University-based Greenhouse Gas Inventorying and Mitigation

A Case Study of the University Park Campus of Penn State University

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Penn State University

- Issues of Scale
- Inventory and Calculator
- Mitigation Planning
- Lessons Learned
- Where do we go from here?

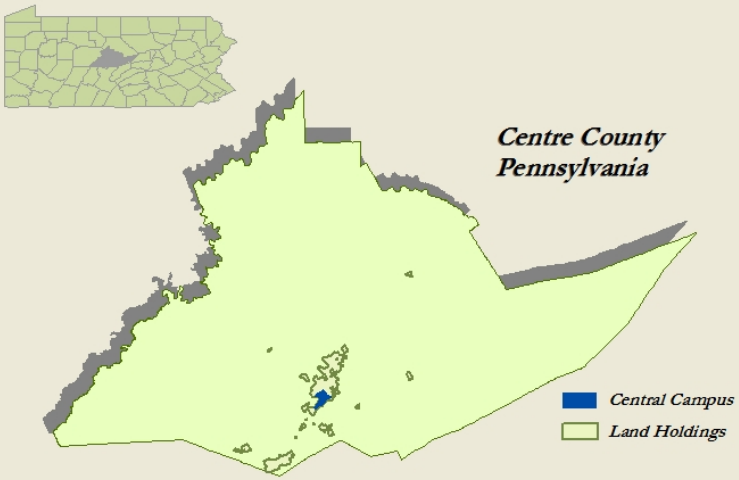
Across the Globe, Around the Corner

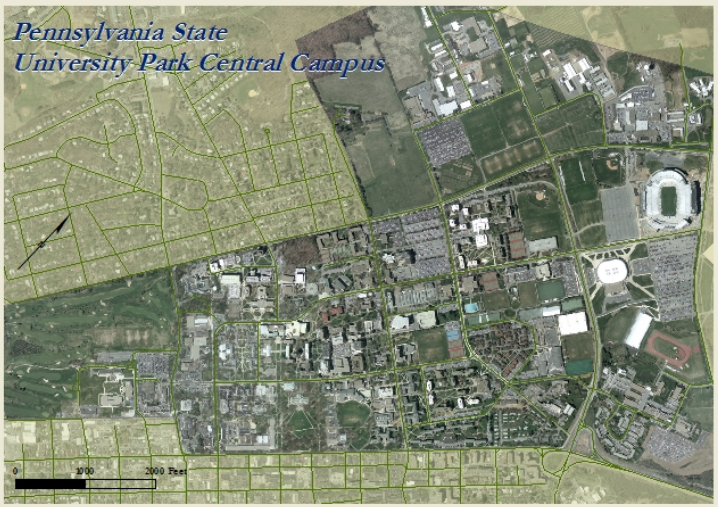
- GHG emissions are a global problem
- But solutions could be local
  - ability to incorporate local variations in economy, geography, and community structure
  - emissions happen at the local scale
  - involve local stakeholders

Universities as Local Places

- Universities offer a unique opportunity for GHG inventorying and mitigation planning activities
  - autonomous
  - centralized data availability
  - resource for current climate change research

