The NRECA Policy Simulator[1]

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1. Introduction

The National Rural Electric Cooperative Association (NRECA) represents the interests of cooperative electric utilities and the communities they serve.[2] Cooperative electric utilities are owned by the consumers, and have been established to provide at-cost electric service, especially to rural communities. NRECA provides legislative, legal and regulatory services; as well as many other services to its member cooperatives. At present, NRECA is analyzing several policy changes being considered that may affect the cooperatives and their communities. These include: 1) electric industry restructuring; 2) legislation to encourage adoption of new generation technologies; and 3) various incentive programs to reduce carbon emissions.

To support this analysis, NRECA sought the development of a modeling tool that could examine the effects of alternative policies on the electric cooperatives at a detailed geographical level. After initial consultations, Inforum proposed and developed a model which provides economic forecasts for 3140 counties comprising the U.S., as well as 3496 electric utilities of various types. Each county model tracks output, employment, earnings and capital income for 11 private sectors and 3 government sectors.This model works as a satellite to the Inforum *IdLift* model. The *IdLift* model is an interindustry macro model with 97 production sectors. The NRECA Policy Simulator (*NPS*) links county economic activity to the national model, and then forecasts sales and revenues of electric utilities, based on the counties in which they operate.

Section 2 of this paper reviews the policy issues that *NPS* was designed to address. Section 3 describes the various databases that were brought together to build the model. Section 4 describes the estimated electricity demand regressions. Section 5 outlines the model's structure and solution sequence. In section 6, selected results from a carbon tax scenario are presented. Finally, in section 7, suggestions for future development are entertained.

2. Policies Affecting Rural Cooperatives and Their Members

As outlined above, several impending policy issues are of great interest to the electric cooperatives. At the present time, there are three that stand out. The following paragraphs describe those policy issues and how they may be addressed in the modeling environment.

Electric utility industry restructuring - What will be the effect of electric utility industry restructuring (wholesale and retail competition) on household budgets, business location decisions, and the wider economy? We can start with Department of Energy (DOE) assumptions about the effect of restructuring on of the cost of transmission and distribution of power by region. We can then analyze the impact on retail rates for residential, commercial, and industrial customers. A cross-sectional demand sensitivity analysis can then establish the elasticity of electricity demand with respect to rates for customers with different general characteristics. From that the change in output and employment by industry and region can be computed.

Alternative generation technologies - What are the costs, benefits, and economic impact of alternative generation technologies, fuel costs, and carbon emission mitigation policies? We can analyze this issue by tracing the effect on rates among cooperative utilities with different characteristics.

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[2] See the NRECA web site http://www.nreca.org for more information on the history and policy interests of NRECA.

Sequestration to reduce carbon emissions - Carbon sequestration is a strategy to pay farmers, ranchers, foresters, and fruit growers to sequester sufficient carbon to offset carbon emissions of fossil generating plants. What would be the effect on the agricultural sector of a sequestration policy designed to offset 30% of the generating plant emissions? We could make assumptions about the market price of carbon emissions permits (ranging from $3-10 per ton) and the effect they would have on the cost of power, the cost of modifying agricultural and forestry practices to establish carbon sinks, and the cost of alternatives to carbon sequestration, such as renewable technologies, clean coal, and distributed generation.

With these and related policy issues in mind, a model design was drafted that incorporated sufficient realism without being unduly costly. Some of the objectives of the model are to analyze the impact of these policies and changes in the utility industry on NRECA member cooperatives, their residential, commercial, and industrial customers, and the economic environment of the communities they serve. The objective was also to examine the comparative impact on cooperative, municipal, public, and investor-owned utility service territories, rural vs. urban areas, and state-level aggregations of utilities by type.

3. Elements of the *NPS* Database

The *NPS* database consists of national level data from the Inforum *IdLift* model, aggregated to the 14 sector level, county level data, based on the Regional Economic Information System (REIS) from the U.S. Bureau of Economic Analysis, and electric utility data from Resource Data International (RDI).

The 14 sectors used in *NPS* are listed in table 1. The data from *IdLift* include output in current and constant dollars, prices, employment, productivity, labor compensation, proprietors' income, other return to capital, indirect business taxes, total value added, personal consumption expenditures, federal defense expenditures, federal nondefense expenditures, state & local government expenditures and total final demand.

Data for the 3140 counties comprising the U.S. include population, employment, total earnings, number of households, total wages and salaries, other labor income, proprietors' income, dividends, interest and rental income, transfer income, social insurance contributions, and a residence adjustment.[3] Data for earnings and employment are available from each county for the 14 sectors listed in table 1. In addition to these data, estimates were made for current and constant dollar output, return to capital, and indirect business taxes. Table A-1 shows a sample of the 3140 counties.

The electric utility data is available from RDI for a set of 3496 utilities. These data consist of sales in megawatt hours (Mwh), revenue, and number of customers, for five markets: Residential, Commercial, Industrial, Public and Other. Table A-2 shows a sample of the list of utilities.

Residential customers are defined as household establishments that consume energy primarily for space heating, water heating, air conditioning, lighting, refrigeration, cooking and clothes drying. Commercial actually includes both commercial and industrial establishments which have demands generally less than 1000 kilowatt hours (kW). Industrial includes commercial and industrial establishments which have demands generally greater than 1000 kW. Public is energy supplied to ultimate consumers for public street and highway lighting. Other includes any customers not included in the other four categories, and is primarily for agricultural use.Average price data were also calculated by dividing revenue by megawatt hour sales in each market, by utility.

[3] The residence adjustment accounts for individuals who live in one county or area, but earn their income in another. The earnings variable includes them in their county of employment, but the personal income variable includes them in the county of residence.

The County-Utility Bridge

An immediate problem that arose was that of relating economic activity in a given county to demand for a utility, as well as relating utility prices of a given utility to demand for electricity in a county. The solution to this problem was the development of a county-utility bridge matrix, which is a crucial component of the model. The bridge is used to convert data available by county to data by utility, and vice versa. The rows of this bridge matrix correspond to the 3140 counties, and the columns to the 3496 utilities. The bridge was initially filled with some data that could be used to relate utility service area to counties. For this purpose, we have used the number of households (meters) served in 1990. Although the matrix is quite large, only the nonzero cells are stored, of which there are at present only about 8000 out of a total possible of 11 million. This bridge is conceptually similar to the product-industry bridge, used in the Inforum *IdLift* model, which distributes value added by industry to value added by product, and vice-versa.

To see how the bridge works, examine the situation where revenue must be distributed from electric utility revenue by utility to electric utility revenue by county. The bridge is first scaled so that the column sums are equal to the vector of utility revenue by utility. The matrix is then a revenue distribution, and the vector which is the row sum will be the implied county revenue. Now, if we start with a different vector of electric revenue by county (calculated from the simulator for instance) and want to convert it to utility, we simply scale the matrix so that the row sum is equal to the new county vector. The column sum of the matrix will be the new vector of electric utility revenue by utility. The technique will work well as long as there are no row sums or column sums of the original matrix that are equal to zero, for counties or utilities with non-zero data.

An example will help to make this clear. The first table below shows a hypothetical world with 4 utilities serving 3 counties. The original bridge matrix shows how the households are distributed by country and by utility that serves them.

	Utility 1	Utility 2	Utility 3	Utility 4
County 1	400	0	100	0
County 2	900	300	0	0
County 3	0	600	0	400

The real world matrix is much more sparse than this one, but this example should highlight the main points.

The first example is the distribution of a vector of Mwh of sales by utility, to Mwh sales by county. This is done based on the household distribution. The next tableau shows the Mwh vector by utility:

	Utility 1	Utility 2	Utility 3	Utility 4
Mwh sales	13000	9000	1400	1200

The original households matrix is scaled so that the column sums equal the Mwh sales by utility. Then, the sum across the rows of the new matrix will be the implied Mwh sales by county.

