End-of-Term Report
2003–2008

Strategic Plan
for 2009–2013

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End-of-Term Report 2003–2008

and

Strategic Plan for 2009–2013

International Energy Agency Implementing Agreement for Co-operation in the Research, Development, and Deployment of Wind Energy Systems

Approved by the IEA Renewable Energy Working Party (REWP) and the Committee for Energy Research in Technology (CERT) and the Executive Committee of IEA Wind

October 31, 2008

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1. PREFACE

The current term of the International Energy Agency (IEA) Implementing Agreement for Cooperation in the Research, Development, and Deployment of Wind Energy Systems (IEA Wind) ends 31 October 2008. The Agreement began in 1977. The most recent extension of the Agreement was approved by CERT action IEA/GB(98)34 in October 2003.

This document was prepared following the *Guidelines for End-of-Term Reports for IEA Implementing Agreements* issued 26-27 June 2001 by the IEA Committee on Energy Research and Technology (CERT) including updates on 28 November 2001 and 7 June 2002. The report includes information to assist the CERT and its Renewable Energy Working Party (REWP) to evaluate the proposed extension of IEA Wind for an additional five years. Data in the IEA Wind End-of-Term Report and Strategic Plan are structured following the *Criteria and Review Process for the Extension of Implementing Agreements*, adopted by the IEA Energy Technology Collaboration Division in Paris on 29 July 2002.

This Report was prepared for review and approval after the first IEA Wind Executive Committee (ExCo) meeting of 2008. It was unanimously approved by email ballot September 18, 2008. This report was forwarded to the REWP with recommendations for continuation of the Agreement for an additional five years. It includes an updated five-year Strategic Plan consistent with the *CERT Strategic Plan 2007–2011*. The extension of the IEA Wind Agreement through was approved at the 51st CERT meeting on October 7, 2008. Final copyediting was completed October 31, 2008.

2. EXECUTIVE SUMMARY

Based on the CERT criteria for extension of Implementing Agreements, the activities described in this End-of-Term Report, and the activities proposed in the Strategic Plan, it can be concluded that:

1. Technology and information development by IEA Wind has been useful to the participants and is consistent with IEA goals as expressed in the CERT review process.
2. A clear vision and role for continuing the work has been developed for IEA Wind that meets CERT review criteria.
3. Collaborative networks serve mainly the IEA/OECD governments, but outreach efforts are under way to all interested governments and industry from any country.
4. Activities of IEA Wind have been well managed and responsive to the changing needs of the expanding global market for wind energy systems.

Consequently, the Executive Committee proposed a five-year extension of the Agreement to 31 October 2013. This extension was approved by the IEA REWP and by the CERT in October 2008.

2.1. End-of-Term Report

As described in this end-of-term report, the participants of the IEA Wind Agreement have worked productively toward the objectives set out in the 2003 Strategic Plan [1]. Key issues of integration of wind power into the electricity system, offshore wind development, and social acceptance of wind energy projects are being addressed, and the work is having significant impact on expanded wind energy development. The cooperative research tasks are rewarding participants with benefits many times the monetary and in-kind efforts they contribute. Industrial and utility participation is informing the research tasks, and the information sharing and distribution of the ExCo is being well managed and is contributing to policy development in the Member Countries and at IEA.

2.2. Strategic Plan

The IEA Wind ExCo generated a Strategic Plan for the period 2009 to 2013 through a consensus process, based on the recommendations of the participants in a Topical Expert Meeting on Long-Term Research Needs the results of a survey conducted among the IEA Wind Members. The objective of these initiatives was to identify future research needs through the timeframe 2020. The key RD&D areas for the wind energy sector were identified by the IEA Wind ExCo as follows:

1. Wind technology research to improve performance and reliability at competitive costs
2. Power system operation and grid integration of high amounts of wind generation including development of fully-controllable, grid-friendly “Wind Power Plants”
3. Planning and performance assessment methods for large wind integration
4. Offshore wind in shallow and deep waters
5. Social, educational, and environmental issues.

In the next five years the IEA Wind Agreement will focus on the completion of the R&D work already initiated related to the five themes above. Task 11, Base Technology Information

Exchange will contribute to each theme by calling Topical Expert Meetings as requested by the Members and by coordinating development of Recommended Practices stemming from completed work of the research Tasks.

Theme 1 will focus on the development of new methods and components of wind turbines for the improvement of performance and reliability at competitive costs - Task 19, Wind Energy in Cold Climates; Task 27, Consumer Labeling of Small Wind Turbines; 29 Task 29, MexNex(t) Aerodynamic Models and Wind Tunnel Data and new initiatives.

Theme 2 will be addressed by Task 25, Power Systems with Large Amounts of Wind Power and new initiatives.

Theme 3 will be addressed by the recently approved Task 29, MexNex(t) Aerodynamic Models and Wind Tunnel Data and new initiatives to assess performance of large wind parks in complex and forested terrains.

Theme 4 will be addressed by the conclusions of Task 23, Offshore Wind Technology Deployment which will be used to propose new initiatives.

Theme 5 will be addressed by the ongoing Task 28, Social Acceptance of Wind Energy Projects, and by potential new initiatives to increase the educational capacity of the wind energy institutions.

2.3. Self-Evaluation of Current and Proposed Terms

At the 61st ExCo meeting in Aalborg, Denmark, the Chair handed out a questionnaire about the future of the IEA Wind Implementing Agreement for representatives to fill in. The form listed the CERT evaluation criteria and asked for ratings 1-5 for the term just finishing. The other side of the form asked Members to list 10 important research areas for the next five-year term in order of priority. The responses have served as guidance for the plans for the next term.

3. END-OF-TERM REPORT

Before developing the Strategic Plan for the next term, participants in IEA Wind reviewed the activities of the term just completed and compared the objectives set out with the results accomplished. The strategy and scope of activities were evaluated in light of the accomplishment of objectives. The results of this self-evaluation led directly to the development of the Strategic Plan in Section 4 of this report. This End-of-Term Report section reviews the activities of the term just completed and is organized according to the Guidelines for End-of-Term Reports [from IEA/CERT(2001)35].

3.1. Objectives and Strategy

The IEA Wind ExCo strategy is to advance deployment of wind energy generation capacity by providing information both on wind energy technology and on issues relevant to deployment of wind energy systems. To provide high-quality, relevant information, the ExCo conducts two kinds of activities.

1. Strategic Research

IEA Wind sponsors strategic research tasks (Annexes to the Agreement) conducted by organizations in member countries. Ideas and R&D projects presented by Members for new areas for co-operation are continuously considered by the ExCo for new research activities.

2. Information Distribution

IEA Wind collects information from member countries and distributes it in its Annual Report, through its Web site (www.ieawind.org), and through presentations at international conferences by the Chair, Vice Chairs, and other representatives of IEA Wind.

3.1.1. Strategic research

The objectives and scope of the IEA Wind Agreement have evolved over the five-year term just completed (2003–2008). Early in the term, the ExCo voted to change the name of the Agreement from “IEA Implementing Agreement for Co-operation in the Research and Development of Wind Turbine Systems” to the “IEA Implementing Agreement for Co-operation in the Research, Development, and Deployment of Wind Energy Systems.” The addition of “deployment” to the title reflects the increasing attention of the Member Countries’ governments to deployment issues needing research. The broadened objectives of the Agreement have resulted in the following research tasks that conduct applied research, system analysis, and design work to provide information and analysis on issues affecting technology deployment:

- Base technology information exchange (Task 11),
- Wind energy in cold climates (Task 19),
- Dynamic models of wind farms for power systems studies (Task 21) (completed),
- Offshore wind technology development (Task 23),
- Integration of wind and hydropower systems (Task 24) (completed),
- Power systems with large amounts of wind power (Task 25),
- Cost of wind energy (Task 26),
- Quality labeling of small wind turbines (Task 27), and
- Social acceptance of wind energy projects (Task 28).

Also this term, two aerodynamic research tasks were begun and one of these was completed.

- HAWT aerodynamics and models from wind tunnel tests (Task 20) Completed and
- MexNex(t) aerodynamic models and wind tunnel measurements (Task 29)

Two other technical research tasks were completed early in the term.

- Wind turbine round-robin test program (Task 16) (completed) and
- Database on wind characteristics (Task 17) (completed).

As a direct result of the work of these research tasks, IEA Wind has released more than 30 important technical reports and more than 100 journal articles and conference presentations (see www.ieawind.org) between 2003 and 2008. Nearly every research task has contributed to at least one dissertation, and sometimes up to five or six dissertations have applied work performed in a single IEA Wind research task.

During the term, four research tasks were completed and final reports issued along with journal articles published and conference papers presented. Another three tasks were ongoing over the term and issued state-of-the-art reports, submitted journal articles, and made conference presentations. They will continue their work into the next period. Four new research tasks were approved in 2007 and 2008 addressing the key issues of estimating costs, increasing safety for small wind turbines, improving social acceptance of wind energy projects, and continuing important aerodynamic analyses to improve models for wind turbine design. Several of these new tasks have been described in the IEA *OPEN Energy Technology Bulletin*.
Results from the work take many forms: shared databases, numerous technical papers and reports, Recommended Practice reports, proceedings from meetings, web sites, regular Annual Reports, brochures, and other publications.

IEA Wind will begin the next term with eight active research tasks, two more than at the beginning of the previous term, and more countries and more organizations are participating on average in each task.

