



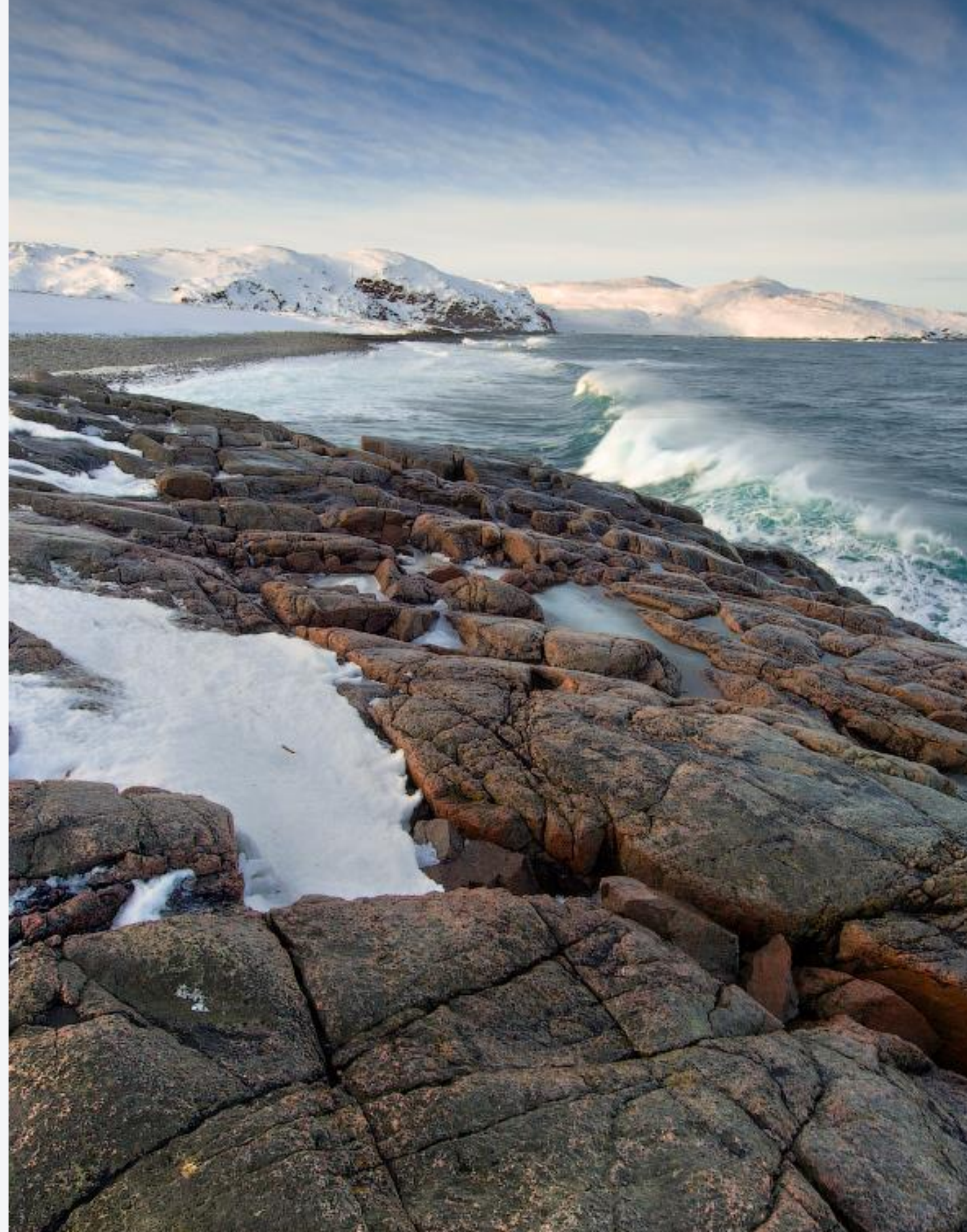
NORTHERN (ARCTIC) FEDERAL UNIVERSITY  
NAMED AFTER M.V. LOMONOSOV



# WIND ENERGY FOR THE FAR NORTH

Pavel Maryandyshev

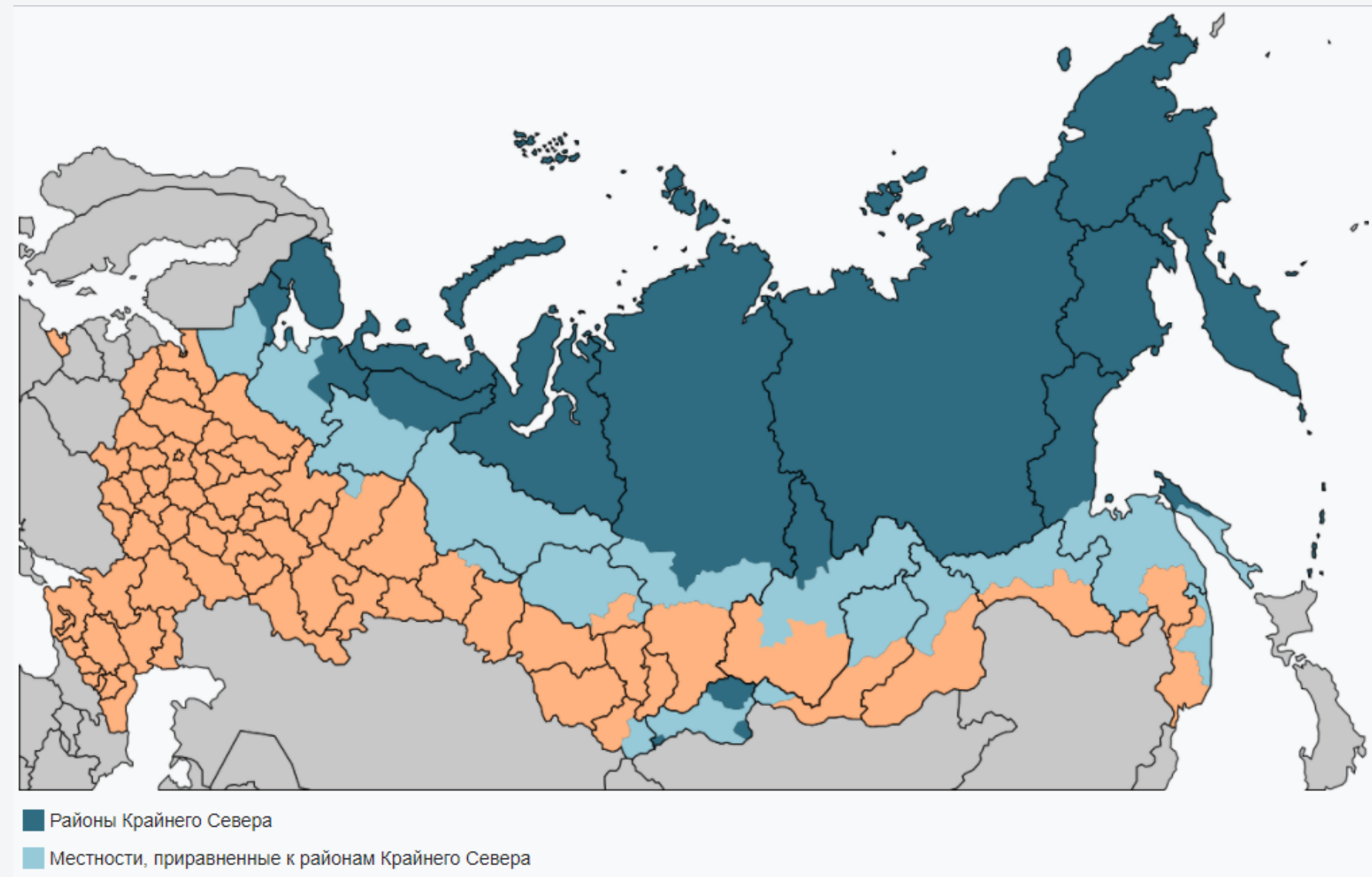
Professor of the department of power engineering





