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石油代替エネルギー開発の現状（EU）

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新エネルギー・産業技術総合開発機構
委託先　日本貿易振興会

「EU における石油代替エネルギー開発導入政策・動向」

委託先　　　　日本貿易振興会

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わが国の石油代替エネルギーの開発導入を有効かつ効率的に推進するためには、海外の主要国の石油代替エネルギーの開発導入・動向、その背景となる経済産業動向および地球環境問題への対応等に関する情報を継続して円滑かつ的確に収集することが重要である。本調査は以上の観点より、政治、経済、技術政策等の多面的視点をもってより高度かつ直接的な情報源から情報収集を行ったものである。

まえがき

本報告書は、日本貿易振興会が新エネルギー・産業技術総合開発機構より委託されて実施した海外調査の結果を取りまとめたものである。

1993 年 11 月、マーストリヒト条約の発効を受け、欧州共同体の基礎となる欧州連合(European Union:EU)が発足し、従来の「EC」は「EU」と変わり、EC 委員会は「欧州委員会」となった。このマーストリヒト条約では、エネルギー分野を含む政策全体の枠組みを規定する、従来とは異なる全体目標が掲げられている。しかし、石油代替エネルギー源を例に取ってみても、EU の最終エネルギー総消費量の約 4%を占めるが(1991)、加盟国間で大きな差がある(英国 1%からポルトガル 17%まで)などの問題点がある。この報告書は、このような統一エネルギー市場への問題点を踏まえながら、EU におけるエネルギー政策ならびに石油代替エネルギー政策、開発状況等について述べてゆく。

本調査は EU の石油代替エネルギーの開発動向を把握する目的で、日本貿易振興会ロンドン・センターが実施した。本調査の実施にあたり、情報提供や資料提供でご協力下さった方々に心から感謝するしだいである。

平成 8 年 3 月

日本貿易振興会

目　次

Ⅰ．概要

Summary

This report discusses the policies for the development and introduction of oil-alternative energy and the state of such energy in the European Union.

The report is based on the report of two years ago and last year's report on related themes and focuses on the trends in 1995. Accordingly, only a brief explanation is made, as needed, about the previous background and history. Please refer to the past reports for detail.

In section1.1, we introduce the way EU is watching to their enviromental problem and an outline of their energy policy. First of all, we refer to the fundamental aim of EU policy and the expected role of their energy policy. Next, we describe the situation of major fuel and energy, and describe how oil-alternative energy is used. In 1995, while three countries became new EU members, EU aimed at forming the unified energy market again. But for the opposite of France, they can't form it yet. We refer to the argument about it which is on the last stage now. And we introduce the argument that they have begun on new EU energy policy.

In section1.2, we refer to the policy about oil-alternative energy. We explain the relations between EU energy and environment policy, and introduce three kinds of program adjusted in environment policy. We describe details and direction of JOULE-THERMIE, the program on the forth frame work open since 1995.

In section1.3, we refer to the present condition and prospect of use of oil-alternative energy. Based on the last year's report, we introduce major topics and trends in technical, practical, and commercial respects from the later half of 1994 to the later half of 1995.

From November, 1993, the European Community has developed into European Union based on the Maastricht Treaty. It may be said that the European Community stands on the European Union, but we do it with "EU" instead of "EC".

Currency unit; 1ECU=approximately 133 yen in addition to above
(in January, 1996).

概要

本報告書では、欧州連合(EU)における石油代替エネルギーの開発と導入の政策ならびに普及状況について述べる。

本書の内容は、関連するテーマについての一昨年の報告書、ならびに昨年度の報告書を踏まえた上で、1995年における動向に的を絞っている。したがって過去の背景や経緯については、必要に応じて簡単な説明を行うが、詳細については過去の報告書を参照していただきたい。

1.1節では、EUの環境問題への取り組みとエネルギー政策の概要を紹介する。はじめにEU政策の基本的目標と，エネルギー政策に求められる役割について言及する。次に、EUにおける主要な燃料とエネルギーの状況、および石油代替エネルギーの利用状況に関連する問題について述べる。1995年度には、新しい3国がEUメンバーとなるとともに、遅れに遅れているエネルギー統一市場の形成を促進するための動きが再開され、今年度に決着されるかに見えた．しかし、フランスを中心とする反対が強硬なため、さらに年を越した。議論はかなり煮詰まってきているのでその動向を紹介する。また、新たなEUエネルギー政策の方向についての議論が始まっているので、その動向についても述べる。

1.2 節では、石油代替エネルギーに関する政策と、それを実施するための各種の施策手段について述べる。EU のエネルギー政策と環境政策の関連に触れ、環境政策に整合した新エネルギー技術の利用およびエネルギーインフラ基盤の改善を目的とした 3 種類のプログラムを紹介する。1995 年から公募が始まっている EU の第 4 次フレームワーク研究開発プログラムにおける新エネルギープログラムである、JOULE-THERMIE の内容詳細、活動方針の概要についても述べる。

1.3 節では、石油代替エネルギー技術の導入、開発利用の近況と展望について述べる。ここでは、昨年度の報告書で紹介した全体的状況を前提とした上で、主として 1994 年後半から 95 年後半までに見られた、技術導入や実用化面、商業面における主な話題や動向を個別技術ごとに紹介し、さらには今後の展望について述べる。

なお 1993 年 11 月からは、欧州共同体(EC)はマーストリヒト条約に基き欧州連合(European Union:EU)に発展した。欧州共同体(EC)はこの同盟的下部組織(EU)の上に立つ体制機構と言えるが、用語表記では従来の「EC」に代わり「EU」とし、EC 委

員会を「欧州委員会」、EC 理事会を「欧州理事会」と統一する。なお通貨単位は、
1ECU ＝ 約 133 円(1996 年 1 月)である.

Ⅱ．本論

1. EUにおける石油代替エネルギー政策、開発、導入普及の動向

1.1 EUのエネルギーと環境政策の動向

1.1.1 政策の基本的目標

EECからECにかけて基礎となってきたローマ条約に代わり、新たに欧州連合の設立基盤となったマーストリヒト条約では、エネルギー分野を含む政策全体の枠組みを規定する、従来とは異なる次のような全体目標を掲げている。

(1)「国境の無い地域と経済・通貨連合の創造により、均衡がとれ持続可能な経済と社会の発展」を促進する。この発展とEU競争力強化が実現できるかどうかは、エネルギーが適正価格で無理なく確保できるかどうかに依存する。加盟国エネルギー政策の整合化と収斂とは、経済政策一本化の一要素である。

(2)「持続可能」な経済社会の発展のためには、環境保護の視点を全EU政策に盛り込むことが求められる。エネルギー政策の課題は、経済バランスを維持しながら、EUと開発途上国の環境保護に寄与することである。

(3)共通の「外交・安全政策」を掲げるとEUの国際的地位は向上するが、同じことがエネルギー分野でも言える。エネルギーはEUの安全上で重要な役割を担うため、生産国とは安定した政治・経済的関係を維持し、またエネルギー輸送の安全を確保しなければならない。

(4)EU内部の経済・社会的結合が強化され、欧州横断ネットワークで周辺や遠隔地との交流が容易になるにつれ、それをエネルギー政策の中に反映しつつ、エネルギー価格や所得当たり消費量の地域格差の是正を促進しなければならない。

この全体目標の枠内でEUエネルギー政策に求められる役割は、次の2つである。

*EUに備わる多くの政策手段を、共通エネルギー政策と適合した形で、活用できるようにすること。

*加盟諸国の政策相互間の矛盾に起因する各種の歪みを未然に防ぎ、共通目標に向かって加盟国政策が、ますます収斂し一本化するように先導すること。

しかし、経済発展にとり重要なエネルギー市場の統一に関しては、加盟諸国の意見の一致が難しく、共通の経済的、政治的目標を掲げた統一的エネルギー政策の実現は難航している。1996年からは、EU融合を促進するための政府間協議(IGC)が開始されるが、エネルギー統一市場の推進は主要課題の一つである。欧州委員会では95年始め、加盟国政策の整合化を

促進するための布石として「欧州連合のエネルギー政策のために」と題するグリーンペーパー(COM(94) 659,FINAL, 11.1.1995)を発行し、現状の政策が含む問題点を指摘した上で、将来の方向付けと目標についての見解を明らかにしつつ、各国関係者に対しエネルギー政策に係わる広範囲な議論と合意作りを求めた。追ってその結果を基に白書を発行し、将来のエネルギー政策に反映していく予定である。

1.1.2 EUのエネルギー現況

まず現在のEUにおける、主要な燃料とエネルギーの状況、および石油代替エネルギー利用状況、および関連する主要事項について整理する。

石炭は EU では重要なエネルギー源で、EU エネルギー総消費量の 20%を占め、その内68%は域内産である。特に発電用燃料としては、総発電量の 36%と最大の割合を占める。近年、EU炭は生産コスト高のため使用量が減り、その分を輸入炭が補う傾向が続いているが、効率の高い燃焼技術等の新技術による環境問題への対応が不可欠となっている。

石油の消費動向は、交通分野に依存するため、自動車利用に根本的な変化が無い限り、輸入依存度の低下は困難である。EUの総消費量5億3500万石油相当トン(1992)の78%は域外からの輸入である。天然ガスの消費量は増加を続けており、特に、原発の将来性が不透明なことから、建設が容易で効率の高い天然ガス火力発電所の新設が盛んである。EU の総消費量2億2900万石油相当トン(1992)の内、約60%はEU産で、残りの大部分はノルウェーからの輸入である。 電力消費量は交通部門の燃料需要に次ぐ需要成長分野で、1995年から5年間の年間消費量の平均成長率は2%で、2000年には2150GWhに達する予想である。その期間内には、85GW(その内、高効率・低コストの天然ガス複合サイクル発電所を中心としたガス火力が 60GW)が新設され、年間の発電能力増加率は 2.2%となる勢いである。そのためすでに、将来のガス需要増と価格上昇とが懸念されている。原子力発電のシェアは 34%であるが、2005-10 年にかけて原発の大部分では設備更新が必要であり、10 年程の工期を考えると、EU ではまもなく原発の位置づけに関する議論が盛んになると思われる。

第1.1.2-1表には、旧EC12加盟国における、エネルギーバランスと二酸化炭素排気量および主要エネルギー指標を示す(1980－1992年)。

第1.1.2-2表には、旧EC12加盟国および、新加盟国のスウェーデン、フィンランド、オーストリアの3国を加えた15EU諸国の発電用燃料内訳を示す(1993:発電量2128TWh、発電能力

520GW) 新メンバーの加盟で、水力発電のシェアが増加した。

1.1.3 石油代替エネルギーおよび関連する問題

石油代替エネルギー源は、EU の最終エネルギー総消費量の約 4%を占めるが(1991)、加盟国間で大きな差がある(英国 1%からポルトガル 17%まで)。実用化している石油代替エネルギー源の内、約 60%は木材と固形廃棄物、約 35%は水力発電と、この両者で大部分を占める。石油代替エネルギー利用促進のための総合的施策の、ALTENER プログラムでは、2005年までに寄与率を 8%に倍増する目標である。

発電(1991:180TWh)では、圧倒的に水力発電であるが、2005 年までに大型水力を除く石油代替エネルギー技術による発電量を、3 倍増する計画である。一方熱源では、2330 万石油相当トン(1991)が利用されており、そのほとんどは薪、木屑、藁のようなバイオマスである。

欧州委員会の見解では、水力を始めとして地熱、埋立地ガスは技術的に成熟しており、小規模ながら限定された商業化がすでに行われている。それに次いで、風力と太陽熱利用は、立地条件が有利な場所では、競争力が生まれたか、あるいは生まれつつある段階にある。また、太陽光発電、液体バイオ燃料、エネルギー過疎地での小型発電は、すでに技術的には成熟してはいるが、未だにコスト競争力がついていない。一方、エネルギー作物による発電には、将来性があり、関連する新技術の開発が必要とされている。最後に、通常燃料との競争力の点から見ると、波力発電技術の可能性は限られている。また、こうした新技術の実用化を促進するためには、補助金や各種優遇措置あるいは規制の導入等の適切な政策的支援が必要との立場である。

第 1.1.3-1 表には、発電および熱発生への石油代替エネルギー源の利用を示す。

第 1.1.3-2 表には、旧 EU12 ヶ国での石油代替エネルギーの総生産量(総国内消費量)を示す(1992 年)。

第 1.1.3-3 表には、上の総消費量のうち発電に使用された量を示す。

寒冷な地域が広い EU ではエネルギー最終消費量の 40%は建物に関係し、CO2 排気量では 20%を占める。その内大部分は暖房用(住宅用 70%、業務用 55%)、次いで電気機器用、温水用となっている。そのため EU では、建物での省エネの浸透のために力を入れている。数例を上げると、建物へのエネルギーに重点を置いた設計と利用技術に関する共通基準(BAT)の普及、暖房用の新技術や機器である高効率ボイラー、熱回収システム、冷却と通気の新シス

テム、小型蛍光ランプ等の新照明器具、建物のエネルギー管理システム等の普及がある。欧州委員会では以上の施策だけで、将来的に建物関連のエネルギー消費量の 20%が節約できる予想である。

運輸交通部門に関連したエネルギーと環境問題は、一層重要な問題になりつつある。80 年代にはエネルギー総需要が 6.2%増加した反面、運輸交通部門での需要は 26.8%と圧倒的伸びを示し、最終総消費量の 30%を越え、今後も増加の一途を辿る予想である。その 80%は自動車、ことに 50%以上は自家用車が占める。今後の対策には、都市部の輸送システム体制の効率強化、大量貨物輸送・交通等の一層効率的な管理、燃費低下・エンジン効率向上・新型自動車(ハイブリッド、電気自動車等)、新燃料や代替燃料の導入(加圧天然ガス、バイオ燃料等)の 4 施策が上げられている。また、それと平行して、課税(外部コストの内部化)面での措置、公共交通に関する意識・行動様式の修正(私用車に代わる公共交通機関の利用増加)を進めるための施策導入が求められている。しかし環境保護問題が一層緊急化する事態になると、さらに根本的な対応が必要となろう。

1.1.4 EU エネルギー政策の概要

(1) 統一エネルギー市場と現在の問題点

現状では EU の各加盟諸国は、エネルギー製品の自由流通を阻害する多くの国家規制を抱えており、さらに、加盟国間における環境保護に対する取り組み姿勢、特に発電に対する規制の在り方の違いも自由競争に対する大きな障害の一つとされている。EU では、各加盟国の法規の間に整合化と相互承認を一層進めることにより、統一市場の発展を促そうとしている。

エネルギー市場は燃料別に状況が極めて異なっており、現在最大の焦点となっているのは、天然ガスと電力の市場自由化である。電力とガスの統一自由市場の形成が難航し、検討開始から通算 6 年間も暗礁に乗り上げているのは、特にフランスの強硬な反対が大きな原因であり、国有企業によるエネルギー独占体制がその背景にある。EU の努力で、すでに多くの副次的問題が解決され、現在の議論の焦点は、「交渉による」第 3 者アクセス(Third Party Access: TPA)か単一購入者(SB)かを選択する、あるいは両者を調節する段階に集まっている。

ガスと電力市場の自由化に関しては、1992 年 2 月、欧州委員会がガスと電力の統一市場に係わる共通ルールを定めるための指令案を発議し、競争と市場自由化を促進するために、送電網とガスパイプラインに対する第 3 者のアクセスを「法律で義務化する」ことが提案された。しかし、欧州議会でのその第 1 回審議過程や欧州理事会では加盟国からの反対が多く、欧州委員会では反対意見を加味した指令原案の改訂版を 1993 年 12 月に発表したが、ここでは、送

電網やパイプラインの操業者との「交渉による」第3者アクセス方式に内容が改められた。

その後1994年1月からの閣僚理事会ではこの改訂版の検討が続けられ、5月、解決を要する重要問題を5点に絞り込み、その内の4点については、11月の閣僚理事会において政治的合意に到達したが、理事会による指令採択を表明するための「共通の立場」を決定するには到らなかった。その理由は、フランスから突如として単一購入者案(Single Buyer:SB)が持ち出されたため、最も重要な最終的問題について合意が難航しているからである。

これはすなわち、交渉・第3者アクセス(TPA)か単一購入者(SB)かの選択、あるいは両者の調整に関する問題である。交渉 TPA によれば、例えば任意の発電業者は、送配電網の操業者との自由な交渉を通じて輸送費用等を決定し、購入希望の消費者に電力を販売できる。加盟国政府は、こうした自由市場が競争を阻害せず、適正に機能するように監督しなければならない。

この交渉 TPA 方式により、大方の合意が得られると思われたが、フランスは頑固に反対を続け、1994年後半、ついにその代案として SB 方式を持ち出してきた。これは、国等の地域毎に単一の独占的エネルギー購入・流通業者を置き、それを通じて消費者の利益に叶った自由競争と欧州統一市場の形成をはるとするものである。しかし、このアイデアには何らかの形で、自由市場の発展を抑え、中央コントロールの余地を残そうとする印象がつきまとい、複雑でわかりにくく、その波及効果についても疑問が多いものである。

エネルギー国内市場が解放的な英国はもとより、独占による高エネルギー価格の維持には強く反対を続けている産業界を抱えるドイツは、フランス案には全面的に反対である。しかし、フランス政府には国有企業の独占体制を危うくするような政策を採用できにくい国内事情があり、1995年12月の欧州理事会では合意が不可能となり、決定は1996年の閣僚理事会以降に持ち越しとなっている。

(2) エネルギー統一市場に関するその他の施策

a. エネルギー関連の欧州規格

統一市場の形成と円滑な機能を保証する手段の一つとして、欧州規格(EN)の作成が大きな役割を果たしている。

エネルギー分野では、欧州委員会の委任を受けた CEN／CENELEC がすでに、発電・配送電用設備、低・中・高電圧に関する物理特性・送電線・変圧器・その他の設備、石油産業(探鉱、生産、精油、パイプ配送)と天然ガス産業(探鉱、生産)用の設備・機械の 711 項目、精油製品、ガス配送と流通用の設備、ソーラーパネル、風力タービン、エネルギー利用効率(ボイラ

ー、建物断熱、家庭用ガス機器用)に関連する欧州規格を作成済みないしは作成作業を進めている。

b. 欧州横断エネルギー・ネットワーク

EU では、加盟諸国を含む欧州全体を対象とする交通・通信・エネルギーのネットワーク確立を、来世紀の課題とし、その推進に極めて積極的に取り組んでおり、欧州理事会と欧州議会とが、欧州委員会によるネットワークに関する提案(「欧州横断エネルギーネットワーク」の形成に関するガイドライン;EU 官報、COM(93)685, 1994.1.19、および全ネットワーク建設の財政面に関連する規則案;COM(94)62, 1994.3.2)を採択したことにより、EU では、ネットワークの開発に関する整合性ある共通方針の確立、欧州の金融資源のより効率的な活用、域外諸国との協力、に係わる施策の推進が可能となっている。

現在は、今後の活動目標やプロジェクト推進に必要な環境を創設するための方法に関する欧州委員会の提案、および活動予算 1.05 億 ECU が、理事会と議会に提出され検討が続けられており、間もなく理事会で採択、決定される見通しである。

c. 域外諸国との協力

EU は域外諸国との間で、多くの協力活動を行っているが、特に隣接する中東欧諸国とCIS諸国では、エネルギー産業の近代化と環境保護の強化が重要な課題で、その成功は EU にも大きな関心事であるため、中でも原子力の安全を含むエネルギー分野に高い優先度を置いた支援を積極的に続けている。

中東欧諸国は将来の加盟国候補であり、EU 産業の市場でもあるところから、地域企業や地域機関と提携し地域産業のニーズへの対応に努め、国の政策立案と EU からの技術移転に際し中心的仲介役を果たすことを目的として、インフラ基盤としてのエネルギーセンターの設置を進めている。エネルギーセンターには、政策立案支援エネルギーセンター(支援対象国のエネルギー政策立案の支援 を専門とし、国の行政機関により運営されている)と技術移転エネルギーセンターとがある。後者は後述する THERMIE の枠内で運営され、産業と緊密に提携し、現在、中東欧と CIS 諸国には 14 センターが設立済みである。民間機関として、全て国首都に置かれ、地域の機関や企業との提携を構築している。

d. 欧州エネルギー憲章

欧州エネルギー憲章は、EU のエネルギー安定供給の確保とエネルギー市場統合推進のた

めに重要な施策として、1990 年欧州理事会で誕生した。その後の活動は欧州の枠を越えて国際的に成長し、1991 年末にはハーグで基本憲章の 50 ヶ国以上の参加国による調印が行われ、その後は細目決定のための国際交渉を経て、1994 年末には、憲章について 48 ヶ国の調印が終わっている。

憲章の目的は、西側技術、ノウハウ、資金を、東欧と旧ソ連圏でのエネルギー資源の探鉱、開発、輸送等の推進に活用することにより、その経済発展と政治安定化に寄与すると同時に、消費国での安定供給の確保に寄与することにある。

1.1.5 EU エネルギー政策における基本原則

EU エネルギー政策では、加盟国の国策間の矛盾ばかりでなく、しばしば異なる達成目標間での矛盾に見舞われる状況の中で、EU 産業の競争力向上、域内へのエネルギー供給の安全確保、環境保護の間にバランスを維持することが課題である。同時に、政策の前提として、エネルギー市場が制約を受けずに自由に機能できることが不可欠である。したがって、市場の機能を保証する目的で EU が公的規制を通じて市場に介入する措置は、公共一般の利益に沿った場合だけに限定されており、そのための指針として次の基本原則が置かれている。

* エネルギーの一般消費者および産業消費者にとり、市場は、健全な経済条件の下で安定した状況を達成するための主要な手段である。
* 規制の導入に対しては厳しい制約を加え、操業者間に効果のある競争を維持する上で不可欠な措置に限るべきである。また、規制は、エネルギー効率向上用の投資を妨げるような市場自由化を牽制する機能を果たすこともできる。
* 統一市場との関連では、エネルギーの供給断絶の事態に対処するために必要な政策手段が、行使できるようになっていなければならない。

加盟諸国の政策を支援する EU の施策は、各国政策相互間の整合化と収斂を通じて最終的に、加盟国の政策と EU 政策とを互いに収斂させていくことを意図している。加盟諸国のエネルギー政策相互間に違いがあっても、エネルギー統一市場は、経済の基本的要因に対して重要な貢献を果たし、価格低下、生産・輸送・流通面での効率向上が期待されている。また、意志決定の分散化、消費者ニーズへの適合、生産合理化、産業協力の緊密化、技術革新へのインセンティブ等の寄与により、生産性は向上すると見られている。EU では、規制による介入は必要最小限とし、エネルギーでは、正当性が明確な 4 分野、公共サービスの使命保護と消費者保護、エネルギーの安定供給、環境保護、エネルギー効率改善のみに限っている。また、国と

EU の規制策が適切かどうかを評価する作業は、理事会から中立独立の専門家による MOLITOR グループに委託されている。このグループは、委嘱により法規制が EU 経済の発展を阻害する可能性がないかどうかについて調査を行って答申する。また、産業界が公共の利益に沿った施策を自ら導入できる分野では、公的規制は行われない。

1.1.6　環境保護とエネルギー政策

EUの1990年代における主要課題の一つは、地球的規模での環境問題と経済発展・エネルギー問題との調和で、2000年の二酸化炭素ガス排出量を1990年レベルに安定化、SO 2 排気量を70%大幅削減、NOxの20%低減を目標としている。EU環境保護政策の面では、以下に挙げる各種の施策を実施中である。

また、産業全体の国際競争力を強化する方向で、環境の外部コストを低下するとともに、コストの内部化への努力を強めようとしている。特に、欧州委員会では、環境政策を全政策分野に組込み、市場原理にかなう政策手段を活用することがコストの内部化には不可欠だと、機会ある毎に繰り返し主張しているが、加盟国を代表する理事会においては各論での合意が簡単ではない。

(1) 第5次環境アクションプログラム

欧州連合の基礎であるマーストリヒト条約では、「全ての EU 政策の立案と施行の中には、環境保護に関する要求が、導入されていなければならない」としている。それを受けたものが、1993 年に理事会が決定した「持続可能な発展に向けて」と題する第 5 次環境活動プログラムで、2000年までの主要な環境課題を網羅し、それぞれの達成目標を明らかにした。

ここでは、欧州社会が「持続可能な発展に向けて」進むためには、現在の消費生活と生活態度を改める必要があるとの考え方を基本としている。プログラム活動の重点は、天然資源の持続可能な管理の確立、総合的な汚染制御と廃棄物の発生予防、再生が不可能な形態のエネルギー消費を低減、交通・運輸面での管理の改善、市街地における環境の質的向上、公衆の健康と安全の向上に置かれている。経済分野では特に工業、エネルギー、運輸、農業、観光・旅行業に重点を置き、環境政策の推進のための組織として産業界、地方自治体、その他専門機関からの幅広い代表による「環境協議フォーラム」を設置している。

(2) 総合的汚染予防と低減

欧州委員会は1993年10月「環境に悪影響を与える工業プラントと製品からの汚染物質排出

の総合的予防と低減」に関する EU 指令原案を発表し、環境保護を一層強化する方向を打ちだした。その目的は、既存の数多くの個別規制を体系化することにより総合的環境管理体系を確立し、大気、水、陸の環境への工業プラントや製品からの汚染を低減・予防し、個々の環境媒体間での汚染責任の押しつけをなくすことにある。運営に当たっては、公衆、産業界、加盟国、欧州委員会の全体が関与する方向を打ち出し、規制介入と責任面でのバランス維持を目指している。各加盟国では単一の責任官庁の下に環境行政を一本化し、環境規制値は現行最高レベルの技術を基礎としてコストと利益のバランスを考慮した上で、産業部門毎に決定される。

(3) 環境管理と監査スキーム

1993 年 6 月に欧州理事会で採択された「産業部門における企業の自主的参加による、環境管理と監査に関する共同体スキームに係わる理事会規則」に基づく制度は、1995 年 5 月から全 EU 加盟国で国内法として実施されている。これは当面ボランタリー形式をとり、汚染発生源の主体である製造企業の社内に環境管理活動を導入するように求めており、管理システムの形式は、EU 内ですでに実績ある ISO9000 による品質管理システムに類似している。

自主参加した企業では、自社の環境パフォーマンスを不断に改善するため、環境方針を立案、その実施方法と日程を決め、内部監査を含む社内の環境管理体制を構築し、公認の環境検証人による定期的な検査・評価を事業所単位で受け、その検査で受認されれば認定証明書を受け、欧州委員会に同スキームへの参加が登録され、ロゴマークの使用が認められる。同時に企業は「環境声明」の形で、確認された環境パフォーマンスの目標達成情報を、社会に公表する義務がある。

(4) 今後のエネルギー政策に必要とされる環境的視点

環境保護を前提とした、インフレのない持続可能な成長が、欧州連合の大原則の一つである。そこで欧州委員会では、この原則に沿った発展を実現するためには、次のようなエネルギー施策が必要だとしている。

* 競争力、安定供給、環境保護の 3 大目標の相互間に、相乗効果を追求し、目標の相互間に衝突が生まれた場合には、それを迂回する施策を導入する
* 外部コストの内部化を、エネルギー政策と環境政策の中心課題とし、理論的および実際的問題の検討を踏まえ、この政策を徐々に展開する
* エネルギー政策に環境問題を組込む手段としては、製品や工程の標準規格化、排気規制

値、税公課の優遇措置、自主協定、民事責任等を活用する。手段の選択における主要な評価基準として、コスト効率と共同責任を採用する

＊エネルギー効率を提供する事業機会を育成する市場を強化する

＊地球温暖化に関する、本格的な長期的エネルギー戦略の立案が必要である。また、この長期的戦略を確定する上で決定的に重要な要因は、貢献できる技術、および石油代替エネルギーのような環境調和型技術を考慮に入れた、エネルギー供給バランスの促進である

1.2 石油代替エネルギーに関する政策

1.2.1 概要

EU エネルギー政策は、環境政策と密接に関連づけられ、エネルギー政策の立案段階で環境保護への考慮がより大きな比重を占めるにつれて、コスト効率が高く、よりバランスの取れた施策が探索されるようになってきたが、施策の実施手段としては規制、税制、助成金とが用いられている。

EU 法規制を手段とする施策の中心は、エネルギー効率の改善に関するもので、現行の社会・経済体制では活用できていない膨大な潜在的省エネ能力の発現を目指している。税制手段では、EU 規模でのエネルギー／二酸化炭素課税の導入が試みられたが、反対が強くペンディングとなっている。

助成金を手段とする施策としては、環境政策に整合した新エネルギー技術の利用およびエネルギーインフラ基盤の改善を目的とした、次の 3 種類のエネルギー関連プログラムの支援が行われており、以下にその概要を述べる。

(1) SAVE　：エネルギー効率の改善に取り組む政策プログラム

(2) ALTENER：石油代替エネルギー（再生可能エネルギー）の利用、CO2 排気の削減目標に関する政策プログラム

(3) JOULE＋THERMIE：エネルギー技術の研究開発と実用化準備に係わる技術活動プログラム

SAVE プログラムでは、加盟国のエネルギー効率に関係するインフラの改善に寄与するため、1996 年までの 5 年間に 3500ECU の予算で、数々のパイロット試験活動に助成金を与えている。助成対象は、教育訓練、総合的資源利用計画、民間融資、コジェネレーション、輸送

部門のエネルギー効率、モニター活動、情報普及活動等である。これは、1991年からの5ヶ年計画で、EUにおけるCO_2排気量の安定化を進める手段として、大きな役割を担っている。革新的技術の研究開発とは直接の関係はなく、次の3要素から成立っている。

・技術的施策：エネルギー最終消費者の40%を占める建物でのエネルギー有効活用を主要な対象とし、ボイラーの性能向上、建物の断熱、標準化とエネルギー監査、建物のエネルギー効率の認定証明、家庭用設備に対するエネルギー使用基準の確立等の施策を進めている。また、コジェネレーション普及の障害となりうる法的、商業的規制の撤廃に取り組んでいる。また建物の暖房、空調、温水供給用の費用を、実際の使用量を基準にして請求して支払う請求書制度の導入、ボイラーと車両の定期的検査、エネルギー多消費事業に対するエネルギー監査の導入を試みている。

・経済的施策：省エネを促進するために民間融資を含む各種の投融資の奨励活動を行っており、これには公共部門への省エネに対する第3者投資家からの融資の奨励も含まれている。また最低コスト計画法や消費者サイドでのエネルギー管理の普及を奨励している。

・消費者行動に関する施策：プログラムの重要な部分であり、消費者、特に企業でのエネルギー使用量モニターや省エネ的使用目標を設定するための支援、教育訓練、情報普及活動が主要な内容である。こうした消費者に対する情報普及活動を欧州全体で調整しその効果を上げるため、欧州委員会は、1993年、省エネ担当政府機関をメンバーとする欧州エネルギーネットワークを設置し、国際的に優れた省エネ技術の収集とその各加盟国での普及に力を入れている。

エネルギー効率の改善に関しては、省エネ投資に対する行政的および構造的障害を除去し、同時にエネルギー設備用の基準を確立するために、体系的な施策プログラムを準備している。これまでには次の3件、集中暖房用ボイラー、家庭用機器に利用するエネルギーラベルのシステム、EUのCO_2政策の一環となる非商業的製品のためのフレームワーク、に関する規定が採択を終わっている。

準備中の指令としては、電力・ガス部門における総合的資源利用計画に関するものがあり、電力・ガス企業の収益が使用量には直接依存しないようなフレームワーク、および消費者はより少ないエネルギー消費量でそのニーズを満足できるようなフレームワークの構築を、その目的としている。

ALTENERプログラムは、石油代替エネルギーの利用を一層促進するために、1997年まで

の 4 年間に 4000 万 ECU の予算で進められている。
その目的は、石油代替エネルギーの情報普及や政策調整、あるいは加盟国のバイオマス国立センター間の調整等の活動のような、石油代替エネルギー源の実用化を振興するための、フレームワークの確立である。その主要な活動内容は、ローカルエネルギー源と公的資金の有効活用、石油代替エネルギーの実用化と製品市場の確立、その欧州エネルギー市場への総合化、融資やその他経済的施策の実施、教育訓練と情報普及、EU 外部との協力等である。現在は、バイオ燃料と太陽温水システムの分野で法規制と基準の導入を準備中であり、風力タービンの実用化を促進するため、風力発電機に関する各加盟国の基準の整合化を予定している。

これは SAVE とともに、EU の CO2 安定化目標を達成するための主要な政策手段とされており、次の個別目標の達成を通じて、全体目標の「2000 年までに、実質で 1 億 8000 万トンの二酸化炭素ガス排気量の低減」を実現するとしている。

・石油代替エネルギーの比率を EU 全エネルギー需要の 4%から 8%に倍増
　(エネルギ-発生量では 4300 万 toe から約 1 億 1000 万 toe に増加)
・石油代替エネルギー源による発電量を 3 倍増(8GW,25TWh を 27GW,80TWh に)
・自動車用全消費燃料のバイオ燃料割合を 5%に(年間消費量換算 1100 万 toe)

THERMIE プログラムは 1994 年までの 5 年間に 7 億 ECU の予算で、EU にとり重要なエネルギー技術の開発、実証、普及のための活動を助成し、特に石油代替エネルギー技術の実用化と省エネ推進のための大型プロジェクトの支援には、最大の比重が置かれてきた。1994 年からは JOULE と合体され JOULE-THERMIE として進められている。その詳細については、次項に紹介する。

1.2.2 研究技術開発プログラム (JOULE-THERMIE) の概要

第 4 次フレームワークプログラム(1994−1998 年)からは、EU の研究開発活動は産業ニーズと産業競争力の強化により一層寄与すべしとの命題のもとに、各技術分野で新しい施策が導入されたが、非原子力エネルギー分野では、従来は独立して実施されていた JOULE と THERMIE の両プログラムが、CEET(クリーンで効率的エネルギー技術)の実用化推進をその重点目標として、一本化された。従来と同様、JOULE では長期的性格の研究開発活動、THERMIE では実証活動を対象とし、公募は 95 年初頭から始まり、同年末からは選定されたプロジェクト毎に契約締結が進んでいる。プログラムの基本目的は、次の通りである。

＊広い意味でのエネルギー安全への貢献(経済的に実行可能な新しい信頼性のあるエネル

ギー技術の確保）

＊エネルギー生産と消費とが環境、特に二酸化炭素の排気に与える影響の改善

＊エネルギー産業の技術基盤の強化への貢献（経済、雇用、輸出、社会融合、域外との国際協力等への貢献を含む）

EUフレームワークプログラムの総予算123億ECU（約1兆6360億円）の内、研究・技術開発・実証試験活動には106億8600万ECUがあてられており、その配分割合では情報技術（32%）、産業・材料技術（18.7%）に次ぎ、非原子力エネルギーには10億200万ECU（9.4%）と3番目に力が入れられている。さらに、環境・気候に対する予算（8%）、および産業・材料技術分野で行われている環境調和型の製造技術への予算を加えると、エネルギー・環境保護は予算規模が第2の活動分野となり、EUの真剣な取り組み姿勢が反映されている。

新JOULEの全体予算は約3億8000万ECUと、従来のプログラム予算の2倍以上と大幅に増額されたが、これはエネルギー研究への重点が高まったこと、および産業ニーズに密接に関連した活動が増えたことによる。残りの約6億2000万ECUは、THERMIEとその他の施策に充当される。以下では、すでにプロジェクト公募と選定が始まったJOULE-THERMIE計画のプログラム活動方針、特に石油代替エネルギーに関する活動方針について述べる。

第1.2.2-1表には、JOULE-THERMIEプログラムの予算概要、公募・選定・契約・研究開始の日程等を示す。

第1.2.2-2表には、プログラムにおける各種の異なった活動の目的、主要実施者、担当EU総局を示す。

1.2.3　プログラム内容と活動方針の概要

新しいプログラム内容は次の通りである。JOULEの対象分野は、エネルギー研究技術開発戦略、エネルギーの合理的な利用、化石燃料、エネルギー技術の普及、再生可能エネルギーの5件である。ここでは、最初の4分野の目的と技術的活動内容について概要を述べ、再生可能エネルギーについては、項を改めて詳細を紹介する。また石油代替エネルギーをここでは、EU用語に従い、再生可能エネルギーとする。なお、見出し後のカッコ内数字は、第1回公募（1995年末までに研究契約終了分）に当てられる予算金額を示す。

(1) エネルギー研究技術開発戦略 (1200 万 ECU)

エネルギーに関連をもつ、環境と持続可能な発展、社会発展、雇用増進、社会融合、産業競争力、生活スタイル、途上国の経済発展、世界・地域レベルでの経済発展等とエネルギーとの間の複雑な関係の理解を深めることを目的とする。 活動内容:各種の研究技術開発政策に関する全体的分析、エネルギーのための社会経済研究、エネルギー問題分析用モデリング、エネルギー・環境・経済に関する対話用フォーラムの設立、加盟国・先進国・国際機関等の政策の分析、成果普及と技術振興のための方法の開発

(2) エネルギーの合理的な利用 (4500 万 ECU)

消費部門でのエネルギー需要を低減し、新しい効率の高いクリーンエネルギー技術の開発と実用化と普及を図るための研究開発と実証活動であり、EU レベルでの活動には特に適した分野である。建物、産業、運輸へのクリーン技術の応用と普及の他に、エネルギー消費と排気ガスで急速な増加を示している運輸部門には特に重点をおく。

活動内容:建物での合理的利用、産業における合理的利用と環境汚染の低減、エネルギー産業および燃料電池、輸送における合理的利用

(3) 化石燃料 (2500 万 ECU)

研究開発では、排気ガスの低減、エネルギー変換と利用効率の改善、化石燃料の火力発電所の経済性の向上を全体目的とする。特に、石炭利用における環境公害の低減、燃焼に関する研究、輸送用燃料の改良、欧州の炭化水素資源の探鉱方法の改善に力を入れる。実証活動では、全ての化石燃料を対象とし、欧州技術が重要なブレークスルーを達成しそうな特定事項に的を絞った助成を行う。

活動内容:固体燃料用のクリーン技術(石炭等とバイオマスと廃棄物の混合利用)、
通常の水蒸気サイクル(燃料混合技術、発電所関連)、新しい先端的サイクル、
燃焼の基礎(研究開発のみ)、輸送用の新燃料、炭化水素の相互変成の改善、
よりクリーンな輸送用燃料(ガソリン、ディーゼル、その他代替品)、炭化水素、
資源評価と管理、深層の複雑構造、海盆の解析、探鉱(実証のみ)、
生産(新生産設備、回収法改善)、輸送問題(ガス、液体)、
天然ガス(貧鉱ガス資源に関する技術の実証)

(4) エネルギー技術の普及 (200万ECU)

この活動の目的は、エネルギーの合理的利用、再生可能エネルギー、化石燃料に関する優れたエネルギー技術の普及と実用化の推進である。

活動内容:エネルギー技術の応用に関する市場調査、情報資料の作成と発行、情報・プロジェクト研究成果の普及(技術ワークショップ、セミナー、会議、プロジェクト現場訪問、展示会等)、エネルギープログラム活動を促進するための施策と助言の提供、応用や管理に携わる人々に対する訓練の実施、新技術の普及を促進するための適切な融資メカニズムの開発、普及活動や協力活動支援に携わる各種機関の活動強化

1.2.4 再生可能エネルギーの開発・利用に関する活動 (1億ECU)

このプログラムでは、再生可能エネルギー技術の実用化を促進するため、再生可能エネルギー技術のコスト競争力、信頼性の改善、および既存のエネルギー供給者における理解と信頼の強化を目的としている。また、技術問題のみならず、政策に係わる ALTENER プログラムの基礎となる経済社会問題とも取り組み、地方自治体や主要なエネルギー企業との協力体制を進めていく。

