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large generator fails. That is, the BG units will provide Ten Minute Reserve capacity. An important feature of most backup units (mostly, they are internal combustion engines or gas turbines) is that they can be rapidly started. In fact, most BG units can be brought on line within ten minutes, the criterion to qualify as a Ten Minute Reserve according to Eskom practice. Therefore, these BG units can be used as Ten Minute Reserve units, even though they are not actually operating during normal duty. Using BG units to provide Ten Minute Reserve will save energy and reduce emissions of greenhouse gasses, while still keeping these BG units available to satisfy their primary mission, which is to operate during emergencies to provide electricity for critical services.

**Survey of Backup Generators in South Africa**

Surveys were conducted on the available BG capacity at two levels. A detailed survey identified 101 MW of BG capacity located in the province of KwaZulu Natal in order to obtain detailed information required for a design of an incentive system described below. A grosser survey was conducted to estimate the total BG capacity in all of Eskom's service territory. A minimum of 670 MW of standby BG capacity in South Africa was estimated from this survey.

**Automated Standby Generation Dispatch System**

One of the approaches to reducing CO₂ emissions is to dispatch backup generation to supply ten-minute reserves. The specific approach uses commercially available monitoring and control systems to dispatch the backup generation units. The core of the proposed approach is to use the Signature System™, jointly developed by Dranetz-BMI and Electrotek Concepts, in cooperation with the Electric Power Research Institute and Tennessee Valley Authority. The Signature System, when coupled to conventional system control and data acquisition (SCADA) systems, are deployed at sites where backup generators are located, to monitor and control the DG units located within the enclosure. Each Signature System communicates with a system aggregator, via an internet connection, and will respond to dispatch orders from the Eskom system dispatcher.

The unique value of the system is premised on large amount of existing standby or emergency generation in South Africa, which is now used only in the event of a utility supply disruption. With incremental modifications of the electrical interconnections and control, and the addition of the information system overlay in the form of the generator

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3 For a description of the Signature System™, see Task 3 report, Conceptual Architecture and Requirements for an Automated Standby Generation Dispatch System.
interface controller, it is conjectured that a capacity resource can be created to take advantage of market prices for 10-minute reserves.

For existing BG with automatic transfer switches, the following table details the estimated costs for the information system components.

<table>
<thead>
<tr>
<th>Item</th>
<th>Comment</th>
<th>Number per Installation</th>
<th>Unit Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local DG Interface and Control Unit (infoNode)</td>
<td>Includes communication interface</td>
<td>1</td>
<td>$4000</td>
<td>$4000</td>
</tr>
<tr>
<td>Local Data Acquisition Unit</td>
<td>Must be configured for direct and continuous measurement of load in transferrable circuits</td>
<td>1</td>
<td>$1200</td>
<td>$1200</td>
</tr>
<tr>
<td>Generator Status Interface</td>
<td>Mini RTU-like module for collection of generator status and other low-speed analog signals</td>
<td>1</td>
<td>$1500</td>
<td>$1500</td>
</tr>
<tr>
<td>Local Control Interface</td>
<td>Integration with existing SCADA for automated operation of generator and transfer switch; additional hardware for digital output if there is no system available</td>
<td>1</td>
<td>$500</td>
<td>$500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$7700</strong></td>
</tr>
</tbody>
</table>

**Incentive system for BG Owners**

The shortfall in operating revenues that would be experienced for the approximately 75 MW of BG units in KwaZulu Natal if they were dispatched 100 times per year to provide 10-minute reserves in lieu of the existing centralized coal-fired plants ranges from $500K to $800K per year for the 75 MW of BG in KwaZulu Natal.

In the Task 1 report it is estimated that about 750 MW of BG replacing existing coal-fired units for 10-minute reserves will reduce nearly a half million tons of CO2 emissions. The savings that could be realized by replacing existing coal-fired plants with BGs is about $3 million of which $1 million ($2/ton CO2 reduced) is derived from CO2 emission allowance credits. However, based on the above, a minimum of $5 million to $8 million would have be provided to BG owners to compensate them for turning on their generators. There are two direct ways of providing this amount of payment; 1) obtain a higher price for CO2 emission credits and/or 2) impose a carbon tax on emissions.

4 See task 4 report, “Incentive system for BG Owners.”

CONCLUSION

To generate adequate revenue to BG owners would require a combination of a carbon tax and CO₂ emission reduction credits of from $3 million to $5 million per year or about $6.5 to $10.5 per ton of CO₂ reduced.