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DOE/PE/70143-02 Volume 2
Volume 2 of 3 Volumes

Fossil 2 Energy Policy Model Documentation

Fossil 2 Documentation

October 1980

Prepared for:
U.S. Department of Energy
Assistant Secretary for Policy and Evaluation
Office of Analytical Services
Under Contract No. AC01-79PE70143

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October 1980

Prepared for:

U.S. Department of Energy

Assistant Secretary for Policy and Evaluation

Office of Analytical Services

Washington, D.C. 20585

Prepared by:

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Arlington, Virginia 22209

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FOSSIL2 DOCUMENTATION

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NOTE *****
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NOTE Energy Demand Sector of FOSSIL2
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NOTE Department of Energy
NOTE Energy Transition Project
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NOTE Version Release Date:
NOTE March 1980
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 NOTE *****
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 NOTE Domestic Economy Subsector
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 NOTE

DEGNP.K=DEPCNP.K*DEGNPM.K
 DEGNP -Domestic economy- Gross national product (\$)
 DEPCNP -Domestic economy- Potential gross national product (\$)
 DEGNPM -Domestic economy- Gross national product multiplier (Dimensionless)

20240 A

DEGNPM.K=SMOOTH((NEAP.K/NEAP50)^DEPE,DEPAT)
 DEPE=-.12
 DEPAT=1

20250 A
 20260 C
 20270 C

DEGNPM -Domestic economy- Gross national product multiplier (Dimensionless)
 SMOOTH -First order information delay
 NEAP -Net energy- Average price (\$/Btu)
 NEAP50 -Net energy- Average price in 1950 (\$/Btu)
 DEPE -Domestic economy- Price elasticity (Dimensionless)
 DEPAT -Domestic economy- Price adjustment time (Year)

NOTE

DEPCNP.K=DEPCNP.J+(DT)(DEGNPIR.JK)
 DEPCNP=DEGNPI
 DEGNPI=674E9

20290 L
 20300 N
 20310 C

DEPCNP -Domestic economy- Potential gross national product (\$)
 DT -Time increment between calculations
 DEGNPIR -Domestic economy- Gross national product increase rate (\$/Yr)
 DEGNPI -Domestic economy- Gross national product initial (\$)

DEGNPIR.KL=DEPCNP.K*(DELGGR.K+DERYGR.K)

20320 R

DEGNPIR -Domestic economy- Gross national product increase rate (\$/Yr)
 DEPCNP -Domestic economy- Potential gross national product (\$)
 DELGGR -Domestic economy- Long term GNP growth rate (Fraction/Yr)
 DERYGR -Domestic economy- Recessions years growth rate (Fraction/Yr)

DELGGR.K=	TABHL(DELGGRT,TIME.K,1950,2030,5)*1E-2	20330 A
DELGGRT=	6.8/.9/3.8/5.5/1.7/2.3/3.45/3.3/3.1/2.5/2.2/1.9/1.6/1.3/.9/0/0	20340 T
DELGGR	-Domestic economy- Long term GNP growth rate (Fraction/Yr)	
TABHL	-Tabular relationship	
DELGGRT	-Domestic economy- Long term GNP growth rate table (Table)	
TIME	-Actual time during simulation	
DERYGR K=	TABHL(DERYGRT,TIME.K,1968.1987,1)*1E-2	20350 A
DERYGRT=	0/2.9/2.7/2.3/1/1/-8/1.5/2.2/2.2/1.9/-3.15/-3.32/3.38/.76/1.14/1.52/2.2/0/0	20360 T
DERYGR	-Domestic economy- Recessions years growth rate (Fraction/Yr)	
TABHL	-Tabular relationship	
DERYGRT	-Domestic economy- Recession growth rate table (Table)	
TIME	-Actual time during simulation	
DEINF.K=	CLIP(DEPINF,DEHINF,TIME.K,1968)	20370 A
DEHINF=	.01	20380 C
DEPINF=	.055	20390 C
DEINF	-Domestic economy- Inflation rate (Fraction/Yr)	
CLIP	-Function switched during the run	
DEPINF	-Domestic economy- Post 1968 rate of inflation (Fraction/Yr)	
DEHINF	-Domestic economy- Historical rate of inflation (Fraction/Yr)	
TIME	-Actual time during simulation	

NOTE

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 NOTE *****
 NOTE
 NOTE Net Energy Demand Subsector
 NOTE
 NOTE *****
 NOTE
 NOTE

NECD.K=NED.K-NEDD.K 20490 A

NECD -Net energy- Centralized demand (Btu/Yr)
 NED -Net energy- Demand (Btu/Yr)
 NEDD -Net energy- Decentralized demand (Btu/Yr)

NEDD.K=DSEUD.K 20500 A

NEDD -Net energy- Decentralized demand (Btu/Yr)
 DSEUD -Decentralized solar- End-use demand (Btu/Yr)

NED.K=NEID.K*DLINF3(1-STEP(NEPCS,NECSY)/100,NECSDT) 20510 A

NEPCS=4.4 20520 C

NECSY=1979 20530 C

NECSDT=5 20540 C

NED -Net energy- Demand (Btu/Yr)
 NEID -Net energy- Indicated demand (Btu/Yr)
 DLINF3 -Third order information delay
 STEP -Step-shaped exogenous input
 NEPCS -Net energy- Policy conservation savings (Fraction/Yr)
 NECSY -Net energy- Conservation savings initiation year (Year)
 NECSDT -Net energy- Conservation savings development time (Year)

NEID.K=NED50*NEDMI.K*NEDMP.K*NEDMA.K 20541 A

NED50=29.6E15 20542 C

NEID -Net energy- Indicated demand (Btu/Yr)
 NED50 -Net energy- Demand in 1950 (Btu/Yr)
 NEDMI -Net energy- Demand multiplier from income (Dimensionless)
 NEDMP -Net energy- Demand multiplier from price (Dimensionless)
 NEDMA -Net energy- Demand multiplier from availability (Dimensionless)

NEPD.K=NECD.K*DLINF3(1-STEP(NEOCS,NEOCSY)/100,NECSDT) 20543 A

NEOCS=2.4 20544 C

NEOCSY=2200 20545 C

NEPD -Net energy- Potential demand (Btu/Yr)
 NECD -Net energy- Centralized demand (Btu/Yr)
 DLINF3 -Third order information delay
 STEP -Step-shaped exogenous input
 NEOCS -Net energy- Oil conservation savings (Fraction/Yr)
 NEOCSY -Net energy- Oil conservation savings year (Year)
 NECSDT -Net energy- Conservation savings development time (Year)

NOTE

NEDMI.K=(DEGNP.K/DEGNPI)^NEIE

NEIE=.95

NEDMI -Net energy- Demand multiplier from income (Dimensionless)
DEGNP -Domestic economy- Gross national product (\$)
DEGNPI -Domestic economy- Gross national product initial (\$)
NEIE -Net energy- Income elasticity (Dimensionless)

20580 A

20590 C

NOTE

NEDMP.K-SMOOTH((NEDP.K/NEAP50)^(NEPE),NEDAT)

NEDAT=10

NEPE=-.5

NEDMP -Net energy- Demand multiplier from price (Dimensionless)
SMOOTH -First order information delay
NEDP -Net energy- Delivered price (\$/Btu)
NEAP50 -Net energy- Average price in 1950 (\$/Btu)
NEPE -Net energy- Price elasticity (Dimensionless)
NEDAT -Net energy- Demand adjustment time (Year)

20610 A

20620 C

20630 C

NOTE

NEDMA.K-SMOOTH(NECDR.K,NEAAT)

NEAAT=5

NEDMA -Net energy- Demand multiplier from availability (Dimensionless)
SMOOTH -First order information delay
NECDR -Net energy- Consumption demand ratio (Dimensionless)
NEAAT -Net energy- Availability averaging time (Year)

20650 A

20660 C

NOTE

NEDP.K=NEAP.K+STEP(NEPXT,NEXTY)

NEPXT=1.00E-6

NEXTY=2200

NEDP -Net energy- Delivered price (\$/Btu)
NEAP -Net energy- Average price (\$/Btu)
STEP -Step-shaped exogenous input
NEPXT -Net energy- Policy excise tax (\$/Btu)
NEXTY -Net energy- Excise tax initiation year (Year)

20680 A

20690 C

20700 C

NEAP.K=(TODP.K*TOCR.K+TGDP.K*TGCR.K+TEP.K*TECR.K+DCP.K*DCCR.K+DSP.K*DSCR.K)/NECR.K

NEAP=NEAP50

NEAP50=2.07E-6

NEAP -Net energy- Average price (\$/Btu)
TODP -Total oil- Delivered price (\$/Btu)
TOCR -Total oil- Consumption rate (Btu/Yr)
TGDP -Total gas- Delivered price (\$/Btu)
TGCR -Total gas- Consumption rate (Btu/Yr)
TEP -Total electric- Price (\$/Btu)
TECR -Total electric- Consumption rate (Btu/Yr)
DCP -Domestic coal- Price (\$/Btu)
DCCR -Domestic coal- Consumption rate (Btu/Yr)
DSP -Decentralized solar- Price (\$/Btu)
DSCR -Decentralized solar- Consumption rate (Btu/Yr)
NECR -Net energy- Consumption rate (Btu/Yr)
NEAP50 -Net energy- Average price in 1950 (\$/Btu)

20710 A

20730 N

20740 C

NECR.K=TOCR.K+TGCR.K+DCCR.K+TECR.K+DSCR.K

20750 A

NECR -Net energy- Consumption rate (Btu/Yr)
TOCR -Total oil- Consumption rate (Btu/Yr)
TGCR -Total gas- Consumption rate (Btu/Yr)
DCCR -Domestic coal- Consumption rate (Btu/Yr)
TECR -Total electric- Consumption rate (Btu/Yr)
DSCR -Decentralized solar- Consumption rate (Btu/Yr)

TOCR.K=(TOEUD.K+DGCUR.O.K)*TOPDR.K

20760 A

TOCR -Total oil- Consumption rate (Btu/Yr)
TOEUD -Total oil- End-use demand (Btu/Yr)
DGCUR.O -Domestic gas- Curtailments to oil (Btu/Yr)
TOPDR -Total oil- Production demand ratio (Dimensionless)

TGCR.K=TGEUD.K-DGCUR.K

20770 A

TGCR -Total gas- Consumption rate (Btu/Yr)
TGEUD -Total gas- End-use demand (Btu/Yr)
DGCUR -Domestic gas- Curtailments (Btu/Yr)

DCCR.K=(DCEUD.K+DGCURC.K)*DCPDR.K

20780 A

DCCR -Domestic coal- Consumption rate (Btu/Yr)
DCEUD -Domestic coal- End-use demand (Btu/Yr)
DGCURC -Domestic gas- Curtailments to coal (Btu/Yr)
DCPDR -Domestic coal- Production demand ratio (Dimensionless)

TECR.K=TEEUD.K*TEPDR.K

20790 A

TECR -Total electric- Consumption rate (Btu/Yr)
TEEUD -Total electric- End-use demand (Btu/Yr)
TEPDR -Total electric- Production demand ratio (Dimensionless)

DSCR.K=DSEUD.K

20800 A

DSCR -Decentralized solar- Consumption rate (Btu/Yr)
DSEUD -Decentralized solar- End-use demand (Btu/Yr)

NECDR.K=NECR.K/(NEPD.K+NEDD.K)

20810 A

NECDR=1

20820 N

NECDR -Net energy- Consumption demand ratio (Dimensionless)
NECR -Net energy- Consumption rate (Btu/Yr)
NEPD -Net energy- Potential demand (Btu/Yr)
NEDD -Net energy- Decentralized demand (Btu/Yr)

NOTE

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 NOTE Interfuel Substitution -- Coal Demand Subsector
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DCEUD.K=NECD.K*DCDMI.K*DCDMP.K*DCDMA.K*DLINF3(1+STEP(DCPCS,DCCSY)/100,DCCSDT) 20930 A
 DCPCS=70 20950 C
 DCCSY=1979 20960 C
 DCCSDT=10 20970 C

DCEUD -Domestic coal- End-use demand (Btu/Yr)
 NECD -Net energy- Centralized demand (Btu/Yr)
 DCDMI -Domestic coal- Demand multiplier from income (Dimensionless)
 DCDMP -Domestic coal- Demand multiplier from price (Dimensionless)
 DCDMA -Domestic coal- Demand multiplier from availability (Dimensionless)
 DLINF3 -Third order information delay
 STEP -Step-shaped exogenous input
 DCPCS -Domestic coal- Policy conservation savings (Fraction/Yr)
 DCCSY -Domestic coal- Conservation savings initiation year (Year)
 DCCSDT -Domestic coal- Conservation savings development time (Year)

NOTE

DCDMI.K=TABHL(DCDMIT,DEGNP.K/DEGNPI,1,4.6,.4) 20990 A
 DCDMIT=.355/.15/.12/.065/.065/.065/.065/.065/.065 21000 T
 DCDMI -Domestic coal- Demand multiplier from income (Dimensionless)
 TABHL -Tabular relationship
 DCDMIT -Domestic coal- Demand multiplier from income table (Table)
 DEGNP -Domestic economy- Gross national product (\$)
 DEGNPI -Domestic economy- Gross national product initial (\$)

NOTE

DCDNF.K=SMOOTH(TABHL(DCDMPT,(DCP.K/TODP.K)/DCPR70,.5,1.5,.1),NEDAT) 21020 A
 DCDMPT=1.4/1.29/1.2/1.12/1.05/1/.95/.91/.88/.85/.82 21030 T
 DCPR70=.30 21040 C
 DCDMP -Domestic coal- Demand multiplier from price (Dimensionless)
 SMOOTH -First order information delay
 TABHL -Tabular relationship
 DCDMPT -Domestic coal- Demand multiplier from price table (Table)
 DCP -Domestic coal- Price (\$/Btu)
 TODP -Total oil- Delivered price (\$/Btu)
 DCPR70 -Domestic coal- Price ratio in 1970 (\$/Btu)
 NEDAT -Net energy- Demand adjustment time (Year)

NOTE

DCDMA.K=SMOOTH(DCPDR.K/TOPDR.K,NEAAT) 21060 A
 DCDMA -Domestic coal- Demand multiplier from availability (Dimensionless)
 SMOOTH -First order information delay
 DCPDR -Domestic coal- Production demand ratio (Dimensionless)
 TOPDR -Total oil- Production demand ratio (Dimensionless)
 NEAAT -Net energy- Availability averaging time (Year)

NOTE

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Interfuel Substitution -- Electricity Demand Subsector

TEEUD.K=NECD.K*TEDMI.K*TEDMP.K*TEDNA.K*SMOOTH(1-STEP(TEPCS,TECSY)/100,NECSDT)
TEPCS=0
TECSY=2200

21160 A
21180 C
21190 C

TEEUD -Total electric- End-use demand (Btu/Yr)
NECD -Net energy- Centralized demand (Btu/Yr)
TEDMI -Total electric- Demand multiplier from income (Dimensionless)
TEDMP -Total electric- Demand multiplier from price (Dimensionless)
TEDNA -Total electric- Demand multiplier from availability (Dimensionless)
SMOOTH -First order information delay
STEP -Step-shaped exogenous input
TEPCS -Total electric- Policy conservation savings (Fraction/Yr)
TECSY -Total electric- Conservation savings initiation year (Year)
NECSDT -Net energy- Conservation savings development time (Year)

NOTE

TEDMI.K=TABHL(TEDMIT,DEGNP.K/DEGNPI,1,7.0,-.4)
TEDMIT=.043/.073/.085/.093/.1/.107/.114/.121/.126/.129/.133/.137/.141/.145/.149/.153
TEDMI -Total electric- Demand multiplier from income (Dimensionless)
TABHL -Tabular relationship
TEDMIT -Total electric- Demand multiplier from income table (Table)
DEGNP -Domestic economy- Gross national product (\$)
DEGNPI -Domestic economy- Gross national product initial (\$)

21210 A
21220 T

NOTE

TEDMP.K=SMOOTH(TABHL(TEDMPT,(TEP.K/TODP.K)/TEPR70,.5,1.5,.1),NEDAT)
TEDMPT=2/1.67/1.43/1.25/1.11/1/.91/.83/.77/.71/.67
TEPR70=2.84

21240 A
21250 T
21260 C

TEDMP -Total electric- Demand multiplier from price (Dimensionless)
SMOOTH -First order information delay
TABHL -Tabular relationship
TEDMPT -Total electric- Demand multiplier from price table (Table)
TEP -Total electric- Price (\$/Btu)
TODP -Total oil- Delivered price (\$/Btu)
TEPR70 -Total electric- Price ratio in 1970 (\$/Btu)
NEDAT -Net energy- Demand adjustment time (Year)

NOTE

TEDNA.K=SMOOTH(TEPDR.K/TOPDR.K,NEAAT)
TEDNA -Total electric- Demand multiplier from availability (Dimensionless)
SMOOTH -First order information delay
TEPDR -Total electric- Production demand ratio (Dimensionless)
TOPDR -Total oil- Production demand ratio (Dimensionless)
NEAAT -Net energy- Availability averaging time (Year)

21280 A

NOTE

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 NOTE Interfuel Substitution -- Gas Demand Subsector
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 NOTE *****
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 NOTE

TGEUD.K=NECD.K*TGDMP.K*TGDMI.K*TGDMA.K*SMOOTH(1-STEP(TGPCS,TGCSY)/100,NECSDT) 21380 A
 TGPCS=0 21400 C
 TGCSY=2200 21410 C
 TGEUD -Total gas- End-use demand (Btu/Yr)
 NECD -Net energy- Centralized demand (Btu/Yr)
 TGDMP -Total gas- Demand multiplier from price (Dimensionless)
 TGDMI -Total gas- Demand multiplier from income (Dimensionless)
 TGDMA -Total gas- Demand multiplier from availability (Dimensionless)
 SMOOTH -First order information delay
 STEP -Step-shaped exogenous input
 TGPCS -Total gas- Policy conservation savings (Fraction/Yr)
 TGCSY -Total gas- Conservation savings initiation year (Year)
 NECSDT -Net energy- Conservation savings development time (Year)

NOTE

TGDNI.K=TABHL(TGDMIT,DEGNP.K/DEGNPI,1,7.0,.4) 21430 A
 TGDMIT=.162/.25/.285/.3/.31/.325/.34/.36/.38/.397/.406/.411/.414/.417/.419/.42 21440 T
 TGDMI -Total gas- Demand multiplier from income (Dimensionless)
 TABHL -Tabular relationship
 TGDMIT -Total gas- Demand multiplier from income table (Table)
 DEGNP -Domestic economy- Gross national product (\$)
 DEGNPI -Domestic economy- Gross national product initial (\$)

NOTE

TGDMP.K=SMOOTH(TABHL(TGDMPT,(TGDP.K/TODP.K)/TGPR70,.8,3.0,.2),NEDAT) 21460 A
 TGDMPT=1.25/1/.83/.71/.63/.56/.50/.45/.42/.38/.36/.33 21470 T
 TGPR70=.38 21480 C
 TGDMP -Total gas- Demand multiplier from price (Dimensionless)
 SMOOTH -First order information delay
 TABHL -Tabular relationship
 TGDMPT -Total gas- Demand multiplier from price table (Table)
 TGDP -Total gas- Delivered price (\$/Btu)
 TODP -Total oil- Delivered price (\$/Btu)
 TGPR70 -Total gas- Price ratio in 1970 (\$/Btu)
 NEDAT -Net energy- Demand adjustment time (Year)

NOTE

TGDMA.K=SMOOTH(TGPDR.K/TOPDR.K,NEAAT)

21500 A

TCDMA -Total gas- Demand multiplier from availability (Dimensionless)
SMOOTH -First order information delay
TGPDR -Total gas- Production demand ratio (Dimensionless)
TOPDR -Total oil- Production demand ratio (Dimensionless)
NEAAT -Net energy- Availability averaging time (Year)

NOTE

TGDP.K=TGP.K+STEP(TGPXT,TGXTY)

21520 A

TGPXT=.50E-6

21610 C

TGXTY=2200

21620 C

TGDP -Total gas- Delivered price (\$/Btu)
TGP -Total gas- Price (\$/3tu)
STEP -Step-shaped exogenous input
TGPXT -Total gas- Policy excise tax (\$/Btu)
TGXTY -Total gas- Excise tax initiation year (Year)

NOTE

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 NOTE Interfuel Substitution -- Oil Demand Subsector
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 NOTE *****
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TOEUD.K-NEPD.K-DCEUD.K-TEEUD.K-TGEUD.K

21720 A

TOEUD -Total oil- End-use demand (Btu/Yr)
 NEPD -Net energy- Potential demand (Btu/Yr)
 DCEUD -Domestic coal- End-use demand (Btu/Yr)
 TEEUD -Total electric- End-use demand (Btu/Yr)
 TGEUD -Total gas- End-use demand (Btu/Yr)

NOTE

TODP.K=TOP.K+STEP(TOPXT TOXTY)

21740 A

TOPXT=.50E-6

21840 C

TOXTY=2200

21850 C

TODP -Total oil- Delivered price (\$/Btu)
 TOP -Total oil- Price (\$/Btu)
 STEP -Step-shaped exogenous input
 TOPXT -Total oil- Policy excise tax (\$/Btu)
 TOXTY -Total oil- Excise tax initiation year (Year)

NOTE

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NOTE Solar-Geothermal Energy Production Subsector

NOTE

NOTE

NOTE

NOTE

DSEUD.K=NED.K*DSDMI.K*DSDMP.K

DSEUD -Decentralized solar- End-use demand (Btu/Yr)

NED -Net energy- Demand (Btu/Yr)

DSDMI -Decentralized solar- Demand multiplier from income (Dimensionless)

DSDMP -Decentralized solar- Demand multiplier from price (Dimensionless)

21960 A

NOTE

DSDMI.K=TABHL(DSDMIT,TIME.K,1950,2030,10)

DSDMIT=0/0/0/0/.009/.014/.019/.023

DSDMI -Decentralized solar- Demand multiplier from income (Dimensionless)

TABHL -Tabular relationship

DSDMIT -Decentralized solar- Demand multiplier from income table (Table)

TIME -Actual time during simulation

21980 A

21990 T

NOTE

DSDMP.K=SMOOTH(TABHL(DSDMPT,(DSP.K/(CEAP.K/CEEUE))/DSPTT,2,1.8,.2),NEDAT)

DSDMPT=7/3.5/1.9/1.3/1/.83/.71/.53/.55

CEEUE=.62

DSDMP -Decentralized solar- Demand multiplier from price (Dimensionless)

SMOOTH -First order information delay

TABHL -Tabular relationship

DSDMPT -Decentralized solar- Demand multiplier from price table (Table)

DSP -Decentralized solar- Price (\$/Btu)

CEAP -Centralized energy- Average price (\$/Btu)

CEEUE -Centralized energy- End-use efficiency (Dimensionless)

DSPTT -Decentralized solar- Price ratio in 1975 (\$/Btu)

NEDAT -Net energy- Demand adjustment time (Year)

22010 A

22020 T

22030 C

DSP.K=TABHL(DSPTT,TIME.K,1950,2030,10)*1E-6

DSPTT=20/20/20/16/14/13/12/11/10

DSPTT=2.75

DSP -Decentralized solar- Price (\$/Btu)

TABHL -Tabular relationship

DSPTT -Decentralized solar- Price table (Table)

TIME -Actual time during simulation

DSPTT -Decentralized solar- Price ratio in 1975 (\$/Btu)

22031 A

22032 T

22033 C

$CEAP.K = (TODP.K * TOCR.K + TGDP.K * TGCR.K + TEP.K * TECR.K + DCP.K * DCCR.K) / CECR.K$

22040 A

CEAP=NEAP50

22060 N

CEAP -Centralized energy- Average price (\$/Btu)
TODP -Total oil- Delivered price (\$/Btu)
TOCR -Total oil- Consumption rate (Btu/Yr)
TGDP -Total gas- Delivered price (\$/Btu)
TGCR -Total gas- Consumption rate (Btu/Yr)
TEP -Total electric- Price (\$/Btu)
TECR -Total electric- Consumption rate (Btu/Yr)
DCP -Domestic coal- Price (\$/Btu)
DCCR -Domestic coal- Consumption rate (Btu/Yr)
CECR -Centralized energy- Consumption rate (Btu/Yr)
NEAP50 -Net energy- Average price in 1950 (\$/Btu)

$CECR.K = TOCR.K + TGCR.K + DCCR.K + TECR.K$

22070 A

CECR -Centralized energy- Consumption rate (Btu/Yr)
TOCR -Total oil- Consumption rate (Btu/Yr)
TGCR -Total gas- Consumption rate (Btu/Yr)
DCCR -Domestic coal- Consumption rate (Btu/Yr)
TECR -Total electric- Consumption rate (Btu/Yr)

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NOTE Gas Production Sector of FOSSIL2
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NOTE Department of Energy
NOTE Energy Transition Project
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NOTE Version Release Date:
NOTE March 1980
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 NOTE Gas Supply-Demand Balance: Capacity Utilization Subsector
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DGCUF.K=DGRCUF.K*DGDSU.K+DGUCUF.K*(1-DGDSU.K) 30230 A

DGCUF -Domestic gas- Capacity utilization factor (Fraction)
 DGRCUF -Domestic gas- Regulated capacity utilization factor (Fraction)
 DGDSU -Domestic gas- Deregulation schedule for CUF (Fraction)
 DGUCUF -Domestic gas- Unregulated capacity utilization factor (Fraction)

DGRCUF.K=MIN(DGRCUFM,DGUCUF.K) 30240 A

DGRCUFM=.8 30250 C

DGRCUF -Domestic gas- Regulated capacity utilization factor (Fraction)
 MIN -Function selecting the smaller of two values
 DGRCUFM -Domestic gas- Regulated capacity utilization factor maximum (Fraction)
 DGUCUF -Domestic gas- Unregulated capacity utilization factor (Fraction)

DGUCUF.K=TABLE(DGCUFT,(DGGD.K-PGCR.K-LNCR.K)/DGPC.K,0,1,1,.1) 30260 A

DGCUFT=0/.1/.2/.3/.4/.5/.6/.7/.8/.9/.9/.9 30270 T

DGUCUF -Domestic gas- Unregulated capacity utilization factor (Fraction)
 TABLE -Tabular relationship
 DGCUFT -Domestic gas- Capacity utilization factor table (Table)
 DGGD -Domestic gas- Gross demand (Btu/Yr)
 PGCR -Pan-am gas- Consumption rate (Btu/Yr)
 LNCR -Liquified natural gas- Consumption rate (Btu/Yr)
 DGPC -Domestic gas- Production capacity (Btu/Yr)

DGDSU.K=SMOOTH(CLIP(0,1,TIME.K,DGDYI),DGEAT) 30280 A

DGDSU -Domestic gas- Deregulation schedule for CUF (Fraction)
 SMOOTH -First order information delay
 CLIP -Function switched during the run
 TIME -Actual time during simulation
 DGDYI -Domestic gas- Deregulation year initial (Year)
 DGEAT -Domestic gas- Economic averaging time (Year)

DGGD.K-TGGD.K-AGCR.K-SNCR.K	30290 A
DGGD -Domestic gas- Gross demand (Btu/Yr)	
TGGD -Total gas- Gross demand (Btu/Yr)	
AGCR -Alaskan gas- Consumption rate (Btu/Yr)	
SNCR -Synthetic natural gas- Consumption rate (Btu/Yr)	
TGGD.K-TGND.K/TGDE	30300 A
TGDE=1	30310 C
TGGD -Total gas- Gross demand (Btu/Yr)	
TGND -Total gas- Net demand (Btu/Yr)	
TGDE -Total gas- Distributional efficiency (Fraction)	
TGND.K-TGEUD.K+OUDG.K	30320 A
TGND -Total gas- Net demand (Btu/Yr)	
TGEUD -Total gas- End-use demand (Btu/Yr)	
OUDG -Oil/gas utilities- Demand for gas (Btu/Yr)	
DGPC.K-CGPC.K+UGPC.K+MGPC.K+HGPC.K	30330 A
DGPC -Domestic gas- Production capacity (Btu/Yr)	
CGPC -Conventional gas- Production capacity (Btu/Yr)	
UGPC -Unconventional gas- Production capacity (Btu/Yr)	
MGPC -Low/medium Btu gas- Production capacity (Btu/Yr)	
HGPC -High-Btu gas- Production capacity (Btu/Yr)	
TGPR.K-DGPR.K+AGCR.K+PGCR.K+LNCR.K+SNCR.K	30340 A
TGPR -Total gas- Production rate (Btu/Yr)	
DGPR -Domestic gas- Production rate (Btu/Yr)	
AGCR -Alaskan gas- Consumption rate (Btu/Yr)	
PGCR -Pan-am gas- Consumption rate (Btu/Yr)	
LNCR -Liquified natural gas- Consumption rate (Btu/Yr)	
SNCR -Synthetic natural gas- Consumption rate (Btu/Yr)	
DGPR.K-CGPR.K+UGPR.K+HGPR.K+MGPR.K	30350 A
DGPR -Domestic gas- Production rate (Btu/Yr)	
CGPR -Conventional gas- Production rate (Btu/Yr)	
UGPR -Unconventional gas- Production rate (Btu/Yr)	
HGPR -High-Btu gas- Production rate (Btu/Yr)	
MGPR -Low/medium Btu gas- Production rate (Btu/Yr)	
TGPDR.K-TGPR.K/TGGD.K	30360 A
TGPDR -Total gas- Production demand ratio (Dimensionless)	
TGPR -Total gas- Production rate (Btu/Yr)	
TGGD -Total gas- Gross demand (Btu/Yr)	
TGPR.K-TGPR.K/(TGGD.K-DGCUR.K)	30370 A
TGPDR=1	30380 N
TGPR -Total gas- Production-consumption ratio (Dimensionless)	
TGPR -Total gas- Production rate (Btu/Yr)	
TGGD -Total gas- Gross demand (Btu/Yr)	
DGCUR -Domestic gas- Curtailments (Btu/Yr)	
TGPDR -Total gas- Production demand ratio (Dimensionless)	

NOTE

DGCUR.K=MAX(0,DGGD.K-PGCR.K-LNCR.K-DGCUF.K*DGPC.K)
 DGCUR -Domestic gas- Curtailments (Btu/Yr)
 MAX -Function selecting the larger of two values
 DGGD -Domestic gas- Gross demand (Btu/Yr)
 PGCR -Pan-am gas- Consumption rate (Btu/Yr)
 LNCR -Liquified natural gas- Consumption rate (Btu/Yr)
 DGCUF -Domestic gas- Capacity utilization factor (Fraction)
 DGPC -Domestic gas- Production capacity (Btu/Yr)

30400 A

DGCURO.K=DGCUR.K*DGPDO
 DGPDO=.8

30410 A

30420 C

DGCURO -Domestic gas- Curtailments to oil (Btu/Yr)
 DGCUR -Domestic gas- Curtailments (Btu/Yr)
 DGPDO -Domestic gas- Fraction demanded as oil (Fraction)

DGCURC.K=DGCUR.K*(1-DGPDO)

30430 A

DGCURC -Domestic gas- Curtailments to coal (Btu/Yr)
 DGCUR -Domestic gas- Curtailments (Btu/Yr)
 DGPDO -Domestic gas- Fraction demanded as oil (Fraction)

DGFEDP.K=TABHL(DGFEDPT,PGWP.K/LNWP.K,C,2,.2)-

30440 A

DGFEDPT=1/.98/.95/.9/.8/.5/.2/.1/.05/.02/0

30450 T

DGFEDP -Domestic gas- Fraction of import demand to Pan-american sources (Fraction)
 TABHL -Tabular relationship
 DGFEDPT -Domestic gas- FEDP table (Table)
 PGWP -Pan-am gas- Wellhead price (\$/Btu)
 LNWP -Liquified natural gas- Wellhead price (\$/Btu)

DGIMD.K=DGGD.K-PGCR.K-LNCR.K-.85*DGPC.K

30460 A

DGIMD -Domestic gas- Import demand (Btu/Yr)
 DGGD -Domestic gas- Gross demand (Btu/Yr)
 PGCR -Pan-am gas- Consumption rate (Btu/Yr)
 LNCR -Liquified natural gas- Consumption rate (Btu/Yr)
 DGPC -Domestic gas- Production capacity (Btu/Yr)

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 NOTE Gas Supply-Demand Balance Pricing Subsector
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TGP.K=(DGWP.K*DGPR.K+AGWP.K*AGCR.K+PGWP.K*PGCR.K+LNWP.K*LNCR.K+SNWP.K*SNCR.K)/TGPR.K+TGDCHG
 TGP=.98E-6
 TGDCHG=.80E-6

30550 A
 30570 N
 30580 C

TGP -Total gas- Price (\$/Btu)
 DGWP -Domestic gas- Wellhead price (\$/Btu)
 DGPR -Domestic gas- Production rate (Btu/Yr)
 AGWP -Alaskan gas- Wellhead price (\$/Btu)
 AGCR -Alaskan gas- Consumption rate (Btu/Yr)
 PGWP -Pan-am gas- Wellhead price (\$/Btu)
 PGCR -Pan-am gas- Consumption rate (Btu/Yr)
 LNWP -Liquified natural gas- Wellhead price (\$/Btu)
 LNCR -Liquified natural gas- Consumption rate (Btu/Yr)
 SNWP -Synthetic natural gas- Wellhead price (\$/Btu)
 SNCR -Synthetic natural gas- Consumption rate (Btu/Yr)
 TGPR -Total gas- Production rate (Btu/Yr)
 TGDCHG -Total gas- Delivery charge (\$/Btu)

DGWP.K=(DGUWP.K*DGDS.K+DGRWP.K*(1-DGDS.K))*(CGPR.K/DGPR.K)+DGUWP.K*(1-(CGPR.K/DGPR.K))
 DGWP=.19E-6

30590 A
 30600 N

DGWP -Domestic gas- Wellhead price (\$/Btu)
 DGUWP -Domestic gas- Unregulated wellhead price (\$/Btu)
 DGDS -Domestic gas- Deregulation schedule (Dimensionless)
 DGRWP -Domestic gas- Regulated wellhead price (\$/Btu)
 CGPR -Conventional gas- Production rate (Btu/Yr)
 DGPR -Domestic gas- Production rate (Btu/Yr)

DGDS.K=SMOOTH(CLIP(1 0,TIME K,DGDYI),DGDRT)
 DGDYI=1979
 DGDRT=6

30610 A
 30620 C
 30630 C

DGDS -Domestic gas- Deregulation schedule (Dimensionless)
 SMOOTH -First order information delay
 CLIP -Function switched during the run
 TIME -Actual time during simulation
 DGDYI -Domestic gas- Deregulation year initial (Year)
 DGDRT -Domestic gas- Deregulation adjustment time (Year)

DGUWP.K=MAX(DGCCPS.K,DGPMN.K*DGPMN.K+DGACST.K)

30640 A

DGUWP -Domestic gas- Unregulated wellhead price (\$/Btu)
 MAX -Function selecting the larger of two values
 DGCCPS -Domestic gas- Ceiling price schedule (\$/Btu)
 DGPMN -Domestic gas- Profit margin normal (\$/Btu)
 DGPMH -Domestic gas- Price multiplier (Dimensionless)
 DGACST -Domestic gas- Average cost (\$/Btu)

DGRWP.K=DGPMN.K+DGACST.K 30650 A
 DGRWP -Domestic gas- Regulated wellhead price (\$/Btu)
 DGPMN -Domestic gas- Profit margin normal (\$/Btu)
 DGACST -Domestic gas- Average cost (\$/Btu)

DGACST.K=DGCST.K/DGPR.K 30660 A
 DGACST -Domestic gas- Average cost (\$/Btu)
 DGCST -Domestic gas- Cost (\$/Yr)
 DGPR -Domestic gas- Production rate (Btu/Yr)

DGPMN.K=DGROEN.K*DGEQ.K/(DGPC.K*DGCUFN*(1-DGTR)) 30670 A
 DGPMN -Domestic gas- Profit margin normal (\$/Btu)
 DGROEN -Domestic gas- Normal return on equity (Fraction/Yr)
 DGEQ -Domestic gas- Equity (\$)
 DGPC -Domestic gas- Production capacity (Btu/Yr)
 DGCUFN -Domestic gas- Capacity utilization factor normal (Fraction)
 DGTR -Domestic gas- Tax rate (Fraction)

DGROEN.K=CLIP(DGPROEN,DGHROEN,TIME.K,DGRPY)+DEINF.K 30680 A
 DGHROEN=.10 30690 C
 DGPROEN=.25 30700 C
 DGRPY=2200 30710 C
 DGROEN -Domestic gas- Normal return on equity (Fraction/Yr)
 CLIP -Function switched during the run
 DGPROEN -Domestic gas- Policy return on equity normal (Fraction/Yr)
 DGHROEN -Domestic gas- Historical return on equity normal (Fraction/Yr)
 TIME -Actual time during simulation
 DGRPY -Domestic gas- ROE regulation policy initiation year (Year)
 DEINF -Domestic economy- Inflation rate (Fraction/Yr)

DGPMH.K=TABHL(DGPMHT,DGGD.K/(DGPC.K*DGCUFN),.6,1.6,.2) 30720 A
 DGPMHT=0/.3/1/1.7/2.8/5 30730 T
 DGCUFN=.80 30740 C
 DGPMH -Domestic gas- Price multiplier (Dimensionless)
 TABHL -Tabular relationship
 DGPMHT -Domestic gas- Price multiplier table (Table)
 DGGD -Domestic gas- Gross demand (Btu/Yr)
 DGPC -Domestic gas- Production capacity (Btu/Yr)
 DGCUFN -Domestic gas- Capacity utilization factor normal (Fraction)

DGCPST.K=CLIP(TABHL(DGCPST,TIME.K,1978,1985,1)*1E-6,0,TIME.K,DGDYI) 30750 A
 DGCPST=0/1.92/1.99/2.06/2.14/2.23/2.32/2.42 30760 T
 DGCPST -Domestic gas- Ceiling price schedule (\$/Btu)
 CLIP -Function switched during the run
 TABHL -Tabular relationship
 DGCPST -Domestic gas- Ceiling price schedule table (Table)
 TIME -Actual time during simulation
 DGDYI -Domestic gas- Deregulation year initial (Year)

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NOTE Gas Financing: Source of Funds Subsector

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DGNI.K=(1-DGTR)*(DGREV.K-DGCST.K)+DGITC*DGNPC.K+UGNTC.K*UGPR.K

30860 A

DGTR=.35

30870 C

DGITC=.07

30880 C

DGNI -Domestic gas- Net income (\$/Yr)
DGTR -Domestic gas- Tax rate (Fraction)
DGREV -Domestic gas- Revenue (\$/Yr)
DGCST -Domestic gas- Cost (\$/Yr)
DGITC -Domestic gas- Investment tax credit (Fraction)
DGNPC -Domestic gas- New plants completed (\$/Yr)
UGNTC -Unconventional gas- Ness tax credit (\$/Btu)
UGPR -Unconventional gas- Production rate (Btu/Yr)

DGREV.K=(DGWP.K+DGG.S.K)*DGPR.K

30890 A

DGREV -Domestic gas- Revenue (\$/Yr)
DGWP -Domestic gas- Wellhead price (\$/Btu)
DGG.S -Domestic gas- Government subsidy (\$/Btu)
DGPR -Domestic gas- Production rate (Btu/Yr)

DGG.S.K=(UGGS.K*UGPR.K)/DGPR.K+(MGGS.K*MGPR.K+HGGS.K*HGPR.K)/DGPR.K

30900 A

DGG.S -Domestic gas- Government subsidy (\$/Btu)
UGGS -Unconventional gas- Government subsidy (\$/Btu)
UGPR -Unconventional gas- Production rate (Btu/Yr)
DGPR -Domestic gas- Production rate (Btu/Yr)
MGGS -Low/medium Btu gas- Government subsidy (\$/Btu)
MGPR -Low/medium Btu gas- Production rate (Btu/Yr)
HGGS -High-Btu gas- Government subsidy (\$/Btu)
HGPR -High-Btu gas- Production rate (Btu/Yr)

DGCST.K=CGCST.K+UGCST.K+HGCST.K+MGCST.K+DGDEP.K+DGINT.K

30910 A

DGCST -Domestic gas- Cost (\$/Yr)
CGCST -Conventional gas- Cost (\$/Yr)
UGCST -Unconventional gas- Cost (\$/Yr)
HGCST -High-Btu gas- Cost (\$/Yr)
MGCST -Low/medium Btu gas- Cost (\$/Yr)
DGDEP -Domestic gas- Depreciation (\$/Yr)
DGINT -Domestic gas- Interest (\$/Yr)

NOTE

DGGA.K=DGGA.J+(DT)(DGINV.J-DGGAR.J<-DGVLI.JK)

30940 L

DGGA=3.2E9

30950 N

DGGA -Domestic gas- Gross assets (\$)
DT -Time increment between calculations
DGINV -Domestic gas- Investment (\$/Yr)
DGGAR -Domestic gas- Gross asset retirements (\$/Yr)
DGVLI -Domestic gas- Value loss due to inflation (\$/Yr)

DGGAR.KL=DGGA.K*DGARF.K

30960 R

DGGAR -Domestic gas- Gross asset retirements (\$/Yr)
DGGA -Domestic gas- Gross assets (\$)
DGARF -Domestic gas- Asset retirement factor (Fraction/Yr)

DGARF.K=(CGPA.K*CGARF+UGPA.K*UGARF+MGPA.K*MGARF+HGPA.K*HGARF)/DGPA.K

30970 A

DGARF -Domestic gas- Asset retirement factor (Fraction/Yr)
CGPA -Conventional gas- Physical assets (\$)
CGARF -Conventional gas- Asset retirement factor (Fraction/Yr)
UGPA -Unconventional gas- Physical assets (\$)
UGARF -Unconventional gas- Asset retirement factor (Fraction/Yr)
MGPA -Low/medium Btu gas- Physical assets (\$)
MGARF -Low/medium Btu gas- Asset retirement factor (Fraction/Yr)
HGPA -High-Btu gas- Physical assets (\$)
HGARF -High-Btu gas- Asset retirement factor (Fraction/Yr)
DGPA -Domestic gas- Physical assets (\$)

DGVLI.KL=DGGA.K*DEINF.K*(1-STEP(1,DGPLAY))

30980 R

DGPLAY=2200

30990 C

DGVLI -Domestic gas- Value loss due to inflation (\$/Yr)
DGGA -Domestic gas- Gross assets (\$)
DEINF -Domestic economy- Inflation rate (Fraction/Yr)
STEP -Step-shaped exogenous input
DGPLAY -Domestic gas- Price-level accounting initiation year (Year)

NOTE

DGNA.K=DGGA.K*DGADF

31010 A

DGADF=.50

31020 C

DGNA -Domestic gas- Net assets (\$)
DGGA -Domestic gas- Gross assets (\$)
DGADF -Domestic gas- Accumulated depreciation fraction (Fraction)

DGEQ.K=DGNA.K*DGEF

31030 A

DGEF=.95

31040 C

DGEQ -Domestic gas- Equity (\$)
DGNA -Domestic gas- Net assets (\$)
DGEF -Domestic gas- Equity fraction (Fraction)

DGDEBT.K=DGNA.K*DGDF

31050 A

DGDF=(30/70)*DGEF

31060 N

DGDEBT -Domestic gas- Debt (\$)
DGNA -Domestic gas- Net assets (\$)
DGDF -Domestic gas- Debt fraction (Fraction)
DGEF -Domestic gas- Equity fraction (Fraction)

DGINT.K=DGIR.K*DGDEBT.K

31070 A

DGINT -Domestic gas- Interest (\$/Yr)

DGIR -Domestic gas- Interest rate (Fraction/Yr)

DGDEBT -Domestic gas- Debt (\$)

DGIR.K=DGIRN+DEINF.K

31080 A

DGIRN=.025

31090 C

DGIR -Domestic gas- Interest rate (Fraction/Yr)

DGIRN -Domestic gas- Interest rate normal (Fraction/Yr)

DEINF -Domestic economy- Inflation rate (Fraction/Yr)

DGDRMT.K=DGDEBT.K/DGDL

31100 A

DGDL=10

31110 C

DGDRMT -Domestic gas- Debt repayment (\$/Yr)

DGDEBT -Domestic gas- Debt (\$)

DGDL -Domestic gas- Debt life (Year)

DGDEP.K=DGGA.K/DGBLC

31120 A

DGBLC=17

31130 C

DGDEP -Domestic gas- Depreciation (\$/Yr)

DGGA -Domestic gas- Gross assets (\$)

DGBLC -Domestic gas- Book life of capital (Year)

NOTE:

DGIF.K=DGNI.K-DGDIV.K+DGDEP.K-DGDRMT.K

31150 A

DGIF -Domestic gas- Internal funds (\$/Yr)

DGNI -Domestic gas- Net income (\$/Yr)

DGDIV -Domestic gas- Dividends (\$/Yr)

DGDEP -Domestic gas- Depreciation (\$/Yr)

DGDRMT -Domestic gas- Debt repayment (\$/Yr)

DGDIV.K=TABHL(DGDPOT,DGROI.K/DGEOIM.K,.8,2,-4)*DGNI.K

31160 A

DGDPOT=.6/.5/.35/.25

31170 T

DGDIV -Domestic gas- Dividends (\$/Yr)

TABHL -Tabular relationship

DGDPOT -Domestic gas- Dividend payout table (Table)

DGROI -Domestic gas- Return on investment (Fraction/Yr)

DGROIN -Domestic gas- Return on investment normal (Fraction/Yr)

DGNI -Domestic gas- Net income (\$/Yr)

$DGROI.K = (DGNI.K + DGINT.K) / (DGEQ.K + DGDEBT.K)$ 31180 A
 DGROI -Domestic gas- Return on investment (Fraction/Yr)
 DGNI -Domestic gas- Net income (\$/Yr)
 DGINT -Domestic gas- Interest (\$/Yr)
 DGEQ -Domestic gas- Equity (\$)
 DGDEBT -Domestic gas- Debt (\$)

$DGROIN.K = DGROIR + SMOOTH(DEINF.K, DGEAT)$ 31190 A
 $DGROIR = .08$ 31200 C
 DGROIN -Domestic gas- Return on investment normal (Fraction/Yr)
 DGROIR -Domestic gas- Return on investment real (Fraction/Yr)
 SMOOTH -First order information delay
 DEINF -Domestic economy- Inflation rate (Fraction/Yr)
 DGEAT -Domestic gas- Economic averaging time (Year)

$DGROIX.K = SMOOTH(DGROI.K / DGROIN.K, DGEAT)$ 31210 A
 $DGEAT = 5$ 31220 C
 DGROIX -Domestic gas- Return on investment index (Dimensionless)
 SMOOTH -First order information delay
 DGROI -Domestic gas- Return on investment (Fraction/Yr)
 DGROIN -Domestic gas- Return on investment normal (Fraction/Yr)
 DGEAT -Domestic gas- Economic averaging time (Year)

NOTE

$DGFA.K = DGIF.K + DGEFA.K$ 31240 A
 DGFA -Domestic gas- Funds available (\$/Yr)
 DGIF -Domestic gas- Internal funds (\$/Yr)
 DGEFA -Domestic gas- External funds available (\$/Yr)

