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ΑΝΑΚΟΙΝΩΣΗ ΤΗΣ ΕΠΙΤΡΟΠΗΣ ΠΡΟΣ ΤΟ ΣΥΜΒΟΥΛΙΟ

με θέμα

"ΤΟ ΦΑΙΝΟΜΕΝΟ ΘΕΡΜΟΚΗΠΙΟΥ ΚΑΙ Η ΚΟΙΝΟΤΗΤΑ"

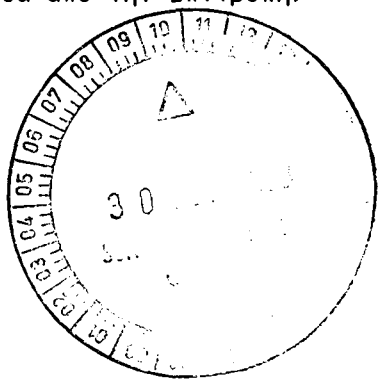
και

Σχέδιο

ΨΗΦΙΣΜΑ ΤΟΥ ΣΥΜΒΟΥΛΙΟΥ

για το φαινόμενο θερμοκηπίου και την Κοινότητα

(υποβληθείσα από την Επιτροπή)



Ανακοίνωση της Επιτροπής προς το Συμβούλιο

με θέμα

"ΤΟ ΦΑΙΝΟΜΕΝΟ ΘΕΡΜΟΚΗΠΙΟΥ

ΚΑΙ Η ΚΟΙΝΟΤΗΤΑ"

ΠΕΡΙΕΧΟΜΕΝΑ

ΠΕΡΙΛΗΨΗ ΚΑΙ ΣΥΜΠΕΡΑΣΜΑΤΑ

Α. ΠΕΡΙΛΗΨΗ

Α.1. Εισαγωγή

Στις 19 Ιουλίου 1988 η Επιτροπή αποφάσισε να συστήσει διυπηρεσιακή ομάδα με στόχο να επεξεργασθεί μέχρι τα μέσα του Νοεμβρίου 1988 ορισμένες προκαταρκτικές ιδέες για ενδεχόμενη κοινοτική δράση όσον αφορά το "Φαινόμενο θερμοκηπίου".

Στόχος του παρόντος εγγράφου, το οποίο βασίζεται στο έργο της ανωτέρω ομάδας, είναι η ανασκόπηση του ζητήματος αυτού και η υποβολή συμπερασμάτων και συστάσεων για τις περαιτέρω ενέργειες που πρέπει αμέσως να αρχίσουν, για τη δράση που πρέπει να αναληφθεί επειγόντως και για τον πιθανό ρόλο της Ευρωπαϊκής Κοινότητας στη διεθνή συζήτηση σχετικά με το σύνθετο αυτό πρόβλημα.

Α.2. Το φαινόμενο θερμοκηπίου

Α.2.1. Οι τρέχουσες κλιματικές συνθήκες στη γη διέπονται σε μεγάλο βαθμό από τη σύνθεση της ατμόσφαιρας.
Οι υδρατμοί, το διοξείδιο του άνθρακος (CO_2), το μεθάνιο (CH_4) το υποξείδιο του αζώτου (N_2O), το όζον (O3) και, πιο πρόσφατα, οι χλωριοφθοριωμένοι υδρογονάνθρακες (CFC), απορροφώντας μέρος της υπέρυθρης ακτινοβολίας που εκπέμπεται από τη γη προς αντιστάθμιση της εισρέουσας ηλιακής ακτινοβολίας, αποθηκεύουν μέρος της τελευταίας στην ατμόσφαιρα.

Α.2.2. Ο άνθρωπος μεταβάλλει με πρωτόγνωρους ρυθμούς τη σύνθεση της ατμόσφαιρας. Οι συγκεντρώσεις όλων των λεγόμενων "αερίων θερμοκηπίου" αυξάνονται, λόγω της παρέμβασης των ανθρώπινων δραστηριοτήτων στους βιοχημικούς κύκλους των ουσιών αυτών. Το μέγεθος των μεταβολών αυτών είναι σημαντικό από πλευράς ενδεχόμενων κλιματικών μεταβολών.

Γνωρίζουμε σήμερα ότι το θερμικό ισοζύγιο της γης αποσταθεροποιείται, και ότι θα επακολουθήσουν ορισμένες θερμαντικές και πιθανές συναρτώμενες κλιματικές μεταβολές, ανάλογα με το μέγεθος της εν λόγω αποσταθεροποίησης.

Α.2.3. Το αερίο που έχει τη μεγαλύτερη ευθύνη για το φαινόμενο θερμοκηπίου είναι το CO_2, οι εκπομπές του οποίου οφείλονται κατά κύριο λόγο στην καύση ορυκτών καυσίμων (5 GTONS άνθρακα/έτος*), στην καύση ξύλων και στην αποσύνθεση της δασικής βιομάζας που συνδέεται με την αποδάσωση (0,5-2GTONS άνθρακα/έτος).

Σήμερα το CO_2 είναι υπεύθυνο σε ποσοστό κατά τι μεγαλύτερο του 50 % για το φαινόμενο θερμοκηπίου. Ένα 25 % του φαινομένου βαρύνει τους χλωριοφθοριωμένους υδρογονάνθρακες (CFC) που χρησιμοποιούνται σε σειρά εφαρμογών όπως τα αεροζόλ, τα δοχεία σπρέϋ, τα μηχανήματα κλιματισμού, τα ψυγεία, οι διαλύτες, η συσκευασία, κλπ. Το υπόλοιπο ποσοστό αποδίδεται στο μεθάνιο (CH_4) από τα ζώα εκτροφής, τους ορυζώνες, την εκμετάλλευση φυσικού αερίου, την ατελή καύση βιομάζας και άνθρακα, το υποξείδιο του αζώτου (N_2O) που προέρχεται από την καύση ορυκτών καυσίμων και από τη χρήση αζωτούχων λιπασμάτων, καθώς και το τροποσφαιρικό όζον που οφείλεται σε φωτοχημικές διεργασίες στη ρυπαρή ατμόσφαιρα. Οι εκπομπές αερίων θερμοκηπίου έχουν αυξηθεί σημαντικά τις τελευταίες δεκαετίες.

Α.2.4. Με βάση τα αποτελέσματα των κλιματικών μοντέλων σε παγκόσμια κλίμακα, συνάγεται το συμπέρασμα ότι η γη άγει προς αύξηση της μέσης θερμοκρασίας της επιφάνειας, της τάξεως των 1,5-4,5°C, λόγω του διπλασιασμού της συγκέντρωσης των προβιομηχανικών ισοδύναμων αερίων θερμοκηπίου. Με τους σημερινούς ρυθμούς, αυτό αναμένεται να συμβεί πριν το έτος 2050.

Α.2.5. Τα σημερινά κλιματικά μοντέλα δεν είναι σε θέση να παράσχουν αξιόπιστες περιφερειακές εκτιμήσεις των ενδεχόμενων κλιματικών μεταβολών που να ανταποκρίνονται στην προαναφερθείσα μέση αύξηση της επιφανειακής θερμοκρασίας.
Οι πρώτες εκτιμήσεις υποδηλώνουν ότι στην Ευρώπη η αύξηση της θερμοκρασίας ενδέχεται να είναι μεγαλύτερη απ' ότι ο παγκόσμιος μέσος όρος.

Α.2.6. Οι έμμεσες επιπτώσεις των κλιματικών αυτών μεταβολών θα μπορούσαν να συνοψισθούν ως εξής:
- αύξηση της θαλάσσιας στάθμης (από 30 cm σε 1,5 m προκειμένου περί αυξήσεως της θερμοκρασίας της τάξεως των 1,5-4,5°C),
- μείωση των πάγων της θάλασσας,
- μείωση των υδάτινων πόρων σε ορισμένες περιοχές,
- μεταβολές της γεωργικής παραγωγικότητας,
- επιπτώσεις στην ανθρώπινη υγεία και την οικολογία.

* 1 Gton= 10^9 τόνοι = 1.000 εκατομμύρια τόνοι

Α.3. Το διεθνές πλαίσιο και οι προοπτικές

Α.3.1. Στο "Διεθνές Συνέδριο για την εκτίμηση και το ρόλο του CO_2 και άλλων αερίων θερμοκηπίου στις μεταβολές του κλίματος και συναρτώμενες επιπτώσεις" (VILLACH, 9-15 Οκτωβρίου 1985), επετεύχθη επιστημονική συναίνεση για τις βασικές συνιστώσες του φαινομένου θερμοκηπίου, που αναφέρονται στις προηγούμενες παραγράφους.

Α.3.2. Τα συμπεράσματα του συνεδρίου του VILLACH αναπτύχθηκαν περαιτέρω σε συμπόσιο της ΕΟΚ στις Βρυξέλλες (3-5 Νοεμβρίου 1986) με θέμα "το CO_2 και άλλα αέρια θερμοκηπίου: κλίμα και συναρτώμενα φαινόμενα" και σε συνέδρια πρακτικής εργασίας (WORKSHOPS στο VILLACH (28 Σεπτεμβρίου - 20 Οκτωβρίου 1987) και το BELLAGIO (9-13 Νοεμβρίου 1987) με θέμα "διαμόρφωση πολιτικής για την αντιμετώπιση των κλιματικών μεταβολών".

Α.3.3. Το φαινόμενο θερμοκηπίου απετέλεσε επίσης το αντικείμενο των εργασιών της επιτροπής BRUNDTLAND. Κατόπιν συστάσεων της εν λόγω επιτροπής, πραγματοποιήθηκε στο Τορόντο παγκόσμιο συνέδριο με θέμα "η μεταβαλλόμενη ατμόσφαιρα, επιπτώσεις για την παγκόσμια ασφάλεια" (27-30 Ιουνίου 1988). Το συνέδριο αυτό συνέστησε μεταξύ άλλων και τις ακόλουθες ενέργειες:

- Κύρωση του πρωτοκόλλου του Μοντρεάλ για τις ουσίες που προκαλούν μείωση του στρώματος όζοντος. Το πρωτόκολλο πρέπει να αναθεωρηθεί το 1990 ώστε να εξασφαλισθεί η σχεδόν ολοσχερής εξάλειψη των εκπομπών πλήρως αλογονωμένων χλωριοφθοριωμένων υδρογονανθράκων (CFC) το έτος 2000.
- Θέσπιση ενεργειακής πολιτικής για τη μείωση των εκπομπών CO_2 και άλλων ιχνών αερίων προκειμένου να μειωθούν οι κίνδυνοι μελλοντικής παγκόσμιας θέρμανσης.
- Μείωση των εκπομπών CO_2 κατά 20 % περίπου των επιπέδων του 1988 κατά το έτος 2005, ως αρχικός συνολικός στόχος των εκβιομηχανισμένων χωρών.
- Καθορισμός στόχων για βελτιώσεις της ενεργειακής αποτελεσματικότητας που συνδέονται άμεσα με περιορισμούς του CO_2 και άλλων αερίων θερμοκηπίου.
- Έναρξη της κατάρτισης μίας ευρείας παγκόσμιας σύμβασης.
- Δημιουργία ενός Παγκόσμιου Ταμείου Ατμοσφαίρας.

Α.3.4. Μια πιθανή βραχυπρόθεσμη απόρροια των ανωτέρω διεθνών δραστηριοτήτων είναι η ήδη από το 1989 έναρξη της διαδικασίας για την κατάρτιση συμφωνίας σχετικά με το θέμα του θερμοκηπίου, που θα περιελάμβανε ενδεχομένως πρωτόκολλα για τον περιορισμό των εκπομπών αερίων θερμοκηπίου.

Α.3.5. Επόμενοι βασικοί σταθμοί στην πορεία για τη σύναψη της συμφωνίας αυτής θα είναι πιθανότατα:

- το διεθνές συνέδριο πρακτικής εργασίας (WORKSHOP) για τη νομοθεσία και την πολιτική, που θα πραγματοποιηθεί στην Οττάβα στις αρχές του 1989,
- μια υψηλού επιπέδου πολιτική συνδιάσκεψη που θα συγκληθεί το φθινόπωρο του 1989 από το Υπουργείο Περιβάλλοντος των Κάτω Χωρών,
- η Δεύτερη Παγκόσμια Συνδιάσκεψη για το Κλίμα, Γενεύη, Ιούνιος 1990,
- η Διακυβερνητική Συνδιάσκεψη για την τόνωση της Ανάπτυξης το 1992, που θα μπορούσε να αποτελεόει το κορυφαίο γεγονός.

Α.4. Δυνατές ενέργειες

Α.4.1. Η πολιτική αντιμετώπισης του φαινομένου θερμοκηπίου θα μπορούσε να περιλαμβάνει προληπτικά μέτρα και/ή μέτρα προσαρμογής.

Α.4.2. Οι προληπτικές ενέργειες αποβλέπουν στη μείωση των εκπομπών αερίων θερμοκηπίου προκειμένου να αμβλυνθούν οι αναμενόμενες επιπτώσεις.

Όσον αφορά το CO_2, ο ενεργειακός τομέας εν γένει και η δασοκομία στις τροπικές περιοχές αποτελούν τους σημαντικότερους τομείς προς παρέμβαση.

Μεταξύ των ενεργειακών μέτρων που θα συνέβαλλαν στη μείωση των εκπομπών CO_2 θα μπορούσαν να περιλαμβάνονται:

- η αύξηση της ενεργειακής αποτελεσματικότητας (τόσο από πλευράς προμήθειας όσο και από πλευράς ζήτησης),
- η στροφή προς καύσιμα που περιέχουν λιγότερο άνθρακα,
- η προαγωγή ανανεώσιμων πηγών ενέργειας και η αύξηση της χρήσης της βιομάζας,
- η προαγωγή της ασφαλούς πυρηνικής ενέργειας.

Ιδιαίτερη σημασία φαίνεται να έχει η προαγωγή καινοτόμων ενεργειακών τεχνολογιών για τη στήριξη των μέτρων αυτών.

Σε μακροπρόθεσμη βάση, η δημιουργία νέων ενεργειακών συστημάτων που δεν βασίζονται στον άνθρακα, θα μπορούσε να συμβάλει σημαντικά στον περιορισμό των εκπομπών CO_2.

Βεβαίως, τα παραπάνω μέτρα δεν έχουν όλα την ίδια αποτελεσματικότητα. Επιπλεόν, απαιτείται προσεκτική εκτίμηση της οικονομικής βιωσιμότητάς τους.

Στόχος της δασικής πολιτικής πρέπει να είναι η αναστροφή των σημερινών τάσεων αποδάσωσης, ιδίως στις περιοχές του ισημερινού. Προς το σκοπό αυτό ειδικότερα, θα ήταν αναγκαία η προαγωγή υποκατάστατων του ξύλου που χρησιμοποιείται σε μαζική κλίμακα ως καύσιμο στις περιοχές αυτές, και η προαγωγή βάσιμων γεωλογικών πρακτικών, κατά τρόπον ώστε η γεωργική ανάπτυξη να μη συνεπάγεται ευρείας κλίμακας καύση δασών για τον καθαρισμό εδαφών για γεωργικές χρήσεις.

Α.4.3. Οι δυνατές ενέργειες για τον περιορισμό των εκπομπών αερίων θερμοκηπίου όπως το CH_4 και N_2O είναι λιγότερο σαφής, δεδομένης της αβεβαιότητας που χαρακτηρίζει τις εκπομπές των εν λόγω ουσιών.

Τα εξής σημεία θα μπορούσαν να διερευνηθούν:

- η ελαχιστοποίηση της διαφυγής CH_4 κατά την εξόρυξη μεταφορά και χρησιμοποίηση φυσικού αερίου.
- Η ελαχιστοποίηση της διαφυγής CH_4 από τους χώρους ελεγχόμενης εναπόθεσης.
- Η ελαχιστοποίηση της εκπομπής N_2O κατά την καύση ορυκτών καυσίμων.
- Η μελέτη δυνατών βελτιώσεων στη διαχείριση του ζωϊκού κεφαλαίου, στην ορυζοκαλλιέργεια και στη διαχείριση των λιμνοθαλασσών, με στόχο τη μείωση της αποδέσμευσης CH_4.
- Η μελέτη των δυνατοτήτων βελτίωσης των διαχειριστικών πρακτικών λίπανσης, με σκοπό την μείωση της απελευθέρωσης N_2O κατα τη χρήση αζωτούχων λιπασμάτων.

Α.4.4. Στην περίπτωση των χλωριοφθοριωμένων υδρογονανθράκων (CFC), η σχεδόν ολοσχερής εξάλειψη των εκπομπών CFC θα ήταν δυνατή κατά το έτος 2000, με τον περιορισμό της παραγωγής και την ανάκτηση, την ανακύκλωση ή την καταστροφή των CFC στα υφιστάμενα προϊόντα.

Α.4.5. Ενδέχεται να απαιτηθεί η λήψη μέτρων προσαρμογής (δηλαδή μέτρων που απαιτούνται για την πρόληψη ή τον περιορισμό των καταστροφών που οφείλονται σε κλιματικές μεταβολές και συναρτώμενα φαινόμενα) προκειμένου να αντιμετωπισθούν οι επιπτώσεις που, παρά τα προληπτικά μέτρα, καθίστανται ενδεχομένως αναπόφευκτες.

Στην παρούσα φάση δεν είναι δυνατόν να καθοριστούν λεπτομερώς τα μέτρα προσαρμογής που θα χρειαζόταν να ληφθούν στην Κοινότητα, λόγω της έλλειψης μιας αξιόπιστης περιφερειακής εκτίμησης των ενδεχόμενων επιπτώσεων.

Σε γενικές γραμμές, τα μέτρα προσαρμογής για την αντιμετώπιση της ανόδου της στάθμης της θάλασσας θα μπορούσαν να περιλαμβάνουν θαλάσσια αντιπλημμυρικά φράγματα, εθνικά ασφαλιστικά προγράμματα κατά των πλημμυρών, κατασκευή τεχνητών λιμνών (για την αντιμετώπιση της ηυξημένης περιεκτικότητας σε αλάτι), την εγκατάλειψη ανεπτυγμένων περιοχών σε ζώνες χαμηλού υψομέτρου, επανεγκατάσταση πληθυσμών μακρυά από τις ευπρόσβλητες περιοχές, προστασία των παράκτιων οικοσυστημάτων.

Χρειαζεται περισσότερη μελέτη για τον καθορισμό πιθανών μέτρων προσαρμογής σε άλλους τομείς όπως η γεωργία και η δασοκομία.

Β. ΣΥΜΠΕΡΑΣΜΑΤΑ ΓΙΑ ΤΟ ΤΙ ΓΝΩΡΙΖΟΥΜΕ ΣΗΜΕΡΑ ΣΧΕΤΙΚΑ ΜΕ ΤΟ ΦΑΙΝΟΜΕΝΟ ΘΕΡΜΟΚΗΠΙΟΥ

Β.1. Η σύνθεση της γήινης ατμόσφαιρας μεταβάλλεται σημαντικά από τις ανθρώπινες δραστηριότητες.

Με βάση τα αποτελέσματα παγκόσμιων κλιματικών μοντέλων, οι επιστήμονες συμφωνούν ότι ο διπλασιασμός της ισοδύναμης ατμοσφαιρικής συγκέντρωσης CO_2 θα έχει ως αποτέλεσμα μια αύξηση της μέσης επιφανειακής θερμοκρασίας της τάξεως των 1,5-4,5°C. Ένας τέτοιος διπλασιασμός είναι πιθανό να συμβεί το πρώτο ήμισυ του επόμενου αιώνα.

Σύμφωνα με τα κλιματικά δεδομένα, η επακόλουθη μεταβολή των μέσων παγκόσμιων κλιματικών συνθηκών θα "ξεπερνά το φάσμα" των κλιμάτων που υπήρξαν στο ιστορικό παρελθόν και κατά τις πρόσφατες γεωλογικές περιόδους."

Β.2. Τα διάφορα φαινόμενα που θα συνοδεύουν τις εν λόγω κλιματικές μεταβολές και οι λεπτομερείς κοινωνικοοικονομικές συνέπειες τους δεν μπορούν επί του παρόντος να εκτιμηθούν κατά τρόπο αξιόπιστο. Ωστόσο, από τις προκαταρκτικές εργασίες που έχουν γίνει σχετικά με το θέμα αυτό, προκύπτει ότι οι κίνδυνοι είναι εξαιρετικά υψηλοί και οι ενδεχόμενες άμεσες και έμμεσες επιπτώσεις ενδεχομένως διαλυτικές.

Β.3. Πρόσφατα διεθνή γεγονότα έχουν προσδώσει έναν επείγοντα χαρακτήρα στην παγκόσμιας κλίμακας συζήτηση που διεξάγεται επί του θέματος. Είναι σαφές πλέον ότι τώρα είναι η στιγμή για τη χάραξη βιώσιμων στρατηγικών, επιταχύνοντας παράλληλα την ερευνητική προσπάθεια.

Γ. ΣΥΜΠΕΡΑΣΜΑΤΑ ΤΗΣ ΕΠΙΤΡΟΠΗΣ

Γ.0. Ακολουθεί περίληψη των κυριότερων συμπερασμάτων της παρούσας έκθεσης. Το κεφάλαιο IV του παρόντος εγγράφου περιλαμβάνει πλήρη παρουσίαση των εν λόγω συστάσεων.

Γ.1. Η Κοινότητα πρέπει να εφαρμόσει πλήρως τη σύμβαση της Βιέννης για την προστασία του στρώματος όζοντος και το πρωτόκολλο του Μοντρεάλ για τις ουσίες που εξασθενίζουν το στρώμα όζοντος, και να συμμετάσχει ενεργά στην επαναδιαπραγμάτευση του εν λόγω πρωτοκόλλου.

Γ.2. Η Κοινότητα πρέπει να ενθαρρύνει την έναρξη συζητήσεων για τις δυνατότητες μιας διεθνούς συμφωνίας για τη μελλοντική προστασία της ατμόσφαιρας. Θα πρέπει να είναι έτοιμη να συμβάλει σημαντικά στην προετοιμασία και διαπραγμάτευση μιας τέτοιας συμφωνίας, η οποία θα μπορούσε να περιλαμβάνει τον καθορισμό συγκεκριμένων στόχων για τον περιορισμό των εκπομπών αερίων θερμοκηπίου, καθώς και καθορισμό των μέτρων και προγραμμάτων για τη μείωση των εκπομπών.

Γ.3. Κατά συνέπεια, η Επιτροπή θα αναλάβει την πρωτοβουλία της έναρξης ενός ουσιαστικού προγράμματος μελέτης των επιλογών πολιτικής για την αξιολόγηση του εφικτού, του κόστους και των αναμενόμενων αποτελεσμάτων ενδεχόμενων μέτρων περιορισμού των εκπομπών αερίων θερμοκηπίου.

Οι κύριοι τομείς ενός τέτοιου προγράμματος πρέπει να είναι:

- προσδιορισμός και τεχνική αξιολόγηση μέτρων και τεχνολογιών που μπορούν να μειώσουν τις εκπομπές αερίων θερμοκηπίου,

- ανάλυση των οικονομικών, βιομηχανικών, ενεργειακών, κοινωνικών και θεσμικών επιπτώσεων των ανωτέρω ενδεχόμενων μέτρων και τεχνολογιών,

- διαμόρφωση και αξιολόγηση σεναρίων πολιτικής που να αναφέρονται ειδικότερα σε πιθανούς στρατηγικούς στόχους ανωτάτων ορίων εκπομπής CO_2 ,

- δημιουργία ενός πλαισίου αναλυσης των αποφάσεων,

- διαμόρφωση και αξιολόγηση πολιτικών προσαρμογής.

Γ.4. Η Κοινότητα και τα κράτη μέλη πρέπει από τώρα να λαμβάνουν υπόψη στις αποφάσεις τους για τη χάραξη πολιτικής (όσον αφορά την ενέργεια ή άλλους τομείς που αφορούν το εν λόγω ζήτημα) το πρόβλημα των ενδεχόμενων κλιματικών μεταβολών που συνδέονται με το φαινόμενο θερμοκηπίου. Η ενσωμάτωση της παραμέτρου αυτή θα απέτρεπε υψηλότερες δαπάνες στο μέλλον.

Γ.5. Επιπλέον, η Επιτροπή θα αναλάβει άμεση δράση για την ενίσχυση και επέκταση των προσπαθειών στον τομέα της εξοικονόμησης ενεργείας, της βελτίωσης της ενεργειακής αποτελεσματικότητας, της ανάπτυξης νέων ενεργειακών πηγών, της χρήσης ασφαλούς πυρηνικής τεχνολογίας.

Θα πρέπει να δοθεί υψηλή προτεραιότητα στην επιτάχυνση της ανάπτυξης και προαγωγής καινοτόμων τεχνολογιών εμπορικής κλίμακας στους εν λόγω τομείς.

Δεν υπάρχει αμφιβολία ότι οι ενέργειες αυτές δικαιολογούνται τόσο λόγω ενεργειακών όσο και λόγω περιβαλλοντικών αναγκών, ανεξάρτητα από την αβεβαιότητα που χαρακτηρίζει ορισμένες επιστημονικές πλευρές του φαινομένου θερμοκηπίου.

Εξαιρετικά σημαντική θα ήταν η δυνατότητα της ποσοτικοποίησης, σε όρους μείωσης του Co_2, των βελτιώσεων της ενεργειακής αποτελεσματικότητας.

Γ.6. Η Κοινότητα πρέπει να υποστηρίξει δραστήρια ερευνητικά προγράμματα που αφορούν όλες τις πλευρές του φαινομένου θερμοκηπίου και να δημιουργήσει νέες ενεργειακές τεχνολογίες που να έχουν τη δυνατότητα περιορισμού των εκπομπών CO_2.

I. AN INTRODUCTION TO THE GREENHOUSE ISSUE

What the "greenhouse effect" is in short

1. The climate conditions we experience on earth are due, among other things, to the presence of the atmosphere around it and to its present composition. Without the atmosphere, the average surface temperature of the earth, which is presently of around 15°C, would be as low as -18°C.

In fact, the heat balance of the earth, which receives radiation from the sun and reflects or re-emits it into the space, is largely governed by the composition of the atmosphere.

Firstly water vapour, mostly concentrated in the lower atmosphere, is an effective absorber of both incoming solar and outgoing infrared earth's radiation and contributes very significantly to determine the average surface temperature of the earth.
Moreover, other substances such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs) have the property of being nearly transparent to incoming radiation from the sun but to retain some of the energy re-emitted by the earth as long wavelenght infra-red radiation.

Ozone also contributes to the absorption of infra-red radiation emitted by the earth.(1)
The overall outcome of this mechanism is that part of the radiant energy coming from the sun is trapped in the lower atmosphere.

2. The present scientific knowledge allows us to conclude that any significant change in the atmospheric concentrations of the above mentioned substances would result in a change of the global thermal balance of the earth.

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(1) Stratospheric ozone (the "ozone layer") is a strong absorber of ultraviolet radiation from the sun. Moreover ozone contributes to the absorption of infrared radiation from the earth. Tropospheric ozone contributes therefore to trap heat in the lower atmosphere. Any change in the vertical distribution of ozone would contribute to affect the thermal balance of the earth.

In particular an increase in the atmospheric concentrations of CO_2, CFCs, CH_4, N_2O, tropospheric ozone, which are often called "greenhouse gases", would result in more heat to be trapped in the lower troposphere and then in some warming and possible associated climate changes depending on the size of such greenhouse gases concentration increase. This phenomenon is usually referred to as the "greenhouse effect" because its basic mechanism is similar to that in a greenhouse where incoming radiation energy from the sun is partly transformed to infrared radiation by the ground, warms the air and is then retained by the glass from escaping again.