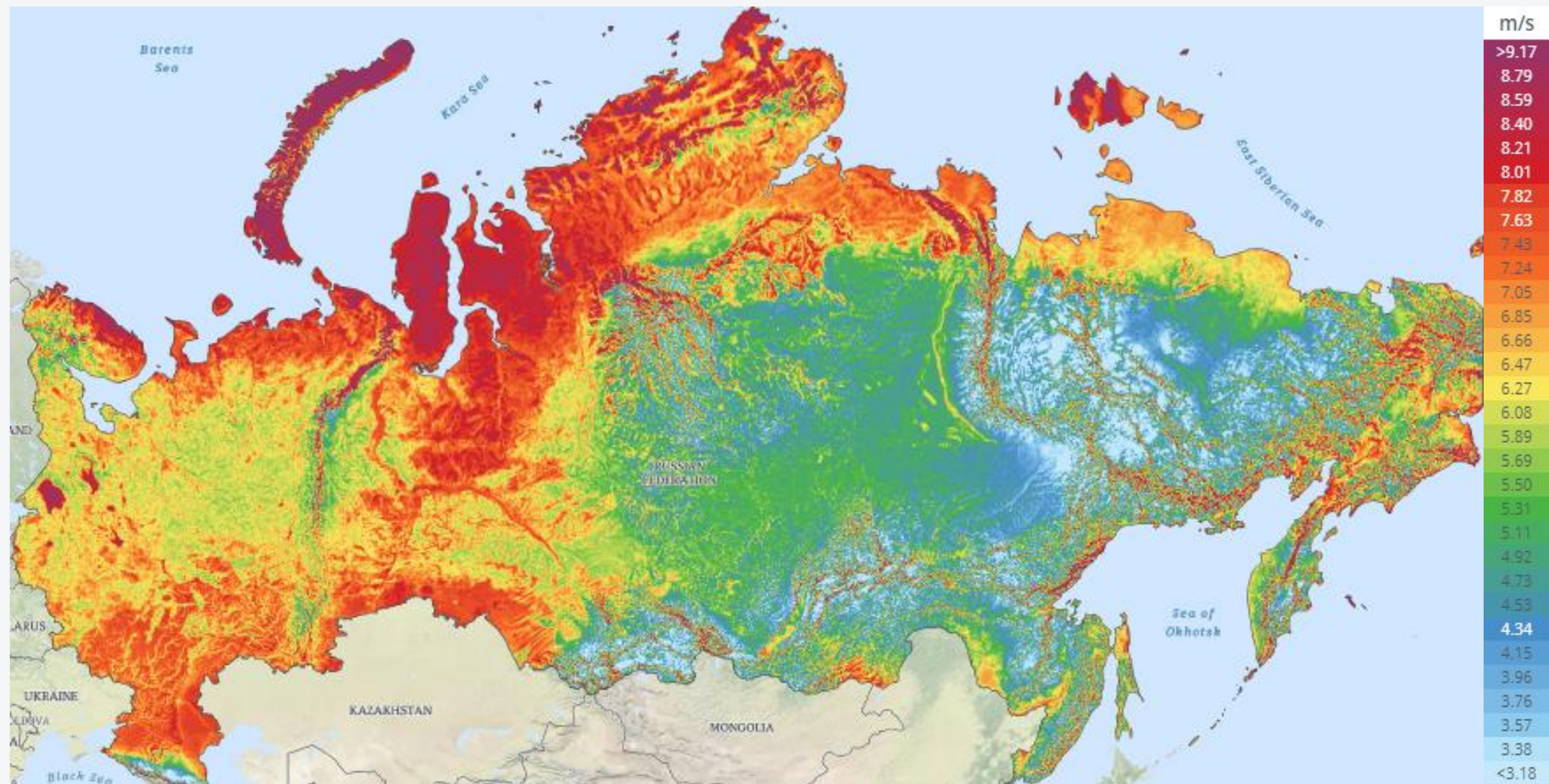


Map of centralized power supply networks



Map of the Russian High North





### Map of Russian wind resources

Electricity production by remote diesel power plants is  
15 billion kWh annually.

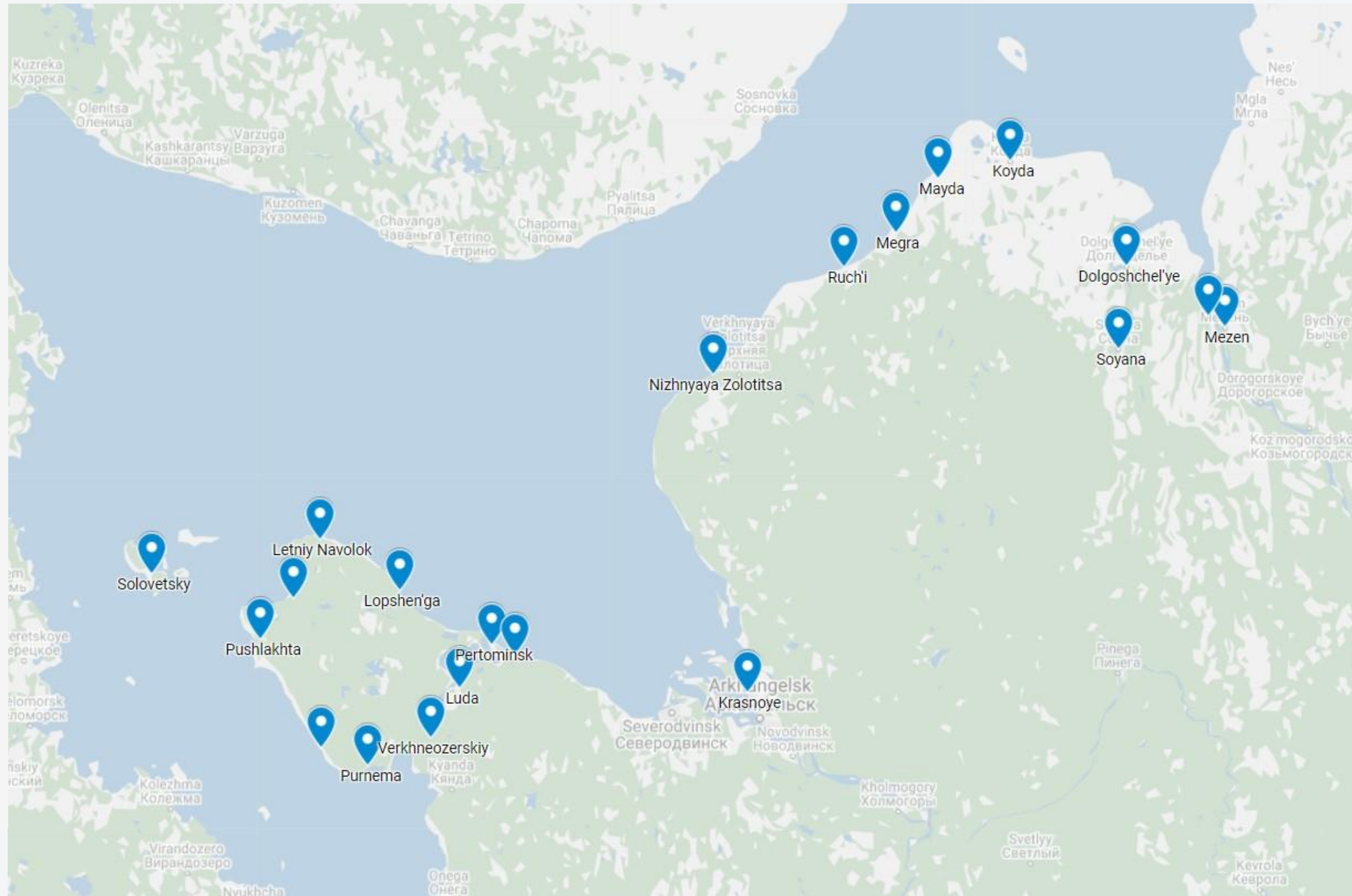
Total wind power generation in 2019 was 0.3 billion kWh.



