# Windpotential in der Ukraine

GEO-NET

Potsdam, Windenergietage 2019

# WHO IS GEO-NET?

**GEO-NET** has been conducting developments, advisements and analysis in the field of wind energy since 1996.

**GEO-NET** is a client oriented consultant for privat and public customers – from communities  to state authorities.

**GEO-NET** has branch offices in Ukraine, South Africa, Vietnam and Brazil

# TEAM

The GEO-NET-Team consists of an interdisciplinary group of 43 experts coming from various scientific backgrounds:

+ Geographers
+ Meteorologists
+ Engineers
+ Software engineers
+ etc.

# CERTIFIED

Deutsche Akkreditierungsstelle GmbH

Akkreditierung

GEO-NET Umweltconsulting GmbH
Große Pfahlstraße 5a, 30161 Hannover

Windmessungen und Messdatenanalyse, Bestimmung von Windpotential und Energieerträgen von Windenergieanlagen sowie Bestimmung des Referenzertrages von Windenergieanlagen

According to **DIN EN ISO 9001:2008** by TÜV NORD

TÜV NORD CERT GmbH ISO 9001

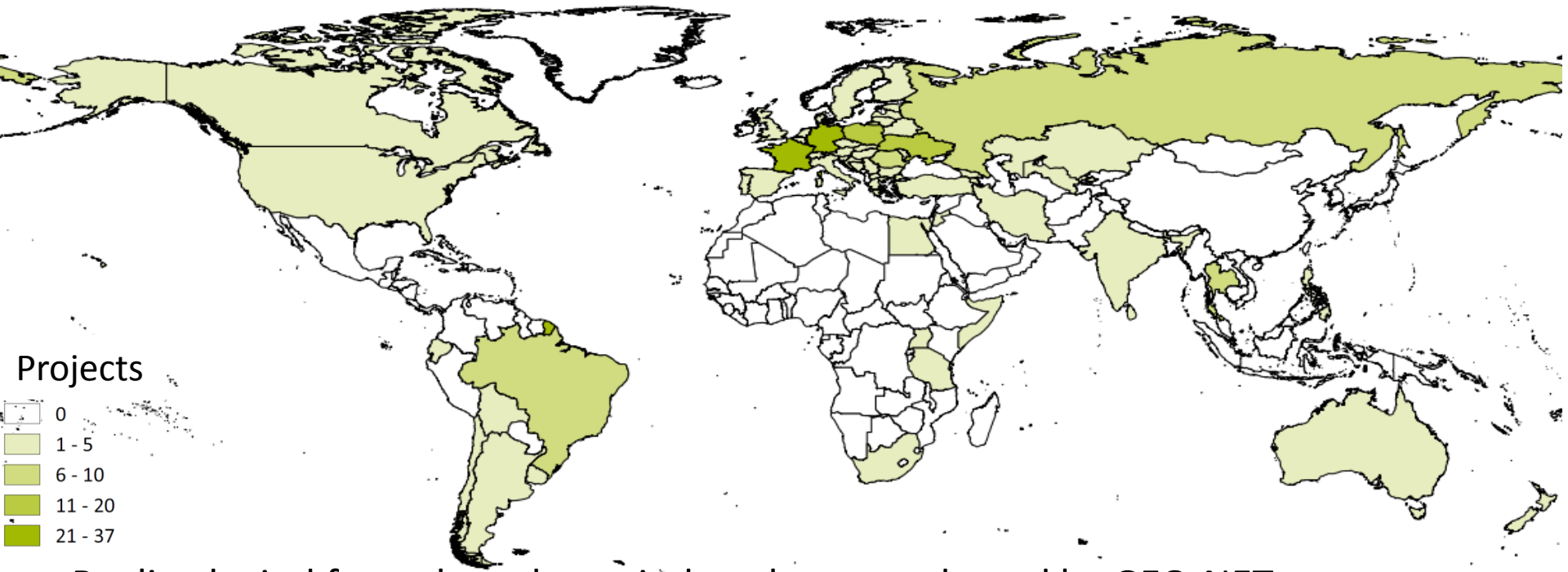
ilac-MRA

DAkkS Deutsche Akkreditierungsstelle D-PL-11132-01-00

International accredited as wind potential analysis and energy yield calculation laboratory including measurement campaigns and reference yield calculations according to **DIN EN ISO/IEC 17025:2005** by the DAkkS.

