Fellowship Presentation

Stennis Space Center

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August 28, 2018

Summer Research Projects

- Three major projects were considered this summer:
  - Key Management Systems and Fleet Reduction
    - What are key management systems and how would they be implemented at SSC?
    - What are some ways that SSC can work to reduce the number of fleet vehicles?
  - Property Disposal and Redistribution
    - How does the property disposal process at SSC compare to the process at MAF?
    - Are there any ways to improve the property disposal process?
  - Usage of Electric Vehicles at SSC
    - How could electric vehicles be implemented at SSC?
    - What infrastructure would be needed to use electric vehicles at SSC?
    - How do other government installations (particularly the VA in Biloxi) use electric vehicles?
- Curriculum Plan

Key Management and Fleet Reduction

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Key Management Systems

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- Key Management Systems are a way to control access to fleet vehicles at a particular location
- Kiosks are set up in particular areas where there is a needed access to a number of vehicles
- Users can check out keys for vehicles from the system (usually by entering a PIN number) and return keys to the same location
- Computerized software tracks vehicle usage, as well as other important aspects related to the vehicles

Implementation at SSC

- Because of the size of the SSC site and the scattered location of all vehicles, a key management system would only make sense at the three buildings with more than 20 vehicles
  - 1100, 8000, 9114
- The key management system would include:
  - 3 key cabinets at 3 locations (containing different numbers of keys)
  - PIN number used for access to the cabinets/keys
  - Fleet Software that allows:
    - Logging of vehicle problems
    - Tracking of Driver's license expiration
    - Simple reservations (Admin only)
    - Users can report at least one "problem code" when vehicle is returned (low fuel, check engine light, etc.)
  - 2 years of hardware/software/remote support
  - Remote installation
- Cost for the complete system = $32,650

Optimal Fleet

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NASA's OPTIMAL FLEET PROFILE 2020

	VEHICLE TYPE	FUEL TYPES / CONFIGURATIONS: Petroleum Dedicated Vehicles	Petroleum Dedicated LGHG Vehicles	Hybrid & Petrol/Alt Multi-Fuel Vehicles	Alt Fuel Dedicated Vehicles	Zero Emission Vehicles	GRAND TOTAL
PASSENGER	Low-speed Vehicle	-	-	-	-	246	246
	Sedan/St Wgn Subcompact	-	25	104	2	61	192
	Sedan/St Wgn Compact	31	-	141	1	7	180
	Sedan/St Wgn Midsize	2	-	53	-	-	55
	Sedan/St Wgn Large	-	-	2	-	-	2
	MD Sedan/St Wgn Large	-	-	-	-	-	-
	Sedan Limousine	-	-	-	-	-	-
	MD Sedan Limousine	-	-	-	-	-	-
	Subtotal	33	25	300	3	314	675
OTHER PASS	LD SUV 4x2	21		103	-		124
	LD SUV 4x4	46	-	97	-	-	143
	MD SUV	10	-	-	-	-	10
	LD Minivan 4x2 (Passenger)	18	-	265	-	-	283
	LD Minivan 4x4 (Passenger)	9	-	-	-	-	9
	LD Van 4x2 (Passenger)	2	-	80	-	-	82
	LD Van 4x4 (Passenger)	2	-	-	-	-	2
	MD Van (Passenger)	11	-	26	-	-	37
	Subtotal	119	-	571	-	-	690
TRUCK	LD Minivan 4x2 (Cargo)	25	-	24	-	-	49
	LD Minivan 4x4 (Cargo)	-	-	-	-	-	-
	LD Van 4x2 (Cargo)	29	-	48	-	-	77
	LD Van 4x4 (Cargo)	3	-	5	-	-	8
	MD Van (Cargo)	71	-	123	1	-	195
	LD Pickup 4x2	93	-	293	3	-	389
	LD Pickup 4x4	24	-	70	-	-	94
	MD Pickup	80	-	77	15	-	172
	LD Other 4x2	7	-	-	-	-	7
	MD Other	97	-	126	-	-	223
	HD	304	-	-	-	-	304
	Subtotal	733	-	766	19	-	1,518
OTHER	LD Ambulance	20	-	2	-	-	22
	Ambulance	-	-	-	-	-	-
	MD Bus	8	-	-	-	4	12
	HD Bus	23	-	-	-	-	23
	Subtotal	51	-	2	-	4	57
	TOTAL ALL TYPES	936	25	1,639	22	318	2,940