$DGEFA.K = DGGR.K * MAX(DGGA.K, DGPAMI)$ 31250 A
 DGEFA -Domestic gas- External funds available (\$/Yr)
 DGGR -Domestic gas- Growth rate (Fraction/Yr)
 MAX -Function selecting the larger of two values
 DGGA -Domestic gas- Gross assets (\$)
 DGPAMI -Domestic gas- Physical assets of a mature industry (\$)

$DGGR.K = TABHL(DGGRT, DGROIX.K, .3, .3, .3)$ 31260 A
 $DGGRT = 0/.025/.052/.07/.09/.105/.12/.13/.14/.15/.15$ 31270 T
 DGGR -Domestic gas- Growth rate (Fraction/Yr)
 TABHL -Tabular relationship
 DGGRT -Domestic gas- Growth rate table (Table)
 DGROIX -Domestic gas- Return on investment index (Dimensionless)

NOTE

DGFN.K=MAX(0,(DGFFPA.K-DGPA.K-DGPUC.K+DGAFACT.K*DGARF.K*(DGPA.K+DGFFPA.K)/2)/DGFCEN)

31290 A

DGFCEN=.85

31310 C

DGFN -Domestic gas- Funds needed (\$/Yr)
 MAX -Function selecting the larger of two values
 DGFFPA -Domestic gas- Future physical assets (\$)
 DGPA -Domestic gas- Physical assets (\$)
 DGPUC -Domestic gas- Plants under construction (\$)
 DGAFACT -Domestic gas- Average facility construction time (Year)
 DGARF -Domestic gas- Asset retirement factor (Fraction/Yr)
 DGFCEN -Domestic gas- Fraction to capital expenditures normal (Fraction)

DGFFPA.K=DGNPA.K*EXP(DGNPA.K/DGSPA.K-1)

31320 A

DGFFPA -Domestic gas- Future physical assets (\$)
 DGNPA -Domestic gas- Normal physical assets (\$)
 EXP -Exponential function
 DGSPA -Domestic gas- Smoothed physical assets (\$)

DGNPA.K=DGGD.K/DGCUFN*DGCC.K

31330 A

DGNPA -Domestic gas- Normal physical assets (\$)
 DGGD -Domestic gas- Gross demand (Btu/Yr)
 DGCUFN -Domestic gas- Capacity utilization factor normal (Fraction)
 DGCC -Domestic gas- Capital cost (\$/(Btu/Yr))

DGSPA.K=DGSPA.J+(DT)(DGNPA.J-DGSPA.J)/DGAFACT.J

31340 L

DGSPA=DGSPA1

31350 N

DGSPA1=1.8E9

31360 C

DGSPA -Domestic gas- Smoothed physical assets (\$)
 DT -Time increment between calculations
 DGNPA -Domestic gas- Normal physical assets (\$)
 DGAFACT -Domestic gas- Average facility construction time (Year)
 DGSPA1 -Domestic gas- Smoothed physical assets initial (\$)

DGCC.K=DGPA.K/DGPC.K

31370 A

DGCC -Domestic gas- Capital cost (\$/(Btu/Yr))
 DGPA -Domestic gas- Physical assets (\$)
 DGPC -Domestic gas- Production capacity (Btu/Yr)

DGPA.K=CGPA.K+UGPA.K+MGPA.K+HGPA.K

31380 A

DGPA -Domestic gas- Physical assets (\$)
 CGPA -Conventional gas- Physical assets (\$)
 UGPA -Unconventional gas- Physical assets (\$)
 MGPA -Low/medium Btu gas- Physical assets (\$)
 HGPA -High-Btu gas- Physical assets (\$)

DGPUC.K=CGPUC.K+UGPUC.K+MGPUC.K+HGPUC.K

31390 A

DGPUC -Domestic gas- Plants under construction (\$)
 CGPUC -Conventional gas- Plants under construction (\$)
 UGPUC -Unconventional gas- Plants under construction (\$)
 MGPUC -Low/medium-btu gas- Plants under construction (\$)
 HGPUC -High-btu gas- Plants under construction (\$)

DGAFCT.K=((CGFCR.JK+UGFCR.JK)*NGFCT+MGFCR.JK*MGFCT.K+HGFCR.JK*HGFCT.K)/DGNPC.K

31400 A

DGAFCT -Domestic gas- Average facility construction time (Year)
 CGFCR -Conventional gas- Facility completion rate (\$/Yr)
 UGFCR -Unconventional gas- Facility completion rate (\$/Yr)
 NGFCT -Natural gas- Facility construction time (Year)
 MGFCR -Low/medium Btu gas- Facility completion rate (\$/Yr)
 MGFCT -Low/medium Btu gas- Facility construction time (Year)
 HGFCR -High-Btu gas- Facility completion rate (\$/Yr)
 HGFCT -High-Btu gas- Facility construction time (Year)
 DGNPC -Domestic gas- New plants completed (\$/Yr)

DGNPC.K=CGFCR.JK+UGFCR.JK+MGFCR.JK+HGFCR.JK

31420 A

DGNPC -Domestic gas- New plants completed (\$/Yr)
 CGFCR -Conventional gas- Facility completion rate (\$/Yr)
 UGFCR -Unconventional gas- Facility completion rate (\$/Yr)
 MGFCR -Low/medium Btu gas- Facility completion rate (\$/Yr)
 HGFCR -High-Btu gas- Facility completion rate (\$/Yr)

NOTE

DGINV.K=MAX(0,MIN(DGFA.K,DGFN.K)*DGFCE.K*DGCEL.K)

31440 A

DGINV -Domestic gas- Investment (\$/Yr)
 MAX -Function selecting the larger of two values
 MIN -Function selecting the smaller of two values
 DGFA -Domestic gas- Funds available (\$/Yr)
 DGFN -Domestic gas- Funds needed (\$/Yr)
 DGFCE -Domestic gas- Fraction to capital expenditures (Fraction)
 DGCEL -Domestic gas- Capital expenditure limit (Fraction)

DGFCE.K=TABHL(DGFCET,DGROIX.K,0,1.5,.3)

31450 A

DGFCET=0/.25/.4/.75/.85/.93

31460 T

DGFCE -Domestic gas- Fraction to capital expenditures (Fraction)
 TABHL -Tabular relationship
 DGFCET -Domestic gas- Fraction to capital expenditures table (Table)
 DGROIX -Domestic gas- Return on investment index (Dimensionless)

DGCEL.K=TABHL(DGCELT,DGGRI.K,0,.35,.05)

31470 A

DGCELT=1/1/1/1/1/.8/.4/0

31480 T

DGCEL -Domestic gas- Capital expenditure limit (Fraction)
 TABHL -Tabular relationship
 DGCELT -Domestic gas- Capital expenditure limit table (Table)
 DGGRI -Domestic gas- Growth rate indicated (Fraction/Yr)

DGGRI.K=(DGAGR.K/SMOOTH(DGAGR.K,DGTGR)-1)/DGTGR

31490 A

DGGRI -Domestic gas- Growth rate indicated (Fraction/Yr)
 DGAGR -Domestic gas- Assets for growth rate (\$)
 SMOOTH -First order information delay
 DGTGR -Domestic gas- Time for growth rate (Year)

DGAGR.K=DGPA.K+DGPUC.K

31500 A

DGAGR -Domestic gas- Assets for growth rate (\$)
 DGPA -Domestic gas- Physical assets (\$)
 DGPUC -Domestic gas- Plants under construction (\$)

NOTE

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 NOTE Gas Financing: Use of Funds Subsector
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CGINV.KL=DGINV.K*(CGAW.K/DGAU.K) 31600 R
 CGINV=.4E9 31610 N

CGINV -Conventional gas- Investment (\$/Yr)
 DGINV -Domestic gas- Investment (\$/Yr)
 CGAW -Conventional gas- Allocation weight (Dimensionless)
 DGAU -Domestic gas- Allocation weight (Dimensionless)

CGAW.K=(CGMCST.K*1E6)^DGWF 31620 A
 CGAW -Conventional gas- Allocation weight (Dimensionless)
 CGMCST -Conventional gas- Marginal cost (\$/Btu)
 DGWF -Domestic gas- Weighting factor (Dimensionless)

CGMCST.K=CGCCR*CGSCC.K+CGOMC.K 31630 A
 CGCCR=.151 31640 C

CGMCST -Conventional gas- Marginal cost (\$/Btu)
 CGCCR -Conventional gas- Capital charge rate (Fraction/Yr)
 CGSCC -Conventional gas- Specific capital cost (\$/(Btu/Yr))
 CGOMC -Conventional gas- Operating and maintenance (O&M) cost (\$/Btu)

CGSCC.K=CGCC.K*CGSCH.K/DGCUFN 31650 A
 CGSCC -Conventional gas- Specific capital cost (\$/(Btu/Yr))
 CGCC -Conventional gas- Capital cost (\$/(Btu/Yr))
 CGSCH -Conventional gas- Secondary constraint multiplier (Dimensionless)
 DGCUFN -Domestic gas- Capacity utilization factor normal (Fraction)

CGSCH.K=TABHL(DGSCMT,CGGRI.K,.04,.2D,.04) 31660 A
 DGSCMT=1/1/1.5/2.1/3.0 31670 T
 CGSCH -Conventional gas- Secondary constraint multiplier (Dimensionless)
 TABHL -Tabular relationship
 DGSCMT -Domestic gas- Secondary constraint multiplier table (Table)
 CGGRI -Conventional gas- Growth rate indicated (Fraction/Yr)

CGGRI.K=(CGAGR.K/SMOOTH(CGAGR.K,DGTGR)-1)/DGTGR 31680 A
 DGTGR=2 31690 C
 CGGRI -Conventional gas- Growth rate indicated (Fraction/Yr)
 CGAGR -Conventional gas- Assets for growth rate (\$)
 SMOOTH -First order information delay
 DGTGR -Domestic gas- Time for growth rate (Year)

CGAGR.K=MAX(DGPAMI,CGPA.K+CGPUC.K) 31700 A
 CGAGR -Conventional gas- Assets for growth rate (\$)
 MAX -Function selecting the larger of two values
 DGPAMI -Domestic gas- Physical assets of a mature industry (\$)
 CGPA -Conventional gas- Physical assets (\$)
 CGPUC -Conventional gas- Plants under construction (\$)

NOTE

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UGINV.KL=DGINV.K*(UGAW.K/DCAW.K) 31750 R
 UGINV=0 31760 N
 UGINV -Unconventional gas- Investment (\$/Yr)
 DGINV -Domestic gas- Investment (\$/Yr)
 UGAW -Unconventional gas- Allocation weight (Dimensionless)
 DCAW -Domestic gas- Allocation weight (Dimensionless)

 UGAW.K=(UGSP.K*1E6)^DGWF*STEP(1,UGCY) 31770 A
 UGCY=1980 31780 C
 UGAW -Unconventional gas- Allocation weight (Dimensionless)
 UGSP -Unconventional gas- Support price (\$/Btu)
 DGWF -Domestic gas- Weighting factor (Dimensionless)
 STEP -Step-shaped exogenous input
 UGCY -Unconventional gas- Commercialization year (Year)

 UGSP.K=UGMCST.K-UGGS.K-UGNTC.K 31790 A
 UGSP -Unconventional gas- Support price (\$/Btu)
 UGMCST -Unconventional gas- Marginal cost (\$/Btu)
 UGGS -Unconventional gas- Government subsidy (\$/Btu)
 UGNTC -Unconventional gas- Ness tax credit (\$/Btu)

 UGMCST.K=(UGCCR+UGECR.K)*UGSCC.K+UGCMC.K 31800 A
 UGCCR=.151 31810 C
 UGMCST -Unconventional gas- Marginal cost (\$/Btu)
 UGCCR -Unconventional gas- Capital charge rate (Fraction/Yr)
 UGECR -Unconventional gas- Excess charge due to risk (Fraction/Yr)
 UGSCC -Unconventional gas- Specific capital cost (\$/(Btu/Yr))
 UGOMC -Unconventional gas- Operating and maintenance <O&M> cost (\$/Btu)

 UGECR.K=UGCCRR*MAX(0,(DGPAMI-UGPA.K)/DGPAMI) 31820 A
 UGCCRR=.068 31830 C
 UGECR -Unconventional gas- Excess charge due to risk (Fraction/Yr)
 UGCCRR -Unconventional gas- Capital charge due to risk (Fraction/Yr)
 MAX -Function selecting the larger of two values
 DGPAMI -Domestic gas- Physical assets of a mature industry (\$)
 UGPA -Unconventional gas- Physical assets (\$)

 UGSCC.K=UGCC.K*UGSCM.K/DGCUFP 31840 A
 UGSCC -Unconventional gas- Specific capital cost (\$/(Btu/Yr))
 UGCC -Unconventional gas- Capital cost (\$/(Btu/Yr))
 UGSCM -Unconventional gas- Secondary constraint multiplier (Dimensionless)
 DGCUFP -Domestic gas- Capacity utilization factor for planning (Fraction)

UGSCM.K-TABHL(DGSCMT,UGGRI.K,.04,.20,.04) 31850 A
 UGSCM -Unconventional gas- Secondary constraint multiplier (Dimensionless)
 TABHL -Tabular relationship
 DGSCMT -Domestic gas- Secondary constraint multiplier table (Table)
 UGGRI -Unconventional gas- Growth rate indicated (Fraction/Yr)

UGGRI.K=(UGAGR.K/SMOOTH(UGAGR.K,DGTGR)-1)/DGTGR 31860 A
 UGGRI -Unconventional gas- Growth rate indicated (Fraction/Yr)
 UGAGR -Unconventional gas- Assets for growth rate (\$)
 SMOOTH -First order information delay
 DGTGR -Domestic gas- Time for growth rate (Year)

UGAGR.K=MAX(DGPAMI,UGPA.K+UGPUC.K) 31870 A
 UGAGR -Unconventional gas- Assets for growth rate (\$)
 MAX -Function selecting the larger of two values
 DGPAMI -Domestic gas- Physical assets of a mature industry (\$)
 UGPA -Unconventional gas- Physical assets (\$)
 UGPUC -Unconventional gas- Plants under construction (\$)

UGGS.K=CLIP(0,STEP(MAX(0,UGSCST.K-DGWP.K),UGPSY),UGPR.K/TCPR.K,UGDMS) 31880 A
 UGDMS=1 31890 C
 UGGS -Unconventional gas- Government subsidy (\$/Btu)
 CLIP -Function switched during the run
 STEP -Step-shaped exogenous input
 MAX -Function selecting the larger of two values
 UGSCST -Unconventional gas- Support cost (\$/Btu)
 DGWP -Domestic gas- Wellhead price (\$/Btu)
 UGPSY -Unconventional gas- Price-support initiation year (Year)
 UGPR -Unconventional gas- Production rate (Btu/Yr)
 TCPR -Total gas- Production rate (Btu/Yr)
 UGDMS -Unconventional gas- Desired market share (Fraction)

UGSCST.K=(UGCCR+UGEGR.K)*(UGCC.K/DCCUFP)+UGOMC.K 31900 A
 UGPSY=2200 31910 C
 UGSCST -Unconventional gas- Support cost (\$/Btu)
 UGCCR -Unconventional gas- Capital charge rate (Fraction/Yr)
 UGEGR -Unconventional gas- Excess charge due to risk (Fraction/Yr)
 UGCC -Unconventional gas- Capital cost (\$/(Btu/Yr))
 DCCUFP -Domestic gas- Capacity utilization factor for planning (Fraction)
 UGOMC -Unconventional gas- Operating and maintenance <O&M> cost (\$/Btu)
 UGPSY -Unconventional gas- Price-support initiation year (Year)

UGNTC.K=UGNTCM*TABHL(SHNTCT,OOP.K,3.11E-6,3.91E-6,.80E-6)*STEP(1,UGNTCY) 31920 A
 UGNTCM=.40E-6 31930 C
 UGNTCY=2200 31940 C
 UGNTC -Unconventional gas- Ness tax credit (\$/Btu)
 UGNTCM -Unconventional gas- Ness tax credit multiplier (Dimensionless)
 TABHL -Tabular relationship
 SHNTCT -Shale oil- Ness tax credit table (Table)
 OOP -OPEC oil- Price (\$/Btu)
 STEP -Step-shaped exogenous input
 UGNTCY -Unconventional gas- Ness tax credit initiation year (Year)

NOTE

HGINV.KL-DGINV.K*(HGAW.K/DGAW.K)

31960 R

HGINV=0

31970 N

HGINV -High-Btu gas- Investment (\$/Yr)
 DGINV -Domestic gas- Investment (\$/Yr)
 HGAW -High-Btu gas- Allocation weight (Dimensionless)
 DGAW -Domestic gas- Allocation weight (Dimensionless)

HGAW.K=(HGSP.K*1E6)^DGWF

31980 A

HGAW -High-Btu gas- Allocation weight (Dimensionless)
 HGSP -High-btu gas- Support price (\$/Btu)
 DGWF -Domestic gas- Weighting factor (Dimensionless)

HGSP.K=HGMCSST.K-HGGS.K

31990 A

HGSP -High-btu gas- Support price (\$/Btu)
 HGMCSST -High-Btu gas- Marginal cost (\$/Btu)
 HGGS -High-Btu gas- Government subsidy (\$/Btu)

HGMCSST.K=(SGCCCR+HGECCR.K+HGEIDC.K)*HGSICC.K+HGOMC+HGFCST.K

32000 A

SGCCCR=.121

32010 C

HGMCSST -High-Btu gas- Marginal cost (\$/Btu)
 SGCCCR -Synthetic gas- Capital charge rate (Fraction/Yr)
 HGECCR -High-Btu gas- Excess charge due to risk (Fraction/Yr)
 HGEIDC -High-Btu gas- Excess charge due to interest under const. (Fraction/Yr)
 HGSICC -High-Btu gas- Specific capital cost (\$/(Btu/Yr))
 HGOMC -High-Btu gas- Operating and maintenance <O&M> cost (\$/Btu)
 HGFCST -High-Btu gas- Feedstock cost (\$/Btu)

HGECCR.K=SGCCRR*(1-STEP(1,HGLGY))*MAX(0,(DGPAMI-HGPA.K)/DGPAMI)

32020 A

SGCCRR=.059

32030 C

HGLGY=2200

32040 C

HGECCR -High-Btu gas- Excess charge due to risk (Fraction/Yr)
 SGCCRR -Synthetic gas- Capital charge due to risk (Fraction/Yr)
 STEP -Step-shaped exogenous input
 HGLGY -High-Btu gas- Loan guarantee initiation year (Year)
 MAX -Function selecting the larger of two values
 DGPAMI -Domestic gas- Physical assets of a mature industry (\$)
 HGPA -High-Btu gas- Physical assets (\$)

HGEIDC.K=SGCCRC*(1-STEP(1,HGDCY))

32050 A

SGCCRC=.004

32060 C

HGEIDC -High-Btu gas- Excess charge due to interest under const. (Fraction/Yr)
 SGCCRC -Synthetic gas- Capital charge due to interest under const. (Fraction/Yr)
 STEP -Step-shaped exogenous input
 HGDCY -High-Btu gas- Construction delay change year (Year)

HGSCC.K=HGCC.K*HGSCM.K/DGCUFP

HGSCC -High-Btu gas- Specific capital cost (\$/(Btu/Yr))
HGCC -High-Btu gas- Capital cost (\$/(Btu/Yr))
HGSCM -High-Btu gas- Secondary constraint multiplier (Dimensionless)
DGCUFP -Domestic gas- Capacity utilization factor for planning (Fraction)

32070 A

HGSCM.K=TABHL(DGSCMT,HGGRI.K,.04,.20,.04)

HGSCM -High-Btu gas- Secondary constraint multiplier (Dimensionless)
TABHL -Tabular relationship
DGSCMT -Domestic gas- Secondary constraint multiplier table (Table)
HGGRI -High-Btu gas- Growth rate indicated (Fraction/Yr)

32080 A

HGGRI.K=(HGAGR.K/SMOOTH(HGAGR.K,DGTGR)-1)/DGTGR

HGGRI -High-Btu gas- Growth rate indicated (Fraction/Yr)
HGAGR -High-Btu gas- Assets for growth rate (\$)
SMOOTH -First order information delay
DGTGR -Domestic gas- Time for growth rate (Year)

32090 A

HGAGR.K=MAX(DGPAMI,HGPA.K+HGPEC.K)

HGAGR -High-Btu gas- Assets for growth rate (\$)
MAX -Function selecting the larger of two values
DGPAMI -Domestic gas- Physical assets of a mature industry (\$)
HGPA -High-Btu gas- Physical assets (\$)
HGPEC -High-Btu gas- Plants under construction (\$)

32100 A

HGGS.K=CLIP(0,STEP(MAX(0,HGSCST.K-DGWP.K),HGPSY),HGPR.K/TGPR.K,HGDMS)

HGDMS=1

HGPSY=2200

HGGS -High-Btu gas- Government subsidy (\$/Btu)
CLIP -Function switched during the run
STEP -Step-shaped exogenous input
MAX -Function selecting the larger of two values
HGSCST -High-Btu gas- Support cost (\$/Btu)
DGWP -Domestic gas- Wellhead price (\$/Btu)
HGPSY -High-Btu gas- Price-support initiation year (Year)
HGPR -High-Btu gas- Production rate (Btu/Yr)
TGPR -Total gas- Production rate (Btu/Yr)
HGDMS -High-Btu gas- Desired market share (Fraction)

32110 A

32120 C

32130 C

HGSCST.K=(SGCCR+HGEER.K+HGEIDC.K)*(HGCC.E/DGCUFP)+HGOMC+HGFCST.K

HGSCST -High-Btu gas- Support cost (\$/Btu)
SGCCR -Synthetic gas- Capital charge rate (Fraction/Yr)
HGEER -High-Btu gas- Excess charge due to risk (Fraction/Yr)
HGEIDC -High-Btu gas- Excess charge due to interest under const. (Fraction/Yr)
HGCC -High-Btu gas- Capital cost (\$/(Btu/Yr))
DGCUFP -Domestic gas- Capacity utilization factor for planning (Fraction)
HGOMC -High-Btu gas- Operating and maintenance <O&M> cost (\$/Btu)
HGFCST -High-Btu gas- Feedstock cost (\$/Btu)

32140 A

NOTE

MGINV.KL=DGINV.K*(MGAW.K/DGAW.K)

32160 R

MGINV=0

32170 N

MGINV -Low/medium Btu gas- Investment (\$/Yr)

DGINV -Domestic gas- Investment (\$/Yr)

MGAW -Low/medium Btu gas- Allocation weight (Dimensionless)

DGAW -Domestic gas- Allocation weight (Dimensionless)

MGAW.K=(MGSP.K*1E6)^DGWF*MGHMS.K

32180 A

MGAW -Low/medium Btu gas- Allocation weight (Dimensionless)

MGSP -Low/medium-btu gas- Support price (\$/Btu)

DGWF -Domestic gas- Weighting factor (Dimensionless)

MGHMS -Low/medium Btu gas- Multiplier from market share (Dimensionless)

MGHMS.K=TABHL(MGHMST, MGPC.K/TGND.K, 0, .15, .025)

32190 A

MGHMS=1/1/1/1/1/1/.8/0

32200 T

MGHMS -Low/medium Btu gas- Multiplier from market share (Dimensionless)

TABHL -Tabular relationship

MGHMS -Low/medium Btu gas- Multiplier from market share table (Table)

MGPC -Low/medium Btu gas- Production capacity (Btu/Yr)

TGND -Total gas- Net demand (Btu/Yr)

MGSP.K=MGHCST.K-MGGS.K

32210 A

MGSP -Low/medium-btu gas- Support price (\$/Btu)

MGHCST -Low/medium Btu gas- Marginal cost (\$/Btu)

MGGS -Low/medium Btu gas- Government subsidy (\$/Btu)

MGHCST.K=(SGCCR+MGEICR.K+MGEIDC.K)*MGSCC.K+MGOMC+MGFCST.K

32220 A

MGHCST -Low/medium Btu gas- Marginal cost (\$/Btu)

SGCCR -Synthetic gas- Capital charge rate (Fraction/Yr)

MGEICR -Low/medium Btu gas- Excess charge due to risk (Fraction/Yr)

MGEIDC -Low/medium Btu gas- Excess charge due to interest under const. (Fraction/Yr)

MGSCC -Low/medium Btu gas- Specific capital cost (\$/(Btu/Yr))

MGOMC -Low/medium Btu gas- Operating and maintenance <O&M> cost (\$/Btu)

MGFCST -Low/medium Btu gas- Feedstock cost (\$/Btu)

MGEICR.K=SGCCRR*(1-STEP(1,MGLGY))*MAX(0,(DGPAMI-MGPA.K)/DGPAMI)

32230 A

MGLGY=2200

32240 C

MGEICR -Low/medium Btu gas- Excess charge due to risk (Fraction/Yr)

SGCCRR -Synthetic gas- Capital charge due to risk (Fraction/Yr)

STEP -Step-shaped exogenous input

MGLGY -Low/medium Btu gas- Loan guarantee initiation year (Year)

MAX -Function selecting the larger of two values

DGPAMI -Domestic gas- Physical assets of a mature industry (\$)

MGPA -Low/medium Btu gas- Physical assets (\$)

MGEIDC.K=SGCCRC*(1-STEP(1,MGCDY))

32250 A

MGEIDC -Low/medium Btu gas- Excess charge due to interest under const. (Fraction/Yr)

SGCCRC -Synthetic gas- Capital charge due to interest under const. (Fraction/Yr)

STEP -Step-shaped exogenous input

MGCDY -Low/medium Btu gas- Construction delay change year (Year)

MGSCC.K=MGCC.K*MGSCM.K/DGCUFP

32260 A

MGSCC -Low/medium Btu gas- Specific capital cost (\$/(Btu/Yr))
 MGCC -Low/medium Btu gas- Capital cost (\$/(Btu/Yr))
 MGSCM -Low/medium Btu gas- Secondary constraint multiplier (Dimensionless)
 DGCUFP -Domestic gas- Capacity utilization factor for planning (Fraction)

MGSCM.K=TABHL(DGSCMT,MGGRI.K,.04,.20,.04)

32270 A

MGSCM -Low/medium Btu gas- Secondary constraint multiplier (Dimensionless)
 TABHL -Tabular relationship
 DGSCMT -Domestic gas- Secondary constraint multiplier table (Table)
 MGGRI -Low/medium Btu gas- Growth rate indicated (Fraction/Yr)

MGGRI.K=(MGAGR.K/SMOOTH(MGAGR.K,DGTGR)-1)/DGTGR

32280 A

MGGRI -Low/medium Btu gas- Growth rate indicated (Fraction/Yr)
 MGAGR -Low/medium Btu gas- Assets for growth rate (\$)
 SMOOTH -First order information delay
 DGTGR -Domestic gas- Time for growth rate (Year)

MGAGR.K=MAX(DGPAMI,MGPA.K+MGPUK.K)

32290 A

MGAGR -Low/medium Btu gas- Assets for growth rate (\$)
 MAX -Function selecting the larger of two values
 DGPAMI -Domestic gas- Physical assets of a mature industry (\$)
 MGPA -Low/medium Btu gas- Physical assets (\$)
 MGPUK -Low/medium-btu gas- Plants under construction (\$)

MGGS.K=CLIP(0,STEP(MAX(0,MGSCST.K-DGWP.K),MGPSY),MGPR.K/TGPR.K,MGDMS)

32300 A

MGDMS=1

32310 C

MGPSY=2200

32320 C

MGGS -Low/medium Btu gas- Government subsidy (\$/Btu)
 CLIP -Function switched during the run
 STEP -Step-shaped exogenous input
 MAX -Function selecting the larger of two values
 MGSCST -Low/medium Btu gas- Support cost (\$/Btu)
 DGWP -Domestic gas- Wellhead price (\$/Btu)
 MGPSY -Low/medium Btu gas- Price-support initiation year (Year)
 MGPR -Low/medium Btu gas- Production rate (Btu/Yr)
 TGPR -Total gas- Production rate (Btu/Yr)
 MGDMS -Low/medium Btu gas- Desired market share (Fraction)

MGSCST.K=(SGCCR+MGECR.K+MGEIDC.K)*(MGCC.K/DGCUFP)+MGOMC+MGFCST.K

32330 A

MGSCST -Low/medium Btu gas- Support cost (\$/Btu)
 SGCCR -Synthetic gas- Capital charge rate (Fraction/Yr)
 MGEER -Low/medium Btu gas- Excess charge due to risk (Fraction/Yr)
 MGEIDC -Low/medium Btu gas- Excess charge due to interest under const. (Fraction/Yr)
 MGCC -Low/medium Btu gas- Capital cost (\$/(Btu/Yr))
 DGCUFP -Domestic gas- Capacity utilization factor for planning (Fraction)
 MGOMC -Low/medium Btu gas- Operating and maintenance <O&M> cost (\$/Btu)
 MGFCST -Low/medium Btu gas- Feedstock cost (\$/Btu)

NOTE

DGAU.K=CGAU.K+UGAU.K+HGAU.K+MGAU.K

DGCUFP=.9

DGPAMI=12.5E9

DGWF=-10

DGAU -Domestic gas- Allocation weight (Dimensionless)

CGAU -Conventional gas- Allocation weight (Dimensionless)

UGAU -Unconventional gas- Allocation weight (Dimensionless)

HGAU -High-Btu gas- Allocation weight (Dimensionless)

MGAU -Low/medium Btu gas- Allocation weight (Dimensionless)

DGCUFP -Domestic gas- Capacity utilization factor for planning (Fraction)

DGPAMI -Domestic gas- Physical assets of a mature industry (\$)

DGWF -Domestic gas- Weighting factor (Dimensionless)

32350 A

32360 C

32370 C

32380 C

NOTE
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 NOTE Conventional Gas Production Subsector
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CGPA K=CGPA J+(DT)(CGFCR.JK-CGPAR.JK) 32460 L
 CGPA=3.2E9 32470 N
 CGPA -Conventional gas- Physical assets (\$)
 DT -Time increment between calculations
 CGFCR -Conventional gas- Facility completion rate (\$/Yr)
 CGPAR -Conventional gas- Physical asset retirements (\$/Yr)

CGPAR.KL=CGPA.K*CGARF 32480 R
 CGARF=.045 32490 C
 CGPAR -Conventional gas- Physical asset retirements (\$/Yr)
 CGPA -Conventional gas- Physical assets (\$)
 CGARF -Conventional gas- Asset retirement factor (Fraction/Yr)

CGFCR KL=DELAY3P(CGINV.JK,NGFCT,CGPUC.K) 32500 R
 NGFCT=3 32510 C
 CGFCR -Conventional gas- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 CGINV -Conventional gas- Investment (\$/Yr)
 NGFCT -Natural gas- Facility construction time (Year)
 CGPUC -Conventional gas- Plants under construction (\$)

NOTE

CGR.K=CGR.J+(DT)(-CGRER.J) 32530 L
 CGR=CGRI 32540 N
 CGRI=794E15 32550 C
 CGR -Conventional gas- Resources (Btu)
 DT -Time increment between calculations
 CGRER -Conventional gas- Resource extraction rate (Btu/Yr)
 CGRI -Conventional gas- Resources initial (Btu)

CGRER K=CGCP.K*CGPA.K 32560 A
 CGRER -Conventional gas- Resource extraction rate (Btu/Yr)
 CGCP -Conventional gas- Capital productivity ((Btu/Yr)/\$)
 CGPA -Conventional gas- Physical assets (\$)

CGCP.K=TABLE(CGDMT CGR.K/CGRI 0 1 .1)*CGCPN 32570 A
 CGDMT=0/.025/.05/.1/ .15/ .25/ .35/ .65/ .8/ .9/1 32580 T
 CGCPN=4.2E6 32590 C
 CGCP -Conventional gas- Capital productivity ((Btu/Yr)/\$)
 TABLE -Tabular relationship
 CGDMT -Conventional gas- Depletion multiplier table (Table)
 CGR -Conventional gas- Resources (Btu)
 CGRI -Conventional gas- Resources initial (Btu)
 CGCPN -Conventional gas- Capital productivity normal ((Btu/Yr)/\$)

CGCC.K=1/CGCP.K 32600 A
 CGCC -Conventional gas- Capital cost (\$/(Btu/Yr))
 CGCP -Conventional gas- Capital productivity ((Btu/Yr)/\$)

CGEOMC.K=(CGECF+CGLBF.K)*CGCC.K 32610 A
 CGECF=.27 32620 C
 CGEOMC -Conventional gas- Exploration O&M cost (\$/Btu)
 CGECF -Conventional gas- Exploration cost factor (Fraction/Yr)
 CGLBF -Conventional gas- Lease bonus factor (Fraction/Yr)
 CGCC -Conventional gas- Capital cost (\$/(Btu/Yr))

CGLBF.K=TABHL(CGLBFT,TIME.K,1950,1990,10) 32630 A
 CGLBFT=0/0/.1/.25/.25 32640 T
 CGLBF -Conventional gas- Lease bonus factor (Fraction/Yr)
 TABHL -Tabular relationship
 CGLBFT -Conventional gas- Lease bonus factor table (Table)
 TIME -Actual time during simulation

NOTE

CGURES.K=CGURES.J+(DT)(CGURA.JK-CGRX.JK) 32660 L
 CGURES=175E15 32670 N
 CGURES -Conventional gas- Unproven reserves (Btu)
 DT -Time increment between calculations
 CGURA -Conventional gas- Unproven reserve additions (Btu/Yr)
 CGRX -Conventional gas- Revisions and extensions (Btu/Yr)

CGURA.KL=CGRER.K*CGRXF/CGPDF 32680 R
 CGRXF=CGPDF-1 32690 N
 CGPDF=3.5 32700 C
 CGURA -Conventional gas- Unproven reserve additions (Btu/Yr)
 CGRER -Conventional gas- Resource extraction rate (Btu/Yr)
 CGRXF -Conventional gas- Revision and extension factor (Dimensionless)
 CGPDF -Conventional gas- Potential discovery factor (Dimensionless)

CGRX.KL=CGURES.K/CGRXD 32710 R
 CGRXD=16 32720 C
 CGRX -Conventional gas- Revisions and extensions (Btu/Yr)
 CGURES -Conventional gas- Unproven reserves (Btu)
 CGRXD -Conventional gas- Revision and extension delay time (Year)

CGROMC.K=CGRXCF*SMOOTH(CGCC.K,2) 32730 A
 CGRXCF=.12 32740 C
 CGROMC -Conventional gas- Revision and extension O&M cost (\$/Btu)
 CGRXCF -Conventional gas- Revision and extension cost factor (Fraction/Yr)
 SMOOTH -First order information delay
 CGCC -Conventional gas- Capital cost (\$/(Btu/Yr))

NOTE

CGRES.K=CGRES.J+(DT)(CGDR.JK+CGRX.JK-CGRDR.JK)

32760 L

CGRES=189E15

32770 N

CGRES -Conventional gas- Proven reserves (Btu)
 DT -Time increment between calculations
 CGDR -Conventional gas- Discovery rate (Btu/Yr)
 CGRX -Conventional gas- Revisions and extensions (Btu/Yr)
 CGRDR -Conventional gas- Reserves depletion rate (Btu/Yr)

CGDR.KL=CGRER.K/CGPDF

32780 R

CGDR -Conventional gas- Discovery rate (Btu/Yr)
 CGRER -Conventional gas- Resource extraction rate (Btu/Yr)
 CGPDF -Conventional gas- Potential discovery factor (Dimensionless)

CGRDR.KL=CGPR.K

32790 R

CGRDR -Conventional gas- Reserves depletion rate (Btu/Yr)
 CGPR -Conventional gas- Production rate (Btu/Yr)

CGPR.K=CGPC.K*DGCUF.K

32800 A

CGPR -Conventional gas- Production rate (Btu/Yr)
 CGPC -Conventional gas- Production capacity (Btu/Yr)
 DGCUF -Domestic gas- Capacity utilization factor (Fraction)

CGPC.K=CGRES.K/CGMRPR.K

32810 A

CGPC -Conventional gas- Production capacity (Btu/Yr)
 CGRES -Conventional gas- Proven reserves (Btu)
 CGMRPR -Conventional gas- Minimum reserve production ratio (Year)

CGMRPR.K=TABLE(CGRPRT,TIME.K,1950,2030,10)

32820 A

CGRPRT=23/16.5/10.0/9.5/9.5/9.5/9.5/9.5/9.5

32830 T

CGPOMC=.03E-6

32840 C

CGMRPR -Conventional gas- Minimum reserve production ratio (Year)
 TABLE -Tabular relationship
 CGRPRT -Conventional gas- Reserve production rate table (Table)
 TIME -Actual time during simulation
 CGPOMC -Conventional gas- Production O&M cost (\$/Btu)

NOTE

CGCST.K=CGDR.JK*CGEOMC.K+CGRX.JK*CGROMC.K+CGPR.K*(CGPOMC+CGRP.K)

32860 A

CGCST -Conventional gas- Cost (\$/Yr)
CGDR -Conventional gas- Discovery rate (Btu/Yr)
CGEOMC -Conventional gas- Exploration O&M cost (\$/Btu)
CGRX -Conventional gas- Revisions and extensions (Btu/Yr)
CGROMC -Conventional gas- Revision and extension O&M cost (\$/Btu)
CGPR -Conventional gas- Production rate (Btu/Yr)
CGPOMC -Conventional gas- Production O&M cost (\$/Btu)
CGRP -Conventional gas- Royalty payments (\$/Btu)

CGRP.K=TABHL(CGRPT,TIME.K,1950,1990,10)*SMOOTH(DGWP.K,2)

32880 A

CGRPT=0/0/.15/.15/.15

32890 T

CGRP -Conventional gas- Royalty payments (\$/Btu)
TABHL -Tabular relationship
CGRPT -Conventional gas- Royalty payment table (Table)
TIME -Actual time during simulation
SMOOTH -First order information delay
DGWP -Domestic gas- Wellhead price (\$/Btu)

CGOMC.K=CGEOMC.K+CGPOMC+CGRP.K

32900 A

CGOMC -Conventional gas- Operating and maintenance <O&M> cost (\$/Btu)
CGEOMC -Conventional gas- Exploration O&M cost (\$/Btu)
CGPOMC -Conventional gas- Production O&M cost (\$/Btu)
CGRP -Conventional gas- Royalty payments (\$/Btu)

NOTE

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 NOTE *****
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 NOTE Unconventional Gas Recovery Subsector
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UGPA.K=UGPA.J+(DT)(UGFCR.JK-UGPAR.JK) 33000 L
 UGPA=0 33010 N

UGPA -Unconventional gas- Physical assets (\$)
 DT -Time increment between calculations
 UGFCR -Unconventional gas- Facility completion rate (\$/Yr)
 UGPAR -Unconventional gas- Physical asset retirements (\$/Yr)

UGPAR.KL=UGPA.K*UGARF 33020 R
 UGARF=.045 33030 C

UGPAR -Unconventional gas- Physical asset retirements (\$/Yr)
 UGPA -Unconventional gas- Physical assets (\$)
 UGARF -Unconventional gas- Asset retirement factor (Fraction/Yr)

UGFCR.KL=DELAY3P(UGINV.JK,NGFCT,UGPUC.K) 33040 R

UGFCR -Unconventional gas- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 UGINV -Unconventional gas- Investment (\$/Yr)
 NGFCT -Natural gas- Facility construction time (Year)
 UGPUC -Unconventional gas- Plants under construction (\$)

NOTE

UGR.K=UGR.J+(DT)(-UGRDR.JK) 33060 L
 UGR=UGRI 33070 N
 UGRI=135E15 33080 C
 UGR -Unconventional gas- Resources (Btu)
 DT -Time increment between calculations
 UGRDR -Unconventional gas- Reserves depletion rate (Btu/Yr)
 UGRI -Unconventional gas- Resources initial (Btu)

 UGRDR.KL=UGPR.K 33090 R
 UGRDR -Unconventional gas- Reserves depletion rate (Btu/Yr)
 UGPR -Unconventional gas- Production rate (Btu/Yr)

 UGPR.K=UGPC.K*DGCUF.K 33100 A
 UGPR -Unconventional gas- Production rate (Btu/Yr)
 UGPC -Unconventional gas- Production capacity (Btu/Yr)
 DGCUF -Domestic gas- Capacity utilization factor (Fraction)

 UGPC.K=UGCP.K*UGPA.K 33110 A
 UGPC -Unconventional gas- Production capacity (Btu/Yr)
 UGCP -Unconventional gas- Capital productivity ((Btu/Yr)/\$)
 UGPA -Unconventional gas- Physical assets (\$)

 UGCP.K=TABLE(UGDMT,UGR.K/UGRI,0,1,.2)*UGCPN 33120 A
 UGDMT=0/.1/.2/.36/.6/1 33130 T
 UGCPN=.22E6 33140 C
 UGCP -Unconventional gas- Capital productivity ((Btu/Yr)/\$)
 TABLE -Tabular relationship
 UGDMT -Unconventional gas- Depletion multiplier table (Table)
 UGR -Unconventional gas- Resources (Btu)
 UGRI -Unconventional gas- Resources initial (Btu)
 UGCPN -Unconventional gas- Capital productivity normal ((Btu/Yr)/\$)

 UGCC.K=1/UGCP.K 33150 A
 UGCC -Unconventional gas- Capital cost (\$/(Btu/Yr))
 UGCP -Unconventional gas- Capital productivity ((Btu/Yr)/\$)

 UGCST.K=UGPR.K*UGOMC.K 33160 A
 UGCST -Unconventional gas- Cost (\$/Yr)
 UGPR -Unconventional gas- Production rate (Btu/Yr)
 UGOMC -Unconventional gas- Operating and maintenance <O&M> cost (\$/Btu)

 UGOMC.K=UGCCF*UGCC.K 33170 A
 UGCCF=.26 33180 C
 UGOMC -Unconventional gas- Operating and maintenance <O&M> cost (\$/Btu)
 UGCCF -Unconventional gas- Capital cost factor (Fraction/Yr)
 UGCC -Unconventional gas- Capital cost (\$/(Btu/Yr))

NOTE

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 NOTE *****
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 NOTE Synthetic High-Btu Gas Production Subsector
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HGPA.K=HGPA.J+(DT)(HGFCR.JK-HGPAR.JK) 33280 L
 HGPA=0 33290 N

HGPA -High-Btu gas- Physical assets (\$)
 DT -Time increment between calculations
 HGFCR -High-Btu gas- Facility completion rate (\$/Yr)
 HGPAR -High-Btu gas- Physical asset retirements (\$/Yr)

HGPAR.KL=HGPA.K*HGARF 33300 R
 HGARF=.026 33310 C

HGPAR -High-Btu gas- Physical asset retirements (\$/Yr)
 HGPA -High-Btu gas- Physical assets (\$)
 HGARF -High-Btu gas- Asset retirement factor (Fraction/Yr)

HGFCR.KL=DELAY3P(HGINV.JK,HGFCT.K,HGFUC.K) 33320 R

HGFCR -High-Btu gas- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 HGINV -High-Btu gas- Investment (\$/Yr)
 HGFCT -High-Btu gas- Facility construction time (Year)
 HGPUC -High-btu gas- Plants under construction (\$)

HGFCT.K=SMOOTH(CLIP(SGPFCT,SGHFCT,TIME.K,HGCDY),SGHFCT) 33330 A
 SGHFCT=7 33340 C
 SGPFCT=5 33350 C
 HGCDY=2200 33360 C

HGFCT -High-Btu gas- Facility construction time (Year)
 SMOOTH -First order information delay
 CLIP -Function switched during the run
 SGPFCT -Synthetic gas- Policy facility construction time (Year)
 SGHFCT -Synthetic gas- Historical facility construction time (Year)
 TIME -Actual time during simulation
 HGCDY -High-Btu gas- Construction delay change year (Year)

NOTE

HGDC.K=HGPC.K*DGCUF.K/HGCE

33380 A

HGCE=.74

33390 C

HGDC -High-Btu gas- Demand for coal (Btu/Yr)
HGPC -High-Btu gas- Production capacity (Btu/Yr)
DGCUF -Domestic gas- Capacity utilization factor (Fraction)
HGCE -High-Btu gas- Conversion efficiency (Dimensionless)

HGPR.K=HGPC.K*DGCUF.K*DCPDR.K

33400 A

HGPR -High-Btu gas- Production rate (Btu/Yr)
HGPC -High-Btu gas- Production capacity (Btu/Yr)
DGCUF -Domestic gas- Capacity utilization factor (Fraction)
DCPDR -Domestic coal- Production demand ratio (Dimensionless)

HGPC.K=HGCP*HGPA.K

33410 A

HGCP=.101E6

33420 C

HGPC -High-Btu gas- Production capacity (Btu/Yr)
HGCP -High-Btu gas- Capital productivity ((Btu/Yr)/\$)
HGPA -High-Btu gas- Physical assets (\$)

HGCC.K=1/HGCP

33430 A

HGCC -High-Btu gas- Capital cost (\$/(Btu/Yr))
HGCP -High-Btu gas- Capital productivity ((Btu/Yr)/\$)

HGCST.K=HGPR.K*(HGOMC+HGFCST.K)

33440 A

HGOMC=1.10E-6

33450 C

HGCST -High-Btu gas- Cost (\$/Yr)
HGPR -High-Btu gas- Production rate (Btu/Yr)
HGOMC -High-Btu gas- Operating and maintenance <O&M> cost (\$/Btu)
HGFCST -High-Btu gas- Feedstock cost (\$/Btu)

HGFCST.K=DCMMP.K*.6/HGCE

33460 A

HGFCST -High-Btu gas- Feedstock cost (\$/Btu)
DCMMP -Domestic coal- Minemouth price (\$/Btu)
HGCE -High-Btu gas- Conversion efficiency (Dimensionless)

NOTE

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 NOTE Synthetic Medium-Btu Gas Production Subsector
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MGPA.K=MGPA.J+(DT)(MGFCR.JK-MGPAR.JK) 33560 L
 MGPA=0 33570 N

MGPA -Low/medium Btu gas- Physical assets (\$)
 DT -Time increment between calculations
 MGFCR -Low/medium Btu gas- Facility completion rate (\$/Yr)
 MGPAR -Low/medium Btu gas- Physical asset retirements (\$/Yr)

MGPAR.KL=MGPA.K*MGARF 33580 R
 MGARF=.026 33590 C

MGPAR -Low/medium Btu gas- Physical asset retirements (\$/Yr)
 MGPA -Low/medium Btu gas- Physical assets (\$)
 MGARF -Low/medium Btu gas- Asset retirement factor (Fraction/Yr)

MGFCR.KL=DELAY3P(MGINV.JK,MGFCT.K,MGPUC.K) 33600 R

MGFCR -Low/medium Btu gas- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 MGINV -Low/medium Btu gas- Investment (\$/Yr)
 MGFCT -Low/medium Btu gas- Facility construction time (Year)
 MGPUC -Low/medium-btu gas- Plants under construction (\$)

