UNM

CLIMATE ACTION PLAN

SEPTEMBER 2009

GREEN FOOTPRINT

The University of New Mexico™

UNIVERSITY OF NEW MEXICO • OFFICE OF SUSTAINABILITY • ALBUQUERQUE, NEW MEXICO

The University of New Mexico is committed to reducing energy usage and our impact on the environment. Our president, Dr. David J. Schmidly, is passionate about environmental issues and in April 2008 led the way for the University to adopt "Sustainability" as a core value.

In writing our first Climate Action Plan (CAP), we followed two parallel paths. The Carbon Neutral Task Force formed by the Sustainability Council and headed by Jeff Zumwalt, Associate Director - Utilities, met for over a year and developed a list of projects. These projects outline specific actions and goals that UNM can accomplish in five year increments with a reasonable level of funding and technological advances. A description of these projects can be found in Part VI of this document. We also asked Dr. Bruce Milne, director of the Sustainability Studies program, and his Sustainability 434 students to assist us in the CAP process and they put together a report titled "Carbon Neutrality at UNM." The students presented this plan at an open forum in May and invited the UNM community, neighborhoods associations, local environmentalists, and others to give their input.

The documents compliment each other as they cover all aspects of sustainable practices and emphasize the desire and ability of the students, staff, faculty, and administration of UNM to reach carbon neutrality. The Office of Sustainability combined both documents into the attached Climate Action Plan.

We submit this Climate Action Plan, a combination of ideas and ideals, conceived to continue UNM on its path to a sustainable future.

- UNM Sustainability Council, September 2009

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I. Executive Summary

President David J. Schmidly signed the American College & University President's Climate Commitment (ACUPCC) in June 2007, committing the University of New Mexico (UNM) to carbon neutrality. Though UNM had already initiated a number of carbon-emission reduction initiatives, this commitment was a bold move to place UNM at the forefront of climate and sustainability leadership in the 21st Century. The climate action plan is due to the ACUPCC in September 2009. This plan is an initial attempt at formulating that strategic action plan and mapping the reduction of 80% of the Albuquerque campus 2006 emissions by 2030.

The recommended measures, which combined would eliminate a minimum of 70% of the Albuquerque campus 2006 emissions by 2030, are as follows:

- Recognize the need and act to promote a community which closes resource loops and encourages cooperative green businesses;
- Establish a phased 20-30 megawatt renewable energy system on UNM's roofs to provide electricity;
- Install smart grid technology to decrease and streamline UNM's electricity demand;
- Commit to moving commuters out of cars and into mass transit, onto bicycles, or onto feet;
- Exceed Architecture 2030's guidelines and phase in carbon neutral new and renovated buildings;
- Establish a Revolving Loan Fund to capture and reuse savings and earnings from sustainability projects to fund future sustainable projects.

UNM has stepped up to the plate and has the capacity to use its influence as an anchor institution to promote climate-action and sustainability on a regional scale. At the same time, it has the potential to drastically reduce its long-term energy and resource costs while improving the well-being of its community members. Enacting carbon neutrality is a long-term strategic interest and in the best interest of the University and the climate.

II. Introduction

Vision: UNM will achieve a zero net carbon emissions campus while ensuring and improving its economic strength, community cohesiveness, and environmental footprint, along with the well-being of individual community members.

Mission: Outline a feasible plan to drastically reduce emissions produced by the three biggest carbon sources on UNM's Albuquerque campus: electricity, transportation, and heat. This plan will meet the ACUPCC's deadline for a carbon neutrality plan and provide a direction for further efforts to reach zero net carbon emissions.

Universities today face unpredictable energy costs, budget cuts, student financial insecurity, rising employee insurance contributions, and other grave challenges to solvency and resiliency. These symptoms reflect global issues and require bold action to alleviate: continued social inequality and upheaval; increasing environmental degradation; higher economic uncertainty; and greater climate change as greenhouse gases are released to fuel conspicuous consumption and rising populations who conduct 'business as usual.' Our inaction will only worsen these grave situations.

When President David J. Schmidly signed the American College & University Presidents' Climate Commitment, he joined the ranks of 620 leading academic institutions that are shifting the nation towards carbon neutrality , energy security, budget stability and ecologically-minded prosperity (see Text Box 1 for requirements of the APUPCC). Reversing the effects of anthropogenic global warming is the defining challenge of the 21st century. Sustainability is not only possible, it is imperative.

The time has come for the University of New Mexico to help reposition our state and region to the forefront of the green economy and support the holistic well-being of all New Mexicans. The following plan outlines radical yet common sense steps that the University can make to join fellow universities in establishing the moral leadership and strategic direction that is needed to address this challenge. Already, the Physical Plant Department and several academic departments have begun to lead the way in noteworthy climate action. The University has made it a strategic objective to reduce campus carbon emissions by 80 percent by the year 2030 and establish the needed framework to make UNM carbon neutral by the year 2050.

While this plan focuses on achieving zero net emissions, its authors recognize that carbon neutrality is only one step towards achieving a robustly sustainable institution. A truly sustainable university campus will be a clearinghouse for sustainable research and encourage green practices and entrepreneurship. In 2008, President Schmidly signed University Business Policies and Procedures (Big Red) 2100 "Sustainability," which outlines principals and the role of governance, operations, curriculum and research, and community service in creating a sustainable campus. This policy and recommendations to increase its comprehensiveness, are found in the appendices.

This plan will (1) review UNM's Greenhouse Gas Inventory and past climate action; (2) discuss a comprehensive strategy towards carbon neutrality, and (3) analyze major challenges and potential actions for the University to take. Our focus will be on the three main sources of UNM's carbon emissions: electricity, thermal energy (heating and cooling), and transportation (commuting and fleet). These fall into 'scopes' as outlined in Table 1.

Text Box 1: Requirements of the ACUPCC

- Within 2 months of their Implementation start date, signatories are committed to submitting information on the institutional structure for developing their climate action plans, including designating the institutional liaison and the two tangible actions that will be implemented before the end of year 2;
- Within 1 year, signatories are committed to reporting the results of their GHG emissions inventories;
- Within 2 years, signatories are committed to submitting their climate action plans;
- Within 3 years and at least every other year thereafter (years 5, 7, 9 etc.), signatories are committed to updating their GHG emissions inventories;
- Within 4 years and at least every other year thereafter (years 6, 8, 10 etc.), signatories are committed to submitting narrative reports describing progress in implementing their climate action plans.

Table 1: Emission Scopes, Ownership & Control

Scopes	Sources	Ownership of Emissions	Control of Emissions
1	Vehicle fleet, natural gas burned to create steam heat and/or electricity on campus	UNM	UNM-direct
2	Electricity or heat purchased from a third party such as PNM or NM Gas Co.	Third Party	UNM-indirect
3	Faculty/staff/student commuting	Third Party	Third Party

III. Background

A. Greenhouse Gas Inventory

Those schools that sign onto the ACUPCC are required to keep an inventory of the six green house gases (GHGs) recognized by the Kyoto Protocol. In accordance with this requirement Jeffrey A. Zumwalt, Associate Director of the UNM Physical Plant Department, conducted a baseline GHG Inventory analyzing UNM's emissions for the calendar year 2006 (See Figure 3 and Table 2). We will be using the inventory of 2006 as the baseline measurement for further reductions. The methodology for the analysis was adopted from the "Greenhouse Gas Protocol" developed by the World Business Council for Sustainable Development and the World Resources Institute. Gases are measured using a scale of Carbon Dioxide equivalents. The inventory includes emissions from the Central Campus, North Campus and South Campus.

Figure 2: Causes of UNM's Green House Gas Emissions

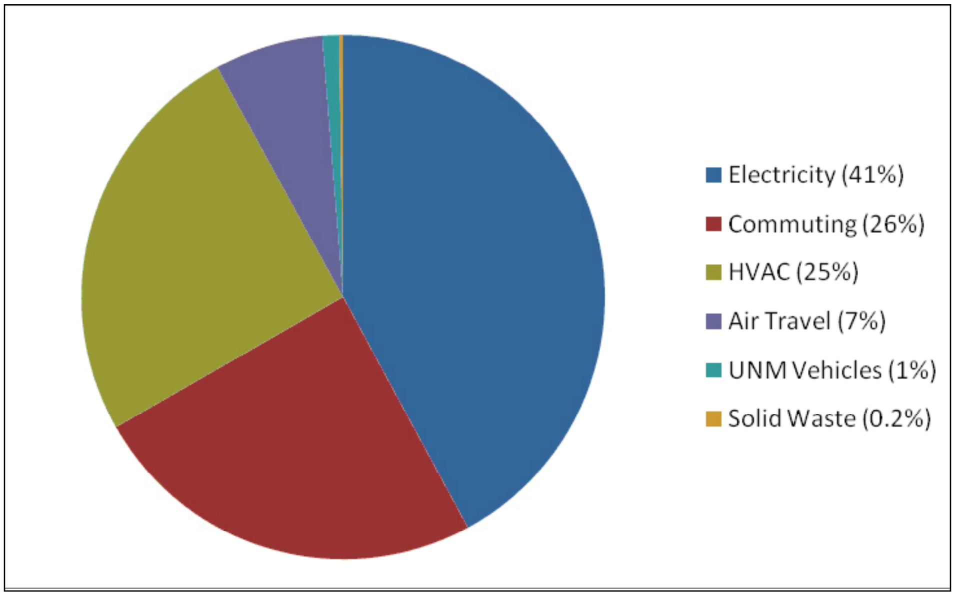


Table 2: Sources of UNM Greenhouse Gas Emissions

Origin	Emissions MTCDE	%
Electricity	72,131	41
Commuting	45,245	26
Heating	33,291	19
Air Travel	11,484	7
Cooling	10,038	6
UNM Vehicles	1,792	1
Solid Waste	406	0.2

A.1 Three Largest Emitters:

Electricity

The largest emitters of GHGs are the Scope 2 emissions, which involve the indirect creation of the energy. PNM is the primary provider of power to the campuses. The largest amount is provided by the electricity and lighting of the school, which includes energy consumed by the many IT services offered by the school which are powered nearly 24 hours a day.

HVAC

Another large source of emissions is the energy used to heat and cool buildings. Large amounts of heating and cooling energy are used.

Transportation

Since UNM is a school where less than 10 percent of its active students live on school property it is considered a commuter school. Another 75 percent of the Faculty, Students and Staff live within a 3 mile radius of the University, giving the surrounding neighborhoods an unwelcome encroachment of car traffic. Considering that an average student travels up to 22 miles to school. And also 15 percent of the student body reside over 60 miles from the campus. The UNM Parking and Transportation Services, which is independent of both the University and the state legislature, employs over 70 full time bus drivers.

A.2 Scopes

Currently the emission of carbon or greenhouse gases (GHG) is divided into three different scopes:

i. Scope 1—Direct carbon emissions and energy consumed by the University's infrastructure. For example, the on-campus generation of heat by UNM (See Table 3).
ii. Scope 2—Any indirect amount of energy used, in the case of UNM our electricity comes from PNM. For example, the outside energy used to supplement electricity use (See Table 4).
iii. Scope 3—Externalities associated with both Scope 1 and 2's operations. For example, the transportation of individuals and of the food consumed at the University (See Table 5.)

Table 3 - UNM Scope 1 (Direct) GHG Emissions

Source	Energy (MMBtu)	GHG (MTCDE)
Natural Gas (utilities)	775,378	41,052
Gasoline	14,695	1,057
Diesel	2,921	213
Natural Gas (vehicles)	9,792	521
Total:	802,786	42,844

Table 4 - UNM Scope 2 (Indirect) GHG Emissions

Source	Energy (MMBtu)	GHG (MTCDE)
Purchased Electricity	837,657	74,408
Purchased Heating	0	0
Purchased Cooling	0	0
Total:	837,657	74,408

Table 5 - UNM Scope 3 (External) GHG Emissions		
Source	Energy (MMBtu)	GHG (MTCDE)
Student Commuting	483,158	34,770
Faculty/Staff Commuting	145,573	10,475
Air Travel	58,243	11,484
Solid Waste	n/a	406
Total:	686,974	57,135

B. History of Climate Initiatives at UNM

UNM, as an anchor institution, has provided sustainable models and practices for the rest of the local community to build upon.

In 2006, Bill Richardson issued Executive Order 2006-001 which is the green building initiative, wherein all newly constructed state buildings in excess of 15,000 square feet be built to a minimum and achieve a minimum rating of LEED Silver.

In November 2006 Dr. Bruce Milne of UNM's Biology dept. proposed the formation of a Sustainability Studies Program, which would incorporate an inter-disciplinary curriculum.

In 2007, President Schmidly signed into ACUPCC, which provided the connections and implementations of over 600 other American campuses, and their goal to achieve carbon neutrality.

2009. On January 22 Bill Richardson signed into executive order the creation of "Green Jobs Cabinet." This Cabinet will comprise of different chair people from the fields of education, energy, and natural resources.9

IV. Strategic Framework

Through time, the campus carbon plan will be adjusted to accommodate evolving policies, technologies, costs, and opportunities. Thus, a strategic framework to serve current and future plans establishes criteria and principles to guide future choices. The strategic framework for carbon emission reduction and sustainability satisfies three criteria:

(1) Outcomes are measurable, achievable, and performance-based,

(2) Fiscal responsibility is adhered to, and

(3) Risks to the University are characterized and minimized.

Achievement of carbon neutrality requires measures of performance, cost, and risk. The carbon neutral plan seeks a quantitative net-zero balance between carbon emissions and uptake to avoid catastrophic climate change (IPCC 2007). Best practice campus carbon planning (APPA 2009) relates directly to the three criteria by: (1) maintaining carbon inventories for each campus, (2) performing cost-benefit assessment of alternative policies and actions to balance carbon emissions, and (3) including analysis of trends (Smith 2007) that expose the University to various levels of risk, e.g., rising energy costs. Inventoried carbon falls into one of three scopes including: (1) direct on-campus utility operations, (2) indirect purchased fossil fuel power, and (3) other sources of carbon, both upstream and downstream from campus, as incurred by purchasing, professional travel, and commuting.

The strategic framework is founded on the principle of holism (UNM Policy 2100) whereby designs and solutions pay-forward to support and restore systems that provide the materials and energy for well-being (Hawken et al. 1999). From UNM Policy 2100, From UNM Policy 2100, "the Principle of Holism [means] the system as a whole determines in an important way how the parts behave. The system includes physical, biological, chemical, social, economic, and cultural elements among others.
Holism encourages strategies that couple desired outcomes to incentives.
Holism includes [life-cycle] accounting for environmental and social impacts beyond the geographic confines of the campus...
Holism views waste as potential resource and thus favors strategies that follow the hierarchy of waste prevention, recycling/reuse, treatment, and disposal.
Holism requires transparency via participatory planning practices, open documentation, visible implementation, and effective communication to students, faculty, staff, and the public."
Holism embraces the triple-bottom line of sustainability (Brundtland 1987), namely social equity, environmental protection, and economic opportunity, often abbreviated as people, planet, and profit. Social equity and well-being (e.g., Maslow 1943) encompass four dimensions: body, mind, heart, and spirit, which point to physical needs, knowledge, connection, and meaningfulness, respectively (Covey 2004). Global surveys reveal a disconnect between economic wealth and holistic, subjective well-being (Fig. 1). Thus, lives bereft of connection and meaningfulness are due in part to excessive economic production that concentrates wealth in the hands of an elite minority while compromising the democratic foundations of free society (Alperovitz 2005, Speth 2008).

Holism affords the view that UNM is an anchor institution (Alperovitz 2005) where inherent long-term stability and demand for goods and services justify a partnership of "town and gown" (Freeland 2005). UNM could drive growth of a local green economy where students and the institution benefit through cooperative models of ownership and wealth. Thus, the plan envisions ways to leverage the financial risks of students and their families to accomplish the University's goals of retention and graduation. For example, the creation of student-owned businesses, such as the Lobo Growers Market (est. 2007), to serve the campus and community would enable students to accrue equity while employed, and ultimately dividends after graduation, thereby lessening the financial risk of remaining in school.

