Low-carbon societies: a challenging transition for an attractive future

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The Low-Carbon Society (LCS) research project (Strachan et al., 2008a) is examined for its insights about the scale, nature and timing of the deployment of low-carbon technologies. In addition to ‘carbon price only’ policies, other incentives and demand-side efforts are needed in order to embed climate policies into broader development approaches. The question of what constitutes transition pathways is considered. Fundamental institutional, individual and social changes are needed to accompany economic and technological change as energy is embedded in overall development patterns. The cost assessment of decarbonization policies may be too optimistic if it is only considered as the final outcome of a LCS, and if the inevitable hindrances and setbacks along the transition pathway are disregarded. The significance of transition costs is highlighted, together with their causes: social and short- and medium-term economic costs and adjustments in macroeconomic dynamics. Although the overall welfare costs of LCS are likely to be smaller than the benefits (including the co-benefits), a clear and realistic understanding of potential transition difficulties is necessary in order to define the robust policy mix needed to underpin it.

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1. Introduction

Over 30 years ago, Amory Lovins (1977) published a provocative, prescient essay on Soft Energy Paths to describe a vision of an advanced society in which the ‘Faustian bargain’ with nuclear energy would not be inevitable. Since then, the context has changed in two important respects. First, a new ‘Devil’ has appeared, in the shape of the threat of a dangerous disturbance of our climate system; and, second, we are no longer living in the times of prophets, and the political momentum now seems irreversible, pressing for a bifurcation towards a low-carbon society. Thus, the question no longer seems to be whether some decarbonization of the world economy is desirable, but whether a high enough degree of decarbonization is conceivable within a time frame short enough to it to have a chance of keeping the temperature increase to less than 2°C above that of the pre-industrial period.

The articles presented in the Climate Policy supplement, Modelling Long-term Scenarios for Low Carbon Societies (Strachan et al., 2008a), show under what conditions this perspective is not merely a utopian daydream. In this commentary, we first discuss their insights about the scale and timing of the deployment of low-carbon technologies. Second, we underline the necessary mobilization of a large set of incentives beyond ‘carbon price only’ policies and the embedding of climate policies into a broader bifurcation of development styles. We then play Devil’s advocate by questioning the optimism of the cost assessment of decarbonization policies and, accepting the optimistic message stemming from this issue about the possibility of low-carbon-emissions futures, we question the importance of transition costs. Without a play on words, we suggest that, although these articles convincingly show the main features of a soft energy future for advanced societies, the transition towards this future may not resemble a soft pathway.

2. Technology: a too-constrained trajectory?

While the Climate Policy supplement reports numerous quantitative exercises based on different assumptions and modelling approaches applied to different geographical scopes, they all reveal robust trends about the technological revolution necessary to attain a low-carbon society (LCS). Across almost all the simulations that achieve a halving of global emissions by 2050, or a national target consistent with such a global target, this challenge requires both a complete decarbonization of the power supply and a significant shift of modes and technologies in transportation.

In the power sector, complete decarbonization is mostly achieved by a spectacular joint deployment of three technologies: (i) nuclear, (ii) capture and sequestration on coal- and gas-fired plants, and (iii) renewables. For example, most of the reported LCS-compatible trajectories report that the use of CCS allows the potential to achieve 20–30% of total emission reductions in 2050, reaching 10–20 GtCO₂/year in 2050.

However, it is common knowledge that all three options are characterized by various social and/or technical issues that could hamper their deployment on such a large scale: nuclear is constrained by social acceptance and a suspicion of contributing to proliferation risks; CCS technologies are still at an experimental stage (with uncertainty about their cost efficiency and various unresolved issues regarding the transportation of compressed CO₂ between the place of capture and the reservoir, leakage, and social acceptance); and the large-scale deployment of renewables is also constrained by ‘NIMBY’ objections (e.g. onshore wind power) and is conditional upon a large-scale move to less centralized energy networks and successful innovations to overcome a number of technical barriers.

