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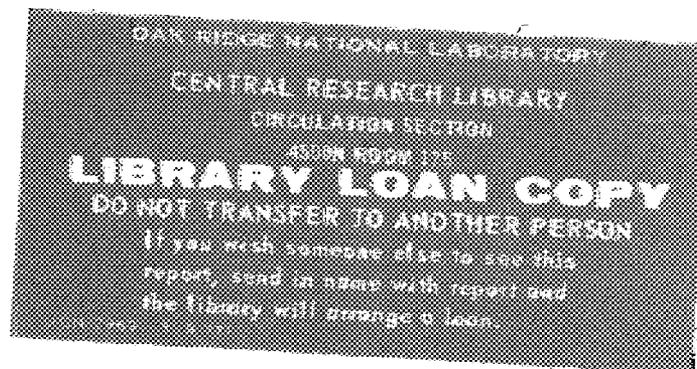
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A Comparison Study of the RAMSGAS Model and the National Energy Policy Plan Projections to 2010

E. A. Browne
D. B. Reister
L. D. Trowbridge



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Engineering Physics and Mathematics Division

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ABSTRACT

This report documents the results of a validation exercise comparing the RAMS World Natural Gas Model to the National Energy Policy Plan Projections to 2010. The purposes of this study are twofold: (1) determine the changes necessary to RAMSGAS input parameters to duplicate NEPP-85 results; and (2) test the flexibility and robustness of the RAMSGAS model by demonstrating its capability to produce results higher than the NEPP-85 high growth case, and lower than the NEPP-85 low growth case. Four scenarios were developed for the study: a reference scenario, NEPP-match scenario, and high and low growth scenarios. The changes made to RAMSGAS in this study were to the numerical values of the parameters only; no equations were altered. Comparisons were made between projections of world oil and natural gas prices and production through 2010.

The results of this study show that RAMSGAS is easily capable of duplicating the long-term trends of the NEPP-85 study. Short term behavior could only be duplicated by large adjustments to RAMSGAS parameters, and not all parameters could be exactly matched.

1. INTRODUCTION

The Oak Ridge National Laboratory and its subcontractor, Applied Management Sciences, have developed the RAMSGAS model¹ under the sponsorship of the Department of Energy's Office of Advanced Fuels, Technology, Extraction, and Environmental Controls (AFTEEC). The model was designed to simulate the transition from natural gas to unconventional gas in the context of the forces that shape the world market for gaseous fuels and is intended to be a flexible model that can produce a wide range of scenarios.

The Department of Energy's Office of Policy, Planning and Analysis recently released a new series of detailed projections of national and world energy trends (NEPP-85).² To demonstrate the flexibility of RAMSGAS, the parameters in RAMSGAS were adjusted to replicate and bound the scenarios in NEPP-85. The specific goals for this study were:

- (1) Determine the changes necessary to RAMSGAS input parameters to approximately duplicate NEPP-85 results for natural gas and oil consumption for the U.S., OECD, and Free World, while using the NEPP-85 oil price projections and matching NEPP's U.S. average delivered gas price as closely as possible.
- (2) Test the flexibility and robustness of the model by demonstrating the capability of RAMSGAS to project higher growth than the NEPP-85 high growth case and to project lower growth than the NEPP-85 low growth case.

The only changes made to RAMSGAS in this study were to the numerical values of the parameters. The RAMSGAS equations were not altered to match the NEPP-85 forecasts.

A DOE computer simulation model called WOIL was used in developing the NEPP-85 energy projections. WOIL is the most recent version of a model that DOE began to develop in 1977. WOIL forecasts the supply and demand for all forms of energy for six regions of the world for each year from 1960 to 2010. For five of the world regions (the Centrally Planned Economies [CPE] region is excluded), WOIL forecasts primary energy supply (oil, gas, coal, nuclear, and solar) and energy demand by sector (residential, commercial, industrial, and transportation). For the CPE region, WOIL forecasts the net energy trade (oil, gas, and coal) with the rest of the world, which NEPP-85 calls the "Free World".

NEPP-85 presents a number of scenarios in addition to the base case. These include low and high world energy demand scenarios, alternate U.S. resource base scenarios, and alternate U.S. energy efficiency scenarios. Only the alternate world energy demand scenarios will be examined here, though the others could also be simulated with the RAMSGAS model.

In addition to the broader scope and greater level of detail in the models used in the NEPP-85 study, there are a number of differences in the meaning of data in NEPP-85 as compared to RAMSGAS. These should be kept in mind when examining the comparisons. Specific differences are:

1. NEPP-85 published projections of U.S. gas prices and consumption by sector (industrial, commercial, residential) but did not publish an average price for the United States or the other world regions. RAMSGAS forecasts an average gas price for each of nine demand regions. In this study, a weighted average U.S. gas price was calculated from NEPP sectoral price and consumption data and compared to the North America average delivered gas price forecast by RAMSGAS.

2. The definitions of regions in RAMSGAS and NEPP-85 may not be identical, but are of the same general scale. The RAMSGAS results presented in this report define U.S. as 90% of the consumption figures for North America; OECD as North America, West Europe, and Oceania; and Free World as all seven non-communist regions of the model.
3. NEPP-85 does not list 1985 values. The 1984 values in NEPP-85 are treated as 1985 values for purposes of comparison.

Four scenarios were developed using RAMSGAS for this comparison study: a reference scenario, a match of the NEPP-85 scenario, and high and low growth scenarios. The RAMSGAS high and low growth scenarios were developed to demonstrate the model's ability to easily span the range of NEPP outputs; they do not attempt to duplicate their NEPP-85 counterparts of the same names.

The four RAMSGAS scenarios are compared to three NEPP-85 scenarios in Tables 1 to 3 and Figs. 1 to 8. The seven forecasts of consumption of natural gas, oil, and the total of gas and oil are displayed in Tables 1 to 3 for the United States, OECD, and the Free World (the United States is included in the OECD, which is included in the Free World). The gas consumption for the RAMSGAS match scenario is compared to the three NEPP-85 scenarios in Figs. 1 to 3 for the three regions (United States, OECD, and Free World). The oil consumption for the RAMSGAS match scenario is compared to the three NEPP-85 scenarios in Figs. 4 to 6 for the three regions. The gas and oil consumption for the RAMSGAS high and low scenarios is compared to the high and low NEPP-85 scenarios for the OECD region in Figs. 7 and 8.

The remainder of this report will discuss how the parameters of RAMSGAS were adjusted to produce the match scenario and the high and low scenarios. The parameters for the reference case are discussed in

the model documentation (Ref. 1). The model equations are discussed in Appendix B of the model documentation.

