Designing the Habitat of the Future for Islands 25 Bioclimatic Dwellings for the Island of Tenerife

The big weight of residential and services sectors on islands give rise to the fact that the highest incidence energy consumption is related with buildings and dwellings. On islands, new energy technologies can engage a profitable alliance with traditional building, as island people have historically taken advantage from local climatic conditions and materials, achieving imaginative and comfortable habitats.
The project of 25 bioclimatic dwellings for the island of Tenerife is being carried out. It represents a most serious bet to face the future of sustainable island buildings.

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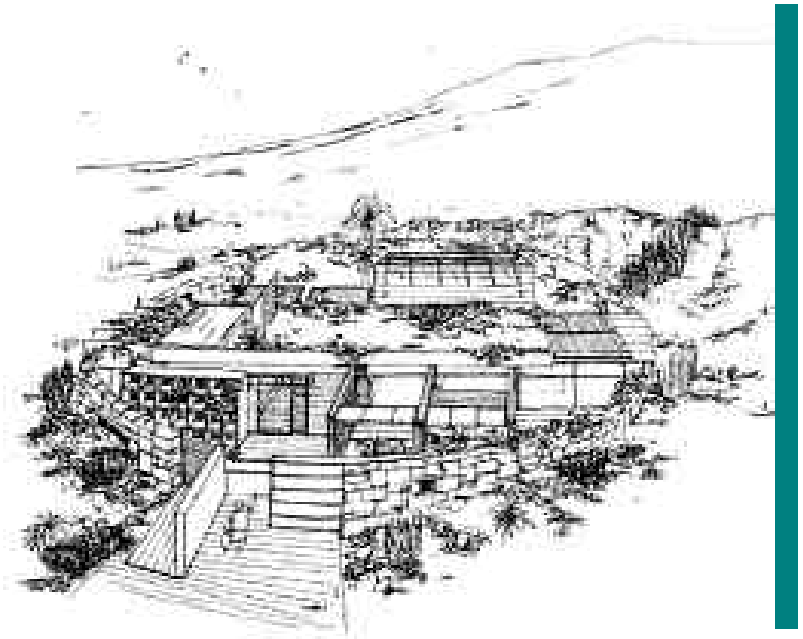
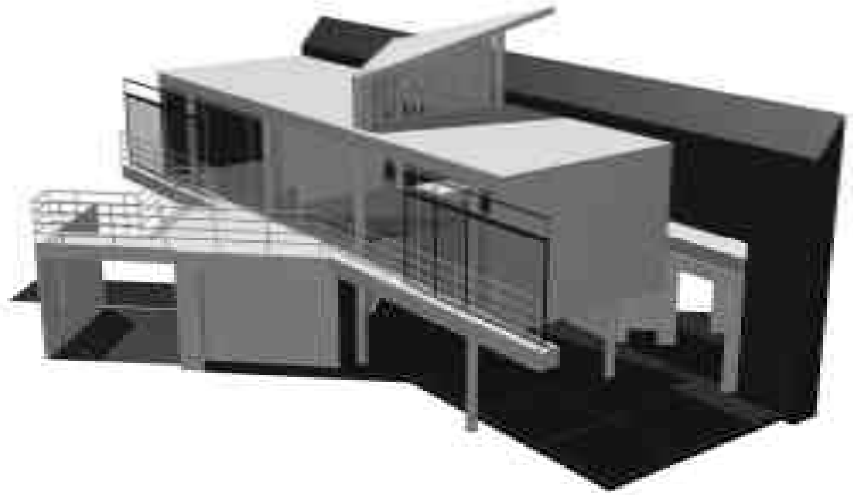
The project "25 Bioclimatic Dwellings for the Island of Tenerife" is aimed to provide an example to the needs of real bioclimatic development of different self-sufficient dwellings. With this example we could check, analyse and prove: the design itself, the implementation of renewable energies to different designs and the economic viability of a future commercial exploitation. And finally, to provide a physical environment as an ideal place for dissemination and diffusion of results on performances in a not sectarian way.

This performance should help reducing the following problems:

- High energy consumption in dwelling.
- High emission of pollutants as a consequence of building.
- Scarce use of renewable energy and recycled water system.

