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EXECUTIVE SUMMARY

California State University, Northridge (CSUN) employs more than 2,700 faculty and staff and has a student enrollment of over 35,000, almost 95% of whom commute to campus. Because transportation accounts for 41% of California’s GHG emissions and 96% of transportation fuels are petroleum based, a study of CSUN commuting patterns and transportation preferences was carried out in the Spring of 2010 in an effort to address the carbon footprint of current commuting and to examine more sustainable options for the future. We found that 74% of the faculty, staff, and students who commute to campus travel via single occupancy vehicle—a car, van, or truck. The rate is higher among faculty and staff (85%) compared to students (72%). Only 8% of the survey respondents commute via public transport (3% train, 5% bus) and 7% carpool. Most of the remaining 11% walk, skate, or bicycle to campus. Commuters travel an average of 14.5 miles to campus from all parts of Los Angeles and Ventura Counties, but the majority commute from the San Fernando Valley. Based on these data, we calculated that the annual total energy expended in commuting to campus is approximately 175 GWh, equivalent to 12.3 kWh/person/day (365 days per year). The annual carbon dioxide emissions resulting from campus commuting total approximately 42,260 tonnes. This is equivalent to an average of 1.08 tonnes/person/year, or 3.0 kg/person/day (365 days per year).

When asked about their transportation preferences, CSUN commuters said that convenience and flexibility are the most important considerations when choosing a commute mode. They also expressed willingness to use alternate modes of transportation to come to the campus. Of the three alternatives provided—carpooling, public transit, and bicycling—carpooling enjoys the widest support across majorities of faculty, staff, and students, with more than two thirds of CSUN commuters who are not currently carpooling expressing willingness to use this mode. About half would use public transit and nearly two out of five would bicycle if conditions were right. Carpooling is particularly appealing to students, with an impressive 80% expressing willingness to use this commute mode. When it comes to the factors that might encourage carpooling among students, the ability to find other commuters who have similar schedules and who commute from their area, a discounted parking permit for carpoolers, and a guaranteed ride home in an emergency top the list.

Based on these findings, we recommend that the university encourages commuters to carpool and bicycle to campus by providing access to a common pool of ridesharing partners and opportunities, and by providing facilities to encourage bicycle use to and on campus. Support for such initiatives and others to encourage the use of alternative transportation, such as carpooling, bicycling and public transit are good investments in the future of the university, the region and the planet.
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Commuting Practices at CSUN

Introduction

California is the 12th largest emitter of carbon dioxide in the world. Recognizing the potentially disastrous effects of global warming and the role that California plays, on September 27, 2006 Governor Arnold Schwarzenegger signed AB 32, the Global Warming Solutions Act into law. This law sets the road map for California to reduce its greenhouse gas emissions over the next fifty years with targets of a reduction to 1990 levels by 2020 (a 25% reduction over current levels) and to 80% below 1990 levels by 2050. In other related legislation, the California Air Resources Board has adopted a Low Carbon Fuel Standard (LCFS), which requires fuel providers to gradually reduce the carbon content of passenger vehicle fuels sold in California by 10% by the year 2020.

Transportation accounts for 41% of California’s GHG emissions and 96% of transportation fuels are petroleum based. There is more than one registered vehicle for every licensed driver in California. The dearth of adequate public transport in the Los Angeles region and the predominance of motor vehicles as the primary means of commuting contribute greatly to carbon dioxide emissions and air pollution in this region. California State University, Northridge (CSUN) employs more than 2,700 faculty and staff and has a student enrollment of over 35,000, almost 95% of whom commute to campus. In an effort to address the carbon footprint of current commuting and to examine more sustainable options for the future, a study of CSUN commuting patterns was carried out in the Spring of 2010. This report details the study and its findings.

1. Commuter Practices

A commuting practices and transportation preferences survey was distributed to a randomly selected sample of faculty, staff, and students in the spring of 2010. The survey was administered online between March 16 and May 5, 2010. In total, 2,264 faculty, staff, and students responded for an overall response rate of 23%. Of those responses, 2,099 gave valid zip codes and were included in the commuting analysis that follows. The full sample of 2,264 responses was included in the transportation preferences analysis that is presented later in this report.

For the 2,099 cases used in the commuting analysis, the margin of error is 2.2% at the 95% confidence level. The margin of error for the 208 faculty members is 6.9%. The margin of error for the 484 staff members is 4.5%. Finally, the margin of error for the 1,407 students is 2.7%. Thus, some care must be exercised in extrapolating subgroup data.

1.1 Modes, Starting Points and Distances

Based on our analysis of survey respondents, 74% of commuters to campus travel via single occupancy vehicle (SOV) - a car, van or truck. The rate is higher amongst faculty (85%) compared to students (72%) probably due at least partially to the substantial number of students that live within walking distance of campus, a fact not shared by the faculty. Only 8% of the survey respondents commute via public transport (3% train, 5% bus) and 7% carpool. Most of the remaining 11% walk, skate, or bicycle to campus (see Figure 1). The “other” category includes those who motorcycle, vanpool or get dropped off at the campus.

A Geographic Information System (GIS) was used to map the commuting locations of survey respondents by zip code in a process known as geocoding. Street addresses were not employed due to confidentiality considerations. Locations are positioned at the centroid of the zip code. Figure 1 shows the proportion of survey respondents from each subgroup of the campus population commuting by various transportation methods.
code area polygon which naturally introduces a small error in the computed distances to campus. It can be assumed, however, that these small random errors will not introduce any bias into the results. Using a database of streets and highways, network analysis tools within the ArcGIS® software were then employed to calculate the shortest driving distances to campus from these mapped locations and computed distances were appended to each survey record for use in further analysis.

Commuters travel an average of 14.5 miles to campus but there is large variability, this distance having a standard deviation of 13.8 miles. The median value is considerably lower than the average, at 11.0 miles, indicating a skewed distribution with a large number living closer to campus. On average faculty live further from campus than both students (14.2 miles) and staff (13.6 miles), at a mean distance of 18.7 miles (see Figure 2).

An analysis of transport method by distance shows that overall train riders commute the greatest distance to campus, and not surprisingly, those who walk, skate or bicycle travel the least distance. The average train rider travels 33 miles each way to CSUN, bicyclists 3 miles, and walkers less than 2 miles (Figure 3). The “other” category shows staff commuting an average of more than 25 miles to campus. These are predominantly those travelling by vanpool.

