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The IPTS REPORT

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EUROPEAN COMMISSION
Joint Research Centre

ENGLISH VERSION

ABOUT THE IPTS REPORT

The IPTS Report was launched in December 1995, on the request and under the auspices of Commissioner Cresson. What seemed like a daunting challenge in late 1995, now appears in retrospect as a crucial galvaniser of the IPTS' energies and skills.

The Report has published articles in numerous areas, maintaining a rough balance between them, and exploiting interdisciplinarity as far as possible. Articles are deemed prospectively relevant if they attempt to explore issues not yet on the policymaker's agenda (but projected to be there sooner or later), or underappreciated aspects of issues already on the policymaker's agenda. The long drafting and redrafting process, based on a series of interactive consultations with outside experts, guarantees quality control.

The clearest indication of the report's success is that it is being read. An initial print run of 2000 for the first issue (00) in December 1995 looked optimistic at the time, but issue 00 has since turned into a collector's item. Total readership rose to around 10,000 in 1997, with readers continuing to be drawn from a variety of backgrounds and regions world-wide, and in 1998 a shift in emphasis towards the electronic version on the Web has begun.

The laurels the publication is reaping are rendering it attractive for authors from outside the Commission. We have already published contributions by authors from such renowned institutions as the Dutch TNO, the German VDI, the Italian ENEA and the US Council of Strategic and International Studies.

Moreover, the IPTS formally collaborates on the production of the IPTS Report with a group of prestigious European institutions, with whom the IPTS has formed the European Science and Technology Observatory (ESTO), an important part of the remit of the IPTS. The IPTS Report is the most visible manifestation of this collaboration.

The Report is produced simultaneously in four languages (English, French, German and Spanish) by the IPTS; to these one could add the Italian translation volunteered by ENEA: yet another sign of the Report's increasing visibility. The fact that it is not only available in several languages, but also largely prepared and produced on the Internet World Wide Web, makes it quite an uncommon undertaking.

We shall continue to endeavour to find the best way of fulfilling the expectations of our quite diverse readership, avoiding oversimplification, as well as encyclopaedic reviews and the inaccessibility of academic journals. The key is to remind ourselves, as well as the readers, that we cannot be all things to all people, that it is important to carve out our niche and continue optimally exploring and exploiting it, hoping to illuminate topics under a new, revealing light for the benefit of the readers, in order to prepare them for managing the challenges ahead.

Preface

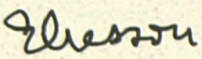
Women in Science

Women's presence in most of the economic, social and political spheres of today's world has considerably increased over the years. However, women are still underrepresented in the scientific research and technological development areas.

The reasons for the generally low percentage of women active in European research are many and complex, even if the lack of statistical information makes precise comparisons difficult. Women scientists, like all women, are faced with the dilemma of reconciling working and private life, career and family. Professional discrimination between male and female scientists manifests itself in various ways, for instance, women rarely rise to positions of seniority, even in those areas where women graduates outnumber their male colleagues. The unfortunate consequence is that women are more likely to leave the scientific career for other professional openings.

The European Union has always considered equal opportunity to be one of the fundamental principles of European democracy and a major consideration in all its policy-making. The European Commission is engaged in increasing the involvement of women scientists in Re3D activities conducted throughout the EU. This is partly because they are under-represented, but also because they bring a specific approach and sensitivity.

The 5th Framework Programme is the occasion for the Commission to be positively committed towards better access for women to the European research effort. In this context, the EC has prepared a Communication on "Women and Science: mobilising women to make European research richer" with the objective of creating opportunities for a greater participation of women in scientific research. This is our real chance to give a new face to research in the next millennium.



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EDITORIAL

Dimitris Kyriakou

In last July's and October's editorials we alluded to different ways of addressing 'externalities' – a term referring to consequences of actions taken by economic agents which do not accrue to the agents themselves, but to others, or often, to society as a whole.

We suggested that one solution, often associated with the British economist Pigou, to this discrepancy between private and social preferences, is to impose taxes/subsidies to bring individual preferences in line with social ones. A less obvious one, dating from the early sixties, dubbed the Coase theorem after its inventor, was largely responsible for getting Ronald Coase the Nobel award in Economics, in the early nineties. The Coase theorem states that for two economic agents A, B when A's actions generate a negative externality for B, and transaction costs are zero for both parties, it is optimal in terms of social welfare to allow the two agents to negotiate a payment to resolve the issue - either through A's compensating B for the damage A's activity inflicts upon B, or through B's compensating A for the benefits A will forego by discontinuing the activity.

We also indicated that in the case of positive transaction costs, the theorem states that optimality would dictate the allocation of the property right to the side with the higher transaction costs. We also indicated that the key issue then becomes the allocation of property rights, suggesting that it is not easy to disentangle the invisible hand of the market from the hidden fist of the state.

We also presented a case in which each economic agent has its own preferred level of acceptable pollution, agents are mobile across jurisdictions, and there are pollution spillover effects – all quite realistic assumptions. If in each jurisdiction, the enfranchised group decides on the target level of acceptable pollution - and concomitant compensation - through some majority rule mechanism, then mobile minorities may opt to move into jurisdictions inhabited by agents with pollution preferences similar to their own, allowing 'pollution-lovers' to become the majority in some of those jurisdictions. Through cross-jurisdictional spillovers, those pollution lovers force environmental degradation on the other jurisdictions as well.

We suggested that one solution would call for the inclusion of all injured parties in the decision-making process, enlarging the jurisdiction and enfranchising all those affected by pollution. Enlarging the jurisdiction and enfranchising all those affected by pollution, necessitates their being represented by their government, which, if the jurisdiction has grown sufficiently in size through the inclusion process,

brings us back to the Pigouvian tax, in the form of compensation paid by polluter to injured party, with the government being one of the parties in the transaction.

Government cannot be avoided on this issue; if it is pushed out the door, it comes back in through the window. As the desirable size of the jurisdiction expands, government can reappear as the representative of the population of the jurisdiction, and by revealing its Pigouvian mantle underneath the Coasian one show that those two can be viewed as two sides of the same coin.

Attentive readers have asked how the analysis may change if we relax the assumption of cross-jurisdictional mobility.

Let us begin by assuming total lack of mobility across jurisdictions. In such a case in jurisdictions in which 'pollution-lovers' are in the majority polluting activities will be concentrated. Note that given the existence of spillovers their neighbours who may be 'pollution-haters' in the majority will still suffer from cross-border pollution. If 'pollution-haters' are in the majority in all jurisdictions, pollution will not be tolerated anywhere, and the absence of mobility will guarantee there will be no reshuffling allowing the formation of 'pollution-loving' majorities, causing cross-border pollution. This picture is reversed if 'pollution-lovers' happen to be in the majority everywhere: in that case there can be no safe-haven created through migration for 'pollution-haters'.

The perfect immobility assumption in effect reduces the jurisdictions to monolithic behaviour, and the analysis back to the original Coasian one.

Note that this schematic account downplays interesting questions about strategic interactions in case there is mobility (which could be nicely treated in a game theoretic model – e.g. using a trembling-hand-perfect equilibrium), as well as optimal clustering of islands of 'pollution-haters' in case there are varying degrees of 'pollution-aversion'.

Finally, if we make the more realistic assumption that there is mobility, only it bears high (but finite) costs, then migration will be observed when the damage inflicted on an agent due to pollution rises beyond the fixed costs of migration.

In this 'costly-but-possible' version of mobility the analysis we made for the case of mobile minorities holds, albeit triggered at higher levels of pollution.

Biotechnology for Environmentally Safe Agriculture

Miguel Vega, *IPTS*, Laurent Bontoux, *DGXII* and Antonio Llobell, *CSIC*

Issue: In Europe some uses of biotechnology are meeting vocal opposition from certain quarters. Nevertheless, the vast amount of knowledge acquired recently in biology can be used to develop and apply *biotechnology for an environmentally safe agriculture*. Public acceptance and a new policy impetus can serve to promote the introduction of safe and competitive agricultural technologies that have a minimum environmental impact.

Relevance: Increasing long-term health and environmental concerns regarding the use of standard agrochemicals (pesticides and fertilizers) is leading to increased controls and limitations on their use. This underscores the need to explore alternatives, including the use of biotechnology, and to weigh up options in a risk-assessment structure.

Introduction

Agriculture worldwide has become reliant on agrochemicals in order to achieve yield targets cost-effectively

Agrochemicals play a major role in meeting yield requirements in world food production cost-effectively. However, concern has arisen out of findings relating them to human health and environmental problems. Some pesticides contain active ingredients that have been shown to act as hormone disruptors in acute and chronic toxicity studies, possibly causing loss of fertility, carcinogenesis and mutagenesis. Widespread application to most cash crops means pesticides are present in the ecosystems, aquifers and water systems of the EU's main agricultural areas. In the long-term, this could have repercussions for both the natural environment and human health.

There is mounting concern about the effect of certain agrochemicals on the environment and human health

These health concerns have led to a tightening of EU regulations on pesticide residues entering the food chain. One example is the new directive on baby food, passed this October, requiring that pesticide residues be kept below detection limits. In the same vein, the EU is studying the feasibility of taxing pesticides in an attempt to reduce their application. This situation raises an important economic question: if the use of pesticides is restricted and taxed, will productivity be affected and food prices increase?

Agricultural biotechnology offers a possible alternative, permitting yield levels to be maintained without the intensive use of agrochemicals. However, biotechnology is still at an early stage of development, and further research is needed into its impact on human beings and the environment.

Health risks related to pesticides

The most common way for pesticides to enter the food chain is as chemical traces on crops they

have been used to treat. Nevertheless, they can also enter the food chain via contaminated drinking water or dietary animal fats and fish.

Over the past few decades many pesticides have been banned or otherwise restricted because of concern over their carcinogenic potential or other risk to human health or the environment. Hazard assessment and epidemiological studies of pesticides show that many, if not all, are potentially toxic to humans. At lower doses they possibly pose a risk of cancer, neurological damage and loss of fertility, although these effects have yet to be fully quantified.

It has become increasingly clear that cancer arises as a result of genetic alterations. These may be inherited or a result of the mutation of somatic cells. To be more explicit, agents that cause DNA damage or cell replication in certain cell populations will increase cancer risk. This effect is called genotoxicity. Although the genotoxicity of pesticides remains poorly defined, some substances present in pesticide formulations may be genotoxic or may cause indirectly damage to DNA by promoting the formation of oxygen free radicals.

Apart from carcinogenesis, recent scientific studies have suggested that some synthetic compounds found in pesticides can act as hormone disrupters. There is now evidence that, in some cases, wildlife has suffered adverse effects from exposure to environmental chemicals that interact with the endocrine system and therefore with hormone function. In many instances the specific hormones involved in both animals and humans are chemically identical. This profound similarity suggests that although few human studies have been done, endocrine-related effects first observed in animals may also be manifested in human populations.

At least four major categories of adverse biological effects may be linked to exposure to endocrine-disrupting chemicals (EDCs): cancer, reproductive and developmental alterations, neurological and immunological effects.

Suspected hormone disrupters include persistent organohalogens, synthetic pesticides, phthalates and heavy metals. Synthetic pesticides suspected of having reproductive and endocrine-disrupting effects include insecticides, herbicides, fungicides and nematicides. Many of these pesticides enter the food chain in the form of chemical traces from pesticide-treated crops. A major question to be addressed is whether low concentrations of pesticides residues in the food chain (chemical traces) exert any endocrine disrupting effect in humans.

