The Austin College Climate Action Plan

8 October 2010

Executive Summary

Former Austin College President Oscar Page signed the American College and University Presidents Climate Commitment (PCC) during the summer of 2008. Shortly after being installed as President, Marjorie Hass recommitted the college to the PCC obligation and expanded the focus of the initiative to Austin College Thinking Green, a broad effort to move the campus toward sustainability.

Signatories of the PCC are given two years to develop a climate action plan that identifies a target date for climate neutrality (when the college's net greenhouse gas emissions, as calculated by the PCC system, will equal zero) and a plan for achieving that target. This document is Austin College's Climate Action Plan.

There are three ways to become carbon neutral and a sensible plan incorporates all three. One may conserve resources, such as energy, and thus reduce emissions. One may shift from consumption of resources whose use emits greenhouse gases, such as electricity generated by burning coal, to resources whose use emits negligible quantities of such gases, such as electricity generated by wind turbines. Or one may fund other efforts that reduce the concentration of greenhouse gases in the atmosphere and thus compensate for one's own emissions. The latter is the only option for neutralizing activities that unavoidably consume fossil fuels, such as air travel for sports teams or study abroad.

The Austin College Climate Action Plan is based upon conserving resources and shifting to clean energy sources as feasible, and offsetting that remaining minority of emissions that cannot be avoided by conservation or shifts in energy sources.

The plan has a target climate neutrality date of 2020 and is founded upon a goal of 2% reduction in electricity and natural gas use per year (20% reduction by 2020) combined with a shift to wind-generated electricity. The staff of the Physical Plant achieved annual 1.75% reductions in energy consumption during 2004-2008 using only behind-the scenes measures.

If the conservation goals are achieved then the savings from energy conservation will far exceed the cost premium of wind-generated electricity and carbon offsets, both over the life of the initiative and during each year of the project. Some of the difference will be necessary to fund conservation initiatives that enable the energy savings. Any remainder will represent true financial savings to the college.

Because the plan requires substantial conservation it will involve all segments of the campus community and create numerous educational opportunities.

Introduction

Signatories of the American College and University Presidents Climate Commitment (PCC) are required to develop Climate Action Plans that describe the school's target date for carbon neutrality and a plan for reaching that goal. This document serves that purpose for Austin College.

Even at this early stage in the campus's involvement in the PCC, the project has created numerous, intensive educational opportunities for students, faculty and staff that builds on the more than 10-year track record of student-initiated projects to reduce the environmental impact of the college. Over the last two years, since former President Page signed the PCC, numerous students have analyzed greening opportunities and written greening proposals, served as key members of the PCC President's Advisory Committee (now the Thinking Green Advisory Committee), completed the college's first greenhouse gas inventory, begun collecting the data for our second greenhouse gas inventory, and played key roles in organizing and managing the college's new green service event, Green Serve, and first annual residence hall energy saving competition. Meanwhile, previous good cooperation among faculty, staff, administrators, and ARAMARK concessionaires has become much more intentional as we more aggressively analyze and implement new actions to reduce the college's environmental impact, many of which have been proposed by students. Recently implemented initiatives include composting, expanded recycling, removing excessive lighting, and experimenting with trayless dining. Participation in the PCC has also facilitated conventional educational opportunities to discuss climate change and related issues among the faculty, in courses, and in seminars and similar settings.

This plan sets ambitious goals for Austin College, goals that have the potential not only to make the college carbon neutral (as defined by the PCC) but also to serve as an example to the larger community. There is also the potential to save the college substantial and increasing annual sums due to energy conservation.

As of fiscal year 2008 Austin College's greenhouse gas emissions totaled some 14,000 metric tons of carbon dioxide equivalent per year (MT eCO_2 per year). Carbon neutrality will have been achieved when the 14,000 $MTeCO_2$/year is reduced to zero.

The notion of carbon neutrality

Carbon neutrality refers to a condition where an entity has no net impact on atmospheric greenhouse gases. (Carbon is not the only relevant element, but the term "carbon neutrality" is now commonly understood to refer to the notion of no net impact on atmospheric greenhouse gases, so we use it here.) The PCC initiative defines which activities and impacts are to be tallied when inventorying a college's greenhouse gas emissions. Some relatively minor sources are not included in the PCC inventory procedure. Because several types of molecules function as greenhouse gases but have different per-molecule impacts on greenhouse warming, greenhouse gas inventories are typically converted into carbon dioxide equivalents, abbreviated eCO_2.

