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Preparing for the Next, Very Long Crisis: Towards a 'Cool' Science and Technology Policy Agenda For a Globally Warming Economy

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ABSTRACT

This short paper on a very big subject deals with a worry - a worry that the present economic crisis is likely to contribute to the already-existing temptations of governmental and private actors alike to behave in a time-inconsistent fashion when responding to the challenge of climate change. The specific concern here is that science and technology research commitments be launched soon enough on the scale that is likely to be needed, and that timely steps be taken toward the supportive adaptations in long-standing institutional and regulatory readjustments that can render those investments in knowledge more effective. Institutional changes, new incentive mechanisms and a rethinking of national policies with regard to exploitation of the international regime of intellectual property protections - are needed to successfully address the looming crisis of global climate change.

Keywords: GHG emissions, CO2 pricing, Strategic Energy Technologies, EU SET Plan, green technologies, R&D, IRP, global technology transfers.

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The motivation for this short paper on a very big subject is a worry – a worry that the present economic crisis is likely to contribute to the already-existing temptations of governmental and private actors alike to behave in a time-inconsistent fashion when responding to the challenge of climate change. The specific concern here is that science and technology research commitments be launched soon enough on the scale that is likely to be needed, and that timely steps be taken toward the supportive adaptations in long-standing institutional and regulatory readjustments that can render those investments in knowledge more effective.

Given the numerous serious but essentially transient occasions on which the attention of governments is susceptible to being deflected from dealing with chronic economic problems, it is hardly too early, and now risks being too late for major actions that would have payoffs in terms of affordable green house gas reductions two decades in the future, when they really will be needed. The world is confronted with a problem that simply is not "storable"; the challenge of global warming is one that grows in size and severity if counteraction is deferred, until it will reach a point of instability beyond with ameliorative measures will cease to be feasible. This really is different from the Y2K problem.

As obvious as that might seem, justification for continuing to call attention to it can be found in the halting progress toward coordinated international agreements to address climate change issues, and the recent indications that the effect of the current economic crisis --aside from some marginal influence on the allocation of expenditures scheduled by "stimulus" programs -- has tended to sap the policy momentum that had developed during 2006-2007 behind public R&D programs and institutional initiatives to expand the portfolio of affordable technological means of controlling global warning.

International negotiations about concerted actions among the leading industrial countries to reduce green-house gas (GHG) emissions are preceding slowly, and in many respects the initial "bargaining" stance taken by some important players, notably Japan and the US, has been a disappointment. Certainly, they have fallen far short of the EU Member Countries' endorsement (in December 2008) of the package of EC Directives designed to activate its "20-20-20" renewable energy strategy[2]: 20% reduction of green-house gas (GHG) emissions by 2020, and 20% of energy consumption from renewable sources. Indeed, Europe has gone farther by pledging a 30% reduction in GHG emissions if the UN negotiations that will be held in Copenhagen this coming December manage to arrive at a general agreement.

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[1] *EcolePolytechnique & Telecom Paris Tech, UNU-MERIT, and Stanford Unversity*

[2] See the "*20 20 by 2020: Europe's climate change opportunity*" communication from the Commission; COM(2008) 30 final.

At this juncture however, perhaps as is only to be expected in the negotiations of this kind, there is scant sign that the economically advanced nations are preparing to address the specific calls by major developing countries, including China, India and Brazil. The latter's initial position is that the wealthy countries should commit to make disproportionately larger emissions reductions, technology transfers and programs of financial aid not only for climate change infrastructure investments in the developing world, but also in compensation for restrains on further intensive exploitation of their coal and forest resources. Whatever will be the "bargained outcome" of the present efforts to put in place a successor to the expiring Kyoto Treaty, one can anticipate – and hope – that it will emerge as just a small and comparatively easily achieved step in the extended sequence of increasingly difficult negotiations which yielded an adequate collective response to the unfolding long-run crisis of climate change.

"A crisis" can be defined as a situation in which the need for decision and action is both apparent and urgent, but in which exactly what one should do remains uncertain and undecided. This would seem to characterize the present challenge of mobilizing the commitment and coordination of global resources necessary to stabilize green house gas (GHG) concentrations at 450-750 parts per million (ppm) – which the 2007 Report of the Intergovernmental Panel on Climate Change (IPCC) concluded would be sufficient to hold global warming at the level of 2 degrees centigrade. Nonetheless, it is possible to say in very broad outline what can and should be done.