To built up a single house as a model, without a fixed location, is an unreal example from the point of view of estimated cost and performance in an urban net. And the construction of a development of 25 bioclimatic dwelling, based on an unique design, is a strong limit to experimentation and research about materials, design and renewable energy implementation solutions. Both examples reduce the quantity and quality of results for further replication of the product or technique acquired during the project.
The main objective of the present proposal is the application of combined strategies to provide sustainable solutions to the problem of energy in buildings. On the basis of this approach, we propose a rational bioclimatic criteria in dwelling designs which allows to take maximum advantage of materials chosen and environmental conditions. Such criteria make possible a considerable saving of energy for heating, cooling and lighting purpose. Once the energy requirements for dwellings are established at rational levels, RE implementations of photovoltaic and wind power can be introduced at competitive costs. Besides the aim of setting up the basis for small urban developments, self-sufficient from the point of view of energy, innovative approaches are proposed to provide maximum integration of RE devices into building structures. The diversity of





solutions offered by a development of 25 different bioclimatic, RE powered dwellings, represent an interesting feature which has never carried out before. In order to make this experience accessible to any scientific, technical or any collective which could be interested, the dwellings will be enabled in lodging regime. The Visitors Centre which will complement the urbanization and where the common RE resources will be placed is conceived as a physical nexus for the whole development. Equipped with areas for holding congresses and conferences, it will act as an ideal environment for dissemination and diffusion of results on performance conditions of development.

The bioclimatic nature of dwellings provide a considerable energy saving so that renewable resources incorporated are able to meet the requirements (ie high efficiency integrated PV structures, 2kWp per dwelling, and solar thermal devices in all of them and wind turbines with power ranging 0.6-5 kW in four dwellings). The 25 houses will be built forming a development with no emission of pollutants and common resources (like the treatment plant) will be placed in the Visitors' Centre. Monitoring of performances will be carried out for dwellings in order to check the behaviour indoor of dwellings and the self-sufficiency characteristic of the development.

The project started with a call for the international, public tender, which was open to architects whose qualifications had been accepted by any of the National Departments of the International Union of Architects, and were able to participate either individually or as directors of multidisciplinary teams.

The Selection Committee proceeded to the public reading of the results on October 1995. Committee took into account the integral value of the proposals and their financial feasibility and yield, their adaptation to the environment, their response to the surrounding conditioning factors, the use which is made of the bioclimatic conditions of the location and research into the use of recyclable materials. All the works met the required common constructive characteristics:

- Standard 500 m2 plots with a maximum built-up surface of 120 m2.
- 3-4 rooms and standing no more than two store high.
- Cost of construction per m2 should not surpass 1000 ECU.

From the point of view of energy resources, the selected dwellings are supplied with the electricity of PV panels and/or wind turbines. The electrical grid will support these installations to guarantee a continuous supply.

The authors of the 25 winnings proposals were commissioned for the corresponding execution project. The tenderer who obtained the first prize is being also commissioned for the making of a Visitors Centre.

The total number of teams that attended was 397 from all over the world and the 25 selected works.

The main objectives of the project are:

- The construction of a development of 25 bioclimatic dwelling based on different designing approaches and using recycled and recyclable materials with individual solutions to the energy problem by mean of renewable energy, and common solutions for water supply. The whole structure is to be understood as a non-polluting development, self-sufficient regarding energy and water and achieve important saving through the bioclimatic nature of design.
- To provide innovative solutions for PV integration in buildings. To optimise performances of PV implementations and reducing cost of installations by using direct current at high voltage and high efficiency PV cells.
- To give a local solution to many problems regarding energy production and consumption, as well as the use of renewable energy at a small scale. The dwellings will be integrated in a urban development that would allow a technical and scientific tourism to come and stay in this place using the common areas and evaluating results. The experience could be applied later in other areas with similar characteristic, allowing the dissemination of experience and knowledge developed in this kind of buildings.

The bioclimatic approach will produce a considerable saving in energy since the building will take advantage of environmental conditions to meet the energy requirements indoor. This results are reached through a carefully selection of materials which are finally responsible for thermal behaviour. Aspects like global heat gain or losses have been analysed to work properly the sun daily cycle. Natural ventilation schemes have been implemented in designs to avoid expensive energy consuming and non-healthy, air conditioned equipment.

