

Project Description

For

**Meso-Scale and Micro-scale
Modelling in China**

- CMA Component-

WED Reprogramming September 2007
PMO

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1. Background and context

1.1 Project Justification

Regarding the background in general, reference is made to:

Programme Document, Renewable Energy Programme, Wind Energy Development (WED), People's Republic of China, Final, Danida Ref. No. 104.Kina.1.MFS.2, November 2005.

The Programme Document describes the National Sector Context, including context, key sector institutions, main related donor activities, Agreed assistance, Strategic and methodological approach, Scope and objective, as summarised in the quote below:

"Description

China's energy consumption is increasing dramatically and there is a need to find alternative and environmentally friendly energy sources. China has therefore approved a new Renewable Energy Law on February 28th 2005, setting the overall legal frame for further development of renewable energy in China. The law will come into force by January 1st 2006.

There are good wind resources in China. These can be utilised to reach the targets for renewable energy and save huge amounts of pollution. However, in order to fully harness the wind resources in an efficient and sustainable manner, China needs to further develop the regulatory framework at national level and enhance skills on national and provincial planning and development of wind projects. There is also a need for improved wind measurements and resource assessments as well as need for improved knowledge, analyses, and tools for large-scale integration of wind energy into the power transmission systems. Finally there is a need for improved skills for management and operation of wind farms and knowledge of wind turbine technology.

This renewable energy programme will contribute to enhance the sustainable use of wind energy through knowledge transfer and capacity building at central level and in the three North-eastern provinces Heilongjiang, Jilin and Liaoning.

The development objective of the programme is:

Renewable energy contributes significantly to the energy supply in China.

The intermediate objective of the programme is:

Framework, plans and capacities improved on effective exploitation of wind energy at national level and in the three selected provinces.

The programme is divided into three elements: 1) Wind energy planning, 2) Support to institutes of excellence, and 3) Training of stakeholders.

The expected outputs of the programme are:

- Regulatory framework is in place, which will facilitate that wind energy projects are being planned, tendered and approved at optimal sites and according to procedures,*
- Design of wind energy projects are based on quality data and methodologies, allowing for efficient use of the wind resources for power production,*

Wind farms in the North-eastern provinces are better developed managed and operated. Networks are established and functioning among relevant stakeholders in the wind energy sector.“

The programme will focus on capacity building of institutions. This will imply training of people, but the aim is to secure that in depth knowledge is embedded in the partner organisations in order to secure long-term sustainability.

“The WED project will Support to Institutes of Expertise with the following immediate objective:

a. ...

b. Institutes of expertise understand the concept of MESO-scale wind models and can use output as input for the WAsP (Wind Atlas Analysis and Application Programme) model and conduct training in wind energy measurement techniques, wind data analysis, preparation of wind atlases and micro siting;

...”

[end of quote]

China Meteorological Administration (“CMA”) is the main implementing institution in relation to wind resources. In the immediate objectives linked to the WED project, CMA as an Institute of Expertise is expected to understand the concept of MESO-scale wind models and can use output as input for the WAsP model and conduct training in wind measurement techniques, wind data analysis, preparation of wind atlases and micro-siting. And the Centre for Wind and Solar Energy Resources Assessment (CWSERA, CMA) will fully benefit from the programme and shall be able - through training - to understand and use the WAsP model to an extent, where CWSERA can teach others, and also supplement the model with necessary additional wind measurements to fully benefit from the model.

Risø National Laboratory, Technical University of Denmark, (Risø DTU) has been active for decades in this area, and has developed the WAsP software, a microscale modelling tool for

wind farm energy calculations, and the KAMM/WAsP method, for the calculation of wind resources over large areas. The KAMM/WAsP system output is compatible with WAsP, which allows mesoscale results to be applied all the way down to the microscale for wind farm energy calculations.

CMA has also been engaged in mesoscale modelling activities for wind energy applications. The model from Environment Canada, MM5, is currently being used extensively for wind mapping in China. Other models such as RAMS, MC2, ABL (Atmospheric Boundary Layer model) are also being used. CMA has been using the WAsP microscale model for wind resource assessment and siting for more than 10 years and will also be able to apply the Canadian model MS-Micro, which is part of the AnemoScope Wind Energy Simulation Toolkit (WEST) now installed in CMA. CMA further has plans for in-house modification of the MS-Micro model (not supported by WED).

1.2 Project Initiation

At the first WED Steering Committee meeting on 27 October 2006, it was approved to undertake the mesoscale modelling for wind resource assessment as described in the Programme Document, with capacity building and mapping initially for the three NE provinces of Heilongjiang, Jilin and Liaoning. The approach intended is to establish a so-called twinning arrangement between CMA and Risø DTU, for which agreements with the Danish institutional twinning partner shall be made in accordance the rules of the Danish Ministry of Foreign Affairs for Institutional Cooperation, June 2004. The twinning arrangement further entails that Risø DTU will finance part of its own participation.

Risø DTU visited CMA and WED in Beijing during the period 4-12 December 2006 in order to discuss the possibilities for such a twinning arrangement with CMA. Subsequently a number of meetings between CMA, Risø DTU and WED have further discussed the content of the CMA component, the outcome of which is included in these Project Descriptions.

At the latest WED PSC meeting on 04 June 2007 it was decided to entrust a team of 4 people with the drafting of 3 sets of Project Descriptions adapted to the revised implementation strategy by which 3 central level institutions will assume responsibility for implementation of 3 “packages” of WED supported activities.

