Century 21 Village (C21V)

Intelligent Eco-Villages

A Sustainable Path to Eradicate

Extreme Poverty

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6/11/2019

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Executive Summary

In the underdeveloped areas of the world where inadequate food, water and shelter are the norm and instability is a constant companion which includes the Caribbean populations, twenty-five percent of Latin America, seventy percent of sub-Saharan Africa and fifty percent of South Asia. Large numbers of the population are living in substandard housing or are homeless. In 2011, our planet's population was seven billion people. The projected figure for 2045 is nine billion. By 2045, we will need 70% more food. That calls for new technologies and ways of growing food with less water than today. Food, Water, and Shelter are a major part of the solution, but to build sustainable communities requires a well thought out architecture and implementation plan.

The Intelligent Eco-Village (IEV) is the solution. IEV deployments provide the answer to the logistics and educational issues of sustainable living. IEV's are modular constructs that support intelligent monitoring of food, water, shelter, climatic, agricultural stresses and threat levels of the village area.

The IEV grow domes provide a highly secure productive food source in a small footprint while dramatically reducing the amount of water used.   Grow Domes are structures that provide an artificial growing environment that can grow fresh produce anywhere, regardless of the weather or time of day. The average outdoor field yields 2.5 pounds of produce per square foot. A grow dome with the perfect temperature for plant growth and time cycled grow lighting can produce 200+ pounds of produce per square foot of growing space. Providing two orders of magnitude more food while using less than 10% of the water need in outdoor growing.

Technologies alone no do not make communities sustainable, however integrating support and education to nurture evolving cultures as they elevate from extreme poverty to sustainability will.   The IEV Deployment plan provides an integrated plan while supporting educational, healthcare, water and sanitation capabilities and resources enabling the communities to thrive. The IEV deployment plan follows a hierarchy enabled by communications to provide logistics and support for long-term sustainability. Each region has a management center to provide support to the district centers which in turn provides support to the Eco-villages.

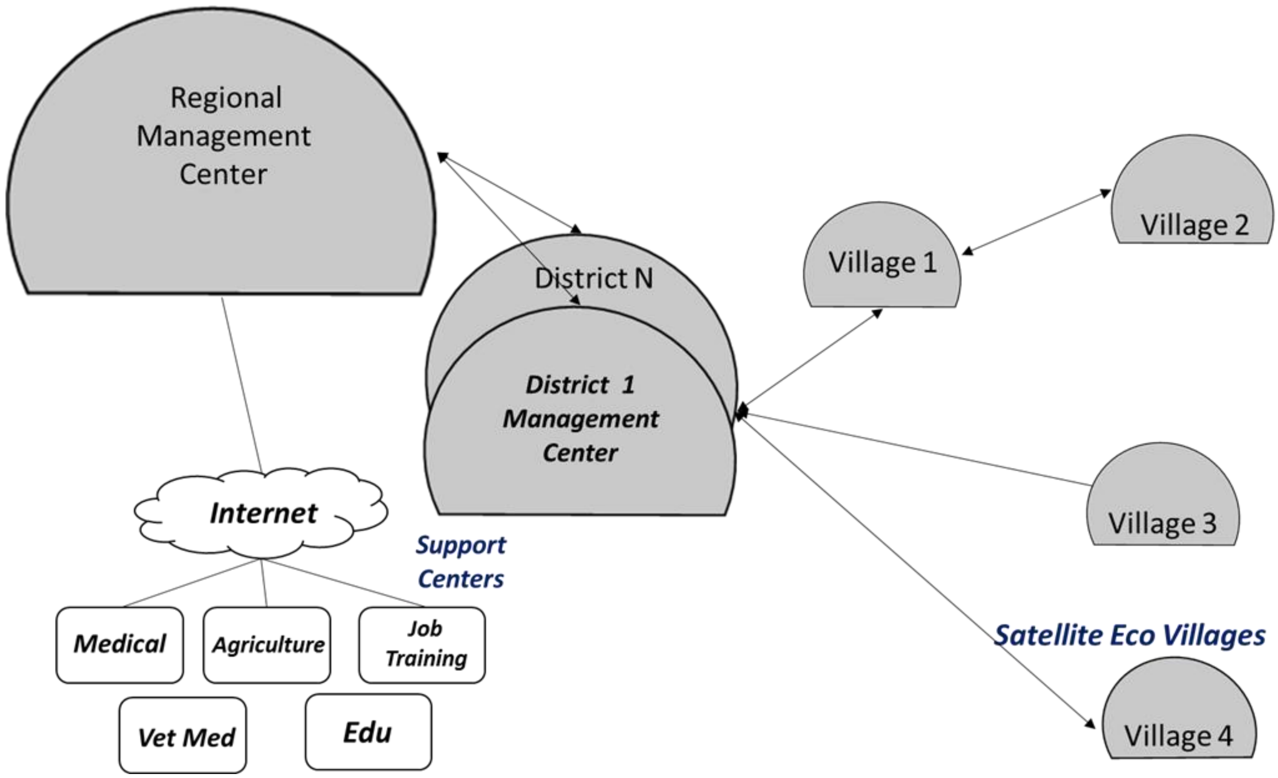

Figure 1 IEV Hierarchy of deployment

The IEV integrates a number of solutions providing an approach that is modular and allows for differences in terrain, weather, food, and water availability, as well as social/cultural requirements of the area. Included in the hierarchy of deployment is the capability to stage Pre-positioned Expeditionary Assistance Kit (PEAK) + trailers which are a disaster relief capability described in Appendix C.
According to the UN, our world has 1.6 billion people living in substandard housing and 100 million homeless. During the next thirty years, this number will increase to nearly two billion unless action is taken. By reviewing the current approaches used by NGOs as well as the PEAK programs limited deployments and evolving them to better provide rapid delivery and maximize community involvement. IEV deployments will provide sustainable food, water, and shelter with more usable space and longer life cycles than current approaches. The homes and schools built using the IEV approach will be capable of surviving weather, fires, earthquakes as well as small arms fire, shrapnel and remain operational for hundreds of years if properly maintained.

What is an IEV?

An Eco-Village is defined as a traditional community using local participatory processes to integrate ecological, economic, social, and cultural dimensions of sustainability in order to regenerate social and natural environments.

An IEV adds the necessary water, food, shelter, communications, and sensors to provide for distance learning, Telemedicine for both humans and livestock, as well as climatic and agricultural sensors that enable remote monitoring and advising on crop statuses. The deployment plan includes instructors and master craftsmen at the regional and district centers to provide real-time support to the satellite villages and hamlets.

