DRS TECHNOLOGIES
A Finmeccanica Company

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Energy Recovery From Generator Testing

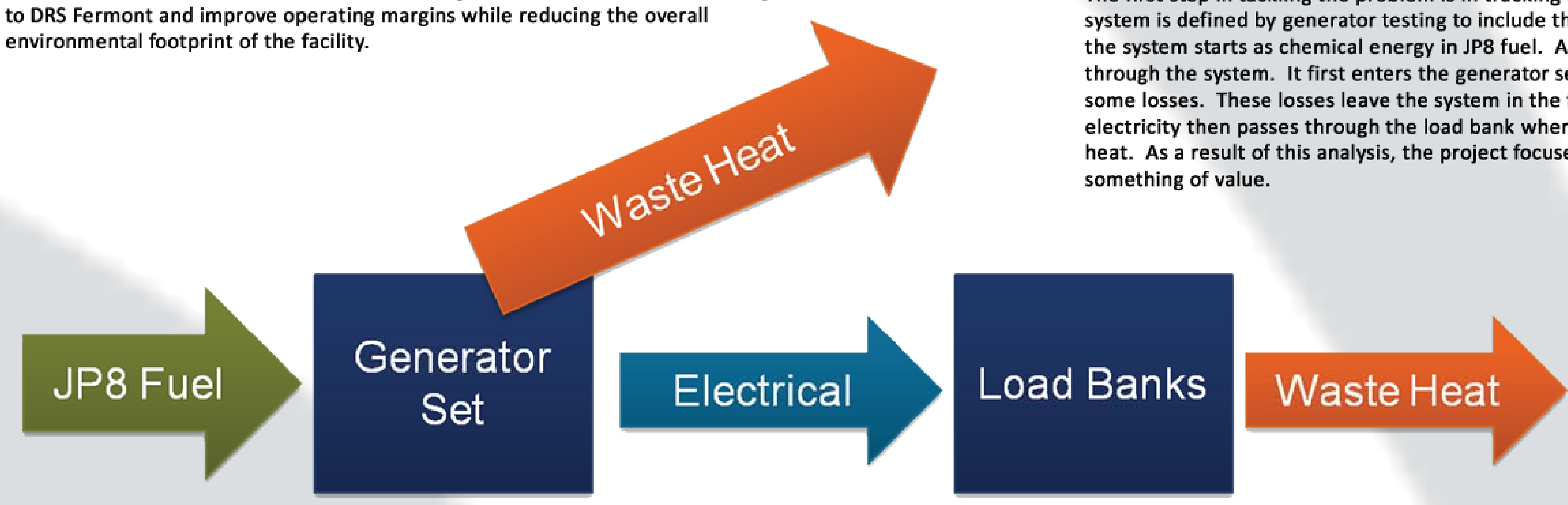
The Problem

DRS Fermont operates generator set ("genset") testing facilities which provides a checkout test to 100% of units shipped in addition to more extensive testing of selected units. This testing process is mandated by Defense Standards for gensets and the procurement contracts under which DRS supplies the military. The testing requires that gensets be tested under resistive and reactive loads at various power outputs and various failure conditions to ensure that the gensets remain stable and operational.

This study examines ways in which the output of gensets during testing can be monetized rather than released as waste. Doing so can offset the cost of testing to DRS Fermont and improve operating margins while reducing the overall environmental footprint of the facility.

Following The Energy

The first step in tackling the problem is in tracking energy as it flows through the system. The system is defined by generator testing to include the generator and load bank. The only energy in the system starts as chemical energy in JP8 fuel. Analysis then follows this energy as it flows through the system. It first enters the generator set where it is converted into electricity with some losses. These losses leave the system in the form of waste heat. The energy converted into electricity then passes through the load bank where it is converted from electricity into waste heat. As a result of this analysis, the project focused on changing the end energy forms into something of value.



Waste Heat From Load Banks

The second waste energy stream to be examined was the waste heat from the load banks. Again the energy leaving in the form of heat was of significant quantity, but exceedingly low quality. This is due to the airflow management system currently on the load banks which is designed to keep them near ambient temperature. Again, the solutions of highest value surrounded helping to heat the facility in the winter and cool it in the summer.

In following where this waste energy came from, the team found that it came from electricity, which is a high quality energy form. Since the load banks were not outside of the scope of this project, it was determined that they could be changed to allow electricity to pass through the system for monetization. The difficulty in such a solution was that the load banks were the units involved in testing the load banks, and a different solution that passed electricity through would need to fulfill those same testing requirements.

Waste Heat from Generators

The first waste energy stream to be examined was the waste heat from the generators. The energy flow analysis showed that the energy leaving in this form had significant quantity, but not high quality. As a result, the team attempted to find ways of using low quality heat for maximal value. The solutions of highest value appeared to be in using the heat to help heat the facility in the winter and utilizing other technologies which would allow the low quality heat to cool the facility during the summer.

