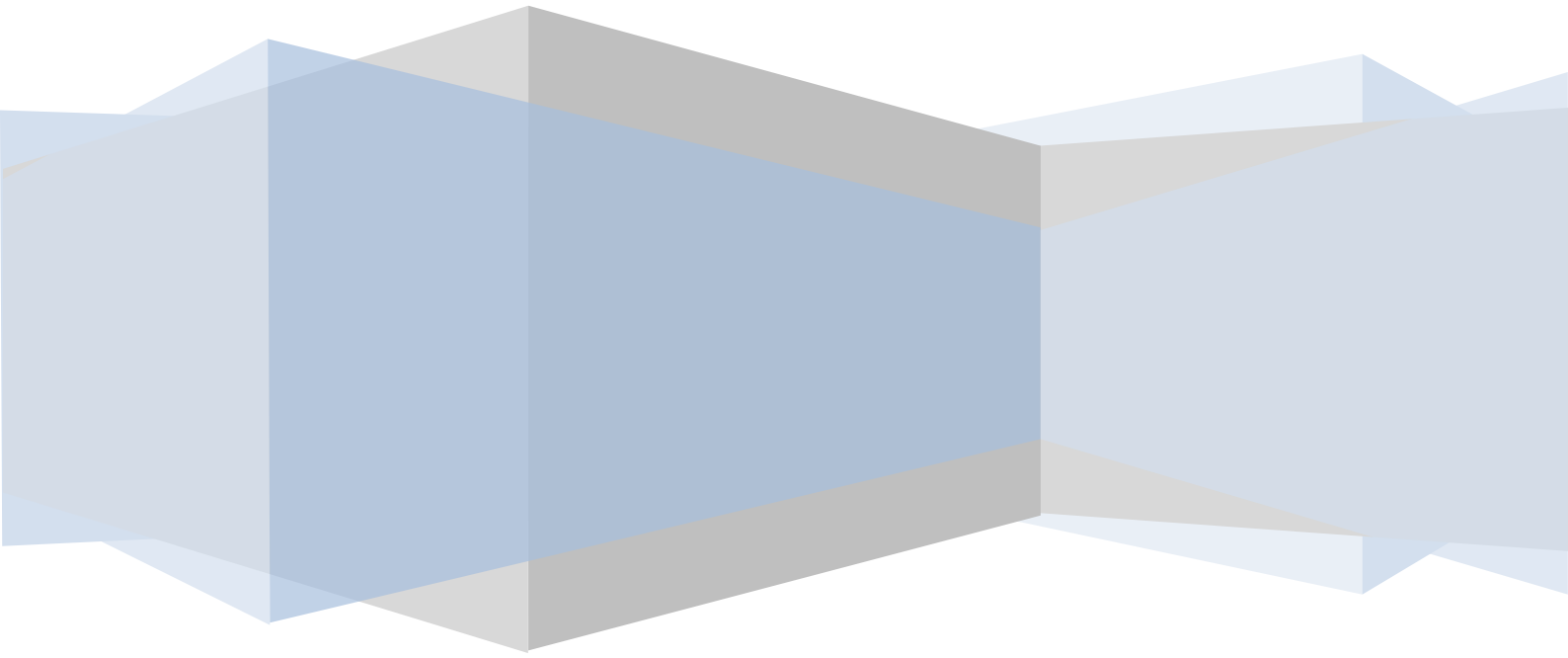
The Sino-Danish programme for Wind Energy Development
The Sino-Danish program for Renewable Energy Development

International Workshop on Large Scale Wind Power Grid Integration

Beijing 22 and 23 October 2009



Content

The summary was prepared by Kaare Sandholt, Ea Energy Analyses together with the RED secretariat and the WED Program Management Office.

Introduction

Wind power developed rapidly in China during the recent years. From 2006 to 2008, wind power capacity has doubled each year. By mid 2009 the total installed capacity of wind turbines in China was app. 16.8 GW. It is expected that Chinese wind power capacity will reach 100 – 120 GW before the end of 2020.

