Jungle Power – A More Remote AC Bus

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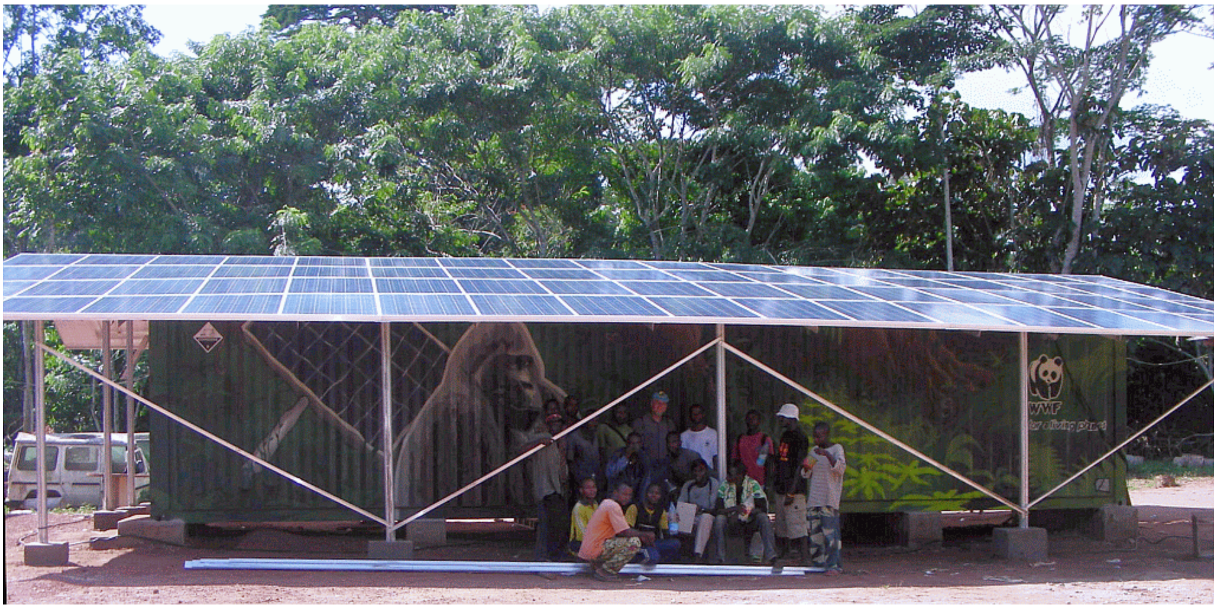


abstract: The Dzanga-Sangha Reserve in the **Central African Republic** is probably one of the world´s most remote protected **rainforest** areas, much to the benefit of the rare species of lowland gorilla, forest elephant and the local pygmy population Ba'Aka.
The park is co-managed by the "**WWF**-World Wide Fund For Nature" with sponsoring from the German **Regenwald-Stiftung**. In 2008 wwf decided to switch from the old, failing generator supply to a **solar hybrid mini-grid**, along with stringent measures of **energy conservation** and management. After a careful energy audit Technosol designed an **AC-bus** system with a **22 kWp PV** generator which should overcome the dependency on the old generators and their fuel demands. For 15 buildings, an entirely new **distribution network** was installed, state of the art energy saving devices introduced and an energy metering system deviced. The installation is operating since **August 2009.**
In such remote locations, the reliability of the AC-bus over other generator-based solutions will be demonstrated and with the support of international organisations like the wwf the practical application of solar hybrid supply becomes a landmark of sustainable energy concepts.

The Dzanga Sangha Project Right in the Congo basin, where the Central African Republic meets Cameroon and Congo-Brazzaville, the "WWF-World Wide Fund For Nature" is assisting the management of the CAR's National Dzanga Sangha Reservation. It is famous for their rare population of lowland gorillas and forest elephants. Two jungle-camps provide a modest base station for researchers, visitors and the local Ba'Aka pygmy forest rangers. A larger camp for the administration is located on the Sangha river next to the village of Bayanga. While the jungle-camps only had rudimentary power supply of occasionally recharged car-batteries for radio communication, the Bayanga camp enjoyed a small power grid from a set of old diesel generators.

As it happens when a free power service is available, everyone made most use of it, so lines were extended to the water pump, to the mayor's office and to the nearby Doli Lodge. With electricity for free, electric geysers heated the water, villagers would charge batteries for their homes and energy efficient appliances were no priority. All these extensions of a makeshift network broke down regularly, so work ended abruptly when rain came. Expensive and infrequent fuel supply and increasing repair efforts on the generators led to tightly scheduled generating hours, where work had to be crammed into few hours and often was abruptly terminated by generator cut out. So, the improvement of project work demanded a change.