The seriousness of the endocrine disrupter hypothesis has led the European Parliament to pass a non-binding resolution calling for hormone-mimicking substances to be phased out. It states that, with little scientific evidence about the possible dangers to human and animal fertility and other health effects, the precautionary principle requires the substances to be removed from the market.

Agricultural biotechnology

Over the last few decades agriculture has grown increasingly chemical-dependent. Pesticides have come to play an important role in meeting world food needs. Beyond yield improvements, the reliance on chemicals has underemphasized crop protection. The chemical dependency of agriculture leads many to think that there is no alternative to pesticides in the short term.

However, a new trend is opening the way towards the reduction of the reliance on chemicals: the use of biotechnology and the

Genotoxicity, or the ability to damage DNA, is a particular concern given its relationship to cancer and hereditary defects

Pesticides suspected of having reproductive and endocrine-disrupting effects include insecticides, herbicides, fungicides and nematicides

The use of biotechnology and the incorporation of crop protection strategies within plant breeding programmes may offer an alternative to reliance on chemicals

incorporation of crop protection strategies within plant breeding programmes. This trend is being propelled by new knowledge of molecular biology and the associated biotechnology techniques. These include recombinant DNA technologies which are a pool of techniques that allow DNA from any source to be isolated and transferred between different organisms.

The two main biotechnology techniques involved in recent developments are genetic selection, which uses biotechnology to enhance traditional selective breeding techniques, and genetic modification, which actually changes the organism's DNA so as to introduce new traits in a much more targeted way. This allows desired traits to be expressed in a useful plant variety without losing the plant's valuable characteristics.

Biotechnology allows desirable traits to be incorporated directly without the limitations of selective breeding in terms of possible donors and time-consuming trial and error

The application of biotechnology to agriculture therefore makes available a series of valuable tools with which to fight pests and disease, although their use may require prior research on the organism's vital processes. Also, before attempting the genetic improvement of crop plants, a large body of research in plant genetics is needed (e.g. the *Arabidopsis* genome project). The outcome of this research will be a better understanding of genetic mechanisms and a greater knowledge of gene function.

Health and environmental concerns of agricultural biotechnology

The idea of releasing genetically modified plants, animals or microorganisms (generically called "genetically modified organisms" or

Table 1

Biotechnology practices for pesticide substitution: Genetic selection

Practice	Remarks and examples
Improved plant varieties	Use of map-based or marker based techniques for the identification of resistance gene -gene loci- for subsequently cross breeding to improve pest and pathogen resistance in commercial plant varieties.
Biocontrol agents	Selection of microorganisms to compete in agricultural fields with harmful organisms (insect, nematodes, virus, fungi and bacteria): - Antagonistic (competition) microorganisms such as *Trichoderma* and *Glicocadium* to reduce populations of fungal pathogens. - Microorganisms producing antimicrobial substances such as *Pseudomonas* and *Bacillus*. - Insect parasites such as entomopathogenic fungi, *Bacillus Thuringensis* and baculovirus. - Other strategies are insect and plant pathogen predators; nematode pathogenic bacteria and fungi; and sterile mates in insect population.
Biocides	Toxic products excreted by microorganisms to control insects, weeds and plant pathogens. E.g. antimicrobial and other metabolites such as Strobilurins.
Other sources of resistance	Genomes of wild plant varieties and other organisms (specially biocontrol organisms) as sources of novel genes and compounds.

Table 2

Biotechnology practices for pesticide substitution: Genetic engineering

Practice	Remarks and examples
Insect resistant plants	Genetic engineering using endotoxin coding sequences originating from the bacterium *Bacillus thuringiensis.* Genetic engineering using plant-derived genes: - Plant genes encoding enzyme inhibitors interfering with the digestive process in insects such as proteinase and amylase inhibitors. - Plant genes encoding toxic substances such as lectins, chitinases and alkaloids.
Virus resistant plants	Genetic engineering using pathogen-derived genes. This strategy is based on the phenomenon that a pathogen's genome is a source of resistance: - Genetically engineering plants to express the coat protein of viruses. - The use of viral genes coding for proteins involved in the replication cycle and systemic transport of viruses within the plant. - The use of interfering RNA sequences such as satellite RNAs as well as antisense and sense RNAs. Genetic engineering using plant-derived genes: - Genes encoding pathogenesis-related proteins (PR). Triggering hypersensitive response (HR) and systemic acquired resistance (SAR). - Plant genes encoding anti-viral proteins: ribosome-interactive proteins (RIPs). - Natural host R (resistance) genes. Cloning and insertion of natural anti-viral resistance genes in plants. Other sources of genes for engineering virus resistance crops: - Mammalian antibodies to confer disease resistance in plants. - The use of interferon system, a component of the mammalian defence system.
Bacterial and fungal resistant plants	Genetic engineering using pathogen-derived genes: - Transgenic approaches leading to elicitation of hypersensitive response (HR) and systemic acquired resistance (SAR). - Plant transformation with bacterial genes that confer autoinmunity to bacterial phytotoxins. Genetic engineering using plant and non-pathogenic microbe genes: - Genes expressing antipathogenic proteins such as chitinases and RIP (Ribosome Inhibiting Protein), normally present in the seeds of barley. - Transgenic plants expressing small antimicrobial peptides such as thionons, lipid-transfer proteins, 2S albumins andcysteine-rich antimicrobial peptides. - Transgenic expression of antifungal enzymes with fungal cell wall degrading activities (chitinases, glucanases, proteases). - Natural host R (resistance) genes. Cloning, insertion and expression of natural anti-bacterial and anti-fungal resistance genes from plants. Genetic engineering to express avirulence bacterial and fungal genes: - Transgenic plants carrying a two-component genetic cassette (sensor and effector genes) -expressed by plant promoter- that activates HR (strategic cell death). - Transgenic plants expressing constitutively H_2O_2-generating gene, which is toxic to microbes and can trigger HR.
Improved control agents	Transgenic strains of microorganisms expressing genes conferring better biocontrol qualities: - Field application of microbes with increased antagonistic capacity. - Fermentation process for production of low risk compounds (biocides) using transgenic microorganisms under confined conditions.

GMOs) into the environment is currently a matter of debate. The most important health and environmental concerns are direct toxicity (including allergies), transfer of undesirable genetic information across the species barrier and increased resistance to antibiotics. Nevertheless, much of the public anxiety stems from a lack of understanding of the basic science involved and confusion with other food-borne diseases.

In general, fears surrounding the release of genetically modified organisms, or GMOs are the result of misconceptions

There are a number of reasons why these fears are exaggerated:

- Toxicity
  The human gut naturally hosts enormous populations of microorganisms and has evolved to cope with foreign nucleic acids and proteins, such that there is no risk of genetic transfer from ingested matter.
- Crossing the species barrier
  A major issue associated with the use of this technology is that it allows genetic information to cross the species barrier. DNA already crosses species barriers in nature. It is transferred both within and between species, for example from viruses to bacteria, or viruses to humans. So far, however, the spontaneous transfer of DNA from plants to microbial or animal species has never been observed.
- Gene transfer by normal means in pollen
  Gene transfer may pose a threat to the environment by disturbing the existing balance between organisms. However, it is important to realize that any genetic balance is a dynamic one, with gene mutations and rearrangements occurring frequently as normal events in all living organisms. Nevertheless, solutions potentially able to reduce or suppress gene transfer have been developed. These are the use of male sterile clones (when the seeds are not the required product), the use of hybrids to suppress gene transfer by pollen, and transformation of mitochondria and chloroplasts (exploiting the fact that unlike the nuclear genome, the chloroplast or the mitochondria genome is not normally transferred by pollen).
- Antibiotic resistance
  Most gene transfer methods rely on a second gene, known as a marker gene, to enable the selection of transgenic plants. In the majority of cases to date, this marker gene has been the neomycin phosphotransferase (NPTII) gene. NPTII inactivates and provides resistance to the antibiotics kanamycin and neomycin. Methods have been devised to eliminate these marker genes from the crop plant if necessary. It might also be worth considering that as increasingly desirable traits become available for transformation, this may become almost essential. Use of a marker gene in one transformation precludes its use for subsequent modifications. Thus unless markers are removed, new markers will continually be required for each new trait to be inserted. The issue is being addressed at several labs (private and public) and in the long run no markers will be needed.

Risk assessment

Risk assessment of GMOs needs to consider the mobility of inserted genes and their effect on other natural resistance mechanisms

Biotechnology risk assessment aims to evaluate hazards to human health and the environment resulting from the application of biotechnology techniques. One of the most important tasks concerning safety of transgenic organisms is to assess long-term effects. This includes overseeing the mobility of the inserted genes and assessing the continuous expression of resistant genes, as these may affect non-targeted organisms and may disrupt or interrupt the evolution of other natural resistance mechanisms.

The development of risk assessment procedures should include a risk/benefit comparison of current agrochemicals and agricultural biotechnology so as to quantify and

compare the impact that both chemical and biological technologies have on human health and the environment. This comparison should seek to evaluate the broad pros and cons of the various alternatives, and to allow citizens and policy-makers to make educated choices based on the estimated risks and benefits.

Regulatory framework

Scientific findings relating pesticides in the food chain to human diseases is encouraging policy-makers to establish regulatory maximum residue limits for pesticides in foodstuffs. At the same time, an increasingly indiscriminate use of the precautionary principle is hindering the development of the best alternative to pesticides: biotechnology.

The challenge today is to develop a European policy simultaneously protecting the public and the environment, promoting research and fostering the competitiveness of the agriculture and of the biotechnology industry. Today, the regulatory framework on agricultural biotechnology is made of a few European Directives and Regulations. The main ones are:

- Directive on the Deliberate Release into the Environment of Genetically Modified Organisms (GMOs): The European Commission recently presented a proposal (COM/98/0085) for amending the Directive so as to harmonize European approaches to the issue. Several Member States have refused to approve the commercialization of GMOs approved in other Member States in their territories and others have called for a moratorium. The European Parliament's Committee on the Environment, Public Health and Consumers proposed a Europe-wide moratorium on all transgenic crops awaiting authorization to be placed in the market. The monitoring and regulatory system laid down by this Directive is already stricter than those applied to almost any other area of human activity including new drug discovery.
- Council Regulation (EC) No 1139/98 of 26 May 1998 Concerning the Compulsory Indication of the Labelling of Certain Foodstuff Produced from Genetically Modified Organisms: part of the scientific community thinks that one of the main reasons for opposition to GMOs in Europe is the lack of enforcement of this regulation. The labelling of GMOs has taken European food-control bodies by surprise and they are having some difficulty implementing this regulation, e.g. the lack of reliable identification techniques. In this context, the JRC (Joint Research Centre of the European Commission) has recently validated a screening method that permits detection of GMOs in foodstuff.
- Directive on the Legal Protection of Biotechnological Inventions (98/44/EEC) concerning intellectual property: IP appears to be a very delicate issue. On the one hand, it allows effort and invention to be rewarded. Indeed, this is important as many SMEs or public groups working specifically on identifying resistance genes are beginning to look like DNA-boutiques for large companies. On the other hand, given the high costs of producing GMOs -including patent applications and fulfilling regulations- together with the monopolistic dominance of a few groups in agricultural biotechnology, it may discourage smaller organizations from producing their own selected or engineered organisms. It also may lead to alienating producers and consumers from a few products.