1.3 Project Context

1.3.1 CMA

CMA has been engaged in mesoscale modelling activities for wind energy applications for some years. The model from Environment Canada, MC2, is currently being used extensively for wind mapping in China. Other models such as RAMS, MM5, ABL (Atmospheric Boundary Layer model) are also being used. The WRF model is also being considered by CMA.

As the national body for meteorological measurements, weather forecasting, etc. CMA has a long track record of operating comprehensive networks of meteorological stations in all regions of China. The measurements are performed according to World Meteorological Organisation (WMO) standards or better. More recently, CMA has also been engaged in wind resource assessment activities and has experience in installation and operation of tall masts. Furthermore, CMA has profound knowledge of the climatological conditions encountered in China.

CMA has been using the WAsP microscale model for wind resource assessment and siting for more than 10 years and will also be able to apply the Canadian model MS-Micro, which is part of the AnemoScope Wind Energy Simulation Toolkit (WEST) now installed in CMA. CMA further has plans for in-house modification of the MS-Micro model.

CMA is in the process of initiating major project activities in wind resource assessment, among others a large nationwide 5-year programme, which is planned to include more than 400 measurement stations and mesoscale modelling to aim for complete geographical coverage of all of China, with high resolution and high quality wind resource assessment. This programme, financed by the Ministry of Finance has a budget of approx. 200 million CNY.

This project called “High Resolution Wind Energy Assessment Project” will be organized by NDRC, MoF and CMA. CMA will be in charge of the wind measurements, data analysis, mesoscale modelling (WEST model has been selected) and wind assessment. Data will be measured for at least 2 years. Most of the masts will be used for calibration of models.

The above project will focus on areas where high wind potential was previously found. The resolution of the output from the mesoscale modelling will be in the order of 1 x 1 km.

CMA confirms that the present WED-supported projects and twinning arrangement with Risø National Laboratory DTU, Denmark, as described herein, can contribute to improving the quality of techniques for mesoscale modelling and for the microscale modelling for application of their results. These improved techniques could be applied in the national programme and contribute to improving the quality – provided that the results of the WED-project will be

available in due time before the final mesoscale modelling in the national programme, i.e. before the end of 2009. Moreover, there will be exchange of experiences throughout the twinning activities.

1.3.2 Risø DTU

Risø DTU has been active for decades in wind energy assessment area, and has developed the WAsP software, a microscale modelling tool for wind farm energy calculations, and the KAMM/WAsP method, for the calculation of wind resources over large areas.

The KAMM/WAsP system output is compatible with WAsP, which allows mesoscale results to be applied all the way down to the microscale for wind farm energy calculations.

Risø DTU is now beginning to use the WRF mesoscale model in wind energy studies, and this model is seen as a likely successor to the KAMM mesoscale model.

Risø DTU has been active for decades in the area of microscale modelling (WAsP) and has worked with meteorological sensors and measurements for almost half a century. Risø DTU has designed, developed and manufactured several meteorological sensors and data acquisition systems; noticeably the Risø cup anemometer, which today is considered one of a few industry-standard cup anemometers for wind resource assessment and wind turbine power performance testing and verification. Because of its long history within wind power activities, Risø DTU is well acquainted with the special requirements for accurate and reliable wind measurements posed by the wind industry.

1.4 The Purpose of these Project Descriptions

The final draft of these Project Descriptions will be recommended for adoption by the PSC, following which agreement(-s) referencing these Project Descriptions is expected to be entered into. This agreement will have 4 parties, i.e. CMA, Risø, RDE and NDRC.