	Utility 1	Utility 2	Utility 3	Utility 4	Mwh by county
County 1	4000	0	1400	0	5400
County 2	9000	3000	0	0	12000
County 3	0	6000	0	1200	7200
Total	13000	9000	1400	1200	

The next example demonstrates how to move in the other direction, from county to utility. Much of the economic and demographic data is available by country, and to construct data by utility we also make use of the bridge. In this case, we will start with output data by county that needs to be distributed to utility.

Here is the vector of output by county:

	Output
County 1	5000
County 2	2400
County 3	4000

The original matrix is scaled, this time by row. Now the column totals are the estimates for industrial output (a demand indicator) for each utility, based on the household distribution.

	Utility 1	Utility 2	Utility 3	Utility 4	Output by county
County 1	4000	0	1000	0	5000
County 2	1800	600	0	0	2400
County 3	0	2400	0	1600	4000
Output by Utility	5800	3000	1000	1600	

There are several things to make clear about the bridge. Although the starting points are the same matrix, the matrices obtained by scaling in either direction are not similar to each other. (That is, one matrix is not a constant multiple of the other.) However, the process is invertible, which is to say, we can return to the original vales of one vector, if we return the other vector to the values implied by that distribution.

Demand Indicators

The demand indicators are variables constructed for the regression equations of electricity demand (in Mwh sales) by major sector. The demand indicators are calculated based on sectoral outputs and the national input-output coefficients for electricity consumption. For example, the demand indicator for industrial electricity consumption is formed as:

$$D_{Industrial} = \sum_{j \in Industrial} A_{6j} q_j$$

where:

A is the national input-output direct coefficients matrix, aggregated to 14 sectors

q is real sectoral output

the "industrial" group is mining, construction, manufacturing, and transportation, communication and public utilities, except electric utilities

sector 6 is the electric utilities sector

The interpretation of this demand indicator is the amount of electricity input in constant dollars that would be needed in a certain county, given the levels of sectoral outputs of each buying sector, and the input-output relationships that we observe at the national level. The demand indicator is necessarily imperfect since the national input-output matrix is only an approximate measure of electricity use per sector at the county level. However, the demand indicator constructed in this way gives a better measure than the sum of sectoral outputs for how electricity demand should change with changes in outputs, especially if the composition of outputs is changing within the industrial group.

The demand indicator for the commercial group is formed in the same way, but using the I-O coefficients and output levels of the agricultural services, wholesale trade, retail trade, finance insurance and real estate, and services sectors.

The demand indicator for "other" is simply the output of the agricultural industry. The demand indicator for the government sector is total government spending in the county.

Before they can be used in the demand regression equations described below, the demand indicators are converted to the utility basis using the county-utility bridge matrix.

4. The Cross-Sectional Electricity Demand Equations

To relate demand by market to electricity price changes, cross-sectional demand regressions were estimated for each of the five markets, using the RDI utility data described above. The quantity variable used was Mwh sales, and the price variable was the average utility rate per Kwh by market. Demographic data compiled by NRECA was also used in the residential regressions. Finally, the demand indicators described above were bridged to the utility level to adjust for demand differences.

The Commercial Sector

Of the total of roughly 3500 utilities in the database, only about 1840 had enough variables present to be included in the regressions for commercial and industrial. The final estimated equation for the commercial sector was:

LSALECOM = C - 0.87*LRATECOM + -.09*LDEMCOM + 0.92*LCUSTCOM

where: *C* = function of state dummies and ERS Beale codes.

LSALECOM = log of utility sales to the commercial sector

LRATECOM = log of utility rate per Kwh for the commercial sector

LDEMCOM = log of demand indicator for the commercial sector

LCUSTCOM = log of number of commercial utility customers

The constant term *C* is consists of the actual constant term of the equation plus two dummy variable effects, and thus varies by utility. The meaning of the state dummies is clear. The ERS Beale codes are classifications for the rural/urban classification of the county, and are defined in table 3.[4]

The omitted state dummy is for Alaska, and the omitted ERS Beale code was 0. Table 4 contains a report of the estimated parameters and statistics from the regression. The coefficient on *LRATECOM* (0-0.87) can be interpreted as the long run price-elasticity. Both the demand indicator and number of customers were included as demand variables. Each customer (utility meter) accounts for some fixed amount or minimum of electricity consumption, and the demand variable picks up electricity consumption that varies with economic activity. In the case of commercial customers, the bulk of the demand is estimated to arise from the customers variable. This makes sense, since most commercial use is for lighting, air-conditioning, computers and registers.[5] The sum of the elasticities of sales with respect to the demand indicator and number of customers is approximately one, which is in accord with our *a priori* expectation. The fit of this equation was rather good for a cross-sectional regression, with an R-squared of .915.

The Industrial Sector

The final estimated equation for the industrial sector was:

LSALEIND = C -2.58*LRATEIND + 0.34*LDEMIND + 0.48*LCUSTIND

where the variables are defined just as in the commercial sector. The more detailed set of regression parameters is provided in table 5. The estimated price elasticity for this equation is rather high. Some plotting and scanning of the price and sales data verified that the coefficient reflected the patterns observed in the data. However, this elasticity may be partly due to location decisions of industrial firms, rather than being a true price elasticity. In other words, firms that anticipate that they will have a high share of electricity cost will tend to locate in areas where electricity is relatively cheap. This phenomena will bias our coefficient upwards for use in time-series forecasting. We are considering constraining this elasticity to a smaller number. The industrial equation allocates a larger share of demand to the demand indicator variable than the commercial equation. Industrial customers' consumption of electricity is driven by electric motors, electro-chemical process needs, welding, and other production activities, which vary with the level of output. However, there are still space heat, lighting and air-conditioning requirements, so the number of customers is still important. The total of the demand indicator and customers elasticities was 0.82. This is smaller than our *a priori* elasticity of 1.0, but it could be there are more significant economies of scale in electricity use in the industrial sector. The fit of this equation was also quite good, with an R-squared of .761.

The Residential Sector

For the residential sector, 2240 utilities had sufficient data to be included in the regression. The estimated equation is:

LSALERES = *C* -0.35**LRATERES* + 0.71**HIAGESHARE* + 0.13**LCUSTMI*

where *LSALERES* = log of sales to the residential sector

LRATERES = log of utility rate per Kwh for the residential sector

HIAGESHR = share of over 65 population

LCUSTMI = log of customers per mile

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4 The ERS is the U.S. Department of Agriculture, Economic Research Service.

5 Ideally, one would like to obtain data on number of square feet of space. However, this data was not available to us.

The detailed set of regression coefficient estimates is shown in table 6. The price elasticity estimated for the residential sector is -.35, much lower than that of the commercial or industrial sector. After performing several exploratory regressions, the share of elderly and the population density were chosen as useful non-price explainers of the variation of electricity demand by utility. Note that no measure of number of customers was used in this regression, nor was the left-hand side variable put in per-capita form. The residential demand equations were much harder to fit than the commercial or industrial equations. The R-squared of the final equation used was only .387.

The Other Sector

As described above, this sector is comprised mostly of agriculture. In the total sample, 1408 observations had the necessary data to ber included in this regression. The final estimated equation for the other sector was:

LSALEOTH = C - 1.35**LRATEOTH* + .27**LDEMOTH* + .47**LCUSTOTH*

where: C = ERS Beale codes

LSALEOTH = log of utility sales to the other sector

LRATEOTH = log of utility rate per Kwh for the other sector

LDEMOTH = log of demand indicator for the other sector

LCUSTOTH = log of number of utility customers (meters) in the other sector

Note that state dummies were not used in this regression, as they did not add much to the explanatory power. The estimated price elasticity in this sector of -1.35 is between that of industrial and commercial. As in the commercial sector, the elasticity of demand with respect to the demand indicator variable was significantly less than 1.0 (.27). Even the sum of the demand indicator elasticity and the elasticity with respect to the number of customers (.47) was less than 1.0 (.74). This equation should be revisited, as it implies significant economies of scale in electricity use in the agriculture sector, which may not be realistic.