Strong sustainability (Speth 2008:120) closes the loops between resource supplies, use, and waste (McDonough and Braungart 2002). Waste is valued as a resource that enhances and preserves the productivity of land, water, and nature to support human needs. Strong sustainability includes management of greenhouse gas emissions within a carbon cap & trade policy (Krupp and Horn 2008). Management extends throughout the value chain from raw resource extraction through product use and disposal/recycling, in keeping with trends at state, regional, national, and international levels. Strong sustainability points toward solutions that include waste avoidance technology, power purchase agreements, creation of a campus-neighborhood zone within City zoning, and anchor enterprises such as student-owned green living and learning centers, a campus farm, student-owned restaurants connected to the farm, incentives for near-campus living by students, faculty, and staff that reduces commutes, with conscious development of shop-play opportunities to promote safety and well-being.

In summary, the strategic framework for long-term carbon neutral planning addresses performance, financial responsibility, and risk through focus on carbon inventory, cost-benefit analysis, and trend assessment, respectively. Carbon accounting includes direct, indirect, and miscellaneous flows that cut across various sectors including electricity, thermal energy, water, structures, landscape, transportation, and food. Strategic guidelines available as Architecture 2030 and the US Green Building Council's LEED standards address major sectors and serve as models for application to food, landscape, and transportation. Holism is the guiding principle, where well-being is achieved by satisfying needs of the body, mind, heart, and spirit. Conceptualizing the campus as an anchor institution opens opportunities for thriving community relationships that feed back to reduce financial risks of students and thereby improve recruitment, retention, and graduation rates.

1. Alperovitz, Gar. 2005. America Beyond Capitalism: Reclaiming Our Wealth, Our Liberty, and Our Democracy. John Wiley & Sons.

2. APPA 2009. The Educational Facilities Professional's Practical Guide to Reducing the Campus Carbon Footprint. Association for Physical Plant Administrators (APPA), Alexandria, Virgina.

3. Covey, S. R. 2004. The 8th Habit: From Effectiveness to Greatness. Free Press. New York.

4. Freeland, R. M. 2005. Universities and cities need to rethink their relationships. Chronicle of Higher Education. 5/13/2005.

5. Hawken, P., A. Lovins, and L. Hunter Lovins. 1999. Natural Capitalism. Little, Brown and Company. Boston, New York, London.

6. Krupp, F. and M. Horn. 2008. Earth: The Sequel. W. W. Norton and Co. New York and London.

7. Maslow, A. H. 1943. A Theory of Human Motivation. Psychological Review 50(4):370-96.

8. McDonough, W., and M. Braungart. 2002. Cradle to Cradle: Remaking the Way We Make Things, by North Point Press.

9. Smil, Vaclav. 2008. Global Catastrophes and Trends: The Next Fifty Years. The MIT Press. Cambridge.

10. Speth, James Gustave. 2008. The Bridge at the Edge of the World: Capitalism, the Environment, and Crossing from Crisis to Sustainability. Yale University Press, New Haven.

V. Key Recommendations

A. Ensuring a Sustainable Campus

Carbon neutrality is a single piece in the puzzle of creating a sustainable campus. Thus, this document necessarily recognizes a need for planning for sustainability as well as for carbon neutrality. This section will briefly discuss the major facets of a sustainable campus and the appropriate priorities to be adopted therein.

1. Energy

i. Stop adding to the problem - encourage greater conservation and efficiency measures to achieve the greatest carbon savings and financial savings at the lowest cost ("low-hanging fruit," sustainable insulation, tighter regulation of heating and cooling buildings, etc.)

ii. Invest in Renewable Energy - To power campus, UNM should invest in renewable energy such as solar panels, wind turbines and combined solar/wind turbines. A new entity, REGAIA (Renewable Energy Generation Administrative Interdepartmental Alliance) could be created to regulate energy generation and distribution for the campus on a day-to-day basis. By working closely with the Environmental Services – Grounds and Landscaping, Sustainability Studies program, Engineering department and the College of Architecture and Design during development and progression of the energy generation process, students could learn vital skills for the new green economy.

iii. Encourages research in renewable energy - UNM should encourage research on viable alternative energy forms, such as ethanol produced from algae, and more efficient wind and solar collectors.

iv. Invest in community – UNM could start an Electric Co-op after it achieves generation capabilities. The standard rural electric co-op model could be used: People off-campus can get on the green UNM grid if they provide a certain amount (some amount greater than 40% less than 80% required) of their own electricity. This way, UNM can make money, and people in the community can save money.

2. Facilities

i. Require new facilities to incorporate the greenest technologies available – New facilities should exceed Architecture 2030 standards and LEED Gold Standard, made with organic materials where possible. They should be designed to incorporate energy generation and conservation as well as rainwater/wastewater sequestration and recycling. New campus buildings could be designed by a task force consisting of students and professors from the Sustainability Studies Program and the College for Architecture and Design. The task force could include one outside architect as a consultant.

ii. Renovate old buildings with new sustainable technologies - When refurbishing facilities, incorporate energy generation and green materials and increase efficiency (of electricity, water, etc.) wherever possible.

3. People

i. Well-being - UNM should acknowledge the physical, spiritual, social, and intellectual needs of its community members. For example, living wages, community research service learning courses, and University-wide events are known to foster interconnectedness and general well-being .

ii. Social justice in purchasing & investing – UNM should ensure that its endowment and purchasing practices support green, fair trade businesses.

iii. Incubate sustainable cooperatives to serve campus community – UNM's role as an anchor institution for economic development encourages residents to build, own, and operate businesses that provide goods and services to the University in a carbon neutral manner (Milne).

iv. Create a community resource center for sustainability and green entrepreneurship - UNM's role as an anchor institution can serve the community by creating a resource center for community members to learn about and develop sustainable projects and businesses.

4. Consumables

i. Implement a 'Waste Not' campaign - Discourage the purchase of disposable items and encourage recycling and the purchase (or manufacture) of recycled and eco-friendly items. UNM should implement a recycled-paper-only policy. Food and plant waste should go to an on-site compost to enrich landscaping or continue to go to Soilutions.
ii. Shift UNM towards sustainable food practices - On-campus dining facilities should expand its purchase of local, organic and/or fair trade food (prioritized in that order). UNM should either ally with La Montanita Co-op or start a food co-op of its own to ensure that fresh, local produce is available to the students. In order to be fully sustainable, UNM could produce a large portion of the food students consume at UNM.
iii. Invest in on-campus vertical farms - Current research shows that vertical farms are potentially the most efficient and carbon neutral means of producing large amounts of food. UNM could use vertical farms to feed its community and create a revenue stream.

5. Water

i. Implement a strict policy of water efficiency
ii. Strive to increase the efficiency of its water systems.
iii. Replace unnecessary portions of grass with Xeriscaping
iv. Improve water reclamation capabilities – Via storing rainwater, converting runoff into useable water, etc.

B. Roadmap to Innovation: The Regenerative Enterprise Zone (RED)

"We can begin to change the minds of the world not only ... through what we teach students, but by embodying what we teach through how we design, how we actually build and run campuses as microcosms of the larger society. " David Orr

The plan envisions a systematic approach to managing carbon flows on campus and at the interface with the city. Within the strategic framework of the carbon neutrality plan, financial risks that typically compromise students' abilities to remain in school and graduate are valued as opportunities to accomplish the institution's strategic goals. UNM's role as an anchor institution (Alperovitz 2005) for economic development encourages residents to build, own, and operate businesses that provide goods and services to the University in a carbon neutral manner. Student employees earn equity and dividends that offset expenses while in school and help to repay debts after graduation. Over time, carbon neutrality is achieved by developing the campus and surroundings into a Regenerative Enterprise District (RED).

Flows of resources through our conventional campus (Fig. 1) are essentially linear, where inputs produce low-value outputs and waste (Fig. 2). In the near term, modifications of the flows are possible by switching to clean energy sources that generate carbon credits of monetary value that can support further improvements.

Figure 1: Linear flows of energy and material through the conventional campus.

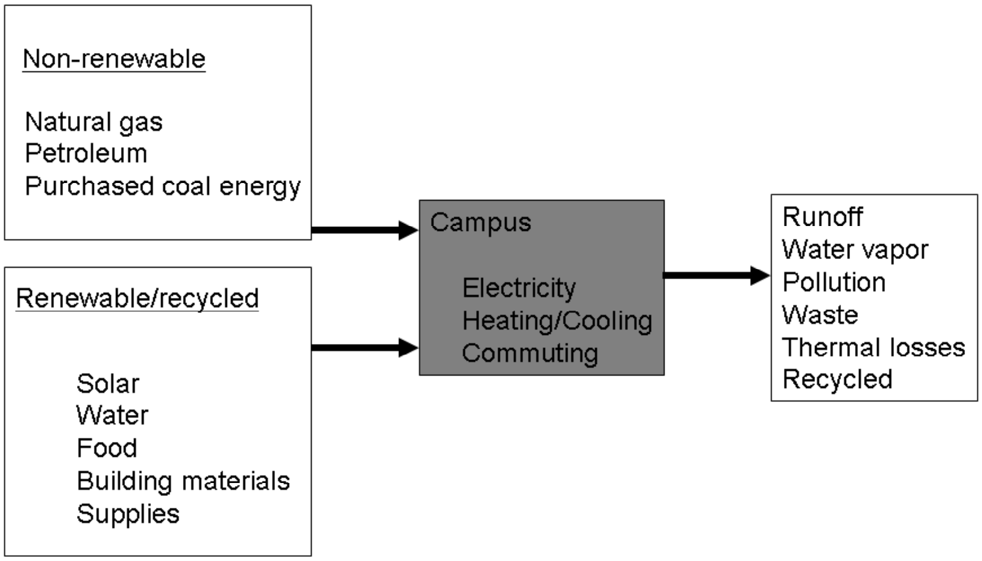
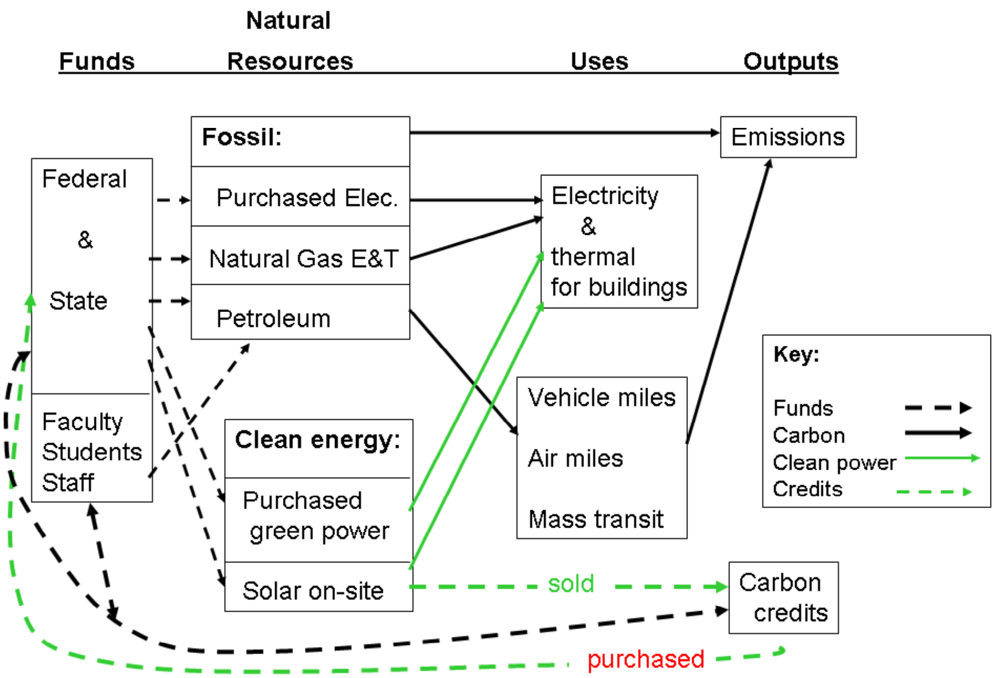
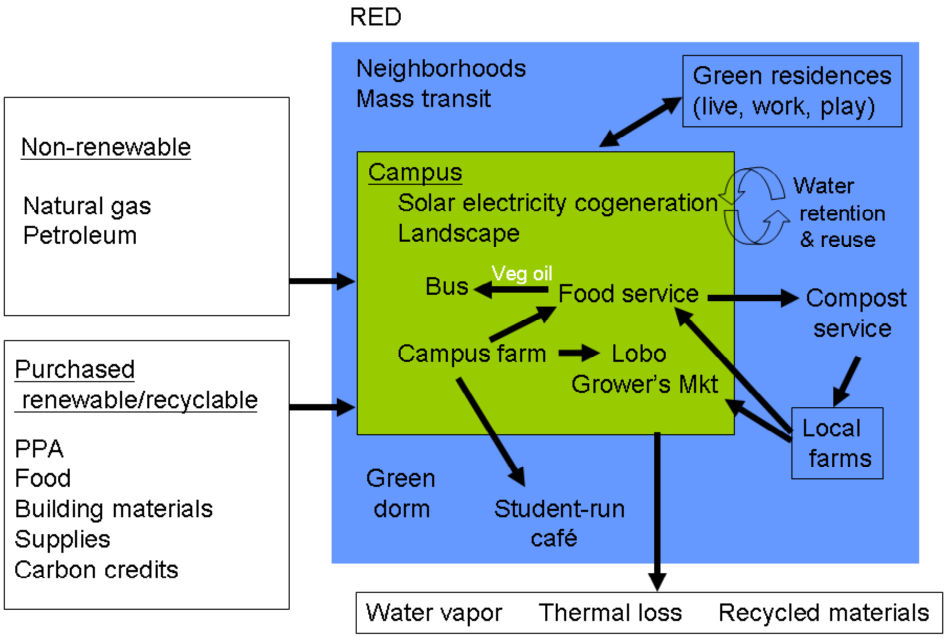


Figure 2: Near-term flows of expenditures, resources, emissions and carbon credits.



In the longer term, a holistic design establishes flows of energy and material in loops throughout integrated systems (Alexander 2002). Other campuses such as Syracuse University and Oberlin College pioneered holistic solutions for individual buildings and are currently redeveloping adjacent neighborhoods. A similar approach is envisioned for UNM and its neighborhood partners. With guidance from the Albuquerque City Planning Department, the RED (Fig. 3) will add diversity to the necklace of centers that stretch along Central Avenue from east to west including the International District, Nob Hill, EDO, Downtown, Old Town, the Biopark, and Atrisco.

Figure 3. Regenerative Enterprise District (RED) includes the UNM campus and surrounding neighborhoods. The district houses worker-owned businesses that connect via flows of energy, materials, and money.



Linked by mass transit, the network of centers provides low-carbon access to venues for living, working, and playing. A string of growers' markets, including the Lobo Growers' Market (LGM), provides access to local, organic food while supporting local farmers, thereby helping to keep dwindling agricultural land in production, with attendant benefits for water quality, food security, and biodiversity (Kloppenburg et al. 1996).

Within the RED, on-campus solar thermal generation, smart grid, and an extensive campus fresh food system are key infrastructural elements around which cycles of waste recovery and resource regeneration can form. Associated student- and worker-owned, carbon neutral, enterprises (e.g., the g-Dorm, a LEED platinum dormitory; the Lobo Growers' Market; an organic cafe; Table 1) are living and learning venues that generate income shared by campus, students, parental-investors, and the community. The vision includes partnerships with landlords who retrofit properties for greener living in exchange for contact with prospective student renters in good academic and financial standing. The carbon-intensive campus of today contrasts sharply with the educational and economic vitality of the RED.

Table 1. Crude estimates of costs and benefits of sustainable enterprises for the RED.