1.5 Terminology used

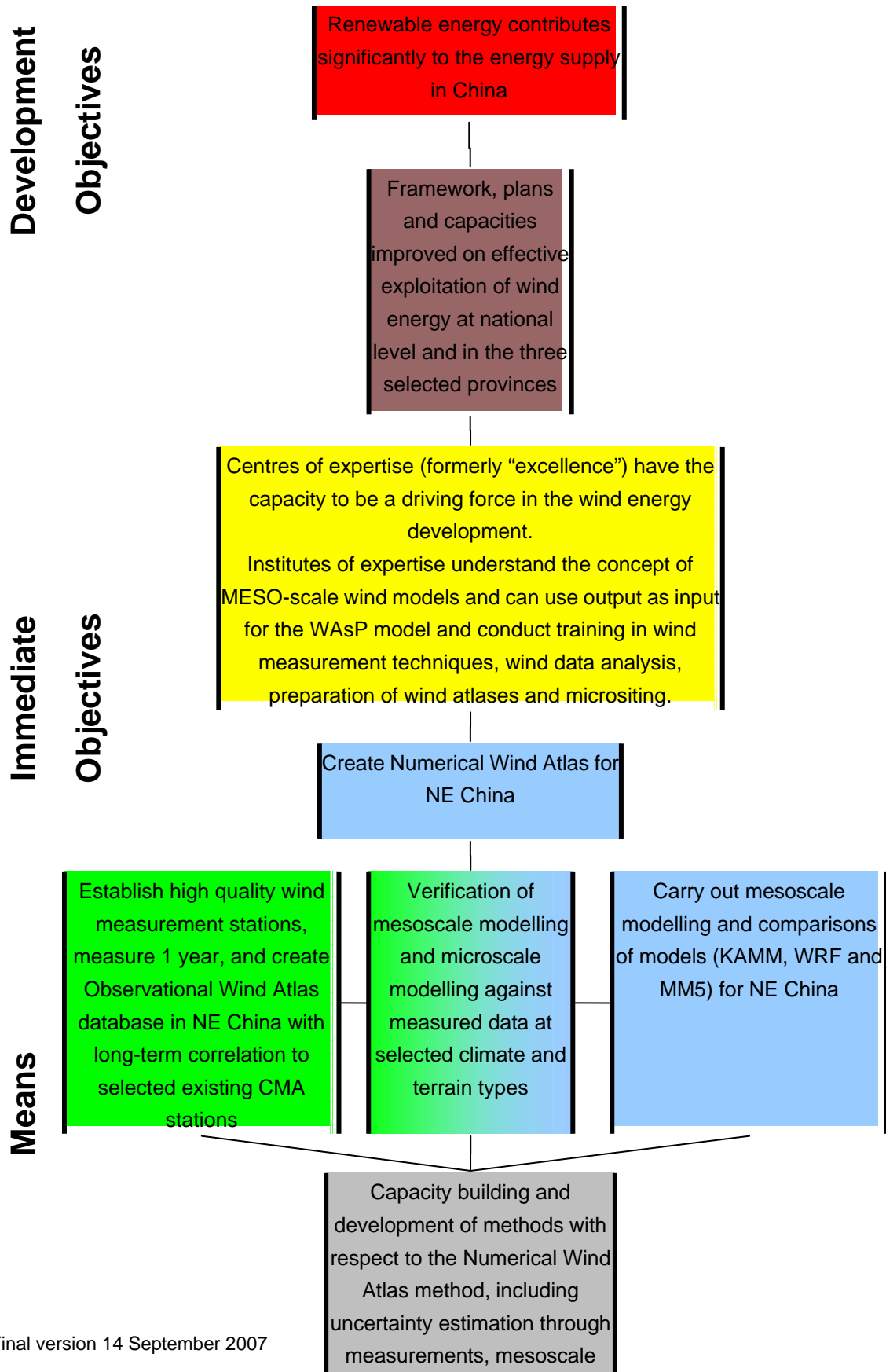
In these Project Descriptions the term **component** is used to describe the package of projects included in the Project Descriptions for CMA. Similarly, two other sets of Project Descriptions will describe the CEPRI and CHECC components.

The CMA component consists of a small number of **projects** and each project has a number of **activities** and **milestones**.

2. Goal and objectives

The objective tree shown below reflects the discussions between CMA and Risø DTU and how the twinning arrangement and projects can contribute to the development objectives through the project's immediate objectives, achieved through the four main projects:

- 1) mesoscale modelling,
 - 2) measurements, and
 - 3) microscale modelling as well as
 - 4) a project regarding guidelines for application,
- each associated with extensive capacity building.



3. Scope of work

The Twinning arrangement between CMA and Risø DTU has a scope of work which falls into 4 projects:

A01 - Mesoscale

- Wind classes
- Terrain elevation
- Terrain roughness
- Model configuration
- KAMM – at Risø DTU
- WRF – at CMA and Risø DTU
- MM5 – at CMA, for comparison (based on existing model)
- Post processing of mesoscale outputs
- Mesoscale results vs. measured data
- Creation of a Numerical Wind Atlas for NE China
- Training – on the job at Risø DTU

A02 – Measurements

- Design
- Procurement, shipment, customs clearance, tax and VAT exemption, necessary import permits
- Siting and necessary approvals
- Construction and installation
- Operation and data collection
- Data analyses
- Technical training – on the job and introductory course

A03 – Microscale

- Wind speed and direction distributions
- Terrain elevation
- Terrain roughness
- Sheltering obstacles
- WAsP Modelling
- Microscale results vs. measured data
- Creation of Observational Wind Atlas for selected measurement sites in NE China
- WAsP training

A04 – Application

- Develop tools - guidelines and training materials

- Course for trainers
- Workshops as technical working sessions and progress reporting for PIU
- Final Workshop for invited stakeholders

In addition to the four projects A01, A02, A03 and A04, the Twinning arrangement contains a general activity for **PIU Coordination and steering – common for the four projects**.

Further detail on the scope of work is provided in section 4.3 and in the activity based budgets.

4. Methodology and Implementation

4.1 Strategy

The main strategy of the component is to initiate a long-term twinning arrangement between CMA and Risø National Laboratory DTU, which initially aims at securing transfer of knowledge of the Wind Atlas methodology, which will enable CMA to utilize, maintain and refine the adaptations of the Numerical Wind Atlas and the models applied – both models for micro- as well as for mesoscale modelling.

WED can only support the activities described in these Project Descriptions during the remainder of the WED implementation period, but it is hoped that the cooperation between the 2 institutions will be able to continue beyond this point due to mutual interest and thus develop into a truly long-term relationship.

From WED project, CMA and PMAs' experts will have a thorough understanding of the Risø DTU KAMM/WAsP numerical wind atlas methodology and the merits and limitations of WAsP and other microscale models, which will be achieved through a detailed run through of the necessary steps of the methodology and through detailed analyses of the state-of-the-art wind measurements obtained at a minimum of 12 meteorological masts which will be installed in the three provinces of NE China (Liaoning, Jilin and Heilongjiang provinces).

The network of meteorological masts is intended to provide a unique, high-quality database of wind measurement. In order to secure high quality of these and future CMA measurement programs, all masts will be equipped with double sensor systems. Along with CMA's standard choice of sensors (economy sensors), the masts will be equipped with state of the art sensors meeting demanding specifications used for commercial European wind projects. Part of the wind data analysis will be to analyse and explain the differences (if any) between the 2 sets of measured data obtained.

