**Modeling an Integrated High Efficiency Scenario using the**

**2014 National Energy Modeling System**

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# Introduction

Georgia Tech's School of Public Policy assisted Duke University's Nicholas Institute of Environmental Policy Solutions (NIEPS) in its project with the World Resources Institute aimed at informing and analyzing potential US climate mitigation policies in the post-2020 period. The project involved constructing scenarios consisting of multiple policies applied to various sectors of the US economy. Georgia Tech was tasked with analyzing policies to promote energy efficiency in residential and commercial buildings and industry.

In collaboration with Duke University, Georgia Tech (GT) conducted the energy-economic modeling of a set of policy scenarios that define an “Integrated High Efficiency Scenario.” This modeling was performed using the School of Public Policy's version of the Energy Information Agency's (EIA's) National Energy Modeling System (NEMS) released in 2014. NEMS analyzes energy consumption changes by fuel type[[1]](#footnote-1) along with policy scenario and energy market assumptions. Since the model is run on Georgia Tech computers, we call it “GT-NEMS”.[[2]](#footnote-2) NEMS uses resource supply and price data based on federal, state, and local laws and regulations in effect at the time of the analysis. The NEMS integrating module ensures general market equilibrium fuel prices and quantities across all twelve modules including supply (oil and gas, coal, and renewable fuels), demand (residential, commercial, industrial, and transportation sectors), energy conversion (electricity and petroleum markets), and macroeconomic and international energy market factors. NEMS is well suited to projecting how alternative energy policies might impact energy markets over time because it has a detailed methodology for evaluating the market penetration of end-use technologies in different sectors of the economy, although less so in the industrial sector. NEMS’ “bottom-up” technology configuration enables an assessment of technology investments, energy prices, energy consumption and expenditures, carbon abatement, and pollution prevention over time and across regions of the U.S.

The 2014 NEMS release includes the Reference case from which EIA developed its 2014 Annual Energy Outlook, which is the point of departure for the policy scenarios described here. This Reference case is the “counterfactual” projection that is the business-as-usual trend estimate, given known technology and technological and demographic trends.

The Integrated High Efficiency Scenario is defined by a set of policies including the following:

Residential appliance standards

Commercial High Demand Technology equipment performance

Stricter building energy codes in the residential and commercial sectors, focused on improved building envelope and HVAC equipment efficiency

An extended investment tax credit to accelerate the adoption of industrial combined heat and power (CHP) systems, lower cost biomass resources that expand paper production and therefore CHP operations, and stricter industrial motor standards

Accelerated development and deployment of energy-efficient equipment in five energy-intensive industrial sectors.

The following section describes the Integrated High Efficiency Scenario in more detail.

# Scenario Definition

The modeling of an Integrated High Efficiency Scenario relies heavily on a set of NEMS side cases prepared by EIA in conjunction with the release of the *2014 Annual Energy Outlook*. We build our integrated scenario by starting with the assumptions of the **High Demand Technology** side case, which:

“assumes earlier availability, lower costs, and higher efficiencies for more advanced residential and commercial equipment. For new residential construction, building code compliance is assumed to improve after 2013, and building shell efficiencies are assumed to meet ENERGY STAR requirements by 2023. Existing residential building shells exhibit 50% more improvement than in the Reference case after 2013. New and existing commercial building shells are assumed to improve 25% more than in the Reference case by 2040. Industrial sector assumes earlier availability, lower costs, and higher efficiency for more advanced equipment and a more rapid rate of improvement in the recovery of biomass byproducts from industrial processes….” (AEO, 2014, p. E-8).

For the residential sector, the High Demand Technology case assumes that “residential advanced equipment is available earlier, at lower costs, and/or at higher efficiencies (Navigant Consulting, Inc. with SAIC, 2011) Existing building shell efficiencies exhibit 50% more improvement than in the Reference case after 2013. For new construction, building code compliance is assumed to improve after 2013, and building shell efficiencies are assumed to meet ENERGY STAR requirements by 2023. Consumers evaluate investments in energy efficiency at a 7% real discount rate.” (IEA, 2014, p. E-9).

