Residential and Commercial Subcommittee
Summary of Work Plans Recommended for Quantification

Work Plan No.	Work Plan Name	Annual Results (2020)			Cumulative Results (2009-2020)		
		GHG Reduc-tions ($MMtCO_2e$)	Costs (Million $)	Cost-Effective ness ($/tCO_2e$)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effective ness ($/tCO_2e$)
	High Performance Buildings						
1	High Performance State and Local Government Buildings	1.6			6.7		
2	High Performance School Buildings	1.1			4.6		
3	High Performance Commercial (private) Buildings	5.3			22.1		
4	High Performance Homes (Residential)	11.1			50.6		
	Sub-total High Performance Buildings	19.1			84.0		
5	Commission Buildings						
6	Re-Light PA	6.6	$619	$94	51.0	$854	$17
7	Re-Roof PA						
8	Appliance Standards	1.0	-$55	-$55	6.5	-$238	-$36
9	Geothermal Heating and Cooling						
10	DSM - Natural Gas	7.3	-$42	-$6	40.5	-$293	-$7
11	B5 Bioheat Initiative	0.3	$112	$329	4.6	$1,163	$253
12	DSM - Electricity	Options below are imported from Electricity Subcommittee for review by Res/Com Subcommittee					
	Reduced Load Growth	7.0	-$447	-$62	25.0	-$933	-$38
	Stabilize Load Growth	11.0	-$690	-$62	37.0	-$1,408	-$38
13	DSM - Water						
??	Department of General Services (DGS) – Initiative to Reduce Energy Use by State Government	Need input from DEP					
	PA values embodied energy in building materials, including historic structures	Not quantified					

Work Plan No.	Work Plan Name	Annual Results (2020)			Cumulative Results (2009-2020)		
		GHG Reduc-tions ($MMtCO_2e$)	Costs (Million $)	Cost-Effective ness ($/tCO_2e$)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effective ness ($/tCO_2e$)
	Sustainability education programs	Not quantified					
	Adaptive building reuse	Not quantified					
Sector Total After Adjusting for Overlaps							
Reductions From Recent Actions							
Sector Total Plus Recent Actions							

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; NPV = net present value; TBD = to be determined.

Negative values in the Cost and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above draft work plans is for reference purposes only; it does not reflect prioritization among these important draft work plans.

RC-1.– 4. High Performance Buildings

The High Performance Buildings workplans are a consolidation of many workplans (text from those plans follows the results section below). The main goals for the workplan generally come from the GHG 2030 Challenge building goals with some revisions from subcommittee. These goals are summarized in the following tables. We have estimated the GHG emission reductions for Pennsylvania through 2020, assuming that these goals are met. The key assumptions and results of that analysis are shown below.

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 workplans is also needed. The other workplans 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:

Note that for fossil fuel reductions we also included fossil fuel use due to electricity consumption, so goals are interpreted as "energy consumption"

New Buildings Goals and standards

		2015	2020	2030
New Commercial (private)	Overall goal (relative to 2007 building)	50% fossil fuel reduction	70% fossil fuel reduction	80% fossil fuel reduction
	Performance standard	LEED Silver ENERGY STAR 75	LEED Silver ENERGY STAR 85	??
	Fraction of buildings that meet standard	100% of new buildings	100% of new buildings	100% of new buildings
	Deployment of renewable energy	To be determined	To be determined	To be determined
New Commercial (Commonwealth owned or operated)	Overall goal (relative to 2007 building)	60% fossil fuel reduction	80% fossil fuel reduction	100% fossil fuel reduction
	Performance standard	LEED Silver ENERGY STAR 85	LEED Silver ENERGY STAR 85	??
	Fraction of buildings that meet standard	100% of new buildings	100% of new buildings	100% of new buildings
	Deployment of renewable energy	To be determined	To be determined	To be determined
New Commercial (Schools)	Overall goal (relative to 2007 building)	50% fossil fuel reduction	70% fossil fuel reduction	80% fossil fuel reduction
	Performance standard	LEED Silver ENERGY STAR	LEED Silver ENERGY STAR	??

		2015	2020	2030
		85	85	
	Fraction of buildings that meet standard	100% of new buildings	100% of new buildings	100% of new buildings
	Deployment of renewable energy	To be determined	To be determined	To be determined
New Residential	Overall goal (relative to 2007 building)	50% fossil fuel reduction	70% fossil fuel reduction	80% fossil fuel reduction
	Performance standard	HERS 50	HERS 40	HERS 30
	Fraction of buildings that meet standard	100% of new buildings	100% of new buildings	100% of new buildings
	Deployment of renewable energy	To be determined	To be determined	To be determined

Notes: Overall goals reflect 2030 GHG goals
Looking for input from subcommittee on Performance standards that will help set policies to achieve the Overall goals
Fraction of buildings that meet standard is currently set to 100% to reflect a mandate policy (rather than incentives that would likely reach a smaller fraction of buildings)

Existing Buildings Goals and standards

		2015	2020	2030
Existing Commercial (private)	Overall goal (relative to 2007 building)	30% fossil fuel reduction	40% fossil fuel reduction	50% fossil fuel reduction
	Performance standard	ENERGY STAR 75	LEED EB Silver ENERGY STAR 80	LEED EB Silver ENERGY STAR 85
	Fraction of buildings that meet standard	20% of existing buildings	50% of existing buildings	100% of existing buildings
	Deployment of renewable energy	To be determined	To be determined	To be determined
Existing Commercial (Commonwealth owned or operated)	Overall goal (relative to 2007 building)	40% fossil fuel reduction	50% fossil fuel reduction	70% fossil fuel reduction
	Performance standard	ENERGY STAR 75	LEED EB Silver ENERGY STAR 80	LEED EB Silver ENERGY STAR 85
	Fraction of buildings that meet standard	20% of existing buildings	50% of existing buildings	100% of existing buildings
	Deployment of	To be	To be	To be

		2015	2020	2030
	renewable energy	determined	determined	determined
Existing Commercial (Schools)	Overall goal (relative to 2007 building)	30% fossil fuel reduction	50% fossil fuel reduction	70% fossil fuel reduction
	Performance standard	ENERGY STAR 75	LEED EB Silver ENERGY STAR 80	LEED EB Silver ENERGY STAR 85
	Fraction of buildings that meet standard	20% of existing buildings	50% of existing buildings	100% of existing buildings
	Deployment of renewable energy	To be determined	To be determined	To be determined
Existing Residential	Overall goal (relative to 2007 building)	60% fossil fuel reduction	80% fossil fuel reduction	100% fossil fuel reduction
	Performance standard	HERS 50	HERS 40	HERS 40
	Fraction of buildings that meet standard	20% of existing buildings	50% of existing buildings	100% of existing buildings
	Deployment of renewable energy	To be determined	To be determined	To be determined

Notes: Overall goals reflect 2030 GHG goals
Looking for input from subcommittee on Performance standards that will help set policies to achieve the Overall goals
Fraction of buildings that meet standard is currently set to 100% to reflect a mandate policy (rather than incentives that would likely reach a smaller fraction of buildings)

Possible Vehicles to support Workplan goals

RC-1 High Performance State and Local Buildings

- "High-Performance PA Buildings" – All Commonwealth owned or funded construction projects must meet a performance level equivalent to a minimum of LEED Silver plus an Energy Star rating of 85. (See HB 45, SB 672)
- "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 attached.
    - Commonwealth agencies shall include in their decision-making processes appropriate and careful consideration of greenhouse gas 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 shall integrate the greenhouse gas emission impacts as early in the Agency planning processes as possible.

  - Commonwealth agencies will require analysis of GHG impacts in all award and approval (permits, grants, procurements, etc) decisions. Entities submitting applications for consideration will be required to include a comprehensive analysis of the greenhouse gas impacts of the proposed project. The Commonwealth agencies are only requiring an analysis be performed.
  - The intent of this initiative is to educate involved parties, inform the commonwealth, and to potentially reduce the GHG impacts of a project. If projects with similar costs and benefits are proposed, the project with the lowest GHG impact will be given preference.

- Require U.S. EPA Energy Star Portfolio Manager benchmarking for all Commonwealth of Pennsylvania (CWoPA) owned and leased facilities by 2009. Establish a goal of minimum Energy Star rating of 75 for all CWoPA buildings by the year 2020.
- Implement the equivalent to LEED-EB, Green Gloabes, etc., certification for ongoing operation and maintenance and Energy Star ratings for all Commonwealth buildings. Meet at least the equivalent to LEED-EB Silver certification and an Energy Star score of 75 for all existing buildings by year 2020.
- Require U.S. EPA Energy Star Portfolio Manager benchmarking for all Commonwealth of Pennsylvania (CWoPA) publicly owned and leased educational facilities by 2010. Establish a goal of minimum Energy Star rating of 75 for all public school buildings by the year 2020.

RC-2 High Performance Schools

- "Illuminating Education" – Current GGGC/OETD program to distribute CFL lamps to middle school students in PA as part of overall energy curriculum program.
- Continue emphasis on existing efforts to reduce energy consumption at universities through full implementation and seek new energy saving initiatives to meet or exceed the 1.5% annual EUI reduction goal. The following are some of the tools available to achieve this goal:
  - Guaranteed Energy Saving Program
  - Energy manager staffing
  - Aggressive building operating system control
  - Behavioral changes
  - LEED and Energy Star efforts
- The "green campus initiative" is a program for all PA colleges, universities, private schools and secondary schools to minimize environmental impact 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, 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
- The Pennsylvania State System of Higher Education (PASSHE) has participated in the Commonwealth's effort to purchase green energy attributes. In addition, Universities have attempted to implement small scale green energy production on their campuses for educational purposes.
- This initiative establishes and supports PA 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.

RC-3 High Performance Commercial Buildings (private)

- "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. (See HB 46, SB 673)

- Require energy information to be included in a "seller's disclosure" for commercial real estate transfers. Alternatively, an Energy Star portfolio manager energy use index would be required. 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."
- Incorporate green building requirements in the statewide building code (UCC).
  - 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, storm water, materials, etc. Ultimate goal will be zero-carbon buildings[1] 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.
  - New construction will not be permitted if plans/subsequent building do not need High Performance Buildings

- 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).

[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.

