The Pennsylvania Housing Research Center

PHRC Year in Review

July 2014 – June 2015

Published August 2015

Pennsylvania Housing Research Center
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Introduction

The purpose of this document is to provide a summary of activities the Pennsylvania Housing Research Center has pursued and products that have been delivered between July 1, 2014 and June 30, 2015.

Each year, the Pennsylvania Housing Research Center (PHRC) seeks to conduct a series of projects that collectively satisfy the following criteria. Projects should:

- meet the needs of the residential construction industry and the housing consumer in Pennsylvania;
- be consistent with the mission and goals of the PHRC;
- be affordable and feasible, given the resources available and the prevailing constraints on time, expertise, and facilities; and
- be a balanced program of projects that address both the long- and the short-term needs of the industry.

The PHRC receives funds from multiple sources including funds collected under Act 157 of 2006, which established a two dollar fee collected for each building permit to support training and education for the construction industry. To assure that programs funded in whole or part with Act 157 monies meet the needs of the construction industry, Act 157 requires that education, training and other activities provided by the PHRC be approved by its Industry Advisory Council (IAC).

The projects undertaken were developed with input and assistance from the PHRC's Industry Advisory Council (IAC). This body consist of builders, developers, design professionals, code officials, manufacturers, suppliers, remodelers, and industry associations as well as state and federal agencies. After a thorough discourse at the spring IAC meeting in April 2014, the members of the IAC voted on projects they felt were the highest priority for the industry.

The result of this input was the "*PHRC Project Plan, July 2014 – June 2015*", which outlined projects that the PHRC would undertake during this time period. The plan included only those projects that were to receive funds provided to the PHRC by the Commonwealth of Pennsylvania through the Act 157 permit fees. When appropriate, the PHRC attempts to use state funding to leverage outside support. It should also be noted that the PHRC undertook an array of additional projects that did not receive any state funds. Some of these projects are included in this report but are identified as having no support from the Act 157 funds.

Through the MOC that Penn State University has with the Department of Community and Economic Development (Contract #27-872-0001), the PHRC is required to submit to DCED annual work plan and an annual report summarizing the activities for the previous year with respect to the fee. This "Year in Review, 2014-2015" is submitted to meet the annual report requirement.

PART I - Education, Technical Assistance & Outreach

The PHRC has a mandate to transfer knowledge by providing the necessary training and education to the wide variety of groups that make up the housing industry. To meet this mandate the PHRC offers a wide array of activities to educate and transfer appropriate technologies to the industry. These activities can include the development and delivery of educational programming using a variety of media, the hosting of conferences/symposia, and the publication of reports, as well as serving as a general resource to the industry in answering questions.

Counting workshops, webinars, speaker services, and conferences, the PHRC has provided 66 educational services to 2,240 individuals during this reporting period (Table 1).

Table 1. Summary of all PHRC Educational Programs for the 2014-2015 Project Year

PROGRAM	Activities for 2014-2015	
	# of Events	# of Attendees
Workshops	30	525
Webinars	9	544
Speaker Service	22	880
PHRC Conferences/PCCA Symposium	5	291
TOTAL	**66**	**2,240**

The distribution of the number of educational services over the past 15 years is plotted in Figure 1. The total number of programs delivered during the 2014-2015 period is 66, which is more than the average number of programs offered each year since the PHRC started receiving the Act 157 funds (64) and the same number of programs as the 2013-2014 project year

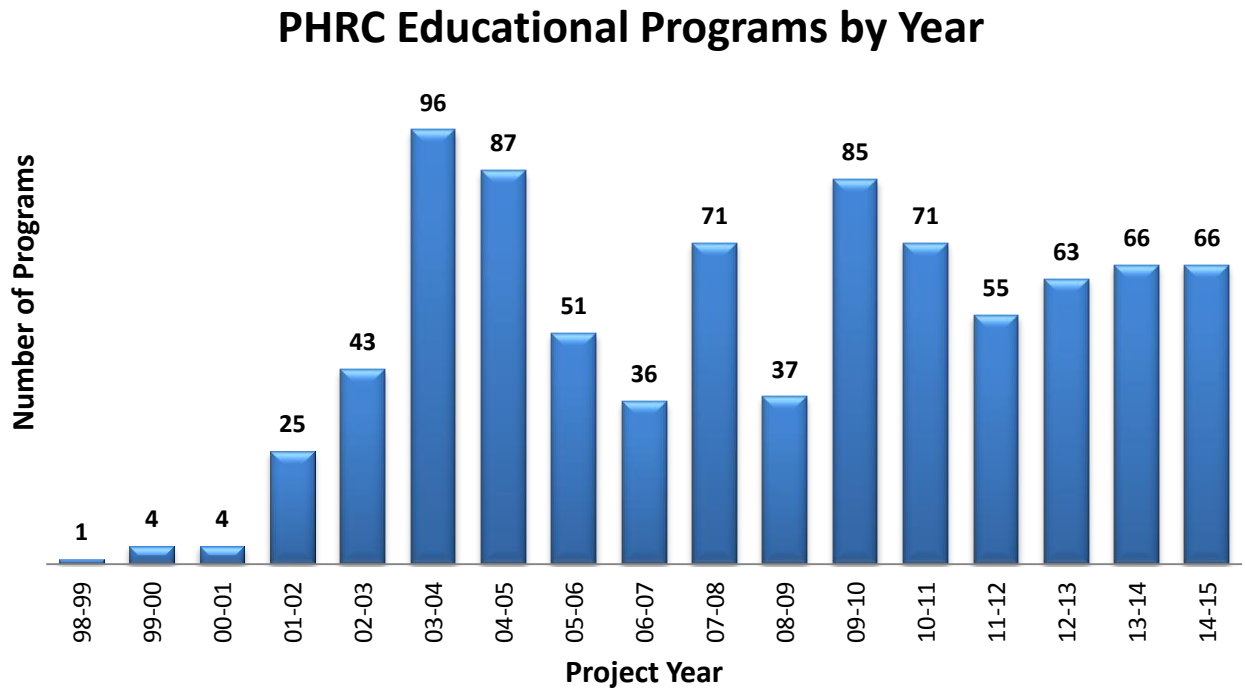

Figure 1. PHRC Educational Programs by Year.

The five general categories of the PHRC's work in this area include:

A. Workshop Delivery
B. New Workshop Development
C. Webinar Development and Delivery
D. General Technical Assistance, Technology Transfer, & Outreach Activities
E. Builder Briefs

The following sections labeled A through E of the report will provide further details on the PHRC's accomplishments in each of these categories.

A. Workshop Delivery

The PHRC has developed and maintains a wide array of workshops for all sectors of the construction industry with a focus on residential construction. These programs are intended to address technical issues facing the industry. Additionally, the PHRC will customize programs to better meet the needs of an industry partner. Workshops are geared to an audience that may include builders, remodelers, trade contractors, design professionals, teachers, and building code officials.

The following is a full list of in-person training programs available for delivery by the PHRC.

