GLOBAL LONG TERM ENERGY AND CO2 EMISSION SCENARIOS UNDER LAND USE CONSTRAINTS

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CONTEXT AND OBJECTIVES

3 major Challenges :

- Under current energy policies, energy needs and associated CO2 emissions are expected to double between now and 2050
- Fossil fuel resources scarcity, especially for oil, will intensify
- Food demand would increase by 70% by 2050 [EC SCAR, 2011]

- These driving forces will drastically increase the pressure on land use in order to:
  - Respond to the food challenge
  - Develop bioenergy and biofuels in order to compensate at least partly the expected decline of oil resources
  - Preserve some areas for CO2 sequestration or for biodiversity
  - Support urbanization and development in emerging countries

- The objectives of the work presented here are twofold :
  - evaluate the potential for bioenergies and their roles in the future energy supply, taking into account land use constraints
  - estimate the impacts on CO2 emissions of land use changes induced by biomass production in different energy scenarios

SCENARIOS SIMULATION USING MESCALITO – A SIMPLE GLOBAL ENERGY MODEL

Mescalito major Characteristics :

- Long term horizon : 2100
- The World in 4 regions:
  EU27, North America, Asia and Rest of World
- Supply and Demand simulated independently

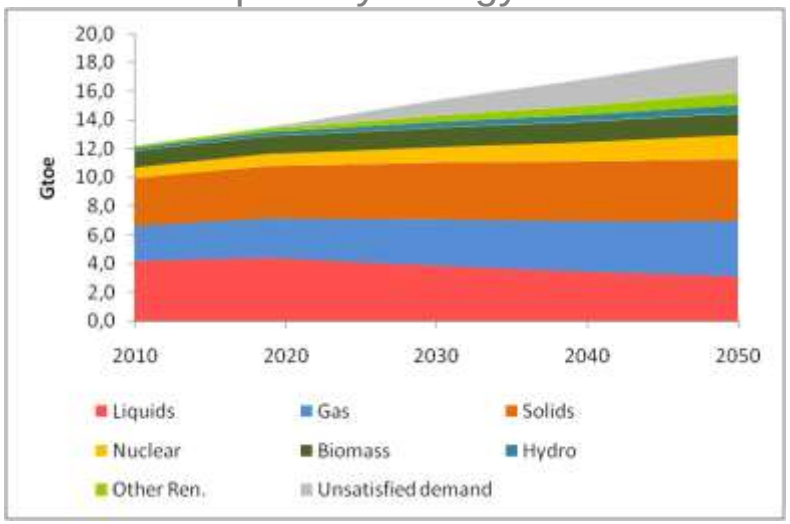
Mescalito provides an estimation of possible energy imbalance between supply and demand

An equilibrium can be reached by iterations with input assumption adjustments and/or by mobilising unused possible production (typically, additional coal or gas can be produced in order to meet unsatisfied demand

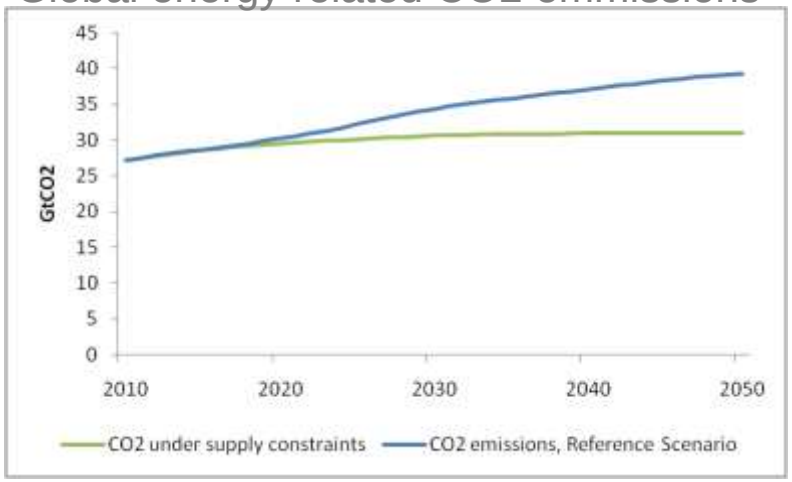
Main Messages from our Reference Scenario :

