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Regulation of Air Pollution and Economic Growth in Ukraine: A General Equilibrium Approach

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Research Objectives

1. Evaluate the different scenaria of Ukrainian economic development and air pollution

2. Evaluate the domestic measures vs. international collaboration options to regulate Ukrainian air pollution:
   - domestic ETS
   - post-Kyoto targets based on the ongoing negotiations
   - linkage of Ukrainian and European ETS

3. Incorporate NOx, CO, NMVOC, $PM_{2.5}$ and PM_{10} into the ICES model

4. What effect these instruments will have on:
   - levels of air pollution (CO2, SOx, NOx, CO, NMVOC, TSP)
   - mortality/morbidity from air pollution
   - Ukrainian economic performance

5. Develop the policy recommendations

1 Ukrainian economy at a glance

- Energy-intensive and resource-based economy that operates outdated industrial infrastructure
- Energy intensity per capita and per GDP (PPP) is one of the highest in the world (IEA)
- Highly dependent on imported energy: 77% of oil and 72% of gas consumed in the country are imported
- Great potential for energy savings and reductions in GHG emissions due to the low energy efficiency (World Bank):
- 750 M t CO2-e can be reduced with MAC below $8/tCO2-e
- 1/3 of this emission reduction can be achieved via energy efficiency
- 1.35 bln t CO2-e of “hot air” during 2008-201
- 56 Mt CO2-e of Ukrainian AAUs were sold so far (July 2010)

2 Ukrainian Energy Sector and Air Pollution

Ukraine's energy sector is a major contributor to local and transboundary air pollution:

- 96% of NOx •93% of SOx • 50% of TSP
- 70% of domestic GHG • 78% domestic CO_2
- annual mortality from NOx, SOx ,TSP is 192,000 YOLL (World Bank)
- $PM_{2.5}$ causes 6% of mortality in Ukraine
- economic damage related to mortality from air pollution exceeds 4% of GDP (A.Golub,E.Strukova, A.Markandya)

- CO_2 has never been regulated in Ukraine

3 Ukrainian post-2012 GHG policy:

GHG abatement by 20 % until 2020 and by 50% until 2050 taking 1990 as a baseline year **(COP-15 Copenhagen)**

but:

- i.e. in 2020 Ukrainian GHG has to grow by 60% vs. 2007 (in 2007 GHG emissions were 50% of 1990 level)
- Ukrainian production has already slumped down by 30% (2009 vs 2008) which led to further GHG abatement
- Prospects regarding the fast economic recovery are pessimistic

4 The main principles of UNFCCC`s “equitable” reductions:

2º C target: GHG stabilization at 550 ppm by 2100. i.e. CO_2 at 450 ppm (~30% CO_2 reduction by 2050 vs. 1990) and non-CO_2 at similar rates

-**Sovereignty and acquired rights:** all countries have a right to use the atmosphere and current emissions constitute a ‘status quo right’

-**Historical responsibility**: the greater the contribution to the global warming, the greater the share in the mitigation

-**Capability:** the greater the ability to pay for emission reduction, the greater the share in the mitigation

- **Egalitarian:** each person has an equal right to use the atmosphere

Scenaria: Ukraine in a Post Kyoto world

ET90. 20% CO_2 reduction by 2020 and 50% by 2050 vs. CO_2 level of 1990 **(Ukrainian target, Sovereignity and acquired rights)**

ET06. 20% CO_2 reduction by 2020 and 50% by 2050 vs. CO_2 level of 2007 **(NEAA, ERC, IIASA target for Ukraine)**

Hist. 22% increase in CO_2 emissions by 2050 comparing with 2007 level. **(Historical responsibility principle)**

MAC. equalization of Ukrainian MAC with the global one allows for 14% increase in national CO_2 by 2050 from the level of 2007(**the Capability Principle**)

pCap. 77% reduction of Ukrainian CO_2 by 2050 vs. 2007. **(Egalitarian principle)**

BAU. no emission reduction, baseline trajectory

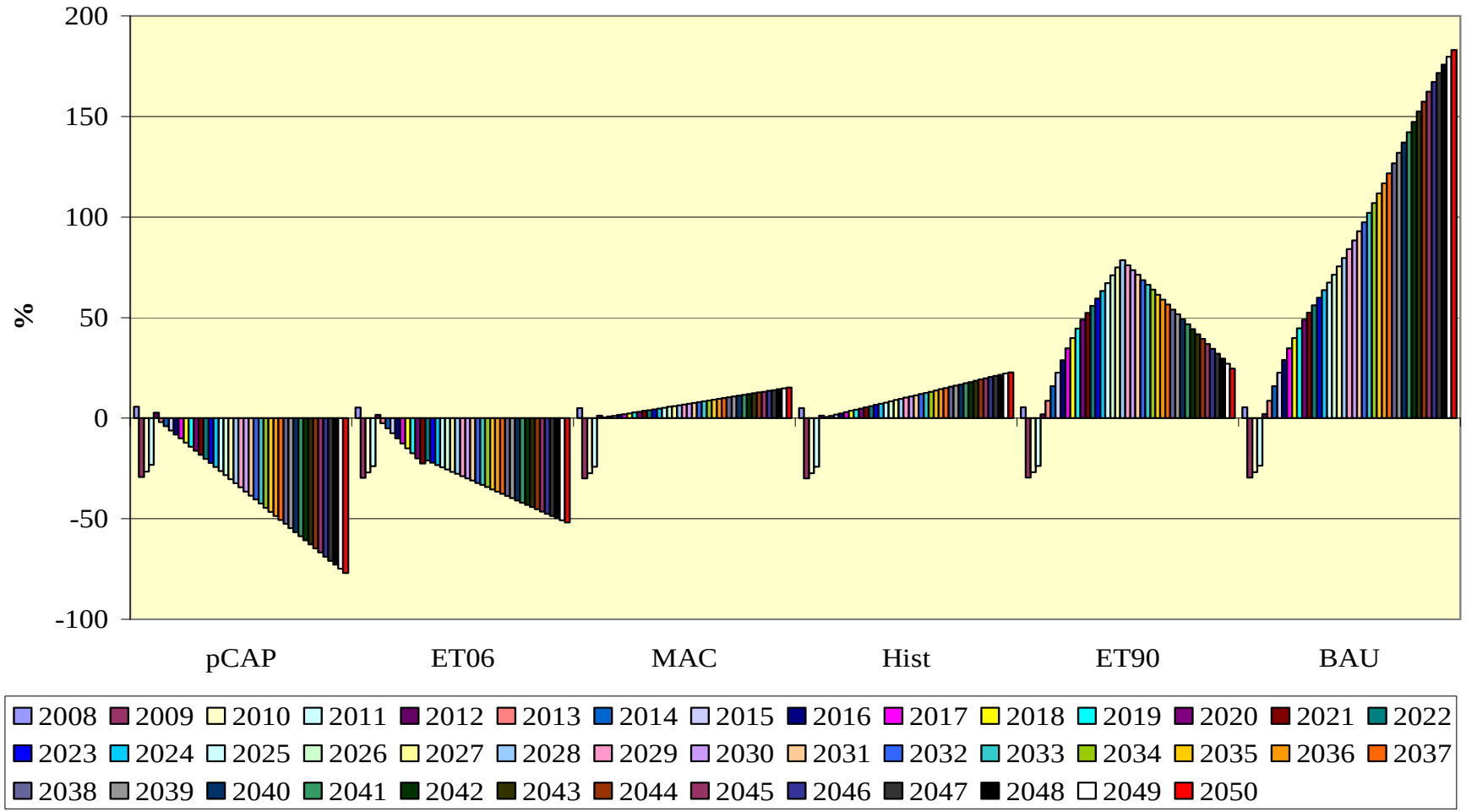
Methodology:

A dynamic forward-looking general equilibrium model of Ramsey-Cass-Koopmans type (GAMS/MPSGE)

No emission reduction for Ukraine until 2012

- **Instrument: domestic CO_2 emission trading**
- **Permits allocation: 100% output-based grandfathering in 2013 but amount of auctioned permits is increased each year in order to arrive to 100% auctioning in 2050**

Results:



