

Western Washington University

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Electrify My Ride!

By: Thomas Brissenden, James Maxwell Scher

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1.0 Executive Summary

Currently over 90% of the U.S.'s oil consumption is from the transportation sector. Electric Vehicles (EV's) are poised to change that. The university through its actions and its influence will help drive the EV market. In part by exposing young minds, expanding the knowledge base, and driving demand. All which will fuel innovation and participation in this growing field. A field which is massively important in the struggle to achieve climate neutrality.

By replacing the campus fleet we can greatly help WWU lower its environmental impact. The vehicles of the campus fleet account for 1.5% of WWU total GHG emissions. Since campus offsets its electrical use with Renewable Energy Certificates, a complete fleet conversion would amount to a reduction of 616 metric tons of Co2 emissions annually. Furthermore widespread visibility of the campus fleet makes this an ideal project for engaging students and raising awareness of electric vehicles and their varied uses. Also by having students at the Vehicle Research Institute perform regular maintenance on the EV's, there is an opportunity to directly involve students in a real world application of electric vehicles. Furthermore by creating a student group to track the cost effectiveness of the EV pilot program, business and economics students can gain first hand experiences with the blossoming alternative energies market.

Through the course of this project we have identified a number of potential departments and FM employees who would best use an EV, as well as the most promising EV's models on the market today.

1. A Gem eL for use by Greg Hough as a transport to and from campus. Where it can then be used by the Custodial Supervisors as transport around campus when Necessary.
2. A Gem eXL for use by the campus grounds keepers. This version of the Gem has a much greater carrying capacity of 4-500lbs + 2 passengers.

We suggest purchasing these two electric vehicles next year instead of the fossil fuel vehicles scheduled for replacement by Facilities Management (FM). By supplementing the cost difference (to be determined by FM) with the Green Energy Fee, we will be able to pilot EV use on campus. In doing so we will be able to test the improved vehicles and techniques for EV uses, as well as gauge their effectiveness in reducing costs.

1.1 Statement of Need

Over the next two years Facilities Management (FM) tentatively plans on replacing ten vehicles in the campus fleet. Five this year and five the next. The need to lower WWU's Co2 emissions has fueled an interest in replacing these vehicles with more environmental friendly alternatives. We propose replacing two of this year's five vehicles with Electric Vehicles (EV's), to prove the viability of the new EV models as an alternative to the use of fossil fueled vehicles in the FM fleet.

1.2 Organization Information

Facilities management (FM) is the organization in charge of ensuring campus assets such as general maintenance, gardens on campus and keeping the University up to par, all behind the scenes. By having efficient tools to complete these tasks FM can allow for WWU to function smoothly and effectively. FM is split up into different departments that function separately depending on what needs to be accomplished, each has a special function to fulfill.

1.3 What are Electric Vehicles (EVs)?

Electric Vehicles have been in use around the globe for about 100 years. Some of the original models were first based off of a horseless carriage. Modern day technology has vastly increased the viability of electric vehicles and made it capable of achieving both a fast top speed and the ability of traveling up to about 100 miles on one charge. There are hundreds of kinds of electric vehicles that are available including a mix of biofuel and other Internal Combustion Engine (ICE) hybrid vehicles.

On campus we need vehicles that can carry a minimum of about a half a ton payload. Therefore we are mainly considering the use of the Gem eL and the Gem eXL. These are classified as Low Speed Vehicles (LSV) meaning that it is a four wheeled vehicle that in general does not exceed 30 mph and weighs less than 3,000 lbs. Generally EVs operate off of an AC or DC motor. The DC motor operates essentially the same from the drivers point of view, but under the hood is a very different set up. By applying pressure to the gas pedal which is hooked up to a set of potentiometers (variable resistors), the signal is then relayed to the DC controller, which regulates the amount of energy/power exerted. The power comes from sets of batteries at a certain voltage (usually for a total of about 100V or more) and delivers the current through the DC controller to the DC motor. AC controller operating systems are more complex, requiring more batteries/other equipment, but essentially operates off the same system. AC/DC motors also have very different capabilities and needs but because both the eL and eXL have DC operating systems we will focus on them. The Gem eL and eXL operate with 72V DC controller and motor. Having a DC operating system in general means less maintenance and also that the motor has the capability of overdrive, where the capacity can be increased by 5 times for a short amount of time.¹ This will be helpful in times of need of excess power. This is just a short summary about the workings of electric vehicles and their capabilities.