(1) 再生可能エネルギーの統合

ここでは、再生可能エネルギーの社会の日常生活とエネルギー市場への導入と統合を促進するべく、供給側と需要側に関連する技術的、経済的、社会的施策の導入に関する問題を取り扱う。活動では、国政府や地方自治体、業界や専門団体、一般企業等との協力を柱とし、さらにEUの関連機関である地域開発基金、社会基金、融合基金、共通農業政策(CAP)等からの協力を得る。活動目標としては(イ) ALTENERプログラムにおける2005年の目標を達成するための経路と方策手段に関するシナリオの開発、計画および実施、(ロ)再生可能エネルギーの実用性を高めるための詳細計画(経済的社会的統合に必要な準備、導入に対する障害の克服、製品開発と標準規格に対する貢献)、(ハ)開発途上国の農村電化に不可欠な施策の明確化、を掲げている。

(2) 太陽光発電

太陽光発電(PV)は、設備の簡便性と環境調和性の点から最も有望な技術の一つとされており、研究の全体的目標はシステムのコストダウンであり、電力については数メガワットの発電においてkW時あたり1ECUの電力コストを目指したガイドラインの設定を考えている。PVシステム

の実証では、政策立案者と金融機関と密接な連携を保ち、PV に対する意識の向上と、EU ばかりでなく途上国における大型 PV 市場の発展を促進する重点施策を行っている。

(3) 建物における再生可能エネルギー

研究開発は、建物における省エネと再生可能エネルギー利用に関して、標準規格の準備段階における従来の研究活動を継続し、重点を新しい技術、標準規格や規制の改善、ソーラー建築の原理に基づく新しい都市建築のコンセプトにおく。実証では、パッシブ型とアクティブ型のシステムの応用と統合化に関する活動を継続し、旧式建物の改修再開発と新しい低エネルギー建築の両者を対象とする。

(4) 風力発電

欧州の風力発電技術は 1980 年代に急速に発展し、EU の主要国ではその実用化導入が盛んとなってきた。そこで研究開発では、基本的問題の研究を継続し、主に従来からの大型風車タービン WEGA-2 プロジェクトの成果を利用して、さらに大型のタービン開発に発展させると同時に、小型タービンのコスト効率と信頼性の向上を目指す。実証では、性能・効率・信頼性の向上、コストと騒音の低減および、現行の実用化で問題になっている立地不足と公衆の反対への対処に高い優先度をおく。コスト低減目標としては、欧州の現行最低の電力価格レベル(例えば、ガス火力発電ではキロワット時で約 0.04ECU)とする。また、アルプス等のより複雑な地勢における建設可能性についても検討を続ける。

(5) バイオマスと廃棄物からのエネルギー

バイオマスは、EU エネルギー資源の安定供給面からばかりではなく、環境面、地域・農村開発の面からも重視されている。現状すでに、膨大な森林・農業廃棄物の処理問題があり、加えて共通農業政策(CAP)の減反政策で余剰となった農地利用の課題がある。また途上国でも、重要な資源である。研究開発では、バイオマスの利用増加のため、固体原料の熱化学的変換による発電と自動車燃料への利用に重点をおく。実証では、新しいエネルギー利用面とエネルギー変換プラントのコスト競争力の改善強化に重点をおく。

バイオマスの研究開発は、エネルギープログラムの他、AIR(農産業)プログラムでも助成の対象とされている。後者では、原材料の生産・輸送・処理工程に重点を置くのに対し、前者では固体バイオマスのエネルギーへの変換と利用に重点がある。特にこの両者にまたがる総合的プロジェクトは優遇されている。

(6) 水力発電

EUに残された未知の資源地における小型水力発電(5MW、例外として10MWまで)のプラント建設による実証。主要目標の一つは、建設投資金額の低減。

(7) 地熱エネルギー

欧州では過去20年間に、通常の地熱エネルギー利用に関する技術の研究開発は、ほとんど終了しているため、現在は高温岩体(HDR)に重点が置かれている。現在は、1994-95 年プロジェクトによりアルザスで大規模な開発プロジェクトが進められており、1996 年初頭に予定されている見直しで前向き評価が下されれば、研究用パイロットプラントの建設に発展する。

(8) エネルギー貯蔵およびその他の技術

＊研究開発

a. 先端的なエネルギー貯蔵に関する研究開発(長寿命バッテリー、フライホイール、水素・燃料電池等。蓄電、化学熱貯蔵、相変態熱貯蔵)

b. 波力発電の研究開発(海岸に中能力のﾊﾟｲﾛｯﾄ発電ﾌﾟﾗﾝﾄの建設。長期的コスト、構造設計、送電網との接続、基礎的問題の研究、海流に関する研究等)

c. 太陽熱発電ﾊﾟｲﾛｯﾄﾌﾟﾗﾝﾄの開発(EU 域外の地中海沿岸諸国との共同研究)

＊実証

d. 公益企業との共同による太陽熱発電プラントの実証(ソーラー・ガス)

e. 波力エネルギーと潮流エネルギーの実証プロジェクト(技術面で実用規模での応用と実用化が、可能となる段階に達した場合)

f. 各種の再生可能エネルギー源を組み合わせた、ハイブリッドシステムの実証

1.3 石油代替エネルギー技術の導入と開発利用の近況と展望

EU 諸国における、石油代替エネルギー技術に対する取り組みと利用状況の全体像については、昨年度の報告書に詳細が紹介されている。

そこで本報告書では、そうした全体的状況を前提とした上で、主として1994年後半から95年後半までに見られた、技術導入や実用化面、商業面における主な話題や動向を、個別技術ご

とに紹介する。個別技術の観点から最も動きの見られるのは、風力発電、ソーラー発電と建築への利用、バイオマス・廃棄物の焼却とバイオ燃料の 3 分野である。

1.3.1 風力発電

(1) 大型タービン時代の到来と風力タービン産業界

西欧の 18 風力タービンメーカーの技術水準は「MW 級」の実用タービンを販売できるところまで達しており、それには JOULE における、大型機に関するプロジェクト成果が大いに貢献している。例えば、オランダ Nedwind グループは、1994 年 3 月に最初の 1MW 商用機の設置を行い、その後 18 社のほとんどがプロトタイプの稼働、完成ないしは製作中で、1996−97 年には小規模生産に乗り出す構えである。その他 1995 年末までには、ドイツの Enercon 社が最初の 1.5MW 機を Aurich の本社近くに、Tecke Windtechnik 社が 1.5MW 機を Emdenn 近くに設置した。造船とタービン製造の Husumer Schiffswerft でも、1MW 機 4 基による発電プラントを造船所近くに建設し、将来計画としてドイツ最初のオフショア風力発電ファームの建設免許を、シュレスビヒ・ホルスタイン州のオフショア風力パーク管理機関が申請した。これはバルト海上に建設され、1997 年から 1MW 機 10 基で発電を始め、最終的にはそれを 65 基まで拡張する計画である。以上は、沿岸地帯の例であるが、内陸工業地帯の北ライン・ウェストファーレン州においても、Nordex が Hoexter に 1MW タービン 2 基を設置する計画を発表している。

デンマークでは、Vestas 社が Tjaerborg に 1.5MW タービンを設置し、Nordtank 社も同一能力のプロトタイプを Ebsjerg に設置した。一方では、このような大型機における技術的、経済的メリットの有無についての議論が始まりつつある。

現状の事業面においては、デンマークの風力タービン産業は世界一を誇り、同国のタービンメーカー6 社は世界トップ 10 社以内を占め、世界市場の約 50%を占有している。この他の 4 社は、米国 1 社、ドイツ 2 社、インド 1 社である。

94 年デンマーク産業は製品の 85%を輸出し、輸出依存度が極めて高い。一方、米国企業とドイツ企業の輸出比率は、それぞれ 40%と 10%にすぎない。デンマークは、特にインド市場で強く同国需要の 80%以上をまかなってきている。しかし国内市場は停滞し、同国特有の民間消費者グループによる建設は落ち込み、地域電力会社が政府に約束した風力発電への投資計画の達成は、すでに 2 年近く遅れている。しかし、輸出の好況により雇用状況は良く、1994−95 年度の伸びは 51%でタービンメーカーとその下請けを含む風力タービン産業の全従業者数は

8500 人となっている。

フランスでも同様な活況が、タービンブレードメーカーの ATV (Atout Vent) 社で見られる。同社は世界のブレード大手 5 社の一つで、炭素繊維とエポキシ樹脂による大型一体ブレード製品が主力である。1994 年に同社売上は、570 万 F フラン (110 万ドル)、従業員 12 名だったが、すでに 1995 年前半期には 35 名に増え、売上は年間 3000 万 F フランに迫る活況を呈し、1996 年には売上が 1 億フラン、利益が 1200 万フランとなる予想である。それは、Douai に工費 1650 万フランの新工場をオープンしたためで、今後は近接するオランダとドイツへの輸出に対応する。また従来の Fuveau 工場はイタリーとスペインへの輸出に重点をおく。

(2) ドイツの風力発電

ドイツではこの 5 年間に風力発電が急速な発展を遂げ、1995 年末に設置が終わった発電能力は、1000MW の大台を越えた模様である。1995 年 6 月時点ですでに、タービン数 3027 基 (836.7MW) の発電施設が操業中であり、さらに 1995 年前半期だけで 204MW (タービン数 441 基) が設置された。この成長は前年同期比で、発電能力で 108.3%、タービン数で 48%の増加で、大型タービンの普及によりタービン平均出力は 463kW となった。既存施設による発電量は、1.9TWh/yr と見られ、全電力需要の 0.4%に相当している。

ドイツの風力発電地域は、北海岸に面するシュレスビヒ・ホルスタイン州に 362MW、内陸北部のニーダーザクセン州に 237MW となっているが、内陸工業地帯の北ライン・ウェストファーレン州でも 66MW を有して健闘している。

ほとんどのタービンは、Enercon、Tacke Windtechnik、AN Maschinenbau の国内 3 社とデンマークの Vestas と Micon が供給している。

1990 年から始まったドイツの風力発電ブームの火つけ役は、連邦研究省が始めた「250MW 風力エネルギープログラム」である。次いで促進役を果たしたのは、1991 年に導入された「電力供給法」(電力会社に対し、私的業者の石油代替エネルギー源による電力を、プレミアム付きで購入し送電網に受け入れる義務を負わせた法律) であり、風力発電が最もその恩恵を享受して大発展を遂げた。この結果、公益発電業者側でのコスト増加は 1994 年に 1 億 3500 万マルク (9500 万ドル) と見られている。しかし、最近ではこのブームにも陰りが見え始めてきた。タービンメーカーに対する最近の調査結果では、仕掛りと受注残高が落ち込みつつあり、1996 年の国内需要は冷え込む予想であり、各社とも輸出拡大による製造設備稼働を迫られている。その理由は、250MW プログラムが終了に近づき風力用助成予算が縮小していること、および上

の「電力供給法」の将来性に疑問を投げかける事件の発生である。この事件とは、1995 年初頭に公益電力会社が、プレミアム支払の拒否や憲法裁判所での違憲審査を叫んで、この法律に対する批判キャンペーンを始めたことである。これで国内では議論が沸騰し大騒ぎとなったが、年末には連邦政府が法律の当面の有効性を保証する一方、カールスルーエ地方裁判所は裁定を違憲裁判所に委ねるとし、水力発電所に支払を拒否した企業についての審理は高裁の違憲裁定待ちとして却下し、当面は小康状態に入っている。

(3) スペインでの発展とギリシャ民間事業の動向

最近スペインでは、風力発電ファームの建設ラッシュの動きが表面化し、以下に挙げる数例は、1995 年における活発な動向を反映している。同国再生可能エネルギー庁では、1991 年に同国の 2000 年までの風力発電目標として元々175.2MW(PAEE プログラム)を掲げたが、最近の発展は当時目標を大幅に上回り、その後 1991−1994年目標は達成され、1997年目標は 330MW に修正されている。

同国のタービンメーカー Gamesa 社では、これまでデンマーク Vesta 社と共同しながら、スペイン地方自治体政府による 4 件の風力発電ファーム建設に取り組んできたが、最近、スペインには今後 15 年間に 2GW の風力発電能力があるとして、積極的な事業活動に乗りだした。その動きの最初は、Navarra 水力エネルギー(ENH)が進める Navarra の El Perdon 風力発電ファームである。ここに同社が納入した 6 基の Gamesa Eolica 500kW タービンは、1994 年末から稼働を始めているが、1996 年に設定した合計 20MW の能力達成を目指して、同社では続く 34 基を納入中である。同社では、この El Perdon は氷山の一角で、さらに地方自治体による数件の 300-600MW 級の大型計画があるとしている。

Ebro 川の周辺地域では、Navarra の他、Aragon と Rioja 地域においてもファーム建設の投資が展開されており、その総額は 1050 億ペセタ(8 億 6000 万ドル)の規模で、その主体は Navarra 公益会社の ENH である。EHN では 950 億 Pta で、この地域に 556MW の能力を有するファーム 16 件を建設し、さらにサラゴサ電力会社(ERZ)と折半で、1994 年末オープンした La Muela の Parque Eolico de Aragon(Made 社製 330kW が 16 基、5.28MW、10.56GWh/yr)の拡張を行い、それに加えて Iberdora 社と共に Rioja にファームを新設する。また、 La Muela にはすでに、別の風力発電ファームの Parque Eolico La Muela (545kW)が操業中である。

さらに、Tarifa 地方の第 4 番目の風力ファームが 1995 年 9 月末に稼働を始めた。能力は同国最大の 30MW で、米国の風力タービンメーカー Kenetech 社が同社の 330kW 機(33M-

VS)90 基により 130GWh/年を発電する。これは純粋な民間プロジェクトで、米仏スペインの銀行 4 社が 66 億 Pta(5400 万ドル)の建設費用をまかなった。発電設備の制御は、衛星通信でサンフランシスコの Kenetech 本社が行い、電力は公益送電会社を通じて販売されている。また Kenetech は、Galicia 地方で、建設費 450 億 Pta の大型風力発電ファームを計画している。Tarifa 地方で操業している他の 3 件のファームは Seasa(30.48MW、72GWh/yr)、Parque Eolica de Tarifa(440kW、1.2GWh/yr)、Parque Eolicode Monteahumada(1.95MW、5GWh/yr)である。タービンは全てスペインメーカー3 社の、Ecotecnica(30,150,300kW)、Made(150,180,300kW)、AWP(100kW)による製品である。また、公益企業 Endesa は、北スペイン海岸の Cedeira に Made 社製の 330kW タービン 55 基による、16.5MW の風力発電ファームを建設する計画を打ち出している。

一方、ギリシャはこれまで出遅れていたが、最近、石油代替エネルギー促進法が導入されるに及んで、民間の関心が一挙に高まり、特にクレタ島などにおける風力発電ブームがスタートしている。この法律で、国営独占企業の公共電力公社(PPC)は、私的発電による電力の購入を義務付けられるとともに、石油代替エネルギー源の開発プロジェクトのライセンス認可権限も、大きく制約されることになった。すなわち、PCC の権限はプロジェクトの技術的要因に関するものだけに制限され、1 ヶ月以内に産業・エネルギー大臣に意見具申がない場合には、PCC はプロジェクトに同意したものと見なされることになった。

こうした背景で、クレタ島では 10 件(104MW)もの風力発電の民間プロジェクトの認可申請が出され、すでに 2 件のファームが認可を受けている。両者の建設費は 62 億 Dr(2600 万ドル)、Vestas 製 V-39 タービン(500kW)により 1996 年末に操業開始の予定で、総発電量は 58GWh/yr と予想されている。

1.3.2 バイオマス・廃棄物

(1) 廃棄物のエネルギー利用のための組織

European Energy-from-Waste Coalition(欧州「廃棄物からエネルギーを」連合:EEWC)は、最近設立された欧州レベルにおけるロビー活動機関で、目的は、法規制当局、産業経済界および一般公衆に対し、廃棄物のエネルギー源としての利用を呼びかけ、その推進にあたることである。その会員は、原料素材メーカー、エネルギー原料メーカー、2 次エネルギーメーカー、エネルギー機器メーカー、消費財メーカー、廃棄物関係機関・企業等と広範囲にわたっており、次の課題は、地方自治体会員の増加である。

William Seddon-Brown 会長は、西欧で年間排出される約 1 億 3000 万トンの都市固形ゴミで全電力需要の 5%をまかない、輸入石炭を半減できると説いている。現在は 358 基の焼却発電所で、都市固形ゴミの 24%(3324 万 ton/yr)がエネルギー発生用に利用されているに過ぎない。エネルギー生産では、北欧諸国とスイスが最も進んでおり、スウェーデンの例では、暖房の 15%をまかなっている。しかし、その他諸国では未だに発展の余地が多く残されている。

第 1.3.2-1 図には、欧州エネルギー発生用ゴミ焼却能力の現状を示す。

EEWC では、次の 4 つの目的を掲げている。

＊廃棄物焼却エネルギー生産の環境的利点の、科学的根拠に立脚した議論

＊廃棄物焼却エネルギー生産の持つ、社会的、経済的利点の理解普及

＊新技術の実証

＊欧州レベルにおける精度の高い情報収集と統計データの確立

EEWC の当面の対応課題の一つは、廃棄物焼却に対する環境保護面からの反対である。EEWC によれば、約 3 トンの都市ゴミ焼却により、二酸化炭素の増加に寄与する石炭 1 トンが節約でき、埋立地の大幅節減が可能となる。現在では、新技術の利用で有害物質の排出に対処でき、そうした対策を要求する法規制の枠組みも揃いつつある。特にダイオキシンの問題も解決が可能で、オランダの例では、2000 年までに焼却能力を倍増するのと平行して、有害排気を大幅に低減しダイオキシン排出は 85%削減する計画である。またスウェーデンでは、85 年から始まった都市ゴミ焼却でのダイオキシン排出低減活動により、96%削減されている。EEWC では、焼却処理の重要性を訴えつつ、共通の排気基準や標準規格の確立、エネルギー利用を当然のこととする意識の定着に努めるとしている。

(2) スペインの廃棄物利用動向

スペイン政府は、2000 年に目標を定めた再生可能エネルギー利用計画(PAEE)を積極的に推進中である。バイオマスは、スペインでも最も使用量の多い石油代替エネルギー源で、PAEE ではバイオマス・廃棄物の利用目標として 42 万 7000 石油相当トン(toe)を掲げている。1994 年、同国のバイオマス生産量は 375 万 toe と全石油代替エネルギー使用量の 59.7%にあたる。利用分野では、家庭用が 210 万 toe と最大で、伝統的な農林廃材の薪炭利用である。次いで、パルプ・製紙業が 19%、飲食産業が 10%、材木産業が 8.3%、窯業が 3.4%となっている。

また、PAEE 計画の順調な進展で 1994 年末までには、農業・産業廃棄物利用が促進されて 74789toe に達し、現在設備建設中の 30157toe 分と合わせた 104946toe は、PAEE の同分野目標である 28 万 toe の約 38%に上る。農業・産業廃棄物利用分野は、PAEE 全体目標の 65%を占めている。バイオガスでは、現在の生産量は 11792toe/yr、設備建設計画済みが 1072toe 分で、両者で PAEE 目標 27000toe(全体目標の 6.3%)の 48%が達成されている。この他に、PAEE 全体目標に対する貢献割合としてはバイオ燃料が 19%、エネルギー作物と農林業廃棄物が 4.7%とされ、その活動はこれからの課題だが、計画立案はすでに終わっている。

政府の計画推進には、IDEA(国立金融機関)、ICO(Institutio de Credito Oficial)、Endesa(電力公社)が融資面で協力している。バイオマス関係では PAEE 推進のため、IDEA 主導ですでに 340 億 Pta(2 億 8100 万ドル)が投資されており、その内 74 億 Pta は公的資金、18 億 Pta は民間資金である。

IDEA では、石油代替エネルギーへのプロジェクト融資に加え民間投資家に対し、資源評価、技術調査、資金計画、エネルギー販売による投資回収計画等に関する助言と支援を与えている。また、計画のエネルギー生産目標が達成された時点で、設備所有権を投資家に移転している。IDEA が仲介した完全民間資金によるバイオマス発電所はすでに 6 件あり、内 4 件は製材産業関係で 9340toe/yr の他、オリーブ瓶詰め会社における残留オリーブ種の利用設備と綿糸会社の設備の両者で 585toe/yr を生産している。その建設費用は 3 億 3970 万 Pta、全体で節約される燃料は 9920toe/yr(1 億 590 万 Pta)と見積もられている。

ICO では、産業・エネルギー省予算や地方自治体政府の事業予算の支出仲介にあたり、銀行に対する融資条件は総投資額の 70%、期限 10 年を上限とし、利率は基準金利＋1%あるいは長期では 0.5%固定としている。このシステムでは、公的機関や民間のプロジェクト提唱者の委任により、融資を受ける銀行自らが、プロジェクト事業の実現性を明確にして、ICO に提案し審査と承認を受ける。ICO は 1994−95 年の 2 年間に、130 件の環境関係プロジェクトに 188 億 Pta を融資することで、その他の追加投資 793 億 Pta を引出したが、この環境プロジェクト中には、10 分野以上の石油代替エネルギープロジェクトが含まれている。

同国独特の事例には、アンダルシア地方では、オリーブ廃棄物を燃料としたコジェネレーションの試運転で 1995 年 9 月からの 6 週間に、1GWh を発電したとの発表がある。操業者の Vetejar は、地域電力会社(Sevillana de Electricidad)と再生可能エネルギー共同組合(Oleicola El Tejar)のジョイントベンチャーで、プラントの設立にもあたった。設備能力は 12.9MW で、この地域で発生するオリーブ廃棄物の利用を目的と、年間 14 万トンのオリーブ絞

りかすを燃料とし、第 1 年目は 12.6GWh の発電だけを目標としている。アンダルシアでは、1960 年代から廃棄物の一部を搾油機や乾燥機の動力用燃料としていたが、水分 60%を含む廃棄物の燃焼には問題があった。今回の設備では流動床システムを導入し、含水廃棄物の処理を行っているが、効率は現状 30-60%である。同地方の年間オリーブ収穫量 300 万トンの80%、240 万トンは廃棄物であるから、共同組合ではコジェネの将来性に期待し、年間 15 万トンを燃料とする同プラント規模の設備 16 基により、同地方の総電力需要の 6%に相当する201.6GWh の発電が可能になる上、廃棄物問題も同時に解決するとしている。

(3) 自動車用バイオ自動車燃料の最近の動向

欧州最大の自動車会社フォルクスワーゲンは、菜種油原料によるディーゼル代替燃料の実用化開発を 10 年以上続けており、将来的は全燃料の 5%がこれに置き代わると予測する一方、実用化の進展速度は、燃料課税の動向に著しく左右されるとしている。現在では、オーストリアやフランスを始め欧州大陸の諸国では、菜種油メチルエステル用給油スタンド網が次第に拡がりつつあり、ドイツでも現在、250 ヶ所の石油スタンドがバイオディーゼルを販売するまでになっている。同社がすでに市販を始めた Golf Ecomatic モデルは、菜種エステル代替燃料を使用し、それをディーゼル油と任意の割合で混合しても利用することができる。

一方、ドイツ石油産業連盟はバイオディーゼル普及に反対で、エネルギーと環境保護は、農業補助金をさらに増額するための別の口実にすぎないとしている。その主張では、菜種生産のためにはさらに余計なエネルギーが消費されるため、環境保護への貢献には疑問があり、バイオ燃料の生産コストはリッター当たりせいぜい 2 マルク(1.45 ドル)で、通常ディーゼルの 0.3-0.4 マルクと比較してバイオに経済性が生まれるには、現行の原油価格の約 20 ドル／バレルが、200ドル／バレルに高騰した場合である。それがなければ、現行のリッター当たり1.50マルクと高額の補助金が必要で、万一にも自動車燃料の 5%がこれに取って代わる事態となれば、補助金額は年額20億マルクと途方もない額となる。しかも、ガットにより安価な外国製品が輸入されるから、税金による補助金でドイツ農民ではなく、国外の農民を養うことになると訴えている。

1993 年の EU 共同農業政策(CAP)の改革で、農民は補助金の替わりに休耕を義務づけられている農地に非食糧用作物を栽培しても補助金を受けられることになった。農業技術に強く産業競争力のあるデンマークでは、非食糧用作物としてバイオ燃料用エネルギー作物が、生産を伸ばしつつある。中でも最も人気があるのは菜種で、ほとんどがバイオ燃料用に他の EU諸国に輸出されている。

デンマークでは、1993年時点で20万8000ヘクタールが指定休耕地だったが、同年にはその内 18000 ヘクタールが非食糧作物の生産を開始し、1995 年には食糧生産を休耕している農地面積は約 25 万ヘクタールだが、非食糧生産用農地は約 5 万ヘクタールに増加した。一方、自国内にはバイオ燃料の生産や利用促進に関する優遇措置等は存在せず、関係者はバイオ燃料に対する国税の廃止を訴えている。

フランスでは減反補助金対策として、政府の環境・エネルギー管理エイジェンシー(ADEME)が、バイオ燃料の 3 分野、すなわち菜種油とそのメチルエステル誘導体、石油燃料へのバイオエタノール 5-10%混合燃料とそのエーテル誘導体の 10-15%混合燃料(ETBE)、最後に家庭や都市汚水処理場のスラッジからのバイオガス生産に重点を置いている。ADEMEでは、エンジンへのバイオ燃料利用に関する技術的問題はすでに解決済みとして、リッター当たり混合燃料価格の 1 フラン(0.2 ドル)までのコストダウンを重視している。ADEMEは、長年フランスの各都市でバスを含む各種の車種により、菜種油エステルやエタノール等の性能試験を続けてきており、今後の実用化推進に必要な情報は十分に揃っているとしている。特にエチル・テルチオ・ブチル・エーテル(ETBE)は無鉛ガソリンに 15%まで混合でき、環境的に優れているとして、石油大手のELFとTOTALではその利用に積極的である。ELFでは、すでに ETBE 用エタノールを年間 50 万ヘクトリッター生産し、現在はさらに 2 ヶ所のプラント建設を計画中である。TOTAL でも、2 プラント建設を計画している。

また、フランスの原料メーカー Diester では、菜種油メチルエステルが実用生産段階に入りつつあるが、その 60%を石油精油所に、30%を独立系石油製品流通業者に販売している。生産量は1993年3万3000トンから、1995年は10万トンを越え、1996年は18万トンを予定している。同社では、国内3ヶ所で生産しているが、今後は、ひまわり油エステルの開発を計画中であり、石油企業のバイオ燃料への関心は年々増加中としている。同社の中長期見通しで重要な役割を果たす 3 要因は、エンジンメーカーによる菜種油燃料の認知、欧州全体をカバーする新しい課税システム、菜種栽培農家に対する投資回収率の改善である。

1.3.3 太陽エネルギー

オーストリアでは、太陽エネルギーの利用面積が1995年に100万平米を突破したことが発表された。パネル面積の年間平均伸び率は約10%で、その大部分は、家庭や温水プール用である。太陽光発電用は、送電費用が著しく高い山岳地帯で多用されている。環境保護派の計算では、このパネル面積で年間 SO2 排気 602トン、CO 排気 234トン、CO2 排気 30 万トンが削

減されている。また、南オーストリアの電力会社の Kelag では、本社ビルに 85 平米の太陽電池パネルを設置しビル用電力の足しにしている。建設費 250 万シリング(26 万ドル)の設備は、能力 10.2kW で、年間発電量は 8GWh である。同社の設置目的は情報収集のためである。なお、同国の電力需要の 75%近くは、水力発電によっている。

ドイツ連邦の首都ボン市では、アーヘン市とレムシャイド市に続き、「電力供給法」に基づく発電事業として、同市最初の太陽光発電設備が建設中である。これは個人投資家が、工費 90 万マルクで製材所の屋根上 500 平米に発電パネルを設置し、年間に約 1000 時間の太陽光を利用する構想である。この法律により公益電力事業者が小規模発電者に支払う kW 時あたりプレミアム付き料金は、通常料金 0.23 マルクに対し 2 マルクである。

南ドイツのバイエルン州政府は、2000 年までに州の一次エネルギー消費量に占める石油代替エネルギーの割合を、現在の 7%から 13%に増やす(内訳:水力発電は現行と同じ 6%、バイオマスが 5%、残りの 2%は風力、ソーラー、地熱、ヒートポンプ等)計画である。その予算としては、1995 年と 1996 年に年間 3350 万マルクを用意している。また、ソーラーパネルやヒートポンプを家屋やビルの上に設置する場合には、設備の規模に応じ 1500-25000 マルクの助成金が支給される。

ドイツ最大の個人用ソーラー発電パネルは、15.6kW であったが、最近ボッフム市の土壌・水質分析化学研究所が 36.5kW のパネルを設置し、それを越えた。非晶質と結晶シリコンの面積 360 平米のパネルで、年間 23000kWh を発電する予定。これで、従業員 40 名の同研究所の電力使用量の 30%をまかない、少量を公共送電網にも供給している。ただし、同研究所の計算では kW 時コストは 3－4 マルクとなる。建設費用 110 万マルクの半額は、連邦科学省の助成金である。

ドイツのフラウンホーファー研究協会の一部門ソーラー・エネルギー・システムでは、アルパイン・クラブの依頼で、南山岳地帯の山小屋用に太陽光発電設備を建設中で、すでに 15 戸の山小屋では発電中である。山小屋では、これまでディーゼルエンジンで発電していた。一例のミンデルハイム小屋では、15 平米の集光器により、ディーゼル発電時間が半減し、年間 3400 リッターの燃料が節減される一方、毎日 700 リッターの温水が供給されている。また、同研究協会では、ベルヒテスガーデン国立公園において、単に電力と温水だけでなく家屋暖房用の熱も供給

できる総合的ソーラーシステムのコンセプトを開発試験中である。

さらに同協会が試験を継続中のソーラー・ハウスは、1994−95 年の最初の冬を外部からのエネルギー導入なしで越冬し、1 年間にエネルギーを完全自給自足する成果を挙げた。徹底した省エネ設計の家屋で、自然光を暖房にも利用し、自然光以外の暖房熱は、太陽光電力で水を電解して得た水素で発生し、合計で 72kWh に過ぎなかった。日常生活の電力用には燃料電池も使用し、天候不順が続く時には、夏に電解で得た水素燃料で発電した。この家屋は、発電効率 80%以上、能力 1kW を有する騒音・公害のないミニ・コジェネ装置といえる。

THERMIE では、太陽エネルギーを利用した、欧州の気候に合った省エネ的ソーラーハウスの建築技術と部品・部材の開発に力を入れ、特に PASSYS の名で知られる、太陽エネルギーを「パッシブ」に利用する開発プロジェクトでは、欧州 14ヶ所で 35 の試験用建物で試験研究が続けている。パッシブとは、熱損失を最少としつつ与えられる太陽エネルギーを最大限に活用し、最低エネルギーコストで最適な居住快適さの達成を目的とする技術である。この試験に使用される測定機器は、収集データの比較を容易とするため全て同一の標準規格に基いている。その第 1 期は 1986-89 年に、第 2 期は 1989−93 年に行われた。その成果として、試験施設を繋ぐ活動が PASLINK プロジェクトとして今も継続されている。また、個々の試験建物とは独立に、取り替えの効く屋根部分だけの開発を行う COMPASS プロジェクトも続けられている。

PASSYS の成果である新しい建築方法、部品、資材等は、必要に応じ EU 建築製品指令を通じ、加盟国の建築国内法規に採用される方向に発展している。指令を具体化する国内立法に続き、その施行手段となる製品や手法に関する工業標準規格の整備のため、EU の委託により欧州標準化機関 CEN の TC89 の場で加盟国標準化機関の代表者が協力し、合意に基づく欧州規格(EN)案を作成後、EU 理事会に提案し採択されると EU 官報に指令関連規格として発表される。こうして欧州規格が決定されると、それは自動的に各加盟国の国家規格となり、同時に建築製品指令に関連する欧州規格は、通常の任意の工業規格ではなく、建築規制法に基づく義務規格として、業者はその遵守を強制されることになる。このように EU の研究開発活動は、加盟国の法規制に影響を及ぼしつつある。

1.3.4 地熱利用と小型水力発電

ドイツのシュベリンでは、地熱プラントが稼働を始めた。これは熱のみを供給し、規模は 10.5MW と同国最大で、同国のその他 17 地熱プラント全体規模に匹敵する。1100 世帯と商業開発団地と皮革工場用の温水と暖房用熱を供給し、ピーク時負荷用にはガスボイラーを備

えている。工費 1800 万マルク(1300 万ドル)の半分は、連邦と州政府の補助金で、公益企業の Wemag が操業に当たっている。

フランスでは、電力独占法により能力 8MVA 未満の設備だけが、電力を国有フランス電力(EdF)に販売を許されている。1994年同国の石油代替エネルギー源による発電量は、水力発電を除き一次エネルギー消費量の 1.8%(420 万石油相当トン)だったが、1800 万石油相当トンをまかなう水力発電を入れると9.7%の寄与となる。水力発電の内約10%は、約1700件の小型水力発電所による。その多くは地方自治体が操業者で、年間平均売上は 400 万フラン(82 万ドル)と自治体歳入の約 15%を占める。例えば、Vosges 地方の La Bresse の自治体では、スキー場と地元産業用の電力の 16%を自給し購入量を節約し、北部の Cateau Cambresis の自治体では、建設費用約 42 万フランの投資で廃棄ダムを修復し、13.4MW の新型発電タービンで、給水塔の揚水用と公共建物用の電力を供給し、年間 6 万フランの電力料金を節約している。また Voges 地方で、土壌中で腐敗する花鉢のメーカー Fertil 社の例では、3基の小型水力発電設備により年間 2GWh を発電し、週 5 日 24 時間稼働の工場用電力をまかない、週末には余剰電力を EdF に販売している。これにより同社では、年間 50 万フランの電力料金を節約している。

1.3.5 今後の展望

EU の一次エネルギー需要に占める石油代替エネルギーの割合は、やっと 4%程度になったが、石油代替エネルギーを振興するための総合的政策の ALTENER プログラムでは、2005年までにそれを 8%に高める目標を掲げている。

しかしEUの予想によれば、現在計画されている加盟国の施策やEU施策のみでは、石油代替エネルギーの利用程度は、2010年においても6.5%と低水準に留まる。一方、EUが現在提案している施策が追加されれば、2010 年には 9%に達する。さらに進んで加盟国と EU とで、エネルギー生産と流通に係わる外部コストやその他社会コストの内部化を完全に考慮した施策を展開すれば、利用水準は 13%以上と顕著な程度になり得る。すなわち国政府や EU レベルでの、エネルギー産業に対する規制やエネルギー問題への干渉がかなり必要とされてくる。したがって、こうした干渉がマクロ経済や社会問題に与える影響に関し、適切な干渉程度を測る指針となり得る、費用/利益の関係についての研究が不可欠と考えられている。

個別技術の近未来の動向では、風力発電の実用化がさらに進展することに続き、バイオマスと廃棄物のエネルギー利用への取り組みがますます重点課題となってくる。特に、バイオマス

利用は、EU 年間予算約 10 兆円の 47%を食いつぶす農漁業助成と、22%を占める地域社会開発関係の施策の効率を改善する点からも、社会的、政治的に重要な役割を果たし得ると見られている。また太陽エネルギーの利用は欧州の気候に適した建築技術の発展を促し、それを反映した新しいビルが目につく。今後とも、こうした方向における欧州の発展が注目される。

第 1.1.2-1 表 EU のエネルギーバランス(1890-1992)

(百万石油相当トン)	1980	1986	1990	1991	1992
一次エネルギー生産	543.37	681.87	636.22	631.05	625.46
固形	256.67	247.89	212.39	188.51	173.83
石油	92.93	153.38	116.26	117.08	120.47
天然ガス	131.60	127.88	131.43	144.50	145.52
原子力	47.11	135.03	158.54	161.94	166.68
水力と風力	15.51	14.31	12.61	13.79	13.91
地熱エネルギー	1.89	1.73	1.98	1.95	1.98
その他	1.66	1.67	3.02	3.29	3.06
純輸入	624.78	499.35	591.75	617.15	629.83
固形	56.75	63.94	78.31	87.53	90.75
石油	519.55	365.00	426.61	441.77	449.66
原油	503.78	343.49	404.23	413.15	436.45
石油製品	15.77	21.52	22.38	28.63	13.21
天然ガス	47.10	69.15	85.22	87.21	88.40
電力	1.38	1.25	1.61	0.64	1.03
ＥＵ域内総消費量	1123.07	1139.15	1197.34	1212.57	1206.77
固形	302.24	305.17	294.76	274.08	256.11
石油	574.87	484.45	510.86	525.16	534.95
天然ガス	178.13	195.61	214.06	231.63	229.05
その他（１）	67.83	153.92	177.65	181.70	186.66
発電量（ＴＷｈ）	1501.95	1728.09	1905.18	1959.07	1976.26
原子力	177.98	533.45	632.67	650.96	678.63
水力（揚水を含む）	188.18	179.89	160.78	176.50	179.69
火力	1135.80	1014.73	1111.72	1131.60	1117.94
発電能力（ＧＷ）	364.42	431.92	458.82	456.44	459.61
原子力	35.97	85.39	104.32	103.65	104.66
水力・風力	65.10	77.06	81.35	81.92	82.88
火力	263.35	269.47	273.14	270.87	272.14
平均負荷率（％）	47.0	45.7	47.4	49.0	49.1
火力発電用燃料	273.82	242.33	261.88	266.78	260.29
固形	164.05	171.93	179.20	180.07	174.55
石油	72.34	36.44	41.82	44.49	46.12
ガス	33.88	30.56	35.86	36.98	34.59
地熱エネルギー	1.89	1.73	1.98	1.95	1.98
その他	1.66	1.67	3.02	3.29	3.06
平均熱効率（％）	35.7	36.0	36.5	36.5	36.9
非エネルギー用途	73.30	73.53	78.29	82.76	83.68
最終エネルギー総需要	747.34	745.42	772.64	784.43	782.73
固形	90.41	91.94	77.46	65.85	57.30
石油	394.45	358.44	368.86	380.66	382.66
ガス	146.74	162.40	175.54	187.43	191.43
電力	108.04	123.14	137.58	141.16	142.93
熱量	7.70	9.50	13.19	9.33	8.41
その他	0	0	0	0	0
ＣＯ２排気（百万CO2トン）	3142	2938	3006	3061	3009
人口（百万人）	333.97	338.87	343.56	345.05	346.65
ＧＤＰ（Bil.ECU1985基準）	3191	3523	3978	4018	4064
総消費/GDP（teo/1985MECU）	352	323	301	302	297
総消費/人口（kgeo/人）	3363	3362	3485	3514	3481
発電量/人口（kWh/人）	4497	5100	5545	5678	5701
CO2排気/人口（CO2ﾄﾝ/人）	9.41	8.67	8.75	8.87	8.68
輸入依存率（％）	54.3	42.6	47.9	49.6	50.8

（１）原子力、水力、風力、その他の電力資源および輸入電力を含む。
('Energy in Europe, 1993 Annual Report'; June 1994, CEC DG XVIII)

第1.1.2-2表 発電用燃料の内容(1993年)

（ａ）旧ＥＣ１２加盟国
総発電量：１８５８ＴＷｈ、発電能力：４５５ＧＷ

（ｂ）ＥＵ１５加盟国（新加盟国：スウェーデン、フィンランド、オーストリア）
総発電量：２１２８ＴＷｈ、発電能力：５２０ＧＷ

燃料種類	使用割合（％）	
	（ａ）	（ｂ）
石炭	３６．４	３３．１
原子力	３４．１	３３．９
水力	９．９	１４．２
石油	９．８	８．９
天然ガス	８．７	８．３
その他	１．１	１．６