We can identify three ways in which government can constructively respond to the "climate change crisis." One is by pricing the damages caused by GHG emissions, through "carbon tax" or "cap and trade" programs that introduce transferable emissions licenses. This could induce individuals and firms to "internalize" the costs of the potential emissions-related damages resulting from their present operating routines and contemplated changes therein. Moreover, if the issuance of licenses were set so that they gave rise to binding constraints for a sufficiently large number of enterprises, the result at the margin would mimic the effects of regulatory emissions standards in raising incentives for private investment emission-reducing technologies.

It is important at the outset to notice that this approach – favored among a wide consensus of economists – relies on the market the allocate resources used directly and indirectly in activities that result in GHG emissions, as well as in investments that will affect the future costs of reducing such emissions. The potential deficiencies of market processes in allocating resources when the good to be produced and distributed possess "public goods properties" are well known among academic economists, and reductions of GHG emissions un-contestably qualifies as global public goods. Further, tradable permissions to emit (on which a market is expected to put prices) are intangible assets, and there is today for regrettable reasons a far more widely shared perception the potentialities of unregulated markets for financial assets and derivatives to function badly. Viewed from these perspectives, the sanguine reception the has greeted government announcements that the first-line public response to the climate change crisis will be to rely upon a new market, and the absence of skepticism and precautionary attention to the institutional structure and regulation of emissions-permission markets, is really quite remarkable. This is not the occasion to further detail doubts on this score, but taking note of them should serve to further emphasize the likely importance of the two other items that appear on the thinking economist's "to-do list".

The second mode of response is through publicly funded research and development programs to stimulate the search for new knowledge, and novel combinations of existing knowledge to generate a broad portfolio of technologies that directly or indirectly could yield significant reductions in GHG emissions, This could be seen as a continuation of recommendations for "public business-as-usual" in the form of or as calling for a rethinking about how best to both stimulate and direct the search for knowledge, its effective dissemination and application in technological innovations.

A third line of response is precautionary in a different sense, namely, undertaking and encouraging the development of technical and organizational expertise that will reduced the future costs of actions aimed a mitigating the disruption and damage that would ensue from the rise in GHG concentrations during the coming decades – during which it is likely that the struggle to stabilize them will not meet with complete successes. Here too there is a need for knowledge-portfolio widening and deepening, to which a differently focused category R&D programs can contribute by exploring the possibilities of reducing vulnerabilities of structures and people to "extreme weather", including adaptive population redistribution and geo-engineering. Projects of this kind are highly context-sensitive, and call for close interaction and knowledge exchanges, and extensive feedbacks among solution providers and solution-users in a multiplicity of specific industrial and environmental setting.

Although 2007 and 2008 saw a salutary awakening of governmental and private sector attention to the long-term climate change "crisis"—notably in the EU, where it brought forward ambitious and far-reaching policy proposals such as the European Commission's Strategic Energy Technology (SET) Plan (2007)[3], it is quite evident that that relevant policy actions in both the public and private spheres will be subject to serious coordination and "time inconsistency" problems. Immediate social and economic, not to say political concerns always intrude and compete for the attention of public agencies; at each moment these distractions from "chronic problems" a special locus, demanding attention to this industry or that sector, to some provinces and social groups but not others; or they curtailing the abilities of governments dependent upon tax revenues to honor long-term programmatic commitments while meeting short-term public expenditure needs.

This is happening around us at the moment: the current financial and macroeconomic "crisis" has been serious enough to deflect attention from strategies that would address global warming through by means of sustained major public sector commitments of scientific and technologically research investment, and the adverse macroeconomic demand situation has compounded the difficulties of inducing business investment in appropriately "green" production and distribution facilities. What has become more attractive to the governments of the Member countries, and hence for the European Commission, are the variety of shorter-term tactics aimed at stimulating aggregate demand in ways that would *implement already available technologies for "green" purposes*: retro-fitting buildings for greater energy efficiency, supporting the automotive industry to increase production of low-CO_2 vehicles using electric batteries and second generation bio-fuels, investment subsidies for grid infrastructures to create more integrated European markets for electricity current generated by wind- and water-turbines.

