SSE Power Distribution

Innovation Funding Incentive Reports

Scottish Hydro Electric Transmission Ltd

for period 1 April 2007 to 31 March 2008

Contents

1. Executive Summary

Over the last year, the Innovation Funding Incentive (IFI) has become more established within SSE Power Distribution (SSEPD). Our experience of the distribution network activities carried out within the IFI scheme has made a significant contribution to a greater recognition within SSEPD of the importance of research and development activities along with the successful deployment of innovations.

During the year ended 31 March 2008, Scottish Hydro Electric Transmission Limited (SHETL) has initiated a programme of transmission research and development projects.

This programme has a wide range of activities with specific projects to address identified problem areas. In particular, we have projects that are looking to improve the capability of the transmission network and facilitate the connection of renewable generation. Wherever possible we have sought to minimise the cost of these activities by seeking complementary funding and forming collaborations.

The total qualifying expenditure for the reporting period of 1 April 2007 to 31 March 2008 has been £440,000 for SHETL.

2. Introduction

As part of the April 2005 Distribution Price Control Review (DPCR), Ofgem (the regulatory body for the energy industry) introduced an Innovation Funding Incentive (IFI). The primary aim of this incentive was and is to encourage network operators to apply innovation in the way they pursue the technical development of their networks. This has now been extended to the electricity transmission licensees. A Good Practice Guide (Engineering Recommendation G85 Issue 2 – December 2007) has been produced and is available free of charge via the website of the Energy Networks Association (ENA): www.energynetworks.org.

The IFI mechanism is intended to provide funding for projects primarily focused on the technical development of the networks to deliver value (i.e. financial, quality of supply, environmental, safety) to end consumers. IFI projects can embrace aspects of transmission and distribution system asset management from design through to construction, commissioning, operation, maintenance and decommissioning. A network operator is allowed to spend up to 0.5% of its Base Transmission Revenue (subject to a minimum of £500,000) on eligible IFI projects.

Open reporting (i.e. available in the public domain) of IFI projects is required by Ofgem; this is intended to stimulate good management and promote sharing of innovation good practice.

In line with this, we will publish our IFI reports on the SSE Power Distribution (SSEPD) website: www.ssepd.co.uk. To enhance their accessibility, they will also be available on Ofgem's website: www.ofgem.gov.uk

SSEPD and its energy network subsidiary SHETL welcomes this initiative as a positive measure to further improve customer service, enhance safety, address environmental issues and reduce costs.

3. Scope

This document contains SHETL's IFI annual report produced in accordance with Special Licence Condition J5.

It details activities in the period from 1 April 2007 to 31 March 2008.

A summary report has been provided for the licence area supported by detailed individual project reports. These reports have been produced in accordance with the Regulatory Instructions and Guidance issued by Ofgem and ENA Engineering Recommendation G85 and G85 Issue 2.

In addition to reporting on activities in 2007/08 we have included information on current projects and intended developments.

4. Overview of IFI Activity

Our programme of transmission IFI projects in 2007/08 is made up of a number of projects which have originated as a result of collaborative work with external organisations and others which have originated internally. The latter have emerged from our own analysis of areas of work which could benefit from an innovative approach such as maximising overhead line capacity by deploying dynamic line rating equipment coupled with newly available Global Systems for Mobile (GSM) communications technology.

In the SHETL area, considerable amounts of renewable generation, mainly wind farms, are in the process of being connected to our network. However, network constraints have become apparent in many geographic areas which currently limit the amount of generation we can connect until extensive transmission reinforcements are completed. We believe innovative methodologies can be developed to allow more generation to be connected to the existing infrastructure. SHETL are progressing research to reduce the effect of current constraints.

This work continues in 2008/09 and involves the evaluation of two dynamic line rating systems in order to develop our understanding of these techniques which could lead to determining the extent to which the capacity of the existing infrastructure can best be utilised.

5. Financial Summary

Qualifying expenditure for the reporting period of 1 April 2007 to 31 March 2008 has been £440,000 for SHETL of which £35,000 relates to internal costs. The overhead costs associated with the employment of a full time R&D Manager and a Project Manager have been apportioned across the portfolio of projects.