# REMOTE DIESEL POWER PLANTS

## Settlements

- Mezen
- Solovetsky
- Kamenka
- Dolgoshchel'ye
- Koyda
- Ruch'i
- Soyana
- Nizhnyaya Zolotitsa
- Pertominsk
- Lopshen'ga
- Letnyaya Zolotitsa
- Verkhneozerskiy
- Luda
- Mayda
- Purnema
- Megra
- Pushlakhta
- Lyamtsa
- Krasnoye
- Letniy Navolok
- Krasnaya Gora



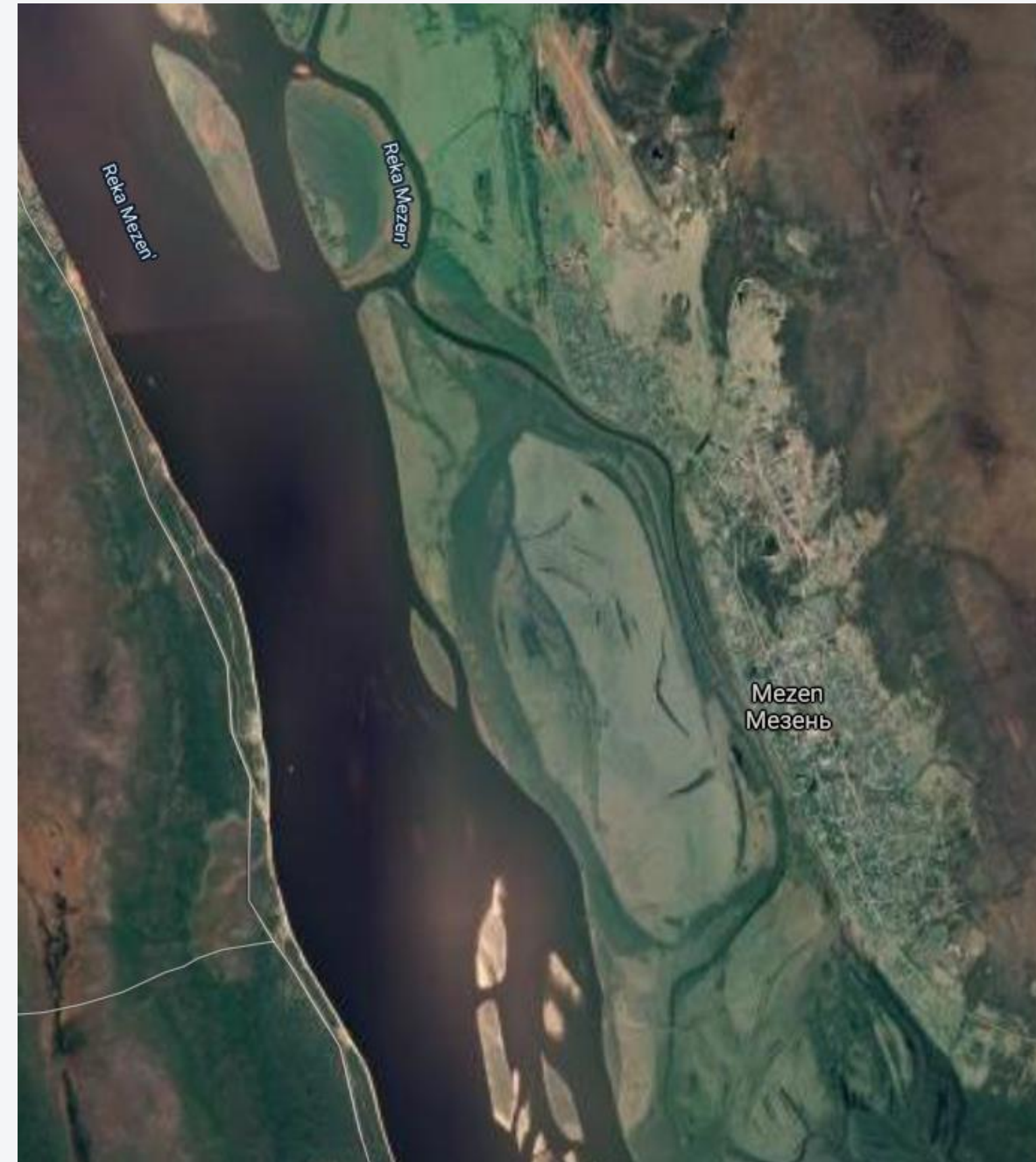




# Pilot Cases

## MEZEN CITY

The population of the city is about 3,000 people



MEZEN CITY



# Pilot Cases

## MEZEN CITY

Diesel power plant

Fuel delivery is carried out by trucks and water transport



MEZEN CITY



