High-Performance Buildings

Summary:
This initiative embodies the goals of "The 2030 Challenge," that would establish higher efficiency and therefore lower operating cost buildings. These high performance buildings include new and existing buildings in the residential, commercial, institutional and government sectors.

Background and Overview:
Buildings are a major source of demand for energy and materials that produce by-product greenhouse gases. It will require immediate and significant action in the building sector to slow the growth rate of greenhouse gas emissions in Pennsylvania.
Recently, Architecture 2030 has issued **The 2030 Challenge** asking the global architecture and building community to adopt the following targets:

- All new buildings, developments and major renovations shall be designed to meet a fossil fuel, greenhouse gas (GHG)-emitting, energy consumption performance standard of 50 percent of the regional (or country) average for that building type, as defined in The 2030 Challenge.
- At a minimum, an equal amount of existing building area shall be renovated annually to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50 percent of the regional (or country) average for that building type, as defined in The 2030 Challenge.
- Architecture 2030 established the following fossil fuel reduction standard for all new buildings and major renovations:
  60 percent of buildings in 2010
  70 percent of buildings in 2015
  80 percent of buildings in 2020

Architecture 2030 envisioned that these targets would be accomplished by implementing innovative sustainable design strategies, generating on-site renewable power and/or purchasing (20 percent maximum) renewable energy and/or certified renewable energy credits. However, no such renewable power goals have been established.

The main goals for this work plan generally come from the Architecture 2030 Challenge building goals, with some revisions from the subcommittee. These goals are summarized in Tables 1 and 2. Following the tables are proposed implementation steps to meeting these goals. The GHG emission reductions for Pennsylvania through 2020 were estimated assuming that these goals are met. The key assumptions and results of that analysis are provided later in this work plan initiative.

The quantification analysis helps provide an overall indication of potential GHG emission reductions. However, to better understand the changes to Pennsylvania's building sector equipment and practices, analysis on individual work plans is also needed. The other work plans for quantification will help indicate the ability for the state to meet the goals listed here, and will also provide estimates of the costs for meeting these goals.

Goals:

Table 1. New Buildings Goals and Standards

		2015	2020
New Commercial (Commonwealth owned or operated)	Overall goal (relative to 2005 building)	60% fossil fuel and electricity reduction	80% fossil fuel and electricity reduction
	Performance standard	LEED Silver ENERGY STAR 85	LEED Silver ENERGY STAR 85
	Fraction of buildings that meet standard	100% of new	100% of new
New Commercial (Schools)	Overall goal (relative to 2005 building)	50% fossil fuel and electricity reduction	70% fossil fuel and electricity reduction
	Performance standard	LEED Silver ENERGY STAR 85	LEED Silver ENERGY STAR 85
	Fraction of buildings that meet standard	100% of new	100% of new
New Commercial (private)	Overall goal (relative to 2005 building)	50% fossil fuel and electricity reduction	70% fossil fuel and electricity reduction
	Performance standard	LEED Silver ENERGY STAR 75	LEED Silver ENERGY STAR 85
	Fraction of buildings that meet standard	100% of new	100% of new
New Residential	Overall goal (relative to 2005 building)	50% fossil fuel and electricity reduction	70% fossil fuel and electricity reduction
	Performance standard	HERS 50	HERS 40
	Fraction of buildings that meet standard	100% of new	100% of new

