

## ***ENVIRONMENTAL BENEFITS OF THE ILZRO RAPS PERU PROGRAM***

### ***Introduction***

There are several major environmental benefits which make the installation of hybrid RAPS systems in rural communities very attractive. One of the major objectives, and indeed, one of the economic driving forces encouraging the deployment of the type of RAPS system we are planning to install is that diesel genset run time will be shortened, even though 24-hour electricity will be provided. This, in turn, will result in the reduction of the emissions of the many pollutants that are inherent in diesel operation. These include carbon dioxide, oxides of nitrogen, total organic compounds—hydrocarbons, carbon monoxide, smoke and particulate matter, and sulfur oxides. These pollutants are associated with adverse human health consequences as well as having adverse effects on the environment. Also, the more the diesels are used the more likely oil spills will occur both in the vicinity of the engines, and also during transportation of diesel fuel and lubricating oils. These factors are important, especially in environmentally sensitive areas such as the Amazon rainforest, where these systems will be installed.

### ***Reduction of Greenhouse Gases***

Diesel emissions contain large quantities of carbon dioxide. Carbon dioxide is, of course, the major “greenhouse gas” which is thought to contribute to global warming. While global warming is still a controversial issue, alarms have been raised and

governments around the world have agreed that “the balance of evidence suggests a discernable human influence on global climate”. In 1997, the Kyoto Protocol on climate change was agreed to by many countries, including Peru, and its objective was to reduce the emissions of greenhouse gases and, consequently, the impact of these gases on climate change. Among the agreed steps to be taken by signatory countries was to “Implement and/or further elaborate policies and measures in accordance with its national circumstances, such as: (iv) Promotion, research, development and increased use of new and renewable forms of energy, of carbon dioxide sequestration technologies and of advanced and innovative environmentally sound technologies.” Clearly, RAPS meets that requirement. Greenhouse gas reduction is, therefore, a major benefit of RAPS.

Greenhouse gas reduction was also our justification for seeking funds from the Global Environmental Facility for assistance in installing these prototype RAPS systems. We have indeed been granted these funds from GEF as of June, 2000. As part of our application to obtain these funds we attempted to calculate the quantity of greenhouse gases which will be prevented from being released if hybrid RAPS systems can be installed and replicated throughout the Amazon region of Peru. From these calculations extrapolations can be made to all of Peru, and of course, to countries with similar rural populations and electricity requirements throughout the world.

We have concentrated on the Loreto region of Peru. This is where we will install the prototype systems and from where we have the best data. We know that in Loreto, which is the Amazon region of Peru, there are approximately 3000 rural communities without access to electricity. There are records of some 130 of these communities with

small diesel gensets that provide electricity for limited periods of time. In Peru, as a whole, there are 70,000 such communities.

RAPS facilities will be installed in two of these communities namely, Padre Cocha and Indiana in the Loreto Region. These communities were selected mainly because of their awareness of the beneficial impact of the technology combined with their full commitment to support the initiative. Currently, these villages use diesel generators which supply energy for only four to five hours per day. The RAPS systems will provide a 24-hour basic electricity service.

Based on data provided by the Peruvian Ministry of Energy and Mines (MEM), fuel consumption for the 200-kW diesel in Indiana, which runs 5 hours per day, is 42 liters per hour. The new 100-kW diesel in Padre Cocha consumes half this quantity. Thus, the fuel consumption is approximately 210 liters per day at Indiana and 105 liters per day at Padre Cocha. Over a 20-year period, the total fuel consumption for both sites under the present condition would be 2,299,500 liters.

According to the engineering estimates of ILZRO RAPS Peru, the total 20-year fuel consumption under the RAPS scenario would be 1,967,040 liters. With the assumption that, eventually, 24 hour electricity will be demanded by the inhabitants, the total 20-year fuel consumption for a 'prime' diesel system would be 8,070,900 liters. The associated CO<sub>2</sub> emissions have been calculated using 2.716 kg CO<sub>2</sub> per liter and 99% oxidation of oil-derived fuel. These factors given in Tables A1 and 3.1, respectively, in the *Workbook for Calculating Greenhouse Gas Reductions from Projects Using Renewable Energy*, a publication of the *Australian International Greenhouse Partnership (IGP)* ; non-CO<sub>2</sub> emissions have been ignored, as recommended by the IGP.

