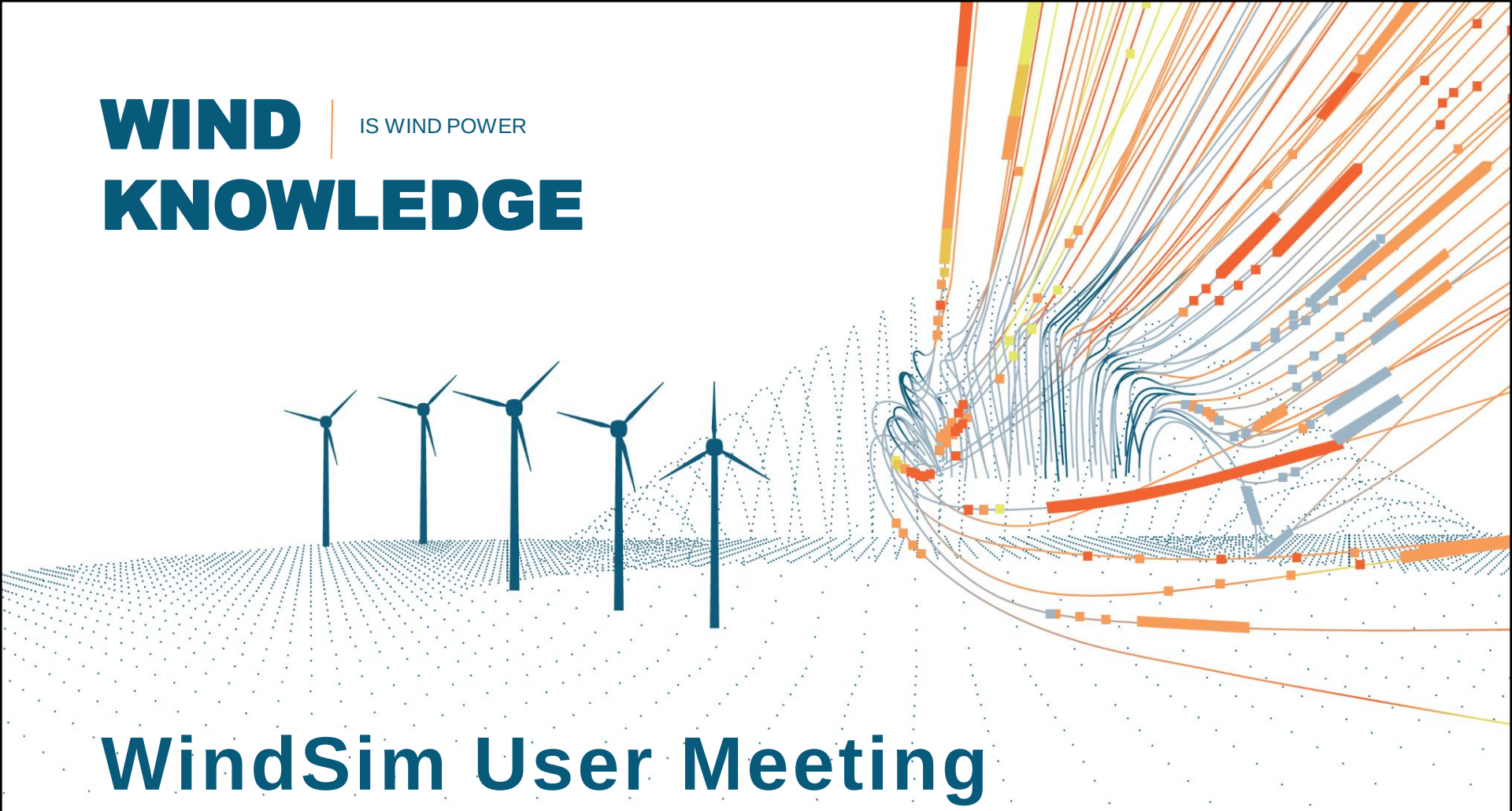
WIND KNOWLEDGE | IS WIND POWER



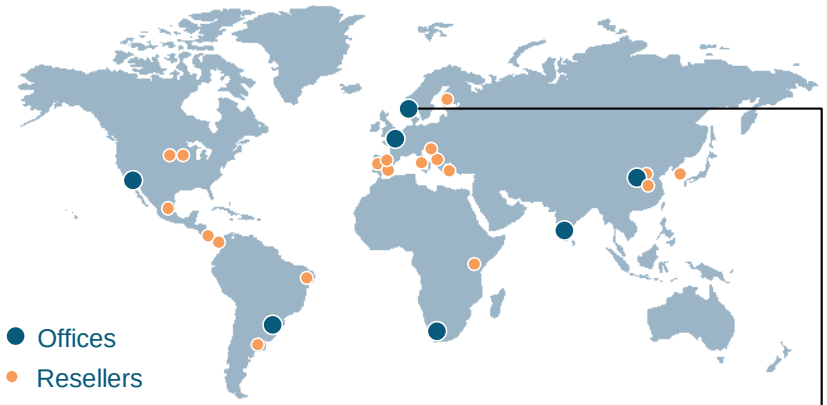
WindSim User Meeting
Welcome and recent Development

PRESENTED BY: Xuan Wu, Country Manager

windsim

WindSim has a global reach with worldwide offices and resellers

Overview company, offices and resellers



- WindSim serves more than 250 customers in 50 countries
- WindSim has offices in Norway, USA, China, Brazil, South Africa, India and France
- Resellers partners in: Argentina, Brazil, Canada, China, Costa Rica, Finland, Greece, Italy, Kenya, Korea, Mexico, Portugal, Serbia, Spain, Turkey and USA