# Pilot Cases

## YAGRY ISLAND

The population of the city is about 180,000 people  
Two thermal power plants



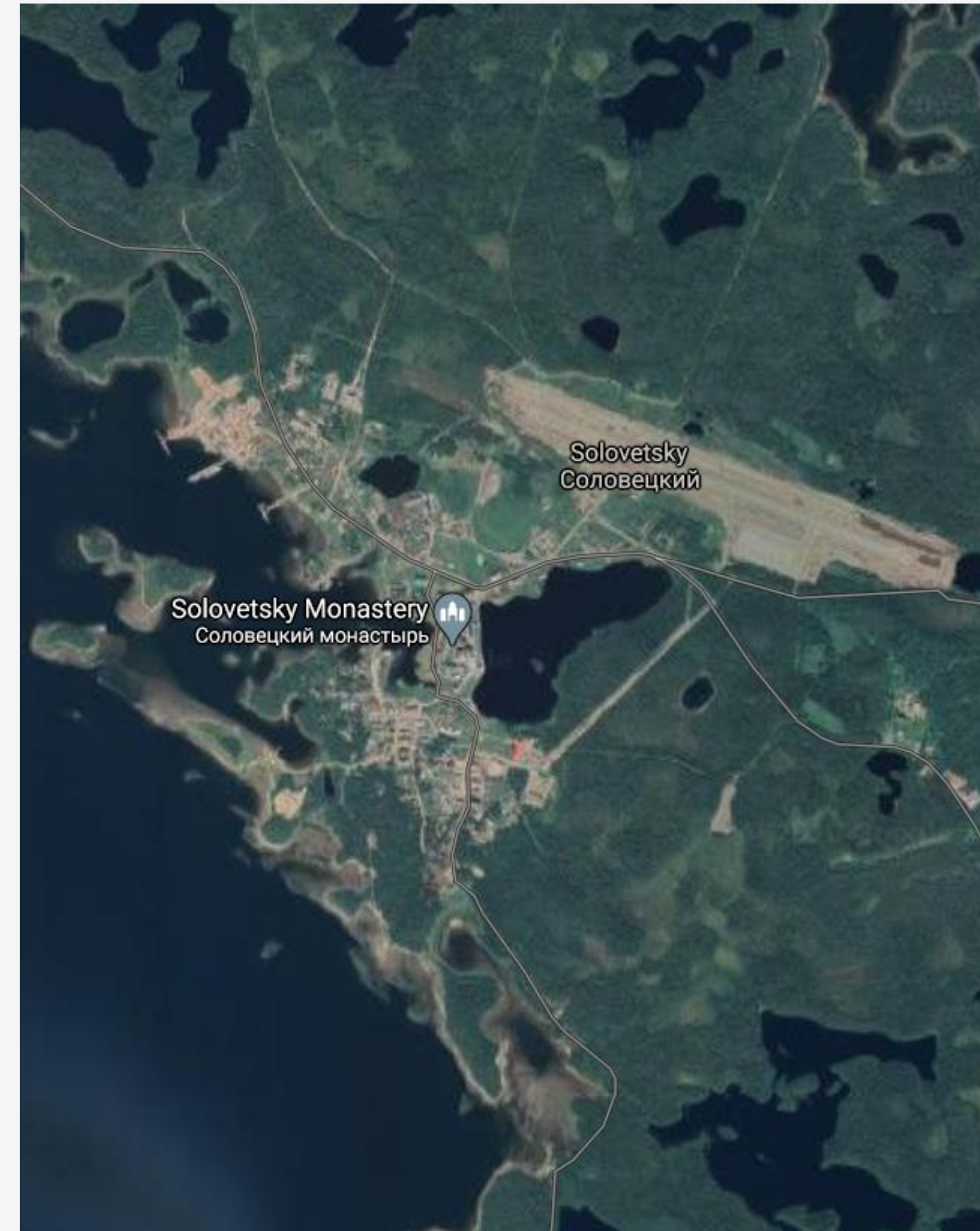
YAGRY ISLAND



# Pilot Cases

## SOLOVETSKY ISLANDS

The population of the settlement is about 1,000 people



SOLOVETSKY ISLANDS



# Power Supply



Diesel tanks

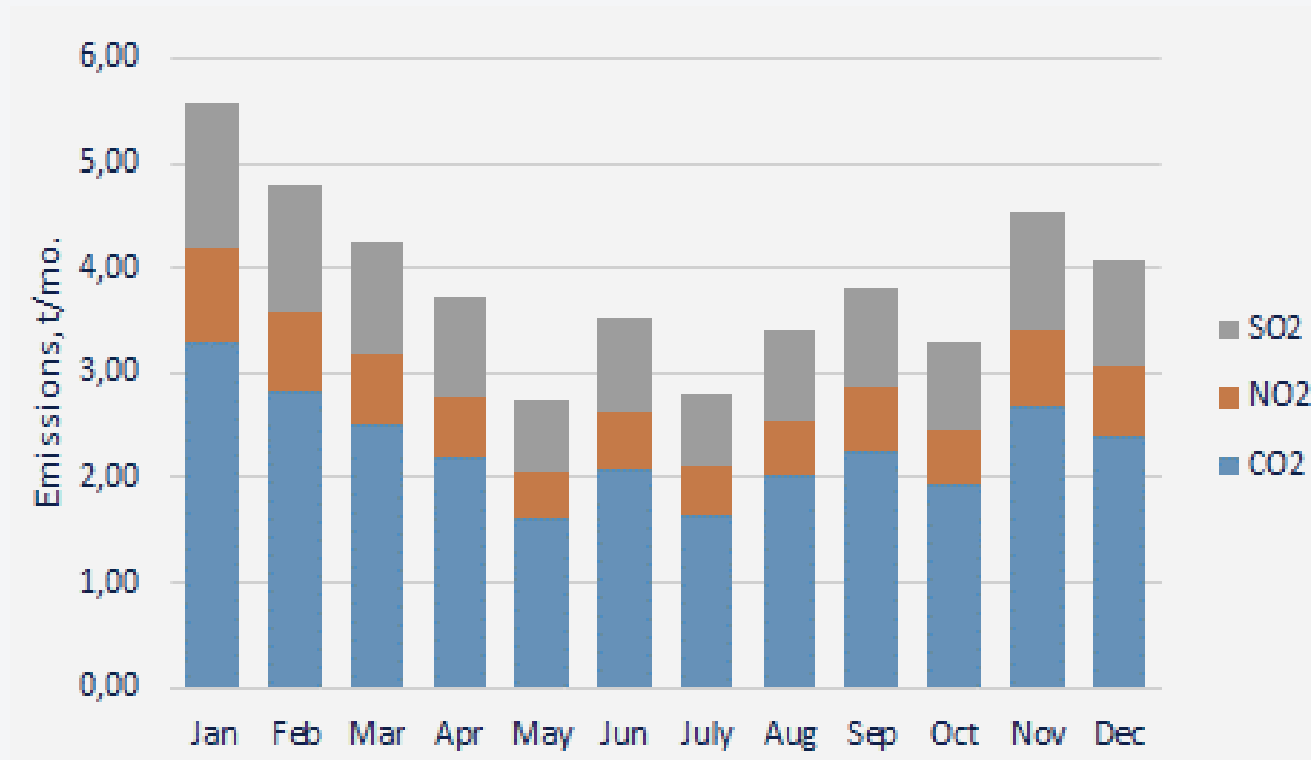
Shipping way

The main type of fuel – diesel fuel and diesel oil

Diesel fuel is delivered to the archipelago during the sea navigation (from May to October)



# Power Supply



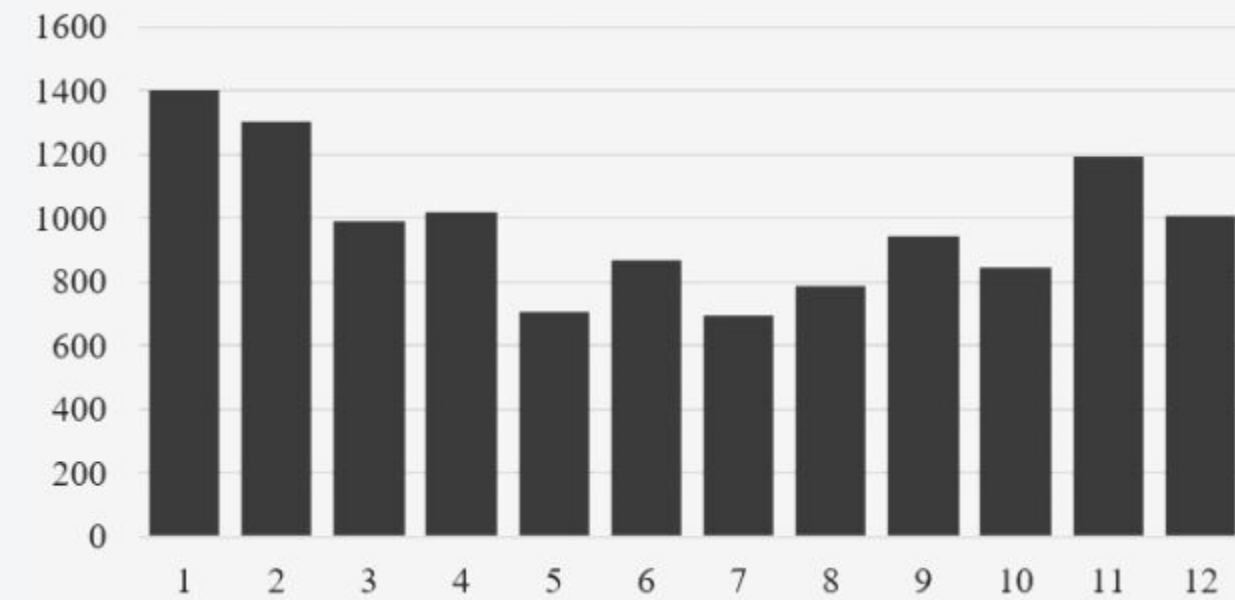
Monthly emissions of pollutants (2016)