Industrial issues

Today, most of the world seed business is in the hand of 5-6 large companies. These companies, such as Hoechst or Monsanto, were

Whilst increasingly stringent regulations are being imposed on pesticides, being indiscriminately overcautious is hindering development of the best alternative i.e. biotechnology

A tougher regulatory atmosphere is making it harder for biotech SMEs to thrive the way they have in the US

traditionally large chemical companies that appear to have adopted a long-term strategy to move into life sciences. This could indicate a strong shift away from massive use of agro-chemicals. These companies are working on alternative, biotechnology based strategies coupled to the selective use of chemicals. Transgenic plants expressing herbicide-resistance and insect-resistance genes are already on the market. Ironically though, some of the new genetically engineered plant varieties such as herbicide resistance crops depend on the application of specific types and amounts of chemicals to reach their improved yields, possibly compounding public concerns.

At the same time, there is an obvious lack of interest by these same large companies in biological control, perhaps because biocontrol products are limited to small niche markets. R&D in these areas is mainly led by small companies and research groups from scientific institutions. Most of this research is financed by public funds. This has led to the creation of a strong scientific base but few practical technologies or economically viable results. In the US an increasing number of SMEs, research institutes and universities are developing and producing biocontrol products, while in the EU the initiatives from the private sector in this field are scarce. One reason for this situation may be that registration procedures and approval for marketing genetically selected microorganisms or derived-products are not affordable to SMEs.

Conclusions

The regulatory trend towards the restriction of pesticide use could significantly increase the yield losses due to plant diseases and pests if no alternative is found soon. Although these restrictions are being imposed on the grounds of better food quality and environmental protection, agrochemicals remain the main form of crop protection worldwide.

In order to make progress towards weaning agriculture off chemicals it is essential that the emerging contributions from biotechnology be better understood by both the public and policy-makers.

Biotechnology undoubtedly has the potential to make major contributions to the development of sustainable agriculture. The main advantage of agricultural biotechnology is to allow farmers to reduce their reliance on agrochemicals (both pesticides and fertilizers) to achieve the desired yields. If properly done, this will deliver the combined benefits of health improvements for the consumer, decreased environmental impacts and increased competitiveness.

While it is essential to insist on obtaining an ever safer use of biotechnology, if society is to fully benefit from its potential its introduction should not be exclusively based on its intrinsic safety profile but also on its safety relative to the chemicals-based agriculture it aims to replace. The precautionary principle must be applied but should in no circumstance become a barrier for innovation nor bar our society from gaining access to significant long-term environmental and public health improvements.

Updated regulations and better communication to the public are essential if Europe is to avoid falling behind in the international development of *biotechnology for an environmentally safe agriculture.*

Biotechnology undoubtedly has the potential to make a contribution to sustainable agriculture, but needs the understanding of the public and policy makers in order to do so

The safety standards applied to biotechnology should take the precautionary principle into account, but should judge its safety relative to the chemicals-based agriculture it aims to replace

Keywords
agrochemicals, GMOs, environmental impact, regulatory framework

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Building Experience: Energy Efficient Buildings

Tonino Amorelli, *CEST*

Issue: The development of large commercial, governmental and even residential buildings which take advantage of energy efficient design and incorporate on-site renewable energy sources could have a major impact on achieving and maintaining Kyoto targets on reducing carbon dioxide (CO_2) emissions in the future. Although demonstration sites across Europe have been built, the lessons learnt in their development and subsequent performance have not penetrated the wider marketplace.

Relevance: Since the 1997 Kyoto agreement renewed attention has been paid to carbon dioxide emissions. Heavy industry and transport usually bear the brunt of controls, while buildings, covering all sectors including non-industrial, are neglected. With many major construction activities planned years in advance it is important to ensure that energy efficiency considerations are a high priority.

Introduction

Buildings may be responsible for as much as 50% of CO_2 emissions, but so far have received little attention in attempts to improve energy efficiency

For a number of years questions of energy efficiency, energy security and protection of the environment have been the top of the developed world's political and economic agenda. Much has been made of the effects of industrial activity and transport in these areas. After the Kyoto round of discussions on global climate change there is even greater pressure on developed countries to renew efforts to minimize emissions and improve energy efficiency throughout industry. The concentration on transport, and heavy industry has already started to bear fruit, and not only environmentally. US President, Bill Clinton recently stated that, "Every action the US has taken since 1970 to clean up the environment has led to more jobs and a diversifying economy", emphasizing the opportunities that can arise from environmentally sound practices and innovation.

Until recently, however, the impact of one of the major net contributors to CO_2 emissions - buildings- has been virtually ignored. It is now widely recognized that buildings contribute almost 50% of all CO_2 emissions. Yet, despite this alarming estimate there has been little evidence of widespread uptake of energy efficient technologies and designs, although they have been known about for decades. One of the main deterrents is cost; it is the common perception that implementing new concepts requires large

investments. The lack of forward-looking companies, together with capital market imperfections, means that the long term financial benefits of reduced energy consumption tend not to be fully grasped. Moreover, the benefits to the workforce from improving working conditions and reducing possible effects from so-called "sick-building syndrome" induced by artificial air-conditioning systems and poor material use, are hard to quantify.

Buildings are by their nature intended to be long lasting, so relying solely on new building projects cannot be the only solution. It is also necessary to address the important issue of retrofitting old buildings. This would not necessarily involve a complete overhaul of existing sites, nor would this be practical, but some retrofitting could be accomplished stepwise. However, to assess which option - retrofitting or new building - is most beneficial "whole-life costs" must be taken into account.

Design Capabilities

Energy efficiency trends for a number of years have focused on electronic equipment such as low energy lighting and office equipment. There has been less emphasis on the building envelope. In particular this refers to:

- general physical attributes - roof, walls, foundation, insulation, seals, doors
- fenestration (design and placement of windows)
- movements of air in and out of the building (infiltration, exfiltration)
- heat loss and gain through windows, ceilings floors and walls, and
- internal heat transfer mechanisms.

Some of these aspects are described in Table 1. Approaches to energy efficiency must adapt these factors to suit the climate in which the building project is situated.

Another factor currently being considered, although we will not look at it here, is studying the energy efficiency of supplying the raw materials by a complete examination of their life-cycle.

In the US efforts are concentrating on considering the "whole building". From an engineering perspective this means that the building should be viewed as an integrated systems design rather than a number of individual components. It is easier for designs of this type to incorporate new technologies and take advantage of solar and other renewable energy sources. The US Department of Energy has developed a modelling tool which can evaluate the energy performance of small commercial building designs. It hopes that by doing this, the service will promote the dissemination of experience, and help companies to understand the potential benefits of utilizing designs of this type.

Experience with New and Older Buildings

There are examples of where energy efficient programmes have been able to use energy efficiency technologies, as seen in Table 2, all of which have been supported by the THERMIE Programme.

This demonstration part of the JOULE-THERMIE programme has supported, and continues to part-fund, projects which clearly show the benefits of new energy efficient technologies and designs. However, the question arises as to why the dissemination of these practices is so limited, despite the European Commission's efforts. At the recent Expo98 in Lisbon, emphasis was placed on the use of existing, but little used, technologies in the building of the exhibition. What was also stressed

The techniques applicable to new and existing buildings differ, but both need to be addressed

Concern for efficient electrical systems needs to be complemented with appropriate design of the envelope to make the most of natural heat and light

The 'whole building' approach views the building as an integrated system rather than a collection of individual components

Table 1. Building Envelope Considerations

	Fenestration	For light, solar heating and natural ventilation
Cold Climates	• Large, south facing fenestration allows in light and heat and so reduces the need for "artificial" heating • Overhangs increase shade and reduce solar radiation in summer months, reducing the need for air-conditioning	
Warm Climates	• North facing fenestration- allows light while minimising solar radiation, so reducing the need for air-conditioning	
General	• Poor frame design can affect performance - aluminium windows are good heat conductors and thus no good for cold climates • East-West facing windows - high heat gains in summer, high heat losses in winter. Small windows are required with internal or external shading	
	Doors	
General	• Insulated solid doors are best suited to reduce heat loss or gain • Commercial glass doors must take into consideration the same factors described above for fenestration • Frames should also be considered, as for fenestration • Heavily used commercial doors/entrances could be revolving or doubled to create "air buffers" and reduce excessive heat loss or gain	
	Glass	For windows or doors
General	Coatings • allow/restrict daylight transmittance to increase/decrease solar heating respectively and subsequently reduce the need for heating or air-conditioning • shading coefficients - allow/restrict heat transmittance with similar results to transmittance factors • low-emittance - reduces heat emitted from warm pane to cold, placed on the internal pane in cold climates, externally in warm climates	
	Other aspects	
General	Insulation • blankets, rigid board and loose-fill give good insulation properties to reduce excessive heat loss or gain Moisture and Air Leakage Control • reduces condensation and possible structural damage • vapour barriers reduce excessive heat loss or gain • avoidance of thermal bridges which add to heat loss or gain	

Adapted from: US DoE, Energy Efficiency and Renewable Energy Network

Dramatic energy cost savings are possible and cost effective technologies exist for both new buildings and refits

was that no extra cost was involved. As regards housing, some French architects have claimed that designing in energy saving features would add only 1% to their fees, but would reduce energy consumption by up to 30%.

In the UK, the Building Research Establishment set up an Environmental Assessment Method (BREEAM) eight years ago, which aimed to get the message over to developers and to gauge results. In the financial year to April 1997, the estimated

Table 2. Energy Efficiency Buildings Projects

LOCATION	DESIGN/TECHNOLOGY APPLIED
Bournville House (Birmingham - UK)	Transparent insulation applied to external walls
Caja España (León - E)	Power co-generation system
Chamartín RENFE Station (Madrid - E)	Power co-generation system
Maison Pleiade (B)	Home automation system to control comfort parameters
The Green Building (Dublin - EI)	Natural ventilation and light
ESTI Technology Hall (JRC-Ispra - I)	Rational hot air distribution
Self-sufficient Solar House (Freiburg - D)	Solar energy and structural design
Congress and Exhibition Hall (Linz- A)	Natural light and new window designs
Anglia University (Chelmsford - UK)	Natural ventilation and lighting
Low Energy Office (Köln - D)	Insulation, natural ventilation and lighting
Leeds City Office Park (Leeds - UK)	Natural ventilation and lighting

Examples taken from "Energy-Conscious Building Approaches" DGJRC/DGXVII

energy savings/benefits of their programme totalled ECU615m, equivalent to an emission reduction of 1.4 million tonnes of carbon. They themselves have recently moved into new offices which make use of many of the practices they promote and believe the result is 30% more energy efficient than standard designs.

Many opportunities to innovate in the construction sector are left to new developments. More often than not the tailored solution to a problem is not immediately transferable to a second project, although there is a basis for some sort of standardization. Energy labelling offers a way of giving information about the energy-related properties of materials. The use of U-values - a measure of insulating ability (low U-values means better insulating capacity) is an example of this, but so far users are not particularly familiar with it.

There are considerable opportunities for improving energy efficiency and reducing subsequent emissions to be obtained by refitting existing buildings. Stepwise approaches rather than complete overhaul[1] could catalyse the market for better and more energy efficient components. Increased demand could lead to reduced cost and so encourage greater uptake.