Table 2. Existing Buildings Goals and Standards

		2015	2020
Existing Commercial (Commonwealth owned or operated)	Overall goal (relative to 2005 building)	40% fossil fuel and electricity reduction	50% fossil fuel and electricity reduction
	Performance standard	ENERGY STAR 75	LEED EB Silver ENERGY STAR 80
	Fraction of buildings that meet standard	20% of existing	50% of existing
Existing Commercial (Schools)	Overall goal (relative to 2005 building)	30% fossil fuel and electricity reduction	50% fossil fuel and electricity reduction
	Performance standard	ENERGY STAR 75	LEED EB Silver ENERGY STAR 80
	Fraction of buildings that meet standard	20% of existing	50% of existing
Existing Commercial (private)	Overall goal (relative to 2005 building)	30% fossil fuel and electricity reduction	40% fossil fuel and electricity reduction
	Performance standard	ENERGY STAR 75	LEED EB Silver ENERGY STAR 80
	Fraction of buildings that meet standard	20% of existing	50% of existing
Existing Residential	Overall goal (relative to 2005 building)	60% fossil fuel and electricity reduction	80% fossil fuel and electricity reduction
	Performance standard	HERS 50	HERS 40
	Fraction of buildings that meet standard	20% of existing	50% of existing

Notes: Energy reductions refer to on-site energy consumption.

Pennsylvania established a state-wide building code in Act 45 of 2005. The PA Uniform Construction Code (UCC) incorporates the International Construction Code (ICC) family of codes, such as the building

code, plumbing codes, and electrical codes. The 2009 ICC includes a basic energy code that commercial buildings must achieve. Pennsylvania did not adopt 2012 ICC and, therefore, 2009 ICC will be the state building code in the commonwealth until 2015.

The **Residential Green Building Code 2010 (NGBS) ICC-700** is available for adoption by local municipalities in Pennsylvania to meet the goals above. Some PA Municipalities have adopted the ICC-700 as an option (such as West Chester Borough).

The ICC has recently developed an overlay code, the **International Green Construction Code (IgCC)**, that incorporates commercial performance standards consistent with goals and commercial building performance standards listed above. The IgCC was developed using a collaborative approach of the public, code officials, builders, developers, architects, engineers, insurance, and real estate agents. The IgCC was first available for consideration by Pennsylvania in 2012 and has already been adopted by a number of states (such as Maryland and Arizona). Adoption of the IgCC will provide municipalities in Pennsylvania the option to implement energy savings that meet the goals above. Pennsylvania did not adopt IgCC in 2012. The next scheduled version is IgCC 2015.

The Pennsylvania Uniform Construction Code (UCC) Review and Advisory Council (RAC) was established by Act 106 of 2008. The council is composed of code officials, builders, developers, architects, engineers, insurance, and real estate agents. The council is charged with making recommendations to the Governor, the General Assembly and the Department of Labor and Industry regarding proposed changes to Act 45, The Pennsylvania Construction Code Act, and reviewing the latest triennial code revisions (2012, 2015, 2018…) issued by the International Code Council contained in the International Codes enforceable under the PA Uniform Construction Code. The Council is required to submit a report to the secretary of Labor and Industry within 12 months following publication of the latest triennial codes specifying each code revision that is to be adopted as part of the Uniform Construction Code.

Possible Implementation Steps:

In addition to the other efficiency work plans, which are technology and action-based work plans that may contribute to meeting the goals of this High-Performance Buildings initiative, the following implementation steps are presented for consideration in each of the four categories:

High-Performance State and Local Government Buildings

- "High-Performance PA Buildings"—All Commonwealth of Pennsylvania-owned or -funded construction projects must meet a performance level equivalent to a minimum of LEED Silver plus an Energy Star rating of 85. Versions of this bill have been introduced in 2009/10 session and again in 2011/12 session. The House Environmental Resources and Energy Committee ~~has~~ approved Representative Kate Harper's, R-Montgomery, green building legislation by a 21-4 vote in 2011/12. House Bill 193 would require high-performance green building standards in most major construction projects involving state-owned buildings. Additionally in 2011/12, Senate Bill 1136 (Rafferty) ~~is~~ was similar companion State Owned Green Building bill. Consider adopting the **International Green Construction Code (IgCC) in 2015**, that incorporates commercial performance standards consistent with goals and commercial building performance standards listed above. Support educational and training sessions about the IgCC provided by professional associations and providers.
- The Department of General Services (DGS) is building a benchmarking database and will be utilizing existing contract capacity with the Penn State Facilities Engineering Institute to begin the auditing/benchmarking process for Commonwealth-owned facilities. Other implementation steps could include:
  - Revise facility manager job descriptions and train staff to incorporate benchmarking into their standard operating procedures.

