Appendix A-1: Summary of changes to the CEF-NEMS model for the Buildings Sector.

We modified the AEO99 Version of NEMS to create CEF-NEMS Scenarios for the buildings sector. Copies of all modified source code and input files are available at ftp://ftp.eap.lbl.gov/CEF-NEMS/drafts/v11.991213/inputs/

Residential Sector

For the residential sector, detailed off-line analysis is used to estimate the policy induced energy savings potential. We then change hurdle rates, technology costs, and growth trends in CEF-NEMS in order to match the stand-alone mode CEF-NEMS forecast to the energy savings results from our detailed spreadsheet analysis. The assumptions and results for the spreadsheet analysis are contained in Appendices B-1, C-1, and D-1.

The changes implemented to recreate the off-line energy savings estimates in the Residential Module of CEF-NEMS are listed below. In this section, source code modifications are explicitly listed and input file changes are summarized.

Source code modifications were made to the Residential Module in the following areas:

(1) Furnace fan electricity consumption

(2) TV electricity consumption

(3) Lighting electricity consumption

(4) Other electricity consumption (in coils, motors, and electronics sub-categories)

(5) New home thermal shell indices

(6) Price-induced discount rate changes

(7) A new Distributed Generation subroutine that adds solar photovoltaic, fuel cell, and microturbine technology to the module

Input file modifications were made to the Residential Module in the following areas[1]:

(1) minimum efficiency standards

(2) technology choice implicit discount rates[2]

(3) technology characteristics (capital costs, operating costs, and efficiencies)

---

[1] The RTEK "includes" file was modified to accommodate a larger rtekty technology input file.

[2] The implicit discount rate is defined as the ratio of the Beta1 and Beta2 logit parameters used in the residential module to determine technology choice.

Detailed Source Code Changes

(1) Furnace fan electricity consumption

Advanced Scenario

We created an energy consumption multiplier to calibrate energy consumption to off-line analysis estimates in 2010 and 2020. The multiplier is set to 1.0 in 2000 and allowed to decline by a constant rate (0.2%/year) between 2001 and 2010 such that in a stand-alone run the resulting energy consumption in 2010 is equivalent to that predicted off-line. Similarly, the 2010 multiplier value is allowed to decline by a constant rate (1.5%/year) between 2011 and 2020 such that in a stand-alone run the resulting energy consumption in 2020 is equivalent to that predicted off-line.

The source code on lines on line 4749 to 4755 is replaced by the following code segment:

```
               FANMOD = 1.0                            ! LBNL
               IF (CURIYR > 11) THEN                   ! LBNL
                  FANMOD = (1.0 - 0.002)**(CURIYR-11) ! LBNL ADV
               ENDIF                                   ! LBNL
               IF (CURIYR > 21) THEN                                          ! LBNL
                  FANMOD  =  (1.0  -  0.002)**(11)*(1.0-0.015)**(CURIYR-21)  !  LBNL
ADV
               END IF                                                         ! LBNL
               FANCON(CURIYR,R)=FANCON(CURIYR,R)+ ((
     2         (EQCESE(CURIYR,RECCL,B,R)+EQCRP90(PREVYR,RECCL,B,R)+
     3          EQCSR90(PREVYR,RECCL,B,R))*FAN*FANUEC(r,b)+
     4         EQCADD(PREVYR,RECCL,B,R)*FAN*NFANUEC(curiyr,r,b) +
     5        (EQCREP(PREVYR,RECCL,B,R)+EQCSUR(PREVYR,RECCL,B,R))*
     6          FAN*AFANUEC(curiyr,r,b))*
     7           ((prices(4,r,curiyr)/prices(4,r,4))**alpha  ))*FANMOD
```

Moderate Scenario

Same as above, except the 2001-2010 decline rate is changed from 0.2%/year to 0.025%/year and the 2011-2020 decline rate is changed from 1.5%/year to 0.45%/year.