Strikingly, when a LCS is aimed at, the magnitude of the required decarbonization is so ambitious that we are no longer in situation of a free choice from a menu of various technologies. Modelling results support the idea that a simultaneous deployment of nuclear, CCS and renewables is required, with a strict time schedule that is respected all over the globe. The sensitivity tests on CCS and nuclear performed by Remme and Blesl (2008) give a foretaste of the tensions that would characterize the necessary technological bifurcations: any constraint on CCS or nuclear weighs heavily on mitigation costs for such a target, casting doubt on the feasibility of a complete decarbonization in the supply sector if technological change is slower than expected.

Unsurprisingly, this technological revolution requires high prices for CO₂, generally greater than $100/tCO₂ in 2050 (e.g. Barker et al. (2008) chose to set $100/tCO₂ as early as 2030 and to maintain it constant beyond 2030; while Remme and Blesl (2008), Edmonds et al. (2008) and Akimoto et al. (2008) reached $330/tCO₂, $170/tCO₂ and $205/tCO₂ respectively, by 2050). However, it is remarkable that almost all the modellers added complementary measures to this steep profile of carbon price increases in order to reach a LCS target. In fact they suggest, with various degrees of insistence, that a large pivoting of energy systems will be supported only by changes in carbon prices and without specific efforts on the demand side.
3. Beyond ‘carbon-price only’ policies: questions of institutions and development styles

The strategy explored by Barker et al. (2008) is based on complementary worldwide extra R&D investments on promising mitigation technologies to accelerate technical change beyond the pace that can be reached through the incentive of carbon prices only. Such investments could be subsidized by a proportion of domestic carbon taxes and facilitated by the reduction of risks through post-Kyoto agreements, leading to increasing carbon prices. As the E3MG model incorporates induced technical change and the Keynesian multiplier effect of gross investment, it allows for turning a 1.9% world GDP loss in 2050 into a 1.1% net gain using a carbon-price-only policy with additional oriented investments, while achieving a 3 GtC additional reduction. The result is encouraging for China, where a 10.1% loss is lowered to –3.4% in 2050. This result is not so surprising if one bears in mind that any carbon constraint exerts a more significant burden on emerging countries undertaking a carbon-intensive development catch-up than on industrially mature countries (explaining the –10.1% result) but, at the same time, these countries will receive most of the world’s technological spill-overs over the first part of this century (explaining the 7.5% gain between the two mitigation scenarios).

We do not intend to discuss the robustness of these rather encouraging results. The point to be highlighted is that they rely on a decisive political precondition, i.e. the parallel deployment of tax reforms in all countries, and of institutions facilitating technological spill-overs throughout the world. Past experience casts some doubt on the likelihood of such a parallel deployment over the short run. It would thus be more reasonable and secure to search for additional margins of freedom on the demand side beyond the consumers’ response to the carbon prices needed to accelerate technical change. The crucial question is whether, ultimately, it is possible to bypass more fundamental institutional changes and even evolutions of individual and social values in order to achieve deep emissions reductions embedded in a general bifurcation toward sustainable pathways.

Most contributions in the Special Issue share the view, albeit often implicitly, that one should not count on changes in values and lifestyles (Bataille et al., 2008) and should instead concentrate on ways of accelerating energy efficiency at the end-use level. They bring a very useful clarification to the debate about the role of price and non-price instruments, which are still obscured by the false a priori assumption that the non-price measures represent a ‘free lunch’ and could be a substitute for unpopular pricing policies. The CIMS model handled by Bataille et al. brings original and valuable insights, since it incorporates not only highly disaggregated technological details and endogenous technical change but also more realistic assumptions about real microeconomic behaviours than the conventional optimization models (transaction costs, risk-aversion, and inertia in the interpretation of economic information).

Applying technology-specific regulations to buildings and transportation, they show that the non-pricing policies in Canada may contribute to almost 50% of the reductions in 2035 and 27.5% in 2050. These policies could play an even more important role in China, where their contribution reaches 34% of total reductions in 2050.

