# UNIVERSITY OF ARKANSAS'S GREENHOUSE GAS EMISSION REDUCTION PLAN

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## THE PROBLEM

- University of Arkansas (UA) emitted 171,585 metric tons of carbon dioxide (MTCO2e) into the atmosphere in 2011.
- Greenhouse gas (GHG) emissions from human activity contribute to Earth's climatic warming trend, changing our climate and weather, raising sea levels, and as a worst case scenario, potentially transforming Earth from a host to hostile planet.
- Fossil fuel consumption is the main source of human derived GHG emissions, yet the environmental burden can be minimized by using conservation practices and alternative energy sources.

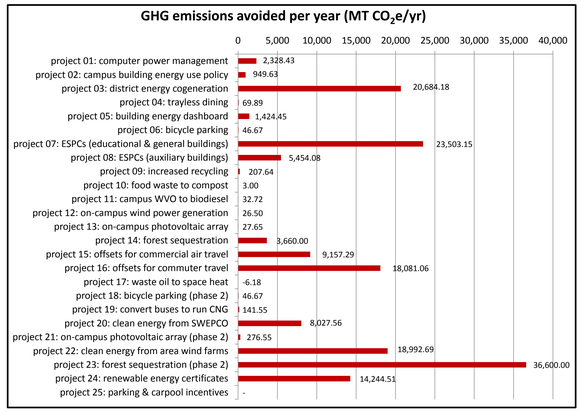
## BACKGROUND INFORMATION

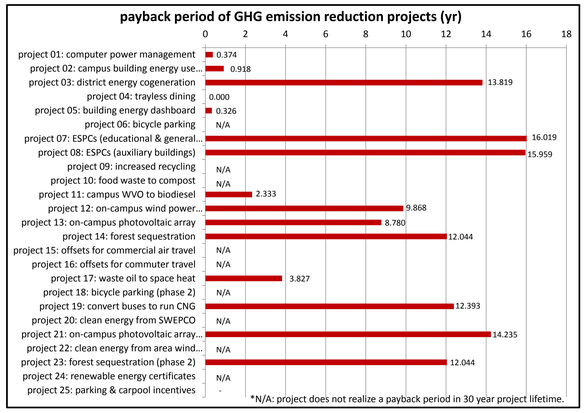
- UA signed the American College and University Presidents' Climate Commitment (ACUPCC) in 2007 and intends to be climate neutral, with a net zero sum of GHG emissions from campus activity, by 2040.
- UA's Office for Campus Sustainability (UAOCS) drafted the GHG Emission Reduction Plan (GHGERP) which outlines 25 proposed projects and quantifies GHG emission reductions and cost estimates for each project.

## THE PROJECT

- This sustainability capstone project improved the GHGERP by updating proposed project data and assumptions while also turning the old static report into a dynamic economic analysis tool.
- The new GHGERP can be quickly updated in Excel to keep all 25 project proposals and their associated calculations up to date and valid.
- Additional economic calculations like payback period have been added to determine projects' economic viability alongside the GHG emission reduction, initial cost, emissions avoided per $ spent, and net present value calculations.
- Most projects accrue savings from energy conservation and efficiency measures which can actually finance the initial cost of the energy conservation project.
- Projects that offer a short payback period are more likely to be approved by UA as the project is economically viable as an investment even if the GHG emission reductions are discounted.
- Individual project descriptions can be seen in the table below and project calculations are shown in the tables to the right.

