Proposal

Call Identifier: FP7-ENERGY-2008-TREN-1

Title: PV Solar Pseudo-Satellite High Power System for Renewable Electricity Generation by Microwave-Beaming Transmission

Acronym: PV MICROBEAMING

Work Program: Energy-2008-2:RENEWABLE ELECTRICITY GENERATION 2.1 PHOTOVOLTAICS

Sub-Work Programme: Energy-2008-2.1.3 Multiple benefits of PV systems

Type of funding scheme: Collaborative Project (Small or medium-scale focused research project)

Name of the coordinating person:
Prof. Dr. Arie Lavie
arlavie@zahav.net.il
CTI- Creative Technologies Israel
tel: 972-2-6452086; fax: 972-2-6452489

List of Participants:

Participant no	Participant Organization name	Country
1.CTI	Creative Technologies Israel Ltd.	Israel
2.ENSC	Ecole Normale Superieure de Cachan	France
3.INTEGRAS	INTEGRASYS S.A.	Spain
4.CeNTI	Centre for Nanotechnology & Smart Materials	Portugal
5.STRATXX	STRATXX Holding AG	Switzerland
6.SAFT	SAFT Industrial Batteries Group	France
7.DLR	Deutsches Zentrum furLuft und Raumfahrt eV	Germany
8.IE	Intelligent Energy Ltd	UK
9.RosAero	RosAeroSystems International Ltd.	Russia
10.		

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B1:Scientific and/or technical quality, relevant to the topics addressed by the call

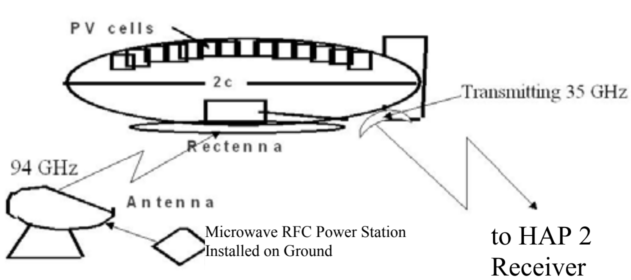
B1.1: Concept and Objectives

Concept

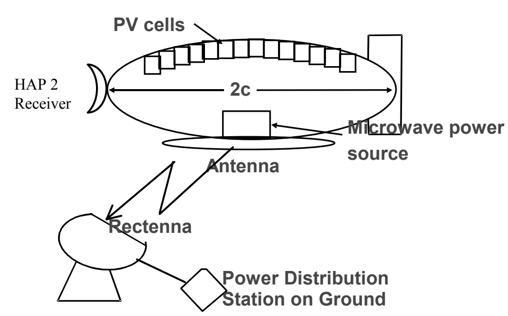
This Collaborative Project tends to provide major scientific breakthrough for high risky/high impact long term emerging idea of research aiming to determine the feasibility terms and conditions for new technology field of an efficient wireless transmission of improved PV alternative energies by high power Microwave-Beaming (MICROBEAMING) technology, from the level of today state-of-the-art of few Watts to the level of Mega Watts in the future. Applications of high power transmission could be in the field of generating alternative energies, for instance, in an optimal improved way at specific sites (Solar/Sun energy, Hydrogen energy, Wind energy, etc.) to power plant allocated at long distances. Such applications would provide better exploitation of improved alternative energies and impose societal economic impact. Today only a small fraction of Solar/Alternative improved energy sources are exploited due to lack of useful wireless power transmission from the site where energy could be optimally generated to the specific users and customers. Other uses of high power MICROBEAMING technology are in power transmissions to charge energy accumulating devices placed in remote areas or at long distances.

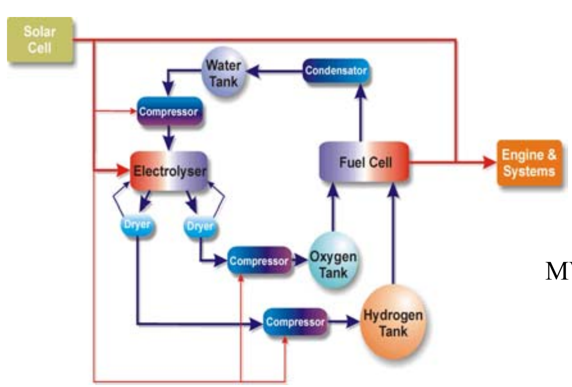
In this proposal the concept of microwave beaming transmission of high power generated by improved ground regenerative fuel cell energy station to HAP1 (High Altitude Platform1), and then to a very long distance hovering HAP2 (High Altitude Platform2 at thousands of kms from HAP1), and then to ground power distribution station to various customers, is investigated. In the following figures an illustrative description of the concept is presented.

