THE IPTS REPORT

Produced by IPTS and issued in Cooperation with the European S&T Observatories Network

Environment

- Clean production technologies: figuring out key issues for the future
- Is Europe marketing the recyclability of its products?

Transport

- Combining the wheel with the flywheel?

Biotechnology

- Epic-making advances in genome analysis and their potential impact

Information Technology

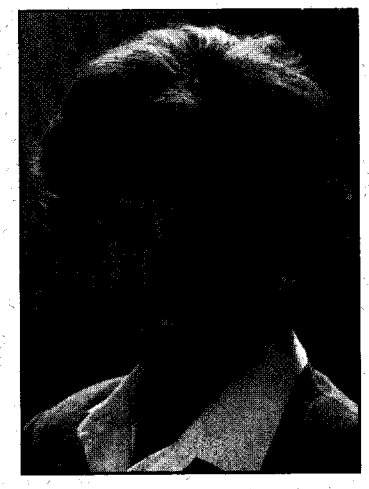
- European and US trends in ATM use: are regulations delaying the introduction of multimedia in Europe?
- Electronic Cash: two sides to the coin
- Rethinking telecommunications infrastructure competition

Nº 00 DECEMBER 1995

European Commission
Directorate-General XII
Science, Research and Development

Joint Research Centre

PREFACE



I welcome this first issue of the monthly IPTS Report on technology watch as a major event in several respects.

First there is the satisfaction of seeing a long-cherished project come to fruition; successive responsibilities have confirmed my belief that information is better shared than guarded.

But there is also the fact that the lack of any real technology watch activity is one of the major weaknesses of European research, in particular since the practice is highly developed among some of our main competitors, such as Japan. Europe urgently needs an effective early warning and rapid response mechanism. That was one of the main aims in setting up the Seville institute. Its function is to collect, process and disseminate among European policy-makers information on recent technological advances and the way in which they are taken into account in Europe and elsewhere, particularly among our major industrial competitors.

The IPTS Report has a crucial contribution to make to this process. It is the first highly visible initiative of the new institute set up under the umbrella of the Joint Research Centre, which in so doing takes up the challenge of dedicating its scientists and engineers to reconnaissance, networking and reporting on the cutting edge of technology.

The monthly frequency of publication will also stimulate internal collaboration.

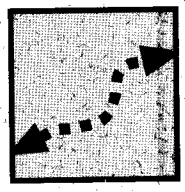
Above all, the Report is a means of achieving a high enough public profile and sufficiently broad scope, to encourage our fellow readers to take part in the exchange of concise, rapid and strategic information.

This networking of intelligence so ardently desired by all policy-makers will not happen overnight. I urged IPTS director H. J. Allgeier to disseminate the Report from the outset in four languages to a readership which, albeit diverse[1], is vital to the day-to-day conduct of our Community activity. In doing so my aim is to ensure that, in a context of ever faster technological change, we all come to depend on it to fire the imagination, alert us to change and keep our activities in perspective.

Ehrenson

1 Including not only decision-makers at the Commission, but also the Council, the European Parliament, expert committees such as IRDAC and CREST, the scientific consultants to the permanent representations, the industry and research ministers of the Member States, and European industrial associations and federations - in all, a readership of nearly 3,000 (?) from January 1996.

Combining the Wheel with the Flywheel?



Zero-emission vehicles such as electric vehicles powered by electrochemical batteries, do not at present offer a completely satisfactory performance in terms of range and acceleration, and therefore might not be fully embraced by the consumer. Modern flywheels can be considered as an alternative/complementary electromechanical energy storage device. Recent developments using modern composite materials have resulted in devices that may outperform batteries in certain ways, and offer a particularly high power density which is comparable to - or even better than - that of the internal combustion engine. Thus flywheel powering should help greatly consumer acceptance of the electric car. Even though the performance of flywheels has been proven in laboratory tests, their commercial exploitation may require greater focus on, and support for R&D effort in this field.

At present the growth of individual transport is overwhelmingly dominated by vehicles powered by the internal combustion engine (ICE), and this is causing increasing environmental concern. In the future, zero emission or ultra low emission vehicles (ZEV or ULEV, respectively), such as battery-powered electric or hybrid vehicles (in the sense of multi-source power generation), are projected to replace standard internal combustion engine cars as far as possible, at least in urban areas. Previous pilot experiments have demonstrated that acceptance of this new type of vehicle (ZEV or ULEV) will depend largely on the extent to which it can meet those customer needs that the ICE-powered car presently satisfies. These are related in particular to range and acceleration - which themselves are a factor of the energy and power density - as well as to the cost of the alternative power source.

Overcoming range and acceleration limitations

Present electric vehicles (EVs), are mostly powered by electrochemical batteries and suffer from low range and limited acceleration because of the limited energy and power densities offered by today's batteries. Even a future generation of batteries, whose goals are defined by the (perhaps over-optimistic) long term objectives of the US ABC-programme, would not result in a vehicle with performance similar to present ICE cars (Figure 1).

In order to overcome this difficulty, present efforts are aimed at developing a hybrid vehicle, which is an electric vehicle combined with a small internal combustion engine. While the range (energy density related) problem would clearly be eased, lack of acceleration, due to the low power density of the chemical batteries, would still pose a major problem with regard to user acceptance.