The development of wind power in China reduces the environmental impact of energy production by reducing CO_2, SO_2 and other harmful emissions. Furthermore wind power production counters the increasing fossil fuel dependency, and mitigates fuel price fluctuations, as well as dependency on imports, thus supporting security of energy supply.

This rapid development has however introduced a number of challenges, especially regarding integration of wind power into the electricity system. Some of the main issues are briefly described below:

- *Insufficient grid infrastructure*. By the end of 2008 the total installed capacity reached 12 GW, but only about 9 GW was connected to the grid. As well as new transmission line building failed to keep pace, existing lines have limited capacity and cannot accommodate all power from wind farms. With the planned seven new 10 GW wind farm clusters, this situation is likely to deteriorate in the future, if not substantial efforts to improve the existing grid infrastructure are taken.
- *Difficulties in system integration of wind power*. Many of the existing power units are not very flexible regarding load-following capability, and the power plant operators have yet little or no incentives to improve this.
- *The technical standard of the wind turbines* is not sufficient to ensure system stability. This makes it difficult to integrate large amount of wind power into the system without jeopardizing the security of supply.

These challenges are serious threats to the further development of wind power in China, and they are not easily solved. However, similar challenges have been solved in other countries with an already much higher penetration of wind power than to be anticipated for China. The Sino-Danish Renewable Energy Development (RED) and Wind Energy Development (WED) programs therefore decided to organise an international workshop on large scale wind power grid integration in Beijing in conjunction with the China 2009 Wind Power Exhibition and Conference. The purpose of the workshop was to present and discuss the actual challenges for the grid integration of wind power in China from an international perspective, and thereby develop ideas and suggestions for future activities under the RED programme, which could help removing barriers for an efficient integration of the anticipated wind power development in China.

The workshop has been jointly organized by the Sino-Danish programme for Wind Energy Development (the WED programme) and the Sino-Danish program for Renewable Energy Development (the RED programme). A number of Chinese and international experts contributed to this workshop and the organisers wish to express their gratitude for the efforts from all participants to make the workshop a success.

This summary provides an overview of the presentations and discussions and highlights the conclusions and recommendations from the workshop. The full presentations are enclosed in the annex together with short biographies of the speakers.

For the RED programme

Wang Zhongying

National Programme Manager

of the RED programme

For the WED programme

Dong Luying

Director of the WED Programme

Management Office

Workshop agenda

Thursday 22 October 2009
09:00 — 10:30 Opening Ceremony and Keynote Speeches
Chair: Li Junfeng, CREA
Opening Remarks: Dong Xiufeng, Renewable Energy Department, National Energy Administration Xue Huifeng, National People's Congress Soren Kristoffersen, Royal Danish Embassy Kang Bingjian, Ministry of Commerce
Keynote Speech: Challenges in Chinese Wind Grid Integration, Wang Zhongying, Energy Research Institute
Keynote Speech: Large Wind Grid Integration, Christian Kjaer, EWEA

11:00 — 12:30 Session 1: International Experience of Wind Grid Integration	
Co-chairs: Kaare Sandholt, Ea Energy Analyses and Mr.Qin Haiyan, Director of CWEA	
Speaker	Topic
Peter Jørgensen, Vice President, Energinet.dk	Integration of Wind Power in the Danish Energy System – preparing for 50% RES in the Electricity System 2020
Agustin Diaz, Senior Engineer, Red Electrica de España	Spanish Experience in Wind Power Integration
Wayne Coste, Principal Engineer, ISO New England	Wind Power Integration in New England

Press Release of Chinese Version of Wind Power to Combat Climate Change 14:00 — 14:30