4.2 *Twinning*

The CMA component of WED will be implemented as a so-called Twinning arrangement between CMA and Risø DTU in accordance with the Danish Rules for Twinning - the Danish Ministry of Foreign Affairs rules for Institutional Cooperation, June 2004, from which the following is a quote:

In respect of budget and accounts, institutional cooperation with State institutions is administrated as grant-financed research activity, in accordance with the Ministry of Finance's Economic-Administrative Guidelines for grant-financed research activities: "Direct expenses are divided into direct wage expenses and other direct expenses, including equipment and other procurements needed for the project. In addition, there will be a contribution towards shared expenses of 20% of the direct expenses. The project budget, including the contribution to shared expenses, should be divided into the institution's share (co-financing) and the grant applied for".

The budget estimate for Risø DTU's components has been determined using these rules, using Risø salary rate per hour valid for 2007 with an increase of 3% due to the expected project duration of 2 years starting September 2007. Risø DTU's overhead rate is 110%. WED offers to cover 20% of all direct costs, which leaves 90% to be covered by Risø DTU's own budget, from the basic funding for co-financing of research projects. However, this Risø DTU co-financing is reduced slightly by the fact that WED also is contributing an overhead of 20% on direct expenses for equipment and travels. The amounts are shown in the budget estimate.

This co-financing contribution from Risø DTU will therefore have to be consumed in accordance with Risø DTU requirements for applying basic funding resources for research. From a Risø DTU perspective this Twinning is not a Technical Assistance activity, but it will have to be considered similar to a research project with research contents similar to projects in other research programmes like the Danish national energy research programmes, thus allowing Risø DTU to operate within the framework of the Twinning as in other research projects in order to produce the required research results – all within the conditions and budget allocated for the Twinning.

4.3 *Methodology*

The diagram below summarises the four main projects Mesoscale, Measurements, Microscale and Application, leading to the necessary verification and results presented, and made available in the form of a Numerical Wind Atlas as well as an Observational Wind Atlas for the three provinces in NE China. The projects are intended to follow a balanced approach with emphasis on both mesoscale and microscale, and in the end emphasis on its application for planning of wind energy – both aimed at authorities and investors. Because conveying the

Project Name and No.	A01 - Meso-scale modelling Project
	<p>The improvements will be achieved through</p> <ol style="list-style-type: none"> 1. the suitability of the spatial datasets for direct application in wind farm projects, so that the resulting data is of greatest use and relevance to wind farm developers, 2. the careful consideration of uncertainty throughout all steps in the wind resource calculations, including a final estimate of uncertainty on the spatial wind resource datasets, 3. the adaptation of the methods within the modelling and analysis to the specific terrain and climate types found in China. <p>The first central result of this collaboration will be wind resource data sets and maps for three test regions, performed jointly by CMA and Risø DTU.</p>
Responsible Organisation	CMA. At CMA Centre for Wind and Solar Energy Resources Assessment (“CWSERA”) will be responsible.
Scope of Work	<ul style="list-style-type: none"> • Wind classes • Terrain elevation • Terrain roughness • Model configuration • KAMM – at Risø DTU • WRF – at CMA and Risø DTU • MM5 – at CMA, for comparison (based on existing model) • Post processing of mesoscale outputs • Mesoscale results vs. measured data • Creation of a Numerical Wind Atlas for NE China • Training – on the job at Risø DTU
Work Plan	<p>Background</p> <p>Both CMA and Risø DTU have experience in wind resource calculation using mesoscale models, microscale models and observations.</p> <p>Risø DTU has been active for decades in this area, and has developed the WAsP software, a microscale modelling tool for wind farm energy calculations, and the KAMM/WAsP method, for the</p>

Project Name and No.	A01 - Meso-scale modelling Project
	<p>calculation of wind resources over large areas.</p> <p>The KAMM/WAsP system output is compatible with WAsP, which allows mesoscale results to be applied all the way down to the microscale for wind farm energy calculations.</p> <p>Risø DTU is now beginning to use the WRF mesoscale model in wind energy studies, and this model is seen as a likely successor to the KAMM mesoscale model.</p> <p>CMA has also been engaged in mesoscale modelling activities for wind energy applications. The model from Environment Canada, MM5, is currently being used extensively for wind mapping in China. Other models such as RAMS, MC2, ABL (Atmospheric Boundary Layer model) are also being used. The WRF model is also being considered by CMA.</p> <p>An important part of the capacity building of the collaboration will be a thorough understanding of the Risø DTU's KAMM/WAsP numerical wind atlas methodology. This can be achieved through a detailed run through of the necessary steps of the methodology.</p> <p>However because Risø DTU does not see KAMM as the long term mesoscale model within its own methodology, it is not worthwhile focusing the capacity building too much on elements specific to that model. Therefore Risø DTU will generalize the methodology to be applicable in more than one mesoscale model.</p> <p>Because CMA has experience in other mesoscale models, the collaboration should give rise to mutual learning. From the mesoscale point of view <u>CMA will gain from Risø DTU's knowledge and experience of the KAMM/WAsP method and application of WRF, and Risø DTU will gain from the experience gained from CMA's use of WRF, MM5, RAMS, and MC2.</u></p> <p>Numerical wind atlas methodology</p> <p>The methodology can be broken down into four distinct steps:</p> <ol style="list-style-type: none"> 1. Pre-processing; the selection of the wind classes used to