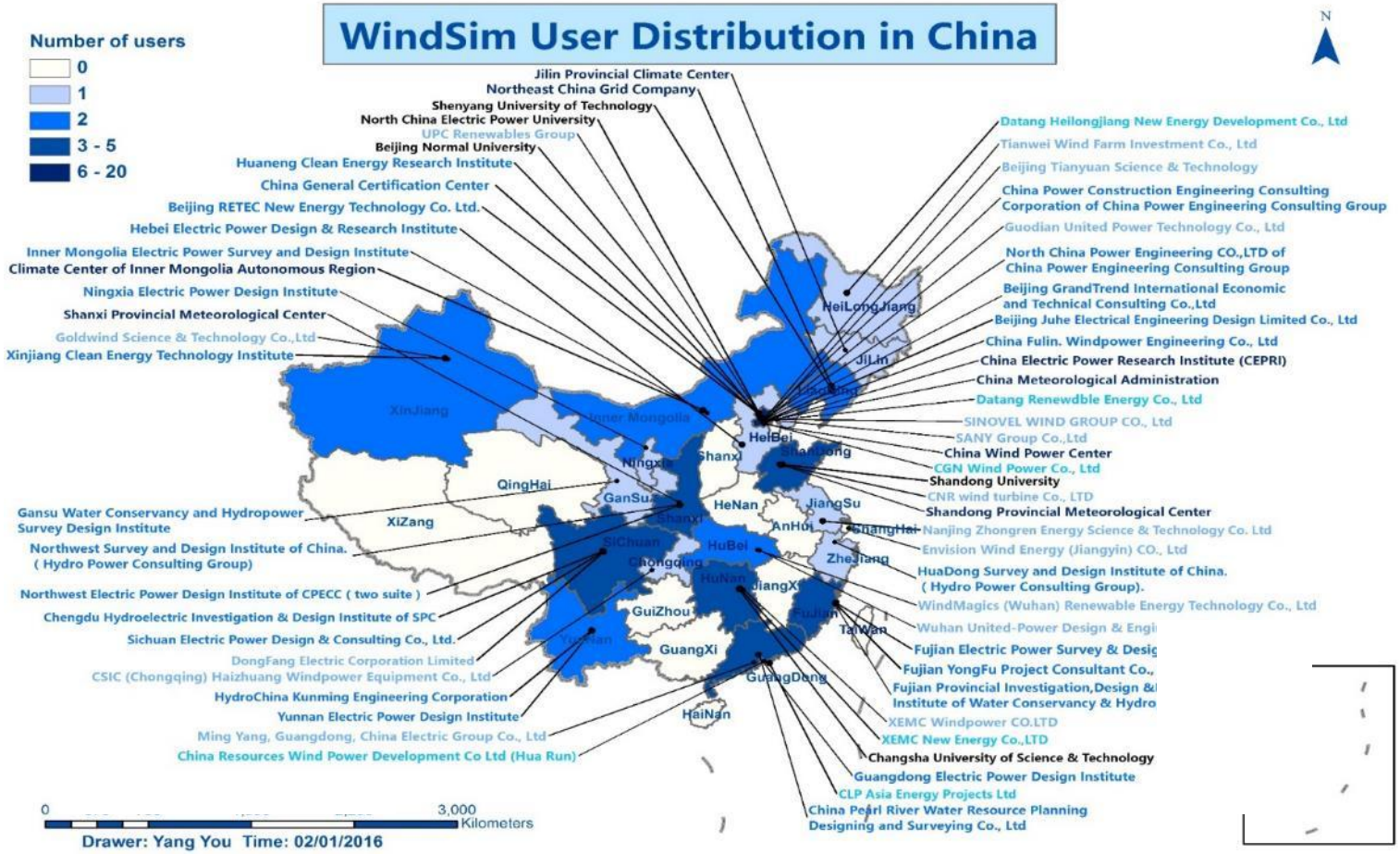
WindSim HQ in Tønsberg, Norway

- Company established in 1993, privately held
- WindSim - World class software launched in 2003
- Business areas
  - Software solutions, consulting services and training
    - Wind energy assessment and wind farm simulations
      - Wind farm lifecycle
      - Onshore and offshore
    - Other wind assessment
      - Power line and grid optimization
      - PV industry

WindSim is a leading wind CFD modelling software with customers all around the world

- Customer segments:
  - Turbine manufactures
  - Wind farm developers, owners and operators
  - IPPs
  - Engineering and consulting companies
  - Research institutes
  - Universities

