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# Three Scenarios for Electric and Hybrid Vehicle Commercialization

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# THREE SCENARIOS FOR ELECTRIC AND HYBRID VEHICLE COMMERCIALIZATION

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ABSTRACT

Three electric and hybrid vehicle (EHV) market-penetration scenarios are developed for 1995, 2000, 2005, and 2010. The first scenario is intended to maximize the substitution of electricity for gasoline in the 101 metropolitan areas of the U.S. that are nonattai nment areas for ozone; by 2010, 12 million EHVS are projected to be operating in those areas. The second scenario focuses on the nine metropolitan areas with the worst ozone problems and projects six million electric vehicles in the nine areas by 2010. The third scenario, like the first, projects 12 million EHVs in operation by 2010 but distributes the vehicles to all metropolitan statistical areas. The vehicles are distributed to the metropolitan areas as a function of area population and off-peak marginal cost of electricity for the local power pool. The scenarios contain several different EHV cars, vans, and trucks (differences include battery type, a.c. or d.c. drive, and hybrid or straight electric mode). Daily electricity consumption is calculated for each metropolitan area for the country by scenario year.

## 1 INTRODUCTION

Two scenarios for market penetration by alternative-fuel vehicles are being developed as part of the U.S. Department of Energy's ongoing assessment of the costs and benefits of developing a flexible- and alternative-fuel transportation system in the U.S. The three fuels with the most potential to be used as neat or neat-neat fuels and to be introduced in the 1990s are methanol, compressed natural gas (CNG), and electricity. Prior studies in the U.S. Department of Energy (DOE) assessment have indicated the most likely vehicle markets for each of these fuels.[1-5] For example, second cars in multicar households have been identified as a likely market for battery-powered vehicles. The scenarios under development draw from these studies to estimate potential penetration by each alternative-fuel vehicle in each scenario, given two distinctly different scenario objectives. This paper describes electric and hybrid vehicle (EHV) penetration in the two scenarios, as well as in a third scenario that is not constrained to the specifics of the DOE study. (This third scenario is described in Sec. 4 of this document.)

The first scenario, the "energy security" scenario, focuses on the potential energy security benefits of displacing a significant amount of oil. Alternative-fuel vehicles, including methanol vehicles, CNG vehicles, and EHVS, are introduced in sufficient numbers to displace a total of one million barrels of petroleum per day. This displacement level could affect world oil prices significantly. The vehicles are generally expected to be dual-fuel (i.e., able to operate on either an alternative fuel or conventional fuels), which allows their distribution and use throughout the U.S. EHVs are considered most likely to penetrate the market in areas that can also take advantage of their significant vehicle emission-reduction benefits. Thus, in this scenario, they are assumed to be introduced into the 101 metropolitan regions -- CMSAs, MSAS not in CMSAs, and some countries (mainly in Maine and Kentucky)" -- that are nonattainment areas for ozone. This scenario is also referred to as the "101-city" scenario.

The second scenario, the "environmental" scenario, is motivated solely by environments 1 concerns. Alternative-fuel vehicles, including EVS, are assumed to be required in the nine metropolitan regions with the worst ozone air-quality problems (as in the President's proposed Clean Air Act Amendments of June 1989) or preferentially marketed in these areas. The nine metropolitan regions comprise the Hartford CMSA, New York CMSA, Baltimore MSA, Philadelphia CMSA, Chicago CMSA, Milwaukee CMSA, Houston CMSA, Los Angeles CMSA, and San Diego MSA. This scenario is also called the "nine-cities" scenario. The vehicles are assumed to be dedicated (as opposed to dual-fuel) vehicles in order to maximize their environmental benefit. The schedule for introduction is based on the assumption that the rate of alternative-fuel vehicle introduction is essentially consistent with that proposed in the President's program: 0.5 million "clean fuel" vehicles in 1995, 0.75 million in 1996, and 1.0 million each year thereafter through 2004. Sales of at least 1.0 million "clean fuel" vehicles per year are expected to continue in subsequent years.

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"An MSA (metropolitan statistical area) is a geographical area that includes the named city and economically connected countries in one or more adjacent states. CMSAS (C for consolidated) include all adjacent MSAs.

## 2 TOTAL MARKET PENETRATION

Hamilton analyzed potential markets for EHVS in a study he conducted for the DOE assessment.[1] He concluded that, on the basis of the performance and recharging requirements of EHVS, 45% of all light-duty vehicles (LDVS) could be EHVs, if cost were not a consideration. EHVS could be used by fleets made up of vehicles with range requirements no greater than 80 miles, assuming the vehicles are parked overnight on company premises. Moreover, EHVS maybe used by households with off-street parking and (for EVS only) households with a conventionally fueled vehicle (CV) available for long trips.

Given this sizeable potential market and assuming that EHVS are economically competitive with CVS and/or that policies are in place to foster or require the use of EHVS, EHV market penetration by 2010 is expected to be constrained largely by the rate at which vehicle (mainly battery) production facilities can be built and put into operation. The emergence of volume EHV manufacturing will take time. In his report, Hamilton developed a scenario for EHV production through 2000. This scenario, reproduced in modified form in Table 1, constitutes a hypothetical schedule for completing the development and demonstration of projected EHV technology and for establishing the facilities required to produce these EHVS in volume (e.g., new battery plants, powertrain factories, and vehicle assembly lines). Here, Hamilton's scenario has been adapted to form the basis of the energy security and environmental EHV market-penetration scenarios.

The major modifications made to Hamilton's scenario were as follows: we assumed that production will start four years later than Hamilton assumed; we extended production six years, to 2010; and we added a longer-range "advanced battery" electric car. Currently announced plans for EV production in the next few years are more modest than Hamilton's projections, and there are no announced plans for the production of HVS. For these reasons, we delayed the time frame of Hamilton's projections by four years. Modest EV production expected in the next few years will have little impact by 1995. Hamilton's projections were also extended to the year 2010, because that year is the focal point of the estimates of market penetration for all three alternative-fuel vehicles.

The most important factor determining the EHV production scenarios is how quickly battery technology evolves from the current lead-acid battery to more advanced batteries. The assumptions regarding rate of battery introduction are important because the more advanced batteries allow for greater vehicle range. Greater range makes the EV more acceptable to the market and increases its utilization. Hamilton's original scenario assumed the introduction of nickel-iron batteries by 1990. This was optimistic, and we have revised the projected schedule to assume production by 1995. Hamilton's scenario did not include production of more advanced batteries than the nickel-iron. In both the energy security and the environmental scenarios, a more advanced battery (with a range of as much as 200 mi) is assumed to be introduced in the 2000-plus time frame.

TABLE 1 Hamilton's Scenario for Production of Electric and Hybrid Vehicles (thousands of vehicles sales)

| Year | Electric: Direct Current I%/Acid, Van | Electric: Direct Current Ni-Fe, Van | Electric: Alternating Current Ni-Fe Van | Electric: Alternating Current Ni-Fe Truck | Electric: Alternating Current Ni-Fe Car | Hybrid (alternating current Ni-Fe) Van | Hybrid (alternating current Ni-Fe) Truck | Hybrid (alternating current Ni-Fe) Car |
|---|---|---|---|---|---|---|---|---|
| 1988 | 0.1 | | | | | | | |
| 1989 | 1 | | | | | | | |
| 1990 | 1 | 0.1 | | | | | | |
| 1991 | 1 | 1 | | | | | | |
| 1992 | | 1.0 | 1 | | | | | |
| 1993 | | 1.0 | 50 | | | | | |
| 1994 | | | 50 | 100 | | 1 | | |
| 1995 | | | 50 | 10(-I | 100 | 10 | | |
| 1996 | | | 50 | 100 | 100 | 100 | | |
| 1997 | | | 50 | 100 | 10CI | 100 | 100 | |
| 1998 | | | 50 | 100 | 100 | 100 | 100 | 100 |
| 1999 | | | 50 | 100 | 100 | 100 | 100 | 200 |
| 2000 | | | 50 | 100 | 100 | 100 | 100 | 400 |

No assumption about the specific battery type was made because a variety of battery types may be able to achieve this range.

A production-constrained schedule, incorporating all the above modifications to Hamilton's scenario, was first developed for the energy security scenario. In this scenario, specified in Table A.1 in the appendix, nearly 12 million EHVS will be in operation in the year 2010. Six million will be EVS, half of which will be powered by nickel-iron batteries and half by advanced batteries, and another six million will be HVS. The same six million EVS are assumed to be in operation by 2010 in the environmental scenario, although their production schedule is slightly different than that of the energy security scenario (see appendix, Table A.2). Both scenarios include the assumption that total production increases each year to 2010. Sales of EVS level off by 2010 in the energy security scenario, but an increase in total EHV sales occurs because of the increase in

HV sales. EV sales in the environmental scenario are “smoothed” in order to maintain the assumption of increased total production each year.

The number of EHVS in these scenarios is small relative to the potential vehicle applications Hamilton projects could be converted. to EHVS: 93 million in 2000. Even limiting penetration to the nine worst ozone nonattainment areas, it appears that sufficient markets exist so that the EHV market penetration projected here will not be constrained by a total market limit. The nine areas contain approximately 22% of the U.S. population and can be assumed to account for approximately the same proportion of total vehicles.

# 3 REGIONAL MARKET PENETRATION

The national totals derived in Sec. 2 are distributed regionally in the scenarios. It is assumed that, all other things being equal, the price of off-peak electricity will determine the number of EHVS per capita in each metropolitan area. Given appropriate load-management rates or devices, EHVS are expected to be recharged during the evening hours ("off-peak"). Most off-peak power is generated by coal and nuclear power plants, since these units have the lowest marginal costs (operating, maintenance, and fuel costs). In general, nuclear plants have much lower marginal costs than coal plants. Distributing the EHVS using off-peak marginal costs thus means distributing relatively more EHVS to those areas with nuclear power, in turn, would assist with the achievement of the environmental goal of reduced urban ozone.

Table A.3 in the appendix presents, for each of the 101 ozone nonattainment areas, its local utility, the power pool in which the utility participates, and the lowest and highest off-peak marginal costs of the power pool and marginal plant's fuel types. The nine metropolitan regions of the environmental scenario are a subset of the 101 metropolitan regions. Current marginal costs may not be valid by 2010, especially for cities with a significant number of EHVS charging at night. However, current costs are used in this analysis because of the lack of estimates of future marginal costs in these areas.

Tables A.4 and A.5 in the appendix list the distributions of EHVS to the 101 cities and EVS to the nine cities, respectively (i.e, the regional market penetration scenarios). The distribution from the production scenarios to the cities in each year is linearly proportioned as follows:

$$N_{mt} = POP_m \times MCF_m \times MF_t$$

where:

$N_{mt}$ = the number of EVS or EHVS in metropolitan area m and year t;
$POP_m$ = the 1987 population of metropolitan area m;
$MCF_m$ = the marginal cost factor for metropolitan area m's utility, calculated as the ratio of the average off-peak marginal cost for all utilities represented in the table divided by the average off-peak marginal cost of the utility serving m; and
$MF_t$ = the mapping factor, which for year t maps the national EHV fleet onto each $POP_m$.

The factor $MCF_m$ is proportional to the inverse of the local utility's off-peak marginal cost, so a lower marginal cost means proportionally more EHVs. The utility's off-peak marginal cost is the average of the 1988 high and low values listed in Table A.3. Neither urban population nor utility marginal costs are forecast for future years in the scenarios. The implied assumption, because these two parameters are used as scaling factors, is that the values of these factors will change but that they will remain proportionally the same relative to each other (i.e., utility marginal costs will all change in proportion to each other, as will urban populations).

Table A.6 in the appendix presents estimates of weekday electricity consumption by EHVS for both the energy security and the environmental scenarios. The estimate of daily electricity use by EHVS of each battery type is based on Hamilton's analysis of daily travel and EHV recharge requirements. The energy security scenario is projected to use approximate y 250 GWh per average weekday, while the environmental scenario is projected to use near] y 120 GWh per weekday. Because fleet vehicles are operated more on weekdays, electricity use on an average day [weekday and weekend included] would be lower, 220 GWh/d and 112 GWh/d, respectively. In the energy security scenario, EHVS will displace approximately 280,000 barrels of petroleum per day (bbl/d), and in the environmental scenario they will displace 160,000 bbl /d.

Tables A.4 and A.5 present the total electricity demand by city to charge these vehicles. The power required from one utility by 2000 can be substantial, particularly in the nine-city environmental scenario. However, it is expected that the power will be provided by the power pool.