  - Revise Guaranteed Energy Savings Act (GESA)/energy service company (ESCO) language to incorporate Energy Star performance-based requirements.
  - Mandate that all FY 2013–2014 and future GESA/ ESCO projects adopt the Energy Star performance-based requirements.
  - Continue working with EPA to streamline the work process and minimize the costs associated with implementing Energy Star performance requirements into building operational procedures.
  - Ask the (PUC) to develop and mandate that all PA utilities conform to a uniform billing structure and format to allow automated billing data entry into the Energy Star Portfolio Manager database.
  - Hire and train in-house staff to run program, or educate existing qualified ESCOs on new requirements.
- "Green Strings" - All Commonwealth funding programs, whether grants, loans, tax credits, tax incentives, etc., will have at least a minimal expectation of energy/resource conservation results.
  - The intent of this initiative is to educate involved parties, inform the Commonwealth, and potentially reduce the GHG impacts of building projects. If projects with similar costs and benefits are proposed, the project with the lowest GHG impact will be given preference.
  - Commonwealth agencies should include in their decision-making processes appropriate and careful consideration of GHG emission effects from proposed actions, and their alternatives. This will be done to understand, minimize, and/or avoid potential adverse effects from GHG emissions from the proposed actions, as much as possible. Commonwealth agencies will integrate the GHG emission impacts as early in their planning processes as possible.
  - Commonwealth agencies to require analysis of GHG impacts in all building-related award and approval (permits, grants, procurements, etc) decisions. Entities submitting applications for consideration will be required to include a comprehensive analysis of the GHG impacts of the proposed project. The Commonwealth agencies are only requiring an analysis be performed.
- Require U.S. Environmental Protection Agency (EPA) Energy Star Portfolio Manager benchmarking for all Commonwealth-owned and -leased facilities by 2020.
- Establish a goal of minimum Energy Star rating of 75 for all Commonwealth buildings by 2020.
- Implement the equivalent of LEED for Existing Buildings (LEED-EB), Green Globes, or other certification for ongoing operation and maintenance (O&M) and Energy Star ratings for all Commonwealth buildings. Meet at least the equivalent of LEED-EB Silver certification and an Energy Star score of 75 for all existing buildings by 2020.
- Revise GESA/ESCO language to incorporate the equivalent of LEED-EB and Energy Star performance-based requirements.
- Require all current and future GESA/ESCO projects to adopt the equivalent of LEED-EB and Energy Star performance-based requirements.
- Establish a Pennsylvania Community and Local Government Climate Change Collaborative Clearinghouse to overcome barriers to progress on climate change actions. The project would do the following:
  - Assist communities to develop comprehensive plans that include buildings, transportation, agriculture, land-use planning, and commercial and industrial operations.
  - Provide grants and incentives for communities to conduct inventories and develop plans to monitor their progress.
  - Compile data and offer awards to communities that exceed their goals or demonstrate other significant progress.
  - Assist DEP in achieving Act 70 requirements.

Formatted: Bullets and Numbering

High-Performance School Buildings

- Require EPA Energy Star Portfolio Manager benchmarking for all Commonwealth-owned and leased educational facilities by 2020.
- Establish a goal of minimum Energy Star rating of 75 for all public school buildings by 2020.

