Emerging Technologies (ET)

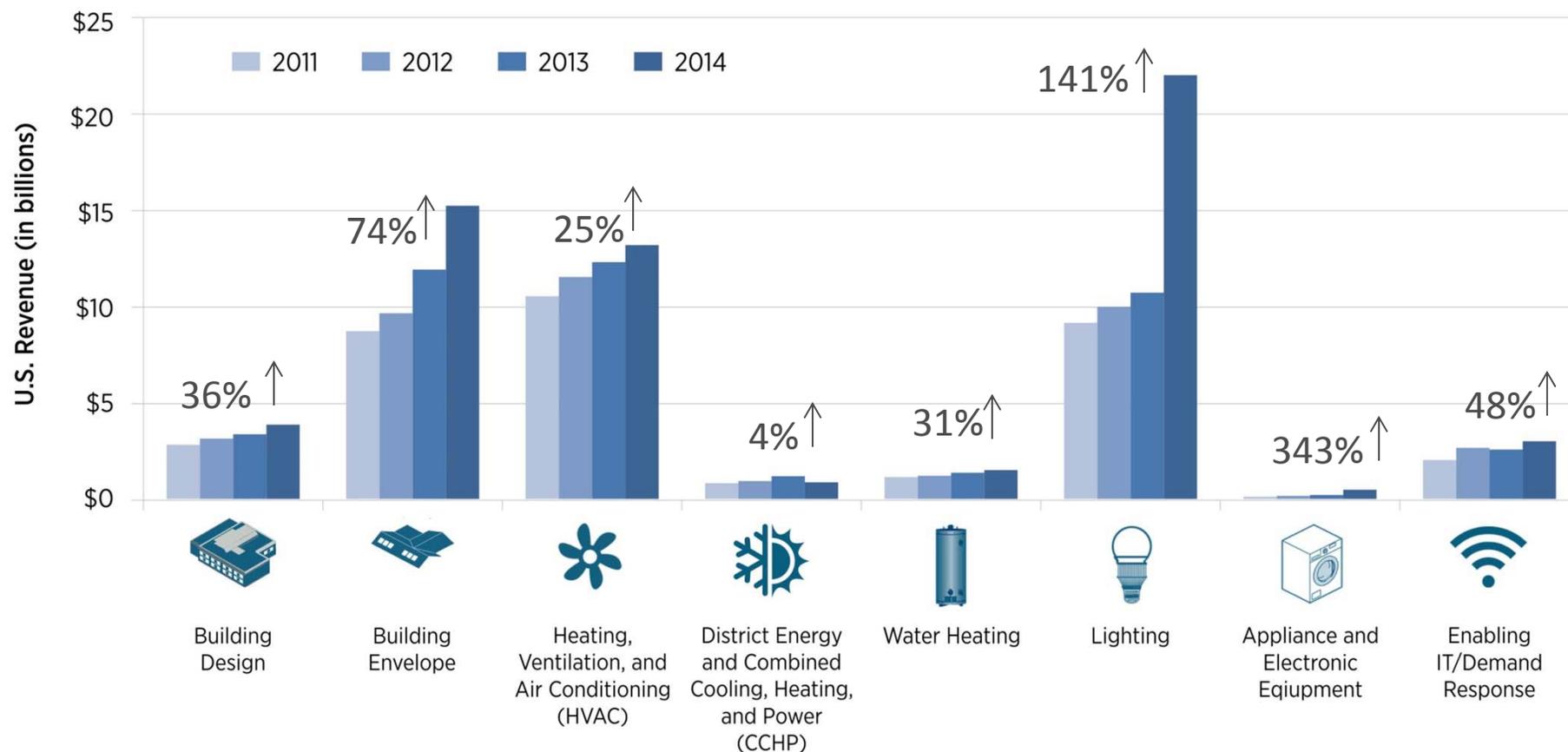U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Pat Phelan (patrick.phelan@ee.doe.gov)
April 14, 2015

Why Support Buildings Energy Efficiency R&D?