Project Name and No.	A01 - Meso-scale modelling Project
	<p>represent the large scale meteorological conditions.</p> <ol style="list-style-type: none"> 2. Mesoscale simulation; the calculation of wind fields over the terrain for each of the wind classes. Terrain resolution is typically 5 km, but other resolutions can be used. 3. Post-processing; the analysis of the results of the mesoscale simulations in order to create wind atlas maps and datasets for direct application of WAsP or possibly other microscale models. 4. Verification; comparison of the mesoscale-derived wind data with observation-based wind data. Observation-based wind data will include the met station under this project and to the largest extent possible also wind data from other CMA met stations. <p>All four parts will be covered in detail in the collaboration between CMA and Risø DTU.</p> <p>Sensitivity studies</p> <p>In the chosen test areas, trials of various different methods within the steps 1-3 will be tested. This work can be undertaken by Risø DTU or CMA as appropriate. This work will be facilitated by Risø DTU creating a more generalized interface between steps 1 to 2 and 2 to 3. Thereby allowing output from the pre-processing to go to either KAMM or WRF, and allowing output from KAMM or WRF to go into the post-processing.</p> <p>Thus sensitivity of the wind resource calculations to a single change in one of the methods in steps 1, 2 or 3 can be assessed. To elaborate on this point the following examples are given:</p> <ol style="list-style-type: none"> 1. Pre-processing; sensitivity to the chosen height for the classification, sensitivity to the number of wind classes, sensitivity to the stability measure used in the classification, etc. 2. Mesoscale simulation; sensitivity to the mesoscale model used for the simulations, KAMM, WRF, possibly MM5 also, sensitivity to vertical and horizontal resolution, sensitivity to physical parameterization schemes within the models, etc.

Project Name and No.	A01 - Meso-scale modelling Project
	<p>3. Post-processing; sensitivity to the method used to interpolate model winds to standard heights, sensitivity to the correction method used to account for mesoscale terrain features, etc.</p> <p>Indeed, testing all possible combinations of these sensitivities would be a very big task. However it will be possible to select a subset of combinations and still gain a tremendous amount of understanding of how uncertainties come about in the methodology.</p> <p>CMA and Risø DTU are to be considered equal partners in this work, however stressing that the bulk of capacity building will be aimed at CMA. CMA participation in all activities is encouraged to the degree possible by the resources available and the framework of these Project Descriptions.</p> <p>Throughout this collaboration between CMA with Risø DTU, CMA will be a full partner in the results of this work and stand to benefit directly from the findings that come from them.</p> <p>Quality assessment</p> <p>Throughout this project much attention will be given to the quality of the wind resource estimation. As much as possible uniformity in quality is the objective. Therefore the specific nature of the difference test areas needs to be addressed. For example different terrain types and climate types will quite possibly require a different treatment.</p> <p>Methods for estimating the likely uncertainty of the wind resource data will be developed. One possibility of how to do this is to employ the sensitivity studies mentioned in the previous section as part of the input to the uncertainty calculations. Distance from verification measurement masts could be another input.</p> <p>This aspect of the collaboration is an innovative and much desired part of a wind mapping procedure.</p>
Inputs	<ul style="list-style-type: none"> • Equipment (computers and PC-cluster) • Data from project A02

Project Name and No.	A01 - Meso-scale modelling Project
	<ul style="list-style-type: none"> • Terrain data and NDVI • Re-analysis data
Outputs	<ul style="list-style-type: none"> • Regional wind climates (WASP *.LIB files) • Predicted wind resource for selected terrain site coordinates • Maps and database for test region in NE China • Uncertainties • Parameters • Numerical Wind Atlas for NE China <ul style="list-style-type: none"> • E.g. report, web site, poster, fact sheets, etc.
Indicators & means of verification	<ul style="list-style-type: none"> • Training report approved • Maps and database completed and made available in public domain. • Final project report published and made available in public domain • Project completion and evaluation report completed • Financial audit report without qualifications received
Prerequisites and context	<ul style="list-style-type: none"> • Data accessible within budgeted means • All CMA and Risø DTU resources made available to the extent included in these Project Descriptions • All findings to be put in public domain
Related WED activities	This project is depending upon project A02 and related to A03 and A04.
Remark	

Project Name and No.	A02 – Measurements Project
Component	CMA
Objective	Capacity building at CMA in high quality wind measurements and providing input for A01 and A03 (mesoscale and microscale modelling projects)
Responsible Organisation	CMA. At CMA Centre for Wind and Solar Energy Resources Assessment (“CWSERA”) will be responsible.
Scope of Work	<ul style="list-style-type: none"> • Design • Procurement, shipment, customs clearance, tax and VAT exemption, necessary import permits • Siting and necessary approvals • Construction and installation • Operation and data collection