(1) Residential Building Scholars (RBS)/Residential Code Scholar (RCS)/Code Refresher programs are intended for those wishing to attain the RBS designation or for code officials looking for a short review of the key code issues in a 1-day version, as opposed to the multi-day academy version. These programs are also well-suited for anyone interested in an introduction to building codes, an update from 2006 to 2009 IRC provisions, or information to make inspections go more smoothly. For the 2013-2014 plan, the program was expanded to include the Residential Code Scholar certificate for code officials who complete four out of the five programs and pass exams at the end of each program.

a.	IRC Building	1 day
b.	IRC Plumbing	1 day
c.	IRC Mechanical	1 day
d.	IRC Electrical	1 day
e.	Residential Energy Codes	1 day

(2) Focused Topics programs are designed to immerse the student more deeply into a particular aspect of construction. These programs are ideal for meeting continuing education requirements for RBS designees and certified code officials.

a.	Advanced Framing – Increasing Performance & Reducing Costs	½ day
b.	Beginner's Blueprint Reading	1 day
c.	Building with Exterior Rigid Foam	½ day
d.	International Residential Code Inspections	2 day
e.	Photovoltaic Installation and Inspection	1 day
f.	Residential Deck Design and Construction	1 day
g.	Residential Fire Sprinklers	1, 2 day
h.	Residential Mechanical Compliance Program	1 day
i.	Solar Hot Water Installation and Inspection	1 day
j.	Special Issues with Two-Family Dwellings and Townhouses	1 day
k.	Fundamentals of Exterior Plaster & Thin Stone Veneer Assemblies	½, 1 day
l.	Energy Plan Review and Inspection	1 day
m.	High-Performance, Code Compliant HVAC Systems	Varies
n.	Building Envelope Design and IECC Code Compliance	1 day
o.	Residential Plan Review and Inspection	1 day

(3) Academy Programs are typically offered twice per year through the Pennsylvania Construction Codes Academy (PCCA). These programs are geared toward beginning code officials seeking to pass their certification exams, or anyone interested in a comprehensive overview of residential building codes.

a. International Residential Code – Building Essentials 4 day
b. International Residential Code – Plumbing Essentials 4 day
c. International Residential Code – Mechanical Essentials 4 day
d. International Residential Code – Electrical Essentials 4 day
e. Residential Energy Code Essentials 2 day

Report: During the 2014-2015 project year, the PHRC delivered 31 workshops to 694 builders, remodelers, educators, code officials, design professionals, and planners during this reporting period (please see Table 2 for detail).

Table 2. PHRC Workshops Held July 1, 2014 through June 30, 2015

PROGRAM	In-person/ Online	# of Programs	# of Attendees
Achieving Compliance with the International Energy Conservation Code in Commercial Occupancies	Online	1	96
Building Envelope Design and IECC Code Compliance	In-Person	5	96
Achieving Energy Code Compliance in Exterior Wall Assembly	In-Person	1	11
Fundamentals of Exterior Plaster and Thin Stone Veneer	In-Person	1	30
Commercial Plan Review/Inspections	In-Person	3	73
Electrical Essentials Academy	In-Person	1	21
IECC Commercial Energy Training Program	In-Person	2	35
IRC Building Code Academy – 4 days	In-Person	1	29
IRC Plumbing Code Refresher – 1 day	In-Person	3	64
IRC Plumbing Code Academy – 4 days	In-Person	1	16
IRC Mechanical Academy – 4 days	In-Person	1	15
IRC Mechanical Code Refresher – 1 day	In-Person	3	53
IRC Energy Academy – 2 days	In-Person	1	14
IRC Electrical Code Refresher – 1 day	In-Person	5	102
2015 IRC Sneak Peak – 1 day	In-Person	1	17
Residential Fire Sprinklers/Multifamily	In-Person	1	22
Total Programs Held		**31**	**694**

* Note: Attendees for online courses indicate the number of people who have completed the program as of date of report. A total of 165 are enrolled in the online program.

Online Training Programs

With tight budgets, the need for web-based training is greater than ever. The 2014-2015 reporting period was the second year for introducing Self-Paced Online Training Programs. The online program "Achieving Compliance with the International Energy Conservation Code in Commercial Occupancies" was launched in July 2014. It is a self-paced program that allows participants to watch program videos on their own schedule. There are quiz questions for each of the 25 modules, and participants must get the questions correct to move on to the next module. A total of 165 people have enrolled in the program, and so far, 96 people have completed all modules of the program. The feedback from the program is very positive. This program was funded through grant money from the PA DEP and not developed using Act 157 funds.

B. New Workshop Development

The PHRC develops and updates new workshops to address issues challenging the residential construction and design industry (builders, developers, design professionals, remodelers, building code officials, materials suppliers, etc.) During this period the following programs were developed:

1. Expand 1/2-day Stucco Program to Full Day

Description: The PHRC has an existing half-day training program on "Stucco & Adhered Masonry Veneer". In light of the recent increase in stucco failures related to moisture intrusion, this ½-day program will be expanded to a full-day program to include a discussion of the lessons learned from these failures, as well as more in-depth detail on wall assemblies and flashing details. This discussion will also incorporate a fundamental discussion of building science concepts necessary for understanding the transport of moisture through these exterior wall systems.

Manager/PI: Wolfgang

Report: The new full day workshop titled "Fundamentals of Exterior Plaster and Thin Stone Veneer Assemblies" was developed, reviewed, and launched in 2015. This workshop was offered as a pilot at the Navy Yard in Philadelphia, PA. In total, 30 individuals attended this workshop and provided valuable feedback. The workshop will be modified based on participant and instructor feedback and will be offered on a regular basis throughout PA moving forward.

2. 2015 IRC Sneak Peek

Description: The 2015 International Residential Code (IRC) was published on June 1st, 2014, and the Pennsylvania Uniform Construction Code (UCC) Review and Advisory Council (RAC) was in charge of conducting a review of these latest triennial code revisions and required to submit a report to the secretary of Labor & Industry within 12 months following its publication, specifying each code revision that is to be adopted as part of the UCC. This program gave a brief overview of the process the RAC followed to review the code revisions and then dove into the details of the 2015 revisions. Code provisions in the 2015 IRC are not enforceable unless Pennsylvania adopts the code, or portions of the code, but it was still important for industry stakeholders to know what's in the code should it have been adopted and also to be educated about new provisions in the 2015 IRC in order to formulate and present viewpoints to the RAC at public hearings, RAC meetings, or to submit public comment forms. This program discussed changes to the latest triennial version of the IRC and included changes to the administrative, building planning, building construction, energy, plumbing, mechanical, and electrical sections.

Manager: Heitzmann

Report: This new PHRC half-day program included content on the RAC process, how to "get involved," and a review of potential code changes that could take effect if adopted

in PA. The course also resulted in the development of a 1 hour speaking engagement on the RAC process and a 1 hour informational webinar. This effort resulted in the development and delivery of four events – one workshop at the PHRC Housing and Land Development Conference, one webinar, and two speaker services – reaching over 100 industry professionals.

3. Educating the Next Generation

Description: Educating the "next generation" of residential trade contractors and design professional is essential for the future of residential construction. The construction of a residential structure has as much to do with science as it does with knowledge for construction practices. Today's industry leaders can support secondary schools in laying a good foundation for this information. The PHRC will pursue multiple avenues to reach out and include the next generation of tradespeople in programs. Outreach activities will include trying to increase participation of vocational students and instructors in the PHRC conference, PCCA symposia, and PHRC webinars. This project involves longer-term relationship building between the PHRC and the vocational school instructors that will benefit both organizations well beyond the current project cycle.

Manager/PI: Blansett

Report: Scholarship were offered for the first time for the Housing Day of the 2015 PHRC Conference to allow trade students to attend the conference for free and provided a much reduced rate for their instructor/chaperon. Due to school cancellation from an ice storm on the day of the conference, the students were not permitted to attend. We intend to repeat the scholarship program for the 2016 conference with greater success.

Chris Hine now serves on the advisory committee for the drafting program at the State College High School and Bryan Heitzmann serves on the advisory committee for the carpentry program at CPI.

