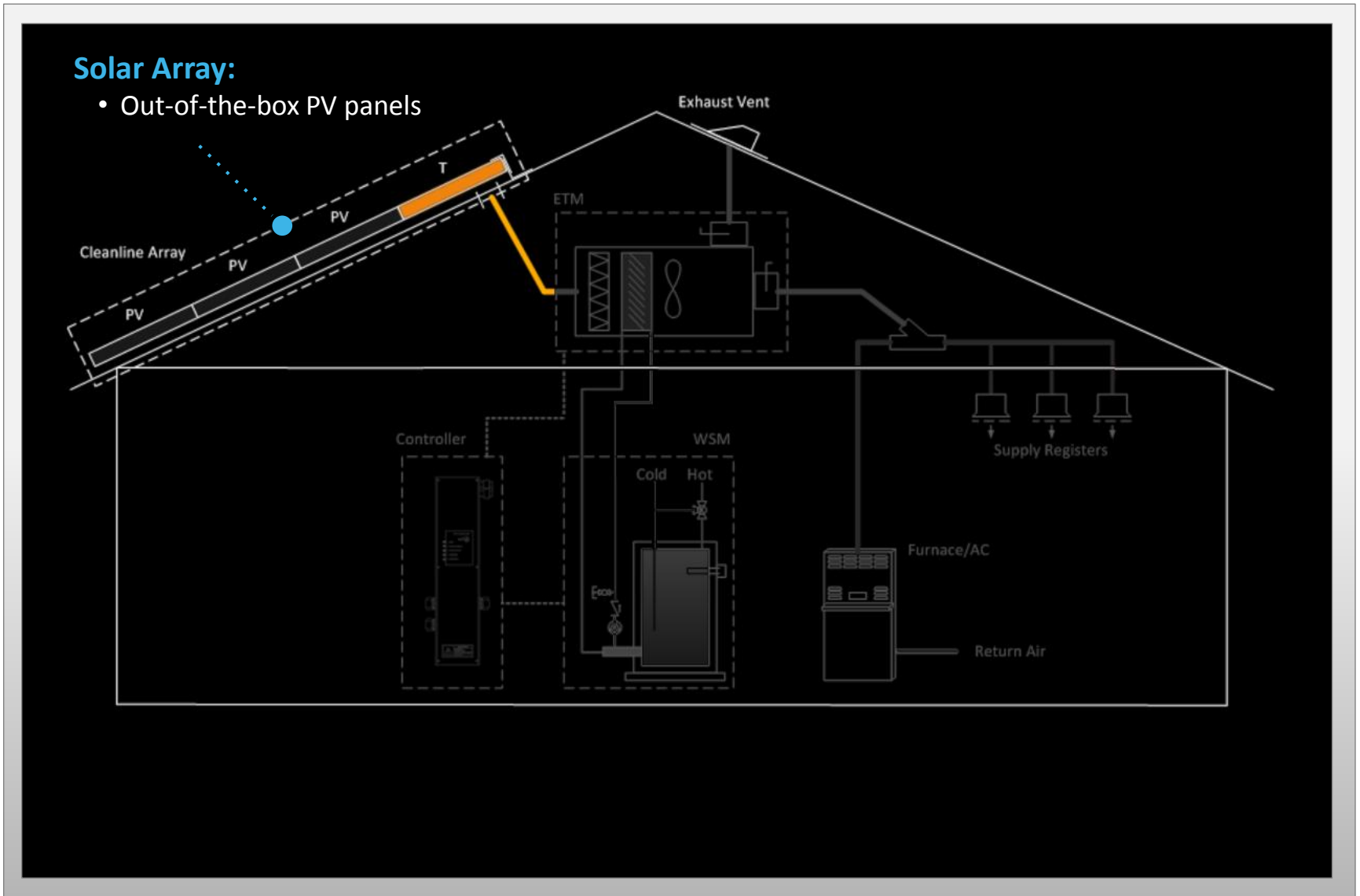
# Echo developed through DoE funding between 2005 - 2010



# Echo Solar System Schematic and Key Components

## Solar Array:

- Out-of-the-box PV panels





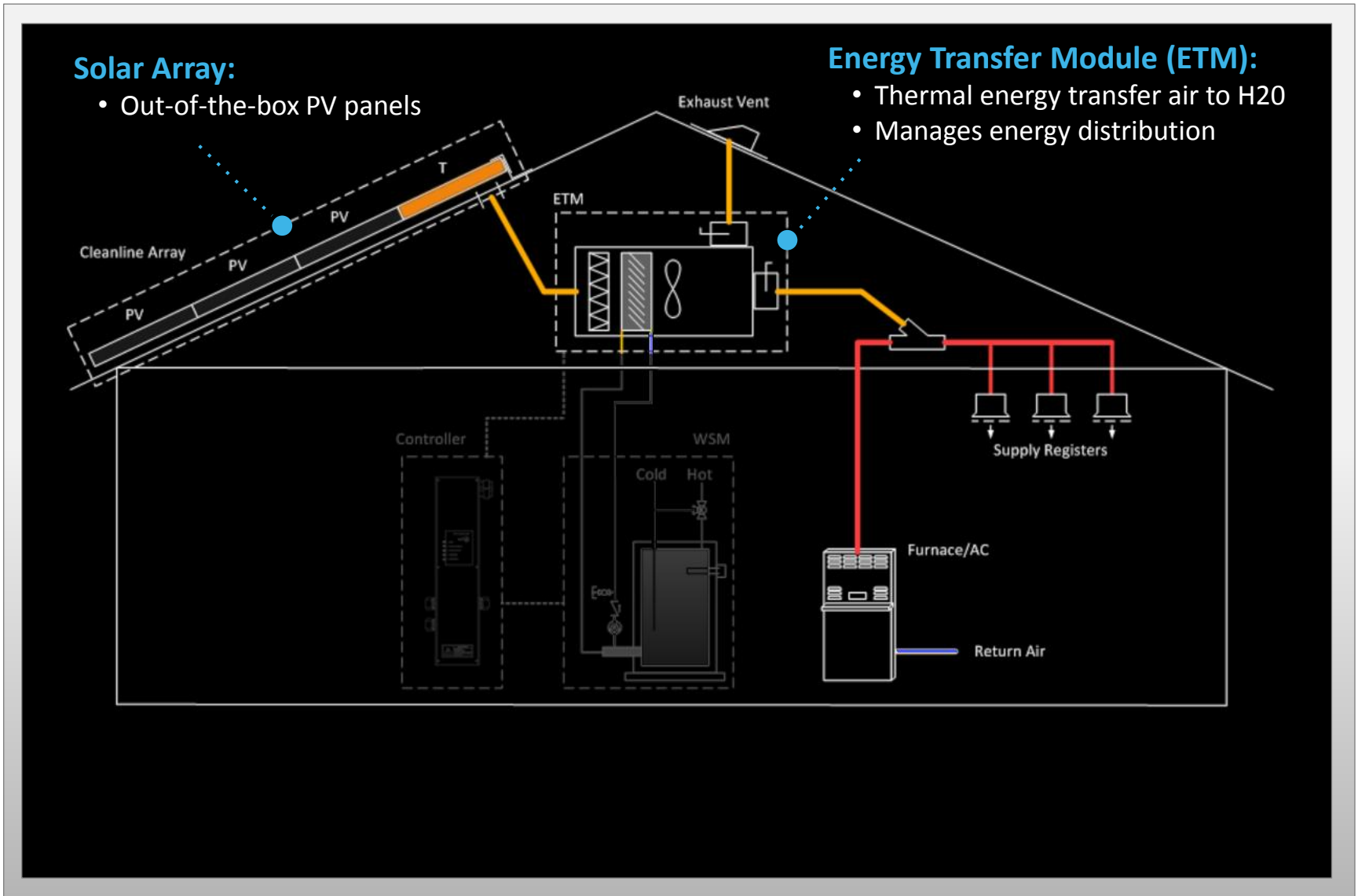
# Echo Solar System Schematic and Key Components

## Solar Array:

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## Energy Transfer Module (ETM):