Financial information on the IFI projects relevant to the reporting year 1 April 2007 to 31 March 2008 are contained in the individual reports for SHETL and set out in the following sections and listed in appendix 1.

Adoption costs have not been included at this stage but will be evaluated and taken into consideration as individual projects progress and application to the business can be more accurately assessed.

6. Conclusion

SSEPD recognises the key role that research and development can play in enabling our industry to meet the challenges of an ageing infrastructure, a need for continuous improvement in customer service and the changing generation mix with the growing importance of distributed energy resources.

We are committed to the successful exploitation of our current programme of projects and will develop our portfolio to address areas that will deliver further benefits.

Section 7

Scottish Hydro Electric

Transmission Ltd

IFI Report

for period

1 April 2007 – 31 March 2008

Scottish Hydro Electric Transmission Ltd IFI Report

Summary report of IFI project activities:– April 2007 – March 2008

Base Transmission Revenue , PRt	£51.6m
IFI Allowance	£500,000
Unused IFI Carry Forward to 2008/2009, KIFIt	£60,000
Number of Active IFI Projects	5
Summary of benefits anticipated from IFI Projects.	PV of benefits is £1,745,000 Various customer, safety, and environmental benefits will accrue along with more effective utilisation of existing assets
External Expenditure 2007/2008 on IFI Projects	£405,000
Internal Expenditure 2007/2008 on IFI Projects	£35,000
Total expenditure 2007/2008 on IFI projects.	**£440,000**
Benefits actually achieved from IFI projects to date.	Nil as projects are at an early stage

Regulatory Report for IFI Reporting year 2007/08 Scottish Hydro Electric Transmission Ltd	**£m**
IFI carry forward to 2008/09 (£m)	**£0.060**
Eligible IFI Expenditure (£m)	**£0.440**
Eligible IFI Internal Expenditure (£m)	**£0.035**
Base Transmission Revenue (£m)	**£51.6**

Section 8

Scottish Hydro Electric Transmission Ltd

Individual IFI Project Reports

for period

1 April 2007 – 31 March 2008

Flow Battery Trial: – April 2007 – March 2008

Description of project	The provision of standby ac and dc supplies at transmission substation sites have almost exclusively been provided by generators and lead acid batteries. New technologies are now emerging which may offer superior performance with reduced maintenance and installation costs but to date there has been no operational experience within the UK. An early review of the available options was completed during 2006 as part of an internal innovation initiative and this has suggested that modular flow battery technology is currently one of the most suitable options sufficiently advanced to be considered for a trial installation. The study will initially comprise an evaluation of existing flow battery technologies and manufacturers to determine any safety or environmental constraints. A contract will be placed with a suitable supplier to provide and install a complete system connected as the standby supply for ac supply. The performance of the battery and control systems will be monitored remotely by a consulting engineering company for a period of one year. Maintenance activities will be recorded and the consultant will produce a report detailing how the unit has performed. The suitability of the technology will be fully discussed and recommendations for future flow battery installations shall also be included.		
Expenditure for financial year 2007/08	Internal = £3900 External = £84,000 Total = £87,900	Expenditure in previous financial years	£0
Technological area and / or issue addressed by project	. There are five main objectives of the study 1. To establish the suitability of a flow battery for providing substation ac and dc supplies as an alternative to conventional generators and lead acid batteries. 2. Gain operational experience in the operation and maintenance of an established flow battery technology. 3. Test the viability of monitoring conventional and new battery technologies remotely using proprietary software and a data link. 4. Validate the round trip efficiency claims for this type of energy storage device. 5. Determine the economic and operational benefits of using flow battery technology in existing substation asset replacement programmes.		
Type(s) of innovation involved	Technical Substitution / Radical		
Expected Benefits of Project	Provision of an alternative standby supply for substations where supplies would traditionally have been provided by either a discreet network connection which may require extensive works to provide the supply. Or from a standby generator installation at site. Environmental and safety benefits are expected from the deployment of the system due to the outdoor location. Financial benefits will result in the reduction of construction costs for the building due to the outdoor location of the units.		