Other outreach activities to the next generation include speaking engagements with Penn State Civil Engineering classes, Penn State Architectural Engineering classes; and chaperoning multiple tours for Penn State students and State College High school students, as well as advising the Penn State NAHB student chapter and their RCMC team, which took 1st place at the 2015 competition at the International Builders Show.

4. Mock-up Based Training: Step Flashing Assembly

Description: Over the past two years the PHRC has compiled a mock-up library. These mock-ups have been used as visual aids in speaking engagements with presentations of 45 minutes to 1 hour, as well as, a 4 hour workshop titled Energy Efficiency in Exterior Wall Assemblies. During this project year we will develop a roof/wall intersection mock-up that will demonstrate step flashing details at the critical intersection of roofs and walls.

Manager/PI: Hine

Report: The Step Flashing mock-up has been built and is ready to be included in the Exterior Water Management speaking engagement along with the 4 hour workshop titled Building Envelope in 3D: Design, Details & Demonstration. This mock-up shows the correct placement of step flashing, housewrap, shingles, underlayment, kick-out flashing and drip edge. This mock-up that shows a correct roof/wall intersection will be a great visual addition to the existing programs along with any newly developed program or workshop explaining this construction scenario.

C. Webinar Development and Delivery

In today's economic climate, there is a need for technical programs without the added cost of hotel stays and transportation. To meet this need the PHRC has continued its successful monthly webinar series presented on the second Tuesday of every month (Sept – May) at 1:00pm. Special Topics webinars are also developed and delivered when there is a need for timely update on a particular topic, such as a piece of adoption of regulation or legislation related to the construction industry. Webinars are delivered live, and are also archived for on-demand viewing. One certification maintenance credit is offered for each webinar for PA code officials. As appropriate, AIA Learning Units (LUs) for architects and professional development hour (PDHs) for engineers have are offered. Continuing education credits are offered following the liver version of the webinar and not for viewing an archived recorded.

Manager/PI: Heitzmann

Report: The PHRC delivered nine webinars during this reporting period to a total of 544 people. Due to the PA Housing and Land Development Conference, no webinar was held in March. See Table 3 for the summary of webinars and attendees.

Table 3. 2014-2015 Webinar series titles and number of attendees

Webinar Series		
Month	**Title/Topic**	**Number of Attendees**
September	Requirements for Fire Protection of Light Weight Floor Systems	86
October	Insulating with Exterior Rigid Foam	121
November	The Appraisal Process	17
December	Fundamentals of Stucco and Manufactured Stone Claddings	71
January	Aging in Place, Part 2	37
February	Aging in Place, Part 3	47
February	Special Webinar: PA Code Review and Adoption Process	71
March	No Webinar, PHRC Conference	-
April	The Do's and Don'ts of Crawlspace Design and Construction	51
May	Thermal Bridging in Residential Construction	43
	Total Attendees	**544**

D. General Technical Assistance, Technology Transfer, & Outreach Activities

This reporting item is a continuation or expansion of activities to transfer information and publications to builders, remodelers, design professionals, building code officials and others involved in the residential construction industry.

Manager/PI: Blansett

Report: The PHRC had organized, developed, and/or delivered the follow activities:

1. The Annual Pennsylvania Housing and Land Development Conference
2. PCCA Symposium
3. Speaker Service and conference presentations
4. General outreach activities

1. <u>The Annual Pennsylvania Housing and Land Development Conference</u>

This two-day event provides information and updates on issues of interest to the residential construction industry. The intended audience is builders, remodelers, code officials, design professionals, home performance contractors and other industry related professionals. Day 1 of the conference focuses on issues related to the housing

structures and their systems, while Day 2 focuses on Land Development. Training programs are also offered on Day 2 of the conference.

Report: The 23rd annual Housing and Land Development Conference was held on March 4th and 5th, 2015 at the Penn Stater Conference Center and Hotel in State College, PA. Given that each day caters to distinct audiences of the residential building industry, for the purposes of reporting each day is recorded as a separate event. Table 4 shows the number of people at each event.

Table 4. Attendees at the Housing Day and Land Development Day of the PHRC Annual Conference.

Event	# of people
Housing Day of PHRC Annual Conference (March 4)	79
Land Development Day of PHRC Annual Conference (March 5)	61

Housing Day (Day 1): The Conference has typically been held the third week in February and was moved back two weeks this year in hopes that we would avoid bad winter weather that has disrupted several conferences in the past. Unfortunately, two weeks was not enough to avoid a nearly state-wide winter storm. The day started off with some less than impressive weather, but the Conference started off with a musical keynote speaker. Eric Werling, Program Manager for the Building America program through the Department of Energy, started the day off with his Keynote Address titled "Paving the Road to Zero Energy" which also included a couple musical numbers. After the conclusion of the Keynote, the conference then broke out into three separate tracks which were geared toward different audiences/professions within the industry.

- Design & Innovation Track
  - "Finally, The Truth about Condensation" by Brian Lieburn
  - "The Time is Now: Advances in Small Ducts and Comfort" by Andrew Poerschke
  - "Balancing Cost and Performance in Energy Efficient and Affordable Housing" by Lisa Iulo, Bruce Quigley & Peter Vargo
- Construction Track
  - "Residential Truss Bracing and Safety" by Tim Riegel
  - "Prescriptive Residential Wood Deck Construction Guide (DCA6)" by Lori Koch
  - "Top 10 Framing Challenges" by Mary Uher
- Building Code Track (PCCA Symposium, Central)

- "Connecting the Dots: Coordination of UCC and NFIP Regulations" by Daniel Fitzpatrick
- "Stormwater from the Code Perspective" by Jennifer Orr
- "Code Adoption Process and UCC Q&A" by Sarah Miller & Bob Buddenbohn

After lunch we convened for a Plenary Session titled "Overview of the PA Code Adoption Process". This session had three speakers, each discussion different parts of the process. The speakers for this presentation were Katie Blansett, Bob Buddenbohn & Sarah Miller.

Exhibit space was offered again this year. The organizations that participated in the space were Simpson Strong Tie, 84 Lumber, Weyerhaeuser & Dupont. Thanks to these organizations, the break area was filled and gave attendees a chance to converse with product suppliers and manufacturers.

There were also 29 people registered for the PCCA Central Symposia that was held concurrently with the Housing Conference.

PHRC Mix and Mingle Reception: The Mix and Mingle Reception (sponsored by Dupont) was also held at the Penn Stater Conference Center Hotel. This year's activities included the celebration of the Penn State NAHB Student Chapter's first place win at the 2015 International Builders Show Residential Construction Management Competition in Las Vegas. The Penn State DOE Race to Zero Competition Team was also recognized. Additionally, the reception hosted a guided craft beer tasting from Happy Valley Brewing Co, a local restaurant and craft brewery.

Land Development Day (Day 2): Day 2 of the PHRC Conference (Land Development) started off with a one hour delay due to the severe weather and campus closure, but once the sessions started, Robert Hankin and Neal Fisher from the Hankin Group kicked it off with a Keynote presentation titled Eagleview: Being "Green" when it was Just a Color. After the conclusion of the Keynote, the conference broke out into two tracks.

