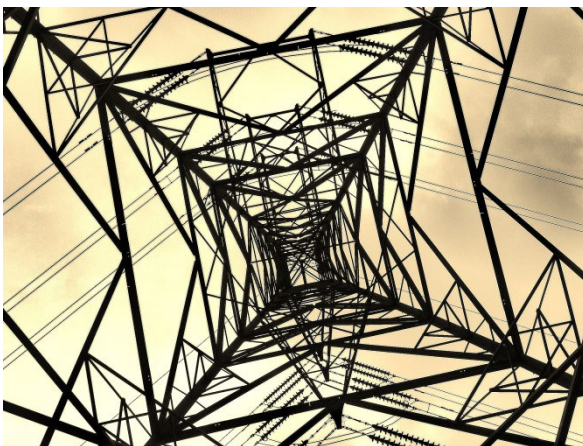


POWER SYSTEM DYNAMICS



Electrical Engineering
Solutions

PSD Company Profile

March 2022

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1.0 Introduction

PSD was founded in 2001 to offer a range of consulting services based on planning, engineering, project management, construction, commissioning, and maintenance of electrical facilities. PSD provides specialist electrical engineering services for Renewable IPP, Hybrid Renewable Energy Resources (HRES), High Voltage Direct Current (HVDC), series capacitors, dynamic reactive power compensation (SVC and STATCOM), series capacitors, shunt reactive compensation, and harmonic filters for transmission and distribution networks. The range of services provided includes feasibility studies, investigations, conceptual studies, power system studies, engineering studies, preparation of technical specifications, Owner's Engineer procurement support and bid evaluation, and technical support during project execution including design reviews, witnessing of factory tests, and witnessing of site acceptance tests and commissioning tests. Their consultants have specialised knowledge in their respective fields and they have, collectively, many years experience in the electricity supply industry, with considerable experience in Africa the Middle East, and Asia. PSD also provides renewable energy grid integration studies and project engineering support.

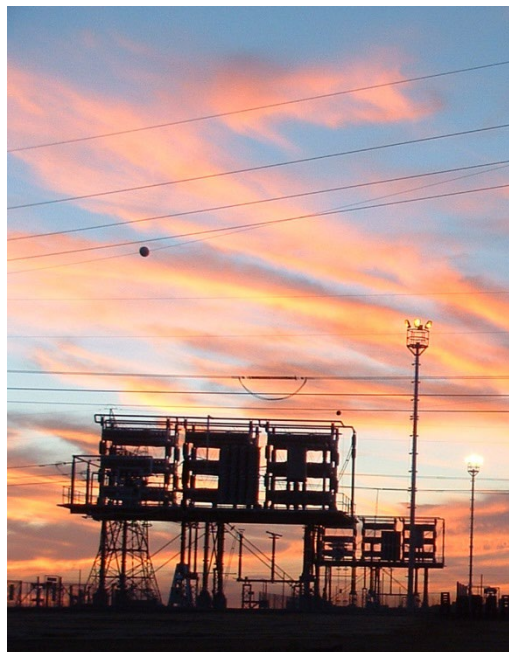


PSD is a training provider and license distributor for PSCAD™ / EMTDC™ software

PSD offers a wealth of international and regional project experience in transmission and distribution systems and has put together a strong team of proposed international consultants. Details of our relevant experience are listed in section three. Brief pen portraits are provided in section four. Given our background and expertise, we are confident of our ability to work with our clients and contribute to the success of the energy sector in Southern Africa, but also worldwide.

2.0 Background & Organisation

2.1 PSD Consulting Engineering (Pty) Ltd



PSD of South Africa was founded in 2001 to offer a range of specialist electrical engineering services for power systems. PSD's main areas of expertise are transmission planning and development, power system analysis and design studies and investigations, generation integration, electrification, substations, lines, Static VAR Compensators (SVC's), STATCOM, AC and DC systems, reactive power compensation systems including shunt and series capacitor installations, and general power equipment. PSD has been engaged and doing work on sub-transmission and transmission systems worldwide, at voltages from 380V up to 765kV.

The services provided by PSD are comprehensive, ranging from conceptual plans, feasibility studies, preliminary costing, budgeting, design and tender specifications, implementation, and commissioning. It also covers the complete integration of primary and secondary plants, while acting as the Owner's Engineer.

PSD prides itself in our capability to assist clients from the integration of new technology into their grids and in particular Renewable Energy Resources, (Solar, Wind, and Battery Energy Storage), Fixed Series Compensation, HV and EHV Shunt Compensation/Filters, SVC, and STATCOM technology. PSD provides both knowledge transfer as well as training on all aspects of the technology for clients, starting from System Studies, Specification, development of tender and evaluation rules, as well as life cycle approach to SVC and STATCOM systems. This in-house capability has allowed PSD to work closely with clients, identify their special needs and adapt accordingly.

2.1.1 Planning, Operations, and Technical

PSD compiles master plans for the development of transmission and distribution networks. The aim is to balance expected electricity usage, capital investments, quality of supply, services levels, demand-side management, network optimization, and economic returns in designing power systems. Our capabilities include:

- Planning studies and investigations, including generation of alternative solutions and basic conceptual design
- Power system analysis studies
- Load flow and short-circuit analysis
- Transient (machine) and dynamic stability studies
- Small signal stability analysis
- Technical evaluation
- Alternative selection (based on technical and economic evaluations)
- System operating studies and evaluation
- System reliability studies.

2.1.2 System Design, Technical Specifications, and Engineering Support

PSD performs engineering design work for FACTS (SVC and STATCOM), HVDC, series capacitors, dynamic and static shunt compensation, and transmission and distribution lines and substations. Our engineers have, collectively, many years of experience in the transmission engineering environment and we are adept at performing engineering design studies and investigations, including

- Electromagnetic transient simulations
- Insulation coordination, including device switching and energisation studies
- Renewable Energy Grid Integration studies and Project Engineering support
- Harmonic and other power quality studies and investigations
- Equipment rating
- Owner's engineer role for Fixed Series Compensation, EHV and HV shunt compensation/filters, SVC and STATCOM projects.
- Development of technical specifications and evaluation of bids.
- Engineering support during project implementation phase including design reviews, witnessing of factory tests, witnessing of site acceptance tests, and commissioning tests.
- Witnessing of RTDS testing of control and protection systems for SVC, STATCOM (FACTS), and HVDC devices.

PSD has executed projects from the study phase throughout up to the final stage, acting as the Owner's engineer or specialist advisor and consultant. PSD has relevant project execution experience having worked with different OEMs on recent projects, including ABB (and HAPG), GE (Previously Alstom), Siemens, Mitsubishi, RXHK (previously RXPE), and other OEMs. PSD, together with its associates, can design, supply, deliver, construct, and commission substations and transmission lines up to 400 kV.

PSD most recent SVC/STATCOM projects that PSD fulfilled the role as Specialist Owner's engineer/advisor are: SEB Tondong STATCOM (Sarawak, Malaysia), SVC Kotlakhpat - Pakistan (ABB), SVC Klafastadir - Iceland, Nampula STATCOM - Mozambique (RXPE), SVC DEWA Dubai (Mitsubishi), LTWP STATCOM -Kenya (RXPE), SVC Amazon project - Brazil (Siemens), SVC Jeddah North - Saudi Arabia (Alstom /GE), Hybrid SVC/STATCOM Hail, Al Jouf, Medinah East - Saudi Arabia (Siemens), HHR SVC - Saudi Arabia (ABB), STATCOM (Capital, UAE)

2.1.3 Commissioning of Primary and Secondary Plant

Our services include the supervision and commissioning of electrical installations, including:

- Indoor and outdoor substations
 - (6,6 kV to 765 kV)
- Cable and transmission line distribution networks
 - (6,6 kV to 132 kV)
- Electrical supply installations for large developments and complex networks
- Protection control, metering, and DC supplies relating to power systems



2.1.4 Renewable Energy Integration

PSD and its associated companies executed numerous renewable energy integration projects including windfarms, solar PV, BESS, hydro. This included Grid Code Compliance studies up to Grid Code Compliance testing. The projects also included hybrid grids and microgrids. The countries vary from South Africa, Malawi, Kenya, Sweden, Finland, Qatar and Saudi Arabia. The projects included software model development and validation in DigSilent and PSCAD..

The projects covered some of the largest of its kind in the world such as the Lake Turkana Windfarm (Kenya), the Red Sea Company Grid (Saudi Arabia).

2.1.5 Power Reticulation

PSD and its associated companies have implemented supply technologies at low voltage, ranging from underground cabling to overhead topologies. Insulated aerial bundle conductor systems, as well as open-wire designs, have been used. They have integrated low voltage systems supplied from both mini-substations and pole-mounted transformer equipment.

PSD and its associated companies have worked on numerous projects ranging from small rural systems of 0.3 kVA after diversity maximum demand (ADMD) per user to urban networks above 6.0 kVA ADMD per user. They have done small towns of less than 100 dwellings to large towns of more than 20 000 dwellings. In addition to residential settlements, they have reticulated industrial parks, large office complexes, and commercial centres.