U.S. Revenue by Advanced Building Technology Type

Source: Advanced Energy Now 2015 Market Report

Emerging Technologies R&D Goals

As a result of ET sponsored research, cost effective technologies will be introduced into the marketplace by 2020 that will be capable of reducing a building's energy use by 25% relative to 2010 cost effective technologies, and 35% by 2030.

Technology-specific targets relative to the 2030 primary energy consumption projected by the *2010 Annual Energy Outlook*:
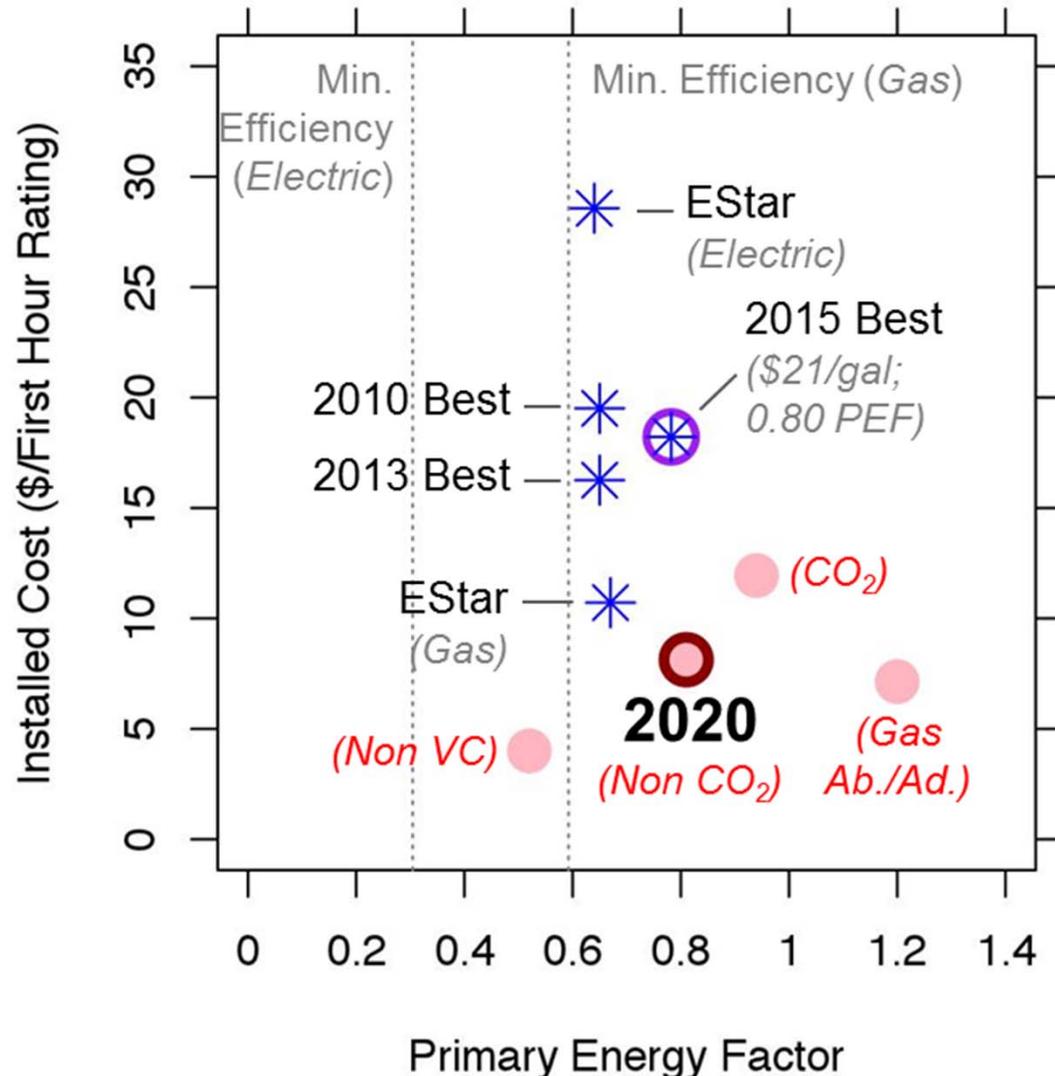
2020