Greenhouse gases : emission sources and atmospheric concentration trends

3. The atmospheric concentrations of all most important greenhouse gases have increased over recent times and are still increasing.

4. In case of carbon dioxide (CO_2) :

   a. Emission sources :

   Most of anthropogenic CO_2 emissions are due to fossil fuels burning (around 5 Gtons* of carbon per year). Moreover a significant contribution comes from burning of wood and decomposition of biomass related to deforestation (uncertain quantity, most likely in the range 0,5 - 2 Gtons of carbon per year corresponding to a rate of deforestation in the tropical regions of 10 to 20 millions ha/y).

   CO_2 world yearly emissions from burning of fossil fuels have increased in 25 years, since 1960, from around 2,5 Gt of carbon to more than 5 Gt of carbon in 1985.

   Coal and oil give by now an almost equal contribution to emission with slightly more than 2 Gt of carbon each, followed by gas with less than 1 Gt of carbon per year.

   It is estimated that since one century, around 170 Gt of carbon have been emitted, of which around 100 Gt in the last 25 years.

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* 1 Gton = 10^9 tons = 1000 million tons

The share of CO_2 emissions per year from fossil fuels for different parts of the world and its recent evolution is showed in the following table :

CO_2 emissions in million tons of carbon/y
and as % of world total

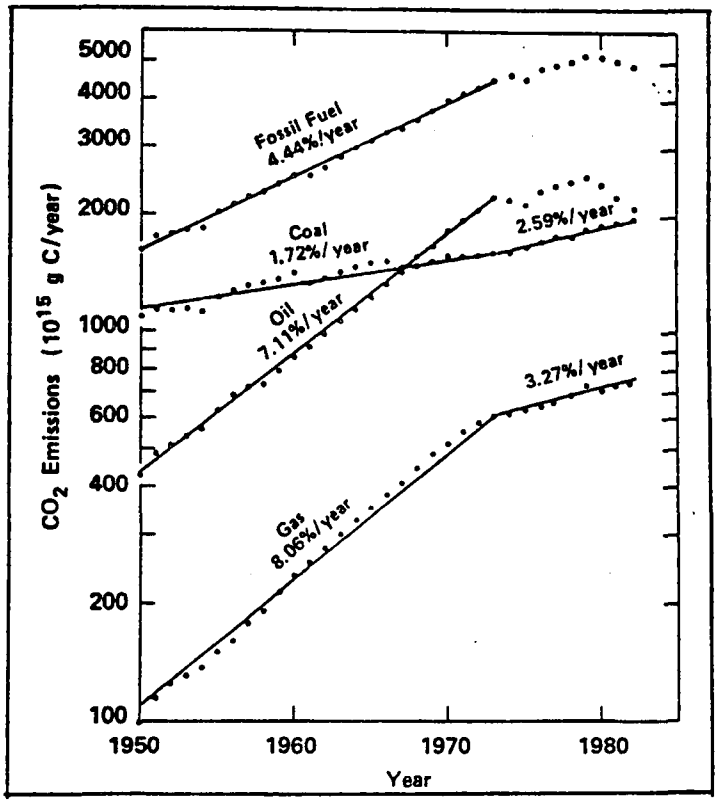
	1950		1965		1980	
Region	Mt/y*	%	Mt/y*	%	Mt/y*	%
North America	723	44,7	1003	32,1	1380	26,7
URSS and Eastern Europe	291	18,0	750	24,0	1251	24,2
China	23	1,4	178	5,7	439	8,5
Western Europe	379	23,4	643	20,6	853	16,5
Japan, Australia	45	2,8	137	4,4	300	5,8
Developing Countries	92	5,7	250	8,0	631	12,2
Others (worldwide gas flaring, bunkers)	63	3,9	163	5,2	310	6,0
World total	1618	100	3126	100	5170	100

Source : "Atmosphere carbon dioxide and the global carbon cycle"
US DOE/ER-0239, edited by J.R. Trabalka, Dec. 1985

* absolute figures are rounded to next million ton.

The figures above show the dramatic increase of CO_2 emissions in all regions of the world from 1950 to 1980.
The share of the total world emissions of China and developing countries has significantly increased in the same period due i.a. to the demographic trends in these regions.

The trends of CO_2 world emission from different fossil fuels for the period 1950-1982 are shown in next figure. (source : US DOE/ER-0239 report referred to above) :



The steep increase of yearly CO_2 emissions from oil and natural gas has been slowed down or even reversed after the first oil crisis, thus reflecting the worldwide energy policy efforts to restrict the use of oil, by improvements in energy efficiency and an increased use of nuclear energy and/or solid fuels. Consequently CO_2 emissions from coal have increased after the first oil shock, from a yearly rate of 1,72% to 2,59% up to 1982.

Emission data for 1985 show the following contribution from various fossil fuels :

Fuel	1985 CO_2 emissions in million tons carbon/y
gas	807
oil	2189
coal	2181
gas flaring	52
Total	5229

Source : I. Mintzer, WRI, 1988

Per capita CO_2 emissions from fossil fuels for different countries are shown in the following table, referred to 1982 :

Country	Per capita CO_2 emissions (tons of carbon per inhabitant)
United States	4,9
German Dem. Rep.	4,9
Canada	4,4
Czechoslovakia	4,1
Australia	3,9
Soviet Union	3,3
Poland	3,0
Belgium	3,0
Germany, Fed. Rep.	2,9
United Kingdom	2,5
Netherlands	2,5
France	2,0
Japan	1,9
Italy	1,5
Spain	1,4
China	0,5
Brazil	0,3
India	0,1
World average	1,0

Calculated from : Smith, I.M. (1988) : CO_2 and climate change; Draft technical review, EIA Coal Research, London, and UN statistical data

b. Atmospheric concentrations trends :

Since 1960 to 1985 the average yearly atmospheric concentration of CO_2 has increased from 315 to 345 ppm.*
There is evidence that the pre-industrial concentration of this gas was around 275-285 ppm. The rate of concentration increase for CO_2 has accelerated in recent years : it was an average of 1 ppm per year in the 70ties and is by now about 1,5 ppm per year.

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* 1 ppm = part per million = 0,0001%

CO_2 concentration increase is determined by the effect of manmade emissions, mostly due to fossil fuel burning and deforestation, on the global carbon cycle : natural carbon sinks (mainly the oceans and vegetation) are no longer sufficient to balance such increasing emissions and this leads to more CO_2 stored in the atmosphere.

5. In case of chlorofluorocarbons (CFC's) :

a. Emissions sources :

CFC's are man-made chemicals used in a variety of applications such as aerosol spray cans, air conditioning, refrigerators, solvents, packaging, etc.

b. Atmospheric concentration trends

The atmospheric concentration of CFC-11 and CFC-12 at four sites widely dispersed in the world ranged from 0,21 to 0,23 ppb* and 0,37 to 0,39 ppb respectively in 1985.

Even if the present atmospheric concentration of these substances is by several orders of magnitude lower than that of CO_2, one has to note that the rate of growth of such concentration has been much higher than that of CO_2, around 5-7% per year, the efficiency in trapping heat of some of them is 10,000 higher than CO_2' on a molecule by molecule basis and the residence time in the atmosphere of some of these substances is extremely long (up to more than 100 years).

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* 1 ppb = part per billion = 0,0000001%

6. In case of methane (CH_4) :

a. Emission sources :

Present man-made emissions of CH_4 come mainly from livestock, rice paddy fields, natural gas exploitation, burning of biomass and coal. Natural emissions from biota are also relevant and the overall CH_4 cycle is not well known.

Rough estimates give the following emission levels for the various sources (expressed in million tons; the range indicated in brackets shows the dispersion of estimates made by various authors) :

Natural Sources (million tons per year) :

Enteric fermentation (wild animals)	5 (+/- 3)
Wetlands (swamps, etc.)	110 (+/- 50)
Lakes	4 (+/- 2)
Tundra	3 (+/- 2)
Oceans	10 (+/- 3)
Termites and other insects	25 (+/- 20)
Other	40 (+/- 40)

Man-Made Sources (million tons per year) :

Enteric fermentation (cattle, etc.)	75 (+/- 35)
Rice paddies	70 (+/- 30)
Biomass burning	70 (+/- 40)
Natural gas and mining losses	50 (+/- 25)
Solid Waste	30 (+/- 30)

(Source : US Dept. of Energy - "A Primer on Greenhouse Gases" - DOE/NBB0083 - March 88.)

b. Atmospheric concentration trends :

Atmospheric concentration of CH_4 has increased since old times (from 0,7 ppm before 1700 A.D. to 1,54 and 1,68 ppm in the southern and northern hemisphere respectively, in 1983). Average yearly increase over 30 years from 1951 to 1981 has been of 1,1%.

7. In case of nitrous oxide (N_2O) :

a. Emission sources :

Man-made emissions of N_2O are mainly due to combustion of fossil fuels and biomass. Agricultural soils (both natural and fertilized) seem also to give a significant contribution.
Natural emissions are due to terrestrial and ocean biota.

Again the quantitative evaluation of emissions from various sources is most difficult. It is estimated that the overall emissions are as follows (expressed in million tons; the range indicated in brackets shows the dispersion of estimates made by various authors) :

Natural Sources (million tons of N per year) :

Oceans and estuaries	2.0 (+/- 1.0)
Natural soils	6.5 (+/- 3.5)

Man-Made Sources (million tons of N per year) :

Fossil fuel combustion	4.0 (+/- 1.0)
Biomass burning	0.7 (+/- 0.2)
Fertilized soils	0.8 (+/- 0.2)
Cultivated natural soils	1.5 (+/- 0.5)

(Source : US Dept. of Energy - "A Primer on Greenhouse Gases" - DOE/NBB0083 - March 88.)

b. Atmospheric concentration trends :

N_2O atmospheric concentration has increased from a pre-industrial 290 ppb to about 300 ppb in 1985. The present rate of increase is around 0,25% per year.

8. It is to be underlined that the present increase in concentration of greenhouse gases is due to the interference of human activities with the natural cycles. Yet there are significant uncertainties concerning the quantitative relationships between emissions of greenhouse gases and the observed increase of their atmospheric concentrations.

9. Moreover it is not possible at this stage to give reliable forecasts of future emission trends because of the wide range of factors influencing those trends. However scenarios may be developed using different assumptions.

10. It is reasonable to expect further and accelerating increase in the atmospheric concentrations of some greenhouse gases over the next 50 years.

Potential climate consequences of increasing greenhouse gases concentrations

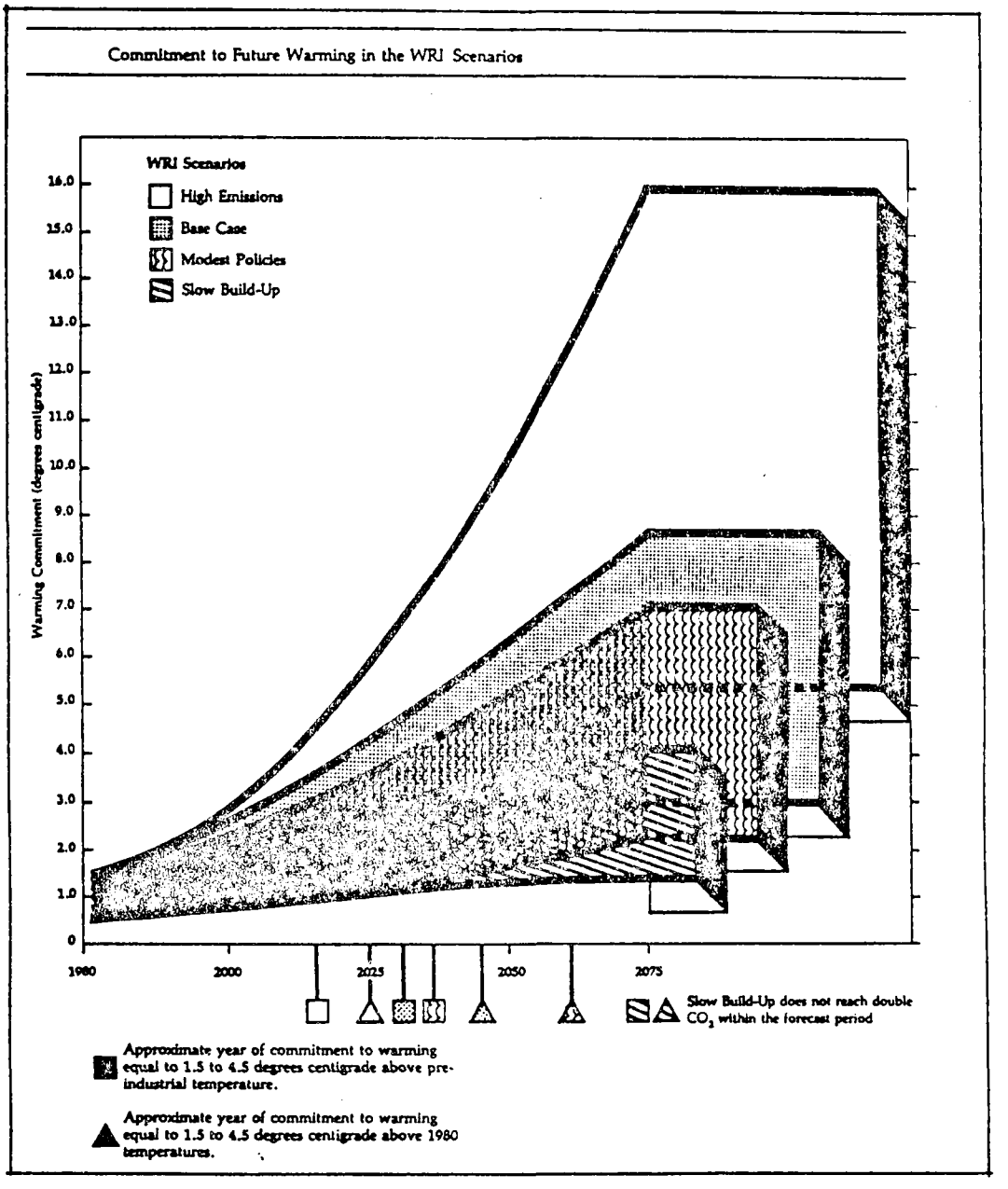
11. The observed and the expected increases in atmospheric concentrations of greenhouse gases (and then the increase in the heat quantity which is trapped in the lower atmosphere) undoubtedly will result in some warming and possible associated climate changes.
However, very significant uncertainties subsist about the shape and the rate of such climate changes and in particular about the degree of the warming and its timing.
From this point of view, uncertainties about the potential role of climatic feedbacks due to clouds, vegetation etc. are particularly relevant.
It is estimated that the different greenhouse gases contribute at present to the overall greenhouse forcing roughly in the following proportion : 55% for CO_2, 25% for CFC's, 20% for CH_4, N_2O and O_3 together.

The possible development of the overall greenhouse effect of the above mentioned gases until the year 2075 has been tentatively evaluated by the World Resources Institute in terms of forecasts for the average warming commitment with reference to 4 scenarios encompassing hypotheses about future developments from "do nothing" and high growth to voluntaristic emission reduction policies.

The hypotheses on which this exercise has been based are presented at page 23.
It should be underlined that it has not been taken account here of the likely positive consequences of the recent Montreal protocol on CFC's. The WRI study gives only a very limited role to nuclear energy in all scenarios. In none of the scenarios mentioned, the share of nuclear in total primary energy supply exceeds 4.5% by 2025. In other studies this share is much higher, for example, IIASA = 23%, WEC (83) = 13%, Goldenberg = 7%, Edmons = 19%. The Commission's own energy 2000 study sees the share of nuclear in world energy supplies as follows : 1983 = 3.3%, 1990 = 5.4%, 2000 = 7.1%. Environmental costs for nuclear range from $7.5 to $10/GJ whereas those for coal are between $0.15 and $1.20/GJ. In the case of oil $0.00 to $0.75/GJ. No environmental cost is assigned to renewable energies.

This model as any other one suffers from both structural and input data limitations. However the usefulness of such models is to help structuring the policy debate on such a complex issue and to identify critical areas for further research and study.

The results are summarized in next figure.

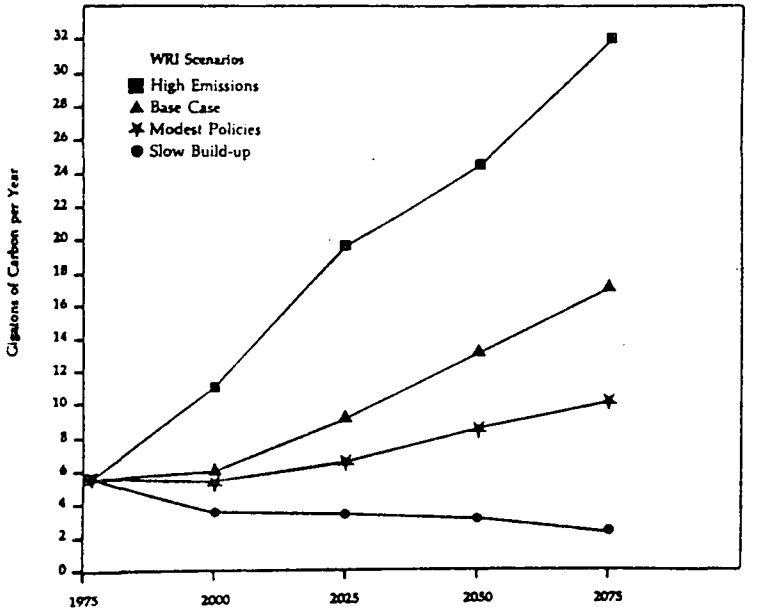


Source : Mintzer I.M. (1987); "A Matter of Degrees,
WRI, Washington DC, USA

Energy Policies in the WRI Scenarios

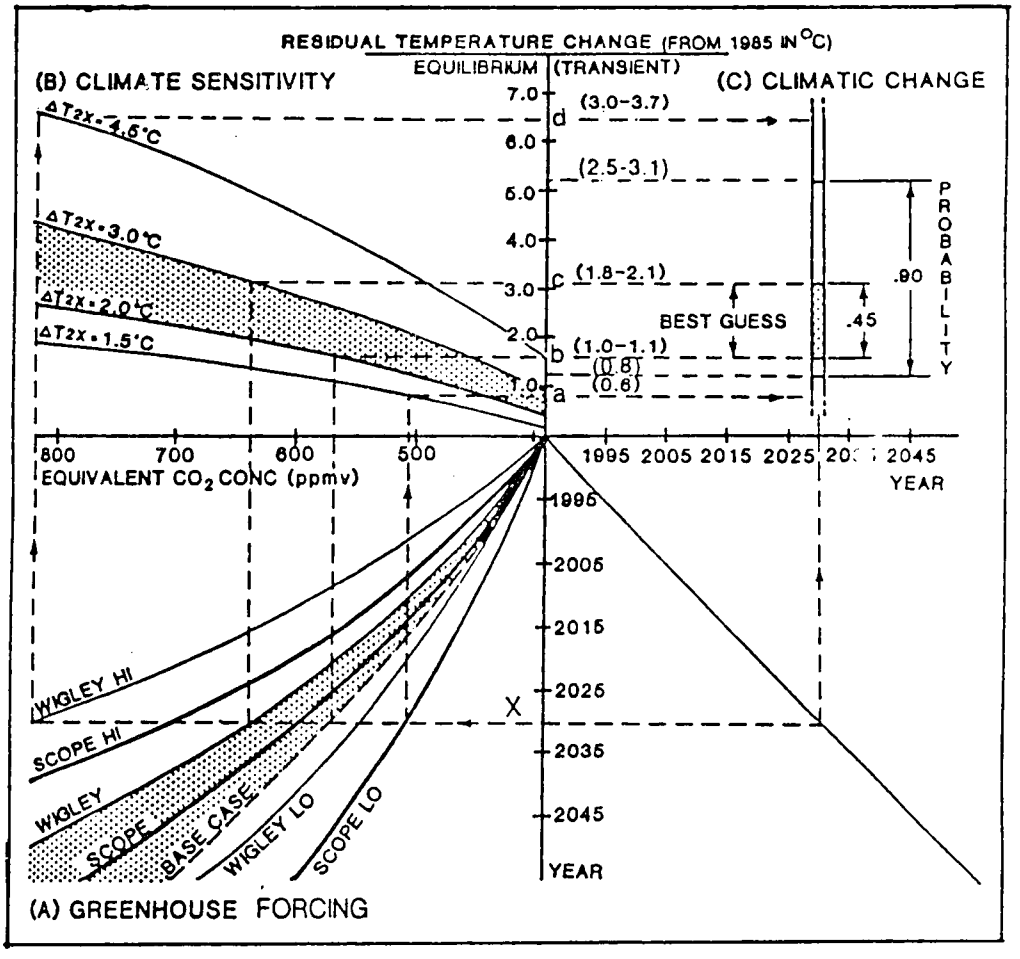
	Related Energy Model Parameter Value
Base Case Scenario	
• "Business-As-Usual," the inertial model of growth and change in the world energy industry	
• No policies to slow carbon dioxide emissions	
• Minimal stimulus to improve end-use efficiency	(Rate of change = 0.8% per year)
• Modest stimulus for synfuels development	(Final Price = $3.15-$4.25 per GJ in 2005)
• Minimal stimulus for development of solar energy systems	(Final Price = $16.50 per GJ in 2025)
• No policy to limit tropical deforestation or to encourage reforestation	
• Minimal environmental costs included in price of energy	($0.30 per GJ for coal; $1.00 per GJ for synfuels)
High Emissions Scenario	
• Accelerated growth in energy use is encouraged	
• No policies to slow carbon dioxide emissions	
• No stimulus to improve end-use efficiency	(Rate of change = 0.2% per year)
• Modest stimulus for increased use of coal	(Rate of improvement = 0.75% per year)
• Strong stimulus for synfuels development	(Final Price = $2.75-$3.50 per GJ in 1995)
• No stimulus for development of solar energy systems	(Final Price = $20 per GJ in 2040)
• Rapid deforestation and conversion of marginal lands to agriculture	
• Token environmental costs included in price of energy	($0.15 per GJ for coal; $0.50 per GJ for synfuels)
Modest Policies Scenario	
• Strong stimulus for improved end-use efficiency	(Rate of change = 1.0% per year)
• Modest stimulus for solar energy	(Final price = $15.00 per GJ in 2025)
• Substantial efforts at tropical reforestation and ecosystem protection; more intensive rather than extensive agriculture encouraged	
• Substantial environmental costs imposed on energy prices to discourage solid fuel use and encourage fuel-switching	($0.60 per GJ for coal; $1.50 per GJ for synfuels)
Slow Build-up Scenario	
• Strong emphasis placed on improving energy efficiency	(Rate of improvement = 1.5% per year)
• Rapid introduction of solar energy encouraged	(Final Price = $12.00 per GJ in 2000)
• Major global commitment to reforestation and ecosystem protection	
• High environmental costs imposed on energy prices to discourage solid fuel use and encourage fuel-switching	($1.20 per GJ for coal; $3.00 per GJ for synfuels)

Total Emissions of CO_2 in the WRI Scenarios (Gigatons of Carbon per Year)



By a different approach, Dr. R.A. Warrich of the Climatic Resarch Unit of the University of East Anglia in Norwich - UK, has recently tried to link emission forecasts and likely climatic changes and to assign probabilities to the possible outcome.

The results of this exercise are summarized in the following graph :



Legend :

- WIGLEY, SCOPE, BASE CASE indicate projections of greenhouse gases emissions
- T2X is the climate sensitivity expressed as equilibrium temperature increase due to a doubling of the equivalent CO_2 concentration
- "transient temperature" is the temperature increase at a given date due to the greenhouse forcing
- "equilibrium temperature" is the warming to which earth would have been committed at a given date due to the greenhouse effect.

The following conclusions i.a. have been drown by the author of the above mentioned evaluation :

"- Given the range of scientific uncertainties, the warming to which we will be committed in 2030 is 0.8-6.4°C. The chance of falling outside this range is less than 1%.

- The "best-guess" range is 1.5-3.1°C warmer than today. The probability of warming within this range is 45%.

- The 90% confidence interval is 1.1-5.1°C. This median value - the best guess - is 2.8°C."

12. The presently available climate models predict (with various degrees of uncertainties) the following climate and associated impacts[1] :

- **Global-Mean Surface Warming** (very probable). For a doubling of atmospheric carbon dioxide (or its radiative equivalent from all of the greenhouse gases), the long-term global-mean surface warming is expected to be in the range of 1.5 to 4.5°C. The most significant uncertainty arises from the effects of clouds. Of course, the actual rate of warming over the next century will be governed by the growth rate of greenhouse gases, natural fluctuations in the climate system, and the detailed response of the slowly responding parts of the climate system, i.e., oceans and glacial ice.

- **Global-Mean Precipitation Increase** (very probable). Increased heating of the surface will lead to increased evaporation and, therefore, to greater global mean precipitation. Despite this increase in global average precipitation, some individual regions might well experience decreases in rainfall.

- **Polar Winter Surface Warming** (very probable). As the sea ice boundary is shifted poleward, the models predict a dramatically enhanced surface warming in winter polar regions. The greater fraction of open water and thinner sea ice will probably lead to warming of the polar surface air by as much as 3 times the global mean warming.

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(1) Source : NRC (1987); Current Issues in Climate Change, National Research Council, Washington DC, USA.

- **Summer Continental Dryness/Warming** (likely in the long term). Several studies have predicted a marked long-term drying of the soil moisture over some mid-latitude interior continental regions during summer. This dryness is mainly caused by an earlier termination of snowmelt and rainy periods, and an earlier onset of the spring-to-summer reduction of soil wetness. Of course, these simulations of long-term equilibrium conditions may not offer a reliable guide to trends over the next few decades of changing atmospheric composition and changing climate.

- **High-Latitude Precipitation Increase** (probable). As the climate warms, the increased poleward penetration of warm, moist air should increase the average annual precipitation in high latitudes.

To complete the picture of expected direct effects, it is worth mentioning also a :

- **Large Stratospheric Cooling** (virtually certain). Reduced ozone concentrations in the upper stratosphere will lead to reduced absorption of solar ultraviolet radiation and therefore less heating. Increases in the stratospheric concentration of carbon dioxide and other radiatively active trace gases will increase the radiation of heat from the stratosphere. The combination of decreased heating and increased cooling will lead to a major lowering of temperatures in the upper stratosphere.

This last effect seems quite important as a possible efficient and rapid "finger-print" of the greenhouse effect given that "the expected changes in the upper stratosphere are nearly of an order of magnitude greater than the expected surface changes and that they are not affected by the ocean thermal inertia and by cloud feedback effects (processes which are a source of considerable uncertainty in assessing tropospheric climate change)" (WMO, 1985).

13. It is worth stressing again that uncertainties on the shape, on the regional distribution and on the rate of such changes should not hide the fact that observed and expected increase in greenhouse gases atmospheric concentrations <u>will</u> modify the thermal balance of the earth and therefore <u>will</u> bring some warming and possible associated climate modification.

As it was put as a conclusion at a symposium on "CO_2 and other greenhouse gases : climatic and associated impact" organized by the Commission on 3 to 5 November 1986 :

"- Although quantitative uncertainties in models remain, it is now believed that increasing concentrations of greenhouse gases will produce a significant change during the 21st century.
- ... This warming of 1.5 to 4.5° is expected ot occur over the next 50 years.
- Over Europe the range of model results shows that average summer temperatures could increase by 2 - 6°C, winter average temperatures by 4 - 10°C. In winter precipitation would increase ..."

Potential impacts of climate changes

14. Potential impacts of the above mentioned climate changes will of course depend on the size and rate of the latter. At the symposium on "CO_2 and other greenhouse gases" mentioned in paragraph 13, it was concluded that :

"The expected climatic change will have profound effects on sea-level, global ecosystems, agriculture, water resources and sea-ice."