## PROJECT ANALYSIS




| emission reduction project | initial cost | annual cost | net present value | MT $CO_2e$ avoided/yr | $/MT $CO_2e$ avoided | payback period (yr) | % towards $CO_2e$ neutrality | status** |
|---|---|---|---|---|---|---|---|---|
| **campus policies:** | - | - | - | - | - | - | - | - |
| project 01: computer power management | $75,000 | $0 | $5,881,026 | 2,328.43 | -84.19 | 0.374 | 1.33% | c |
| project 02: campus building energy use policy | $75,000 | $0 | $2,354,125 | 949.63 | -82.63 | 0.918 | 0.54% | c |
| project 25: parking & carpool incentives | - | - | - | - | - | - | - | d |
| **conservation and efficiency:** | - | - | - | - | - | - | - | - |
| project 03: district energy cogeneration | $12,828,000 | $450,732 | $3,724,858 | 20,684.18 | -6.00 | 13.819 | 11.78% | c |
| project 04: tray less dining | $0 | $0 | $421,393 | 69.89 | -200.98 | 0.000 | 0.04% | a |
| project 05: building energy dashboard | $40,000 | $4,000 | $3,483,687 | 1,424.45 | -81.52 | 0.326 | 0.81% | c |
| project 06: bicycle parking | $150,000 | $0 | $699,431 | 46.67 | -499.56 | N/A | 0.03% | c |
| project 07: ESPCs (educational & general buildings) | $42,000,000 | $0 | $18,120,074 | 23,503.15 | -25.70 | 16.019 | 13.39% | a |
| project 08: ESPCs (auxiliary buildings) | $9,700,000 | $0 | $4,251,309 | 5,454.08 | -25.98 | 15.959 | 3.11% | a |
| project 09: increased recycling | $100,000 | $28,000 | -$482,151 | 207.64 | 77.40 | #N/A | 0.12% | a |
| project 10: food waste to compost | $8,000 | $10,000 | -$209,890 | 3.00 | 2332.11 | #N/A | 0.00% | b |
| project 17: waste oil to space heat | $12,500 | $0 | $126,020 | -6.18 | N/A | 3.827 | 0.00% | a |
| project 18: bicycle parking (phase 2) | $250,000 | $0 | $599,431 | 46.67 | -428.14 | N/A | 0.03% | c |
| project 19: convert buses to run CNG | $1,850,000 | $27,500 | $3,651,433 | 141.55 | -859.85 | 12.393 | 0.08% | c |
| **renewable energy:** | - | - | - | - | - | - | - | - |
| project 11: campus WVO to biodiesel | $20,000 | $3,000 | $452,945 | 32.72 | -461.44 | 2.333 | 0.02% | a |
| project 12: on-campus wind power generation | $26,164 | $0 | $41,611 | 26.50 | -52.35 | 9.868 | 0.02% | c |
| project 13: on-campus photovoltaic array | $23,845 | $0 | $46,895 | 27.65 | -56.52 | 8.780 | 0.02% | c |
| project 20: clean energy from SWEPCO | $0 | $62,845 | -$1,931,341 | 8,027.56 | 8.02 | #N/A | 4.57% | e |
| project 21: on-campus photovoltaic array (phase 2) | $425,477 | $0 | $281,926 | 276.55 | -33.98 | 14.235 | 0.16% | c |
| project 22: clean energy from area wind farms | $0 | $377,070 | -$11,312,087 | 18,992.69 | 19.85 | #N/A | 10.82% | c |
| **sequestration:** | - | - | - | - | - | - | - | - |
| project 14: forest sequestration | $1,110,000 | $0 | $1,001,566 | 3,660.00 | -9.12 | 12.044 | 2.08% | c |
| project 23: forest sequestration (phase 2) | $11,100,000 | $0 | $10,015,659 | 36,600.00 | -9.12 | 12.044 | 20.84% | c |
| **purchase offsets:** | - | - | - | - | - | - | - | - |
| project 15: offsets for commercial air travel | $0 | $91,573 | -$2,747,188 | 9,157.29 | 10.00 | #N/A | 5.22% | c |
| project 16: offsets for commuter travel | $0 | $180,811 | -$5,424,317 | 18,081.06 | 10.00 | #N/A | 10.30% | c |
| project 24: renewable energy certificates | $0 | $188,535 | -$5,656,043 | 14,244.51 | 13.24 | #N/A | 8.11% | c |
| **totals:** | $79,793,986 | $1,424,065 | $27,390,371 | **163,979.70** | | | **93%** | |

status**: a - approved, funded, and underway; b - approved, funding pending; c - approval pending, funding pending; d - proposed, detailed research pending; e - external decision process

## RESULTS

- Project 01, 02, and 05 are low cost, quick payback projects with a combined GHG emission reduction of 4,700 $MTCO_2e$ per year.
- After payback, in less than one year, the reduction in electricity would save UA $390,000 on average per year.
- UA has already undertaken Projects 07 and 08. These energy saving performance contracts (ESPCs) which cost $52 million, save 29,000 $MTCO_2e$ per year, and will save $740,000 on average per year after the payback period has been realized.
- Project 03, although significant at $13 million, is less than the ESPCs while offering a comparable payback period and emission reductions of 20,600 $MTCO_2e$ per year.
- Forest sequestration is attractive as well, but this project assumes that emission offsets are being considered and would otherwise be purchased and therefore savings would be realized.
- Even if every single project in the GHGERP was implemented, UA's campus would still be a net emitter of GHGs as only 93% of current emissions would have been eliminated or sequestered.