- Site Design Track
  - "It's Not How Dense You Make It, It's How You Make It Dense; Creative Architecture and Land Planning Solutions for Challenging Infill Sites" by David Clinger
  - "The ABC's of FBZ's, A Close-Up Look at Form-Based Codes" by Thomas Comitta (web-based due to weather)
  - "Building a Better ommunity: Design Trends after the Great Recession" by Claire Worshtil
- Water Management Track

- "Capturing and Beneficial Reuse of Stormwater" by Bud Newton & Jennifer Orr
- "Opportunities for Decentralized Wastewater and Wastewater Reuse" by Mark Garlicki
- "Act 162 – Buffer Requirements in PA" by Jennifer Orr
- "Stormwater Management in Karst Regions" by Scott Brown & Katie Blansett

Exhibit space was offered for the first time this year during the Land Development day. The organizations that participated in the space were ACF Environmental and FX Browne. Thanks to these organizations, it gave attendees a chance to converse with other industry professionals.

There were 61 attendees for the Land Development day of the conference.

Training (Day 2): Two training classes were also offered in conjunction with the conference.

- Track 1 – Full-Day (sponsored by PCCA, supported by DEP/DOE funds)
  - Commercial Energy Plan Review and Inspection
- Track 2 - Two Half-Day Sessions
  - 2015 IRC Sneak Peek
  - Achieving Energy Code Compliance in an Exterior Wall Assembly

2. PCCA Symposium

The PHRC worked with the PCCA to plan and deliver the 6th Annual PCCA Symposium East, West and Central. The Central Symposium was held in conjunction with the PHRC Housing Conference. The PHRC assisted in developing the agenda for all three Symposia, secured speakers, and also delivered one session at each Symposia. The East and West programs drew from the content of the 2015 PHRC Pennsylvania Housing and Land Development Conference and consisted of two tracks addressing technical issues being faced by building code officials. The East Symposium was held in King of Prussia, and the West Symposium was held in Cranberry. Table 5 shows the date and number of people at each event.

Table 5. Attendees at the Housing Day and Land Development Day of the PHRC Annual Conference.

Event	# of people
PCCA Symposia Central - in conjunction with the PHRC Housing Conference (March 4)	29
PCCA Symposia East (March 25)	76
PCCA Symposia West (April 8)	46

3. Speaker Engagements

The PHRC participates in talks, seminars, and conferences directed at the housing and land development industries. This may include trade and professional association functions and regional meetings, local association meetings, or state or national conferences. Over the 2014-2015 reporting period, the PHRC delivered 22 speaker services, reaching 880 people. Speaker service and conference presentations included:

- Blansett, K. – "Green Infrastructure as a Tool for Stormwater Management," *PA Society of Professional Engineers Boot Camp*, Cranberry Township, PA, June 8, 2015. ~ (70 attendees)
- Blansett, K. – "Green Infrastructure & Its Application in State College," *Stormwater Symposium hosted by the PSU Office of Physical Plant*, University Park, PA, May 21, 2015. ~ (120 attendees)
- Blansett, K. – "Land Development Process," - *SEO Annual Conference,* Harrisburg, PA, March 9, 2015. ~ (30 attendees)
- Blansett, K. – "Land Development Process in PA," *PA Society of Professional Engineers Boot Camp*, Cranberry Township, PA, June 8, 2015. ~ (40 attendees)
- Wolfgang, B. – "Slab Insulation in Residential Construction," *PA Society of Professional Engineers Boot Camp*, King of Prussia, PA, April 14, 2015. ~ (35 attendees)
- Heitzmann, B. – "Air Barrier Model Presentation," *PFS Corporation*, The Woodlands Resort, Scranton, PA, January 16, 2015. ~ (64 attendees)
- Heitzmann, B. – "The Code Adoption Process," *BIA of Northeast PA*, Kingston, PA, January 28, 2015. ~ (18 attendees)
- Heitzmann, B. – "The Code Adoption Process," *Central Susquehanna BA*, Danville, PA, April 22, 2015. ~ (20 attendees)

- Heitzmann, B. – "The Code Adoption Process," *Lezzer Lumber Conference*, State College, PA, February 5, 2015. ~ (60 attendees)
- Heitzmann, B. - "Insulation: Is This 'Stuff' Right?," *Carbon County BA*, Bowmanstown, PA, September 17, 2014. ~ (17 attendees)
- Heitzmann, B. - "Insulation: Is This "Stuff" Right?," *PCCA Symposia (West),* Pittsburgh, PA, April 8, 2015. ~ (20 attendees)
- Heitzmann, B. – "Windows/Flashing," *Sunset Construction Open House*, Belleville, PA, April 11, 2015. ~ (16 attendees)
- Hine, C. – "Code Compliant Air Barriers," *Commonwealth Building Code Officials Conference*, Seven Springs, PA, October 22, 2014. ~ (12 attendees)
- Hine, C. – "Code Compliant Air Barrier," *Lebanon County BA*, Lebanon, PA, October 21, 2014. ~ (29 people)
- Hine, C. – "Energy Efficiency in Exterior Wall Assembly –3 model program," *84 Lumber*, Pittsburgh, PA, December 17, 2014. ~ (37 attendees)
- Hine, C. – "Exterior Water Management," *Commonwealth Building Code Officials Conference*, Seven Springs, PA, October 22, 2014. ~ (12 attendees)
- Hine, C. - "Insulation: Is This 'Stuff' Right?," *Central Susquehanna BA*, Lewisburg, PA, November 19, 2014. ~ (24 people)
- Hine, C. – "Insulation: Is This 'Stuff' Right?," *Commonwealth Building Code Officials Conference*, Seven Springs, PA, October 22, 2014. ~ (12 attendees)
- Hine, C. - "Insulation: Is This 'Stuff' Right?," *PBA Board Meeting*, State College, PA, August 1, 2014. ~ (35 attendees)
- Hine, C. – "Insulation: Is this "Stuff" Right?," *PCCA Symposia (East)*, King of Prussia, PA, March 25, 2015. ~ (52 attendees)
- Kamel, E. and Memari, A. M., (2015). "Energy Efficiency and Sustainability Attribute of the Solar Decathlon Projects," *Proceedings of the ASCE 2015 Architectural Engineering Institute Conference*, Milwaukee, Wisconsin, March 24-27, 2015, pp. 483-494.
- Leung, M.-Y., Yu, J., and Memari, A. M., (2014). "Managing Indoor Facilities in Public Housing To Improve Elderly Quality of Life," *Proceedings of the 40th IAHS World Congress on Housing*, December 16-19, 2014, Funchal, Portuguese Madeira Island, pp. 1-13.
- Ramaji, I. J. and Memari, A. M., (2015). "Information Exchange Standardization for BIM Application to Multi-Story Modular Residential Buildings," *Proceedings of the ASCE 2015 Architectural Engineering Institute Conference*, Milwaukee, Wisconsin, March 24-27, 2015, pp. 13-24.
- Solnosky, R. L. and Memari, A. M., (2015). "Sustainability Matrices for Efficient and Innovative Residential Building Wall Systems," Proceedings of the

Engineering Solutions for Sustainability: Materials & Resources, March 18-19, 2015, Orlando, FL, 12 p.

- Wolfgang, B. – "Wood as a Construction Material," PSU CE class 336, University Park, PA, November 12 & 14, 2014. ~ (31 attendees)
- Wolfgang, B. – "Wood as a Construction Material," *PSU CE class 336*, University Park, PA, April 8 &10, 2015. ~ (146 attendees)

5. General Outreach Activities

The general outreach activities of the PHRC include activities to let builders know about the PHRC and the services and publications it provides. These activities may include PHRC mailings, promotional pamphlets, articles in research or trade journals, answering phone and email questions, and the maintaining PHRC's website, as well as various relevant technical meetings attended by PHRC staff.

Publications

The following list includes the scholarly publications published during the reporting period.