For the commercial sector, the High Demand Technology case assumes “that commercial advanced equipment is available earlier, at lower costs, and/or with higher efficiencies than in the Reference case. Energy efficiency investments are evaluated at a 7% real discount rate. For new and existing buildings in 2040, building shell efficiencies are assumed to show 25% more improvement than in the Reference case.” (IEA, 2014, p. E-10).

For the industrial sector, the High Demand Technology case assumes “earlier availability, lower costs, and higher efficiency for more advanced equipment (Navigant Consulting, Inc. with SAIC, 2012; FOCIS Associates, 2005) and a more rapid rate of improvement in the recovery of biomass byproducts from industrial processes—i.e., 0.7%/year as compared with 0.4%/year in the Reference case. The same assumption is incorporated in the Low Renewable Technology Cost case, which focuses on electricity generation. Although the choice of the 0.7% annual rate of improvement in byproduct recovery is an assumption in the High Demand Technology case, it is based on the expectation of higher recovery rates and substantially increased use of CHP in that case. Due to integration with other NEMS modules, potential feedback effects from energy market interactions are captured.” (IEA, 2014, p. E-10-11).

We then add pieces of software code from several other side cases as described below:

From the **No Sunset** case and **Extended Policies** case, we include “an assumption for CHP that extends the existing ITC for industrial CHP through the end of the projection period.” Additionally, the **Extended Policies** case includes “an increase in the capacity limitations on the ITC by increasing the cap on CHP equipment from 15 megawatts (MW) to 25 MW and eliminating the system-wide cap of 50 MW. These assumptions are based on the proposals made in H.R. 2750 and H.R. 2784 of the 112th Congress.” (IEA, 2014, p. E-11).

From the **Low Renewable Technology Cost** side case we assume that “biomass feedstocks are 20% less expensive for a given resource quantity… and the industrial sector assumes a higher rate of recovery for biomass byproducts from industrial processes.” (IEA, 2014, p. E-6).

Additional modifications were made to create the integrated efficiency scenario. The following sections describe how these assumptions are used to model a set of policy initiatives aimed at fostering greater energy efficiency in the U.S. energy end-use system.

## Residential Appliance Standards

This set of residential appliance standards was modeled as follows, using specifications in the scedes.all.wri.as+bc.txt scedes file. These specifications come from the WRI report: *Can the U.S. Get There from Here? Using Existing Federal Laws and State Action to Reduce Greenhouse Gas Emissions* (http://www.wri.org/publication/can-us-get-there-here).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Residential Appliances | 1st standard year | % improvement relative to base\* | 2nd standard year | % improvement relative to base case | Cost increase (% relative to appliance cost in High Demand Tech case) |
| Dishwasher | Use AEO2014 best available demand tech | | | |  |
| Clothes washer | Use AEO2014 best available demand tech | | | |  |
| Clothes dryer | Use AEO2014 best available demand tech | | | |  |
| Range/oven | Use AEO2014 best available demand tech | | | |  |
| Microwave | 2018 | 15% |  |  |  |
| Furnace fan | 2016 | 30% | 2021 | 40% |  |
| Central AC | Use AEO2014 best available demand tech | | | |  |
| Room AC | 2014 | 12% | 2022 | 28% | 47% |
| Heat pump | Use AEO2014 best available demand tech | | | |  |
| Water heater | Use AEO2014 best available demand tech | | | |  |
| Refrigerator | 2014 | 25% | 2020 | 40% | 50% |
| Freezer | 2014 | 25% | 2020 | 40% | 50% |
| Residential Miscellaneous Electricity Uses | 1st standard year | % improvement < BAU UEC | 2nd standard year | % improvement < BAU UEC |  |
| Computer | 2016 | 50% |  |  |  |
| TV | 2016 | 60% |  |  |  |
| Set-top boxes | 2017 | 30% |  |  |  |
| External power supply | 2015 | 30% | 2017 | 40% |  |
| Battery charger | 2016 | 30% | 2018 | 40% |  |
| Residential Lighting | 1st standard year | Efficiency (lumen/watt) | 2nd standard year | Efficiency (lumen/watt) | |
| Incandescent lamps | 2015 | 20 | 2020 | 65 |  |
| All other GSLs | Use AEO2014 best available demand tech | | | |  |
| Reflector lamps | 2020 | 45 |  |  |  |
| Linear fluorescent | 2018 | 97 |  |  |  |