- Consider adopting the **International Green Construction Code (IgCC) in 2015** that incorporates commercial performance standards consistent with goals and commercial building performance standards listed above. Support educational and training sessions about the IgCC provided by professional associations and providers.
- Continue implementation of *Illuminating Education* program—~~Current~~ Governor's Green Government Council/Office of Energy and Technology Development (GGGC/OETD) program to distribute compact fluorescent lamps (CFLs) to middle school students in PA as part of an overall energy curriculum program.
- Continue efforts of *Pennsylvania State System of Higher Education (PASSHE*) *Energy Consumption Reduction*—Continue emphasis on existing efforts to reduce energy consumption at Pennsylvania state universities through full implementation and seek new energy saving initiatives to meet or exceed the 1.5 percent annual energy use intensity (EUI) reduction goal. The following are some of the tools available to achieve this goal (Projected GHG reduction from PASSCHE EUI goal as estimated by the Department of Environmental Protection are included; these projected reductions are not included in the quantitative analysis):
  - Guaranteed Energy Saving Program (GESA) (0.04 $MMtCO_2e$))
  - Aggressive building operating system control (0.005 $MMtCO_2e$)
  - Behavioral changes (0.02 $MMtCO_2e$)
  - LEED and Energy Star efforts (0.01 $MMtCO_2e$)
  - Total Reduction: 0.075 $MMtCO_2e$
- Increase utilization of campus energy managers.
  - About half of the PASSHE universities have established positions for energy managers. These positions are typically funded out of energy consumption and unit cost savings achieved through the work of the energy manager.
  - Energy managers utilize the building control systems to aggressively manage the heating, ventilation, and air conditioning systems (and sometimes lighting) to minimize energy consumption while maintaining an environment conducive to the university's mission.
  - Energy managers are also instrumental in managing and successfully implementing university GESA projects.
- Implement a *Green Campus Initiative* for all Pennsylvania colleges, universities, private schools, and secondary schools to minimize environmental impacts and create "learning labs" for sustainability. Develop and support an effective process to promote energy and sustainability concepts.
- Provide leadership and resources to schools for a comprehensive approach to lower energy use and energy costs, reduce GHG emissions from buildings and transportation, improve water and wastewater management, increase recycling, reduce disposal of hazardous waste, and promote procurement of environmentally friendly products.
- Use a team-based approach that engages administrative staff, students, faculty and technical experts.

High-Performance Commercial Buildings (Private) Buildings

- Incorporate green building requirements in the statewide building code (Uniform Construction Code [UCC]). Consider adopting the **International Green Construction Code (IgCC) in 2015, as an option,** that incorporates commercial performance standards consistent with goals and commercial building performance standards listed above. Support educational and training sessions about the IgCC provided by professional associations and providers.
  - This could be a phased-in approach that begins in the first years with Energy Star standards, and expands to cover high-performance standards for energy, water, stormwater, materials, etc. The

ultimate goal will be zero-carbon buildings[1] throughout the Commonwealth – a goal that is aligned with the 2030 Challenge.
  - UCC improvements will need to include a much higher level of administration and enforcement than what currently exists. Statewide emphasis on training must occur.
- *High-Performance Tax Credits*—Tax credits for private-sector construction projects that meet a performance level equivalent to a minimum of LEED Silver plus an Energy Star rating of 85.
- Require energy information to be included in a "seller's disclosure" for commercial real estate transfers. Alternatively, require an Energy Star portfolio manager energy use index. The "seller's disclosure" consists of a property disclosure statement; the seller is currently not obligated by the statute to make any specific investigation. A third-party-verified energy audit should be an additional document and not part of "seller's disclosure."
- Implement an *Airport Efficiency Initiative* - Under this initiative, the Governor of Pennsylvania would issue an Executive Order requesting all Federal Aviation Regulation (FAR) Part 139 airports to improve their energy efficiency by 10 percent. The individual airports (which include all facilities leased or owned by the airport) will be given flexibility to achieve the efficiency goal. This will allow each facility to find the most cost-effective options to meet the target. Under the Executive Order, applicable airports would be encouraged to coordinate with Pennsylvania Department of Transportation's (PennDOT's) Air Services Committee to develop plans to achieve the energy efficiency goal. An example of a similar initiative includes Washington State Governor Gary Locke's 10 percent energy efficiency goal for airports. The Seattle Tacoma International Airport (SEA-TAC) achieved this goal by installing 60 motor controllers on escalators, replacing inefficient lighting with energy-efficient fixtures, and retrofitting older heating and cooling systems with more efficient equipment.