MGFCT.K=SMOOTH(CLIP(SCPFCT,SGHFCT,TIME.K,MGCDY),SGHFCT) 33610 A
 MGCDY=2200 33620 C

MGFCT -Low/medium Btu gas- Facility construction time (Year)
 SMOOTH -First order information delay
 CLIP -Function switched during the run
 SCPFCT -Synthetic gas- Policy facility construction time (Year)
 SGHFCT -Synthetic gas- Historical facility construction time (Year)
 TIME -Actual time during simulation
 MGCDY -Low/medium Btu gas- Construction delay change year (Year)

NOTE

MGDC $K=MGPC.K \cdot DGCUF.K / MGCE$

33640 A

MGCE=.80

33650 C

MGDC -Low/medium Btu gas- Demand for coal (Btu/Yr)
MGPC -Low/medium Btu gas- Production capacity (Btu/Yr)
DGCUF -Domestic gas- Capacity utilization factor (Fraction)
MGCE -Low/medium Btu gas- Conversion efficiency (Dimensionless)

MGPR $K=MGPC.K \cdot DGCUF.K \cdot DCPDR.K$

33660 A

MGPR -Low/medium Btu gas- Production rate (Btu/Yr)
MGPC -Low/medium Btu gas- Production capacity (Btu/Yr)
DGCUF -Domestic gas- Capacity utilization factor (Fraction)
DCPDR -Domestic coal- Production demand ratio (Dimensionless)

MGPC $K=MGCP \cdot MGPA.K$

33670 A

MGCP=.155E6

33680 C

MGPC -Low/medium Btu gas- Production capacity (Btu/Yr)
MGCP -Low/medium Btu gas- Capital productivity ((Btu/Yr)/\$)
MGPA -Low/medium Btu gas- Physical assets (\$)

MGCC $K=1/MGCP$

33690 A

MGCC -Low/medium Btu gas- Capital cost (\$/(Btu/Yr))
MGCP -Low/medium Btu gas- Capital productivity ((Btu/Yr)/\$)

MGFCST $K=MGPR.K \cdot (MGOMC+MGFCST.K)$

33700 A

MGOMC=.43E-6

33710 C

MGFCST -Low/medium Btu gas- Cost (\$/Yr)
MGPR -Low/medium Btu gas- Production rate (Btu/Yr)
MGOMC -Low/medium Btu gas- Operating and maintenance <O&M> cost (\$/Btu)
MGFCST -Low/medium Btu gas- Feedstock cost (\$/Btu)

MGFCST $K=(DCP.K-CEFCF)/MGCE$

33720 A

MGFCST -Low/medium Btu gas- Feedstock cost (\$/Btu)
DCP -Domestic coal- Price (\$/Btu)
CEFCF -Centralized energy- Fuel cost factor (\$/Btu)
MGCE -Low/medium Btu gas- Conversion efficiency (Dimensionless)

NOTE

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 NOTE Liquefied Natural Gas Production Subsector
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LNCR K=LNCRM.K+LNNLC.K 33820 A
 LNCR -Liquefied natural gas- Consumption rate (Btu/Yr)
 LNCRM -Liquefied natural gas- Consumption rate maximum (Btu/Yr)
 LNNLC -Liquefied natural gas- New long term contracts (Btu/Yr)

LNCRM.K=TABLE(LNCRT TIME K,1950,2030.5)*1E15 33830 A
 LNCRT=0/0/0/0/0/0/.3/.8/ 8/.8/.8/.8/.8/.8/.8/.8 33840 T
 LNCRM -Liquefied natural gas- Consumption rate maximum (Btu/Yr)
 TABLE -Tabular relationship
 LNCRT -Liquefied natural gas- Consumption rate table (Table)
 TIME -Actual time during simulation

LNNLC.K=LNNLC.J+(DT)(LNLCCR.JK-LNLCCR JK) 33850 L
 LNNLC=0 33860 N
 LNNLC -Liquefied natural gas- New long term contracts (Btu/Yr)
 DT -Time increment between calculations
 LNLCCR -Liquefied natural gas- Long term contract initiation rate ((Btu/Yr)/Yr)
 LNLCCR -Liquefied natural gas- Long term contract expiration rate ((Btu/Yr)/Yr)

LNLCCR KL=CLIP(LNILCCR.K,0,TIME.K,1979) 33870 R
 LNLCCR -Liquefied natural gas- Long term contract initiation rate ((Btu/Yr)/Yr)
 CLIP -Function switched during the run
 LNILCCR -Liquefied natural gas- Indicated long term contract initiation rate (Btu/Yr)
 TIME -Actual time during simulation

LNILCCR K=MAX(0 LNNLC.K/LNCL+LNDALC.K/LNLCCAT) 33880 A
 LNLCCAT=10 33890 C
 LNCL=20 33900 C
 LNILCCR -Liquefied natural gas- Indicated long term contract initiation rate (Btu/Yr)
 MAX -Function selecting the larger of two values
 LNNLC -Liquefied natural gas- New long term contracts (Btu/Yr)
 LNCL -Liquefied natural gas- Contract life (Year)
 LNDALC -Liquefied natural gas- Desired additions to long term contracts (Btu/Yr)
 LNLCCAT -Liquefied natural gas- Long term contract adjustment time (Year)

LNDALC.K=(1-DGFEDP.K)*DGIMD.K 33910 A
 LNDALC -Liquefied natural gas- Desired additions to long term contracts (Btu/Yr)
 DGFEDP -Domestic gas- Fraction of import demand to Pan-american sources (Fraction)
 DGIMD -Domestic gas- Import demand (Btu/Yr)

LNLCEK.KL=LNNLC.K/LNCL

33920 R

LNLCEK -Liquified natural gas- Long term contract expiration rate ((Btu/Yr)/Yr)
LNNLC -Liquified natural gas- New long term contracts (Btu/Yr)
LNCL -Liquified natural gas- Contract life (Year)

LNWP.K=MAX(TABLE(LNWPT,TIME.K,1950,2030,10)*1E-6,OOP.K)

33930 A

LNWPT=2.14/3.00/3.00/3.00/3.00/3.00/3.00/3.00

33940 T

LNWP -Liquified natural gas- Wellhead price (\$/Btu)
MAX -Function selecting the larger of two values
TABLE -Tabular relationship
LNWPT -Liquified natural gas- Wellhead price table (Table)
TIME -Actual time during simulation
OOP -OPEC oil- Price (\$/Btu)

NOTE

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 NOTE Alaskan Gas Supply Subsector
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AGCR.K=AGSSP.K+AGNSP.K 34190 A
 AGCR -Alaskan gas- Consumption rate (Btu/Yr)
 AGSSP -Alaskan gas- South slope production (Btu/Yr)
 AGNSP -Alaskan gas- North slope production (Btu/Yr)

AGNSP.K=STEP(.9E15,AGNSPY) 34200 A
 AGNSPY=1986 34210 C
 AGNSP -Alaskan gas- North slope production (Btu/Yr)
 STEP -Step-shaped exogenous input
 AGNSPY -Alaskan gas- North slope production initiation year (Year)

AGSSP.K=CLIP(AGSSP1.K,AGSSP2.K,TIME.K,1980)*1E15 34220 A
 AGSSP -Alaskan gas- South slope production (Btu/Yr)
 CLIP -Function switched during the run
 AGSSP1 -Alaskan gas- South slope production 1980-2030 (Btu/Yr)
 AGSSP2 -Alaskan gas- South slope production 1972-1980 (Btu/Yr)
 TIME -Actual time during simulation

AGSSP1.K=TABHL(AGSSP1T.TIME.K,1980,2030,5) 34230 A
 AGSSP1T=.2/.235/.38/.49/.49/.49/.49/.49/.49/.49 34240 T
 AGSSP1 -Alaskan gas- South slope production 1980-2030 (Btu/Yr)
 TABHL -Tabular relationship
 AGSSP1T -Alaskan gas- SSP1 table (Table)
 TIME -Actual time during simulation

AGSSP2.K=TABHL(AGSSP2T.TIME.K,1972,1980,1) 34250 A
 AGSSP2T=0/.1/.1/.1/.2/.2/.2/.2/.2 34260 T
 AGSSP2 -Alaskan gas- South slope production 1972-1980 (Btu/Yr)
 TABHL -Tabular relationship
 AGSSP2T -Alaskan gas- SSP2 table (Table)
 TIME -Actual time during simulation

AGWP.K=OOP.K 34270 A
 AGWP -Alaskan gas- Wellhead price (\$/Btu)
 OOP -OPEC oil- Price (\$/Btu)

NOTE

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 NOTE Pan-American Gas Supply Subsector
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PGCR.K=PGCRM.K+PGNLC.K 34360 A

PGCR -Pan-am gas- Consumption rate (Btu/Yr)
 PGCRM -Pan-Am gas- Consumption rate minimum (Btu/Yr)
 PGNLC -Pan-am gas- New long term contracts (Btu)

PGCRM.K=TABLE(PGCRT,TIME.K,1950,2030,5)*1E15 34370 A

PGCRT=0/0/.15/.4/.8/.8/.9/.2/.07/0/0/0/0/0/0 34380 T

PGCRM -Pan-Am gas- Consumption rate minimum (Btu/Yr)
 TABLE -Tabular relationship
 PGCRT -Pan-am gas- Consumption rate table (Table)
 TIME -Actual time during simulation

PGNLC.K=PGNLC.J+(DT)(PGLCIR.JK-PGLCER.JK) 34390 L

PGNLC=0 34400 N

PGNLC -Pan-am gas- New long term contracts (Btu)
 DT -Time increment between calculations
 PGLCIR -Pan-am gas- Long term contract initiation rate (Btu/Yr)
 PGLCER -Pan-am gas- Long term contract expiration rate (Btu/Yr)

PGLCIR.KL=CLIP(PGILCIR.K,0,TIME.K,1979) 34410 R,

PGLCIR -Pan-am gas- Long term contract initiation rate (Btu/Yr)
 CLIP -Function switched during the run
 PGILCIR -Pan-am gas- Initiated long term contract initiation rate (Btu/Yr)
 TIME -Actual time during simulation

PGILCIR.K=MAX(0,PGNLC.K/PGCL+PGDALC.K/PGLCAT) 34420 A

PGLCAT=10 34430 C

PGCL=20 34440 C

PGILCIR -Pan-am gas- Initiated long term contract initiation rate (Btu/Yr)
 MAX -Function selecting the larger of two values
 PGNLC -Pan-am gas- New long term contracts (Btu)
 PGCL -Pan-am gas- Contract life (Year)
 PGDALC -Pan-am gas- Desired additions to long term contracts (Btu/Yr)
 PGLCAT -Pan-am gas- Long term contract adjustment time (Year)

PGDALC.K=DGFEDP.K*DGIMD.K 34450 A

PGDALC -Pan-am gas- Desired additions to long term contracts (Btu/Yr)
 DGFEDP -Domestic gas- Fraction of import demand to Pan-american sources (Fraction)
 DGIMD -Domestic gas- Import demand (Btu/Yr)

PGLCER.KL=PGNLC.K/PGCL 34460 R

PGLCER -Pan-am gas- Long term contract expiration rate (Btu/Yr)
 PGNLC -Pan-am gas- New long term contracts (Btu)
 PGCL -Pan-am gas- Contract life (Year)

PGWP.K=.96*OOP.K 34470 A

PGWP -Pan-am gas- Wellhead price (\$/Btu)
 OOP -OPEC oil- Price (\$/Btu)

NOTE

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NOTE Supplementary Equations for Gas Demand for Coal
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NOTE

TGDC.K=HGDC.K+MGDC.K

34570 A

TGDC -Total gas- Demand for coal (Btu/Yr)
HGDC -High-Btu gas- Demand for coal (Btu/Yr)
MGDC -Low/medium Btu gas- Demand for coal (Btu/Yr)

NOTE

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NOTE Oil Production Sector of FOSSIL2
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NOTE Department of Energy
NOTE Energy Transition Project
NOTE
NOTE Version Release Date:
NOTE March 12, 1979
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NOTE Oil Supply-Demand Balance: Capacity Utilization Subsector

NOTE

NOTE *****

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DOCUF.K=TABHL(DOCUFT,MIN(DOGD.K,DOPC.K*DOCUFC.K)/DOPC.K,0,1,1,.1)

40230 A

DOCUFT=0/.1/.2/.3/.4/.5/.6/.7/.8/.9/.9

40240 T

DOCUF -Domestic oil- Capacity utilization factor (Fraction)

TABHL -Tabular relationship

DOCUFT -Domestic oil- Capacity utilization factor table (Table)

MIN -Function selecting the smaller of two values

DOGD -Domestic oil- Gross demand (Btu/Yr)

DOPC -Domestic oil- Production capacity (Btu/Yr)

DOCUFC -Domestic oil- Controlled capacity utilization factor (Fraction)

DOGD.K=TOGD.K-AOPR.K

40250 A

DOGD -Domestic oil- Gross demand (Btu/Yr)

TOGD -Total oil- Gross demand (Btu/Yr)

AOPR -Alaskan oil- Production rate (Btu/Yr)

TOGD.K=TOND.K/TODE

40260 A

TODE=.98

40270 C

TOGD -Total oil- Gross demand (Btu/Yr)

TOND -Total oil- Net demand (Btu/Yr)

TODE -Total oil- Distributional efficiency (Fraction)

TOND.K=TOEUD.K+OUDO.K+DGCURO.K+SNDO.K

40280 A

TOND -Total oil- Net demand (Btu/Yr)

TOEUD -Total oil- End-use demand (Btu/Yr)

OUDO -Oil/gas utilities- Demand for oil (Btu/Yr)

DGCURO -Domestic gas- Curtailments to oil (Btu/Yr)

SNDO -Synthetic natural gas- Demand for oil (Btu/Yr)

DOPC.K=COPC.K+EOPC.K+SHPC.K+CLPC.K

40290 A

DOPC -Domestic oil- Production capacity (Btu/Yr)

COPC -Conventional oil- Production capacity (Btu/Yr)

EOPC -Enhanced oil- Production capacity (Btu/Yr)

SHPC -Shale oil- Production capacity (Btu/Yr)

CLPC -Coal liquids- Production capacity (Btu/Yr)

DOCUFC.K=TABHL(DOCFCT SMOOTH((DOWP.K/CLIP(DOUWP.K,DODWP.K,TIME.K,DOCUFY)),2),.8,1,.05)
 DOCFCT=.8/.8/.8/.85/.9
 DOCUFC=.8
 DOCUFY=2200

40300 A
 40310 T
 40320 N
 40330 C

DOCUFC -Domestic oil- Controlled capacity utilization factor (Fraction)
 TABHL -Tabular relationship
 DOCFCT -Domestic oil- Controlled capacity utilization factor table (Table)
 SMOOTH -First order information delay
 DOWP -Domestic oil- Wellhead price (\$/Btu)
 CLIP -Function switched during the run
 DOUWP -Domestic oil- Unregulated wellhead price (\$/Btu)
 DODWP -Domestic oil- Desired wellhead price (\$/Btu)
 TIME -Actual time during simulation
 DOCUFY -Domestic oil- Capacity utilization control initiation year (Year)

TOPR.K=DOPR.K+DICR.K+POPR.K+AOPR.K

40340 A

TOPR -Total oil- Production rate (Btu/Yr)
 DOPR -Domestic oil- Production rate (Btu/Yr)
 DICR -Domestic imports- Consumption rate (Btu/Yr)
 POPR -Pan-Am oil- Production rate (Btu/Yr)
 AOPR -Alaskan oil- Production rate (Btu/Yr)

DOPR.K=COPR.K+EOPR.K+CLPR.K+SHPR.K

40350 A

DOPR -Domestic oil- Production rate (Btu/Yr)
 COPR -Conventional oil- Production rate (Btu/Yr)
 EOPR -Enhanced oil- Production rate (Btu/Yr)
 CLPR -Coal liquids- Production rate (Btu/Yr)
 SHPR -Shale oil- Production rate (Btu/Yr)

TOPDR.K=TOPR.K/TOGD.K

40360 A

TOPDR=1

40370 N

TOPDR -Total oil- Production demand ratio (Dimensionless)
 TOPR -Total oil- Production rate (Btu/Yr)
 TOGD -Total oil- Gross demand (Btu/Yr)

NOTE

DICR.K=(DIIMD.K-POPR.K)*OOPDR.K 40390 A
 DIICR -Domestic imports- Consumption rate (Btu/Yr)
 DIIMD -Domestic imports- Import demand (Btu/Yr)
 POPR -Pan-Am oil- Production rate (Btu/Yr)
 OOPDR -OPEC oil- Production demand ratio (Dimensionless)

POPR.K=MIN(DIIMD.K,POPRM.K) 40400 A
 POPR -Pan-Am oil- Production rate (Btu/Yr)
 MIN -Function selecting the smaller of two values
 DIIMD -Domestic imports- Import demand (Btu/Yr)
 POPRM -Pan-Am oil- Production rate maximum (Btu/Yr)

DIIMD.K=MIN(DOCD.K-DOPR.K,DIQUOT.K) 40410 A
 DIIMD -Domestic imports- Import demand (Btu/Yr)
 MIN -Function selecting the smaller of two values
 DOCD -Domestic oil- Gross demand (Btu/Yr)
 DOPR -Domestic oil- Production rate (Btu/Yr)
 DIQUOT -Domestic imports- Quota (Btu/Yr)

DIQUOT.K=CLIP(TABHL(DIQUOTT,TIME.K,1978,1990,2)*1E15,TOGD.K,TIME.K,DIQY) 40420 A
 DIQUOTT=99/18.1/18.1/18.1/18.1/18.1/18.1 40430 T
 DIQY=2200 40440 C
 DIQUOT -Domestic imports- Quota (Btu/Yr)
 CLIP -Function switched during the run
 TABHL -Tabular relationship
 DIQUOTT -Domestic imports- Quota table (Table)
 TIME -Actual time during simulation
 TOGD -Total oil- Gross demand (Btu/Yr)
 DIQY -Domestic imports- Quota initiation year (Year)

NOTE

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 NOTE Oil Supply-Demand Balance: Pricing Subsector
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TOP.K=TOAWP.K+TODCHG

40540 A

TOP=2.92E-6

40550 N

TODCHG=2.02E-6

40560 C

TOP -Total oil- Price (\$/Btu)
 TOAWP -Total oil- Average wellhead price (\$/Btu)
 TODCHG -Total oil- Delivery charge (\$/Btu)

TOAWP.K=((DOAWP.K)*(DOPR.K+AOPR.K)+DIP.K*(DICR.K+POPR.K))/TOPR.K

40570 A

TOAWP -Total oil- Average wellhead price (\$/Btu)
 DOAWP -Domestic oil- Average wellhead price (\$/Btu)
 DOPR -Domestic oil- Production rate (Btu/Yr)
 AOPR -Alaskan oil- Production rate (Btu/Yr)
 DIP -Domestic imports- Price (\$/Btu)
 DICR -Domestic imports- Consumption rate (Btu/Yr)
 POPR -Pan-Am oil- Production rate (Btu/Yr)
 TOPR -Total oil- Production rate (Btu/Yr)

DOAWP.K=(DOWP.K*DOPR.K+AOWP.K*AOPR.K)/(DOPR.K+AOPR.K)

40580 A

DOAWP -Domestic oil- Average wellhead price (\$/Btu)
 DOWP -Domestic oil- Wellhead price (\$/Btu)
 DOPR -Domestic oil- Production rate (Btu/Yr)
 AOWP -Alaskan oil- Wellhead price (\$/Btu)
 AOPR -Alaskan oil- Production rate (Btu/Yr)

DOWP.K=CLIP(MIN(DOIWP.K,DIP.K),DODWP.K,TOPEP.K,.995)

40590 A

DOWP=.90E-6

40600 N

DOWP -Domestic oil- Wellhead price (\$/Btu)
 CLIP -Function switched during the run
 MIN -Function selecting the smaller of two values
 DOIWP -Domestic oil- Indicated wellhead price (\$/Btu)
 DIP -Domestic imports- Price (\$/Btu)
 DODWP -Domestic oil- Desired wellhead price (\$/Btu)
 TOPDR -Total oil- Production demand ratio (Dimensionless)

DODWP.K=MAX((DOPMN.K+DOACST.K)*DOPMM.K,DOACST.K)

40610 A

DODWP -Domestic oil- Desired wellhead price (\$/Btu)
 MAX -Function selecting the larger of two values
 DOPMN -Domestic oil- Profit margin normal (\$/Btu)
 DOACST -Domestic oil- Average cost, (\$/Btu)
 DOPMM -Domestic oil- Price multiplier (Dimensionless)

DOIWP.K=(DOUWP.K*DODS.K+DORWP.K*(1-DODS.K))*(COPR.K/DOPR.K)+DOUWP.K*(1-(COPR.K/DOPR.K)) 40620 A

DOIWP -Domestic oil- Indicated wellhead price (\$/Btu)
DOUWP -Domestic oil- Unregulated wellhead price (\$/Btu)
DODS -Domestic oil- Deregulation schedule (Dimensionless)
DORWP -Domestic oil- Regulated wellhead price (\$/Btu)
COPR -Conventional oil- Production rate (Btu/Yr)
DOPR -Domestic oil- Production rate (Btu/Yr)

DODS.K=CLIP(DODS2.K,DODS1.K,DODSS,1.5)*STEP(1,1978) 40630 A
DODSS=2 40640 C

DODS -Domestic oil- Deregulation schedule (Dimensionless)
CLIP -Function switched during the run
DODS2 -Domestic oil- Deregulation schedule option 2 (Dimensionless)
DODS1 -Domestic oil- Deregulation schedule option 1 (Dimensionless)
DODSS -Domestic oil- Deregulation schedule switch (Dimensionless)
STEP -Step-shaped exogenous input

DODS1.K=TABHL(DODS1T,TIME.K,1975,2000,5) 40650 A
DODS1T=0/.15/.26/.32/.37/.42 40660 T

DODS1 -Domestic oil- Deregulation schedule option 1 (Dimensionless)
TABHL -Tabular relationship
DODS1T -Domestic oil- Deregulation schedule 1 table (Table)
TIME -Actual time during simulation

DODS2.K=TABHL(DODS2T,(TIME.K-DODYI)/DODRT,0,1,1) 40670 A
DODS2T=0/1 40680 T
DODRT=2 40690 C
DODYI=1979 40700 C

DODS2 -Domestic oil- Deregulation schedule option 2 (Dimensionless)
TABHL -Tabular relationship
DODS2T -Domestic oil- Deregulation schedule 2 table (Table)
TIME -Actual time during simulation
DODYI -Domestic oil- Deregulation year initial (Year)
DODRT -Domestic oil- Deregulation adjustment time (Year)

DOUWP.K=CLIP(MIN(DODWP.K,DIP.K),DODWP.K,TOPDR.K,.995) 40710 A

DOUWP -Domestic oil- Unregulated wellhead price (\$/Btu)
CLIP -Function switched during the run
MIN -Function selecting the smaller of two values
DODWP -Domestic oil- Desired wellhead price (\$/Btu)
DIP -Domestic imports- Price (\$/Btu)
TOPDR -Total oil- Production demand ratio (Dimensionless)

DORWP.K=CLIP(DOERWP.K,DORRWP.K,TIME.K,1978) 40720 A

DORWP -Domestic oil- Regulated wellhead price (\$/Btu)
CLIP -Function switched during the run
DOERWP -Domestic oil- EPCA regulated wellhead price (\$/Btu)
DORRWP -Domestic oil- Return-regulated wellhead price (\$/Btu)
TIME -Actual time during simulation

DOERWP.K=CLIP(DOEP2A.K,DOEPCA1.K,TIME.K,1985)

40730 A

DOERWP -Domestic oil- EPCA regulated wellhead price (\$/Btu)

CLIP -Function switched during the run

DOEP2A -Domestic oil- EPCA regulated price 1985-2010 (\$/Btu)

DOEPCA1 -Domestic oil- EPCA wellhead price 1977-1985 (\$/Btu)

TIME -Actual time during simulation

DOEPCA1.K-TABHL(DOEP1T,TIME.K,1977,1985,2)*1E-6

40740 A

DOEP1T=1.28/1.35/1.43/1.49/1.55

40750 T

DOEPCA1 -Domestic oil- EPCA wellhead price 1977-1985 (\$/Btu)

TABHL -Tabular relationship

DOEP1T -Domestic oil- EPCA table (Table)

TIME -Actual time during simulation

DOEP2A.K-TABHL(DOEP2T,TIME.K,1985,2010,5)*1E-6

40760 A

DOEP2T=1.55/1.66/1.73/1.76/1.8/1.8

40770 T

DOEP2A -Domestic oil- EPCA regulated price 1985-2010 (\$/Btu)

TABHL -Tabular relationship

DOEP2T -Domestic oil- EPCA2 table (Table)

TIME -Actual time during simulation

DORRWP.K=DOPMN.K+DOACST.K

40780 A

DORRWP -Domestic oil- Return-regulated wellhead price (\$/Btu)

DOPMN -Domestic oil- Profit margin normal (\$/Btu)

DOACST -Domestic oil- Average cost (\$/Btu)

DOACST.K=DOCST.K/DOPR.K

40790 A

DOACST -Domestic oil- Average cost (\$/Btu)

DOCST -Domestic oil- Cost (\$/Yr)

DOPR -Domestic oil- Production rate (Btu/Yr)

DOPMN.K=DOROEN.K*DOEQ.K/(DOPC.K*DOCUFN*(1-DOTR))

40800 A

DOPMN -Domestic oil- Profit margin normal (\$/Btu)

DOROEN -Domestic oil- Normal return on equity (Fraction/Yr)

DOEQ -Domestic oil- Equity (\$)

DOPC -Domestic oil- Production capacity (Btu/Yr)

DOCUFN -Domestic oil- Capacity utilization factor normal (Fraction)

DOTR -Domestic oil- Tax rate (Fraction)

DOROEN.K=CLIP(DOPROEN,DOHROEN,TIME.K,DORPY)+DEINF.K

40810 A

DOHROEN=.10

40820 C

DOPROEN=.25

40830 C

DORPY=2200

40840 C

DOROEN -Domestic oil- Normal return on equity (Fraction/Yr)

CLIP -Function switched during the run

DOPROEN -Domestic oil- Policy return on equity normal (Fraction/Yr)

DOHROEN -Domestic oil- Historical return on equity normal (Fraction/Yr)

TIME -Actual time during simulation

DORPY -Domestic oil- ROE regulation policy initiation year (Year)

DEINF -Domestic economy- Inflation rate (Fraction/Yr)

DOPMM.K=TABHL(DOPMMT,DOGD.K/(DOPC.K*DOCUFN),.8,1.25,.05)

40850 A

DOPMMT=.9/.925/.95/.975/1/1.15/1.3/1.7/2.1/2.4

40860 T

DOCUFN=.8

40870 C

DOPMM -Domestic oil- Price multiplier (Dimensionless)

TABHL -Tabular relationship

DOPMMT -Domestic oil- Price multiplier table (Table)

DOGD -Domestic oil- Gross demand (Btu/Yr)

DOPC -Domestic oil- Production capacity (Btu/Yr)

DOCUFN -Domestic oil- Capacity utilization factor normal (Fraction)

NOTE

DIP.K=OOP.K+STEP(MAX(DIGP-OOP.K,0),DITARY)

40890 A

DITARY=2200

40900 C

DIGP=4.5E-6

40910 C

DIP -Domestic imports- Price (\$/Btu)

OOP -OPEC oil- Price (\$/Btu)

STEP -Step-shaped exogenous input

MAX -Function selecting the larger of two values

DIGP -Domestic imports- Goal price (\$/Btu)

DITARY -Domestic imports- Tariff initiation year (Year)

NOTE

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 NOTE Oil Financing: Source of Funds Subsector
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DONI.K=(1-DOTR)*(DOREV.K-DOCST.K)+DOITC*DONPC.K+SHNTC.K*SHPR.K
 DOTR=.35
 DOITC=.07

41010 A
 41020 C
 41030 C

DONI -Domestic oil- Net income (\$/Yr)
 DOTR -Domestic oil- Tax rate (Fraction)
 DOREV -Domestic oil- Revenue (\$/Yr)
 DOCST -Domestic oil- Cost (\$/Yr)
 DOITC -Domestic oil- Investment tax credit (Fraction)
 DONPC -Domestic oil- New plants completed (\$/Yr)
 SHNTC -Shale oil- Ness tax credit (\$/Btu)
 SHPR -Shale oil- Production rate (Btu/Yr)

DOREV.K=DOPR.K*(DOWP.K+DOGS.K-(BOWET.K*(DOWPPR.K/DOPR.K)))

41040 A

DOREV -Domestic oil- Revenue (\$/Yr)
 DOPR -Domestic oil- Production rate (Btu/Yr)
 DOWP -Domestic oil- Wellhead price (\$/Btu)
 DOGS -Domestic oil- Government subsidy (\$/Btu)
 DOWET -Domestic oil- Wellhead excess profits tax (\$/Btu)
 DOWPPR -Domestic oil- Windfall profit production (Btu/Yr)

DOGS.K=(EOGS.K*EOPR.K)/DOPR.K+([SHGS.K*SHPR.K+CLGS.K*MIN(CLPR.K,3.2E15)]/DOPR.K)

41050 A

DOGS -Domestic oil- Government subsidy (\$/Btu)
 EOGS -Enhanced oil- Government subsidy (\$/Btu)
 EOPR -Enhanced oil- Production rate (Btu/Yr)
 DOPR -Domestic oil- Production rate (Btu/Yr)
 SHGS -Shale oil- Government subsidy (\$/Btu)
 SHPR -Shale oil- Production rate (Btu/Yr)
 CLGS -Coal liquids- Government subsidy (\$/Btu)
 MIN -Function selecting the smaller of two values
 CLPR -Coal liquids- Production rate (Btu/Yr)

DOWET.K=MAX(0,(DOWP.K-DIBP79.K)*.50)*STEP(DODS.K,DOWETY)
 DOWETY=2200

41060 A
 41070 C

DOWET -Domestic oil- Wellhead excess profits tax (\$/Btu)
 MAX -Function selecting the larger of two values
 DOWP -Domestic oil- Unregulated wellhead price (\$/Btu)
 DIBP79 -Domestic imports- Base price 1979 (\$/Btu)
 STEP -Step-shaped exogenous input
 DODS -Domestic oil- Deregulation schedule (Dimensionless)
 DOWETY -Domestic oil- Wellhead excess profits tax initiation year (Year)

DIBP79.K=2.25E-6*EXP(.02*(TIME.K-1979))

41080 A

DIBP79 -Domestic imports- Base price 1979 (\$/Btu)
 EXP -Exponential function
 TIME -Actual time during simulation

DOWPPR.K=COPR.K+EOPR.K*(1-STEP(1,EOWEY))
 EOWEY=2200

41090 A
 41100 C

DOWPPR -Domestic oil- Windfall profit production (Btu/Yr)
 COPR -Conventional oil- Production rate (Btu/Yr)
 EOPR -Enhanced oil- Production rate (Btu/Yr)
 STEP -Step-shaped exogenous input
 EOWEY -Enhanced oil- Wellhead excess tax for enhanced recovery year (Year)

DOCST.K=COCST.K+EOCST.K+CLCST.K+SHCST.K+DODEP.K+DOINT.K

41110 A

DOCST -Domestic oil- Cost (\$/Yr)
 COCST -Conventional oil- Cost (\$/Yr)
 EOCST -Enhanced oil- Cost (\$/Yr)
 CLCST -Coal liquids- Cost (\$/Yr)
 SHCST -Shale oil- Cost (\$/Yr)
 DODEP -Domestic oil- Depretiation (\$/Yr)
 DOINT -Domestic oil- Interest (\$/Yr)

NOTE

DOGA.K=DOGA.J+(DT)(DOINV.J-DOGAR.JK-DOVLI.JK)
 DOGA=25.6E9

41140 L
 41150 N

DOGA -Domestic oil- Gross assets (\$)
 DT -Time increment between calculations
 DOINV -Domestic oil- Investment (\$/Yr)
 DOGAR -Domestic oil- Gross asset retirements (\$/Yr)
 DOVLI -Domestic oil- Value loss due to inflation (\$/Yr)

DOGAR.KI=DOGA.K*DOARF.K

41160 R

DOGAR -Domestic oil- Gross asset retirements (\$/Yr)
 DOGA -Domestic oil- Gross assets (\$)
 DOARF -Domestic oil- Asset retirement factor (Fraction/Yr)

DOARF.K=(COPA.K*COARF+EOPA.K*EOARF+SHPA.K*SHARF+CLPA.K*CLARF)/DOPA.K

41170 A

DOARF -Domestic oil- Asset retirement factor (Fraction/Yr)
 COPA -Conventional oil- Physical assets (\$)
 COARF -Conventional oil- Asset retirement factor (Fraction/Yr)
 EOPA -Enhanced oil- Physical assets (\$)
 EOARF -Enhanced oil- Asset retirement factor (Fraction/Yr)
 SHPA -Shale oil- Physical assets (\$)
 SHARF -Shale oil- Asset retirement factor (Fraction/Yr)
 CLPA -Coal liquids- Physical assets (\$)
 CLARF -Coal liquids- Asset retirement factor (Fraction/Yr)
 DOPA -Domestic oil- Physical assets (\$)

DOVLI.KI=DOGA.K*DEINF.K*(1-STEP(1,DOPLAY))
 DOPLAY=2200

41180 R
 41190 C

DOVLI -Domestic oil- Value loss due to inflation (\$/Yr)
 DOGA -Domestic oil- Gross assets (\$)
 DEINF -Domestic economy- Inflation rate (Fraction/Yr)
 STEP -Step-shaped exogenous input
 DOPLAY -Domestic oil- Price-level accounting initiation year (Year)

NOTE

DONA.K=DOGA.K*DOADF

41210 A

DOADF=.50

41220 C

DONA -Domestic oil- Net assets (\$)

DOGA -Domestic oil- Gross assets (\$)

DOADF -Domestic oil- Accumulated depreciation fraction (Fraction)

DOEQ.K=DONA.K*DOEF

41230 A

DOEF=.95

41240 C

DOEQ -Domestic oil- Equity (\$)

DONA -Domestic oil- Net assets (\$)

DOEF -Domestic oil- Equity fraction (Fraction)

DODEBT.K=DONA.K*DODF

41250 A

DODF=(30/70)*DOEF

41260 N

DODEBT -Domestic oil- Debt (\$)

DONA -Domestic oil- Net assets (\$)

DODF -Domestic oil- Debt fraction (Fraction)

DOEF -Domestic oil- Equity fraction (Fraction)

DOINT.K=DOIR.K*DODEBT.K

41270 A

DOINT -Domestic oil- Interest (\$/Yr)

DOIR -Domestic oil- Interest rate (Fraction/Yr)

DODEBT -Domestic oil- Debt (\$)

DOIR.K=DOIRN+DEINF.K

41280 A

DOIRN=.025

41290 C

DOIR -Domestic oil- Interest rate (Fraction/Yr)

DOIRN -Domestic oil- Interest rate normal (Fraction/Yr)

DEINF -Domestic economy- Inflation rate (Fraction/Yr)

DODRMT.K=DODEBT.K/DODL

41300 A

DODL=10

41310 C

DODRMT -Domestic oil- Debt repayment (\$/Yr)

DODEBT -Domestic oil- Debt (\$)

DODL -Domestic oil- Debt life (Year)

DODEP.K=DOGA.K/DOBLC

41320 A

DOBLC=17

41330 C

DODEP -Domestic oil- Depretiation (\$/Yr)

DOGA -Domestic oil- Gross assets (\$)

DOBLC -Domestic oil- Book life of capital (Year)

NOTE

DOIF.K=DONI.K-DODIV.K+DODEP.K-DODRMT.K

41350 A

DOIF -Domestic oil- Internal funds (\$/Yr)
DONI -Domestic oil- Net income (\$/Yr)
DODIV -Domestic oil- Dividends (\$/Yr)
DODEP -Domestic oil- Depreciation (\$/Yr)
DODRMT -Domestic oil- Debt repayment (\$/Yr)

DODIV.K=TABHL(DODPOT,DOROI.K/DOROIN.K*.82,.4)*DONI.K

41360 A

DODPOT=.6/.5/.35/.25

41370 T

DODIV -Domestic oil- Dividends (\$/Yr)
TABHL -Tabular relationship
DODPOT -Domestic oil- Dividend payout table (Table)
DOROI -Domestic oil- Return on investment (Fraction/Yr)
DOROIN -Domestic oil- Return on investment normal (Fraction/Yr)
DONI -Domestic oil- Net income (\$/Yr)

DOROI.K=(DONI.K+DOINT.K)/(DOEQ.K+DODEBT.K)

41380 A

DOROI -Domestic oil- Return on investment (Fraction/Yr)
DONI -Domestic oil- Net income (\$/Yr)
DOINT -Domestic oil- Interest (\$/Yr)
DOEQ -Domestic oil- Equity (\$)
DODEBT -Domestic oil- Debt (\$)

DOROIN.K=DOROIR+SMOOTH(DEINF.K,DOEAT)

41390 A

DOROIR=.08

41400 C

DOEAT=5

41410 C

DOROIN -Domestic oil- Return on investment normal (Fraction/Yr)
DOROIR -Domestic oil- Return on investment real (Fraction/Yr)
SMOOTH -First order information delay
DEINF -Domestic economy- Inflation rate (Fraction/Yr)
DOEAT -Domestic oil- Economic averaging time (Year)

DOROIX.K=SMOOTH(DOROI.K/DOROIN.K,DOEAT)

41420 A

DOROIX -Domestic oil- Return on investment index (Dimensionless)
SMOOTH -First order information delay
DOROI -Domestic oil- Return on investment (Fraction/Yr)
DOROIN -Domestic oil- Return on investment normal (Fraction/Yr)
DOEAT -Domestic oil- Economic averaging time (Year)

NOTE

NOTE

DOFA.K=DOIF.K+DOEFA.K

41450 A

DOFA -Domestic oil- Funds available (\$/Yr)
 DOIF -Domestic oil- Internal funds (\$/Yr)
 DOEFA -Domestic oil- External funds available (\$/Yr)

DOEFA.K=DOGA.K*DOGR.K

41460 A

DOEFA -Domestic oil- External funds available (\$/Yr)
 DOGA -Domestic oil- Gross assets (\$)
 DOGR -Domestic oil- Growth rate (Fraction/Yr)

DOGR.K=TABHL(DOGR1,DOROIX.K,.6.3.6,.3)

41470 A

DOGR1=0/.02/.04/.06/.08/.1/.12/.13/.14/.145/.15

41480 T

DOGR -Domestic oil- Growth rate (Fraction/Yr)
 TABHL -Tabular relationship
 DOGR1 -Domestic oil- Growth rate table (Table)
 DOROIX -Domestic oil- Return on Investment index (Dimensionless)

NOTE

DOFN.K=MAX(0,(DOFPA.K-DOPA.K-DOPUC.K+DOAFCT.K*DOARF.K*(DOPA.K+DOFPA.K)/2)/DOFCEN)

41500 A

DOFCEN=.8

41520 C

DOFN -Domestic oil- Funds needed (\$/Yr)
 MAX -Function selecting the larger of two values
 DOFPA -Domestic oil- Future physical assets (\$)
 DOPA -Domestic oil- Physical assets (\$)
 DOPUC -Domestic oil- Plants under construction (\$)
 DOAFCT -Domestic oil- Average facility construction time (Year)
 DOARF -Domestic oil- Asset retirement factor (Fraction/Yr)
 DOFCEN -Domestic oil- Fraction to capital expenditures normal (Fraction)

DOFPA.K=DONPA.K*EXP(DONPA.K/DOSPA.K-1)

41530 A

DOFPA -Domestic oil- Future physical assets (\$)
 DONPA -Domestic oil- Normal physical assets (\$)
 EXP -Exponential function
 DOSPA -Domestic oil- Smoothed physical assets (\$)

DONPA.K=DOGD.K/DOCUFF*DOCC.K

41540 A

DOCUFF=.78

41550 C

DONPA -Domestic oil- Normal physical assets (\$)
 DOGD -Domestic oil- Gross demand (Btu/Yr)
 DOCUFF -Domestic oil- Capacity utilization factor for forecasting (Fraction)
 DOCC -Domestic oil- Capital cost (\$/(Btu/Yr))

DOSPA.K=DOSPA.J+(DT)(DONPA.J-DOSPA.J)/DOAFCT.J

41560 L

DOSPA=DOSPAI

41570 N

DOSPAI=22.7E9

41580 C

DOSPA -Domestic oil- Smoothed physical assets (\$)
 DT -Time increment between calculations
 DONPA -Domestic oil- Normal physical assets (\$)
 DOAFCT -Domestic oil- Average facility construction time (Year)
 DOSPAI -Domestic oil- Smoothed physical assets initial (\$)

DOCC.K=DOPA.K/DOPC.K

41590 A

DOCC -Domestic oil- Capital cost (\$/(Btu/Yr))
DOPA -Domestic oil- Physical assets (\$)
DOPC -Domestic oil- Production capacity (Btu/Yr)

DOPA.K=COPA.K+EOPA.K+SHPA.K+CLPA.K

41600 A

DOPA -Domestic oil- Physical assets (\$)
COPA -Conventional oil- Physical assets (\$)
EOPA -Enhanced oil- Physical assets (\$)
SHPA -Shale oil- Physical assets (\$)
CLPA -Coal liquids- Physical assets (\$)

DOPUC.K=COPUC.K+EOPUC.K+CLPUC.K+SHPUC.K

41610 A

DOPUC -Domestic oil- Plants under construction (\$)
COPUC -Conventional oil- Plants under construction (\$)
EOPUC -Enhanced oil- Plants under construction (\$)
CLPUC -Coal liquids- Plants under construction (\$)
SHPUC -Shale oil- Plants under construction (\$)

DOAFCT.K=(COFCR.JK*COFCT+EOFCT+SHFCR.JK*SHFCT.K+CLFCR.JK*CLFCT.K)/DONPC.K

41620 A

DOAFCT -Domestic oil- Average facility construction time (Year)
COFCR -Conventional oil- Facility completion rate (\$/Yr)
COFCT -Conventional oil- Facility construction time (Year)
EOFCT -Enhanced oil- Facility completion rate (\$/Yr)
EOFCT -Enhanced oil- Facility construction time (Year)
SHFCR -Shale oil- Facility completion rate (\$/Yr)
SHFCT -Shale oil- Facility construction time (Year)
CLFCR -Coal liquids- Facility completion rate (\$/Yr)
CLFCT -Coal liquids- Facility construction time (Year)
DONPC -Domestic oil- New plants completed (\$/Yr)

DONPC.K=COFCR.JK+EOFCT.JK+SHFCR.JK+CLFCR.JK

41640 A

DONPC -Domestic oil- New plants completed (\$/Yr)
COFCR -Conventional oil- Facility completion rate (\$/Yr)
EOFCT -Enhanced oil- Facility completion rate (\$/Yr)
SHFCR -Shale oil- Facility completion rate (\$/Yr)
CLFCR -Coal liquids- Facility completion rate (\$/Yr)

NOTE

DOINV.K=MAX(0,MIN(DOFA.K,DOFN.K)*DOFCE.K)

41660 A

DOINV=3E9

41670 A

DOINV -Domestic oil- Investment (\$/Yr)
MAX -Function selecting the larger of two values
MIN -Function selecting the smaller of two values
DOFA -Domestic oil- Funds available (\$/Yr)
DOFN -Domestic oil- Funds needed (\$/Yr)
DOFCE -Domestic oil- Fraction to capital expenditures (Fraction)

DOFCE.K=TABUL(DOFCE, DOROIX.K, .3, 1.5, .3)

41680 A

DOFCET=0/.5/.75/.85/.93

41690 A

DOFCE -Domestic oil- Fraction to capital expenditures (Fraction)
TABUL -Tabular relationship
DOFCET -Domestic oil- Fraction to capital expenditures table (Table)
DOROIX -Domestic oil- Return on investment index (Dimensionless)

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 NOTE Oil Financing: Use of Funds Subsector
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 NOTE
 NOTE

COINV.KL=DOINV.K*(COAW.K/DOAW.K) 41800 R
 COINV=3E9 41810 N

COINV -Conventional oil- Investment (\$/Yr)
 DOINV -Domestic oil- Investment (\$/Yr)
 COAW -Conventional oil- Allocation weight (Dimensionless)
 DOAW -Domestic oil- Allocation weight (Dimensionless)

COAW.K=(COMCST.K*1E6)^DOWF 41820 A
 DOWF=-10 41830 C

COAW -Conventional oil- Allocation weight (Dimensionless)
 COMCST -Conventional oil- Marginal cost (\$/Btu)
 DOWF -Domestic oil- Weighting factor (Dimensionless)

COMCST.K=NOCCR*COSCC.K+COOMC.K+DOWET.K 41840 A
 NOCCR=.151 41850 C

COMCST -Conventional oil- Marginal cost (\$/Btu)
 NOCCR -Natural oil- Capital charge rate (Fraction/Yr)
 COSCC -Conventional oil- Specific capital cost (\$/(Btu/Yr))
 COOMC -Conventional oil- Operating and maintenance <O&M> cost (\$/Btu)
 DOWET -Domestic oil- Wellhead excess profits tax (\$/Btu)

COSCC.K=COCC.K*COSCM.K/DOCUFN		41860 A
COSCC	-Conventional oil- Specific capital cost (\$/(Btu/Yr))	
COCC	-Conventional oil- Capital cost (\$/(Btu/Yr))	
COSCM	-Conventional oil- Secondary constraint multiplier (Dimensionless)	
DOCUFN	-Domestic oil- Capacity utilization factor normal (Fraction)	
COSCM.K=TABHL(DOSCMT,COGR.K,.04,.20,.04)		41870 A
COSCM	-Conventional oil- Secondary constraint multiplier (Dimensionless)	
TABHL	-Tabular relationship	
DOSCMT	-Domestic oil- Secondary constraint multiplier table (Table)	
COGR	-Conventional oil- Growth rate (Fraction/Yr)	
COGR.K=(COAGR.K/SMOOTH(COAGR.K,DOTGR;-1)/DOTGR		41890 A
DOTGR=2		41900 C
COGR	-Conventional oil- Growth rate (Fraction/Yr)	
COAGR	-Conventional oil- Assets for growth rate (\$)	
SMOOTH	-First order information delay	
DOTGR	-Domestic oil- Time for growth rate (Year)	
COAGR.K=MAX(DOPAMI,COPA.K+COPUC.K)		41910 A
COAGR	-Conventional oil- Assets for growth rate (\$)	
MAX	-Function selecting the larger of two values	
DOPAMI	-Domestic oil- Physical assets of a mature industry (\$)	
COPA	-Conventional oil- Physical assets (\$)	
COPUC	-Conventional oil- Plants under construction (\$)	

NOTE

EOINV.KL=DOINV.K*(EOAW.K/DOAW.K)

41940 R

EOINV=0

41950 N

EOINV -Enhanced oil- Investment (\$/Yr)
DOINV -Domestic oil- Investment (\$/Yr)
EOAW -Enhanced oil- Allocation weight (Dimensionless)
DOAW -Domestic oil- Allocation weight (Dimensionless)

EOAW.K=(EOSP.K*1E6)^DOWF*STEP(1,EOCY)

41960 A

EOCY=1980

41970 C

EOAW -Enhanced oil- Allocation weight (Dimensionless)
EOSP -Enhanced oil- Support price (\$/3tu)
DOWF -Domestic oil- Weighting factor (Dimensionless)
STEP -Step-shaped exogenous input
EOCY -Enhanced oil- Commercialization year (Year)