3.1.2. Information distribution

During the past five-year term, IEA Wind published five issues of the IEA Wind Annual Report and distributed 2,500 printed copies each year. Beginning in 2005, the IEA Wind Annual Report (published continuously since 1977) includes an Executive Summary with improved statistics about wind energy in the Member Countries, including wind generation’s contribution to national electrical demand and wind sector economic turnover. The 270-page Annual Reports are sent to ExCo members for distribution within their countries to key target audiences. The Annual Reports are also available for free download on the IEA Wind Web site and have been assigned ISBN numbers to improve visibility to non-member countries.

Since 2003, more than 20 presentations have been given by the Chair and representatives of the ExCo on behalf of the Agreement about its work and the accomplishments of the research tasks. IEA Wind representatives gave presentations at the Australian Wind Energy Association and Global Wind Energy Council (GWEC) International Conference (2006) and at the Korean International Workshop for Wind Energy (2007). Operating Agents of all tasks have contributed to or chaired sessions at the major trade organization conferences: American Wind Energy Association (AWEA), European Wind Energy Association (EWEA), GWEC, etc. The Chair and vice chairs attended IEA/ETO-sponsored NEET workshops in 2007: Brazil, China, and South Africa. IEA Wind representatives have also attended IEA-sponsored workshops such as the one on G8+5 grid integration in 2006 to make sure accurate information regarding wind energy is being discussed. And the Chair attends the Spring REWP meeting to report on activities of IEA Wind.

ExCo members also contributed to key IEA publications such at the *Energy Technology Essentials* and *Energy Technologies at the Cutting Edge*. The ExCo Planning Committee has also taken a more active role in providing comments to IEA draft documents such as the electricity chapter for *IEA Global Energy Technology Perspectives* (2005–2006), the chapter on wind energy for *Energy Technology Perspectives* (2007), and the publication *Contribution of Renewable Energy Technologies to Energy Security* (2006–2007). The Secretary has supplied posters and documents to IEA-sponsored events including the IEA Ministerial Technology Fairs and NEET workshops.

The budget of the Common Fund supports many of these information activities including the Annual Report, the Web site, travel by the Chair and Vice Chairs to IEA meetings and conferences on behalf of the ExCo, and the work of the Secretary.

3.2. Participation of Countries, Industry, and Utilities

This term the IEA Wind Agreement welcomed three new members: the Republic of Korea, Portugal, and the first Sponsor member, the European Wind Energy Association. With the joining of Korea, membership in Asia and the Pacific Region increased, and the European Wind Energy Association brings important industrial perspective to the discussions during ExCo meetings and to the research tasks.

3.2.1. Member countries

By the close of 2008, 20 member countries, the European Commission, and the EWEA participated in the IEA Wind Agreement (Table 1). Portugal, Korea, and the EWEA joined during the term just completed. Some contracting parties changed within member countries, and New Zealand officially withdrew from the Agreement in 2003.

During this term, an active Membership Committee has solicited participation by observers in ExCo meetings to increase membership. The new members resulted from these efforts by the Membership Committee. Representatives from the following countries were invited at least once to attend ExCo meetings: Argentina, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Cyprus, France, India, Korea (Republic of), New Zealand (to rejoin), Panama, Poland, Portugal, Russia, South Africa, Turkey, and Uruguay.

The following organizations were also invited as observers between 2003 and 2008: AWEA, EWEA, the IEA Hydrogen IA, the IEA RETD IA, TPWind, and the World Wind Energy Association. EWEA responded by joining the Agreement and is an active participant in ExCo meetings and tasks. The presence of other organizations has contributed to ExCo meeting information exchange and promoting cooperation with appropriate research tasks.

Non-member country participation is a topic that is being addressed in the strategic planning process. Many countries could benefit from membership in IEA Wind, but participation has been limited and there are obstacles to overcome. These barriers include funding for membership fees, administrative complexities, and travel cost to attend meetings.

Table 1 — Contracting Parties to IEA Wind in 2008

Governmental Participants

Australia	Clean Energy Council
Austria	Republic of Austria
Canada	Natural Resources Canada
Denmark	Danish Energy Authority
European Commission	Commission of the European Communities
Finland	Technical Research Centre of Finland (VTT Energy)
Germany	Forschungszentrum Jülich GmbH
Greece	Ministry of Industry/Energy and Technology (CRES)
Ireland	Sustainable Energy Ireland
Italy	CESI RICERCA S.p.A and the Italian National Agency for New Technologies, Energy and the Environment (ENEA) Casaccia
Japan	Government of Japan
Korea	Republic of Korea
Mexico	Instituto de Investigaciones Eléctricas (IIE)
Netherlands	Netherlands Agency for Energy and the Environment (SenterNovem)
Norway	Norwegian Water Resources and Energy Directorate (NVE)
Portugal	National Institute for Engineering, Technology and Innovation (INETI)
Spain	Instituto de Energías Renovables (IER) of the Centro de Investigación; Energética Medioambiental y Tecnológica (CIEMAT)
Sweden	Energimyndigheten
Switzerland	Swiss Federal Office of Energy
United Kingdom	Department of Trade and Industry
United States	U.S. Department of Energy

Sponsor Participants

EWEA	European Wind Energy Association

3.2.2. Industry and utility involvement

Participants in IEA Wind recognize the importance of involving industry and utilities in the research tasks and information activities of the Agreement. This key objective was included in the 2003 Strategic Plan so that design of the research tasks would be informed by industry and utility needs and so that the R&D results would transfer quickly into the marketplace. During the term just completed, efforts to include industry were rewarded by the inclusion of the EWEA as the first sponsor member of the Agreement. In addition, industry and utility participation in IEA Wind research tasks has increased significantly during the term. A brief description of industry and utility involvement in the research tasks during the term follows. More detail can be found on the Task Web pages accessible from www.ieawind.org.

Task 11, Base Technology Information Exchange, included representatives from industry and utilities as invited by the ExCo members from participating countries (see Task 11 Web pages at www.ieawind.org Proceedings and Summaries lists of attendees at each Topical Experts Meeting and Joint Action Symposium).

Task 19, Wind Energy in Cold Climates, actively solicits input from the commercial sector and makes the data available for their use in designing wind generation projects and turbines.

Task 21, Dynamic Models of Wind Farms for Power System Studies, has included wind farm operators, transmission system operators (TSOs), and utilities in the data collection, analysis, and distribution of the task. The Operating Agent (OA) has been invited to meetings and workshops of utility and regulatory bodies (including the International Electro-Technical Commission [IEC]) to present the results of the task.

Task 23, Offshore Wind Technology Deployment, Subtask 1 has attracted many participants from industry and utilities to the meetings on critical issues of offshore deployment. Subtask 2 has active participation of wind turbine manufacturers. This may be because the model turbine used to test foundation models allows corporate designers to participate in the research without revealing any trade secrets. The experience gained in this task is then immediately used in industry to improve turbine designs.

Task 24, Integration of Wind and Hydropower Systems, has elicited significant participation by utilities that include hydropower in their generation mix.

Task 25, Power Systems with Large Amounts of Wind Power, (which will continue and will incorporate the work of Task 24) has active participation of research institutes and universities as well as of TSOs of most countries involved. The OA has been invited to meetings and workshops of the most relevant TSOs, utilities, and regulatory bodies to present the results of the task (e.g. the International Council on Large Electric Systems (CIGRE), the Utility Wind Integration Group (UWIG), and others).

Task 26, Cost of Wind Energy, began in late 2007 and intends to reach out to economic ministries and organizations developing cost models, including IEA.

Task 27, Consumer Labeling of Small Wind Turbines, just began in July 2008 and will encourage industry and standards groups to participate in the development of a labeling system that encourages common, simple, easy-to-apply, and low-cost testing procedures to guarantee the performance of this equipment.

Task 28, Social Acceptance of Wind Energy Projects, began in 2008 and will include university researchers, permitting bodies, developers, and organizations of local planning officials.

Task 29, MexNex(t) Aerodynamic Models and Wind Tunnel Measurements, is just beginning to attract participants from research institutes. Participants from research institutes and industry will also be involved in validating their models.

3.3. Programme and Nature of Work Completed

The annual work programme for IEA Wind includes the budgeted activities of the Secretariat and the Planning Committee and the work plans of the research tasks. These plans and budgets are reviewed and approved each year at the second ExCo meeting of the year.

3.3.1. Research task accomplishments

Each member of the IEA Wind Agreement participates in at least one of the collaborative research tasks (Annexes to the Agreement). The tasks completed and underway during this term are all cost-shared and task-shared, where the work is shared among the countries, and the countries share the cost of the OA. The OA acts as the coordinator of the research task. To cover the expenses of the OA, participants contribute funds as a task fee, which varies with the complexity of the task and the number of countries sharing the expenses. For example, most member countries participate in Task 11, Base Technology Information Exchange. This ongoing task (managed by Vattenfall) sponsors Topical Experts Meetings, Joint Action Symposia, and Recommended Practices. The cost for 2008 was 5,300 USD per country. For most tasks, once a country has committed to the task, any number of organizations (universities, research institutes, consultancies, government entities, and industrial enterprises) within the country may participate and share in the research results.

Results from IEA Wind task work, joint actions, recommended practices, and analysis of implementation progress and policies are published as journal articles by participating researchers and presented in some public conferences and forums. Details about the work of the tasks and the participants are presented below.

