PROSPECTIVE PERFORMANCE INDICATORS OF ELECTRICITY PRODUCTION IN SPAIN

Diego García-Gusano[1*], Daniel Garraín[2], Diego Iribarren[1], Helena Cabal[2], Javier Dufour[1,3]

[1] Systems Analysis Unit, Instituto IMDEA Energía, E-28935 Móstoles, Spain
[2] Energy System Analysis Unit, CIEMAT, E-28040 Madrid, Spain
[3] Department of Chemical and Energy Technology, Rey Juan Carlos University, E-28933 Móstoles, Spain

* diego.garcia@imdea.org

Nantes 2016 SETAC Europe

INTRODUCTION

Although environmental modelling methodologies such as Life Cycle Assessment (LCA) are well-known tools for the analysis of sustainability issues, there is a gap in managing the time dimension [1]. Many studies carry out assessments assuming predefined systems concerning the future or use roadmaps from the literature. This work involves a **detailed LCA study from a consequential perspective by using a national energy system optimisation model**, TIMES-Spain. This **methodological linkage** strengthens the discussion on how the electricity production mixes should be built in the future according to **key prospective performance indicators** [2,3].

METHODOLOGICAL FRAMEWORK

- ✓ TIMES-Spain, built with the **TIMES energy optimisation model generator** developed by an implementing agreement of the International Energy Agency, provides energy-related technology mixes for satisfying the energy demand in all economic sectors (industry, transport, etc.) under different assumptions [2].
- ✓ A couple of scenarios were implemented: a **Business as Usual scenario "BaU"** with restrictions from European Directives, and an **exploratory scenario enforcing an 80% reduction** in the total Spanish CO_2 by 2050 vs 2005 levels.
- ✓ **LCA** computation was performed for the set of existing and new electricity production technologies.
- ✓ An **LCA/TIMES harmonisation procedure** was carried out avoiding potential double counting of emissions. In this regard, existing processes in TIMES-Spain were adapted to include a fraction of the burdens linked to infrastructure by assuming a residual lifetime according to the year of installation.