Rev. April 2017

SSC's OPTIMAL FLEET

Vehicle Type	"Optimal Number"	Current SSC Number (GSA)
Low-Speed	21	0
Sedan/Subcompact	16	3
Sedan/Compact	15	17
Sedan/Midsize	5	22
Sedan/Large	0	0
LD SUV 4x2	11	7
LD SUV 4x4	12	3
MD SUV	1	0
LD Minivan 4x2 (Passenger)	24	19
LD Minivan 4x4 (Passenger)	1	0
LD Van 4x2 (Passenger)	7	3
LD Van 4x4 (Passenger)	0	0
MD Van (Passenger)	3	14
LD Minivan 4x2 (Cargo)	4	0
LD Minivan 4x4 (Cargo)	0	0
LD Van 4x2 (Cargo)	7	5
LD Van 4x4 (Cargo)	1	0
MD Van (Cargo)	17	12
LD Pickup 4x2	***33***	***95***
LD Pickup 4x4	8	8
MD Pickup	***15***	***27***
LD Other 4x2	1	0
MD Other	19	17
HD	26	27
LD Ambulance	2	1
MD Bus	1	0
HD Bus	2	3
TOTAL	252	283

- **SSC "Optimal" number based on a fleet reduction of 31 vehicles**
  - **8.6% of NASA total**

Recommendations

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- Short-term:
  - *SSC should consider implementing a KeyTracer system in at least one building (perhaps 1100).*
    - Easier to add additional systems in the future
    - Would be half the price for a system at three buildings ($14,375)
    - It would give the administrators experience with the software
  - *SSC should focus on reducing the number of LD & MD Pickup Trucks in the fleet before other vehicles*
- Long term:
  - *SSC should implement a KeyTracer system that extends throughout as much of the site as possible*
    - Consolidate keys spread across multiple buildings
    - The information gathered could lead to further reduction of the fleet
  - *The "optimal fleet" provides further guidelines on which vehicles can likely be eliminated*
    - It may make sense to consider the following vehicle levels:
      - Midsize Sedans (perhaps switch to Compacts)
      - MD Vans

Property Disposal

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Property Disposal Similarities

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The processes at each site (SSC and MAF) are extremely similar to one another.

- **Both sites**
  - Accept items from both NASA and tenant of the sites
  - Use the same computer system for disposal (DSPL) and for setting up sales with GSA
  - Follow a similar process in accepting materials and logging materials into the warehouse
  - Follow the NASA Export Control process
  - Screen items through NASA and other federal and state agencies before sale
  - Conducts sales through the GSA Auction website
  - Recycle/scrap materials that are not sold in order to generate additional revenue

Property Disposal Differences

The differences between the two sites are minimal, but do exist.

- **MAF also maintains equipment status in Maximo**
  - **SSC does not yet use Maximo, but will in the near future**
- **SSC has a much larger warehouse and has many more items that could potentially be sold.**
  - **Many more non-NASA tenants!**
- **SSC conducts more sales per year**
- **MAF has union restrictions on work that occurs within the warehouse.**
- **MAF has only one permanent person working in property disposal.**
  - **A second warehouse worker is assigned there for 20 hrs per week, but is often used for other tasks at MAF.**