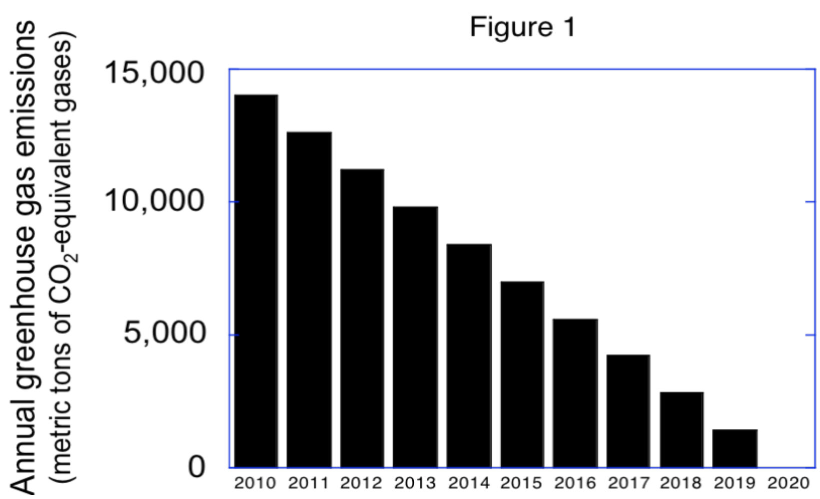
There are three ways to achieve carbon neutrality: resource conservation, shifts from use of greenhouse-gas emitting resources to carbon neutral energy resources, and "offsetting." The first two, conservation and shifts in resource consumption, avoid causing greenhouse gas emissions. The third, offsetting, compensates for greenhouse gas emissions by funding other activities that prevent emissions that otherwise would have occurred elsewhere, or that remove greenhouse gases from the atmosphere. Such funding is manifested through the purchase of "carbon offsets."

Conservation is ideal because it prevents emissions and saves money on resource purchases (e.g. of electricity), but 100% conservation is not possible. Shifts from consuming carbon-emitting to carbon-neutral resources, such as from coal-generated electricity to wind-generated electricity, is the next most desirable choice from an environmental perspective, but usually incurs a price premium. (Greener options often have a higher market price than the dirtier options because society at large, not the particular consumers, pays for the environmental damage associated with the dirtier resources). The third option, "offsetting," is a last resort when conservation and shifting resource consumption are not possible.

Offsetting is necessary to "neutralize" air travel and other actions, such as commuting in gasoline-powered cars, that cannot be made green through conservation or switching to green fuels. Conserving air travel would mean not flying and there is presently no carbon-neutral airplane fuel, so air travel necessarily adds to one's carbon footprint and therefore can only be neutralized by funding another action that compensates for the greenhouse warming effect of the air travel.

Carbon neutrality target date

2020 is Austin College's target climate neutrality date. We intend to achieve linear reduction of GHG emissions from 2010 to 2020 (Figure 1). Austin College's Thinking Green Advisory Committee determined that earlier climate neutrality dates are too soon to be financially or technically feasible. Student members of the committee, students enrolled in ENVS 479, Environmental Policy, and others students who were consulted nearly unanimously argued that target dates more than 10 years away would not be meaningful to students. The committee agreed that a plan that does not enthuse the students would fail one of the primary objectives of the PCC, to serve as an educational tool that can serve as an example for society at large. Failing to capture the interest and imagination of students would also almost surely ensure failure because achieving the plan goals will require broad campus support and cooperation.



A ten-year time frame is convenient for other reasons as well. The college uses a five-year strategic planning cycle and is presently completing a strategic plan. Therefore, the period for achieving carbon neutrality is synchronized with two strategic planning cycles. Furthermore, a ten-year time frame lends itself to simple, clear annual goals. This plan has annual goals of 2% energy conservation and 10% annual reduction in GHG emissions relative to a 2010 baseline, both of which readily lend themselves to annual auditing and reporting. Progress toward the plan goals will be continuously tracked and goals will be periodically reevaluated. The first formal reevaluation will be 36 months after the plan is adopted. Reevaluations may necessitate alterations to timetables or other components of the plan.

<u>Basic features of the Austin College Climate Action Plan</u>

The Austin College Climate Action Plan relies upon conservation and shifts in resource consumption wherever possible, and includes the purchase of carbon offsets only for those college operations that cannot be neutralized through conservation or shifts in resource consumption (primarily air travel, automobile commuting, and natural gas that fuels boilers). The plan does not prescribe a specific set of particular changes to campus operations. Rather it sets a long-term goal and annual goals. This document includes a list of options available to the college for reducing its carbon footprint. We expect other opportunities to become available over the course of the plan's implementation. The Thinking Green Advisory Committee is responsible for evaluating and recommending particular greening actions.