The first scenario is reflective of the current situation and assumes that the currently operating gensets run 5 hours per day. The second scenario would have the gensets run 24 hours per day. The third scenario is the RAPS scenario, that is, running the gensets for 2.75 hours, but also providing 24 hour electricity. The results are as follows:

Scenario 1	6,183 t CO <sub>2</sub>
Scenario 2	21,701 t CO <sub>2</sub>
Scenario 3	5,289 t CO <sub>2</sub>

Therefore, if the existing gensets at the pilot project sites were augmented by RAPS components and run according to our design we could anticipate a reduction in CO<sub>2</sub> of 894 t over a 20 year period based on the current limited electricity being provide. More appropriately, however, these comparisons should be made with 24-hour electricity provided by diesel-only and by the hybrid RAPS system we have designed. In that case, the CO<sub>2</sub> savings from the pilot installations alone would be 16,412 t CO<sub>2</sub> over the next 20 years.

The objective of the overall RESPAR program is to provide sustainable 24-hour electricity to villages in the Amazon Region of Peru. As is the case in the two pilot sites, the villages are reachable only by watercraft and there is no practical way for the villages to be connected to the national grid system. As mentioned earlier, there are approximately 3000 rural communities in the Loreto Region without access to electricity and records for some 130 of these communities who use small diesel generators to provide electricity for limited periods of time.

In Loreto, 146 diesel gensets have been identified to be in current use, ranging up to 500kW in rating. It is assumed that the generators run 5 hours per day at 50 to 75% of load. This assumption is based on information supplied by E. Ferreyros S.A., which is one of the participants in the RESPAR program, and is the Peruvian distributor of Caterpillar and Solarex products.

Using data from two suppliers of diesel generators, Caterpillar and Detroit Diesel, it has been calculated that fuel consumption ranges from 3.25 to 3.95 kW per liter at 100% load. Thus the average fuel consumption is 3.6 kW per liter. Using this value, calculations have been made of the specific fuel consumption of each of the 146 diesel generators identified in the survey. The resulting total fuel consumption at 100% load is 3766.5 liters per hour. As noted above, however, the generators presently run 50 to 75% of load. Using data from the manufacturer, it has been ascertained that the average fuel consumption of the 146 diesel generators running at 50% - 75% of load would then be 2410.5 kg CO<sub>2</sub> liters per hour. This average value is taken to calculate the baseline CO<sub>2</sub> emissions from existing generators, again using the factors 2.716 kg CO<sub>2</sub> per liter and 99% oxidation of oil-derived fuel. The following two baselines have been determined for a RAPS system with a 20-year life.

- Baseline 1: Present situation, 5-hours per day running time

236,573 t CO<sub>2</sub>

- Baseline 2: 24-hours per day running time

1,135,550 t CO<sub>2</sub>

- Proposed RAPS system for Loreto Region: 24-hours per day running time (100% Of load)

203,307 t CO<sub>2</sub>

Therefore, the savings in CO<sub>2</sub> emissions would be approximately 33,266 t CO<sub>2</sub> when compared with the present situation (Baseline 1). However, it is considered that a 24-hour running time (Baseline 2) is the ‘single most likely alternative’ given the growing demand for a continuous supply of electricity. In this case, the CO<sub>2</sub> savings would be 932,243 t CO<sub>2</sub>. A very similar figure was obtained using average emission factors for CO<sub>2</sub> from a diesel genset manufacturer (Detroit Diesel) and from the U.S. Environmental Protection Agency.