CSUN’s population come to campus from all parts of Los Angeles and Ventura Counties, but the majority commute from the San Fernando Valley. Plate 1 shows the percentage of respondents commuting from each zip code. Hatching indicates those regions from which at least 10 survey respondents (0.5%) commute. Concentric rings around CSUN with a spacing of 5 miles are shown.

There follows a series of maps showing the primary mode of transportation for each zip code. The percentages represent the proportion of commuters from within each zip code region travelling by a given means of transport and thus reveal how choice of commuting method varies geographically. In analyzing these maps, it is important to consider the number of commuters travelling from each region since data are subdivided by both geographic region and transport method, leaving in some cases only a few survey respondents within a given region and category.
Hatching is used to denote regions in which data from at least 10 survey respondents were received. The colors of unhatched areas have little statistical significance.

Plate 2 shows that car drivers are universally distributed amongst all commuting regions. Seventy-four percent of the campus population commutes to campus via single occupancy vehicle, driving an average of 15.0 miles each way. From the 56% of respondents who were able to state the fuel efficiency of their vehicle, the average is estimated to be 25.4 miles per gallon. Using fuel economy data for combined city/highway driving published by the U.S. Department of Energy and vehicle data (make, model and year) gathered from the survey, the driver estimate was determined to be accurate to within 3% of that expected from EPA’s fuel efficiency data for the vehicles in use.

Plate 3 shows the starting commuting locations for carpoolers. Only 7% of those surveyed travel to campus via carpool. An additional 0.4% travel via vanpool (all staff); and another 0.6% are dropped off (mainly students by parents). The average occupancy of carpool vehicles driven to campus is 2.24. Carpoolers travel an average of 18.3 miles to campus and are proportionately higher in an area tending out to the Antelope Valley.

Train riders travel further to campus than any other transportation category, an average of 33.2 miles each way. There are proportionately more train riders amongst staff and faculty than students. Overall approximately 2.5% of the campus population commutes by train, the greatest proportion coming from the west (Ventura County). See Plate 4.

Plate 5 shows the distribution of the 5.5% of CSUN commuters who travel by bus. A higher proportion of students than staff or faculty ride the bus (6.9%). The average commuting distance for bus riders is 14.4 miles. Their starting points tend to be in the areas immediately surrounding the campus to its south and east and those coming from the Antelope Valley.

On average the survey respondents commute to campus 3.8 days per week, students and faculty attending on average 3.5 days per week (survey includes some part-timers) and staff an average of 4.8 days/week.

1.2 Comparison with informal survey, Fall 2008

An informal survey was distributed to students via outreach and website solicitation in Fall 2008 to gather information on commuting habits. In this survey students were asked for their method of transport, address and the number of days they came to campus. It is instructive to compare the results of the formal probability study presented above with those from the Fall 2008 survey. In the non-probabilistic (informal) survey, 635 students living off campus responded and a further 38 living on campus responded. For the purposes of the commuting analysis, these on-campus responses are ignored.

In the Fall 2008 survey, 82.8% of student respondents living off campus drive to school, 6.1% use public transport (bus or train), fewer than 0.5% carpool; 3.6% bicycle and 7.4% walk. These proportions are close to those found in the more recent (Spring 2010) survey, with the most notable difference lying in the slightly higher percent commuting in single occupancy vehicles and a decrease in those choosing to carpool. The total proportion of students travelling by car is similar in both surveys suggesting that the more detailed questioning of the recent (Spring 2010) survey categorizing more drivers as carpoolers. In any case, we can surmise that between 79% and 84% of students travel to campus by car, with less than 10% of these sharing the vehicle with others.

A GIS was used to map the addresses of the student survey respondents. In this case an exact address was used (as opposed to the zip code regions used in the Spring 2010 study). Using network analysis, routes to campus along major roads were determined and the one-way commuting distance to campus computed for each student surveyed. The average of these distances was found to be 14.2 miles, the same value as that determined for students in the Spring 2010 study. Those walking, walk an average of less than a mile and bicyclists tend to be recreational riders, cycling an average of less than 3 miles to school.

On average students were enrolled in classes 3.2 days per week and those polled commuted to campus 3.6 days per week – numbers consistent with the 3.5 days per week for students obtained in the Spring 2010 poll.

These data are employed in a carbon footprint calculation for comparison with the recent study.

1.3 Bicycle facilities at CSUN

A study was conducted on the availability and use of bicycle racks on the CSUN campus to gather in-
Plate 1. Points of origin. Zip code regions for the greater Los Angeles region. Color density is used to represent the proportion of the campus population commuting from each region.
Plate 2. Car drivers. Zip code regions for the greater Los Angeles region. Color density is used to represent the proportion of the region’s campus commuters travelling via single occupancy vehicle.
Plate 3. Carpoolers. Zip code regions for the greater Los Angeles region. Color density is used to represent the proportion of the region's campus commuters travelling via carpool.
Plate 4. Train riders. Zip code regions for the greater Los Angeles region. Color density is used to represent the proportion the region’s campus commuters travelling via train.
Plate 5. Bus riders. Zip code regions for the greater Los Angeles region. Color density is used to represent the proportion of the region’s campus commuters travelling via bus.
formation on bicycling practices on campus. This was conducted by a student in the Geography Department in the Spring 2010 semester.

The survey was conducted with a random sample of bicyclists who were utilizing the bicycle racks on campus during February – April, 2010 in late morning and mid-afternoon. 100 responses were received, 69% male, and 31% female. Based on the relatively small sample size, there is a 10% margin of error in the results. The distribution of survey respondents by standing is shown in Figure 4 below. It is interesting to note the dramatic fall-off in bicycle use that occurs between the freshman and sophomore years. Survey responses suggest that this is at least partially due to the fact that many students move to off campus housing between their freshman and sophomore years. Whereas only 5.7% of CSUN students live in campus housing, 36% of the bicyclists came from campus dormitories.

97% of bicyclists traveled less than three miles to campus. 85% came directly from their residence and of the remainder, 66% drove to an off-campus parking location and then rode their bicycles and the remaining 34% commuted by bus and then rode to campus.

There are 151 bike rack locations on campus containing 8 different types of rack with an estimated total capacity of 1474 bicycles. Examples of the most common of these are shown in Figure 5 below.