The plan requires that electricity and natural gas consumption decline by 2% of the 2010 quantity every year from 2011 through 2020. Such reduced consumption of electricity and natural gas would result in significant savings to the college and may exceed costs of green energy or carbon offsets (described in detail below). Some conservation actions, such as encouraging lights to be switched off, require little or no expenditure. Others, such as upgrading capital equipment, require initial investments. It is not possible to precisely anticipate the expenditures that will be necessary to achieve conservation goals because new conservation technologies continually become available.

The plan also includes a shift in electricity consumption from our present supply, which is generated by a mixture of fuels, including 15% renewable fuels, to 100% commercially available, wind generated, carbon neutral electricity. This will be achieved by purchasing renewable energy credits (RECs).[1]

The plan requires the purchase of carbon offsets to neutralize emissions that cannot be avoided by conservation or made carbon neutral by switching energy sources. The bulk of the college's greenhouse emissions that can only be neutralized by buying carbon offsets are emissions due to air travel and consumption of natural gas and gasoline. The plan does not recommend the purchase of carbon offsets until 2015.

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[1] RECs represent the price premium for purchasing wind-generated electricity. Various wind generators add electricity to the grid. Consumers extract energy from the grid. Some consumers contract specifically to buy green electricity, such as wind-generated electricity. Other consumers simply contract to buy electricity from unspecified generation sources. Wind farms may not be able to sell all of their electricity at a price premium as "green" electricity. For the remainder they may sell RECs. Purchasers of RECs are then credited with effectively having purchased the green. More information on RECs is available at this Environmental Protection Agency website (http://www.epa.gov/grnpower/gpmarket/rec.htm).

Conservation necessary to achieve the plan goals

The plan of 2% reduction in electricity and natural gas consumption per year creates tangible annual conservation goals (Table 1). This goal will be challenging but seems plausible. The staff of the physical plant achieved an average of 1.75% savings per year from 2004-2008 by using only behind the scenes efficiency improvements, without the help of behavioral changes on the part of the campus community or even any alterations to operations that were noticeable to the campus community. For comparison, Executive Order 13514, signed by President Obama on 5 October 2009 requires federal agencies to adopt a variety of conservation measures including reducing vehicle fleet petroleum use by 2% per year. (http://www.fedcenter.gov/programs/eo13514/, accessed 22 July 2010).

Table 1. Annual future consumption targets for natural gas and electricity. The cost saving estimate assumes current prices for electricity and natural gas.

Fiscal year	Natural gas consumption (MMBTU)	Electricity consumption (MWh)	Annual utility savings versus 2010 baseline
2010	48000	13500	$0
2011	47040	13230	$35,237
2012	46080	12960	$70,474
2013	45120	12690	$105,710
2014	44160	12420	$140,947
2015	43200	12150	$176,184
2016	42240	11880	$211,421
2017	41280	11610	$246,658
2018	40320	11340	$281,894
2019	39360	11070	$317,131
2020	38400	10800	$352,368