In particular such impacts could involve :

15. Sea level rise

Over the past 100 years, while global mean temperature has increased by approximately 0.5°C, sea level has risen by 10-15 cm. (Source : US-EPA (1986); "Effects of Changes in Stratosphere Ozone and Global Climate", Volume 1).

The projected global warming could have the following results :

. heating and therefore expanding the ocean water;
. melting of mountain glaciers;
. melting of the large ice sheets in Greenland and Antarctica;
. a possible (but unlikely) surge of a major portion of the Antarctic ice sheet into the ocean.

A wide range of different estimates for future sea level rise are available.
The most likely range for such increase by the middle of next century seems to be in the order of 30 cm to 1,5 meter (Toronto Conference, June 1988).

A significant rise in sea level would :

- permanently inundate many coastal wetlands and lowlands;
- accelerate coastal erosion;
- exacerbate coastal flooding and storm damage;
- increase the salinity of estuaries and coastal aquifers.

16. **Reduction of Sea Ice**

As the climate warms, total sea ice is expected to be reduced. This is a very probable effect.

17. **Water Resources Impacts**

Greenhouse warming may result in significant changes in precipitation patterns. While it is likely that global mean precipitation will increase, some regions may experience decreases in rainfall. Several studies predict substantial increases in summer dryness at mid-latitudes. As well as the impacts that this will have on agriculture, water resource reduction may affect the following :

- availability of water for human consumption;
- power generation;
- effluent dilution;
- navigation.

18. **Agriculture**

It should be mentioned that an increase in the CO_2 atmospheric concentration would stimulate vegetable growth by increasing photosynthesis rate and therefore could have per se a beneficial direct effect on crops and vegetation. This direct effect is difficult to quantify especially since the concomitant temperature increase would reduce the rate of net photosynthesis. Moreover any attempt to take it

into account should try to strike a balance between such direct effect and indirect impacts of increasing CO_2 concentration through climatic modifications.

The greenhouse warming could affect agriculture and forestry mostly by altering :

. total water availability and seasonal distribution of rainfall at regional level;
. length of growing season;
. number of extreme temperature events.

There are two perspectives on the agricultural impacts of climate change.

- The "Slow change" view : emphasises the significance of gradual increases in mean surface temperatures expected to lead to gradual, long-term and cumulative changes in average regional climates and agricultural patterns.

- The "Extreme events" view : emphasises changes in the frequencies of unusually disruptive events; impact of climate change comes not only from the average but mainly from the extreme event, e.g. droughts, flooding.

There is already concern among some experts that recent regional extreme events could be more than just climate fluctuations.

The main possible effects of climate variations on agriculture are summarised below (2) :

"- changes in length of the potential growing season and changes in plant growth rates;

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(2) Source : Parry M.L. et al (Eds) (1987) ; The Impact of Climate Variations on Agriculture, Volume 1, Assessments in Cool, Temperate and Cold Regions, Reidel, Dordrecht, The Netherlands.

- changes in mean yield and in the variability of yields;

- changes in the level of crop certainty and in the crop quality;

- changes in the sensitivity of plants to application of fertilisers, pesticides and herbicides."

Moreover climate changes could indirectly significantly affect agriculture in certain regions of the world through possible effects on soil characteristics, water resources, hydrology, pests and diseases etc.

At present, there is uncertainty about the nature, the magnitude and location of impacts. Studies so far conclude the following :

- Areas particularly sensitive to shifts in temperature and rainfall levels are high latitude, semi-arid and high-altitude regions.

- Warming appears to be detrimental to cereals in the core wheat-growing areas of Europe and North-America.

- Investigations of possible impacts in Canada, Finland and Northern USSR using climate data from the model by Hansen [1] et al, show reduced yields of spring-sown crops such as wheat, barley and oats, due to the increased moisture stress early in the growing period.

Impacts on agriculture would result in impacts on the local community, regional and national economies, in particular through changes in farm income and profitability, changes in regional production costs, changes in regional and national food production, changes in regional farm income disparities, changes in regional economic activity and employment.

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(1) Hansen J. et al (1983) : "Efficient Three-Dimensional Global Models for Climate Studies : Models I and II", Monthly Weather Review III, pp. 609-662.

In conclusion it is not possible under the present state of knowledge to give more than a tentative and qualitative description of possible effects of climate changes on agriculture given the large uncertainties about the regional shape and size of such changes and the lack of detailed research and studies on the likely response of agricultural systems in various regions of the world.
Urgent efforts are required to improve understanding of these aspects both at global level because of the potentially disruptive food security effects and at Community level because of the direct potential socio-economic impacts.

19. **Forest Ecosystems and Timber Production**

It is worth noticing that the same general comment on the direct potential effect of CO_2 on vegetation made at the beginning of paragraph 18 applies here too.

Predicted impacts include the following :

- modification of botanical and zoological composition of natural forest ecosystems;
- increase of forest decline in natural and manmade forest stands;
- modifications in forest productivity and forest management;
- disturbance of timber- and woodproducts markets and trade;
- danger of extinction of certain forest tree species and local ecotypes with a limited geographical distribution and by this a reduction of global genetic variability of forests.

20. **Human Health Impacts**

It should also be mentioned that a global warming could also have impacts for human health. It could in particular :

- possibly enable some diseases which require warm year-round temperatures to survive at higher latitudes;
- cause more frequent famines and shortages of food supplies (extreme events);

Expansion of tropical climates and concurrent expansion of the range of tropical diseases would mostly affect developing countries that already face health problems.

21. **Ecology and Fisheries Impacts**

The following potential ecological impacts are worth mentioning :

- impacts on less managed ecosystems;
- impacts on marine ecosystems;
- multiple stresses on some species which could become extinct, resulting in a significant decline in biodiversity;
- impact on wildlife reserves (the impact would depend on whether the reserve's boundaries encompass areas to which plants and animals could migrate).

The level of impact would depend on the rate of change in climate and thus the time allowed for acclimatisation and ecological species shifts.

Finally it is worth mentioning that since the ocean and atmosphere are coupled, both the distribution and abundance of fishery resources are capable of being modified by climate.
However, it is controversial how much observed changes in particular fishery stocks are due to climate and other natural causes or to overfishing.

II. THE INTERNATIONAL FRAMEWORK AND PERSPECTIVES

Introduction

22. Le rôle joué par certains gaz présents dans l'atmosphère dans les équilibres thermiques de la terre était connu dans ses grandes lignes déjà vers la moitié du siècle dernier (Tyndall, 1863; Arrhenius, 1896; Chamberlin, 1899).

Les premières mesures systématiques de la concentration du CO_2 par un réseau mondial ont toutefois démarré seulement en 1958.

Depuis lors l'augmentation observée de cette concentration a poussé les milieux scientifiques à entreprendre et à intensifier la recherche sur tous les aspects de l'effet serre.
Ce n'est toutefois que très récemment que ce sujet a commencé à faire l'objet de l'attention des responsables politiques.
Les problèmes bien connus concernant la couche d'ozone qui ont entraîné des négociations internationales et des décisions politiques ont en effet porté l'attention de ces responsables politiques sur les risques globaux liés aux modifications de notre atmosphère causées par l'action de l'homme et sur la necessité de préparer les réponses concrètes à donner aux indications scientifiques de plus en plus inquiétantes concernant l'éventualité de modifications du climat.

As a consequence, the following recent events have marked an important evolution in attitudes towards the greenhouse issue :

- the "Villach" conference (Villach-Austria, 9-15 October 1985);
- the European Parliament resolution on measures to counteract CO_2 rising concentrations (September 1985)
- The EEC Symposium on "CO_2 and other greenhouse gases" (Brussels, 3-5 November 1986);
- The Workshops on "Developing policies for responding to climatic change" (Villach-Austria, 28 September-2 October 1987 and Bellagio-Italy, 9-13 November 1987);
- The Brundtland Commission's report
- The World Conference on "The changing atmosphere" (Toronto, 27-30 June 1988).

The last event is of particular importance for future development and its outcome is presented in the next paragraph.

Details about the other events mentioned above are given in the Annex to this document.

The world conference on "The changing atmosphere, implications for global security" - Toronto, 27-30 june 1988

23. This high level conference has been organized at the initiative of the Canadian government to follow-up some of the conclusions and recommendations of the Brundtland commission report.
More than 300 scientists and policy makers from 48 countries, United Nations organizations, other international bodies and non-governmental organizations participated in the sessions.

Of the conference conclusions and recommendations, the following seem most important and are therefore reproduced in full :

"- Humanity is conducting an enormous, unintended, globally pervasive experiment whose ultimate consequences could be second only to a global nuclear war. The Earth's atmosphere is being changed at an unprecedented rate by pollutants resulting from human activities, inefficient and wasteful fossil fuel use and the effects of rapid population growth in many regions. These changes represent a major threat to international security and are already having harmful consequences over many parts of the globe.

- Far-reaching impacts will be caused by global warming and sea level rise, which are becoming increasingly evident as a result of continued growth in atmospheric concentrations of carbon dioxide and other greenhouse gases. The best predictions available indicate potentially severe economic and social dislocation for present and future generations, which will worsen international tensions and increase the risk of conflicts among and within nations. It is imperative to act now."

The following immediate actions are recommended :

"A. <u>Actions by Governments and Industry</u>

- Ratify the Montreal Protocol on Substances that Deplete the Ozone Layer. The Protocol should be revised in 1990 to ensure nearly complete elimination of the emissions of fully halogenated CFCs by the year 2000. Additional measures to limit other ozone-destroying halocarbons should be considered.

- Set energy policies to reduce the emissions of CO_2 and other trace gases in order to reduce the risks of future global warming. Stabilizing the atmospheric concentrations of CO_2 is an imperative goal. It is currently estimated to require reductions of more than 50 percent from present emissions levels. Energy research and developmental budgets must be massively directed to energy options which would eliminate or greatly reduce CO_2 emissions and to studies undertaken to further refine the target reductions.

- Reduce CO_2 emissions by approximately 20 percent of 1988 levels by the year 2005 as an initial global goal. Clearly, the industrialized nations have a responsibility to lead the way, both through their national energy policies and their bilateral and multilateral assistance arrangements. About one-half of this reduction would be sought from energy efficiency and other conservation measures. The other half should be effected by modifications in supplies.

- Set targets for energy efficiency improvements that are directly related to reductions in CO_2 and other greenhouse gases. A challenging target would be to achieve the 10 percent energy efficiency improvements by 2005. Improving energy efficiency is not precisely the same as reducing total carbon emissions and the detailed policies will not all be familiar ones. A detailed study of the systems implications of this target should be made. Equally, targets for energy supply should also be directly related to reductions in CO_2 and other greenhouse gases. As with efficiency, a challenging target would again be to achieve the 10 percent energy supply improvements by 2005. A detailed study of the systems implications of this target should also be made. The contributions to achieving this goal will vary from region to region; some countries have already demonstrated a capability for increasing efficiency by more than 2 percent a year for over a decade.

- Apart from efficiency measures, the desired reduction will require (i) switching to lower CO_2 emittaing fuels, (ii) reviewing strategies for the implementation of renewable energy especially advanced biomass conversion technologies; (iii) revisiting the nuclear power option, which lost credibility because of problems related to nuclear safety, radioactive wastes, and nuclear weapons

proliferation. If these problems can be solved, through improved engineering designs and institutional arrangements, nuclear power could have a role to play in lowering CO_2 emissions.

- Negotiate now on ways to achieve the above-mentioned reductions.

- Initiate management systems in order to encourage, review and approve major new projects for energy efficiency.

- Vigorously apply existing technologies, in addition to gains made through reduction of fossil fuel combustion, to reduce (i) emissions of acidifying substances to reach the critical load that the environment can bear; (ii) substances which are precursors of tropospheric ozone; (iii) other non-CO_2 greenhouse gases.

- Label products to allow consumers to judge the extent and nature of the atmospheric contamination that arises from the manufacture and use of the product.

B. Action by Member Governments of the United Nations, Non-Governmental Organizations and Relevant International Bodies.

- Initiate the development of a comprehensive global convention as a framework for protocols on the protection of the atmosphere. The convention should emphasize such key elements as the free international exchange of information and support of research and monitoring, and should provide a framework for specific protocols for addressing particular issues, taking into account existing international law. This should be vigorously pursued at the International Workshop on Law and Policy to be held in Ottawa early in 1989, the high-level political conference on Climate Change in the Netherlands in the Fall, 1989, the World Energy Conference in Canada in 1989 and the Second World Climate Conference, Geneva, June 1990, with a view to having the principles and components of such a convention ready for consideration at the inter-governmental Conference on Sustainable Development in 1992. These activities should in no way impede simultaneous national, bilateral and regional actions and agreements to deal with specific problems such as acidification and greenhouse gas emissions.

- Establish a World Atmosphere Fund, financed in part by a levy on fossil fuel consumption of industrialized countries, to mobilize a substantial part of the resources needed for implementation of the Action Plan for the Protection of the Atmosphere.

- Support the work of the Inter-governmental Panel on Climate Change to conduct continuing assessments of scientific results and initiate government-to-government discussion of responses and strategies.

- Devote increasing resources to research and monitoring efforts within the World Climate Programme, the International Geosphere Biosphere Programme and Human Response to Global Change Programme. It is particularly important to understand how climate changes on a regional scale are related to an overall global change of climate. Emphasis shouls also be placed on better determining the role of oceans and global heat transport and the flux of greenhouse gases.

- Increase significantly the funding for research, development and transfer of information on renewable energy, if necessary by the establishment of additional and bridging programmes; extend technology transfer with particular emphasis on the needs of the developing countries; and upgrade efforts to meet obligations for the development and transfer of technology embodied in existing agreements.

- Expand funding for more extensive technology transfer and technical cooperation projects in coastal zone protection and management.

- Reduce deforestation and increase afforestation making use of proposals such as that in the World Commission on Environment and Development"s (WCED) report, "Our Common Future", including the establishment of a trust fund to provide adequate incentives to enable developing nations to manage their tropical forest resources sustainably.

- Develop and support technical cooperation projects to allow developing nations to participate in international mitigation efforts, monitoring, research and analysis related to the changing atmosphere.

- Ensure that this Conference Statement, the Working Groupe reports and the full Proceedings of the World Conference, "The Changing Atmosphere : Implications for Global Security" (to be published in the Fall, 1988) are made available to all nations, to the conferences mentioned under paragraph 26, and other future meetings dealing with related issues.

- Increase funding to non-governmental organizations to allow the establishment of environmental education programmes and public awareness campaigns related to the changing atmosphere. Such programmes would aim at sharpening perception of the issues, and changing public values and behaviour with respect to the environment.

- Allocate financial support for environmental education in primary and secondary schools and universities. Consideration should be given to establishing special groups in university departments for addressing the crucial issues of global climate change.

Future possible developments

24. A possible short-term outcome of the above mentioned international activites is initiation, already in 1989, of the process for preparing a comprehensive global convention on the protection of the atmosphere.

Limitations to the emissions of greenhouse gases would then be agreed by specific protocols in the frame of such convention.

25. Next essential events on the way to that convention might probably be :

- the international workshop on law and policy to be held in Ottawa early in 1989;

- a high level political conference to be convened in the autumn 1989 by the Netherlands Ministry of the Environment;

- the Second World Climate Conference, Geneva, June 1990;

- the Intergovernmental Conference on sustainable Development in 1992 which could be the culminating event.

26. The substance of the convention mentioned under 24 above (and of associated protocols) as far as the greenhouse issue is concerned could probably consist in :

a) greenhouse gases emission reduction targets for developed countries;

b) new development aid schemes to help developing countries to limit the increase of their greenhouse gases emissions by use of appropriate technologies and to reverse deforestation trends;

c) a new impetus to scientific and technical international cooperation on all the aspects relevant for the greenhouse issue.

27. Renegotiation of the Montreal Protocol on CFC's is a very likely short term development.

28. Policy discussions on the way how to deal with the greenhouse effect might be very complex because of the many far reaching and interrelated aspects of the issue.

In this respect, it is worth stressing the global, complex and differentiated nature of the challenge put by the greenhouse issue.

This was well presented in the following statement at the Bellagio (1987) workshop (see Annex) :

"... the participants emphasized the relationship between the issue of climatic change, including policy responses to it, and a number of other issues, above all in the field of environment and development. This relationship underlines the importance of the differences in impact by region, and hence by country, of climatic change and the extent to which these differences affect the effort of the international community in promoting sustainable development.

The report of the Brundtland Commission has explained the ramifications of these numerous interconnections. The significance of the difference in regional impact should not, however, be allowed to detract from the emphasis on the comunity as a whole in facing it. Still less should it encourage any attempts to divide countries or regions into "winners" or "losers". This is not a "zero-sum" game. Unless action is taken, it could be a negative sum game of highly uncertain proportions."

III. REVIEW OF POSSIBLE ACTIONS

Introduction

29. Preliminary indications from research results and the state of the international debate call for urgent consideration of further action on the greenhouse issue.

Such action, of which the following paragraphs give an overview, could include :

- research;
- preventive measures (i.e. measures to curb greenhouse gases emissions);
- adaptive measures (i.e. measures to adapt to climatic changes and to their impacts if those seem likely to be unavoidable despite preventive measures).

30. Policy measures may be classed into three groups :

(a) those which have to be taken at an international level and require international agreement (e.g. reduction of CO_2 emissions);
(b) those which may be taken at a European level (e.g. planning for water resources, agricultural and forest planning) or in specific countries e.g. through development aid programmes (conservation of tropical forests, wetlands, coastal ecosystems, appropriate energy policies, etc.);

(c) those of an intermediate character (e.g. decisions on the energy mix to be adopted, taking account of (a) and of particular European conditions).

The group to which any particular measure belongs may determine the time necessary to its adoption and require a proper approach.
Measures of an international character may ignore specific local conditions; local measures cannot do so.

31. The above mentioned factors have to be taken into account in order to correctly coordinate the policy decision timing and the research timing. In fact this coordination is essential for two reasons :

(a) the uncertainties as regards the climate change and its impacts increase with increasing spatial and temporal definition : the ultimate answer one is expecting from scientific research is what will happen, when, where. Now the "what" becomes increasingly uncertain as the range of the "when" and "where" becomes smaller. Yet such knowledge is vital for any planning which decision makers could consider.

(b) in order to take policy decisions it is crucial to know

- which danger, when and where, one has to face and what consequences upon the environment, the economy, the society at large are to be expected;
- how to implement at best the measures decided;

Therefore, the study of policy options and scientific research have to go in parallel, and there must be a continuous feedback between the two. Only in this way can one avoid that decisions are unduly delayed or that they are taken without taking fully into account research results. Research itself should benefit from that interaction process, by being continuously reoriented towards specific objectives and actual problems and needs.

Research activities

32. Already since 1980, the Commission of the European Communities is carrying out a research programme in Climatology, whose main research areas are concerned with the study of the evolution of climate in the past, with climate modelling, with the man-induced climate change and with the impacts that such change could have on European land and water resources. The symposium held in Brussels in November 1986 (Annex B) was organised in the frame of this programme and was meant to provide the scientific consensus available at that date.

Research is being focussed especially on the climatic effects of greenhouse gases, and climatologically significant processes imperfectly understood as yet, such as atmosphere-ocean interactions, the water vapour-greenhouse feedback, the cloud feedback, aerosol and cloud climatology, biospheric sources and sinks of trace gases, climatic aspects of ozone changes and troposphere-stratosphere interactions, the effects of glabal warming on the melting rate of ice shelves.

33. In the near future the Climatology research programme of the Commission will put a greater stress on the impacts which climate change could have on important sectors of the European environment.

Such intensified research should concern in particular :

(1) The rise in sea level and its impacts on the European coasts (prediction of future sea-level changes, the change in storm surge risks for European coastal installations, the impacts on coastal ecosystems and coastal land use).

(2) The impacts of a changing climate on European crops, forests, water resources (bioclimatic shifts of crops and forests, changes in productivity, the sensitivity of European crops to increased CO_2 and climate change, the impacts on surface and ground water supplies).

(3) The effects of the climate change as regards the progressive aridification of the Mediterranean Europe (effects of climatic and meteorological factors on soil degradation, the impact of progressive drought on vegetation).

(4) The occurrence and frequency of extreme events and their impacts upon agriculture and industry (the impacts of the alternance of droughts and heavy rainfall on European land resources, the impacts of meteorological extremes such as hail and frost on European agriculture and industry).

(5) The melting of Alpine glaciers.

(6) The study of the social, economic and political factors conditioning probable future emission rates of greenhouse gases, and likely to be affected by any policy option that could be adopted.

(7) The study of socio-economic impacts, in particular in the Community, due to climatic changes, for the various relevant aspects, such as consequences for agriculture, consequences for costline regions of the sea level rise, etc.

Such research should be supplemented by a sound monitoring of atmospheric and oceanic conditions. International agreements should allow to place instrumentation where it is needed and to have access to space based monitoring systems. A vital component of a monitoring programme is the utilisation of space technology to understand the processes which control the earth's climate system and its sensitivity to natural and man-induced changes.

34. Environmental constraints, especially the reduction of air pollution, call for a balanced pursuit of environmental and energy objectives. As far as CO_2 is concerned, the objective can also be achieved through progress in the development and availability of techniques, processes and products allowing rational use of energy and the efficient and economic use of renewable energy sources and by safe nuclear energy.

These considerations provide ample justification for a specific energy R&D programme in the fields of renewable energies, rational use of energy and safe nuclear technology which will ensure continuity of the progress made since 1975 and guarantee that optimum benefits be gained from the new energy technologies developed so far.

35. Elimination of CO_2 at the source could eventually become a new domain of resarch. No economically or technically feasible technologies are yet available.
New directions for research in this field should be explored.

36. Moreover, the management of the CO_2 problem implies both the definition of global reduction objectives and the implementation of these objectives. The first aspect of the problem requires to determine by how much the emissions will need to be reduced and the pace of that reduction. The implementation action will have to determine the economic activities that will bear the major part of this reduction, the allocation of this reduction among the different actors and the institutional approaches to arrive at these objectives.

System Analysis can, in principle, provide the adequate basis for looking at these questions. Energy-Environment models give the possibility of finding efficient ways of achieving emission goals; Climate models are there to assess the impact of emissions on the environment and to help construct scenarios of adaptive measures; Energy-economy models allow to compute the impact on the economic systems of the costs incurred by the reduction of emissions.

The models developed in the System Analysis Community research programme should be adapted and used in the direction defined above for analysing energy related CO_2 emissions reduction measures and programmes.

The aim of such research would be to evaluate the feasibility and the costs of various reduction objectives as well as to assess their impact on the energy and economy sectors.

Preventive action (greenhouse gases emission reduction)

37. Preventive action is any action aiming at curbing the expected increase in greenhouse gases atmospheric concentrations.
This could mean aiming first at reducing the rate of increase of those concentrations and in the longer term at stabilizing them. Reduction of greenhouse gases concentrations does not seem at this stage a realistic objective but could be a very long term goal.

38. The only way at hand to control future trends of greenhouse gases concentrations is limiting man-made emissions including, in case of CO_2, reversing the present trend of deforestation in tropical regions.

Preventative action is further discussed with reference to the most relevant greenhouse gases here below.

39. **Carbon dioxide (CO_2) emissions**

As shown in paragraph 4 of chapter I, CO_2 emissions are mostly due to fossil fuels burning and forest wood burning or forest biomass decomposition.
Preventive action could therefore include measures to be taken in the energy sector (including energy for industry and transportation) and in the forestry and agricultural sectors as far as action in these sectors could help to preserve forests.

A tentative list of actions aiming at CO_2 emissions reduction which could be studied might include :

A. Energy related measures for CO_2

There are several types of technical energy related measures that could curb CO_2 emissions, as listed below.
Of course not all those measures are equally efficient or cost-effective and one should make a clear distinction between the physical potential of CO_2 emission reduction of a given measure and its economic viability.

The following technical measures, which are listed without any ranking or priority, may provide ways to reduce CO_2 emissions from carbon-based fuels :

a. Energy Efficiency

- improving the efficiency of energy demand (e.g. more efficient light bulbs, better insulation, more efficient cars, electronic regulations, etc.);

- improving the efficiency of energy supply (e.g. cogeneration, introduction of combined cycle possibly integrated with high-temperature nuclear reactors, develoment of MHD, etc.);

b. Energy Supply

- fuel switching to less CO_2 emitting fuels (the relation of CO_2 emitted quantities with regard to a unit of energy produce for the combustion of lignite, hard coal, oil and natural gas is as follows : 121, 100, 88, 58);
- increased use of non carbon based renewable energies (pe. solar, windpower, hydro, geothermal, photovoltaics);
- increased use of nuclear power.

c. Biotic sources

- Use biomass for energy purposes (such as wood for heating or cooking in developing countries) in a sustainable way so that the CO_2 atmospheric balance is not affected significantly;

d. CO_2 technology abatement

- Although at present no economically or technically feasible technologies seem to be available, this possibility should not be excluded for the future.

e. Long-term development

- Introduction of non-carbon based energy systems in their various forms combined with electricity and hydrogen as secondary energy carriers.

Any policy decision aiming at reducing CO_2 emissions in the energy sector should be carefully examined taking fully into account the specific objectives and constraints existing at international, community and national level in this sector. On the other hand, any future decision in the field of energy policy should take into account the problem of potential climate changes linked to the greenhouse effect.

System analysis models have been extensively used in the past for exploring consequences of economic-energy-environmental related measures and the use of such analytical models may provide information on the feasibility of measures to achieve CO_2 reduction goals. Scenarios analysis can complete such information and identify technologies which have a good chance of contributing to that objective and hence should deserve more attention.

B. Measures related to forestry and natural ecosystems

a. Conserve forest resources

- promote appropriate agricultural practices and organization in developing countries to avoid that agricultural land demand cause further deforestation;

- assist developing countries to improve their ability to manage forests in a manner that ensures that they are exploited on a sustainable basis;

- reinforce prevention and fighting of forest fires;

- promote actions to monitor and restore declining forests;

- provide alternatives to and improve the efficiency of the utilisation of fuel-wood for cooking in developing countries.

b. Promote afforestation

- increase reafforestation efforts notably in subtropical and tropical regions;

- promote agroforestry, especially in developing countries.

c. Natural ecosystem protection

- promote the conservation of ecosystems directly or indirectly relevant for the global carbon cycle.

40. **CFCs emissions**

Possible preventative actions are :

a. Constrain use
b. Constrain production
c. Recapture and recycle or destroy

41. **CH_4, N_2O emissions**

Actions which could be considered are :

a. Minimize CH_4 losses in extraction, transport and use of natural gas.
b. Minimize CH_4 losses from landfills.
c. Minimize N_2O emission from fossil fuels burning.
d. Study possible improvements in livestocks management, rice cultivation and lagoons management, aiming at reducing CH_4 release.
e. Study possible improved fertilizing management practices to reduce N_2O release from nitrogen fertilizers use.

42. The possible use of mechanisms such as taxation of products that cause greenhouse gas emissions or of emissions themselves where this is feasible, could be considered to stimulate or complement technology measures.

Planned adaptation

43. Planned adaptation involves taking account of potential greenhouse impacts in long-term planning, most likely at the regional and national levels.
Consideration of such measures in long term planning becomes necessary if it is believed that :

- impacts are likely to occur which society will not be able to adjust to in the short term;
- implementation of preventative measures is unlikely to be sufficiently effective in time (e.g. even if emission controls were implemented now, it is possible that significant impacts will occur due to the atmospheric warming to which we are already committed).