The Public Sector

The public sector regression followed the form of the other sector, i.e.:

LSALEPUB = C - .79**LRATEPUB*+ .46**LCUSTPUB*

where: C = State dummies and ERS Beale codes

LSALEPUB = log of utility sales to the public sector

LRATEPUB = log of utility rate per Kwh for the public sector

LCUSTPUB = log of number of utility customers (meters) in the public sector

The price elasticity for the public sector is reasonable (-.79). The elasticity with respect to number of customers is significantly less than one.

5. The Structure of *NPS*

The construction of the NRECA Policy Simulator was done in two stages. In the first stage, historical data at the local level was estimated based on national relationships. This data set was then used as the historical starting point for making model projections.

Estimation of County Historical Data Not Available from published sources

The step of estimating data not available from the county or utility database is done by a program that works like a model, but over the historical interval (1969 to 1999)

The first step of this program is to reads data from the national model *IdLift,* aggregate that data, and insert it into the model database. These variables include the A-matrix, or direct coefficients matrix, output in constant and current prices, domestic prices, employment, labor productivity (output/employment), personal consumption by commodity in constant and current prices, total final demand, labor compensation, proprietors' income, total earnings (labor compensation plus proprietors' income), total return to capital, indirect business taxes, total value added, total federal government final demand, and total state & local government final demand. This data is used to form other variables described below. In running the simulator, the forecast data is in many case calculated in the same way as the historical data.

After filling the historical data file with 14-sector national data, the program converts the revenue and sales data by utility to county level, using the county-utility bridge. With total electric utility revenue by county in hand, the sector Transportation, communication and public utilities (TCPU) can be split into two parts. First, total revenue for the group as a whole is estimated by multiplying the ratio of current price output to employment at the national level by employment at the county level. Then, the share of electric utility revenue to this total is used to split employment and constant price output. In a few cases, electric utility revenue obtained by passing through the bridge was greater than current price output in the original TCPU sector. In these cases, we used the national shares of the two industries to do the split.

Constant and current price output for the other 12 sectors is obtained by multiplying the national ratio of these variables to employment by the employment by county by industry. Indirect business taxes by industry are derived as a share of current price output equal to that of the national data, for each industry. Capital type income by industry is calculated as a ratio to total earnings (labor compensation plus proprietors' income) equal to that of the national data for each industry. Total value added is then the sum of earnings, return to capital and indirect business taxes. In a small number of cases, the value added so estimated is larger than nominal output. In these cases, nominal output is set equal to total value added.

Electric utility sales (Mwh) and revenue by the five market areas are then distributed to the 14 industry sectors, using shares of intermediate sales of electricity in the national 14 sector I-O table to do the distribution. The link to the twelve industries and to consumption is as described in table 2. Note that Residential revenue is defined to be equal to personal consumption of Electric utilities in current prices.

Next, total consumption by county is estimated by applying the ratio of personal consumption to personal income at the national level to personal income by county. Personal consumption of electricity in current prices is set equal to residential consumption of electricity, derived above. Consumption of the other commodities is then determined by using the national shares of the non electric part of current price consumption by commodity. Figure 1 summarizes the historical data flow.

The NRECA Policy Simulator (NPS) Program

Like the historical data program *NPS* first collects and aggregates various data from *IdLift* which will be used both as driver variables and allocator variables. Particularly important is sectoral output, since regressions have been developed by 14 sectors that relate county output to national output.

The model starts by making a first pass estimate of personal income by county. This estimate is made by growing lagged personal income by county by the growth rate of personal income at the national level. The model iteration loop begins by figuring how much of personal income is personal consumption, using the national share of personal consumption in personal income. Then the first pass estimate of the electricity share in that total consumption is calculated by moving the lagged share by the growth of the national share. That share is then used to derive consumption of electricity, in current prices. Personal consumption of the non electricity commodities is obtained by sharing out the non-electricity consumption by county by the corresponding national shares.

Next, output by industry for each county is estimated using estimated output regressions. These are of two types. “National” industries are related to the national output of the same industry. “Local” industries, which include Retail trade, Construction, Services and State & local government, are related to total personal consumption in each county. Federal government output is moved forward by the growth rate of the total national federal government spending. Current price output by industry is derived by multplying the national price level for that industry by the constant price output estimate.

Next, demand indicators for each major market are derived by county, and then converted to demand indicators by utility using the bridge matrix. Electricity prices by market by utility are moved forward by the growth rate of the national electricity price. The number of customers by utility is set to grow at the same rate as the demand indicator, but this can be changed by the user of the model.

Once the price, demand indicators and customers variables have been calculated, the electricity demand equations described in section 4 are calculated. The result of these equations is Mwh sales of electricity by market, by utility. These sales are then converted back to the county level using the bridge. Total utility revenue by market is calculated by multiplying the Mwh sales by the price per Mwh. Mwh sales by county by market are aggregated to a total for each county, and this figure is used to move the estimate of the electric utility industry output.

Employment by industry is formed using national employment/output ratios times sectoral constant price output. Total earnings are formed by first growing the earnings/employment ratio by county by the national growth rate in employment to earnings for each industry, and then multiplying by employment. Current price output by industry is formed simply by multiplying constant price output by industry by the national price index. Value added by industry is calculated based on the national ratio of value added to current price output, and capital income is formed as the difference of total value added and total earnings by industry. Population in each county is assumed to move in step with employment. This assumes a constant jobs/population ratio in each county.

Finally, personal income by county is formed by moving the lagged value forward by the growth in total earnings. The model compares the personal income vector with the last guess of personal income, and returns to the top of the model loop if they are not sufficiently close. Several iterations are usually required before the model reaches convergence.

Many of the variables in the model can be fixed exogenously by the user. These fixes may be overrides, indexes, growth rates, add-factors or multiplication factors. By changing the path of certain variables, we can investigate the effects of these variables on other variables, either for an individual county, or a set of counties grouped by some criterion. The next section sketches the results of increasing prices by utility due to the imposition of a carbon tax.

6. Example of a Simulation with *NPS*: A Carbon Tax

In this example, the RDI database of utilities was used to estimate the effects on each utility's price of a $10/ton carbon tax. At the utility plant level, data is available for annual heat input by fuel and the carbon emissions per unit of heat by fuel. (This is nearly constant across all types of coal.) From this data, total carbon emissions by plant were obtained. Multiplying tons of carbon by the tax rate yielded total carbon tax per plant.[6]

At the level of generating companies we know the annual power sales to wholesalers and retail customers (in MwH), and this is used to calcualte the shares of electricity output purchased by each electric utility. Carbon cost is then distributed to utilities by these shares of power purchases from each plant. The increase in total cost was then divided by the total MwH sales to obtain the average incremental cost per MwH, by utility.

Table 9 shows price increments in percentage terms for the first several utilities in the list. Note the wide variation in percentage increases across plants. This is due to differences in fuel mix, capital cost structure and other differences in cost factors. We'll focus on the changes in one utility, and trace the effects on the utility and the economic region.

Before running *NPS*, the national Inforum *IdLift* model is run. The only change that we assume for this run is that the average price of electricity changes. To calculate the size of the price increase, we form a weighted average of the price increases of all utilities in the database. For the 10$/ton carbon tax case, the average price increase is 13.7 percent. Note that this price increase is expected to: 1) reduce demand for electricity; 2) raise the prices of other sectors which use electricity, causing reductions in their output; 3) raise the overall price level slightly, so that nominal GDP, personal income and other nominal variables may rise slightly; 4) reduce GDP and employment slightly, at least in the short run.

Note that the utility named Adams-Columbia Electric Coop is calculated to experience a price increase of 14.8%. The price increase was implemented by multiplying the prices for each market in the base case by 1.148, from 2001 to 2005. No price discrimination was assumed.

First we will trace what counties this price increase will affect. Although the utility database indicates that Adams-Columbia is located in Adams county, Wisconsin (FIPS 55001), table 10 indicates that it actually serves customers in several counties in Wisconsin. The largest customer base is in Wood county, and the bulk of customers can be found in Adams, Columbia, Marquette, Waushara and Wood counties. (The numbers to the left of the counties in table 10 indicate the position within the vector of counties, not the FIPS code.)