Two contributions go beyond the strategies focusing exclusively on technological change, by addressing the question of possible bifurcations of development patterns. In some quarters, such changes are viewed as a kind of ethical claim, politically unrealistic in a period where emerging countries are catching up with the consumption levels of the OECD countries. Interestingly, this perspective is explored in the context both of Japan and of India.

Fujino et al. (2008) explore ‘a calmer, slower and nature-oriented society’, while trying to sketch what could be a bifurcation towards sustainable development that goes beyond shifts to low-carbon or more efficient technologies. Even if Japan has already made significant efforts to enforce efficient technologies in the past, the scenarios developed by Fujino et al. show that reorganization and optimization of activities can provide an additional 65–75% improvement in global energy intensity of GDP in 2050 compared with 2000. The Japanese example mirrors the situation of all developed countries some decades ahead, where it may be possible to explore many additional margins of freedom to reduce energy consumption and GHG emissions, such as the demand for mobility and dematerialization.

Even more striking is the projection of an alternative development pattern by Shukla et al. (2008) for India, in which there is still a very low per capita energy demand and large energy efficiency gaps. The ‘sustainable development’ bifurcation, conducted through early choices in urban planning, modal shift, building design, and material substitution and recycling, lead to a much lower material and energy content of growth. Shukla et al. suggest that the fundamental reason for such a bifurcation is not the mitigation of climate change but the prevention of risks that may undermine the sustainability of Indian development: the ‘enormous pressure’ (disruption) on natural resources and ecosystems as well as the health impacts of local air quality, and energy security at both the local and national levels. Climate policies are no longer considered to be at the margin of development decisions but are embedded from the outset.
in their design. A co-benefit of this pathway is to place India on a low-carbon trajectory, so that it can meet the same cumulative carbon emissions with a higher level of emissions in 2050 and a much lower carbon value – $20 instead of $100 – than in the conventional ‘carbon tax only’ strategy.

Shukla et al.’s article acts as a timely reminder that the question of alternative development patterns in the South is not a pipe-dream of ecologists or left-wing intellectuals in the North. It was proposed as early as the 1960s by first-class development economists (G. Myrdal, A. Sen, R. Dumont and R. Prebisch), for reasons only marginally related to the environment, and then reinforced after the Stockholm Conference in 1972, with the finding that disruptions of the environment create stumbling blocks for the development process. But, despite the formal reference to sustainable development, during the 1990s the tendency to distance the setting of climate regimes from debates about development served, de facto, to lower the chances of engaging developing countries in ambitious climate policies.

We suggest that it is uncertain whether the distinction between acting under constant or changing sets of individual and social values is relevant. This distinction is undoubtedly necessary for analytical purposes. However, from a policy-oriented point of view, to overcome either the political barriers to large eco-taxes or the myriad of corrections arising from market deficiencies inhibiting the penetration of energy efficiency, presupposes a high level of climate concern indicative of a broader set of changes in public opinion and individual behaviours.

4. Overall economic costs: too good to be true?

Now the crucial question arises, as posed by any political leader before entering their country into binding commitments: at what cost? Obviously the range of marginal costs computed and presented in this Special Issue (from $100/tCO₂ to $330/tCO₂ in 2050) are higher than the figures given in the IPCC’s latest report for a less stringent 550 ppm CO₂-equivalent stabilization target, which ranged from $15/tCO₂ to $155/tCO₂ (IPCC, 2007, p. 19). However, the value of carbon cannot be considered as a proxy for the overall social costs that result from all the general equilibrium effects, including the possible economic benefit from the recycling of revenues of a carbon tax or auctioned emissions permits. In this respect, the few articles in this supplement that provide global cost assessments deliver very good news.