Urgent need for low emission vehicles ...

... but in acceleration and range internal combustion engines are hard to beat

J. Naegele, E-mail: jochen.naegele@jrc.es. P. Canarelli, E-mail: patrick.canarelli@jrc.es

even the internal combustion engine.
Other flywheel characteristics also appear very attractive. The charging time can be as low as 15 minutes, which can be compared to the many hours required to charge a battery. In addition, its charge / discharge efficiency is greater than 0.9, instead of 0.6 - 0.8 with batteries, and the self-discharge losses are close to 1% per day while battery losses can peak at several percentage points per day.

Safety and costs: surmountable issues

A further advantage is the fact that most of the know-how needed to design and engineer flywheels is already available. Yet some development is needed for production of cost-effective, stronger fibres for the composite materials. In addition to this, further improvements in magnetic bearings, which would lead to better rotor balance, and high performance motor / generators are required.

There are two main drawbacks associated with flywheels: safety and cost. The safety issue is indeed of particular concern, with uncontrolled energy release occurring in cases of accidental rotor failure. Yet this problem is greatly reduced if there is adequate engineering of the rotor and the containment vessel. Setting several small flywheel units in place of a single large one should improve safety as well.

At first glance, the cost issue is dominated by the expensive composite materials (particularly carbon fibre composites) and the flywheel production process itself. Yet this needs to be qualified. Firstly, less expensive high-strength glass fibres are now available, and even the price of carbon fibres is coming down. Furthermore, even though it appears that the production price of flywheels is considerably higher than that of lead acid batteries, the lifetime and the charge / discharge efficiency advantage should result in a price advantage over the battery.

The main vehicular applications that can be imagined for flywheels depend very much on their actual performance. First, because of their strong performance compared with other power sources, flywheels could be used in pure electric vehicles. Due to their higher energy density and efficiency, the projected range for such vehicles could be substantially greater than that of battery powered cars. In addition, user acceptance should be higher because of better acceleration and convenience, due to their large power density and quick recharging time. It is also worth emphasising the importance of the higher charge / discharge efficiency of flywheels compared to that of batteries. Given that it is likely that all electric vehicles will recover braking energy in order to combat the low range problem, simulations have shown that the efficiency advantage alone of a flywheel-powered electric vehicle would achieve double the range of a battery-powered electric vehicle during urban driving.

Safety (like cost) is a concern but is not an insuperable problem

Second, if the energy stored in the vehicle is still too low to provide sufficient range, then flywheels can be employed favourably as the buffer energy and power source for a hybrid vehicle (Figure 2). In this concept, they would be recharged when needed by a small on-board internal combustion engine, allowing large power peaks to be delivered by the flywheels. This would make the vehicle similar, in terms of range, acceleration and pleasure of driving, to the traditional internal combustion engine car. **Finally, the use of flywheels as a buffer source for battery powered electric vehicles, i.e. for satisfying peak power demand, would substantially improve battery durability** and also would allow for efficient braking energy recovery.

Flywheel cost is coming down rapidly due to advances in glass and carbon fibres

J. Naegele, E-mail: jochen.naegele@jrc.es. P. Canarelli, E-mail: patrick.canarelli@jrc.es

substantial advantages over alternative power sources, they deserve serious consideration.
- Among the features offered by the flywheel, the very high power density (and hence higher acceleration) should strongly boost user acceptance of alternative vehicles, and this should help make the mass diffusion of clean cars more likely.
- Today's flywheels need development - rather than basic research - which focuses on taking them out of the laboratory and applying them in the real world.

Keywords

Flywheel, electromechanical battery, energy storage, future car, zero emission vehicle (ZEV), ultra low emission vehicle (ULEV), electric vehicle (EV), hybrid vehicle, market acceptance of EVs, composite materials, defence industry conversion.

Information Sources

• *"Electromechanical battery program at the Lawrence Livermore National Laboratory"*, Post R. F. , Bender D. A. and Meritt B. T., Proceedings of the 29th Intersociety Energy Conversion Engineering Conference, Monterey, CA, USA, 7 - 12 August 1994.
• "*Technology assessments of advanced energy storage systems for electric and hybrid vehicles*", US Department of Energy Report, No. DOE/CE/50337-T1, 30 April 1993.
• "*Flywheel energy storage technology workshop*", Oak Ridge National Laboratory / DOE, Oak Ridge, TN, USA, 2 - 4 November 1993.
• "*Hybridantriebe mit Schwungradenergiespeicher*" - ("*Flywheel Hybrid Power Source*"), J. W. Biermann, ÖZE, Jg. 32, HEFT 9, pp 331 - 336, 1979.
• *"Flytech"*, BRITE EURAM III, proposal BE 95 - 1616, 1995

Authors & Contact

Jochen Naegele, Tel.: (+34-5) 44 88 265; Fax: (+34-5) 44 88 339. E-mail: jochen.naegele@jrc.es ;
Patrick Canarelli, Tel.(+34-5) 44 88 303; Fax: (+34-5) 44 88 339. E-mail: patrick.canarelli@jrc.es