At this stage it is not possible to cover, even in qualitative and simple way, all the adaptive measures which could be worth considering in relation to the various potential impacts of the greenhouse effect. However, it is worth giving some indications concerning potential measures for possible sea-level rise and for impacts on agriculture.

44. **Possible adaptation measures concerning sea level rise could include :**

- Sea walls/flood barriers.
- National flood insurance programmes.
- Construction of reservoirs (to combat increased salinity).
- Abandonment of developed regions in low lying areas.
- Other relocation of populations away from vulnerable sites.
- Protection of coastal ecosystems.

45. **Examples of measures which could be considered in order to adapt to impacts on agriculture are :**

- More efficient use of fertilisers.
- Changes of land use to optimise and to stabilize production;
- Changes of policy to maintain national food security;
- Changes to policies supporting land management, such as soil erosion control, water management, etc.

Cooperation with developing countries

46. All the above measures, both as regards preventive action and as regards planned adaptation, should also be developed to take into account the needs of the developing countries, and how the Community's development aid policy can contribute towards the prevention and the adaptation of the greenhouse effect. In particular :

a) by enhancing the type of projects that can actively contribute to prevention such as those which are directed at reducing deforestation, conserving wetlands, coastal ecosystems and the genetic diversity or arid ecosystems;

b) by taking into account the consequences of the greenhouse effect in medium-term project planning (e.g. agricultural programmes, livestock programmes, fisheries and any projects related to long-term investments on lowlands which may be affected by the forecasted increase of ocean level);

c) by ensuring that base line data being gathered for the purpose of implementing development projects be made accessible to the Community research programme on the greenhouse effect.

IV. CONCLUSIONS OF THE COMMISSION

47. The Community should implement fully the Vienna Convention for the protection of the ozone layer and the Montreal Protocol on substances that deplete the ozone layer. This will involve the adoption and application by all Member states of the proposed Council Decision, Regulation and Resolution agreed to by the Council on 16 June 1988.

48. The Community should participate actively in the efforts toward renegotiation by 1990 of the Montreal Protocol on substances that deplete the ozone layer. The Protocol should be revised so that the CFC's emissions could be almost totally eliminated by the year 2000 as recommended by the Toronto conference.

49. The Commmunity should welcome initiation of discussions on the possibilities of an international agreement for the future protection of the atmosphere. It should be prepared to give an important contribution to the preparation and negotiation of such an agreement which might include the establishment of specific targets for limiting emissions of greenhose gases as well as definition of emission reduction measures and programmes.

50. Therefore, the Commission will take the initiative to launch a substantial policy-options study programme to evaluate the feasibility, costs and likely results of possible measures to limit greenhouse gases emissions. Results of such programme would give useful inputs to the international debate on the issue.

The main areas of such programme should be :

- identification and technical assessment of measures and technologies in various relevant fields capable to reduce greenhouse gases emissions;

- analysis of economic, industrial, energy, social and institutional implications and impacts of the above mentioned possible measures and technologies;

- structuring and evaluating policy scenarios referred in particular to possible strategic targets for CO_2 emission ceilings.

A reliable greenhouse gases emission inventory would be needed in this frame.
The focus of the exercise should be on Europe in a first instance.

- establishing a decision analysis framework in order to link probabilistically policy options and their likely results an benefits.

- identifying and evaluating adaptive policies to cope with unavoidable effects under the different scenarios resulting from the decision analysis exercise.

The Commission has developed several energy-economy and energy-environment models and those models and the experience gained in policy analyses of energy-environment interactions should be fully exploited when starting new work on the greenhouse issue.

The above mentioned work programme should be closely linked to the research and development activities on relevant subjects such as climatology and energy.
Moreover a framework should be created to allow systematic exchange of views and rapid feedbacks among scientists and policy makers.

51. The greenhouse effect is a global problem, the Community should therefore play an important part in the definition of a global policy, involving in particular developing countries, towards a sustainable development.

Community work on the greenhouse issue should be structured and scheduled so to allow synergism and collaboration with international organizations and third countries. In particular the Commission work programme should fully take account of parallel activities in the frame of the panel on climate change of WMO/UNEP and of OECD and IEA.

52. The Community and its Member States should by now take into account in their policy decisions (related to energy or other sectors relevant to the issue) the problem of potential climate changes linked to the greenhouse effect.
Early consideration of such issue could avoid higher costs in future.

53. Moreover the Commission will take urgent action to reinforce and expand efforts in the field of energy savings, energy efficiency improvement, development of new energy sources, use of safe nuclear technology. The accelerated development and promotion of innovative commercial-scale technologies in these fields should be given high priority.
There is no doubt that such action is justified because of both energy and environmental requirements, independent of uncertainties on some scientific aspects of the greenhouse issue.
Of special importance would be the possibility to quantify energy efficiency improvements in terms of CO_2 reductions.

54. The Community should sustain vigorous research programmes on all the relevant aspects of the greenhouse issue and should promote new energy technologies having the potential to limit CO_2 emissions.

55. Activities should be reinforced and expanded in the frame of existing cooperation agreements of the EC with mediterranean countries with the aim both of promoting sustainable development in those countries and of helping them to prevent likely impacts of the greenhouse issue on their environment.

56. The Commission will also prepare urgent action in the field of aid to developing countries both as regards preventive and as regards adaptation measures.

In particular :

- An attempt should be made to classify and map geographical areas which are particularly vulnerable to the greenhouse effect (such as, for instance, islands whose mean altitude above sea level is precariously low, coastal states, etc. Such maping would form a reference basis against which policies could be evaluated. It would certainly be a first step towards adapting policy as regards aid to developing countries.

- The greenhouse effect should as much as possible be taken into account in considering the feasibility of major projects such as, for instance, dams, agricultural projects which involve major modifications to the environment and in being particularly cautious in evaluating any project which may have a negative input on

tropical forests, wetlands, coastal ecosystems or mountain ecosystems. Instruments should be developed to assess the long-term sensitivity of development projects to the greenhouse effect. Preparedness against natural disaster also at some stage have to be increased, in respect of the type of calamities which the greenhouse effect may make more likely. (For example the strength of tropical storms which is expected to increase.) In preparing national regional conservation strategies one should ensure that adequate account is taken of the greenhouse effect.

57. In parallel to the work needed to evaluate possible policy options, existing research programmes should be strenghten to better understand the potential impacts of the greenhouse effect on European regions. These programmes should consider both the physical and the socio-economic direct and indirect impacts.

In this frame the risks for the coastline regions of the Community related to possible sea level rise should be assessed so that information useful for land use planning is available to developers and competent authorities.

58. Finally, the Commission will set up a Committee to exchange information on all the aspects of the greenhouse issue. Member States and the Commission should be represented in this Committee.

ANNEX

Recent major events on the greenhouse issue

A. **The "VILLACH" Conference (International conference on the assessment and the rate of CO_2 and of other greenhouse gases in climate variations and associated impacts (Villach - Austria, 9-15 October 1985))**

This conference was jointly convened by UNEP, WMO and ICSU with participation of scientists from twenty nine developed and developing countries.

The following sentences appear in the statement adopted by this conference :

"Many important economic and social decisions are being made today on long-term projects - major water resource management activities such as irrigation and hydro-power; drought relief; agricultural land use; structural designs and coastal engineering projects; and energy planning - all based on the assumption that past climatic data, without modification, are a reliable guide to the future. This is no longer a good assumption since the increasing concentrations of greenhouse gases are expected to cause a significant warming of the global climate in the next century."

.....

"While some warming of climate now appears inevitable due to past actions, the rate and degree of future warming could be profoundly affected by governmental policies on energy conservation, use of fossil fuels, and the emission of some greenhouse gases."

.....

"Based on evidence of effects of past climatic changes, there is little doubt that a future change in climate of the order of magnitude obtained from climate models for a doubling of the atmospheric CO_2 concentration could have profound effects on global ecosystems, agriculture, water resources and sea ice."

.....

"Governments and regional inter-governmental organizations should take into account the results of this assessment (Villach 1985) in their policies on social and economic development, environmental programmes, and control of emissions of radiatively active gases."

.....

"Public information efforts should be increased by international agencies and governments on the issues of greenhouse gases, climate change and sea level, including wide distribution of the documents of this Conference (Villach 1985)."

.....

"Major uncertainties remain in predictions of changes in global and regional precipitation and temperature patterns. Ecosystem responses are also imperfectly known. Nevertheless, the understanding of the greenhouse question is sufficiently developed that scientists and policy-makers should begin an active collaboration to explore the effectiveness of alternative policies and adjustments. Efforts should be made to design methods necessary for such collaboration."

B. The EEC Symposium on "CO2 and other greenhouse gases : climatic and associated impacts (Brussels, 3-5 November 1986)

Upon the initiative of Dr. K.H. Narjes, Vice-President of the Commission of European Communities, a Symposium organised by the CEC, DG XII, was held in Brussels from 3 - 5 November 1986. It was attended by about 60 leading European and US scientists, who reviewed the whole issue of the climate change that will take place as a consequence of the accummulation of the atmospheric CO_2 and other greenhouse gases.

Further to the conclusions on the scientific aspects of the greenhouse issue, mentioned in the relevant sections of this document, the following recommendations were presented as a conclusion of this Symposium :

"- The time has come for taking a decisive step toward converting the dialogue between scientists and decision makers from a remote, intermittent and casual reading of reports of the other party to a closer and more interactive exchange of views.

- It is recommended that a means be established for obtaining the necessary exchange of information between policy analysts, decision makers and the scientific community involved in the issue."

C. The workshops on "Developing policies for responding to climatic change" (Villach - Austria, 28 September-2 October 1987 and Bellagio - Italy, 9-13 November 1987)

These meetings were called following the scientific consensus reached at the Villach conference in order to "start policy analysis to identify the widest possible range of social responses for limiting or adapting to climatic changes".

Apart from the statement mentioned in paragraph 28 of this document, the following conclusions/recommendations were presented :

"Immediate steps to limit greenhouse gas emissions

(1) Ozone Protocol Immediate approval and implementation of the Protocol on Substances that Deplete the Ozone Layer (thereby reducing CFC emissions). Recommend that it be ratified urgently and that after expedited scientific review the parties consider acceleration of the schedule for reductions in CFCs and eventual elimination of emissions not only for ozone layer protection but particularly for greenhouse gas limitation.

(2) Energy Policies
Governments should immediately begin to reexamine their long-term energy strategies with the goals of achieving high end-use efficiency, reducing multiple forms of air pollution and reducing CO_2 emissions. Research and development on alternative (non-fossil) energy systems must be greatly intensified.

(3) Deforestation Policies
Recommend support for increased measures to reduce deforestation, e.g. locally appropriate actions along the lines of the Tropical Forest Action Plan, 1987. Such measures are currently necessary because of the effects of tropical deforestation on agriculture,

energy, soil erosion, flooding and drought, etc. The contribution of deforestation to greenhouse gas induced climatic change is a powerful additional reason for measures to reduce deforestation.

(4) Other Trace Gases

Measures should be taken to avoid industrial and societal actions in the future which unduly contribute to emissions of greenhouse gases to the atmosphere. Examples include landfills that emit methane; N_2O reduction strategies; agricultural practices, etc.

Immediate steps to limit the impact of sea-level rise

(5) River and Coastal Zone Policies

International unions of geographic, coastal and geodetic and soil sciences and/or government agencies should develop maps to identify coastal areas vulnerable to sea-level rise, river regulation and intensifying land-use. Planning for large new industrial, tourist and urban installations near the sea should allow for the risks of possible sea-level rise.

Immediate steps to improve understanding of the greenhouse effect and options for dealing with it

(6) Management tools

Policy and scientific research should investigate further the utility of particular goals as management tools. An environmental goal expressed in terms of a rate of change of temperature or sea-level is easy to relate to observed historic rates of change. Such an environmental goal is related to the ambient concentration of greenhouse gases (expressed in terms of CO_2 equivalence) and thus to the emissions and for each of these, regulatory targets can be set in line with the long-term environmental goal.

(7) Monitoring

The problem of significant climate warming may call for a considerable increase in existing available monitoring activities, both with regard to global climate and its variability and sea-level changes, atmospheric chemistry and rainfall chemistry, as well as the consequences for the environment of any significant warming.

It is therefore recommended that WMO/WCP (World Meteorological Organization / World Climate Programme) and UNEP/GEMS (Unite Nations Environment Programme / Global Environmental Monitoring System) carry out a joint study of :

- what new climate observing system activites are required for monitoring the changing climate;
- what activities are required for monitoring the consequences of the changing climate.

The IOC through the Global Sea Level Observing System should give urgent attention to strengthening the monitoring of sea-level changes worldwide.

(8) Research

ICSU, UNEP and WMO jointly support the World Climate Programme (WCP), which is the focus for the further study of both basic research issues concerning global climatic change and questions about climatic impact. The World Climate Research Programme (WCRP) is an important component of the WCP, as the assessment of possible or likely future climatic changes rests on a comprehensive understanding of the global climate system.

Similarly, the new research programme IGBP (International Geosphere Biosphere Programme), initiated by ICSU, addresses the scientific problems that we are now confronting when trying to understand the biological and geochemical interactions that contribute to future climatic change and are of importance for understanding climatic impacts.

Increased support for scientific research for both the WCRP and IGBP should be given high priority."

D. The Brundtland Commission's report

The World Commission on environment and Development has been created on the basis of an UN General Assembly resolution in 1983 as an independent body to formulate and present proposals and recommandations concerning the critical environment and development problems with the aim of promoting a sustainable development.

Its report was presented to the General Assembly of UN during its 42nd Session in the fall of 1987.

This report asks for a urgent start of negotiating procedures to develop international agreement on strategies to cope with the greenhouse issue. It is suggested to consider :

"- improved monitoring and assessment of the evolving phenomena;
- increased research to improve knowledge about the origins, mechanisms, and effects of the phenomena;
- the development of internationally agreed policies for the reduction of the causative gases; and
- adoption of strategies needed to minimize damage and cope with the climate changes and rising sea level."

The report also suggests that such negotiations should aim at an international convention on "management policies for all environmentally reactive chemicals released into the atmosphere".

E. The European Parliament resolution

The European Parliament has adopted on 12th September 1986 the following resolution on measures to counteract the rising concentration of CO_2 in the atmosphere :

" The European Parliament

- having regard to the motion for a resolution tabled by Mr. Linkohr on research and policy measures to counteract the rising concentration of carbon dioxide in the atmosphere ('greenhouse effect') (Doc. B2-1430/84).

- having regard to the report of the Committee on Energy, Research and Technology and to the opinion of the Committee on the Environment, Public Health and Consumer Protection (Doc. A2-68/86).

A. noting the growing scientific certainty that the earth's average temperature s rising as a result of non-natural releases into the atmosphere of carbon-dioxide and propellants from fossil-fuel burning, intensive farming and industrial activities and deforestation respectively.

B. noting that an increasing temperature build-up, which is greater at the poles than at the equator, will bring about a shift in the earth's climatic zones, resulting in radical and, in some cases, disastrous changes in economic-activity patterns.

C. pointing out that the only scientifically established facts about global temperature build-up are the scale thereof and thus the number of years remaining until its effects become apparent, assuming no change in human-activity patterns.

D. pointing out the need to obtain essential scientific data on the slow but perceptible changes in the environment of the world in order to establish the extent of the changes taking place, and the measures to be taken to avoid or reduce their unfavourable effects and to exploit beneficial consequences.

1. Stresses that it is imperative to make more-reaching countermeasures than those currently implemented to combat pollution, provided such measures are directed at releases of both carbon dioxide and propellants, since, contrary to earlier assumption, the latter are just as significant a cause of temperature build-up as the former;

2. Calls upon the Commission, in future activities in the field of agricultural, industrial and energy policy and in negotiations with both national and international authorities, to put forward measures with a view to a substantial reduction of harmful discharges, thus benefiting the environment too;

3. Emphasizes in this connection the automatic benefit to be gained from large-scale energy-saving and rational use of energy, possibly in tandem with exploitation of cleaner energy sources and flue-gas purification respectively;

4. Calls for a worldwide policy of reafforestation, for which the Community should provide an example with its own forestry policy;

5. Calls for financial Community development policy measures to help put an end to the deforestation of rain forests in Third World countries;

6. Calls on the Council when drawing up the new framework programme for research to allocate more resources to the area of climatology, especially relating to changing temperature gradients including ocean-atmosphere interaction;

7. Stresses that preventing pollution of the world's seas is an essential requirement for climatic stability;

8. Recalls that it is incumbent upon the industrialized countries of the Northern hemisphere, which are largely responsible for jeopardizing climate, to ensure that the developing nations are given access to the latest technological know-how;

9. Instructs its Members, in collaboration with the relevant scientific quarters, to inform the public - and particularly the operators directly responsible - about the implications of the human activities in question, while explaining the need for effective measures;

10. Instructs its committee responsible to include in their opinions a climatic-impact assessment of future Community-level activities with a view to reducing the current temperature build-up;

11. Instructs its President to forward this resolution and the report of its committee to the Council and the Commission."

Πρόγραμμα εργασίας της Επιτροπής
σχετικά με την ανάλυση των επιλογών πολιτικής
για την αντιμετώπιση των κινδύνων που συνδέονται
με το "φαινόμενο θερμοκηπίου"

I. ΠΕΡΙΕΧΟΜΕΝΟ ΤΟΥ ΠΡΟΓΡΑΜΜΑΤΟΣ

Στόχος του προγράμματος αυτού είναι η ανάδειξη των δεδομένων που χρειάζονται για να καθοριστεί ο πιθανός ρόλος της Κοινότητας και των κρατών μελών της όσον αφορά τον προσδιορισμό και την προώθηση, στο κατάλληλο διεθνές πλαίσιο, των μέτρων που είναι αναγκαία για την αντιμετώπιση των κινδύνων που συνδέονται με το φαινόμενο θερμοκηπίου.

Προς το σκοπό αυτό το παρόν πρόγραμμα εργασίας διαλαμβάνει τα ακόλουθα θέματα:

A. Διαμόρφωση των επιλογών πολιτικής για την πρόληψη/περιορισμό των εκπομπών αερίων θερμοκηπίου.

Θα καθοριστούν τα μέτρα που χρειάζονται για να επιτευχθούν στρατηγικοί περιορισμοί των εκπομπών των διαφόρων αερίων θερμοκηπίου. Για κάθε αέριο θερμοκηπίου, αυτό συνεπάγεται λεπτομερή εκτίμηση των διαθέσιμων επιλογών για τη μείωση των εκπομπών, το επίπεδο της μείωσης των εκπομπών που συνεπιφέρει κάθε επιλογή, και τη δέσμη των μέτρων που χρειάζονται για να επιτευχθούν στρατηγικές μειώσεις. Οι δυνατότητες πρόληψης/περιορισμού των εκπομπών θα εξετασθούν για τους ακόλουθους τομείς:

- παραγωγή ενεργείας,
- κατανάλωση ενεργείας (συμπεριλαμβανομένης της μεταφοράς),
- βιομηχανική παραγωγή,
- χρήση προϊόντων,
- γεωργικές δραστηριότητες.

Θα χρειαστεί μία κατάλληλη προσέγγιση ώστε να ληφθούν υπόψη οι ιδιαιτερότητες χωρών ή ομάδων χωρών. Ειδικότερα θα χρειαστεί να ληφθούν υπόψη τα ακόλουθα σημεία:

- το επίπεδο οικονομικής ανάπτυξης,
- η τρέχουσα ενεργειακή πολιτική,
- η γεωγραφία.

Β. Επιπτώσεις των επιλογών για τη μείωση των εκπομπών.

Οι επιλογές μείωσης των εκπομπών θα εξεταστούν προκειμένου να εκτιμηθούν τα ακόλουθα σημεία:

- τεχνικές και βιομηχανικές επιπτώσεις,
- δημοσιονομικές και οικονομικές επιπτώσεις,
- πολιτικές, θεσμικές και κοινωνικές επιπτώσεις.

Γ. Δημιουργία πλαισίου ανάλυσης των αποφάσεων.

Θα δημιουργηθεί ένα πλαίσιο ταξινόμησης των διαθέσιμων πληροφοριών για όλες τις πλευρές του φαινομένου θερμοκηπίου, κατά τρόπον ώστε να καταστεί δυνατός ο προσδιορισμός των ενδεχόμενων οφελών (από πλευράς μείωσης των κινδύνων κλιματικών μεταβολών, κλπ.) που αντιστοιχούν σε διαφορετικές επιλογές πολιτικής. Το πλαίσιο θα λαμβάνει υπόψη :

- τις εκπομπές και τη μείωση των εκπομπών,
- τις επιπτώσεις της εν λόγω μείωσης,
- τα διαθέσιμα επιστημονικά δεδομένα για τα ενδεχόμενα οφέλη εναλλακτικών ελέγχων των εκπομπών.

Το πλαίσιο θα διαμορφωθεί κατά τρόπον ώστε να λαμβάνεται υπόψη η αβεβαιότητα που αφορά τις εκπομπές, την αποτελεσματικότητα των ελέγχων, τις κλιματικές μεταβολές και τις συνέπειες, και θα επιτρέπει τον προσδιορισμό των πιθανότερων αποτελεσμάτων των διαφόρων ενεργειών.

Το πλαίσιο θα επιτρέπει επίσης την εξέταση των αποτελεσμάτων των επιβραδυντικών μέτρων. Διαγράφοντας τις βασικές συνιστώσες του προβλήματος και εντοπίζοντας βασικές παραμέτρους αβεβαιότητας που επηρεάζουν στο μεγαλύτερο βαθμό τα αποτελέσματα, το πλαίσιο θα αποτελέσει σημαντικό εργαλείο για την αξιολόγηση των μέτρων και για την επικέντρωση των μελλοντικών ερευνών σε θεμελιώδους σημασίας ζητήματα προς λήψη αποφάσεων.

Δ. Αξιολόγηση των ενδεχόμενων θετικών αποτελεσμάτων διαφόρων επιλογών πολιτικής με τη βοήθεια ενός πλαισίου ανάλυσης αποφάσεων και κατάρτιση σεναρίων για την εξέλιξη του κλίματος και τις σχετικές επιπτώσεις ως αποτέλεσμα της υλοποίησης επιλογών για τον έλεγχο των εκπομπών.

Το πλαίσιο θα χρησιμοποιηθεί για τον προσδιορισμό των πιθανών αποτελεσμάτων των εναλλακτικών επιλογών μείωσης των εκπομπών, και το χρονοδιάγραμμα εφαρμογής τους (σενάρια). Θα προσδιορίζει επίσης τις σχετικές πιθανότητες επίτευξης θετικών αποτελεσμάτων.

Ε. Προσδιορισμός και αξιολόγηση των μέτρων εφαρμογής που χρειάζονται στο πλαίσιο των διαφόρων σεναρίων που έχουν καταρτιστεί βάσει της προηγούμενης παραγράφου Δ.

Ακόμη και με την εφαρμογή πολιτικής ελέγχου των εκπομπών, παραμένουν κίνδυνοι που συνδέονται με τις παρελθούσες και τις μελλοντικές εκπομπές στην ατμόσφαιρα. Ως εκ τούτου, θα χρειαστεί να προσδιοριστούν μέτρα προσαρμογής (δηλ. μέτρα για την προστασία των ανθρώπων, της ιδιοκτησίας και της γεωργίας), για την αντιμετώπιση των κινδύνων αυτών. Θα προσδιοριστεί η έκταση και θα εντοπιστούν γεωγραφικά οι βασικοί παραμένοντες κίνδυνοι και θα αξιολογηθούν οι επιπτώσεις από πλευράς κόστους και χρόνου από τη λήψη διαφόρων μέτρων προσαρμογής. Τα μέτρα προσαρμογής θα χρειαστούν ιεράρχηση, ώστε να εξασφαλιστεί η μέγιστη δυνατή μείωση των παραμενόντων κινδύνων με τους διαθέσιμους πόρους, και ώστε η προσοχή να επικεντρωθεί σε βασικούς τομείς απουδαιότητας.

II. ΛΕΠΤΟΜΕΡΗΣ ΚΑΤΑΛΟΓΟΣ ΔΡΑΣΤΗΡΙΟΤΗΤΩΝ

Η υλοποίηση του προγράμματος αυτού θα απαιτήσει μεταξύ άλλων και τις ακόλουθες δραστηριότητες:

Α. Πρόβλεψη εκπομπών και επιλογές για τη μείωση των εκπομπών.

i Κατάρτιση προβλέψεων για τις εκπομπές κάθε αερίου θερμοκηπίου. Οι εκπομπές αυτές πρέπει να αναλύονται (α) κατά περιοχή (β) ανά πολιτικές, στρατηγικές και οικονομικές ομάδες.

ii Ο καθορισμός παραγόντων (εκτός της άσκησης ελέγχου) που είναι δυνατό να επηρεάσουν τις μελλοντικές εκπομπές. Εκτίμηση του κατά πόσο είναι πιθανοί και ανάπτυξη εναλλακτικών σεναρίων εκπομπών.

iii Καθορισμός των διαθέσιμων επιλογών ελέγχου των εκπομπών για κάθε αέριο θερμοκηπίου. Εκτίμηση της έκτασης των ενδεχόμενων μειώσεων στο πλαίσιο των διαφόρων σεναρίων εκπομπής.

Β. Εκτίμηση των επιπτώσεων των επιλογών ελέγχου των εκπομπών

i Αξιολόγηση της πρακτικότητας, του κόστους και του χρονοδιαγράμματος εφαρμογής για καθένα των μέτρων περιορισμού των εκπομπών.

ii Εκτίμηση των κοινωνικών και οικονομικών επιπτώσεων.

iii Εκτίμηση των επιπτώσεων από πλευράς κατανομής (α) σε μεμονωμένες χώρες, (β) μεταξύ χωρών, (γ) μεταξύ πολιτικών και στρατηγικών ομάδων.

Γ. Δημιουργία πλαισίου για τη συστηματοποίηση των πληροφοριών που προκύπτουν κατά τη διάρκεια του προγράμματος εργασίας

Το πλαίσιο πρέπει :

- να προβάλλει τις συνέπειες των εναλλακτικών μέτρων, συμπεριλαμβανομένων του κόστους και των ενδεχόμενων οφελών,

- να προβάλλει τις επιπτώσεις από τη λήψη μέτρων σε διαφορετικές χρονικές επιλογές,

- να προβάλλει την εγκυρότητα πιθανών αποφάσεων (για τις στρατηγικές ελέγχου ή τις στρατηγικές προσαρμογής), λαμβάνοντας υπόψη τις αβεβαιότητες όσον αφορά τις προβλέψεις και τα διαθέσιμα επιστημονικά δεδομένα,

- να προβάλλει την περαιτέρω έρευνα που απαιτείται για τη στήριξη των ληπτέων αποφάσεων.

Δ. Αξιολόγηση των στρατηγικών ελέγχου των εκπομπών

i Καθορισμός των πιθανών θετικών αποτελεσμάτων που θα προέκυπταν από τις στρατηγικές ελέγχου των εκπομπών. Το έργο αυτό θα απαιτήσει μία κριτική ανασκόπηση των μηχανισμών που συνδέουν τις συγκεντρώσεις αερίων θερμοκηπίων με την πλανητική θέρμανση, με ιδιαίτερη αναφορά σε συστήματα ανάδρασης, τα χρονοδιαγράμματα και τις επιπτώσεις για τα περιφερειακά κλίματα.

ii Με βάση την κριτική ανασκόπηση, προετοιμασία μιας εκτίμησης των πιθανοτήτων των εναλλακτικών προβλέψεων και των επιπτώσεών τους. Η εργασία αυτή πρέπει να συστηματοποιεί τις απόψεις των κυριότερων εμπειρογνωμόνων και να κρίνει τη σκοπιμότητα του συγκεκριμένου καθορισμού πιθανοτήτων που να αντανακλούν την αβεβαιότητα των διαφόρων σεναρίων.

iii Με βάση τις πληροφορίες αυτές, και τις πληροφορίες για τους περιορισμούς των εκπομπών (Α) και τις επιπτώσεις τους (Β), το πλαίσιο αποφάσεων που αναφέρεται στο σημείο Γ θα χρησιμοποιηθεί για να αξιολογηθούν το κόστος, τα οφέλη και οι άλλες επιπτώσεις των εναλλακτικών επιλογών ελέγχου των εκπομπών.

