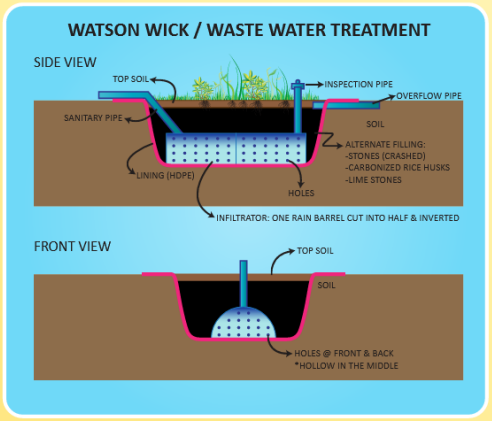
Waste and Wastewater (WW)

A biological water treatment adopting the so called Watson Wick design is installed in the cottage for waste water purification. Watson Wicks, also known as pumice wicks, are a very simple, inexpensive septic system alternative; shallow, subsurface bio swales designed to reuse the nutrients and water for irrigating and feeding plants.

WW1: Pumice Wick – an inexpensive alternative to a conventional septic system; The top soil can be used for gardening, water and nutrients are supplied by the water treatment system below the surface.

WW2: Solid waste segregation – garbage bins are allocated for proper waste segregation at source.



Supply Chain (SC)

The ZCR project promotes integration of the food supply in a resort or hotel as part of the sustainable supply chain strategy.

SC1: Locavore – "Locavore" is a concept of consuming local and organically grown food.

Building Monitoring System (BMS)

The whole building performance is monitored and analyzed for knowledge transfer and dissemination.

BMS1: Weather Station – All relevant weather data such as solar radiation, wind speed and –direction, outside temperature, humidity and rainfall are recorded on site.

BMS2: Sensors inside the building – Monitoring devices are installed to determine a quantified performance of the building and its consumption. Among the collected data are indoor temperature, humidity and the energy consumption of the building. The data are analyzed for knowledge sharing and ultimately enable policy makers to have a basis for the revision of standards and guidelines for buildings and energy systems in the Philippines.

DIY Appropriate Technologies (AT) Samples (AT)

A number of "Do It Yourself" appropriate technologies were developed within the capacity building program of the ZCR project for local production.

AT1: DIY appropriate technologies developed for local production include a solar water heater, improved cook stoves, biogas digester, recycled LED lights and hot water from the waste heat of generators.

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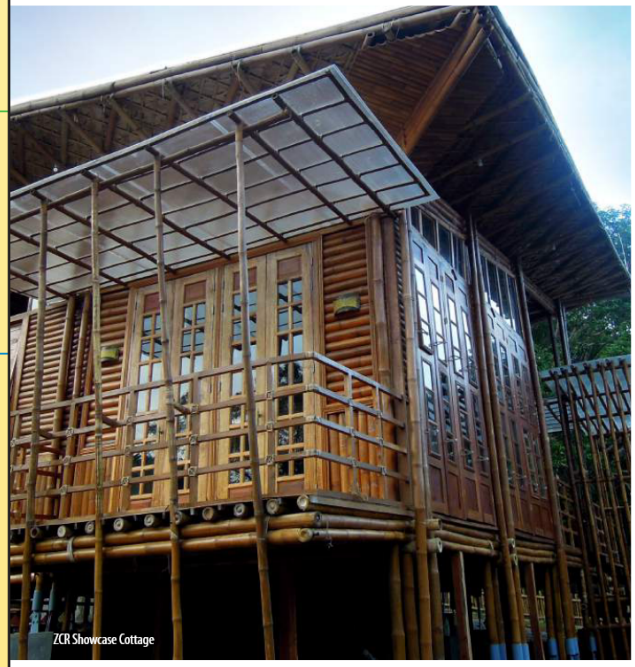
Zer Carb Res On rts