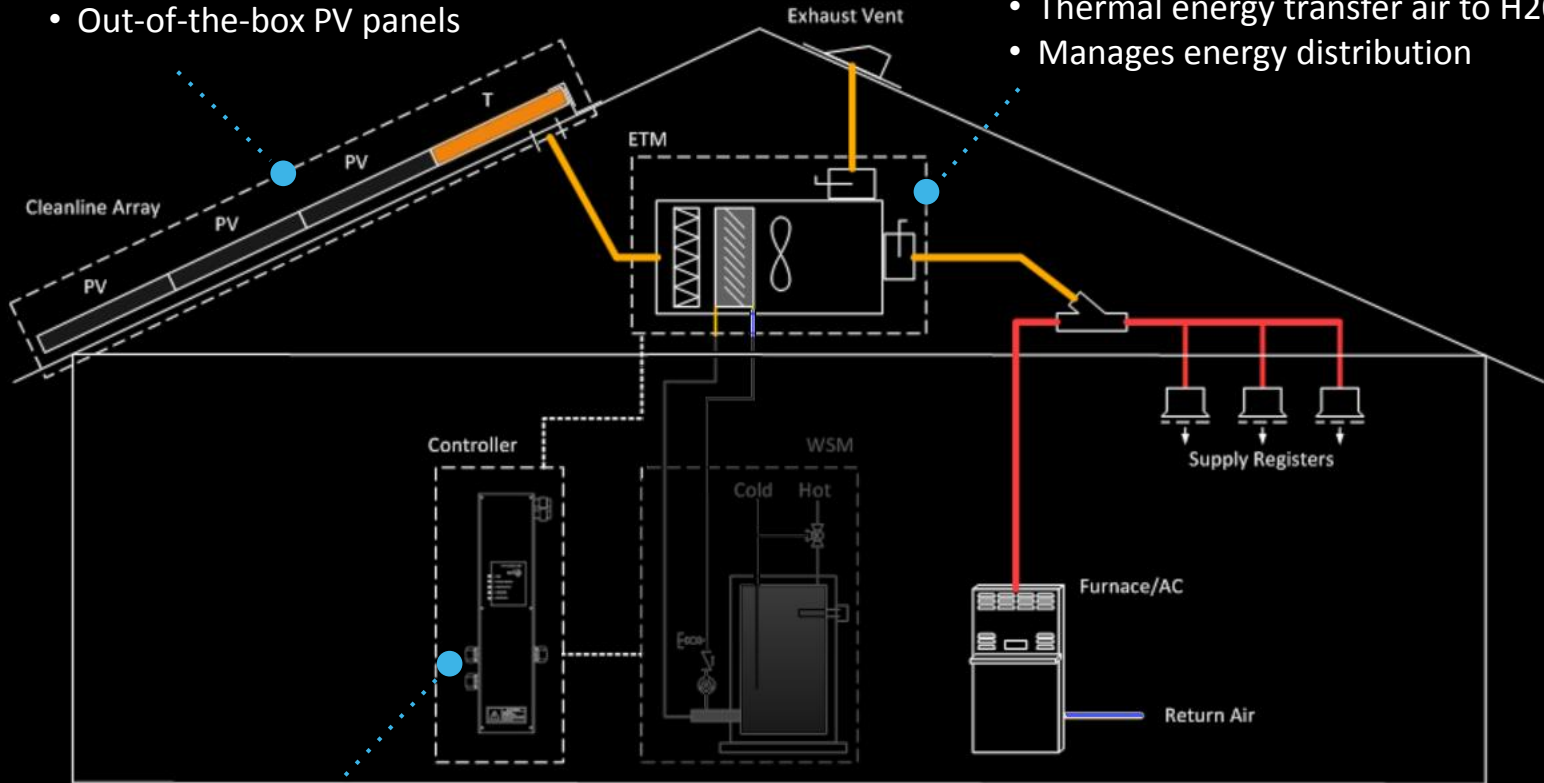
- Thermal energy transfer air to H2O
- Manages energy distribution



# Echo Solar System Schematic and Key Components

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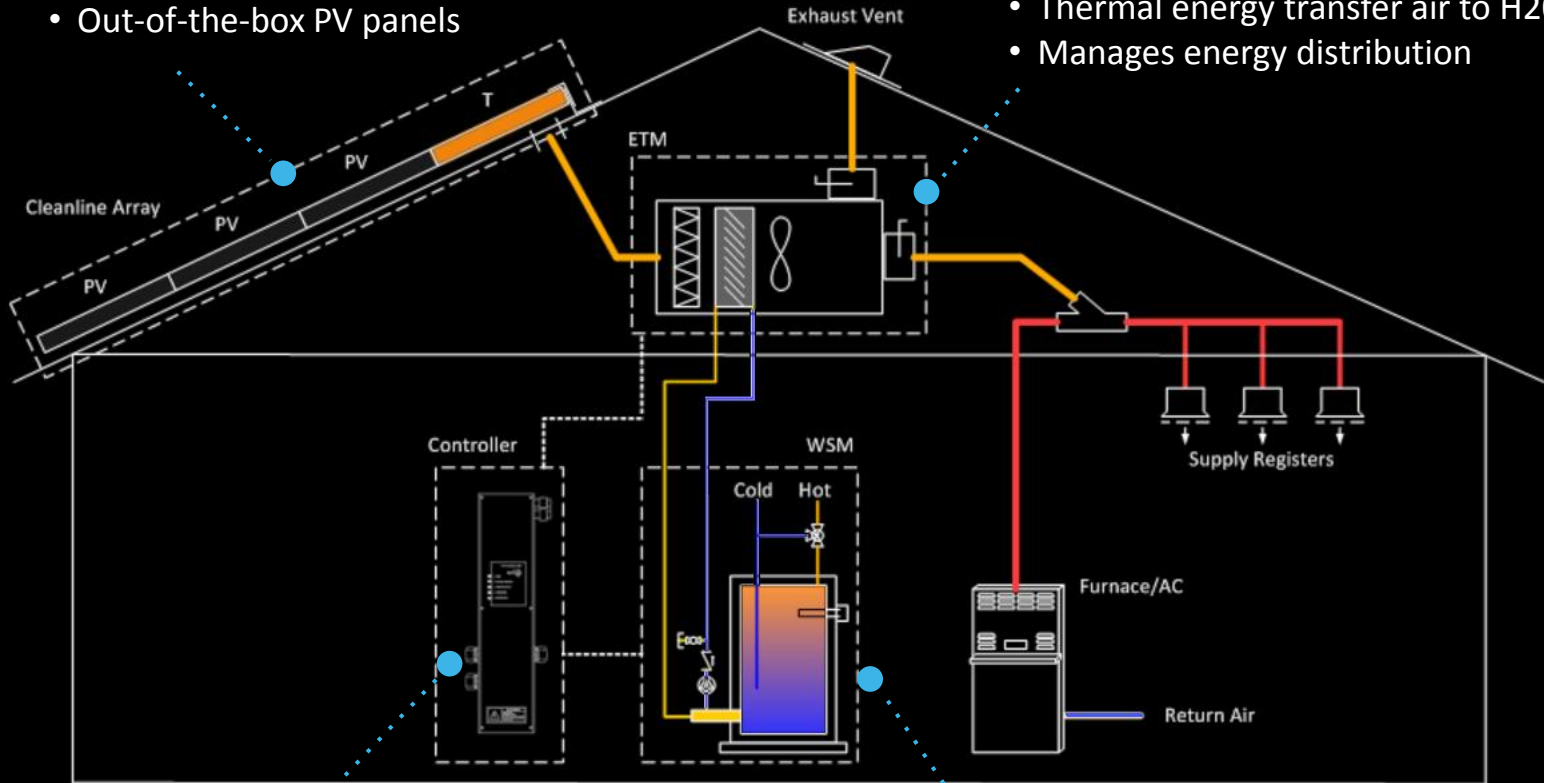
## Echo Controller:

- An intelligent control system
- Regulates echo solar system operation

# Echo Solar System Schematic and Key Components

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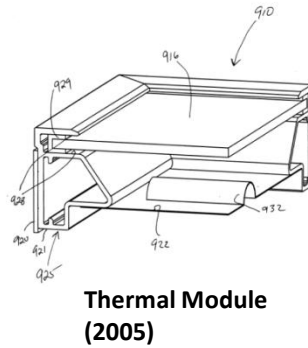
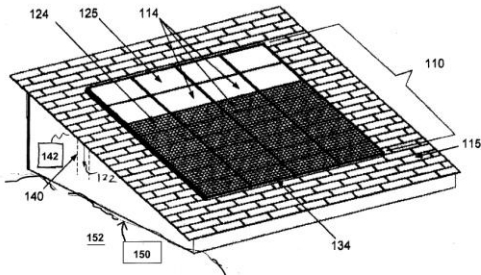
## Water Side Mechanicals (WSM):

