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CCAT

ALTERNATIVE ENERGY SOURCES FOR A FIRST RESPONDER ENVIRONMENT

Center for Commercialization of Advanced Technology (CCAT) at San Diego State University Research Foundation (SDSURF)

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BACKGROUND

The TechSolutions Program was established by the Department of Homeland Security's Science and Technology Directorate to provide information, resources and technology solutions that address mission capability gaps identified by the emergency response community. The goal of TechSolutions is to field technologies that meet 80% of the operational requirement, in a 12 to 15 month time frame, at a cost commensurate with the proposal. Goals are accomplished through rapid prototyping or the identification of existing technologies that satisfy identified requirements.

Recent submissions by First Responders to TechSolutions identified issues with the current power sources being used in field environments that alternative power sources, such as wind or solar, might be able to fill. Initial responses by solicitation to this identified gap went through a series of reviews by First Responders and Business Experts and were found not satisfactory. This process reflected a need to further refine and understand the technology requirements needed to fill this gap. The Center for Commercialization of Advanced Technology (CCAT) at San Diego State University Research Foundation (SDSURF) undertook a study to further explore this issue with the support of the Regional Technology Center (RTC). The study incorporated a survey of First Responders from around the U.S. to better understand the issues with the current modular power sources. This enabled a refinement of the requirements to provide a more concise guideline for technology providers as the current state of the requirements was both limited and overly broad.

In addition, it was unclear to evaluators, what alternative power products are being developed or are currently on the market, and if these products met the identified needs of the First Responder. By developing a better understanding of the First Responder needs and the existing products, CCAT is able to refine and produce solicitation guidance. This study assists in CCAT's ability to succeed when selecting providers to meet these technology gaps

PROCEDURE

The RTC, in collaboration with CCAT created a survey for the First Responders to understand the nature and magnitude of their portable power needs. This survey and the detailed results are in Appendix A. A short summary follows in this section. In addition, the RTC conducted research into potential power source solutions and their state of development. The results are included in the following section.

SURVEY SUMMARY

A month-long online survey was conducted to assess the need for, problems with, and purpose of alternative energy solutions within the First Responder sector. A total of 27 First Responders answered the survey from throughout the U.S. The survey results showed the need for portable power in many areas and a great interest in alternative power options. Key issues

were a need for self-sustaining power generation and storage during an incident response. The following summary highlights significant results found by the survey.

Question 1: How important is the availability of portable power in your mission?

Respondents were asked to rank four options (tactical surveillance, immediate response, long-term response, and special needs) to identify where portable power was critical. Of the four options, only one: "Tactical Surveillance" did not receive the highest "critical to mission" mark. Results clearly show that First Responders are dependent on portable power to achieve their mission.

Question 2: What equipment drives your greatest need for portable power?

The most critical equipment, ranked number one by every respondent, was computers. Communications towers and light sources came in second. This question did not differentiate between long and short term response issues which might have impacted some of the tertiary responses such as food preparation and other long term specific needs.

Question 3: What deficiencies would you like improved given current power capabilities?

The biggest identified concerns were safety, logistics and refueling. In particular, access to fuel was very often selected as a concern. What this shows is that a system that does not need refueling, such as a solar array or wind turbines, are potential gap fillers. Size, noise, fumes and environmental impact responses indicated a lower priority among these deficiency rankings.

Question 4: Provide the number of each type of equipment needed.

As expected this question provided a huge range of selections. This supports the notion that power supplies should be modular and able to scale as needed to support incidents as they increase in size and resources based on the number of responding agencies and the size of the incident.

Question 5: If an alternative power solution were available that met your needs, what would be an acceptable price?

Respondents prefer less expensive alternative power solutions at the price point of $1000.00-$5000.00, but many respondents felt that higher wattage solutions would not be attainable at the lower price point. Therefore, respondents equally chose $5000.00 and up as a viable price point for alternative power solutions that could meet first responder needs.

Question 6: Would you be willing to pay up front to achieve savings in 10-15 years with the lack of fuel and maintenance logistics?

Many of the survey takers skipped this question. Respondents who answered were split nine to eight regarding this proposition. Many of the agencies currently rent their generators making this question irrelevant to their jurisdiction.

In comments, respondents surveyed concluded that solar as an alternative energy source is the most viable near term solution to augment current portable power needs. Staffing and cost will determine much of the feasibility for these systems; however the survey did show a need for modular power and great interest in a modular, scalable source that is cost effective, robust and self-contained.