- Due to resources and capacities constraints, the risk of supply shortages would increase from 2020 onwards
- Additional efforts on gas and coal supply would be needed to meet global energy needs, but with dramatic consequences on CO2 emissions

Global primary energy balance

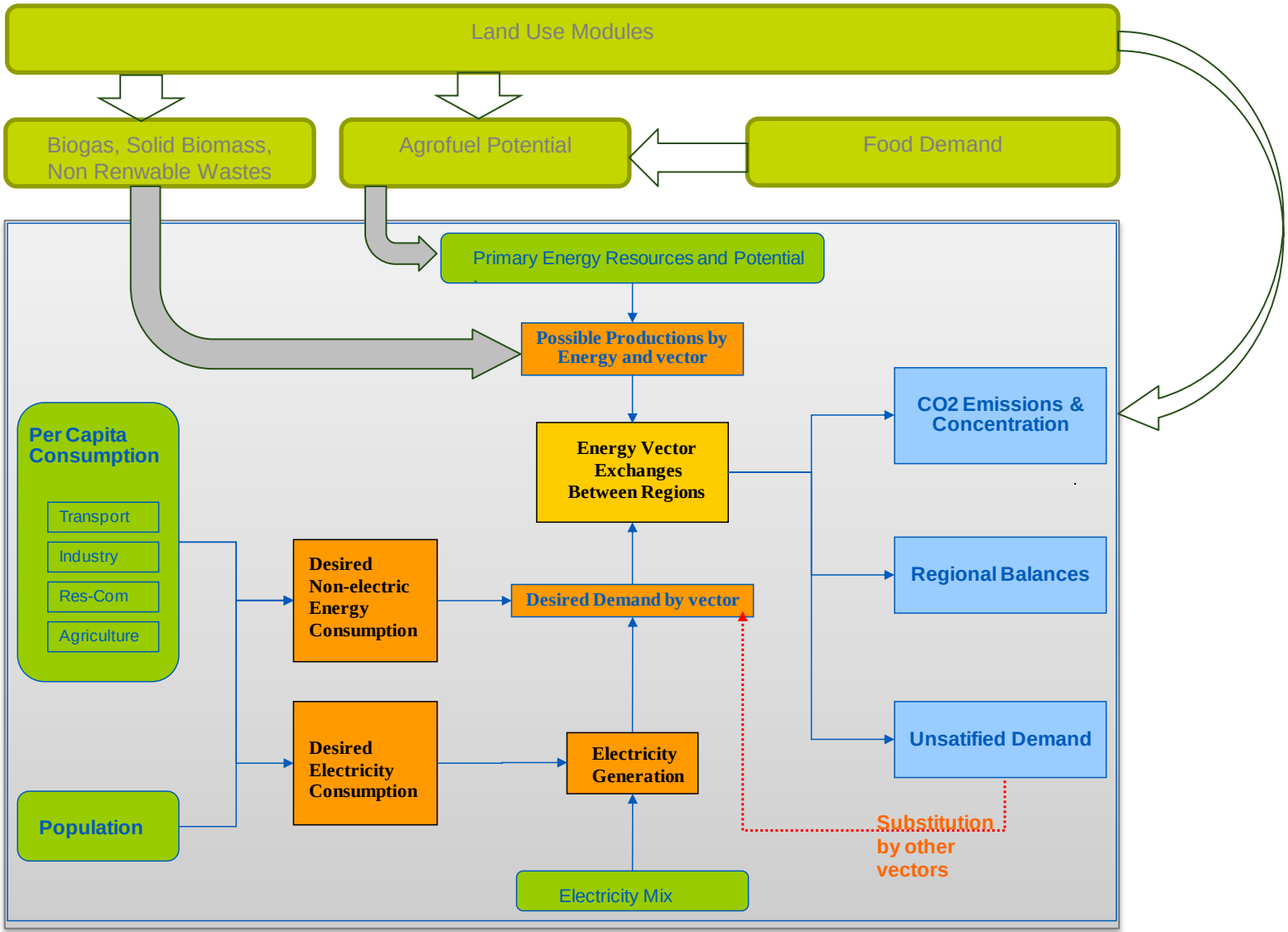


Global energy related CO2 emmissions



BIOENERGY CONTRIBUTION - METHODOLOGY

- MESCALITO has been enhanced in order to take into account land use constraints and evaluate theirs implications on Bioenergy supply and CO2 emissions