- Donovan, L. T. and Memari, A. M. (2015). "Feasibility Study of Determination of Seismic Performance Factors for Structural Insulated Panels," ASCE *Journal of Architectural Engineering*, Vol. 21, No. 2, B4014007(1-13); DOI: http://dx.doi.org/10.1061/(ASCE)AE.1943-5568.0000163, Online publication Date: October 30, 2014.
- Kamel, E. and Memari, A. M., (2015). "Review of Enclosure and Other Components of Solar Decathlon Competition Projects 2002-2013," Final Report, The Pennsylvania Housing Research Center.
- Kauffman, A. L. and Memari, A. M., (2014). "Performance Evaluation of Different Masonry Infill Walls with Structural Fuse Elements Based on In-Plane Cyclic Load Testing," *Buildings*, Vol. 4, pp. 605-634, doi:10.3390/buildings4040605.
- Memari, A. M., Huelman, P. H., Iulo, L. D., Laquatra, J., Martin, C., Andrew McCoy, A. P., Nahmens, I., and Williamson, T., (2014). "Residential Building Construction -- State-of-the-Art Review," ASCE *Journal of Architectural Engineering*, Vol. 20, No. 4, Special Section: Housing and Residential Building Construction, pp. B4014005-1 to B4014005-38, http://dx.doi.org/10.1061/(ASCE)AE.1943-5568.0000157 .
- Memari, A. M., Solnosky, R. L., Tufano, J., and Dillen, M., (2014). "Comparative Study on Multi-hazard Resistance and Embodied Energy of Different Residential Building Wall Systems," *Journal of Civil Engineering and Architecture Research*, Vol. 1, No. 6, pp. 367-387.

- Memari, A. M., Shirazi, A., Kremer, P. A., and Behr, R. A., (2014). "Seismic Vulnerability Evaluation of Architectural Glass in Curtain Walls", *Journal of Civil Engineering and Architecture Research*, Vol. 1, No. 2, pp. 110-128.
- O'Brien, W. C. and Memari, A. M., (2014). "Prediction of Seismic Cracking Capacity of Glazing Systems," *Earthquakes and Structures Journal*, Vol. 8, No. 1, pp. 101-132, DOI: http://dx.doi.org/10.12989/eas.2015.8.1.101.
- Standley, J. A. and Memari, A. M., (2014). "Evaluation of a Transparent Wall System for Residential Construction," *The Open Civil Engineering Journal*, Vol. 8, pp. 143-153, DOI: 10.2174/1874149501408010143.

Patent

- Title: "Transparent Sustainable Wall System,"
  Inventors: A. M. Memari and Joseph A. Standley
  U.S. Patent No.: US 8,833,012 B2
  Date Patent Issued: September 16, 2014
  PSU Invention Disclosure No. 3427

Conferences/Meetings Attended

The following is a list of the housing industry-related conferences and meetings attended by the PHRC personnel.

- Blansett, K., Heitzmann, B., Hine C., Excel Homes Factory Tour and Lindbacks Meeting, Liverpool, PA, April, 10, 2015
- Blansett, K., Heitzmann, B., Hine, C. and Wolfgang, B. National Association of Home Builders' International Builders Show and NAHB Student Chapter Residential Construction Management Project Competition. Las Vegas, NV, January 20-22, 2015.
- Heitzmann, B., Hine, C. and Wolfgang, B. IBACOS Best Practices Research Alliance Tech Summit, Pittsburgh, PA, May 26-27, 2015.
- Hine, C. and Wolfgang, B. Ritz-Craft Plant Tour and Meeting, Mifflinburg, PA, November 3, 2014.
- Memari, A. M., DOE Proposal Panel Review, Washington, DC, April 16-17, 2015
- Memari, A.M. and Wolfgang, B. Intertek (formerly Architectural Testing) Facility Tour and Collaboration Meeting, York, PA, June 30, 2015.
- Memari, A. M., National Association of Home Builders' International Builders Show, and NAHB Student Chapter Residential Construction Management Project Competition, Las Vegas, NV, January 17-21, 2015.
- Memari, A. M., NIST National Fire Research laboratory (NFRL), Gaithersburg, MD, May 13, 2015.

- Memari, A. M., Smart Grid Center at Navy Yard, Philadelphia, PA, June 2, 2015
- Wolfgang, B. WUFI Pro Workshop, National Building Science Corporation, San Francisco, CA, September 9-10, 2014.

Service in Professional Societies

The PHRC staff and faculty are involved in a variety of organizations at both the state and national level.

Pennsylvania Committees and Organizations

- Blansett, K. PA Stormwater Technical Workgroup – Executive Committee
- Blansett, K. Pennsylvania Society of Professional Engineers – Central Region Vice-President and Chair of Education Committee
- Wolfgang, B. Builders Association of Central PA, Education Committee Chairman

National and International Committees and Organizations

- Memari, A.M., and K. Blansett. American Society of Civil Engineers, member.
- Memari, A. M., American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (AIME) Symposium on Engineering Solutions for Sustainability: Materials and Resources, March 18-19, 2015, Orlando, FL

  Role: Member of Steering Committee on behalf of ASCE-AEI to help organize a session on housing aspects
- Memari, A. M., Architectural Engineering Conference 2015, MSOE, Milwaukee, Wisconsin, March 24-27, 2015; Role: Chair, Steering Committee
- Memari, A. M., National Consortium of Housing Research Centers, Executive Committee meeting, Alexandria, VA, July 8-9, 2014
- Memari, A. M., National Consortium of Housing Research Centers, Executive Committee and Annual meeting, National Housing Endowment meetings; Las Vegas, NE, January 17-21, 2015

External Organization Workshops

- Memari, A. M., University Professor's Masonry Workshop, March 8-10, 2015, Organized by The Masonry Society, Role: Host

Annual Newsletter

Over the past few years the annual newsletter has been published in January to keep interested parties up-to-date on recent PHRC activities and to promote the PA Housing and Land Development conferences. This year the newsletter schedule is shifted to be more aligned with the project reporting and planning. The 2015 newsletter is expected to be mailed in late summer and will include project reports from the 2014-2015 project year and highlights of projects to come in the 2015-2016 year.

E. Builder Briefs

Description: The PHRC continues its series of short technical documents that address specific issues that have been identified by builders or remodelers. These documents are intended to be quick to read with a lot of the information presented graphically or pictorially.

Manager/PI: Blansett

Report: Four Builder Briefs have been completed during this reporting period:

- Heitzmann, B. *Challenges, Considerations, and Concerns for Indoor Air Quality*, University Park, PA. June 2015.
- Hine, C. *Fundamentals of Crawlspace Design & Construction in PA*, University Park, PA. June 2015.
- Wolfgang, B. *Moisture Considerations for Insulated Roof / Ceiling Assemblies*, University Park, PA. June 2015.
- Wolfgang, B. *Moisture Considerations for Insulated Wall Assemblies*, University Park, PA. June 2015.

PART 2 - Applied Research

A very important function of the PHRC is to undertake or stimulate research and development on materials, products, procedures, and processes related to the housing industry. These efforts may have a longer-term or a more fundamental focus than other projects. The projects that are listed below foster partnerships and draw on the expertise and strengths of the persons, groups and facilities available the Pennsylvania State University.