Unique position in China with more than 90 companies using WindSim software

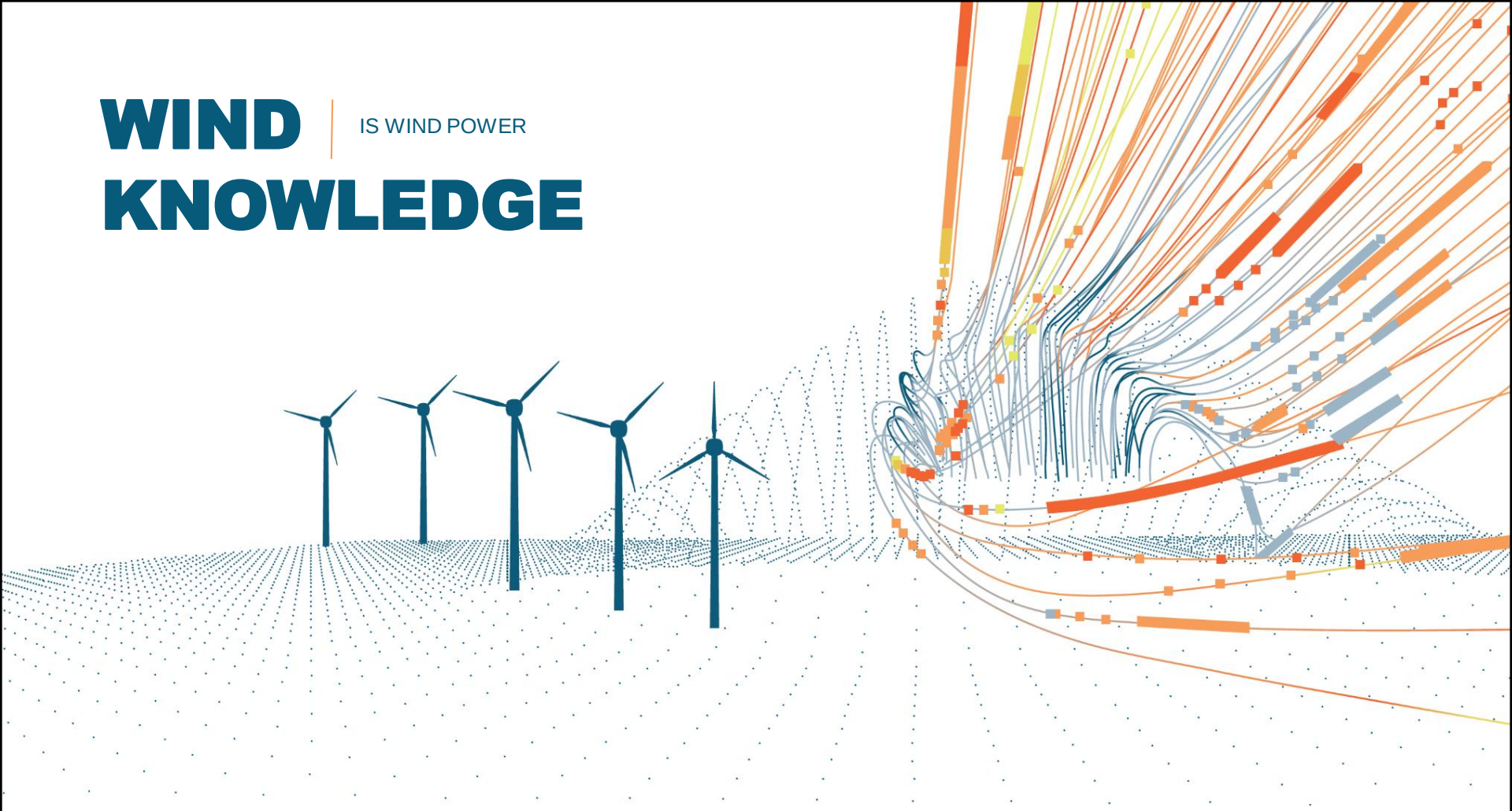


Updated Jan 2016

WindSim User Meeting Objectives

- Wind industry moving forward – Discuss needs and challenges
- Updates from WindSim on software development activity
- Share user experiences, learn from each other, networking
- Have fun ☺

WIND KNOWLEDGE | IS WIND POWER



Recent development

windsim

Content

- Most important features in WindSim 9.0
- New features in WindSim 10.0
- Ongoing research projects

Content

- Most important features in WindSim 9.0
- New features in WindSim 10.0
- Ongoing research projects

New features WindSim 9.0

- Rotor equivalent wind speed
- Export to the new CFD input format of WindPRO - FLOWRES
- Export to Google Earth

- Faster energy module calculation
- Reduced files in binary format

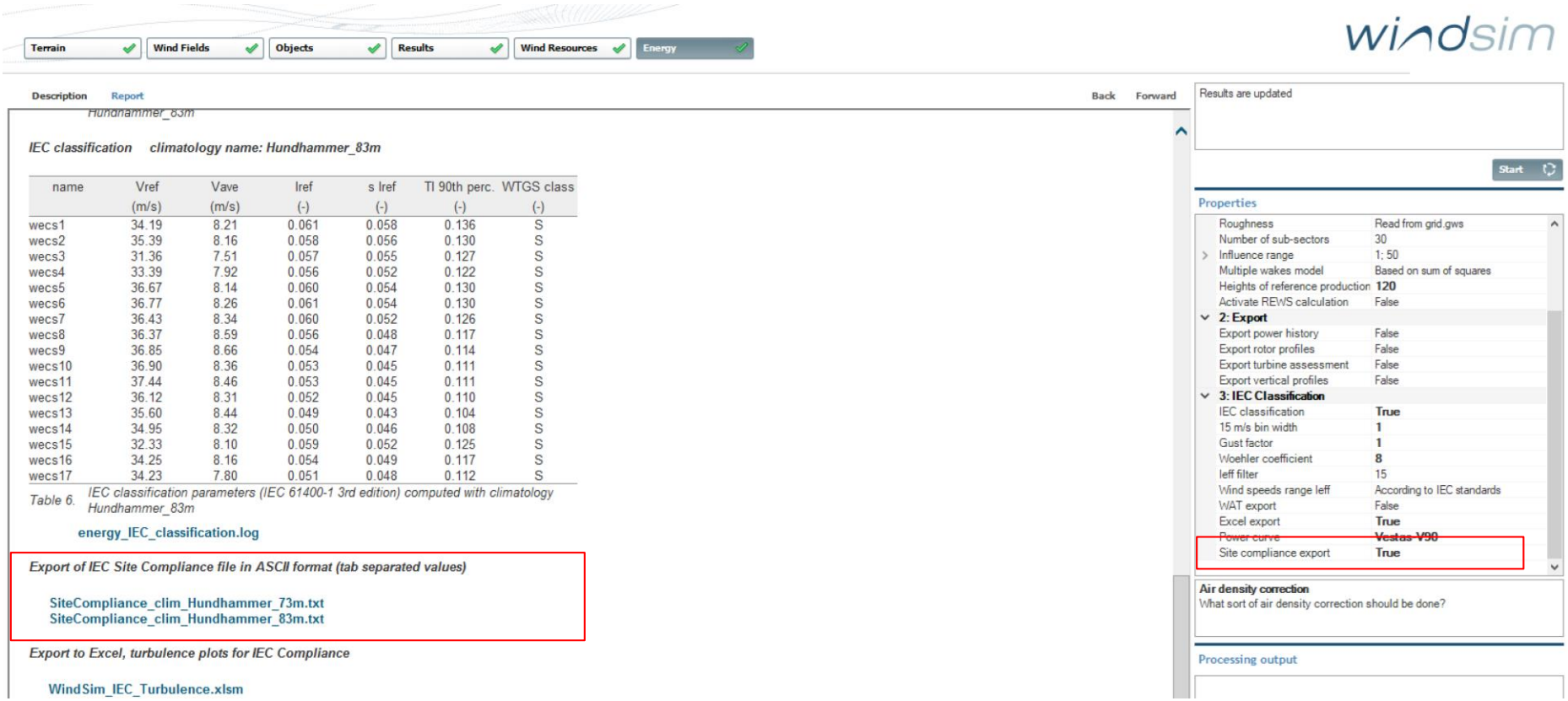
- TI map for 15m/s bin in wind resource module
- Site compliance file
- Excel tools for FMV, C2 value determination, IEC plots
- Spot value plots with logarithmic scale
- Select spot value height
- Easy access to folders