BASELINE SCENARIO AND METHODOLOGY

In concert with the survey, the RTC researched potential power source alternatives and their state of development. To allow them to be compared with each other, a baseline scenario was developed to determine the typical power system requirement for an emergency response incident. As might be expected, the analysis revealed that First Responder needs varied greatly. The baseline scenario is an average that exercises and experimentation have shown to be realistic for a mid-sized base camp that must operate day and night for a period of 72 hours. The methodology allows the power requirements to be easily scaled to larger or smaller scenarios, and therefore will be useful for future technology assessments. Each form of alternative energy was evaluated to determine how it would apply in the context of this scenario. This allowed the cost to be estimated and then compared to the current standard being used within the environment.

The scenario assumes that a specified set of equipment, shown below, is required for the incident response. The total power consumption of the equipment is determined and that power consumption is used as the capacity requirement for a prospective power source. Note that to the extent that only a subset of the equipment is being used at any one time, the power source capacity requirement could be reduced. However this reduction would affect all of the sources equally, and so would not substantially change this report's conclusions.

Typical Equipment	Equipment Power Consumption Watts	Common #'s of Equipment	Total Power Needed Watts
Computer	100	4	400
Printer	46 to 800	1	800
Radio Chargers	~100	2	200
Cell Phone Chargers	10	5	50
Lights	500	2	1000
			Totals=~2450

Currently, the power required for this scenario would be provided by a portable Honda Generator EU3000iS, or similar make. This generator uses one-half gallon per hour of liquid fuel (for example gasoline or diesel) for a rated output of 2800 watts.[1] The generator is listed on the Internet for a retail price of approximately $2,400. We will estimate that fuel for the generator costs $3.45/gallon (Fuel prices based on advertised price as of Jan 5, 2011). First responder agencies may qualify for better pricing but this scenario provides the basic estimates.

To estimate the lifetime cost of power of such a generator, we assume that the unit will operate for 1000 hours continuously (assuming routine maintenance) before requiring

[1]Honda Power Equipment, Generator – Information Sheets
~http://www.hondapowerequipment.com/pdf/manuals/31ZT7601.pdf

replacement. Thus the cost of this power system, including fuel but excluding maintenance costs is:

Capital cost	$2400
Useful life	~1000 hours
Battery storage capacity required	none
Unit cost for fuel	$3.45 gallon
Total fuel cost over useful life	$1725
Total System Cost	**$4125**

Note that for the 72 hour scenario, fuel cost is $124.

Capital costs of equipment purchase are included in each option with the amount of time required to break even with the baseline "current" scenario where the information was available.

OVERVIEW OF ALTERNATE ENERGY SOURCES

With the survey results guiding this baseline information, alternative energy sources were identified and studied. Moreover, additional information includes; a summary of each technology; along with the pros and cons; and an estimate of what a typical First Responder scenario would cost based on each alternative energy source.

In an attempt to investigate the most comprehensive array of sources; nuclear, hydropower and geothermal sources were initially considered, but these are not reasonable alternatives. These sources require significant infrastructure support and would not be a realistic source of modular power within current constraints.

BIOFUELS

Biofuels are essentially a gasoline substitute that can be used as a fuel for generators like the Honda Generator mentioned above. While biofuels may serve the environment well, they have little to no impact on the needs of the First Responder. Because they are liquid fuels that must be transported from the supplier to the base camp, biofuels at best have the same logistics requirements as gasoline. However, the products are not available on the open commercial market as national regulations prevent their sale. Consumers must join "biofuel clubs" to purchase these products from suppliers.[2] There is little financial impetus to do so as fuel cost, particularly biodiesel, is similar to fossil fuel costs. (In San Diego, websites advertised biodiesel at $3.22/gallon and diesel at $3.49 on Jan 5, 2011.) With limited availability, excessive regulations and lack of logistical support, biofuel does not provide the stability needed for a disaster response scenario. It is however, a promising future technology and the only alternative that can provide immediate power at a similar cost to existing capability.

BIOFUELS SCENARIO:

Typical Equipment	Equipment Power Consumption Watts	Common #'s of Equipment	Total Power Needed Watts
Computer	100	4	400
Printer	46 to 800	1	800
Radio Chargers	~100	2	200
Cell Phone Chargers	10	5	50
Lights	500	2	1000
			Totals=~2450

[2] U.S. Department of Energy, Alternative Fuels & Advanced Vehicles Data Center ~http://www.afdc.energy.gov/afdc/laws/laws/US/tech/3251

Capital Cost	$2400
Useful life	~1000 hours
Battery storage capacity required	none
Unit cost for fuel	$3.22 gallon
Total fuel cost over useful life	$1610
Total System Cost	**$4010**

Note that for the 72 hour scenario, fuel cost is $116.

**Biofuels provide no significant change in cost to this scenario. This environment would make logistics more difficult due to the lack of availability and need for membership to purchase the fuel.

