Economic Growth Analysis System (EGAS) Version 4.0

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ABSTRACT

The Economic Growth Analysis System (EGAS) is an emissions activity forecast software model that provides State and local governments with an EPA-approved set of emissions activity growth factors. The EGAS was first developed in 1992 and was last updated as Version 3.0 in 1995. This paper describes the updates and revisions that have been made to the model in Version 4.0 and provides some information on the model's strengths and limitations, as well as opportunities for potential model improvements.

INTRODUCTION

Air pollution programs have always depended on predictive models for gaining a better understanding of what emission quantities will be in the future. Model results are used to construct emission trends; assist in the development of air quality plans; determine how and where air pollution can be reduced most efficiently; and track progress toward meeting the requirements of air pollution control mandates. The objective of this project was to update an EPA model that produces emissions growth data for use in projecting emissions. This model, the Economic Growth Analysis System (EGAS), was first developed in 1992 and was last updated in 1995 as Version 3.0. Since 1998, EPA has been funding the development of EGAS Version 4.0. The goals of this update were to revise the current EGAS software to create a tool for future emissions modeling and control strategy analyses that:

- is more user-friendly than EGAS 3.0;
- runs under Windows 95/98/NT; and
- incorporates current economic information, forecasting procedures, and source category lists.

This paper is organized into three main sections. As a way of providing background on EGAS 4.0, the first section provides an overview of Version 3.0. This EGAS 3.0 discussion is followed by a section describing the specific data sources and algorithms utilized to produce emissions growth factors in EGAS 4.0, and a section identifying limitations of the current model, as well as potential future model improvements.

EGAS VERSION 3.0

Version 3.0 of EGAS is a DOS software model with 1990-2015 projections capability.[1] As with Version 4.0, EGAS 3.0 is composed of three tiers: a national economic tier, a regional economic tier, and a growth factor tier. The first tier includes available National economic forecasts. The second tier uses these National forecasts to drive regional economic models. The third tier utilizes the regional economic growth rates projected by the second tier in developing and assigning growth factors to specific emission source categories. The EGAS 3.0 also includes the BEAFAC utility, which provides a

set of Bureau of Economic Analysis (BEA) growth factor data that are completely independent from the EGAS tier structure operations.

Tier 1: The National Economic Tier

The EGAS 3.0 national economic tier includes a Regional Economic Models, Inc. (REMI) model of the United States, which is primarily based on macroeconomic projections from the Bureau of Labor Statistics (BLS). In addition, the EGAS 3.0 national economic tier provides EGAS users with the option to use macroeconomic forecasts from Wharton Econometric Forecasting Associates (WEFA).

The national tier in EGAS 3.0 functions to allow users to forecast urban and regional economic growth using a common assumption about national economic growth. The EGAS 3.0 national tier also provides users with the ability to use the most current national economic forecasts and to simulate the effects of different levels of national growth on emission-producing activity in nonattainment areas. The national economic tier operates the same in EGAS 4.0 as EGAS 3.0.

Tier 2: The Regional Economic Tier

The EGAS 3.0 regional economic tier includes separate economic models for each of the nonattainment areas and attainment portions of States. The largest geographic area covered by an economic model was a State.

The regional economic models included in EGAS 3.0 were built by REMI. The models simulate interaction between the 14 major sectors of an economy and produce estimates of total output for 210 private non-farm BLS sectors. The BLS sectors are closely related to three-digit Standard Industrial Classification (SIC) codes. Outputs from the regional models are used as input data for the growth factor tier of EGAS 3.0. For fuel combustion sectors, for example, REMI forecasts of socioeconomic activity are used as inputs to energy consumption models to project future changes in fuel demand.

The EGAS 3.0 REMI models are designed to forecast future activity in an area and to simulate the effects of a policy change in an area on future activity levels. The models allow the user to simulate the effects of changes in 101 economic policy variables, which are listed in Table 1-3 of the EGAS 3.0 Reference Manual.[1]

The EGAS 4.0 regional economic tier is largely similar to EGAS 3.0 in that the regional economic tier is based on regional economic models developed by REMI. However, the updated models included in EGAS 4.0 have reduced the available number of BLS sectors from 210 to 168. In addition, due to resource constraints, it was necessary to remove the EGAS 3.0 policy change simulation capability from EGAS 4.0.