- WindSim Express improvements

- Integration towards Windplanner

Site compliance file

- All information necessary for a site compliance study in one file
  -



name	Vref (m/s)	Vave (m/s)	Iref (-)	s Iref (-)	TI 90th perc. (-)	WTGS class (-)
wecs1	34.19	8.21	0.061	0.058	0.136	S
wecs2	35.39	8.16	0.058	0.056	0.130	S
wecs3	31.36	7.51	0.057	0.055	0.127	S
wecs4	33.39	7.92	0.056	0.052	0.122	S
wecs5	36.67	8.14	0.060	0.054	0.130	S
wecs6	36.77	8.26	0.061	0.054	0.130	S
wecs7	36.43	8.34	0.060	0.052	0.126	S
wecs8	36.37	8.59	0.056	0.048	0.117	S
wecs9	36.85	8.66	0.054	0.047	0.114	S
wecs10	36.90	8.36	0.053	0.045	0.111	S
wecs11	37.44	8.46	0.053	0.045	0.111	S
wecs12	36.12	8.31	0.052	0.045	0.110	S
wecs13	35.60	8.44	0.049	0.043	0.104	S
wecs14	34.95	8.32	0.050	0.046	0.108	S
wecs15	32.33	8.10	0.059	0.052	0.125	S
wecs16	34.25	8.16	0.054	0.049	0.117	S
wecs17	34.23	7.80	0.051	0.048	0.112	S

Excel Tools

Flow Model Verifier

Stand-alone tool to compare vertical profiles of several CFD simulations with measurements

Automatic C2 value determination

Global data base to find Leaf Area Index in your region and calculation of a suitable C2 value depending on forest height and forest type

IEC plots

Compare simulated turbulence intensity to the IEC class values

WindSim Express

- GLC30 land use data set included (30 m resolution)
    - http://www.globallandcover.com/GLC30Download/index.aspx
    - 10 different land use types
- Editable roughness table
- Usage of map files easier as you do not need to give a coordinate system
- Write out ows file in the beginning => WindSim Express as quick creation tool for tws and ows files

Content

- Most important features in WindSim 9.0
- New features in WindSim 10.0
- Ongoing research projects

New features WindSim 10.0

- WRB file (export to OpenWind)
- Weighting of wind resource map by distance and trust
- Speed-up energy module
- New 3D component for visualization
- Atmospheric stability classification from measurements
- New actuator disc model
- Hypre solver
- Larger models

Content

- Most important features in WindSim 9.0
- New features in WindSim 10.0
- Ongoing research projects

Ongoing research projects

• The most important topic of the recent years was **forest, forest** or **forest**

• Having **more precise forest data sets** for tree height and leaf area index together with **a good forest parametrization** in our CFD code, we can conclude from validation studies that the **forest modeling is doing very well** and there is not so much more we can improve for the moment

=> We can finally look at other interesting topics:

Atmospheric stability

Meso-microscale coupling

Blockage effect

Atmospheric Stability

- Atmospheric Stability is implemented into WindSim since almost 10 years
- A lot of other CFD codes have copied WindSim's approach => cannot be that bad, or?
- Still not many people use atmospheric stability in CFD and the reasons are:
  - the lack of qualitatively good measurements or modelled data to determine the atmospheric stability parameter
  - The lack of understanding of how to handle atmospheric stability, what atmospheric stability means for the wind speed profile and for which sites accounting for atmospheric stability can improve the CFD results

Atmospheric Stability

- Therefore, WindSim thought it was a good idea to involve all necessary parties into a collaboration: site assessment engineers, measurement device producers, mesoscale modelers ad CFD code developers. The goal was to give: Best practices for quantifying, interpreting, and utilizing atmospheric stability measurements using standard wind resource assessment sensors and CFD simulations => collaboration between EON, NRG Systems, Vortex, and WindSim