TECHNOSOL since 1985 is specialized in integrated PV supply concepts, many of them pioneering in difficult locations. As such concepts always have an impact on the local community and require new technical capacity, they always are implemented with a technical training and a user management component. A supply network for health stations at the Darfour border of upper Congo in 1987 is an early example, the installation of a 52 kWp Grid integration on the Pacific Island of Niue in 2009 is one more recent. The combination of technical expertise with development-sensitive implementation is an asset which Technosol today provides as a service, such as the rural electrification programs in

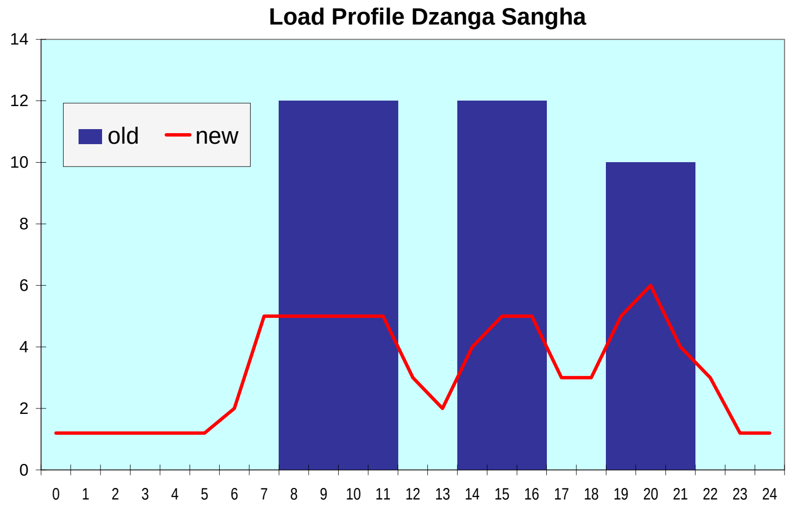
the Philippines or, right now, in the Kingdom of Tonga and in the Republic of Vanuatu.

Project design The development of a power supply concept for a remote location like Dzanga Sangha involves

1st a load assessment, understanding the load profile and demand quality
2nd technology selection, considering the resources and service level and
3rd implementation with training and sustainable management components

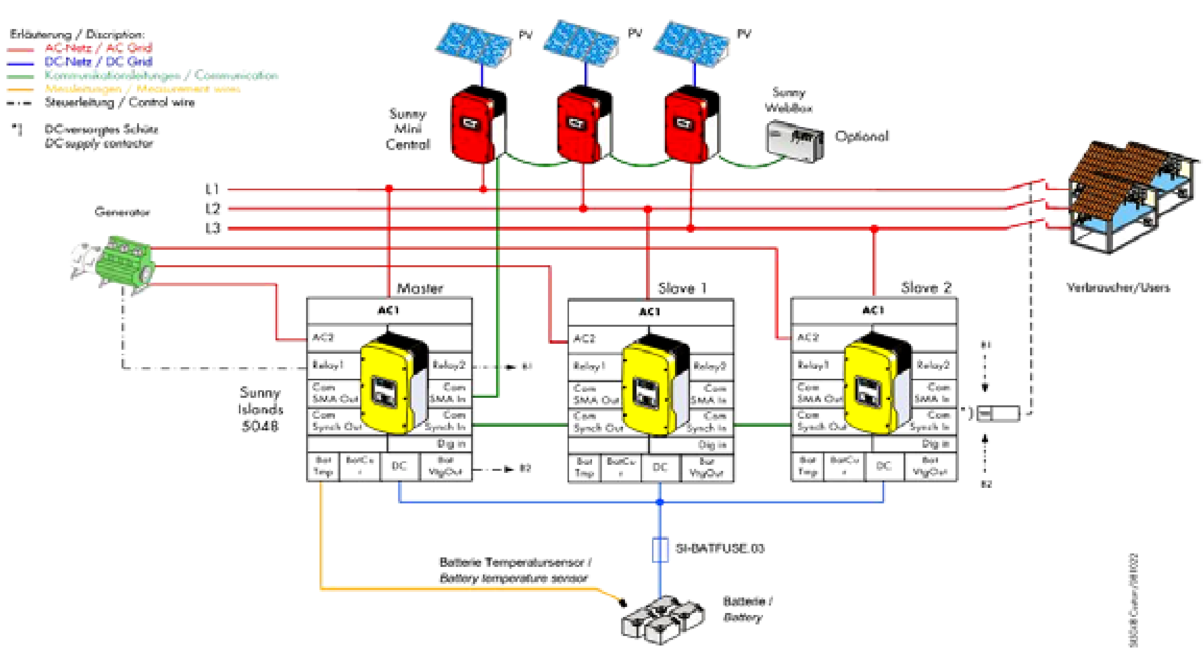
The load assessment is most crucial to the project design, but usually no accurate data are available, so either an appraisal visit to the site is required or the experience of the engineer must envisage the type of appliances and use pattern. In this case, the second was applied and with some communication a fairly accurate load profile was established. Next, design would look for energy saving opportunities and replace e.g. electric water heaters with closed-loop solar water heaters, the old refrigerators with modern A++ units and the light bulbs with quality energy saving lamps.

