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JOINT OPTIMISATION OF REGIONAL ENERGY AND CCS INFRASTRUCTURE SYSTEMS OF MOROCCO, PORTUGAL AND SPAIN

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Overview

In the field of energy, policy and decision makers often need to understand not only what technology options best satisfy their objectives under changing external conditions and when, but also where the big infrastructures that implement those options can be optimally located. Even more so, this is necessary when energy transport infrastructures have to be decided.
This research is carried out in the framework of the COMET project – Integrated infrastructure for CO_2 transport and storage in the west MEdiTerranean – which is a 3-year (2010-2012) research project funded by the 7th Framework Research Program of the European Commission (FP7), grant # 212011. For more info, visit the project website: http://comet.lneg.pt/. This research aims to set up a methodology for representing both spatial and time dimensions of energy systems in a single technical economic model, and calculating dynamic and geographically resolved economic equilibrium scenarios, dependent on user chosen exogenous variables.

Methods

The modellers are confronted with the problem of matching in a technical economic framework an energy system model, without geographical information inside a country (such as the member states in a standard TIMES model), and a geo-referenced system of pipelines connecting emission sources with CO_2 permanent storage locations,
In other words it is demanded to match an energy model with a transport model, and build a hybrid energy-transport model.
Besides building the model, there is the problem of solving an LP program with myriads of integer variables.

The methodology assumes that the single region TIMES models of Morocco, Portugal and Spain continue to be developed, updated and used for policy analysis. At run time the 3 single region TIMES models are linked to the TIMES-CCS infrastructure model. In the CCS specific TIMES model each cluster – emission or/and sink – is equivalent to a region; one region can include both clusters, if sources of emissions and sinks are very close. Each region has a subset of the following elements:

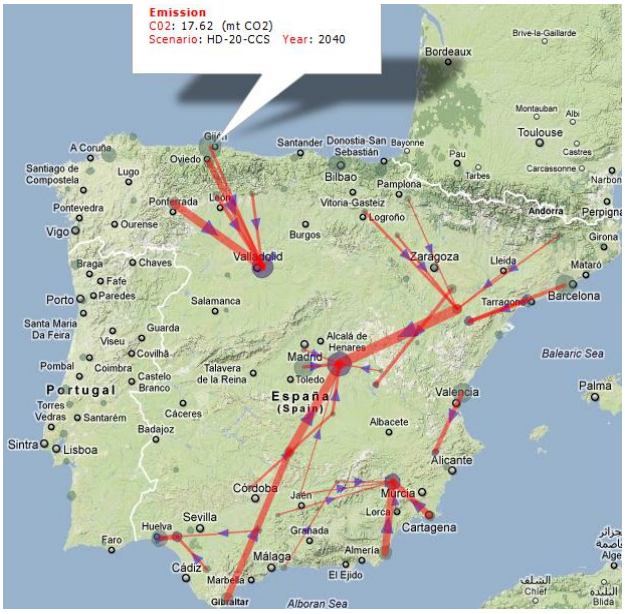
- 35 commodities representing CO_2 emission by fuel and sector, in each period;
- 35 CO_2 capture technologies, one per CO2 stream, in each period, with their investment costs, lifetime, operating and maintenance cost, fuel consumption;
- 35 commodities representing the CO_2 captured flows, by sector and fuel
- purification technologies to combine the 35 emission streams into a few concentrations suitable for transportation and storage;
- 3 commodities, representing out-flows of CO_2, each with a different purity level;
- one technology to inject the CO_2 flows into the permanent storage; and
- as many CO_2 integer variables trade links technologies, as suggested by the GIS analysis.

Results

The modelling team is expected:

- to provide possible long term developments of the Moroccan, Portuguese and Spanish energy systems, in exploratory and policy scenarios;
- to assess the role of CCS in the national portfolio of mitigation measures under several exploratory and policy scenarios; and
- to build cost effective CO_2 source-transport-sinks combinations for each scenario (see figures).

The scenarios built with the integrated Morocco-Portugal-Spain MARKAL-TIMES multi-regional model take into account future developments and policies of the whole energy sector. The base scenario include coordinated assumptions for each of the three countries about: CO_2 national emission caps, CCS technologies learning curves with emphasis on different transport options, energy demand, CO_2 storage potential and primary energy costs.



In this figure the emission sources are the green points and the blue points are all the available sinks. The red lines are the routes that link emission sources with sinks. The thickness of each line is proportional to the CO^2 volume transported from the pipeline.

Scenario 20% CO_2 reduction in all the periods from 2020 to 2050

Conclusions

The rationale of the proposed methodology is to overcome three often perceived difficulties:

- to compare CCS options with other technological options – more energy efficiency, renewable generation, nuclear, etc. – on the same playing field, which is here achieved by including CCS options as well as other technological options in the same model
- to inject consistency in the dynamic of source emissions, which is achieved here by driving the geo-referenced emissions with the development of the national systems; and
- to make all future projections scenario and year dependent.

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