Location, location, location

In many cases it is not a simple matter of examining the application of materials and structural design of the building itself. As we shall describe, it is also necessary to assess the location

In many cases it is not a simple matter of examining the application of materials and structural design of the building itself. It is also necessary to assess the location and situation of the construction site itself

and situation of the construction site itself. These environmental factors should not concentrate only on climate considerations - i.e. cool northern Europe and warmer southern Europe, but also on the scope of the local landscape to contribute to the energy needs of the site. There may be opportunities to take advantage of renewable energy sources -wind and tidal power as well as solar. In many cases this can contribute to national resources as well as meeting the building's energy needs.

There is no shortage of design know-how, but cost is a limiting factor in uptake

Two recent designs in the UK, a Sainsbury's supermarket at the Millennium Village in Greenwich, London and Hyndburn Council offices in Lancaster, demonstrate this - both are currently under construction and both involve the regeneration of a brown-field site.

At the London site, Sainsbury's opted for

- natural-ventilation and lighting
- underfloor heating using waste heat from refrigerators
- thick concrete walls and floors to a store heat energy during the day and release it at night
- earth mounded sides to reduce heat loss in winter and heat gain in summer. This will also enable them to absorb noise from delivery lorries
- renewable energy sources - wind turbines and solar cells

Demonstration projects could play an important role, but need to focus on applications benefiting Europe's citizens directly

The Lancaster council project, which is part-funded by Thermie and touted to be the UK's first zero-energy public building, will use,

- south facing orientation to make best use of sunlight
- renewable energy sources
  - wind - a single turbine
  - solar cells - roof mounted and providing 35MWh a year (20% of the site's annual requirement)
  - water - a water-to-water heat pump
- thick walls to reduce heat loss
- lighting control systems to maximise daylight use

The site is an excellent example of how the natural environment can be exploited without negative impacts, and in fact, the building's lower energy requirements mean that the site is a net contributor to the national grid.

Conclusions

The question of cost will always be paramount in the minds of companies planning major, or even minor, building developments. There is no shortage of design know-how, technologies or overall experience, but as is often the case for the acceptance and application of new and innovative technologies, cost is very much the limiting factor.

However, as an opportunity to meet new environmental controls and standards, energy efficient construction stands out as a possible solution to the growing concerns over CO_2 emissions. The combination of energy efficient buildings with measures affecting electrical appliances could have a major impact and is an area which, if targeted, could have short and long term benefits for all concerned.

At a recent conference held by the European Commission in Lisbon there again was a call for support for research and demonstration projects. Funding of ECU300m was proposed. However, at the same conference, the reasoning behind this funding was questioned because few "ordinary people" benefited from the results. With the Fifth Framework Programme also dedicating part of its work to the "city of tomorrow" and "energy efficiency for a competitive Europe", and again looking for demonstration projects, it is important to

promote innovative approaches which are able to benefit Europe's citizens directly.

The underlying problem is that whereas the financial means exist for the development exploitation of these projects in demonstration projects, there is little effective dissemination of the lessons learned to the wider-market place. And it is here where a much larger impact could be envisaged environmentally, economically and socially. Inertia on the part of industry could be addressed through tax incentives for the application of the technologies, or tighter regulation at the planning stage. A fuller understanding of the cost/benefit of using these alternatives could also play a role, as could identifying more closely at which stakeholders in the decision making process to target the relevant information.

A combination of these efforts could have a significant impact across a broad range of industries. Apart from creating new employment opportunities they would support the creation of sustainable cities rather than providing just a small number of sustainable buildings.

Keywords

energy efficiency, construction, renewable energy, best practice, Kyoto

Note

1- Recently suggested by consultants Oscar Faber.

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Strategic Niche Management: a tool for the market introduction of new transport concepts and technologies

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Issue: Transport and mobility systems are confronting severe problems of congestion, pollution and resource consumption. While many promising and sustainable new transport technologies and mobility concepts have been developed over the last decades, the pace of their introduction has been disappointingly slow. New alternative options face a broad range of technical, social, economic and institutional barriers.

Relevance: Traditional technology-oriented policy measures are an important tool for the R&D-phase, but do not deal with the integration of new technologies into the complex socio-technical system of transport. A more comprehensive strategy is needed which takes the expectations of all stakeholders carefully into account, expands single experiments to market niches, and finally enables the transformation of the dominant technological regime in a more sustainable direction. During this process, it is necessary to find an appropriate balance between the necessary protection of immature technology competing with the established technological regime on the one hand and the need to spur improvements by competition on the other.

Introduction

In view of traffic related pollution, noise and congestion it seems increasingly urgent to move towards sustainable mobility. A long-term re-orientation of the development paths of our transport systems appears to be necessary. This calls for exploring more radical changes than we have witnessed in recent years.

The introduction of radically new transport technologies and concepts is regarded as one of the key options for addressing these problems while maintaining the current possibilities of access and mobility. Many experiments and demonstration projects have been set up in this respect, e.g. with concepts such as:

- Electric vehicle schemes and other alternative propulsion systems with zero- or ultra-low-emissions (battery, hybrid and fuel-cell driven vehicles, alternative fuels like hydrogen, methanol, CNG, LPG or DME).
- Individualized and demand-oriented public transport striving for flexibility and privacy so as to compete with the advantages of individual transport. Intermediate schemes between taxis and public transport have proved to be economically successful in off-peak hours in public transport.

- Car-sharing and car-pooling to use current transportation capacities more efficiently by using the same car simultaneously or alternately by different drivers.
- Information, reservation and ticketing schemes to simplify access to public transport and facilitate the operation of intermodal transport chains.
- Intelligent transport systems using advanced information and communication technologies to smooth traffic flows.
- Telematic access control systems to reduce pollution and secure sustainable mobility in ecologically and culturally sensitive areas.

However, although many new alternatives have been suggested, they often do not manage to go beyond the experimental stage. Apparently, they all have potential benefits, but they come into conflict with the dominant transport structures, organizations and institutions and with general mobility behaviour (i.e. the so-called "technological regime"). Reliance on individual technological experiments and market mechanisms alone appears unlikely to change these structural constraints and to trigger a long-term change in the predominant transport regime. Experience shows that innovations frequently succeed by achieving initial acceptance and improvements in "niches", protected areas of application especially suited for the emerging technology. In passenger transport structural barriers are reinforced by the current patterns of individual mobility behaviour and by the complexity of interactions between technological and social factors (e.g. current lifestyles and housing patterns strongly favour the widespread use of the private car).

The social acceptance and successful diffusion of new technologies are crucial, but often neglected, elements of the innovation process. A shift away from a technology-oriented policy approach towards a more diffusion and innovation-management oriented strategy seems appropriate. The interests of users and other stakeholders, the continued improvements of the technology during market introduction, and the development of a supportive organisational and policy framework should be co-ordinated in a mutual learning and adjustment process.

Besides this "bottom-up" approach, management of demonstration projects is still required as new technologies and concepts need protection in their early stages so as to improve in readiness for competition. This should be complemented by a strategy to proceed from isolated experiment to extended market niches, e.g. in a country, and finally to a transformation of the dominant technological regime as a whole, if possible across Europe.

Recent experience with the management of experiments and demonstration projects involving alternative transport technologies and concepts have made it possible to identify several barriers to their wider uptake. This experience will also help develop a new strategy for facilitating the transition to a more sustainable transport system.

Recent experience: Where are the main barriers, trade-offs and dilemmas?

Beyond normal project management problems, there are several typical reasons why seemingly promising experiments might fail during the process of niche development. Some of these are illustrated by the example of the electric vehicle niche described in Box 1.

First of all, there is a *lack of understanding of the specific needs and interests of all stakeholders.* Frequently managers of implementation projects decide top-down and fail to identify and involve supporters of the

A wide range of technologies have been proposed as part of the solution to the problems of pollution, noise and congestion arising from current transport technologies and patterns

Uptake, however, has been disappointing. Current habits and patterns of mobility behaviour create a powerful barrier to innovation

The consideration of some important factors is necessary if a technology is to catch on: such as the needs and interests of all stakeholders, an appropriate protective environment, and realistic expectations

Box 1. The electric vehicle niche in Europe

Experiments with electric vehicles have been carried out in many European countries during the last ten years. These were initially not interconnected and were often based on quite distinct technologies. The Swiss light electric vehicle programme, which culminated recently in large-scale test in Mendrisio, built on the earlier networks of alternative vehicle promoters. The programme made successful use of competitive mechanisms among different communities interested in hosting the large-scale experiment. Although only Mendrisio got the main programme, the other cities are still connected to each other and build on experiments elsewhere in Switzerland.

France is the country where the strongest support was given to electric vehicles. Électricité de France and the main car manufacturers were involved in large experiments. Recently a very challenging experiment took place in St. Quentin-en-Yvelines ("Praxitèle"), combining up-to-date EV-technology with latest-generation telematics and smart-card technology. However, serious technical problems have been encountered. The city of La Rochelle has not only run several experiments with EVs since the early seventies, but has also attracted EV-related industries to set up nearby (e.g. control systems, batteries, etc.). The technology used in La Rochelle is far more conventional than in St. Quentin and relies on converted standard vehicles, but it has made it possible to learn a lot about user behaviour.

Based on the La Rochelle experiment, Coventry has implemented a similar programme, although its aspirations are rather modest and have not lead to many new insights.

The most important German EV experiment took place on the island of Rügen under very special and isolated conditions. The lack of industry backing meant it did not achieve any breakthroughs, but rather discredited EVs in Germany.

In general, it needs to be taken into account that the framework conditions in the countries differ significantly. Clearly France, with its large share of nuclear power, can see more potential in EVs than Germany with its coal-based power generation system. Switzerland has an excellent railway system for long-distance transport, which offers good opportunities for combination with EVs, which are by definition relatively short range.

Source: Prätorius/Lehrach 1998, Lane 1998, Simon/Hoogma 1998, Simon 1998, Harms/Truffer 1998a

project or to anticipate opposition and so prepare pre-emptive strategies to overcome it. The development of a support network of stakeholders and communication to a broader public are of decisive importance for a successful experiment and niche-development process.

Often, *the protective measures and competitive incentives are inadequate.* Experiments need to be protected in their early development phase in order to enable learning processes and improvements. Inadequate protection of new technologies and concepts in the innovation process is a typical

reason why experiments fail. Too little protection or phasing it out too soon might mean that the new concept couldn't resist the pressure of the market. On the other hand competitive pressure is a strong incentive for improvement. This implies that there should not be too much protection either, but rather an intelligent balance between protective and competitive mechanisms during niche development.

Participants in an experiment often have *unrealistic expectations about the potential of the experiment* and neglect important *intermediate steps* needed to *adapt* a technology to a market context. Experiments should neither pursue too ambitious goals nor insignificant achievements. Modular projects with consecutive development stages could be a promising strategy to consolidate achievements and review/change the strategy in the light of experience gained. Flexibility, willingness to learn from experience and to improve the technology or concept is necessary during the whole project.

Isolated experiments are repeatedly not complemented by a *strategy of expanding them into market niches*. The interconnection and extension of experiments to niches is the crucial phase for a new technology as many conditions change relative to the original small-scale experiment. The requirements for the concept change as it moves from pioneer users to a wider public with more rigorous demands. Structural incompatibilities with the institutional and political framework may also prevent wider uptake.