Table 2 — Participation in Research Tasks During the Term 2003–2008

	Research task numbers								
Participant	11	16	17	19	20	21	23	24	25
Australia								x	
Austria									
Canada	x	x		x	x			x	
Denmark	x	x	OA		x	x	OA		x
European Commission	x								
Finland	x			OA		x		x	OA
Germany	x			x			x		x
Greece		x			x				
Ireland	x					x			x
Italy									
Japan	x		x						
Korea	x						x		
Mexico	x								
Netherlands	x		x		x	x	x		x
Norway	x		x	x	x	OA	x	x	x
Portugal						x			x
Spain	x				x				x
Sweden	OA		x	x	x	x	x	x	x
Switzerland	x			x				x	
United Kingdom	x					x	x		x
United States	x	OA	x	x	OA	x	OA	OA	x
EWEA									x
	1987-ongoing	1995-2004	1999-2004	2001-2008+	2003-2008	2003-2007	2004-2008+	2004-2008	2005-2008+

Task 11, Base Technology Information Exchange (continuing)

This ongoing task promotes wind turbine technology through information exchange between experts on R&D topics of common interest. There are 16 countries and the EU in Task 11. They are: Canada, Denmark, European Commission, Finland, Germany, Ireland, Japan, Korea, Mexico, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

The range of Topical Expert Meetings and Joint Actions conducted during the last term from 2003 through 2008 are presented in Table 3. These meetings often result in the formation of a proposal for an IEA Wind research task (Annex). During this term, the following tasks were proposed as a result of meetings organized under Task 11: Task 23, Offshore Wind Technology Deployment; Task 24, Integration of Wind and Hydropower Systems; Task 25, Power Systems with Large Amounts of Wind Power; Task 26, Cost of Wind Energy; Task 27, Consumer Labeling of Small Wind Turbines; and Task 28, Social Acceptance of Wind Energy Projects. Task 29, MexNex(t) has grown out of Joint Action meetings held in collaboration with Task 20, HAWT Aerodynmics and Models from Wind Tunnel Measurements.

Task 11 has produced 19 reports distributed to participants and to member country ExCo representatives during the term [2]. To increase the visibility and availability of Task 11 reports, while maintaining incentive for task membership, the participants voted to make reports older than one year publicly available. They are posted on the Task 11 Web pages accessed through www.ieawind.org. Participants also voted to make the recommended practices documents available to non-member countries.

Table 3 — Topical Expert Meetings Held During the Term 2003–2008

	Topical Expert Meeting Subjects	Joint Action Subjects
2003	Integration of wind and hydropower systems	Aerodynamics of wind turbines (in collaboration with Task 20)
		Wind characteristics
2004	Acceptability of wind turbines in social landscapes	Aerodynamics of wind turbines (in collaboration with Task 20)
	Issues of offshore technology development	Wind forecasting techniques
	System integration of wind turbines	
2005	Radar, radio, radio links, and wind turbines	Aerodynamics of wind turbines (in collaboration with Task 20)
	Obstacle marking of wind turbines	
	Methodologies for cost estimation of wind energy	
2006	Operation and maintenance of wind power stations	Aerodynamics of wind turbines (in collaboration with Task 20)
	Challenges of reliable small wind turbines	
	Smart structures for blades of large wind turbines	
2007	Remote wind speed sensing with sodar, lidar, and satellites	Aerodynamics of wind turbines (in collaboration with Task 20)
	Wind and wave measurements offshore	
	Radar, radio, and wind turbines	
	Social acceptance of wind energy projects	
	Long-term R&D needs for IEA Wind	
2008	Smart Structures, follow up	
	Drive train dynamics and gear boxes	
	Forecasting wind energy production	
	Wind park performance assessment in complex terrain	

Task 16, Wind Turbine Round Robin Test Program (completed)
This task served to validate wind turbine testing procedures, analyze and resolve sources of discrepancies, and improve the testing methods and procedures. Four countries participated: Canada, Atlantic Wind Test Site (AWTS); Denmark, Risø Test Station for Wind Turbines; Greece, Center for Renewable Energy Sources (CRES); and the United States, National Renewable Energy Laboratory (NREL) (OA). Field tests were conducted at participating national laboratories and test centers, using a standardized 50-kW wind turbine. Comparison test results were used to validate test procedures and establish reciprocity among certification testing laboratories. The task was completed in 2003 and the final report published [3].

Task 17, Database on Wind Characteristics (completed)
As a follow-up to the EU-DG XII (JOULE) project, this project has provided wind energy planners and designers, as well as the international wind engineering sector, with easy access to quality-controlled, time-domain wind field measurement data collected in a wide range of environments (wind climates, terrain types, and wind turbine wakes). Denmark (OA), Japan, Norway, Sweden, and the United States participated in Task 17 and by October 2003, the database included more than 161,000 hours of wind field time series data from more than 62 sites. The task was completed, a final report was published [4], and the database now functions independently. The data may now be accessed for a fee at the Web site http://www.winddata.com.

Task 19, Wind Energy in Cold Climates (continuing)
This task was begun in 2001 to develop guidelines for applying wind energy in cold climates by gathering and sharing of information on operational experience and modeling. The seven participating countries include Canada, CETC/CANMET; Finland (OA), VTT; Germany, ISET; Norway, Kjeller Vindteknikk; Sweden, WindREN AB; Switzerland, ENCO Energie-Consulting AG; and the United States, NREL. They established a preliminary site classification formula for wind turbine designers, manufacturers, project developers, and wind energy producers. The task participants also collect data on the reliability and availability of standard and adapted wind turbine technology operating in cold climates.

Several key reports have been issued by this task. A state-of-the art report was published in April 2003 [5]. In March 2005, participants published a report in the form of an expert group study Wind Energy Projects in Cold Climates to provide the best available recommendations on this topic, reduce the risks involved in undertaking projects in cold climates, and accelerate the growth of wind energy production in areas that have been overlooked. This document addresses many special issues that must be considered over the lifetime of a cold-climate wind energy project. The Task Web pages (accessed from www.ieawind.org) are open to the public and include a discussion forum as well as links to data and reports generated by the project. A proposal to extend the work of the task past 2008 is under consideration of the ExCo for the September 2008 meeting.

Task 20, Horizontal Axis Wind Turbine (HAWT) Aerodynamics and Models from Wind Tunnel Measurements (completed)
This task to improve the accuracy and reliability of aerodynamics models began in 2003. Nine countries participated in this work: Canada, École de Technologie Supérieure; Denmark, Risø National Laboratory and Technical University of Denmark; Germany, University of Kiel; Greece, Center for Renewable Energy Systems (CRES); the Netherlands, Energieonderzoek Centrum Nederland (ECN) and Technical University of Delft; Norway, Institutt for Energiteknikk; Spain, Centro Nacional de Energias Renovables (CENER); Sweden, Gotland

University and Royal Institute of Technology; and the US, NREL (OA). The work compared theoretical aerodynamic model predictions of wind turbine blade and structural performance and loads with actual measurements taken in carefully controlled wind tunnel tests on actual turbines. The final report was published in 2008 [6], and the Task was closed. The final report includes reports by participants on data acquisition or reduction, data quality studies or uncertainty analyses, data analysis or exploitation activities, findings regarding wind turbine fluid mechanics, new/modified model subcomponents and validations, and new/modified integrated models and validations. The work has resulted in more than 34 journal articles, numerous conference presentations and two dissertations. The aerodynamic work of this task will be continued in Task 29, MexNex(t) Aerodynamic Models and Wind Tunnel Measurements, approved in April 2008.

Task 21, Dynamic Models of Wind Farms for Power Systems (completed)
This task began in 2003 to coordinate the development of wind farm models for use in combination with software packages for simulation and analysis of power system operation. The task included participants from nine countries: Denmark: Risø; Finland: VTT; Ireland: University College Dublin; the Netherlands: ECN and TU Delft; Norway, SINTEF Energy Research; Portugal: INETI; Sweden, Chalmers University of Technology; the UK: University of Manchester; and the US, NREL. Measurement data of wind farm output has been collected and shared among the participants. A benchmark test procedure for models was developed. The benchmark test procedure was used to compare simulation results against measurements. The final report was published in 2008 [7].

Task 23, Offshore Wind Technology Deployment (final report in 2009)
Participation in IEA Wind Task 23 gives participants an overview of the technical and environmental assessment challenges encountered in offshore applications and identifies areas of further R&D. This was a key issue identified for research in the IEA Wind 2003 Strategic Plan. Ten countries have committed to this work: Canada, Denmark (OA), Germany, Netherlands, Norway, Portugal, Spain, Sweden, UK, and the US (OA). So far, this work has two Subtasks. Subtask 1 on Experience with Critical Deployment Issues has explored ecological issues and regulations; electrical system integration; and external conditions, layouts, and design of offshore wind farms by holding meetings of interested parties.

Subtask 2 is exploring wind turbine technologies for applications in water deeper than 30 m. The objective of the task is to compare and validate the existing computer models for analyzing and evaluating offshore wind turbines on various types of foundations. This subtask has participation from industrial organizations including Vestas, Siemens, Eslam, DNV, Garrad Hassan and GL Windenergie, CarlBro, Ramboll, RePower, Norske Hydro, and Acciona Energia. Participating countries pay one fee and may have as many organizations involved as they like. The results of the task are so far reserved only for participants on a password-protected portion of the Task 23 Web site accessible from www.ieawind.org. This task will continue into the next term.