# 4 THE ALL-CITY SCENARIO

A third scenario developed in the course of the present study is based on the assumptions of the 101-city (energy-security) scenario, except that all CMSAS and all MSAS not in CMSAs are used. This "all-city" scenario was developed because many cities in the Southeast and in the upper tiers of states west of the Great Lakes are attainment areas for ozone; thus, they are not in the 101-city scenario and are not EHV markets. The several counties included in the 101-city scenario that are not MSAS are not in this all-city scenario. The net change in number of "cities" between the two scenarios is 46.

The total 1978 population in the 101-city scenario is 135 million, while for the all-city scenario it is 162 million; thus, no large difference in EHV penetration exists for the cities in both scenarios. The main difference between the two scenarios is that the EHVS are distributed over somewhat different sets of cities (see Table A.7 in the appendix). Since both scenarios have the same number and mix of EHVS in each year, tota electricity consumption is the same in each year.

## 5 CONCLUSIONS

One may ask whether the scenarios developed here are reasonable. Figures 1 and 2 show EHV sales and fleets by year for both the energy security and the environmental scenarios (and the distribution of EVs to the nine cities of the environmental scenario). One test for reasonableness is 10 compare these scenarios with the introduction of new automotive product lines in the recent past. The now quite popular minivan may furnish a good comparison.

As Table 2 shows, about 150,000 m inivans were sold in 1984. In four years, that number i ncreased to 850,000. In 1999, in both scena rim, more than 150,000 EHVs/EVs are projected to be sold. Over the next four years, EHV sales are projected to be slower than the minivan sales: 545,000 by 2003 in the 101-city scenario and 270,000 in the nine-city scenario. T'bus, the production scenarios shown here are realizable by the automotive industry, if sufficient economic incentives exist.

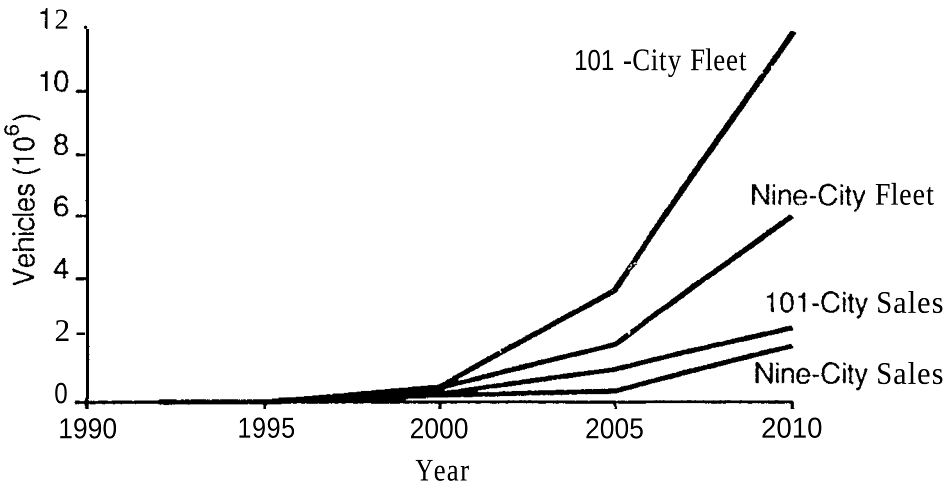


FIGURE 1 101-City and Nine-City Electric anti Hybrid Vehicle Fleet and Sales

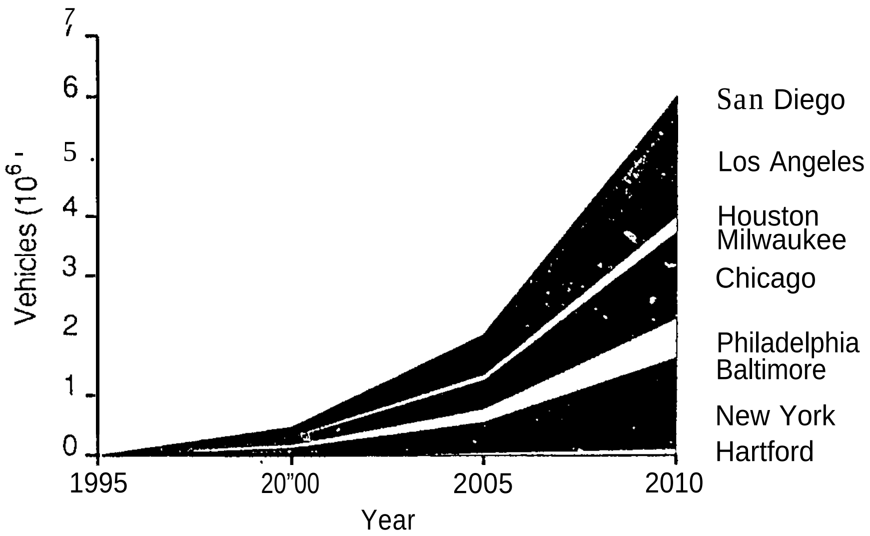


FIGURE 2 Electric Vehicle Fleet Distribution by the Nine Cities

TABLE 2 Comparison of Projected Electric and Hybrid Vehicle Sales with Recent Minivan Sales (thousands of vehicles)

| Minivans | | Electric and Hybrid Vehicles | | |
|---|---|---|---|---|
| | | | Sales | |
| Year | Sales | Year | 101-City | Nine-City[a] |
| 1984 | 147 | 1999 | 151 | 175 |
| 1985 | 341 | 2000 | 260 | 200 |
| 1980 | 543 | 2001 | 350 | 250 |
| 1987 | 628 | 2002 | 450 | 250 |
| 1988 | 851 | 2003 | 545 | 270 |

[a] EVs only.

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APPENDIX:

**Scenario** Details

TABLE **A.1** 101-City Electric and Hybrid Vehicle Sales and Fleet

| | Thousands of EHVS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | EV (d.c.) | | EV (a.c.) | | | HV | | | | | |
| Year | Pb-A, Van | NiFe, Van | NiFe, Van | NiFe, Truck | NiFe, Car | NiFe, Van | NiFe, Truck | NiFe, Car | EV Car, Adv. Batt | Net New EHVS | EHV Fleet Total |
| 1992 | 0.1 | | | | | | | | | 0.1 | 0.1 |
| 1$93 | 1 | | | | | | | | | 1 | 1.1 |
| 1994 | 1 | | | | | | | | | 1 | 2.1 |
| 1995 | 1 | 0.1 | | | | | | | | 1.1 | 3.2 |
| 1996 | 1 | 1 | | | | | | | | 2 | 5.2 |
| 1$97 | | 10 | 1 | | | | | | | 11 | 16.2 |
| 1998 | | 10 | 50 | | | | | | | 60 | 76.2 |
| 1999 | | | 50 | 100 | | 1 | | | | 151 | 227.2 |
| 2000 | | | 50 | 100 | 100 | 10 | | | | 260 | 487.2 |
| 2001 | -0.5 | | 50 | 100 | 100 | 100 | | | | 349.5 | 836.7 |
| 2002 | -0.5 | | 50 | 100 | 100 | 100 | 100 | | | 449.5 | 1286.2 |
| 2003 | -0.5 | -5 | 50 | 100 | 100 | 100 | 100 | 100 | | 544.5 | 1830.7 |
| 2004 | -0.5 | -5 | 50 | 100 | 200 | 100 | 100 | 200 | | 744,5 | 2575.2 |
| | -0.5 | -5 | 50 | 100 | 200 | 100 | 100 | 400 | 100 | 1044.5 | 3619.7 |
| 2006 | -0.5 | -5 | 50 | 50 | 200 | 100 | 100 | 400 | 200 | 1094.5 | 4714.2 |
| 2007 | -0.5 | -1.1 | 0 | 0 | 200 | 100 | 100 | 400 | 400 | 1198.4 | 5912.6 |
| 2008 | -0.3 | | -50 | -50 | 400 | 100 | 200 | 600 | 600 | 1799.7 | 7712.3 |
| 2009 | -0.3 | | -50 | -100 | 400 | 200 | 200 | 699 | 800 | 2049.7 | 9762 |
| 2010 | | | -50 | -200 | 200 | 200 | 200 | 800 | 1000 | 2150 | 11912 |
| Total | 0 | 0 | 301 | 400 | 2200 | 1211 | 12(XI | 3500 | 3100 | 11912 | |

TABLE A.2 Nine-City Electric Vehicle Sales and Fleet

| | Thousands of EVS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | EV (d.c.) | | EV (a.c.) | | | | | |
| Year | Pb-A, Van | NiFe, Van | NiFe, Van | NiFe, Tmck | NiFe, Car | EV Car, Adv. Batt | Net New EVS | EV Fleet Total |
| 1992 | 0.1 | | | | | | 0.1 | 0.1 |
| 1993 | 1 | | | | | | 1 | 1.1 |
| 1994 | 1 | | | | | | 1 | 2.1 |
| 1995 | 1 | 0.1 | | | | | 1.1 | 3.2 |
| 1996 | 1 | 1 | | | | | 2 | 5.2 |
| 1997 | | 10 | 1 | | | | 11 | 16.2 |
| 1998 | | 10 | 50 | | | | 60 | 76.2 |
| 1999 | | | 50 | 75 | 50 | | 175 | 251.2 |
| 2000 | | | 50 | 100 | 50 | | 200 | 451.2 |
| 2001 | -0.5 | | 50 | 100 | 100 | | 249.5 | 700.7 |
| 2002 | -0.5 | | 50 | 100 | 100 | | 249.5 | 950.2 |
| 2003 | -0.5 | -5 | 50 | 100 | 125 | | 269.5 | 1219.7 |
| 2004 | -0.5 | -5 | 50 | 125 | 125 | | 294.5 | 1514.2 |
| 2005 | -0.5 | -5 | 50 | 75 | 125 | 100 | 344.5 | 1858.7 |
| 2006 | -0.5 | -5 | 50 | 75 | 125 | 150 | 394.5 | 2253.2 |
| 2007 | -0.5 | -1.1 | 0 | 0 | 200 | 250 | 448.4 | 2701.6 |
| 008 | -0.3 | | -50 | -50 | 300 | 500 | 699.7 | 3-401.3 |
| 2009 | -0.3 | | -50 | -1oo | 400 | 800 | 1049.7 | 4451 |
| 2010 | | | -50 | -200 | 500 | 1300 | 1550 | 6001 |
| Total | 0 | 0 | 301 | 400 | 2200 | 3100 | 6001 | |

TABLE A.3 101-City Utility, Power Pool, Marginal Off-Peak Cost, and Marginal Off-Peak Plant Type

