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Green Growth

Green growth is now a central theme of the international climate change negotiations. The Rio+20 Conference in June will concentrate on green growth as one of its main priorities. The Europe 2020 strategy has identified green growth as a fundamental pillar of EU economic policy. This Forum takes stock of the academic discussion and examines the theoretical and empirical underpinning of the concepts of green growth and employment through environmental policy.

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Religion and Reality in the Search for Green Growth

The newfound popularity of "green growth" should not surprise. Repeated failures in international climate negotiations have led to the search for new motivations for emissions reduction. In parallel, the major emitters continue to endure economic stagnation and political instability in the aftermath of the 2008 financial crisis. The notion of "green growth" suggests a way out of both problems. Were "green growth" to become a reality, it would bypass the myriad problems of climate change mitigation – who should pay, how much, and when. If "green growth" were possible, then the shift to a low-emissions economy could pay for itself by catalysing a wave of investment, innovation and job creation. Rich countries could re-found economic competitiveness in an array of new "green" industries, while emerging markets could support their ongoing development on a foundation of new low-emissions technology.

But "green growth" today remains more religion than reality. The short-term jobs and investment generated by the move to renewable energy will come at substantial cost, last only as long as the retrofit period itself, and will partially displace jobs in legacy energy sectors. Longer-term prospects are equally unpromising. Radical success in renewable energy adoption will mean an energy system as reliable, ubiquitous and flexible as today's fossil fuel-based system. Beyond lower emissions, however, "green" electrons will provide consumers few obvious advantages over the "brown" electrons they use today. Absent new energy capabilities or improved energy services, the possibilities for economic growth based solely in the energy sector appear very limited.

This article considers how green growth might move from religion to reality. We make three straightforward arguments: *first*, that green growth will require a systems transformation; *second*, that a growth-inducing systems transformation must look beyond the energy sector; and *third*, that both green growth and energy systems transformation will require a range of policy interventions that go well beyond conventional prescriptions for emissions pricing and R&D subsidies. Appealing to the broad-based growth catalysed by earlier transformations in energy, transport, and information technology, we argue that the real green growth challenge lies in discovering the transformative potential of a low-emissions energy system for economic production and social innovation writ large.

Renewable Energy, Jobs and Growth

The green growth debate has emphasised job creation and export-led growth in energy sector jobs and technologies alone, rather than the intrinsic growth-generating dynamics of low-emissions technology itself. We summarise those arguments here to drive home the following point: that this narrow focus risks damaging both the long-term prospects for green growth and the broader enthusiasm for climate policy. Justifying climate policy

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by pointing to short-term gains to energy sector employment or export-led growth may undermine the long-run justification for climate change mitigation if those benefits do not materialise. It also risks international conflict over trade and industrial policy that damages both cooperation on emissions reduction and the broader framework of international trade cooperation.[1] Durable green growth will, instead, require a broader vision of the role of new forms of energy in sustaining and expanding economic possibility.

Mistaking Short-term Jobs for Long-term Growth

In the aftermath of the 2007-2009 financial crisis, the "green jobs" variant of the green growth argument gained currency across the industrial world. United States President Barack Obama, the European Union, and a range of American states and European countries have all sought to tie green energy investment to job creation.[2] This led to a significant quantity of economic stimulus funds – billions of dollars, equivalent to anywhere from 10% to 80% of national stimulus budgets – directed at energy efficiency, renewable energy, and energy-related research and development.[3] Support for these activities was buttressed by fears that insufficient domestic energy investment would lead to permanent disadvantages in a new green technology frontier, particularly vis-à-vis new economic powerhouses like China.[4]

This emphasis on jobs should raise immediate concerns on two fronts. First, a focus on job creation in the green energy sector alone cannot form the basis of sustained economic growth in advanced industrial societies. If those jobs result from Keynesian demand stimulus, as in 2008-2010, their viability will necessarily fade as the economy returns to full employment. The long-term opportunities for employment growth are similarly limited. Advanced industrial societies have fully built-out energy systems and relatively modest growth in energy demand. "Green jobs" will thus often replace "brown jobs" in operation of the energy system; and the new "green jobs" created for the period of system retrofitting will necessarily be short-lived, lasting only as long as the retrofit itself. Finally, those "green" jobs will have limited impact on the overall employment picture, as they emphasise the energy sector alone rather than the economy as a whole.[5]

1 For a broader treatment of individual green growth arguments and economics, see M. Huberty, H. Gao, J. Mandell: Shaping the Green Growth Economy: a review of the public debate and prospects for success, Report prepared for the Mandag Morgen Green Growth Leaders Forum, http://greengrowthleaders.org/wp-content/uploads/2011/04/Shaping-the-Green-Growth-Economy_report.pdf. Last accessed 9 May 2011.

2 For the European Union, see The European Commission: An Energy Policy for Europe, Communication to the European Parliament and European Council, Document SEC (2007) 12, Brussels, Belgium 2007, The European Union. For the Danish emphasis on job creation from renewable energy, see The Danish Government: Danish Energy Strategy 2050, Denmark 2011, Danish Climate and Energy Ministry. For related arguments from prominent figures in the public debate, see V. Jones: The Green Collar Economy: how one solution can fix our two biggest problems, San Francisco 2008, HarperOne; and the European Green Party: A green new deal for Europe: manifesto for the European election campaign, 2009.

3 E. Barbier: Green stimulus, green recovery and global imbalances, in: World Economics, Vol. 11, 2010, No. 2, pp. 149–177.

4 See, for instance, European Union Commissioner for Energy Gerhard Oettinger, who justified increased EU support for low-carbon technologies on the fear that Europe would "start lagging behind China and the USA". Speech of Commissioner Oettinger at ENERI 2010, Brussels Presidency Conference on Infrastructure of Energy Research, 29 November 2010.

5 The scale of the energy sector points to the limits of job creation in that sector alone. For instance, Denmark obtains about 10% of its overall exports from its wind energy sector. But that sector employs only 24,000 people, or about 1% of the Danish workforce. In most Western economies, the total value of energy consumption runs at about 2-4% of GDP; not insignificant, but also not very large compared with the economy as a whole. As such, betting on massive job creation through renewable energy rings hollow.

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Second, the quality of those jobs is also open to question. Investments in green electricity may generate more jobs per unit of installed capacity than an investment in equivalent brown energy capacity.[6] But this implicitly suggests that the green energy industry achieves, at present, lower labour productivity than the fossil-fuel power sector. If the goal is pure Keynesian job creation to employ idle labour, then this justification may make sense. Moreover, this productivity differential mimics other periods of new technology adoption: learning how best to incorporate new technologies necessarily requires some up-front expenditure. But in those earlier periods, the intrinsic advantages of new technologies – lacking in renewable energy – helped offset the higher up-front labour intensity. Presently, "green tech" lacks such advantages. Thus as a long-term employment strategy, the deployment of a low-emissions energy system appears, on its own, to have limited capacity to sustain broad employment gains or high wages in advanced industrial economies.

Export-led Growth and the New Green Mercantilism

Export-led growth in new green technology provides a second growth channel commonly cited in popular green growth arguments. Countries now openly express concerns that the failure to create domestic markets in green energy will lead to lost global competitiveness in emerging industrial sectors. But as Huberty and Zachmann[7] have shown, comparative advantage in "green" technologies will likely concentrate in countries the industrial clusters of which already contain closely related forms of industrial and innovative expertise. Thus the connection between "green growth" and export competitiveness offers poor justification for low-emissions investments in many countries.

Furthermore, there is little reason to believe that green goods are *necessarily* insulated from the erosion of manufacturing competitiveness that has challenged developed economies in other sectors. The recent difficulties of firms like Solyndra, QCells, and FirstSolar testify to increasingly intense competition driven by rapid process innovation in East Asia.[8] Commodification and process innovation have kept down the cost of taking emissions out of the energy system, while simultaneously undermining attempts at coupling emissions reduction to domestic job creation. Furthermore, Dechezleprêtre et al.[9] provide evidence that policies using demand-pull investment in low-emissions energy goods will generate significant spillover effects that benefit foreign as well as domestic firms.

Using domestic low-emissions investment to drive comparative advantage abroad also poses political risks. China and the US area are already engaged in a series of fights in the World Trade Organisation over subsidies for renewable energy technologies and renewable energy deployment.[10] Given the lack of obvious channels for green growth beyond command of export markets, this conflict was perhaps inevitable. But it foreshadows a new "green mercantilism" which, like its 19th century predecessor, threatens to justify an array of restrictive economic policies at home and the aggressive political pursuit of zero-sum markets abroad. Given mercantilism's legacy of economic and political costs, reviving it to justify low-emissions energy policy appears unwise.

Beyond Energy: Green Growth and Systems Transformation

Thus most arguments for green growth derive their claims about job creation or investment gains from a narrow focus on one aspect or another of the energy sector. These arguments do not hold up well to scrutiny. Rather, in their focus on the short-term employment or investment prospects for installing renewable energy technology or retrofitting buildings, they self-consciously limit their scope of impact and pose an array of economic and political risks.

Instead, we argue that any discussion of green growth must start from the premise that effective climate change mitigation will require the *transformation*, rather than marginal modification, of legacy energy systems. Reduc-

6 D.M. Kammen, D. Engel: Green Jobs and the Clean Energy Economy, Thought Leadership Papers Series No. 4, Copenhagen 2009, Copenhagen Climate Council, at http://www.copenhagenclimatecouncil.com/dumpfile.php?file=ZmlsZWJveC8xODk=&filename=VExTMDQgX0dyZWVuSm9icy5wZGY=.

7 M. Huberty, G. Zachmann: Green exports and the global product space: Prospects for EU industrial policy, Working paper No. 556, Brussels 2011, Bruegel.

8 See, for instance, S. Nicola: Merkel's green jobs ambition stalls with cuts for solar, Bloomberg Businessweek, 30 April 2012, online at http://www.businessweek.com/news/2012-04-29/merkel-s-green-jobs-ambition-stalls-with-cuts-for-solar, accessed 1 May 2012, on the shakeout of the German solar industry and its consequences for "green" job creation.

9 A. Dechezleprêtre, M. Glachant: Does foreign environmental policy influence domestic innovation? Evidence from the wind industry, Working paper, 2011, CERNA, Mines ParisTech, Paris, France.

10 See here K. Bradsher: To conquer wind power, China writes the rules, in: The New York Times, 15 December 2010, A1; M. Scott: GE, Vestas fall behind in China's 'Tough' wind market, in: The New York Times, 14 May 2010; and T. Woody: China snaps up California Solar Market, The New York Times Green Blog, 14 January 2010, at http://green.blogs.nytimes.com/2010/01/14/china-snaps-up-california-solar-market/#more-38129.

tions of 50-80% in fossil fuel emissions will require going beyond mere replacement of fossil fuel power plants. Rather, it will also require substantial changes to the power transmission and distribution infrastructure, improvements in end-user energy efficiency, and the use of information-enabled intelligence to better manage supply and demand. All these technical changes will require, in turn, corresponding changes to the markets and regulatory structures that frame energy production, distribution and use. Each of these changes provides an opportunity to capitalise on the transformation as a catalyst for broader economic growth. Identifying these opportunities, however, will require more careful consideration of the link between systems transformation and economic opportunity.

Systems Transformation and Economic Growth: Lessons from the ICT Revolution

The industrial age has undergone a series of systems transformations, each with profound consequences for job creation, investment and the organisation of production. For energy in particular, successive shifts from wood to coal, coal to oil, and from thermal to electrical energy fundamentally altered what was possible in the economy. The growth we associate with each of these shifts depended almost entirely on these changes to the broader trajectory for the organisation of production, distribution, and the use of goods and services in the economy, rather than the investment required for the transformation itself.[11]

We do not presume to know whether a low-emissions energy systems transformation holds the same growth possibilities. However, we argue that any viable approach to green growth will require a strategy capable of discovering whether they exist. How best to structure the technological, economic and political experimentation necessary to do so is thus the real question at the heart of the green growth problem.

To better understand how this might occur, we focus on the information technology revolution as a powerful example of how the evolution – or perhaps revolution – in a particular technology domain can have transformative effects in the economy and lead to widespread growth. The history of the ICT revolution provides three important lessons for the transformation of the energy system: first, the network proved to be a crucial enabling technology; second, the growth opportunities generated by the transformation came predominately from the possibilities it created in the broader economy, rather than the IT sector itself; and third, regulatory intervention and public support played a co-equal role with private ingenuity in initiating and driving the transformation.