Maximum advantage will be taken of sunny climate in the chosen location from several points of view. First of all, an optimum working for PV installations foreseen. On the other hand the energy saved by a smart utilisation of daylight contributes noticeably to maintain the energy consumption rates very down respect conventional dwellings.
As is mentioned above, the solution contributed by each of 25 dwelling project is slightly different respect the way RE are implemented. All of them introduce PV resources, at an amount of 2 kW which will be integrated in the very structure of roofs. Four of them introduce an extra small wind turbine with powers ranging 600 - 5000 W based on different technologies. The whole amount of energy produced by the 25 dwellings will be injected to electric grid and double register systems (consumption/ contribution to grid) will be installed to check the expected zero average net consumption.
In order to check the performances and working conditions in each dwelling, several sensors and probes that will measure indoor parameters for a later analysis and monitoring, and other specific ones depending on the main characteristics of each dwelling (anemometers and wind vanes in air tubes, temperature and humidity in special places, etc.). The device for each of the dwellings include:

- Vertical temperature profile probes.
- Inside / Outside wall temperature probes.
- Humidity probes.
- Air flow measuring device.
- People presence sensors.

These sensors will be complemented with weather stations, which will measure parameters such as sun radiation, outside temperature, pressure, humidity and energy consumption and generation registers that discriminate the source of origin (PV panels, wind generator and grid). All the data will be collected in a concentrator that will process all the information and send it, with an specific protocol, to a central computer in the Visitors' Centre and, eventually, a local computer for the data acquisition of each of the house. The central computer will perform a global data compilation of the whole development, allowing access to the results either individual or globally in real time analysis. It will also serve as a storage unit and will allow, with the use of several devices, a real-time monitoring of the performance of the dwelling and a data processing of the desired time space.
The development is complemented with a visitors centre which purpose is to receive and inform all those persons who may be interested in learning about the results being obtained in the bioclimatic environment. It will consist in a two storeys building with a built-up surface of approximately 900 m2 containing a multifunctional hall for the exhibitions and acts with a capacity for at least 100 persons, offices for the administrative staff of the development and corresponding services and a small cafeteria, in service of the research staff who may be living temporarily in the development.
The 25 bioclimatic dwellings development shall be located on the coastline of the south of the Island of Tenerife (Spain), along a dry ravine. The main reason for choosing this location lies in the enormous potential found in relation to the renewable energy sources: large number of sun hours, constant winds of a considerable force (7-8 m/s), scarce rainfall and arid land. Nevertheless, its situation near the coast enables experiences on water desalination using RE. Tenerife is one of the islands of the Canarian archipelago, which is situated in the Atlantic, near the African continent.
The development will be placed near the headquarter of ITER, and it is conceived as an outdoor laboratory. Once the dwellings are built, ITER will monitor the efficiency of each one of them, with an expected output that will be really useful for later applications in a national and international scope.

