The IMACLIM Network Charter

The community of researchers engaged in the development of IMACLIM models shares two core methodological principles:

1. Designing policy-relevant outlooks requires combining the economist's and the engineer's approaches to describing human systems[1]

1.1 Interrelations between consumption patterns, production & end-use techniques and geographical localisations shape the economic, social and environmental characteristics of development pathways and thus their sustainability. They constrain the development path of energy systems as well as that of other key technical systems such as agriculture, urban geography, transportation and industrial systems.

1.2 A prerequisite to modelling such interrelations, i.e. to connecting expertise that remains fragmented so far, is to construct 'hybrid' datasets that reconcile national accounting—the integrative framework of economic analysis at economy-wide level—and underlying physical balances *via* relevant sets of prices.

1.3 Among physical balances, the energy balance stands out[2] but other dimensions deserve close scrutiny: the physical composition of investment flows (tons of steel, cement, glass, *etc.*);[3] physical measures of transportation activities (passenger- and ton-kilometres) or of space occupation (use of natural land, extension of artificial surfaces, housing surfaces); the physical water system; *etc.*

1.4 The microeconomic toolbox of utility and production functions is ill-equipped to represent the inertias and discontinuities of technical systems dynamics that constrain behavioural changes.[4] 'Bottom-up' analysis is more adapted to a consistent description of technologies, equipment stocks and consumption flows, particularly at shorter time horizons.

1.5 Outlining alternative development pathways therefore requires addressing the major scientific challenge of linking 'bottom-up' analysis to economy-wide or 'top-down' analysis, to warrant that technical systems are projected in consistency with macroeconomic conditions regarding relative prices, investment availability, private and public budget constraints, *etc.* [5]

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[1] Hourcade et al. (2006) provide a general introduction to "hybrid modelling".
[2] Combet *et al.* (2014) describe the IMACLIM methodology of energy and economic data hybridisation.
[3] Le Treut (2018) produces analysis based on extended hybridisation for France.
[4] Ghersi and Hourcade (2006) demonstrate this point in the case of energy.
[5] Ghersi (2015) surveys the 'linking experiments' conducted with IMACLIM for the energy systems.

2. Exploring the initiation and conduct of transformation pathways, in contrasted contexts and under multiple uncertainties, calls for mobilising a wide array of modelling paradigms

2.1 Analysing the transition processes that lead to long-term socio-economic futures, and the conditions to their triggering and deployment, is as important as analysing long-term socio-economic futures in themselves.

2.2 Addressing both close and distant time horizons requires combining model specifications that acknowledge short-term inertias and long-term flexibilities of the technical, social and institutional systems, at all scales of analysis including at the most aggregate macroeconomic level.

2.3 The gap between potential and effective economic growth deserves scrutiny at all time horizons: 'second best' dimensions of real economies should be at the core of the modelling agenda.[6] They encompass the inertia of physical capital, the constrained mobility of labour, the imperfect foresight of economic agents or the constrained access to capital.

2.4 The distributive impacts of transformation pathways and their retroactions on aggregate consumption, savings, investment and capital flows, as well as their consequences on the magnitude and role of informal economic activity, should not be overlooked.

2.5 The multiple uncertainties characterising the technical, social and economic dimensions of the produced outlooks call for the exploration of scenarios combining potentially contrasted viewpoints on all three dimensions.

2.6 On the economic dimension, providing microfoundations to the producer's and the consumer's behaviour is not an absolute necessity. Alternative scenario-based approaches, or 'structuralist' analyses considering stylised economic facts, can allow embarking information from other fields of social sciences about individual and collective behavioural changes, particularly at closer time horizons.

2.7 Analyses at national scale should always be conducted under explicit assumptions regarding the future of globalisation, i.e. in light of specific conjectures regarding international trade of goods and services, financial flows, industrial geography and human migrations.

[6] Ghersi (2014) develops this point in the case of low-carbon policy modelling.