Measuring the economic effects of the energy transition with the Three-ME model

5th February 2014: ETSAP-UCC Workshop
Macroeconomic Multisectoriel Model of Evaluation of the energetic and Environmental policies

Conceived by the ADEME and the OFCE since 2008
(Observatoire Français des Conjonctures Economiques)

Aggregate Supply and aggregate demand model,

Like the « neo keynesians » models which are currently used for the economic forecasting (Mesange INSEE and the Direction of the treasury, NEMESIS from Paris 1)

The model combines a top-down approach based on a neo-keynesian structure and bottom-up features in the modelling of consumption behavior
The ThreeME Model

- Macroeconomic Multisectorial Model for the Evaluation of Environmental and Energy policy
  
  - *Prices are not perfectly flexible (Mark up theory)*
  
  - *Wages are not perfectly flexible (Wage settings curve)*
  
  - *Interest rate is fixed by the Central Bank (Taylor rule)*
  
  - *Supply and demand interact together.*
  
  - *Increase in energy efficiency and sobriety with the fuel prices*
  
  - *Investment choices between energivor and sober equipments*
  
  - *Substitution between energy sources and transportation modes*
• 24 production sectors and 17 energetic sub-sectors

• The model takes into account the effect of a demand transfer from a sector to another in:

  • Employment and energy consumption,
  • Imports and exports
  • Hence the demand level and economic activity
  • Ex: a growth in renewable energy and a decrease of thermic central production lead to a growth in employment since they are more jobs intensive, and a decrease of energy imports.

• It takes into account the impact of credit supply on the production capacities (the monetary creation).
• Hence the eviction effect between investments is only limited
  Since spendings are not only financed by saving but also by credit supply

  Ex : a growth in building renovation
  • Does not generate a drop in households consumption in others areas,
  • People spendings diminish only by an amount equal to the annuities of debt induced
    by the renovation, less the amount of energy savings.

• One can show the existence of a double dividend
  • Not only because of a switch between labor taxes and energy taxes

  Ex : A growth in renewable investments
  • Generates a growth in global investment (the eviction effect is only limited)
  • That entails a growth in jobs and consumption (the supply boosts the demand)
  • Which leads to a increase in production (the demand boosts the supply)
  • And a decrease in unemployment
The energy consumption is not directly related to income

- Energy related to the number of buildings and cars
- Avoids unrealistic rebound or wealth effects
  Ex : Heating at 35 °C ! Having 5 cars per person !

The households base their investment trade-off between the different energy classes according to the usage cost.

- There are three classes of housing and vehicles.
- The usage cost is function of the energy cost, the cost of investment, the credit cost and the public subsidies.
- Their market shares evolve according to the evolution in the using costs.

A sobriety effect is taken into account through the price dynamic.

- The households reduce their heating and fuel expenditures when there is a rise in the energy prices.
• **Supply** *(production and imports) is determined by the demand*

Desired production factors quantities are determined by profit maximization

  – Under a constraint of a KLEM production function
  – Under a constraint of prices relative rigidities: they adjust slowly to the optimum (mark-up over united costs)

• **Firms do some investments in energy efficiency**

  • There is a capital vs energy substitution when its relative price is growing
  • They may change their energy sources
  • There is an endogenous technical progress.
The Business As Usual (BAU) scenario

- **Policies are not modified**
  - subsidies
  - Energy taxes

- **The growth rate is equal to 1.8%**
  Sum of the productivity gain (1.4%) and the population growth (0.4%)

- **Energy prices are the same as the IEA forecasting**

- **Virtual scenario, which allows to appreciate the modifications induced by the transition.**

⇒ Final energy consumption is equal to 156 MtepEf in 2030 and 138,5MtepEf in 2050.
The mix Evolution in the BAU scenario

BAU scenario
Energy mix in Mtep pe
source ThreeME 2013
The BAU scenario is modified by exogenous shocks

- **An electric mix modification**
  - The nuclear share reaches 50% in 2030, and 25% in 2050 in the scenario Médian, and 18% in the « scenario bas »
  - The Coal and Oil electricity plants are closed in 2030
- **A heating mix modification**
  - The natural gas share declines from 77% to 25% in the heat distribution between 2006 and 2050
- **A taxes reform**
  - A carbon tax is implemented and calibrated to reach the desired level of each energy source
  - (the firms submitted to the European CO2 trading system ETS are exempted)
  - The carbon tax receipts are distributed to the households and to the firms via a decrease in their labour fees
  - A increase in electricity and heating taxes
- **An electrical vehicles penetration(9,9M eq full elec en 2050)**
Three scenarios have been simulated by the ADEME.