\*The percentage of relative improvement refers to how much more the improvement is greater than the improvement in the reference case. For example, the 60% improvement in TVs compared to the base is not that TVs are using 60% less than the base case, but that the improvement seen in the base case at the given year is increased by 60%.

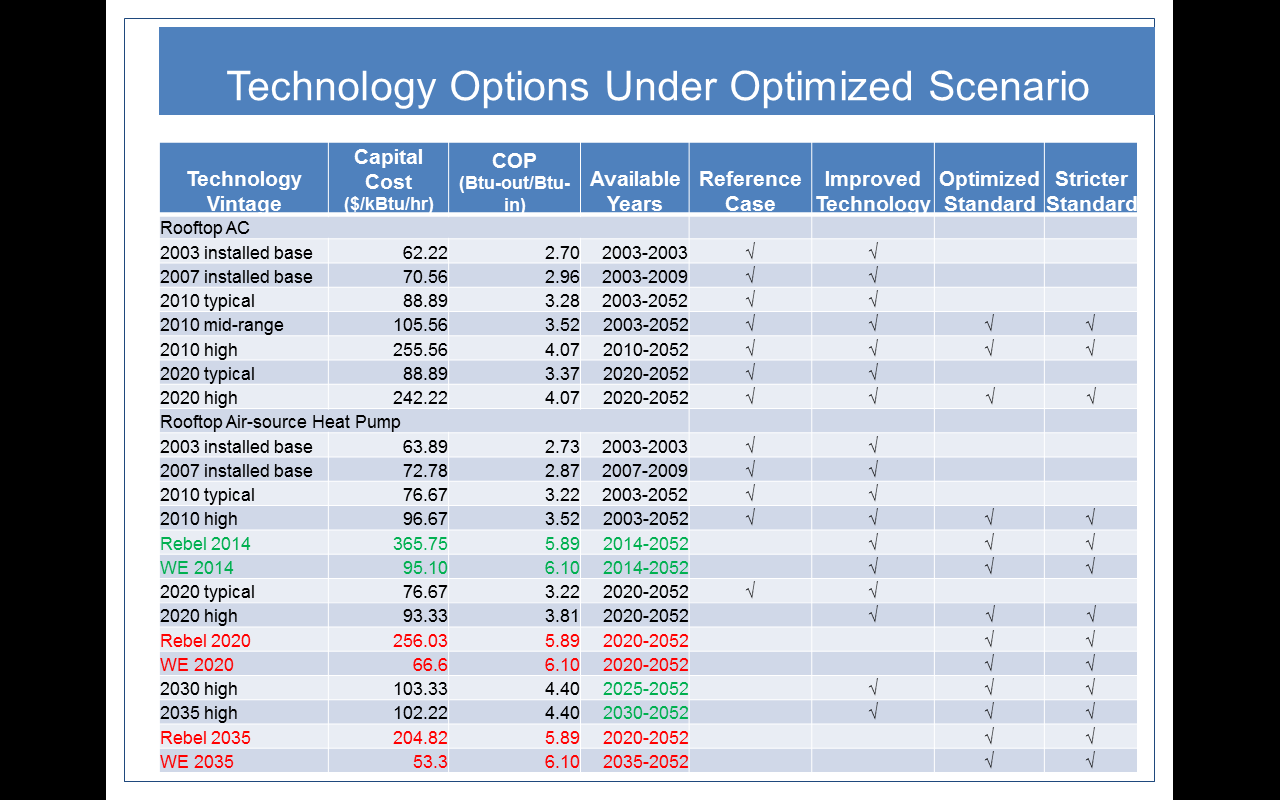
## Commercial Appliance Standards

Commercial appliances are modeled using the **High Demand Technology** side case. This included applying the kintense file from the **High Demand Technology** side case. In kintense, the energy intensity of office equipment PC, non-PC and miscellaneous equipment is reduced by 45%. Possible standards for commercial miscellaneous electricity end uses were characterized in an effort to strengthen the High Demand Technology assumptions, but it was decided not to include them in the integrated efficiency scenario.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| COMMERCIAL MISCELLANEOUS ELECTRICITY USES | | 1st standard year | % Improvement below BAU Unit Energy Consumption (UEC) | |  | | |
| Server | 2016 | | 45% |  | |  |  |
| Monitor | 2018 | | 25% |  | |  |  |
| Printer/copier | 2018 | | 50% |  | |  |  |
| Computer | 2016 | | 50% |  | |  |  |

## Building Codes – Residential and Commercial

The stricter residential and commercial building codes that are modeled in the **High Demand Technology** side case. We developed the ability to model the introduction of two new integrated heat pump air conditioning units for rooftop use in the commercial sector. The following table shows how the two new rooftop units could be added to the ketch file in the commercial sector. This was not implemented, but it could be explored in the future and has been implemented in another Georgia Tech research project.