14:30 — 15:50 Session 2: International Incentives and Policies on Wind Grid Integration	
Chair: Peter Jørgensen, Vice President, Energinet.dk and Yang Xiaosheng, Long Yuan Power Group	
Speaker	Topic
Kaare Sandholt, Partner, Ea Energy Analyses	Integration of wind power – a stakeholder perspective
Kevin Porter, Senior Analyst, Exeter Associates Inc.	A Review of Large-Scale Wind Grid Integration in the United States
Henrik Rosenberg, Balslev Consulting Engineers A/S	Developing grid codes – experiences from the WED-program

16:10 — 17:30 Session 3: Grid Integration Technology	
Speaker	Topic
Finn Strøm Madsen, President, Vestas Technology R&D	What can grid friendly turbines do for China
Jiang Liping, Deputy Chief Engineer, State Grid Energy Research Institute	Chinese wind power grid integration – current status and the future
Azusawa Noboru, Chief Engineer and CTO, Hitachi Co, Ltd.	Wind turbine system and grid system
Chi Yongning, deputy chief engineer of renewable energy department, China Electric Power Research Institute	Wind Power Grid Code Research and Formulation in China

Friday 23 October 2009 09:00 – 11:00 Panel Discussion: Large Scale Wind Power integration in China – Challenges and solutions
Chair: Gao Hu, Center for Renewable Energy Development, Energy research Institute, National Development and Reform Commission and Kaare Sandholt, Ea Energy Analyses

Opening ceremony and key note speeches

The workshop was opened by remarks by Mr. Dong Xiufeng, Renewable Energy Department, National Energy Administration, Mr. Xue Huifeng, National People's Congress, Mr. Søren Kristoffersen, the Royal Danish Embassy, and Mr. Kang Bingjian, Ministry of Commerce.

In his keynote speech Mr. Wang Zhongying gave an overview of the current situation for wind power in China. China has good wind resources and the development of wind power is very rapid with a doubling of the installed capacity each year. Among the challenges is the transmission grid which currently limits the further development of wind power. New transmission lines are required because the load centres for electricity consumption are far from the regions with good wind conditions. Also the development of solar energy for electricity production will require reinforcement of the transmission grid. Balancing of wind power is also a challenge. China has a limited amount of hydro power which otherwise could be the solution for the balancing problems, and the large number of CHP plants have currently limited ability for regulating the power production.

Mr. Wang also pointed out that the quality of wind power production has to be improved in order to ensure a stable electricity grid. But it is not only the wind turbines and the forecasting of wind power production which have to be improved. There is a need for development of a smart grid which enables a much more flexible power system. If the grid companies should be able to accept more wind power in the electricity system, it is necessary to ensure local integration of wind power, better synchronisation between the transmission grids and finally development of a smart grid. Experiences from other countries, e.g. Denmark and Spain, show that it is possible to have a large amount of wind power in the system.

China has started preparing for the future development of wind power. A number of transmission grid project are launched which will give a more integrated electricity grid in the country, and plans for the development of intelligent electricity grids have been developed in order to have a strong intelligent grid before 2020. Also the improvement of wind forecasting will facilitate a better wind power integration. In the future we will also see better possibilities for storing the electricity produced from fluctuating renewable energy sources. The future cost of wind power should also be taken into account. Large shares of wind power introduce higher costs for integration, and incentives for the further development of wind power should be developed.

Finally Mr. Wang gave a vision for the future development as a stepwise improvement of the conditions for wind power integration, starting with better local integration of wind power. Second step will be better synchronisation of the transmission grid, a revision of the Renewable Energy Law and a reform of the electric power system. Third step is the development of a smart grid due to intensified R&D. The long-term vision could be a global synchronised electric network!

The second key note speaker, Christian Kjær, Chief Executive Officer from the European Wind Energy Association, gave an overview of the recent experiences and challenges for the European wind power development based on the EWEA report "Large scale integration of wind energy in the European energy supply – analysis, issues and recommendations". The report is also available in Chinese. The conclusions of the report are briefly:

- Power and energy balancing is very important in order to ensure large scale wind power integration. Power systems already employ flexible mechanisms to follow the varying load and plant outages that cannot always be accurately predicted.

