The University of New Hampshire

Meeting Campus Emissions Requirements with Landfill Gas as Primary Fuel for Central Heating Plant

IDEA CampusEnergy2018

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Meeting Campus Emissions Requirements with Landfill Gas as Primary Fuel for CHP

- UNH Durham – Flagship Campus of USNH
  - Founded in 1866
  - 1,766 acres
  - 16,000 students
  - Land, Sea, and Space Grant College
  - 6,000,000 square feet of maintained building space
  - Provides all building heat and domestic hot water
  - Provides approximately 85-90% of campus electricity

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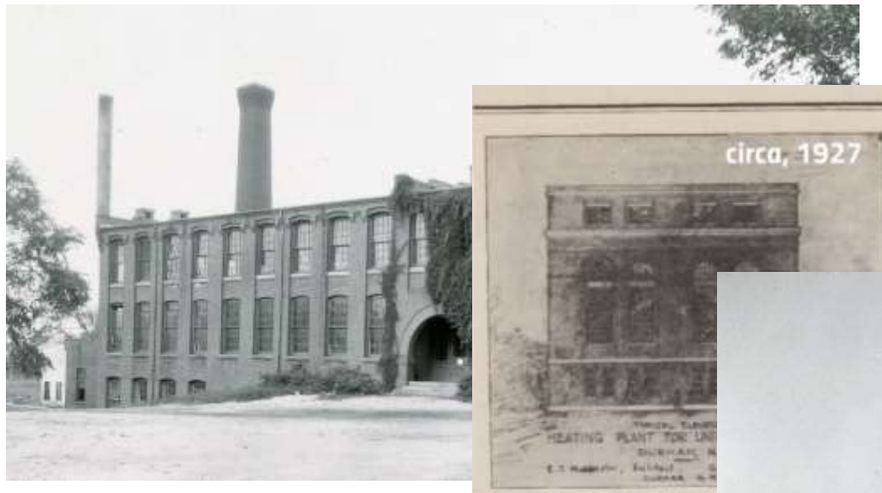
- Originally operated coal-fired Central Heating Plant
  - Initial power house designed 1911
  - New heating plant built in 1927
- Converted to residual oil firing in late 1940s
- Natural gas arrived on Durham campus in 1992



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UNH Energy Initiatives over Time

- 1970s – Energy Management
- 1980s
  - Added back pressure turbine
  - Steam conversion to distributed heating/hot water
- 1990s
  - Lighting efficiency upgrades
  - New construction standards
  - Natural gas added to campus utility systems
- 2000s
  - Combined Heat and Power Plant (2004), $28M
  - Philbrook Chiller Plant
  - Landfill Gas to Energy Project (ECOLine project 2007)

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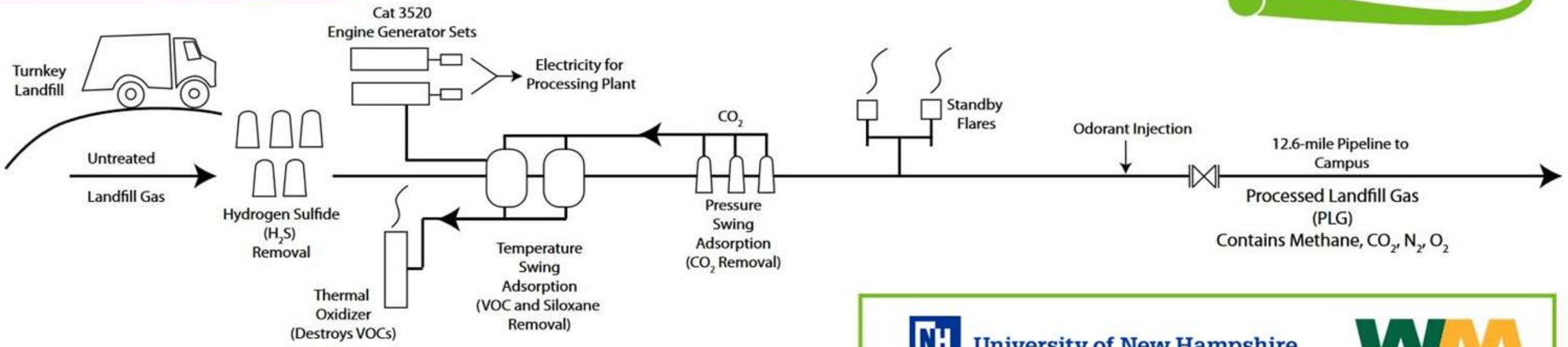
ECOLine Project