Building Energy Autonomous Resorts
Creating Appropriate Technology Solutions


ZCR Showcase Cottage

Zero Carbon Resorts (ZCR)
Demonstration Building

Project funded by:

switchasia

European Union's Switch-Asia Program

Project implemented by:

GrAT Center for Appropriate Technology

Introduction to the ZCR Demonstration Building

The overall objective of this showcase is to demonstrate the feasibility of an innovative building concept that significantly reduces CO_2 emissions and demonstrates resource-efficient solutions in the building sector using indigenous and locally available materials. To this end, a highly resource and energy-efficient building has been built in Puerto Princesa, Palawan. The ZCR showcase cottage shows a minimum of grey energy over its entire life cycle, from production of materials to the use phase and the recycling possibilities. This is achieved with a maximum utilization of regional renewable resources (bamboo, clay). The building is powered by renewable energies and 100% energy autonomous using a demand-oriented energy system based on solar energy.

This building is funded by the European Union under the Switch-Asia Programme. It was implemented and co-funded by GrAT-Center for Appropriate Technology (Lead Partner) with the project partners: Palawan Council for Sustainable Development (PCSD) and Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT)- Plataforma Solar de Almeria (PSA).

Key Features of the Demonstration Building

Passive Cooling (PC)

Passive cooling is a design approach that focuses on heat gain control and heat dissipation in a building in order to improve the indoor thermal comfort with low or no energy consumption. The ZCR showcase cottage achieved thermal comfort by means of design and construction principles rather than by energy using appliances. Design and construction principles include:

PC1: Shading – Wide overhangs provide shading for the entire building.

PC2: Natural ventilation – floors slats, ventanillas, hot air exhausts at the top of the ceiling, a stilt structure, big windows and openings at strategic locations provide natural ventilation for the entire building. The ZCR cottage is a structure on stilts, a very similar design concept to a Philippine "bahay kubo". With the entire building area raised from the ground, it allows for perfect natural ventilation.

PC3: Thermal Mass – thermal masses are integrated in the building in form of a rammed earth wall and the massive structure in the bathroom area. An innovative concept is the use of rammed earth made from materials on site. Excavated soil from the foundations was sifted and mixed with sand and water in the right proportion then, pressed into a mold and compacted layer by layer.

The thermal properties of the rammed earth make it an excellent temperature controller that can moderate peak temperatures. Due to the thickness and density of the material heat penetration of the wall is very slow and the internal temperature of the building remains relatively stable.

PC4: Night and ground cooling – to cool down the thermal masses at night, wind direction was considered and breezeways with creeping plants were installed that channel cooled air into the building. These breezeways are located at the northeast and southwest corner of the cottage to facilitate cool breezes and lead them to the cottage all-year-round.

PC5: Reflection – an aluminum foil in between the "tadtad" and the "anahaw" is installed for reflection of solar radiation. In combination with the natural roof material this ensures minimum surface temperatures on the ceiling and therefore increases thermal comfort inside the building.

PC6: The orientation of the building – the orientation of the ZCR showcase cottage was designed to minimize energy loads and maximize natural resources. The PV panels are directly facing the south to maximize the energy yield. The butterfly design of the roof allows central collection of rain water.

Building Materials (BM)

The ZCR Showcase Cottage is made of renewable resources and regionally available materials.

BM1: Bamboo – is a type of giant, wood-like grass with utmost strength and durability. It is one of the fastest growing-plants worldwide[1]. The cottage is primarily constructed of 90-95% bamboo. The species of bamboo used in the construction are Patong and Bayog. A pressure seawater treatment was used for insect protection.

BM2: Anahaw leaves – Anahaw (Saribus rotundifolius) is a round-leaf palm found in Southeast Asia, and it is regarded one of the national symbols in the Philippines. In the ZCR cottage, this leaf is used as the material for the ceiling.

BM3: Rattan – is locally known as "Yantok or Uway". Design elements of the cottage are mostly made from yantok.

BM4: Wood – wood is also used in the cottage especially for parts of the flooring, connecting elements and interior furniture.