Two diesel power plants

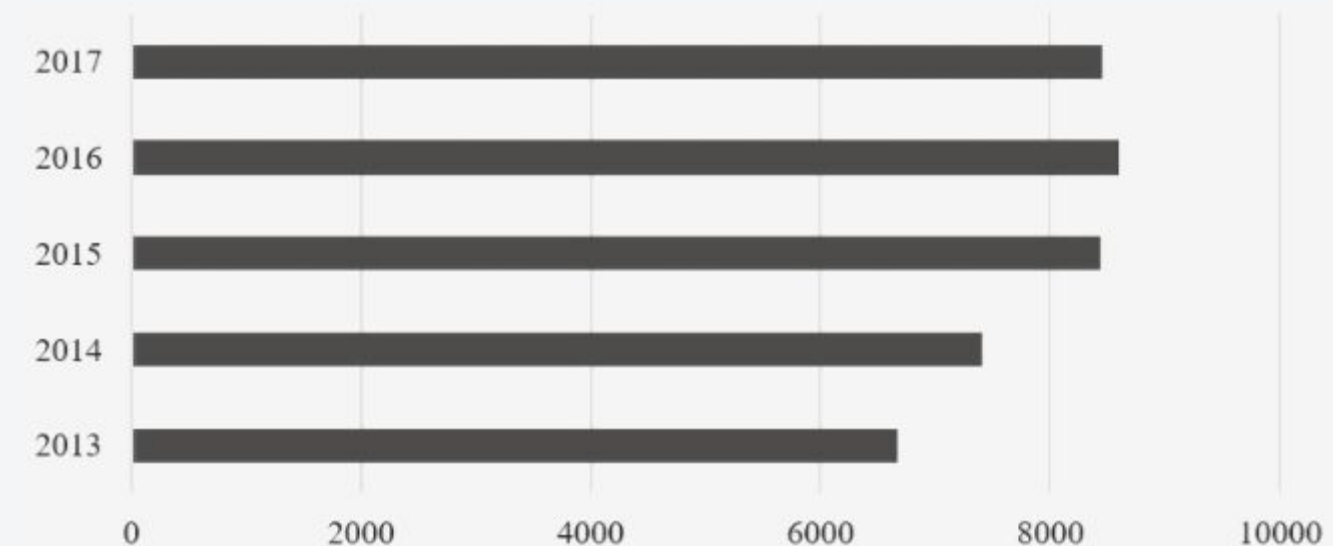
Equipped with six Cummins diesel-generator sets

Total power of sets – 6,2 MW

In winter, up to 50% of the electrical load is the load of electric heating of the buildings

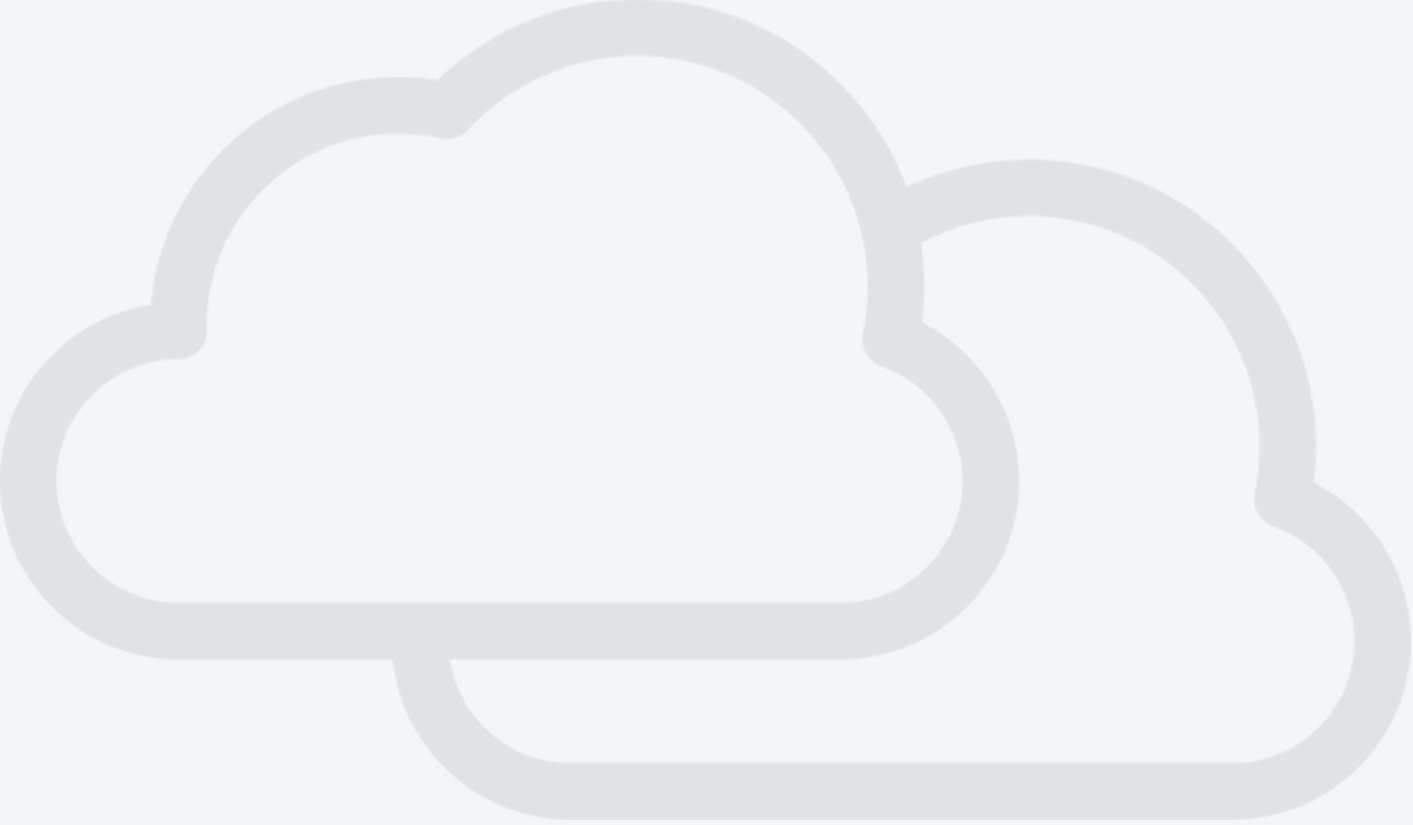


Average monthly electrical power, kW (2016)