Of the 151 campus bike racks on campus, 18 are located in the northern part of the campus and the majority of these are wave-type racks and are located within the dormitory area (see Plate 6). Most are protected under nine bicycle shelters which can each hold 17 to 60 bicycles. The total capacity of the northern campus bike racks is 376 bikes. Bicycle racks in the dormitory areas are very well used, whereas those by the Student Satellite Union had much lower usage.

132 bike racks are located in the southern part of the campus with an overall capacity of 1098 bikes (see Plate 7). The most popular ones are located near the Sierra Complex, Manzanita Hall, Redwood Hall, and the Student Union. Those on the east side of the Redwood Hall are poorly utilized.

Two locations on campus are consistently found to have bicycles parked in undesignated areas or off the bike racks provided. These areas are west of Chaparral Hall and the entrance to the softball field (see Plate 8). Chaparral Hall does not have enough bike racks and it is very common to see bicycles parked along the ramps on the west entrance. A major problem with this is the obstruction this causes for building access to students with disabilities.

2. Energy and Carbon footprint

The energy consumption and carbon emissions associated with commuting are highly dependent on the transportation method. In comparing these, fuel efficiency averages from Clean Air Cool Planet were employed. These are 22.1 mpg for automobiles, 39.7 mpg for buses, 132.3 mpg for trains. For carpoolers the vehicle total was divided by the average occupancy rate of 2.24. Gasoline is assumed to have an energy content of 36.7 kWh/gallon and diesel fuel, 40.5 kWh/gallon; associated carbon dioxide emissions are 8.8 kg/gallon for gasoline and 10.2 kg/gallon for diesel. For an average commute to campus of 14.5 miles the comparative energy use in a single daily commute is shown in Figure 6.

To examine comparative emissions associated with each transportation method, Figure 7 shows the
Plate 6. Map showing locations and usage of bicycle racks on North campus.
Plate 7. Map showing locations and usage of bicycle racks on South campus.
Plate 8. Map showing locations of bicycles parked in undesignated areas.
potential carbon dioxide emissions for each mode of transport if the entire campus population were to commute to campus an average of 4 days/week, 30 weeks per year. A shift of campus commuters from cars to trains and bicycles would cut potential emissions by more than a factor of five, and a shift to carpools and buses would roughly halve the emissions.

Actual annual energy use and carbon dioxide emissions associated with commuting to campus were calculated by extrapolating survey data assuming an average of 50 commuting weeks for staff and 30 for faculty and students. Survey respondents were subdivided by type (staff/faculty/student) and by mode of transport (Figure 1). The percentage of each type travelling by each means was used to estimate the total number of campus commuters for each transport mode based upon a faculty of 2105 (full and part time), staff of 1599 and student count of 35,198 (Fall 2009 data). For each of the 21 subsets (3 positions x 7 travel modes) the average number of commuting days and average commuting distance was calculated and using fuel energy and emissions data above, extrapolated to the campus population.

The annual total energy expended in commuting to campus is approximately 175 GWh (see Figure 8). This is equivalent to an annual average of 4.5 MWh/person, or 12.3 kWh/person/day (365 days per year).

The annual carbon dioxide emissions resulting from campus commuting total approximately 42,260 tonnes. This is equivalent to an average of 1.08 tonnes/person/year, or 3.0 kg/person/day (365 days per year). Of this annual total 35,235 tonnes are due to student commuting, 3,695 tonnes due to faculty and 3,333 due to staff.

In the informal survey carried out in Fall 2008 in which only students were surveyed, 33,076 tonnes of carbon dioxide were estimated to be emitted annually in student commuting for a slightly higher student population (38,201) than was employed in this study. Thus the current (Spring 2010) probabilistic study gives a carbon footprint approximately 6.5% higher than the earlier estimate — fair agreement considering the small number of students surveyed (635) in the Fall 2008 survey and the uncertainties associated with number of days of attendance, fuel efficiency of vehicles and commuting mileage.

3. Transportation Preferences

In addition to the commuting practices of the CSUN community, data from the public opinion survey were also used to assess the needs of CSUN commuters. Whereas the commute analysis presented above was based on the 2,099 cases with valid zip codes, the transportation preferences analysis presented here is based on the full sample of 2,264 responses.
For the 2,264 cases used in the transportation preferences analysis, the margin of error is 2% at the 95% confidence level. The margin of error for the 220 faculty is 6.7%, for the 486 staff members, 4.5% and for the 1,558 students, 2.5%.

### 3.1 Satisfaction with Commute Mode

Overall, CSUN commuters are satisfied with their commute mode (see Figure 10). In fact, only 10 percent of commuters are dissatisfied with their current mode of transportation. Among the small minority of dissatisfied commuters, the feeling is strongest among those using public transit—33% of bus riders and 17% of train riders are not satisfied with their commute mode. In general, students are less satisfied than faculty and staff with their commute mode. This is likely related to the fact that students are more likely than faculty and staff to take the bus or get dropped off.

Conversely, the most satisfied commuters are those who ride a bicycle (94%), drive alone (93%), carpool (91%), or walk to campus (89%).

### 3.2 Factors that are Important when Choosing a Commute Mode

Given the high level of satisfaction among CSUN commuters, it is worth exploring the considerations that people make when choosing a commute mode. When asked to rank five factors from most important to least important when it comes to deciding how to travel to campus, convenience and flexibility stand out as the most important among all CSUN commuters (see Figure 11). About 36% of students, 61% of faculty, and 48% of staff cite this factor as the most important. Travel...
time, safety, and cost take a distant second to convenience and flexibility. It is worth noting that cost is about five times as important to students as it is to faculty, although less than a quarter of students cite it as the most important factor. Finally, only 5% of the entire population cites conserving energy as the top consideration when choosing a commute mode. The fact that convenience, flexibility, and travel time top the list of important considerations helps to explain why such a large percentage of CSUN commuters choose to drive their own vehicles to campus. These factors are even more important to faculty than to other members of the campus community, resulting in a faculty who rely on commuting in their own vehicles to an even greater degree than students or staff.