- Solar storage tank and pump group
- Recovers and stores heat

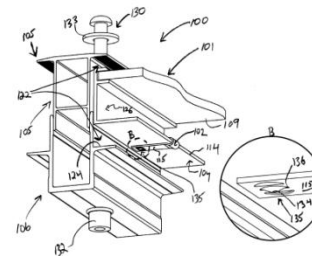
# More than 40 patents filed and 10 US patents awarded

## Array Development (22 Patents)

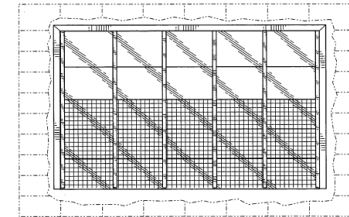
**PVT Array Concept (2005)**



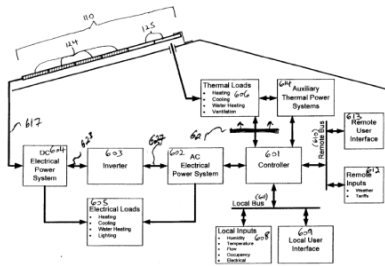
**Electrical Grounding (2006)**



**Array Design Patent (2008)**

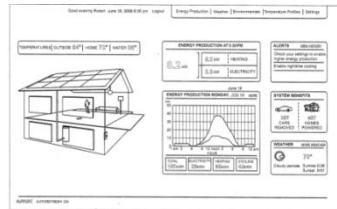


## Mechanical Systems & Controls (10 Patents)



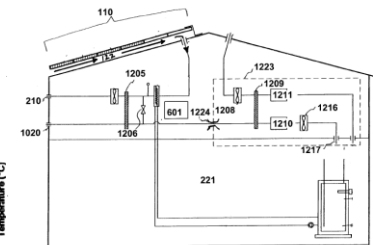
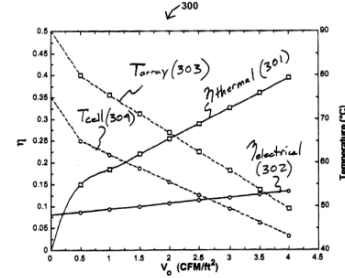
**Home Controls Integration (2006)**

**Consumer UI (2008)**



## Systems Level IP (10 Patents)

**PVT Array Control (2006)**



**Thermally Driven Cooling (2006)**

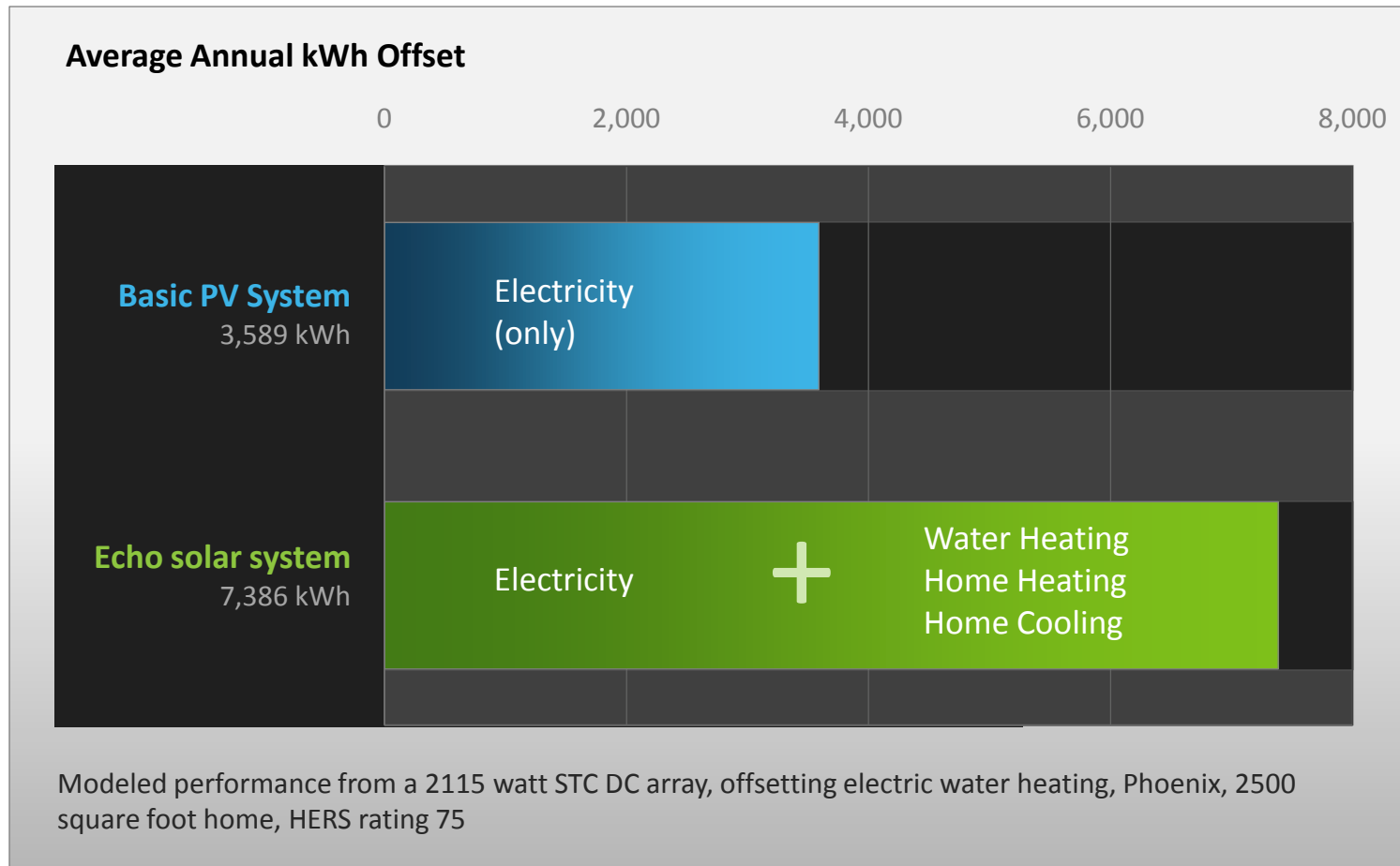
## Section 3

# How does Echo benefit homeowners

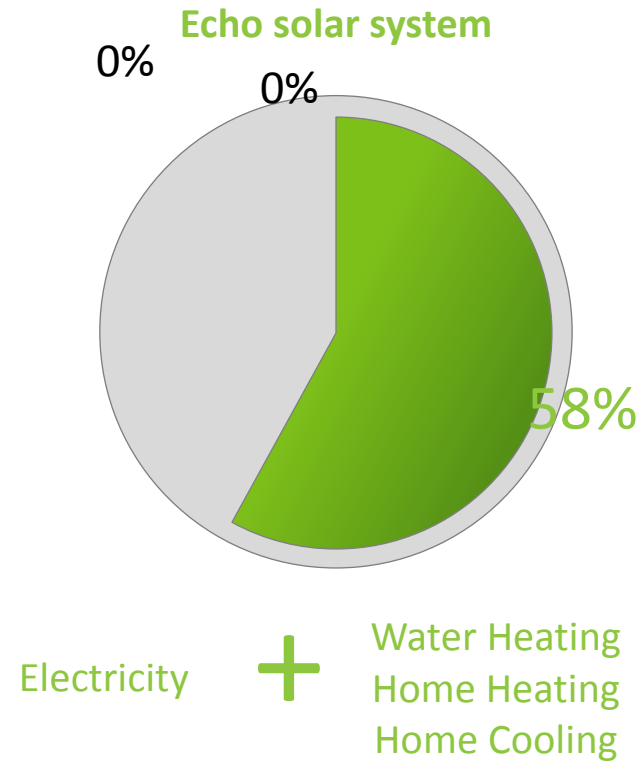
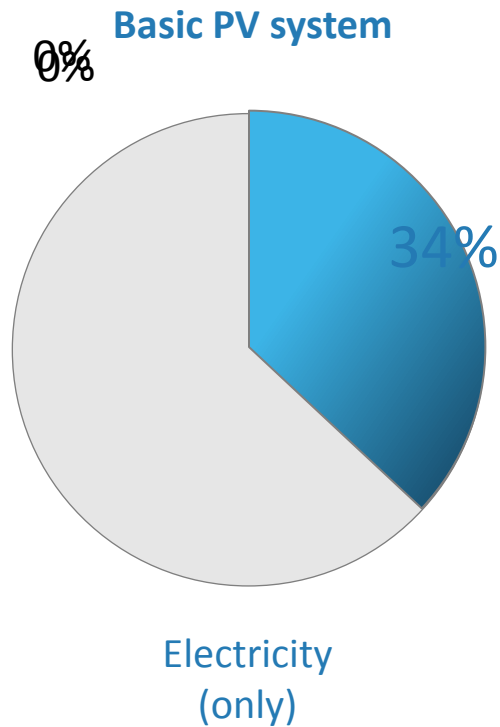
2009 National Poll, SEIA