2.1.6 Energy Management

PSD and its associated company principals are experienced in integrated electricity planning, power system economics, tariff design, loss management, and energy accounting. We always seek an optimal combination of actions, risks, and investments that will satisfy the customer's electricity needs, provide optimal electricity value and be financially viable to the utility.

2.1.7 Project Management

PSD and its associated company principals are experienced project managers and they applied for registration as Professional Construction Project Managers. They have managed contracts using FIDIC, NEC, and JBCC contract documents and have a sound knowledge and understanding of the OHS Act (including the construction regulations) and construction law.

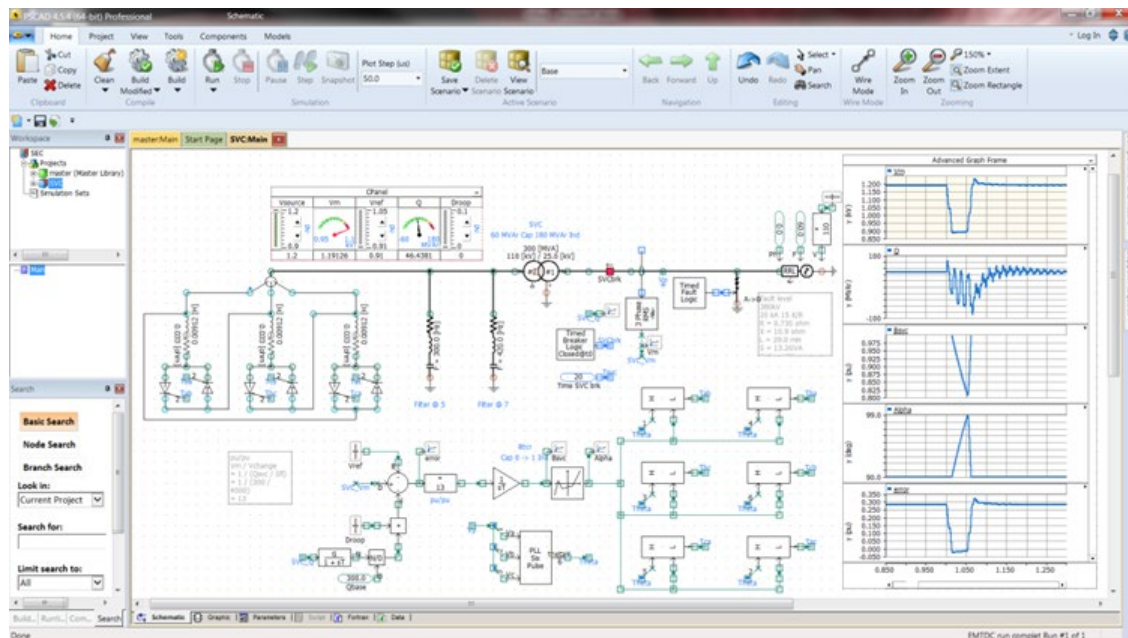
2.1.8 Employees

PSD is based on principles of high-quality, professional service. The team of consultants has specialised knowledge in their respective fields and they have, collectively, many years of experience in the electricity supply industry, both domestic and international. A large portion of the consultants have, in the past, been employed by a major utility; this gives us a unique understanding of the technical, commercial, and business activities that pertain to utilities.

2.1.9 Facilities

PSD has a completely equipped office with general office support staff and modern facilities, including computers, printers and plotter, fax, copying facilities, internet, and telephone facilities. PSD operates a documentation system designed to comply with ISO 9000. PSD has access to most of the commercially available computer software as well as “in-house” developed software. In addition to Micro-Station, AutoCAD, MS-Projects, various graphics packages, and the MS Office suite for general use, PSD or their staff has been involved in the use of computer software for power system design and analysis work for more than ten years. During this period use has been made of 'proprietary' and also 'in-house' software. PSD has extensive experience in the use of the following power system analysis software:

- PSS/E & PSS/U power system simulation software developed by PTI (Power Technology Incorporated)
- Power Factory network analysis software developed by DigSilent
- PSCAD/EMTDC Power Systems Simulation software developed by the HVDC Research Centre, Winnipeg, Canada.



3.0 Meet the Team

Presented below are pen portraits of our employees. Our senior personnel is recognised as experts in their professional fields. With PSD's expertise and experience, we are confident of our ability to work successfully with the Client to find and deploy the best solution for any project.

3.1 Septimus Boshoff

Managing Director/CEO - PSD Consulting Engineering

MEng cum laude (Electrical and Electronic), BEng, Pr. Eng



Septimus Boshoff has 35 years of professional experience, working on projects in South Africa, Mozambique, Namibia, Tanzania, Saudi Arabia, Kenya, Malawi, Swaziland, Sweden, Germany, Iceland, Brazil, UAE (Dubai, and Abu Dhabi), Oman, Qatar, Pakistan, Uganda, Malaysia, Sweden, Finland, and Canada. He has provided consulting services for analysis, design, specification, and project engineering of power quality equipment, power electronic systems, and reactive power compensation systems, including FACTS devices (SVC's, STATCOM) in the high voltage power transmission industry, as well as power quality matters. Septimus is a Senior Member of the IEEE and a team member of IEEE in the development of the initial IEEE 1031 SVC specification as well as the IEEE 1052 STATCOM specification. He is currently a Senior Member of IEEE WG on SVC/STATCOM, as well as other IEEE WGs SVC/STATCOMs.

Septimus has experience in bilateral power supply agreements between utilities (international) as well as between utilities and end-users with specific reference to all technical matters including power quality and Grid Codes. He is experienced in Reliability, Availability, and Maintenance (RAM) as well as re-engineering and maintenance of FACTS devices in the high voltage power transmission industry. Sep is skilled in engineering simulation and analysis of power system problems, including harmonic impact analysis and assessment of high voltage power systems of FACTS devices as well as renewable plants such as WTG, PV, and BESS. Septimus brings strong team leadership and project management skills, which encompass technical, contract management, and consulting services. Relevant projects he has undertaken include numerous SVC projects, STATCOM projects, series compensation projects, and system studies.

3.2 Chris van Dyk

Specialist Electrical Engineer BEng (Electrical)



Chris is a Specialist Electrical Engineer, co-founder, and director of PSD, with over 25 years of network studies experience. He has expertise in the SVC design, shunt, series, and neutral reactive power compensation systems; Conducting harmonic and transient studies related to the transmission line and substation equipment; Modelling FACTS device control systems using PSCAD/EMTDC, verification using RTDS, and presenting PSCAD training. :

Recent projects:

- Review the grid connection studies of the Maguga hydro plants in Swaziland, the Hogaliden wind power project in Sweden, and the Sumec PV plant in Malawi.
- Design 3x60MVar filters connected to the Khalifa B-Shakbout, Mussafah M12, and Al-Nahda substations at 132kV in the Central Emirates transmission network of TRANSCO. The design includes harmonic measurements of the background harmonic levels, selection of the filter tuning frequency, and rating of the C-type filter equipment.
- Design 3x100MVar filters connected to the Maziyyad, Towayya, and Al Ain Power House substations at 132kV in the Al-Ain transmission network of TRANSCO. The design includes harmonic measurements of the background harmonic levels, selection of the filter tuning frequency, and rating of the C-type filter equipment.
- Design 3x60MVar filters connected to the Khor Khwair, Fila, and Wasit substations at 132kV in the Northern Emirates transmission network of TRANSCO. The design includes harmonic measurements of the background harmonic levels, selection of the filter tuning frequency, and rating of the C-type filter equipment.
- Oversee the grid code compliance study for the 60MW PV plant at Salima in Malawi.
- Conduct the commercial operational testing of the 300MW Lake Turkana Wind Farm project in Kenya.
- Kenya: Consultant to LTWP for STATCOM (3 x 200MVar) project, design to final commissioning
- Mozambique: Consultant to EDM for STATCOM (150MVar) design, to final commissioning
- Pakistan: Consultant to NTDC for SVC Kotlakhpat (515MVar) project, design to final commissioning
- Saudi Arabia: Consultant to SEC on Series compensation studies and projects
- Saudi Arabia: Consultant to SEC on Large SVC projects for load stability
- South Africa: Engineering consultant to Eskom for the development of an SVC specification for 2x350MVar at 400 kV for the Coega smelter project
- GMPC network, Eskom - ZESA – HCB interconnection, South Africa, Zambia, Mozambique
- Namibia: HVDC VSC feasibility for NamPower
- Namibia: Auas SVC model, NamPower Transmission network

3.3 Reinette van der Merwe

Pr. Electrical Engineer

BEng (Electrical & Electronic), Pr. Eng.



Reinette is a Senior Electrical Engineer with thirteen years of experience as an engineer of which seven was spent working in the renewable energy space as well as High Voltage Transmission industry and in particular, on SVC and Statcom projects. Reinette was responsible for carrying out Grid Code Compliance studies, determining additional reactive power requirements, doing technical coordination, site assessment, and measurements, preparing technical documentation including draughting of AutoCAD drawings, development of performance verification tests, and system and grid integration / commercial operation tests. She has vast experience with DigSilent Powerfactory power simulation software.

