Addressing Uncertainty in TIMES Using Monte Carlo Methods

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Scope of the Project

- The development of classical MC methods to treat uncertainty for:
  - The national TIMES models, and
  - The global TIAM model
- Policy assessment of the Paris Agreement including (feasibility, costs, carbon values, and market penetration of technologies)
- PhD with the MC-TIMES addressing key uncertainties for Ireland
- Contribution to an ETSAP workshop on uncertainty to be organized in 2017 (proposal of Brian)

MC Methodology

- MC methods propagate uncertainty of input data in complex models defining the uncertainty of outputs (probability density functions “pdf”).
- We consider as stochastic input different parameters like the socio-economy, the de-coupling of energy and economy, the availability of resources, specific costs of technologies and the climate sensitivity.
- LHS (sampling methods) are applied to reduce the number of required MC runs for reliable statistics.
- MC has been successfully applied in many IA-Models while the applicants have experience with MERGE (Kypreos) and Prometheus (Panos)

Formulation of MCA-TIAM or TIMES

- The operationalization of MC-TIAM in Windows will follow the approach applied in MERGE, based on the following:

- First, we solve the reference case of TIAM and create a GDX file for restarting and apply LH sampling of the stochastic input, then

- We distributed the MC-runs to 4 PCs, starting the MC loop with 50 cases in each PC while:
  - In each PC the MC loop restarts from the REFERENCE case, defines new stochastic input parameters per run, and adjusts the matrix
  - Finally we solve TIAM, report and store output results.

- At the end of the MC loop, we retrieve results and perform statistical analysis.

Reducing computer time

- First, we remain linear (partial equilibrium TIAM) and with LHS the number of runs is expected to be about 200
- According to James Glynn using a good PC, TIMES (constrained) needs about 60 seconds per case.
  Thus for 200 cases we need a clock-time of 3.33 hours.
- TIAM (constrained again) needs a maximum of 4 minutes but with 4 PCs we have again 1 minute per case or 3.33 hours.
- Time could be further reduced with a better sort of LHS input data for efficient restarting.

Conclusions - Deliverables

- MCA-TIMES will be coded similar to the PSI version of MERGE while the expected computing times are human.

- With the exception of the Reference case, MC development will be based on GAMS (55% of the budget) and includes the following:

  - The MC batch command files and MC loop organization
  - TIMES Report Generator (RG),
  - Statistical Package

- Then, applications will follow for Ireland and the COP21 Agreement.

- Technical reports will describe a) the user's manual b) first application of MC-TIMES (Ireland) and c) the assessment of the COP21 Agreement based on MC-TIAM (45% of the budget).

Atmospheric greenhouse gas concentrations
DG-ENV, Indicator Assessment Prod-ID: IND-2-en

CO_2 concentration alone increased to 397 ppm in 2014

The concentration of all greenhouse gases, including cooling aerosols, reached a value of 441 ppm in CO_2 eq (2014)

The exceedance of 1.5 °C temperature increase, post-industrial, will happen with more than 50% chances.

The GHG concentration level consistent with 2 °C could be exceeded over the next decades

ETSAP and uncertainty analysis

- Uncertainty in climate change prevails and the difficulties to satisfy the COP21 policy aimining to remain below 2 °C (not even speaking about the 1.5 °C) are well known.

- It will be wise to Address Uncertainty in TIMES Using Monte Carlo Methods complementing Robust and Stochastic methods available in ETSAP and eventually to combine MC with stochastic scenarios for hedging policies.

- We hope to be able to discuss all these options and possibilities in a forthcoming ETSAP workshop (or Conference) on the treatment of uncertainties using ETSAP tools evaluating the Paris Agreement.