# Echo Delivers 2X The Energy Of A Basic Solar System

Solar electric energy + solar thermal energy = more energy



# Echo Satisfies More of the Home's Energy Needs



Modeled performance from a 2860 watt STC DC array, offsetting electric water heating, Phoenix, AZ, 2500 square foot home, HERS rating 75

# Echo Saves Homebuyers More \$ Money

**John Doe**






123 ABC Street

Phoenix, AZ

March 16, 2011

## Home Energy Performance

Electric Utility: APS  
 Water Heating: Electric  
 Hot Water: Standard  
 Usage: Normal

Energy Generation Performance	Echo Solar System		Basic Solar	
	kWh	Monthly Savings	kWh	Monthly Savings
Electricity 	4927	\$ 470	4,927	\$470
Water Heating 	2157	\$ 206	—	—
Home Heating 	234	\$ 22	—	—
Home Cooling 	737	\$70	—	—
Ventilation 	—**		—	—
<b>Totals</b>	<b>8,055 (+69%)</b>	<b>\$768 (+69%)</b>	<b>4,927</b>	<b>\$470</b>



# Echo Complements The Curb Appeal Of Beautiful Homes

Sleek aesthetics create a system your homebuyer will be proud to show off.



# Echo Includes State Of The Art Performance Monitoring



# Echo's provides remote control of home energy systems

Echo transforms a computer or mobile phone into a 'home remote control'.

## Convenience and Comfort

Control your home thermostat from anywhere in the world, simply and easily.

## Energy Savings

Intelligent thermostat controls save energy while maintaining home comfort.



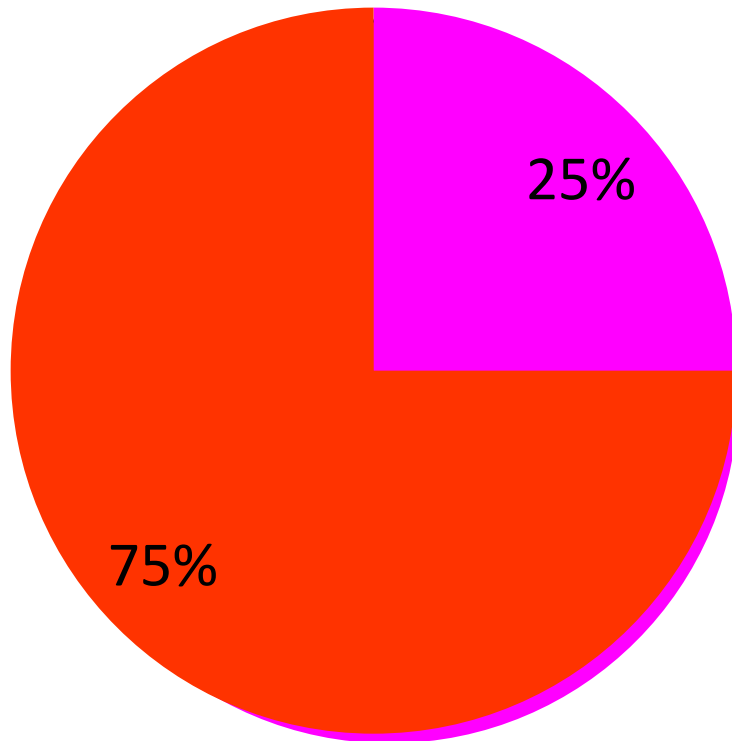
## Section 3

# Echo and Building Energy Use

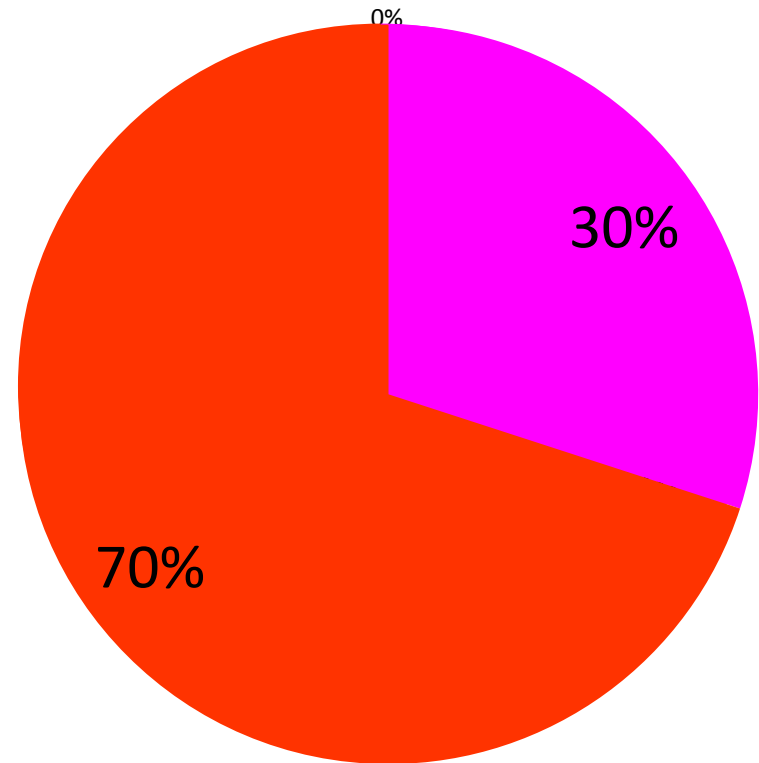
2009 National Poll, SEIA

# Echo Satisfies More of the Home's Energy Needs

## Tucson



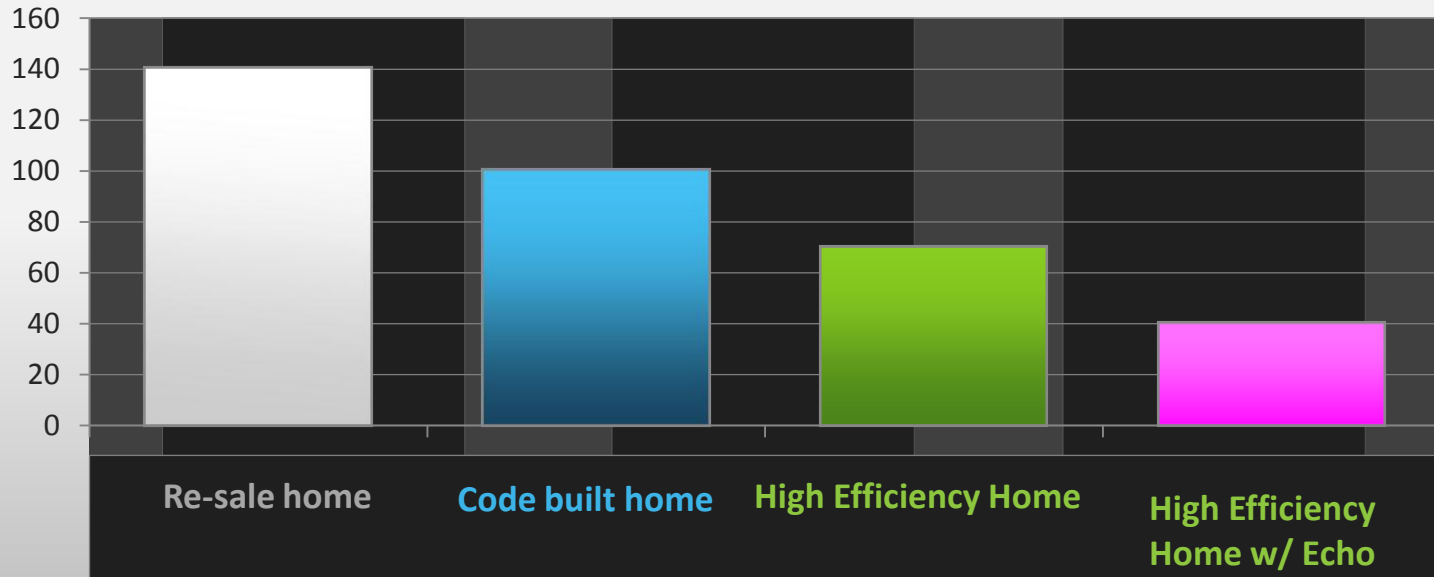
## San Francisco



**Efficient Inefficient**

# Echo Delivers 2X Energy So Your Home Gets Better “Miles Per Gallon”

*New Homes with Echo attains HERS scores of 25 - 40*



HERS ratings may vary home to home

## Section 4

# Echo & Water Heating

# Water Heating System Advantages

Echo has options for both closed and open loop water heating

Echo transfer heat from air to water using an Energy Transfer Module and heat exchanger