Table 11 shows a county economic summary for Wood county, Wisconsin. Since the model is dynamic, and the effects differ by year, this table presents averages for the period 2001-5. (This is what the header for the column "01|05" means.) Total employment in this county in the base case was an average of 63984. Employment declined in the 10$/ton carbon tax case by 75 people. Nominal personal income rose. However, this rise is very small (less than .5 percent) and is mostly due to the higher average price level. The table of output by industry shows how the various industries are affected in terms of real output changes. The electric utility industry of course suffers the largest decline in output, -11.8 million in constant 1987 dollars. This is a decline of 15.8 percent. Now, table 12 shows that Wood county is served not only by the Adams-Columbia Electric Coop, but also by 7 other utilities. These utilities were calculated to have different ranges of price increase, ranging from 9.0 percent to 16.2 percent (with the exception of the Wisconsin River Power Co., which was small, and presumably hydro.) The calculated weighted average price increase for Wood county is 12.8 percent. The demand response that is larger

[6] Proposed legislation states that the utilities will only pay tax on incremental carbon emissions since 1990. Therefore, our calculation overstates the cost of the tax. We intend to refine this exercise by calculating only the incremental emissions since 1990.

than the price change in this case means that the average demand elasticity over all 5 markets for the 8 utilities serving Wood county is roughly -1.23 (15.8/12.8).

Other industries also suffered declines in output. Manufacturing declined by 2.7 million (-.12 percent). Farms, Agricultural services, Mining, Wholesale trade also suffer slight declines. Other industries show an increase in activity. The largest increase is in Services, which increases by 2.1 million (+.14 percent). Recall that certain industries, such as Construction, Retail trade and Services are considered "local" and are based on total personal consumption in the county. The Electric utility is based on the electricity demand regressions. In the other industries, the changes in output are based on changes in the national model. These industries include: Agriculture and Agricultural services, Mining, Manufacturing, Transportation, Communication and Utilities, Wholesale trade, and Finance, insurance and real estate.

Employment in each county is calculated on national level labor productivity trends, and sectoral output in the county. Table 12 shows that total employment declines by 75 people in Wood county. This total decline is comprised of a decline of 71 in Retail trade, a decline of 26 in Electric utilities, small declines in Farms, Construction and Manufacturing, and increases in employment in Transportation, Communication and Utilities and Services.

The last block of table 12 shows the changes in total earnings by industry. The Electric utility industry and the Retail trade industry show a decline in earnings, but the increases in other sectors are enough to bring the total increase to 7.6 million dollars. This comprises about half of the total increase in Personal income shown at the beginning of table 12. Other components of personal income, not shown, include Dividends, interest and rent, Transfer payments, Contributions to social insurance, and the Residence adjustment.

7. Conclusions and Further Development

The initial trial runs with *NPS* indicated that it already serves as a useful tool to analyze local impacts of a carbon tax or other policy change which affects utility prices. In almost all respects, the modeling system has served the original goals of developing a national/local model that integrates electric utility prices and demand into county models with industry detail. However, there are several issues requiring further attention:

- Are the price elasticities estimated from the cross-section data appropriate for a time-series model? The average elasticities for the industrial sector (-2.6) and the other sector (-1.35) seem rather high. Perhaps it would be desirable to pool cross-section and time-series data to estimate a more realistic elasticity. Alternatively, we could constrain the elasticity in the regression to match other published results in the literature.
- Endogenizing the rate calculation might be a fruitful direction in which to take this model. The RDI utility database contains a wealth of data on purchased fuels, capital cost and labor cost. An industry-wide costing model could be estimated and integrated into *NPS,* rather than calculating rate changes outside the model in "back-of-the-envelope" fashion.
- We may need to rethink the linkage between the county models and the national model. For sectors such as wholesale trade and manufacturing, it may be useful to base output on both national level output and county level personal consumption.

Table 1. Industry and Government Sectors in NPS

#	*Industry Title*	*SIC Definition*
1	Farming	01, 02
2	Agricultural services, forestry, fisheries	07, 08, 09
3	Mining	10, 12, 13, 14
4	Construction	15, 16, 17
5	Manufacturing	20 - 39
6	Electric Utilities	491, pt. 493
7	Transportation, communications, and public utilities, except electric utilities	40 – 49, exc. 491, pt. 493
8	Wholesale trade	50, 51
9	Retail trade	52 - 59
10	Finance, insurance and real estate	60 - 67
11	Services	70 - 89
12	Federal civilian	N/A
13	Federal military	N/A
14	State & local	N/A

Table 2. Correspondence of 5 RDI Market Categories to 14 Sectors and Personal Consumption

Market	*Sectoral Correspondence*
Residential	Personal consumption of electricity
Industrial	Mining, Construction, Manufacturing, Transportation, communication and public utilities, except electric
Commercial	Wholesale trade, Retail trade, Finance, insurance and real estate, Services
Public	Federal government, State & local government
Other	Agriculture, agricultural services, forestry and fisheries

Table 3. ERS Beale Codes and Their Definitions

ERS Beale Code	*Definition*
	METROPOLITAN COUNTIES (0-3)
0	Central counties of metropolitan areas of 1 million population or more
1	Fringe counties of metropolitan areas of 1 million population or more
2	Counties in metropolitan areas of 250 thousand to 1 million population
3	Counties in metropolitan areas of less than 250 thousand population
	NONMETROPOLITAN COUNTIES (4-9)
4	Urban population of 20 thousand or more, adjacent to a metropolitan area
5	Urban population of 20 thousand or more, not adjacent to a metropolitan area
6	Urban population of 2,500 to 19,999, adjacent to a metropolitan area
7	Urban population of 2,500 to 19,999, not adjacent to a metropolitan area
8	Completely rural (no places with a population of 2,5000 or more, adjacent to a metropolitan area
9	Completely rural (no places with a population of 2,5000 or more, not adjacent to a metropolitan area

Table 4. Estimated Regression for Commercial Sector

Dependent Variable: LSALECOM
Method: Least Squares
Date: 05/04/01 Time: 14:12
Sample(adjusted): 1 3479
Included observations: 2852
Excluded observations: 627 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.599759	0.189622	40.07836	0.0000
SDUM1	0.706727	0.188761	3.744028	0.0002
SDUM2	0.154830	0.091530	1.691573	0.0908
SDUM3	0.073747	0.118340	0.623180	0.5332
SDUM4	0.504697	0.142085	3.552076	0.0004
SDUM5	0.181700	0.112253	1.618672	0.1056
SDUM7	0.373414	0.214870	1.737861	0.0823
SDUM8	1.295697	0.631383	2.052157	0.0402
SDUM9	0.442490	0.202162	2.188792	0.0287
SDUM10	0.237793	0.096418	2.466273	0.0137
SDUM11	0.511381	0.076063	6.723110	0.0000
SDUM12	0.887030	0.368714	2.405742	0.0162
SDUM13	0.266511	0.074209	3.591340	0.0003
SDUM14	0.064045	0.185241	0.345740	0.7296
SDUM15	0.235711	0.083851	2.811077	0.0050
SDUM16	0.050306	0.074627	0.674099	0.5003
SDUM17	0.086842	0.077234	1.124393	0.2609
SDUM18	0.213785	0.091595	2.334035	0.0197
SDUM19	0.300272	0.111039	2.704205	0.0069
SDUM20	-0.188605	0.103426	-1.823583	0.0683
SDUM21	0.108196	0.213848	0.505950	0.6129
SDUM22	-0.206725	0.201980	-1.023493	0.3062
SDUM23	0.262772	0.094814	2.771434	0.0056
SDUM24	0.207541	0.064102	3.237660	0.0012
SDUM25	0.081441	0.068025	1.197221	0.2313
SDUM26	0.301092	0.097179	3.098317	0.0020
SDUM27	0.013316	0.129996	0.102432	0.9184
SDUM28	0.507050	0.076968	6.587835	0.0000
SDUM29	0.346029	0.127430	2.715439	0.0067
SDUM30	-0.047320	0.079924	-0.592055	0.5539
SDUM31	0.533893	0.193316	2.761768	0.0058
SDUM32	0.317555	0.175489	1.809539	0.0705
SDUM33	0.192718	0.136029	1.416746	0.1567
SDUM34	0.828175	0.202773	4.084250	0.0000
SDUM35	-0.367094	0.099899	-3.674634	0.0002
SDUM36	0.132924	0.076695	1.733168	0.0832
SDUM37	0.050403	0.081547	0.618085	0.5366
SDUM38	-0.041269	0.115349	-0.357774	0.7205
SDUM39	-0.100103	0.094495	-1.059352	0.2895
SDUM40	0.221096	0.285210	0.775205	0.4383
SDUM41	0.279600	0.106177	2.633334	0.0085
SDUM42	0.306841	0.097352	3.151863	0.0016
SDUM43	0.381408	0.078450	4.861802	0.0000
SDUM44	0.034310	0.064763	0.529774	0.5963
SDUM45	0.239172	0.119164	2.007075	0.0448
SDUM46	-0.076820	0.145168	-0.529178	0.5967

SDUM47	-0.076941	0.145013	-0.530576	0.5958
SDUM48	0.058695	0.096265	0.609720	0.5421
SDUM49	0.047792	0.075371	0.634090	0.5261
SDUM50	-0.174420	0.240398	-0.725547	0.4682
SDUM51	0.141580	0.147912	0.957192	0.3386
ERSDUM2	-0.239882	0.075405	-3.181237	0.0015
ERSDUM3	-0.303755	0.058331	-5.207470	0.0000
ERSDUM4	-0.349307	0.062717	-5.569610	0.0000
ERSDUM5	-0.376772	0.070626	-5.334750	0.0000
ERSDUM6	-0.530593	0.074682	-7.104658	0.0000
ERSDUM7	-0.432029	0.058972	-7.326004	0.0000
ERSDUM8	-0.470621	0.058737	-8.012342	0.0000
ERSDUM9	-0.427080	0.082016	-5.207268	0.0000
ERSDUM10	-0.488213	0.068195	-7.159112	0.0000
LRATECOM	-0.869889	0.039142	-22.22405	0.0000
LDEMCOM	0.091326	0.008835	10.33678	0.0000
LCUSTCOM	0.918947	0.010735	85.60278	0.0000

R-squared	0.915461	Mean dependent var	9.852739
Adjusted R-squared	0.913582	S.D. dependent var	2.133644
S.E. of regression	0.627225	Akaike info criterion	1.926821
Sum squared resid	1097.225	Schwarz criterion	2.058382
Log likelihood	-2684.646	F-statistic	487.1269
Durbin-Watson stat	2.025711	Prob(F-statistic)	0.000000

Table 5. Estimated Regression for Industrial Sector

Dependent Variable: LSALEIND
Method: Least Squares
Date: 05/04/01 Time: 14:11
Sample(adjusted): 2 3479
Included observations: 1999
Excluded observations: 1479 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	16.82791	0.362253	46.45354	0.0000
SDUM1	2.451619	0.584364	4.195363	0.0000
SDUM2	0.903085	0.181986	4.962389	0.0000
SDUM3	0.771636	0.237120	3.254208	0.0012
SDUM4	0.729185	0.312290	2.334958	0.0196
SDUM5	0.945079	0.223018	4.237687	0.0000
SDUM7	1.098765	0.398046	2.760397	0.0058
SDUM8	1.508531	1.156897	1.303945	0.1924
SDUM9	1.352035	0.414714	3.260161	0.0011
SDUM10	0.655296	0.221567	2.957554	0.0031
SDUM11	0.824306	0.165282	4.987258	0.0000
SDUM12	3.393663	0.677400	5.009837	0.0000
SDUM13	0.144851	0.162623	0.890718	0.3732
SDUM14	-0.540314	0.394005	-1.371339	0.1704
SDUM15	0.292996	0.191447	1.530423	0.1261
SDUM16	0.210514	0.160207	1.314013	0.1890
SDUM17	-0.173978	0.188557	-0.922681	0.3563
SDUM18	0.474976	0.183981	2.581658	0.0099
SDUM19	-0.067700	0.236984	-0.285671	0.7752
SDUM20	0.788524	0.203063	3.883142	0.0001
SDUM21	0.270091	0.418212	0.645824	0.5185
SDUM22	1.270852	0.416155	3.053795	0.0023
SDUM23	0.564293	0.194128	2.906805	0.0037
SDUM24	0.210649	0.145954	1.443262	0.1491
SDUM25	0.196303	0.147076	1.334704	0.1821
SDUM26	1.208033	0.189125	6.387501	0.0000
SDUM27	-0.500152	0.300241	-1.665835	0.0959
SDUM28	0.572531	0.180152	3.178042	0.0015
SDUM29	0.229047	0.291419	0.785972	0.4320
SDUM30	-0.169775	0.172074	-0.986635	0.3239
SDUM31	1.646682	0.374977	4.391417	0.0000
SDUM32	0.911093	0.421736	2.160342	0.0309
SDUM33	0.607604	0.302677	2.007434	0.0448
SDUM34	0.651800	0.418874	1.556074	0.1199
SDUM35	-0.887552	0.209732	-4.231841	0.0000
SDUM36	0.291483	0.159833	1.823672	0.0684
SDUM37	-0.645816	0.175408	-3.681791	0.0002
SDUM38	0.101106	0.230237	0.439139	0.6606
SDUM39	0.161377	0.203606	0.792592	0.4281
SDUM40	0.525036	0.585114	0.897323	0.3697
SDUM41	0.728776	0.230052	3.167875	0.0016
SDUM42	-0.249430	0.235129	-1.060822	0.2889
SDUM43	1.521057	0.151246	10.05681	0.0000
SDUM44	-0.133421	0.147827	-0.902549	0.3669
SDUM45	-0.597390	0.283074	-2.110366	0.0350
SDUM46	0.273950	0.309372	0.885502	0.3760

SDUM47	1.282889	0.293519	4.370722	0.0000
SDUM48	-0.180206	0.215416	-0.836547	0.4030
SDUM49	0.158838	0.162303	0.978656	0.3279
SDUM50	0.051100	0.677262	0.075450	0.9399
SDUM51	-0.279442	0.319684	-0.874122	0.3822
ERSDUM2	-0.489061	0.160210	-3.052618	0.0023
ERSDUM3	-0.263419	0.117295	-2.245783	0.0248
ERSDUM4	-0.308545	0.129201	-2.388111	0.0170
ERSDUM5	-0.363263	0.143553	-2.530516	0.0115
ERSDUM6	-0.574519	0.154319	-3.722930	0.0002
ERSDUM7	-0.555230	0.120531	-4.606525	0.0000
ERSDUM8	-0.522398	0.119988	-4.353743	0.0000
ERSDUM9	-0.913027	0.197656	-4.619281	0.0000
ERSDUM10	-0.826889	0.151508	-5.457741	0.0000
LRATEIND	-2.580659	0.079652	-32.39908	0.0000
LDEMIND	0.335695	0.015181	22.11279	0.0000
LCUSTIND	0.484546	0.015309	31.65161	0.0000

R-squared	0.761418	Mean dependent var	10.35665
Adjusted R-squared	0.753778	S.D. dependent var	2.313108
S.E. of regression	1.147782	Akaike info criterion	3.144549
Sum squared resid	2550.495	Schwarz criterion	3.321050
Log likelihood	-3079.977	F-statistic	99.65519
Durbin-Watson stat	1.985395	Prob(F-statistic)	0.000000

Table 6. Estimated Equation for Residential Sector

Dependent Variable: LMWHHH
Method: Least Squares
Date: 05/15/01 Time: 16:43
Sample(adjusted): 1 3479 IF RATERES < 150
Included observations: 2282
Excluded observations: 911 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.844513	0.337413	8.430358	0.0000
SDUM1	1.106889	0.263236	4.204936	0.0000
SDUM2	0.464425	0.121656	3.817517	0.0001
SDUM3	0.317235	0.140320	2.260804	0.0239
SDUM4	-0.022896	0.156770	-0.146048	0.8839
SDUM5	-0.153085	0.137171	-1.116021	0.2645
SDUM7	-0.107272	0.222382	-0.482379	0.6296
SDUM8	-0.013766	0.603397	-0.022815	0.9818
SDUM9	0.327807	0.210868	1.554563	0.1202
SDUM10	0.503777	0.124921	4.032771	0.0001
SDUM11	0.912670	0.111720	8.169270	0.0000
SDUM12	-0.416172	0.604074	-0.688943	0.4909
SDUM13	0.121608	0.111049	1.095089	0.2736
SDUM14	0.672919	0.189435	3.552248	0.0004
SDUM15	0.189205	0.117740	1.606974	0.1082
SDUM16	0.052486	0.110781	0.473785	0.6357
SDUM17	0.204504	0.113883	1.795738	0.0727
SDUM18	0.290011	0.121843	2.380203	0.0174
SDUM19	0.261780	0.134826	1.941611	0.0523
SDUM20	-0.081140	0.130909	-0.619821	0.5354
SDUM21	0.115992	0.218957	0.529745	0.5963
SDUM22	0.001605	0.230996	0.006949	0.9945
SDUM23	-0.276200	0.124816	-2.212856	0.0270
SDUM24	0.042634	0.105598	0.403741	0.6864
SDUM25	0.327515	0.107574	3.044549	0.0024
SDUM26	0.408914	0.124363	3.288067	0.0010
SDUM27	0.801817	0.151104	5.306387	0.0000
SDUM28	0.634025	0.114228	5.550511	0.0000
SDUM29	0.984286	0.150057	6.559407	0.0000
SDUM30	0.158511	0.115079	1.377414	0.1685
SDUM31	0.036509	0.220774	0.165369	0.8687
SDUM32	-0.069059	0.188134	-0.367076	0.7136
SDUM33	-0.054612	0.155159	-0.351975	0.7249
SDUM34	0.158198	0.220137	0.718636	0.4724
SDUM35	-0.046328	0.132399	-0.349908	0.7264
SDUM36	0.137735	0.112920	1.219757	0.2227
SDUM37	0.346126	0.116853	2.962060	0.0031
SDUM38	0.591868	0.140773	4.204410	0.0000
SDUM39	-0.339024	0.124910	-2.714143	0.0067
SDUM40	-0.398461	0.313801	-1.269789	0.2043
SDUM41	0.526068	0.131775	3.992164	0.0001
SDUM42	0.430649	0.125728	3.425239	0.0006
SDUM43	0.805494	0.113002	7.128142	0.0000
SDUM44	0.312030	0.105310	2.962973	0.0031
SDUM45	0.221894	0.141920	1.563514	0.1181
SDUM46	0.330537	0.145221	2.276096	0.0229

SDUM47	0.052170	0.166216	0.313867	0.7537
SDUM48	0.430221	0.126579	3.398826	0.0007
SDUM49	0.018170	0.112121	0.162054	0.8713
SDUM50	-0.650150	0.243266	-2.672594	0.0076
SDUM51	0.064079	0.163728	0.391375	0.6956
ERSDUM2	0.353178	0.073686	4.792982	0.0000
ERSDUM3	0.254440	0.057583	4.418695	0.0000
ERSDUM4	0.300301	0.062624	4.795288	0.0000
ERSDUM5	0.209468	0.070554	2.968897	0.0030
ERSDUM6	0.338013	0.077013	4.389041	0.0000
ERSDUM7	0.440800	0.058070	7.590829	0.0000
ERSDUM8	0.453020	0.060065	7.542181	0.0000
ERSDUM9	0.430726	0.094751	4.545859	0.0000
ERSDUM10	0.546885	0.077759	7.033093	0.0000
LRATERES	-0.350135	0.071801	-4.876439	0.0000
HIAGESHARE	0.717534	0.297625	2.410864	0.0160
LCUSTMI	0.133289	0.006578	20.26241	0.0000

R-squared	0.386506	Mean dependent var	2.679049
Adjusted R-squared	0.369364	S.D. dependent var	0.748662
S.E. of regression	0.594532	Akaike info criterion	1.825135
Sum squared resid	784.3462	Schwarz criterion	1.983403
Log likelihood	-2019.479	F-statistic	22.54814
Durbin-Watson stat	1.954569	Prob(F-statistic)	0.000000

Table 7. Estimated Equation for Other Sector

Dependent Variable: LSALEOTH
Method: Least Squares
Date: 05/04/01 Time: 14:12
Sample(adjusted): 1 3378
Included observations: 1408
Excluded observations: 1970 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.78462	0.354801	30.39626	0.0000
ERSDUM2	-1.563614	0.232017	-6.739210	0.0000
ERSDUM3	-0.883492	0.165720	-5.331243	0.0000
ERSDUM4	-1.554125	0.177899	-8.736017	0.0000
ERSDUM5	-1.562302	0.215557	-7.247752	0.0000
ERSDUM6	-1.662742	0.203693	-8.162963	0.0000
ERSDUM7	-2.053647	0.162564	-12.63281	0.0000
ERSDUM8	-2.087156	0.152092	-13.72303	0.0000
ERSDUM9	-2.022831	0.275959	-7.330174	0.0000
ERSDUM10	-2.198103	0.184134	-11.93752	0.0000
LRATEOTH	-1.358946	0.062674	-21.68295	0.0000
LDEMOTH	0.272684	0.019824	13.75495	0.0000
LCUSTOTH	0.465525	0.019512	23.85876	0.0000

R-squared	0.609999	Mean dependent var	7.709428
Adjusted R-squared	0.606644	S.D. dependent var	2.358414
S.E. of regression	1.479153	Akaike info criterion	3.630006
Sum squared resid	3052.111	Schwarz criterion	3.678478
Log likelihood	-2542.524	F-statistic	181.8258
Durbin-Watson stat	1.946168	Prob(F-statistic)	0.000000

Table 8. Estimated Equation for Public Sector

Dependent Variable: LSALEPUB
Method: Least Squares
Date: 05/04/01 Time: 13:13
Sample(adjusted): 2 3492
Included observations: 1740
Excluded observations: 1751 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.923535	0.301142	32.95305	0.0000
SDUM1	0.625576	0.388765	1.609136	0.1078
SDUM2	1.272336	0.255499	4.979807	0.0000
SDUM3	0.670200	0.345095	1.942073	0.0523
SDUM4	0.842717	0.396513	2.125318	0.0337
SDUM5	1.026046	0.291257	3.522825	0.0004
SDUM7	0.754217	0.575068	1.311528	0.1899
SDUM8	3.303111	1.486445	2.222154	0.0264
SDUM9	1.719454	0.864339	1.989328	0.0468
SDUM10	0.924515	0.250133	3.696099	0.0002
SDUM11	0.877113	0.256448	3.420235	0.0006
SDUM12	1.950938	0.867530	2.248840	0.0247
SDUM13	-0.093995	0.211674	-0.444056	0.6571
SDUM14	0.791364	0.569269	1.390142	0.1647
SDUM15	-0.149076	0.266947	-0.558448	0.5766
SDUM16	0.486375	0.219474	2.216091	0.0268
SDUM17	0.537743	0.269921	1.992225	0.0465
SDUM18	0.985416	0.249583	3.948253	0.0001
SDUM19	1.214173	0.356048	3.410137	0.0007
SDUM20	0.625368	0.256234	2.440615	0.0148
SDUM21	1.217072	0.506893	2.401043	0.0165
SDUM22	0.572667	0.508218	1.126813	0.2600
SDUM23	0.729944	0.265056	2.753918	0.0060
SDUM24	0.602891	0.179561	3.357588	0.0008
SDUM25	0.497936	0.235568	2.113772	0.0347
SDUM26	2.078920	0.259263	8.018566	0.0000
SDUM27	-0.216732	0.371625	-0.583200	0.5598
SDUM28	0.911546	0.238050	3.829223	0.0001
SDUM29	-0.523803	0.363811	-1.439767	0.1501
SDUM30	0.378523	0.216600	1.747564	0.0807
SDUM31	0.768968	0.508895	1.511054	0.1310
SDUM32	1.706648	0.577088	2.957344	0.0031
SDUM33	0.623181	0.345321	1.804644	0.0713
SDUM34	0.908382	0.614744	1.477658	0.1397
SDUM35	0.439728	0.253459	1.734908	0.0829
SDUM36	-0.093861	0.295518	-0.317617	0.7508
SDUM37	0.360390	0.374726	0.961742	0.3363
SDUM38	0.183870	0.288115	0.638182	0.5234
SDUM39	0.595678	0.327462	1.819074	0.0691
SDUM40	2.140034	0.750423	2.851769	0.0044
SDUM41	0.646160	0.364887	1.770850	0.0768
SDUM42	0.048647	0.275821	0.176372	0.8600
SDUM43	1.932433	0.196266	9.845972	0.0000
SDUM44	0.039219	0.209446	0.187250	0.8515
SDUM45	0.519411	0.458999	1.131619	0.2580
SDUM46	1.033861	0.355402	2.908992	0.0037

SDUM47	0.415185	0.356874	1.163395	0.2448
SDUM48	0.094300	0.243929	0.386588	0.6991
SDUM49	0.452361	0.193681	2.335601	0.0196
SDUM50	1.454768	0.612483	2.375197	0.0177
SDUM51	0.237916	0.438354	0.542749	0.5874
ERSDUM2	-1.555494	0.222562	-6.989029	0.0000
ERSDUM3	-0.910571	0.159798	-5.698265	0.0000
ERSDUM4	-1.016686	0.176843	-5.749070	0.0000
ERSDUM5	-1.404316	0.203650	-6.895730	0.0000
ERSDUM6	-1.461915	0.211362	-6.916645	0.0000
ERSDUM7	-1.787933	0.166811	-10.71830	0.0000
ERSDUM8	-1.811895	0.163042	-11.11304	0.0000
ERSDUM9	-1.955867	0.254432	-7.687200	0.0000
ERSDUM10	-2.142209	0.198239	-10.80622	0.0000
LRATEPUB	-0.795031	0.057985	-13.71090	0.0000
LCUSTPUB	0.461255	0.019122	24.12203	0.0000

R-squared	0.538067	Mean dependent var	6.616451
Adjusted R-squared	0.521275	S.D. dependent var	2.134564
S.E. of regression	1.476904	Akaike info criterion	3.652755
Sum squared resid	3660.131	Schwarz criterion	3.847365
Log likelihood	-3115.897	F-statistic	32.04202
Durbin-Watson stat	1.925050	Prob(F-statistic)	0.000000

Figure 1. Historical Data Flow

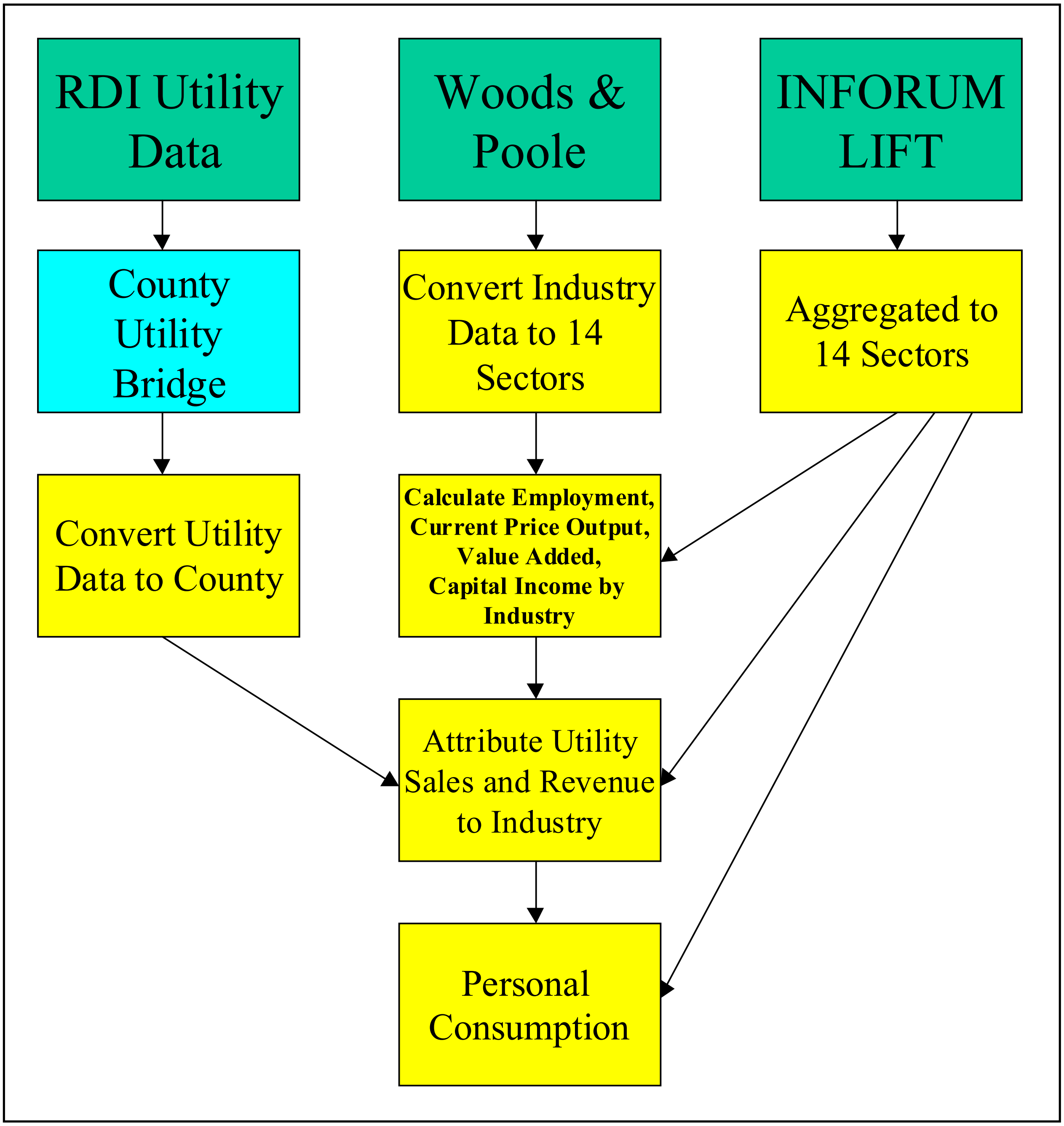

Figure 2. Flow of the NRECA Policy Simulator

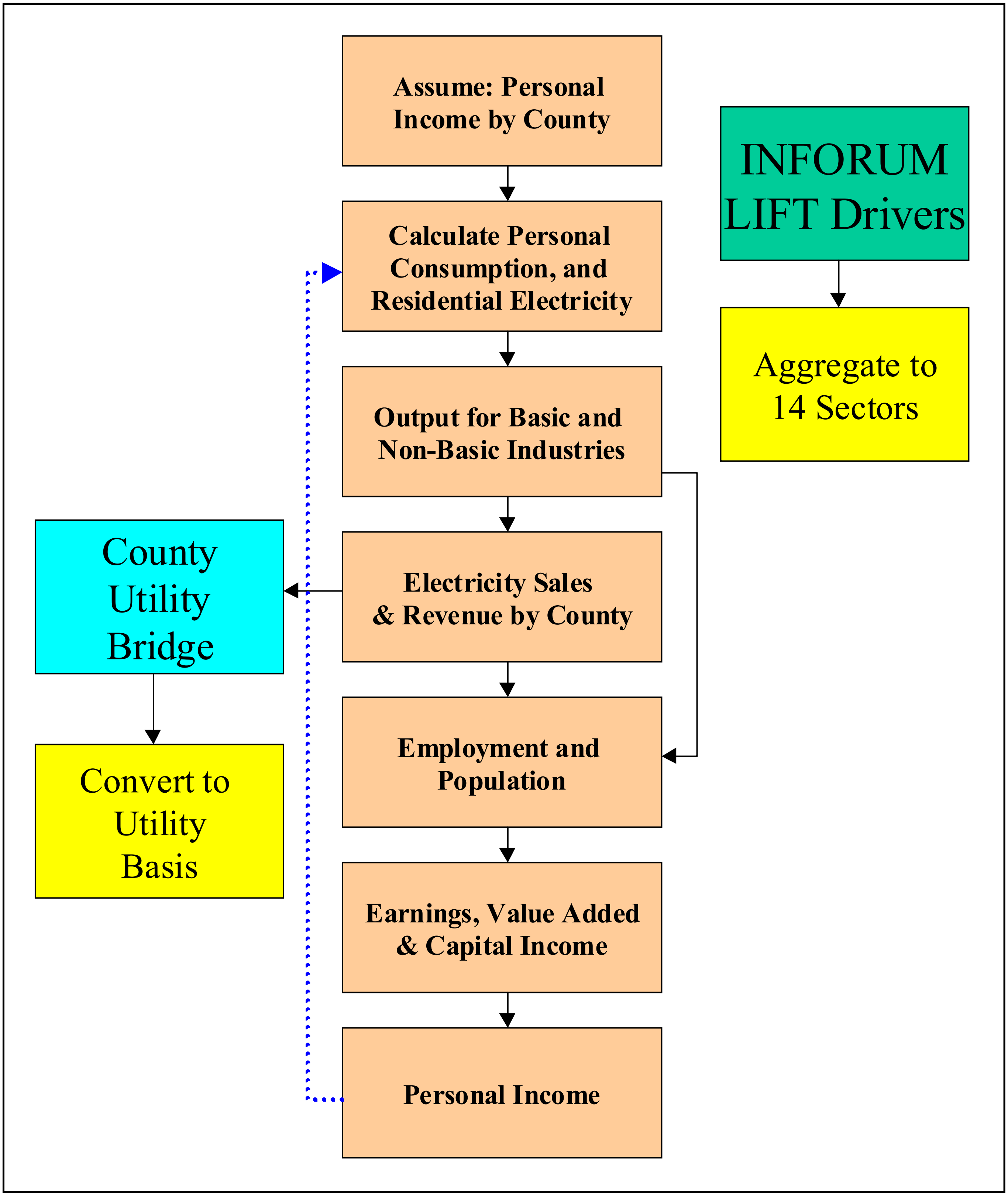

Table 9. Price Increments for Selected Utilities with $10/ton Carbon Tax

Utility ID	Utility Name	Cost Increment (percent) at 10$/ton
00034	Abbeville Water & Electric Plant	
00055	Aberdeen Electric Dept.	4.9%
00059	Abbeville Water & Power Plant	9.7%
00084	A & N Electric Coop, Inc.	11.4%
00087	Ada Municipal Electric	8.4%
00097	Adams Electric Coop	
00108	Adams-Columbia Electric Coop	14.8%
00118	Adams Rural Electric Coop, Inc.	11.9%
00122	Arcade Municipal Electric Dept.	
00123	Adel Light & Gas Dept.	
00149	Afton Municipal Electric Light System	
00150	Adrian Public Utility	
00155	Agralite Electric Coop	
00157	Advance Municipal Light & Power	18.7%
00162	Aiken Electric Coop, Inc.	1.8%
00174	Aitkin Public Utilities Commission	14.3%
00176	AJO Improvement Co.	7.9%
00182	Akron Light & Water	34.3%
00183	Akron Municipal Electric Util.	
00189	Alabama Electric Coop, Inc.	1.6%
00191	Alamo Power District No. 3	
00192	Akiachak Native Community Electric Co.	
00195	Alabama Power Co.	10.9%
00198	Alton Electric Dept.	
00201	Alachua Electric Dept.	4.4%
00202	Black Creek Electric Dept.	
00207	Alameda Bureau of Electricity	
00213	Alaska Electric Light & Power Co.	
00219	Alaska Power & Telephone Co.	
00220	Alaska Power Administration	
00221	Alaska Village Electric Coop, Inc.	
00228	Albany Light, Gas & Water Dept.	
00229	Albany Light & Power Dept.	14.8%
00230	Albany Water, Gas & Light Commission	
00232	Albemarle Electric Distribution System	
00240	Albemarle Electric Membership Corp.	
00241	Albertville Utilities Board	4.9%
00244	Albion Light & Water Plant	
00261	Alcoa Generating Corp.	14.4%
00266	Alpha Electric Dept.	
00276	Alcorn County Electric Power Association	4.9%

Table 10. Distribution of Households from Adams-Columbia Electric Coop

Provider: 7 Adams-Columbia Electric Coop

Households in each county served by utility (1990 estimate)

3046 Adams,WI	3994
3056 Columbia,WI	2375
3058 Dane,WI	866
3059 Dodge,WI	620
3069 Green Lake,WI	278
3084 Marquette,WI	2980
3095 Portage,WI	764
3102 Sauk,WI	373
3115 Waushara,WI	2601
3117 Wood,WI	9681
SUM: Households in each utility	24532

Table 11. Summary Comparison for Wood County, Wisconsin

```
     Titles of Alternate Runs
     Line 1: CSV file for base case
     Line 2: CSV file for 10$/ton case case - difference from base
     (Alternatives are shown in deviations from base values.)

         Non Industry Variables
                                        01|05
 Total employment                       63984
                                          -75
 Personal income                      2537681
                                        13482

         Gross output by industry in constant $
                                        01|05
 1. Farms                              142817
                                         -160
 2. Agr. services, forestry, fisher     37302
                                          -37
 3. Mining                                589
                                           -2
 4. Construction                       194656
                                           48
 5. Manufacturing                     2235808
                                        -2745
 6. Electric utility                    74391
                                       -11777
 7. Trans., Comm, PU Other             869466
                                         -110
 8. Wholesale trade                    194370
                                         -134
 9. Retail trade                       460883
                                          394
10. Finance, insurance & real estat    399781
                                          359
11. Services                          1422273
                                         2052
  TOTAL                               6114358
                                       -12220


         Total employment by industry
                                        01|05
 1. Farms                                1685
                                           -1
 2. Agr. services, forestry, fisher       440
                                            0
 3. Mining                                  3
                                            0
 4. Construction                         3287
                                           -1
 5. Manufacturing                       10589
                                           -9
 6. Electric utility                      167
                                          -26
```

7. Trans., Comm, PU Other	5562
	2
8. Wholesale trade	1769
	0
9. Retail trade	11112
	-71
10. Finance, insurance & real estat	2178
	0
11. Services	22701
	37
TOTAL	63984
	-75

Total earnings by industry

	01|05
1. Farms	23176
	87
2. Agr. services, forestry, fisher	5612
	22
3. Mining	49
	0
4. Construction	136791
	212
5. Manufacturing	567768
	29
6. Electric utility	5626
	-313
7. Trans., Comm, PU Other	203484
	4596
8. Wholesale trade	67190
	320
9. Retail trade	170165
	-251
10. Finance, insurance & real estat	44003
	336
11. Services	768397
	2437
TOTAL	2139348
	7662

Table 12. Utilities Serving Wood County, Wisconsin

Utilities serving: 3117 Wood County, WI			**Calculated Price Increase**
7	Adams-Columbia Electric Coop	9681.0	**14.8%**
544	Clark Electric Coop	8697.0	**9.0%**
631	Consolidated Water Power Co.	2310.0	**10.7%**
1725	Marshfield Electric & Water Dep	7446.0	**13.0%**
2089	Oakdale Electric Coop	598.0	**16.2%**
3146	Wisconsin Power & Light Co.	8497.0	**16.0%**
3149	Wisconsin Rapids Water & Light	6196.0	**13.1%**
3150	Wisconsin River Power Co.	821.9	**0.0%**
SUM:	Households in each utility	44246.9	**12.8%**