Project Name and No.	A02 – Measurements Project
	<ul style="list-style-type: none"> • Data analyses • Technical training – on the job and introductory course
Work Plan	<p>This is a preliminary Work Plan to be discussed in details during the Inception in Beijing.</p> <ul style="list-style-type: none"> • CMA will select some candidate sites for wind resource measurements in all three provinces. All sites shall be in areas with GSM mobile phone coverage and different types of landscape shall be looked at. • CMA and Risø DTU will together perform a physical site visit at the selected locations and site selection in view of the project objectives and framework. • CMA will deliver and after site visits also erect the 12 meteorological masts, including foundations, fencing, access roads, etc. • CMA will deliver 12 Chinese standard measuring systems including the normal mounting booms for the sensors. • Masts are of lattice type designed for climbing by trained technicians for installation of measurement equipment • Risø will deliver equipment for 12 Danish standard wind resource stations according to the figure in appendix 2. • Each of the 12 Risø measurement stations includes the following sensors: <ul style="list-style-type: none"> ⇒ 3 cup anemometers ⇒ 2 wind vanes ⇒ 1 absolute temperature ⇒ 1 temperature gradient ⇒ 1 relative humidity ⇒ 1 rain gauge • Support fixtures and cables are included for all sensors. • All Risø cup anemometers are wind tunnel calibrated including a possible recalibration after one year of measurements. • CMA will deliver the needed mounting booms for the Risø equipment according to a detailed description delivered by Risø. • The Risø equipment will be shipped from Denmark to China, and CMA will take over the ownership from the point of entry

Project Name and No.	A02 – Measurements Project
	<p>in China.</p> <ul style="list-style-type: none"> • CMA will do all custom clearance, local transport, land acquisition or rental, arrange access and permissions arrange that land is safe for work and traffic, arrange procurement and erection of masts on appropriate jointly selected sites. • GSM data network coverage will be accessible at all the selected 12 measuring sites • CMA will purchase the needed local SIM cards to communicate with the GSM data network. • State of the art wind measurement technique training will be held in China. The main part is planed to be on the job training combined with an introductory course. • The “on the job training” and the supervision from Risø DTU is planned only to take place at one of the two sites in each of the three provinces. The other site shall be installed by CMA staff without Risø DTU participation. Risø DTU will later inspect the installation on these sites. • Training will be at ground level meaning up to 10 m above the surface. The actual physical installation of all equipment in the masts will be carried out by CMA staff. • The data flow is suggested to be centralised at the CMA headquarter in Beijing. All stations can be accessed on-line and data can be downloaded to CMA. From here, data from all 12 stations and both types of systems can be transferred in a copy to Risø DTU in Denmark. • Risø DTU will deliver a PC to be installed at CMA in Beijing. This PC includes the needed software to communicate and download data from the stations using the GSM data network. • In Denmark, Risø DTU will setup secure Web pages with graphical data presentation, and ascii file download from all stations and keep it running on-line for the 12 month measurement period. • Both Risø and CMA will follow the measurement on the Web pages during the measurement period, so any found problems can be repaired locally a.s.a.p. by CMA staff. • After finishing the measurement period a systematic quality control and analysis of the complete data set will end with a

Project Name and No.	A02 – Measurements Project
	<p>data report.</p> <ul style="list-style-type: none"> • Verification of measured data against models as well as evaluation of measurement uncertainties based on the double instrumentation will be performed at the conclusion of the measurement period.
Inputs	<ul style="list-style-type: none"> • 12 meteorological stations equipped with double sensors • Infrastructure for met stations • Notebook PCs for data collection and analyses • Database and web display software
Outputs	<ul style="list-style-type: none"> • Database • Statistics • Observed wind climates • Report on measurements
Indicators & means of verification	<ul style="list-style-type: none"> • Training report approved • Valid data for one full year is delivered • Project completion and evaluation report completed • Audit clearance received
Prerequisites and context	<ul style="list-style-type: none"> • Necessary import approvals are obtained • All findings to be put in public domain
Related WED activities	This project is closely related to and depending upon projects A01 and A03. It provides input for A04.
Remark	The general layout of a met mast is shown in Appendix 2.

Project Name and No.	A03 – Microscale Project
Component	CMA
Objective	<p>To develop the capacity to calculate improved observational wind atlas data sets and improved predicted wind climates through the combination of microscale modelling techniques and state-of-the-art wind measurements.</p> <p>The improvements will be achieved through</p> <ol style="list-style-type: none"> 1. the suitability of measured data sets for wind atlas analysis and application, so that the resulting data and procedures are of greatest use and relevance to wind farm developers. State-of-the-art equipment will be employed so as to minimise the uncertainty in the wind measurements, 2. the careful consideration of uncertainty throughout all steps of

Project Name and No.	A03 – Microscale Project
	<p>the wind atlas and wind resource calculations, including a final estimate of the uncertainty on the observed, regional and predicted wind resource estimates,</p> <p>3. the adaptation of the methods within the modelling and analyses to the specific terrain and climate types found in China.</p> <p>The central result of this collaboration will be wind resource data sets and local maps for no less than 12 sites in the three pilot provinces in NE China, performed jointly by CMA and Risø DTU. If more relevant data from other CMA met stations can be made available this will strengthen the observational wind atlas.</p>
Responsible Organisation	CMA. At CMA Centre for Wind and Solar Energy Resources Assessment (“CWSERA”) will be responsible.
Scope of Work	<ul style="list-style-type: none"> • Wind speed and direction distributions • Terrain elevation • Terrain roughness • Sheltering obstacles • WAsP modelling • Microscale results vs. measured data • WAsP training • Creation of Observational Wind Atlas for selected measurement sites in NE China
Work Plan	<p>Background</p> <p>Risø DTU has been active for decades in the area of microscale modelling (WAsP) and has worked with meteorological sensors and measurements for almost half a century. Risø DTU has designed, developed and manufactured several meteorological sensors and data acquisition systems; noticeably the Risø cup anemometer, which today is considered one of a few industry-standard cup anemometers for wind resource assessment and wind turbine power performance testing and verification. Because of its long history within wind power activities, Risø DTU is well acquainted with the special requirements for accurate and reliable wind measurements posed by the wind industry.</p> <p>As the national body for meteorological measurements, weather</p>