(European Commission Energy Green Paper: January 1995)

第 1.1.3-1 表　発電および熱発生における石油代替エネルギー源の利用状況（1991 年）

石油代替エネルギーによる総発電量　：　１８０　ＴＷｈ

石油代替エネルギーによる総熱発生量：　２３３０万　石油相当トン

石油代替エネルギーの種類	利用割合（％）	
	発電用	熱発生
大型水力	８６．０	－
小型水力	８．３	－
バイオマス	３．５	９７．５
地熱	１．６	２．０
風力　＋　太陽光	０．６	－
太陽熱	－	０．５

(European Commission Energy Green Paper: January 1995)

第 1.1.3-2 表　旧 EU12 ヶ国での石油代替エネルギー生産量(1992)
生産量　＝　総国内消費量

（単位：　１０００石油相当トン）

加盟国	水力	風力	他(1)	地熱	ﾊﾞｲｵﾏｽ	ｿｰﾗｰ	総合計
ベルギー	29	1	324	1	244	0	599
デンマーク	2	78	0	1	1206	3	1290
フランス	5885	0	193	155	8832	15	15080
ドイツ	1489	3	1221	7	3283	6	6009
ギリシャ	189	1	0	3	537	75	805
ｱｲﾙﾗﾝﾄﾞ	70	0	0	0	107	0	177
イタリー	3629	0	395	2169	2973	7	9173
ﾙｸｾﾝﾌﾞﾙｸﾞ	6	0	26	0	6	0	38
オランダ	10	13	224	0	539	2	787
ポルトガル	399	1	151	1	2751	25	3148
スペイン	1627	0	99	2	3655	22	5405
イギリス	474	3	425	1	307	5	1215
ＥＵ合計	13809	99	3058	2340	24260	160	43726

(1)　主として産業廃棄物および都市ゴミ

第 1.1.3-3 表　旧 EU12 ヶ国での石油代替エネルギーによる発電量 (1992)
発電への使用量（地域暖房施設への熱量利用を含む）

（単位：　１０００石油相当トン）

加盟国	水力	風力	他 (1)	地熱	ﾊﾞｲｵﾏｽ	ｿｰﾗｰ	総合計
ベルギー	29	1	324	0	0	0	354
デンマーク	2	78	0	0	700	0	780
フランス	5885	0	193	0	174	0	6252
ドイツ	1489	3	1221	0	477	0	3190
ギリシャ	189	1	0	0	0	0	190
ｱｲﾙﾗﾝﾄﾞ	70	0	0	0	0	0	70
イタリー	3629	0	395	1977	0	0	6001
ﾙｸｾﾝﾌﾞﾙｸﾞ	6	0	26	0	0	0	32
オランダ	10	13	224	0	54	0	300
ポルトガル	399	1	151	0	0	0	551
スペイン	1627	0	99	0	1	0	1727
イギリス	474	3	425	0	87	0	989
ＥＵ合計	13809	99	3058	1977	1493	0	20436

(Energy in Europe: CEC DG-XVII. June 1994)

第 1.2.2-1 表　JOULE-THERMIE プログラムの予算概要とプロジェクト選定日程

活動分野	予算＊ (MECU)	対象	公募開始	公募締切	選抜	処理開始	契約開始
研究開発 第１次公募	180	一部を除く全	1994 12.15	1995 3.24	1996 5-6月	1995 9-10月	1995 10-11
研究開発 第２次公募	200	未定	1996 9.15	1997 1月	1997 2-3月	1997 6-7月	1997 7-8月
実証 毎年公募	各年	別途発表	1994 12.15	1995 3.24	1996 5-6月	1995 9-10月	1995 10-11
合計４回	108.5	未定	95/6/7 9月	95/6/7 1月	95/6/7 3-4月	95/6/7 7-8月	95/6/7 8-9月
中小企業の技術振興	48	全分野	95.3以後常時ｵｰﾌﾟﾝ	ﾌﾟﾛｸﾞﾗﾑ終了まで	199-98 5-6月	195-98 9-10月	195-98 10-11月
普及 政策・戦略 実証支援	58	全分野	95.3以後常時ｵｰﾌﾟﾝ	ﾌﾟﾛｸﾞﾗﾑ終了まで	199-98 5-6月	195-98 9-10月	195-98 10-11月

＊予算は、研究契約に対する助成支出概算（百万ＥＣＵ）。プロジェクト委託契約研究の全体費用は、企業参加者の負担を含めると、この数字の約倍額となる。

(Non-Nuclear Energy Information Package, CEC 1995)

第1.2.2-2表　JOULE-THERMIEプログラムの活動形態別の目的、主要実施者、EU担当総局

活動形態	目的	通常の参加者	担当総局
1)　基礎研究	コンセプトの開発	大学 研究機関	12
2)競争前段階的な研究開発	疑似ー実用化製品の完成まで 通常は実験室規模まで	企業に大学や研究機関が協力	12
3)「実験的」ﾊﾟｲﾛｯﾄﾌﾟﾗﾝﾄ	スケールアップに技術的リスクが伴う製品、工程、設備等	企業に研究者や操業者が協力	12 17
4)「商用化前段階的」ﾊﾟｲﾛｯﾄﾌﾟﾗﾝﾄ	ｽｹｰﾙｱｯﾌﾟや実操業条件での試験に経済・技術的ﾘｽｸが伴う場合 通常は実用規模の設備等	企業と設備の操業者	17
5)　実証	商業リスクの最少限まで低減 関係者の関心を喚起する	企業と設備の操業者	17
6)　普及	市場の拡大を促進する	企業と設備の操業者	17

（注）　競争力前段階、「商用化前段階的」等の表現は、ＥＵ助成研究開発政策に特有の用語であり、ＥＥＣ設立を決めたローマ条約において、共同体による研究開発活動助成金が、企業の公正な自由競争を阻害してはならないとする規定に基づいている。したがって、フレームワークプログラムでは、ＥＵ産業の競争力強化を目標とする一方では、直ちに市販や実用が可能な製品や工程・設備の開発助成を行ってはならないとしており、参加者には成果の利用と同時にその公開が、強く義務づけられている。

(Non-Nuclear Energy Information Package, CEC 1995)

第 1.3.2-1 表　欧州における都市ゴミ焼却設備の台数と処理能力
およびそのエネルギー獲得への利用率

国名	都市ゴミ焼却設備数	ｴﾈﾙｷﾞｰ獲得率（%）	焼却能力（千ﾄﾝ/年）	ｴﾈﾙｷﾞｰへの能力利用（%）
ｵｰｽﾄﾘｱ	2	100	336	100
ﾍﾞﾙｷﾞｰ	25	44	2240	62
ｽｲｽ	30	77	2860	90
ﾄﾞｲﾂ	47	100	11230	100
ﾃﾞﾝﾏｰｸ	29	100	2060	100
ｽﾍﾟｲﾝ	7	57	680	79
ﾌﾗﾝｽ	137	55	10310	75
ｲｸﾘｰ	16	63	1480	72
ﾙｸｾﾝﾌﾞﾙｸﾞ	1	100	168	100
ﾉﾙｳｪｰ	5	100	410	100
ｵﾗﾝﾀﾞ	10	90	2800	97
ｽｳｪｰﾃﾞﾝ	17	100	70	100
ﾌｨﾝﾗﾝﾄﾞ	1	100	70	100
ｲｷﾞﾘｽ	31	19	3640	29
合計	358	67	40050	83

(European Energy from Waste Coalition. 1995)

参考資料

"ENERGY IN EUROPE"

ENERGY POLICIES AND TRENDS IN THE EUROPEAN COMMUNITY

WHAT SORT OF ENERGY POLICY DOES EUROPE NEED ?

BY Yves Galland
French Industry Minister

France backed the Commission in its initiative of drafting a Green Paper on energy in order to offset the lack of a clear view of what a common energy policy might entail.

There is a broad consensus about the objectives - or rather the policy directions - set out in the Green Paper: competitiveness, security of supply, environmental protection. These are also the objectives of French energy policy. Likewise, France cannot but endorse the general analysis made in the Green Paper which is based on a study of the European Union's energy balance and prospects.

Above and beyond these policy directions, it is vital to define a proper long-term energy strategy for the European Union since, while the Green Paper provides a basis for discussion, it does not propose quantified targets for a given date, e.g. with regard to energy self-sufficiency, fuel diversity, energy efficiency or the reduction of carbon dioxide emissions. That is in fact why I have used the term "policy directions" rather than "objectives".

It falls to the Member States as a whole to put into perspective these objectives and the definition of appropriate ways of achieving them, in order to construct a long-term strategy in response to certain fundamental questions:

- When we talk about security of supply, do we mean short or long-term security? Looking to the long term, it is quite obvious, for example, that European coal, which is uncompetitive and on the decline, does not have a role to play. Are we thinking of market competitiveness or lasting competitiveness? Where electricity is concerned, for example, the market tends to favour investment with the shortest payback periods, e.g. gas turbines, even though gas is not the most competitive energy source for generating base-load electricity, day in day out throughout the year. However, a more proactive approach, based on lasting competitiveness, would favour hydroelectricity, nuclear power or imported coal, the cheapest base-load energy sources.
- Where the greenhouse effect is concerned, it would seem that only long-term measures will have a lasting effect, and these can only succeed in practice if careful consideration is given to excise duties, taxation, and other incentives for choosing the least polluting energy sources, namely new and renewable energy sources and nuclear power, which do not produce CO2.

Similarly, the European partners should go further than simply exchanging views and look ahead to the future in order to identify the main threats to Europe's energy balance, and how to meet these threats head on:

- How can Europe's growing dependence on external energy supplies, which is likely to rise from 50% to 70% in the next fifteen years, be curbed?
- Can we content ourselves with surging dependence on external gas supplies, rising from 40% at present to 70% in 2010 and nearly 80% in 2020 ?
- If the gas boom predicted by Commission studies results in a price hike, possibly of around 50% towards 2005, how can we then avoid greater recourse to Middle East oil, which is already much in demand in the United States and will be increasingly called upon by the Asian countries, especially if they experience a coal crisis as a result of the alignment of indigenous coal prices on world prices? Would there not then be another risk of an oil crisis?
- More generally, can Europe content itself with growing dependence on (mainly imported) oil and gas which already cover 68% of its consumption?
- At this stage in the deliberations, while not prejudging the underlying intentions of the authors of the Green Paper, a formal criticism has to be made: can this discussion document content itself with such a brief mention of nuclear power, which is actually one of the few indigenous energy sources which can be developed in Europe, and undeniably contributes to the diversification of Europe's energy balance, is a highly competitive energy source for bas-load electricity

generation and, what is more, does not produce carbon dioxide?

Moving away from these purely technical matters, we should consider two fundamental questions on which the European partners will have to make progress in the short term if they want to press ahead with the establishment of a European energy policy. I am referring to the concept of the internal market and the principle of subsidiarity.

The Green Paper sets out from the principle of the pre-eminence of the internal market. France quite agrees that the needs of individuals and industrial users should be satisfied at the lowest possible cost while meeting the requirements of security of supply and environmental protection since competition is a factor in technical progress and is undoubtedly beneficial for industrial consumers anxious to have complete freedom of choice.

For example, opening up the electricity generation monopoly can help to improve economic efficiency and the transparency of the European electricity system.

However, given the long-term threats and risks mentioned above, can we put our faith exclusively in the invisible hand of the market?

While France believes that it is legitimate to define European energy policy objectives, expecting them to be achieved mostly through the free play of market forces would be tantamount to denying the very existence of a specific energy policy designed to achieve those objectives where they do not fit in with the logic of the market.

Referring to the pre-eminence of the market raises another question: how can we establish a balance between the market on the one hand and the concept of public service or general economic interest obligations on the other? This concept exists in most European Union Member States. The concept of public service varies in scope depending on a country's history, administrative organization and economic traditions. In any given State it may vary with time. In France, the concept of public service is based on a few fundamental principles, such as continuity of service, equality of access and treatment for users and universality of service. This *modus operandi*, which applies to the grid energy sources, has proved its merits. Nevertheless, it can be improved upon and adapted to the European context. France has in fact made proposals to this effect. However, does the market concept justify completely calling into question the economic organization of a number of Member States?

In this respect, it is important that greater substance should be given to the concept of general economic interest obligations which, to my way of thinking, are defined restrictively in the Green Paper. I believe that there is a need for greater pragmatism here, taking into account the diversity of energy policies pursued by the Member States, which, as the Commission stresses in the Green Paper, is not a disadvantage but an opportunity.

By the same token, we should now consider another dimension of European energy policy. At what level should the policy directions defined be developed and implemented? In other words, how should the concept of subsidiarity be applied?

Clearly, the action to be taken can be divided between three levels: the OECD, the European Union, and the individual Member States. What is the appropriate level?

The answer will no doubt depend on the sector concerned. In the case of coal, for example, there is a world market which works admirably, and no intervention is needed other than for social or regional reasons to do with employment. Where oil is concerned, there are effective crisis procedures administered by the IEA, which do not need to be duplicated.

On the other hand, with gas the problem is clearly regional since there are three main gas markets in the world: the North American market, the European market and the Asian market. Europe is therefore an appropriate level at which to analyse natural gas, and France is quite happy that there should be long-term reflection at European level on gas supplies in Europe.

Where refining and oil products are concerned, there are major risks of relocation which could be sparked off by an excessive opening up of the single market to the outside or by excessively demanding environmental standards which might dissuade operators from investing in modernization in Europe. That is why France feels that it is essential that a European refining capacity should be safeguarded.

Last but not least, turning to nuclear power, it is essential that Europe should stand up for its industry. This is true of the capital goods involved, where there is keen American and Japanese competition. It also applies to enrichment, where Europe has a strong and efficient industry: in this connection, it is vital that the market should not be excessively disturbed as a result of nuclear materials being imported from neighbouring regions at prices way below market prices

Are additional Community instruments necessary?

Yes, where economic analysis and forward studies are concerned, which should be stepped up at European Union level since it is crucial that the Member States should have a common vision of their future and the risks and problems involved.

For the rest, the main thing is to take stock of the existing instruments and ensure better coordination between the Member States on matters such as the environment, the internal market, taxation, competition, etc.

It is quite obvious that the question of security underlies each component of the energy sector. Would it be possible to establish, ultimately, mechanisms similar to those of the common foreign and security policy (CFSP) which are cooperative and not binding? The question should at least be asked.

All in all, it has to be admitted that the degree of convergence between the domestic energy policies of the Member States remains rather limited. They are pursued in contexts which are much too disparate for them to be able to converge in the short term since there is a very great variety in terms of the energy situations in the individual countries, their indigenous resources, and their energy production, transport/transmission and distribution systems, and the structure of their electricity-generating facilities, a variety which is attributable to historical, social, geographical and geological factors and which can only increase with the enlargement of the European Union to include yet more States.

What we must therefore avoid at all costs is to seek an artificial and premature consensus between the European Union Member States. On the contrary, a much more modest and pragmatic approach is needed to begin with, this being the only realistic way of expediting matters. France recommends applying the principle of subsidiarity (a) to the determination by each Member State of its energy policy as a function of its specific features and (b) with regard to the definition by each of them of general economic interest obligations.

At Community level, better use should be made of what already exists and joint forward economic analysis should be carried out to ensure a uniform view of long-erm risks and problems that might be encountered in relation to Europe's energy supplies.

On the basis of this clear and common view of the future, we can determine what we really can do best together. In this way we can gradually harmonize European energy polices. It will be a long-term enterprise, but it is the only realistic way to make progress towards a common energy policy.

FINLAND AND THE ENERGY CHALLENGES OF EUROPE

BY Antti Kalliomäki
Finnish Minister of Trade and Industry


Antti KALLIOMÄKI

The accession of Finland to the European Union required a number of difficult issues to be negotiated and solved before membership became possible. I am glad to say that energy did not belong to the problem areas. Emphasis and approach in our energy policy are very much the same as generally adopted in Europe and in the EU.

Finland, being heavily dependent on imported energy, has attached great importance to security issues. As my country is, at the same time, one of the most energy-intensive industrialized economies in the world, energy efficiency has always been a concern of the energy producers, users and the Government. Environment protection is taken very seriously due to the fragile arctic nature of the country. All these elements of energy policy are carried through in a market-oriented framework that is, I dare say, one of the most liberal ones in Europe.

Against this background one can understand that membership did not really change the substance of energy policy.The only major area where special arrangements were negotiated was nuclear fuel supply. There we wanted to ensure smooth transition to the new Euratom environment and to preserve diversity of supply.

We look forward to playing an active role in energy cooperation within the EU. We believe that it will also bring positive inputs to national energy policy. We also hope to be able to contribute constructively to EU activities in this field.

Below I will highlight some specific issues that currently are both on the Finnish and European energy policy agenda.

Internal Energy Market

Energy pricing and markets in Finland have been gradually deregulated since the 1980s. In the early 1980s oil and coal imports were subject to import licences. Licences for electricity imports were removed only this year, and thus energy imports are no longer controlled by the Government.

Again until the early 1980s end-user prices for oil-products were regulated, but there are no longer any specific Government price controls in energy markets including electricity retailing and wholesaling. Energy prices are determined in general by the markets and the Government does not interfere in price setting or mechanisms.

Transmission prices of electricity are, however, kept under surveillance by a new electricity market regulator due to the monopoly nature of that business. Pricing for the network services has to be reasonable and fair, but without recourse to regulations, for instance on permissible rates of return.

The Finnish Electricity Act has undergone an overall revision, the aim of which has been further to liberalize power transmission at all voltages, i.e. local distribution lines included. Any producer can sell electricity to any end-user or retailer throughout the whole nation. This is a real Third Party Access principle. Differentiation of operations and increased transparency of electricity prices and costs support that goal. The Act entered into force at the beginning of June 1995.

Finland has no statutory scheme for the planning of national electricity capacity. Permits are no longer required even for the very largest plants. Only nuclear and hydro power need licences under the particular legislation. Free competition is thus a fact in electricity generation. For land use, environmental protection and similar reasons, appropriate permits or licences are, of course, required.

It is therefore hardly surprising that Finland is in favour of internal electricity markets in Europe. We have supported the principle of negotiated TPA in the Council. We see that for a relatively small market like Finland, international cooperation and competition are both favourable and fruitful. We also see that further harmonisation of national rules and regulation would help to improve the functioning of the internal energy market. In the electricity and gas markets harmonisation has, however, much less importance in the competition field compared to such problems as remaining exclusive rights or restricted access to networks. Harmonisation can fine-tune the market but is not a pre-condition for trade. International trade has been with us for centuries but harmonisation is a relatively new idea.

Environment and Climate Change

In its energy report to Parliament in autumn 1993, the Finnish Government adopted goals for halting the growth of CO_2-emissions from energy production and use by the end of the '90s. Finland has been practising sustainable forestry for decades now, and consequently forests are expected to sequester increasing amounts of atmospheric carbon for at least the next 15 - 20 years. This means that even more carbon will be bound in the forests. Maintenance of this reservoir is an important part of Finland's climate policy.

Finland considers that implementation of effective policies and measures is a key to the fulfilment of these commitments. The main focus in Finland's climate strategy is to strengthen those emission reduction programmes that are already under way.

Firstly, in 1990 Finland became the first country in the world to adopt a carbon dioxide tax, and the system has gradually been improved since then. We should like to see this type of measure as an important element in the future negotiations on a protocol. We also supported the idea of an European CO_2-tax at the Essen summit.

The Finnish energy conservation programme aims at even more efficient end-use of energy in individual sectors. This would reduce consumption of energy by 10 - 15 % from the 1990-level by the year 2000.

The aim of the new bioenergy programme is to increase use of bioenergy by at least a quarter from the present level by the year 2005. At present, some 13 % of energy production in Finland is covered by biomass.

Technology programmes have now been under way for several years beginning in the 1980s, and in 1993 the government launched eight new energy technology development programmes, which focus on new and renewable energy technologies. We believe that solutions based on new technologies will have a major role in the future for achieving real emission reductions.

These are the main policies we have considered to be the most effective under Finnish conditions. However, there are great differences between the parties concerned, as regards their starting points, resources and capabilities.

The special features of Finnish energy production are the large shares of nuclear and hydro power, combined heat and power (CHP), district heating and biofuels. Therefore, specific emissions of CO_2 are also relatively low and our capacity to reduce them are limited in future. We expect that energy-related CO_2 emissions will increase up to 2000 by 25-30 %. In 1990, CO_2 emissions from Finnish energy production and consumption and industry totalled some 54 million tonnes.

Finland considers that the current commitments in articles 4.2 (a) and (b) of the Climate Convention are just a first step and that they are inadequate. We see the Berlin mandate as useful as the next step to start a process for negotiating a protocol. The future negotiations should focus on a wide range of instruments, tools and measures from which each country or a group of countries could choose the most suitable and cost-effective measures for their own circumstances. This should take into account differences in starting points and approaches, economic structures and resource bases, the need to maintain strong and sustainable economic growth, available technologies and other individual circumstances.

Nuclear Energy and Nuclear Safety

Finland is one of the eight EU Member States whose electricity production is partly based on nuclear energy. The four existing power reactors with a total capacity of 2310 MWe were brought on line in the late 1970s and early 1980s. Today they satisfy about 30 % of Finland's electricity demand.

Both the two 445 MWe VVER units at Loviisa, operated by Imatran Voima Oy (IVO), and the two 710 MW BWR units at Olkiluoto, operated by Teollisuuden Voima Oy (TVO), have functioned reliably and safely throughout their operational history. The average yearly load factors of the Finnish units have constantly been among the best in the world.

All attempts to construct additional nuclear power plants have run into political difficulties. The latest project, which was approved by the Government in March 1993, did not get the Parliament's approval, required under the Finnish nuclear legislation.

Finland is totally dependent on other countries for supplies of uranium as well as for conversion, enrichment and fuel fabrication services. The necessary security of supply has been achieved through diversification of sources. One of the aims in Finland's accession negotiations was to ensure that transition to the new supply environment existing in Euratom would take place smoothly and preserve this vital diversity of supplies.

Finland is one of the few countries which already has an operating repository for low and medium active nuclear wastes. A programme to find a site for final disposal of spent fuel elements before the year 2000 was also started in the early of the 1980s and is going on well. In December 1994 Parliament passed a law which definitively excluded the reprocessing option for fuel used in Finnish reactors by requiring direct disposal of this fuel in Finland. The same law also forbids disposal of foreign spent fuel and other nuclear wastes in Finland.

The expertise which has ensured the high level of nuclear safety in Finland, and especially that acquired through the adaptation of the two VVER reactors to western safety requirements, has also been used to provide assistance in upgrading existing reactors of this type in Russia itself, both bilaterally and through EU co-operation (TACIS etc ...)

East-West Energy Cooperation

Like other western industrialized countries and multilateral organisations Finland has started programmes of cooperation and technical assistance in order to help development in the countries of the Former Soviet Union and those of Central and Eastern Europe.

The emphasis of the Finnish energy assistance programmes is on nuclear safety and energy conservation. The most important target countries are the Russian Federation and Estonia.

In early 1992 an agreement on cooperation with neighbouring areas was signed between Finland and the Russian Federation. The purpose of the agreement is to create a legislative framework for this cooperation as well as to encourage regional and local authorities in cross-border contacts.

In 1992 - 1994 Finland allocated FIM 30 million about ECU 5 million for bilateral cooperation in nuclear safety. The financing is planned to remain at about ECU 2 million a year for the next few years. In addition, Finland has joined the Nuclear Safety Account set up at the European Bank for Reconstruction and Development (EBRD).

Two major studies on energy planning and energy conservation in the Russian Federation have been completed. The Energy Plan for Karelia describes the past and future development trends in the society of this region, identifies the present energy demand and supply situation, and analyses the likely development of the economy and the energy sector up to the year 2015. The Energy Conservation Study on Nine Industrial and Energy Utility Plants in the Russian Federation deals with the energy consumption of major energy consuming plants, estimates energy conservation potentials and suggests technically and economically feasible measures for energy conservation.

In Estonia, the Finnish Ministry of Trade and Industry is financing a number of projects aiming at improved energy efficiency and better environmental performance in the energy sector.

Based on extensive trading relations with the countries of the Former Soviet Union, Finnish companies and organisations have good capabilities in dealing with these countries. As a new member of the European Union Finland is naturally willing to join forces with other Member States in helping third countries to develop their energy economies.

CONFERENCE ON EUROPEAN UNION ENERGY POLICY

Brussels, 22-23 June 1995

C. Papoutsis, Member of the Commission

This conference was held here by the 'Club de Bruxelles' organisation with the theme 'What should European Union Energy Policy Be?', and attracted attendance by over three hundred representatives from almost every branch of energy-related industry, and both public and private sector institutions, national, European, and International. This important event in fact was organised at the behest of DG XVII and set in the context of its Winter 1995 Green Paper on future EU energy policy[1]. The opening keynote addresses were by French Industry Minister Yves Galland and Commissioner Papoutsis; leading figures from industry and representative including environmental bodies, as well as senior Commission officials and members of the European Parliament, made for lively panel discussions. The full text of proceedings will be published in due course, but, alongside the article by Minister Galland which we are pleased to publish in this issue, Commissioner Papoutsis' address to the Conference is included in full below.

Mr President, Minister,
Ladies and Gentlemen,
I am very pleased to open today this important Conference, about Energy Policy. It provides an excellent opportunity to analyse the objectives of the Green Paper, and provide useful input for the forthcoming White Paper on Energy Policy.
The debate on energy policy and the Green Paper is also important in view of the need to discuss energy policy in the context of the Inter-Governmental Conference in 1996.
I would like to remind you that the Community has had an energy policy for some time. Until the middle of the last decade, the policy was largely driven by security of supply concern.
However, the progressive implementation of the internal market, and the emergence of environmental problems, have changed rather radically the context in which energy policy has to be developed. We also have to keep in mind that the geopolitical and economic context has also changed significantly outside the Union.
All these factors justify the launching of a broad debate among interested parties about the future of a european energy policy. The Green Paper has provided the basis of reflection, first of all, for the other institutions - European Parliament, Economic and social Committee and the Council. The resolution adopted by the Council on 1st June, under the capable presidency of Minister Galland, has provided a constructive basis for further policy development. But in parallel to the work of the institutions, I attach great importance to the views on the Green Paper of all the actors in the energy field-trade unions and environmental protection organisations.
A White Paper which will result from these discussions, has been announced, and I plan to make it available by the end of the year . This paper will have to achieve two main objectives.
Firstly, it has to propose broad policy orientations and to fix a long term work programme towards their implementation.
Secondly, the White Paper will contribute to the reflections in view of the Inter-Governmental Conference in 1996.
It is clear that energy is a field of mixed responsibility between the National and Community levels. Serious issues, such as our increasing dependence on energy imports, or global problems, such as environmental questions, will need to be faced by consistent policies at both levels.
As stated in the Green Paper, what we seek is not harmonisation of national policies. The goal is to foster globally efficiency of the measures taken,

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[1] *COM(94) 659 fin, 11.01.95, published subsequently as a supplement to Energy in Europe (E,F,D, SP)*

through the joining of forces throughout the Community.

I am convinced that, although appropriate Community instruments already exist in the Treaties, they need to be aligned to energy policy and global economic requirements.

The convergence concept presented in the Green Paper seeks to promote a new relationship between national and Community policies.

The actors in the energy field, either private or public, are facing very important challenges. I am pleased that occasions like todays' Conference provides an opportunity to discuss these questions in depth.

Three objectives are identified in the Green Paper:

- *global competitiveness,*
- *security of supply and,*
- *protection of the environment.*

I hope each of these will be examined in length.

A first question we have to address is how our energy policy can reinforce the overall economic competitiveness of enterprises in the European Uion. And how can we ensure that technological developments contribute to this process.

Competitiveness is an essential element of the economic future of the Community. We all recognise the importance of competitiveness for maintaining jobs, welfare and quality of life. Energy policy cannot be considered outside this context, as an isolated case. The energy sector has to participate in the Community efforts towards improved competitiveness. Industry is rightly concerned with this question.

The White Paper on growth, competitiveness and employment already introduced the idea that the energy sector should, and can, participate in the improvement of the global competitiveness. The improvement of competitiveness will be achieved by implementing two instruments.

Firstly, a better functioning of the market, through both the simplification of community rules and the market integration. This means that we have to open up monopolies to competition, but at the same time ensure that there is adequate protection of the public service mission.

Secondly, technology development and its penetration into the markets are key parameters for improved competitiveness. The Green Paper describes the potential for technology to be exploited in producing energy, in consuming it and reducing accordingly the damaging impact on the environment.

I am convinced that more efficient technology is required in all energy sectors.

Continuing progress in this field would have positive impact on the energy balance of the Union, and also would mean a better position of our industries on international markets.

It is up to the private sector to continue its efforts towards this objective, Nevertheless, public authorities cannot waive their responsibility. Clearly Not all the technological development needs to be supported but there are many cases where it should be.

Unfavourable prices for example, - as it is presently the case for renewable energy sources - may endanger their potential to participate in the future energy supply of the Community; and that is where support for the develoment and penetration of the technology is important.

The 4th framework programme, Thermie II, SAVE II, and Altener are all Community Support Programmes which make a valid contribution towards the development, diffusion and penetration of technological advances.

Promotion of improvement of energy efficiency and the exploitation of new and renewable energy sources are also important if we are to narrow the gap between developed and less-developed regions of the Community. The pursuit of the social and economic cohesion objective, established in the Treaty, can also be achieved through an energy policy, which is aimed at improved competitiveness.

The second question that the Green Paper wants to address is how energy supply can be rendered more secure inside the European Union, especially to peripheral and isolated regions and those that are less developed.

Security of supply, as I said earlier, has always been a great concern, both for governments and for industry. For the citizens of the Community, security of supply means access to an uninterrupted flow of energy, of steady quality, at a fair and affordable price. This is highly dependent of the international market, since the Community presently imports half of its energy requirements.

The coal and oil markets are more international than the electricity and gas markets, which have more a regional nature. Nevertheless, all energy sources, except for renewable energy, are internationally traded.

External relations are essential in order to increase the economic inter-linkage between producing and consuming areas. Trade agreements and technical co-operation are based on the common interest between parties. The notion of security of supply is today a broader concept than simply a relationship between supplier and consumer. Without ignoring the need to have measures for crisis management, the emphasis today has shifted towards building sound relationships for the benefit of both partners.

Within the Community itself, it is necessary to secure energy supplies for peripheral or less developed regions at an acceptable price. Therefore, a favourable climate must be established, enabling economic actors *to take the risk of building the infrastructure required to provide energy. The Community can also participate through its policy of developing Trans European Networks for energy.*

Moreover, these regions are endowed with new and renewable energy sources. The favourable conditions for developing renewables have to be exploited with incentives from public authorities. The systematic and serious development of renewables as well as the promotion of energy efficiency could make an important contribution towards reducing the Community dependency on imported energy.

The third issue addressed by the Green Paper is how European Union energy policy can integrate environmental concerns. This includes the aspect of how the European Union can assist public authorities in the promotion of energy efficiency.

Integration of environment concern in other policies is provided for by the Treaty. The question is how to achieve this in the most efficient way in the energy sector. The Green Paper states that a strategy for internalisation of environmental costs, using market based instruments, is the most efficient way.

Although some consequences on competitiveness are sometimes feared, we should recognise that internalisation of environmental or social costs, linked with energy prices, are also a way of providing an incentive to energy efficiency, by using more efficient technology, notable in the industrial sector. Incentives for the exploitation of renewable energy sources can also be provided in this way.

The single market, working in an integrated and efficient way, can play a role, as it will permit the industry to adapt production to needs. Such conditions may be beneficial to energy efficiency, since industrial investment is an important tool for progress in this respect.

As concerns the action areas of public authorities, the promotion of energy efficiency is one of the areas in the energy field for which there is policy concensus.

However, two external triggering factors are lacking :

- *higher energy prices, which could be an incentive to consumers, and*
- *the general economic conditions which would create a favourable climate for investments.*

Therefore, public intervention is still necessary. The use of economic instruments, including tax incentives, needs to be examined. A regulatory approach may in some cases also be needed, provided it is implemented in a way that does not hamper market functioning.

Finally, I would like to highlight two points : the necessity of international cooperation in the energy sector, and the importance of a clear role for the Community in energy policy.

International co-operation is probably the area of Community responsibility where a consensus will be the easiest to reach. Contributing to a favourable climate for investments through a persistent dialogue with energy producers is no longer contested. I would even say that, the role of the Commission has been fully recognised .

Facing challenges going beyond Community borders, such as the environmental questions or co-operation in technology transfer to developing countries, are also recognised as natural responsibilities for the Community. A political dialogue is also crucial in order to develop common ways of analyzing the situation and finding consistent solutions.

In the Union's programmes, international co-operation has been more and more taken into account. The question is : is it sufficient? I believe that new policy guidelines would have to focus on the major challenges facing the Union. Todays Conference will help - I hope - to identify these.

One of these challenges is clearly the global nature of the environment and how to handle it. Another challenge is to find the right balance in the energy sector between a fully free market system aiming at making profit, and the necessary public authorities involvement to secure an adequate service to the citizens.

I believe very strongly in the important role the European Union has to play in facing the challenges of energy policy.

We need to mobilise Community instruments, existing or new ones to be defined, in a coherent way in view to ensure market functioning and to bring added value to actions taken at national level. The implementation of these instruments does require to have common objectives at community level that will permit to achieve consistency and efficiency. Convergent approaches within Member States are essential to such objectives.

As a concluding remark, I would like to tell you that I'm in favour of an energy chapter within the Treaty. Considering the importance of energy for our economies, for the citizens of Europe and their welfare, I believe we need to give energy policy a framework in which it can be developed efficiently and effectively.

This, and all the other issues will be dealt in the White Paper, as a result of an in-depth reflection.

I wish you a fruitful debate over the next two days, and I will look forward to hearing the results of your discussion. ▢

MEETING OF THE ENERGY COUNCIL, 1 JUNE 1995

As many readers will have learnt from the Press, this meeting was a significant one especially concerning the very difficult matter of progress towards completion of the Internal Market in electricity. Common positions were also achieved by Council on Commission proposals concerning the Trans-European Energy Networks which go a long way towards accelerating progress in this vital area. In addition to articles on the central aspects of the single market file elsewhere in this issue, and of course the coverage in the keynote articles, we have therefore also taken the space to include the complete conclusions of the Council meeting as these were published in the Press Release following the meeting.

COMPLETION OF THE INTERNAL MARKET - ELECTRICITY

Following the modified proposals for Directives on setting up common rules for the internal gas and electricity market, after consultation of the European Parliament and of the Economic and Social Committee, and while confirming the conclusions adopted by the Council on November 1992 and November 1994, the Council:

1. REAFFIRMS the four points of agreement as identified in the 29 November 1994 Council conclusions, keeping in mind the need for further discussion and clarification with regard to market liberalization beyond the production sector and other aspects of the Directive, for instance that of harmonization and taking into account the fact that each of these 5 key topics should represent part of an overall agreed solution;

2. RECALLS that, in the above-mentioned conclusions of 29 November 1994, the Council requested further discussion on how to open the markets beyond the area of electricity production, especially on the question of the possible simultaneous introduction of a negotiated TPA and a so-called single-buyer system. In this context it agreed to verify that both approaches, in a spirit of reciprocity, lead to equivalent economic results and, therefore, to a directly comparable level in the opening of markets and to a directly comparable degree of access to electricity markets and that they conform to the provisions of the Treaty;

3. NOTES the Commission's working paper on the organization of the internal electricity market, following the request expressed by the Energy Council at its meeting on 29 November 1994;

4. CONFIRMS, in the light of this working paper, that one of the Directive's main objectives concerning the internal electricity market is to increase competition in the interests of all consumers, and that, to this end, European electricity systems must progressively take market mechanisms into account, allowing in particular for the situation of independent producers and eligible consumers, in the framework of flexible and pragmatic solutions which will:

- permit the performance of public service obligations imposed on electricity undertakings in the general economic interest, including objectives set by each Member State regarding security of supply and environmental protection. The implementation of these obligations, in accordance with the Treaty, and in particular with Article 90(2) thereof taken as a whole, will include, for those Member States which so wish, the implementation of long-term planning, as cited by the Commission and in line with the Council conclusions of 30 November 1992, as being a means of ensuring these objectives. The development of trade must not be affected to an extent that would be contrary to the interests of the Community;

- take into consideration the principle of subsidiarity and the different situations and forms of organization in the various Member States in this sector as well as endogenous resource utilization;
- take into account the question of transitional arrangements, in accordance with the conclusions of the Council at its meeting on 30 November 1992;

5. CONSIDERS that the two systems, both within the European Community and within those countries of the European Community which so wish, can co-exist subject to certain conditions, intended to ensure reciprocity between the two systems and equivalent effects, being met as indicated in paragraph 2. There is agreement on the following points without prejudice to the discussions to be continued on these conditions, as indicated in paragraph 6:

- the single buyer must purchase electricity under objective conditions that guarantee in particular transparent transport prices and a total lack of discrimination;
- a system of authorizations granted to independent producers, based on transparent criteria, will be introduced along with competitive bidding procedures in the zone covered by the single buyer, while complying with the provisions of paragraph 4;
- within a single-buyer system, eligible consumers in accordance with the principle of equivalence referred to above, will be able to negotiate supply contracts abroad, while complying with the provisions of paragraph 4;
- the appropriate conditions for transparency in transport and distribution will be defined in both systems so as to guarantee that any sort of discrimination or predatory behaviour, in particular in intra-Community trade, is avoided;
- appropriate and effective regulatory and control mechanisms and mechanisms for the settlement of disputes will be introduced in both systems so as to avoid any abuse of a dominant position to the detriment in particular of consumers;
- in the single-buyer system, producers who are not bound by contract with the single buyer should be able to export their electricity via the network of the single buyer, provided that there is sufficient transport capacity on that network and that this is technically feasible;

6. CONSIDERS that further discussions are necessary on the following points:

- the building and use of direct lines;
- the question of the definition of independent producers;
- the question of the definition of all eligible consumers and of their rights and responsibilities;
- the concrete conditions for accepting or rejecting authorizations for independent producers in relation to planning and to the capacity of the system and the conditions under which independent producers may negociate supply contracts with eligible consumers;
- the question of possible quantitative limits on the electricity imported by eligible consumers;
- the issue of integrated companies in both systems, as regards production, transport and distribution, so as to avoid discrimination, cross-subsidization and unfair competition;
- the question of who will be responsible, in both systems, for the organization of the tender procedures;
- the detailed procedures as regards transitional periods and arrangements;
- the problem of stranded investments;
- the conclusions to be drawn in particular from the working document submitted on 11 May 1995 by the Commission on the specific nature of small systems, particularly small highly interconnected systems, in particular as regards the realization of direct lines;

7. INVITES the Permanent Representatives Committee to finalize its work on the basis of these conclusions to enable the Council to adopt a common position before the end of the year."

TRANS-EUROPEAN ENERGY NETWORKS

The Council approved its common positions on two proposals for Decisions concerning trans-European energy networks.

These are: a proposal laying down a series of guidelines, and another concerning measures aimed at creating a more favourable context for the development of those networks.

Once formally adopted after the texts have been finalized, the common positions will be forwarded to the European Parliament under the joint decision-making and cooperation procedures respectively.

1. THE FIRST COMMON POSITION defines the nature and scope of action by the Community on guidelines on trans-European energy networks. It establishes a series of guidelines covering the objectives, priorities and broad lines of action by the Community on trans-European energy networks. These guidelines identify projects of common interest on trans-European electricity and natural gas networks. An indicative list of projects of common interest mentioned in the text is attached.