Tier 3: The Growth Factor Tier

The third tier represents the largest component of EGAS. Housed within the EGAS 3.0 growth factor tier are the commercial, residential, industrial, and electric utility energy models; a VMT module; a physical output module; and a Crosswalk. As identified at the end of this section, several of the EGAS 3.0 energy forecasting approaches were substantially revised in Version 4.0.

The commercial, residential, and industrial energy models in Version 3.0 were modified from models originally developed by Argonne National Laboratories (ANL) for use in the National Acid Precipitation Assessment Program (NAPAP). The residential energy model, the Household Model of

Energy (HOMES), was first developed for use in the NAPAP model set in the mid-1980s. In EGAS 3.0, REMI forecasts of population data for nonattainment areas and attainment portions of States and State-level fuel price forecasts are input to HOMES to develop estimates of residential fuel consumption growth for seven fuels for each of the nonattainment areas and attainment portions of States.

The commercial energy model, the Commercial Sector Energy Model (CSEMS), was also first developed for use in the NAPAP model set in the mid-1980s. The EGAS 3.0 inputs to CSEMS included State-level fuel price forecasts and REMI forecasts of population and personal income at the sub-State level.

The industrial energy model, the Industrial Regional Activity and Energy Demand Model (INRAD), was developed to predict how energy use will be influenced by energy prices and the general level of economic activity. As modified for EGAS 3.0, INRAD estimates coal, oil, gas, and electricity consumption for the following sectors: food, textiles, upstream paper products, downstream paper products, upstream chemicals, downstream chemicals, glass, glass products, and metals. Inputs to INRAD include State-level forecasts of fuel prices and REMI sub-State forecasts of the relative costs of capital, labor, and materials.

Electricity generation by electric utilities is forecast in EGAS 3.0 using the Neural Network Electric Utility Model (EUMOD). EUMOD is a behavioral model which used three embedded neural networks to calculate annual generation activity indices and annual generation resulting from combustion of coal, oil, and natural gas in each of the forty-eight contiguous States. In contrast to traditional electric utility models, EUMOD uses artificial intelligence to learn to relate the amount of electricity generated from data describing generating capacity, climate, peak loads, fuel prices, and power pool effects.

The VMT module projected VMT growth factors for the EGAS 3.0 modeling areas. The first-phase EGAS 3.0 VMT projection method (1990-1996) is based on Federal Aid Urbanized Area Highway Performance Monitoring System (HPMS) data for 1985-1990. The methodology uses regression analysis of these data to establish short-term non-attainment area-level trends in VMT growth. For projections beyond 1996, EGAS 3.0 allocates national VMT growth as projected by the EPA MOBILE4.1 Fuel Consumption Model to individual areas based on population growth projected by the REMI model.

The EGAS 3.0 physical output module relies on total output (sales) data generated by the REMI models. Industrial source categories were ranked by their contributions to industrial VOC emissions and equations were developed for the largest VOC categories. These equations related changes in physical output by BLS sector with changes in total sales and a time trend to capture technological change. These equations provide better estimates of VOC-producing activity than total sales alone because they estimate change in actual material output, which is related to the use of VOC producing materials, such as surface coatings and degreasers. For industrial VOC categories for which equations were not developed, activity levels are forecast using total sales forecasts from the REMI models.

The Crosswalk is the final component of the EGAS 3.0 system. The Crosswalk translates growth factors from the energy, VMT, and physical output modules into growth by Source Classification Code (SCC). The EGAS 3.0 Crosswalk was developed by individually matching each of the approximately 7,000 SCCs in the model with an appropriate growth factor from the Tier 3 modules. This allows different growth factors to be applied to different emission sources from the same industrial category. For example, forecasts of fuel consumption in upstream chemical manufacturing are developed by INRAD, while forecasts of physical output of upstream chemical products are developed in the physical

output module. This methodology accounts for the possibility that future emissions associated with an SIC code will vary by type of emissions process. This is consistent with the SCC system of classification which differentiates according to not only industrial category, but also to processes within that category.

EGAS 3.0 also includes an independent utility, BEAFAC, which is incorporated into the Emissions Preprocessor System. BEAFAC outputs growth factors calculated from State-level BEA economic projections. In EGAS Version 3.0, BEAFAC growth factors are generally based on projections of 2-digit SIC code industry earnings. There are no economic modeling interactions between this utility and the rest of EGAS.