Apart from the original result of Barker et al., who found net GDP benefits from climate policies, the other studies show very low costs: Strachan et al. (2008b), with the MARKAL-Macro model, concluded that a domestic 80% reduction target in the UK would entail GDP losses of less than 2.21% in 2050, depending on the magnitude of the climate coalition; Shukla et al. (2008), with MARKAL-AIM, found GDP losses of less than 1.35%; and in Fujino et al. (2008), the additional investment costs in Japan represent between 0.83% and 1.06% of the GDP depending upon the variant. With such figures, the 2050 income level of the reference scenario would be reached only a few months to 1 year later in the carbon-constrained scenarios.

Even without retaining the most pessimistic values of climate change damages displayed in the Stern Review (Stern, 2007), one can question why the international community still hesitates to adopt ambitious GHG emissions cuts. Part of the explanation lies in the vagaries of political gamesmanship, but another part may reflect a credibility gap with regard to the modelling results. Even those decision-makers most inclined to climate-friendly policies know that some of the suggested measures entail non-negligible short-term economic and social costs: early scrapping of existing capital stocks, adverse impacts of carbon prices on the purchasing power of low-income populations, and impacts on competitiveness. Their reaction is well expressed by Stavins et al.’s (2007) comment on the Californian climate programme: ‘Too good to be true’.

The risk of distrust toward numerical exercises is real and, if distrust were to occur, it would be both harmful and misleading. To avoid this, it is important to resolve a misunderstanding about the real meaning of those figures, given the methodological state of the art. This misunderstanding stems from the confusion between a soft energy future and soft energy paths. The progress since Lovins’ time is that the current state of the art can portray conceivable low-carbon futures that are technically and economically consistent. However, although the models produce carbon prices and income levels for each point in time over the projected period, it is more doubtful whether these values represent the transition period in a realistic manner. This comes back to more profound methodological issues than the validity of the assumptions of reference scenarios questioned by Pielke et al. (2008).

First, as stated by the IPCC:

Most models use a global least-cost approach to mitigation portfolios and with universal emissions trading, assuming transparent markets, no transaction cost, and thus perfect implementation of mitigation measures throughout the 21st century (IPCC AR4 WGIII SPM, Box 3).
At the core of the problem lies the 'perfect expectation' hypothesis which, however useful it may be for designing long-term equilibria, ignores the anxiety of decision-makers generated by the interplay between uncertainty and inertia in technical systems and institutions.

Second, all the models allow the assessment of global GDP losses, but one (E3MG) uses a general equilibrium analysis based on the canonical Solow-type growth model. This model provides:

- a systematic way to talk about and to compare equilibrium paths for the economy. [...] In doing so, however, it failed to come to grips adequately with an equally important and interesting problem: the right way to deal with deviations from equilibrium growth (Solow, 1988).

Its growth engine certainly allows economies to bounce back very quickly on a natural balanced pathway. However, it does not help to detect transition problems which may magnify mitigation costs over the short term: propagation effects across sectors, inertia of capital stocks, political constraint to compensation, heterogeneity of decision routines in the industrial sector, or ‘misperception’ of the general equilibrium effects.

It is generally reported, as in the articles of Edmonds et al. (2008) and Strachan et al. (2008b), that the larger the participation in international carbon trading, the lower the policy costs will be, thanks to the low abatement costs in developing countries. This is true in any ‘first best’ setting, but the models do not account for the adverse impact of a significant carbon price (say $40) on lowered income generation and, more precisely, the risk to the emerging middle classes of a slower departure from a subsistence-level standard of life. As shown previously by Hourcade and Gherzi (2002), revenues from carbon exports and the lower prices of oil and gas imports may not always compensate for this adverse effect.

More generally, the growth engine behind current general equilibrium analysis fails to capture the contradictions to be resolved by any post-Kyoto regime:

- most of the infrastructures (energy, buildings, transportation) of emerging countries will be established in the following two or three decades, causing an important irreversibility effect in terms of GHG accumulation;

- carbon prices emerging from carbon markets will not be high enough to change decision routines in due time in sectors governed by determinants other than energy prices, but are likely to hurt the most GHG-intensive countries in the meantime.