## Industrial CHP Investment Tax Credit; Stricter Industrial Motor Standards

This following set of industrial policies was modeled as follows, using specifications in the “scedes.indhech.d111111x.txt” scedes file:

30% investment tax credits for CHP are extended through 2040

The rate of decline for CHP system costs is increased

The pulp and paper industry's supply of biomass is increased[[3]](#footnote-3)

Enables EIA's “high-tech” assumptions, which includes triggering a high-tech flag which increases the speed of cost declines for CHP systems and improves electric motor efficiencies.

The **extended policies** side case extends the investment tax credits for CHP.

The **High Demand Technology** side case assumptions include more efficient CHP systems, motors, and improved technology and process efficiency.

The **low-cost renewables** side case increases biomass supply for CHP.

## Increased Energy Efficiency in Five Manufacturing Subsectors

Technology possibility curves for five major energy-consuming industries are improved to levels consistent with studies of the economic potential for industry

To reach the GHG emission standards for 5 manufacturing subsectors, greater EE was modeled by modifying the AEO NEMS technology possibility curves (TPCs) and unit energy consumption (UEC) values to meet the energy consumption reductions shown in the table below. Existing equipment is assumed to achieve 80 percent of the total change, which is then divided out to yield the annual improvement figure. New equipment is modeled as achieving a technology policy curve (TPC) 50 percent improved over the existing equipment. High and Low cases were developed, based on the highest and lowest economic potentials reported in Brown, Cox, and Cortes (2010):