Enterprise	Initial Capitalization	Annual Operations	Annual Gross Receipts	Carbon Balance MTCDE/yr
Lobo Grower's Market	$2,000	$20,000	$20,000	6
Green Lobo Café (1200 sf @ $300)	360,000	140,000	144,000	C-Neutral
Green Dorm (110 beds)	1,800,000	200,000	544,500	C-Neutral
Farm	50,000	100,000	100,000	-3

Alexander, C. 2002. The Nature of Order. Center for Environmental Structure, Berkeley, California.
Alperovitz, Gar. 2005. America Beyond Capitalism: Reclaiming Our Wealth, Our Liberty, and Our Democracy. John Wiley & Sons.
Kloppenburg, J., Jr., j. Hendrickson, and G. W. Stevenson. 1996. Coming in to the foodshed. Agriculture and Human Values 13(3):33-42.

C. Electricity Recommendation #1: Solar Power/Power Purchase Agreements (PPA)

Steps to a Solar-Powered UNM

UNM's Electricity use accounts for 41% of its carbon emissions. To solve this problem quickly, we would like to see UNM utilize renewable energy for its electricity needs. One very viable solution would be solar: it can be installed on existing rooftops at UNM, making the most efficient use of space. On-site generation minimizes the percentage of energy lost in transmission and avoids any potential conflicts with owners of the energy grid (PNM). Further, renewable energy generating facilities on UNM campus could serve as learning opportunities for students in a variety of departments such as Engineering, Community and Regional Planning, and Environmental Science. UNM's current peak electrical load is 25 MW.

The following are 3 potential solutions to realizing on-site solar generation at UNM:

1. Buy and Install Solar Panels at UNM expense

UNM buys, installs and owns solar panels on their roofs. Priority is given to local businesses that manufacture/supply or install.

Benefits:

- UNM-owned power producing facility
- Utilization of Revolving Fund to finance further RE projects (see Section G)
- Local economic development
- PNM transmission lines are not used

Risks/ Drawbacks:

- Substantial up-front capital investment
- Installed technology could become obsolete

Currently, PNM will pay large facilities (over 1 MW) $ 0.15/kWh that is produced and used on site. Any amount of energy that is unused will go into PNM's grid which they will buy at cost or $ 0.05/kWh. PNM offers this agreement under a 20-year contract .

To illustrate with a small scale example:

UNM produces 1000 kWh and uses 800 kWh on-site and the remaining 200 kWh are sold back into the grid. PNM pays UNM $ 0.15/kWh for the 800 kWh used on-site and $ 0.05/kWh for the 200 kWh that are sent to the grid.

A 10 MW photovoltaic system will cost about $ 50,000,000 to build and install. This estimate will factor in $ 20,000/ year for operations and management, which is minimal for solar PV systems. Therefore, the cost of a 10 MW system with a 30 year lifetime is $ 50,600,000.

Applying this to a 10 MW system gives a total cost equation:
Total Cost= costs –benefits

Total cost will equal our initial investment of $ 50,000,000 plus the annual O&M cost of $ 20,000, or $ 50,600,000. Total benefits will be equal to the avoided cost of supplying electricity to UNM's buildings plus the total energy use of the buildings for which we will receive Renewable Energy Credits plus any extra energy produced that PNM buys from UNM.

C =Total cost
X=energy used on-site
Y= "extra" energy sold to the grid
Z= years of PV system operation
C= ($ 50,600,000) –
{[$ 0.05/kWh] X + [$ 0.15/kWh] X} + [($ 0.05/kWh) Z]

The payback period would increase if UNM did not use all the energy produced and sold it to the grid because buyback rates are lower. It is in our best interest to use all power generated. Further, utilizing Lobo Energy, Inc. as the purchaser of the PV system may make UNM eligible for a 30% tax rebate.

Assuming that UNM uses all the energy that it produces (10 MW):

Power produced by system per month:
10,000KW x 155 hours of sunshine/month= 1,550,000 kWh /month

Because UNM would not purchase this amount of energy from PNM, calculated monthly savings:

(1,550,000 kWh) (0.05$/kWh)= $ 77,500 per month= $ 930,000 /year

PNM also pays $ 0.15/kWh for renewable energy produced and used on-site:

(1,550,000 kWh) ($ 0.15/kWh)= $ 232,500 per month=$ 2,790,000 /year

Total benefits per year for 10 MW PV system = ($ 930,000 + $ 2,790,000) =$ 3,720,000

Our initial investment of 50,600,000$ will be paid off in less than 14 years (50,600,000/3,720,000)= 13.6 years

Our proposed solution is a phased investment:
10 MW by 2012
10 MW by 2022
10 MW by 2030
Total: 30 MW of Solar Power by 2030

2. Go through a private company

UNM enters a PPA with a company such as Sun Edison who will install panels on UNM roofs and charge only for the electricity generated. Basically, this agreement would be just like a traditional PPA but the power plant would be on-site, on the roofs.

Benefits:

- No up-front capital costs
- 20 year PPA means that UNM knows their energy costs for the next 20 years
- Protection against obsolete technology (UNM buys the power, not the equipment)
- Any "extra" energy is sold to PNM.

Risks/ Drawbacks:

- Currently, no NM-based companies have the capabilities of Sun Edison, meaning that the PPA project would not benefit NM companies. This creates tension within our vision of UNM as an anchor institution, providing economic development opportunities to the community.
- Depending on the agreement, UNM may not be able to make any direct decisions pertaining to the operations of the power plants.

3. Renting solar panels

UNM rents solar panels installed on their roofs. UNM would only pay the company to rent the panels, and the electricity generated would be solely UNM's property.

Benefits:

- No up-front capital costs
- Protection against obsolete technology
- Any "extra" energy is sold to PNM

Risks/Drawbacks:

- Currently, no NM-based companies operate under a solar renting business model, which means that the solar project would not benefit NM companies. This creates tension within our vision of UNM as an anchor institution, providing economic development opportunities to the community.
- Depending on the agreement, UNM may not be able to make any direct decisions pertaining to the operations of the power plants.

4. Storage and Electric Co-op

Once the campus is generating its own renewable energy, an appropriate amount of excess electricity (enough for a few days at least) should be stored in batteries for emergency purposes, and further excess electricity can be sold back to the power provider. However, for UNM to take a leadership role in sustainability, it could create a neighborhood co-op. If someone off-campus wanted to join the co-op, they would have to produce a certain amount of the total energy they use (somewhere between 40% and 80%) through renewable means like solar power in order to have most (20-40%) of the rest of their energy be provided by the excess energy UNM has produced (the remainder, if there is any, could be made up by the homeowner by purchasing from PNM). This would provide revenue to the University (since UNM would be selling energy directly to the consumer) and promote renewable energy generation while not burdening UNM's energy infrastructure.

D. Electricity Recommendation # 2: Smart Grid

America's electricity grid is built upon what many consider to be an antiquated principle: Make large amounts of electricity and have it always available to end users whether they need it or not. It's much like the way most home water heaters keep water constantly hot even when it is not being used. It is also a strictly one-way relationship, with utilities supplying power to end users, but not vice-versa. UNM has an exciting opportunity to become a model for new smart-grid technology in Albuquerque and the nation and help to spur on the movement towards a more advanced energy infrastructure to go with the other advances in energy technology. This new grid system is called the "smart grid". It is the digitization of the power grid, combining the reliability of our traditional grid with the adaptability and information sharing capabilities of the internet.

Albuquerque Mayor Martin Chávez became the first mayor in the country to sign the GridWise Constitution at a conference exploring more efficient methods for distributing and consuming electricity. Maintaining that momentum, UNM, PNM, and ECI (Energy Control Inc.) have begun a partnership to create a direct link between the monitoring and control systems at UNM and PNM. This partnership must continue to be supported and strengthened, allowing UNM to become the first completely 'smart' powered University.

Benefits:

- Puts responsibility back into the hands of users, creating sustainable futures through awareness.
- New grid self-heals after power disturbances
- Enables active user participation in demand response
- Operates resiliently against physical and cyber attacks
- Accommodates distributed generation and storage alternatives (i.e. electric cars, etc.)
- Optimizes assets to operate efficiently
- Bi-directional communication infrastructure enables intelligent use and production, making the grid more efficient on both ends.
- Government grants available to help offset costs.

Risks/Drawback

- High upfront costs for implementation

E. Thermal Energy Recommendation: Exceed Architecture 2030 Standards

Emissions from thermal energy use (heating and cooling of buildings) account for 25% of UNM's carbon emissions. LoboTherm is a model of emissions from thermal energy for heating buildings. LoboTherm specifies the rates of energy use in conventional and green buildings and how use changes through time. The model represents net growth in square footage, loss of square footage through decommissioning, renovation of conventional into green buildings, construction of new greener buildings, and ongoing improvements in energy efficiency through design and by selective decommissioning. Reductions in emissions are modeled to identify opportunities for intervention. A feasible scenario is provided that reduces emissions to approximately 20% of 2006 levels by 2030. Priorities for monitoring and making updates to LoboTherm are included.

LoboTherm model

1) Square footage – conventional and green

In 2006, UNM Albuquerque campus had 6,621,455 square feet of conventional building space. With Governor Richardson's executive order, all new and renovated space is required to meet USGBC LEED Silver criteria. Although LEED Silver does not mandate a particular reduction in carbon emissions, the mandate effectively creates two categories of square footage: conventional and green. Mary Kenney (Planning Officer, PCD) expects total square footage to grow at b = 150,000 sq. ft. per year. Architecture 2030 assumes that existing stock turns over every 50 years through decommissioning and renovation. Thus, LoboTherm describes conventional square footage through time, $S_{c,t}$, as a linear decline from 2006 to 2056 according to:

$$S_{c,t} = S_{c,0} - (S_{c,0} /50)t \qquad [1]$$

Where $S_{c,0}$ is the total square footage in 2006 and t is years since 2006. LoboTherm then examines the fate of each square foot through time by representing the fraction μ of $S_{c,t}$ that is taken out of service and the fraction r of the surviving (1 - μ) $S_{c,t}$ square feet renovated from conventional to green. LoboTherm is given the fraction of remaining conventional renovated, r, and solves for μ consistent with Eq. 1. Thus, conventional square footage (Figure E1) behaves as:

$$S_{c,t+1} = S_{c,t} - \mu S_{c,t} - r(1-\mu)S_{c,t}$$

[2]

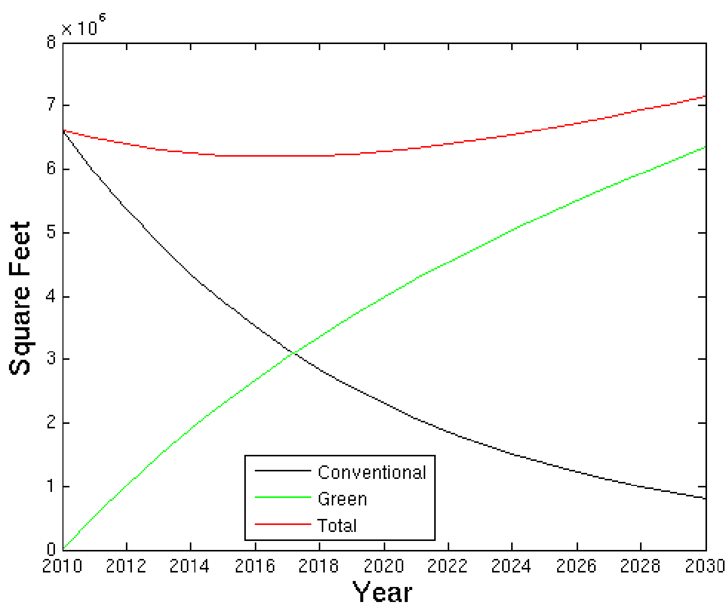


Figure E1. LoboThem predictions of conventional and green square footage, 2010-2030.

Green square footage grows by new construction and renovation according to:

$$S_{g,t+1} = S_{g,t} + r(1-\mu)S_{c,t} + b$$

[3]

2) **Emission intensity per square foot**

In 2006, conventional space was heated with natural gas. Combustion produced $CO2$, $CH4$, and $N2O$ in amounts of 48,671.8, 4,863, and 0.097 MT, respectively. Conversion factors of 23 lbs $CO2$ equivalent per lb of $CH4$ and 296 lbs $CO2$ equivalent per lb of $N2O$, give thermal emissions in 2006 of 48,812 MTCO¬2e. Division by $S_{c,0}$ gives a thermal emission intensity of δ_{2006} = 0.0074 MTCO2e/ft2. LoboTherm assumes that PPD and PCD will prioritize buildings with highest emissions per square foot for decommissioning and renovation; thus δ is assumed to ramp down through time to 80% of δ_{2006} by 2056, which gives δ_{2030} = 0.0068 MTCO2e/ft2. The validity of this assumption is untested.

3) **Performance criteria for green buildings**

Architecture 2030 seeks carbon neutral buildings by 2030 along a smooth glide path beginning with 50% reductions in energy use immediately. However, given the substantial amount of conventional space at UNM, the planning exercise determined it necessary to be more aggressive about improvements in building performance. Thus, new and renovated square footage is scheduled in the plan to use only 30% the thermal energy of conventional buildings in years 2010 – 2015, 15% in 2015-2019, 10% in 2020-2024, 5% in 2025-2029, and 0% in 2030.

4) **Renovation**

The plan calls for 6% of conventional square footage to be renovated each year to the scheduled performance standard. Experiments with higher rates of renovation caused the total square footage (i.e., net of conventional and green) to dip unacceptably early in the time frame, possibly creating a space shortage

5) **Note about calculations**

Building stock is a mixture of square feet constructed or renovated at various times according to various performance standards; performance standards that change through time apply to new construction and renovations made in a given year. Thus, total emissions from extant green buildings in a given year are the integral across square footage built or renovated in years up to and including that year.

Planned scenario

The assumptions and prescribed tactics approach the goal of reducing thermal emissions (Figure E2). Decommissioning and renovation of conventional space provides the greatest reduction. Rates of increase in emissions from green space become lower through time as performance standards become more stringent. Care is needed as the target date approaches to ensure that emissions from green space do not exceed those of the remaining conventional stock. More aggressive plans for total thermal emissions that overshoot the target at any date create leeway for underperformance in the transportation sector plan.

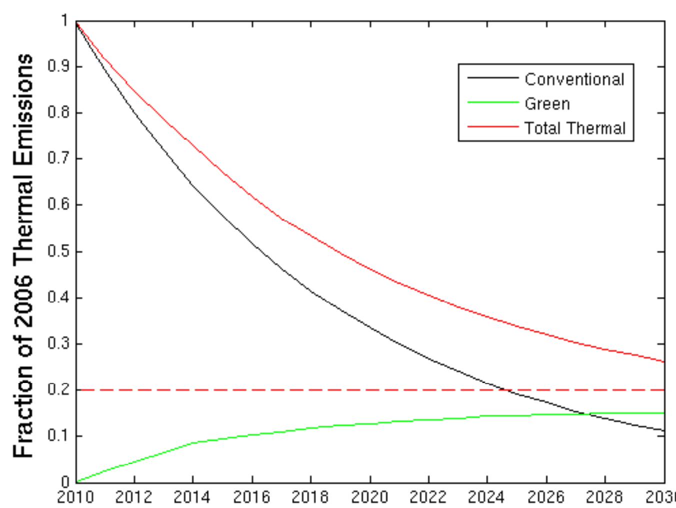


Figure E2. Modeled trends in emissions from conventional and green square footage from 2010-2030 as a fraction of thermal emissions in 2006. Total emissions (red) are reduced 30% by 2015.

Priorities for assessment and mid-course correction

1. Energy reductions attributed to Lobo Energy Educators have not been included in LoboTherm but should be included once trends are established. The information would justify lower rates of decommissioning and possibly avoid the temporary dip in total square footage in the early years (Figure 1).

2. Examine the untested assumption that the leakiest buildings are decommissioned or renovated first. The resulting improvement in mean energy demand per square foot of existing conventional buildings should be monitored and used to update LoboTherm.

