

# **9th IET International Conference on AC and DC Power Transmission 2010**

**(ACDC 2010)**

**IET Conference Publications 570**

**London, United Kingdom  
19 – 21 October 2010**

**ISBN: 978-1-61782-379-4**

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2010) by the Institution of Engineering and Technology  
All rights reserved.

Printed by Curran Associates, Inc. (2011)

For permission requests, please contact the Institution of Engineering and Technology  
at the address below.

Institution of Engineering and Technology  
P. O. Box 96  
Stevenage, Hertfordshire  
U.K. SG1 2SD

Phone: 01-441-438-767-328-328  
Fax: 01-441-438-767-328-375

[www.theiet.org](http://www.theiet.org)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2634  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

## TABLE OF CONTENTS

<b>System Advantages In Conversion Of AC Transmission Lines To DC.....</b>	1
<i>L. Barthold, R. Adapa, H. Clark, D. Woodford</i>	
<b>Voltage Source Converter (VSC) HVDC For Bulk Power Transmission - Technology And Planning Method.....</b>	6
<i>D. Westermann, D. Van Hertem, A. Küster, R. Atmuri, B. Klöckl, T. Rauhala</i>	
<b>Coordination Of Multiple Power Flow Controlling Devices In Transmission Systems .....</b>	12
<i>D. Van Hertem, R. Eriksson, L. Söder, M. Ghandhari</i>	
<b>Analysis Of Multi-Infeed HVDC Systems With Inverter And Rectifier Connected To The Same AC Network .....</b>	18
<i>E. Rahimi, A. M. Gole, J. B. Davies</i>	
<b>Detailed Modeling Of Large Interconnected AC/DC Systems Using A Real-Time Digital Simulator .....</b>	23
<i>R. P. Wierckx, N. Dhaliwal</i>	
<b>The Role Of Facts And HVDC In The Future PAN-European Transmission System Development .....</b>	29
<i>A. L'Abbate, G. Migliavacca, U. Häger, C. Rehtanz, S. Rüberg, H. Ferreira, G. Fulli, A. Purvis</i>	
<b>Steady-State And Transient Performance Of DC Transmission Systems Based On HVDC Technology .....</b>	37
<i>G. P. Adam, O. Anaya-Lara, G. Burt</i>	
<b>Series Compensation For Extended Utilization Of Power Transmission Systems .....</b>	42
<i>R. Grünbaum, P. Halvarsson, P. Jones</i>	
<b>Introducing Series Compensation In The UK Transmission Network.....</b>	47
<i>C. Hor, J. Finn, G. Thumm, S. Mortimer</i>	
<b>Enhancing The Transmission Capability Using Facts: The Finnish Experience .....</b>	52
<i>T. Rauhala, J. Jyrinsalo, H. Kuisti</i>	
<b>Description And Evaluation Of 3-Level VSC Topology Based STATCOM For Fast Compensation Applications.....</b>	57
<i>J. Alio, A. Syomushkin, R. Jessler</i>	
<b>HVDC - Enabling The Transition To An Energy System Based On Renewables .....</b>	60
<i>O. Vestergaard, B. Westman, G. McKay, P. Jones, J. Fitzgerald, B. Williams</i>	
<b>Harmonic Performance Requirements Of An HVDC Connection; Network Owner Perspective .....</b>	66
<i>Z. Emin, F. Ghassemi, J. J. Price</i>	
<b>Life Extension Issues For HVDC Control Systems .....</b>	72
<i>R. Wachal</i>	
<b>Demonstration And Implementation Of Technical Scheme For Ningdong-Shandong ±660 KV DC Power Transmission Project .....</b>	76
<i>Weibing Wen, Hao Chang, Weiyang Yin, Jichao Fan, Jing Zeng, Yun Zhang</i>	
<b>Ultra-High Power Thyristor Valves For HVDC In Developing Countries .....</b>	81
<i>C. C. Davidson, R. M. Preedy, J. Cao, C. Zhou, J. Fu</i>	
<b>A New 500MW Back To Back Station To Provide Power Exchange Between Uruguay And Brazil.....</b>	86
<i>N. M. Macleod, C. Horwill, R. E. Bonchang, D. Castagna, M. Croce, M. Artenstein</i>	
<b>Harmonic Studies For Offshore Windfarms .....</b>	91
<i>A. Shafiu, A. Hernandez, F. Schettler, J. Finn, E. Jørgensen</i>	
<b>An Integrated Approach To Offshore Electricity Transmission .....</b>	97
<i>A. Hiorns, R. Smith, D. Wright</i>	
<b>Active Stator, A New Generator Topology For Direct Drive Permanent Magnet Generators .....</b>	102
<i>S. Loddick</i>	
<b>Topologies Comparison Of Multi-Cell Medium Frequency Transformer For Offshore Farms .....</b>	107
<i>P. Monjean, J. Delanoë, J. Auguste, C. Saudemont, J. Sprooten, A. Mirzaian, B. Robyns</i>	
<b>Offshore Wind Developments And SQSS .....</b>	112
<i>P. Espie, A. Hardcastle, M. Hook</i>	
<b>DC Transmission And Distribution System For A Large Offshore Wind Farm.....</b>	117
<i>C. Zhan, C. Smith, A. Crane, A. Bullock, D. Grieve</i>	
<b>Innovative Concepts For Hybrid Multi-Level Converters For HVDC Power Transmission .....</b>	122
<i>C. C. Davidson, D. R. Trainer</i>	
<b>A New Simulator Laboratory For Research And Development Of VSC HVDC Topologies And Control Algorithms.....</b>	127
<i>R. S. Whitehouse, C. D. M. Oates, J. Maneiro, N. M. Macleod</i>	

<b>Modular Multi-Level Converter Based HVDC System For Grid Connection Of Offshore Wind Power Plant</b>	132
<i>U. N. Gnanarathna, S. K. Chaudhary, A. M. Gole, R. Teodorescu</i>	
<b>Network Fault Tolerant Voltage-Source-Converters For High-Voltage Applications</b>	137
<i>G. P. Adam, S. J. Finney, B. W. Williams, D. R. Trainer, C. D. M. Oates, D. R. Critchley</i>	
<b>Chain-Link Based HVDC Voltage Source Converter Using Current Injection</b>	142
<i>A. M. Cross, D. R. Trainer, R. W. Crookes</i>	
<b>A New Hybrid Multi-Level Voltage-Source Converter With DC Fault Blocking Capability</b>	147
<i>M. M. C. Merlin, T. C. Green, P. D. Mitcheson, D. R. Trainer, D. R. Critchley, R. W. Crookes</i>	
<b>Autonomous Converter Control In A Multi-Terminal HVDC System</b>	152
<i>C. D. Barker, R. Whitehouse</i>	
<b>Control Of Multi-Terminal DC Transmission System Based On Voltage Source Converters</b>	157
<i>G. P. Adam, S. J. Finney, B. W. Williams, K. Bell, G. M. Burt</i>	
<b>Frequency Sensitivity Analysis Of AC Grids Connected To MTDC Grid</b>	162
<i>T. M. Haileselassie, K. Uhlen</i>	
<b>Offshore Grids In Europe: The Strategy Of Ireland For 2020 And Beyond</b>	167
<i>A. Garzillo, M. V. Cazzol, A. L'Abbate, G. Migliavacca, A. Mansoldo, A. Rivera, M. Norton</i>	
<b>The North Sea Super Grid - A Technical Perspective</b>	174
<i>T. K. Vrana, R. E. Torres-Olguin, B. Liu, T. M. Haileselassie</i>	
<b>Valve Section Capacitance For 660KV HVDC Converter Valves</b>	179
<i>S. Xiao, J. Cao, M. W. Donoghue</i>	
<b>Nodal Harmonic Impedance Derivation Of AC Network In PSS/E</b>	184
<i>Xueguang Wu, S. Sadullah, B. Matthews, W. Xu</i>	
<b>Voltage Source Converter In High Voltage Applications: Multilevel Versus Two-Level Converters</b>	189
<i>Yushu Zhang, G. P. Adam, T. C. Lim, S. J. Finney, B. W. Williams</i>	
<b>Protection Scheme Design For Meshed VSC-HVDC Transmission Systems Of Large-Scale Wind Farms</b>	194
<i>J. Yang, J. E. Fletcher, J. O'Reilly, G. P. Adam, S. Fan</i>	
<b>Multi-Objective Security Constrained Optimal Reactive Dispatch Applied To The GB Transmission Network</b>	199
<i>P. Macfie, P. Hurlock, G. Taylor, M. Irving</i>	
<b>Control Block Diagram Representation Of An HVDC System For Sub-Synchronous Frequency Interaction Studies</b>	204
<i>C. Karawita, U. D. Annakkage</i>	
<b>Coupling Between DC Lines With A Neutral Conductor And Parallel AC Lines</b>	209
<i>J. Z. Zhou, R. S. Burton, D. E. Fletcher, J. B. Davies</i>	
<b>Evaluation Of Capacitor Commutated Converter HVDC For Qinghai-Xizhang Interconnection Project</b>	214
<i>Wen Jun, Wang Jun, Liying Wang, Yin Wei-Yang, Liu Bao-Hong</i>	
<b>Comparison Of Dynamic Performance Of Meshed Networks With Different Types Of HVDC Lines</b>	219
<i>R. Preece, J. V. Milanovic</i>	
<b>Potential Benefits Of Decoupling The Scotland-England Network Using VSC-HVDC</b>	224
<i>O. A. Giddani, G. P. Adam, O. Anaya-Lara, G. Burt, K. L. Lo</i>	
<b>Modified Distance Protection In Presence Of UPFC On A Transmission Line</b>	229
<i>S. Jamali, A. Kazemi, H. Shateri</i>	
<b>Investigating The Potential Contribution Of Future Offshore Wind Turbines To Frequency Stability During Major System Disturbances</b>	235
<i>D. D. Banham-Hall, C. A. Smith, G. A. Taylor, M. R. Irving</i>	
<b>Ride-Through-Fault Capabilities Of DFIG Wind Farm Connected To A VSC Station During A DC Fault</b>	240
<i>D. Campos-Gaona, E. L. Moreno-Goytia, O. Anaya-Lara, G. Burt</i>	
<b>An Intra-Bundle Coaxial PLC System For HVDC Transmission Lines</b>	245
<i>L. Barthold, D. Woodford, D. Smith</i>	
<b>Decentralised Control For Damping Multimodal Oscillations Through CSC/VSC Based HVDC Transmission Technologies</b>	250
<i>Y. Pipelzadeh, B. Chaudhuri, T. C. Green</i>	
<b>Study On The SSO Caused By HVDC Link In Hybrid AC-DC Power Systems</b>	255
<i>Z. Li, Q. L. Wan, X. P. Zhang, B. B. Wang, K. L. Zhou</i>	
<b>Operation Of Doubly Fed Induction Generators In Power Systems With VSC-HVDC Transmission</b>	260
<i>K. Elkington, H. Latorre, M. Ghandhari</i>	
<b>Transient Stability Enhancement By TCSC Controllers Using Remote Input Signals</b>	266
<i>N. T. Anh, D. Van Hertem, J. Driesen</i>	

<b>HVAC/HVDC Strategy For Solving Power Delivery Shortages To A Localised Area Of A National Grid.....</b>	271
<i>J. Smith, W. C. Stemmet, G. Atkinson-Hope</i>	
<b>Adaptive Tools To Conduct Harmonic Analysis Using Time Domain Software .....</b>	276
<i>W. C. Stemmet, J. Smith, G. Atkinson-Hope</i>	
<b>Implementation Aspects Of A Sequential AC/DC Power Flow Computation Algorithm For Multi-Terminal VSC HVDC Systems .....</b>	281
<i>J. Beerten, S. Cole, R. Belmans</i>	
<b>Dynamic Modelling Of VSC-HVDC For Connection Of Offshore Wind Farms .....</b>	287
<i>B. Rios, R. Garcia-Valle</i>	
<b>Modelling And Control Of Offshore Wind Farm With VSC-HVDC Transmission System.....</b>	291
<i>D. C. Kong, X.-P. Zhang</i>	
<b>A Low Loss Modular Multilevel Voltage Source Converter For HVDC Power Transmission And Reactive Power Compensation .....</b>	297
<i>R. Feldman, M. Tomasini, J. C. Clare, P. Wheeler, D. R. Trainer, R. S. Whitehouse</i>	

**Author Index**