1. Learning from the Experience of Solar Decathlon

Description: The Solar Decathlon program is a very successful Department of Energy (DOE) sponsored competition that challenges colleges to design, construct and operate

solar powered homes for energy efficiency, cost-effectiveness and various other criteria such as renewable energy, clean energy, and advanced building technologies. The program started in 2002 and has so far been held during 2002, 2005, 2007, 2009, and 2011. Teams from universities in the U.S. and other countries participate at the competition. Although the competition will result in one team winning first place, each team uses different features from which much can be learned. In particular, if the target audience will be the builders and developers, there are many useful features that this audience may benefit from for different applications. The goal of this project is to develop a collection of learning materials from the significant investment and effort that has so far gone into the Solar Decathlon program. In particular, the detailed designs of all of the past solar decathlon homes will be reviewed to identify special features that were used for each home. These features will then be categorized and tabulated with their attributes. Then the features and their impact considering various performance criteria will be compared taking into account the analyses results generated by each team in their projects.

Manager/PI: Memari

Report: The project has been completed and the final report submitted to PHRC for publication as a research report. The report is currently being edited by PHRC before its publication.

2. Evaluation of Wall Insulation Retrofit Options for Existing Homes

Description: According to the 2011 DOE Building energy Data Book, the energy consumption breakdown for the residential building enclosure is as follows: Roofs: 1.00 Quads, Walls: 1.54 Quads, Foundation: 1.17 Quads, Infiltration: 2.26 Quads, and windows (conduction): 2.06 Quads, a Quad is defined as 1015 BTU. Because of the great heat loss through windows, there has been significant development in new energy efficient window systems. The next component that has also been focused on is the insulation types for new construction. Currently, various insulation materials have been developed to offer options beyond traditional fiberglass batt insulation. These options include various types of loose insulation materials, different rigid insulation boards, foam insulation, sandwich boards of vapor barrier and rigid insulation, sandwich boards of sheathing and rigid insulation, etc. Most of these products are suitable for new construction. However, information and understanding about the suitability and appropriateness of different insulation systems for retrofit purposes is not readily available. The thought of the expense to tear down drywall or exterior sheathing to add insulation has not encouraged such retrofit projects.

Nonetheless, because the issue is of great importance to reduce energy loss in existing homes through walls with poor insulation, it is proposed that a project be undertaken to look into all possible methods and materials/components suitable for retrofitting existing walls to enhance energy efficiency. In the process, some new ideas can be developed as well and suggested to the industry. Each method will be evaluated for energy saving enhancement through modeling using available software such as a combination of THERM, WINDOW and Energy 10, which can provide energy performance of a typical home with retrofitted wall as compared with a standard baseline wall system. The potential condensation issues will also be studied by using software such as WUFI. The study will

also develop a cost analysis for each option so that various retrofit methods can be compared for energy consumption as well as retrofit cost and payback period

Manager/PI: Memari

Report: The project is continuing to make progress. A comprehensive literature review consisting of over 100 references (articles, papers, reports) is now complete, and a draft report has been prepared that summarizes most retrofit concepts found in the literature. The next stage of the work is to qualitatively evaluate the retrofit options deemed appropriate for residential buildings and presenting side by side comparison of the options based on their attributes and merits. Finally, a quantitative comparison of the retrofit options with respect to their potential for energy savings will be developed. An abstract on the project has been submitted to the 3rd Residential Building Design and Construction Conference, and the paper for the conference is now is under preparation.

3. Resuspension and Transport of Allergen Carrier Particles in Residential HVAC Systems

Description: HVAC systems play an important role in transporting allergen carrier particles that trigger asthma episodes in residential indoor environments. Unfiltered particles deposited on interior duct surfaces resuspend and transport when disturbed under mechanical vibration and varying air flow conditions in the system. However, experimental data is needed to characterize the behaviors of individual allergen-carrier particles in response to HVAC system disturbances and to inform modeling work that will lead to better design and performance guidance for builders seeking to improve indoor air quality in residential settings. A combination of experimental work in residential settings and in a more controlled laboratory resuspension chamber setup is proposed to characterize the resuspension of allergen-carrier particles deposited in residential HVAC ductwork and to obtain resuspension rate data for individual allergen-carrier particles in various HVAC system environments. The results of this research investigation are expected to provide a better understanding of the behavior of allergen sources in residential homes that would benefit the Pennsylvania housing industry and its residents.

Manager/PI: Dr. James Freihaut (Penn State Department of Architectural Engineering)

Report: Laboratory resuspension experiments using the modified resuspension facility programmed to simulate the range of acquired vibration disturbances, humidity, dust loading, reservoir type and air disturbances recorded during in-field resuspension experiments in the Morningstar home and Washington DC condo subject residences are ongoing. Supplemental experiments are also underway to evaluate resuspension behavior of fungal spore, cat dander, dog dander, ragweed pollen, birch pollen, quartz dust, subject home collected dusts, and NIST indoor reference dusts subjected to more extreme variations in humidity, turbulence intensity of swirl flows, dust loading and input vibration waveforms. In addition to the modifications made to the resuspension facility upgraded for this project to allow faithful scaled playback of the acquired vibration patterns from the residences with the facilities' electromagnetic shaker and tighter humidity control within the custom-constructed glovebox enclosure system, other modifications have been

necessary for improved control over weighing operations, dust loading, turbulence intensity, enclosure static pressure control and flow splitting during resuspension experiments.

Journal papers titled "Particle Resuspension Rates from Duct Surfaces," and "Humidity Effects of Resuspension of Indoor Allergen Carrier Particles" can be finalized with the laboratory data being collected. A submission for the PHRC Third Residential Building Design and Construction Conference, March 2016 titled "Matched field and laboratory indoor particle resuspension experiments," can also be completed once the final laboratory data is collected.

4. Performance Optimization and Development of a Home Modular Delivery System

Description: The objective of this research is to expand affordable home energy performance by developing an optimized modular delivery system, a Kit-of-Parts (KoP), applicable for infill development of new homes and for retrofitting existing homes. This innovative system of components will result in homes that surpass Energy-Star performance for energy-efficiency, have improved indoor air quality, and provide realistic options for aging-in-place. Most notably it will provide a way to deliver high quality, well-designed, small affordable housing projects on a broad scale.

Manager/PI: Prof. Lisa Iulo (Penn State Department of Architecture)

Report: A report and graphic overview is being finalized for the Performance Optimization and Development of a Home Modular Delivery System research. A presentation of the phase II development of this project, as it relates to a 31 unit in-fill development in Lewisburg PA, was presented in the Integrated Building Systems/Passive Design track of the American Solar Energy Society (ASES) SOLAR 2015 conference at the Penn Stater in State College, PA on July 27, 2015.

5. Passive Cooling Opportunities for Seasonal Energy Savings in Mass-Produced Homes

Description: Over the last several decades construction practices of contemporary residential structures have improved significantly resulting in good energy performance. The building envelopes are properly insulated, windows are carefully chosen for their resistance to heat flow, gaps in construction are meticulously sealed, and the heating and cooling equipment is selected for high performance. These homes are known as high performance or super-insulated.

While the structures are produced with energy conservation in mind, one major contributor to the final outcome is the home owner or occupant. This project focuses on the prediction of energy savings utilizing passive strategies that promote specific occupant behaviors (operational strategies) to extend the period when the cooling equipment can remain idle. During the period of time when the equipment remains idle, 100% energy savings is realized. If the idle period is 20% of the year, 20% of the annual energy is saved.

Using the basic assumption of "degree-days" to illustrate the point, heating of a tradition residence is considered unnecessary when the outside temperature is above 65°F. By the same definition, cooling is assumed to be needed when outside condition is above 65°F. In the summer, the system is said to be operating at 100% of its cooling load during the summer design condition (hot days). Similarly, the heating system operates at its peak load when outside conditions reach its winter design condition. When outside temperature is 65°F, it is assumed that no energy is spent.