EOSP.K=EOMCST.K-EOGS.K

41980 A

EOSP -Enhanced oil- Support price (\$/3tu)
EOMCST -Enhanced oil- Marginal cost (\$/3tu)
EOGS -Enhanced oil- Government subsidy (\$/Btu)

EOMCST.K=(EOCCR+EOECR.K)*EOSCC.K+EOMC.K+DOWET.K*(1-STEP(1,EOWEY))

41990 A

EOCCR=.151

42000 C

EOMCST -Enhanced oil- Marginal cost (\$/3tu)
EOCCR -Enhanced oil- Capital charge rate (Fraction/Yr)
EOECR -Enhanced oil- Excess charge due to risk (Fraction/Yr)
EOSCC -Enhanced oil- Specific capital cost (\$/(Btu/Yr))
EOMC -Enhanced oil- Operating and maintenance <O&M> cost (\$/Btu)
DOWET -Domestic oil- Wellhead excess profits tax (\$/Btu)
STEP -Step-shaped exogenous input
EOWEY -Enhanced oil- Wellhead excess tax for enhanced recovery year (Year)

EOECR.K=EOCCRR*(1-STEP(1,EOLGY))*MAX(0,(DOPAMI-EOPA.K)/DOPAMI)

42010 A

EOCCRR=.022

42020 C

EOLGY=2200

42030 C

EOECR -Enhanced oil- Excess charge due to risk (Fraction/Yr)
EOCCRR -Enhanced oil- Capital charge due to risk (Fraction/Yr)
STEP -Step-shaped exogenous input
EOLGY -Enhanced oil- Loan guarantee initiation year (Year)
MAX -Function selecting the larger of two values
DOPAMI -Domestic oil- Physical assets of a mature industry (\$)
EOPA -Enhanced oil- Physical assets (\$)

EOSCC.K=EOCC.K*EOSCM.K/DOCUFN

42040 A

EOSCC -Enhanced oil- Specific capital cost (\$/(Btu/Yr))
EOCC -Enhanced oil- Capital cost (\$/(Btu/Yr))
EOSCM -Enhanced oil- Secondary constraint multiplier (Dimensionless)
DOCUFN -Domestic oil- Capacity utilization factor normal (Fraction)

EOSCM.K=TABHL(DOSCMT,EOGR.K,.04,.20,.04)

42050 A

EOSCM -Enhanced oil- Secondary constraint multiplier (Dimensionless)
TABHL -Tabular relationship
DOSCMT -Domestic oil- Secondary constraint multiplier table (Table)
EOGR -Enhanced oil- Growth rate (Fraction/Yr)

EOGR.K=(EOAGR.K/SMOOTH(EOAGR.K,DOTGR)-1)/DOTGR

42060 A

EOGR -Enhanced oil- Growth rate (Fraction/Yr)
EOAGR -Enhanced oil- Assets for growth rate (\$)
SMOOTH -First order information delay
DOTGR -Domestic oil- Time for growth rate (Year)

EOAGR.K=MAX(DOPAMI,EOPA.K+EOPUC.K)

42070 A

EOAGR -Enhanced oil- Assets for growth rate (\$)
MAX -Function selecting the larger of two values
DOPAMI -Domestic oil- Physical assets of a mature industry (\$)
EOPA -Enhanced oil- Physical assets (\$)
EOPUC -Enhanced oil- Plants under construction (\$)

EOGS.K=STEP(MAX(0,EOMCST.K-DOWP.K),EOPSY)

42080 A

EOPSY=2200

42090 C

EOGS -Enhanced oil- Government subsidy (\$/Btu)
STEP -Step-shaped exogenous input
MAX -Function selecting the larger of two values
EOMCST -Enhanced oil- Marginal cost (\$/Btu)
DOWP -Domestic oil- Wellhead price (\$/Btu)
EOPSY -Enhanced oil- Price-support initiation year (Year)

NOTE

CLINV.KL=DOINV.K*(CLAW.K/DOAW.K)

42110 R

CLINV=0

42120 N

CLINV -Coal liquids- Investment (\$/Yr)
DOINV -Domestic oil- Investment (\$/Yr)
CLAW -Coal liquids- Allocation weight (Dimensionless)
DOAW -Domestic oil- Allocation weight (Dimensionless)

CLAW.K=(CLSP.K*1E6)^DOWF*STEP(1,CLCY)

42130 A

CLCY=1981

42140 C

CLAW -Coal liquids- Allocation weight (Dimensionless)
CLSP -Coal liquids- Support price (\$/Btu)
DOWF -Domestic oil- Weighting factor (Dimensionless)
STEP -Step-shaped exogenous input
CLCY -Coal liquids- Commercialization year (Year)

CLSP.K=CLMCST.K-CLIP(0,CLGS.K,CLAMS.K,CLDMS)

42150 A

CLDMS=3.9E15

42160 C

CLSP -Coal liquids- Support price (\$/Btu)
CLMCST -Coal liquids- Marginal cost (\$/Btu)
CLIP -Function switched during the run
CLGS -Coal liquids- Government subsidy (\$/Btu)
CLAMS -Coal liquids- Actual market share (Fraction)
CLDMS -Coal liquids- Desired market share (Fraction)

CLMCST.K=(SOCCR+CLECR.K+CLEIDC.K)*CLSCC.K+CLOMC+CLFCST.K

42170 A

CLMCST -Coal liquids- Marginal cost (\$/Btu)
SOCCR -Synthetic oil- Capital charge rate (Fraction/Yr)
CLECR -Coal liquids- Excess charge due to risk (Fraction/Yr)
CLEIDC -Coal liquids- Excess charge due to interest under const. (Fraction/Yr)
CLSCC -Coal liquids- Specific capital cost (\$/(Btu/Yr))
CLOMC -Coal liquids- Operating and maintenance <O&M> cost (\$/Btu)
CLFCST -Coal liquids- Feedstock cost (\$/Btu)

CLECR.K=SOCCRR*(1-STEP(1,CLLGY))*MAX(0,(DOPANI-CLPA.K)/DOPAMI)

42180 A

CLLGY=2200

42190 C

CLECR -Coal liquids- Excess charge due to risk (Fraction/Yr)
SOCCRR -Synthetic oil- Capital charge due to risk (Fraction/Yr)
STEP -Step-shaped exogenous input
CLLGY -Coal liquids- Loan guarantee initiation year (Year)
MAX -Function selecting the larger of two values
DOPANI -Domestic oil- Physical assets of a mature industry (\$)
CLPA -Coal liquids- Physical assets (\$)

CLEIDC.K=SOCCRC*(1-STEP(1,CLCDCY))

42200 A

CLEIDC -Coal liquids- Excess charge due to interest under const. (Fraction/Yr)
SOCCRC -Synthetic oil- Capital charge due to interest under const. (Fraction/Yr)
STEP -Step-shaped exogenous input
CLCDCY -Coal liquids- Construction delay change year (Year)

CLSCC.K=CLCC.K*CLSCM.K/DOCUFP 42210 A
 CLSCC -Coal liquids- Specific capital cost (\$/(Btu/Yr))
 CLCC -Coal liquids- Capital cost (\$/(Btu/Yr))
 CLSCM -Coal liquids- Secondary constraint multiplier (Dimensionless)
 DOCUFP -Domestic oil- Capacity utilization factor for planning (Fraction)

CLSCM.K=TABHL(DOSCMT,CLGR.K,.04,.20,.04) 42220 A
 CLSCM -Coal liquids- Secondary constraint multiplier (Dimensionless)
 TABHL -Tabular relationship
 DOSCMT -Domestic oil- Secondary constraint multiplier table (Table)
 CLGR -Coal liquids- Growth rate (Fraction/Yr)

CLGR.K=(CLAGR.K/SMOOTH(CLAGR.K,DOTGR)-1)/DOTGR 42230 A
 CLGR -Coal liquids- Growth rate (Fraction/Yr)
 CLAGR -Coal liquids- Assets for growth rate (\$)
 SMOOTH -First order information delay
 DOTGR -Domestic oil- Time for growth rate (Year)

CLAGR.K=MAX(DOPANI,CLPA.K+CLPUC.K) 42240 A
 CLAGR -Coal liquids- Assets for growth rate (\$)
 MAX -Function selecting the larger of two values
 DOPANI -Domestic oil- Physical assets of a mature industry (\$)
 CLPA -Coal liquids- Physical assets (\$)
 CLPUC -Coal liquids- Plants under construction (\$)

CLGS.K=STEP(MAX(0,CLSCST.K-DOWP.K),CLPSY)*(CLIP(1,0,DIIMD.K,1E15)) 42250 A
 CLPSY=2200 42260 C
 CLGS -Coal liquids- Government subsidy (\$/Btu)
 STEP -Step-shaped exogenous input
 MAX -Function selecting the larger of two values
 CLSCST -Coal liquids- Support cost (\$/Btu)
 DOWP -Domestic oil- Wellhead price (\$/Btu)
 CLPSY -Coal liquids- Price-support initiation year (Year)
 CLIP -Function switched during the run
 DIIMD -Domestic imports- Import demand (Btu/Yr)

CLSCST.K=(SOCCR+CLECR.K+CLEIDC.K)*(CLCC.K/DOCUFP)+CLOMC+CLFCST.K 42270 A
 CLSCST -Coal liquids- Support cost (\$/Btu)
 SOCCR -Synthetic oil- Capital charge rate (Fraction/Yr)
 CLECR -Coal liquids- Excess charge due to risk (Fraction/Yr)
 CLEIDC -Coal liquids- Excess charge due to interest under const. (Fraction/Yr)
 CLCC -Coal liquids- Capital cost (\$/(Btu/Yr))
 DOCUFP -Domestic oil- Capacity utilization factor for planning (Fraction)
 CLOMC -Coal liquids- Operating and maintenance <O&M> cost (\$/Btu)
 CLFCST -Coal liquids- Feedstock cost (\$/Btu)

CLANS.K=((CLPA.K+CLPUC.K)/CLCC.K) 42280 A
 CLANS -Coal liquids- Actual market share (Fraction)
 CLPA -Coal liquids- Physical assets (\$)
 CLPUC -Coal liquids- Plants under construction (\$)
 CLCC -Coal liquids- Capital cost (\$/(Btu/Yr))

NOTE
 SOCCR=.146 42300 C
 SOCCRR=.078 42310 C
 SOCCRC=.019 42320 C
 DOSCMT=1/1/1.5/2.1/3.0 42325 T
 DOPANI=12.5E9 42330 C

SOCCR -Synthetic oil- Capital charge rate (Fraction/Yr)
 SOCCRR -Synthetic oil- Capital charge due to risk (Fraction/Yr)
 SOCCRC -Synthetic oil- Capital charge due to interest under const. (Fraction/Yr)
 DOSCMT -Domestic oil- Secondary constraint multiplier table (Table)
 DOPANI -Domestic oil- Physical assets of a mature industry (\$)

SHINV.KL=DOINV.K*(SHAW.K/DOAW.K)

42340 R

SHINV=0

42350 N

SHINV -Shale oil- Investment (\$/Yr)

DOINV -Domestic oil- Investment (\$/Yr)

SHAW -Shale oil- Allocation weight (Dimensionless)

DOAW -Domestic oil- Allocation weight (Dimensionless)

SHAW.K=(SHSP.K*1E6)^DOWF*SHIMWC.K*STEP(1,SHCY)

42360 A

SHCY=1981

42370 C

SHAW -Shale oil- Allocation weight (Dimensionless)

SHSP -Shale oil- Support price (\$/Btu)

DOWF -Domestic oil- Weighting factor (Dimensionless)

SHIMWC -Shale oil- Investment multiplier from water constraint (Dimensionless)

STEP -Step-shaped exogenous input

SHCY -Shale oil- Commercialization year (Year)

SHSP.K=SHMCST.K-SHGS.K-SHNTC.K

42380 A

SHSP -Shale oil- Support price (\$/Btu)

SHMCST -Shale oil- Marginal cost (\$/Btu)

SHGS -Shale oil- Government subsidy (\$/Btu)

SHNTC -Shale oil- Ness tax credit (\$/Btu)

SHMCST.K=(SOCCR+SHECR.K+SHEIDC.K)*SHSCC.K+SHOMC.K

42390 A

SHMCST -Shale oil- Marginal cost (\$/Btu)

SOCCR -Synthetic oil- Capital charge rate (Fraction/Yr)

SHECR -Shale oil- Excess charge due to risk (Fraction/Yr)

SHEIDC -Shale oil- Excess charge due to interest under const. (Fraction/Yr)

SHSCC -Shale oil- Specific capital cost (\$/(Btu/Yr))

SHOMC -Shale oil- Operating and maintenance <O&M> cost (\$/Btu)

SHECR.K=SOCCRR*(1-STEP(1,SHLCY))*MAX(0,(DOPAMI-SHPA.K)/DOPAMI)

42400 A

SHLCY=2200

42410 C

SHECR -Shale oil- Excess charge due to risk (Fraction/Yr)

SOCCRR -Synthetic oil- Capital charge due to risk (Fraction/Yr)

STEP -Step-shaped exogenous input

SHLCY -Shale oil- Loan guarantee initiation year (Year)

MAX -Function selecting the larger of two values

DOPAMI -Domestic oil- Physical assets of a mature industry (\$)

SHPA -Shale oil- Physical assets (\$)

SHEIDC.K=SOCCRC*(1-STEP(1,SHCDCY))

42420 A

SHEIDC -Shale oil- Excess charge due to interest under const. (Fraction/Yr)

SOCCRC -Synthetic oil- Capital charge due to interest under const. (Fraction/Yr)

STEP -Step-shaped exogenous input

SHCDCY -Shale oil- Construction delay change year (Year)

SHSCC.K=SHCC.K*SHSCM.K/DOCUFP 42430 A
 SHSCC -Shale oil- Specific capital cost (\$/(Btu/Yr))
 SHCC -Shale oil- Capital cost (\$/(Btu/Yr))
 SHSCM -Shale oil- Secondary constraint multiplier (Dimensionless)
 DOCUFP -Domestic oil- Capacity utilization factor for planning (Fraction)

SHSCM.K=TABHL(DOSCMT.SHGR.K,.04,.20,.04) 42440 A
 SHSCM -Shale oil- Secondary constraint multiplier (Dimensionless)
 TABHL -Tabular relationship
 DOSCMT -Domestic oil- Secondary constraint multiplier table (Table)
 SHGR -Shale oil- Growth rate (Fraction/Yr)

SHGR.K=(SHAGR.K/SMOOTH(SHAGR.K,DOTGR)-1)/DOTGR 42450 A
 SHGR -Shale oil- Growth rate (Fraction/Yr)
 SHAGR -Shale oil- Assets for growth rate (\$)
 SMOOTH -First order information delay
 DOTGR -Domestic oil- Time for growth rate (Year)

SHAGR.K=MAX(DOPAMI,SHPA K+SHPUC.K) 42460 A
 SHAGR -Shale oil- Assets for growth rate (\$)
 MAX -Function selecting the larger of two values
 DOPAMI -Domestic oil- Physical assets of a mature industry (\$)
 SHPA -Shale oil- Physical assets (\$)
 SHPUC -Shale oil- Plants under construction (\$)

SHGS.K=CLIP(0,STEP(MAX(0,SHMCST.K-DOWP.K),SHPSY),SHPR.K/TOPR.K,SHDMS) 42470 A
 SHDMS=1 42480 C
 SHPSY=2200 42490 C
 SHGS -Shale oil- Government subsidy (\$/Btu)
 CLIP -Function switched during the run
 STEP -Step-shaped exogenous input
 MAX -Function selecting the larger of two values
 SHMCST -Shale oil- Marginal cost (\$/Btu)
 DOWP -Domestic oil- Wellhead price (\$/Btu)
 SHPSY -Shale oil- Price-support initiation year (Year)
 SHPR -Shale oil- Production rate (Btu/Yr)
 TOPR -Total oil- Production rate (Btu/Yr)
 SHDMS -Shale oil- Desired market share (Fraction)

SHNTC.K=SHNTCM*TABHL(SHNTCT OOP.K,3.11E-6,3.91E-6,.80E-6)*STEP(1,SHNTCY)
 SHNTCT=1/0
 SHNTCM=.40E-6
 SHNTCY=2200

42500 A
 42510 T
 42520 C
 42530 C

SHNTC -Shale oil- Ness tax credit (\$/Btu)
 SHNTCM -Shale oil- Ness tax credit multiplier (Dimensionless)
 TABHL -Tabular relationship
 SHNTCT -Shale oil- Ness tax credit table (Table)
 OOP -OPEC oil- Price (\$/Btu)
 STEP -Step-shaped exogenous input
 SHNTCY -Shale oil- Ness tax credit initiation year (Year)

SHINWC.K=TABHL(SHIMWCT,(SHPA.K+SHPUC.K),SHCC.K/SHPCWC,0,1,.2)
 SHIMWCT=1/1/1/1/.8/0
 SHPCWC=3.7E15

42540 A
 42550 T
 42560 C

SHIMWC -Shale oil- Investment multiplier from water constraint (Dimensionless)
 TABHL -Tabular relationship
 SHIMWCT -Shale oil- Investment multiplier water constr. table (Table)
 SHPA -Shale oil- Physical assets (\$)
 SHPUC -Shale oil- Plants under construction (\$)
 SHCC -Shale oil- Capital cost (\$/(Btu/Yr))
 SHPCWC -Shale oil- Production capacity under water constraint (Btu/Yr)

NOTE

DOAW.K=COAW.K+EOAW.K+CLAW.K+SHAW.K
 DOCUFP=.9

42580 A
 42590 C

DOAW -Domestic oil- Allocation weight (Dimensionless)
 COAW -Conventional oil- Allocation weight (Dimensionless)
 EOAW -Enhanced oil- Allocation weight (Dimensionless)
 CLAW -Coal liquids- Allocation weight (Dimensionless)
 SHAW -Shale oil- Allocation weight (Dimensionless)
 DOCUFP -Domestic oil- Capacity utilization factor for planning (Fraction)

NOTE

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COPA.K=COPA.J+(DT)(COFCR.JK-COPAR.JK) 42690 L
 COPA=25.6E9 42700 N

COPA -Conventional oil- Physical assets (\$)
 DT -Time increment between calculations
 COFCR -Conventional oil- Facility completion rate (\$/Yr)
 COPAR -Conventional oil- Physical asset retirements (\$/Yr)

COPAR.KL=COPA.K*COARF 42710 R
 COARF=.045 42720 C

COPAR -Conventional oil- Physical asset retirements (\$/Yr)
 COPA -Conventional oil- Physical assets (\$)
 COARF -Conventional oil- Asset retirement factor (Fraction/Yr)

COFCR.KL=DELAY3P(COINV.JK,COFCT,COPUC.K) 42730 R
 COFCT=3 42740 C

COFCR -Conventional oil- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 COINV -Conventional oil- Investment (\$/Yr)
 COFCT -Conventional oil- Facility construction time (Year)
 COPUC -Conventional oil- Plants under construction (\$)

NOTE

COR.K=COR.J+(DT)(-CORER.J) 42760 L
 COR=CORI 42770 N
 CORI=727E15 42780 C

COR -Conventional oil- Resources (Btu)
 DT -Time increment between calculations
 CORER -Conventional oil- Resource extraction rate (Btu/Yr)
 CORI -Conventional oil- Resources initial (Btu)

CORER.K=COCP.K*COPA.K 42790 A

CORER -Conventional oil- Resource extraction rate (Btu/Yr)
 COCP -Conventional oil- Capital productivity ((Btu/Yr)/\$)
 COPA -Conventional oil- Physical assets (\$)

COCP.K=TABLE(CODMT,COR.K/CORI, -.5,1,.1)*COCPN 42800 A
 CODMT=0/0/0/0/0/0/.05/.1/.15/.2/.3/.4/.5/.65/.8/1. 42810 T
 COCPN=.72E6 42820 C

COCP -Conventional oil- Capital productivity ((Btu/Yr)/\$)
 TABLE -Tabular relationship
 CODMT -Conventional oil- Depletion multiplier table (Table)
 COR -Conventional oil- Resources (Btu)
 CORI -Conventional oil- Resources initial (Btu)
 COCPN -Conventional oil- Capital productivity normal ((Btu/Yr)/\$)

COCC.K=1/COCP.K 42830 A
COCC -Conventional oil- Capital cost (\$/(Btu/Yr))
COCP -Conventional oil- Capital productivity ((Btu/Yr)/\$)

COEOMC.K=(COECF+COLBF.K)*COCC.K 42840 A
COECF=.12 42850 C
COEOMC -Conventional oil- Exploration O&M cost (\$/Btu)
COECF -Conventional oil- Exploration cost factor (Fraction/Yr)
COLBF -Conventional oil- Lease bonus factor (Fraction/Yr)
COCC -Conventional oil- Capital cost (\$/(Btu/Yr))

COLBF.K=TABHL(COLBFT,TIME.K,1950,2000,10) 42860 A
COLBFT=.03/.03/.03/.03/.05/.1 42870 T
COLBF -Conventional oil- Lease bonus factor (Fraction/Yr)
TABHL -Tabular relationship
COLBFT -Conventional oil- Lease bonus factor table (Table)
TIME -Actual time during simulation

NOTE

COURES.K=COURES.J+(DT)(COURA.JK-CORX.JK) 42890 L
COURES=COURES.I 42900 N
COURES.I=205E15 42910 C
COURES -Conventional oil- Unproven reserves (Btu)
DT -Time increment between calculations
COURA -Conventional oil- Unproven reserve additions (Btu/Yr)
CORX -Conventional oil- Revisions and extensions (Btu/Yr)
COURES.I -Conventional oil- Unproven reserves initial (Btu)

COURA.KL=CORER.K*CORXF.K/COPDF 42920 R
COPDF=5.8 42930 C
COURA -Conventional oil- Unproven reserve additions (Btu/Yr)
CORER -Conventional oil- Resource extraction rate (Btu/Yr)
CORXF -Conventional oil- Revision and extension factor (Dimensionless)
COPDF -Conventional oil- Potential discovery factor (Dimensionless)

CORXF.K=COPDF-1 42940 A
CORXF -Conventional oil- Revision and extension factor (Dimensionless)
COPDF -Conventional oil- Potential discovery factor (Dimensionless)

CORX.KL=COURES.K/CORXD 42950 R
CORXD=13 42960 C
CORX -Conventional oil- Revisions and extensions (Btu/Yr)
COURES -Conventional oil- Unproven reserves (Btu)
CORXD -Conventional oil- Revision and extension delay time (Year)

COROMC.K=CORXCF*SMOOTH(COCC.K,2) 42970 A
CORXCF=.10 42980 C
COROMC -Conventional oil- Revision and extension O&M cost (\$/Btu)
CORXCF -Conventional oil- Revision and extension cost factor (Fraction/Yr)
SMOOTH -First order information delay
COCC -Conventional oil- Capital cost (\$/(Btu/Yr))

NOTE

CORES.K=CORES.J+(DT)(CODR.JK+CORX.JK-CORDR.JK)

43000 L

CORES=171E15

43010 N

CORES -Conventional oil- Proven reserves (Btu)

DT -Time increment between calculations

CODR -Conventional oil- Discovery rate (Btu/Yr)

CORX -Conventional oil- Revisions and extensions (Btu/Yr)

CORDR -Conventional oil- Reserves depletion rate (Btu/Yr)

CODR.KL=CORER.K/COPDF

43020 R

CODR -Conventional oil- Discovery rate (Btu/Yr)

CORER -Conventional oil- Resource extraction rate (Btu/Yr)

COPDF -Conventional oil- Potential discovery factor (Dimensionless)

CORDR.KL=COPR.K

43030 R

CORDR -Conventional oil- Reserves depletion rate (Btu/Yr)

COPR -Conventional oil- Production rate (Btu/Yr)

COPR.K=COPC.K*DOCUF.K

43040 A

COPR -Conventional oil- Production rate (Btu/Yr)

COPC -Conventional oil- Production capacity (Etu/Yr)

DOCUF -Domestic oil- Capacity utilization factor (Fraction)

COPC.K=CORES.K/COMRPR.K

43050 A

COPC -Conventional oil- Production capacity (Etu/Yr)

CORES -Conventional oil- Proven reserves (Btu)

COMRPR -Conventional oil- Minimum reserve production ratio (Year)

COMRPR.K=TABLE(CORPRT.TIME.K,1950,2030,10)

43060 A

CORPRT=11/10.6/7.5/7.5/7.5/7.5/7.5/7.5

43070 T

COPOMC=.05E-6

43080 C

COMRPR -Conventional oil- Minimum reserve production ratio (Year)

TABLE -Tabular relationship

CORPRT -Conventional oil- Reserve production rate table (Table)

TIME -Actual time during simulation

COPOMC -Conventional oil- Production O&M cost (\$/Btu)

NOTE

COCST.K=CODR.JK*COEOMC.K+CORX.JK*COROMC.K+CJPR.X*(COPOMC+CORP.K)

43100 A

COCST -Conventional oil- Cost (\$/Yr)

CODR -Conventional oil- Discovery rate (Btu/Yr)

COEOMC -Conventional oil- Exploration O&M cost (\$/Btu)

CORX -Conventional oil- Revisions and extensions (Btu/Yr)

COROMC -Conventional oil- Revision and extension O&M cost (\$/Btu)

COPR -Conventional oil- Production rate (Btu/Yr)

COPOMC -Conventional oil- Production O&M cost (\$/Btu)

CORP -Conventional oil- Royalty payments (\$/Btu)

CORP.K=CORPF*SMOOTH(DOWP.K,2)

43120 A

CORPF=.15

43130 C

CORP -Conventional oil- Royalty payments (\$/Btu)

CORPF -Conventional oil- Royalty payment factor (Fraction/Yr)

SMOOTH -First order information delay

DOWP -Domestic oil- Wellhead price (\$/Btu)

COOMC.K=COEOMC.K+COPOMC+CORP.K

43140 A

COOMC -Conventional oil- Operating and maintenance <O&M> cost (\$/Btu)

COEOMC -Conventional oil- Exploration O&M cost (\$/Btu)

COPOMC -Conventional oil- Production O&M cost (\$/Btu)

CORP -Conventional oil- Royalty payments (\$/Btu)

NOTE

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 NOTE Enhanced Oil Recovery Subsector
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EOPA.K=EOPA.J+(DT)(EOFCR.JK-EOPAR.JK) 43240 L
 EOPA=0 43250 N

EOPA -Enhanced oil- Physical assets (\$)
 DT -Time increment between calculations
 EOFCR -Enhanced oil- Facility completion rate (\$/Yr)
 EOPAR -Enhanced oil- Physical asset retirements (\$/Yr)

EOPAR.KL=EOPA.K*EOARF 43260 R
 EOARF=.045 43270 C

EOPAR -Enhanced oil- Physical asset retirements (\$/Yr)
 EOPA -Enhanced oil- Physical assets (\$)
 EOARF -Enhanced oil- Asset retirement factor (Fraction/Yr)

EOFCR.KL=DELAY3P(EOINV.JK,EOFCT,EOPUC.K) 43280 R
 EOFCT=3 43290 C

EOFCR -Enhanced oil- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 EOINV -Enhanced oil- Investment (\$/Yr)
 EOFCT -Enhanced oil- Facility construction time (Year)
 EOPUC -Enhanced oil- Plants under construction (\$)

NOTE

EOR.K=EOR.J+(DT)*(-EORDR.JK)

43310 L

EOR=EORI

43320 N

EORI=175E15

43330 C

EOR -Enhanced oil- Resources (Btu)

DT -Time increment between calculations

EORDR -Enhanced oil- Reserves depletion rate (Btu/Yr)

EORI -Enhanced oil- Resources initial (Btu)

EORDR.KL=EOPR.K

43340 R

EORDR -Enhanced oil- Reserves depletion rate (Btu/Yr)

EOPR -Enhanced oil- Production rate (Btu/Yr)

EOPR.K=EOPC.K*DOCUF.K

43350 A

EOPR -Enhanced oil- Production rate (Btu/Yr)

EOPC -Enhanced oil- Production capacity (Btu/Yr)

DOCUF -Domestic oil- Capacity utilization factor (Fraction)

EOPC.K=EOPC.K*EOPA.K

43360 A

EOPC -Enhanced oil- Production capacity (Btu/Yr)

EOPC -Enhanced oil- Capital productivity ((Btu/Yr)/\$)

EOPA -Enhanced oil- Physical assets (\$)

EOPC.K=TABLE(EODMT,EOR.K/EORI,0,1,-2)*EOCPN

43370 A

EODMT=0/.15/.30/.38/.45/1

43380 T

EOCPN=.11E6

43390 C

EOCP -Enhanced oil- Capital productivity ((Btu/Yr)/\$)

TABLE -Tabular relationship

EODMT -Enhanced oil- Depletion multiplier table (Table)

EOR -Enhanced oil- Resources (Btu)

EORI -Enhanced oil- Resources initial (Btu)

EOCPN -Enhanced oil- Capital productivity normal ((Btu/Yr)/\$)

EOCC.K=1/EOCP.K

43400 A

EOCC -Enhanced oil- Capital cost (\$/(Btu/Yr))

EOCP -Enhanced oil- Capital productivity ((Btu/Yr)/\$)

EOOMC.K=EOCCF*EOCC.K

43410 A

EOCCF=.166

43420 C

EOOMC -Enhanced oil- Operating and maintenance <O&M> cost (\$/Btu)

EOCCF -Enhanced oil- Capital cost factor (Fraction/Yr)

EOCC -Enhanced oil- Capital cost (\$/(Btu/Yr))

EOCST.K=EOPR.K*EOOMC.K

43430 A

EOCST -Enhanced oil- Cost (\$/Yr)

EOPR -Enhanced oil- Production rate (Btu/Yr)

EOOMC -Enhanced oil- Operating and maintenance <O&M> cost (\$/Btu)

NOTE

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 NOTE Coal Liquefaction Subsector
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CLPA.K=CLPA.J+(DT)(CLFCR.JK-CLPAR.JK) 43530 L
 CLPA=0 43540 N

CLPA -Coal liquids- Physical assets (\$)
 DT -Time increment between calculations
 CLFCR -Coal liquids- Facility completion rate (\$/Yr)
 CLPAR -Coal liquids- Physical asset retirements (\$/Yr)

CLPAR.KL=CLPA.K*CLARF 43550 R
 CLARF=.026 43560 C

CLPAR -Coal liquids- Physical asset retirements (\$/Yr)
 CLPA -Coal liquids- Physical assets (\$)
 CLARF -Coal liquids- Asset retirement factor (Fraction/Yr)

CLFCR.KL=DELAY3P(CLINV.JK,CLFCT.K,CLPUC.K) 43570 R
 CLFCR -Coal liquids- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 CLINV -Coal liquids- Investment (\$/Yr)
 CLFCT -Coal liquids- Facility construction time (Year)
 CLPUC -Coal liquids- Plants under construction (\$)

CLFCT.K=SMOOTH(CLIP(CLPFCT,CLHFCT,TIME.K,CLCDCY),CLHFCT) 43580 A
 CLHFCT=10 43590 C
 CLPFCT=5 43600 C
 CLCDCY=2200 43610 C

CLFCT -Coal liquids- Facility construction time (Year)
 SMOOTH -First order information delay
 CLIP -Function switched during the run
 CLPFCT -Coal liquids- Policy facility construction time (Year)
 CLHFCT -Coal liquids- Historical facility construction time (Year)
 TIME -Actual time during simulation
 CLCDCY -Coal liquids- Construction delay change year (Year)

NOTE

CLPR.K=CLPC.K*DOCUF.K*DCPDR.K

43630 A

CLPR -Coal liquids- Production rate (Btu/Yr)
CLPC -Coal liquids- Production capacity (Btu/Yr)
DOCUF -Domestic oil- Capacity utilization factor (Fraction)
DCPDR -Domestic coal- Production demand ratio (Dimensionless)

CLPC.K=CLCP*CLPA.K

43640 A

CLCP=.096E6

43650 C

CLPC -Coal liquids- Production capacity (Btu/Yr)
CLCP -Coal liquids- Capital productivity ((Btu/Yr)/\$)
CLPA -Coal liquids- Physical assets (\$)

CLCC.K=1/CLCP

43660 A

CLCC -Coal liquids- Capital cost (\$/(Btu/Yr))
CLCP -Coal liquids- Capital productivity ((Btu/Yr)/\$)

CLCST.K=CLPR.K*(CLOMC+CLFCST.K)

43670 A

CLOMC=.88E-6

43680 C

CLCST -Coal liquids- Cost (\$/Yr)
CLPR -Coal liquids- Production rate (Btu/Yr)
CLOMC -Coal liquids- Operating and maintenance <O&M> cost (\$/Btu)
CLFCST -Coal liquids- Feedstock cost (\$/Btu)

CLFCST.K=(DCP.K-CEFCF)/CLCE

43690 A

CLCE=.70

43700 C

CLFCST -Coal liquids- Feedstock cost (\$/Btu)
DCP -Domestic coal- Price (\$/Btu)
CEFCF -Centralized energy- Fuel cost factor (\$/Btu)
CLCE -Coal liquids- Conversion efficiency (Dimensionless)

CLDC.K=CLPC.K*DOCUF.K/CLCE

43710 A

CLDC -Coal liquids- Demand for coal (Btu/Yr)
CLPC -Coal liquids- Production capacity (Btu/Yr)
DOCUF -Domestic oil- Capacity utilization factor (Fraction)
CLCE -Coal liquids- Conversion efficiency (Dimensionless)

NOTE

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 NOTE Shale Oil Subsector
 NOTE *****
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 NOTE

SHPA.K=SHPA.J+(DT)(SHFCR.JK-SHPAR.JK) 43810 L
 SHPA=0 43820 N

SHPA -Shale oil- Physical assets (\$)
 DT -Time increment between calculations
 SHFCR -Shale oil- Facility completion rate (\$/Yr)
 SHPAR -Shale oil- Physical asset retirements (\$/Yr)

SHPAR.KL=SHPA.K*SHARF 43830 R
 SHARF=.026 43840 C

SHPAR -Shale oil- Physical asset retirements (\$/Yr)
 SHPA -Shale oil- Physical assets (\$)
 SHARF -Shale oil- Asset retirement factor (Fraction/Yr)

SHFCR.KL=DELAY3P(SHINV.JK,SHFCT.K,SHPUC.K) 43850 R

SHFCR -Shale oil- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 SHINV -Shale oil- Investment (\$/Yr)
 SHFCT -Shale oil- Facility construction time (Year)
 SHPUC -Shale oil- Plants under construction (\$)

SHFCT.K=SMOOTH(CLIP(SHPFCT,SHHFCT,TIME.K,SHCDCY),SHHFCT) 43860 A
 SHHFCT=10 43870 C
 SHPFCT=5 43880 C
 SHCDCY=2200 43890 C

SHFCT -Shale oil- Facility construction time (Year)
 SMOOTH -First order information delay
 CLIP -Function switched during the run
 SHPFCT -Shale oil- Policy facility construction time (Year)
 SHHFCT -Shale oil- Historical facility construction time (Year)
 TIME -Actual time during simulation
 SHCDCY -Shale oil- Construction delay change year (Year)

NOTE

SHR.K=SHR.J+(DT)*(-SHRDR.JK)

SHR=SHRI

SHRI=5800E15

SHR -Shale oil- Resources (Btu)
DT -Time increment between calculations
SHRDR -Shale oil- Reserves depletion rate (Btu/Yr)
SHRI -Shale oil- Resources initial (Btu)

43910 L
43920 N
43930 C

SHRDR.KL=SHPR.K

SHRDR -Shale oil- Reserves depletion rate (Btu/Yr)
SHPR -Shale oil- Production rate (Btu/Yr)

43940 R

SHPR.K=SHPC.K*DOCUF.K

SHPR -Shale oil- Production rate (Btu/Yr)
SHPC -Shale oil- Production capacity (Btu/Yr)
DOCUF -Domestic oil- Capacity utilization factor (Fraction)

43950 A

SHPC.K=SHCP.K*SHPA.K

SHPC -Shale oil- Production capacity (Btu/Yr)
SHCP -Shale oil- Capital productivity ((Btu/Yr)/\$)
SHPA -Shale oil- Physical assets (\$)

43960 A

SHCP.K=TABLE(SHDMT,SHR.K/SHRI,0.1,.2)*SHCPN

SHDMT=0/.25/.5/.7/.9/1

SHCPN=.108E6

SHCP -Shale oil- Capital productivity ((Btu/Yr)/\$)
TABLE -Tabular relationship
SHDMT -Shale oil- Depletion multiplier table (Table)
SHR -Shale oil- Resources (Btu)
SHRI -Shale oil- Resources initial (Btu)
SHCPN -Shale oil- Capital productivity normal ((Btu/Yr)/\$)

43970 A
43980 T
43990 C

SHCC.K=1/SHCP.K

SHCC -Shale oil- Capital cost (\$/(Btu/Yr))
SHCP -Shale oil- Capital productivity ((Btu/Yr)/\$)

44000 A

SHOMC.K=SHCCF*SHCC.K+SHST

SHCCF=.157

SHST=.73E-6

SHOMC -Shale oil- Operating and maintenance <O&M> cost (\$/Btu)
SHCCF -Shale oil- Capital cost factor (Fraction/Yr)
SHCC -Shale oil- Capital cost (\$/(Btu/Yr))
SHST -Shale oil- Severance tax (\$/Btu)

44010 A
44020 C
44030 C

SHCST.K=SHPR.K*SHOMC.K

SHCST -Shale oil- Cost (\$/Yr)
SHPR -Shale oil- Production rate (Btu/Yr)
SHOMC -Shale oil- Operating and maintenance <O&M> cost (\$/Btu)

44040 A

NOTE

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 NOTE *****
 NOTE
 NOTE Alaskan Oil Supply Subsector
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AOPR.K=(AOSSP.K+AONSP.K)*1E15 44140 A

AOPR -Alaskan oil- Production rate (Btu/Yr)
 AOSSP -Alaskan oil- South slope production (Btu/Yr)
 AONSP -Alaskan oil- North slope production (Btu/Yr)

AOSSP.K=TABHL(AOSSPT,TIME.K,1950,2030,5) 44150 A

AOSSPT=0/0/0/.23/.46/.43/.51/.52/1.07/1.22/1.34/1.23/.85/.4/0/0/0 44160 T

AOSSP -Alaskan oil- South slope production (Btu/Yr)
 TABHL -Tabular relationship
 AOSSPT -Alaskan oil- South slope production table (Table)
 TIME -Actual time during simulation

AONSP.K=AOONS.K+AONNS.K 44170 A

AONSP -Alaskan oil- North slope production (Btu/Yr)
 AOONS -Alaskan oil- Old North slope production (Btu/Yr)
 AONNS -Alaskan oil- New North slope production (Btu/Yr)

AOONS.K=CLIP(AOONS2.K.AOONS1.K,TIME.K,1980)
 AOONS -Alaskan oil- Old North slope production (Btu/Yr)
 CLIP -Function switched during the run
 AOONS2 -Alaskan oil- Old North slope production 1980-2020 (Btu/Yr)
 AOONS1 -Alaskan oil- Old North slope production 1975-1980 (Btu/Yr)
 TIME -Actual time during simulation

44180 A

AOONS1.K=TABHL(AOONS1T,TIME.K,1975,1980,1)
 AOONS1T=0/0/.64/1.01/2.67/3.09
 AOONS1 -Alaskan oil- Old North slope production 1975-1980 (Btu/Yr)
 TABHL -Tabular relationship
 AOONS1T -Alaskan oil- ONS1 table (Table)
 TIME -Actual time during simulation

44190 A

44200 T

AOONS2.K=TABHL(AOONS2T,TIME.K,1980,2030,5)
 AOONS2T=3.09/3.17/1.95/.87/.29/.11/0/0/0/0/0
 AOONS2 -Alaskan oil- Old North slope production 1980-2020 (Btu/Yr)
 TABHL -Tabular relationship
 AOONS2T -Alaskan oil- ONS2 table (Table)
 TIME -Actual time during simulation

44210 A

44220 T

AONNS.K=TABHL(AONNST,TIME.K,1980,2030,5)
 AONNST=0/.22/1.69/2.93/3.52/3.60/3.15/2.1/.75/.2/0
 AONNS -Alaskan oil- New North slope production (Btu/Yr)
 TABHL -Tabular relationship
 AONNST -Alaskan oil- New North slope production table (Table)
 TIME -Actual time during simulation

44230 A

44240 T

AOWP.K=SMOOTH(OOP.K,DOEAT)
 AOWP -Alaskan oil- Wellhead price (\$/Btu)
 SMOOTH -First order information delay
 OOP -OPEC oil- Price (\$/Btu)
 DOEAT -Domestic oil- Economic averaging time (Year)

44250 A

NOTE

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POPRM.K=TABLE(POPRMT,TIME.K,1950,2030,5)*1E15
POPRMT=0/0/0/0/0/0/0/0/0/0/0/0/0/0/0/0
POPRM  -Pan-Am oil- Production rate maximum (Btu/Yr)
TABLE  -Tabular relationship
POPRMT -Pan-Am oil- Production rate maximum table (Table)
TIME   -Actual time during simulation

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44340 A
44350 T

-85-

NOTE
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NOTE Supplementary Equations for Oil Demand for Coal
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TODC.K=CLDC.K

TODC -Total oil- Demand for coal (Btu/Yr)
CLDC -Coal liquids- Demand for coal (Btu/Yr)

44450 A

NOTE

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NOTE Coal Production Sector of FOSSIL2
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NOTE Department of Energy
NOTE Energy Transition Project
NOTE
NOTE Version Release Date:
NOTE March 1980
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 NOTE Coal Supply-Demand Balance: Capacity Utilization Subsector
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DCCUF.K=TABHL(DCCUFT,DCGD.K/DCPC.K,0,1,2,.1) 60240 A
 DCCUFT=0/.1/.2/.3/.4/.5/.6/.7/.8/.9/.95/.98/1 60250 T

DCCUF -Domestic coal- Capacity utilization factor (Fraction)
 TABHL -Tabular relationship
 DCCUFT -Domestic coal- Capacity utilization factor table (Table)
 DCGD -Domestic coal- Gross demand (Btu/Yr)
 DCPC -Domestic coal- Production capacity (Btu/Yr)

DCGD.K=DCND.K/DCDE 60260 A
 DCDE=1.0 60270 C

DCGD -Domestic coal- Gross demand (Btu/Yr)
 DCND -Domestic coal- Net demand (Btu/Yr)
 DCDE -Domestic coal- Distributional efficiency (Fraction)

DCND.K=TEDC.K+TODC.K+TGDC.K+DCEUD.K+DCED.K+DGCURC.K 60280 A

DCND -Domestic coal- Net demand (Btu/Yr)
 TEDC -Total electric- Demand for coal (Btu/Yr)
 TODC -Total oil- Demand for coal (Btu/Yr)
 TGDC -Total gas- Demand for coal (Btu/Yr)
 DCEUD -Domestic coal- End-use demand (Btu/Yr)
 DCED -Domestic coal- Export demand (Btu/Yr)
 DGCURC -Domestic gas- Curtailments to coal (Btu/Yr)

DCED.K=TABHL(DCEDT.TIME.K,1950,2030,10)*1E15 60290 A
 DCEDT=1.7/1.1/1.5/1.5/2.1/2.4/2.7/3.1/3.5 60300 T

DCED -Domestic coal- Export demand (Btu/Yr)
 TABHL -Tabular relationship
 DCEDT -Domestic coal- Export demand table (Table)
 TIME -Actual time during simulation

DCPC.K=SCPC.K+UCPC.K 60310 A

DCPC -Domestic coal- Production capacity (Btu/Yr)
 SCPC -Surface coal- Production capacity (Btu/Yr)
 UCPC -Underground coal- Production capacity (Btu/Yr)

DCPR.K=SCPR.K+UCPR.K 60320 A

DCPR -Domestic coal- Production rate (Btu/Yr)
 SCPR -Surface coal- Production rate (Btu/Yr)
 UCPR -Underground coal- Production rate (Btu/Yr)

DCPDR.K=DCPR.K/DCGD.K 60330 A
 DCPDR=1 60340 N

DCPDR -Domestic coal- Production demand ratio (Dimensionless)
 DCPR -Domestic coal- Production rate (Btu/Yr)
 DCGD -Domestic coal- Gross demand (Btu/Yr)

NOTE

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 NOTE Coal Supply-Demand Balance: Pricing Subsector
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DCP.K=DCMMP.K+DCDCHG.K 60440 A
 DCP=.92E-6 60450 N

DCP -Domestic coal- Price (\$/Btu)
 DCMMP -Domestic coal- Minemouth price (\$/Btu)
 DCDCHG -Domestic coal- Delivery charge (\$/Btu)

DCDCHG.K=CLIP(DCFCHG.K,DCHCHG,TIME.K,1977) 60460 A
 DCHCHG=.54E-6 60470 C

DCDCHG -Domestic coal- Delivery charge (\$/Btu)
 CLIP -Function switched during the run
 DCFCHG -Domestic coal- Future charge (\$/Btu)
 DCHCHG -Domestic coal- Historical charge (\$/Btu)
 TIME -Actual time during simulation

DCFCHG.K=DCHCHG*EXP(.01*(TIME.K-1977)) 60480 A

DCFCHG -Domestic coal- Future charge (\$/Btu)
 DCHCHG -Domestic coal- Historical charge (\$/Btu)
 EXP -Exponential function
 TIME -Actual time during simulation

DCMMP.K=DCPMN.K*DCPMN.K+DCACST.K 60490 A
 DCHMP=.38E-6 60500 N

DCMMP -Domestic coal- Minemouth price (\$/Btu)
 DCPMN -Domestic coal- Profit margin normal (\$/Btu)
 DCPMM -Domestic coal- Price multiplier (Dimensionless)
 DCACST -Domestic coal- Average cost (\$/Btu)

DCACST.K=DCCST.K/DCPR.K 60510 A

DCACST -Domestic coal- Average cost (\$/Btu)
 DCCST -Domestic coal- Cost (\$/Yr)
 DCPR -Domestic coal- Production rate (Btu/Yr)

DCPMN.K=DCROEN.K*DCEQ.K/(DCPC.K*DCCUFN*(1-DCTR))

60520 A

DCPMN -Domestic coal- Profit margin normal (\$/Btu)

DCROEN -Domestic coal- Normal return on equity (Fraction/Yr)

DCEQ -Domestic coal- Equity (\$)

DCPC -Domestic coal- Production capacity (Btu/Yr)

DCCUFN -Domestic coal- Capacity utilization factor normal (Fraction)

DCTR -Domestic coal- Tax rate (Fraction)

DCROEN.K=DCHROEN+DCINF.K+SMOOTH(STEP(.05,1974),5)

60530 A

DCHROEN=.05

60540 C

DCROEN -Domestic coal- Normal return on equity (Fraction/Yr)

DCHROEN -Domestic coal- Historical return on equity normal (Fraction/Yr)

DCINF -Domestic coal- Inflation rate (Fraction/Yr)

SMOOTH -First order information delay

STEP -Step-shaped exogenous input

DCPMN.K=TABHL(DCPNMT,DCGD.K/DCPC.K,.6,1.0,.1)