Table 1. RAMSGAS and NEPP Comparison: U.S. Consumption

U.S. Gas Consumption (Trillion Cubic Feet)						
(Assumes U.S. uses approx. 90% of NA gas)						
	1985	1990	1995	2000	2005	2010
RAMS Base	18.64	18.56	18.90	19.85	21.18	21.61
RAMS Low	18.64	17.63	17.19	16.70	16.02	15.31
RAMS Match	17.74	18.91	19.88	19.59	18.80	17.74
RAMS High	18.64	19.60	20.66	21.88	23.10	23.71
NEPP Low	17.74	18.52	19.20	18.81	17.74	17.06
NEPP Base	17.74	18.91	19.88	19.59	18.81	17.74
NEPP High	17.74	19.40	20.57	20.27	19.88	18.23
Sum of Squares (RAMS Match - NEPP Base)					.00	
U.S. Oil Consumption (Trillion Cubic Feet Equivalent)						
(Assumes U.S. uses approx. 90% of NA oil)						
	1985	1990	1995	2000	2005	2010
RAMS Base	33.56	34.17	34.12	33.97	34.37	32.65
RAMS Low	33.56	33.37	32.27	30.30	26.99	23.30
RAMS Match	31.93	34.04	35.79	35.27	33.84	31.93
RAMS High	33.56	36.03	37.31	38.27	38.76	37.83
NEPP Low	32.40	34.51	34.24	34.22	33.64	32.87
NEPP Base	32.40	34.78	34.66	35.08	34.46	34.46
NEPP High	32.40	35.07	34.93	35.85	35.62	36.86
Sum of Squares (RAMS Match - NEPP Base)					8.87	
U.S. Oil and Gas Total Consumption (TCF Equivalent)						
	1985	1990	1995	2000	2005	2010
RAMS Base	52.20	52.73	53.02	53.82	55.55	54.26
RAMS Low	52.20	51.00	49.46	47.00	43.01	38.61
RAMS Match	49.67	52.95	55.67	54.86	52.64	49.67
RAMS High	52.20	55.63	57.97	60.15	61.86	61.54
NEPP Low	50.14	53.03	53.44	53.03	51.38	49.93
NEPP Base	50.14	53.69	54.54	54.67	53.27	52.20
NEPP High	50.14	54.47	55.50	56.12	55.50	55.09
Sum of Squares (RAMS Match - NEPP Base)					8.88	

Table 2. RAMSGAS and NEPP Comparison: OECD Consumption

OECD Gas Consumption (TCF)						
	1985	1990	1995	2000	2005	2010
RAMS Base	30.16	30.60	31.77	33.93	36.86	38.85
RAMS Low	30.16	29.05	28.85	28.47	27.72	27.10
RAMS Match	28.47	30.94	31.97	32.58	32.37	32.17
RAMS High	30.16	32.35	34.86	37.66	40.65	43.53
NEPP Low	28.47	30.12	30.74	30.95	30.54	30.33
NEPP Base	28.47	30.95	31.98	32.60	32.39	32.19
NEPP High	28.47	31.57	33.01	33.84	34.25	33.43
Sum of Squares (RAMS Match - NEPP Base)					.00	
OECD Oil Consumption (TCFE)						
	1985	1990	1995	2000	2005	2010
RAMS Base	75.17	76.16	75.76	75.21	75.85	71.67
RAMS Low	75.17	74.34	71.62	67.06	59.61	51.31
RAMS Match	70.48	99.70	78.65	76.61	72.69	72.69
RAMS High	75.17	80.62	83.44	85.60	86.69	84.32
NEPP Low	71.60	78.00	79.65	78.82	76.13	72.63
NEPP Base	71.60	79.02	80.06	79.23	76.34	73.45
NEPP High	71.60	79.64	80.27	79.02	76.76	73.86
Sum of Squares (RAMS Match - NEPP Base)					451.67	
OECD Oil and Gas Total Consumption (TCFE)						
	1985	1990	1995	2000	2005	2010
RAMS Base	105.33	106.76	107.53	109.14	112.71	110.52
RAMS Low	105.33	103.39	100.47	95.53	87.33	78.41
RAMS Match	98.95	130.64	110.62	109.19	105.06	104.86
RAMS High	105.33	112.97	118.30	123.26	127.34	127.85
NEPP Low	100.07	108.12	110.39	109.77	106.67	102.96
NEPP Base	100.07	109.97	112.04	111.83	108.73	105.64
NEPP High	100.07	111.21	113.28	112.86	111.01	107.29
Sum of Squares (RAMS Match - NEPP Base)					451.57	

Table 3. RAMSGAS and NEPP Comparison: Free World Consumption

FREE WORLD Gas Consumption (TCF)						
	1985	1990	1995	2000	2005	2010
RAMS Base	33.80	35.22	38.11	42.50	48.15	53.61
RAMS Low	33.80	33.71	34.88	35.45	35.14	35.07
RAMS Match	35.69	38.80	42.48	46.61	51.57	59.04
RAMS High	33.80	37.25	41.48	46.45	52.24	58.96
NEPP Low	35.70	37.76	40.65	43.74	47.66	54.47
NEPP Base	35.70	38.79	42.50	46.63	51.58	59.01
NEPP High	35.70	39.62	43.95	48.90	54.88	62.93
Sum of Squares (RAMS Match - NEPP Base)					.00	
FREE WORLD Oil Consumption (TCFE)						
	1985	1990	1995	2000	2005	2010
RAMS Base	100.70	103.34	105.49	107.57	110.68	107.03
RAMS Low	100.70	101.97	101.15	95.93	85.12	73.14
RAMS Match	95.31	139.74	108.34	106.57	108.45	122.05
RAMS High	100.70	109.46	114.92	119.65	123.05	121.54
NEPP Low	95.32	105.23	111.00	115.96	116.99	116.58
NEPP Base	95.32	106.88	112.66	116.99	118.02	118.43
NEPP High	95.32	107.91	113.89	118.02	119.47	120.29
Sum of Squares (RAMS Match - NEPP Base)					1311.7	
FREE WORLD Oil and Gas Consumption (TCFE)						
	1985	1990	1995	2000	2005	2010
RAMS Base	134.50	138.56	143.60	150.07	158.83	160.64
RAMS Low	134.50	135.68	136.03	131.38	120.26	108.21
RAMS Match	131.00	178.54	150.82	153.18	160.02	181.09
RAMS High	134.50	146.71	156.40	166.10	175.29	180.50
NEPP Low	131.02	142.99	151.65	159.70	164.65	171.05
NEPP Base	131.02	145.67	155.16	163.62	169.60	177.44
NEPP High	131.02	147.53	157.84	166.92	174.35	183.22
Sum of Squares (RAMS Match - NEPP Base)					1313.4	