An ATM network can support many types of service which may come into any of the four categories: (i) loss-sensitive, delay-sensitive, (ii) loss-insensitive, delay-sensitive, (iii) loss-sensitive, delay-insensitive, and (iv) loss-insensitive, delay-insensitive. It can further reserve and allocate a fixed bandwidth for a connection carrying a continuous bit stream for isochronous traffic (repeating in time such as 8khz voice samples), allocate a bandwidth range for a variable bit stream for plesiochronous traffic (i.e. variable frequency signals such as interactive compressed video), as well as allocate no specific amount of bandwidth and rely on statistical sharing among bursty sources. It may also provide multiple priorities in any of the above categories. The services can span the entire range from interactive - such as telephony and online data retrieval - to distributed - such as video and stereo hi-fi broadcasts and multicasts for conferencing and database updates. All specifications concerning ATM are to be found in the ATM user network interface specification (UNI) - version UNI 3.1.

represents a massive investment both in research and development, as well as deployment and integration. On the other hand, the software investment required to make the ATM network work is substantial. Considerable work is also required in developing new network management paradigms and protocols to control and manage effectively the bandwidth and services that the revolution in communication technology promises.

The market by segment

Having presented some of the ATM fundamentals, the next question is the degree to which the market has taken up ATM. The market for ATM-based products and services in business communication may be divided into three segments: Public Network Infrastructure, Local Area Networks (LAN) and Wide Area Networks (WAN). This segmentation is determined by existing market structures, by the rate of new technology deployment and by the regulatory environment.

The **Local Area Network** market segment includes workstations and other workgroup products, adaptors for client/server architectures and other technologies (Fiber Distributed Data Interface, token ring, ethernet, etc.) and backbone products (including those serving a university campus facility). **This market is characterised by a large number of players, many diverse technological solutions and rapid technology innovation.**

The **Wide Area Network** market segment includes enterprise networks operating over leased lines (or, less commonly, a privately-owned infrastructure such as optical fibre) and those provided as virtual private networks by a public network operator. It also includes interworking with other wide-area technologies such as Frame Relay and Packet Switching. This market is characterised by a variety of regulatory regimes which are moving at different speeds towards deregulation. **There are a relatively small number of service providers, with new entrants and the extension of geographic coverage of existing players.**

The **Public Network Infrastructure (PNI)** seg-

ATM market uptake in Europe depends on the market segment...

Alois Frotschnig, E-mail: alois.frotschnig@jrc.es. Dimitrios Kyriakou, E-mail: dimitrios.kyriakou@jrc.es

considered as the first step in this direction. Moreover, data private networks play a large role in Europe and will heavily rely on what value added service providers can offer.

Time-lag of 6 to 18 months in ATM Local Area Networks

Finally, the main feature of any comparison between the European and US Local Area Network markets is their similarity. The major differentiating factor is the time-lag of 6 to 18 months displayed by the European market. But in terms of technology, applications, user demands and expectations the two markets track each other remarkably closely.

CONCLUSIONS

From a product point of view, apart from the physical interfaces, e.g. 1.5 Mbit/s and 45 Mbit/s in the US and 2 Mbit/s and 34 Mbit/s in Europe, there are no major differences between the US and Europe. **The competitive nature of the US market has led to the earlier availability, at lower cost, of ATM cell relay services.** The emergence of alternative service providers in Europe is likely to see the availability of a similar choice of services, although European tariffs may remain higher. However, the differences are related to timing, in many instances. This is particularly true of the LAN market **where the European market can be characterised as lagging behind the US market by 6 to 18 months. The differences in the WAN and Infrastructure markets are created by the differences in the regulatory environment.** As the European market becomes increasingly liberalised and alternatives and cross-border service providers appear, the differences may diminish. **In the short term, the most significant effect is the inflated cost of bandwidth in Europe compared with the US.** This may slow down the development of broadband services and applications in Europe compared with the US.

... it closely tracks the US in the LAN market (6-18 month delay)

... but lags more seriously behind in the WAN market and public infrastructure market,

Keywords

ATM, LAN, WAN, Europe-USA

Information Sources

• Zahir Ebrahim (1992): *A Brief Tutorial on ATM.* A HTML document available at the **URL: http://av.avc.ucl.ac.uk/atm.htm**

• ATM-Forum: *Comparison of European and US Market. Trends in ATM Implementation.* An HTML document prepared by the ATM Forum, European Market Awareness Committee. see **URL: http://www.atmforum.com/atmforum/US_vs_Euro_Mkt_Trends.html**

Author

Alois Frotschnig, Tel.: (+34-5) 44 88 245, E-mail: alois.frotschnig@jrc.es

Contact

Dimitrios Kyriakou, Tel.: (+34-5) 44 88 298; Fax: (+34-5) 44 88 326. E-mail: dimitrios.kyriakou@jrc.es

cash, through a collaborating bank. **This version of i-cash is a form of money-token consisting of strings of ones and zeros, including special 'anti-forgery', 'anti-duplication' substrings.** The absence of the latter activates an alerting mechanism in the 'issuer's' program, when a 'forgery' is encountered. What is crucially different about this scheme is the anonymity it offers. **The identity of the user of these tokens is untraceable - except when a 'forgery' is encountered, in which case the original user can be identified.**

Repercussions for the medium term...