# EXPERIENCE WORLDWIDE

Measurements, potential studies and expertises of GEO-NET

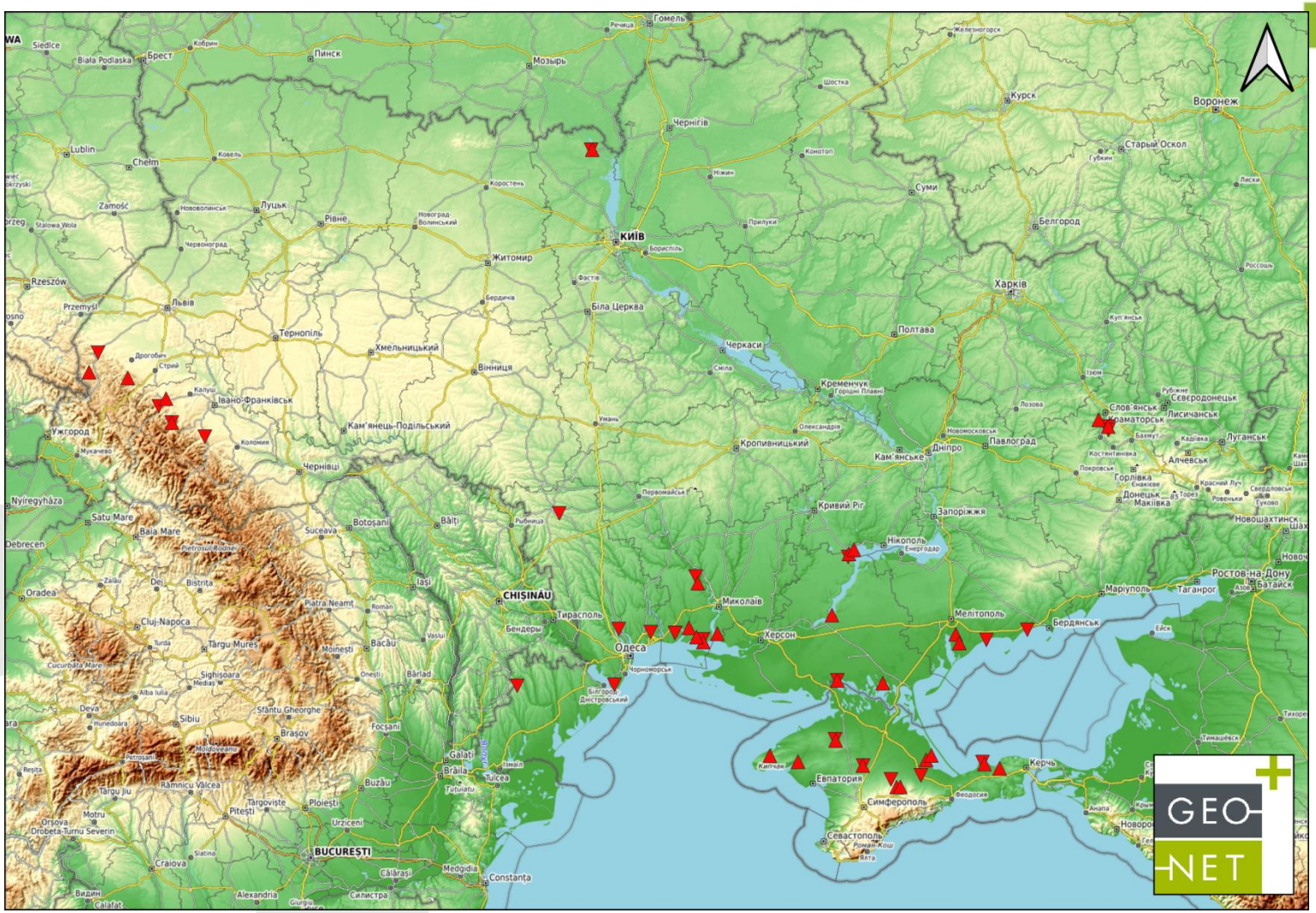



## Realised wind farms based on wind analyses conducted by GEO-NET:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sweden: | 7,5 MW | Hungary: | 5,6 MW | Ukraine: | 82,5 MW | Brazil: | 500 MW |
| Germany: | 5.500 MW | Bulgaria: | 104 MW | Czech Republic: | 62 MW | Chile: | 90 MW |
| Belgium: | 9 MW | Romania: | 519 MW | Poland: | 320 MW | Uruguay: | 50 MW |
| Swizerland: | 2,3 MW | Croatia: | 82 MW | Latvia: | 20,7 MW | | |
| France: | 480 MW | Greece: | 25,5 MW | Australia: | 844 MW | | |
| Italy: | 102 MW | Turkey: | 318 MW | | | | |

# EXPERIENCE IN THE UKRAINE

Measurements, potential studies and analysis made by GEO-NET




Wind measurement: ▲ wind potential study/energy yield assessment: ▼

# Windpotential of Ukraine

**… What can we say from experience in > 50 projects and 12 years in Ukraine:**

**GOOD Windpotential** can be expected at the coast line of black sea and the southern part.

**GOOD Windpotential** also at selected sites inlands.

**Carpathian Mountains:** … it depends. Sites with good wind potential and medium wind potential (very) close together. Elevated sites do not necessarily have good wind speeds.

➔ Public **available wind maps for Ukraine** have so far **no validation** and show significant **deviations from measurements**, especially in complex terrain

# Windpotential of Ukraine

- There is **wind potential and space for wind farms** also **inlands**, which isn‘t yet explored by developers, most projects concentrate on the coast line

- Projects in **Carpathian mountains**:
  - **Site selection** should be made very **carefully** considering access route, available area for placement of turbines, number of measurements needed…

  - **Budget** for single measurement is increased by +50 – 100% due to need for heating and independent power supplies.

  - **Improper power supply** (often seen: heating supplied by solar panels ☹) means to **loose data** and **miss good wind conditions during winter.**

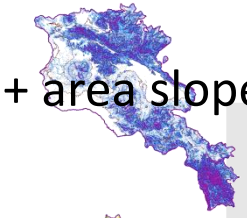
# Besides wind potential…

- **Procedure for payments is much different**: Specific supply or service contract required to release payments to foreign accounts.
- **Custom** procedure often „takes ***some*** time“ (…)
- ➔Use experiencend supply chains to avoid delays and high costs for building this experience
- Local contractors are available (e.g. met mast supply) and solves above issues to a high extend, **supervision is highly recommended** to safeguard compliance of work to international standards

# HOW TO FIND new WIND FARM SITES

# Search Area Procedure

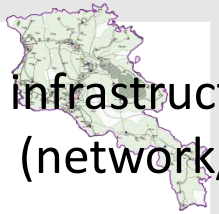
+ area slope



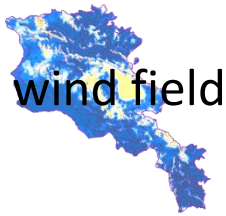
+ land use

+ reserves

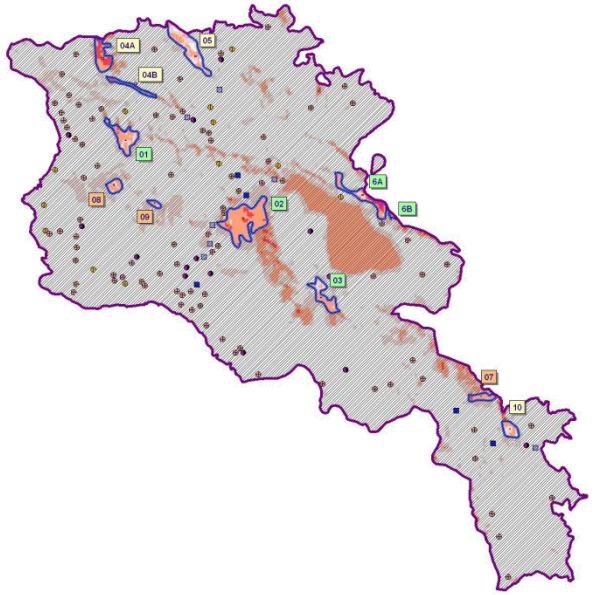
+ infrastructure
(network/traffic)