Lighting:	30%
HVAC:	10%
Water Heating:	20%
Appliances:	15%
Windows/Envelope:	15%
Sensors & Controls:	10%

2030

Lighting:	65%
HVAC:	25%
Water Heating:	35%
Appliances:	30%
Windows/Envelope:	35%
Sensors & Controls:	20%

Tracking Progress on Efficiency & Cost: Water Heaters

2020 R&D targets are shown for:

Electric
- **Non-CO_2 vapor compression**
- **CO_2 vapor compression**
- **Non vapor compression**

Gas-Fired
- **Absorption/Adsorption**

2015 Best Source: Lowe's, Home Depot, & Sears product data for ~50-60 gallon residential heat pump water heater
Energy Star Source: http://www.energystar.gov/index.cfm?c=water_heat.pr_crit_water_heaters
Fed. Min. Std. Sources: *Electric* - http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27#recentupdates ;
Gas -http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27#recentupdates

Supply Curves - Current and Future Technologies

2030 Cost Effective Primary Energy Savings
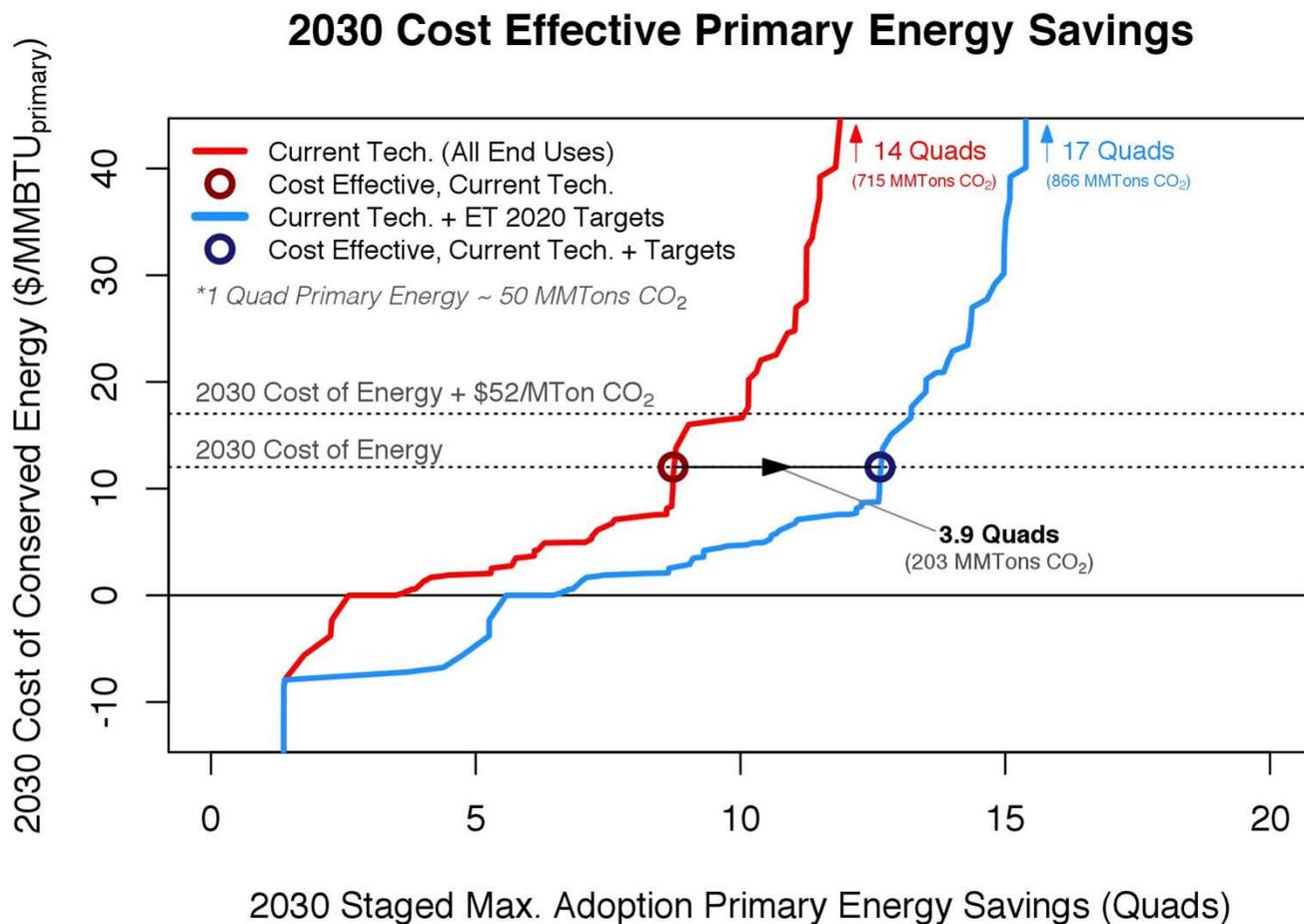
ET 2020 research targets enable an additional 4 Quads of cost-effective energy savings in 2030