Electricity production, MWh

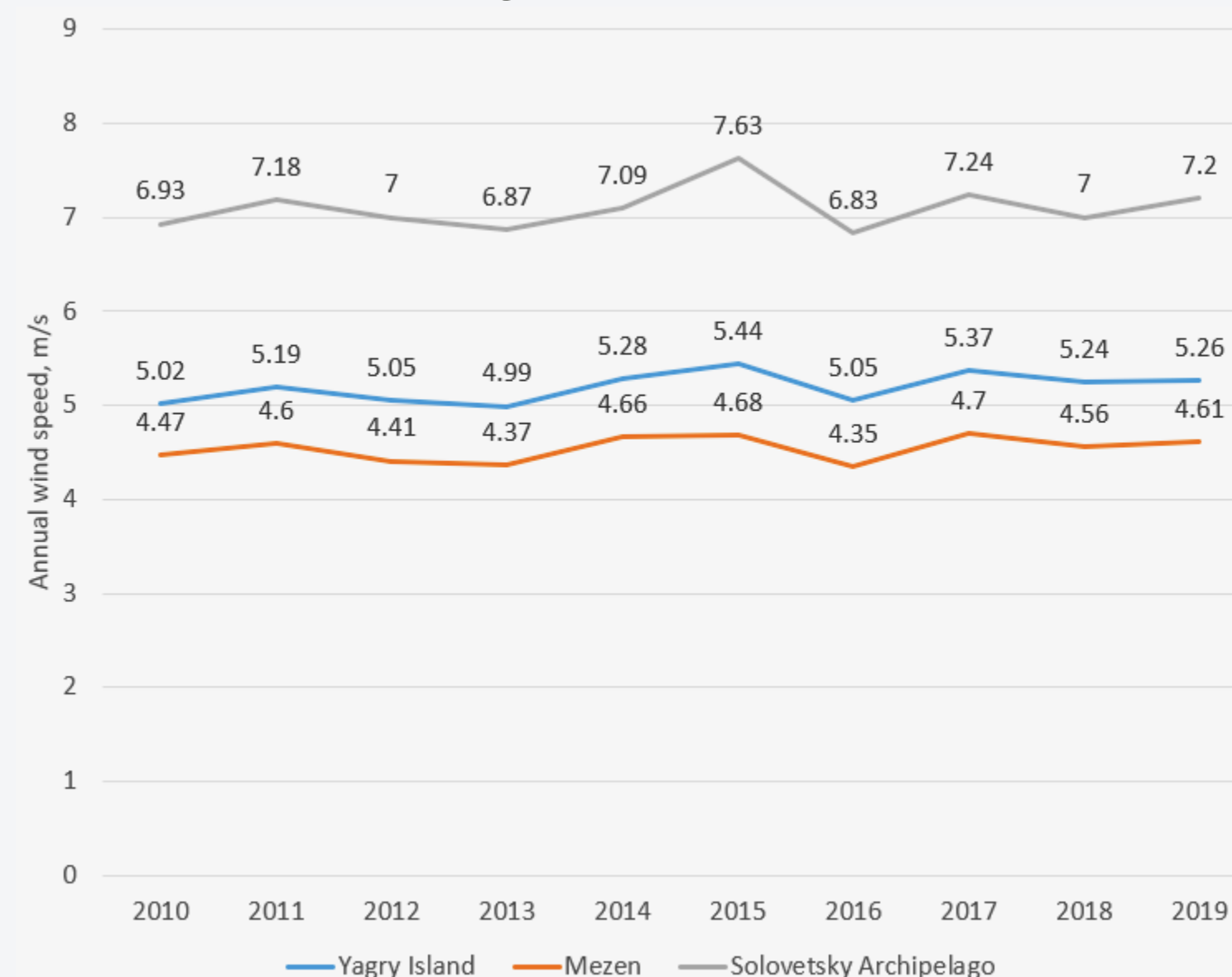




# Wind Speed Analysis

Wind speeds measured daily from 2010 to 2019  
Satellite measurements of the NASA database were used