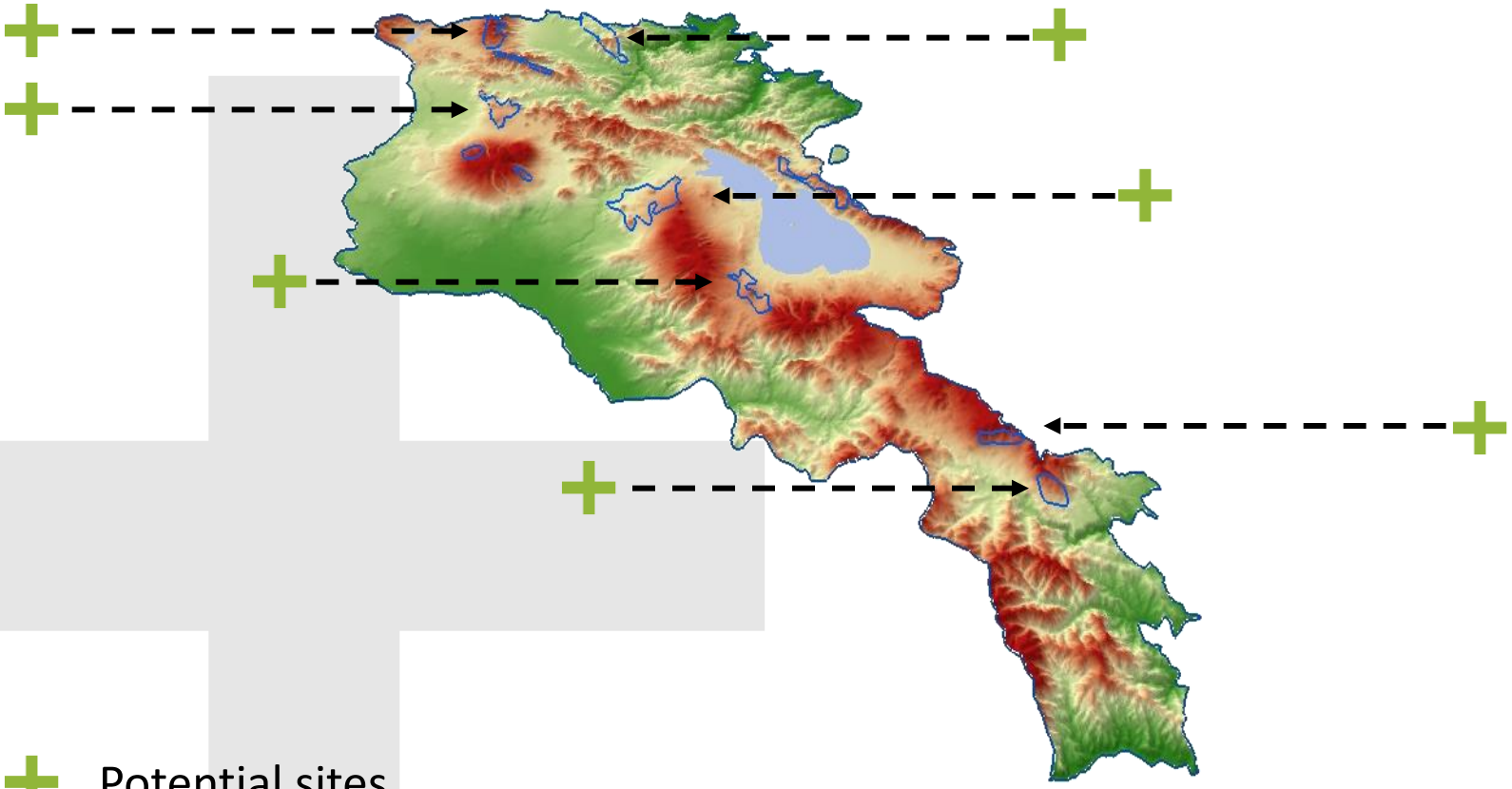
+ wind field



+ terrain height



# DETERMINATION OF SUITABLE SITES



Potential sites

# SITE ASSESSMENT

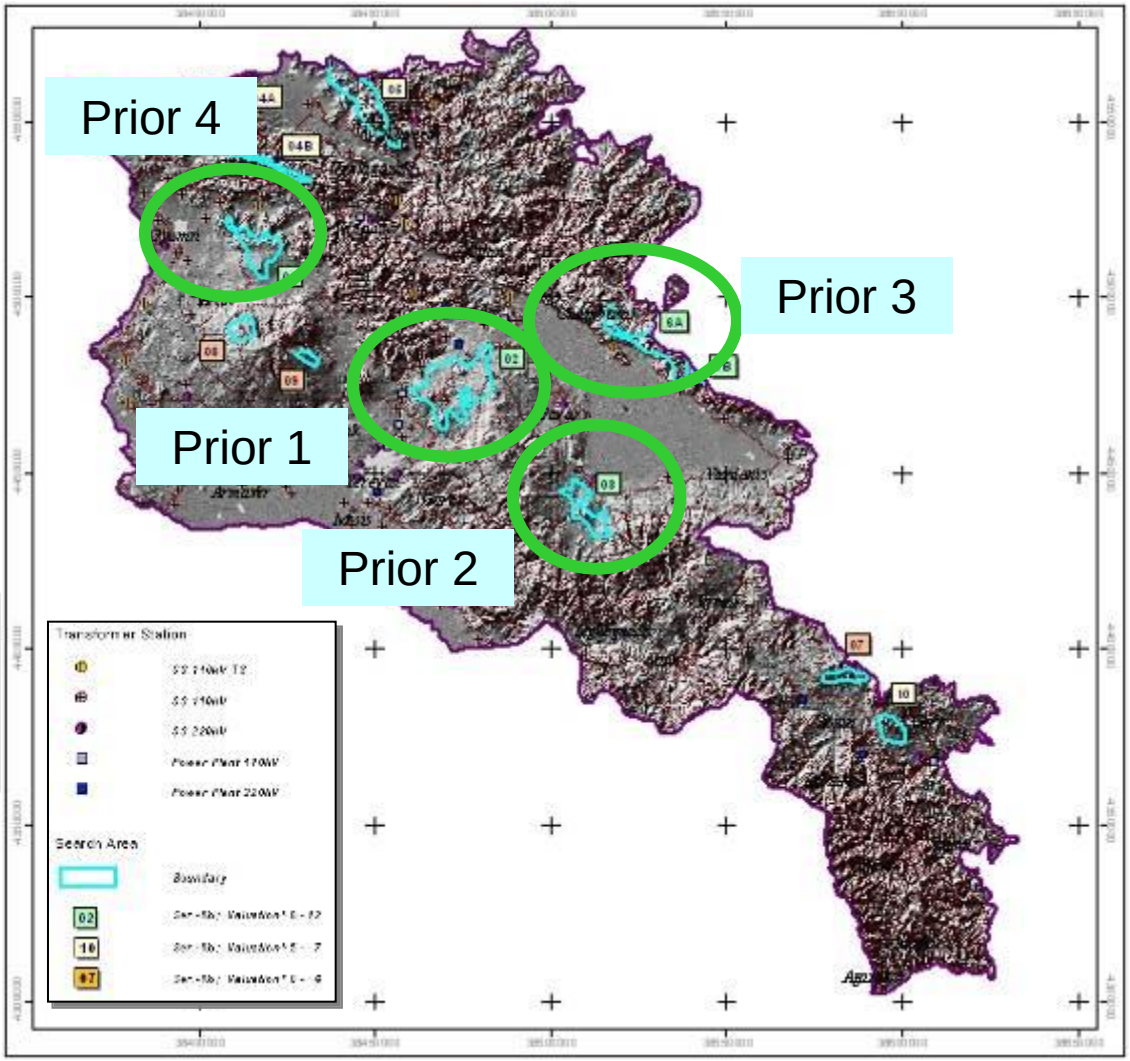
| Identification | | Criteria for Grading | | | | | | Sum of Valuation, Rank Order |
|---|---|---|---|---|---|---|---|---|
| | | Wind Speed | | Distance Transformer Station | | Elevation above Ground | | |
| Ser.-NO* | Name | MEAN (m/s) | Valuation-1 | km | Valuation-2 | MEAN (m) | Valuation-3 | |
| 2 | YEREVAN-O | 7,0 | 4 | 9 | 4 | 2116 | 4 | **12** |
| 6A | CHAMBARAK-S | 7,0 | 4 | 6 | 4 | 2425 | 2 | **10** |
| 6B | CHAMBARAK-S | 7,2 | 4 | 7 | 4 | 2679 | 0 | **8** |
| 3 | GAVAR-S | 6,5 | 2 | 6 | 4 | 2342 | 2 | **8** |
| 1 | GYMRI-O | 6,6 | 2 | 12 | 2 | 2194 | 4 | **8** |
| 4A | GYMRI-N | 7,3 | 4 | 12 | 2 | 2727 | 0 | **6** |
| 4B | GYMRI-N | 7,1 | 4 | 14 | 2 | 2665 | 0 | **6** |
| 10 | GORIS-N | 6,4 | 0 | 9 | 4 | 2326 | 2 | **6** |
| 5 | TUMANIAN-W | 6,3 | 0 | 12 | 2 | 1868 | 4 | **6** |
| 8 | ARTIK-S | 6,6 | 2 | 11 | 2 | 2863 | 0 | **4** |
| 7 | SISIAN-N | 6,9 | 2 | 16 | 2 | 2747 | 0 | **4** |
| 9 | APAHAN-S | 6,4 | 0 | 17 | 0 | 2646 | 0 | **0** |