Such developments have clear positive repercussions. They facilitate the growth of business on the Internet, and, more importantly, they **potentially could provide a strong overall boost to business activity**. Using i-cash and a good bookkeeping program anyone can launch a business on the Internet, with substantially fewer regulatory obstacles than in the real (as opposed to the virtual) marketplace. Furthermore, if accepted as a medium of exchange, i-cash could substantially reduce transaction costs by expediting instant settlement of often complex financial obligations.

On the other hand, policymakers need to be alerted not only to the positive effects, but also to the potential headaches which i-cash may cause. Since traffic of strings of digits on the Internet can be very fast, token money can move readily from computer to computer, from jurisdiction to jurisdiction, making it **very hard for tax authorities to assess and tax true taxable income.**

There may be justifiable worries for banks as well. I-cash will undoubtedly initially be regarded with considerable suspicion by many people - as were banknotes, checks and credit-cards when they first were introduced. With i-cash the long process of money abstraction (from banknotes to checks to credit-cards) reaches its purest abstract form. The facilitating effect of i-cash on commerce **may undermine the banks' importance** - and profits - in such transactions, by reducing the role they play and the commissions they charge.

...money abstraction ad extremum

...and the longer term

Money matters

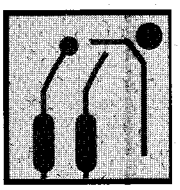
If, furthermore, i-cash develops a good reputation it may start being used as a store of value and not only as a medium of exchange. To achieve this it would need to be convertible into real cash, through the issuer guaranteeing one-to-one correspondence between the amount of i-cash outstanding and real cash kept in the issuer's vaults. In such a scheme i-cash balances would earn no interest, because any interest they earned would have to be 'paid' towards the interest foregone by the 'frozen' real cash backing the outstanding i-cash. Since there could be no interest there could be no lending, and hence i-cash is not a particularly attractive source of income for the banks. In a competitive environment the commissions they could charge on the issuing or conversion of i-cash would have to be very low. It is also true that, due to the difficulty in converting across foreign currencies, i-cash may face limitations in international commerce (or conversely, it may prove an excellent means of conducting black-market operations in foreign exchange).

...for banks

Taking the analysis a step further, **just as the one-to-one correspondence with gold - originally used to back the new banknotes - was eventually interpreted more loosely and lending in cash flourished, so, too, lending in i-cash might develop.** Although this might be good news for the banks, it could

Dimitrios Kyriakou, E-mail: dimitris.kyriakou @ jrc.es

Rethinking Telecommunications Infrastructure Competition



Cost reductions due to technological developments and deregulation are leading to liberalisation of telecoms infrastructure provision - not just competition in the provision of telecoms services. It is the cost of infrastructure - which in turn depends on the state of technology - that will determine the best transitional strategy. The latter may justifiably include a pooling of effort and resources, followed by careful connection charge regulation. The key to the construction of the Multimedia Information Society (MIS) network is to make private enterprise pay for a broadband network (rather than a large number of inadequate narrowband ones) and then, if necessary, regulate interconnection charges during a transitional period, so that no-one is excluded from entering the service provision market. A further consideration may be that public telephone operators (PTOs) can gain from participation in such joint exercises.

Although there is virtually full agreement that telecoms service provision should - and will be - liberalised, the case for telecom infrastructure provision is not as clear, especially with regard to the transitional process during which competing infrastructures will be constructed. "Free-riding behaviour" and incomplete appropriability of profits, as well as uncertainty about project profitability (at least in the short to medium term) do not bode well for fiber optics, ATM (asynchronous transfer mode, advanced switching technologies), and broadbanding. It may be the case that some wealthy firm sees an opportunity to make a certain and timely profit by building the broadband backbone of the Multimedia Information Society (MIS) network. It would then, however, want to operate not as a service retailer but as an infrastructure subletter. It is unclear how the issues of universal service provision, security and prevention of collusion between the service-providing and infrastructure-providing parts of a firm will be resolved.

Crucial observations setting the stage...

It may be that the above scenario is too hypothetical. The time scale for recouping the investment in building the infrastructure may be too long, especially in light of the need for the price of the new 'broadband' service not to be much higher than the tariff for its currently available, more primitive, version (a rule of thumb is that it should be no more than c. 1.5 times higher). Recent empirical evidence from the UK shows that rival newcomers do not set up their own full networks. They may lay certain lines, but they also use those of the existing, established provider, which in most cases cover the entire country.

It can be stated from the very outset that distribution is suffering from falling profit margins, and hence there is pressure to provide new, value-added services. On the other hand, local calls cannot be exploited as a source of revenue, not just for political reasons but also be-

Technology drives costs down but... ... the transition phase in liberalisation is critical

Reluctance to undertake possibly unprofitable investment...

Dimitrios Kyriakou, E-mail: dimitris.kyriakou @ jrc.es

ABOUT IPTS

The IPTS is one of the eight institutes of the Joint Research Centre. Its specificity is the observation and follow up of technological change in the broad sense, in order to get a better understanding of its links with economy and society. IPTS develops methodology to carry out this task with scientific rigor starting with technologies in the fields of energy, environment, information technology, biotechnologies and materials, and gradually covering all technology fields. At the same time the institute carries out research to improve the understanding of the impact of new technologies and their benefits and more generally the relationship between technology, economy and society.