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HVAC: Recent Highlights

Transcritical CO$_2$ Supermarket Refrigeration System
Oak Ridge National Laboratory's (ORNL's) cooperative research and development agreement (CRADA) with **HillPhoenix**

- Low GWP refrigerant (CO$_2$), with 25 percent lower energy consumption than existing systems, and 78% lower GHG emissions


New Low-GWP Refrigerant for Supermarkets
Oak Ridge National Laboratory's (ORNL's) cooperative research and development agreement (CRADA) with **Honeywell**

- Honeywell and ORNL have developed Solstice N40, a non-toxic hydrofluoroolefin (HFO) -based refrigerant alternative for R-404A, the most common refrigerant used
- Offers a lower-global-warming potential and energy-saving replacement for R-404A

Search for Low-GWP Refrigerants
Research by NIST and CUA to identify low-GWP refrigerants: Best Paper Award for 2013/14 *Int. J Refrigeration*

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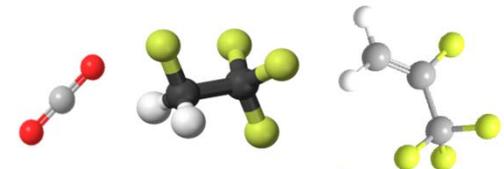
Building Energy Modeling: Recent Highlights

EnergyPlus (ET) – state-of-the-art BEM capabilities

- Transition to C++, open-source code maintenance & distribution tools (GitHub)
- Two releases: v8.2 (9/14), v8.3 (3/15) 15% faster than FORTRAN v8.1—20,000+ downloads/release
- New features: data-center models, heat-pump models, improved equipment sizing, generalized plant operation schemes, faulty equipment models, integrated basement & ground coupling models, etc.

OpenStudio (CBI) –open extensible BEM application platform

- Four releases: v1.4 (6/14) to v1.7 (3/15)—20,000+ downloads/release
- New features: Amazon EC2 cloud support, spreadsheet based interface, increased coverage of HVAC systems, gbXML import, RADIANCE integration, 175 measures in BCL, etc.