**Valuation:**

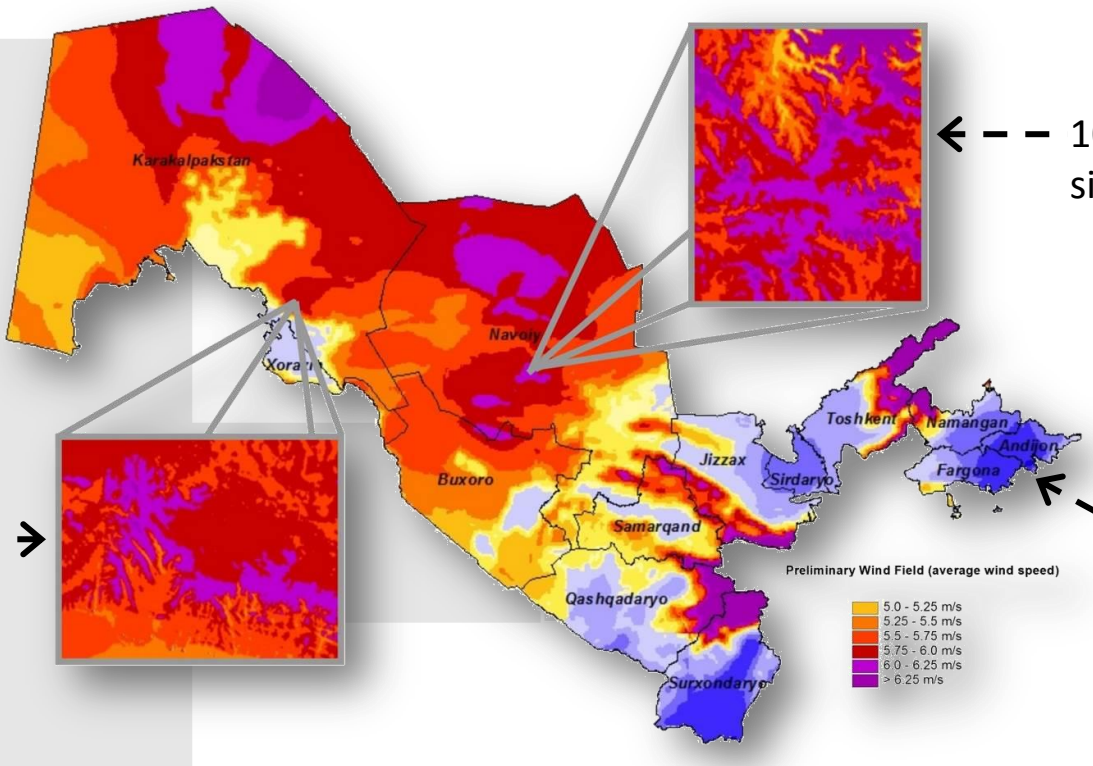
| Value | Points | Value | Points | Value | Points |
|---|---|---|---|---|---|
| >7,0 | 4 | <10 | 4 | <2250 | 4 |
| 7,0-6,5 | 2 | 10-17 | 2 | 2250-2500 | 2 |
| <6,5 | 0 | >17 | 0 | >2500 | 0 |

* = The numeration corresponds to the labeling in the "Power Density and Power Supply in the Search Areas" map

# TOP LOCATIONS



# Example: WIND ATLAS UZBEKISTAN (2015)




100m wind field site II

100m wind field site I

2.0 km wind field Uzbekistan

Countrywide modeling of wind conditions with FITNAH 3D (2km grid)