Height - 50 meters



Height - 10 meters

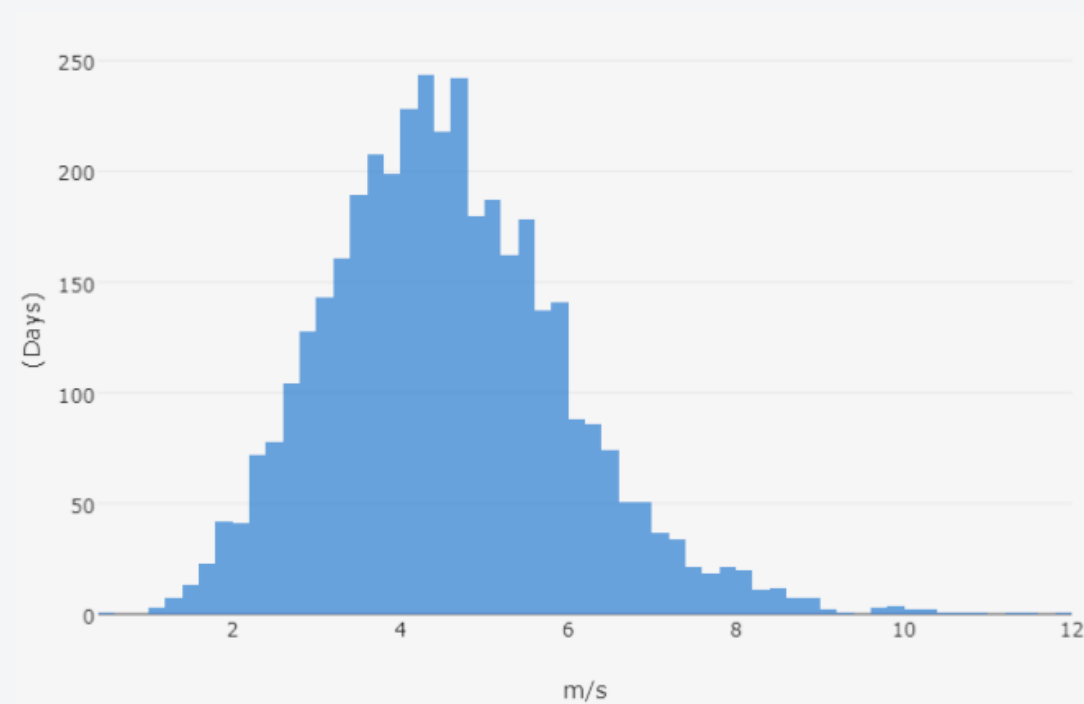




# Wind speed distribution

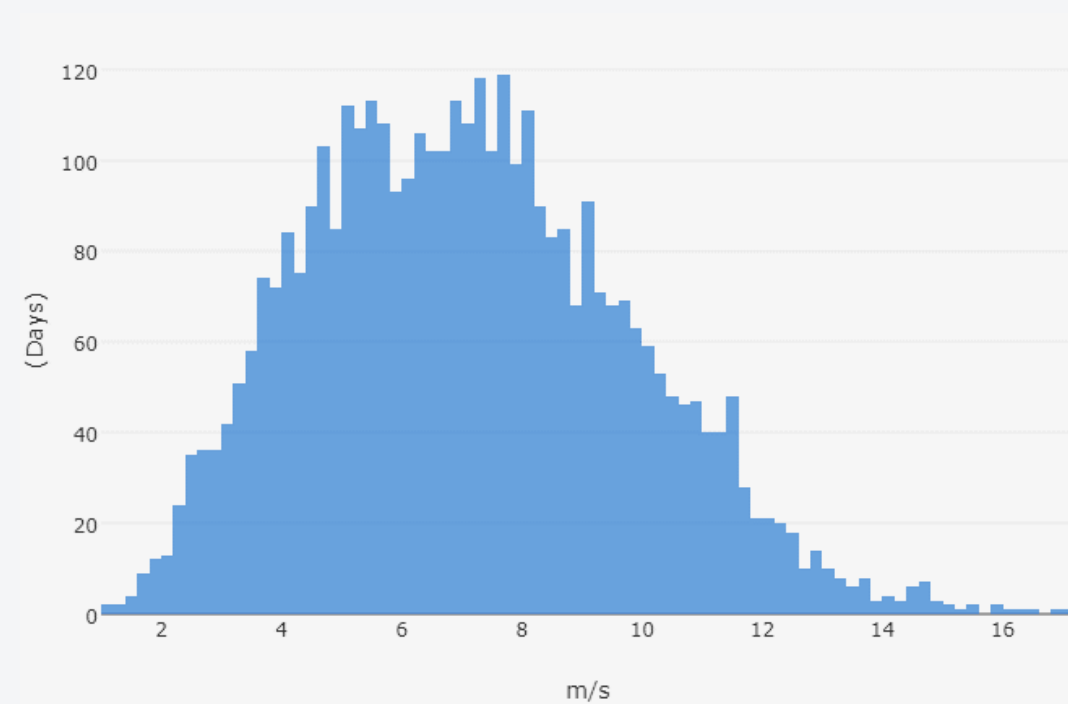
## MEZEN CITY

Height - 50 meters



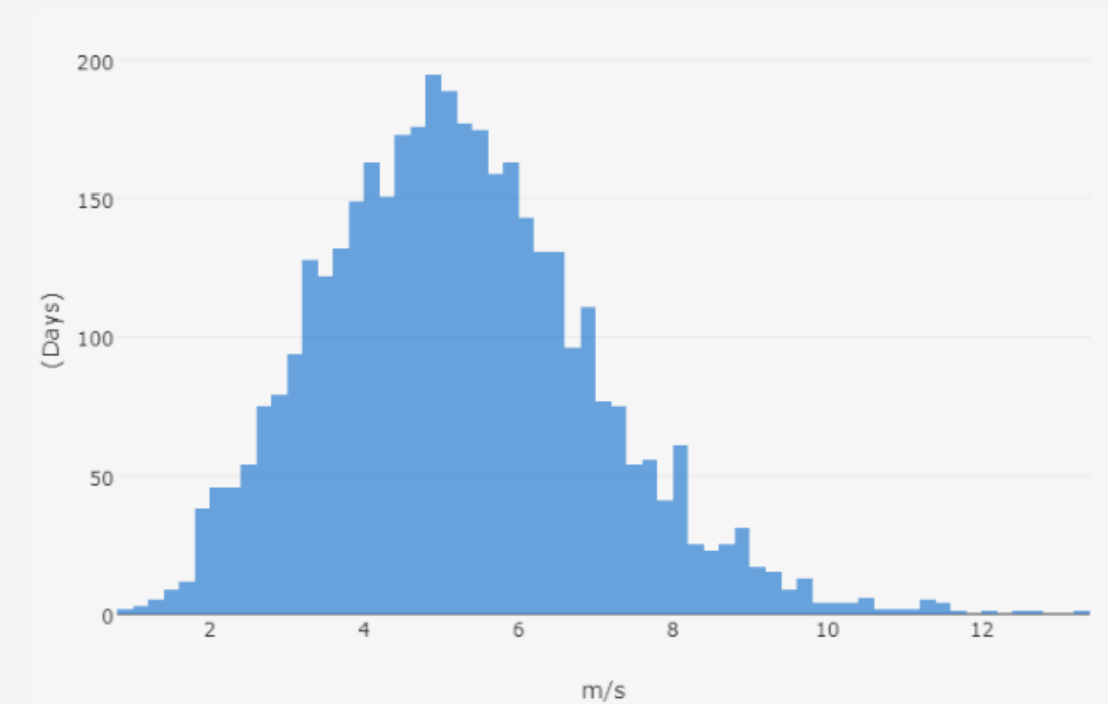
## SOLOVETSKY ISLANDS

Height - 50 meters



## YAGRY ISLAND

Height - 50 meters