An example of the communication is the installation of Wi-Fi to cover the village so that both children and adults have access to educational materials. The connectivity to the World Wide Web also enables the community school to link to any number of distance learning capabilities.

The Instrumented IEV will provide jobs and on the job training for the following:

1. Creating Immediate Jobs
    a. building out the various domes
    b. setting the domes up and maintaining the communications and infrastructure of the village systems
        i. Solar power jobs and innovation
        ii. Water purification and plumbing jobs and innovation
2. Provide long-term jobs supporting the grow domes
3. Providing educational resources
    a. Education for children through 12th grade to include distance learning capabilities where the communication systems allow
    b. Adult education in Sanitation, Agriculture, nutrition, power and water systems management
4. Providing critical healthcare resources including
    a. Healthcare clinics set up for medical stability operations (i.e., Doctors without borders)
    b. Telemedicine capabilities for Crisis response

The instrumented IEV will provide cost effective enhancements to current aid projects by providing innovations based on COTS technologies integrated into to the IEV to enhance agriculture yields, remote monitoring of weather and threat sensor capabilities. The following technology sections are examples of currently available COTS systems to show the kinds of capabilities other options will be evaluated based on site requirements for each village.

IEV Technologies

Within this section, the primary technologies under consideration for the IEV will be described. It should be noted that the technologies are dependent on the village location and needs. Villages located in colder climates will require the insulation of the monolithic domes while, in the tropical regions or regions that use long burning indoor stoves for cooking and heat, the Eco shells may be adequate. The same holds true of the water systems. Some locations may require Desalinization while other may only require a well and filter system.

Food

Monolithic Grow Domes provide the best growing environment, and they do it more efficiently and economically than any other type of structure. They can be located from the arctic to the equator and equipped with computerized programs for temperature control and grow lighting that can actually trick a vegetable or a fruit into growing faster. With this modern low-cost lighting, plants can be grown anytime, anywhere. Monolithic

Grow Domes are virtually airtight allowing CO2 content and oxygen content to be properly maintained.

Plants grown in a field will often produce 2.5 pounds per square foot per year. In a Monolithic Grow Dome, those same plants will produce 200 to 300 pounds per square foot per year. Typically, only 10% of the water used to grow food outdoors is needed to grow it indoors. How is this possible? Water in produce production outside is lost in two ways evaporation from the soil and evapotranspiration from the plants. This water is lost to the atmosphere, however in a grow dome this water is recovered and put back into the system.

Grow domes provide protection from inclement weather, and, with care, from insects, molds, and germs. Farmer and plant are protected from planting to harvest regardless of the weather.

The Monolithic Grow Dome is super energy efficient – many times more efficient than any other structure. Power to maintain growing temperatures will be 50% to 90% less than that required in conventional buildings. A Monolithic Grow Dome requires minimum maintenance and will remain undamaged by water and chemicals with a service life of centuries.

Throughout the world the population density in cities, towns, villages, and hamlets varies dramatically as do the transportation capabilities. For this reason, the grow dome concept is as scalable as the IEV deployment strategy. The grow domes will need to scale from grow cabins supporting small hamlets of less than one hundred people to the massive population density of urban centers like Lahore Pakistan where numerous multi-dome complexes might be needed.

Large grow domes and dome complexes:

In high population densities, large grow domes or complexes of large grow domes can be configured to provide large quantities of fresh fruits and vegetables all year long. Large grow domes of 300+ ft. diameter could produce ~100million pounds/year of fresh organic fruits and vegetables. Enough produce to feed ~150,000 people. Multiplexes of large domes could be built near the poorest areas of major cities and could provide employment for hundreds and if not thousands of people in the running, management and distribution of the products produced in the dome complexes. The poorest communities in the areas of the Grow dome complexes could be replaced with IEV complexes allowing the employees to have safe homes and schools for their families.

Placing several grow dome multiplexes in close proximity to major cities could dramatically improve the quality and availability of fresh organic produce and decrease the cost to the consumers. All while dramatically reducing the water needed to grow the much-needed food.

Small grow Cabin:

Small grow cabins have a production rate that can support small hamlets and villages of 50 -300 people. A grow cabin is a small monolithic dome scalable to different sizes to support different sized communities.

- Easily maintained at a specific temperature
- Utilized during the entire year

- Requires minimum maintenance (i.e., cleaning and painting every few years)
- Outfitted with trays to grow food hydroponically or in soil

Other Advantages

Smaller Grow domes can be used in communities to allow the fields previously used for sustainment gardening to return to natural grazing lands or converted to raise cash crops. In a separate grow dome fish can be grown on the ground floor of the grow dome as well as fowl such as the Pharaoh Quail or Guinea fowl. The use of the ground floor for fish or fowl may require a larger dome with multiple floors but is well worth the Return on Investment.

Light necessary to grow the food can be supplied by a Light Emitting Diode (LED) system specifically tuned for plant development, or Microwave Powered Sulfur lamps (MPS) system with a complete solar spectrum in its light or fluorescents. Both LED and MPS use a fraction of the energy that traditional lighting requires. So it’s affordable and produces significantly less heat than traditional grow lights.

Figure 2 Grow Cabin

Figure 3 This Large Grow Dome can be equipped with multiple floors and produce more food than 100 acres of outdoor land while using less than 10% of the water/pound of food produced

Shelter

A June 2010 Conference of the UN Centre for Human Settlements reported that our planet now includes 100 million homeless – mostly women and children. The problem is not just homelessness. At least 600 million people, in developing nations, live in shelters that are life threatening or health threatening. Every day approximately 50,000 die as a result of poor shelter, polluted water, and inadequate sanitation. Obviously, as great as the need is for shelter, building inadequate ones is costly in terms of both human life and money. The team is defining *shelter* as permanent housing that meets basic human needs. But in some cases, shelters may be more than basic. The United Nations defines the space requirement for a family of up to eight as a dwelling with a floor area of 28 square meters. A monolithic dome with a diameter of 6 meters nets a 28-square-meter structure.

Infrastructure requirements will vary by location and population density and may include medical clinics, schools, sewage treatment, waste reclaim plants, drinking water, irrigation water, electrical systems, communication systems, transportation systems, and roads.

Figure 4 Ecoshell Village in Indonesia

To provide the most protective long-lived yet cost effective shelter the team has selected the Monolithic concrete domes in one of three variants:

- Monolithic domes
- Ecoshell I
- Ecoshell II's.