With regard to the objectives, the Community should promote the interconnection, interoperability and development of trans-European energy networks and access to such networks in accordance with current Community law, with the aim of:

- allowing effective operation of the internal market in general and of the internal energy market in particular while encouraging the rational production, distribution and utilization of energy resources and the enhancement of renewable energy resources, so as to reduce the cost of energy to the consumer and render the European economy more competitive;
- facilitating the development and reducing the isolation of the less-favoured regions of the Community, thereby helping to strengthen economic and social cohesion;
- strengthening the security of energy supplies, inter alia by means of closer relations with non-Community countries in the energy sector in their mutual interest, in particular in the framework of the European Energy Charter Treaty and cooperation agreements concluded by the Community.

The common position establishes the following priorities for action by the Community on trans-European energy networks:

- for electricity networks:

- the connection of isolated electricity networks to the interconnected European networks;
- the development of interconnections between Member States and of internal connections insofar as necessary in order to enhance these interconnections;
- the development of interconnections with non-Community countries in Europe and the Mediterranean region which contribute to improving the reliability and security of the Community's electricity supply networks or to adding to electricity supplies to the Community;

- for natural gas networks:

- the introduction of natural gas into new regions;
- the connection of isolated gas networks to the interconnected European networks, including the improvements needed to the existing networks for this purpose and the connection of the separate natural gas networks;
- increasing the transmission (gas delivery pipelines), reception and storage capacities needed to satisfy demand, and diversification of supply sources and routes for natural gas.

The broad lines of action by the Community on trans-European energy networks must be:

- the identification of projects of common interest;
- the creation of a more favourable context for development of these networks.

Any energy network project may be considered to be of common interest if it corresponds to the objectives and priorities set and displays potential economic viability taking economic, social and technical factors into account.

In this connection, the Council considers that the concept of viability includes not only the financial profitability of the projects but also other considerations such as the reliability and security of energy supplies, the strengthening of economic and social cohesion and protection of the environment in the Community.

A committee composed of the representatives of the Member States will assist the Commission in implementing the Decision, in particular with regard to updating the list of projects of common interest.

2. THE COMMON POSITION concerning a more favourable context for the realization of projects of common interest in connection with trans-European energy networks and for the interoperability of such networks on a Community-wide scale identifies the action to be taken to achieve those objectives.

The text therefore provides that the Community should promote as necessary:

- technical cooperation projects between the entity or entities responsible for the trans-European energy networks involved in the proper functioning of European interconnections;
- cooperation between Member States through mutual consultations with a view to facilitating implementation of the authorization procedures for the realization of projects on trans-European energy networks in order to reduce delays.

In close collaboration with the Member States concerned, the Commission should take all relevant initiatives for promoting the coordination of the activities in question.

As regards the creation of a more favourable financial context for the development of trans-European energy networks, the common position provides that the Community:

- may provide financial support as part of the action on trans-European energy networks. These measures would be adopted by the Commission in accordance with the provisions of the Council Regulation laying down general rules for the financing of trans-European networks;
- will take account of the projects of common interest in providing assistance from its Funds, instruments and financial programmes applicable to those networks, within the terms of their own rules and purposes.

A committee composed of the representatives of the Member States will assist the Commission in implementing the Decision.

GREEN PAPER "FOR A EUROPEAN UNION ENERGY POLICY" - COUNCIL RESOLUTION

1. CONSIDERS that the publication of the Commission Green Paper entitled "For a European

Union Energy Policy" published on 11 January 1995 is an important stage in the debate on a European Union energy policy;

2. NOTES with satisfaction the consultations on the Green Paper for a European Union energy policy organized with the Member States' energy authorities and with organizations representing energy operators and consumers within the Union;

3. RECALLS that, in conformity with its conclusions on 29 November 1994, improved competitiveness, strengthened security of supply, citizens' quality of life and enhanced protection of the environment, taking into account the obligations arising out of the Framework Convention on Climate Change, are main objectives to be considered in the context of energy policy: these objectives must also take into account the principle of subsidiarity and economic and social cohesion;

4. BELIEVES that any consideration of energy policy should be based on the following observations and principles:

- without prejudice to the role of the Member States and of industry, in line with the provisions of the Treaties, the European Community does have a number of powers which imply a common view on Member States' approaches within the Community;
- there is always major uncertainty regarding long-term economic forecasting for energy, against which background energy policy must be defined in the long term; this is why energy policy, to the extent that it is based on a long term approach, must define the general framework which would allow inter alia undertakings to incorporate this uncertainty into their investment choices;
- an appropriate institutional framework in the energy field must be established taking into consideration the need to complete the internal market and to respect the general principles of competition, as well as, wherever they exist and according to the conditions established by the Treaty, services of general economic interest;
- security of supply and satisfaction of energy needs on economically and environmentally acceptable terms presupposes in particular diversification and flexibility of supply and efficient use of energy in all sectors, as well as a research and technological development policy;
- means of transportation of fossil fuels and electricity, including networks, contribute to the security of European Union supplies and to the implementation of the internal energy market and must therefore be developed as appropriate;
- the clear link between energy policy and environmental and climatic protection makes it necessary to evaluate in depth the interrelation between environmental and energy policy initiatives;
- energy is a decisive long-term factor for the improvement of the competitiveness of European economies on which economic growth within the European Union is closely dependent;
- closer relations with third countries are imperative not only for the European Union's security of supply but also because energy cooperation may contribute to economic development and political stability;
- the influence energy decisions have on the fundamental parameters of economic and social cohesion necessitates taking into account as appropriate, in the elaboration of energy policy, actions and programmes in the energy sector, the objective of strengthening economic and social cohesion;

5. CONSIDERS that improved convergence of energy policies within the European Union must first consider use of existing Community instruments, should take into account the observations and principles mentioned above and should go towards:

- the incorporation of energy policies, including the completion of the internal market in natural gas and electricity, in the strategy for renewed growth, employment, competitiveness and cohesion within the European Union;
- regular assessment of the existing European Community legislation in the energy sector and where necessary repeal of those rules that are no longer needed;
- better alignment of energy and environmental goals and, to this effect, consideration and, to the extent necessary and practicable, development of instruments such as economic incentives, internalization of environmental costs and the dissemination of information;
- the development of the requisite energy infrastructure, in particular trans-European networks, where the need arises and on economically viable terms;
- closer relations with third countries in the field of energy and, if appropriate, e.g. with signatories of the European Charter Treaty and with the Mediterranean countries, the development of international agreements, thereby creating a necessary dialogue on the fundamental aspects of energy policy;
- the promotion of efficiency and conservation in the energy field, including for example transport savings and, where appropriate, combined heat and power production, and the promotion of new and renewable energy sources and indigenous resources, for the purposes of environmental protection and of reducing energy dependence on satisfactory economic terms;
- the evaluation of existing measures and consideration of measures to be introduced, where necessary, taking into account, as appropriate and inter

alia, the role of the International Energy Agency to the extent of its specific competence, concerning supplies, so as to cope with possible risks of a cut-off of supplies and to contribute to security of supplies in the long term;

• diversification of supplies for the purpose of bringing stability to the energy sector, taking account of all forms of energy production, subject to compliance with the provisions of the Treaty concerning safety, security and environmental protection,

6. CONSIDERS that the operation of the internal market requires the strengthening of consultation and cooperation between the Member States within the Community and the development of Community methods of analysis, in particular with respect to the functioning of market mechanisms, which could enlighten the Community decision-making process,

7. INVITES the Commission, when developing the White Paper, to continue its extensive consultations in particular with Member States."

Energy Efficiency of Household Refrigeration Appliances

The Council noted the progress of discussions on the proposal for a Directive on energy efficiency requirements for household electric refrigerators, freezers and their combinations.

The aim of the proposal, which is part of the SAVE programme, is to establish minimum standards of energy efficiency for the household appliances concerned, thus helping to reduce CO_2 emissions.

After a discussion, the Council instructed the Permanent Representatives Committee to continue examining the proposal.

Examination of Community Law in the Energy Field

The Council took note of the information provided by the Commission on its work on simplifying Community law in the energy field.

Community Programme providing financial Support for the Promotion of European Energy Technology (1995-1998) ('Thermie II')

The Council studied the proposal for a Regulation concerning a Community programme providing financial support for the promotion of European energy technology (1995-1998) ("THERMIE II").

It examined the Presidency's compromise proposal to use appropriations entered under the 1995 budget without prejudging further discussions on the programme, and suggestions made by certain delegations.

In conclusion, the Council instructed the Permanent Representatives Committee to continue examining the proposal in the light of its discussions.

European Energy Charter

The Council took note of the progress of proceedings in the context of the European Energy Charter.

Negotiations on the Energy Charter Treaty and the Energy Charter Protocol on energy efficiency and related environmental aspects were completed in 1994. Those documents were opened for signature in Lisbon on 17 December 1994. Fourty-five countries have signed to date. The Treaty is open for signature until 16 June 1995.

The second meeting of the Provisional Charter Conference was held in Brussels on 5 and 6 April 1995. The next Provisional Charter Conference is scheduled for September 1995.

Euro-Mediterranean Conference

The Council had before it a note from the Presidency on regional cooperation in the energy field in the context of the Euro-Mediterranean Conference in Barcelona.

The note's starting point is the finding that the European Union's security of supply in hydrocarbons involves the Mediterranean region as well as Eastern Europe. Energy is also an important development factor in countries where distribution management is complicated by the isolation of rural areas and urban growth.

After a discussion, the Presidency considered that any discussion of a Euro-Mediterranean partnership must attach considerable importance to energy problems, an important development factor in countries where the networks supply only a small percentage of the population and where distribution management is complicated by the isolation of rural areas and rapid urban growth.

The Presidency therefore asked the Commission to:

• examine the French Presidency's proposals in greater depth, taking account in particular of the conclusions of the Tunis Conference held in March 1995, with a view to the Barcelona Conference in November 1995;

• assign appropriate financial resources to the objectives identified, within the framework of the financial resources to be allocated by the European Community to its framework programme for partnership with the countries of the Southern and Eastern Mediterranean.

INVESTMENTS OF INTEREST TO THE COMMUNITY

The Council took note of a Commission report to the Council, pursuant to Regulation 1056/72, on the collection of information concerning investments of interest to the Community in the petroleum, natural gas and electricity sectors, corresponding to existing or planned capacity or capacity under construction on 1 January 1993.

Table 1 : Trans-European Energy Networks

INDICATIVE LIST OF PROJECTS OF COMMON INTEREST : ELECTRICITY NETWORKS	
United Kingdom	Magee - Crytton - Moffat
Greece - Italy	Ipiros - Puglia
Germany - Denmark	Bjaeverskov - Bentwisch
France - Belgium	Moulaine - Aubange
France - Italy	Grande Ile - Piossasco
France - Spain	Cazaril - Aragon
Belgium - Luxembourg	Aubange - Bertrange
Spain - Portugal	Aldeadavila - Douro Int. Meson - Lindoso
Finland - Sweden	
Denmark : East-West link	
Netherlands : North-East region	Zwolle - Meeden - Eemshaven
France : Norht-East region	Sierrentz - Mulbach
Italy : North-South and East-West routes	15 partial projects
Spain	Bay in Biscary - Mediterranean route
Portugal : Improvements to the interconnection with Spain	Pego-Rio Major II Recarei - Doura Int.
Greece : East-West route	
Germany - Norway	including upgrading of grids
Italy - Switzerland	Gorlago - Robbia
Austria - Italy	Lienz - Sandrigo
Greece - Turkey	Thessaloniki - Hamitabat
Norway - Netherlands	including upgrading of grids
Spain - Morocco	Pinar - Melloussa
Baltic ring : Denmark, Sweden, Finland, Estonia	Latvia, Lithuania, Belarus, Poland, Germany
GAS NETWORKS	
Spain	Galicia, Estremadura, Andalucia, Valencia-South, Murcia, LNG Ferrol
Portugal	Setubal - Braga
Greece	Bulgaria-Athens, LNG Revithoussa

EU DISCUSSIONS ON THE INTERNAL ENERGY MARKET AND THE ROLE OF CONSUMERS

BY A. Klom , DG XVII
Unit for Completion of the Internal Market

The role of consumers, be they industrial or domestic, distribution companies or small enterprises, is not an issue forgotten in the context of the lengthy debates on the completion of the internal energy market, especially in the areas of electricity and natural gas. This article aims to explain a number of key issues which are under discussion in the debate on the completion of the internal energy market, and related to these the objective position of consumers. To be as topical as possible, it will focus specifically on the electricity market and the proposals belonging to that area, the aim being to clarify and explain the following issues:

- What have been the developments in the field of the internal market for energy over the past few years?
- What is Third Party Access or TPA ?
- What is the Single Buyer approach ?
- What is the position of domestic consumers ?
- What is the present state of affairs ?

THE INTERNAL MARKET FOR ENERGY - RECAPITULATION

In February 1992 the Commission adopted proposals for Council Directives for the internal market in electricity and for the internal market in natural gas. In January 1993 the Economic and Social Committee gave its opinion on these proposals; in November 1993 the European Parliament gave its opinion in first reading on the proposals, suggesting a large number of amendments. Taking account of a number of Parliament's amendments, but not all of them, and of discussions in the Council, the Commission amended its proposals in December 1993.

Since January 1994 discussions in the Council have focussed on the amended electricity proposal, the aim at present being to adopt a common position. As both proposals follow the so-called co-decision procedure, this means that after adoption of a common position by the Council, Parliament will have to give its opinion in second reading on the proposals. Only after this can Parliament and Council, together, formally adopt the Directives.

The Energy Council of May 1994, on the basis of the amended electricity proposal, identified five key issues to be solved in order for a common position were to be reached. The following Energy Council of November 1994 reached political agreement on four of the five issues, though formally no common position was adopted. These four key issues relate to public service obligations, procedures for new production capacity, the unbundling of accounts and the role of the network operator.

Disagreement still prevails on the fifth key issue, which in effect therefore the one is preventing the Council from arriving at a common position. This vital issue is that of access to the network, also called third party access (TPA).

WHAT IS THIRD PARTY ACCESS ?

The original proposal by the Commission introduced the concept of regulatory or mandatory third party access to electricity grids and to gas pipelines, as a means of achieving greater competition and liberalisation in these markets. This would entail generation companies having direct access to electricity consumers by means of transportation, against fair payment, of their supplies through the grid.

Faced with opposition in the Council and Parliament to mandatory TPA, the Commission in its amended proposal introduced the idea of negotiated third party access, as a compromise to meet the concerns expressed on this issue. In negotiated TPA producers of electricity can still get access to consumers via the electricity grid by means of negotiations with the network operator. These negotiations would deal with the tariff for transportation. The network operator, if part of an integrated utility company, will have to be at least administratively independent, and will have to 'unbundle accounts' as regards production, transmission and distribution. This means that negotiations with the grid operator should be free and that Member States will have to ensure that they are conducted in good faith and that none of the parties abuses its negotiating position soustrating a succesful outcome of negotiations. The network operator may refuse access where he lacks the necessary transport capacity, or where fulfilling the contract in question would prevent him from carrying out public service obligations assigned to him by the Member State.

Should disputes arise in such negotiations, whether relating to the contract or to the negotiations themselves, then the parties will be able to go to a dispute settlement authority. Such an authority will be appointed by Member States and could be either an existing entity, such as an arbitration court or a competition authority, or could be newly established. However, direct appeal to Community law also remains possible before a court of law. The dispute settlement authority will have access to the unbundled accounts of the network operator and will this way be able to judge whether negotiations on the tariffs and the technical requirements of transmission are fair and reasonable or not.

The consumers involved in negotiated TPA will be on the one hand large industrial consumers with an annual consumption of 100 GWh of electricity or 25 million m3 of gas, and on the other hand distribution companies, without any restrictions as to their size or consumption.

The amended proposals of the Commission are part of the second phase of a three-phased approach to complete the internal energy market. The second phase will aim to establish a minimum level of liberalisation and opening-up of European electricity and gas markets. It will leave open the possibility for Member States individually to go beyond that minimum level by lowering eligibility threshholds for consumers. Based on the results of this second phase, the Commission will make proposals on the necessary measures for the third and final phase of liberalisation.

This multi-phased approach means that as things stand the consumers eligible for negotiated TPA would be final industrial consumers and distributors. The Commission's objective is that the advantages of liberalisation be passed on indirectly through distributors to domestic consumers and to small and medium-sized enterprises (SME's). This degree of opening up markets is not as for-reaching as can at present be found in some Member States. However, for the Union as a whole it will at least form a starting, minimum but common, level of opening of markets. In a later phase further liberalisation may be considered.

WHAT IS THE SINGLE BUYER APPROACH ?

During the course of discussions in the Council on the amended electricity proposals in 1994, France suggested the idea of a Single Buyer approach, as an alternative to the Commission's negotiated TPA. The idea was further developed by the French authorities, and in October of last year they presented a six-page document to Member States and the Commission entitled "Functions, Role and Tasks of the Sole Purchaser", which sets out the French proposal in detail.

The Single Buyer would be the only entity within the area of the network that it covers that would be allowed to buy and to sell electricity. All producers, on a competitive basis, would sell to the Single Buyer. New producers would be admitted to the area by calls for tender, to be organised by the Single Buyer, which would also have to cover offers of electricity from existing generation capacity in neighbouring countries.

The Single Buyer would also fulfil all the tasks of the network operator, including day-to-day balancing of supply and demand and the management of interconnectors with other networks. The Single Buyer would be obliged to ensure security of supply, optimisation of investments, equal treatment between consumers and respect of the environment.

All consumers whether industrial consumers or distributors within the Single Buyer's area would have to buy their supplies from him. The Single Buyer purchasing will try to optimise its prices by his competitive. However, consumers would have the option to set up direct lines between themselves and producers outside the Single Buyer area, so as to able to import cheaper supplies. In addition, large industrial consumers could benefit economically from an import mechanism which would allow them to buy external supplies which are then resold to the Single Buyer network at the border of the system. The Single Buyer would buy in these external supplies at its own sales price minus a published transport tariff, subject to the same conditions as in negotiated TPA, namely availability of the necessay transport capacity and respect of public service obligations. Distributors under the French proposal would not be allowed to import.

Such a proposed system is quite different in organisation as compared to the Commission's amended proposal for negotiated TPA. Not only are there clear differences in the importing opportunities to be allowed for consumers, but also the internal system of the network is more closed as regards direct consumer access to production capacity. For large industrial consumers there will still be some possibilities to get access to external supplies of electricity, but for distributors, and through them for

SME's and domestic consumers, the Single Buyer will be the only supplier of electricity.

WHAT IS THE POSITION OF DOMESTIC CONSUMERS ?

In a negotiated TPA system distributors have full right of negotiated access to electricity networks and will be able to enter into supply contracts with domestic and external suppliers of electricity. Supply contracts would be negotiated, and access to the network would also be subject to negotiations. The network may refuse access on the grounds of endangerment of the fulfilment of public service obligations assigned to it by the Member State.

Member States may also impose public service obligations on distributors as regards security, regularity, quality and price of supplies. Such obligations can act as a shield for domestic consumers by ensuring essential services. Competition will of itself also *protect* consumer interests. Member States may determine the rights and obligations of distribution companies and of their customers. Furthermore Member States may also impose the obligation to supply consumers in a given area, and they may regulate tariffs, for instance to ensure equal treatment of consumers. These measures contribute to protection of the consumer's interest on the one hand, while on the other hand distributors may thereby indirectly, pass on the advantages of liberalisation to domestic consumers. Member States remain free to establish pricing policies and tariff regulations, within the framework of Community law.

Distributors, and indeed all other consumers, will have the right to establish direct lines between themselves and a producer for direct supply of electricity. Though this option of supplies through direct lines is not very likely, to be attractive for domestic consumers, it can offer advantages to distributors and SME's below the eligibility threshhold of 100 GWh who would be able in this way to contract competitive by priced supplies of electricity, which could be delivered by a direct line, bypassing the network.

In contrast to this, according to the French proposal for a Single Buyer system distributors could buy their supplies only from the Single Buyer. However, France has pointed out that this is not intrinsic to the Single Buyer system, but only to the particular French conception thereby. The Single Buyer would try to optimise its purchasing policy as regards the generators it has under contract, buying electricity according to an economic merit order and thus trying to purchase overall at the lowest possible price. Distributors would be offered an average, optimised, price for supplies by the Single Buyer. Domestic consumers would then be supplied by distributors on the basis of these 'averaged' and optimised supplies.

Both the Single Buyer and distributors would have to fulfil public service obligations. This would guarantee the quality, regularity and security of supplies to domestic consumers, as well as a number of other important concerns which France has not yet specified. However, a characteristic of the French proposal is that the Single Buyer would also ensure continuation of the pricing policy called "perequation" or price-equalisation. This policy requires that homogenous categories of consumers throughout the whole of the territory covered by the network would have to pay the same price for the same supplies. This means that distributors would, in the French model, have to follow this policy in their sales to domestic consumers.

The possibility of establishing a direct line to a point of production would be an exception to the general rule according to the French proposal and in particular open to distributors, or domestic consumers.

The foregoing shows that the results of these two different approaches to liberalisation of the electricity market would be quite different for domestic consumers in both systems. As competitive forces are of less importance in the Single Buyer system consumer protection thanks to free market conditions would be less pronounced.

WHAT IS THE PRESENT STATE OF AFFAIRS ?

The November 1994 Energy Council which failed to reach agreement on the TPA/Single Buyer issue, requested the Commission to examine, and report to Council on, the consequences of side-by-side implementation of negotiated TPA and a so-called Single Buyer system for competition in general, for producers and for consumers. The Single Buyer system would have to be measured for compatibility with the EC Treaty and as regards the reciprocity between the two systems in terms of an equivalent degree both of opening of markets and of access to markets.

Given the onerous nature of this task, the Commission has given high priority to examination. To begin with, it commissioned a consultant, the Energiewirtschaftliches Institut (Institute of Energy Economics) of Cologne University to undertake a thorough technical analysis of the implications of coexistence and reciprocity between the two systems concerned.

Based on the input from this study, Commission services prepared a working paper on the issue of TPA/Single Buyer coexistence with the title "Commission Working paper on the organisation of the

Internal Electricity Market"[1]. This working paper was adopted on 22 March 1995 and subsequently sent to the Council as the Commission's response to its November 1994 request.

The working paper concluded that the French proposal for a Single Buyer system is not as such compatible with the EC Treaty and that it would not guarantee reciprocity between the two systems, nor equivalent economic results. However, in an attempt to break the deadlock in the Council on this issue, and based on the understanding that in the second phase of completion of the internal energy market flexible solutions will have to be found for harmonising Member States' different electricity industry structures in Member States, the Commision suggested a number of adaptions to the French proposal for a Single Buyer, which would ensure at compatibility with the Treaty and reciprocity between the two systems. In doing so the Commission has kept a close eye on the position of consumers in both systems, to ensure that neither in the negotiated TPA approach under a modified Single Buyer system, would consumers lose out on a fair chance to have access to a choice of competitive electricity supplies, offered either from within their or outside countries. With this in mind the Commission's adaptions to the Single Buyer system contribute to reciprocal opportunities for eligible consumers to find competitive supplies in the internal electricity market.

In both systems eligible consumers would be large industrial consumers and distributors. As such, domestic consumers would also get a better chance in both systems to enjoy the advantages, albeit indirectly through distributors, of greater competition and liberalisation.To clarify where developments are now leading in this area, on the basis of the Commission working paper, discussions in the Council are continuing with the aim of finding a common position; the Council agreed in its November 1994 conclusions that this should be done before the end of 1995. To this end, the four key issues on which a political agreement was already reached in the Council in November 1994 will have to be transposed into legal language. However, for a common position to be reached in the Council, Member States still have to agree on the central issue of network access.

The Commission hopes that with the working paper it has prepared, and with the suggestions for adaptations to the Single Buyer system which it has put forward in that paper, it has made a substantial contribution to the process of finding common ground for an agreement on completing the internal electricity market. Once this point has been reached, and with the agreement of the European Parliament, European consumers can start looking forward in the not too distant future to a more open, competitive, secure and European market for electricity supplies.

1 SEC (95)464 final, 22.03.95

DIFFERENT APPROACHES TO ELECTRICITY LIBERALISATION

Can Negotiated Third Party Access and the Single Buyer Model coexist ?

BY A.M. Klom, DG XVII
Unit for Completion of the Internal Market

INTRODUCTION

On 29 November 1994 the Energy Council in its conclusions of the meeting invited the Commission to study the consequences of side-by-side introduction and application of the Commission's proposal for a negotiated third party access (TPA) system and the French proposal for a so-called Single Buyer system within the internal electricity market. The Council asked the Commission to verify whether these two approaches were equivalent in terms of economics, reciprocity and compatibility with the EC Treaty.
In addition, the Council expressed its conviction that the completion of the internal electricity market requires flexible solutions, which must be applied in a spirit of reciprocity between Member States. The following article aims to explain the context of these questions, and will attempt to clarify and summarize the response given by the Commission on this important issue.

THE CONTEXT OF THE DISCUSSION ON THE INTERNAL MARKET FOR ELECTRICITY

In 1989 the Commission mapped out a gradual approach for the achievement of the internal energy market. This approach consisted of a number of proposals based on four general principles: firstly the need for a gradual approach to enable the industry to adjust to its new environment; secondly subsidiarity to enable Member States to opt for the system best suited to their circumstances; thirdly the avoidance of excessive regulation; and fourthly a legislative approach based on Article 100A of the Treaty which entails a political dialogue with the Council, the Economic and Social Committee and the European Parliament.
The Commission opted for a three-phased approach. In a first phase in1990 and 1991 directives were adopted concerning electricity and gas transit in the Community and the transparency of prices charged to industrial consumers. A second phase involving greater liberalisation of the electricity sector, including the limited introduction of a system of third party access, was initiated in February 1992 with the proposals for directives for common rules for the internal market in electricity and in natural gas. A third phase, with greater liberalisation, will be considered on the basis of the results of the second phase.
The proposals under discussion since 1992 were amended by the Commission in December 1993 on the basis of the opinion in first reading of the Parliament, and based on the discussions of Member States in the Council. From the very beginning the Commission has taken a very open and cooperative approach on the subject of the gradual liberalisation of energy markets in Europe. When, during the course of discussions on the amended electricity proposal in 1994, France suggested the possibility of a Single Buyer model as an alternative to the Commission's proposal, the Commission took an open view to this concept as well. This then forms the background for the Council's request to ask the Commission to examine the side-by-side application of the two systems.
During the Energy Council meeting of 29 November 1994 overall agreement was reached on four elements in the amended electricity proposal. Since then the Council has tried to translate this political agreement into legal texts which can be used as the text of a common position of the Council, which the latter in its conclusions of 29 November 1994 undertook to adopt by the end of 1995. The four elements on which this agreement was reached deal with the issue of public service obligations, which may be imposed by Member States on electricity companies for the general economic interest. They cover there quirement of the unbundling of accounts in vertically-integrated companies for the activities of production, transmission and distribution. They cover the role and functioning of the network operator and they cover the procedures

for establishing new production capacity within a particular market.

Examination of the Single Buyer system

With these agreements in mind, and based on the request of the Council, the Commission has undertaken to study the consequences of a side-by-side application of a negotiated TPA and a Single Buyer system. Due to the fact that agreement had already been reached on the other issues it was important that the Commission make its examinations as quickly as possible, so as to enable the Council finally to complete its discussions and adopt a common position.

In a preparatory phase the Commission asked the *Energiewirtschaftliches Institut* (Institute of Energy Economics) of the University of Cologne to make a technical analysis of the questions under consideration. On the basis of this analysis inputs, the Commission made its own economic and legal analysis of the two systems involved.

The basis for the analysis is of course the examination of the two systems put forward. The negotiated TPA approach forms a system in which electricity producers can sell supplies directly to eligible consumers by means of negotiating access to the network. Negotiations with the network operator would deal with transport tariffs and conditions, and would be subject to a dispute settlement mechanism. Eligible consumers could shop around inside and outside the system for competitive electricity supplies, while the network operator is responsible for ensuring system security and the fulfilment of public service obligations.

The Single Buyer model, as originally proposed by France, is a system in which in principle only a single entity would buy and sell electricity. All producers would sell to the Single Buyer on a competitive basis; all consumers would buy from the Single Buyer against optimised prices. The Single Buyer would manage the network, undertake long-term planning and optimisation of investments, and would ensure respect of services of general economic interest. Direct contract negotiations are only foreseen for electricity imports managed via the Single Buyer.

The Commission's working paper, after describing both systems, looks at specific issues which become crucial if both systems were to be introduced simultaneously to the internal electricity market. The paper compares the internal organisations of the systems, analyses the negotiating of the contracts in each, it takes a specific look at the Single Buyer's behaviour and goes on to analyse the effect of parallel coexistence of direct lines and investments. To answer the question of compatibility with the EC Treaty a thorough legal analysis is added which, basing itself on the Treaty and on jurisprudence of the European Court of Justice, tries to disect the different elements of the Single Buyer concept and analyse their implications as regards the Treaty.

The Commission's proposal

Based on the questions asked by the Council, the Commission reached the conclusion in its working paper that the Single Buyer model as proposed by France can be neither considered as equivalent to the Commission's proposal for negotiated TPA, nor provides for reciprocity, since it falls short of what is desirable and achievable from a competition point of view. A high degree of reciprocity could only be assured between the systems if certain basic adaptations were applied to the present Single Buyer model. Both systems must be based on a common and transparent definition as regards the categories of eligible consumers.The opening of the market would be achieved via the coverage of these eligible consumers.

As regards simultaneous introduction of both systems and their compatibility with the Treaty, it can be concluded that the Single Buyer system, in its present form with an internal monopoly structure, is to be considered as a measure of equivalent effect to a quantitative restriction on imports within the wearing of Article 30 of the EC Treaty. Furthermore, it should not contain obstacles to the freedom of establishment going beyond constraints imposed by public security.

The French proposal would result in all supplies and production being channelled de facto through the Single Buyer. A system which channels imports and exports through an intermediary is contrary to the principle of free movement of goods. Exclusive rights resulting in absolute control over imports, transmission and distribution are prima facie contrary to the basic Community principles of free movement and competition and cannot automatically be justified on public service grounds, but need to be analysed case by-case in order to ensure respect of the principle of proportionality.

Security of supply reasons could justify an exemption based on "public security" provided in article 36 of the EC Treaty. There is no evidence in the case law of the European Court of Justice leading to automatic suspension of the Treaty rules on free movement and competition. As the negotiated TPA system shows, security of supply and *public* service obligations can be met in a system more open to competition.

It is obvious that according to their different security of supply situations Member States organize electricity markets according to their needs. The Single Buyer system seeks to provide an organisation of the electricity market based on long-term system planning aiming at securing supply with central management of production, transport and distribution. Without affecting the goal of this long term planning and security of supply, adaptations to the Single Buyer system would be necessary to ensure compatibility with the Treaty and for reasons of economic equivalence.

To ensure a maximum of reciprocity and compatibility with the Treaty, the Commission has suggested that the Single Buyer system should have to meet the following conditions. Firstly, in the case of the Single Buyer system eligible consumers should have the freedom to contract electricity supplies with external producers under the same conditions as and with domestic independent power producers.

Secondly, both systems could generate directly comparable and acceptable results if the import regime under the Single Buyer model is governed by an obligation on the Single Buyer to buy unlimited quantities of imported electricity under certain obljective conditions, by transparency of tariffs for to use of the transmission system and thereby transparency of prices to be paid by the Single Buyer for imported electricity. Furthermore, electricity imports should only be subject to objective and justified constraints (i.e. lack of interconnected capacity or for public security reasons).

Thirdly, in order to ensure that the principles of objectivity, transparency and non-discrimination are respected, to guarantee that competition is not distorted, to avoid the risk of potential discrimination, and to achieve neutral and independent treatment, the Single Buyer, where it is part of an integrated undertaking, should be fully unbundled in terms of full separation of management and of information flows between its different activities, especially in terms of production and supply.

Fourthly, tendering procedures for new and additional production capacities, which are more restrictive in competition terms than authorisation systems, should only be organised and decided by public authorities or other independent entities appointed for this purpose.

Fifthly, to redress the imbalance between authorisation and tendering procedures, independent producers should, even under tendering systems, benefit from parallel authorisations to strengthen competitive forces. A transparent definition for independent producers in Single Buyer systems must be introduced, on the basis of quantitative capacity threshholds. In addition, autoproducers, export-producers and producers of power on the basis of renewables, waste and CHP, should also benefit from parallel authorisations to fulfil the need for their specific type of production capacity.

Finally, in the Single Buyer system all eligible consumers would need to have the freedom to construct and use direct lines for transactions with external producers and domestic independent producers (and vice versa for producers to supply eligible consumers) in accordance with article 7 of the amended proposal for a Directive of December 1993.

Only when the Single Buyer system meets these requirements can it be considered as compatible with the EC Treaty and providing reciprocity of economic results and opening of markets. Any parallel coexistence of two different systems within the same internal electricity market, based on flexible solutions, would have to ensure this as a minimum requirement for coexistence.

The Direction of the present discussions

The working paper containing the examination of the two systems does not form any new legislative proposal from the side of the Commission.The only proposals on the table for discussion are the amended proposals of the Commission of December 1993. The aim of the working paper is to respond to the November 1994 request of the Council and to provide new ideas to the Council in order to help the negotiations. The Commission favours rapid adoption and implementation of a Directive as the best means of achieving the internal electricity market. However, it does recognise the difficulties faced by some Member States, and therefore by means of the working paper is showing the way towards a negotiated solution. With this flexible approach the Commission is taking account of Member States' concerns such as flexibility, subsidiarity and energy security,while fully respecting the fact that Member States have different structures with regard to the organisation of the electricity sector.

The Council of energy ministers met on 1 June 1995 to discuss the working paper on the internal electricity market. During this meeting the Council followed the Commission in its basic conclusions of the working paper, namely that the two systems are so different that they only could coexist on the basis of certain defined conditions. However, as regards these conditions for coexistence the Council only reached political agreement on some of the conditions, being the obligation to buy for the Single Buyer, the parallel authorisation system, the possibility of TPA in Single Buyer systems for exports of electricity and the possibility for eligible consumers to enter into direct negotiations to import electricity. All other conditions were brought together in a list of issues which the Council will have to dicsuss during the Spanish Presidency. In short, it is clear that there is agreement on the principle of coexistence, but that only a few of the conditions have in fact been agreed on, and that many still have to be discussed.

The Commission is genuinely interested in encouraging a bridging solution to break through the current political deadlock in the Council. This is shown by the effort made through the working paper. Of course, if in spite of this effort, the Council does not reach a solution, then the Commission will have to use all the powers and means at its disposal to bring about completion of the internal electricity market. As such the approach of the Commission in the working paper is a pragmatic one, which offers the chance of reaching realistic and tangible results in the forseeable future, dependent of course on the outcome of the Council's discusions.

REVISION OF COMMUNITY LEGISLATION IN THE ENERGY SECTOR

BY Anna Aguado, DG XVII
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The Brussels European Council of December 1993 stated the importance of starting an exercise aiming simplify or eliminate certain legislative acts which could adversly affect the activities of economic operators and particularly of small and medium enterprises.

On the same subject, the Commission White Paper on Growth, Competitiveness and Employment also indicates that Member States should pay special attention to the improvement of flexibility within their enterprises and in the labour market, both by eliminating excessive rigidities resulting from existing legislation and by greater mobility of workers.

In order to help to initiate the process, the Commission has set up an independent group of experts, the Molitor Group (after its chairman) to examine national and Community legislation in selected sectors, which might have a negative impact on economic development in the European Community. Energy was included amongst the sectors subject to scrutiny.

Taking into consideration that nevertheless, energy legislation will not be examined as its first priority by the Group, the Energy Council of 29 November 1994 invited the Commission to present a report on the revision of existing Community energy legislation, with proposals to simplify, update or eliminate legislation wherever necessary or possible.

In response to this invitation the Commission has started its own analysis of Community energy legislation in two areas : rational use of energy and oil. These areas had already been chosen during the German Presidency since some of the legislative acts concerned, adopted at different times, address similar topics.

The aim of the report being prepared is to give the Commission's opinion on the necessity or not to maintain legislative acts subject to revision. The need to repeal or not each of those legislative acts will be clearly justified both from legal and practical points of view.

On the basis of the results of this legal and practical analysis, the Commission will present formal proposals for the repeal of directives, regulations or decisions and for avoiding reference in the future to recommendations or resolutions which seem no longer relevant.

The Commission believes that this general exercise can lead to very positive results in terms of efficiency of EU Energy legislation and intends to continue this process of simplification as and where necessary.

In conducting this initiative, the Commission will ensure that full consistency is maintained at all time with the work of the MOLITOR Group in its work of reviewing the Community legislation.

TRANS-EUROPEAN ENERGY NETWORKS

BY Ian Gowans, DG XVII
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Since the appearance of the last article on this subject there have been several significant developments, both as regards the Commisssion's proposals for the energy networks and the work of the Christophersen Group, culminating in the submission of network projects for approval by the Essen European Council of December 1994.

As regards the Commission's proposals for guidelines and a more favourable context for energy network development, these were the subject of a common political position of the Council of Energy Ministers of the EU held in June 1995.

Projects of common interest identified under the guidelines will be candidates for aid to the carrying-out of feasibility studies, which will have to demonstrate their economic viability in the broad sense. There is also provision in the Financial Regulation for projects to be supported by means of interest rate rebates and loan guarantees. The "favourable context" proposal, for its part, will aim at fostering technical cooperation between the network bodies as well as cooperation in granting authorisations by the Member States concerned.

Given the favourable opinions of the European Parliament on these proposals (November 1994 for the Financial Regulation and May 1995 for the other proposals), followed by successful second readings, it should be possible for them finally to be adopted by the Council of Ministers in time for their implementation and the commitment of appropriations inthe second half of 1995.

As regards the appropriations, the Commission has sought provision for a total of 112 MECU for expenditure on energy networks, 1995-1999. The expenditure, together with that on the networks in the transport and telecommunications sectors, will be governed by the same Financial Regulation. This was the subject of a common position of the Council of Economic and Finance Ministers in April 1994 and an opinion of the European Parliament in November. It will, like the guidelines proposals, require a second reading by the European Parliament beforeit can be finally adopted by the Council later this year.

The situation as regards the priority energy projects identified by the Christophersen Group follows on from their examination by the Heads of State and Government at the European Council of Essen, to which the Christophersen Group had reported.[1] Council followed the main recommendations of the Christophersen Group on giving priority to the ten energy projects which were at the most advanced state of readiness. These ten priority energy projects have been followed up by the Commission and by the European Investment Bank. In line with the recommendations of the Christophersen Group adopted by the European Council at Essen, the Commission will in each year in December submit, after consultation with the Member States, a report to the European Council on progress on the Trans-European networks, and the priority projects in particular; it will forward this report to the European Parliament.

The ten priority energy projects are the following :

Electricity Interconnections

- a4 Greece - Italy
- b6 France - Italy
- b7 France - Spain
- b10 Spain - Portugal
- c2 Denmark : East-West

Natural gas projects

- e5 f6 Main pipelines system in Portugal and interconnections with N and S Spain
- e6 Greece
- f6 Spain : internal pipelines and LNG terminal : connections with Portugal
- h4 Algeria - Morocco - Spain
- h7 Russia - Belarus - Poland - EU : section in Germany

1 The report has now been published as ISBN 92-826-8995-6 'Trans-European Networks', and may be obtained from the Energy in Europe *office*

These priority projects face two broad categories of problems,financial and procedural.