- Project approval and pipeline construction started in 2007
- Landfill Gas Processing Facility construction started in 2008
- PLFG delivered to Durham campus in March 2009
- First University to use landfill gas as primary energy source

UNH Rochester Processing Plant



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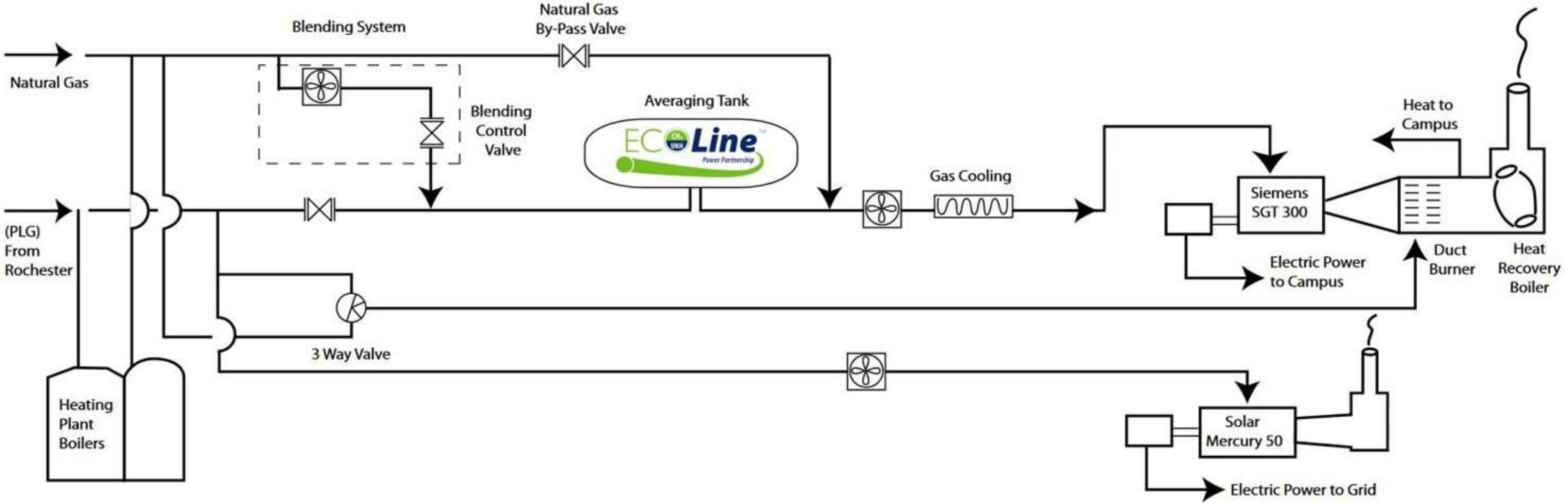
UNH Durham Co-Gen Plant



- What's the Deal with PLFG?
  - Produced as landfill materials decompose
  - Lower btu value than Natural Gas (~50% CH_4 vs. 96% CH_4)
  - WM Turnkey Landfill producing more LFG than WM could use
    - WM flaring 6,000 scfm at project design (growing to 12,000 scfm)
- Air permitting a critical path item

What have been the operational challenges UNH has faced to date?

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- Variable raw gas quantity delivered to LFGTE Facility
  - Design based on 7,500 scfm (future forecast of 12,000 scfm)
  - Current average quantity ~4,000 scfm
- Variable raw gas quality
  - Initial design was for 400 ppm TRS (spikes > 1,500 ppm)
  - Exceedances of short term SO_2 NAAQS when flaring raw gas
  - State agency air permit implications
  - Increased O&M expenses (i.e. replace sulfur removal media at shorter intervals)

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- Maintaining gas quality and quantity as delivered to Durham campus
  - Wobbe Index
  - Methane content
  - Upset conditions due to weather or operations
- Fluctuating campus demand
- LFG production impacted by seasonality and changing waste disposal trends
- Coordination of 6 independent operations

What have been the impacts to UNH from moving away from oil to PLFG/NG?