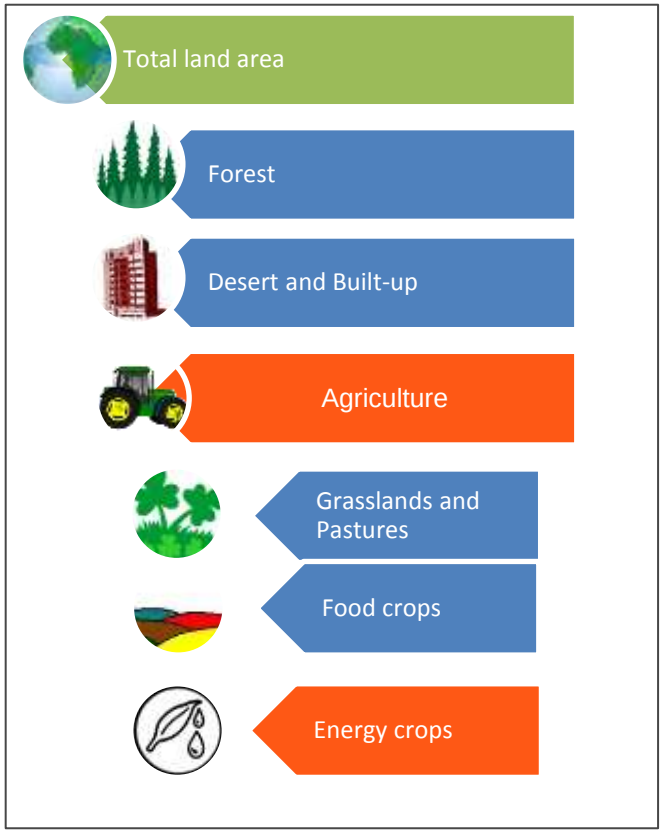
LAND AVAILABILITY PROJECTIONS

- Land Areas are divided into 5 categories
- Projections based on historical trends and macro-economic variables for Forest, Desert and Built-up
- ➢ **Agricultural area are then deduced by difference with the total land area**

- Food diet scenarios provide demand for agricultural products
- Combined with agricultural productivity assumptions, we obtain demand for food crops and pastures