3. Performance of both conventional and green buildings should be monitored to detect departures from the plan. For example, if a backlog of decommissioning and renovation accrues for even one year, adjustments need to be made to get back on track.

4. Opportunities may put reductions in thermal emissions ahead of schedule. Windfall savings should be used in the revolving fund to accelerate any lagging parts of the plan for commuting and electricity.

F. Thermal Energy Clarification: Understanding LEED and Architecture 2030 Standards

The ACUPCC states in section 2.A that all new building and renovations must meet or exceed USGBC LEED Silver rating. UNM already has this standard mandated by the Big Red policy 2100 section 4.2.1. and the fact that it is an entity of the State of New Mexico. Although the LEED rating system is a step in the right direction, it only addresses superficial initial carbon reductions---a major problem to a plan with the express intent to reach carbon neutrality. A more appropriate guideline is the Architecture 2030 policy, a plan created by a native New Mexican, Ed Mazria. This guide addresses the important issue of life span carbon reduction, focusing on a more deeply-rooted sustainability than the LEED rating system.

While the LEED silver standard is an appropriate initial step towards carbon reduction, it does not deal with carbon neutrality goals after occupation of the building takes place. LEED silver awards points based on initial energy reductions of buildings but stops there.

The Architecture 2030 Initiative provides a long-term energy reduction implementation system that culminates in carbon neutrality goal by the year 2030. This approach is much more appropriate in dealing with carbon neutrality goals for the UNM campus. Therefore, this plan proposes the adoption of the Architecture 2030 energy reduction goals instead of LEED standards. Not only will this reduce extensive financial expenses required for LEED accreditation, it will also provide continued financial savings through the continued reduction of energy through the years after building occupation.

According to Architecture 2030, the fossil fuel reduction standard for all new buildings and major renovations shall be increased to:

- 60% in 2010
- 70% in 2015
- 80% in 2020
- 90% in 2025
- **100% in 2030** (using no fossil fuel GHG-emitting energy to operate)

In order for UNM campus to achieve a minimum of 80% carbon emission reductions by 2030, it must take the lead and be even more aggressive with its building standards. These targets may be accomplished by implementing innovative sustainable design strategies, generating on-site renewable power and/or purchasing (20% maximum) renewable energy and/or certified renewable energy credits.

The problem with the LEED rating system is that it deals with a point-based rating system with a variety of areas to choose points from. These areas cover a wide variety of important aspects in building and construction but most areas do not deal with Carbon Neutrality.

LEED 2009 for New Construction and Major Renovations certifications are awarded according to the following scale:

- Certified 40–49 points
- Silver 50–59 points
- Gold 60–79 points
- Platinum 80 points and above

And these points do not necessarily deal with reductions in carbon emissions of a building. Reduction options are available but these point options are not required to gain any level of LEED certification. Therefore, gaining a LEED certification level does not guarantee green house gas emission reduction for a building. The LEED certification is a step in the right direction but may fall short of attaining 80% emissions reduction or resulting in carbon neutrality by the plan's scheduled deadline of 2030.

Benefits to adopting Architecture2030 Standards:

- More aggressive carbon emission standards
- Has a quantifiable emission reduction goal and deadlines for completion
- Addresses carbon neutrality in the building sector that is not covered by LEED
- Implementation guidelines are tailored to each state's building codes and are available free online

Drawbacks to adopting Architecture2030 Standards:

- Standards and implementation is much more strict than LEED

For more information please refer to:

Architecture2030: *http://www.architecture2030.org/home.html*
LEED: *http://www.usgbc.org/DisplayPage.aspx?CategoryID=19*

G. Travel Recommendation: Commuting/Travel Theory

Currently, commuting and travel account for 34% of UNM's carbon emissions. The University's commuting problem is the city's commuting problem as travel to and from the Albuquerque campus is the largest trip generator in the metro-area and is therefore a large community-wide source of GHG emissions. The following section discusses accommodations and incentives geared to reduce the impacts of commuter traffic to the University and promote alternative means of travel, optimistically setting the forefront for the City of Albuquerque to promote and encourage such transportation means throughout its transit policies. A travel theory has been included to further scrutinize the commuting done by students. A model has been created to quantify the information over the next 20 years.

By adopting UNM's travel theory, the LoboTran model of commuting, as well as personal recommendations for the Parking and Transportation departments, UNM can reduce 80 percent of the current commuting emissions by 2030.

Plan for Commuter Transportation

Abstract:
The LoboTran model of emissions from transportation identifies sources and rates of emissions from commuting and professional air travel. In practice, LoboTran can guide prescribed policy changes and help to design incentives that will shift behavior and thereby lower emissions. LoboTran specifies the main sources of emissions and the ways that sources change through time.

As well as providing UNM's baseline commuting practices, LoboTran includes potential improvements in fuel efficiency, prescribed shifts between modes of transportation, and reductions in travel distance as people move closer to campus. In practice, education and incentive programs will be needed to shift behaviors; campus and city planning together could promote more residences near campus, thereby reducing commute distances. However these changes are made, the resulting reductions in emissions are modeled by LoboTran to assess outcomes and to identify opportunities for intervention.

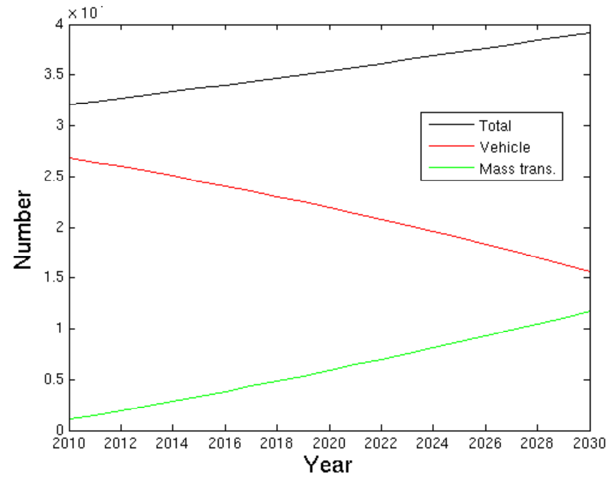


Figure G1. Prescribed trends in number of commuters, vehicle riders, and mass transit riders..

LoboTran Model

Emissions from commuter travel depend on the number of vehicle trips, the distance traveled per trip, and the emissions per mile. These factors vary in combination and are subject to changes through time. The travel theory (see section above) provides a framework for the practices of the commuters and travelers.

1) Number of commuters

In 2010 there will be anticipated 31,725 commuters on the main campus (Zumwalt 2008) with expected increases of 1% per year. This total number of commuters, N, is partitioned into fractions that use personal vehicles, mass transit, and walking/cycling; the latter category combines carbon neutral modes. Through time, the number of commuters in each category (i.e., Nv, Nm , and Nw) can change, thereby making total emissions better or worse. LoboTran prescribes shifting commuters away from vehicles (currently 86% of the total) to either mass transit (30% by 2030) or pedestrian (30% by 2030) and doing so smoothly (linearly) over 20 years (Figure 1).

2) Vehicle load

Vehicles emit carbon dioxide, so commuters are allocated to vehicles according to a "load factor" (i.e., number of vehicles per commuter, L). The number of vehicles is then Nv L. In 2009, L is approximately 1 for personal vehicles. The plan calls for a car pooling program where 80% of vehicles contain two passengers round trip by 2030. For mass transit, load translates into passenger miles per gallon of fuel, assumed to be 40 in 2009 and throughout the time frame.

3) Distance and fuel efficiency

Fuel consumption per vehicle trip, Fv, is the round trip distance (RTD) per trip, d, divided by miles per gallon, M. In 2009 we have Fv = 22 / 22 = 1. Trends in federal CAFE standards affect efficiency over time. The plan includes 0.8 MPG/yr improvement in fuel efficiency assuming that the Energy Independence and Security Act of 2007 takes effect. Thus, after 10 years with no change in RTD, Fv will decrease to 22/30 = 0.73 gallons per round trip. LoboTran prescribes that 20% of all commuters will reduce their 2010 commute distance by 50% by 2030. Thus, there are four independent parameters: (a) mean round trip distance per trip; (b) fuel efficiency; (c) fraction of commuters who reduce their RTD by 2030, and (d) percent reduction in personal RTD. Such changes in statistics are achieved by myriad actual practices and thus represent aggregated behavior. Surveys that report these four parameters can feed directly into updated LoboTran calculations.

The model is blind to inadvertent shifts in commuter category that occur when commuters relocate their residence. For example, a dorm dweller that moves to Rio Rancho both increases travel distance and moves from the pedestrian to vehicular or mass transit category. A spatially resolved model would be necessary to untangle interactions of this sort.

4) Number of trips and work week

The number of trips per vehicle per year is 159, based on a five-day work week. Some fraction of trips in each category could be eliminated by a 4-day work week policy.

Thus, p5 and p4 = (1 – p5) are the fractions of commuters that have 5- and 4-day work weeks, respectively. The plan represents the effect of shifting 30% of 5-day workers to 4-day weeks by 2030.

5) Emissions projections

Total emissions (MTCD/yr) from commuting by vehicle and mass transit is written

$$Ec = 0.0088 \sum_{k \in \{p5,\, 0.8p_4\}} k \sum_{j \in \{v,\, m\}} T_j d_j M_j^{-1} N_j L_j \qquad [2]$$

where j denotes the category of commuter, 0.0088 is MTCO2/gallon of fuel, and k takes the values p5 and 0.8 p4. Multiplying by k = p5 attributes a full 5-day week's commute to the fraction of the commuters that work 5 days. Multiplying by

k = 0.8 p4 accounts for the 20% emissions reduction in the commutes conducted by the 4-day commuters.

Assessment of Options

Opportunities to reduce emissions can be scrutinized by recognizing that changes occur by: (a) changes in T, N, d, M, and L, and (b) modifications of the dependence of E on T, N, d, M, and L. For a given factor such as N, the product of its changes in time multiplied by the dependence of E on N explains how much the total emissions will vary as a consequence. Reasonable expectations can be made for how each factor will behave through time. For example, current increases in the number of vehicular commuters are exacerbating emissions. In time, their conversion to mass transit riders will drive down the emissions (negative changes in emissions). In the long term, equilibration at a new steady-state number of vehicular commuters will curtail further improvements by this means. For distance traveled, near-term prospects for improvement are dim, yet strategic development of on-campus housing and residences near campus will lower commute distance.

Planned Scenario

LoboTran accommodates many tactics for reducing carbon emissions from commuting. Choices were made regarding the reference year (2006), the target date (2030), and the emissions target (20% of 2005 emissions). Tactical prescriptions specify performance levels to reach by the target date and were implemented smoothly from beginning to end, rather than abruptly. The gradual implementation simulated the outcomes of prolonged education campaigns or incentive programs and turnover in fleet-wide fuel efficiency. In practice, education campaigns would be implemented until the prescribed level of performance is reached.

Tactics available include:

(1) Work week: Shifting some fraction of commuters to a 4-day work week.
For example, from 2010 to 2030, 30% of commuters shift year by year from a 5-day work week to a 4-day week.

(2) Trips: Changing the number of vehicle trips per year,

(3) Distance: Shifting the round trip distance for some fraction of the commuters by a constant factor,
(4) MPG: Raising fuel efficiency,
(5) Travel mode: Reallocating commuters from vehicles to mass transit or pedestrian,
(6) Car pooling: Shifting some fraction of commuters to car pools.

For the period 2010 to 2030 the prescriptions were:

- Shift 30% of commuters to a 4-day work week
- Keep the annual number of vehicle trips to 159 per vehicle
- Shift 20% of commuters to one half of their original personal round trip distance
- Assume that CAFE standards will improve fuel efficiency by 0.8 MPG per year
- Reallocate commuters to 40, 30, and 30% for vehicular, mass transit, and pedestrian categories, respectively.
- Shift 80% of the vehicular commuters to car pooling with two occupants per vehicle.

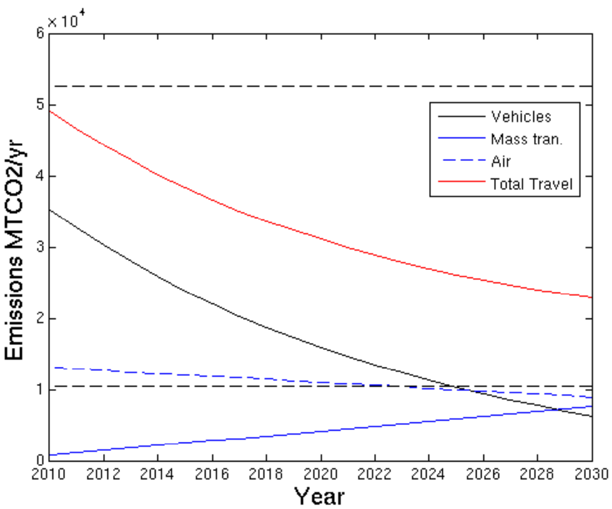


Figure G2. Emissions from travel. Upper dashed line is 2005 total travel emissions. Lower dashed is target for 2030. In 2030, total emissions (red) exceed target.

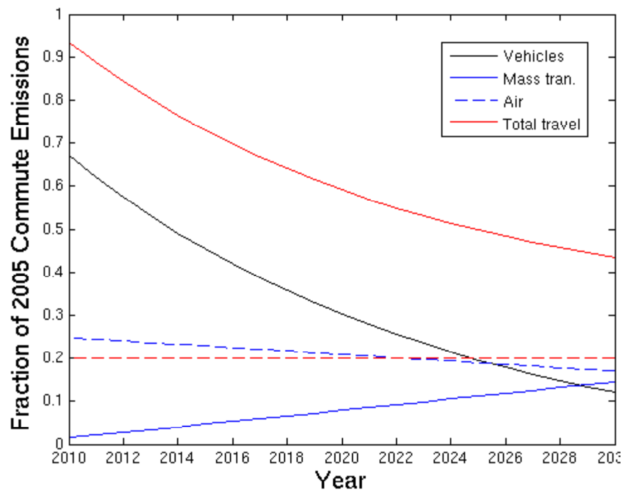


Figure G3. Portions of emissions from travel relative to 2005. Lower red dashed line is target of 20% of 2005 total travel emissions.

The scenario is revealing. First, the plan reduces per capita emissions from 1.53 to 0.58 MT CO2 person-1 yr-1 in 2030, a 62% reduction. Second, emissions from vehicular and air travel are extremely recalcitrant, despite somewhat aggressive prescriptions for car pooling, which is the most effective way to reduce emissions from personal vehicles. Third, the high efficiency of mass transit means that even after increasing ridership from 2% to 30% of commuters the net impact is relatively small. Fourth, it is counter productive to allow emissions from mass transit to exceed emissions from vehicles by any appreciable amount at the target date. Indeed, given that air travel alone approximates the target emissions, it becomes necessary to either zero out emissions from both vehicles and mass transit, or to compensate by overshooting the targets in the electricity and thermal sectors. Total emissions from commuting and air travel were only reduced to 43% of the 2005 levels and failed to hit the target by 2030. By 2015, travel emissions were 75% of 2005 emissions.

Implementation of the Tactics

1) Shift 30% of commuters to a 4-day work week

   This can easily be done by changing the work schedule of personnel. Throughout the 2008-2009 school year, UNM Parking and Transportation Services have sold 18,000 parking permits (permit sales do not include those who temporarily park in or around the University area) 10,000 of which are sold to students alone. This number is not limited and such passes will continue to be given out as demanded therefore, further promotion of this program could successfully increase its utilization by students.

   By having these parking passes not only lot-specific and day-specific, more students will be able to conveniently reach the University but also opt for alternative forms for transportation on the days disallowed on the passes. For those commuters that would be commuting everyday to campus it would respectively cost more.

2) Reallocate commuters to 40%, 30%, and 30% for vehicular, mass transit, and pedestrian categories, respectively.

One initiative that has proven successful at the University thus far is the distribution of free bus passes to students. This program allows students to obtain free bus passes; encouraging the use of public transit and lowering the number and amount of travels to campus. Here are some means to achieving this relocation.