- We have come quite far and EON has an oral presentation at WindEurope

- But still there are some open questions

- The ultimate goal for WindSim is to have an automated stability classification from measurements in the software and give advice how to set-up the simulations

Meso-Microscale Coupling

- There are sites where knowing the atmospheric stability is not enough => The atmospheric flow patterns are too complex

- Phd on Meso-Microscale Coupling done by Pablo Duran:

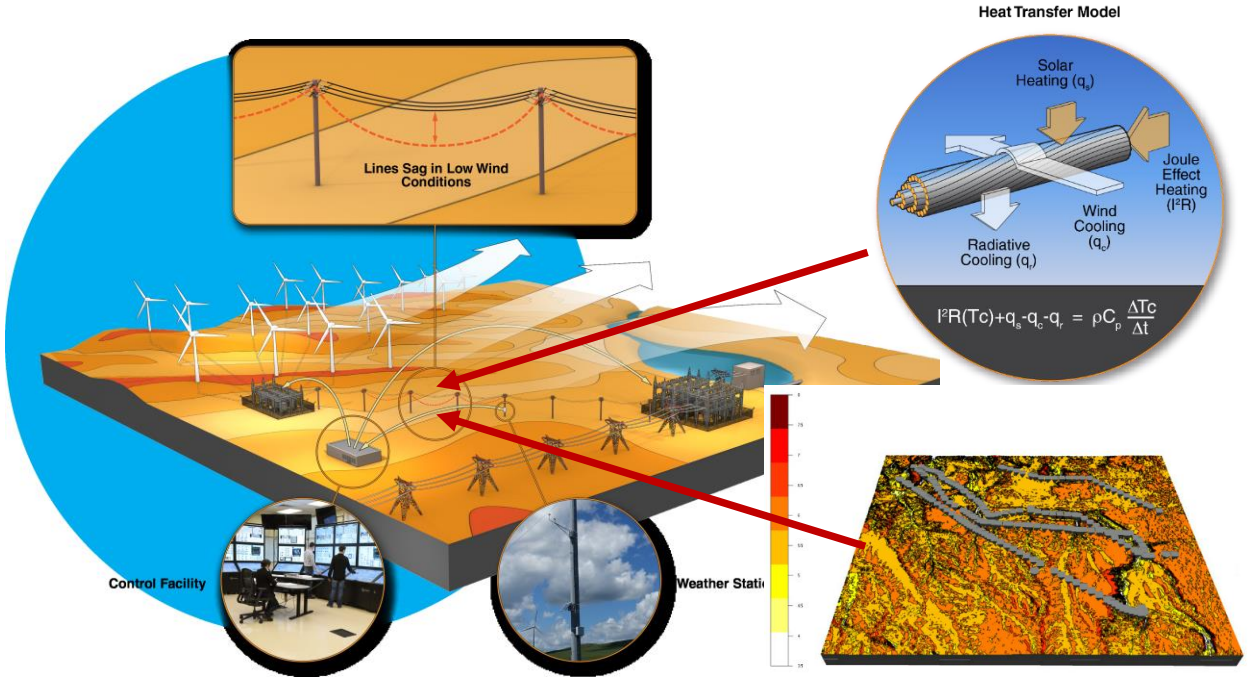
  - Investigate meso-microscale coupling together with the Novia University of Applied Sciences, Finland – finished this year and results will be shown today

  - Investigating meso-microscale coupling together with EON on flat sites with thermal flow patterns => ongoing and results will be shown today

  - Investigating mesoscale coupling together with Mainstream Renewable Power on complex sites in Chile => ongoing, but the best method for such a coupling still has to be developed

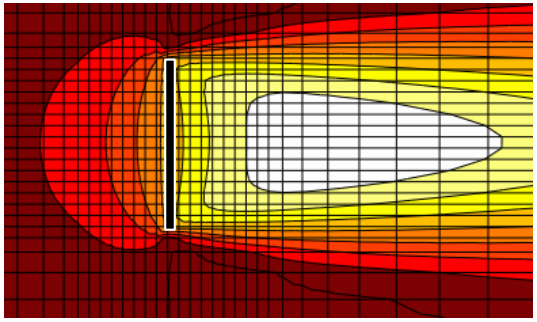
Ongoing research projects

- NowWind: Nowcasting for wind energy production - an integrated modelling approach
  - Presentation of a poster here at WindEurope
- Innovation Norway funding for Dynamic Line Rating based on CFD
  - nominated for the R&D 100 award in the USA
-