Sometimes the *institutional and regulatory framework is not modified* to facilitate the diffusion of the new technology or concept. In many cases in the past innovative technological solutions could not prevail as a result of unfavourable institutional, political, social and economic framework conditions. The dominant technologies are usually well adjusted to the framework conditions, and thus implicitly "protected". In the long run, new niche technologies can only achieve a significant market share and an economy of scale if unfavourable framework conditions are modified to facilitate their uptake.

Strategic Niche Management

Using experience gained through a number of demonstration projects, a new approach to the management of the process of introducing sustainable transport technology and concepts has been developed recently under the name 'Strategic Niche Management' (SNM, Kemp/Schot/Hoogma 1998). Although the focus is here on the application of SNM to transport, it could obviously also be applied in other technological areas.

Strategic Niche Management addresses the introduction and diffusion process in terms of *both* its technological aspects *and* its socio-economic context. Special attention is paid to the building up of support networks; changes required in the institutional framework for mobility provision; and, facilitating social and technological learning processes geared towards the needs of final users *and* the longer-term objectives for sustainable mobility. SNM aims to incorporate the interests of all the different stakeholders essential to the success of a niche development process by development of a *network of supporting actors*. Special attention is paid to the requirements of future users as the stakeholder group, which finally decides the success or failure of a technology. In addition, the opinion of indirectly involved groups is taken into account to anticipate and abate opposition. Organized interaction, e.g. in the form of workshops among all players, is a substantial component of SNM because it facilitates the

Strategic Niche Management is a way of looking at technology uptake which addresses the introduction and diffusion process in terms of both its technological aspects and its socio-economic context

articulation of needs and interests, and thus enables a learning process to take place. Looking beyond technological improvements, which are only one of a number of factors concerning mobility-related problems, SNM tries to establish a shared understanding of the expectations of stakeholders and to assess and improve the long-term development potential of a new technology.

Strategic Niche Management can be described in terms of five overlapping phases

Strategic Niche Management can be described in terms of five overlapping phases, all of which are crucial to the success of an experiment-based niche development process (Table 1). These phases are characterized by different trade-offs and dilemmas which ought to be taken into account carefully when managing a niche development process. They could bring a new technology or concept from an isolated experiment to the level of a significant niche, and in the longer term contribute to a change of the dominant paradigm of the transport system.

SNM tries to bring together the top down approach to the institutional and organizational framework with bottom up support for technological innovation

Strategic Niche Management views the uptake of new technologies as requiring more than just top-down regulations and policies. Nor are networking and learning processes always sufficient to bring about successful market introduction. SNM relies much more than traditional technology policy on a combination of cooperative support strategies for technology innovation and diffusion processes (the "bottom-up element") with adjustments of the institutional and organizational framework for mobility provision (the "top-down element").

For example, the very successful car-sharing initiative in Switzerland was initially a "grassroots" movement, but it got an initial major boost by the establishment of a professionalized carrier organization, and a second boost when the public transport operator in Zürich agreed to cooperate with car-sharing (see Box 2). In the case of the Mendrisio experiment the organizers kept technological options open enough to avoid an early locking in on the wrong track and were able to stimulate fruitful competition among them within the protected environment of the project.

SNM is thus neither a technology-push nor a demand-pull approach. Rather it suggests a combined strategy, balancing learning about user needs and technical possibilities on the one hand with the creation of support and structural adaptations on the other. However, it is often difficult to convince decision-makers of the usefulness of changing established framework conditions. If an experiment proves to be promising and finds widespread support, there can indeed be enough pressure to convince decision-makers to attempt changes in the framework conditions and thus to move towards a more sustainable transport regime. This is the point at which public policy-making comes into play.

Policy conclusions

The lessons to be drawn from the SNM-perspective and the underlying experiences can be used first of all to guide the set-up and implementation of experiments. They are thus an input for individuals or organizations seeking to promote the uptake of new technologies (e.g. government agencies). But they can also be used by industrial or private actors who could benefit as users or suppliers of the new technology. The insights from SNM can also help optimize the design of programmes for technology development and diffusion, and help to adjust the regulatory and policy framework to support the stabilization of new transport technology niches. The advantage of SNM is that the concept can be applied beyond transport to any process of technical or organizational innovations. SNM is therefore of equal interest to industry introducing new products on the market; technology policy makers supporting innovation and industrial competitiveness; transport operators

Table 1. Overview of the dilemmas and trade-offs in the Strategic Niche Management process of mobility innovations

Phases of an SNM-Process	Basic dilemmas and trade-offs: Some key lessons
Identifying a new concept	(1) Consider technologies or concepts which are as close as possible to the current regime, but which offer the potential to induce more radical changes later on. (2) Seek to keep a number of options open; therefore phase your experiments and organize them in modules in order to avoid their becoming too complex.
Designing an experiment	(3) Keep the experiment sufficiently broad in terms of partners (users, suppliers, government, operators) and have committed partners in the team. (4) A successful experiment is not necessarily conducive to niche formation; a failed experiment can still be very instructive. (5) Try to avoid over-protection and explore which types of market pressure could already be implemented in the experiment. (6) Create opportunities for the active involvement of users in the experiment to learn about their needs.
Implementing an experiment	(7) Create opportunities for discussing results of the experiment with indirectly affected groups. (8) Monitor the tacit and implicit expectations and visions of the participants and try to articulate them clearly. (9) Seek broad coverage of opportunities for learning about new implications of a technology. (10) Think about currently established mobility patterns and the changes which the new technology/concept may bring about.
Expanding an experiment to a niche	(11) Be aware of changing requirements in terms of network structure in the course of the progress and scaling-up of the experiment. (12) Consider which kinds of complementary policies could be conducive, necessary or detrimental to the niche technology/concept. (13) Look for opportunities to replicate an experiment and try to keep the accumulated experience available in the network. (14) The technology or concept needs to be adapted to mass users when the niche is growing.
Review of the protection of an experiment	(15) Seek to establish smart ways of protecting an experiment. (16) Seek to establish productive and smart ways of protecting a niche within the prevailing transport framework. (17) When phasing out a niche development process, try to enlist the established network into the development of other options for addressing similar problems.

Source: Weber, M. et al. (1998)

SNM is applicable to other technologies outside of the domain of transport and mobility

aiming at innovative solutions; and, local authorities trying to move the transport system towards sustainable mobility.

SNM puts emphasis on understanding social needs, bottom-up network development processes, and learning from stakeholder feedback. However, it also points out where potential points of intervention for policy makers lie. The adjustment of institutional, political, organizational and regulatory framework conditions to guide the niche expansion of new technologies and concepts clearly falls within the responsibilities of public authorities. By funding selected technologies in their R&D stage, policy makers also cooperate with industry and stakeholders at the level of experiments.

Policy makers are generally confronted in SNM with the necessity to find a balance between different alternatives. A balance needs to be found in the following areas:

- *Protection versus competition.* The right mixture of protective mechanisms and competitive pressure is the key for successful market introduction. In particular the phasing out of support at the end of the market introduction needs careful attention and a kind of exit strategy to avoid excessive attachment to an unsuccessful technology.
- *Top-down versus bottom-up project management.* Both approaches should complement and not compete with each other. A combination of bottom–up assessment of stakeholders' needs during the early stages of innovation with more top-down management of the later stages of the diffusion process (scaling up of experiments and regime shift) seems appropriate.
- *Incremental versus radical innovations.* A technology deviating too much from the existing regime only has a slim chance of being successful because it would imply too radical a change of user behaviour. On the

Box 2. The car-sharing niche in Europe and the importance of organisational and institutional adjustments

Car sharing initiatives have emerged in several European countries in the last years. Originally regarded by many as little more than grassroots movements, they have in some cases transformed themselves into highly professionalized services. *Mobility*, the merger of the two older car-sharing initiatives in Switzerland is now an organisation with nearly 20,000 members with close to 1000 cars. Its success was partly due to the foundation of a highly professionalized organization and the introduction of an electronic reservation system, but in the early phase of development it relied heavily of enthusiastic support by its members, too. Since the quality of car-sharing is now widely recognized, even the public transport operator in Zürich has entered into a co-operation agreement with *Mobility*. The Swiss example has recently found followers in Austria where a similar organization is being set up. In Germany, car-sharing initiatives are more scattered across the country, but in Berlin in particular a successful and professional scheme has emerged. The Dutch examples may be less advanced than in Switzerland, but it is also a quite successful service. Government has played a more prominent role in its early establishment and promoted the creation of a carrier organization.

Source: Harms/Truffer 1998b

other hand, only minor modifications cannot achieve the long-term goal of sustainable mobility. Even in the case of incremental changes the long term goal of sustainable mobility has to be kept in mind and be integrated in the policy framework.

- *Range of technical alternatives covered by the experiment.* Focusing efforts on one option reduces costs and increases efficiency but entails the risk of getting locked in on the wrong track. A broad range of alternatives allows flexible adaptation of the experiment but endangers it by complicated organisation and lack of focus.
- *Balance between all kinds of options.* Support should not be concentrated only to technological improvements. Technological and complementary organizational and institutional innovations need to be combined in an intelligent way.
- Balance between *R&D funding* versus support of *market introduction* (timing of support measures). The rapid pace of the innovation process demands prospective technology support be given to policy makers so they can foresee emerging technological changes and perceive the right moment for an experiment. Money spent for the market introduction of a technology will not be available for R&D of the next innovation step. Limited resources mean demonstration projects have to be selected carefully. SNM cannot replace R&D activities, but rather seeks to enhance the efficiency of early stages of the diffusion process of technologies.

In general terms, transport technology policy programmes should place more emphasis on the establishment of niches in the early diffusion process of new technologies and concepts rather than to support for R&D in the narrow sense. This does not negate the need for technical research, but argues for closer integration of development work and social learning until the new technologies have stabilized. At least, this would reduce the risk of ending up with technologies which nobody wants.

These issues could become important in the implementation of the Fifth Framework Programme, aiming as it does to establish a closer link between technical and socio-economic research. R&D projects could be exploited more efficiently, if they are monitored with regard to the associated social and networking patterns underlying the introduction process of new transport technologies and concepts. In principle, technology-based demonstration projects or research programmes could even be evaluated on the basis of criteria derived from the SNM-perspective.

In general, transport technology policy programmes should concentrate not so much on the basic technology research as creating and developing niches in order for them to gain a foothold

About the authors

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Keywords

strategic niche management, technology diffusion, sustainable mobility

Endnote

The perspective and findings reported here are based on work done under the DG XII-co-funded project on "Strategic Niche Management as a Tool for Transition to a Sustainable Transportation System" and the associated ESTO-project on "Strategic Management of Sustainable Transport Innovations" (**http://www.jrc.es/projects/snm**). In June 1998, a conference was organized on this subject in Seville to discuss the concept of SNM with transport operators, manufacturers, researchers and policy-makers. The results of the conference have been integrated in the workbook on Strategic Niche Management (Weber *et al.* 1998).

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Lower Oil Prices: Long-Term Concerns

Balbino Uribe, *University of Granada*, Irving Spiewak, *IPTS* and Antonio Soria, *IPTS*

Issue: Since the beginning of 1998 price volatility of a magnitude unprecedented since 1986 (apart from the Gulf War period) has been apparent in world oil markets. These fluctuations have been accompanied by unusually low oil prices. As a result, incentives to invest in alternatives to OPEC oil have been substantially reduced, and the risks of reduced innovation in energy technology have been greatly increased.