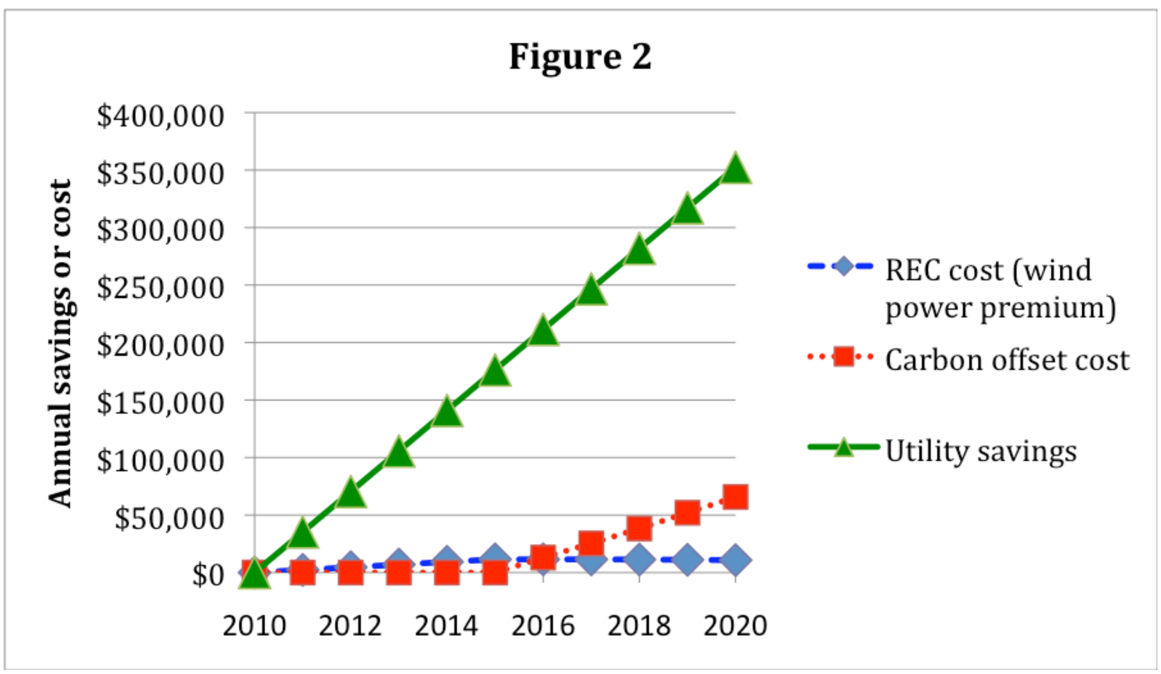
Projected costs and savings associated with the above scenario

The Climate Action Plan will save money through reduced expenditures for purchase of electricity and natural gas. The plan will incur expenses to pay for capital equipment upgrades necessary to implement conservation actions, to pay the premium for wind-generated electricity or RECs, and to pay for carbon offsets. The savings from reduced utility consumption are projected to exceed the costs of REC and offset purchases every year, leaving the difference as a potential budget available to fund conservation efforts. Any monies not needed to fund conservation efforts would result in true savings to the college as a result of implementing the plan.

Figure 2 shows the expected utility cost savings and expenditures for RECs (wind power) and for carbon offsets from 2010 to 2020. The solid line with the triangles shows projected savings on natural gas and electricity. The dashed line with the diamonds shows the projected wind power cost premium. The dotted line with the squares shows the projected cost for purchases of carbon offsets. Note that the projected utility savings exceed the projected REC and offset costs each year, with the difference increasing annually. Note also that the plan does not require carbon offset purchases until 2015. Years subsequent to 2020 would equal 2020, when the college would be carbon neutral, unless further conservation were achieved, in which case utility savings would increase further and costs of offsets and/or RECs would decline.

The difference between the utility savings and the costs of RECs and offsets in figure 2 would be available to fund conservation measures necessary to achieve utility savings.

One could argue that conservation alone (without the concurrent purchase of RECs and offsets) would save even more money, but that argument assumes that the necessary conservation could be achieved without the college's PCC commitment. The Thinking Green Advisory Committee believes that, absent the PCC commitment, the effort would involve many fewer people and would not energize student participation, resulting in a failure to achieve conservation goals and savings opportunities. During the 2008-2009 school year the Thinking Green Advisory Committee met with representatives of various student groups to inquire about what measures would be necessary to inspire widespread, enthusiastic participation among students and the clear response was that the students would do their part if they saw tangible evidence that the college was leading the way. The students made clear that students in general would be unlikely to get behind an effort that seemed little more than a money saving initiative whereas early data suggests students can play a major role in achieving these savings if they are inspired to do so. The initial results for this year's first annual residence hall energy saving competition show reductions in energy use of 4 to 17% compared to the previous year.



Budgeting for conservation initiatives and purchases of RECs and offsets

While the plan may accrue substantial savings due to energy conservation, it will incur three categories of expenses: costs of conservation efforts such as upgraded capital equipment; purchases of RECs (wind power); and purchases of carbon offsets. The total projected costs for RECs and offsets are shown in figure 2 and in detailed tabular form in table 2. We plan to raise new gifts to finance REC and offset purchases. (See the next section of this document.)

Table 2. Projected costs for purchases of RECs (the wind power price premium) and for carbon offsets. To meet plan goals the sum of the two costs must be raised from new gifts.