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UNH Historical Emissions (Tons/Year)

Year	PM	SO_2	NOx	CO	VOC	TOTAL
2016	18.0	9.5	30.9	20.1	6.0	84.4
2015	17.0	15.7	37.7	33.2	16.7	120.2
2014	16.7	18.7	35.9	94.1	18.9	184.3
2013	15.0	12.7	34.4	95.8	17.4	175.2
2012	17.7	10.6	36.0	127.3	18.5	210.0
2011	19.1	13.3	40.0	111.4	19.9	203.8
2010	14.3	19.1	39.7	91.3	10.2	174.7
2009	**25.7**	**75.6**	**60.7**	**133.5**	**33.7**	**331.6**
2008	13.9	37.0	29.7	63.0	14.0	157.7
2007	13.2	53.9	49.5	42.8	10.8	170.2
2006	**14.2**	**159.9**	**49.3**	**18.5**	**4.7**	**246.6**
2005	18.6	258.2	68.1	10.7	1.5	357.1
2004	19.0	263.2	68.5	10.4	1.4	362.5
2003	20.3	282.3	73.4	11.1	1.4	388.5
2002	16.4	227.2	60.6	10.2	1.3	315.7
2001	17.6	244.1	64.1	10.3	1.3	337.4
2000	18.5	257.0	66.9	10.4	2.2	355.1
1999	18.0	249.2	62.8	8.4	1.9	340.3
1998	15.5	216.0	58.2	10.4	1.9	302.0
1997	17.9	206.2	51.1	14.6	2.3	292.1
1996	18.2	252.0	67.1	7.8	5.4	350.5

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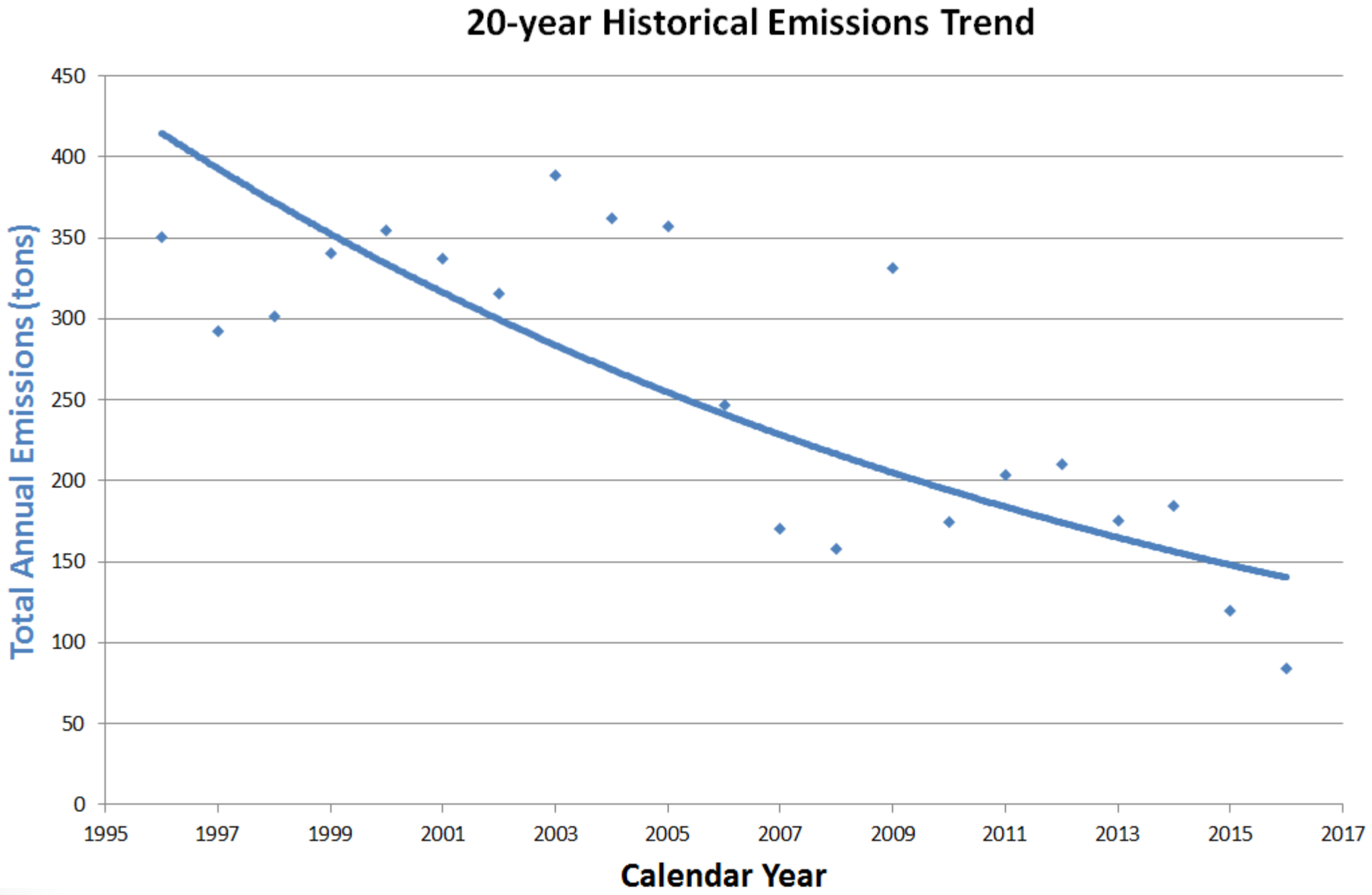