Recent projects:

- Sarawak 2 x ±120 MVar Statcom tender and conceptual design review.
- TRANSCO Eastern reactive power compensation conceptual design and functional technical specifications, power quality measurements, and analysis including Flicker, Harmonics, and Phase Unbalance.
- Greefspan II 55 MW solar PV plant Grid Code compliance studies including hot commissioning testing and commercial operation tests.
- Lake Turkana 300MW Wind Farm Grid Code compliance studies.
- Sweden Högaliden Wind Farm (DIgSilent): Hogaliden Wind Farm Engineering and Compliance studies to verify the design parameters of the new 100MW wind farm and to also determine its compliance to the numerous regulations in the Västerbotten province of Sweden. The Vestas turbine model was used to carry out studies as per requirements of the EU grid code, Swedish grid code, and the local industrial network operator requirements.
- Kipeto 100MW Wind Farm Grid Code compliance studies.
- Qatar 800MWp solar PV plant entire suite of network studies review.
- Eswatini Hydro Plant (DIgSilent): In collaboration with Civil Engineering Consultants, Reinette carried out feasibility studies for a new hydropower plant and expansion to an existing hydropower plant.
- Malawi Salima Grid Code Compliance Study (DIgSilent): Responsible for carrying out the complete set of steady-state and dynamic studies (including the PV Inverter model from Huawei) to assess whether 60MW Solar Power Plant is compliant with the Malawi Grid Code and Renewable grid code requirements. Made recommendations regarding the sizing of static var generators to comply with the reactive power capability of the plant.
- Kenya grid from 220kV to 400kV network conversion: Network studies.
- Lake Turkana Wind Farm task force: Statcom performance verification tests development and operational and dispatch related work.
- Abu Dhabi Lot 1 reactive compensation strategy: compilation of +200MVar (Inductive) -400MVar (Capacitive) SVC/STATCOM specification. Compile prequalification report as part of the procurement plan. Provide the client with harmonic measurement guidelines in terms of IEC 61000.

- Oman Electricity Transmission Company, a compilation of general SVC/Statcom specification, carries out site visits to assess which substation is best suited for installation of Statcom and to gather battery limit and scope of work information for inclusion in the detailed SVC/Statcom specifications. Provide the client with harmonic measurement guidelines in terms of IEC 61000.
- EdM STATCOM project; Specification of equipment and compiling equipment data sheets of the 150MVar STATCOM that will be connected to the 220kV busbar at the Chimuara substation in Mozambique.
- DEWA SVC project consists of coordinating with protection specialists on the specification for 2x400MVar SVCs to be installed at CARX and NADHA substations in Dubai.
- Aries SVC project; Project engineering and coordination and specification of equipment and compiling equipment data sheets and drawings of the 400 MVar SVC that will be installed at ESKOM's Aries Substation in the Northern Cape, South Africa
- STE transmission network, Project coordination, and specification of Fixed Series Capacitors (FSC) and SVC system compiling equipment data sheets and drawings for the FSCs and SVCs to be installed at Inchope, Lupata, and Vilanculos Substations in Mozambique.

3.4 Theuns van Staden

Electrical Engineer

BEng (Hons) (Electrical).



Theuns completed his honours in Electrical Engineering at the University of Pretoria in the Energy research group where he focussed on energy management and optimisation as well as renewable energy. He was also an assistant lecturer during his post-graduate studies.

Theuns has experience in low voltage systems in the mining sector. Theuns has shifted to the High Voltage Transmission sector, specifically reactive power compensation. Theuns is responsible for creating network models and carrying out studies using both DigSilent Powerfactory, PSS/E, and PSCAD ®.

Recent projects:

- Pakistan – Current limiting 220 kV reactor sizing studies in PSCAD was done for K-Electic. This included Load Flow, Short Circuit, and Dynamic studies. Ratings, sizes, and locations were determined from the studies and the stresses on the existing breakers were determined. Assisted in the network building and a portion of the switching studies.
- Pakistan – An insulation coordination study on a selected 500kV transmission line in the NTDC network in Pakistan. Insulation coordination and switching studies were done to validate the basic electrical stresses and clearances. Responsible for the switching studies done in PSCAD.
- Oman – Reactive power compensation studies were undertaken to enhance the power transfer capacity and stability of a new 400kV interconnector OHL. Was responsible for the optimal sizing of the shunt reactors and NERs of each line segment using PSCAD, insulation coordination, and switching studies to determine equipment stresses.
- South Africa – Grid code compliance and insulation coordination studies were done on Greefspan II, a 55MW PV plant in the Northern Cape. Was responsible for the insulation coordination study and the on-site compliance tests.
- Kenya – Grid code compliance studies for a 100MW windfarm in Kenya. Was responsible for building the case file in DigSilent and compiling portions of the study.
- Kenya – Network studies to determine the effects of converting a portion of the network from 220 kV to 400kV that connects to a 300MW windfarm. Grid code compliance studies and dynamic reactive power compensation studies were done, in both PSCAD and DigSilent, to determine the compliance of the plant as well as to identify the suitability of existing equipment installed.
- United Arab Emirates – Dynamic and static reactive power compensation systems in the eastern region. This includes harmonic measurements, harmonic integration studies for 2 shunt capacitor banks and one dynamic reactive power compensator. Was responsible for building the network in PSCAD and modifying the PSS/E files, the dynamic simulations and compiling the report for both the DRPC and the two shunt filter banks.
- United Arab Emirates – Power Quality studies on the Northern Emirates grid and Harmonic integration studies of 3 x shunt capacitor banks in the Northern Emirates.
- United Arab Emirates – Power Quality studies on the Al Ain grid and Abu Dhabi grid and Harmonic integration studies of 6 x shunt capacitor banks in Al Ain grid and Abu Dhabi.
- Saudi Arabia – Sizing of NER reactors on the JOUF-HAIL transmission line.
- Sweden – Grid compliance study of a 100 MW wind farm in Högaliden, Sweden
- Swaziland – Grid Impact study on the expansion of the Maguga hydropower station project.

3.5 Septimus Boshoff Jnr

Electrical Engineer

MSc. (Power and Energy Systems)



Septimus specialises in power system studies, machine learning, and renewable energy generation. During his research studies, he worked on projects that included neural networks, complex systems, modelling wind turbine drive trains with PSCAD®, and hardware-in-the-loop phasor measurement units with an RTDS.

Recently, he's worked on projects that included lightning and switching insulation coordination, and frequency analysis of power networks. In summary, he's proficient in physics and mathematics that govern electricity theory both static and dynamic, electromagnetic fields, fault analysis, control systems, and reactive power compensation.

Recent Projects:

- Tondong SEB - Power Network Frequency and Impedance Scans [Malaysia]
- Energo Eastern – prepared Data sheet / schedules
- The Red Sea Project: Reviewed the design of the Hybrid Renewable Energy System, and verified machine stability including the governor and exciter control systems. Performed energisation studies of the specified solar inverter.
- NESPAK Matiari: Simulated a large section of the southern electricity network in Pakistan, a performed breaker switching and lightning insulation coordination studies, and a line transposition study dedicated to the new nuclear power station.

4.0 PSD's Experience

PSD has provided expertise for projects in South Africa, Saudi Arabia, Sweden, Malawi, Swaziland, Sarawak Malaysia, Pakistan, USA, Mozambique, Iceland, Brazil, Zambia, UAE, Oman, Botswana, Uganda, Tanzania, Namibia, Kenya, Philippines, and the Democratic Republic of the Congo. Selected projects are detailed below:

PSD Selected Technical Experience		
Date	Client	Project
2021	G7 Renewable Energies, South Africa, (ONGOING)	Contracted to complete grid code compliance studies on a 132 MW Hybrid Independent Power Provider (OYA) in the Western Cape as part of ESKOM's Risk Mitigation IPP Procurement Programme. The plant consists of a mix of PV (155 MW), wind (83 MW), BESS (40 MW), and diesel generators (106 MW).
2021	Redcap (Sub consultants to TNEI)	Impofu Wind Farms: Modelled in PSCAD a section of the South African Eastern Cape network under several operating conditions, faults, and events (Successful and Unsuccessful ARC). The network study included the OEM models, series capacitors, numerous wind farms, synchronous generators, and a STATCOM. Recommended optimising strategies for the wind farm controllers and DRPC.
2021	Eskom South Africa	TPS performed harmonic integration studies for four filter banks for Eskom. The harmonic integration studies included the development of the network file, network impedance scans, filter design, filter interaction, switching studies, and equipment ratings. Different filter configurations were compared and the most optimal designs for the filters were selected.
2021	Eskom (PSCAD / MHI representatives)	Facilitated the purchase of software maintenance
2021	Zutari (PSCAD / MHI representatives)	Facilitated the purchase of PSCAD software license
2021	AF Consult	PSD performed the harmonic assessment and studies for the Lestijärvi 457MW Wind Power in Finland
2022	Transrail	PSD developed network parameters for transmission line models for a network in Mozambique
2022	Mita-Technik	PSD develop a PSCAD model for a hybrid Renewable IPP Power Plant Controller
2022	Lekela Windfarm (Egypt)	PSD is assisting Lekela on the harmonic compliance and investigation into the 250 MW West Bakr Windfarm in Egypt