3.3 Willingness to Use Alternate Modes of Transportation

Despite high levels of satisfaction with the methods they currently use to get to campus, CSUN commuters are willing to use alternate modes at least one day a week under the right circumstances. Of the three alternatives provided—carpooling, public transit, and bicycling—carpooling enjoys the widest support across majorities of every subgroup of the population (see Figure 12). More than two thirds of CSUN commuters who are not currently carpooling would be willing to do so, compared with about half who would use public transit and about two out of five who would bicycle if conditions were right. Carpooling is particularly appealing to students, with an impressive 80% expressing willingness to use this commute mode.

The trend is similar among solo drivers, with carpooling the most popular potential alternative to driving alone (77%), followed closely by public transit (73%). A smaller but still considerable majority of those who drive alone would bicycle if the circumstances were right (62%). Among those who are satisfied with their current commute mode, the only alternative that garners majority support is ridesharing, with 66% of satisfied commuters willing to carpool.

In order to learn what kinds of incentives would encourage people to use the three alternatives offered, we drew on surveys conducted on other California university campuses, as well as informal focus group meetings with CSUN commuters. We then presented survey respondents with a number of factors and asked them whether each one would increase the likelihood that they would use a particular mode at least once a week.
3.4 Carpooling

Respondents were presented with six incentives that might encourage people to carpool. For students, who are the most willing to carpool under the right conditions, four considerations in particular stand out. Two involve the coordination of a carpool. 42% of students say they would carpool if they could find other commuters who have similar schedules, while 37% would do so if they could find people who commute from their area (see Figure 13).

Other incentives popular with students are a discounted parking permit for carpoolers and a guaranteed ride home in an emergency. Factors that are less important to students when considering whether to carpool are being able to get to know the person beforehand and finding others who have similar driving habits and preferences.

The ability to find other commuters with similar schedules also tops the list of considerations that is most likely to encourage ridesharing among faculty (37%) and staff (29%). Other factors that would increase the likelihood that faculty and staff would carpool include a guaranteed ride home in an emergency and the ability to find others who commute from the same area. Discounted parking permits for carpoolers are also important to staff. Importantly, the impact that a discounted parking permit would have on increasing carpooling is almost three times higher for students (40%) than for faculty (14%), which highlights the importance of cost as a consideration for students when choosing a commute mode. Being able to get to know someone beforehand and finding others with similar driving habits are important considerations to less than 20% of staff and 10% of faculty.

Overall, carpooling is considered by CSUN commuters to best address all five of the factors we asked people if they consider when choosing a commute mode (see Figure 14). Of those who say that convenience and flexibility are the most important considerations, 65% would carpool. Only half of those who value convenience and flexibility would take public transit and one third would bicycle. Carpooling is also perceived to be the best alternative to those who place the highest value on travel time, safety, cost, and conserving energy.

Among those who offered explanations for why they would not carpool under any circumstance, the three most cited reasons are related to concerns about the difficulty of coordinating commute schedules with others (35%), the lack of a need to carpool because of the close proximity of their home to campus (22%), and concerns about being able to find other commuters who live near them and who share similar driving habits and preferences (14%).

3.5 Public Transit

About half of faculty, staff, and students and nearly three-quarters (73%) of those who drive alone to campus are willing to use public transit under the right circumstances (see Figure 12 above). In general, all members of the campus community would consider using public transit if routes were shorter, transit schedules worked better with commuters’ schedules, and transit stops were more conveniently located (see Figure 15). Whilst everyone would value more conveniently located stops off campus, students in particular would use public transit more if there were a bus stop on campus, an idea that is proposed in plans for a CSUN Transit Center. Although the cost, comfort, and safety of public transit are less of an incentive than routes, schedules, and stops, students would be more inspired than faculty and staff by improvements to both. Notably, one
third of students would be more likely to use public transit once a week if the cost were lower.

Those who value convenience, travel time, safety, and cost are more willing to carpool than to use public transit (see Figure 14 above). In other words, public transit is perceived as less convenient, longer in travel time, less safe, and more expensive than carpooling among those who value each of those factors. However, those whose most important consideration is conserving energy are just about as likely to try public transit as carpooling.

Among those who offered explanations for why they would not use public transit under any circumstance, the four most cited reasons are the inefficiency of the transit system in terms of the time it takes to get to campus and the number of transfers (24%), the preference for another commute mode (20%), the lack of a need to use public transit because of the close proximity of their home to campus (15%), and concerns about the public transit schedule (12%).

3.6 Bicycling

Overall, about two out of five CSUN commuters are willing to bicycle to campus under the right conditions (see Figure 12 above). Students are considerably more likely than faculty and staff to consider this alternative—46% of students, 14% of faculty, and 32% staff say they would bike to campus if the circumstances were right. Although people who drive alone are more willing to carpool or use public transit under the right circumstances, a solid majority of solo drivers would bike to campus.

Of the seven incentives offered to respondents that might encourage bicycling, bicycle lockers that would prevent bicycles from being stolen or vandalized topped the list (see Figure 16). 28% of students, 18% of faculty and 21% of staff say this incentive would inspire them to ride. Improvements to bicycle routes would also increase ridership, with CSUN commuters saying they would bicycle to campus if there were clearly marked, designated routes on (15%) and off (19%) campus. The condition of off campus routes is more important to all than the condition of on campus routes, but students feel more strongly about on campus routes than faculty and staff. This difference likely reflects the need for students to travel between buildings during the day.
and commuting times from places like Los Angeles (25 miles) can typically take two hours and three different transport vehicles. Where transit routes exist and travel times are more comparable to driving times, commuters to campus are willing to use alternative means (e.g. train travel from Ventura County). However, such options are sadly lacking. The situation is expected to improve in the next year with the addition of a transit center on campus, which will allow local metro buses to bring students directly to the campus. However, this does not address the larger issue of the sparse network of local rail and commuter bus routes to the areas. In addition, although the City of Los Angeles now has a master plan of extensive bicycle lanes and paths, the sad reality is that most of these are still just plans and few serve the university campus. Bicycle commuting over the average commute distance of almost fifteen miles therefore requires for the most part, navigation of major thoroughfares whilst sharing lanes with vehicles moving at speeds of 45 mph or more – not an attractive proposition for the average rider. Commuters are thus for the most part, forced into their own vehicles to get around, a mode of transport to which those growing up in this area have become accustomed.