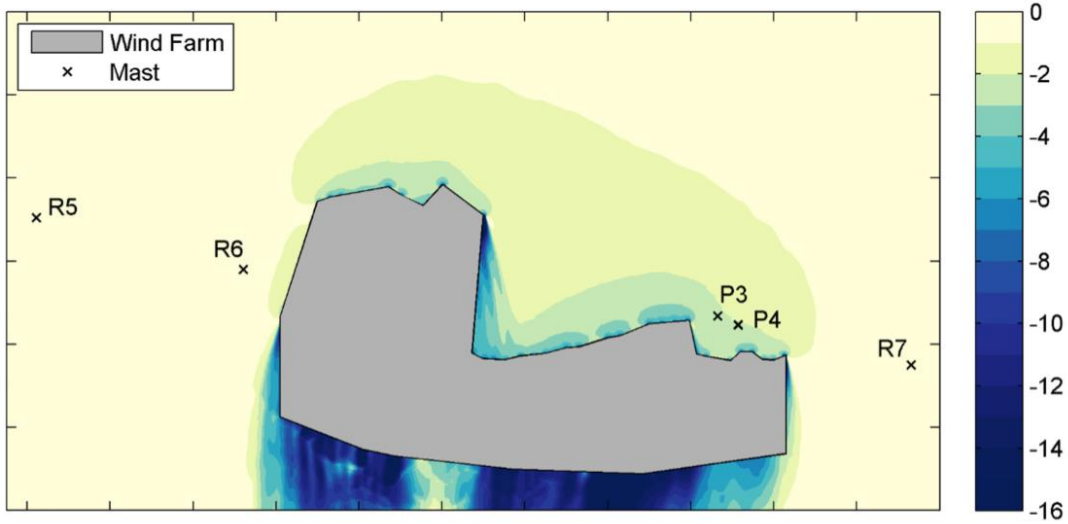


Blockage effect

- Turbines reduce the wind speed also upfront a turbine



- For large wind farms that effect can be quite important (source DNV GL):



Blockage effect

- To model this effect we have a good actuator disc model

- But we need to get a numerical grid which is more flexible to keep the number of cells down => we need an unstructured grid and a faster solver

- We are looking for customers who want to be part of a joint industry project to get the necessary funding and good validation data

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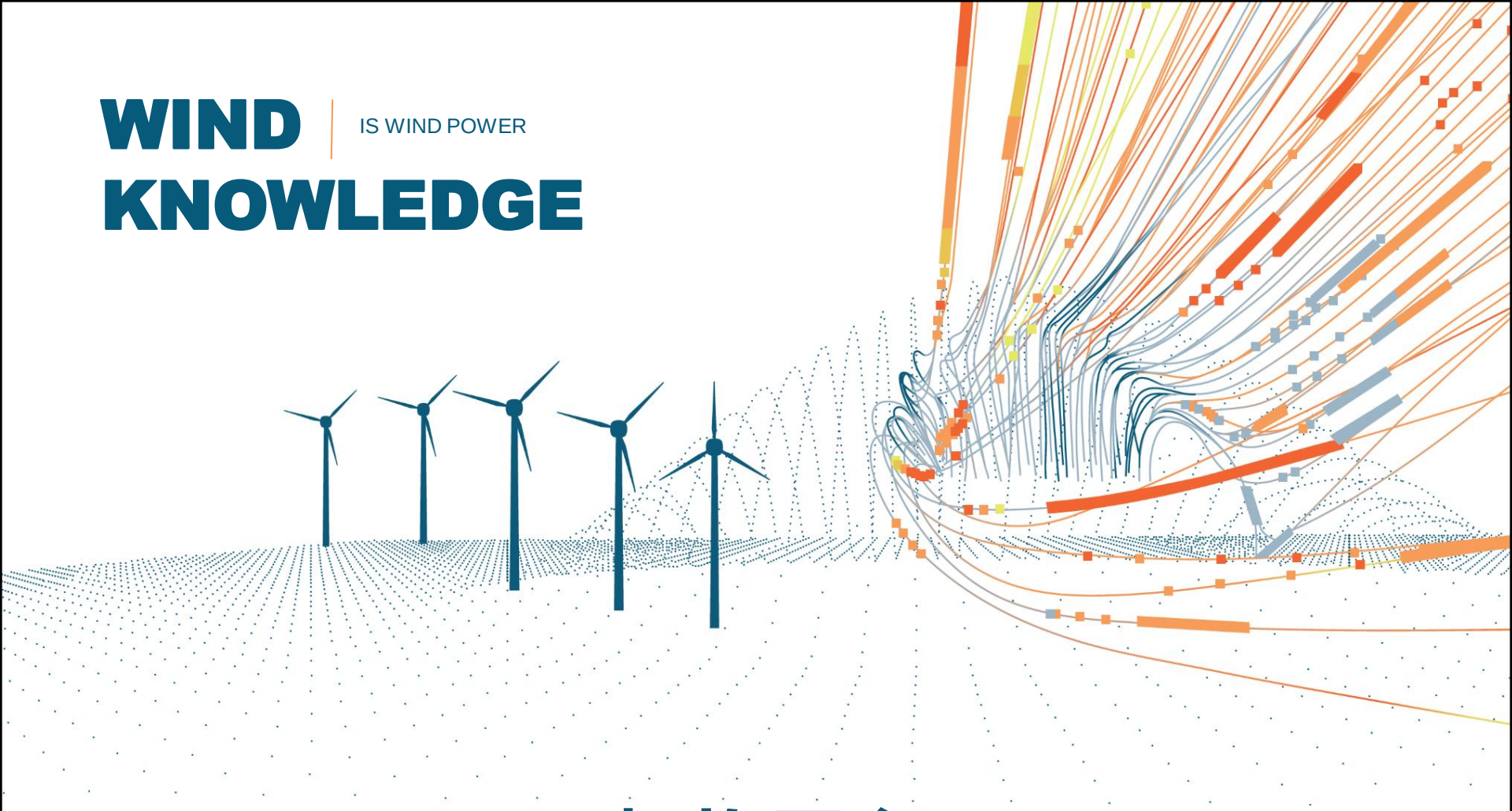

WindSim B/S架构平台

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WindSim 云平台和云计算

为什么需要云平台和云计算

1 云计算是巨量流体力学计算的必然选择

在风资源计算的过程中，有两个过程是需要进行大量数值计算的，分别是风流定向流体力学（CFD）计算和AEP及IEC计算过程。其中（CFD）通常需要数小时乃至几天，而AEP和IEC的计算，对于风机和测风塔数量较多的项目也需要花费大量的时间。而在云端，上述计算过程可以在很短时间内完成。