The IPTS' competitive edge is to be neutral while being totally pervaded by the EU philosophy and fully aware of EU policies and actions. This allows for the creation of bridges between the different fields of EU action and to contribute to the creation of a common knowledge base at the disposal of all stakeholders.

The purpose of this work is not scientific pursuit in itself. The Institute aims to support the decision-maker in the management of change whenever science and technology have an important role to play.

The main client for IPTS' work is the Commission. First, the Commissioner for Science and Technology, but more generally the Commission as a whole. The Commission and the Commissioners are to be seen as the strategic nerve centre of the European decision making process, as a centre of management of change, not of problems of subsidiary interests, but of problems of key importance to our society as a whole, problems that call for decisions which have to be taken at a European level, complementing those to be taken a national level.

Hence, indirectly, the clients of the IPTS are those concerned with preparing the initiatives to manage change - the Commission services - those concerned with the decision process itself - the Member States and Parliament- all those concerned by the consequences of any decisions or initiatives and, finally, again those concerned with the management, that is the implementation of such decisions, such as the Commission services, and other agencies and institutions in the Member States.

It is therefore in close cooperation with the decision-maker, that the missions of the institute have been defined as follows:

1. **Technology watch.** This mission should allow for a quick and reliable access to existing technological information, its processing and its diffusion in view of alerting the European decision maker about major events and trends with significant social, economic or political consequences. The Institute will also aim at satisfying the much broader function of a truly European Science and Technology Observatory by means of a network of similar organisations operating at national level. All the interested partners share the responsibility of carrying out technological watch as a "joint venture" in order to be aware of all relevant, significant and outstanding scientific and technological events.

2. **Technology, employment, competitiveness.** Given that employment is one of the major preoccupations of EU institutions and society, the driving force for all IPTS'activities is the compound Technology - Employment - Competitiveness. This entails the identification of promising technologies, and the analysis of their potentials in view of job creation, economic growth and social welfare. Regular synthesis of real experiences and analyses will be produced, highlighting the pros and cons of every option in view of facing needs and problems of the EU. IPTS will therefore undertake prospective studies in specific subjets

European Commission
Directorate General XII - Science, Research And Development
JOINT RESEARCH CENTRE

Institute for
Prospective Technological Studies
Seville
IPTS

Dear reader,

We are pleased to enclose the first issue of a new IPTS publication - the first example of the most visible product of our Technology Watch activities. IPTS is concerned with promoting understanding of the interface between S/T and the socio-economic system. But, as part of the EU Commission Services, we take a European perspective on the issues we tackle. As EU decision-makers are our main target, this report is intended to focus on innovations in S/T, trends and events which call for action or reflection at EU level.

This task is not an easy one, because the interaction between S/T and the system within which it operates is of a complex and multidisciplinary nature. This is why many of the items that you will find in the IPTS report cannot be related to any one specific technological field but rather touch on several fields and overlap considerably with economic, social and - ultimately - political considerations.

Please note that one of our aims is to stimulate debate amongst the parties concerned about the issues we raise. You are therefore invited to send letters to the editor or to get in touch with us by e-mail, letter or fax in order to confirm, contradict or add a new viewpoint to the topics dealt with in this publication.

We are initially launching an introductory phase of the monthly IPTS report, and this will end in July '96. The reason is that this report is intended to be as useful as possible to its readers and we will try to improve it during this learning phase, taking into consideration your expectations. Although we will conduct a readers' survey in our March '96 issue, please feel free to let us know your opinion from the very outset.

Please do not hesitate to contact the authors of the various items or any member of the IPTS staff to discuss any topic of interest or to find out about other IPTS activities.

The ultimate responsibility for the contents of this report lies in the hands of IPTS, but we publicly acknowledge the valuable contribution of our partners in the European Science and Technology Observatory Network (ESTO), without whom this publication would not have been possible.

We hope to add a modest contribution to the current S/T debate in Europe and look forward to hearing from you.

Yours sincerely

H. J. Allgeier

European Commission
Directorate General XII - Science, Research and Development
JOINT RESEARCH CENTRE

the upgrading/broadbanding of the infrastructure at minimal public expense during the transition period. It should be noted that in general a very large part of the costs are civil-engineering costs (digging, etc.). This explains why the use of existing ducts, pylons, etc. is extremely important, and why other utilities controlling such conduits are flirting with joining the telecoms race - some of them using frequencies greater than 1 MHz, at which noise from power lines can be limited. Moreover, developments in mobile telephones and the fact that newcomers do not have to worry about milking every drop out of the existing copper network - as do the public telephone operators (PTOs) who own it - may make them more eager than the PTOs to launch new infrastructure. The possibility of collaborating with other conduit-owning utilities may reduce drastically the civil engineering costs of the exercise; they will then cherrypick the best-paying, broadband-hungriest customers. These considerations suggest that collaboration and pooling may facilitate the transition towards fully competitive markets, and should convince even sceptical PTOs to join in and opt for co-constructing the broadband backbone instead of being left out. If not, then newcomers will indeed be welcome to take the risk and set up their own infrastructure.