2.0 Methodology

Our methodology for this project has followed a fairly linear path. We began by first meeting with the FM VP Bill Managan. He informed us about the previous EV Pilot project. We then compared the findings of that project with other universities contemporary experiences with EV use. These pieces of information coupled with

¹ "How Electric Cars Work" How Stuff Works. Brain, Marshall 2012.
< <http://auto.howstuffworks.com/electric-car3.htm> >

updated knowledge of EV's gave us a solid base to begin building upon. (See Appendix for full interview)

2.1 EV Pilot Program 2003

Facilities Management has worked with electric vehicles in the past. The experience that was incurred was not very positive. The vehicles proved to be more expensive than the fossil fueled vehicles they replaced. This was mainly due to large maintenance costs. The price difference, as discovered by the the strategic vehicle planning commission, between fossil fuel vehicles and EV's is \$0.63/mile. Fossil fueled vehicles at the time cost on average \$0.93/mile and the EV's \$1.51/mile. (See attached excel sheet).

Yet in their report they identified two key ways in which to decrease that price difference. One was to diminish the number of FM fleet vehicles. However doing so (as stated in the 2006 report) would have various widespread negative effects on the productivity of the FM fleet. The other option was to relocate FM shops to a more central location on campus. This option although complicated offsets one key negative quality of heavy duty electric vehicles. Most have a top speed of 25 mph. Diminishing the distance these vehicles need to travel is the best way to offset this.

2.2 (Contacts and meetings)

Our meetings with FM VP Bill Managan proved particularly useful. From him we learned:

- What vehicles are in need of replacement and the required tasks. This let us know exactly what the EVs need to be able to accomplish. We also discovered that most likely these vehicles will not even be replaced as FM is behind in schedule and often times their vehicles remain in use much later than the scheduled replacement date. We learned that FM is replacing five mid sized chevy S-10 Pickups. These are best vehicles for replacment with EV's as they have lower carrying capacities.
- Past experiences with Electric Vehicles. Attached is the previous report from the Strategic Vehicles Committee. This, in detail, runs through some of the findings from the previous pilot program. This includes the recorded cost of maintenance, mileage, purchase cost, age and replacement cost. This can be utilized as a model for future data collection to assess the project's success.
 - High maintenance costs were one thing that is pointed out by this report.
- Potential Shops that could best utilize EV's as they had smaller loads, and less travel requirements.
 - Campus Gardeners
 - Randy Godfrey <Randy.Godfrey@wwu.edu>
 - Maintenance Mechanics:
 - but they have to be able to get downtown
 - but carry less then gardeners

- Loyd Hungate...650-2879
- Fire extinguisher people (looking into bikes now)
 - Scott Stilts...650-3208
- Custodians
 - Have warehouse on campus.
 - Have 2 vehicles.
 - Manager: Don Backensen...650-3932
- Quality Assurance Coordinator: Greg Hough

2.3 (Case Studies / Insider Interviews)

The use of electric vehicles on other campus' around the country has recently become more prevalent. According to AASHE 59 universities in the US employ EV's in their campus fleets. The number of vehicles in each fleet ranges from 1 to 225. Our research has lead us to contact several universities and we have found mixed results.

Phone interview with chief engineer, Jeff Major, of the EV institute at **Bowling Green State University**. The institute even created an electric hybrid powered bus. The bus was in use for about a year and funded by grants from congress and other funds from NASA. The chief engineer working for them explained that lack of funding and interest were the two main challenges facing the implementation of EVs. The electric bus was actually switched back to its main, diesel operating system. The main reason being that there was a lack of funding from the institution and a lack of interest in the public sector.

Evergreen State University in Olympia, WA also has experience working with electric vehicles. They have a similar climate although their campus is not as hilly. Also, their experience EV use on campus is limited and depends upon what you need accomplished. This is why they have specific designated users/tasks for the EVs to be used for. For example, short trips to campus and back, or for use with some of the gardeners. They also explained that the larger EVs they worked with lacked the power and durability to perform to the necessary standard. We can utilize this in terms as a loose model for the use of EV's on our campus

MIT has also provided a great resource with tons of information on all kinds of EVs and their potential use in the modern day world.

Just a little south, **Seattle University** employees 21 EV's.