60550 A

DCPNMT=0/.4/1/2/3.5

60560 T

DCCUFN=.80

60570 C

DCPMN -Domestic coal- Price multiplier (Dimensionless)

TABHL -Tabular relationship

DCPNMT -Domestic coal- Price multiplier table (Table)

DCGD -Domestic coal- Gross demand (Btu/Yr)

DCPC -Domestic coal- Production capacity (Btu/Yr)

DCCUFN -Domestic coal- Capacity utilization factor normal (Fraction)

NOTE

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 NOTE Coal Financing: Source of Funds Subsector
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DCNI.K=(1-DCTR)*(DCREV.K-DCCST.K)+DCITC*DCNPC.K 60670 A
 PCTR=.30 60680 C
 DCITC=.07 60690 C

DCNI -Domestic coal- Net income (\$/Yr)
 DCTR -Domestic coal- Tax rate (Fraction)
 DCREV -Domestic coal- Revenue (\$/Yr)
 DCCST -Domestic coal- Cost (\$/Yr)
 DCITC -Domestic coal- Investment tax credit (Fraction)
 DCNPC -Domestic coal- New plants completed (\$/Yr)

DCREV.K-DCMMP.K*DCPR.K 60700 A
 DCREV -Domestic coal- Revenue (\$/Yr)
 DCMMP -Domestic coal- Minemouth price (\$/Btu)
 DCPR -Domestic coal- Production rate (Btu/Yr)

DCCST.K=UCCST.K+SCCST.K+DCDEP.K+DCINT.K 60710 A
 DCCST -Domestic coal- Cost (\$/Yr)
 UCCST -Underground coal- Cost (\$/Yr)
 SCCST -Surface coal- Cost (\$/Yr)
 DCDEP -Domestic coal- Depreciation (\$/Yr)
 DCINT -Domestic coal- Interest (\$/Yr)

NOTE

DCGA.K=DCGA.J+(DT)(DCINV.J-DCGAR.JK-DCVLI.JK) 60730 L
 DCGA=5.8E9 60740 N
 DCGA -Domestic coal- Gross assets (\$)
 DT -Time increment between calculations
 DCINV -Domestic coal- Investment (\$/Yr)
 DCGAR -Domestic coal- Gross asset retirements (\$/Yr)
 DCVLI -Domestic coal- Value loss due to inflation (\$/Yr)

DCGAR.KL=DCGA.K*DCARF 60750 R
 DCARF=.05 60760 C
 DCGAR -Domestic coal- Gross asset retirements (\$/Yr)
 DCGA -Domestic coal- Gross assets (\$)
 DCARF -Domestic coal- Asset retirement factor (Fraction/Yr)

DCVLI.KL=DCGA.K*DCINF.K 60770 R
 DCVLI -Domestic coal- Value loss due to inflation (\$/Yr)
 DCGA -Domestic coal- Gross assets (\$)
 DCINF -Domestic energy- Inflation rate (Fraction/Yr)

NOTE

DCNA.K=DCGA.K*DCADF

60820 A

DCADF=.60

60830 C

DCNA -Domestic coal- Net assets (\$)

DCGA -Domestic coal- Gross assets (\$)

DCADF -Domestic coal- Accumulated depreciation fraction (Fraction)

DCEQ.K=DCNA.K*DCEF

60840 A

DCEF=.80

60850 C

DCEQ -Domestic coal- Equity (\$)

DCNA -Domestic coal- Net assets (\$)

DCEF -Domestic coal- Equity fraction (Fraction)

DCDEBT.K=DCNA.K*DCDF

60860 A

DCDF=(35/65)*DCEF

60870 N

DCDEBT -Domestic coal- Debt (\$)

DCNA -Domestic coal- Net assets (\$)

DCDF -Domestic coal- Debt fraction (Fraction)

DCEF -Domestic coal- Equity fraction (Fraction)

DCINT.K=DCIR.K*DCDEBT.K

60880 A

DCINT -Domestic coal- Interest (\$/Yr)

DCIR -Domestic coal- Interest rate (Fraction/Yr)

DCDEBT -Domestic coal- Debt (\$)

DCIR.K=DCIRN+DEINF.K

60890 A

DCIRN=.025

60900 C

DCIR -Domestic coal- Interest rate (Fraction/Yr)

DCIRN -Domestic coal- Interest rate normal (Fraction/Yr)

DEINF -Domestic energy- Inflation rate (Fraction/Yr)

DCDRMT.K=DCDEBT.K/DCDL

60910 A

DCDL=10

60920 C

DCDRMT -Domestic coal- Debt repayment (\$/Yr)

DCDEBT -Domestic coal- Debt (\$)

DCDL -Domestic coal- Debt life (Year)

DCDEP.K=DCGA.K/DCBLC

60930 A

DCBLC=20

60940 C

DCDEP -Domestic coal- Depreciation (\$/Yr)

DCGA -Domestic coal- Gross assets (\$)

DCBLC -Domestic coal- Book life of capital (Year)

NOTE

DCIF.K=DCNI.K+DCDIV.K+DCDEP.K+DCDRMT.K 60960 A
 DCIF -Domestic coal- Internal funds (\$/Yr)
 DCNI -Domestic coal- Net income (\$/Yr)
 DCDIV -Domestic coal- Dividends (\$/Yr)
 DCDEP -Domestic coal- Depreciation (\$/Yr)
 DCDRMT -Domestic coal- Debt repayment (\$/Yr)

DCDIV.K=TABHL(DCDPOT,DCROI.K,0,.16,.04)*DCNI.K 60970 A
 DCDPOT=.9/.8/.55/.45/.4 60980 T
 DCDIV -Domestic coal- Dividends (\$/Yr)
 TABHL -Tabular relationship
 DCDPOT -Domestic coal- Dividend payout table (Table)
 DCROI -Domestic coal- Return on investment (Fraction/Yr)
 DCNI -Domestic coal- Net income (\$/Yr)

DCROI.K=(DCNI.K+DCINT.K)/(DCEQ.K+DCDEBT.K) 60990 A
 DCROI=.025 61000 N
 DCROI -Domestic coal- Return on investment (Fraction/Yr)
 DCNI -Domestic coal- Net income (\$/Yr)
 DCINT -Domestic coal- Interest (\$/Yr)
 DCEQ -Domestic coal- Equity (\$)
 DCDEBT -Domestic coal- Debt (\$)

DCROIN.K=DCROIR+SMOOTH(DCINF.K,DCEAT)+SMOOTH(STEP(.03,1974),5) 61010 A
 DCROIR=.04 61020 C
 DCROIN -Domestic coal- Return on investment normal (Fraction/Yr)
 DCROIR -Domestic coal- Return on investment real (Fraction/Yr)
 SMOOTH -First order information delay
 DCINF -Domestic coal- Inflation rate (Fraction/Yr)
 DCEAT -Domestic coal- Economic averaging time (Year)
 STEP -Step-shaped exogenous input

DCROIX.K=SMOOTH(DCROI.K/DCROIN.K,DCEAT). 61030 A
 DCEAT=16 61040 C
 DCROIX -Domestic coal- Return on investment index (Dimensionless)
 SMOOTH -First order information delay
 DCROI -Domestic coal- Return on investment (Fraction/Yr)
 DCROIN -Domestic coal- Return on investment normal (Fraction/Yr)
 DCEAT -Domestic coal- Economic averaging time (Year)

NOTE

DCFA.K=DCIF.K+DCEFA.K

61060 A

DCFA -Domestic coal- Funds available (\$/Yr)
DCIF -Domestic coal- Internal funds (\$/Yr)
DCEFA -Domestic coal- External funds available (\$/Yr)

DCEFA.K=DCGA.K*DCGR.K

61070 A

DCEFA -Domestic coal- External funds available (\$/Yr)
DCGA -Domestic coal- Gross assets (\$)
DCGR -Domestic coal- Growth rate (Fraction/Yr)

DCGR.K=TABHL(DCGRT,DCROIX.K,.4,1.4,.2)

61080 A

DCGRT=0/.1/.15/.2/.23/.25

61090 T

DCGR -Domestic coal- Growth rate (Fraction/Yr)
TABHL -Tabular relationship
DCGRT -Domestic coal- Growth rate table (Table)
DCROIX -Domestic coal- Return on investment index (Dimensionless)

NOTE

DCFN.K=MAX(0,(DCFPA.K-DCPA.K-DCPUC.K+DCFCT*DCARF*(DCPA.K+DCFPA.K)/2)/DCFCE.N)

61110 A

DCFCE.N=.85

61130 C

DCFCT=1.5

61140 C

DCFN -Domestic coal- Funds needed (\$/Yr)
MAX -Function selecting the larger of two values
DCFPA -Domestic coal- Future physical assets (\$)
DCPA -Domestic coal- Physical assets (\$)
DCPUC -Domestic coal- Plants under construction (\$)
DCFCT -Domestic coal- Facility construction time (Year)
DCARF -Domestic coal- Asset retirement factor (Fraction/Yr)
DCFCE.N -Domestic coal- Fraction to capital expenditures normal (Fraction)

DCFPA.K=DCNPA.K*EXP((DCNPA.K/DCSPA.K-1)*DCFCT/DCEAT)

61150 A

DCFPA -Domestic coal- Future physical assets (\$)
DCNPA -Domestic coal- Normal physical assets (\$)
EXP -Exponential function
DCSPA -Domestic coal- Smoothed physical assets (\$)
DCFCT -Domestic coal- Facility construction time (Year)
DCEAT -Domestic coal- Economic averaging time (Year)

DCNPA.K=DCGD.K/DCCUFP*DCCC.K

61160 A

DCCUFP=.70

61170 C

DCNPA -Domestic coal- Normal physical assets (\$)
DCGD -Domestic coal- Gross demand (Btu/Yr)
DCCUFP -Domestic coal- Capacity utilization factor for planning (Fraction)
DCCC -Domestic coal- Capital cost (\$/(Btu/Yr))

DCSPA.K=DCSPA.J+(DT)(DCNPA.J-DCSPA.J)/DCEAT

61180 L

DCSPA=DCSPAI

61190 N

DCSPAI=1.5E9

61200 C

DCSPA -Domestic coal- Smoothed physical assets (\$)

DT -Time increment between calculations

DCNPA -Domestic coal- Normal physical assets (\$)

DCEAT -Domestic coal- Economic averaging time (Year)

DCSPAI -Domestic coal- Smoothed physical assets initial (\$)

DCCC.K=DCPA.K/DCPC K

61210 A

DCCC -Domestic coal- Capital cost (\$/(Btu/Yr))

DCPA -Domestic coal- Physical assets (\$)

DCPC -Domestic coal- Production capacity (Btu/Yr)

DCPA.K=SCPA.K+UCPA.K

61220 A

DCPA -Domestic coal- Physical assets (\$)

SCPA -Surface coal- Physical assets (\$)

UCPA -Underground coal- Physical assets (\$)

DCPUC.K=SCPUC.K+UCPUC.K

61230 A

DCPUC -Domestic coal- Plants under construction (\$)

SCPUC -Surface coal- Plants under construction (\$)

UCPUC -Underground coal- Plants under construction (\$)

DCNPC.K=SCFCR.JK+UCFCR.JK

61240 A

DCNPC -Domestic coal- New plants completed (\$/Yr)

SCFCR -Surface coal- Facility completion rate (\$/Yr)

UCFCR -Underground coal- Facility completion rate (\$/Yr)

DCINV.K=MIN(DCFA.K,DCFN.K)*DCFCEN

61250 A

DCTGR=2

61260 C

DCINV -Domestic coal- Investment (\$/Yr)

MIN -Function selecting the smaller of two values

DCFA -Domestic coal- Funds available (\$/Yr)

DCFN -Domestic coal- Funds needed (\$/Yr)

DCFCEN -Domestic coal- Fraction to capital expenditures normal (Fraction)

DCTGR -Domestic coal- Time for growth rate (Year)

NOTE

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 NOTE Coal Financing: Use of Funds Subsector
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SCINV.KL=DCINV.K*SCAW.K/DCAW.K
 SCINV=SCINVI
 SCINVI=.03E9

61360 R
 61370 N
 61380 C

SCINV -Surface coal- Investment (\$/Yr)
 DCINV -Domestic coal- Investment (\$/Yr)
 SCAW -Surface coal- Allocation weight (Dimensionless)
 DCAW -Domestic coal- Allocation weight (Dimensionless)
 SCINVI -Surface coal- Investment initial (\$/Yr)

SCAW.K=(SCMCST.K*1E6)^DCWF*(1-STEP(1,SCMY))

61390 A

SCAW -Surface coal- Allocation weight (Dimensionless)
 SCMCST -Surface coal- Marginal cost (\$/Btu)
 DCWF -Domestic coal- Weighting factor (Dimensionless)
 STEP -Step-shaped exogenous input
 SCMY -Surface coal- Moratorium initiation year (Year)

SCMCST.K=SCCCR.K*SCSCC.K+SCOMC.K+SCDCHG
 SCDCHG=.20E-6

61400 A
 61410 C

SCMCST -Surface coal- Marginal cost (\$/Btu)
 SCCCCR -Surface coal- Capital charge rate (Fraction/Yr)
 SCSCC -Surface coal- Specific capital cost (\$/(Btu/Yr))
 SCOMC -Surface coal- Operating and maintenance <O&M> cost (\$/Btu)
 SCDCHG -Surface coal- Delivery charge (\$/Btu)

SCCCR.K=.080+SMOOTH(STEP(.05,1974),5)

61420 A

SCCCR -Surface coal- Capital charge rate (Fraction/Yr)
 SMOOTH -First order information delay
 STEP -Step-shaped exogenous input

SCSCC.K=SCCC.K*SCSCH.K/DCCUFP

61430 A

SCSCC -Surface coal- Specific capital cost (\$/(Btu/Yr))
SCCC -Surface coal- Capital cost (\$/(Btu/Yr))
SCSCH -Surface coal- Secondary constraint multiplier (Dimensionless)
DCCUFP -Domestic coal- Capacity utilization factor for planning (Fraction)

SCSCH.K=TABHL(DCSCMT,SCGR.K,.04,.20,.04)

61440 A

SCSCH -Surface coal- Secondary constraint multiplier (Dimensionless)
TABHL -Tabular relationship
DCSCMT -Domestic coal- Secondary constraint multiplier table (Table)
SCGR -Surface coal- Growth rate (Fraction/Yr)

SCGR.K=(SCAGR.K/SMOOTH(SCAGR.K,DCTGR)-1)/DCTGR

61460 A

SCGR -Surface coal- Growth rate (Fraction/Yr)
SCAGR -Surface coal- Assets for growth rate (\$)
SMOOTH -First order information delay
DCTGR -Domestic coal- Time for growth rate (Year)

SCAGR.K=MAX(DCPAMI,SCPA.K+SCPUC.K)

61470 A

SCMY=2200

61480 C

SCAGR -Surface coal- Assets for growth rate (\$)
MAX -Function selecting the larger of two values
DCPAMI -Domestic coal- Physical assets of a mature industry (\$)
SCPA -Surface coal- Physical assets (\$)
SCPUC -Surface coal- Plants under construction (\$)
SCMY -Surface coal- Moratorium initiation year (Year)

NOTE

UCINV.KL=DCINV.K*UCAW.K/DCAW.K

UCINV=UCINVI

UCINVI=.3E9

UCINV -Underground coal- Investment (\$/Yr)
DCINV -Domestic coal- Investment (\$/Yr)
UCAW -Underground coal- Allocation weight (Dimensionless)
DCAW -Domestic coal- Allocation weight (Dimensionless)
UCINVI -Underground coal- Investment initial (\$/Yr)

61500 R

61510 N

61520 C

UCAW.K=(UCMCST.K*1E6)^DCWF

UCAW -Underground coal- Allocation weight (Dimensionless)
UCMCST -Underground coal- Marginal cost (\$/Btu)
DCWF -Domestic coal- Weighting factor (Dimensionless)

61530 A

UCMCST.K=UCCCR.K*UCSCC.K+UCOMC.K+UCLCST.K

UCMCST -Underground coal- Marginal cost (\$/Btu)
UCCCR -Underground coal- Capital charge rate (Fraction/Yr)
UCSCC -Underground coal- Specific capital cost (\$/(Btu/Yr))
UCOMC -Underground coal- Operating and maintenance <O&M> cost (\$/Btu)
UCLCST -Underground coal- Labor cost (\$/Btu)

61540 A

UCCCR.K=.080+SMOOTH(STEP(.05,1974),5)

UCCCR -Underground coal- Capital charge rate (Fraction/Yr)
SMOOTH -First order information delay
STEP -Step-shaped exogenous input

61550 A

UCSCC.K=UCCC.K*UCSCM.K/DCCUFP

UCSCC -Underground coal- Specific capital cost (\$/(Btu/Yr))
UCCC -Underground coal- Capital cost (\$/(Btu/Yr))
UCSCM -Underground coal- Secondary constraint multiplier (Dimensionless)
DCCUFP -Domestic coal- Capacity utilization factor for planning (Fraction)

61560 A

UCSCM.K=TABHL(DCSCMT,UCGR.K,.04,.20,.04)

UCSCM -Underground coal- Secondary constraint multiplier (Dimensionless)
TABHL -Tabular relationship
DCSCMT -Domestic coal- Secondary constraint multiplier table (Table)
UCGR -Underground coal- Growth rate (Fraction/Yr)

61570 A

UCGR.K=(UCAGR.K/SMOOTH(UCAGR.K,DCTGR)-1)/DCTGR

UCGR -Underground coal- Growth rate (Fraction/Yr)
UCAGR -Underground coal- Assets for growth rate (\$)
SMOOTH -First order information delay
DCTGR -Domestic coal- Time for growth rate (Year)

61580 A

UCAGR.K=MAX(DCPAMI,UCPA.K+UCPUC.K)

UCAGR -Underground coal- Assets for growth rate (\$)
MAX -Function selecting the larger of two values
DCPAMI -Domestic coal- Physical assets of a mature industry (\$)
UCPA -Underground coal- Physical assets (\$)
UCPUC -Underground coal- Plants under construction (\$)

61590 A

NOTE

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 NOTE Surface Coal Production Subsector
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SCPA.K=SCPA.J+(DT)(SCFCR.JK-SCPAR.JK)
 SCPA=1.5E9

61730 L
 61740 N

SCPA -Surface coal- Physical assets (\$)
 DT -Time increment between calculations
 SCFCR -Surface coal- Facility completion rate (\$/Yr)
 SCPAR -Surface coal- Physical asset retirements (\$/Yr)

SCPAR.KL=SCPA.K*SCARF
 SCARF=.05

61750 R
 61760 C

SCPAR -Surface coal- Physical asset retirements (\$/Yr)
 SCPA -Surface coal- Physical assets (\$)
 SCARF -Surface coal- Asset retirement factor (Fraction/Year)

SCFCR.KL=DELAY3P(SCINV.JK,DCFCT,SCPUC.K)

61770 R

SCFCR -Surface coal- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 SCINV -Surface coal- Investment (\$/Yr)
 DCFCT -Domestic coal- Facility construction time (Year)
 SCPUC -Surface coal- Plants under construction (\$)

NOTE

SCR.K=SCR.J+(DT)(-SCRDR.JK)
 SCR=SCRI
 SCRI=2400E15

61790 L
 61800 N
 61810 C

SCR -Surface coal- Resources (Btu)
 DT -Time increment between calculations
 SCRDR -Surface coal- Reserves depletion rate (Btu/Yr)
 SCRI -Surface coal- Resources initial (Btu)

SCRDR.KL=SCPR.K

61820 R

SCRDR -Surface coal- Reserves depletion rate (Btu/Yr)
 SCPR -Surface coal- Production rate (Btu/Yr)

NOTE

SCPR.K=DCCUF.K*SCPC.K

61840 A

SCPR -Surface coal- Production rate (Btu/Yr)

DCCUF -Domestic coal- Capacity utilization factor (Fraction)

SCPC -Surface coal- Production capacity (Btu/Yr)

SCPC.K=SCCP.K*SCPA.K

61850 A

SCPC -Surface coal- Production capacity (Btu/Yr)

SCCP -Surface coal- Capital productivity ((Btu/Yr)/\$)

SCPA -Surface coal- Physical assets (\$)

SCCP.K=TABLE(SCDMT,SCR.K/SCRI.0,1,.2)*SCCPN*SCPMS.K

61860 A

SCDMT=0/.2/.4/.6/.8/1

61870 T

SCCPN=2.8E6

61880 C

SCCP -Surface coal- Capital productivity ((Btu/Yr)/\$)

TABLE -Tabular relationship

SCDMT -Surface coal- Depletion multiplier table (Table)

SCR -Surface coal- Resources (Btu)

SCRI -Surface coal- Resources initial (Btu)

SCCPN -Surface coal- Capital productivity normal ((Btu/Yr)/\$)

SCPMS -Surface coal- Productivity multiplier from safety (Dimensionless)

SCPMS.K=SMOOTH(CLIP(.65,1,TIME.K,1970),DCSAT)

61890 A

DCSAT=3

61900 C

SCPMS -Surface coal- Productivity multiplier from safety (Dimensionless)

SMOOTH -First order information delay

CLIP -Function switched during the run

TIME -Actual time during simulation

DCSAT -Domestic coal- Safety adjustment time (Year)

SCCC.K=1/SCCP.K 61910 A
 SCCC -Surface coal- Capital cost $(\$/(\text{Btu}/\text{Yr}))$
 SCCP -Surface coal- Capital productivity $((\text{Btu}/\text{Yr})/\$)$

 SCOMC.K=SCCF*SCCC.K+SCST.K+SCRSC.K 61920 A
 SCCF=.58 61930 C
 SCMC -Surface coal- Operating and maintenance <O&M> cost $(\$/\text{Btu})$
 SCCF -Surface coal- Cost factor $(\text{Fraction}/\text{Yr})$
 SCCC -Surface coal- Capital cost $(\$/(\text{Btu}/\text{Yr}))$
 SCST -Surface coal- Severance tax $(\$/\text{Btu})$
 SCRSC -Surface coal- Reclamation standards cost $(\$/\text{Btu})$

 SCCST.K=SCPR.K*SCMC.K 61940 A
 SCCST -Surface coal- Cost $(\$/\text{Yr})$
 SCPR -Surface coal- Production rate (Btu/Yr)
 SCMC -Surface coal- Operating and maintenance <O&M> cost $(\$/\text{Btu})$

 SCST.K=STEP(1,SCSTY)*TABHL(SCSTT,(TIME.K-SCSTPY)/SCSTPT,0,1,1)*1E-6 61950 A
 SCSTY=1975 61960 C
 SCSTT=.20/.60 61970 T
 SCSTPT=20 61980 C
 SCSTPY=2200 61990 C
 SCST -Surface coal- Severance tax $(\$/\text{Btu})$
 STEP -Step-shaped exogenous input
 SCSTY -Surface coal- Severance tax initiation year (Year)
 TABHL -Tabular relationship
 SCSTT -Surface coal- Severance tax table (Table)
 TIME -Actual time during simulation
 SCSTPY -Surface coal- Severance tax policy initiation year (Year)
 SCSTPT -Surface coal- Severance tax policy time (Year)

 SCRSC.K=STEP(SCIRSC,SCRSY) 62000 A
 SCRSY=1975 62010 C
 SCIRSC=.13E-6 62020 C
 SCRSC -Surface coal- Reclamation standards cost $(\$/\text{Btu})$
 STEP -Step-shaped exogenous input
 SCIRSC -Surface coal- Indicated reclamation costs $(\$/\text{Btu})$
 SCRSY -Surface coal- Reclamation standards initiation year (Year)

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 NOTE Underground Coal Production Subsector
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UCPA.K=UCPA.J+(DT)(UCFCR.JK-UCPAR.JK)
 UCPA=4.3E9

62120 L
 62130 N

UCPA -Underground coal- Physical assets (\$)
 DT -Time increment between calculations
 UCFCR -Underground coal- Facility completion rate (\$/Yr)
 UCPAR -Underground coal- Physical asset retirements (\$/Yr)

UCPAR.KL=UCPA.K*UCARF
 UCARF=.05

62140 R
 62150 C

UCPAR -Underground coal- Physical asset retirements (\$/Yr)
 UCPA -Underground coal- Physical assets (\$)
 UCARF -Underground coal- Asset retirement factor (Fraction/Year)

UCFCR.KL=DELAY3P(UCINV.JK,DCFCT,UCPUC.K)

62160 R

UCFCR -Underground coal- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 UCINV -Underground coal- Investment (\$/Yr)
 DCFCT -Domestic coal- Facility construction time (Year)
 UCPUC -Underground coal- Plants under construction (\$)

NOTE

UCR.K=UCR.J+(DT)(-UCRDR.JK)
 UCR=UCRI
 UCRI=7000E15

62180 L
 62190 N
 62200 C

UCR -Underground coal- Resources (Btu)
 DT -Time increment between calculations
 UCRDR -Underground coal- Reserves depletion rate (Btu/Yr)
 UCRI -Underground coal- Resources initial (Btu)

UCRDR.KL=UCPR.K

62210 R

UCRDR -Underground coal- Reserves depletion rate (Btu/Yr)
 UCPR -Underground coal- Production rate (Btu/Yr)

NOTE

UCPR.K=DCCUF.K*UCPC.K

62230 A

UCPR -Underground coal- Production rate (Btu/Yr)
 DCCUF -Domestic coal- Capacity utilization factor (Fraction)
 UCPC -Underground coal- Production capacity (Btu/Yr)

UCPC.K=UCCP.K*UCPA.K

62240 A

UCPC -Underground coal- Production capacity (Btu/Yr)
 UCCP -Underground coal- Capital productivity ((Btu/Yr)/\$)
 UCPA -Underground coal- Physical assets (\$)

UCCP.K=TABLE(UCDMT,UCR.K/UCRI,0.1,.2)*UCCPN*UCPMS.K*UCTM.K
 UCDMT=0/.2/.4/.6/.8/1
 UCCPN=4.1E6

62250 A
 62260 T
 62270 C

UCCP -Underground coal- Capital productivity ((Btu/Yr)/\$)
 TABLE -Tabular relationship
 UCDMT -Underground coal- Depletion multiplier table (Table)
 UCR -Underground coal- Resources (Btu)
 UCRI -Underground coal- Resources initial (Btu)
 UCCPN -Underground coal- Capital productivity normal ((Btu/Yr)/\$)
 UCPMS -Underground coal- Productivity multiplier from safety (Dimensionless)
 UCTM -Underground coal- Technology multiplier (Dimensionless)

UCTM.K=TABHL(UCTMT,TIME.K,1950,2000,10)
 UCTMT=1/.52/.27/.22/.22/.22

62280 A
 62290 T

UCTM -Underground coal- Technology multiplier (Dimensionless)
 TABHL -Tabular relationship
 UCTMT -Underground coal- Technology multiplier table (Table)
 TIME -Actual time during simulation

UCPMS.K=SMOOTH(TABLE(UCPMST,UCAR.K,D.1.25,.25),DCSAT)
 UCPMST=0/.4/.72/.85/1/1.05

62300 A
 62310 T

UCPMS -Underground coal- Productivity multiplier from safety (Dimensionless)
 SMOOTH -First order information delay
 TABLE -Tabular relationship
 UCPMST -Underground coal- PMS table (Table)
 UCAR -Underground coal- Adjustment rate (Dimensionless)
 DCSAT -Domestic coal- Safety adjustment time (Year)

UCAR.K=CLIP(UCRSS,UCNSS,TIME.K,1969)
 UCNSS=1
 UCRSS=.5

62320 A
 62330 C
 62340 C

UCAR -Underground coal- Adjustment rate (Dimensionless)
 CLIP -Function switched during the run
 UCRSS -Underground coal- Regulated safety standards (Dimensionless)
 UCNSS -Underground coal- Normal safety standards (Dimensionless)
 TIME -Actual time during simulation

UCCC.K=1/UCCP.K

62350 A

UCCC -Underground coal- Capital cost (\$/(Btu/Yr))
 UCCP -Underground coal- Capital productivity ((Btu/Yr)/\$)

UCOMC.K=UCCF*UCCC.K
 UCCF=.135

62360 A
 62370 C

UCOMC -Underground coal- Operating and maintenance <O&M> cost (\$/Btu)
 UCCF -Underground coal- Cost factor (Fraction/Yr)
 UCCC -Underground coal- Capital cost (\$/(Btu/Yr))

UCCST.K=UCPR.K*(UCOMC.K+UCLCST.E)

62380 A

UCCST -Underground coal- Cost (\$/Yr)

UCPR -Underground coal- Production rate (Btu/Yr)

UCOMC -Underground coal- Operating and maintenance <O&M> cost (\$/Btu)

UCLCST -Underground coal- Labor cost (\$/Btu)

UCLCST.K=(UCLW.K/UCCLR.K)*UCCC.E

62390 A

UCLCST -Underground coal- Labor cost (\$/Btu)

UCLW -Underground coal- Labor wages (\$/Laborer-Yr)

UCCLR -Underground coal- Capital-to-labor ratio (\$-capital/Laborer)

UCCC -Underground coal- Capital cost (\$/(Btu/Yr))

UCLW.K=UCLWN*UCLWM.K

62400 A

UCLWN=16500

62410 C

UCLW -Underground coal- Labor wages (\$/Laborer-Yr)

UCLWN -Underground coal- Labor wages normal (\$/Laborer-Yr)

UCLWM -Underground coal- Labor wage multiplier (Dimensionless)

UCLWM.K=TABLE(UCLWMT.TIME.K.1950,2030.10)

62420 A

UCLWMT=1/1.2/1.6/2/2.4/2.6/2.8/2.9/3.0

62430 T

UCLWM -Underground coal- Labor wage multiplier (Dimensionless)

TABLE -Tabular relationship

UCLWMT -Underground coal- Labor wage multiplier table (Table)

TIME -Actual time during simulation

UCCLR.K=UCCLR.N*UCCLM.K

62440 A

UCCLR.N=11500

62450 C

UCCLR -Underground coal- Capital-to-labor ratio (\$-capital/Laborer)

UCCLR.N -Underground coal- Capital-to-labor ratio normal (\$-capital/Laborer)

UCCLM -Underground coal- Capital/labor multiplier (Dimensionless)

UCCLM.K=TABLE(UCCLMT.TIME.K.1950,2000.10)

62460 A

UCCLMT=1/3.0/9.0/12.0/13.9/14

62470 T

UCCLM -Underground coal- Capital/labor multiplier (Dimensionless)

TABHL -Tabular relationship

UCCLMT -Underground coal- Capital/labor multiplier table (Table)

TIME -Actual time during simulation

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NOTE Electricity Generation Sector of FOSSIL2
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NOTE Department of Energy
NOTE Energy Transition Project
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NOTE Version Release Date:
NOTE March 1980
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 NOTE Electricity Supply-Demand Balance: Capacity Utilization Subsector
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SECUF.K=TABHL(SECUFT.SED.K/SEPC.K 0 1 2)
 SECUFT=0/ 2/ 4/ 6/ 8/ 85

70230 A
 70240 T

SECUF -Steam electric- Capacity utilization factor (Fraction)
 TABHL -Tabular relationship
 SECUFT -Steam electric- Capacity utilization factor table (Table)
 SED -Steam electric- Demand (Btu/Yr)
 SEPC -Steam electric- Production capacity (Btu/Yr)

SED.K=TEGD.K-HEPR.K-HTPR.K

70250 A

SED -Steam electric- Demand (Btu/Yr)
 TEGD -Total electric- Gross demand (Btu/Yr)
 HEPR -Hydro electric- Production rate (Btu/Yr)
 HTPR -Hydrothermal electric- Production rate (Btu/Yr)

TEGD.K=TEND.K/TEDE

70260 A

TEGD -Total electric- Gross demand (Btu/Yr)
 TEND -Total electric- Net demand (Btu/Yr)
 TEDE -Total electric- Distributional efficiency (Fraction)

TEND.K=TEEUD.K

70270 A
 70280 C

TEDE= 91

TEND -Total electric- Net demand (Btu/Yr)
 TEEUD -Total electric- End-use demand (Btu/Yr)
 TEDE -Total electric- Distributional efficiency (Fraction)

SEPC K=LWPC K+BNPC K+ECPC K+NCPC K+FBPC K+OUPC K+PVPC K+CCPC K+OTPC K+BMPC K+STPC K+WEPC K

70290 A

SEPC -Steam electric- Production capacity (Btu/Yr)
 LWPC -Light water nuclear electric- Production capacity (Btu/Yr)
 BNPC -Breeder nuclear electric- Production capacity (Btu/Yr)
 ECPC -Emission controlled coal- Production capacity (Btu/Yr)
 NCPC -Non-Emission controlled coal- Production capacity (Btu/Yr)
 FBPC -Fluidized bed coal electric- Production capacity (Btu/Yr)
 OUPC -Oil/gas utilities- Production capacity (Btu/Yr)
 PVPC -Photovoltaic electric- Production capacity (Btu/Yr)
 CCPC -Combined cycle coal electric- Production capacity (Btu/Yr)
 OTPC -Ocean thermal electric- Production capacity (Btu/Yr)
 BMPC -Biomass electric- Production capacity (Btu/Yr)
 STPC -Solar thermal- Production capacity (Btu/Yr)
 WEPC -Wind electric- Production capacity (Btu/Yr)

TEPR K=SEPR K+HEPR K+HTPR K

70310 A

TEPR -Total electric- Production rate (Btu/Yr)
 SEPR -Steam electric- Production rate (Btu/Yr)
 HEPR -Hydro electric- Production rate (Btu/Yr)
 HTPR -Hydrothermal electric- Production rate (Btu/Yr)

SEPR K=FBPR K+ECPR K+NCPR K+LWPR K+BNPR K+OUPR K+PVPR K+CCPR K+OTPR K+BMPR K+STPR K+WEPR K

70320 A

SEPR -Steam electric- Production rate (Btu/Yr)
 FBPR -Fluidized bed coal electric- Production rate (Btu/Yr)
 ECPR -Emission controlled coal- Production rate (Btu/Yr)
 NCPR -Non-Emission controlled coal- Production rate (Btu/Yr)
 LWPR -Light water nuclear electric- Production rate (Btu/Yr)
 BNPR -Breeder nuclear electric- Production rate (Btu/Yr)
 OUPR -Oil/gas utilities- Production rate (Btu/Yr)
 PVPR -Photovoltaic electric- Production rate (Btu/Yr)
 CCPR -Combined cycle coal electric- Production rate (Btu/Yr)
 OTPR -Ocean thermal electric- Production rate (Btu/Yr)
 BMPR -Biomass electric- Production rate (Btu/Yr)
 STPR -Solar thermal- Production rate (Btu/Yr)
 WEPR -Wind electric- Production rate (Btu/Yr)

TEPDR K=TEPR K/TEGD K

70340 A

TEPDR=1

70350 N

TEPDR -Total electric- Production demand ratio (Dimensionless)
 TEPR -Total electric- Production rate (Btu/Yr)
 TEGD -Total electric- Gross demand (Btu/Yr)

NOTE

NOTE
 NOTE *****
 NOTE
 NOTE Electricity Supply-Demand Balance: Pricing Subsector
 NOTE
 NOTE *****
 NOTE
 NOTE

TEP.K=SMOOTH(SEALP.K.SERRT.K) 70450 A
 TEP=TEPI 70460 N
 TFPI=10.20E-6 70470 C

TEP -Total electric- Price (\$/Btu)
 SMOOTH -First order information delay
 SEALP -Steam electric- Allowed price (\$/Btu)
 SERRT -Steam electric- Regulation delay time (Year)
 TEPI -Total electric- Price initial (\$/Btu)

SERRT.K=TABHL(SERRTT.TIME.K.1950.2030.10) 70480 A
 SERRTT=5/5/2/2/2/2/2/2 70490 T

SERRT -Steam electric- Regulation delay time (Year)
 TABHL -Tabular relationship
 SERRTT -Steam electric- Regulation delay time table (Table)
 TIME -Actual time during simulation

SEALP.K=SEACST.K+TEPM.K 70500 A
 SEALP=SEALPI 70510 N
 SEALPI=10.20E-6 70520 C

SEALP -Steam electric- Allowed price (\$/Btu)
 SEACST -Steam electric- Average cost (\$/Btu)
 TEMPM -Total electric- Price markup (\$/Btu)
 SEALPI -Steam electric- Allowed price initial (\$/Btu)

SEACST.K=SECST.K/(TEDE*(SEPC.K*MIN(SECUF.K.7))) 70530 A

SEACST -Steam electric- Average cost (\$/Btu)
 SECST -Steam electric- Cost (\$/Yr)
 TEDE -Total electric- Distributional efficiency (Fraction)
 SEPC -Steam electric- Production capacity (Btu/Yr)
 MIN -Function selecting the smaller of two values
 SECUF -Steam electric- Capacity utilization factor (Fraction)

TEPM.K=SEALROE.K*SEEQ.K/(TEDE*(SEPC.K*MIN(SECUF.K.7)))*(1-SETR.K)) 70540 A

TEPM -Total electric- Price markup (\$/Btu)
 SEALROE -Steam electric- Allowed return on equity (Fraction/Yr)
 SEEQ -Steam electric- Equity (\$)
 TEDE -Total electric- Distributional efficiency (Fraction)
 SEPC -Steam electric- Production capacity (Btu/Yr)
 MIN -Function selecting the smaller of two values
 SECUF -Steam electric- Capacity utilization factor (Fraction)
 SETR -Steam electric- Tax rate (Fraction)

SEALROE K=CLIP(SEPROE SEHROE TIME K SERRY)+DEINF.K
 SEHROE=.07
 SEPROE= 10
 SERRY=2200

70550 A
 70560 C
 70570 C
 70580 C

SEALROE -Steam electric- Allowed return on equity (Fraction/Yr)
 CLIP -Function switched during the run
 SEPROE -Steam electric- Policy return on equity (Fraction/Yr)
 SEHROE -Steam electric- Historical return on equity (Fraction/Yr)
 TIME -Actual time during simulation
 SERRY -Steam electric- Rate reform initiation year (Year)
 DEINF -Domestic economy- Inflation rate (Fraction/Yr)

NOTE

SEACUF K=CLIP(SEPACUF K SEHACUF K TIME K SELMPY)

70600 A

SEACUF -Steam electric- Average capacity utilization factor (Fraction)
 CLIP -Function switched during the run
 SEPACUF -Steam electric- Policy avg. capacity utilization factor (Fraction)
 SEHACUF -Steam electric- Historical avg. capacity utilization factor (Fraction)
 TIME -Actual time during simulation
 SELMPY -Steam electric- Load management policy initiation year (Year)

SEHACUF K=TABHL(SEACUFT TIME K 1950 2030.10)

70610 A

SEACUFT=.55/.52/.50/.4/.45/.45/.45/.45/.45

70620 T

SEHACUF -Steam electric- Historical avg. capacity utilization factor (Fraction)
 TABHL -Tabular relationship
 SEACUFT -Steam electric- Average capacity utilization table (Table)
 TIME -Actual time during simulation

SEPACUF K=TABHL(SEPCUFT TIME K 1950 2030.10)

70630 A

SEPCUFT=.55/.52/ 5/.4/.5/.55/ 55/ 55/ 55

70640 T

SELMPY=1980

70650 C

SEPACUF -Steam electric- Policy avg. capacity utilization factor (Fraction)
 TABHL -Tabular relationship
 SEPCUFT -Steam electric- PACUF table (Table)
 TIME -Actual time during simulation
 SELMPY -Steam electric- Load management policy initiation year (Year)

NOTE

NOTE
 NOTE *****
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 NOTE Electric Utility Financing: Source of Funds Subsector
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 NOTE

SENI.K=(1-SETR.K)*(SREV.K-SECST.K)+SEITC*SENPC K 70750 A
 SENI -Steam electric- Net income (\$/Yr)
 SETR -Steam electric- Tax rate (Fraction)
 SREV -Steam electric- Revenue (\$/Yr)
 SECST -Steam electric- Cost (\$/Yr)
 SEITC -Steam electric- Investment tax credit (Fraction)
 SENPC -Steam electric- New plants completed (\$/Yr)

SETR.K=TABHL(SETRT TIME.K.1950.2030.10) 70760 A
 SETRT=.40/.35/ 25/ 20/ 20/ 20/ 20/ 20/ 20 70770 T
 SEITC=.07 70780 C
 SETR -Steam electric- Tax rate (Fraction)
 TABHL -Tabular relationship
 SETRT -Steam electric- Tax rate table (Table)
 TIME -Actual time during simulation
 SEITC -Steam electric- Investment tax credit (Fraction)

SREV.K=TEP.K*TEDE*SEPR K 70790 A
 SREV -Steam electric- Revenue (\$/Yr)
 TEP -Total electric- Price (\$/Btu)
 TEDE -Total electric- Distributional efficiency (Fraction)
 SEPR -Steam electric- Production rate (Btu/Yr)

SECST.K=SEPCST.K+SEDEP K+SEINT.K 70800 A
 SECST -Steam electric- Cost (\$/Yr)
 SEPCST -Steam electric- Production cost (\$/Yr)
 SEDEP -Steam electric- Depreciation (\$/Yr)
 SEINT -Steam electric- Interest (\$/Yr)

SEPCST.K=TDCST.K+NCCST.K+ECCST.K+FBCST.K+OUCST.K+PVCST.K+LWCST.K+BNCST.K+CCST.K+OTCST.K+BMCST.K+
 STCST K+WECST.K 70810 A
 SEPCST -Steam electric- Production cost (\$/Yr)
 TDCST -Transmission and distribution- Cost (\$/Yr)
 NCCST -Non-Emission controlled coal- Cost (\$/Yr)
 ECCST -Emission controlled coal- Cost (\$/Yr)
 FBCST -Fluidized bed coal electric- Cost (\$/Yr)
 OUCST -Oil/gas utilities- Cost (\$/Yr)
 PVCST -Photovoltaic electric- Cost (\$/Yr)
 LWCST -Light water nuclear electric- Cost (\$/Yr)
 BNCST -Breeder nuclear electric- Cost (\$/Yr)
 CCCST -Combined cycle coal electric- Cost (\$/Yr)
 OTCST -Ocean thermal electric- Cost (\$/Yr)
 BMCST -Biomass electric- Cost (\$/Yr)
 STCST -Solar thermal- Cost (\$/Yr)
 WECST -Wind electric- Cost (\$/Yr)

NOTE

SEGA.K=SEGA.J+(DT)(SEINV.J-SEGAR.JK-SVLI.JK)

SEGA=SEGA1

SEGA1=30E9

SEGA -Steam electric- Gross assets (\$)
DT -Time increment between calculations
SEINV -Steam electric- Investment (\$/Yr)
SEGAR -Steam electric- Gross asset retirements (\$/Yr)
SVLI -Steam electric- Value loss due to inflation (\$/Yr)
SEGA1 -Steam electric- Gross assets initial (\$)

70840 L
70850 N
70860 C

SEGAR.KL=SEGA.K*SEARF.K

SEGAR -Steam electric- Gross asset retirements (\$/Yr)
SEGA -Steam electric- Gross assets (\$)
SEARF -Steam electric- Asset retirement factor (Fraction/Yr)

70870 R

SEARF.K=(SEAR1.K+SEAR2.K)/SEPA.K

SEARF -Steam electric- Asset retirement factor (Fraction/Yr)
SEAR1 -Steam electric- Asset retirement factor 1 (Fraction/Yr)
SEAR2 -Steam electric- Asset retirement factor 2 (Fraction/Yr)
SEPA -Steam electric- Physical assets (\$)

70880 A

SEAR1.K=NCPA.K*NCARF+ECPA.K*ECARF+FBPA.K*FBARF+OUPA.K*OUARF+CCPA.K*CCARF+OTPA.K*OTARF

SEAR1 -Steam electric- Asset retirement factor 1 (Fraction/Yr)
NCPA -Non-Emission controlled coal- Physical assets (\$)
NCARF -Non-Emission controlled coal- Asset retirement factor (Fraction/Yr)
ECPA -Emission controlled coal- Physical assets (\$)
ECARF -Emission controlled coal- Asset retirement factor (Fraction/Yr)
FBPA -Fluidized bed coal electric- Physical assets (\$)
FBARF -Fluidized bed coal electric- Asset retirement factor (Fraction/Yr)
OUPA -Oil/gas utilities- Physical assets (\$)
OUARF -Oil/gas utilities- Asset retirement factor (Fraction/Yr)
CCPA -Combined cycle coal electric- Physical assets (\$)
CCARF -Combined cycle coal electric- Asset retirement factor (Fraction/Yr)
OTPA -Ocean thermal electric- Physical assets (\$)
OTARF -Ocean thermal electric- Asset retirement factor (Fraction/Yr)

70890 A

SEAR2.K=BMPPA.K*BNARF+STPA.K*STARF+WPPA.K*WEARF+PVPA.K*PVARF+LWPA.K*LWARF+BNPA.K*BNARF

SEAR2 -Steam electric- Asset retirement factor 2 (Fraction/Yr)
BMPPA -Biomass electric- Physical assets (\$)
BNARF -Biomass electric- Asset retirement factor (Fraction/Yr)
STPA -Solar thermal- Physical assets (\$)
STARF -Solar thermal- Asset retirement factor (Fraction/Yr)
WPPA -Wind electric- Physical assets (\$)
WEARF -Wind electric- Asset retirement factor (Fraction/Yr)
PVPA -Photovoltaic electric- Physical assets (\$)
PVARF -Photovoltaic electric- Asset retirement factor (Fraction/Yr)
LWPA -Light water nuclear electric- Physical assets (\$)
LWARF -Light water nuclear electric- Asset retirement factor (Fraction/Yr)
BNPA -Breeder nuclear electric- Physical assets (\$)
BNARF -Breeder nuclear electric- Asset retirement factor (Fraction/Yr)

70910 A

SEVLI.KL=SEGA.K*DEINF.K*SEPLAS.K

70930 R

SEVLI -Steam electric- Value loss due to inflation (\$/Yr)

SEGA -Steam electric- Gross assets (\$)

DEINF -Domestic economy- Inflation rate (Fraction/Yr)

SEPLAS -Steam electric- Price-level accounting schedule (Dimensionless)

SEPLAS.K=TABHL(SEPLAST (TIME K-1980)/5 0 1.1)

70940 A

SEPLAST=1/0

70950 T

SEPLAS -Steam electric- Price-level accounting schedule (Dimensionless)

TABHL -Tabular relationship

SEPLAST -Steam electric- Price-level accounting schedule table (Table)

TIME -Actual time during simulation

NOTE

SENA.K=SEGA.K*SEADF

70970 A

SEADF=.80

70980 C

SENA -Steam electric- Net assets (\$)

SEGA -Steam electric- Gross assets (\$)

SEADF -Steam electric- Accumulated depreciation fraction (Fraction)

SEEQ.K=SENA.K*SEEF

70990 A

SEEF=.4

71000 C

SEEQ -Steam electric- Equity (\$)

SENA -Steam electric- Net assets (\$)

SEEF -Steam electric- Equity fraction (Fraction)

SEDERT.K=SENA.K*SEDF

71010 A

SEDF=(55/45)*SEEF

71020 N

SEDERT -Steam electric- Debt (\$)