Task 24, Integration of Wind and Hydropower Systems (final report in 2009)
Addressing integration issues was also a key objective of the IEA Wind 2003 Strategic Plan. Within IEA member countries, more than 400 GW of hydropower capacity is available and in excess of 100 GW of wind power capacity. Eight participants joined this effort to conduct co-operative research in the areas of generation, transmission, and economics of integrating wind and hydropower systems: Australia, Hydro Tasmania; Canada, Natural Resources Canada,

Manitoba Hydro, Hydro Quebec; Finland, VTT; Norway, Sintef Energy Research, Statkraft Energy; Sweden, KTH Swedish Institute of Technology; Switzerland, EW Ursern; and the United States, NREL (OA), Arizona Power Authority, Bonneville Power Administration, and Grant County Public Utility District. The task has provided a common format for reporting case study results and identified technically and economically feasible system configurations for integrating wind and hydropower. The work of the task is documented in a library of reports available on the Task 24 Web site accessible from www.ieawind.org. A final report will be issued in 2009 [8].

Task 25, Power Systems with Large Amounts of Wind Power (continuing)

This task began in 2005 to address the issue of integrating wind energy into power systems by analyzing and further developing the methodology to assess the impact of wind power on power systems. Participants include the following countries and organizations: Denmark, Risø National Laboratories,TSO Energinet.dk; EWEA; Finland, VTT Technical Research Centre of Finland (OA), TSO Fingrid will follow the national project); Germany, ISET, TSO E.ON, TSO RWE, Ecofys participated in the kickoff meeting); Ireland, ECAR, TSO Eirgrid; Norway, SINTEF, Statkraft; Netherlands, we@sea, ECN, TUDelft; Portugal, INETI, TSO REN, INESCPorto, UTLIST; Spain, University of Castilla La Mancha, TSO REE participated in kickoff; Sweden, KTH (Lennart Söder); the UK, Centre for Distributed Generation and Sustainable Electrical Energy; and the United States, NREL, UWIG.

This research task has established an international forum for exchange of knowledge and experiences related to power system operation with large amounts of wind power. The goal of this forum is to facilitate the highest economically feasible wind energy penetration within electricity power systems worldwide. The task analyzes and develops methodologies to assess the impact of wind energy on power systems with an emphasis on technical operation. The goal has been to involve TSOs with the R&D task work. The participants have collected and shared information on the experience gained and have conducted additional studies during the task. The case studies address different aspects of power system operation and design: balancing, grid impacts, and capacity credit of wind power.

The task has issued a state-of-the-art report [9] on the knowledge and results gained so far. Participants are developing guidelines on the recommended methodologies to estimate the system impacts and the costs of wind power integration. Also, best practice recommendations are being formulated on system operation practices and planning methodologies for high wind penetration. A proposal for continuation of the work beyond 2008 will be considered in September 2008.

Task 26, Cost of Wind Energy (continuing)

Discussions about this task began in 2007 to develop a common, transparent methodology for estimating the cost of wind energy and to identify the primary differences among countries. So far, Canada; Denmark, Risø; European Wind Energy Association; Germany; the Netherlands, ECN; Sweden; and the United States, NREL have expressed interest in the task. Sensitivity analyses to identify the most significant parameters will be performed. Subsequent work will include estimating future wind technology cost and performance, primarily through learning curve analysis, and proposing ways of comparing wind energy costs to costs of other generation technologies.

Task 27, Consumer Labeling of Small Wind Turbines (continuing)

This task, approved in April 2008, will develop a system of quality labelling for consumers of small wind turbines. Potential participants include: Germany: Institut für Solare

Energieversorgungstechnik (ISET), Ireland: Association of Irish Energy Agencies, Italy, Japan: Japan Electrical Manufactures' Association (JEMA), Portugal: INETI, Spain: Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT) (OA), and Switzerland. The task will produce an IEA Wind Recommended Practice for Quality Labelling of Small Wind Turbines. It will also provide information for anyone interested in buying a small wind turbine, such as recommended methodologies and independent test reports on: SWT Power performance curves, SWT Acoustic noise emissions, SWT Strength and safety, and SWT Duration test. Reliable third party testers already exist, such as national laboratories, universities, and certification entities. The OA of this task will direct SWT manufacturers seeking to label their products to these groups. It should be noted that the actual testing of the wind turbines is out of the scope of this Task. The primary goals are to build bridges between SWT manufacturers and third-party testers and to provide private companies with a commonly accepted testing methodology. This task will complete its work in three years.

Task 28, Social Acceptance of Wind Energy Projects (continuing)

This task began work in 2008 to improve understanding by distinguishing three dimensions of social acceptance, namely socio-political acceptance, community acceptance, and market acceptance. Potential participants include: Canada, Denmark, Finland, Germany, Ireland, Italy, the Netherlands, Norway, Sweden, Switzerland (OA), and the United States. The task will establish an international forum for exchange of knowledge and experiences related to social acceptance and other societal issues. It will issue regular newsletters to keep participants informed of the issues and progress of the work. It will produce a state-of-the-art report on the knowledge and results so far on social acceptance of wind power installations, including a list of studies and online library of reports/articles. The work will establish "Best Practices" and tools for policy makers and planners to reduce project risks, reduce the time required to realize wind energy projects, and speed up the exploitation of the full potential of wind energy in the participating countries. The task will also establish strategies and communication activities to improve or to maintain the image of wind power.

Task 29, MexNex(t) Aerodynamic Models and Wind Tunnel Measurements (continuing)

As IEA Wind Task 20, HAWT Aerodynamics and Data from Wind Tunnel Measurements and the EU MEXICO project are completed in 2008, this Task will apply the data and analyses to improve aerodynamic models for wind turbine design. At the beginning of the Task, the following countries and organisations have expressed interest: Canada (École de technologie supérieur, Montreal), Denmark(DTU-RISO), Germany(University of Stuttgart, University of Applied Sciences, Kiel), Israel (Technion), Japan (Mie University/National Institute of Advanced Industrial Science), Korea (Kier), Netherlands(ECN (OA), University of Delft), Norway (Institute for Energy Technology/Norwegian University of Science and Technology, Spain (CENER), Sweden(Royal Institute of Technology/University of Gotland), United States (NREL). The European Union project MEXICO (Measurements and Experiments In Controlled conditions) collected data from 2001 to 2006 in the large German/Dutch Wind tunnel (DNW). The database can be used to validate and/or improve design and analysis models. This analysis of data will improve models but will take years of work. The IEA Wind Task 20 began analysis of the NASA Ames database. IEA Wind Task 29 will be a joint effort in which the Mexico measurements (together with the previously made NASA-Ames measurements) are evaluated. The goal is to validate and improve aerodynamic models including: Yawed flow models, Dynamic Inflow models, Free vortex wake models, Dynamic stall models (in yaw), General inflow modelling, Tip models, 3D models, CFD blade flow and near wake flow. The results (i.e.

the insights on accuracy of different models, and the recommendations/descriptions for model improvement) will be made public. The Task began in April 2008 and will continue through 2011.

3.3.2. Secretariat and Planning Committee activities

IEA Wind has expanded both internal and external information exchange within the constraints of the Common Fund budget supplied by member fees. To keep the costs of participating low, much of the information dissemination burden is placed on the ExCo members and on the Planning Committee, who contribute in-kind effort to the Agreement.

- ExCo meetings, a key vehicle for information exchange, now generally include a representative from IEA headquarters and invited observers from key organizations. They are organised so that one meeting each year addresses wind energy R&D activities and the other meeting addresses deployment and incentives.
- The IEA Wind Annual Report includes a chapter from each participating country and from each task OA describing activities for the calendar year just completed. Each year 2,500 printed copies are distributed by the ExCo members within their countries and at selected IEA events. These 270-page reports are substantive and comprehensive, providing an accurate historical record of the research, development, deployment, and maturation issues associated with this renewable energy technology in much of the world. The Executive Summary of the report contains trend data from the history of IEA Wind and extracts important information from the individual country chapters.
- A model press release about the IEA Wind Annual Report is provided to the ExCo members by the Secretary with the shipment of their printed reports. It is up to the ExCo members to publicise and distribute the report to target audiences within their countries.
- The IEA Wind public Web site (http://www.ieawind.org) has links to IEA Wind task Web sites, to the national sites of member countries, and to IEA. Some public information on IEA Wind has also been available on the IEA Web site.
- A password-protected Web site for ExCo Members only is used to post pre-meeting materials, official documents, materials presented at ExCo meetings, and documents available for review by all ExCo members.
- Design of a corporate image for reports, presentations, and correspondence was contracted from the Common Fund and began to be implemented at the end of the term. A color folder with the new logo was distributed to Members to use when handing out information about IEA Wind activities.
- Support for IEA Paris initiatives has been provided by the Secretary and Planning Committee. These included attending NEET meetings in Brazil, China, and South Africa (excellent potential participants in the IEA Wind Agreement), attending REWP meetings, supplying materials for ministerial meetings, reviewing draft IEA documents that address wind technology, and supplying text for drafts of IEA annual reporting documents.
- Completed release of paperback reprint in 2005 by Cambridge University Press of *Wind-Diesel Systems: A guide to the technology and its implementation*, 1994, pp 249. This book was the result of work coordinated by IEA Wind between 1985 and 1994. The Agreement receives royalties to the Common Fund from the sale of the book.

3.4. Coordination with Other Bodies

The main strengths of the IEA Wind Implementing Agreement (IA) in dealing with other Agreements or international programs are the large country representation in IEA Wind (20 members), the established research participation and knowledge of the subject area, and the effective management of the cooperation. Coordination brings benefits to IEA Wind and to the other organizations by avoiding duplication and/or contradiction of research results by promoting discussion of issues and research methods at the design stage of tasks. IEA Wind has coordinated (through the ExCo and through the research tasks) with the following IEA IAs: Demand-Side Management, Electricity Networks Analysis, Research & Development (ENARD), Hydrogen, Hydropower, Ocean Energy Systems, and Renewable Energy Technology Deployment (RETD). In addition, as required by the topic of the research tasks, cooperation takes place with the relevant international bodies such as CIGRE, IEC, TP Wind, various industrial and utility groups.