As regards finance, the situation as at March 1995 was that the three overhead electricity connection projects (France-Italy, France-Spain and Spain-Portugal) faced no financing problems, but two other projects, Italy-Greece and east-West Denmark, did. Of the gas projects, the financing of those in Portugal had been finalised together with that of the two Spanish pipelines connecting with Portugal and the Tangier-Tarifa section of the pipeline from Algeria. For the section of that pipeline between Tarifa and Córdoba, as well as for the other gas projects and those in Greece and involving Eastern Europe, finance had not yet been tied up.

The second category of difficulty, that of technical and administrative procedural problems, faces four out of five of the electricity projects, and has delayed the commencement or progress of construction work. In fact, only the East-West Denmark project is to be affected by such problems. For the priority gas projects, procedural delays are less frequent; they concern environmental impact or problems in the granting of permission for gas to be used for electricity generation.

The Christophersen Group as such has ceased to exist, but work on the resolution of the problems affecting the ten priority projects, and on the three others on the Group's "B" list of less advanced projects, continues under the Group of Commissioners on Trans-European Networks which has been set up with Mr Kinnock as Chairman. The "B" list includes two electricity projects for connections between Austria and Italy and Norway and the Continent, and the more complex "Baltic Ring" project, which provides for several electricity interconnections between countries bordering that Sea ◘.

WAYS OF FINANCING COGENERATION PROJECTS IN THE EU : THE ATTRACTION OF THIRD PARTY FINANCING

Madrid, 3 March 1995

BY R. Alvim de Faria, DG XVII
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This article aims at an overview of possible ways of financing cogeneration projects in the EU and suggests guidelines designed to ensure better penetration for cogeneration on the European energy market. The concept of Third Party Financing will be stressed throughout.

INTRODUCTION

It is generally accepted that western economies are now less vulnerable to the effects of possible oil crises as a result of policies pursued concerning energy savings, geographical diversification of supply, and fuel-switching.

On the other hand, economic growth in recent years has resulted in an increase in energy consumption. What is more, comparatively low prices have discouraged efforts to use energy more efficiently. The following question therefore arises: given the limited resources available, how can growth be encouraged while, at the same time, protecting the environment and not jeopardizing the security of energy supply?

- The first priority is to control energy demand by using energy more efficiently;
- The second priority is sound management of the quantities of energy available to satisfy the needs of growth. This entails a transfer of <u>technological and financial resources</u> to less well-off regions. The only real way to guarantee sustainable and cheap energy tomorrow is to encourage the spread of new technology financing techniques today.

One of the main obstacles to the development of innovative energy technologies is the availability of investment financing. When economic growth and energy prices are low, the market is slow to react to advanced energy technologies. A large range of ways of financing new investments are available on the market, and would-be investors have to chose from among them the most suitable financing method at any given time.

There are four major obstacles to investments in energy technologies:

- **Investors' unawareness of the best available energy technologies.** There are cost-effective technologies which can slash energy consumption. However, there is sometimes a lack of transparency worldwide, and cost-effective technologies may go virtually unnoticed in a particular country or sometimes even in an entire region;
- **No priority for energy audits in firms.** Since 1985, as a result of new priorities such as the need to cut staffing costs, electronic automation and falling energy prices, energy auditing to secure the best performance on the basis of the most recent technologies available is no longer a priority for firms;
- **No priority for investments in energy technologies.** The impact of an energy-related investment is insignificant compared with the total cost borne by firms (on average 12% of business costs). As a result, a big reduction in a firm's energy bill does not necessarily produce a substantial reduction in overall costs;
- **Financial restrictions in a period of low economic growth.** Firms are unwilling to mobilize capital to invest in energy-related technologies at a time when they have more pressing requirements, such as adjusting to a rather depressed economy. ***It is therefore necessary to find financing techniques which will have little or no impact on a firm's balance-sheet.***

After dealing briefly with financial instruments which can facilitate penetration and application of efficient energy technologies in firms and also the rôle which the Commission plays, or may be able to play in the near future with regard to such instruments both within the EC and outside, a brief allusion in this context to the THERMIE and SAVE programmes will complete this overview.

Financial Instruments

Although many of the financial instruments available are well known, it is probably useful to give a rundown of the various financial alternatives with which an investor may be faced, and to classify the EU resources available to overcome obstacles to the introduction of efficient energy technologies.

Grant Aid

Grants reduce investment costs and promote the financing of the remaining investment. There are several energy programmes which provide grants for private companies in order to encourage investment. In the case of the EU programmes (e.g. JOULE - THERMIE), the aim of the grants is not to improve a company's profit and loss accounts but instead to help it to overcome the technological and financial risks always associated with innovation (which, according to OECD and EC studies, is perceived as a way of meeting society's needs more effectively).
There are also national and regional programmes designed to provide grants for the private sector. In the case of some national and regional programmes, the grants given by way of financial support for projects are often nothing more than subsidies.

Incentives

National incentives include tax relief and accelerated depreciation, among other measures for investments in innovative technologies (e.g. in France, Germany and Belgium). Interest rate subsidies and loan/equity guarantees may also be offered in order to reduce the risks associated with private sector investments in SMEs. At Community level, instruments have been developed to facilitate leasing arrangements, interest rate subsidies (which give private investors a cheaper source of financing and consequently increase the value of their investment) and guarantee funds.
It should be noted that all the motivations mentioned here depend more on regulatory and political aspects than on market forces.

Self-Financing

A company which generates sufficient cash as a result of its activities can finance its investments internally without any recourse to the capital market. Internal cash flows remain the main source of funds for large companies. This type of financing is rarely available to SMEs and when it is the other obstacles mentioned remain. As a result, firms and *SMEs in particular will endeavour to obtain a complete package with a minimum of technological involvement and self-financing.*

Equity financing

A rapidly growing company will find it hard to finance its growth and will need equity financing. Equity investment in new private companies is generally referred to as venture capital. In order to support the development of venture capital companies throughout Europe, the Commission has developed several instruments to facilitate SME access to financing and encourage joint ventures through proprietorial financing.

Debt financing

Companies may find debt financing attractive because the interest payments are (in most cases) tax-deductible: this reduces a company's tax burden and hence increases its value. However, there is a danger that excessive borrowing may result in financial difficulties.
Companies may often obtain debt financing at competitive rates (e.g. via the European Investment Bank (EIB) which operates on a non-profitmaking basis and finances companies by means of individual or global long-term loans).
However, equity financing and debt financing by companies (in particular SMEs) does not help to overcome the additional obstacles mentioned in the introduction, for which other financial instruments are necessary.

Other financial instruments

Increasingly frequently mention is made of controlling demand and least-cost planning. Least-cost planning is a method of optimizing energy investments by considering supply-side and demand-side options for satisfying the growing demand for energy services: it compares costs in order to curb demand in line with the contribution of new supply possibilities. The concept originated in the United States where public services have realized that increasingly often it is financially more attractive to invest in very efficient equipment which reduces electricity consumption than to invest in new power stations: nowadays, it is much more cost-effective to save energy than to build new generating capacity.
The idea behind controlling demand is to help consumers to make cost-effective investments in energy-saving measures. Public services need to establish marketing strategies to sell conservation measures to millions of very different independent decision-makers: their aim now is to sell not energy but sell energy efficiency. The decisive factor in favour of the introduction of least-cost planning in Western Europe is the environment: energy efficiency causes less damage to the environment than energy consumption. The economic benefits are also

significant, not just for the public services but also for investors in general.

One way for utilities to develop an energy demand control policy is to incorporate into their structures an ESCO (Energy Service Company) to assess and install energy conservation measures in the customer's premises. ESCOs introduce energy-saving measures using third party financing techniques.

THIRD PARTY FINANCING

Third Party Financing was developed to help companies finance investment without affecting their balance-sheets. A user of efficient energy technologies does not finance the initial outlay. Instead, he reimburses the technology supplier by making payments related to the performance of the technology installed. Third party financing always includes technological assistance and in-house energy audits. The user therefore does not have to concern himself with technological considerations. The ESCO provides a combination of engineering, financial and marketing skills, carrying out detailed energy audits and chosing appropriate reliable technologies for making the planned energy savings.

General Definition

Third party investment is based on a contract whereby a private company or public institution enlists the services of an Energy Service Company (ESCO) which assumes responsibility for all phases of investments designed to increase energy efficiency.

The ESCO finances all investment costs (design, plans, materials, labour, commissioning, performance measurement and monitoring), and it is reimbursed the total cost of the investment but in proportion to the energy savings achieved. Financing covers the physical and non-physical part of the investment.

The benefits of Third party financing

• The services provided by a third party investment company

One way of overcoming the obstacles associated with energy efficiency investments is to call upon a specialized third party investment company specializing in long pay-back periods. It may offer to take over the entire financial investment but it also contributes its manpower resources and technical capabilities, and of course ensures risk management. A third party investment company will identify the investments needed in order to save energy and provide the customer with advice, services and the financial resources needed to carry out a project.

It will assume a number of responsibilities, including:

- economic and financial assessment of the project;
- financial arrangements and the provision of funds to make it possible to decide on investments rapidly;
- customer representation and safeguarding of customer interests;
- post-commissioning performance management.

• The financial benefits

Third party investment ensures total financing. The beneficiary preserves his equity and lines of credit. The investment does not generally appear as a commercial debt and in no way affects the customer's financial independence ratios. Cash-flow forecasts do not have to take account of the success or failure of the project. There is a direct link between the savings made as a result of the investments and the amount of the reimbursements, which is never the case with a conventional loan.

• Contractual guarantees

The third party investment company guarantees:

- the ceiling for the project completion budget; (excess amounts to be borne by the third party)
- the completion time;
- equipment performance throughout the duration of the project;
- permanent customer access to accounts and invoices relating to investments concerning him.

• Contract period

A maximum period is laid down by contract for the reimbursement. Any balance outstanding after the maximum project period is cancelled and must be taken over by the third party investment company. If the customer so wishes, early reimbursement of investments is permissible.

THE ROLE OF THE EU : HELPING TO OVERCOME THE FINANCIAL OBSTACLES

The European Commission has set up a number of targeted programmes and schemes designed to facilitate access to financing for particularly worthwhile projects.

GRANTS AND INCENTIVES

The Thermie and SAVE Programme

Europe's economic and industrial context, characterized by the internal market objective, demands a solid energy base. The Community's energy situation is still suffering from a lack of security, regional disparities and unresolved environmental problems. One solution to these problems is to develop and exploit new energy technologies. That is why the Council of the European Union has adopted a series of programmes for the promotion of energy technology in Europe, starting as early as 1974.

On 23 November 1994, the Council approved the latest initiative, the new JOULE-Thermie programme, a specific programme of RTD, including demonstration, in the field of non-nuclear energy. The promotion and demonstration part of the programme is covered by Thermie of course which takes its name from the 1990-1994 programme which had similar objectives. For the first time, Thermie is included in the EU's RTD framework programme, thereby improving the links with the other R&D programmes. The new programme also includes a new activity concerning an overall energy RTD strategy with regard to energy-environment-economy inter-relationships. The Thermie programme will run from 1994 to 1998 with a total budget of ECU 532 million. Its main objectives are as follows:

- to improve energy efficiency on the supply side and on the demand side;
- to promote greater penetration of renewable energy sources;
- to encourage cleaner use of coal and other solid fuel;
- to maximize the exploitation of EU oil and gas resources.

The means used by Thermie are as follows:

- direct financial support for projects in the fields of rational use of energy, renewable energy sources and solid fuel;
- financial support for other activities, such as:
  - energy demonstration strategy,
  - dissemination of energy technology,
  - preparatory, flanking and support measures, and
  - SME technology stimulation.

Most of the other activities are carried out via the network of Organizations for the Promotion of Energy Technologies (OPETs) which at present consists of 49 private and public national and regional institutions in the Member States.

The SAVE programme is a five-year Community programme in the field of energy saving. It was launched in 1991 to help Member States to boost and coordinate their national energy efficiency programmes, the underlying idea being to have a comprehensive series of legislative measures supported by pilot projects and make a substantial effort to improve the flow of information between Member States and between the Community and other interested parties. A SAVE II programme with the same basic features is planned for the period from 1 January 1996 to 31 December 2000.

Specific third party financing initiatives

The EC encourages third party financing by financing the SAVE programme developed by DG XVII and the Technology Performance Financing (TPF) system developed by DG XIII under the SPRINT programme. In both cases, Thermie can contribute by selecting projects suitable for third party financing.

On 26 June 1992 the Commission submitted a proposal for a Directive under the SAVE programme containing a series of measures including the promotion of third party financing of investments in energy efficiency in the public sector, a measure which will have an impact on energy efficiency and hence CO2 emissions.

The Thermie Regulation gives the Commission the possibility of introducing other appropriate financial mechanisms if necessary, in accordance with the procedures laid down in the Regulation.

Given the clear need on the market for new financial instruments such as third party financing, Thermie (together with SAVE) has the task of *motivating and convincing all the parties involved in third party financing*. External investors (banks and other financial institutions), energy distribution companies, engineering companies and consultancies (potential ESCOs), equipment manufacturers/suppliers and technology users. The network of OPETs plays a key role in bringing participants together and promoting third party financing.

STRATEGIES FOR THE NEAR FUTURE

- Finding resources even to finance good investments is a constant problem in EC industry and in all the countries where Thermie activities are carried out. Financial institutions do not like taking risks and may demand a high rate of return on any type of financing.
- The Community can play an important role in facilitating companies' access to financing. It may:
  - help to make the technology market more transparent: with more information at their disposal, financial institutions will be able to make a better estimate of the risks and reduce the cost of their available funds;
  - reduce investment costs by offering grants for projects which are difficult to finance because of major technical and economic risks: reducing investment costs while preserving the profits generated by a project will increase its value;
  - facilitate companies' access to equity financing by stimulating the venture capital markets within and outside the EC;
  - stimulate other investments by providing loan guarantees, interest rate subsidies and other non-market-orientated schemes.
- It seems clear that third party financing is the most appropriate financial instrument for breaking down the barriers erected by market forces. Consequently, great efforts are being made to promote it. To this end, it is necessary
  - to derive greater benefit from the complementarity between SAVE and Thermie in order to promote third party financing activities, the role of Thermie being chiefly:

(i) to develop and/or promote innovative energy technologies which can be reproduced elsewhere, which generate major energy savings, and which have a favourable environmental impact, through financial support for innovative or dissemination projects deriving from Community or national programmes;

(ii) to carry out vigorous promotional activities in order to encourage the application and market penetration of "ready for market" energy technologies with the same characteristics as the projects supported;

(iii) to disseminate and provide expertise with regard to energy-specific financial arrangements such as third party financing, basically through the network of OPETs. These activities should be targeted by country and adapted in the countries where there are no ESCOs.

- persuade the financial institutions to invest more in third party financing operations. Once third party financing has taken off, the financial institutions should become major players in the promotion of third party financing;
- to set up a network of third party financing companies (Energy Service Companies - ESCOs) incorporating financial institutions and if possible energy distributors;
- to promote joint ventures between several ESCOs at international level in the case of major projects or a series of similar projects in order to spread the risks between several companies or encourage the dissemination of successful initiatives;
- to use part of the Thermie fund in future to stimulate the degree of involvement of financial institutions and third party financing companies which have the task of promoting this product on the market.
- in a second stage, to examine together with national and multilateral financial institutions the possibility of extending third party financing to include all the countries where the Thermie programme can operate (Community, Latin America, Eastern Europe, CIF, Baltic States, etc.).

Conclusions

There are many reasons for combining efforts under SAVE and Thermie (and other related units/programmes) with regard to third party financing in order to ensure optimal cross-fertilization between the various Community programmes. More widespread application of this technique will not only help to achieve energy, environment and technology objectives, but also help to improve the employment situation in the European Union.

By way of conclusion, while cogeneration is undoubtedly a technology with a very promising future, it should never be forgotten that every project is a specific case and that major progress still needs to be made ...

Any decision in this connection must therefore be preceded by a technical and economic feasibility study covering the following factors:

- the price of the fuels used;
- the purchase price of top-up and standby electricity;
- the pay-back period;
- the price for selling the surplus electricity generated to the grid.

THE MARKET FOR SOLID FUELS IN THE COMMUNITY IN 1994 AND THE OUTLOOK FOR 1995

BY J. Piper, DG XVII
Unit for Solid Fuels

The European Commission recently published its latest annual report on the Community market for solid fuels (hard coal, coking coal, lignite and peat) covering the most recent estimates from Member States' administrations for 1994 and the forecasts for the current year. This report is required under the terms of Article 46 of the ECSC Treaty which states that, to provide guidance on the course of action to be followed by all concerned, and to determine its own course of action, the European Commission must conduct a study of market and price trends.

Since three new Member States - Austria, Finland and Sweden - joined at the beginning of January 1995, homogeneous data was not available at the time of writing for inclusion in the report. Throughout the report, therefore, the terms "Community" or "European Union" refer to the 12 Member States as of the end of 1994, although there is a specific chapter included at the end presenting the main energy features of the new Member States.

For the Community, 1994 saw a relatively strong recovery of economic growth, with real GDP estimated to have grown by more than 2½% over the year as a whole. For the current year, GDP is expected to grow by around 3%. As a result, total energy demand may have risen by around 1½% during 1994, as compared to the previous year and, bearing in mind the current economic forecasts and assuming normal weather conditions, could increase further this year.

PRODUCTION OF SOLID FUELS IN THE COMMUNITY.

Production of hard coal in the Community continues to be affected, to varying degrees, by the policies to restructure, rationalize, modernize and improve competitiveness. Total production is expected to have decreased from 158.6 Mt in 1993 to 132 Mt in 1994, with the most significant changes occurring in the United Kingdom (where production is estimated to have fallen by nearly 28%, or 18.9 Mt), Germany (with a decrease of 10.4% or 6.6 Mt) and France (with a decrease of 13% or 1.1 Mt). Spain, on the other hand, may well have seen the increase in opencast production more than offsetting the decline in underground production, to the tune of some 0.1 Mt. Portugal closed its only hard coal mine during 1994.

In contrast, 1995 may well see one of the smallest variations in production since the early 1980's. Current estimates for Community production are for some 130.4 Mt, which would only be some 1.6 Mt lower than the 1994 figure. The most significant decreases are expected in the United Kingdom and Spain, each with a 3.3% drop (or 1.6 Mt and 0.6 Mt respectively). France and Germany, on the other hand, could see production increase by 0.6 Mt and 0.2 Mt respectively.

Lignite production in the Community in 1994 is estimated to have been some 284.0 Mt, which is 4.8% or 14.5 Mt less than in the previous year. This is due mainly to the lower production in Germany (13.5 Mt less) and Spain (2 Mt less), since Greece could have increased production by some 2.2 Mt. For 1995, the forecasts point to a further decline of some 5.3% or 15 Mt for the Community, to a new total of some 269 Mt. Once again, only Greece expects to significantly increase lignite production (by 1 Mt to reach 58 Mt), whilst Germany believes its production will continue to fall, by some 15.6 Mt, to a new low of 192.7 Mt.

Coke production is expected to continue to decline, with a 4.5% or 1.7 Mt drop to 37.7 Mt in 1994 and a further reduction of 1.8% or 0.7 Mt forecast for 1995, although the coke-production/nominal capacity ratio does appear to be improving as production capacity has been cut back sharper. With the steel industry absorbing about 90% of the coke available on the internal market and the continued structural and technological changes taking place in this industry (including the increased production of steel from electric arc furnaces), it is not surprising that coke production is in continuous decline.

The annual average Community underground workforce, which fell by 27,900 during 1993, is expected to have fallen again during 1994 by some 18,800, or 15%, to a new low of around 106,700. Approximately half of these losses were in the United Kingdom, followed by Germany with one third. For 1995, job losses are forecast to be at a much more moderate pace, given that the period of intensive restructuring in the British coal industry is almost complete. Job losses could therefore be around 4,500 and be for mainly in Germany and Spain.

Productivity continues to increase, a logical consequence of the restructuring measures adopted in all the coal-producing Member States, which are concomitant with the closure of the least profitable and generally least efficient pits. For the Community as a whole, productivity rose from 762 kilograms per underground worker per hour in 1993 to 768 in 1994 and could increase to about 800 in 1995.

Demand for solid fuels in the Community.

The report highlights that the total demand for solid fuels, in terms of gross inland consumption, may have declined by 1% in the Community during 1994, compared to 1993. This is largely accounted for by the expected 5% decline in the demand for lignite since the demand for hard coal, in terms of consumption, may have actually increased by 1%. For 1995, current forecasts point to a similar trend; a modest recovery for hard coal and a further fall for lignite.

Deliveries of hard coal in the Community are expected to have fallen significantly to 259.7 Mt in 1994, down some 5.2% or 14.2 Mt compared to 1993. This is the third year of decline and represents the lowest figure seen in the Community. However, a closer analysis of these figures indicates that the United Kingdom alone has been largely responsible for this drop since if this country were excluded from the totals, then total inland deliveries during 1994 would have seen an increase of almost 2 Mt compared to the previous year.

It is also important to note that the decreases in deliveries have mainly affected the Community hard coal producing countries, with Spain the only exception.

Forecasts for 1995 point to a slight rise in internal hard coal deliveries in the Community to 260.8 Mt, an increase of 0.4% or 1.0 Mt. This would indicate an end to the period of decline which has led to a contraction of the market by 72 Mt since 1991.

When examining the estimates for actual consumption of hard coal for 1994, however, it is quickly evident that there has been a noticeable draw on the stocks at the power plants, of some 15 Mt. This would imply that actual consumption figures for 1994 could be broadly similar to those for 1993, and such a draw on stocks could be similarly repeated in 1995, thus maintaining a fairly stable level of hard coal consumption in the Community.

Imports into the Community.

The report notes that, in 1994, imports of hard coal from non-Community countries are expected to have risen by 3.5% or 4 Mt, compared to the previous year, to a total of 120 Mt. Of this, some 26.5% are coking coals, with the rest being of thermal qualities (which have accounted for the principal increases).

In comparison with the previous year, Belgium saw the largest increase of 1.8 Mt, followed by Denmark with 1.5 Mt and the Netherlands with 1.1 Mt. Only in the United Kingdom and France did imports fall, by 1.9 Mt and 0.9 Mt respectively. In the United Kingdom this was a result of the increased penetration of gas, better performance by nuclear plants, and the concentration on reducing the huge stockpiles of coal. For France, the decline reflects that the good utilization rate of nuclear power plants and higher hydro-electricity production.

For 1995, Community coal imports could again increase, although more modestly, by 2.4 Mt to a total of 122.4 Mt. Most countries anticipate a slight increase in imports, with the biggest increase of 1.3 Mt forecast in Germany. However both the United Kingdom and the Netherlands expect a drop in imports (by 1 Mt and 0.4 Mt respectively).

On the supply side, the United States remained the major exporter to the Community with some 27% of the market in 1994, followed by South Africa with 23% and Australia with 17%. Whilst the picture is expected to be one of modest gains spread across most of the traditional suppliers, with gains for Australia, Poland and the United States (with an additional 1.7 Mt, 1.6 Mt and 1 Mt respectively), the CIS and Colombia are both expected to have seen sales the Community decline.

For 1995, no significant changes are anticipated amongst the suppliers, although South Africa and Poland are expected to show the biggest gains.

CIF (cost, insurance, freight) prices for both imported coking coal and imported steam coal during 1994, expressed in terms of US dollars, were on average some 4% lower than in the previous year. However, the tightening of the balance between offer and demand on the international market, after several years that have seen large surpluses on the market, and a significant rise in maritime freight rates, have led to considerable pressure on prices. With the recent scarcity of coal on the spot markets, prices could increase during 1995, especially those for steam coals.

THE NEW MEMBER STATES.

The report then briefly gives an overview of the energy features of the three new Member States.

In **Austria**, coal accounts for some 13% of gross energy demand. Whilst there is no indigenous hard coal mining, Austria does have a declining lignite industry which currently produces some 0.5 Mtoe. A large proportion of the imported hard coal comes from Poland. For the production of electricity, some 65-70% is hydro, gas is responsible for 14% and solid fuels for 11%.

In **Finland**, hard coal accounts for some 13% of total energy demand, with another 19% accounted for by other solid fuels. Peat is the principal indigenous fuel as Finland does not produce coal or lignite. Most imported coal comes from Poland and Russia. As to electricity production, some 34% is nuclear, 26% is hydro, other solid fuels are responsible for 15% and hard coal for 14%

In **Sweden**, hard coal accounts for some 5.1% of total energy demand and under 2% of electricity generation. Hydro is responsible for 51% of Swedish electricity generation and nuclear nealy 44%, although the country is committed to phasing out nuclear power by the year 2010 if environmentally acceptable alternatives can be found. ◘

Table 1 : Comparaison of the main features of the solid fuels market

	1993 actual	*1994* estimates	*1995* forecast	*1994/1993* (%)**	*1995/1994* (%)**
HARD COAL					
Resources					
- Production	158.6	132.0	130.4	-16.8	-1.2
- Recoveries	2.5	1.5	1.7	-38.6	7.5
- Imports from third countries	115.9	120.0	122.4	3.5	2.0
Total	**277.1**	**253.5**	**254.4**	**-8.5**	**0.4**
Deliveries					
- To coking plants	52.5	50.4	50.9	-4.0	0.9
- To power stations*	183.6	172.0	172.2	-6.3	0.1
- To others	37.9	37.3	37.7	-1.5	1.0
- Exports to third countries	0.4	0.3	0.3	-18.0	-5.2
Total	**274.3**	**260.0**	**261.0**	**-5.2**	**0.4**
COKE					
Resources					
- Production	39.4	37.7	37.0	-4.5	-1.8
- Imports from third countries	3.1	3.7	3.8	18.6	3.3
Total	**42.5**	**41.4**	**40.8**	**-2.8**	**-1.3**
Deliveries					
- To steel industry	37.1	39.4	38.3	6.2	-2.9
- Other deliveries within the Community	4.8	4.1	3.8	-14.4	-7.5
- Exports to third countries	0.7	0.7	0.6	1.0	-15.3
Total	**42.6**	**44.2**	**42.7**	**3.8**	**-3.6**
LIGNITE AND PEAT					
Resources					
- Production and imports	301.5	286.7	271.7	-4.9	-5.2
Deliveries					
- To briquetting plants	47.7	38.4	33.4	-19.6	-12.8
- To power stations	233.8	229.9	221.8	-1.6	-3.5
- Others (incl. exports to third countries)	20.0	18.8	16.5	-6.2	-12.2
Total	**301.5**	**287.1**	**271.7**	**-4.8**	**-5.3**

(!) Note that the sums may not add up due to rounding.

* Including industrial power stations

** The variations are calculated in kt

E.U. COAL-FIRED THERMOELECTRIC POWER PLANTS

Environmental Control

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FOREWORD

Fossil fuels burned in the production of electricity produce a variety of gases and particulates. If these gases and particulates are not captured by pollution control equipment they are released into the atmosphere.
Among the gases emitted during the burning of fossil fuels the most important are carbon dioxide (CO_2), sulphur dioxide (SO_2), and nitrogen oxides (NO_x).
Sulphur is an element that is present in almost all types of coal, although some kinds of coal contain more sulphur than others depending on the location of the coal mine and the type of coal being mined. The average percent of sulphur contained in coal ranges typically from 0.3% to 2.5%, exceeding in some cases 8%. During combustion the sulphur combines with oxygen to form SO_2 that, as it enters the atmosphere, mixing with oxygen and trace substances forms a variety of sulphur compounds. In addition, the presence of light, moisture, and other pollutants in the atmosphere may also be important in activating the complex changes that sulphur emissions undergo.

Table 1 : SO2 and NOx Overall Emission Ceiling for 'Existing' Large Combustion Plants

Member State	LCI SO_2 Emissions 1980	SO2 Emission Ceiling (Kton/y) and % Reduction Over Adjusted LCI Emissions 1980			LCI NO_x Emissions (as NO_2) 1980	NOx Emissions Ceilings (Kton/y) and % Reduction Over Adjusted LCI Emissions 1980	
	(kton)	1993	1998	2003	(kton)	1993	1998
Belgium	530	318 (-40)	212 (-60)	159 (-70)	110	88 (-20)	66 (-40)
Denmark	323	213 (-34)	141 (-56)	106 (-67)	124	121 (-3)	81 (-35)
France	1910	1146 (-40)	764 (-60)	573 (-70)	400	320 (-20)	240 (-40)
Germany	2225	1335 (-40)	890 (-60)	668 (-70)	870	696 (-20)	522 (-40)
Greece	303	320 (+6)	320 (+6)	320 (+6)	36	70 (+94)	70 (-94)
Ireland	99	124 (+25)	124 (+25)	124 (+25)	28	50 (+79)	50 (+79)
Italy	2450	1800 (-27)	1500 (-39)	900 (+63)	580	570 (-2)	428 (-26)
Luxembourg	3	1.8 (-40)	1.5 (-50)	1.5 (-50)	3	2.4 (-20)	1.8 (-40)
Netherlands	299	180 (-40)	120 (-60)	90 (-70))	122	98 (-20)	73 (-40)
Portugal	115	232 +102)	270 +135	206 (+79)	23	59 (+157)	64 (+178)
Spain	2290	2290 (-0)	1730 (-24)	1440 (-37)	366	368 (+1)	277 (-24)
UK	3883.	3106 (-20)	2330 (-40)	1553 (-60)	1016	864 (-15)	711 (-30)

Nitrogen in the air combines during the combustion process with oxygen to generate NOx mainly at high temperature (1450÷1500 °C, O2 content and residence time being important factors) (Thermal NO_X). Nitrogen chemically combined in the coal is partially converted to nitrogen oxides being function of fuel type (Fuel NO_X). Further NOx production is generated by the reaction of hydrocarbon free radicals with nitrogen in the combustion air (Prompt NO_X).

Sulphur dioxide and nitrogen oxides are referred to as precursors to acid deposition, because they react with other chemicals in the atmosphere to form sulphuric acid and nitric acid, respectively. These two acids do not accumulate in the atmosphere, but are absorbed by rain droplets, thus discharging acid onto the earth in the form of "acid rain". In addition, sulphuric acid may form microscopic droplets that can be deposited directly onto the ground. This form of deposition, as well as the direct capture of sulphur dioxide by vegetation, is referred to as dry deposition.

The increased use of fossil fuels in recent years, as well extensive deforestation, has caused a build-up of carbon dioxide in the atmosphere. This increase of CO_2 causes the atmosphere to absorb infrared radiation reflected from the earth that would otherwise have been dissipated into space. This phenomenon, which could increase global temperatures, is called the "greenhouse" effect.

November 24 1988, the Council of the European Union adopted a "Directive (N°609) on the limitation of emissions of pollutants into the air from large combustion plants" that prescribed a series of limits for the progressive reduction of total annual emissions from existing large combustion plants.

A summary of the final emission limit standards and application phases of each Member States is reported in Table1.

To respond to the concerns of the European Union related to emissions of sulphur oxides and nitrogen oxides the Member States passed the respective environmental regulation prescribing the emission limit standards depending on the type of fuel burned and the combustion device used and defining the time limits for retrofitting applications.

Emission Reduction Technologies

Emission reduction is accomplished with different control technologies for the two pollutants considered, sulphur dioxide and nitrogen oxides. An overview will be given below of the available methods.

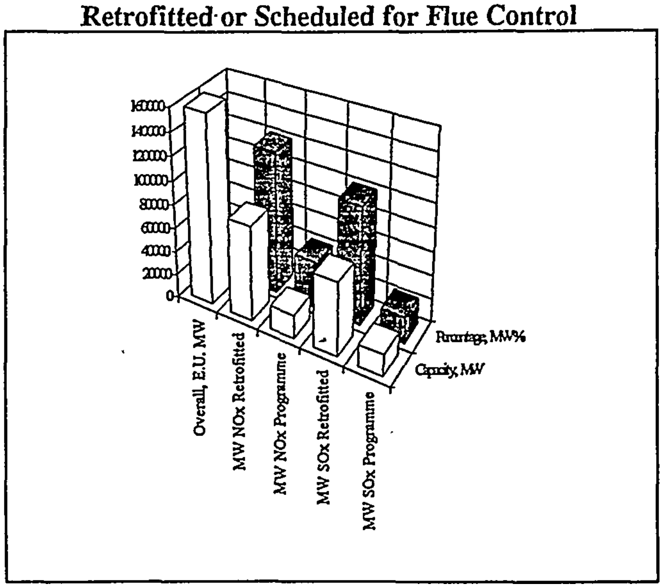
SO_2
- switch to coal with lower sulphur content or less polluting fuels, such as natural gas
- equipment for flue gas desulphurization (FGD), humid or dry
- boiler conversion to the fluidized-bed combustion (FBC) process or to the integrated-gassification combined cycle (IGCC), not yet in extensive use.

NO_X
- adoption of a low combustion temperature profile (NOx formation depends primarily on the flue gas temperature), using staged combustion, as Over Fire Air (OFA)
- use Low-NOx-Burners (LNB)
- Gas Reburning (GR), introducing CH4 in equivalent quantity of about 20% of the main fuel at a furnace level higher than that of the main burners [3-4]
- fluidized bed combustion (FBD).

In order to perform an analysis on the retrofit of E. U. coal-fired thermoelectric units to control flue gas pollutants such as NO_X and SO_2, information* on the activities and programmes of European coal-fired power plants were collected with the help of European utilities.

E.U. Coal-fired Thermoelectric Units Retrofitted or Scheduled for Flue Gas Control

Figure 1 : EU. Power Plant Capacity as MW Retrofitted or Scheduled for Flue Control



E.U. power plant capacity as MW retrofitted with or scheduled for de-NO_X and/or de-SO_X of the flue gas is shown in Figure 1 where the columns of the graph indicate the progress made in completing projects and organizing programmes expressed as power plant capacities, while in Table 2 below the corresponding exact values for the environmental activities are reported:

Table 2 : De-Nox and de-SOx Retrofitting Activities

Technology	MW retrofitted	% MW retrofitted *	MW in programme	% MW in programme
de-NO_x	76073	48	18981	12
de-SO_x	58417	40	18593	12
* respect to the overall capacity of the Coal-fired Thermoelectric Units of 159642 MW				

The environmental control activities, shown in the above graph, has been especially developed in Germany and all the Member States are working the reduction of air pollutants progressively introducing their own environmental regulations and related application phases. The activities developed to date and future programmes of each Member State are evaluated using a statistical technique - the 'Weighted Average Retrofit (WAR)' - which summarizes the flue gas control adopted in the power plants, for each Member State, by means of the following formula:

$$\text{Weighted Average Retrofit} = \frac{\sum_1 vi*MW(R)i}{\sum_1 niMWi} \times 100$$

where:

- i denotes a coal-fired thermoelectric unit
- v the number of the retrofitted unit
- n the number of the unit i
- MW(R) the capacity of the retrofitted unit i
- MW the capacity of the unit i

The calculated values of the 'Weighted Average Retrofit' (WAR) are reported in Table 3. The 'WAR' summarizes the historical data of flue gas control activities and gives information to understand, statistically, the level of retrofitting (up to-day and future) of E.U. power plant park.

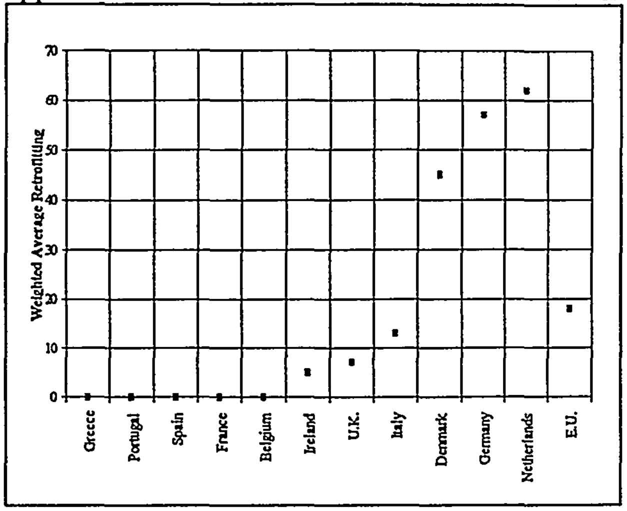
Table 3 : 'Weighted Average Retrofit' for Flue Gas Control of E.U. Coal-fired Thermoelectric Boilers (to date ans scheduled)

Member Stat	$\frac{\sum_1 vi*MW(R)i}{\sum_1 ni*MWi} \times 100$			
	de-Nox to-day	de-NOx progr.*	de-SOx to-day	de-SOx progr.*
Belgium	0.7	0.0	0.0	0.7
Denmark	45.2	0.3	7.5	0.0
France	0.5	0.0	1.2	1.3
Germany	56.3	0.02	59.7	0.02
Greece	0.0	7.1	0.0	2.1
Ireland	4.8	1.2	0.0	0.0
Italy	12.6	3.2	1.3	4.4
Netherlands	63.3	1.52	35.1	5.1
Portugal	0.0	38.9	0.0	4.1
Spain	0.0	0.1	0.0	1.1
UK	6.8	3.1	0.6	55.8
E.U.	17.6	0.9	11.6	0.9
* The figures de-NOx progr. and de-SOx progr. include both coal-fir				

The statistical order of WAR in adopting de-NOx flue gas equipment to date is reported in Figure 2 a showing the different level of Member State's activities:

- the Netherlands, Germany, and Denmark have almost completed the required reduction of nitrogen oxides (the time limits for the former German Democratic Republic are SO_2 from 1 January 1994 and NOx from 1 July 1996) due to implication in forest damage and increasing acidification of surface waters in North Europe

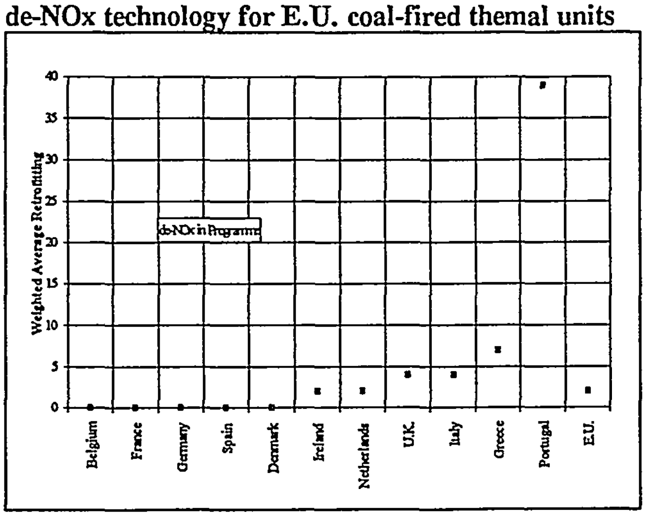
Figures 2a : 'Weighted average Retrofit' of de-NOx application to date in E.U. coal-fired thermal units.



• Italy, U.K., Ireland (although allowed by the Directive to increase NO_X emission), and Belgium started in adopting de-NO_X facilities with programmes less intensive compared to the Netherlands, Germany, and Denmark due to the lower percentage reduction prescribed by the 1988 Directive of the Council of the European Union. Meanwhile, the advanced technologies are deeply improved such as Low NOx Burners and Gas Reburning able to respect the required emission limits during combustion avoiding the adoption of the more expensive Selective Catalytic Reactors

• Greece, Portugal, and Spain have to starts in future being allowed to prolong and/or increase the current emissions (see Table 1).