RELEVANT COMPANIES

- New Leaf Biofuel is a San Diego-based biodiesel supplier creating the fuel through collection of used restaurant oil and other vegetable waste. Due to proximity, this company was used for primary data collection on pricing and logistical issues.
- Chevron and the other major oil companies have biofuels pilot efforts throughout the country.
- National and international investors are supporting small business in the development of these fuels.

SOLAR

Solar–generated electricity is produced when photovoltaic (PV) solar cells are exposed to sunlight. The cells are typically combined into panels which produce low-voltage, direct-current electricity that is then converted using an "inverter" into the 120 volt AC electricity needed for most of the items in the baseline scenario. Solar is the most advanced and commercially available of the alternative energy options. Solar panels are quiet, operate without fumes, and do not need fuel to operate, but they have a major operational limitation in that they can produce power only when there is sufficient sunlight. To compensate, many companies offer a towable solar panel that links into batteries for a field station power source. While this is an acceptable solution, the number of panels must typically be more than double what might otherwise be needed for daytime use since the system must produce enough energy to meet the daytime requirements plus enough to store for nighttime use.[3] Other major disadvantages are their cost, size, and technological inefficiencies. Current solar panel platforms require a large amount of onsite space (particularly if they do not move to constantly point at the sun) and are much more expensive than the current generator options. Furthermore, a backup generator system may be required in case the base camp experiences consecutive cloudy days. For jurisdictions that are willing to spend upfront, solar systems can eventually break even with a fuel-driven system in 20 to 25 years.

SOLAR SCENARIO

Typical Equipment	Equipment Power Consumption Watts	Common #'s of Equipment	Total Power Needed Watts
Computer	100	4	400
Printer	46 to 800	1	800
Radio Chargers	~100	2	200
Cell Phone Chargers	10	5	50
Lights	500	2	1000
			Totals=~2450

A solar system (with fixed panels) required to power the equipment in the scenario above would be structured as follows:

[3] Solar Photovoltaic (PV) –Solar Electricity Basics ~http://www.otherpower.com/otherpower_solar.html

Requirements:	
Assumed hours of peak sunshine per day	5 hours
Nameplate PV power rating required	12 kW
Capital Cost for PV Panels & inverters	$47,250
Useful life	20 years
Battery storage capacity required	47.5 kW-hrs
Unit cost for batteries	$300 $/kW
Useful life	~500 charging cycles
Battery Capital Cost	$14,250
Total Initial System Purchase Cost	**$61,500**

**Solar power adds a huge initial investment and requires a large amount of base camp space during a scenario. The size of the required solar panels would consist of 523 square feet and need to be hauled by a truck. The estimated break-even point would take 20 to 25 years of no fuel in these scenarios. However, it is not clear that a solar powered source would be able to provide complete power and could potentially require a generator if the weather was not ideal. In addition, PV panels degrade at an unknown rate, so efficiencies may not be guaranteed for the 20 to 25 years required to break even in this technology. [4] Note that batteries have a fixed lifetime also. The actual lifetime of a battery depends on the type of battery used, but a rule of thumb is that a battery may be fully charged and then fully discharged a total of 500 times before it must be replaced.

RELEVANT COMPANIES

There are many suppliers of mobile solar power. Pure Power Distribution, GreenSolar, Iris Technology and Mobile Solar Power are just a few that have been looked at in the San Diego area. There are no companies providing a portable tracking solar panel capability at this scale of production.

[4] http://www.otherpower.com/otherpower_solar.html

WIND

Like solar panels, wind turbines do not need fuel to operate. Instead, the wind spins a propeller blade that then turns an electrical generator that typically produces 120 Volt AC electricity. The basic system has the operational limitation that it can produce power only when the wind is blowing at a sufficiently high velocity. As a general rule of thumb, the wind speeds at any given location are highest in the mid to late afternoon, which is when a wind generator will produce power. Again like solar, if 24-hour power is required, a wind power system must incorporate battery storage and must be sufficiently large to produce the immediately required power plus enough to store for use when the wind is not blowing.

The wind industry does not have a good sampling of portable products. As wind turbines base their efficiency and power output on the blade length (longer blades produce more power), most of the research and funding has gone into large fixed–site systems. In addition, the lack of ability to store wind energy has focused the industry on connectivity to the grid as an alternate power source to fixed base-load power. Portable units tend to be small (less than 1000 Watts) and require mounting on poles so that they are high enough to get the wind they need. For example, a commercially available small (17 pound) turbine needs a 27 mph wind to generate its rated power of 400 Watts. Assuming that the wind blows for 5 hours per day, this relatively small turbine size means that numerous turbines are required to generate the ~60 kW-hours per day needed for the baseline scenario.[5] Furthermore, in areas where the wind is unreliable, a backup generator may be required. Wind can also be combined with solar to extend the time period in which the alternative source produces energy. Most mobile wind suppliers combine a wind/solar hybrid with a diesel generator. All these characteristics make this a difficult product for use as support to emergency response.