- Hence, power systems dynamics are not a principal obstacle to increasing the penetration of wind power and R&D should continue to further improve the knowledge on dynamic interaction of power systems and large scale wind power generation

- In this context, the transparent development of grid codes and other technical requirements for wind power plants are important.

- Grid upgrades and related costs are not an isolated wind power issue. Grid extensions and reinforcement will benefit the whole power system.

- Fuel replacement and capacity credit of wind power will benefit the overall security of supply.

- The economic impacts of wind power integration are beneficial.

Mr. Kjær pointed out that the ambitious target for wind power in Europe (230 GW in 2020) calls for a complete overhaul of the way electricity is generated, supplied and consumed, through e.g. "smart grids" and creation of a single European grid based on new grid technology.

Finally Mr. Kjær mentioned EWEA's 20 year offshore network development plan, which recommends building a transnational offshore grid infrastructure to connect 40 GW offshore wind power by 2020 and 150 GW by 2030.

Session 1: International Experience of Wind Grid Integration

Session 1 on international experience on wind power grid integration was chaired by Mr. Kaare Sandholt, Partner in the Danish consultancy Ea Energy Analyses and Mr.Qin Haiyan, Director of the Chinese Wind Energy Association.

Peter Jørgensen, Vice President from the Danish Transmission System Operator (TSO) Energinet.dk presented first on the status and prospects of wind power integration into the Danish grid. Currently, the Danish wind turbines produce more than 20 percent of the Danish electricity consumption, and Peter Jørgensen described the Danish experiences with handling of this large amount of wind from a grid operator's point of view. Furthermore he explained how the Danish TSO is preparing for the future with 50 percent wind power in the Danish electricity system. He pointed out, that an efficient integration of large scale wind power from a Danish point of view requires:

- A strong (international) transmission grid to trade and balance in a wide geographical area
- Efficient international electricity markets with clear price signals and trading close to real-time
- High flexibility in generation and demand with technical connection requirements for all resources
- Coherent energy systems and planning – electricity, heat and transportation – to increase flexibility and economic efficiency and reduce environmental impact
- A revised power system control architecture for active control of distributed resources.

The next speaker, Mr. Agustin Diaz, Engineer from the Spanish TSO Red Electrica de España (REE), gave insight in the Spanish experience with large-scale integration of wind power. The situation in Spain is quite different from the situation in Denmark. While Denmark has strong interconnectors with the surrounding countries and neighbouring power grids, Spain has very limited access to international interconnectors. Furthermore, the wind farms are situated far from the Spanish load centres with consequently long distance transport of electricity from the wind farms to consumers. Based on the Spanish experiences, Mr. Diaz came up with the following recommendations:

- It is necessary that wind power plants contribute to the system needs, both in a steady state and in a dynamic regime. A minimum of conventional generation would however still be necessary in order to guarantee the demand supply and stability.
- Transmission network plans need to be implemented on time.

- Specific and adequate wind power technical requirements (i.e. grid codes) that allow the acceptable behaviour of the electrical system is needed in order to ensure the maximum utilization of the wind production and the most efficient development of the wind power sector
- Higher flexibility for the power system is required for achieving an optimal integration of wind power resources in daily system operation consistent with system. The main solutions appointed for this purpose are additional hydro storage pumping, fast thermal units (open cycle gas turbines) and stronger international interconnections.
- Adequate size of power reserves to avoid risks of imbalance
- Providing real time visibility and controllability of wind power to the system operator allow the maximum integration of wind power into the system and avoid risky situations.

Finally, Wayne Coste Principal Engineer from the North American Independent System Operator ISO New England presented the planning of wind power integration in New England. The region has currently about 90 MW wind power and about 1600 MW wind farms are expected to be operating by the end of 2010.

