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## **Report on “Electricity Market Restructuring and Consumers”**

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### **DISCLAIMER**

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## **Executive Summary**

This report describes a longer-term project that forms the basis of a PhD dissertation. During the first phase the objective was to define and model the electricity industry and market in Alberta prior to restructuring, to detail the changes that occurred with restructuring, and to provide an initial quantitative assessment of how prices changed as a result of restructuring. The second phase involves examining the evolution of other North American jurisdictions that have a similar electricity generation environment to Alberta in order to determine what might have been expected to happen in the electricity industry in Alberta if restructuring had not occurred. Based on this analysis, the ultimate objective is to provide a more rigorous assessment of the effects of restructuring on electricity prices in Alberta by distinguishing between the effects on electricity prices that are due to restructuring and the effects that are likely to have occurred anyway.

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## **1. Introduction**

Different levels of electricity market restructuring have been undertaken in several Canadian provinces, most notably Alberta and Ontario. Other provinces, such as British Columbia and Quebec, have adopted different structural or regulatory changes in order to adapt their systems to neighbouring restructured markets in the U.S. At a general level, restructuring initiatives have been sold to consumers, particularly residential consumers, as being able to deliver lower electricity prices than would otherwise be the case. However, following restructuring, consumers in many jurisdictions observed that electricity prices increased. While these price changes could be due to a variety of factors, they have frequently been attributed specifically to effects of restructuring. Such attribution might indeed be justified, but it is not necessarily appropriate to simply compare prices before and after restructuring to determine the effects of such a significant change in market structure.

The purpose of this project is to evaluate the effects of electricity restructuring on consumers in Alberta from a wider perspective. In particular, account will be taken of the changes that would have been expected to occur in the market, and in electricity prices, if restructuring had not occurred, thereby providing a baseline to which the restructuring that did take place can be contrasted. With this framework in place it will be possible to compare alternative scenarios that might have been adopted instead of the particular form of restructuring that occurred. It will also be possible to consider the impact of restructuring on energy efficiency behaviour, and in particular, whether and to what extent fuel switching, retrofits, or conservation measures have been induced.

During the first phase of this study the objective was to define and model the electricity industry and market prior to restructuring, to detail the changes that occurred with restructuring, and to provide an initial quantitative assessment of how prices changed as a result of restructuring. The second phase involves examining the evolution of other North American jurisdictions that have a similar electricity generation environment to Alberta in order to determine what might have been expected to happen in the electricity industry in Alberta if restructuring had not occurred. Based on this analysis, the ultimate objective is to provide a more rigorous assessment of the effects of restructuring on electricity prices in Alberta by distinguishing between the effects on electricity prices that are due to restructuring and the effects that are likely to have occurred anyway.

The outline of the remainder of this report is as follows. In the next section we provide a brief outline of the general approach used in the first phase of this project and the types of issues that necessitate the analysis in the second phase. In Section 3 an outline of the Phase 2 analysis is presented.

## **2. A Preliminary Approach to Modelling the Effect of Restructuring on Electricity Prices**

The basic framework that is used here involves the formulation and subsequent estimation of a structural model of the determinants of electricity prices in the period prior to restructuring. This estimated model is used with observed values of the relevant variables in the post-restructuring period to forecast electricity prices that would have been observed in the post-restructuring period in the absence of restructuring. In its simplest form, forecasted electricity prices that are found to be systematically less than the observed electricity prices in the post-restructuring period would indicate that electricity prices increased as a result of restructuring. Further, the

size of the differences between the forecasted and actual values of electricity prices could be used to provide a quantitative measure of the extent of electricity price changes that resulted from restructuring.

Despite the simplifications that are adopted here, the analysis serves a number of useful purposes. First, the analysis with this base case can be used to determine if there is prima facie evidence that electricity prices increased as a result of restructuring. Second, it provides a base case to which other specifications can be compared. For example, if it was thought that generation capacity would have been only 90% as large if there had been no restructuring, this modification could be made to the generation capacity variable, and electricity prices re-forecast. In this way, the effects of various variables that might be expected to have had different values in the absence of restructuring can be easily evaluated.