(2) TV electricity consumption

Advanced Scenario

We created an energy consumption multiplier to calibrate energy consumption to off-line analysis estimates in 2010 and 2020. The multiplier is set to 1.0 in 2000 and allowed to decline by a constant rate (0.9%/year) between 2001 and 2010 such that in a stand-alone run the resulting energy consumption in 2010 is equivalent to that predicted off-line. Similarly, the 2010 multiplier value is allowed to decline by a constant rate (1.05%/year) between 2011 and 2020 such that in a stand-alone run the resulting energy consumption in 2020 is equivalent to that predicted off-line.

The following code segment replaces the source code on lines 11178 to 11179:

```
      TVMOD = 1.0                          ! LBNL
      IF (Y>11) THEN                       ! LBNL
         TVMOD = (1.0 - 0.009)**(Y-11)     ! LBNL  OK FOR ADV
      ENDIF                                ! LBNL
      IF (Y>21) THEN                                          ! LBNL
         TVMOD = (1.0 - 0.009)**(11)*(1.0 - 0.0105)**(Y-21)   ! LBNL OK FOR ADV
      ENDIF                                                   ! LBNL
      DO 50 D=1,MNUMCR-2
        TVCON(Y,D)=0.0
      DO 50 B=1,MNUMBLDG
C         TVCON(y,d)=TVCON(y,d)+(TVEQP(Y,B,D)*TVNUEC(Y,d,b))
C     1       *((PRICES(4,D,CURIYR)/PRICES(4,D,4))**ALPHA)
         TVCON(y,d)=TVCON(y,d)+((TVEQP(Y,B,D)*TVNUEC(Y,d,b))       ! LBNL
     1       *((PRICES(4,D,CURIYR)/PRICES(4,D,4))**ALPHA))*TVMOD   ! LBNL
```

Moderate Scenario

Same as above, except the 2011-2020 decline rate is changed from 1.05%/year to 0.5%/year.

(3) Lighting electricity consumption

Advanced Scenario

We created an energy consumption multiplier to calibrate energy consumption to off-line analysis estimates in 2010 and 2020. The multiplier is set to 1.0 in 2000 and allowed to decline by a constant rate (1.2%/year) between 2001 and 2010 such that in a stand-alone run the resulting energy consumption in 2010 is equivalent to that predicted off-line. Similarly, the 2010 multiplier value is allowed to decline by a constant rate (3.6%/year) between 2011 and 2020 such that in a stand-alone run the resulting energy consumption in 2020 is equivalent to that predicted off-line.

The following code segment replaces the source code on lines 10900 to 10907:

```
      LTMOD = 1.0                          ! LBNL
      IF (Y>11) THEN                       ! LBNL
         LTMOD = (1.0-0.012)**(Y-11)       ! LBNL   OK FOR 2010 ADV
      END IF                               ! LBNL
      IF (Y>21) THEN                                        ! LBNL
         LTMOD = (1.0-0.012)**(11)*(1.0-0.036)**(Y-21) ! LBNL OK FOR ADV
      END IF                                                ! LBNL
      DO 50 D=1,MNUMCR-2
        LTCON(Y,D)=0.0
      DO 50 B=1,MNUMBLDG
         ltcon(y,d)=ltcon(y,d)+((eh(y,b,d)*ltnuec(y,b,d) +          ! LBNL
     1nh(y-1,b,d)*(SQNEW(y-1,b,d)/SQRFOOT(4,B,D))*ltnuec(y-1,B,D)+ ! LBNL
     1          HSEADD(y,b,d)*sqftlts(y,b,d)*ltnuec(y,B,D)+        ! LBNL
     2( EH(Y,B,D)+NH(Y,B,D))*TCHNUEC(Y,B,D)*DISPLACE)              ! LBNL
     5*(((PRICES(4,D,CURIYR))/PRICES(4,D,4))**ALPHA))*LTMOD        ! LBNL
```

Moderate Scenario

Same as above, except the 2001-2010 decline rate is changed from 1.2%/year to 0.08%/year and the 2011-2020 decline rate is changed from 1.575%/year to 0.8%/year.