Also, by way of comparison, a consultant to ILZRO calculated the CO<sub>2</sub> emissions savings in a somewhat different way, using data from the Santa Barbara Air Pollution Control district and comparing the fuel consumption from using a prime diesel versus our RAPS system to produce 300kW hrs of 24-hour electricity per day—our base case. Assuming 150 communities in Peru were to install such systems—remember, there are some 70,000 rural communities in Peru, the CO<sub>2</sub> emissions savings over 20 years would be nearly 1 million tons. Using these assumptions, the following 20-year savings in additional pollutant emissions were also calculated.

- Nitrous Oxides 21,072,106 kgs
- Total Suspended Particulates 806,237 kgs
- Hydrocarbons 2,795,710 kgs
- Sulfur Dioxides 1,044,444 kgs
- Carbon Monoxide 29,757,479 kgs

Therefore, using a variety of available inputs including data from the Loreto region of Peru, we have established that there would be significant savings in the emissions of greenhouse gases and other noxious pollutants if hybrid RAPS systems were to be successfully installed, operated and replicated in rural areas of Peru.

### ***Recycling of Batteries and Used Oil***

There are two primary items in the RAPS system that will require recycling for environmental purposes. These are the batteries and the used engine lube oil. The batteries are made largely from lead, so it is critical to the environment that they are disposed of properly at the end of service. This task will be done when the new batteries are purchased and installed. Typically, the battery installer will remove the old batteries and send them to a recycling center. Since nearly all of the batteries will be replaced at the same time, they will be sold to a secondary recycling business to ensure that they are removed in an environmentally appropriate manner from the community. The financial incentive to do this recycling comes from the fact that the used batteries have a significant salvage value.

Disposal of used lube oil from the diesel generators has traditionally been a problem with remote generators. This used oil is generated every time an oil change is performed, which is 35 times per year for a continuously operating diesel generator. For a 200-kW generator with a 30-liter oil sump, the annual production of waste oil is 1,000 liters, or 5 full drums. Because of the dramatic reduction in the operating hours of a hybrid system, only four oil changes are required a year. Total production of used oil is

60 liters per year at the 300 kW per day community and 120 liters per year at the larger community.

Disposal of used oil traditionally has been accomplished by one of three methods:

1. removal of oil from site for recycling;
2. burning of used oil by dripping it into the fuel supply of the generator;
3. pouring it into the ground.

Obviously, method (3) is totally unacceptable for environmental reasons.

Method (2) is also unacceptable because of increased emissions from the generator. Thus, the only reasonable choice is to collect the oil and transport it to a centrally located recycling facility (in Iquitos). Because of the small amounts of oil produced, this can easily be done once a year during one of the fuel delivery or maintenance visits. There will be a written procedure with the maintenance subcontractors with a specific check-off to ensure that the oil is recycled in this manner. Along with the oil recycling procedure, the fuel delivery or maintenance sub-contractors should also be required to remove all used fuel drums from the site during each visit.

### ***Replication***

The RESPAR initiative has sparked considerable national interest and expects to generate investments in RAPS systems from both the public and the private sectors, and to lay the foundation for a large-scale program. The plans are to encourage replication of the systems in communities which currently rely entirely on diesel generators to produce electricity. This will represent a substantial decrease in greenhouse gas emissions, compared with providing 24-hour electricity solely by diesel generators. The program

will also improve the capability for building, operating and maintaining RAPS systems, and hence will strengthen the national capacity of Peru to participate in the Clean Development Mechanism (CDM) put forth by the Kyoto Protocol and the United Nations Framework Convention on Climate Change. To meet the requirements of the CDM mechanisms, a system will be put in place to measure and monitor the actual reductions in greenhouse gas emissions. This will give the project the potential for participating in the Carbon Emissions Trading Market and should attract investors to participate in its development. In addition, the educational component of the program will train consumers on the efficient use of energy and will promote income-generation activities.

These actions will allow the ILZRO RAPS PERU Program to not only increase the productive activities and the economic well-being of the rural areas of the Amazon Region, but will provide major environmental benefits through the reduction of greenhouse gases and the recycling of used batteries and oil. Thus, regional development will be accelerated in concert with added protection to the environment. The RESPAR initiative will thus have the opportunity of being viewed by many as a potentially highly credible CDM initiative.