Impacts of oil product demand and CO_2 price uncertainties on investment in biomass pre-treatment units to supply second-generation biofuel units

the French case study

Elodie Le Cadre[1], Frédéric Lantz [2]

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Université Paris Dauphine

[1] IFP Direction Economie et Veille, France. elodie.lecadre@ifp.fr
[2] IFP School, France. frederic.lantz@ifp.fr

- Need of renewable energy sources (EEA report, 2006; European Commission, 2009)

  - 70% of the EU's energy needs are expected to be met by imported products, compared to 53,8 % today

  - Energy production and consumption account for 81.5% of the total green house gas (GHG) emissions in the EU-25

- The European renewable energy target: to 20% by 2020 regarding 1990

  - Renewable energies in electricity, heating and cooling and transport. Biofuels : as a substitute for transportation fuels and to make up for crude oil shortfall. EU minimum binding target of 10% biofuel use by 2020.

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- The expectation on the biomass

  - Biomass is a key of the clean solid fuels development

  - Currently biomass delivers around 4% of the EU's primary energy

  -Sources of biomass : forest and agricultural residues, co-products for wood processing industry and short rotation coppice plantations.

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- Renewable energy based on biomass

  - Biomass to Liquid (BTL) technology, a second-generation biofuel process, power either by Biomass Integrated Gasification Combined Cycle or existing co-firing.

  - The pre-treatment step has a significant influence on the performance of bioenergy chains, especially on logistics.

- Biomass pre-treatment for bioenergy

  - To densify biomass and to save transport, storage and handling costs.

  - Torrefaction is a very promising technology due to its high process efficiency (94%) compared to pelletisation (84%) and pyrolysis (64%) (Uslu,2008).

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- The development of second generation biofuels leads to study its biomass supply:

  - in quantities

  - and return on investment for the producers of biomass.

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Definition of the uncertainties

- CO_2 price uncertainty

  The CO_2 price may influence the competitiveness of the oil fuel and modify the input choice between coal and biomass for co-firing and BTL units or steel industries.

- Oil product uncertainty

  We assume the demand in torrefied biomass coming from BTL units is uncertain. Indeed, the refinery could be supplied by a mix of pet coke or coal and biomass.

  The percentage of incorporation will depend on the BTL unit profitability related to oil price.

We study the impact of these uncertainties on the level of production of torrefied units.

- How could be developped the pre-treatement industry which is key step between the biomass supply and several major players: refining industry, power, heat and steel industries?

- How oil product demand and CO_2 price uncertainties impact the investment in biomass pre-treatment units?

Irreversible investment decision models under uncertainty

- Option-value models (Henry, 1974; Epstein, 1980; McDonald & Siegel (1986); Dixit & Pindyck , 1994)

  - A sunk invested capital and a irreversible investment decision .

  - Study of the flexibility of the investor to invest earlier or gain more information by postponing investment.

  - One uncertainty: the input or output price

- Contribution to the irreversible investment litterature

  - Introduction of two uncertainties including oil product demand and CO_2 price uncertainties.