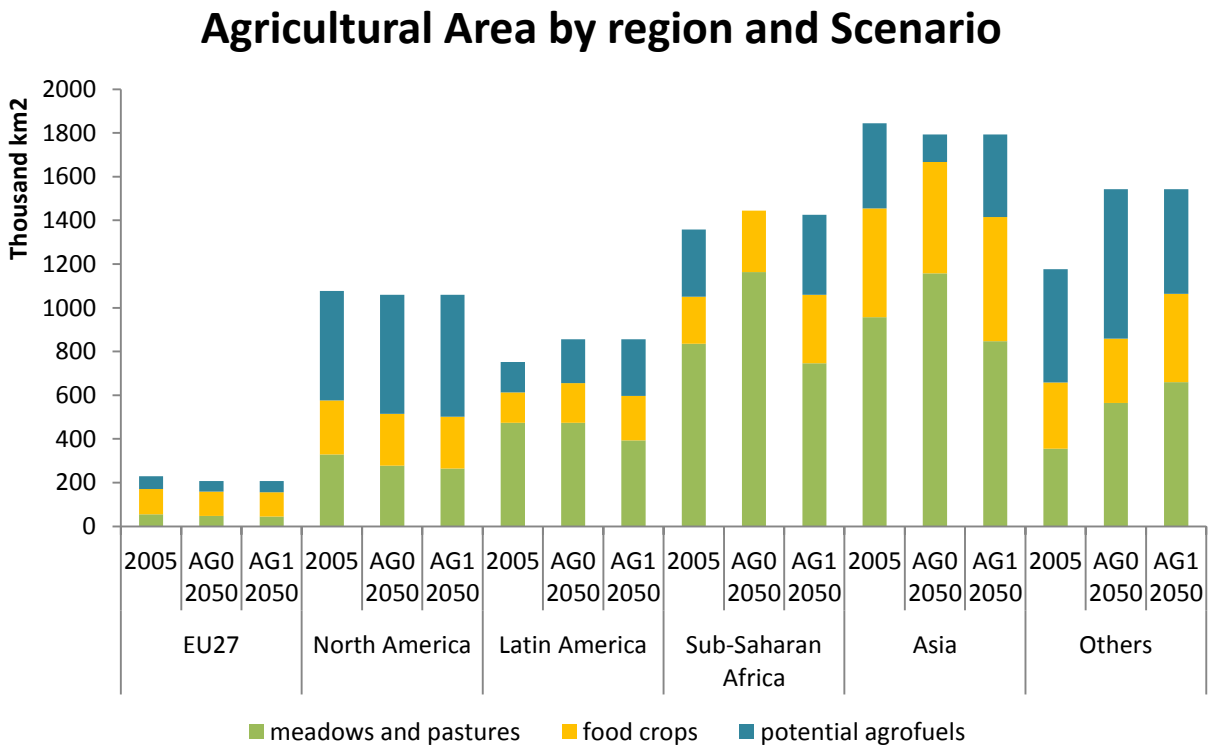
- ➢ Remaining agricultural areas are supposed available for crops dedicated to energy production

- ➢ **Scenarios :**
  - A Reference scenario in which agrofuels increase steadily
  - 2 Scenarios exploring agrofuel potential based on Agrimonde study



Food Diet	Productivity: low	Productivity: high
More meat trend		AG0
less meat	AG1	