RC-4 High Performance Homes

- "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 Keystone HELP program to offer greater degree of assistance (much lower loan rates) to homeowners implementing energy-saving measures based on whole-house energy audit. (See also PHFA's "Keystone Renovate and Repair" program, and Maine Home Performance Program)
- "LEED for Homes" – Require that all new homes bear an Energy Star rating (15% more energy efficient than code-compliant construction). Increase required efficiency requirement every 5 years all new homes are carbon-neutral.

- Incorporate green building requirements in the statewide building code (UCC).
    - 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, storm water, materials, etc. Ultimate goal will be zero-carbon 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.
    - New construction will not be permitted if plans/subsequent building do not need High Performance Buildings
- 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).
- Require energy information to be included in a "seller's disclosure" for residential real estate transfers.
- Require all new construction in Pennsylvania to achieve a minimum of LEED certification by incorporating green building requirements in the statewide building code (UCC).
- Require building performance labels that reflect actual utility usage (more information needed)
- Develop energy improvement mortgages (EIM) or energy efficient (EE) mortgages and promotes these products in PA.
- The Pennsylvania Home Climate Champion Collaborative provides vision, clarity and access to human and physical resources so that 100,000 homes will achieve substantial (greater than 60%) energy reductions while maintaining or improving indoor air quality, resilience to storms and power outages, adaptability, comfort, and affordability between

[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.

now and 2025. Five % of these demonstration projects should achieve PassivHaus energy independence goals of 90% energy reduction with 10% met by renewable energy.

- Offer 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 greenhouse gas emissions. Propose blending all existing programs and efforts, and applying for federal loan guarantees and special project funding, and seeking partnerships with utilities and others (manufacturers, contractors, NPO's, etc…).
- "Blending" could occur by working with the federal government and other PA agencies (and possibly utilities), with the intention of voluntarily partnering with the DEP to integrate these existing grant programs.

Implementation Steps:

- Support integrity of UCC as it gets negotiated in the General Assembly.
- Propose modifications to UCC to increase energy standards for all new construction.
- Provide/oversee training and education on how new standards will be achieved.
- Support legislative proposals (with possible amendments to achieve greater savings) and determine high-performance rating system to be used (LEED, Green Globes, other).
- Develop 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. Chapter 75 of the Pennsylvania Home Inspection Law states that an inspection company must be a not for profit franchise, have membership in more than 10 states, require inspectors not to become fully accredited unless they have performed or participated in more than 100 home inspections, and must pass a recognized accredited examination. It also requires members to comply with a code of conduct and attend continuing professional education classes.

- The Residential Real Estate Transfer Law must be amended to require energy audits for real estate transfers. This would require legislative action.
- Additionally the mortgage industry must recognize 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. In order to have a Pennsylvania policy of requiring lenders to provide Energy Mortgages it's 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 the program 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.

- Propose adding "green strings" to existing PA programs, adding DOE Title XVII loan guarantees and thereby reducing interest rates by ~0.5%.
- Negotiate new contract with AFCFirst, PA Treasury, PHFA, and DCED based on a "home performance" funding model.
- Possibly engage utility companies and others on ways to plug into the program, such as providing energy conservation packets to homeowners, or providing grants to train home performance contractors and/or grants to purchase home diagnostic equipment.
- Additional implementation steps would need to be further defined and established.
- Need to provide:
    - Customer assistance to identify which measures to deploy in order to optimize energy savings,
    - Certified building science professionals trained to properly identify and install the most cost effective energy-savings measures,
    - Quality assurance and control,
    - Funding for taking a whole-house approach,
    - Finance rates that truly provide incentives to consumers.

- The Department of General Services 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. Other implementation steps could include:
    - Develop Energy Star strategy work group, DGS, OETD and GGGC
    - Revise facility manager job descriptions and train staff to incorporate benchmarking into their standard operating procedures.
    - Revise GESA / ESCO language to incorporate Energy Star performance-based requirements.
    - Mandate all FY 2009-2010 and future GESA / ESCO projects adopt the Energy Star performance-based requirements.
    - Continue working with U.S. EPA to streamline work process and minimize costs associated with implementing Energy Star performance requirements into building operational procedures.
    - PUC to develop and mandate all PA utilities conform to a uniform billing structure and format to allow automated billing data entry into Energy Star Portfolio Manager database.
    - Develop / hire in-house staff to run program or educate existing qualified ESCOs on new requirements.

- Continue LEED strategy work group, DGS and Governor's Green Government Council (GGGC)
- Revise GESA / ESCO language to incorporate the equivalent to LEED-EB and Energy Star performance-based requirements.
- Complete the two (2) pilot projects (Governor's Residence and RCSOB) – and mandate implementation of the policies developed in these pilot projects for ALL CWoPA facilities.
- Mandate all FY 2009-2010 and future GESA / ESCO projects adopt the equivalent of LEED-EB and Energy Star performance-based requirements.
- Continue working with USGBC and U.S. EPA to streamline work process and minimize costs associated with implementing LEED and Energy Star principles and performance requirements into building operational procedures.
- Develop / hire in-house staff to run program or educate existing qualified ESCOs on new requirements.
- Support legislative proposals, with possible amendments to achieve greater savings. Examples, special session House Bill 4 of 2008
- Determine high-performance rating system to be used (LEED, Green Globes, other).
- Modify DGS Architect/Engineer RFP/contract to require a higher standard of competency for design professionals performing state-funded design work.
- Secure an agreement with developer of rating system (i.e. USGBC) for acceptance of portfolio standards for the state, reducing costs to register, certify and commission the projects.
- The GGGC will continue to work with the PA School Board Officials and their newly formed Green Committee to develop this initiative. Other implementation steps could include:
    - Develop Energy Star strategy work group, PDE, DGS, OETD, PUC and GGGC
    - Develop language for facility manager job descriptions and train staff to incorporate benchmarking into their standard operating procedures.
    - Revise GESA / ESCO language to incorporate Energy Star performance-based requirements.
- Mandate all FY 2009 and future GESA / ESCO projects adopt the Energy Star performance-based requirements.
    - Continue working with U.S. EPA to streamline work process and minimize costs associated with implementing Energy Star performance requirements into building operational procedures.
    - PUC to develop and mandate all PA utilities conform to a uniform billing structure and format to allow automated billing data entry into 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.

- Continue implementation of Guaranteed Energy Saving Act (GESA) projects.
    - Currently, one university has completed a GESA project, three universities have projects in construction, and the remaining ten universities and the Dixon University Center are in the process of conducting investment grade audits.

  - The GESA projects are expected to reduce energy consumption by about 20% for PASSHE. This equates to about $10 million in annual energy savings through implementing energy compensation measures, including upgrades to lighting systems, heating and air conditioning systems, utility distribution systems and building system controls.
- Increase utilization of campus Energy Managers.
  - About one 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.
- Aggressive building operating system control. Up to one-half of an energy managers time can be spent in analyzing and manipulating building operating system controls to minimize energy usage.
- Behavioral changes. To effectively modify the behavior of the building occupants requires: analysis of building level energy consumption, surveying occupants to identify behaviors and motivators, and developing a plan to modify behaviors and educate where the occupants are motivated to participate. This process must be repeated and adjusted continuously to ensure momentum is not lost through the significant turnover of students.
- LEED and Energy Star efforts.
  - Continue to evaluate projects on a case by case basis for application of LEED and/or Energy Star standards.
  - Attempt to increase funding available for capital projects to avoid the initial cost limitations of projects over the preferred project life cycle cost.

Existing Measures:

- No LEED or high-performance requirements exist in PA. EPACT 2005 tax credits for certain Energy Star measures do exist.
- 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 (R&R) 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.
- U.S. EPA and U.S. DOE: Home Performance with ENERGY STAR program, a model program which 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 Alternative Energy Portfolio Standard, PA utilities are required to explore energy efficiency measures prior to applying for capacity increases.

- DCED: Currently runs PA's WAP (Weatherization Assistance Program) and has contractors, auditors, and program administration in place.
- PA Home Energy: A NPO-sponsored residential energy audit and performance evaluation program serving WPP utility customers.
- ECA (Unnamed Program): Start-up program, similar to PA Home Energy serving Philadelphia and Pittsburgh metro areas.
- Alternative Energy Investment Act: $92.5 million from this Act 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:

RC-1 High Performance State and Local Buildings

Other Data, Assumptions, Calculations	2012	2020/all	Units
Total State/Local gov Floorspace in Pennsylvania	857	928	million sq ft
Estimated (see "PA_BLDG_Activities" worksheet in this workbook) based on USDOE EIA CBECS (comercial survey) data for the Mid-Atlantic region, extrapolated using DEP approach.			
Annual demolition of commercial floorspace		0.58%	
Taken from analysis by DEP, see PA_Bldg_activities sheet in this workbook. Based on analysis by AIA research corporation for Architecture 2030, national values.			
Est. area of new State/Local Gov space per year in PA	13.7	14.4	million sq ft
Calculated based on annual floorspace estimates above. Note high growth in 2006 and 2007 based on article from American Institute of Architects (see PA_Bldg_Activities page).			
Implied Average Electricity Consumption per Square Foot Commercial Space in Pennsylvania as of 2005		10.60	kWh/yr
Implied Average Natural Gas Consumption per Square Foot Commercial Space in Pennsylvania as of 2005		34.57	kBtu/yr
Estimate based on Reference case forecast, using average intensity of all commercial buildings in PA - REVIEW OF ASSUMPTION NEEDED			

CALCULATION OF SAVINGS

	2012	2020/all	Units
New construction floorspace covered by program, annual	7	14	million sq ft
Existing building floorspace covered by program, annual	27	44	million sq ft
Energy consumption, Reference case			
Energy consumption in new commercial buildings			
Electricity	611	664	billion BTU
Natural gas	320	328	billion BTU
Total	931	991	billion BTU
Estimate based on Reference case forecast			
Energy consumption in new commercial buildings, per sq foot			
Electricity	45	46	thousand BTU
Natural gas	23	23	thousand BTU
Total	68	69	thousand BTU
Estimate based on Reference case forecast, using average intensity of all commercial buildings in PA - REVIEW OF ASSUMPTION NEEDED			