## SUSTAINABILITY

- This capstone project shows that these different projects in the GHGERP, focusing on GHG emission reductions, also make economic sense if you consider expenses and savings over the lifetime of the project. This ties together the built and managed systems of sustainability as newer power generation and building technologies allow for cleaner energy to start with, then a more efficient use of that energy, which if accounted for over the project's lifetime shows positive economic returns.
- The natural systems of sustainability are a major factor in this project as the main goal of the project is to reduce GHG emissions to create a climate neutral campus.
- The social systems of sustainability are also pertinent because universities offer a stage where projects like these can resonate and grow, reaching out and informing other groups about what is possible and what is economically viable.

## COMMENTS

- Before I started this project I was under the impression that sustainable projects, or green/environmental/restoration projects were expensive but they were undertaken because of environmental stewardship.
- I now realize that many projects can be good investments when just looking at the economics as long as you consider the flux of payments over the life of the project.
- Now give consideration to the environmental and social aspects of these projects and the triple bottom line looks even more attractive than the economics alone.

## GHG emission reduction project descriptions (01 – 13)

Project 01 improves power management for IT systems campus wide. Software would manage computer servers, printers, monitors, and other components.
Project 02 implements a building energy use policy that establishes uniform temperature set points and building use times for all general and educational use buildings.
Project 03 installs a combined heat & power (CHP) cogeneration system to produce electricity and heat for district energy use on campus.
Project 04, initiated by Chartwells in 2008, reduces food waste simply by removing trays from the dining halls.
Project 05 installs Lucid building energy dashboards in the 20 residence halls on campus. Research shows dashboards make residents aware of energy usage and is effective in promoting conservation.
Project 06 increases the number of bike loops on campus from approximately 1,000 to 1,500 at a cost of $100 per bike loop, and adds an additional covered bike shelter at a cost of $100,000.
Project 07 consists of 3 existing energy savings performance contracts (ESPCs) which guarantee energy savings through building energy conservation and efficiency measures.
Project 08 consists of energy savings performance contracts (ESPCs)for Arkansas Union, Housing, and Athletics which guarantee energy savings through building energy conservation and efficiency measures.
Project 09 increases campus recycled material from 430 tons per year to 500 tons per year. (Paper, cardboard, cans, & bottles)
Project 10 installs a composting tub for dining hall food waste and allocates a part time worker to collect food waste and maintain the tub.
Project 11 began production in January 2009 and is processing waste vegetable oil (WVO) from the 4 dining halls into biodiesel to be used by university.
Project 12 installs 25 kW capacity of wind power on campus.
Project 13 installs 25 kW capacity of solar power on campus.

## GHG emission reduction project descriptions (14 – 25)

Project 14 is to purchase a pine forest and sustainably manage it to sequester and offset campus GHG emissions.
Project 15 introduces a direct pay-as-you-go payment by every department in the university that will offset GHG emissions for about $10 per MT $CO_2e$.
Project 16 introduces a direct payment for the university to offset GHG emissions caused by commuter travel for about $10 per MT $CO_2e$.
Project 17 burns used motor oil for space heat in the Bus Barn.
Project 18 increases the number of bike loops on campus from approximately 1,500 to 2,000 at a cost of $100 per bike loop, and adds an additional covered bike shelter at a cost of $200,000.
Project 19 replaces 10 buses of the Razorback Transit fleet with new compressed natural gas (CNG) buses costing $110,000 each. Initial cost also includes $750,000 towards a CNG fueling station.
Project 20 purchases clean energy from SWEPCO at an additional cost over fossil fuel derived power.
Project 21 installs 250 kW capacity of solar power on campus.
Project 22 purchases electricity from area wind farms at $.015/kWh more than electricity from SWEPCO.
Project 23 is to purchase a pine forest and sustainably manage it to sequester and offset campus GHG emissions.
Project 24 purchases renewable energy certificates (RECs) to offset GHG emissions and support regional projects that implement clean energy production.
Project 25 will consider a wide range of parking and carpool incentives to reduce emissions from commuter travel.

**This poster was prepared in partial fulfillment of SUST 4103 Sustainability Capstone**