One of our most useful resources in through this project has been Larry Lane. Head of the EV project at the **University of North Carolina**, Charlotte. UNCC currently operates 65 low speed EV's. Through the incorporation of these EV's as well as flex fuel vehicles UNCC has been able to decrease FM fleet costs, and the fleets environmental impact. While simultaneously raising awareness and educating campus students staff and faculty on the importance of environmental stewardship.

Larry also shared with us some of the key ways in which UNCC has been able to decrease the costs of its EV's.

- Fewer Drivers: This greatly decreased maintenance costs caused by extreme student drivers. Much better to have less drivers with a small amount of training of proper vehicle use.
- Do not use constantly: Better for trips from A to B where they are parked for a time, and possibly charged.
- Don't use fast charge systems: They tend to overheat the battery causing decreasing its capacity over time.
- Important to use Opportunistic Charging: Have stations positioned so whenever the car is parked it can be charged.
- Drum brakes on front and back can help alleviate problems caused by starting and stopping vehicles on hills.
- Better to use Gel batteries for maintenance. When acid batteries overheat they corrode wires.

3.0 Research & Analysis

Through our research we have found that most Universities like WWU who have tried to use EV's in their FM fleet, find they are more expensive than their fossil fueled alternatives. However, the price gap between the two vehicle types is constantly narrowing, as electric vehicle technology improves.

Keeping this in mind, our goal for this project has been to find ways to decrease that price gap even further through more efficient EV use. All while addressing key concerns of FM over maintaining the current levels of service they provide to campus. Our thought process has been to:

1. To determine those who could best use EV's given their abilities. To do so we have attempted to identify those who are/can:
 - a. Possibly be part of an EV pool. Which uses the EV only occasionally when necessary.
 - b. Carry lighter loads (<300-400 lbs not including 2 passengers)
 - c. Decrease their trip length/frequency by:
 - i. Having an FM Shop on campus.
 - ii. Filling one large truck with the most needed tools and parking it in a central location on campus.
 - iii. Having a FM breakroom on campus.
 - d. Use strategically Positioned Charging stations.
2. Decrease maintenance costs by:
 - a. Having less drivers per EV vehicle
 - b. Improving driving habits.
 - i. Never go over curbs.
 - c. Use of gel batteries.
 - d. Change charging unit to dedicated 15 amp circuit.
3. Determine the best EV for WWU use based on:
 - a. Other universities experiences.

- b. Ability to meet determined vehicle uses.
- c. Expected costs.
- 4. Determine the other benefits of EV use on campus:
 - a. Decreased Co2 emissions determined by:
 - i. Determining the lifetime Co2 Emissions of a GEM eL
 - 1. Our electricity received from PSE emits about 0.000464529118546 metric tons of GHG's (mostly Co2) per kWh
 - ii. Finding the Average CO2 output from Chevy S-10
 - 1. Total average mileage: 4375 Miles a year.
 - 2. Average CO2 emissions per mile for small truck: 1.15 lb/mile.
 - 3. Avg CO2 for one Chevy S-10 per year: 5,031.25 lbs/year².
 - b. Higher visibility for WWU sustainability efforts.
 - i. Having easily identifiable EVs will illuminate this sustainability project to students, faculty and Staff, as well as visitors.
 - ii. Setting an example for Bellingham/WWU will help spread knowledge and bring this technology to new levels.
 - c. Educating Students Staff and Faculty about electric vehicles:
 - i. By having information about our EV's readily available online, people can easily learn more about EV's, their use, their importance, and there applications on campus.
 - ii. VRI students can perform maintenance on the vehicles to learn more about them and potentially save money.
 - iii. CBE students can learn the potential cost obstacles for EV's by performing hands on cost benefit analysis of the pilot program.

4.0 Recommendations:

Based on our research and analysis thus far we suggest replacing two of five FM vehicles scheduled for replacement with Gem eL electric vehicles. In general the Gem's have improved greatly since the 2002 model was purchased by FM. In the words of UNC Charlotte's Fleet Manager, Larry Lang, if you were familiar with the internal components of the older Gem models you wouldn't even recognize the 2012 version. One of the major changes has been the completely redesigned brain. Now the control and charger unit are together positioned behind the battery to prevent moisture damage. Overall a decade of research and development has greatly improved the maintenance requirements of the Gem model. Based on this we suggest:

1. A Gem eL for use by Greg Hough as a transport to and from campus. Where it can then be used by the Custodial Supervisors as transport around campus when Necessary.