Without argument, it is desirable that this "low- hanging fruit" be quickly plucked; that "stimulus" funding and induced private sector investment be steered towards those form of employment-generation, rather than other projects where the social rates of return are not as high. Nevertheless, settling for these measures leaves un-addressed "the climate change crisis" – defined as the state of not knowing what eventually will be both necessary and practicable means to stabilize GHG concentrations at a level that will not melt the polar caps, and trigger a runaway process that will put large areas of the world's developed and developing countries under water. It is generally agreed in scientifically and technically informed circles that to avert this will require the development and eventual global deployment of a range of technologies -- for energy supply and end-use, land-use, agriculture, and transportation support of adaptive population redistributions -- that either have still to reach the proto-type stage, or if they have done so, remain far from widespread commercial feasibility. For example, even in the field of electric vehicles, lithium-ion batteries for plug-in electric vehicles that would have a 40 mile range still cost about $10,000 apiece.

[3] See http://ec.europa.eu/energy/technology/set_plan/set_plan_en.htm

The precautionary principle argues against waiting for the needed breakthroughs to happen spontaneously, or for the private sector to step forward and gamble on the prospective profitability of owning the intellectual property on critical technologies to avert environmental catastrophes (especially not when it is likely that truly critical patents would become subject to compulsory licensing). Due weight therefore should be given in government climate change and energy strategies to the key potential benefit of undertaking major programs of focused scientific and technological research and development investment at this time, because they could dramatically reduce the costs of having drastically to restrict GHG emissions by other means in the future.

The commitments of global resources that one should envisage are really quite daunting. A back-of-the-envelop calculation may serve to underscore this, by starting from an estimate made for the McKinsey Global Institute (Enkvist, Nauclér and Riese, 2008) that the projected growth of global energy demand could be cut in half by an investment of $170 billion a year (earning a private internal rate of return of 10 percent per annum) in each of the 12 years from 2008 to 2020. But considerably more than a 50 percent cut in global energy use concentrated on GHG emitting sources would be required. The IPCC Report called for a reduction in annual GHG emissions from just under 50 billion tons in 2007 to 5-10 billion tons in 2050, an implied reduction of 80 to 90 percent. More recent studies suggest that that may be insufficient to stop the planet's temperature from rising above the 2 degrees centigrade level, because the initial simulations underestimated some of the positive feedback effects of transitional warming. (More heat-absorbing ground becomes exposed by the retreat of glaciers, the seas' will become less absorb CO_2, and, worse, climatic changes and polar ice sheets that break up and float into more temperate waters may disrupt the oceanic convex ion cycles and cause the release of gases that otherwise would remain compressed in the cold depths.)

If we therefore allow that the 50 percent cut in projected demand for carbon-fuel sourced energy – effecting a 40-45 billion ton reduction in GHG emission -- would still leave another equal cut in emissions to be achieved, this implies the need for a further, 100 percentage point reduction from the level achieved by the first $1.70 trillion worth of investment. To take into account the likelihood that the second equal volume reductions in GHG emissions will be more costly than the first, suppose that the investment requirements are proportional to the percentage reductions at each stage, so that the second step will cost twice the capital sum on the first step, or $3.40 trillion. The total bill, at $5.1 trillion is manageable, but nonetheless considerable: about 12 percent of 2008 global GDP, and almost 50 percent of global fixed investment expenditures in 2008 prices. While this can be spread out over more than a decade, the bulk of it probably would have to be concentrated within the coming decade and a half in order to have the capital formation in place by 2030.

What could be achieved by a successfully focused program of exploratory R&D investment – not considered, nor included the foregoing calculations based upon the MGI study – is the creation of technologies that would lower the investment costs of achieving the required GHG reductions, and make it rational to delay the most lumpy and irreversible of the capital formation commitments in order to preserve the option of implementing more efficient technologies when these emerged. But exploratory research is particularly uncertain, and risks therefore call for an early start with a diversified research portfolio from which the more promising lines can be selected for further development.

Viewed from that perspective, it is disappointing to observe the signs that the current macro-economic crisis has deflected the EC's focus, at least temporarily away from its SET Plan for Europe, in favor of emphasizing the near term approach of lowering the region's GHG emissions by establishing regulations and a market mechanism to price such emissions. As recently as November 3rd of last year, EU's Energy Commissioner, Andris Piebalgs, in a speech in London (Piebalgs, 2008) was setting out the elements of "the Commission's vision for renewables" in terms of the role that a range of available technologies would play in achieving the "20-20-20" targets proposed by the Commission, and emphasizing the very

modest costs that would be entailed in deploying biomass-using Combined Heat and Power installations, solar-, wind- and tidal-generation technologies for electricity, and second generation biofuels for the transport sector. The concluding point of his message was the affordability of the SET Plan's "package" for energy-intensive sectors, even in the current economic crisis. This was because provision had been made to use the revenues raised by the proposed Emissions Trading Scheme to compensate the carbon-fuel using sectors that were most affected by the pricing of GHG emissions. The thought that such compensation would work to offset the pressures on those firms to alter their production methods or energy sources, however, did not stop the Commissioner from concluding that "it is time to realize that we don't have a long-term choice about developing a low carbon economy. Climate change, vulnerability to high fossil fuel prices and energy security mean that we must not let current market turmoil distract us." Indeed, would that he had not already been distracted.