RC-4: High-Performance Homes (Residential)

- Incorporate green building requirements in the statewide building code (UCC).
- Consider adopting the **Residential Green Building Code 2010 (NGBS) ICC-700** across the state, as an option for municipalities to meet the residential goals and ~~residental~~residential building performance standards listed above Support educational and training sessions about the IgCC provided by professional associations and providers.
  - Require all new residential construction in Pennsylvania to achieve a minimum of LEED certification.
  - This could be a phased-in approach that begins in the first years with Energy Star standards, and expands to cover high-performance standards for energy, water, stormwater, materials, etc. The ultimate goal will be zero-carbon residential buildings[2] throughout the Commonwealth.
  - UCC improvements will need to include a much higher level of administration and enforcement than what currently exists. Statewide emphasis on training must occur.
- Provide tax credits for private-sector construction projects that meet a performance level equivalent to a minimum of LEED Silver plus an Energy Star rating of 85. Several current legislative proposals based on this objective are being considered. (See HB 46, SB 673.)
- *Energy Audits at Real Estate Transfer*—Energy audit required as part of "seller's disclosure" information in a residential sales transaction.
- *Keystone Home Performance*—Retooling of the Keystone HELP program to offer a greater degree of assistance (much lower loan rates) to homeowners implementing energy-saving measures based on a

[1] A zero-carbon house is a building where net carbon dioxide emissions resulting from all energy used in the dwelling are zero or better. This includes the energy consumed in the operation of the space heating/cooling and hot-water systems, ventilation, all internal lighting, cooking and all electrical appliances.
[2] A zero-carbon house is a building where net carbon dioxide emissions resulting from all energy used in the dwelling are zero or better. This includes the energy consumed in the operation of the space heating/cooling and hot-water systems, ventilation, all internal lighting, cooking and all electrical appliances.

whole-house energy audit. (See also the Pennsylvania Housing Finance Agency's (PHFA's) Keystone Renovate and Repair program and Maine Home Performance Program).

- *LEED for Homes*—Require that all new homes have an Energy Star rating (15 percent more energy efficient than code-compliant construction). Increase the efficiency requirement every 5 years until all new homes are carbon-neutral.
- Implement a *Pennsylvania Home Climate Champion Collaborative* to provide vision, clarity, and access to human and physical resources so that 100,000 homes will achieve substantial (greater than 60 percent) energy reductions, while maintaining or improving indoor air quality, resilience to storms and power outages, adaptability, comfort, and affordability between now and 2025. Five percent of these demonstration projects should achieve the German PassivHaus energy independence goals of 90 percent energy reduction, with 10 percent met by renewable energy.
- Require energy information to be included in a "seller's disclosure" for residential real estate transfers.
- Require building performance labels that reflect actual utility use.
- Develop energy improvement mortgages or energy-efficient mortgages and promote these products in PA.
- Offer the Commonwealth residential sector an incentive for implementing whole-house performance, provide consumer and contractor education, create jobs, spur marketplace development, and significantly improve PA's existing housing stock while reducing energy consumption and associated GHG emissions. Propose blending all existing programs and efforts, applying for federal loan guarantees and special project funding, and seeking partnerships with utilities and others (manufacturers, contractors, nonprofit organizations, etc.).