Monolithic domes are the most expensive and require the most equipment to build, but are incredibly well insulated and require 75% less heating and cooling than traditional buildings. Ecoshell I and II's are normally uninsulated but can have a limited amount of insulation added. Monolithic gazebos can be built up to 40 feet in diameter and provide excellent open air schools as well as outdoor kitchens in tropical environs. The Ecoshells are very quick to build and cost effective costing approximately less than $1,000 USD of materials to build the dome and another $2,000-3000 to finish with appliances, plumbing, and electrical hookups. This cost does not include Infrastructure costs such as power, sewer, and water connections.

Figure 5 finished Ecoshell I in Indonesia

Figure 6 Ecoshell I Gazebo outdoor Kitchen

Why chose monolithic domes? The project in Indonesia started out with a $1,000,000 budget and finished at $836,000.
63% of the total cost was in roads, parkways, sidewalks, water, sewer, electric. With 6 water wells being drilled on the property and fitted with filters and plumbed to the 6 sanitation facilities. The land was donated by the government at no cost to the project. 370 people assisted in the building of 71 homes a masjid, medical clinic, a school and 6 sanitation facilities that have toilets, bathing and laundry facilities. The average cost per dome in concrete and rebar was ~$800.00 USD Finished price per dome was under $3,000.00 USD. The equipment that was used and the air forms were left with two men in the village who have now built another 125 domes for people in Indonesia and made a successful small business for themselves.
The team knows of no other structure that can provide the floor space survivability and cost effectiveness of the concrete domes. These domes can survive hurricanes,

Typhoons, Tornados, and Earthquakes not to mention they provide higher resistance to bullets and shrapnel than any conventionally built housing.

Current estimates project that 1,000 of the 20 foot Eco Shell I domes like the ones built in Indonesia could be built for ~$10 million USD in Haiti. This price does include the building of schools, healthcare clinics, and playgrounds; but does not does not include the infrastructure cost of roads, water, sanitation/sewer and electric services.

Water:

Water is the key to the survival of mankind and their livestock. According to the Global Health Council, over 1.3 million children die annually because of water borne illness. The impact of cholera in Haiti and diarrheal diseases are directly linked to contaminated water and inadequate sanitation. Water purification can be very complex when trying to remove heavy metals and chemicals for large numbers of people in large cities. However for the developing countries that have limited or no prior water infrastructure, there are a number of options. From the simple but very effective Two bucket household systems, to solar powered desalinization systems and filter systems capable of producing tens of thousands of gallons of pure water per day.   Each location will be assessed for water availability, usage to include a ten-year forecast for growth, to include over specifying to provide support for disaster operations as needed.
Once the site is assessed the appropriate system will be deployed. Logistics is key to long-term stability in the developing nations and selections of water systems will be managed to minimize replacement and repair parts and training.

Sanitation:

Sanitation is a critical component of the health and welfare of any community. In the underdeveloped areas of the world proper toilet and bathing facilities and education are limited if they exist at all. Within the IEV, we can take one of two approaches. The first approach is each home has a toilet and sink with segregated community bathing and laundry facilities. The second approach is for each home to have a sink, toilet and bathing facilities with a community laundry facility. For toilets, the intent is to use dry composting toilets to reduce water consumption and alleviate the need for complex septic/sewer systems.

Community Power

From the equator to the Arctic Circle remote power is a complex issue. Power systems engineers must take into account the environmental effects on batteries and power generating systems and then adjust the power system based on these effects to meet the needs of the village to include a percentage for future growth and the planned system degradation of power generation over the life cycle of the power system. The RSDI team has systems and power engineering capabilities that span solar, wind, hydroelectric, geothermal, biomass, hydrocarbon and hybrid power generation system that are made up of a mix of the aforementioned systems. Agricultural villages may have the power systems augmented with bio-char power generators that provide power and fertilizer as an output of burning biomass.

One unique feature of using domes is that vertical wind generators benefit greatly from the air flow across the domes. In essence, the dome forces the air to flow upwards and accelerate due to the angle and form of the domes rise this means higher wind speed are generated at the top of the dome than the actual ground speed of the wind thus generating high power output of the generator.

The RSDI team has experience in deploying off grid power systems in remote locations with difficult logistics such as helicopter only access. Sites that require monitoring of endangered species and the very strict environmental constraints that go with working on protected lands. The team designs and builds robust power systems that require little maintenance and what maintenance is required can be accomplished with limited technical knowledge.

Power distribution will follow international and local safety standards. Power will be needed to be distributed to the school the communications equipment, the grow dome and the individual houses for lighting. The intent is to provide power to each dome so that LED lighting can be used to, prepare food, allow the students to study by, to charge cell phones, tablets, and other essential items.

Community Communications

A key resource in providing stability to remote villages is to provide good communications and to provide critical services via the communications. The community center by itself does not educate the village in how to use it nor does it provide critical knowledge this must be taught and the communication link to the village and community center is the key to this evolution. With the advancements in microwave radios the availability of up to 10GB/sec microwave links is now possible for short links, with 2GB/s link capable of reaching 20+ KMs reliably and 1 GB/Sec link capable of 100 KM links we can now link the smallest of villages and hamlets to the mainstream of education and knowledge. By using the hierarchical approach laid out in the deployment plan the team can rapidly deploy not only the villages but the communication infrastructure along with the jobs to go with the construction and maintenance of the systems.

The IEV communication concept is to provide two-way communication capable of at a minimum supporting:

- Education supports via remote learning
- Interactive adult learning E-Learning Sites for precision agriculture, irrigation instruction, trade, and job training women's literacy
- Interactive education
- Agriculture information (weather data and soil sensor data)
- Internet access
- Local threat data
- News

With the rapid advances in the internet and the cellular communication industries, it is now possible to provide Village wide Wi-Fi and Voice over Internet Protocol (VoIP) systems allowing villages to be able to communicate with others in local villages or in the world community. As part of the schools provided in the IEV computers such chrome books or tablets that will allow self-paced learning and adult learning. Optional deployment of Wi-Fi first cellular phone capability will allow the masses in the underdeveloped nations to become a true part of the global community.

Expansion of Education:
In many countries there is a lack of qualified teachers and the IEV school network will be designed to support remote teaching enabling teachers at any location on the network to teach multiple locations via video teleconferencing or WebEx type of applications. Multiple classrooms can be built to support separation of sexes or ages to facilitate learning and to meet cultural requirements.