Outline

I. Methods

II. Preliminary Results

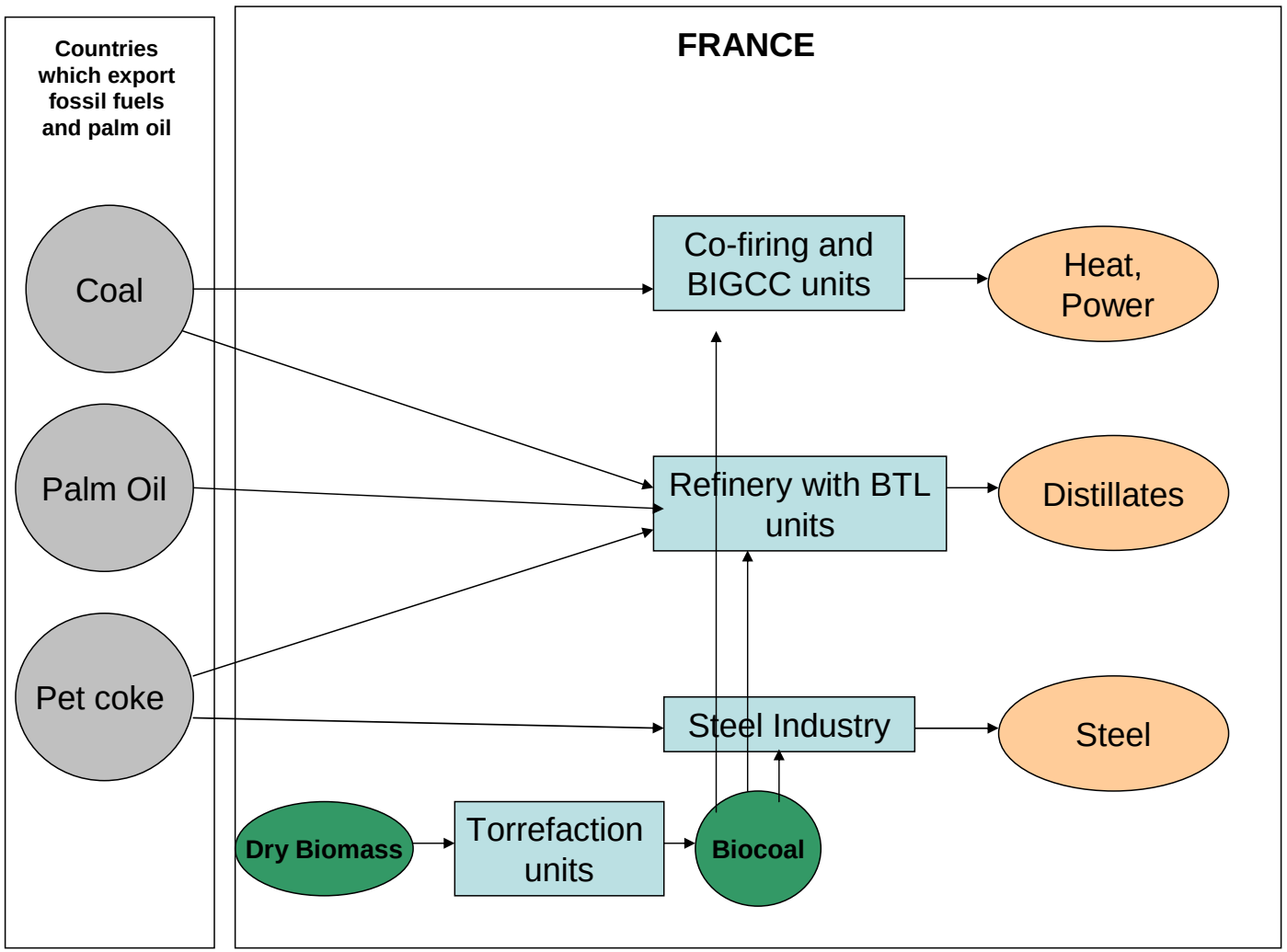
- Data and calibration

- Impacts of oil product demand and CO_2 price uncertainties on the level of production

-Interactions between this biofuel supply and the refining industry.

IV. Concluding remarks

The flow diagram



The torrefaction model

Investor = a group of biomass producer

- We modelize torrefaction units able to use different types of biomass.
- It is a model of optimization under constraints based on the linear programming. The models of linear programming are easy to implement relative at the answers which they bring to the complex problems of the refinery. They make it possible to determine (Baumol, 1963):

  - the expenditure for the purchase of a resource (crude oil, inputs);

  - quantities of product final to be produced;

  - quantities of each type of resource to be allocated to each type of product.

Parameters and Constrains of the torrefaction model

Parameters
Input prices
Technical coefficient (yields, consumptions)
Output prices
Costs of production
Investment costs
Demand of final products
Specification of different types of biomass
Limits availability of inputs

Constrains of the torrefaction model	Number
Demand equations	3
Supply in biomass	6
Availability of the ressources	6
Constrains of capacity and investment	undefined
Quality constrains	undefined

The OURSE model

- The model of the industry of the refinery is based on the model of refinery "'Oil is Used in Refineries to Supply Energy (OURSE, cf Lantz *et al*, 2004) of IFP.
- It is a model of optimization based on the linear programming. It is flexible and can be adapted to the study carried out by modification of the geographical representation representativeness (national, regional or world), the level of detail (mono or multi-refineries), the studied period (short, average or long run), etc (for an exhaustive description of the model to see Saint-Antonin, 1998; Tehrani Nedjad Mr., 2007).
- We modelize the French case with a mono-refinery representating all the French refinery sector.

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Data and calibration

- We use figures from the litterature to characterize the different sources of biomass and to build the model of the torrefaction units.

  - Technology choice: Uslu *et al.*, 2008, Bridgeman *et al.*,2007, Bergman, 2005.

  - Data on ressources: the French project REGIX (Unified references, methods and experiments to enable improved evaluation of potential agricultural and forestry lignocellulosic resources for bioenergy in France).

  - The torrefied biomass demand forecast has been determined through a technico-economic survey of steel, power and refining industries.
- The calibration run of the OURSE model has been done for year 2005 according to refining capacities of each aggregated area considered, but also to their crude oil prices and availabilities and their oil product demand and specifications.

Impact of oil product demand and CO_2 price uncertainties

- Two scenarios have been considered : a reference scenario with a business as usual evolution of the automotive fuel demand and an environmental scenario with carbon taxes and a lower oil automotive fuel demand.
- In a second step, we assume the demand in biocoal pellets coming from BTL units is uncertain. Indeed, the refinery could be supplied by a mix of pet coke or coal and biomass. The percentage of incorporation will depend on the BTL unit profitability related to the oil price.
- Finally, we study the consequences of uncertain demand and uncertain CO_2 price on the level of production of the torrefied biomass units.

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Interactions between the biofuel supply and the refining industry

- To provide diesel demand, refiners could complete their fuel oil production with :

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  - import coal and petcoke to produce synthetic diesel.

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Limits

- In our model, the oil price is determinist. What will be the consequences of a stochastic oil price on the level of torrefaction production units?
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Concluding remarks

- The development of BTL production is clearly linked to growth of diesel oil product demand, high fuel prices and high CO_2 price.
- While biomass producers are faced to uncertainties about the biomass demand, entrepreneurs of emerging renewable energy technology wonder about reliability of biomass suppliers and biomass ressources. They prevent them from engaging in innovation projects. Which uncertainties should be reduced to stimulate the bioenergy chains?
- Member States must draw up national action plans, describing the measures they intend to take to achieve their respective targets, and forward them to the Commission by June 2010. These plans may be revised in the case of non-respect of the intermediate trajectories.
- If policymakers decide to focus on biomass supply chain, what energy policies could be implemented to promote the emerging torrefaction process and supply second generation biofuels units?

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