Supporting Steps to Meet Targeted Goals:

- Support the integrity of the UCC as it gets negotiated in the General Assembly.
  - Consider adopting the **Residential Green Building Code 2010 (NGBS) ICC-700** developed with the National Home Builders Association across the state, as an option for municipalities to meet the residential goals and residental building performance standards listed above.
  - Consider adopting the **International Green Construction Code (IgCC) in 2015** as an option that incorporates commercial performance standards consistent with goals and commercial building performance standards listed above. Support educational and training sessions about the IgCC provided by professional associations and providers.
- Develop an accreditation system for energy auditors.
  - Companies with the appropriate expertise should conduct energy audits. While the requirements for determining expertise exist as guidelines for reputable companies, third-party-verified requirements are ill defined and span a broad spectrum of energy efficiency.
- Educate the mortgage industry on the benefits of recognizing a standardized home rating system and adjust the current mortgage profile to include value realized as a result of increased energy efficiency.
  - Energy audits coupled with energy mortgages could increase the number of families qualified for mortgages. Energy mortgages credit a home's efficiency rating into the loan by proportionately increasing the value of the home. To have a Pennsylvania policy of requiring lenders to provide energy mortgages, it is necessary to adopt a standardized home rating system, like the one adopted by the Residential Energy Services Network (RESNET). Home energy ratings provide a standard measurement of a home's energy efficiency. Ratings can be used for both new and existing homes. An effective rating system will include all information necessary for a lender to judge the worthiness of a home to meet the criteria for an energy mortgage. The program is already established through the mortgage industry and the National Association of State Energy Officials; however, it is not that widespread, with only 19 accredited providers in Pennsylvania.
  - Basing a mortgage on the home efficiency rating allows the buyer to borrow more on the basis that the monthly utility bills will be proportionally less. In cases where the home is in need of

energy-efficient upgrades, an Energy Improvement Mortgage could help finance the upgrades in an existing home by allowing the owner to use a portion of the mortgage payment to pay for the cost of the upgrades.

- Continue working with the U.S. Green Building Council (USGBC) and EPA to streamline work processes and minimize the costs associated with implementing LEED and Energy Star principles and performance requirements into building operational procedures.
- Modify the DGS Architect/Engineer Request for Proposal (RFP)/contract to require a higher standard of competency for design professionals performing state-funded design work.
- Secure an agreement with a developer of rating systems (e.g., USGBC) for acceptance of portfolio standards for the state, reducing costs to register, certify, and commission the projects.
- Require all current and future GESA/ESCO projects to adopt the Energy Star performance-based requirements.
  - Continue working with EPA to streamline work processes and minimize the costs associated with implementing Energy Star performance requirements into building operational procedures.
  - Ask the PUC to develop and mandate that all PA utilities conform to a uniform billing structure and format to allow automated billing data entry into the Energy Star Portfolio Manager database (based upon California Assembly Bill 1103).
  - Advocate and increase participation in the Build Green Schools initiative and the Green Schools Pledge.

Existing Measures:

- No LEED or high-performance requirements exist in PA. Energy Policy Act (EPAct) 2005 tax credits for certain Energy Star measures do exist.
- The Keystone HELP Program offers reduced-interest unsecured loans for Pennsylvania residents to purchase energy-efficient equipment, such as HVAC, windows, hot water heaters, etc.
- *PHFA*—Keystone Renovate & Repair Loan Program can be used to pay for repairs and improvements that increase the basic livability of the home, including additions and construction, that makes the home safer, more energy efficient, or more accessible to people with disabilities or people who are elderly.
- *EPA and DOE*—The model Home Performance with ENERGY STAR program uses a comprehensive, whole-house approach to improving energy efficiency and comfort at home, while helping to protect the environment.
- *PUC*—As part of the AEPS, PA utilities are required to explore energy efficiency measures prior to applying for capacity increases.
- *DCED*—The department currently runs PA's Weatherization Assistance Program (WAP), and has contractors, auditors, and program administration in place.
- *PA Home Energy*—A nonprofit organization-sponsored residential energy audit and performance evaluation program serving WPP utility customers.
- *ECA (unnamed program)*—This start-up program is similar to PA Home Energy, serving the Philadelphia and Pittsburgh metro areas.
- *Alternative Energy Investment Act*— This Act originally ~~provides~~ provided $92.5 million for residential and commercial energy efficiency activities and other initiatives. A portion of this money will be integrated into the Keystone HELP Program and the PHFA.