Energy-related industry CO_2,% vs. 2007

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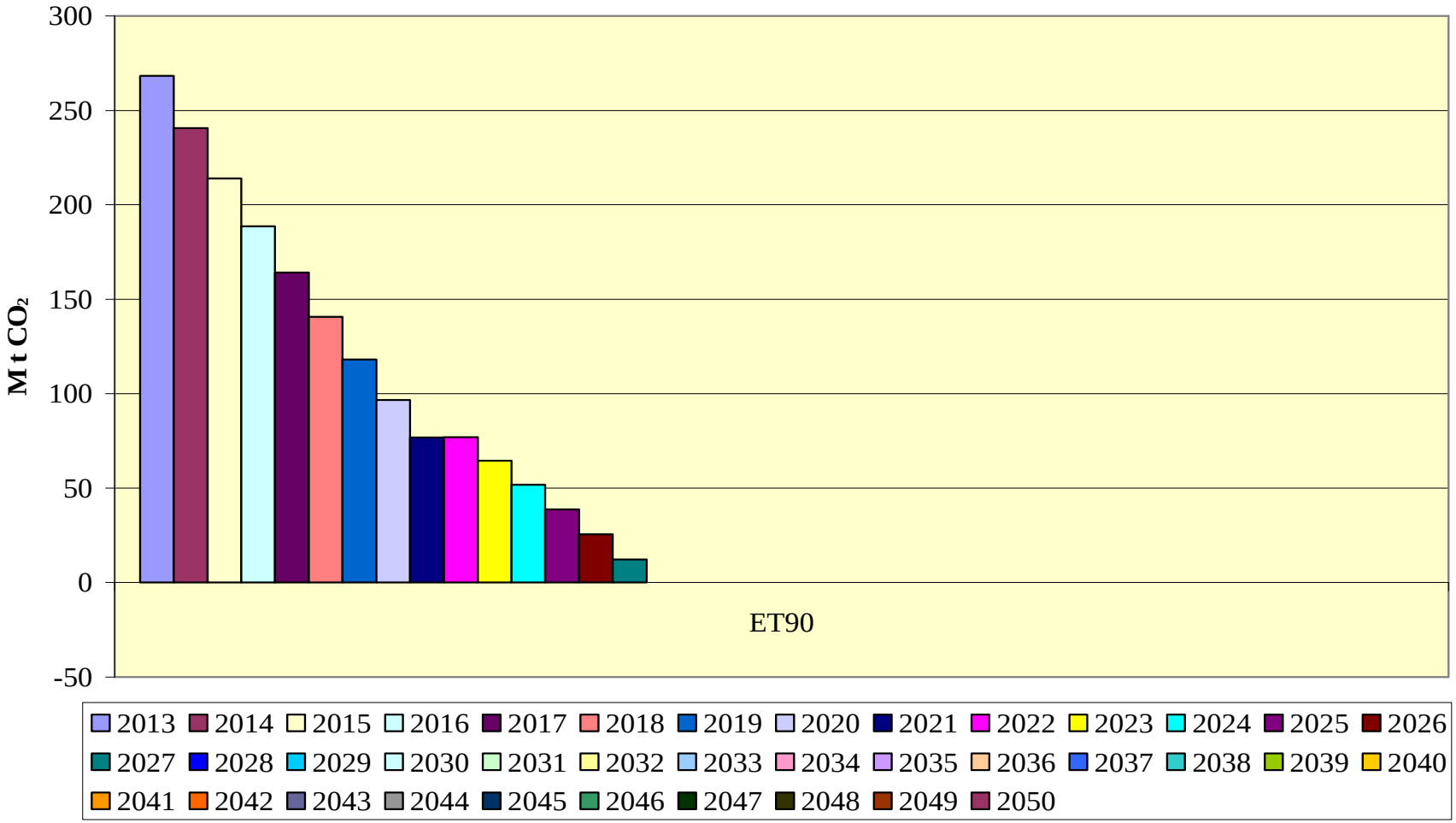
Results:



Excess of the AAUs

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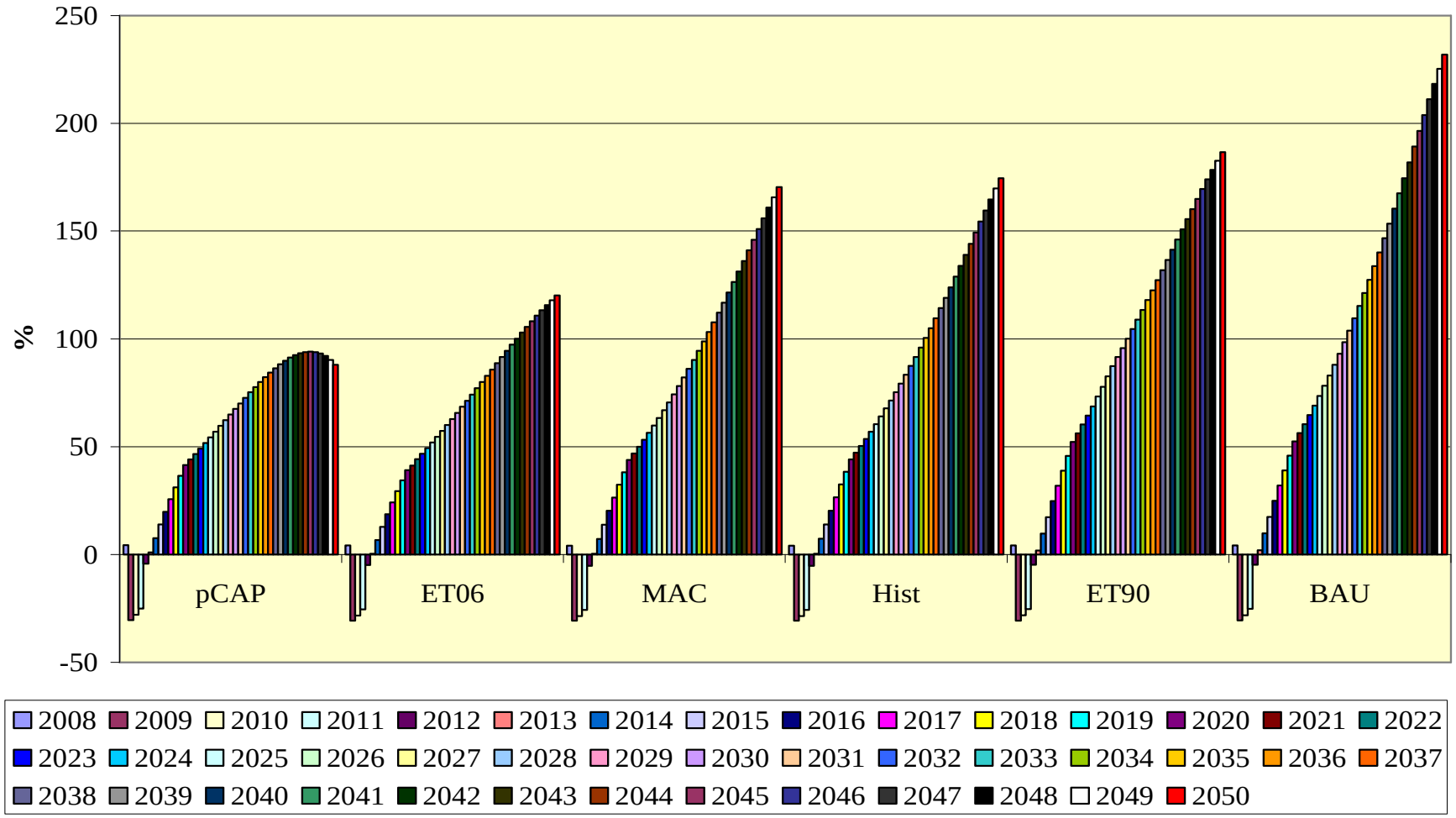
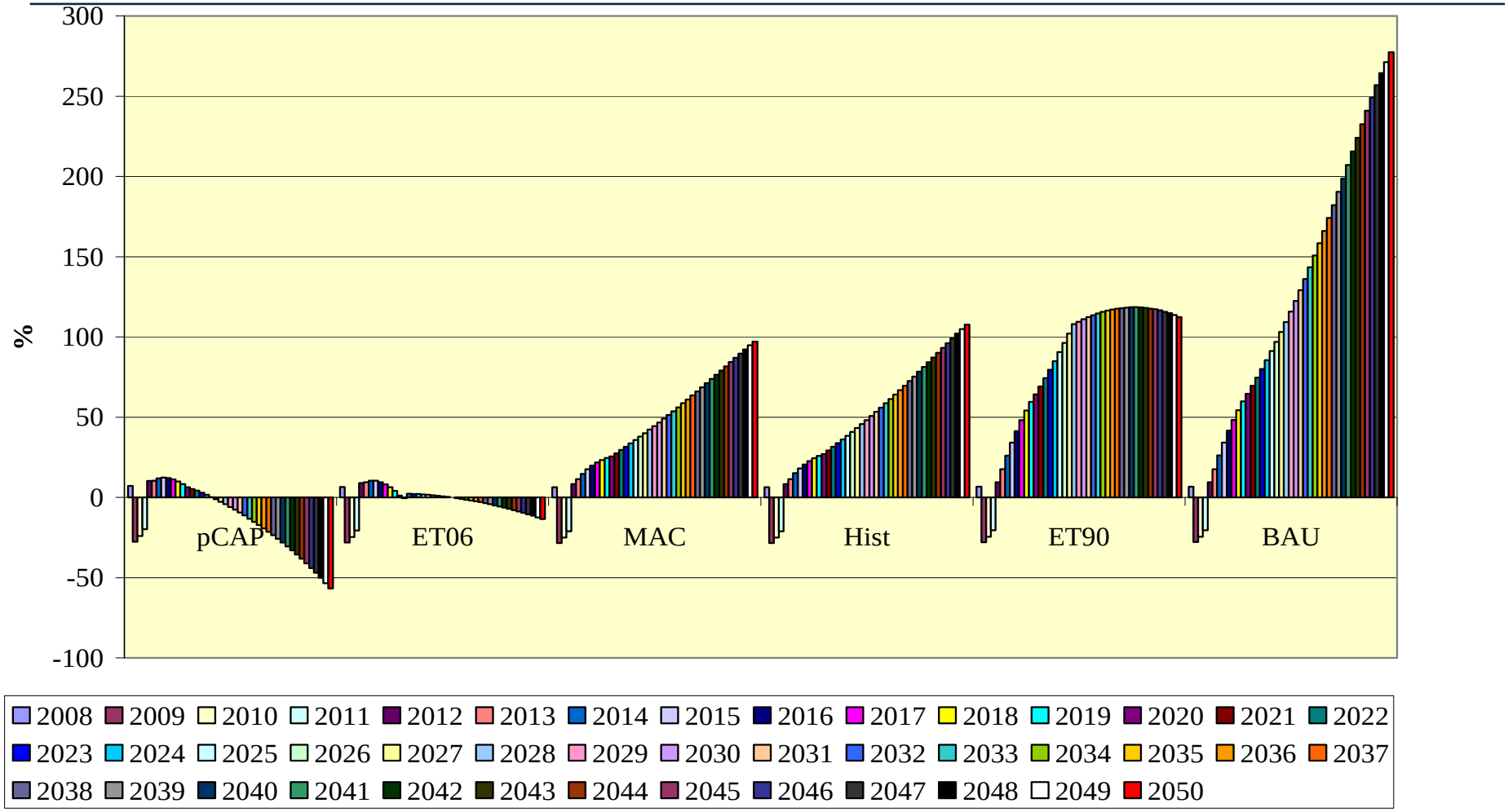
Results:



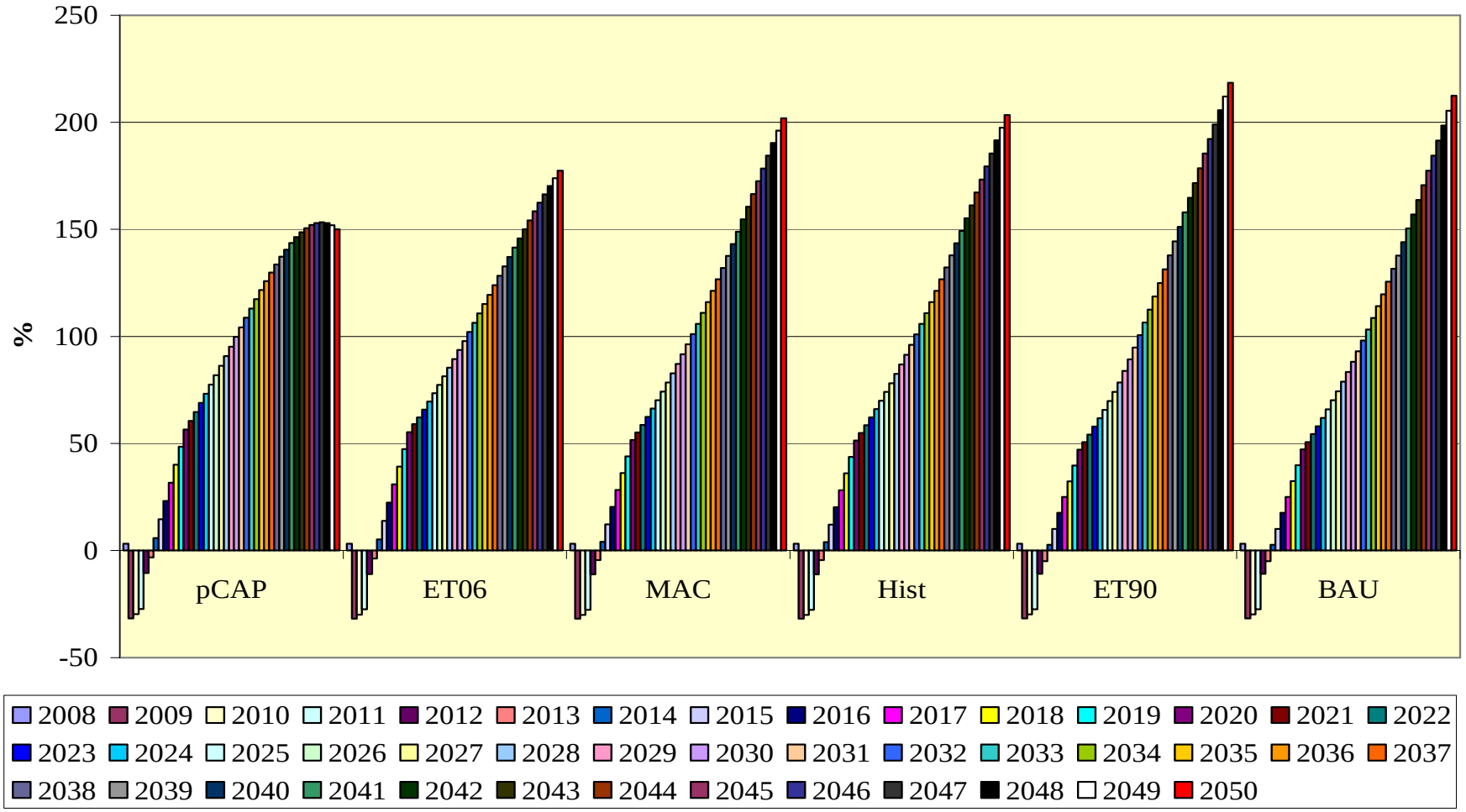
Cumulative industry output, % vs. 2007

Results:



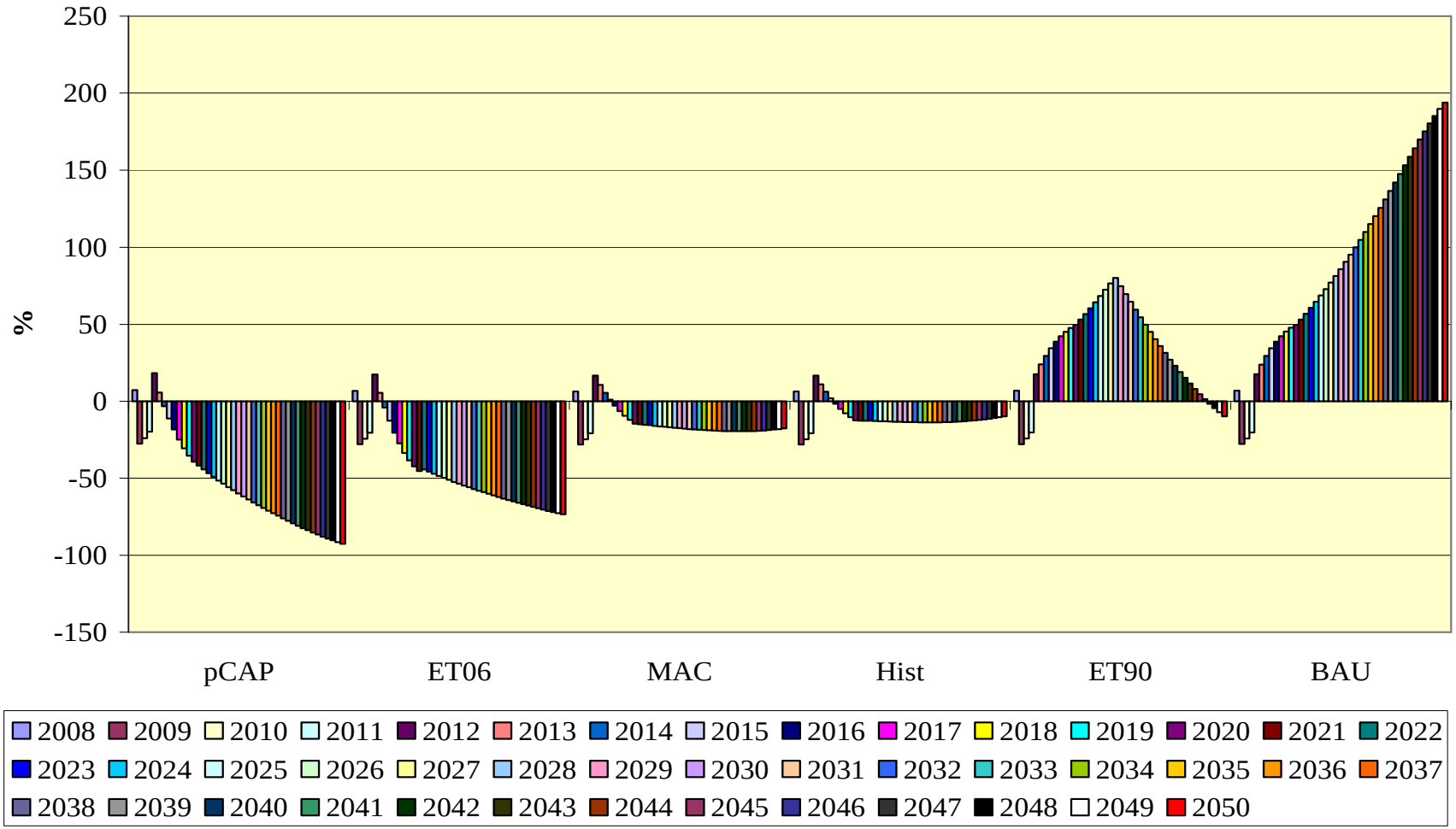
Output of the most energy intensive sectors, % vs. 2007

Results:



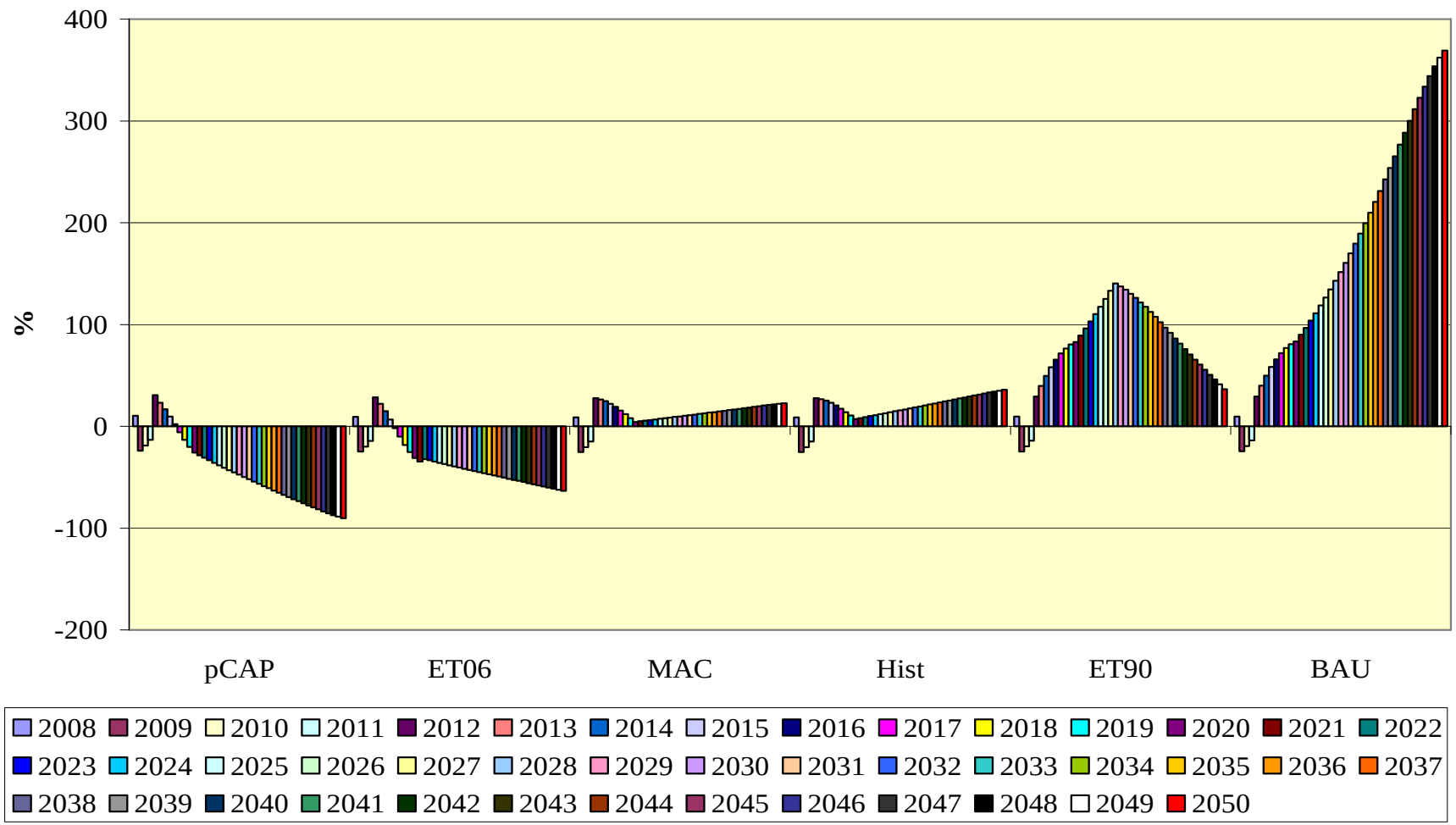
Output of the least energy intensive sectors, % vs. 2007

Results:



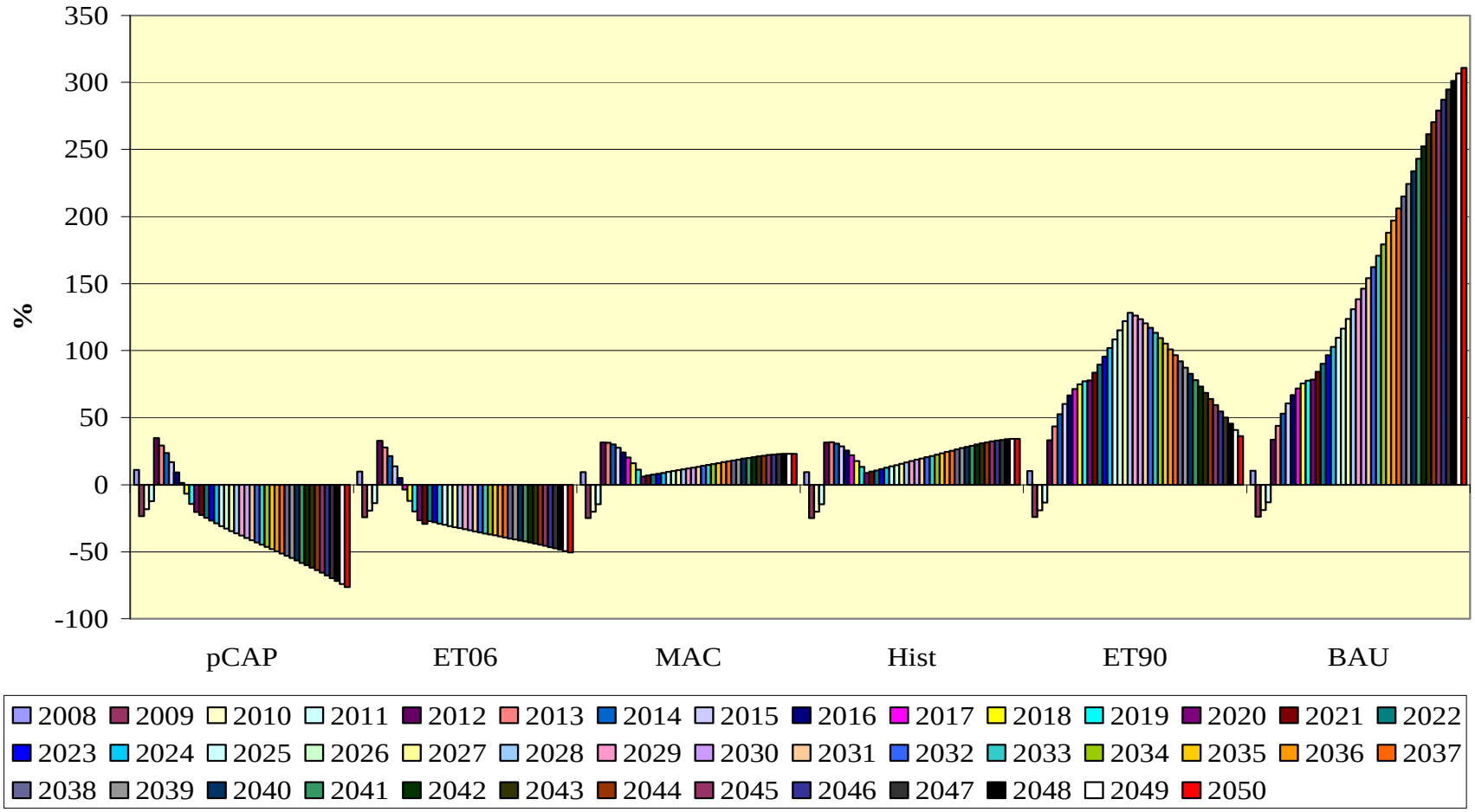
Output of the coal sector, % vs. 2007

Results:



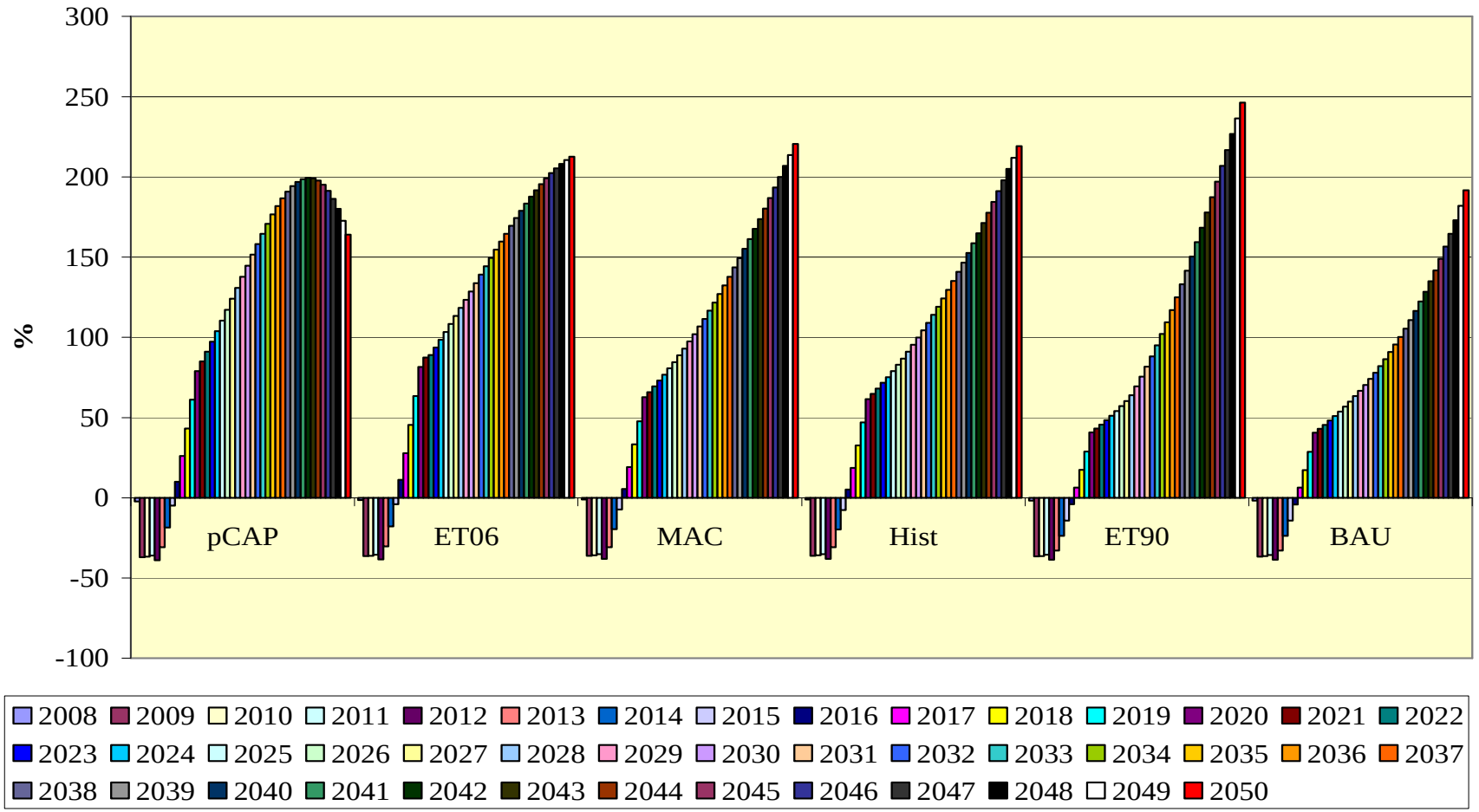
Output of the coke sector, % vs. 2007

Results:



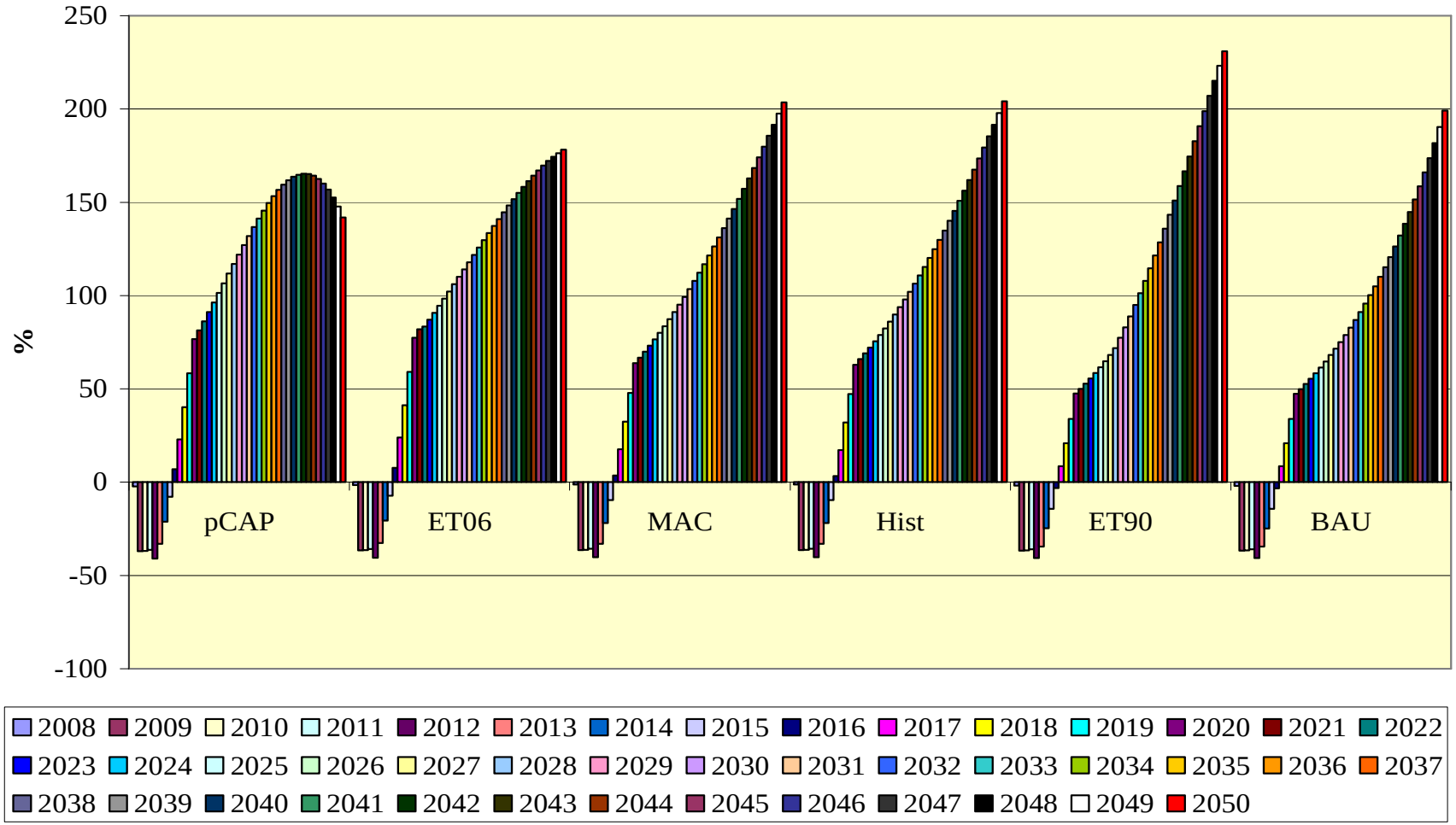
Output of the metallurgical sector, % vs. 2007

Results:



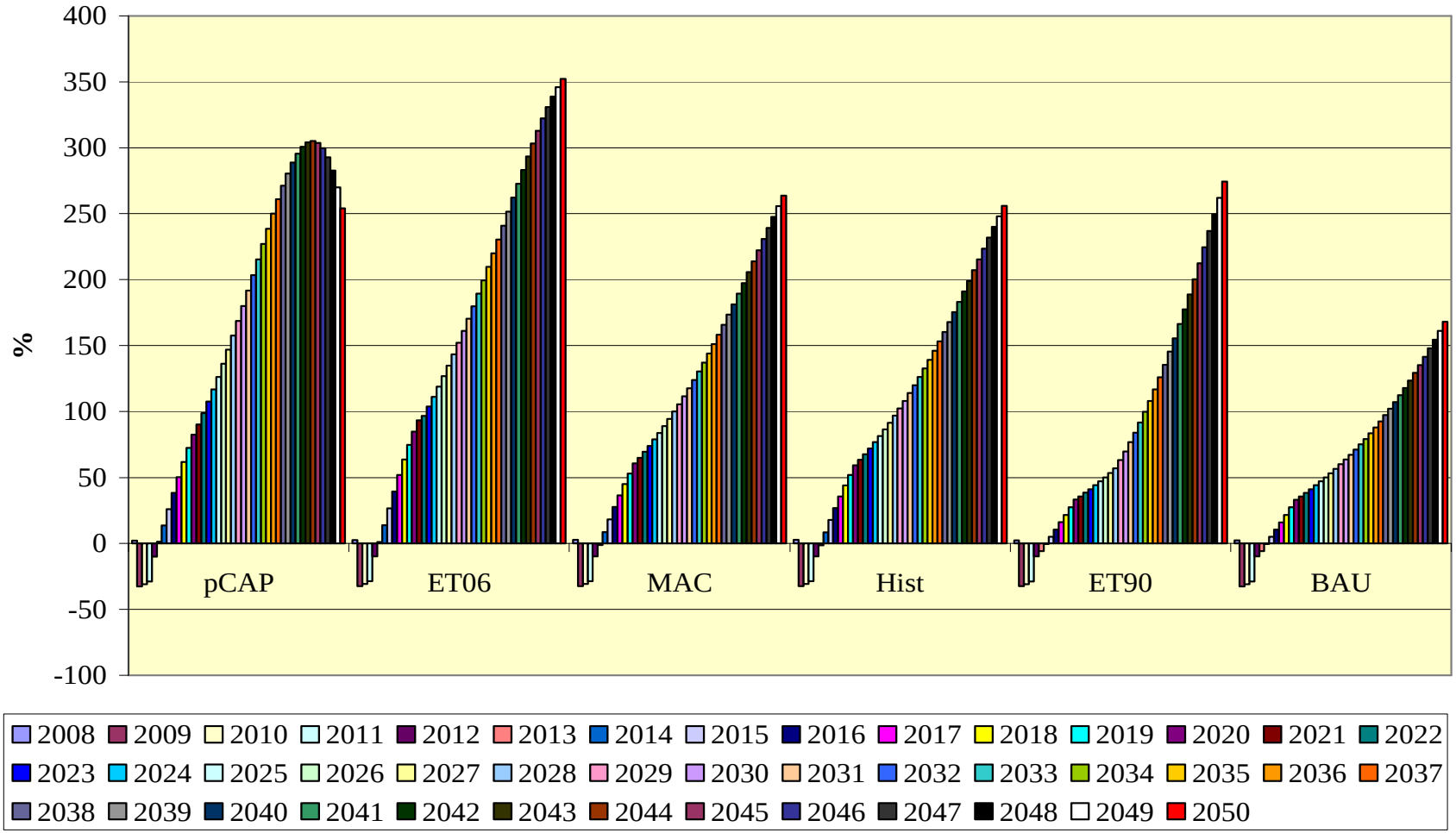
Output of the food processing sector, % vs. 2007