SENA -Steam electric- Net assets (\$)

SEDF -Steam electric- Debt fraction (Fraction)

SEEF -Steam electric- Equity fraction (Fraction)

SEINT.K=SEIR.K*SEDEBT.K

71030 A

SEINT -Steam electric- Interest (\$/Yr)

SEIR -Steam electric- Interest rate (Fraction/Yr)

SEDEBT -Steam electric- Debt (\$)

SEIR.K=SEIRN+DEINF.K

71040 A

SEIRN=.025

71050 C

SEIR -Steam electric- Interest rate (Fraction/Yr)

SEIRN -Steam electric- Interest rate normal (Fraction/Yr)

DEINF -Domestic economy- Inflation rate (Fraction/Yr)

SEDRMT.K=SEDERT.K/SEDL

71060 A

SEDL=35

71070 C

SEDRMT -Steam electric- Debt repayment (\$/Yr)

SEDEBT -Steam electric- Debt (\$)

SEDL -Steam electric- Debt life (Year)

SEDEP.K=SEGA.K/SEBLC

71080 A

SEBLC=35

71090 C

SEDEP -Steam electric- Depreciation (\$/Yr)

SEGA -Steam electric- Gross assets (\$)

SEBLC -Steam electric- Book life of capital (Year)

NOTE

SEIF.K=SENI.K-SEDIV.K+SEDEP.K-SEDRMT.K

SEIF -Steam electric- Internal funds (\$/Yr)
SENI -Steam electric- Net income (\$/Yr)
SEDIV -Steam electric- Dividends (\$/Yr)
SEDEP -Steam electric- Depreciation (\$/Yr)
SEDRMT -Steam electric- Debt repayment (\$/Yr)

71110 A

SEDIV.K=SEDPDF*SENI.K

SEDPDF=.66

SEDIV -Steam electric- Dividends (\$/Yr)
SEDPDF -Steam electric- Dividend payout fraction (Fraction)
SENI -Steam electric- Net income (\$/Yr)

71120 A

71130 C

SEROI.K=(SENI.K+SEINT.K)/(SEEQ.K+SEDEBT.K)

SEROI -Steam electric- Return on investment (Fraction/Yr)
SENI -Steam electric- Net income (\$/Yr)
SEINT -Steam electric- Interest (\$/Yr)
SEEQ -Steam electric- Equity (\$)
SEDEBT -Steam electric- Debt (\$)

71140 A

SEROIN.K=SEROIR+SMOOTH(DEINF.K SEEAT)

SEROIR=.05

SEROIN -Steam electric- Return on investment normal (Fraction/Yr)
SEROIR -Steam electric- Return on investment real (Fraction/Yr)
SMOOTH -First order information delay
DEINF -Domestic economy- Inflation rate (Fraction/Yr)
SEEAT -Steam electric- Economic averaging time (Year)

71150 A

71160 C

SEROIX.K=SMOOTH(SEROI.K/SEROIN.K SEEAT)

SEEAT=5

SEROIX -Steam electric- Return on investment index (Dimensionless)
SMOOTH -First order information delay
SEROI -Steam electric- Return on investment (Fraction/Yr)
SEROIN -Steam electric- Return on investment normal (Fraction/Yr)
SEEAT -Steam electric- Economic averaging time (Year)

71170 A

71180 C

NOTE

NOTE

SEFA.K=SEIF.K+SEIFA.K

71210 A

SEFA -Steam electric- Funds available (\$/Yr)
 SEIF -Steam electric- Internal funds (\$/Yr)
 SEIFA -Steam electric- External funds available (\$/Yr)

SEIFA.K=SEGA.K+SEGR.K

71220 A

SEIFA -Steam electric- External funds available (\$/Yr)
 SEGA -Steam electric- Gross assets (\$)
 SEGR -Steam electric- Growth rate (Fraction/Yr)

SEGR.K=TABUL(SEGRT.SEROIX.K.0.3.3.3)*CLIP(SEUBM.1.TIME.K.SEUBGY)

71230 A

SEGRT=0/.03/.056/.08/.10/.115/.13/.135/.14/.145/.15/.15

71240 T

SEUBGY=1980

71250 C

SEUBM=1.15

71260 C

SEGR -Steam electric- Growth rate (Fraction/Yr)
 TABUL -Tabular relationship
 SEGRT -Steam electric- Growth rate table (Table)
 SEROIX -Steam electric- Return on investment index (Dimensionless)
 CLIP -Function switched during the run
 SEUBM -Steam electric- Utility backout multiplier (Dimensionless)
 TIME -Actual time during simulation
 SEUBGY -Steam electric- Utility backout initiation year (Year)

NOTE

SEFN.K=MAX(0 (SEFPA.K-SEPA.K-SEPUC.K+SEAFCT.K*SEARF.K*(SEPA.K+SEFPA.K)/2)/SEFCE)

71280 A

SEFN -Steam electric- Funds needed (\$/Yr)
 MAX -Function selecting the larger of two values
 SEFPA -Steam electric- Future physical assets (\$)
 SEPA -Steam electric- Physical assets (\$)
 SEPUC -Steam electric- Plants under construction (\$)
 SEAFCT -Steam electric- Average facility construction time (Year)
 SEARF -Steam electric- Asset retirement factor (Fraction/Yr)
 SEFCE -Steam electric- Fraction to capital expenditures (Fraction)

SEFPA.K=SENPA.K*EXP(SENPA.K/SESPA.K-1)

71300 A

SEFPA -Steam electric- Future physical assets (\$)
 SENPA -Steam electric- Normal physical assets (\$)
 EXP -Exponential function
 SESPA -Steam electric- Smoothed physical assets (\$)

SENPA.K=SEPA.K+(SEDPC.K-SEPC.K)*SECC.K

71310 A

SENPA -Steam electric- Normal physical assets (\$)
 SEPA -Steam electric- Physical assets (\$)
 SEDPC -Steam electric- Desired production capacity (Btu/Yr)
 SEPC -Steam electric- Production capacity (Btu/Yr)
 SECC -Steam electric- Capital cost (\$/(Btu/Yr))

SEDPC.K=SED.K/SEACUF.K

71320 A

SEDPC -Steam electric- Desired production capacity (Btu/Yr)
 SED -Steam electric- Demand (Btu/Yr)
 SEACUF -Steam electric- Average capacity utilization factor (Fraction)

ESPA K=SESPA J+(DT)(SENPA J-SESPA J)/SEAFCT.J

SESPA=SESPAI

SESPAI=25 6E9

SESPA -Steam electric- Smoothed physical assets (\$)
DT -Time increment between calculations
SENPA -Steam electric- Normal physical assets (\$)
SEAFCT -Steam electric- Average facility construction time (Year)
SESPAI -Steam electric- Smoothed physical assets initial (\$)

71330 L

71340 N

71350 C

SECC.K=(SECC1.K+SECC2.K)/SEPA K

SECC -Steam electric- Capital cost (\$/(Btu/Yr))
SECC1 -Steam electric- Capital cost 1 (\$/(Btu/Yr))
SECC2 -Steam electric- Capital cost 2 (\$/(Btu/Yr))
SEPA -Steam electric- Physical assets (\$)

71360 A

SECC1.K=NCCC.K*NCPA.K+ECCC.K*ECPA.K+FBCC.K*FBPA.K+OUCG.K*OUPA.K+CCCC.K*CCPA.K+OTCC.K*OTPA.K

SECC1 -Steam electric- Capital cost 1 (\$/(Btu/Yr))
NCCC -Non-Emission controlled coal- Capital cost (\$/(Btu/Yr))
NCPA -Non-Emission controlled coal- Physical assets (\$)
ECCC -Emission controlled coal- Capital cost (\$/(Btu/Yr))
ECPA -Emission controlled coal- Physical assets (\$)
FBCC -Fluidized bed coal electric- Capital cost (\$/(Btu/Yr))
FBPA -Fluidized bed coal electric- Physical assets (\$)
OUCG -Oil/gas utilities- Capital cost (\$/(Btu/Yr))
OUPA -Oil/gas utilities- Physical assets (\$)
CCCC -Combined cycle coal electric- Capital cost (\$/(Btu/Yr))
CCPA -Combined cycle coal electric- Physical assets (\$)
OTCC -Ocean thermal electric- Capital cost (\$/(Btu/Yr))
OTPA -Ocean thermal electric- Physical assets (\$)

71370 A

SECC2.K=BMCC.K*BMPPA.K+STCC.K*STPA.K+WECC.K*WEPA.K+PVCC.K*PVPA.K+LWCC.K*LWPA.K+BNCC.K*BNPA.K

SECC2 -Steam electric- Capital cost 2 (\$/(Btu/Yr))
BMCC -Biomass electric- Capital cost (\$/(Btu/Yr))
BMPPA -Biomass electric- Physical assets (\$)
STCC -Solar thermal- Capital cost (\$/(Btu/Yr))
STPA -Solar thermal- Physical assets (\$)
WECC -Wind electric- Capital cost (\$/(Btu/Yr))
WEPA -Wind electric- Physical assets (\$)
PVCC -Photovoltaic electric- Capital cost (\$/(Btu/Yr))
PVPA -Photovoltaic electric- Physical assets (\$)
LWCC -Light water nuclear electric- Capital cost (\$/(Btu/Yr))
LWPA -Light water nuclear electric- Physical assets (\$)
BNCC -Breeder nuclear electric- Capital cost (\$/(Btu/Yr))
BNPA -Breeder nuclear electric- Physical assets (\$)

71390 A

SEPA K=NCPA.K+ECPA.K+FBPA.K+OUPA.K+PVPA.K+LWPA.K+BNPA.K+CCPA.K+OTPA K+BMPA.K+STPA.K+WEPA.K

71410 A

SEPA -Steam electric- Physical assets (\$)
 NCPA -Non-Emission controlled coal- Physical assets (\$)
 ECPA -Emission controlled coal- Physical assets (\$)
 FBPA -Fluidized bed coal electric- Physical assets (\$)
 OUPA -Oil/gas utilities- Physical assets (\$)
 PVPA -Photovoltaic electric- Physical assets (\$)
 LWPA -Light water nuclear electric- Physical assets (\$)
 BNPA -Breeder nuclear electric- Physical assets (\$)
 CCPA -Combined cycle coal electric- Physical assets (\$)
 OTPA -Ocean thermal electric- Physical assets (\$)
 BMPA -Biomass electric- Physical assets (\$)
 STPA -Solar thermal- Physical assets (\$)
 WEPA -Wind electric- Physical assets (\$)

SEPUC K=NCPUC.K+ECPUK.K+FBPUC.K+OUPUC.K+PVPUC K+LWPUC.K+BNPUC.K+CCPUC.K+OTPUC.K+BMPUK.K+STPUC.K+
 WEPUC K

71430 A

SEPUC -Steam electric- Plants under construction (\$)
 NCPUC -Non-emission controlled coal- Plants under construction (\$)
 ECPUC -Emission controlled coal- Plants under construction (\$)
 FBPUK -Fluidized bed coal electric- Plants under construction (\$)
 OUPUC -Oil/gas utilities- Plants under construction (\$)
 PVPUC -Photovoltaic Electric- Plants under construction (\$)
 LWPUC -Light water nuclear electric- Plants under construction (\$)
 BNPUC -Breeder nuclear electric- Plants under construction (\$)
 CCPUC -Combined cycle coal electric- Plants under construction (\$)
 OTPUC -Ocean thermal electric- Plants under construction (\$)
 BMPUC -Biomass electric- Plants under construction (\$)
 STPUC -Solar thermal- Plants under construction (\$)
 WEPUC -Wind electric- Plants under construction (\$)

SEAFCT.K=(SEAFCT1.K+SEAFCT2.K)/SENPC.K

71450 A

SEAFCT -Steam electric- Average facility construction time (Year)
 SEAFCT1 -Steam electric- Average facility construction time part 1 (***)
 SEAFCT2 -Steam electric- Average facility construction time part 2 (***)
 SENPC -Steam electric- New plants completed (\$/Yr)

SEAFCT1.K=NCFCTR.JK*NCFCT K+ECFCTR.JK*ECFCT.K+FBFCTR JK*FBFCT+OUFCTR.JK*OUFCT+CCFCTR.JK*CCFCT+OTFCTR.JK*
 OTFCT

71460 A

SEAFCT1 -Steam electric- Average facility construction time part 1 (***)
 NCFCTR -Non-Emission controlled coal- Facility completion rate (\$/Yr)
 NCFCT -Non-Emission controlled coal- Facility construction time (Year)
 ECFCTR -Emission controlled coal- Facility completion rate (\$/Yr)
 ECFCT -Emission controlled coal- Facility construction time (Year)
 FBFCTR -Fluidized bed coal electric- Facility completion rate (\$/Yr)
 FBFCT -Fluidized bed coal electric- Facility construction time (Year)
 OUFCTR -Oil/gas utilities- Facility completion rate (\$/Yr)
 OUFCT -Oil/gas utilities- Facility construction time (Year)
 CCFCTR -Combined cycle coal electric- Facility completion rate (\$/Yr)
 CCFCT -Combined cycle coal electric- Facility construction time (Year)
 OTFCTR -Ocean thermal electric- Facility completion rate (\$/Yr)
 OTFCT -Ocean thermal electric- Facility construction time (Year)

SEAF2.K=BMFCR JK*BMFCT+STFCR JK*STFCT+WEFCR JK*WEFCT+PVFCR JK*PVFCT+LWFCR JK*NUFCT.K+BNFCR JK*
NUFCT.K

71480 A

SEAF2 -Steam electric- Average facility construction time part 2 (***)
BMFCR -Biomass electric- Facility completion rate (\$/Yr)
BMFCT -Biomass electric- Facility construction time (Year)
STFCR -Solar thermal- Facility completion rate (\$/Yr)
STFCT -Solar thermal- Facility construction time (Year)
WEFCR -Wind electric- Facility completion rate (\$/Yr)
WEFCT -Wind electric- Facility construction time (Year)
PVFCR -Photovoltaic electric- Facility completion rate (\$/Yr)
PVFCT -Photovoltaic electric- Facility construction time (Year)
LWFCR -Light water nuclear electric- Facility completion rate (\$/Yr)
NUFCT -Nuclear utilities- Facility construction time (Year)
BNFCR -Breeder nuclear electric- Facility completion rate (\$/Yr)

SENPC.K=NCFCR JK+ECFCR JK+FBFCR JK+OUFCR JK+PVFCR JK+LWFCR JK+BNFCR JK+CCFCR JK+OTFCR JK+BMFCR JK+
STFCR JK+WEFCR JK

71500 A

SENPC -Steam electric- New plants completed (\$/Yr)
NCFCR -Non-Emission controlled coal- Facility completion rate (\$/Yr)
ECFCR -Emission controlled coal- Facility completion rate (\$/Yr)
FBFCR -Fluidized bed coal electric- Facility completion rate (\$/Yr)
OUFCR -Oil/gas utilities- Facility completion rate (\$/Yr)
PVFCR -Photovoltaic electric- Facility completion rate (\$/Yr)
LWFCR -Light water nuclear electric- Facility completion rate (\$/Yr)
BNFCR -Breeder nuclear electric- Facility completion rate (\$/Yr)
CCFCR -Combined cycle coal electric- Facility completion rate (\$/Yr)
OTFCR -Ocean thermal electric- Facility completion rate (\$/Yr)
BMFCR -Biomass electric- Facility completion rate (\$/Yr)
STFCR -Solar thermal- Facility completion rate (\$/Yr)
WEFCR -Wind electric- Facility completion rate (\$/Yr)

NOTE

SEINV K=MIN(SEFA.K SEFN K)*SEFCE
SEINV=SEINVI
SEINVI=3.6E9
SEFCE=.85

71530 A
71540 N
71550 C
71560 C

SEINV -Steam electric- Investment (\$/Yr)
MIN -Function selecting the smaller of two values
SEFA -Steam electric- Funds available (\$/Yr)
SEFN -Steam electric- Funds needed (\$/Yr)
SEFCE -Steam electric- Fraction to capital expenditures (Fraction)
SEINVI -Steam electric- Investment initial (\$/Yr)

NOTE

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ACINV.K=SEINV.K*(ACAW.K/SEAW.K) 71650 A
 ACINV -Avg. conventional coal electric- Investment (\$/Yr)
 SEINV -Steam electric- Investment (\$/Yr)
 ACAW -Avg. conventional coal electric- Allocation weight (Dimensionless)
 SEAW -Steam electric- Allocation weight (Dimensionless)

ACAW.K=(ACMCST.K*1E6)^SEWF 71660 A
 ACAW -Avg. conventional coal electric- Allocation weight (Dimensionless)
 ACMCST -Avg. conventional coal electric- Marginal cost (\$/Btu)
 SEWF -Steam electric- Weighting factor (Dimensionless)

ACMCST.K=(NCMCST.K*NCFCR.JK+ECMCST.K*ECFCR.JK)/(NCFCR.JK+ECFCR.JK) 71670 A
 ACMCST -Avg. conventional coal electric- Marginal cost (\$/Btu)
 NCMCST -Non-Emission controlled coal- Marginal cost (\$/Btu)
 NCFCR -Non-Emission controlled coal- Facility completion rate (\$/Yr)
 ECMCST -Emission controlled coal- Marginal cost (\$/Btu)
 ECFCR -Emission controlled coal- Facility completion rate (\$/Yr)

NOTE

NCINV.KL=ACINV.K*NCMS.K 71700 R
 NCINV=NCINVI 71710 N
 NCINVI=3E9 71720 C
 NCINV -Non-Emission controlled coal- Investment (\$/Yr)
 ACINV -Avg. conventional coal electric- Investment (\$/Yr)
 NCMS -Non-Emission controlled coal- Moratorium schedule (Fraction)
 NCINVI -Non-Emission controlled coal- Investment initial (\$/Yr)

NCMS.K=TABHL(NCMST (TIME.K-NCMY)/NCMT 0 1 1) 71730 A
 NCMST=1/0 71740 T
 NCMT=15 71750 C
 NCMY=1969 71760 C
 NCMS -Non-Emission controlled coal- Moratorium schedule (Fraction)
 TABHL -Tabular relationship
 NCMST -Non-Emission controlled coal- Moratorium schedule table (Table)
 TIME -Actual time during simulation
 NCMY -Non-Emission controlled coal- Moratorium initiation year (Year)
 NCMT -Non-Emission controlled coal- Moratorium delay time (Year)

CMCST.K=(NCCCR+NCEIDC.K)*NCSCC.K+NCOMC+NCFCST.K

71770 A

NCCCR=.100

71780 C

NCMCST -Non-Emission controlled coal- Marginal cost (\$/Btu)
 NCCCR -Non-Emission controlled coal- Capital charge rate (Fraction/Yr)
 NCEIDC -Non-Emission controlled coal- Excess charge due to interest under const. (Fraction/Yr)
 NCSCC -Non-Emission controlled coal- Specific capital cost (\$/(Btu/Yr))
 NCOMC -Non-Emission controlled coal- Operating and maintenance <O&M> cost (\$/Btu)
 NCFCST -Non-Emission controlled coal- Feedstock cost (\$/Btu)

NCEIDC.K=NCCCR*TABHL(SEEIDCT,(TIME.K-NCCDCY)/NCCDCT,0,1,1)

71790 A

NCCCR=.009

71800 C

NCEIDC -Non-Emission controlled coal- Excess charge due to interest under const. (Fraction/Yr)
 NCCCR -Non-Emission controlled coal- Capital charge due to interest under const. (Fraction/Yr)
 TABHL -Tabular relationship
 SEEIDCT -Steam electric- Excess interest during construction table (Table)
 TIME -Actual time during simulation
 NCCDCY -Non-Emission controlled coal- Construction delay change year (Year)
 NCCDCT -Non-Emission controlled coal- Construction delay change implementation time (Year)

NCSCC.K=NCCCP.K*NCSCM.K/NCCUFP

71810 A

NCCUFP=.6

71820 C

NCSCC -Non-Emission controlled coal- Specific capital cost (\$/(Btu/Yr))
 NCCCP -Non-Emission controlled coal- Capital cost of production plant (\$/(Btu/Yr))
 NCSCM -Non-Emission controlled coal- Secondary constraint multiplier (Dimensionless)
 NCCUFP -Non-Emission controlled coal- Capacity utilization factor for planning (Fraction)

NCSCM.K=TABHL(DESCMT,NCGR.K,.04,.20,.04)

71830 A

NCSCM -Non-Emission controlled coal- Secondary constraint multiplier (Dimensionless)
 TABHL -Tabular relationship
 DESCMT -Steam electric- Secondary constraint multiplier table (Table)
 NCGR -Non-Emission controlled coal- Growth rate (Fraction/Yr)

NCGR.K=(NCAGR.K/SHOOTH(NCAGR.K,SETGR)-1)/SETGR

71840 A

NCGR -Non-Emission controlled coal- Growth rate (Fraction/Yr)
 NCAGR -Non-Emission controlled coal- Assets for growth rate (\$)
 SHOOTH -First order information delay
 SETGR -Steam electric- Time for growth rate (Year)

NCAGR.K=MAX(SEPAMI,NCPA.K+NCPUC.K)

71860 A

NCAGR -Non-Emission controlled coal- Assets for growth rate (\$)
 MAX -Function selecting the larger of two values
 SEPAMI -Steam electric- Physical assets of a mature industry (\$)
 NCPA -Non-Emission controlled coal- Physical assets (\$)
 NCPUC -Non-emission controlled coal- Plants under construction (\$)

NOTE

ECINV.KL=ACINV.K*(1-NCMS.K).

71880 R

ECINV=0

71890 N

ECINV -Emission controlled coal- Investment (\$/Yr).

ACINV -Avg. conventional coal electric- Investment (\$/Yr)

NCMS -Non-Emission controlled coal- Moratorium schedule (Fraction)

ECMCST.K=(ECCCR+ECEIDC.K)*ECSCC.K+ECONC+ECFCST.K

71900 A

ECCCR=.100

71910 C

ECMCST -Emission controlled coal- Marginal cost (\$/Btu)

ECCCR -Emission controlled coal- Capital charge rate (Fraction/Yr)

ECEIDC -Emission controlled coal- Excess charge due to interest under const. (Fraction/Yr)

ECSCC -Emission controlled coal- Specific capital cost (\$/(Btu/Yr))

ECONC -Emission controlled coal- Operating and maintenance <O&M> cost (\$/Btu)

ECFCST -Emission controlled coal- Feedstock cost (\$/Btu)

ECEIDC.K=ECCCR*TABHL(SEEIDCT.(TIME K-ECCDCY)/ECCDCT.0.1.1)

71920 A

ECCCR=.009

71930 C

ECEIDC -Emission controlled coal- Excess charge due to interest under const. (Fraction/Yr)

ECCCR -Emission controlled coal- Capital charge due to interest under const. (Fraction/Yr)

TABHL -Tabular relationship

SEEIDCT -Steam electric- Excess interest during construction table (Table)

TIME -Actual time during simulation

ECCDCY -Emission controlled coal- Construction delay change year (Year)

ECCDCT -Emission controlled coal- Construction delay change implementation time (Year)

ECSCC.K=ECCCP.K*ECSCM.K/ECCUFP

71940 A

ECCUFP=.6

71950 C

ECSCC -Emission controlled coal- Specific capital cost (\$/(Btu/Yr))

ECCCP -Emission controlled coal- Capital cost of production plant (\$/(Btu/Yr))

ECSCM -Emission controlled coal- Secondary constraint multiplier (Dimensionless)

ECCUFP -Emission controlled coal- Capacity utilization factor for planning (Fraction)

ECSCM.K=TABHL(SECNT ECGR K. 04. 20..04)

71960 A

ECSCM -Emission controlled coal- Secondary constraint multiplier (Dimensionless)

TABHL -Tabular relationship

SECNT -Steam electric- Secondary constraint multiplier table (Table)

ECGR -Emission controlled coal- Growth rate (Fraction/Yr)

ECGR.K=(ECAGR.K/SMOOTH(ECAGR.K SETGR)-1)/SETGR

71970 A

ECGR -Emission controlled coal- Growth rate (Fraction/Yr)

ECAGR -Emission controlled coal- Assets for growth rate (\$)

SMOOTH -First order information delay

SETGR -Steam electric- Time for growth rate (Year)

ECAGR.K=MAX(SEPAMI.ECPA.K+ECPUC.K)

71980 A

ECAGR -Emission controlled coal- Assets for growth rate (\$)

MAX -Function selecting the larger of two values

SEPAMI -Steam electric- Physical assets of a mature industry (\$)

ECPA -Emission controlled coal- Physical assets (\$)

ECPUC -Emission controlled coal- Plants under construction (\$)

NOTE

FBINV.KL=SEINV.K*(FBAW K/SEAW.K)

72000 R

FBINV=0

72010 N

FBINV -Fluidized bed coal electric- Investment (\$/Yr)
SEINV -Steam electric- Investment (\$/Yr)
FBAW -Fluidized bed coal electric- Allocation weight (Dimensionless)
SEAW -Steam electric- Allocation weight (Dimensionless)

FBAW.K=(FBMCST K*1E6)^SEWF*STEP(1 FBCY)

72020 A

FBCY=1990

72030 C

FBAW -Fluidized bed coal electric- Allocation weight (Dimensionless)
FBMCST -Fluidized bed coal electric- Marginal cost (\$/Btu)
SEWF -Steam electric- Weighting factor (Dimensionless)
STEP -Step-shaped exogenous input
FBCY -Fluidized bed coal electric- Commercialization year (Year)

FBMCST.K=(FBCCR+FBECR.K+FBCCRC)*FBSCC.K+FBOMC+FBFCST.K

72040 A

FBCCR=.100

72050 C

FBCCRC=0

72060 C

FBMCST -Fluidized bed coal electric- Marginal cost (\$/Btu)
FBCCR -Fluidized bed coal electric- Capital charge rate (Fraction/Yr)
FBECR -Fluidized bed coal electric- Excess charge due to risk (Fraction/Yr)
FBCCRC -Fluidized bed coal electric- Capital charge due to interest under const. (Fraction/Yr)
FBSCC -Fluidized bed coal electric- Specific capital cost (\$/(Btu/Yr))
FBOMC -Fluidized bed coal electric- Operating and maintenance <O&M> cost (\$/Btu)
FBFCST -Fluidized bed coal electric- Feedstock cost (\$/Btu)

FBECR K=FBCCRR*(1-STEP(1.FBLGY))*MAX(0 (SEPAMI-FBPA.K)/SEPAMI)

72070 A

FBCCRR=.028

72080 C

FBLGY=2200

72090 C

FBECR -Fluidized bed coal electric- Excess charge due to risk (Fraction/Yr)
FBCCRR -Fluidized bed coal electric- Capital charge due to risk (Fraction/Yr)
STEP -Step-shaped exogenous input
FBLGY -Fluidized bed coal electric- Loan guarantee initiation year (Year)
MAX -Function selecting the larger of two values
SEPAMI -Steam electric- Physical assets of a mature industry (\$)
FBPA -Fluidized bed coal electric- Physical assets (\$)

FBSCC.K=FBCCP*FBSCM K/FBCUFP

72100 A

FBCUFP= 6

72110 C

FBSCC -Fluidized bed coal electric- Specific capital cost (\$/(Btu/Yr))
FBCCP -Fluidized bed coal electric- Capital cost of production plant (\$/(Btu/Yr))
FBSCM -Fluidized bed coal electric- Secondary constraint multiplier (Dimensionless)
FBCUFP -Fluidized bed coal electric- Capacity utilization factor for planning (Fraction)

FBSCM K=TABHL(DESCMT FBGR K..04..20 .04)

72120 A

FBSCM -Fluidized bed coal electric- Secondary constraint multiplier (Dimensionless)
TABHL -Tabular relationship
DESCMT -Steam electric- Secondary constraint multiplier table (Table)
FBGR -Fluidized bed coal electric- Growth rate (Fraction/Yr)

FBGR.K=(FBAGR.K/SMOOTH(FBAGR.K SETGR)-1)/SETGR

72130 A

FBGR -Fluidized bed coal electric- Growth rate (Fraction/Yr)
FBAGR -Fluidized bed coal electric- Assets for growth rate (\$)
SMOOTH -First order information delay
SETGR -Steam electric- Time for growth rate (Year)

FBAGR.K=MAX(SEPAMI FBPA K+FBPUC.K)

72140 A

FBAGR -Fluidized bed coal electric- Assets for growth rate (\$)
MAX -Function selecting the larger of two values
SEPAMI -Steam electric- Physical assets of a mature industry (\$)
FBPA -Fluidized bed coal electric- Physical assets (\$)
FBPUC -Fluidized bed coal electric- Plants under construction (\$)

NOTE

CCINV.KL=SEINV.K*(CCAW.K/SEAW.K)

72160 R

CCINV=0

72170 N

CCINV -Combined cycle coal electric- Investment (\$/Yr)

SEINV -Steam electric- Investment (\$/Yr)

CCAW -Combined cycle coal electric- Allocation weight (Dimensionless)

SEAW -Steam electric- Allocation weight (Dimensionless)

CCAW K=(CCMCST.K*1E6)^SEWF*STEP(1 CCCY)

72180 A

CCCY=1992

72190 C

CCAW -Combined cycle coal electric- Allocation weight (Dimensionless)

CCMCST -Combined cycle coal electric- Marginal cost (\$/Btu)

SEWF -Steam electric- Weighting factor (Dimensionless)

STEP -Step-shaped exogenous input

CCCY -Combined cycle coal electric- Commercialization year (Year)

CCMCST.K=(CCCCR+CCECR.K+CCCCRC)*CCSCC.K+CCOMC+CCFCST.K

72200 A

CCCCR=.100

72210 C

CCCCRC=0

72220 C

CCMCST -Combined cycle coal electric- Marginal cost (\$/Btu)

CCCCR -Combined cycle coal electric- Capital charge rate (Fraction/Yr)

CCECR -Combined cycle coal electric- Excess charge due to risk (Fraction/Yr)

CCCCRC -Combined cycle coal electric- Capital charge due to interest under const.(Fraction/Yr)

CCSCC -Combined cycle coal electric- Specific capital cost (\$/(Btu/Yr))

CCOMC -Combined cycle coal electric- Operating and maintenance <O&M> cost (\$/Btu)

CCFCST -Combined cycle coal electric- Feedstock cost (\$/Btu)

CCECR.K=CCCCRR*(1-STEP(1 CCLGY))*MAX(0.(SEPAMI-CCPA.K)/SEPAMI)

72230 A

CCCCRR=.028

72240 C

CCLGY=2200

72250 C

CCECR -Combined cycle coal electric- Excess charge due to risk (Fraction/Yr)

CCCCRR -Combined cycle coal electric- Capital charge due to risk (Fraction/Yr)

STEP -Step-shaped exogenous input

CCLGY -Combined cycle coal electric- Loan guarantee initiation year (Year)

MAX -Function selecting the larger of two values

SEPAMI -Steam electric- Physical assets of a mature industry (\$)

CCPA -Combined cycle coal electric- Physical assets (\$)

CCSCC.K=CCCCP*CCSCH K/CCCUFP

CCCUFP=.6

CCSCC -Combined cycle coal electric- Specific capital cost (\$/(Btu/Yr))
CCCCP -Combined cycle coal electric- Capital cost of production plant (\$/(Btu/Yr))
CCSCH -Combined cycle coal electric- Secondary constraint multiplier (Dimensionless)
CCCUFP -Combined cycle coal electric- Capacity utilization factor for planning (Fraction)

72260 A

72270 C

CCSCH K=TABHL(DESCMT CCCR.K. 04 .20 .04)

CCSCH -Combined cycle coal electric- Secondary constraint multiplier (Dimensionless)
TABHL -Tabular relationship
DESCMT -Steam electric- Secondary constraint multiplier table (Table)
CCCR -Combined cycle coal electric- Growth rate (Fraction/Yr)

72280 A

CCCR.K=(CCAGR K/SMOOTH(CCAGR K SETGR)-1)/SETGR

CCCR -Combined cycle coal electric- Growth rate (Fraction/Yr)
CCAGR -Combined cycle coal electric- Assets for growth rate (\$)
SMOOTH -First order information delay
SETGR -Steam electric- Time for growth rate (Year)

72290 A

CCAGR.K=MAX(SEPANI.CCPA.K+CCPUC K)

CCAGR -Combined cycle coal electric- Assets for growth rate (\$)
MAX -Function selecting the larger of two values
SEPANI -Steam electric- Physical assets of a mature industry (\$)
CCPA -Combined cycle coal electric- Physical assets (\$)
CCPUC -Combined cycle coal electric- Plants under construction (\$)

72300 A.

NOTE

OUINV.KL-SEINV.K*(OUAW.K/SEAW.K)

OUINV=OUINVI

OUINVI=1.5E9

OUINV -Oil/gas utilities- Investment (\$/Yr)
SEINV -Steam electric- Investment (\$/Yr)
OUAW -Oil/gas utilities- Allocation weight (Dimensionless)
SEAW -Steam electric- Allocation weight (Dimensionless)
OUINVI -Oil/gas utilities- Investment initial (\$/Yr)

72320 R

72330 N

72340 C

OUAW.K=(OUMCST.K*1E6)^SEWF*STEP(1 OUCY)

OUCY=1950

OUAW -Oil/gas utilities- Allocation weight (Dimensionless)
OUMCST -Oil/gas utilities- Marginal cost (\$/Btu)
SEWF -Steam electric- Weighting factor (Dimensionless)
STEP -Step-shaped exogenous input
OUCY -Oil/gas utilities- Commercialization year (Year)

72350 A

72360 C

OUMCST.K=(OUCCR*OUSCC.K+OUONC+OUFCST.K)*CLIP(1.3.1 TIME K.OUMY)

OUMY=1978

OUCCR=.100

OUMCST -Oil/gas utilities- Marginal cost (\$/Btu)
OUCCR -Oil/gas utilities- Capital charge rate (Fraction/Yr)
OUSCC -Oil/gas utilities- Specific capital cost (\$/(Btu/Yr))
OUONC -Oil/gas utilities- Operating and maintenance <O&M> cost (\$/Btu)
OUFCST -Oil/gas utilities- Feedstock cost (\$/Btu)
CLIP -Function switched during the run
TIME -Actual time during simulation
OUMY -Oil/gas utilities- Moratorium initiation year (Year)

72370 A

72380 C

72390 C

OUSCC.K=OUCCP.K*OUSCM.K/(OUCUFP*OUCMP.K)

72400 A

OUCUFP=.6

72410 C

OUSCC -Oil/gas utilities- Specific capital cost (\$/(Btu/Yr))

OUCCP -Oil/gas utilities- Capital cost of production plant (\$/(Btu/Yr))

OUSCM -Oil/gas utilities- Secondary constraint multiplier (Dimensionless)

OUCUFP -Oil/gas utilities- Capacity utilization factor for planning (Fraction)

OUCMP -Oil/gas utilities- Capacity multiplier from peaking (Fraction)

OUSCM.K=TABHL(DESCMT.OUGR.K .04..20 .04)

72420 A

OUSCM -Oil/gas utilities- Secondary constraint multiplier (Dimensionless)

TABHL -Tabular relationship

DESCMT -Steam electric- Secondary constraint multiplier table (Table)

OUGR -Oil/gas utilities- Growth rate (Fraction/Yr)

OUGR.K=(OUAGR.K/SMOOTH(OUAGR.K SETGR)-1)/SETGR

72430 A

OUGR -Oil/gas utilities- Growth rate (Fraction/Yr)

OUAGR -Oil/gas utilities- Assets for growth rate (\$)

SMOOTH -First order information delay

SETGR -Steam electric- Time for growth rate (Year)

OUAGR.K=MAX(SEPAMI OUPA.K+OUPUC.K)

72440 A

OUAGR -Oil/gas utilities- Assets for growth rate (\$)

MAX -Function selecting the larger of two values

SEPAMI -Steam electric- Physical assets of a mature industry (\$)

OUPA -Oil/gas utilities- Physical assets (\$)

OUPUC -Oil/gas utilities- Plants under construction (\$)

NOTE

PVINV.KL=SEINV.K*(PVAW.K/SEAW.K)

72460 R

PVINV=0

72470 N

PVINV -Photovoltaic electric- Investment (\$/Yr)

SEINV -Steam electric- Investment (\$/Yr)

PVAW -Photovoltaic electric- Allocation weight (Dimensionless)

SEAW -Steam electric- Allocation weight (Dimensionless)

PVAW K=(PVMCST.K*1E6)~SEWF*STEP(1 PVCY)

72480 A

PVCY=1988

72490 C

PVAW -Photovoltaic electric- Allocation weight (Dimensionless)

PVMCST -Photovoltaic electric- Marginal cost (\$/Btu)

SEWF -Steam electric- Weighting factor (Dimensionless)

STEP -Step-shaped exogenous input

PVCY -Photovoltaic electric- Commercialization year (Year)

PVMCST.K=(PVCGR+PVECR.K)*PVSCC.K+PVOMC

72500 A

PVCCR=.100

72510 C

PVMCST -Photovoltaic electric- Marginal cost (\$/Btu)

PVCCR -Photovoltaic electric- Capital charge rate (Fraction/Yr)

PVECR -Photovoltaic electric- Excess charge due to risk (Fraction/Yr)

PVSCC -Photovoltaic electric- Specific capital cost (\$/(Btu/Yr))

PVOMC -Photovoltaic electric- Operating and maintenance <O&M> cost (\$/Btu)

PVECR.K=PVCRR*(1-STEP(1 PVLGY))*MAX(0.(SEPAMI-PVPA.K)/SEPAMI)

72520 A

PVCCR=.028

72530 C

PVLGY=2200

72540 C

PVECR -Photovoltaic electric- Excess charge due to risk (Fraction/Yr)

PVCCR -Photovoltaic electric- Capital charge due to risk (Fraction/Yr)

STEP -Step-shaped exogenous input

PVLGY -Photovoltaic electric- Loan guarantee initiation year (Year)

MAX -Function selecting the larger of two values

SEPAMI -Steam electric- Physical assets of a mature industry (\$)

PVPA -Photovoltaic electric- Physical assets (\$)

PVSCC.K=PVCCP.K*PVSCM.K/PVCUFP

72550 A

PVCUFP=.26

72560 C

PVSCC -Photovoltaic electric- Specific capital cost (\$/(Btu/Yr))

PVCCP -Photovoltaic electric- Capital cost of production plant (\$/(Btu/Yr))

PVSCM -Photovoltaic electric- Secondary constraint multiplier (Dimensionless)

PVCUFP -Photovoltaic electric- Capacity utilization factor for planning (Fraction)

PVSCM.K=TABUL(DESCMT,PVGR.K,.04,.20,.04)

72570 A

PVSCM -Photovoltaic electric- Secondary constraint multiplier (Dimensionless)

TABUL -Tabular relationship

DESCMT -Steam electric- Secondary constraint multiplier table (Table)

PVGR -Photovoltaic electric- Growth rate (Fraction/Yr)

PVGR.K=(PVAGR.K/SMOOTH(PVAGR.K,SETGR)-1)/SETGR

72580 A

PVGR -Photovoltaic electric- Growth rate (Fraction/Yr)

PVAGR -Photovoltaic electric- Assets for growth rate (\$)

SMOOTH -First order information delay

SETGR -Steam electric- Time for growth rate (Year)

PVAGR.K=MAX(SEPAMI,PVPA.K+PVPUC.K)

72590 A

PVAGR -Photovoltaic electric- Assets for growth rate (\$)

MAX -Function selecting the larger of two values

SEPAMI -Steam electric- Physical assets of a mature industry (\$)

PVPA -Photovoltaic electric- Physical assets (\$)

PVPUC -Photovoltaic Electric- Plants under construction (\$)

NOTE

LWINV.KL=SEINV.K*(LWAW K/SEAW K)

72610 R

LWINV=0

72620 N

LWINV -Light water nuclear electric- Investment (\$/Yr)

SEINV -Steam electric- Investment (\$/Yr)

LWAW -Light water nuclear electric- Allocation weight (Dimensionless)

SEAW -Steam electric- Allocation weight (Dimensionless)

LWAW.K=(LWMCST.K*1E6)^SEWF*STEP(1 LWCY)*(1-STEP(1.LWMY))

72630 A

LWCY=1950

72640 C

LWMY=2200

72650 C

LWAW -Light water nuclear electric- Allocation weight (Dimensionless)

LWMCST -Light water nuclear electric- Marginal cost (\$/Btu)

SEWF -Steam electric- Weighting factor (Dimensionless)

STEP -Step-shaped exogenous input

LWCY -Light water nuclear electric- Commercialization year (Year)

LWMY -Light water nuclear electric- Moratorium initiation year (Year)

LWMCST.K=(LWCCR+LWEIDC.K+LWERR.K)*LWSCC.K+LWOMC+LWFCST.K

72660 A

LWCCR= 109

72670 C

LWMCST -Light water nuclear electric- Marginal cost (\$/Btu)

LWCCR -Light water nuclear electric- Capital charge rate (Fraction/Yr)

LWEIDC -Light water nuclear electric- Excess charge due to interest under const. (Fraction/Yr)

LWERR -Light water nuclear electric- Environmental risk rate (Fraction/Yr)

LWSCC -Light water nuclear electric- Specific capital cost (\$/(Btu/Yr))

LWOMC -Light water nuclear electric- Operating and maintenance <O&M> cost (\$/Btu)

LWFCST -Light water nuclear electric- Feedstock cost (\$/Btu)

LWEIDC.K=LWCCRC*TABHL(SEEIDCT (TIME.K-NUCDCY)/NUCDCT.0 1 1)

72680 A

LWCCRC=.009

72690 C

LWEIDC -Light water nuclear electric- Excess charge due to interest under const. (Fraction/Yr)

LWCCRC -Light water nuclear electric- Capital charge due to interest under const.(Fraction/Yr)

TABHL -Tabular relationship

SEEIDCT -Steam electric- Excess interest during construction table (Table)

TIME -Actual time during simulation

NUCDCY -Nuclear utilities- Construction delay change year (Year)

NUCDCT -Nuclear utilities- Construction delay change implementation time (Year)

LWERR.K=TABHL(LWERRT TIME K 1980 1990 2)*STEP(1 LWERY)

72700 A

LWERRT= 01/ 01/0/0/0/0

72710 T

LWERY=1970

72720 C

LWERR -Light water nuclear electric- Environmental risk rate (Fraction/Yr)

TABHL -Tabular relationship

LWERRT -Light water nuclear electric- Environmental risk rate table (Table)

TIME -Actual time during simulation

STEP -Step-shaped exogenous input

LWERY -Light water nuclear electric- Environmental risk rate initiation year (Year)

LWSCC.K=LWCCP.K*LWSCM.K/LWCUPP

72730 A

LWCUPP=.6

72740 C

LWSCC -Light water nuclear electric- Specific capital cost (\$/(Btu/Yr))

LWCCP -Light water nuclear electric- Capital cost of production plant (\$/(Btu/Yr))

LWSCM -Light water nuclear electric- Secondary constraint multiplier (Dimensionless)

LWCUPP -Light water nuclear electric- Capacity utilization factor for planning (Fraction)

LWSCM.K=TABHL(DESCMT.LWGR K .04. 20. 04)

72750 A

LWSCM -Light water nuclear electric- Secondary constraint multiplier (Dimensionless)

TABHL -Tabular relationship

DESCMT -Steam electric- Secondary constraint multiplier table (Table)

LWGR -Light water nuclear electric- Growth rate (Fraction/Yr)

LWGP.K=(LWAGR K/SMOOTH(LWAGR K SETGR)-1)/SETGR

72760 A

LWGR -Light water nuclear electric- Growth rate (Fraction/Yr)

LWAGR -Light water nuclear electric- Assets for growth rate (\$)

SMOOTH -First order information delay

SETGR -Steam electric- Time for growth rate (Year)

LWAGR K=MAX(SEPAMI LWPA K+LWPUC.K)

72770 A

LWAGR -Light water nuclear electric- Assets for growth rate (\$)

MAX -Function selecting the larger of two values

SEPAMI -Steam electric- Physical assets of a mature industry (\$)

LWPA -Light water nuclear electric- Physical assets (\$)

LWPUC -Light water nuclear electric- Plants under construction (\$)

NOTE

BNINV.KL=SEINV.K*(RNAW K/SEAW.K)

72790 R

BNINV=0

72800 N

BNINV -Breeder nuclear electric- Investment (\$/Yr)

SEINV -Steam electric- Investment (\$/Yr)

RNAW -Breeder nuclear electric- Allocation weight (Dimensionless)

SEAW -Steam electric- Allocation weight (Dimensionless)

RNAW.K=(BNMCST.K*1E6)^SEWF*STEP(1 BNCY)*(1-STEP(1 BNMV))

72810 A

BNCY=2015

72820 C

BNMV=2015

72830 C

RNAW -Breeder nuclear electric- Allocation weight (Dimensionless)

BNMCST -Breeder nuclear electric- Marginal cost (\$/Btu)

SEWF -Steam electric- Weighting factor (Dimensionless)

STEP -Step-shaped exogenous input

BNCY -Breeder nuclear electric- Commercialization year (Year)

BNMV -Breeder nuclear electric- Moratorium initiation year (Year)

BNMCST.K=(BNCCR+BNCCR.K+BNEIDC.K)*BNSCC.K+BNOMC+BNFCST.K

72840 A

BNCCR=.109

72850 C

BNMCST -Breeder nuclear electric- Marginal cost (\$/Btu)

BNCCR -Breeder nuclear electric- Capital charge rate (Fraction/Yr)

BNECR -Breeder nuclear electric- Excess charge due to risk (Fraction/Yr)

BNEIDC -Breeder nuclear electric- Excess charge due to interest under const. (Fraction/Yr)

BNSCC -Breeder nuclear electric- Specific capital cost (\$/(Btu/Yr))

BNOMC -Breeder nuclear electric- Operating and maintenance <O&M> cost (\$/Btu)

BNFCST -Breeder nuclear electric- Feedstock cost (\$/Btu)

BNECR.K=BNCCRR*(1-STEP(1,BNLGY))*MAX(0 (SEPAHI-BNPA.K)/SEPAHI)

72860 A

BNCCRR=.122

72870 C

BNLGY=2200

72880 C

BNECR -Breeder nuclear electric- Excess charge due to risk (Fraction/Yr)

BNCCRR -Breeder nuclear electric- Capital charge due to risk (Fraction/Yr)

STEP -Step-shaped exogenous input

BNLGY -Breeder nuclear electric- Loan guarantee initiation year (Year)

MAX -Function selecting the larger of two values

SEPAHI -Steam electric- Physical assets of a mature industry (\$)

BNPA -Breeder nuclear electric- Physical assets (\$)

BNEIDC.K=BNCCRC*TABHL(SEEIDCT (TIME.K-NUCDCY)/NUCDCT D 1 1)

72890 A

BNCCRC=.009

72900 C

BNEIDC -Breeder nuclear electric- Excess charge due to interest under const. (Fraction/Yr)

BNCCRC -Breeder nuclear electric- Capital charge due to interest under const. (Fraction/Yr)

TABHL -Tabular relationship

SEEIDCT -Steam electric- Excess interest during construction table (Table)

TIME -Actual time during simulation

NUCDCY -Nuclear utilities- Construction delay change year (Year)