Community Sensors:

To support the logistics and safety of the deployed communities, sensor suites capable of providing monitor, control and security of all communities' assets will be integrated into the community infrastructure. Sensor data will be uploaded to a horizontal collaboration database to provide multiple support organizations the ability to assist remote communities via electronic learning and remote troubleshooting assistance. Imagine a Ph.D. From a leading university being able to review images in near real-time and assist a remote village in diagnosing a crop or livestock issue and enabling the district or regional support teams to provide remediation.

Horizontal Collaboration Environments for Secure Data Exchange and Management

Providing a horizontal collaboration environment enables local, regional and global information exchange that can provide a better understanding on local and global issues and initiatives. From a global perspective, the Horizontal collaboration space allows authorized users to access sensor data such as health, weather and soil moisture data for use in Climate modeling and crop advisory roles. Thus, Universities, NGOs, and Governments around the world can help support the IEV via the cloud.   This means the world's health organizations can see trends in the health issues from villages to regions. This could lead to an understanding of epidemics and controls of health issues prior to regional or pandemics. Weather data can be used by a climatologist, NGOs, and government agencies. Weather data is of great value to climatologist studying climate change, but it is also of great value to all agencies responding to a natural disaster as this data can be used to plan and drive the logistics to the areas affected by the disaster. Having real-time weather data to enhance responders understanding of the environment they will be facing to include video feeds from IEV would be of great benefit to the responding agencies.   Soil sensor and weather data can use by Universities and agronomist adopting regions and having graduate students and professors reviewing and advising on when and how the crops should be managed from the application of fertilizers or pesticides to water management all stress points of the local village's crops could be reviewed and assessed remotely. This would enable the global community to know when and if aid will be needed and provide such aid early ahead of the “power curve” rather than after a failure has destabilized an area and or region.

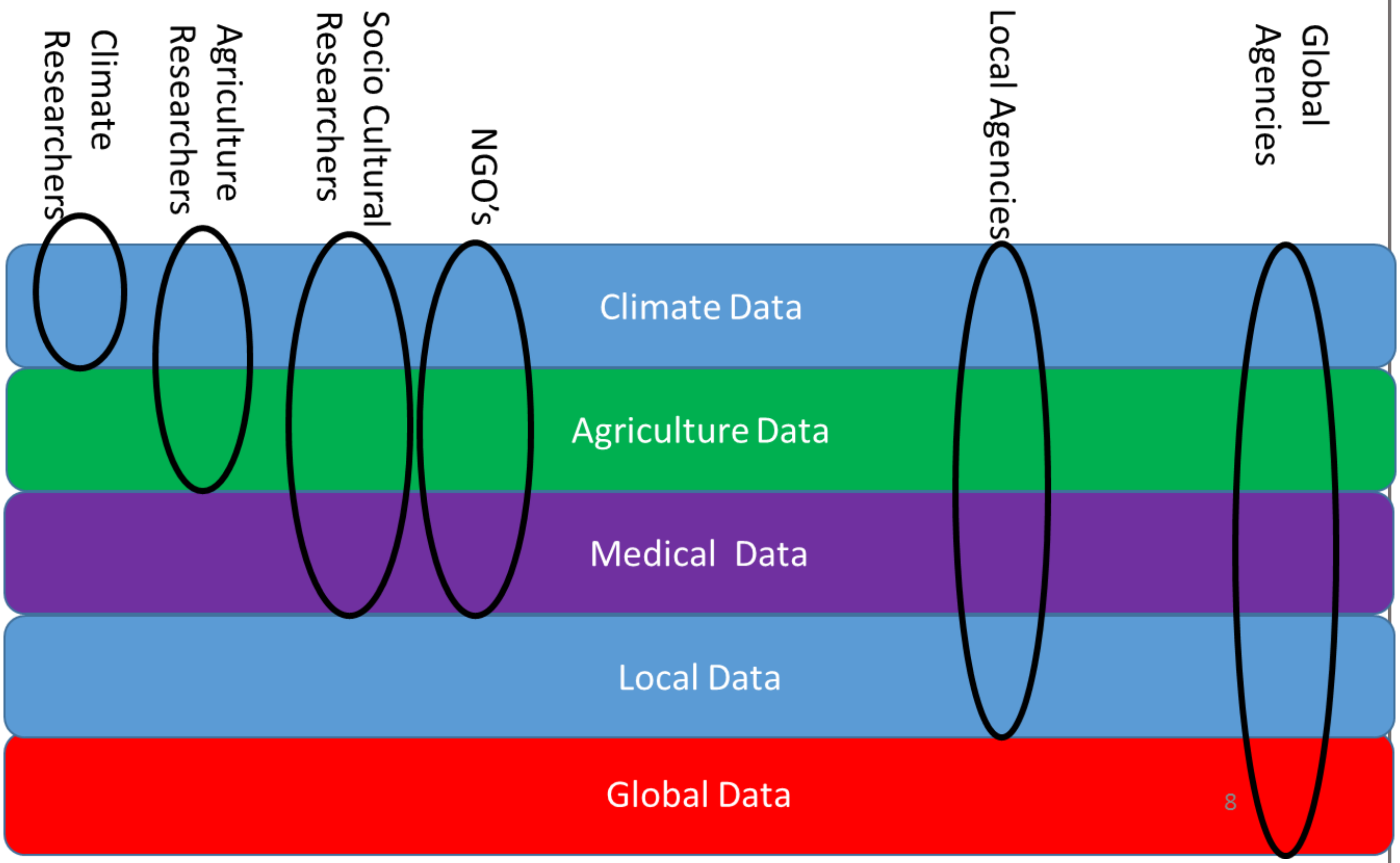

Figure 7 Horizontal Collaboration Database

Deployment Approach

To facilitate long-term stability, the deployment of the IEV must be approached in a logistically sustainable manner. The approach to deploying Instruments IEV differs from prior efforts in that a tiered approach is used. There are three types of instrumented IEV Regional centers, the district Centers, and the satellite villages. The regional center will be a large complex to include a hospital and all of the support and training facilities necessary to maintain and manage all of the district centers and satellite villages within the region. In most Cases the Regional center will be the home of the PEAK+ trailers however in locations where the terrain and or the limited road systems the PEAK+ trailers may be strategically distributed across the district centers.

The District Center will be strategically sited to facilitate logistics support to the Satellite villages. This allows for the district Centers to be used as the base of operations for medical teams working the region to have a base with high bandwidth communications to use for reach back referrals or for live telemedicine events. The District Center would also have living quarters for the medical teams to use as well as full pharmacy capabilities. The district Centers will be equipped with a garage to house the prime movers to get medical, educational and agricultural teams to and from the satellite villages as well as to pull PEAK+ trailers if the District Center is PEAK + Equipped. The intent is to have District Centers directly connected to wired communications infrastructure or capable of the link into wire infrastructure via high capacity microwave links. The District Centers would then provide communications infrastructure to the Satellite villages via terrestrial links saving satellite communications for only those site that cannot be supported via terrestrial means. Further delineation of the deployment hierarchy is shown in appendix A.