Table 2. Increased Energy Efficiency in Five Manufacturing Subsectors

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **HIGH** | Bulk Chemicals | Refining | Pulp and Paper | Iron and Steel | Cement |
| Reference Case  Projected Energy  Consumption in 2030  (in quads) | 6.08 | 6.07 | 2.15 | 1.38 | 0.44 |
| Integrated Efficiency | 4.98 | 4.67 | 1.3 | 0.59 | 0.34 |
| % Change (2017-2030) | -18.1 | -23.1 | -39.5 | -57.2 | -22.7 |
| Existing | -14.5 | -18.4 | -31.6 | -45.8 | -18.2 |
| New | -21.7 | -27.7 | -47.4 | -68.7 | -27.2 |
|  |  |  |  |  |  |
| Annual % Improvement | | |  |  |  |
| Existing | -0.01316 | -0.01677 | -0.02875 | -0.04163 | -0.0165 |
| New | -0.01974 | -0.02516 | -0.04313 | -0.06245 | -0.0272 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **LOW** | Bulk Chemicals | Refining | Pulp and Paper | Iron and Steel | Cement |
| Reference Case  Projected Energy  Consumption in 2030  (in quads) | 6.08 | 6.07 | 2.15 | 1.38 | 0.44 |
| Integrated Efficiency | 5.89 | 5.77 | 2.01 | 1.17 | 0.36 |
| % Change (2017-2030) | -3.1 | -4.9 | -6.5 | -15.2 | -18.2 |
| Existing | -2.5 | -3.9 | -5.2 | -12.2 | -14.5 |
| New | -3.8 | -5.9 | -7.8 | -18.3 | -21.8 |
|  |  |  |  |  |  |
| Annual % Improvement | | |  |  |  |
| Existing | -0.00227 | -0.00359 | -0.00474 | -0.01107 | -0.0132 |
| New | -0.00341 | -0.00539 | -0.0071 | -0.0166 | -0.0198 |

# Results

The Integrated High Efficiency Scenario results in overall reductions of electricity consumption and CO2 emissions.

**3.1 Electricity Consumption**

In terms of electricity consumption, the Integrated High Efficiency Scenario reduces U.S. electricity consumption by 30.9% in residential sector, 14.4% in commercial sector, and 5.3% in industrial sector in the year 2030, relative to the Reference case.

**Figure 1. Electricity Consumption by Sector**

**3.2 CO2 Emissions**

In terms of CO2 emission, the Integrated High Efficiency Scenario results in a 28.7% reduction of CO2 emissions from 2012 to 2030 in residential sector, compared to 1.5% increases during the same period in the Reference case. In the commercial sector, the Integrated High Efficiency Scenario results in a 5.5% reduction of CO2 emissions from 2012 to 2030, relative to 7.1% increases in the Reference case. In the industrial sector, the Integrated High Efficiency Scenario leads to CO2 emission increases by 7.6% for the same period, relative to 16.0% increases in the Reference case. Overall, the Integrated High Efficiency policies will contribute to reduce CO2 emissions by 6.6% from 2012 to 2030 in all sectors (including electric power and transportation sectors), while the U.S. would emit 4.3% more CO2 during the same period in the business-as-usual case.

**Figure 2. Energy-Related CO2 Emissions of the U.S. and Its Electric Power Sector**

**Figure 3. Energy-Related CO2 Emissions by Sector**

**3.3 Electricity Fuel Mix**

Turning to the impacts of the integrated high efficiency case upon the electric power industry, we find that the Integrated High Efficiency Policy Scenario reduces electricity generation dramatically while causing some changes to the US generation portfolio. Figure 4 below displays these major impacts. The Integrated High Efficiency Scenario reduces total electricity generation by 14% compared to the reference case. Meanwhile, the Integrated High Efficiency Scenario does little to affect the trajectory of coal’s share of the generation portfolio; in 2030, coal’s share of US generation differs by less than 1% between the Integrated High Efficiency Scenario and the reference case. Natural gas’s share of the generation portfolio in 2030 under the High Efficiency Scenario is 5 percentages points lesser than in the reference case. Finally, the share of the US generation portfolio constituted by renewable sources is only 1% greater under the Integrated High Efficiency Scenario than under the reference case.

**Figure 4: Electric power supply impacts of the integrated high efficiency case**

**3.4 Electricity Prices**

The impact of the Integrated High Efficiency Policy Scenario upon electricity prices is negative across the three demand sectors. Although the residential sector experiences a price increase in the early years of the forecast (2014-2024), the trend reverses in 2025; by 2030, the residential electricity price in the Integrated High Efficiency Scenario is 2% lesser than that of the reference case. For the commercial sector, the 2030 electricity price in the Integrated High Efficiency Scenario is 4% lesser than that of the reference case. For the industrial sector, the 2030 electricity price in the Integrated High Efficiency Scenario is 6% lesser than that of the reference case.