The ICT revolution was a systems transformation in two senses. First, it required a transformation of both the technologies for computation and communication, and the broader regulatory and market context that determined how firms and consumers adopted those technologies. Second, it generated massive spillover benefits by transforming the possibilities for economic activity in the broader economy. The major changes we associate with ICT – in logistics, inventory management, retailing, firm structures and other domains, while unimaginable without ICT, were themselves not purely ICT innovations. Instead, by altering the possibilities for economic production across a wide range of sectors, the ICT revolution ensured that most of its growth potential would come from outside the ICT sector itself.

Achieving this kind of transformative growth required both private investments in new technologies and business models, and public support for open, competitive, standards-based markets in which those investments could thrive. Government support for both R&D and procurement – largely in the American defence and space sectors – initiated the modern IT industry and drove much of its early demand. Government policing of the network and technology monopolies controlled by AT&T, IBM and Microsoft restricted incumbent firms' ability to hinder competition and innovation. In parallel, private sector innovation generated a new set of business models – the small start-up and the venture capitalist – and firms, including future giants like Intel and AMD, founded on an array of new technologies. Together, this activity seeded both radical innovation and intense competitive pressure. Finally, the public sector's role in generating a redundant, open communications protocol produced a network – the internet – that became an innovation platform unto itself, driving waves of new innovation that competed on product and service quality rather than network access.

Real doubts exist as to whether a low-emissions energy systems transformation holds the same promise for economic growth as ICT. Spectacular success in adding

11 For coal, see J. Nef: The Rise of the British Coal Industry, London 1932, George Routledge and Sons, and R.P. Sieferle: The subterranean forest: energy systems and the Industrial Revolution, Cambridge 2001, The White Horse Press. For electrification, see T.P. Hughes: The Electrification of America: the system builders, in: Technology and Culture, Vol. 20, No. 1, 1979, pp. 124-161; T.P. Hughes: Networks of Power: electrification in Western society, 1880-1930, Baltimore 1983, The Johns Hopkins University Press; and C. Perez: Structural change and the assimilation of new technologies in the economic and social system, in: Futures, Vol. 15, No. 5, 1983, pp. 357-375. For energy transitions in broad historical perspective, see V. Smil: Energy in world history, 1994, Westview Press; V. Smil: Energy Transitions: History, Requirements, Prospects, New York 2011, Praeger.

renewable energy to the energy system will mean that energy users will notice no difference between today's coal-generated electrons and tomorrow's wind-generated electrons. All the investment in storage, the smart grid and new energy sources will go towards ensuring that today's patterns of energy use remain viable. In contrast to the first era of electrification, this transformation presently offers few obvious new possibilities for energy use. Meanwhile, achieving these ends will require substantial public and private investment over decades, in an era marked – for the rich countries in particular – by austerity and retrenchment.

Searching for the Opportunities in Systems Transformation

However, the economic significance of radical systems changes often comes in disguise. The advantages of a new technological system are rarely evident at the outset. While the potential of ICT appears obvious in retrospect, at the outset even industry insiders wildly underestimated the potential for their own products. IBM, the apocryphal story goes, projected that it would sell only a handful of its new mainframes. Translating the idea of the microprocessor to even an engineering audience required Intel's marketing director to have a PhD in electrical engineering.[12] Most cell phones today contain vastly more memory than Bill Gates thought even a personal computer would ever need.

The marketplace may yet discover similarly real advantages to "green" tech not obvious at present. But the very different nature of this transformation, and the very large investments it will require, mean that the participants – private and public sector alike – must proactively identify the conditions that would support the process of experimentation that discovery will require. That process will prove a necessary precursor to policy that can go beyond merely driving the development and adoption of "green" energy to enable the broader adaptation in the economy as a whole.

Instruments and Policy Goals

Climate change mitigation confronts policymakers with a wide range of choices in service of both "green growth" and a low-carbon energy systems transformation. The most vibrant policy debates today concern the role that four different policy instruments should play:

- carbon pricing to incentivise technological development, low-emissions energy adoption, and behavioural change;
- technology policy to support research and development;
- regulatory policy to change market rules to favour new forms of energy production, distribution and use[13];
- direct state action for public infrastructure investment and industrial policy.

Conventional policy wisdom for carbon emissions mitigation calls for a credible, sustainable and high carbon price, perhaps supplemented by subsidies to basic research and development for new energy technologies.[14] Such policy, its advocates argue, will allow the economy to discover the most efficient way of reducing emissions. In contrast, other options – such as industrial policy, subsidy of renewable energy sources or mandates for energy efficiency – are seen as inefficient meddling in the market that will ultimately cost more than a policy reliant on price alone.

We can debate whether a price-based approach would suffice if the only goal were emissions reduction. But the conventional policy wisdom falls short if we hope to exploit the possibilities of energy systems transformation for economic growth. Three shortcomings stand out:

- the preconditions for a successful carbon pricing policy – a universal, sustainable, high carbon price – appear politically difficult domestically and impossible internationally;
- it is by no means clear that an efficient carbon price set at the marginal cost of emissions can overcome the network externalities present in the energy system;
- the carbon price offers little support for the coordination and market reform developments critical to future energy innovations.

The political shortcomings pose particularly acute challenges. Since any price on carbon is entirely a political

12 W. Davidow: Marketing High Technology: an insider's vie, New York 1986, The Free Press.

13 These three elements of the energy system are configured differently in each country by regulation and ownership structure, creating distinct national dynamics of demand and supply. Hence there will not be one universal trajectory to a low carbon future and cannot be a single best regulatory strategy.

14 W. Nordhaus: Designing a Friendly Space for Technological Change to Slow Global Warming, in: Energy Economics, Vol. 33, No. 4, 2010, pp. 665-673.

construct, a product of a mix of taxes and subsidies, the durability of the carbon price depends on the ability of a political system to sustain it. Sustainability will depend entirely on the relative ability and desire of carbon price supporters and opponents to influence policy. Even if environmental interests can build a coalition to pass carbon pricing, political science research makes clear that the concentrated economic interests that lose from carbon prices will likely still succeed in eroding the carbon price over time.[15] These problems worsen with higher and more punitive carbon prices. Thus "high" prices undermine both "universal" and "sustainable" prices, putting the viability and effectiveness of a price-driven energy systems transformation in doubt.

Points of Leverage in a Green Energy Systems Transformation

Looking beyond emissions pricing, however, policymakers face difficult choices about where and how to apply other policy tools in diverse regional and national contexts. With limited resources, policymakers have little choice but to seek points in the energy system where limited interventions can change the trajectory of development, by altering the choices of actors throughout the system. Past transformations, like that of ICT, pointed to the role of networks as levers for catalysing broad changes to the trajectory of an industry. Do similar levers exist for energy, which if pulled would induce broad private investment to capture the diverse advantages of the new system?

We define a lever to be a change or set of changes to part of the system that, if carried out, will induce or enable complementary changes in the rest of the energy system. For the case of the energy system, the power grid provides an excellent example of such a lever. The grid is central to choices about how to produce, distribute and use energy; and changes in the grid alter options in all three dimensions of the energy system. Consequently the grid provides significant leverage for policies intent on accomplishing energy systems transformation. Transforming today's power grids from passive means of energy transport to an active platform for innovation will require an array of technological and regulatory changes. Digital intelligence in the grid can enable both greater energy efficiency and new and different forms of renewable energy integration. But capitalising on the possibilities of such change will require complementary changes in grid access, control and standardisation. Together, these changes may provide the leverage for both the technological advances required for the adoption of new energy sources, and the investment and employment required for green growth.

The Search Process in Multiple Countries: National Idiosyncrasy and Experimentation

Economies as diverse as Denmark, South Korea, California and Colorado have pursued economic growth strategies that link action on climate change mitigation to new economic opportunities. Amidst the diversity of policy seen in these and other green growth strategies, two dimensions appear particularly critical. *First*, a country's choices on energy policy in particular derive from a set of idiosyncratic national goals – whether for energy security and independence, reliability, affordability, emissions reduction or other goals. *Second*, those goals are viewed through the lens of a country's domestic resources, natural or otherwise. For example, as Zysman and Kelsey[16] make clear, the sharp contrast between China and Denmark reflects sharply different priorities.

"Denmark's core problems and objectives have to do with: (1) ensuring predictable availability of energy at an acceptable long-term cost, ideally by achieving energy independence; (2) driving economic growth; and (3) lowering emissions. Choosing to make green industry a core of Denmark's economy – and choosing to structure its economy and infrastructure to take full advantage of this industry – creates a unified solution to all of Denmark's problems.

China, by contrast, needs to do the following: (1) achieve massive, near-future increases in energy availability; (2) continue growing economically at a rapid rate; and (3) very much secondarily, deal with a growing particulate emissions problem. Moreover, it is well-endowed with coal, a cheap-but-dirty energy source. Given the current state of technology, these objectives mandate both green technology and brown growth. Denmark's solution would not solve China's problems."

Amidst the diversity of strategies, instruments and goals, however, we find commonality in the political requirements for creating a stable foundation for green growth. That foundation requires a deal between industry and those who would advocate significant transformation of the energy system. Sometimes those advocates will be

15 E. Patashnik: Reforms at risk: what happens after major policy changes are enacted, Princeton 2008, Princeton University Press.

16 J. Zysman, N. Kelsey (eds.): The Green Growth Economies Project, Part Two: Country Cases and Analysis, prepared for the Mandag Morgen Green Growth Leaders Forum, 2011.

environmental or energy consumer groups, as in California or Colorado. In others, as in the case of Korea, the advocates will include or be led by government strategists concerned with security – either energy security in a narrow sense, or national security more broadly – or with finding the basis of a new trajectory of economic growth. No matter where the initial impetus comes from, however, the energy system transformation cannot be sustained by environmental consciousness alone. Rather, it requires a broader deal that brings economic interests inside the coalition in favour of a low-carbon energy systems transformation. And the process of building and sustaining that coalition will necessarily require a multifaceted policy approach.

Conclusions

Today, green growth remains largely "religion". Governments pursuing it have done so either as a justification for environmental policy, or on the basis of faith in a new approach to industrial development. But the opportunities that appeared in past instances of large-scale technological transformations have yet to materialise in this one, and appeals to short-term job creation or export-led growth face limits of their own making. Thus the potential for "green growth" lies in the discovery, rather than exploitation, of whatever opportunities low-emissions technology may hold for broader patterns of economic activity.

There are three significant implications of our argument:

- first, with limited resources, policymakers should seek points in the energy system where limited interventions can change the trajectory of development, by altering the choices of actors throughout the system;
- second, enduring economic and political success in a green energy-led systems transformation can only come from the possibilities it would create for the broader economy;
- third, achieving this transformation will require a complex set of offsetting deals, and an array of policy instruments, capable of compensating those discomfited or disadvantaged while allowing market incentives to induce the enormous private investments required.

At such an early juncture we cannot presume to know whether a green growth "reality" will emerge. We can, however, identify the shortcomings of today's faith-based arguments for green growth, and anticipate what a durable green growth strategy would require of firms, consumers and governments. Moving green growth from religion to reality will, we argue, require a technological and economic transformation akin to those of the emergence of steam, rail or information technology. That transformation will not come through a focus on one technology or another, nor through reliance on short-term job creation, nor from abstract appeals to economic efficiency. Rather, it will require attention to the restructuring of the energy system as a whole, the opportunities present in the transformation for widespread economic activity, and the role that policy must play in structuring and facilitating that systems transformation.

Arno Behrens and Bert Colijn

The Socio-Economic Transition towards Sustainability and its Impacts on Jobs in Europe

At the 1992 UN Conference on Environment and Development (UNCED) held in Rio de Janeiro, 178 governments adopted the Agenda 21, an agenda aimed at promoting sustainable and environmentally sound development on the global level. In 1992, there was widespread consensus that economic development and environmental protection need to go hand in hand and that local, national and global strategies are required to provide economic growth while halting and reversing the effects of environmental degradation. However, 20 years after UNCED in Rio and despite broad recognition of, and commitment to, the principles of sustainable development, "action has not moved beyond the margins and certainly has not led to the core changes needed to support a transition to sustainable development".[1] Although such a transition might generally be regarded as desirable, there is still a lack of highly organised societal driving forces and the transition towards a more sustainable society "is more a matter of reason than of passions, and certainly does not yet appear to be the logical and inevitable next stage".[2] While there has been some progress in terms of poverty alle-

1 J. Drexhage, D. Murphy: Sustainable Development: From Brundtland to Rio 2012, Background paper commissioned by the Panel secretariat, Highlevel Panel on Global Sustainability, New York 2010, United Nations, p. 1.