In other words, these (developing) countries will not suffer from a $200/t carbon price in 2050 but from a [Q1]€30–50/t price in 2020.

5. Conclusions: towards a renewed research blueprint

The substantive conclusion stemming from the Climate Policy Special Issue, Modelling Long-term Scenarios for Low Carbon Societies is that, given the inertia of the deployment of carbon-free technical systems and the uncertainty about what will be the best candidates to supplant fossil fuels (both from an economic and an environmental point of view), it could be safer to play on complementary policy tools in parallel to a steadily increasing value of carbon, such as spatial re-organization, dematerialization, infrastructures, etc. These policy instruments and behavioural changes would allow for a relaxation of the constraints on technology and innovation.

The implications of this are that energy is ultimately a sector embedded in the overall development patterns, and no LCS is plausible without paying attention to transportation and urban dynamics, to agriculture and land-use dynamics, and to how industry could regard LCS as a new innovation frontier at both the product level and the process level.

These implications are enough to open a new research agenda, mobilizing scientific communities together with energy modellers. But because transition is the real challenge, the core of this agenda is to develop modelling tools that do not assume idealized conditions of perfect foresight and fast learning along a balanced growth pathway. The metaphor of the elephant and rabbit stew (see Hogan and Manne, 1977) is valid along long-run equilibrium pathways. However, it seems implausible that large departures from current trends in sectors such as energy, buildings and transportation induced by significant price signals and fiscal reforms will not entail, over the short and medium run, non-marginal adjustments in the macroeconomic dynamics.

This does not mean that accounting for non-negligible transition costs will lead to the downward revision of the ambitousness of climate policies. First, transition costs matter even more on the side of climate impacts and to address adaptation to climate change impacts (Hallegatte, 2007). Second, the mechanisms explaining transition costs are also effective along reference scenarios, so that those scenarios can hardly be held to be optimal. The latter point is critical.
for the assessment of costs of the transition towards LCS because it diversifies the levers for double-dividend policies: reforming fiscal systems, redirecting investment to R&D, strengthening energy security, preventing investment shortages in infrastructures, and improving local environments.

On the policy side, the material collected together in this Special Issue conveys a consistent and useful message about the content that should constitute any efficient climate regime: a way of stabilizing expectations, long-term agreements built upon a diversification of the policy instruments, and the flexibility to account for the heterogeneity of the real world and to organize the overlapping of measures at the various time horizons of a long transition pathway.

The joint evolution of the research and policy agenda (necessary to account for the difficulties of the transition pathway) may not be successful without a change in how modelling results are used in the policy-formation process. Although the energy models indicate the feasibility of a LCS over the long run, provided that almost all the available margins of freedom are mobilized, there is still the temptation to stick to optimistic economic cost assessments which describe the ‘new’ long-term equilibrium and tend to underestimate the transition pathways. This reflex is largely due to the need to form a consensus and to refute the idea that an ambitious climate policy will force people to ‘return to candlelight’. But denying the potential difficulties can be counterproductive, creating a ‘too good to be true’ reflex when the moment of truth has come in the face of real decisions. After all, given the revolution to be organized in technical systems and the changes to be operated in consumption behaviours, a Churchillian attitude may be largely preferable. A LCS is a likely ‘no-regrets’ option, but ‘no-regrets’ is not without effort. The role of scientists is to provide guidance about where the stumbling blocks are on the pathway and what could be a well-designed policy mix (more complicated than a global carbon price stemming from a pure worldwide cap-and-trade) that minimizes the risks of high transition costs.

References


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Q1 p. 12 In the sentence “In other words, these (developing) countries will not suffer from a $200/t carbon price in 2050 but from a €30–50/t price in 2020”, you suddenly change from giving the price in dollars to giving it in euros. Please check and correct if necessary.