3.5. Information Dissemination

See Section 3.3 for a summary of the activities of the Secretariat and Planning Committee.

3.6. Scale of Activities and Management

Overall control of information exchange and of the R&D tasks is vested in the ExCo. The ExCo consists of a Member and one or more Alternate Members designated by each contracting party that has signed the Implementing Agreement. Most countries are represented by one contracting party, usually a government department or agency. Some countries have more than one contracting party within the country. International organizations may join the Implementing Agreement as sponsor members.

The ExCo meets twice each year to exchange information on the R&D programs of the members, to discuss work progress on the various tasks, and to plan future activities. The meeting is presided over by the Chair and two Vice Chairs. Decisions are reached by majority vote or by unanimity when financial matters are decided. Members share the cost of administration for the ExCo through annual contributions to the Common Fund. Contributions are based on the size of the economy as determined by the Organization for Economic Co-operation and Development (OECD) and IEA. The Common Fund supports the efforts of the Secretariat and other expenditures approved by the ExCo in the annual budget. Additional investments by Members in the Agreement are discussed in Sections 3.6.1–3.6.3.

To exchange information, all participating countries are encouraged to attend at least one of the two ExCo meetings held each year. These two-day meetings are hosted by one of the Member Countries. An additional half-day visit is usually planned to see a new wind project or manufacturing plant, including exchange of valuable technical information. Local industry representatives are encouraged by the host organization to meet the ExCo Members informally during the tours.

The IA text has been augmented by written Procedures for Research Tasks [10] approved by the ExCo for developing, conducting, and closing an IEA Wind research task.

3.6.1. IEA Wind annual membership

Contracting Parties pay an annual membership fee to a Common Fund which covers administrative expenses incurred in connection with the ExCo, including the Secretariat, travel to represent the ExCo, and some publications (e.g. Annual Report, Website, brochures, etc.). The cost of participation in IEA Wind has been kept low. From 2003–2008, the cost of participation has increased about 10%, from 2,690 USD/yr to 2,960 USD/yr for each share (see Table 4 Note 1 for country membership fees in 2007 and 2008). During the same period, the annual budget has increased from 98,600 USD in 2002 to 121,360 USD in 2008, partly due to new members joining the Agreement.

The ExCo objective of maintaining a budget surplus equal to or exceeding one-half of the annual revenue has been achieved throughout the term. Assets in the bank accounts and receivables were 125,225 USD at the end of 2002 and 91,746 USD at the close of 2007. The Common Fund is managed by NREL in the United States. An independent audit of the financial records is conducted annually. Costs to participants have been kept low thanks to new members and careful budgeting. However, increasing costs for printing and shipping the Annual Report may prompt another small increase in the coming term. Any increase in the scope of activity, for example increased efforts to publicize the work of the Agreement, may also prompt an increase in fees.

The IEA Wind ExCo structure has proven to be a flexible framework for cooperative action. The services of a part-time secretary for handling day-to-day operations in conjunction with the in-kind efforts of the Chair, Vice Chairs, and Planning Committee has proven effective. The Secretary's duties include editing the Annual Report, writing minutes of the ExCo meetings, managing administrative activities such as budgeting and preparing invoices, overseeing Web site development and maintenance, and preparing most correspondence with the ExCo members, OAs, and invited participants. Additional writing tasks are sometimes contracted as well.

The following level of effort has been expended in the last two years of the term just completed.
Secretary: 2 days per week (paid from Common Fund)
Chair: 1 day per week (in-kind contribution)
Vice Chairs: 2 days per month (in-kind contribution, 2 people)
Planning Committee: 1 day per month each (in-kind contribution, 5 members)

Table 4— Budget for 2007 and 2008

Budget Table	Budget 2008	Budget 2007
Revenues		
Paid Contributions	$121,360.00	$121,360.0
Royalties		
Total Revenues	$121,360.00	$121,360.0
Costs		
A ExCo Secretary - PWT Communicatio		
Labor - Secretary's duties, edit Annual Report, Web content	$46,737.00	$45,597.0
Administration - direct costs, including Web site	$5,150.00	$5,000.0
Travel	$7,175.00	$7,000.0
Total Secretary	$59,062.00	$57,597.0
B Annual Report		
Executive Summary/Overview Chapter	$12,398.00	$12,096.0
Design and Layout	$17,890.00	$17,452.0
Printing and Distribution	$23,292.00	$22,724.0
Total Annual Report	$53,580.00	$52,272.0
C Miscellaneous		
Approved travel for ExCo	$6,068.00	$4,707.0
Travel for Chair to REWP Meeting	$2,000.00	$2,000.0
Total Miscellaneous	$8,068.00	$6,707.0
Subtotal - Baseline Operating Expenses	$120,710.00	$116,576.0
D Expenses for Continuation		
End of Term Report	$0.00	$4,000.0
Strategy Plan	$0.00	$0.00
Logo/image Development	$2,000.00	$11,880.0
Folder Development	$0.00	$10,000.0
Total Expenses for Continuation	$2,000.00	$25,880.0
Total Costs	$122,710.00	$142,456.0
NET INCOME	**($1,350.00)**	**($21,096.0**

Notes to Budget Table

1. Revenues

Funds to receive against invoices to members in 2007. The members are:	Contributors	Total Contributior
A Austria,Denmark,EWEA,Finland,Greece,Ireland,Korea,Mexico,Norway,Portugal,Sweden	11	$32,560
B Australia,Canada,Netherlands,Italy,Spain,Switzerland, UK	7	$41,440
C European Commission,Germany,Japan,USA	4	$47,360

3.6.2. Task participation costs and in-kind effort

Participants in a research task contribute to the expenses incurred by the OA for managing the effort. The participants agree to a budget for these expenses in advance. The new term for IEA Wind begins with eight active research tasks. The fees vary according to the work proposed for the OA and the number of participants. Participants also conduct portions of the work designated in the program of work as their in-kind contribution to the effort. Cooperative research tasks with in-kind contributions of effort, in combination with a cost-shared contribution to support the OA, are being used in all of the active tasks this term and in the proposed next term.

During the current term, seven new Annexes (tasks) have been approved (compared to three new Annexes in the previous term and two in the term before that). At the close of this term, eight tasks were active (compared to six at the end of the previous term). This metric indicates an increased interest in IEA Wind and confidence in the value of IEA Wind research activities. It also indicates increased efficiency of the ExCo in identifying issues, encouraging response, and administering the approval of new Annexes.

3.6.3. Meeting costs

Participants contribute by covering the travel expenses for their members to attend meetings and workshops. The ExCo meets twice annually, and some of the research tasks meet several times per year. Toward the end of this term, travel costs have been minimized by holding “net meetings” by email and videoconferencing whenever possible.

3.7. Achievements and Benefits

In addition to advancing the technology, leveraging national research dollars, and lowering the cost of wind energy, the work of IEA Wind is contributing significantly to training the next generation of researchers. The shortage of trained wind energy experts has been identified as a constraining factor by several key studies. As indicated below, the cooperative research efforts of IEA Wind are contributing to the work of students in their dissertations. Through participation in these tasks, students are introduced to international research and to the latest in technical progress in the field.

3.7.1. Work toward objectives of the 2003 Strategic Plan

The two main objectives of the IEA Wind Agreement as stated in the 2003 Strategic Plan [11] remained the same throughout the term.

1. Co-operative research, development, and deployment of wind turbine systems, and
2. Information exchange on planning and implementation of wind energy activities in the participating countries.

The activities of IEA Wind over the completed term were consistent with the IEA’s Mission described in the CERT Strategic Plan [12]: to promote the development and deployment of advanced clean energy technologies in the member countries and around the globe. Response to the 2007 CERT plan will be discussed in the Strategic Plan portion of this report (Section 4). Table 5 is adapted from the IEA Wind 2003 Strategic Plan and summarizes the activities of the term just completed that addressed the CERT and IEA Wind objectives.

Table 5 – IEA Wind Strategic Objectives 2003–2008

CERT Objectives	IEA Wind Objectives	Accomplishments in Completed Term
1. To better identify and promote effective and innovative policies that **stimulate energy technology R&D.**	To actively promote effective co-operation on wind energy R&D through workshops, seminars, and collaborative work programmes. To improve the quality and breadth of wind energy policy information and analyses applied in the member countries.	Cooperation promoted by Task 11 activities throughout the term. Work programmes include completed (Tasks 16, 17, 20, 21, and 24), continuing (Tasks 11 and 19), and initiated (Tasks 20, 21, 23, 24, 25, 26, 27, 28, and 29) research tasks. Policy information provided by IEA Wind Annual Reports and by reports of research tasks.
2. To more clearly define and analyse energy technology issues and opportunities, and to enhance **development of analytical tools** that inform and support policy and program development in member countries.	To encourage the development of analytical tools addressing the integration of wind energy into future energy supply systems. To review future needs in wind technology R&D, in integration of wind into the energy supply system, and in other deployment issues and opportunities.	Integration tools developed in research Tasks 21, 23, 24, and 25. Long-term R&D meeting under Task 11. State-of-the-art reports Tasks 19, 23, 24, and 25.
3. To more vigorously foster **international networking and collaboration** in energy technology R&D.	To encourage the increased participation of the commercial sector in activities and planning. To increase collaboration across appropriate implementing agreements. To widen the influence of IEA Wind through collaboration with additional international bodies, exploiting appropriate IEA channels and initiatives.	New member EWEA, invitations to AWEA and other relevant organisations. Cooperation with IEA Hydropower IA, Hydrogen IA, RETD, and ENARD. Participation in IEA-sponsored NEET meetings: Brazil, China, South Africa.
4. To more effectively **communicate key lessons learned** through the CERT's activities to IEA member country governments and agencies, the research sector, and other interested parties.	To raise the profile of the activities and outputs of IEA Wind and increase the circulation of information.	Conference presentations on task results by OAs (Tasks 11, 19, 20, 21, 23, 24, 25, 26, and 28) and by ExCo Chair and Vice Chairs; contributed posters, annual reports, and brochures to IEA ministerial meetings. Public release of Task 11 reports after one year and all Recommended Practices; participation in international conferences in Australia and Korea.