Year	REC cost (Wind power price premium)	Carbon offset cost	Total cost of RECs & carbon offsets
2010	$0	$0	$0
2011	$2,323	$0	$2,323
2012	$4,646	$0	$4,646
2013	$6,969	$0	$6,969
2014	$9,292	$0	$9,292
2015	$11,475	$741	$12,216
2016	$11,475	$13,020	$24,495
2017	$11,475	$25,299	$36,774
2018	$11,340	$38,291	$49,631
2019	$11,070	$51,998	$63,068
2020	$10,800	$65,704	$76,504

Table 3 shows that utility savings are projected to substantially exceed costs of RECs and carbon offsets. However, costs will be accrued in the process of achieving those utility savings. For example, capital equipment upgrades will require equipment purchases. Annual budgets for such investments will be based on recent savings in utility costs due to previous conservation efforts. Actual annual budgets for conservation investments will be based upon estimated energy savings due to prior conservation investments, estimated returns of particular new investments, and larger college budget considerations.

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Table 3. Projected utility savings, projected costs of RECs and offsets, and the difference between the two. The latter represents the annual conservation budget. Any of the latter not needed to achieve conservation goals would represent net financial savings to the college.

Year	Annual utility savings versus 2010 baseline	Total cost of RECs & carbon offsets	Difference between utility savings & cost of RECs plus carbon offsets
2010	$0	$0	$0
2011	$35,237	$2,323	$32,914
2012	$70,474	$4,646	$65,828
2013	$105,710	$6,969	$98,741
2014	$140,947	$9,292	$131,655
2015	$176,184	$12,216	$163,968
2016	$211,421	$24,495	$186,926
2017	$246,658	$36,774	$209,884
2018	$281,894	$49,631	$232,263
2019	$317,131	$63,068	$254,064
2020	$352,368	$76,504	$275,864

New gifts to support purchases of RECs and carbon offsets

Our intention is that the costs of new RECs and carbon offsets will be covered by new gifts designated expressly for these purposes. Several members of the campus community have expressed an interest in contributing to such efforts. With approximately 1600 students, faculty, and staff, the cost to purchase enough offsets to make the college carbon neutral immediately would be approximately $90 per person per year (with current rates of energy consumption and electricity sources). If 2% of the members of the campus community (32 individuals) contribute their share of this cost beginning in 2011 and thereafter ($90 per year each), and an additional 2% contribute their share each subsequent year, these contributions would exceed the annual costs of RECs and offsets for the first five years of the plan, when no or only a few carbon offsets are necessary to purchase. For such $90 per person contributions to meet the total costs of RECs plus offsets for the entire plan period would require the annual number of contributors shown in table 4. This number of on-campus contributors might be reasonable to expect for the first few years of the plan, but not for the last few when the need to purchase carbon offsets accelerates the annual increase in necessary outlays and thus accelerates the rate of increase in the number of contributors.

Opportunities to reduce plan expenses

Study abroad air travel: The plan assumes that the college will pay for carbon offsets necessitated by study abroad air travel. If students pay some or all of these expenses, the costs to the college will be reduced. Approximately 11% of the college's FY 2008 GHG emissions were due to study abroad air travel. These offsets would cost the students (or the college) about $16,000/year at current prices.

Conservation of resources other than electricity and natural gas: Electricity and natural gas account for about two thirds of the colleges greenhouse gas emissions and therefore provide the greatest opportunity for conservation, but other conservation opportunities exist. In theory, the college could reduce its greenhouse gas emissions through reduced air travel by faculty or staff, reduced gasoline consumption by the college fleet, conservation associated with commuting (such as carpooling or a shift in the average fuel efficiency of vehicles driven by employees), or reduced fertilizer use. Improvements in any of these areas would reduce necessary carbon offset purchases.

Table 4. The number of individuals contributing $90 per year necessary to raise the necessary funds for REC and carbon offset purchases.

Year	Number of required contributors	Percentage of total campus population of 1600
2010	0	0
2011	26	2
2012	52	3
2013	77	5
2014	103	6
2015	136	8
2016	272	17
2017	409	26
2018	551	34
2019	701	44
2020	850	53

Carbon sequestration in compost, biomass, or soil: The PCC accounting mechanism allows for deductions from an institution's impact due to production of compost or accumulation of biomass (generally trees) on college properties but it does not appear that the college can expect to appreciably reduce its carbon footprint through these mechanisms, at least not in the short term. (These activities produce multiple important benefits besides carbon sequestration and their carbon sequestration is substantial, just not large relative to the college's entire footprint.) The college began composting food preparation waste with wood chips in spring of 2010 and has produced compost at an approximate rate of 10 cubic meters per year, which would amount to about 6 metric tons per year and a little over 3 MT of avoided eCO_2 per year. Since the college's total GHG emissions are some 14,000 MT

eCO_2 per year it does not appear that compost can appreciably reduce this total. In the future we may wish to further evaluate the potential of carbon sequestration in trees or in soil, but documentation of such processes would be more technically challenging than measuring compost production and these are slow processes that must happen over large areas to sequester substantial amounts of carbon.