(4) Other electricity consumption (coils, motors, electronics sub-categories)

Advanced Scenario

We created an energy consumption multiplier to calibrate energy consumption to off-line analysis estimates in 2010 and 2020. The other electricity is split into three components: coils, motors, and electronics. The multiplier is set to 1.0 in 2000 and allowed to decline by a constant rate (0.9%/year for coils, 1.1%/year for motors, and 2.95%/year for electronics) between 2001 and 2010. The multiplier affects the resulting energy consumption such that in a stand-alone run the 2010 value is equivalent to that predicted off-line. Similarly, the 2010 multiplier value is allowed to decline by a constant rate (0.15%/year for coils, 0.75%/year for motors, and 7.13%/year for electronics) between 2011 and 2020 such that in a stand-alone run the resulting energy consumption in 2020 is equivalent to that predicted off-line.

The following code segment replaces the source code on lines 11283 to 11297:

```
      COILRED = 1.0                          ! LBNL
      MOTRRED = 1.0                          ! LBNL
      ELECRED = 1.0                          ! LBNL
      IF (Y>11) THEN                         ! LBNL
         COILRED  = (1.0-0.0090)**(Y-11)     ! LBNL OK FOR ADV
         MOTRRED  = (1.0-0.0110)**(Y-11)     ! LBNL OK FOR ADV
         ELECRED  = (1.0-0.0295)**(Y-11)     ! LBNL OK FOR ADV
      ENDIF                                  ! LBNL
      IF (Y>21) THEN
         COILRED  = (1.0-0.0090)**(11)*(1.0-0.0015)**(Y-21) ! LBNL OK FOR ADV
         MOTRRED  = (1.0-0.0110)**(11)*(1.0-0.0075)**(Y-21) ! LBNL OK FOR ADV
         ELECRED  = (1.0-0.0295)**(11)*(1.0-0.0713)**(Y-21) ! LBNL OK FOR ADV
      ENDIF
C      WRITE(*,*)'LBNL RES OTHER MOD C,M,E ',Y+1989+1,
C     *          COILRED,MOTRRED,ELECRED
      DO 20 D=1,MNUMCR-2
          ELTRCN(Y+1,D)=0.0
         COILCN(Y+1,D)=0.0
         MOTRCN(Y+1,D)=0.0
           DO 20 B=1,MNUMBLDG
         ELTRCN(Y+1,D)=ELTRCN(Y+1,D)+((NH(Y+1,B,D)+EH(Y+1,B,D))
     1    *( ELTRUEC(D,B)*ELTRPEN(Y)))*ELECRED                    ! LBNL
     2    *((PRICES(4,D,CURIYR)/PRICES(4,D,4))**ALPHA)
         COILCN(Y+1,D)=COILCN(Y+1,D)+((NH(Y+1,B,D)+EH(Y+1,B,D))
     1    *( COILUEC(D,B)*COILPEN(Y)))*COILRED                    ! LBNL
     2    *((PRICES(4,D,CURIYR)/PRICES(4,D,4))**ALPHA)
         MOTRCN(Y+1,D)=MOTRCN(Y+1,D)+((NH(Y+1,B,D)+EH(Y+1,B,D))
     1    *( MOTRUEC(D,B)*MOTRPEN(Y)))*MOTRRED                    ! LBNL
     2    *((PRICES(4,D,CURIYR)/PRICES(4,D,4))**ALPHA)
 20   CONTINUE
```

Moderate Scenario

Same as above, except the 2001-2010 decline rate for electronics is changed from 2.95%/year to 2.73%/year, the 2011-2020 decline rate for coils is changed from 0.75%/year to 0.55%/year, and the 2011-2020 decline rate for electronics is changed from 7.13%/year to 2.73%/year.

(5) New home thermal shell indices

Advanced Scenario

We created a thermal shell index multiplier to improve the shell efficiency of new homes. The multiplier is set to 1.0 in 2000 and allowed to decline by a constant rate (1.0%/year) between 2001 and 2010. Similarly, the 2010 multiplier value is allowed to decline by a constant rate (2.0%/year) between 2011 and 2020.