	The deployment of the system will allow a greater insight into the possible applications for the flow battery technology which is used within the PB150.				
Expected Timescale to adoption	2 Years	Duration of benefit once achieved	10 Years		
Estimated Success probability (at start of project)	50%				
PV of Project Costs	£ 165,525	PV of Project Benefits	£277,230	NPV of Project	£115,137
Commentary on project progress and potential for achieving expected benefits	The project is currently on target with the initial scope for the project agreed along with technical specifications for the unit. Site installation is expected during the next few months with the test and evaluation programme to commence on completion of installation.				

275kV Woodpole Design: – April 2006 – March 2007

Description of project	Scottish and Southern Energy are to investigate the possibility of a single wood pole line operating at 275kV. The system would be unearthed and would use Upas (300mm^2) as the single conductor.				
Expenditure for financial year 2007/08	Internal = £3,900 External=£4230 Total = £8130	Expenditure in previous financial years	£0		
Technological area and / or issue addressed by project	The initial purpose of the project was to investigate the following:- • Feasibility • Aspects of design • Support structures • All major line components required • Costs This will be followed by the production of the stage developments:- • Stage 1 – Outline design • Stage 2 – Modeling and analysis of structures • Stage 3 – Detailed design, engineering drawings and structure drawings with materials lists.				
Type(s) of innovation involved	Incremental / Significant / Technological Substitution				
Expected Benefits of Project	The principal output of this project will comprise:- • A comprehensive report detailing the deliverables of stages 1, 2 & 3 which will satisfy all the objectives of each of the stages namely: • A detailed engineering specification which will allow SSE to construct a 275kV Low Profile Overhead line virtually anywhere in the UK and allowance is made for site construction difficulties that may be encountered; • Overall design compliance with CDM Regulations will be demonstrated				
Expected Timescale to adoption	3 Years	Duration of benefit once achieved	10 Years		
Estimated Success probability (at start of project)	50 %				
PV of Project Costs	£254,230	PV of Project Benefits	£406,768	NPV of Project	£152,538
Commentary on project progress and potential for achieving expected benefits	A feasibility study has been completed for consideration with the project currently under review.				

Dynamic Line Rating: – April 2006 – March 2007

Description of project	There has been growing interest in the use of dynamic ratings for transmission circuits. This is the concept of varying the thermal rating of part or all of a circuit according to the ambient conditions. A number of systems have now been developed varying in complexity from using macro weather data to online dynamic measurements of circuit parameters. This project will assess current available technologies and how these can be integrated within the system operator's display and functional tools. The implications of deploying these systems will be investigated with regards to load management and system planning.		
Expenditure for financial year 2007/08	Internal = £4,900 External = £96,000 Total = £100,900	Expenditure in previous financial years	£0
Technological area and / or issue addressed by project	Understand the available technologies for dynamic load monitoring and their capabilities. Understand the benefits and risks for different parts of the business. Trial selected technologies and evaluate their performance.		
Type(s) of innovation involved	Technical Substitution / Radical		
Expected Benefits of Project	A review of the currently available technologies. Determination of how dynamic circuit ratings can be used in control rooms and by planners and the implications. This will include any changes in structure or new information sharing that may be required. Investigate the benefits and any additional risks associated with dynamic ratings Investigate how the software associated with different dynamic ratings can be incorporated into SSE network management systems. Identify a suitable trial site for dynamic circuit ratings and select the dynamic rating system(s) to be used. Install the dynamic rating equipment and monitor for 12 months. Evaluate the additional capacity achieved with the equipment. Make recommendations as to the addition or different modelling planners may have to carry out when developing new parts of the network. Make recommendations as to how extensively the technology can be used and in what areas of the network. Make an estimation of the resulting savings in capex and opex.		
Expected Timescale to adoption	1-3 years	Duration of benefit once achieved	2-7 years
Estimated Success probability (at start of project)	50%		

PV of Project Costs	£152,504	PV of Project Benefits	£197,481	NPV of Project	£48,465
Commentary on project progress and potential for achieving expected benefits	The initial phase of the project has been to select suitable systems for evaluation of information. The chosen systems will provide output information for evaluation as to the possible increase in capacity which could have been ulitised on the trial circuits. Installation of the Valley Group CAT-1 equipment has taken place on four circuits within the SHETL area; data will be required for calibration over the forthcoming months with expected data output for evaluation in 12 months time. Evaluation of a second identified system is being considered at present in order to provide correlation between systems. System interfaces with existing SCADA systems are being investigated in order to determine the optimum end user display format for the network operators.				