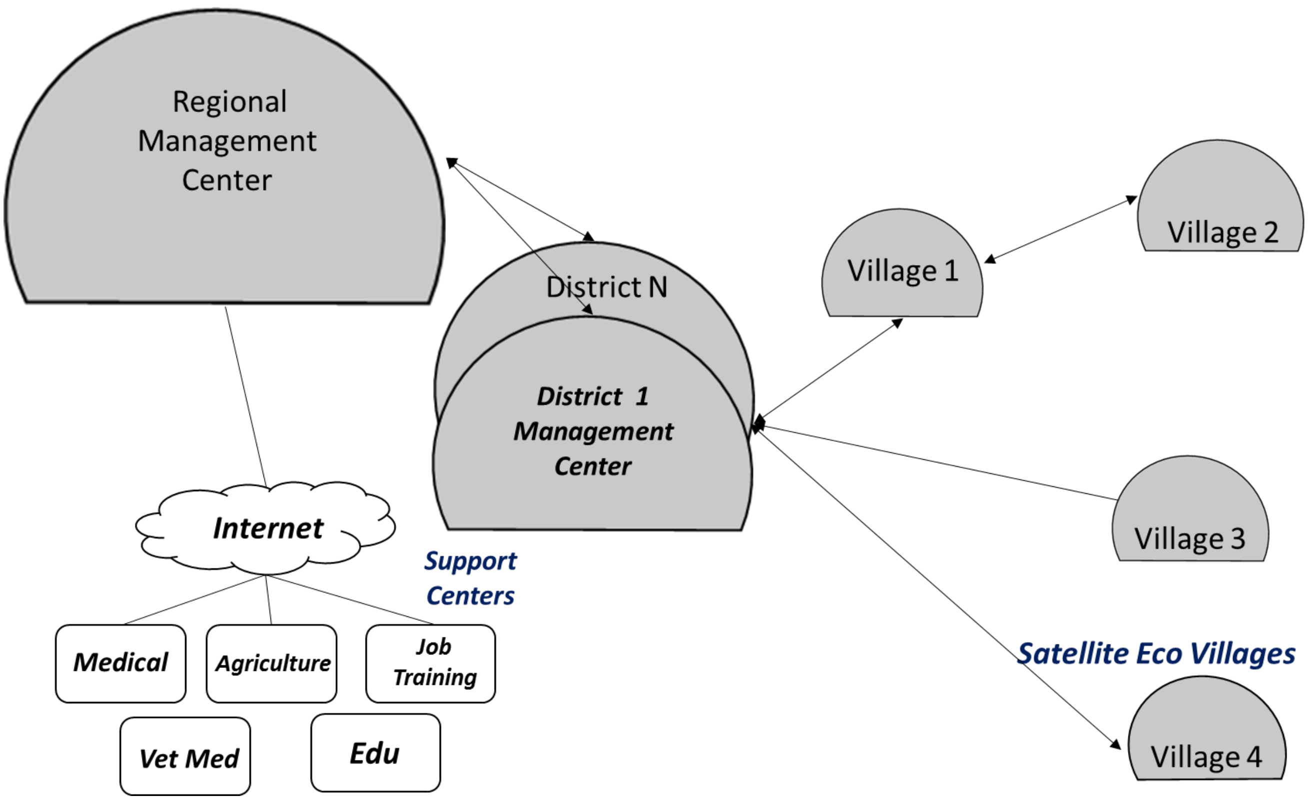

Figure 8IEV Communications Connectivity

Conclusion:

According to the World Bank: *More than a billion people worldwide still live in extreme poverty, and many more experience hunger and are vulnerable to environmental or price shocks. Undernutrition remains one of the world's most serious but least addressed public health challenges. Nearly one-third of children in developing countries are underweight or stunted (low height for age), and undernutrition contributes to one-third of all child deaths.*

IEV deployments provide a real lasting solution. However, we are in a race against global climate change and growing world populations requiring more food and using more water. To meet the needs of today and to fulfill the obligations to our future we must act now and begin fielding IEVs with grow domes to provide high yields of food while using 90% less water than conventional farming. IEV grow domes can produce fresh organic produce in less than two months from startup allowing food aid to rapidly be diminished and even ended in months from the establishment of the IEV. A properly integrated IEV deployment provides education and training enabling sustainable food and water security to all communities and enables people in extreme poverty to rise up and become members of the global economy.

Path Forward

The IEV concept outlined can be quickly realized. RSDI suggest an Indefinite Delivery Indefinite Quantity (IDIQ) contract approach be used to fund this effort as it allows the most flexibility to define the deliverables for each deployment. The initial contract would be a short duration requirements definition effort that may include a site survey of the first deployment site to enable accurate estimates of the cost to build. Then the team would develop proposals to the task orders, schedule deployments and begin building IEVs.