Typically, electricity prices are modeled using a time series approach, since the objective is often to forecast electricity prices in the future. The models that are used are those typically observed in a times series analysis context, such as ARIMA models, mean reverting models, GARCH models, etc. However, the approach that is required here involves structural modeling, since the aim is to compare forecasts based on the model that applied before restructuring to actual values obtained subsequent to the restructuring, where the forecasts are based on actual values of the explanatory variables in the post-restructuring period.

There are at least two approaches that could be used in structural modeling of electricity prices in the pre-restructuring period. The first could be termed an accounting approach, in that it would

be based on the cost-of-service (COS) regulation that was used to determine electricity prices in this period. Specifically, since a regulator determined the price of electricity by ensuring that it covers all costs, including a regulated rate of return, the only requirements of this approach are a list of the costs considered by the regulator, along with specification of the regulated rate of return. Then, in the post-restructuring period, electricity prices in the absence of restructuring could be forecast by adding these costs together, including the required rate of return, to determine required revenues, which would then be divided by the amount of electricity that was to be delivered. Unfortunately, in the post-restructuring period, in the absence of regulation, it is not possible to obtain data on costs, so that electricity price forecasts could not be obtained in this way.

The second approach, which is used here, involves focusing on the main determinants of the price of electricity and econometrically determining their numerical importance in determining the price. Essentially this process views the regulator and regulation process that was in place prior to restructuring as being a veil that simply hides the individual roles of these variables. For example, the prices of fuels used to generate electricity are likely to be important determinants of the price of electricity itself. From a regulator's viewpoint, all that is required is the cost of fuels, which is added to other costs, etc. However, for our purposes it is necessary to quantify the role of each fuel price, since then fuel prices in the post restructuring period can be used along with the values of other relevant variables to forecast the electricity price in this period.

A key requirement in determining the structural form for a model of electricity prices in the pre-restructuring period is the identification of the relevant variables. However, in view of the

forecasting that is to be undertaken, the variable selection must be guided by the likely availability of data in both the pre- and post-restructuring periods. Of course there are also a number of other issues that must also be addressed, such as determining the appropriate functional form, etc.

The approach that is used here to structurally model electricity prices is akin to a production function, in which various inputs combine to produce output. Here the “inputs” are the various components of costs, while the “output” is the electricity price. Of course, it is also necessary to control for the effects of various other factors that may affect the relationship between these costs and the price. Nevertheless, as a first step in identifying the main determinants of the electricity price, it is convenient to focus on the main components included in the cost of service approach. This suggests that the main determinants of the electricity price would include capital and installation (C&I) costs, fuel (F) costs, and operation and maintenance (O&M) costs. However, modelling the electricity price by mimicking the cost of service method ignores other variables of interest that could possibly be affecting the electricity price, such as capacity utilization, economic growth, etc. Thus, the electricity price function needs to be augmented by other relevant variables so that we can control for their effects on the electricity price. These additional variables are identified through a review of the literature on electricity industry and electricity industry restructuring as well as information pertaining to the electricity industry in Alberta. Based on this analysis, a general specification for the electricity price determination equation is as follows:

Electricity price = f (coal price, natural gas price, generating capacity,  
generating capacity utilization, annual wage, user cost of  
capital, heat rate, economic growth (electricity demand),  
weather, California electricity price, random error term)

This model specifies the determinants of the electricity price in a functional specification that is analogous to an augmented production function. It is important to note, however, there are a number of other variables that have been suggested in various other studies that may be important determinants of the electricity price. These have been omitted here due to the limited number of variables that can be included due to the short period of data availability, the desire to keep the model as simple as possible by focusing on the primary variables, and the belief that some of these effects may be captured by variables already included in the model. Examples of possibly relevant omitted variables include the volatility (rather than just the level) of the natural gas price – many proponents of restructuring have argued that electricity prices would have increased even in the absence of restructuring due to higher and more volatile natural gas prices – as well as excess supply (supply-demand), which may capture the effect of power shortages on electricity prices, although this latter effect may be adequately reflected in the capacity utilization variable that is included in the above specification.