2 M. Fischer-Kowalski, H. Haberl (eds.): Socioecological Transitions and Global Change, Advances in Ecological Economics, Cheltenham, Northampton 2007, Edward Elgar, p. 7.

viation, access to energy, the integration of environmental and social concerns into government and business decisions, and increased investment in green technologies, "negative trends continue to prevail".[3] In fact, the global environmental crisis is worsening with global warming, biodiversity loss, transboundary air and water pollution, contamination of the oceans and seas and degradation of land resources continuing at unprecedented speed. Similarly, many of the world's natural resources are already overstretched to an extent that endangers their availability for socioeconomic processes and thus for sustaining future development.

One of the key roots of the growing environmental degradation is the increasing extraction and use of natural resources and the related increase in waste generation and emissions. Between 1992 and 2009, total use of construction minerals, biomass, fossil energy carriers, and ores and industrial minerals increased by over 61% to reach some 68 billion metric tonnes.[4] Furthermore, resource extraction activities are likely to accelerate in view of the fast expansion of new consumer classes in emerging countries, where people increasingly achieve lifestyles comparable to those in industrialised countries. If present trends continue, global resource use could triple between now and 2050.[5] These trends are clearly incompatible with sustainable development, considering the fact that socioeconomic activities are already putting pressures on the world's ecosystems beyond a sustainable level.[6]

Climate change mitigation, closely related to a more rational use of natural resources[7], will play an essential role in the transition towards sustainability. WBGU[8], for example, notes that although climate protection alone" cannot guarantee the conservation of the natural life-support systems" on which life on Earth depends, it is likely that without it "mankind will soon have to do without some essential development opportunities".[9] Substituting fossil fuels with other low-carbon (or zero-carbon) energy sources is thus at the heart of the socio-ecological transition towards sustainability.

Parameters for a Socio-Ecological Transition Towards Sustainability

The concept of a socio-ecological transition is based on the notion that human societies interact with systems in the natural environment. There are different patterns of this interaction, referred to as "socio-ecological regimes". These are characterised by the different energy systems upon which they depend, i.e. by the sources and dominant conversion technologies of energy.[10] A transition from one socio-ecological regime to another is then called a socio-ecological transition (SET).[11]

There are two prominent examples of SETs in human history.[12] The first one was the Neolithic revolution some 4500-10500 years ago[13] transforming hunters and gatherers into agrarian societies. The second was the industrial revolution, which led to the transition of agrarian societies to industrial societies with a strong dependence on fossil fuels. This industrial revolution took place in most parts of Europe in the 18th and 19th centuries and is ongoing in many emerging economies and developing countries.

Historically, human interference with the environment increased with each transition. Krausmann et al.[14], for example, show that per capita material and energy use increase by a factor of 3-5 as societies transform from an agricultural to an industrial regime. Similarly, the composition of material inputs changes substantially to a higher share of carbon-intensive and non-renewable natural resources. These (ongoing) changes have been unprecedented in human history and it appears that as a consequence the "safe operating space for humanity" has already been exceeded in at least three dimensions: climate change, biodiversity loss and interference with

3 J. Drexhage, D. Murphy, op. cit., p. 12.
4 F. Krausmann, S. Gingrich, N. Eisenmenger, K.H. Erb, H. Haberl, M. Fischer-Kowalski: Growth in global materials use, GDP and population during the 20th century, in: Ecological Economics, Vol. 68, No. 10, 2009, pp. 2696-2705.
5 United Nations Environment Programme (UNEP): Decoupling Natural Resource Use and Environmental Impacts from Economic Growth, A Report of the Working Group on Decoupling to the International Resource Panel, UNEP 2011.
6 See J. Rockström, W. Steffen, K. Noone et al.: A safe operating space for humanity, in: Nature, Vol. 461, 2009, pp. 472-475.
7 See A. Behrens: Restructuring the socio-economic metabolism – A policy oriented approach to dematerialisation and decarbonisation, Dissertation, Alpen-Adria University Klagenfurt, Institute of Social Ecology of the Faculty for Interdisciplinary Studies of Austrian Universities (IFF Vienna), 2011.
8 German Advisory Council on Global Change (WBGU): World in Transition – A Social Contract for Sustainability, Flagship Report, Berlin 2011, WBGU.
9 Ibid., p. 2.
10 R.P. Sieferle: Why did industrialization start in Europe (and not in China)?, in: R.P. Sieferle, H. Breuninger (eds.): Agriculture, Population and Economic Development in China and Europe, Stuttgart 2003, Breuninger Stiftung , pp. 7-89.
11 M. Fischer-Kowalski, H. Haberl (eds.), op. cit.
12 R.P. Sieferle, F. Krausmann, H. Schandl, V. Winiwarter: Das Ende der Fläche – Zum gesellschaftlichen Stoffwechsel der Industrialisierung, Köln 2006, Böhlau.
13 See also J. Diamond, P. Bellwood: Farmers and their Languages: The first Expansions, Science, Vol. 300, 2003, pp. 597-603.
14 F. Krausmann, M. Fischer-Kowalski, H. Schandl, N. Eisenmenger: The global socio-metabolic transition: past and present metabolic profiles and their future trajectories, in: Journal of Industrial Ecology, Vol. 12, No. 5/6, 2008, pp. 637-656.

the nitrogen cycle.[15] Similarly, rising pressures on natural resources have led to the most extended and steepest boom of commodity prices ever.[16] UNEP concludes that "by depleting the world's stock of natural wealth – often irreversibly – this pattern of development and growth has had detrimental impacts on the well-being of current generations and present tremendous risks and challenges for future generations".[17]

In order to avoid increasing threats to global security and stability, an SET towards a sustainable socio-ecological regime will be required based on a transition away from carbon-intensive fossil fuels to a low-carbon energy system. Incremental adjustments or improvements are not likely to succeed given the scale of the challenge. Instead, a qualitative new state of the system is envisaged requiring major change in the patterns of social organisation and culture, production and consumption, as humanity progresses beyond the current industrial model towards a more sustainable future.

The key challenge for sustainable development will be to reconcile the highly energy- and resource-intensive prosperity of industrialised countries and the aspiration of developing countries to follow western development models within the environmental limits posed by the biosphere. Both industrialised and developing countries will need to share common but differentiated responsibilities. High-consuming industrialised countries, including the European Union, will need to reduce their energy and resource use in absolute terms to make available environmental space for growth in other world regions. Developing and emerging economies, on the other hand, will need to increase consumption related to growing populations and increasing living standards using energy and natural resources as efficiently as possible.

Europe in the Lead?

Although not specifically directed at an all-embracing "socio-economic transition", the European Union has put in place several policy initiatives aimed at reducing greenhouse gas emissions and at increasing European resource and energy efficiency. Flagship policies include the medium-term policy of reducing greenhouse gas emissions by 20% by 2020 compared to 1990 levels and increasing the share of renewables in the energy mix to 20% by 2020. In the longer term, the EU is committed to reducing greenhouse gas emissions to 80-95% below 1990 levels by 2050. The EU Emissions Trading Scheme is one of the key instruments for achieving these targets. Furthermore, the EU is currently negotiating a new energy efficiency directive with the aim of achieving its energy efficiency target for 2020 (i.e. of reducing primary energy consumption by 20% compared to projections).

Similarly important in the context of an SET was the adoption of the Europe 2020 Strategy in 2010, which aims to put Europe on track for smart, sustainable and inclusive growth. One of the seven flagship initiatives of this strategy is the initiative on resource efficiency, which aims to decouple the use of natural resources from economic growth and envisages a range of new policy measures including action on raw materials, energy efficiency and biodiversity, as well as roadmaps to decarbonise the economy, energy and transport. It also advocates the stepping up of the use of market-based instruments, phasing out environmentally harmful subsidies and the greening of the tax systems.

With these (and other) initiatives, Europe has certainly taken a leading position worldwide in greening its economy. The motivation behind this is manifold and includes real or alleged long-term financial benefits, improved security of supply, improved export competitiveness and job creation. As regards the latter, the European Commission is funding a research project in the context of its Seventh Framework Programme (FP7) aimed at analysing future possible developments of the European labour market(s) in the face of a socio-ecological transition away from fossil fuels. Although research in the NEUJOBS project[18] will continue until early 2015, some key research questions and preliminary results will be presented in the following.

How does the Socio-Ecological Transition Influence Jobs?

The SET reflects on many more sectors than the energy -and resource-related ones. The process of making our society more sustainable in terms of resource use is one that has been taking place for decades now and is gaining more and more traction across the world. The effects are becoming more widespread and therefore the move towards a more resource efficient economy and related technologies can be considered similar to the adoption of

15 J. Rockström, W. Steffen, K. Noone et al., op. cit.
16 World Bank: Global Economic Prospects – Commodities at the Crossroads, Washington DC 2009, World Bank.
17 United Nations Environment Programme (UNEP): Towards a Green Economy – Pathways to Sustainable Development and Poverty Eradication, UNEP 2011, p. 14
18 NEUJOBS – Creating and Adapting Jobs in Europe in the Context of a Socio-Ecological Transition. For more information, please visit www.neujobs.eu.

a general purpose technology.[19] The main characteristics of general purpose technologies (GPT) include the possibility of application within a large range of uses, large potentials for technological improvements and the possibility of creating by-products, the large number of products and processes that can adopt the technologies, and the complementarity with other technologies.[20] The technologies developed and developing within the context of the SET, e.g. sustainable energy technologies, seem to fit this picture.

As with other general purpose technologies, like the invention of the steam engine or the increasing application of information and communication technologies (ICT), the labour market landscape can be influenced quite substantially. Depending on where in the process of adopting the general purpose technology an economy is, it will have a small to very large impact on job creation, skill development, labour market regulation and participation and education. The ICT revolution for example, has resulted in a mature ICT industry that according to Eurostat is now responsible for 6.2 million jobs across the EU and is affecting many millions more in different industries. To see how the socio-ecological transition is affecting the labour market, an assessment of green jobs and greening skills is very interesting from the point of view of policy-makers, but also of the private sector and the workforce itself.

The green industry is a substantial and growing industry that is working on creating a more sustainable economy. There are several motivations for the creation of these jobs. First, there is the intrinsic motivation of organisations to work in this field in order to increase their profitability. Second, government incentives and corporate social responsibility may drive green industry. Finally, there are environmental changes that require work in this field. Besides the creation of new jobs related to the socio-ecological transition, there are also jobs that will see subtle changes in skill requirements as they are further away from the initial development of the GPT and will only adopt the technology as a user later in the process of the adoption of the technologies.

In Europe the SET is currently at a stage in which not only specialists are involved in the process, but as resource efficiency becomes more important in organisations across Europe it is influencing more and more occupations in a subtle manner, increasingly blurring the distinction between green and not-green.[21] This means that the notion of a purely green job is now fading as the concept is becoming more and more integrated into everyday life. The implications are that the greening of jobs does not require the building of a specific set of skills, but for many occupations simply requires upskilling. On the other hand, there seems to be a clear need for highly skilled experts who work in the sustainability field. This requires an increased number of people with technical skills that are mostly acquired in STEM (science, technology, engineering and mathematics) studies, according to the CEDEFOP findings. The need for more people with such skills in order to advance green technology seems to be the most pressing, more than specific green skills that need to be developed.

How Many Green Jobs Are There in the European Union at the Moment?