Among those who value convenience, flexibility, travel time, safety, cost, and conserving energy as the most important considerations when choosing a commute mode, bicycling trails behind carpooling and public transit as modes of transportation they would consider (see Figure 14 above). In fact, those who value convenience and flexibility the most are half as willing to bicycle as they are to carpool. Although bicycling is not considered convenient, it is associated with energy conservation by those who value that consideration. More than half of those who consider energy conservation when choosing a commute mode would consider bicycling to campus.

Among those who offered explanations for why they would not bicycle under any circumstance, the two most cited reasons are the distance between their home and campus (77%) and the safety risk involved in sharing the road with vehicles and riding on streets without clearly marked bicycle routes (5%).

4. Discussion

This analysis clearly demonstrates that commuting to California State University, Northridge is dominated by drivers of single occupancy vehicles. Given its place in the San Fernando Valley, such a finding is hardly surprising. The university is not served well by public transport, and commuting times from places like Los Angeles typically take two hours and three different transport vehicles. However, such options are sadly lacking. The situation is expected to improve in the next year with the addition of a transit center on campus, which will allow local metro buses to bring students directly to the campus. However, this does not address the larger issue of the sparse network of local rail and commuter bus routes to the areas. In addition, although the City of Los Angeles now has a master plan of extensive bicycle lanes and paths, the sad reality is that most of these are still just plans and few serve the university campus. Bicycle commuting over the average commute distance of almost fifteen miles therefore requires for the most part, navigation of major thoroughfares whilst sharing lanes with vehicles moving at speeds of 45 mph or more – not an attractive proposition for the average rider. Commuters are thus for the most part, forced into their own vehicles to get around, a mode of transport to which those growing up in this area have become accustomed.

There are some significant problems which result from this dependency on single occupancy vehicles. Fifty-one percent of those living in the South Coast Air Basin live within a mile of a freeway and ever-increasing volumes of traffic on these mean that residents of the region suffer from extended exposure to particulate matter, fumes and noise. The South Coast Air Basin experiences
the worst air quality in the nation, exceeding the ozone and particulate matter federal standards by more than any other metropolitan area in the country. This leads to over a million cases of respiratory illnesses and school absences each year, cardiac and pulmonary problems, impaired lung development, asthma and other health issues.

Carbon emissions from vehicles account for 41% of California’s greenhouse gas emissions, the increasing concentrations of which are contributing to the global warming problem. The threat from climate change has led to the passage of legislation to reduce emissions of these gases both internationally and regionally and California’s landmark law, AB32, mandates a reduction by approximately 25% over current levels by 2020 and to 80% below these by 2050. Much progress towards meeting these goals and improving the environmental quality of our region could be made by reducing the number of vehicles on our highways and roads. California State University, Northridge can make an important contribution by instituting measures to help reduce the number of single occupancy vehicles coming to campus each day, estimated to be about 21,000. Based on this study, the annual carbon dioxide emissions resulting from students commuting to campus are approximately 35,200 tonnes for 2009/10 and 7,000 tonnes for faculty and staff for a total of 42,200 tonnes. In 2006, the campus reported its energy use and greenhouse gas emissions to the CSU Chancellor’s Office as part of the CSU statewide Emissions Inventory Report. The emissions resulting directly from energy use on campus (combustion of natural gas, petroleum used in campus vehicles, and consumption of electricity) were estimated to be 22,641 tonnes for 2006. In a more recent Sustainability Study report prepared by Digital Energy, Inc., the 2007/08 carbon footprint of the university is estimated to be 29,835 tonnes/year (32,888 tons/year). In that same report, Digital Energy Inc. projects that based on the 2035 Master Plan, these emissions will grow to 66,026 tonnes annually by 2035 – double that of the 2007/08 year. These figures do not include so-called “Scope 3” emissions from indirect sources such as commuting. The commuting carbon footprint calculated here is 1.4 times that of the direct energy use footprint. Because of the magnitude and impact of such emissions, this Sustainability Study recommends that the CO₂ emissions caused by student commuting are included in future campus carbon footprints.

Given the unsatisfactory nature of currently available public transport options, we recommend that the university encourages commuters to carpool and bicycle to campus by providing access to a common pool of ridesharing partners and opportunities, and by providing facilities to encourage bicycle use to and on campus. Based on our study, more than two thirds of CSUN commuters would be willing to carpool if conditions were right. Carpooling is particularly appealing to students, with an impressive 80% expressing willingness to use this commute mode. Software applications are commercially available which connect potential riders to each other based on schedule and location, and many of these applications have the ability to restrict the pool of users to reduce risk. Such applications are already in use in many of the UC and CSU schools.

Although the university does not have control over bicycle routes off campus, bicycling to and around campus could be encouraged and supported by improvement of campus facilities such as routes around campus, storage lockers and showers, and maintenance facilities. A faculty/student study is currently underway to research the routes and habits of current bicyclists on campus, and to recommend possible bicycle paths/routes within the existing infrastructure. Also underway are plans to start a student run bicycle cooperative within the USU which would serve as an educational and maintenance facility by providing bicycle training, safety classes, bike repair and instruction.

Support for such initiatives and others to encourage the use of alternative transportation, such as carpooling, bicycling and public transit are good investments in the future of the university, the region and the planet.

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REFERENCES


2. Areeya Tivasuradej, Geography Dept.

3. The Clean Air Cool Planet Campus Carbon Calculator (http://www.cleanair-coolplanet.org/toolkit/inv-calculator.php) is the leading tool for assessing campus greenhouse gas emissions and is the “tool of record” for most of the 600 signatories to the American Colleges and University Presidents Climate Commitment. Fuel efficiency data are obtained from the Bureau of Transportation Statistics (http://www.bts.gov/publications/national_transportation_statistics/).

4. from Table C.4 California Climate Action Registry General Reporting Protocol v3.0 (http://www.climateregistry.org/tools/protocols/general-reporting-protocol.html)

5. Data from California State University Profile, Fall 2009. Available from the Office of Institutional Research (http://www.csun.edu/~instrsch/). Assumes part-time staff commute to campus half as often as their full-time equivalents.


APPENDIX I

QUESTIONNAIRE AND RESULTS

Date Survey Conducted: March 16—May 5, 2010
Total Sample: 2,264 CSUN Students, Faculty, and Staff
Students: 1,558
Faculty and Staff: 706
Margin of Error for total sample: +/-2% at 95% Confidence Level
Margin of Error for Students: +/- 2.5% at 95% Confidence Level
Faculty and Staff: +/- 3.8% at 95% Confidence Level

Results shown below are for the total sample.