RC-2 High Performance Schools

Other Data, Assumptions, Calculations	2012	2020/all	Units
Total School Building Floorspace in Pennsylvania (million square feet)	720	780	
Estimated (see "PA_BLDG_Activities" worksheet in this workbook) based on USDOE EIA CBECS (comercial survey) data for the Mid-Atlantic region, extrapolated using DEP approach.			
Annual demolition of commercial floorspace		0.58%	
Taken from analysis by DEP, see PA_Bldg_activities sheet in this workbook. Based on analysis by AIA research corporation for Architecture 2030, national values.			
Est. area of new school building space per year in PA (million square	11.5	12.1	
Calculated based on annual floorspace estimates above. Note high growth in 2006 and 2007 based on article from American Institute of Architects (see PA_Bldg_Activities page).			
Implied Average Electricity Consumption per Square Foot school building Space in Pennsylvania as of 2005		10.60	kWh/yr
Implied Average Natural Gas Consumption per Square Foot school building Space in Pennsylvania as of 2005		34.57	kBtu/yr
Estimate based on Reference case forecast, using average intensity of all commercial buildings in PA - REVIEW OF ASSUMPTION NEEDED			

CALCULATION OF SAVINGS

	2012	2020/all	Units
New construction floorspace covered by program, annual	6	12	million sq ft
Existing building floorspace covered by program, annual	23	37	million sq ft
Energy consumption, Reference case			
Energy consumption in new school building buildings			
Electricity	514	558	billion BTU
Natural gas	269	275	billion BTU
Total	783	834	billion BTU
Estimate based on Reference case forecast			
Energy consumption in new school building buildings, per sq foot			
Electricity	45	46	thousand BTU
Natural gas	23	23	thousand BTU
Total	68	69	thousand BTU
Estimate based on Reference case forecast, using average intensity of all commercial buildings in PA - REVIEW OF ASSUMPTION NEEDED			

RC-3 High Performance Commercial Buildings (private)

Other Data, Assumptions, Calculations	2012	2020/all	Units
Inputs to/Intermediate Results of Calculation of Electricity and Gas Savings			
Total Commercial (Private) Floorspace in Pennsylvania (million square feet)	3,597	3,895	
Estimated (see "PA_BLDG_Activities" worksheet in this workbook) based on USDOE EIA CBECS (comercial survey) data for the Mid-Atlantic region, extrapolated using DEP approach.			
Annual demolition of commercial floorspace		0.58%	
Taken from analysis by DEP, see PA_Bldg_activities sheet in this workbook. Based on analysis by AIA research corporation for Architecture 2030, national values.			
Est. area of new commercial (private) space per year in PA (million square feet)	57.5	60.3	
Calculated based on annual floorspace estimates above. Note high growth in 2006 and 2007 based on article from American Institute of Architects (see PA_Bldg_Activities page).			

Implied Average Electricity Consumption per Square Foot Commercial Space in Pennsylvania as of 2005	10.60	kWh/yr
Implied Average Natural Gas Consumption per Square Foot Commercial Space in Pennsylvania as of 2005	34.57	kBtu/yr

CALCULATION OF SAVINGS

	2012	2020/all	Units
New construction floorspace covered by program, annual	29	60	million sq ft
Existing building floorspace covered by program, annual	113	185	million sq ft
Energy consumption, Reference case			
Energy consumption in new commercial buildings			
Electricity	3,690	4,008	billion BTU
Natural gas	1,932	1,979	billion BTU
Total	5,622	5,987	billion BTU
Estimate based on Reference case forecast			
Energy consumption in new commercial buildings, per sq foot			
Electricity	45	46	thousand B
Natural gas	23	23	thousand B
Total	68	69	thousand B
Estimate based on Reference case forecast			

RC-4 High Performance Homes

Other Data, Assumptions, Calculations	2012	2020/all	Units
Total Residential Housing Units in Pennsylvania	5,513,044	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.			
Implied persons per housing units in Pennsylvania (for reference only)	2.26	2.26	
Annual demolition of residential floorspace		1.43%	
Based on average lifespan of home of 70 years, placeholder estimate			
Estimated number of new residential units per year	85,901	85,701	
Calculated based on estimates above.			
Implied Average Electricity Consumption per Housing Unit in Pennsylvania as of 2005 (see Note 2)		9.90	MWh/yr
Implied Average Natural Gas Consumption per Housing Unit in Pennsylvania as of 2005 (see Note 2)		46.56	MMBtu/yr

CALCULATION OF SAVINGS

	2012	2020/all	Units
New construction housig units covered by program, annual	42,951	85,701	housing ur
Existing building housing units covered by program, annual	169,954	242,325	housing ur
Energy consumption, Reference case			
Energy consumption in new residential buildings			
Electricity	5,060	4,783	billion BTU
Natural gas	2,776	2,677	billion BTU
Total	7,836	7,460	billion BTU
Estimate based on Reference case forecast			
Energy consumption in new residential buildings, per housing unit			
Electricity	58.9	55.8	MMBTU/h
Natural gas	32.3	31.2	MMBTU/h
Total	91.2	87.0	MMBTU/h
Estimate based on Reference case forecast			

GHG Reductions:

Work Plan No.	Work Plan Name	Annual Results (2020)			Cumulative Results (2009-2020)		
		GHG Reduc-tions ($MMtCO_2e$)	Costs (Million $)	Cost-Effective ness ($/tCO_2e$)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/tCO_2e$)
	High Performance Buildings						
1	High Performance State and Local Government Buildings	1.6			6.7		
2	High Performance School Buildings	1.1			4.6		
3	High Performance Commercial (private) Buildings	5.3			22.1		
4	High Performance Homes (Residential)	11.1			50.6		
	Sub-total High Performance Buildings	**19.1**			**84.0**		

Economic Costs:
To be determined

Potential Overlap:
To be determined

Other Involved Agencies:

- DGS
- Labor & Industry
- DCED
- Department of State's State Real Estate Commission
- Public Utility Commission
- Pennsylvania Housing Finance Agency
- PA Housing and Finance Authority
- Fannie Mae
- PA Treasury
- US EPA / DOE
- PDE
- All Commonwealth Agencies

RC-5. Commissioning and Retro-commissioning

Summary: Promote the common practice of performing commissioning and retro-commissioning processes on newly constructed, renovated, and existing buildings for the purpose of ensuring optimal performance of building systems.

Goals: To be determined

Possible Vehicles: Promote the common practice of performing commissioning processes on newly constructed and/or renovated buildings for the purpose of ensuring optimal performance of building systems.

Building project teams are currently familiar with ASHRAE standards which cite building commissioning as good practice. (Guideline 0-2005)

Building Operator Training - expands existing training for building operators to include energy management training. Building operators, such as maintenance technicians, lead custodians, and plant engineers, currently have little formal training in building efficiency.

Implementation Steps: This program may be implemented through stricter municipal/state building codes. Certain tax incentives and/or credits may also be assigned to assist in full implementation.

Several mainstream certification standards also promote the practice of performing building commissioning making the activity seem more attractive.

An example of such a program is the California Governor's Green building Executive Order and AB 32 which calls for all California state buildings greater than 50,000 sq. ft. be retro-commissioned by June 30, 2013 and re-commissioned every five years. Nearly 25 RCx are at or near completion. The energy efficiency measures implemented through this program to date have a verified electricity savings of approximately 10%.

Key Assumptions: To be determined

Potential GHG Reduction: To be determined.

Work Plan No.	Work Plan Name	Annual Results (2020)			Cumulative Results (2009-2020)		
		GHG Reduc-tions ($MMtCO_2e$)	Costs (Million $)	Cost-Effectiveness ($/tCO_2e$)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/tCO_2e$)
5	Commissioning and Retro-commissioning						

Economic Cost: To be determined.

Potential Overlap:
To be determined

Other Involved Agencies: ASHRAE; Leadership in Energy and Environmental Design (LEED®) Certification; BOMA; IFMA; EPA

RC-6. Lighting

Summary: This initiative is a critical building technology that accelerates replacement of less efficient outdoor and indoor lighting systems, including maximizing use of daylighting in indoor settings. It applies to residential and commercial buildings as well as parks, street lights and parking facilities.

Actively invest in PA manufacturing, sales, green collar jobs and green building infrastructure by relamping, re-fixturing, upgrading lighting systems, windows, and control systems This would also measurably improve the pastoral and remarkable qualities of the State, the quality of light delivered, and the health and safety of residents.

Goals: The following requirements would be set:

Lighting Performance goals

- LPD .9 watt/sqft connected load as maximum for all workplaces
- (New construction effective immediately, existing by 2020, linear % each year).

Fixture performance

- LOR 70% minimum (lighting output ratio, an index of fixture effectiveness) (all new construction, all building types and for all fixture replacements).

Lamp performance (for all new lamp purchases, for all point of sale by 2015)

- 90 mean lumens/watt lamps
- Mercury not to exceed 80 picograms per lumen hour, 5 milligrams of mercury per lamp
- CRI of 85 minimum
- 92% luminance maintenance (lamp depreciation) over rated life

Controls and System Performance (new construction and existing by 2015)

- individual lighting controls for 90% of occupants
- occupancy sensors in single occupancy rooms or short time of use rooms
- commissioning of installed lighting system including controls.

Daylight (all non-residential buildings)

- 25 fc of daylight to 90% of occupied spaces (new construction and historic buildings)
- Seated views for 90% of occupants (new construction and historic buildings)
- Glazing with visible transmission over 50%, SHGC under 50% **or**
- 1.5 ratio of visible light divided by SHGC in summer (whenever replacements are made).
- Window blinds/shades to ensure daylighting and view without glare and overheating (all buildings 2015)
- Daylight responsive controls for all fixtures within 15 feet of window (all building 2012)

Exit lighting (all new construction, 2012 existing)

- Maximum 5 watts per fixture or 'face'

Site lighting (all new construction, 2012 existing)

- LPD .15 watt/sq.ft. max
- No night sky pollution (0% above 90o cutoff)
- zone occupancy controls in large parking lots.
- LED Traffic lights
- No LED billboard faces.