Data used to estimate the electricity price model are obtained from a variety of sources. In many cases there are alternative sources that provide different numerical values for the variables of interest, in which case the model is estimated using the alternative series to determine whether the results are sensitive to this choice. Although some variables are available on a more-frequent basis, the data frequency is limited by the fact that data for some variables are only available annually. Since the data do not extend prior to the early 1960s for some of the variables, and since structural breaks may be evident for earlier data, the pre-restructuring period of analysis that is used here begins in 1965. Also, since the effects of the restructuring process began to

surface in 1998, even though retail competition was not actually introduced until 2001, the pre-restructuring period model is initially estimated using annual data for the period 1965 to 1998, although sensitivity analysis with respect to the end point is used to ascertain the importance of this choice.

The purpose of our model is to forecast electricity prices in the post restructuring period so as to determine whether, as a first start, the model is a good predictor of electricity prices or not and whether at a very preliminary level the model predicts that prices declined or rose after restructuring. For this purpose, annual predictions were made for the period 1999-2002 based on the model estimated using data from 1965-1998. Since we have actual electricity prices for 1999-2002, the difference between the actual and predicted values of electricity prices will indicate whether prices rose or declined post restructuring. Although the estimated model is preliminary, and remains subject to testing and respecification, the initial findings are that the predicted prices in the post-restructuring period exceed the actual prices, suggesting that retail prices actually fell as a result of restructuring. This result did not change when the model was estimated using slightly different sample periods, from 1965-1996 and from 1965-1997, to check whether the definition of the onset of restructuring would alter the results.

A drawback of the approach used in this first phase of the analysis is that values of various variables that are observed in the electricity market in Alberta – both in the period leading up to restructuring and in the period since restructuring occurred – are treated as though they would have been observed even if there had been no electricity market restructuring. Thus, for example, observed changes in capacity, fuel prices, etc., are treated as though they are exogenous

in the sense that they are unaffected by the restructuring process. Proponents of restructuring would argue that this is unlikely to be the case for all these variables. Therefore, to obtain a clearer picture of the effects of restructuring on the electricity price it is necessary to control for the effects of restructuring on other variables. This is the focus of the second phase of the analysis.

### **3. Accounting for the Effects of Restructuring on Other Variables**

To the extent that restructuring of electricity markets is undertaken because these markets are not functioning optimally, or as desired, it would be expected that there would be a number of changes that occur directly as a result of the restructuring. For example, capacity increases that occur subsequent to restructuring may not have been expected to occur in the absence of restructuring, etc. Hence, treating observed values of variables subsequent to restructuring as though they would have occurred even if there had been no electricity market restructuring, as in the first component of the analysis, may not be appropriate. If, for example, capacity increases would not have occurred without restructuring, then as capacity constraints were reached in the non-restructured environment, electricity prices might have increased even more than was observed with restructuring, or alternatively some other problems may have occurred such as brown-outs or black-outs as electricity demand neared or exceeded electricity supply. For reasons such as these, in evaluating the effects of restructuring it is necessary to separately account for changes in variables that could be viewed as occurring due to the restructuring from those that would have been likely to occur anyway. The problem is how to distinguish these two sets of changes. Analysis of this issue underlies the second component of the analysis in this project.