All in all, the potential for green jobs seems to be large, but it is difficult to find statistics on the matter. While much work has been done on estimating the number of green jobs in the United States, not much can be found on how large European green employment actually is. The work that has been done covers only a few countries in Europe, which makes it difficult to make an EU-wide estimation – not least because there are large differences among European countries in adopting green technologies. It is thus safe to conclude that while in some countries the SET is only at a very early stage of development, it is much more mature in others, leading to more green employment. When looking at the specific country estimates, Eurostat provides data for the Environmental Goods and Services Sector. However, the data is not available on a consistent basis – estimates have been calculated for different countries for different years – and seems to be inconsistent with other data on green jobs for individual countries. Germany, according to the German Ministry for the Environment, employed 381,600 people in the clean energy industry in 2011, but Eurostat reports around 75,891 jobs for 2007. Even though it is very difficult to make a serious estimation for the EU from this, there is a lot that can be learned from the work that has been done in this regard. The estimates differ vastly as the definition of “green” and “green industry” differs per study. Since there is no obvious definition of a “green job”, it is very difficult to make a consistent assessment of the impact of the SET on the labour market and especially on job creation. Therefore, it

19 B. Colijn, M. Bukowski, L. Coutinho, E. Ketteni, T. Mamuneas, R. Massari, P. Naticchioni, P. Pashardes, G. Ragusa, B. Van Ark: Implications of Innovation for the Organisation of Production and the Employment Structure, NEUJOBS State of the Art Report, www.neujobs.eu/publications.

20 R.G. Lipsey, C. Bekar, K. Carlaw: What Requires Explanation?, in: E. Helpman (ed.): General Purpose Technologies and Economic Growth, Cambridge, MA 1998, MIT Press, pp. 15-54, here 38.

21 CEDEFOP: Skills for Green Jobs, Luxembourg 2010, Publications Office of the European Union.

is important that the concept is quantified in a transparent and comparable manner to increase attention to the matter in the policy arena.

Who Will Be Most Influenced by the Socio-Ecological Transition?

While there are issues with the definition and measurements of green jobs, the skill bias can be discussed more easily. It seems that the more direct job creation comes from highly skilled jobs, but that many low and medium skilled jobs are being indirectly affected (rather than actually created). When looking at current trends between skill levels, the hollowing out of medium skilled jobs has been one of the primary concerns in recent years and has been much studied. Autor et al.[22] have found evidence that the labour market in the United States has increasingly become polarised in terms of occupations and wage increases since the late 1980s. The number of medium skilled jobs has decreased and the wage difference between low and medium skilled workers has also ceased to increase. The same pattern can be observed in Europe. Goos et al.[23] and Maselli[24] show job polarisation[25] in 17 out of 27 European countries. The reasons for the job polarisation that Goos et al. and Autor et al. have found can for a large part be attributed to emerging ICTs, which have replaced routine jobs and therefore have placed a burden on the medium skilled.

Unlike the rise of widespread ICT use, the SET is unlikely to affect medium skilled employment negatively, quite the contrary. The types of jobs that will be positively influenced by the transition are technical jobs, which, according to Martinson et al.[26] and Dierdorff et al.[27], are mostly at a medium skill level. The estimations by Martinson et al. suggest that the lowest potential for job creation is in the low skilled category. On the other hand, the jobs that are created or upgraded for the low skilled will likely receive a wage premium.[28] The overall effect is thus ambiguous even though the bias seems to be towards benefits for high and medium skilled workers. A closer look at how this affects Europe will be very interesting as it will show whether this could provide potential for the European medium skilled.

While green jobs are generally associated with "good jobs", this is not necessarily the case – especially in the low skilled segment. This can be derived from the fact that many low skilled green jobs are in sectors like waste management and recycling[29], which are industries that can be regarded as hazardous. This means that the effects of the SET on the labour market does not necessarily seem to be positive when the health and safety aspect of the job is considered (Eurostat accidents at workplace data). There is potential for moving towards good green jobs for the low skilled though, as suggested by Martinson et al. Targeted training is vital for the low skilled to move towards green jobs and the related upskilling could also lead to higher wages. The main challenges surrounding the SET for the low skilled seem to be in health and safety regulations for green industries and in properly targeted training to prepare the low skilled for the upskilling necessary to move to greener jobs.

Is the Current Policy Climate Beneficial for the Socio-Ecological Transition?

With unemployment rates far above 10% in the euro area and exceeding 20% in some EU member states, government action could be beneficial for job creation and environmental purposes. The potential of the SET to create jobs can thus help to reduce unemployment, if properly stimulated. While many European countries showed ambitions to stimulate the SET during the 2008-2012 recession by creating large stimulus packages that often involved a focus on green investments, the current economic situation seems to be less promising. Stimulus has made way for austerity in the recent years, which is likely to hinder the creation of green jobs in at least two ways. The job creation benefits a lot from the direct injections into the economy that have been made by governments, which are currently under pressure. Besides that, subsidies on green innovations and sustainable business practices are being cut in several European countries. This is a direct negative effect of the European sovereign debt crisis on the SET, but there are also indirect effects. As there

22 D. Autor, L. Katz, M. Kearney: The polarization of the US labor market, in: The American Economic Review, Vol. 96, 2006, pp. 189-194.
23 M. Goos, A. Manning, A. Salomons: Job polarization in Europe, in: American Economic Review, Vol. 99, 2009, pp. 58-63.
24 I. Maselli: The Evolving Supply and Demand of Skills in the Labour Market, in: Intereconomics, Vol. 47, No. 1, 2012, pp. 22-30.
25 Job polarisation is the phenomenon of the relative increase in employment of the low and highly skilled as compared to the medium skilled.
26 K. Martinson, A. Stanczyk, L. Eyster: Low-Skill Workers' Access to Quality Green Jobs, in: The Urban Institute, Brief 13, 2010.
27 E.C. Dierdoff, J.J. Norton, D.W. Drews, C.M. Kroustalis, D. Rivkin, P. Lewis: Greening of the World of Work: Implications for O*NET SOC and New and Emerging Occupations, Raleigh NC 2009, National Center for O*NET Development.
28 J. Bivens, J. Irons, E. Pollack: Green Investments and the Labor Market: How Many Jobs Could be Generated and What Type?, Washington DC 2009, Economic Policy Institute.
29 M. Renner, S. Sweeney, J. Kubit: Green Jobs: Towards a Decent Work in a Sustainable, Low-Carbon World, Geneva 2008, UNEP/ILO/IOE/ITUC; CEDEFOP, op. cit.

is a need for more highly STEM-skilled people in the job market, budget cuts on education will likely harm the potential for green job growth for the high skilled indirectly. Budget cuts on innovation in general will also likely curb the possibilities for green growth as a GPT needs innovation, and research and development, on the products to make it more affordable and therefore competitive and to make it mainstream. The challenge for policymakers in the coming years will therefore be to invest smartly in industries that can help to prevent a deceleration of the SET and thereby to continue to facilitate increasing green job growth.

Conclusions

In view of rising global environmental pressures related to increasing levels of material and energy consumption, Europe has taken a leading position in greening its economy. Key motivations for European policymakers include long-term financial benefits, improved security of supply, improved export competitiveness and job creation. As regards the latter, the biggest potential for green jobs growth are for medium skilled workers, which indicates that the SET could provide a counterbalance to the undermining of the position of medium skilled workers with regard to employment and wages. This is an interesting phenomenon that requires more research, e.g. on changes by occupation, to get a better idea of the potential. The highly skilled will mostly benefit in the technical and engineering field, as STEM workers are currently in shortage. Low skilled workers seem to benefit least from the SET. The main challenge here is how to train the low skilled most efficiently for them to upskill into a better paying job with better conditions. For the statistical community the biggest challenge is how to measure green employment in a useful and consistent manner, so that good insights into the green labour market can be given to raise the awareness of policymakers. In times of shrinking budgets, this might be crucial for giving policymakers the right tools to allocate budgets.

Richard S.J. Tol

Green Growth: Killing Five Birds with One Stone?

One of the principles of public policy is that the regulator needs one policy instrument for each goal.[1] Politicians prefer to kill two birds with one stone, or rather five birds. If you believe the rhetoric, green energy will solve the problems of sluggish growth, high unemployment, peak oil, energy security and climate change. This is wishful thinking.

The European economy is suffering from the Great Recession. High public debt and nervous capital markets leave little room for much-needed fiscal stimulus. Unemployment is high. Energy prices are high too because supply has not kept up with rapidly rising demand in Asia and is even below potential due to a series of natural disasters and political events. High prices have reminded people of the finiteness of fossil fuel resources. Remaining resources are increasingly concentrated in countries with an ambivalent, or even hostile, attitude towards the prosperity of the Western world. Carbon dioxide emissions continue to rise and the prospect of climate change is unabated.

It is tempting to try a silver bullet: a carbon-neutral energy technology, perpetual and home-grown, that employs many people and propels economic growth to new heights. If it sounds too good to be true, it usually is. That did not stop the US government labelling its stimulus package the Green New Deal. China and South Korea similarly labelled their stimulus packages. In Europe and Japan too, greenness is generally believed to be good for growth.

In this paper, I examine these claims. I begin with green growth and continue with green jobs before turning to energy security and climate change.

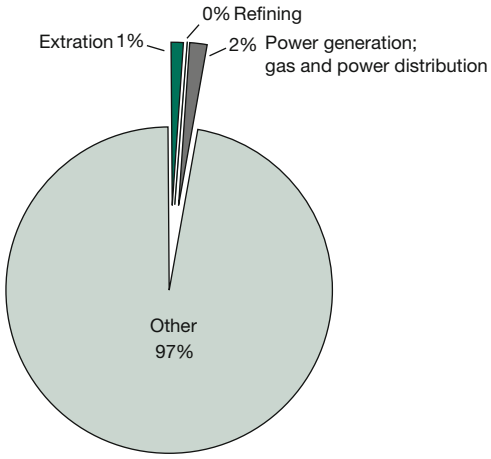
Green Growth

Let us begin with some basic statistics. Figure 1 shows value added, by sector in 2007, in the 15 countries that have been part of the EU for a long time.[2] Sectors are aggregated to three energy sectors (extraction, refining, power generation and distribution) and other economic activity. The total energy sector is small, about 3% of the economy. This immediately implies that the energy sector cannot drive economic growth. A 10% growth rate in the energy sector implies a 0.3% growth rate for the overall economy.

1 J. Tinbergen: On the Theory of Economic Policy, Amsterdam 1952, North Holland.

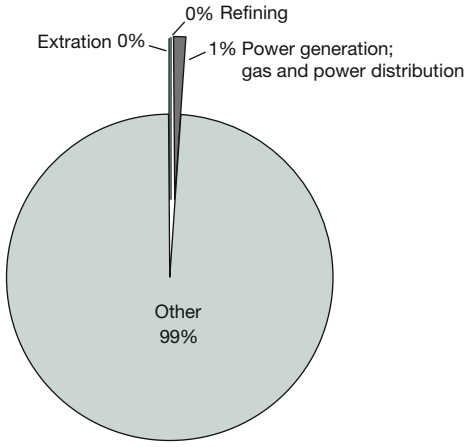
2 M. O'Mahony, M.P. Timmer: Output, Input, and Productivity Measures at the Industry Level: The EU KLEMS Database, in: Economic Journal, Vol. 119, No. 538, 2009, pp. F374-F403.

Figure 1
Value Added by Sector in the EU15 in 2007



Source: EU KLEMS database, March 2011, http://www.euklems.net/.

Figure 2
Employment Added by Sector in the EU15 in 2007



Source: EU KLEMS database, March 2011, http://www.euklems.net/.

There are limits to the volume of energy use. In fact, energy efficiency has steadily improved over time.[3] This suggests that the desired growth of the value of energy use would primarily come from an increase in energy prices rather than energy volumes. Energy, however, is an input into production and a necessary consumption good. Typically, one would argue that, for the sake of economic growth, production inputs and necessary goods should be cheap. Indeed, energy price shocks often precede recessions.[4]

The green revolution is within the energy sector. As renewable energy expands, fossil energy contracts. There are few if any spillovers from change in the energy sector on the productivity of other sectors – electricity is electricity, heat is heat, and propulsion is propulsion.

Denmark is often cited as proof that green energy stimulates economic growth. Denmark is a small country. Rapid growth in a subsector can mean rapid growth in the overall economy of a region. This cannot be scaled up to a continental economy. Denmark's experience would be hard to emulate by other countries. Denmark's wind industry was built on a history of excellence in mechanical engineering and light industry. Denmark was one of the few countries to bet heavily on renewable energy.[5] At the moment, many countries do. Competition is fierce, margins are low, and the success rate of new innovations is small. Most importantly, wind power is still not economically viable without government support. Denmark's wind industry started growing when first the German government and later other governments started to support wind power.[6] The Danish economy benefitted from that support. However, at a European scale, this was transfer of wealth rather than wealth creation.