Key Assumptions:

High Performance State and Local Buildings

Other Data, Assumptions, Calculations	2013	2020	Units
Total Commercial Floorspace in Pennsylvania (million square feet)	866	928	
Estimated based on USDOE EIA CBECS (commercial survey) data for the Mid-Atlantic region, extrapolated.			

Annual demolition of commercial floorspace		**0.58%**	
Based on analysis by AIA research corporation for Architecture 2030, national values.			
Est. area of new commercial space per year in PA (million square feet)	**13.8**	**14.4**	
Calculated based on annual floorspace estimates above. Note high growth in 2006 and 2007 based on article from American Institute of Architects.			
Estimated number of new residential units per year	**86,013**	**85,701**	
Calculated based on estimates above.			
Implied ave. electricity consumption per sq. ft. commercial space		10.60	kWh/yr
Implied ave. natural gas consumption per sq. ft. commercial space		34.57	kBtu/yr
Estimate based on Reference case forecast, using average intensity of all commercial buildings in PA			

Calculation of Savings	**2013**	**2020**	**Units**
New construction floorspace covered by program, annual	**5**	**14**	million sq ft
Existing building floorspace covered by program, annual	**54**	**44**	million sq ft
Energy consumption, Reference case			
Energy consumption in new commercial buildings			
Electricity	332	313	billion BTU
Natural gas	270	284	billion BTU
Total	601	597	billion BTU
Estimate based on Reference case forecast			
Energy consumption in new commercial buildings, per sq foot			
Electricity	24	22	Th. BTU/sq ft
Natural gas	19	20	Th. BTU/sq ft
Total	43	42	Th. BTU/sq ft
Estimate based on Reference case forecast, using average intensity of all commercial buildings in PA			

High Performance School Buildings

Other Data, Assumptions, Calculations	**2013**	**2020**	**Units**
Total School Building Floorspace in PA (million sq. ft.)	**728**	**780**	million sq ft
Estimated based on USDOE EIA CBECS (comercial survey) data for the Mid-Atlantic region, extrapolated using DEP approach.			
Annual demolition of commercial floorspace		**0.58%**	
Based on analysis by AIA research corporation for Architecture 2030, national values.			
Est. area of new school building space per year in PA (million sq. ft.)	**4.2**	**12.1**	million sq ft
Calculated based on annual floorspace estimates above.			
Implied ave. electricity consumption per sq. ft. school building space		10.60	kWh/yr
Implied ave. natural gas consumption per sq. ft. school building space		34.57	kBtu/yr

Calculation of Savings	**2013**	**2020**	**Units**
New construction floorspace covered by program, annual	**1**	**12**	million sq ft
Existing building floorspace covered by program, annual	**48**	**40**	million sq ft
Energy consumption, Reference case			
Energy consumption in new school building buildings			
Electricity	101	263	billion BTU
Natural gas	82	239	billion BTU
Total	184	502	billion BTU
Estimate based on Reference case forecast			

Energy consumption in new school building buildings, per sq foot			
Electricity	24	22	Th. BTU/sq ft
Natural gas	19	20	Th. BTU/sq ft
Total	43	42	Th. BTU/sq ft

Estimate based on Reference case forecast, using average intensity of all commercial buildings in PA