Selection of areas for 2 Windparks with each 100 MW

# WIND POTENTIAL STUDY Uzbekistan

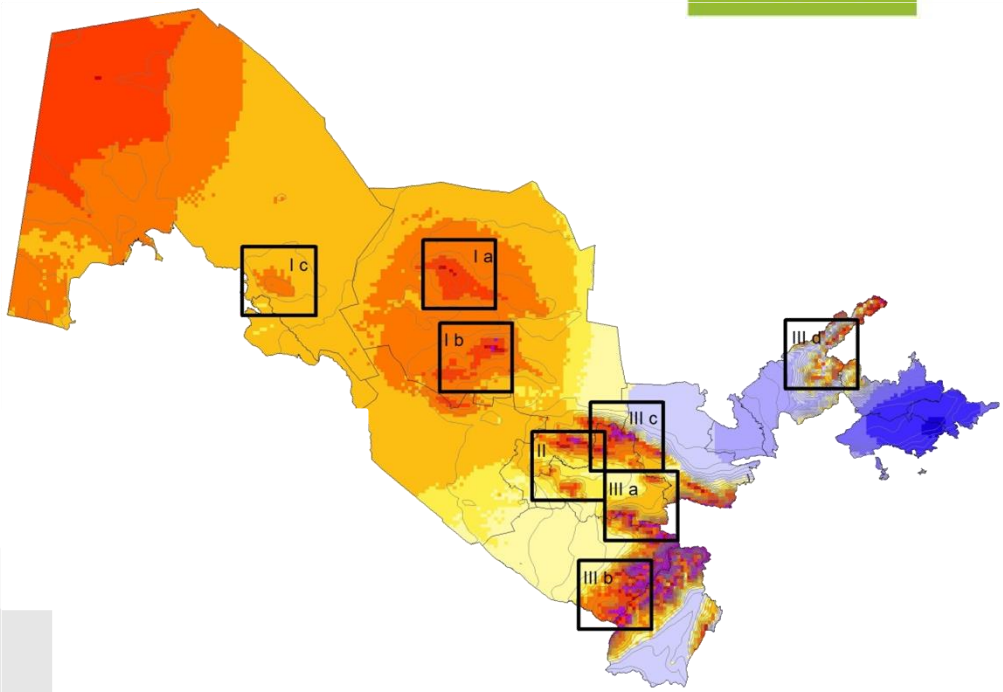
GEO-NET, 2014-2016

## Categories:

**I:** Moderate complex Terrain:
- good wind conditions
- Grid and roads available

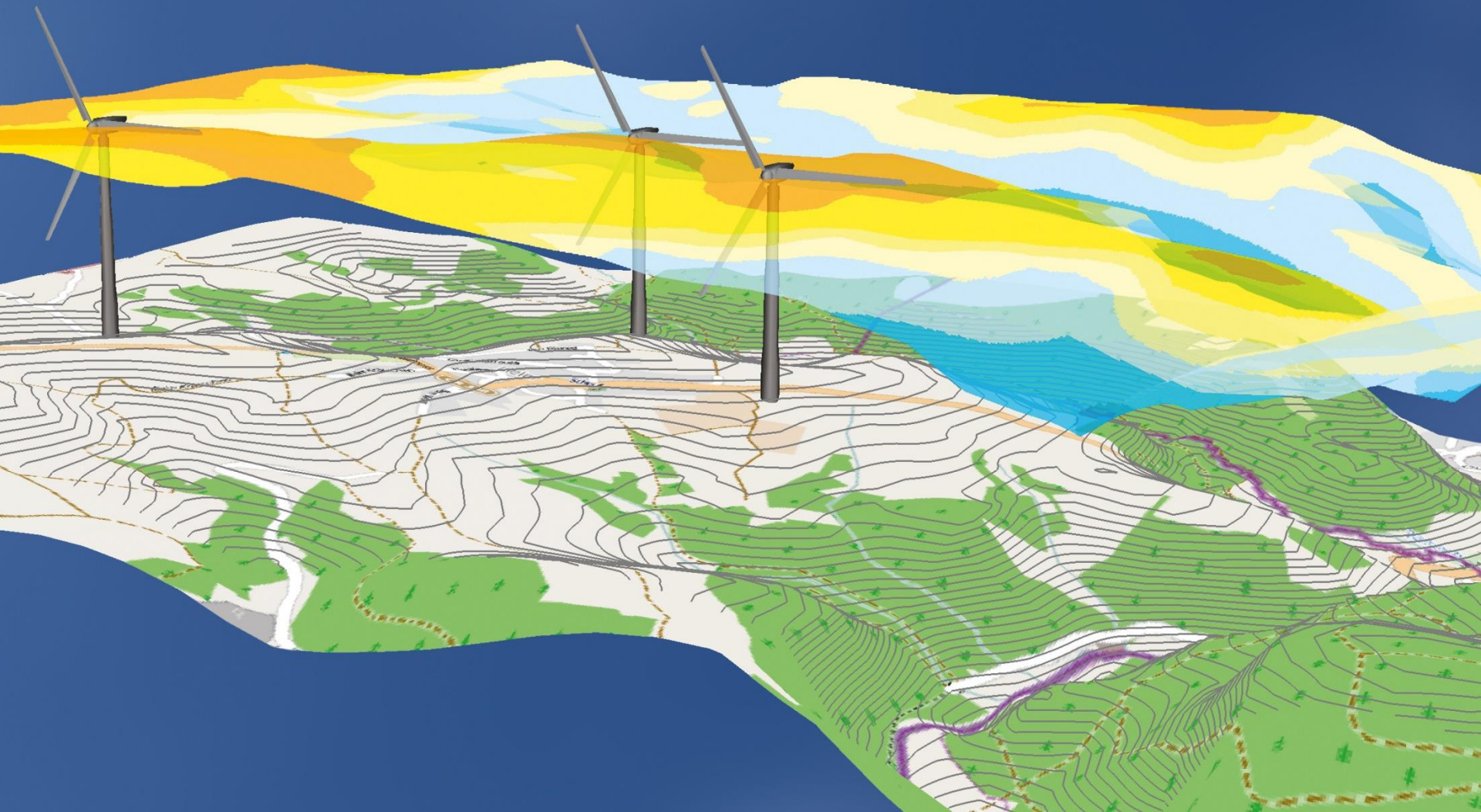
**II:** Complex Terrain:
- steep descents and ascends
- great elevations < 3000m
- good wind conditions
- Grid and roads available

**III:** Complex Terrain:
- steep descent and ascends
- greatest elevations > 3000m
- good wind conditions
- Grid and roads available




➔ Further assessments and data required to determine and select categorie II and III sites, wind measurements required in all categories to determine wind potential to sufficient extend