To analyze this issue, the evolution of electricity markets is examined in other North American jurisdictions in order to determine which of these have a similar electricity environment to Alberta. Here the types of factors that are considered include the extent to which the electricity market is regulated, the fuels used for electricity generation (since different fuels have different availability, lead times, costs, etc.), the availability of electricity supplies from outside the jurisdiction to meet peak or unexpected demands, etc. (since Alberta has limited capability in this regard), the extent of the transmission system, growth in electricity demand and supply, as well as the likelihood of meeting capacity constraints. Of course no one jurisdiction will mimic Alberta, so that it may be more appropriate – or even necessary – to consider aspects of electricity environments from more than one jurisdiction. Based on the assumption that behaviour in (certain aspects of) these other jurisdictions would to some extent mimic what might have been expected to occur in Alberta in the absence of restructuring, it is possible, obviously with some uncertainty, to assess what might have been expected to happen in the electricity industry in Alberta if restructuring had not occurred.

Based on this assessment, the main objective of this second component of the study is to modify the analysis in the first component by distinguishing between the effects on electricity prices that are due to restructuring and the effects that are likely to have occurred anyway. This will therefore allow a more rigorous assessment of the effects of restructuring on electricity prices in Alberta. It will also facilitate an examination of whether the outcomes might be expected to have been different if a different form of restructuring had been utilized. In terms of modifying the previous analysis, the idea is to use information about what has occurred in other

jurisdictions that have and have not undergone electricity market restructuring to identify the likely effects of restructuring in Alberta on the control variables that are used in the regression analysis. Next, forecasts of the electricity price in the post-restructuring period in Alberta would be obtained from the same regression model as before but with the values of the explanatory variables in this period (and possibly also in the later part of the pre-restructuring period) modified to account for changes that are identified as being due to the restructuring. These forecasted prices would be devoid of the effect of restructuring and would therefore indicate how prices would have looked in the absence of restructuring. Essentially the difference between the actual prices (that incorporate the effect of restructuring) and forecast prices (that are devoid of the effect of restructuring) can then be attributed to restructuring. Of course, the key to this approach involves identification of the direction and magnitude of the effect of restructuring on the relevant explanatory variables. To deal with the uncertainty that is obviously inherent in several aspects of this approach, it is proposed in subsequent work to use simulation with alternative values and/or distributions of the explanatory variables to assess the sensitivity of the results to the specifications that are used.

The direction and magnitude of the effects of restructuring on other variables can be obtained through at least two sources. The various case studies conducted by the US Department of Energy (US DOE) provide a starting point for evaluating the effects of competition on variables like heat rates, operating costs and capital costs. This information can be supplemented with data analysis of electricity markets from various US states that are similar to Alberta in terms of the electricity market, and where restructuring was either implemented or considered, so as to obtain information on the impact of restructuring on variables not considered in the US DOE

case studies. Data from the various states may also be more suitable for comparison with Alberta, since the US DOE case studies may not be reflective of the Alberta electricity market situation.

### **3.1 U.S. Restructuring**

Much of the impetus for electricity restructuring in the US stemmed from chronically low natural gas prices during the 1990s (Institute for Energy, Law & Enterprise, 2003:6). However, states in the US with electricity prices higher than the national average like California, New York, and Massachusetts were the first to move toward restructuring, while others with low electricity prices required greater assurance of consumer benefits before they made the plunge (Sitzer, 1998). As such, states with an average electricity price below 6 cents/kWh had less incentive for restructuring (EIA, 2000a: 43).<sup>1</sup>

While such studies indicate why electricity market restructuring was pursued in several US jurisdictions, they generally do not provide information about trends in variables like generation capacity, generation, fuel mix, coal prices and natural gas prices in the specific context of restructuring. This information on trends is useful for our analysis as that provides a broader picture of electricity market conditions before and after restructuring and hence allows us to determine any common features among the jurisdictions that have restructured their electricity markets and among the jurisdictions that have not.

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<sup>1</sup> However, even without restructuring, competition had already begun at the wholesale level in Washington (Golden, 1998).