US GAS CONSUMPTION

RAMS/NEPP Comparison

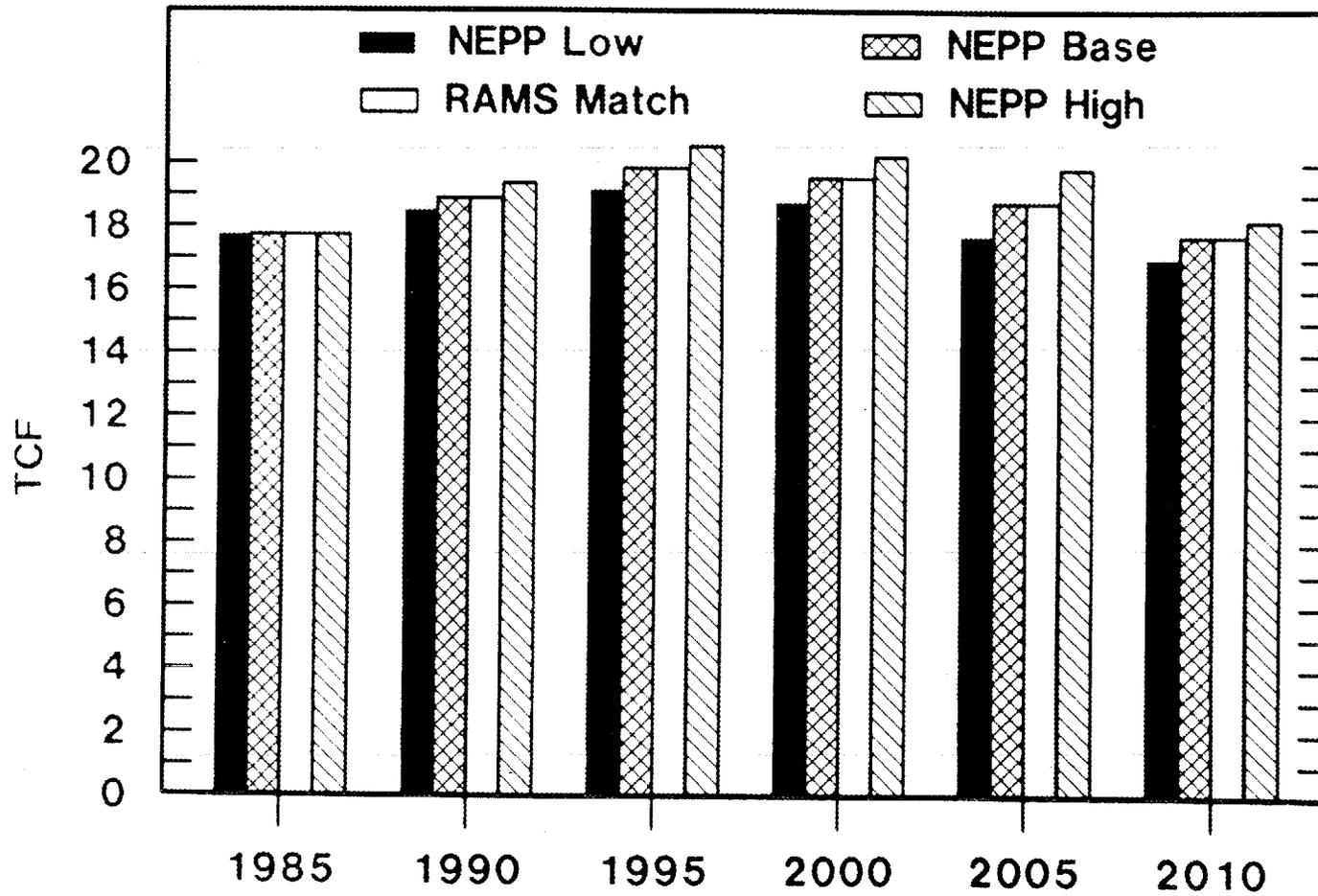


Fig. 1. U.S. Gas Consumption for the Match Scenario

OECD GAS CONSUMPTION

RAMS/NEPP Comparison

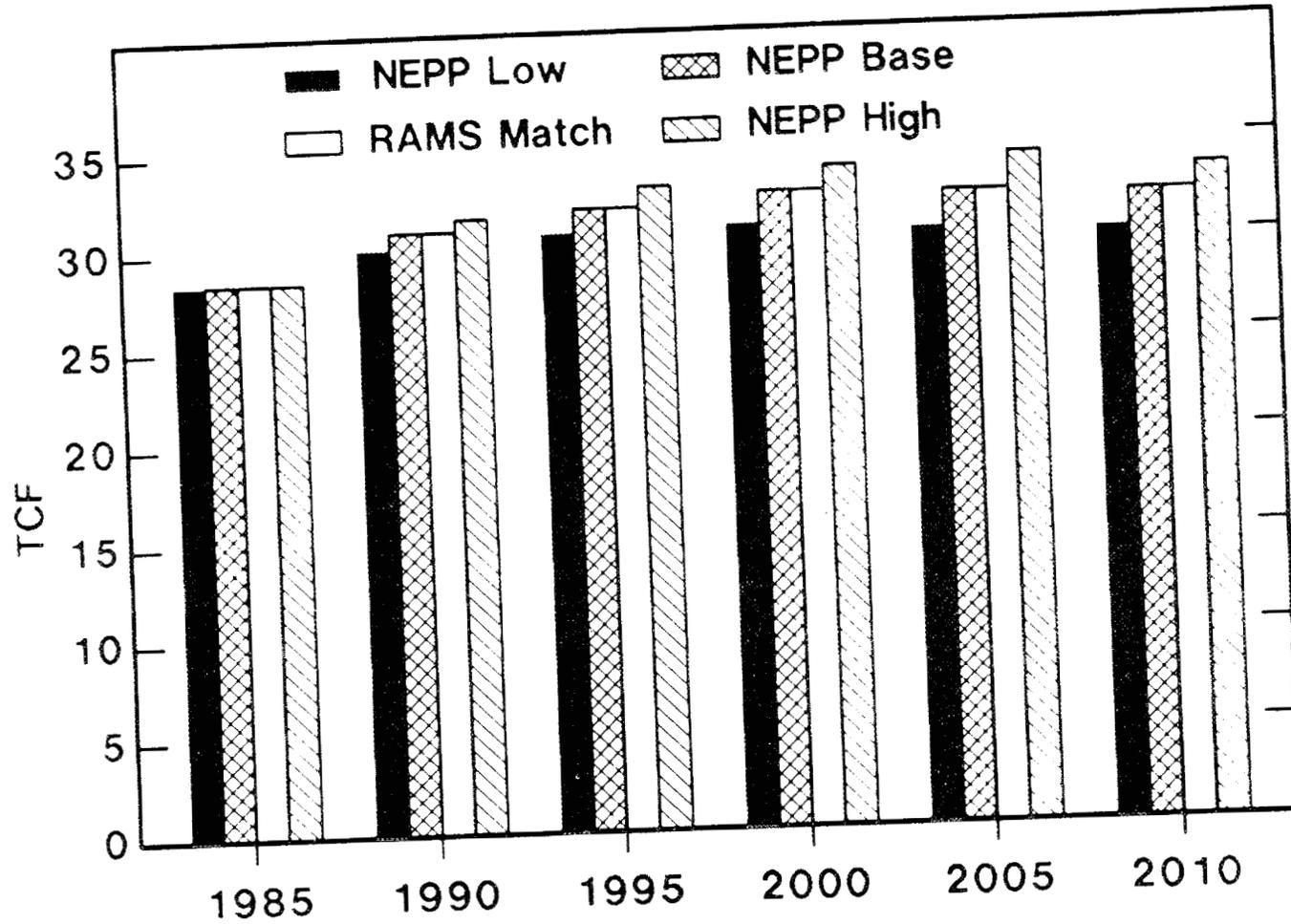


Fig. 2. OECD Gas Consumption for the Match Scenario

FREE WORLD GAS CONSUMPTION

RAMS/NEPP Comparison

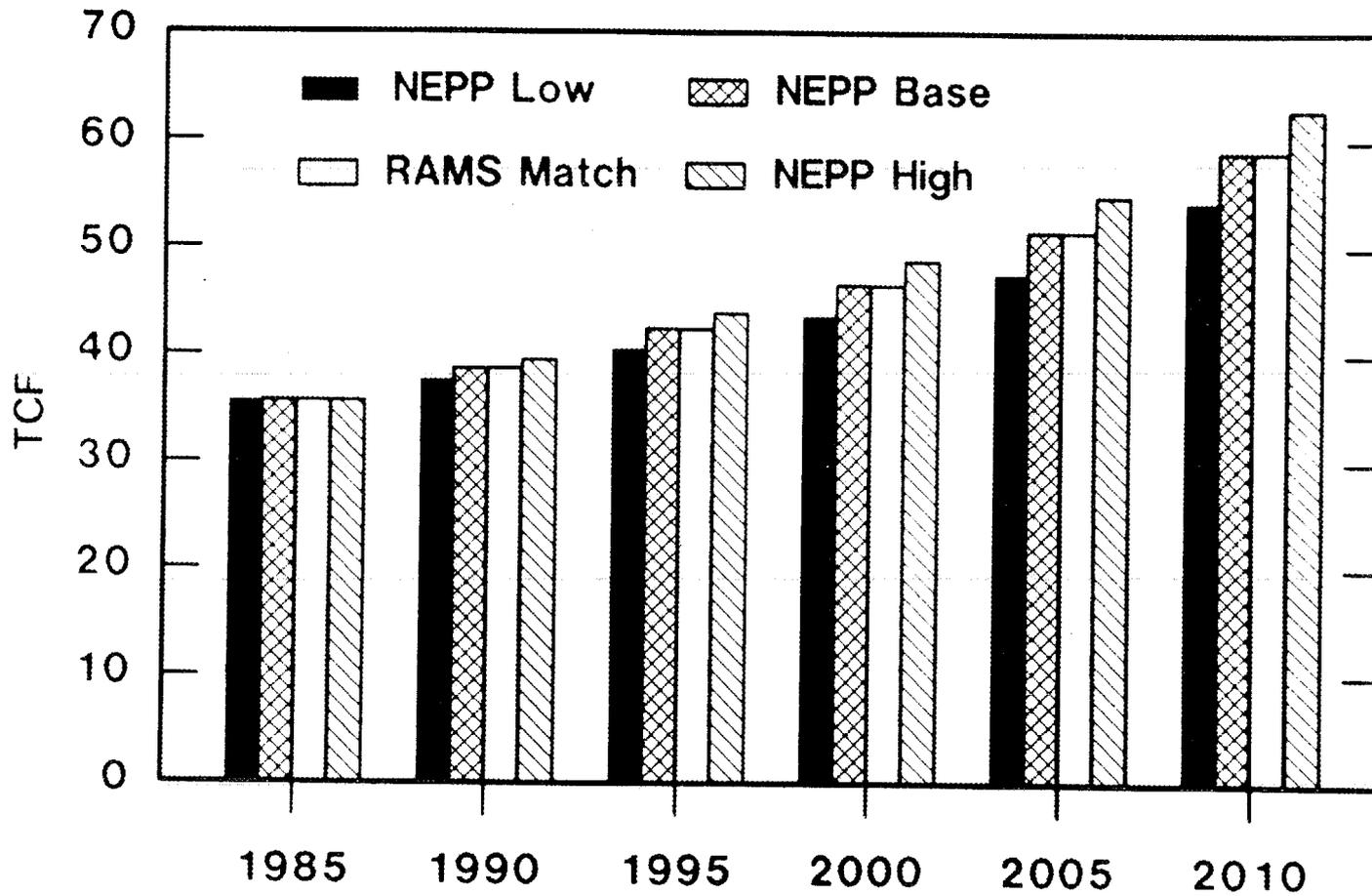


Fig. 3. Free World Gas Consumption for the Match Scenario

US OIL CONSUMPTION

ORNL DWG NO. 85C-17883

RAMS/NEPP Comparison