Relevance: The current oil market tensions were apparently triggered by an OPEC decision to increase its oil production ceiling. While it is often argued that competition is growing in the oil market, the recent developments demonstrate that OPEC still holds a dominant position. Oil importing countries are realizing short-term benefits from the low prices, but should carefully consider their long-term energy security requirements, which include alternative fuels and more efficient technologies.

Introduction: long term pricing policies and short term volatility

The process of commoditization of oil has transformed it into negotiable merchandise within transparent international markets and sophisticated deal negotiation mechanisms. After the collapse of the crude market in 1986 official prices of the producing countries were replaced by linked prices tied, through differentials, to the prices of so-called marker crudes, particularly North Sea Brent and US West Texas Intermediate. The international commodity markets are much more volatile than the previous official pricing system. But, their influence in the long run is not as large as might be thought.

The recent sudden changes in the crude market are tied to the fall in prices triggered by a 10% rise in the OPEC production ceiling. It should be borne in mind that OPEC as a whole owns about 75% of the world's proven reserves, but holds only 40% of the market share. It is well known that the commitment of some of the OPEC countries to the agreements on production quotas is rather weak. However, most of the large producing countries seem to be favourable towards restricting their production in order to support prices. Theirs can be considered a long-term perspective.

An important issue is the wide divergence of interests among oil producers both within and outside OPEC. Indeed, there is a difference of more

Since the collapse of official prices in 1986 oil prices have been low, but recently, increasingly volatile

Although OPEC accounts for only 40% of world market share it owns 75% of known reserves, and in particular, the cheapest oil to extract

than an order of magnitude between the ground price (determined by the marginal extraction costs of some of the Gulf countries, about 0.3-0.5 $/barrel) and the marginal costs of competitive producers (for example the North Sea producers, at around $10/barrel). Above this there is a ceiling price, set by the cost of backstop technologies such as shale oil (above $30/barrel), coal liquefaction, or renewables, (above 40 $/bbl). This is two orders of magnitude above the ground price.

Changing expectations, in both the long and short term, may induce large fluctuations within this price window. For example, the Kyoto climate change agreement, Asian financial turmoil, and political tensions in the Gulf, can all produce dramatic changes in the price expectations of the oil commodity markets.

We shall look first at the importance of collusive agreements for the oil market and their role in the stability of recent years, and then analyse the possible future development of stability, bearing in mind that technological advances can help marginal producers to substantially reduce their production costs. Finally, the possible technology policies of oil consuming countries, in response to collusion among the large oil producers, will be discussed.

OPEC has managed to maintain prices relatively stable even during periods of turmoil thanks to its idle capacity. It has now used part of this capacity to up production ceilings

OPEC needs to hold prices artificially high by setting quotas, but in so doing encourages other competitors into the market

Oligopoly, stability and price levels

For several years now, the popular press has looked only at the day-to-day functioning of the market, disregarding -without apparent justification- the background tendencies of the crude oil market. The market stability of the last eleven years, only interrupted during the Gulf crisis, can have induced such an attitude.

It should be remembered that since the collapse of the market in 1986, OPEC has proclaimed itself to be the protector of stability (Subroto, 1994). It has avoided the mistakes of the 70s and early 80s, when tensions in the market were habitual. The commercial instruments the organization uses to serve its stability strategy throughout this period been the price link (commoditization of oil) and the maintenance of considerable idle capacity by the large producers (Yamani, 1992). This idle capacity allows OPEC to achieve considerable increases in output rapidly, for example so as to compensate for interruptions in supply from Kuwait and Iraq. Now this spare capacity has allowed the organization's ceiling to be increased.

The constancy of the ceiling for five years has come to conceal its importance as a commercial policy instrument and has induced doubts about the market power of OPEC. Forecast of its imminent demise has been anticipated by some (Berg *et al.*, 1997). OPEC member countries themselves have expressed surprise and concern about the intensity of the market response to the recent change to the production ceiling, making clear the structural importance of the limit. The growth of non-OPEC producers and their advanced technology currently put the OPEC member states in a difficult position. They need relatively high oil prices to support their economies in the near-term, but good prices also encourage their competitors in the mid to long-term.

In short, in terms of the long-term evolution of the crude market, what needs to be underlined is that the stability of recent years can be attributed to the presence, from the supply side, of significant idle capacity with which to face situations such as the Gulf War, and (and this is equally important) to the maintain quota/price ceilings within OPEC. The existence of competing producers outside of OPEC, and political and security considerations (such as the role of the US and Iraq in the region) mean OPEC's price

freedom is more limited than it was in the 70s. These non-OPEC countries need to remain competitive – and this will depend on their use of technology to offset higher extraction costs.

World oil market polarization and technological change

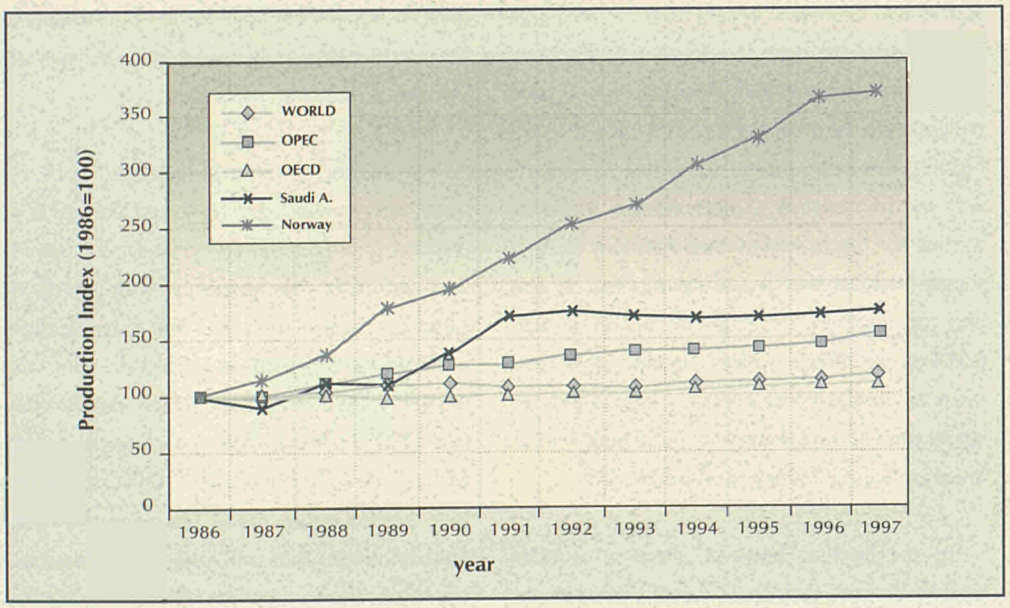
Oil producers have become more or less polarized into two groups: the large-reserve, low-cost producers -mostly within OPEC- and the competitive producers with significantly higher costs –including producer countries in the OECD. The competitive producers, and especially those within the OECD, require continually improved technology to maintain their market share. This includes better tools for oil exploration, horizontal drilling of wells, secondary and tertiary recovery techniques, and deep-sea technology. Of course, the effectiveness of this improved technology is limited by the physical availability of the oil resource, which has been depleted in many of the older fields.

Figure 1 illustrates how percentage increases in oil production since 1986 have occurred largely outside of OPEC (in the competitive producers). However, a closer look at the figure also reveals that OPEC has been increasing its share of the world market during the reported period. The recent downturn in the oil price could spark a considerable increase in demand, especially from the developing countries (Amirahmadi, 1996). This is building up huge, inflexible, demand for oil that will, at some time in the future, be satisfied primarily by OPEC (at a price depending on ceiling imposed by the extraction costs faced by existing or emerging competitors). In view of this it is clear that the world oil market cannot be understood without taking a long time perspective.

A crucial aspect of the energy policies of OECD countries is mitigation of their vulnerability to oil supply fluctuations. The high price of crude during the period 1973-1986 encouraged the exploration and operation of high cost fields, and therefore

World oil production is now broadly split between large, low cost producers mostly within OPEC, and higher cost, high technology producers outside

Figure 1. Time course of output from producers worldwide



Source: Based on BP Statistics (http://www.bp.com/bpstats/)

increased the polarization phenomenon. It is clear that technological advances in the production of oil can reduce the effects of this polarization (but not the polarization itself) and, as a consequence, the temporary energy dependency of the industrialized countries. But, these advances finally create a disincentive to development in other technological sectors, particularly for substitution and conservation (Orasch *et al.*, 1997). In fact, there is negative feedback influencing the shape of oil prices over the long term (Uribe, 1997).

Expectations about future trends become self-fulfilling prophecies as producers let more or less oil onto the market accordingly

In the medium term, if the production capacity is reduced as consequence of technological cycle exhaustion (indeed, according to an autonomous technological evolution model the fall in marginal costs would be transient (Campbell *et al.* 1998), new supply restriction shocks cannot be ruled out - confirming the cyclical movement of oil prices characteristic of their history. Moreover, in the case of a non-renewable, non-depreciable, single-use resource, such as oil, the development of proven reserves are influenced via positive, destabilizing feedback from price signals and, particularly, from price expectations. Indeed, if lower prices are expected, production will be accelerated in order to benefit from the (still) high prices and anticipate the price fall, therefore flooding the market and inducing a real price collapse. On the other hand, if expectations are of higher prices in the future, the owners of deposits will try to maintain greater reserve volumes, waiting for higher prices, and therefore cause a supply shortage that would raise prices. In one way or another, expectations create a self-fulfilling prophecy, unless urgent, short-term financial requirements prevail. These trends go some way to explaining the oscillating and at times convulsive history of oil prices.

Large producers have several reasons to allow prices to drop in the medium term. Among these is defending the market for oil against conservation technologies and energy substitution

At the present, however, there is a major worldwide issue that could partially mitigate the consequences of the polarization process: the climate change threat. This can be viewed as an opportunity to bring energy efficiency closer to long-term economic efficiency (Gunn, 1997), and the Kyoto protocol may act as a stimulus in that direction. The internalization of the environmental costs of the use of fossil energy would reduce the threat of the oil shocks, since it can promote technological advances that would make oil reserves last longer. Energy vulnerability and climatic vulnerability can both be reduced by the same policies favouring alternative technology.

Large producer collusive strategies

At present, the relative abundance of reserves and the diminishing marginal costs induce the large producers to let prices fall so as to avoid long term penalties. This can be of interest to them for several reasons: (a) to impose discipline within the cartel and enforce production reduction agreements with countries outside of OPEC; (b) to expel part of the production of high cost countries from the market; (c) to encourage substitution of other energies by oil; and (d) to discourage technological investments in oil conservation and production of other energies. As may be seen, most of these reasons relate to a long term policy, and one which is especially valuable to the large producers.

The strategic importance climatic change avoidance policies for the future course of oil demand is not lost on OPEC leaders, as may be deduced from the frequency with which the subject comes up in the organization's publications. This issue is termed *demand safety* (Yergin, 1992), in contrast to the *supply safety*, that OPEC claims to have guaranteed since the end of the oil shock years. OPEC complains that carbon-taxes could increase the fiscal discrimination that oil suffers in developed countries relative to other fossil energy sources. The imminence of the Kyoto conference could be

one of the reasons for the increase in the OPEC production ceiling in November 1997. OPEC intended to show the difficulty of reducing oil demand, since the ceiling increase can make the price of oil very competitive compared with other energies. Although to some extent it was overtaken by events in both Asia and the Middle East, we should not underestimate the power of these collusive instruments.