This analysis can be extended to comparing the values of generation capacity, generation, fuel mix, coal prices and natural gas prices variables of the US jurisdictions with those from Alberta to determine the jurisdiction that best mimics Alberta. Comparisons can also be made among the two types of US jurisdictions, those that restructured versus those that did not, on the basis of census subdivision and North American Electric Reliability Council (NERC) classifications. Of course, the two types of jurisdictions (restructured and not restructured) can also be compared across various US states, ignoring the classifications of census subdivisions and NERC regions. In addition to electricity market restructuring, the status of natural gas industry restructuring is also be considered here because higher electricity prices associated with restructuring have often been partly attributed to higher natural gas prices. Thus, having information on the state of natural gas restructuring may indicate whether higher gas prices are a consequence of gas market restructuring and also whether gas market restructuring is partly responsible for aspects of the post electricity market restructuring scenario.

In terms of census subdivisions, the US is divided into four census regions which are further subdivided into nine divisions. These regions are groupings of states that subdivide the US solely for securing statistical data and the states are not necessarily grouped according to geographical, historical or cultural bonds.<sup>2</sup> Comparative analyses between the restructured and non-restructured US jurisdictions can be conducted on the basis of census subdivisions to follow the standard practice of reporting statistical results on this basis. Alternatively, different jurisdictions could be compared on the basis of the interconnectivity of the electricity markets through grid lines, in other words, using the NERC regions.

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<sup>2</sup> Wikipedia, [http://en.wikipedia.org/wiki/United\\_States\\_Census](http://en.wikipedia.org/wiki/United_States_Census), accessed on June 27, 2006

The North American Electric Reliability Council (NERC) was formed in 1968 to promote the reliability and adequacy of bulk power supply in the electric utility systems of North America. NERC consists of several regional reliability councils, just like the census subdivisions, comprised of the interconnected power regions of the United States, Canada, and Mexico.<sup>3</sup> However, these NERC regions are not firmly defined as there appears to be a change in the composition of states resulting from changed status of interconnectivity. Moreover, the regional councils themselves seem to have been redefined over time. In view of these changes, for the purposes of our analysis it may be better to use the classification of states by census subdivisions as opposed to classification by NERC regions simply because the benefit of analyzing states in well defined groups may outweigh analyzing states based on the interconnectivity of their grid lines especially if, as in Alberta's case, the interconnection is of secondary importance.

Just as the NERC regions have been defined differently over time, so has electricity market restructuring been defined differently according to various documents on the restructuring status of the different US states. For example, according to the document 'US Restructuring at a Glance' from the National Energy Affordability and Accessibility Project,<sup>4</sup> Oregon and West Virginia have delayed or suspended electricity market restructuring whereas Wisconsin has pursued with restructuring as of 2003. However according to the 2006 'Restructuring Status of Electricity Markets' information from the Federal Energy Management program of the US DOE Energy Efficiency and Renewable Energy,<sup>5</sup> Oregon has implemented electricity market

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<sup>3</sup> EIA, [http://www.eia.doe.gov/glossary/glossary\\_n.htm](http://www.eia.doe.gov/glossary/glossary_n.htm), accessed in May 2006

<sup>4</sup> U.S. Restructuring at a Glance, <http://www.neap.ncat.org/restructuring/>, National Energy Affordability and Accessibility Project, updated April 2003

<sup>5</sup> Restructuring Status of Electricity Markets, [http://www1.eere.energy.gov/femp/program/utility/utilityman\\_staterestruc.html](http://www1.eere.energy.gov/femp/program/utility/utilityman_staterestruc.html), Federal Energy Management program of the US DOE Energy Efficiency and Renewable Energy, updated April 2006

restructuring, West Virginia has merely been studying and observing restructuring, whereas Wisconsin has not pursued any action. While the information from 2006 is clearly more current, it is interesting to note the discrepancy between the two sources of information on the restructuring status of US electricity markets. The 2006 information on the US jurisdictions does not make a clear distinction between states that restructured and those that did not. Instead the US jurisdictions are classified under six categories based on the status of restructuring as shown in Table 1.