Process Flow Chart

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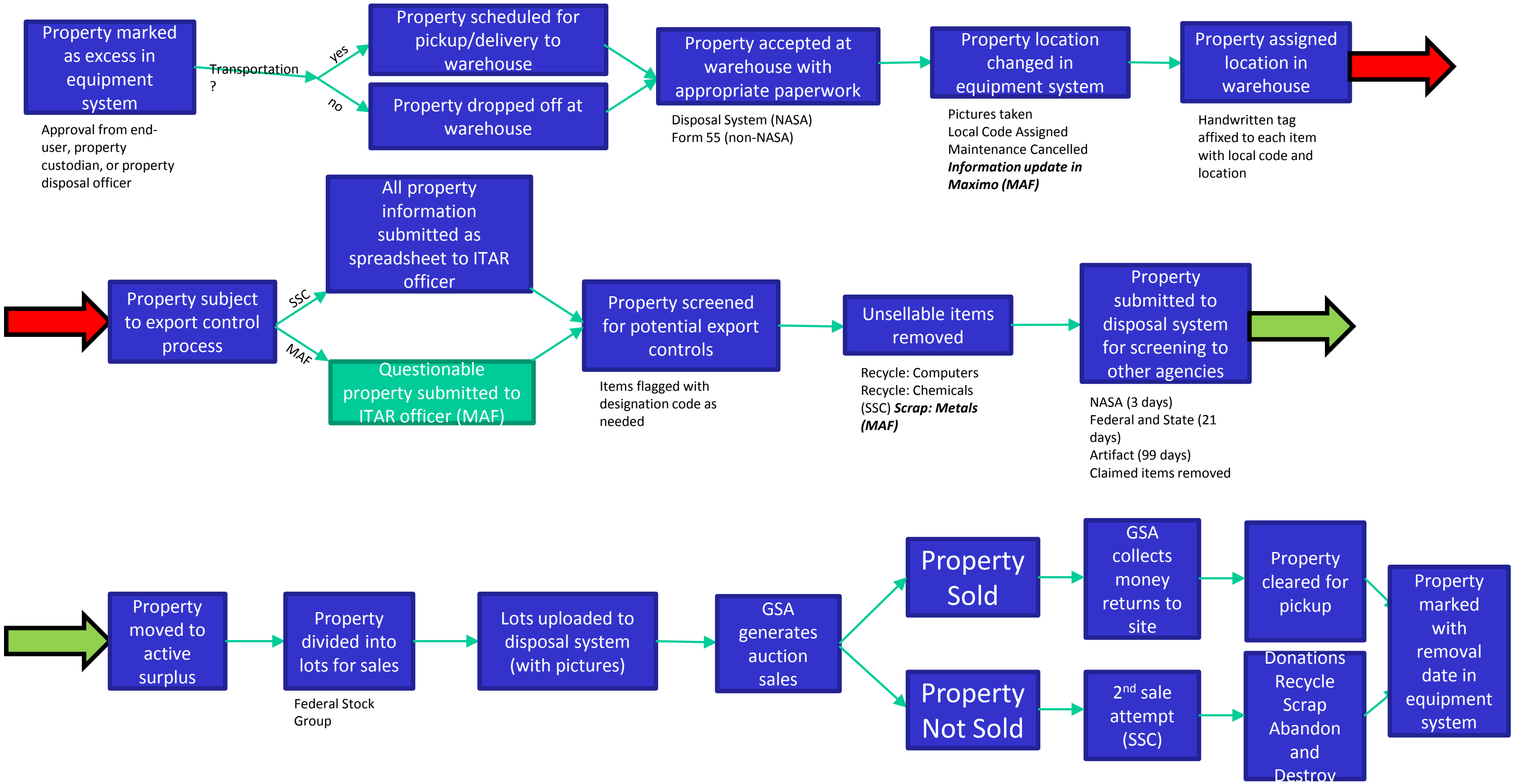
- **The property disposal process at SSC and MAF are extremely similar. Minor differences are noted in the image.**



Site Revenue

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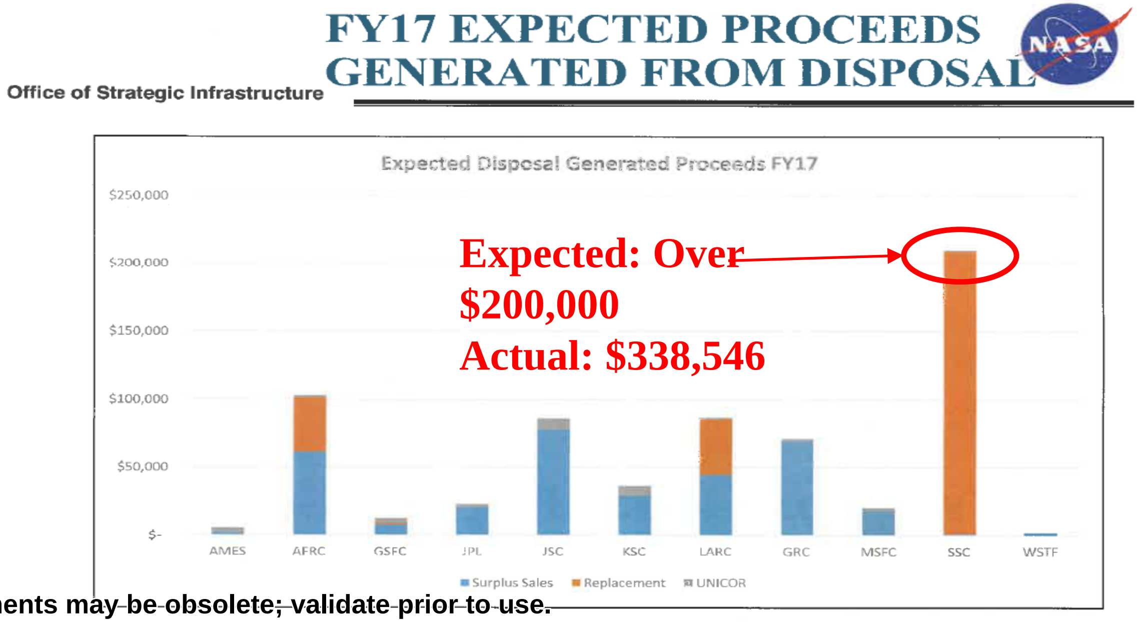
Based on the number of sales, SSC has the most revenue potential. The reasons for this assumption are based on the following:

- **SSC Generated $480,577 in revenue (Approximately $520 per day)**
  - **Between November 2015 and May 2018**
  - **Including 2 cargo barges that sold for $231,400 (nearly twice the acquisition cost!)**
- **For FY 17, SSC had the highest expected proceeds from disposal compared to other NASA sites**