Figures 2b : 'Weighted Average Retrofit' for sheduled de-NOx technology for E.U. coal-fired themal units



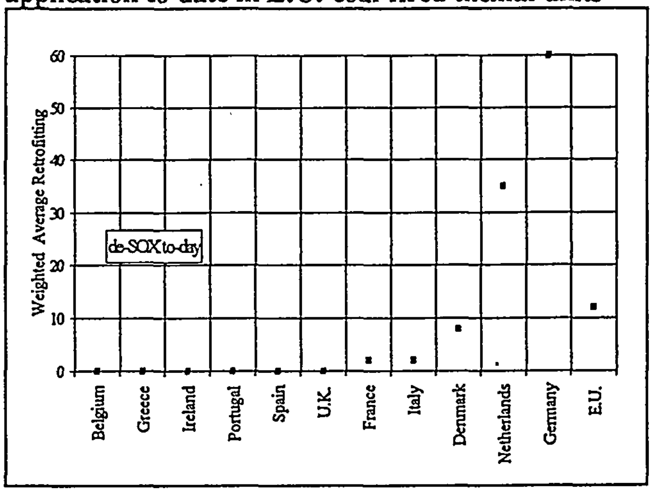
The trend of "WAR" for scheduled de-NOx equipment is shown in Figure 2 b giving the following information:

• Portugal will start with an intensive de-NOx project (from the year 2000)

• Greece will adopt de-NOx technologies in line with the limits reported in Table 1 either in terms of overall boiler capacity or as application time

• the other Member States will complete their own projects in the years 1995-2002 with few exception.

Figures 2c : 'Weighted Average Retrofit' of de-SOx application to date in E.U. coal-fired themal units



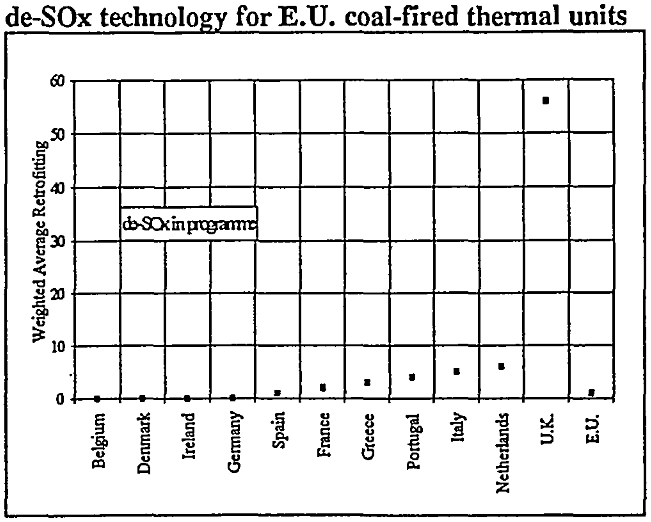
The "WAR" data given in Figure 2 c indicates the statistical behaviour of de-SOx technical systems applied to date by each Member State:

• Germany, Netherlands, and Denmark have been the most active in reducing SO2 emissions and have almost completed their overall projects

Italy, France, and U.K. have already adopted de-SOx systems respecting the required SO2 reduction indicated in Table 1.

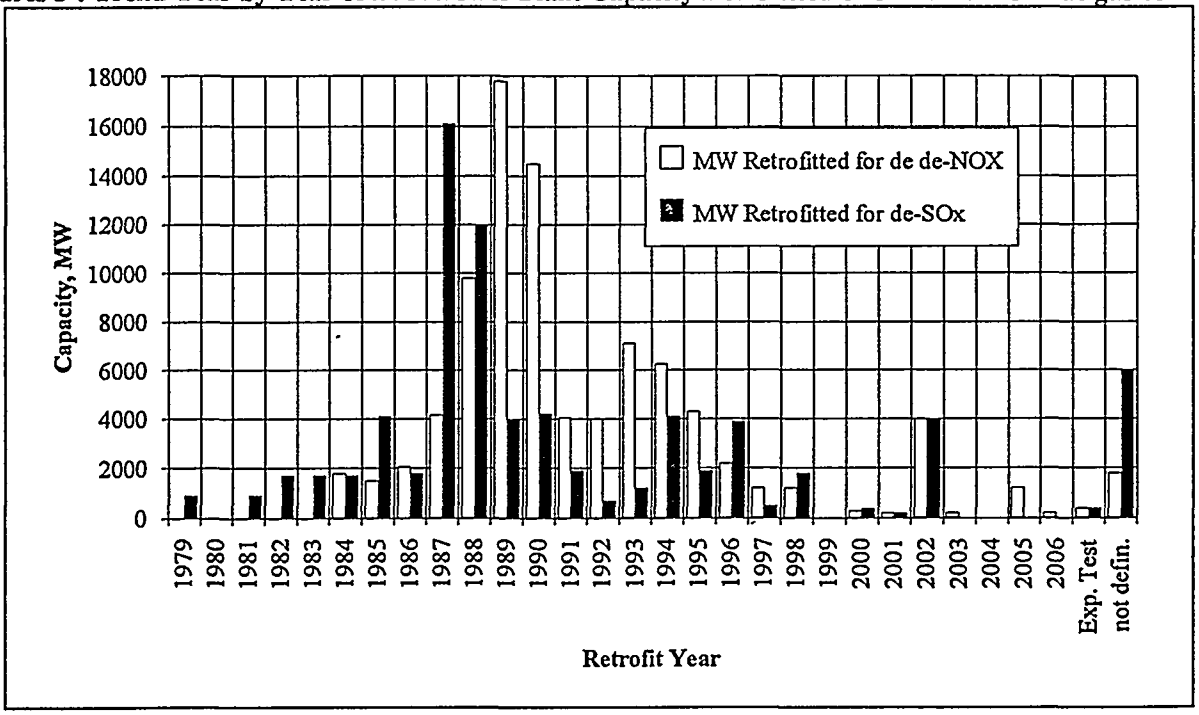
• Belgium, Greece, Ireland, Portugal, and Spain had not yet adopted any flue gas desulphurization systems at the time the data were collected.

Figures 2d : 'Weighted Average Retrofit' of scheduled de-SOx technology for E.U. coal-fired thermal units



For future de-SOx activities the "WAR" data reported in Figure 2 d shows the major programme of the U.K., to be completed within the 2002, and the remaining activities of Netherlands, Italy, Portugal, Greece, France, and Spain.
To complete the scenario for the environmental retrofitting projects of the Member States in the European Union, the trend of de-NO_X and de-SO_X activities, expressed as capacity retrofitted year by year up to 2006, is shown in Figure 3. The maximum of the coal-fired boiler retrofit is concentrated in the years 1987˜1990, mainly due to the time limits laid down by German, Dutch, and Danish environmental rules, while a second peak appears for the years 1992˜1996 due to the group of Member States required to reduce the emission percentage to a level lower than of the three former countries, namely, Belgium, Italy and U.K. A third peak, the U.K. projects, is forecast around the year 2002 and represents the main tail of the environmental programme that will complete the major action promoted by the E.U. Council Directive.

Figures 3 : Trend Year by Year of E.U. Power Plant Capacity Retrofitted or scheduled for flue gas control



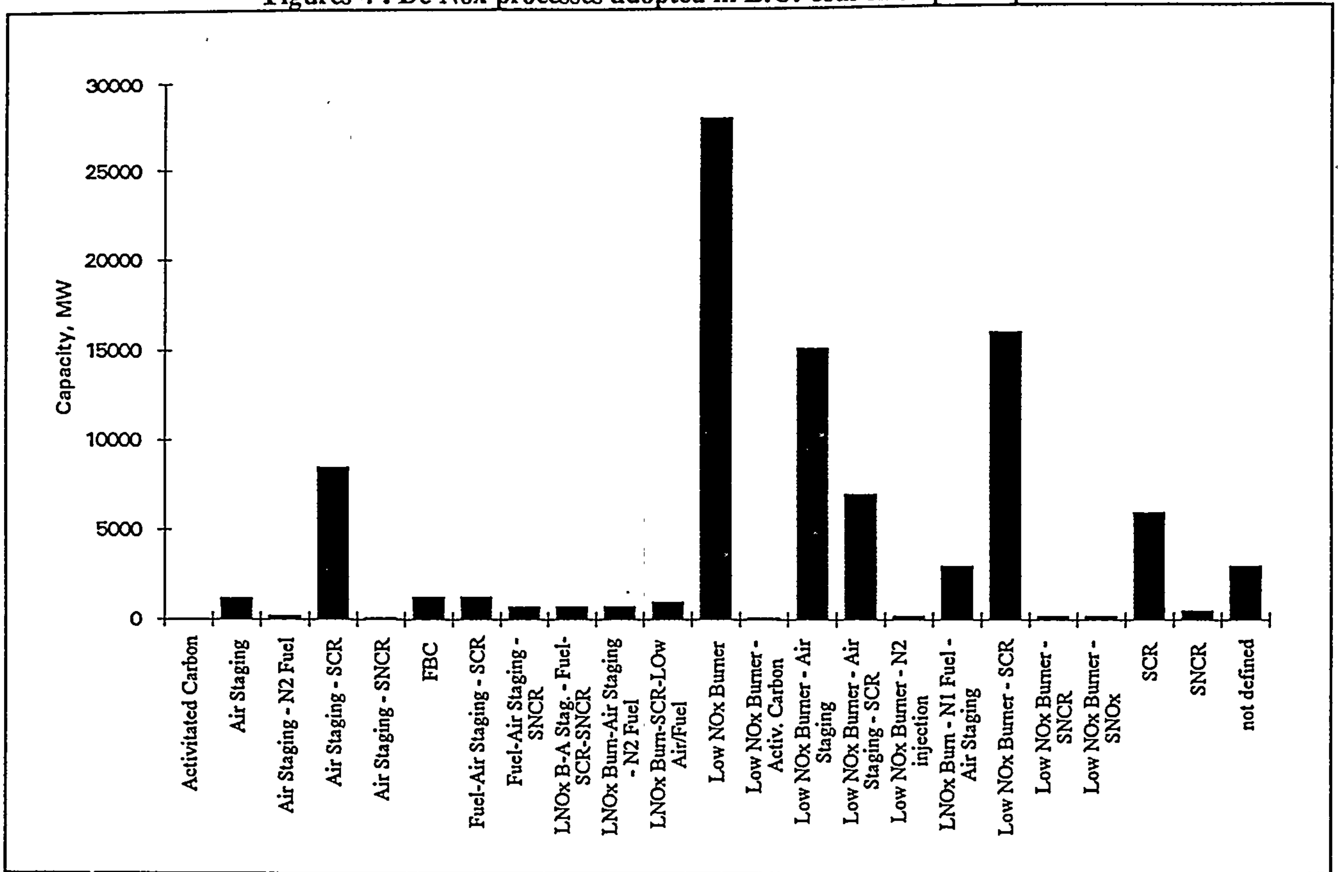
De-NO_X and de-SO_X Technologies Selected in E.U. Coal-fired Thermoelectric Plants

De-NO_X and de-SO_X technologies employed in E.U. coal-fired thermoelectric plants were selected among those processes available and commercially mature in the early 1980s to comply with the environmental requirements of the E.U. Council Directive and the related environmental regulations of each Member State.

Generally utilities designed their own power plant retrofits performing adequate preliminary feasibility studies to ensure several decision-steps such as:

- site-specific alternative environmental technologies
- analysis evaluating the consequences of the projects examined on air quality, water quality, and solid waste disposal
- analysis evaluating the cost effectiveness of the environmental technologies to be adopted in the specific power plant considering firstly the retrofit installation investment, and operation and maintenance costs, and secondly the capacity, age, and efficiency of the existing boilers.

Figures 4 : De-Nox processes adopted in E.U. coal-fired power plants



Further, utilities were required to comply with the emission standards of their own Member State that are more or less strict compared to those of other Member States

Consequently, each utility was required to install environmental technologies able to remove a percentage of pollutants to the degree necessary to meet the most stringent standards that it faces. For example, if desulphurization standards require removal of 70+90 percent of sulphur dioxide emissions the utility must install a Flue Gas Desulphurization (FGD) unit; by contrast, if the percentage of SO_2 removal is less strict the utility install less expensive desulphurization systems such as switching the fuel to coal with a lower sulphur content.

The same considerations apply to nitrogen oxide emission control: the more stringent the standard limits, the more efficient must be the de-NO_x technology. Consequently the selection may range from a staged combustion process through Low NOx Burners to a SCR system as emission control requirement increase.

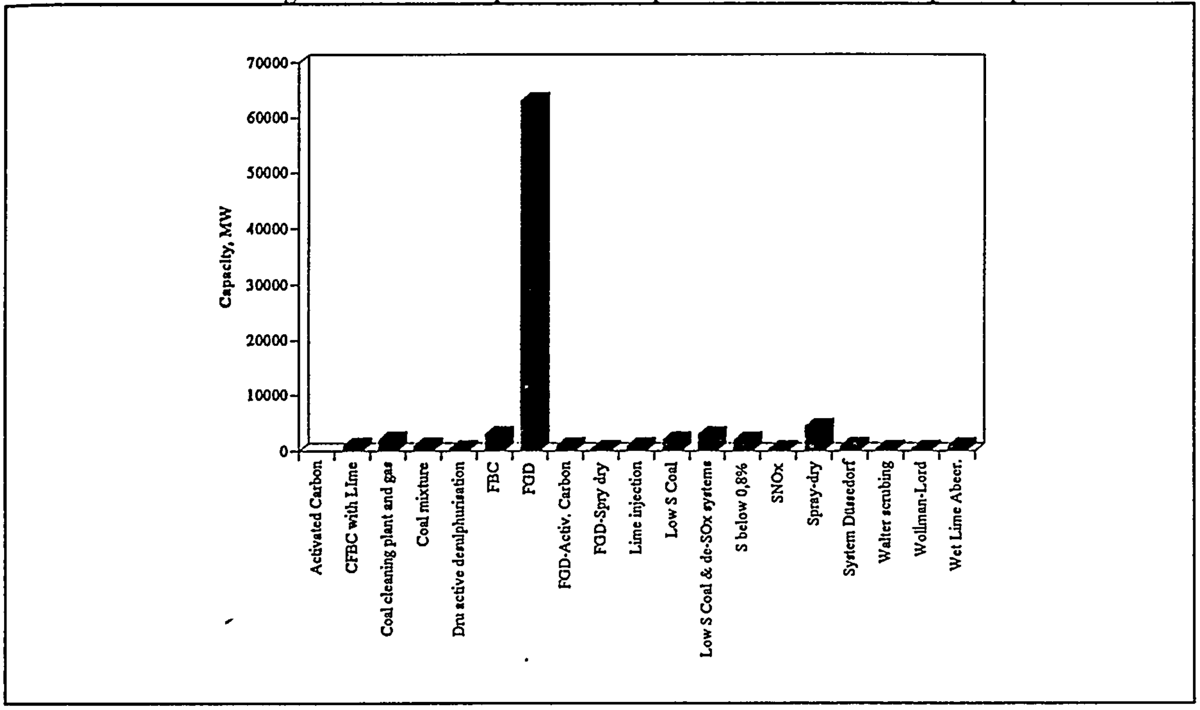
On the basis of the above concerns, the environmental processes adopted in E.U. Coal-fired power plants for NO_x and SO_2 emission control are shown in Figures 4 and 5: namely, the most widespread de-NO_x processes are based on the following systems or on combination of them:

	Process	MW Retrofitted
1.	Air Staging-SCR	8614
2.	Low NOx Burner	28370
3.	Low NOx Burner Air Staging	15611
4.	Low NOx Burner - Air Staging-SCR	7142
5.	SCR	6533
6.	Low NOx Burner - SCR	16565

while, the de-SO2 technology is based mainly on Flue Gas Desulphurization, as shown in the following Table:

	Process	MW Retrofitted
1.	FGD	63206
2.	Spray-dry	4158
3.	Low Sulph. Coal & de-Sox System	1400
4.	Low Sulphur Coal	1100
5.	Coal Cleaning and natural gas	1050

Figures 5 : De-SOx processes adopted in E.U. coal-fired power plants



CONCLUSION

In November 1988 the European Union formally agreed a Directive on the limitation of emission pollutants into the air from large combustion plants and the Member States passed their own Environmental Rules prescribing the emission standards and time limits for retrofitting.

~76000 MW of E.U. coal-fired power plants have been retrofitted to date for control of NOx emission and ~58500 MW for control of SOx emission; future programmes are designed to reduce the NOx and SOx emission for ~19000 MW and ~18600 MW, respectively, by the year 2002.

A statistical analysis was developed to evaluate the environmental activities of each Member State on the basis of information collected on 677 coal-fired thermoelectric units having an overall capacity of about 160000 MW.

As far as coal-fired power plants are concerned:

- Denmark, Germany and the Netherlands have almost completed their overall projects for de-NOx and de-SOx emission control
- France, Italy and U.K. respected the NOx and SOx reduction indicated by the Directive and have scheduled the remaining activities to be completed by the 2002
- other Member States being allowed to prolong and/or increase current emissions are going to start with their own environmental programmes.

The maximum rate of retrofit activities was developed in the years 1987+1990 and 1992+1995, while the maximum for future programmes is concentrated in the year 2002.

The environmental processes adopted in E.U. coal-fired power plants for NO_x and SO_x emission control are based on the following systems or combinations of them:

NOx Low NO_x Burner, Low NO_x Burner + SCR, Low NO_x Burner + Air Staging, Low NO_x Burner + Air Staging + SCR, Air Staging + SCR, and SCR

SOx FGD, Spray-dry, and other systems such as switching to coal with lower sulphur content

The reduction of emissions from coal-fired power plants may be increased by improving the total efficiency and thus reducing the emissions per unit of useful energy: to-day, this strategy is based on the adoption of advanced combustion technologies such as fluidized bed combustors and the integrated gasification combined cycle. These two advanced technologies are able to eliminate or reduce the two pollutants examined above to the emission limit values prescribed by the E.U.'s current environmental regulations [5-8].

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E.U. COAL-FIRED THERMOELECTRIC POWER PLANTS

Boiler Efficiency and Environmental Performances

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FOREWORD

Greater efficiency of coal-fired thermoelectric boilers is a key element for a number of energy targets such as higher conversion of coal to energy, better control of sulphur and nitrogen oxides, solid and liquid wastes, greenhouse gases, and other emissions resulting from coal use.

Efforts in improving coal-use efficiency can help to resolve the conflict between the necessary increase in coal use due to the increased energy demand and the legitimate growing concern about the related environmental impact.

Several repowering technologies, such as replacing the boiler with a new combustion configuration operating as a combined cycle by adding a gas turbine or by adopting new, cleaner, burners based on highly efficient coal combustion or gasification technology, are commercially available. By contrast the strategy of plant refurbishment - increasing life-time of the coal-fired units by 20 years - is less expensive than repowering and thus is generally preferred.

Potential global climate change due to increases in the concentration of greenhouse gases in the atmosphere has attracted considerable attention as an emerging environmental issue. Even if there are scientific uncertainties related to global climate change, the 'not regret' strategy implies that actions are necessary to reduce emissions of greenhouse gases. Increasing power generating efficiency is a key option in this strategy.

In order to perform an analysis of the efficiency of European Union (E. U.) coal-fired thermoelectric units and their impact on the environment, information on the characteristics of this power plants such as capacity, age, efficiency, operation, and boiler renewing/repowering were collected with valuable support of the European utility companies. Additional information on coal-fired generating units that are under construction or in various stages of planning were also acquired.

E. U. COAL-FIRED POWER PLANT

Historically, most of the electricity generation capacity in the E.U. has been based on coal-fired power plants. After the two oil shocks of 1973 and 1979, reduced availability of oil imports and increasing fuel oil costs made coal-fired generation even more important. In addition, utilities have either retrofitted existing oil-fired steam units to burn coal, or operated gas- and oil-fired boilers to meet peak-loads only. There are some exceptions where the large existing stock of oil-fired capacity obliged the utilities to continue using liquid fuel. Nevertheless, the new and future plants have been designed to burn coal.

Table 1 : Number and Total Capacity of Coal-fired Power Plants in the E.U. (existing and planned)

Member State	Existing		Project	
	N°	(MW)	N°	(MW)
Belgium	31	4000	2	775
Denmark	42	8156	3	945
France	36	11397	-	-
Germany	282	42217	1	553
Greece	21	4683	6	2210
Ireland	19	1340	-	-
Italy	41	10642	21	7650
Netherlands	11	4495	4	2140
Portugal	8	1714	3	995
Spain	40	11082	-	-
UK	146	39648	-	-
Overall EU	677	144374	40	15268

The stock of E.U. coal-fired power plant electricity generating is represented in Table 1 reporting number and overall capacity (MW) of existing and planned boilers by Member State[1].

The coal-fired electricity generating capacity of about 160 GW installed in the European Union represents about the 64% of the total thermal capacity, and 52% and 39% respectively when hydroelectric and hydroelectric & nuclear capacities are included. These figures indicate the strategic importance of coal as source for thermoelectric production. Capacity at project status amounts to 15757 MW and represents a growth of about 10% of the existing thermoelectric coal-fired power plant capacity.

Table 2 reports the percentages by Member State of installed and at project status coal-fired generating capacity compared to the total internal energy sources (fuel oil, natural gas, hydro, nuclear and others). Figures are also given for the percentage of total E.U. existing and at project status coal-fired capacity. The figures show massive use of coal in absolute terms in Germany and U.K., medium in Italy, France, and Spain. It is also important to underline the high percentage of coal use in electricity generation in Denmark (99%), and Greece (71%) compared to other energy sources.

Table 2 : % by Member State of coal-fired electricity generating Capacity compared to E.U. capacity and other internal energy sources

Member State	EU %	Internal %
Belgium	3.0	33.8
Denmark	5.7	99.5
France	7.1	11.0
Germany	29.9	48.7
Greece	4.3	71.0
Italy	11.2	32.2
Netherlands	4.2	37.6
Portugal	1.7	39.6
Spain	6.9	26.4
UK	24.8	54.1

Thermal Unit and Carbon Dioxide

The increased use of fossil fuels in recent years has caused not only an extensive deforestation but also a build-up of carbon dioxide in the atmosphere. This increase in CO_2 causes the atmosphere to absorb infrared radiation reflected from the earth that would otherwise have been dissipated into space. This phenomenon which could increase global temperatures, is known as the 'greenhouse' effect.

These potential increases in temperature are of concern because they could cause climatic changes, shift in agricultural zones, and partial melting of the polar ice caps resulting in flooding of coastal areas.

The CO_2 reduction from the power plants might mitigate this phenomenon, though significant uncertainties remain regarding global warming.

Reduction in power plant CO_2 release reduction by using of scrubbing systems is today the only foreseeable option, it is but so expensive that it can not be adopted in electrical utilities and in all other industrial sectors. However, carbon dioxide emissions can be reduced by increasing conversion efficiency of coal-fired thermal boilers in a number of ways:

- for plant repowering:

- cleaner-burners in highly efficient coal combustion systems that can reach efficiencies of up to 45%, a considerable improvement over conventional technologies with efficiencies in the 33-35 percent range

- for new plants:

- clean coal technologies such as pressurized fluidized bed and gasification technology in combined cycle [1-3] with gas turbine yielding efficiencies of up to 50% and possibly more with a more advanced cycle.

Due to the increased conversion efficiencies of these technologies, carbon dioxide emissions are reduced by 10 to 15 % for each 5-percentage-point improvement in conversion efficiency.

In order to evaluate the scope for reducing CO_2 emissions E.U. coal-fired thermoelectric plants have been analysed according to age, size and efficiency. The results are presented below.

Technologies for High Efficiency Coal Conversion in the E.U. Power Plants

Today's new coal combustion processes have been developed at demonstration and commercial scale to satisfy the rapidly changing environmental, economic, and technical performance requirements being imposed on E.U. power plants.

The repowering of the existing E.U. power plants must satisfy stringent site selection and environmental requirements while producing electricity efficiently and with a high level of reliability. In other words, the new technologies to be applied to the selected existing power plants have to offer the potential for a cleaner environment and lower power costs by contributing to the solution of issues relating to acid rain, global climate change, future energy needs, and energy security.

1 *At the time of writing, the European Union still consisted of 12 Member States*

Given the above mentioned requirements, the new technologies of interest to E.U. utilities can be placed in the following three categories:

- Advanced Combustion. New coal-fired technology [4-7] is based on the cyclone combustor concept, mainly developed in the USA. Coal is burned in a separate chamber outside the water-wall furnace and the hot combustion gases then pass into the boiler where the heat exchange takes place. The advantage is that the ash is kept out the furnace cavity and does not deposit on boiler tubes lowering heat transfer efficiency. Further, not having degradation of the boiler tubes' surface due to ash removal in the prechamber, boiler efficiency is enhanced over time.

Other new coal-fired technology able to reduce environmental emission is based on positioning air ports at designed level so that coal is combusted in stages and NO_x emission can be reduced by up to 70%÷80%. Injecting limestone into the combustion chamber also has the potential to reduce sulphur emission by up to 90%.

- Fluidized-bed Combustion. Fluidized-bed Combustion [8-10] can be either atmospheric (AFBC) or pressurized (PFBC - at pressures 6÷16 times higher than normal atmospheric). The pressurized fluidized-bed combustion offers potentially higher efficiency and less waste products than the atmospheric fluidized-bed process. Systematic improvements have modified the earlier design (bubbling- or circulating-bed) bubbling beds with solid recirculation, fluid beds with internal circulation, and hybrid designs combining several fluidization concepts.

Polluting emissions are reduced by controlling combustion parameters in order to maintain the flue gas temperature at 750÷900°C and by injecting sorbent as limestone: under these conditions the sulphur capture is enhanced (up to 93%) and NO_x emissions are reduced.

- Integrated Gasification Combined Cycle. The Integrated Gasification Combined Cycle (IGCC) process [11-14] basically consists of four steps:

- fuel gas formed by reacting coal with high-temperature steam and air or oxygen,
- fuel gas purification at room temperature (advanced systems are going to clean the hot gas),
- combustion of the clean gas and electricity generation via a gas turbine driven by the hot exhaust gases,
- the residual heat in the exhaust gases and from the gasifier is used in a conventional steam turbine generator to produce additional electricity.

The IGCC process is the cleanest and most efficient system: it is able to remove up to 99% of sulphur from coal (scrubbers in conventional plant typically remove 90%) and partly convert coal's nitrogen into ammonia removed subsequently by conventional chemical processes. NO_x produced in combustion with air are held to an acceptable level by staging the combustion process or by adding moisture to hold down the flame temperature.

Current efficiency levels may be increased and cost per unit of power lowered when the hot gas (over 1100°C) clean-up process (bed of zinc ferrite particles and others) is commercially assessed [15-16].

The Thermie programme of the Commission of the European Union has funded the 335 MW_e project in Puertellano, Spain, based on the PRENFLO coal gasification process. The main objectives of the programme are demonstration of the technical and economical feasibility of an IGCC plant while testing various types of coal from Europe and confirmation of the clean generation of electricity from coal. The gas desulphurization system leads to very low SO_2 contents in the flue gas and the mixing with nitrogen from the air separation unit also achieves very low NO_x emissions[17].

AGE OF E.U COAL-FIRED POWER PLANT

The design of coal-fired power plant has in the past been based on the general assumption that the technical and economical life would be of about 30 years. However several power plants now operating are 35÷40 years old.

The '30 years'expectation was that power plant units would be replaced with new units which would meet load requirements and through the use of technological improvements produce power at lower cost, and have higher availability and higher efficiency.

This expectation has not been fulfilled because of a number of factors such as low load growth, increasing construction costs, competing fuel, siting difficulties, and increasing uncertainty as to local authority regulatory approval.

Utilities have recognised that the potential lifetime of existing plant may be far in excess of the design assumption and that there can be numerous technical and economical advantages in continuing to operate these 'old' power plants.

Thus, extending the life of the power plants to reach as much as 50÷60 years service or longer could be economically advantageous. The aims for extending the life time might be as follows:

- extension or improvement of availability, reliability, and heat rate of power plant performance in an economically beneficial manner
- improvement of power plant safety, and environmental protection to meet new regulations
- increasing the thermal efficiency of coal-fired power plant so that the plants become as economically viable and as low on CO_2 emissions as new power plant designs.

The feasibility of extending the life of the E.U. coal-fired power plants to meet the above aims can be evaluated, using a statistical technique - the 'Weighted Average Age (WAA)'- to review the power plant status, for each Member State, by means of the following formula:

$$\text{Weighted Average Aged} = \frac{\sum_i \alpha i * MWi}{\sum_i MWi}$$

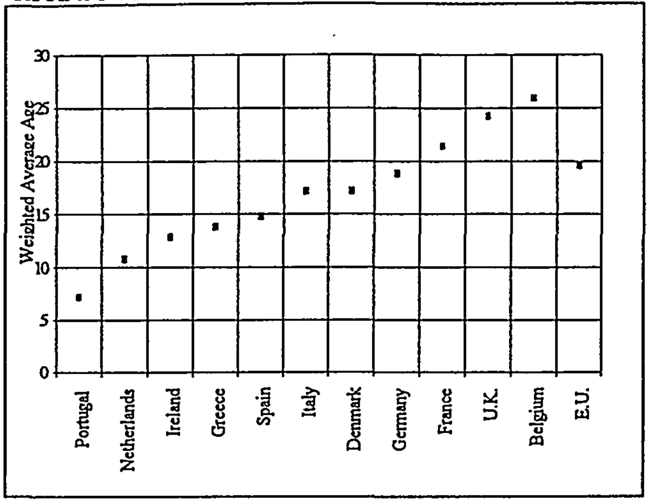
Where : - i denotes a coal-fired thermoelectric unit
- α the age of the unit i
- MW the capacity of the unit i

Table 3 : 'Weighted Average Age' of EU Coal-fired Power plants

Member State	$\frac{\sum i\ \alpha i * MWi}{\sum i\ MWi}$
Belgium	25.9
Denmark	17.2
France	21.4
Germany	18.8
Greece	13.8
Ireland	12.8
Italy	17.2
Netherlands	10.8
Portugal	7.2
Spain	14.8
UK	24.2
EU	19.6

The calculated values of the 'Weighted Average Age' (WAA) are given in Table 3. The 'WAA' synthesizes the historical data of power plant age and provides information for understanding, statistically, the level of obsolescence of power plant.
The 'WAA' data given in Figure 1 indicates statistically which Member States' power plants should have the most interest in extending the life of their coal-fired power plants, as one of the most cost-effective options for meeting their future energy requirements. The need to consider extending the life of coal-fired power plants increases from Portugal (installed capacity 1714 MW), Netherlands (4495 MW), Ireland (1340 MW), Greece (4683 MW), and Spain (11032 MW)- the 'WAA' varies in the range 7÷15 -; through Italy (10937 MW), Denmark (8156 MW), and Germany (47073 MW) - 'WAA' 15÷20 -; to France (11397 MW), U.K. (39548 MW), and Belgium (4000 MW) - 'WAA' 20÷26 -.

Figure 1 : 'Weighted Average Age' of E.U. Coal-fired Power Plant



The 'Weighted Average Age' has also been calculated using the power plant data separated into three classes:

- Over 30 years
- Between 20 and 30 Years
- Below 20 years

in order to provide more detailed information on the statistical level of obsolescence of the power plants in each Member State.

'WEIGHTED AVERAGE AGE' OF THREE AGE-RANGE CLASSES OF COAL-FIRED BOILERS

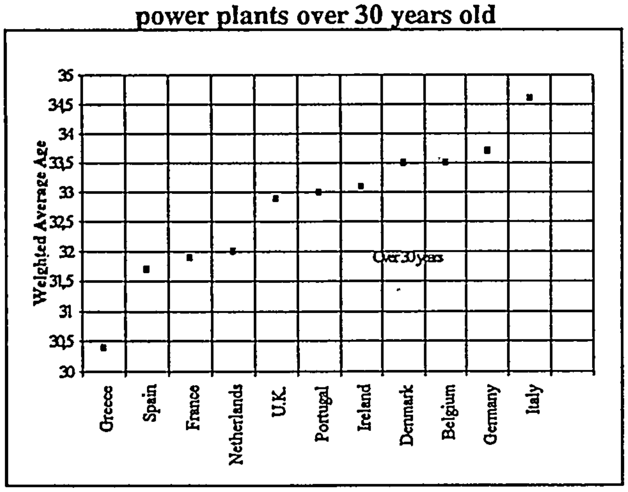
Table 4 : 'Weighted Average Age' of EU Coal-fired Power Plant Park Split Three Age-range classes

Member State	$\frac{\sum i\ \alpha i * MWi}{\sum i\ MWi}$		
	Over 30 years	20-30 years	below 20 years
Belgium	33,5	25,8	15,8
Denmark	33,5	24,6	9,2
France	31,9	24,6	10,0
Germany	33,7	24,4	9,7
Greece	30,4	24,4	10,5
Ireland	33,1	27,9	7,7
Italy	34,6	24,3	4,9
Netherlands	32,0	27,4	7,2
Portugal	33,0	27,5	5,0
Spain	31,7	24,1	11,7
UK	32,9	24,0	13,9
EU	33,3	24,3	14,2

The calculated values of the 'Weighted Average Age' of the three age-range classes are reported in Table 4, showing the differences in the statistical level of

obsolescence among the three classes and the previous overall evaluation due to the different industrial evolution of each Member State.
These differences are emphasised in Figure 2 which gives the 'WAA' for the over 30 years power plant life for each Member State. This shows that the 'WAAs' vary over the range 30÷35.

Figure 2 : 'Weighted Average Age' of coal-fired power plants over 30 years old



The order of the Member States and capacities concerned are reported in Table 5.

Table 5 : Member States and Power Plant Capacity

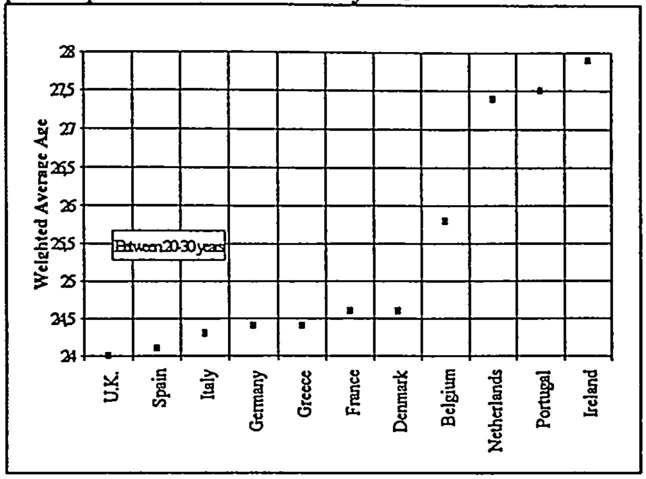
Member State	MW	Member State	MW
Greece	363	Ireland	185
Spain	209	Denmark	692
France	1080	Belgium	1243
Netherlands	125	Germany	8247
U.K.	7790	Italy	1133

Table 6 : Member State and Power Plant Capacity

Member State	MW	Member State	MW
U.K.	25828	Denmark	3158
Spain	2377	Belgium	1846
Italy	5213	Netherlands	655
Germany	15578	Portugal	100
Greece	700	Ireland	110
France	7299	E.U.	62864

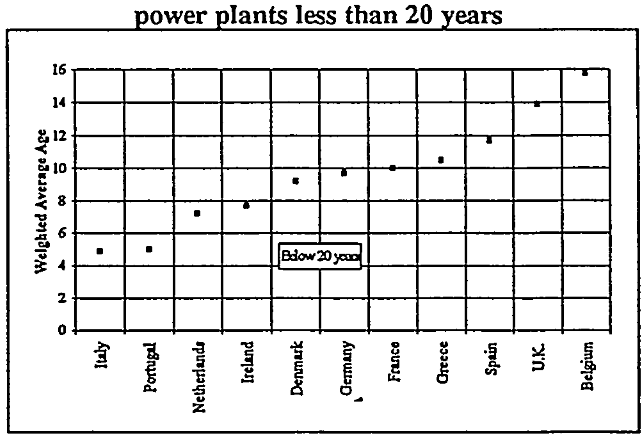
Figure 3 presents the Weighted Average Age for the class between 20÷30 years showing two plateaus, a lower one covering seven countries in the range 24÷26 and a higher range ('WAA'~28) covering power plants in Netherlands, Portugal, and Ireland constructed around 1965.

Figure 3 : 'Weighted Average Age' of coal-fired power plants between 20÷30 years



The order of the Member States and Power Plant capacities concerned are reported in Table 6.
The below '20 years old' class shows (Figure 4) 'WAAs' vary in the range 5÷16; these values indicate that the level depends on the years of installation of the new coal-fired units power plants in each Member State.

Figure 4 : 'Weighted Average Age' of coal-fired power plants less than 20 years



The order of the Member States and Power Plant capacities concerned are reported in Table 7.

Table 7 : Member States and Power Plant Capacity

Member State	MW	Member State	MW
Greece	3260	Ireland	1045
Spain	8446	Denmark	4306
France	3018	Belgium	911
Netherlands	3715	Germany	23248
U.K.	5930	Italy	4591
Portugal	1564	E.U.	60393

E.U. COAL-FIRED POWER PLANT SIZE

The 'Average Capacity per coal-fired thermal unit' for each Member State is given in the Table 8.

Table 8 : 'Average Capacity (MW) per Coal-fired thermal unit' for each Member State

Member State	Ratio	Member State	Ratio
Belgium	129	Italy	260
Denmark	194	Netherlands	409
France	317	Portugal	214
Germany	167	Spain	277
Greece	223	U.K.	272
Ireland	71	E.U.	213

The 'Average Capacity (MW) per coal-fired thermal unit', that varies between 71 of Ireland and 317 of France, is also an index of the power plant concentration or dispersion in the country. Although fuel conversion efficiency and economical electricity generation both increase with the unit size, utilities often prefer for management reasons, or due to local constraints, to install boilers of lower capacity.

To increase the efficiency and economy of the power plants, the new tendency has been to construct boilers of higher capacity as demonstrated by the 'Average Capacities (MW) per coal-fired boiler over 30 years, below 30 years and at project status' of single Member State reported in Table 9.

Table 9 : 'Average Capacity (MW) per Coal-fired Thermal Unit over, less than 30 years old and at projects Status' for each State Member

Member State	Ratio MW/Number boilers		
	over 30 y	Below 30 y	project
Belgium	86	160	388
Denmark	63	178	315
France	163	353	-
Germany	92	208	255
Greece	68	249	368
Ireland	16	110	-
Italy	103	279	404
Netherlands	125	437	535
Portugal	50	226	326
Spain	105	285	-
U.K.	95	438	-
E.U.	90	265	382

It is possible to note: e.g.,

- in Germany, due to the low 'Average Capacities' of the coal-fired thermal units over (92) and less than (208) 30 years old, there are plants at project status with an average capacity of 255 MW;
- in U.K., since the 'Average Capacity' of the plants over 30 years old is high (438), they consider unnecessary to plan new units;
- in Italy, due to the low 'Average Capacities' of the coal-fired thermal units over (103) and less than (279) 30 years old, they have planed plants with an average capacity of 444 MW;
- in France, since the 'Average Capacity' of boilers below (163) and over (353) 30 years old is high, there are no new units planned.

In other words, Member States with power plants of low capacity have been obliged to plan new units of high capacity to balance the reduced efficiency of existing units.

E.U. COAL-FIRED POWER PLANT EFFICIENCY

The efficiency of E.U. coal-fired thermal units varies between 19% and 44% within the collected available data[2] Table 10 presents the correlation for each range with the various parameters (number, average age and mean capacity of boilers).

Table 10 : E.U. Coal-fired Thermal Units : Efficiency versus Number, Average Age and Mean Capacity of Boilers

Efficiency Range %	N° Boiler	Average Age	Average Capacity, MW
19÷30	55	28	118
30÷35	190	26	221
35÷45	222	21	334

Low efficiency values correlate with old boilers of small capacity, while high efficiency values correspond to new thermal units of relative higher capacity, and, specifically to the characteristics of boilers with efficiency in the range 35÷45% probably due to the specific boiler design.

The variation of efficiency with boiler age and capacity is well illustrated in Figures 5 and 6, where the trend of thermal unit efficiency is correlated with capacity (MW) and year of first operation, respectively.