² "Emission Facts: Annual Emissions and Fuel Consumption for Passenger Cars and Light Trucks" US Environmental Protection Agency, April 2000. 13 May 2012 < EPA.gov/oms/consumer/f00013.htm >

2. A Gem eXL for use by the campus grounds keepers. This version of the Gem has a much greater carrying capacity of 4-500lbs + 2 passengers.

5.0 Budget

FM has a budget of about \$120,000 to spend on the replacement of 5 vehicles, which are the chevy s10 model. This truck costs around \$20,000 to purchase new and will last about 12-18 years. They are supposed to be replaced every 8 years but that has not happened according to plan. This means at the steady rate of change, we will have around \$100,000 as a potential budget for 5 vehicles. For the two EVs we could potentially spend about \$40,000 of that, initial vehicle purchase costs.

EV cost: estimated our chosen model will cost around \$12,000 apiece. Which is about \$8,000 less than the S-10 in initial costs. FM estimates (based on previous EV use by FM) have the cost difference between an EV and S-10 at around 0.63 cents more per mile because of maintenance issues.

We propose using the Green Energy Fee to pay for the projected price difference between the GEM's and the traditional Fossil Fueled vehicles, as determined by FM.

6.0 Future Works

Going forward a great deal of preliminary work is still necessary. We Must determine the potential charging infrastructure required on campus. As well as determine a concrete schedule for use of the various EV's. Finally we must determine the amount of Green Energy Fee money that would be required to supplement the purchase of these EV's.

The purchase of the EV's however is only the beginning. The body of this project will involve determining which of our suggest changes in EV use, and maintenance works the best. As well as determining through their implementation which uses the EV's are most suited for. This means an on going examination of the EV program. We suggest having FM continue to cost analysis of the EV's as they do with their other vehicles. While having the operators of the EV's keep journals of major positive and negative aspects of the program.

EV use is not possible for all of the FM fleet, some vehicles are needed to carry extra equipment and make long trips. In future to attained a true low impact fleet, other alternatives besides EV's need to be investigated. We have compiled information on some alternatives to both EV's and conventional fossil fuels which had higher top speeds and carrying capacity. However further research will be required in the future.

- Biofuel vehicles:
 - Using our used cooking oils to produce biofuel could cut down on costs of biodiesel powered vehicles. Not only would these vehicles

be capable of speeds in excess of 25 mph, they can also carry a heavy payload. This would lead to an almost equal reduction of CO2 in the atmosphere and also allow for the reuse of cooking oils from the schools dining halls/restaurants.

- However this option is less likely as we are currently paid for our used cooking oil, which is turned into biodiesel.

7.0 Appendix

Table # 1 FM Vehicle Summary

Vehicle Summary									
Date 4-5-12									
	Actual Expenses FY10	Actual Expenses FY11	Actual Expenses FY12 thru Mar	Predicted Expenses FY12	Predicted Costs per Replacement Vehicle FY12	Predicted Percent Future Increase	Predicted Expenses FY13	Predicted Costs per Replacement Vehicle FY13	
Total Shop Vehicles on Replacement Schedule		85							
Total Shop Vehicles to maintain (Add Supers & loaners)		107							
Fuel - FISVTL or 31010-5710-850VER-E231	71,544	90,825	86,068	114,757	1,350	5%	120,495	1,418	
Maintenance T&M - FIVMN or 30610-5710-850BUM									
Labor		35,952	29,581	39,441	464		39,441	464	
Good & Services		130,117	101,657	135,542	1,595	3%	139,609	1,642	
Total		166,069	131,238	174,984	2,059		179,050	2,106	
Accident repair fee - FIOOPS or 30610-5710-850ACC		568	6,988	7,500	88	3%	7,725	91	
Shop Vehicle Annualized Replacement at 1% inflation per yr		143,059	143,059	143,059	1,683	1%	144,490	1,700	
Fleet Shop Equip Annualize Replacement at 3% inflation per yr		13,278	13,278	13,278	156	3%	13,676	161	
		413,799	380,631	453,578	5,336		465,436	5,476	

VP Facilities Management Bill Managan Interviews

First Interview

1. The ones in mailroom super pool Cost 1.51\$ per mile.....
2. Previous Vehicles: Gems, (overgrown gold cats)
 - o Batteries were 700-750 cycle range.
 - o Now in the mail room
 - o Charged twice a day.
 - o Top speeds of 25 mph
3. Even at 5\$ gas regular fossil fueled vehicles were still at only 1.13 or so a mile
4. They know how much they have to spend each year to keep up with replacement.
 - o So its scheduled but they don't have any money.