Minimum Cost of Transportation

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- An important factor in transporting materials is determining the minimum cost of transportation
- The *total annual cost* for transporting an object can be broken down as:
  - Employee work hours (3 workers, $10 per hour, 8 hrs per day, 3 days per week, 52 weeks per year) = $37,440
  - Fuel cost (5 miles per gal, 80 miles per trip, 3 days per week, 52 weeks per year) = $7,488
  - Maintenance/External ($0.22 per mile, 80 miles per trip, 3 days per week, 52 weeks per year) = $2,746
- For a total annual cost of $47,674
- The “annual capacity” of the transportation (based on a fullness ratio of 70%) was calculated:
- 116 m^3 * 70% * 156 = 12,667.2 m^3 / year
- The cost per unit volume can be calculated:

$$\frac{Total\ Annual\ Cost}{Annual\ Capacity} = \frac{\$47,674}{12,667.2} = \$3.76/m^3$$

Minimum Cost of Transportation

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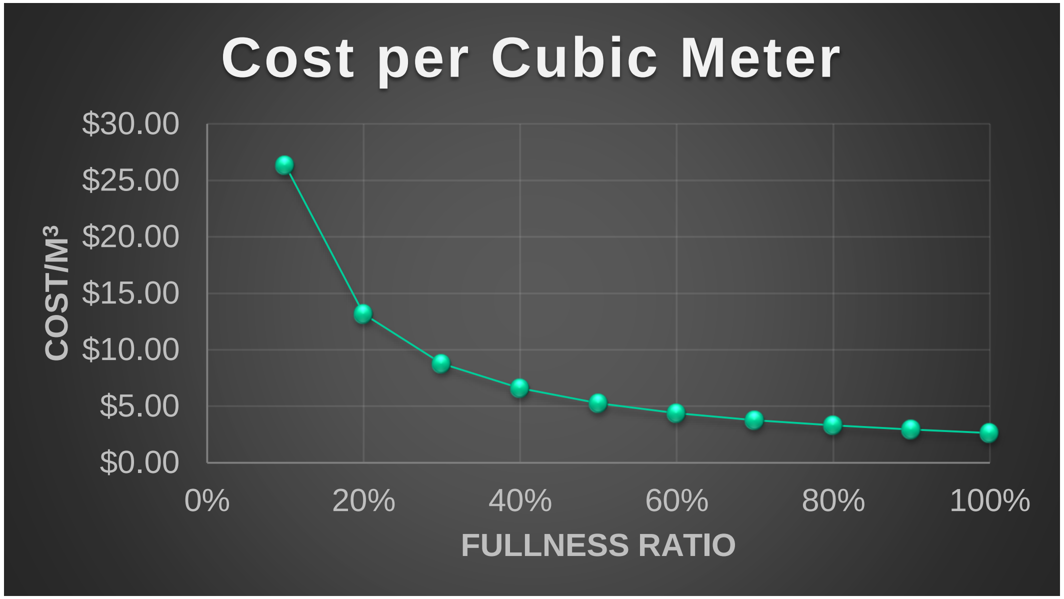
- This value varies based on the “fullness” of the truck
- As larger items are transported they take up more space, decreasing the “fullness” of the truck and increasing the cost
- The variation of cost per cubic meter with respect to fullness ratio is shown below:



- A truck-load (116 m^3) only 20% full would cost $1,527 to transport

Loss of non-NASA revenue at SSC

- One major benefit of property disposal at SSC is the access to property disposed of by non-NASA tenants
  – Tenants can dispose of their property through SSC's redistribution office
  – Tenants save money on shipping to their own redistribution office
  – SSC assumes ownership, sells the property through GSA, and collects the revenue
- By moving redistribution to MAF, this revenue would be lost!
  – Tenants would not want to pay for shipping to MAF
  – NASA would not pay to ship their materials