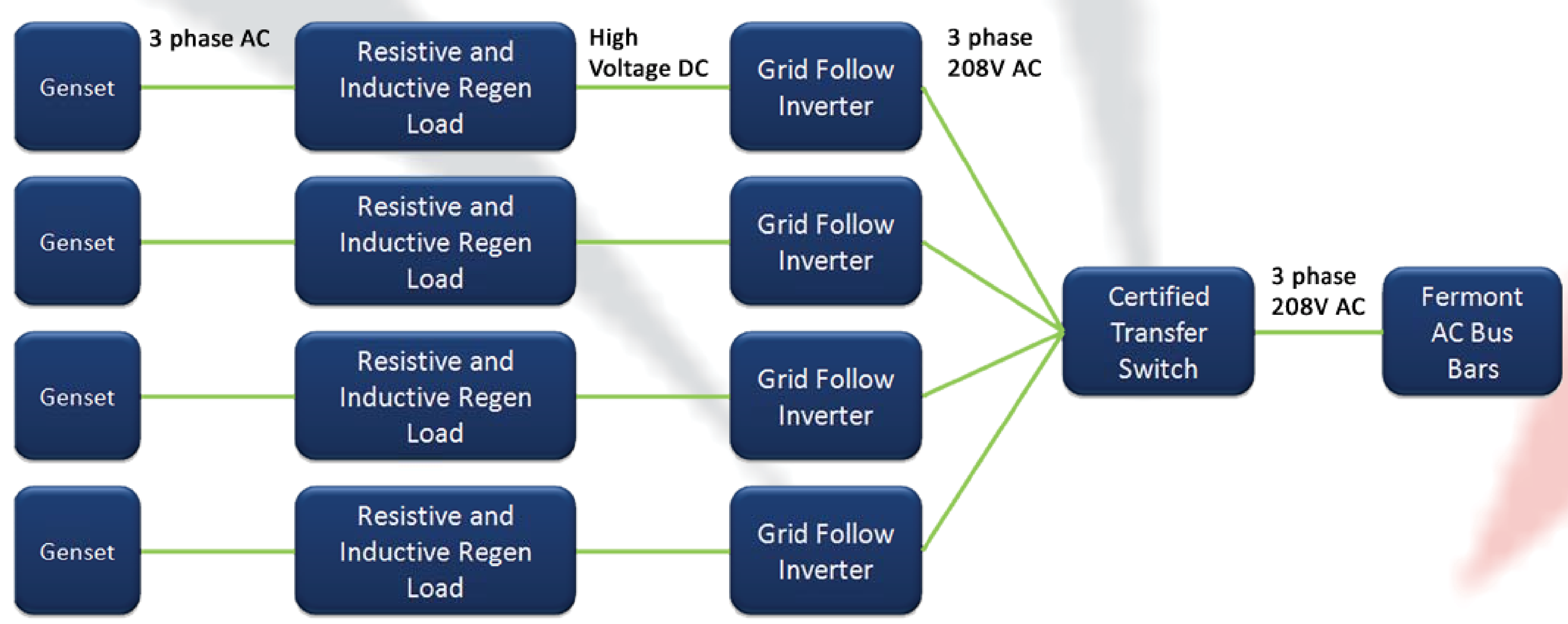
The other possibility is to try and find where the waste energy comes from in order to determine a way of utilizing it further upstream. In this case, the only way to change this would be to remove the waste stream from the generator set, which is well outside of the scope of this project.

The Solution: Regenerative Load Banks

The solution we found to recovering economic value from the generator testing process is Regenerative Electronic Load Banks. Regenerative Load Banks operate by producing a "virtual" load of an arbitrary form with poly-phase bridges that shunt current at the desired rates from the desired phases of the generator.

The diagram to the right shows how four of these load banks can be arrayed to construct a complete load cell for use at DRS Fermont. This cell would test 4 of the smaller gensets while recovering the energy they create during testing.

There are several constraints on the regenerative load, foremost of which is testing requirements for gensets. It is not reasonable to alter the military specification testing regime proscribed in the procurement contract to allow for recovery. The load system must also comply with state and local regulations for devices connected to and feeding the electric grid. For this reason the inverters and transfer switch are all off-the-shelf and pre-certified components to minimize the regulatory overhead of the system.