PSD Selected Technical Experience

Date	Client	Project
2021	JCM Power (Malawi)	Salima IPP GCC Derogation and PQ design PSD assisted JCM with the Salima project GCC derogation and also performed the PQ design, including filter design for the 75 MW Salima PV IPP in Malawi
2021	Greefspan South Africa	TPS embarked on a measurement campaign of the Greefspan 2 55MW PV Plant in order to identify the cause of abnormal harmonic emissions by installing various power quality recorders at different locations in the plant and used the data to discern the origin of the harmonic emissions. The conclusion of the measurement campaign was used to design optimal filters to solve the harmonic emissions of the plant.
2021	Sarawak Energy Berhad (Sub consultants to Amplitude Power Asia (Pte) Ltd)	AHF SEB reactive power study with Amplitude Power Provide services to reinforce the SEB system with respect to reactive power compensation to strengthen the stability of the long and weak transmission grid system. The deliverables include a feasibility study providing mitigation solutions, a reactive power compensation study that includes steady-state and transient dynamical performance of the system, and the optimum location, sizing and design concepts of a reactive power compensation solution that complies with the State Grid Code, Transmission System Operation Standard, Planning Criteria and the Guidelines of SEB.
2020	The Red Sea, Saudi Arabia, (Sub consultant to AJEC) (ONGOING)	<p>The Red Sea Project is a large-scale Hybrid Renewable Energy System (HRES) that operates autonomously, without connection to the SEC utility network. The Project will be developed on the West coast of Saudi Arabia, in the Tabouk region. The HRES comprises of Solar (285 MW) and Biofuel generation (140 MW), with Battery storage facilities (150 MW), distributed over several substations that are connected by overhead lines and submarine cables.</p> <p>PSD provided specialist engineering services relating to:</p> <ol style="list-style-type: none"> a) Grid impact studies included load flow studies, short circuit studies, dynamic and transient stability studies, supervisory control and data acquisition studies, power quality and harmonics studies, and insulation coordination studies. b) PSD also had to complete grid compliance studies for the different plants (PV, BESS, Biofuel generation). c) RTDS and EMT validation: Testing and verification of protection and control systems on real-time based simulator platforms such as RTDS or HIL. d) Scope of services includes bid evaluations of the preferred bidder for each of the different technologies.

PSD Selected Technical Experience

Date	Client	Project
2020	NEOM, Saudi Arabia, (Consultant to ACWA) (ONGOING)	<p>The Neom project is a large-scale Hybrid Renewable Energy System (HRES) that feeds a single point load and connects to the SEC utility network. The Project will be developed on the coast, south of Al Wajh, in the Tabuk region. The generation comprises 1.5GW of wind generation and 2.5GW of PV solar generation.</p> <p>PSD was tasked with reviewing the suite of studies that accompany such a project. The concept data was provided by the Client and PSD investigated and provided recommendations on the suitability and adequacy of the solutions. PSD also reviewed the load flow studies to determine the optimal size and locations for DRPCs. PSD also reviewed the equipment rating to determine their suitability for the project.</p>
2020	K-ELECTRIC, Pakistan	<p>Current limiting 220 kV reactor sizing studies were done for K-Electic. This included Load Flow, Short Circuit, and Dynamic studies. Ratings, sizes, and locations were determined from the studies and the stresses on the existing breakers were determined. This included Load Flow, Short Circuit, and Dynamic studies. Ratings, sizes, and locations were determined from the studies and the stresses on the existing breakers were determined.</p>
2020	NESPAK, Pakistan	<p>NTDC expressed its interest in validating the insulation coordination data of a 500kV double circuit quad bundle transmission line. PSD carried out an insulation coordination study to validate the basic electrical stresses and clearances of the line. This included lightning and very fast transient overvoltage (VFTO) studies and switching studies to evaluate line equipment such as line reactors, breakers, and surge arresters.</p>
2020	Qatar, (Sub consultant to Energo) (ONGOING)	<p>The 800.15MW Al-Kharsaah photovoltaic (PV) power project is the first large-scale solar power plant being developed in Qatar. The solar power plant shall be connected at 132kV to Qatar transmission system through a 220/132kV substation and further by 2 double-circuit 132kV OHL and 1 double-circuit 220kV OHL.</p> <p>PSD was tasked to review the study results, such as Load Flow Studies, Short Circuit Studies, Reactive power capability studies at the connection point, Transient Stability Studies, Dynamic Studies, Grid Impact Study (system stability studies), Insulation Coordination, and Very fast transient overvoltage (VFTO) studies and Harmonic Analysis Studies. outlined below.</p>
2020 - ongoing	Transco, UAE (Sub consultant to Energo)	<p>Specialist consultancy services relating to:</p> <ol style="list-style-type: none"> a) The simulation studies, design, and specification of 2x100MVar capacitor banks at 220kV in the Eastern Emirates transmission network of TRANSCO. The design includes harmonic measurements of the background harmonic levels, selection of the filter tuning frequency, and rating of the C-type filter equipment.

PSD Selected Technical Experience

Date	Client	Project
		<p>b) The simulation studies, design, and specification of +/-300MVAR DRPC (SVC or STATCOM) connected to the Mahawi substation at 132kV in the Abu Dhabi transmission network of TRANSCO. The design includes harmonic measurements of the background harmonic levels, Scope of services includes tender clarifications and evaluation, STATCOM design review – primary plant component design, control and protection system, valve and cooling design, layout, etc. – and witness of factory tests, specialist site supervision and commissioning.</p>
2020	LTWP Kenya	<p>From 2009 to the present, PSD has been providing specialist engineering consultancy services related to the 3x±100MVAR STATCOMs for the 300MW Lake Turkana Windfarm Project (LTWP) – the largest wind farm in Africa. Services included design reviews, RTDS testing, and site commissioning. In addition, PSD performed the Commercial operational testing of the wind farm and its interface to the overall Kenyan grid which was connected to the grid at 220kV. In 2020, PSD performed specialist EMT network studies to determine the impact on LTWP when the Point of Connection is converted from 220kV to 400kV. PSD also carried out the grid code compliance assessment concerning KNTGC (published May 2017) for the scenario after the KETRACO/KPLC grid is converted from 220kV to 400kV.</p>
2020	Greefspan South Africa	<p>PSD performed the grid code compliance assessment of the Greefspan 2 55MW PV Plant at 132kV concerning the South African Renewable Grid Code – Version 3.0. The assessment included several power system simulation studies to evaluate the steady-state and dynamic behaviour of the PV Plant and its impact on the network. The simulation studies conducted covered: 20° phase jump, Low Voltage Ride Through (LVRT), High Voltage Ride Through (HVRT), frequency range simulations, reactive power capability, and power quality simulations.</p>
2020	Kipeto, Kenya	<p>The Kipeto wind project will generate 100MW and consist of 6 blocks of wind turbine groups. The total installed capacity of the plant is 102.9 MW and will be connected at 220kV (Unominal) to the existing Kenyan network. PSD modelled the Wind Farm in DigSilent Power Factory to carry out the grid code compliance simulations concerning the KNTGC (published May 2017). The integration of a 36 MVar dynamic reactive power compensator (STATCOM) was also considered by using a generic model.</p>
2019	eSwatini, Swaziland	<p>Maguga Hydro integration and Grid Code Compliance Study Knight Piesold is the lead consultant for the Maguga Hydro projects, Swaziland. PSD, as a sub-consultant performed the complete suite of steady-state and dynamic studies to assess whether Maguga Hydror Power Plant is compliant with the eSwatini Grid Code and Renewable Grid Code requirements.</p>

PSD Selected Technical Experience

Date	Client	Project
2020	OETC, Oman (Sub consultant to Energo)	Technical specialist assistance jointly with ENERGOPROJECT ENTEL including simulation studies to determine the reactive power compensation requirements for the new 400 kV North-South Interconnector Phase-1.
2019	TRANSCO, UAE (Sub consultant to GOPA-Intec)	Specialist consultancy services relating to: <ol style="list-style-type: none"> a) The simulation studies, design, and specification of 3x60MVar filters connected to the Khalifa B-Shakbout, Mussafah M12, and Al-Nahda substations at 132kV in the Central Emirates transmission network of TRANSCO. The design includes harmonic measurements of the background harmonic levels, selection of the filter tuning frequency, and rating of the C-type filter equipment. b) The simulation studies, design, and specification of 3x100MVar filters connected to the Maziyad, Towayya, and Al Ain Power House substations at 132kV in the Al-Ain transmission network of TRANSCO. The design includes harmonic measurements of the background harmonic levels, selection of the filter tuning frequency, and rating of the C-type filter equipment.
2019	TRANSCO, UAE (Sub consultant to Energo)	Specialist consultancy services relating to the studies, design, and specification of 3x60MVar at 132kV filters connected to the Khor Khwair, Fila, and Wasit substations at 132kV in the Northern Emirates transmission network of TRANSCO. The design includes harmonic measurements of the background harmonic levels, selection of the filter tuning frequency, and rating of the C-type filter equipment.
2019	Sumec Malawi	Malawi Salima Grid Code Compliance Study PSD performed the complete suite of steady-state and dynamic studies to assess whether 60MW at 132kV Solar Power Plant is compliant with the Malawi Grid Code and Renewable Grid Code requirements. PSD consulted the Client regarding the sizing of static var generators to comply with the reactive power capability of the plant.
2019	Skanska, Sweden	Hogaliden Wind Farm Engineering and Compliance studies AF Consult and PSD were jointly contracted by Skanska to carry out the simulation studies to verify the design parameters of the new 100MW wind farm at 150kV and to also determine its compliance to the numerous regulations in the Västerbotten province of Sweden. PSD was responsible for the following main tasks: <ul style="list-style-type: none"> • Transient Overvoltage Study • Fault Studies • Reactive Power Control Study • Voltage Performance Study • Harmonic Performance Study