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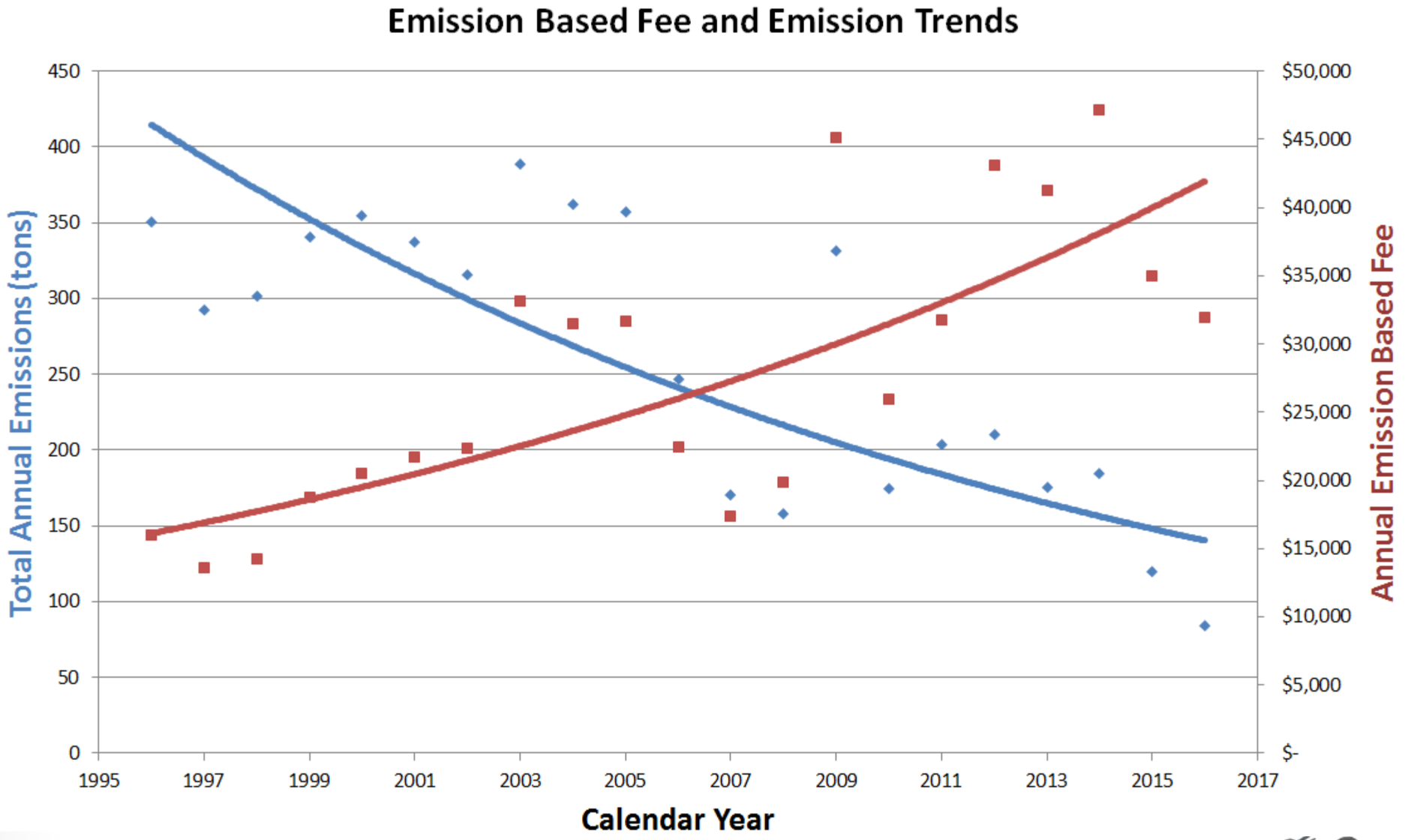