# + FITNAH 3D-MODEL



# FITNAH. WHAT‘S THAT?

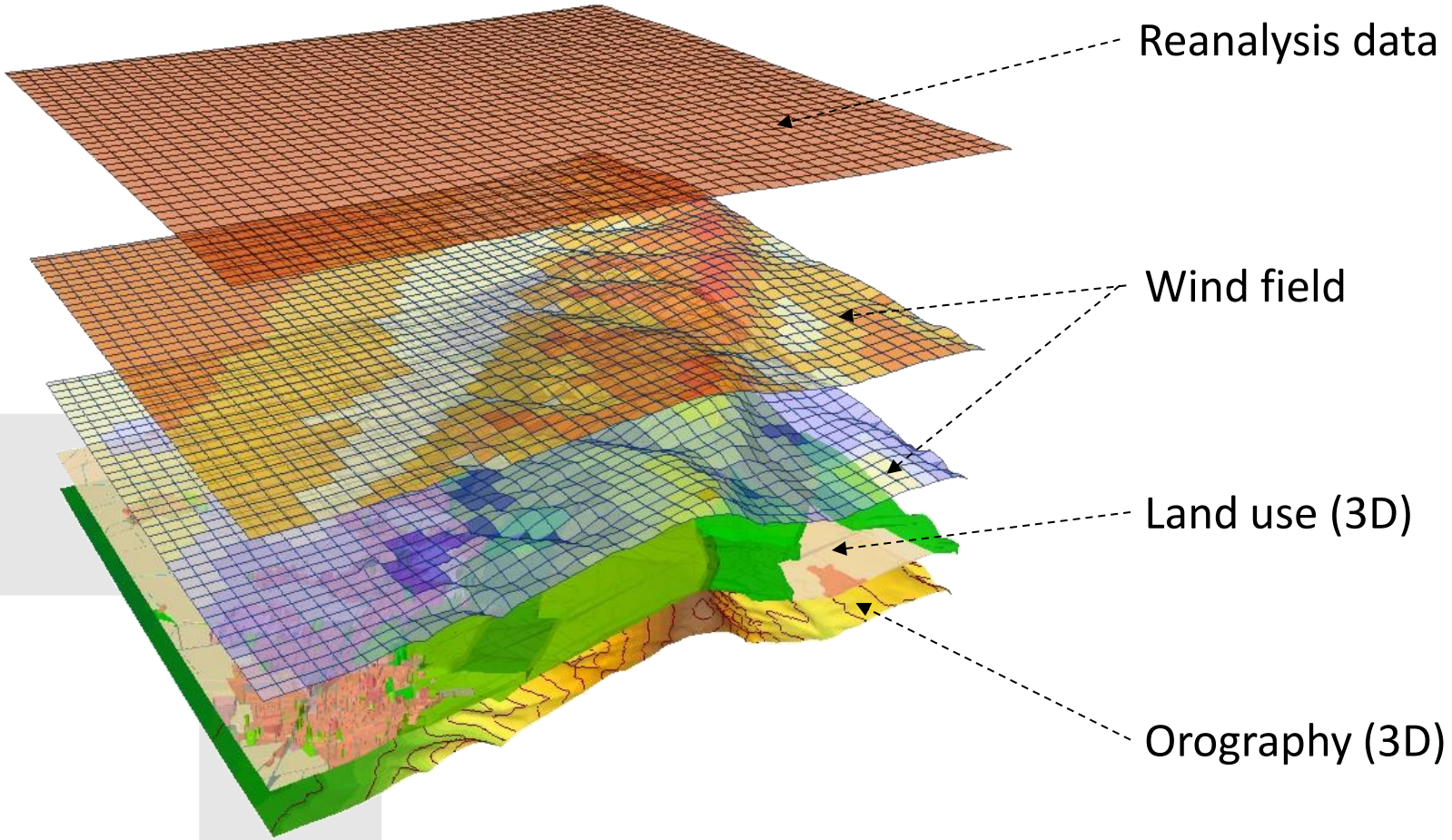
**FITNAH** is a three dimensional, non-hydrostatic mesoscale model (GROSS, G.; 1991) utilized for the calculation of wind fields and climatic parameters (e.g. cold air mass flows, temperature fields).

**FITNAH** is for **F**low over **I**rregular **T**errain with **N**atural and **A**nthropogenic **H**eat-Sources.

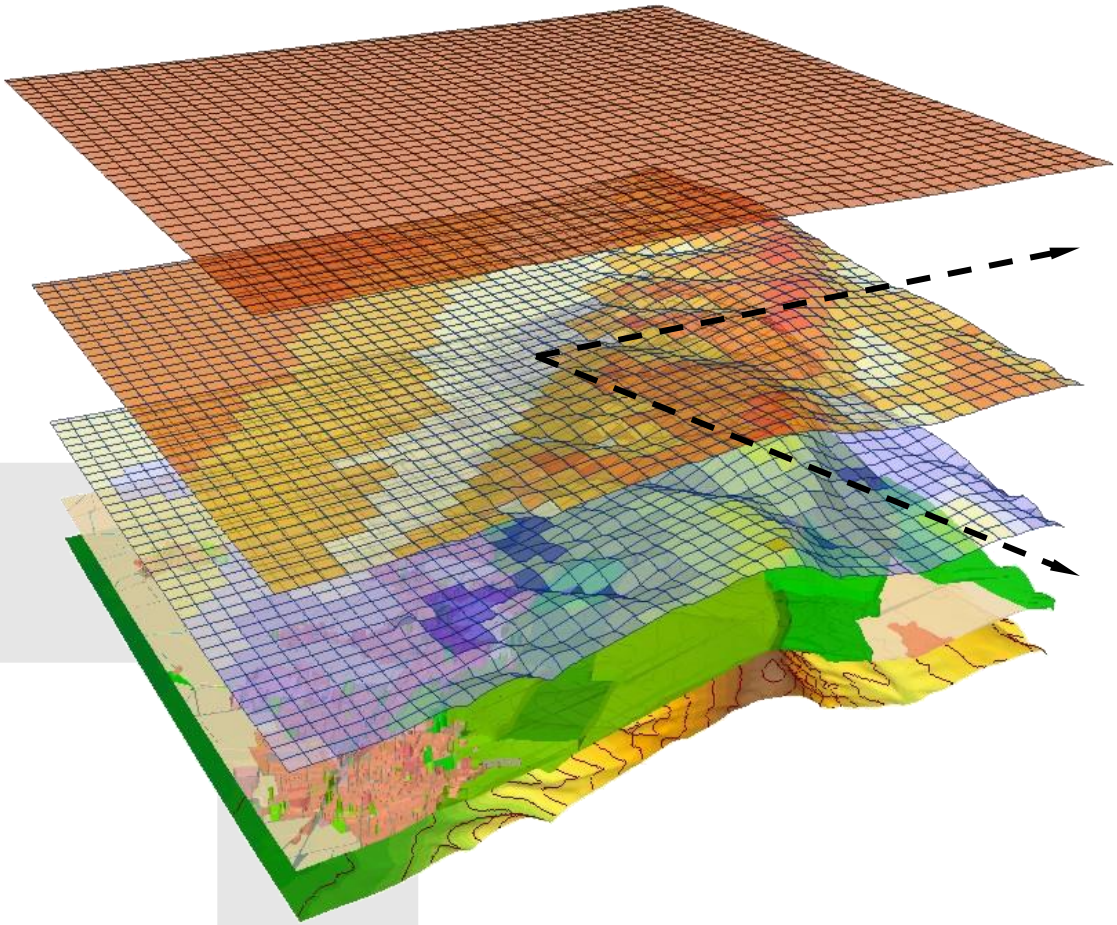
**FITNAH** has been developed by Prof. Dr. Günther Gross (GROSS, 2002) and is constantly improved and updated by Prof. Dr. Gross and GEO-NET.