PSD Selected Technical Experience

Date	Client	Project
2019	TRANSCO, UAE (Sub- Consultant to Energo)	TRANSCO Northern Emirates, Energo Carry out power quality measurements and analysis at three 132kV Grid Stations. Shunt capacitor bank studies, including ferro-resonance, reactive compensation, and fast transformer switching (TRAC). Responsible for compiling the technical specifications (including drawings and datasheets) for 3 x 60MVar C-Type Filters.
2019	SEB, Sarawak Malaysia	Tondong STATCOM project Consulting Services (Owner's Engineer) during the tender, design, and construction phases of the Tondong STATCOM) project – 2 x +/-120MVar at 275kV MMC Technology STATCOM s. Scope of services includes tender clarifications and evaluation, STATCOM design review – primary plant component design, control and protection system, valve and cooling design, layout, etc – and witness of factory tests, site supervision, and commissioning.
2019	Lake Turkana Wind Power, KPLC and KETRACO	Lake Turkana Wind Power Commercial operation PSD performed the Commercial operation testing of the 300MW at 220kV Lake Turkana Windfarm Project (LTWP) and its interface to the overall Kenyan grid. LTWP is the biggest wind farm in Africa with 365 turbines and 3x±100MVar STATCOMs.
2018	Lake Turkana Wind Power, KPLC and KETRACO	Lake Turkana Wind Power Task Force PSD, in their capacity of STATCOM specialist consultants, has been appointed by LTWP to provide technical support and join forces with KPLC and KETRACO to mitigate various operational issues of Lake Turkana Windfarm Project (LTWP) and its interface to the overall Kenyan grid. PSD provides engineering consultancy services, including Training, System Studies, Protection, Operations, and Dispatch as well as Commercial Commissioning.
2018	Connect, St Helena, South Atlantic Ocean	St Helena power quality measurements and study As part of their power quality monitoring program CONNECT appointed PSD to measure the power quality of the electricity supply on St. Helena Island. This included the installation of 11 power quality measurement instruments and analysis of the results. Concerns had to be identified and solutions recommended.
2018	Botswana Power Company (Sub- Consultant to Norconsult)	Maun Substation Reactive Power Compensation PSD was responsible for Power System studies to determine the level of reactive power compensation required at Maun 132/11 kV Substation. PSD also undertook Harmonic Measurements, verification of loading parameters of the PSS/e software model, and designed an optimized network reactive power compensation solution. Further services provided included preparation of tender documents for the design, supply, installation, testing, and

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Date	Client	Project
		commissioning of the reactive power compensation equipment, witnessing of factory and site acceptance tests, and engineering support during the warranty period.
2017	Abu Dhabi TRANSCO (Sub consultant to Tractebel)	Abu Dhabi Lot 1 reactive compensation strategy: SVC/STATCOM detailed studies, a compilation of +200MVar (Inductive) -400MVar (Capacitive) SVC/STATCOM specification. Compile prequalification report as part of the procurement plan. Provide the client with harmonic measurement guidelines in terms of IEC 61000.
2017	OETC, Oman (Sub- Consultant to Tractebel) Muscat, Oman	Engineering Consultancy Services Static Var Compensators (SVC's) Consultancy Service for Reactive Power Compensation Strategy: PSD is responsible for the SVC/STATCOM specification, and SVC Control modifications. Review of International Criteria, Study Methodology, and Assumptions, Steady State Assessment, Load Modelling, Dynamic Reactive Power Assessment.
2016	Ministry of Energy and Water development Zambia	Complementary Study on Power Trade Volumes, Wheeling Arrangements, and Impact on the Interconnected Networks for the Zambia-Tanzania-Kenya (ZTK) Interconnector Project PSD performed the technical feasibility studies relating to the interconnection of EHV transmission grids of Zambia, Tanzania, and Kenya. The studies included small signal stability studies, transient fault analysis, load flow studies, and dynamic stability studies for the interconnection of the Southern African Power Pool (SAPP) and the East African Power Pool (EAPP). PSD also offered best practice solutions to load flow and stability constraints that were encountered during the study.
2015	Sterling Wilson, South Africa	90 MW Solar Plant in De Aar, Northern Cape Third-Party Inspection of electrical equipment during the manufacturing process to verify that the equipment complies with International and local standards. Services included: <ul style="list-style-type: none"> • Reviewing of equipment technical parameters • Reviewing of manufacturer's inspection and test plans/procedures • Witnessing of routine testing • Witnessing of type testing • Inspection of overall workmanship The equipment which was inspected and evaluated included MV Cables, 22 kV Station Transformers, Inverter Stations, String Combiner Boxes, and Module Mounting Structures.
2015	Juwi Renewable Energies, South Africa	Swartland Solar Park PSD developed a PSCAD Model suitable for EMT Simulations for the Swartland Photovoltaic Plant with a 5 MW generation capacity.

PSD Selected Technical Experience

Date	Client	Project
2015	SEC, Saudi Arabia	<p>Dynamic Reactive Compensation projects</p> <p>Detailed design reviews and project execution support for SVC's, STATCOM 's and Hybrids, including tender preparation, bid adjudication - phased over several years. Detailed network models are developed to calculate the harmonic impedance and perform EMT studies.</p>
2014	<p>Hidroelectric a Cahora Bassa, Mozambique</p> <p>Sub- Consultant to WSP Parsons Brinckerhoff</p>	<p>Songo HVDC converter station upgrade, Cahora Bassa HVDC scheme, Mozambique</p> <p>Engineering consulting services for ongoing support to the client for definition, specification, and implementation of projects to improve the reliability and technical performance of the existing HVDC station in the short to medium term. Phase 1 included the replacement of 3 x single-phase converter transformers, DC smoothing reactors, DC surge arresters, and DC optical CTs. Phase 2 includes the refurbishment of converter transformers, replacement of a backup diesel generator, purchase of a spare converter transformer, replacement of 220kV ac surge arresters, and replacement of critical components on the valves and valve base electronics.</p> <p>Preparation of technical specifications for a major upgrade to the Songo converter station to improve reliability and technical performance in the long term. The scope of the project includes replacement of HVDC control and protection systems, converter valves, valve cooling, ac filters, dc filters, ac and dc equipment, ac and dc auxiliary systems, and the installation of a 220kV transfer busbar. It also includes the replacement of the Grid Master Power Controller with a Grid Power and Frequency Controller.</p>
2017	<p>Transco (Sub- Consultant to Tractebel) Abu Dhabi, UAE</p>	<p>Engineering Consultancy Services Static Var Compensators (SVC's) Consultancy Service for Reactive Power Compensation Strategy: PSD is responsible for the SVC/STATCOM specification, and SVC Control modifications.</p> <p>Review of International Criteria, Study Methodology and Assumptions, Steady State Assessment, Load Modelling, Dynamic Reactive Power Assessment</p> <p>Install 50MVAR capacitor banks at AASW 220 kV SS, Install new POD at AASW 220 kV SVC, Modify the existing SVC POD at Musaffah 400/220 kV SS from the 220 kV side to the 400 kV side</p> <p>Refurbish the existing SVC cooling system for AASW and Musaffah SVCs.</p>
2014	ALDWYCH TURKANA LIMITED, Kenya	<p>Lake Turkana Wind Power (Jointly with DNVGL)</p> <p>Consulting Services during the design and construction phase of the DRPC (STATCOM) project – 3 x +/-100MVar STATCOM s. Scope of services includes STATCOM design review – primary plant component design, control and protection system, valve and cooling design, layout, etc. – and witness of factory</p>