3.7.2. Technology development and deployment

Every research task of IEA Wind has "success stories" resulting from the work. Some of these are highlighted in the task descriptions of Section 3.3.1 Research Accomplishments. Others are listed below.

3.7.3. Networking

The main advantage of the IEA Wind approach to information flow among researchers is the multinational nature of the meetings. All meetings have included no fewer than 4 represented countries and often include 10 to 15. These researchers will be from several of the major geographic areas (North America, Europe, Asia, or the Pacific Region). This broad representation expands the effect of experiences in any one country and reduces the likelihood of repeated mistakes or duplicated efforts. Exposure to this broader perspective is especially important for new researchers who may have a narrow view of the issues surrounding their interest in wind energy research.

Another advantage of IEA Wind meetings is the focused nature of the topics and the diverse group of discussants invited to address them.

In summary, benefits from the networking include:

- Reduced research cost by eliminating duplication of efforts
- Improved quality of research through peer review
- The international scope broadens the view of participants
- IEA tends to be less bureaucratic than most other networks
- Project strategy is largely determined directly by participating country members
- All participants are chosen as recognized experts in their field doing significant research
- IEA wind work is widely used by the research and policy community.

3.7.4. Policy relevance

The two types of activity of the IEA Wind Agreement are relevant to policy: strategic research and information distribution.

1. Strategic Research

The impetus for research tasks comes from the member countries as a result of the need for answers in the policy arena, so the results are immediately relevant. For example, the work to understand integration of large amounts of wind power into the utility grid supplied important information to policy makers in Ireland that helped reverse a ban on new wind energy development. Experts Meetings under Task 11 have improved communication among the parties concerned about radar impacts of wind energy systems that are holding up development in some countries. Contributions of Task 21 benchmark procedures to IEC standards efforts have improved power system studies conducted as part of wind farm design and permitting process. The experience sharing of Task 24 participants has improved the design of proposed projects to integrate wind and hydropower systems. Both the experience sharing and modeling efforts of Task 23 are influencing policy and improving the designs for offshore wind energy projects.

2. Information Distribution

Many new and innovative mechanisms and incentives for encouraging wind energy development are discussed at the ExCo meetings. Attending ExCo meetings provides a good opportunity for new government employees to gain international perspective on policy options. Information on the wide array of policy options in use in the Member countries is reported in the IEA Annual Report, the only comprehensive and authoritative source for this kind of information.

3.7.5. Efficient use of R&D resources

As indicated in the questionnaire filled out by IEA Wind participants and the April 2008 ExCo meeting, the highest marks were given to the questions about the added value of participation in the Agreement. Justified transaction costs, contribution to country energy technology goals, and use of R&D results by countries were highly ranked. To collect estimates of the value of the in-kind work performed and shared within the research tasks, the reporting format and design of Annex texts were revised this term. Drawing from the Annex texts and work plans of four tasks started and/or completed during the term, we see the enormous value received for a modest contribution by each participant.

- Task 20 HAWT Aerodynamics and Models from Wind Tunnel Measurements.
  Contribution per participant: 9,375 USD plus in-kind effort
  Total value of shared labor: 2,036,300 USD
- Task 21 Dynamic Models of Wind Farms for Power System Studies
  Contribution per participant: 15,500 Euro plus in-kind effort
  Total value of shared labor: 4,760,000 Euro
- Task 24 Integration of Wind and Hydropower Systems
  Contribution per participant: 16,430 USD plus in-kind effort
  Total value of shared labor: 6,237,000 USD
- Task 25 Power Systems with Large Amounts of Wind Power
  Contribution per participant: 7,002 Euro
  Total value of shared labor: 9,528,000 Euro

These numbers, while impressive, are only a small part of the value gained during participation in research tasks as discussed above. So comparison of tasks on labor value alone is not appropriate. For example, no value has been assigned to the increased access to the NASA data that participants received in Task 20. However, these numbers do indicate that investment in this kind of cooperative research effort yields major savings in R&D costs.

3.7.6. Overall significance and main achievements

The IEA Wind ExCo and research tasks have continued contributing to the advancement of wind energy technology and deployment during the last five years. Since the Agreement began in 1977, the countries most interested in promoting wind energy have participated.

Main achievements of the IEA Wind come from the research tasks.

- Task 11 Experts Meetings identified topics that have become seven new research tasks. Other topics explored this term may still evolve into research tasks for the coming term. Task 11 has also introduced new researchers to IEA Wind and the potential for international cooperation.
- Task 17 produced a commercially available database of wind characteristics for all researchers to use.
- Task 19 produced a state-of-the-art report and recommendations regarding wind energy in cold climates.
- Task 20 increased access to NASA wind tunnel data for the 12 participating organizations and allowed them to improve their models as a result.
- Task 21 contributed to IEC standards development and provided a benchmark procedure for validating dynamic models of wind farms. A common database for benchmark testing of wind turbine and wind farm models was set-up and operated as an aid for securing good-quality models.
- Task 23 Subtask 1 providing a forum for networking and sharing experiences on critical issues of offshore deployment. Task 23 Subtask 2 is providing a modeling forum for industry and research institutes addressing issues of foundations for offshore turbines.
- Task 24 developed and applied a case study approach to clarifying issues of wind/hydropower integration. The report addressed some issues thought to be critical and highlighted others that had been overlooked.

- Task 25 is providing credible analysis and methodologies to demonstrate the small negative and significant positive effects of large amounts of wind generation on the power system.
- And finally, all of the research tasks are helping to train the next generation of wind energy researchers.

4. STRATEGIC PLAN FOR 2009–2013

The purpose of this Strategic Plan for 2009–2013 is to provide direction and focus for the activities of the International Energy Agency Implementing Agreement for Co-operation in the Research, Development, and Deployment (RD&D) of Wind Energy Systems (IEA Wind) over the next five-year term. It builds on the Strategic Plan developed for the prior five-year term (2003-2008), which is available at www.ieawind.org. The IEA Wind Executive Committee (ExCo) generated this new Strategic Plan through a consensus process and is based on the recommendations of participants in the Task 11 Topical Expert Meeting (TEM) Long-Term Research Needs held on December 6–7, 2007 in Berlin, Germany (13). This Strategic Plan also incorporates views of the IEA Wind ExCo recorded in a survey conducted at the 61st ExCo meeting on April 22–24, 2008 in Aalborg, Denmark.

At the TEM on Long-Term Research Needs, the latest wind energy technology was reviewed by a wide array of interested experts. Based on this review, conclusions were drawn about the research needed to increase the penetration of wind energy in the world's energy mix, while reducing cost and enhancing performance.

IEA Wind will use the following RD&D areas to guide its activities during the next five-year term and beyond. The Plan is organized into three parts. First, the Plan presents the research needs identified by IEA Wind as strategic in the medium to long term to develop the full potential of the wind sector. Second, the Plan presents the strategic areas where IEA Wind will organize R&D activities over the next five years. Third, the Plan describes R&D Tasks for the coming term, both those that are scheduled to continue from the last term and those that will be initiated during the next term.

The key RD&D areas for the wind energy sector were identified by the IEA Wind ExCo as follows:

1. Wind technology research to improve performance and reliability at competitive costs
2. Research on power system operation and grid integration of high amounts of wind generation including development of fully-controllable, grid-friendly "Wind Power Plants"
3. Planning and performance assessment methods for large wind integration
4. Research on offshore wind in shallow and deep waters
5. Research on social, educational, and environmental issues

4.1. Long-Term Research Needs for the Wind Sector

The core activity of the Wind Implementing Agreement continues to be collaboration on technology R&D to improve cost and performance and to increase the deployment of wind energy systems. The successful formula of the preceding terms will remain the cornerstone of future activities. In the years ahead, IEA Wind will draw from this list of long-term research needs to initiate new research tasks and continue those under way.

4.1.1. Wind technology research to improve performance and reliability at competitive costs

Developers and financial institutions want (and need…) reliable and cost effective wind turbines rather than just larger ones….[2]

Experts and the IEA Wind ExCo identified six areas for research to reduce costs and improve performance.

4.1.1.1 Reduce production costs by using new and recycled materials, new production techniques, and new methods for transport and installation.

The cradle to cradle concept fits the wind sectors renewable nature like a glove...[2]

The wind turbine industry employs materials and components that use large amounts of energy during production. The costs of these components are rising – driving up the overall price of wind technology. Work is needed to: Transition from single unit manufacturing to automated serial production to provide cost reduction through economies of scale; Use new materials such as thermoplastics and permanent magnets; Recycle materials when older turbines are exchanged for newer ones. The "cradle to cradle" concept for recycling needs to be fully applied in the wind sector.