Modeling Economic Benefits

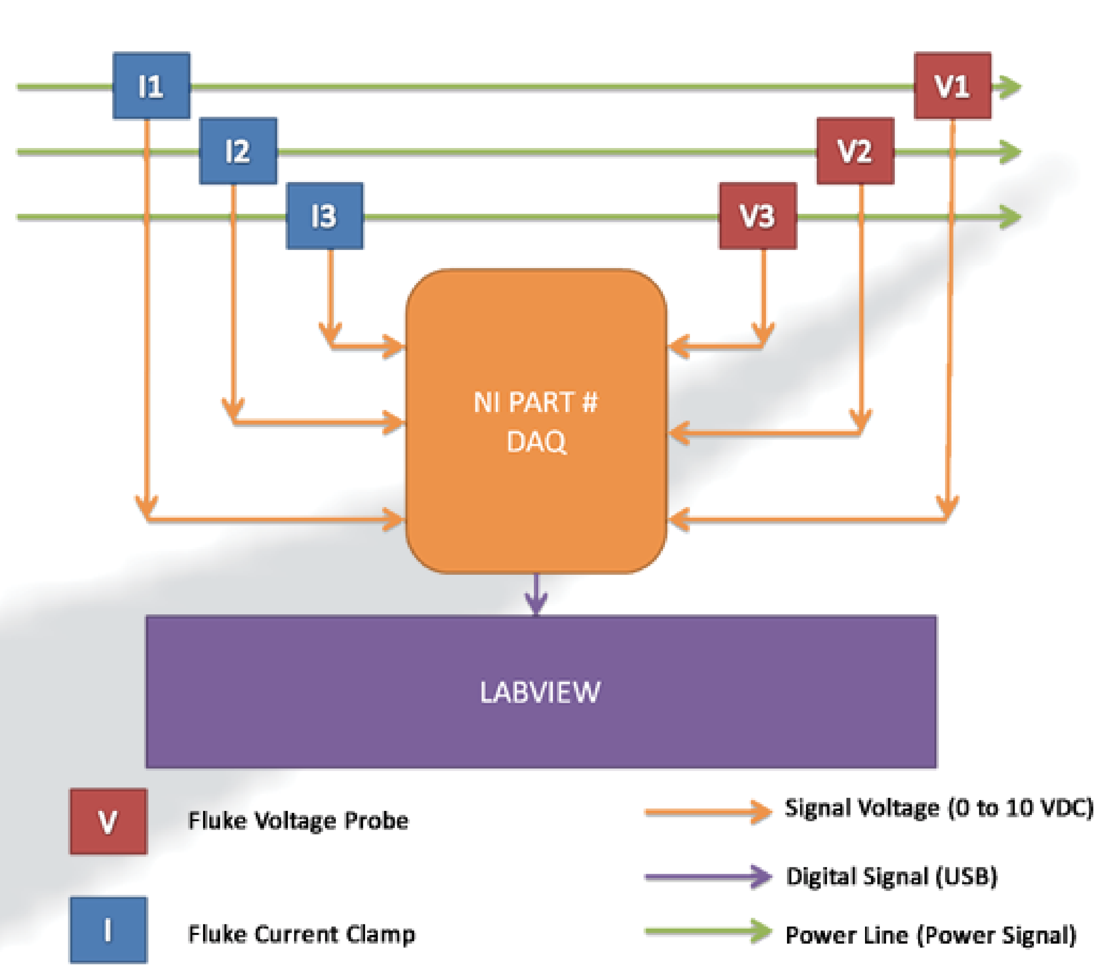
Quantifying the economic returns of switching to an electronic load bank recovery system required the creation of an economic model to determine its benefits. This model would include the various costs and returns associated with a regenerative load bank. The output would show the length of time required for the system to break-even as well as the returns over time. The model was constructed in such a way that as assumptions change, DRS would be able to correct the model to reflect those changes.

The other part of the economic benefits section involved looking at the incentives which DRS can utilize to help implement regenerative load banks. The team searched for various programs which would help offset the cost of creating the system. The incentives found were in different forms offering different utility in terms of helping DRS. Grants and zero interest loans were the most common incentives found.

Testing and Qualification

Military Specifications require that each load bank meet certain requirements that govern how close load banks must come within the nominal power values specified by the Procurement Documents. In order to verify that the regenerative loadbanks meet this requirement, we created a testing system using LabVIEW software.

The testing system uses an NI data acquisition card to take differential voltage inputs and send them to the software. Voltage probes with a 100:1 reduction are used to convert line voltage to the 0-10V input signal for the DAQ, and current clamps transducer sensed current to a similar signal. LabVIEW software takes these raw data in and converts them into line voltage and current before performing calculations on them. The most important variables are the Real, Apparent, and Reactive power, as well as the impedance.



Deployment

The overall structure of the system is based around ease of implementation using external sources for each component. The external components used are a regenerative load bank, certified grid connect inverter, and certified transfer switch. The architecture of the proposed system is meant to be one that can be phased in cell by cell and component by component in order to minimize testing down time. Thus, each genset has its own load bank and inverter, which connect into a transfer switch that each group of gensets shares.

In terms of power, the regenerative load banks will be smaller than the present setup, but will maintain a 1:1 ratio of load bank to generator. This will help keep costs lower because the electronic components do not need to be oversized. The 1:1 ratio also means that in the event of a component failure, only one test station is affected. Those connect into the AC bus bars of the DRS Fermont facility. Optionally, a battery storage system can be connected between the regenerative load bank and inverter.

Vendors

Several companies have been identified and contacted with regard to supplying electronic regenerative load banks. None of these vendors offer an AC electronic regenerative load as a commercial product at this time. Several are in the process of developing a product or would be willing to develop such a product.

To formalize the process of contacting vendors a Request for Proposals (RFP) was developed and transmitted to vendors. Responses to the RFP formed the basis of our economic estimates of product cost and allowed us to provide DRS with opportunities to develop and deploy the regenerative load. Companies with great potential include PPM Instruments and TesSol, both of whom responded to the RFP.