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Disasters: Photovoltaics for Special Needs

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1. ABSTRACT

The National Hurricane Center tracks the path of a hurricane to determine where it will make landfall. People in harm's way are informed of its approach and the need to evaluate options to prevent injury and protect lives. One of the many groups of people at high risk is those with special needs. They have health conditions that require special care. Before a disaster, these individuals live in hospitals, care facilities and homes. During and following a disaster, many would be moved, along with their supplies, equipment and a caretaker, to a special needs shelter. Others would stay with relatives or friends until notified they could return home.

The energy requirements of special needs people are as different as their health conditions. In most cases, electricity is critical to their survival, whether in a shelter or home. One person may have a heart condition requiring only medicine, while others rely on various machines that require hundreds of watts of power. Ideally, these individuals would consider the advantages of creating disaster-resistant houses. A safe, reliable alternative to a gasoline or diesel generator is a photovoltaic (PV solar electric) system. The power system should be utility-interactive with battery back-up to ensure continuous operation to power critical equipment. The homes of special needs people are excellent candidates for modification to include PV as a critical power supply. With this type of advance planning, a special needs person would have an excellent chance of staying at home in the event of a power outage. Implemented collectively, disaster resistant homes with a renewable energy source would reduce shelter efforts, emotional stress and recovery costs.

2. INTRODUCTION

Hurricane season starts June 1 and ends November 31 and affects the Atlantic and Gulf Coast states. The National Hurricane Center tracks the path of a hurricane to determine where it will make landfall. People in harm's way are informed of its approach and the need to evaluate options to prevent injury and protect lives. In 2004, the State of Florida, USA, was ravaged by four major hurricanes which prompted the biggest series of evacuations due to a natural disaster, requiring 9 million people to seek shelter somewhere other than their home. Hurricanes Charley, Frances, Ivan and Jeanne did major damage to 40,000 buildings and destroyed 25,000 homes, leaving over 8 million people without electricity.

One of the many groups of people at high risk was those with special needs. They have health conditions that require special care. Before the disaster, they live in hospitals, care facilities and private homes. During and following a disaster, many would be moved to a special needs shelter where they would continue to receive the care they need. Others would stay with relatives or friends out of harm's way until notified they could return to their home. Many years ago, the Florida State Legislature established statutes defining County Government and School Board responsibility for safety of life and property during a declared emergency. Public schools are the primary source of public shelter during emergencies, currently accounting for about 93 percent of statewide hurricane shelter space.

In Brevard County, there are over 3000 registered special needs people with a wide variety of health needs ranging from those who need monitoring and supervision to individuals requiring critical care. There are currently 4

major hospitals and a large number of nursing homes in the County. In the event of a disaster, many people in these facilities and in private homes would be moved to special needs shelters. Each person is expected to bring required medical supplies and to be accompanied by a personal caregiver. The State and County Health Departments, local hospitals and care facilities supply nurses and doctors to shelters to provide care and respond to medical emergencies.

Our dependence on energy characterizes our daily lives through the use of medical equipment, computers, communications products, refrigerators, televisions, water heaters and lighting. Energy requirements of special needs people are as different as their health conditions to the general public. One person may have a heart condition requiring only medicine, while others rely on oxygen concentrators to stay alive using hundreds of watts of power. The use of emergency generators is recommended by The Federal Emergency Management Agency and American Red Cross guidelines and standards for schools used as shelters. Our schools are powered by local utilities; in addition, the County provides gasoline or diesel generators to about half the shelters and they are considered a necessity for special needs shelters. Electricity is critical to the survival of these individuals.

3. INDEPENDENT SUPPORT SYSEM

There are several organizations that support people with disabilities and special health needs. The Sunflower House of Brevard, Center for Independent Living, Community Service Council, Senior Citizen Centers and Housing and Urban Development are a few of these organizations. They provide support in various ways, from low cost housing, to rehabilitation, to health services, education and personal welfare counseling. The Center for Independent Living helps give these individuals a greater feeling of independence and self worth by helping them live on their own and provide for themselves.

Existing independent living programs have promoted resource development and capability enhancement for special needs people and should now apply that support to include disaster mitigation and preparedness. These individuals' capability to effectively deal with every day issues should allow them to survive a disaster too. Their homes have been modified to address their disabilities or special health needs, such as walkways and ramps, hand supports, medical equipment, breathing apparatuses and air conditioning. With the right equipment and support, they should be able to sustain quality of life even in a disaster and be able to stay where they are most comfortable - their home - a building already modified to address their disability or special health needs.