A significant part of the cost of today's wind power plants come from the transport and commitment of heavy infrastructures for installation. Work is needed to improve logistics – optimization of transport type, time and installation – through: Sustainable, intelligent and low-cost transport means (boat, train, and truck) and installation equipment and concepts designed especially for large wind power plants; Procedures for commissioning on quay, transport, and assembly.

4.1.1.2 Increase component and sub-system performance and reliability.

System improvements are required to meet the necessary cost reduction; single component improvement is not enough). [2]

New and improved components for wind power plants should be incorporated by: Adding intelligence to get smart rotors, flexible drive trains, and magnetic bearings; Developing new bearing structures; Developing advanced multi-megawatt, low-speed generators; Improving generators through characterization of problems and better understanding of transient behavior for power system simulation; Using superconducting generators to reduce weight, decrease size, and avoid gearboxes; Achieving better communication between wind turbine systems, components, and the electric grid.

4.1.1.3 Reduce costs of wind turbine towers.

…about 26% of the wind turbine cost derives from the tower…[2]

Wind plants use large amounts of steel and developers must compete with rising world demand for steel. Decreasing the amount of steel needed for wind turbine towers offers a good opportunity to reduce costs. With this in mind, some manufacturers are producing concrete towers. In the coming years, an enormous impact on the overall cost of wind energy could be achieved by research to identify processes, materials, and strategies that minimize loads on towers. Research to explore alternative tower materials will also be important.

4.1.1.4 Reduce operations and maintenance costs that are driven by subcomponent characteristics.

Reliability is a key issue today. Design life does not live up to production service life [2].

To reduce O&M costs, research is needed to: Study component reliability by comparing the rate and type of failures to design life; Develop condition-monitoring O&M (learn from best practices in industries such as oil and gas); Increase availability (a function of reliability and accessibility); Improve the reliability of small turbines; Improve security of operation and, for offshore wind, ship safety; Develop reliable sensing devices (learn best practices from other industries such as aircraft, oil, and gas); Develop remote sensors with intelligent software (the use of redundant sensors and measuring devices is common in other energy sectors, but not for wind turbines).

4.1.1.5 Explore Advanced Design Concepts

Incremental development is important but new concept development must always be there: Up scaling is a method not an objective....[2]

Experts agree that research is needed to produce new design concepts in both the short and long term. Some ideas worth exploring are: New rotor concepts—achieve larger diameter rotors without increasing structural loads and develop more efficient and reliable drive trains; Lighter structural design—this element is not necessarily a design driver, but it is a subordinate cost driver; New drive train concepts—increase efficiency, reliability, and ease of maintenance; Combine passive control methods built-in with multi-variable control; Fast up-scaling: 'skip' the first half of the blade, make it a 'truss;' Applied research on aerodynamics and wakes; Control strategies for load reduction—adapt turbines to anticipated loads in various situations; Design validation—current design standards are considered not to be conservative enough in certain areas; e.g., loads and load transmission in drive trains for static and dynamic situations.

4.1.1.6 Improve Test Facilities

We "desperately" need large full-scale test facilities for onshore and offshore wind energy!...[2].

Today's test facilities must be adapted and new facilities developed to: Test larger blades, innovative drive trains, and new materials to verify design models and performance characteristics; Test wind turbines designed to operate in cold climates; Assess the dynamic interferences between the wind turbine's natural frequencies and the effects of wind, waves and currents are needed for floating systems for deep offshore applications; Test and validate the ride through-fault capability of individual wind turbines and of wind farms.

4.1.2. Power system operation and grid integration of high amounts of wind generation

Power variable sources as wind, need to cope and respond to the power system transient events and quality of service. However grids systems must also change to accommodate, not only the variability of demand, but also the one from the generation, with specially focus on renewable sources, if we want to build an energetically sustainable future [2].

4.1.2.1 Grid Integration and System Operation

Research should provide: New concepts to address grid integration and power quality issues; Smart control of turbines (power control);Operation of power system with high wind penetration – system operation and balancing of the power system; Development and validation of dynamic models of wind power plants and aggregation of multiple wind power plants for assessment of the power transient behavior; Security of supply.

4.1.2.2 New Integrated Power System Applications

The "smart grids" of the 21st century will be characterized by the distributed contribution of all energy sources, not only in terms of generation, but also in what relates to production regulation and to the contribution to the control and stability of the power system [2].

Research should explore: Advanced energy storage solutions; Plug-in vehicles (benefits: energy storage and transportation); Integrated demand-side and wind generation management; Wind power plant in combination with reversible hydropower station (with pumped storage); New applications for production regulation such as water desalinization, clean water production, and hydrogen production.

4.1.2.3 Fully-Controllable, Grid-friendly Wind Power Plants

Wind power plants must be grid-friendly, but power systems must also be wind-friendly….[2].
Research should: Improve energy production forecasting for system operation; Provide for regulation and control of wind generation: wind power as a dispatchable, "ride-through-fault" power source; Develop control models and systems to optimize the output of wind farms as power plants; Assess the feasible wind contribution for voltage and frequency regulation; Improve communication between system operators, DSO , wind power plants and wind turbines; Provide monitoring and central control systems for aggregates of wind power plants.

4.1.3. Planning and performance assessment methods for large wind integration

"There is no favorable wind, if we don't know where we are going...."[Seneca]

4.1.3.1 Wind Field Knowledge

Research is needed to: Improve resource assessment and forecasting - develop forecasting tools with increased accuracy; Explore methods to recover the kinetic energy in the wake of wind turbines and arrays to optimize the energy production of wind power plants; Increase knowledge of wind field in front of the turbine for improved control strategies.

4.1.3.2 Wind Power Plant Performance in Complex Conditions

Deployment of large wind power plants in complex (mountainous or forested) terrain introduces added challenges in the characterization of the wind behavior inside the plant, the development of wakes, and the operation of wind turbines in highly turbulent fields. Simple wind models currently in use are inaccurate and introduce severe problems from a financial and operational perspective. Research is needed to develop: Reliable tools (computational fluid dynamics -CFD, wind tunnel and field tests); Accurate Energy Production Assessment for wind power plants, with special focus on complex terrain; Accurate wake models for large wind power plants; Methods to optimize and smooth the power output of large wind power plants; Methods to determine the interference of wind turbines (aerodynamic and electric); Models to determine noise propagation for medium to very complex terrain; Prediction tools for deployment in cold climate areas: Rime ice forecasting, icing events prediction, turbulence effects, and snow-covered blades effects; Objective methods for siting risk assessment.

4.1.4. Offshore wind in shallow and deep waters

Offshore wind energy is important in countries committed to meeting large portions of electric demand with wind energy. Offshore wind deployment in 2008 had costs ranging from 150% to 200% higher than for installations onshore. However, this is a potentially unlimited resource, if the deep offshore waters are conquered. IEA Wind has organized workshops outlining issues and has coordinated modeling work on offshore foundations. Developing offshore wind energy presents design challenges including predicting loads from the combined forces of wind, waves and ice; designing support structures for shallow and deep waters (>30 m); developing systems for transportation, installation, and maintenance of turbines; and developing larger machines. To further reduce the cost of offshore wind energy, special wind turbine designs are needed for shallow and deep waters. Although offshore wind is more mature then the ocean energy technology, there are common constraints and deployment steps. Co-operation with IEA Ocean Energy Systems and IEA Renewable Energy Technology Deployment (RETD) Implementing Agreements.

4.1.4.1 Offshore Wind Power Plants in Coastal Waters (<50 m)

Research is needed to achieve: Offshore wind and ocean measurements and resource assessment – today, insufficient data is available for siting offshore wind plants; Sustainable, intelligent and low-cost transport means (boat, train, etc.) and installation equipment and concepts dedicated for offshore wind development; Improved access to offshore structures; New foundation design concepts for shallow waters – reduce cost of structures and installation; Remote and satellite measuring systems; Offshore applications – optimization of traditional structures and development of new low-cost, easy-to-install structures; Environmental impact assessments for offshore wind development; Integrated wind and wave energy conversion technologies for shallow water.

4.1.4.2 Offshore Wind Power Plants in Deep Waters

Research is needed to contribute to: Offshore planning, measuring, and monitoring methods for deep waters; New foundation design concepts for deep waters – floating technologies for wind turbines and power plants; New concepts for large multi-megawatt wind technologies for deep waters; Offshore infrastructures and construction development (rigs, mooring and anchoring).

4.1.5. Social, educational, and environmental issues

Even where the economics of wind energy are favorable, deployment can only occur when the public and the planning authorities accept the technology. This requires an appreciation of the benefits of wind energy that weigh against any local visual and environmental effects. The evaluation of this balance is often complicated by its subjective nature and by the circulation of misinformation.

4.1.5.1 Social Acceptance of Wind Energy Projects

Local resistance to new wind energy projects is becoming more commonplace as the number of installed wind turbines are increasing in spite of public surveys that have revealed very high levels of support for the renewable energy technology, and wind energy in particular. Activities are needed to: Establish an international forum for exchange of knowledge and experiences related to social acceptance and other societal issues; Document the state-of-the-art on current knowledge and results on social acceptance of wind power installations and provide a library of relevant; Establish best practices and tools for policy makers and planners to reduce project risks, accelerate time of project development, accelerate development of the full potential of wind energy to meet regional and national targets; Establish strategies and communication activities to improve or maintain the image of wind power; Develop an internationally accepted method for calculating the cost of energy for wind systems and the resulting cost of energy from wind energy projects; Determine the learning curve for wind energy to allow governments and the research community anticipate the future trends of wind generation costs; Compare the cost of wind energy with those of other electricity generation technologies and determine the value of wind energy in terms of its contribution to reducing greenhouse gas emissions, to decreasing electricity prices, and decreasing the overall risk of the energy system.