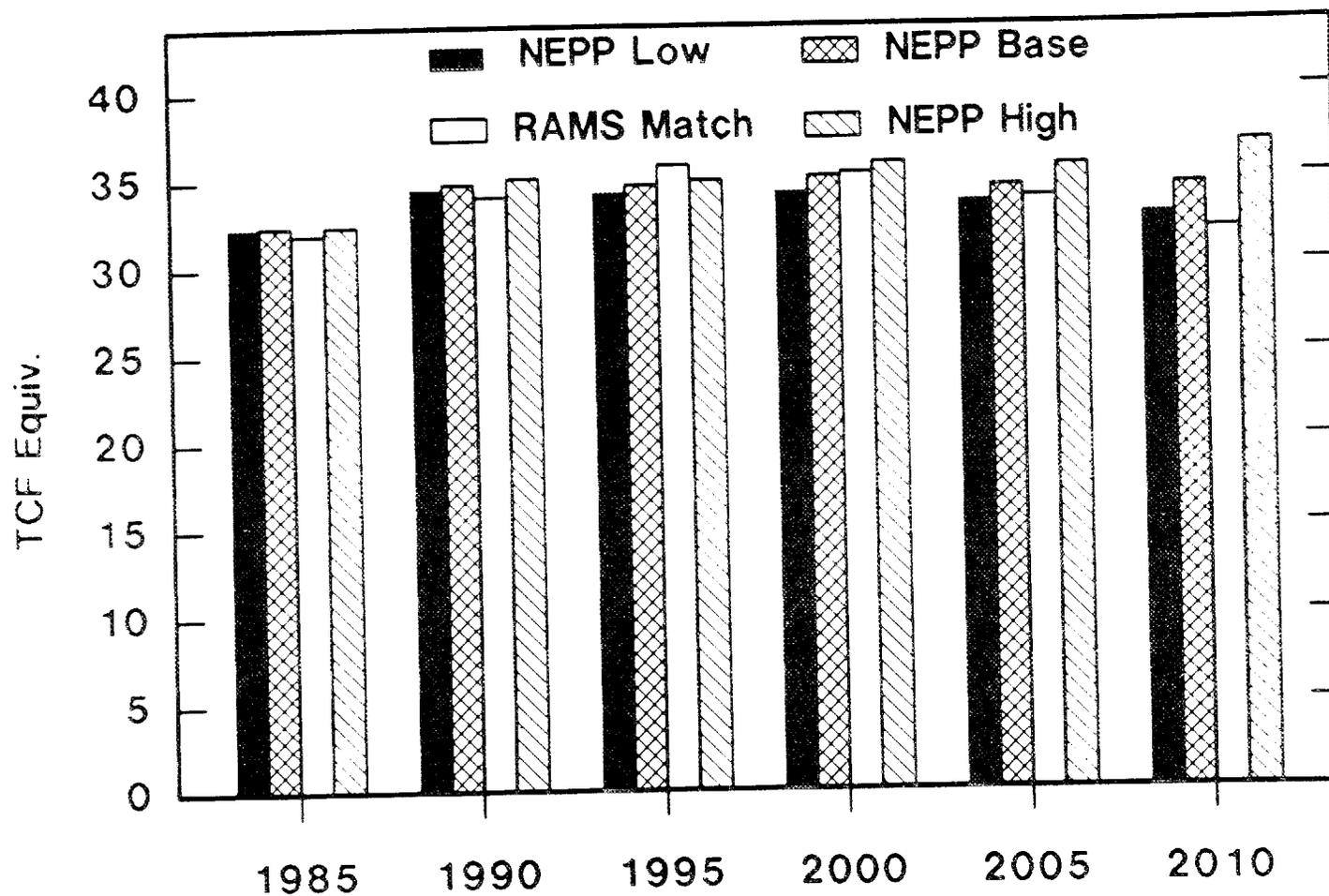


Fig. 4. U.S. Oil Consumption for the Match Scenario

OECD OIL CONSUMPTION

ORNL DWG NO. 86C-17884

RAMS/NEPP Comparison

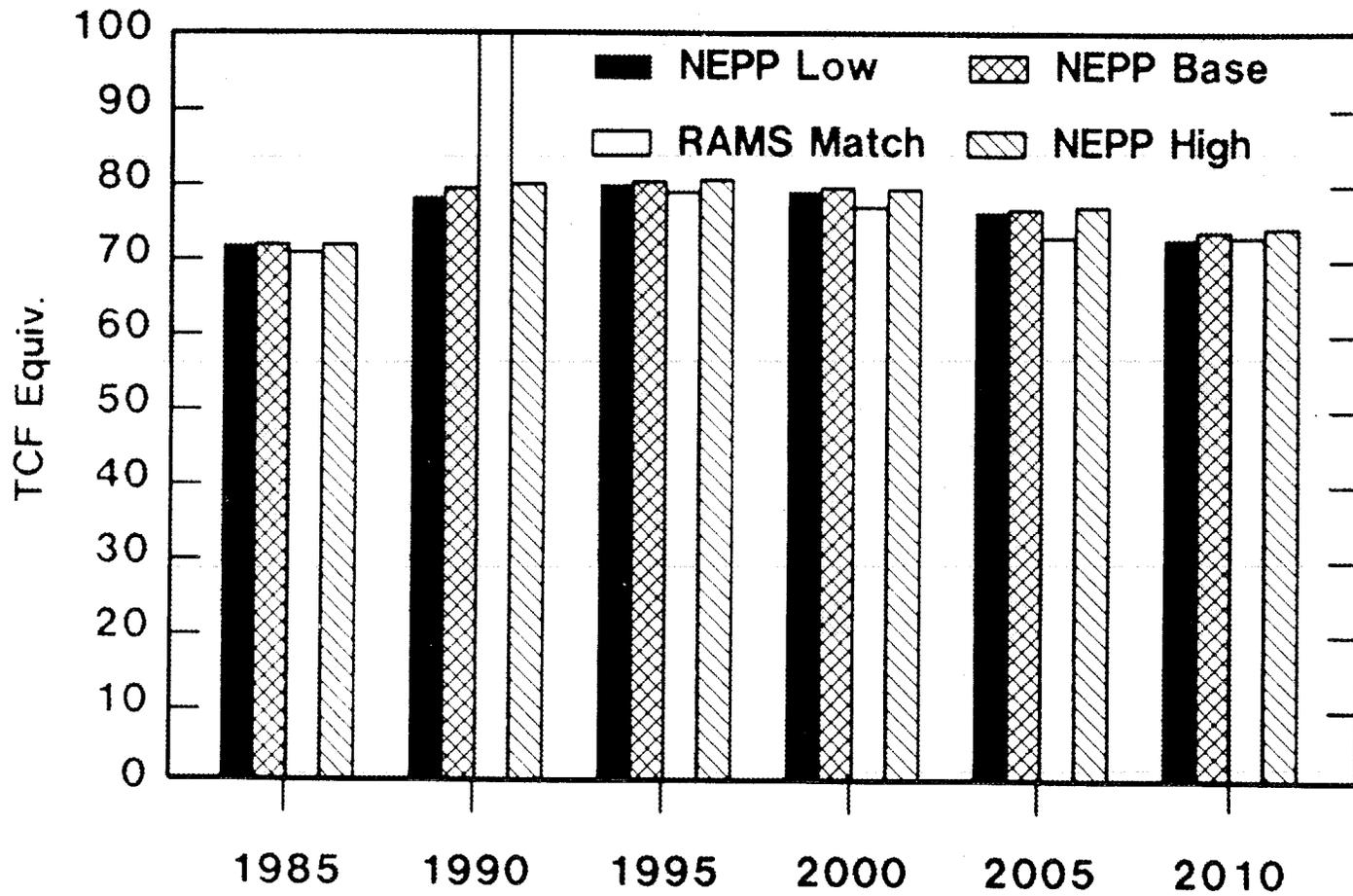


Fig. 5. OECD Oil Consumption for the Match Scenario

FREE WORLD OIL CONSUMPTION

RAMS/NEPP Comparison

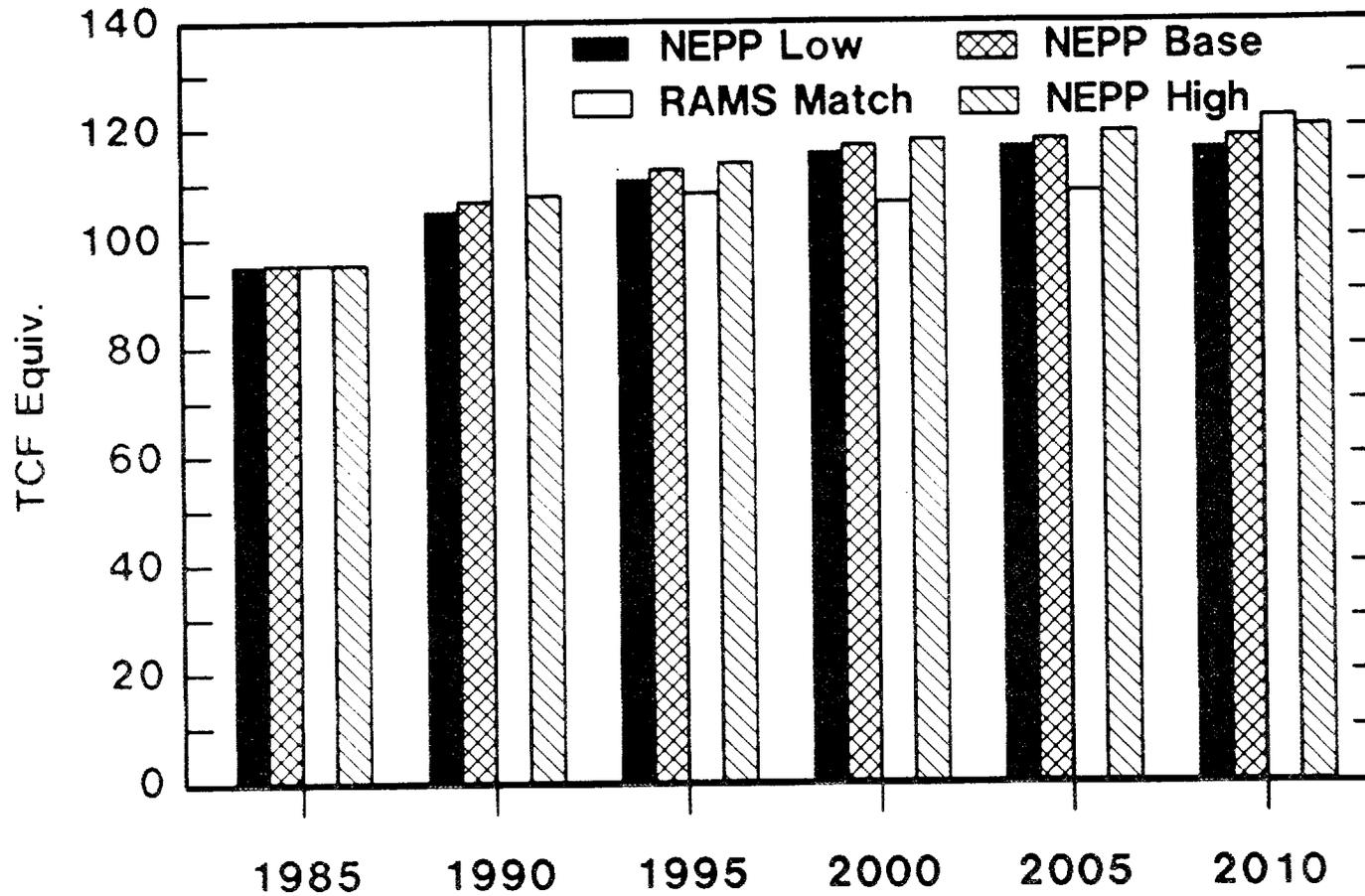


Fig. 6. Free World Oil Consumption for the Match Scenario

OECD GAS CONSUMPTION

RAMS/NEPP Comparison

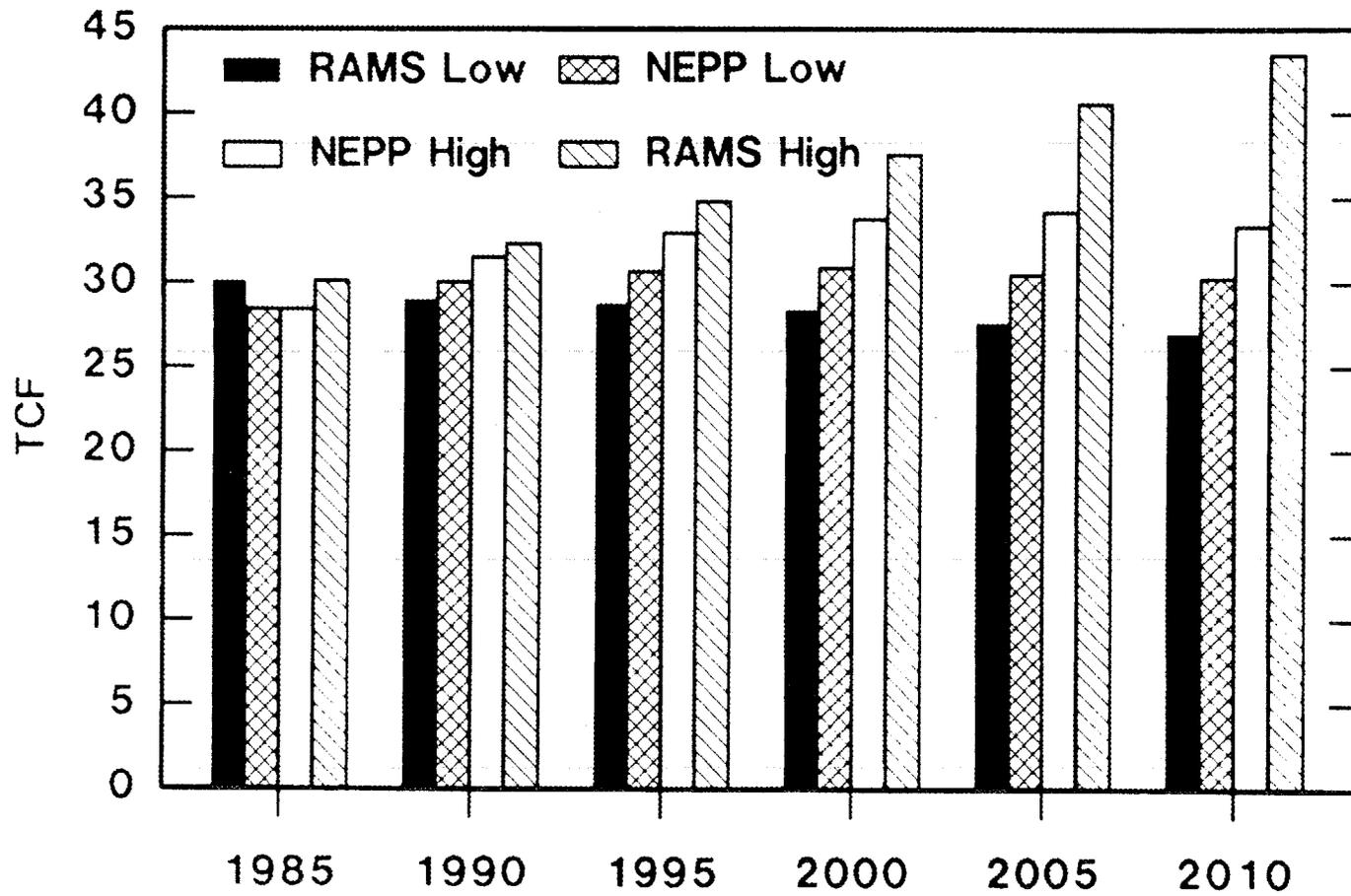