WIND SCENARIO

Typical Equipment	Equipment Power Consumption Watts	Common #'s of Equipment	Total Power Needed Watts
Computer	100	4	400
Printer	46 to 800	1	800
Radio Chargers	~100	2	200
Cell Phone Chargers	10	5	50
Lights	500	2	1000
			Totals=~2450

A wind system required to power the equipment in the scenario above would be structured and cost as follows:

[5] Energy Planet – Renewable Energy Directory ~http://www.energyplanet.info/Wind_Energy/

Power Requirements:

5 hours of 27 mph wind per day
Power output ~ 0.400 kW
Total Daily energy output per turbine ~ 2 kW-hrs

30 Turbines excluding inverter/controller and towers

Capital cost per turbine	$930
Total Turbine cost	$27,900
Battery storage capacity required	47.5 kW-hrs
Unit cost for batteries	$300 /kW-hrs
Battery capital cost	$14,250
Useful Life	~500 charging cycles
Inverter controller (cost per unit)	$750
Number of inverters:	30
Total inverter cost	$22,500
Total System Cost:	**$64,650**

**Several assumptions have been made in this scenario as the wind industry does not have a good sampling of modular products. For example instead of 30 inverters, perhaps one large inverter could be purchased saving a small amount of capital cost

RELEVANT COMPANIES

- **Bergey WindPower** is a company that supplies packages and components of wind power systems. Unfortunately, they focus on medium to large turbines and require fixed infrastructure. This company is involved in many "off the grid" experiments, all of which use generators to store the power produced by wind/solar hybrids.
- **Sky Built Powe**r provides mobile power systems primarily for the military. Their systems combine solar, wind, battery, and diesel generator power onto military-grade or other trailers. They have created shipping, skid or truck deployable systems. These systems are quite mobile but default to diesel generators as do most power supplies in this area.

HYDROGEN FUEL CELL

Hydrogen fuel cycle technology produces electricity as a result of the chemical combination of hydrogen gas and oxygen. It is considered a clean technology because the waste product is water. In a sense this is conceptually similar to producing electricity by burning gasoline in an internal combustion engine (like the Honda Generator) with carbon dioxide as the waste product. The hydrogen is stored in a cartridge, which is inserted into the fuel cell, and the oxygen is supplied by air. Again like the Honda Generator, use of a fuel cell involves a logistics issue: ensuring the supply of hydrogen-filled cartridges to the base camp.

The hydrogen fuel cell is not well commercialized and appears to be at the research stage. The only identified commercially viable effort uses hydrogen cartridges that are four times larger than AA batteries and produces 4.8 times as much electricity as a AA battery.[6]

There is much discussion on the technology and viability of the hydrogen fuel cell. As this is all at the research and prototype level, it does not appear to be appropriate for use in incident response, nor does it appear to address the logistics, costs and safety issues deemed important in the First Responder survey.

HYDROGEN SCENARIO

As the baseline scenario cannot be applied to this technology, this comparison is presented: Hydrogen figures are based on the MiniPack for sale from Horizon Fuel Cell Technologies:

One hydrogen cartridge is 81 mm long and 22 mm in diameter. It stores 12 Watt-hours of energy. That gives the cartridge an energy storage density 0.00039 Watt-hours per cubic millimeter. (12/ (81 x [pi/4 * 22^2])

To achieve this density, various items must be purchased such has a recharger, a fuel cell to extract the energy. To use this capability, an end user would need to purchase ~ $900.00 worth of product.

Currently, a AA nickel metal hydride battery (which is rechargeable) is 50 mm long and 14 mm in diameter and holds 2.5 Watt-hours of energy. The energy storage density of the AA battery is 0.00032 Watt-hours/cubic millimeter (2.5/ (50 x [pi/4 * 14^2]). To achieve this, batteries must be purchased costing ~$15.00 with a recharger.

The hydrogen system holds only 22% more energy on a volume basis yet costs significantly more. Furthermore, the hydrogen system needs a hand held fuel cell to extract the energy whereas AA batteries can be used directly. They both need chargers with an outside source of power to recharge their “fuel”. This hydrogen system appears to be a technology whose strengths (innocuous waste product) are not advantageous for the First Responder mission.

[6] Horizon Fuel Cell Technologies, Portable Power ~http://www.horizonfuelcell.com/electronics.htm

CONCLUSION & RECOMMENDATION

Alternative energies such as solar, wind, and others, while desirable to address the covert requirements, safety concerns, fueling and logistics issues, have not matured to the point that they are a viable alternative to the current portable energy source of the commonly used diesel generator. While there is extensive alternative energy research being funded, nothing is likely to be developed and marketable within the 12 to 15 months performance objective of the TechSolutions program.