4.1.5.2 Education and Training

International collaboration between national programs and industry experts is essential to providing the necessary education and training for the global wind industry. Work is needed to: Establish an international academic network among leading national universities and laboratories to educate students, transfer knowledge, and provide research opportunities for post-graduates and professors; Establish cooperative research and development agreements between national state-of-the-art test facilities and field demonstration facilities; Expand the participation of the commercial sector in developing an international academic network and cooperative R&D agreements between national programs and seek opportunities for industry co-funding.

4.1.5.3 Environmental Impacts

Wind energy offers many benefits to the environment, especially compared with other forms of electricity production. Wind energy production can also negatively affect local ecology and communities and may require methods to mitigate risks and uncertainties. Work is needed to: Organize international workshops relating to critical environmental research issues for onshore and offshore wind power projects to identify RD&D gaps that are of national interest and identify specific joint research areas requiring further investigation; Exchange baseline environmental data and research methods for pre- and post construction studies; Establish criteria for comparing environmental impact assessments among nations for onshore and offshore wind developments; Develop comparative methodologies from avian and mammal and surveys and assess potential cumulative effects to the land and marine ecosystems; Establish best practices for planning and approval procedures related to the permitting and monitoring of wind power projects.

4.1.5.4 Military and Other Issues

Among military and civilian pilots there is a serious concern about the impact of wind parks on planes and helicopters operating at low altitudes in extreme emergency situations (e.g. forest fires, offshore oil and gas platforms during storms and fog). To help remove this barrier to wind energy development, work is needed to: Determine the minimum non-interference flow fields of flying devices and wind turbines to assess the safety of flights under these conditions; Determine the interference of wind turbines on communications and radio links or misidentification of moving wind turbines on radar systems.

4.2. Meeting Research Needs in the Framework of the IEA Wind Cooperative Agreement: Strategic Plan for the Period 2009–2013

For the next five years the Wind Implementing Agreement will conduct research Tasks addressing the five key research areas identified by IEA Wind and presented in Section 4.1. The specific R&D Tasks in place and potential activities for the new term are presented bellow. For a detailed description of the active Tasks, see Section 3.3.1.

4.2.1. Wind Technology research to improve performance and reliability at competitive costs

Activities in Place in 2008

- *Task 11, Base Technology Information Exchange*
- *Task 19, Wind Energy in Cold Climates*
- *Task 26, Cost of Wind Energy*
- *Task 27, Consumer Labeling of Small Wind Turbines*
- *Task 29, MexNex(t) Aerodynamics*

Possible activities for the new term

- Work on new materials
- Work on automated manufacturing
- Work on improving methods of transport and installation
- Work on drivetrain (gearbox) reliability
- Work on tower designs
- Design of advanced blade structures
- Support increased availability and effectiveness of testing facilities and methods for cold climate and offshore wind

4.2.2. Power system operation and grid integration of high amounts of wind generation and the development of fully-controllable system-friendly wind power plants

Activities in place 2008

- *Task 11, Base Technology Information Exchange*
- *Task 25, Power Systems with Large Amounts of Wind Power*

Possible activities for the new term

In the power system integration area, close cooperation with other IEA Implementing Agreements can increase the effectiveness of the results. Of special note is the intended co-operative research regarding “New integrated power system applications with high wind penetration” conducted with the Demand Side Management and the Energy Storage Agreements.

- Work to address grid integration and power quality
- Develop smart controls
- Work on methods to balance the power system

- Improve and validate dynamic models that aggregate wind power plants to assess transient behavior
- Demonstrate security of supply through capacity credit and power system's flexibility
- Enhance regulation and control of wind generation as a dispatchable power source that can ride through faults
- Develop control models and systems to optimize the output of wind farms as power plants
- Assess the feasible contribution of wind power for voltage and frequency regulation
- Advanced energy storage solutions for high wind penetration (Energy Storage Agreement)
- Plug-in vehicles for energy storage and transportation (Hybrid and Electric Vehicles Agreement)
- Integrated demand-side management and wind generation management (Demand-Side Management Agreement)
- Wind power plant in combination with reversible hydro power station (with pumped storage). (Hydropower Agreement)
- New applications for the regulation of wind generation such as production of desalinated and clean water, hydrogen, and others.

4.2.3. Planning and performance assessment methods for large wind integration

Activities in place 2008

- *Task 11, Base Technology Information Exchange*
- *Task 19, Wind Energy in Cold Climates*
- *Task 25, Power Systems with Large Amounts of Wind Power*
- *Task 26, Cost of Wind Energy*
- *Task 28, Social Acceptance of Wind Energy Projects*

Possible activities for the new term

- Improve resource assessment and forecasting tools
- Develop recommended practices
- Develop and validate performance assessment tools (computational fluid dynamics, wind tunnel, and field tests
- Develop methods for energy production assessment, with special focus on complex and densely forested terrains
- Applied research on aerodynamics and wakes

4.2.4. Offshore wind in shallow and deep waters

Activities in place 2008

- *Task 11, Base Technology Information Exchange*
- *Task 23, Offshore Wind Technology Development*
- *Task 25, Power Systems with Large Amounts of Wind Power*

Possible activities for the new term

- Research to improve wind and ocean measurements for resource assessment
- Research on offshore infrastructures and construction such as transport, rigs, mooring, and anchoring
- Research to optimize traditional structures and develop new low-cost, easy-to-install structures
- Research and modeling to validate floating technologies for wind turbines in deep water
- Promote test facilities for offshore wind turbines in water
- Co-operation with IEA Ocean Energy Systems and IEA Renewable Energy Technology Deployment (RETD) Implementing Agreements on common constraints and deployment steps.

4.2.5. Social, educational, and environmental issues

Activities in place 2008

- *Task 11, Base Technology Information Exchange*
- *Task 19, Wind Energy in Cold Climates*
- *Task 23, Offshore Wind Technology Development*
- *Task 25, Cost of Wind Energy*
- *Task 27, Consumer Labeling of Small Wind Turbines*
- *Task 28, Social Acceptance of Wind Energy Projects*

Possible activities for the new term

- Establish an IEA Wind Network of Training Institutions with links for wind energy employment entities, within the IEA wind website
- Establish a network among test facilities and field demonstration sites
- Develop methodologies to compare environmental impact studies
- Facilitate exchange of information on radar and radio effects of turbines

4.3. Strategic Objectives and Plan

Table 6 — Action Plan to Meet Objectives 2009–2013

Strategic Objective	Key Issues	Forward Plan	Action Path
1. Wind technology research to improve performance and reliability at competitive costs	➢Basic R&D: increased value and reduced uncertainties, cost reduction.	➢Continue core technology R&D activities ➢Increase engagement with the commercial sector.	➢Exploit existing mechanisms to continue to identify and advance the state-of-the-art across R&D topics ➢Convene expert meetings and new annexes on offshore issues.
2. Power system operation and grid integration of high amounts of wind generation	➢Systematization and development of methods to assess the impact of the wind generation on the power system design and regulation.	➢Continue core R&D activities ➢Assess balance costs depending on the structure of the energy mix ➢Assess capacity credit and flexibility of representative power systems.	➢Continue to advance the state-of-the-art in the area of power system operation with large wind penetration ➢Convene expert meetings and new annexes on “grid integration issues” ➢Increase engagement with the power system operation sector.
3. Planning and performance assessment methods for large wind integration	➢Need dynamic models, performance assessment methods, and improved methods to estimate production in complex terrain.	➢Expand on existing grid-integration and power quality work ➢Develop new computational fluid dynamics and energy balance methods with special focus on complex and densely forested terrains.	➢Consider additional expert meetings to complement the work under Task 25. ➢Consider new tasks on performance assessment.
4. Offshore wind in shallow and deep waters	➢Need to model loads and design support structures for deep water (>30 m) and floating structures ➢Need better transport, installation, and maintenance.	➢Increase emphasis on offshore technology and environmental issues ➢Conduct periodic review of long-term R&D needs ➢Gain increased input from industry.	➢Extend foundation design work of Task 23 ➢Based on final reports of Task 23, develop new Task proposals ➢Expert meeting on long-term R&D needs towards the end of this term ➢Review strategy document and generate annual work plan.

Strategic Objective	Key Issues	Forward Plan	Action Path
5. Social, educational, and environmental issues	➢Increase relevance of IEA activities for member countries ➢Wind within future energy supply systems ➢Energy systems modeling ➢Support mechanisms and markets for wind in the context of all renewables ➢ Increasing the visibility and quality of information generated ➢Environmental and societal issues: effects on flora and fauna, visual influence.	➢Gain the more active involvement of the commercial sector ➢Gain participation of planning and policy steak holders. ➢ Increase membership and information dissemination activities.	➢Continue Task 28 work to address societal issues ➢National representatives continue to liaise with relevant commercial sector organisations ➢Hold dedicated events with the commercial sector ➢Collaborate with other implementing agreements ➢Continue presentations at targeted events ➢Exploit appropriate IEA dissemination channels ➢Continue to produce and distribute the annual report ➢Update the strategy annually.

4.4. Strategy and Performance Review

This latest Strategic Plan is for use as a guiding reference document and not as a rigid commitment to a course of action. Therefore there will be periodic reviews to take proper account of changes in circumstance in light of the thinking behind the existing strategy.

The annual review of this Strategic Plan should involve an appraisal of objectives and should take account of any movement on key issues. The review should result in the generation of an annual action plan. The annual strategy review and associated action plan will fulfil the IEA requirement for an annual work programme.

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