275kV Alternative Conductor: – April 2006 – March 2007

Description of project	New Conductor system for L3 towers operating at 275kV An overhead line project has been identified which requires a second circuit to be strung to allow for the export of power from the wind farm connections. Planning's request was for 700mm^2 AAAC operating at 50Deg C giving 1240A pre-fault continuous rating (1470A post fault). Tower analysis revealed that the conductor would overload the towers and would have approx. 50 ground clearance issues requiring towers to be increased in height. This proposal is to cover the development of an alternative conductor to reduce the clearance issues and reduce the loading on the towers without decreasing the rating.		
Expenditure for financial year 2007/08	Internal = £ 16,400 External = £131,000 Total = £147,000	Expenditure in previous financial years	£0
Technological area and / or issue addressed by project	1) Produce conductor systems and testing specifications and procedure for declaration of conformity all for conductors operating at 132kV and above to allow tendering process to take place. 2) Use a consultancy engineering company to advise and carry out study to determine possible conductor options available and provide engineering brief to aid tendering process. 3) Identify through tender process a conductor manufacturer able and willing to develop conductor to suit the Project specific data and loading conditions. 4) Conductor manufacturer and fittings manufacturer to produce conductor sample, carry out type testing of conductor, associated insulators and fittings to ensure project specification met. 5)) Use a consultancy engineering company to advise and assist with conductor development and to carry out quality control throughout the difference phases of conductor development and testing. 6) Carry out further engineering design checks to determine effect of new conductor on the L3 tower suite i.e. to identify and include solutions for: ground clearance issues; tower member strengthening; foundation reinforcement requirements.		
Type(s) of innovation involved	Incremental / Technological Substitution		
Expected Benefits of Project	A specification for the procurement of a new conductor will result from a successful output from the project which includes verification of conformity and testing specification. Conductor and fittings manufacturers will be identified for the supply of the conductor and fittings. Upgrading of transmission circuits without the requirement for major infrastructure development is expected. The project will have addressed the issues surrounding ground clearance, tower strengthening and foundation reinforcement requirements along with associated financial cost benefits.		

Expected Timescale to adoption	3 Years	Duration of benefit once achieved	30 Years		
Estimated Success probability (at start of project)	50%				
PV of Project Costs	£ 233,163	PV of Project Benefits	£678,773	NPV of Project	£476,357
Commentary on project progress and potential for achieving expected benefits	Tendering works now complete and the successful tenderer on board and working on the conductor development works. The SSE specification SP-PS-363 is in Draft format at present and will be reviewed and updated as necessary during development with a final version authorised and issued following completion of this type registration process (on-going internal costs still being incurred). Lamifil appointed to develop the conductor system i.e. their proposed 625mm^2 AAAC compact conductor. Lamifil have purchased the appropriate raw materials to refine the dies necessary to manufacture the conductor. Tyco are also in the process of developing joints to match the outer diameter of the conductor. Both parties (Lamifil lead role) working to develop a testing schedule to meet the Project Specification which will include provision and delivery of all necessary materials (insulators, fittings, etc.) at the test laboratory sites for a full conductor systems test rather than just the individual parts. The early indications are that the manufacturing of the conductor and joints would be complete around the 2nd May 2008 with the supplier's internal mechanical tests and adjustments carried out thereafter over a three week period. The first tests would start week commencing 19th May 2008 with an end date of 22nd July 2008, but these dates may vary and move depending on progress made. LSTC have been appointed and on-going debate and support being provided to aid the process with regard to quality control, conductor development and suitability for use on L3 towers.				