**Figure 5: Electricity prices by sector**

**3.5 Macroeconomic Indicators**

The Integrated High Efficiency Scenario yields an increase in 2030 US GDP of $10 billion. The 2030 US GDP for the reference case is $2.14 trillion, whereas the 2030 US GDP for the Integrated High Efficiency Scenario is $2.24 trillion. The 2030 manufacturing sector’s value-of-shipment for energy-intensive industries gains $10 billion, going from $2.17 trillion in the reference case to $2.18 trillion in the Integrated High Efficiency Scenario. The 2030 manufacturing sector value-of-shipment for non-energy-intensive industries increases by $132 billion, going from $4.974 trillion in the reference case to $5.116 trillion in the Integrated High Efficiency Scenario.

Overall, the results suggest that an Integrated High Efficiency Scenario could provide a low-cost pathway to achieving significant CO2 emission reductions.

# References

Brown, Marilyn A, Matt Cox, and Rodrigo Cortes. 2010. “Transforming Industrial Energy Efficiency,” *The Bridge* (Washington, DC: National Academy of Engineering), Fall, pp. 22-30.

Navigant Consulting, Inc. with SAIC, High Demand Technology assumptions for the buildings sector are based on U.S. Energy Information Administration, EIA—Technology Forecast Updates—Residential and Commercial Building Technologies—Advanced Case (2011).

Navigant Consulting, Inc. with SAIC, EIA—Technology Forecast Updates—Residential and Commercial Building Technologies—Advanced Case (2012).

FOCIS Associates, Industrial Technology and Data Analysis Supporting the NEMS Industrial Model (2005).

# Acknowledgments

The Georgia Tech team wishes to thank Etan Gumerman (Duke University), and Karl Hausker, Rebecca Gasper, Kristin Meek, and Nate Aden (World Resources Institute) for supporting this work financially and also intellectually by sharing the substantial knowledge about energy systems modeling and policies with us. In addition, we are grateful to the Energy Information Administration’s team leaders and analysts who spent time consulting with the Duke-Georgia Tech team on options for modling a low-carbon future in NEMS, including: Dan Skelly, Paul Kondis, Elizabeth Sendich, Erin Boedecker, Kay Smith, Russ Tarver, Kelly Perl, Chris Namovicz, and Eric Krall. Nevertheless, the authors take full responsibility for any errors in this manuscript.

**Methodological Appendices and Documentation:**

Files and other backup information on this project can be found on the Georgia Tech T-square site under NEMS User Group: Duke-WRI project.

The README file prepared by Jeff Hubbs is in:

/cygdrive/l/result\_library/special\_cases/wri\_duke\_combined\_scenarios/input/ alongside the scedes file that was used to run it. The lines appearing after the "<" symbol belong to the first file listed in the diff arguments (in this case, the ref2014 scedes file) and the appearing after the ">" symbol belong to the second file listed in the diff arguments. So where you see

607c607

< RSMELSN=$NEMS/input/rsmels.v1.14.txt

---

> RSMELSN=/cygdrive/m/nemshome/yw3/WRI/rsmels-as.txt

that means that in line 607, the RSMELSN identifier refers to the stock rsmels.v1.14.txt in the ref2014 scedes file and to Yu's rsmels-as.txt in her scedes.all.wri.as+bc.txt file. But as the README explains, the two sets of differences were then applied to the stock hightech scedes file, when was then further altered to grab the stock "high tech" ktek file.

Below are two sets of diff output between scedes.all.ref2014.d102413a vs. scedes.all.wri.as+bc.txt and

scedes.all.ref2014.d102413a vs. scedes.indhech.d111111x.txt. Both of the above scedes\*.txt files used scedes.all.ref2014.d102413a as their starting point and both sets of diff results were applied to scedes.all.hightech.d121813a to produce the scedes file used for this "all-up" run for Duke/WRI.  Also, the scedes file's KTEKN variable was changed to point to $NEMS/mid/kja/aeo2014/ktek/ktek\_high2014.xml.