No Water on the roof – reduced risk of freezing

Extends the range of climates where glycol is not required

Reduces system cost

Increases performance

Echo is certified to both OG-100 and OG-300 solar water heating standards

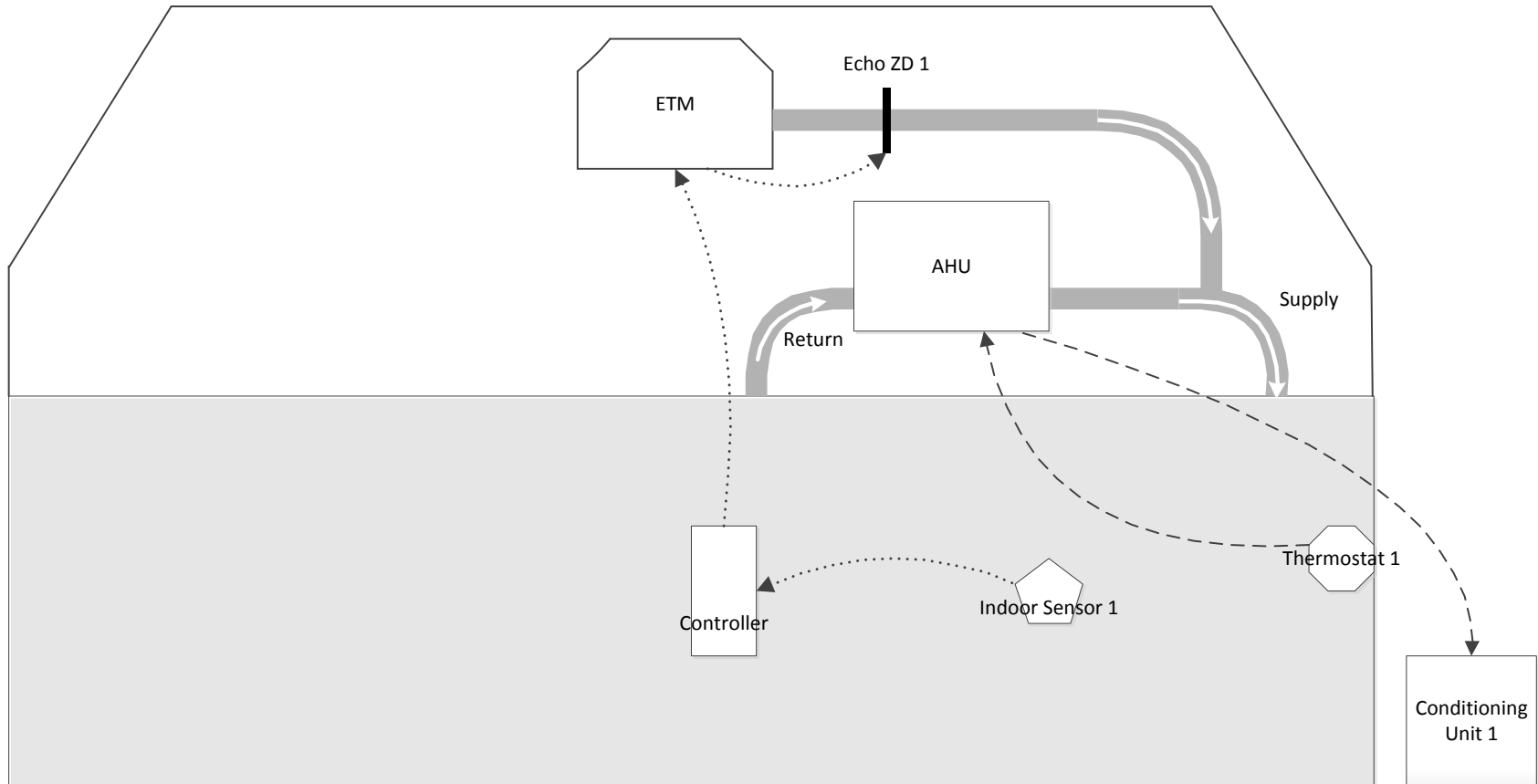
Solar Fraction for a 2.1 KW system ranges from 50% to 90% depending on climate



## Section 5

# Echo Heating and Cooling

# Basic Echo HVAC architecture

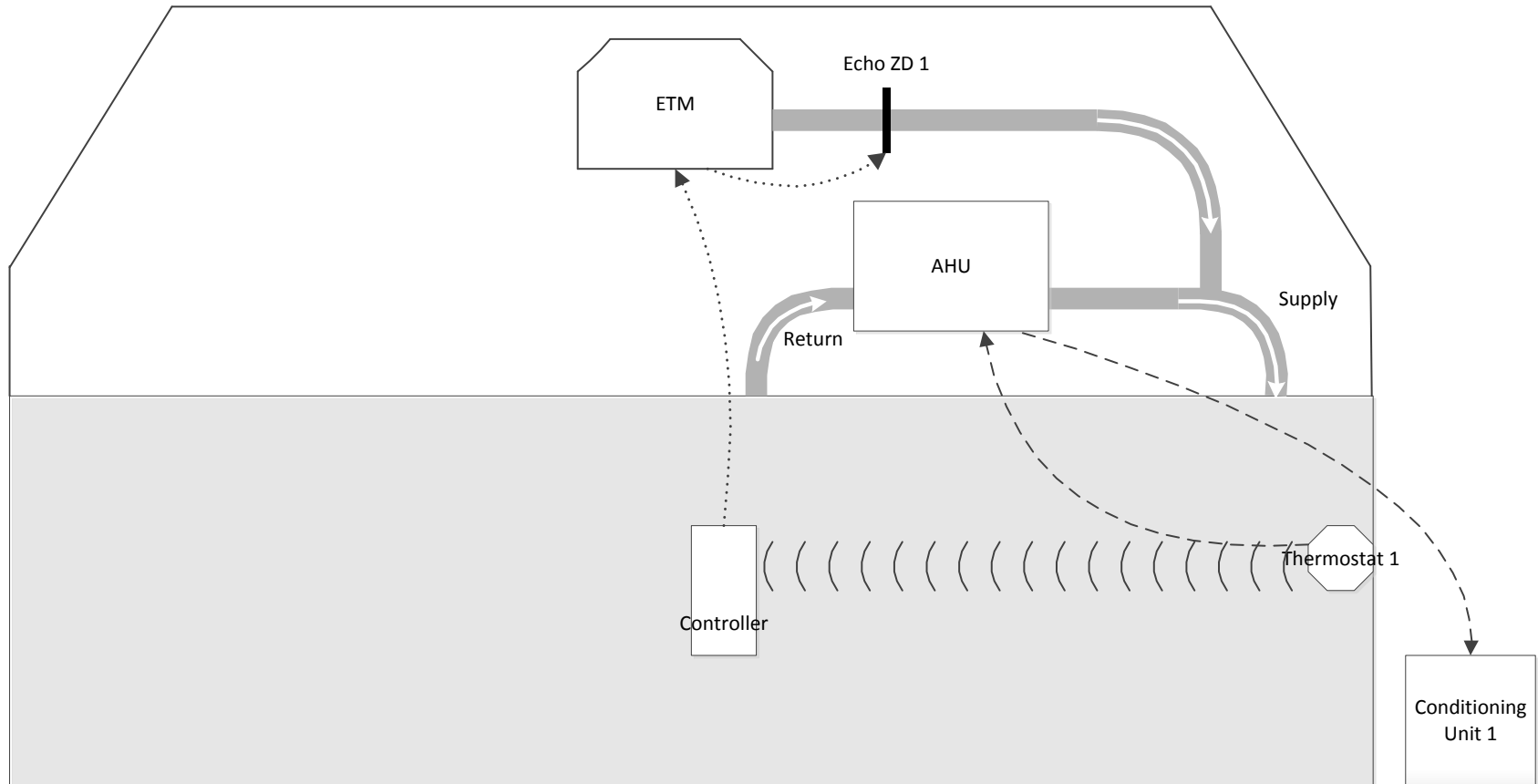


Echo is controlled independent of HVAC system

Echo ties into ducting downstream of Air Handler to provide proper distribution

Indoor and outdoor temp sensors turn Echo on for heating and cooling

# Optional Wireless Thermostat



Echo Controller communicates with wireless thermostat

Echo operating mode is synchronized to thermostat operating mode

# How do you save energy?

Building Passive Storage – slab and insulation

Psychometric Comfort Ranges – ASHRAE standard 55

People are comfortable over a range of indoor conditions – 72 F is not the only comfort point

