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$ontext
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Title: long-run screening curve analysis
Remark: A LP capacity expansion model without network. The output is the ratio
        of new capacity. The key is the imposition of NOx cap.

set
h plant index /1*1453/
t time period /1*20/
tc technology /1*13/
ff fuel type /coal, gas/
ll /up,lo/
f /1*9/
oz(t) ozone period
pp(h) dynamic set of existing generators
p new tech /coal,igcc,adnuke,con_cc, ad_cc, con_ct, ad_ct/
a attributes
/scap,plantid,pcaid,ownerid,fuel,state,arain,nox,so2,frate,varom,fcost,hrate,hrsen,capsen,
maxres,year,type,cfac,match/
aa nox cap /otc_00, otc_01, otc_02, arain/
aload /Load, Hours/
anew attributes for new capacity
/lcost,fcost,vcost,hrate,cfac,frate,arain,otc,so2,nox,fixom,fuel/;
oz(t)=yes$(ord(t)<=10);

*Include generator data*
table d(h,a) pjm and ecar generation information
$include c:\My Stuffs\My
Research\epa\capacityexpansion\model\pjm_ecar_generation_data_revised.txt
;
table dn(p,anew) new generation info
$include c:\My Stuffs\My
research\epa\capacityexpansion\model\new_cap_nems_01011.txt
;
table cap(h,aa) emission cap affiliation
$include c:\My Stuffs\My Research\epa\capacityexpansion\model\pjm_nox_cap.txt
;
table dload(t,aload) load block
$include c:\My Stuffs\My
Research\epa\capacityexpansion\model\screen_curve_PJM_ECAR_load_block_90s_120
1.txt
;
parameter
b(t) blcok width
load(t) demand in period t
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retire(h) retire index;


b(t)=dload(t,"hours");
load(t)=dload(t,"load");


scalar
capnox nox cap /129110/
scale scale to adjust for % of permits used /0.8/
m multiplier /1.0187/
pen penality on unserved energy /10000000/
pso2 price of so2 permis /750/

parameter
e(h) plant h nox emission rate
c(h) variable cost
cn(p) new p generation
fcap(f) firm total capacity
en(p) new p type generation nox emission rate
rcost(h) additional cost for coal after 30 yrs;


rcost(h)=0;
rcost(h)$(d(h,"type")=13 and d(h,"year")>1965)=0*d(h,"scap");

*efficiency or heat rate adjustment*
*capacity adjustment*
c(h)=d(h,"varom")+d(h,"hrate")*d(h,"fcost")/100000+pso2*d(h,"so2")*cap(h,"arain");
*in $/MWh and in tons/MWh*
e(h)=d(h,"hrate")*d(h,"nox")/2000000;
en(p)=dn(p,"nox")*dn(p,"hrate")/2000000;
cn(p)=dn(p,"vcost")+dn(p,"hrate")*dn(p,"fcost")/1000+pso2*dn(p,"so2")*dn(p,"arain");
*cn("coal")=dn("coal","vcost")+dn("coal","hrate")*dn("coal","fcost")/1000+pso2*dn("co
al","so2")*dn("coal","arain");
*cn("con_cc")=dn("con_cc","vcost")+dn("con_cc","hrate")*dn("con_cc","fcost")/1000+p
so2*dn("con_cc","so2")*dn("con_cc","arain");
*cn("ad_cc")=dn("ad_cc","vcost")+dn("ad_cc","hrate")*dn("ad_cc","fcost")/1000+pso2*
dn("ad_cc","so2")*dn("ad_cc","arain");
*cn("con_ct")=dn("con_ct","vcost")+dn("con_ct","hrate")*dn("con_ct","fcost")/1000+ps
o2*dn("con_ct","so2")*dn("con_ct","arain");
*cn("ad_ct")=dn("ad_ct","vcost")+dn("ad_ct","hrate")*dn("ad_ct","fcost")/1000+pso2*d
n("ad_ct","so2")*dn("ad_ct","arain");
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variables
tcost total cost (objective);

positive variables
x(h,t) output level of h plant located in i node in t period
xn(p,t) output level of p generation at i node in st state in t period
u(p) new capacity in i node p type of capacity in st state
us(t) unserved energy at node i period t;

parameters
rt(h) retire vairable (0 retired and 1 otherwise);


*Fixed Values
*x.fx(h,t)$(d(h,"year")<1965 and d(h,"type") <> 7 and d(h, "type")<>11)=0;

rt(h)=1;
rt(h)$(d(h,"year")<1965 and (d(h,"type") <> 7 or d(h, "type")<>11))=0;

equations
obj objective minimize cost
eq1(h,t) less than plant capacity
eq1n(p,t)
eq2(h)
eq2n(p)
eq3 load constraints
eq4 epa nox cap
eq5 icap constraint or reserved margin
;
*+sum((i,t),us(i,t)*b(t)*pen)

*d(h,"cfac")=0.8;
obj..tcost=e=sum((h,t),x(h,t)*b(t)*c(h))+sum(p,(dn(p,"lcost")*1000+dn(p,"fixom")*1000
)*u(p))+ sum((p,t),xn(p,t)*cn(p)*b(t)+sum(h,rcost(h)*rt(h)));
eq1(h,t)..x(h,t)=l=d(h,"scap")*(1-d(h,"frate"))*rt(h);
eq1n(p,t).. xn(p,t)=l=u(p)*(1-dn(p,"frate"));
eq2(h)..sum(t,x(h,t)*b(t))=l=8760*d(h,"scap")*d(h,"cfac");
eq2n(p) .. sum(t,xn(p,t)*b(t))=l=8760*dn(p,"cfac")*u(p);
eq3(t)..sum(h,x(h,t))+sum(p,xn(p,t))-load(t)=g=0;
eq4..sum((h,t)$(cap(h,"otc_02")=1 and
oz(t)),x(h,t)*e(h)*b(t))+sum((p,t)$oz(t),xn(p,t)*en(p)*b(t))=l=capnox*scale;
eq5.. sum(h,d(h,"scap")*rt(h))+sum(p,u(p))=g=load("1")*1.15;

model pjm /all/;
option iterlim=1000000000;
option ResLim=100000000;
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solve pjm using mip minimizing tcost;
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