NUCDCT -Nuclear utilities- Construction delay change implementation time (Year)

BNSCC K=BNCPP*BNSCM.K/BNCUFP
BNCUFP= 6

72910 A
72920 C

BNSCC -Breeder nuclear electric- Specific capital cost (\$/(Btu/Yr))
BNCPP -Breeder nuclear electric- Capital cost of production plant (\$/(Btu/Yr))
BNSCM -Breeder nuclear electric- Secondary constraint multiplier (Dimensionless)
BNCUFP -Breeder nuclear electric- Capacity utilization factor for planning (Fraction)

BNSCM.K=TABHL(DESCMT BNGR K. 04..20..04)

72930 A

BNSCM -Breeder nuclear electric- Secondary constraint multiplier (Dimensionless)
TABHL -Tabular relationship
DESCMT -Steam electric- Secondary constraint multiplier table (Table)
BNGR -Breeder nuclear electric- Growth rate (Fraction/Yr)

BNGR.K=(BNAGR.K/SMOOTH(BNAGR.K.SETGR)-1)/SETGR

72940 A

BNGR -Breeder nuclear electric- Growth rate (Fraction/Yr)
BNAGR -Breeder nuclear electric- Assets for growth rate (\$)
SMOOTH -First order information delay
SETGR -Steam electric- Time for growth rate (Year)

BNAGR.K=MAX(SEPAMI BNPA.K+BNPUC.K)

72950 A

BNAGR -Breeder nuclear electric- Assets for growth rate (\$)
MAX -Function selecting the larger of two values
SEPAMI -Steam electric- Physical assets of a mature industry (\$)
BNPA -Breeder nuclear electric- Physical assets (\$)
BNPUC -Breeder nuclear electric- Plants under construction (\$)

NOTE

OTINV.KL=SEINV K*(OTAW.K/SEAW.K)

OTINV=0

OTINV -Ocean thermal electric- Investment (\$/Yr)
SEINV -Steam electric- Investment (\$/Yr)
OTAW -Ocean thermal electric- Allocation weight (Dimensionless)
SEAW -Steam electric- Allocation weight (Dimensionless)

72970 R

72980 N

OTAW.K=(OTMCST.K*1E6)^SEWF*STEP(1 OTCY)

OTCY=1980

OTAW -Ocean thermal electric- Allocation weight (Dimensionless)
OTMCST -Ocean thermal electric- Marginal cost (\$/Btu)
SEWF -Steam electric- Weighting factor (Dimensionless)
STEP -Step-shaped exogenous input
OTCY -Ocean thermal electric- Commercialization year (Year)

72990 A

73000 C

OTMCST.K=(OTCCR+OTECR.K)*OTSCC.K+OTOMC

OTCCR= .101

OTMCST -Ocean thermal electric- Marginal cost (\$/Btu)
OTCCR -Ocean thermal electric- Capital charge rate (Fraction/Yr)
OTECR -Ocean thermal electric- Excess charge due to risk (Fraction/Yr)
OTSCC -Ocean thermal electric- Specific capital cost (\$/(Btu/Yr))
OTOMC -Ocean thermal electric- Operating and maintenance <O&M> cost (\$/Btu)

73010 A

73020 C

OTECR.K=OTCCRR*(1-STEP(1.OTLGY))*MAX(0 (SEPAMI-OTPA.K)/SEPAMI)

OTCCRR= .099

OTLGY=2200

OTECR -Ocean thermal electric- Excess charge due to risk (Fraction/Yr)
OTCCRR -Ocean thermal electric- Capital charge due to risk (Fraction/Yr)
STEP -Step-shaped exogenous input
OTLGY -Ocean thermal electric- Loan guarantee initiation year (Year)
MAX -Function selecting the larger of two values
SEPAMI -Steam electric- Physical assets of a mature industry (\$)
OTPA -Ocean thermal electric- Physical assets (\$)

73030 A

73040 C

73050 C

OTSCC.K=OTCCP.K*OTSCM.K/OTCUFP

73060 A

OTCUFP=.6

73070 C

OTSCC -Ocean thermal electric- Specific capital cost $(\$/(\text{Btu}/\text{Yr}))$

OTCCP -Ocean thermal electric- Capital cost of production plant $(\$/(\text{Btu}/\text{Yr}))$

OTSCM -Ocean thermal electric- Secondary constraint multiplier (Dimensionless)

OTCUFP -Ocean thermal electric- Capacity utilization factor for planning (Fraction)

OTSCM.K=TABHL(DESCMT OTGR.K..04..20..04)

73080 A

OTSCM -Ocean thermal electric- Secondary constraint multiplier (Dimensionless)

TABHL -Tabular relationship

DESCMT -Steam electric- Secondary constraint multiplier table (Table)

OTGR -Ocean thermal electric- Growth rate (Fraction/Yr)

OTGR.K=(OTAGR.K/SMOOTH(OTAGR.K SETGR)-1)/SETGR

73090 A

OTGR -Ocean thermal electric- Growth rate (Fraction/Yr)

OTAGR -Ocean thermal electric- Assets for growth rate (\$)

SMOOTH -First order information delay

SETGR -Steam electric- Time for growth rate (Year)

OTAGR.K=MAX(SEPAMI OTPA.K+OTPUC.K)

73100 A

OTAGR -Ocean thermal electric- Assets for growth rate (\$)

MAX -Function selecting the larger of two values

SEPAMI -Steam electric- Physical assets of a mature industry (\$)

OTPA -Ocean thermal electric- Physical assets (\$)

OTPUC -Ocean thermal electric- Plants under construction (\$)

NOTE

BMINV.KL=SEINV.K*(BMAW.K/SEAW.K)

73120 R

BMINV=0

73130 N

BMINV -Biomass electric- Investment (\$/Yr)

SEINV -Steam electric- Investment (\$/Yr)

BMAW -Biomass electric- Allocation weight (Dimensionless)

SEAW -Steam electric- Allocation weight (Dimensionless)

BMAW.K=(BMHCST.K*1E6)^SEWF*STEP(1.BMCY)

73140 A

BMCY=1980

73150 C

BMAW -Biomass electric- Allocation weight (Dimensionless)

BMHCST -Biomass electric- Marginal cost (\$/Btu)

SEWF -Steam electric- Weighting factor (Dimensionless)

STEP -Step-shaped exogenous input

BMCY -Biomass electric- Commercialization year (Year)

BMHCST.K=(BMCCR+BMECR.K)*BMSCC.K+BMOMC+BMFCST.K

73160 A

BMCCR=.100

73170 C

BMHCST -Biomass electric- Marginal cost (\$/Btu)

BMCCR -Biomass electric- Capital charge rate (Fraction/Yr)

BMECR -Biomass electric- Excess charge due to risk (Fraction/Yr)

BMSCC -Biomass electric- Specific capital cost (\$/(Btu/Yr))

BMOMC -Biomass electric- Operating and maintenance <O&M> cost (\$/Btu)

BMFCST -Biomass electric- Feedstock cost (\$/Btu)

BMECR.K=BMCCRR*(1-STEP(1.BMLGY))*MAX(0.(SEPAMI-BMPA.K)/SEPAMI)

73180 A

BMCCRR=.028

73190 C

BMLGY=2200

73200 C

BMECR -Biomass electric- Excess charge due to risk (Fraction/Yr)

BMCCRR -Biomass electric- Capital charge due to risk (Fraction/Yr)

STEP -Step-shaped exogenous input

BMLGY -Biomass electric- Loan guarantee initiation year (Year)

MAX -Function selecting the larger of two values

SEPAMI -Steam electric- Physical assets of a mature industry (\$)

BMPA -Biomass electric- Physical assets (\$)

BMSCC.K=BMCCP.K*BMSCM.K/BMCUFP

73210 A

BMCUFP=.65

73220 C

BMSCC -Biomass electric- Specific capital cost (\$/(Btu/Yr))

BMCCP -Biomass electric- Capital cost of production plant (\$/(Btu/Yr))

BMSCM -Biomass electric- Secondary constraint multiplier (Dimensionless)

BMCUFP -Biomass electric- Capacity utilization factor for planning (Fraction)

BMSCM K=TABHL(SECMT BMGR.K .04,.20,.04)

73230 A

BMSCM -Biomass electric- Secondary constraint multiplier (Dimensionless)

TABHL -Tabular relationship

SECMT -Steam electric- Secondary constraint multiplier table (Table)

BMGR -Biomass electric- Growth rate (Fraction/Yr)

BMGR.K=(BMAGR.K/SMOOTH(BMAGR.K.SETGR)-1)/SETGR

73240 A

BMGR -Biomass electric- Growth rate (Fraction/Yr)

BMAGR -Biomass electric- Assets for growth rate (\$)

SMOOTH -First order information delay

SETGR -Steam electric- Time for growth rate (Year)

BMAGR.K=MAX(SEPAMI BMPA.K+BMPUC.K)

73250 A

BMAGR -Biomass electric- Assets for growth rate (\$)

MAX -Function selecting the larger of two values

SEPAMI -Steam electric- Physical assets of a mature industry (\$)

BMPA -Biomass electric- Physical assets (\$)

BMPUC -Biomass electric- Plants under construction (\$)

NOTE

STINV.KL=SEINV.K*(STAW.K/SEAW.K)

73270 R

STINV=0

73280 H

STINV -Solar thermal- Investment (\$/Yr)
SEINV -Steam electric- Investment (\$/Yr)
STAW -Solar thermal- Allocation weight (Dimensionless)
SEAW -Steam electric- Allocation weight (Dimensionless)

STAW.K=(STMCST.K*1E6)^SEWF*STEP(1 STCY)

73290 A

STCY=1980

73300 C

STAW -Solar thermal- Allocation weight (Dimensionless)
STMCST -Solar thermal- Marginal cost (\$/Btu)
SEWF -Steam electric- Weighting factor (Dimensionless)
STEP -Step-shaped exogenous input
STCY -Solar thermal- Commercialization year (Year)

STMCST K=(STCCR+STECR.K)*STSCC.K+STOMC

73310 A

STCCR=.100

73320 C

STMCST -Solar thermal- Marginal cost (\$/Btu)
STCCR -Solar thermal- Capital charge rate (Fraction/Yr)
STECR -Solar thermal- Excess charge due to risk (Fraction/Yr)
STSCC -Solar thermal- Specific capital cost (\$/(Btu/Yr))
STOMC -Solar thermal- Operating and maintenance <O&M> cost (\$/Btu)

STECR K=STCCRR*(1-STEP(1 STLGY))*MAX(0.(SEPANI-STPA.K)/SEPANI)

73330 A

STCCRR=.028

73340 C

STLGY=2200

73350 C

STECR -Solar thermal- Excess charge due to risk (Fraction/Yr)
STCCRR -Solar thermal- Capital charge due to risk (Fraction/Yr)
STEP -Step-shaped exogenous input
STLGY -Solar thermal- Loan guarantee initiation year (Year)
MAX -Function selecting the larger of two values
SEPANI -Steam electric- Physical assets of a mature industry (\$)
STPA -Solar thermal- Physical assets (\$)

STSCC K=STCCP.K*STSCM K/STCUFF
STCUFF=.5

73360 A
73370 C

STSCC -Solar thermal- Specific capital cost (\$/(Btu/Yr))
STCCP -Solar thermal- Capital cost of production plant (\$/(Btu/Yr))
STSCM -Solar thermal- Secondary constraint multiplier (Dimensionless)
STCUFF -Solar thermal- Capacity utilization factor for planning (Fraction)

STSCM K=TABHL(DESCMT STGR.K .04..20..04)

73380 A

STSCM -Solar thermal- Secondary constraint multiplier (Dimensionless)
TABHL -Tabular relationship
DESCMT -Steam electric- Secondary constraint multiplier table (Table)
STGR -Solar thermal- Growth rate (Fraction/Yr)

STGR.K=(STAGR.K/SMOOTH(STAGR.K SETGR)-1)/SETGR

73390 A

STGR -Solar thermal- Growth rate (Fraction/Yr)
STAGR -Solar thermal- Assets for growth rate (\$)
SMOOTH -First order information delay
SETGR -Steam electric- Time for growth rate (Year)

STAGR.K=MAX(SEPAMI STPA.K+STPUC.K)

73400 A

STAGR -Solar thermal- Assets for growth rate (\$)
MAX -Function selecting the larger of two values
SEPAMI -Steam electric- Physical assets of a mature industry (\$)
STPA -Solar thermal- Physical assets (\$)
STPUC -Solar thermal- Plants under construction (\$)

NOTE

WEINV.KL=SEINV.K*(WEAW.K/SEAW.K)

73420 R

WEINV=0

73430 N

WEINV -Wind electric- Investment (\$/Yr)

SEINV -Steam electric- Investment (\$/Yr)

WEAW -Wind electric- Allocation weight (Dimensionless)

SEAW -Steam electric- Allocation weight (Dimensionless)

WEAW.K=(WEMCST.K*1E6)^SEWF*STEP(1.WECY)

73440 A

WECY=1980

73450 C

WEAW -Wind electric- Allocation weight (Dimensionless)

WEMCST -Wind electric- Marginal cost (\$/Btu)

SEWF -Steam electric- Weighting factor (Dimensionless)

STEP -Step-shaped exogenous input

WECY -Wind electric- Commercialization year (Year)

WEMCST.K=(WECCR+WEECR.K)*WESCC.K+WEOMC

73460 A

WECCR=.100

73470 C

WEMCST -Wind electric- Marginal cost (\$/Btu)

WECCR -Wind electric- Capital charge rate (Fraction/Yr)

WEECR -Wind electric- Excess charge due to risk (Fraction/Yr)

WESCC -Wind electric- Specific capital cost (\$/(Btu/Yr))

WEOMC -Wind electric- Operating and maintenance <O&M> cost (\$/Btu)

WEECR.K=WECCRR*(1-STEP(1.WELGY))*MAX(0 (SEPAMI-WEPA.K)/SEPAMI)

73480 A

WECCRR=.028

73490 C

WELGY=2200

73500 C

WEECR -Wind electric- Excess charge due to risk (Fraction/Yr)

WECCRR -Wind electric- Capital charge due to risk (Fraction/Yr)

STEP -Step-shaped exogenous input

WELGY -Wind electric- Loan guarantee initiation year (Year)

MAX -Function selecting the larger of two values

SEPAMI -Steam electric- Physical assets of a mature industry (\$)

WEPA -Wind electric- Physical assets (\$)

WESCC.K=WECPP.K*WESCM.K/WECUFP

73510 A

WECUFP=.4

73520 C

WESCC -Wind electric- Specific capital cost (\$/(Btu/Yr))

WECPP -Wind electric- Capital cost of production plant (\$/(Btu/Yr))

WESCM -Wind electric- Secondary constraint multiplier (Dimensionless)

WECUFP -Wind electric- Capacity utilization factor for planning (Fraction)

WESCM.K=TABHL(SESCHT,WEGR.K,.04,.20,.04)

73530 A

WESCH -Wind electric- Secondary constraint multiplier (Dimensionless)

TABHL -Tabular relationship

SESCHT -Steam electric- Secondary constraint multiplier table (Table)

WEGR -Wind electric- Growth rate (Fraction/Yr)

WEGR.K=(WEAGR.K/SMOOTH(WEAGR.K,SETGR)-1)/SETGR

73540 A

WEGR -Wind electric- Growth rate (Fraction/Yr)

WEAGR -Wind electric- Assets for growth rate (\$)

SMOOTH -First order information delay

SETGR -Steam electric- Time for growth rate (Year)

WEAGR.K=MAX(SEPAMI,WEPA.K+WEPUC.K)

73550 A

WEAGR -Wind electric- Assets for growth rate (\$)

MAX -Function selecting the larger of two values

SEPAMI -Steam electric- Physical assets of a mature industry (\$)

WEPA -Wind electric- Physical assets (\$)

WEPUC -Wind electric- Plants under construction (\$)

NOTE

SEAW.K=ACAW.K+PBAW.K+OUAW.K+PVAW.K+LVAW.K+BRAW.K+CCAW.K+OTAW.K+BMAW.K+STAW.K+WEAW.K

73570 A

SEWF=-10

73590 C

SESCHT=1/1/1.5/1.5/1.5

73600 T

SEPAMI=60E9

73610 C

SEEIDCT=0/1

73620 T

SETGR=2

73630 C

SEAW -Steam electric- Allocation weight (Dimensionless)

ACAW -Avg. conventional coal electric- Allocation weight (Dimensionless)

PBAW -Fluidized bed coal electric- Allocation weight (Dimensionless)

OUAW -Oil/gas utilities- Allocation weight (Dimensionless)

PVAW -Photovoltaic electric- Allocation weight (Dimensionless)

LVAW -Light water nuclear electric- Allocation weight (Dimensionless)

BRAW -Breeder nuclear electric- Allocation weight (Dimensionless)

CCAW -Combined cycle coal electric- Allocation weight (Dimensionless)

OTAW -Ocean thermal electric- Allocation weight (Dimensionless)

BMAW -Biomass electric- Allocation weight (Dimensionless)

STAW -Solar thermal- Allocation weight (Dimensionless)

WEAW -Wind electric- Allocation weight (Dimensionless)

SEWF -Steam electric- Weighting factor (Dimensionless)

SESCHT -Steam electric- Secondary constraint multiplier table (Table)

SEPAMI -Steam electric- Physical assets of a mature industry (\$)

SEEIDCT -Steam electric- Excess interest during construction table (Table)

SETGR -Steam electric- Time for growth rate (Year)

NOTE
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 NOTE Transmission and Distribution Subsector
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TDCG.K=TABHL(TDCCT TIME.K.1950.2030.10)*1E-6
 TDCCT=5/5/5/10/10/10/10/10/10
 TDOMC=.50E-6

73710 A
 73720 T
 73730 C

TDCG -Transmission and distribution- Capital cost (\$/(Btu/Yr))
 TABHL -Tabular relationship
 TDCCT -Transmission and distribution- Capital cost table (Table)
 TIME -Actual time during simulation
 TDOMC -Transmission and distribution- Operating and maintenance <O&M> cost (\$/Btu)

TDCST.K=TDOMC*TEDE*SEPR K

73740 A

TDCST -Transmission and distribution- Cost (\$/Yr)
 TDOMC -Transmission and distribution- Operating and maintenance <O&M> cost (\$/Btu)
 TEDE -Total electric- Distributional efficiency (Fraction)
 SEPR -Steam electric- Production rate (Btu/Yr)

NOTE

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 NOTE Coal Utilities Without Emissions Control Subsector
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NCPA K=NCPA.J+(DT)(NCFCR.JK-NCPAR.JK+CCCVR JK)

73840 L

NCPA=NCPAI

73850 N

NCPAI=23.2E9

73860 C

NCPA -Non-Emission controlled coal- Physical assets (\$)
 DT -Time increment between calculations
 NCFCR -Non-Emission controlled coal- Facility completion rate (\$/Yr)
 NCPAR -Non-Emission controlled coal- Physical asset retirements (\$/Yr)
 OCCVR -Oil/gas-to-coal fired electric- Conversion rate (\$/Yr)
 NCPAI -Non-Emission controlled coal- Physical assets initial (\$)

NCPAR.KL=NCPA.K*NCARF

73870 R

NCARF=.011

73880 C

NCPAR -Non-Emission controlled coal- Physical asset retirements (\$/Yr)
 NCPA -Non-Emission controlled coal- Physical assets (\$)
 NCARF -Non-Emission controlled coal- Asset retirement factor (Fraction/Yr)

NCFCR KL=DELAY3P(NCINV.JK,NCFCT.K,NCPUC.K)

73890 R

NCFCR -Non-Emission controlled coal- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 NCINV -Non-Emission controlled coal- Investment (\$/Yr)
 NCFCT -Non-Emission controlled coal- Facility construction time (Year)
 NCPUC -Non-emission controlled coal- Plants under construction (\$)

NCFCT.K=TABHL(NCFCTT.(TIME.K-NCCDCY)/NCCDCT.0.1.1)

73900 A

NCFCTT=5/10

73910 T

NCCDCT=10

73920 C

NCCDCY=2200

73930 C

NCFCT -Non-Emission controlled coal- Facility construction time (Year)
 TABHL -Tabular relationship
 NCFCTT -Non-Emission controlled coal- Facility construction time table (Table)
 TIME -Actual time during simulation
 NCCDCY -Non-Emission controlled coal- Construction delay change year (Year)
 NCCDCT -Non-Emission controlled coal- Construction delay change implementation time (Year)

NOTE

NCPR.K=SECUF K*NCPC.K*DCPDR K

73950 A

NCPR -Non-Emission controlled coal- Production rate (Btu/Yr)
 SECUF -Steam electric- Capacity utilization factor (Fraction)
 NCPC -Non-Emission controlled coal- Production capacity (Btu/Yr)
 DCPDR -Domestic coal- Production demand ratio (Dimensionless)

NCPC.K=NCPA.K/NCACC.K

73960 A

NCPC -Non-Emission controlled coal- Production capacity (Btu/Yr)
 NCPA -Non-Emission controlled coal- Physical assets (\$)
 NCACC -Non-Emission controlled coal- Average capital cost (\$/(Btu/Yr))

NCACC.K=SHOOTH(NCCC.K,SEATPA)

NCCC=NCACCI

NCACCI=.25E-6

NCACC -Non-Emission controlled coal- Average capital cost (\$/(Btu/Yr))
SHOOTH -First order information delay
NCCC -Non-Emission controlled coal- Capital cost (\$/(Btu/Yr))
SEATPA -Steam electric- Averaging time for physical assets (Year)
NCACCI -Non-Emission controlled coal- Average capital cost initial (\$/(Btu/Yr))

73970 A

73980 N

73990 C

NCCC.K=TDCC.K+NCCCP.K

NCCC -Non-Emission controlled coal- Capital cost (\$/(Btu/Yr))
TDCC -Transmission and distribution- Capital cost (\$/(Btu/Yr))
NCCCP -Non-Emission controlled coal- Capital cost of production plant (\$/(Btu/Yr))

74000 A

NCCCP.K=TABHL(NCCCT,TIME.K,1950,2030,10)*1E-6

NCCCT=16/10/6/11/16/16/16/16/16

NCCCP -Non-Emission controlled coal- Capital cost of production plant (\$/(Btu/Yr))
TABHL -Tabular relationship
NCCCT -Non-Emission controlled coal- Capital cost table (Table)
TIME -Actual time during simulation

74010 A

74020 T

NCCST.K=NCPR.K*(NCOMC+NCFCST.K)

NCOMC=.78E-6

NCCST -Non-Emission controlled coal- Cost (\$/Yr)
NCPR -Non-Emission controlled coal- Production rate (Btu/Yr)
NCOMC -Non-Emission controlled coal- Operating and maintenance <O&M> cost (\$/Btu)
NCFCST -Non-Emission controlled coal- Feedstock cost (\$/Btu)

74030 A

74040 C

NCFCST.K=(DCP.K-CEFCF)/NCCE.K

NCFCST -Non-Emission controlled coal- Feedstock cost (\$/Btu)
DCP -Domestic coal- Price (\$/Btu)
CEFCF -Centralized energy- Fuel cost factor (\$/Btu)
NCCE -Non-Emission controlled coal- Conversion efficiency (Dimensionless)

74050 A

NCDC.K=NCPC.K*SECUP.K/NCCE.K

NCDC -Non-Emission controlled coal- Demand for coal (Btu/Yr)
NCPC -Non-Emission controlled coal- Production capacity (Btu/Yr)
SECUP -Steam electric- Capacity utilization factor (Fraction)
NCCE -Non-Emission controlled coal- Conversion efficiency (Dimensionless)

74060 A

NCCE.K=TABHL(NCCET,TIME.K,1950,2030,10)

NCCET=.24/.31/.32/.32/.32/.32/.32/.32

NCCE -Non-Emission controlled coal- Conversion efficiency (Dimensionless)
TABHL -Tabular relationship
NCCET -Non-Emission controlled coal- Conversion efficiency table (Table)
TIME -Actual time during simulation

74070 A

74080 T

NOTE

CEFCF=.31E-6

SEATPA=13

CEFCF -Centralized energy- Fuel cost factor (\$/Btu)
SEATPA -Steam electric- Averaging time for physical assets (Year)

74100 C

74110 C

NOTE

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NOTE Coal Utilities With Emissions Control Subsector

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NOTE

NOTE

ECPA.K=ECPA.J+(DT)(ECFCR.JK-ECPAR.JK)

74210 L

ECPA=0

74220 N

ECPA -Emission controlled coal- Physical assets (\$)

DT -Time increment between calculations

ECFCR -Emission controlled coal- Facility completion rate (\$/Yr)

ECPAR -Emission controlled coal- Physical asset retirements (\$/Yr)

ECPAR.KL=ECPA.K*ECARF

74230 R

ECARF=.011

74240 C

ECPAR -Emission controlled coal- Physical asset retirements (\$/Yr)

ECPA -Emission controlled coal- Physical assets (\$)

ECARF -Emission controlled coal- Asset retirement factor (Fraction/Yr)

ECFCR.KL=DELAY3P(ECINV.JK,ECFCT.K,ECPUK.K)

74250 R

ECFCR -Emission controlled coal- Facility completion rate (\$/Yr)

DELAY3P -Third order pipeline material delay

ECINV -Emission controlled coal- Investment (\$/Yr)

ECFCT -Emission controlled coal- Facility construction time (Year)

ECPUK -Emission controlled coal- Plants under construction (\$)

ECFCT.K=TABHL(ECFCTT.(TIME K-ECCDCY)/ECCDCT.0.1.1)

74260 A

ECFCTT=5/10

74270 T

ECCDCT=10

74280 C

ECCDCY=2200

74290 C

ECFCT -Emission controlled coal- Facility construction time (Year)

TABHL -Tabular relationship

ECFCTT -Emission controlled coal- Facility construction time table (Table)

TIME -Actual time during simulation

ECCDCY -Emission controlled coal- Construction delay change year (Year)

ECCDCT -Emission controlled coal- Construction delay change implementation time (Year)

NOTE

ECPR.K=SECUF.K*ECPC.K*DCPDR.K

74310 A

ECPR -Emission controlled coal- Production rate (Btu/Yr)

SECUF -Steam electric- Capacity utilization factor (Fraction)

ECPC -Emission controlled coal- Production capacity (Btu/Yr)

DCPDR -Domestic coal- Production demand ratio (Dimensionless)

ECPC.K=ECPA.K/ECACC.K

74320 A

ECPC -Emission controlled coal- Production capacity (Btu/Yr)

ECPA -Emission controlled coal- Physical assets (\$)

ECACC -Emission controlled coal- Average capital cost (\$/(Btu/Yr))

ECACC.K=SMOOTH(ECGC.K,SEATPA)

74330 A

ECACC -Emission controlled coal- Average capital cost (\$/(Btu/Yr))
SMOOTH -First order information delay
EGCC -Emission controlled coal- Capital cost (\$/(Btu/Yr))
SEATPA -Steam electric- Averaging time for physical assets (Year)

ECCC.K=TDCC.K+ECCCP.K

74340 A

ECCC -Emission controlled coal- Capital cost (\$/(Btu/Yr))
TDCC -Transmission and distribution- Capital cost (\$/(Btu/Yr))
ECCCP -Emission controlled coal- Capital cost of production plant (\$/(Btu/Yr))

ECCCP.K=TABHL(ECCCT,TIME.K,1950,2030,10)*1E-6

74350 A

ECCCT=19/13/9/15/20/20/20/20/20

74360 T

ECCCP -Emission controlled coal- Capital cost of production plant (\$/(Btu/Yr))
TABHL -Tabular relationship
ECCCT -Emission controlled coal- Capital cost table (Table)
TIME -Actual time during simulation

EGCST.K=ECPR.K*(ECONC+ECFCST.K)

74370 A

ECONC=.97E-6

74380 C

EGCST -Emission controlled coal- Cost (\$/Yr)
ECPR -Emission controlled coal- Production rate (Btu/Yr)
ECONC -Emission controlled coal- Operating and maintenance <O&M> cost (\$/Btu)
ECFCST -Emission controlled coal- Feedstock cost (\$/Btu)

ECFCST.K=(DCP.K-CEFCF)/ECCE.K

74390 A

ECFCST -Emission controlled coal- Feedstock cost (\$/Btu)
DCP -Domestic coal- Price (\$/Btu)
CEFCF -Centralized energy- Fuel cost factor (\$/Btu)
ECCE -Emission controlled coal- Conversion efficiency (Dimensionless)

ECDC.K=ECPC.K*SECUF.K/ECCE.K

74400 A

ECDC -Emission controlled coal- Demand for coal (Btu/Yr)
ECPC -Emission controlled coal- Production capacity (Btu/Yr)
SECUF -Steam electric- Capacity utilization factor (Fraction)
ECCE -Emission controlled coal- Conversion efficiency (Dimensionless)

ECCE.K=TABHL(ECCET,TIME.K,1950,2030,10)

74410 A

ECCET=.18/.28/.30/.30/.32/.32/.32/.32

74420 T

ECCE -Emission controlled coal- Conversion efficiency (Dimensionless)
TABHL -Tabular relationship
ECCET -Emission controlled coal- Conversion efficiency table (Table)
TIME -Actual time during simulation

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FBPA K=FBPA.J+(DT)(FBFCR.JK-FBPAR.JK)

74520 L

FBPA=0

74530 N

FBPA -Fluidized bed coal electric- Physical assets (\$)

DT -Time increment between calculations

FBFCR -Fluidized bed coal electric- Facility completion rate (\$/Yr)

FBPAR -Fluidized bed coal electric- Physical asset retirements (\$/Yr)

FBPAR KL=FBPA.K*FBARF

74540 R

FBARF=.011

74550 C

FBPAR -Fluidized bed coal electric- Physical asset retirements (\$/Yr)

FBPA -Fluidized bed coal electric- Physical assets (\$)

FBARF -Fluidized bed coal electric- Asset retirement factor (Fraction/Yr)

FBFCR.KL=DELAY3P(FBINV.JK,FBFCT.FBPUC.K)

74560 R

FBFCT=5

74570 C

FBFCR -Fluidized bed coal electric- Facility completion rate (\$/Yr)

DELAY3P -Third order pipeline material delay

FBINV -Fluidized bed coal electric- Investment (\$/Yr)

FBFCT -Fluidized bed coal electric- Facility construction time (Year)

FBPUC -Fluidized bed coal electric- Plants under construction (\$)

NOTE

FBPR.K=SECUF.K*FBPC.K*DCPDR.K.

74590 A

FBPR -Fluidized bed coal electric- Production rate (Btu/Yr)
SECUF -Steam electric- Capacity utilization factor (Fraction)
FBPC -Fluidized bed coal electric- Production capacity (Btu/Yr)
DCPDR -Domestic coal- Production demand ratio (Dimensionless)

FBPC.K=FBPA.K/FBACC.K

74600 A

FBPC -Fluidized bed coal electric- Production capacity (Btu/Yr)
FBPA -Fluidized bed coal electric- Physical assets (\$)
FBACC -Fluidized bed coal electric- Average capital cost (\$/(Btu/Yr))

FBACC.K=SMOOTH(FBCC.K,SEATPA)

74610 A

FBACC -Fluidized bed coal electric- Average capital cost (\$/(Btu/Yr))
SMOOTH -First order information delay
FBCC -Fluidized bed coal electric- Capital cost (\$/(Btu/Yr))
SEATPA -Steam electric- Averaging time for physical assets (Year)

FBCC.K=TDCC.K+FBCCP

74620 A

FBCCP=20.0E-6

74630 C

FBCC -Fluidized bed coal electric- Capital cost (\$/(Btu/Yr))
TDCC -Transmission and distribution- Capital cost (\$/(Btu/Yr))
FBCCP -Fluidized bed coal electric- Capital cost of production plant (\$/(Btu/Yr))

FBFCST.K=FBPR.K*(FBOMC+FBFCST.K)

74640 A

FBOMC=1.55E-6

74650 C

FBFCST -Fluidized bed coal electric- Cost (\$/Yr)
FBPR -Fluidized bed coal electric- Production rate (Btu/Yr)
FBOMC -Fluidized bed coal electric- Operating and maintenance <O&M> cost (\$/Btu)
FBFCST -Fluidized bed coal electric- Feedstock cost (\$/Btu)

FBFCST.K=(DCP.K-CEFCF)/FBCE

74660 A

FBFCST -Fluidized bed coal electric- Feedstock cost (\$/Btu)
DCP -Domestic coal- Price (\$/Btu)
CEFCF -Centralized energy- Fuel cost factor (\$/Btu)
FBCE -Fluidized bed coal electric- Conversion efficiency (Dimensionless)

FBDC.K=FBPC.K*SECUF.K/FBCE

74670 A

FBCE=.34

74680 C

FBDC -Fluidized bed coal electric- Demand for coal (Btu/Yr)
FBPC -Fluidized bed coal electric- Production capacity (Btu/Yr)
SECUF -Steam electric- Capacity utilization factor (Fraction)
FBCE -Fluidized bed coal electric- Conversion efficiency (Dimensionless)

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 NOTE Coal Utilities With Combined Cycle Combustion Subsector
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CCPA.K=CCPA J+(DT)(CCFCR.JK-CCPAR.JK) 74780 L
 CCPA=0 74790 N

CCPA -Combined cycle coal electric- Physical assets (\$)
 DT -Time increment between calculations
 CCFCR -Combined cycle coal electric- Facility completion rate (\$/Yr)
 CCPAR -Combined cycle coal electric- Physical asset retirements (\$/Yr)

CCPAR.KL=CCPA K*CCARF 74800 R
 CCARF=.011 74810 C

CCPAR -Combined cycle coal electric- Physical asset retirements (\$/Yr)
 CCPA -Combined cycle coal electric- Physical assets (\$)
 CCARF -Combined cycle coal electric- Asset retirement factor (Fraction/Yr)

CCFCR.KL=DELAY3P(CCINV.JK.CCFCT CCPUC.K) 74820 R
 CCFCT=5 74830 C

CCFCR -Combined cycle coal electric- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 CCINV -Combined cycle coal electric- Investment (\$/Yr)
 CCFCT -Combined cycle coal electric- Facility construction time (Year)
 CCPUC -Combined cycle coal electric- Plants under construction (\$)

NOTE

CPR.K=SECUF.K*CCPC.K*DCPDR.K

CCPR -Combined cycle coal electric- Production rate (Btu/Yr)
SECUF -Steam electric- Capacity utilization factor (Fraction)
CCPC -Combined cycle coal electric- Production capacity (Btu/Yr)
DCPDR -Domestic coal- Production demand ratio (Dimensionless)

74850 A

CCPC.K=CCPA.K/CCACC.K

CCPC -Combined cycle coal electric- Production capacity (Btu/Yr)
CCPA -Combined cycle coal electric- Physical assets (\$)
CCACC -Combined cycle coal electric- Average capital cost (\$/(Btu/Yr))

74860 A

CCACC.K=SHOOTH(CCCC.K,SEATPA)

CCACC -Combined cycle coal electric- Average capital cost (\$/(Btu/Yr))
SHOOTH -First order information delay
CCCC -Combined cycle coal electric- Capital cost (\$/(Btu/Yr))
SEATPA -Steam electric- Averaging time for physical assets (Year)

74870 A

CCCC.K=TDCC.K+CCCCP

CCCCP=17.6E-6

CCCC -Combined cycle coal electric- Capital cost (\$/(Btu/Yr))
TDCC -Transmission and distribution- Capital cost (\$/(Btu/Yr))
CCCCP -Combined cycle coal electric- Capital cost of production plant (\$/(Btu/Yr))

74880 A

74890 C

CCCST.K=CCPR.K*(CCOMC+CCFCST.K)

CCOMC=.87E-6

CCCST -Combined cycle coal electric- Cost (\$/Yr)
CCPR -Combined cycle coal electric- Production rate (Btu/Yr)
CCOMC -Combined cycle coal electric- Operating and maintenance <O&M> cost (\$/Btu)
CCFCST -Combined cycle coal electric- Feedstock cost (\$/Btu)

74900 A

74910 C

CCFCST.K=(DCP.K-CEFCF)/CCCE

CCFCST -Combined cycle coal electric- Feedstock cost (\$/Btu)
DCP -Domestic coal- Price (\$/Btu)
CEFCF -Centralized energy- Fuel cost factor (\$/Btu)
CCCE -Combined cycle coal electric- Conversion efficiency (Dimensionless)

74920 A

CCDC.K=CCPC.K*SECUF.K/CCCE

CCCE=.4

CCDC -Combined cycle coal electric- Demand for coal (Btu/Yr)
CCPC -Combined cycle coal electric- Production capacity (Btu/Yr)
SECUF -Steam electric- Capacity utilization factor (Fraction)
CCCE -Combined cycle coal electric- Conversion efficiency (Dimensionless)

74930 A

74940 C

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 NOTE Oil and Gas Utilities Subsector
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OUPA K=OUPA.J+(DT)(OUFCR.JK-OUPAE.JK-OCCVR.JK)
 OUPA=OUPAI
 OUPAI=11.3E9

75040 L
 75050 N
 75060 C

OUPA -Oil/gas utilities- Physical assets (\$)
 DT -Time increment between calculations
 OUFCR -Oil/gas utilities- Facility completion rate (\$/Yr)
 OUPAR -Oil/gas utilities- Physical asset retirements (\$/Yr)
 OCCVR -Oil/gas-to-coal fired electric- Conversion rate (\$/Yr)
 OUPAI -Oil/gas utilities- Physical assets initial (\$)

OUPAR.KL=OUPA K*OUARF
 OUARF=.011

75070 R
 75080 C

OUPAR -Oil/gas utilities- Physical asset retirements (\$/Yr)
 OUPA -Oil/gas utilities- Physical assets (\$)
 OUARF -Oil/gas utilities- Asset retirement factor (Fraction/Yr)

OUFCR.KL=DELAY3P(OUINV.JK.OUFCT CUPEC.K)
 OUFCF=5

75090 R
 75100 C

OUFCR -Oil/gas utilities- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 OUINV -Oil/gas utilities- Investment (\$/Yr)
 OUFCF -Oil/gas utilities- Facility construction time (Year)
 OUPUC -Oil/gas utilities- Plants under construction (\$)

OCCVR KL=CLIP(CLIP(0 OCCIR.K.TIME.K OCCYC).0.TIME K.OCCYI)

75110 R

OCCVR -Oil/gas-to-coal fired electric- Conversion rate (\$/Yr)
 CLIP -Function switched during the run
 OCCIR -Oil/gas-to-coal fired electric- Conversion rate indicated (\$/Yr)
 TIME -Actual time during simulation
 OCCYC -Oil/gas-to-coal fired electric- Conversion year completed (Year)
 OCCYI -Oil/gas-to-coal fired electric- Conversion year initial (Year)

OCCIR K=OCGC77*OUCC.K/(OCCYC-OCCYI)
 OCGC77=.46E15
 OCCYI=1980
 OCCYC=1985

75120 A
 75130 C
 75140 C
 75150 C

OCCIR -Oil/gas-to-coal fired electric- Conversion rate indicated (\$/Yr)
 OCGC77 -Oil/gas-to-coal fired electric- Generating capacity in 1977 (Btu/Yr)
 OUCC -Oil/gas utilities- Capital cost (\$/(Btu/Yr))
 OCCYC -Oil/gas-to-coal fired electric- Conversion year completed (Year)
 OCCYI -Oil/gas-to-coal fired electric- Conversion year initial (Year)

NOTE

<p> OUPR.K=SECUF.K*OUPC.K*OUPDR.K OUPR -Oil/gas utilities- Production rate (Btu/Yr) SECUF -Steam electric- Capacity utilization factor (Fraction) OUPC -Oil/gas utilities- Production capacity (Btu/Yr) OUPDR -Oil/gas utilities- Production demand ratio (Dimensionless) </p>	75170 A
<p> OUPC.K=OUPA.K/OUACC.K*OUCMP.K OUPC -Oil/gas utilities- Production capacity (Btu/Yr) OUPA -Oil/gas utilities- Physical assets (\$) OUACC -Oil/gas utilities- Average capital cost (\$/(Btu/Yr)) OUCMP -Oil/gas utilities- Capacity multiplier from peaking (Fraction) </p>	75180 A
<p> OUACC.K=SMOOTH(OUCC.K,SEATPA) OUCC=OUACCI OUACCI=23E-6 OUACC -Oil/gas utilities- Average capital cost (\$/(Btu/Yr)) SMOOTH -First order information delay OUCC -Oil/gas utilities- Capital cost (\$/(Btu/Yr)) SEATPA -Steam electric- Averaging time for physical assets (Year) OUACCI -Oil/gas utilities- Average capital cost initial (\$/(Btu/Yr)) </p>	75190 A 75200 N 75210 C
<p> OUCMP.K=TABHL(OUCMPT,TIME.K,1970,2020,5) OUCMPT=1/.9/.85/.80/.65/.6/.6/.6/.6/.6 OUCMP -Oil/gas utilities- Capacity multiplier from peaking (Fraction) TABHL -Tabular relationship OUCMPT -Oil/gas utilities- Capacity multiplier from peaking table (Table) TIME -Actual time during simulation </p>	75220 A 75230 T
<p> OUCC.K=TDCC.K+OUCCP.K OUCC -Oil/gas utilities- Capital cost (\$/(Btu/Yr)) TDCC -Transmission and distribution- Capital cost (\$/(Btu/Yr)) OUCCP -Oil/gas utilities- Capital cost of production plant (\$/(Btu/Yr)) </p>	75240 A
<p> OUCCP.K=TABHL(OUCCT,TIME.K,1950,2030,10)*1E-6 OUCCT=15/10/7/10/11/12/12/12/12 OUCCP -Oil/gas utilities- Capital cost of production plant (\$/(Btu/Yr)) TABHL -Tabular relationship OUCCT -Oil/gas utilities- Capital cost table (Table) TIME -Actual time during simulation </p>	75250 A 75260 T
<p> OUCST.K=OUPR.K*(OUOMC+OUFCST.K) OUOMC=.65E-6 OUCST -Oil/gas utilities- Cost (\$/Yr) OUPR -Oil/gas utilities- Production rate (Btu/Yr) OUOMC -Oil/gas utilities- Operating and maintenance <O&M> cost (\$/Btu) OUFCST -Oil/gas utilities- Feedstock cost (\$/Btu) </p>	75270 A 75280 C
<p> OUFCST.K=GEFCST.K*OUFDG.K+OEFCEST.K*(1-OUFDG.K) OUFCST -Oil/gas utilities- Feedstock cost (\$/Btu) GEFCST -Gas electric- Feedstock cost (\$/Btu) OUFDG -Oil/gas utilities- Fraction demanded as gas (Fraction) OEFCEST -Oil electric- Feedstock cost (\$/Btu) </p>	75290 A

OUDOG.K=SECUF.K*OUPC.K/OUCE.K

75300 A

OUDOG -Oil/gas utilities- Demand for oil and gas (Btu/Yr)
SECUF -Steam electric- Capacity utilization factor (Fraction)
OUPC -Oil/gas utilities- Production capacity (Btu/Yr)
OUCE -Oil/gas utilities- Conversion efficiency (Dimensionless)

NOTE

OUFG.K=OUDOG.K*OUFDG.K

75320 A

OUFG -Oil/gas utilities- Demand for gas (Btu/Yr)
OUDOG -Oil/gas utilities- Demand for oil and gas (Btu/Yr)
OUFDG -Oil/gas utilities- Fraction demanded as gas (Fraction)

OUFG.K=OUDOG.K-OUFG.K

75330 A

OUFG -Oil/gas utilities- Demand for oil (Btu/Yr)
OUDOG -Oil/gas utilities- Demand for oil and gas (Btu/Yr)
OUFG -Oil/gas utilities- Demand for gas (Btu/Yr)

OUFDG K=TABHL(OUFDGT TIME.K 1950.2000.5)*1E-2

75340 A

OUFDGT=50/70/76/76/66/49/40/33/29/26/22

75350 T

OUFDG -Oil/gas utilities- Fraction demanded as gas (Fraction)
TABHL -Tabular relationship
OUFDGT -Oil/gas utilities- Fraction demanded as gas table (Table)
TIME -Actual time during simulation

GEFCST.K=(TGP.K-GEFCF)/OUCE.K

75360 A

GEFCF=.60E-6

75370 C

GEFCST -Gas electric- Feedstock cost (\$/Btu)
TGP -Total gas- Price (\$/Btu)
GEFCF -Gas electric- Fuel cost factor (\$/Btu)
OUCE -Oil/gas utilities- Conversion efficiency (Dimensionless)

OEFCST.K=(TOP.K-OEFCF)/OUCE K

75380 A

OEFCF=1.82E-6

75390 C

OEFCST -Oil electric- Feedstock cost (\$/Btu)
TOP -Total oil- Price (\$/Btu)
OEFCF -Oil electric- Fuel cost factor (\$/Btu)
OUCE -Oil/gas utilities- Conversion efficiency (Dimensionless)

OUCE.K=TABHL(NCCET.TIME.K 1950 2030.10)

75400 A

OUCE -Oil/gas utilities- Conversion efficiency (Dimensionless)
TABHL -Tabular relationship
NCCET -Non-Emission controlled coal- Conversion efficiency table (Table)
TIME -Actual time during simulation

OUPDR.K=TGPCR.K*OUFDG.K+TOPDR.K*(1-OUFDG.K)

75410 A

OUPDR -Oil/gas utilities- Production demand ratio (Dimensionless)
TGPCR -Total gas- Production-consumption ratio (Dimensionless)
OUFDG -Oil/gas utilities- Fraction demanded as gas (Fraction)
TOPDR -Total oil- Production demand ratio (Dimensionless)

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 NOTE Photovoltaic Utilities Subsector
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PVPA K=PVPA J+(DT)(PVFCR.JK-PVPAR.JK)

75500 L

PVPA=0

75510 N

PVPA -Photovoltaic electric- Physical assets (\$)
 DT -Time increment between calculations
 PVFCR -Photovoltaic electric- Facility completion rate (\$/Yr)
 PVPAR -Photovoltaic electric- Physical asset retirements (\$/Yr)

PVPAR.KL=PVPA.K*PVARF

75520 R

PVARF=.011

75530 C

PVPAR -Photovoltaic electric- Physical asset retirements (\$/Yr)
 PVPA -Photovoltaic electric- Physical assets (\$)
 PVARF -Photovoltaic electric- Asset retirement factor (Fraction/Yr)

PVFCR.KL=DELAY3P(PVINV.JK PVFCT PVPUC.K)

75540 R

PVFCT=5

75550 C

PVFCR -Photovoltaic electric- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 PVINV -Photovoltaic electric- Investment (\$/Yr)
 PVFCT -Photovoltaic electric- Facility construction time (Year)
 PVPUC -Photovoltaic Electric- Plants under construction (\$)

NOTE

PVPR.K=SECUF.K*PVPC.K

PVPR -Photovoltaic electric- Production rate (Btu/Yr)
SECUF -Steam electric- Capacity utilization factor (Fraction)
PVPC -Photovoltaic electric- Production capacity (Btu/Yr)

75570 A

PVPC.K=PVPA.K/PVACC.K

PVPC -Photovoltaic electric- Production capacity (Btu/Yr)
PVPA -Photovoltaic electric- Physical assets (\$)
PVACC -Photovoltaic electric- Average capital cost (\$/(Btu/Yr))