Loss of non-NASA revenue at SSC

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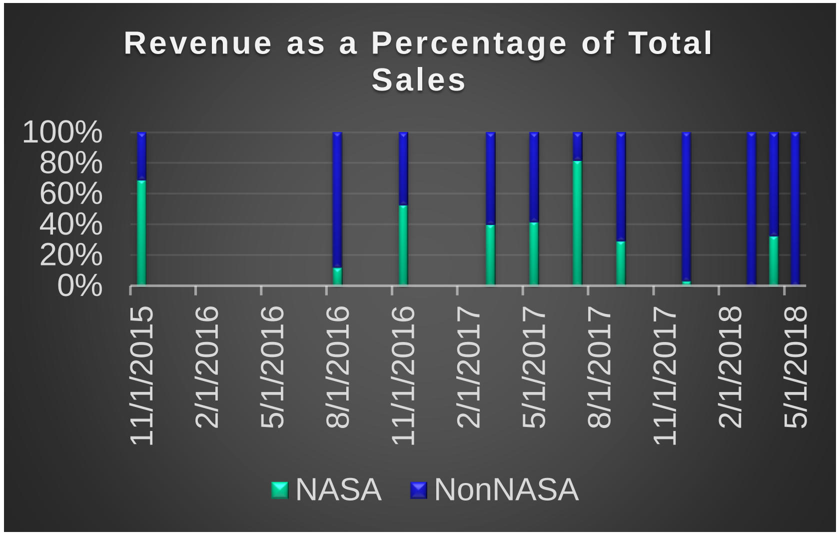
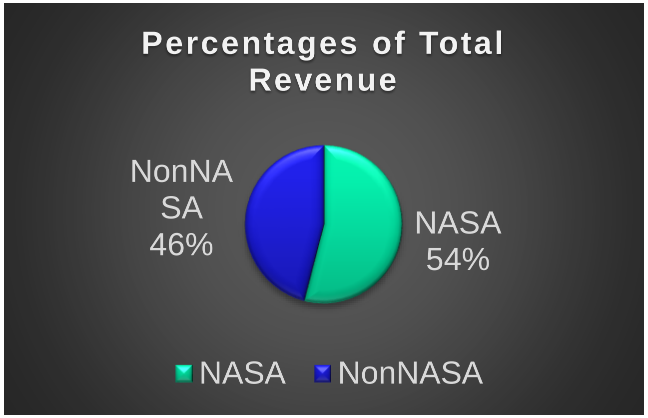
- **To determine the impact of this loss of revenue, data for sales from Nov. 2015 to May 2018 were collected:**
  - **The sale of barges were removed from this analysis and considered a "special event"**



DATE of SALE	TOTAL REV	R(N)	R(nN)
11/6/2015	$99,008.00	$68,440.38	$30,567.62
8/26/2016	$15,243.00	$1,797.00	$13,446.00
11/8/2016	$1,399.00	$741.00	$658.00
3/3/2017	$27,500.00	$11,071.43	$16,428.57
5/19/2017	$697.00	$292.33	$404.67
7/5/2017	$51,742.00	$42,324.12	$9,417.88
9/27/2017	$25,808.00	$7,608.56	$18,199.44
12/22/2017	$11,208.00	$331.00	$10,877.00
3/9/2018	$2,757.00	$0.00	$2,757.00
4/6/2018	$6,122.00	$2,006.17	$4,115.83
5/18/2018	$7,693.00	$0.00	$7,693.00
	$249,177.00	$134,611.99	$114,565.01



Electric Vehicles

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Electric Vehicle (EV) Usage at SSC

- At this point there are currently no electric vehicles used on site
  - 12 Hybrid vehicles are in use (more to come by Oct. 1)
  - All are regenerative hybrids, meaning they charge a battery while braking (not plug-in hybrids)
- For EVs to be useful here, there would have to be infrastructure put into place
  - Specifically the installation of 1 or 2 electric vehicle chargers
- There are plans for the acquisition of EVs at SSC in the near future:
  - As mandated by an executive order, by 2020 at least 20% of the incoming fleet vehicles must be zero emission or plug-in hybrid (currently 0%)
  - GSA offers electric alternatives to traditional internal combustion engines (ICEs) at a small cost increase
    - Offset by mileage cost

Potential Benefits/Problems of EVs

Benefits:

- EVs immediately reduce the fuel costs and maintenance costs
  - EVs do not require maintenance such as oil changes and fuel filters
  - Electric vehicles require battery maintenance but this is covered as part of the GSA lease
    - Because of this the lease time for EVs may be slightly different

Problems:

- The cost of installing charging infrastructure may be prohibitive to using electric vehicles
  - MAF has recently installed a Level 2 Dual port charging station by Chargepoint (cost of design, installation, construction = $74,000)
  - SSC B-1100 ($211,200)
  - SSC B-3226 ($79,029)

Chargepoint EV Chargers

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- **MAF's Chargepoint Dual Port Charger**
  - Two cars can be charged at once
  - Charger is networked to internet through cellular network
    - Reports can be downloaded at any time
  - Optional parts and labor warranty