Train Passes

The University recently negotiated a deal with the City of Albuquerque Transportation Department to discount the cost of riding the NM Railrunner for university students and is keeping open the possibility of issuing free train passes. Individuals are motivated by monetary incentives; through issuing free train passes more students, most of whom endure limited budgets, will be stimulated to partake in traveling by means of public transportation such as the newly established train system.

Biking Pedestrianism

Albeit, the University needs to implement campus bicycle and pedestrian programs and projects aimed at increasing such means of travel rather than commuting. Increasing the number of bike lockers housed on campus, would help. Currently, the University houses an inadequate number of such lockers, an easy solution to such a problem would be to simply increase the number for lockers. By not accommodating the demanded supply of such lockers, the University could be deterring students from biking to campus.

Considering the percentage of the University population that resides near the campus, increasing pedestrian and bicycle travel to campus could make a substantial difference in reducing carbon emissions.

The University needs to establish programs which promote alternative means of transportation such as pedestrianism/ bicycling since encouragement of such means of travel could have a substantial impact of on the carbon emissions produced by UNM's current commuting.

Guaranteed Ride Home Service

Currently, the University offers a guaranteed ride home service that is intended as insurance for the students. An individual may receive a ride to their desired destination in cases where an emergency may arise, however many students do not know this service exists. There is a need for further promotion of this assistance service so that those commuters, who feel uneasy about engaging in alternative transportation in the evening.

Marketing

As already mentioned travel to and from the Albuquerque campus is the largest trip generator in the metro-area. The transition into alternative transportation means of travel will have to take a behavioral change in the values of the University's commuting body.

3) Shift 80% of the vehicular commuters to car pooling with two occupants per vehicle. Discouraging single drivers yield significant benefits ranging from extensive cost savings related to parking infrastructure to reduced traffic congestion in the local community. According to the travels, thus, we identify a key principle: Vehicles, not people, emit greenhouse gases associated with travel.

AlterNetRide

Throughout this program the University is working with AlterNetRide, an organization that connects subscribes within the optimum car pooling economy within the area, in order to match potential carpoolers. Once a car pool group of 2 to 8 people has been established the University will amend parking permits to allow pool members to share an individual parking permit reducing each member's parking costs while reducing the amount of commuting and parking traffic. At present, although the AlterNetRide is available to everyone, only faculty and staff are eligible for shared parking permits greatly lessening the impact this program could have on the reducing the number of single occupant vehicles which commute to and from the University daily.

Another implementation of this tactic would be shifting over to benefits already in place. Recently, the City of Albuquerque Transportation Department began issuing green parking permits which allow owners of hybrid, alternative fuel or fuel-efficient vehicles to become eligible to park freely at any city-owned parking meter; a program which has proven relatively successful thus far and would be an obtainable option for reducing commuting emission for the University.

Since the demand for parking in the University area, especially on campus is high the University can take advantage of such demand by setting up a green parking initiative which through the use of economic incentives, like free campus parking, this program could encourage students, faculty and staff to transition to hybrid or fuel efficient vehicles; the success of such a transition could lead to greatly reduced carbon emissions produced by UNM's commuting body.

The ABQRide, Albuquerque's city sponsored transit system announced in August 2007 that a deal was passed with PATS striking an agreement to allow all UNM free bus passes along with the full-time, student status. This is included with the already one million monthly bus rides that are taken, which is a huge increase from FY '06 where the annual ridership was 8.5 million. The bus fleet is used to transport students in buses and shuttles, and alleviate the traffic around the school. Since the beginning of the program about it is estimated 10,000 to 12,000 students, faculty and staff take advantage of this offer.

H. Financing Recommendation: Campus Sustainability Revolving Loan Funds

Campus sustainability revolving load funds hold promise to be a very effective financing mechanism for campus sustainability projects. When projects decrease a university's costs or create financial returns, all or part of these savings or revenues is returned to the revolving loan funds until the loan is paid back. Or, if the fund is paid back beyond the initial loan, the fund can grow and gain the ability to fund more ambitious projects.

This type of revolving fund has already been implemented in diverse college and university settings and has experienced success. The range of funding has also varied widely, though those with significant funding have tended to provide the best returns. For example, the Harvard University Green Campus Loan Fund started at $3 million dollars and had nearly a 30% rate of return on investments during its initial 2 ½ years.

In staying with the spirit of student education and empowerment, schools such as Macalester College and Connecticut College have representatives from diverse areas of the campus community on their boards. Macalester College's fund especially encourages student-initiated projects.

Though not all sustainability projects may have a feasible payback period for the revolving loan funds, these funds highlight the long-term savings and benefits created by investment in green projects. As the carbon credit market grows, the initial sustainability investments supported by these funds are likely to provide lucrative carbon-savings.

The Association for the Advancement of Sustainability in Higher Education (AASHE) has an excellent guide on creating a Campus Sustainability Revolving Fund.

I. Foodshed

Farms, run efficiently and sustainably, can not only be carbon neutral in their operations, but also provide local carbon sequestration. They can also provide waste recycling, research and learning opportunities, and potential for profit for the University. However, as ideal as it would be to have the food students eat be grown in their backyard, UNM must suffer space restrictions. Thus the solution seems to be not to grow out, but grow up.

Vertical farms are essentially buildings wherein the entire process of growing crops is sequestered and highly controlled so that humans are able to, simply put, produce more food on less land more sustainably, without things like lightning, pestilence or foraging animals ruining any crops. A vertical farm would be able to sequester carbon emissions, recycle water, produce local, organic food (that the University would be able to make a healthy profit from), provide opportunities for classroom learning and research, and UNM could make money off the excess energy produced by power plants (solar, combined solar/wind, wind) installed on top of the facility itself, while the farm mostly runs on electricity generated from its integrated biogas facility, which would convert UNM/city waste into energy. Vertical farms would drastically reduce the carbon footprint (and in the long-term, the financial expenditures) of this campus, taking into account not only the carbon emissions as a result of growing the crops in the traditional, agribusiness way, but also the transportation costs, costs of soil degradation, processing costs, and all other financial and environmental costs of growing food far away in a traditional manner and getting it to the students. Because this is still a developing technology, and one seems to be able to continuously discover more ways in which a vertical farm can save money and carbon, it is impossible at the moment to give those calculations. However, in the appendix you will find some cost estimates showing that with our current data on vertical farms, one could be built on campus and pay it off within seven years. The University should immediately allocate resources to on-campus research into vertical farms with the end goal of designing and ultimately building a working example. UNM must take a leadership role in combating the global food crisis as well as sustainability, and it is clear that vertical farms are critical tools in both struggles.

VI. Project Plan

In the meantime, (while the vertical farms are being researched and built) on-campus dining facilities should begin providing more local, organic, fair trade food (priorities in that order) in order to begin alleviating the environmental and social costs of the current food system. UNM should either ally with La Montanita Co-op or start a food co-op of its own (UNM Food Co-op) to ensure that fresh, local produce is available to the students. This is not only for the health of the students, but also to cut costs (local is cheaper, less transportation time) encourage community cohesion, and encourage sustainable farming practices. UNM should also have a small plot of land set aside for a community farm, not run by any department, but rather run by students and included in the UNM Food Co-op in order to strengthen the community, add to the local foodshed and lower overall carbon emissions.

The project plan is a list of specific projects that will be pursued in order to achieve carbon neutrality at UNM. The plan is divided into three sections; 2010 - 2015, 2016 - 2020, and 2020 and Beyond. The general thought of the carbon neutrality team was that emphasis should be placed on the first time period for three reasons. The first is that these projects will require more immediate attention. The second reason is that these projects utilize existing technologies and can be more accurately defined. The last reason is that there are many technologies under development that will result in future projects. Thus, any effort to define projects in the further years is likely in vain due to technological advancements that will render them less desirable.

The list of projects was developed in accordance with the main categories contributing to carbon production at UNM; Heating and Cooling, Electricity, Commuting, and Air Travel. The projects are presented in a prioritized listing with the highest priority projects at the top of the list for each time period. The projects were prioritized according to the cost associated with reducing a metric tonne of carbon dioxide. In most instances, the projects provided a net savings as opposed to a net cost. These projects have a "positive" cost per tonne as opposed to the projects that do not have a savings component and are "negative". The other consideration in developing the list of projects was the percentage reduction in each of the categories. The Carbon Neutrality Plan specifies targets for reductions in each of the main categories. Thus, three projects were added to the first time period in order to maintain pace with the projections in the plan.

In many cases funding has already been identified for projects and these are identified with an asterisk. The bottom of each time period summarizes the list of projects for that time period. The 2010 - 2015 time period is projected to reduce carbon emissions at UNM by 36% at an initial cost of $13,300,000. However, $9,600,000 of the initial cost has already been funded. Thus, this plan requires only an additional $3,700,000 for the projects listed in 2010 - 2015. The projects listed in the other time periods are primarily "placeholders" that represent projects that could be employed today to achieve more carbon reductions. However, it is likely that the projects in these time periods will be altered significantly in future plans.

2010 - 2015: 10% reduction from 2005 by 2015

Project Number	Description	Initial Cost	Annual Costs
HC6	Behavior-Based heating/cooling conservation program*	$ 5,496,189	$ 399,157
EL2	Solar Energy - 2000 kW PV	$ 2,321,330	$ 12,000
AT4	Campus wide travel budget reduction of 10%	$ -	$ -
AT3	Air travel reduction program	$ 5,000	$ 1,000
EL8	Delamp - Remove unnecessary bulbs from fixtures	$ 390,625	$ -
HC2	FY09 Renovations (Mitchell, New Bookstore)*	$ -	$ -
EL17	Stage Lighting - Fine Arts*	$ -	$ -
EL4	Unplug water coolers (100)	$ 250	$ -
EL12	Zimmerman lighting controls	$ 20,000	$ -
EL18	Clean Energy Grant - Lighting	$ 123,000	$ -
EL5	Vending machine energy controllers (100)*	$ 18,000	$ -
HC7	Clean Energy Grant - HVAC	$ 157,000	$ -
EL6	Behavior-Based electricity conservation program*	$ 2,245,011	$ 163,043
EL11	Converting from 32W bulbs to 28W bulbs	$ 250,000	$ -
HC1	FY09 Energy Services Projects*	$ 820,000	$ -
EL7	Occupancy sensors	$ 462,500	$ -
EL13	Steam Turbine Generator (1 MW) in lieu of PRV*	$ 1,000,000	$ 10,000
CM1	Compressed school week (4 - 10 hour days)	$ -	$ -
AT1	Air travel offset program to fund other projects	$ 1,000	$ 50,000
CM3	Expand free transit passes	$ -	$ 65,000

		Total Possible	MTCDE Reduction
	Electricity	74,408	28,903
	Commuting	45,245	11,311
	Heating and Cooling	43,329	12,200
	Air Travel	11,484	11,484
	UNM Fleet	1,792	-
		176,258	63,899 36%

*** Projects which funding is already secured.**

17,626

Annual Savings	Annual MTCDE Savings	NPV of Project	$ per MTCDE	Payback Period (years)
$ 3,198,514	8,666	$9,389,976	169.6	2.0
$ 804,083	2,464	$ 7,549,777	153.2	2.9
$ 277,171	1,148	$ 3,454,162	150.4	-
$ 277,171	1,148	$ 3,436,699	149.6	0.0
$ 380,744	2,970	$ 1,257,797	84.7	1.0
$ 35,352	347	$ 440,560	63.5	-
$ 18,476	210	$ 230,256	54.7	-
$ 4,378	50	$ 54,308	54.5	0.1
$ 22,183	253	$ 256,447	50.7	0.9
$ 68,758	783	$ 733,872	46.9	1.8
$ 7,314	83	$ 38,476	46.2	2.5
$ 109,431	1,113	$ 1,525,215	45.7	1.4
$ 1,306,486	14,882	$ 6,584,360	44.2	2.0
$ 135,587	1,544	$ 337,020	43.6	1.8
$ 204,974	2,075	$ 1,734,425	41.8	4.0
$ 135,587	1,544	$ 584,466	37.8	3.4
$ 361,652	4,119	$ 4,405,752	35.7	2.8
$ -	6,787	$ -	0.0	No Savings
$ -	9,187	$ (48,619)	0.0	No Savings
$ -	4,525	$ (810,044)	-9.0	No Savings

Total Initial Cost	Total NPV
$ 13,309,905	$ 61,154,905
$ 3,730,705	Total Initial Costs for New Funding

2016 - 2020: 20% reduction from 2005 by 2020

Project Number	Description	Initial Cost	Annual Costs
EL3	Wind Energy Phase 1 - 5000 kW	$ 5,000,000	$ 95,410
EL15	Wind Energy Phase 2 - 5000 kW	$ 5,000,000	$ 95,410
EL19	Future Lighting Technology (LED)	$ 3,500,000	$ -
EL16	Solar Energy - 8000 kW PV (no PNM REC)	$ 9,285,319	$ 12,000
HC8	Daytime Solar Heating - no storage	$ 3,300,000	$ 33,000
EL14	Cogeneration (6 MW GTG and HRSG)	$ 8,000,000	$ 830,000
		Total Possible	
	Electricity	45,505	45,505
	Commuting	33,934	-
	Heating and Cooling	31,129	1,961
	Air Travel	-	-
	UNM Fleet	1,792	-
		112,359	47,466 63%

2020 and Beyond:

Project Number	Description	Initial Cost	Annual Savings
CM	Renewable energy credits	$ 15,000	$ -
HC	Undefined Future Technologies (20% of 2006 emissions)		
		Total Possible	MTCDE Reduction
	Electricity	-	-
	Commuting	33,934	2,228
	Heating and Cooling	29,167	29,167
	Air Travel	-	-
	UNM Fleet	1,792	-
		64,893	31,395 81%

35,252

Annual Savings	Annual MTCDE Savings	NPV of Project	$ per MTCDE	Payback Period (years)
$ 856,544	9,756	$ 4,485,413	23.0	6.6
$ 856,544	9,756	$ 6,700,496	22.9	6.6
$ 610,141	6,950	$ 1,907,833	22.9	5.7
$ 955,265	9,856	$ 2,469,847	12.5	9.8
$ 277,826	1,961	$ 463,571	7.9	13.5
$ 1,303,720	14,850	$ (717,762) -	1.6	16.9

MTCDE Reduction	Total Initial Cost	Total NPV
$ 34,085,319 $ 34,085,319	$ 15,309,396 Total Initial Costs for New Funding	

Annual MTCDE Savings	NPV of Project	$ per MTCDE	Payback Period (years)
$ 2,228 35,252	$ (15,000)	$ (7)	No Savings

Total Initial Cost	Total NPV
$ 239,718	$ 15,294,396

VII. Conclusion

This is a living document – an ongoing, thorough effort to bring the UNM campus to a state of carbon neutrality and sustainability. Our initial recommendations will only move the University to at least a 70% reduction by 2030:

- Recognize the need and act to promote a community which closes resource loops and encourages cooperative green businesses;
- Establish a phased 20-30 megawatt renewable energy system on UNM's roofs to provide electricity;
- Install smart grid technology to decrease and streamline UNM's electricity demand;
- Commit to moving commuters out of cars and into mass transit, onto bicycles, or onto feet;
- Exceed Architecture2030's guidelines and phase in carbon neutral new and renovated buildings;
- Establish a Revolving Loan Fund to capture and reuse savings and earnings from sustainability projects to fund future sustainable projects.

These recommendations do not plan for complete neutrality and as such, the American College & University Presidents' Climate Commitment requires that schools resubmit their strategic action plans every two years. Additionally, all of UNM's branch campuses must also create strategic climate plans. As technologies improve and campuses change, it is only fitting that these plans be re-evaluated and expanded. Regular peer review and constructive, informed criticism are necessary to ensure the integrity of this documents and thus to ensure that the document produces the necessary changes on campus.