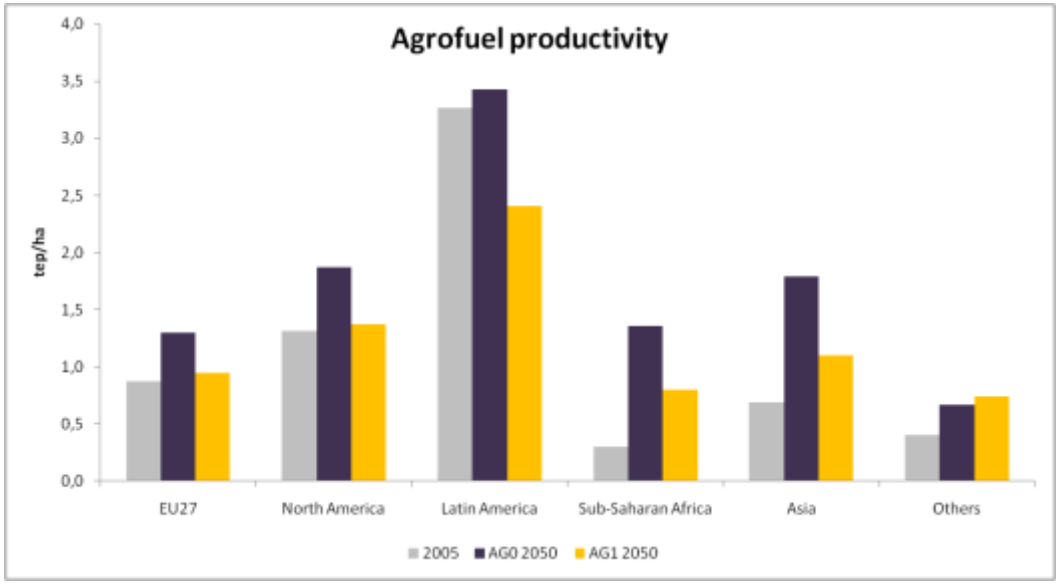
CROPS AND PASTURE

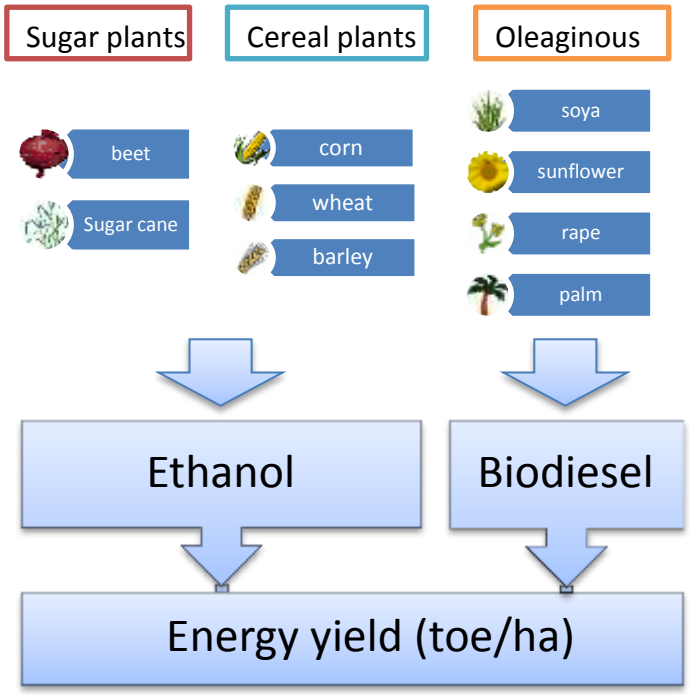


- Agricultural land increase Latin America, Sub-Saharian Africa and in Eastern Europe (Others). It decreases slightly in other regions
- Agrofuel potentials land exist in all regions (except SubS. Afr. In AG0)
- Major agrofuel potentials located in North America and Eastern Europe

FROM AVAILABLE AREA TO ENERGY PRODUCTION

- 9 types of energy crops considered
- Share of available land allocated to each crops based on FAPRI Scenario up to 2025 and kept constant afterwards
- FAPRI Conversion factors from, ton to liter and toe



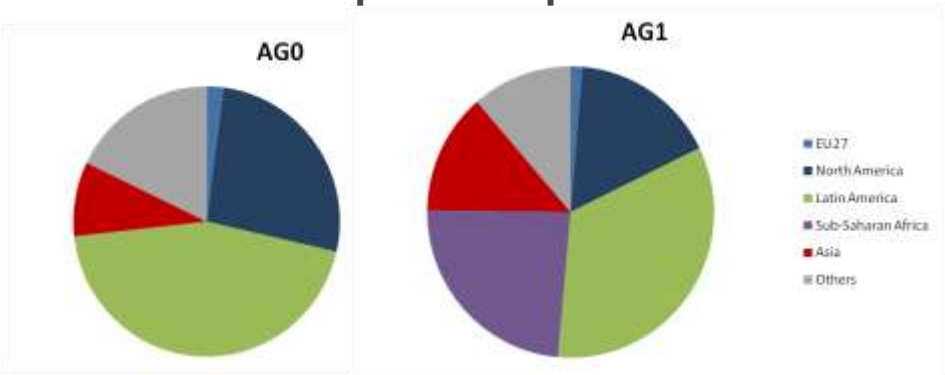


➢ Agrofuel productivity increases in most regions, with most significant growth in Sub-Saharan Africa and Asia

AGROFUEL POTENTIAL AND BIOMASS ENERGY PRODUCTION

- The combination of remaining agricultural area and productivity for energy crops (toe/ha) provides agrofuel potential