Ε. Αξιολόγηση των μέτρων προσαρμογής

i Ανασκόπηση των επιπτώσεων των διαφόρων επιπέδων θέρμανσης στην υποδομή και τον ανεφοδιασμό της Ευρώπης σε τρόφιμα· εντοπισμός άλλων βασικών επιπτώσεων. Αξιολόγηση των επιπτώσεων σε άλλες πολιτικές και οικονομικές ομάδες κρατών.

ii Ανασκόπηση των επιλογών για την αντιμετώπιση των ενδεχόμενων μεταβολών (i) στην Ευρώπη (π.χ. νέες καλλιέργειες, μεταβολή πρακτικών προγραμματισμού κλπ.).

iii Με βάση την αξιολόγηση υπό (Δ) και το πλαίσιο που αναφέρεται υπό (Γ), εκτίμηση του κόστους και των οφελών από εναλλακτικά μέτρα προσαρμογής· εκτίμηση των πιθανοτήτων να αποδειχθούν αποτελεσματικά τα εν λόγω μέτρα προσαρμογής, λαμβανομένων υπόψη των προβλεπόμενων επιπτώσεων.

III. ΚΑΤΕΥΘΥΝΤΗΡΙΕΣ ΓΡΑΜΜΕΣ ΓΙΑ ΤΗΝ ΥΛΟΠΟΙΗΣΗ ΤΟΥ ΠΡΟΓΡΑΜΜΑΤΟΣ

Α. Κατά την εκτέλεση του προγράμματος αυτού η Επιτροπή θα λάβει πλήρως υπόψη τις άλλες σχετικές δραστηριότητες, τόσο σε κοινοτική όσο και σε παγκόσμια κλίμακα, όπως:

- το ερευνητικό πρόγραμμα ΕΚ για την κλιματολογία και τους φυσικούς κινδύνους,

- τα αποτελέσματα πρόσφατων διεθνών συνεδρίων (όπως το συνέδριο για τη Μεταβαλλόμενη Ατμόσφαιρα, Τορόντο, Ιούνιος '88),

- την ομάδα εργασίας UNEP/WMO για τη μεταβολή του κλίματος,

κλπ.

Προς το σκοπό αυτό η Επιτροπή θα δημιουργήσει το κατάλληλο πλαίσιο συνεργασίας με τους αρμόδιους οργανισμούς που ενέχονται σε τέτοιες δραστηριότητες.

Β. Επικουρούμενη από την επιτροπή που αναφέρεται στο άρθρο 1 της απόφασης, η Επιτροπή θα καθορίσει τις διαδικασίες και τις συγκεκριμένες φάσεις του εν λόγω προγράμματος εργασίας, καθώς και τις πληροφορίες που θα πρέπει να παράσχουν τα κράτη μέλη.

Οι αρμόδιοι οργανισμοί και οι κυβερνητικές υπηρεσίες των κρατών μελών θα συνδεθούν με το πρόγραμμα εργασίας μέσω της ανωτέρω επιτροπής.

IV. Χρηματοδότηση του προγράμματος

Οι πόροι που υπολογίζονται ως αναγκαίοι για την εφαρμογή του προγράμματος ανέρχονται σε 6 εκατ. ECU.

Σχέδιο

Ψήφισμα του Συμβουλίου για το φαινόμενο θερμοκηπίου και την Κοινότητα

Το Συμβούλιο των Ευρωπαϊκών Κοινοτήτων,

Έχοντας υπόψη :

τη συνθήκη για την ίδρυση της Ευρωπαϊκής Οικονομικής Κοινότητας,

το σχέδιο ψηφίσματος που υπέβαλε η Επιτροπή,

Εκτιμώντας :

ότι η συνθήκη για την ίδρυση της Ευρωπαϊκής Οικονομικής Κοινότητας, όπως τροποποιήθηκε από την Ενιαία Ευρωπαϊκή Πράξη προβλέπει τη διαμόρφωση και εφαρμογή μιας κοινοτικής πολιτικής για το περιβάλλον και ότι η ίδια η συνθήκη προβλέπει επίσης ότι κατά την επεξεργασία της δράσης της στον τομέα αυτόν, η Κοινότητα λαμβάνει υπόψη τα διαθέσιμα επιστημονικά και τεχνικά δεδομένα και τα πλεονεκτήματα και τις επιβαρύνσεις που μπορούν να προκύψουν από τη δράση ή την απουσία δράσης,

ότι το παρόν ψήφισμα αντανακλά τις σκέψεις που διατυπώθηκαν στο ψήφισμα της 19ης Οκτωβρίου 1987 σχετικά με το πρόγραμμα δράσης των Ευρωπαϊκών Κοινοτήτων σε θέματα περιβάλλοντος (1) δηλαδή από τη σκοπιμότητα της ανάληψης δράσης σε κατάλληλο επίπεδο και την ανάγκη συντονισμού των δραστηριοτήτων σε διεθνές επίπεδο, της στάθμισης των πλεονεκτημάτων και επιβαρύνσεων των μελετώμενων ενεργειών και της κατάλληλης τεχνικής και πολιτικής προετοιμασίας της εν λόγω δράσης,

ότι τα διαθέσιμα επιστημονικά δεδομένα, και ειδικότερα τα αποτελέσματα από τα Κοινοτικά Προγράμματα Περιβαλλοντικής Έρευνας, δείχνουν ότι η σύνθεση της ατμόσφαιρας μεταβάλλεται σημαντικά από ανθρώπινες δραστηριότητες και, σύμφωνα με τα διαθέσιμα κλιματικά μοντέλα, το γεγονός αυτό μπορεί τελικά να συνεπιφέρει, μέσω του λεγόμενου "φαινομένου θερμοκηπίου", κλιματικές μεταβολές που συνεπάγονται σημαντικές επιπτώσεις στο περιβάλλον, στους ανθρώπους και τις δραστηριότητές τους,

ότι, δεδομένης της φύσης και του μεγέθους των κινδύνων που συνεπάγεται το φαινόμενο θερμοκηπίου είναι επείγον να εξεταστούν οι δυνατότητες δράσης με στόχο την πρόληψη ή των περιορισμό των κινδύνων αυτών,

(1) ΕΕ αριθ. C 328 της 7.12.1987, σ. 1.

ότι στα πρόσφατα διεθνή συνέδρια έχει επιτευχθεί ευρύτατη συναίνεση για την ανάγκη της επείγουσας εξέτασης μέτρων για τον περιορισμό των εκπομπών αερίων θερμοκηπίου,

ότι, δεδομένης της συνθετότητας του φαινομένου θερμοκηπίου και των πολυάριθμων και εκτεταμένων συνεπειών τόσο του εν λόγω φαινομένου όσο και των μέτρων πρόληψης και περιορισμού των επιπτώσεών του, απαιτείται προσεκτική εκ των προτέρων εξέταση των πιθανών επιλογών πολιτικής, η οποία θα έπρεπε να γίνει με κατάλληλες μεθοδολογίες, στις οποίες λαμβάνονται κυρίως υπόψη κατά τρόπο επαρκή οι αβεβαιότητες που παραμένουν όσον αφορά πολλές πλευρές του εν λόγω θέματος,

ότι έχει εξαιρετική σημασία το να μπορεί η Κοινότητα και τα κράτη μέλη της να συμβάλουν καθοριστικά στη διαμόρφωση και επεξεργασία των αποφάσεων πολιτικής που ενδεχομένως να ληφθούν στα κατάλληλα διεθνή πλαίσια προκειμένου να αναληφθούν οι αποτελεσματικότερες ενέργειες κατά των κινδύνων κλιματικών μεταβολών,

εγκρίνει την ανακοίνωση της Επιτροπής "το φαινόμενο θερμοκηπίου και η Κοινότητα" και υιοθετεί τα κυριότερα συμπεράσματα και συστάσεις της,

δηλώνει ότι η Κοινότητα οφείλει να δώσει μεγαλύτερη προσοχή στους κινδύνους ενδεχόμενων κλιματικών μεταβολών που συνεπάγεται το φαινόμενο θερμοκηπίου και οφείλει να συμβάλει ουσιαστικά στην προαγωγή του προβληματισμού και της συζήτησης γύρω από πιθανά μέτρα αντιμετώπισης των εν λόγω κινδύνων,

προσυπογράφει την πρωτοβουλία της Επιτροπής για την έναρξη προγράμματος εργασίας σχετικά με την αξιολόγηση των επιλογών πολιτικής για την αντιμετώπιση των κινδύνων που συνδέονται με το φαινόμενο θερμοκηπίου και εγκρίνει τους στόχους του προγράμματος αυτού,

καλεί τα κράτη μέλη να συνεργαστούν ενεργά με την Επιτροπή για την εκτέλεση του ανωτέρω προγράμματος εργασίας και να συντονίσουν στο πλαίσιο αυτό τις σχετικές δραστηριότητές τους όσον αφορά το φαινόμενο θερμοκηπίου,

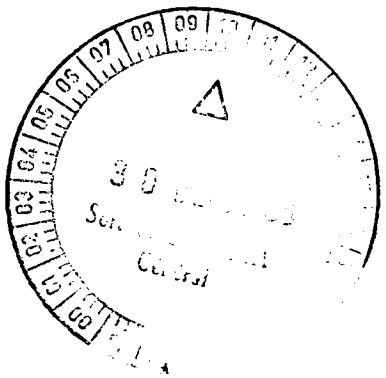
καλεί την Επιτροπή να υποβάλει στο Συμβούλιο και το Ευρωπαϊκό Κοινοβούλιο έκθεση στα μέσα του 1990 και, στα τέλη του 1991, τελική έκθεση για τα αποτελέσματα του εν λόγω προγράμματος εργασίας και τα προκύψαντα συμπεράσματα.

COMISIÓN DE LAS COMUNIDADES EUROPEAS

COM (88) 656 Filan

Comunicación de la Comisión al Consejo

"EL PROBLEMA DEL EFECTO INVERNADERO Y LA COMUNIDAD"



Comunicación de la Comisión al Consejo

"EL PROBLEMA DEL EFECTO INVERNADERO Y LA COMUNIDAD"

ÍNDICE

RESUMEN EJECUTIVO Y CONCLUSIONES

A. RESUMEN

A.1. Introducción

El 19 de julio de 1988, la Comisión decidió crear un grupo formado por personas de distintos servicios para que presentase, a mediados de noviembre del mismo año, un conjunto de ideas preliminares acerca de posibles medidas comunitarias contra el efecto invernadero.

El objetivo del presente documento, basado en el trabajo de dicho grupo, es ofrecer una visión general del tema y presentar sus conclusiones y recomendaciones referentes al trabajo que se ha de emprender inmediatamente, a las medidas que hay que adoptar urgentemente y al papel que puede desempeñar la Comunidad en el debate internacional de un tema tan complejo.

A.2. El efecto invernadero

A.2.1. Las condiciones climáticas actuales de la Tierra vienen determinadas en gran proporción por la composición de la atmósfera. El vapor de agua, el dióxido de carbono (CO_2), el metano (CH_4), el óxido nitroso (N_2O), el ozono (O_3), y, desde hace poco, los CFC (clorofluorocarbonos), absorben parte de los rayos infrarrojos que emite la Tierra para compensar los que recibe del sol y los almacenan en la atmósfera.

A.2.2. El hombre está alterando la composición de la atmósfera a un ritmo sin precedentes. La concentración de los llamados "gases de invernadero" está aumentando debido a la interferencia de la actividad humana en los ciclos biogeoquímicos de dichas sustancias. La envergadura de estas alteraciones es tal que puede suponer importantes cambios climáticos.

Actualmente sabemos que el equilibrio térmico de la Tierra está siendo modificado, lo que va a producir un fenómeno de calentamiento y posiblemente cambios climáticos relacionados con el mismo, según la importancia de esta alteración.

A.2.3. El gas de invernadero más abundante es el CO_2, emitido sobre todo por la combustión de combustibles fósiles (5 gigatoneladas* de carbono al año), de madera y por la descomposición de la biomasa forestal producida por la despoblación forestal (entre 0,5 y 2 gigatoneladas de carbono al año).

El CO_2 es, en efecto, la causa de más del 50% del efecto invernadero. Otro 25% del fenómeno se puede atribuir a los CFC empleados en múltiples usos como aerosoles, aire acondicionado, disolventes, material de embalaje y empaquetado, etc. El resto se le puede achacar al metano (CH_4) procedente del ganado, campos de arroz, explotaciones de gas natural, combustión inadecuada de biomasa y carbón; al óxido nitroso (N_2O) producido por la combustión de combustibles fósiles y por los abonos nitrogenados y al ozono troposférico procedente de los procesos fotoquímicos de la atmósfera contaminada. Las emisiones de "gases de invernadero" han registrado un aumento considerable durante las últimas décadas.

A.2.4. Si nos fijamos en la evolución de los tipos climáticos mundiales, podemos deducir que la Tierra va a ser sometida a un ascenso de las temperaturas medias de superficie que oscilará entre 1,5 y 4,5° C, debido a la duplicación del equivalente de la concentración de gases de invernadero en la era pre-industrial. Al ritmo actual, se espera que este fenómeno se desencadene antes del año 2050.

A.2.5. Los patrones climáticos actuales no pueden ofrecer una evidencia clara y fidedigna de las posibles alteraciones climáticas derivadas del ya mencionado aumento de las temperaturas de la superficie de la Tierra. Según estimaciones aproximadas, el aumento de temperatura en Europa podría ser superior a la media mundial.

A.2.6. Las repercusiones indirectas de tales cambios climáticos se podrían resumir del modo siguiente:

- subida del nivel del mar (entre 30 cm y 4,5 m. correspondientes a un calentamiento entre 1,5 y 4,5° C);
- disminución de la cantidad de hielo marino;
- disminución de los recursos acuáticos en algunas zonas;
- alteraciones de la productividad agraria;
- repercusiones en la salud humana y en los sistemas ecológicos.

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* Gigatonelada = 10^9 t = 1.000 millones de toneladas.

A.3. El contexto internacional. Perspectivas

A.3.1. En la "Conferencia Internacional sobre la evaluación del papel del CO_2 y otros gases de invernadero en las alteraciones climáticas y sus repercusiones" (Villach, 9 a 15 de octubre de 1985) se alcanzó un consenso científico acerca de los hechos básicos del efecto invernadero.

A.3.2. Las conclusiones de la Conferencia de Villach se ampliaron en un simposio de la CEE que se celebró en Bruselas (del 3 al 5 de noviembre de 1986): "El CO_2 y otros gases de invernadero: repercusiones climáticas y derivadas", y en un seminario en Bellagio (9 al 13 de noviembre de 1987): "Estrategias de adaptación a los cambios climáticos".

A.3.3. También la Comisión Brundtland incluyó el tema en su programa de trabajo. De acuerdo con sus recomendaciones se celebró en Toronto, del 27 al 30 de junio, una "Conferencia mundial sobre los cambios en la atmósfera y sus consecuencias para la seguridad mundial". En ella se aconsejaron, entre otras, las siguientes medidas:

- Ratificar el Protocolo de Montreal sobre sustancias que destruyen la capa de ozono. El Protocolo debería ser revisado en 1990 para garantizar la eliminación casi total de las emisiones de CFC totalmente halogenados para el año 2000;
- Adoptar políticas energéticas que tiendan a reducir las emisiones de CO_2 y de otros gases traza para disminuir el riesgo de calentamiento de la tierra;
- De aquí al año 2005, un objetivo de alcance mundial de los países industrializados debería ser reducir aproximadamente un 20% de las emisiones de CO_2 y de otros gases de invernadero.
- Empezar los preparativos para una convención mundial.
- Crear un Fondo Mundial de la Atmósfera.

A.3.4. Uno de los resultados a corto plazo de estas actividades internacionales es el posible inicio del proceso de preparación, ya en 1989, de un acuerdo sobre el efecto invernadero que puede incluir protocolos para limitar las emisiones de gases de invernadero.

A.3.5. Entre los próximos acontecimientos que van a desembocar en dicho acuerdo, hay que mencionar sobre todo:

- el seminario internacional sobre derecho y política que se ha de celebrar en Ottawa a principios de 1989;
- una conferencia política de alto nivel, que será organizada en el otoño de 1989 por el Ministerio de Medio Ambiente de los Países Bajos;
- la Segunda Conferencia Mundial del Clima (Ginebra, junio de 1990);
- la Conferencia Intergubernamental de Desarrollo en 1992, que puede ser el acontecimiento culminante.

A.4. Posibles medidas

A.4.1. Las medidas para luchar contra el efecto invernadero deben revestir carácter preventivo y/o de adaptación.

A.4.2. Medidas preventivas son aquéllas que tratan de frenar las emisiones de gases de invernadero para así reducir los efectos previstos.

En el caso del CO_2, los sectores en los que hay que actuar con prioridad son el energético y la silvicultura en las zonas tropicales.

Algunos ejemplos de medidas en el sector energético que pueden contribuir a limitar las emisiones de CO_2:

- aumentar el rendimiento energético (tanto en la vertiente de la oferta como en la de la demanda);
- pasar a utilizar combustibles que contengan menos carbono (por ejemplo, gas natural en lugar de carbón);
- fomentar el uso de fuentes de energía renovables y el uso rentable de biomasa;
- fomentar el uso de energía nuclear segura.

El impulso a las nuevas tecnologías de la energía como apoyo de estas medidas reviste una especial importancia.

A largo plazo, los sitemas energéticos no basados en el carbono pueden contribuir significativamente a frenar las emisiones de CO_2.

Está claro que no todas las medidas mencionadas tienen el mismo grado de eficacia; además, es preciso calcular su viabilidad económica.

Las medidas en el ámbito de la silvicultura deberían orientarse a contrarrestar las actuales tendencias de despoblación forestal, concretamente en las zonas tropicales. Esto supondría fomentar el uso de sustitutos de la madera, combustible de primer orden en dichas zonas, e impulsar prácticas agrícolas racionales, para que la expansión agrícola no implique la quema de grandes extensiones para obtener terrenos de cultivo.

A.4.3. Es más difícil dictar medidas para reducir las emisiones de gases de invernadero como el CH_4 y el N_2O, debido a la falta de conocimientos en lo referente a la emisión de estas sustancias.

Sería necesario introducir medidas como las siguientes:

- reducir al mínimo las pérdidas de CH_4 durante la extracción, el transporte y el uso de gas natural;
- reducir al mínimo las emisiones de CH_4 de los vertederos;
- reducir al mínimo las pérdidas de N_2O durante la combustión de combustibles sólidos;
- estudiar la posibilidad de mejorar las técnicas de gestión del ganado, de los campos de arroz y de las zonas pantanosas, para reducir las emisiones de CH_4;
- estudiar la posibilidad de racionalizar el uso de abonos para reducir las emisiones de N_2O procedentes de los abonos nitrogenados.

A.4.4. En lo que respecta a los CFC, debería ser viable la total eliminación de las emisiones de CFC para el año 2000, limitando su producción, recuperando, reciclando o destruyendo los CFC contenidos en productos ya existentes.

A.4.5. Pueden ser necesarias ciertas medidas de adaptación (las destinadas a prevenir o a paliar los perjuicios causados por los cambios climáticos y los efectos derivados de los mismos) para hacer frente a situaciones que resulten inevitables a pesar de las medidas preventivas.

A estas alturas no es posible precisar qué medidas de adaptación serán necesarias en la Comunidad debido a la falta de una evaluación local fidedigna de las posibles repercusiones.

En general, las medidas de adaptación relativas a la subida del nivel del mar constarán de: construcción de barreras contra las mareas y las inundaciones, programas nacionales de seguros contra inundaciones, construcción de pantanos (para combatir el aumento de la salinidad), abandono de zonas desarrolladas situadas en terrenos bajos, nueva ubicación de las poblaciones en lugares no expuestos a riesgos y protección de los ecosistemas costeros.

Es necesario profundizar más en las investigaciones para establecer posibles medidas en otros sectores como la agricultura y la silvicultura.

B. CONCLUSIONES SOBRE EL ESTADO DE LOS CONOCIMIENTOS ACERCA DE LA PROBLEMÁTICA DEL EFECTO INVERNADERO

B.1. Las actividades del ser humano están alterando de modo significativo la composición de la atmósfera terrestre.

Basándose en la evolución de los tipos climáticos mundiales, los científicos han llegado a la conclusión de que si se dobla el equivalente de la concentración atmosférica de CO_2, se producirá un aumento de la temperatura media de la superficie que oscilará entre 1,5 y 4,5°C. Este fenómeno puede suceder a mediados del próximo siglo.

Si nos fiamos de los datos climáticos, el resultado del cambio en las condiciones climáticas medias mundiales quedará "fuera de la gama de climas que ha existido durante el pasado histórico y durante las eras geológicas recientes".

B.2. En este momento, no se pueden calcular exactamente las distintas repercusiones de estas alteraciones climáticas y sus consecuencias socio-económicas. Sin embargo, todas las investigaciones incipientes realizadas al respecto revelan la existencia de riesgos alarmantes y de unas posibles consecuencias directas e indirectas muy perjudiciales.

B.3. En los recientes encuentros internacionales se le ha otorgado un carácter urgente al debate mundial del problema. Ha quedado muy claro que ha llegado el momento de poner en práctica soluciones viables al tiempo que se acelera el ritmo de las investigaciones.

C. CONCLUSIONES DE LA COMISIÓN

C.0. A continuación se resumen las principales conclusiones de este informe. En el capítulo IV de este documento se ofrece una descripción más detallada de las mismas.

C.1. La Comunidad debería aplicar el Convenio de Viena para la protección de la capa de ozono y el Protocolo de Montreal sobre sustancias que destruyen la capa de ozono, además de participar de forma activa en la negociación de dicho Protocolo.

C.2. La Comunidad debería impulsar el inicio de debates sobre la posibilidad de un acuerdo internacional para la futura protección de la atmósfera. Debería hallarse en condiciones de contribuir de modo significativo a la preparación y a la negociación de un acuerdo de tales características que podría fijar objetivos precisos para limitar las emisiones de gases de invernadero y establecer medidas y programas de reducción de las mismas.

C.3. Por lo tanto, la Comunidad va a tomar la iniciativa de lanzar un programa intensivo de estudio de las posibilidades existentes donde se evalue la viabilidad, los costes y los posibles resultados de las distintas medidas para limitar las emisiones de gases de invernadero.

El programa debería constar de varias partes esenciales:

- creación y evaluación técnica de medidas y tecnologías destinadas a disminuir las emisiones de gases de invernadero;

- análisis de las repercusiones económicas, industriales, sociales e institucionales de dichas medidas y tecnologías;

- esquemas de actuación, estructuración y evaluación especialmente referidos a los posibles objetivos estratégicos para fijar un tope a la emisión de CO_2.

- marco de análisis de decisiones;

- crear y ponderar medidas de adaptación.

C.4. La Comunidad y sus Estados miembros deberían, a partir de ahora, incorporar a sus políticas (energéticas o de cualquier otro sector relacionado con este tema) el problema de los posibles cambios climáticos producidos por el efecto invernadero. Un enfoque preventivo del asunto puede evitar costes más elevados en el futuro.

C.5. Se deberían tomar más decisiones urgentes para reforzar y aumentar los esfuerzos ya existentes para ahorrar energía, mejorar el rendimiento energético, desarrollar nuevas fuentes de energía e investigar en el campo de la tecnología nuclear segura.

Debería dársele un carácter prioritario al rápido desarrollo y al fomento de técnicas comerciales innovadoras en estos sectores.

No cabe duda de que tales medidas están más que justificadas debido a las necesidades energéticas y medioambientales, a pesar de la falta de conocimientos que aún rodea a algunos aspectos científicos del fenómeno.

La posibilidad de valorar las mejoras del rendimiento energético en lo que se refiere a la disminución del CO_2 resulta especialmente importante.

C.6. La Comunidad debería apoyar programas intensivos de investigación de todos los aspectos relacionados con el efecto de invernadero y lanzar nuevas tecnologías energéticas capaces de reducir las emisiones de CO_2.

I. AN INTRODUCTION TO THE GREENHOUSE ISSUE

What the "greenhouse effect" is in short

1. The climate conditions we experience on earth are due, among other things, to the presence of the atmosphere around it and to its present composition. Without the atmosphere, the average surface temperature of the earth, which is presently of around 15°C, would be as low as -18°C.

   In fact, the heat balance of the earth, which receives radiation from the sun and reflects or re-emits it into the space, is largely governed by the composition of the atmosphere.

   Firstly water vapour, mostly concentrated in the lower atmosphere, is an effective absorber of both incoming solar and outgoing infrared earth's radiation and contributes very significantly to determine the average surface temperature of the earth.
   Moreover, other substances such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs) have the property of being nearly transparent to incoming radiation from the sun but to retain some of the energy re-emitted by the earth as long wavelenght infra-red radiation.

   Ozone also contributes to the absorption of infra-red radiation emitted by the earth.(1)
   The overall outcome of this mechanism is that part of the radiant energy coming from the sun is trapped in the lower atmosphere.

2. The present scientific knowledge allows us to conclude that any significant change in the atmospheric concentrations of the above mentioned substances would result in a change of the global thermal balance of the earth.

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(1) Stratospheric ozone (the "ozone layer") is a strong absorber of ultraviolet radiation from the sun. Moreover ozone contributes to the absorption of infrared radiation from the earth. Tropospheric ozone contributes therefore to trap heat in the lower atmosphere. Any change in the vertical distribution of ozone would contribute to affect the thermal balance of the earth.

In particular an increase in the atmospheric concentrations of CO_2, CFCs, CH_4, N_2O, tropospheric ozone, which are often called "greenhouse gases", would result in more heat to be trapped in the lower troposphere and then in some warming and possible associated climate changes depending on the size of such greenhouse gases concentration increase. This phenomenon is usually referred to as the "greenhouse effect" because its basic mechanism is similar to that in a greenhouse where incoming radiation energy from the sun is partly transformed to infrared radiation by the ground, warms the air and is then retained by the glass from escaping again.

Greenhouse gases : emission sources and atmospheric concentration trends

3. The atmospheric concentrations of all most important greenhouse gases have increased over recent times and are still increasing.

4. In case of carbon dioxide (CO_2) :

   a. Emission sources :

   Most of anthropogenic CO_2 emissions are due to fossil fuels burning (around 5 Gtons* of carbon per year). Moreover a significant contribution comes from burning of wood and decomposition of biomass related to deforestation (uncertain quantity, most likely in the range 0,5 - 2 Gtons of carbon per year corresponding to a rate of deforestation in the tropical regions of 10 to 20 millions ha/y).

   CO_2 world yearly emissions from burning of fossil fuels have increased in 25 years, since 1960, from around 2,5 Gt of carbon to more than 5 Gt of carbon in 1985.

   Coal and oil give by now an almost equal contribution to emission with slightly more than 2 Gt of carbon each, followed by gas with less than 1 Gt of carbon per year.

   It is estimated that since one century, around 170 Gt of carbon have been emitted, of which around 100 Gt in the last 25 years.