The following code is inserted on line 4355:

```
SHMOD = 1.0
IF (CURIYR > 11) THEN
   SHMOD = 1.0 - 0.01*(CURIYR-11)    ! advanced
ENDIF
IF (CURIYR > 21) THEN
   SHMOD = 0.9 - 0.02*(CURIYR-21)  ! advanced
ENDIF
IF (F.EQ.1 .AND. R.EQ.1) THEN
   WRITE(*,*)'LBNL NEW SHELL MOD ',SHMOD
ENDIF
```

And the following segment of code is inserted on line 4368:

```
NHSHELL(CURIYR,F,R) = NHSHELL(CURIYR,F,R) * SHMOD  ! LBNL
NCSHELL(CURIYR,R)= NCSHELL(CURIYR,R) * SHMOD       ! LBNL
```

Moderate Scenario

No changes were made to new home thermal shell indices in the Moderate Scenario.

(6) Price-induced discount rate change

Advanced Scenario

Price-induced discount rate changes were removed.

Behavioral changes exist in 10 places in the source code (beginning on lines: 3694, 5011, 5945, 6544, 7202, 8306, 8834, 9532, 10116, and 10765). All 10 instances of the code were commented out from the model. Those 10 code segments resemble or are identical to the following code:

```
C      IF ((CURIYR.GT.10).AND.
C     1         (PRICES(F,R,CURIYR).GT.PRICES(F,R,10))) THEN
C       HRDRATE=RTECBTA1(RECTY)/RTECBTA2(RECTY)
C       ELIGBLE=HRDRATE - 0.15
C        IF (ELIGBLE.GT.0.0) THEN
C         HRDADJ= ELIGBLE *
C     *      ((PRICES(F,R,CURIYR)/PRICES(F,R,10))**ALPHA1 )
C
C         RTECBTA1(RECTY) = (HRDADJ+0.15) * RTECBTA2(RECTY)
C        END IF
C      END IF
```

Moderate Scenario

Same as the Advanced Scenario.

(7) Distributed Generation Subroutine

Advanced Scenario

This subroutine was added to the end of the source code. The subroutine was received from EIA and is a part of AEO 2000. No changes were made to this code.

Moderate Scenario

Same as the Advanced Scenario.

Summary of input file changes

Advanced Case

In the *rtekty* technology input file, standards were implemented by removing all technologies not satisfying the following efficiency criteria:

Technology	Efficiency	Start Date
clothes washers*	Horizontal axis	2003
gas water heaters	0.60 EF	2004
elec water heaters	0.95 EF	2004
Refrigerators	421 kWh/yr	2010
room air conditioners	10.5 SEER	2010
central air conditioners	13 SEER	2006
elec. air-source heat pumps	13 SEER/7.6 HSPF	2006

* the default NEMS horizontal axis clothes washer efficiency is used as the minimum standard level.

In addition to standards, the following implicit discount rate modifications were implemented in the *rtekty* technology characteristics input file:

Technology	NEMS Implicit Discount Rate	CEF-NEMS Implicit Discount Rate	Period
clothes washers	391%	15%	2001-2020
clothes dryers	90%	15%	2001-2020
Refrigerators	19%	15%	2001-2020
freezers	39%	15%	2001-2020
distillate waterheater	150%	15%	2001-2020
elec waterheater	83%	18%	2005-2020
gas waterheater	47%	95%	2001-2020
air/ground source heat pump	42%	15%	2001-2020
room air conditioners	125%	15%	2001-2020
central air conditioners	50%	15%	2001-2020
gas dryers	47%	15%	2001-2020
gas furnace #4	15%	2.5%	2011-2020
gas furnace #3	15%	2.5%	2005-2020
air source heat pump cooling	50%	15%	2001-2020

The following equipment efficiency characteristics were modified in the *rtekty* input file (efficiency units are BTU out/ BTU in unless otherwise noted):

Technology	CEF-NEMS efficiency	NEMS efficiency	Period
air source HP #4 heat	4.0	2.78/2.93	2011-2020
central air conditioner #4	6.0	5.28	2011-2020
refrigerator #3	350 kWh/yr	400 kWh/yr	2005-2010
refrigerator #3	150 kWh/yr	400 kWh/yr	2011-2020

Finally, the following retail and installed cost characteristics (1998 dollars) were modified in the *rtekty* input file:

Technology	CEF-NEMS installed cost	NEMS installed cost	CEF-NEMS retail cost	NEMS retail cost	Period
Air source HP #3 heat [1]	2665	3217	3400	4150	2001-2004
Air source HP #3 cool [1,2]	1733	1733	0	0	
Air source HP #3 heat [1]	2665	3185	3400	4100	2005-2014
Air source HP #3 cool [1,2]	1715	1715	0	0	
Air source HP #3 heat [1]	2665	3055	3400	3900	2015-2020
Air source HP #3 cool [1,2]	1645	1645	0	0	
Air source HP #4 heat [1]	2665	3510	3400	4500	2011-2014
Air source HP #4 cool [1,2]	1925	1925	0	0	
Air source HP #4 heat [1]	2665	3380	3400	4300	2015-2020
Air source HP #4 cool [1,2]	1820	1820	0	0	
Central air #4	2500	3300	1800	2500	2011-2014
Central air #4	2500	3100	1800	2300	2015-2020
Gas furnace #4	1300	1650	680	1300	2011-2014
Gas furnace #4	1300	1600	680	900	2015-2020
Gas radiator #3	4845	6000	2145	3500	2011-2014
Gas radiator #3	4845	5750	2145	3000	2015-2020
Gas waterheater #2	N/A	No change	225	190	2004
Gas waterheater #3	340	400/425	190	275/300	2001-2020
Gas waterheater #4	650	2360/2000/1800	1000	2200/1800/1500	2001-2020
Refrigerator #3	530	850/550/700	480	800/500/650	2001-2020
Room air #3	450	760	350	1660	2005-2020

[1] NEMS uses two records for each heat pump in *rtekty*, one for heating and one for cooling. Heat Pump installed and retail costs are treated differently. Installed costs are apportioned between heating and cooling, while the retail cost is contained solely in the heating record.

[2] Cooling costs were not changed but are included to explain why retail costs appear to be higher than installed cost for HP heating.

Moderate Case

In the *rtekty* technology input file, standards were implemented by removing all technologies not satisfying the following efficiency criteria:

Technology	Efficiency	Start Date
clothes washers*	horizontal axis	2006
gas water heaters	0.60 EF	2004
elec water heaters	0.95 EF	2004
room air conditioners	10.5 SEER	2010
central air conditioners	13 SEER	2006
elec. air-source heat pumps	13 SEER/7.6 HSPF	2006

* the default NEMS horizontal axis clothes washer efficiency is used as the minimum standard level.

In addition to standards, the following implicit discount rate modifications were implemented in the *rtekty* technology characteristics input file:

Technology	NEMS Implicit Discount Rate	CEF-NEMS Implicit Discount Rate	Period
clothes washers	391%	15%	2001-2020
clothes dryers	90%	15%	2001-2020
refrigerators	19%	15%	2001-2020
freezers	39%	15%	2001-2020
distillate waterheater	150%	15%	2001-2020
elec waterheater	83%	18%	2001-2020
gas waterheater	47%	15%	2001-2020
air/ground source HP heating	42%	15%	2001-2020
room air conditioners	125%	15%	2001-2020
central air conditioners	50%	15%	2001-2020
gas dryers	47%	15%	2001-2020
air source HP cooling	50%	15%	2001-2020

The following equipment efficiency characteristics were modified in the *rtekty* input file (central air efficiency units are BTU out / BTU in) :

Technology	CEF-NEMS efficiency	NEMS efficiency	Period
Ccntral air #4	5.64	5.28	2011-2020
Refrigerator #3	350 kWh/yr	400 kWh/yr	2005-2010
Refrigerator #3	250 kWh/yr	400 kWh/yr	2011-2020

Finally, the following retail and installed cost characteristics (1998 dollars) were modified in the *rtekty* input file:

Technology	CEF-NEMS installed cost	NEMS installed cost	CEF-NEMS retail cost	NEMS retail cost	Period
Air source HP #3 heat [1]	2665	3217	3400	4150	2001-2004
Air source HP #3 cool [1,2]	1733	1733	0	0	
Air source HP #3 heat [1]	2665	3185	3400	4100	2005-2014
Air source HP #3 cool [1,2]	1715	1715	0	0	
Air source HP #3 heat [1]	2665	3055	3400	3900	2015-2020
Air source HP #3 cool [1,2]	1645	1645	0	0	
Air source HP #4 heat [1,3]	3380	3380	4300	4300	2015-2020
Air source HP #4 cool [1]	1435	1820	0	0	
Central air #4	2500	3300	1800	2500	2011-2014
Central air #4	2500	3100	1800	2300	2015-2020
Gas furnace #4	N/A	No change	680	2000	1993-2004
Gas furnace #4	1300	1650	680	1300	2005-2014
Gas furnace #4	1300	1600	680	900	2015-2020
Gas radiator #3	5445	5750	2145	3000	2015-2020
Gas waterheater #2	N/A	No change	225	190	2004
Gas waterheater #3	340	400/425	190	275/300	2001-2020
Refrigerator #3	530	850/550/700	480	800/500/650/700	2001-2020
Room air #3	605	760	505	660	2011-2020

[1] NEMS uses two records for each heat pump in *rtekty*, one for heating and one for cooling. Heat Pump installed and retail costs are treated differently. Installed costs are apportioned between heating and cooling, while the retail cost is contained solely in the heating record.

[2] Cooling costs were not changed but are included to explain why retail costs appear to be higher than installed cost for HP heating.

[3] Heating costs were not changed but are included to accompany cooling portion and show retail costs.

Commercial Sector

For the commercial sector, detailed off-line analysis is used to estimate the policy induced energy savings potential. We then change hurdle rates, technology costs, growth trends, and penetration rates in CEF-NEMS in order to match the stand-alone mode CEF-NEMS forecast to the energy savings results from our detailed spreadsheet analysis. The assumptions and results for the spreadsheet analysis are contained in Appendices B-1, C-1, and D-1.

The changes implemented to recreate the off-line energy savings estimates in the Commercial Module of CEF-NEMS are listed below. In this section, source code modifications are explicitly listed and input file changes are summarized.

Source code modifications were made to the Commercial Module in the following areas:

(1) Decision rule shares

(2) Price-induced discount rate changes

(3) Gas other energy consumption

Input file modifications were made to the Commercial Module in the following areas:

(1) Distribution of technology choice time preference premiums (hurdle rates)

(2) Technology characteristics (capital costs, operating costs and efficiencies)

Detailed Source Code Changes

(1) Decision rule shares

Advanced Scenario

We modified decision rule shares for end-uses where discount rate changes were not sufficient to reach the desired energy savings (space heating, space cooling, and ventilation). For space heating, behavior shares for new equipment purchases were set to 70% same fuel. For space cooling, behavior shares for new equipment purchases were set to 50% least cost and 50% same fuel. For Ventilation, all decisions were set to least cost.

On line 3756, the following code is inserted to modify decision rule shares:

```
C LBNL -- MODIFY DECISION RULES HERE
C     BehaviorShare(s,b,d,u)
C
C     space heating -- s=1,b=all,d=1,u=all 1.0 for
C
      IF (CURIYR .EQ. 12 .AND. CURITR .EQ. 1) THEN
```

```
         WRITE(*,*)'LBNL -- MODIFYING DECISON RULES',CURIYR+1989
         DO b= 1, CMnumBldg
C           SPACE HEATING
            BehaviorShare(1,b,1,1) = 0.30  ! set most
            BehaviorShare(1,b,1,2) = 0.70  ! decisions to
            BehaviorShare(1,b,1,3) = 0.00  ! same fuel


           DO d= 1, CMDecision
C           SPACE COOLING
            if (d .le. 2) then
               BehaviorShare(2,b,d,1) = 0.50 ! set new/repl
               BehaviorShare(2,b,d,2) = 0.50 ! decisions to
               BehaviorShare(2,b,d,3) = 0.00 ! least cost
            endif

C           VENTILATION
            BehaviorShare(4,b,d,1) = 1.00  ! set all
            BehaviorShare(4,b,d,2) = 0.00  ! decisions to
            BehaviorShare(4,b,d,3) = 0.00  ! least cost

           ENDDO
         ENDDO
      ENDIF
C END LBNL
```

Moderate Scenario

Same as Advanced Scenario except that Behavior Shares for space heating were set to 100% same fuel.

(2) Price-induced discount rate changes:

Advanced Scenario

Price-induced discount rate changes were removed.