Results:



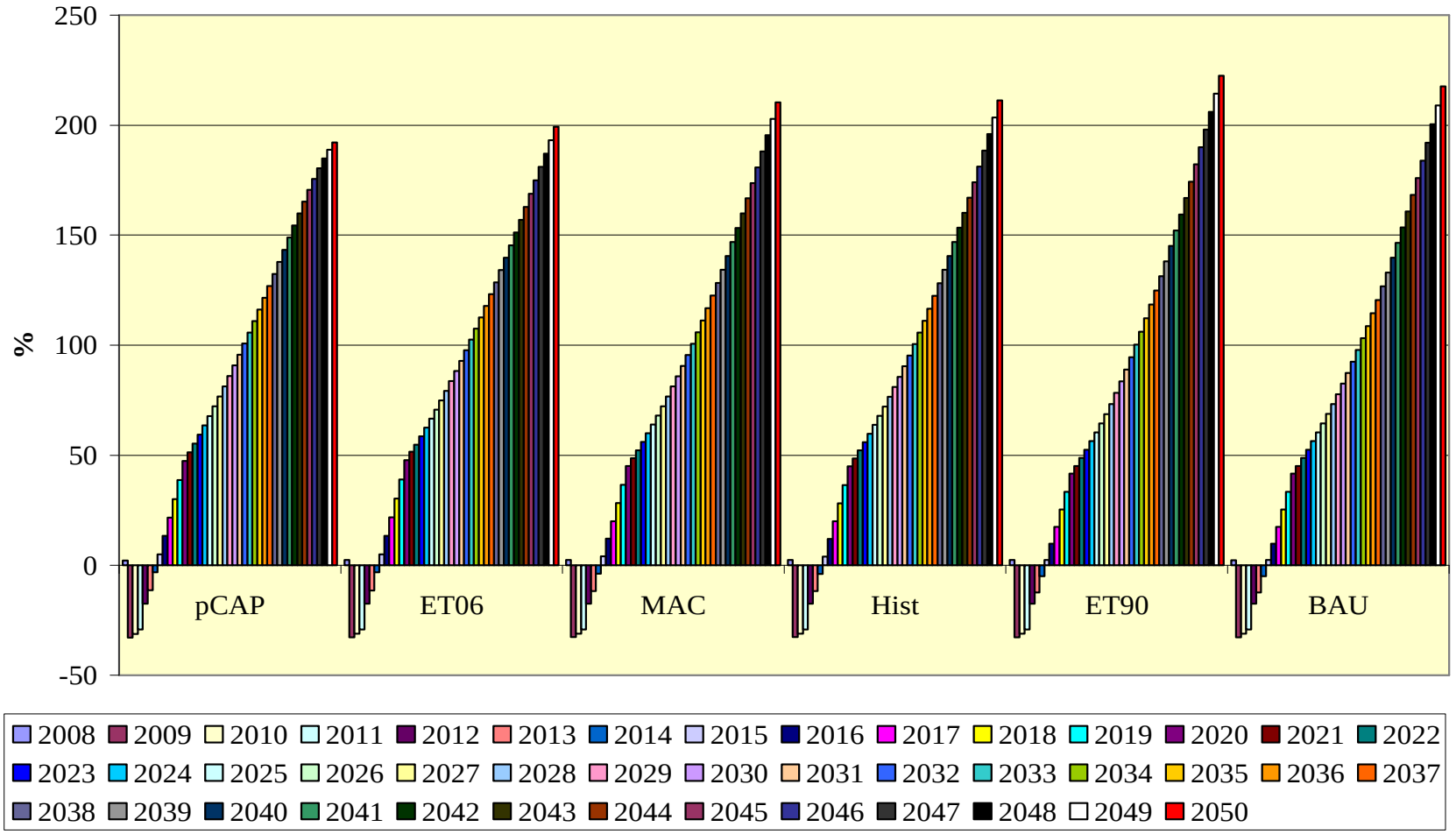
Output of the agricultural sector, % vs. 2007

Results:



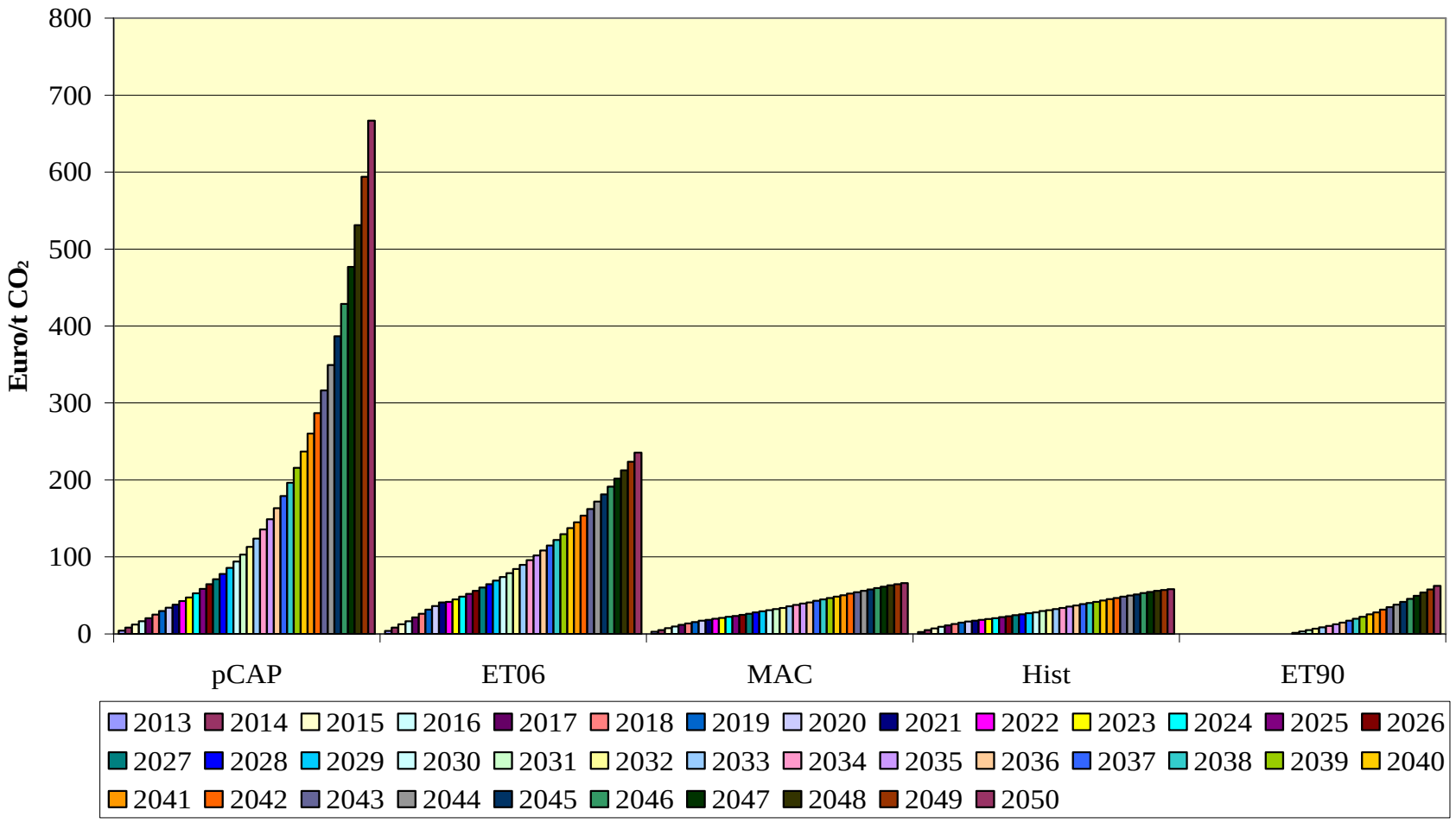
Pulp and paper production, % vs. 2007

Results:



Output of the ROI aggregate, *% vs. 2007*

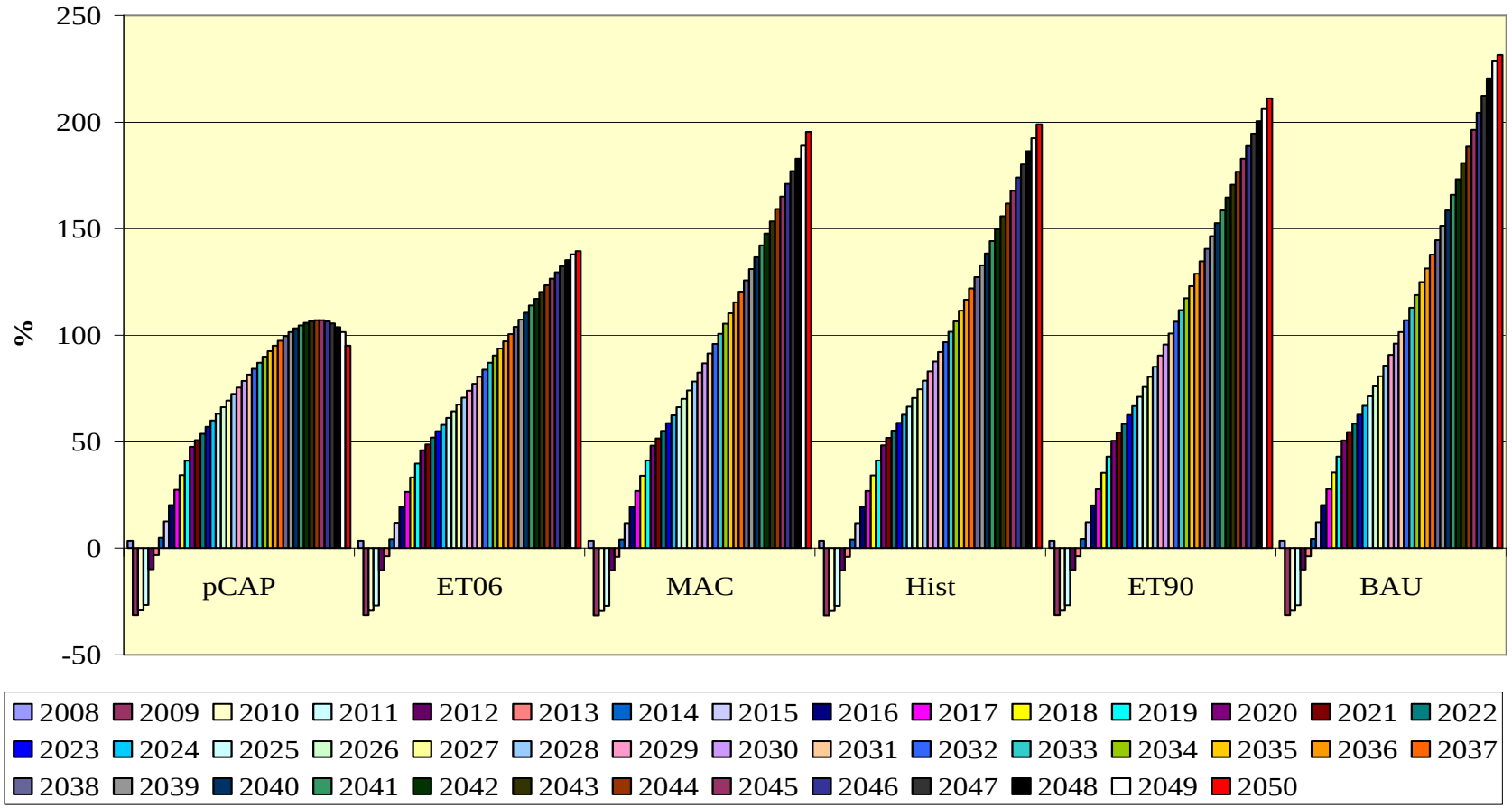
Results:



MAC, Euro/t CO_2

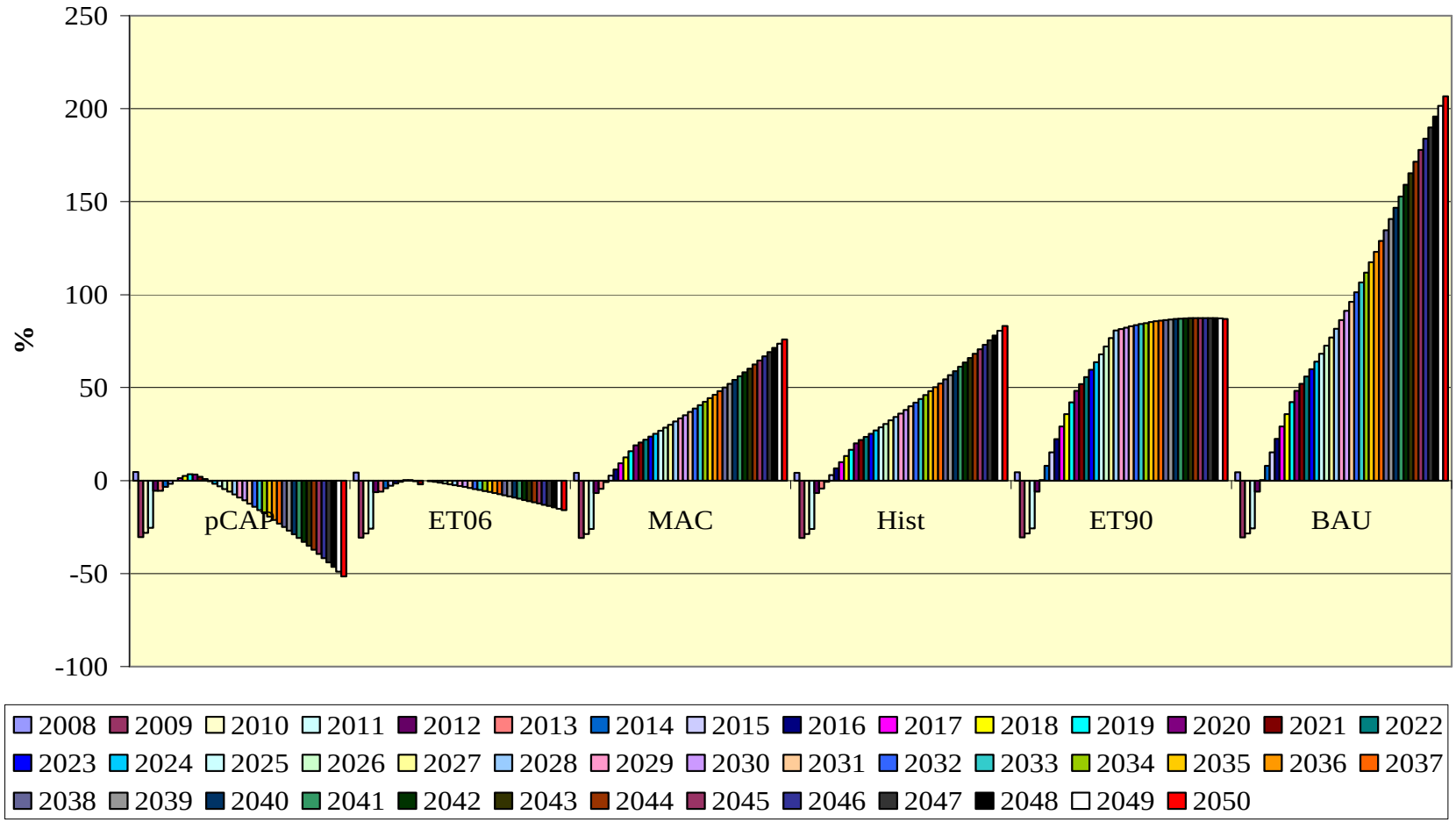
Fondazione Eni Enrico Mattei

Results:



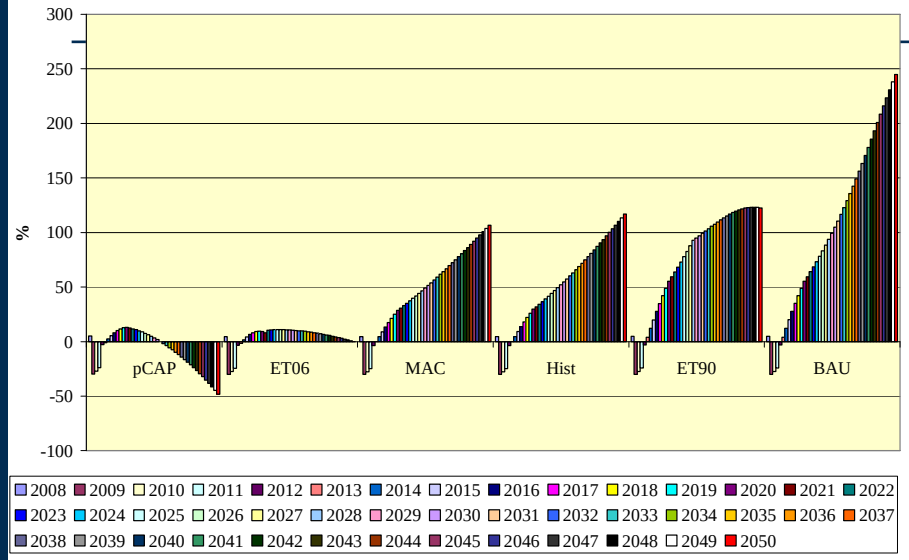
GDP, % vs. 2007

Results:

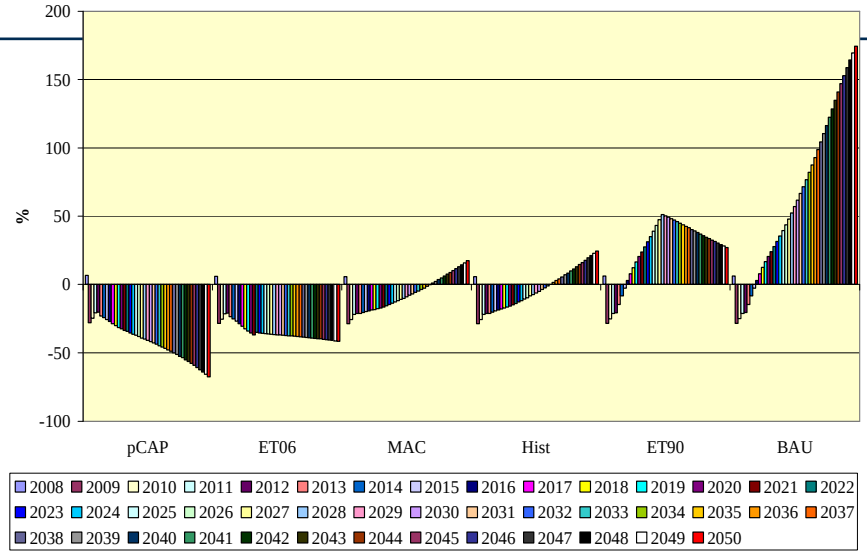


Domestic energy consumption, % vs. 2007

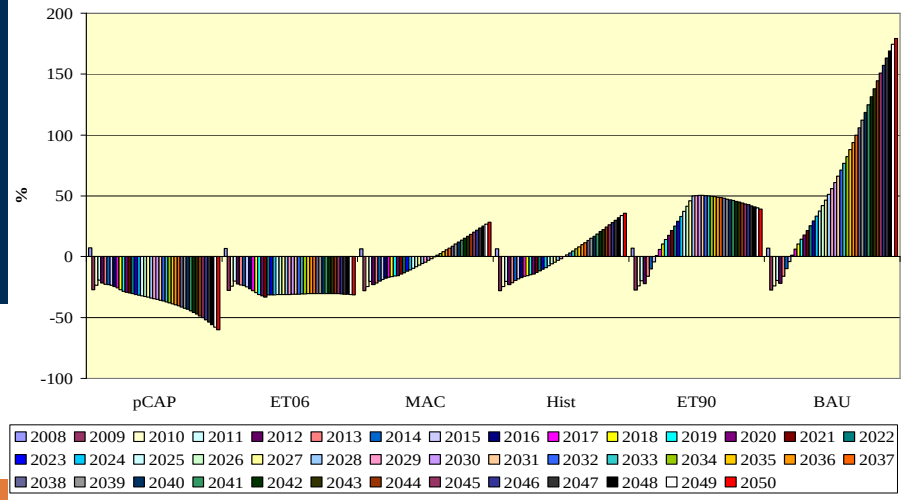
Results:



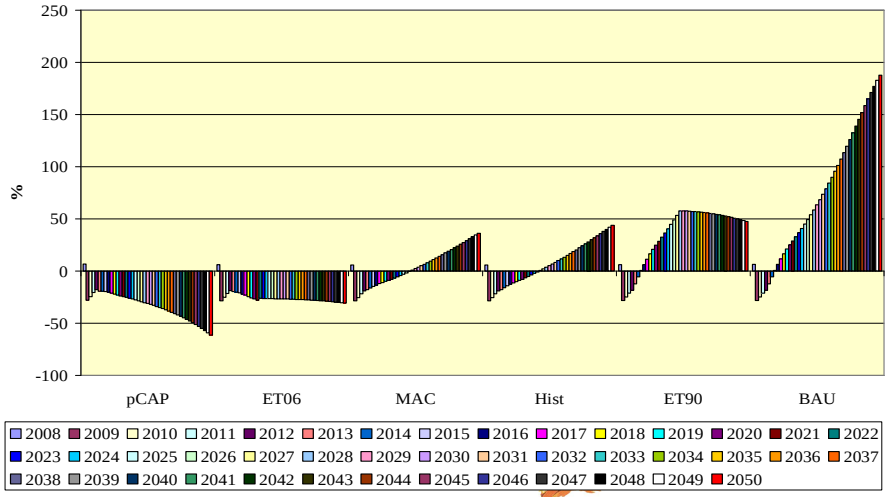
NO_X (% vs. 2007)



SO_X (% vs. 2007)



TSP (% vs. 2007)



Mortality and morbidity (% vs. 2007)

Insights:

CO_2 abatement fits the national interests of Ukraine

- Reduced energy consumption
- Structural changes towards the least-energy intensive industries
- Signigicant health improvements due to reduced air pollution

The magnitude of these effects strongly depends on stringency of CO_2 reduction target

All scenaria show similar pace of growth in cumulative output and GDP until 2020

- Even the most even stringent pCap and ET06 scenaria can be considered as policy measure in 2013-2020

- Such targets may be adopted for a longer term if significant technological improvements in energy saving are achieved in the country

- Otherwise scenaria MAC and Hist that ensure both economic growth and CO_2 abatement can be selected

Work in progress:

- Simulate the alternative Post-Kyoto policies for different regions and the ancillary benefits associated with them with the ICES model developed by FEEM

Inclusion of the sector-level CO_2 trade into the ICES

The idea:

- **To shock the sectoral CO_2 prices/CO_2 emissions at different rates**
- **To include selected sectors in the regional CO_2 trading**
- **To specify which sectors can trade CO_2 internationally**

Inclusion of the sector-level CO_2 trade into the ICES

Region r

Domestic ETS sectors	Non–ETS sectors
Carbon price- SCTAX (r,i)= SCTAX (r,j)=…=NCTAXets(r)	Carbon priceS- SCTAX (r,l), SCTAX (r,k), …
Metallurgy, Pulp&Paper, … ,Aviation, Other EIS	Trade, Services, …, Road Transport
International CO_2 trade Carbon price- MARKCTAX	
Domestically trading sectors are involved (either all or none!) SCTAX (r,i)=SCTAX(r,j)=…=NCTAXets(r)= = MARKCTAX NCTAXets(r) = NCTAXets(p) = = NCTAXnets(s)=…=MARKCTAX	Non-ETS sectors are involved (can be any) SCTAX (r,k)= SCTAX(r,l)=… =NCTAXnets(r) NCTAXnets(r) =NCTAXets(s)=…=MARKCTAX

Inclusion of the sector-level CO_2 trade into the ICES

- COEFFICIENT TSEC(r,i) :1 = sector trades CO_2 domestically
- COEFFICIENT TREG(r,i) :1 = sector trades CO_2 internationally

SCTAX(r,i) =
(1-TREG(r,i))*TSEC(r,i)* (NCTAXets(r) + slackETSctax(r,i))
+ (1-TREG(r,i))*(1-TSEC(r,i))*(NCTAXnets(r) + slacknETSctax(r,i))
+ TREG(r,i)*TSEC(r,i)*MARKCTAX
+ TREG(r,i)*(1-TSEC(r,i))*MARKCTAX

ETS sectors in region R trade CO_2 internationally: (all,r: sum(i, TSEC(r,i)*TREG(r,i)) ge 1)

NCTAXets(r) = MARKCTAX + slackRegET(r)

Non- ETS sectors in region CO_2 trade internationally: (all,r: sum(i, (1-TSEC(r,i))*TREG(r,i)) ge 1)

NCTAXnets(r) = MARKCTAX +slacknRegET(r)

slackETSctax(r,i)
slacknETSctax(r,i)
slackRegET(r)
slacknRegET(r)

Slack variables, used to exogenize/endogenize sectoral or regional carbon prices

Inclusion of the sector-level CO_2 trade into the ICES

- **gSco2(r,j,i) - % change in CO2 by fuel by sector by region**
  - changes proportionally to the sectoral fuel consumption

- **Carbon limit for ETS sectors in region R:**

CO2Qets(R)*gco2Qets(R) = sum(j,egycom3,**sum**(i,tr_com_hh,
TSEC(R,i)*SCO2(R,j,i)*gSco2(R,j,i))

- **Carbon limit for non- ETS sectors in region R:**

CO2QnETS(R)*gco2QnETS(R) = sum(j,egycom3,**sum**(i,tr_com_hh,
(1-TSEC(R,i))*SCO2(R,j,i)*gSco2(R,j,i))

- **Regional carbon limit:**

CO2Q(R)*gCO2Q(R) =D_ETS(R)*CO2Qets(R)*gco2Qets(R)+
D_nETS(r)*CO2QnETS(R))*gco2QnETS(R)

Inclusion of air pollutants into the ICES

- Pollutants: NOX, CO, NMVOC, PM2.5, PM10
- Linked to the sectoral fuel consumption and to the output
- Regions: EU-16 (the largest EU economies and the aggregate of the smallest), Russia, Ukraine, FSU,China&India, MENA, Africa,Latin America, Canada, USA, ROW
- Projection of pollutants' baseline into 2020

Simulation with ICES the post-2012 GHG policies

- Alternative post-Kyoto targets and instruments of GHGs reduction for Annex I and Annex II countries
- Assessment of potential benefits from emission trading between the EU and FSU countries as their marginal abatement costs considerably vary

Thank you!

Questions? Suggestions?

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