HAP 1 Schematic



HAP 2 Schematic





MW RFC Power Station

However it should be emphasized that this is only one possible concept, and other concepts can also be developed when the project is completed regarding the wireless transmission of improved alternative energies

MICROBEAMING would also provide potential impacts to: 1) Security and Citizen Protection Services providing ability to defeat suspected objects; 2) Improving Security of Information and Telecom transmission in the range of 35 GHz - 94 GHz; 3) MICROBEAMING technology will enhance significantly the state-of-the-art in antennas/RECTENNAS development.

Recently, research works conducted in New York Institute of Technology (Final report Nr 993/41349-01 December 2006) in co-operation with Japanese Research Institute show significant progress in the development of "High Power Microwave-Beaming Technology" including new high power source in the GHz range and new transmit antennas design. In this CP a scientific challenge justification will be given for long term MICROBEAMING research of foundational nature based on laboratory experiments and on preliminary field-tests of Test-Bench operating at 94 GHz frequency and transmitting 20W/20KW power to measure an overall transmit/absorbed energy significantly improved efficiency to an order of 25%-30%. <u>The tests to be conducted here will be done for the first time worldwide</u> and will approve the feasibility and effectiveness of the MICROBEAMING technology in the new field of wireless point-to-point power transmission of improved alternative energies generated in an optimal way.

Recently work has been directed to characterize efficient radiation sources, such as free-electron lasers and masers operating in the millimeter wavelengths for radiative power beaming to UAVs (Unmanned Air Vehicles).A space frequency model was also developed to calculate atmospheric transmission as a function of weather conditions and heights, a model which will be used in this project. References:

1) Y.Pinhassi, I.M. Zakover, A.Eichenbaum, A.Gover: Efficient electrostatic-accelerators free-electron masers for athmospheric power beaming", The 6th special issue on high power microwave generation on the IEEE Transactions on Plasma Sciences, Vol. 24, (1996) 1050-1057
2) Y.Pinhassi, A.Yahalom, O.Harpaz, G. Vilner: " Study of ultra wideband transmission in the extremely high frequency (EHF) band", IEEE Trans. On Antennas and Propagation, 52 (2004), 2833-2842

Objectives

The objectives of the proposed concept to be investigated are:

a) To explore the feasibility of increasing the use of "Renewable Electricity Generation" by implementing the proposed concept explained above, and
b) To explore the feasibility of developing a new "Smart Energy Network" by implementing the above explained concept

We expect to get from this project:

- Feasibility approval for this high risk/high impact technology
- Feasibility approval that applications in different technological sectors can be implemented
- Feasibility approval that highly ambitious and challenging objectives of the project are tangible

The MICROBEAMING Foundational Research Challenge

Based on previous research on military applications, a scope of work, budget and preliminary schedule is presented in this project for an experimental assessment of the possibility of using electromagnetic (EM) beamed power for wireless efficient power transmission applications of alternative energies for civilian needs, but also for security need to defeat objects of threat that are located at large distance from the emitter/transmitter antenna. Such system could basically be researched to impair transfer of power to be absorbed at the receiver/RECTENNA and used by an absorbing device as self generated energy, but to not permanently harm human beings, and that are classified as non-lethal wireless transmission (NLWT) devices.

The use of focused electromagnetic beams for the efficient, wireless transmission of energy from one point to another is an important area of fundamental research challenge aiming to solve hard problems beyond the present state-of-the-art technology in the sector. The frequency of operation for such systems (including development of power source for given frequency and development of efficient antenna/RECTENNA array) is a crucial research choice:

1. In order to avoid the effects of atmospheric attenuation, frequencies below approximately 6 GHz must be used. For example, at the ISM frequencies 2.45 GHz, the atmosphere is practically transparent even under conditions of high humidity and rain. However at this frequency, the dimensions for the required transmit and receive antennas would be in the range of 50 meters. Antennas dimensions as such would be prohibitively expensive if constructed as continuous rigid structure. It is proposed to research the use of arrays of non-uniformly spaced, relatively small antenna elements to achieve the required electromagnetic focusing, refs. [3, 4]. Such antenna arrays would be lighter, mobile and far less expensive to build than a single large, continuous, rigid antenna structure.