In particular, the survey respondents showed great interest and openness to alternative power sources. Their major concerns with currently used portable power systems (e.g., diesel generators) involved logistics: The need for fuel and refueling, and the staffing and associated costs to maintain and operate the systems. A system that could be set up and basically ignored would be welcome as First Responders could then focus on their primary mission without interruption. Among the alternative technologies considered, solar power is the most mature and therefore the closest to meeting this need. However, the intermittent nature of solar power makes it problematic, as it must be supplemented with energy storage technology and with a conventional battery backup system to provide for times when the sun is absent. In addition, the costs of these systems are still not competitive with what is currently used in the market, such as a diesel generator.

Many of these technologies are still in the early stages of research and commercialization with much needed advancement prior to their deployment. Additionally, First Responders need reliable products that will not fail during a disaster, many alternative energy providers are not proven and are in test phases or limited production. Nevertheless, the industry is growing rapidly and other government organizations, such as the Department of Energy (DOE) and Department of Defense (DoD), are spending money to further accelerate their development. Once the technology is more mature, these products have potential applications within the First Responder community. This study took a broad brush approach to alternative energy sources and their viability. However, there is still much to be gained in better understanding the various needs of the First Responder and how they use mobile power sources. For instance, how do the mobile power needs of Law Enforcement compare to those of Fire or Emergency Medical Services? There are questions about First Responder standard operating procedures (SOP) regarding mobile power in rural, suburban, and urban environments. Such as, do rural First Responder agencies have different requirement needs than those in urban or suburban areas? Or, are there rural agency needs for mobile power not relevant to the needs of highly urban areas? Also, do technical limitations such as generator/battery longevity play a role in each of these areas SOPs?

The understanding of SOPs during an incident is critical to the development of effective alternative energy. For example, if agencies typically staff more personnel during the day, the need for energy storage/batteries will be less, bringing costs down. This report assumed a

constant level of work for 72 hours; however the report did not study typical operational environments during events. Understanding true operational requirements will greatly enhance the knowledge of how to meet and present technology gaps specific to agency type and work flow allowing TechSolutions to field targeted alternative power technology enhancements to agencies in a manner that will provide efficiencies to their specific mission.

Additionally, while pure alternative energy sources may not be available in 12-15 months, there are methods being developed to enhance current operations. Hybrid batteries could help alleviate fuel logistics and maintenance issues. Energy management systems may give generators a higher level of operational efficiency and longevity. Fuel additives may improve the efficiency with which a generator operates. Industry is currently pursuing these capabilities for the commercial environment.

In conclusion, identification of incremental capability enhancements and how they would assist the First Responder is a means by which TechSolutions could facilitate the introduction of new technologies to the first responder communities within its stated 12-15 months objective. An expanded research study is recommended to include the following:

1. Survey a larger nationwide sample of first responder agencies in each of the distinct operational mission areas – fire, law enforcement, medical, etc.
2. Identify the types alternative power systems in use and equipment specifications and performance characteristics including operational and maintenance costs
3. Identify technology products and development efforts that could be used to enhance operational performance and mitigate key issues (cost, safety, etc.)
4. Provide technical, operational, and logistic assessment of the introduction of technology enhancements including auxiliary components, adjunct power systems, etc.

The objective of the study would be to better characterize the energy (portable or otherwise) operational requirements of the various first responder groups (fire, police, medical, etc) and by demographic service regions (urban, suburban, rural, etc) and to identify technologies that would enhance performance, reduce operational costs, mitigate safety and other issues.

APPENDIX A: DETAILED SURVEY RESULTS

- **Question 1:** How Important is the availability of portable Power (e.g., Generator)?
  - *Rank all options: 1-5: 1(not important) & 5 (critically important)*

1. For Tactical Surveillance — Create Chart | Download

	1	2	3	4	5	Rating Average	Response Count
A.	18.2% (4)	4.5% (1)	**40.9% (9)**	22.7% (5)	13.6% (3)	3.09	22
					Comments Show Responses		4
					answered question		22
					skipped question		5

2. For Immediate Emergency Response (0-72 hrs.) — Create Chart | Download

	1	2	3	4	5	Rating Average	Response Count
B.	0.0% (0)	0.0% (0)	0.0% (0)	27.3% (6)	**72.7% (16)**	4.73	22
					Comments Show Responses		4
					answered question		22
					skipped question		5

3. For Long Term Secondary Response (73 hrs. plus) — Create Chart | Download

	1	2	3	4	5	Rating Average	Response Count
C.	0.0% (0)	9.1% (2)	4.5% (1)	18.2% (4)	**68.2% (15)**	4.45	22
					Comments Show Responses		3
					answered question		22
					skipped question		5

- **Cont. Question 1:** How Important is the availability of portable Power (e.g., Generator)?
  - *Rank all options: 1-5: 1(not important) & 5 (critically important)*

4. For Special Needs Response (Nursing Homes/Special Care Facilities) Create Chart Download

	1	2	3	4	5	Rating Average	Response Count
D.	14.3% (3)	4.8% (1)	14.3% (3)	19.0% (4)	**47.6% (10)**	3.81	21
					Comments Show Responses		4
					answered question		**21**
					skipped question		**6**

Question 2: What Equipment Drives your greatest need for portable power?
Identify key equipment in order of priority where 1=highest priority. These are "must haves" items during an emergency. If you do not use equipment on this list, mark it N/A.