Third party applications & services – if they succeed, we have succeeded

- Autodesk EnergyPlus Cloud service
- NORESCO's CBECC-Com Title-24 performance-path compliance tool
- Sefaira Systems early-stage design application
- "Opened up" Xcel Energy's EDAPT (Energy Design Assistance Program Tracker) to other utilities
- Three SBIR phase I awards for EnergyPlus/OpenStudio extensions, applications & services
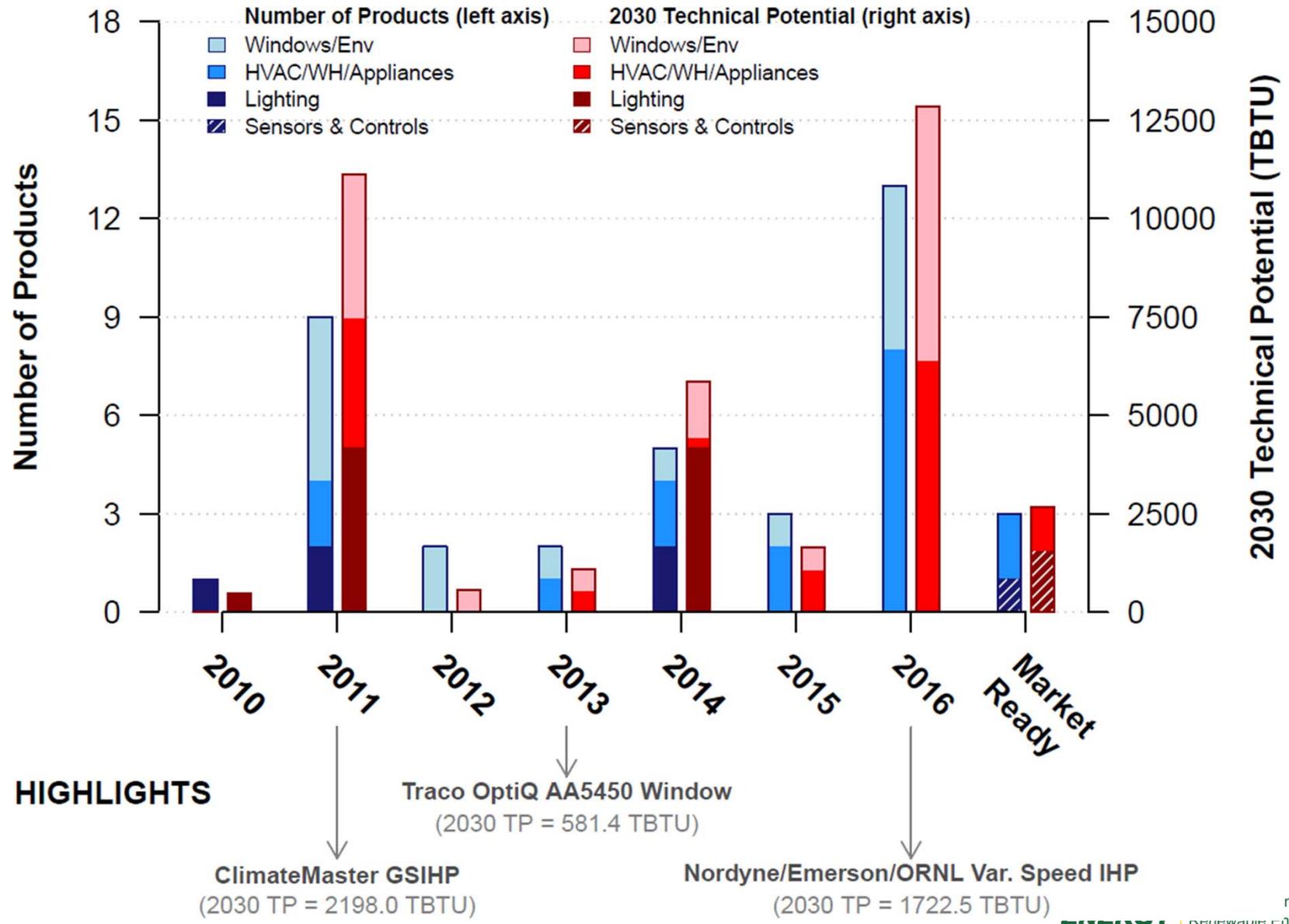
Community Support

- UnmetHours peer-to-peer help site—300 active users, 700+ questions in 6 months
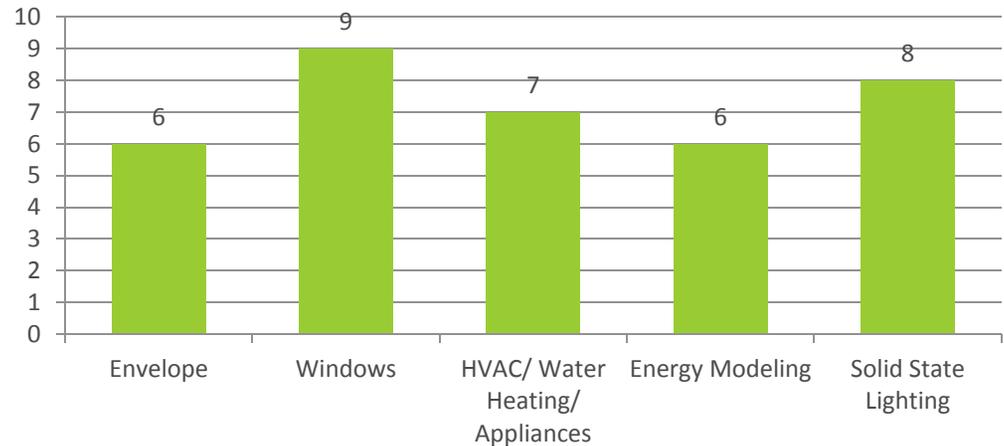- New IBPSA-based Building Energy Software Tools Directory