No/low cost Education Campaign

- Wash reflectors, lenses to maximize light output
- Install occupancy and daylight sensors, turn it off campaign
- Delamp where light levels are not needed (brighter in corridor than offices?)
- Raise or tilt the blinds and use daylight

Key Assumptions:

Assumptions and Calculations	2012	2020	Units
Residential			
Number of housing units	5,513,044	5,570,337	
Single-family	4,222,992	4,266,878	
http://pasdc.hbg.psu.edu/pasdc/whats_new/2008factsfortheweb.pdf			
Multi-family	1,290,052	1,303,459	
Fraction of Residential Electricity Consumption as Lighting		8.8%	
National average based on Residential Energy Consumption Survey data from 2001 survey (http://www.eia.doe.gov/emeu/recs/recs2001/enduse2001/enduse2001.html).			
Residential electricity consumption as lighting	5,075	5,762	GWh
Power demand of existing lamps		60.0	W
Power demand of new lamps		15.0	W
Difference between old lamp and new lamp		45.0	W
Daily hours of operation		6.0	h
Rate of uptake of high-efficiency lamps	60%	100%	
Assumed			
Lifetime		5.0	yr

Existing power intensity of lighting		14.5	lm/W
Assume incadescent bulbs http://www.ccri.edu/physics/keefe/light.htm		0.069	W/lm
New power intensity of lighting		90.0	lm/W
From workplan goals		0.011	W/lm
Energy savings	2,284	4,321	GWh
Number of high-efficiency lamps in use	23,173,824	43,847,699	lamps
Number of lamps replaced annually	10,700,156	9,462,423	lamps
Cost premium		$3.00	one-time
		$0.69	$ / lamp / year
Gross annual cost	$32	$28	$ million

Commercial

Total floorspace	5,174	5,604	million sq.ft.
Total office floorspace	1,267	1,372	million sq.ft.
Total floorspace added (new construction)	329.9	1,008.3	million sq.ft. / yr
Total office floorspace added (new construction)	52.5	160.5	million sq.ft. / yr
Fraction of Commercial Electricity Consumption as Lighting		23.1%	
National average based on Commercial Building Energy Consumption Survey data from 1999 (http://www.eia.doe.gov/emeu/cbecs/enduse_consumption/intro.html).			
Commercial electrictiy consumption as lighting	11,606	13,176	GWh
Office electricity consumption as lighting	2,842	3,226	GWh
Commercial electrictiy consumption as lighting - new construction	740.0	2,370.9	GWh
Office electricity consumption as lighting - new construction	117.8	377.5	GWh

Lighting Performance Goals

Existing lighting power density		2.0	W / sq.ft.
Proposed lighting power density		0.9	W / sq.ft.
Proposed From workplan goals			
Rate of update in existing buildings	20%	100%	
Electricity savings - existing buildings only	1,195	5,943	GWh
Electricity savings - new construction only	407.0	1,304.0	GWh
Electricity savings - total	1,602	7,247	GWh
Residual electricity use - existing buildings only	9,671	4,862	GWh
Residual electricity use - new construction only	333.0	1,066.9	GWh
Residual electricity use - total	10,004	5,929	GWh
Cost premium		0.4	$/sq ft
US DOE Energy efficiency and renewable energy website, The Business Case for Sustainable Design in Federal Facilities http://www1.eere.energy.gov/femp/sustainable/sustainable_federalfacilities.html www1.eere.energy.gov/femp/pdfs/buscase_appendixb.pdf			
conversion, google calculator		11	*sq ft / m2*
incremental cost of changing power density	**$204**	**$197**	**$ million**

Fixutre Performance Goals

Existing power intensity of lighting		60.0	lm/W
Assume incadescent bulbs http://www.ccri.edu/physics/keefe/light.htm		0.017	W/lm
New power intensity of lighting		90.0	lm/W
From workplan goals		0.011	W/lm
Rate of uptake of high-efficiency lamps	60%	100%	
Assumed			
Electricity savings - existing buildings only	1,977	1,912	GWh
Electricity savings - new construction only	135	420	GWh
Electricity savings - total	2,112	2,332	GWh
Residual electricity use - existing buildings only	7,694	2,950	GWh
Residual electricity use - new construction only	198.4	647.3	GWh
Residual electricity use - total	7,892	3,597	GWh
Cost premium		$4.00	one-time
		$0.92	$ / lamp / year
Lifetime		5.0	yr
Difference between old lamp and new lamp		19	W
Daily hours of operation		10	h / d
Number of days in use annually		261	d / yr
Existing power per lamp	*Assumed*	44	W / lamp
Existing lighting power density	*Assumed*	1.1	W / sq.ft.
Estimate of lamps in PA	129,349,494	140,090,500	lamps
Number of lamps replaced annually	25,869,899	28,018,100	lamps
Incremental cost of replacing lamps	**$103**	**$112**	**$ million**

Daylighting

Reduction in lighting energy consumption		44%	
Attachment in email from Vivian Loftness - e-BIDS Guidelines for High Performance Buidlings 2005			
Percentage of existing buildings that are historic		0.5%	by floorspace
Applicable floorspace (new construction and historic)	355.8	1,036.3	million sq.ft. / yr
Electricity savings - existing buildings only	16.93	6.49	GWh
Electricity savings - new construction only	87.28	284.80	GWh
Electricity savings - total	104.20	291.29	GWh
Residual electricity use - existing buildings only	7,677	2,943	GWh
Residual electricity use - new construction only	111.1	362.5	GWh
Residual electricity use - total	7,788	3,306	GWh
Cost premium - levelized		$0.22	$ / sq.ft.
Attachment in email from Vivian Loftness - e-BIDS Guidelines for High Performance Buidlings 2005			

Exit sign - 5 W / face

Annual savings per sign		12	kWh / sign / yr
Attachment in email from Vivian Loftness - Architect of the Capital - Emergency Lighting			
Density of signs		0.00013	signs / sq.ft.
Attachment in email from Vivian Loftness - Architect of the Capital - Emergency Lighting and http://www.aoc.gov/cc/cobs/rhob.cfm			
Rate of uptake in existing buildings	100%	100%	
Number of signs	160,068	173,712	signs
Cost of unit retrofit	*Annualized*	$4	$ / sign / yr
http://www.cmhc-schl.gc.ca/en/inpr/bude/himu/waensati/waensati_039.cfm			
Total cost of retrofit	$0.62	$0.68	$ million
Energy savings	1.92	2.08	GWh / yr

GHG Reductions: (to be determined)

Work Plan No.	Work Plan Name	Annual Results (2020)			Cumulative Results (2009-2020)		
		GHG Reduc-tions ($MMtCO_2e$)	Costs (Million $)	Cost-Effectiveness ($/$tCO_2e$)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/$tCO_2e$)
6	Re-Light PA	6.5	$199	$31	50.3	-$381	-$8

Economic Cost: To be determined

Potential Overlap: To be determined

RC-7. Re-Roof Pennsylvania

Summary: This initiative mandates standards of thermal resistance for all new roofing projects.

Goals: To be determined

Possible Vehicles:

- High reflectivity should be mandatory for all commercial buildings to minimize cooling loads.
- Thermal resistance standards (R/U factors) should be raised to minimize both cooling and heating loads.
- Green roofs should be promoted with incentives for benefits to cooling, carbon sequestration and storm water management.
- Skylights for daylighting should be mandatory for roof replacements in buildings sized less than four stories with deep sections that result in windowless spaces for occupants.
- Shading or insulation from renewable energy systems as secondary goals should be explored.

Potential GHG Reduction: To be determined

Work Plan No.	Work Plan Name	Annual Results (2020)			Cumulative Results (2009-2020)		
		GHG Reduc-tions ($MMtCO_2e$)	Costs (Million $)	Cost-Effectiveness ($/tCO_2e$)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/tCO_2e$)
7	Re-Roof Pennsylvania						

Economic Cost: To be determined

Potential Overlap: To be determined

RC-8. Appliance Standards

Summary: This initiative establishes efficiency standards for appliances and devices selected by the American Council of Energy Efficiency Engineers according to the following criteria[3]:

- A standard would achieve significant energy savings
- The standard would be cost-effective for the purchaser
- Products that meet the standard are readily available
- The state can implement the standard at low cost
- Federal preemptions do not apply

Goals

Per ACEEE (2009)[4], set standards for the following appliances:

Residential (Single Family and Multi-Family)

- HVAC equipment
- Water heating
- Refrigeration
- Appliances
- Furnace fan
- Plug load

Commercial

- HVAC
- Water heating
- Refrigeration
- Office equipment
- Appliances

Information Sources:

ACEEE (2009) is the primary information source for this quantification.

Key Assumptions:

[3] ACEEE (2006) Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards www.aceee.org/pubs/a062.htm

[4] ACEEE (2009.04) Potential for Energy Efficient, Demand Response, and Onsite Solar Energy in Pennsylvania http://www.aceee.org/pubs/e093.htm

Other Data and Assumptions	2012	2020	Units
Average annual cost for state appliance efficiency standards *ACEEE (2009) Table 18*		$92.54	$ million
Number of years before full penetration		**10**	yr
Percent penetration by year	30%	100%	
Percent replacement	100%	10%	
Annual gross cost	$39	$129	$ million
Annual cost savings	$55	$184	$ million
Net cost of program	-$17	-$55	$ million
Energy savings			
Electricity	660	2,200	GWh / yr
Average annual electricity savings for state appliance efficiency standards *ACEEE (2009) Table 16*		1,581	GWh / yr

GHG Reductions:

Work Plan No.	Work Plan Name	Annual Results (2020)			Cumulative Results (2009-2020)		
		GHG Reduc-tions ($MMtCO_2e$)	Costs (Million $)	Cost-Effectiveness ($/tCO$_2$e)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/tCO$_2$e)
8	Appliance Standards	1.0	-$55	-$55	6.5	-$238	-$36

Economic Cost: see above

Possible Overlap: To be determined

RC-9. Distributed Energy – Geothermal Heating and Cooling Appliance Standards

Summary: Pennsylvania's rich water resources are not used to any extent as a strategic approach to reducing energy consumption and carbon emissions. Water, however, is a superb energy carrier and, in geothermal heating and cooling, allows us to tap the renewable energy stored in the earth just below frost line. According to the US Department of Energy, geothermal heating and cooling can save 30-60% over conventional combustion-based heating and electric chillers or air conditioners and can reduce carbon emissions by a similar amount.

All of the historic towns and cities in the Commonwealth were founded on top of and adjacent to water resources. Development of community-based (district) geothermal infrastructure (e.g., Warren PA municipal geothermal system) will support economic redevelopment while simultaneously reducing energy consumption and lowering carbon emissions. Where district systems are not feasible, geothermal outfitting or retrofitting of individual buildings will provide similar benefits, for the near term and for a sustainable future.