Old CRT-computers can favourably be upgraded with efficient laptops, which has the additional advantage to better cope with power disruptions.
All of these demand management efforts resulted in a load profile providing full 24 hours 7 days service and 93% less energy requirement.



The design of the supply concept Bayanga chose hybrid generation so as to incorporate the existing Diesel as backup to the PV generator. The AC-bus design was preferred to a DC-bus, because Bayanga would get a new grid, in which different generators could be fitted in different locations. The three-phase 230 V/50 Hz grid would connect 15 offices and residences with a ground cable. The grid is built by 3 SunnyIsland 5048 inverter/chargers, drawing from a 48 V 3000 Ah Hoppecke OPzS battery. A 22 kWp PV generator is the main power source, feeding into the grid via one Sunnyboy7000 inverter on each phase. Maximum power therefore is a nominal 36 kVA. Surplus energy is stored via the SI into the battery. On low battery, the Diesel GenSet can be cut in manually, with the SI synchronizing to the motor generator. Batteries and inverters are installed inside the transport container which is shaded by the PV generator structure, so the interior temperature is not above ambient. All plant data are logged on an SD card, and the daily profiles emailed to Germany for initial monitoring. Supply so far proves ample, so the water pump can be powered as well, reducing the GenSet to a mere backup.

Technical Data:
Solar Generator 22,44 kWp with 102Solar panel REC 220 Wp
3 Inverter/Chargers SunnyIsland SI5048 connected in three phases
3 inverters SunnyBoy 7000 in 6 strings of 17 panels
48 batteries Hoppecke 12 OPzS 1500 connected in 2 strings of 48 V



Energy management For many electricity users power is either off or on, and while it is on maximum use can be made of it, sometimes until something gives. This is especially true when consumption is not priced, because there is no incentive for energy saving. In the Bayanga camp, the result was that often appliances were not switched off at all, because the scheduled GenSet would anyway cut in and out everything at once. The new 24/7 supply is very comforting, allows for extended work hours and longer light in the evening however, the use of switches has to be learned again. There are sophisticated power management controllers, also the use of energy limiters similar to prepayment meters were considered, but these are costly and often circumvented. Each building connection instead, was equipped with a kWh-meter, so extensive consumption would be detected. The task of reading those meters and checking that unused items are switched off is then assigned to an energy warden. This way, energy conscious behaviour is more of a social interaction than a mechanically enforced regulation. The implementation may be slower and will need management support, but is more sustainable.

A new supply concept can also meet reservation from the former generator operators. The entire fuel chain, from truck drivers to GenSet service men provides employment, income, benefits, which disappear with the solar supply. For a while the GenSet therefore was run "just in case" but management needs to look into these changes if the new investment is to become economically viable.

Lessons learned

- Whether sophisticated technology would be a suitable solution for a remote location was a frequent question. In the case of the DSP project, the installation and commissioning went surprisingly well, initial flaws were reliably detected by the system and could be remedied, so the overall impression is that of a technology mature for a challenging environment. While the replacement of e.g. a "simple" inverter will cost here as much as that of a more sophisticated unit, the crucial question is whether the technology chosen now will be less prone to failure. As of this time this is affirmative.
- Mounting and connection of the PV supply system with local workforce also went well, continuous guidance with proper planning provided. Particularly young people, even if not technically educated, find fun in mounting good material with good tools. The challenge may be to keep up the fun, so not everyone would walk away at will, and to discourage cutting corners. Guided installation is a viable concept, creates ownership and helps sustainability.
- After installation, the project is not finished; rather the greatest challenge then is a conscious management. Interventions like the DSP project bring about substantial change to a community, and change needs to be managed. This entails
- education about what is proper consumption and not
- social competence to handle stories, excuses, abuses, and
- good communication to respond for a good service quality.

There is a tendency to look at projects like this as a challenge to technology and its optimization. After so many years of field experience with PV island systems however, we by now know enough about technical requirements and proper equipment to ensure a good technical solution.

Still, a project might not be sustainable if too little attention is spent on social acceptance. Technology alone cannot solve social problems, but it can contribute to new solutions.