Re-Roof Pennsylvania

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

Goals: Replace 75 percent of commercial building roof areas with more energy-efficient roofing at the time of regular replacement. (See Table 1 for roof types.)

Table 1. Portfolio of Roof Replacements for Commercial Buildings

Types of Roofs	2015	2020
Light colored, super insulated	65%	50%
Green roofs with super insulation	5%	10%
Solar PV roofs with super insulation	2.5%	15%

Implementation:

- Green roofs should be promoted with incentives for benefits to cooling, carbon sequestration, and storm water management.
- Skylights for day-lighting should be encouraged for roof replacements in buildings lower 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.
- Consider adopting the **International Green Construction Code (IgCC) in 2015**, that incorporates commercial performance standards consistent with goals and commercial building elements listed above. Support educational and training sessions about the IgCC provided by professional associations and providers.
- Alternatively, amend the Pennsylvania Uniform Construction Code (UCC) so high reflectivity is mandatory for all commercial buildings to minimize cooling loads.
- In addition, adopt latest version of International Construction Code so thermal resistance standards (R/U factors) minimize both cooling and heating loads.
- Support the financial feasibility of solar roof systems.
- Recycle funding of Renewable Energy Program and extend The Alternative and Clean Energy (ACE) program.

Assumptions:

- Only commercial buildings.
- All public and private.
- 75 percent are less than 4 stories; roof is 25 percent of floor space.
- 20–25-year roof replacement on commercial buildings, but many roofs in PA have not been replaced regularly recently so there is pent-up need for replacement; assume 5 percent roof replacement a year until 2030.
- Replace with light-colored (75 percent dark now, 15 percent cooling energy savings with light colored roofs, no cost delta).
- Replace with light-colored and super-insulated R40 (10 percent heating energy savings and 20 percent cooling energy savings).
- AEPS requirements increase every year and will jump in 2015/2016. SRECs may increase in value at that point, making solar more financially feasible.
-
- Equip solar photovoltaic (PV) roofs with super insulation (10 percent heating and cooling energy savings, distributed power generation PA GHG savings)

Table 2. Key Data and Assumptions

Key Data and Assumptions, Year 2020		
Incremental Cost of Roof Replacement (relative to regular roof replacement)		
Upgrade from R-11 to R-30 roof insulation[1]	0.08	$/sq. ft. roof ($2010)
Light colored, super insulated[2]	1.07	$/sq. ft. roof ($2010)
Green roofs with super insulation[3]	10.89	$/sq. ft. roof ($2010)
Solar PV roofs with super insulation[4]	82.80	$/sq. ft. roof ($2010)
Energy Savings from Roof Replacement		
Light colored, super insulated		
Heating[5]	0.1	
Cooling[6]	0.113	
Green roofs with super insulation		
Heating[5]	0.1	
Cooling[6]	0.48	
Solar PV roofs with super insulation		
Heating[5]	0.1	
Cooling[7]	0.113	
Electricity capacity	12	W/sq.ft. roof
Capacity factor[5]	0.13	
Electricity generation	13.67	kWh/sq.ft. roof
Avoided Electricity Cost	**130**	**$/MWh**
Avoided Natural Gas Cost	**4.61**	**$/MMBtu**

[1]ACEEE (2009) Table B-10

[2]e-BIDS Guidelines for High Performance Buildings 2005 cites $0.89/sq. ft. for light-colored membrane; no reference to super insulation

[3]Dirksen (email from Vivian Loftness) and ACEEE (2009)

[4]Implied from ACEEE (2009) p. 227

[5]Assumption

[6]e-BIDS Guidelines for High Performance Buildings 2005; not PA-specific

[7]Assume same as light colored

Potential GHG Reduction:

Table 3. Estimated GHG Reductions and Cost-effectiveness

Work Plan Name	Annual Results (2020)			Cumulative Results (2013-2020)		
	GHG Reductions ($MMtCO_2e$)	Costs (Million $)	Cost-Effectiveness ($/tCO_2e$)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/tCO_2e$)
Re-Roof Pennsylvania	0.8	$1,110	$1,412	2.4	$2,786	$1,168
Light-colored materials	0.2	$0	-$1	0.7	$25	$36
Green roofs	0.1	$81	$775	0.3	$155	$587
PV roof	0.5	$1,030	$2,068	1.4	$2,259	$1,579

Economic Cost: See Table 3

Potential Overlap: Overlaps with AEPS and High Performance Buildings.

Subcommittee Recommendations

This action plan has three alternative considerations - light colored highly insulated roofs with excellent payback and very manageable costs; green roofs with high costs but measurable benefits in reducing heat island effect and offering carbon sequestration as well as major aesthetic advantages; and photovoltaic roofs with the highest cost but obvious benefits as a distributed energy source. All three should be considered, in addition to solar hot water systems, to advance the States competitiveness.

Buildings have a natural cycle for re-roofing in the order of 20-25 years, meaning that 4-5 percent of PA roofs are in the process of selecting new roof materials. The differences in these three alternatives make the selection of a single alternative difficult.

Roofs have a natural cycle of replacement and hence are excellent opportunities for innovation that achieves GHG gains or new energy sources.

The opportunity to replace roofs with integral solar photovoltaic and solar domestic hot water systems is a growth area for both manufacturing and installers. PA should take a lead in this area. At a very minimum, well-insulated, highly reflective roofs (need not be light colored) should be mandated.