| | | | | Annual Off-Peak Marginal Cost of Electricity | | | |
|---|---|---|---|---|---|---|---|
| | | | | Law | | High | |
| Metropolitan Area | utility | NERC Code | Pool # | mils/kWh | Type Of Generation[a] | mils/kWh | Type of Generation* |
| Anderson, S.C., (Clemson, S.C.) | Duke Power Co. | SERC | 19 | 7.534 | (1) | 7.687 | (1) |
| Atlanta, Ga. | Georgia Power Co. | SERC | 17 | 18.631 | (2) | 18.631 | (2) |
| Birmingham, Ala. | Alabama Power Co. | SERC | 17 | 18.631 | (2) | 18.631 | (2) |
| Charlotte-Gastonia-Rock Hill, N.C. | Duke Power Co. | SERC | 19 | 7.534 | (1) | 7.534 | (1) |
| Columbia, S.C. | South Carolina Elec. & Gas Co. | SERC | 19 | 7.534 | (1) | 7.534 | (1) |
| Edmonson County, Ky. (Bowling Green) | Bowling Green, City of | SERC | 18 | 7.586 | (1) | 7.586 | (1) |
| Fayetteville, N.C. | Fayetteville, City of | SERC | 19 | 7.534 | (1) | 7.534 | (1) |
| Greensboro-Winston Salem-High Point, N.C. | Duke Power Co. | SERC | 19 | 7.534 | (1) | 7.534 | (1) |
| Greenville-Spartenburg, S.C. | Duke Power Co. | SERC | 19 | 7.534 | (1) | 7.534 | (1) |
| Huntsville, Ala. | Huntsville, City of | SERC | 18 | 7s86 | (1) | 7.586 | (1 |
| Jacksonville, Fla. | Jacks. nville, City of | SERC | 19 | 7.534 | (1) | 7.534 | (1) |
| Knoxville, Term. | Knoxville, City of | SERC | 18 | 7s86 | (1) | 7.5% | (1) |
| Livingston County, Ky. (Paducah) | Pad.cab, City of | SERC | 18 | 7s86 | (1) | 7.%6 | (1) |
| Lexington-Fayette, Ky | Kentucky Utilities Co. | ECAR | 32 | 16.185 | (2) | 16.185 | (2) |
| Louisville, Ky.-Ind. | Louisville Gas & Electric Co. | ECAR | 32 | 16.185 | (2) | 16.185 | (2) |
| Memphis, Term.-Ark.-Miss | Memphis, City of | SERC | 18 | 7,586 | (1) | 7S86 | (1) |
| Miami CMSA | Florida Power & Light Co. | SERC | 16 | 22.919 | (2) | 23.74 | (2) |
| Montgomery, Ala. | Alabama Power Co. | SERC | 17 | 18.631 | (2) | 18.631 | (2) |
| Nashville, Term. | Nashville, City of | SERC | 18 | 7.586 | (1) | 7.5a6 | (1) |
| Owensboro, Ky. (adj. Hancock County) | Owensboro, City of | ECA R | 32 | 16.185 | (2) | 16.185 | (2) |
| Raleigh-Durham, N.C. | Carolina Power & Light Co. | SERC | 19 | 7.534 | (1) | 7.534 | (1) |
| Tampa-St. Petersburg-Clea rwater, Fla. | Tampa Electric Co. | SERC | 16 | 22.919 | (2) | 23.74 | (2) |
| Canton, Ohio | Ohio Power Co. | ECAR | 1 | 18.687 | (2) | 18.6$7 | (2) |
| Chicago CMSA | Commonwealth Edison Co. | MAIN | 8 | 7.709 | (1) | 7.709 | (1) |
| Cincinnati CMSA | Cincinnati Gas & Electric Co. | ECAR | 31 | 19.666 | (2) | 19.666 | (2) |
| Cleveland CMSA | Cleveland Elec. illuminating Co. | ECAR | 2 | 15,53 | (2) | 15.53 | (2) |
| Columbus, Ohio | Columbus Southern Power Co. | ECAR | 1 | 18.687 | (2) | 18.687 | (2) |
| Dayton-Springfield, Ohio | Dayton Power & Light Co. | ECAR | 31 | 19.666 | (2) | 19.666 | (2) |
| Detroit CMSA | Det roi t Edison Co. | ECA R | 4 | 20.259 | (2) | 20.259 | (2) |
| Grand Rapids, Mich. | Consumers Power Co. | ECA R | 4 | 20.259 | (2) | 20.259 | (2) |
| Indianapolis, Ind. | Indianapolis Power & Light Co | ECA R | 33 | 16.17 | (2) | 1617 | (2) |
| Kewaunee County, Wis. | Wisconsin Public service Co. | MAIN | 11 | 17,%'5 | (2) | 17.995 | (2) |
| Lafayette-West Lafayette, Ind. | Public Service Co. of Indiana | ECAR | 33 | 16.17 | (2) | 16.17 | (2) |
| Milwaukee CMSA | Wisconsin Electric Power Co. | MAIN | 11 | 17.995 | (2) | 17.995 | (2) |
| Muskegon, Mich. | Consumers Power Co. | ECAR | 4 | 20.259 | (2) | 20.259 | (2) |
| Sheboygan, Wis. | Wisconsin Power & light Co. | MAIN | 11 | 17.995 | (2) | 17.995 | (2) |
| South Bend-Mishawaka, Ind. | Indiana Michigan Power | ECAR | 1 | 18.687 | (2) | 18.687 | (2) |
| Toledo, Ohio | Toledo Edison Co. | ECAR | 2 | 15.53 | (2) | 15.53 | (2) |
| Youngstown, Ohio-Penn. (inc. Sharon, Penn.) | Ohio Edison Co. | ECAR | 2 | 15.53 | (2) | 15.53 | (2) |
| Baton Rouge, La. | Gulf States Utilities Co, | SPP | 20 | 18.679 | (3) | 18.679 | (3) |
| Beaumont-Port Arthur, Texas | Gulf States Utilities Co. | SPP | 20 | 18.679 | (3) | 18.679 | (3) |

TABLE A.3 (Cent'd)

| Metropolitan Area | utility | NERC Code | Pool # | Annual Off-Peak Marginal Cost of Electricity: Low mils/kWh | Low Type of Generation" | High mils/kWh | High Type of Generation' |
|---|---|---|---|---|---|---|---|
| Boston CMSA | Boston Edison Co. | NPcc | 14 | 7.62 | (1) | 20.7 | (2) |
| Hancock County, Maine (Acadia Nat. Park) | Bangor Hydro-Electric Co. | NPcc | 14 | 7.62 | (1) | 20.7 | (2) |
| Hartford CMSA | Connecticut Light & Power Co. | NPCC | 14 | 7.62 | (1) | 20.7 | (2) |
| Knox County, Maine | Central Maine Power Co. | NPcc | 14 | 7.62 | (1) | 20.7 | (2) |
| Lincoln County, Maine | Central Maine Power Co. | NPcc | 14 | 7.62 | (1) | 20.7 | (2) |
| Lewiston-Auburn, Maine | Central Maine Power Co. | NPcc | 14 | 7,62 | (1) | 20.7 | (2) |
| Manchester, N.H. | Public Ser. Co. of New Hampshire | NPcc | 14 | 7.62 | (1) | 20.7 | (2) |
| Portland, Maine | Central Maine Power Co. | NPcc | 14 | 7.62 | (1) | 20.7 | (2) |
| Portsmouth-Dover-Roch., N. H.-Maine | Public Ser. Co. of New Hampshire | NPcc | 14 | 7.62 | (1) | 20.7 | (2) |
| Providence CMSA | Narragansett Electric Co. | NPCC | 14 | 7.62 | (1) | 20.7 | (2) |
| Springfield, Mass. | Western Massachusetts Elec. Co. | NPCC | 14 | 7.62 | (1) | 20.7 | (2) |
| Waldo County, Maine | Central Maine Power Co. | NPcc | 14 | 7.62 | (1) | 20.7 | (2) |
| Worcester, Mass. | Massachusetts Electric co. | NPcc | 14 | 7.62 | (1) | 10.7 | (2) |
| Albany-Schenectady-Troy, N.Y. | Niagara Mohawk Power Co. | NPcc | 15 | 15.061 | (2) | 21.074 | (2) |
| Atlantic City, N.J. | Atlantic City Electric Co. | MAAC | 7 | 7.556 | (1) | 15.061 | (2) |
| Buffalo CMSA | Niagara Mohawk Power Co. | NPCC | 15 | 15.061 | (2) | 21.074 | (2) |
| Essex County, N.Y. (Whiteface Mtn.) | Niagara Mohawk Power Co. | | 15 | 15.061 | (2) | 21074 | (2) |
| Jefferson County, N.Y. | Niagara Mohawk Power Co. | NPcc | 15 | 15.061 | (2) | 21.074 | (2) |
| New York CMSA | Consolidated Edison Co. of N.Y. | NPCC | 15 | 15.061 | (2) | 21.074 | (2) |
| Poughkeepsie, N.Y. | Central Hudson Gas & Elec. Corp. | NPCC | 15 | 15.061 | (2) | 21.074 | (2) |
| Allentown-Bethlehem, Penn | Pennsylvania Power & fight Co. | MAAC | 7 | 7.5s6 | (1) | 15.061 | (2) |
| Altoona, Penn. | Pennsylvania Electric Co. | MAcc | 7 | 7.556 | (1) | 15.061 | (2) |
| Baltimore, Md. | Baltimore Gas & Electric Co. | MAAC | 7 | 7.556 | (1) | 1s061 | (2) |
| Charleston, W.Va. | Appalachian Power Co. | ECAR | 1 | 18.687 | (2) | 18.687 | (2) |
| Erie, Penn. | Pennsylvania Electric Co. | MAAC | 7 | 7.556 | (1) | 15.061 | (2) |
| Greenbrier County, W.Va. | West Virginia Power | ECAR | 10r3 | 16.095 | (2) | 18.687 | (2) |
| Harrisburg-Lebanon-Ca rlisle, Penn. | Pennsylvania Power & Light Co | MAAC | 7 | 7.556 | (1) | 15.061 | (2) |
| Huntington-Ashland, W.Va.-Ky.-Ohio | Appalachian Power Co. | ECAR | 1 | 18.687 | (2) | 18.687 | (2) |
| Johnstown, Pmn. | Pennsylvania Electric Co. | MAAC | 7 | 7.556 | (1) | 15.061 | (2) |
| Lancaster, Penn. | Pennsylvania Power & Light Co | MAAC | 7 | 7.556 | (1) | 15.061 | (2) |
| Norfolk-Va. Beach-Newport News, Va. | Virginia Power | SERC | 19 | 7.534 | (1) | 7.687 | (1) |
| Parkersburg-Marietta, W.Va .-Ohio | Monongahela Power Co. | ECAR | 3 | 16.095 | (2) | 16.095 | (2) |
| Philadelphia CMSA | Philadelphia Electric Co. | MAAC | 7 | 7.556 | (1) | 15.061 | (2) |
| Pittsburgh CMSA | Duquesne Light Co. | ECAR | 2 | 15.53 | (2) | 15.53 | (2) |
| Reading, Penn. | Metropolitan Edison Co. | MAAC | 7 | 7.556 | (1) | 15.061 | (2) |
| Richmond-Petersburg, Va. | Virginia Power | | 19 | 7.534 | (1) | 7.687 | (1) |
| Scranton-Wilkes-f3arre, Penn. | Pennsylvania Power & Light Co | MAAC | 7 | 7.5% | (1) | 15061 | (2) |
| Sussex County, Del. | Seaford, City of | MAAC | 7 | 7.5% | (1) | 15.061 | (2) |
| Washington, D.C.-Md.-Va. | Potomac Electric Power Co. | MAAC | 7 | 7.556 | (1) | 15.061 | (2) |
| York, Penn. | Metropolitan Edison Co. | MAAC | 7 | 7.556 | (1) | 15.061 | (2) |

TABLE A.3 (Cent’d)

| Metropolitan Area | Utility | NERC Code | Pool # | Annual Off-Peak Marginal Cost of Electricity: Low, mils/kWh | Low, Type of Generation[a] | High, mils/kWh | High, Type of Generation[a] |
|---|---|---|---|---|---|---|---|
| Dallas CMSA | Texas Utilities Electric Co. | ERCOT | 5-6 | 14.588 | (2) | 19.179 | c ) |
| El Paso, Texas | El Paso Electric Co. | WSCC(Az-NM) | 26 | 7.369 | (1) | 10.426 | (3) |
| Houston CMSA | Houston fighting & Power Co. | ERCOT | 5-6 | 14.588 | C) | 19.179 | (2) |
| Lake Charles, La. | Gulf States Utilities Co. | SPP | 20 | 18.679 | (3) | 1S.679 | (3) |
| Tulsa, Okla. | Public Service Co, of Oklahoma | SPP | 21 | 18.631 | (2) | 1S.631 | (2) |
| Kansas City, Mo.-Ks. | Kansas City Power & Light Co. | SPP | [illegible] | 15.969 | (3) | 15.969 | (3) |
| St. Louis, Mo.-Ill. | Union Electric CO. | MAIN | 9-10 | 16.967 | (2) | 16.967 | (2) |
| Salt Lake City-Ogden, Utah | Utah Power & fight Co. | WSCC(RMPP) | 28 | 12.405 | (3) | 13.222 | (3) |
| Bakersfield, Calif. | Pacific Gas & Electric Co. | WSCC(Ca-SNv) | 27 | 7.38 | (4) | 12.302 | (2) |
| Fresno, Calif. | Pacific Gas & Electric Co. | WSCC(Ca-SNv) | 27 | 7.38 | (4) | 12.302 | (2) |
| Los Angeles CMSA | Los Angeles, City of | WSCC(Ca-SNv) | 27 | 7.38 | (4) | 12.302 | (2) |
| Modesto, Calif. | Modesto Irrigation District | WSCC(Ca-SNv) | 27 | 7.39 | (4) | 12.302 | (2) |
| Phoenix, Ariz. | Arizona Public Service Co. | WSCC(Az-NM) | 26 | 7.569 | (1) | 10.426 | (3) |
| Sacramento, Calif | Sacramento Mun. Utility Dist. | WSCC(Ca-SNv) | 27 | 7.3s | (4) | 12.302 | (2) |
| San Diego, Calif. | San Diego Gas & Electric Co. | WSCC(Ca-SNv) | 27 | 7.38 | (4) | 12.302 | (2) |
| San Francisco, Calif. | Pacific Gas & Electric Co. | WSCC(Ca-SNv) | 27 | 7.38 | (4) | 12,302 | (2) |
| Santa Barbara-Santa Maria-Lompoc, Calif. | Southern California Edison | WSCC(Ca-SNv) | 17 | 7.38 | (4) | 12.302 | (2) |
| Stockton, Calif. | Pacific Gas & Electric Co. | WSCC(Ca-SNv) | 27 | 7.38 | (4) | 12.302 | (2) |
| Visalia-Tulare-Porterville, Calif. | Southern California Edison | WSCC(Ca-SNv) | 27 | 7.39 | (4) | 12.302 | (2) |
| Portland CMSA | Portland General Electric Co. | WSCC(NWPP) | 25 | 9.735 | G) | 13.879 | (3) |