There are limits to safely staying in a home during a disaster, such as type of home construction, location in a flood area or surge zone and other mandatory evacuation considerations. When a hurricane threatens, special needs people require special care beyond the needs of those without disability. A wheel chair, medical equipment, breathing apparatuses and other equipment must be moved with them. Since there are thousands of special needs people, transportation to and from a shelter is a major task amidst the disaster efforts. The County's shelter program must accommodate them, their equipment and caretakers, requiring greater resources during a time of emergency. Present homes may be the best places to shelter them if they are not in a mandatory evacuation area.

4. ENERGY NEEDS

Some special needs people have one or more health problems needing one or more machines, while others need only monitoring. In some cases, their health problem requires that they be in an air conditioned space to keep there body cool and the air clean. A wide variety of equipment is used by disabled and special needs people (Table 1). Energy requirements are different for each device, from a few watts to hundreds of watts. The hours of operation of each device is different, as some are only used once a day and other devices are use continuously.

Table 1: Medical Equipment list

Medical Item	**Watts**	**Hours**	**Period**
Oxygen concentrator	400	24	day
Nebulizer	20-50	0.1	3-4 hr
Apnea Monitor	120	sleeping	day
G-tube-feeding machine	350	feeding	day
Trach Tube machine	450	24	day
Dialysis/RO	2200	4-5	3 days
Defibrillator	160	0.1	as needed
Ventilator	400	24	day

To understand the energy needs of an individual, one needs to know that individual, as they may have single or multiple health problems. The biggest load is for oxygen, ventilator, and trach equipment, which operates 24 hours a day. Many people have one major health issue, such as kidney disease requiring a dialysis and reverse osmosis machine that may operate for 4 hours every 3 days. Some equipment is activity based. For example, the apnea

monitor is only used when sleeping and the G-tube is only used when feeding, making actual usage variable. The defibrillator is used the least and hopefully not at all, except during a heart attack.

5. ONE SOLUTION

Many newer homes survived the forces of the recent hurricane season due to the new, stronger building codes put in place after the year 2000. The Institute of Building and Home Safety promotes the Fortified Building program which strengthens buildings to be hurricane-resistant along with the Federal Alliance for Safe Homes program. These programs use construction practices, roof to foundation tie downs, shutters and other applications to make the buildings disaster-resistant. These programs promote safety and save lives, but do not address the operational or functional capability of the building. Following a disaster, if the building is still there, you need to be able to operate your business or live in your home. A lack of power can cause you seek shelter elsewhere, or purchase a gasoline or diesel generator. Generators have caused deaths and injuries through fires and carbon monoxide poising, and have burned down homes that survived the hurricane forces. After a disaster, the noise of engine generators makes traumatic stress worse. Fuel may be hard to obtain if fueling stations are without power.

A new approach in shelter management for people with disabilities and special health needs is to make their homes and care facilities disaster-resistant and energy secure. Ideally, homeowners and care centers should consider the advantages of creating disaster-resistant houses and facilities with renewable energy resources. The concept is to fortify structurally their homes and living facilities and provide fail safe energy resources to power their needs. The purpose is to maintain the operation of their habitats so as not to impact their lives and burden public shelter programs. Making a building as energy efficient as possible, so as to approach zero energy input by an outside utility, promotes energy assurance and security. The less energy the building needs, the less energy that has to be supplied, even in an emergency. Renewable energy sources can be implemented cost effectively for energy efficient buildings to assure that the lights will stay on. Renewable energy, such as solar thermal hot water and photovoltaics (solar electric), can provide the necessary power to keep a business operating and a home livable. Buildings built to Rebuild America, Energy Star or Leadership in Energy and Environmental Design (LEED) standards help promote energy conservation to levels needed for cost effective renewables.

Solar powered equipment requires no fuel, so the length of operation poses no problem when the solar power system is properly designed. Photovoltaic (PV) is an environmentally benign, inexhaustible source of electrical energy that is also quiet. PV is a viable, cost effective resource for small portable and stand alone electrical power applications, since it offers lower operating costs than gasoline generators. PV systems are modular, allowing various outputs, and the addition of battery storage to a PV system allows 24 hour operation. PV-powered systems are a natural solution, because they can be designed specifically for stand alone operation without utility power as a critical power supply. A viable use for PV is to meet emergency demands in large-scale disasters, where power will be out for long periods of time and survivor support is difficult to provide. If structures are still standing after a disaster, PV can serve as a critical power supply or back-up system or completely power a building. PV can provide all of the power that a special needs person should need to stay in their home.