Important assumptions & uncertainties

Prices: All cost estimates in this document are based upon the current, 2010, prices shown in table 5. These will surely change in the future. Costs could increase relative to those estimated, but if electricity or natural gas costs increase then the savings associated with conservation would also increase.

Table 5. Prices used in forecasting projections.

Electricity price / kWh	$0.10
Natural gas price / million BTU	$8.58
REC price / MWh	$1.00
Carbon offset price / metric ton eCO_2	$10.00

RECs are presently inexpensive in Texas due to ample wind-based electricity generation relative to demand for RECs. (The college should consider buying up a reserve supply of RECs now for use in future years.) Carbon offset costs have been fairly stable but could be affected by future legislation or international agreements. Increases in either REC or carbon offset costs would alter these projections. All things considered, it is not obvious whether the use of current prices is conservative or optimistic, but it certainly is not a worst-case financial scenario.

As noted above, progress toward plan goals will be continuously tracked and formally evaluated after 36 months, with any necessary plan changes made at that time.

Achievable conservation: The plan assumes that the college will be able to achieve a constant absolute rate of decline in electricity and natural gas consumption equal to 2% of FY 2008 consumption (20% reduction by 2020). This goal will be challenging but seems within reason given that physical plant personnel were able to reduce electricity and natural gas use 1.75%/year from 2004 to 2008 without the help or even awareness of the members of the college community. A special challenge will result from the construction and operation of the IDEA center and any new housing because new buildings will increase the college's energy consumption. The PCC commitment is based on total consumption and makes no accommodation for increased building space on campus.

Implemented and available conservation measures

The college has already implemented many conservation measures, and partially implemented others. Other measures remain to be evaluated for implementation. Various sources provide lists of options [e.g. the AASHE planning "wiki" http://www.aashe.org/wiki/climate-planning-guide and Heede R. and Swisher J. (2002)

Oberlin College: Climate Neutral by 2020, Rocky Mountain Institute (http://www.nicholas.duke.edu/news/ roberstonseminars/swisher-oberlin2020final.pdf]

- # implemented action
- ^ implementation in progress or partial implementation
- \- potential action evaluated but deemed unsuitable for Austin College.

Efforts to alter behaviors

(Degree of implementation is difficult to assess for this category)

Behavior changes: electricity consumption

^ Turn devices off (lights, computers, TVs, game consoles)
Unplug or turn power off to remotely controlled devices
Unplug or turn power off to battery chargers
^ Use energy saving features of computers
Plug in laptops only when necessary
Use powerstrips to ease power shut offs
Use stairs, not elevators
Hold building energy competitions
Install real-time energy consumption displays to encourage conservation
Make examples of efficient and wasteful buildings (and their occupants)
Create a reward system for individuals who identify conservation opportunities

Behavior changes: natural gas consumption

Shorten showers (students have reported taking 45 min showers)

Behavior changes: reduced paper consumption & solid waste production

^ Use reusable drink containers
^ Increase recycling
^ Waste less food
^ Submit and grade papers electronically
Shift more communication from paper to electronic format

Behavior changes: commuting

Consider preferred parking spaces for carpools & high mileage vehicles

Carbon sequestration

Food preparation waste composting
Post-consumer food waste composting
Soil carbon accumulation on campus properties
Tree planting on empty campus lots

Campus fleet

Transition to hybrid gas-electric vehicles (e.g. Ford Fusion)
Offer bicycles or industrial tricycles as alternative to energy-inefficient golf carts
Retrofit electric golf carts with rooftop solar-panel battery chargers
Avoid unnecessary flights

Building & outdoor energy conservation (non-behavioral)

Lighting

^ Remove unnecessary fluorescent bulbs
Avoid indirect lighting
^ Install occupancy sensors to control lighting
Install timers to control lighting
Install daylight sensors that override lighting
Ban incandescent bulbs & halogen torchiere lamps
Use task lighting rather than full room lighting
^ Convert outdoor lighting to high-pressure sodium
Eliminate or reduce decorative outdoor lighting
Consider outdoor solar-powered LED fixtures
Paint walls white or off white to maximize reflectivity
Convert T-12 fluorescent fixtures to T-8 or T-5 & convert 32 watt T-8 lamps to lower wattage
Convert exit signs to LED bulbs