...also with regard to high civil engineering costs

Keywords

telecoms infrastructure competition, multimedia, information society, broadbanding, regulation, access, international vs. local competition

Information Sources

• J. Harper's model in Telecommunications Policy , May-June 1995, pp 285-298.

• Conferences on telecoms, multimedia, information society and converging technologies, held in Brussels (June 1995), Geneva (October 1995) as well as internal EU Commission discussions with G. Comyn (DGIII), A. Dumort (DGXIII), G. Metakides (DGIII), A. Jacquemin (DGXII), etc.; comments by D. Neumann (VDI), R. Barre (OST), M. Rader (ITAS-Karlsruhe).

Author & Contact

Dimitrios Kyriakou, Tel.: (+34-5) 44 88 298, Fax: (+34-5) 44 88 326. E-mail : dimitris.kyriakou@jrc.es

The current size of the Global Environmental Market (GEM) is estimated at between US$ 200 billion and US$ 300 billion per year. According to the US Office of Technology Assessment (OTA) these variations are due to differences in definition, methodology, interpretation and quality of data. Each assessment has its own particular view of what sectors belong to the GEM. Areas like cleaner production, municipal waste collection, noise abatement, water supply equipment etc. were not considered in all cases. But most of the difference seems to be related to the extent to which clean technologies are taken into account. While FERRIER and IFC partly include clean technologies, OECD and ECOTEC exclude them completely from their US$ 200 billion estimate. **This leads us to believe that the available statistics underestimate and misrepresent the real size of the market.** This fact has been recognised by Eurostat, which is currently developing a novel system to improve environmental statistics. There is also a striking difference between GEM forecasts for the year 2000. While European sources focus on the US$ 300 billion per year estimate, US sources anticipate a US$ 600 billion market size, mainly because of the potential expansion of clean technologies [IFC, OTA].

bal markets such as the chemical and aerospace industries (500 and 180 US$ billion respectively in 1990)- see box for more details .

Despite caution being recommended as regards the reliability of assessments of the market potential, **the US$ 600 billion figure is commonly being used by the Clinton administration to justify R&D spending and promotion of exports of environmental technologies** (Interagency Environmental Technologies Exports Working Group). Unlike the USA, we have not observed any systematic use of Global Enviromental Market estimates in Europe, although such data is continuously being improved and offers potential as a policy tool [SESSI].

Figuring out the emerging technological changes

Following the era of 'end-of-pipe technologies'(e.o.p's) introduced in response to environmental regulations over the last 30 years as an attempt to mitigate the pollution from traditional production processes, there is now clear evidence that industry has started moving pro-actively towards integrated clean production by re-examining long-used technologies and replacing them with modern, waste-free processes. Current surveys of industrial attitudes confirm this trend. A study by the American Chemical Society paraphrases one typical interviewee, "We are in the midst of a replacement technology revolution where we are escaping from some of the technology introduced in the past 50 years". [Am. Chem. Soc.]. Feasibility studies for a future environmental statistics system in Europe anticipate that classic environmental technology will cease to be distinguished from common production technologies in the long-term [RBF].

... as others have realised before Europe

The bell tolls for end-of-pipe technologies

Clean production technologies are the future

D. Papameletiou, E-mail: demosthenes.papameletiou@jrc.es

be needed. Specialised information exchange procedures and "technology-watch" data bases will be one of the main tools. These will contribute to the early identification of R&D needs and to "lower risk" R&D planning and allocation of resources - which will generally become more complex due to the higher lead times of the research projects, compared to those for e.o.p's.

Monitoring of technology and analysis of the 'adoption rate' of clean production technologies will obtain clearer definitions which can be applied systematically not only to identify R&D needs and goals but also to describe dynamically the emerging 'state of the art' clean production technologies. BAT-driven, (Best Available Techniques), integrated environmental policies for authorising industrial activity, which consider the total environment impact, also offer potential for stimulating innovation for cleaner production.

A new EC policy tool, the IPC Directive (Integrated Pollution Prevention Control), has now reached a common position in the June 1995 Council of Environment Ministers and its future implementation has a high potential to contribute to a strong European role in the development of clean technologies. The Directive will usher in a new era of environmental and industrial policy by regulating approval procedures for all kinds of industrial activity (above a certain capacity threshold) according to integrated criteria which take into account the environment as a whole. The BAT concept will be applied throughout Europe, thus systematically ensuring harmonisation of technology use and compliance with achievable emission limits. R&D and the demonstration of novel clean production routes will be stimulated by the rigorous BAT determination and updating procedure according to a detailed approach foreseen by the directive.

Compared to Europe, the USA and Japan lag behind with regard to such institutional innovation, and have been slow to move away from the traditional single-media management system which is merely prolongs the end-of-pipe technology era. **Overall the comparative advantage which Europe could obtain through an integrated approach lies in the fact that legislators who are at present split into separate single media services will now be forced to rethink the permitting procedures, and industry in turn will have an opportunity to rethink its processes in integrated terms.** Rigorous management of the exchange of information offers further scope to fine-tune R&D specifications and facilitate R&D planning. The integration of environmental policy will favour the fast introduction of novel technologies into the marketplace.