$ **diff /cygdrive/m/n14/homedir/scedes.all.ref2014.d102413a WRI/tsquare\_contents/Residential-Yu\ Wang/AS+BC/scedes.all.wri.as+bc.txt**

3,4c3,4

< EXBUILD=1

< RDCVFACT=1

---

> EXBUILD=0

> RDCVFACT=0

22c22

< MAXITR=6

---

> MAXITR=2

601,602c601,602

< RSMSHLN=$NEMS/input/rsmshl.v1.10.txt

< RSMEQPN=$NEMS/input/rsmeqp.v1.14.txt

---

> RSMSHLN=$NEMS//mid/wco/aeo2014/sidecases/rsmshl-best.txt

> RSMEQPN=/cygdrive/m/nemshome/yw3/WRI/rsmeqp-as.txt

605c605

< RSMLGTN=$NEMS/input/rsmlgt.v1.17.txt

---

> RSMLGTN=$NEMS/mid/wco/aeo2014/sidecases/rsmlgt-best.txt

607c607

< RSMELSN=$NEMS/input/rsmels.v1.14.txt

---

> RSMELSN=/cygdrive/m/nemshome/yw3/WRI/rsmels-as.txt

$ **diff /cygdrive/m/n14/homedir/scedes.all.ref2014.d102413a Industrial-Matt\ Cox/scedes.indhech.d111111x.txt**

19c19

< NRUNS=8

---

> NRUNS=20

22c22

< MAXITR=6

---

> MAXITR=2

290c290

< INDRUNN=$NEMS/input/indrun.v1.24.txt

---

> INDRUNN=$NEMS/input/indrun.v1.22.1.2.txt

410c410

< WODSUPPN=$NEMS/input/wodsupp.v1.44.txt

---

> WODSUPPN=$NEMS/rec/gja/aeo2014/sidecases/locstren/wodsupp.lcr\_2014.txt

463c463

< ITECHN=$NEMS/input/itech.v1.105.txt

---

> ITECHN=/cygdrive/m/nemshome/wc6/wriindrun/itechhechigh.txt

531c531

< INDCOGENN=$NEMS/input/indcogen.v1.11.xml

---

> INDCOGENN=/cygdrive/m/nemshome/wc6/wriindrun/indcogen\_indsc.xml

[2014] ~/WRI/tsquare\_contents

**Modeling details for the commercial sector**

We also explored using the following files to model commercial codes and standards:

Standards

|  |  |  |  |
| --- | --- | --- | --- |
|  | kintens.wri.txt |  |  |
|  | koffpen.best2014.txt | elctronic intensities | |
|  | kprem.v1.27.txt | electronics |  |
|  | ktek.best2014.xml | appliance standards |  |
| Codes | comm\_best2014.obj | includes shell improvements | |

**Modeling details for the industrial sector**

Peter Gross (EIA) wrote the following about using technology possibilities curves in the industrial sector module of NEMS‬‬:

Based on a pre-determined assumption regarding the “relative energy intensity” (REI) of the equipment in the final projection year (2040) compared to the base year (2010) the TPC can be constructed, as follows:

ENPINT(2040) = ENPINT(2010) \* (1 + TPC)^(2040 – 2010)

which means that TPC = [ENPINT(2040)/ENPINT(2010)]^[1/(2040 – 2010)] – 1

and the predetermined REI is just ENPINT(2040)/ENPINT(2010).

This REI (and therefore TPC) is different in general for both old and new equipment. Each year the TPCs are applied to the energy intensities (ENPINT) to get the next year’s TPC (note that the TPC is subject to some slight acceleration via fuel prices…see pp. 100 – 101 of <http://www.eia.gov/forecasts/aeo/nems/documentation/industrial/pdf/m064(2013).pdf)>. In the ind.f code this operation is simply:

        ENPINT(IV,IFUEL,ISTEP)=ENPINTLAG(IV,IFUEL,ISTEP)\*(1.+TPCRate(iv))

where iv = 1 for old (vintage) equipment and iv = 3 for new equipment.