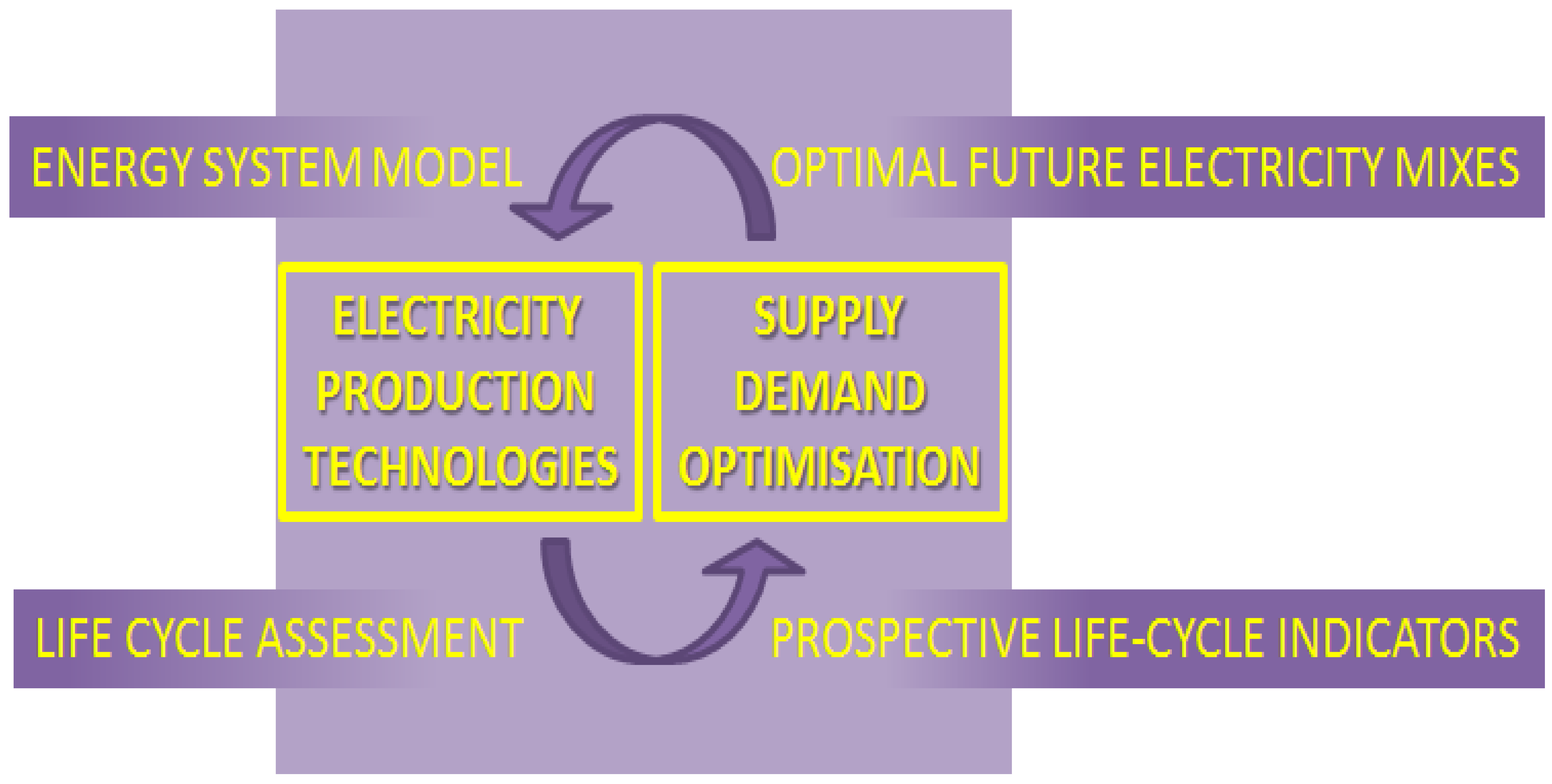

Figure 1: Conceptual approach to prospective life-cycle indicators.