Enabling better user behavior – The Prius Effect

What matters is the minimum and maximum temperatures

Educate users on savings energy by adapting behavior w/ thermostats

What does Echo do

Uses Building Passive storage to float home temperature

Defer heating and cooling energy usage by charging the home with solar heating and night sky radiant cooling

# ECHO Virtual Thermostat

Designed to exploit building passive storage and comfort range to maximize energy savings

The screenshot displays the ECHO Virtual Thermostat interface. At the top left is the 'echo' logo. The top navigation bar includes 'Home', 'Energy Production', 'Temperature Profiles', 'Thermostat', and 'Settings'. The main interface is divided into several sections:

- Intuitive Modes with default:** Includes buttons for 'MANUAL', 'PRE-PROGRAMMED SETTINGS', 'HOME', 'SLEEP', and 'AWAY'.
- CALENDAR:** Features 'ON' and 'OFF' buttons, with a note: 'CALENDAR SCHEDULE WILL BE RESTORED AT 6:00 AM'.
- “Dial” Thermostat:** A large circular dial with temperature markings from 50 to 90. The current temperature is 70. A 'SET TO' box shows 70. Below the dial are 'Easy Setpoint Adjustment' and 'CURRENT TEMP' labels. A 'MODE: HEATING' indicator is shown with a flame icon.
- Heat/Cool Mode:** Includes a 'SAVE ENERGY MODE' button with 'ON' and 'OFF' options.
- SET YOUR HOME OCCUPANCY SCHEDULE:** A grid showing occupancy status for each hour of the day across the week. The legend indicates: HOME (yellow), SLEEP (blue), and AWAY (orange).

Annotations on the interface include:

- 'Turn Calendar “Off” to Hold temp' pointing to the 'OFF' button.
- 'Easy Setpoint Adjustment' pointing to the '70' in the 'SET TO' box.
- 'SE mode for high demand periods' pointing to the 'SAVE ENERGY MODE' button.
- 'Comfort Band – low end HP/ high end solar' pointing to the 70-degree mark on the dial.
- 'Advanced setting' pointing to a gear icon.
- 'Easy to set “Drag and Drop” Calendar' pointing to the occupancy schedule grid.

# ECHO Thermostat features

A classic “speedometer” look to provide an intuitive dial type control

Intuitive, easy to use calendar

Acts as a programmable thermostat, with a more user friendly design

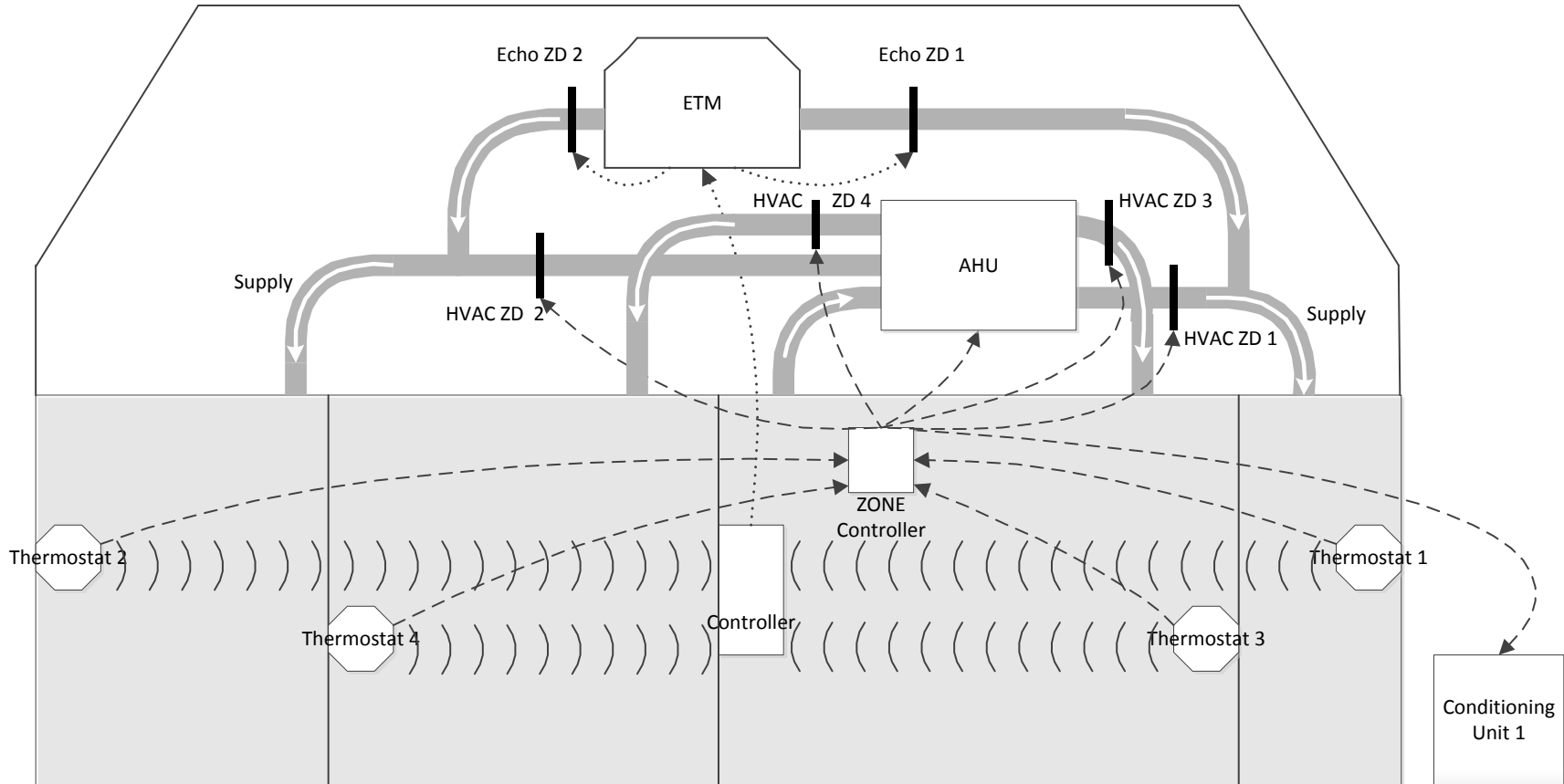
Single point control, seamless control for all space conditioning systems

Remote control from anywhere in the world

Comfort band concept to reduce fossil fuel usage and optimize solar heating and night cooling

Eliminate any conflict between Echo and auxiliary system

# How does it work with complex high efficiency HVAC systems



A 4 zone system with 4 wireless thermostats. Echo controller reads temp and mode on all thermostats – web UI for all T-stats. Echo connects downstream of AHU into multiple zones  
Zone Controller co-ordinates HVAC system operation between the zones – Echo does not connect to zone controller.=

## Section 6

# Echo Smart Ventilation



# What is unique about Echo Ventilation

Promotes a healthier indoor environment with ASHRAE 62.2 compliant ventilation

Echo can provide heated air to the space in winter and cool air in the summer

## Intermittent Ventilation Strategy

ASHRAE 62.2 allows intermittent ventilation with higher air flow rates operating for a fraction of 12 and 24 hr cycles