Ranking														
	1	2	3	4	5	6	7	8	9	10	11	12	N/A	Response Count
Computer	**38.9% (7)**	5.6% (1)	11.1% (2)	11.1% (2)	5.6% (1)	5.6% (1)	0.0% (0)	5.6% (1)	11.1% (2)	5.6% (1)	0.0% (0)	0.0% (0)	0.0% (0)	18
Monitor	**31.3% (5)**	0.0% (0)	6.3% (1)	12.5% (2)	6.3% (1)	6.3% (1)	0.0% (0)	6.3% (1)	0.0% (0)	6.3% (1)	0.0% (0)	6.3% (1)	18.8% (3)	16
Camera/Surveillance	12.5% (2)	6.3% (1)	12.5% (2)	0.0% (0)	0.0% (0)	6.3% (1)	12.5% (2)	6.3% (1)	0.0% (0)	6.3% (1)	12.5% (2)	6.3% (1)	**18.8% (3)**	16
Cell Phone Battery Charger	**17.6% (3)**	5.9% (1)	11.8% (2)	5.9% (1)	5.9% (1)	**17.6% (3)**	11.8% (2)	5.9% (1)	11.8% (2)	5.9% (1)	0.0% (0)	0.0% (0)	0.0% (0)	17
Radio Charger	**23.5% (4)**	17.6% (3)	17.6% (3)	0.0% (0)	5.9% (1)	11.8% (2)	0.0% (0)	0.0% (0)	0.0% (0)	11.8% (2)	0.0% (0)	5.9% (1)	5.9% (1)	17
Mobile Communications Tower	**35.3% (6)**	11.8% (2)	17.6% (3)	0.0% (0)	0.0% (0)	0.0% (0)	11.8% (2)	5.9% (1)	0.0% (0)	11.8% (2)	0.0% (0)	5.9% (1)	0.0% (0)	17
Lights	**29.4% (5)**	11.8% (2)	11.8% (2)	17.6% (3)	0.0% (0)	0.0% (0)	0.0% (0)	5.9% (1)	0.0% (0)	11.8% (2)	5.9% (1)	5.9% (1)	0.0% (0)	17
Coffee Maker	6.7% (1)	13.3% (2)	0.0% (0)	6.7% (1)	13.3% (2)	0.0% (0)	6.7% (1)	13.3% (2)	0.0% (0)	0.0% (0)	6.7% (1)	6.7% (1)	**26.7% (4)**	15
Food Prep	5.9% (1)	**11.8% (2)**	5.9% (1)	5.9% (1)	**11.8% (2)**	5.9% (1)	5.9% (1)	5.9% (1)	5.9% (1)	**11.8% (2)**	0.0% (0)	**11.8% (2)**	**11.8% (2)**	17
Refrigeration	11.8% (2)	5.9% (1)	5.9% (1)	5.9% (1)	**17.6% (3)**	5.9% (1)	5.9% (1)	0.0% (0)	11.8% (2)	5.9% (1)	5.9% (1)	0.0% (0)	**17.6% (3)**	17
Printer/Fax	5.9% (1)	**11.8% (2)**	**11.8% (2)**	**11.8% (2)**	**11.8% (2)**	0.0% (0)	**11.8% (2)**	5.9% (1)	**11.8% (2)**	**11.8% (2)**	5.9% (1)	0.0% (0)	0.0% (0)	17
Basic Medical Equipment	**29.4% (5)**	5.9% (1)	5.9% (1)	11.8% (2)	5.9% (1)	5.9% (1)	11.8% (2)	11.8% (2)	0.0% (0)	0.0% (0)	0.0% (0)	5.9% (1)	5.9% (1)	17
Power Tools	**23.5% (4)**	17.6% (3)	11.8% (2)	0.0% (0)	0.0% (0)	0.0% (0)	5.9% (1)	11.8% (2)	5.9% (1)	5.9% (1)	5.9% (1)	11.8% (2)	0.0% (0)	17
													answered question	**18**
													skipped question	**9**

Question 2: Comments:

1. Ventilation Equipment, A/V Equipment (Tue, Dec 14, 2010 6:57 PM)
2. Depending on size and complexity of incident. (Wed, Dec 8, 2010 9:54 AM)
3. Monitor - comes with the computer / Food Prep - we have MRE's, so food prep would be a lower item (Wed, Dec 8, 2010 8:19 AM)
4. Bathroom facility is needed at the very beginning also. (Wed, Dec 8, 2010 7:44 AM)

Question 3: What deficiencies would you like improved given current power capabilities?
Rank all options: 1-5: 1(not important) & 5 (critically important)

1. Noise — Create Chart | Download

	1	2	3	4	5	Rating Average	Response Count
1.	5.0% (1)	5.0% (1)	**55.0% (11)**	15.0% (3)	20.0% (4)	3.40	20
						Comments	0
						answered question	**20**
						skipped question	**7**

2. Fumes — Create Chart | Download

	1	2	3	4	5	Rating Average	Response Count
2.	0.0% (0)	5.3% (1)	**36.8% (7)**	26.3% (5)	31.6% (6)	3.84	19
						Comments Show Responses	1
						answered question	**19**
						skipped question	**8**

3. Time (Duration before Refueling) — Create Chart | Download

	1	2	3	4	5	Rating Average	Response Count
3.	0.0% (0)	22.2% (4)	**27.8% (5)**	**27.8% (5)**	22.2% (4)	3.50	18
						Comments	0
						answered question	**18**
						skipped question	**9**

Cont. Question 3: What deficiencies would you like improved given current power capabilities?
Rank all options: 1-5: 1(not important) & 5 (critically important)

4. Logistics (e.g. refueling) Create Chart Download

	1	2	3	4	5	Rating Average	Response Count
4.	5.3% (1)	10.5% (2)	15.8% (3)	**36.8% (7)**	31.6% (6)	3.79	19
						Comments	0
						answered question	**19**
						skipped question	**8**

5. Access to fuel Create Chart Download

	1	2	3	4	5	Rating Average	Response Count
5.	5.3% (1)	10.5% (2)	15.8% (3)	26.3% (5)	**42.1% (8)**	3.89	19
						Comments	0
						answered question	**19**

6. Availability of manpower to check, refuel, and maintain the generators Create Chart Download

	1	2	3	4	5	Rating Average	Response Count
6.	0.0% (0)	26.3% (5)	21.1% (4)	21.1% (4)	**31.6% (6)**	3.58	19
						Comments Show Responses	1
						answered question	**19**
						skipped question	**8**

Cont. Question 3: What deficiencies would you like improved given current power capabilities?
Rank all options: 1-5: 1(not important) & 5 (critically important)

7. Size — Create Chart | Download

	1	2	3	4	5	Rating Average	Response Count
7.	5.6% (1)	16.7% (3)	**38.9% (7)**	22.2% (4)	16.7% (3)	3.28	18
					Comments Show Responses		1
					answered question		**18**
					skipped question		**9**

8. Environmental impact of response — Create Chart | Download

	1	2	3	4	5	Rating Average	Response Count
8.	15.8% (3)	21.1% (4)	**36.8% (7)**	15.8% (3)	10.5% (2)	2.84	19
					Comments		0
					answered question		**19**
					skipped question		**8**

9. Reliability — Create Chart | Download

	1	2	3	4	5	Rating Average	Response Count
9.	0.0% (0)	10.5% (2)	15.8% (3)	10.5% (2)	**63.2% (12)**	4.26	19
					Comments Show Responses		1
					answered question		**19**
					skipped question		**8**

10. Safety — Create Chart | Download

	1	2	3	4	5	Rating Average	Response Count
10.	0.0% (0)	15.8% (3)	15.8% (3)	10.5% (2)	**57.9% (11)**	4.11	19
					Comments		0
					answered question		**19**
					skipped question		**8**

Question 4: In an incident, when power is not available, how many of each item listed, would a portable power source be required to keep running?
(Provide the number of each type of equipment needed)