132kV Trifurcating Joint: – April 2006 – March 2007

Description of project	It is proposed to develop a new 132kV 3 core fluid filled cable to single core polymeric cable trifurcating joint.				
Expenditure for financial year 2007/08	Internal = £5,900 External=£90,000 Total = £95,900		Expenditure in previous financial years	£0	
Technological area and / or issue addressed by project	The manufacture of 3 core fluid filled cables will cease during 2008 when Prysmian close the factory at Eastleigh, Hampshire. There are currently two manufacturers providing a joint for this purpose but both joints are very large and require a joint hole about 12 metres long and 3 metres wide. The practicality of installing these joints in built up areas will be very difficult and may entail laying long lengths of cable to find suitable joints bays. The aim of this project is to develop a new joint that can be installed in a much shorter joint bay and use a plug and socket connection for the polymeric cable. Most of the components used in the joint have already been designed and type tested but have not been used in this combination before. The project is to design a suitable joint with the design, testing and manufacture of the joint carried out by G&W in USA. It is anticipated that the project will take about 9 months to complete starting in February 2008				
Type(s) of innovation involved	Incremental / Significant / Technological Substitution				
Expected Benefits of Project	Development, testing and production of a full specification for the manufacture of a 138kV transition joint for oil filled cable systems to XLPE cable systems. Environmental benefits are expected from the reduction in leakage rates from the oil filled cables in use.				
Expected Timescale to adoption	3 Years		Duration of benefit once achieved	10 Years	
Estimated Success probability (at start of project)	50 %				
PV of Project Costs	£115,116	PV of Project Benefits	£185,240	NPV of Project	£32,202
Commentary on project progress and potential for achieving expected benefits	Project is currently on target with the development of the specification for the joint having been completed. Test joints are to be completed on test rig on delivery of suitable sections of oil filled cable which are required in order to carry out the test joints.				

Appendix 1: Summary Listing of IFI Project Costs

	SHETL Int Cost	**SHETL Total Cost**
Flow Battery Trial	£3,900	£87,900
275kV Wood Pole Design	£3,900	£8,130
Dynamic Line Rating	£4,900	£100,900
275kV Alternative Conductor	£16,400	£147,000
132kV Trifurcating Joint	£5,900	£95,000
Total	**£35,000**	**£440,000**

Appendix 2

Dynamic Line Rating on SHETL Transmission Overhead Lines Using the CAT-1 System

WHY TENSION MONITORING?

1. Increases transmission capabilities by 10-30%, safely and economically.

- Unmonitored lines are operated on conservative assumptions (static or "book" ratings).
- When a transmission path is contingency-limited, a small rating increase in the limiting line makes a much larger improvement in the complete interface rating.

2. Very high accuracy - measures sag within 1-2 inches (3-6 cm).

3. Rates lines the same way they are designed.

- Each span must maintain mandated regulatory clearances to the ground.
- Keeping tensions above design minimum values guarantees safe clearances.
- Tensions vary due to variation in line currents, wind, solar radiation, and ambient temperature.

4. Tension is directly related to the average conductor temperature of the suspension section.

- Weather data and spot conductor surface temperature are not accurate measures.

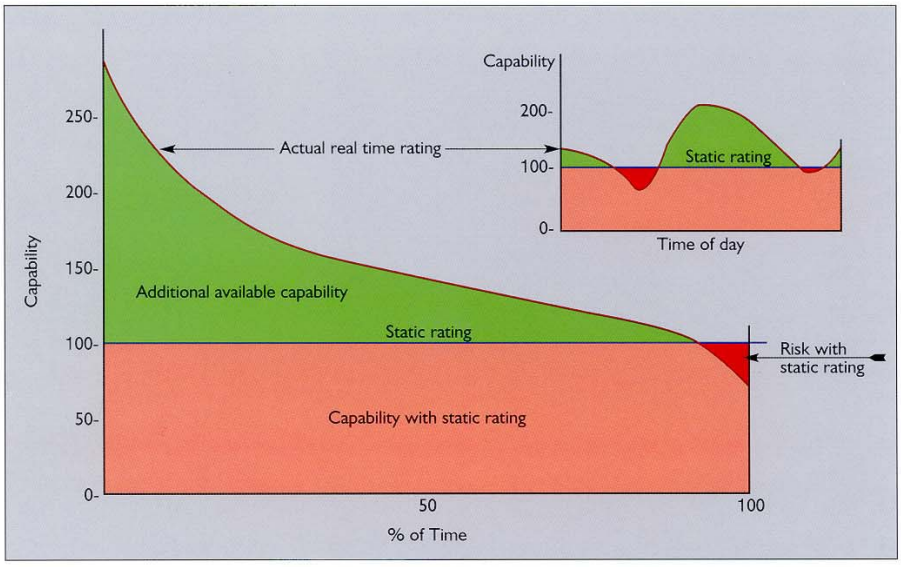
5. Even conservative "book" ratings are not 100% safe and reliable.