Fig. 7. OECD Gas Consumption for the High/Low Scenario

OECD OIL CONSUMPTION

RAMS/NEPP Comparison

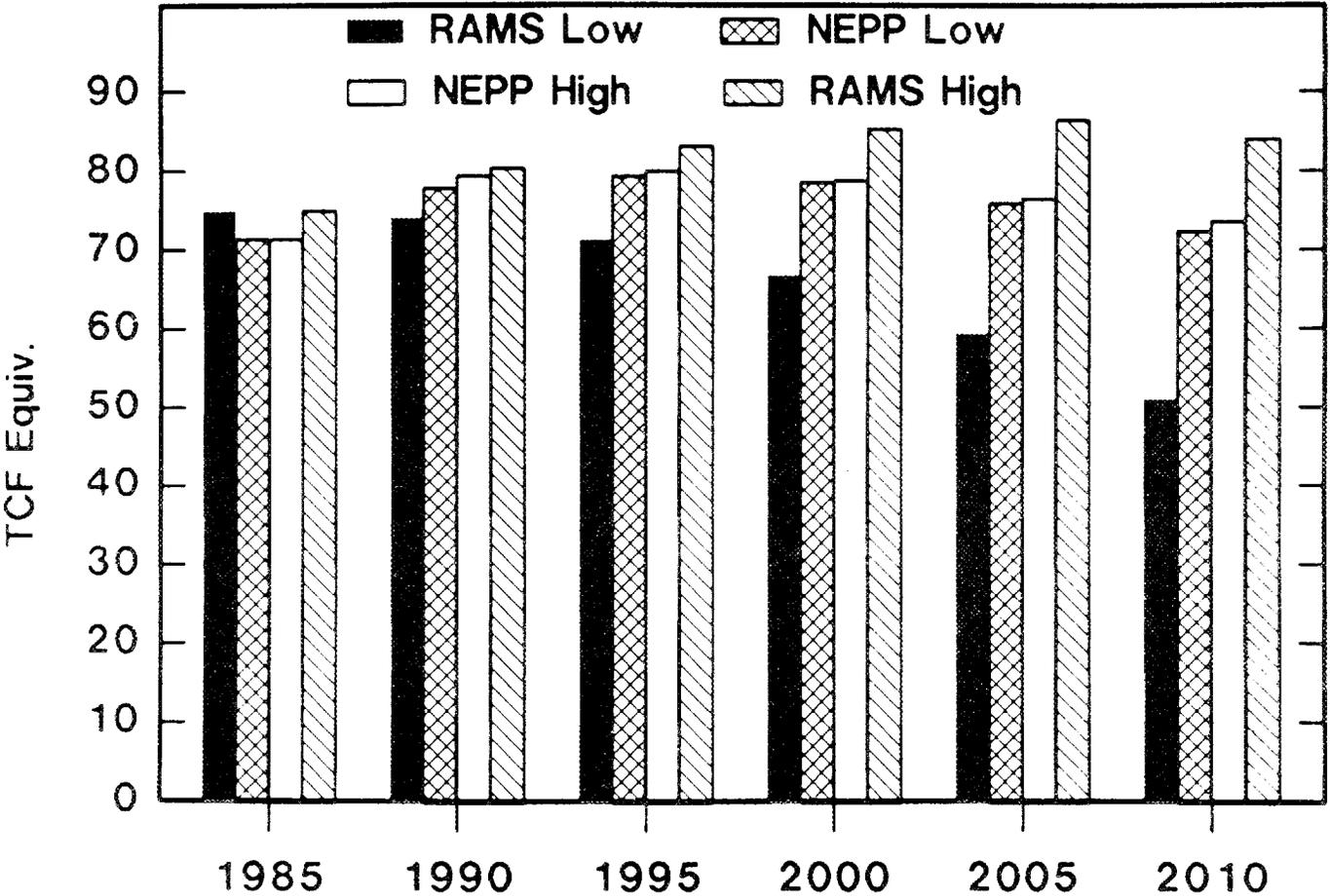


Fig. 8. OECD Oil Consumption for the High/Low Scenario

2. RAMSGAS MATCH SCENARIO

Three sets of parameter changes were required to generate the NEPP Match scenario: match the gas price, match the gas share, and match the gas demand. The first set of parameter changes was required to align the RAMSGAS forecast of average gas prices in North America with figures calculated from NEPP data for the U.S. Using the NEPP assumptions for world oil price as an input to RAMSGAS, we altered the wellhead cost parameters [α , m , and n , and the floor parameter (the parameters are defined and discussed in reference one)] to produce the best possible match of NEPP projected gas prices in the U.S. The criterion for the "best" match was to minimize the sum of the squares of the differences between RAMSGAS and NEPP. The results of the gas price match are displayed in Table 4 and Fig. 9.