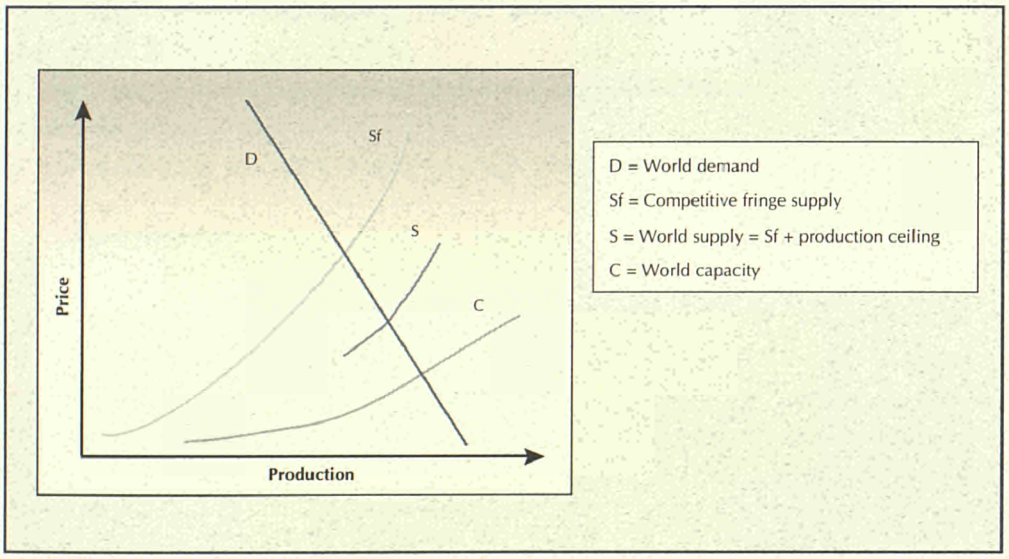
Oil demand exhibits price inelasticity in the short term (and its progressive concentration in the transport sector means this has not decreased in the recent years (Greene *et al.*, 1988), but considerable price elasticity in the long term (Jones, 1996). This provides the basis for collusive agreements – within the limits set by demand and supply from the competitive fringe (Figure 2). In the long run, however, the downward pressure on prices caused by shrinking demand and technological advances in the conservation and the production of oil can lead (as they have done) to a loss of market share for the countries that are a party to the collusive agreement. Nevertheless, this downward pressure on prices may (also in the long run), reduce the operating margin of high cost fields (typically operated in the competitive market fringe), and therefore reinforce the position of the cartel, with its low marginal costs and large reserves. Indeed, current low prices are causing problems for numerous producer countries, which are experiencing an alarming reduction in their oil revenues.

Although it may seem difficult to reconcile the objectives of different large producers within OPEC, this has in fact been possible, even during times of tension such as the Iran-Iraq war, though, again, one should not lose sight of the different security considerations since the Gulf war.

Obviously, the relationship of OPEC with foreign producers also varies. Some of these countries, such as Mexico, have been very close to the Organization since 1986; others such as Norway, have kept their distance. However, a warning shot, such as raising the OPEC production ceiling, is all that is needed for many of them to

A downturn in oil prices may hurt large producers in the short term, but if they drive higher cost producers out of the market they can expect long term gains

Figure 2. Crude price formation in the short term



Source: Uribe, 1997

accept the collusive arrangements. The motive for limiting their production is that they are obliged to do so in order to avoid more serious problems, such as a steep fall in prices. Even Norway, which is strongly opposed to these agreements, has sometimes felt obliged to acquiesce.

Conclusion

OPEC's strategy of maintaining stability by means of significant idle capacity and a production ceiling continues to dominate the oil market. The power of these collusive instruments was demonstrated by the tensions that were generated by the agreement to increase the ceiling last November.

For several years now decreasing marginal costs worldwide as a result of technology has limited OPEC's ability to raise prices. Nevertheless, the extraordinary distance between the marginal costs of OPEC producers and the competing fringe producers should not be forgotten. The large OPEC producers seem willing to allow lower prices in the expectation of advantages in the long run. These derive from several factors: improved discipline within the cartel, expulsion from the market of high cost producers, the agreement with outside producers, and –particularly noteworthy- the discouragement of investment in technologies for oil conservation and alternative energies.

The foreseeable exhaustion of the technological cycle, the increase in demand and its inelasticity, lead one to think that, in spite of the high level of current reserves, new oil shocks can not be ruled out. To reinforce this, the oil sector is still as tightly bound as ever to geopolitical events.

The energy diversification policies and the collaboration between oil-related sectors in the producer and consumer countries are advisable to prevent future shocks. The implementation of policies to combat climate change are also especially important in this respect, by its stimulus on technological change in oil conservation. What is crucial from the technological viewpoint is (a) continued emphasis on arch into renewables, regardless of low oil prices; and (b) cost-reducing innovation for non-OPEC producers (e.g. for locating and extracting reserves) so that the costs of entering and leaving the market are reduced, in order to block any attempt to use predatory pricing to exploit cartel positions.

The oil-sector is still tightly bound to geopolitical events and a long run of steady prices is no reason for complacency about the possibility of future shocks

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Keywords
oil prices, world oil market, energy security, climate change

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Cooperation between Southern-Eastern Mediterranean countries and the EU: The renewable energy sector

Miquel A. Aguado-Monsonet, *IPTS*

Issue: Renewable energy technologies are becoming more widespread in southern Mediterranean countries, thanks to developed countries' cooperation programmes and international aid. However, it is still not clear what is the best way for programmes to meet real renewable energy needs.

Relevance: The European Community Development Programme has begun to focus on the question of how it may develop after the year 2000. The outcome will depend particularly on two processes: the expiry of the Edinburgh principles on the EC budget (1999) and the revision of the Lomé Convention (February 2000). Decision makers need to be informed by considerations regarding the most effective cooperation strategies.

The Mediterranean region and the European Union

Although not a major partner in terms of trade, non-EU Mediterranean (SEM) countries are a priority target for cooperation programmes, absorbing around 25% of the total EU budget for cooperation programmes.

The **main areas of cooperation** with SEM countries can be extracted from the Council resolutions taken between 1992 and 1997. Listed in order of importance, these are coordination and coherence, health, food aid, the fight against poverty, population control, education, and social policy. In the same vein, the main areas of cooperation identified by the World Bank, United Nation Development Programme, and the European Union (1997) in the SEM countries are summarized in Table 1.

Since 1995, Community cooperation with the Mediterranean region has been channelled within the framework of the Barcelona Declaration for a Euro-Mediterranean partnership. This defined the MEDA programme, which represents the starting point of the cooperation system with all south-eastern Mediterranean (SEM) countries. The countries included in that declaration, and consequently that can access MEDA funds are Algeria, Cyprus, Egypt, Israel, Jordan, Lebanon, Malta, Morocco, Palestine, Syria, Tunisia and Turkey.

The average annual commitment for the MEDA programme over the last years has been 800 millions ECU. However, the 1997 and 1998

Table 1. Main areas of cooperation with non-EU Mediterranean countries (Cheru; Worldbank)

Country	Priority areas identified for international cooperation
Morocco	Health, education, agriculture, water and sanitation, National Program for Poverty Reduction, Education, Representation, Poverty Alleviation, Social Fund, Social Welfare
Egypt	Economic Reform/Management, Public Enterprises, Tourism
Lebanon	Reform of the Ministry of Finance to perform its fiscal policy role
Syria	Environment, Supply-Side Efficiency and Energy Conservation and Planning
Mediterranean region	Reduce the effects of environmental degradation
Global Program	Water and Sanitation Program from GEF

MEDA budget has been increased to 1,100 MECU. That figure has been only surpassed by the cooperation funds addressed to CEEC and CIS countries. The financial perspectives of external actions for this year (EC budget) and estimates of appropriations for the European Development Fund (EDF) are expected to increase for the MEDA programme.

Table 1 would seem to suggest that cooperation on energy issues is not considered a strategically important area, and the same phenomenon can be detected when the World Bank and other International funds are analysed. The cooperation programmes between the SEM and the EU-15 countries in the energy field normally take the form of commercial transactions between the energy utilities from the north and the south. The energy interconnection between the two sides of the Mediterranean sea has been the most important cooperation issue in recent years. For instance, the projects for the electrical connection between Greece-Turkey and Turkey-Israel, the electrical connection already established between Italy and Tunisia, the gas pipeline between Algeria and Spain and the electrical connection between Morocco and Spain are some of the business-oriented energy projects linking both sides of the Mediterranean. However, there is also a pressing need to provide the population in SEM countries with electricity.

Cooperation on energy issues with countries on the other side of the Mediterranean may not appear high on the stated list of EU priorities, but a number of important projects have already been undertaken

Electricity sector in southern-eastern Mediterranean countries

Electricity is provided by a state-owned monopoly in all of the south-eastern Mediterranean (SEM) countries, and in each there is a need to extend the network to reach the whole population. In some countries the rate of electrification needs to be very high if governments are to satisfy the increasing electricity demands from a growing population and/or to increase of the general welfare of the population. With the exception of Israel and Algeria, a tremendous economic effort is needed for these countries to bring electricity to the whole population. Turkey, Lebanon, Egypt and Jordan are the countries that need to make the greatest economic effort (in terms of

Most south-eastern Mediterranean (SEM) countries are facing pressing needs to extend electricity supply to large sections of the population

Table 2. Current State of Electricity Supply and Predicted Future Demand in SEM Countries

Morocco's electricity generating capacity in 1997 was 3,750 MW. Analysts predict that an additional 2,000 MW capacity will need to be installed by 2010. Morocco is arguably the leading SEM country in its commitment to encouraging private power. 92% of the country's energy supply has to be imported. The rural electrification rate is low and a major programme (PERG) is underway to rapidly expand rural electrification.

Algeria is almost alone among SMC countries in that its early 1998 generating capacity of 5,300 MW provided it with a comfortable generating surplus. In the late 1980s and the 1990s this meant it could sell off excess power production to Morocco and Tunisia. This being the case, it is highly unlikely that much new capacity will be constructed before 2000, even allowing for the retirement of several hundred megawatts of older generating plant. The current mainstays of the Algerian electricity network are gas-powered power plants. Although Algeria also uses alternative sources for generating electricity.

Egypt's installed electricity generation capacity in early 1998 stood at about 14,600 MW. (20% Hydro). While supply was generally plentiful, planners still foresaw the need for annual increments of about 5% in supply capacity to keep up with demand over the period 1998-2010. Egypt has traditionally used a wide variety of methods to finance its new electricity infrastructure. Particularly in the 1980s it made liberal use of cheap financing from both the World Bank and USAID. It also borrowed heavily from the African Development Bank and, after 1989 (when political relations were re-established with Saudi Arabia), it used Arab development funds from Gulf countries. Finally, Egypt was also able to call upon non-Arab bilateral development funds, especially those from Japan, Germany, France and the UK.