Travel Offsite

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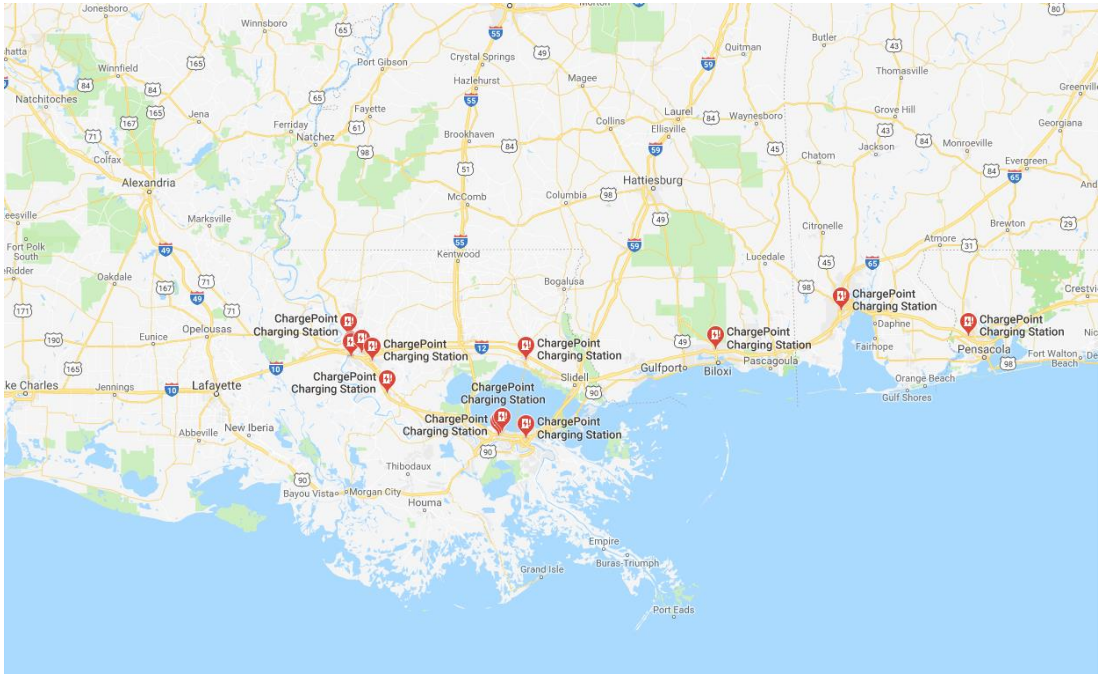
Would electric vehicles at SSC be able to travel offsite?

- **Because of the charging station at MAF, an electric vehicle should be able to go back and forth from SSC to MAF**
  - **Ford Focus Electric (a GSA vehicle used at MAF) can travel about 100 miles on a single charge**
- **Additionally there are other charging stations located in the general area**



Cost Analysis of GSA Vehicles

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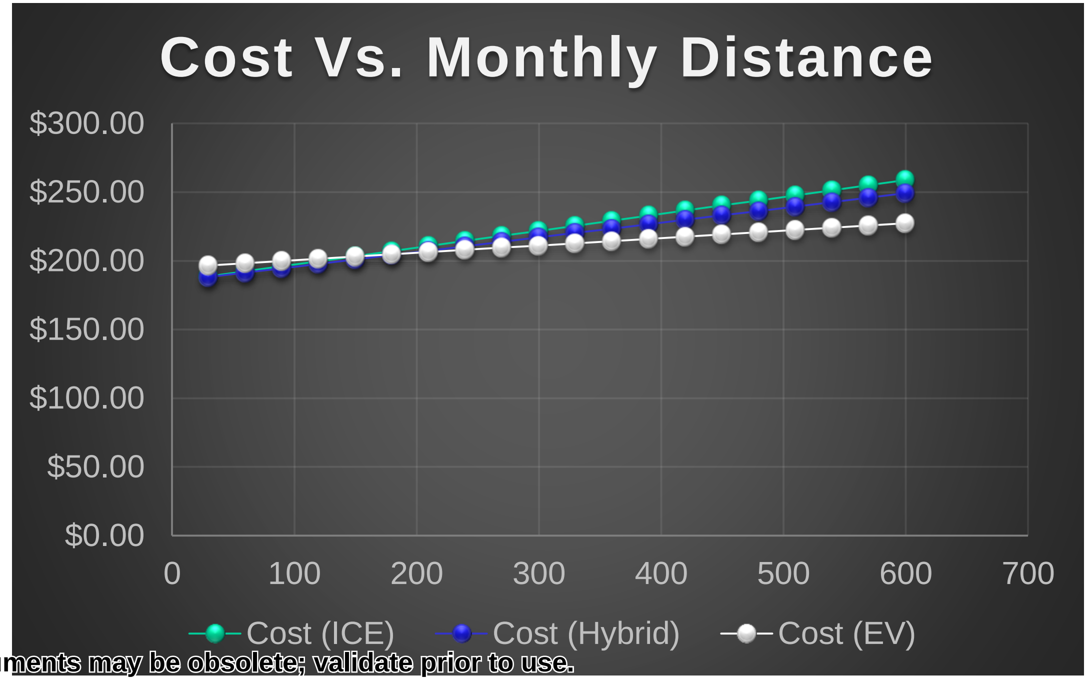
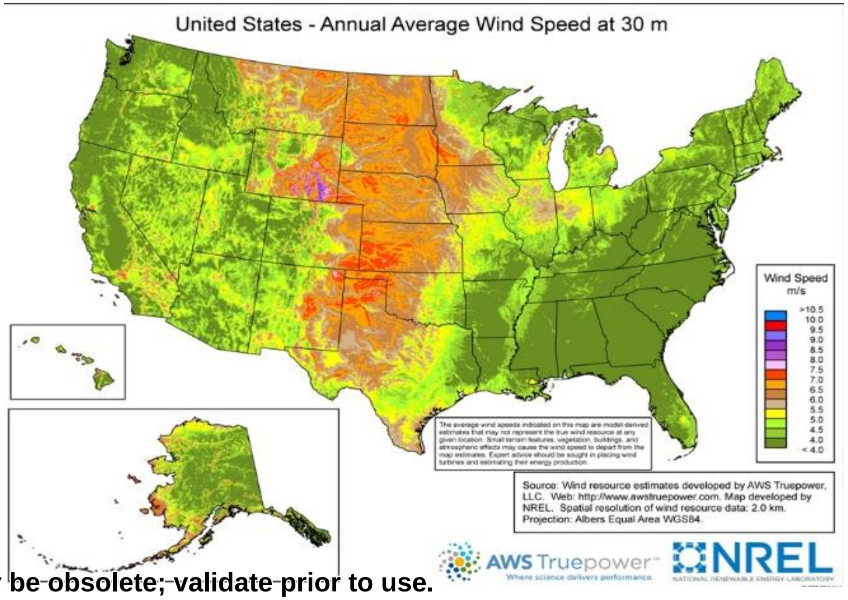
- A cost analysis was done to compare the use of ICEs, EVs, and hybrids (excluding cost of EV charging infrastructure)
  - All of these vehicles are available through GSA
- An analysis was done to determine how the cost of vehicles change based on the distance traveled
  - The cost is basically the same for each vehicle!
  - EVs become cheaper the more they are driven!