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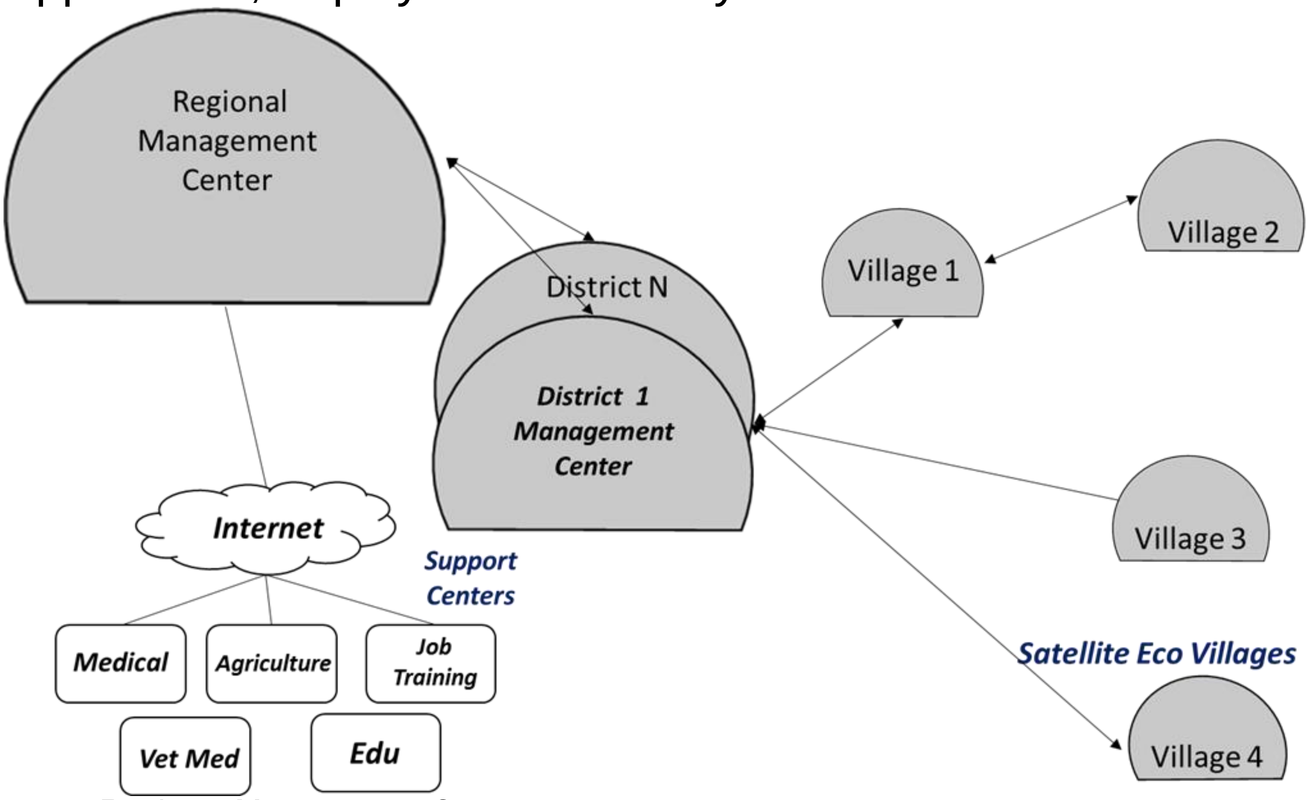
Appendix A, Deployment hierarchy:



- Regional Management Center
  - Strategically sited For Communications to Districts
  - Large hospital and education facility
    - May include support village and infrastructure for staff
    - Optional garage for PEAK +trailers and prime movers supporting staff travels to districts
  - Microwave links to District/Satellite villages Includes tower
  - High bandwidth connection to The internet
  - Large grow Dome facilities sized for 1.5x local population
    - Provide education on maintaining and running grow domes
    - Maintains traveling staff to manage the regions IEVs
  - E-learning capacities for Classrooms supporting
    - K-12 Education
    - Adult education
    - Health and sanitation
    - Agriculture
    - Vocational training
  - Large Scale Sanitation facilities
    - Water purification
    - Toilet/shower

- District Center
  - Large Healthcare clinic with full-time staff and education facility
    - May include support village and infrastructure for staff
    - Optional garage for prime movers supporting staff travels to satellite villages
  - Microwave links to Regional and Satellite villages Includes tower
  - High bandwidth connection to The internet
  - Intermediate grow Dome facilities sized for 1.5 x expected local population
    - Provide education on maintaining and running grow domes
    - Maintains traveling staff to maintain all IEV in the district
  - Schools with E-learning capacities for Classrooms supporting
    - K-12 Education
    - Adult education
    - Health and sanitation
    - Agriculture
    - Vocational training
  - Large Scale Sanitation facilities
    - Water purification
    - Toilet/shower
- Satellite villages
  - Basic medical clinic for visiting medical teams with Telemedicine capabilities
  - basic grow Dome facilities sized for 1.5 x expected population
  - School
    - E-learning capacities/ Classrooms supporting
    - K-12 Education
    - Adult education
    - Health and sanitation
    - Agriculture
    - Vocational training
  - Sanitation facilities
    - Water purification
    - Toilet/shower

- Eco-Hamlet
  - Basic grow Dome facilities sized for expected population
  - School/medical clinic for visiting medical teams with Telemedicine capabilities
    - E-learning capacities/ Classrooms supporting
    - K-12 Education
    - Adult education
    - Health and sanitation
    - Agriculture
    - Vocational training
  - Sanitation facilities
    - Water purification
    - Toilet/shower

Appendix B Shelters:

The Monolithic dome: Monolithic Domes can be designed to fit any architectural need: homes, cabins, churches, schools, gymnasiums, arenas and stadiums, bulk storages, and grow domes.

Monolithic Domes meet FEMA standards for providing *near-absolute protection* and have a proven ability to survive tornadoes, hurricanes, earthquakes, most manmade disasters, fire, termites, and rot. They are cost-efficient, earth-friendly, extremely durable and easily maintained. Most importantly, a Monolithic Dome uses about 50% less concrete and requires approximately 50% energy for heating and cooling than a same-size, conventionally constructed building. Monolithic domes can be built to sizes larger than 300 foot in diameter.

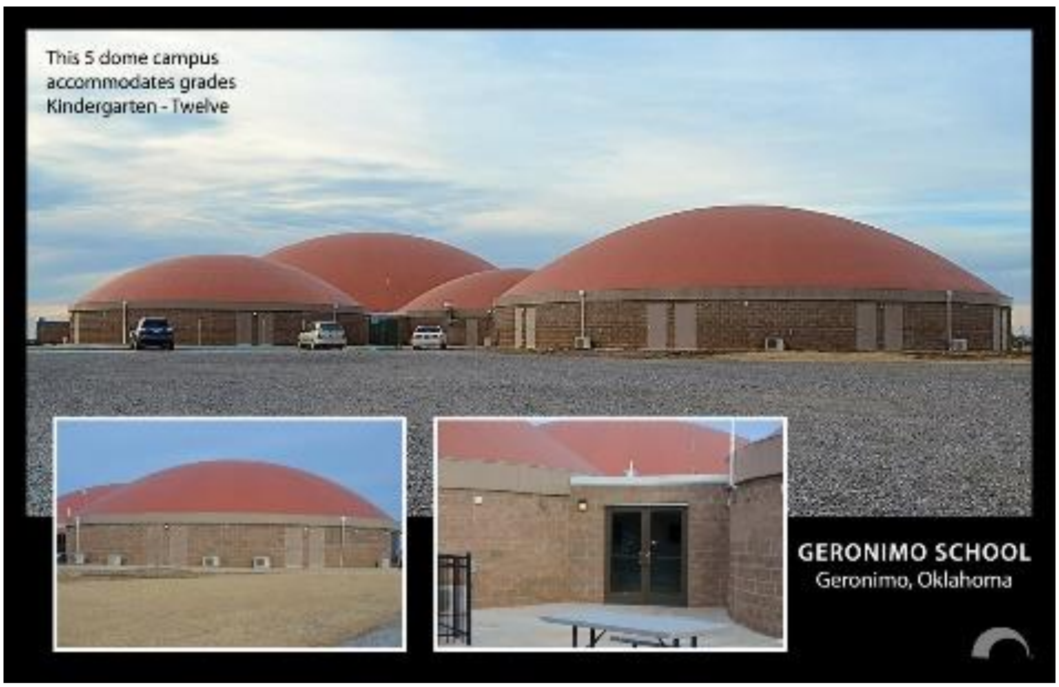


Figure 9 School Complex in Geronimo Oklahoma

Figure 10 Island Resort in the Caribbean note the roof added for aesthetics only

Figure 11 Domes can be designed in many shapes

Eco Shells:

The Eco Shells work as practical housing only in equatorial climates where the temperature fluctuates from very hot to hot. In less developed countries where cheap, permanent structures are greatly needed, EcoShells often can fill the bill.

The Eco Shell I: An EcoShell I is a concrete, thin shell dome whose construction process includes a relatively new technique called Airforming. This technique uses an Airform that's made of a high-strength, high-tech fabric. When inflated, the Airform, looking like a semi-rigid balloon, creates the EcoShell's dome shape. The Airform used in the construction of an EcoShell I is removable and reusable. With proper care, it can be used 100 or more times, and that feature significantly lessens construction costs for projects involving more than one structure. For an EcoShell I, concrete is layered onto the exterior of the inflated Airform. Usually, the shell is not insulated, but can be if required. Construction of an Ecoshell I is dependent on weather conditions as the concrete is exposed during construction. Size limited to ~40-foot diameter domes

The Eco shell II: Like an EcoShell I, an EcoShell II is a concrete, thin shell dome whose construction process includes Airforming. For an EcoShell II, concrete is layered onto the interior of the inflated Airform. The shell is not usually insulated, but can be by adding polystyrene beads, vermiculite or perlite into some of the concrete as it is applied. This insulation and the thermal mass of the concrete does provide some thermal protection. The EcoShell II construction is not affected by weather conditions. Size limited to ~40 diameter domes

Eco Shell I gazebo: In most tropical countries where there is a hot climate the people have learned to cook outside to keep the heat out the house. For these location the Gazebo dome can be provided as an outdoor kitchen and dining area.

Appendix C: Community Instrumentation

Weather Instrumentation

Deployment of weather stations as a part of the village instrumentation package provides much-needed data for many possible subscribers. High-resolution weather data including:

- Wind direction
- Wind speed/gusts
- Altimeter setting
- Temperature/Dew point
- Relative Humidity
- Density altitude
- Solar radiation
- Latitude & Longitude

The high-resolution weather data could serve multiple consumers to include: Regional governments, Climatologist worldwide, military planners, NGO's, Medical evacuation operators, Transportation industries, and military airlift operations in near real-time.
This Weather data would be uploaded via the IEV communications infrastructure to the cloud and directly into the horizontal collaboration space for use by all user communities. Imagine the impact of real live weather data from around the world on the study and monitoring of climate and the associated environment impacts.

Wireless Crop/Soil Sensors

Crop production is the heart of villages around the world. Crop failures destroy villages and cost millions in aid each year to sustain and relive villages in attempts to prevent infiltration and recruitment of villagers and whole villages into terrorist groups and their networks. A Key component of the IEV concept is a fully-automated network for 'around-the- clock' monitoring of soil moisture, Temperature, and salinity levels. This network includes high-resolution probes with 6, 9 or 12 sensors evenly spaced to a depth of 2, 3 or 4 feet below ground level. Moisture readings from all sensors are automatically collected at user-configurable rates and stored in a secure database server with password-protected access. From the authorized user's web browser, graphs can be viewed over the entire growing season for each probe and sensor clearly indicating crop water uptake and root development at all sensor depths, clearly indicating when irrigation is needed. This not only saves cost but significantly improves yield potential.

Security Sensors

Each village faces any number of potential threats to the safety of the people and village infrastructure. With the addition of the Grow domes and the solar power and communications groups looking to destabilize or to acquire some of the capabilities may resort to sabotage and or theft or vandalism of the assets. A number of security sensors are available to support village security and these sensors can be remotely recorded and managed to allow district or regional authorities to identify and prosecute the offenders.

Sensors that can be deployed as a part of the IEV system are too numerous to account for in this paper, but this a brief list of core capabilities to be considered:

Area surveillance packages that could include:

- Cellular nodes with intelligence gathering capabilities to include target phone tracking intercept and recording
- High-Resolution Short-Range Ground Surveillance Radar with Slew to Cue camera control software
    - SR-200 radar is a low-cost automated perimeter defense radar for encampments, installations, and critical infrastructure sites. The SR200 radar supports multiple autonomous sensor installations, where each sensor wirelessly communicates with the control center and has an independent solar power supply. The novel system eliminates the need for power and communication cabling infrastructure and offers the best quality system for significantly lower costs
    - SR-200 radar is a high resolution, state of the art, digital beam forming radar which autonomously monitors detects and alerts on moving or stationary objects in the defended perimeter. A PC located in a central control room controls the entire surveillance system. Due to its extremely low power consumption, SR-200 radar is powered solely by its integrated solar panel and backup battery. SR-200 radar is equipped with wireless communications, enabling quick and seamless installation without any power or communication cabling infrastructure. SR-200 radar can be combined with a day & night electro-optical sensor enabling automatic targeting and identification of radar detections.

- Day/night or thermal Cameras
- Depending on export restrictions for each site a suite of Day/Night and thermal cameras will be acquired from commercial sources and placed in ruggedized housings for deployment as needed. Bulletproof housings can be provided for most cameras to protect from up to 7.62x51 NATO or up to .50 Cal if required.
- Unmanned Ground Sensors (UGS)
- A number of seismic sensors are now available for perimeter security for commercial enterprises and with the proliferation of these sensors the team will determine the best option for each site that requires UGS.
- Other sensors as available or required
- Other sensor types from UAS to MASINT can be specified as required dependent on the threat environment.