2. At altitudes above the earth’s atmosphere, and beyond to outer Space, electromagnetic frequencies of 10 GHz and higher can propagate without experiencing atmospheric absorption. Also, for short distances of 1 to 2 km or less, the effects of atmospheric absorption are not excessive. For example, at 94 GHz, the attenuation through dry air for a distance of 1 km is approximately 0.1 dB. (The attenuation at this frequency would increase sharply under conditions of high humidity and rain.) The diameter and weight of antenna structures required for efficient beam focusing is inversely proportional to the frequency of operation. At 94 GHZ a transmit antenna diameter of 2.5 m would have electromagnetic focusing properties equivalent to that of a transmit antenna diameter of 100 m at 2.5 GHz. At frequencies in the range of 94 GHz, called the millimeter range, the development of a rectenna, the integrated receive antenna, and power rectification system presents a very difficult challenge. The rectenna must provide efficient conversion of the incident high frequency electromagnetic energy to a usable DC power source. Efficient rectenna performance has been achieved at microwave frequencies (e.g. 2.45 GHz) but not yet in the high millimeter range (e.g. 94 GHz). It is proposed to research the use of specialized array synthesis algorithm, ref.(a, b),to achieve efficiently performing rectenna at 94 GHz. References:

3) S. Blank,“An Algorithm for the Empirical Optimization of Antenna Arrays”, IEEE Trans. AP, vol. AP-31, No. 4, pp.685-689, July 1999.

4) S.J. Blank and M.F. Hutt, “On the Empirical Optimization of Antenna Arrays”, IEEE Antennas & Propagation Magazine, April, 2005.

The implementation of this concept is relevant to generation of alternative energies in sites where power transmission is needed and to be efficient, and to being actively pursued by numerous research agencies throughout the world. Various nomenclatures have been assigned to this concept depending on the various configurations proposed for research and its implementation.

In many cases, the terms microwaves are used interchangeably with the term EM waves. Three important factors to be characterized in these research systems:
a) Their power levels,
b) The spectrum of frequencies used and
c) The waveform time dependence of the emissions.
With respect to power, levels < 2 kW are generally classified as low power electromagnetics (LPEM) with levels up to tens of megawatts (MW) designated as high power electromagnetics (HPEM). The spectrum emitted can range from single frequency operations, all the way to ultra wide band (UWB) operations in which energy is emitted with a spectrum ranging from hundreds of MHz to 4-5 GHz (see ref. B above). The goals of this project in general will be:
a) Analyze NLWT technologies in accord with the definition of mission requirements.
b) Develop specialized simulation software for NLWT computer experimentation and performance evaluation.
c) Research, develop and construct an experimental proof-of-concept NLWT system.

With respect to goal a, our effort will focus on the various levels of system output to assure that the system researched will meet the requirements of the mission. With regard to goal b, a NLWT simulation software will be based on development of specialized EM computational software packages. With regard to the main implementation goal c, it is proposed to research full -scale system operating at 94GHz/20kW (average)-100kW (peak) starting with a scaled experiment at 94GHz/20W that will be used to evaluate key parameters of the full-sized system, to achieve an overall transmitted/absorbed power efficiency of 25%-30% with compare to hardly acceptable few percent efficiency of the today state-of-the-art technology. The research will be based on novel approach by utilizing laboratory developed components of power source and the emitter/receiver in order to achieve required performance and efficiency at minimum project cost

The concept for such test arises from the need to assess feasibility of using micro-wave beaming system to wireless power transmission of alternative energy. To do so one of the key metrics is to measure the power density at the receiving antenna, rectenna instrumented to determine, among other variables, both the average and peak power densities. Preliminary estimates indicate that for the full scale 20KW beamed power case, with the target allocated at about 200m from beaming source, the values are approximately 100KW/m^2 (average) and 500KW/m^2 (peak). Scaling the beamed power to 20W (which is the case in this project) indicates that in the proposed test we may see about 50W/m2 (5mW/cm2).