Goals: To be determined

Possible Vehicles:

- Map/identify potential sources of water: unused old wells that would still be productive, water-filled mine tunnels, surface water, recycled gray water, sewage treatment plant effluent, retention basin storm water, harvested rainwater, and water from a subsurface aquifer
    - Consider ways in which overload on existing stormwater network might be eased by district HVAC loops
    - Consider ways in which co-located process water within a community might be integrated into district water loop system
        - Develop/assist in developing community water resource database/diagrams
- Loan/matching program for community-based infrastructure
- Formation of regional/community electronic cooperatives to support infrastructure development (based on current USDA program that supports rural electric cooperatives for installation of geothermal systems).

Potential GHG Reductions: To be determined

Work Plan No.	Work Plan Name	Annual Results (2020)			Cumulative Results (2009-2020)		
		GHG Reduc-tions ($MMtCO_2e$)	Costs (Million $)	Cost-Effectiveness ($/tCO_2e$)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/tCO_2e$)
RC-9	Distributed Energy – Geothermal Heating and Cooling						

GHG savings for office building
Based on http://www.ornl.gov/sci/btc/pdfs/com_ghpoverview.pdf as provided by Nina Baird

For office building 25,000 square foot

	Conventional gas furnace and air conditioning		Best available GSHP	
Heating / Cooling Efficiency	11.0 EER / 90% AFUE		25.8 EER / 4.9 COP	
Annual Cooling Energy Use	37,700	kWh	20400	kWh
Annual Heating Energy Use	1970	therms	10900	kWh
Annual Cooling GHG emisisons	17.2	t CO2e	9.3	t CO2e
Annual Heating GHG emissions	10.4	t CO2e	5.0	t CO2e
Total GHG emissions	27.6	t CO2e	14.3	t CO2e

One therm = 100000 BTU

Savings per sq ft 0.000532467 t CO2e / sq ft

	Annual GHG savings (MMTCO2e)
Fraction of PA floorspace	
5%	0.15
10%	0.30
25%	0.75
50%	1.49

Economic Cost: To be determined

Potential Overlap:

DCED Renewable Energy Program: Geothermal and Wind Projects (Jan. 2009)

Potential Complimentarily: Potential integration with DOE/Oak Ridge National Laboratory's interest in extending/funding infrastructure for geothermal heating and cooling.

Other Involved Agencies:
Department of Community & Economic Development

RC-10. Demand Side Management (DSM) - Gas

Summary: Replacing or upgrading inefficient household appliance that utilize natural gas with more energy efficient models.

Goals:
Residential sector: 36% reductions from reference case natural gas demand in 2025
Commercial sector: 28% reductions from reference case natural gas demand in 2025

Value from Pennsylvania: Energy Efficiency, Demand Response and On-Site Solar Potential. American Council for Energy Efficient Economy (ACEEE) 2009. See page 19 for residential and page 26 for commercial. This represents the cost-effective potential. Note that these savings are greater than the amount identified as ACEEE analysis as achievable by the set of policies analyzed. The policy analysis led to savings of 15% natural gas in 2025, for residential and commercial combined (see page 46). This workplan assumptions imply stronger policies than those identified by ACEEE (mostly standards and utility programs)

Possible Vehicles:

1. Air Sealing and Insulation (10-40% annual energy savings)
   - Pennsylvanians using NG for heating use about 600 therms per household.
   - Assumptions: By air sealing & insulation, consumers could probably easily save ¼ of this. ½ of total heating-household may be able to participate.

2. Increase furnace and boiler efficiency from x to >95 AFUE .
   - Nationwide and in PA, about 50% of homes use NG for heating.
   - The minimum allowed AFUE rating for a non-condensing, fossil-fueled, warm-air furnace is 78%; the minimum rating for a fossil-fueled boiler is 80%; and the minimum rating for a gas-fueled steam boiler is 75%.
   - Although older furnace and boiler systems had efficiencies in the range of 56%-70%, modern conventional heating systems can achieve efficiencies as high as 97%, converting nearly all the fuel to useful heat for your home. Energy efficiency upgrades and a new high-efficiency heating system can often cut your fuel bills and your furnace's pollution output in half. Upgrading your furnace or boiler from 56% to 90% efficiency in an average cold-climate house will save 1.5 tons of carbon dioxide emissions each year if you heat with gas, or 2.5 tons if you heat with oil. (DOE, Energy Savers)
   - Therefore consumers could expect to see a range in energy savings from 15 to 50% "heating season" improvements (depending on age and efficiency of equipment being replaced). Using the same assumptions for #1 above (150 therms per household), this measure may expect to see similar or higher MMTCO2e results (for Natural Gas). However, the CO2 advantage for "air sealing and insulating" is due to the additional electric savings from the summer air conditioning season.

3. Solar domestic hot water heaters

- Heating water accounts for 14-25% of total household energy consumption. Solar water heaters can provide 85% of DHW needs.
- The calculated avoided emissions below are a very rough approximation of savings for this measure. Assumptions:
    - Approximately 130 Therms per household saved ¼ of the total households (heating & non-heating customers) may have adequate solar exposure for solar thermal applications.

4. Instantaneous hot water heaters with an Energy Factor > .80

- For homes that use 41 gallons or less of hot water daily, demand water heaters can be 24% to 34% more energy efficient than conventional storage tank water heaters.
- They can be 8% to 14% more energy efficient for homes that use a lot of hot water – around 86 gallons per day. You can achieve even greater energy savings of 27% to 50% if you install a demand water heater at each hot water outlet.
- Assumptions:
    - Approximately 150 therms per household for water heating. This measure may save 25% or 38 therms /household.
    - 1/2 of the total households (heating & non-heating customers) may be able to participate. 0.50(2,062,693+182,959) = 1,122,826 households.

5. Use ENERGY STAR front-loading washing machines.

- Most ENERGY STAR qualified washers extract more water from clothes during the spin cycle. This reduces the drying time and saves energy and wear and tear on your clothes.
- ENERGY STAR qualified clothes washers clean clothes using 50% less energy than standard washers (including energy used in the washing process, including machine energy, water heating energy, and dryer energy).
- Assumptions
    - Natural gas clothes dryers may use around 42 therms per year. Assume front loading washing machines will save 25% of the drying energy or 10.5 therms per household.
    - Assume ½ of total households may be able to participate, 0.50(2,062,693+182,959)= 1,122,826 households.

6. Pilot Lights

- Standing pilot lights may use over 7 therms (700,000 btus) of gas per appliance, if left on year round.
- Removing old appliances that have pilot lights on full time with appliances that have electronic (intermittent) ignitions could create savings.
- Some people feel that standing pilot lights on appliances are gradually becoming the exception, instead of the rule, with new appliances on the market using electronic ignitions. However, even though electronic ignition pilot lights are becoming increasingly common, without legislation, standing pilots may not disappear by 2025 because they are cheaper to manufacturer, and the appliance is sometimes viewed as

solution to emergency heat when the electric goes out, because they do not need electric to start.

- Assumptions:
    - Assume that 1/4 of the natural gas heating households has at least one appliance with a standing pilot light.

- This initiative would institute public benefit funds for investment in residential, commercial and industrial energy efficiency and renewable energy programs through third-party administrators.

Implementation Steps:

- Market driven
- Encourage natural gas utilities to engage in consumer education initiatives regarding these efficient technologies.
- Potential opportunity for appliance efficiency legislation

Key Assumptions:

Other Data, Assumptions, Calculations		2012	2020/all	Units
Analysis				
RCI Gas Sales Covered	*(from inventory)*	414,382	415,519	Billion Btu
Residential		254,778	247,865	Billion Btu
Commercial		159,604	167,655	Billion Btu
Industrial		0	0	Billion Btu
Conversion Factor: Million Btu per Thousand Cubic feet			1.03	MMBtu/Mcf

Cost of Saved Energy:
Residential Sector: $5.29
Commercial Sector: $3.28
Source: ACEEE 2009 report, see above

Table 6. Residential Natural Gas Efficiency Potential and Costs by End-Use (2025)

End-Use	Savings (MMBtu)	Savings relative to Reference Case (%)	% of Total Efficiency Potential	Levelized Cost of Saved Energy ($/MMBtu)
Single Family Gas	**74,070**	**35%**	**100%**	**$5.01**
Space Heating	47,540	22%	64%	$3.70
Water Heating	16,840	8%	23%	$7.90
Cooking	920	0.4%	1%	$9.34
Existing	65,300	30%	88%	$4.86
New Homes	8,770	4%	12%	$4.82
Multifamily Gas	**9,620**	**46%**	**100%**	**$7.47**
Space Heating	4,350	20%	45%	$6.86
Water Heating	3,360	16%	35%	$3.04
Cooking	100	0.5%	1%	$11.71
Existing	7,810	37%	81%	$5.28
New Homes	1,810	9%	19%	$9.40
All Residential Gas	**83,690**	**36%**	**100%**	**$5.29**
Space Heating	51,890	22%	62%	$3.96
Water Heating	20,200	9%	24%	$7.09
Cooking	1,010	0.4%	1%	$9.57
Existing	73,10	31%	87%	$4.91
New Homes	10,590	5%	13%	$5.61

Table 10. Commercial Natural Gas Efficiency Potential and Costs by End-Use

End-Use	Savings (MMBtu)	Savings over Reference Case (%)	% of Efficiency Potential	Weighted Levelized Cost of Saved Energy ($/MMBtu)
HVAC equipment & controls	26,200,000	15%	54%	$ 2.39
Building shell	2,000,000	1%	4%	$ 0.30
Water Heating	5,400,000	3%	11%	$ 6.27
Cooking	4,000,000	2%	8%	$ 1.11
Other	7,200,000	4%	15%	$ 8.43
Existing Buildings	44,700,000	26%	93%	$ 3.19
New Buildings	3,500,000	2%	7%	$ 2.45
Total Gas	48,200,000	28%	100%	$ 3.28

Source: ACEEE 2009

Avoided Cost of Natural Gas:
All sectors: $8.40

GHG Reductions and Economic Costs:

Work Plan No.	Work Plan Name	Annual Results (2020)			Cumulative Results (2009-2020)		
		GHG Reduc-tions ($MMtCO_2e$)	Costs (Million $)	Cost-Effectiveness ($/tCO_2e$)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/tCO_2e$)
10	DSM - Natural Gas	7.2	-$42	-$6	39.8	-$293	-$7

Other Involved Agencies: N/A

Cost: To be determined

Potential Overlap:

- Reduced Load Growth Work Plan
- HB 2200 Work Plan
- Appliance Standards Work Plan
- Alternative Energy Investment Act Work Plan
- Others

Other Involved Agencies: PA Utilities Commission

RC-11. B5 Bioheat Initiative

Summary: This initiative aims to blend all heating oil sold in PA with a 5% blend of biodiesel. Bioheat is the industry term for heating oil that is blended with biodiesel. Heating oil is essentially the same as diesel with some difference in sulfur content and a colorant added to deter tax evasion through its potential use as a transportation fuel. The use of Bioheat has been proven to reduce maintenance concerns and burns cleaner than conventional heating oil. Significant, positive experience utilizing Bioheat exists. Numerous customers throughout southcentral and southeastern PA have been using Bioheat in their furnaces and boilers for the past few years. The state Department of General Services also has Bioheat on contract for state agencies.