Renewable Energy

8) Would renewable energy (wind,solar) be viable as source of energy for EV charging?

- **To offset the cost of electric vehicle charging, renewable energy could be used**
- **Two sources were considered: wind, solar**
- **The MS Gulf Coast does not receive a great deal of wind over a given year.**
  - **The cost of installation may never be recovered from the energy generated**



Renewable Energy

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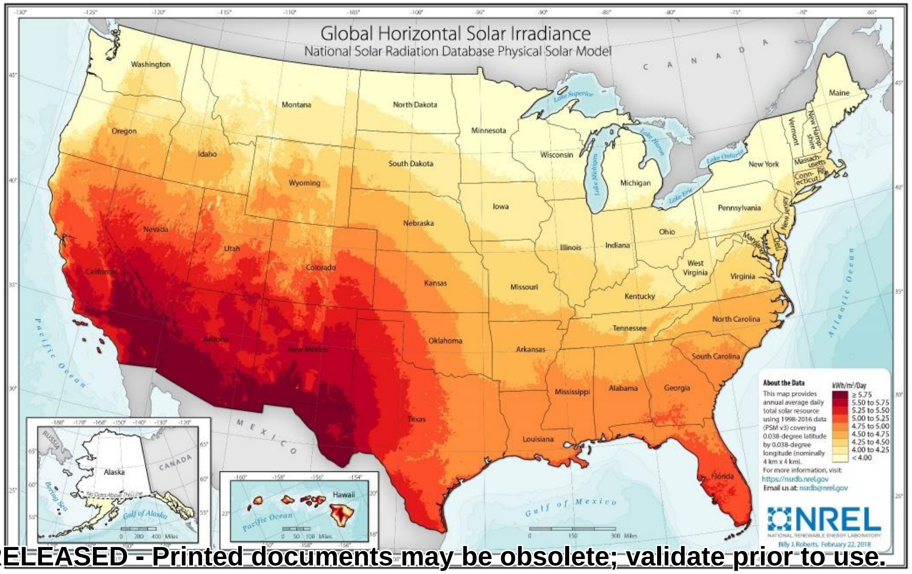
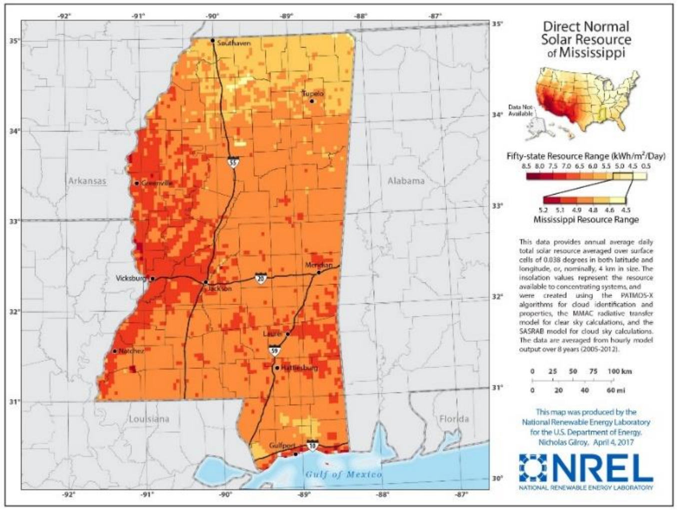
- The MS Gulf Coast does receive a great deal of sunlight during a given year, approximately 5.0 kWh/m^2/day of sunlight irradiance
- The minimal size of a solar array (to generate 4,464 kWh annually) was calculated to be 15.67 m^2
  - Based on a 360 Watt solar panel
- The cost of the panels for this array = $4,348 (9 panels)
  - Even at this cost, the chargers still need to be connected to grid (requiring installation costs similar to the charging station)