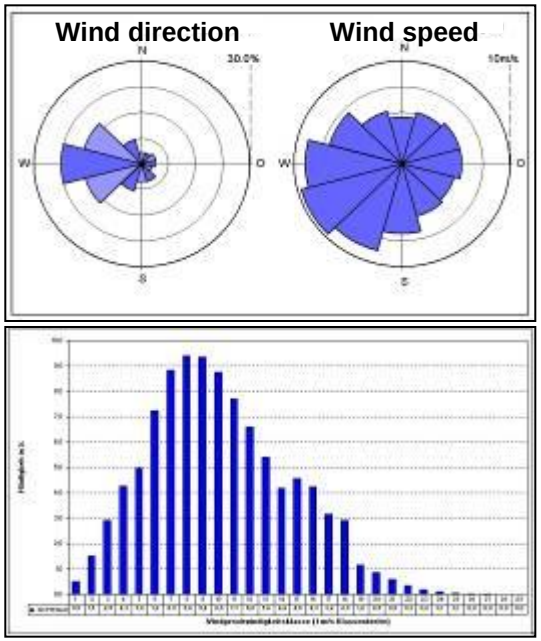
**FITNAH** is more than CFD: it is able to take into acount climatologic parameters

# WIND FIELD SIMULATION



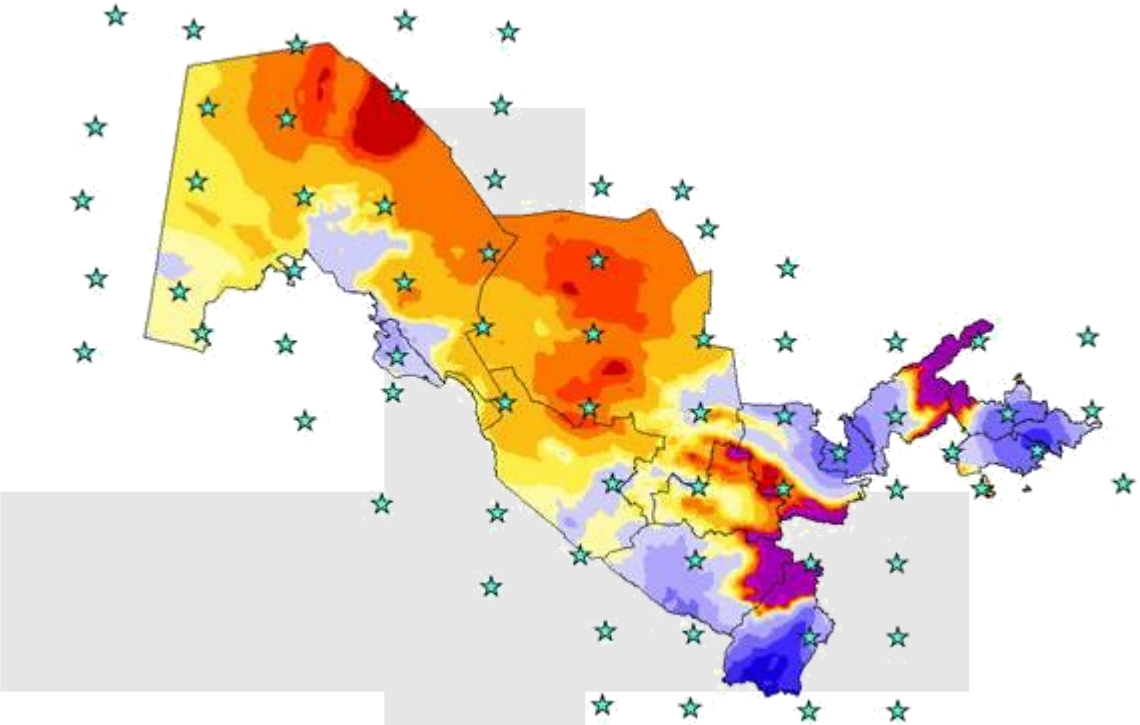
# WIND FIELD





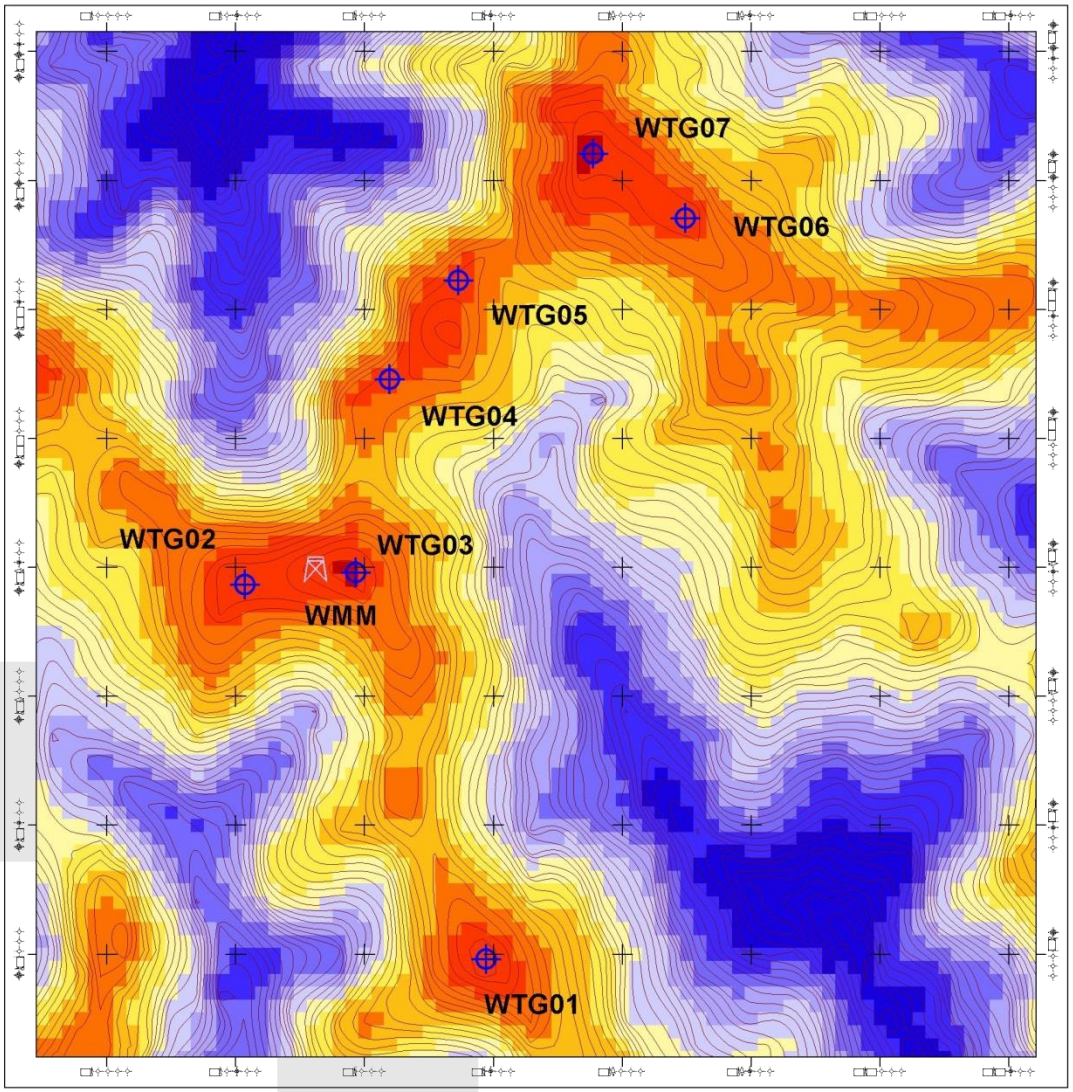

Each grid field has its own specific wind statistic

# WINDFIELD+



**Example:** Use of several data sources at a large-capacity wind field calculation.
Various re-analyzes and wind data from other sources can be used as input parameters.