RESULTS AND DISCUSSION

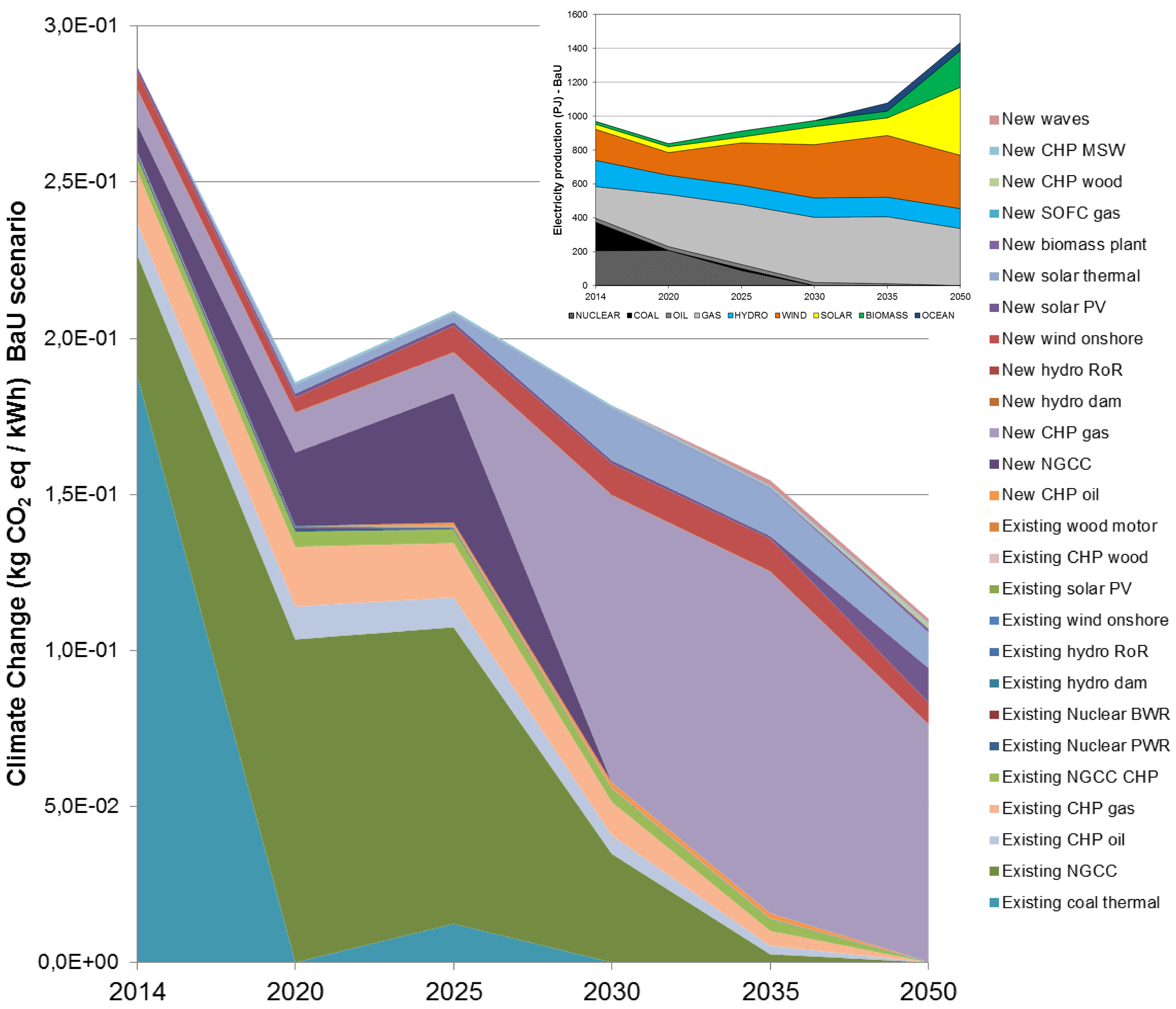

Figure 2: Evolution of the Climate Change indicator in a BaU scenario. Top right: Evolution of power generation under BaU scenario in the Spanish energy model.