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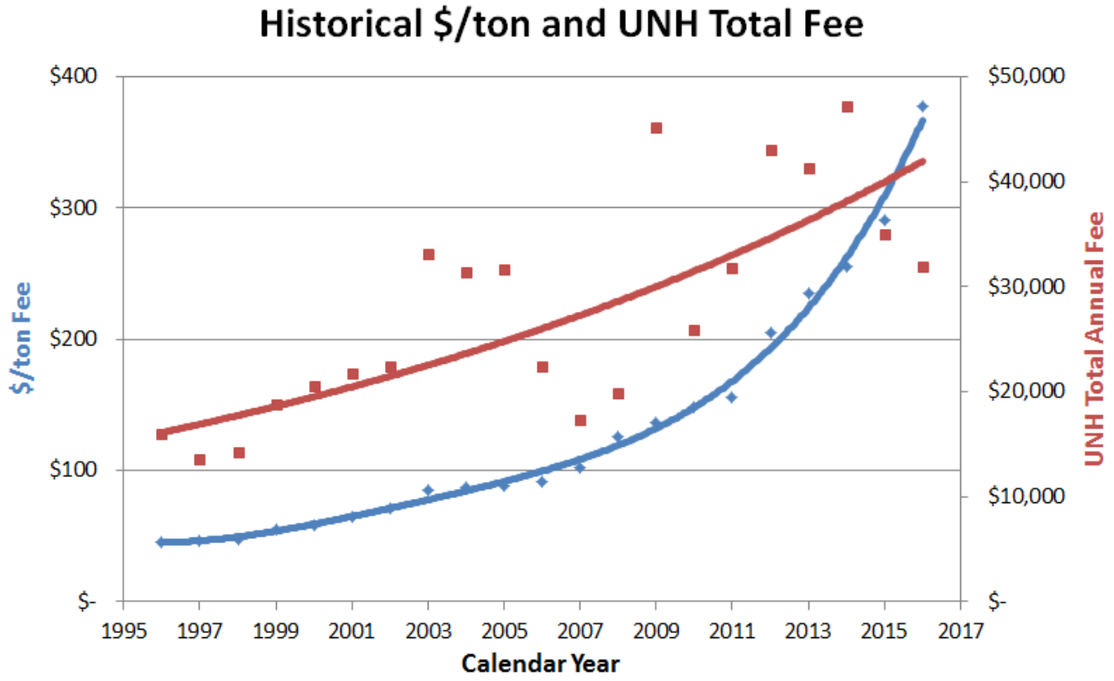
Aside decreasing its environmental impact, why are reducing emissions important to UNH?

Year	ton/year	$/ton	cost/year
2016	84.4	$377.85	$31,902
2015	120.2	$291.13	$34,994
2014	184.3	$255.84	$47,160
2013	175.2	$235.50	$41,250
2012	210.0	$205.27	$43,101
2011	203.8	$156.05	$31,801
2010	174.7	$148.60	$25,954
2009	331.6	$136.15	$45,147
2008	157.7	$125.85	$19,842
2007	170.2	$102.04	$17,362
2006	246.6	$90.95	$22,429
2005	357.1	$88.61	$31,644
2004	362.5	$86.75	$31,443
2003	388.5	$85.37	$33,165
2002	315.7	$70.80	$22,352
2001	337.4	$64.33	$21,707
2000	355.1	$57.65	$20,472
1999	340.3	$55.17	$18,772
1998	302.0	$47.25	$14,270
1997	292.1	$46.64	$13,623
1996	350.5	$45.66	$16,004

If UNH did not reduce actual emissions over past 20 years, 2016 EBF would be: 350.5 tons X $377.85/ton = $132,436.43!