Goal: Replace 5% of heating oil with biodiesel.

Implementation Steps: Representatives from the Northeast Regional Biomass Program, including PA, have been working in association with oil heat industry representatives to promote greater awareness and acceptance of Bioheat among both customers and distributors. Further discussions should occur between the Departments of Public Welfare, the Office of Consumer Advocate and the DEP so that all are aware of potential economic considerations in implementing such an initiative. Implementation would require legislative action. Adequate injection blending facilities would need to be in place around the state to support this measure.

Potential GHG Reduction: To be determined

Work Plan No.	Work Plan Name	Annual Results (2020)			Cumulative Results (2009-2020)		
		GHG Reduc-tions ($MMtCO_2e$)	Costs (Million $)	Cost-Effectiveness ($/tCO_2e$)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/tCO_2e$)
RC-11	B5 Bioheat Initiative	0.3	$112	$329	4.6	$1,163	$253

Economic Cost: To be determined

Potential Overlap:

- Biofuels Investment and In-State Production Act

Other Involved Agencies: Department of Welfare

Projected Heating Oil Consumption and Associated B5 Bioheat Requirements							
Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	
#2 Heating Oil	929,363,000	909,673,787	890,401,704	871,537,914	853,073,766	835,000,795	
Biodiesel for B5 Bioheat	46,468,150	45,483,689	44,520,085	43,576,896	42,653,688	41,750,040	
Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	
#2 Heating Oil	817,310,712	799,995,406	783,046,937	766,457,534	750,219,588	734,325,655	
Biodiesel for B5 Bioheat	40,865,536	39,999,770	39,152,347	38,322,877	37,510,979	36,716,283	
Year	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
#2 Heating Oil	718,768,446	703,540,828	688,635,818	674,046,581	659,766,427	645,788,808	632,107,315
Biodiesel for B5 Bioheat	35,938,422	35,177,041	34,431,791	33,702,329	32,988,321	32,289,440	31,605,366

Baseline consumption data for PA is from EIA's Petroleum Navigator (http://tonto.eia.doe.gov/dnav/pet/pet_cons_prim_dcu_SPA_a.htm).

Diesel* Production GHG Lifecycle Assessment (LCA) (Includes Production-Related GHGs & Finished Fuel Carbon Content, Expressed as CO2e/Gallon)						
	CO2	CH4	N2O	Total CO2e	Carbon Content (Lbs CO2/Gal.)	Total LCA (Lbs. CO2e/Gal.)
G/MMBTU	20,142	109.1	0.343			
MMBTU per Gallon	0.1284	0.1284	0.1284			
GWP	1	23	296			
CO2e	2586.23	322.19	13.04	6.44	22.38	28.82

`Biomass-Based Diesel' means renewable fuel that is biodiesel as defined in section 312(f) of the Energy Policy Act of 1992 (42 U.S.C. 13220(f)) and that has lifecycle greenhouse gas emissions, as determined by the Administrator, after notice and opportunity for comment, that are at least 50% less than the baseline lifecycle greenhouse gas emissions. Notwithstanding the preceding sentence, renewable fuel derived from co-processing biomass with a petroleum feedstock shall be advanced biofuel if it meets the requirements of subparagraph (B), but is not biomass-based diesel.

RC-12. Utility Incentives for Electricity Demand-Side Management

Summary: Amplify the future impacts of utility demand-side management programs by removing the financial disincentives to program success which are characteristic of traditional ratemaking practices, developing rate decoupling and related rate redesigns and/or positive performance incentives to spur higher levels of energy savings and GHG reductions.

Goals: To be determined

Possible Vehicles: This strategy builds upon the energy efficiency and conservation program of Act 129 / House Bill 2200 which mandates the introduction of utility demand-side management (DSM) programs. States which have the most successful energy efficiency programs, i.e., those which achieve superior rates of electric energy savings, tend on the whole to have adopted incentives for utilities.[5] An analysis of state-level data from across the nation indicates a pronounced relationship between the use of incentives and reductions in annual electricity sales. States which were the most aggressive, employing both performance incentives as well as rate decoupling, achieved savings rates 3.2-fold higher than the scale achieved in states with no DSM incentives (such as Pennsylvania). The following table illustrates this relationship.

Table 1
Relationship Between Reduced Statewide Electricity Sales And Use of Utility DSM Incentives[6]

State Approach to Electric Efficiency Incentives	Average Incremental Savings in Electricity Use
No incentives	0.19%
Performance incentives only	0.34%
Rate decoupling only	0.34%
Both performance incentives and decoupling	0.60%

Traditional ratemaking impedes full utilization of energy efficiency opportunities by eroding utility revenues as these programs are implemented. The linkage between efficiency, energy sales and utility financial margins arises from rate designs which make utility profits dependent upon sales volume, and which fail to provide returns on efficiency investments comparable to those realized by investments in traditional capacity.

Mechanisms for addressing the financial impacts to utilities include performance target incentives, shared savings incentives, and rate-of-return adders, as well as rate decoupling to address both lost margin recovery and the throughput incentive. In-depth discussions of these

[5] For simplicity's sake, the term 'incentives' is used here to refer to both rate decoupling and positive performance incentive mechanisms. It does not include basic program cost recovery which is already allowed under Act 129.
[6] The figures in this table were developed using the data on statewide electricity sales and electric utility incentives published in *The 2008 State Energy Efficiency Scorecard*, American Council for an Energy Efficient Economy, October 2008, pages 9-17.

issues and regulatory approaches can be found in the references cited at the end of this workplan.

The need to reformulate utility incentives and disincentives is gaining increasing scrutiny in states across the nation that are seeking more effective strategies for accelerating energy efficiency utilization. Each of the top performing states now use some form of incentives for DSM. This trend is on the rise. Today, more than half the states (29) use some form of financial incentives for DSM. As state investments in energy efficiency programs increase, the attention to appropriate price signals for DSM is likewise growing.

Assumptions: To be determined

Potential GHG Reduction:

Work Plan No.	Work Plan Name	Annual Results (2020)			Cumulative Results (2009-2020)		
		GHG Reduc-tions ($MMtCO_2e$)	Costs (Million $)	Cost-Effectiveness ($/tCO_2e$)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/tCO_2e$)
12	DSM - Electricity	Options below are imported from Electricity Subcommittee for review by Res/Com Subcommittee					
	Reduced Load Growth	7.0	-$447	-$62	25.0	-$933	-$38
	Stabilize Load Growth	11.0	-$690	-$62	37.0	-$1,408	-$38

Economic Cost: To be determined

Implementation Steps:

- Enabling legislation is needed
- The PUC will need to determine the specific form of incentives to be used

Potential Overlap:

- Reduced Load Growth

Other Involved Agencies: PUC, state legislature

SOURCES OF FURTHER INFORMATION

American Council for an Energy Efficient Economy, *the 2008 State Energy Efficiency Scorecard*, October 2008.

American Council for an Energy Efficient Economy, Aligning *Utility Interests with Energy Efficiency Objectives: A Review of Recent Efforts at Decoupling and Performance Incentives*, October 2006.

ICF International, *Utility Performance Standards, Oversight, and Cost Recovery,* Briefing for the Maryland Energy Administration, September 2007.

National Association of Regulatory Utility Commissioners, *Decoupling for Electric & Gas Utilities: Frequently Asked Questions*, September 2007.

Regulatory Assistance Project, *Energy Efficiency Policy Toolkit*, January 2007.

Regulatory Assistance Project, *Overview of Utility Incentives*, Presentation to the New Mexico Public Regulation Commission, July 2008.

Regulatory Assistance Project, *Revenue Decoupling Standards and Criteria*, Report to the Minnesota Public Utilities Commission, June 2008.

USEPA and USDOE, *Aligning Utility Incentives with Investment in Energy Efficiency, A Resource of the National Action Plan for Energy Efficiency*, November 2007.

FOLLOWING WORKPLANS IMPORTED FROM ELECTRICITY SUBCOMMITTEE FOR REVIEW BY RES/COMM SUBCOMMITTEE

Electricity 2. Reduced Load Growth Work Plan for Potential GHG Reduction Measure

Strategy Name: Reduced Load Growth

Lead Staff Contact: Joe Sherrick (717-772-8944)

Summary: This initiative identifies the carbon emissions benefits associated with curbing the rate of growth in electricity consumption in PA. This strategy builds upon the conservation requirements of Act 129 of 2008, which requires 1.0% and 2.0% reductions in electricity consumption from 2010, by 2011 and 2013, respectively. Act 129 also requires the PUC to assess the potential for additional cost-effective reductions. The scenario developed in this work plan builds upon Act 129 by requiring biennial reductions in electricity consumption equal to 1.5% per period (.75% per year), beginning in 2015 and carrying through 2025. The energy efficiency investments under this workplan therefore reach 8.25% of load by the end of 2025 (11 years at 0.75% per year). These reductions are calculated from the previous years estimated consumption.

Please note that this analysis does not include the very modest consumption and associated system losses from municipalities that are service providers or the rural electric cooperatives.