At the moment, renewable energy can only compete in the market with (generous) government support, be it in the form of subsidies, tax breaks, price intervention or purchase orders. This is not the most effective way to stimulate renewables. Energy is a slow sector, with long-lived capital and R&D that takes decades to come to fruition. Government support is fickle. Its characteristic lifetime does not match that of the energy sector. More importantly in this context, the government cannot subsidise the economy to grow. Government support for specific energy technology typically amounts to picking winners, with the government often backing the wrong horse. Few support programmes for renewable energy are technology neutral. The literature on infant industries concludes that government support for immature technologies creates companies that often excel in lobbying the government for further support but rarely conquer markets on their own strength.[7]

3 P. Zhou, B.W. Ang: Decomposition of aggregate CO_2 emissions: A production-theoretical approach, in: Energy Economics, Vol. 30, No. 3, 2008, pp. 1054-1067.

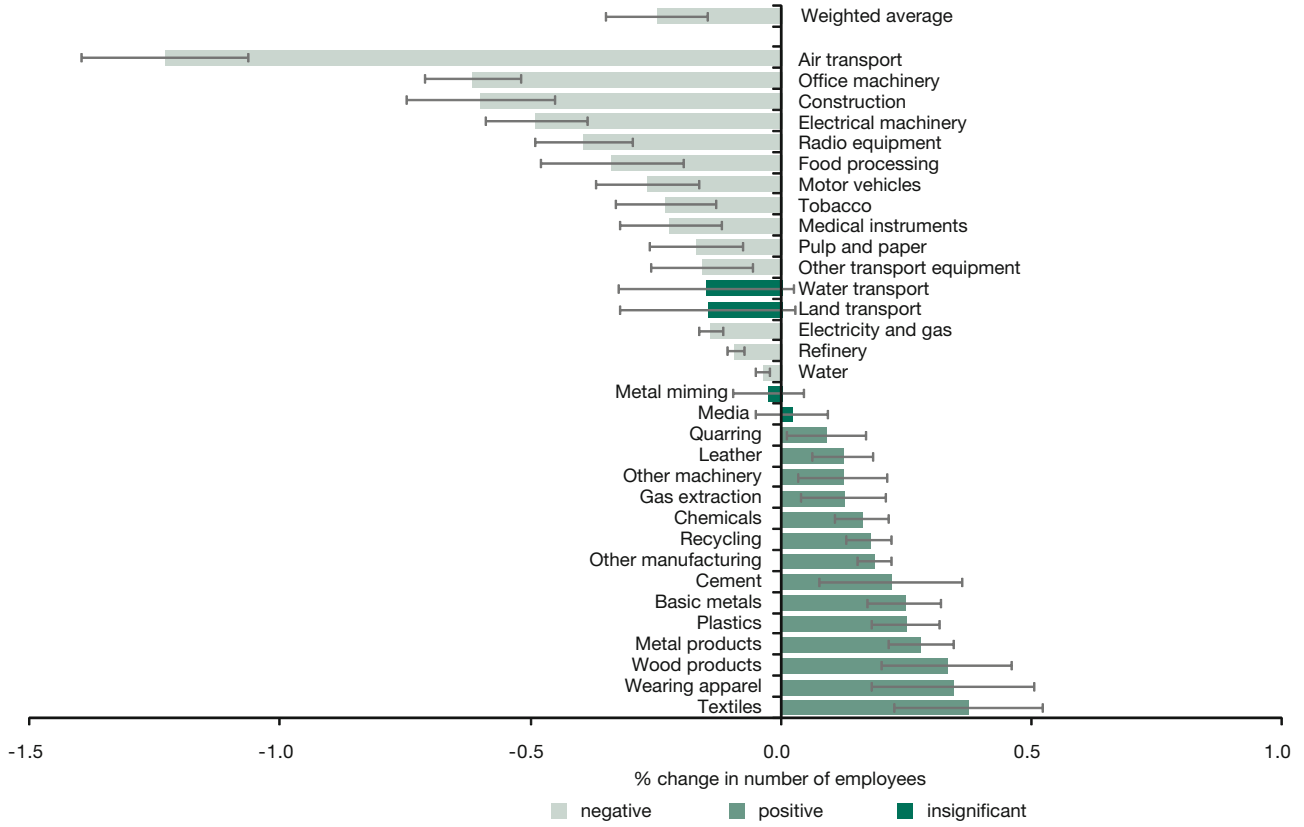
4 J.D. Hamilton: This is what happened to the oil price – Macroeconomy relationship, in: Journal of Monetary Economics, Vol. 38, No. 2, 1999, pp. 215-220.

5 A. Brunt, D. Spooner: The development of wind power in Denmark and the UK, in: Energy and Environment, Vol. 9, No. 3, 1998, pp. 279-296.

6 A. Michaelowa: The German wind energy lobby: How to promote costly technological change successfully, in: European Environment, Vol. 15, No. 3, pp. 192-199.

7 A.O. Krueger, B. Tuncer: An Empirical Test of the Infant Industry Argument, in: American Economic Review, Vol. 72, No. 5, 1982, pp. 1142-1152.

Figure 3
The Effect of a 1% Increase in Energy Taxes on Private Employment in Europe



Source: N. Commins, S. Lyons, M. Schiffbauer, R.S.J. Tol: Climate policy and corporate behaviour, in: Energy Journal, Vol. 32, No. 4, 2011, pp. 51-68.

Green Jobs

Figure 2 repeats Figure 1 but now for employment. The energy sectors employ about 1% of the labour force. Rapid growth of employment in the energy sector therefore does not lead to rapid growth of employment. Comparing Figures 1 and 2 reveals that energy is labour-extensive. It is the wrong sector to target for tackling unemployment.

The debate about "green jobs" is often distorted by accounting errors. The greening of energy affects employment through three channels:

1. Jobs are created in renewable energy.

2. Jobs are destroyed in fossil fuels.

3. The rate and structure of employment growth is affected by energy prices.

It is tempting to focus on gross job creation (1), but it is net job creation (1+2) that matters. But because the energy sector employs so few people, the third channel typically dominates. A switch to renewable energy leads to higher energy prices. This slows down economy growth, and it slows down employment growth.

There is a sizeable literature on the so-called double dividend, which investigates whether it is feasible to reduce greenhouse gas emissions and unemployment at the same time.[8] This literature concludes that this is indeed feasible, but only under particular conditions.[9] Specifically, emissions and unemployment may both fall if the tax burden is shifted from labour to emissions – although this is not necessarily the case. These conditions are not met. Carbon taxes play a minor role in climate policy, and tax revenue has not been used to cut labour taxes. There is no reason to suspect that climate policy has had a positive effect on employment, or will.

8 R. Patuelli, P. Nijkamp, E. Pels: Environmental tax reform and the double dividend: A meta-analytical performance assessment, in: Ecological Economics, Vol. 55, No. 4, 2005, pp. 564-583.

9 A.L. Bovenberg, F. van der Ploeg: Consequences of Environmental Tax Reform for Unemployment and Welfare, in: Environmental and Resource Economics, Vol. 12, No. 2, 1998, pp.137-150.

Figure 3 summarises the estimated impact of energy taxes on employment in the private sector in Europe.[10] The model was estimated using data for some 66 000 firms over 12 years. The data are from Europe, where energy taxes vary considerably between countries and over time. Effective taxes also vary considerably between sectors. Overall, a 1% increase in energy taxes reduces employment by 0.2%. Sectors respond very differently to changes in energy taxation, with large positive and negative results alongside negligible effects. Other results in the same paper suggest that firms respond to energy taxes by substituting labour for capital.

Energy Security

Energy security means different things to different people.[11] Energy security covers technical faults in the energy system, disruptions of supply due to natural disasters or enemy activity, domestic control over energy supply chains and resource scarcity. I discuss each in turn, focusing on greenhouse gas emissions. Because energy security is an amalgamation of problems, each of which is different from climate change, it should come as no surprise that energy security policy and climate policy overlap, but do not coincide, and may even contradict one another.[12]

The energy system has many components, each of which may break at any given time. This is particularly problematic for electricity. As electricity cannot be stored, backup power needs to be available almost instantaneously. Although technical faults are common, blackouts are not because the system is sufficiently robust with much redundancy. However, a greening of the energy sector may well make the system less secure in this sense of the word. Because solar and wind power are decentralised, the grid will be longer with more nodes. Furthermore, solar and wind power are volatile, uncontrollable and unpredictable. Energy security thus falls as more renewable energy penetrates the system.

Fossil fuels are often exploited in areas that are prone to natural disasters or in countries that are unstable, incompetent or unfriendly to the West. However, renewable energy is not without risks either. Wind power is prone to disruption by storm, and the Sahara is often seen as great source of solar power. A more diverse energy supply would mitigate such risks, but an energy supply dominated by renewables would be risky too.

Some commentators claim that importing energy is bad for the economy, a primitive notion that ignores all literature since Ricardo.[13] International trade is typically beneficial. Programmes to create national champions by shielding infant industries from foreign competition have not been particularly successful.[14] There is a long and unsuccessful history of attempts to reduce the dependence on imported energy.[15]

Fossil fuel reserves are finite. The world may well run out of conventional oil and gas over the course of the 21st century. Renewable energy is only one of the alternative solutions. Unconventional oil and gas, coal, and nuclear are other options. The market appears to be betting on unconventional oil and gas at the moment.

Climate Change

Climate change is the best reason to reduce greenhouse gas emissions. We cannot expect greenhouse gas emission reduction to substantially stimulate economic growth or job creation – in fact, the impact is most likely negative. There are stronger links between energy security and greenhouse gas emissions, but the two goals are not well aligned. Energy security may imply higher greenhouse gas emissions, and emission abatement may reduce energy security. Therefore, greenhouse gas emission reduction policy is best justified by a concern about climate change.

Climate change is a sound reason to reduce greenhouse gas emissions. Starting with Nordhaus[16], economists have consistently argued that carbon dioxide and other greenhouse gases are negative externalities.[17] This justifies public intervention.

10 N. Commins, S. Lyons, M. Schiffbauer, R.S.J. Tol: Climate policy and corporate behaviour, in: Energy Journal, Vol. 32, No. 4, 2011, pp. 51-68.

11 B. Kruyt, D.P. van Vuuren, H.J.M. de Vries, H. Groenenberg: Indicators for energy security, in: Energy Policy, Vol. 37, No. 6, 2009, pp. 2166-2181.

12 M. Bazilian, B.F. Hobbs, W. Blyth, I. MacGill, M. Howells: Interactions between energy security and climate change: A focus on developing countries, in: Energy Policy, Vol. 39, No. 6, 2011, pp. 3750-3756; J. Bollen, S. Hers, B. van der Zwaan: An integrated assessment of climate change, air pollution, and energy security policy, in: Energy Policy, Vol. 38, No. 8, 2010, pp. 4021-4030; S.P.A. Brown, H.G. Huntington: Energy security and climate change protection: Complementarity or tradeoff?, in: Energy Policy, Vol. 36, No. 9, 2008, pp. 3510-3513; H.G. Huntington, S.P.A. Brown: Energy security and global climate change mitigation, in: Energy Policy, Vol. 32, No. 6, 2004, pp. 715-718.

13 D. Ricardo: Principles of Political Economy and Taxation, London 1817, John Murray.

14 H.J. Bruton: A Reconsideration of Import Substitution, in: Journal of Economic Literature, Vol. 36, No. 2, 1998, pp. 903-936.

15 D. Kline, J.P. Weyant: Reducing Dependence on Oil Imports, in: Energy Economics, Vol. 4, No. 1, 1982, pp. 51-64.

16 W.D. Nordhaus: Economic Growth and Climate: The Case of Carbon Dioxide, in: American Economic Review, Vol. 67, No. 1, 1977, pp. 341-346.