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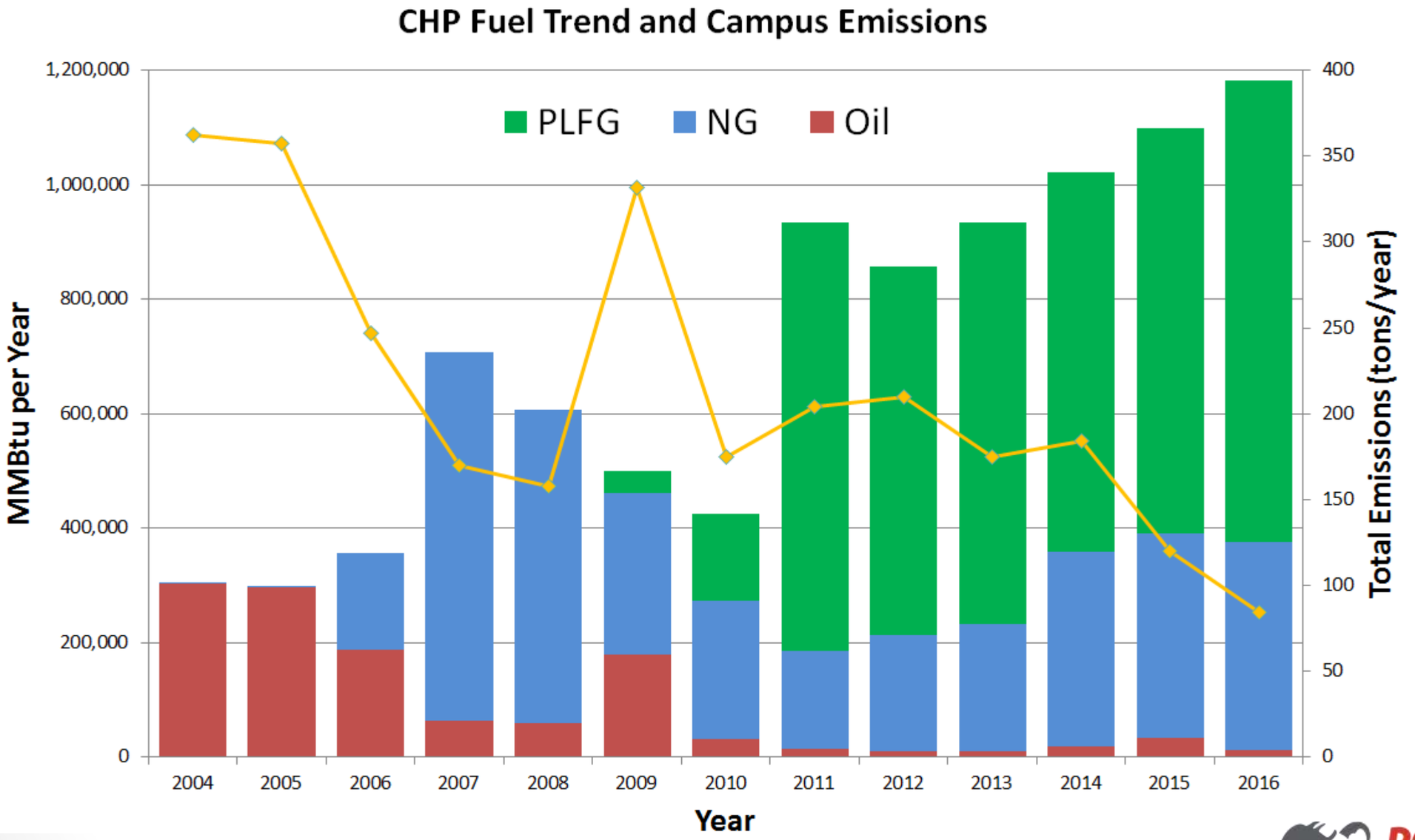

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Some notable results of UNH's efforts:

- AASHE STARS Platinum Rating (one of only three schools in U.S.)
- EPA Award: 2009 Project of the Year – Landfill Methane Outreach Program (LMOP)
- Inclusion on Sierra Club's "Cool Schools" list since 2010
- 2008 "Lean and Green" award from Business NH Magazine
- US News and World Report's "top-ten eco-friendly colleges" in 2012
- Top grade in the 2008, 2009, and 2010 Sustainable Endowments Institute College Sustainability Report Cards
- WildCAP – Helps UNH move towards WildCAP goals of 50% GHG reduction from 2001 baseline by 2020.


Questions?
Thank You!