Additional details on EGAS 3.0 are provided in the EGAS 3.0 Reference Manual and User's Guide.[1,2] In EGAS 4.0, the Growth Factor Tier incorporates modules and information that are similar to that included in EGAS 3.0 with the following major exceptions:

1. The commercial, residential, industrial, and electric generation energy models have been replaced with energy forecast data from the U.S. Department of Energy;

2. The VMT module incorporates the availability of new Highway Performance Monitoring System VMT data, updated population forecasts from the REMI models, and a slightly revised approach to developing growth factors based on the second-phase VMT forecasts;

3. The physical output module has been updated to incorporate nonroad growth factors based on growth rates from EPA's draft NONROAD model, and to incorporate new regression equations relating REMI output, population, or gasoline and oil consumption expenditures data with emissions activity data;

4. The Crosswalk module was updated to include new SCCs, and the EGAS 3.0 Crosswalk's SCC-growth indicator matches were reviewed and revised to reflect the revisions made to other EGAS modules (e.g., the use of energy forecasts from the Department of Energy); and

5. The BEAFAC utility was revised to incorporate the latest set of BEA gross State product forecasts and to assign BEA projection categories to the new SCCs included in EGAS 4.0.

The following section presents additional information on the revisions that were made to the EGAS 3.0 Growth Factor Tier in creating EGAS 4.0.

EGAS VERSION 4.0

Because EGAS Version 4.0 uses a base year of 1996, Version 4.0 growth factors are expressed in index form with all 1996 growth factors equal to '1.0'. The updated EGAS now possesses projections capability through the year 2020 (the final year for which economic projections were available from WEFA). The discussion of EGAS 4.0 revisions is organized into the following sections:

- REMI models;
- Physical output module;
- Energy modules;
- VMT module;

- Crosswalk module;
- BEAFAC utility; and
- Windows operating system/User interface

REMI Models

The EPA obtained and incorporated updated REMI economic models into EGAS 4.0.[3] Although these models are similar to the models incorporated in EGAS 3.0, there are a number of substantial differences, which are highlighted below.

The national economic tier of the updated REMI models incorporates a new set of underlying national macroeconomic projections. The updated REMI models are now primarily based on the BLS Employment Outlook: 1996-2006 moderate projections. Between 1996 and 2006, REMI uses a labor-force-trended forecast based on the BLS moderate growth benchmark projections. After 2006, REMI uses the BLS moderate-growth labor force participation rates and the Census Bureau's middle population projections for the United States to forecast the labor force. Once the BLS forecast is extended to 2035, REMI uses the latest short-term national forecast from the University of Michigan's Research Seminar in Quantitative Economics (RSQE) to update the U.S. forecast with current national business cycles.

The geographic definitions included in the EGAS 3.0 REMI models were retained in Version 4.0 except for the addition of three modeling areas in North Carolina. These modeling areas are:

- Raleigh-Durham (Chatham, Durham, Franklin, Johnston, Orange, and Wake counties);

- Charlotte (Cabarrus, Gaston, Iredell, Lincoln, Mecklenburg, Rowan, and Union counties in North Carolina and York county in South Carolina); and

- Greensboro-Winston Salem (Alamance, Davidson, Davie, Forsyth, Guilford, Randolph, Stokes, and Yadkin counties).

Because of the addition of these areas, it was also necessary for EPA to incorporate minor revisions to two additional EGAS 3.0 regions. For EGAS 4.0, the “rest-of-State” modeling area for North Carolina was revised to eliminate the counties included in the three new modeling regions described above and the South Carolina modeling area was reduced by the one county (York) included in the Charlotte modeling region. A complete list of EGAS modeling areas is included in the EGAS Version 4.0 Reference Manual.[4]

Because the REMI models are developed using BLS data, the list of economic sectors included in these models are the same as the sectors included in the BLS projections. EGAS 3.0 incorporated REMI models that included 210 BLS private non-farm sectors. The updated set of BLS projections only includes 168 private non-farm sectors. For some emission sectors, therefore, it was necessary for EGAS 4.0 to use forecasts for a broader industry category than was the case in EGAS 3.0.