- 143,000 a year for the vehicles they have (107) 85 of those they are going to be replaced but they don't have the money.
 - i. So while these trucks are worked on /replaced they need loners
 - ii. They replace 5-6 vehicles a year to keep up with that 143 + inflation
 - iii. They do however on avg replace a vehicle every 14 years. It's supposed to be every 8.
 - iv. They have asked for 5 vehicles this year worth 143,000

(2012 39-44 2013 44-48)

1. Chev flat bed → Out door maintenance: Small dirt to anything large...sometimes put snow plows on them...super heavy duty
2. Dodge Pick up →
3. Chev s10- pick up → Smaller one. More likely to replace.
4. Chev cargo van →
5. Ford ranger P/u →
6. 3 of them are small pickups. And could be replaced like S10
 - a. usually handle about ½ ton
 - b. mostly likely carrying more around 500lbs.
 - c. 25mph is too slow often times. Some of them have to go downtown. So they need to be able to hit 35.
 - d. They have looked seriously at the ability for switching out vehicles depending on the job.
 - e. If their working individually it can waste a great deal of time.

- One other hook is charging infrastructure
 - Could they plug in on campus? Or could they go all day and then be plug in at night
- Hes not real worried about electric costs
- Vehicles scheduling depends on the trade. Some have specific vehicles like one maintenance who does bigger maintenance. Most trading goes on in the ground shop. Because some need to be able to dump some carry some have 4wd. Like snow plows

Primary Concerns/Questions

1. How far these campus people have to go
2. Cost per mile
3. Can they handle hills
4. Does it slow it them down?
5. Weight and capacity

BASICS THEY WANT:

1. Low cost per mile
2. High carrying capacity
3. Top speeds of 35mph+
4. High endurance

Second Interview

What Model/Year GEM did facilities original purchase? When was this?

Gem EL

What kind of breaks did those vehicles have? Disc?

Disc on front drum on the rear

What were the main matienence issues?

- Axesl torn off on steep hills when accelerating or breaking
- No defrost in winter.
- A lot of charger issues
- had to replace brain box, it didn't like moisture
- Gem batteries had charge cycle life of about 750. And duty cycle issues.

4) Will the replacements for the three S-10 smaller pickups be used off campus? What specific needs do these vehicles need to be able to perform (as much detail here as possible would be helpful)?

Who uses small pickups: Gardeners.

5) What specific uses did you use the GEM for before? Or did you try it at everything?

Just about everything

6) On avg how many people were using the EV's? Is there any way to limit this?

Lots of students mainly.

7) What options do you see for getting a FM shop on campus?

- Waterfront development. VRI goes to water front and vacates part of first floor of engineering technology FM can take it over and all kinds of other transport options will be open.
- C-lot might help but would be problematic. Wouldnt allow a pull bar. Building costs might be a couple of hundred per sq foot.
- Talk to Francis Halle (space administrator---old main fourth floor)
- But would have to move at least one shop. One shop that could be up there is technical mateniene they take up less than 1000 sq ft.
- They Purchase parking stalls. So having multiple cars would require more spots which costs money and are in high demand.
- What about one big truck centrally located with stuff?

- Service oriented maintenance need to go alone. So this would require extra transfers and trips
- Which crews and trades can get by with a smaller rig.

UNC—Insider Interview----Fleet manager: Larry Lang: lblane@uncc.edu

1) Most importantly, how do your costs pre mile compare?

Not sure.

2)

a) What kind of uses are you using the electric vehicles for?

For everything from VIP tours to mechanics. House keeping plumbers, grounds department...

b) Do you have different types of vehicles for different uses?

Gem unit is just a two seater (personel mover)
Can get form 4ft bed to 6ft bed.

- 4ft bed for cleaning
- Maintenance uses 6ft bed, 5ft tool box on either side
- **Important to match vehicle with application of vehicle**
- Most problem with three shifts that house keeping have.
 - Third shift comes in and utility cart was sitting there but it was used on first shift and eventually dies...so problem with having it fully charged
 - **Electric vehicles say they have longer range but are not made for straight usage.**
 - **More for point a to b and then parking for awhile**
 - Not good for constant use.
 - So they don't use them constantly in motion.
 - If a unit is assigned to an individual the maintenance and damage is less than in a pool of people.
 - So they have a zoned assigned to 15-20 people.
 - They also use "Opportunistic charging." When people go long distance they use a lot of energy. So when they pull back in they just right away plug in.

c) What is your range of speeds and carrying capacities?