- The final energy demand remains always the same.

- On the supply side, the nuclear share is different:
  - Low Scenario: the nuclear share reaches 50% in the final electricity demand in 2030 and 18% in 2050
  - Median Scenario: the nuclear share reaches 25% in the final electricity demand in 2050
  - High Scenario: the nuclear share reaches 50% in the final electricity demand in 2050.
The energy final consumption reach 126 MtepEf in 2030 and 78 MtepEf in 2050.
The macroeconomic results

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
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<tr>
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<td>Unemployment rate</td>
<td>(b)</td>
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<tr>
<td>employment</td>
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<td>public deficit</td>
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<td>(d)</td>
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<td>90</td>
<td>88</td>
<td>77</td>
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<td>(e)</td>
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<td>(f)</td>
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<td>4</td>
<td>5</td>
<td>14</td>
<td>18</td>
<td>30</td>
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Legend : difference between the "business as usual" scenario unless for (d); relativ difference for (a);
(a) (b) in %; (c) in % of GDP; (d) indice = in 2006; (e) in constant Euros per ton of CO2;

These results were obtained in May 2013. They might change as we will collect more precise datas.
Households disposal incomes
less energy and debt charges in billions of constants euros
Comparative analysis

The GDP gains are quite the same because:
- There is a decreasing in the share of nuclear in the GDP
- The relative convergence between the nuclear and renewables prices
Jobs variations by sectors

Jobs losses and gains by sectors in 2050
Sc. ADEME Médian
source ThreeME

-200000 -150000 -100000 -50000 0 50000 100000 150000 200000 250000 300000

- Other industries
- services
- Renewable heating
- Renewable Electricity
- Thermic plants
- Nuclear plants
- Biocarb
- Fossil fuels
- Road transportation
- Collectiv Transportation
- Building construction
- Vehicles construction
- Agriculture

+330 000 jobs in 2030 and +825 000 in 2050
The trade-off deficit is lower in the scenario Haut since the propensity to import equipments is weaker in the nuclear sector than others.
The public Debt evolution in % GDP

The public debt
Scénario ADEME Médian
Index of the debt/GDP ratio
Source ThreeME 2013

Debt/GDP sc ADEME Médian
Debt /GDP sc BAU
The carbon tax rate in €/tCO₂

Carbon tax rate
Scenario ADEME Median
in real euros per tonne of CO²
Source ThreeME 2013
• without redistribution, the carbon tax has a negative effect on GDP
  
  • Simulation of the Quinet scenario: -0.3% in GDP in long term
  • Impact on employment near zero, thanks to a growth in investment (energy efficiency)

• With a redistribution, the tax has a positive effect on GDP and employment in the long term:

  • Decrease in labor cost
  • Growth of the sectors which do not consume a lot of energy
  • Increase in labor intensity and reduction in imports
  • In the long term, the net present value of investments is positive (the reduction in the energy bill is higher than the debt reimbursement)
  • The expansive effect of the tax redistribution is more important than the recessive effect of the tax increase.
A double dividend

- Increase in jobs and economic activity, decrease in GHG
  
  - GDP growth difference by **3% in 2050** with respect to the BAU scenario.
  
  - In level, GDP X2 between 2012 and 2050
  
  - Decrease in unemployment rate by **1.6 pts in 2050**, and the creation of more than **800 000 jobs**
  
  - GES emissions divided **by 4 since 1990**, reduction by 50% in energy demand
  
  - Carbon tax rate near **350€/tCO2 in 2050**