17 R.S.J. Tol: The Social Cost of Carbon, in: Annual Review of Resource Economics, Vol. 3, 2011, pp. 419-443.

Jorge Núñez Ferrer

Investing Where It Matters – A Sustainable "Green Growth" Agenda for the EU Budget

For the EU budget, some net contributing member states are fighting to impose cuts and austerity, while net recipients fight to preserve policies supporting narrow national interests. Discussions from both camps largely disregard the economic rationale of a common budget and its potential to generate economies of scale and even save resources by pooling them. We are, however, rapidly approaching the time when decisions need to be taken on actual policies rather than absolute figures. There is a real need for member states to look at actual policies and how to align them with the multiple challenges the EU is facing. It is time for the member states to concentrate on what matters.

Room for New Budget Objectives?

The EU budget exists to help the EU reach its objectives, and those are changing and mutating with the times. The budget, however, is still structured for the objectives of maintaining an agricultural single market and cohesion. With the practice of pre-allocating funding at the national and regional levels, many new objectives are just channelled through those policies. This method is imperfect and inconvenient, and this handicap is compounded by large vested interests, in particular the agricultural lobby.

The budget is also under pressure not to grow, and in the present crisis even to fall, while preserving pre-allocated traditional policies, thus not allowing important areas to develop in which the EU could contribute a major value added.

Today, this presents us with a difficult conundrum. With the financial crisis, the member states want the budget to "reflect" the austerity measures undertaken by the member states, i.e. to cut the budget. However, rarely does a member state offer to scarify its "national entitlement" under the CAP or cohesion payments. Cuts have to be found elsewhere, and elsewhere is R&D, trans-European infrastructures and external action, three key areas of high value added and important long-term returns to the EU in terms of growth. There are areas in which the EU budget can be cut, but those with low European value added. Member states should also "reflect" the difficult domestic austerity measures by allowing the budget cuts to focus on areas of low return in the same way as member states should do themselves with their domestic budget. The member states' interest in appropriating the budget is reflected in Baldwin's paper[1], which described the budget as an essentially national redistribution mechanism. Even the wealthiest member states get half of their contributions back.

Given the challenges ahead for Europe, there is a real need to focus on what matters most. What should today be the first and foremost objectives of the budget? The first should be to develop the potential of the single market, focusing on collaboration in the areas of research and innovation (RDI) and developing the necessary infrastructures to close the missing links for a single European market, for example in energy. This means a focus on long-term growth. It should be complemented by a strategy of resource efficiency, and energy and economic sustainability, ranging e.g. from investments in renewable energy and smart grids to the protection of water resources.

Thus the budget has to develop instruments for stainable long-term growth using the potential returns of the single market using to the largest possible extent.

This strategy could be referred to as a green growth agenda, but that would be misleading given the association of green with the green movement. There is a need to introduce a real shift in the economic structure of the European economy, including a shift away from fossil fuel usage, not only for environmental and climatic reasons but because of pure long-term economic growth requirements.

As an illustration, a report by Gigol and Mack[2] quantifies the costs of fuel imports for the EU. €408 bn were paid by the EU27 between 9/2010 and 10/2011 – i.e. 3% of the EU27 GDP. As a comparison, this is equivalent to nearly three times the EU budget and is 50% higher than the EU's total investment in RDI. With fuel costs rising and a stagnating EU economy, for many member states

1 R. Baldwin: The Real Budget Battle: Une crise peut en cacher une autre, CEPS Policy Brief No. 76, CEPS, Brussels, June 2005.
2 S. Gigol, S.M. Mack: No stabilization of the Euro without a green new deal, European Parliament's green alliance, 2012.

fuel imports do not contribute to growth but reduce it. A long-term strategy for reducing fuel imports is needed.

Neglected Potential of the EU Budget

The EU budget offers a panoply of opportunities to pool resources to address the challenges ahead. In many areas EU action can make a difference, but member states only see the budget as a cost item in their balance sheet and ignore the benefits which EU investments in a strategy oriented towards sustainable growth (largely reflected in the Europe 2020 strategy) could bring to their economies and ultimately to the state coffers. The budget can be transformed into a powerful *investment* tool for the future.[3] This requires targeted reforms, which the budget discussions on the future Multiannual Perspectives 2014-2020 are not addressing.

On the positive side, the European Commission proposals for the next Multiannual Financial Framework have incorporated to some extent the Europe 2020[4] strategy mainly *within* the existing expenditure categories.

The EU should play a central role in guiding, and financially assisting, the achievement of those goals. In fact, the EU budget, through its leverage mechanism, its importance in many regions and the rules governing it (such as procurement procedures), has the potential to exert a strong influence over investment decisions by governments and individuals. This potential influence has never been properly exploited and has often been undermined by badly targeted policies and wrong incentives.

Sustainable Long-term "Green" Growth

The EU budget can be catalytic by focusing on its capacity to generate:

- *Economies of scale:* At the EU level, it is possible to allocate funds more efficiently by developing cross-border investments that increase their impact. This is crucial in the areas of research and innovation, transport and logistics, energy security and climate change. Europe needs to develop its potential to strengthen its economy, its competitiveness and its place in the global markets for innovative products.
- *Leverage:* The EU budget is an important instrument for raising funds for EU objectives. This can be a key element for increasing the rate of innovation and thus reinforce the technological lead Europe has developed in a number of sectors (such as energy). It can mobilise funds to develop missing infrastructures and attract funding for other EU priorities. The need for substantial new funding means that the EU budget is ill-equipped to deal with its objectives. Nevertheless, the increasing role of innovative financial instruments, where the EU budget provides guarantees to financial institutions, ensures a much larger leverage and multiplier effect compared to traditional co-financed grants. This allows the budget to magnify its impact with modest resources.

Contributions to a Long-term Sustainable Europe

There are substantially four areas where the EU budget can have a strong impact on Europe's long-term growth and sustainability:

- R&D and innovation
- energy and transport
- resource efficiency
- strategic planning.

The first three are areas of direct investment in infrastructure and capacity, the fourth is indirect, but powerful. The EU budget mechanisms require multiannual strategic planning which in turn improves the quality of governance and policy implementation.

Accelerating Research and Innovation

Innovation is recognised as a key element in today's globalised economy for increasing the rate of economic growth. It is also identified as a key element for addressing some of the complex global challenges the world is facing, i.e. climate change and resource over-exploitation.

It is widely recognised that the EU's rate of investment in RDI is too low, with the added caveat that this shortage is more acute in the private sector.[5] RDI is a quintessential area for public intervention, in particular for pre-commercial phases. For later stages of development it is

3 J. Núñez Ferrer, D. Tarschys: Investing where it Matters – An EU budget for long term growth, CEPS Task Force Report, Brussels 2012.

4 European Commission: Communication on EUROPE 2020: A strategy for smart, sustainable and inclusive growth, COM(2010) 2020, Brussels 2010.

5 K. Uppenberg: R&D in Europe, Expenditures Across Sectors, Regions and Firm Sizes, CEPS, EIB special report, 2009.

in the public interest to have an entrepreneurial and innovative business and industrial sector. Given the situation in the EU, there is a need for action to incentivise the private sector to invest and also to collaborate with research institutes and other businesses to develop new, more competitive and more resource-efficient, greener technology. The latter is not only a "green" agenda, but an economically rational focus, given the rising costs of materials and fuel. A future competitive economy needs to have reduced costs in both.

RDI support is best handled at EU level because it can capture the potential of cross-border collaboration and create economies of scale. This is an essential area in which the subsidiarity principle would allocate a very large share of RDI expenditure to the EU level. It not only allows the allocation of funding more efficiently, but it also allows the funding of collaborative projects that no single member state could manage by itself. Support needs to be provided in tailored forms, with basic non-commercial frontier research financed by grants, and more industrial research supported only at the demonstration and deployment stages with mixes of grants and loans, e.g. innovative financial instruments such as the Risk Sharing Finance Facility (RSFF).[6]

The risk sharing finance facility is an essential tool for bridge financing, generating a leverage effect to provide investment support of more than 20 times the modest EU grants.

To achieve the EU's transition to a low-carbon, more sustainable economy it is necessary to deploy more funding to energy and to resource efficiency research. The former has been recognised by the SET-Plan, and the latter is starting to become a priority in particular, but indirectly, in materials science. A full range of financial options is needed, covering the basic, industrial and demonstration research stages.

Greener Energy and Transport at EU Level

Another priority is to invest in the infrastructures of the future. Funding from the proposed Connecting Europe Facility will need to provide the necessary starting capital for a large number of infrastructure projects in the energy and transport sectors. A clear focus should be on interconnectivity and the development of a solid European grid, as well as low-carbon transport modes.

On the financial side, the investment requirements in the area of transport and energy are very large and will call for assistance from the public sector.[7] The nature and level of support required varies depending on the infrastructure and the market. The European Commission estimates that the investment needed to complete the priority European power and gas networks is in the range of €200 billion up to 2020, half of which will have to be provided by the public sector. For transport the Commission estimates that €500 billion will be needed for the trans-European networks, of which €250 billion is required to complete the missing links in the core network.[8]

For this purpose, it is important that there are sufficient resources and that the project bonds proposed by the European Commission are introduced soon. Project bonds are essential to cover the collapse of traditional guarantors and lenders to public infrastructure projects and are one of the few possible responses to the present weakness in infrastructure investment.[9] The situation will not reverse soon, as the restrictions imposed on the financial sector by Basel III reduce the lending capacity of the banking sector to such projects. Project bonds are particularly suitable for energy connections, due to their higher potential of positive revenue streams compared to other infrastructure. This could attract the attention of private investors and accelerate grid development.

Resource Efficiency

An area of priority which is largely neglected is resource efficiency. While the EU has presented a initiative for resource efficiency[10], the objectives of the initiative seem highly disconnected from the EU budget proposals or other actions at European or local level. It is important to point out that resource efficiency is not only about agriculture, land and water in the CAP, a confusion generated by the European Commission's tendency to equate natural resources to agriculture.

6 J. Núñez Ferrer, F. Figueira: Achieving Europe's R&D Objectives: Delivery tools and the role of the EU Budget, Report No. 6, SIEPS, Sweden 2011; J. Núñez Ferrer, C. Egenhofer, M. Alessi: SET-Plan, from concept to Successful Implementation, CEPS Task Force Report, May 2011.

7 This includes national public funds, the EU budget and public investment banks.

8 J. Núñez Ferrer, A. Behrens, C. Egenhofer: For a sustainable, competitive and greener EU budget – Integrating the Climate Change objectives of the EU, Task Force Report, CEPS, 2009.

9 S. Withana, J. Núñez Ferrer, K. Medarova-Bergstrom, A. Volkery, S. Gantioler: Mobilising private investment for climate change action in the EU: The role of new financial instruments, IEEP, London/Brussels 2011.

10 European Commission: A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy, Brussels, 26.1.2011, COM(2011) 21.

Resource efficiency has to be seen as a holistic approach to reducing the resource depletion caused by economic activity. The acceleration in demand for rare metals, minerals, fishing resources, biofuels etc. needs to be reversed by a reinforced policy on reducing waste and increasing recycling and reprocessing. More is needed in terms of regulation and financial support to bring forward the EU's initiative which for the moment is more a discourse than a policy.

A first action should be focusing on the low-hanging fruit of waste management; there are quick solutions available in this area. Waste is a source of considerable pollution, health hazards and methane emissions; action can be quick and effective.

Strategic Planning

Last but not least, the EU budget can have a strong influence on strategic planning. 80% of EU funding is managed at national level and subject to national or regional programming. To have a coherent European policy it is necessary that the individual programmes are prepared in line with the innovation, energy, transport and resource efficiency objectives. The rules of the EU budget, from earmarking funds to specific objectives down to procurement rules will shape the strategy undertaken.

Particular attention has to be paid to the EU's cohesion policy. It represents a substantial, transnational transfer system among member states aimed at fostering growth in lagging regions. Despite its limited size, the EU's cohesion policy has had a significant impact on the development path of the recipient regions. Its effects are most apparent in the new member states, where it assists in the development of major infrastructure and, more importantly, influences national development strategies, as well as such aspects as national public procurement rules. The ability of the cohesion policy to have a bearing on development choices in the beneficiary areas is central to fostering actions that lead to the development of a sustainable, energy independent, low-carbon and resource efficient Europe. In addition the EU will increasingly be facing climate adaptation problems and the EU funds can be a key for solidarity and cross-border actions.

