Re-Light Pennsylvania

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, streetlights, and parking facilities.
Actively invest in PA manufacturing, sales, green collar jobs, and green building infrastructure by relamping, re-fixturing, and 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~~Implementation:
Propose e~~E~~stablishment of the following goals in the Commonwealth:

Lighting Performance goals

- Lighting power density (LPD) 0.9 watt/sq.ft. connected load as maximum for all workplaces.
- New construction effective immediately; existing construction by 2020, with a linear percentage increase in performance each year.

Fixture Performance

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

Lamp Performance (for all new lamp purchases, for all points 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 (color rendering index) of 85 minimum.
- 92 percent luminance maintenance (lamp depreciation) over rated life.

Controls and System Performance (new construction by 2015; existing buildings by 2020)

- Individual lighting controls for 90 percent 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 foot candle (fc) of daylight to 90 percent of occupied spaces (new construction and historic buildings).
- Seated daylight access for 90 percent of occupants (new construction and historic buildings).
- Glazing with visible transmission over 50 percent, solar heat gain coefficient (SHGC) under 50 percent 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 (new construction by 2015; existing buildings by 2020).
- Daylight-responsive controls for all fixtures within 15 feet of window (new construction by 2015; existing buildings by 2020).

Exit Lighting (all new construction by 2015; existing buildings by 2020)

- Maximum 5 watts per fixture or "face."

Site Lighting (all new construction by 2015; existing buildings by 2020)

- LPD 0.15 watt/sq.ft. max.
- No night sky pollution (0 percent above 90° cutoff).
- Zone-occupancy controls in large parking lots.
- Light-emitting diode (LED) traffic lights.
- No LED billboard faces.

No- or Low-Cost Education Campaign

- Wash reflectors, lenses to maximize light output.
- Install occupancy and daylight sensors.
- Promote the Turn It Off campaign.
- Delamp where light levels are not needed.
- Raise or tilt the blinds and use daylight.

Key Assumptions and Calculations:

Assumptions and Calculations	2013	2020	Units
Residential			
Number of housing units	5,520,197	5,570,337	
Single-family	4,228,471	4,266,878	
http://pasdc.hbg.psu.edu/pasdc/whats_new/2008factsfortheweb.pdf			
Multi-family	1,291,726	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	5,010	5,336	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	66%	95%	
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
		0.011	W/lm
Energy savings	2,818	4,002	GWh
Number of high-efficiency lamps in use	28,596,115	40,607,603	lamps
Number of lamps replaced annually	11,645,045	8,485,363	lamps
Cost premium		$3.44	one-time
		$0.79	$ / lamp / year
Gross annual cost	$40	$29	$ million
Emissions avoided	1.9	2.8	$MMtCO_2e$
Net annual cost	-$327	-$492	$ million

Commercial

Lighting Performance Goals

Existing lighting power density		2.0	W / sq.ft.
Proposed lighting power density		0.9	W / sq.ft.
Rate of update in existing buildings	30%	100%	
Electricity savings - existing buildings only	1,739	5,338	GWh
Electricity savings - new construction only	325	785	GWh
Electricity savings - total	2,064	6,122	GWh
Residual electricity use - existing buildings only	9,392	5,794	GWh
Residual electricity use - new construction only	266	642	GWh
Residual electricity use - total	9,658	6,435	GWh
Cost premium		$0.36	$/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		11	sq ft / m2
Gross cost of changing power density	**$179**	**$179**	**$ million**
Emissions avoided (stand alone)	1.4	4.2	$MMtCO_2e$
Net cost of changing power density	**-$90**	**-$618**	**$ million**

Fixture 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
		0.011	W/lm
Rate of uptake of high-efficiency lamps in existing buildings	66%	95%	
Assumed			
Electricity savings - existing buildings only	2,432	2,098	GWh
Electricity savings - new construction only	71	261	GWh
Electricity savings - total	2,503	2,359	GWh
Residual electricity use - existing buildings only	6,960	3,696	GWh
Residual electricity use - new construction only	195.2	380.5	GWh
Residual electricity use - total	7,155	4,076	GWh
Cost premium (4-ft. 32 W T8)	*one-time*	$2.99	$ / lamp
		$0.69	$ / 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	125,363,629	125,363,629	lamps
Number of lamps replaced annually	25,072,726	25,072,726	lamps
Gross cost of replacing lamps	**$75**	**$75**	**$ million**
As stand alone			
Electricity savings - existing buildings only	2,980	4,186	GWh
Electricity savings - new construction only	148	475	GWh
Electricity savings - total	3,128	4,661	GWh
Emissions avoided	2	3	$MMtCO_2e$
Net cost of replacing lamps	**-$251**	**-$232**	**$ million**