University Park, PA



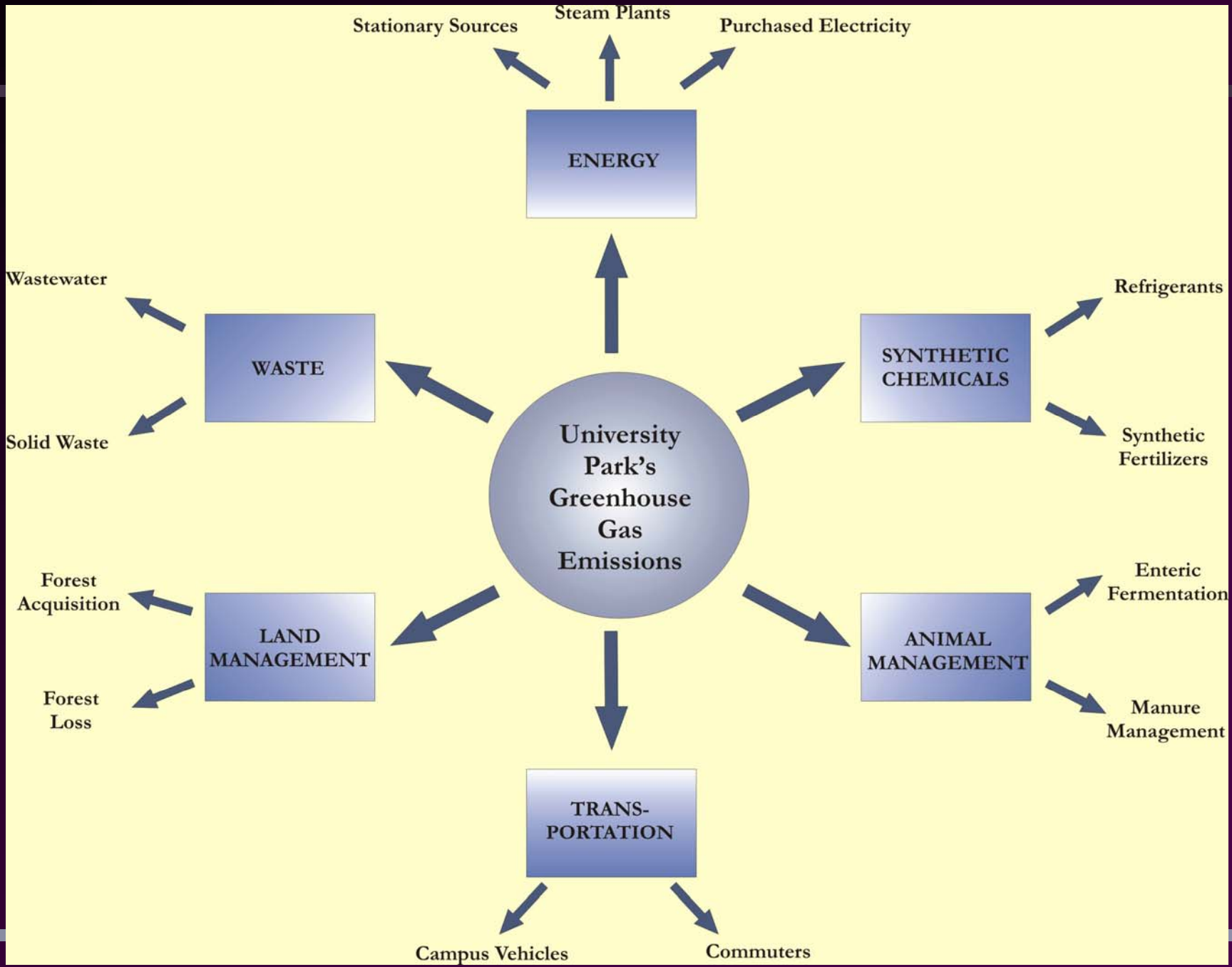


Steuer, 2004

- 43,000+ full time students
- 14,000+ full time faculty and staff
- 758 ‘buildings’
- 15.5 million gross sq ft
- 2262 classrooms and labs
- 2 steam plants

Inventory and Calculator Methods

- Activity-based emission estimates by sector
- Activity data X emission factor = emissions
  - IPCC *Revised 1996 IPCC Guidelines for National GHG Inventories*
  - EPA *Inventory of U.S. GHG Emissions and Sinks 1990-2002*.
  - EPA's Emission Inventory Improvement Program (EIIP) *Estimating Greenhouse Gas Emissions Volume VIII*
  - Clean Air Cool Planet (CACP) *GHG Inventory Calculator v. 4.0*
- Geographic Information Systems (GIS)
  - (TARN Model)
- Sectors
  - Energy, Transportation, Waste, Land Management, Animal Management, Synthetic Chemicals


University Park's Greenhouse Gas Emissions
ENERGY
Stationary Sources
Steam Plants
Purchased Electricity
WASTE
Wastewater
Solid Waste
SYNTHETIC CHEMICALS
Refrigerants
Synthetic Fertilizers
LAND MANAGEMENT
Forest Acquisition
Forest Loss
ANIMAL MANAGEMENT
Enteric Fermentation
Manure Management
TRANS-PORTATION
Campus Vehicles
Commuters