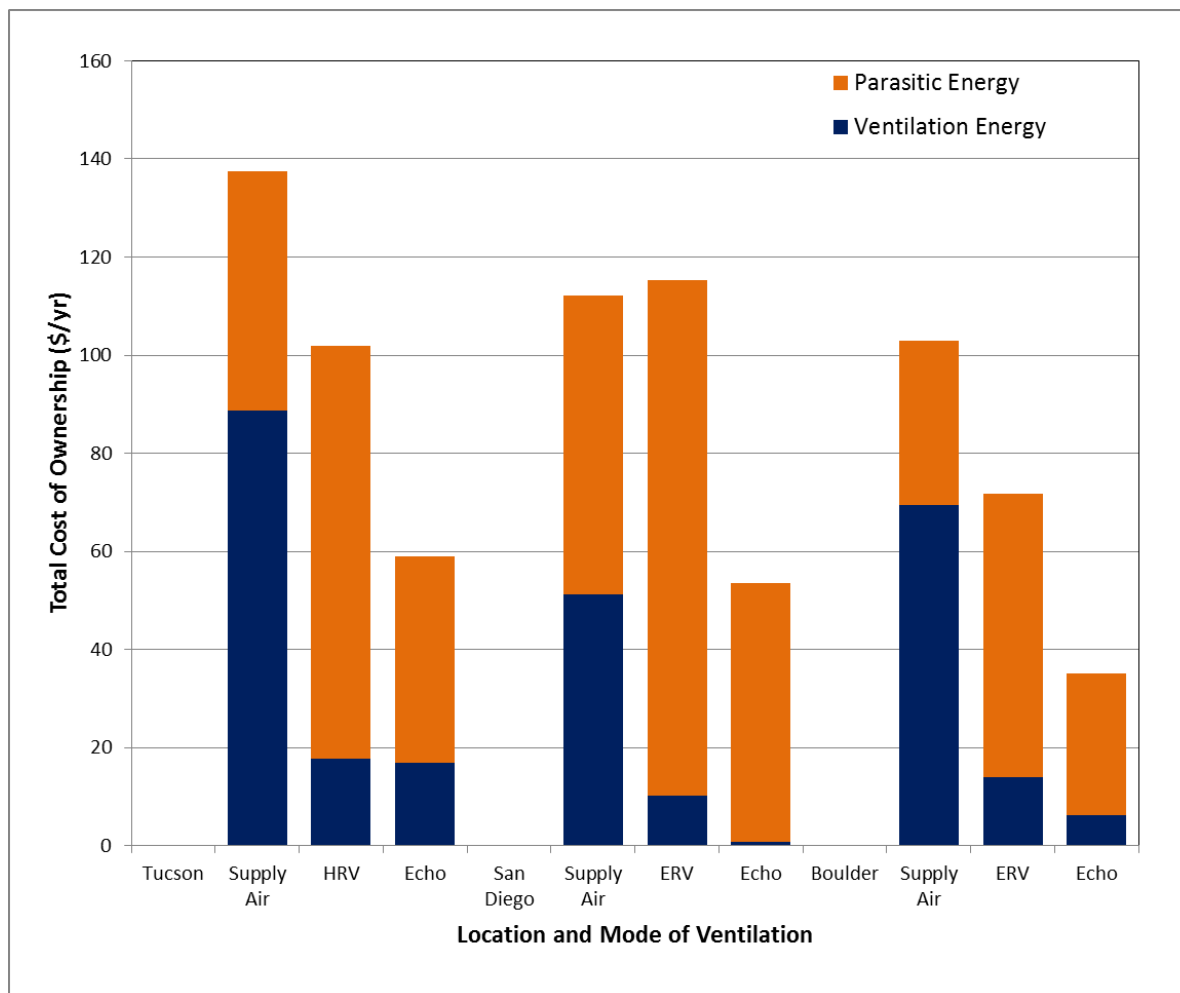
Echo operates at 3 – 5 time base ventilation rates using variable speed fans at 0.2 W/CFM

Standard cooling and heating operation count to ventilation credit

Reduces energy use for ventilation by 40 – 80%, especially in dry climates

# Energy Efficient Ventilation

Sum of fan energy and heating and cooling energy lower than alternate methodologies in western climates



## Section 6

# System Commissioning, Monitoring and Fleet Management

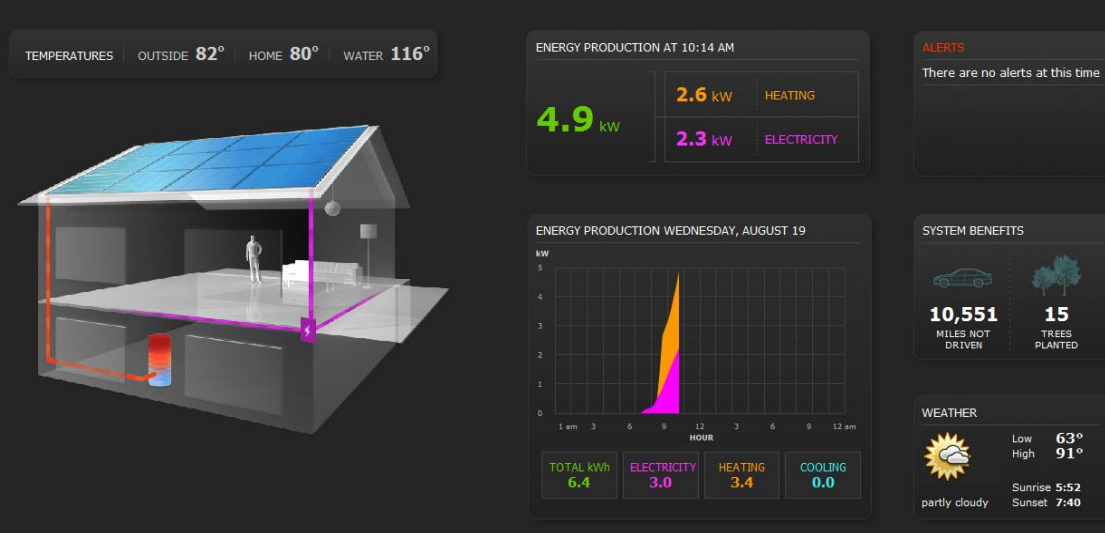
# Complete system commissioning with remote verification

SmartComm ensures that the full system is operational and meets criteria for airflow, PV production, based on system design.

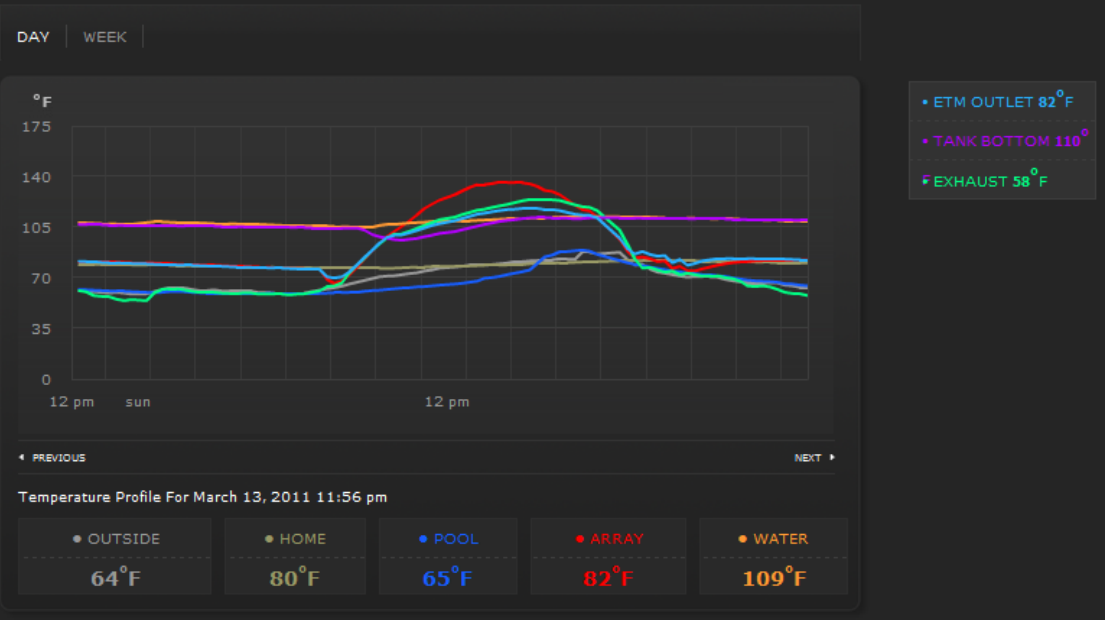
Commissioning data stored in central database and available to partners