Due to a combination of historical reasons and the absence of fossil fuel resources the **Palestinian Authority** has to import energy from Israel. According to the Palestine Energy Research Centre, per capita electricity consumption will increase by 10% per year after 1998. The annual electricity demand has reached the 1354 GWh. About 140 villages still suffer from either the absence of electrical services or interrupted supply. People living in these villages account for 13% of the total Palestinian population (4.5% are without electricity and 8.5% have partial electricity (8 hours per day) using small Diesel generators).

Israeli fossil resources are fairly scarce and almost all energy supply has to be imported. Solar energy in Israel is mostly used for residential water heating, and is equivalent to about 2-3% of total electricity consumption. Wind energy resources are very limited.

Turkish electricity demand rose by 11.8% in 1996 compared with the previous year, the highest growth rate in the world. Turkey is likely to spend about $70bn in the period 1998-2010 for this infrastructure –enough to triple current capacity. An important question facing the Turkish electricity industry in early 1998 concerned the prospects for electricity privatisation. If privatisation legislation were passed, incentives for locally generated investment to finance new electricity infrastructure would be substantially increased. However, for political reasons, the chances of this happening at any time before the end of the decade seem remote. BOT (Build Operate Transfer) would probably remain the preferred option for financing new electricity infrastructure in Turkey over the period 1998-2010, provided that the prevailing legislative obstacles are removed. Turkey has significant hydraulic resources.

infrastructure cost for the electrification divided by GNP) to build new electricity infrastructure. Estimates from the *World Bank* and *The Financial Times* show that around 110 billion ECU are needed for the next ten years to electrify the region. Nevertheless, as the table below shows, the electricity sector is not the same situation in all the SEM countries.

Renewable energies in the non-European Mediterranean countries

The increasing use of renewable energies (REs) in the Mediterranean region is fully consistent with most scenarios of social and economic development in the region and this will continue over the coming decades. A rapidly expanding energy market together with major changes in the structure of the energy sector is a trend that can only continue to increase as European Union markets and those of the southern Mediterranean become more and more integrated. These two elements offer themselves considerable opportunities for renewable energies, and it will be up to the industry to seize them. Using renewable energy sources has local, regional and global advantages.

SEM countries have the common characteristic of high levels of solar radiation (4 to 6 kWh/m^2/day). The wind resources are also extensive, sites with good wind resources being available in almost all the countries. Thus, given the scarcity of fossil resources in some of the SEM countries, and their social and environmental benefits, renewable energies are ideally placed to meet their growing demand at local, regional and national levels. Aware of these factors, the European Commission is promoting renewable technologies strongly inside and outside of the Union. Both UNESCO and the EC have detected a number of projects or programmes in the field applicable to these countries.

Nevertheless, renewable energies have not generally been taken into account in electrification plans in these countries. RE technologies are considered to be a possible solution in those national electrification plans where the electricity grid is not scheduled to reach outlying areas within the next ten years. In those cases, renewable energies can be considered as an option for electrification. Table 3 summarizes the renewable energy plans implemented or to be implemented in the near future in some SEM countries.

The cooperation projects or programmes between the EU and the SEM countries in the renewable energies sector are small in relation to the potential of the region. The most widespread technology across the region is solar energy. The main reason for this is that it is modular and so more affordable for the cooperation funds. Wind energy has very good opportunities in specific locations but is not widespread. Biomass and solar thermal technologies are less popular as a result of technical problems or difficulties in adapting them to the region. However, the potential for rural electrification is enormous considering both the expected increase in the population and the potential for increasing the welfare of the population.

Nevertheless, the record of disseminating RE technologies into rural areas in SEM countries has not been particularly good. The main reason has been the lack of infrastructure support, as the systems are mainly beyond the capabilities of local commercial operators. This support includes training local technicians and entrepreneurs, research and development of new products, marketing, financing and credit schemes, education and networking. As a result, it has not been possible to develop well-targeted projects, undertake complementary initiatives,

Increasing integration of energy markets on both sides of the Mediterranean will create opportunities for renewable energies as most SEM offer optimal conditions for them

The spread of renewable energies into rural areas in SEM countries has been held back by a lack of infrastructure support

Table 3. Renewable Energy Initiatives in the SEM Countries

The government of **Algeria** has implemented a photovoltaic programme to install solar home systems in remote villages. This project aims to electrify 1,000 households located in 20 villages. Other projects will develop PV power plants to supply electricity to isolated networks now fed by diesel plants. The solar plant, which opened at Melouka in 1985, was reputed to be the largest such plant in the world.
A 50 MW wind power plant is under development at Tetouan (**Morocco**) as an Independent Power Project. Biomass has some potential with the use of agricultural waste and more than 200 sites for minihydro power plants (5 kW to 200 kW) have been identified. A solar thermal plant near Jerada is under study. The rural electrification programme promoted by the government concerns mainly the extension of the electrical grid but deals also with decentralised electrification with renewable energy systems for small and dispersed villages mainly by photovoltaic technology.
In 1978 **Tunisia** launched a national plan to promote renewable energies (RE). A detailed appraisal of the RE resources has been carried out; and has been identified solar and wind resources as the most important. The electricity actors and other organisations concerning rural electrification have carried out several projects related to rural electrification of remote houses with PV.
Since 1980, the **Egyptian** Ministry of Electricity and Energy has formulated a national strategy for the development of renewable energy applications and energy conservation measures. The targets are going to be fulfilled primarily using solar, wind and biomass technologies. Up to 2005 the programme includes 400 MW of wind farms and 300 MW of integrated solar thermal combined cycle plants (with about 15% solar contribution). A 5MW-wind farm is currently in operation using locally-manufactured turbines. The solar photovoltaic programme in Egypt aims to accelerate the introduction of photovoltaics in small villages in remote areas.
Renewable energy activities in **Palestine** are few and far between. Some cooperation initiatives have begun to establish promotion of renewable energies in the Palestinian territory.
Studies are underway to assess wind energy potential in **Turkey**. The geothermal resources are located in the Western Anatolian region and a 15 MW geothermal plant is in operation. The potential for small-scale hydropower is very important, the country having installed capacity of 350 MW. The contribution of renewable energies (excluding hydro) is estimated to reach 100 MW in the year 2000 and 1,000 MW in the year 2020.
A single 5 MWe wind farm is operating at the north of Golan Heights (**Israel**) and there is a plan to add two more wind farms. Israel's electrical utility is considering integrating a solar power plant with the local grid when the technology is economically feasible. Meanwhile, RE technologies are being monitored and field-tested by means of small demonstration plants.
In 1983, the Renewable Energy Research Centre (RERC) was established in **Jordan**. It has the capacity to perform conduct research, development and demonstration projects.

provide close continuous support and respond rapidly to unexpected problems. Local management has brought a number of benefits when compared to similar projects run by large companies. These initiatives normally reduce the costs of operation and administration, increase the payment rates and involve local industries.

It is important to mention that renewable energy technologies are not market competitive with conventional energy technologies. Less developed countries such as SEM countries cannot afford the extra cost, so cooperation aid is essential if these technologies are to become widespread in SEM countries. Consequently, if Europe wants to reinforce its renewable energy industry, solve environmental problems of the Mediterranean area and contribute to reducing the carbon emissions of SEM countries, the funds to promote those energies need to be increased. Reinforcing the multilateral approach of development aid against the national approach may contribute to a better-defined strategy for the diffusion of this kind of technology in the area. This type of cooperation can make more ambitious projects affordable and help make planning more consistent. This aid is quite crucial for the development of a strong and coherent renewable energy market in the SEM countries.

A coherent cooperation programme is essential for a coherent RE market in the Mediterranean area. However, there are a number of obstacles. These include the fact that Member States keep a close control over the European development programme; EC budgets for Development Aid (ODA) have increased rapidly since 1990 and some management problems have appeared as a result; the overall contributions of EU countries to multilateral institutions is being reduced; approximately half of the budgeted funds for development cooperation are not actually spent; Member States do not seriously engage in a process to improve EU aid.

Conclusions

Most southern-eastern Mediterranean countries are interested in the renewable energy technology sector. Successful implementation of renewable energy technology projects is vital for countries that are trying to create the infrastructure necessary to sustain economic development.

Approaches to encouraging the widespread uptake of renewable energy systems vary greatly depending upon the technology and organizations involved. But from the lessons learned from renewable energy projects in the region we can highlight the following:

- Stakeholder participation is beneficial in tailoring a technology to the demand environment. In addition, costs may be reduced through mobilization of local resources and expertise and increasing participation often raises local levels of responsibility and commitment.
- Well-planned, well-assessed proposals should give a higher project success rate, encourage proposals of a similar calibre lower financial and other barriers. It is also important not to debase the delivered energy service by offering free gifts. Consumers will resist purchasing goods when others have received theirs free, and the lack of intrinsic value would hamper the establishment of important second-hand markets.
- Funding bodies may be bilateral or multilateral aid organizations. Ideally, their programmes need to be independent of day-to-day political involvement whilst remaining compatible with relevant government strategy.
- Provision of basic energy services to communities is a specific niche energy market. In such markets a classic dilemma is the competition for land to provide fuel for energy, a direct cash return, and food. Such conflicts make it difficult to establish a sustainable fuel market. Such schemes are invariably intended to address social or technology transfer rather than economic needs. Targeted incentives are probably necessary but should be planned for phase-out, and payment schemes need to suit customer's cash and credit situations.

The additional capital cost of renewable energies compared with conventional sources makes some form of aid crucial if SEM countries are to adopt them. In addition, a multilateral approach can make more ambitious projects possible

- Rural electrification programmes, which encourage development beyond simple provision of basic energy services, are another niche market. The programme should also aim to encourage local employment, with development of the associated education, training and infrastructure.

The cooperation aid budget in the EC has faced a number of problems. Nevertheless, this aid is crucial for the development of a coherent renewable energy market in the SEM countries. More emphasis should be placed on EC cooperation funds than on national (bilateral) cooperation funds. Multilateral aid funds can afford bigger projects and can focus better on the needs of the countries. The budget spent in multilateral cooperation funds are discussed more thoroughly and consequently can tackle the real problems of those countries better. It is true that more discussion can result in longer implementation times, but the outcome is usually projects for which there is greater agreement between donors and receivers. Another positive aspect is the possibility of defining a strategy for the Mediterranean region. The joint implementation of energy projects in the SEM countries is also another possibility and now seems as very promising strategy for increasing commercial exchanges and involving the industry to cooperate.

About the author

Miquel A. Aguado-Monsonet holds a doctorate in Chemical Engineering from the University of Barcelona, after working as a professor of Chemical and Enviroment Engineering he started work at IPTS on projects related with renewable energies. His main research interests are in the fields of Energy, and Chemical, Environment and Food Engineering, and is currently responsible for the "Implementation of Renewable Energy in the Southern Mediterranean Countries" Project.

Keywords

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The purpose of this work is to support the decision-maker in the management of change pivotally anchored on S/T developments. In this endeavour IPTS enjoys a dual advantage: being a part of the Commission IPTS shares EU goals and priorities; on the other hand it cherishes its research institute neutrality and distance from the intricacies of actual policy-making. This combination allows the IPTS to build bridges betwen EU undertakings, contributing to and co-ordinating the creation of common knowledge bases at the disposal of all stake-holders. Though the work of the IPTS is mainly addressed to the Commission, it also works with decision-makers in the European Parliament, and agencies and institutions in the Member States.

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