Activity Data

Year	Stationary Sources of Energy				
	Boilers, Heaters, Generators				
	Natural Gas (mcf)	Fuel Oil 2 (barrels)	Diesel (barrels)	Propane (barrels)	**Total**
1990	51436	5183	59.52	2770	N/A
1991	56405	5198	59.52	2770	N/A
1992	60473	4943	59.52	2770	N/A
1993	69298	4727	59.52	2770	N/A
1994	85401	4519	59.52	2770	N/A
1995	95603	4195	59.52	2770	N/A
1996	96098	3884	59.52	2770	N/A
1997	90237	3861	59.52	2770	N/A
1998	87030	7029	59.52	2770	N/A
1999	75023	6095	59.52	2770	N/A
2000	101485	5526	59.52	2770	N/A
2001	126399	4973	59.52	2770	N/A
2002	131893	5647	59.52	2770	N/A

Activity Data

Year	Purchased Electricity					
	Coal % of total	Nat Gas % of total	Oil % of total	Other % of total	Renewable % of total	**Total** (kwh)
1990	64.01%	26.48%	1.25%	8.26%	0.00%	175030747
1991	64.01%	26.48%	1.25%	8.26%	0.00%	184023959
1992	64.01%	26.48%	1.25%	8.26%	0.00%	191941608
1993	64.01%	26.48%	1.25%	8.26%	0.00%	201776432
1994	64.01%	26.48%	1.25%	8.26%	0.00%	211483292
1995	64.01%	26.48%	1.25%	8.26%	0.00%	221569222
1996	64.01%	26.48%	1.25%	8.26%	0.00%	227099724
1997	64.01%	26.48%	1.25%	8.26%	0.00%	227218964
1998	64.01%	26.48%	1.25%	8.26%	0.00%	242668208
1999	64.01%	26.48%	1.25%	8.26%	0.00%	252206355
2000	64.01%	26.48%	1.25%	8.26%	0.00%	264314466
2001	63.45%	26.26%	1.24%	8.22%	0.83%	275026555
2002	60.81%	25.16%	1.19%	7.84%	5.00%	282611284

Activity Data

Year	Steam Plants			
	Coal (tons)	Natural Gas (mcf)	Other (N/A)	**Total**
1990	64362	150598	0	N/A
1991	64022	156112	0	N/A
1992	65939	167379	0	N/A
1993	66934	157894	0	N/A
1994	65860	154200	0	N/A
1995	66633	208826	0	N/A
1996	71207	166158	0	N/A
1997	73208	164157	0	N/A
1998	67247	135824	0	N/A
1999	67216	179925	0	N/A
2000	68619	121653	0	N/A
2001	69417	141194	0	N/A
2002	68793	185562	0	N/A

$C0_2$ Emissions (for example)