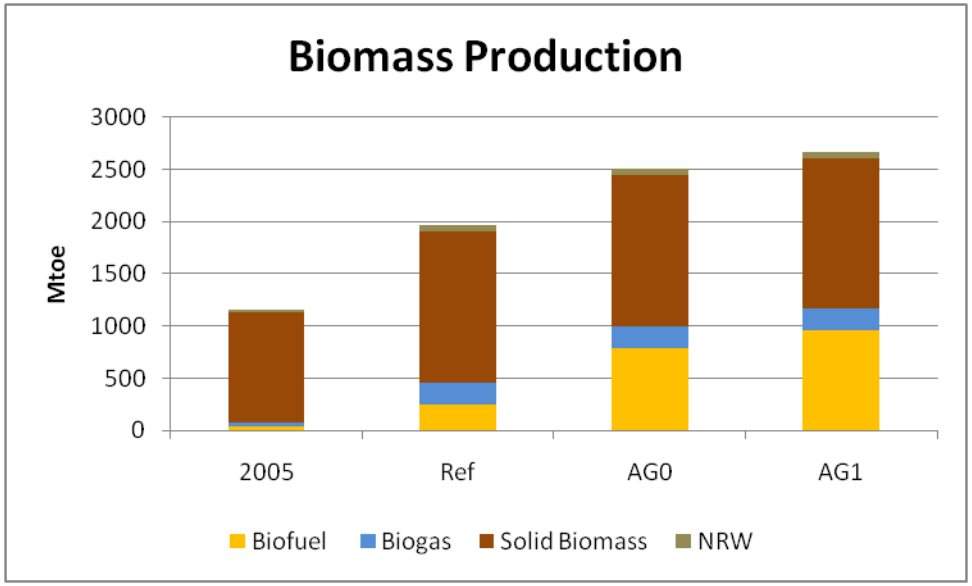
2050 potential production



770 Mtep **930 Mtep**

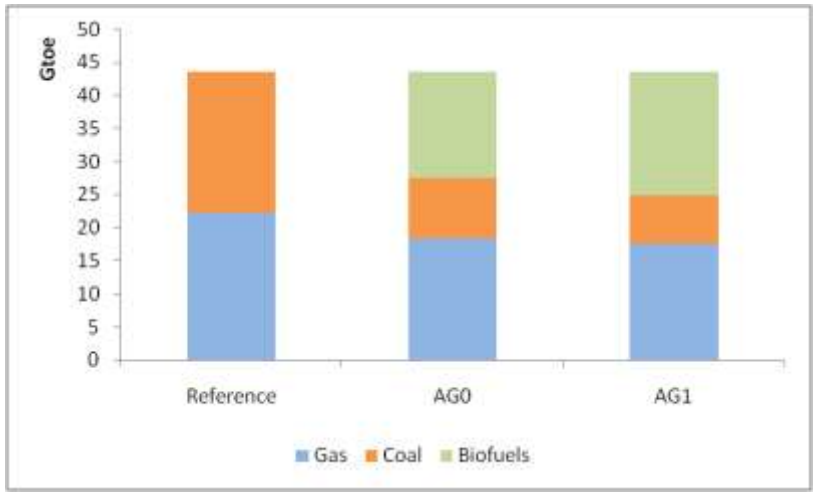
- AG1 allows to produce more agrofuels than AG0 in Mtoe
- Major agrofuel potentials located in Sub-Saharan Africa, latin America, North America, Eastern Europe

- Biomass remains largely consumed in a solid form
- Total biomass production represents less than 15% of global energy needs in 2050