In Europe we are presently facing through the expected introduction of the IPC directive a future where environmental, industrial and R&D policies can meet each other in an unprecedented manner. The next step would be to start thinking on common strategies for a long-term sustainable development of clean production techniques on this promising path.

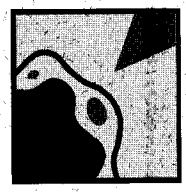
Institutional innovation is helping towards such an integrated approach

Keywords

Clean production technologies, market analysis, environmental policy, integrated pollution prevention and control, technology change, environmental policy, RDD policy, IPC directive, BAT.

D. Papameletiou, E-mail: demosthenes.papameletiou@jrc.es

Epic-Making Advances in Genome Analysis and their Potential Impact



With the sequencing of a complete microbial genome (*Haemophilus influenzae*) in only thirteen months (Science, July 28, 1995, p. 499), geneticists have proved that they now have the tools for fast analysis of the human genome, the entirety of human genes. This achievement shows that the ten years effort put into technical developments are beginning to pay off. The rapidly increasing knowledge on genes and genomes, largely ignored by the general public, has the potential to revolutionise the health care market sooner than expected. The market for disease diagnosis and therapy will be dominated by those possessing property rights on genes and techniques. Serious concerns about the ethical and social impact will not stop these developments, but appropriate European R&D strategies and intellectual property rights schemes should ensure that the European health care industry and labour markets can gain a significant share in the international markets.

The genome is the entirety of all genetic information of an organism, coded by the sequence of different chemical groups (nucleotides or base pairs) in the DNA. Certain changes in the sequence in the human genome cause genetic diseases or predispose to complex disorders like cancer, hypertension, diabetes, etc. Knowing the entire sequence of nucleotides of the human genome provides fundamental information for the discovery of genes and their disease-causing mutations. Knowing the genes and their abnormalities allows diagnosis and - when effective and safe techniques become available - gene therapy to cure patients affected by genetic disorders. Therefore the sequencing of the human genome has become a critical challenge for science.

If the human genome is the predominant target - what is the significance of the recent sequencing of the *Haemophilus influenzae* genome, which has only 1.8 million nucleotide pairs, compared to the three billion making up the human genome - especially since only 0.1% of the human genome has been sequenced systematically during the past decade ?

Potential for rapid sequencing

Fast new algorithm bringing cost and time needed down

Speed and cost are two crucial parameters. Initiatives to sequence the human genome started in 1984. At that time it was generally agreed that large-scale sequencing was not appropriate before a considerable increase in speed and a reduction of cost from what was then US$5.00 to at least 50 cents per base pair had been achieved. **The achievement of sequencing the *H. influenzae* genome in only 13 months and for just half a dollar per base pair shows that after**

Kay Beese, E-mail: Kay.Beese@jrc.es

ning of the next century already, others believe that we would have to wait a few more decades.

Exploiting market opportunities

Genetic diagnosis faces both difficulties and opportunities, but the real challenge lies in cure of genetic disorders - gene therapy. Although more than 70 clinical tests have been launched since 1989 - in some cases improving the situation of the patients - no patient has been cured yet by gene therapy. The range of diseases that can be targeted with current methods seems narrow, and many technical problems still have to be overcome. Researchers surveyed in the course of an OTA study disagreed markedly about whether gene therapy would emerge as a major means of treatment over the next 10 to 20 years (Phamaceutical R&D: Costs, Risks and Rewards. Office of Technology Assessment, Washington).

Despite the technical problems still to be solved, there are few doubts that public institutions will not be able to keep up with the demand for new health care services like genetic tests and gene therapy - thereby opening up a tremendous market for private biomedical services. **This market will be dominated by those who have the knowledge of genes, the techniques for rapid genetic screening and the methods for gene therapy. The most crucial capital will be the knowledge of genes, as those who have this knowledge also have the basic prerequisite for diagnosing and, eventually, curing the diseases.**

US companies are increasingly trying to capture the gene market. In order to earn its share in this global market, European R&D and industry will rely on an effective information technology infrastructure, appropriate intellectual property right schemes to protect their findings, and clarity about the conditions arising from the discussion of ethical and social considerations.

In any case, actual cure may be quite a few years beyond diagnosis

Intellectual property rights are the key in the evolution of the market for genetic diagnosis and therapy

Keywords

Genome analysis, genetic screening, gene therapy, health care industry

Information Sources

- *Science* Vol. 268, June 2, 1995, 1270
- *Science*, Vol. 269, 28 July 1995, 499
- OTA 1993 *Pharmaceutical R&D: Costs, Risks and Rewards.* Office of Technology Assessment, Washington

Author & Contact

Kay Beese, Tel.: (+34-5) 44 88 324; Fax: (+34-5) 44 88 326. E-mail: Kay.Beese@jrc.es

Keywords

Recycling, life cycle marketing, environment-friendly products, Europe vs. US

Author

Marcus Nicolai, Tel.: (+34-5) 44 88 286. E-mail: marcus.nicolai@jrc.es

Contact

Demosthenes Papameletiou, Tel.: (+34-5) 44 88 289. E-mail: demosthenes.papameletiou@jrc.es

Brief Notes

Keywords: EU-US relationship, Spanish presidency, IPTS, role of science and technology, competition vs. cooperation

Contact: Dimitrios Kyriakou, Tel.: (+34-5) 44 88 298: Fax: (+34-5) 44 88 326. E-mail: dimitris.kyriakou@jrc.es

A New Mission for the China-EU Biotechnology Centre

The CEBC was inaugurated in Beijing in November 1991, as a result of a decision taken by President Delors and Dr Song Jian, for a joint venture between the China National Centre for Biotechnology Development and DG XII. It started as an information/communication centre servicing the biotech research communities in China and in Europe. But in recent years the centre has increasingly also assumed the role of a consulting office for European and Chinese biotech-related industries seeking partners for business/industrial co-operation or even the establishment of joint ventures.