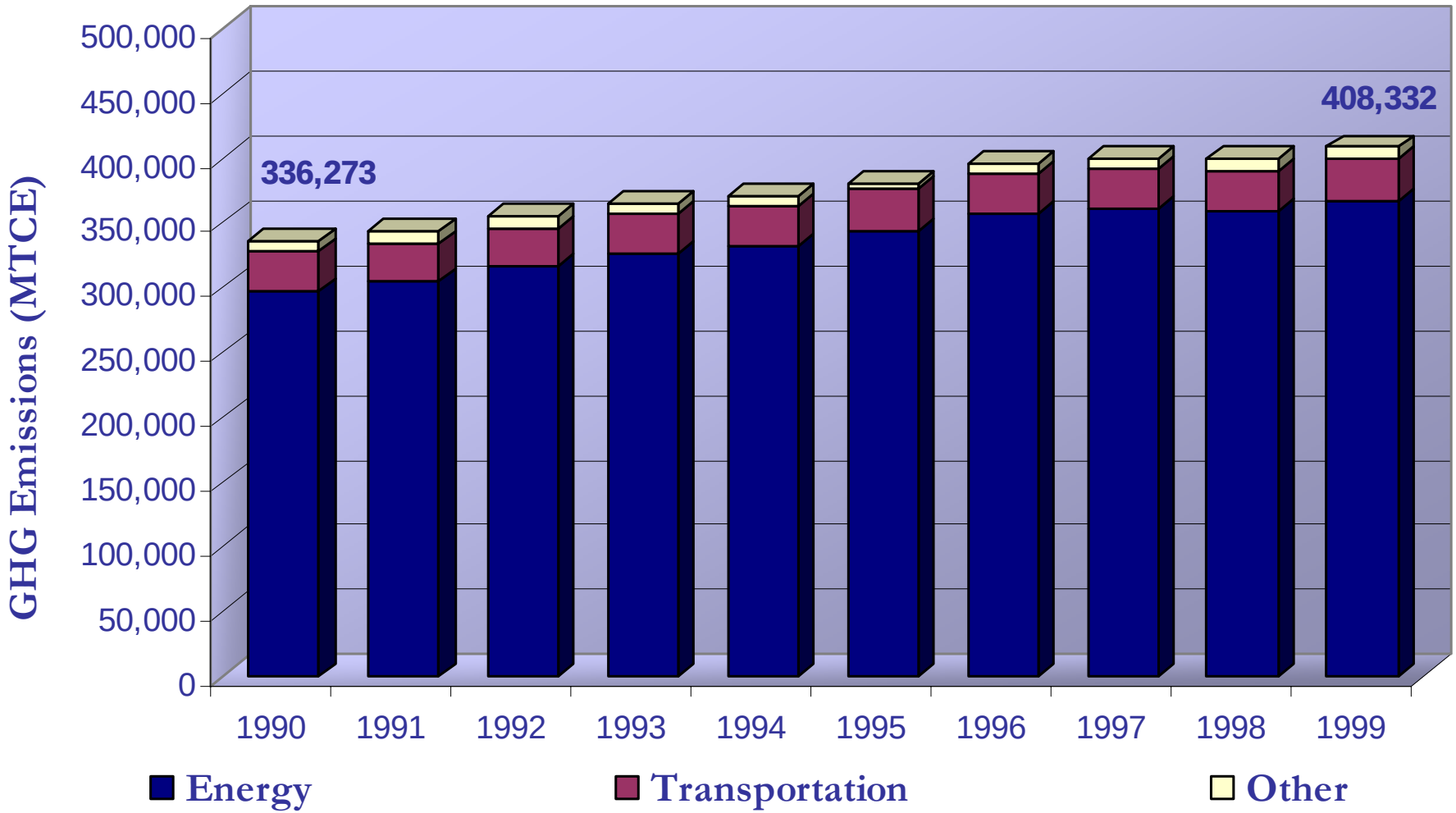
Year	Stationary Sources				
	Boilers, Heaters, Generators				
	Natural Gas (MTCO2E)	Fuel Oil 2 (MTCO2E)	Diesel (MTCO2E)	Propane (MTCO2E)	Total (MTCO2E)
1990	2803	2189	25	692	5710
1991	3074	2196	25	692	5987
1992	3296	2088	25	692	6101
1993	3777	1997	25	692	6491
1994	4654	1909	25	692	7281
1995	5210	1772	25	692	7700
1996	5237	1641	25	692	7595
1997	4918	1631	25	692	7266
1998	4743	2969	25	692	8430
1999	4089	2574	25	692	7381
2000	5531	2334	25	692	8583
2001	6889	2101	25	692	9707
2002	7188	2385	25	692	10291

Also calculates CH_4, N_20, and has an ‘other’ tab for customization
Converts everything to $MTC0_2E$

GHG Emissions ($MTC0_2E$)