Status 1: Which of the following best describes you?
69% student
22 full-time staff [skip to q2]
5 tenured or tenure-track faculty [skip to q2]
4 part-time faculty [skip to q2]

Results omitted

1. Do you live in CSUN student housing or off campus this semester?
91% Off-campus
9 CSUN student housing [skip to q4]

Q2 and Q3. Please enter the city and zip code from which you typically commute to the CSUN campus this semester.
Results omitted

4. In a typical (non-furlough) week this semester, how many days do you come to the CSUN campus?
1% 0 days [skip to q19]
4 1 day
15 2 days
18 3 days
25 4 days
34 5 days
3 6 days
0 7 days

5. What is the primary mode of transportation that you use most often to come to the CSUN campus this semester?
[options rotated]
2% Amtrak, Metrolink Train, or Metro Rail
0 Antelope Valley Transit Authority Bus
4 Bicycle [skip to q16]
6 Carpool [skip to q8]
1 CSUN Housing Tram [skip to q16]
70 Drive alone [skip to q11]
5 Metro Bus
1 Motorcycle, motorized scooter, or moped [skip to q11]
1 Skateboard, scooter, or rollerblade [skip to q16]
0 Vanpool [skip to q10]
9 Walk [skip to q16]
1 Someone drops me off [skip to q16]

6. How do you usually travel between your commute address and the bus stop or train station?
3% Bicycle
20 Bus
3 Carpool
17 Drive alone
12 Someone drives me and drops me off
45 Walk

7. How do you usually travel between the bus stop or train station and the CSUN campus?
2% Bicycle
18 Bus
22 CSUN Shuttle
0 Someone drives me
58 Walk
[go to q16]
8. When you come to campus in a carpool or rideshare, how many people usually occupy the vehicle, including yourself?

- 82% 2 people
- 13% 3 people
- 4% 4 people
- 1% 5 or more

9. When you come to campus in a carpool or rideshare, are you ever the driver of the vehicle?

- 74% Yes [go to q11]
- 26% No [go to q16]

10. Are you a member of the CSUN Vanpool Program or another vanpool program?

- 100% CSUN Vanpool Program [go to q16]

Please answer the questions below about the vehicle (car, truck, van, motorcycle, or moped) that you drive to campus most often, whether you drive alone or are the driver of a carpool or rideshare.

11. Please select the make of the vehicle you drive to campus most often from the list below.

*Top 5 responses shown.*

- 25% Toyota
- 18% Honda
- 8% Ford
- 8% Nissan
- 4% Volkswagen

12. Please enter the model of the vehicle you drive to campus most often.

*Results omitted.*

13. Please select the year of the vehicle you drive to campus most often.

*Top 5 responses shown.*

- 9% 2006
- 9% 2005
- 9% 2007
- 8% 2003
- 8% 2008

14. How many miles per gallon (MPG) does your vehicle typically average?

*Results omitted.*

15. When you drive this vehicle to campus this semester where do you usually park?

- 80% CSUN parking lot or structure with a parking permit
- 7% CSUN parking lot or structure with a temporary pass
- 13% Off campus

16. How satisfied are you with your primary mode of transportation?

- 52% Very satisfied
- 38% Somewhat satisfied
- 7% Somewhat dissatisfied
- 3% Very dissatisfied

17. What percentage of the days you come to campus this semester do you use this mode of transportation?

- 73% 100 of the days% [skip to q20]
- 22% 75 to 99%
- 4% 50 to 74%
- 1% less than 50%

18. What is the other mode of transportation that you use regularly to come to the CSUN campus this semester?

*Options rotated*

- 0% Other
- 3% Amtrak, Metrolink Train, or Metro Rail
- 1% Antelope Valley Transit Authority Bus
- 9% Bicycle
- 23% Carpool
- 8% CSUN Housing Tram
- 28% Drive alone
- 9% Metro bus
- 2% Motorcycle, motorized scooter, or moped
- 1% Skateboard, scooter, or rollerblade
- 14% Walk
- 2% Someone drops me off

19. Is the reason you don’t come to campus related to transportation?

- 9% Yes
- 91% No
20. Would you be willing to bicycle to campus at least one day a week this semester or in a future semester?
38% Yes, under the right conditions
57 No, not under any circumstances [skip to q22]
5 I already bicycle to campus at least one day a week [skip to q23]

Which of the following would increase the likelihood that you would bicycle to campus at least one day a week?
[options rotated]

21a. CSUN offered bicycle technique and safety classes on campus.
48% No Effect
8 Very Unlikely
10 Somewhat Unlikely
19 Somewhat Likely
10 Very Likely
5 Would Definitely Bicycle

21b. There were clearly marked, designated bicycle routes OFF campus.
17% No Effect
5 Very Unlikely
7 Somewhat Unlikely
22 Somewhat Likely
30 Very Likely
19 Would Definitely Bicycle

21c. There were clearly marked, designated bicycle routes ON campus.
23% No Effect
5 Very Unlikely
7 Somewhat Unlikely
24 Somewhat Likely
26 Very Likely
15 Would Definitely Bicycle

21d. There were facilities on campus for bicycle maintenance, such as tire inflation equipment.
15% No Effect
4 Very Unlikely
8 Somewhat Unlikely
30 Somewhat Likely
26 Very Likely
17 Would Definitely Bicycle

21e. There were more bicycle parking near the buildings I visit on campus.
19% No Effect
3 Very Unlikely
5 Somewhat Unlikely
24 Somewhat Likely
31 Very Likely
18 Would Definitely Bicycle

21f. There were bicycle lockers that would prevent my bicycle from being stolen or vandalized.
12% No Effect
3 Very Unlikely
4 Somewhat Unlikely
22 Somewhat Likely
33 Very Likely
26 Would Definitely Bicycle

21g. There were facilities where I could change and/or shower once on campus.
30% No Effect
8 Very Unlikely
9 Somewhat Unlikely
22 Somewhat Likely
19 Very Likely
12 Would Definitely Bicycle

22. Please briefly tell us why you would not bicycle to campus under any circumstances.
Open ended; responses omitted

23. Would you be willing to take public transit to campus at least one day a week this semester or in a future semester?
50% Yes, under the right conditions
42 No, not under any circumstances [skip to q24g]
8 I already bus to campus at least one day a week [skip to q25]
Which of the following would increase the likelihood that you would take public transit to campus at least one day a week?