Wayne Coste summarised the experience from New England in this way:

- Comprehensive energy system planning is necessary in order to deploy large amount of wind power, including simulations of various power system operation scenarios
- The System Operator has a leading role in this planning process – and cooperation between System Operators is key to success in wind power integration
- Development of the transmission grid is necessary in order to integrate wind power
- Development of specific recommendations for technical requirements for wind generation operations (i.e. Grid codes) is necessary, including the ability to withstand low-voltage conditions, to provide voltage support to the system, to adjust megawatt output supporting the operation of the system and to control high wind cut-out behaviour. Furthermore is it necessary for the TSO/ISO to have access to data from the wind farms.

Mr. Kaare Sandholt wrapped up the session. He pointed out that the three presentations were good examples from proactive system operators, taking responsibility for a sufficient development of wind power integration measures, herewith ensuring a continuous development of large-scale wind power. However, the presentations also revealed that rapid development of wind power poses many challenges for the grid and for system operation, not only in China, but all over the world. This provides a basis for joint efforts for solving these challenges by a continuing dialogue among the stakeholders on national and international level, and by joint R&D effort and common studies on wind power integration. There seems to be a general agreement about the necessary means for an efficient grid integration of wind power:

- Resilient grids and strong interconnectors to other system areas
- Technically demanding grid codes for wind turbines (and other production units)
- Flexible power production units and flexible electricity systems, including demand management
- Comprehensive planning for the whole system, including wind power, other power production units, the entire grid and the future system operation.

Session 2: International Incentives and Policies on Wind Grid Integration

Session 2 on international incentives and policies for wind power grid integration was chaired by Chair: Yang Xiaosheng, Long Yuan Power Group and Peter Jørgensen, Vice President of Energinet.dk.

Kaare Sandholt, Ea Energy Analyses, presented first on the role of the different stakeholders and their interactions in the process of ensuring an efficient integration of wind power in the power system. The major stakeholders are the government (on national or provincial level), local authorities, grid companies and system operators, power producers, wind power developers, wind turbine manufactures and

consumers. Mr. Sandholt pointed out that in particular system operators have role in ensuring good wind power integration because they are responsible for the overall security of supply and system stability. History shows that system operators may display very different approaches toward the development of wind power – from resistance or a passive attitude to an active or even proactive role in the development and integration of wind power. The negative or passive attitude is often caused by serious concerns about the risk of jeopardizing the system stability by introducing wind power into the grid. On the other hand, when such concerns are being addressed properly, the system operators tend to become a more proactive stakeholder. Mr. Sandholt also stressed the importance of a close and transparent dialogue between the stakeholders. It is important to recognise each other's role, and at the same time strive to reach shared solutions to the challenges. A well designed and comprehensive planning process with frequent involvement from the various stakeholders is definitively one of the most important means in that respect.

The next speaker was Kevin Porter, Senior Analyst from the North American consultancy Exeter Associates Inc., who reviewed the Large-Scale Wind Grid Integration in the United States, based on a newly published paper which is available in English and Chinese (the paper can be found on the web site www.efchina.org). He commented that while new transmission is very important and vital and necessary for accessing remote wind resources that are from large population areas, new transmission is not sufficient by itself. He noted that the grid still needs to be operated reliably, even with new transmission. Concerning Smart Grid, Mr. Porter said there is a lot of activity with smart grids in the United States, but wind and solar integration are at best only a very small part of smart grid activities in the U.S., planned or operational. More importantly, he cautioned that smart grid should not be considered a pre-requisite for adding more wind capacity. He pointed out that Denmark, being at 20% wind, is a different situation entirely, but most countries are at low levels of wind penetration, and a lot can be done with "dumb grid" strategies, such as reducing scheduling intervals.