6. THE APPROACH

An integrated approach to addressing critical energy issues, energy production and consumption should be followed to balance and assure an improved level of energy security and reliability. Distributed energy generation can be applied to building design using renewable energy sources where more than one energy source is used. The use of photovoltaics, solar thermal or wind is needed to ensure sustainability. Solar thermal or hot water systems are cost effective and offset the need to generate electricity to produce hot water. Wind energy, which may be available at night when solar is not, enhances the energy mix. If one or more sources have failed, one or more of the other energy sources could supply the energy needed for the load.

To meet the energy needs of special needs people, two levels of renewable generation could be provided. The first level is geared to power critical energy needs in the home or care facility to ensure needed power is available to maintain key operations. The second level of generation may be to power the whole building and produce as much as is consumed. Both levels take advantage in energy efficient disaster-resistant building design and use backup power systems that may be stand-alone or grid-tied. The first Level is of most interest to provide a critical power supply (CPS) concept where critical energy needs are identified and incorporated into a power supply design to ensure needed power is available to maintain key operations and functions of a building. As an example, during a power outage or disaster, the special needs person will want to have electricity for

operation of a lamp, necessary medical equipment, refrigerator and a radio. This concept would apply to homeowners, in addition to, any business that may need a few lights for safety and a cash register to complete sales. Most consumers would consider these items critical to maintaining business operations, building functions and personal lifestyle until utility power is restored.

Whether only critical items are powered or the whole building, a CPS power panel using renewable energy should be incorporated into the building design. Critical power supply can be achieved by connecting a sub panel to the main power panel of a building. Critical items are connected to the sub panel. Through a transfer switch the sub panel would be powered by utility power or an alternative energy source, such as a PV system, wind, small hydro, solar thermal, microturbines, geothermal or a hydrogen fuel cell generator. Emergency power transfer systems like this are already available at local hardware suppliers and electrical contractors. Utilities recommend their use to protect power line workers from back feeding from engine generators as shown in Figure 1. This design concept integrates a distributed energy source to a specific load, providing energy assurance. The local utility could power from 1 to 99 percent of the building's energy needs and the building would have critical energy items powered by dual or multiple sources of energy. Ideally, the truly disaster-resistant building would be a zero-energy home or building that ensures a higher level of energy security.

Fig. 1: Critical Power Supply Panel

Energy analyses of various homeowners' needs suggest that a minimum of 1.5 kW photovoltaic array with a 2 kW inverter and battery storage would continuously power most critical household needs, such as refrigerator and a light. This minimum PV system with a thermal water system would allow the special needs person and caretaker to live their home. To power their medical equipment would take various sizes of PV systems depending on their health needs, sized for Florida, as shown in Table 2. The PV systems listed are not too big for mounting on a home. The system would be utility-interactive with battery back-up to power critical items during power outages. During normal times, the PV system would provide demand side management, offsetting energy consumption. During outages, the system would power critical items required to survive. The energy sources need to be integrated into a comprehensive energy management system to provide a "smart home" energy mix.

Table 2: PV system for medical use

Medical item	**PV Watts**
Oxygen concentrator	3,200
Trach Tube machine	3,000
Ventilator	3,000
Dialysis/RO	2,400
G-tube-feeding machine	600
Apnea Monitor	500
Nebulizer	100
Defibrillator	100

7. CONCLUSION

Special needs people are more dependent on power for their safety and health than the general public. A power outage, whether caused by a natural or manmade disaster or a minor weather-related event, temporarily highlights the importance of electricity in our daily lives, but can be life threatening to those with special needs. Normal power outages do not necessarily prompt housing in a shelter. Therefore, the need for improved energy assurance is for all times, day or night, reaching beyond the use of a gasoline or diesel generator.

This new shelter approach enhances the concept of disaster-resistant buildings going beyond being structurally sound to include functional and operational capabilities. This concept incorporates disaster fortification strategies with conservation and renewable energy concepts to meet the energy needs of people with disability and special health needs. With this type of advanced planning, a special needs person would have an excellent chance of staying safely in their home, designed to support their health needs, in the event of a power outage. The proposed home shelter design offers energy security in the face of an uncertain energy supply. Ultimately, this concept empowers individuals to take care of themselves in the event of a disaster.

The implementation of energy efficient practices, distributed energy sources and the use of renewable resources assures that the needed energy would be available for the special needs person. Ideally, creating zero energy homes and buildings would ensure the highest level of energy security and safety. Making modifications to homes and buildings by incorporating even minimal changes, such as the addition of a small photovoltaic array with batteries, would enhance safety, health and energy security and yield long-term financial and environmental benefits.

This building method may cost more at the time of construction, but delivers priceless life and property saving benefits after a disaster. Creating true disaster-resistant buildings would reduce impact on shelters, emotional stress and recovery costs as well as improve quality of life.

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