- Important area to be aware, Sales men are attrocest on what they say they can do
- Make sure to test cars.

- Two types of units
- Utility cart which cannot be license for road. Top speed 17-18 mph.
- LSV (neighborhood electric vehicle) top speed of 25 mph. Can be street legal with 35mp or less. They don't do this because they're a closed campus. But they do use these on campus.
- Maximum of 3-400lb on back and 2 men for Gem. GEM LXD handles a little more ~500 + two passengers.
- § Biggest weakness in gem is front suspension design. Control arm bushings will break when go over curbs.
- § Different driving habits make all the difference
- Straight acceleration.
- A little bit a slow down going up real long hill so the get 7horse power mower.

3) How far does your staff have to go? Maximum? Avg.?

Very far. They have a very large spread out campus.

4) Do you have a hilly or flat campus?

Hilly.

Five vehicles equip with drum breaks. Elevated much of those problems. The rest have disc breaks on the front.

5) How are your EV's endurance?

- Going green is very nice. Less noise and emissions. Even with accounting for electric co2 pounds emmsions. But very expensive. Costly initial investment, and maintenance is high. Get our own maintenance batteries not lead acid batteries. When batteries get to hot will corrode battery wires, use Gel batteries.
- Tried different chargers. But batteries and charging people haven't gotten together to figure same logarithm. Some batteries want to charge quick others slow, that's determined by charger. Best luck with Gel batteries on a slow charge.

6) How have you handled charging infrastructure?

- 20 amp Dedicate circuit. There fore you need a charging cord that can handle that. A 10-3 wire. Other wise you will likely have charging problem.
- They have 2 actual charging stations
- One handles 12 one 30
- Some at other locations
- Dedicated circuits coming out of buildings
- Some charged every other day. Odd #s charge on odd number nights and even on even.

7) What have been your biggest challenges? How did you overcome them?

- Each brand has its own particular quarks. At least one thing wrong. They got 3 4 5 different brands.
 - Bad ones: Columbia summit car (bad safety design flaw).

- Club car has problem with non LSV, after they put all weight in from batteries and didn't redesign frame. Ware out tires in 6 weeks.
- Main thing is that no matter what there more expensive.
- Fuel injected vehicles get cleaner burn. So now they buy Flex Fuel.
- Some things they wont be able to substitute with EV's.
- Don't do fast charge system. Santa Barbra uses fast charger. They used them with all kinds f batteries but ended up blowing them out. Want to use trickle charge, 6-8hrs. Fast charge takes it to 80% of charge which batteries will begin to turn into the max, this will keep decreasing. Also the high heat. Will hurt the battery
- Other best word of advice is beware of what salesmen tell you.

Seattle Univeristy Interview---Lead Mechanic: Geroge Hooper

hooperg@seattleu.edu 206-296-6146 (never got back to us)

- 21 vehicles now
- Started in 2000 its been about 12 years
- A lot of them they got used. Boeing surplus store and UW surplus. More used then new.
- All used for trades
 - Plumbers mechanics painters

Custodial Services, DON:

1. How often do they have to go back to the physical plant? What would help diminish these trips?
2. Would a smaller locker, or a large car packed with supplies left somewhere on campus, or an entire shop on campus, significantly diminish the amount of trips the grounds crew needs to make back and forth to the physical plant on a given day? Which do you think would work best? Why?
3. How much would you say an avg. load for someone in your deptment weighs.
4. How frequently are you driving vehicles on campus
5. What supplies does everyone need to carry with them on campus. How does this vary?
6. Is there anyone in your deptmartment that needs a lighter load? Whats their schedule
7. Could you see using an EV intermittently? Who would be able to do this?
8. What are your feelings about using EV's in your deptmernt instead of fossil fueled vehicles.
 - They don't delivery their own supplies. They get them through the commissary take the supplies to their closets.
 - Largest trip would be 300-350lbs.
 - Try to limit that to once a day.
 - Use bike to deliver paper work
 - Only time they take the truck is in the morning to transport people from physical plant to campus.
 - They have 3 areas on campus N S MIDDLE. So they stage equipment in those areas

- 1 vehicle used for outlying areas (truck route) takes 4 people and a lot of equipment.
- One vehicle used to truck people to campus.
- Also the super visor vehicle. But it goes down town. Needs to carry about 300 lbs. But they encourage supervisors to walk. Often drive two or three times a day still.