Because NEPP assumes a fall in gas prices, it was necessary to use a negative value for the parameter m . This was not originally intended in the design of the model, but was required to allow the gas price to fall. Since there is only one set of conventional resource cost parameters in RAMSGAS, the NEPP-85 price forecast for the United States was used to determine the shape of the natural gas supply curve for all 11 conventional supply regions in the model.

The second set of parameter changes was required to match the gas share of the total oil and gas market for each region. The gas shares are controlled by the parameter ρ . The gas shares forecast by NEPP-85 are displayed in Table 4 for the three NEPP regions (United States, OECD, and Free World). For the United States, NEPP-85 forecasts that the gas share will be almost constant (the maximum

Table 4. RAMSGAS and NEPP Comparison: Gas Shares and Price

U.S. Share of Gas (out of Total Oil and Gas Demand)						
	1985	1990	1995	2000	2005	2010
RAMS Match	35.72%	35.71%	35.71%	35.71%	35.71%	35.72%
NEPP Base	35.38%	35.22%	36.45%	35.83%	35.31%	33.98%
Sum of Squares (RAMS Match - NEPP Base)						0.04
OECD Share of Gas						
	1985	1990	1995	2000	2005	2010
RAMS Match	28.77%	23.68%	28.90%	29.84%	30.81%	30.68%
NEPP Base	28.45%	28.14%	28.54%	29.15%	29.79%	30.47%
Sum of Squares (RAMS Match - NEPP Base)						0.22
FREE WORLD Share of Gas						
	1985	1990	1995	2000	2005	2010
RAMS Match	27.24%	21.73%	28.17%	30.43%	32.23%	32.60%
NEPP Base	27.25%	26.63%	27.39%	28.50%	30.41%	33.26%
Sum of Squares (RAMS Match - NEPP Base)						0.32
U.S. Average Gas Price Projections (\$/MMBTU)						
	1985	1990	1995	2000	2005	2010
RAMS Match	4.99	4.72	5.38	6.45	8.27	9.73
NEPP Base	5.03	4.71	5.67	6.86	7.82	9.93
Sum of Squares (RAMS Match - NEPP Base)						0.50

US AVERAGE GAS PRICE

ORNL DWG NO. 86C-17888

RAMS/NEPP Comparison

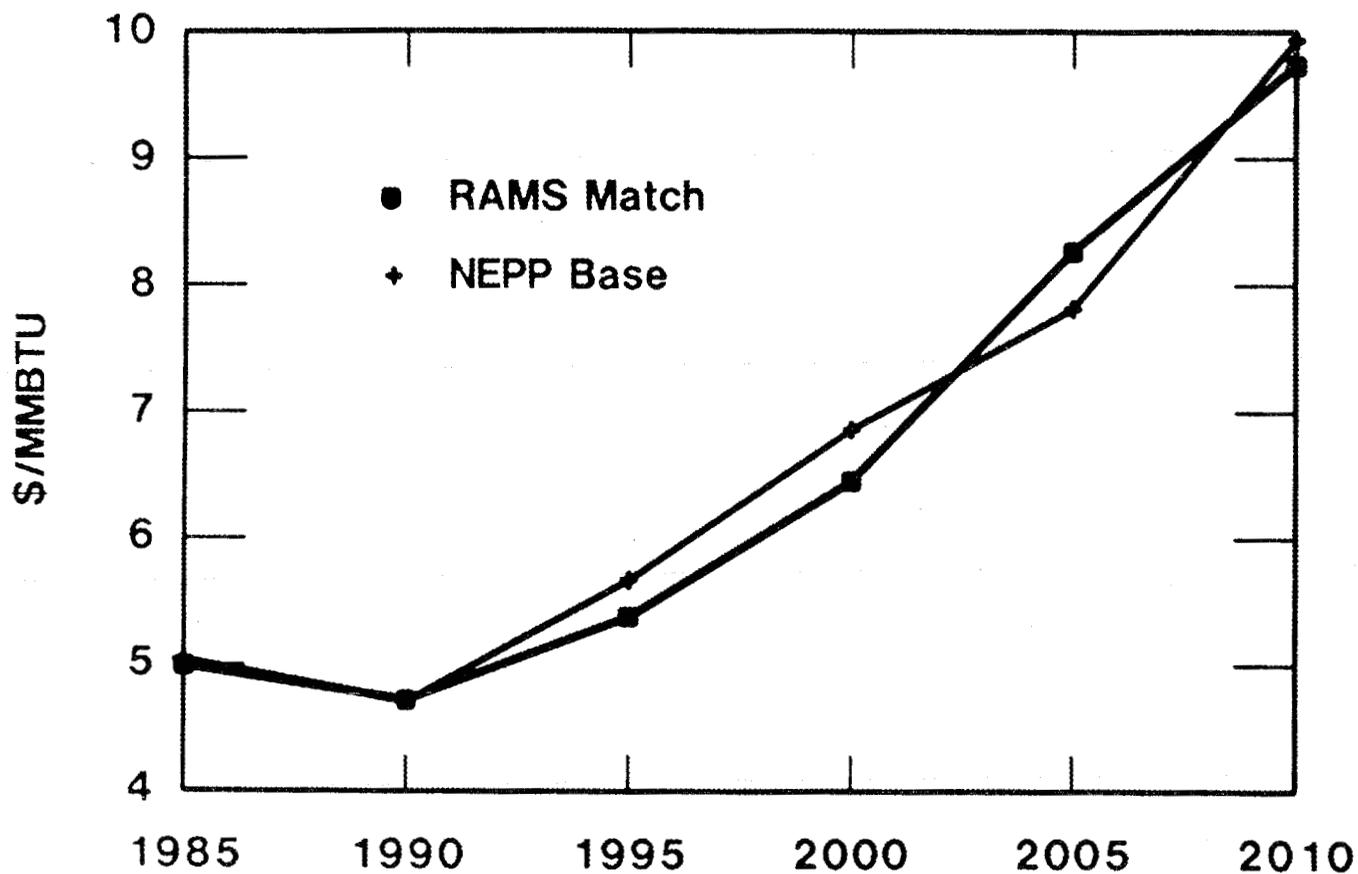


Fig. 9. RAMS/NEPP Gas Price Trajectories

share is 36% and the minimum share is 34%). For the OECD, NEPP-85 forecasts a gradual increase in the gas share from 28% to 30%. Since the gas share for the United States is almost constant, the gas share for Western Europe and Oceania must be increasing. For the Free World, NEPP-85 forecasts an increase in gas share from 27% to 33%. Since the gas share for the Free World is increasing faster than for the OECD, the four developing regions of the Free World must have large increases in gas share.

The parameter ρ was varied to produce the best match by RAMSGAS to the NEPP-85 gas shares (the criterion was to minimize the sum of the squares of the differences between the NEPP-85 and RAMSGAS forecasts). The optimum shares are displayed in Table 4, while the optimum parameter values are displayed in Table 5. For the United States, the optimum value for the parameter was $\rho=0$. For Western Europe and Oceania, the optimum value was $\rho=-3$. For the four developing regions (South America, Africa, Middle East, and Asia), the optimum value was $\rho=-2$.