[options rotated]

24a. I had easy access to a bus stop or train station from my commute address.
9%  No Effect
3   Very Unlikely
3   Somewhat Unlikely
16  Somewhat Likely
35  Very Likely
34  Would Definitely Bus

24b. The bus or train schedule worked better with my schedule.
6%  No Effect
3   Very Unlikely
4   Somewhat Unlikely
18  Somewhat Likely
32  Very Likely
37  Would Definitely Bus

24c. The bus or train routes were shorter and took less time to arrive on campus.
8%  No Effect
3   Very Unlikely
3   Somewhat Unlikely
16  Somewhat Likely
30  Very Likely
40  Would Definitely Bus

24d. There were a bus stop on campus.
10% No Effect
3   Very Unlikely
4   Somewhat Unlikely
21  Somewhat Likely
31  Very Likely
31  Would Definitely Bus

24e. Public transit cost less.
16% No Effect
5   Very Unlikely
5   Somewhat Unlikely
21  Somewhat Likely
25  Very Likely
28  Would Definitely Bus

24f. Public transit were safer and/or more comfortable.
17%  No Effect
3   Very Unlikely
7   Somewhat Unlikely
24  Somewhat Likely
26  Very Likely
23  Would Definitely Bus

24g. Please briefly tell us why you would not take public transit to campus under any circumstances.
Open ended; responses omitted

25. Would you be willing to carpool to campus at least one day a week this semester or in a future semester?
66%  Yes, under the right conditions
23  No, not under any circumstances [skip to q28a]
11  I already carpool to campus at least one day a week [skip to q28a]

Which of the following would increase the likelihood that you would carpool to campus at least one day a week? [options rotated]

26a. I could find others to carpool with who have schedules similar to mine.
3%  No Effect
2   Very Unlikely
3   Somewhat Unlikely
18  Somewhat Likely
35  Very Likely
39  Would Definitely Carpool

26b. I was guaranteed a ride home in an emergency.
8%  No Effect
2   Very Unlikely
4   Somewhat Unlikely
19  Somewhat Likely
34  Very Likely
33  Would Definitely Carpool
26c. I could find others who have similar driving habits and preferences (music, radio, smoking, speed, etc).
17% No Effect
4 Very Unlikely
7 Somewhat Unlikely
29 Somewhat Likely
26 Very Likely
17 Would Definitely Carpool

26d. I could find others who commute from close to my address.
3% No Effect
2 Very Unlikely
3 Somewhat Unlikely
20 Somewhat Likely
38 Very Likely
34 Would Definitely Carpool

26e. I could get to know the person/people beforehand.
9% No Effect
3 Very Unlikely
6 Somewhat Unlikely
25 Somewhat Likely
33 Very Likely
24 Would Definitely Carpool

26f. CSUN offered preferred or discounted parking for carpools.
8% No Effect
4 Very Unlikely
4 Somewhat Unlikely
20 Somewhat Likely
29 Very Likely
35 Would Definitely Carpool

27. Please briefly tell us why you would not carpool to campus under any circumstances. 
Open ended; responses omitted

Please rank the following from least important to most important when it comes to choosing your means of transportation to campus.

28a. Convenience/Flexibility
7% 1 Least Important
12 2
16 3
24 4
41 5 Most Important

28b. Cost
18% 1 Least Important
20 2
25 3
19 4
18 5 Most Important

28c. Reducing pollution, conserving energy
44% 1 Least Important
23 2
18 3
10 4
5 5 Most Important

28d. Safety
13% 1 Least Important
25 2
23 3
19 4
20 5 Most Important

28e. Travel Time
9% 1 Least Important
14 2
20 3
31 4
26 5 Most Important
APPENDIX II

Cost-benefit analysis of carpooling and other alternative means of commuting to CSUN

Alternative means of commuting can be financially beneficial to both the student and the university. By switching from a single occupancy vehicle to public transport, bicycling, or carpooling the student will likely save money (as well as energy and carbon emissions). Since parking structures to accommodate campus commuters are expensive to construct, the university can save money in the long-term by postponing the need to build further structures. The following is an analysis of the cost savings to both students and the university which can be realized through ridesharing.
Between the year 2000 and 2010, the total number of enrolled students increased at an average annual (compounding) rate of 1.95%. If this rate of growth continues for the next 15 years, the number will increase from 35,272 in 2010 to 47,124 by 2025. Allowing for staff and faculty commuting, parking space needs are estimated at a rate of roughly 0.5 spaces per FTE (full time equivalent). If the current commuting practices continue, growth in FTE will necessitate the addition of approximately 4,600 parking spaces by 2025. Parking needs will increase by 1,500 spaces over current demand by 2015 and by 2,000 spaces by 2017. The cost of constructing a new 1,500 or 2,000-space lot can be deferred, potentially indefinitely, by the shift of commuters from single occupancy vehicles (SOV) to carpools. With 10% of SOV-commuting students shifted to carpooling, the additional need over current demand would be reduced to approximately 3,400 by 2025; and with 20% carpooling, it would be reduced to approximately 2,200 spaces. The chart below shows the postponement time for parking structure construction as a function of the proportion of students switching to carpooling.

A 1,500-space structure that would be built in 2015 in the absence of carpooling (red dashed curve) could be delayed by 4 years if 10% of SOV students carpool and by 8 years if 20% of students carpool (blue arrows). A 2,000-space structure would be similarly delayed (black arrows).

![Figure 1. Reduced demand and construction delay for new parking structure.](image)

For less aggressive growth (1.0%/year in FTE, compounding) and current commuting practices, the current demand is not expected to grow by 1,500 until the year 2020. This would be postponed approximately 7 years by a switch of 10% of SOV students to carpooling. For more aggressive growth (2.5%/year in FTE, compounding) and current practices, demand would grow by 1,500 by the year 2014 and be postponed by 3 years by a 10% switch to carpooling.

The next parking lot slated for construction is the new G6 structure. Exact construction date depends on a number of factors including the decisions made about faculty/staff housing and the construction of more student housing. Current estimates are that this structure will accommodate between 1,500 and 2,000 spaces and will begin construction around 2015. At today’s rate, bare construction is estimated to be approximately $12,500/space and $15,000/space with all other costs factored in. Assuming that 75% of the project cost would be fi-
nanced through a 30-year bond, a 6% rate on that bond would turn this into a present value cost of $28,200/space.