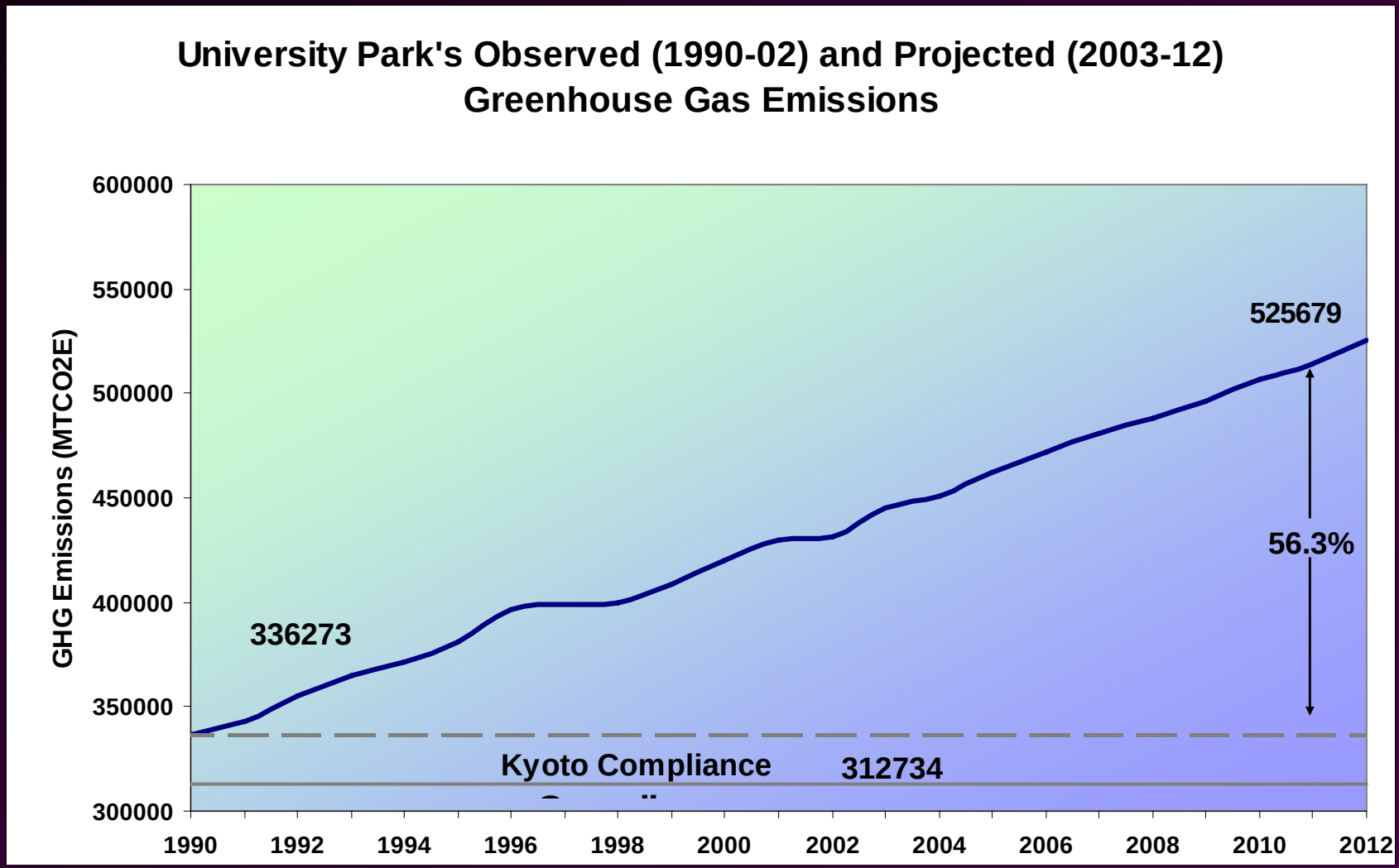
Year	Stationary Sources				
	Boilers, Heaters, Generators				
	Natural Gas (MTCO2E)	Fuel Oil 2 (MTCO2E)	Diesel (MTCO2E)	Propane (MTCO2E)	**Total** (MTCO2E)
1990	2820	2193	25	708	5746
1991	3092	2199	25	708	6025
1992	3315	2091	25	708	6140
1993	3799	2000	25	708	6532
1994	4682	1912	25	708	7327
1995	5241	1775	25	708	7749
1996	5269	1643	25	708	7645
1997	4947	1633	25	708	7314
1998	4771	2974	25	708	8478
1999	4113	2579	25	708	7425
2000	5564	2338	25	708	8635
2001	6930	2104	25	708	9767
2002	7231	2389	25	708	10353

Emissions by Sector



Steuer, 2004

Emissions at University Park



Adapted from Steuer, 2004

We have an inventory, now what?