- Safe ratings should be based on zero wind, unless the lines are monitored.

6. The most widely accepted thermal rating method in the world.

- Between 1991-2000, over 70 utilities installed more than 200 CAT-1 systems* on 5 continents.
- Over two thirds of the 30 largest utilities in North America use CAT-1.
- The majority already use CAT-1 for real time rating data direct to their EMS.

*U.S. Patents #5,235,861, #5,517,864, #5,559,430, #5,918,288



Additional available capability with CAT-1 real time rating

ACCURATE AND EASY-TO-USE THERMAL RATING DATA

The data you need

Tensions, Net Radiation Temperatures, sags, clearances, conductor temperature, capability

CAT-1 measures the most meaningful data for rating calculations: Tensions and Net Radiation Temperatures (NRT). Tension and NRT measurements both take into account the effects of ambient temperature along with wind and solar effects, emissivity and conductor time constant. The result?

- Simplified rating calculations
- Highly accurate ratings

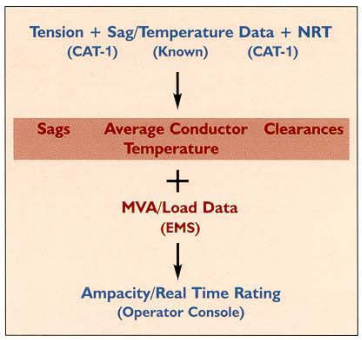


Figure 1 - Tension to Real Time Rating

Getting from Tension to Ratings

Figure 1 shows how CAT-1 measurements are used to calculate the rating information of most interest to you - conductor temperature, sags, clearances, and real time ratings.

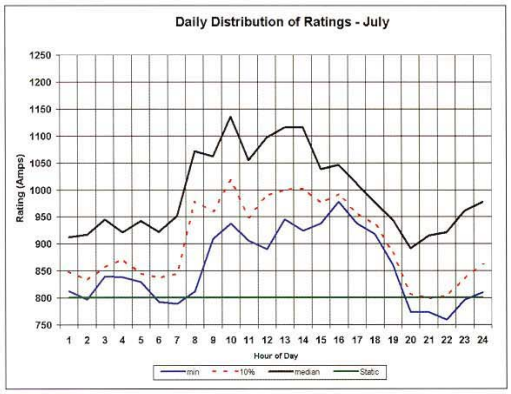


Figure 2 - Forecasted ratings facilitate better, more economical decisions

Forecasted ratings

- Short, medium, long term statistical rating forecasts:
  - 30 minute – Contingency response
  - 1-4 hour – Minimizing or avoiding dispatch changes
  - 24 hour – Dispatch, generation, and outage scheduling
  - Quarterly – Planning and design
- Backed up by accurate, observable CAT-1 real time ratings
- For power marketing, operations planning, maintenance scheduling, and asset management decisions
- Derives optimal operating decisions based on real time ratings

Why are increased ratings possible?

1. A change in wind speed from 2 ft/sec to 4 ft/sec increases capability by 20-30%.

- Wind is the most significant weather variable influencing ratings.
- Knowing actual, instead of assumed wind effects is critical.

2. High winds and high ambient temperatures generally coincide.

- Provides favorable daytime rating conditions.
- Simple "ambient-adjusted" ratings thus are often erroneous and may be dangerous.

3. Wind data from meteorological sites is poorly suited for ampacity analysis.

- Simultaneous wind speed measurements at two sites one mile apart typically vary in a 2:1 ratio.
- Anemometers have stall speeds of 4-5 ft/sec, exaggerating the occurrence of thermally limiting "calm".
- Meteorological sites are in very different terrain and elevation than transmission corridors.