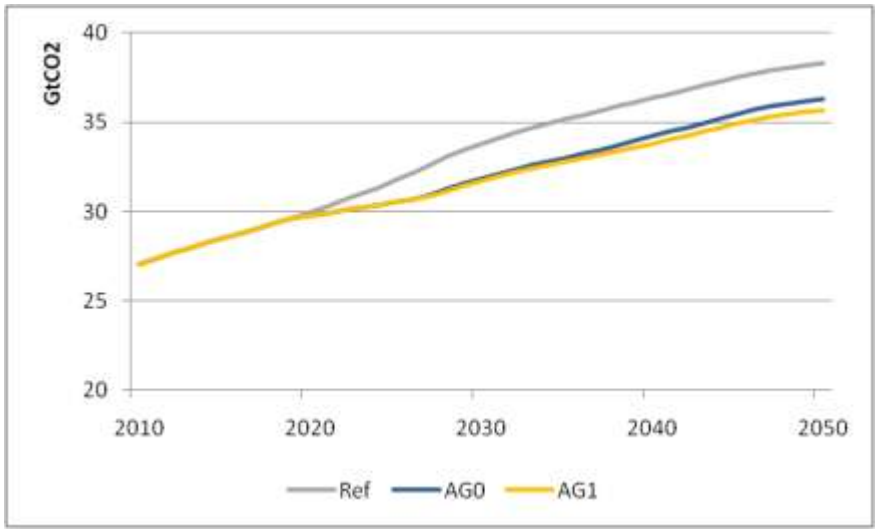


GLOBAL ENERGY SCENARIO AND RELATED CO2 EMISSIONS

Cumulated additional energy production to meet global energy demand



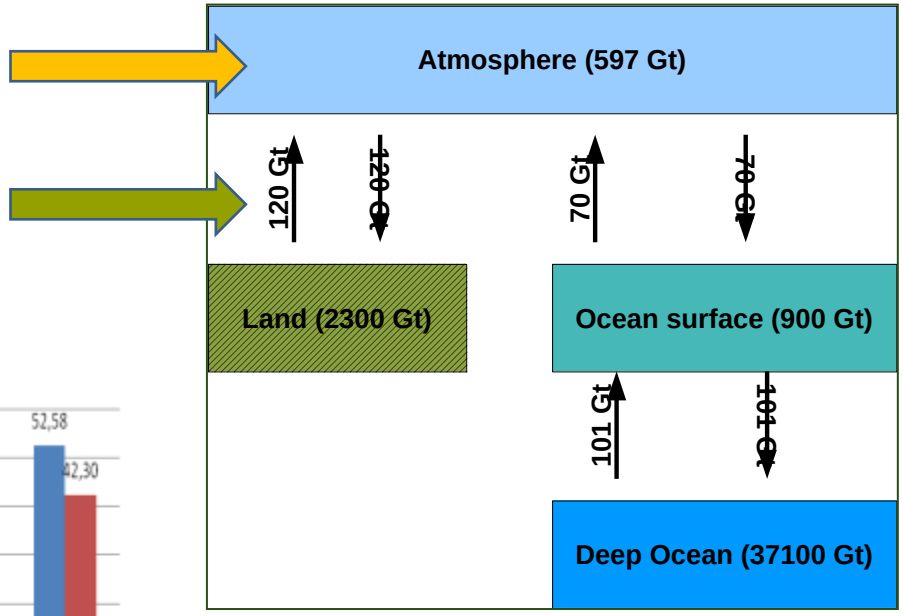
Fossil energy related CO2 emissions

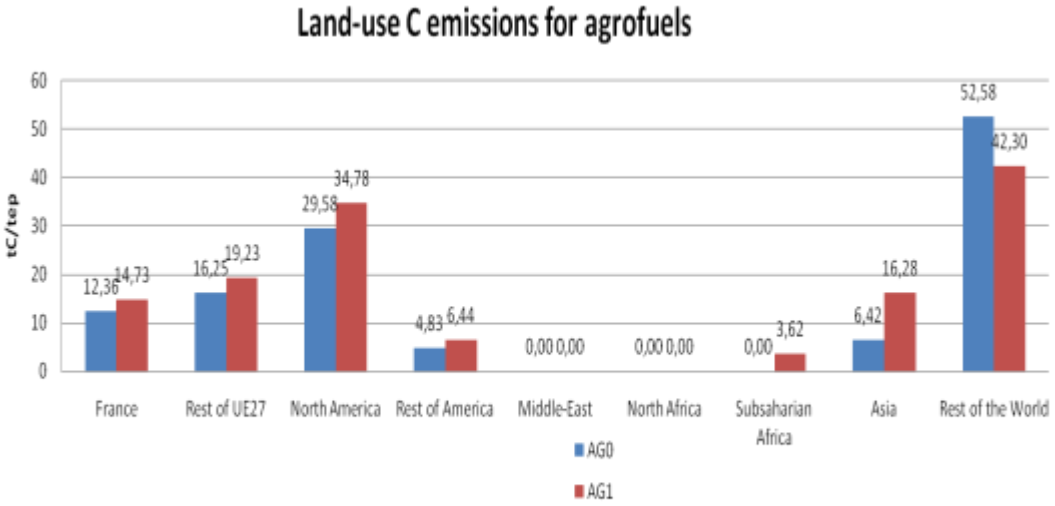


- The contribution of agrofuels is significant but fossil fuels (coal and gas) would still represent the majority of the additional energy supply needed to balance the system
- The differences between agrofuel production among scenarios are relatively limited due to opposite effects of assumptions on productivity and food diets
- Similar Fossil fuels related CO2 emissions trends