In the graphs the efficiency trend seems to be correlated positively with electricity generating capacity, negatively with the construction year approaching asymptotically, in both the cases, the

2 The analysis of efficiency has not been performed on overall E.U. coal-fired boilers since data for this specific parameter are not available for all the existing 677 coal-fired thermal units, but only for 467. Nevertheless, due to the large quantity of the available data (69% of the total) the results of this analysis of the correlation between efficiency and various other parameters (capacity, age, and operation hours) of the coal-fired boilers may be considered statistically reliable.

range 38÷42%. The scattering of the points from the mean in Figure 6 may be explained by the necessity in recent years to construct boilers of low capacity due to different factors such as site constraints or local limited electricity demand: in fact, in Figure 5, the distribution of the points related to efficiency versus capacity approaches the asymptote with a narrow range, while the area of boilers below 100 MW is particularly dense.

The analysis of Figures 5 and 6 and Table 10 indicates that the conventional design of thermoelectric units has reached the maximum conceptual development and further improvements in efficiency must be reached with new technologies to be applied in existing or new power plants.

Figure 5 : Trend of E.U. coal-fired boilers versus capacity

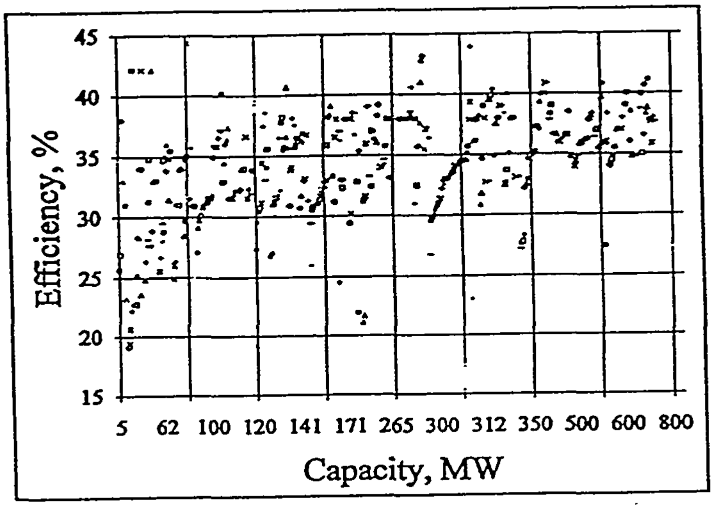
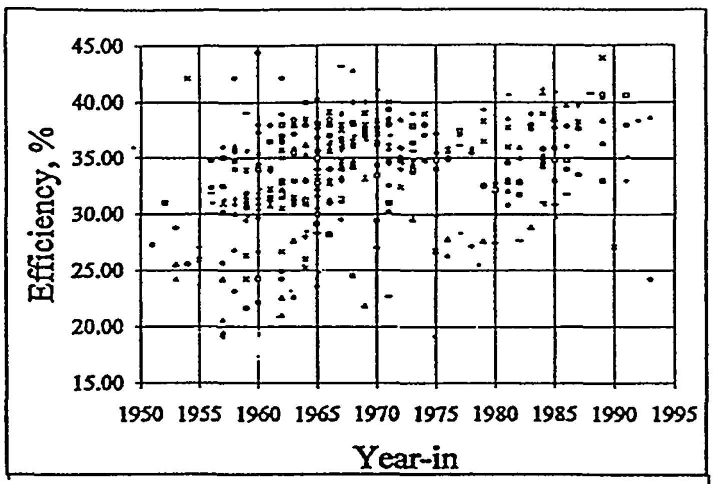


Figure 6 : Trend of E.U. coal-fired boilers versus year of first operation



Priority in Repowering Existing Coal-Fired Power Plants

To produce aggregates and averages for the coal-fired boiler efficiency of each Member State at capacity and age level, the statistical formula 'Weighted Average Efficiency (WAE)' is then applied to the E.U. coal-fired thermoelectric unit data, where:

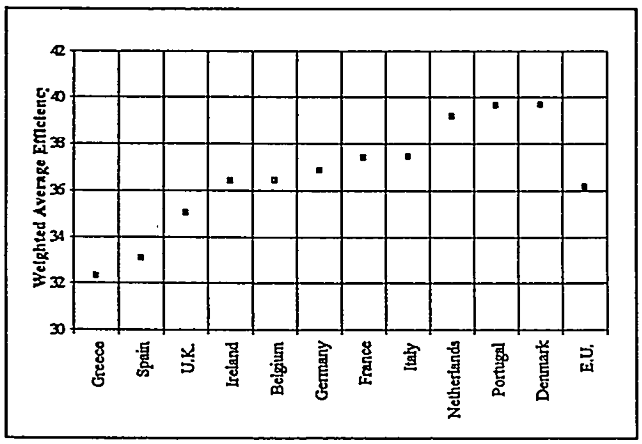
$$\text{Weighted Average Efficiency} = \frac{\sum_i \eta i * MWi * (1/Ai)}{\sum_i MWi * (1Ai)}$$

and : i denotes a coal-fired thermoelectric unit
η the efficiency of the unit i
MW the capacity of the unit i
A the age of the unit i

The calculated values of the 'Weighted Average Efficiency' are reported in Table 11 showing a range between 32÷40. The 'WAE' synthesizes the data of power plant efficiency and provides statistical information highlighting the comparative level of conversion of fuel into useful energy of E.U. coal-fired power plants. Furthermore, the best 'WAE' values averaging between 39 and 40 of some coal-fired power plants do represent a focal point for those Member States which are below this figure.

The statistical series in Figure 7 shows the priority that should be given by each Member State to repowering the coal-fired power plants in order to produce the maximum of useful energy and controlling the flue gas emission, specifically, greenhouse gases.

Figure 7 : Trend of 'Weighted Average Efficiency' of the E.U. coal-fired thermoelectric units



In order to define the priority index for repowering coal-fired boilers characterized by greater age and lower capacity, the 'WAE' formula has been applied on coal-fired boiler data subdivided in three classes of efficiency: namely, below 30%, between 30÷35% and over 35% (Table 12).

'WAE' for Efficiencies Below 30%

The result of this analysis indicates that the 'WAE' for efficiencies below 30% varies in the range 24÷30 indicating that the electrical productivity of the power plants is very low as to the capacity of the single boilers, while the age is high: repowering of the units is urgent in order to reach a mean threshold of efficiency to justify their life extension.

Table 12 : 'Weighted Average Efficiency' of E.U. Coal-fired Power Plant calculated in three Efficiency Classes : below 30%, 30÷35% and over 35%

Member State	Σiηi*MWi*(1/Age) / Σi MWi* (1Age)		
	Below 30%	30÷35%	Over 35%
Belgium	28.77	34.26	36.67
Denmark	34.07	33.81	40.12
France		34.01	38.02
Germany	24.69	33.20	38.21
Greece	28.46	32.01	35.12
Ireland	26.24		38.01
Italy		33.37	38.56
Netherlands			39.17
Portugal	28.17		39.93
Spain	27.58	33.24	35.65
U.K.	24.68	33.90	36.66
E.U.	26.22	33.38	37.98

In this class of efficiency the total capacity of the power plants is 6502 MW and average operating hours per year 4512. Due to the very low capacity (e.g. Belgium 53 MW, Denmark 160 MW, Ireland 425 MW, and Portugal 150 MW) and operating hours (e.g. Greece 2475 hour/year) of some Member State's boilers the repowering should focus o the boilers of the other Member States that have the following capacities:

- Germany, 1163 MW
- Spain, 2193 MW
- U.K., 680 MW

giving an overall capacity of 4036 MW. The efficiency improvement obtainable by coupling existing coal-fired thermal units with a gas turbine in combined cycle could reach value of 40%. Nevertheless, the advantages in electricity production and CO_2 reduction should be carefully evaluated by the three Member States because the savings may not be cost effective given the number of boilers and the related ratio capacity (MW)/number of boilers, that is:

Member State	N. Boiler	Ratio MW/N.boiler
Germany	12	97
Spain	7	313
U.K.	6	113

Instead, an advantageous strategy could be to combine repowering activities for coal-fired boilers of this efficiency class on two levels:

• retrofit of those boilers of adequate thermal capability with advanced combustion technologies such as cyclone combustors where the coal is burned in a separate chamber outside the furnace cavity (keeping the ash out of the boiler tubes) and simultaneously connected to a gas turbine in order to reach an overall efficiency up to 45÷50%

• promotion of new Integrated Gasification Combined Cycle (IGCC) projects, drawing on the experience and success of the Puertellano Plant, Spain, to be installed in existing sites providing a double advantage:

- utilization of existing sites for the IGCC process overcoming the constraint and uncertainty in having new sites approved by the local authority
- substitution of old plants having low efficiency (averaging 28% in Germany, Spain and U.K.) and high CO_2 emission with new plants with efficiency up to 50%.

'WAE' for the 30÷35% Efficiency Class

The 'WAE' for the 30÷35% efficiency class gives figures in a very narrow range (32÷34) indicating that coal-fired boilers are similar in capacity and year of construction.

A priority scale of the Member States which should repower their own electrical facilities can be obtained by submitting the power plants belonging to this efficiency class, given their comparative age and electrical capacity, to an analysis of parameters as total capacity, average operating hours per year, and ratio 'Capacity (MW)/Number of boilers'. The priority scale can be calculated by the formula as follows:

$$\text{Priority Scale} = \frac{MWi * Hi * Ri}{\sum i\ MWi * Hi * Ri} * 100$$

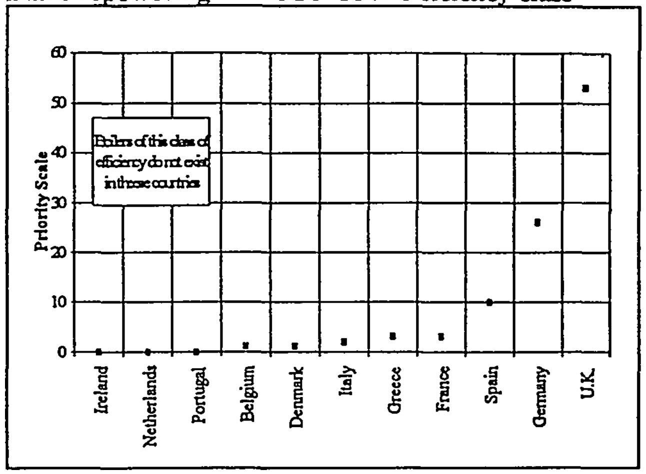
Where :

- i denotes a Member State
- MW the overall capacity of the Member State i
- H the power plant average operating hours of the Member State i
- R de ratio capacity (MW)/number of boilers of the Member State i

This priority scale gives information on the power plants for which increasing boiler efficiency provides a means of meeting future energy requirements and, at same time, reducing CO_2 emissions at European Union level: in fact, the prospects for an increase in energy production combined with a decline in CO_2 emissions are negligible or reasonable depending on whether capacity, operating hours, and boiler size of the power plants are low or high values, respectively.

The priority scale given in Figure 8 shows the Member States which may reconfigure as combined cycle plants by adding gas turbines to their own electric facilities more usefully.

Figure 8 : Trand of the Priority Scale in Power Plant repowering in the 30÷35% efficiency class



Therefore, the most probable Member State candidates for repowering in this efficiency class are U.K., Germany, and Spain with the following power plant capacity, operating hours and number of coal-fired thermal units:

Member State	Capacity MW	Operation Hours/Yrs	Number of boilers
U.K.	18625	5652	75
Germany	11805	5028	58
Spain	5300	6695	22

Other Member State candidates may be France and Italy with the following characteristic parameters :

Member State	Capacity MW	Operation Hours/Yrs	Number of boilers
France	1415	4607	6
Italy	1318	6695	11

The power plants, shown in the two above tables, repowered with a combined cycle can reach efficiencies of up to 55%.

In agreement with the priority scale other most important factors determining the need for new electric generating capability must be considered by Member States by analysing macro-economic factors, such as the Gross National Products and the cost of the fuel and electricity and peak demand and energy requirements.

'WAE' for Over 35% Efficiency Class

The 'WAE' for the over 30% efficiency class shows data in the high range 35÷40 due to the high capacity (MW) and recent year construction of single boilers coupled to efficient thermal conversion of the coal.

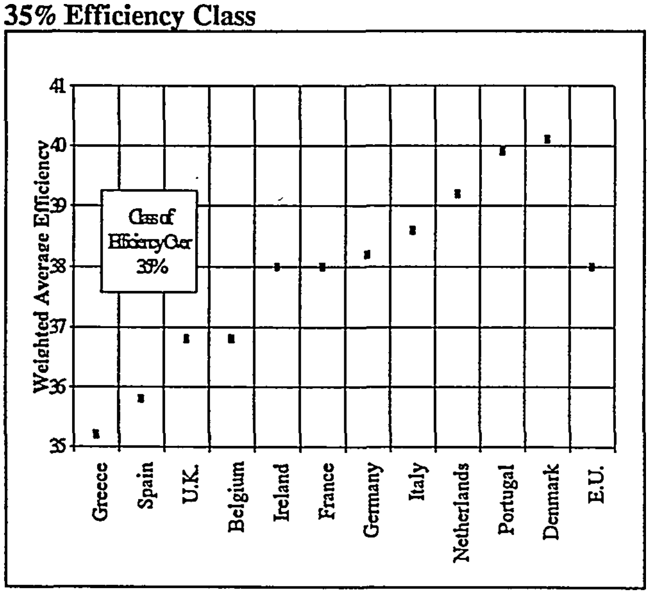
The overall capacity of this efficiency class is 79219 MW that is 1.5 times the total capacity of the other classes. The average size of the coal-fired thermoelectric units, expressed as ratio of total capacity (MW)/number of boilers, is 334, 1.5 and 2.8

times that of the classes below 30% and 30÷35%, respectively.

The 'WAE' statistical series derived from the data of the over 35% efficiency class given in Figure 9 indicates two levels of priority for the repowering of coal-fired boilers, namely below 37 and over 38. But the programme of retrofitting activity to improve the efficiency of the thermal Plants is difficult to define for a series of reasons:

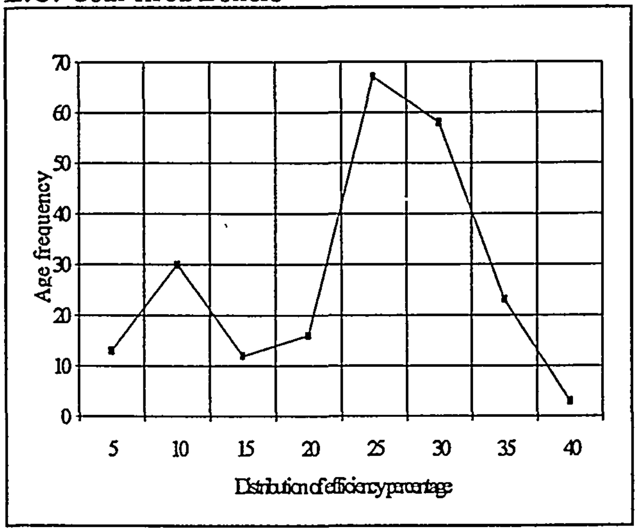
- the average age is 21 years with the frequency distribution of the boiler age, classified every five years, shown in the histogram in Figure 10. The coal-fired units exceeding thirty years account for a small proportion of the boilers in this class, ca. 12%. Utilities, keeping in view the life time of the boilers, can consider it economically advantageous to operate them far in excess thirty years.

Figure 9 : Behaviour of the "'Weighted Average Efficiency' of the Coal-fired Boilers of the Over 35% Efficiency Class



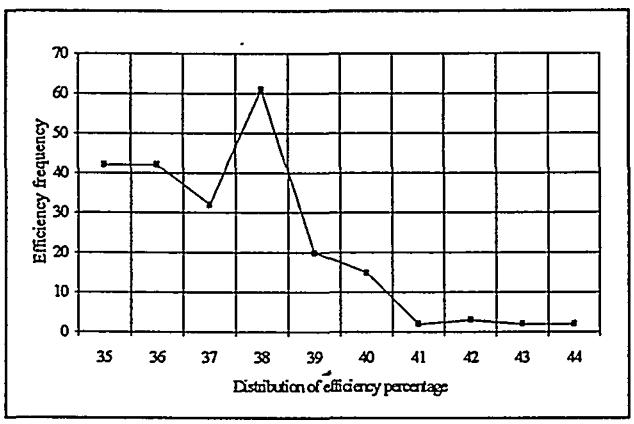
- average efficiency is 38% with the frequency distribution of the thermal conversion of the coal, classified every five per cent, shown in Figure 11. This efficiency level of coal-fired thermal units is the maximum potential for current conventional process design developments.

Figure 10 : Frequency distribution of the Age of E.U. Coal-fired Boilers



- the repowering of boilers of this class efficiency would be not as cost-effective as for the previous two efficiency class since the application of advanced combustion technologies and IGCC processes is a necessary substitution. In fact, the above new systems provide a means of satisfying a rising demand for electricity, while providing an environmental benefit.

Figure 11 : Frequency distribution of the Efficiency of E.U. Coal-fired Boilers



Potential Reduction of CO_2

Carbon dioxide emissions can be reduced by 10 to 15% for each 5-percentage-point improvement in conversion efficiency when adopting high coal conversion technologies, as previously reported.

Related to the 'WAE' calculated for the three different classes of boiler efficiency the hypothesis on Member State's potential candidates for repowering of their power plants, an evaluation of the maximum potential reduction of CO_2 can be performed as follows:

Carbon dioxide emissions from E.U. coal-fired Power Plants[3] in 1993 (1992 value reduced by 2%) result to be: $CO_2 = 1165$ Mt

and Carbon dioxide specific emissions per installed MW: $CO_2/MW = 6.3 \times 10^{-3}$ Mt

- Hypothesis for repowering the class of coal-fired boilers with an efficiency lower than 30%

Power plant candidates for repowering activities are found in Germany, Spain, and U.K.
- Overall capacity = 4036 MW
- average efficiency = 26.8%
- Current CO_2 emission = 25.3 Mt/y
- repowered efficiency = 50%
- CO_2 reduction emission = 11.7 ÷ 1706 Mt/y

- Hypothesis for repowering the class of coal-fired boilers with an efficiency between 30÷35%

Power Plant candidates for repowering activities are found in Germany, Spain, and U.K.
- Overall capacity = 35370 MW
- average efficiency = 32.7%
- Current CO_2 emission = 223.7 Mt/y
- repowered efficiency = 55%
- CO_2 reduction emission = 99.8 ÷ 149.6 Mt/y

A gradual repowering of about 20% per year of the coal-fired Power Plants will give a CO_2 reduction of about 22÷33 million t/year and would be a realistic goal for the E.U. coal-fired thermoelectric sector to attain.

Further reduction can be matched if power plants in France and Italy are included among the candidates, too. The additional CO_2 reduction are estimated to be 7.7÷11.6 million t/year.

E.U. coal-fired Power Plant generating electricity related to the collected data consists of 677 existing thermal units for a total capacity of 144347 MW and 40 thermal units at project status for a total capacity of 15268 MW.

The statistical analysis based on the 'Weighted Average Age', calculated on the aggregate and analytical (three age ranges) data for the boilers, gives an indication of the level of obsolescence of E.U. Power Plants and the need to extend the life of coal-fired thermal units.

The analysis based on the available efficiency data for 467 E.U. coal-fired thermoelectric units, indicates the following:

- an overall capacity of 122672 MW, with mean operating hours per year of 4983 and an average efficiency of 34%, ranging from 19 to 44%.

The statistical analysis based on the 'Weighted Average Efficiency' of the boilers classified in three efficiency range, namely below 30%, between 30÷35% and over 35%, gives an overview of E.U. coal-fired power plants, as follows:

3 Data from 'Energy in Europe' 1993 - Annual Energy Review - European Commission - Directorate-General for Energy (DG XVII). Special Issue, June 1994

below 30% range of efficiency

- 55 boilers with a total installed capacity of 6502 MW and mean operating hours per year of 4512, and efficiency ranging from 24 to 30%
- statistical candidates for repowering are situated in the following Member States:

Member State	N. Boilers	Overall MW	Operating Hours per Year
Germany	12	1163	5510
Spain	7	2193	5597
U.K.	6	680	3828

- the hypothesis on the repowering of the candidate power plants may be based on two strategy levels:
- boilers of related higher capacity and efficiency retrofitted with cyclone combustors and coupled in combined cycle with gas turbines with an increase in efficiency of up to 40÷45%
- promotion of the IGCC process in those plants having the oldest boilers with corresponding low capacity and efficiency in order to use existing sites and increase efficiency up to 50%.

30÷35% range of efficiency

- 190 boilers with a total installed capacity of 41951 MW, with mean operating hours per year of 4968, and efficiency ranging from 32 to 34%
- statistical candidates for repowering are situated in the following Member States:

Member State	N. Boilers	Overall MW	Operating Hours per Year
Germany	75	18625	5652
Spain	58	11805	5028
U.K.	22	5300	6695

- repowering hypothesis of the candidate Power Plants based on the adoption of combined cycle with gas turbines to reach efficiencies up to 55%.

over 35% range of efficiency

- 222 boilers of total installed MW equal to 74219, with mean operating hours per year of 4972 and efficiency ranging from 35 to 44%
- repowering should only be considered in the distant future for the following reasons:
- the average age of the boilers is 21 years and only 12% of the coal-fired units are older than thirty years. Generally, utilities keeping in view the life time of the boilers can consider it economical to operate them for much longer than thirty years.
- the (35÷44%) efficiency level is the maximum potential for conventionally-designed coal-fired thermal units
- the repowering of boilers in this efficiency class would be not cost-effective due to the relatively recent construction of the units and the higher coal conversion in producing electricity compared to boilers in two other efficiency class. Therefore, the application of

advanced combustion technologies should start with the first two efficiency classes examined above.

Related to the greenhouse gas effect, designing new power plants (to be installed on the oldest sites) with advanced combustion configurations such as pressurized fluidized bed and gasification technology in combination with gas turbines can add a further benefit to the environment due to the elimination of flue gas scrubbers. As already discussed the elimination of SO_2 in IGCC's and fluidized bed processes varies in the range from 90 to 99% allowing the discharge of the flue gas in the atmosphere without the use of de-SO_x scrubbers that actually add CO_2 to the air because via the chemical reaction with $CaCO_3$ and have negative effect on plant efficiency.

Related to the economy, the proposed advanced technologies for repowering E.U. coal-fired power plants require a higher level of investment than new conventional pulverized fuel thermal units, nevertheless they may be able to produce power at a lower cost per kWh for the following reasons:

- the electrical-thermal efficiency of up to 45÷55% reduces the specific kWh cost directly because conventional power plant efficiency generally range between 30÷40% depending on the age and size of the units
- the use of advanced technology, new materials and equipment resulting from the demonstration and optimisation at power plants (i.e. Puertellano project) facilitates the design and construction of the new installations
- although the reduction in CO_2 produced per MW is not a cost advantage, nevertheless it is a clear environmental target for the future and a concomitant economic advantage with the improvement in efficiency of the new technologies.

CO_2 reduction can be maximized at 111.5÷167.2 Mt/yr by repowering the boilers in the efficiency below 30% and 35÷40% ranges belonging to the Member States selected via the 'Weighted Average Efficiency' (CO_2 reduction increases to 119.2÷178.8 million t/year including France and Italy).

A gradual repowering of this 20% of the installed capacity would correspond to a CO_2 reduction of about 22÷33 million t/year (24÷36 million t/year including France and Italy).

It would be noted that the Commission has been requested to implement action related to this problem by the European Parliament Resolution of the 21 December 1993.

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ANALYSIS OF THE BEST WAY : MOX FUEL

The optimum route for disposal of surplus weapons grade plutonium

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INTRODUCTION

In the following presentation it is assumed that, under of the START agreements, warheads will be dismantled at a rate close to 2000 per year, freeing up a significant quantity of highly enriched uranium and weapons grade plutonium in the coming years to come. From a technical standpoint, as far as the plutonium is concerned, disposal in the short term on a meaningful industrial scale represents a major problem for the countries concerned. But, to keep in long term storage large quantities of weapons grade plutonium can obviously not be recommended either. This would be at variance with the very spirit of the disarmament initiatives, to mention only one reason.

OPTIONS FOR DISPOSAL OF WEAPONS GRADE PLUTONIUM

Currently available technologies allow of two main options which can effectively prevent weapons grade plutonium from being used for illicit activities:

- Either to use it as nuclear fuel in civilian power plants thus to leaving the residual plutonium (which has not been fissioned) as reactor-grade plutonium associated with the fission products in the spent fuel. Progressive recovery of that plutonium can await later reprocessing at a stage when such fissile material may become attractive for civilian purposes; for example, around 30% of the plutonium recycled in a typical LWR[1] of 1000 MWe unit size, and loaded with one third MOX fuel will be burnt and the remainder ends up as residual reactor grade plutonium in the spent fuel
- or to dispose of it, after appropriate processing to render the material unusable for diversion. The most frequently proposed method is to blend the plutonium with fission products, to fabricate a kind of artificial high by active waste, vitrify this blend as it is done for fission products after reprocessing, and finally to dispose of it in a deep geological repository.

The US National Academy of Sciences has concluded in its study on weapons grade plutonium disposal that both options offer a comparable degree of security against to diversion.

However, it is also noted in this study that :

- if plutonium is burnt in reactors, its isotopic composition is greatly modified, rendering it definitely much less attractive if not useless for the production of nuclear explosives. This is the essential point, since under the other option the fission products would decay in some hundreds of years, after which the remaining radioactivity will of itself no larger provide any serious protection against diversion. Consequently, mixing weapons grade plutonium with fission products to form high by active waste cannot be considered to be a definitive solution;
- the use of plutonium in civilian power plants of course generates electricity, thus not only turning "swords into ploughshares" but adding an economic incentive to this option. Indeed, 100 tons of Pu recycled in LWRs represent 2000 TWh, or about one year's of electricity consumption in Europe.

In a previous presentation[2] we demonstrated that there is, not only for the non-proliferation considerations of the high cost of interim storage, every incentive to use surplus weapons grade plutonium as fuel as quickly as possible after it becomes available from the dismantlement of nuclear warheads.

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1 *Light Water Reactor*

2 *Disposal of Surplus Separated Plutonium, Influence of Interim Storage of Plutonium, A. Decressin and E. Vanden Bemden, NATO International Scientific Exchange Programme, 16-19 Oct. 94, IPPE, Obninsk, Russia*

WHICH TYPES OF REACTORS COULD BE EFFICIENT USED

The fastest way to use weapons grade plutonium as fuel is to recycle it in existing power reactors such as LWRs and, perhaps, at a later stage, in fast neutron reactors (FNRs) which have still to be built. New reactor concepts may also be envisaged burning the plutonium stocks even more efficiently. But the time required for their development and industrial deployment could be longer than the time needed by conventional reactors to use the entire of the plutonium surplus forecasted to become available in the near future.

Indeed, Light Water Reactors of modern design can be fuelled with MOX for a substantial part of their cores (30% or even more) without major core modifications.

The first large commercial LWR power plants were loaded with MOX fuel in Germany in 1982 and in France in 1987; around 15 tons of plutonium have already been recycled in Europe to date. In the European Union close to 30 reactors will soon have been loaded with this fuel. Current MOX manufacture capacity is about 60 tons annually. Extension programmes are under way leading to a capacity of 400 tons by the year 2000, which would use around 15 tons of Pu/year.

In the USA, more than 100 LWRs are currently in operation and most of these are perfectly able to accept MOX as fuel at least up to 1/3 of the core.

In the Russian Federation, seven VVER-1000 produce electricity and it is expected that 10 to 15 additional PWRs could be connected to the grid by the year 2010.

In the Ukraine, ten VVER-1000 reactors are operating and five are under construction. All these reactors could certainly serve as plutonium burners when partially loaded, as a first step, with MOX fuel, close to 1/3 of the core. In a more distant future, new designs of LWR could permit operating with 100% MOX fuel cores.

Fast neutron reactors (FNRs) if built would certainly constitute more efficient plutonium burners. Their efficiency in this respect is around five times greater than that of LWRs (fuelled with 1/3 MOX). The future Russian fast reactor type BN 800, for instance, could be fuelled each year with 1.6 tons of plutonium, the first core 2,3 t plutonium[3].

However, as of today FNRs are still in the demonstration phase. In the USA, the fast reactor concept has never got beyond the experimental phase and nothing suggests that the intention exists to promote such development over the coming decades.

On its side, the Russian Federation plans progressively to load the BN 600 with plutonium, and the Russian authorities have announced that they envisage building three to four BN 800 fast reactors by the year 2010.

SCENARIOS FOR PLUTONIUM USE IN POWER REACTORS

For the use of weapons grade plutonium as fuel in civilian power plants, various scenarios can be selected involving different types of power reactors and plutonium recycling routes (fast or thermal recycling route). In our study, we have analysed certain scenarios with the view to examining the impact of the reactor type and the recycling route chosen on the total time needed to eliminate a given amount of weapons grade plutonium by irradiation and thus conversion into spent fuel elements.

Six scenarios have been studied (see table 1) involving:

- PWRs of current design and of 1000 MWe unit size loaded with one third of the core with MOX fuel
- Advanced Fast Neutron Reactors of 800 MWe unit size loaded with 100% MOX fuel, and
- Advanced PWRs of 1000 MWe unit size loaded with 100% MOX fuel.

The following assumptions have been adopted for annual loadings of weapons grade plutonium per reactor :

- 300 kg for 1000 MWe PWRs at 1/3 MOX;
- 900 kg for 1000 MWe PWRs at 100% MOX;
- 1500 kg for 800 MWe FNRs (First core 2500 kg weapons grade plutonium).

For the sake of comparison, it is assumed that the firm decision to go ahead with a given scenario is taken at the same date in all six cases. In order to cover a broad range of possibilities for each reactor type, three reference and three accelerated scenarios have been evaluated to see the effect of an increased number of reactors operating with MOX on the total time needed to eliminate a given amount of plutonium. The times have been calculated under the six scenarios needed to eliminate 50 tons and 100 tons respectively of weapons grade plutonium.

Before discussing the results, it has to be noted that even if it is assumed that the decision is taken at the same date to go ahead with a certain scenario, the point in time when the first MOX load is manufactured and loaded into the first reactor of the kind chosen in the scenario, will not be the same for each scenario. In practice this will depend on the availability both of the type of reactor of the recycling route chosen. In other words, a certain setting-up time has to be accounted for at the end of which the following conditions have to be fulfilled, among others:

3 Utilization of Plutonium in Nuclear Power Industry of Russia - V.N. Mikhailov (Minatom, Russia) and al.
Paper distributed at the International Policy Forum: Management and Disposition of Nuclear Weapon Material, March 8-11, 1994, Leesburg, Virginia, USA.

- the first reactor of the type considered in the scenario must be in industrial operation or brought into operation and capable of accepting MOX fuel on an industrial scale;
- the technology needed to manufacture MOX must be available;
- the sub-industries of the plutonium cycle must be available, licensed and operational (MOX fuel fabrication plants, specific MOX fuel transport systems the necessary psecial containers, etc.);
- all administrative conditions, including safeguards procedures laided down for MOX use have to be satisfied;
- the fuel for the first MOX load must have been supplied to the first power station involved in the scenario.

Taking all the above into consideration, the setting-up time will amount to at least 6 years, in the case that for instance, existing conventional LWRs with 1/3 MOX loadings are envisaged as plutonium burners.

If Fast Neutron Reactors (FNRs) were to chosen for the recycling of weapons grade plutonium, a minimum delay of 11 years would have to be assumed for the setting-up time, given that the first industrial FNR using plutonium still has to be built, licensed and industrially operated (in Russia, for instance, the BN 600 took 12 years from the start of construction to full operation, and the comparable period in the case of . Superphénix in France was 9 years).

If a new type of LWR has to be designed from scratch, built, licensed and industrially operated with 100% MOX cores, even longer setting-up time might have to be assumed, due to the fact that experience must probably first be gained with operation of these reactors with uranium fuel and/or MOX fuel but with fuel loads under than 100%.

Taking into account these considerations, effective recycling of plutonium in reactors would not begin earlier than perhaps 6 to 15 years following the firm decision taken to do so. If on the other hand, existing LWRs capable of being loaded with a third of the core with MOX fuel are to be deployed, wich shorter run-in time coulg be achieved. If FNRs or a new type of LWR capable of being loaded with 100% MOX fuel are envisaged, it is not necessary the case that subsequent reactors of that type could be built and operated following shortly upon the first one, since satisfactory experience would have to be gained with the first unit before operation or even construction of the following units.

DISCUSSION OF THE RESULTS

Taking into account all the constraints set out above, some general trends may be concluded from the scenarios examined :

- Once a firm decision has been taken to go ahead with a given scenario, the total times needed, including setting up time, for the disposal of 50 and 100 tons of weapons grade plutonium are 20 to 25 years and 25-35 years respectively.
- Within each category of scenarios, reference or accelerated, the difference in the results is small but increases with the quantity of weapons grade plutonium to be eliminated, the largest difference being 4 years:

This rather small difference may be attributed to:

- the inevitably slow and gradual start-up of the operational phase of the scenarios, meaning as from when plutonium is actually used in the power plants;
- the often major delays between the operation of the first unit to be built a new advanced reactor type and due to demonstration requirements;
- the longer setting-up time required if advanced reactor types are preferred, which is only partly compensated by their more efficient plutonium-burning characteristics.

Generally speaking it may be concluded from our analysis that there is no major interest in developing new exotic reactor concepts for the sole purpose of eliminating a given quantity of weapons grade plutonium in the order of 100 tons. In this case, the favourite option is to use existing reactors and those in an advanced stage of development in the country concerned as quickly as possible.

However, industrial approaches towards the problem could have an influence on the lead times of the scenarios and especially on the setting up times. Considering the state of MOX recycling development in Russia and in the USA for example, three possibilities could be envisaged:

- Use could be made of the existing technologies and the experience of countries where such technologies have been developed over many years. MOX fuel could be fabricated in these countries to the extent that non-committed capacity is available, or in additional MOX fabrication plants still to be built. Howerver transportation of weapons grade material is generally considered to be an issue fraught as the difficulties, at least from the public acceptance and therefore political point of view.
- Technology transfers on a commercial basis or industrial joint ventures between the specialized companies and the countries having surplus plutonium could be enhanced, with the aim of building and operating the MOX fuel fabrication plants, including

all necessary services and substructures, on the site where the plutonium is available.

- A third possibility is, of course, that the countries possessing weapons grade plutonium develop the necessary R&D and set up the chosen recycling routes on their own. Start-up and development of such national industrial programmes would probably take more time than in the previous cases. Indeed, such programmes often depend to a very large extent on government financing which, in general, takes more time than direct cooperation between partners, whose goal is to be commercially efficient and thus to obtain results as soon as possible.

Of these three industrial approaches, the second one could present many advantages, from the economic point of view, as it seems to be the most promising way to get rid of increasing amounts of weapons grade plutonium quickly. In this context, it is noted once again that in the European Union several countries have gained considerable experience in the fabrication and use of plutonium in nuclear power plants.

CONCLUSIONS

Disposal of weapons grade plutonium is a goal which should be achieved as quickly as possible and be performed safely and economically, the aim being also to preserve the energy resource it constitutes for the future. Using weapons grade plutonium as fuel for nuclear reactors appears to be the best solution.

In order to save time and therefore consequence money, it may be concluded from some scenarios involving different reactor types, that there is an economic incentive (time-saving) to use the weapons grade plutonium as fuel in existing LWRs, since this route offers the shortest time span.

Among the various possible industrial approaches, close and effective international industrial cooperation, including commercial know-how transfer agreements and industrial joint ventures, could advantageously be organized involving companies having long experience in the field of MOX fuel production and MOX fuel use in LWRs.

Table 1 : Scenarios : Number of reactors fuelled each year with MOX

	Reference scenarios			Accelerated scenarios		
Year	1a	2a	3a	1b	2b	3b
	1000 MWe PWRs 1/3 MOX	800 MWe FNRS	1000MWe PWRs 100 % MOX	1000 MWe PWRs 1/3 MOX	800 MWe FNRS	1000 MWe PWRs 100 % MOX
"do"						
1						
2						
3						
4						
5						
6	1(a)			1(a)		
7	2			2		
8	3			3		
9	4			4		
10	5			5		
11	6	1(b)	1(b)	7	(1)b	1(b)
12	7			9		2
13	8			11	2	3
14	9		2	13	3	5
15	10	2		15	4	7
16	11		3	17	5	9
17	12		4			
18	13	3	5			
19	14		6			
20	15	4	7	(c)	(c)	(c)
21	16		8			
22	17	5	9			
23						
24						
25						
26	(c)	(c)	(c)			

Table 2 : Time needed (ts + te) to achieve the scenario's objectives

Scenarios categories	time after "do" (years)	
	50t WGPu	100t WGPu
Reference scenarios		
1a : PWRs 1000 MWe 1/3 MOX	23	33
2a : FNRs BN 800 type	23	30
3a : PWRs 1000 MWe advanced design, 100 % MOX	23	29
Average time	**23**	**30**
Accelerated scenarios		
1b : PWRs 1000 MWe 1/3 MOX	21	30
2b : FNRs BN 800 type	20	27
3b : PWRs 1000 MWe advanced design, 100 % MOX	19	26
Average time	**20**	**28**

参考資料

RENEWABLE ENERGY SOURCES STATISTICS IN THE EUROPEAN UNION

1. RENEWABLE ENERGY SOURCES STATISTICS IN THE EUROPEAN UNION

The present national and European Union policies in favour of new and renewable energy technologies recognise their importance in improving the security of supplies and reducing the emissions of greenhouse gases. Following the two oil crises, energy demand is met today by a broader range of energy sources, a trend which will certainly also be observed in the future.

New and renewable energy technologies will assume an important role in this scenario of supplies diversification, especially because of increasing public opposition to nuclear energy at international level. The contribution of renewable energy sources will be further enhanced by the measures which have been adopted on stabilising CO_2 emissions, emissions due mainly to the combustion of fossil fuels and linked to serious damage of the environment.

Primary energy production of renewable energy sources in the European Union in 1991 was 1 910 PJ, representing 7% of overall primary energy production. The observed increase over the 1989-91 reference period is due essentially to hydro-power which shows a substantial rise due to exceptionally unfavourable weather in 1989. However, the importance of the RES in the various Member States varies considerably depending on the existence of fossil fuel reserves, their energy policies and in particular specific measures taken in promotion of renewable energy sources at national level. In Luxembourg, renewable energy sources are the only indigenous sources available. In Portugal, renewable energy sources cover 96.4% of primary energy production due to the availability of hydro-power, extensive forests and limited fossil fuel resources. In Italy, renewable energies contribute 31.3% to primary energy production because of important hydro, geothermal and biomass resources as well as limited fossil fuel resources and strong public opinion against nuclear energy. The contribution of renewable energy sources to primary energy production is also important in Spain (18.5%) Greece (18.3%), France (14.2%) and Denmark (10.7%); on the other hand, it is well below the EU average contribution in the case of the United Kingdom (0.5%) and the Netherlands (1.4%), both Member States having important fossil fuel reserves.

Renewable energy sources covered 3.7% of total energy demand (primary energy) in the European Union in 1991. Essentially, it is hydro-power and biomass (mainly firewood) which at present make a significant contribution. It is mainly the availability of these two resources in combination with specific energy policy measures which explain the importance of renewable sources in the case of Portugal (17.1%), Greece (7.6%), France (6.8%), Spain (6.6%), Denmark (6.4%), and Italy (5.5%).