B1.2 Progress beyond the state of the art

Alternative Energy Power Transmission: ground to HAP – High Altitude Platform
As an example of prospective scientific challenging application of MICROBEAMING is the following high power MICROBEAMING transmission ground to high altitude (10-20 km) long endurance (month) aircraft or airship propelled during day time by using absorbed sun light power and during night time by using MICROBEAMING received power. Such HAP-High Altitude Platform (see following scheme) hovering at altitude of 10-20 km above clouds and

performing the following functions:

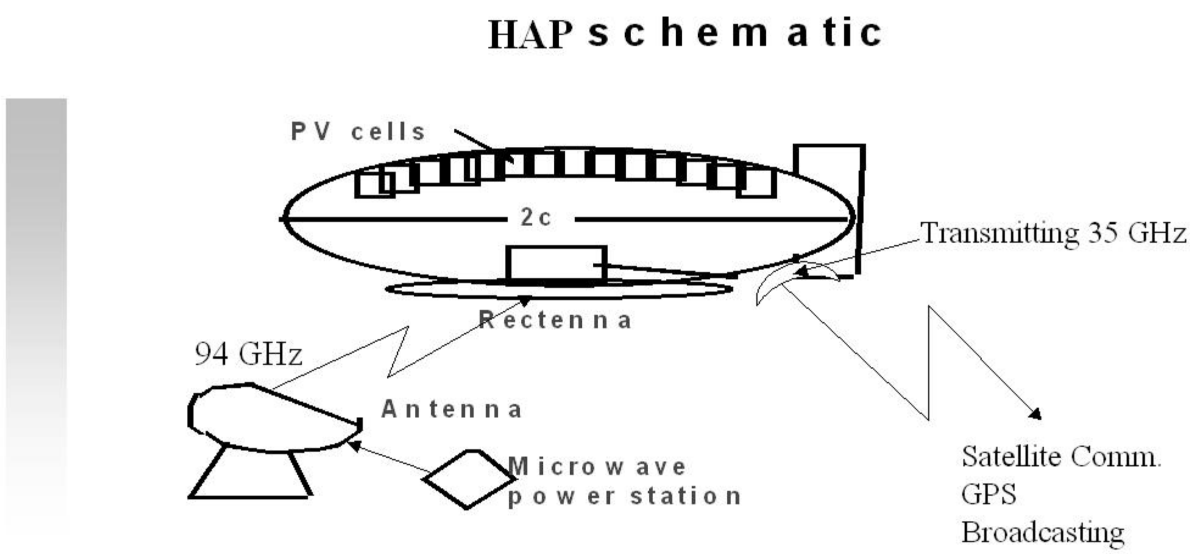
a) Absorbing directly during day a concentrated Sun Light Power by efficient photovoltaic cells.

b) Absorbing during night power transmitted from ground by highly efficient RFC (regenerative fuel cell) through microwave beaming system allowing the extremely narrow beam to penetrate clouds and foggy atmosphere at certain frequencies, to the rectenna of the HAP.

At the present state-of-the-art, the proposed research project will concentrate on the specifications required for the efficient microwave-beaming transmission of absorbed energy (see following scheme). Preliminary feasibility work on MICROBEAMING carried out so far suggest that if a specially designed ground antenna of 50 m in diameter attached to 1 MW MICROBEAMING power source then the absorbed power by the rectenna Pr having diameter Dr and absorbed power density Sr at frequencies f will (without atmospheric attenuation) be as follows:

f(GHz)	Dr(m)	Sr(W/m2)	Pr(KW)
2.45	147.0	17	288.4
5.80	62.1	95	287.6
35.0	10.3	3,435	286.1
94.0	2.5		285.6

The smaller antenna would have advantages that might outweigh atmospheric losses. Such important figures will be covered in this CP project and tested at 94 GHz by a Test-Bench site as described later in the work plan.



The proposed project supports an extremely exciting and pioneering research to deal with the "hard" problem of high power MICROBEAMING transmission of alternative energies.

Applications of solar power and solar energy generation

a) Photovoltaic system – Solar energy generation

Solar cells that are resistant to environment at those altitudes, that are thin, flexible and light and can be easily fixed to the surface of the aircraft wingspan. Of course these solar cells must be coupled with another power system for night operations; this could be with fuel cells or batteries. The traditional solar cell is a single crystal semi-conductor deposited onto glass, which is efficient but heavy and expensive. Newer technology that would be applied for aircraft is an amorphous silicone cell deposited onto a polyimide film, resulting in a very thin film (800 Angstrom) and at much lower price for about the same efficiency. This is also a very flexible cell.