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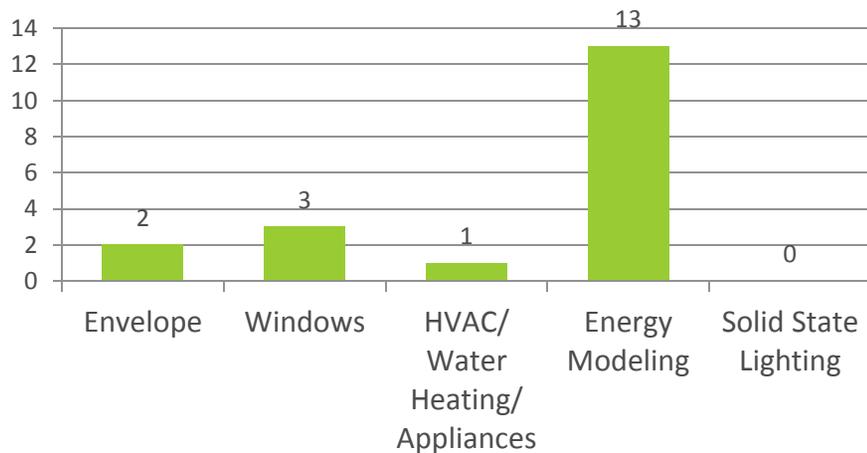# Commercialized Technologies & Energy Impacts from ET Funding

2014 Intellectual Property (IP) & Journal Articles from ET Funding

The Windows/Envelope Sub-Program generated the most IP in 2014.