BM5: The use of *concrete* has been minimized due to resource efficient stilt foundations.

[1] Guinness. "Fastest growing plant". Retrieved 22 August 2014.

Zero Carbon Resorts

Renewable Energy (RE)

Solar PV panels are the source of electric power for the entire cottage. Solar thermal energy is also used for water heating and cooking. For lighting purposes, sunlight is channeled into the building via solar lighting tubes. In order to achieve autonomy of energy supply, the load demand of all utilities in the cottage was computed. Using this diverse range of solar applications, the electricity consumption of the ZCR cottage could be brought down to only 4% of a conventional vacation house.

RE1.1: PV Panels – Solar panels are the only source of electric power for the entire cottage.
- This product has been provided for demonstration by Australian Solar Power House Inc.

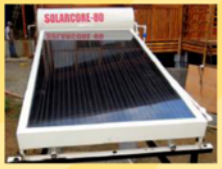
RE1.2: Inverter and Controller for PV – this combination of inverter, charge controller and safety components are responsible for running the cottage's solar power system.
-This product has been provided for demonstration by Australian Solar Power House Inc.

RE1.3: Storage system for electricity – Given the rainy days in the Philippines, sufficient buffer storage was also considered for sizing of the batteries. The batteries are located below the floor at the coolest place in the building to maximize their lifetime and performance.
-This product has been provided for demonstration by Australian Solar Power House Inc.

RE2: Tubular solar lighting device – Captures the natural light from the sun through a dome and reflects it down a highly reflective tube. On the ceiling it passes a lamp shaped diffuser which spreads the light evenly in the room. This eliminates electricity costs for lighting during daytime even in usually darker areas like the bathroom. *- This product has been provided for demonstration by SG Eco Industries, Inc.*

RE3: Solar Cooker – A solar cooker uses the energy of direct sunlight and converts it into heat of up to 200 degrees Celsius. With an additional storage system, this particular solar cooker can cook food even at night. This direct use of solar thermal energy leads to a huge reduction of electricity or LPG costs. *-This product is developed by GrAT-Center for Appropriate Technology*

RE4: Solar Water Heater – Water heating as another energy intensive service is also done with a solar thermal collector. A conventional house would have an annual consumption of 5,475 kWh of electricity which is replaced by solar thermal energy



Efficient Technologies (ET)

A number of efficient technologies are being used in the cottage which contribute to its low energy consumption.

ET1: Low wattage high volume ceiling fan – The only active cooling components in the ZCR showcase cottage are the low wattage high volume ceiling fans. During hot days, this fan will be operated at 5 to18 watts.

ET2: Efficient Lighting – All light bulbs being used in the ZCR cottage are high efficient LED (Light Emitting Diode) lamps.

Water (W)

The cottage is designed to utilize rainwater for water supply. Only about 10% of the annual rainfall hitting the roof is needed to supply all water needs in the building. With the use of water efficient technologies such as a low consumption water closet, low flow shower heads and faucets, the water demand as well as the waste water volume is reduced.

W1: The inverted shape of the roof – allows for rainwater collection of the entire roof area in a single downspout, no gutters are required around the roof.

W2: Rainwater collection system – A collection tank and cistern form the main storage for the collected rain water.

W3: Leaf Eater and First Flush Diverter – In order to collect only clean rain water, a so called leaf eater and a first flush diverter are used. The leaf eater removes larger particles like leaves and twigs while the first flush diverter allows for washing off dust and dirt from the roof before directing the flow to the storage system. *-This product has been provided for demonstration by Emerald Vinyl Corp.*

W4: Filtration System – A natural filtration is added to the system to further purify the water before going to the cistern.

W5: Low consumption closet, low flow shower heads and faucets – To reduce water consumption, a dual flush closet is being used with a water consumption of 3 to 6 liters per flush. The shower head has a maximum flow of 6 to 7 liters per minute and the faucets 2 to 4 liters per minute.