HATCH

Power Delivery and Integration

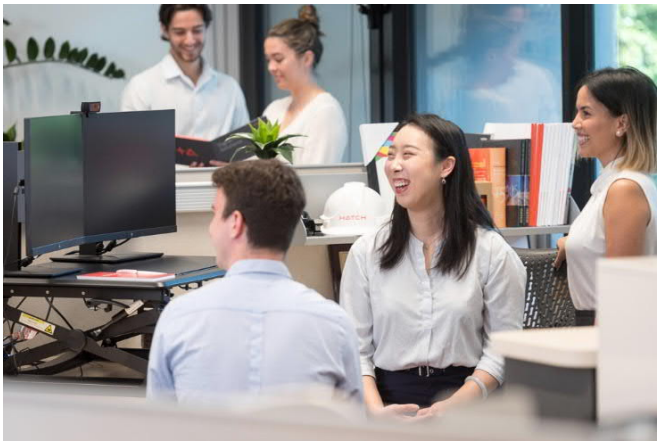
Statement of Qualifications

October 2020

About Us

Sectors

- Energy
- Metals
- Infrastructure
- Hatch Digital
- Hatch Investments



Hatch recruits and trains the best talents from universities around the world

Hatch is an organisation who is passionately committed to the pursuit of a better world, creating positive change through our visions and our ability to work with clients to develop smarter, efficient and innovative ideas. An employee-owned, multidisciplinary professional services firm, Hatch delivers a comprehensive array of technical and strategic services to the Mining, Metallurgical, Energy, and Infrastructure sectors, including consulting, information technology, engineering, process development, and project and construction management. Hatch has served clients for over six decades, our corporate roots extending over 100 years and our diverse project experience stretching across more than 150 countries around the world.

Hatch Australia operates from six offices operating in New South Wales, Queensland, Victoria and Western Australia, and is administered by its head office in Brisbane. The region employs 1000 professionals who tackle some of the toughest issues and drive positive change.

Hatch is recognised as a highly valued partner by all clients, bridging the gaps between research and innovative technologies, engineering and reliable operations. We are particularly known for working with senior client management to develop business strategies; managing and optimising production; executing projects that involve the scale-up of process technologies; and managing start-ups, commissioning and ramp-ups.

We deliver unprecedented business results for Hatch clients through our commitment to quality, lower operating costs, more efficient utilisation of capital assets, higher standards for safety and risk management, faster start-ups and continuous performance improvements in all projects and programs.

Energy

Hatch has designed and managed power and energy projects around the globe

BUSINESS UNITS

Power

Oil and Gas

Powering the energy needs of tomorrow, Hatch provides EPCM, consulting and technologies for the planning, engineering and delivery of infrastructure in the power and energy sectors. Business units draw on the resources of the project delivery group, which encompasses engineering and project execution disciplines: *civil, electrical, geotechnical, hydraulic, mechanical and procurement*.

Other specialties include economics, planning, environmental and community interface.

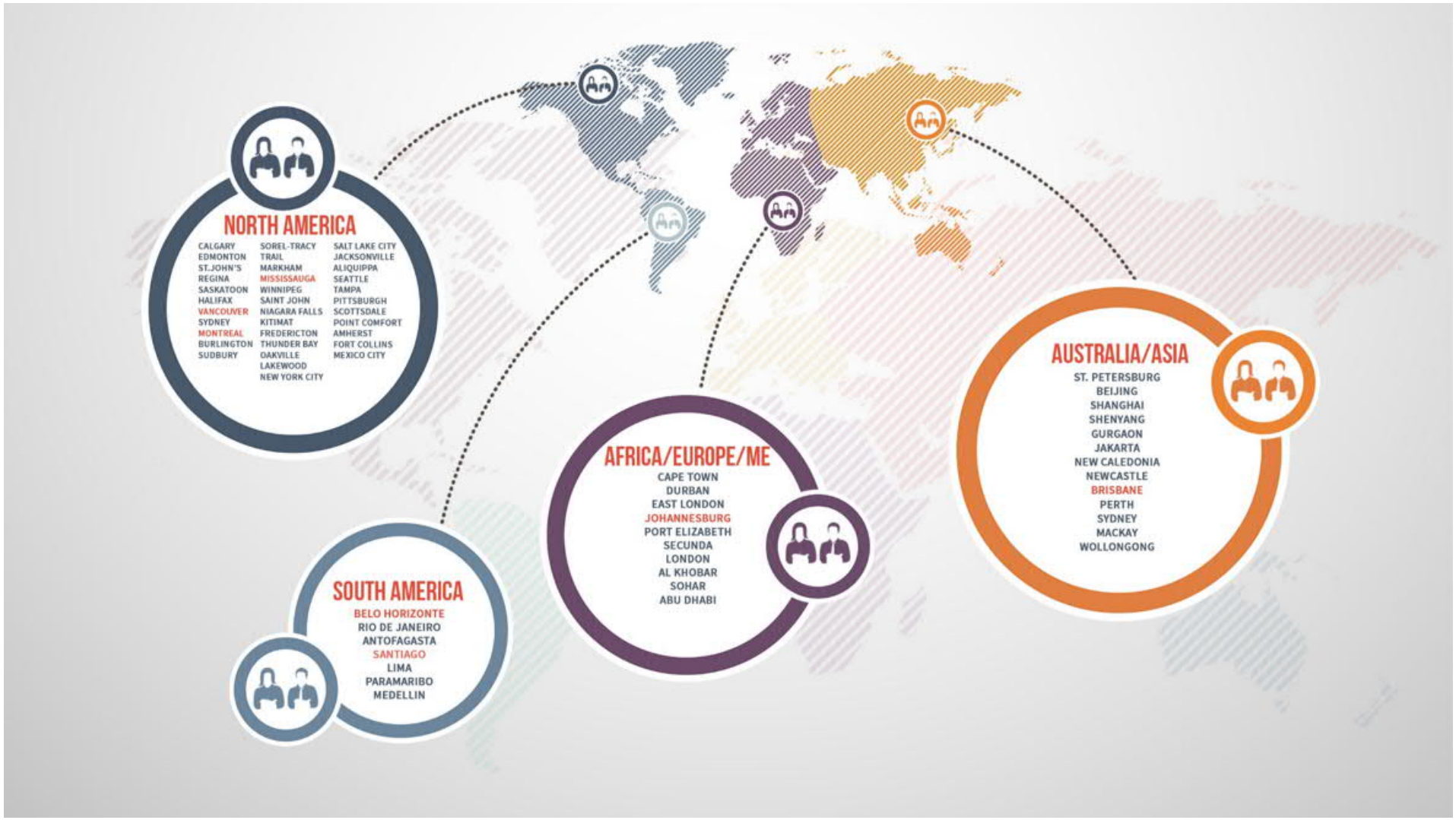
We are finding new ways to generate, distribute, and use energy to achieve the profound transformation.

SUB-SECTORS

- Hydroelectric and water resources
- Wind power
- Solar power
- Geothermal, ocean and other alternative energies
- Thermal power
- Nuclear power
- Power Delivery and Integration (including Transmission and Distribution)
- Power business management consulting
- Energy technologies, including gasification and coal-to-liquids
- Energy performance improvements
- Water and power resources optimization
- Upstream oil sands, including surface mining and steam-assisted gravity drainage
- Downstream oil and gas upgrading and refining
- Conventional (gas and sulfur developments)
- Liquefied natural gas
- Offshore oil and gas

HATCH

Principal Offices



Hatch Commitment to Australian Power Industry

In-depth knowledge of policy and regulatory frameworks is combined with state-of-the-art technologies and techniques to plan and deliver power grid networks that are sustainable and meet public needs at least cost.

Contacts

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Hatch has been actively supporting the Australian power industry for over twenty years. Recognising the unparalleled changes in the electricity industry, now spear headed by Australia, Hatch has increased its capacity to offer assistance to all the sectors of the power industry in the region.

Our commitment has culminated in developing a dedicated team of capable and expert engineers located in the main centres of Australia. The team is supported by our extensive global experience and resources.

The generator performance and power system assessments are complemented by our power system modelling and analysis centre of excellence located in Winnipeg, Manitoba, Canada. Together, this brings many decades of global power system planning experience using state-of-the-art tools and utility-trained professionals. Our in-depth knowledge of the regulatory and commercial business environment in Australia, and our close working relationships with clients ranging from network service providers to system operators and generation developers, allows us to provide a complete range of development planning and analytical services.

Generation Connection Studies

Hatch provides advice for connection of renewable and fossil fuelled generators, ranging from site identification to completion of commissioning and testing. Our advice optimises investments and reduces the project risks based on prevailing policy and regulatory frameworks, coupled with in-depth analysis of technical, regulatory and economic considerations. We use our knowledge and experience of the state of the art generation technologies, including *solar, wind, hydro, battery storage, hydrogen, and thermal, for their modelling and analysis.*

Hatch's services for supporting our generation development clients include:

- Conceptual design and project feasibility studies, covering system expansion, rehabilitation or upgrading
- Generation performance standard development, generator model development, testing and benchmarking, power quality assessment
- Generator performance testing, studies for verification of generator models and generation performance
- Technical due diligence studies
- Micro-grid design and integration
- Use of commercially available power system analysis software with sophisticated

modeling and simulation capabilities, to deliver regulatory compliant projects within the shortest time.

Power System Studies

Hatch provides engineering services through expert modeling and analysis using state-of-the-art planning tools including:

- Feasibility studies for bulk power transfers and system reinforcement needs
- Generator interconnection studies and system impact analysis
- Power system operation analysis, operating procedure and process development
- Power system stabilizer tuning
- Transient switching analysis
- Protection and control studies
- Review of transmission constraints and development of constraint equations
- Expertise in state-of-the-art software tools for power system planning and analysis.

Transmission System Planning

Hatch provides expert decision analysis support leading to optimized capital investments including:

- System load forecasting
- Development of expansion plans
- Environmental impact analysis
- Least-cost analysis of alternative plans based on regulatory investment tests
- Economic and financial analysis for major investments

Expert decision analysis support is used to optimize capital investments.

- Preparation of master plans for system development, defining schedule and budget costs for combinations of facilities investments, operational program requirements, and demand side management initiatives
- Regional transmission interconnections.
- Investigation and assessment of effectiveness and viability of non-network solutions as alternatives to transmission augmentations

Analytical Techniques

- Power flow analysis
- Short-circuit analysis
- Transient stability investigations
- Small signal stability analysis
- Electromagnetic transient analysis
- System reliability performance evaluation
- Switching surges and resonance phenomena
- EMF analysis
- Financial and economic analysis with benefit/cost ratios, internal rates of return and life-cycle cost comparisons.

Analytical Tools

- PSS®E
- DIgSILENT Power Factory
- Aspen One-Liner
- PSLF
- PSS-ADEPT
- PSCAD
- EDSA
- ETAP
- ATP
- EMTP
- Matlab
- ESKAM
- EasyPower.

Power System Planning and Special Studies

Representative Renewable Energy Experience in Australia

Project Title	Client	Location	Scope of Work
Integrated Solar and Combined Cycle Gas Turbine Project	Aquasol Infrastructure	Australia	Feasibility study of a hybrid 150 MW gas turbine combined cycle and 30 MW concentrated solar power.
GEMCO Solar PV Network Study	South32	Australia	Detailed study of High PV Integration to GEMCO Mine, up to 14 MW. Description of Hybrid Power Operation, Control Strategy, Solar Assessment and detailed electrical analysis of the network. (H-352903)
Cannington Wind Power Project Cost Estimate	South32	Australia	Detailed wind power project cost estimate at scoping level with energy storage at low to high wind power penetration (8, 12, 20 MW) to Cannington Mine (H-353406)
AEMO Grid Studies	AEMO	Australia	Hatch has been retained by the AEMO to perform grid compliance studies for several projects across Australia. This includes both PSSE and PSCAD studies and covered approximately a total of 2 GW of solar, wind and BESS connection projects.
Development of Generic PSCAD models for Windfarms	Powercor	Australia	Hatch has been contracted to develop detailed generic models in PSCAD for the Oakland Hill (OWF), Yambuk (YWF) and the Codrington (CWF) windfarms. This is supporting the creation of a wide-area network PSCAD model for completing full Impact Assessments for prospective generator connections to Powercor Network.
Wide area PSCAD studies	TransGrid	Australia	Hatch is presently providing System Strength Full Impact assessment studies to TransGrid. The studies involve modelling and simulating the NSW transmission network and connected generation in PSCAD.

Project Title	Client	Location	Scope of Work
GPS Due Diligence Assessments	Powercor	Australia	Hatch is presently assisting Powercor with due diligence assessment of generator connection applications and System Strength Full Impact assessment studies. The studies involve modelling and simulating the Victorian transmission network and connected generation in PSCAD.
Battery Energy Storage Systems (BESS) – Integration and Development	Risen Energy	Australia	Hatch is presently providing services to Risen Energy to integrate and develop large grid connected BESS systems in Australia.

Other Worldwide Representative Experiences

+ Engineering Investigations

Years/Project Title	Client	Location	Scope of Work
2019-Ongoing Santa Rita Wind Farm, Transformer failure study (H-360591)	Invenergy	USA	The 302.4 MW Wind Farm had issues with pad mount transformer failure upon energisation of the feeder. Hatch was engaged to investigate the root cause of the failure through detailed Electro Magnetic Transient (EMT) type simulation studies using PSCAD software.
2019 Voltage imbalance studies	BC Hydro Study	Canada	Hatch was engaged to perform Detail Power System Studies to determine the root cause for voltage imbalance at the load side for a 60 MVA microgrid system. The load side and the generating station side voltages were compared and detailed studies in PSCAD were undertaken to investigate the performance of each piece of equipment in the system.
2018	Wataynikaneyap Power		Hatch was engaged to perform Electro Magnetic Transient studies in PSCAD to investigate 230 kV, 115 kV, 44 kV, and 25 kV

Years/Project Title	Client	Location	Scope of Work
Wataynikaneyap Powewr TRV Studies			breaker operation, considering fast switching transients.
2019-ongoing Forensic Simulations for Windfarm Transformer Failures (H-360591)	Confidential	USA	Our client was having numerous transformer failures within their network. Hatch was contracted to perform forensic simulations on the system to assist in determining the root-cause. Hatch identified potential resonances and subsequent over-voltages.
2019-ongoing Integration Studies for a 300MW Windfarm in Texas (H-359773)	Confidential	USA	Our client was having difficulty integrating their project in the ERCOT system due to technical issues. Hatch was retained to assist with very detailed studies required to integrate the power, proving successful in doing so without an modifications to the clients main circuit equipment.
2018 Hardwoods Generator Failure	Confidential	Canada	During the energisation of the client's synchronous condenser (SC) transformer, a concurrent failure of a generator occurred. The Client determined that the point on wave (POW) device associated with the SC transformer was incorrectly programmed and may have caused an excessive voltage deviation and/or unbalances at a generator bus at a local station. Hatch was contracted to carry out simulations in PSCAD to try and replicate this event and determine what voltages the generator would have experienced.

+ Modelling and HVDC Studies

Years/Project Title	Client	Location	Scope of Work
2018-2019 RTDS Modelling Support – Various Projects	GE Energy	Stafford, UK	RTDS modelling support for various HVDC Projects

(H-358119)			
2018-ongoing Feasibility Studies for the Grainbelt Express HVDC line (H-358113)	Invenergy	USA	Hatch has been engaged to provide expert services to look at the integration of the 4000MW Grainbelt Express line. Study tasks to date include; *PSSE model development and HVDC Technology assessment*.
2018-ongoing Study Support for the Lower Churchill HVDC Project (H-357864)	Nalcor Energy	Canada	This project involves study support for the integration of the Labrador Island HVDC link. Studies include; *Dynamic Performance Studies, Transformer and AC Filter Energization Studies, RTDS model development, arc flash analysis*
2012–2014 Technical Specifications for HVdc Converter Stations (H-342652)	ENL Maritime Link Inc.	Nova Scotia, Canada	Emera Newfoundland and Labrador (ENL) plans to interconnect Newfoundland and Nova Scotia power systems through a ± 200 kV HVdc transmission link (overhead line and subsea cable), facilitating 500 MW power exchange. Hatch is developing integrated power system models in PSS®E and PSCAD formats and conducting all relevant system studies to prepare technical specifications for converter stations at both ends, ensuring the stipulated reliability criteria is met.

+ System Planning

Years/Project Title	Client	Location	Scope of Work
2018-ongoing PJM Interconnection support (H-359038)	Brookfield	USA	This project is looking at various options to upgrade an existing facility for interconnecting into the PJM system. The scope includes costing, PJM interconnection requirements and assistance with getting the project in the queue, system studies and specification development.
2016 Transmission Planning Study Services (H-351685)	Alberta Electricity System Operator (AESO)	Alberta, Canada	The services provided to this client include transmission adequacy studies, transient stability studies, short circuit current studies and system inertia studies.

Years/Project Title	Client	Location	Scope of Work
2016 Transient Stability Studies and Analysis – AA2 Queue (H-346606)	PJM Interconnection LLC	Pennsylvania, USA	Transient stability studies and analyses for various types of new generating facilities, assessing impacts of these generation projects (10 studies in 2016) on transient stability of the existing PJM interconnected power system. We are identifying and verifying transmission reinforcement requirements. Over 130 study projects completed in Queues Q thru AA2, from 2009-16.
2015 Transmission Capacity Assessment (H-350155)	NextEra Energy Resources, LLC	Florida, USA	Transmission capacity assessment studies for multiple renewable generation projects in different states of USA. Detailed power system analyses were carried out for these evaluations.
2015 Transient Stability Studies and Analysis – Y & Z Queue (H-346606)	PJM Interconnection LLC	Pennsylvania, USA	Transient stability studies and analyses for various types of new generating facilities to assess impacts of these generation projects (15 studies undertaken to date in Y and Z queue) on transient stability of the existing PJM interconnected power system. Hatch is identifies and verifies transmission reinforcement requirements.
2018-ongoing PJM Interconnection support (H-359038)	Brookfield	USA	This project is looking at various options to upgrade an existing facility for interconnecting into the PJM system. The scope includes costing, PJM interconnection requirements and assistance with getting the project in the queue, system studies and specification development.
2016 Transmission Planning Study Services (H-351685)	Alberta Electricity System Operator (AESO)	Alberta, Canada	The services provided to this client include transmission adequacy studies, transient stability studies, short circuit current studies and system inertia studies.
2016 Transient Stability Studies and Analysis – AA2 Queue (H-346606)	PJM Interconnection LLC	Pennsylvania, USA	Transient stability studies and analyses for various types of new generating facilities, assessing impacts of these generation projects (10 studies in 2016) on transient stability of the existing PJM interconnected

Years/Project Title	Client	Location	Scope of Work
			power system. We are identifying and verifying transmission reinforcement requirements. Over 130 study projects completed in Queues Q thru AA2, from 2009-16.
2015 Transmission Capacity Assessment (H-350155)	NextEra Energy Resources, LLC	Florida, USA	Transmission capacity assessment studies for multiple renewable generation projects in different states of USA. Detailed power system analyses were carried out for these evaluations.
2015 Transient Stability Studies and Analysis – Y & Z Queue (H-346606)	PJM Interconnection LLC	Pennsylvania, USA	Transient stability studies and analyses for various types of new generating facilities to assess impacts of these generation projects (15 studies undertaken to date in Y and Z queue) on transient stability of the existing PJM interconnected power system. Hatch is identifies and verifies transmission reinforcement requirements.
2013–2014 Thickwood Hills 240 kV Development Study (H-344820)	Alberta Electricity System Operator (AESO)	Alberta, Canada	Detailed system studies (steady-state, transient stability and transient switching) to establish the need for Thickwood Hills 240 kV substation, level of shunt compensation and associated reconfiguration of the 240 kV transmission network in the Fort McMurray area. The purpose was to facilitate power dispersal of the proposed 500/240 kV substation in the Thickwood area.
2012–2014 Transient Stability Studies and Analysis – X & Y Queue (H-332634)	PJM Interconnection LLC	Pennsylvania, USA	Transient stability studies and analyses for 16 new generating facilities of different types, assessing impacts of these generation projects on transient stability of the existing PJM interconnected power system. Hatch identifies and verifies transmission reinforcement requirements.

Years/Project Title	Client	Location	Scope of Work
2012–2013 Clover Bar Blackstart Study (H-341950)	Alberta Electricity System Operator (AESO)	Alberta, Canada	Detailed system studies (steady-state, transient stability and transient switching) to investigate whether the Clover Bar Energy Center is suitable to provide Blackstart services for five power plants in the Edmonton and Fort Saskatchewan area.
2012–2013 Fort McMurray Transmission Development Study (H-340563)	Alberta Electricity System Operator (AESO)	Alberta, Canada	Comprehensive transmission system planning studies to identify bulk transmission needs in the ten year time frame, preparing functional specifications for the required transmission facilities including their cost estimate.
2012 Transient Stability Studies and Analysis – W Queue (H-332634)	PJM Interconnection LLC	Pennsylvania, USA	Transient stability studies and analyses for 17 new generating facilities, assessing impacts of these generation projects on transient stability of the existing PJM interconnected power system. Hatch identifying and verifying transmission reinforcement requirements.
2011–2012 Northwest Area Operation Planning Study (H-340075)	Alberta Electricity System Operator (AESO)	Alberta, Canada	System studies to develop guidelines for power system operators and evaluate system operating limits for different cut-planes in a large geographical region.
2011–2012 Transient Stability Studies and Analysis – V Queue (H-332634)	PJM Interconnection LLC	Pennsylvania, USA	Transient stability studies and analyses for 37 new generating facilities to assess impacts of these generation projects on transient stability of the existing PJM interconnected power system. Hatch identifying and verifying transmission reinforcement requirements.
2011–2012 Fort McMurray Regional Planning Study (H-338368)	Alberta Electricity System Operator (AESO)	Alberta, Canada	System studies for evaluation of system expansion and reinforcement requirements in the Fort McMurray region of Northeastern Alberta. Preparation of technical documentation for need assessment applications for multiple development projects.

Years/Project Title	Client	Location	Scope of Work
2010–2012 Functional Requirements of Generator and Control System Parameters (H-334611)	Yukon Energy Corporation	Yukon, Canada	Dynamic system studies to establish design parameters for a generation facility affecting transmission design/protection and operations. The objective was to define functional requirements of dynamic parameters for a generator and its associated control systems (including excitation and governing systems), which can operate in an islanded system. Also, reactive compensation requirements were evaluated for the long lightly loaded transmission lines.
2011 10-Year Planning Study for the Ajax/Pickering Area (H-334291)	Veridian Connections	Ontario Canada	Update of 2006/2007 report with new information. Develop load growth from land use and other info. Developed a 10 year forecast and proposed transition strategy to meet load growth. Evaluated several options to delay the need for a new substation (TS): (a) reconfigure distribution feeder service areas, (b) evaluate different methods of power factor improvement, (c) evaluate energy conservation and demand management impact.
2011 Fort McMurray System Operating Limits (H-339180)	Alberta Electricity System Operator (AESO)	Alberta, Canada	System studies to evaluate operating security limits (transfer-in and transfer-out) for various cut-planes in Northern Alberta, recognizing all NERC security criteria.
2011 Athabasca Area Regional Planning Study (H-338367)	Alberta Electricity System Operator (AESO)	Alberta, Canada	System studies for evaluation of system expansion and reinforcement requirements in the Athabasca region of Northern Alberta. Prepared a justification document for need assessment application.
2010 Fort McMurray Reactive Power Study (H-336775)	Alberta Electricity System Operator (AESO)	Alberta, Canada	System studies for evaluation of reactive power requirements in the Northeastern 240-kV system of Alberta.

Years/Project Title	Client	Location	Scope of Work
2010-2011 WSB Transmission System Assessment Study (H-333926)	Shell Wind Energy	Alberta, Canada	Transmission system adequacy assessment study to identify any transmission constraints due to the incorporation of 775 MW of wind generation into the Alberta transmission network (with and without requiring any network upgrades). The analysis established the value of the maximum generation capacity that can be added without requiring any transmission system reinforcements and evaluated appropriate mitigation measures for eliminating transmission system constraints, if any.
2010–2011 Brazeau Blackstart Study (H-337019)	Alberta Electricity System Operator (AESO)	Alberta, Canada	System studies for evaluation of Blackstart capabilities in a weak area of the Alberta electric power system.
2010–2011 Transient Stability Studies and Analysis – U Queue (H-332634)	PJM Interconnection LLC	Pennsylvania, USA	Transient stability studies and analyses for 13 new generating facilities to assess impacts of these generation projects on transient stability of the existing PJM interconnected power system. Hatch identifying and verifying transmission reinforcement requirements.
2010–2011 Bi-pole Block Impact Assessment Study (H-329567)	Nalcor Energy	Newfoundland, Canada	Bi-pole block impact assessment study investigating the impact of a bi pole block on the island ac system. The objective was to review and assess the adequacy of the existing under frequency load shedding (UFLS) scheme in the case of a permanent bi-pole block and to ensure that a portion of the island system remains intact and stable. In this context, the existing UFLS scheme was revised with seven different UFLS settings.
2010 GLOW Transmission System Study (H-334966)	New York Power Authority	New York, USA	Transmission system adequacy assessment study determining the impacts of the proposed addition of multiple offshore wind power projects to the New York State transmission system. The purpose is to

Years/Project Title	Client	Location	Scope of Work
			identify transmission system upgrades or reinforcement requirements downstream of the point of interconnection (POI) for the proposed addition of wind projects. If upgrades or reinforcements are found to be needed, Hatch will estimate the costs for these transmission facilities.

+ Connection Studies

Project Title	Client	Location	Scope of Work
2016–2017 Connection Studies for Battery Energy Storage System (H-351197)	NextEra Energy Canada Development and Acquisition Inc	Alberta, Canada	The scope of work involves preparation of Project Data Update Package for Stage 1 & 2, Connection Study, Facility Study, Cost Estimate and Connection Study proposal. The studies are carried out per AESO scope, guidelines & applicable system reliability standards and requirements.
2016-17 Integration of PV and CSP Renewable in the South African Electricity Network	Confidential	South Africa	The project involved a system study for a possible 450 MW renewable power project. It involved transmission system capacity studies to highlight possible risks and shortcomings.
2015-16 Grid Code Study – Abeinsa Xina 100 MW CSP Plant	Abeinsa EPC	South Africa	The project involved grid integration studies of independent power producers (IPP) into the South African national grid. Studies were performed for a CSP plant. DIgSILENT power factory was used to perform all the necessary studies, from both a load flow and transient point of view. Hatch assisted with exemption applications as well as the Grid Code Compliance evaluation phase of the project.
2015	Confidential	South Africa	The project involved a system study for three possible gas powered generating stations. It

Project Title	Client	Location	Scope of Work
Integration of Gas Powered Generation into the South African Electricity Network			involved transmission system capacity studies to highlight possible risks and shortcomings.
2015 Generation Interconnection Feasibility Studies (H347901)	Recurrent Energy, Inc.	Ontario, Canada	Generation interconnection assessment studies were performed to identify the most appropriate transmission interconnection alternatives and maximum generation capacities. These capacities were evaluated through power flow and production simulation analyses without requiring transmission upgrades.
2014-2015 Grid Code Study – Abeinsa KaXu 100 MW and Khi 50 MW CSP plants	Abiensa EPC	South Africa	The project involved grid integration studies of independent power producers (IPP) into the South African national grid. Studies were performed for a CSP plant. DIgSILENT power factory was used to perform all the necessary studies, from both a load flow and transient point of view. Hatch assisted with exemption applications as well as the Grid Code Compliance evaluation phase of the project.
2013 Grid Compliance Study	Biotherm	South Africa	Steady state and dynamic simulation studies investigating Grid Connection Compliance studies, including Voltage ride through and frequency deviation for two PV renewable plants. The studies also included the action of the Power Plant Controller.
2013 Grid Compliance Study	juwi	South Africa	Steady State and Dynamic simulation studies investigating Grid Connection Compliance studies, including Voltage ride through and frequency deviation for a wind farm. The studies also included the action of the Power Plant Controller and improvements to its control. Grid Code non-compliance exemption requested.
2012–2013 Harmonic Assessment Study for St. Leon Wind Facility (H-341989)	Algonquin Power Company	Manitoba, Canada	The St. Leon wind generating facility underwent an expansion which entailed adding ten additional wind generators, one collector circuit and upgrading four capacitor banks from 9.6 to 13.2 MVAR each. In the course of this expansion it was found that the harmonic voltage distortion 519. Hatch conducted a set of coordinated harmonic measurements, performed transient (EMTP)

Project Title	Client	Location	Scope of Work
			analysis to seek insight and designed harmonic filters that are being implemented.on the 34.5 kV exceeded the recommendations of IEEE Std-
2011–2012 Large CSP Plant, South Africa	Confidential	South Africa	Prefeasibility and bankable feasibility studies for connection of a 500 MW concentrated solar power (CSP) project. The assignment included an appointment to handle negotiations with Eskom for the grid connection, design of the substations and lines required and negotiation support with the generation license application with the electricity regulator (NERSA).
2010–2012 Hopefield Wind Farm	UMOYA	Western Cape, South Africa	System studies (steady state and transient stability) for the integration of 120 MW of wind power into the Eskom Distribution network and studying the impact on the Eskom Network.

Hatch Team

Hatch has the capability and capacity to offer support to all the sectors of the power industry in Australia. The team consists of dedicated, experienced, and expert engineers located in main centres in Australia and supported by our global network of engineers specialised in different disciplines.

The following capability matrix summarises the depth of talent nominated to provide services only in the generator connections, system studies and network planning space in Australia. CVs of the identified key personnel are also provided.

Depending on the area of support required by out clients, we can either expand this pool of resources or assemble dedicated and specialised teams for providing innovative and most effective solutions for you.

Capability Matrix – Connections, System Studies, Network Planning and Tools

Resources			Generator Connections						Power System Studies						Network Planning				Analytical Tools					
Name	Experience (years)	Title / Position	Feasibility / Impact Studies	Modelling / Benchmarking	Testing / Commissioning	Power Quality	System Strength (FIA)	Due Diligence	Stability / SSR / SSTI	HVDC / FACTS	EMT Studies	Load Flow / Short Circuit	Protection	Controller Design / Tuning	Long Term Planning / Forecasting	Network Expansion / Augmentations	Planning Criteria and Standards Development	Investment / Options Analysis	PSS/E	DigSILENT	PSCAD	MATLAB / Simulink	Python	RTDS
Dan Kell	21	Global Lead – HVDC & FACTS	X	X		X	X	X	X	X	X	X	X	X					X		X		X	X
Vajira Pathirana	23	Global Lead – System Studies	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X		X			
Nalin Pahalawatta	30	Australasia Lead – Power delivery and Integration	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	
Salim Anwari	6	Senior Engineer – Power delivery and Integration	X	X	X		X	X				X		X		X	X		X	X	X		X	
Samadhi Liyanage	3	Power Systems Engineer	X	X		X	X	X			X	X							X	X	X	X	X	
Yasas Rajapaksha	3	Power Systems Engineer	X	X			X	X			X	X		X					X		X	X	X	X
Elham Karimi	7	Power Systems Specialist	X	X		X		X			X	X		X					X		X	X		

Resources			Generator Connections						Power System Studies						Network Planning				Analytical Tools					
Name	Experience (years)	Title / Position	Feasibility / Impact Studies	Modelling / Benchmarking	Testing / Commissioning	Power Quality	System Strength (FIA)	Due Diligence	Stability / SSR / SSTI	HVDC / FACTS	EMT Studies	Load Flow / Short Circuit	Protection	Controller Design / Tuning	Long Term Planning / Forecasting	Network Expansion / Augmentations	Planning Criteria and Standards Development	Investment / Options Analysis	PSS/E	DigSILENT	PSCAD	MATLAB / Simulink	Python	RTDS
Amir Mosaddegh	7	Power Systems Specialist		X		X					X	X					X		X		X		X	
Anupama Konara	4	Power Systems Specialist	X	X					X	X		X		X					X					X
Zhuang Zhang	3	Power Systems Specialist				X				X		X		X					X		X	X		X
Christopher Wan	11	Electrical and Controls Engineer	X	X						X		X		X	X									
Faraz Majid	6	Power Systems Engineer	X	X					X		X	X			X				X		X			
Udana Gnanarathna	10	HVDC & FACTS Engineer							X	X	X	X									X			
Susan Derrah	19	Senior Power Systems Engineer				X						X	X	X							X	X		
Devni Jayasekera	3	Power Systems Engineer				X			X			X	X	X							X	X		

HATCH - POWER SYSTEM MODELLING, SIMULATION AND ANALYSIS

Dan Kell

PROJECT LEAD ENGINEER

Education & Qualifications
Bachelor of Science, Electrical Engineering, 1999
Masters of Science, Electrical Engineering, 2005

Professional Affiliations
Engineers Geoscientists Manitoba – Member
Professional Engineers and Geoscientists, Newfoundland and Labrador

Experience
21 Years

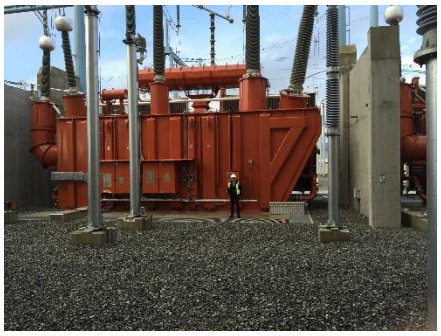
Location
Winnipeg

Specialties
HVDC, Switching Studies, Interconnection Studies, PSCAD, RTDS, Power Quality

Dan is a professional electrical engineer with a wide range of engineering experiences including utility and international consultancy activities, with a focus on HVDC and FACTs, the integration of renewable energy and electromagnetic transient (EMT) studies.

Dan has been working in the Australian energy market since 2010 starting with assistance on some due diligence work on the Basslink Interconnecter. He is currently leading Hatch's engagement with the AEMO which has included work on half a dozen projects and supporting the Murray and Direct Link HVDC upgrade.

This practical field experience is coupled with a great deal of experience in power system simulation, in particular in the area of time-domain electromagnetic transient modelling with PSCAD and RTDS looking at both AC and DC studies which include system interaction studies, breaker studies, insulation coordination and feasibility studies.



Dan standing in front of the world's largest HVDC converter transformer as part of his BPA HVDC work

Dan's role on the Songo ACF3 project included initial site assessment and background harmonic measurements, studies to determine the required performance and ratings of the components from both a steady-state and dynamic perspective and final commissioning.

RELEVANT PROJECT EXPERIENCE

PSCAD Forensic Analysis, Newfoundland and Labrador Hydro, Newfoundland, Canada
Created a detailed PSCAD/EMTDC and PSSE model of the Newfoundland Power system to investigate the effect of 200 MVA transformer inrush current during energization on the neighbouring substations. This study also looked at potential harmonic resonances in the system.
Study Type Performed: TRV, Switching, Inrush, Interaction, Forensic Simulations

Various Projects, AEMO, Australia
Hatch has been retained to provide network modelling and study support for various interconnection requests. To date, Hatch has supported the AEMO of 6 projects since Q4 of 2019. Services include expert advice, simulation support (in PSCAD and PSSE), vendor meetings and due diligence studies.
Study Type Performed: Model Creation, Validation, RUG development

Various Windfarms, PowerCor, Australia
Hatch has been engaged to create three windfarm models for use by PowerCOr in their wide system studies.
Study Type Performed: Model Creation, Validation, RUG development

Watay Switching Studies, Watay power, Ontario, Canada
Performed switching studies for the proposed Wataynikaneyap Project which will connect 17 remote communities in Northern Ontario via 1700km of transmission line. Switching studies were undertaken for all substations to assess the breaker requirements and the transformer inrush effects.
Study Type Performed: TRV, Switching, Inrush

Transient Overvoltage Assessment, Pattern Energy, USA
This study investigated the transient overvoltage issue that was encountered at a 288MW wind farm. The problem was investigated using PSCAD and various mitigation techniques were considered.
Study Type Performed: TRV, Switching, Inrush, dynamic system modelling

Transformer Failures, Confidential, USA
This study included a detailed modelling of the wind farm to investigate the root cause for padmount transformer failure. The wind farm model was created in PSCAD and various phenomena including transients, resonances, etc. were investigated.
Study Type Performed: TRV, Switching, Inrush, dynamic system modelling

HATCH

Cahora Bassa AC Filter Study, HCB, Songo, Mozambique
This project saw the addition of a third ac filter at the Songo converter station. Carried out numerous studies which looked at the performance and rating of the new and existing equipment in both a steady-state and transient environment. This included creating a detailed model of the Cahora Bassa HVDC system in PSCAD.
Study Type Performed: TRV, Switching, AC/DC, Insulation Coordination

Plains and Eastern HVDC Project, Clean Line Energy, USA
Provided detailed engineering services for the Plains and Eastern HVDC Line. This link was to be rated at +/-600kV, 4300MW and included a mid-point 500MW tap. The system was to transmit wind energy from Oklahoma to the load centres in Arkansas and Tennessee. Performed the system and feasibility studies.
Study Type Performed: AC/DC, Interaction, Feasibility

Celilo Up-Rate Project, BPA, Oregon, USA
This project looked at upgrading the Northern Terminal of the Pacific Inter-Tie from 3100MW to a converter rating of 3800MW. As only the Celilo terminal was to be upgraded, work had to consider the existing system at the Sylmar converter station in California and minimize the outage time. This project included some of the world's largest converter transformers. Performed the system and feasibility studies in both PSCAD and RTDS
Study Type Performed: AC/DC, Interaction, Feasibility

Multi-infeed Study, Energinet.dK, Denmark
Developed a detailed PSCAD model of the complete Energinet.dK grid, including detailed OEM HVDC models to study the impact of multi-infeed HVDC due to distributed generation. This work included detailed benchmarking of the HVDC models against the actual system and benchmarking of the integrated model against actual disturbances in the ac system. Once the model was benchmarked, planning studies were performed to determine the amount of conventional generation needed to ensure system stability.
Study Type Performed: AC/DC, Interaction, Feasibility

Wolf Creek Nuclear Trip - Root Cause Analysis, TRC Engineering, USA
Developed detailed PSCAD and RTDS models to determine the root cause failure mode which caused the facility to trip. This included detailed modelling of the auxiliary system including detailed saturation modelling of the CTs. Once the modelling was completed a site visit was conducted and the affected relays were tested with the RTDS
Study Type Performed: Switching, Forensic Simulations

Series Capacitor Switching studies, Confidential, USA
Performed detailed design studies for an OEM vendor for the series capacitor bids. Studies included MOV sizing, switching and fault analysis
Study Type Performed: Switching, Insulation Coordination

HATCH

Vajira Pathirana, P.Eng., Ph.D.

Global Lead Power System Planning/Studies

Education & Qualifications
Ph.D., Electrical Engineering, University of Manitoba, Winnipeg, Manitoba, Canada, 2004

B.Sc., University of Moratuwa, Moratuwa, Sri Lanka, 1996

Professional Affiliations
Engineers Geoscientists Manitoba - Member

Experience
23 years

Location
Winnipeg, MB, Canada

Specialties
HVDC, Feasibility and Planning Studies, Transient Simulation Studies, Protection and Control

Vajira Pathirana, Ph.D., P.Eng., is a professional engineer with over twenty years of experience in planning, designing, specification, construction, testing and commissioning of high voltage AC and DC transmission systems. His experience includes pre-feasibility and feasibility studies, planning studies, electromagnetic transient studies, power system protection design, substation automation design, Owner's Engineer services, construction management services, as well as project planning, management and coordination.

Vajira has been involved in many high voltage DC and AC transmission projects in North America, Europe and Asia performing feasibility studies, developing technical specifications, reviewing tenders and design documentation and performing commissioning.

Vajira is also an Adjunct Professor at the Department of Electrical and Computer Engineering at University of Manitoba.

RELEVANT PROJECT EXPERIENCE

GNWT WGSL Transmission Route Study, NWT, Canada; Project Manager: This project involves transmission route study and system stability studies for a 800 km, 100 MVA, 230 kV transmission line connecting two standalone AC grids. The project involves identification of family of structures considering optimal conductor selection, river crossings, weather conditions and maximum expected spans. The studies also include identifying stability issues in the system and shunt compensation requirements.

Atlantic Grid Development (AGD), Atlantic Wind Connection (AWC) Project, New Jersey, United States, Project Advisor: This project investigated the feasibility of a 6000 MW VSC based offshore HVDC grid that was designed to link offshore wind farms to several states along the U.S. Atlantic coast. Work included planning and pre-engineering studies for the offshore HVDC grid. Served in working groups for defining requirements for converters, protection schemes, and grid controllers.

Alberta Electric System Operator (AESO), Alberta Transmission System Project Scope Development, Alberta, Canada, Project Engineer: This project involved feasibility studies for integration of two ±500 kV, 2000 MW HVDC systems to the Alberta Interconnected Electric System (AIES). The studies included multi-infeed interaction analysis, AC system strength evaluation, identifying connection locations, developing station single line diagrams, determination of reactive power and voltage regulation requirements, identifying system constraints and grid connection aspects and defining functional requirements for the two HVDC schemes.

Dakota Gasification Company, Transmission System Expansion Project, Dakota, United States, Technical Advisor: This project involved performing protection coordination studies and developing protection settings using ASPEN simulations for a transmission system expansion project.

Nevada Energy, 345 kV Transmission System Development Project, Nevada, United States, Project Engineer: Performed PSCAD studies for parallel line resonance and single pole reclosing investigations for 345 kV transmission system development.

AltaLink, Transformer Modelling, Alberta, Canada, Project Engineer: The work involved developing a database with transformer information, calculating transformer impedance for each transformer based on available information, producing transformer summary sheets and preparing PSS/E models for each transformer.

Alberta Electric System Operator (AESO), Underground Cable Project, Alberta, Canada, Project Engineer: Performed studies to evaluate the reactive compensation requirements and determine the reactor sizes at the terminal stations for a proposed 500 kV underground cable project in the Edmonton area.

Teck Cominco Metals Ltd., Waneta 230/63kV Substation Replacement Project, British Columbia, Canada, Lead Design Engineer: This project involved designing control and protection schemes, developing protection settings, development of commissioning procedures, configuration of protection relays, and energization testing of the station.

Manitoba Hydro, Generator Parameter Estimation Project, Manitoba, Canada, Project Engineer: The work included development of PSCAD user interface modules for generator, exciter and governor models for parameter optimization, creation of PSCAD test cases, and building an interface to control the test cases.

HATCH - POWER SYSTEM MODELLING, SIMULATION AND ANALYSIS

Nalin Pahalawatta

SYSTEM STUDY LEAD

Education & Qualifications
Bachelor of Science in Electrical Engineering (First Class Honours),
PhD in Electrical Engineering,
Master of Business Administration

Experience
30+ years

Specialities
Power system analysis and planning. , HVDC transmission, Renewable generation integration, modelling and control.

Connected
Fellow of Engineers Australia, Member of IET, IEEE, and Cigre, Registered Charted Professional Engineer in UK and in Australia.

Over 30+ years, Nalin's experience includes responsibility for the operation, medium, and long-term planning of the HV electricity transmission networks including planning of new load, generation and distribution network connections. Nalin also has experience planning and specification of ancillary services in the National Electricity Market (NEM) in Australia, as well as development of network and plant models.

Nalin has a strong background on HVDC system research, planning and operation. He has significantly contributed to modelling and analysis of HVDC controller performances, planning of New Zealand Interisland HVDC link and Basslink.

Recently he investigated of use of energy storage systems for transmission capacity augmentation, for providing frequency control ancillary services and for effectively managing the intermittency of renewable energy sources.

Nalin has been a member of several advisory panels and working groups for generation plant modelling, planning and operation of high voltage networks, nationally and internationally. He has been:

- The Convenor of the CIGRE working group on "Connection of wind farms to weak AC networks" (2014 - 2016).
- the recipient of the Cigre Technical Award in 2013, in recognition of his services to the HVDC industry

New Zealand HVDC Pole 3 switch yard
Nalin led the initial planning and justification of the replacement of the aged mercury-arc pole 1 of the New Zealand interisland HVDC link.

RELEVANT PROJECT EXPERIENCE

Experience in Power System Planning.

Senior Technical Director, GHD (2018 – 2020)
Nalin led the preparation of generator performance standards for thermal and renewable generation plants and supported the connection negotiations with the network service providers and AEMO. Provided system planning and operation advice to AEMO, Western Power, Transpower and ARENA. Led generator connection due diligence and system strength assessment services for TransGrid and South Australia Power Networks.

Principal Consultant, Network Planning, TransGrid (2017 - 2018)
Provided leadership and advice on transmission technology and development of electricity transmission grid, in particular for meeting the challenges associated with transitioning to a renewable energy future.

Manager, Power System Analysis, TransGrid (2012 – 2017)
Responsible for the operational, medium and long-term planning of the high voltage electricity transmission network in New South Wales including planning of new load, generation and distribution network connections.

Manager, Network Models, Australian Energy Market Operator (AEMO) (2012)
Responsible for collecting, quality assurance of, and making available, the network and plant models to the NEM participants as well as for AEMO's business functions.

Manager, Network Capability, AEMO, (2010-2012) Responsibilities included contributions to National and Victorian planning functions as well as providing planning advice for new connections, asset replacement and refurbishment in Victoria.

Team Leader, Transmission Planning, Transpower New Zealand Ltd (2000 – 2010)
Responsible for planning of several major grid augmentation projects and for development of several key operation policies. The augmentation planned included 400 kV, 200 km transmission line to Auckland, reactive power support for Auckland, Christchurch, and Upper South Island and the inter-island HVDC upgrade.

Nalin is experienced in planning of reactive power support, including modelling and implementation of, synchronous condensers, SVCs and STATCOMs for mitigating voltage instability.

Knowledge of integration of renewable energy systems and market services.

- Preparation of generator performance standards (GPS), and generator connection studies for solar farms Yarrabee, Walla-Walla and Yarranlea, and the Barkers Inlet thermal power station. Supported generator connection applications and negotiations with TNSPs and AEMO, for renewable generation connections, including Coopers Gap and Lincoln Gap windfarms (2018 – 2020).
- GPS due diligence studies and system strength full impact assessment studies for TransGrid and South Australia Power Networks. (2018 – 2020)
- Led the R2 model compliance assessment for Bungala solar farm (2020).
- Reviewed the generator compliance template and supported the assessment of rule changes associated with classification of contingency events, performance of standalone power systems and management of system strength, for Australian Energy Market Commission (2019-2020)
- Reviewed the operational effectiveness of the Western Power's Generator Interim Access tool, (2020)
- Review and comparison of NZ Planning criteria with International good industry practice, and review of non-transmission options for managing reactive power requirements for Transpower NZ Ltd (2019 - 2020)
- Convenor of the CIGRE working group on "Connection of wind farms to weak AC networks" (2014 - 2016). The working group resulted in publication of a technical brochure which highlighted the need for using high fidelity models and stability simulation tools for assessing the stability of the non-synchronous generator connections. The recommendations of the working group are now widely accepted and used internationally, including Australia and USA.
- Managed receiving generator models and their integration with AEMO's Operations and planning data management system (OPDMS). OPDMS is the main analysis tool AEMO and TNSPs presently use for investigating stability constraints in NEM. AEMO (2011-2012)
- Led a successful completion of a stakeholder consultation process for defining, assessing, and planning the Network Support and Control Ancillary Services (NSCAS) procured by AEMO for ensuring system security AEMO (2012)
- Managed contributions to AEMO stakeholder consultations on Voltage Control and System Restart Ancillary Service procedures. TransGrid (2015-2016).

Relevant Publications.

- Battery Storage for Enhancing the Performance of Transmission Grids
  N. Pahalawaththa, A. Kingsmill, H. Klingenberg, Paper No C4-118, Cigre 2018 General Session in Paris, August 2018
- Connection of Wind Farms to Weak AC Networks - Cigre Brochure 671.
  Cigre working Group B4.62, Convenor: Nalin Pahalawaththa, December 2016,
- FACTS for Enabling Wind Power Generation, Peeter Muttik, John Haddow, Cathy Chalmers, Garth Gum Gee, Nalin Pahalawaththa. Presented at the Cigre 2010 Session, Paris, August 2010
- Reactive Power Problems Require Proactive Solutions
  Geoff Love, Stuart MacDonald, Kent Yu, Christine Hill, Nalin Pahalawaththa, Presented at the Electricity Engineers Association Annual Conference, Christchurch, June 2007
- Dynamic Voltage Stability of Auckland Metropolitan Load Area
  S. MacDonald, D. Boyle, T. George and N. Pahalawaththa, IEEE Power Systems Conference and Exposition, PSCE '06, pp 589-594, 2006
- Gone with the wind
  N. C. Pahalawaththa, Doug Goodwin, Presented at the Electricity Engineers Association Annual Conference, Christchurch, June 2004
- SVC Dynamic Analytical Model
  D. Jovcic, N. Pahalawaththa, M. Zavahir, H. A. Hassan, IEEE Transactions on Power Delivery, Volume 18, No. 4, October 2003, pp. 1455 - 1461
- HVDC Operation in the New Zealand Deregulated Electricity Market
  Mohamed Zavahir, Predrag Milosevic, Nalin Pahalawaththa, Derrick Westenra, Presented at the CIGRE 39th Session, Paris, September 2002.

HATCH – POWER SYSTEMS MODELLING AND ANALYSIS

Salim Anwari

SENIOR ENGINEER, POWER DELIVERY AND INTEGRATION

Education & Qualifications
Bachelor of Engineering (Electrical Engineering) (Hons.1), University of New South Wales, 2014

Professional Affiliations
Member of CIGRE Australian Panel C4

Specialties
Power System Studies, Renewable Generation Connection Studies, Generator Testing

Salim has demonstrated experience in all aspects of the generator connections process in the NEM, including pre-feasibility, connection enquiry, connection application, generator and control system testing and model validation.

Salim has significant experience in preparing all the components of an asynchronous connection application, resolving associated due diligence enquiries from AEMO and TNSP's, closing issues registers and successfully negotiating GPS, leading to 534A/B.

Salim is a proficient user of power system simulation and automation tools including, PSS/E, PSCAD, PowerFactory, ETRANplus, Mudpack and Python packages. In addition to technical capability, Salim also has demonstrated experience in successfully leading and managing technical projects, including management of resources, budgets and timelines.

Salim has contributed to over 1 GW of asynchronous generation connection projects in the NEM.

RELEVANT PROJECT EXPERIENCE

NER Compliance Assessment for Generator Connections and Development of Generator Performance Standards

Performed detailed power system modelling and NER compliance assessments for numerous large scale generator connections in the NEM including site specific controller tuning, model acceptance testing, RMS/EMT model benchmarking, releasable user guide development, preparation of datasheets, voltage control strategy and generator performance standard (GPS) development.

Negotiation of GPS and Resolution of AEMO/TNSP Due Diligence Enquiries / Technical Lead / Project Management

Led team of engineers as well as subcontractors to successfully deliver multiple large scale generator connection projects in the NEM, including active involvement in the resolution of due-diligence enquiries from AEMO/TNSP, negotiation of GPS, system strength remediation requirements, liaison with developers and equipment suppliers including SMA, Ingeteam, Power Electronics and others. Acted as the single point of contact for both internal and external stakeholders, assisted in the resolution of grid connection issues and managed resources, budgets and timelines.

System Strength Impact Assessments

Performed full impact assessments (FIA) and associated due diligence on behalf of TransGrid, to assess system strength impact of proposed asynchronous connections to weak areas of the NEM. The assessment also included a review of options to resolve identified system strength issues, including synchronous condenser modelling and controller re-tuning. The FIA was undertaken using AEMO/TransGrid's wide area PSCAD model with ETRANplus for parallel processing functionality.

Excitation Control System (AVR and PSS) Tuning

Design of settings for a new digital excitation control system (AVR, UEL, OEL and PSS) replacing the analogue system on the Mintaro OCGT generator. The PSS settings were derived based on small signal stability assessments and tuning undertaken in Mudpack.

HATCH

Generator and Control System Testing (R2), and Dynamic Model Validation

- Mintaro Power Station Gas Turbine Generator Excitation Control System and Governor Upgrade – Testing, R2 Model Validation
- SAPN TG North (Edinburgh) Emergency Power Station (5 Gas Turbine Generators) – R2 Testing and Commissioning, R2 Model Validation
- SAPN TG South (Lonsdale) Emergency Power Station (4 Gas Turbine Generators) – R2 Testing and Commissioning, R2 Model Validation

Transmission Network Planning Investigations and Power System Reviews

- AEMO Power System Frequency Risk Review (PSFRR) for 2020 – Assisted AEMO in the development of the PSFRR including review of power system frequency risks associated with non-credible contingency events in the NEM, review of historical non-credible contingency events, assessment of performance of emergency frequency control schemes (EFCS), consultation with all TNSP's and internal AEMO stakeholders and preparation of the report for publication.
- TransGrid Western NSW Network Development Plan – Identification of Grid Impact and Required Network Augmentation to facilitate the connection of Large-Scale Renewable Energy Projects (450 MW) in the Western NSW Network
- Horizon Power North West Interconnected System (NWIS) Pilbara Power Project – Impact of Additional Generation on Transient Stability Constrained Transfer Limits, Critical Fault Clearing Times and Under Frequency Load Shedding (UFLS) Schemes

Technical Feasibility Studies and Grid Impact Assessment for Renewable Energy Connections

Performed feasibility studies to assess the grid impact of several proposed renewable generation connections to TransGrid's transmission network. Steady state studies were undertaken to assess impact on thermal constraints, voltage stability (QV and PV analysis) and short circuit levels.

Transmission/Distribution Network Design (Overhead Lines, Underground Cables, Earthing Systems)

- West Dapto Electrical Relocation Works, Endeavour Energy, NSW – Concept Design of new 33 kV Overhead Line and 11 kV Underground Cable sections
- Smithfield Electrical Relocation Works, Endeavour Energy, NSW – Detail Design of new 33 kV overhead line sections terminating at Smithfield Zone Substation
- Digital Train Radio System (DTRS) Project, Sydney Trains – Design of Power Supply and Earthing Systems for Transmitter Base Stations and Communication Towers. Analysis using CDEGS of Earth Potential Rise (EPR) Phenomena.

Secondments

Horizon Power, Western Australia (June 2016 – December 2016) – Technical review of PV system connection applications, connection studies in DIgSILENT PowerFactory for commercial/residential PV systems with battery storage, development of effective and efficient internal processes for the assessment of PV system application compliance and the training of staff to undertake such assessments. Revision of requirements for integration of inverter based embedded generation on the Horizon Power Network.

Significant projects

Some generation development and refurbishment projects Salim has contributed to in the above capacities include;

- 450 MW Yarrabee Solar Farm
- 300 MW Walla Walla Solar Farm
- 200 MW Kiamal Solar Farm with 190 MVA synchronous condenser
- 151 MW Mortlake South Wind Farm
- 30 MW Cohuna Solar Farm
- TG North and South Emergency Power Station
- 90 MW Mintaro Power Station excitation and governor control system upgrade

HATCH

HATCH - POWER SYSTEM MODELLING, SIMULATION AND ANALYSIS

Samadhi Liyanage

POWER SYSTEMS ENGINEER

Education & Qualifications

PhD Candidate, School of Electrical, Computer and Telecommunications Engineering, University of Wollongong, Australia.

BSc Eng (Hons), Electrical and Electronics Engineering, University of Peradeniya, Sri Lanka, 2015

Professional Affiliations

Student member of the IEEE Power and Energy Society

Specialties

Power System Studies, Renewable Energy

Samadhi is also a PhD candidate in the University of Wollongong (UOW), and her research focuses on harmonics generated by inverter-connected electricity generating systems.

She has experience in modelling, simulation and testing of inverters. She has worked as a Trainee Engineer in power generation, transmission and distribution divisions in Ceylon Electricity Board (CEB), the largest electricity supplier in Sri Lanka.

Samadhi is an experienced user of specialized power systems analysis software including PSCAD, PowerFactory, and Matlab, and programming languages Fortran and Python.

She is an active member of IEEE Power and Energy Society (PES) and currently working as the General Secretary in IEEE PES UOW student branch chapter.

Samadhi is modelling and assessing the adequacy of the presently used models of inverter connected generators for representing their power quality performance.

RELEVANT PROJECT EXPERIENCE

Modelling of Large-scale Inverter Connected Generating Systems

Presently, as a part of her PhD research, Samadhi is investigating the low-order harmonics generated by the large-scale inverter connected generating systems and assessing the applicability of existing inverter harmonic models under various inverter and grid operating conditions. PSCAD is used as the main simulation tool for this project.

Inverter Testing - Australian Power Quality and Reliability Centre (APQRC)

Power quality performance of single-phase and three-phase inverters has been tested in a controlled environment. Each inverter was subjected to several capability tests under various operating conditions to assess the quality of inverter operation.

Generator Performance Modelling and Assessment

Samadhi has assessed the performance of a weak area of a power system, connected to many renewable generators, using PSCAD wide area network model.

HATCH - POWER SYSTEM MODELLING, SIMULATION AND ANALYSIS

Yasas Rajapakse

ENGINEER, POWER DELIVERY AND INTEGRATION

Education & Qualifications

MASc, Electrical Engineering, University of Toronto, Toronto (ON), Canada, 2020

BSc, Electrical Engineering, University of Manitoba, Winnipeg (MB), Canada, 2017

Specialties

Power System Modelling, Power System Studies

Yasas Rajapakse graduated with a Master's degree from the University of Toronto in Electrical Engineering and a Bachelor's degree from the University of Manitoba in Electrical Engineering with a focus in power and energy systems.

His expertise includes Power System Modelling and Simulation, Power Electronics Simulations, Power System Stability and Control Design and Analysis.

He has experience in electromagnetic transient simulations, assessment of the performance of the power system protection systems, power system voltage stability studies, modelling and simulation of generator control interactions, and generator performance assessment.

Yasas is a competent user of many software tools for power system/power electronics simulation and analysis including PSS®E, PSCAD, RTDS real-time simulator, PLECS, MATLAB/Simulink, and Python.

Yasas has designed, simulated and implemented a DC microgrid and the microgrid controller.

RELEVANT PROJECT EXPERIENCE

MICROGRID - MODELLING, SIMULATION AND IMPLEMENTATION

As a part of Yasas' Masters degree research, he designed, tested and implemented a decentralized energy management strategy for a DC microgrid to ensure long-term health and protection of energy storage systems, including:

- Confirming the design and functionality of energy management system using PSCAD simulations
- Design of the distributed controls for the microgrid to ensure desired performance, including its stability
- Confirming the performance of the microgrid, including energy storage and solar power elements, by its physical implementation

EMT STUDIES AND PROTECTION RELAY SIMULATION

- Developed a PSCAD model of DC arc fault for HVDC systems.
- Automated testing of line differential protection relay model developed for PSCAD using python scripts.

ANALYSIS OF VOLTAGE INSTABILITY

Examined different cases of voltage stability using quasi-steady state analysis and real-time simulations using RTDS real-time simulator

GENERATOR PERFORMANCE MODELLING AND ASSESSMENT

Yasas has assessed the performance of a weak area of a power system, connected to many renewable generators, using PSCAD wide area network model.

TECHNICAL SPECIALIST

Elham Karimi, PhD, EIT

Power System Studies Specialist, PD&I

Education & Qualifications

PhD, Electrical and Computer Engineering, 2017

MSc, Electrical Engineering, 2012

BSc, Electrical Engineering, 2010

Professional Affiliations

PEO (Professional Engineers of Ontario): In-Training Member

Experience

6+ years

Specialties

Power System Simulations, Interconnection studies, Transmission expansion studies, Hybrid Microgrid, Power system modeling, PSCAD

Elham is an Electrical EIT with the Mississauga Hatch Office and she is a member of the PD&I group. Her main areas of expertise include system studies of distribution systems, including the development of DER integration projects (PV systems, Wind turbines, Energy storage systems); economic analysis of hybrid microgrids; frequency, voltage regulation and power flow studies; power quality assessment and harmonic analysis; mathematical modeling; power system simulations and optimization.

At Hatch, she has been involved in various power system studies and business case assessment of solar and wind projects, hydrogen-fuel cell and Electric truck projects and independent engineering assessment of wind projects. She worked at the Nanticoke solar farm construction site for more than 7 months as on-site Electrical Quality Inspector where she completed various tasks including quality inspections and verification of the electrical work on site and review of the engineering documents and drawings.

She has experience in conducting power system simulations using various software, including PSCAD, EasyPower, Matlab, etc. and has been involved in various projects performing interconnection studies, system analysis, forensics investigations, feasibility studies and system modeling.

RELEVANT PROJECT EXPERIENCE

PSCAD mode Development, Powercor, Australia, Power System Modeling. The scope of this project is to develop PSCAD models for various Wind Farms as well as STATCOM units, based on provided PSSE models. The performance of the PSCAD model is benchmarked against PSSE models.

Consultancy Services for AEMO Network Development, Australian Energy Market Operator, Australia, Power System Analysis. The scope of this task is to assist with the evaluation of proposed generator connection applications including power system studies, Model acceptance testing, Assessment of generator performance standards, Assessment of the generating system's capability to achieve the proposed generator performance standards and Project management. The assessments are performed in PSCAD and PSSE for various assessment guidelines including reactive power capability, frequency and voltage disturbances, response to contingency events, voltage and reactive power control and active power control. Various projects seeking 5.4.3 letter approval or final registration were assessed for compliance with NER and AEMO guidelines.

Transformer Failure Investigation, Wind farm, TX, US, Power System Modelling and Analysis. This study included a detailed modelling of the wind farm to investigate the root cause for padmount transformer failure. The wind farm model was created in PSCAD and various phenomena including transients, resonances, etc. were investigated.

Transient Overvoltage (TOV) Assessment, Wind farm, TX, US, Power System Analysis. This study included investigating the transient overvoltage issue that was encountered in system modelling of the wind farm. The problem was investigated using PSCAD and various mitigation techniques were considered.

Power System Stabilizer Design and Evaluation, NL, Canada, Power System analysis. This study included a design and evaluation of a PSS4B model in MATLAB/SIMULINK and was compared with the results of a PSS2B design. The performance of the design was investigated using MATLAB and PSSE.

HATCH

Transient Recovery Voltage (TRV) Study, SK, Canada, Power System Analysis. This study included modelling and analyzing of a power system with connected generators to investigate the TRV capability of the circuit breakers. This study was conducted in EasyPower and PSCAD and power flow, short circuit and transient behaviour of the system were analysed and recommendations regarding the switching equipment capabilities were provided.

HATCH - POWER SYSTEM MODELLING, SIMULATION AND ANALYSIS

Amir Mosaddegh, P.Eng., Ph.D., MIEEE

POWER SYSTEM SPECIALIST

Education & Qualifications

PhD, Electrical and Computer Engineering, 2016
Master of Science, Electrical Engineering – Power – Protection of Electrical Networks, 2011
Bachelor of Science, Electrical Engineering – Power, 2008

Professional Affiliations

Professional Engineers Ontario – P.Eng.
Institute of Electrical and Electronics Engineers (IEEE) – Member

Experience

7+ years

Specialties

Power System Studies, Smart Grid, Electric Vehicles, Asset Management, Optimization Methods

Amir is a self-motivated and dependable Professional Engineer while achieving high performance with minimal supervision. He is an experienced distribution and transmission system specialist and smart grid and demand response program analyst with excellent client and project management skills. Amir is action-oriented with strong ability to communicate effectively with technology, executive, and business audiences.

- He is a knowledgeable and professional specialist with broad experience across multiple disciplines and is suited to this role.
- Demonstrated experience in programming and using power engineering software with expertise in the area of simulation and power system studies, area of reliability and power quality, asset management studies, maintenance, repair, and operations (MRO) roadmap and business case programs, grounding and circulating current, data analytics, optimization methods, and developing standards for utilities.
- Proven track record in engineering consulting and proficiency in power system design and analysis.

Amir's role on the Powercor PSCAD Windfarm Model included PSCAD modeling of all windfarms and STATCOMs, benchmarking of system behaviors compared to the existing PSSE models, and providing PSCAD RUG files.

Amir's role on the project of YEC Blackstarting Feasibility Study included modeling of inverter-based BESS model, investigation on different switching scenarios of system energization during blackstarting process, and determination of BESS inverter rating, with a discussion of possible alternatives to reduce the BESS inverter rating size.

RELEVANT PROJECT EXPERIENCE

Powercor Australia Ltd., PSCAD Windfarm Model, Power System Specialist (H363095) – Project included development of PSCAD models for three windfarms and two STATCOMs, with a benchmarking study to the existing PSSE models.

- Amir developed the PSCAD models of all three type 1 and type 2 windfarms and STATCOMs in the PSCAD with all respected dynamic parameters used in the PSSE models.
- Amir developed the releasable user guide (RUG) files to Powercor of PSCAD models of all windfarms.
- Amir conducted the benchmarking of system behavior in the PSCAD versus PSSE models with several testing scenarios to investigate the performance of PSCAD models.

Yukon Energy Corporation (YEC), Battery Energy Storage System (BESS) Blackstarting Feasibility Study, Principal Investigator (H362094) – Project included BESS inverter-based model in PSCAD, PSCAD conversion model of YEC transmission system, and interconnection studies of BESS during blackstarting.

- Amir modeled an inverter-based BESS system in a voltage controller mode suitable for blackstarting studies.
- Amir revised the YEC transmission system, converted the model into PSCAD, and the proposed route of black starting.
- Amir conducted a feasibility study of BESS interconnection and determined the appropriate BESS inverter rating to provide enough reactive power due to the inrush current during the system energization. Sequence blackstarting and inrush current limiters technologies have been discussed as alternatives to reduce the BESS inverter rating size.

HATCH

HATCH - POWER SYSTEM MODELLING, SIMULATION AND ANALYSIS

Anupama Konara

Power System Specialist

Education & Qualifications

PhD, Electrical and Computer Engineering, University of Manitoba, Winnipeg (MB), Canada, 2016

BSc Eng, Electrical and Electronics Engineering, University of Peradeniya, Sri Lanka, 2009

Experience

4+ years

Specialties

Power System Modeling, Power System Studies

Dr. Konara has over four years of experience working as a power system studies consultant conducting impact study assessment of interconnection requests. With a strong academic background, Ms. Konara obtained her Ph.D. from University of Manitoba with the specialization in small signal analysis. A novel control algorithm was designed as part of her research for tuning synchrophasor-based robust power system stabilizer.

Expertise highlights

- Power System Modeling (HVDC, thermal, solar, wind and storage generators in Siemens-PTI's PSS®E)
- Power System Simulations
- Power System Stability
- Impact Study Assessment of Interconnection Requests
- Design of Damping Controllers

RELEVANT PROJECT EXPERIENCE

Grain Belt Express, System Studies Lead, Invenergy (Current).
Carrying out system studies for HVDC line interconnecting at three ISOs (SPP, MISO, and AECI).

- Carrying out weekly study meeting to collect relevant data/ study procedure
- Preparing study outlines
- Carrying out steady-state and stability studies

Refurbishment of the Songo HVDC Converter Station - Brownfield 3 Project, Project Support, **Hidroeléctrica de Cahora Bassa** (2020).
Created a detailed PSS®E model of Mozambique network for short circuit study which involved:

- Gathered data for short-circuit modelling from multiple sources/parties;
- Prepared a detailed list of assumptions for short-circuit modeling in PSS®E;
- Communicating with customer/consultants to identify potential future upgrades in the area;
- Multiple models were developed for different planning horizons.
- Prepared the steady-state PSS®E model of HVDC for other studies.

HVDC Consulting Services for SeaLink, Project Support, NextEra (2020).
Sub-Synchronous Torsional Interactions (SSTI) Screening Analysis was performed:

- The analysis was performed in PSS®E using multiple planning base cases and contingencies provided;
- Developed scripts to generate results under many contingency scenarios;
- Prepared study reports and recommendations

System Impact Study Assessment, System Studies Consultant with PSC North America working for PJM ISO (2016-2020).

Performed stability study assessment of generator interconnection requests for many projects complying with utilities, NERC, TO and other applicable criteria.

- Prepared scope of work and carried out system impact studies of generator interconnection requests using PSS/E;
- Prepared and tested PSS/E generic and user models of generators (solar, wind, storage and thermal);
- Managed multiple queue projects and their deadlines;
- Reviewed work of team members to ensure quality and consistency;
- Communicated with clients to ensure accuracy and delivery of results on time.

Design of Synchro-phasor-based Robust Power System Stabilizer, Research Assistant, University of Manitoba (2010-2015).

The research project was carried out as part of PhD study.

- Investigated how synchro-phasor-based remotely measured signals in large-scale interconnected electrical power systems could be used to develop effective power system stabilizers;
- Studied the effect of delays and data-dropout in the synchro-phasor communication networks on the performance of the stabilizers using Real Time Digital Simulator (RTDS);
- Developed a novel algorithm for designing a robust power system stabilizer that uses remotely measured signals available from Phasor Measurement Units (PMU). The proposed algorithm guarantees the robustness of the stabilizer under multiple contingencies and the controller was tested in RTDS;
- Produced a technical paper in IEEE transactions on Power Systems and attended conferences to present technical papers.

HATCH / POWER SYSTEMS

Zhuang Zhang

Power Systems Specialist

Education & Qualifications

Bachelor of Electronics Engineering, Southeast University, Nanjing, China, 2011

Master of Economics, Nanjing University, Nanjing, China, 2016

Master of Electrical Engineering, University of Manitoba, Winnipeg, Canada, 2020

Experience

3+ years (including research experience in master's program)

Specialties

Power system study, Grounding study, Controls of power electronic system.

Zhuang is a Power Systems Specialist with a strong academic background in electrical engineering and related experience in power system study and grounding study.

She has been involved with multiple HVDC projects, including PSCAD modelling, system performance studies and feasibility studies.

She has various experiences with system study software tools, including PSCAD/EMTDC, RTDS/RSCAD, OPAL-RT, MATLAB for power system simulation and CDEGS for grounding study.

RELEVANT PROJECT EXPERIENCE

LCP PSCAD Model Development, Winnipeg, Canada, Electrical Engineer, 2020
Project included PSSE/PSCAD model benchmarking and power system studies

- Zhuang's role included power system studies: steady state, short-circuit level, harmonic impedance, and contingency simulation for multiple cases.
- Power system study using simulation tools: PSSE, E-TRAN, PSCAD.

Thunderhead Wind Farm Harmonic Impedance study, Winnipeg, Canada, Electrical Engineer, 2020
Project included building PSCAD model and power system studies

- Zhuang's role included preparing PSCAD model for the system and harmonic impedance scan.
- Power system study using simulation tools: PSCAD.

Technical report on Converting an AC Transmission Line to DC, Winnipeg, Canada, Electrical Engineer, 2020
Project included identifying the opportunities, technical and economic feasibility study of Converting an AC Transmission Line for HVDC operation

- Zhuang's role included literature review, gap analysis and preparing the table of contents and final report.
- **Southerland Transmission Line ROW Study, Winnipeg, Canada, Electrical Engineer, 2020**

Project included an assessment of the potential AC interference

- Zhuang's role included grounding study and Right-of-Way (ROW) study.
- Grounding study using CDEGS software, including the tool modules: RESAP, MALT, MALZ, TRALIN.

HVDC simulation project, Winnipeg, Canada, Research student, 2018

- LCC-based HVDC transmission system modelling using PSCAD, including transient stability and steady-state simulation.
- Controller design, harmonic analysis, filter design, and DC and AC fault analysis.

CORE TEAM MEMBER

Faraz Majid

POWER SYSTEM ANALYST

Education & Qualifications
B.Eng Electrical Engineering, 2012, McMaster University

Experience
7 + years

Affiliations
Golden Key International Honour Society – Member

PEO – P. Eng.

Specialties
Grid Impact Assessment, Transient and Steady State Analysis

Faraz has been with Hatch for more than 7 years during which he performed a number of power system studies, transmission line design projects, and power distribution system design projects. Much of his work has been related to power system studies that include building of power system models, conducting power flow, short circuit, transient stability and voltage stability analysis.

Faraz has been involved in different power system studies project involving TC Energy, AESO, Natural Resource Canada Driland, and Next Era Energy to name a few. He has also provided power system engineering support for Bruce Power projects. He has worked on the preliminary assessment of a large pumped storage project, which included power flow studies and issues during the last phase of the project.

- Knowledge of Power flow, transient and load flow studies
- Skilled with contingency and grid assessment analysis
- Versed in power system tools and grid assessment programs
- Adaptable to a variety of projects and teams

RELEVANT PROJECT EXPERIENCE

AEMO, Generator application assessment, Australia, Power System Analyst

AEMO retained Hatch to provide technical assistance in conducting assessment of generator connection applications. The scope of the work was to assess and verify that the PSSE model of the generator adhered to the NER requirements and the generator's GPS clauses.

- Reviewed the technical details of the PSSE model of the generator connections.
- Performed GPS clauses specific dynamic simulations in PSSE in order to review the Generator performance standards (GPS).
- Created AEMO's due diligence reports for generator applications, summarizing findings and recommendations.

Confidential, Pumped-storage hydroelectricity, Ontario, Power System Analyst

Confidential is planning to develop a pumped-storage hydroelectricity in Ontario. Hatch was retained to propose preliminary connection options and their capital costs for the pumped-storage facility.

- Performed load flow analysis to identify any thermal and voltage violations for the different options.
- Provided engineering support to Client during the IESO's Technical feasibility study.
- Advised on the planning of the next phase of the project.

Next Era Energy, Ghost Pine Battery Energy Storage System, Alberta, Canada, Power System Analyst

Ghost Pine Energy (Next Era Energy) is adding battery energy storage capability to their existing wind farm.

- Assessed the impact of the connection and completed the Engineering study report required by the system operator (AESO)
- Preformed power flow, short circuit, voltage stability and transient stability analysis.

AESO, Fort McMurray Area Transmission Development, Fort McMurray (FMM) Area, Alberta, Canada, Junior Engineer

A power flow and voltage analysis were required for the 500-kV transmission project, comprising of two long 500kV lines

- Performed load-flow analysis, voltage stability and transient stability studies to determine the operating limits for Fort McMurray area transmission system
- Assessed operating limits for transfer-in and -out of the FMM area for 2013, 2015 and 2020 timeframes at different stages of major transmission reinforcements and/or generation scenarios
- Determined reactive power compensation requirements and reactor placement arrangement for the high voltage line.

Christopher Wan

ELECTRICAL & CONTROLS ENGINEER

Education & Qualifications
Bachelor of Science (B.Sc.) in Electrical Engineering, University of Calgary, 2009

Completed International Internship at the University of British Columbia, University of Calgary, 2009

Experience
11+ years

Specialties
Thermal & nuclear power generation, renewable energy, transmission, distribution

Christopher is an Electrical and Controls Engineer with 11 years of experience in power, instrumentation and control systems selection.

He is a knowledgeable and professional Electrical & Controls Engineer with demonstrated experience in various areas such as:

- Feasibility Studies
- Technology options for natural gas generation units
- Calculation of generator parameters
- Assisted in the development of Wind Generation projects
- Engineer for the modelling, long-term planning, forecasting and operations coordination teams
- Performed analysis of the long term outlook forecast of the Alberta Electricity Market
- Ran high voltage power system studies, supporting the development of the Renewable Electricity Program.

Wan's 's role was Intermediate Electrical & Controls Engineer for Hatch Upside Engineering

Wan's role was Electrical Engineer Co-op for Suncor Energy

RELEVANT PROJECT EXPERIENCE

Hatch Upside Engineering Ltd, Alberta, Canada, Intermediate Electrical & Controls Engineer

- Provided valuable information to assist in the development of a business case for brownfield power generation projects, reaching out to potential clients and existing members of the Power Pool.
- Represented Upside at the Independent Power Producers Society of Alberta (IPPSA) Annual Conference Trade show along with stakeholder sessions to represent the interests of Independent Power Producers in the AESO Connection Process.
- Reviewed technology options for natural gas generation units. Reviewed Cost of New Entry (CONE) Report for various gas generation units and previously installed capacity.
- Assisted in the estimation of Engineering, Procurement and Construction (EPC) costs as well as non-EPC owner's costs for 50 MW Simple Cycle Gas unit. Worked closely with the client to develop a roadmap for application to the Alberta Electric System Operator to connect in the 240 KV transmission system with associated regulatory and engineering hurdles.
- Calculated generator parameters for 1 MW Synchronous Generator in coordination with FortisAlberta Distributed Generation (DG) application.
- Assisted in the development of PSLF HVDC model for connection of Wind Generation projects and prepared training materials for the running of power simulation tools.

Alberta Electric System Operator, Alberta, Canada, Engineer.

- Engineer for the modelling, long-term planning, forecasting and operations coordination teams.
- Assisted in delivering the long-term transmission plan, studying the Edmonton Transmission Development Project.
- Performed analysis of the long term outlook forecast, and simulated the 2015-2018 operations of the Alberta Electricity Market.
- Delivered system outage coordination plans on a weekly basis to Real-Time Operation Managers, and updated the System Controller Procedures, operational reports and compliance record-keeping.

HATCH

- Released snapshots of the Alberta Integrated Electrical System as packages on yearly (Public Base Case Suite), seasonally (Operation Planning Cases), and weekly (Operational Coordination Cases) basis.
- Reworked the process of collection requests from outside stakeholders, and sharing Critical Energy Infrastructure Information (CEII) under the Regulations of the Federal Energy Regulatory Commission (FERC).
- Ran high voltage (13.8 kV – 500 kV) power system studies, supporting the development of the Renewable Electricity Program (REP), and interconnection studies, interacting with study engineers contracted to perform high level feasibility studies.

Evraz Inc. NA, Alberta, Canada, Asset Maintenance Controller.

- Supervised maintenance of all electrical equipment at Circular Steel Mill, ranging from large cranes, heat treat facilities and high speed conveyor belts to emergency diesel generators.
- Coordinated multi-million-dollar maintenance budget, communicating change management to ensure mutual understanding.

Suncor Energy, Alberta, Canada, Electrical Engineer Co-op.

- Conducted analysis of electrical historian data with Interplant, covering the SCADA information of all Suncor assets.
- Verified computerised ETAP model of High Voltage Electrical System, interfacing with the AESO PSSE/PSLF models, ensuring compatibility.
- Ran simulations of breaker configurations to decide ideal current levels, and modifying protection settings as needed.
- Performed arc flash and short circuit analysis on high voltage systems using ETAP and Easypower, supporting a team of over 30 electric technicians, reviewing historical faults and making recommendations to optimise protection controls while enabling a culture of Safety with a goal of Journey to Zero Harm.

HATCH - POWER SYSTEM MODELLING, SIMULATION AND ANALYSIS

Udana Gnanarathna

HVDC Engineer

Education & Qualifications
Ph.D., Electrical Engineering, University of Manitoba, Winnipeg, Manitoba, Canada, 2014

M.Sc. Nuclear and Quantum Engineering, (E.E.), Korea Advanced Institute of Science and Technology, Daejeon, South Korea, 2007

B.Sc. in Electrical Engineering (First Class Honors), University of Moratuwa, Katubedda, Sri Lanka, 2004

Professional Affiliations
Engineers Geoscientists Manitoba - Member

Experience
10 years

Location
Winnipeg

Specialties
Power System Studies
PSCAD
HVDC Engineering
Renewable Power Integration
Commissioning

Udana Gnanarathna, is a professional engineer providing specialist engineering consulting services in HVDC/FACTS Engineering and Power System Studies.

Udana has extensive experience with electromagnetic transient (EMT) studies for power system transients, including Transient Overvoltage (TOV), Insulation Coordination, Capacitor bank switching, Transient recovery voltage (TRV) across breakers, and Sub-Synchronous Resonance (SSR)/Sub-Synchronous Control Interactions (SSCI) analysis. Udana also has a broad background in HVDC/FACTS projects and has been involved with projects in the USA, Europe, Asia, and in Australia. The experience includes design studies. specification development, technical bid evaluation, review of studies, equipment specifications, designs, and test reports during detailed design, witnessing factory tests, commissioning support, and providing HVDC training.

Dr. Gnanarathna has successfully defended his doctoral dissertation on “Efficient modelling of modular multilevel HVDC converters (MMC) on electromagnetic transient simulation programs” in 2014. This research enables the modelling of large MMC based HVDC systems on personal computers. He has been involved with developing the MMC library models for PSCAD simulation software.

Dr. Gnanarathna is a member of the CIGRE working groups: B4-81 “Interaction between nearby VSC-HVDC converters, FACTs devices, HV power electronic devices and conventional AC equipment” and B4-85 “Interoperability in HVDC systems based on partially open-source software”.

RELEVANT PROJECT EXPERIENCE

- **Sun Cable Australia-ASEAN Power Link (AAPL) Project, Project Engineer.** The proposed Sun Cable AAPL is a three-terminal VSC based HVDC connection that will transmit 2GW of power generated from renewable resources near Tennant Creek, in the Northern Territory, Australia to Singapore via Indonesian seas. Udana has performed a high-level electrode assessment for monopolar ground return operation and is currently performing studies to select the HVDC configuration for the project.
- **SSR and SSCI Evaluation Studies - Los Angeles Department of Water & Power (LADWP), Project Engineer.** LADWP is developing a project to build a new 500 kV transmission line to connect the Apex Generating Station (Apex GS) to the Crystal Switching Station (Crystal SS) in Nevada. The purpose of this study was to determine that the new system configuration was SSR/SSCI-proof and that it would not negatively impact other generating facilities in the vicinity. Udana's work included study the sub-synchronous control interaction (SSCI) phenomenon for nearby Moapa PV, Apex PV, and Big Water PV generator plants resulting from the transmission line upgrades.
- **Chapel Rock Substation - Altalink, Project Engineer.** Udana performed switching over-voltage studies and insulation coordination studies for the 500 kV Chapel Rock substation for AltaLink. This study was performed to confirm the required insulation levels for design of the substation and to ensure proper breaker specification.
- **Offshore Oil Field Project - Worley Parsons, Project Engineer.** Udana performed PSCAD studies, including transient overvoltage and insulation coordination to evaluate two AC options of power supply for an offshore oil field in the Kingdom of Saudi Arabia.

- **Intermountain Power Project (IPP) - Intermountain Power Authority (IPA), Project Engineer.** Udana performed fundamental frequency dynamic overvoltage (DOV) study for Intermountain Power Project (IPP) HVDC system for IPP Renewal Project.
- **Walnut Ridge Wind Project - AMEC Foster Wheeler, Project Engineer.** Udana performed studies to evaluate transient overvoltage on back to back capacitor bank switching at Walnut Ridge wind farm connection substation for the following transient events:
  - Energization inrush
  - Back-to-back energization
  - Outrush into a nearby fault
  - Restrike of breaker pole within a capacitor bank
- **TRV Studies on Circuit Breakers at Borden Substation - Maritime Electric, Project Engineer.** Maritime Electric (MECL) is developing a new cable interconnection between the PEI power system and NB power system. Udana carried out studies to determine the maximum system transient recovery voltage (TRV) and transient switching overvoltage values resulting from fault clearing events, cable energizing, and high-speed reclosing (with trapped charge) in Borden Substation.
- **Nalcor – Labrador West transmission upgrade - AMEC, Project Engineer,** Udana performed a SPTR study on the proposed transmission line for the transmission upgrade project. The work involved:
  - Modelled the system using PSCAD
  - Evaluated the switching overvoltage, single pole reclosing transient recovery voltage (TRV), and rate of rise of the recovery voltage (RRRV) for the 230 kV and 315 kV transmission line configurations.
- **EuroAsia HVDC Project in Europe, Project Engineer.** The EuroAsia Interconnector is a ±500 kV, 1000 MW bipolar VSC based HVDC cable interconnector, and will be connected between the Greek, Cypriot, and Israel. Udana was involved with technical specification package development and technical bid evaluation.
- **Manitoba Hydro BPIII in Manitoba Canada, Project Engineer** - The Manitoba Hydro Bipole III is a new Line Commutated Converter (LCC) HVDC transmission system, transferring 2000 MW hydropower from Northern Manitoba to the Winnipeg area, a distance of 1400 km. Udana has been involved with:
  - Reviewing manufacturer's study reports, equipment specifications, designs, and test reports
  - Witnessing of factory tests
  - Technical bid evaluation
- **Great River Energy CU HVDC Upgrade in USA, Project Engineer.** The Great River Energy (GRE) CU HVDC system is a 1,230 MW ±415 kV bulk power transmission system and transfers the output of the Coal Creek station generating plant in North Dakota to the Minneapolis area in Minnesota, a distance of 700 km. Recently, GRE undertook a valve and control replacement, due to the age of the system. Udana was a key member of the project and provided the following services:
  - Reviewed technical reports of studies, equipment specifications, designs and test reports during the project execution stage
  - Participated in witnessing of factory tests
  - Provided on-site commissioning support for system tests
- **50 Hertz Kriegers Flak Combined Grid Solution Project, Lot 1 Back to- Back Converter Station in Germany, Project Engineer.** This 410 MW VSC HVDC station connects the Kriegers Flak offshore wind power plant to the German grid in northern Germany. Udana provided Engineering consulting services during the detailed design and engineering phase of the project.
- **Pacific Inter-Tie (PDCI) Sylmar Filter Replacement in USA, Team Lead.** This project saw the complete AC and DC filters replacement of the southern terminal of the Pacific Inter-Tie. Udana provided Engineering consulting services during the detailed design and engineering phase of the project.
- **Hyosung 200 MW MMC HVDC system in South Korea, Project Engineer** - Hyosung Heavy Industries is currently developing 200 MW MMC type HVDC. Udana's activities included:
  - Developed Hardware-in-the-loop simulation (HILLS) testing procedure
  - Performed engineering studies

CORE TEAM MEMBER

Susan Derrah

SENIOR ENGINEER

Education
MEng, Electrical, McMaster University, 2000
BEng, Electrical, McMaster University, 1998

Professional Affiliations
Licensed P.Eng., Ontario, Canada

Experience
19+ years

Specialties
Power Quality Analysis, PSCAD and MATLAB Simulations, Power Electronics

Susan is a Professional Engineer specializing in technologies for power quality mitigation at plants with electric arc furnaces. She has been involved in the design and equipment specifications for each Hatch SPLC installation since 2000, a system that stabilizes the active power or current of an electric arc furnace using fast controls with thyristor switches. Experience includes generating furnace PVI diagrams, simulating furnace behaviour using PSCAD and MATLAB, design and specification of SPLC reactors and thyristor switches.

Susan acted as Project Manager for the study phases and the FEL3 Basic Engineering of an active power compensation system using thyristor-controlled resistor banks at Koniambo Nickel SAS.

Susan managed FEL3 Basic Engineering for a new Hatch designed active power compensation system to address plant power quality at Koniambo Nickel.

Susan performed multiple PSCAD simulations for the fast SPLC controls at Pronico electric arc furnace.

RELEVANT PROJECT EXPERIENCE

Koniambo Nickel SAS, FEL3 Basic Engineering of Active Power Compensation, New Caledonia. Project Manager.

- Project manager for FEL3 Basic Engineering of a Hatch designed thyristor-controlled resistor bank for active power to reduce the impact of furnace losses of arcs on the generating station.
- Coordinated completion of time domain simulations, Controls Design Basis and Electrical Design Basis.
- Prepared preliminary sketch of the yard layout showing all major equipment.
- Prepared tender ready specifications for these two major equipment packages and worked with Vendors to obtain firm bids.
- Bids were used to prepare the FEL4 installation and construction cost estimate for the system.

PT Vale Indonesia Tbk, Power Demand Stabilization Options Study, Indonesia.

- Project manager for study of options for stabilizing the power demand on the PT Vale generating stations to reduce the requirements for new generation with the future addition of a new furnace load.
- Prepared sketches of PTVI single line diagrams for various grid configuration options and PVI diagrams showing fast power changes with the SPLC controls.
- Coordinated work on recommendation of SPLC, SVC and HGMS systems and the associated CAPEX.

ProNico, SPLC Detailed Engineering, Guatemala.

- Responsible for simulations and calculations used to design the thyristor firing angle selection for the ProNico SPLC.
- PSCAD furnace power circuit simulation and MATLAB scripts used to calculate the required firing angles for SPLC power and current control for all transformer taps with both delta and wye connections.
- PSCAD simulations to assess fault conditions and protection settings.
- MATLAB simulations to determine the optimal furnace transformer operating tap to be used by the SPLC control algorithm.
- Updated digital filter designs for SPLC control software.

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CORE TEAM MEMBER

Devni Jayasekera, EIT.

POWER AND CONTROL EIT

Education & Qualifications
BASc, Electrical Engineering, University of Waterloo, Waterloo, Ontario, Canada

Professional Affiliations
Professional Engineering-In-Training

Experience
3+ years

Specialties
Power Quality Mitigation Technology, Power System Modeling, PLC programming

Devni is an Intermediate Engineer with 3 years of experience in power and control system design. Specializing in designing and analyzing operation of Hatch Smart Predictive Line Controller (SPLC) technology which uses predictive thyristor control to improve power quality of Electrical Arc Furnaces. She has experience using PSCAD and MATLAB to model operation of power system behavior with integration of various technologies for power quality mitigation. Recent electrical experience includes design of an active power compensation technology using thyristor-controlled resistors for a Nickel smelter in New Caledonia.

Devni also has experience with development and implementation of PLC based Hatch Achieva Coating Control System. Recent control experience include design, testing and successful commissioning of AchievaCC system in galvanizing line at Gary, Indiana.

RELEVANT PROJECT EXPERIENCE

Active Power Compensation Technology, EIT, Koniambo Nickel SAS, Voh, New Caledonia

- Power system modeled in PSCAD to determine optimal size of resistor banks, study potential protection schemes, and create preliminary control strategies.
- Lead client workshop to identify and mitigate potential risks associated with integrating new technology to existing power system.
- Prepared technical specifications for load resistor for thyristor-based control options. Involved in technical discussions with vendors and client on design of new technology.

Driland Microgrid, EIT, Natural Resources Canada, Alberta, Canada

- Involved in designing and sizing renewable generation and energy storage options for the development of Microgrid.
- Prepared technical report outlining potential revenue streams based on Alberta's wholesale electricity market and power system.
- Modelled stability of wind generation and energy storage in PSCAD

No.2 GACT Line Achieva Coating Control System, EIT, U.S. Steel Midwest, Indiana, United States

- Development of PLC based Achieva Coating Control system on No.2 GACT Line. Control software programmed in RSLogix Studio 5000, and HMI displays created in FactoryTalk Studio. Reporting package setup using IBA software and Hatch Historian.
- Successful commissioning and start up of system on site.

SPLC Design Optimization for Low Power and Current Operation, Co-op Student, Hatch, Mississauga, Ontario

- Study conducted on SPLC operation under low power and current conditions using PSCAD software. Calculated and carried out MATLAB analysis to determine overall performance and optimal range of thyristor firing angles for new SPLC switch configuration.

Work Packages for Sustaining Capital Projects, Senior Technical Student, Toronto Hydro, Toronto, Ontario

- Created Work Packages that consisted of project estimate, detailed work instructions, asset breakdown, preliminary design drawings and risk assessments related to project.
- Conducted field assessments with designing and engineering team to ensure feasibility of work within the area.

HATCH

Hatch is an employee-owned, multidisciplinary professional services firm that delivers a comprehensive array of technical and strategic services, including consulting, information technology, engineering, process development, and project and construction management to the Mining, Metallurgical, Energy, and Infrastructure sectors.

Hatch has served clients for over six decades with corporate roots extending over 100 years and has project experience in more than 150 countries around the world.

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