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	<p>forecasting, etc. CMA has a long track record of operating comprehensive networks of meteorological stations in all regions of China. The measurements are performed according to World Meteorological Organisation (WMO) standards or better. More recently, CMA has also been engaged in wind resource assessment activities and has experience in installation and operation of tall masts. Furthermore, CMA has profound knowledge of the climatological conditions encountered in China.</p> <p>CMA has been using the WAsP microscale model for wind resource assessment and siting for more than 10 years and will also be able to apply the Canadian model MS-Micro, which is part of the AnemoScope Wind Energy Simulation Toolkit (WEST) now installed in CMA. CMA further has plans for in-house modification of the MS-Micro model.</p> <p>An important part of the capacity building of the collaboration will be a thorough understanding of the merits and limitations of WAsP and other microscale models and of the wind atlas methodology. This can be achieved through detailed analyses of the state-of-the-art wind measurements obtained at 6 tall met. masts which are going to be installed in the three provinces of NE China as part of the project (option for 7 more masts). This network of tall masts should provide a unique, high-quality database of wind measurements against which the microscale models and methodologies can be tested and verified.</p> <p>Comparison with other wind measurements systems – which are routinely installed and operated for wind resource assessment in China – may also be carried out at the reference masts.</p> <p>Because CMA has vast experience in Chinese climatological conditions, and will gain experience in other microscale models during the project, the collaboration should give rise to mutual learning. From the measurements point of view CMA will gain experience in the special requirements and instruments related to state of the art wind measurements for wind power applications. From the microscale point of view CMA will gain from Risø DTU's knowledge and experience of the industry-standard WAsP</p>

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	<p>software, and Risø DTU will gain from the experience obtained from CMA's use of MS-Micro and derivatives thereof.</p> <p>Observational wind atlas methodology The methodology can be broken down into four steps:</p> <ol style="list-style-type: none"> 1. Pre-processing; the construction of wind speed and direction distributions used to represent the observed meteorological conditions. Construction of the small-scale terrain descriptions of the terrain around the meteorological station: elevation map, roughness length map and specification of sheltering obstacles. 2. Microscale modelling; the calculation of the effects of the terrain descriptions on the wind climate observed at the meteorological station. The WAsP modelling is typically done with standard modelling parameters, but other parameter settings can be applied. 3. Post-processing; the analysis of the results of the microscale simulations in order to create wind atlas data sets for direct application with WAsP or possibly other microscale models such as MS-Micro. Steps 2 and 3 are carried out in one process in the WAsP software. 4. Verification; the comparison of the microscale-derived wind speed and direction distributions with observation-based wind distributions. <p>All four parts will be covered in detail in the collaboration between CMA and Risø DTU.</p> <p>Sensitivity studies In the chosen test areas, trials of various different methods within steps 1-3 above will be carried out. This work will be undertaken by Risø DTU or CMA as appropriate.</p> <p>Thus, the sensitivity of the wind resource calculations to a single change in one of the methods in steps 1, 2 or 3 can be assessed. To elaborate on this point the following examples are given:</p>

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	<ol style="list-style-type: none"> 1. Pre-processing; sensitivity of the microscale modelling to elevation and roughness length descriptions derived from different data sources, e.g. topographical maps, SRTM elevation data, satellite imagery, etc. 2. Microscale modelling; sensitivity to the microscale model used, e.g. WAsP and possibly MS-Micro, and sensitivity to physical parameterization schemes within the models, etc. WAsP parameter studies. 3. Post-processing; sensitivity to the standard heights and roughness classes used for establishing the regional wind climates, sensitivity to the terrain descriptions, etc. 4. Verification; the sensitivity of the comparisons to climatological or topographical characteristics of the different sites, e.g. atmospheric stability or ruggedness index, distance to the reference mast, etc. <p>Indeed, testing all possible combinations of these sensitivities would be a very big task. However, it will be possible to select a subset of combinations and still gain a tremendous amount of understanding of how uncertainties come about in the methodologies.</p> <p>CMA and Risø DTU will be full partners in the analyses and results of this work, and both stand to benefit directly from the findings that come from them.</p> <p>Quality assessment</p> <p>Throughout the project much attention will be given to the quality of the wind measurements and of the wind resource estimation. As much as possible uniformity in quality is the objective. Therefore the specific nature of the different test areas needs to be addressed. For example different terrain types and climate types will quite possibly require a different treatment.</p> <p>Methods for estimating the uncertainty of the wind resource will be</p>

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	<p>developed. One possibility of how to do this is to employ the sensitivity studies mentioned in the previous section as part of the input to the uncertainty calculations.</p> <p>This aspect of the collaboration is an innovative and much desired part of current wind resource assessment and siting procedures – in China and worldwide.</p>
Inputs	<ul style="list-style-type: none"> • WAsP software packages (4) • WAsP Engineering software packages (4) • Windpro software (1) • Surfer/Global mapper software package (1) • Desktop PCs for microscale modelling (2)
Outputs	<ul style="list-style-type: none"> • Regional wind climates (WAsP *.lib files) • Predicted wind resource for selected terrain site coordinates • Maps and database for test-region in NE China • Uncertainties • Observational Wind Atlas for NE China <ul style="list-style-type: none"> • E.g. report, web site, poster fact sheets
Indicators & means of verification	<ul style="list-style-type: none"> • Training report approved • Maps and database for test region in NE China are published • Project completion and evaluation report completed • Financial audit report without qualifications received
Prerequisites and context	<ul style="list-style-type: none"> • Necessary data accessible • All findings to be put in public domain
Related WED activities	This project is closely related to and depending upon projects A01 and A02. It provides input for A04.
Remark	

Project Name and No.	A04 – Application Project
Component	CMA
Objective	Capacity building at CMA in dissemination of know-how in application of mesoscale and microscale modelling and wind measurement techniques
Responsible Organisation	CMA. At CMA Centre for Wind and Solar Energy Resources Assessment (“CWSERA”) will be responsible.