At 22 km altitude, the solar power is over 1 kW/m². With a 8% efficiency for the solar array, that is translated into 80 W electricity per m². For an airship with total surface that could reach 25-30.000 m², only a small percentage of the surface needs to be covered with solar cells as the required daytime required power should be something like 400 kW (of which 15 for the payload). For aircraft applications a different consideration should be assumed as explained later.

The lenticular shape offers for the solar cells some advantages. Even if using solar energy as the primary source of power is accepted as a reasonable approach,several aspects have to be kept in mind looking in some more level of detail. First of all, the different basic technologies for solar cells shall be discussed. They are also summarised in Table 1.

b) Crystalline Solar Cells

The most common solar cell type is the crystalline type. Also here different sub-types are existent. A cheap and therefore very often used type is the polycrystalline silicone type. Available efficiencies are up to 17% and they are in mass production (although there these high efficiencies are not reached). The next type is the monocrystalline silicone type, which is slightly more expensive, but higher efficiencies of up to 24% could be reached. For space applications, where power/weight ratio is extremely important, Ga-As cells are used. These have once more higher efficiencies of 25% and more, but they are extreme expensive, about 10 times more than polycrystalline silicone. An advantage is that they have a lower temperature-dependency of efficiency than the silicone cells. This could be of advantage if thermal balancing is a problem.

All these types have the disadvantage that they have to be sawed out of a block of the base material and will then be modified in a defined way before they work as solar cells. Only the upper microns are really working actively on the solar power – electric power conversion process, but the thinner the individual cells are sawed, the more of them are lost during production due to the brittleness of the material. This explains also why thinner (and lighter) cells are far more expensive. A thickness of down to 250 microns are possible (for special applications also 150µm have been achieved), but for the size of an HALE airship generator, thicker cells would have to be expected if the generator should be built in an acceptable time scale and a reasonable price.

c) Thin Film Solar Cells

The solar cell type which has been produced in the largest amount is the amorphous silicone type. This is used for a large amount of solar powered calculators, watches and other small consumer electronics. The main disadvantages of this type is that it has only poor efficiency (about 8% max.) and also a degradation problem: the efficiency is going down over time due to the solar radiation. The low efficiency is compensated by the approach using multi-gap cells. Here, layers of different wavelength sensitivity are combined. These cells are not available on a commercial scale. The same problem occurs with Chalkopyrit cells, e.g. cells which use different substrates instead of silicone such as $CuInSe_2$, $CuGaSe_2$, and CuInS2. These types promise higher efficiencies and have not the problem of degradation, but serious research is required before they are available for commercial applications with acceptable efficiency.

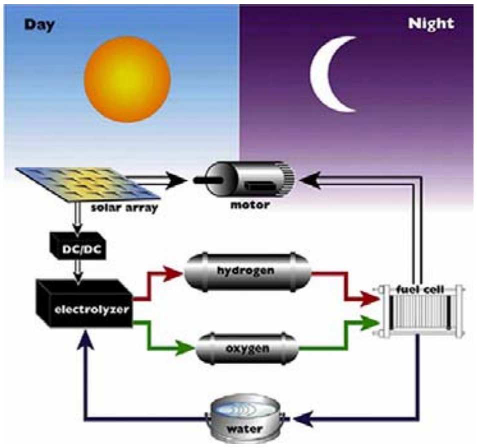
The main disadvantage of all these thin film cells is that up to now they are put on top of a heavy glass plate. This is no problem for terrestrial applications, but would cause a problem for integrating them into an airship envelope and reduces the power/ weight ratio seriously. Research efforts are under way to use plastic films as the base layer or metallic foils which then have to be isolated before they can be used.

Type	Efficiency **[%]**	Price	Commercial Available
crystalline			
Ga-As	25	10	Yes
monocrystalline Si	24	1,2	Yes
polycrystalline Si	17	1	Yes
Thin-film			
amorphous Si	8		Yes
multi-gap a-Si	13		No
Chalkopyrit	17		No