Typical energy conservation strategies aim to reduce the peak design conditions. This reduction results in a proportional saving throughout the year. While reduction of design load is absolutely necessary and saves energy, an often overlooked opportunity is to expand the period when neither heating nor cooling is used in a home. This strategy depends on occupant behavior. The question is: can passive design strategies be incorporated in residential structures to promote "better" occupant behavior, that is will the occupant leave the cooling and heating equipment de-energized for longer periods? Not running the equipment results in 100% energy savings during those times.

There are significant hours within the mid-Atlantic region where passive solar or natural ventilation can provide thermal comfort in residential situation without the aid of mechanical heating and cooling equipment. Combining Bin weather data and the energy demand curve can produce a 3-dimentional diagram where the volume of the histograms represent the total energy used (Btu/hr x Hours), which allows for the calculation of the possible energy savings when the de-energized period is expanded using passive strategies.

An important parameter to explore is the resultant thermal comfort offered by the alternative cooling strategies. ASHRAE Standard 55 specifically addresses the more-stringent occupant comfort expectations in mechanically cooled spaces. Occupant expectations are less stringent in naturally cooled spaces. This phenomenon will be integrated into the study. This study will first establish the limitations defined by this standard. As a second step, consider the design criteria when natural ventilation is an integral part of the design.

Manager/PI: Prof. Moses D.F. Ling (Department of Architectural Engineering)

Report: The two computer models of the home are complete, and the data from these simulations have been gathered. The data will be evaluated over the next several weeks and the final report is expected by the end of the year.

6. Shear Wall Opportunities in Residential Construction

Description: Current building codes and standards for residential construction are complex and easily misunderstood when it comes to the requirements pertaining to wood shear walls. Whether they are engineered or prescriptive the design intent has the potential to be lost resulting in improper construction of walls that can lead to poor performance and failure (both aesthetically and structurally). This pilot study will cumulate the vast knowledge regarding residential shear walls options, provide comparisons between behavior and design steps, and finally recommend best practices for constructing. The results will give designers and builders a better understanding of the

complexity of shear wall code provisions and how to go about designing and constructing shear walls through clarifying code intent.

Manager/PI: Dr. Ryan Solnosky and Prof. M. Kevin Parfitt (Department of Architectural Engineering)

Report: The project has completed its critical research as it was intended to as approved by the PHRC. Currently, the final report is being written with some additional material being added as the refinement continues. We are also drafting a conference paper (for the PHRC spring conference) and journal paper on the results. Once these papers are completed/in a final draft form, the more simplified Builder Brief will be generated for the PHRC.

7. Prototype of an Architectural Light Therapy System to Promote Successful Aging in Place

Description: The goal of the project is to develop a working prototype of a residential living environment outfitted with a novel architectural lighting system designed to promote health by stimulating the human circadian system while maintaining standards for visual quality. The space will be instrumented with measurement devices to verify light exposure performance and will serve as a model for future clinical trials and larger-scale residential installations. This project fosters the research/industry partnership that was a founding goal of the center. The PHRC has provided seed money to fund the first phase of this project.

Manager/PI: Dr. Kevin Houser (Department of Architectural Engineering)

Report: The project team has completed its major goals and is awaiting dissemination of the work through a peer-reviewed journal.

PART 3 - Applied Projects

These groups of projects are application oriented and have a direct need by the residential construction industry. This includes the development and support of standards, and longer term initiatives.

1. Moisture Management in Homes

Description: Moisture damage to home incurs unwanted repair costs to homeowners and potential health hazards if left untreated. Although there is a considerable amount of information about waterproofing and use of vapor barriers and flashings, water damage to basement walls due to rain on basement windows (without proper and reliable well cover protection), water damage to above grade walls due to window failure/malfunction, water damage to floors and ceiling drywall due to overflow of bathroom toilet or tub are common occurrences. In this study, sources of water damage will be identified and, where needed, new concepts such as basement window solutions or bathroom waterproofing ideas will be developed. In particular, the existing monitoring and sensor

technologies will be reviewed and potential applications for homes to detect intruding moisture and alarming the homeowner of potential problems will be explored.

Manager/PI: Memari

Report: The project has been completed and a final edit is under way before it is submitted to PHRC. The authors of the report are: Anthony Jellen, Ehsan Kamel, and Ali Memari. It is expected that the report will be submitted by the end of August 2015.

2. Details that Work: Foundations and Passive Radon Systems

Description: This Passive Radon System detail will demonstrate critical design and construction practices to help in the reduction of radon in residential construction.

Manager/PI: Hine

Report: This detail has been created and is available for download on the PHRC website through the Details that Work detail book.

3. Crawlspaces

Description: During the 2014-2015 project year a webinar regarding with the design and construction will be completed. This webinar will include both code requirements along with best practice idea for designing and constructing a durable crawlspace. To complete this webinar, critical details will be developed to help with the ease of conveying key points. Along with the webinar and details, a Builder Brief will also be developed.

Manager/PI: Hine

Report: The webinar "The Do's and Don'ts of Crawlspace Design and Construction was complete and delivered. Details have also been developed and are available for download on the PHRC website through the Details that Work detail book. A builder brief titled "Fundamentals of Crawlspace Design and Construction" has also been completed and available for download from the PHRC website or in hard copy upon request.

4. Insulation Modeling and Durability Assessment

Description: New insulation materials and systems are being introduced to the construction industry quite often, but how these new systems interact with other portions of the building envelope is not often understood. This project will take a fundamental look at common building assemblies and materials found throughout Pennsylvania. Computer modeling software (such as WUFI) will be used to simulate the effects of seasonal temperature changes, wetting/drying cycles, and construction imperfections. These hygrothermal models will allow for analysis of the durability and efficiency of different insulation systems and envelope assemblies (i.e. flash and batt, exterior foam etc.).

Manager/PI: Wolfgang

Report: This project was separated into two distinct parts: Roof/Ceiling Assemblies and Wall Assemblies. Based on journal articles, trade publications, and industry best practices, two Builder Briefs were developed which outline moisture-related considerations for designing and constructing insulated wall and roof/ceiling assemblies. These Builder Briefs focused on moisture accumulation and moisture transport principles as they affect the durability of the system over seasonal cycles. Both Builder Briefs will be used to develop and deliver a single webinar in Fall 2015. The documents are available for download from the PHRC website or in hard copy upon request.

5. Stucco: Code Review/Analysis and State of the Art Report

Description: An increase in the number of stucco failures has spurred the need for further investigation. This project will study and address the possibility of stucco failure related to moisture infiltration and rot from installation performed in accordance with the code requirements as outlined in the IRC 2000, 2003, 2006, and 2009 model codes. Each code cycle will be evaluated independently due to variations in the requirements in each code cycle.

Manager/PI: Wolfgang

Report: Each publication of the IRC from 2000 – 2009 was reviewed as they related to exterior plaster wall assemblies. Revisions in pertinent sections, including exterior plaster, vapor retarder, and water-resistive barrier requirements, were analyzed. The revisions and the potential impact of the revisions were summarized in a 24-page report titled "Impact of Building Codes on Exterior Plaster in Pennsylvania." This report will be completed by the end of September and then available for download on the PHRC website.

6. The Fundamentals of Indoor Air Quality in Residential Buildings

Description: Indoor air quality (IAQ) is a term which refers to the quality of air within and around buildings, especially as it relates to the health and comfort of building occupants. In fact, improving the quality of indoor air is vital for human health. This project will study the topic of IAQ and the pollutants that affect it, such as gases, like carbon monoxide or radon, microbial contaminants, like mold or bacteria due to moisture intrusion, improper and inadequate ventilation or make-up air, or any other pollutant or condition that can induce adverse health conditions. This project will provides guidance to help recognize common pollutants, understand the potential health impacts of poor indoor air quality, identify sources of indoor pollutants, and recognize methods of improving the air quality within a home.