2 云平台是项目管理和数据管理的必然选择

风资源评估过程中的项目和数据通常掌握在工程师个人手中，通常难以做到统一的管理和再利用。通过云平台的账户管理和云存储技术，所有项目的细节均可很方便地获取，能有效地提高项目和数据管理的效率。

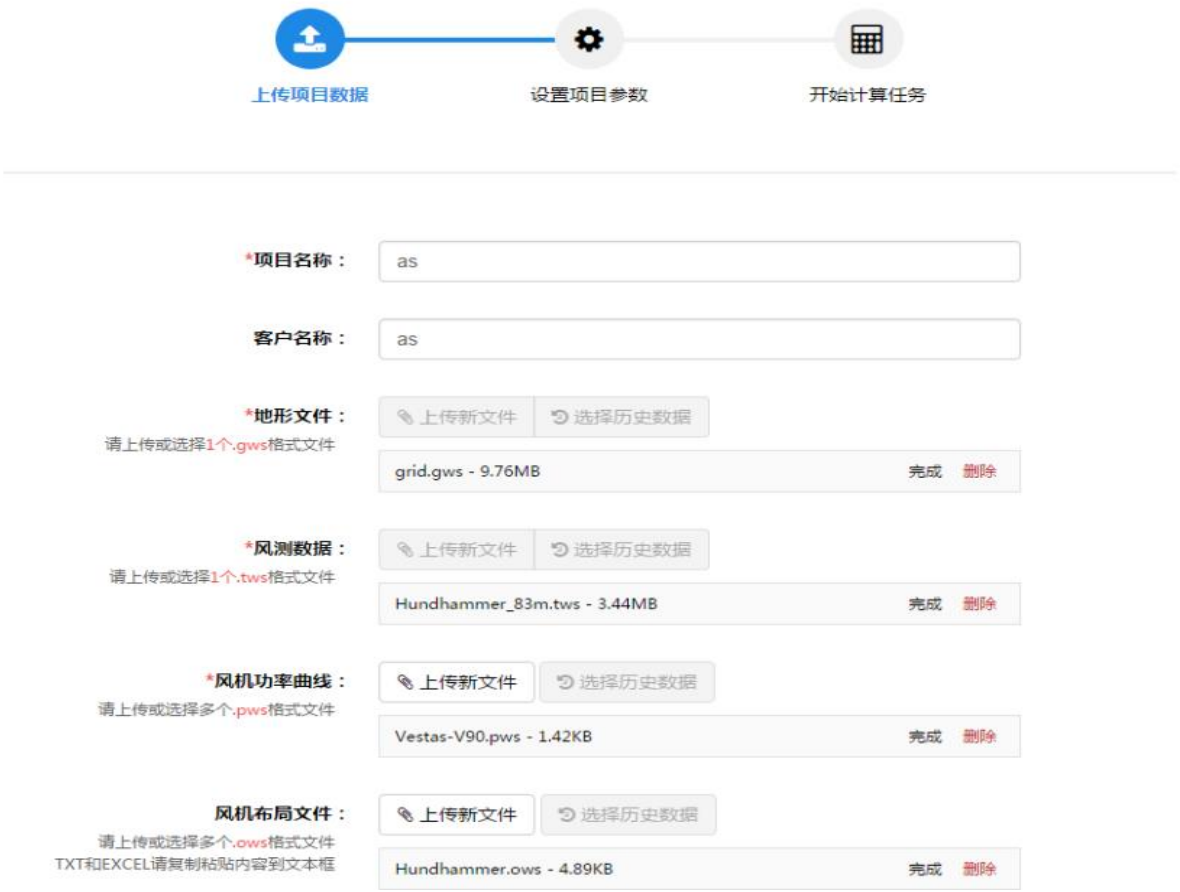
3 云平台也是未来未来技术和管理扩展的必然选择

随着建成项目的增加，利用云平台也可以实现建成项目的后评估和风电场性能实际监控。对于未来项目的科学化管理也具有重要的意义。

WindSim 云平台和云计算

最终云平台的结构体系将如上图所示，风资源项目相关的工作将完全在云端完成计算和存储，方便实现项目的管理、数据的管理以及项目的后评估等各项功能。
目前，云平台的主要功能还集中于模拟的部分，其目标在于使用户能够在一到两个小时内完成常规风资源评估的计算任务，快速获得发电量的评估结果。