Following the same trend, the joint EU-China workshops co-sponsored and co-organised by the CEBC, also incorporate an industrial dimension wherever possible. A typical example of this will be the workshop on Human Vaccinology scheduled for the second week of January 1996, which will bring together not only scientists and researchers but also producers and pharmaceutical companies.

An area of biotech in which the CEBC has played a major role as facilitator and organiser of mutual exchanges in the last two years is biosafety and the release of transgenic organisms. Following a successful EU-China workshop on this sensitive topic (the first of its kind involving China and foreign countries) in the summer of 1993, a joint expert mission took place in June 1995. A number of field release sites of transgenic plants were visited, samples were taken and joint analysis is under way.

Keywords: China, biotechnology, vaccinology

Contact: Patrice Laget, Tel: (+34-5) 44 88 277; Fax: (+34-5) 44 88 339. E mail: patrice.laget@jrc.es

Artificial Nose

The human nose has traditionally performed the function of aroma quality-control in most manufacturing processes. Unlike sound, there is no scale for measuring the intensity and quality of aromas, which up to now have been assessed by assigning dilution factors necessary to reach the limits of perception. Researchers at the Technical University of München-Weihenstephan are presently developing novel sensors which closely correlate to particular classes of chemical compounds, similar to the receptors in the human nose. Recent advances in organic chemistry as well as electronics and computing have led to the development of sensors which allow the assessment of an aroma by means of processing software. Sensors tested to date include conducting polymers, MOS-semiconductors and coated quartz oscillators. These are normally combined in arrays in order to provide an aroma fingerprint or aroma map. Real-time pattern recognition and

Brief Notes

Lags in Life Cycle Assessment (LCA) of Future Cars - the Example of Electric Vehicle Batteries

There is a consensus amongst consumers, politicians and car manufacturers, that minimal environmental impact will be a crucial design - and even marketing - element for cars in the future. At present the most advanced methodological tool for measuring the environmental impact of a product is life cycle assessment (LCA). In the current design of electric cars, batteries account for 20 - 30 % of the vehicle mass, and have an average life of 3 years. For an average car life-span of, typically, 12 years in Europe this will result in 800 to 1,000 kg of used batteries per car life, often containing significant quantities of hazardous materials such as cadmium. This fact will become increasingly relevant as battery-powered electric cars are set to become more common, in the light of measures attempting to minimise environmental impact. The most drastic example is legislation in California, which requires 10% of cars to be zero-emission vehicles by the year 2003 - a quota likely to be met by electric cars.

The US Dept. of Energy has created a working group to study the recovery and recycling of Na/S (sodium / sulphur) batteries (97.5 % recyclability is claimed for some Na/S prototypes). **Other battery concepts seem to profit from their ease of recycling. For instance, $NaNiCl_2$ can be split into NaCl, ordinary salt, and Ni, a valuable ingredient for the production of stainless steel, and it even seems likely that revenue from Ni will cover recycling costs.** However, comprehensive data for a comparative LCA of different battery/electric vehicle concepts, e.g. the energy requirement for production and recycling of different battery types, is not yet available.

Keywords: batteries,life-cycle assessment, recyclability, electric cars

Contact: Jochen Naegele, Tel.: (+34-5) 44 88 265; Fax: (+34-5) 44 88 279; E-mail: jochen.naegele@jrc.es. - Marcus Nicolai,Tel.: (+34-5) 44 88 286; Fax: (+34-5) 44 88 279; E-mail: marcus.nicolai@jrc.es Fax: (+34-5) 44 88 279

A Bright Future for Solar Concentrating Technologies.

Recent progress in the performance of the Solar Central Receiver (SCR), also known as the Solar Tower, has created new opportunities for further applications in a wide range of fields such as energy, photo-chemistry, material processing, telecommunications, etc. While the theoretical concepts were already well known, a series of recent technological breakthroughs have made it possible to achieve stable, highly concentrated flux (typically 2,000 to 10,000 suns) at the receiver apertures. These improvements concern the precision of the sun tracking system, the compound parabolic concentrator (CPC), the window which supports high temperature and efficient receivers for heat transfer, laser emission or catalysis. Moreover, the reflecting tower concept, which allows the re-direction of the heliostat beam to the ground, simplifies the design of large scale plant and reduces significantly their cost. Several applications are envisaged:

• direct electricity production with combined cycle systems (gas and steam turbines) using compressed air at high temperatures (900-1350 degrees; 10-30 bars). This can increase the power efficiency by up to 50% over that of more con-