HVAC settings and operation

Use higher summer temperature settings
Use lower winter temperature settings
Maximize night, weekend, vacation etc. temperature setbacks
Install tamperproof or remote thermostats
^ Control space temp remotely by Energy Management System
^ Limit range of occupant-controlled thermostats
^ Restrict use of portable space heaters
# Restrict HVAC & fan operating schedules
More efficient space utilization, such as evening class locations
Replace older AC equipment with maximum efficiency models
Avoid use of inefficient window air conditioners
Clean cooling coils on a regular basis
Maximize use of "free cooling" with economizer cycle
Convert electric space and water heating to natural gas

Appliance energy efficiency

^ Adopt Energy Star standard
Residence hall appliance policies (e.g. only Energy Star appliances)
Install Vending Misers®

Food service

Switch to trayless or tray-by-request-only dining
Compost post-consumer food waste (see also carbon sequestration section)
Evaluate efficiencies of food service appliances

Building shells

Seal leaks (e.g. weatherstrip Moody windows)

Replace doors or add weatherstripping to doors with large gaps (e.g. Moody east door, Roo Suite doors)
Close storm windows during heating & cooling seasons.
- Open windows in spring & fall
Improve insulation
Replace inefficient windows
Add low emissivity window film

Laboratory Ventilation and Fume Hoods

(items marked # are included in IDEA Center design)
Switch to "green chemistry" that doesn't require fume hoods
Turn off 100% outside air ventilating systems in unoccupied labs.
Decommission/remove unneeded fume hoods
Use ventilated storage cabinets instead of hoods for chemical storage
Retrofit constant volume hoods with variable air volume systems
Retrofit conventional fume hoods with low-flow hoods
Retrofit hoods with heat recovery

Swimming pool

Use pool cover to reduce heating & ventilation required due to evaporation.
High efficiency boilers for pool water heating
Limit natatorium ventilation to that required to meet code or even seek code variance
Install heat recovery

Computer operations and "green computing"

(Completed list to be inserted here)
Replace desktops with laptops
Automated shutdown of computers when buildings are closed

Features of Campus Energy System

Boilers

Replace old boilers with new high efficiency boilers
Do not oversize replacement boilers
Retrofit boilers with variable flame burners
Consider multiple high efficiency modular boilers to improve efficiency by better matching hot water heating loads
Consider replacing boilers with cogenerators that produce electricity
Control boiler output water temperature with outside air temp reset so boiler does not need to heat water hotter than necessary
- Retrofit boilers with flue gas/stack heat recovery

Chillers

Replace old chillers with efficient models w/ approp. efficiency curve
Do not over-size replacement chillers
Operate at peak efficiency (by adjusting water flow, load,

condenser/evaporator water temps, etc.)
Replace old cooling towers with new high efficiency towers

Motors, fans and pumps
Adjust operating schedule to minimize run hours
Replace inefficient old motors, pumps, and air handling units
Control motors serving fans and pumps with variable speed drives
Operate variable speed drives at maximum acceptable turn-down; vary by time of day and occupancy; also vary by season
Convert constant volume fan system to variable air volume
Reduce outside air volume during morning warm-up cycle and where/whenever possible through damper settings and demand control ventilation
Reduce needless pumping by eliminating three-way by-pass valves

Heat recovery
Run around loops
^ Heat wheels
Heat pipes
^ Desiccant wheels
Air-to-air heat exchangers

Energy Management Systems (EMS)
Switch to direct digital control (DDC) systems
^ Purchase EMS systems that are easy to program
Utilize and optimize use of EMS energy conservation programs, e.g.
Optimal start/stop
Night setback
Demand shedding
^ Remote programmed lighting control

<u>Curricular and non-curricular opportunities to study climate change</u>

Austin College's ~1300 students have numerous opportunities to learn about climate change in conventional courses (Table 6) and extracurricular opportunities. Each year some 500 spaces are taken in courses that include coverage of climate change. With 1300 students and students enrolling for four years, that amounts to an average of more than one and one half courses that address climate change per student.