EGAS 3.0 included policy simulation forecasting capabilities that are no longer supported in EGAS 4.0. In EGAS 3.0, users could input changes to a predetermined number of policy variables. For example, an EGAS 3.0 user could model the impact that additional future costs (such as air pollution control costs), would have on future emissions growth. Because of resource limitations, it was not possible to implement the necessary program revisions to account for all of the changes that were made to REMI policy variable designations between EGAS 3.0 and EGAS 4.0. It should be noted, however, that there were significant limitations to EGAS 3.0's policy simulation capabilities. In particular, EGAS

3.0 users could only input information at a very aggregate level. For example, pollution costs imposed on the automobile manufacturing sector would have to be input as a cost increase in the durable goods manufacturing sector. Durable goods manufacturing includes many diverse sectors with little or no relationship to automobile manufacturing (e.g., pulp and paper manufacturing).

Physical Output Module

The EPA projections guidance suggests that physical output be used to forecast emission source growth when possible because physical output growth is a better indicator of emissions growth than value added, industrial earnings, or employment.[5] There are two ways that physical output is measured. The first is the direct measure of actual physical output of an industry (e.g., tons of steel). The second method is indirect and is used when direct measures are not available. This second measure is the value of goods produced in a given year. These dollar output values are then translated to dollar outputs for a base year (e.g., 1992) using price deflators developed for each year (the ratios of the price of the output in the current year divided by the price of the output in the base year). The resulting constant dollar output series provides a surrogate measure of changes in physical output.

For most emission sectors, the EGAS 4.0 physical output module computes growth factors from the REMI constant dollar output forecasts. However, as noted above, the best measure of emissions activity growth is a forecast of the change in physical output that is directly related to each source category's emissions activity. (The term "emission activity" refers to emission sectors that employ the same activity indicator to estimate emissions–emission activities include the number of acres of agricultural fields burned, the number of barrels of crude oil refined, and the number of tons of steel produced). For SCC 30700799 (Plywood Operations, Other Not Classified), the activity that directly relates to emissions levels is the number of tons of plywood processed. Because EGAS does not project the level of this emissions activity, EGAS relies on constant dollar output in the Millwork, Plywood, and Structural Members sector as a surrogate indicator of growth in this emissions activity. Because this sector is not specific to plywood manufacturing, and because constant dollar output may not exactly trend with the trend in physical output, the EGAS 4.0 growth factor for this SCC could be improved upon with more specific emissions activity information.

There are two major changes to the EGAS 3.0 physical output module that EPA implemented in developing EGAS 4.0. The first of these changes was to replace the use of the REMI-derived growth factors for nonroad emission sectors with growth factors from EPA's draft NONROAD model. The second major change concerned new regression analyses used to estimate actual physical output-based growth factors. These revisions are discussed in the following two sub-sections.

Nonroad Source Categories

To keep EGAS consistent with the emissions activity growth factors used in the NONROAD model, EPA incorporated the draft NONROAD model growth factors in EGAS 4.0.[6] Because the growth factors in the draft NONROAD model represent national forecasts, these growth factors do not differ by modeling area. It is important to note that EPA's final NONROAD model may incorporate State-level growth factors for nonroad emission sectors. Before using the EGAS 4.0 growth factors for nonroad emission sectors, interested parties should closely review these values for reasonableness given local conditions. It is also important to note that EPA recommends that local areas directly employ the NONROAD model to develop projection year inventories for nonroad source categories because the model incorporates the effects of emission control regulations based on technology penetration forecasts and equipment turnover assumptions.

Regression Analyses

The second major EGAS 4.0 change concerned the estimation of new regression equations relating REMI socioeconomic data with production or other data that are specifically related to source category emissions activities. A number of concerns were identified from a review of the EGAS 3.0 source categories to which regression adjustments applied. In some instances, regression equation coefficients were applied to sectors with unrelated emission activities. For example, the regression coefficients for the plastic products sector were applied to a solvents category (*Miscellaneous Non-Industrial, Consumer, All Products/Process Total All Solvents*) and the same coefficients were applied to dissimilar source categories (e.g., natural gas combustion and oil combustion categories).

In addition to the concern over the application of the previous product output-based coefficients, the selection of source categories for the EGAS 4.0 regression analysis was revisited because the previous set of regression categories solely emphasized VOC-emitting sectors and because the categories considered for regression analysis were identified based on the highest-emitting sectors in a 1985 emissions inventory. For the EGAS 4.0 update, regression analysis categories were identified based on total criteria pollutant annual emissions from the 1996 National Emission Inventory (NEI). For this effort, total criteria pollutant emissions included emissions from VOCs, oxides of nitrogen (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), and particulate matter of 10 microns or less (PM_{10}). The list of regression analysis sectors was identified based on the emission activities representing the highest 1996 total criteria pollutant emissions. The first step in identifying these activities was to sum the 1996 NEI emissions by SCC for SCCs assigned to REMI indicator growth factors in the EGAS 4.0 Crosswalk. These SCCs were then organized into common emission activities. Next, the emission activity-level emissions were computed from the SCC-level emissions in the NEI. Finally, the emission activities were sorted by total emissions to identify candidate emission activities for regression analyses (e.g., tons of basic oxygen furnace steel production).

The regression analyses were conducted using two major data sets. The first, representing historical constant dollar output data, was obtained from REMI's Economic and Demographic Forecasting and Simulation 14-Sector (EDFS-14) models, which provide national output data for 1969-1996 by BLS sector.[3] The second, representing 1970-1992 national emissions activity data were from an emissions activity data base compiled for use in developing early versions of the NEI inventory. Due to SIC code inconsistencies that occurred between 1971 and 1972, only the post-1971 REMI data were utilized in the regression analyses.

For each of the 25 highest criteria pollutant emission categories identified from the NEI, a determination was first made as to whether historical emission activity data were available from the early NEI data base. If data were available, then these data were regressed against REMI model data for variables identified as potential surrogate indicators for that emissions activity. These regression analyses employed the emissions activity data as the dependent variable. In addition to BLS sector constant dollar output, population, and gasoline and oil consumption expenditures were included as potential explanatory variables in the regression analyses. Because long-term historical data were not available for some emission activities, and the results of the regression analyses were not statistically significant for three emission activities (Aluminum Production-Prebaked, Carbon Black Production-Oil Furnace Process, and Beef Cattle Feedlots), regression coefficients are included in the EGAS 4.0 physical output module for a subset of the 25 highest emission activities. The emission activities for which regression coefficients are incorporated into EGAS 4.0, account for approximately 36 percent of the criteria pollutant emissions covered by the physical output module. The EGAS 4.0 Reference Manual identifies the SCCs which use the regression-based approach for estimating emissions activity growth.[4]

Energy Modules

Argonne National Laboratories (ANL) developed three of the four energy models used in earlier versions of EGAS (CSEMS, HOMES, and INRAD). These energy models were derived from models that had previously been developed by the U.S. Department of Energy's Energy Information Administration (EIA). In discussing potential updates to the EGAS 3.0 versions of these models, ANL raised concerns with the validity of the EGAS 3.0 energy model algorithms because key model parameters were specified using pre-1990 data. Given the changes in energy markets that have occurred since this time and the refinements to energy modeling that have taken place, ANL staff recommended that the EGAS energy models should be replaced with more recently developed models and data.

A review was conducted of energy models for potential use in this effort. A number of options were identified from this review, including incorporation of alternative energy models such as EIA's latest forecasting models, however, resource constraints precluded implementing this option. Instead, EGAS 4.0 directly incorporates EIA energy consumption forecasts from "Annual Energy Outlook 1999" into EGAS 4.0.[7] The EIA projections are based on more up-to-date economic forecasts, energy efficiency requirements, and technology information than the energy models included in EGAS 3.0. The EIA data also provide forecasts for additional fuel types not included in EGAS 3.0, but do not provide the level of geographic detail provided by the EGAS 3.0 energy models. For most energy sectors, the EIA's projections are only available for Census Divisions (set of States). For specific industry-level fuel projections (e.g., distillate fuel use by the chemical manufacturing industry) and some minor electric utility fuel types (e.g., geothermal), EIA's projections are only available at the National level.

Although the EGAS 3.0 electric utility fuel combustion module (EUMOD) was not developed by ANL, for consistency with the other energy modules, EPA also incorporated the EIA's "Annual Energy Outlook 1999" projections data as the basis for electric utility sector emissions growth factors. The EGAS Reference Manual identifies the sector, fuel type, and geographic level of the EIA data that are linked to SCCs in the EGAS 4.0 Crosswalk.[4]

VMT Module

The VMT module in EGAS 4.0 was updated based on the availability of new HPMS VMT data and updated population forecasts from the REMI models. The first-phase EGAS 4.0 VMT projections approach projects near-term VMT (1997-2002) based on a time-series linear regression analysis of historical EGAS modeling region VMT data. The equations employed in this first-phase approach are as follows:

$$VMT_{ij} = Constant + (Trend \times Year) \qquad \text{(Equation 1)}$$

and

$$Growth_{i,j} = VMT_{i,j} / VMT_{i,1990} \qquad \text{(Equation 2)}$$

where:

i	=	EGAS area
j	=	year (1997-2002)
Constant	=	regression constant
Trend	=	regression x-coefficient

For this effort, EPA employed county-level 1984-1997 HPMS VMT data that were used in developing EPA's NEI inventory. The EPA aggregated these data by EGAS modeling area and then performed time-series regression analyses on each area's data. The regression coefficients from these analyses were then used in forecasting near-term VMT for each EGAS modeling region.

For the second-phase VMT forecasting approach, which is used to develop 2003-2020 growth factors, EGAS 4.0 employs a slightly revised method from the one used in EGAS 3.0. As under EGAS 3.0, Version 4.0 adjusts National VMT projections from EPA's MOBILE4.1 Highway Fuel Consumption Model based on the projected relative population growth rate in each EGAS modeling region to the National population growth rate. Equation 4-3 displays the equation used in developing EGAS modeling area VMT estimates. In developing the VMT estimates from this method, EGAS 4.0 uses REMI's updated population projections.

$$VMT_{i,j} \text{ ' } (VMT_{US,j})VMT_{US,1996}) \times (POP_{i,j})POP_{i,1996}) \text{) } (POP_{US,j})POP_{US,1996}) \qquad \text{(Equation 3)}$$

where:

i = EGAS area
j = year (2002 - 2020)

Unlike EGAS 3.0, however, the second-phase approach computes VMT estimates beginning with the final year of the first-phase approach (in this case, 2002). The reason for this change is that EGAS 4.0 does not directly use the VMT growth estimates from the second approach identified in equation 4-3, but rather uses these estimates as an intermediate step. The purpose of this Version 4.0 revision is to eliminate the data disconnect that occurs under EGAS 3.0 between the final year of the first-phase approach and the first year of the second-phase approach. Under EGAS 4.0, the second-phase 2002 VMT estimate is used to compute VMT ratios that are applied to the first-phase VMT estimate for 2002. Therefore, post-2003 VMT growth factors are developed in EGAS 4.0 by applying the VMT ratios from the second-phase VMT forecasts to the first-phase 2002 VMT growth factors.

Crosswalk Module

A number of significant changes were made to develop the EGAS 4.0 Crosswalk module. First, a new comprehensive list of SCCs was used to identify SCCs that had not been included in EGAS 3.0. Based on this list, approximately 2,600 new SCCs were incorporated into the Version 4.0 Crosswalk. These SCCs are either maximum achievable control technology (MACT) source categories (e.g., SCC 62540001–MACT Source Categories, Food and Agricultural Processes, Cellulose Food Casing Manufacture, Cellulose Food Casing), SCCs that are more detailed than the general SCCs that are currently included in EGAS Version 3.0 (e.g., SCC 2801500111–Miscellaneous Area Sources, Agriculture Production, Crops, Agricultural Field Burning, Field Crop is Alfalfa: Headfire Burning); or SCCs that represent completely new source categories (e.g., SCC 31401503–Industrial Processes, Transportation Equipment, Boat Manufacturing, Resin Storage). For this effort, the Crosswalk was updated so that these new SCCs are matched to growth indicators developed by one of the other EGAS modules.

In addition, the EGAS 3.0 Crosswalk's SCC-growth indicator matches were reviewed and revised to incorporate the reduction in BLS sector detail available from the new REMI models and revisions to other EGAS modules (e.g., the use of EIA energy demand forecasts). These efforts resulted in a substantial reduction in the number of SCCs for which EGAS employs a no growth assumption. In EGAS 3.0, more than 350 of the approximately 7,300 SCCs were assigned a no growth assumption.

Many of these were assigned this assumption not because emissions growth was unlikely, but because no specific growth factor for that emissions sector was available from EGAS 3.0. For EGAS 4.0, only SCCs for which no emissions growth seems valid (e.g, SCC 2701200000-Natural Sources, Biogenic, Vegetation) employ this assumption. The EGAS Reference Manual presents the Crosswalk developed for EGAS 4.0.[4]

BEAFAC Utility

In addition to the above revisions, EPA updated the BEAFAC utility, which develops SCC and SIC code-level growth factors from the BEA's regional projections series. These factors are provided in EGAS as an alternative growth factor data set.

The BEA published their latest set of regional projections data in 1995.[8] There are no plans to update these projections in future years. The BEA projections series included in EGAS 3.0 provided forecasts for 1995, 2000, 2005, 2010, 2020, and 2040. As part of BEAFAC, EGAS Version 3.0 incorporated 1991-2015 growth factors developed from BEA's earnings projections. The final set of BEA projections, released in 1995, provide forecasts for the years 1998, 2000, 2005, 2010, 2015, 2025, and 2045. In addition to the earnings data provided in the previous set of BEA projections, this final projections series includes GSP (value added) projections by industry and State. For EGAS 4.0, point and area source growth factors were developed for 1997-2020 based on linear interpolation of the BEA value added data. The value added data were used because the EPA projections guidance states that value added data are preferred over earnings data in projecting emissions.[5] Because of the addition of 2,600 SCCs, it was necessary to assign BEA projection categories to a number of new SCCs. Also, the previous BEAFAC did not include a complete set of projections data for the District of Columbia; BEAFAC was updated to include the BEA forecast data for the District of Columbia.

Although the BEA series provides an EPA-approved source of projections data, EPA suggests that EGAS 4.0 growth factors are preferable. The reasons for this recommendation are:

1) EGAS 4.0 growth factors provide additional geographic precision beyond the State-level BEA factors;

2) EGAS 4.0 growth factors are based on more current economic data and forecasts;

3) EGAS 4.0 growth factors provide more industry precision compared to the BEA factors; and

4) EGAS 4.0 growth factors incorporate emission sector-specific phenomena, such as energy efficiency improvements and the relationship between economic output and emissions activity changes, which the BEA's economic projections do not.

Windows Operating System/User Interface

Version 3.0 of EGAS was developed to run under MS-DOS. As part of the EGAS 4.0 update, the program was converted to run under Windows 95/98/NT. In addition, a new user interface was incorporated to make the model option selections more intuitive, and to provide a processing status screen that indicates model run elapsed time. The user interface is described in the EGAS 4.0 User's Guide.[9]

CONCLUSIONS

The EGAS 4.0 update met the project's objectives by integrating current economic information, forecasting procedures, and source category lists into the model, and by incorporating a more user-friendly interface and Windows 95/98/NT compatibility. The major strength of EGAS is its comprehensiveness, a quality which has been significantly enhanced with the Version 4.0 revision through the addition of 2,600 SCCs and the assignment of growth indicators to many EGAS 3.0 "no growth" assumption SCCs. When combined with resource constraints, however, this comprehensiveness results in EGAS forecasting approach limitations. For example, only a small number of physical output module source categories utilize the regression analysis-based forecasting approach. The vast majority of the source categories in EGAS are assigned constant dollar output data as the emissions growth indicator. The EGAS growth factors will be less representative to the extent that these economic data do not reflect trends in specific emissions activities.

Given this limitation, State and local governments are encouraged to review the EGAS growth factors for reasonableness given any additional information that they may have. This step will have particular importance for the most significant emission sources in a local area. For these sources, the EGAS growth factors are best viewed as the "starting point" in a process that should involve research into the most detailed forecast data that are available and the most sophisticated forecasting approaches that are feasible.

There are a number of areas for future improvements to the model. First, to ensure that the EGAS growth forecasts are based on the most up-to-date economic conditions, it will be important to incorporate more recent economic models and forecasts into the system as they become available. Second, the geographic scope of emissions modeling is likely to change in the future as revisions to nonattainment areas designations are made. As these changes are adopted, a review of the modeling areas in EGAS should be undertaken to determine how best to address future modeling needs. Third, economic data sources are transitioning away from the SIC system and to the use of a new classification system–the North American Industry Classification System (NAICS). It will become important to provide NAICS-output capability in future versions of EGAS as future point source inventories transition to the NAICS codes. And finally, it would be useful to periodically review the Tier 3 growth factor algorithms to identify modules/source categories to be targeted for potential improvements. Such improvements may include the use of regression analysis-based forecasting approaches for additional source categories.

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