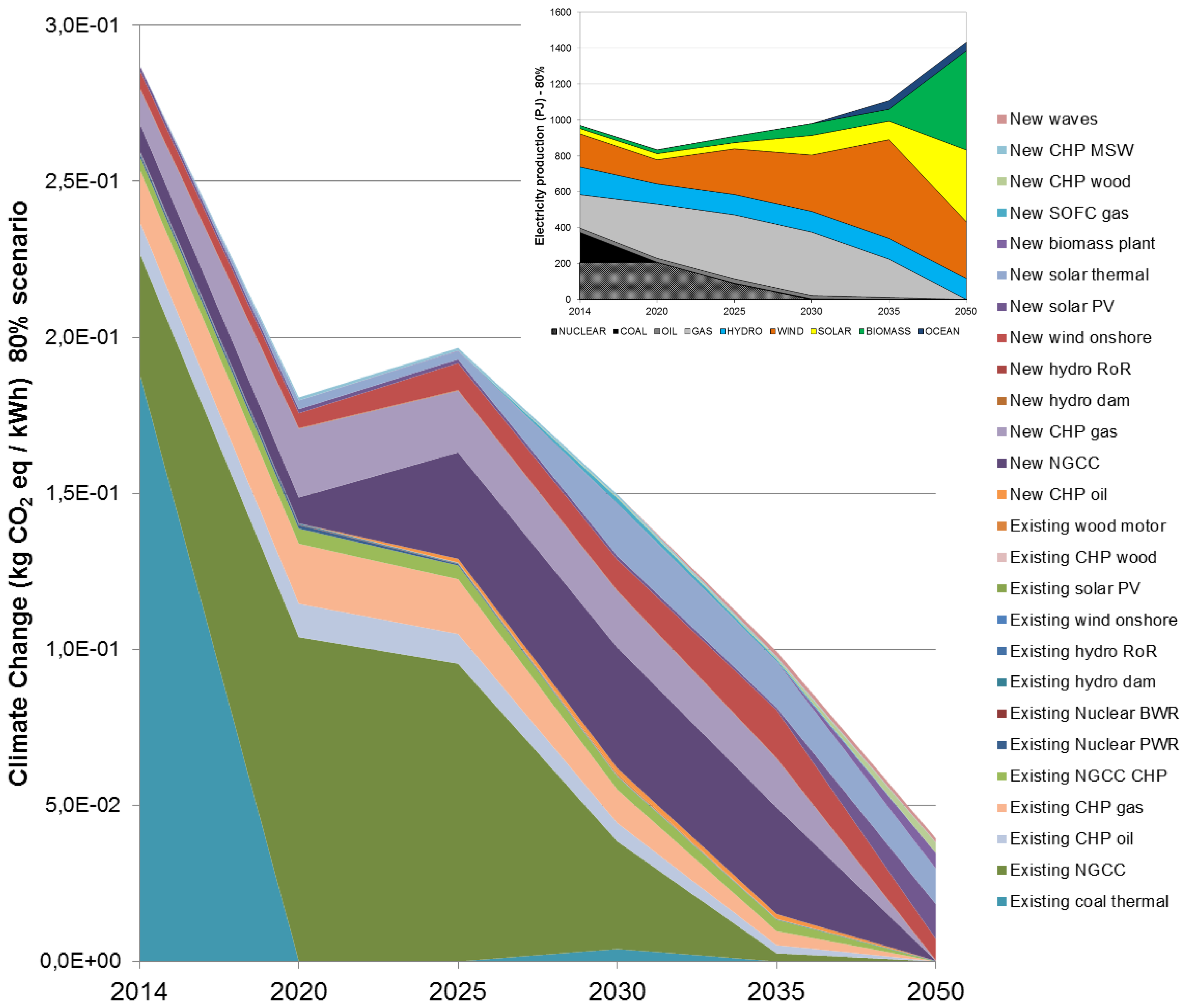

Figure 3: Evolution of the Climate Change indicator in a CO_2-constrained scenario. Top right: Evolution of power generation under CO_2-constrained scenario in the Spanish energy model.

- ✓ The **evolution of the electricity production mixes** from the optimisation process shows that the scenario "BaU" results in a **major presence of natural gas cogeneration** plants in the long term, whereas the scenario "80%" prioritises biomass options [4,5].
- ✓ The evolution of ten life-cycle indicators (from ILCD 2011 and ReCiPe methodologies) shows **global reductions in the long term** ranging from 21% to 85% in the scenario "BaU", and even larger reductions in the scenario "80%".
- ✓ **Climate change decreases significantly when a CO_2-constrained scenario** is considered (Figure 3). Natural gas-based plants arise as the main contributor to climate change from a life-cycle perspective.

CONCLUSIONS

- ✓ **Energy system modelling** is found to be a **valuable tool to carry out LCA** studies in the field of energy, enabling the consideration of prospective performance indicators.

REFERENCES

[1] Ekvall T. 2002. Cleaner production tools: LCA and beyond. J Clean Prod 10:403-406.
[2] Wene CO. 1996. Energy-economy analysis: Linking the macroeconomic and systems engineering approaches. Energy 21:809-824.
[3] Menten F, Tchung-Ming S, Lorne D, Bouvart F. 2015. Lessons from the use of a long-term energy model for consequential life cycle assessment: The BTL case. Renew Sust Energ Rev 43:942-960.
[4] García-Gusano D. 2014. Long-term analysis of the Spanish environmental policies using the life cycle assessment method and energy optimisation modeling. ISBN: 978-84-7834-715-5.
[5] García-Gusano D, Cabal H, Lechón Y. 2015. Long-term behaviour of CO_2 emissions from cement production in Spain: Scenario analysis using an energy optimisation model. J Clean Prod 99:101-111.