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* 1 Gton = 10^9 tons = 1000 million tons

The share of CO_2 emissions per year from fossil fuels for different parts of the world and its recent evolution is showed in the following table :

CO_2 emissions in million tons of carbon/y
and as % of world total

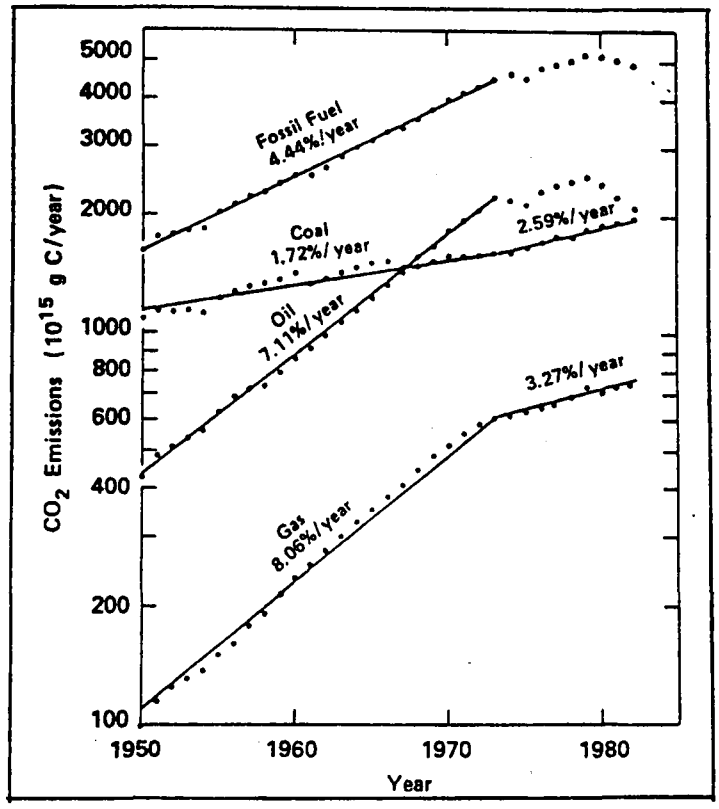
	1950		1965		1980	
Region	Mt/y*	%	Mt/y*	%	Mt/y*	%
North America	723	44,7	1003	32,1	1380	26,7
URSS and Eastern Europe	291	18,0	750	24,0	1251	24,2
China	23	1,4	178	5,7	439	8,5
Western Europe	379	23,4	643	20,6	853	16,5
Japan, Australia	45	2,8	137	4,4	300	5,8
Developing Countries	92	5,7	250	8,0	631	12,2
Others (worldwide gas flaring, bunkers)	63	3,9	163	5,2	310	6,0
World total	1618	100	3126	100	5170	100

Source : "Atmosphere carbon dioxide and the global carbon cycle"
US DOE/ER-0239, edited by J.R. Trabalka, Dec. 1985

* absolute figures are rounded to next million ton.

The figures above show the dramatic increase of CO_2 emissions in all regions of the world from 1950 to 1980.
The share of the total world emissions of China and developing countries has significantly increased in the same period due i.a. to the demographic trends in these regions.

The trends of CO_2 world emission from different fossil fuels for the period 1950-1982 are shown in next figure. (source : US DOE/ER-0239 report referred to above) :



The steep increase of yearly CO_2 emissions from oil and natural gas has been slowed down or even reversed after the first oil crisis, thus reflecting the worldwide energy policy efforts to restrict the use of oil, by improvements in energy efficiency and an increased use of nuclear energy and/or solid fuels. Consequently CO_2 emissions from coal have increased after the first oil shock, from a yearly rate of 1,72% to 2,59% up to 1982.

Emission data for 1985 show the following contribution from various fossil fuels :

Fuel	1985 CO_2 emissions in million tons carbon/y
gas	807
oil	2189
coal	2181
gas flaring	52
Total	5229

Source : I. Mintzer, WRI, 1988

Per capita CO_2 emissions from fossil fuels for different countries are shown in the following table, referred to 1982 :

Country	Per capita CO_2 emissions (tons of carbon per inhabitant)
United States	4,9
German Dem. Rep.	4,9
Canada	4,4
Czechoslovakia	4,1
Australia	3,9
Soviet Union	3,3
Poland	3,0
Belgium	3,0
Germany, Fed. Rep.	2,9
United Kingdom	2,5
Netherlands	2,5
France	2,0
Japan	1,9
Italy	1,5
Spain	1,4
China	0,5
Brazil	0,3
India	0,1
World average	1,0

Calculated from : Smith, I.M. (1988) : CO_2 and climate change; Draft technical review, EIA Coal Research, London, and UN statistical data

b. Atmospheric concentrations trends :

Since 1960 to 1985 the average yearly atmospheric concentration of CO_2 has increased from 315 to 345 ppm.*
There is evidence that the pre-industrial concentration of this gas was around 275-285 ppm. The rate of concentration increase for CO_2 has accelerated in recent years : it was an average of 1 ppm per year in the 70ties and is by now about 1,5 ppm per year.

---

* 1 ppm = part per million = 0,0001%

CO_2 concentration increase is determined by the effect of manmade emissions, mostly due to fossil fuel burning and deforestation, on the global carbon cycle : natural carbon sinks (mainly the oceans and vegetation) are no longer sufficient to balance such increasing emissions and this leads to more CO_2 stored in the atmosphere.

5. In case of chlorofluorocarbons (CFC's) :

a. Emissions sources :

CFC's are man-made chemicals used in a variety of applications such as aerosol spray cans, air conditioning, refrigerators, solvents, packaging, etc.

b. Atmospheric concentration trends

The atmospheric concentration of CFC-11 and CFC-12 at four sites widely dispersed in the world ranged from 0,21 to 0,23 ppb* and 0,37 to 0,39 ppb respectively in 1985.

Even if the present atmospheric concentration of these substances is by several orders of magnitude lower than that of CO_2, one has to note that the rate of growth of such concentration has been much higher than that of CO_2, around 5-7% per year, the efficiency in trapping heat of some of them is 10,000 higher than CO_2' on a molecule by molecule basis and the residence time in the atmosphere of some of these substances is extremely long (up to more than 100 years).

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* 1 ppb = part per billion = 0,0000001%

6. In case of methane (CH_4) :

a. Emission sources :

Present man-made emissions of CH_4 come mainly from livestock, rice paddy fields, natural gas exploitation, burning of biomass and coal. Natural emissions from biota are also relevant and the overall CH_4 cycle is not well known.

Rough estimates give the following emission levels for the various sources (expressed in million tons; the range indicated in brackets shows the dispersion of estimates made by various authors) :

Natural Sources (million tons per year) :

Enteric fermentation (wild animals)	5 (+/- 3)
Wetlands (swamps, etc.)	110 (+/- 50)
Lakes	4 (+/- 2)
Tundra	3 (+/- 2)
Oceans	10 (+/- 3)
Termites and other insects	25 (+/- 20)
Other	40 (+/- 40)

Man-Made Sources (million tons per year) :

Enteric fermentation (cattle, etc.)	75 (+/- 35)
Rice paddies	70 (+/- 30)
Biomass burning	70 (+/- 40)
Natural gas and mining losses	50 (+/- 25)
Solid Waste	30 (+/- 30)

(Source : US Dept. of Energy - "A Primer on Greenhouse Gases" - DOE/NBB0083 - March 88.)

b. Atmospheric concentration trends :

Atmospheric concentration of CH_4 has increased since old times (from 0,7 ppm before 1700 A.D. to 1,54 and 1,68 ppm in the southern and northern hemisphere respectively, in 1983). Average yearly increase over 30 years from 1951 to 1981 has been of 1,1%.

7. In case of nitrous oxide (N_2O) :

a. Emission sources :

Man-made emissions of N_2O are mainly due to combustion of fossil fuels and biomass. Agricultural soils (both natural and fertilized) seem also to give a significant contribution.
Natural emissions are due to terrestrial and ocean biota.

Again the quantitative evaluation of emissions from various sources is most difficult. It is estimated that the overall emissions are as follows (expressed in million tons; the range indicated in brackets shows the dispersion of estimates made by various authors) :

Natural Sources (million tons of N per year) :

Oceans and estuaries	2.0 (+/- 1.0)
Natural soils	6.5 (+/- 3.5)

Man-Made Sources (million tons of N per year) :

Fossil fuel combustion	4.0 (+/- 1.0)
Biomass burning	0.7 (+/- 0.2)
Fertilized soils	0.8 (+/- 0.2)
Cultivated natural soils	1.5 (+/- 0.5)

(Source : US Dept. of Energy - "A Primer on Greenhouse Gases" - DOE/NBB0083 - March 88.)

b. Atmospheric concentration trends :

N_2O atmospheric concentration has increased from a pre-industrial 290 ppb to about 300 ppb in 1985. The present rate of increase is around 0,25% per year.

8. It is to be underlined that the present increase in concentration of greenhouse gases is due to the interference of human activities with the natural cycles. Yet there are significant uncertainties concerning the quantitative relationships between emissions of greenhouse gases and the observed increase of their atmospheric concentrations.

9. Moreover it is not possible at this stage to give reliable forecasts of future emission trends because of the wide range of factors influencing those trends. However scenarios may be developed using different assumptions.

10. It is reasonable to expect further and accelerating increase in the atmospheric concentrations of some greenhouse gases over the next 50 years.

Potential climate consequences of increasing greenhouse gases concentrations

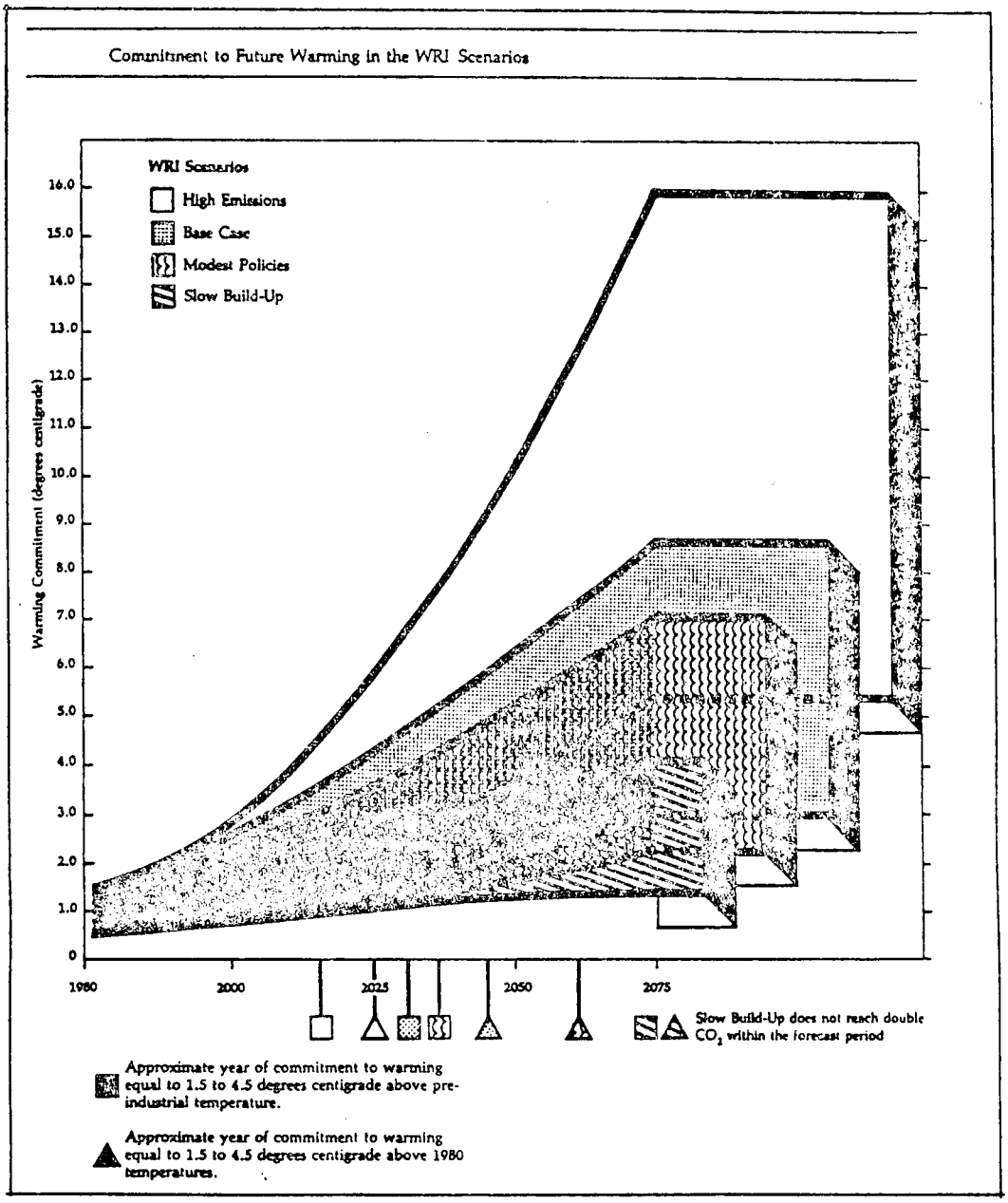
11. The observed and the expected increases in atmospheric concentrations of greenhouse gases (and then the increase in the heat quantity which is trapped in the lower atmosphere) undoubtedly will result in some warming and possible associated climate changes.
However, very significant uncertainties subsist about the shape and the rate of such climate changes and in particular about the degree of the warming and its timing.
From this point of view, uncertainties about the potential role of climatic feedbacks due to clouds, vegetation etc. are particularly relevant.
It is estimated that the different greenhouse gases contribute at present to the overall greenhouse forcing roughly in the following proportion : 55% for CO_2, 25% for CFC's, 20% for CH_4, N_2O and O_3 together.

The possible development of the overall greenhouse effect of the above mentioned gases until the year 2075 has been tentatively evaluated by the World Resources Institute in terms of forecasts for the average warming commitment with reference to 4 scenarios encompassing hypotheses about future developments from "do nothing" and high growth to voluntaristic emission reduction policies.

The hypotheses on which this exercise has been based are presented at page 23.
It should be underlined that it has not been taken account here of the likely positive consequences of the recent Montreal protocol on CFC's. The WRI study gives only a very limited role to nuclear energy in all scenarios. In none of the scenarios mentioned, the share of nuclear in total primary energy supply exceeds 4.5% by 2025. In other studies this share is much higher, for example, IIASA = 23%, WEC (83) = 13%, Goldenberg = 7%, Edmons = 19%. The Commission's own energy 2000 study sees the share of nuclear in world energy supplies as follows : 1983 = 3.3%, 1990 = 5.4%, 2000 = 7.1%. Environmental costs for nuclear range from $7.5 to $10/GJ whereas those for coal are between $0.15 and $1.20/GJ. In the case of oil $0.00 to $0.75/GJ. No environmental cost is assigned to renewable energies.

This model as any other one suffers from both structural and input data limitations. However the usefulness of such models is to help structuring the policy debate on such a complex issue and to identify critical areas for further research and study.

The results are summarized in next figure.

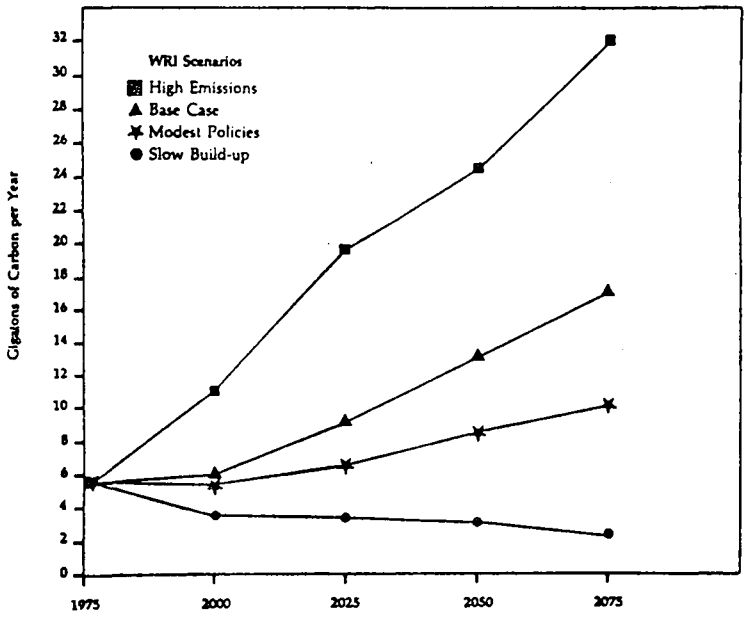


Source : Mintzer I.M. (1987); "A Matter of Degrees,
WRI, Washington DC, USA

Energy Policies in the WRI Scenarios

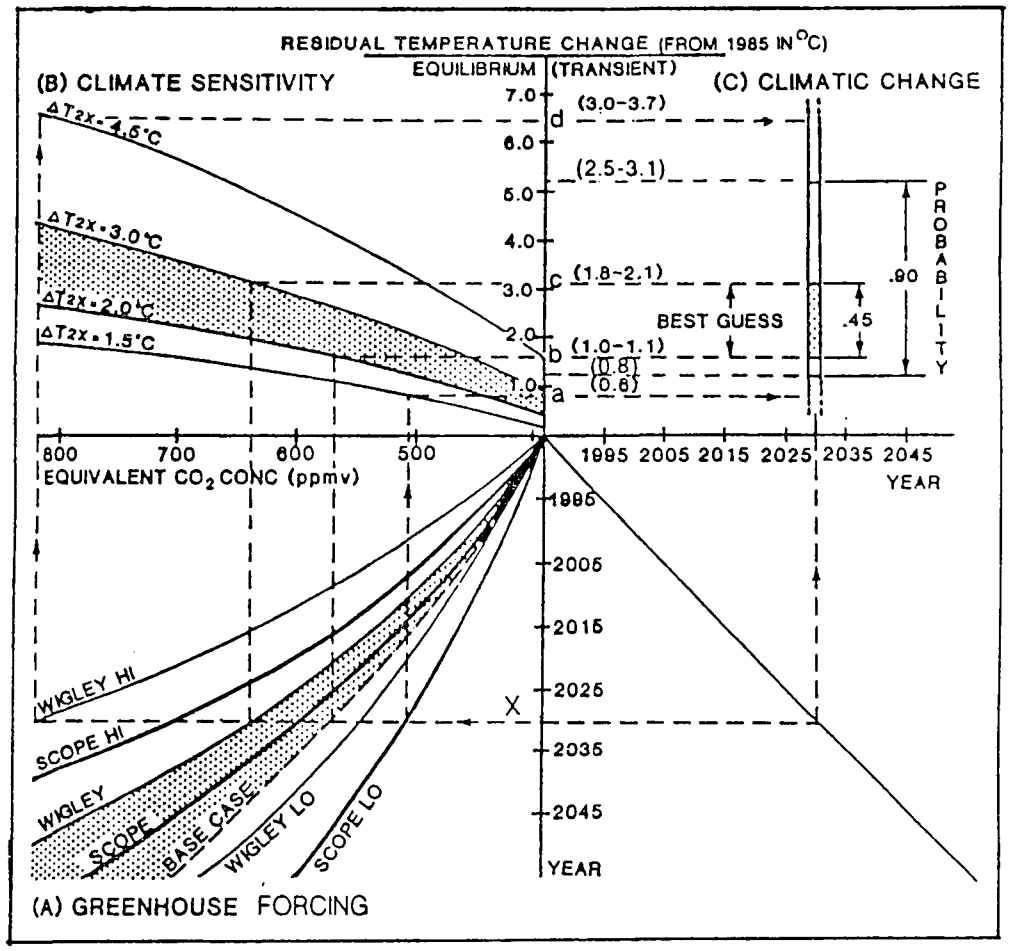
	Related Energy Model Parameter Value
Base Case Scenario	
• "Business-As-Usual," the inertial model of growth and change in the world energy industry	
• No policies to slow carbon dioxide emissions	
• Minimal stimulus to improve end-use efficiency	(Rate of change = 0.8% per year)
• Modest stimulus for synfuels development	(Final Price = $3.15-$4.25 per GJ in 2005)
• Minimal stimulus for development of solar energy systems	(Final Price = $16.50 per GJ in 2025)
• No policy to limit tropical deforestation or to encourage reforestation	
• Minimal environmental costs included in price of energy	($0.30 per GJ for coal; $1.00 per GJ for synfuels)
High Emissions Scenario	
• Accelerated growth in energy use is encouraged	
• No policies to slow carbon dioxide emissions	
• No stimulus to improve end-use efficiency	(Rate of change = 0.2% per year)
• Modest stimulus for increased use of coal	(Rate of improvement = 0.75% per year)
• Strong stimulus for synfuels development	(Final Price = $2.75-$3.50 per GJ in 1995)
• No stimulus for development of solar energy systems	(Final Price = $20 per GJ in 2040)
• Rapid deforestation and conversion of marginal lands to agriculture	
• Token environmental costs included in price of energy	($0.15 per GJ for coal; $0.50 per GJ for synfuels)
Modest Policies Scenario	
• Strong stimulus for improved end-use efficiency	(Rate of change = 1.0% per year)
• Modest stimulus for solar energy	(Final price = $15.00 per GJ in 2025)
• Substantial efforts at tropical reforestation and ecosystem protection; more intensive rather than extensive agriculture encouraged	
• Substantial environmental costs imposed on energy prices to discourage solid fuel use and encourage fuel-switching	($0.60 per GJ for coal; $1.50 per GJ for synfuels)
Slow Build-up Scenario	
• Strong emphasis placed on improving energy efficiency	(Rate of improvement = 1.5% per year)
• Rapid introduction of solar energy encouraged	(Final Price = $12.00 per GJ in 2000)
• Major global commitment to reforestation and ecosystem protection	
• High environmental costs imposed on energy prices to discourage solid fuel use and encourage fuel-switching	($1.20 per GJ for coal; $3.00 per GJ for synfuels)

Total Emissions of CO_2 in the WRI Scenarios (Gigatons of Carbon per Year)



By a different approach, Dr. R.A. Warrich of the Climatic Resarch Unit of the University of East Anglia in Norwich - UK, has recently tried to link emission forecasts and likely climatic changes and to assign probabilities to the possible outcome.

The results of this exercise are summarized in the following graph :



Legend :

- WIGLEY, SCOPE, BASE CASE indicate projections of greenhouse gases emissions
- T2X is the climate sensitivity expressed as equilibrium temperature increase due to a doubling of the equivalent CO_2 concentration
- "transient temperature" is the temperature increase at a given date due to the greenhouse forcing
- "equilibrium temperature" is the warming to which earth would have been committed at a given date due to the greenhouse effect.

The following conclusions i.a. have been drown by the author of the above mentioned evaluation :

"- Given the range of scientific uncertainties, the warming to which we will be committed in 2030 is 0.8-6.4°C. The chance of falling outside this range is less than 1%.

- The "best-guess" range is 1.5-3.1°C warmer than today. The probability of warming within this range is 45%.

- The 90% confidence interval is 1.1-5.1°C. This median value - the best guess - is 2.8°C."

12. The presently available climate models predict (with various degrees of uncertainties) the following climate and associated impacts[1] :

- **Global-Mean Surface Warming** (very probable). For a doubling of atmospheric carbon dioxide (or its radiative equivalent from all of the greenhouse gases), the long-term global-mean surface warming is expected to be in the range of 1.5 to 4.5°C. The most significant uncertainty arises from the effects of clouds. Of course, the actual rate of warming over the next century will be governed by the growth rate of greenhouse gases, natural fluctuations in the climate system, and the detailed response of the slowly responding parts of the climate system, i.e., oceans and glacial ice.

- **Global-Mean Precipitation Increase** (very probable). Increased heating of the surface will lead to increased evaporation and, therefore, to greater global mean precipitation. Despite this increase in global average precipitation, some individual regions might well experience decreases in rainfall.

- **Polar Winter Surface Warming** (very probable). As the sea ice boundary is shifted poleward, the models predict a dramatically enhanced surface warming in winter polar regions. The greater fraction of open water and thinner sea ice will probably lead to warming of the polar surface air by as much as 3 times the global mean warming.

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(1) Source : NRC (1987); Current Issues in Climate Change, National Research Council, Washington DC, USA.

- **Summer Continental Dryness/Warming** (likely in the long term). Several studies have predicted a marked long-term drying of the soil moisture over some mid-latitude interior continental regions during summer. This dryness is mainly caused by an earlier termination of snowmelt and rainy periods, and an earlier onset of the spring-to-summer reduction of soil wetness. Of course, these simulations of long-term equilibrium conditions may not offer a reliable guide to trends over the next few decades of changing atmospheric composition and changing climate.

- **High-Latitude Precipitation Increase** (probable). As the climate warms, the increased poleward penetration of warm, moist air should increase the average annual precipitation in high latitudes.

To complete the picture of expected direct effects, it is worth mentioning also a :

- **Large Stratospheric Cooling** (virtually certain). Reduced ozone concentrations in the upper stratosphere will lead to reduced absorption of solar ultraviolet radiation and therefore less heating. Increases in the stratospheric concentration of carbon dioxide and other radiatively active trace gases will increase the radiation of heat from the stratosphere. The combination of decreased heating and increased cooling will lead to a major lowering of temperatures in the upper stratosphere.

This last effect seems quite important as a possible efficient and rapid "finger-print" of the greenhouse effect given that "the expected changes in the upper stratosphere are nearly of an order of magnitude greater than the expected surface changes and that they are not affected by the ocean thermal inertia and by cloud feedback effects (processes which are a source of considerable uncertainty in assessing tropospheric climate change)" (WMO, 1985).

13. It is worth stressing again that uncertainties on the shape, on the regional distribution and on the rate of such changes should not hide the fact that observed and expected increase in greenhouse gases atmospheric concentrations <u>will</u> modify the thermal balance of the earth and therefore <u>will</u> bring some warming and possible associated climate modification.

As it was put as a conclusion at a symposium on "CO_2 and other greenhouse gases : climatic and associated impact" organized by the Commission on 3 to 5 November 1986 :

"- Although quantitative uncertainties in models remain, it is now believed that increasing concentrations of greenhouse gases will produce a significant change during the 21st century.
- ... This warming of 1.5 to 4.5° is expected ot occur over the next 50 years.
- Over Europe the range of model results shows that average summer temperatures could increase by 2 - 6°C, winter average temperatures by 4 - 10°C. In winter precipitation would increase ..."

Potential impacts of climate changes

14. Potential impacts of the above mentioned climate changes will of course depend on the size and rate of the latter. At the symposium on "CO_2 and other greenhouse gases" mentioned in paragraph 13, it was concluded that :

"The expected climatic change will have profound effects on sea-level, global ecosystems, agriculture, water resources and sea-ice."

In particular such impacts could involve :

15. **Sea level rise**

Over the past 100 years, while global mean temperature has increased by approximately 0.5°C, sea level has risen by 10-15 cm. (Source : US-EPA (1986); "Effects of Changes in Stratosphere Ozone and Global Climate", Volume 1).

The projected global warming could have the following results :

. heating and therefore expanding the ocean water;
. melting of mountain glaciers;
. melting of the large ice sheets in Greenland and Antarctica;
. a possible (but unlikely) surge of a major portion of the Antarctic ice sheet into the ocean.

A wide range of different estimates for future sea level rise are available.
The most likely range for such increase by the middle of next century seems to be in the order of 30 cm to 1,5 meter (Toronto Conference, June 1988).

A significant rise in sea level would :

- permanently inundate many coastal wetlands and lowlands;
- accelerate coastal erosion;
- exacerbate coastal flooding and storm damage;
- increase the salinity of estuaries and coastal aquifers.

16. **Reduction of Sea Ice**

As the climate warms, total sea ice is expected to be reduced. This is a very probable effect.