Email contact with Mr. Greg Hough the Quality Assurance Coordinator to test willingness of using an EV. Emails Attached.

Original Contact: May 10th :

Hello, my name is Thomas Brissenden and I am a student researcher for sustainability here at WWU. My associate, Max Scher and I have been investigating the potential for the use of Electric Vehicles on campus. We have spoken with Bill Managan and Scott Stills about the potential use, and have recieved alot of great information. You were referred to me by Mr. Stills and I was wondering if you wouldnt mind answering a few short questions for me:

1) What exactly is your job title and do you require the use of a vehicle on campus? If so how often do you take trips to campus?

F-M Quality Assurance Coordinator, Yes, about 4 times a week.

2) What do you need to have in your vehicle? An approximate weight?

Space for me and a briefcase, sometimes another passenger, 500 lbs.

3) Do you think an EV capable of speeds 25+ and carrying capacity of about 700 lbs would be feasible for use by anyone on campus? Why or why not?

Yes, but obviously not for everything. If your mostly just getting yourself plus maybe 1 passenger to a meeting or inspection, it works fine. We use to have an electric mini-vehicle with weather canopy that I used all the time successfully even down to 32nd street. Problem it turned out was maintainability cost more than a standard gas powered pickup. Bill Managan probably spoke to that.

So far our research has proved that this will be a difficult task to find an EV appropriate for use on campus. We are still trying to gather further thoughts from workers at FM however, so any input would be helpful. Thank you for your time. - Thomas Brissenden

Next contact : May 17th

Hello again Mr. Hough, This is Thomas Brissenden again (student researcher for sustainability) and I have a few more questions about the use of Electric Vehicles if you don't mind answering them, it would be greatly appreciated.

1) For our proposal we are trying to switch out 3 vehicles from Facilities Management. Would you mind using an Electric Vehicle for your short trips to campus and around the physical plant? We are trying to propose certain uses/departments for the vehicles so that they are suitable for

the operator and a viable transportation option. No, when we had an electric – I used whenever it was available.

2) Is there anyone else in your department, or that you know of who would be willing to operate the EV when needed, as well as you? This would be facilitated through careful planning around the two parties schedules or having a set group (say three EVs) that could be utilized whenever necessary. F-M IT personnel, perhaps renovation cost estimator.

3) If you are comfortable with sharing this information, and it seems like a viable idea, we would like to include your Department in our presentation as a possible candidate for the use of Electric Vehicles... Thanks for your time, any input is helpful. OK, bear in mind I'm only speaking for F-M Quality Assurance Coordinator = 1 person.

Final contact: May 21st

Hello again, Mr Hough, I have one last question for you regarding the use of Electric Vehicles. If you would be so kind as to provide a rough estimate of the schedule that you would need the vehicle for it would be very appreciated, including where you are going and coming from. This way we can have multiple departments sharing several electric vehicles when needed.

All trips are round trip from the physical plant. End destination anywhere on main campus or 32nd street. No set schedule – as needed. It's only practical if I share with other Physical Plant (Management or Capital Development) based employees/depts.

Greg

Phone contact with Scott Stills, within FM, only to discover this would not be a feasible option for his department.

Email contact with Don Loughmiller, an IT specialist to see if this would be a good option for them: May 21

Hello, my name is Thomas Brissenden and I am a student researcher for sustainability here at WWU. My associate, Max Scher and I have been investigating the potential for the use of Electric Vehicles on campus. We have spoken with Bill Managan and Greg Hough about the

potential use, and have received a lot of great information. You were referred to me by Mr. Hough as a potential driver of EVs and I was wondering if you wouldn't mind answering a few short questions for me:

1) What exactly is your job title and do you require the use of a vehicle on campus? If so how often do you take trips to campus?

IT Support Specialist II Yes to get to various offices to work on and replace computer systems

2) What do you need to have in your vehicle? An approximate weight?

The equipment I need when I go to an office for repair or replacement The equipment and weight varies on each task and is put in at time of getting vehicle

3) Do you think an EV capable of speeds 25+ and carrying capacity of two people plus about 400 lbs would be feasible for use by you on campus? Why or why not?