He noted that a over a dozen wind integration studies have been performed in the United States since the 1990s, and more are either underway or are planned. He commented that actual operating experience with wind power in the United States is limited, although increasing. Therefore, wind integration studies have been prospective in nature, i.e., modeling a potential future power system with increasing amounts of wind generation. He pointed out some common themes, with perhaps the most important one that wind integration studies have evolved from whether it is even possible to incorporate wind generation to how and at what cost. Overall, how easy or difficult it will be to integrate wind power depends on the size of the balancing area, as larger balancing areas have more generating resources available to counter wind's variability; how flexible current generating resources are; the availability of ancillary services or an ancillary services market; and whether wind projects are spread out geographically or concentrated geographically. In general, wind integration studies done to date in the U.S. have found that the expected wind integration cost will be under $5.00/MWh for wind capacity penetrations of up to 20%.

He summarized the presented findings by underlining some important measures in wind power integration:

- Conduct wind integration studies
- Implement grid codes
- Implement a wind forecasting system
- Add flexible new generation
- Develop scheduling and dispatch rules that accommodate wind
- Allow for wind curtailment.

He concluded that given China's wind targets and the rapid development of wind to date, and the differences in grid operation practices from those studied in the U.S., that China should consider doing wind integration studies based on state-of-the-art wind integration study methodologies and techniques.

Such a wind integration study should assess the interaction of the variability of load and wind; ramping issues with and without wind; and minimum load with and without wind.

Finally Henrik Rosenberg, Project Director Power Engineering from the Danish company Balslev Consulting Engineers A/S, gave a presentation about developing proper grid codes for wind turbines, based on his experiences from working on a new Chinese grid code as part of the WED-program in cooperation with the China Electric Power Research Institute (CEPRI), itself part of China's State Grid. Henrik Rosenberg underlined the need for a grid code for wind turbines which at the same time allows for a stable power supply and for connecting a large number of wind turbines to the grid. In general wind power plants should be treated as any other power plant when it comes to electrical engineering. The proposed grid code developed in the WED project is based on the grid conditions in China and the continuous need for a reliable electric power supply, also when more wind power is available in the future. Furthermore Mr. Rosenberg pointed out the need for an optimal dispatch of the whole system in order to ensure large scale wind power integration. Also a more flexible power system should be developed, including decoupling thermal and electricity production and introducing thermal storage, electric boilers etc. Finally Mr. Rosenberg recommended reviewing the incentive structure in China to ensure continued success of wind power development.

Peter Jørgensen wrapped up the session. He found that the experiences from wind power integration all point to the same conclusions which were excellent drawn up by the speakers in the session and summarised in Mr. Porter's presentation.

Session 3: Grid Integration Technology

The session on grid integration technology was chaired by [title, name, organization].

The first presenter was Mr. Finn Strøm Madsen, President, Vestas Technology R&D, with a presentation titled "What can grid friendly turbines do for China".

He emphasised that the wind turbine manufacturer is a wind power plant solution provider, and plays an important role along the entire process of integrating wind power into the power system and throughout the entire project lifecycle. Modern wind power plants offer all the functionality the grid may ask for and the solutions are available today. The manufacturer can assist in making studies and provide models of the wind turbines for these studies. To secure compliance, it is important for the manufacturer to maintain and demonstrate a clear translation from grid codes to product specifications. The manufacturer can also assist a TSO in ensuring that grid code and compliance permissions are adequate and accessible. Also, the manufacturer is available to assist to educate the wind power community on how grid codes and wind power plant technology interact.

Finally, Mr. Strøm Madsen ensured that Vestas can and will engage in special projects with state-of-the-art technologies.

The second speaker, Ms. Jiang Liping, Deputy Chief Engineer, State Grid Energy Research Institute, pointed out both, challenges and possible solutions for the continuing development of wind power. According to her presentation the key issues today are:

- The limited ability of grid to accommodate massive wind power generated input;
- Poor planning, i.e. lack of coherence and coordination between power plant construction and grid construction;

- Insufficient accommodating ability due to structural imbalance of power sources – e.g. peak regulation;
- Incomplete technical and managerial standards worsening the impact of large scale integration on grid safety and stability;
- Need for improvement of incentive schemes and support mechanisms.