PSD Selected Technical Experience

Date	Client	Project
		tests, site supervision, and commissioning. Cold commissioning of STATCOM was successfully completed.
2014	NamPower Namibia	<p>Technical Consultant for the addition of 20Mar Capacitive Reactive Power at the Khan Substation</p> <p>The scope of work includes Harmonic measurements, Harmonic integration studies, Electromagnetic Transient switching studies, Electrical parameter optimisation, Functional Specification of the full project to add 20MVar capacitive reactive power at Khan Substation, and contractor design reviews, including supervision during commissioning and protection settings.</p>
2013	EdM (Sub consultant to Norconsult), Mozambique	<p>EdM's Chimuara and Namialo DRPC's (SVC/STATCOM)</p> <p>System studies, harmonic measurements, harmonic apportioning, and Specification writing for the 250MVAR, 220kV SVC / STATCOM at Chimuara and Namialo 220kV substation. Assistance during the project execution phases, including design reviews, Factory witnessing, and final commissioning /performance verification testing</p>
2014	Lesotho Electricity Company (Sub-Consultant to Hifab), Lesotho	<p>Feasibility Study (FS) for the 132 kV transmission line Mohale's hoek-Mphaki</p> <p>Undertake feasibility study on the possibility of Linking Isolated network of Qacha's Nek with LEC transmission grid through 132 KV line from Mohale's hoek substation to Mphaki. Perform detailed system studies and stability analysis (load flow analysis, fault level analysis) for LEC transmission grid with a proposed line for different scenarios.</p>
2013	ESKOM South Africa	<p>Aries 400kV SVC</p> <p>System studies, harmonic measurements, harmonic apportioning, and Specification writing for the 350MVAR, 400kV SVC / STATCOM at Aries 400kV substation.</p>
2012	NTDC Pakistan (together with NESPAK and PPI)	<p>NTDC Kotlakpat SVC</p> <p>Consulting Services during the design and construction phase of the SVC project. Scope of services includes SVC design review – primary plan component design, control and protection system, valve and cooling design, layout, etc. – and witness of factory tests (Control and RTDS) and commissioning supervision and final performance verification testing.</p>
2012	STE (sub-consultant to Norconsult), Mozambique	<p>Mozambique Regional Transmission Development Project Integrated Transmission Backbone System - STE</p> <p>Scope of services included EMT studies (with PSCAD) for the 400kV system comprising of +/- 1400km AC transmission line, multiple substations, SVC's, series capacitors, and line and busbar reactors. The works also included the development of specifications for SVC/STATCOM and Fixed Series Compensation</p>

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Date	Client	Project
2011 – 2016	EdM (sub-consultant to Hifab), Mozambique	Nampula STATCOM project Cabo Delgado Specification review and assistance in tender preparation, bid adjudication, design review of a STATCOM at Nampula Substation, Assistance during the project execution phases, including design reviews, Factory witnessing, and final commissioning /performance verification testing
2011 - 2012	Isolux, Brazil	SVC Assistance - Amazon Project Specification review and assistance in Control System studies, design review of SVCs, and RTDS testing at OEM works of SVC control systems
2011	Landsnet, Iceland	Klafastadir SVC tender review and project design review support: Assist Landsnet on the tender review and adjudication of the Klafastadir SVC. Assistance to Landsnet during the project execution phases on design reviews, factory testing, RTDS, site acceptance testing up to final commissioning and performance verification, etc.
2010	SEC, Saudi Arabia	Safaniyah and other Dynamic Reactive Compensation projects Detailed system studies and specifications up to and including contract award for 15 SVC's including shunt capacitor banks, including tender preparation, bid adjudication - phased over several years. The project included Harmonic measurements at each of the sites.
2010	DEWA, Dubai, UAE	CARX & NADHA 400kV SVC Projects Engineering Consultancy Services for 2 Nos. Static Var Compensators (SVC's) at NHDA & Carx 400 kV Buses and Associated Modification Works. PSD is a sub-consultant together with Kema to Energo. Inclusive of harmonic measurements. PSD is responsible for the SVC specification and technical tender evaluation, and during the contract execution phase responsible for design reviews, technical review of the SVC design, factory witnessing of key components, such as the thyristor valves, control and protection including RTDS testing, and finally site services during final commissioning and performance verification.
2012	CALEDONWI ND, South Africa	CALEDONWIND 138MW Wind Farm Development Grid impact studies for the 400kV connection of a 138MW wind farm facility to be located close to the town of Caledon in the Southern Cape, South Africa
2012 – 2013	EdM (sub-consultant to Hifab) Mozambique	Grid study; EdM Northern network Desktop system study for reactive power system support to the EdM northern grid.

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Date	Client	Project
2011	Al-Jazirah Engineers & Consultants (AJEC), Saudi Arabia	Voltage Regulation Study for SWCC Shaqaiq-2 Water Pumping Scheme Study to determine optimal shunt capacitor size and location for 132kV voltage support to accommodate motor starting for the water pumping scheme. The study included the optimal configuration for harmonic integration.
2011	Ilanga, South Africa	Renewable project grid integration for a 125MW solar geothermal plant: Grid integration and Grid Code compliance studies to connect CSP plants to the Eskom grid.
2011-2012	Mainstream, South Africa	Renewable project grid integration studies for a 50MW PV and a 138MW wind farm. Grid integration and Grid Code compliance studies to connect PV and Wind Generation plants to the Eskom grid.
2011	JUWI, South Africa	Preparation of Connection Cost Estimates Responsible for the preparation of cost estimates for the connection of a 20MW PV plant, to be located near the town of Lephalale in South Africa, to the Eskom grid.
2011	EdM (PSD sub consultant to Vattenfall), Mozambique	Mozambique Regional Transmission Development Project Integrated Transmission Backbone System, "CESUL Transmission Project", Consulting Services For Technical and Economic Feasibility Study for CESUL Transmission Project HVDC as 400kV HVAC: insulation coordination studies, harmonic studies, SSR screening studies, reactive compensation (series and fixed) SVC's and FSC's.
2011-2012	UETCL, (sub-consultant to Hifab), Uganda	Reactive power system studies and specifications for reactive power systems and project technical support Conducted system studies to determine reactive power compensation requirements for the Uganda Transmission grid up to the year 2018. The assignment included the development of technical specifications for the proposed reactive compensation projects.
2011	Eskom, South Africa	ZESA Power transfer capability study Steady-state Analysis of the North to South power transfer capability of the ZESA transmission grid.
2011	ABB, Saudi Arabia	Insulation coordination study for Raz Al-Khair Aluminium smelter Perform insulation coordination, inrush current, and short circuit current study for 380kV, 220kV, and 34.5kV equipment at the 1.35GW Raz Al-Khair aluminum smelter in Saudi Arabia.

PSD Selected Technical Experience

Date	Client	Project
2011	Eskom, South Africa	NER study for Ferrum Mookodi transmission system
2011	Eskom, South Africa	NER study for Medupe transmission system
November 2010 – March / April 2006	Xstrata Mining Company, South Africa	<p>Xstrata Project Lion Mpumalanga, South Africa</p> <p>PSD was commissioned by Xstrata, a large mining company, to do the Engineering, Design, Implementation, and Commissioning of an expansion to an existing 275/33 kV, (2X) 180MVA Substation for their ferrochrome smelter project near Steelpoort, South Africa. The scope of work included:</p> <ul style="list-style-type: none"> • Power factor correction design and specification. • The installation of all LV and HV plant, which will include the installation of a 180 MVA 275/33 kV transformer, the equipping of the four 33 kV feeder bays • The installation of all LV equipment (protection, metering, DC, and Telecomms) in the control building • All conductoring and cabling associated with the above equipment. (HV, LV, and Control) • The installation of the yard earth mat and the bonding of all equipment earth tails with the earth mat • The stoning and fencing of the yard. <p>The services provided include:</p> <ul style="list-style-type: none"> • Power System Studies and Analysis • Substation Engineering and Design • Testing and Commissioning supervision
2010	NTDC, Pakistan	<p>PSCAD training</p> <p>Training on PSCAD software and modeling</p>
2010 – 2011	ERC, Philippines	Review of the Expenditure Forecasts of the National Grid Corporation of the Philippines for the Third Regulatory Period (2011 – 2015) Under Performance-Based Regulation
2009 – 2010	Tenke Fungurume Mining Company, DRC	A Technical Study of the Voltage Stability of the Tenke Fungurume Mining/D.R.C. Southern Katanga 220 kV 50 Hz System (STATCOM project), Inclusive of harmonic measurements.

PSD Selected Technical Experience

Date	Client	Project
2009 – 2012	Kema, Kenya	Dynamic Reactive Power Compensation (3xSTATCOM with shunt capacitors and reactors) for the Lake Turkana Windfarm project in Kenya. Perform dynamic EMT studies and prepare a detailed specification. Assist with technical tender preparation, bid adjudication up to final contract award.
2009	HVT/CEC, Zambia	Shunt capacitor design study Capacitor bank studies for the Zambian utility throughout their network. Inclusive of harmonic measurements.
2009 – 2011	NTDC, Pakistan (together with NESPAK and PPI)	SVC harmonic study and measurements Harmonic impedance studies and measurements for SVC projects in Pakistan.
2009 - 2011	SEC, Saudi Arabia	Central Western Fixed Series compensation project Detailed system studies and specifications up to and including contract award for two Fixed Series Compensation banks, including tender preparation, bid adjudication.
2009	CTC/ Norconsult, Zimbabwe	SVC study Detailed SVC specification studies and specification up to and including contract award for an SVC at Dema Substation (Zimbabwe), including tender preparation, bid adjudication up to final commissioning verification
2009 - 2011	Eskom Distribution (jointly with Aurecon), South Africa	Eskom Distribution masterplans Network master planning for Eskom Distribution.
2009 - 2010	Quanta Technology, USA	PSCAD model development SVC model development and verification in PSCAD.
2009 - ongoing	TransAfrica Projects, South Africa	SVC Technology training Training course on SVC technology and systems
2009 - 2011	Vaal Pipeline Consultants	VSD failure investigation

PSD Selected Technical Experience

Date	Client	Project
	(VRESAP TCTA), South Africa	Failure investigation into VSD drive (4 x 6.6MW) failures, including harmonic measurements, modelling and simulations.
2008 - 2010	EdM, (NorConsult)	Technical and Economic Feasibility Study for Mozambican Integrated Transmission Backbone System
2008	Motraco/TGC , Mozambique	FSC failure investigation Failure investigation into Fixed Series Compensation failure on the Motraco Baberton FSC 400kV bank.
2008 - 2011	NamPower, Namibia	Shunt capacitor bank integration and detailed studies Detailed capacitor tuning and rating studies, including insulation co-ordination studies for transmission shunt capacitor banks at Omburu substation and Otjikoto substation. Assistance during project execution up to final commissioning. Inclusive of harmonic measurements.
June 2007 -	EdM, Mozambique (sub consultant to Hifab)	Nampula SVC project. Cabo Delgado Detailed system studies and specification up and including commissioning and performance verification of a SVC at Nampula Substation, including tender preparation, bid adjudication, design review.
Septemb er 2007	Suez, Mozambique	Generation integration and network planning and substation design Detailed system studies and network integration studies, cost estimates for the integration of the Suez 100MW gas power station in Mozambique.
2007	Eskom, South Africa	Transmission Nuclear power station integration studies: Feasibility studies regarding insulation co-ordination and integration of nuclear power stations into the Eskom Transmission Grid.
2007	HVT, South Africa	Shunt capacitor neutral surge arrester rating study Athene 400 kV, 100MVAR Esselin 275kV, 150MVAR The manufacturer installed a surge arrester in parallel to the inrush reactor of a shunt capacitor bank to reduce the BIL rating of the reactor. The study determined that the energy rating of the arrester during switching and lightning surges.
2008	Eskom, South Africa	Transmission 765kV Series Capacitor banks EMT studies: Detailed EMT studies on six (6) 765kV series capacitor banks, including TRV studies (Alpha – Beta and Zeus/Mercury/Perseus)

PSD Selected Technical Experience

Date	Client	Project
2008	Black Rock Mountain, South Africa	<p>Generation integration studies: Detailed grid code compliance studies for 14MW standby power station at mine.</p>
2008	Eskom, South Africa	<p>Transmission 400kV Series Capacitor banks EMT studies: Detailed EMT studies on three (3) 400kV series capacitor banks, including TRV studies.(Iziko and Serumela)</p>
2008 - 2012	SEC, Saudi Arabia	<p>Central Area Static Var Compensation project Detailed system studies and specification up and including commissioning and performance verification for four (4) 660MVAR SVC's, including tender preparation, bid adjudication, design review.</p> <p>Various shunt capacitor banks is also part of the scope of work: harmonic investigations, filter design and specifications.</p>
2008	TiepCo Saudi Arabia	<p>Dammam Static Var Compensation project Detailed system studies and specification up and including commissioning and performance verification for a 200MVAR SVC's, including tender preparation, bid adjudication, design review.</p>
2006 - 2008	<p>Electricidade de Moçambique (EdM)</p> <p>Jointly undertaken with Maunsell</p>	<p>Maunsell Ltd (New Zealand) in association with PSD Consulting Engineering (Pty) Ltd. (South Africa) developed a Low Cost Rural Electrification Plan (LCREP) to assist the Government of Mozambique (GOM) in fulfilling their vision of 20% of the nation's population having access to electricity by 2020. This project was funded by the Danish Ministry of Foreign Affairs (Danida).</p> <p>Services to Client:</p> <ul style="list-style-type: none"> • Site supervisor and project management • Compilation of master plans for the development of electrical networks in rural areas • Preparation of equipment specifications, standards and drawings • Preparation of rural electrification packages for presentation to donor and funding institutions • Participation in donor conference <p>Project Detail</p> <ul style="list-style-type: none"> • The project assignment included: • Establishment of site office in Maputo, Mozambique • Provision of site supervision and project management services, and project facilities • Extensive data collection, processing and electronic capturing • Development of rural electrification ranking criteria

PSD Selected Technical Experience

Date	Client	Project
		<ul style="list-style-type: none"> • Identifying, defining and quantifying of potential rural electrification projects • Mapping of existing power lines and production of network single-line drawings • Power system studies and analysis including system modelling, power transfer, fault level and losses • Cost estimating • Compilation of rural electrification master plan • Preparation of equipment specifications, standards, drawings, and guidelines • Preparation of rural electrification packages for presentation to donor and funding institutions • PSD participated in an international donor conference that were held in Maputo (Feb. 2008)
2007	Eskom, South Africa	Transmission Shunt capacitor bank for Coega network development including SVC specification and related studies on SVC rating and : Detailed rating and tuning studies for the shunt capacitor bank and SVC's on 400kV
2007	Eskom Distribution; jointly with Thabile Engineering South Africa	Distribution Network MP Network master planning for Eskom Distribution
2006	TransPower New Zealand - Maunsell/AE COM,	Vector disaster recovery plan Network studies and investigations, and the compilation of Vector substation disaster recovery plan (Auckland and Wellington Regions).
2006	SEC, Saudi Arabia	Sakaka shunt capacitor banks Harmonic integration study for the shunt capacitor banks at Sakaka A & B. Inclusive of harmonic measurements.
2006	SEC, Saudi Arabia	Qurayyah surge arrester study Investigate energy rating and location of 380kV surge arresters for the GIS at Qurayyah.

PSD Selected Technical Experience

Date	Client	Project
2006	Eskom, South Africa	<p>Shunt capacitor bank insulation co-ordination study Hydra 400kV, 100MVar Perseus 400kV, 100MVar</p> <p>The manufacturer installed a surge arrester in parallel to the inrush reactor of a shunt capacitor bank to reduce the BIL rating of the reactor. The study verified that the energy rating of the arrester is sufficient during switching and lightning surges.</p>
2006	Eskom, South Africa	<p>Transmission Shunt capacitor bank: Esselen Capacitor Bank Athene Capacitor Bank Mersey Capacitor Bank</p> <p>Detailed rating and tuning studies for the shunt capacitor bank</p>
2006	Eskom, South Africa	<p>AEG SVC external device switching controller</p> <p>Replace the external device switching controller with a digital PLC and include the two new shunt capacitor banks in the switching logic. The project included both hardware and software development, installation and commissioning.</p>
January 2006 – ongoing up to 2008	Eskom	<p>AEG SVC Control and protection upgrade project</p> <p>Engineering support, specifications and project management support for the SVC Control, Protection, Thyristor Valve and Cooling replacement of 5 x 400kV SVC's with a 500 MVar dynamic range each.</p>
2005	SEC, Saudi Arabia	<p>Western Area Static Var Compensation project</p> <p>Detailed system studies and specification up and including commissioning and performance verification for three (3) 660MVAR SVC's, including tender preparation, bid adjudication, design review, RTDS testing of the SVC Control system. Inclusive of harmonic measurements.</p>
2005	SEC, Saudi Arabia	<p>Shunt capacitor bank integration and detailed studies</p> <p>Detailed capacitor tuning and rating studies, including insulation co-ordination studies for transmission shunt capacitor banks. Inclusive of harmonic measurements.</p>
2007	CEC, Zambia	<p>Protection co-ordination study, system adequacy</p> <p>Pilot study</p>
2004	SEC, Saudi Arabia	<p>Shunt reactor studies</p>

PSD Selected Technical Experience

Date	Client	Project
		Detailed reactor studies, including insulation co-ordination studies for transmission connected busbar and line/cable connected reactors
2006	Eskom, South Africa	<p>Vaal South 275kV Transmission Grid Investigation: Re-integration of Lethabo Power Station</p> <p>A planning study was undertaken to evaluate the performance of Eskom's Vaal South 275kV network. A main feature of the Vaal South 275kV system is that Lethabo Power Station, a base-load power station of some 3600MW, is integrated, at 275kV, into this system. The study investigation evaluated the technical performance of the system, and alternative transmission reinforcement options were identified and investigated from both a technical and economic standpoint. The planning study also included a review of the grid compliance status of Lethabo Power Station to ensure that the requirements as stipulated by the National Energy Regulator was met and satisfied. This required, amongst other things, detailed load flow, fault level and transient stability investigations.</p>
January 2007- June 2007	Eskom Transmission, South Africa	<p>Cape Corridor 765kV insulation Co-ordination Study</p> <p>Detailed insulation co-ordination studies for the Cape Corridor 765kV system.</p>
November 2005 - January 2006	BHP Billiton, Mozambique	<p>Mphanda Nkuwa Hydropower Station: Review of Transmission Integration Study</p> <p>Central and Southern Regions, Mozambique</p> <p>PSD was contracted to conduct a review on a study investigation that were done by UTIP looking at future generation and associated transmission projects in Mozambique. The review study considered the transmission integration of a 1300MW hydropower station to be located on the Zambesi River in Mozambique. The review study included the steady state analysis of the proposed 400 kV AC system solution (load flow fault level and power transfer capability calculations), an assessment of the risk of operating the planned AC system with the existing Cahora Bassa HVDC transmission system, and a review of the transmission capital cost estimates for the project. The project is still in the feasibility stage and will represent a major investment in the economy of the Region if it goes ahead. The services provided include:</p> <ul style="list-style-type: none"> • Power System Modelling • Power System Studies and Analysis • HVDC System Analysis • Cost Estimating.
September 2004 - March	Xstrata Mining Company, South Africa	<p>Xstrata Project Lion</p> <p>Mpumalanga, South Africa</p> <p>PSD was commissioned by Xstrata, a large mining company, to do the Engineering, Design, Implementation and Commissioning of a new 275/33 kV,</p>