The following segment of code exists in 2 places in the source code (beginning on lines: 3930 and 4504). Both instances of this code were commented out from the model (as shown):

```
C           IF (PriceDelta(f).GT.1.0) THEN              ! del    LBNL REMOVE
C              IF (EffectHurdle.GT.0.15)                ! del    LBNL REMOVE
C     $        EffectHurdle = (EffectHurdle - 0.15) *   ! del    LBNL REMOVE
C     $        PriceDelta(f) ** HurdleElas(r,s,f)       ! del    LBNL REMOVE
C     $        + 0.15                                   ! del    LBNL REMOVE
C           END IF  ! Check for rising prices and rate over 15 percent. LBNL
REMOVE
```

Moderate Scenario

Same as Advanced Scenario.

(3) Gas other energy consumption

Advanced Scenario

We created an efficiency multiplier to calibrate energy consumption to off-line analysis estimates in 2010 and 2020. The efficiency for other gas energy consumption was increased at a rate of 1%/year between 2001 and 2010 and 16%/year between 2011 and 2020.

The following code segment was inserted:

```
C LBNL -- add efficiency to gas other
         if (CURIYR .gt. 11 .AND. CURIYR .LE. 21) then
          AverageEfficiency(r,b,s,2)=PrevYrAverageEfficiency(r,b,s,2) *
     *                               (1.0 + 0.010)
         elseif (CURIYR .GT. 21) then
          AverageEfficiency(r,b,s,2)=PrevYrAverageEfficiency(r,b,s,2) *
     *                               (1.0 + 0.160)    ! LBNL 6-25-99
         endif
C END LBNL
```

Moderate Scenario

Same as advanced case except the efficiency was increased at a rate of 4%/year between 2011 and 2020.

Summary of input file changes

Advanced Case

In the *ktech* input file, lighting standards were changed to match the EIA's aeo99 hitech scenario. Additionally, other standards were implemented by improving the efficiency (NEMS commercial efficiency units for ventilation are 1000 cfm-hours output / 1000 BTU input) and/or changing the available date for the following technologies:

Technology	Efficiency	Start Date
Electric rooftop a/c 2005 typical	3.02	2005
Electric rooftop a/c 2015 typical	3.22	2010
Gas furnace 2015 typical	0.82	2010
Gas boiler 2015 typical	Unchanged	2010

In addition to standards, the following implicit discount rate modifications were implemented in the *kprem* technology characteristics input file:

		DISCOUNT RATE							
Technology	Source Code	10	1.529	0.554	0.309	0.199	0.136	Total	Period
Space Heating	NEMS	27%	25.4%	20.4%	16.2%	10%	1%	100%	2001-2020
	CEF-NEMS	0	10%	20%	20%	20%	30%	100%	2001-2010
	CEF-NEMS	0	0	0	0	0	100%	100%	2011-2020
Space Cooling	NEMS	27%	25.4%	20.4%	16.2%	10%	1%	100%	2001-2020
	CEF-NEMS	0	0	0	0	0	100%	100%	2001-2020
Hot Water Heating	NEMS	27%	25.4%	20.4%	16.2%	10%	1%	100%	2001-2020
	CEF-NEMS	0	0	25%	25%	25%	25%	100%	2001-2010
	CEF-NEMS	0	0	0	0	0	100%	100%	2011-2020
Ventilation	NEMS	27%	25.4%	20.4%	16.2%	10%	1%	100%	2001-2020
	CEF-NEMS	0	0	0	0	0	100%	100%	2001-2020
Cooking	NEMS	27%	25.4%	20.4%	16.2%	10%	1%	100%	2001-2020
	CEF-NEMS	30%	30%	20%	20%	0	0	100%	2001-2010
	CEF-NEMS	25%	20%	20%	15%	10%	10%	100%	2011-2020
Lighting	NEMS	27%	25.4%	20.4%	16.2%	6%	5%	100%	2001-2020
	CEF-NEMS	20%	20%	20%	15%	15%	10%	100%	2001-2010
	CEF-NEMS	0	20%	25%	25%	25%	5%	100%	2011-2020
Refrigeration	NEMS	27%	25.4%	20.4%	16.2%	10%	1%	100%	2001-2020
	CEF-NEMS	0	0	0	0	0	100%	100%	2001-2020

The following market penetration indexes were modified:

[These changes are not policy induced. We made them because the energy savings from the stand-alone CEF-NEMS runs fell short of those in our off-line analysis even after implementing the source code and input file changes described above. In order to match total forecast electricity savings with our off-line accounting, we adjusted the Office Equipment and Other End Uses penetration rates in the *koffpen* input file. Subsequently, we decided to only use Other End Uses for this "electricity accounting." We then restored Office Equipment rates to a level that had no noticeable effect on end-use consumption, but not exactly to the levels used in the reference case.]