Manager/PI: Heitzmann

Report: A Builder Brief titled "The Challenges, Considerations, and Concerns of Indoor Air Quality" was developed as a result of IAQ topic research and a follow-up one hour long webinar will be delivered in September. The Builder Brief is available for download on the PHRC website or in hard copy upon request.

7. Support of Standards

Description: The PHRC has developed three standards to respond to industry demand. These include *Pennsylvania's Alternative Residential Energy Provisions, Pennsylvania Standards for Residential Site Development Standards,* and *Foundation Systems for Relocated Manufactured Housing*. Each of these standards requires training and timely technical assistance for local governments, builders/developers, design professionals, and contractors. All of these standards are available electronically for free and hard copies are available for a fee.

Manager/PI: Blansett, Wolfgang

Report: The PHRC frequently fields phone calls from building code officials and builders regarding the PHRC standards that are available on the internet. Additionally these standards, specifically the PA Alternative Residential Energy Provisions, were included in other training programs such as Introduction to Building Science and various building science-related speaker services.

PART 4 - Proposals & Contracts

The PHRC continuously seeks to leverage funding from the Commonwealth with funds from other sources. The following is a list of major grant proposals submitted to the government during the 2014-2015 project year. Several other smaller proposals were also submitted and some are under review/negotiation but those not are reported here.

The following research proposals were submitted during this reporting period.

- National Association of Home Builders (NAHB), "Independent Review of FEMA P-942 and NIST NCSTAR 3 Reports", Date: May-December 2015; Funded $15,000 Memari (PI)

- National Science Foundation (NSF), "Collaborative Research RSB: A Sequential Decision Framework to Support Trade Space Exploration of Multi-Hazard Resilient and Sustainable Building Designs", Date: March 1, 2015 – February 28, 2018, Funded $819,189, Memari share of funding – 15% (Senior Personnel)

- National Science Foundation (NSF), "Development of a Lifecycle BIM Framework for Multistory Modular Buildings", Date: August 1, 2015 – July 31, 2018, Submitted October 2014, ($281,887)

- National Science Foundation (NSF), "Saving Buildings from Tornadoes with CFD & FEA -- An Innovative, Interdisciplinary Solution to an Elusive Problem", Date: September 1, 2015 – August 31, 2018, Submitted February 2015, ($603,023)

- Grace Woodward Grant for Collaborative Research in Engineering and Medicine (Penn State College of Engineering and Hershey College of Medicine), "Development of Approaches to Minimize the Effect of the Home Environment on Allergy-Asthma/Irritation Side Effects in Elders", Submitted April 2015 ($50,000).

PART 5 - Act 157 Funds

The PHRC receives funding from diverse sources, including contracts, grants, membership fees, fees for services, and the funds collected under Act 157 of 2006. Additional contributions were made by the Pennsylvania State University through a variety of sources, including the Hankin Endowment and in-kind support.

During this reporting period total project costs were $831,114.05 (Figure 3). Act 157 funds accounted for 63% of these funds, income from fees and services accounts for 16%, and funds from other projects that are not part of Act 157 matching funds accounted for 21%. There were no other grants or contracts this project year.

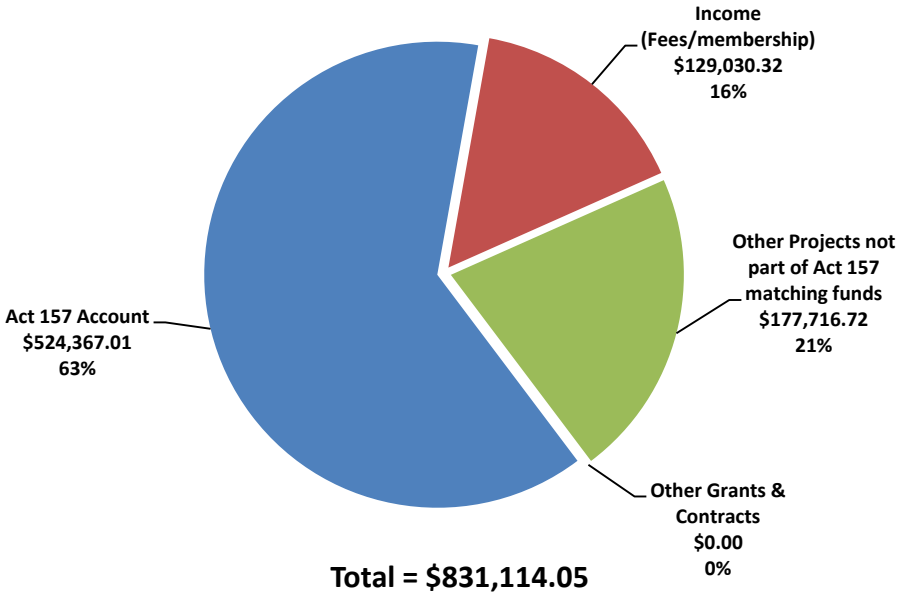

Figure 3. Summary of Funding for the 2014-2015 PHRC Project Year

Act 157 of 2006 funds are collected through a $4 fee on every building permit issued in the Commonwealth, and are dispersed through the Department of Community and Economic Development. PHRC receives 50% of the collected permit fees minus a 7.5% administrative fee. Funds for the 2014-2015 Project Year are based upon funds received from July 2013-June 2014. Table 6 below shows the amount received during the July 2013-June 2014 time period.

Table 6. Summary of Act 157 Funds received during the 2013-2014 fiscal year used for the 2014-2015 PHRC Project Year.

Collection Period	Amount Received
Q3: July 2013 - September 2013	$110,028.75
Q4 October 2013 - December 2013	$116,834.90
Q1: January 2014 - March 2014	$135,370.05
Q2: April 2014 - June 2014	$86,439.40
Total	**$448,673.10**

At the start of the 2014-2015 project year in July 2014, there was balance remaining in the Act 157 account from several previous project years due to the carry forward of portions of salaries from vacant positions. These carried forward funds were utilized this project year to cover personnel costs for a now full staff. Table 7 shows the breakdown of expenses by category for the Act 157 account and additional leveraged funding.

Table 7. PHRC Expenses for the 2014-2015 PHRC Project Year.

Category	Act 157	Leveraged Funds	Total
Total Salaries	$322,041.50	$112,197.83	**$434,239.33**
Total Non-Student Wages		$18,643.77	**$18,643.77**
Total Student Wages	$17,955.00	$2,972.25	**$20,927.25**
Fringe Benefits	$118,287.04	$40,630.85	**$158,917.89**
Supplies and Materials	$692.16	$5,208.12	**$5,900.28**
Communications Services		$4,005.84	**$4,005.84**
Travel	$23,369.93	$69,335.05	**$92,704.98**
Publications	$1,042.70	$978.24	**$2,020.94**
Consulting & Professional Services	$40,100.00	$3,586.00	**$43,686.00**
Copies and Photographic Services	$795.68	$15,848.77	**$16,644.45**
Scholarships		$4,000.00	**$4,000.00**
Tuition and Fees		$20,475.00	**$20,475.00**
Equipment		$4,439.68	**$4,439.68**
Purchased Services		$1,502.14	**$1,502.14**
Miscellaneous	$83.00	$2,923.50	**$3,006.50**
Total	**$524,367.01**	**$306,747.04**	**$831,114.05**