Emissions Reductions

- Work with university stakeholders
  - Engineers, planners, managers
  - Focus groups, individual meetings
- Discuss options for Penn State
  - Physically possible
  - Economically feasible
  - Socially desirable
  - Highest priority
- Look for cost-saving alternatives

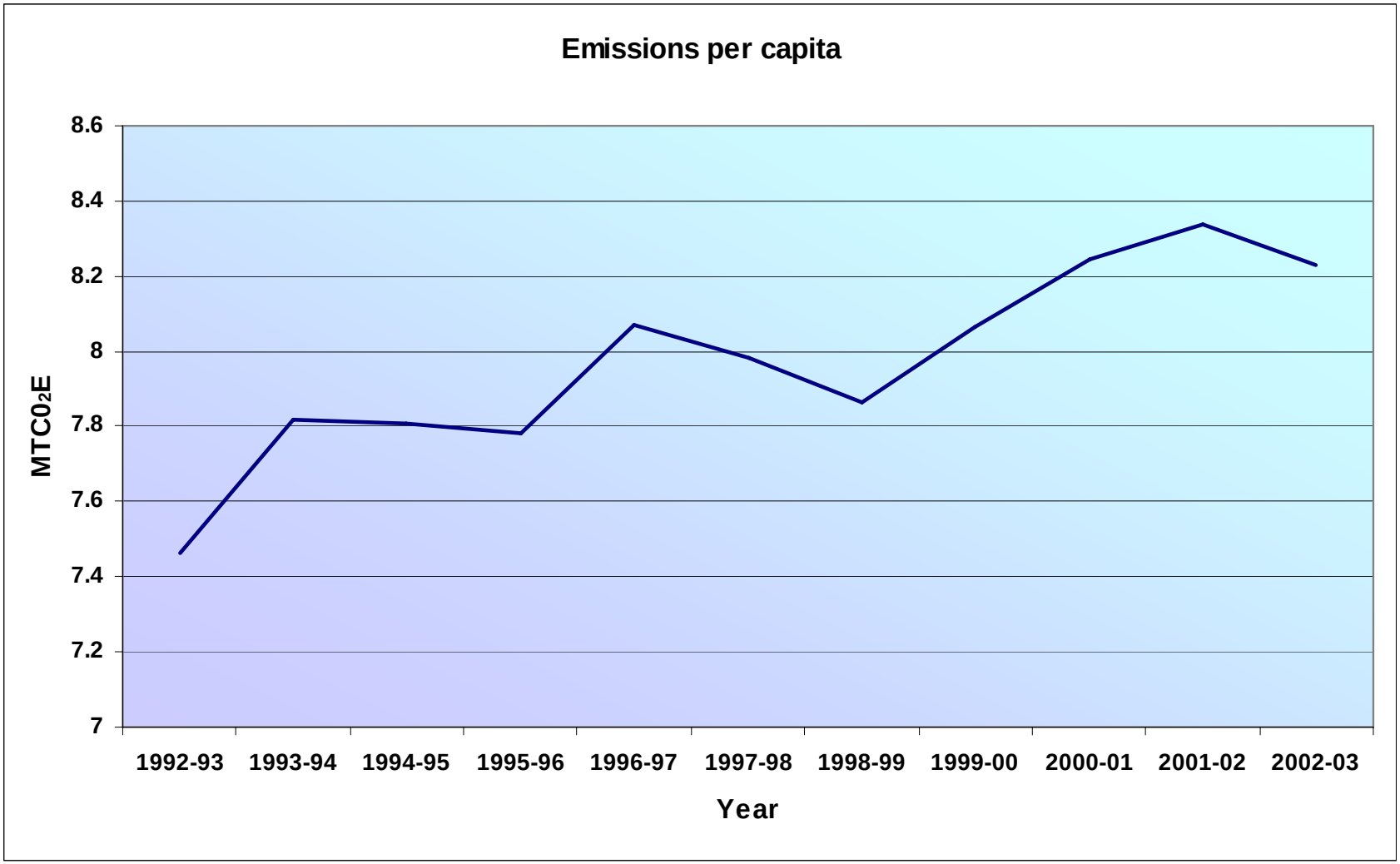
There's Good News and Bad News

- Penn State is already doing a lot!
  - Guaranteed Energy Savings Program
  - Continuous Commissioning Program
  - LEEDs certification
  - EnergyStar purchasing
  - Recycling