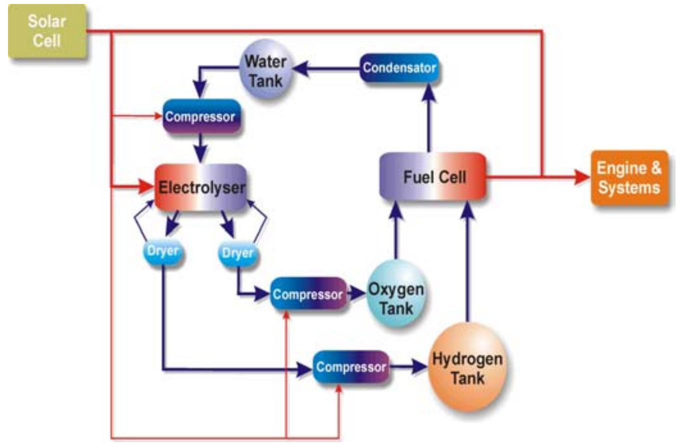
Table 1: Solar cells data

d) Use of Solar Power for Aircraft Propulsion Applications
Regarding the use of solar power for aircraft propulsion it can be assumed that the power generated by 1 m2 photovoltaic cells area with 8% efficiency gives 80 W power and with 25% efficiency it would give 250 W power. If the solar energy would be accumulated in electric battery it would provide for 10-17 day hours 2.50 KWH- 4.25 KWH stored energy. For 2 hours aircraft flight it might be expected to get 1.250 KW–2.125 KW solar power per 1 m2 cells area. If we assume that 100 m2 of the aircraft wingspan area is coated by photovoltaic cells one could expect to get 125-212 KW power to propel the aircraft in a hybrid system or to supply electric power for internal aircraft use.

Alternative solutions for use of solar energy
What is sometimes referred as the “Regenerative Fuel Cell (RFC)” for use at night is certainly an attractive future solution. In the day, the airship drives its propellers and the payload with the solar arrays and uses the surplus power to electrolyse at-night-fuel-cell-produced water into hydrogen and oxygen. At night, the RFCs generate power through the reaction of these gases.



Schematics of a RFC system



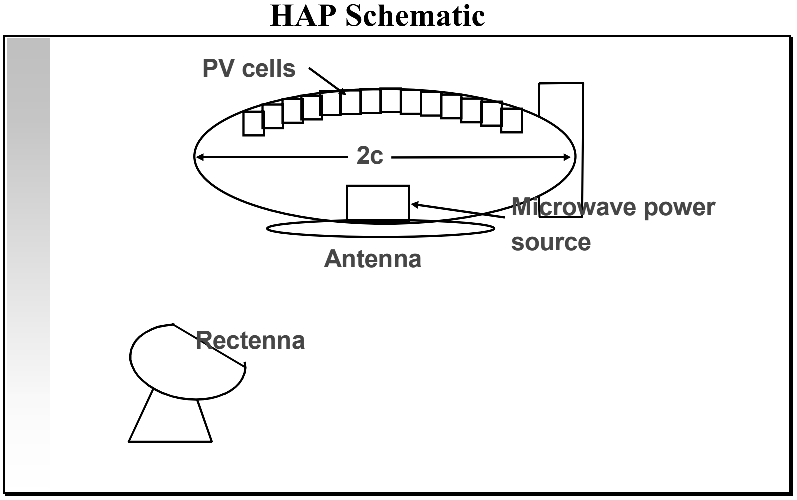
A reversible electro-chemical system ("RFC")

A first view to the complexity of the system can be gained from the above figures, showing the principal layout. As the basic principle for electrolyser and fuel cell is the same, a potential weight reduction could be to use the same stack as an electrolyser and as a fuel cell. This is then called an integrated regenerative fuel cell (IRFC). As all external assemblies give nearly 50% of the whole weight of a fuel cell or an electrolyser, the weight reduction which can be expected is not that high. For ground microwave RFC power-station the weight of the electrolyser is less important and within the new concept presented in this MICROBEAMING project the present state-of-the-art regarding the electrolyser, it can be used for an improved RFC alternative energy generation.

Other MICROBEAMING applications

Other MICROBEAMING applications as described in the Abstract will be described in more details when the full proposal will be prepared. This would include: 1) High Power MICROBEANING transmission of different alternative energies; Safety/citizen protection service; Monitoring for environment and security services; 2) Improvements in Communication applications in the GHz range and new antennas design; 3) Power transmission to charge energy accumulating devices for long endurance operation in an airborne and terrestrial applications.