# Multiple Home Comfort parameters monitored



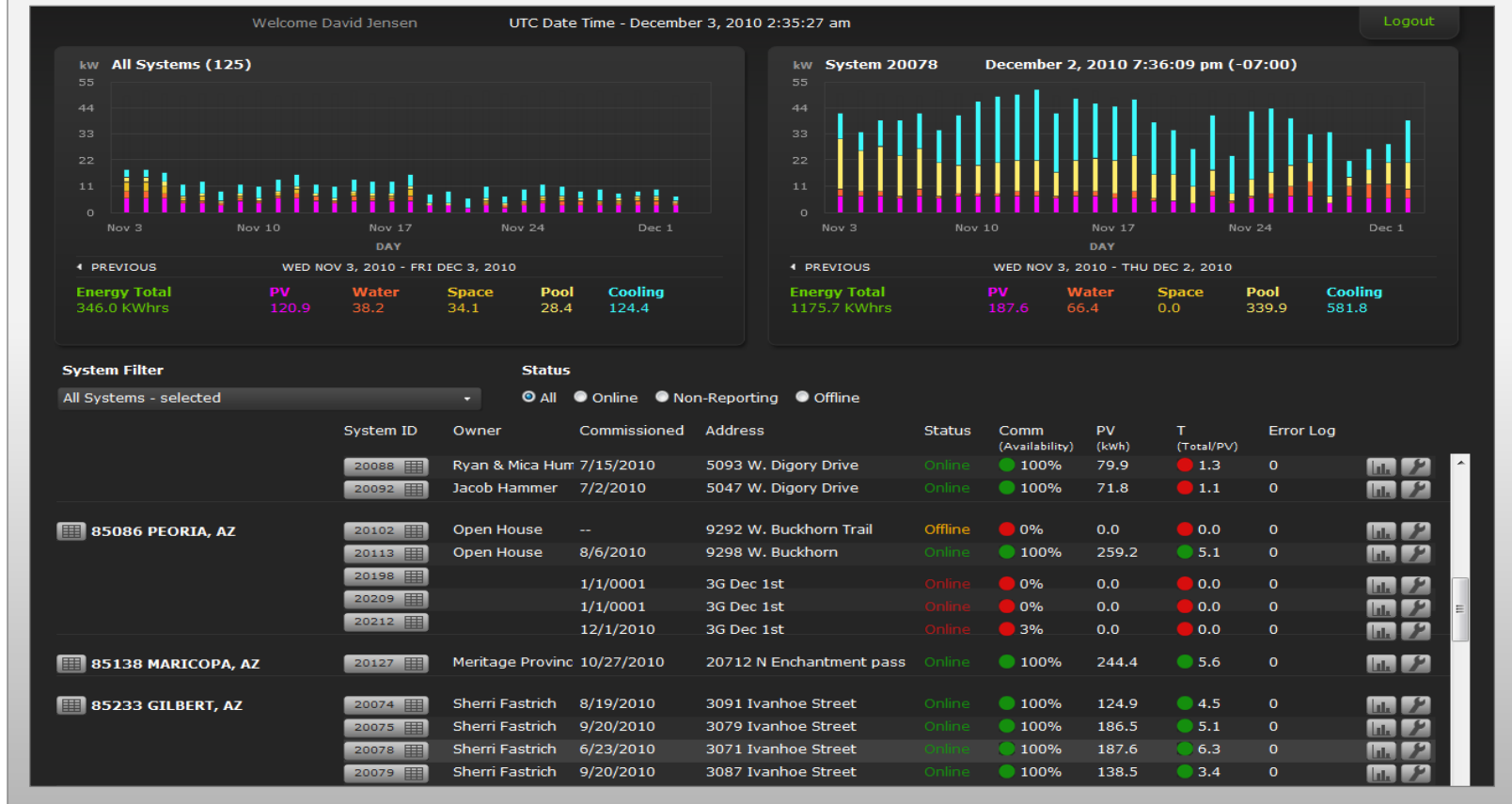
Echo monitors both energy generation and system temperatures related to HVAC and water heating



# Echo Fleet Control Center monitors system performance 24/7

Dealer and Internal Dashboards allow real time monitoring and historical performance evaluation of the fleet

Individual systems can be compared to locational system averages

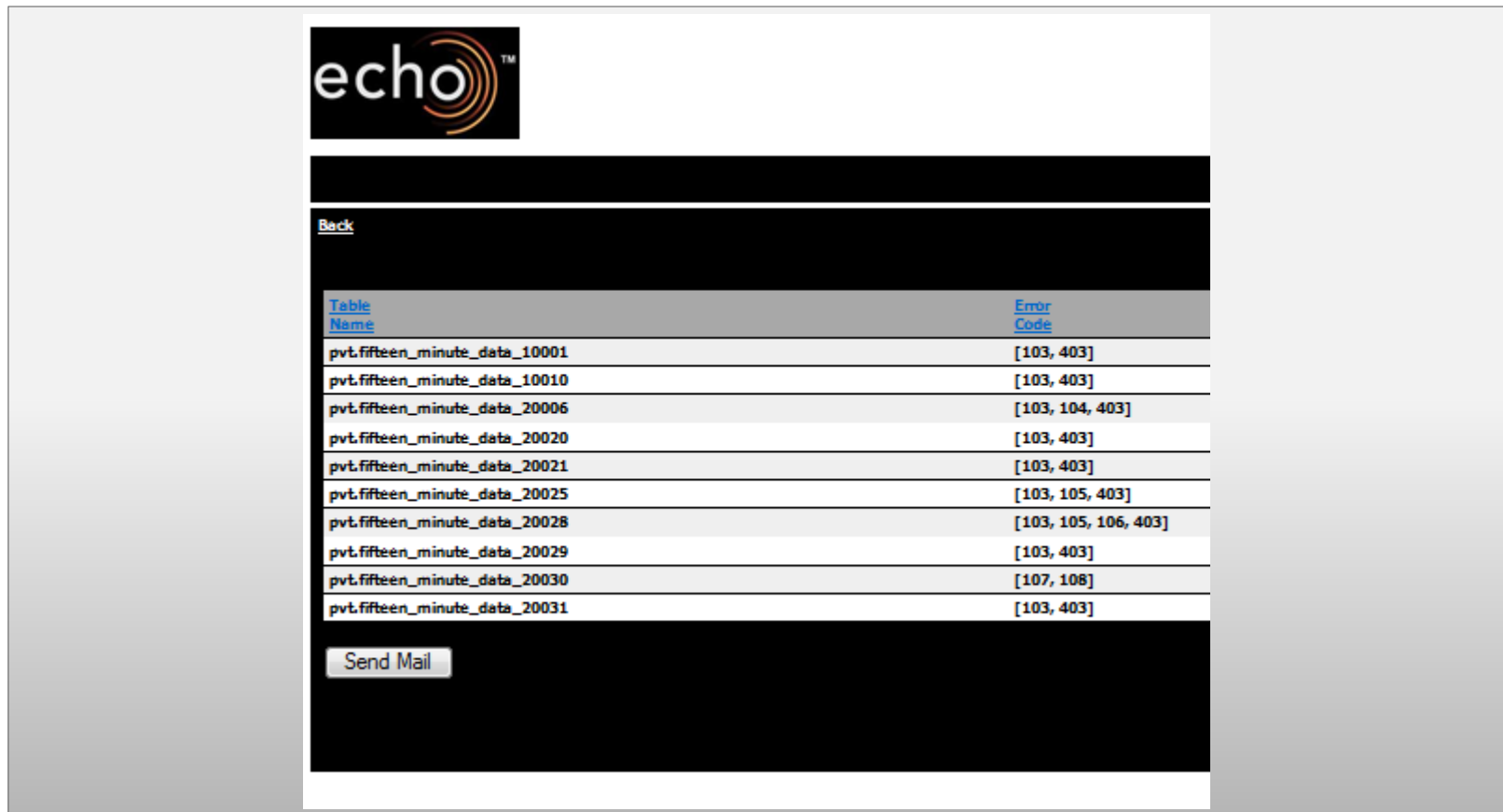


# Automated Diagnostics enables fault finding and rectification

Automated Diagnostics help detect faults as they happen real time

Technical Control center fixes most faults remotely

Echo provides ability to co-ordinate service calls with HVAC and plumbing trades



The screenshot displays the Echo diagnostic interface. At the top left is the Echo logo. Below it is a 'Back' link. The main content is a table with two columns: 'Table Name' and 'Error Code'. The table lists ten entries, each with a unique table name and a corresponding error code. Below the table is a 'Send Mail' button.

Table Name	Error Code
pvt.fifteen_minute_data_10001	[103, 403]
pvt.fifteen_minute_data_10010	[103, 403]
pvt.fifteen_minute_data_20006	[103, 104, 403]
pvt.fifteen_minute_data_20020	[103, 403]
pvt.fifteen_minute_data_20021	[103, 403]
pvt.fifteen_minute_data_20025	[103, 105, 403]
pvt.fifteen_minute_data_20028	[103, 105, 106, 403]
pvt.fifteen_minute_data_20029	[103, 403]
pvt.fifteen_minute_data_20030	[107, 108]
pvt.fifteen_minute_data_20031	[103, 403]