We have provided a prudent and calculated plan, but it is ultimately incomplete and thus requires continued efforts by the Sustainability Studies Program, the Physical Plant Department and the University at large to ensure its scope and effectiveness. This plan offers excellent learning and research opportunities for all members of the campus community. There must be additions to this plan by students, staff and faculty to ensure that a robust sustainability plan thrives on the UNM campus.

Vision for Sustainability

Driving this plan is a vision of our campus as not only a learning and research institution, but as a living, growing community, locally focused and globally aware, natural and honest, expressive and healthy, vibrant and wise. Embedded in this plan is a vision of our campus as a leading institution for the region, country and world, a pillar of human achievement, an example of humanities' days to come and a beacon of light in dark times. In this plan is a vision of what New Mexico can give to the world: a path, a way that other nations and peoples can follow on the march towards sustainability. This plan was written with a vision in mind, and this is that vision of the future.

Wind curls through coiled solar turbines slowly turning atop glowing stucco halls. Names of ancestors and tales of times to come float upon this wind and the people of UNM listen, so strong are the ties of the community, so connected are the people to the land. All around you people are walking to class, sunny as the New Mexican skies, engaging with learning material as they go: passing a philosophy reading group, taking a cupcake from the student-built solar ovens, adding to a magnetic collaborative public sculpture, and putting the finishing touches on and riding a three-person bike built by the Yellow Bike Collective. You stand under the wooden gate of the Yale entrance, on the border of the campus, looking in. You see banners by campus groups hanging from buildings proclaiming, "Give yourself no limitations and you will have none," and "Today the world is yours. Tomorrow will be no different," and "Viva Nuevo Mexico, la Luz de Nuestra Vida," rippling and flapping gently in the setting sun. You turn to look behind you. Down Central Avenue (Rt. 66) cruises the occasional lowrider, bus, or truck, but for the most part the road is filled with bicycles and motorcycles and electric vehicles of all types zipping across the lanes, courteously avoiding the students still jaywalking across the street.

You turn back and begin walking north through the campus, in the direction of the Student Union Building. A combined vertical farm/parking structure looms behind Cassetter Hall to your left, a lush tower turning gray water into drinkable water, carbon dioxide into breathable air and solid waste into energy and nutritious food for the use of the community. Looped around this tower, reaching almost to the top, is the coiled form of the parking structure, made from sustainable materials, topped with solar panels and painted on the outside to resemble Quetzalcoatl, the great feathered serpent, wrapping around the monolith of the vertical farm, capped with spinning solar/wind turbines. Behind the glittering glass of the tower you see the deep green of growing plants and the elegant trickle of water running down the panes. You pause a moment to admire its beauty. You then walk on and after being narrowly avoided by a skateboarder, you see a group of local laborers crafting a new facility to your left, ramming earth into molds and laying wide adobe bricks to build sustainable walls more solid than concrete, for a ziggurat that will both feed and provide energy for its inhabitants. You turn right into the large brick courtyard where Zimmerman still stands to its north, now bristling with solar and wind equipment. There is almost a festive atmosphere, as you see students gathering after their classes to enjoy the sun and one another's company, and to play the Mesoamerican ball game, Ulama, (played by the Aztec, Maya, and cultures as far north as the American southwest) in the sloping court to the east of the library. You turn and see in the middle of the red brick courtyard several booths where people of all walks of life are gathering, trading information and ideas on sustainable living practices and social justice. For these days, people come to UNM from all over the southwest to gather strategies and tools to achieve sustainability and increase well-being in their own communities. Indeed, UNM is nationally known as the sustainable university and the organization to look to for effective, profitable, and equitable sustainability practices, not to mention the institution to go to for research and researchers in the fields of renewable energy, sustainable design, and related subjects. Some even come to UNM just to breathe in the atmosphere, for they realize the kind of revolutionary thinking taking place inside this institution. Benefit concerts and artistic and academic demonstrations occur regularly and spontaneously, inspiring community involvement and green entrepreneurship from all corners of the Albuquerque area and beyond. Students, as a part of "The Project" (a student-run, community and sustainability-based project), have invigorated and inspired the youth and job-seekers of Albuquerque and have started numerous student-run, worker-owned business and non-profits. At this campus, it is clear that the true efficacy of the people is powerful, valuable, and put to good use.

You cross the courtyard and come to the SUB, the Student Union Building. A huge, helix-like combined solar/wind turbine turns in the breeze atop the building, glinting in the setting sun along with the batch of solar panels and weather instruments recently installed. The entire building seems alive with activity, from members of The Project making plans for community enrichment to members of a student group designing a new kind of geothermal energy converter to members of the student union negotiating with administration officials over work-study issues. Inside this building, you can almost see the future: one of cooperation, of advancement, of equity, of sustainability. Inside this building you can see a future obviously not devoid of strife, but nonetheless a future where we have the tools and the fortitude to confront that strife, to rise to meet the challenges that await us. Inside this building, you see what we can become, what we can do together. You see the future of man inside this building, turn back for a moment to glance at the fiery clouds and setting sun of the New Mexico sky, then turn and walk inside, filled to the brim with the spirit of UNM, the spirit of New Mexico, and hope for the future.

VII. Glossary

Energy: Full Circle

Clearly, trappings of the 20th century like internal combustion engines and emergency generators will remain apparent necessities for some time, therefore a suitable alternative to petroleum must be found to operate this technology sustainably. Current research seems to point to the possibility of growing mass amounts of algae in large vertical tubes, and cheaply and efficiently converting this material into bio-fuel usable for any of the applications gasoline and other petroleum-based combustibles are used for. This and other sources of bio-fuel should be actively researched and pursued by UNM for immediate practical purposes, like cheaply fueling the University's fleet of vehicles and assortment of emergency generators. This is the cutting edge of modern energy technology and UNM must pursue this research or risk being left in the proverbial dust of history.

REGAIA: Renewable Energy Generation Administrative Interdepartmental Alliance

The primary function of REGAIA will be to design and regulate energy generation and distribution for the campus on a day-to-day basis. Even if UNM signs on to a Power Purchase Agreement and the company UNM signed with manages much of the process, REGAIA will still be necessary in order to work with the company in order to provide UNM with an energy system that fully and efficiently meets its needs.

REGAIA is an interdepartmental alliance in that the day-to-day operations are in the hands of professionals (that is, people whose job it is to actually build the power plant, wire up the system or sit there and try and make the system more efficient) but design of the system is in the hands of an interdepartmental board (from SUST, grounds, engineering and arch.) of students and professors. Naturally this board should have more professors than students, and meeting times should be regular. REGAIA should have access to any resources from the abovementioned departments and programs, and should have the ability to reach beyond the standard departmental boundaries, hence being an interdepartmental alliance.

IX. Appendices

A. Additional Resources

a. Big Red 2100 Chart by Mary Beggio

BIG RED 2100 SUSTAINABILITY POLICY ANALYSIS — MARY BEGGIO

1. GENERAL ADVANCEMENT OF SUSTAINABILITY IN HIGHER EDUCATION, ACUPPC, + 2. SUSTAINABILITY PRINCIPLE: HOLISM	ORGANIZATIONAL STRUCTURE + RESPONSIBILITY	CAMPUS CULTURE STUDENTS, STAFF, FACULTY, + INITIATIVES	ENVIRONMENTAL PROTECTION	SOCIAL EQUITY	ECONOMIC OPPORTUNITIES
3. GOVERNANCE — SECTION DEFINITION	UNM Sustainability coucil (campus members)	Students, staff, faculty, national + international sustainability initiatives	- Implement + Monitor - Quantitify reduction goals		Campus jobs + community opportunity in clean energy
EXISTING POLICIES + DOCUMENTS		TALLOIRES DECLARATION, ACUPCC, + ARCHITECTURE 2030	ACUPCC, + CARBON NEUTRALITY ACTION PLAN	NEW MEXICO GOVERNOR'S EXECUTIVE ORDER 2006-001	
MISSING INFORMATION		Mind + Aspects of Wellbeing		Deliverables, Accountability, Model	
4. OPERATIONS — SECTION DEFINITION	University network	- Management - Recognition + Awards	- Facilities - Transportation	- Consumption - Purchasing	- Green economy - Corporate responsibility - Reinvesting funding
EXISTING POLICIES + DOCUMENTS		UNIVERSITY VALUES SECTION	USGBC LEED SILVER GHG RED. PLAN		CREATIVE MATERIALS MANAGEMENT PROGRAM
MISSING INFORMATION	Section undeveloped		Architecture2030 + Director of Sustainability	Section underdeveloped, performance measures and data collection, guidelines	
5. CURRICULUM + RESEARCH — SECTION DEFINITION	Collaborative history + knowledge base	Holistic curricula	Professional practice	Impacts included in curriculum developed	- Forward looking - Economic development - Sustainable principles with traditional principles
EXISTING POLICIES + DOCUMENTS					
MISSING INFORMATION			Raise awareness in curricula, implementation plan, rating system DEVELOP DEDICATED COMMMON COURSES	Raise awareness in curricula, implementation plan, rating system	FUTURE TECHNOLOGY COURSES BY 2012
6. COMMUNITY SERVICE — SECTION DEFINITION	- Serve students, staff, faculty, community - Leadership -TBL + SSP -UNM continuing education	- Foster culture - Community members - governance, operations, curriculum + research (3,4,+5)	- UNM as leader - Faculty, staff, + students - Community service projects	- Service projects + activities - Community benefit	- Projects + activities benefit community members - Business planning
EXISTING POLICIES + DOCUMENTS					
MISSING INFORMATION	Implementation plan, Accountability	Performance criteria, Clear communication network, Work with ASUNM	Implementation plan, Awareness	Implementation plan, Awareness	
7. RELATED DOCUMENTS	UNM SUSTAINABILITY SMART OBJECTIVES				

b. Travel Theory and Prescriptions by Bruce T. Milne

Goal:

Create a framework to assess and compare alternative transportation solutions that reduce greenhouse gas emissions.

Basic notion:

Emissions vary with the number of trips times the distance traveled. In the simplest case, emissions E = cNd where a conversion factor c adjusts the product of the number of vehicle trips N times distance traveled d to give emissions in units MTCO2eq. However, the simple model neglects the effects of ancillary factors that modify the consequences of number and distance in uncertain ways. Thus we require a more general framework.

Framework:

From dimensional analysis (Barenblatt 1996), we form the similitude:

$$E \propto N^{\alpha} d^{\beta}$$

where emissions are proportional to the number of vehicle trips, N, and distance, d, raised to exponents α and β, respectively. The exponents are convenient ways to capture the largely unknown effects of ancillary factors such as group behavior, alternative technologies, efficiencies, etc.

Where the exponents are greater than unity, the factor exacerbates emissions. Thus, emissions can be lowered by reducing the number of trips, the distance traveled, or by adopting practices that lower the exponents. The similitude can be applied to air travel, commuting, and travel associated with work at UNM. It can help to identify conditions that favor one mode of travel over another, e.g., air v. driving.

Sensitivities of emissions to elements of the similitude:

The exponents take values other than unity where the impacts of technology and people's behavior make the emissions impacts of N and d contingent on various unknowns. For example, say a professor plans to attend a conference and take two graduate students along. The emissions from the 3 person-trips may or may not be independent of each other (which is an assumption of the simpler model E = cNd), depending on whether they fly in the same planes or not, as the total number of energy-intensive take-offs and landings for the three travelers will vary accordingly.

Thus, we identify a key principle:
Vehicles, not people, emit greenhouse gases associated with travel.

Thus we distinguish person-trips from vehicle-trips. Person-trips can be combined in the same vehicle-trip. The exponents capture the extent to which person-trips are consolidated within vehicle-trips.

Similar complexities arise regarding combinations of travelers, namely, faculty with students, faculty with staff, staff with students, etc., as the urgency of travel in each case affects choices of vehicles, ride-sharing, etc. Where travelers attend national conferences, choice of venue and thus number of hops and connections to central hubs will vary beyond the control of the UNM traveler, yet will affect actual emissions. It is straightforward to interpret behavioral choices and contingencies in relation to elements of the similitude (Table 1, or graphically as Figure 1).

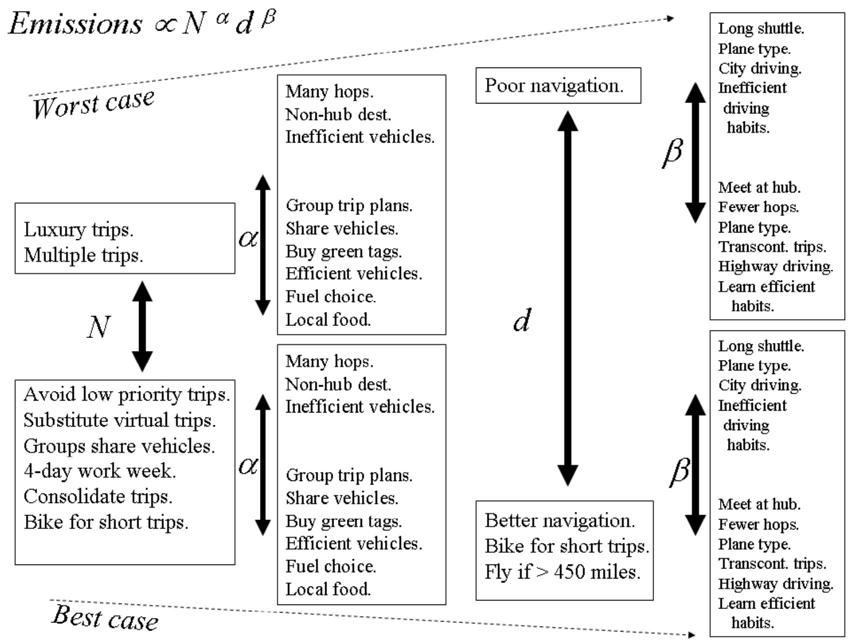


Figure 1: Schematic version of the similitude and the choices that raise or lower (arrows) emissions via each of the four elements of the similitude, N, d, α, and β.

From Table 1 we arrive at prescriptions for individuals and for the campus.

Summary prescription for travelers.

- Limit travel to necessary trips and give preference to trips that involve fewer take offs.
- Walk or bike for short trips.
- Consider a 4-day work week.
- Consolidate destinations where possible.
- Consolidate groups of travelers into fewer planes and vehicles.
- Ask organizations that hold conferences to:
    - a) select aviation hubs for meetings,
    - b) have annual regional chapter meetings and less frequent national meetings,
    - c) introduce teleconferencing and avatar technology for virtual participation, and
    - d) avoid destinations that require long shuttle trips from the airport.
- Purchase green tags to offset emissions.
- Select efficient vehicles.

Summary prescriptions for UNM:
Air travel:

- UNM could become a leader in the development of virtual meeting technology.
- Encourage leaders of academic organizations to plan meetings at aviation hubs. Alternatively, select destinations close to major airports.
- Educate groups of travelers to consolidate themselves in planes.
- Allow the purchase of green tags to offset emissions.
- Clarify the costs and benefits of air v. ground travel for trips of 450 miles.

Ground travel:

- Raise efficiencies of the campus vehicle fleet and adopt electric vehicles.
- Promote 4-day work weeks where possible.
- Educate travelers to consolidate trips, to use car pools, and to use mass transit.
- Create a system to match potential carpoolers. Find incentives.
- Help travelers to clarify the costs and benefits of air v. ground travel for trips of 450 miles.
- Include instructions for fuel efficient driving in driver education classes and make the tips available online.
- Support the Lobo Growers Market to promote local food as a means of offsetting commuter emissions. A local diet is approximately equivalent to eliminating emissions from one day of commuting per week.

Application and sensitivity:

By introducing a constant in the similitude to form an equation, we can differentiate E with respect to N and d. Clearly, the sensitivity $\partial E/\partial$. varies with the value of the respective exponent. In practice, we could identify subpopulations of travelers at UNM, say single passenger commuters from Moriarty, for whom d > E[d] and $\beta < 1$ because of highway driving. Thus, given data, we can classify people into subpopulations based on combinations of values of the four elements of the similitude. As we pose various ways to reduce emissions, we can assess the potential emission reductions for each subpopulation, realizing that the biggest bang for the buck will depend on which subpopulation we have in mind.