Appendix D PEAK+

Disaster Relief Operations and PEAK+ Deployment

The District Center compound will serve a dual use function for disaster recovery. The larger health care center of the district Center would be the medical base of operation during disaster relief operations and the education center will be transformed into the command and control facility for the relief efforts. The garage for the PEAK + trailers and prime movers would become a medical aid area with environmental controls or a rest area for the works operating the centers expanded capabilities. The Communication infrastructure of the District Center includes a communication tower with fixed microwave links to satellite villages and an ad hoc microwave capability to link to PEAK+ trailer deployed within the District Center of operations. The larger water purification capabilities of the District Center would be used to augment the PEAK + water purification capabilities as needed.

PEAK + Trailer

The out brief of the PEAK program stated that improvements in mobility and situational awareness were needed. The PEAK+ was developed as a modular approach to the system allowing the PEAK+ trailers to be set up as a group supporting a wide area of operations or as individual trailers depending on the location the trailer will be deployed. The team selected a COTS trailer that is C-130 certified for rapid redeployment as needed. The trailer has a 106-foot power erected mast intrinsic to it design providing a great improvement over the existing 40 foot personal erected mast. In past programs, this type of trailer was able to be brought to full operation in less than 15 minutes on parking the trailer. The trailer would be powered by a hybrid solar power and DC generator system that minimizes generator run time thereby reducing the logistics support required. The trailer can support a UHF-based situational awareness systems that can track up to 2000 entities in the network or a cellular capability that will be either a private network or could support interfacing to public cellular networks if required. The major difference is data rates and range. The UHF situational awareness radio system can track entities up to 25 KM in optimum terrain whereas the 4G LTE system would be limited to a range of 7KM or less. A hybrid system can be designed and integrated depending on requirements.

Inter trailer communications and backhaul communication for the PEAK+ will be facilitated either by terrestrial microwave or satellite communications. Each trailer will have an Ad Hoc microwave capability that will allow it to talk to any Instrumented eco-village in its area of operations or to any other PEAK+ trailer allowing multiple trailers to be deployed in any number of patterns as long as they have a line of sight to another trailer or to an instrumented eco-village. If no instrumented eco-villages are within line of sight of the microwave any of the PEAK+ trailers can use satellite communications for backhaul individually or one could aggregate for the deployment group depending on bandwidth requirements.

Figure 12 PEAK + Trailer with 109-foot tower

The PEAK+ trailer concept is based on modularity for water purification to enable the trailer to be configured for salt water or fresh water purification on a small and large scale (i.e., 700 to over 17,000 gallons of water per day). The water purification capabilities would be demountable once the PEAK + trailer is positioned for operation the water purifications systems would be redeployed to the optimum locations by the PEAK prime movers. Depending on the requirements for the planned deployment area the trailers could be equipped with multiple water purification system each.

Optional sensors for the PEAK+ are electric Unmanned Air Systems (UAS) to support Search and rescue operations after a disaster. The team recommends electric UAS platforms so that there is no logistics tail beyond charging of batteries which the Trailers power system can support. These UAS can support a number of sensor suites from thermal imaging to day-night imaging and mid-range infrared imaging to support pipeline leak detection operations after earthquakes.

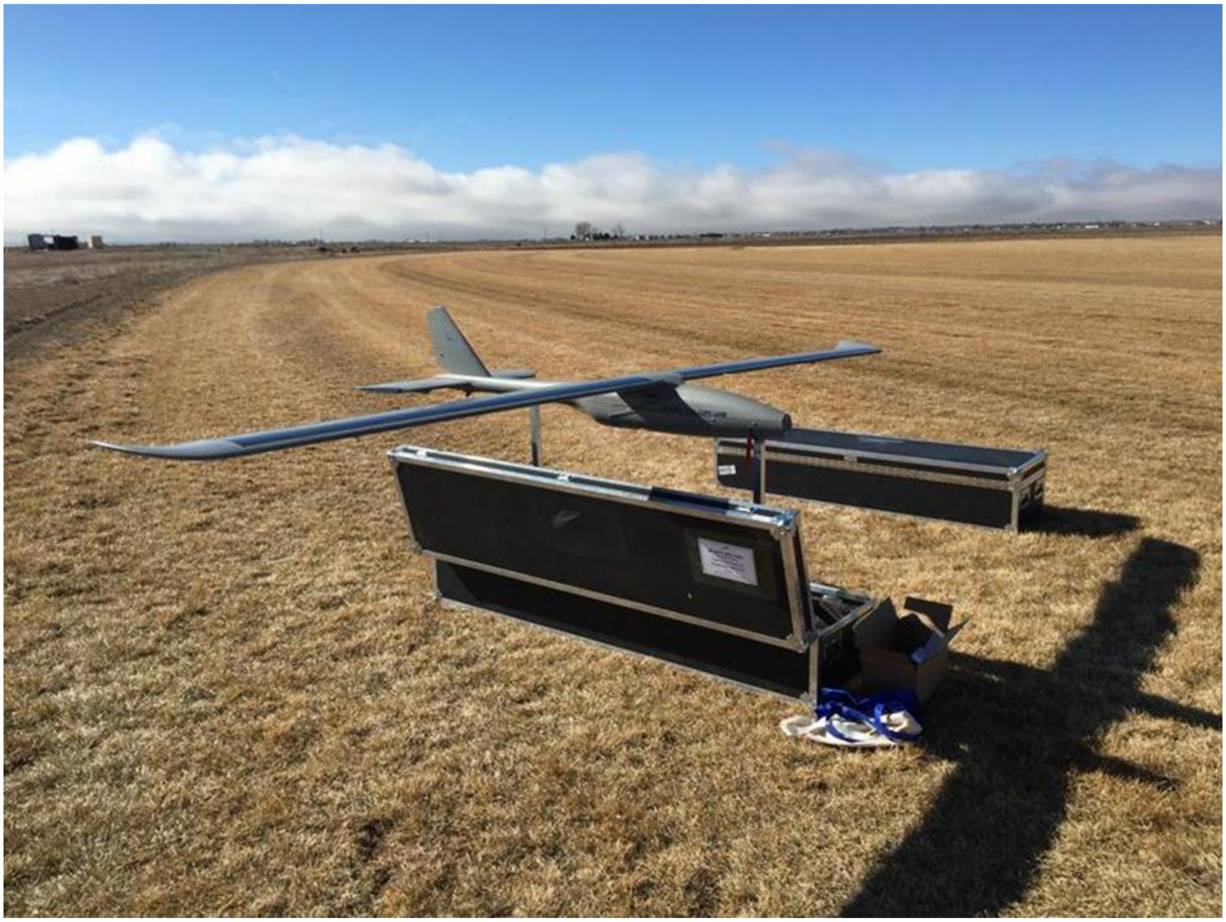


Figure 13 Silent Falcon all electric UAS