Other Involved Agencies: PUC

Possible New Measure(s): A report from the American Council for an Energy Efficient Economy (ACEEE) has been drafted for the PUC and DEP and provides the cost and supply data for the workplan. See: http://www.aceee.org/pubs/e093.htm

Potential Workplan Costs and GHG Reductions: DRAFT (RESULTS HAVE NOT BEEN THOROUGHLY REVIEWED BY ELECTRICITY SUBCOMMITTEE)

Table 2.1 DRAFT Workplan Costs and GHG Results ($2007)

Annual Results (2020)			Cumulative Results (2009-2020)		
GHG Reductions	Costs	Cost-Effectiveness	GHG Reductions	Costs	Cost-Effectiveness
($MMtCO_2e$)	(Million $)	($/tCO_2e$)	($MMtCO_2e$)	(NPV, Million $)	($/tCO_2e$)
7.2	$ (447)	$ (62)	24.8	$ (933)	$ (38)

The net present value of the cost savings resulting from implementation of this workplan from 2009-2020 is estimated at approximately $930 million. The cost savings and emissions reductions are additional to Act 129. The cost savings are more modest compared to Act 129

because the workplan is not implemented until 2015 and has reached efficiency investments equal to 4.5% of sales by 2020. These distant cash flows are then discounted back to the present time.

Notes: The cost estimates (colums 3 and 6) are incremental costs of energy efficient measures including capital cost, operating and maintenance, and labor, above baseline measure costs. The cost estimates are calculated as the costs less avoided energy expenditures. Also, the difference between the 2020 cost effectiveness (column 4) and the cumulative cost effectiveness (column 7) is due, in part, to the effects of discounting the net cash flows over the analysis period of 2009-2020.

- Cost to DEP - None
- Cost to the Commonwealth – Act 129 requires the PUC to hire a program administrator to oversee this process and to provide assessments as to the cost-effectiveness and level of additional reductions that may be possible within PA. The cost for this service is unknown.
- Cost to regulated community or consumer – Not quantified, as of yet. Short-term capital costs may be experienced, depending on a host of issues but short and long-term savings are anticipated. Requires detailed analysis. The ACEEE et al (2009) report assumes that a portion of the cost of each efficiency measure may be spent by the end user and that utility incentives comprise the balance of the initial costs.[7]
- Are there Federal funds available? – Federal funding is not required nor is it available at this time. Limited assistance may be available through the U.S. DOE State Energy Plan but this would most likely be limited to policy analysis and possibly technical support.
- Do these costs fund other programs? No. Any costs are expected to result in changes to consumer behavior.

Quantification Approach and Assumptions

- Reductions from the workplan are assumed to begin in 2015 and implemented at 0.75% per year through 2025 to achieve a rate of 8.25% by 2025.
- Efficiency investments installed under the workplan with expected lifetimes shorter than the planning period are expected to be replaced with equipment with similar cost and performance characteristics. Efficient equipment is cost effective to install initially, and it is assumed that it will be replaced at the end of its life. Thus, the electricity reductions in 2025 under the workplan are held steady through 2030.
- **For cost and other assumptions see Electricity #1—Act 129.**

Implementation Steps: The following, and other, considerations should be examined as policy tools to support this measure:

- Act 129 provides the PUC with the necessary authority to require additional cost-effective reductions in electricity consumption.
- An assessment of electricity consumption reduction potential is necessary to determine if the requirements suggested within this work plan conform to Act 129 requisites. Such a study is underway by ACEEE.

[7] Source: ACEEE et al. (2009). Energy Efficiency, Demand Response, and Onsite Solar Energy Potential in Pennsylvania. April. P. 29. page 48. http://www.aceee.org/pubs/e093.htm

- A legislative amendment to the AEPS establishing a dedicated market share for energy efficiency credits (new tier or carve out) might facilitate achieving this reduction measure by rewarding over-compliance and providing a cost-effective manner to achieve greater reductions.
- Require electric distribution companies to invest in demand side response initiatives, including rebates to consumers.
- Require that all cost-effective supply side and demand side response initiatives have been identified and acted upon before approvals for new generation are granted. In a February 5, 2007 press release http://www.aceee.org/press/e072pr.htm ACEEE reported that, "States from Texas to Vermont are finding energy efficiency resources available at less than 4 cents per kilowatt-hour, compared to the expected cost of power from new plants of 5 to 10 cents."
- Implementing advanced building standards for the commercial, institutional, state and municipal government sectors that establish minimum green building practices and energy efficiency standards.
- Coupled with the advanced building standard, consider a requirement that all commercial, institutional, state and municipal government buildings perform annual benchmarking, similar to that established by the U.S. EPA that documents the gains or losses in energy consumption on a per square foot basis, based on the type of activity occurring. This information is publicly accessible. It educates and encourages building owners and operators to achieve higher performance.
- Work with neighboring states on establishing regional efficiency standards for appliances and electronics where none currently exist or where minimum standards are less than optimal.
- Establish an aggressive phase-out of incandescent lights and/or establish a pricing/tax structure that preferentially treats lighting with a higher lumens to watts ratio.
- Rate decoupling

Potential Overlap:

- Act 129 Work Plan
- Stabilized Load Growth Work Plan
- Industry #2: Industrial Natural Gas and Electricity Best Management Practices

Electricity 3. Stabilized Load Growth Work Plan for Potential GHG Reduction Measure

Strategy Name: Stabilized Load Growth

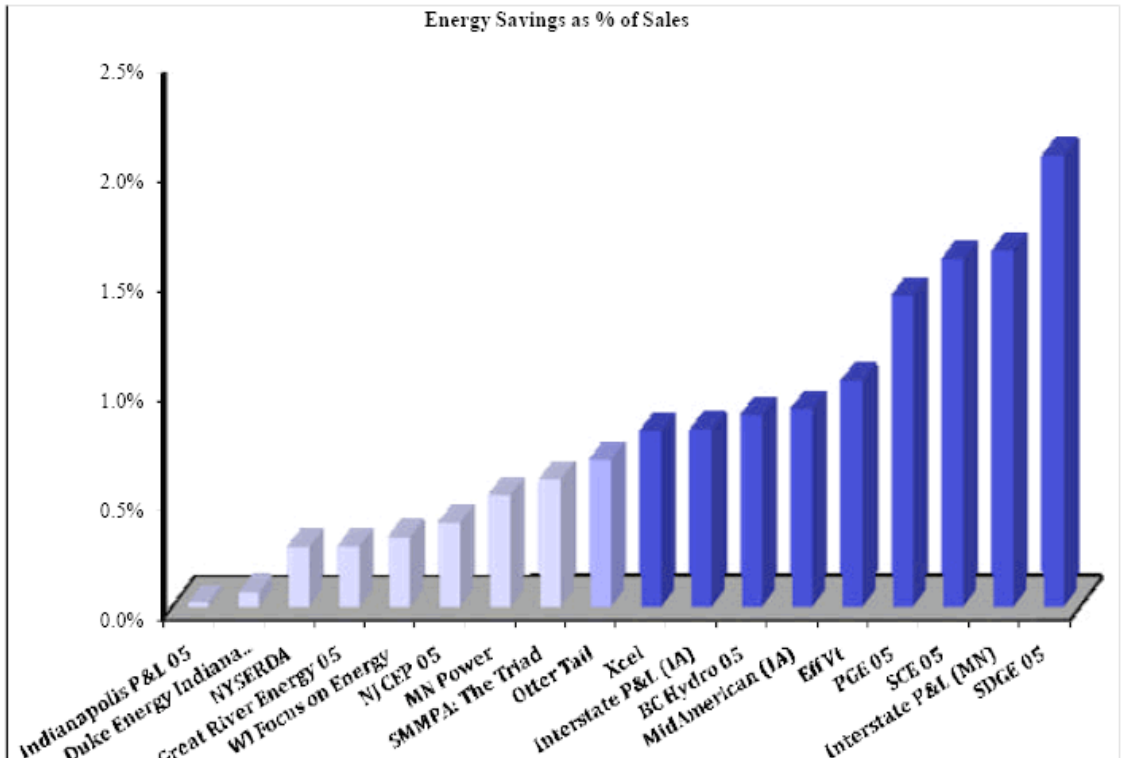
Lead Staff Contact: Joe Sherrick (717-772-8944)

Summary: This measure builds upon the very modest reductions required via Act 129 of 2008. Act 129 requires reductions in consumption of 1.0% by 2011 and 2.0% by 2013, measured against 2010 consumption. The Stabilized Load Growth (SLG) scenario further investigates the potential impact of annual consumption reductions of 0.75% per year in the period 2014 through the end of 2017 followed by a rate of consumption that is held static from 2018 through 2025. Historical annual load growth in PA has been approximately 1.5% per year which is what would be reduced in the 2018 to 2025 period. The annual reductions in 2018-2025 would be based on the previous year's consumption figures and would allow a subsequent one year "true-up" for electricity distribution companies to achieve stabilized consumption levels.
Please note that this analysis does not include the very modest consumption and associated system losses from municipalities that are service providers or the rural electric cooperatives.

The demand reductions under this workplan can be compared to those occurring in other jurisdictions. The following figure shows incremental energy savings as a percent of sales for surveyed utilities across the country.[8] Several states are mandating energy savings akin to the higher performers in Figure 3.1. Iowa's PUC has requested utilities file plans to achieve savings equal to 1.4% of sales, up from 0.8 currently. New York has a target of 15% savings by 2015, which was started in 2007 equating to new energy efficiency investments equal to nearly 2% per year.

[8] Source: Quantec. (2008). Assessment of Energy and Capacity Savings Potential in Iowa Prepared for The Iowa Utility Association. February 15. p. I7-I10 No web link available.

Figure 3.1: Energy Savings as % of First Year Sales



All of the seven organizations with above median DSM spending rates also achieved above median energy savings as a percentage of sales: SDG&E has the highest energy savings as a percentage of sales at about 2.1%, three times the median of 0.7%, while Xcel Energy, Interstate P&L (IA), BC Hydro, MidAmerican (IA) and Efficiency VT achieved savings rates of about 0.9% of sales; PG&E, SCE, and Interstate P&L (MN) achieved savings rates of about 1.5%.

Other Involved Agencies: PUC

Possible New Measure(s): A report from the American Council for an Energy Efficient Economy (ACEEE) has been drafted for the PUC and DEP and provides the cost and supply data for the workplan. See: http://www.aceee.org/pubs/e093.htm

Potential Workplan Costs and GHG Reductions: DRAFT (RESULTS HAVE NOT BEEN THOROUGHLY REVIEWED BY ELECTRICITY SUBCOMMITTEE)

Table 3.1 DRAFT Workplan Costs and GHG Results ($2007)

Annual Results (2020)			Cumulative Results (2009-2020)		
GHG Reductions ($MMtCO_2e$)	Costs (Million $)	Cost-Effectiveness ($/tCO_2e$)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/tCO_2e$)
11.0	$ (690)	$ (62)	37.1	$ (1,408)	$ (38)

The net present value of the cost savings resulting from implementation of this workplan from 2009-2020 is estimated at approximately $ 1.4 billion. The cost savings and emissions reductions are additional to Act 129.