Table 1. Choices that affect emissions in relation to the four elements of the similitude.

Choices for:	Element	Emissions	Flying	Driving
		Lowered	Avoid low priority trips. Group members fly on same plane.	Car pool. Bike for short trips.
Substitute trips with virtual trips. 4-day work week. Consolidate trips.				
		Raised	Luxury trips.	Unconsolidated trips.
		Lowered	Organize to meet at aviation hubs.	Better navigation. Bike for short trips.
Fly if > 450 miles. Drive if < 450 miles.				
		Raised	---	Poor navigation.
		Lowered	Address trip plan for group travel. Consolidate groups on same plane.	Efficient vehicles. Fuel choices. .
Purchase green tags. Buy green tags. Provide choices for combinations of travelers. Eat local food.				
		Raised	Multiple hops. Non-hub destinations.	Inefficient vehicles.
		Lowered	Meet at hub. Fewer hops. Plane type. Transcontinental trips.	Highway driving. Learn efficient driving habits.
		Raised	Long shuttle trip from airport. Plane type.	City driving. Inefficient driving habits

Literature cited: Barenblatt, G.I. 1996. Scaling, self-similarity, and intermediate asymptotics. Cambridge Univ. Press. 386 pp.

c. UNM Greenhouse Gas Inventory Calendar Year 2006 by Jeffrey Zumwalt

Jeffrey A. Zumwalt
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Physical Plant Department

November 12, 2007

Introduction

As the flagship institution of the state of New Mexico, the University of New Mexico has a responsibility to exercise leadership and vision when addressing societal concerns. A recent and significant societal concern is climate change. President Schmidly demonstrated the University's leadership role when he signed the American College and Universities Presidents Climate Commitment June 21, 2007.

The Climate Commitment requires signatory institutions to complete various steps in pursuit of climate neutrality. One of these steps is the calculation of the greenhouse gas emissions from the University. This report is the first greenhouse gas inventory for the University of New Mexico.

This report will quantify the greenhouse gas emissions for the Albuquerque campus. The scope of the analysis includes the north campus, the central campus, and the south campus. The analysis does not include the UNM Hospital, but does include the various smaller buildings located on the periphery of the campus. The methodology for the analysis was adopted from the "Greenhouse Gas Protocol" developed by the World Business Council for Sustainable Development and the World Resources Institute.

Methodology

The Greenhouse Gas Protocol provides detailed guidance for institutions to develop their own inventory. In addition, the protocol directly addresses the issue of "double counting" greenhouse gases (GHG). Double counting of GHG occurs when two or more parties include the same emissions in their respective GHG inventories. An example of this is the GHG associated with commuting to work. This activity generates a finite amount of GHG, but the entity responsible for the GHG is less clear. Both the employee and the employer have the ability to reduce the GHG associated with commuting. Thus, it is likely that both parties will include the commuting GHG in their respective inventories.

The protocol addresses this by delineating between direct and indirect emissions. The employer can provide incentives for the employee such as car pooling or mass transit subsidies. However, it is clear that the effectual decisions such as the type of vehicle, the use of mass transit, the distance of the commute, etc.; are all made by the employee. Accordingly, the GHG emissions associated with commuting to work are "direct" for the employee and "indirect" for the employer.

The protocol categorizes the direct and indirect emissions into three scopes. Scope 1 is direct GHG emissions such as fuel burned to heat a building or gasoline used in a fleet vehicle. Scope 2 is for indirect GHG emissions associated with purchased electricity. Scope 3 is for all other indirect emissions and is defined as emissions that are a consequence of the activities of the institution, but occurs from sources not owned or controlled by the institution.

UNM Scope 1 Emissions

The University of New Mexico directly generates GHG emissions. The primary sources of these emissions are from the fuels used for utilities and campus vehicles. The following table summarizes the emissions in metric tons of carbon dioxide equivalent (MTCDE) from scope 1 sources.

Table 1 - UNM Scope 1 GHG Emissions

Source	Energy (MMBtu)	GHG (MTCDE)
Natural Gas (utilities)	775,378	41,052
Gasoline	14,695	1,057
Diesel	2,921	213
Natural Gas (vehicles)	9,792	521
Total:	802,786	42,844

The natural gas data is from the utility bills from the local utility (Public Service Company of New Mexico) and Coral Energy (wholesale gas provider) including the south campus and other smaller facilities adjacent to the main campus. The gasoline and diesel fuel figures are from the Physical Plant Department's fueling station. The conversion factors were taken from the EPA's "Inventory of Greenhouse Gas Emissions and Sinks 1990 – 2004".

UNM Scope 2 Emissions

The protocol defines scope 2 emissions as those associated with the generation of electricity, heating, or cooling utilities purchased for own consumption.

Table 2 - UNM Scope 2 GHG Emissions		
Source	Energy (MMBtu)	GHG (MTCDE)
Purchased Electricity	837,657	74,408
Purchased Heating	0	0
Purchased Cooling	0	0
Total:	837,657	74,408

UNM Scope 3 Emissions

Scope 3 emissions are a reporting organization's indirect emissions other than those covered in scope 2.

Table 3 - UNM Scope 3 GHG Emissions		
Source	Energy (MMBtu)	GHG (MTCDE)
Student Commuting	483,158	34,770
Faculty/Staff Commuting	145,573	10,475
Air Travel	58,243	11,484
Solid Waste	n/a	406
Total:		57,135

Most of the components of scope 3 emissions are not directly measured. In particular, the commuting and air travel calculations required the use of assumptions and estimates. The commuting values were estimated based on the addresses of the students, faculty, and staff. Human resources provided the zip codes for the fall of 2007. This data was used to calculate an average distance per trip which was then applied to the population data for 2006.

Commuting

About 15% of the student zip codes were for locations that were in excess of 60 miles from campus. It was assumed that these were the addresses of student's homes prior to moving to the Albuquerque area. Thus, the commuting calculation did not include any zip codes that were greater than 60 miles away. These assumptions resulted in an average student commuter distance of just under 22 miles per day for those who drove alone. The calculation for the total number of trips for students assumed that they made one trip to campus for each day in which classes were in session or 159 days. The number of trips for faculty and staff was based on 21 days of annual leave, 10 days of sick leave, and 13 holidays for a total of 217 trips per year. The approach used to estimate the average student commute was also applied to the zip codes for faculty and staff employees. This resulted in a calculated average daily commute of 19.3 miles for faculty and staff. The commuting calculations also assumed that mass transit commuters traveled half of the distance of automobile commuters. This was a rough estimation based on the premise that mass transit options diminished greatly for commuters who lived more than 10 miles from the campus in 2006. The percentage of commuters who car pooled, used mass transit, walked, bicycled, or drove alone was from the 2003 Walker Parking Consultants Study conducted for Parking and Transportation Services.

Air Travel

UNM does not track the miles of air travel for university business. The ACUPCC Implementation Guide September 2007 v1.0 provides a method for estimating air travel. The guide allows for a conversion of total dollars spent on air travel to be converted to miles by using 0.25 $/mile. The UNM accounting system tracks total dollars spent on out of state travel. This value for calendar year 2006 is $7,391,223. It was assumed that half of the total travel cost was for air travel. The result of this estimation method is 14,782,446 miles.

Summary

The total GHG emissions from UNM for calendar year 2006 were 174,386 metric tons of carbon dioxide equivalent. The sources identified in the previous tables can be categorized into particular activities at UNM. Table 4 summarizes the various GHG emissions into causes. This table clearly highlights the three greatest contributors to GHG at UNM; electricity, commuting, and heating. These three causes account for 86% of the total. Any substantive effort to reduce GHG emissions at UNM will require focus on these three areas.

Table 4 - UNM GHG Emissions - Causes

Cause	GHG (MTCDE)	
Electricity	72,131	41%
Commuting	45,245	26%
Heating	33,291	19%
Air Travel	11,484	7%
Cooling	10,038	6%
UNM Vehicles	1,792	1%
Solid Waste	406	0.2%

Appendix A – Conversion Factors

	Units	CO2 kg/unit	CH4 kg/unit	N2O kg/unit
Natural Gas	MMBtu	52.791	0.00528	0.00011
Gasoline	gallon	8.72	0.00174	0.00060
Diesel	gallon	9.99	0.000567	0.00026
Natural Gas (vehicles)	MMBtu	52.791	0.014	0.00041
Purchased Electricity	kWh	0.738	0.0000065	0.0000146
Air Travel	miles	0.774	0.0000076	0.000009
Solid Waste	ton	0	11.16	0

Appendix B – References

1. Clean Air – Cool Planet's Campus Carbon Calculator v5.0
2. ACUPCC Implementation Guide September 2007 v1.0
3. "The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard revised edition" developed by the World Business Council for Sustainable Development and the World Resources Institute.

d. University Business Policies and Procedures 2100 "Sustainability"

THE UNIVERSITY of NEW MEXICO — University Business Policies and Procedures Manual

2100

SUSTAINABILITY

Effective Date: 06/01/08
Subject to Change Without Notice

Authorized by Regents Policy 3.1 "Responsibilities of the President"

1. General

The University of New Mexico recognizes its profound relations with other entities both near and far; past, present and future. The University encourages a diverse campus culture that harmonizes UNM's sustainable goals of environmental protection, social equity, and economic opportunity within the context of its education, research, and public service missions. The University aims to improve performance in all areas of operations thereby meeting the needs of current generations without compromising the prospects of future generations. As a demonstration of this commitment, the University is an active member of the Association for the Advancement of Sustainability in Higher Education (AASHE) and the American College and University Presidents Climate

Commitment. In all activities present and future, the University shall develop systems to manage environmental, social, and economic well-being with specific goals, objectives, priorities, processes, and milestones by which to verify performance. This policy applies to all University property and activities, including branch campuses.

2. Sustainability Principles

The intention of this sustainability policy is to maintain healthy relationships throughout the network of interactions that satisfy the basic needs of health, shelter, food, and transportation. Thus, it adopts the Principle of Holism in which the system as a whole determines in an important way how the parts behave. The system includes physical, biological, chemical, social, economic, and cultural elements among others.

- Holism encourages strategies that couple desired outcomes to incentives.
- Holism includes accounting for environmental and social impacts beyond the geographic confines of the campus. Ecologically ethical practices that may entail relatively long payback periods are favored over decisions based solely on up-front costs alone.
- Holism views waste as potential resources and thus favors strategies that follow the hierarchy of waste prevention, recycling/reuse, treatment, and disposal.
- Holism requires transparency via participatory planning practices, open documentation, visible implementation, and effective communication to students, faculty, staff, and the public.

3. Governance

Colleges and universities have the unique ability to not only incorporate the values of sustainability into all aspects of operations, but they are also positioned to educate and prepare future leaders, employers, and workers in sustainable values and practices that are critical to the future of society and the environment.

3.1. Organizational Structure and Responsibilities

The University is committed to an integrative, collaborative approach to sustainability reflected in curriculum and operations with involvement by all University stakeholders. To accomplish this objective the Provost will appoint a UNM Sustainability Council chaired by the Director of Sustainability (to be appointed and report to the Director of the Physical Plant). The over-arching goal of the Council will be to develop and monitor a comprehensive sustainability plan for UNM. The Council will consist of members of the Provost's Sustainability Committee, the Director of the Sustainability Studies Program, two (2) ad hoc students, and members representing the ASUNM, GPSA, Faculty Senate, Staff Council, Executive Vice President for Administration, Executive Vice President for the Health Sciences Center, Vice President for Finance, Vice President for Student Affairs, Vice President for Human Resources, Vice President for Advancement, Chief Information Officer, the City of Albuquerque, and the New Mexico Climate Change Action Council.

The UNM Sustainability Council will appoint committees to review campus proposals and programs and make recommendations to the Council regarding initiatives for operations, curriculum, research, and community service that the University should pursue in order to meet its sustainability goals of environmental protection, social equity, and economic opportunity.

3.2. Campus Culture

The University will build a campus culture of sustainability which addresses the three key components: environmental protection, social equity, and economic opportunity with involvement from its three primary stakeholder groups: students, faculty, and staff.

3.2.1. Students

Students can play a powerful, dual role not only through academic studies pertaining to sustainability, but also by working with staff and faculty to implement campus sustainability programs and working with the broader community on sustainability issues thereby making the University a clearinghouse for sustainability in New Mexico. To ensure student involvement, the Director of Sustainability will initiate a collaborative program between student organizations and operational departments which provides opportunities for students to be directly involved in sustainability initiatives, through internships and/or volunteer opportunities. In addition, the Director of Sustainability will work with academic areas to provide the opportunity for student involvement in sustainability projects and programs as part of their academic studies.

3.2.2. Faculty

Faculty has a powerful impact on the future of sustainability by preparing students for their roles as future leaders, employers, and workers. Faculty also play a valuable role in creating academic and research knowledge pertaining to environmental protection, social equity, and economic opportunity issues and sharing that information with students, staff, and the community. In addition, faculty will work with staff to identify ways to incorporate UNM's sustainability operational programs into academic and research projects.

3.2.3. Staff

Staff members play a critical role in helping UNM achieve its sustainability goals as front-line advocates for and practitioners of sustainability principles and practices in the day-to-day operations of the University. Staff will review and evaluate their departmental activities to identify ways to reduce energy use, reduce waste, reuse materials and supplies, recycle whenever possible, and take innovative actions which help UNM meet its sustainability goals.

3.2.4. National and International Sustainability Initiatives

UNM will join other colleges, universities, and organizations in committing to sustainability initiatives that align with our sustainability goals. Some of these current initiatives include the Talloires Declaration, the American College and University Presidents Climate Commitment, and Architecture 2030.

3.3. Environmental Protection

In accordance with the American College and University Presidents Climate Commitment (ACUPCC) the Sustainability Council will:

- develop an action plan for achieving carbon neutrality,
- be responsible for implementing and monitoring progress on the other requirements of the ACUPCC, and
- set quantifiable goals for reductions in energy use, water use, resource use, wastewater emissions, and solid waste emissions.

3.4. Social Equity

UNM should consider the principles of environmental justice in its operations, activities, and research, and avoid inequitable and disparate impact where possible. The University is subject to New Mexico Governor's Executive Order 2006-001, which will serve as a guide to the Sustainability Council in implementing sustainability programs.

3.5. Economic Opportunity

The Campus Sustainability Council will identify funding for sustainability projects proposed by students, faculty, and staff and provide work-study opportunities for students. The University will also help boost the State's sustainability industry by increasing demand for clean energy, clean cars, recycled products, and green building materials.

4. Operations

A broad network of University employees supports the educational and research activities of the University. The network provides the facilities, transportation, landscape, utilities, communications, and administrative foundation necessary to operate the University. University operations expend the majority of the overall resources consumed by UNM; therefore the following goals have been developed to incorporate sustainability into University operations.

4.1. Campus Culture

Operations personnel are encouraged to develop an understanding of how their activities are related to sustainability and will be encouraged to develop more sustainable practices. Management will provide employees with access to organizations and resources promoting sustainability and will incorporate sustainability into the University Values Section of employee performance reviews. The Sustainability council will develop a recognition and award program specifically to promote sustainability. Internships and volunteer opportunities will be offered to students to assist with the implementation of operational projects.

4.2. Environmental Protection

The Director of Sustainability will develop a greenhouse gas (GHG) reduction plan with milestones for every five (5) years.

4.2.1. Facilities

The maintenance and operation of campus buildings is the single largest source of campus greenhouse gas (GHG) emissions at UNM. Substantial reduction of campus GHG emissions can only be achieved with campus facilities that are designed with consideration for the environmental impact over the life of the facility. To achieve this objective all construction or renovation projects at UNM will be designed to emphasize the life cycle costs associated with the operations and maintenance of the facility over initial capital costs and to meet or exceed the U. S. Green Building Council's (USGBC) LEED Silver standard per the Governor's Executive Order 2006-001.