HAP Schematic



Scientific and technological objectives of the project

The project objectives are tangible and challenging in the sense of clearly defined scientific objectives that if accumulatively achieved it will present a clear breakthrough and progress well beyond the current state-of-the-art related to renewable electricity generation by extensive using of alternative energies. The scientific approach in this project is based on promising test results do be achieved <u>for the first time worldwide with this MICROBEAMING type of Test-Bench in transmitting at 94 GHz. to long distances the generated power by regenerative fuel cell station.</u>

Relevance to the objectives of ENERGY TREN 1

The proposed project opens up new emerging areas of science and technology; it is novel and has ambitious and challenging objectives relevant to ENERGY priorities. The envisaged risky long-term research is of foundational nature, addresses a major scientific challenge emerging in the MICROBEAMING field and cuts across thematic priorities in ENERGY-renewable electricity generation; smart energy networks- and other priorities as well.

Potential impact

Scientific achievements of the MICROBEAMING research project to develop better exploitation of innovative alternative energies through transmission links to power centers will provide tremendous impact on scientific/technological research, on new industrial branches, on economy and also to some extent to possible independence on conventional fuel energy supply.

The expected impact of this project is:

- To explore new path leading to highly innovative novel technologies for energy applications.
- To contribute to the establishment of a strong scientific and technical base for European science and technology in energy emerging areas.
- To maximize industrial relevance and impact of the research effort, including participation of High Technology SMEs, which represents an added value to the ENERGY 2008 10.1.1 topic.

B1.3 S/T methodology and associated work plan

Partners role

The consortium to be set up for conducting the proposed research work will include:

1) CTI-SME organization, which will coordinate the project. CTI will lead the Work Package 1, the MICROBEAMING Project management, Work Package 9, Technology evaluation, final report and dissemination of results, leading Work Package 2 together with University Microwave Center to be yet finally identified to conduct Microwave-Beaming laboratory experiments at 94 GHz with small scale power.

2) ENSC – Ecole Normale Superieure de Cachan

3) DLR- The Germany Space Centre - the Radar and Microwave Institute having expertise in radar and microwave technologies. DLR will lead Work Package to evaluate the scaling up of MICROBEAMING technology to 20 KW and conduct part of the MICROBEAMING Test - Bench field tests experiments at 94 GHz frequency;

4) CeNTI- Centre for Nanotechnology and Smart Materials involved in energy research beyond tomorrow, having an expertise in use of generating alternative solar power and in MICROBEAMING power transmission. CeNTI will lead Work Package 4 to evaluate electricity generation in the range of MW Power.

5) Intelligent Energy -SME organization to design and provide the fuel cell for the microwave power station. Intelligent Energy will lead Work Package 5 to evaluate feasibility of developing huge ground RFC (Regenerative Fuel Cell) power station.

6) STRATXX- STRATXX Holding AG will provide and operate the balloon/airship with the test

bench. STRATXX will lead Work Package 8 to set up MICROBEAMING Test-Bench and conduct the field test to evaluate the feasibility of the MICROBEAMING system concept.
7) INTEGRASYS S.A. to provide the expertise of antenna/rectenna radars. INTEGRASYS will lead two work packages: WP6 Evaluation of MICROBEAMING system to provide customers with electric high power; and WP7 Specifications of MICROBEAMING system parameters.
8) Intelligent Energy - SME

Project resources

The proposed project is cost-effective providing with sufficient existing resources of participants in know-how, in required facilities and financial resources in order to conduct successfully the MICROBEAMING project. In addition the consortium to be set up will get a paid consultancy support by very relevant organization leading in some aspects of high power MICROBEAMING technology. The project will last 36 months and its estimated cost is about 2,682,800 Euro. The requested grant to the budget (including subcontractors) is 1,567,020 Euro.

Project management

SME-1 will manage the proposed project.SME-1 has extensive experience in managing scientific and RTD projects and in conducting different feasibility studies in the areas of Unmanned Aerial Vehicles, in high power laser and microwave beaming system ,in power plants, in environmental protection and others.SME-1 is the coordinator of a FP6 approved project.

Implementation and work plan

The proposed project aims to provide scientific research for determining parameters required for a long-term research to prospectively achieve efficient high power transmission of alternative energies by using the MICROBEAMING technology. It is expected that the power microwave-beaming technology to be developed will provide with antenna/rectenna power density of 100 KW/m2 with compare to today 30W/m2 power density.Thus to enable sufficient exploitation and use of improved alternative energy generation.

Work plan outline

The proposed project will last 3 years. The structure of the work plan will be based on 4 phases:
Phase1: Scientific research and technology development of high power MICROBEAMING elements, including energy generation and power transmission and evaluate their characteristics, develop specialized simulation software for NLWT, and research of alternative energies point to point wireless power MICROBEAMING transmission at 94 GHz.