17. **Water Resources Impacts**

Greenhouse warming may result in significant changes in precipitation patterns. While it is likely that global mean precipitation will increase, some regions may experience decreases in rainfall. Several studies predict substantial increases in summer dryness at mid-latitudes. As well as the impacts that this will have on agriculture, water resource reduction may affect the following :

- availability of water for human consumption;
- power generation;
- effluent dilution;
- navigation.

18. **Agriculture**

It should be mentioned that an increase in the CO_2 atmospheric concentration would stimulate vegetable growth by increasing photosynthesis rate and therefore could have per se a beneficial direct effect on crops and vegetation. This direct effect is difficult to quantify especially since the concomitant temperature increase would reduce the rate of net photosynthesis. Moreover any attempt to take it

into account should try to strike a balance between such direct effect and indirect impacts of increasing CO_2 concentration through climatic modifications.

The greenhouse warming could affect agriculture and forestry mostly by altering :

- total water availability and seasonal distribution of rainfall at regional level;
- length of growing season;
- number of extreme temperature events.

There are two perspectives on the agricultural impacts of climate change.

- The "Slow change" view : emphasises the significance of gradual increases in mean surface temperatures expected to lead to gradual, long-term and cumulative changes in average regional climates and agricultural patterns.

- The "Extreme events" view : emphasises changes in the frequencies of unusually disruptive events; impact of climate change comes not only from the average but mainly from the extreme event, e.g. droughts, flooding.

There is already concern among some experts that recent regional extreme events could be more than just climate fluctuations.

The main possible effects of climate variations on agriculture are summarised below (2) :

"- changes in length of the potential growing season and changes in plant growth rates;

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(2) Source : Parry M.L. et al (Eds) (1987) ; The Impact of Climate Variations on Agriculture, Volume 1, Assessments in Cool, Temperate and Cold Regions, Reidel, Dordrecht, The Netherlands.

- changes in mean yield and in the variability of yields;

- changes in the level of crop certainty and in the crop quality;

- changes in the sensitivity of plants to application of fertilisers, pesticides and herbicides."

Moreover climate changes could indirectly significantly affect agriculture in certain regions of the world through possible effects on soil characteristics, water resources, hydrology, pests and diseases etc.

At present, there is uncertainty about the nature, the magnitude and location of impacts. Studies so far conclude the following :

- Areas particularly sensitive to shifts in temperature and rainfall levels are high latitude, semi-arid and high-altitude regions.

- Warming appears to be detrimental to cereals in the core wheat-growing areas of Europe and North-America.

- Investigations of possible impacts in Canada, Finland and Northern USSR using climate data from the model by Hansen [1] et al, show reduced yields of spring-sown crops such as wheat, barley and oats, due to the increased moisture stress early in the growing period.

Impacts on agriculture would result in impacts on the local community, regional and national economies, in particular through changes in farm income and profitability, changes in regional production costs, changes in regional and national food production, changes in regional farm income disparities, changes in regional economic activity and employment.

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(1) Hansen J. et al (1983) : "Efficient Three-Dimensional Global Models for Climate Studies : Models I and II", Monthly Weather Review III, pp. 609-662.

In conclusion it is not possible under the present state of knowledge to give more than a tentative and qualitative description of possible effects of climate changes on agriculture given the large uncertainties about the regional shape and size of such changes and the lack of detailed research and studies on the likely response of agricultural systems in various regions of the world.
Urgent efforts are required to improve understanding of these aspects both at global level because of the potentially disruptive food security effects and at Community level because of the direct potential socio-economic impacts.

19. **Forest Ecosystems and Timber Production**

It is worth noticing that the same general comment on the direct potential effect of CO_2 on vegetation made at the beginning of paragraph 18 applies here too.

Predicted impacts include the following :

- modification of botanical and zoological composition of natural forest ecosystems;
- increase of forest decline in natural and manmade forest stands;
- modifications in forest productivity and forest management;
- disturbance of timber- and woodproducts markets and trade;
- danger of extinction of certain forest tree species and local ecotypes with a limited geographical distribution and by this a reduction of global genetic variability of forests.

20. **Human Health Impacts**

It should also be mentioned that a global warming could also have impacts for human health. It could in particular :

- possibly enable some diseases which require warm year-round temperatures to survive at higher latitudes;
- cause more frequent famines and shortages of food supplies (extreme events);

Expansion of tropical climates and concurrent expansion of the range of tropical diseases would mostly affect developing countries that already face health problems.

21. **Ecology and Fisheries Impacts**

The following potential ecological impacts are worth mentioning :

- impacts on less managed ecosystems;
- impacts on marine ecosystems;
- multiple stresses on some species which could become extinct, resulting in a significant decline in biodiversity;
- impact on wildlife reserves (the impact would depend on whether the reserve's boundaries encompass areas to which plants and animals could migrate).

The level of impact would depend on the rate of change in climate and thus the time allowed for acclimatisation and ecological species shifts.

Finally it is worth mentioning that since the ocean and atmosphere are coupled, both the distribution and abundance of fishery resources are capable of being modified by climate.
However, it is controversial how much observed changes in particular fishery stocks are due to climate and other natural causes or to overfishing.

II. THE INTERNATIONAL FRAMEWORK AND PERSPECTIVES

Introduction

22. Le rôle joué par certains gaz présents dans l'atmosphère dans les équilibres thermiques de la terre était connu dans ses grandes lignes déjà vers la moitié du siècle dernier (Tyndall, 1863; Arrhenius, 1896; Chamberlin, 1899).

Les premières mesures systématiques de la concentration du CO_2 par un réseau mondial ont toutefois démarré seulement en 1958.

Depuis lors l'augmentation observée de cette concentration a poussé les milieux scientifiques à entreprendre et à intensifier la recherche sur tous les aspects de l'effet serre.
Ce n'est toutefois que très récemment que ce sujet a commencé à faire l'objet de l'attention des responsables politiques.
Les problèmes bien connus concernant la couche d'ozone qui ont entraîné des négociations internationales et des décisions politiques ont en effet porté l'attention de ces responsables politiques sur les risques globaux liés aux modifications de notre atmosphère causées par l'action de l'homme et sur la necessité de préparer les réponses concrètes à donner aux indications scientifiques de plus en plus inquiétantes concernant l'éventualité de modifications du climat.

As a consequence, the following recent events have marked an important evolution in attitudes towards the greenhouse issue :

- the "Villach" conference (Villach-Austria, 9-15 October 1985);
- the European Parliament resolution on measures to counteract CO_2 rising concentrations (September 1985)
- The EEC Symposium on "CO_2 and other greenhouse gases" (Brussels, 3-5 November 1986);
- The Workshops on "Developing policies for responding to climatic change" (Villach-Austria, 28 September-2 October 1987 and Bellagio-Italy, 9-13 November 1987);
- The Brundtland Commission's report
- The World Conference on "The changing atmosphere" (Toronto, 27-30 June 1988).

The last event is of particular importance for future development and its outcome is presented in the next paragraph.

Details about the other events mentioned above are given in the Annex to this document.

The world conference on "The changing atmosphere, implications for global security" - Toronto, 27-30 june 1988

23. This high level conference has been organized at the initiative of the Canadian government to follow-up some of the conclusions and recommendations of the Brundtland commission report.
More than 300 scientists and policy makers from 48 countries, United Nations organizations, other international bodies and non-governmental organizations participated in the sessions.

Of the conference conclusions and recommendations, the following seem most important and are therefore reproduced in full :

"- Humanity is conducting an enormous, unintended, globally pervasive experiment whose ultimate consequences could be second only to a global nuclear war. The Earth's atmosphere is being changed at an unprecedented rate by pollutants resulting from human activities, inefficient and wasteful fossil fuel use and the effects of rapid population growth in many regions. These changes represent a major threat to international security and are already having harmful consequences over many parts of the globe.

- Far-reaching impacts will be caused by global warming and sea level rise, which are becoming increasingly evident as a result of continued growth in atmospheric concentrations of carbon dioxide and other greenhouse gases. The best predictions available indicate potentially severe economic and social dislocation for present and future generations, which will worsen international tensions and increase the risk of conflicts among and within nations. It is imperative to act now."

The following immediate actions are recommended :

"A. <u>Actions by Governments and Industry</u>

- Ratify the Montreal Protocol on Substances that Deplete the Ozone Layer. The Protocol should be revised in 1990 to ensure nearly complete elimination of the emissions of fully halogenated CFCs by the year 2000. Additional measures to limit other ozone-destroying halocarbons should be considered.

- Set energy policies to reduce the emissions of CO_2 and other trace gases in order to reduce the risks of future global warming. Stabilizing the atmospheric concentrations of CO_2 is an imperative goal. It is currently estimated to require reductions of more than 50 percent from present emissions levels. Energy research and developmental budgets must be massively directed to energy options which would eliminate or greatly reduce CO_2 emissions and to studies undertaken to further refine the target reductions.

- Reduce CO_2 emissions by approximately 20 percent of 1988 levels by the year 2005 as an initial global goal. Clearly, the industrialized nations have a responsibility to lead the way, both through their national energy policies and their bilateral and multilateral assistance arrangements. About one-half of this reduction would be sought from energy efficiency and other conservation measures. The other half should be effected by modifications in supplies.

- Set targets for energy efficiency improvements that are directly related to reductions in CO_2 and other greenhouse gases. A challenging target would be to achieve the 10 percent energy efficiency improvements by 2005. Improving energy efficiency is not precisely the same as reducing total carbon emissions and the detailed policies will not all be familiar ones. A detailed study of the systems implications of this target should be made. Equally, targets for energy supply should also be directly related to reductions in CO_2 and other greenhouse gases. As with efficiency, a challenging target would again be to achieve the 10 percent energy supply improvements by 2005. A detailed study of the systems implications of this target should also be made. The contributions to achieving this goal will vary from region to region; some countries have already demonstrated a capability for increasing efficiency by more than 2 percent a year for over a decade.

- Apart from efficiency measures, the desired reduction will require (i) switching to lower CO_2 emittaing fuels, (ii) reviewing strategies for the implementation of renewable energy especially advanced biomass conversion technologies; (iii) revisiting the nuclear power option, which lost credibility because of problems related to nuclear safety, radioactive wastes, and nuclear weapons

proliferation. If these problems can be solved, through improved engineering designs and institutional arrangements, nuclear power could have a role to play in lowering CO_2 emissions.

- Negotiate now on ways to achieve the above-mentioned reductions.

- Initiate management systems in order to encourage, review and approve major new projects for energy efficiency.

- Vigorously apply existing technologies, in addition to gains made through reduction of fossil fuel combustion, to reduce (i) emissions of acidifying substances to reach the critical load that the environment can bear; (ii) substances which are precursors of tropospheric ozone; (iii) other non-CO_2 greenhouse gases.

- Label products to allow consumers to judge the extent and nature of the atmospheric contamination that arises from the manufacture and use of the product.

B. Action by Member Governments of the United Nations, Non-Governmental Organizations and Relevant International Bodies.

- Initiate the development of a comprehensive global convention as a framework for protocols on the protection of the atmosphere. The convention should emphasize such key elements as the free international exchange of information and support of research and monitoring, and should provide a framework for specific protocols for addressing particular issues, taking into account existing international law. This should be vigorously pursued at the International Workshop on Law and Policy to be held in Ottawa early in 1989, the high-level political conference on Climate Change in the Netherlands in the Fall, 1989, the World Energy Conference in Canada in 1989 and the Second World Climate Conference, Geneva, June 1990, with a view to having the principles and components of such a convention ready for consideration at the inter-governmental Conference on Sustainable Development in 1992. These activities should in no way impede simultaneous national, bilateral and regional actions and agreements to deal with specific problems such as acidification and greenhouse gas emissions.

- Establish a World Atmosphere Fund, financed in part by a levy on fossil fuel consumption of industrialized countries, to mobilize a substantial part of the resources needed for implementation of the Action Plan for the Protection of the Atmosphere.

- Support the work of the Inter-governmental Panel on Climate Change to conduct continuing assessments of scientific results and initiate government-to-government discussion of responses and strategies.

- Devote increasing resources to research and monitoring efforts within the World Climate Programme, the International Geosphere Biosphere Programme and Human Response to Global Change Programme. It is particularly important to understand how climate changes on a regional scale are related to an overall global change of climate. Emphasis shouls also be placed on better determining the role of oceans and global heat transport and the flux of greenhouse gases.

- Increase significantly the funding for research, development and transfer of information on renewable energy, if necessary by the establishment of additional and bridging programmes; extend technology transfer with particular emphasis on the needs of the developing countries; and upgrade efforts to meet obligations for the development and transfer of technology embodied in existing agreements.

- Expand funding for more extensive technology transfer and technical cooperation projects in coastal zone protection and management.

- Reduce deforestation and increase afforestation making use of proposals such as that in the World Commission on Environment and Development"s (WCED) report, "Our Common Future", including the establishment of a trust fund to provide adequate incentives to enable developing nations to manage their tropical forest resources sustainably.

- Develop and support technical cooperation projects to allow developing nations to participate in international mitigation efforts, monitoring, research and analysis related to the changing atmosphere.

- Ensure that this Conference Statement, the Working Groupe reports and the full Proceedings of the World Conference, "The Changing Atmosphere : Implications for Global Security" (to be published in the Fall, 1988) are made available to all nations, to the conferences mentioned under paragraph 26, and other future meetings dealing with related issues.

- Increase funding to non-governmental organizations to allow the establishment of environmental education programmes and public awareness campaigns related to the changing atmosphere. Such programmes would aim at sharpening perception of the issues, and changing public values and behaviour with respect to the environment.

- Allocate financial support for environmental education in primary and secondary schools and universities. Consideration should be given to establishing special groups in university departments for addressing the crucial issues of global climate change.

Future possible developments

24. A possible short-term outcome of the above mentioned international activites is initiation, already in 1989, of the process for preparing a comprehensive global convention on the protection of the atmosphere.

Limitations to the emissions of greenhouse gases would then be agreed by specific protocols in the frame of such convention.

25. Next essential events on the way to that convention might probably be :

- the international workshop on law and policy to be held in Ottawa early in 1989;

- a high level political conference to be convened in the autumn 1989 by the Netherlands Ministry of the Environment;

- the Second World Climate Conference, Geneva, June 1990;

- the Intergovernmental Conference on sustainable Development in 1992 which could be the culminating event.

26. The substance of the convention mentioned under 24 above (and of associated protocols) as far as the greenhouse issue is concerned could probably consist in :

a) greenhouse gases emission reduction targets for developed countries;

b) new development aid schemes to help developing countries to limit the increase of their greenhouse gases emissions by use of appropriate technologies and to reverse deforestation trends;

c) a new impetus to scientific and technical international cooperation on all the aspects relevant for the greenhouse issue.

27. Renegotiation of the Montreal Protocol on CFC's is a very likely short term development.

28. Policy discussions on the way how to deal with the greenhouse effect might be very complex because of the many far reaching and interrelated aspects of the issue.

In this respect, it is worth stressing the global, complex and differentiated nature of the challenge put by the greenhouse issue.

This was well presented in the following statement at the Bellagio (1987) workshop (see Annex) :

"... the participants emphasized the relationship between the issue of climatic change, including policy responses to it, and a number of other issues, above all in the field of environment and development. This relationship underlines the importance of the differences in impact by region, and hence by country, of climatic change and the extent to which these differences affect the effort of the international community in promoting sustainable development.

The report of the Brundtland Commission has explained the ramifications of these numerous interconnections. The significance of the difference in regional impact should not, however, be allowed to detract from the emphasis on the comunity as a whole in facing it. Still less should it encourage any attempts to divide countries or regions into "winners" or "losers". This is not a "zero-sum" game. Unless action is taken, it could be a negative sum game of highly uncertain proportions."

III. REVIEW OF POSSIBLE ACTIONS

Introduction

29. Preliminary indications from research results and the state of the international debate call for urgent consideration of further action on the greenhouse issue.

Such action, of which the following paragraphs give an overview, could include :

- research;
- preventive measures (i.e. measures to curb greenhouse gases emissions);
- adaptive measures (i.e. measures to adapt to climatic changes and to their impacts if those seem likely to be unavoidable despite preventive measures).

30. Policy measures may be classed into three groups :

(a) those which have to be taken at an international level and require international agreement (e.g. reduction of CO_2 emissions);
(b) those which may be taken at a European level (e.g. planning for water resources, agricultural and forest planning) or in specific countries e.g. through development aid programmes (conservation of tropical forests, wetlands, coastal ecosystems, appropriate energy policies, etc.);

(c) those of an intermediate character (e.g. decisions on the energy mix to be adopted, taking account of (a) and of particular European conditions).

The group to which any particular measure belongs may determine the time necessary to its adoption and require a proper approach.
Measures of an international character may ignore specific local conditions; local measures cannot do so.

31. The above mentioned factors have to be taken into account in order to correctly coordinate the policy decision timing and the research timing. In fact this coordination is essential for two reasons :

(a) the uncertainties as regards the climate change and its impacts increase with increasing spatial and temporal definition : the ultimate answer one is expecting from scientific research is what will happen, when, where. Now the "what" becomes increasingly uncertain as the range of the "when" and "where" becomes smaller. Yet such knowledge is vital for any planning which decision makers could consider.

(b) in order to take policy decisions it is crucial to know

- which danger, when and where, one has to face and what consequences upon the environment, the economy, the society at large are to be expected;
- how to implement at best the measures decided;

Therefore, the study of policy options and scientific research have to go in parallel, and there must be a continuous feedback between the two. Only in this way can one avoid that decisions are unduly delayed or that they are taken without taking fully into account research results. Research itself should benefit from that interaction process, by being continuously reoriented towards specific objectives and actual problems and needs.

Research activities

32. Already since 1980, the Commission of the European Communities is carrying out a research programme in Climatology, whose main research areas are concerned with the study of the evolution of climate in the past, with climate modelling, with the man-induced climate change and with the impacts that such change could have on European land and water resources. The symposium held in Brussels in November 1986 (Annex B) was organised in the frame of this programme and was meant to provide the scientific consensus available at that date.

Research is being focussed especially on the climatic effects of greenhouse gases, and climatologically significant processes imperfectly understood as yet, such as atmosphere-ocean interactions, the water vapour-greenhouse feedback, the cloud feedback, aerosol and cloud climatology, biospheric sources and sinks of trace gases, climatic aspects of ozone changes and troposphere-stratosphere interactions, the effects of glabal warming on the melting rate of ice shelves.

33. In the near future the Climatology research programme of the Commission will put a greater stress on the impacts which climate change could have on important sectors of the European environment.

Such intensified research should concern in particular :

(1) The rise in sea level and its impacts on the European coasts (prediction of future sea-level changes, the change in storm surge risks for European coastal installations, the impacts on coastal ecosystems and coastal land use).

(2) The impacts of a changing climate on European crops, forests, water resources (bioclimatic shifts of crops and forests, changes in productivity, the sensitivity of European crops to increased CO_2 and climate change, the impacts on surface and ground water supplies).

(3) The effects of the climate change as regards the progressive aridification of the Mediterranean Europe (effects of climatic and meteorological factors on soil degradation, the impact of progressive drought on vegetation).

(4) The occurrence and frequency of extreme events and their impacts upon agriculture and industry (the impacts of the alternance of droughts and heavy rainfall on European land resources, the impacts of meteorological extremes such as hail and frost on European agriculture and industry).

(5) The melting of Alpine glaciers.

(6) The study of the social, economic and political factors conditioning probable future emission rates of greenhouse gases, and likely to be affected by any policy option that could be adopted.

(7) The study of socio-economic impacts, in particular in the Community, due to climatic changes, for the various relevant aspects, such as consequences for agriculture, consequences for costline regions of the sea level rise, etc.

Such research should be supplemented by a sound monitoring of atmospheric and oceanic conditions. International agreements should allow to place instrumentation where it is needed and to have access to space based monitoring systems. A vital component of a monitoring programme is the utilisation of space technology to understand the processes which control the earth's climate system and its sensitivity to natural and man-induced changes.

34. Environmental constraints, especially the reduction of air pollution, call for a balanced pursuit of environmental and energy objectives. As far as CO_2 is concerned, the objective can also be achieved through progress in the development and availability of techniques, processes and products allowing rational use of energy and the efficient and economic use of renewable energy sources and by safe nuclear energy.

These considerations provide ample justification for a specific energy R&D programme in the fields of renewable energies, rational use of energy and safe nuclear technology which will ensure continuity of the progress made since 1975 and guarantee that optimum benefits be gained from the new energy technologies developed so far.

35. Elimination of CO_2 at the source could eventually become a new domain of research. No economically or technically feasible technologies are yet available.
New directions for research in this field should be explored.

36. Moreover, the management of the CO_2 problem implies both the definition of global reduction objectives and the implementation of these objectives. The first aspect of the problem requires to determine by how much the emissions will need to be reduced and the pace of that reduction. The implementation action will have to determine the economic activities that will bear the major part of this reduction, the allocation of this reduction among the different actors and the institutional approaches to arrive at these objectives.

System Analysis can, in principle, provide the adequate basis for looking at these questions. Energy-Environment models give the possibility of finding efficient ways of achieving emission goals; Climate models are there to assess the impact of emissions on the environment and to help construct scenarios of adaptive measures; Energy-economy models allow to compute the impact on the economic systems of the costs incurred by the reduction of emissions.

The models developed in the System Analysis Community research programme should be adapted and used in the direction defined above for analysing energy related CO_2 emissions reduction measures and programmes.

The aim of such research would be to evaluate the feasibility and the costs of various reduction objectives as well as to assess their impact on the energy and economy sectors.

Preventive action (greenhouse gases emission reduction)

37. Preventive action is any action aiming at curbing the expected increase in greenhouse gases atmospheric concentrations.
This could mean aiming first at reducing the rate of increase of those concentrations and in the longer term at stabilizing them. Reduction of greenhouse gases concentrations does not seem at this stage a realistic objective but could be a very long term goal.

38. The only way at hand to control future trends of greenhouse gases concentrations is limiting man-made emissions including, in case of CO_2, reversing the present trend of deforestation in tropical regions.

Preventative action is further discussed with reference to the most relevant greenhouse gases here below.

39. **Carbon dioxide (CO_2) emissions**

As shown in paragraph 4 of chapter I, CO_2 emissions are mostly due to fossil fuels burning and forest wood burning or forest biomass decomposition.
Preventive action could therefore include measures to be taken in the energy sector (including energy for industry and transportation) and in the forestry and agricultural sectors as far as action in these sectors could help to preserve forests.

A tentative list of actions aiming at CO_2 emissions reduction which could be studied might include :

A. Energy related measures for CO_2

There are several types of technical energy related measures that could curb CO_2 emissions, as listed below.
Of course not all those measures are equally efficient or cost-effective and one should make a clear distinction between the physical potential of CO_2 emission reduction of a given measure and its economic viability.

The following technical measures, which are listed without any ranking or priority, may provide ways to reduce CO_2 emissions from carbon-based fuels :

a. Energy Efficiency

- improving the efficiency of energy demand (e.g. more efficient light bulbs, better insulation, more efficient cars, electronic regulations, etc.);

- improving the efficiency of energy supply (e.g. cogeneration, introduction of combined cycle possibly integrated with high-temperature nuclear reactors, develoment of MHD, etc.);

b. Energy Supply

- fuel switching to less CO_2 emitting fuels (the relation of CO_2 emitted quantities with regard to a unit of energy produce for the combustion of lignite, hard coal, oil and natural gas is as follows : 121, 100, 88, 58);
- increased use of non carbon based renewable energies (pe. solar, windpower, hydro, geothermal, photovoltaics);
- increased use of nuclear power.

c. Biotic sources

- Use biomass for energy purposes (such as wood for heating or cooking in developing countries) in a sustainable way so that the CO_2 atmospheric balance is not affected significantly;

d. CO_2 technology abatement

- Although at present no economically or technically feasible technologies seem to be available, this possibility should not be excluded for the future.

e. Long-term development

- Introduction of non-carbon based energy systems in their various forms combined with electricity and hydrogen as secondary energy carriers.

Any policy decision aiming at reducing CO_2 emissions in the energy sector should be carefully examined taking fully into account the specific objectives and constraints existing at international, community and national level in this sector. On the other hand, any future decision in the field of energy policy should take into account the problem of potential climate changes linked to the greenhouse effect.

System analysis models have been extensively used in the past for exploring consequences of economic-energy-environmental related measures and the use of such analytical models may provide information on the feasibility of measures to achieve CO_2 reduction goals. Scenarios analysis can complete such information and identify technologies which have a good chance of contributing to that objective and hence should deserve more attention.

B. Measures related to forestry and natural ecosystems

a. Conserve forest resources

- promote appropriate agricultural practices and organization in developing countries to avoid that agricultural land demand cause further deforestation;

- assist developing countries to improve their ability to manage forests in a manner that ensures that they are exploited on a sustainable basis;

- reinforce prevention and fighting of forest fires;

- promote actions to monitor and restore declining forests;

- provide alternatives to and improve the efficiency of the utilisation of fuel-wood for cooking in developing countries.

b. Promote afforestation

- increase reafforestation efforts notably in subtropical and tropical regions;

- promote agroforestry, especially in developing countries.

c. Natural ecosystem protection

- promote the conservation of ecosystems directly or indirectly relevant for the global carbon cycle.

40. **CFCs emissions**

Possible preventative actions are :

a. Constrain use
b. Constrain production
c. Recapture and recycle or destroy

41. **CH_4, N_2O emissions**

Actions which could be considered are :

a. Minimize CH_4 losses in extraction, transport and use of natural gas.
b. Minimize CH_4 losses from landfills.
c. Minimize N_2O emission from fossil fuels burning.
d. Study possible improvements in livestocks management, rice cultivation and lagoons management, aiming at reducing CH_4 release.
e. Study possible improved fertilizing management practices to reduce N_2O release from nitrogen fertilizers use.

42. The possible use of mechanisms such as taxation of products that cause greenhouse gas emissions or of emissions themselves where this is feasible, could be considered to stimulate or complement technology measures.

Planned adaptation

43. Planned adaptation involves taking account of potential greenhouse impacts in long-term planning, most likely at the regional and national levels.
Consideration of such measures in long term planning becomes necessary if it is believed that :

- impacts are likely to occur which society will not be able to adjust to in the short term;
- implementation of preventative measures is unlikely to be sufficiently effective in time (e.g. even if emission controls were implemented now, it is possible that significant impacts will occur due to the atmospheric warming to which we are already committed).

At this stage it is not possible to cover, even in qualitative and simple way, all the adaptive measures which could be worth considering in relation to the various potential impacts of the greenhouse effect. However, it is worth giving some indications concerning potential measures for possible sea-level rise and for impacts on agriculture.

44. **Possible adaptation measures concerning sea level rise could include :**

- Sea walls/flood barriers.
- National flood insurance programmes.
- Construction of reservoirs (to combat increased salinity).
- Abandonment of developed regions in low lying areas.
- Other relocation of populations away from vulnerable sites.
- Protection of coastal ecosystems.

45. **Examples of measures which could be considered in order to adapt to impacts on agriculture are :**

- More efficient use of fertilisers.
- Changes of land use to optimise and to stabilize production;
- Changes of policy to maintain national food security;
- Changes to policies supporting land management, such as soil erosion control, water management, etc.

Cooperation with developing countries

46. All the above measures, both as regards preventive action and as regards planned adaptation, should also be developed to take into account the needs of the developing countries, and how the Community's development aid policy can contribute towards the prevention and the adaptation of the greenhouse effect. In particular :

a) by enhancing the type of projects that can actively contribute to prevention such as those which are directed at reducing deforestation, conserving wetlands, coastal ecosystems and the genetic diversity or arid ecosystems;

b) by taking into account the consequences of the greenhouse effect in medium-term project planning (e.g. agricultural programmes, livestock programmes, fisheries and any projects related to long-term investments on lowlands which may be affected by the forecasted increase of ocean level);

c) by ensuring that base line data being gathered for the purpose of implementing development projects be made accessible to the Community research programme on the greenhouse effect.