Now in the itech.txt input file that you have, the first column of numbers is the vintage ENPINT(2010) derived from MECS and other data sources, the second is vintage equipment ENPINT(2040) (assumes again a pre-determined REI), the third is the TPC derived as described above, the fourth is new equipment ENPINT(2010), the fifth is new equipment ENPINT(2040), and the last column is the derived TPC of the new equipment.

The bottom half of this file is set up the same way but used for the “hitech” case.

One caveat to the above discussion: for the new “process flow modules” (aluminum, glass, and cement) a technology choice algorithm, as opposed to the general TPC approach, is used. Also, in the new non-mfg modules, the TPC approach is used, but the TPCs are influenced by other NEMS model parameters such as buildings and heavy truck efficiency evolution.

Background details from Matt Cox:

WODSUPPN=$NEMS/rec/gja/aeo2014/sidecases/locstren/wodsupp.lcr\_2014.txt

Increases biomass supply for biomass CHP (this exact text needs to be added in the scedes replacing the WODSUPPN that currently exists in the reference scedes)

INDRUNN=$NEMS/input/indrun.v1.22.1.2.txt

Tells the model to use the HighTech scenario

INDCOGENN=$NEMS/mid/msi/aeo\_2012/sidecases/no\_sunset/indcogen.xml

Fix Indcogen, then rename the one called in your new scedes.

Oddball thing in the high-tech case: you always buy a new efficient motor when making the choice between rewinding and replacing, regardless of payback.

Super High efficiency case modeling

Modify iTech for bulk chemicals, pulp and paper, iron and steel, and cement applications, based on new TPCs you just calculated from Nat’l Academies/the Bridge

Leave the wood supply as it was in the indsc run; same for indcogen

Old (existing) equipment is assumed to achieve 80% of the % change, which is then divided as an annual improvement. New equipment, matching other assumptions in ITech is modeled as achieving 50% better TPCs than the existing equipment. A High and Low case were developed, based on the highest and lowest economic potentials reported in Brown, Cox and Cortes 2010.

See the clustered directories at M:\graf2000\wcox6\IndEff.txt.

The directories are:

M:\n14\2014 AEO Side Cases\2014 Reference Case\ref2014.0707a.RAN

M:\n14\2014 AEO Side Cases\25$ Carbon Tax Side Case\wc6co2fee25.a.0717a.RAN

M:\nemshome\wc6\wriindrun\indsc.r\d072314a\indsc.r.0723a.RAN

M:\nemshome\wc6\indhech.d\d080314a\indhech.d.0803a.RAN

M:\nemshome\wc6\indhecl.d\d080414a\indhecl.d.0804a.RAN

The following files produce the most ambitious case of industrial energy that we modeled for Duke-WRI.

In your scedes, you will need to use:

FILE: itech: itechhechigh.txt

WHAT IT DOES: This file improves the technology possibility curves in five major energy consuming industries to levels consistent with studies of the economic potential in industry.

FILE: indcogen: indcogen\_indsc.xml

WHAT IT DOES: This file extends the CHP tax credits through 2040. It also contains the information used when the hightech flag is switched on, which increases the speed of cost declines for CHP systems.

1. NEMS reports changes in electricity use and fuel used in electricity generation as well as direct fuel use. [↑](#footnote-ref-1)
2. Even when the same NEMS code is used on two hardware systems with the supporting software, the results could be distinct from those of the EIA. The fact that the GT-NEMS Reference case nearly duplicates the EIA’s Reference case indicates that the two models are essentially identical. [↑](#footnote-ref-2)
3. NEMS scales pulp-and-paper-associated CHP with biomass supply. [↑](#footnote-ref-3)