**Table 1: Restructuring Status of Electricity Markets as of 2006**

<b>I.</b> The transition period for phasing in restructuring has begun in these states, and they are currently implementing a competitive electric utility market for investor-owned utilities.		
Arizona	Maryland	Ohio
Connecticut	Massachusetts	Oregon
Delaware	Michigan	Pennsylvania
District of Columbia	New Hampshire	Rhode Island
Illinois	New Jersey	Texas
Maine	New York	Virginia
<b>II.</b> These states are continuing to study and/or monitor restructuring investor-owned utilities, but are not currently pursuing further action.		
Vermont	Nebraska	Louisiana
Indiana	Florida	Utah
Iowa	West Virginia	Wyoming
Minnesota	Kentucky	Hawaii
Missouri	Mississippi	Washington
<b>III.</b> These states have completed studies investigating restructuring investor-owned utilities (power providers), and have decided not to pursue further action at this time.		
Alabama	Idaho	South Carolina
Alaska	Kansas	South Dakota
Colorado	North Carolina	Tennessee
Georgia	North Dakota	Wisconsin
<b>IV.</b> These states have passed legislation suspending the restructuring process.		
California		
<b>V.</b> These states have passed legislation delaying the restructuring process.		
Montana	Oklahoma	
<b>VI.</b> These states have passed legislation repealing the restructuring process.		
Arkansas	Nevada	New Mexico

Table 1 seems to indicate that categories I, IV, V and VI can be considered as the US jurisdictions that restructured for the purpose of our analysis, whereas the US jurisdictions that fall under categories II and III can be termed as those that did not pursue restructuring. Category I would be important to underscore as these jurisdictions are actively pursuing electricity market restructuring despite the reservations of states in categories IV, V and VI.

If the 2003 'US Restructuring at a Glance' document, from the National Energy Affordability and Accessibility Project, is revisited to note whether electricity market restructuring legislation was passed rather than whether competitive markets have been instituted, then both the 2003 and the 2006 information sources become almost compatible. According to the 2003 source, states which have passed electricity market restructuring legislation are all those which according to the 2006 source fall under category I, IV, V and VI. West Virginia remains the exception, which according to the 2003 source has passed electricity restructuring legislation but according to the 2006 source its electricity market remains un-restructured as it falls under category II.

To check the validity of the 2006 information source, it can be compared with the EIA document 'Status of State Electric Industry Restructuring Activity' dated February 2003,<sup>6</sup> which categorizes the US states under four categories based on electricity market restructuring. The state of restructuring is defined as active, delayed, suspended and not active. These categories subsume the six categories from the 2006 source. The *active restructuring* category corresponds exactly to category I from the 2006 information source, the *delayed restructuring* category

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<sup>6</sup> Status of State Electric Industry Restructuring Activity, EIA, [http://www.eia.doe.gov/cneaf/electricity/chg\\_str/restructure.pdf](http://www.eia.doe.gov/cneaf/electricity/chg_str/restructure.pdf), February 2003

subsumes V and VI, the *suspended restructuring* category parallels category V, and finally the *not active restructuring* category exactly corresponds with categories II and III.

The above analysis would indicate that the six classifications from the 2006 source have been appropriately grouped into two categories of restructured and not restructured. Therefore, for the purpose of our comparative analysis, 27 US states/regions will be considered as not having restructured their electricity markets, and the remaining 24 states will be considered as having restructured, with only 18 of these jurisdictions actively pursuing electricity market restructuring.

According to the February 2003 document, active restructuring refers specifically to retail access, which indicates that for our purposes restructuring would be defined at the retail level and not just at the wholesale level. Finally, while one part of our analysis involves a general comparison of states which have restructured their electricity markets with those that have not, another component of our analysis involves comparing the states within their respective census subdivisions as opposed to NERC regions, as mentioned earlier. The latter analysis is important as it may provide insight into why certain states in a census subdivision chose to restructure their electricity markets whereas others in the same census subdivision chose not to do so.

Table 2 indicates the 51 US jurisdictions based on their census subdivisions and also on the basis of their restructuring status. The 24 states/regions which are in bold are those that have restructured their electricity markets.

**Table 2: U.S. Restructuring Status according to Census Subdivision**

<b>New England</b>	<b>Middle Atlantic</b>	<b>East North Central</b>	<b>West North Central</b>	<b>South Atlantic</b>
<b>Connecticut</b> <b>Maine</b> <b>Massachusetts</b> <b>New Hampshire</b> <b>Rhode Island</b> Vermont	<b>New Jersey</b> <b>New York</b> <b>Pennsylvania</b>	<b>Illinois</b> <b>Michigan</b> <b>Ohio</b> Indiana Wisconsin	Iowa Kansas Minnesota Missouri Nebraska North Dakota South Dakota	<b>Delaware</b> <b>District of Columbia</b> Florida Georgia <b>Maryland</b> North Carolina South Carolina <b>Virginia</b> West Virginia
<b>East South Central</b>	<b>West South Central</b>	<b>Mountain</b>	<b>Pacific</b>	
Alabama Kentucky Mississippi Tennessee	<b>Arkansas</b> Louisiana <b>Oklahoma</b> <b>Texas</b>	<b>Arizona</b> Colorado Idaho <b>Montana</b> <b>Nevada</b> <b>New Mexico</b> Utah Wyoming	Alaska <b>California</b> Hawaii <b>Oregon</b> Washington	

In an attempt to study possible connections between electricity market restructuring and gas market restructuring, the 51 US jurisdictions were also classified according to the status of their gas market restructuring just as was done in the context of electricity market restructuring.

For both electricity and gas markets, when we use the word restructuring, as is consistent with the preceding analysis, it will always refer to restructuring at the retail level since the focus of our analysis involves a study the impact of restructuring on residential consumers. Table 3 presents the restructuring status of gas utilities according to census subdivisions just as Table 2 did in the context of electricity market restructuring. The 25 states/regions in bold in Table 3 are those that have restructured their natural gas markets.

**Table 3: Restructuring Status of Gas Utilities according to Census Subdivisions**

<b>New England</b>	<b>Middle Atlantic</b>	<b>East North Central</b>	<b>West North Central</b>	<b>South Atlantic</b>
<b>Connecticut</b> Maine <b>Massachusetts</b> <b>New Hampshire</b> <b>Rhode Island</b> Vermont	<b>New Jersey</b> <b>New York</b> <b>Pennsylvania</b>	<b>Illinois</b> <b>Indiana</b> <b>Michigan</b> <b>Ohio</b> <b>Wisconsin</b>	Iowa Kansas Minnesota Missouri <b>Nebraska</b> North Dakota <b>South Dakota</b>	<b>Delaware</b> <b>District of Columbia</b> <b>Florida</b> <b>Georgia</b> Maryland North Carolina South Carolina <b>Virginia</b> <b>West Virginia</b>
<b>East South Central</b>	<b>West South Central</b>	<b>Mountain</b>	<b>Pacific</b>	
Alabama <b>Kentucky</b> Mississippi Tennessee	Arkansas Louisiana Oklahoma Texas	Arizona Colorado Idaho <b>Montana</b> Nevada <b>New Mexico</b> Utah <b>Wyoming</b>	Alaska <b>California</b> Hawaii Oregon Washington	

A preliminary examination of Tables 2 and 3 indicates that 24 (47.06%) US jurisdictions have restructured their electricity markets at the retail level and around the same number, that is, 25 US jurisdictions, have restructured their natural gas markets at the retail level. About 16 out of the 25 states (64%) that restructured their natural gas markets also restructured their electricity markets. Of the 27 states that have not restructured their electricity markets, nine (33%) have restructured their gas markets at the retail level.

It may be noted that within states that restructured both their gas and electricity markets, gas markets have mostly either been restructured or restructuring legislation was passed prior to electricity market restructuring legislation or prior to the existence of retail access in electricity markets. Thus, it seems that states that had already implemented gas market restructuring were

more prone toward instituting electricity market restructuring. This raises an interesting question of why – to the extent that gas market restructuring led to volatility in the gas market prices – such states would pursue electricity market restructuring. However, to answer this question, gas prices of the respective states will be required to ascertain whether gas market volatility actually increased subsequent to gas market restructuring in the various states.

Moreover, if higher gas prices result from gas market restructuring and if these gas prices contribute greatly to the wholesale electricity prices then one may deduce that eventually higher electricity prices arose – at least in part – due of gas market restructuring. However, for now data for all the states must be analyzed in order to determine how restructuring has affected various variables like generation capacity, heat rates, emissions, and fuel mix so that this information can be used to modify the analysis in the previous section.

### **3.2 Comparative Analysis**

Data on electricity prices, natural gas prices, coal prices, generation capacity, generation and fuel consumption on all 51 jurisdictions can be analyzed first to determine any differences, based on these variables, between states that restructured their electricity markets and those that did not. Data availability issues preclude any comparative analysis for variables like the user cost of capital, annual wage and heat rates. Information on these three variables is important for the same reason that we are comparing the other variables, that is, determining how restructuring has affected such variables. Economic growth can be computed through the data on real gross state

product available for the US jurisdictions from 1987 to 2004 from the Bureau of Economic Analysis of the US Department of Commerce<sup>7</sup>.

One of the basic tools that will be used to compare the differences between the variables of the two kinds of states will be the difference of means test, which will help to indicate whether there is any significant difference between the two kinds of states based on the values of each of the variables. Having done this, the next step in the analysis would be to determine which US jurisdiction electricity market closely mimics the Alberta electricity market. In this regard the tools of correlation and absolute differences can be used to select states which have the highest correlation and lowest absolute differences with Alberta with respect to each of the variables.

Of course it is unlikely that any one state will mimic Alberta exactly on the basis of each of the variables. Therefore, we may have to consider the top five or ten US states that have the highest correlation and the lowest absolute differences with Alberta with respect to each of the variables. Having done this, the states can be compared with respect to the variables mentioned above within census subdivisions based on their restructuring status. According to this analysis, we can determine the effects of some states within a census subdivision choosing to restructure their electricity markets whereas others chose not to do so.

In the final part of this analysis, we will compare the values of the variables across the 51 US states across census subdivisions. The idea is to compare two states, one that has restructured and one that has not, that closely mimic each other with respect to the variables under study. The earlier part of our analysis may provide pointers toward which states can be effectively compared

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<sup>7</sup> BEA, US DOC, <http://www.bea.gov/bea/newsrelarchive/2006/gsp0606.htm>, accessed July 2006

based on correlations and absolute differences. The states that closely mimic each other based on these variables will help determine how the values of those variables can be modified for Alberta in order to modify the regression forecasting analysis described in the previous section.

#### **4. Summary**

This report describes a longer-term project that forms the basis of a PhD dissertation. During the first phase the objective was to define and model the electricity industry and market prior to restructuring, to detail the changes that occurred with restructuring, and to provide an initial quantitative assessment of how prices changed as a result of restructuring. The second phase involves examining the evolution of other North American jurisdictions that have a similar electricity generation environment to Alberta in order to determine what might have been expected to happen in the electricity industry in Alberta if restructuring had not occurred. Based on this analysis, the ultimate objective is to provide a more rigorous assessment of the effects of restructuring on electricity prices in Alberta by distinguishing between the effects on electricity prices that are due to restructuring and the effects that are likely to have occurred anyway.

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