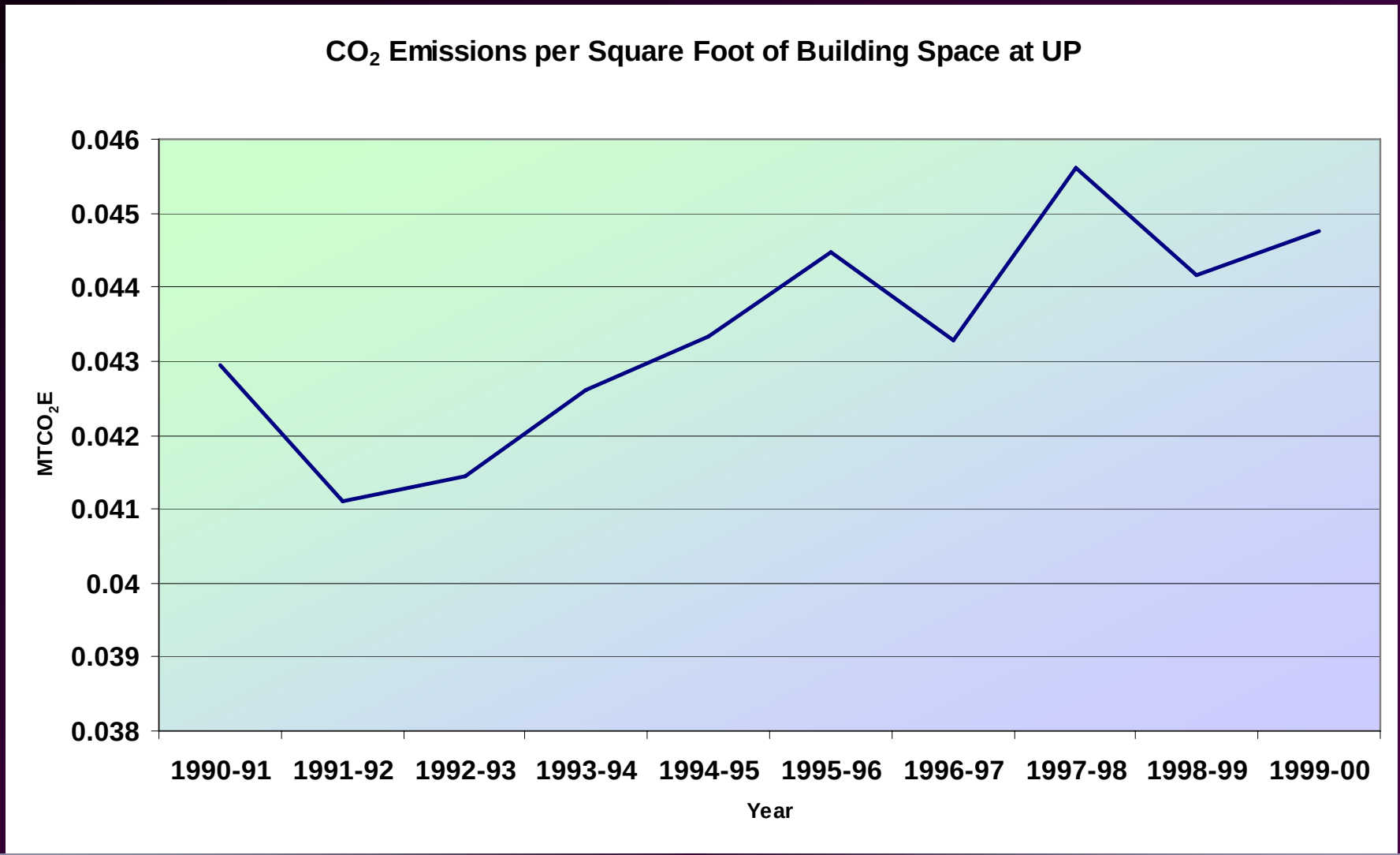
Room for Improvement

- Dissemination of initiatives
- Collaboration – bridge with academia
- Outreach
- Behavioral adaptations

Looking at Emissions Differently



Looking at Emissions Differently



Lessons Learned from the Inventory

- Emission inventories should be performed for multiple years.
- Emission inventory compilers should consider carefully the accuracy of their emission factors.
- Emission inventories should be performed by a team consisting of sector “experts” and an inventory compiler.