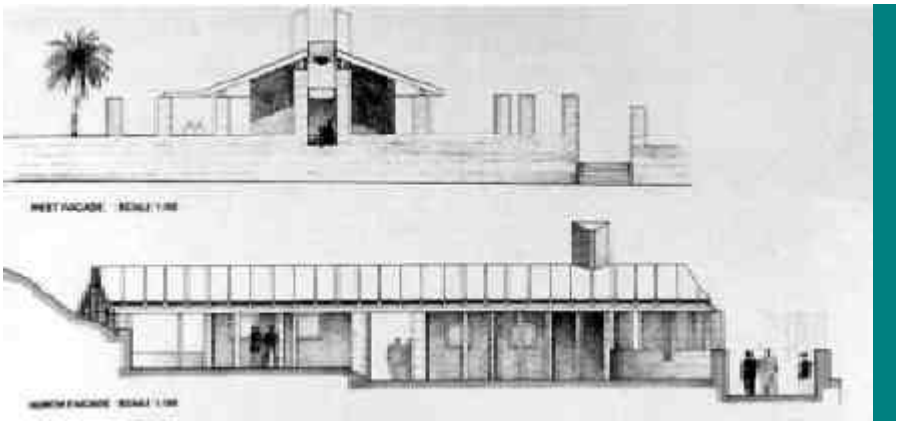
Energy Strategies

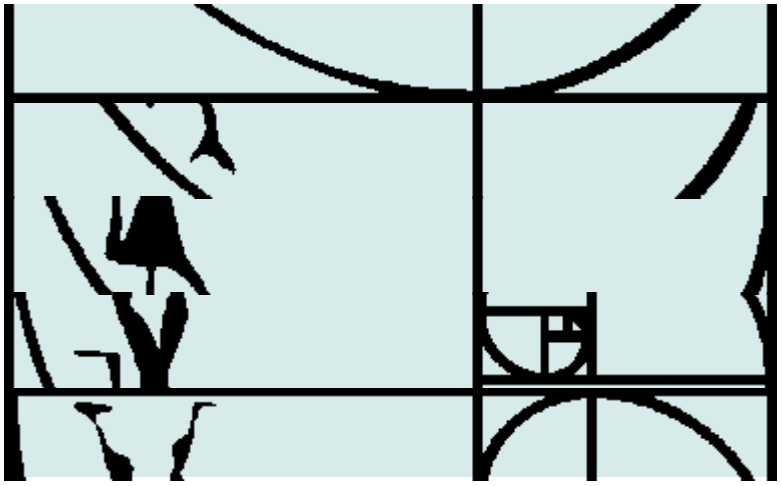
Passive solar cooling and heating.

The basic concern is the thermal behaviour of dwelling taking maximum advantage of useful solar gain. The houses will be isolated in order to avoid non desired gain/ losses, not to mention the added value of reducing noises from outside. For this purpose double glasses in the windows will be used (the reduction in heat losses is about 50%) and a system to keep windows and door perfectly shut as it supposes 40% of change in gain/losses.
The calculations performed during the research phase yield that bioclimatic dwellings designed can save about 70% of heating/cooling costs, producing an additional cost which not exceed 20% in extreme cases. Natural lighting may be provided directly to inner spaces or adjacent to the house exterior. Advanced windows, light shelves, skylights, roof monitors and side lighting will also reduce lighting costs considerably.

Materials and appliances

The materials used for the making of the houses are recycled in the maximum way





possible and, depending on the weather, with thermal inertia. The appliances of the house have been perfectly fitted to the needs of the residents (capacity, power,..) and have the "Ecological label" of the European Community.
Instead of using the traditional bulb lights, low consume ones (20% of the normal consumption) or halogen lamps will be used. It saves 0.5 ton of CO2 to be emitted to the atmosphere to change a 100 w. traditional light for a low consume. Photo-electric and people presence sensors switch off unnecessary lights when not required, producing a saving between 10 and 80%.

Electric generation.

Even though a great percentage of energy is saved with the design and equipment of the house, autonomous installations are needed (wind and solar energy) to meet the electricity needs of each house, besides water treatments plants.
PV panels and wind turbines will not be common resources, but individual solutions for the consumption of each of the dwellings. Each house is equipped with 2 kW of PV panels based on high efficiency solar cells (BP Saturno). These cells introduce new simplified fabrication processes which will lead to reduction of costs and to major penetration of PV in small domestic applications.
The PV installation will be integrated in the very structure of each dwelling (unframed panels) looking for a minimum visual impact and it will work at direct current regime at high voltage. Doing so, the costs of equipment are reduced considerably and performances are higher.
The Visitors Centre will also have a 20 kW PV system for the electric supply of its own installations and also the common facilities for water treatment.

Water supply.

A desalination plant based on reverse osmosis and a purifying system, both placed in the visitors centre, will be suppliers of the water needed for the village. There will be three distribution networks. The water obtained from the sea will be treated in the desalination plant to produce fresh water; it will supply the houses with the first pipe network. The sewage originated in the building will be sent to the Visitors Centre by second network, where it will be treated in a sewage farm. The third network will supply purified water for irrigation.

Active solar energy systems of low temperature use an energy collector, specially suitable for heating water for human use and heating. The main components are the solar collector, a storage system and the distribution or consumption system. The basic element, the collector, contains an absorber which converts the incident solar radiation into collected energy; later on, the energy is transferred to the water for transport directly to the load or to isolated tanks for later use.
The earlier stages of the project have been:

- Analysis of conventional energy system in dwelling. Including individual and common cost analysis.
- Analysis of pollutant emissions on dwelling performances.
- Examples' compilation about the duet, dwelling - renewable energy.
- Theoretic analysis of different houses prototypes in hypothetical locations.
- Call for the international public tender. Out of the teams, that attended, were selected the 25 houses.
- The terrains where the development will be built belong to ITER so no authorisations are needed but the usual ones regarding the local permissions.

The authorisations to execute the " Special Urban Plan ITER" and the Visitors Centre are already obtained. The applications for the bioclimatic development have been already made, and the construction of the Visitors' Centre began in 2000, and will be inaugurated by the end of 2001.