A variety of extracurricular options provide additional opportunities to learn about climate change and other environmental issues. These include:

- Weekly Environmental Issues lunch forums
- The annual environmental service event Green Serve (initiated in spring 2010)
- Annual Green Pledge drives (initiated in spring 2010)
- Membership on the Thinking Green Advisory Committee

- Freshman orientation sessions on campus green efforts (to begin in fall 2011)
- Residence hall energy conservation competitions (begun in fall 2010)
- Food waste reduction initiatives
- Opportunities to manage or assist with campus composting & recycling programs
- Sherman Community Garden

Table 6. Austin College courses that address anthropogenic climate change.

Course	Usual frequency of offering	Approximate enrollment	Class time devoted to anthropogenic climate change
Biology 115, Evolution, Behavior, & Ecology	Annual	180	1 or more sessions
Chemistry 101, Energy: Fuel the Need	Most years	25	6 weeks
Economics 242, Natural Resources and Environmental Economics	Annual	20	1 session
Environmental Studies 235, Fundamentals of Environmental Studies	Every semester	42	2 weeks
Environmental Studies 230 / **Political Science** 230, Globalization	Annual	30	1 week
Environmental Studies 479, Environmental Policy	Annual	10	4 weeks
Exercise & Sports Science 244, Personal Health	Annual	25	1 day
Freshman Seminar (C/I), Different titles and topics each year.	Annual	20	1 day to several weeks
History 163			
History of U.S. Foreign Relations			
Physics 101, The Day after Tomorrow: Global Climate & Extreme Weather	Annual	20	2 weeks
Physics 240, Atmospheric & Environmental Physics	Every other year	10	1.5 weeks
Political Science 241, Chinese Politics	Every other year	30	½ session
Political Science 430, International Relations Theory	Annual	30	1 session
Science 201, Earth, Body, & Mind	Annual	60	1 session
Total typical annual enrollment		~500	

Austin College's plans to expand research efforts toward the achievement of climate neutrality

Current Austin College research projects related to climate change and carbon neutrality include research at the Austin College weather station on Earth surface energy balance, experimental prairie restoration at the Sneed Prairie, and study of novel photo-sensitive molecules for capturing solar energy. Austin College's Richardson Endowment funds faculty research. Faculty wishing to expand research into climate neutrality and related issues are encouraged to apply for these funds.

Austin College solar energy research has two components, one on earth surface energy balance and one on capturing solar energy with novel light-harvesting dyes. The Austin College Weather Station (ACWX), located on Austin College's Sneed Environmental Research Area approximately 10 miles west of Sherman, provides unique opportunities to study weather and climate in North Texas. It uses state-of-the-art research instrumentation to collect typical weather data (air temperature, humidity, wind speed and direction, barometric pressure, and rainfall) as well as nonstandard measurements (soil moisture, soil temperature, solar radiation, and net radiation). Student research projects include investigation of the surface energy balance of a prairie environment, relationships between soil temperature and air temperature, and local signatures of global climate change.

Light harvesting dyes are large, photosensitive molecules that self assemble into intentionally designed, discrete building blocks. The photosensitive molecules serve as the active element of dye-sensitized solar cells (DSCC) whose cost of production is similar to silicon-based cells and whose efficiency and performance is the focus of current research.

A study of the effect of prairie restoration on soil microbial communities will contribute to understanding of the potential of ecosystem restoration to sequester carbon. The project investigates the bacterial and fungal communities associated with particular plant species that occur on different soils. Those data will be useful for predicting changes in soil properties and microbial communities as plant species abundances shift during prairie restoration.

Austin College's plans to expand community outreach efforts toward the achievement of climate neutrality

Austin College's community outreach efforts have four components: a seminar series primarily aimed at the Austin College campus community; an annual environmental service day, Green Serve; annual energy savings competitions in residence halls, and a planned series of interactive forums where a panel of college faculty attempt to answer audience members' questions regarding climate issues.

Austin College's Environmental Issues Lunch Forum is open to the public, as are other seminars and lectures that address environmental topics. Offered weekly over the lunch hour on Tuesdays, the brown bag sessions periodically address climate issues.

During spring of 2010 Austin College initiated an annual environmental service workday called Green Serve. Many of the service projects were off campus in the surrounding community and one of the 2010 projects was a fluorescent light bulb distribution program. Bulbs were distributed with information on their benefits and proper recycling.

During the 2010-11 school year we will initiate a series of forums, initially on campus and then subsequently in the surrounding community, where a panel of Austin College faculty members will attempt to answer audience members' questions about climate change issues. We anticipate that such a forum would be of interest to a variety of local groups because skepticism regarding climate change is widespread in this area. We think that a "stump the chumps" format would be more engaging than more formal presentations and would therefore have more chance of achieving educational goals.