Typical CAT-1 Installation on SHETL Transmission Circuit

Appendix 3

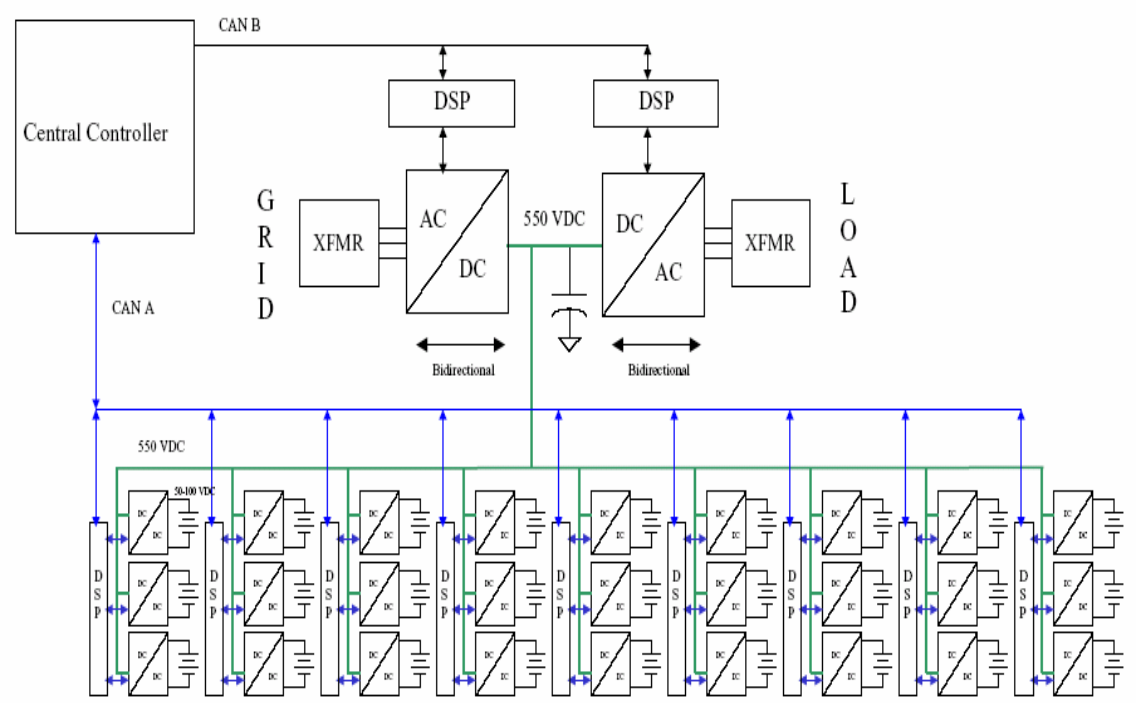
Power Block 150 Energy Management System

SSE has purchased a Power Block 150 in order to evaluate the benefits can be achieved by the system in terms of providing a back up AC supply for its S/S in the event of loss of the grid connection. It is envisaged that on successful completion of the trial that these units will be deployed at sites where the provision of standby supplies via discreet connections to the local network involves costly construction of an overhead line or cable section. Applications at sites where standby diesel sets would have been installed will also be considered for this type of standby supply. Environmental benefits will also arise at these sites with reductions on CO2 emissions from the diesel sets which would previously been installed.
Longer term the unit will give SSE a valuable insight as to the benefits which could be achieved from the units when used larger scale energy storage applications.

The PowerBlock is a compact and modular system that provides enhanced electric reliability and power quality for utilities and power consumers. The PowerBlock system stores 150 kilowatt-hours ("kWh") of energy, which can be dispatched on demand at power levels ranging from 1 kilowatt ("kW") to 100 kW.

This system combines high-capacity, long duration energy storage with advanced control electronics to deliver reliable, high quality power to a customer's facility.

A Block Diagram is shown below:



The PowerBlock system is designed to work in various categories of electric power systems:

- Grid-interactive, which are on-line systems providing high quality uninterrupted power from the electric power grid.
- Grid-independent, which are also known as “distributed” power generation systems that are not connected to the power grid.
- Grid-parallel, which are systems that are connected to the grid in order to provide high quality uninterrupted power and are combined with on-site power generation systems to deliver additional power for peak loads that are higher than the capacity available from the power grid.
- Operate in as a UPS in order to provide site supplies in the event of failure of incoming AC site supplies.