The development of coherent national and regional strategies is complex and requires highly skilled specialists and strong political backing. Many EU countries continue to lack the capacity to develop good strategies and implement them. There is a need to use all the available avenues, such as twinning projects, to transfer the necessary knowledge in these fields. This has been recognised and the European Commission is reinforcing mechanisms to transfer best practice.

The structural funds can play a key role in developing low-carbon zones. The requirements for strategic national and regional multiannual planning are a good platform for developing integrated energy solutions. This offers a particularly good opportunity in regions in which the infrastructure is ageing, mainly in new member states. This allows for the planning of large-scale structures such as smart grids, with renewable energies and private consumer–suppliers playing a strong role.

Rather than patchy isolated investments, the new member states have a unique opportunity to have an integrated solution from the start. Structural programmes have been an amalgamation of loose measures, with renewable energy or energy efficiency support offered as single independent measures unrelated to an overall, coherent energy infrastructure. Patchy upgrades will increase opportunity costs in the future for any integrated solution. Once a new infrastructure is introduced it is costly to replace.

An integrated energy approach requires a clear national strategy. EU funds, national funds, private operators and legislators need to coordinate a multiyear, large-scale, solid strategy. Hence, support from cohesion policy for the development of low-carbon cities or entire regions should be encouraged. The Commission has proposed to reinforce national strategies, but the main focus is on innovation and job creation. How energy investment will be integrated into a coherent strategy is mainly left to the member state.

One promising area for new member states could be to run large-scale pilot programmes for low-carbon zones in cities and regions. This would assist the modernisation of the regions and the creation of green jobs. Apart from infrastructure, support from the European Social Fund (ESF) for acquiring the necessary skills associated with a low-carbon programme would lead to the development of more sustainable regions and indeed a knowledge economy – in line with the growth and jobs objectives of the EU.

It is therefore recommended that the cohesion policy include a significant energy production and efficiency component, with a link to concrete national actions. Such a move should also tie in with the EU's objectives for a single market in energy, and thus include a strong cross-border energy component.

There are also many low-hanging fruits for the cutting of greenhouse gas emissions, in particular for waste management. A stronger focus on this is needed.

Conclusions

The EU's objectives on growth, energy, resource efficiency and climate change need to be the guiding principles of the EU budget. The EU budget is an important and effective tool to generate sustainable solutions towards these objectives at the European level. It is therefore important that member states change their blind requests for a smaller EU budget, or accept that a smaller EU budget would have to change priorities and negatively affect some traditional national beneficiaries.

For the EU to achieve its objectives it is recommended that:

- support for RDI is increased, particularly on energy, climate change and areas of resource efficiency; this support should be provided in the most appropriate form from the stage of basic research to the level of demonstration and deployment;
- support for trans-European and pan-European energy and transport links is boosted, with an emphasis on interconnectors and rail;
- through the guidance function of EU funding, the adoption of the best energy-efficiency practices is promoted, especially
  - the reinforcement of support for energy efficiency and renewable energy;
  - the introduction of best-practice conditionalities across all funding areas;
  - the introduction of energy-efficiency conditionalities and best practices in EU procurement rules;
  - support for the development of low-carbon cities and regions in the EU to test and promote new technologies on a large scale, and take advantage of the need to renew energy grids in new member states;
  - an increase in the EU's interventions on environmental matters, taking into consideration the need to protect ecosystems and promote resource efficiency.
- more resources are concentrated on waste management to reduce methane emissions more quickly.

Michel Aglietta and Jean-Charles Hourcade

Can Indebted Europe Afford Climate Policy? Can It Bail Out Its Debt Without Climate Policy?

Let us start with an unpleasant diagnosis for environmentalists. Many symptoms suggest that climate policies, although repeatedly reaffirmed by the European political institutions, might lose political support in many quarters of public opinion: criticism of the European Climate Roadmap, industry alerts against the adverse effects of tight carbon constraints on industrial employment, cuts in public subsidies to "green" energy sources, and the low electoral success of "green" parties compared with the rise of populist movements fuelled by unemployment and the middle classes' fears of falling behind.

This headwind is not surprising. Public opinion is troubled by two concomitant alerts: the tragic prophecies regarding the public debt, which put us in the inexorable hands of financial markets, and the climate risks which will be bequeathed to our children. These alerts arouse a "no way out" feeling. How can salary reductions, meagre retirement pensions and slimmed down public services prevent globalised markets from reproducing what they have created? The revolt against feelings of powerlessness has always fuelled populism; it currently threatens European political coherence and, ultimately, the climate policies which have historically been iconic of European world leadership.[1]

How can we navigate between the Charybdis of financial debt and the Scylla of climate debt? As with the Odyssean sailors, we need a mental map of the threats lying in wait. The first reflex might be to ignore the climate

1 C.C. Jaeger, T. Barker, O. Edenhofer, S. Faucheux, J.-C. Hourcade, B. Kasemir, M. O'Connord, M. Parry, I. Peters, J. Ravetz, J. Rotmans: Procedural leadership in climate policy: a European task, in: Global Environmental Change, Vol. 7, Issue 3, October 1997, pp. 195-203.

Scylla, at least temporarily. This paper explains why this reflex is inadequate and why a precise map of the threats can actually lead us to see climate policies as one of the ways out of the vicious circle described by Irving Fisher in 1933: "The more the debtors pay, the more they owe."[2] Recently, European Central Bank president Mario Draghi emphasised the necessity of complementing the current European fiscal compact with a growth compact. This paper explains why climate policies can be a central component of such a compact.

Behind the Debt Crisis, the Tensions Caused by Non-Sustainable Development Patterns

The debt crisis did not result solely from laxity in public finance. Since the 1980s, accounting and financial innovations had allowed for the creation of assets composed in part of debt. Unprecedented debt facilities were given to private lenders, especially non-bank banks[3] not subject to the prudential rules imposed on traditional banks. Both banks and non-bank banks were attracted by leveraged buy-outs and by what proved to be a trap – property speculation. The increase of real estate values first and foremost in the USA, imitated in several European countries, owed nothing to chance; it was allowed for, if not explicitly encouraged, by government policies.

Beneath the surface, there was the political necessity to hide the stagnation – indeed the drop – in the purchasing power of American households, which also explains Alan Greenspan's laxity as the chairman of the US Federal Reserve. This stagnation was caused by a pattern of economic globalisation that pressured the wage/labour productivity ratios in US industry through confrontation with foreign countries, including a Chinese industry boosted by the Deng Xiaoping reforms.

The commerce of promises was thus unleashed carelessly. It benefited from the internet bubble and crashed with the burst of the real estate bubble. Because the basic principle of the monetary economy is that credit creates deposits and because financial intermediaries have become tightly intertwined worldwide, the accumulation of "bad debts" in the United States and in some European countries spilled over throughout the world. A systemic shock in 2008 forced national governments to assume private debts, to bail out failing banks and to support collapsing economies. Subsequently, public indebtedness has risen to heights comparable to those provoked by wars. The US experience following World War II shows that debt levels corresponding to 120% of GDP can be absorbed over time without major trauma with a growth rate that is consistently higher than the average real interest rate paid on the debt. This is the difference that matters for orderly debt consolidation. The USA pursued a post-WWII policy of long-term stable inflation rates (around 3%) and a monetary policy aimed at producing negative real interest rates whenever possible.

The first lesson to be drawn from this is that in the aftermath of a major shock to public finances, monetary policy cannot be separated from fiscal policy. The second lesson is that growth is not manna from heaven; it requires specific financial conditions. This is the aim of Ben Bernanke's current policy of circumventing Congress's paralysis: short-term interest rates held close to zero for two more years and the purchase of as many Treasury bonds as necessary to tamp down long-run rates on government bonds so as to induce private investors to buy private assets.

On the other hand, history also tells us what should not be done. Between the two world wars, three waves of bank failures in the USA destroyed capital, triggering outflows of US deposits from banks in central Europe. Credit crunches plunged the US and German economies into depression, sealing the fate of the Weimar Republic and propelling the Nazis into power. In contemporary times, Japan has provided an example of a vicious cycle since the 1990s, when a premature budget austerity plan plunged the country into never-ending stagflation. When the private sector reduces its indebtedness through investment cuts, growth becomes crucially dependent on public investment or on public support for private investment.

The eurozone, grounded on the principle of independence between budget policies (conducted by member states) and monetary policy (conducted by an independent ECB), maintained a separation between its monetary policy doctrine on the one hand and its lender-of-last-resort operations to replace the failed interbank money markets on the other. However, the European crisis worsened markedly in the second half of 2011. Faced with very high interest rates on bonds in Italy and Spain, the devaluation of sovereign debts in bank balance sheets and the risk of an acute credit crunch in the autumn of 2011, the ECB injected around a trillion euros into banks' balance sheets via two auctions of long-term refinancing operations (LTRO) at a 1% interest rate over a three-year period.

2 I. Fisher: The debt-deflation theory of great depressions, in: Econometrica, Vol. 1, 1933, pp. 337-357, here p. 344.
3 P. Krugman: The return of depression economics and the crisis of 2008, New York 2009, WW Norton & Company, p. 224.

Thanks to this injection, sovereign bond market tensions concerning Italy and Spain were transitorily eased, though this respite did not last long. Credit in the private sector has not recovered, and the eurozone as a whole is drifting slowly into recession, threatening the policy of public finance consolidation.

So far the dominant vision of the growth austerity in Europe has been to couple restrictive fiscal policy with so-called structural policies in the labour markets in order to give confidence to financial markets. Lower long-term interest rates would thus trigger investments and enhance growth. This doctrine is based upon flimsy empirical evidence from small and very open economies which enjoyed the leeway of massively devaluing their currencies under conditions of supportive foreign demand. It is at odds with the current eurozone context: a very big and relatively closed economy overall, shackled by generalised austerity, the private sector of which is focused on deleveraging and is overly cautious when it comes to making industrial investments, all in a global economic climate that is not at all supportive.

Therefore it is not surprising that the mood is changing. Calls for active steps to induce growth momentum are no longer restricted to "heterodox" economists; they now come from official circles, not least from the ECB itself. But any attempt to instil a dose of Keynesianism to avoid a collapse of final demand now confronts two limits: it cannot, by itself, reverse the polarisation of industrial activities that has created the deep balance of payment problems within the eurozone, nor can it avoid reviving a development pattern the deadlocks of which have been revealed by the crisis.

Indeed, over the last few decades, the easy access to credit made it easy to ignore the warnings of the "ecological critique" first launched in the 1970s. These warnings were sometimes exaggerated, but they contained several pieces of truth: energy tensions confirmed by repeated oil shocks, frictions over raw materials, the dangers of agricultural modernisation based on industrial intensification, urban sprawl leading to socially exclusive cities with areas disconnected from dense public infrastructures, and technological risks, of which the Deepwater Horizon (BP) offshore oil spill in the Caribbean and the Fukushima accident are the most recent examples.

Therefore the challenge is to trigger a short-term economic recovery and to redirect the growth engine in order to safeguard sustainable development, avoiding heedless expansion phases that regularly collapse into socially costly crises.

Economic Recovery a Necessary but Insufficient Condition for Debt Bailout

Over the very short term, boosting growth through conventional credit facilities is problematic because public debt is contaminated by unrealised losses on the bank's balance sheets, while the banks are vulnerable to deteriorations in public finances. The restructuring of the public debt and the recapitalisation of the banks in certain countries are inescapable. This must be traded against reinforced prudential regulation in order to prevent banks' hazardous risk-taking when they gamble with their capital reserves in order to increase shareholder profits.

Furthermore, history suggests that a credible economic recovery in Europe implies revisiting the absolute separation of budgetary and monetary policies. We are not ignoring the deep differences of cultural attitudes in Europe in this respect. These have deep historical roots that cannot be eradicated overnight. A thin pathway exists, however, for a compromise which is not purely rhetorical and which would restore confidence and put an end to the risks of social splits and political crisis in many European countries.

The recently adopted "fiscal compact" marks some form of consensus that budgetary cooperation must be enforced in the eurozone in order to bring deviant management to heel. Organising the convergence of fiscal systems is also desirable in order to regulate fiscal competition, which potentially distorts the conditions of a "fair" concurrence. This cannot be achieved politically within the space of a few years, but our role as professional economists is to remind public opinion of this basic principle. The creation of an independent European agency to assess medium-term government projections of public finances in the cooperative procedure of the European Semesters is less politically constrained. The agency could provide – quasi as by-products – independent ratings backed by a much better analysis than the three US private rating agencies. More controversial at the present time is the issuing of Eurobonds to attract investors worldwide and to enable a significant decrease in interest rates where they are highest. Guarantees of repayment must be provided if this is to take place.