In the European Union, hydro-power and biomass/wastes are the major renewable energy sources, geothermal, solar and wind energy making a low or even marginal contribution. The use of biomass/waste is predominantly in the form of firewood consumption in households, although wood waste burned in industry as well as the municipal solid waste incineration contribute significantly.

In 1991, electricity generation in the European Union from renewable energy sources was 176 713 GWh representing 9.1% of total electricity generation. Electricity generation is dominated by hydro-power (162 600 GWh). Looking at electricity generation in the EU from biomass/wastes (9 810 GWh in 1991) municipal solid wastes account for 67.9% (6 656 GWh) wood/wood waste and agricultural solid wastes burned in power stations for 18.5% (1 815 GWh), the remaining part being generated from biogas.

In 1991, heat production in the European Union from renewable energy sources was 1 077 PJ (not including heat production from MSW incinerators and district heating plants in Germany), dominated by biomass/wastes (1 057 PJ). Firewood consumption for domestic heating (776 PJ) and combustion of wood waste in industry (196 PJ) for on-site steam/heat production are the main applications.

As regards the individual renewable energy sources we note the following :

1.1. Hydro-power

Hydro-power is the second largest renewable energy source in the EU, accounting for 30.6% (585 360 TJ) of total RES primary energy production in 1991. Electricity production (excluding pumping plants) was 162 600 GWh in 1991, representing a significant increase in comparison to 1989 when there were unfavourable climatic conditions. By the end of 1991, installed capacity was 57 655 MW, showing a modest increase of 1.3% over the reference period. The somewhat insignificant nature of the increase is due to the fact that the economically exploitable potential of large-scale plants has already been developed in the Union. Further development of hydro-power during the reference period took place mainly in Greece, France and Italy. It should be noted that the sole tidal power plant in the EU at la Rance in France is included in the above statistics.

Mini-hydroplants (<1 MW) of a total installed capacity of 1 331 MW in 1991, represent 2.3% of the total installed capacity of hydro-power.

1.2. Wind Energy

The considerable wind potential in the European Union, coupled with the technical maturity and commercial viability of this technology for electricity generation, indicate that this is a promising technology.

In 1991, the installed capacity of wind energy converters in the EU was 645.4 MW, of which 413 MW was in Denmark, 110 MW in Germany and 85 MW in the Netherlands. The installed capacity is expanding fast in the EU having almost doubled over the two-year reference period; certain Member

States (BRD, GR, FR, NL, P) taken individually show even higher expansion rates than the EU average.

In 1991, electricity generation in the EU was 1 080 GWh; following the operation of the new WECs, electricity generation increased significantly during the 1989-1991 period from 526 GWh in 1989 and 819 GWh in 1990 to its 1991 level.

1.3. Solar Energy

Active solar energy made a modest contribution of 6 663 TJ in the EU in 1991, although it is worth noting that the annual increase rate is of the order of 8%.

- **Solar Collectors**

In 1991, the total surface of installed solar collectors in the EU was 3 557 000 square metres, 45% of which was installed in Greece. Germany, France, Italy, Spain and the United Kingdom also have significant surfaces of solar collectors. The heat produced by solar collectors in the EU in 1991 was 6 607 TJ used mainly for domestic hot water and to a lesser extent in the heating of swimming pools. Although there are favourable climatic conditions for the collection of solar energy in the southern Member States, the low expansion rate of installed surfaces of solar panels may be explained by the current low prices of fossil fuels.

Photovoltaic panels

The installed capacity of photovoltaic panels in the EU in 1991 was 13 116 kWp, with an annual increase rate of 25%. Significant reductions in cost due to the use of cheaper materials, along with promotion policies in some Member States, has resulted in this significant deployment of PV panels mainly in small scale stand-alone applications.

1.4. Geothermal Energy

In the EU, electricity production and installed capacity of geothermal power plants in 1991 were 3 207 GWh and 598 MWe respectively. Electricity generation is almost exclusively confined to Italy (588 MWe) due to its vapour dominated geothermal resources while a minor contribution is made by France (5 MWe in Guadeloupe) and Portugal (3 MWe in S. Miguel island).

In contrast to the use of geothermal heat for electricity production, the direct end-use of geothermal heat is more widely spread across the European Union and serves mainly in district heating and agriculture. Direct end-use heat production in the EU was 14 067 TJ in 1991. France (5 029 TJ) has several installations in operation in the Paris and Aquitaine basins, principally for domestic heating. In Italy (8 400 TJ) low enthalpy geothermal heat is used in district heating (Abano, Ferrara, Vincenza, S. Donato regions), spa treatment and in industry.

1.5. Biomass/Wastes

Biomass/Wastes is the most important renewable energy source in the EU. They are of significant importance not only because they contribute to sustainable energy supplies but because energy recovery limits methane emissions to the environment.

Biomass/Wastes contributed 1 222 089 TJ of primary production in the EU in 1991, representing 64% of the total RES primary energy production. It is mainly used in the form of heat, the electricity generated being just 9 810 GWh in 1991.

1.5.1. Municipal Solid Waste

Incineration is the most frequently used method to recover energy from wastes disposed of by households, industry and the tertiary sector across the EU.

In 1991, primary energy production was 165 348 TJ and took place mainly in Germany (80 219 TJ), France (32 055 TJ), Denmark (16 843 TJ) and the Netherlands (18 996 TJ), while this technology is not yet applied in Greece, Ireland and Portugal.

Electricity generation using this source in the EU was 6 656 GWh, in 1991. While most Member States favour using Municipal Solid Waste for electricity generation, significant use of MSW in district heating takes place in France (19 890 TJ), Denmark (12 584 TJ) and Germany. It should be noted that heat production is not available for Germany, reducing the figure for the EU for heat production by 0.6 to 1.0 Mtoe.

1.5.2. Wood/Wood waste/other solid waste

The combustion of firewood and of forestry/agricultural solid waste is the major RES technology in the EU accounting for 53.5% of total RES primary energy production (1 022 362 TJ in 1991). The production of steam and heat in industry and domestic heating are the main applications of this fuel source while electricity generation is of a rather limited extent (1 815 GWh in 1991). The principal fuels used are firewood and wood waste (wood chips, bark etc.) while there is a minor contribution from black liquor, straw and other agricultural wastes.

Firewood consumption in households, which to a large extent is not commercialised, was 775 733 TJ in 1991, representing on average 0.15 kgoe per household in the EU. Portugal (0.45 kgoe), Greece (0.38 kgoe) and France (0.38 kgoe) show significant levels of firewood consumption for domestic heating. It is notable that firewood covers almost 10% of household energy needs in the EU.

The combustion of forestry/agricultural waste in industry for heat production in the EU was 196 089 TJ in 1991, mainly in Spain (68 336 TJ), France (58 103 TJ), Portugal (22 186 TJ) and Italy (24 000 TJ).

The combustion of forestry/agricultural waste including black liquor in power stations in the EU was 43 315 TJ in 1991, generating 1 815 GWh, mainly in Portugal (808 GWh). The heat produced (that is, by CHP plants) was 25 327 TJ, used either on-site by the industrial autoproducers or supplied to the district heating network.

In addition, 7 225 TJ of forestry/agricultural waste was consumed for district heating mainly in Denmark (7 057 TJ). It is noted that statistics for district heating plants in Germany were not available.

1.5.3. Biogas

The anaerobic fermentation of organic wastes is a practice which is rapidly expanding in the EU. Whereas this is an activity which takes place mainly for environmental reasons, energy recovery is often a welcome by-product. In the EU, biogas primary energy production was 34 380 TJ in 1991, mainly in the form of landfill gas, sewage sludge gas and to a lesser extent as biogas produced from agro-food industry effluents. Electricity generation from biogas was 1 318 GWh in 1991 in the EU.

Six Member States practice energy recovery from landfill sites with beneficial effects on the environment through limiting methane emissions.

Sewage sludge treatment with energy recovery is also practised to a variable extent in all Member States with the exception of Greece, Spain and Portugal.

The statistics for the various technologies/applications for all Member States and the EU are presented in tables I.1 to I.15. Although statistics for three years are presented, earlier results (1989) for some Member States and applications are of lower quality since during the second phase of the project (1990/91) better surveying methods were employed giving a wider coverage. It should also be noted that complete time series statistics were not available for all technologies in all Member States especially for higher cost technologies.

TABLE I.1 PRIMARY ENERGY PRODUCTION FROM RENEWABLE ENERGY SOURCES (RES)

		Hydro	Wind	Solar	Geoth.	Biomass /Wastes	TOTAL	% RES contribution to overall primary production	% RES contribution to overall inland consumption
		Units: ktoe							
Belgique/ België	1989	27	0.6	0.8	1.0	448	477	4.0	1.0
	1990	24	0.6	0.8	1.0	448	474	4.0	1.0
	1991	20	0.7	0.9	1.3	474	497	4.3	1.0
Danmark	1989	2	36.9	1.3	1.1	1045	1086	11.8	6.1
	1990	2	52.4	1.7	1.1	1092	1150	11.6	6.3
	1991	2	64.0	2.1	1.1	1198	1267	10.7	6.4
BR Deutschland	1989	1677	2.2	7.4	6.9	5067	6760	3.3	1.9
	1990	1603	10.4	8.4	6.9	5044	6673	3.5	1.9
	1991	1472	18.5	9.4	6.9	5007	6515	3.9	1.9
Ellas	1989	163	0.1	67.2	2.6	1395	1629	16.6	7.2
	1990	152	0.1	75.0	2.6	1396	1626	16.8	7.1
	1991	266	1.0	81.7	2.9	1398	1750	18.3	7.6
España	1989	1664	1.2	21.6	2.4	3970	5659	16.5	6.5
	1990	2185	1.2	22.3	2.4	3757	5968	17.9	6.7
	1991	2346	1.2	22.7	2.4	3803	6175	18.5	6.6
France	1989	4075	0.0	14.8	133.4	9262	13485	12.9	6.2
	1990	4683	0.0	14.8	124.7	9292	14114	13.3	6.4
	1991	4979	0.1	14.8	134.4	10577	15706	14.2	6.8
Ireland	1989	59	0.0	0.0	0.0	85	144	4.3	1.5
	1990	60	0.0	0.1	0.0	108	168	4.9	1.7
	1991	64	0.0	0.1	0.0	108	173	4.9	1.7
Italia	1989	2928	0.2	7.4	2067.0	2899	7902	29.7	5.2
	1990	2719	0.2	7.5	2072.9	2850	7650	28.6	5.0
	1991	3632	0.3	7.6	2049.7	2850	8539	31.3	5.5
Luxembourg	1989	7	0.0	0.0	0.0	39	46	100.0	1.4
	1990	8	0.0	0.0	0.0	37	45	100.0	1.3
	1991	7	0.0	0.0	0.0	38	45	100.0	1.2
Nederland	1989	3	3.2	1.6	0.0	857	865	1.4	1.3
	1990	7	4.5	1.7	0.0	891	905	1.5	1.3
	1991	9	6.2	2.0	0.0	927	944	1.4	1.3
Portugal	1989	520	0.0	9.5	0.0	2211	2741	96.3	16.3
	1990	800	0.1	11.0	3.2	2199	3013	96.3	17.5
	1991	789	0.1	12.7	4.4	2183	2990	96.4	17.1
United Kingdom	1989	408	0.8	5.2	0.5	602	1017	0.5	0.5
	1990	445	0.8	5.2	0.4	592	1042	0.5	0.5
	1991	394	0.9	5.2	0.6	624	1024	0.5	0.5
EU	1989	11534	45.2	136.9	2214.9	27880	41810	6.2	3.4
	1990	12688	70.4	148.5	2215.3	27705	42828	6.5	3.5
	1991	13980	92.9	159.1	2203.8	29188	45624	7.0	3.7

TABLE I.2 PRIMARY ENERGY PRODUCTION FROM RENEWABLE ENERGY SOURCES (RES)

		Hydro	Wind	Solar	Geoth.	Biomass /Wastes	TOTAL	% RES contribution to	
		Units:TJ						overall primary production	overall inland consumption
Belgique/ België	1989	1123	27	35	43	18751	19979	4.0	1.0
	1990	986	27	35	43	18751	19842	4.0	1.0
	1991	853	29	38	53	19857	20830	4.3	1.0
Danmark	1989	83	1544	56	45	43756	45485	11.8	6.1
	1990	101	2196	72	48	45720	48136	11.6	6.3
	1991	94	2678	87	45	50154	53058	10.7	6.4
BR Deutschland	1989	70200	94	312	290	212142	283038	3.3	1.9
	1990	67097	436	354	290	211211	279387	3.5	1.9
	1991	61646	774	394	290	209660	272764	3.9	1.9
Ellas	1989	6840	5	2815	108	58427	68195	16.6	7.2
	1990	6368	6	3140	108	58439	68062	16.8	7.1
	1991	11156	42	3421	123	58523	73266	18.3	7.6
España	1989	69656	48	903	101	166234	236942	16.5	6.5
	1990	91490	50	932	101	157320	249893	17.9	6.7
	1991	98215	52	949	102	159212	258530	18.5	6.6
France	1989	170622	1	618	5586	387785	564612	12.9	6.2
	1990	196085	1	618	5222	389039	590965	13.3	6.4
	1991	208476	3	618	5629	442867	657593	14.2	6.8
Ireland	1989	2491	1	2	0	3549	6043	4.3	1.5
	1990	2506	1	3	0	4511	7021	4.9	1.7
	1991	2682	1	5	1	4535	7223	4.9	1.7
Italia	1989	122605	8	308	86545	121374	330841	29.7	5.2
	1990	113854	8	315	86793	119329	320298	28.6	5.0
	1991	152060	11	318	85820	119329	357538	31.3	5.5
Luxembourg	1989	293	0	0	0	1647	1940	100.0	1.4
	1990	343	0	0	0	1549	1891	100.0	1.3
	1991	285	0	0	0	1600	1884	100.0	1.2
Nederland	1989	134	133	67	0	35865	36199	1.4	1.3
	1990	307	187	73	0	37310	37877	1.5	1.3
	1991	375	261	82	0	38806	39524	1.4	1.3
Portugal	1989	21776	0	398	0	92583	114757	96.3	16.3
	1990	33487	3	460	134	92083	126167	96.3	17.5
	1991	33032	3	534	185	91421	125174	96.4	17.1
United Kingdom	1989	17096	32	216	21	25206	42572	0.5	0.5
	1990	18616	32	216	17	24767	43648	0.5	0.5
	1991	16484	36	216	25	26127	42888	0.5	0.5
EU	1989	482921	1894	5731	92738	1167318	1750602	6.2	3.4
	1990	531240	2947	6218	92755	1160028	1793188	6.5	3.5
	1991	585360	3889	6663	92272	1222089	1910273	7.0	3.7

TABLE I.3 ELECTRICITY GENERATION FROM RENEWABLE ENERGY SOURCES (RES)

		Hydro	Wind	Solar	Geoth.	Biomass /Wastes	TOTAL	Percent contribution to overall electricity generation
		Units: GWh						
Belgique/ België	1989	312	7.4	0.05	0	510	829	1.2
	1990	274	7.4	0.05	0	510	791	1.1
	1991	237	7.9	0.09	0	555	800	1.1
Danmark	1989	23	429.0	0.00	0	188	640	2.9
	1990	28	610.0	0.00	0	141	779	3.0
	1991	26	744.0	0.00	0	285	1055	2.9
BR Deutschland	1989	19500	26.1	0.53	0	4991	24518	4.4
	1990	18638	121.0	1.00	0	5005	23765	4.3
	1991	17124	215.0	1.00	0	4962	22302	4.1
Ellas	1989	1900	1.4	0.06	0	0	1901	5.6
	1990	1769	1.7	0.10	0	0	1771	5.1
	1991	3099	11.8	0.11	0	0	3111	8.7
España	1989	19349	13.4	6.00	0	185	19553	13.3
	1990	25414	14.0	6.00	0	222	25656	17.0
	1991	27282	14.5	6.80	0	222	27526	17.8
France	1989	47395	0.4	0.68	20	800	48216	12.0
	1990	54468	0.4	0.68	20	852	55341	13.3
	1991	57910	0.8	0.68	20	872	58803	13.1
Ireland	1989	692	0.3	0.03	0	0	692	5.1
	1990	696	0.2	0.03	0	0	696	4.9
	1991	745	0.2	0.03	0	0	745	5.0
Italia	1989	34057	2.3	2.30	3155	142	37359	18.0
	1990	31626	2.3	4.10	3222	166	35020	16.4
	1991	42239	3.0	5.00	3182	166	45595	20.8
Luxembourg	1989	81	0.0	0.00	0	49	130	20.2
	1990	95	0.0	0.00	0	45	140	21.4
	1991	79	0.0	0.00	0	51	130	18.6
Nederland	1989	37	36.9	0.40	0	938	1013	1.4
	1990	85	51.9	0.90	0	1015	1153	1.6
	1991	104	72.4	1.20	0	1138	1316	1.8
Portugal	1989	6049	0.1	0.45	0	661	6711	26.0
	1990	9302	0.8	0.45	4	689	9996	35.1
	1991	9176	0.8	0.45	5	808	9990	33.4
United Kingdom	1989	4749	9.0	0.10	0	701	5459	1.7
	1990	5171	9.0	0.10	0	672	5852	1.8
	1991	4579	10.0	0.10	0	751	5340	1.7
EU	1989	134145	526	10.6	3175	9165	147021	7.9
	1990	147567	819	13.4	3246	9317	160961	8.5
	1991	162600	1080	15.5	3207	9810	176713	9.1

TABLE I.4 HEAT PRODUCTION FROM RENEWABLE ENERGY SOURCES (RES)

		Solar	Geothermal	Biomass /Wastes	TOTAL	
		Units: ktoe				
Belgique/ België	1989	0.8	1.0	313	315	
	1990	0.8	1.0	313	315	
	1991	0.9	1.3	310	312	
Danmark	1989	1.3	1.1	911	914	
	1990	1.7	1.1	952	955	
	1991	2.1	1.1	1035	1038	
BR Deutschland	1989	7.4	6.9	2937	2952	*
	1990	8.4	6.9	2910	2926	*
	1991	9.3	6.9	2877	2893	*
Ellas	1989	67.2	2.6	1395	1465	
	1990	75.0	2.6	1396	1473	
	1991	81.7	2.9	1398	1482	
España	1989	21.1	2.4	3913	3936	
	1990	21.7	2.4	3684	3708	
	1991	22.1	2.4	3729	3753	
France	1989	14.7	119.1	8917	9051	
	1990	14.7	110.4	8916	9042	
	1991	14.7	120.1	10188	10322	
Ireland	1989	0.0	0.0	85	85	
	1990	0.1	0.0	108	108	
	1991	0.1	0.0	108	108	
Italia	1989	7.2	200.6	2836	3044	
	1990	7.2	200.6	2775	2983	
	1991	7.2	200.6	2775	2983	
Luxembourg	1989	0.0	0.0	6	6	
	1990	0.0	0.0	7	7	
	1991	0.0	0.0	7	7	
Nederland	1989	1.6	0.0	436	438	
	1990	1.7	0.0	448	449	
	1991	1.9	0.0	453	455	
Portugal	1989	9.5	0.0	2069	2078	
	1990	10.9	0.0	2057	2068	
	1991	12.7	0.0	1997	2010	
United Kingdom	1989	5.2	0.5	342	348	
	1990	5.2	0.4	351	357	
	1991	5.2	0.6	358	363	
EU	1989	136.0	334.2	24161	24631	*
	1990	147.4	325.5	23917	24390	*
	1991	157.8	336.0	25234	25728	*

* Not including statistics for Germany on District Heating and MSW incinerators

TABLE I.5 HEAT PRODUCTION FROM RENEWABLE ENERGY SOURCES (RES)

		Solar	Geothermal	Biomass /Wastes	TOTAL	
		Units: TJ				
Belgique/ België	1989	35	43	13095	13172	
	1990	35	43	13095	13172	
	1991	38	53	12967	13058	
Danmark	1989	56	45	38163	38264	
	1990	72	48	39852	39972	
	1991	87	45	43343	43475	
BR Deutschland	1989	310	290	122988	123588	*
	1990	350	290	121853	122493	*
	1991	390	290	120450	121130	*
Ellas	1989	2815	108	58427	61350	
	1990	3140	108	58439	61687	
	1991	3421	123	58523	62066	
España	1989	881	101	163824	164806	
	1990	911	101	154239	155250	
	1991	925	102	156131	157158	
France	1989	616	4986	373348	378950	
	1990	616	4622	373332	378570	
	1991	616	5029	426552	432197	
Ireland	1989	2	0	3547	3549	
	1990	3	0	4509	4512	
	1991	5	1	4530	4536	
Italia	1989	300	8400	118750	127450	
	1990	300	8400	116210	124910	
	1991	300	8400	116210	124910	
Luxembourg	1989	0	0	270	270	
	1990	0	0	294	294	
	1991	0	0	286	286	
Nederland	1989	66	0	18261	18327	
	1990	70	0	18746	18816	
	1991	78	0	18965	19043	
Portugal	1989	396	0	86625	87021	
	1990	458	0	86125	86583	
	1991	532	0	83618	84150	
United Kingdom	1989	216	21	14316	14553	
	1990	216	17	14706	14939	
	1991	216	25	14977	15218	
EU	1989	5693	13993	1011613	1031299	*
	1990	6170	13628	1001400	1021198	*
	1991	6607	14067	1056552	1077226	*

* Not including statistics for Germany on District Heating and MSW incinerators

TABLE I.6 ELECTRICITY GENERATION AND INSTALLED CAPACITY HYDRO-ELECTRIC PLANTS

		All Plants		Mini (<1MW)	
		Generation GWh	Capacity MW	Generation GWh	Capacity MW
Belgique/ België	1989	312	110	7.3	2.5
	1990	274	110	7.3	2.5
	1991	237	110	5.8	2.6
Danmark	1989	23	9	12.6	5.4
	1990	28	9	15.5	5.5
	1991	26	9	13.9	5.5
BR Deutschland	1989	19500	4551	2850.0	360.0
	1990	18638	4551	2850.0	360.0
	1991	17124	4514	2665.0	360.0
Ellas	1989	1900	1989	8.5	2.2
	1990	1769	2093	8.5	2.2
	1991	3099	2197	11.0	3.9
España	1989	19349	12207	640.5	151.5
	1990	25414	12353	685.0	161.8
	1991	27282	12406	718.7	169.3
France	1989	47395	20223	1099.0	383.0
	1990	54468	20276	1393.0	403.0
	1991	57910	20467	1556.0	410.0
Ireland	1989	692	224	18.0	4.4
	1990	696	227	20.0	7.3
	1991	745	231	24.4	10.6
Italia	1989	34057	12730	1076.0	301.0
	1990	31626	12778	1044.0	317.0
	1991	42239	12890	1366.0	322.0
Luxembourg	1989	81	43	7.0	9.0
	1990	95	43	23.1	9.0
	1991	79	43	20.5	9.0
Nederland	1989	37	25	0.4	0.2
	1990	85	37	0.9	0.2
	1991	104	37	1.0	0.2
Portugal	1989	6049	3373	31.0	27.4
	1990	9302	3350	35.0	23.8
	1991	9176	3339	40.0	23.4
United Kingdom	1989	4749	1407	62.4	13.0
	1990	5171	1403	62.4	13.0
	1991	4579	1412	68.4	14.3
EU	1989	134145	56891	5813	1260
	1990	147567	57230	6145	1305
	1991	162600	57655	6491	1331

TABLE I.7 ELECTRICITY GENERATION AND INSTALLED CAPACITY
WIND ENERGY CONVERTERS

		Capacity	Generation
		MW	GWh
Belgique/ België	1989	4.8	7.4
	1990	4.8	7.4
	1991	4.8	7.9
Danmark	1989	263.0	429.0
	1990	343.0	610.0
	1991	413.0	744.0
BR Deutschland	1989	20.0	26.1
	1990	62.0	121.0
	1991	110.0	215.0
Ellas	1989	1.3	1.4
	1990	1.8	1.7
	1991	6.6	11.8
España	1989	6.0	13.4
	1990	7.2	14.0
	1991	7.3	14.5
France	1989	0.3	0.4
	1990	0.3	0.4
	1991	0.8	0.8
Ireland	1989	0.1	0.3
	1990	0.1	0.2
	1991	0.1	0.2
Italia	1989	2.5	2.3
	1990	2.9	2.3
	1991	3.5	3.0
Luxembourg	1989	0.0	0.0
	1990	0.0	0.0
	1991	0.0	0.0
Nederland	1989	38.7	36.9
	1990	42.7	51.9
	1991	84.5	72.4
Portugal	1989	0.1	0.1
	1990	0.5	0.8
	1991	0.9	0.8
United Kingdom	1989	9.5	9.0
	1990	9.9	9.0
	1991	14.0	10.0
EU	1989	346.3	526.2
	1990	475.2	818.6
	1991	645.4	1080.4

TABLE I.8 ENERGY PRODUCTION AND INSTALLED CAPACITY SOLAR INSTALLATIONS

		Solar Collectors		Photovoltaic Panels	
		Collector's surface 1000m²	Heat Production TJ	Installed capacity kWp	Elec. Generation GWh
Belgique/ België	1989	34	35.1	74	0.05
	1990	34	35.1	74	0.05
	1991	36	37.8	111	0.09
Danmark	1989	44	56.0	0	0.00
	1990	57	72.0	0	0.00
	1991	69	87.0	0	0.00
BR Deutschland	1989	310	310.0	821	0.53
	1990	350	350.0	2000	1.00
	1991	390	390.0	2000	1.00
Ellas	1989	1300	2815.0	254	0.06
	1990	1450	3140.0	160	0.10
	1991	1600	3421.0	160	0.11
España	1989	273	881.4	3000	6.00
	1990	282	910.5	3100	6.00
	1991	286	924.7	3500	6.80
France	1989	342	615.6	835	0.68
	1990	342	615.6	835	0.68
	1991	342	615.6	835	0.68
Ireland	1989	1	1.8	50	0.03
	1990	2	2.6	50	0.03
	1991	3	5.3	50	0.03
Italia	1989	290	300.0	2400	2.30
	1990	290	300.0	3971	4.10
	1991	290	300.0	5100	5.00
Luxembourg	1989	0	0.0	0	0.00
	1990	0	0.0	0	0.00
	1991	0	0.0	0	0.00
Nederland	1989	80	66.0	350	0.40
	1990	84	70.0	750	0.90
	1991	95	78.0	1050	1.20
Portugal	1989	130	396.0	160	0.45
	1990	150	458.0	160	0.45
	1991	170	532.0	160	0.45
United Kingdom	1989	276	216.0	150	0.10
	1990	276	216.0	150	0.10
	1991	276	216.0	150	0.10
EU	1989	3080	5692.9	8094	10.59
	1990	3317	6169.8	11250	13.40
	1991	3557	6607.4	13116	15.45

TABLE I.9 ENERGY PRODUCTION AND INSTALLED CAPACITY GEOTHERMAL PLANTS

		Power Plants		Heat Plants	
		Installed capacity MWe	Elec. Generation GWh	Installed capacity MWth	Heat Production TJ
Belgique/ België	1989	0	0	8	43
	1990	0	0	8	43
	1991	0	0	8	53
Danmark	1989	0	0	8	45
	1990	0	0	8	48
	1991	0	0	8	45
BR Deutschland	1989	0	0	NA	290
	1990	0	0	NA	290
	1991	0	0	NA	290
Ellas	1989	2	0	17	108
	1990	2	0	17	108
	1991	2	0	20	123
España	1989	0	0	NA	101
	1990	0	0	NA	101
	1991	0	0	NA	102
France	1989	5	20	NA	4986
	1990	5	20	NA	4622
	1991	5	20	NA	5029
Ireland	1989	0	0	0	0
	1990	0	0	0	0
	1991	0	0	0	1
Italia	1989	520	3155	550	8400
	1990	520	3222	550	8400
	1991	588	3182	550	8400
Luxembourg	1989	0	0	0	0
	1990	0	0	0	0
	1991	0	0	0	0
Nederland	1989	0	0	0	0
	1990	0	0	0	0
	1991	0	0	0	0
Portugal	1989	3	0	0	0
	1990	3	4	0	0
	1991	3	5	0	0
United Kingdom	1989	0	0	NA	21
	1990	0	0	NA	17
	1991	0	0	NA	25
EU	1989	530	3175	NA	13993
	1990	530	3246	NA	13628
	1991	598	3207	NA	14067

NA = Not Available

TABLE I.10 PRIMARY ENERGY PRODUCTION FROM BIOMASS/WASTES

Units: TJ

		Municipal Solid Waste	Wood/Wood Waste/Other Solid Waste				Biogas	TOTAL
			Households	Industry	District heating	Power stations		
Belgique/ België	1989	4418	7760	367	0	5937	269	18751
	1990	4418	7760	367	0	5937	269	18751
	1991	5314	7760	367	0	5989	427	19857
Danmark	1989	15400	13703	5611	5881	2057	1104	43756
	1990	16013	13779	6061	5776	2844	1247	45720
	1991	16843	14924	6069	7057	3700	1561	50154
BR Deutschland	1989	81800	91278	4100	NA	22500	12464	212142 *
	1990	81800	91278	4103	NA	21799	12231	211211 *
	1991	80219	92185	4689	NA	20336	12231	209660 *
Ellas	1989	0	53510	4899	0	0	18	58427
	1990	0	53510	4911	0	0	18	58439
	1991	0	53510	4995	0	0	18	58523
España	1989	1996	86826	76453	0	534	425	166234
	1990	2667	86826	66868	0	534	425	157320
	1991	2667	87250	68336	0	534	425	159212
France	1989	26589	295184	58103	168	3953	3788	387785 **
	1990	29937	293090	58103	168	3953	3788	389039 **
	1991	32055	344800	58103	168	3953	3788	442867 **
Ireland	1989	0	1651	1803	0	0	94	3549
	1990	0	1872	2544	0	0	95	4511
	1991	0	1872	2544	0	0	119	4535
Italia	1989	1530	92500	24200	0	800	2344	121374
	1990	1692	90000	24000	0	1000	2637	119329
	1991	1692	90000	24000	0	1000	2637	119329
Luxembourg	1989	1368	268	0	0	0	11	1647
	1990	1253	268	0	0	0	28	1549
	1991	1311	268	0	0	0	21	1600
Nederland	1989	16867	15000	1450	0	0	2548	35865
	1990	17982	15000	1750	0	0	2578	37310
	1991	18996	15000	1750	0	0	3060	38806
Portugal	1989	0	61340	25197	0	5958	88	92583
	1990	0	61340	24697	0	5958	88	92083
	1991	0	61340	22186	0	7803	92	91421
United Kingdom	1989	7390	6825	3049	0	0	7942	25206
	1990	6084	6825	3049	0	0	8809	24767
	1991	6251	6825	3049	0	0	10002	26127
EU	1989	157358	725845	205232	6049	41739	31095	1167318 *
	1990	161846	721547	196454	5944	42025	32213	1160028 *
	1991	165348	775733	196089	7225	43315	34380	1222089 *

*Not taking into account District Heating statistics for Germany which are not available.

**Including 7118 TJ in agriculture

TABLE I.11 INCINERATION OF MUNICIPAL SOLID WASTE (MSW)

		Installed capacity	Incinerated waste	Electricity generation	Heat production
		MWe	TJ	GWh	TJ
Belgique/ België	1989	NA	4418	368	300
	1990	NA	4418	368	300
	1991	NA	5314	414	345
Danmark	1989	NA	15400	0	11859
	1990	NA	16013	21	12253
	1991	NA	16843	106	12584
BR Deutschland	1989	NA	81800	4346	NA
	1990	NA	81800	4346	NA
	1991	NA	80219	4169	NA
Ellas	1989	0	0	0	0
	1990	0	0	0	0
	1991	0	0	0	0
España	1989	20	1996	102	120
	1990	27	2667	139	120
	1991	27	2667	139	120
France	1989	NA	26589	371	16302
	1990	NA	29937	423	18380
	1991	NA	32055	443	19890
Ireland	1989	0	0	0	0
	1990	0	0	0	0
	1991	0	0	0	0
Italia	1989	46	1530	85	0
	1990	46	1692	94	0
	1991	46	1692	94	0
Luxembourg	1989	7	1368	48	0
	1990	7	1253	45	0
	1991	7	1311	50	0
Nederland	1989	140	16867	869	1207
	1990	149	17982	933	1530
	1991	173	18996	1025	1531
Portugal	1989	0	0	0	0
	1990	0	0	0	0
	1991	0	0	0	0
United Kingdom	1989	58	7390	286	1830
	1990	38	6084	217	1855
	1991	38	6251	215	1976
EU	**1989**	**NA**	**157358**	**6475**	**NA**
	1990	**NA**	**161846**	**6587**	**NA**
	1991	**NA**	**165348**	**6656**	**NA**

NA = Not Available

TABLE I.12 COMBUSTION OF WOOD/WOOD WASTE/OTHER SOLID WASTE IN POWER STATIONS

		Installed capacity	Fuel consumption	Electricity generation	Heat production
		MWe	TJ	GWh	TJ
Belgique/ België	1989	NA	5937	135	4544
	1990	NA	5937	135	4544
	1991	NA	5989	134	4252
Danmark	1989	NA	2057	148	1214
	1990	NA	2844	74	1913
	1991	NA	3700	118	2451
BR Deutschland	1989	NA	22500	150	21080
	1990	NA	21799	129	20601
	1991	NA	20336	263	17705
Ellas	1989	0	0	0	0
	1990	0	0	0	0
	1991	0	0	0	0
España	1989	115	534	83	0
	1990	115	534	83	0
	1991	115	534	83	0
France	1989	NA	3953	381	519
	1990	NA	3953	381	519
	1991	NA	3953	381	519
Ireland	1989	0	0	0	0
	1990	0	0	0	0
	1991	0	0	0	0
Italia	1989	3	800	22	330
	1990	5	1000	28	400
	1991	5	1000	28	400
Luxembourg	1989	0	0	0	0
	1990	0	0	0	0
	1991	0	0	0	0
Nederland	1989	0	0	0	0
	1990	0	0	0	0
	1991	0	0	0	0
Portugal	1989	NA	5958	661	0
	1990	NA	5958	689	0
	1991	NA	7803	808	0
United Kingdom	1989	0	0	0	0
	1990	0	0	0	0
	1991	0	0	0	0
EU	1989	NA	41739	1580	27687
	1990	NA	42025	1519	27977
	1991	NA	43315	1815	25327

NA = Not Available

TABLE I.13 LANDFILL GAS

		Installed capacity	Gas consumption	Electricity generation	Heat production	
		MWe	TJ	GWh	TJ	
Belgique/ België	1989	0	0	0	0	
	1990	0	0	0	0	
	1991	0	0	0	0	
Danmark	1989	NA	60	2	33	
	1990	NA	60	2	33	
	1991	NA	102	2	71	
BR Deutschland	1989	NA	NA	NA	NA	*
	1990	NA	NA	NA	NA	*
	1991	NA	NA	NA	NA	*
Ellas	1989	0	0	0	0	
	1990	0	0	0	0	
	1991	0	0	0	0	
España	1989	0	0	0	0	
	1990	0	0	0	0	
	1991	0	0	0	0	
France	1989	NA	880	35	377	
	1990	NA	880	35	377	
	1991	NA	880	35	377	
Ireland	1989	0	0	0	0	
	1990	0	0	0	0	
	1991	0	0	0	0	
Italia	1989	7	216	15	0	
	1990	7	252	18	0	
	1991	7	252	18	0	
Luxembourg	1989	0	0	0	0	
	1990	0	0	0	0	
	1991	0	0	0	0	
Nederland	1989	NA	726	11	51	
	1990	NA	724	16	20	
	1991	NA	971	28	77	
Portugal	1989	0	0	0	0	
	1990	0	0	0	0	
	1991	0	0	0	0	
United Kingdom	1989	19	2956	139	1172	
	1990	19	3119	139	1336	
	1991	37	4082	208	1419	
EU	1989	NA	NA	NA	NA	
	1990	NA	NA	NA	NA	
	1991	NA	NA	NA	NA	

* Included in Sewage Sludge Gas
NA = Not Available

TABLE I.14 SEWAGE SLUDGE GAS

		Installed capacity	Gas consumption	Electricity generation	Heat production	
		MWe	TJ	GWh	TJ	
Belgique/ België	1989	NA	65	2.3	38	
	1990	NA	65	2.3	38	
	1991	NA	55	2.3	16	
Danmark	1989	NA	848	34.4	554	
	1990	NA	885	36.1	578	
	1991	NA	921	37.5	602	
BR Deutschland	1989	NA	12464	495.0	6530	*
	1990	NA	12231	530.0	5871	*
	1991	NA	12231	530.0	5871	*
Ellas	1989	0	0	0.0	0	
	1990	0	0	0.0	0	
	1991	0	0	0.0	0	
España	1989	0	0	0.0	0	
	1990	0	0	0.0	0	
	1991	0	0	0.0	0	
France	1989	NA	1443	13.0	1256	
	1990	NA	1443	13.0	1256	
	1991	NA	1443	13.0	1256	
Ireland	1989	0	2	0.1	1	
	1990	0	2	0.1	1	
	1991	0	2	0.1	1	
Italia	1989	35	568	20.0	160	
	1990	35	825	26.0	250	
	1991	35	825	26.0	250	
Luxembourg	1989	NA	11	1.0	2	
	1990	NA	28	0.2	26	
	1991	NA	21	0.3	18	
Nederland	1989	NA	1622	54.0	523	
	1990	NA	1654	64.0	437	
	1991	NA	1853	83.0	592	
Portugal	1989	0	0	0.0	0	
	1990	0	0	0.0	0	
	1991	0	0	0.0	0	
United Kingdom	1989	71	4978	276.0	1432	
	1990	73	5682	316.0	1633	
	1991	91	5912	328.0	1700	
EU	1989	NA	22002	896	10496	*
	1990	NA	22816	988	10090	*
	1991	NA	23264	1020	10306	*

* Including other biogas types in Germany
NA = Not Available

TABLE I.15 GAS FROM AGRO-FOOD INDUSTRY EFFLUENTS

		Gas consumption	Autoconsumption for fermentation	Electricity generation	Heat production
		TJ	TJ	GWh	TJ
Belgique/ België	1989	202	70	4.5	86
	1990	202	70	4.5	86
	1991	371	96	4.7	227
Danmark	1989	75	NA	0.0	46
	1990	77	NA	0.0	56
	1991	77	NA	0.0	56
BR Deutschland	1989	*	*	*	*
	1990	*	*	*	*
	1991	*	*	*	*
Ellas	1989	18	NA	0.0	18
	1990	18	NA	0.0	18
	1991	18	NA	0.0	18
España	1989	425	NA	0.0	425
	1990	425	NA	0.0	425
	1991	425	NA	0.0	425
France	1989	1465	NA	0.0	1465
	1990	1465	NA	0.0	1465
	1991	1465	NA	0.0	1465
Ireland	1989	91	1	0.0	90
	1990	92	1	0.0	91
	1991	115	3	0.0	112
Italia	1989	1250	NA	0.0	1250
	1990	1250	NA	0.0	1250
	1991	1250	NA	0.0	1250
Luxembourg	1989	0	0	0.0	0
	1990	0	0	0.0	0
	1991	0	0	0.0	0
Nederland	1989	200	140	3.6	30
	1990	200	177	1.7	9
	1991	236	199	1.9	15
Portugal	1989	88	NA	0.0	88
	1990	88	NA	0.0	88
	1991	92	NA	0.0	92
United Kingdom	1989	0	0	0.0	0
	1990	0	0	0.0	0
	1991	0	0	0.0	0
EU	1989	NA	NA	NA	NA
	1990	NA	NA	NA	NA
	1991	NA	NA	NA	NA

* Quantities included in those of sewage sludge gas
NA = Not Available