**Advantage:** realistic representation by higher data density




# WIND FIELD

Representation of grid fields in one height

# WHY **FITNAH 3D**

+ realistic simulation of wind flow even over **complex terrain like the caparthian mountains**

+ regional climatic phenomena and regional wind regimes can be simulated

+ detailed modelling of forests, settlements, cities, industrial areas etc.

+ wide range of possible grid resolutions: 50m – 5 km

+ wind field simulations can also be carried out **irrespective of wind measurements**

# LiDAR
# Ressource Measurements

# LiDAR ressource measurement


LiDARs have **advantages over met masts:**

+ Small and portable
+ Measuring hights up to 290m
+ …

**Challenges**

Data evaluation requires advanced knowledge:

+ characteristics of measurement values different compared to cup anemometers
+ measurement error and uncertainties are quite sensitive on terrain and measurement location

# Requirements for bankable LiDAR campaigns

Requirements for LiDAR campaigns according to current international guidelines (**MEASNET 2016**, Annex C2):

**1. Type specific classification (type specific!)** according to IEC 61400-12-1 Ed. 2

→ Leosphere

**Why?:**

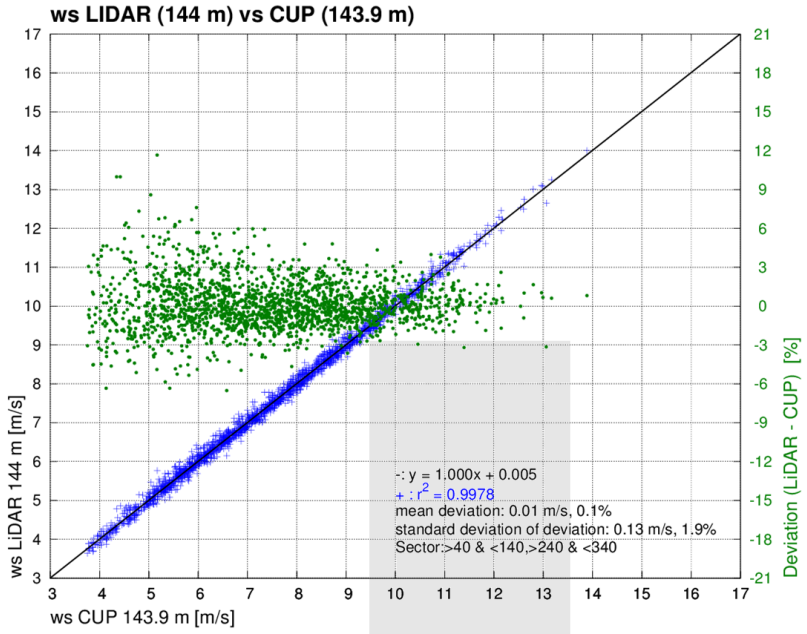
uncertainties depent on on enviromental conditions

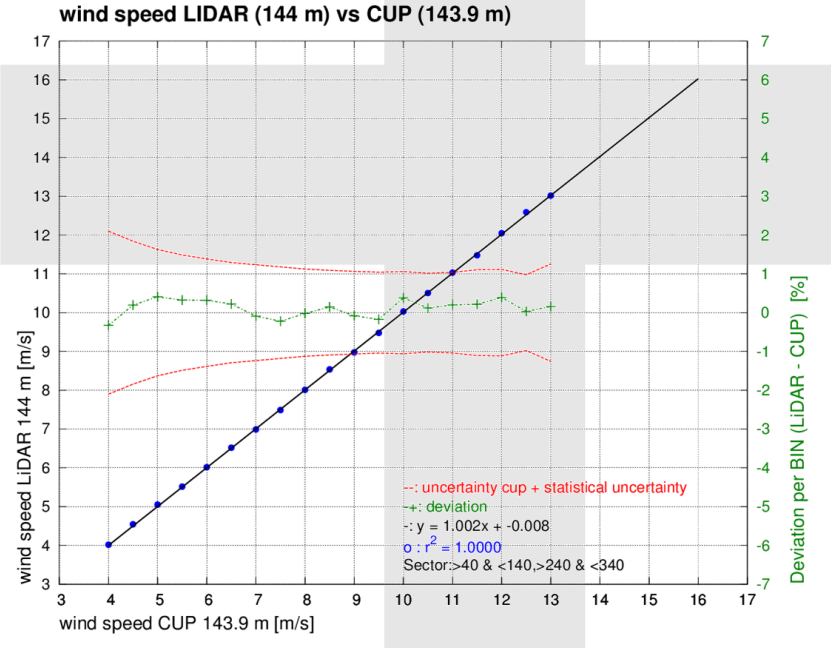
**2. Verification/Validation/Certification** according to IEC 61400-12-1 Ed.2 or IAE Wind

→Before and after each measurement **(device specific!)**

**Why?:**

- ✓ Safeguard tracebility to national standards (cup anemometer)
- ✓ Proove correctness of measurement values (calibration)
- ✓ Determination of uncertainties




# Verification

Similar to calibration cup anemometer

Comparision of LiDAR data to data **calibrated cup anemomometers**

**Objective:**

+ Traceability and **calibration of LiDAR**
+ Determination of measurement-uncertainties

**Why?**

+ measurement uncertainties significantly influence uncertainty of AEP calculation (P75, P90)

# LIDAR in Ukraine

**By experience from 3 campaigns in Ukraine we can say:**

**LiDAR:**

- Short Realisation time (it depends…: custom procedure, power supply…)
- Measurement at greater heights than met mast
- Measurement at variouse locations in a wind farm, if there is a met mast operational and efficiently reduce uncertainty / increase P75/P90
- Verification can be made at local met masts

**Disadvantage:**

- For one campaign, investment usually higher than for a met mast
- Several types available, not all are suitable and provide good data quality


THANK YOU VERY MUCH
FOR YOUR ATTENTION!
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