Number of Item	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	>20	Response Count
Computer	0.0% (0)	11.1% (2)	11.1% (2)	5.6% (1)	11.1% (2)	0.0% (0)	0.0% (0)	0.0% (0)	5.6% (1)	0.0% (0)	11.1% (2)	0.0% (0)	0.0% (0)	5.6% (1)	0.0% (0)	0.0% (0)	5.6% (1)	0.0% (0)	0.0% (0)	0.0% (0)	5.6% (1)	**27.8% (5)**	18
Monitor	16.7% (3)	5.6% (1)	11.1% (2)	5.6% (1)	5.6% (1)	0.0% (0)	0.0% (0)	0.0% (0)	5.6% (1)	0.0% (0)	5.6% (1)	0.0% (0)	0.0% (0)	0.0% (0)	5.6% (1)	0.0% (0)	5.6% (1)	0.0% (0)	0.0% (0)	0.0% (0)	5.6% (1)	**27.8% (5)**	18
Camera/Surveillance	**27.8% (5)**	16.7% (3)	5.6% (1)	0.0% (0)	0.0% (0)	16.7% (3)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	16.7% (3)	0.0% (0)	5.6% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	11.1% (2)	18
Cell Phone Battery Charger	5.6% (1)	0.0% (0)	11.1% (2)	5.6% (1)	0.0% (0)	11.1% (2)	5.6% (1)	0.0% (0)	0.0% (0)	0.0% (0)	16.7% (3)	0.0% (0)	5.6% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	5.6% (1)	**33.3% (6)**	18
Radio Charger	11.1% (2)	0.0% (0)	11.1% (2)	11.1% (2)	0.0% (0)	11.1% (2)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	16.7% (3)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	5.6% (1)	**33.3% (6)**	18
Mobile Communications Tower	5.6% (1)	**55.6% (10)**	27.8% (5)	5.6% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	5.6% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	18
Lights	5.9% (1)	11.8% (2)	5.9% (1)	5.9% (1)	5.9% (1)	11.8% (2)	5.9% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	5.9% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	5.9% (1)	**35.3% (6)**	17
Coffee Maker	**52.9% (9)**	23.5% (4)	11.8% (2)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	11.8% (2)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	17
Food Prep	23.5% (4)	**47.1% (8)**	23.5% (4)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	5.9% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	17
Printer/Fax	0.0% (0)	**23.5% (4)**	**23.5% (4)**	11.8% (2)	0.0% (0)	11.8% (2)	5.9% (1)	0.0% (0)	0.0% (0)	0.0% (0)	11.8% (2)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	11.8% (2)	17
Basic Medical Equipment	**23.5% (4)**	**23.5% (4)**	5.9% (1)	0.0% (0)	0.0% (0)	**23.5% (4)**	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	11.8% (2)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	11.8% (2)	17
Power Tools	**35.3% (6)**	0.0% (0)	11.8% (2)	0.0% (0)	5.9% (1)	11.8% (2)	5.9% (1)	0.0% (0)	0.0% (0)	0.0% (0)	11.8% (2)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	5.9% (1)	11.8% (2)	17
																						answered question	**18**
																						skipped question	9

Question 5: If an alternative power solution were available that met your needs, what would be an acceptable price?

	Response Percent	Response Count
$1000-$5000 per unit	50.0%	9
$5000 to $25000 per unit	38.9%	7
more than $25,000	16.7%	3
answered question		18
skipped question		9

Question 5 Comments:

1. Depends on the size of the power source, it they were 25,000 to 50,000 KW (Tue, Dec 14, 2010 9:34 AM)
2. Cannot purchase equipment for incident mitigation. (Wed, Dec 8, 2010 10:05 AM)
3. CAL FIRE normally rents or leases this type of equipment as needed. (Tue, Dec 7, 2010 2:12 PM)

Question6: Would you be willing to pay up front to achieve savings in 10-15 years with the lack of fuel and maintenance logistics?

	Response Percent	Response Count
Yes	52.9%	9
No	47.1%	8
answered question		17
skipped question		10

ADDITIONAL COMMENTS:

Solar:

1. Having portable solar array systems would help supplement power use and also reduce the amount of Green House gasses emitted and also reduce fossil fuel consumption on a going incident. Solar technology has many advances such as micro inverters which help increase solar panel efficiency. (Fri, Dec 17, 2010 2:50 PM)
2. This would be the primary alternative energy solution for our Mission. (Tue, Dec 14, 2010 7:04 PM)
3. Solar works well in our area, however the amount of power that can be stored is limited. If storage of solar power was improved and the panels were the right size to include on devices, we would be interested in that. We already use solar/generator combinations for our video surveillance and mobile communications trailers. (Wed, Dec 8, 2010 6:46 AM)

Wind:

1. Wind would be nice if it could be portable. Smaller wind turbines are very noisy. Vertical axis wind turbines are quieter and more efficient but technology is still developing. (Fri, Dec 17, 2010 2:50 PM)
2. This would be an option but would be difficult to deploy. (Tue, Dec 14, 2010 7:04 PM)
3. .Storage is the issue. Wind varies during the day, when we are on an incident we work 24/7 and we need enough power to last the duration that we are out there. (Wed, Dec 8, 2010 6:46 AM)

Hydrogen:

1. A great power source if stored safely and deployed away from a terrorist target. (Tue, Dec 14, 2010 7:04 PM)

Alternative Fuels

1. Biodiesel and Ethanol would be good alternative fuel sources. (Tue, Dec 14, 2010 7:04 PM)
2. Fire apparatus and small power equipment. (Tue, Dec 14, 2010 9:34 AM)