CO2 EMISSIONS FROM LAND USE CHANGE (LUC)

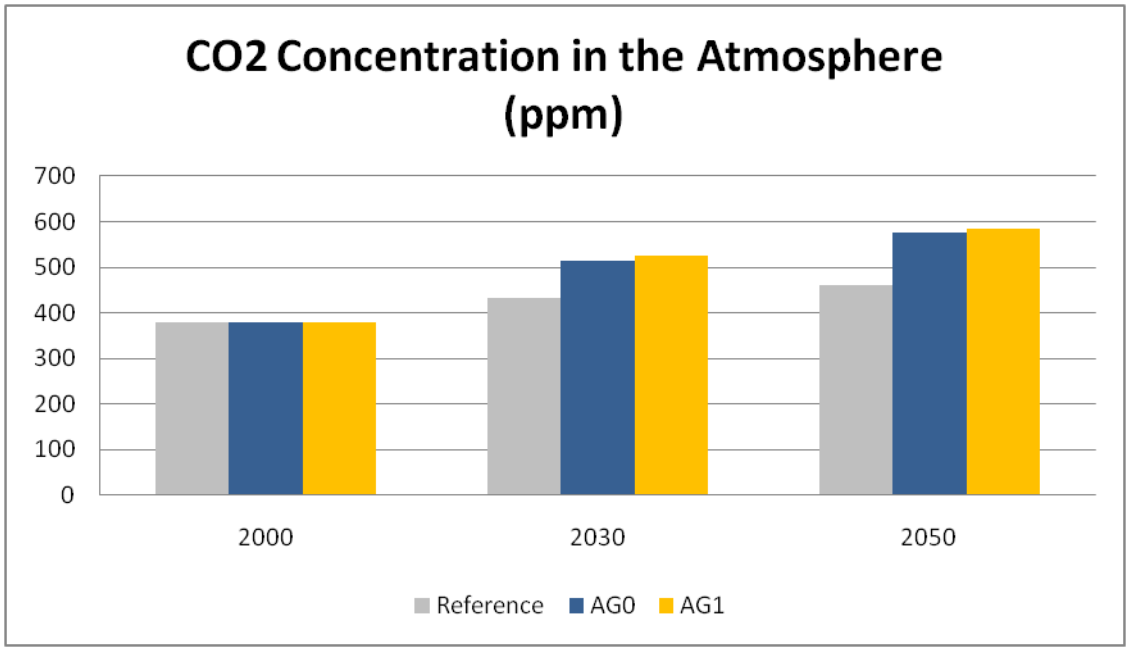
- CO2 concentration are then estimated using a four boxes stock-flux model
- CO2 emissions from fossil fuels are imported from Mescalito core module
- CO2 emissions from land-use change estimated using IPCC CO2 content





- Land-use change impact is more severe in AG1 than in AG0
- The higher C content of grasslands compared to croplands explains this difference

CO2 EMISSIONS AND CONCENTRATIONS



- Higher CO2 concentration in the 2 Agrofuels Scenarios than in the Reference
- The negative effects of LUC more than compensate the direct emissions avoided by the development of agrofuels
- Agrofuels would be less interesting than fossil fuel (even CTL) as a mass option to tackle with oil depletion problem

CONCLUSION

- Limits of this exercice :
  - Second generation agrofuel were not considered
  - The impact of the development of agrofuels on CO2 emissions depends largely on the types of land mobilized and on their carbon contents. The relative carbon content of croplands and grasslands is a key point in the estimation of agrofuels impact on greenhouse effect
  - CO2 emissions would be worsened if the energy needed to increase land productivity (production of fertilizers…) was taken into account

- Key messages :
  - Biomass potential although important remains limited by land availability
  - In the absence of productivity or food regime breakthrough, agrofuels would not be able to compensate the decline of fossil fuels resources
  - Fossil fuels would be more interesting than agrofuels from a climate point of view