[a]Generation Codes: 1 = Nuclear, 2 = Bituminous Lignite, 3 = Subbituminous Anthracite, and 4 = Geothermal

TABLE A.4 101-City Electric Vehicle Distribution and Electricity Use

| Metropolitan Area | Off-Peak Marginal Cost (mils/kWh) Low | High | 1987 Population ($10^6$) | Marginal Cost Factor | Fleet Totals by Year (thousands of EVs) 1995 | 2000 | 2005 | 2010 | Daily Energy Requirement by Year (GWh/d) 1995 | 2000 | 2005 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boston CMSA | 7.62 | 20.7 | 4.093 | 0.971 | 0.085 | 12.949 | 96.204 | 316.833 | 0.0012 | 0.3291 | 2.3575 | 6.7492 |
| Hancock County, Maine | 7.62 | .?0.7 | 0.044 | 0.971 | 0.001 | 0.139 | 1.034 | 3.406 | 0.0000 | 0.0033 | 0.0253 | 0.0726 |
| Hartford CMSA | 7.62 | 20.7 | 1.057 | 0.971 | 0.0'22 | 3.344 | 24.844 | 81.821 | 0.0003 | 0.0798 | 0.6088 | 1.7429 |
| Knox County, Maine | 7.62 | 20.7 | 0.035 | 0.971 | 0.001 | 0.111 | 0.823 | 2.709 | 0.0000 | 0.0026 | 0.0202 | 0.0577 |
| Lincoln County, Maine | 7.62 | 20.7 | 0.0'28 | 0.971 | 0.001 | 0.0s9 | 0.658 | 2.167 | 0.0000 | 0.0?21 | 0.0161 | 0.0462 |
| Lewiston-Auburn, Maine | 7.62 | 20.7 | 0.04 | 0.971 | 0.001 | 0.127 | 0.940 | 3.096 | 0.0000 | 0.0030 | 0.0230 | 0.0660 |
| Manchester, N.H. | 7.62 | 20.7 | 0.0972 | 0.971 | 0.00-2 | 0.30s | 2.285 | 7.524 | 0.0000 | 0.0073 | 0.0560 | 0.1.s03 |
| Portland, Maine | 7.62 | 20.7 | 0.0627 | 0.971 | 0.001 | o.19s | 1.474 | 4.854 | 0.0000 | 0.0047 | 0.0361 | 0.1034 |
| Portsmouth-Dover-Roch., N.H.-Maine | 7.6'2 | 20.7 | 0.026 | 0.971 | 0.001 | 0.082 | 0.611 | 2.013 | 0.0000 | 0.0020 | 0.0150 | 0.0429 |
| Providence CMSA | 7.62 | 20.7 | 1.119 | 0.971 | 0.023 | 3.537 | 26.278 | 86.543 | 0.0003 | 0.0844 | 0.6439 | 1.8435 |
| Springfield, Mass. | 7.62 | 20.7 | 0.517 | 0.971 | 0.011 | 1.636 | 12.152 | 40.020 | 0.0001 | 0.0390 | 0.2978 | 0.8525 |
| Waldo County, Maine | 7.62 | 20.7 | 0.0301 | 0.971 | 0.001 | 0.095 | 0.707 | 2.330 | 0.0000 | 0.0023 | 0.0173 | 0.0496 |
| Worchester, Mass. | 7.62 | 20.7 | 0.41 | 0.971 | 0.009 | 1.297 | 9.637 | 31.737 | 0.0001 | 0.0310 | 0.2361 | 0.6761 |
| Albany-Schenect.-Troy, N.Y. | 15.061 | 21.074 | 0 S46 | 0.761 | 0.014 | 2.098 | 15.584 | 51.324 | 0.0002 | 0.0501 | 0.3s?9 | 1.0933 |
| Atlantic City, N.J. | 7.556 | 15.061 | 0.303 | 1.216 | 0.008 | 1.200 | 8.918 | '29.369 | 0.0001 | 0.0287 | 0.2185 | 0.6256 |
| Buffalo CMSA | 15.061 | 21.07-! | 1.175 | 0.761 | 0.019 | 2.913 | 21.645 | 71.284 | 0.0003 | 0.0695 | 0.5304 | 1.5185 |
| Essex County, N.Y. (Whiteface Mtn.) | 15.061 | 21,074 | 0.0363 | 0.761 | 0.001 | 0.090 | 0.669 | 2.202 | 0.0000 | 0.0021 | 0.0164 | 0.0469 |
| Jefferson County, N.Y. | 15.061 | 21.074 | 0.0906 | 0.761 | 0.001 | 0.225 | 1.669 | 5.496 | 0.0000 | 0.0054 | 0.0409 | 0.1171 |
| New York CMSA | 15.061 | '21.074 | 18.054 | 0.761 | 0.294 | 44.763 | 332.574 | 1095.284 | 0.0040 | 1.0685 | 8.1497 | 23.3317 |
| Poughkeepsie, N.Y. | 15.061 | 21.074 | 0.258 | 0.761 | 0.004 | 0.640 | 4.753 | 15.652 | 0.0001 | 0.0153 | 0.1165 | 0.3334 |
| Allentown-Bethlehem, Penn | 7.556 | 15.061 | 0.666 | 1.216 | 0.017 | 2.638 | 19.601 | 64.554 | 0.0002 | 0.0630 | 0.4803 | 1.3?51 |
| Altoona, Penn. | 7.556 | 15.061 | 0.104 | 1.216 | 0.003 | 0.412 | 3.061 | 10.080 | 0.0000 | 0.0098 | 0.0750 | [illegible] |
| Baltimore, Md. | 7.556 | 15.061 | 2.303 | 1.216 | 0.060 | 9.123 | 67.780 | 223.224 | 0.0008 | 0.2178 | 1.6609 | [illegible] |
| Charleston, W.Va. | 1s,.6s7 | 18.687 | 0.261 | 0.736 | 0.004 | 0.626 | 4.649 | 15.309 | 0.0001 | 0.0149 | 0.1139 | 0.3261 |
| Erie, Penn. | 7.556 | 15.061 | 0.279 | 1.216 | 0.007 | 1.105 | 8.211 | 27.043 | 0.0001 | 0.0264 | 0.2012 | 0.5761 |
| Greenbrier Co., W.Va | 16.095 | 18.687 | 0.0384 | 0.791 | 0.001 | 0.099 | 0.735 | 2.420 | 0.0000 | 0.0024 | 0.0180 | 0.0516 |

TABLE A.4 (Cent'd)

| Metropolitan Area | Off-Peak Marginal Cost (mils/kWh) Low | High | 1987 Population (10⁶) | Marginal cost Factor | Fleet Totals by Year (thousands of EVs) 1995 | 2000 | 2005 | 2010 | Daily Energy Requirement by Year (GWh/d) 1995 | 2000 | 2005 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Harrisburg-Leb.-Car., Penn. | 7.556 | 15.061 | 0.584 | 1.216 | 0.015 | 2.313 | 17.188 | 56.606 | 0.0002 | 0.0552 | 0.4212 | 1.2058 |
| Huntington-Ashland, W.Va.-Ky.-Ohio | 18.687 | 18.687 | 0.323 | 0.736 | 0.005 | 0.774 | 5.753 | 18.946 | 0.0001 | 0.0185 | 0.1410 | 0.4036 |
| Johnstown, Penn. | 7.556 | 15.061 | 0.252 | 1.216 | 0.007 | 0.998 | 7.417 | 24.426 | 0.0001 | 0.0238 | 0.1817 | 0.5203 |
| Lancaster, Penn. | 7.556 | 15.061 | 0.404 | 1.216 | 0.011 | 1.600 | 11.890 | 39.159 | 0.0001 | 0.0382 | 0.2914 | 0.8342 |
| Norfolk-Virginia Beach-Newport News, Va. | 7.534 | 7.687 | 1.346 | 1.806 | 0.052 | 7.923 | 58.863 | 193.858 | 0.0007 | 0.1891 | 1.4424 | 4.12% |
| l'~rkwsburg-Marietta, W. V.-Ohio | 16.095 | 16.095 | 0.0385 | 0.854 | 0.001 | 0.107 | 0.796 | 2.622 | 0.0000 | 0.0026 | 0.0195 | 0.0559 |
| Philadelphia CMSA | 7.556 | 15.061 | 5.891 | 1.216 | 0.153 | 23.336 | 173.379 | 570.999 | o.f!021 | 0.5570 | 4.2486 | 12.1634 |
| Pittsburgh CMSA | 15.53 | 15.53 | 2.296 | 0.885 | 0.043 | 6.623 | 49.205 | 162.051 | 0.0006 | 0.1581 | 1.2058 | 3.452(I |
| Reading, Penn. | 7.556 | 15.061 | 0.324 | 1.216 | 0.008 | 1.283 | 9.536 | 31.404 | 0.0001 | 0.0306 | 0.2337 | 0.66'33 |
| Richmond-Petersburg, Va. | 7.534 | 7.687 | 0.825 | 1.806 | 0.032 | 4.856 | 36.079 | 118.821 | 0.0004 | 0.1159 | 0.8841 | 2.5311 |
| Scranton-Wilkes-Barre, Penn. | 7.556 | 15.061 | 0.731 | 1.216 | 0.019 | 2.896 | 21.514 | 70.854 | 0.0003 | 0.069 I | 0.5272 | 1.5093 |
| Sussex County, Del. | 7.556 | 15.061 | 0.11 | 1.216 | 0.003 | 0.436 | 3.237 | 10.662 | 0.0000 | 0.0104 | 0.0793 | 0.2271 |
| Washington, D.C.-Md.-Va. | 7.556 | 15.061 | 3.646 | 1.216 | 0.095 | 14.443 | 107.306 | 353.397 | 0.0013 | 0.3448 | 2.6295 | 7.5281 |
| York, Penn. | 7.5% | 15.061 | 0.404 | 1.216 | 0.011 | 1.600 | 11.890 | 39.159 | 0.0001 | 0.0382 | 0.2914 | 0.8342 |
| Anderson, S.C. | 7.534 | 7.687 | 0.0287 | 1.806 | 0.001 | 0.169 | 1.255 | 4.134 | 0.0000 | 0.0040 | 0.03418 | 0.0881 |
| Atlanta, Ga. | 18.631 | 18.631 | 2.657 | 0.738 | 0.042 | 6.389 | 47.464 | 156.317 | O.(XQ6 | 0.1525 | 1.1631 | 3.3299 |
| Birmingham, Ala. | 18.631 | 18.631 | 0.917 | 0.738 | 0.014 | 2.205 | 16.381 | 53.949 | 0.0002 | 0.0526 | 0.4014 | 1.1492 |
| Charlotte-Gastonia-Rock Hill, N.C. | 7.534 | 7.534 | 1.091 | 1.825 | 0.043 | 6.487 | 48.196 | 158.727 | 0.0006 | 0.1548 | 1.1810 | 3.3812 |
| Columbia, S.C. | 7.534 | 7.534 | 0.451 | 1.825 | 0.018 | 2.682 | 19.923 | 65.615 | 0.0002 | 0.0640 | 0.4882 | 1.3977 |
| Edmonson County, Ky. (Bowling Green) | 7.586 | 7.586 | 0.0108 | 1.812 | 0.000 | 0.064 | 0.474 | 1.564 | 0.0000 | 0.0015 | 0.0116 | 0.0332 |
| Fayetteville, N.C. | 7.534 | 7.534 | 0.259 | 1.825 | 0.010 | 1.540 | 11.442 | 37.681 | 0.0001 | 0.0368 | 0.2804 | 0.8027 |
| Greensboro-Winston Salem-High Point, N.C. | 7.534 | 7.534 | 0.916 | 1.825 | 0.036 | 5.447 | 40.465 | 133.267 | 0.0005 | 0.1300 | 0.9916 | 2.8388 |

TABLE A.4 (Cent'd)

| Metropolitan Area | Off-Peak Marginal Cost (mils/kWh) | | 1987 Population (lt-1a) | Marginal Cost Factor | Fleet Totals by Year (thousands of EVS) | | | | Daily Energy Requirement by Year (GWh/d) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low | High | | | 1995 | 2000 | 2005 | 2010 | 1995 | 2000 | 2005 | 2010 |
| Greenville-Spartenburg, S.C. | 7.534 | 7.534 | 0.612 | 1.825 | 0.024 | 3.639 | 27.036 | 89.038 | 0.0303 | 0.0869 | 0.6625 | 1.8967 |
| Huntsville, Ala. | 7.586 | 7,586 | 0.163 | 1.812 | 0.006 | 0.963 | 7.151 | 23.552 | 0.0001 | 0.0230 | 0.1752 | 0s017 |
| Jacksonville, Fta. | 7.534 | 7.534 | 0.878 | 1.825 | 0.034 | 5.221 | 38.787 | 127.738 | 0.0005 | 0.1246 | 0.9505 | 2.7211 |
| Knoxville, Tenn. | 7.586 | 7.586 | 0.594 | 1.812 | 0.023 | 3.508 | 26.061 | 85.827 | 0.0003 | 0.0837 | 0.6386 | 1.8283 |
| Livingston Co., Ky. (Paducah) | 7.586 | 7.586 | 0.009 | 1.812 | 0.030 | 0.053 | 0.395 | 1.300 | 0.0000 | 0.0013 | 0.0097 | 0.0277 |
| Lexington-Fayette, Ky. | 16.185 | 16.185 | 0.342 | 0.849 | 0.006 | 0.947 | 7,033 | 23.161 | 0.0001 | 0.0226 | 0.1723 | 0.4934 |
| Louisville, Ky.-Ind. | 16.185 | 16.185 | 0.967 | 0.849 | 0.018 | 2.676 | 19.885 | 65.489 | 0.0002 | 0.0639 | 0.4873 | 1.3950 |
| Memphis, Tenn.-Ark.-Miss. | 7.586 | 7.586 | 0.972 | 1.812 | 0.038 | 5.740 | 42.645 | 140.444 | 0.0005 | 0.1370 | 11-1450 | 2.9917 |
| Miami CMSA | 22.919 | 23.74 | 2.954 | 0.589 | 0.037 | 5.672 | 42.142 | 138.789 | 0.0005 | 0.1354 | 1.0327 | 2.9565 |
| Montgomery, Ala. | 18.631 | 18.631 | 0.297 | 0.7.38 | 0.005 | 0.714 | 5.306 | 17.473 | 0.0001 | 0.0170 | 0.1300 | 0.3722 |
| Nashville, Tenn. | 7.586 | 7.586 | 0.956 | 1.812 | 0.037 | 5.645 | 41.943 | 138.133 | 0.0005 | 0.1348 | 1.0278 | 2.9425 |
| Owensboro, Ky. (adj. Hancock County) | 16.185 | 16.185 | 0.02 | 0.849 | 0.000 | 0.055 | 0.411 | 1.354 | 0.0000 | 0.0013 | 0.0101 | 0.0289 |
| Raleigh-Durham, N.C. | 7.534 | 7.534 | 0.665 | 1.825 | 0.026 | 3.954 | 29377 | 96.749 | 0.0004 | 0.0944 | o.7t 99 | 2.0609 |
| Tampa-St. Petersburg-Clearwater, Fla. | 22.919 | 23.74 | 1.965 | 0.589 | 0.025 | 3.773 | 28.033 | 92.323 | 0.0003 | 0.0901 | 0.6869 | 1.9667 |
| Canton, Ohio | 18.687 | t 8.687 | 0.397 | 0.736 | 0.006 | 0.952 | 7.071 | 23.286 | 0.0001 | 0.0?27 | 0.1733 | 0.4960 |
| Chicago CMSA | 7.709 | 7.709 | 8.147 | 1.783 | 0.311 | 47342 | 351.732 | 1158.380 | 0.0042 | 1.1301 | 86192 | 24.6758 |
| Cincinnati CMSA | 19.666 | 19.666 | 1.715 | (1.699 | 0.026 | 3.907 | 29.024 | 95.587 | 0.0004 | 0.0933 | 0.7112 | 2.0362 |
| Cleveland CMSA | 15.53 | 15.53 | 2.767 | 0.885 | 0.052 | 7.982 | 59.299 | 195.294 | 0.0007 | 0.1905 | 1.4531 | 4,1601 |
| Columbus, Ohio | 18.687 | 18.687 | t .32 | 0.736 | 0.021 | 3.164 | 23.510 | 77.426 | 0.0003 | 0.0755 | 0.5761 | 1.6493 |
| Dayton-Springfield, Ohio | 19.666 | 19.666 | 0.939 | 0.699 | 0.014 | 2,139 | 15.891 | 52336 | 0.0002 | 0.0511 | 03894 | 1.1149 |
| Detroit CMSA | 20.259 | 20.259 | 4.629 | 0.679 | 0.067 | 10.236 | 76.047 | 250.4X3 | 0.0009 | 0.2443 | 1.8635 | 5335 t |
| Grand Rapids, Mich. | 20.259 | 20.259 | 0.657 | 0.679 | 0.010 | 1.453 | 10.793 | 35.547 | 0.0001 | 0.0347 | 0.2645 | 0.7572 |
| Indianapolis, Ind. | 16,17 | 16.17 | 1.229 | 0.850 | 0.022 | 3.405 | 25.296 | 83.309 | 0.0003 | 0.0813 | 0.6199 | 1.7747 |
| Kewaunee County, Wis. | 17.995 | 17.995 | 0.02 | 0.764 | 0.000 | 0.050 | 0370 | 1.218 | 0.0000 | 0.0012 | 0.0091 | 0.02641 |
| Lafayette-West Lafayette, Ind. | 16.17 | 16.17 | 0.0442 | 0.850 | 0s301 | 0.122 | 0.910 | 2.996 | 0.0000 | 0.0029 | 0.0223 | 0.0638 |

TABLE A.4 (Cent’d)

| | Off-Peak Marginal Cost (mils/kWh) | | | | Fleet Totals by Year (thousands of EVS) | | | | Dail y Energy Requirement by Year (GWh/d) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metropolitan Area | Lrrw | High | 1987 Population ($10^6$) | Marginal Cost Factor | I 995 | 2000 | 2005 | 2010 | 1995 | 2000 | 2005 | 2010 |
| Milwaukee CMSA | 17.995 | 17.995 | 1.562 | 0.764 | 0.026 | 3.888 | 28.890 | 95.144 | 0.0003 | 0.0928 | 0.7079 | 2.0268 |
| Muskegon, Mich. | 20.259 | 20.259 | 0.0398 | 0.679 | 0.001 | 0.088 | 0.654 | 2.153 | 0.000? | 0.0021 | 0.0160 | 0.0459 |
| Sheboygan, Wis. | 17.995 | 17.995 | 0.0474 | 0.764 | 0.001 | 0.118 | 0.877 | 2.887 | 0000 | 0.(-$328 | 0.0215 | 0.0615 |
| South Bend-Mishawaka, Ind. | 18.687 | 18.687 | 0.107 | 0.736 | 0.002 | 0.257 | 1.906 | 6.276 | 0.0000 | 0.0061 | 0.0467 | 0.1337 |
| Toledo, Oh io | 15.53 | 15.53 | 0.611 | 0.885 | 0.012 | 1.762 | 13.094 | 43.124 | 0.0002 | 0.0421 | 0.3209 | 0.9186 |
| Youngstown, Ohio-Penn. (inc. Sharon, Penn.) | 15.53 | 15.53 | 0.503 | 0.885 | 0.010 | 1.451 | 10.780 | 35.502 | 0.0001 | 0.0346 | 0.2642 | 0.7563 |
| Baton Rouge, La. | 18.679 | 18.679 | 0.538 | 0.736 | 0.008 | 1.290 | 9.5s6 | 31.570 | 0.0001 | 0.0308 | 0.2349 | 0.6725 |
| Beaumont-Port Arthur, Texas | 18.679 | 18.679 | 0.371 | 0.736 | 0.006 | 0.890 | 6.610 | 21.771 | 0.0001 | 0.0212 | 0.1620 | 0.4638 |
| Dallas CMSA | 14.588 | 19.179 | 3.727 | 0.814 | 0.065 | 9.889 | 73.470 | 2-t 1.963 | 0.0009 | 0.2360 | 1.8004 | 5.1543 |
| El Paso, Texas | 7.569 | 10.426 | 0.573 | 1.528 | 0.019 | 2.853 | 21.196 | 69.805 | O.(MO3 | 0.0681 | 0.519-4 | 1.4870 |
| Houston CMSA | 14.588 | 19.179 | 3.626 | 0.814 | 0.063 | 9.621 | 71.479 | 235.406 | 0.0009 | 0.2297 | 1.7516 | 5.0146 |
| Lake Charles, La. | 1 8.679 | 18.679 | 0.0734 | 0.736 | 0.001 | 0.176 | 1.308 | 4307 | 0.0000 | 0.0042 | 0.0320 | 0.0918 |
| Tulsa, Okla. | 18.631 | 18.631 | 0.733 | 0.738 | 0.012 | 1.762 | 13.094 | 43.124 | 0.0002 | 0.0421 | 0.3209 | 0.9186 |
| Kansas City, Mo.-Kans. | 15.969 | 15.969 | 1.546 | 0.861 | 0.028 | 4.337 | 32.221 | 106.II7 | 0.0004 | 0.1035 | 0.7896 | 2.2605 |
| St. Louis, Mo.-Ill. | 16.%7 | 16.967 | 2,458 | OE1O | 0.043 | 6.490 | 48.216 | 15tL7W | 0.0006 | ^.1549 | 1.1815 | 33ft26 |
| Salt Lake City-Ogden, Utah | 12.405 | 13.222 | 1.055 | 1.073 | 0.024 | 3.688 | 27.403 | 90.248 | 0.0003 | 0.0880 | 0.6715 | 1.9225 |
| Bakersfield, Calif. | 7.38 | 12.302 | 0“505 | 1397 | 0.015 | 2.299 | 17.079 | 56.248 | 0.0002 | 0.0549 | 0.4185 | 1.1982 |
| Fresno, Calif. | 7.3a | 12302 | 0.597 | 1397 | 0.018 | 2.718 | 20.191 | 66.495 | 0.0002 | 0.0649 | 0.4948 | 1.4165 |
| Los Angeles CMSA | 73a | 12302 | 13.471 | 1.397 | 0.403 | 61321 | 455.589 | 1500.417 | 0.0055 | 1.4637 | 11.1642 | 31.9618 |
| Modesto, Calif. | 7.38 | 12302 | 0327 | 1397 | 0.010 | 1.489 | 11.059 | 36.422 | 0.0001 | 0.0355 | 0.2710 | 0.7759 |
| Phoenix, Ariz. | 7.569 | 10.426 | 1.% | 1.528 | 0.064 | 9.758 | 72501 | 238.773 | 0.0009 | 0.2329 | 1 .)’766 | 5.0863 |
| Sacramento, Calif. | 7.38 | 12302 | 1.336 | 1397 | 0.040 | 6.082 | 45.184 | 148.805 | 0.0005 | 0.1452 | 1.1072 | 3.1698 |
| San Diego, Calif. | 7.38 | 12302 | 2.286 | 1397 | 0.068 | 10.406 | 77.312 | 254.618 | 0.0009 | 0.2484 | 1.8945 | 5.4239 |
| San Francisco, Calif. | 7.38 | I 2.302 | 5.953 | 1397 | 0.178 | 27.098 | 201330 | 663.053 | 0.0024 | 0.6468 | 4.9336 | 14.1243 |
| Santa Barbara-Santa Maria-Lompoc, Calif. | 7.38 | 12302 | 0341 | 1397 | 0.010 | 1.552 | 11.533 | 37.981 | 0.0001 | 0.0371 | 0.2826 | 0.8091 |
| Stockton, Calif. | 738 | 12302 | 0.443 | 1397 | 0.013 | 2.017 | 14.982 | 49342 | 0.(XXI2 | 0.0481 | 03671 | 1.0511 |

TABLE A.4 (Cent'd)

| Metropolitan Area | Off-Peak Marginal Coat (mils/kWh) | | 1987 Population (10? | Marginal cost Factor | Fleet Totals by Year (thousands of EVs) | | | | Daily Energy Requirement by Year (GWh/d) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low | High | | | 1995 | 2000 | 2005 | 2010 | 1995 | 2000 | 2005 | 2010 |
| Visalia-Tulare-Porterville, Calif. | 7.38 | 12302 | 0.292 | 1.397 | 0.009 | 1329 | 9.875 | 32.523 | 0.0001 | 0.0317 | 0.2420 | 0.6928 |
| Portland CMSA | 9.735 | 13.879 | I.383 | 1.16i | 0.034 | 5.247 | 38.985 | 128.391 | 0.(XX)5 | 0.1253 | 0.9553 | 2.7350 |
| Total | | | | | 3.200 | 487.200 | 3619.701 | 11921.0 | 00437 | 11.6296 | 88.7004 | 253.9400 |
| Target | | | | | 3.2 | 487.2 | 3619.7 | 11921.0 | 0.0437 | 11 .62% | 88.7004 | 253.9400 |
| Map Factor | | | | | 0.0214 | 3.25836 | 24.20829 | 79.7265 | | | | |

TABLE A.5 Nine-City Electric and Hybrid Vehicle Distribution and Electricity Use

| Metropolitan Area | Off-Peak Marginal Cost (mils/kWh) Low | High | 1987 Population ($10^6$) | Marginal cost Factor | Fleet Totals by Year (thousands of EVs) 1995 | 2000 | 2005 | 2010 | Daily Energy Requirement by Year (GWh/d) 1995 | 2000 | 2005 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hartford CMSA | 7.62 | 20.7 | 1.06 | 0.92 | 0.05 | 7.48 | 31.56 | 94.29 | 0.0007 | 0.1668 | 0.6642 | 1.8387 |
| Ncw York CMSA | 15.061 | 21.074 | 18.1 | 0.72 | 0.67 | 100.13 | 422.37 | 1261.84 | 0.0392 | 2.2318 | 8.8886 | 24.6069 |
| Baltimore, Md. | 7,556 | 15.061 | 2.3 | 1.15 | 0.14 | 20.33 | 85.75 | 256.18 | 0.0019 | 0.453! | 1.8046 | 4.9957 |
| Philadelphia CMSA | 7.556 | 15.061 | 5.89 | 1.15 | 0.35 | 5206 | 219.60 | 656.05 | 00048 | 1.1603 | 4.6213 | 12.7934 |
| Chicago CMSA | 7.709 | 7.709 | 8.15 | 1.69 | 0.71 | 105.67 | 445.73 | 1331.63 | 0.0097 | 2.3552 | 9.3802 | 25.9678 |
| Milwaukee CMSA | 17.995 | 17.995 | 1.56 | 0.72 | 0.06 | 8.66 | 36.55 | 109.19 | 0.0008 | 0.1931 | 0.7692 | 2.1294 |
| Houston CMSA | 14.588 | 19.179 | 3.63 | 0.77 | 0.14 | 21.49 | 90.65 | 270.81 | 0.0020 | 0.4790 | 1.9076 | 5.2810 |
| Los Angeles CMSA | 7.38 | 12.302 | 13.5 | 1.32 | 0.92 | 137.11 | 578.38 | 1727.90 | 0.0126 | 3.0561 | 12.1716 | 33.6954 |
| San Diego, Calif. | 7.38 | 12.302 | 2.29 | 1.32 | 0.16 | 23.26 | 98.11 | 293.10 | 0.0021 | 0.5184 | 2.0647 | 5.7157 |
| Total | | | | | 3.20 | 476.20 | 2008.70 | 6001.00 | 0.0437 | 10.6137 | 42.2720 | 117.0240 |
| Target | | | | | 3.2 | 476.2 | 2008.7 | 6001 | 0.0437 | 10.6137 | 42.2720 | 117.0240 |
| Map Factor | | | | | 0.0516 | 7.6811 | 32.4003 | 96.7961 | | | | |

TABLE A.6 **Daily** Electricity Requirements

| Scenario | Basis and Units | EV (d.c.) | | EV (a.c.) | | | HV | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pb-A, Van | Ni Fe, Van | Ni Fe, Van | Ni Fe, Truck | Ni Fe, Car | Ni Fe, Van | Ni Fe, Truck | Ni Fe, Car | EV Car, Adv. Batt. | Total EHv Fleet |
| | Per Vehicle[a] | | | | | | | | | | |
| Nine-City | (kWh/d) | 13.3 | 24.4 | 24.4 | 24.4 | 20.9 | | | | 17.4 | |
| | Fleet by Year (MWh/d) | | | | | | | | | | |
| | 1995 | 41.23 | 2.44 | 0 | 0 | 0 | | | | 0 | 43.67 |
| | 2000 | 54.53 | 514.84 | 3,684.4 | 4,270 | 2,090 | | | | 0 | 10,613.8 |
| | 2005 | 21.28 | 148.84 | 9,784.4 | 16,470 | 14,107.5 | | | | 1,740 | 42,272 |
| | 2010 | 0 | 0 | 7344.4 | 9,760 | 45,980 | | | | 53,940 | 117,024 |
| | Pcr Vehicle[a] | | | | | | | | | | |
| 101-City | (kWh/d) | 13.3 | 24.4 | 24.4 | 24.4 | 20.9 | 36.9 | 36.9 | 13.7 | 17.4 | |
| | Fleet by Year (MWh/d) | | | | | | | | | | |
| | 1995 | 41.23 | 2.44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43.67 |
| | 2000 | 54-53 | 514.84 | 3,684.4 | 4,860 | 2,090 | 405.9 | 0 | 0 | 0 | 11,629.7 |
| | 2005 | 21.28 | 148.84 | 9,784.4 | 17,080 | 16,720 | 18,855.9 | 14,760 | 9/590 | 1,740 | 88,700.4 |
| | 2010 | 0 | 0 | 7,344.4 | 9,760 | 45,980 | 44,685.9 | 44,280 | 47,950 | 53,940 | 253,940 |

[a] From Hamilton, Table 3.2.

TABLE A.? All-City Electric Vehicle Distribution **and Electricity Use**

| Metropolitan Area | Off-Peak Marginal Cost (mils/kWh) | | 1987 Population ($10^6$) | Marginal Cost Factor | Fleet Totals by Year (thousands of EVs) | | | | Daily Energy Requirement by Year (GWh/d) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low | High | | | 1995 | 2000 | 2005 | 2010 | 19Y5 | 2000 | 2(?35 | 2010 |
| Albany-Schenectady-Troy, N.Y. | 15.061 | 21.074 | 0.846 | 0.803 | 0.012 | 1.796 | 13.345 | 43.951 | 0.0002 | (1.0429 | 03270 | 0.9362 |
| Albuquerque, N.M. | 18.631 | 18.631 | 0.486 | 0.779 | 0.007 | 1.001 | 7.434 | 24.485 | 0.0001 | 0.0239 | 0.1822 | 0.5216 |
| Allentown-lklhlchvrn, Penn. | 7.556 | 15.061 | 0.666 | 1.283 | 0.015 | 2.259 | 16.785 | 55.279 | 0.0002 | 0.0539 | 0.4113 | 1.1776 |
| Appleton-Oshkosh-Neenah, Wis. | 17.995 | 17.995 | 0.309 | 0.806 | 0.004 | 0.659 | 4.894 | 16.118 | 0.0001 | 0.0157 | 0.1199 | 03433 |
| Atlanta, Ga. | 18.631 | 18.631 | 2.657 | 0.779 | 0.036 | 5.471 | 40.645 | 133.860 | 0.0005 | 0.1306 | 0.9960 | 2.8515 |
| Atlantic City, N.]. | 7.5% | 15.061 | 0303 | 1.283 | 0.007 | 1.028 | 7.636 | 25.150 | 0.0001 | 0.0245 | 0.1871 | 0.5357 |
| Bakersfield, Calif. | 7.3H | 12.302 | 0.505 | 1.475 | 0.013 | 1.969 | 14.625 | 48.167 | 0.0002 | 0.0470 | 03584 | 1.0260 |
| Baltimore, Md. | 7.556 | 15.061 | 2303 | 1.283 | 0.051 | 7.813 | 58.041 | 191.154 | 0.0007 | 0.1865 | 1.4223 | 4.0719 |
| Baton Rouge, La. | 1 8.679 | 18.679 | 0.538 | 0.777 | 0.007 | 1.105 | 8.209 | 27.035 | 0.0001 | 0.0264 | 0.2012 | 0.5759 |
| Beaumont-Port Arthur, Texas | I 8.679 | 18.679 | 0.37! | 0.777 | 0.005 | 0.762 | 5.661 | 18.643 | 0.0001 | 0.0182 | 0.1387 | 0.3971 |
| Binghamton, N.Y. | 15.061 | 21.074 | 0.26 | 0.803 | 0.004 | 0.552 | 4.101 | 13.s07 | 0.0000 | 0.0132 | 0.1005 | 0.2877 |
| Birmingham, Ala. | 18.631 | 18.631 | 0.917 | 0.779 | 0.012 | 1.888 | 14.027 | 46.198 | 0.0002 | 0.0451 | 03437 | 0.9841 |
| Boston CMSA | 7.62 | 20.7 | 4.093 | 1.025 | 0.073 | 11.089 | 82.381 | 271314 | 0.0010 | 0.2647 | 2.0188 | 5.7795 |
| Brownsville-Harlingen, Texas | 14s88 | 19.179 | 0.264 | 0.860 | 0.004 | 0.600 | 4.4% | 14.677 | 0.0001 | 0.0143 | 0.1092 | 0.3126 |
| Buffalo CMSA | 15.061 | 21.074 | 1.175 | 0.803 | 0.016 | 2.495 | 18.535 | 61.043 | 0.0002 | 0.05% | 0.4542 | 1.3003 |
| Canton, Ohio | 18.687 | 18.687 | 0397 | 0.777 | 0.005 | 0.815 | 6.055 | 19.941 | (1.0001 | 0.0195 | 0.1484 | 0.4248 |
| Charleston, S.C. | 7.534 | 7.534 | 0.502 | 1.926 | 0.017 | 2556 | 18.9% | 62.542 | 0.0002 | 0.0610 | 0.4654 | 1.3323 |
| Charleston, W.Va. | 18.687 | 18.687 | 0.261 | 0.777 | 0.004 | 0.536 | 3.98! | 13.110 | 0.0000 | 0.0128 | 0.0975 | 0.2793 |
| Charlotte-Gastonia-Rock Hill, N.C. | 7.534 | 7.534 | 1.09 | 1.926 | 0.036 | 5.550 | 41.733 | 135.798 | 0.0005 | 0.1325 | 1.0104 | 2.8928 |
| Chattanooga, Tenn. | 7.534 | 7.534 | 0.432 | 1.926 | 0.014 | 2.200 | 16342 | 53.821 | 0.(KI02 | 0.0525 | 0.4005 | 1.1465 |
| Chicago CMSA | 7.709 | 7.709 | 8.147 | 1.883 | 0.266 | 40.544 | 301.194 | 991.959 | 0.0036 | 0.%77 | 73808 | 21.1305 |
| Cincinnati CMSA | 19666 | 19-666 | 1.715 | 0.738 | 0.022 | 3346 | 24.854 | 81.854 | 0.0003 | 0.0799 | 0.6091 | 1.7436 |
| Cleveland CMSA | 15.53 | 15.53 | 2.767 | 0.934 | 0.045 | 6-835 | 50.779 | 167.237 | 0.0006 | 0.1631 | 1.2444 | 3.5624 |
| Colorado Springs, Colo. | 12.405 | 13.222 | 039 | 1.133 | 0.008 | 1.168 | 8.674 | 28.%9 | 0.0001 | 0.0279 | 0.2126 | 0.6086 |
| Columbia, S.C. | 7534 | 7.534 | 0.451 | 1.926 | 0.015 | 2.297 | 17.061 | 56.188 | 0.0002 | 0.0548 | 0.4181 | 1.1%9 |

TABLE A.7 **(Cent'd)**

| Metropolitan Area | Off-Peak Marginal Cost (mils/kWh) Low | High | 1987 Population ($10^6$) | Marginal Cost Factor | Fleet Totals by Year (thousands d EVS) 1995 | 2000 | 2005 | 2010 | Daily Energy Requirement by Year (GWh/d) 1995 | 2000 | 2005 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Columbus, Ohio | 18.687 | 18.687 | 1.32 | 0.777 | 0.018 | 2.710 | 20.132 | 66302 | 0.0002 | 0.0647 | 0.4933 | 1.4124 |
| Corpus Christi, Texas | 14.588 | 19.179 | 036 | 0.860 | 0005 | 0.818 | 6.077 | 20.014 | 0.0001 | 0.0195 | 0.1489 | 0.4263 |
| Dallas CMSA | 14.588 | 19.179 | 3.727 | 0.860 | 0.0% | 8.469 | 62.913 | 207.200 | 0.0008 | 0.2021 | 1.5417 | 4.4137 |
| Davenport-Rock Island-Moline, Iowa-Ill. | 12.87 | 13.5 | 0.367 | 1.101 | 0.007 | 1.068 | 7.933 | 26.126 | 0.0001 | 0.0255 | 0.1944 | 0.5565 |
| Dnyton-Springfield, Ohirr | 19.666 | 19.666 | 0.939 | 0.738 | 0.012 | 1.832 | 13.608 | 44.817 | 0.0002 | 0.0437 | 0.3335 | 0.9547 |
| Daytona Beach, Fla. | 18.687 | 1 8.687 | 0332 | 0.777 | 0.004 | 0.682 | 5.063 | 16.676 | 0.0001 | 0.0163 | 0.1241 | 0.3552 |
| Denver-Boulder CMSA | 12.405 | 13.222 | 1.861 | 1.133 | 0.037 | 5.572 | 41.393 | 136.324 | 0.0005 | 0.1330 | 1.0143 | 2.9040 |
| Des Moines, lows | 12.87 | 13.5 | 0.385 | 1.101 | 0.007 | 1.120 | 8322 | 27.408 | 0.0001 | 0.0267 | 0.2039 | 0.5s38 |
| Detroit CMSA | 20.259 | 20.259 | 4.629 | 0.716 | 0.058 | 8.766 | 65.120 | 214.468 | 0.0008 | 0.2092 | 1.5958 | 4.5686 |
| El Paso, Texas | 7.569 | 10.426 | 0.573 | 1.613 | 0.016 | 2.443 | 18.150 | 59.776 | 0.0002 | 0.0583 | 04448 | 1.2733 |
| Eric, Penn. | 7.556 | 15.061 | 0.279 | 1.283 | 0.006 | 0.947 | 7.031 | 23.158 | 0.0001 | 0.0226 | 0.1723 | 0.4933 |
| Eugene-Springfield, Ore. | 9.735 | 13.(179 | 0.265 | 1.229 | 0.006 | 0.861 | 6.397 | 21.067 | 0.0001 | 0.0206 | 0.1568 | 0.4488 |
| Evansville, Ind.-Ky. | 16.17 | 16.17 | 0.281 | 0.898 | 0.004 | 0.667 | 4.953 | 16.311 | 0.0001 | 0.0159 | 0.1214 | 03475 |
| Fayetteville, N.C. | 7.534 | 7.534 | 0.259 | 1,926 | 0.009 | 1.319 | 9.798 | 32.268 | 0.0001 | 0.0315 | 0.2401 | 0.6874 |
| Flint, Mich. | 20.259 | 20.259 | 0.435 | 0.716 | 0.005 | 0.824 | 6.120 | 20.154 | 0.0001 | 0.0197 | 0.1500 | 0.4293 |
| Fort Myers-Cirpc Coral, Fla. | 22.919 | 23.74 | 0.295 | 0.622 | 0.003 | 0.485 | 3.604 | 11.869 | 0.0000 | 0.0116 | 0.0883 | 0.2528 |
| Fort Wayne, Ind. | 18.687 | 18.687 | 0364 | 0.777 | 0.005 | 0.747 | 5.551 | 18.283 | 0.0001 | 0.0178 | 0.1360 | 03895 |
| Fresno, Calif. | 738 | 12302 | 0-597 | 1.475 | 0.015 | 2.327 | 17.289 | 56.942 | 0.0002 | 0.0555 | 0.4237 | 1.2130 |
| Grand Rapids, Mich. | 20.259 | 20.259 | 0.657 | 0.716 | 0.008 | 1.244 | 9.243 | 30.440 | 0.0001 | 0.0297 | 0.2265 | 0.6484 |
| Greensboro-Winston Salem-High Point, N.C. | 7534 | 7.534 | 0.916 | 1.926 | 0.031 | 4.664 | 34.651 | 114.121 | 0.0004 | 0.1113 | 0.8491 | 2.4310 |
| Greenville-Spartenburg, S.C. | 7534 | 7.534 | 0.612 | 1.926 | 0.020 | 3.116 | 23.151 | 76.246 | 0.0003 | 0.0744 | 0.5673 | 1.6242 |
| Harrisburg-Lebanon-Carlisle, Penn. | 7.556 | 15.061 | 0.584 | 1.283 | 0.013 | 1.981 | 14.718 | 48.473 | 0.0002 | 0.0473 | 03607 | 1.0326 |
| Hartford CMSA | 7.62 | 20.7 | 1.056 | 1.(T25 | 0.019 | 2.861 | 21.254 | 69.999 | 0.0003 | 0.0683 | 0.5208 | 1.4911 |
| Houston CMSA | 14.538 | 19.179 | 3.626 | 0.860 | 0.054 | 8.239 | 61.209 | 201.585 | 0.0007 | 0.1967 | 1.4999 | 4.2941 |

TABLE A.7 (Cent'd)

| Metropolitan Area | Off-Peak Marginal Cost (mils/kWh) | | 1987 Population ($10^6$) | Marginal Cost Factor | Fleet Totals by Year (thousands of EVs) | | | | Daily Energy Requirement by Year (GWh/d) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low | High | | | 1995 | 2000 | 2005 | 2010 | 1995 | 2000 | 2005 | 2010 |
| Huntington-Ashland, W.Va.-Ky.-Ohio | 18.687 | 18.687 | 0.323 | 0.777 | 0.004 | 0.663 | 4.926 | 16.22.$ | 0.0001 | 0.0158 | 0.1207 | 0.3456 |
| Indianapolis, Ind. | 16.17 | 16.17 | 1.229 | 0.898 | 0.019 | 2.916 | 21.661 | 71.340 | 0.0003 | 0.0696 | 0.5308 | 1.5197 |
| Jackson, Miss. | 18.679 | 18.679 | 0.396 | 0.777 | 0.005 | 0.813 | 6.042 | 19.899 | 0.0001 | 0.0194 | 0.1481 | 0.4239 |
| Jacksonville, Fla. | 7.534 | 7.534 | 0.878 | 1.926 | 0.029 | 4.471 | 33.214 | 109.386 | 0.0004 | 0.1067 | 0.8139 | 2.3301 |
| Johnson City-Kingsport-Bristol, Tenn.-Va. | 7.586 | 7.586 | 0.443 | 1.913 | 0.015 | 2.240 | 16.643 | 54.813 | 0.0002 | 0.0535 | 0.4078 | 1.1676 |
| Johnstown, Penn. | 7.556 | 15.061 | 0.252 | 1.283 | 0.006 | 0.855 | 6.351 | 20,917 | 0.0001 | 0.0204 | 0.1556 | 0.4456 |
| Kansas City, Mo.-Kans. | 15969 | 15.969 | ! .546 | 0.909 | 0.024 | 3.714 | ?7.592 | 90.871 | 0.0003 | 0.0886 | 0.6761 | 1.9357 |
| Knoxville, Tenn. | 7.586 | 7.586 | 0.594 | 1.913 | 0.020 | 3.004 | 22.316 | 73.497 | 0.0003 | 0.0717 | 0.5469 | 1.5656 |
| Lakeland-Winter Haven, Fla. | 7.534 | 7.534 | 0.387 | 1926 | 0.013 | 1.971 | 14.640 | 48.215 | 0.0002 | 0.0470 | 0.3587 | 1.0271 |
| Lancaster, Penn. | 7.556 | 15.061 | 0.404 | 1.283 | 0.009 | 1.371 | 10.182 | 33.533 | 0.0001 | 0.0327 | 0.2495 | 0.7143 |
| Las Vegas, Nev. | 13.549 | 33.904 | 0.6 | 0.612 | 0.006 | 0.970 | 7.207 | 23.736 | O.0001 | 0.0232 | 0.1766 | 0.5056 |
| Lexington-Fayette, Ky. | 16.185 | 16.185 | 0.342 | 0.897 | 0.005 | 0.811 | 6.022 | 19.834 | 0.0001 | 0.0193 | 0.1476 | 0.4225 |
| Little Rink-N. Little Rock, Ark. | 14.588 | 19.179 | 0.512 | 0.860 | 0.008 | 1.163 | 8.643 | 28.464 | 0.0001 | 0.0278 | 02118 | 0.6063 |
| Los Angeles CMSA | 7.38 | 12.302 | 13.471 | 1.475 | 0.345 | 52.516 | 390.128 | 1284.856 | 0.0047 | 1.2534 | 9.%02 | 27.3698 |
| Louisville, Ky.-Ind. | 16.185 | 16.185 | 0.967 | 0.897 | 0.015 | 2.292 | 17.028 | 56.080 | 0.0002 | 0.0547 | 0.4173 | 1.1946 |
| Macon-Warner Robbins, Ga. | 18631 | 18.631 | 0.28 | 0.779 | 0.004 | 0.577 | 4.283 | 14.106 | 0.0001 | 0.0138 | 0.1050 | 0.3005 |
| Madison, Wis. | 17.995 | 17.995 | 0.347 | 0.806 | 0.005 | 0.740 | 5.496 | 18.100 | 0.0001 | 0.0177 | 0.1347 | 0.3856 |
| McAllen-Edinburg-Mission, Texas | 14.588 | 14.588 | 0.379 | 0.995 | 0.007 | 0.997 | 7.404 | 24.386 | 0.0001 | 0.0238 | 0.1814 | 0.5195 |
| Melbourne-Titusville-Palm Bay, Fla. | 22.$119 | 23.74 | 0.375 | 0.622 | 0.004 | 0.617 | 4.581 | 15.088 | 0.0001 | 0.0147 | 0.1123 | 0.3214 |
| Memphis, Tenn.-Ark.-Miss. | 7.586 | 7.586 | 0.972 | 1.913 | 0.032 | 4.916 | 36.517 | 120.267 | 0.0004 | 0.1173 | 0.8949 | 2.5619 |
| Miami CMSA | 22919 | 23.74 | 2.954 | ().622 | 0.032 | 4.858 | 36087 | 118.850 | 0.0004 | 0.1159 | 0.8843 | 2.5317 |
| Milwaukee CMSA | 17.995 | 17.995 | 1.562 | 0.806 | 0.022 | 3.330 | 24.739 | 81.475 | 0.(K303 | 0.0795 | 0.6062 | 1.7356 |
| Minneapolis-St. Paul, Minn. | 12.87 | 13.5 | 2.336 | 1.101 | 0.045 | 6.797 | 50.494 | 166.298 | 0.0006 | 0.1622 | 1.2374 | 3.5424 |
| Mobile, Ala. | 18.631 | 18.631 | 0.483 | 0.779 | 0.007 | 0.995 | 7.389 | 24.334 | 0.0001 | 0.0237 | 0.1811 | 0.5183 |

**TABLE A.7 (Cent’d)**

| Metropolitan Area | Off-Peak Marginal Cost (mils/kWh) | | 1987 Population (10⁶) | Marginal Cost Factor | Fleet Totals by Year (thousands of EVs) | | | | Daily Energy Requirement by Year (GWh/d) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low | High | | | 1995 | 2000 | 2005 | 2010 | 1995 | 2000 | 2005 | 2010 |
| Modesto, Cal if. | 7.38 | 12.302 | 0.327 | 1.475 | 0008 | 1.275 | 9.470 | 31.189 | (1.0001 | 0.0304 | 0.2321 | 0.6644 |
| Montgomery, Ala. | 18.631 | 18.631 | 0.297 | 0.779 | 0.004 | 0.612 | 4.543 | 14.963 | 0.0001 | 0.0146 | 0.1113 | 0.3187 |
| Muskegon, Mich. | 20.259 | 20.259 | 0.0398 | 0.7t 6 | 0.000 | | 0.560 | f .844 | 0.0000 | 0.0018 | 0.0137 | 0.0393 |
| New Haven-Meriden, Conn. | 7.62 | 20.7 | 0.519 | 1.025 | 0.009 | 1.406 | 10.446 | 34.403 | 0.0001 | 0.0336 | 0.2560. | 0.7328 |
| New London-Norwich, Conn.-R.I. | 7.62 | 20.7 | 0.259 | I .025 | 0.005 | 0.702 | 5.213 | 17.168 | 0.0001 | 0.0167 | 0.1277 | 03657 |
| New Orleans, La. | 1 8.679 | 18.679 | 1.321 | 0.777 | 0.018 | 2.713 | 20.156 | 66.381 | 0.0002 | 0.0648 | 0.4939 | 1.4140 |
| New York CMSA | 15.061 | 21.074 | 18.054 | 0.803 | 0.252 | 38.336 | 284.788 | 937.927 | 0.0034 | 0.9150 | 6.9788 | 19.9796 |
| Norfolk-Virginia Beach-Newport News, Va. | 7.534 | 7.687 | 1.346 | 1.907 | 0.045 | 6.785 | 50.406 | 166.m7 | 0.0006 | 0.1619 | 1.2352 | 3.5362 |
| Oklahoma City, Okla | 18.631 | 1s.631 | 0.975 | 0.779 | 0.013 | 2.008 | 14.915 | 49.120 | 0.0002 | 0.009 | 03655 | 1.0464 |
| Omaha, Neb.-Iowa | 12.87 | 13.5 | 0.616 | 1.101 | 0.012 | 1.792 | 13.315 | 43.853 | 0.0002 | 0.0428 | 0.3263 | 0.9341 |
| Orlando, Fla. | 22.919 | 23.74 | 0.935 | 0,622 | 0.010 | 1.538 | 11.422 | 37.618 | 0.0001 | 0.0%7 | 0.2799 | 0.8013 |
| Pensacola, Fla. | 22.919 | 23.74 | 0.344 | 0.622 | 0.004 | 0.566 | 4.202 | 13.840 | 0.0001 | 0.0135 | 0.1030 | 0.2948 |
| Peoria, tn. | 16.967 | 16.967 | 0,339 | 0.855 | 0.005 | 0.767 | 5.694 | 18.754 | (1.0001 | 0.0183 | 0.1395 | 0.3995 |
| Philadelphia CMSA | 7.556 | 15.061 | 5.89 | 1.283 | 0.131 | 19.982 | 148.442 | 488.882 | 0.0018 | 0.4769 | 3.6376 | 10.4141 |
| Phoenix, Ariz | 7.569 | 10.426 | 1.% | 1.613 | 0.055 | 8.357 | 62.084 | 204.469 | 0.0007 | 0.1995 | 1.5214 | 4.3556 |
| Pittsburgh CMSA | 15.53 | 15.53 | 2.296 | 0.934 | 0.037 | 5.672 | 42.135 | 138.770 | 0.0005 | 0.1354 | 1.0325 | 2.9560 |
| Portland CMSA | 9.735 | 13.879 | 1.383 | 1.229 | 0.020 | 4.494 | 33.383 | 109.945 | 0.0004 | 0.1073 | 0.8181 | 23420 |
| Poughkeepsie, N.Y. | 15.061 | 21.074 | 0.253 | 0.803 | 0.004 | 0.548 | 4.070 | 13.403 | 0.0000 | 0.0131 | 0.0997 | 0.2855 |
| Providence CMSA | 7.62 | 20.7 | 1.118 | 1.02.5 | 0.020 | 3.029 | 22.502 | 74.109 | 0.0003 | 0.0723 | 0.5514 | 1.5787 |
| Raleigh-Durham, N.C. | 7.534 | 7.534 | 0.665 | 1.926 | 0.022 | 3-386 | 25.156 | 82.849 | 0.0003 | 0.0808 | 0.6165 | 1.7648 |
| Reading, Penn. | 7.556 | 15.061 | 0324 | 1.283 | 0.007 | 1.099 | 8.166 | 26.893 | 0.0001 | 0.0262 | 0.2001 | 0.5729 |
| Richmond-Petersburg, Va. | 7.534 | 7.6x7 | 0.825 | 1.907 | 0.027 | 4.159 | 30.895 | 101.750 | 0.0004 | 0.0993 | 0.7571 | 2.1675 |
| Rochester, N.Y. | 15.061 | 21.074 | 0.979 | 0.803 | 0.014 | 2.079 | 15.443 | 50.860 | 0.0002 | 0.0496 | 0.3784 | 1.0834 |
| Rockford, Ill. | 7.709 | 7.709 | 0.281 | 1.883 | 0.009 | 1.398 | 10.389 | 34.214 | 0.0001 | 0.0334 | 0.2546 | 0.7288 |
| Sacramento, Calif. | 7.38 | 12.302 | 1336 | 1.475 | 0.034 | 5.208 | 38.691 | 127.427 | 0.0005 | 0.1243 | 0.9481 | 2.7144 |

TABLE A.7 **(Cent'd)**

| Metropolitan Area | Off-Peak Marginal Cost (mils/kWh) Low | High | 1987 Population ($10^6$) | Marginal Cost Factor | Fleet Totals by Year (thousands Of EVs) 1995 | 2000 | 2005 | 2010 | Daily Energy Requirement by Year (GWh/d) 1995 | 2000 | 2005 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saginaw-Bay C@-Midland, Mich. | 2(3.259 | 20.259 | t-).404 | 0.716 | 0.005 | 0.765 | 5.683 | 18.718 | 0.0001 | 0.0183 | 0.1393 | 03987 |
| St. Louis, Mo.-Ill. | 12.405 | 13.222 | 2.458 | 1.133 | 0.048 | 7359 | 54.671 | 180.056 | 0.0007 | 0.1757 | 1.3397 | 3.8355 |
| Salem, Ore. | 10.163 | 13..549 | 0.266 | 1.224 | 0.006 | 0.861 | 6394 | 21.059 | 0.0001 | 0.0205 | 0.1567 | 0.4486 |
| Salinas-Seaside-Monterey, Cal if. | 738 | 12302 | 0343 | 1.475 | 0.009 | 1.337 | 9.933 | 32.715 | 0.0001 | 0.0319 | 0.2434 | 0.6969 |
| Salt Lake City-Ogden, Utah | 12.302 | 13.222 | 1.055 | 1.137 | 0.021 | 3.171 | 23S60 | 77.594 | 0.0003 | 0.0757 | 0.5773 | 1.6529 |
| San Antonio, Texas | 14.5813 | 19.179 | 1.307 | 0.860 | 0.020 | 2.970 | 22.063 | 72.662 | 0.0003 | 0.0709 | 0.5407 | 1.5478 |
| San Diego, Calif. | 7.38 | 12.302 | 2.286 | 1.475 | 0.059 | 8.912 | 66.204 | 218.037 | 0.0008 | 0.2127 | 1.6223 | 4.6446 |
| San Francisco, Cal if. | 7.3n | 12302 | 5.95 | 1.475 | 0.152 | 23.196 | 172.316 | 567.507 | 0.0021 | 0.5536 | 4.2226 | 12.0889 |
| Santa Barbara-Santa Maria-Lompoc, Calif. | 7.38 | 12.302 | ft341 | 1.475 | 0.009 | 1 .3?9 | 9.876 | 32.524 | 0.0001 | 0.0317 | 0.2420 | 0.6928 |
| Sarasota, Fla. | 22.919 | 23.74 | 0.256 | 0.622 | o. 003 | 0.421 | 3.127 | 10.300 | 0.0000 | 0.0100 | 0.0766 | 0.2194 |
| Scranton-Wilkes-fktrrc, Penn | 7.556 | 15.061 | 0.731 | 1.283 | 0.016 | 2.480 | 18.423 | 60.675 | o. 0002 | 0.0592 | 0.4515 | 1.2925 |
| Seattle CMSA | 10.163 | 13.549 | 2341 | 1.224 | 0.050 | 7.575 | 56.274 | 185.335 | 0.0007 | 0.1808 | 1.3790 | 3.9480 |
| Shreveport, La. | 18.679 | 18.679 | 0364 | 0.777 | 0.005 | 0.748 | 5.554 | in.291 | 0.0001 | 0.0178 | 0.1361 | 0.3896 |
| Spokane, Wash. | 10.163 | 13.549 | 0.355 | I .224 | 0.008 | 1.149 | 8.534 | 28.105 | 0.0001 | 0.0274 | 0.2091 | 0.5987 |
| Springfield, Mass. | 7.62 | 20.7 | 0.517 | 1.025 | 0.009 | 1.401 | 10.406 | 34.271 | 0.0001 | 0.0334 | 0.2550 | 0.7300 |
| Stockton, Calif. | 738 | 12.2412 | 0.443 | 1.475 | 0.011 | 1.727 | 12.830 | 42.253 | 0.0002 | 0.0412 | 03144 | 0.9001 |
| Syracuse, N.Y. | 15.061 | 21.074 | 0.443 | 0.803 | 0.006 | 0.941 | 6.988 | 23.014 | 0.0001 | 0.0225 | 0.1712 | 0.4902 |
| Tampa-St. Petersburg-Clearwater, Fla. | 22.919 | 23.74 | 1.965 | 0.622 | 0.021 | 3.231 | 24.005 | 79.059 | 0.0003 | 0.0771 | 0.5883 | 1.6841 |
| Toledo, Ohio | 15.53 | 15.53 | 0.611 | 0.934 | 0.010 | 1.509 | 11.213 | 36.929 | 0.(-KKII | 0.0360 | 0.2748 | 0.7866 |
| Tucson, Ariz. | 7.569 | 10.4'26 | 0.619 | 1.613 | 0.017 | 2.639 | 19.607 | 64.575 | 0.0002 | 0.0630 | 0.4805 | 13756 |
| Tulsa, Okla. | 18.631 | 18.631 | 0.733 | 0.779 | 0.010 | 1.5(I9 | 11.213 | 36.929 | 0.0001 | 0.0360 | 0.2748 | 0.7866 |
| Utica-Rome, N.Y. | 15.061 | 21.074 | 0314 | 0.803 | 0.004 | 0667 | 4.953 | 16.313 | 0.0001 | 0.0159 | 0.1214 | 03475 |
| Visalia-Tulare-Porterville, Calif. | 738 | 12302 | 0.292 | 1.475 | 0.007 | 1.138 | 8.456 | 27.851 | 0.0001 | 0.0272 | 0.2072 | 0.5933 |

TABLE A.7 (Cent'd)

| Metropolitan Arm | Off-Peak Marginal Coat (mils/kWh) Low | High | 1987 Population ($10^6$) | Marginal Cost Factor | Fleet Totals by Year (thousands of EVS) 1995 | 2000 | 2005 | 2010 | Daily Energy Requirement by Year (GWh/d) 1995 | 2000 | 2005 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Washington, D.C.-Md.-Va. | 7556 | 15.061 | 3.646 | 1.283 | 0.081 | 12.369 | 91.888 | 302.626 | 0.0011 | 0.2952 | 2.2517 | 6.4465 |
| West Palm Beach-Boca Raton-Delray Beach, t%. | 22.919 | 23.74 | 0.79 | 0.622 | 0.009 | 1.299 | 9.651 | 31.785 | 0.0001 | 0.0310 | 0.2365 | 0.6771 |
| Wichita, Kans. | 15.969 | 15.969 | 0.47s | 0.909 | 0.007 | 1.141 | 8.477 | 27.920 | 0.0001 | 0.0277 | 0.2077 | 0.5947 |
| Worchester, Mass. | 7.62 | 20.7 | 0.41 | 1.025 | 0.007 | 1.111 | 8.252 | 27.178 | 11.0001 | 0.0265 | 0.2022 | 0.5789 |
| York, Pmn. | 7.556 | 15.061 | 0.404 | 1.283 | 0.009 | 1.371 | 10.182 | 33.533 | 0.0001 | 0.0327 | 0.2495 | 0.7143 |
| Youngstown-Warren, Ohio | 15.53 | 15.53 | 0.503 | 0.934 | 0.008 | 1.243 | 9.231 | 34).401 | 0.0001 | 0.0297 | 0.2262 | 0.6476 |
| Total | | | | | 3.200 | 487.2 | 3619.7 | 11921.0 | 0.0437 | 11.6296 | 88.7(D4 | 253.9400 |
| Target | | | | | 3.2 | 487.2 | 3619.7 | 11921 | 0.0437 | 11.6296 | 88.7004- | 253.9400 |
| Map Factor | | | | | 0.01736 | 2.6435 | 19.638 | 64.6762 | | | | |