The passage of 6 months, and the deepening economic recession has only reinforced the shift of the Commission's focus away from science and technology policies as a key response to the challenge of climate change. May 24th-25th found the Energy Commissioner at the G8 Energy Ministerial Meeting in Rome, calling for a "good investment climate to take the energy sector out of the crisis." The press release reporting his speech mentions that the Commission also was "trying to increase to increase its efforts on research for technologies that will help reduce CO2 emissions, such as carbon capture and storage."[4], but Commissioner Pieblags' intervention in the working session devoted to Energy Strategies to Respond to Global Climate Change, stressed that "Our main tool to drive the energy sector toward a low carbon system is the price of CO2 in an open market." He therefore reminded the audience of "the importance of open and transparent markets in order to assure energy security, together with permanent dialog between producers and consumers in order to create the necessary climate to ensure investment in new generation capacity, infrastructures and the promotion of renewable energies and energy efficiency." The goal of encouraging investment in energy production is evidently stems from energy security concerns, and the virtue of the Emissions Trade Scheme[5] (European Commission, 2006) appears from that perspective to consist in providing a source of subsidies to major energy-users that will help maintain European demand for the required increase in domestic energy generating capacity. Evidently, the GHG emissions reducing purpose of pricing the use of carbon fuels, and the need to sustain a good investment climate for R&D that would lower the costs of renewable energy sources, are being pushed from the center of the energy policy stage and how long it will be before they regain it remains obscured in the uncertainties surrounding the timing of the recovery of aggregate demand in the European economy.

This situation is regrettable and fraught with potentially serious risks. The scale and complexity of the scientific and technological efforts that will be required warrant giving consideration to measures that would enhance the effectiveness of both public and private research investments and technology transfers in a wide array of "green technologies." Beyond the needs for international coordination, and coordinated funding action on the part of governments at different levels, there would seem to be a good case to be made for raising the payoffs from R&D expenditures by avoiding excessive correlation of public and private research portfolio and consequent un-necessary duplication of domestic as well as international efforts. Perhaps in this pressing connection there is a compelling rationale for devising and implement agreements and focused funding for "smart specialization" in applied research and pre-market development of GHG emissions reducing projects on both sectoral and regional basis, venturing even beyond the "entrepreneurial discovery" policy approach that recently has been proposed as the mode through which to pursue "smart specialization" in research, development and training policies in the European Research Area (Foray, David and Hall, 2009).

[4] See http://europa.eu/rapid/pressReleasesAction.do/reference=IP/09/830
[5] See also http://ec.europa.eu/environment/climat/emission/index_en.htm

Furthermore, urgent attention should be given to a range of measures that could enhance the effectiveness of both public and private R&D investment in a wide array of "green technologies," by facilitating knowledge-sharing, adaptation and diffusion of innovations. This would entail a critical rethinking of ways to mitigate the inhibiting effects on exploratory research and cumulative incremental technology development that arise from both long-standing and recently developed features of the intellectual property rights regime. Targeted domains for research exemptions, defined fields in which a combination of a liability approach to IPR infringement and greater reliance on prizes for inventions in defined fields supplements the existing property rights approach are one part of the agenda for careful consideration. But competition policy adjustments to permit efficient pooling of patent, copyright and database rights, and the exercise of existing governmental rights to use patents for public purposes without paying licensing fees, and to mandate compulsory licensing of such inventions to third parties also should claim attention under this se heading.

However radical the foregoing may be deemed to be in some quarters, these proposals for institutional adaptations and innovations to improve the efficiency of resource allocation in the production and distribution of useful knowledge hardly are new and most of them will be found to have been cogently elaborated by legal scholars and economists. If the challenge of the "climate change crisis" does not create a context warranting their receiving a serious hearing in forward-looking EU public policy deliberations, what would?

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