In general, the differences between the gas shares forecast by RAMSGAS and NEPP-85 are small. However, the difference is large for the OECD and the Free World in 1990 (see Table 4). As a consequence, matching the gas quantity in 1990 (see Figs. 2 and 3) causes large errors in the oil forecast in 1990 (see Figs. 5 and 6). Between 1985 and 1990, RAMSGAS forecasts large changes in the gas shares for the OECD and the Free World in response to large changes in the relative prices of oil and gas; the shares drop sharply from 1985 to 1990 and then increase sharply from 1990 to 1995; with the 1995 shares in the neighborhood of the original values. In the real world, large changes

Table 5. RAMSGAS Match Scenario Input Parameters

RAMSOIL PRICE TRAJECTORY	1980	1985	1990	1995	2000	2005	2010
WORLD OIL PRICE \$/MMBTU	4.60	4.98	3.95	5.14	6.34	8.09	9.79
CONVENTIONAL COST PARAMETERS			ALPHA:	0.74	N:	2.30	
			FLOOR:	0.95	M:	-3.50	
OIL + GAS ENERGY GROWTH RATES (%/YEAR):							
	81-85	86-90	91-95	96-00	01-05	06-10	
NORTH AMERICA	-1.980%	-1.680%	4.950%	3.350%	3.660%	2.110%	
WESTERN EUROPE	-2.900%	6.130%	-3.140%	3.600%	3.700%	4.900%	
OCEANIA	-2.900%	6.130%	-3.140%	3.600%	3.700%	4.900%	
SOUTH AMERICA	1.000%	4.200%	0.500%	5.000%	8.800%	10.400%	
AFRICA	1.000%	4.200%	0.500%	5.000%	8.800%	10.400%	
MIDDLE EAST	1.000%	4.200%	0.500%	5.000%	8.800%	10.400%	
ASIA	1.000%	4.000%	0.800%	5.300%	8.900%	10.400%	
FUEL SHARE RHOS:				HISTORICAL DEMAND:			
NORTH AMERICA	0.00		GAS		LIQUIDS		
WEST EUROPE	-3.00						
OCEANIA	-3.00						
SOUTH AMERICA	-2.00		3.83		10.24		
AFRICA	-2.00		1.24		3.00		
MIDDLE EAST	-2.00		2.20		4.01		
ASIA	-2.00		1.48		6.37		

in market shares can occur in the long-run but not in the short-run. The large errors in Figs. 5 and 6 are caused by the fact that RAMSGAS is a long-run model and responds too rapidly to large changes in prices.

To match the historical fuel shares published by NEPP-85, we were required to adjust our historical data for the four developing regions. Our revisions to the historical data are displayed in Table

5. The differences are probably due to different data sources and different regional boundaries.

The final set of parameter changes required to produce the match scenario was to vary the base growth rates of demand for oil plus gas. Some of the growth rates required to produce a match were larger than the range of historical values. For example, the rates for the four developing regions were 9% from 2000 to 2005 and 10% from 2005 to 2010.

Figures 1 to 3 illustrate that RAMSGAS can match the gas consumption forecast of NEPP-85. Figures 4 to 6 illustrate that RAMSGAS has more difficulty in matching the forecasts for both oil and gas. To achieve the match displayed in Figs. 1 to 3, unreasonably large positive and negative growth rates were required (see Table 5).

3. RAMSGAS LOW AND HIGH GROWTH SCENARIOS

Low and high growth scenarios were developed to show RAMSGAS's ability to produce results which easily span the range of results produced by NEPP's high and low growth cases. All parameters are the same as in the default case except oil price trajectories and energy growth rates (see Tables 6 and 7). The low and high growth scenarios are displayed in Tables 1 to 3 and Figs. 7 and 8.

In the low growth scenario, the projected oil price grows at a slower pace than in the default scenario, and the energy growth rates are smaller. Energy growth rates approach zero by the year 2000 for all demand regions and remain at zero from then on. The results of this scenario show a long-term trend of decreasing oil use in all regions and a slightly decreasing demand for gas in all regions except the total Free World, implying a large increase in gas consumption in the developing regions (Latin America, Africa, Middle East, and Asia). Total Free World energy demand decreases, due to large decreases in oil use. The RAMSGAS consumption trajectories for oil and gas go far below the NEPP low growth projections (see Figs. 7 and 8).

The high growth scenario has a more rapid increase in oil price trajectory and sustained energy growth rates of 2.5% to 4.5% in all regions for the entire period 1985 to 2030. Results of this run indicate quickly increasing gas use in all regions, with oil use peaking in 2005 and then declining slightly. In this scenario, gas prices are high relative to oil, but the consumption trajectories for both oil and gas go far above the NEPP high growth projections for the U.S. and OECD, and closely approach NEPP's projections for the Free World (which are already very high).

Table 6. Changes for Low Growth Scenario Input Parameters

RAMSOIL PRICE TRAJECTORY	1980	1985	1990	1995	2000	2005	2010
WORLD OIL PRICE \$/MMBTU	4.60	4.60	4.80	5.20	5.70	6.40	7.40
OIL + GAS ENERGY							
GROWTH RATES (%/YEAR):	81-85	86-90	91-95	96-00	01-05	06-10	
NORTH AMERICA	-1.000%	0.500%	0.800%	0.500%	0.000%	0.000%	
WESTERN EUROPE	-1.500%	0.500%	0.800%	0.500%	0.000%	0.000%	
OCEANIA	-1.000%	0.500%	0.800%	0.500%	0.000%	0.000%	
SOUTH AMERICA	1.000%	2.000%	3.000%	1.500%	0.000%	0.000%	
AFRICA	2.000%	3.000%	3.500%	1.500%	0.000%	0.000%	
MIDDLE EAST	3.000%	4.000%	3.000%	1.500%	0.000%	0.000%	
ASIA	1.000%	2.000%	1.500%	1.500%	0.000%	0.000%	

(All other parameters identical to default scenario)

Table 7. Changes for High Growth Scenario Input Parameters

RAMSOIL PRICE TRAJECTORY	1980	1985	1990	1995	2000	2005	2010
WORLD OIL PRICE \$/MMBTU	4.60	4.70	5.00	5.50	6.10	6.85	8.00
OIL + GAS ENERGY							
GROWTH RATES (%/YEAR):	81-85	86-90	91-95	96-00	01-05	06-10	
NORTH AMERICA	-1.000%	2.500%	2.500%	2.500%	2.500%	2.500%	
WESTERN EUROPE	-1.500%	2.500%	2.500%	2.500%	2.500%	2.500%	
OCEANIA	-1.000%	3.000%	3.000%	3.000%	3.000%	3.000%	
SOUTH AMERICA	1.000%	3.500%	3.500%	3.500%	3.500%	3.500%	
AFRICA	2.000%	4.500%	4.500%	4.500%	4.500%	4.500%	
MIDDLE EAST	3.000%	4.500%	4.500%	4.500%	4.500%	4.500%	
ASIA	1.000%	3.500%	3.500%	3.500%	3.500%	3.500%	

(All other parameters identical to default scenario)

4. CONCLUSIONS

The objective of this study was to demonstrate that RAMSGAS can be used to produce a wide range of scenarios. The scenarios were produced by changing parameters without changing the model equations. To demonstrate the flexibility of RAMSGAS, the parameter values were varied to approximately match the forecast in NEPP-85. After the parameters were adjusted, a close match to the forecast of gas consumption was obtained. Although the short-run errors were sometimes large, RAMSGAS was able to match both the forecasts of oil consumption and gas consumption in the long-run.

In a second demonstration of flexibility, the parameters of RAMSGAS were varied to produce upper and lower bounds for the NEPP-85 scenarios. The high and low growth scenarios show that RAMSGAS is indeed capable of producing a wide range of projections using reasonable assumptions. This flexibility makes RAMSGAS a useful tool for R&D planning under varying assumptions about the future. Considering the differences in intent and level of detail of NEPP and RAMSGAS, this study demonstrates RAMSGAS' ability to duplicate fairly closely a set of reasonable projections.

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