Daylighting

Reduction in lighting energy consumption		44%	
Percentage of existing buildings that are historic		0.5%	by floorspace
Applicable floorspace (new construction and historic)	77.2	76.4	million sq.ft. / yr
Cost premium - levelized		$0.22	$ / sq.ft.
Cost premium	$16.92	$16.74	$ million
As stand-alone			
Electricity savings - existing buildings only	119	274	GWh
Electricity savings - new construction only	260	628	GWh
Electricity savings - total	379	901	GWh
Emissions avoided (stand alone)	0	1	$MMtCO_2e$
Net cost	-$32.39	-$100.57	

Controls and System Performance

Reduction in lighting energy consumption		19%	
Rate of uptake in existing buildings	25%	100%	
Cost premium for new construction		$0.25	$ / sq.ft.

e-BIDS Guidelines for High Performance Buildings 2005
Estimate in document includes ballasts, lamps, etc. Assume 25% of cost is for controls.

Life of measure (life of building)		50	yrs
Levelized incremental cost		$0.01	$ / sq.ft. / yr.
Cost of retrofit		$0.90	$ / sq.ft.

e-BIDS Guidelines for High Performance Buildings 2005
Estimate in document includes ballasts, lamps, etc. Assume 25% of cost is for controls.

Life of measure (remaining life of building)		25	yrs
Levelized cost of retrofit		$0.06	$ / sq.ft. / yr.
Cost premium	$80.79	$320.96	$ million

As stand alone			
Electricity savings - existing buildings only	529	2,115	GWh
Electricity savings - new construction only	112	271	GWh
Electricity savings - total	641	2,386	GWh
Emissions avoided (stand alone)	0	2	$MMtCO_2e$
Net cost	-$2.68	$10.34	$ million
Site Lighting			
Number of vehicles in Pennsylvania	9,610,595	9,697,888	vehicles
Bureau of Transportation Statistics			
Ratio of parking spaces to vehicles		9	spaces / vehicle
Eligible parking lot area	*Assumed*	25%	
Area of parking lots		150	sq.ft. / space
Existing lighting intensity in parking lots	*See Note 3*	0.29	W / sq.ft.
Proposed lighting intensity in parking lots		0.15	W / sq.ft.
Annual hours in operation	*Assumed*	2,920	h / yr
Rate of participation	100%	100%	
Area of parking lot with efficient lighting	3,244	3,273	million sq.ft.
Area of parking lot with efficient lighting (new)	4	4	million sq.ft.
Energy savings	1,307	1,319	GWh / yr
Cost premium - levelized		$0.05	$ / sq.ft.
Gross cost	$0.21	$0.18	$ million
Emissions reduced	1	1	$MMtCO_2e$
Net cost	-$169.92	-$171.49	$ million
Exit sign - 5 W / face			
Annual savings per sign		114	kWh / sign / yr
Density of signs		0.00013	signs / sq.ft.
Rate of uptake in existing buildings	100%	100%	
Number of signs	155,089	155,121	signs
Cost of unit retrofit	*Annualized*	$4	$ / sign / yr
Total cost of retrofit	$0.61	$0.61	$ million
Energy savings	17.66	17.67	GWh / yr
Emissions reduced	0.01	0.01	$MMtCO_2e$
Net cost	-$1.69	-$1.69	$ million

GHG Reductions:

Table 1. Estimated GHG Reductions and Cost-effectiveness

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$)**
10.3	-$1,486	-$64	71.1	-$8,153	-$145

Economic Cost:

See Table 1, above.

Potential Overlap:

- High Performance Buildings Work Plans
- Energy Efficient Appliances

Subcommittee Comments: