

# TRACEABILITY OF HIGH VOLTAGE POWER AND ENERGY MEASUREMENTS FOR THE ELECTRICAL POWER INDUSTRY AND ITS ECONOMIC IMPACT IN A DEREGULATED MARKET

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**Abstract:** The presentation focuses on trade metrology issues and opportunities in the energy sector, in particular the electrical energy sector, in Canada arising from the worldwide deregulation of energy industries and the establishment of trading blocks and free trade zones. The need for a measurement assurance program for electric power/energy to address these issues, and its economic impact in a deregulated market will be discussed. The role of NRC/INMS in assisting a deregulated electric power industry by providing traceability of power and energy measurements under several different operating conditions will be highlighted.

## 1. INTRODUCTION

Many countries, including Canada, are introducing increasing degrees of competition in their energy markets as part of the process of privatization. Their energy sectors are at present undergoing a period of restructuring and privatization. Their corresponding electric utilities are currently being restructured and deregulated. The continuing increase in electricity demand also requires a continuing upgrade of their transmission and distribution systems, and an acceptable level of reliability and system losses. Improving system reliability and minimizing system losses will eventually translate into substantial economic benefits, which can be redistributed to customers, especially the industrial and commercial clients.

## 2. TRACEABILITY ISSUES

Reliable trade measurements, traceable to the primary physical standards, play a key role in facilitating commerce in energy. National metrology institutes, such as the National Research Council of Canada (NRC), the National Institute of Standards and Technology (NIST), and the Centro Nacional de Metrología (CENAM), are essential components of the energy infrastructure of all industrialized countries. In Canada, the legislated responsibility for trade metrology is under the jurisdiction of Measurement Canada – a special operating agency of Industry Canada. Measurement Canada administers and enforces the Electricity and Gas Inspection Act and the Weights and Measures Act. Measurement Canada has the right to intervene where it deems appropriate to establish the

regulations setting minimum performance specifications for instrumentation for use in trading metrology and to approve all instruments for use in such applications. However, the legislated responsibility to maintain the primary physical standards, to which all trade measurements, secondary standards and derived units of measurement are traceable, is the role of the National Research Council of Canada, mainly through the Institute for National Measurement Standards (NRC/INMS).

Deregulation leads to a range of new business-to-business transactions and associated revenue-metering requirements not previously part of the business of supplying energy to the consumer. Deregulation divides, what was previously a single utility, into three sectors: energy suppliers, energy transmitters and energy distributors. This results in the need to measure the quantity and quality of the energy product at every point of financial transaction with a metering system of known accuracy. For the electricity industry in Canada the present value of transactions of approximately \$40 billion per year will increase to at least \$120 billion per year. A small measurement error of 0.5% would translate to an equivalent impact of \$600 million in the transactions. Customers will have to pay this amount. Deregulation introduces not only the potential for a cost-driven commercial demand for more accurate trade measurement but also an opportunity for innovation in instrumentation for trade metrology.

The annual consumption of electricity in Mexico is about 190 billion kWh. For an electricity cost of US\$0.09/kWh, the value of transactions of approximately US\$17 billion per year will increase to at least US\$51 billion. The equivalent impact of a 0.5%

measurement error would translate to approximately an equivalent US\$260 million in the overall transactions.

With a deregulated power industry, the utilities and other electricity providers will be competing for the same customers. Only those companies that can offer reliable services at the lowest price will be able to survive. Energy providers that can demonstrate high power quality through accurate and traceable measurements will have a competitive edge over those who cannot. Similarly, those who can demonstrate better accuracy of their measurement systems would be trusted by consumers and will have an advantage in the market. Traceable and accurate measurements are prerequisite requirements for all the major generating companies supplying energy in a deregulated electricity market.

In trading electricity, there are three subjects of importance to the electrical power industry and its industrial and consumer customers. The first is the cost of electricity, which is primarily determined by the cost of the generation and the efficiency of the transmission and distribution systems in delivering electrical energy to the customers. Improving the overall performance of the system by improving metering and reducing its system losses could translate into substantial economic benefits to the utility and its industrial and commercial consumers. The second is the consumer confidence in the equity of electricity trade. This is affected by the accuracy of the metering of electricity, which requires measurement traceability to national and international standards. The third is access to foreign markets for electrical equipment manufactured domestically. Such access is dependent on the ability of domestic manufacturers to meet the specified requirements of international standards for electrical equipment. Consequently, the corresponding national metrology institute must provide the same measurement capabilities that are used elsewhere in the world to verify and validate test results. This is vital to the manufacturers to compete in the world market and to retain a share of the domestic market.

The establishment of trading blocks and free trade zones is affecting trade in foreign markets. It results in an increasing need to recognize the equivalence of measurement standards and also to respond to the global competitiveness pressures faced by industry in terms of reliable product quality, improved accuracy and the contractual requirements for traceability of physical measurements. Of primary importance in the electrical power industry are the traceability and the acceptable accuracy limits of high voltage power measurements, where the dollar values of transactions are high, usually in the millions of dollars every year. High voltage power measurements not only occur in the measurements of power and energy in high voltage

transmission lines, but also in loss measurements of power system apparatus to determine the overall efficiency of the electric power and energy transmission systems. Of all these loss measurements of power system apparatus, the most critical for the electrical power industry is the measurement of losses of large power transformers and reactors. There is a penalty, which can be as high as \$15,000/kW for every kilowatt of loss exceeding the guaranteed value. This can easily translate into millions of dollars for equipment manufacturers.

A measurement assurance program should be implemented to ensure equity in electricity trade, which is affected by the accuracy of the metering of electricity requiring measurement traceability to national and international standards. In a deregulated market of the electrical power industry, traceability for revenue metering is required not only between the distributor and the customer, but also between the electricity producers and the transmission company and between the transmission company and the distributors. For the latter two metering points, revenue metering will be performed at significantly higher voltages than prior to deregulation, in Canada up to 735,000 V (400,000 V in Mexico). Due to the large amount of electricity measured by the high voltage wholesale revenue metering at these latter two metering points, a small measurement error will have a large economic impact to the detriment of the power producers, the network operators, the distributors and eventually the consumers of the deregulated system. Therefore, the measurement assurance program should include the verification of the accuracy of the high voltage wholesale revenue metering systems by having them tested and calibrated on-site under actual operating conditions. This has created demands for new specialized calibration and test services requiring an appropriate response from NRC/INMS.

## 2. CONCLUSION

The need for a measurement assurance program in a deregulated market is described. The presentation will highlight the role of NRC/INMS in assisting a deregulated electrical power industry by providing traceability and special calibration services in power and energy measurements at low/high voltage under several operating conditions, including on-site measurements of transmission line losses and calibration of power transformer loss measuring systems for clients in Canada and elsewhere.