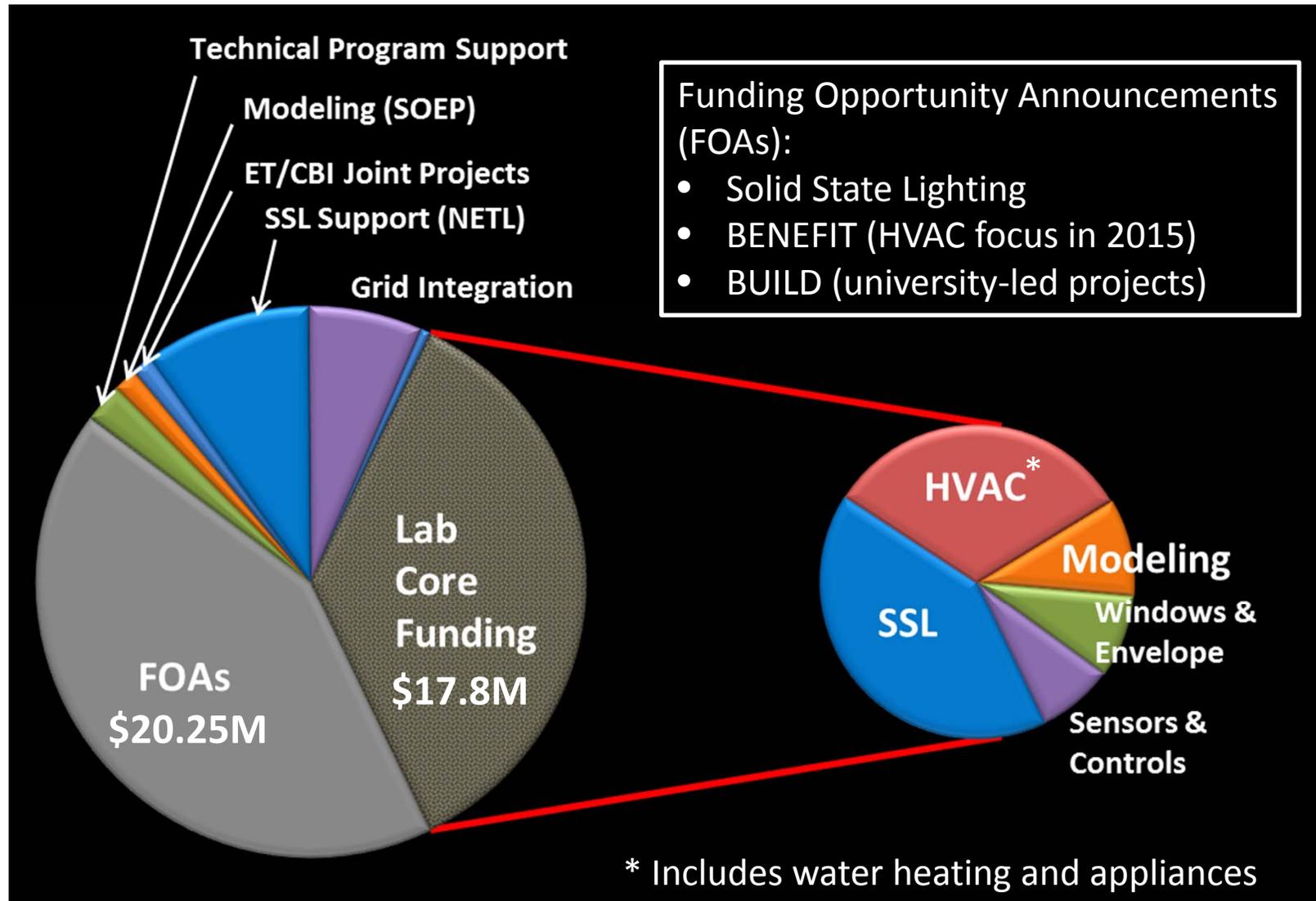**Intellectual Property (Patent Awards and Applications/ Invention Disclosures; Software Licenses and Releases)**

Bar chart values:
- Envelope: 6
- Windows: 9
- HVAC/ Water Heating/ Appliances: 7
- Energy Modeling: 6
- Solid State Lighting: 8

Peer-Reviewed Journal Articles

Bar chart values:
- Envelope: 2
- Windows: 3
- HVAC/ Water Heating/ Appliances: 1
- Energy Modeling: 13
- Solid State Lighting: 0

The Building Energy Modeling Sub-Program generated the most refereed journal articles in 2014; SSL results are not available yet.

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Fiscal Year 2015 Emerging Technologies Funding Distribution

Technical Program Support

Modeling (SOEP)

ET/CBI Joint Projects

SSL Support (NETL)

Grid Integration

Funding Opportunity Announcements (FOAs):
- Solid State Lighting
- BENEFIT (HVAC focus in 2015)
- BUILD (university-led projects)

Lab Core Funding $17.8M

FOAs $20.25M

HVAC*

Modeling

SSL

Windows & Envelope

Sensors & Controls

* Includes water heating and appliances

ET FY15 Budget: $49.9M

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ET Funding for FY16 and Beyond

Funding Opportunity Announcements:

➢ Solid-State Lighting (SSL): R&D advances in LEDs and OLEDs
➢ BENEFIT FOA (BENEFIT = Building ENergy Efficiency Frontiers and Innovation Technologies):
- Topics focused on Multi-Year Program Plan targets
- "Open" topic
- BUILD topic (BUILD = Buildings University Innovators and Leaders Development)

➢ SBIRs (Small Business Innovation Research)
- Generally one SSL topic and one non-SSL topic each year

Lab "Core" Funding:

➢ Capitalize on lab capabilities & facilities
➢ Fill in gaps in the MYPP
➢ Develop and maintain design tools
➢ Develop standard test methods for non-covered products
➢ 3-year projects to be developed as part of this year's Merit Review

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BTO Emerging Technologies

- Research projects
- Roadmaps
- Technical reports
- Funding opportunities
- Webinars

Two roadmaps under development:
- Sensors & controls
- Building energy modeling