WindSim 云平台操作流程



登录云端

新建项目

上传必需的项目文件

WindSim云平台操作流程

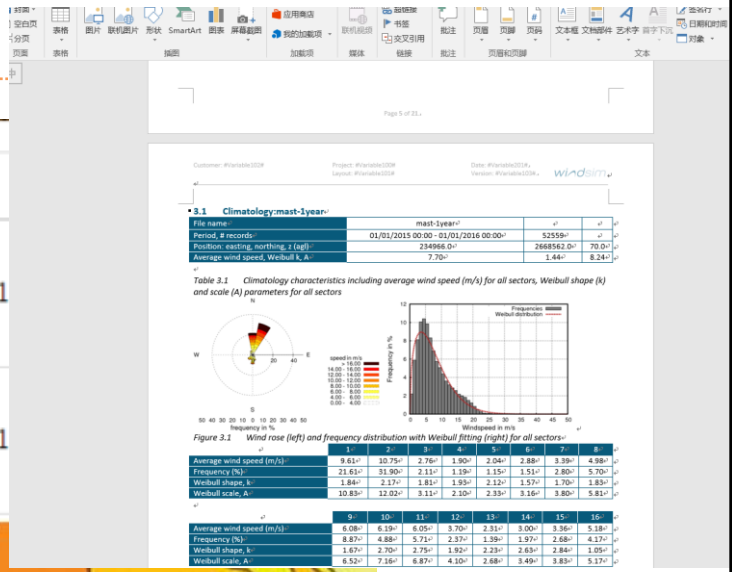
在云端完成项目评估参数设置

WindSim-Cloud E-Solver 云平台操作流程

提交项目任务
云端排队计算

WindSim 云平台操作流程

项目名称	项目状态	项目报告	创建时间
项目名称测试	50%	风机布局信息及可视化图、平均风速、发电量、满发小时、风机的IEC信息	2017-04-1
项目名称测试2	等待计算	风机布局信息及可视化图、平均风速、发电量、满发小时、风机的IEC信息	2017-04-1
项目名称测试3	计算完成	风机布局信息及可视化图、平均 量、满发小时、风机的IEC信息	
项目名称		风机布局信息及可视化图、平均 的IEC信息	



3.1 Climatology:mast-1year

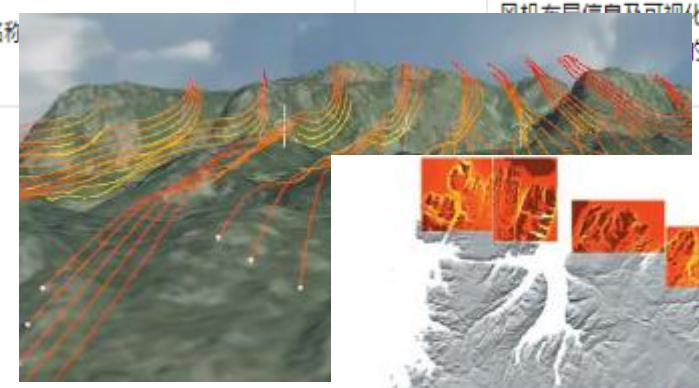
File name	mast-1year		
Period, # records	01/01/2015 00:00 - 01/01/2016 00:00	52559	
Position: easting, northing, z (agl)	234966.0	2668562.0	70.0
Average wind speed, Weibull k, A	7.70		1.44 / 8.24

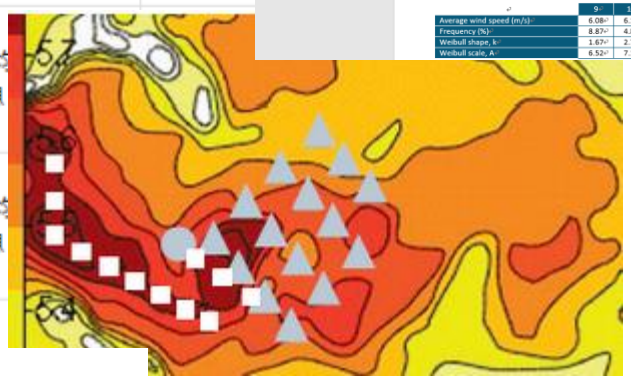
Table 3.1 Climatology characteristics including average wind speed (m/s) for all sectors, Weibull shape (k) and scale (A) parameters for all sectors

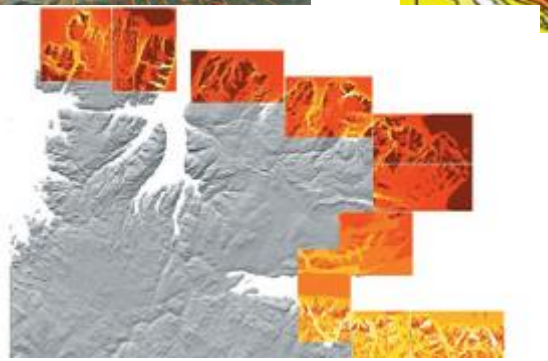
Figure 3.1 Wind rose (left) and frequency distribution with Weibull fitting (right) for all sectors

	1	2	3	4	5	6	7	8
Average wind speed (m/s)	9.61	10.75	2.76	1.90	2.04	2.88	3.39	4.98
Frequency (%)	21.61	31.90	2.11	1.19	1.15	1.51	2.80	5.70
Weibull shape, k	1.84	2.17	1.81	1.93	2.12	1.57	1.70	1.83
Weibull scale, A	10.83	12.02	3.11	2.10	2.33	3.16	3.80	5.81

	9	10	11	12	13	14	15	16
Average wind speed (m/s)	6.08	6.19	6.05	3.70	2.31	3.00	3.36	5.18
Frequency (%)	8.87	4.88	5.71	2.37	1.39	1.97	2.68	4.17
Weibull shape, k	1.67	2.70	2.75	1.92	2.23	2.63	2.84	1.05
Weibull scale, A	6.52	7.16	6.87	4.10	2.68	3.49	3.83	5.17







查看已完成的项目结果
进行项目管理，报告输出

WindSim 云平台的特点

1 强大的云计算能力

单个项目的网格数可达数亿，常规风资源评估项目均可在1-2小时内完成所有计算

2 全面的风资源评估能力

无论是宏观选址还是微观选址，或者后评估计算，在云平台上都能轻松实现

3 更好的用户交互界面和接口

用户只需通过本机的客户端和网络浏览器IE等，即可轻松完成风资源评估的所有工作，对本地硬件资源的需求降至最低

4 更科学的项目管理

用户可通过IE等浏览器实现项目的新建、查看、编辑、删除等工作，并能够通过云端的第三方数据库实现基于扩展风数据库的评估，数据源更多，评估结果更可靠。

Thank you

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