75580 A

PVACC.K=SMOOTH(PVCC.K,SEATPA)

PVACC -Photovoltaic electric- Average capital cost (\$/(Btu/Yr))
SMOOTH -First order information delay
PVCC -Photovoltaic electric- Capital cost (\$/(Btu/Yr))
SEATPA -Steam electric- Averaging time for physical assets (Year)

75590 A

PVCC.K=TDCC.K+PVCCP.K

PVCC -Photovoltaic electric- Capital cost (\$/(Btu/Yr))
TDCC -Transmission and distribution- Capital cost (\$/(Btu/Yr))
PVCCP -Photovoltaic electric- Capital cost of production plant (\$/(Btu/Yr))

75600 A

PVCCP.K=TABHL(PVCCT,TIME.K,1950,2030,10)*1E-6*SENTM

PVCCT=106/106/106/106/54.75/31.37/31.37/31.37/31.37

PVCCP -Photovoltaic electric- Capital cost of production plant (\$/(Btu/Yr))
TABHL -Tabular relationship
PVCCT -Photovoltaic electric- Capital cost table (Table)
TIME -Actual time during simulation
SENTM -Steam electric- New technology cost multiplier (Dimensionless)

75610 A

75620 T

PVCST.K=PVPR.K*PVOMC

PVOMC=.75E-6

PVCST -Photovoltaic electric- Cost (\$/Yr)
PVPR -Photovoltaic electric- Production rate (Btu/Yr)
PVOMC -Photovoltaic electric- Operating and maintenance <O&M> cost (\$/Btu)

75630 A

75640 C

SENTM=1

SENTM -Steam electric- New technology cost multiplier (Dimensionless)

75660 C

NOTE

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 NOTE Ocean Thermal Utilities Subsector
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OTPA K=OTPA.J+(DT)(OTFCR.JK-OTPAR.JK)

75750 L

OTPA=0

75760 N

OTPA -Ocean thermal electric- Physical assets (\$)
 DT -Time increment between calculations
 OTFCR -Ocean thermal electric- Facility completion rate (\$/Yr)
 OTPAR -Ocean thermal electric- Physical asset retirements (\$/Yr)

OTPAR.KL=OTPA K*OTARF

75770 R

OTARF=.011

75780 C

OTPAR -Ocean thermal electric- Physical asset retirements (\$/Yr)
 OTPA -Ocean thermal electric- Physical assets (\$)
 OTARF -Ocean thermal electric- Asset retirement factor (Fraction/Yr)

OTFCR.KL=DELAY3P(OTINV.JK,OTFCT OTPUC.K)

75790 R

OTFCT=6

75800 C

OTFCR -Ocean thermal electric- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 OTINV -Ocean thermal electric- Investment (\$/Yr)
 OTFCT -Ocean thermal electric- Facility construction time (Year)
 OTPUC -Ocean thermal electric- Plants under construction (\$)

NOTE

OTPR.K=SECUF.K*OTPC.K 75820 A
 OTPR -Ocean thermal electric- Production rate (Btu/Yr)
 SECUF -Steam electric- Capacity utilization factor (Fraction)
 OTPC -Ocean thermal electric- Production capacity (Btu/Yr)

OTPC.K=OTPA.K/OTACC.K 75830 A
 OTPC -Ocean thermal electric- Production capacity (Btu/Yr)
 OTPA -Ocean thermal electric- Physical assets (\$)
 OTACC -Ocean thermal electric- Average capital cost (\$/(Btu/Yr))

OTACC.K=SMOOTH(OTCC.K,SEATPA) 75840 A
 OTACC -Ocean thermal electric- Average capital cost (\$/(Btu/Yr))
 SMOOTH -First order information delay
 OTCC -Ocean thermal electric- Capital cost (\$/(Btu/Yr))
 SEATPA -Steam electric- Averaging time for physical assets (Year)

OTCC.K=OTTDCC+OTCCP.K 75850 A
 OTTDCC=20E-6 75860 C
 OTCC -Ocean thermal electric- Capital cost (\$/(Btu/Yr))
 OTTDCC -Ocean thermal electric- Transmission and distribution capital cost (\$/(Btu/Yr))
 OTCCP -Ocean thermal electric- Capital cost of production plant (\$/(Btu/Yr))

OTCCP.K=TABHL(OTCCT,TIME.K,1950,2030,10)*1E-6*SENTM 75870 A
 OTCCT=171/171/171/171/65.59/51.33/51.33/51.33/51.33 75880 T
 OTCCP -Ocean thermal electric- Capital cost of production plant (\$/(Btu/Yr))
 TABHL -Tabular relationship
 OTCCT -Ocean thermal electric- Capital cost table (Table)
 TIME -Actual time during simulation
 SENTM -Steam electric- New technology cost multiplier (Dimensionless)

OTCST.K=OTPR.K*OTOMC 75890 A
 OTOMC=.75E-6 75900 C
 OTCST -Ocean thermal electric- Cost (\$/Yr)
 OTPR -Ocean thermal electric- Production rate (Btu/Yr)
 OTOMC -Ocean thermal electric- Operating and maintenance <O&M> cost (\$/Btu)

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 NOTE Biomass Utilities Subsector
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BMFA .K=BMFA .J+(DT)(BMFCR.JK-BMPAR.JK)

76000 L

BMFA=0

76010 N

BMFA -Biomass electric- Physical assets (\$)
 DT -Time increment between calculations
 BMFCR -Biomass electric- Facility completion rate (\$/Yr)
 BMPAR -Biomass electric- Physical asset retirements (\$/Yr)

BMPAR KL=BMFA K*BMARF

76020 R

BMARF=.011

76030 C

BMARF -Biomass electric- Physical asset retirements (\$/Yr)
 BMFA -Biomass electric- Physical assets (\$)
 BMARF -Biomass electric- Asset retirement factor (Fraction/Yr)

BMFCR.KL=DELAY3P(BMINV.JK BMFCT.BMPUC.K)

76040 R

BMFCT=5

76050 C

BMFCR -Biomass electric- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 BMINV -Biomass electric- Investment (\$/Yr)
 BMFCT -Biomass electric- Facility construction time (Year)
 BMPUC -Biomass electric- Plants under construction (\$)

NOTE

BNPR.K=SECUF.K*BNPC.K

BNPR -Biomass electric- Production rate (Btu/Yr)
SECUF -Steam electric- Capacity utilization factor (Fraction)
BNPC -Biomass electric- Production capacity (Btu/Yr)

76070 A

BNPC.K=BNPA.K/RNACC.K

BNPC -Biomass electric- Production capacity (Btu/Yr)
BNPA -Biomass electric- Physical assets (\$)
RNACC -Biomass electric- Average capital cost (\$/(Btu/Yr))

76080 A

BNACC.K=SMOOTH(BMCC.K,SEATPA)

BNACC -Biomass electric- Average capital cost (\$/(Btu/Yr))
SMOOTH -First order information delay
BMCC -Biomass electric- Capital cost (\$/(Btu/Yr))
SEATPA -Steam electric- Averaging time for physical assets (Year)

76090 A

BMCC.K=TDCC.K+BMCCP.K

BMCC -Biomass electric- Capital cost (\$/(Btu/Yr))
TDCC -Transmission and distribution- Capital cost (\$/(Btu/Yr))
BMCCP -Biomass electric- Capital cost of production plant (\$/(Btu/Yr))

76100 A

BMCCP.K=TABHL(BMCCT,TIME.K,1950,2030,10)*1E-6*SENTM

BMCCT=28.51/28.51/28.51/28.51/25.66/22.81/22.81/22.81/22.81

BMCCP -Biomass electric- Capital cost of production plant (\$/(Btu/Yr))
TABHL -Tabular relationship
BMCCT -Biomass electric- Capital cost table (Table)
TIME -Actual time during simulation
SENTM -Steam electric- New technology cost multiplier (Dimensionless)

76110 A

76120 T

BMCST.K=BNPR.K*(BNOMC+BNFCST.K)

BNOMC=1.75E-6

BNFCST -Biomass electric- Cost (\$/Yr)
BNPR -Biomass electric- Production rate (Btu/Yr)
BNOMC -Biomass electric- Operating and maintenance <OAM> cost (\$/Btu)
BNFCST -Biomass electric- Feedstock cost (\$/Btu)

76130 A

76140 C

BNFCST.K=BMP.K/RNCE

RNCE=.3

BNFCST -Biomass electric- Feedstock cost (\$/Btu)
BMP -Biomass electric- Price (\$/Btu)
RNCE -Biomass electric- Conversion efficiency (Dimensionless)

76150 A

76160 C

BMP.K=BMPN*BMPM.K

BMPN=1.00E-6

BMP -Biomass electric- Price (\$/Btu)
BMPN -Biomass electric- Price normal (\$/Btu)
BMPM -Biomass electric- Price markup (\$/Btu)

76170 A

76180 C

BMPM.K=TABHL(BMPMT,BNPC.K/BMMPC,0,1,1)

BMPMT=1/2

BMMPC=.12E15

BMPM -Biomass electric- Price markup (\$/Btu)
TABHL -Tabular relationship
BMPMT -Biomass electric- Price markup table (Table)
BNPC -Biomass electric- Production capacity (Btu/Yr)
BMMPC -Biomass electric- Mature production capacity (Btu/Yr)

76190 A

76200 T

76210 C

OTE

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 NOTE Solar Thermal Utilities Subsector
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STPA K=STPA.J+(DT)(STFCR.JK-STPAR.JK)

76310 L

STPA=0

76320 N

STPA -Solar thermal- Physical assets (\$)
 DT -Time increment between calculations
 STFCR -Solar thermal- Facility completion rate (\$/Yr)
 STPAR -Solar thermal- Physical asset retirements (\$/Yr)

STPAR.KL=STPA.K*STARF

76330 R

STARF=.011

76340 C

STPAR -Solar thermal- Physical asset retirements (\$/Yr)
 STPA -Solar thermal- Physical assets (\$)
 STARF -Solar thermal- Asset retirement factor (Fraction/Yr)

STFCR.KL=DELAY3P(STINV.JK STFCT STPUC.K)

76350 R

STFCT=5

76360 C

STFCR -Solar thermal- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 STINV -Solar thermal- Investment (\$/Yr)
 STFCT -Solar thermal- Facility construction time (Year)
 STPUC -Solar thermal- Plants under construction (\$)

NOTE

STPR.K=SECUF.K*STPC.K

76380 A

STPR -Solar thermal- Production rate (Btu/Yr)

SECUF -Steam electric- Capacity utilization factor (Fraction)

STPC -Solar thermal- Production capacity (Btu/Yr)

STPC.K=STPA.K/STACC.K

76390 A

STPC -Solar thermal- Production capacity (Btu/Yr)

STPA -Solar thermal- Physical assets (\$)

STACC -Solar thermal- Average capital cost (\$/(Btu/Yr))

STACC.K=SMOOTH(STCC.K,SEATPA)

76400 A

STACC -Solar thermal- Average capital cost (\$/(Btu/Yr))

SMOOTH -First order information delay

STCC -Solar thermal- Capital cost (\$/(Btu/Yr))

SEATPA -Steam electric- Averaging time for physical assets (Year)

STCC.K=TDCC.K+STCCP.K

76410 A

STCC -Solar thermal- Capital cost (\$/(Btu/Yr))

TDCC -Transmission and distribution- Capital cost (\$/(Btu/Yr))

STCCP -Solar thermal- Capital cost of production plant (\$/(Btu/Yr))

STCCP.K=TABHL(STCCT,TIME.K,1950,2030,10)*1E-6*SENTM

76420 A

STCCT=51.34/51.34/51.34/51.34/39.93/37.07/37.07/37.07/37.07

76430 T

STCCP -Solar thermal- Capital cost of production plant (\$/(Btu/Yr))

TABHL -Tabular relationship

STCCT -Solar thermal- Capital cost table (Table)

TIME -Actual time during simulation

SENTM -Steam electric- New technology cost multiplier (Dimensionless)

STCST.K=STPR.K*STOMC

76440 A

STOMC=.75E-6

76450 C

STCST -Solar thermal- Cost (\$/Yr)

STPR -Solar thermal- Production rate (Btu/Yr)

STOMC -Solar thermal- Operating and maintenance <O&M> cost (\$/Btu)

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 NOTE Wind Electric Subsector
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WEPA.K-WEPA J+(DT)(WEFCR.JK-WEPAR.JK)

76550 L

WEPA=0

76560 N

WEPA -Wind electric- Physical assets (\$)
 DT -Time increment between calculations
 WEFCR -Wind electric- Facility completion rate (\$/Yr)
 WEPAR -Wind electric- Physical asset retirements (\$/Yr)

WEPAR.KL-WEPA.K*WEARF

76570 R

WEARF=.011

76580 C

WEPAR -Wind electric- Physical asset retirements (\$/Yr)
 WEPA -Wind electric- Physical assets (\$)
 WEARF -Wind electric- Asset retirement factor (Fraction/Yr)

WEFCR.KL-DELAY3P(WEINV JK.WEFCT WEPUC K)

76590 R

WEFCT=5

76600 C

WEFCR -Wind electric- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 WEINV -Wind electric- Investment (\$/Yr)
 WEFCT -Wind electric- Facility construction time (Year)
 WEPUC -Wind electric- Plants under construction (\$)

NOTE

WEPR.K=SECUF.K*WEPC.K 76620 A
 WEPR -Wind electric- Production rate (Btu/Yr)
 SECUF -Steam electric- Capacity utilization factor (Fraction)
 WEPC -Wind electric- Production capacity (Btu/Yr)

WEPC.K=WEPA.K/WEACC.K 76630 A
 WEPC -Wind electric- Production capacity (Btu/Yr)
 WEPA -Wind electric- Physical assets (\$)
 WEACC -Wind electric- Average capital cost (\$/(Btu/Yr))

WEACC.K=SMOOTH(WECC.K,SEATPA) 76640 A
 WEACC -Wind electric- Average capital cost (\$/(Btu/Yr))
 SMOOTH -First order information delay
 WECC -Wind electric- Capital cost (\$/(Btu/Yr))
 SEATPA -Steam electric- Averaging time for physical assets (Year)

WECC.K=TDCC.K+WECCP.K 76650 A
 WECC -Wind electric- Capital cost (\$/(Btu/Yr))
 TDCC -Transmission and distribution- Capital cost (\$/(Btu/Yr))
 WECCP -Wind electric- Capital cost of production plant (\$/(Btu/Yr))

WECCP.K=TABUL(WECCT,TIME.K,1950,2030,10)*1E-6*SENTM 76660 A
 WECCT=37/37/37/37/28.52/21.39/21.39/21.39/21.39 76670 T
 WECCP -Wind electric- Capital cost of production plant (\$/(Btu/Yr))
 TABUL -Tabular relationship
 WECCT -Wind electric- Capital cost table (Table)
 TIME -Actual time during simulation
 SENTM -Steam electric- New technology cost multiplier (Dimensionless)

WECST.K=WEPR.K*WEOMC 76680 A
 WEOMC=2.5E-6 76690 C
 WECST -Wind electric- Cost (\$/Yr)
 WEPR -Wind electric- Production rate (Btu/Yr)
 WEOMC -Wind electric- Operating and maintenance <O&M> cost (\$/Btu)

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Nuclear Utilities Light Water Reactor Subsector

LWPA.K=LWPA J+(DT)(LWFCR.JK-LWPAR.JK)
LWPA=0

76790 L
76800 N

LWPA -Light water nuclear electric- Physical assets (\$)
DT -Time increment between calculations
LWFCR -Light water nuclear electric- Facility completion rate (\$/Yr)
LWPAR -Light water nuclear electric- Physical asset retirements (\$/Yr)

LWPAR KL=LWPA.K*LWARF
LWARF=.011

76810 R
76820 C

LWPAR -Light water nuclear electric- Physical asset retirements (\$/Yr)
LWPA -Light water nuclear electric- Physical assets (\$)
LWARF -Light water nuclear electric- Asset retirement factor (Fraction/Yr)

LWFCR KL=DELAY3P(LWINV.JK NUFCT.K.LWPUC.K)

76830 R

LWFCR -Light water nuclear electric- Facility completion rate (\$/Yr)
DELAY3P -Third order pipeline material delay
LWINV -Light water nuclear electric- Investment (\$/Yr)
NUFCT -Nuclear utilities- Facility construction time (Year)
LWPUC -Light water nuclear electric- Plants under construction (\$)

NUFCT.K=TABHL(NUFCTT,(TIME.K-NUCDCY)/NUCDCT.0.1.1)
NUFCTT=10/14
NUCDCT=5
NUCDCY=1980

76840 A
76850 T
76860 C
76870 C

NUFCT -Nuclear utilities- Facility construction time (Year)
TABHL -Tabular relationship
NUFCTT -Nuclear utilities- Facility construction time table (Table)
TIME -Actual time during simulation
NUCDCY -Nuclear utilities- Construction delay change year (Year)
NUCDCT -Nuclear utilities- Construction delay change implementation time (Year)

NOTE

LWPR.K=SECUF.K*LWPC.K

76890 A

LWPR -Light water nuclear electric- Production rate (Btu/Yr)
SECUF -Steam electric- Capacity utilization factor (Fraction)
LWPC -Light water nuclear electric- Production capacity (Btu/Yr)

LWPC.K=LWPA.K/LWACC.K

76900 A

LWPC -Light water nuclear electric- Production capacity (Btu/Yr)
LWPA -Light water nuclear electric- Physical assets (\$)
LWACC -Light water nuclear electric- Average capital cost (\$/(Btu/Yr))

LWACC.K=SMOOTH(LWCC.K,SEATPA)

76910 A

LWACC -Light water nuclear electric- Average capital cost (\$/(Btu/Yr))

SMOOTH -First order information delay

LWCC -Light water nuclear electric- Capital cost (\$/(Btu/Yr))

SEATPA -Steam electric- Averaging time for physical assets (Year)

LWCC.K=TDCC.K+LWCCP.K

76920 A

LWCC -Light water nuclear electric- Capital cost (\$/(Btu/Yr))

TDCC -Transmission and distribution- Capital cost (\$/(Btu/Yr))

LWCCP -Light water nuclear electric- Capital cost of production plant (\$/(Btu/Yr))

LWCCP.K=TABHL(LWCCT,TIME.K,1950,2030,10)*1E-6

76930 A

LWCCT=40/14.5/8.5/19/26.5/26.5/26.5/26.5/26.5

76940 T

LWCCP -Light water nuclear electric- Capital cost of production plant (\$/(Btu/Yr))

TABHL -Tabular relationship

LWCCT -Light water nuclear electric- Capital cost table (Table)

TIME -Actual time during simulation

LWCST.K=LWPR.K*(LWOMC+LWFCST.K)

76950 A

LWOMC=.38E-6

76960 C

LWCST -Light water nuclear electric- Cost (\$/Yr)

LWPR -Light water nuclear electric- Production rate (Btu/Yr)

LWOMC -Light water nuclear electric- Operating and maintenance <OAM> cost (\$/Btu)

LWFCST -Light water nuclear electric- Feedstock cost (\$/Btu)

LWFCST.K=LWEEFF.K*RFP.K/LWCE

76970 A

LWCE=.32

76980 C

LWFCST -Light water nuclear electric- Feedstock cost (\$/Btu)

LWEEFF -Light water nuclear electric- Excess fuel factor (Fraction)

RFP -Reactor fuel- Price (\$/Btu)

LWCE -Light water nuclear electric- Conversion efficiency (Dimensionless)

LWDRF.K=LWEEFF.K*(LWPC.K*SECUF.K)/LWCE

76990 R

LWDRF -Light water nuclear electric- Demand for reactor fuel (Btu/Yr)

LWEEFF -Light water nuclear electric- Excess fuel factor (Fraction)

LWPC -Light water nuclear electric- Production capacity (Btu/Yr)

SECUF -Steam electric- Capacity utilization factor (Fraction)

LWCE -Light water nuclear electric- Conversion efficiency (Dimensionless)

LWEEFF.K=CLIP(1,LWEEFN,TIME.K,UFRY)

77000 A

LWEEFN=1.36

77010 C

UFRY=1985

77020 C

LWEEFF -Light water nuclear electric- Excess fuel factor (Fraction)

CLIP -Function switched during the run

LWEEFN -Light water nuclear electric- Excess fuel factor normal (Fraction)

TIME -Actual time during simulation

UFRY -Uranium fuel- Reprocessing initiation year (Year)

NOTE

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 NOTE Nuclear Utilities Liquid Metal Breeder Reactor Subsector
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BNPA.K-BNPA.J+(DT)(BNFCR.JK-BNPAR.JK) 77120 L
 BNPA=0 77130 N

BNPA -Breeder nuclear electric- Physical assets (\$)
 DT -Time increment between calculations
 BNFCR -Breeder nuclear electric- Facility completion rate (\$/Yr)
 BNPAR -Breeder nuclear electric- Physical asset retirements (\$/Yr)

BNPAR.KL-BNPA.K*BNARF 77140 R
 BNARF=.011 77150 C

BNPAR -Breeder nuclear electric- Physical asset retirements (\$/Yr)
 BNPA -Breeder nuclear electric- Physical assets (\$)
 BNARF -Breeder nuclear electric- Asset retirement factor (Fraction/Yr)

BNFCR.KL=DELAY3P(BNINV.JK NUFCT.K BNPUC.K) 77160 R

BNFCR -Breeder nuclear electric- Facility completion rate (\$/Yr)
 DELAY3P -Third order pipeline material delay
 BNINV -Breeder nuclear electric- Investment (\$/Yr)
 NUFCT -Nuclear utilities- Facility construction time (Year)
 BNPUC -Breeder nuclear electric- Plants under construction (\$)

NOTE

BNPR.K-SECUF.K*BNPC K 77180 A

BNPR -Breeder nuclear electric- Production rate (Btu/Yr)
 SECUF -Steam electric- Capacity utilization factor (Fraction)
 BNPC -Breeder nuclear electric- Production capacity (Btu/Yr)

BNPC K-BNPA.K/BNACC K 77190 A

BNPC -Breeder nuclear electric- Production capacity (Btu/Yr)
 BNPA -Breeder nuclear electric- Physical assets (\$)
 BNACC -Breeder nuclear electric- Average capital cost (\$/(Btu/Yr))

BNACC.K=SMOOTH(BNCC.K,SEATPA)

77200 A

BNACC -Breeder nuclear electric- Average capital cost (\$/(Btu/Yr))
SMOOTH -First order information delay
BNCC -Breeder nuclear electric- Capital cost (\$/(Btu/Yr))
SEATPA -Steam electric- Averaging time for physical assets (Year)

BNCC.K=TDCC.K+BNCCP

77210 A

BNCCP=24.9E-6

77220 C

BNCC -Breeder nuclear electric- Capital cost (\$/(Btu/Yr))
TDCC -Transmission and distribution- Capital cost (\$/(Btu/Yr))
BNCCP -Breeder nuclear electric- Capital cost of production plant (\$/(Btu/Yr))

BNCST.K=BNPR.K*(BNOMC+BNFCST.K)

77230 A

BNOMC=.31E-6

77240 C

BNCST -Breeder nuclear electric- Cost (\$/Yr)
BNPR -Breeder nuclear electric- Production rate (Btu/Yr)
BNOMC -Breeder nuclear electric- Operating and maintenance <O&M> cost (\$/Btu)
BNFCST -Breeder nuclear electric- Feedstock cost (\$/Btu)

BNFCST.K=BNRFAF*BNEFF*RFP.K/BNCE

77250 A

BNCE=.4

77260 C

BNFCST -Breeder nuclear electric- Feedstock cost (\$/Btu)
BNRFAF -Breeder nuclear electric- Reactor fuel annualization factor (Fraction/Yr)
BNEFF -Breeder nuclear electric- Excess fuel factor (Fraction)
RFP -Reactor fuel- Price (\$/Btu)
BNCE -Breeder nuclear electric- Conversion efficiency (Dimensionless)

BNDRF.KL=BNEFF*BNFCR.JK*BNCUFP/(BNCC.K*BNCE)

77270 R

BNEFF=3

77280 C

BNRFAF=.10

77290 C

BNDRF -Breeder nuclear electric- Demand for reactor fuel (Btu/Yr)
BNEFF -Breeder nuclear electric- Excess fuel factor (Fraction)
BNFCR -Breeder nuclear electric- Facility completion rate (\$/Yr)
BNCUFP -Breeder nuclear electric- Capacity utilization factor for planning (Fraction)
BNCC -Breeder nuclear electric- Capital cost (\$/(Btu/Yr))
BNCE -Breeder nuclear electric- Conversion efficiency (Dimensionless)
BNRFAF -Breeder nuclear electric- Reactor fuel annualization factor (Fraction/Yr)

NOTE

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 NOTE Nuclear Fuel Production Subsector
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RFR.K=RFR J+(DT)(PFRR JK-LWDRF.JK-BNDRF.JK-RFED.JK)
 RFR=RFRI
 RFRI=4.2E18

77390 L
 77400 N
 77410 C

RFR -Reactor fuel- Resources (Btu)
 DT -Time increment between calculations
 PFRR -Plutonium fuel- Recycle rate (Btu/Yr)
 LWDRF -Light water nuclear electric- Demand for reactor fuel (Btu/Yr)
 BNDRF -Breeder nuclear electric- Demand for reactor fuel (Btu/Yr)
 RFED -Reactor fuel- Export demand (Btu/Yr)
 RFRI -Reactor fuel- Resources initial (Btu)

NOTE

RFED.KL=TABHL(RFEDT.TIME.K,1950,2030,10)*1E15
 RFEDT=0/0/0/0/0/0/0/0/0

77430 R
 77440 T

RFED -Reactor fuel- Export demand (Btu/Yr)
 TABHL -Tabular relationship
 RFEDT -Reactor fuel- Export demand table (Table)
 TIME -Actual time during simulation

NOTE

PFRR.KL=(LWTFCR K+BNTFCR.K)*(STEP(1 BNCY)-STEP(1 BNMY))

77460 R

PFRR -Plutonium fuel- Recycle rate (Btu/Yr)
 LWTFCR -Light water nuclear electric- Total fuel conversion rate (Btu/Yr)
 BNTFCR -Breeder nuclear electric- Total fuel conversion rate (Btu/Yr)
 STEP -Step-shaped exogenous input
 BNCY -Breeder nuclear electric- Commercialization year (Year)
 BNMY -Breeder nuclear electric- Moratorium initiation year (Year)

LWTFCR.K=LWBR*LWPR.K/LWCE
 LWBR= 27

77470 A
 77480 C

LWTFCR -Light water nuclear electric- Total fuel conversion rate (Btu/Yr)
 LWBR -Light water nuclear electric- Breeding ratio (Dimensionless)
 LWPR -Light water nuclear electric- Production rate (Btu/Yr)
 LWCE -Light water nuclear electric- Conversion efficiency (Dimensionless)

BNTFCR.K=BNBR*BNPR.K/BNCE
 BNBR=.30

77490 A
 77500 C

BNTFCR -Breeder nuclear electric- Total fuel conversion rate (Btu/Yr)
 BNBR -Breeder nuclear electric- Breeding ratio (Dimensionless)
 BNPR -Breeder nuclear electric- Production rate (Btu/Yr)
 BNCE -Breeder nuclear electric- Conversion efficiency (Dimensionless)

NOTE

RFP.K=RFP.R.K+RFP.M.K

RFP -Reactor fuel- Price (\$/Btu)
RFP.R -Reactor fuel- Production rate (Btu/Yr)
RFP.M -Reactor fuel- Price markup (\$/Btu)

77520 A

RFP.R.K=TABLE(RFP.R.T.RFP.R.K/RFP.R.I.O 1.1)*1E-6

RFP.R.T=1.93/1.93/1.83/1.68/1.52/1.22/1.76/.65/.50/.44/.33

RFP.R -Reactor fuel- Production rate (Btu/Yr)
TABLE -Tabular relationship
RFP.R.T -Reactor fuel- Production rate table (Table)
RFP.R -Reactor fuel- Resources (Btu)
RFP.R.I -Reactor fuel- Resources initial (Btu)

77530 A

77540 T

RFP.M.K=TABHL(RFP.M.T.TIME.K 1950 2030 10)*1E-6

RFP.M.T=0/0/0/.22/.32/.32/ 32/.32/.32

RFP.M -Reactor fuel- Price markup (\$/Btu)
TABHL -Tabular relationship
RFP.M.T -Reactor fuel- Price markup table (Table)
TIME -Actual time during simulation

77550 A

77560 T

NOTE

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 NOTE Hydropower Utilities Subsector
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HEPR-K-TABHL(HEPRT TIME.K,1950,2030,10)*1E15

HEPRT- 33/.50/.84/1 10/1.22/1.45/1 56/1.66/1.66

HEPR -Hydro electric- Production rate (Btu/Yr)

TABHL -Tabular relationship

HEPRT -Hydro electric- Production rate table (Table)

TIME -Actual time during simulation

NOTE

77660 A

77670 T

NOTE
 NOTE *****
 NOTE
 NOTE Hydrothermal Utilities subsector
 NOTE
 NOTE *****
 NOTE

HTPR K-TABHL(HTPRT.TIME.K,1950.2030.10)*1E15

77760 A

HTPRT=0/0/0/0/0/0/0/0

77770 T

HTPR -Hydrothermal electric- Production rate (Btu/Yr)
 TABHL -Tabular relationship
 HTPRT -Hydrothermal electric- Production rate table (Table)
 TIME -Actual time during simulation

NOTE

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 NOTE Supplementary Equations for Total Demand For Coal
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TEDC.K=NCDC.K+ECDC.K+FBDC.K+CCDC.K

77870 A

TEDC -Total electric- Demand for coal (Btu/Yr)
 NCDC -Non-Emission controlled coal- Demand for coal (Btu/Yr)
 ECDC -Emission controlled coal- Demand for coal (Btu/Yr)
 FBDC -Fluidized bed coal electric- Demand for coal (Btu/Yr)
 CCDC -Combined cycle coal electric- Demand for coal (Btu/Yr)

NOTE

[illegible]

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OPEC Pricing Sector of FOSSIL2

Department of Energy
Energy Transition Project

Version Release Date:
March 1980

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OOPDR.K=1
 OOPDR -OPEC oil- Production demand ratio (Dimensionless) 80160 A

OOP.K=MAX(OOPPB.K/(1.416*5.8E6),.90E-6) 80170 A
 OOP -OPEC oil- Price (\$/Btu)
 MAX -Function selecting the larger of two values
 OOPPB -OPEC oil- Price per barrel (\$/Bbl)

OOPPB.K=CLIP(OOPA79.K,(7.12+STEP(10.38,1973)),TIME.K,1979) 80180 A
 OOPPB -OPEC oil- Price per barrel (\$/Bbl)
 CLIP -Function switched during the run
 OOPA79 -OPEC oil- Price alternative in 1979 (\$/Bbl)
 STEP -Step-shaped exogenous input
 TIME -Actual time during simulation

OOPA79.K=CLIP(OOP32.K,OOP1.K,PCASE,2) 80190 A
 OOPA79 -OPEC oil- Price alternative in 1979 (\$/Bbl)
 CLIP -Function switched during the run
 OOP32 -OPEC oil- Switch for pricing policy (Dimensionless)
 OOP1 -OPEC oil- Low price scenario (\$/Bbl)
 PCASE -Price case (Dimensionless)

OOP32.K=CLIP(OOP3.K,OOP2.K,PCASE,3) 80200 A
 OOP32 -OPEC oil- Switch for pricing policy (Dimensionless)
 CLIP -Function switched during the run
 OOP3 -OPEC oil- High price scenario (\$/Bbl)
 OOP2 -OPEC oil- Mid price scenario (\$/Bbl)
 PCASE -Price case (Dimensionless)

OOP1.K=TABHL(OOP1T,TIME.K,1980,2020,5) 80210 A
 OOP1T=25/25/30/32.5/35/36.25/37.5/38.75/40 80220 T
 OOP1 -OPEC oil- Low price scenario (\$/Bbl)
 TABHL -Tabular relationship
 OOP1T -OPEC oil- Low price scenario price table (Table)
 TIME -Actual time during simulation

OOP2.K=TABHL(OOP2T,TIME.K,1980,2020,5) 80230 A
 OOP2T=30/35/40/42.5/45/46.75/47.5/48.75/50 80240 T
 OOP2 -OPEC oil- Mid price scenario (\$/Bbl)
 TABHL -Tabular relationship
 OOP2T -OPEC oil- Mid price scenario price table (Table)
 TIME -Actual time during simulation

OOP3.K=TABHL(OOP3T,TIME.K,1980,2020,5) 80250 A
 OOP3T=35/45/50/52.5/55/56.75/57.5/58.75/60 80260 T
 PCASE=2 80270 C
 OOP3 -OPEC oil- High price scenario (\$/Bbl)
 TABHL -Tabular relationship
 OOP3T -OPEC oil- High price scenario price table (Table)
 TIME -Actual time during simulation
 PCASE -Price case (Dimensionless)

APPENDIX

INTRODUCTION

DYNAMO is a continuous simulation language developed by the System Dynamics Group at the Massachusetts Institute of Technology in the late 1950's. Although initially intended for use in models of industrial, social, and economic systems, DYNAMO permits the succinct expression of any complex system that may be described in terms of differential equations. It has therefore also been used extensively in the study of biological and environmental systems.

The differential equations of the DYNAMO model specify the rates of flow into and out of the levels, or state variables, of the system. When the model is run on the computer, these equations are integrated over time, simulating the dynamic interaction of the variables in the system. Time delays, feedback, and nonlinear causal relationships -- all properties of complex systems -- are readily represented using DYNAMO. The language also facilitates the determination of the system's relative sensitivity to changes in its parameters or exogenous inputs.

DYNAMO has been designed for use by a person who has some acquaintance with calculus. A sophisticated knowledge of programming or of the particular computer's operating system is generally not required to model a variety of complex systems using DYNAMO. The language is not complicated; once the way DYNAMO advances through time and integrates the system equations is understood, the modeler is free to concentrate on the conceptualization of the problem and construction of the model.

2. DYNAMO EQUATIONS AND FUNCTIONS

2.1 EQUATION TYPES

DYNAMO equations are written in the following form:

Line number	Variable type	Variable Name	=	Mathematical Expression
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- The variable type is a single letter designating the kind of variable being defined by the equation:

L - LEVEL equation

R - RATE equation

A - AUXILIARY equation

N - INITIAL-VALUE equation (of a LEVEL or an
AUXILIARY equation)

C - CONSTANT

T - TABLE

- The variable name is the unique abbreviation for the specific variable that is defined by the equation. The variable name must be followed by the appropriate time postscript. Levels and auxiliaries have the postscript .K; rates have the postscript .JK or .KL. Initial values, constants, and tables do not have time subscripts.
- The mathematical expression defining a variable may range from a single number or variable to a quite complicated combination of terms. The operations of addition, subtraction, multiplication, and division are indicated, respectively, by +, -, *, and /. Multiplication and division are carried out before addition and subtraction. Expressions enclosed in parentheses are evaluated first, and the value is substituted for the parenthetical expression. The sine function, natural log (base E), exponential function, and a number of unique DYNAMO functions such as CLIP, SWITCH, RAMP, NOISE, MIN, and MAX can be used in DYNAMO equations (with some restrictions as discussed below).

2.1.1 Level Equation

A level equation defines the present value of a level variable in terms of its value from the previous evaluation and its change in value in the intervening time increment, DT. The level changes in a time period DT by an amount equivalent to the sum of all rates flowing into (positive) or out of (negative) the level. Numerical instabilities are avoided by setting DT to be a small fraction of the shortest time delay in the model. The following equations for shale oil resources (SHR) is an example of a level equation:

where: L $SHR.K = (SHR.J) + (DT) * (-SHDR.JK)$

SHR.K = the value of SHR at the present time K

SHR.J = the value of SHR at the previous time of evaluation, J, DT time units before the present

DT = the length of the computation interval
(in any desired time units)

SHDR.JK = the rate of change of SHR over the interval DT (from time J to time K), in this case the shale oil depletion rate.

SHDR.JK is preceded by a negative sign, which means that it decreases the value of the level over time. In the simple numerical integration scheme (Euler's Method) used by DYNAMO, the rate of change is assumed to be constant during the small time interval DT.

2.1.2 Rate Equation

A rate equation describes how the rate of flow to or from a level changes, depending on other conditions (variables) in the system. The expression in the rate equation may contain constants, auxiliaries, and levels, and it may use any other of the algebraic and DYNAMO functions available in the DYNAMO compiler. The auxiliaries and levels used in rate equations are written in terms of their values at the present time, represented by the postscript .K. For example, the equation for shale oil capital depreciation rate (SHCD) is:

$$R \quad SHCD.KL = SHCAP.K / SHALC \quad (2.1.2)$$

In the example, the rate SHCD.KL is defined as the division of a level, SHCAP.K, shale oil capital stocks (\$), by a constant, SHALC, average lifetime of capital (years). Every rate variable such as SHCD above is given the postscript .KL if it appear on the left side of an equation, and the postscript .JK if it appears on the right.

2.1.3 Auxiliary Equation

An auxiliary equation defines a component of a rate equation. Rates are separated algebraically into auxiliaries to clarify their structure, i.e., all auxiliary variables could be directly substituted back into rate equations, making them dependent exclusively on levels and constants. Auxiliaries are separated from rate equations only if they represent real-world quantities or concepts, and if they add to the clarity of the system description. An auxiliary equation can contain constants, functions (including table functions), levels, and other auxiliaries. The variable defined in an auxiliary equation always receives the postscript .K.

2.1.4 Initial-Value Equation

An initial-value equation defines the value of a level at the beginning of the simulated time period. The variable name in such an equation is always the initialized level, but it does not contain postscripts. The right-hand side of an initial-value equation can be a number, the variable name of a constant, or a combination of these terms. No terms with postscripts should appear on the right side of an initial-value equation. An example of a level and corresponding initial-value equation is:

$$L \text{ SHR.K} = \text{SHR.J} + (\text{DT}) * (-\text{SHDR.JK}) \quad (2.1.4)$$

$$N \text{ SHR} = 5800\text{E}15 \quad (2.1.4)$$

One initial-value equation must appear for every level equation in a DYNAMO model.

2.1.5 Constant Equation

A constant equation defines the numerical value of a constant. The value must be given explicitly by the programmer. No variables (constant, auxiliary, rate, or other) can appear on the right side of a constant equation. An example would be:

$$C \text{ SH MC} = .65\text{E} - 6 \quad (2.1.4)$$

2.1.6 Table Equation

A tabular equation lists the numerical values of a dependent variable as a function of an independent variable over a specified range. The independent variable and its range are specified in an auxiliary equation preceding the table, as in the following example:

$$A \quad SHDMD.K = TABLE(SHDMDT, SHFRR.K, 0, 1, .2) \quad (2.1.6)$$

$$T \quad SHDMDT = 0/.05/.18/.32/.60/1.0 \quad (2.1.6)$$

The auxiliary equation defines the variable SHDMD, shale oil depletion multiplier, as a table function of SHFRR, shale oil fraction resource remaining. It further specifies that the table SHDMDT gives the value of SHDMD for corresponding values of the independent variable, SHFRR, between 0 and 1 at intervals of 0.2. Equation SHDMDT specifies the values of SHDMD corresponding to each 0.2 increase in the value of SHFRR. For example, when SHFRR = .2, SHDMD = .05, and when SHFRR = 0.6, SHDMD = .32. Since SHFRR.K is the value of a continuously variable quantity, its value may not be exact multiples of 0.2. For odd values of SHFRR.K, DYNAMO linearly interpolates between the adjacent values from the SHDMDT Table. When SHFRR is less than 0 (the lower limit of the table), DYNAMO uses the first value of SHDMD specified in the table (namely, 0); when SHFRR.K is greater than 1, it uses the last value of SHDMD.

2.1.7 Specification Statement

The specification statement is identified by the letters SPEC. It contains information about the length of the time increment DT, the time interval between plotted variables PLTPER, the time horizon of the model (specified by the end time of the simulation LENGTH), and the time period between variables points PRTPER. A SPEC statement could be:

$$SPEC \quad DT = .5/PLTPER = 2/LENGTH = 2000/PRTPER = 5 \quad (2.1.6)$$

In the example, DT was chosen to be .5 time units (years, in FOSSIL2). DT can be set to any fraction or multiple of a year; it is usually set small enough to avoid computational instabilities (generally less than

one-third the length of the shortest delay in the model), yet large enough to minimize the computing time for a model run. The quantities to be plotted are defined by a PLOT statement (described in the next section). PLTPER was set to two time units in the preceding example, so that only the values at every second time unit (year) are actually plotted.

The LENGTH specification can take two forms. The internal variable, TIME, can be initialized by the programmer; for example:

N TIME = 1950. (2.1.7)

Here, LENGTH = 2000 means that the run proceeds until TIME = 2000, that is, for 50 time units. If TIME is not explicitly initialized, the computer supplies the initial value, TIME = 0, and the LENGTH specification then defines the number of time units for the run. PRTPER was set at five years, so values of output variables for every fifth year are printed.

2.1.8 PLOT Statement

The variables whose values are to be plotted in graphical output are specified in a PLOT statement, which gives both the symbol (chosen by the user) representing the variable in the plot and the range of values to be plotted.

PLOT SHCAP = C, SHPC = P/TOPDR = & (0,1)/ (2.1.7)

X GNP = G(0, 5.6E13) (2.1.7)

For example, SHCAP = C means that SHCAP is plotted using the symbol C. By omitting a scale specification for SHCAP and SHPC, the user allows the DYNAMO compiler to set the plot scale's upper and lower limits. The range of SHCAP and SHPC are set so that all values of SHCAP and SHPC that occur in a run are included in the graph. The specification GNP = G(0, 5.6E13) means that GNP is plotted on a scale from 0 to 5.6×10^{13} . Values of GNP outside this range do not appear on the graphical output. A comma or slash is needed to separate each variable, as in the above example. If a comma is used, the preceding variable will be plotted on

the same scale as the subsequent variable. Thus, in the example, SHCAP and SHPC will be plotted on the same scale. A slash is used to delimit variables that are to be plotted on different scales. In the example, the line initiated with an X represents a "continuation line." All information on such a line is assumed to be a direct continuation of the equation or statement immediately preceding it.

2.2 SPECIAL FUNCTIONS

2.2.1 DELAYS

Representation of a time lag or delay is often critical to the success of a dynamic model of a social system. Complex social systems do not respond immediately or completely to changing conditions and inputs, and DYNAMO offers a mechanism to represent different kinds of delays accurately and explicitly. Delays have two dynamically significant characteristics. First, a delay postpones to a later time the full effect of a change in the input function. The average displacement in time is determined by the delay "time constant," which may be either a constant or an auxiliary. Second, a delay modifies the time shape of an input (a distributed time lag). For example, a sudden increase in the input to a delay will be followed by a more gradual increase in the delay output.

Information Delays

The information delays available in DYNAMO represent a smoothing, or exponential averaging, of information about a variable, where the greatest weight is given to the most recent value of the variable and proportionately less weight is given to older information about the variable. This averaging procedure is often used to represent an intuitive averaging process in which the freshest, most recent events influence decisions more than the hazy recollections of past events. Dynamically, the smoothing process filters out rapid, noisy fluctuations, while only slightly modifying long-term trends. The attenuation of fluctuations is more severe as the time constant increases (see Figure A-1).

Figure A-1: Responses of Varying First-Order Information Delays to a Sinusoidal Input

The two information delay structures, or macros, provided in DYNAMO are SMOOTH and DLINF3. In the equation below, X is the input to the delay; it may be a level, a rate, or an auxiliary. AX is the output of the delay, representing the averaged, smoothed, or delayed value of X, with the same dimensional units as X. AT is the averaging time, which may be a constant or an auxiliary. The DYNAMO equations for these information delays are:

$$A \quad AX.K = \text{SMOOTH}(X.K, AT) \quad (2.2.1)$$

$$A \quad AX.K = \text{DLINF3}(S.K, AT) \quad (2.2.1)$$

SMOOTH is a first-order delay containing one internal level; DLINF3 is a third-order delay with three internal levels. For details of the internal equations generated by DYNAMO to give the output variable, see Forrester 1961, Forrester 1968, or DTSS 1975.

The time response of first- and third-order delays to a given input is qualitatively different, although there is no difference between the time response of information or material delays of the same order with the same time constant. Their responses to PULSE, STEP, and RAMP inputs are shown in Figure A-2. Note that a first-order delay gives a finite response in the next DT after the change in input, whereas a third-order delay does not respond immediately but ultimately adjusts more rapidly to the same input change. A third-order delay is a cascaded series of three first-order delays. Higher-order delays can be created similarly by using first- and third-order delays in series.

It can be seen from Figure A-2 that the outputs of the delay functions have almost fully adjusted to the changed inputs after a time of about 3AT. Thus, loosely speaking, 3AT is the delay between a change in the input and the completed response to that change. AT is the average response time of the output to the change in the input.

Figure A-2: Response of First- and Third-Order Delays to PULSE, STEP, and RAMP Inputs

Material Delays

Material delays change the time shape of material flows. The input to a material delay is always a material flow rate. The output is also a rate. Two material delay macros available in DYNAMO are DELAY1 and DELAY3. The former is a first-order delay; the latter is a third-order delay. The input rates in both examples are X. The output rates are the delayed values of X, XD. The adjustment time in both cases is AT, which may be a constant or a variable.

The DYNAMO equations for the delays are:

$$A \quad XD.KL = DELAY1 (X.JK, AT) \quad (2.2.1)$$

$$A \quad XD.KL = DELAY3 (X.JK, AT) \quad (2.2.1)$$

The time response of material delays to different inputs is the same as that for information delays (see Figure A-2) when the adjustment time AT is constant. Further details about the internal structure of the macros generated by the DYNAMO compiler to produce these delays can be found in Forrester 1961, Forrester 1968, Pugh 1970, and DTSS 1975. DELAY3 is used often in FOSSIL2 to represent construction delays in which investment funds do not result in finished production facilities until after a fixed time.

Often it is desirable to know the inventory contents within a material delay. This can be accomplished by writing:

$$AXD.KL = DELAY3P(X.JK, AT, XD.K) \quad (2.2.1)$$

where XC is an output variable which embodies the value of the delay's inventory.

2.2.2 Other Functions

CLIP. The CLIP function is one of several special functions available in DYNAMO. It is used to switch the functional dependence of a variable between two other variables at a specified time.

$$A \quad TGXT.K = CLIP (TGPXT, TGHXT, TIME.K, TGXTY) \quad (2.2.2)$$

As in the above example, the CLIP function has four arguments and should be read as follows: TGXT has the value TGHXT until TIME.K is greater than or equal to TGXTY, in which case TGXT switches to TGPXT and remains there for the duration of the run. This function is commonly used to initiate policy changes in specific years. An equation using a CLIP function must be either a rate or an auxiliary equation. However, any of the four arguments of the CLIP may be a rate, auxiliary, level, or constant. The third argument does not have to be TIME.K, and the fourth does not have to be a year. Other DYNAMO special functions such as the MIN, MAX, SWITCH, COS (cosine), SIN (sine), LOGN (natural log), NOISE, and PULSE functions are described in DTSS 1975.

APPENDIX - REFERENCES

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