Unfortunately at this time the quality of EV's are not able to be feasible do to the Maintenance costs to keep them working cost much more than a standard fueled vehicle at this time

4) If you have a rough estimate of the schedule that you would need the vehicle for it would be very appreciated, including where you are going and coming from. This way we can have multiple departments sharing several electric vehicles when needed.

I check out a vehicle from the FM Supervisor pool when I need one. This is a shared system for those who don't need a vehicle every day

Email contact with MIT lead to the discovery of a vast amount of accessible information on electric vehicles that MIT has posted. The website is cited below.

Email contact Via Green School List Serv with Evergreen State University allowed us contact with another college in Washington that is using EVs on campus.

Thomas,

Evergreen has 11 EV's and a range of experiences at this point. I don't have exact answers to your questions, though I can get most of the information if you need more details.

We began purchasing EV's in 2004-05 so most of them are now maintenance issues. We have a few carts, I don't know the manufacturers right off hand, that are used to deliver mail around campus and for small maintenance trips around campus. Everyone seems happy with those vehicles for those functions.

We also purchased several Miles EV's (sedans and utility trucks) that have been problematic. The main issue was faulty battery packs, the secondary issue was that the manufacturer support and OEM part supply was less than needed. A few of the Miles vehicles remain in use, but most have been side-lined by maintenance issues and incompatibility with our needs. The vehicles are sufficient for use on campus (Evergreen is a broad campus, but relatively flat if you haven't been here), but were not sufficient for a run to town (about 7 miles) for small parts or supplies. Vehicle speed was very slow with a load and one trip would exhaust the batteries. We also found that parking services was not able to carry their tools and boots and run the cabin heater and get a full shift's usage from the Miles. There just wasn't enough juice. We're rethinking our use and maintenance of the Miles EV's, some of them may become demonstration projects. I'm not sure what will develop from that.

We have installed charging stations, both at the maintenance/facilities shops and in one of our parking lots for visitors. The charging stations get some use, and I'm hoping that will increase. Thurston County was within the Nissan Leaf sales area this past year, and we have several in town now, along with an expanding EV charging infrastructure near I-5.

I guess our overall experience, as an early adopter, is that the EV's are limited use vehicles. It's interesting that people seem happy with the carts, that are obviously limited use, but unhappy with the sedans and utility trucks. Maybe because we assume they should have more capacity. However, the specific performance and service issue with the Miles vehicles have soured a few attitudes.

Scott Morgan

Office of Sustainability
The Evergreen State College
360.867.6913

- **Phone interview** with Chief Engineer for EV Institute at Bowling Green State University Recorded below: 8 April 2012

- 1) Contact name & position
- Jeff Major, Chief Engineer at Bowling Green State University.
- 2) Purpose of the project?
- Ohio Hybrid bus project. To employ the use of alternative energy for students to get around, to and from campus.
- 3) "Size" & cost of the project?
-3-4 year project to build the bus. Built with money from a 1 million dollar grant from congress and also worked with NASA
- 4) Timeline for project?
-3-4 years
- 5) Players/stakeholders involved?
-NASA, the EV Institute at BGSU and the grant from congress.
- 6) Reception/perception of the project of the stakeholders?
-They payed for it and it was used as intended for a few years but is now running on diesel again. The people involved lost the momentum behind the project and kind of let it fall to side.
- 7) Biggest challenges? (at least three)

- Disjointed effort in University, lack of funding, license agreement fell through and lack of further interest.

8) If you could do the project over again, what would you do differently/what advice do you have for our team?

-Get the university involved as a whole.

9) How is the project progressing now?

-Now running on purely diesel fuel not electric.

10) Related future projects?

-EV charging stations.

11) Unintended consequences?

-None, just showed the lack of interest in the public/private sector.

- We are still awaiting word from Seattle University who has 21 EV's.

"All about Electric Vehicles" MIT Electric Vehicle Team. < <http://web.mit.edu/evt/links.html> >

"How Electric Cars Work" How Stuff Works. Brain, Marshall 2012.

< <http://auto.howstuffworks.com/electric-car3.htm> >

"Hybrid Vehicles of the VRI" Seal, Michael R. Vehicle Research Institute at WWU."

< http://vri.etec.wvu.edu/hybrids_paper.html >