In order to overcome these barriers Ms. Jiang Liping suggested the following measures:

- A complete legislation – Renewable Energy Law plus supporting regulations combining electricity purchase, power pricing and allocation mechanisms, and compensation mechanisms for thermal power plants;
- Promulgation of mandatory technical standards and management codes for wind power integration, i.e. Integration guidelines, testing and certification system etc.;
- Coherent plan for the future development, combining power planning and grid planning;
- Improved ability of the power system to accommodate wind generated input through enhanced grid construction, – trans-regional networks, and smart grids.

Mr. Azusawa Noboru, Chief Engineer and CTO, Hitachi Co. Ltd. explained how to combine wind turbines and smart grids. He went through a number of examples on how to ensure stability of an electrical system with a large share of wind power. In order to optimise the system and to reduce the blackout duration of power systems, detailed and precise synchronisation analysis must be performed for the planning and construction of power plants.

Mr. Chi Yongning, Deputy Chief Engineer of renewable energy department, China Electric Power Research Institute, presented the results from the wind power grid integration studies and grid code upgrading, carried out as part of the Sino-Danish WED programme. Grid code formulation and implementation as well as wind turbine/wind farm testing are effective ways to ensure the security of power system with integration of large amount of wind power. Implementation of the recommendations contained in these studies would enable effective solutions to solve the power system issues caused by large scale wind power grid integration.

Panel Discussion: Large Scale Wind Power integration in China – Challenges and solutions

The panel discussion was chaired by Mr. Gao Hu, Deputy Director of ERI's Centre for Renewable Energy Development, CRED, Mr. Liu Guiyuan, Deputy Director for the Energy Division, Department of Development Planning, State Grid Corporation and Mr. Kaare Sandholt, Ea Energy Analyses. The panel consisted of most of the speakers from the three previous sessions.

In his opening remarks, Mr. Liu emphasised, that the Chinese power systems are not fully prepared for the large-scale integration of wind power. The existing grid infrastructure needs further development. In addition, the performance of the currently installed wind turbines is not satisfactory from a system operator's point of view, and the grid code needs to be improved. Mr. Liu mentioned that the combined heat and power plants (CHP plants) in the North East of China are not able to reduce electricity production in the winter, when heat production is needed. However this would be technically feasible, but mechanisms should be designed and implemented in order to facilitate the needed investment for such technical solutions and to compensate for losses resulting from reduced power production. Also the future

pricing of wind power should be looked at. The possibilities for a high share of wind power are different in the various regions in China. In some areas there is a lack of regulating power to ensure system stability with a high share of wind power, and curtailing of wind power would be necessary for a number of reasons. Finally Mr. Liu underlined that the development of wind power is closely related to the development of other power producing units and other energy resources. Consequently a comprehensive and long-term planning for the whole power system is needed.

Mr. Henrik Rosenberg mentioned several technical options for a more flexible power production from CHP plants. Steam bypass of the turbine would make it possible to produce heat without electricity from the CHP plants, while heat storage would make it possible to produce more electricity from the CHP plants in hours where the heat consumption is low.

Wayne Coste added that in the long run, storage of electricity in the form of Hydrogen or use of excess electricity for the production of fertilizers could be very relevant. Furthermore Wayne Coste found that development of en electricity market is not a prerequisite for a large-scale development of wind power, but transparency in costs is.

Jens Carsten Hansen, Risø, pointed out that a proper design of wind farms is essential for the success of wind power. The forecasting methods should be improved in order to make wind power production more predictable, thus integrateable into the power supply system.

A representative from the Chinese wind turbine manufacturer Goldwind emphasised that new standards for wind turbines are necessary. The wind turbines from Goldwind are able to meet more stringent requirements. He found that new national standards should be more detailed than the existing grid code.