Project Name and No.	A04 – Application Project
Scope of Work	<ul style="list-style-type: none"> • Develop tools - guidelines and training materials • Course for trainers • Workshops as technical working sessions and progress reporting for PIU • Final Workshop for invited stakeholders
Inputs	<ul style="list-style-type: none"> • Results from A01, A02 and A03 • Software, hardware and models used for A01, A02 and A03
Outputs	<ul style="list-style-type: none"> • Tools-software with guidelines and help • Course materials • Report on best practice
Indicators & means of verification	<ul style="list-style-type: none"> • Tools-software with guidelines and course materials are developed • Training report approved • Project completion and evaluation report completed • Audit clearance received
Prerequisites and context	<ul style="list-style-type: none"> • Timely completion of A01, A02 and A03 projects • All findings to be put in public domain
Related WED activities	This project is closely related to and depending upon projects A01, A02 and A03.
Remark	

In addition to the four projects A01, A02, A03 and A04, the Twinning arrangement contains a general activity for Coordination and steering in the PIU – common for the four projects.

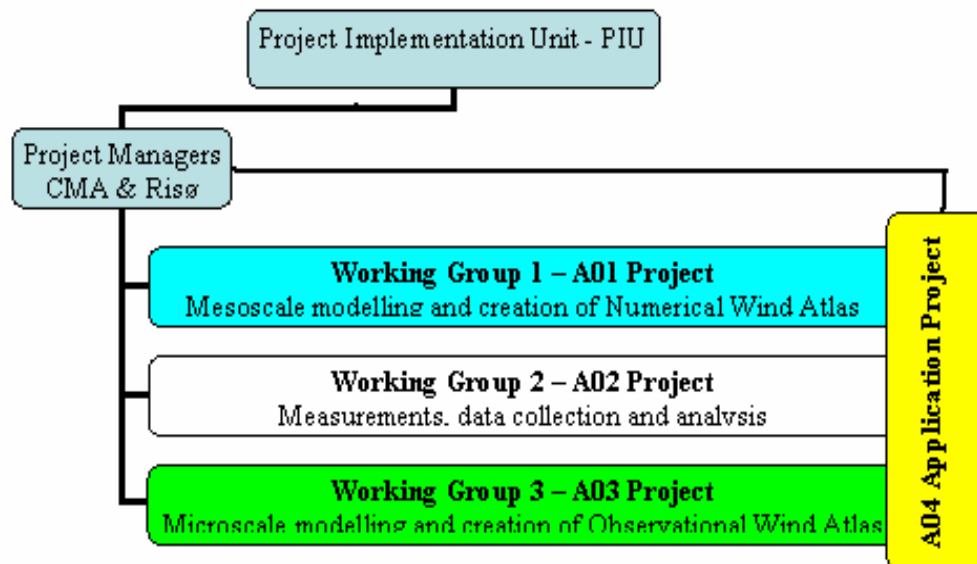
4.5 Logical Framework Matrix

Project Strategy	Indicators for impacts evaluation	Base Year values of the indicators	Target value of the indicators	Sources of verification	Exogenous risks
Intermediate objective					
Framework, plans and capacities improved on effective exploitation of wind energy at national level and in the three selected provinces	Wind atlases for NE provinces established and verified	By 2007 no reliable wind atlases exist	Reliable and proven wind atlases for 3 NE provinces by end of component	Monitoring the impacts by the end of WED programme. Published atlases.	
	CMA capacity in mesoscale and microscale modelling significantly increased	CMA has limited experience in mesoscale and microscale modelling involving uncertainty estimation (2007)	CMA stand well prepared to do nationwide modelling (end component)	Monitoring the impacts by the end of WED programme.	
	CMA capacity in instrumentation of met masts significantly increased	CMA has no dedicated wind energy met. stations (2007)	WED will add the first 12 met masts with state of the art sensors to the CMA portfolio (2008)	Monitoring the impacts by the end of WED programme.	

5. Project Organisation

5.1 Structure

It is suggested that the component shall be conducted in collaboration between CMA and Risø DTU according to the Danish rules for Twinning. A chart showing the suggested organizational setup follows below.



A Project Implementation Unit (PIU) is to be established as the Steering Committee for the CMA component and the Twinning arrangement. The PIU will be established with one representative from each of the parties: CMA and Risø DTU. Detailed work plans for the four working groups, appointment of qualified members of the working groups and all major decisions during the project implementation shall be decided by the PIU within the framework of these Project Descriptions and the Twinning arrangement. The PIU will meet twice a year or more often as required. Meetings should be arranged to allow for participation of Working Group members to the degree possible and relevant and if possible in connection with component workshops.

Project managers will normally participate in PIU meetings.

The PIU is overall responsible for achieving the defined objectives within the budget and time frame defined in these Project Descriptions.

5.2 Management Responsibilities

5.3 Staffing