A delay in construction of four years in the construction of a 1,500-space parking lot via the switch of 10% of students from single occupancy vehicles to carpooling will save the campus $5.5 million in loan payments over those four years. A delay of eight years, achieved through the switch to carpooling by 20% of students, would save a cumulative total of $11 million. In addition to these loan repayment savings the campus would gain potential annual returns from the 25% down payment of approximately $6.3 million (estimated 2015 cost) required that could otherwise be invested elsewhere.

![Figure 2. Cost savings from delay in construction of new parking structure](image)

Partially offsetting these savings would be parking pass revenue which would be reduced by the number of carpooling students. The current cost of an annual student parking pass is $360. Assuming that 90% (estimated) of students commuting to campus via their own vehicle (75.5% of total student headcount) buy an annual pass, the annual student parking revenue is $8.6 million. If 10% of SOV student commuters switch to carpooling, this would result in a loss of 1,277 vehicles to campus and annual revenue of $413.8K assuming 90% buy passes. Over 4 years, assuming 1.95% FTE growth and a 1.5% annual price increase, cumulative loss in revenue amounts to $1.7 million. By 2015 the loss would be $2.1 million over a 4-year period. This is less than half the savings from potential loan repayments. With 20% of students switching to carpooling, a revenue loss of $3.7 million would be incurred over the next eight years, or for an 8-year period beginning in 2015, the cumulative loss would be $4.6 million. These losses are also less than half of the costs of loan repayment over 8 years.

Besides the financial benefits for the campus, students can realize substantial savings from carpooling. Using data from the commuting survey, students drive an average of 3,000 miles a year commuting to campus at a fuel cost of approximately $540 and a total vehicle cost of approximately $1,500. By sharing the cost with just one other student each day, each could save $750 per year on their vehicle costs in addition to half the cost of a parking pass ($180).
Other benefits to the campus and community include a reduction in the number of vehicles coming to campus on a daily basis and thus on street congestion, energy consumption, vehicle emissions and air pollution. With 10% of SOV students carpooling, the daily count of vehicles coming to campus would be reduced by approximately 900 during the academic year; annual energy consumption from commuting would be reduced by about 6.3 million kWh, and annual CO$_2$ emissions by 1,500 tonnes. Proportionately higher savings would be realized through more carpooling.

Carpooling can be institutionalized through the purchase, installation and marketing of ridesharing software applications that provide ride matching opportunities. Such an application has recently been purchased by Parking and Transportation Services. In order to be successful and meet carpooling goals it should be accessible through the CSUN portal and provide a user-friendly interface and mobile applications. Carpooling can also be encouraged through possible incentives such as discounted carpooling parking permits, the dedication of premium parking places for carpoolers, and tiered parking permit price structure.

Although this analysis was prepared for the purpose of investigating the cost and benefits of carpooling, the results can easily be extended to other modes that reduce the numbers of single occupancy vehicles coming to campus each day. Note that cost savings given here will require a switch to alternative modes of commuting by only half as many students (i.e., 5% adopting bicycling is equivalent to 10% carpooling) because carpooling here is assumed to save one vehicle per two students.

The authors would like to thank Colin Donahue, V.P. Facilities Planning, Design and Construction and Alfredo Fernandez, Parking and Transportation Services for providing data and assistance for this analysis.

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Data used in analysis

<table>
<thead>
<tr>
<th>Student data</th>
<th>Data value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Students (2010)</td>
<td>35,272</td>
<td>CSUN Profile</td>
</tr>
<tr>
<td>2010 FTE</td>
<td>27,436</td>
<td>CSUN Profile</td>
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<tr>
<td>Assumed enrollment increase/yr</td>
<td>1.95%</td>
<td>compounding avg (2000–2010)</td>
</tr>
<tr>
<td>Avg commuting days/week</td>
<td>3.51</td>
<td>student avg from survey</td>
</tr>
<tr>
<td>weeks/year</td>
<td>30</td>
<td>academic year</td>
</tr>
</tbody>
</table>

Driving data

| Avg miles round trip         | 28.4       | from survey                                      |
| Fuel cost $/gal              | 4.00       | our estimate                                     |
| Cost of car/mile             | 0.51       | 2010 IRS reimbursement rate                      |
| avg vehicle mpg              | 22.1       | Cool Planet and EPA                              |

Parking data

| Parking spaces needed per FTE | 0.5        | Colin Donahue (est. includes allowance for faculty and staff) |
| Total Spaces (present)       | 12,457     | Cpt. Fernandez                                   |
| # spaces in new structure    | 1,500 – 2,000 | Colin Donahue                               |
| $ Parking Pass/Yr            | $360       | Cpt. Fernandez (student cost)                   |
| Increase in $/parking pass/yr| 1.50%      | our estimate                                     |
| % of students with pass      | 90.00%     | our estimate                                     |

Structure costs

| 2010 cost to build/space     | $12,500 - $15,000 | Colin Donahue (est.) |
| Cost escalation rate (%)/yr  | 2 - 3%           | Colin Donahue (est.) |
| 30 year bond rate            | 6%                | Colin Donahue (est.) |
| % financed                   | 75%               | Colin Donahue (est.) |
| financing over (yrs)         | 30                | Colin Donahue |

Current mode of transport (students) (% of headcount)

| SOV                          | 72.42%         | of headcount (from 2010 survey) |
| Carpool                      | 6.75%          | of headcount (from 2010 survey) |
| Bus                          | 6.89%          | of headcount (from 2010 survey) |
| Train                        | 1.78%          | of headcount (from 2010 survey) |
| Bicycle                      | 3.41%          | of headcount (from 2010 survey) |
| Walk/Skate                   | 7.68%          | of headcount (from 2010 survey) |
| Other                        | 1.02%          | of headcount (from 2010 survey) |
| # per carpool (current)      | 2.17%          | of headcount (from 2010 survey) |
| # current student vehicles   |                  |                                   |
| (SOV+carpool portion)        | 75.53%         | of headcount (from 2010 survey) |

Emissions data

| Energy use (petroleum)       | 36.7145        | kWh/gal (US)                                  |
| regular gasoline             | 8.81           | (kgCO2/gallon)                                |