The development of smart grid components was mentioned, including the use of electric plug-in hybrid cars for storing and supplying power while connected to their charging stations. The panel was divided in the question of when and how much plug-in cars could contribute to load management. Some found that this technology was not to be seen for many years and would contribute little to the system flexibility; others were more optimistic regarding both, the time horizon and impact.

Kevin Porter pointed out that wind power integration is not about wind power alone. The task is to balance production from all power production units against the load, and a number of flexible solutions should be taken into account in an overall system configuration. He also emphasized the need for accurate wind forecasting, not only for the wind power developers but also for the grid companies. Finally, he contrasted the rapid level of wind development in China with what others have said is an inadequate grid code, and warned that this is an unsustainable situation. He urged prompt action on developing a new grid code as soon as possible, and noted that other countries imposed capacity limits or a moratorium on further wind development until stronger grid codes were in place.

Mr. Liu mentioned that the challenges for wind power integration vary between the different regions of China. In the North-East part of China research shows that it is possible to balance wind power if the right incentives for developing a more flexible power system are provided, including compensation mechanisms for thermal power plants and CHP plants. In the North-West part of China new long distance transmission lines should be built in order to accommodate a larger amount of wind power. In addition, new grid technologies should be taken into account. The State Grid Company works according to a coherent planning for the development of the grid. Regarding off shore wind farms, Mr. Liu predicted that after 2020, China will have a large development of such farms, but currently more research is needed for this sector.

Conclusions and recommendations

The workshop gave an excellent overview of the international state of the art regarding the integration of large amount of wind power into the power system. In all countries there are challenges, but also emerging solutions.

Based on the international experiences the following recommendations could be useful for the anticipated further development of wind power in China:

In the short term focus on:

1. A rapid development of a new and stringent grid code for wind turbines. The work supported from the WED program regarding an improved grid code should be utilised to speed up the process of adapting a new national grid code, at least as a national recommendation
2. Consider doing one or more wind integration studies, either regionally by province or provinces, or nationally. Such a study should include "best practices" as learned from other wind integration studies.
3. Reinforcement of the grid is a necessary precondition for the further development of wind power. A transparent comprehensive grid and system planning including the whole power system should be carried out with a strong involvement of all stakeholders
4. It is urgent to develop a more flexible power system, where the existing power units and CHP plants will be able to contribute to the integration and balancing of the fluctuating wind power production. CHP flexibility appears not to be a technical problem but compensation mechanisms might be needed in order to encourage the CHP power producers to invest in flexibility. This includes new mechanisms for the purchase of system services from the power producers.
5. Better forecasting and real time information about the wind power production would substantially improve the grid companies' ability to balance load and production. These measures need more attention.
6. The planned large wind farms will be situated far from the major load centres and long distance transmission of electricity will be necessary. Pilot projects for advanced transmission grids would be valuable for the future development of the Chinese grid.

In a longer perspective focus should be on:

7. Development of smart grid measures, including demand side management measures.
8. Development of coherent energy system with flexible integration of electricity, heating and transportation
9. Development of an advanced transmission grid which would be more suitable to integrate all power producing units and better to manage long distance transport of electricity.

These recommendations lead to the following list of ideas for activities and questions:

- Identify barriers for more flexibility
- How to set up a regime which gives incentives to the different stakeholders (including payment for system services)?
- How to develop scheduling and dispatch rules that accommodate wind?
- How to speed up the process of establishing a general grid code for wind turbines?
- How can experience from the wind power grid code work be used for other RE technologies (e.g. Solar PV)?

- Overview of best practice for long distance transportation of electricity
- Pilot projects for new transmission grid technology
- How can exchange of electricity between system areas be ensured (technical, organizational and regulatory)?
- How to carry out comprehensive wind integration studies, including dispatch of power units, grid bottlenecks and exchange to other system areas?
- How to ensure stakeholder involvement in these studies?
- How does the existing incentive schemes work, what is missing, and how can they be improved?
- How can a coherent energy system be developed?