High Performance Commercial Buildings

Other Data, Assumptions, Calculations	2013	2020	Units
Total Commercial (Private) Floorspace in Pennsylvania (million sq. ft.)	**3,634**	**3,895**	
Estimated based on USDOE EIA CBECS (comercial survey) data for the Mid-Atlantic region.			
Annual demolition of commercial floorspace		**0.58%**	
Based on analysis by AIA research corporation for Architecture 2030, national values.			
Est. area of new commercial (private) space per year in PA (million sq. ft.)	**58.1**	**60.3**	
Calculated based on annual floorspace estimates above.			
Implied average electricity consumption per sq. ft. commercial space		10.60	kWh/yr
Implied average natural gas consumption per sq. ft. commercial space		34.57	kBtu/yr
Calculation of Savings	**2013**	**2020**	**Units**
New construction floorspace covered by program, annual	**39**	**60**	million sq ft
Existing building floorspace covered by program, annual	**111**	**185**	million sq ft
Energy consumption, Reference case			
Energy consumption in new commercial buildings			
Electricity	2,002	1,891	billion BTU
Natural gas	1,628	1,713	billion BTU
Total	3,631	3,604	billion BTU
Estimate based on Reference case forecast			
Energy consumption in new commercial buildings, per sq foot			
Electricity	24	22	Th. BTU/sq ft
Natural gas	19	20	Th. BTU/sq ft
Total	43	42	Th. BTU/sq ft
Estimate based on Reference case forecast			
Energy consumption in existing commercial buildings, per sq foot			
Electricity		36.17	Th. BTU/sq ft
Natural gas		34.57	Th. BTU/sq ft
Estimate based on Reference case forecast			

High Performance Homes

Other Data, Assumptions, Calculations	2013	2020	Units
Total Residential Housing Units in Pennsylvania	5,520,197	5,570,337	
Assumes 2007 number of homes to increase following population through 2020. Based on 2007 PA housing units as provided in U.S Census Bureau annual data, http://www.census.gov/popest/housing/HU-EST2005.html.			
Annual demolition of residential floorspace		**1.43%**	
Based on average lifespan of home of 70 years			
Estimated number of new residential units per year	**86,013**	**85,701**	
Calculated based on estimates above.			
Implied average electricity consumption per housing unit		**9.90**	MWh/yr
Implied average natural gas consumption per housing unit		**46.56**	MMBtu/yr

Implied average petroleum consumption per housing unit		**27.88**	MMBtu/yr
Calculation of Savings	**2013**	**2020**	**Units**
New construction housing units covered by program, annual	57,342	85,701	housing units
Existing building housing units covered by program, annual	164,689	242,325	housing units
Energy consumption, Reference case			
Energy consumption in new residential buildings			
Electricity	2,373	2,240	billion BTU
Natural gas	3,279	3,262	billion BTU
Total	5,651	5,502	billion BTU
Estimate based on Reference case forecast			
Energy consumption in new residential buildings, per housing unit			
Electricity	27.6	26.1	MMBTU/housing unit
Natural gas	38.1	38.1	MMBTU/housing unit
Total	65.7	64.2	MMBTU/housing unit
Estimate based on Reference case forecast			
Energy consumption in existing commercial buildings, per sq foot			
Electricity		33.77	MMBTU/housing unit
Natural gas		46.56	MMBTU/housing unit
Petroleum		27.88	MMBTU/housing unit
Total		108	
Estimate based on Reference case forecast			

GHG Reductions:

Table 3. Estimated GHG Reductions and Cost-effectiveness

	Annual Results (2020)			Cumulative Results (2013-2020)		
Work Plan Name	**GHG Reductions ($MMtCO_2e$)**	**Costs (Million $)**	**Cost-Effectiveness ($/tCO_2e$)**	**GHG Reductions ($MMtCO_2e$)**	**Costs (NPV, Million $)**	**Cost-Effectiveness ($/tCO_2e$)**
High-Performance State and Local Government Buildings	0.7			-1.3		
High-Performance School Buildings	1.2			4.6		
High-Performance Commercial (Private) Buildings	8.0			32.9		
High Performance Homes (Residential)	11.8			49.9		
Total High Performance Buildings	21.7	-$362.9	-$16.7	86.1	-$2,542	-$29.5

Economic Costs:

See Table 3, above.

Potential Overlap:

Overlaps with the following:

- Building Commissioning
- Re-Roof PA
- Re-Light PA
- ~~Appliance Standards~~Energy Efficient Appliances
- Geothermal Heating and Cooling

- DSM – Natural Gas
- ~~DSM –~~ Heating Oil Conservation and Fuel Switching~~Biofuel for Heat~~
- Act 129 Phases I, II & III