Implications

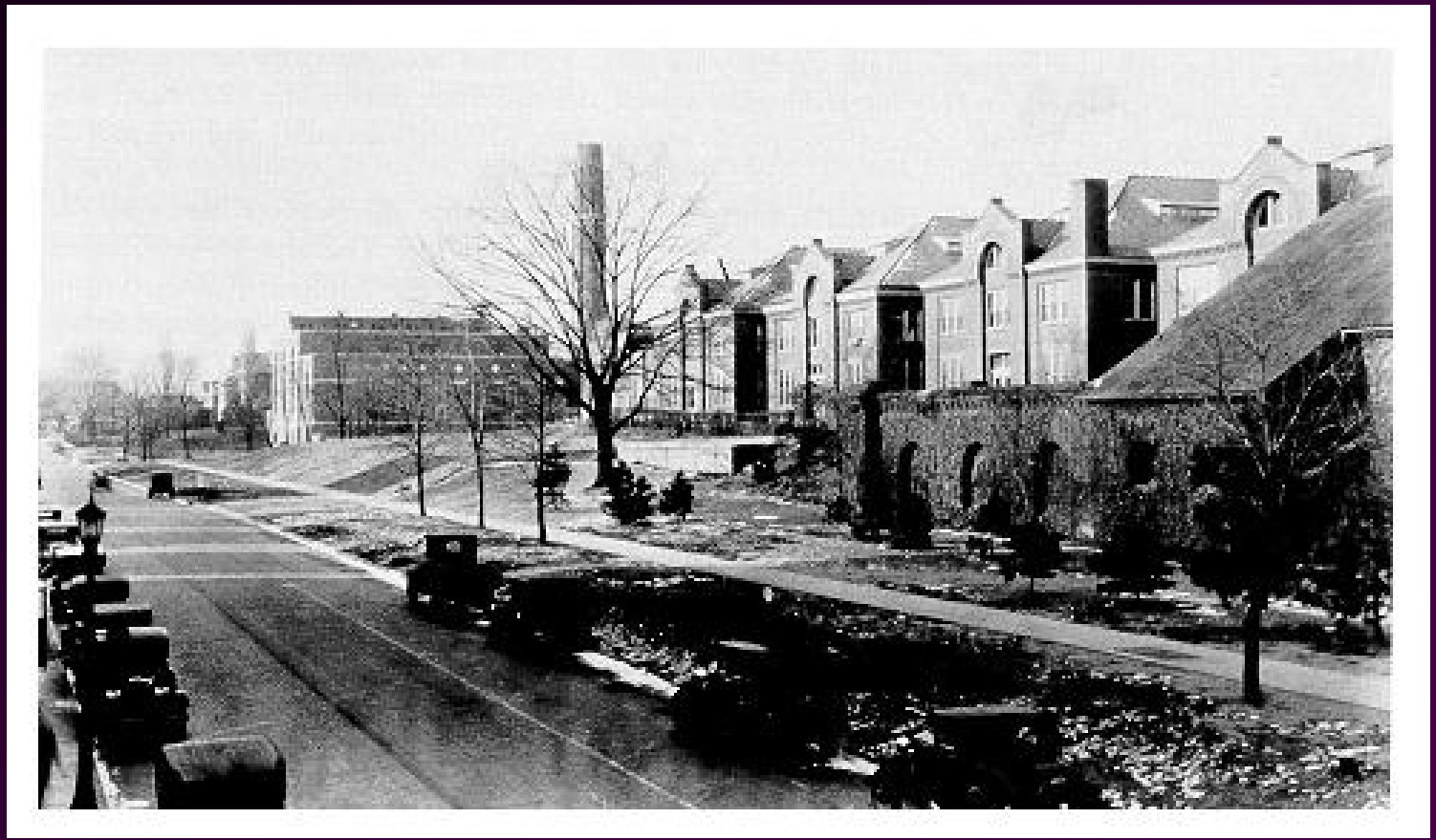
- Shift from technical to behavioral focus
- Despite these efforts, emissions still rising
  - Where do we go from here?

Penn State – Moving Forward

- Continued energy efficiency efforts
- Increased outreach and collaboration
- Environmental Awareness Center
- Formal adoption of MAP
- Beyond University Park – other Commonwealth campuses

Conclusions

- Local scale study is very valuable, university campuses offer unique opportunity
- Emissions must be looked at in specific context in which they are generated
- Penn State is working on technical, lacking on behavioral changes



West Campus Steam Plant circa 1933