		Penetration Ratio by Year		
Technology	Source Code	2000	2010	2020
Office Equipment PC	NEMS	1.863	2.263	2.601
	CEF-NEMS	1.863	2.408	2.650
Office Equipment, non-PC	NEMS	1.105	1.321	1.579
	CEF-NEMS	1.105	1.330	1.610
Other End Uses	NEMS	1.338	2.130	2.714
	CEF-NEMS	1.338	1.540	1.300

Moderate Case

In the *ktech* input file, one standard was implemented by improving the efficiency (units 1000 cfm-hours output / 1000 BTU input):

Technology	Efficiency	Start Date
Electric rooftop a/c 2005 typical	3.02	2005

In addition to the standard, the following implicit discount rate modifications were implemented in the *kprem* technology characteristics input file:

		DISCOUNT RATE							
Technology	Source Code	10	1.529	0.554	0.309	0.199	0.136	Total	Period
Space Heating	NEMS	27%	25.4%	20.4%	16.2%	10%	1%	100%	2001-2020
	CEF-NEMS	0	0	0	0	0	100%	100%	2001-2020
Space Cooling	NEMS	27%	25.4%	20.4%	16.2%	10%	1%	100%	2001-2020
	CEF-NEMS	0	0	0	0	0	100%	100%	2001-2020
Hot Water Heating	NEMS	27%	25.4%	20.4%	16.2%	10%	1%	100%	2001-2020
	CEF-NEMS	0	0	0	25%	25%	50%	100%	2001-2010
	CEF-NEMS	0	0	0	0	0	100%	100%	2011-2020
Ventilation	NEMS	27%	25.4%	20.4%	16.2%	10%	1%	100%	2001-2020
	CEF-NEMS	0	0	0	0	0	100%	100%	2001-2020
Cooking	NEMS	27%	25.4%	20.4%	16.2%	10%	1%	100%	2001-2020
	CEF-NEMS	30%	30%	20%	20%	0	0	100%	2001-2010
	CEF-NEMS	25%	20%	20%	15%	10%	10%	100%	2011-2020
Lighting	NEMS	27%	25.4%	20.4%	16.2%	6%	5%	100%	2001-2020
	CEF-NEMS	15%	15%	20%	20%	15%	15%	100%	2001-2010
	CEF-NEMS	5%	20%	25%	20%	20%	10%	100%	2011-2020
Refrigeration	NEMS	27%	25.4%	20.4%	16.2%	10%	1%	100%	2001-2020
	CEF-NEMS	0	0	0	0	0	100%	100%	2001-2020

Finally, we modified the following market penetration indexes:

[These changes are not policy induced. We made them because the energy savings from the stand-alone CEF-NEMS runs fell short of those in our off-line analysis even after implementing the source code and input file changes described above. In order to match total forecast electricity savings with our off-line accounting, we adjusted the Office Equipment and Other End Uses penetration rates in the *koffpen* input file. Subsequently, we decided to only use Other End Uses for this "electricity accounting." We then restored Office Equipment rates to a level that had no noticeable effect on end-use consumption, but not exactly to the levels used in the reference case.]

		Penetration Ratio by Year		
Technology	Source Code	2000	2010	2020
Office Equipment PC	NEMS	1.863	2.263	2.601
	CEF-NEMS	1.863	2.408	2.650
Office Equipment, non-PC	NEMS	1.105	1.321	1.579
	CEF-NEMS	1.105	1.290	1.570
Other End Uses	NEMS	1.338	2.130	2.714
	CEF-NEMS	1.338	1.540	1.500