4.2.2. Transportation

Transportation to and from the Albuquerque campus, the largest trip generator in the metro-area, is a large community-wide source of GHG emissions. Substantial reduction of transportation related GHG emissions should be achieved by providing incentives and convenient accommodation for low emission transportation options.

4.3. Social Equity

Campus consumption of resources and products shall not knowingly put people elsewhere at significant risk for environmental contamination or diminished social welfare. Products, building materials, furnishings, and food used at the University impact communities elsewhere in the course of resource extraction, manufacturing, distribution, and disposal. Procurement will favor suppliers that demonstrate sustainability practices. When purchasing these items, departments should select vendors that strive to minimize negative impacts on all communities affected.

4.4. Economic Opportunity

The green economy favors energy efficiency, reduced use of materials, minimized waste and pollution, and corporate responsibility for fates of materials over product lifetimes, so whenever possible departments should support the local green industry. In addition, UNM will continue to build a creative materials management program that promotes reuse, reduces consumption, minimizes waste, and maximizes recycling.

Substantive changes to University operations will require dedicated resources. This can be achieved with a specific annual source of funding for sustainability projects and the reinvestment of realized savings from previous projects. Thus, UNM will provide an annual source of funding for sustainability projects and each project that has economic savings will identify the beneficiary of the savings with 50% of the realized savings utilized for future sustainability projects.

5. Curriculum and Research

Education and research are core missions of the University. The curricula in each department were developed over the history of the University as knowledge expanded and external needs evolved, and represent the collective wisdom of generations of educators. As a consequence, changes to the curriculum should not be approached lightly. Nevertheless, we now find ourselves in a situation where sustainability is a moral imperative, not a choice, and special efforts must be made by faculty, administrators, and students alike to ensure that curricula and research evolve rapidly to reflect sustainability issues relevant to each particular area.

Society is challenged to provide the basic needs of health, water, energy, food, shelter, and transportation now and for future generations. To address these societal challenges, each college and school at UNM will strive to integrate sustainability knowledge and methodologies from the sciences, humanities, and arts into curricula and research in order to provide students with educational opportunities and support pertaining to sustainability. In addition, these programs will prepare students for rapidly growing career opportunities in business, education, government, and the non-profit sector linked to sustainability. The Sustainability Studies Program can assist and support colleges and schools as they develop sustainability curricula.

5.1. Campus Culture

A campus culture of sustainability requires a holistic and systemic approach that can be encouraged via the development of interdisciplinary courses, programs, and projects. Flexibility in curricula should be increased so that students can increase their knowledge about sustainability issues of interest. Guest lectures on relevant topics by faculty from different disciplines should also be encouraged to promote awareness of far-reaching impacts of a particular discipline. Performance reviews will reward faculty who make an effort to include sustainability in their teaching. Similarly, awareness of sustainability issues should be part of the assessment of student work.

5.2. Environmental Protection

The professional practice of most disciplines impacts the environment. In each discipline with direct or indirect links to environmental protection, the curriculum should incorporate discussion of impacts on the environment and promote sustainable practices. The development of dedicated common courses in the context of broad areas of study (e.g. engineering, arts and sciences, law) addressing environmental protection and sustainability will be included as part of UNM's core curriculum.

5.3. Social Equity

Social equity is an often overlooked but integral component of any approach to sustainability. The impacts of each discipline on social equity should be considered in curriculum development. Different disciplines impact social equity to different extents. Course content should include concepts of social equity as a consequence of its relevance to the subject matter.

5.4. Economic Opportunity

- Curricula should be forward looking, and highlight the potential for continued economic development afforded by sustainable practices.
- Economic development should be viewed long-term and in a way that accounts as best as possible for true costs.
- The concept of externalities should be used to compare sustainable practices with traditional ones.
- Courses focusing on future technologies and sustainable practices should be developed by 2012. Current courses should be revised by 2010 to reflect a changing economic environment.

6. Community Service

UNM will serve students, faculty, and staff, as well as the community at large, by providing leadership and setting an example of how to achieve the triple bottom line of environmental protection, social equity, and economic opportunity. UNM will export this knowledge through community programs such as UNM Continuing Education, the Research and Service Learning Program (RSLP), Areas of Public Engagement (APE), and internships. In addition, UNM will serve as a clearing house of sustainability information and resources through the Sustainability Studies Program for the wider community.

6.1. Campus Culture
UNM will foster a campus culture of community members initiating and participating in activities that support the University in achieving sustainability through its governance, operations, and curriculum and research.

6.2. Environmental Protection
All campus community members should be aware of the extent to which their actions can negatively or positively impact the environment. In that the University shall strive to establish the lead for environmental protection in New Mexico, it should encourage engagement by faculty, staff, or students in community service projects that positively impact the environment and discourage those that impact the environment negatively.

6.3. Social Equity
University community service projects or activities shall strive to ensure that all members of the community benefit, and that none are left worse off through community service actions.

6.4. Economic Opportunity
In striving to fulfill its mission to provide increased economic opportunity for New Mexicans, the University will consider the environmental and social impacts of proposed community service proposals and business plans as well as profitability. To do so, cross disciplinary approaches to planning will be encouraged.

e. University Business Policies and Procedures 5100 "Energy Management"

THE UNIVERSITY of NEW MEXICO University Business Policies and Procedures Manual

5100
ENERGY MANAGEMENT
Effective Date: February 9, 2009
Subject to Change Without Notice
Authorized by Regents Policy 3.1 "Responsibilities of the President"

1. General

As the State's flagship institution of higher education, the University of New Mexico has a civic, social, and fiscal responsibility to optimize its procurement, production, and consumption of energy. The University will provide the energy education and expertise necessary to support students, faculty, and staff in reducing energy consumption and improving energy efficiency as they learn and work together to fulfill the University's mission. Occupant health, safety, comfort, and program requirements will remain a primary concern as the University works to minimize energy usage. To promote a safe, healthy learning environment and to complement the energy management program, each campus shall review and adhere to the preventive maintenance and monitoring plan administered by the University Physical Plant for all University facilities and systems, including HVAC, building envelope, and moisture management.

2. Roles and Responsibilities

Every member of the University community is expected to be an "energy saver" as well as an "energy consumer." Faculty, staff, and students will strive to reduce energy consumption by minimizing energy usage and using energy only when needed. Every employee is expected to conserve energy and make a positive contribution to maximize energy conservation at the University.

2.1. Building Administrators

The President will assign a dean, director, or department head to serve as the building administrator for each University building. Each building administrator in conjunction with the applicable energy conservation educator will monitor total energy usage of his or her building.

2.2. Energy Conservation Educators

Energy conservation educators:

- assist building administrators in energy management and provide regular reports to building administrators indicating performance with regards to energy savings;
- perform routine audits of all facilities and communicate the audit results to the building administrators; and
- suggest adjustments to the University's energy management systems, including temperature settings and run times for HVAC and other controlled equipment.

2.3. Students

When occupying University facilities, students are expected to conserve energy. Students living in dormitories are responsible for implementing the room energy guidelines developed by the Physical Plant available on their website.

2.4 Faculty and Staff

Faculty and staff must proactively support the University's sustainability goals regarding heating, cooling, lighting, and energy conservation. When occupying their classrooms and offices, faculty and staff members are responsible for complying with the specific measures listed in Section 3. herein and implementing the energy guidelines developed by the Physical Plant available on their website.

3. Specific Measures

3.1. Lighting

Lights should be turned off when not needed and energy efficient lighting should be used whenever possible.

3.2. Heating

Windows and doors of conditioned spaces should be kept closed. During the heating season, room temperatures should be maintained between 68-72°F when occupied. Whenever it is economically and technically feasible, temperatures should be allowed to drop to 55°F during unoccupied periods. The only exceptions to this policy are special areas such as animal care units or research facilities that require constant or warmer temperatures. Areas that are too hot or too cold should be reported as soon as possible to the Physical Plant.

3.3. Cooling

Windows and doors of conditioned spaces should be kept closed. During the cooling season, room temperatures should be maintained between 74-78°F when occupied. Ceiling fans should be operated in all areas that have them. Air conditioning should not be used in classrooms during the summer sessions unless the classrooms are being used for instruction or extracurricular activities. Whenever it is economically and technically feasible, temperatures should be allowed to rise to 85°F during unoccupied periods. The only exceptions to this policy are special areas such as animal care units or research facilities that require constant or cooler temperatures. Areas that are too hot or too cold should be reported as soon as possible to the Physical Plant.

3.4. Computing Equipment

Reasonable steps should be taken to save energy when using computer equipment by following ITS energy saving guidelines listed on the ITS Green Webpage. Computers may need to be left on at certain times for installation of security patches and virus scanning, so computer users should follow the computing energy saving practices established by their IT administrator. For additional information refer to

Policy 2510 "Computer Use Guidelines" and Policy 2520 "Computer Security Controls and Guidelines."

3.5. Office machines

Office machines and appliances should be turned off when not in use, especially each night and during unoccupied times. Fax machines should remain on. Ideally office machines and appliances should be unplugged at night or a power strip should be used which is turned off when the machines and appliances not in use. All capable office machines should be programmed for the "energy saver" mode using the power management feature.

3.6. Procurement

Energy star products must be purchased whenever available. For examples, see the U.S. Environmental Protection Agency Energy Star products list. Additional information and guidelines are available on the Purchasing Department website.

4. Monitoring and Reporting

The Physical Plant will maintain records of energy consumption and the cost of energy and will provide performance information to the President routinely, but no less than once each fiscal year. This report will be used to locate problem areas as well as determine if conservation goals are being met. Any suggestions for ways of reducing energy consumption should be submitted to the Physical Plant. University faculty, staff, and student cooperation and support of energy management is key to its success. The University may use incentive programs in compliance with

Policy 3235 "Staff Recognition and Awards," UBP, to encourage employees to reduce energy use. Participation in energy management is a major component of UNM's sustainability value and should be evaluated in annual performance reviews.

B. Future Contacts, Resources, + Research Available for Final Plan

a. UNM Campus Master Plan – DPS by Mary Beggio

Alternatively, new planning of the UNM Main Campus would provide a different social landscape that should be taken into account in the Carbon Neutrality Plan. A new campus master plan is currently being revised by Dekker/Perich/Sabatini, a local architecture firm, and it is recommended that the Carbon Neutral team get in contact and open communications amongst DPS and other affiliated parties to create cohesion between the plan and future campus planning for UNM.

Contact: http://www.dpsdesign.org/contact-us

b. UNM Fleet by Iain Deason

UNM's fleet provides expediency to the UNM community through the use of mass transportation. As the school's responsibility to cater to the student body, the bus fleet is on the way that students are allowed to make the campus more accessible. Since the school an anchor institution for the Albuquerque community, it provides many chances to people in the area, but the fact the commuting problem of UNM is also Albuquerque's commuting problem, which lends to the 3 mile radius of UNM contains some of the most important public state institutions and hospitals. With combined effort of the city's transportation dept. and UNM free bus passes were given to students, both as an incentive to limit the amount of motorists, and offer a financial break for those students, faculty and staff who otherwise could not afford it. This is model that also been adopted by other campuses.

c. Person Per Watt Efficiency Program (PPWEP) by Renn Halstead

One of the most common problems with energy on large campuses such as UNM is building schedule management. One of the best examples of this problem is late evening classes. Two classes are using two classrooms in a building of one hundred classrooms, so the entire building has to be, for the most part, on. HVAC systems and lights run effectively unused. A new system must be instituted to govern building scheduling. This plan proposes the institution of a new program, called the 'Person Per Watt Efficiency Program'. This program creates a rating system with corresponding efficiency requirements for major campus facilities, taking typology into account. These efficiency requirements would be in terms of persons per watt consumed. After standards are set by the PPD, the program would become a valuable tool for the administration and the PPD to organize campus use. Classes such as those in the example would all be grouped into fewer buildings, not by academic differentiation but by efficiency.

d. Investing in Solar and Combined Solar/Wind by Zachary Perls

The sun and wind are abundant in New Mexico, and the technologies to harness these forces of nature for energy are becoming more sophisticated and efficient almost daily. It must be clear that UNM is taking direct steps toward making carbon neutrality and sustainability realities. The presence on campus of solar panels, combined solar/wind turbines or similar technology would inspire students, investors and laypeople alike to participate in sustainable development as well as garner free energy from the environment. Whether through a PPA or direct investment, we aim to prove beyond a doubt that UNM should, can, and must invest in solar panels and/or combined solar/wind turbines to provide for a large amount of the campus' energy needs. (Need here: example of UNM generation system in terms of cost and power: need real numbers for this.)

e. Vertical Farms: Numbers by Zachary Perls

Apparently, a plan is in the works to build a vertical farm in Las Vegas 30 stories tall that could feed 75,000 people and cost almost 200 million dollars to build, 6 million a year to maintain and is expected to profit 25 million dollars a year from produce, and 15 million a year from tourism. Clearly, not only are vertical farms feasible, there are investors that will make hefty profits from them.

According to Dickson Despommier, Ph. D, and his researchers, a vertical farm that was 21 stories (20 production stories, plus parking/basement) could feed 50,000 people and would cost 83 million dollars to build, 5 million a year to maintain, would have revenue at 18 million a year, and the construction cost could be paid back within 7 years as a result of the yields.

Thus, one that was 14 stories tall could feed 27,500 people (at fall 2008 total enrollment at UNM was 25,820, via the official enrollment report by the office of the registrar), take 55 million to build, cost 2.7 million a year to maintain, and would take in around 12 million a year in revenue.

For UNM a more realistic scenario would be something like this:

A 4 stories tall vertical farm would feed 9,524 people (This could be an opportunity to feed not only those living in the dorms, but those outside as well through selling to grocery stores, restaurants and direct to people through a worker-owned student-run restaurant or the UNM Food Co-op), take 16.8 million to build, .95 million a year to maintain, and would take in around 3.4 million a year in revenue, not to mention recycle waste and bring many advantageous intangibles to UNM and the community.

Stories	People Fed	Up-front Cost	Upkeep (yearly)	Revenue
21	50000	$83 Million	$5 Million	$18 Million
14	27500	$55 Million	$2.7 Million	$12 Million
7	12750	$27.5 Million	$1.3 Million	$6 Million
4	9524	$16.8 Million	$.95 Million	$3.4 Million

C. Proposal for Compiling a Sustainable Project Handbook

a. The SUST 434 students would like to propose the future development of a sustainability project handbook that can become a working document for all sustainable ideas and projects. This handbook will provide a place for student and faculty to compile completed, present, or future projects and proposals and can create a foundation for networking amongst the campus and community. Possible ideas:

- i. Academic Student Projects
  - 1. SUST 499 Sustainability Independent Capstone Project
    - a. Lobo Grower's Market by Rose Chavez.
    - b. Vertical Garden Module by Mary Beggio
    - c. Vegetarian Cookbook by Angelina Lopez
    - d. Seed Exchange

2. Other Student Projects
   a. Architecture Program
   b. Engineering Program
   c. Biology Program
   d. Business Program
   e. Et cetera

ii. Campus Projects
   1. Algae Research
   2. Campus Community Gardens
   3. Smart Grid
   4. Campus Electric Co-op
   5. Bike Share
   6. Power Purchase Agreement (PPA)
   7. Person Per Watt Program (PPWP)
   8. Cap and Trade
   9. George Pearl Hall Roof Garden
   10. Solar Panel's on Engineering Building

iii. Community Projects
   1. Community Gardens
   2. Eco Village
   3. Food Shed New Mexico

Endnotes

For purposes of the ACUPCC, climate neutrality is defined as having no net greenhouse gas (GHG) emissions, to be achieved by minimizing GHG emissions as much as possible, and using carbon offsets or other measures to mitigate the remaining emissions (2009).

Sustainability, from the United Nation's Brundtland Commission, is "Meeting the needs of the present generation without compromising the ability of future generations to meet their needs" (1987).

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