On paper, the setting of a European Finance Notation Agency should calm concerns about the Eurobonds. As its ratings translate judgments on the public sector's value production, sovereign countries would have every interest in being rigorous in their investment choices and in adopting the most efficient fiscal structures. If bonds

finance independently assessed investment projects, these would have a high probability of paying for themselves, and a higher long-term growth would yield supplementary revenues for the states. These revenues would be sufficient to guarantee the solvency of the bonds with low Eurobond interest rates and avoid the creation of fiscal deficit over time.

But governments are not always virtuous and long-sighted. So isn't all this just so much pie in the sky? Eurobonds need to be backed by strong European governance at the very moment when the reactions to the Greek crisis show all too clearly the depth of suspicion among EU members. For the most "virtuous" countries that are concerned about the capacity of other member states to make optimal use of the allocated funds, the Eurobonds would open the way to a laxity that escapes discipline. The distrust is such that strong guarantees are needed to convince the sceptics that the money will be invested in an efficient manner, and in particular to reassure Germany, which is caught between its desire for drastic policies and its fears of a collapse of its neighbours and their markets.

Beyond the problem posed by this cycle of distrust, it is also important to consider the risks of reviving a growth model based on over-consumption fuelled by credit, on competition over salaries, on an agricultural transformation pathway which marginalises remote rural areas, wastes scarce water resources and destroys arable land, on contempt for environmental conservation, on rent-seeking in real estate, land and raw materials and on an energy security dependent on instable and costly geopolitical and military balances of power. A growth recovery launched on this basis would very quickly be confronted with oil shocks, speculative bubbles and splits in the social fabric.

This is why it is so important to deal jointly with the financial and the environmental debts instead of placing them in opposition to each other.

Debt Consolidation, Green Growth and the Buridan's Donkey Syndrome

Genuine rigor consists in seizing the necessary debt consolidation as an opportunity to transform environmental alerts into a long-term development project and to redirect savings and investments towards energy transition and an in-depth reshaping of EU industry: energy efficiency and low-carbon energies, housing renovation, transport infrastructure, health policies prioritising prevention, biotechnologies to underpin the ecological intensification of agriculture and the revival of remote rural areas, material recycling, infrastructures adapted to climate change, life-long investment in human resources.

Let us first recognise that nothing is self-evident and that our contention may remain a litany of pious sentiments. The creation of green jobs may come at the expense of the destruction of non-green jobs and could be slowed down by a lack of training in the new skills, by a deterioration in the balance of trade due to the importation of technologies "not made in Europe", and it could be stalled by controversies as to what is "clean" and what is "dirty". Nuclear energy has been subjected to an exacerbated form of such controversial discussions, as have biotechnologies and carbon sequestration.

The mutation towards sustainable development[4] cannot be delivered by a benevolent planner alone. Neither can it result from the manna from heaven dispensed by R&D investments, nor from the magic of the "market". It requires an iterative process of "trial and error" in multiple public and private initiatives. But this iterative process will never be launched in a context in which there is fear of unemployment and social disruption due to intolerable inequalities, and in which decision-makers are under the hypnosis of short-term myopia.

This is why there will be no green growth without coherent reforms of the fiscal and financial systems to jointly launch appropriate economic signals in order to redirect decisions and lubricate the inevitable frictions of any transition. Environmental tax reforms, including carbon taxes, are necessary in such a context. However, taxes depend almost entirely on decisions that have to be negotiated at the national level in order to account for the specifics of local conditions, and their empowerment cannot but be slow.[5] This is not the case for the adaptation of the financial system, which depends on global coordination and is critical for short-term economic recovery.

There is an urgent need to overhaul the structure of risk and returns on investment. During the last twenty years fiscal policy has pursued a single objective: reduction in the levels of taxation of capital with the aim of favouring

4 The World Commission on Environment and Development: Our Common Future, Report, 1987.

5 Significant carbon taxes pose problems for a few energy-intensive and exposed industries, which makes a harmonisation at the EU level useful. However, if the product of a carbon tax is recycled into lower labour taxes, this problem concerns a very minor part of the EU value added. This part is currently totally covered by the EU ETS. The most important obstacles to carbon taxes are thus country specific: the nature of the pre-existing fiscal systems and the adverse redistributive effects of higher energy prices.

short-term financial gains. At the same time, the business environment has led more and more industrial sectors to prioritise short-term shareholder value over the conventional maximisation of the long-term firm value. These industrial sectors indulged in this practice at the very moment when innovations in market finance led to an undervaluation of risk and a lack of transparency for savers. This resulted in strong incentives to redirect savings away from investments in industry and agriculture. The channelling of savings in the pursuit of capital gains explains the real estate bubble with unsold buildings in Spain and many other countries. This is the main driver of the paradox of a mountain of debt in a world with high savings (45% of GDP in China, petrol revenues, pension and sovereign funds).

These mechanisms created a Buridan's donkey[6] effect: as one does not know where to invest in production with high risk-adjusted returns, one refrains and speculates. Buridan's donkey dies hesitating between oats and a pail of water. A non-directed inflow of money comes to place more oats and water in front of it without breaking its hypnosis by a false calculus.

Carbon Value, Reforms of the Financial System and Economic Recovery

Responding to the challenge of energy transition under climate objectives provides a lever for breaking the Buridan's donkey syndrome by indicating where to invest. This lever is potentially strong because the sectors that are critical for climate change mitigation represent a dominant share of investments in our economies and are critical for social welfare: energy, transport, building, agriculture and basic industries. Providing that sufficient precautions are taken to avoid sacrificing other facets of environmental security[7], the low-carbon energy transition has the advantage that its operational planning can be articulated around a common metric, the carbon.

Carbon prices, whether in the form of taxes or of carbon-trading systems, have to play a role in this transition. But they cannot suffice to break the Buridan's donkey syndrome. They will stay low in the short term. The Durban Conference confirmed that an agreement with emission quotas for each country and market, setting a carbon price worldwide will be out of reach in the coming decade. This is why the Cancun agreement[8] called for a paradigm shift with finance at its heart.

Here lies the operational link between debt policy and a renewed climate policy. The only way of not losing the race against the cumulative effect of increased atmospheric concentration of greenhouse gases is an immediate reduction in the investment risk associated with low-carbon projects. To do so, an agreement on the social value of non-emitted carbon could be the cornerstone of a mechanism apt to reinforce the attractiveness of low-carbon investments compared to other investments, including financial ones.

Low-carbon projects currently present, in addition to the usual risks, those associated with less mature technologies, high capital costs and the uncertainties as to the price of carbon. Let us imagine a political agreement in Europe concerning a carbon value evolving with time. This value could be used to overcome the handicaps associated with low-carbon projects by enhancing their returns on investment and ensuring the necessary liquidities. The evaluation, the selection and the follow-up of such projects should be ensured by an independent entity, as is the case for the Climate Convention's Clean Development Mechanism.

A new class of assets, carbon assets, could be created by the European Central Bank. Their value would be the agreed carbon value, and carbon certificates could be emitted that could be used by development and investment banks to provide loans at preferential rates to low-carbon projects. These carbon certificates would then progressively be accepted by the central bank as a reserve asset (like gold), depending on the state of project completion as certified by the independent authority. Banks could in parallel issue "carbon" financial products, aimed at attracting domestic savers, thanks to a strong public guarantee, a return on investment slightly above that of usual safe deposits and, for part of the population to the "ethical" objective of the investment. They would thus be interested in using the credit facilities provided by the ECB to fund the economy instead of using them to restore their balance sheet.

Such schemes would obviate the risk associated with blind liquidity injection as the growth of carbon-based reserves would be concomitant with controlled wealth production (low-carbon infrastructures) and with the attraction of a portion of public savings away from specu-

6 Jean Buridan, a theologian at the Sorbonne in the 14th century, published a caricature of a donkey to illustrate his argument that it is wise to postpone decisions until all the necessary information is available.

7 For example, too much risk-taking on nuclear security or on bio-energy; all these risks can hardly be signalled only by price mechanisms and have to be tackled by adequate institutions and regulations.

8 Cancun hosted the Conference of the Parties to the Climate Convention in 2010. The Climate Convention was adopted by the United Nations in Rio in 1992; it contains the legal basis of climate negotiations.

lative products.[9] Henceforth the *commerce of promises* would continue but would be directed towards precise objectives. It cannot be suspected of causing "a carbon bubble", as the value of carbon would be fixed by convention and not by the markets. The European Central Bank would pilot the system by determining the quantity of carbon assets as a function of the climate objectives of governments and of the validation of ongoing projects' advancement.

There remains the problem associated with the initial injection of liquidity and of the contribution of institutional investors (mutual funds, life insurers, pension funds) who are by far the largest collectors of savings. This monetary mechanism needs to be articulated with non-banking intermediation through the setting up of a European Ecological Fund (EEF), perhaps under the European Investment Bank, which would issue bonds aimed at institutional investors. These would be Eurobonds that could be launched even in the absence of political agreement on "non-coloured" Eurobonds. The EEF would invest the revenues produced by these sales in a portfolio of "project bonds" and loans to banks to finance projects. To secure a triple A rating the EEF would need to have a public capital guarantee. Such capital could be raised at the European level by a small tax on financial transactions, justified on the basis that financial entities would, in the final analysis, benefit from the system, and by a small European carbon tax.

European Unity and European Leadership in Environmental Affairs

In the current context of destabilisation, tying consistent links between its macroeconomic and environmental policies would help Europe recover its unity. Germany has made the climate issue a major priority based on a strong political compromise. For historical reasons, it is far more sensitive than many of its neighbours to the laxity of monetary policies. It could thus find a system palatable which is submitted to double-checking (control of the money inflow through prices and volumes of carbon assets, physical reality of collateral of the credits controlled by an independent body).

Reviving the economy by means of such a device would indeed be economically sounder than repeated inflows of money to rescue the banking system with no incentive to invest. Moreover, the small European carbon tax could represent a share of domestically recycled carbon taxes set up by member states. These carbon taxes could be progressively matched among countries as a first step towards environmentally oriented fiscal harmonisation in the eurozone.

This climate-friendly financial architecture would help find the narrow pathway between extreme rigor, which would freeze economic growth, and extreme laxity, which would push the burden of debts onto future generations. It would transform the climate challenge into a lever for sustainable growth backed by a "green" content.

As a response to its short-term challenges, this link between climate policy and reforms of the financial system would enable Europe to make a credible offer to the Climate Convention for extending this system worldwide (with optional membership) and for meeting its Copenhagen commitment to pay into a Climate Fund. The natural allies of such a proposal are the emerging economies. In addition to their concerns about climate change damage, they have a long-term interest in avoiding the trap of energy dependence through the appropriate planning of their infrastructures and in limiting the possibilities of speculative bubbles that threaten them in turn. These countries will account for a dominant share (60%) of the infrastructure markets over the coming decades. If generalised, this system would help them to redirect part of their own savings towards endogenous growth that would be less export orientated. It would also help them to diversify their foreign exchange reserves, which they view as a major source of fragility in their current growth strategy. Indeed, it is possible that the carbon assets could be transformed into international reserve money[10], entering the calculation of the SDRs.

The last paragraph outlines avenues which might currently look premature, among other things because the geopolitical environment is critically dependent upon the result of the coming US elections. The first priority is, indeed, to deal with fears and distrust in the eurozone. However, to mobilise Europeans along this safe route between the Charybdis of the financial debt and the Scylla of the climate debt, it might be useful to keep in mind more positive and long-term objectives.

9 Especially if we seize this opportunity to control the access of hedge funds to the markets for petrol and basic commodities.

10 This was suggested by Governor Zhou of the People's Bank of China in a web-based article just before the April 2009 G20 meeting. Recalling the vulnerabilities and systemic risks in the existing international monetary system, he calls for worldwide reflection on an international reserve currency anchored to a stable benchmark and argues in favour of reformed SDRs. About the link between the reform of the IMF and the climate affair, see H. Bredenkamp, C. Pattillo: Financing the Response to Climate Change, IMF Staff Position Note, 25 March 2010.