IV. CONCLUSIONS OF THE COMMISSION

47. The Community should implement fully the Vienna Convention for the protection of the ozone layer and the Montreal Protocol on substances that deplete the ozone layer. This will involve the adoption and application by all Member states of the proposed Council Decision, Regulation and Resolution agreed to by the Council on 16 June 1988.

48. The Community should participate actively in the efforts toward renegotiation by 1990 of the Montreal Protocol on substances that deplete the ozone layer. The Protocol should be revised so that the CFC's emissions could be almost totally eliminated by the year 2000 as recommended by the Toronto conference.

49. The Commmunity should welcome initiation of discussions on the possibilities of an international agreement for the future protection of the atmosphere. It should be prepared to give an important contribution to the preparation and negotiation of such an agreement which might include the establishment of specific targets for limiting emissions of greenhose gases as well as definition of emission reduction measures and programmes.

50. Therefore, the Commission will take the initiative to launch a substantial policy-options study programme to evaluate the feasibility, costs and likely results of possible measures to limit greenhouse gases emissions. Results of such programme would give useful inputs to the international debate on the issue.

The main areas of such programme should be :

- identification and technical assessment of measures and technologies in various relevant fields capable to reduce greenhouse gases emissions;

- analysis of economic, industrial, energy, social and institutional implications and impacts of the above mentioned possible measures and technologies;

- structuring and evaluating policy scenarios referred in particular to possible strategic targets for CO_2 emission ceilings.

A reliable greenhouse gases emission inventory would be needed in this frame.
The focus of the exercise should be on Europe in a first instance.

- establishing a decision analysis framework in order to link probabilistically policy options and their likely results an benefits.

- identifying and evaluating adaptive policies to cope with unavoidable effects under the different scenarios resulting from the decision analysis exercise.

The Commission has developed several energy-economy and energy-environment models and those models and the experience gained in policy analyses of energy-environment interactions should be fully exploited when starting new work on the greenhouse issue.

The above mentioned work programme should be closely linked to the research and development activities on relevant subjects such as climatology and energy.
Moreover a framework should be created to allow systematic exchange of views and rapid feedbacks among scientists and policy makers.

51. The greenhouse effect is a global problem, the Community should therefore play an important part in the definition of a global policy, involving in particular developing countries, towards a sustainable development.

Community work on the greenhouse issue should be structured and scheduled so to allow synergism and collaboration with international organizations and third countries. In particular the Commission work programme should fully take account of parallel activities in the frame of the panel on climate change of WMO/UNEP and of OECD and IEA.

52. The Community and its Member States should by now take into account in their policy decisions (related to energy or other sectors relevant to the issue) the problem of potential climate changes linked to the greenhouse effect.
Early consideration of such issue could avoid higher costs in future.

53. Moreover the Commission will take urgent action to reinforce and expand efforts in the field of energy savings, energy efficiency improvement, development of new energy sources, use of safe nuclear technology. The accelerated development and promotion of innovative commercial-scale technologies in these fields should be given high priority.
There is no doubt that such action is justified because of both energy and environmental requirements, independent of uncertainties on some scientific aspects of the greenhouse issue.
Of special importance would be the possibility to quantify energy efficiency improvements in terms of CO_2 reductions.

54. The Community should sustain vigorous research programmes on all the relevant aspects of the greenhouse issue and should promote new energy technologies having the potential to limit CO_2 emissions.

55. Activities should be reinforced and expanded in the frame of existing cooperation agreements of the EC with mediterranean countries with the aim both of promoting sustainable development in those countries and of helping them to prevent likely impacts of the greenhouse issue on their environment.

56. The Commission will also prepare urgent action in the field of aid to developing countries both as regards preventive and as regards adaptation measures.

In particular :

- An attempt should be made to classify and map geographical areas which are particularly vulnerable to the greenhouse effect (such as, for instance, islands whose mean altitude above sea level is precariously low, coastal states, etc. Such maping would form a reference basis against which policies could be evaluated. It would certainly be a first step towards adapting policy as regards aid to developing countries.

- The greenhouse effect should as much as possible be taken into account in considering the feasibility of major projects such as, for instance, dams, agricultural projects which involve major modifications to the environment and in being particularly cautious in evaluating any project which may have a negative input on

tropical forests, wetlands, coastal ecosystems or mountain ecosystems. Instruments should be developed to assess the long-term sensitivity of development projects to the greenhouse effect. Preparedness against natural disaster also at some stage have to be increased, in respect of the type of calamities which the greenhouse effect may make more likely. (For example the strength of tropical storms which is expected to increase.) In preparing national regional conservation strategies one should ensure that adequate account is taken of the greenhouse effect.

57. In parallel to the work needed to evaluate possible policy options, existing research programmes should be strenghten to better understand the potential impacts of the greenhouse effect on European regions. These programmes should consider both the physical and the socio-economic direct and indirect impacts.

In this frame the risks for the coastline regions of the Community related to possible sea level rise should be assessed so that information useful for land use planning is available to developers and competent authorities.

58. Finally, the Commission will set up a Committee to exchange information on all the aspects of the greenhouse issue. Member States and the Commission should be represented in this Committee.

A N N E X

Recent major events on the greenhouse issue

A. The "VILLACH" Conference (International conference on the assessment and the rate of CO_2 and of other greenhouse gases in climate variations and associated impacts (Villach - Austria, 9-15 October 1985))

This conference was jointly convened by UNEP, WMO and ICSU with participation of scientists from twenty nine developed and developing countries.

The following sentences appear in the statement adopted by this conference :

"Many important economic and social decisions are being made today on long-term projects - major water resource management activities such as irrigation and hydro-power; drought relief; agricultural land use; structural designs and coastal engineering projects; and energy planning - all based on the assumption that past climatic data, without modification, are a reliable guide to the future. This is no longer a good assumption since the increasing concentrations of greenhouse gases are expected to cause a significant warming of the global climate in the next century."

.....

"While some warming of climate now appears inevitable due to past actions, the rate and degree of future warming could be profoundly affected by governmental policies on energy conservation, use of fossil fuels, and the emission of some greenhouse gases."

.....

"Based on evidence of effects of past climatic changes, there is little doubt that a future change in climate of the order of magnitude obtained from climate models for a doubling of the atmospheric CO_2 concentration could have profound effects on global ecosystems, agriculture, water resources and sea ice."

.....

"Governments and regional inter-governmental organizations should take into account the results of this assessment (Villach 1985) in their policies on social and economic development, environmental programmes, and control of emissions of radiatively active gases."

.....

"Public information efforts should be increased by international agencies and governments on the issues of greenhouse gases, climate change and sea level, including wide distribution of the documents of this Conference (Villach 1985)."

.....

"Major uncertainties remain in predictions of changes in global and regional precipitation and temperature patterns. Ecosystem responses are also imperfectly known. Nevertheless, the understanding of the greenhouse question is sufficiently developed that scientists and policy-makers should begin an active collaboration to explore the effectiveness of alternative policies and adjustments. Efforts should be made to design methods necessary for such collaboration."

B. The EEC Symposium on "CO2 and other greenhouse gases : climatic and associated impacts (Brussels, 3-5 November 1986)

Upon the initiative of Dr. K.H. Narjes, Vice-President of the Commission of European Communities, a Symposium organised by the CEC, DG XII, was held in Brussels from 3 - 5 November 1986. It was attended by about 60 leading European and US scientists, who reviewed the whole issue of the climate change that will take place as a consequence of the accummulation of the atmospheric CO_2 and other greenhouse gases.

Further to the conclusions on the scientific aspects of the greenhouse issue, mentioned in the relevant sections of this document, the following recommendations were presented as a conclusion of this Symposium :

"- The time has come for taking a decisive step toward converting the dialogue between scientists and decision makers from a remote, intermittent and casual reading of reports of the other party to a closer and more interactive exchange of views.

- It is recommended that a means be established for obtaining the necessary exchange of information between policy analysts, decision makers and the scientific community involved in the issue."

C. The workshops on "Developing policies for responding to climatic change" (Villach - Austria, 28 September-2 October 1987 and Bellagio - Italy, 9-13 November 1987)

These meetings were called following the scientific consensus reached at the Villach conference in order to "start policy analysis to identify the widest possible range of social responses for limiting or adapting to climatic changes".

Apart from the statement mentioned in paragraph 28 of this document, the following conclusions/recommendations were presented :

"Immediate steps to limit greenhouse gas emissions

(1) Ozone Protocol Immediate approval and implementation of the Protocol on Substances that Deplete the Ozone Layer (thereby reducing CFC emissions). Recommend that it be ratified urgently and that after expedited scientific review the parties consider acceleration of the schedule for reductions in CFCs and eventual elimination of emissions not only for ozone layer protection but particularly for greenhouse gas limitation.

(2) Energy Policies

Governments should immediately begin to reexamine their long-term energy strategies with the goals of achieving high end-use efficiency, reducing multiple forms of air pollution and reducing CO_2 emissions. Research and development on alternative (non-fossil) energy systems must be greatly intensified.

(3) Deforestation Policies

Recommend support for increased measures to reduce deforestation, e.g. locally appropriate actions along the lines of the Tropical Forest Action Plan, 1987. Such measures are currently necessary because of the effects of tropical deforestation on agriculture,

energy, soil erosion, flooding and drought, etc. The contribution of deforestation to greenhouse gas induced climatic change is a powerful additional reason for measures to reduce deforestation.

(4) Other Trace Gases

Measures should be taken to avoid industrial and societal actions in the future which unduly contribute to emissions of greenhouse gases to the atmosphere. Examples include landfills that emit methane; N_2O reduction strategies; agricultural practices, etc.

Immediate steps to limit the impact of sea-level rise

(5) River and Coastal Zone Policies

International unions of geographic, coastal and geodetic and soil sciences and/or government agencies should develop maps to identify coastal areas vulnerable to sea-level rise, river regulation and intensifying land-use. Planning for large new industrial, tourist and urban installations near the sea should allow for the risks of possible sea-level rise.

Immediate steps to improve understanding of the greenhouse effect and options for dealing with it

(6) Management tools

Policy and scientific research should investigate further the utility of particular goals as management tools. An environmental goal expressed in terms of a rate of change of temperature or sea-level is easy to relate to observed historic rates of change. Such an environmental goal is related to the ambient concentration of greenhouse gases (expressed in terms of CO_2 equivalence) and thus to the emissions and for each of these, regulatory targets can be set in line with the long-term environmental goal.

(7) Monitoring

The problem of significant climate warming may call for a considerable increase in existing available monitoring activities, both with regard to global climate and its variability and sea-level changes, atmospheric chemistry and rainfall chemistry, as well as the consequences for the environment of any significant warming.

It is therefore recommended that WMO/WCP (World Meteorological Organization / World Climate Programme) and UNEP/GEMS (Unite Nations Environment Programme / Global Environmental Monitoring System) carry out a joint study of :

- what new climate observing system activites are required for monitoring the changing climate;
- what activities are required for monitoring the consequences of the changing climate.

The IOC through the Global Sea Level Observing System should give urgent attention to strengthening the monitoring of sea-level changes worldwide.

(8) Research

ICSU, UNEP and WMO jointly support the World Climate Programme (WCP), which is the focus for the further study of both basic research issues concerning global climatic change and questions about climatic impact. The World Climate Research Programme (WCRP) is an important component of the WCP, as the assessment of possible or likely future climatic changes rests on a comprehensive understanding of the global climate system.

Similarly, the new research programme IGBP (International Geosphere Biosphere Programme), initiated by ICSU, addresses the scientific problems that we are now confronting when trying to understand the biological and geochemical interactions that contribute to future climatic change and are of importance for understanding climatic impacts.

Increased support for scientific research for both the WCRP and IGBP should be given high priority."

D. The Brundtland Commission's report

The World Commission on environment and Development has been created on the basis of an UN General Assembly resolution in 1983 as an independent body to formulate and present proposals and recommandations concerning the critical environment and development problems with the aim of promoting a sustainable development.

Its report was presented to the General Assembly of UN during its 42nd Session in the fall of 1987.

This report asks for a urgent start of negotiating procedures to develop international agreement on strategies to cope with the greenhouse issue. It is suggested to consider :

"- improved monitoring and assessment of the evolving phenomena;
- increased research to improve knowledge about the origins, mechanisms, and effects of the phenomena;
- the development of internationally agreed policies for the reduction of the causative gases; and
- adoption of strategies needed to minimize damage and cope with the climate changes and rising sea level."

The report also suggests that such negotiations should aim at an international convention on "management policies for all environmentally reactive chemicals released into the atmosphere".

E. The European Parliament resolution

The European Parliament has adopted on 12th September 1986 the following resolution on measures to counteract the rising concentration of CO_2 in the atmosphere :

" The European Parliament

- having regard to the motion for a resolution tabled by Mr. Linkohr on research and policy measures to counteract the rising concentration of carbon dioxide in the atmosphere ('greenhouse effect') (Doc. B2-1430/84).

- having regard to the report of the Committee on Energy, Research and Technology and to the opinion of the Committee on the Environment, Public Health and Consumer Protection (Doc. A2-68/86).

A. noting the growing scientific certainty that the earth's average temperature s rising as a result of non-natural releases into the atmosphere of carbon-dioxide and propellants from fossil-fuel burning, intensive farming and industrial activities and deforestation respectively.

B. noting that an increasing temperature build-up, which is greater at the poles than at the equator, will bring about a shift in the earth's climatic zones, resulting in radical and, in some cases, disastrous changes in economic-activity patterns.

C. pointing out that the only scientifically established facts about global temperature build-up are the scale thereof and thus the number of years remaining until its effects become apparent, assuming no change in human-activity patterns.

D. pointing out the need to obtain essential scientific data on the slow but perceptible changes in the environment of the world in order to establish the extent of the changes taking place, and the measures to be taken to avoid or reduce their unfavourable effects and to exploit beneficial consequences.

1. Stresses that it is imperative to make more-reaching countermeasures than those currently implemented to combat pollution, provided such measures are directed at releases of both carbon dioxide and propellants, since, contrary to earlier assumption, the latter are just as significant a cause of temperature build-up as the former;

2. Calls upon the Commission, in future activities in the field of agricultural, industrial and energy policy and in negotiations with both national and international authorities, to put forward measures with a view to a substantial reduction of harmful discharges, thus benefiting the environment too;

3. Emphasizes in this connection the automatic benefit to be gained from large-scale energy-saving and rational use of energy, possibly in tandem with exploitation of cleaner energy sources and flue-gas purification respectively;

4. Calls for a worldwide policy of reafforestation, for which the Community should provide an example with its own forestry policy;

5. Calls for financial Community development policy measures to help put an end to the deforestation of rain forests in Third World countries;

6. Calls on the Council when drawing up the new framework programme for research to allocate more resources to the area of climatology, especially relating to changing temperature gradients including ocean-atmosphere interaction;

7. Stresses that preventing pollution of the world's seas is an essential requirement for climatic stability;

8. Recalls that it is incumbent upon the industrialized countries of the Northern hemisphere, which are largely responsible for jeopardizing climate, to ensure that the developing nations are given access to the latest technological know-how;

9. Instructs its Members, in collaboration with the relevant scientific quarters, to inform the public - and particularly the operators directly responsible - about the implications of the human activities in question, while explaining the need for effective measures;

10. Instructs its committee responsible to include in their opinions a climatic-impact assessment of future Community-level activities with a view to reducing the current temperature build-up;

11. Instructs its President to forward this resolution and the report of its committee to the Council and the Commission."

Programa de trabajo de la Comisión sobre el estudio de las distintas políticas que pueden aplicarse para hacer frente a la "problemática del efecto de invernadero"

I. CONTENIDO DEL PROGRAMA

Este programa ha de proprocionar los elementos necesarios para definir el papel potencial de la Comunidad y sus Estados miembros a la hora de establcer y fomentar en los foros internacionales pertinentes la medidas necesarias para hacer frente a los riesgos originadas por el efecto invernadero.

Con este objetivo, este programa de trabajo tratará los siguientes temas:

A. Determinación de las distintas políticas para evitar/reducir las emisiones de gases del efecto de invernadero

Se determinarán las medidas necesarias para poder reducir las emisiones de distintos gases del efecto de invernadero hasta alçanzar unos objetivos estratégicos. Esto supone que para cada gas del efecto de invernadero se llevará a cabo una valoración detallada de las distintas opciones de las que se dispone para reducir la emision para calcular el nivel de redución de emisiones que se puede obtener con cada opción, así como el paquete de medidas necesarias para alcanzar las reduciones establecidas como objetivo estratégico. El potencial disponible para evitar/reducir las emisiones se estudiará en los siguientes sectores:

- producción de energía;
- consumo de energía (incluido el transporte);
- producción industrial;
- utilización de los productos;
- actividades agrarias.

Será necesario abordar el problema de manera adecuada para tener en cuenta las distintas situaciones específicas de cada país o grupos de países. Concretamente, habrá que considerar los siguientes factores:

- nivel de desarrollo económico;
- políticas energéticas en vigor;
- geografía.

B. Implicaciones derivadas de las distintas opciones para reducir las emisiones

Cada opción para reducir las emisiones se examinará con objeto de valorar los siguientes puntos:

- implicaciones técnicas e industriales;
- implicaciones económicas y financieras;
- implicaciones políticas, institucionales y sociales.

C. Creación de un marco de análisis de decisiones

Se creará un marco que permita estructurar la información disponible sobre todos los aspectos del efecto invernadero de forma que se puedan determinar las ventajas probables (redución del riesgo de modificar el clima, etc) de cada una de las distintas políticas. Este marco tendrá en cuenta:

- las emisiones y la reducción de las emisiones;
- las implicaciones que conllevan estas reducciones;
- los datos científicos disponibles sobre las ventajas potenciales de los controles de emisiones alternativas.

Este marco se creará para recoger la incertidumbre sobre las emisiones, la eficacia de los controles, los cambios climáticos y los efectos que tienen las emisiones sobre el clima, y además permitirá determinar los resultados más probables derivados de las diferentes actuaciones

El marco también permitirá examinar las implicaciones que se derivarían de que la actuación en este área se retrase. El marco supondrá un importante instrumento para estudiar las actuaciones y concentrar la investigación futura en puntos clave de decisión al quedar estructurado el problema y haberse terminado las áreas principales de incertidumbre en las cuales los resultados pueden variar de manera más sensible.

D. Estudio de las posibles ventajas de las distintas políticas mediante la utilización del marco de análisis de decisiones y determinación del esquema evolutivo climático y el del impacto provocado por la aplicación de las distintas opciones de control de emisiones.

El marco se empleará para establecer los posibles resultados de las distintas opciones alternativas de reducción de emisiones, así como sus pasos de aplicación (esquema evolutivo). También podrá indicar el grado de probabilidad de que las ventajas que se pueden obtener con estas opciones se lleguen a materializar.

E. Determinación y estudio de las medidas de adaptación necesarias para los distintos esquemas evolutivos propuestos en el punto D.

Aunque se apliquen políticas de control de las emisiones se mantendrán aún una serie de riesgos procedentes de las emisiones del pasado y de las emisiones a la atmósfera futuras. Por tanto, habrá que establecer medidas de adaptación para hacer frente a estos riesgos (por ejemplo, medidas para proteger al hombre, la propiedad y la agricultura). Se determinarán la magnitud y el emplazamiento de los riesgos residuales claves, y se estudiarán las implicaciones de costes y tiempo de las distintas medidas de adaptación. Las medidas de adaptación gozarán de prioridad para garantizar que los riesgos residuales se reducen al mázimo mediante el empleo de los recursos disponibles, y que asimismo se preste especial atención a las áreas que suscitan mayor preocupación.

II. LISTA DETALLADA DE ACTIVIDADES

La ejecución de este programa requerirá, entre otras, las siguientes actividades:

A. Previsión de emisiones y opciones de reducción de las mismas.

i Preparar una previsión de emisiones para cada gas del "invernadero". Estas emisiones han de analizarse por (a) regiones, y (b) por grupos políticos, estratégicos y económicos.

ii Determinar factores (dejando aparte la aplicación del control) que probablemente influyan sobre las emisiones futuras. Valorar los grados de probabilidad e idear esquemas evolutivos de las emisiones alternativas.

B. Evaluación de las implicaciones de las distintas opciones de control de emisiones

i Determinar la viabilidad, coste y pasos de aplicación de cada una de las medidas de reducción de emisiones.

ii Evaluar los efectos sociales y económicos.

iii Evaluar los efectos que estas opciones tendrán (a) en los distintos países, (b) entre los distintos países, (c) entre las distintas agrupaciones políticas y estratégicas.

C. Creación de un marco para integrar la información recabada durante el programa de trabajo

Este marco ha de estar concebido para:

- presentar implicaciones de las distintas opciones, incluidos costes y posibles ventajas;

- señalar implicaciones que se derivarían de la actuación en distintos momentos;

- evaluar la solidez de las posibles decisiones (sobre estrategias de control o de adaptación) teniendo en cuenta la poca seguridad de las predicciones y de los datos científicos disponibles;
- centrarse en la investigación que sea necesaria para respaldar las decisiones que haya que tomarse.

D. Evaluación de las estrategias de control de emisiones

i Determinar las posibles ventajas que se puedan derivar de la aplicación de estrategias de control de emisiones. Esta labor exigirá que se lleve a cabo una revisión crítica de los mecanismos que relacionan las concentraciones de gas del "invernadero" con el calentamiento del globo y tratando en particular los temas de los sistemas de alimentación de datos, los pasos de aplicación y las consecuencias que afectan a los climas regionales.

ii A partir de la revisión crítica, preparar un estudio para determinar el grado de probabilidad de que las distintas predicciones alternativas y de sus consecuencias. Este trabajo ha de recoger las opiniones de los principales expertos y ha de reflejar el grado de incertidumbre de los distintos resultados.

iii A partir de la información obtenida sobre reducción de emisiones (A) y sus implicaciones (B), el marco para tomar decisiones creado en el apartado C se empleará para evaluar los costes, ventajas y otras implicaciones de las distintas opciones de control de emisiones.

E. Evaluación de las medidas de adaptación

i Revisar las implicaciones que tendrán los distintos niveles de calentamiento sobre la infraestructura europea y su abastecimiento alimentario; identificar otras implicaciones claves. Evaluar los efectos que tendrán estas medidas sobre otras agrupaciones políticas y económicas de países.

ii Revisar las opciones que podrían aplicarse para responder a los cambios potenciales (i) en Europa (por ejemplo, nuevas variedades de cultivos, sistemas de planificación variables, etc).

iii A partir de la evaluación llevada a cabo en el epígrafe D y empleando el marco creado en el epígrafe C, evaluar los costes y ventajas de las distintas medidas de adaptación; teniendo en cuenta los efectos que se prevé que tendrá cada una de ellas, valorar el grado de probabilidad de que tales medidas de adaptación resulten eficaces.

III. DIRECTRICES PARA LA APLICACIÓN DEL PROGRAMA

A. A la hora de ejecutar este programa la Comisión tendrá muy en cuenta otras actividades relevantes en este terreno llevada a cabo tanto en la Comunidad como en el resto del mundo, tales como:

- el programa de investigación de la CE sobre climatología y riesgos naturales;

- el resultado de las conferencias internacionales celebradas recientemente (tales como la conferencia sobre la Atmósfera en Proceso de Cambio, Toronto, junio 88);

- el grupo de trabajo del PNUMA/OMM sobre cambios climáticos;

etc.

A estos efectos, la Comisión establecerá los lazos de cooperación adecuados con las organizaciones pertinentes encargadas de tales actividades.

B. Asistida por el Comité mencionado en el artículo 1 de la Decisión, la Comisión definirá los procedimientos y concretará los pasos que han de darse en este programa de trabajo, así como la información que han de proporcionar los Estdos Miembros.

Las organizaciones competentes y los Ministerios gubernamentales de los Estados Miembros participarán también en estos trabajos a través del Comité arriba mencionado.

IV. FINANCIAMIENTO DEL PROGRAMA

Se calcula que los fondos necesarios para la aplicación del programa ascienden a 6 millones de ECU.

Proyecto

de

Resolución del Consejo relativa al "efecto invernadero y la Comunidad"

El Consejo de las Comunidades Europeas,

Visto el Tratado constitutivo de la Comunidad Económica Europea,

Visto el proyecto de Resolución de la Comisión,

Considerando que el tratado constitutivo de la Comunidad Económica Europea, modificado por el Acta Única Europea, dispone el desarrollo y la aplicación de una política comunitaria de medio ambiente, y que el mismo tratado estipula que para tomar medidas en este campo la Comunidad deberá tener en cuenta los datos científicos y técnicos a su disposición y las ventajas y perjuicios que pudieran resultar de su actuación o de la ausencia de la misma;

Considerando que la presente Resolución se inspira en las consideraciones expresadas en la Resolución de 19 de octubre de 1987 relativa a un programa comunitario de medio ambiente (1), concretamente la conveniencia de actuar en el nivel apropiado, así como la necesidad de una coordinación internacional del trabajo, de evaluar las ventajas y los costes de las medidas consideradas y de preparar adecuadamente dichas medidas desde el punto de vista técnico y político;

Considerando que los datos científicos disponibles indican, en particular los resultados de los programas de investigación en materia de medio ambiente comunitarios, que las actividades del ser humano están alterando de modo significativo la composición de la atmósfera y que, si nos basamos en los modelos climatológicos existentes, esto

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(1) D.O. nº C 328 de 7.12.1987, pág. 1

podría acarrear al cabo de cierto tiempo, debido al llamado efecto invernadero, modificaciones climáticas con importantes repercusiones sobre el medio ambiente, el hombre y sus actividades;

Considerando que, teniendo en cuenta la naturaleza y las proporciones de los riesgos que supone el efecto invernadero, es urgente examinar las posibles medidas para prevenir o reducir dichos riesgos;

Considerando que en las recientes conferencias internacionales se ha alcanzado un consenso muy amplio en lo que respecta a la necesidad de considerar urgentemente medidas para reducir las emisiones de los gases que provocan el efecto invernadero;

Considerando que, dada la complejidad del problema del efecto invernadero y de las múltiples y profundas implicaciones tanto de este efecto como de las posibles medidas para prevenir o paliar sus consecuencias, se impone analizar un minucioso examen previo de las diversas opciones políticas mediante métodos adecuados que tengan especialmente en cuenta las incertidumbres que aún subsisten en torno a varios aspectos del problema;

Considerando que es sumamente importante que la Comunidad y sus Estados miembros se hallen en situación de contribuir significativamente a la reflexión y a la elaboración de las decisiones políticas que se puedan tomar en los foros internacionales apropiados para actuar del modo más eficaz contra los riesgos de modificaciones climáticas,

Aprueba la Comunicación de la Comisión acerca del "problema del efecto invernadero y la Comunidad" así como sus principales conclusiones y recomendaciones;

Declara que la Comunidad debería prestar un interés creciente a los peligros encerrados en los posibles cambios climáticos relacionados con el efecto invernadero y contribuir de modo significativo a fomentar la reflexión y los debates en torno a las posibles medidas para contrarrestar dichos riesgos;

Aprueba la iniciativa de la Comisión de lanzar un programa de trabajo relativo a la evaluación de las opciones políticas para enfrentarse con los riesgos relacionados con el efecto invernadero así como los objetivos de dicho programa.

Invita a la Comisión a presentar al Consejo y al Parlamento Europeo, a mediados de 1990, un informe de los progresos realizados y un informe final de los resultados obtenidos por el programa de trabajo y de las conclusiones extraídas, a finales de 1991.