Notes: The cost estimates (colums 3 and 6) are incremental costs of energy efficient measures including capital cost, operating and maintenance, and labor, above baseline measure costs. The cost estimates are calculated as the costs less avoided energy expenditures. Also, the difference between the 2020 cost effectiveness (column 4) and the cumulative cost effectiveness (column 7) is due, in part, to the effects of discounting the net cash flows over the analysis period of 2009-2020.

- Cost to DEP - None
- Cost to the Commonwealth – Act 129 requires the PUC to hire a program administrator to oversee this process and to provide assessments as to the cost-effectiveness and level of additional reductions that may be possible within PA. The cost for this service is unknown. It is further assumed that the PUC would perform similar services to oversee the reductions that may be required if such a Stabilized Load Growth initiative were to be implemented.
- Cost to regulated community or consumer – Not quantified, as of yet. Short-term capital costs may be experienced, depending on a host of issues but short and long-term savings are anticipated. Requires detailed analysis. The ACEEE et al (2009) report assumes that a portion of the cost of each efficiency measure may be spent by the end user and that utility incentives comprise the balance of the initial costs.[9]
- Are there Federal funds available? – Federal funding is not required nor is it available at this time. Limited assistance may be available through the U.S. DOE State Energy Plan but this would most likely be limited to policy analysis and possibly technical support.
- Do these costs fund other programs? No. Any costs are expected to result in changes to consumer behavior.
- Are cost savings realized from this initiative? Cost savings are expected but this does require a detailed analysis. The assumption is that reductions will only be required such that can be sustained through cost-effective measures.

Quantification Approach and Assumptions

- Reductions from the workplan are additional to those under Act 129, and are assumed to begin in at the start of 2014 and are implemented through the end of 2017 at 0.75% of sales per year (for a total of 3% of sales). This reduction is expected to reduce Pennsylvania's load growth rate from ~1.60%/year to about 0.85%/year. Then required reductions are equal to the load growth rate from the previous year from 2018 through 2025. By 2020, expected reductions are equal to approximately 7% of sales, and by 2025 reductions amount to 15% of sales.

- Efficiency investments installed under the workplan with expected lifetimes shorter than the planning period are expected to be replaced with equipment with similar cost and performance characteristics. Efficient equipment is cost effective to install initially, and

[9] Source: ACEEE et al. (2009). Energy Efficiency, Demand Response, and Onsite Solar Energy Potential in Pennsylvania. April. P. 29. page 48. http://www.aceee.org/pubs/e093.htm

it is assumed that it will be replaced at the end of its life. Thus, the electricity reductions in 2025 under the workplan are held steady through 2030.

- For cost and other assumptions see Electricity #1—Act 129.

Additional Assumptions:

- Adequate cost-effective reductions exist or will exist, through year 2025, to provide the approximate 27 million MWh of curtailment, as compared to the unchecked, projected rate of growth in electricity consumption. The ACEEE report identifies cost effective efficiency supplies in Table 3.2 of approximately 61 million MWh that significantly exceed the reductions projected under this workplan.

Table 3.2: Summary of Cost-Effective Energy Efficiency Potential by Sector (2025)[10]

Sector	Electricity	
	GWh	%*
Residential	~19,000	10%
Commercial (non-CHP)	~18,000	9%
Industrial (non-CHP)	~13,000	7%
Combined Heat & Power	~11,000	6%
	~61,000	33%

- No reductions would be required if not supported through an analysis of cost-effective measures.

Implementation Steps: The following, and other, considerations should be examined as policy tools to support this measure:

- Act 129 provides the PUC with the necessary authority to require additional cost-effective reductions in electricity consumption.
- The PUC may have the authority within Act 129 of 2008 that would facilitate realization of this reduction measure.
- A legislative amendment to the AEPS establishing a dedicated market share for energy efficiency credits (new tier or carve out) might facilitate achieving this reduction measure by rewarding over-compliance and providing a cost-effective manner to achieve greater reductions.
- Require electric distribution companies to invest in demand side response initiatives, including rebates to consumers.
- Require that all cost-effective supply side and demand side measures have been identified and acted upon before approvals for new generation are granted. In a February 5, 2007 press release http://www.aceee.org/press/e072pr.htm ACEEE reported that, "States from Texas to Vermont are finding energy efficiency resources available at less than 4 cents per kilowatt-hour, compared to the expected cost of power from new plants of 5 to 10 cents."

[10] [10] Source: ACEEE et al. (2009). Energy Efficiency, Demand Response, and Onsite Solar Energy Potential in Pennsylvania. April. P. 14. page 48. http://www.aceee.org/pubs/e093.htm

- Implementing advanced building standards for the commercial, institutional, state and municipal government sectors that establish minimum green building practices and energy efficiency standards.
- Coupled with the advanced building standard, consider a requirement that all commercial, institutional, state and municipal government buildings perform annual benchmarking, similar to that established by the U.S. EPA that documents the gains or losses in energy consumption on a per square foot basis, based on the type of activity occurring. This information is publicly accessible. It educates and encourages building owners and operators to achieve higher performance.
- Work with neighboring states on establishing regional efficiency standards for appliances and electronics where none currently exist or where minimum standards are less than optimal.
- Establish an aggressive phase-out of incandescent lights and/or establish a pricing/tax structure that preferentially treats lighting with a higher lumens to watts ratio.
- Rate decoupling

Potential Overlap:

- Act 129 Work Plan
- Reduced Load Growth Work Plan
- Industry #2: Industrial Natural Gas and Electricity Best Management Practices

RC-13. Demand-Side Management – Water Conservation

Summary: This initiative supports water conservation and yields energy savings. To achieve 25% potable water conservation, enact new utility incentives, conservation credits, smart metering and education programs. The energy impact of water use is estimated as 4% of all electricity consumption nationwide.

Goals:

- Reduce per capita water use by 20% statewide by 2015
- Achieve a 10% overall water savings by 2025.

Possible Vehicles:

Potential GHG Reduction: To be determined

Work Plan No.	Work Plan Name	Annual Results (2020)			Cumulative Results (2009-2020)		
		GHG Reduc-tions ($MMtCO_2e$)	Costs (Million $)	Cost-Effectiveness ($/tCO_2e$)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/tCO_2e$)
13	Demand Side Management (DSM) – Water Conservation						

Economic Cost: To be determined

Potential Overlap: To be determined

Other Involved Agencies:

RC-14. Department of General Services (DGS) – Initiative to Reduce Energy Use by State Government

Need workplan

Require state to use lifecycle accounting for purchases

WORKPLANS THAT ARE NOT QUANTIFIED IN THIS ANALYSIS

Adaptive Building Reuse

Summary: This initiative encourages adaptive building reuse and sourcing of regionally available building materials.

Possible New Measure(s):

By promoting the reuse of historic and existing buildings, the following reductions occur: GHG, landfill waste, new building materials and new infrastructure. The sourcing of regionally available building materials results in similar reductions.

Implementation Steps:

Other Involved Agencies:

PA values embodied energy in building materials, including historic structures

Summary: Promotion of the use of regionally sourced and manufactured building products as well as historic/existing structures.

Other Involved Agencies: Department of Community and Economic Development, Small Business Administration, Local/Regional Economic Development Companies, Pennsylvania Technical Assistance Program, Industrial Resource Centers, Department of General Services COSTAR, PA Historic and Museum Commission, County Historic Societies, PA Historic Landmark Foundation, Young Preservationists of Pittsburgh/PA

Possible Vehicles: Promotion of the use of regionally sourced and manufactured building products as well as historic/existing structures.

The notion of supporting regional communities and economies is becoming widespread in "buy-local" campaigns. Included in that notion is the procurement of building product materials within one's own region. This practice supports local businesses and manufacturers by strengthening demand for local industries instead of relying on shipping from other regions. The buy-local ideology can also reduce the amount of embodied energy in building materials by reducing the distance of travel for those materials. Locally sourced building materials are also a major component of the Leadership in Energy and Environmental Design (LEED®) Rating System.

Included with the concept of embodied energy is the practice of reusing existing structures such as historic buildings. By repurposing buildings, builders are reducing GHG and embodied energy by reducing new infrastructure; reducing landfill waste; and the use of many new building materials typically consumed in the new construction of a building.

Many State and Municipal governments are already promoting the practice of utilizing regional materials within public buildings through legislation.

Potential GHG Reduction: Unknown at this time; can be determined from shipping emission reductions and the reduced amount of daily commuters due to urban density.

Economic Cost: The economic cost of such a program would be easily obtainable through past and present purchasing orders/shipping orders related to the building industry. The great economic impact would be more obvious in the amount of revenue earned through regional sales by Pennsylvania manufacturers. A cost may also be associated with a PA preferred product label/database to be administered by staff.

Implementation Steps: Implementation of this program includes State and Municipal legislation such as that outlined above. Certain tax credits may also be structured and applied to building projects which strive to utilize regionally sourced materials and historic/existing structures.

Potential Overlap:

- Building Performance Labels that Reflect Actual Utility Usage
- High Performance Pennsylvania Building Standards
- High Performance Building Standards for Existing Commonwealth of Pa Buildings

Sustainability Education Programs

Summary: This initiative supports sustainable education programs in primary and secondary schools and post-secondary, college and university programs.

- Introduce or augment environmental/ energy curricula in schools.
- Introduce energy efficiency at community colleges and trade schools.
- Provide training and certification for builders and contractors and building code officials working in energy code enforcement.
- Provide continuing education for design professionals, including architects, engineers, developers, contractors, urban planners and realtors.
- Educate consumers with information programs on efficiency and conservation targeted to reduction and wise use of energy.
- Ensure municipalities coordinate and share resources.

Possible Vehicles:

The establishment of Turn it Off PA! campaign eliminates unnecessary equipment operating hours and appliance loads. This can reduce residential and commercial energy consumption by 25% without loss in quality of life. The limitations are education and needed hardware for equipment. Heating, cooling, lighting and appliance energy conservation and plug loads would be the focus of a multi-stage statewide campaign.