Examples of Solar Canopies

- University of Iowa ($950,000)
  - 180 ft solar canopy installed in 2011
  - Generates approximately 70,000 kWh of energy each year
  - Additional energy is reverted back to UI grid

- Motorcars Honda ($1.7 million)
  - Cleveland Heights, Ohio
  - 335 kW solar canopy
  - Completed in 2015

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Curriculum Plan

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Curriculum Plan

- A curriculum plan will be introduced to build off of the project based on electric vehicles
- As EVs slowly become more prevalent in society information can be easily gathered about them.
- As part of my General Physics class, I will institute a classroom group project that will have the students attempt to solve the following problems:
  - How are electric vehicles different from traditional combustion engines?
  - What is the cost of operating an EV compared to an ICE?
  - What renewable technologies are available for charging? How feasible are they in south MS?
  - How do you calculate values related to EVs?
  - What infrastructure would be needed to support the use of EVs?
  - What considerations would need to be made to institute a fleet of electric vehicles at the college?

Curriculum Plan (Part 1)

- The plan will be instituted across two semesters of General Physics
- Fall Semester:
  - Focus on calculations and understanding of concepts as they relate to electric vehicles including:
    - Work
    - Energy
    - Power
  - Students will have to investigate current EVs and calculate information based on what they learn about those vehicles
  - This will also include information about renewable energy
    - Students will learn how solar panels and wind turbines work as well as how their output can be calculated

Curriculum Plan (Part 1)

- As a group of 3 or more, answer the following questions:
  - Choose 4 fully electric vehicles (any make/model) and determine:
    - The maximum energy that the battery can hold
    - The maximum range of travel of the vehicle on a full charge
  - Using the values, determine the "mileage" of the vehicle (energy used/mile).
  - Rank the vehicles in terms of their "mileage". Which would be the best vehicle to use? Why or why not? *Note:* Take other factors of the vehicle into account as well.
  - Determine the average energy cost in your area ($$$/kWh). How much would it cost to fully recharge each of the cars?
  - Determine about how much energy you would use each year. How much would this cost?

Curriculum Plan (Part 1)

- Choose a city you would like to visit and a vehicle you would like to use. Determine the cost of taking an electric vehicle compared to a traditional internal combustion engine. What other factors may come into play with respect to this trip?
- Consider using renewable energy (wind, solar) as a way to charge your vehicle.
  - Determine (a) the annual average wind speed in south Mississippi and (b) the average solar irradiance (per day) in south Mississippi. Which would be the best to use in this area? Why?
- Investigate wind turbines. In order to fully charge your vehicle for a year what kind of wind turbine would you need? How much would it cost?
- Investigate solar panels. Choose one in particular and determine the area of a solar array (in m^2) that would fully charge the vehicle for a year.

Curriculum Plan (Part 2)

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- Spring Semester:
  - Students will be given a scenario and then must use their knowledge as well as additional research to develop a proposal for instituting EV usage at the college
- As a group of 3 or more, determine a proposal for which electric vehicles should be purchased. In writing your proposal, be sure to answer the following questions. I
  - What type of infrastructure is needed in order to use, store, and maintain a group of 4 EVs?
  - What power supplies are available or could be made available? What would be the cost of this power?
  - What types of vehicles would be available/most useful?
  - What are the benefits of this compared to fuel-operated vehicles? Be specific.
  - Determine the costs of EVs compared to other vehicles in terms of miles driven. Which is cheaper/more expensive?
- Prepare a written proposal as well as a powerpoint presentation for the class.

Curriculum Plan

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- This concept introduces students to how the concepts they study in class can actually be used in a real world application
- It also allows them to practice skills such as:
  - Working in groups
  - Developing proposals
  - Presenting to a group of peers
- Overall, the project will provide them with an understanding of how physics relates to jobs outside of what the they would generally expect