PSD Selected Technical Experience

Date	Client	Project
/ April 2006		<p>(2X) 180MVA Substation for their new ferrochrome smelter project near Steelpoort, South Africa. The scope of work included:</p> <ul style="list-style-type: none"> • The installation of all LV and HV plant, which will include the installation of a two 180 MVA 275/33 kV transformers, the equipping of the four 33 kV feeder bays • The installation of all LV equipment (protection, metering, DC and telecomms) in the control building • All conductoring and cabling associated with the above equipment. (HV, LV and Control) • The installation of the yard earth mat and the bonding of all equipment earth tails with the earth mat • The stoning and fencing of the yard. <p>The Electrical Contract included the following:</p> <ul style="list-style-type: none"> • The provision, testing and commissioning of the complete transformer bays and 33 kV feeder bays, including steelwork and foundations. <p>The services provided include:</p> <ul style="list-style-type: none"> • Power System Studies and Analysis • Substation Engineering and Design • Electrical Installation Work • Testing and Commissioning
August 2005 - October 2005	Eskom, South Africa	<p>Open Cycle Gas Turbine Project: Insulation Coordination Study Investigation Natal and Eastern Cape Regions, South Africa</p> <p>PSD was commissioned by Eskom, the South African electric utility to conduct insulation coordination studies on the transmission systems that are planned to integrate proposed Open Cycle Gas Turbine (OCGT) generation facilities in South Africa. The scope of work included transmission line energization and switching study investigations, lightning studies, line ARC investigations, and an evaluation of the adequacy of installed surge arrestors. The simulations were conducted using PSCAD software and the affected parts of the transmission system were modelled in detailed in the transient domain. The services provided include:</p> <ul style="list-style-type: none"> • Power System Modelling • Power System Studies and Analysis • Substation Engineering.
June 2003 - April 2004	PB Power, Botswana	<p>Morupule Power Station: Transmission Integration Studies Morupule, Botswana</p> <p>PSD was sub-contracted to PB Power South Africa to conduct a study investigation looking at the integration of additional generation capacity at the existing Morupule Power Station in Botswana. Various generation scenarios were evaluated ranging from 200MW to 600MW of additional generation capacity, phased in over a period of 20 years. For each of these scenarios the transmission impact was evaluated and appropriate long term transmission</p>

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		<p>development plans were put together to meet the demands of expanded generation at the Morupule site. For feasibility study purposes, the investigation also included a study to assess the impact of importing energy from neighbouring countries in future, i.e. no additional generation sources were established in Botswana. Future imports from South Africa and north of Botswana (Zambia and Zimbabwe) were evaluated. In both cases, the studies showed that new 400 kV inter-connectors were required to facilitate the import of additional bulk power in the future. The services provided include:</p> <ul style="list-style-type: none"> • Power System Modelling • Power System Studies • Identification of Alternative Options • Study Investigations
2003	Motraco 400kV and 275kV shunt capacitor filter bank project - Motraco and Alstom South Africa	PSD was responsible for the complete engineering design, technical project management and testing and commissioning of the 400kV and 275kV Shunt Filter Capacitor banks.
April 2003 – June 2003	Western Mining Corporation, Mozambique	<p>Corridor Sands Project: Transmission System Integration Study Close to the town of Chibuto, Mozambique</p> <p>WMC is investigating the feasibility of establishing a new silicone smelter in Mozambique, close to the town of Chibuto, approximately 200km northeast of Maputo. As part of the feasibility studies, PSD investigated the technical feasibility of supplying the new smelter project at 275 kV from the existing Komatipoort 275/132 kV Substation in South Africa. A number of alternative supply options were investigated from both a technical and economic point of view; study results were used as input into financial models. The services provided include:</p> <ul style="list-style-type: none"> • Turning ‘customer requirements’ into ‘electrical requirements’ • Steady state power system analysis • Identification of required electrical infrastructure to make supply solutions technically feasible • Planning type studies, e.g. optimal time phasing of reinforcement projects, system MW losses evaluation, etc. • Preparation of abridged technical specification for required 275 kV series and shunt connected capacitors.
Septemb er 2002 – October 2003	NamPower: Auas Smelter / Namibian Electric Utility,	<p>Electrical Supply Study Windhoek, Namibia</p> <p>Study investigation to find the best techno-economic solution to supply a possible 600 MW Ferro-Si/Manganese smelter load, to be located close to the town of Windhoek, from Auas 400/220 kV Substation. Investigations were also</p>

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	Namibia	<p>conducted to assess the impact of the new load on power quality and to determine Quality of Supply (QOS) limits. The services provided include:</p> <ul style="list-style-type: none"> • Identification of alternative electrical supply options • Steady state power system analysis and planning studies • Power Quality assessment and calculation of appropriate QOS limits • Transient (EMT) and temporary over voltage studies.
2002 - 2003	Eskom - Luckhoff 400kV Series Capacitor Bank Installations, South Africa	<p>Eskom (Transmission) replaced and upgraded the three 400kV Luckhoff series capacitor banks. The banks series compensate the 400kV lines between Beta/Perseus and Hydra Substations on the Cape Power Corridor. The project was required to provide increased supply capacity to consumers in the Cape Regions. The capacitor banks were supplied by General Electric of America and it was the first MOV protected series capacitor bank to be installed in the Eskom Transmission Grid. Another unique feature of the project was the joint venture between General Electric and Alstom South Africa which was facilitated by PSD. PSD were appointed as a Technical Consultant on the project and was responsible for project management and the testing and commissioning of the three banks.</p> <p>Services to Client</p> <ul style="list-style-type: none"> • Design review • Factory test witness • Technical coordinator between supplier and utility • Testing and commissioning of HV plant
December 2002 - July 2003	NamPower (Nambian Electric Utility), Namibia	<p>Feasibility study on the proposed Caprivi High Voltage Direct Current (HVDC) Link Caprivi strip, Namibia</p> <p>NamPower, the Nambian electric utility, is evaluating the feasibility of establishing a 1st HVDC transmission line, using voltage source converter (VSC) technology, in Nambia. The HVDC system connects the Katima Mulilo network, currently supplied at 66 kV from Zambia, with the main NamPower Transmission System, thereby providing increased supply capacity to the Katima Mulilo load area. Apart from the supply upgrade to meet the expected growth in load demand, NamPower is also interested in the possibility of using such a HVDC system to establish a new inter-connector with their neighbour country, Zambia. PSD conducts an investigation into the technical feasibility of the proposed HVDC (VSC) transmission system. The services provided include:</p> <ul style="list-style-type: none"> • Network Planning Studies • EMT studies • Determination of electrical parameters as input into functional specification • Development of functional specification.

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<p>August 2002 - June 2003</p>	<p>Eskom Transmission, South Africa</p>	<p>Specifications for two Static VAR Compensators (SVC) Grassridge Substation, South Africa</p> <p>Two new 400 kV 400MVAR SVC's are required as part of the Eastern Cape network strengthening plan. System strengthening is required to make provision for the integration of a possible 1000 MW aluminum smelter, located close to the town of Port Elizabeth in the Coega Industrial Zone, and to meet the forecasted growth in load demand in the region. PSD is responsible for the development and compilation of the technical specifications for the two SVC's. The services provided include the following power system analysis and engineering design studies:</p> <ul style="list-style-type: none"> • Transient Studies (EMT) • Load Flow Studies • Harmonic Studies • Technical Specifications.
<p>2002 - 2004</p>	<p>SEC, Saudi Arabia</p>	<p>East Central Series compensation project Saudi Arabia</p> <p>Extensive studies including specifications for 380kV series capacitor banks. Bid adjudication, design review as well as detailed verification studies on:</p> <ul style="list-style-type: none"> • TRV and RRRV • MOV rating verification • Fault performance verification
<p>December 2002 - February 2003</p>	<p>Eskom, Transmission South Africa</p>	<p>Coega Insulation Coordination Study South Africa</p> <p>Eskom (Transmission) appointed PSD to conduct the necessary Insulation Coordination study investigations for the proposed network extensions under the Coega IDZ development scheme. The studies were divided into 3 phases: (1) Energization and statistical switching studies for the Beta – Delphi 1st 400 kV line, (2) neutral reactor studies for the Beta – Delphi and Hydra – Poseidon 400 kV lines, and (3) phase arrangement studies for the future 132 kV lines between Grassridge 400/132kV Substation and the site for the proposed Pechiney aluminium smelter in the Coega IDZ. The services provided include:</p> <ul style="list-style-type: none"> • Transmission line energization and statistical switching studies • Sizing of transmission line neutral reactor • Unbalance/Phase Arrangement study investigations.