Phase 2: Laboratory experiments of 20W 94 GHz Test-Bench and efficiency measurements of a microwave-beaming transmit/absorb elements, including the research and analysis of alternative energy generation and provision of required power source.
Phase 3: Field tests of the 20W/94GHz Test-Bench, including the operation of alternative energy generation station for microwave power transmission, including antenna/rectenna design and energy absorption and distribution, and a hovering low altitude balloon/airship installed with the absorbing rectenna to experimentally verify the feasibility of efficiently transmitting high power to rectenna for a later full scale design of 20KW system.

Phase 4:Final report to include: a) Feasibility analysis of the MOCROBEAMING project and prospective further research plans; b) Cost benefit analysis for alternative energy generation and high power MICROBEAMING transmission systems; c) Recommendations on how this FET project may be included in future ENERGY programmes.

B6 Partnership and Budget

B6.1 Partnership

Table 1: Partnership

Participant no.	Participant legal name	Organisation type	Role
1 CTI	Creative Technologies Israel Ltd	SME	SME organization, which will coordinate the project. SME-1 has the expertise to make workab new emerging technologies in fields of energy,high altitude platforms,communications, high power laser and microwave beaming systems. CTI is the Coordinator of the FP6-2002-AERO- USE HAAS Project (contract no 516081). CTI will lead the WP1 (Work Package 1) the MICROBEAMING Project management, WP9 (Work Package 9) Technology evaluation, fina report and dissemination of results, and leading WP2 (Work Package 2) together with Univers Microwave Center yet to be finally identified to conduct microwave-beaming laboratory tests with small scale power of 20 watt and antenna/rectenna set up.
2 ENSC	Ecole Normale Superieure de Cachan	RES	
3 DLR	Germany Space Centre	RES	The Germany Space Centre - the Radar and Microwave Institute having expertise in radar and microwave technologies. DLR will lead WP3 (Work Package 3) to evaluate the scaling up of MICROBEAMING technology to 20 KW and conduct part of the MICROBEAMING Test - Bench field tests experiments at 94 GHz frequency.
4 CeNTI	Centre for Nanotechnology and Smart Materials	RES	Joint Research Centre involved in energy research beyond tomorrow, having an expertise in us of generating alternative solar power and in MICROBEAMING power transmission to achieve project objectives to research and conduct laboratory experiments with the Test-Bench. JRC will lead WP4 (Work Package 4) to evaluate electricity generation in the range of Mega Watt Power using solar/sun energy efficiently absorbed by huge ground solar cells power stati using advanced techniques of concentrating lenses to increase energy efficiency.
5 Intelligent	Intelligent Energy Ltd	SME	SME organization to design and provide the fuel cell for the microwave power station in the Test-Bench and implement project results. Intelligent Energy will lead WP5 (Work Package 5) to evaluate the feasibility of developing huge ground RFC (Regenerative Fuel Cell) power

			station and provide ZEPPELIN with the fuel cell generator to produce the required electrical power for the Test-Bench experiment to be conducted by Zeppelin.
6 STRATXX	STRATXX Holding AG	SME	STRATXX Industrial Group will provide and operate the balloon/airship with the rectenna installation in the MICROBEAMING Test-Bench for the experiment to be conducted. STRATXX will lead WP8 (Work Package 8) to set up complete MICROBEAMING Test-Ben and conduct the field test to evaluate the feasibility of the MICROBEAMING system concept.
7 INTEGRAS YS	INTEGRASYS S.A.	IND	Integrasys S.A. to provide the expertise of antenna/rectenna radars required for the full scale MICROBEAMING system when provided to customers. INTEGRASYS will lead two work packages: WP6 Evaluation of MICROBEAMING system to provide customers with electric high power in the range of MW generated by alternative energies; and WP7 Specifications/Definition of MICROBEAMING system parameters.

B6.2 Budget

Table 2: Estimated budget

Estimated budget (Euro)					
Partner	RTD activities	Demonstration	Management	Other activities	Total
CTI	385,760		107,240		493,000
ENSC	300,000				225,000
DLR	382,800				382,000
CeNTI	310,000				310,000
Intelligent	235,000				235,000
STRATXX	910,000				910,000
INTEGRAS YS	352,000				352,000
Totals:	2,975,560		107,240		2,882,800
Requested EC funding:	1,651,780		107,240		1,759,020