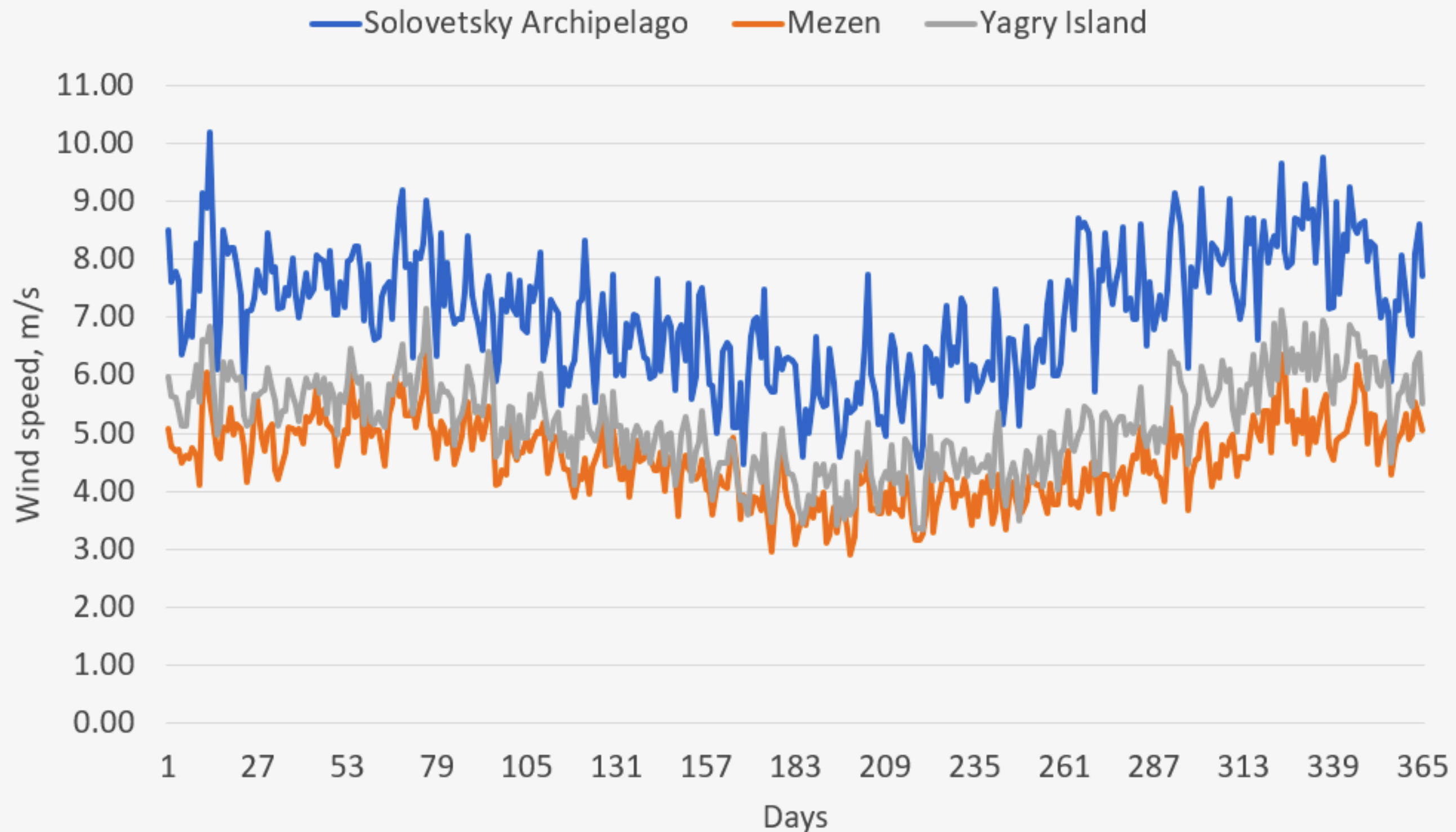




# Wind speed variation

Averaged over 10 years

Height 50 meters

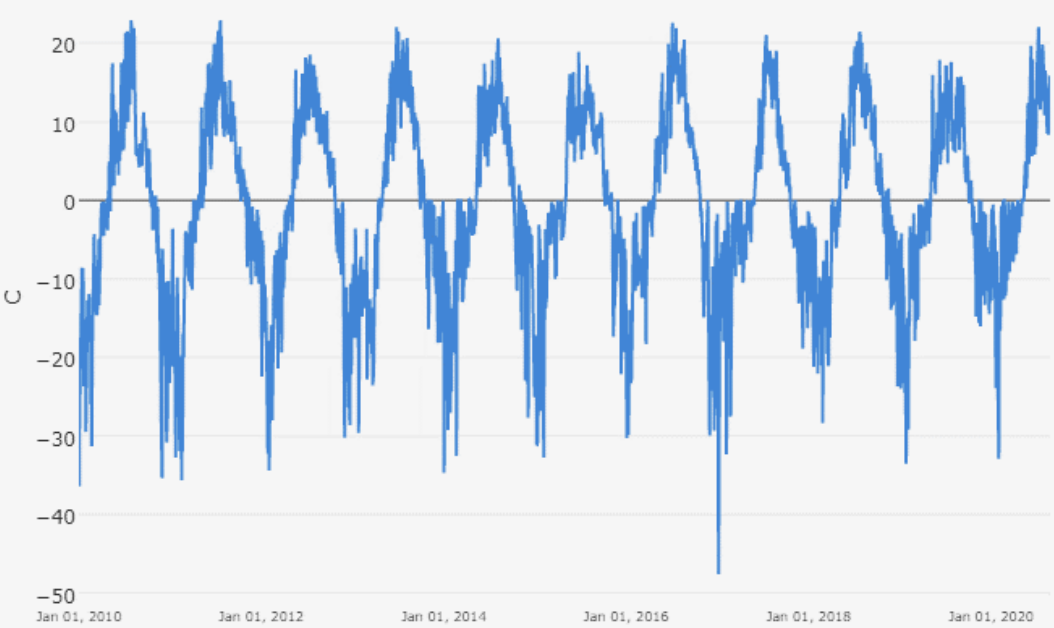




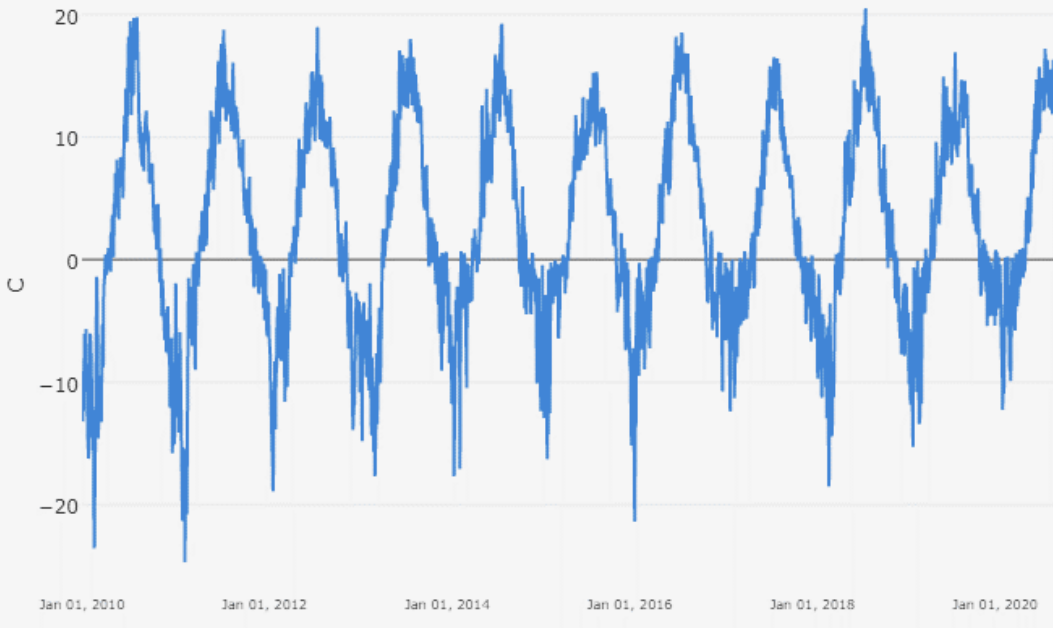
# Air temperature analysis

Graphs of temperature changes

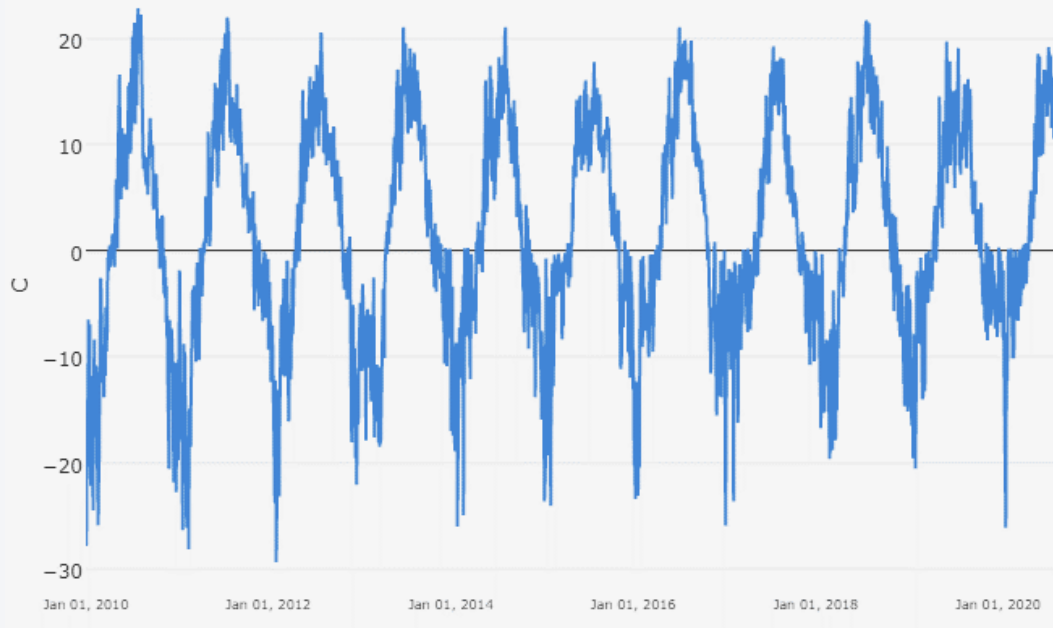
MEZEN  
CITY



SOLOVETSKY  
ISLANDS



YAGRY  
ISLAND

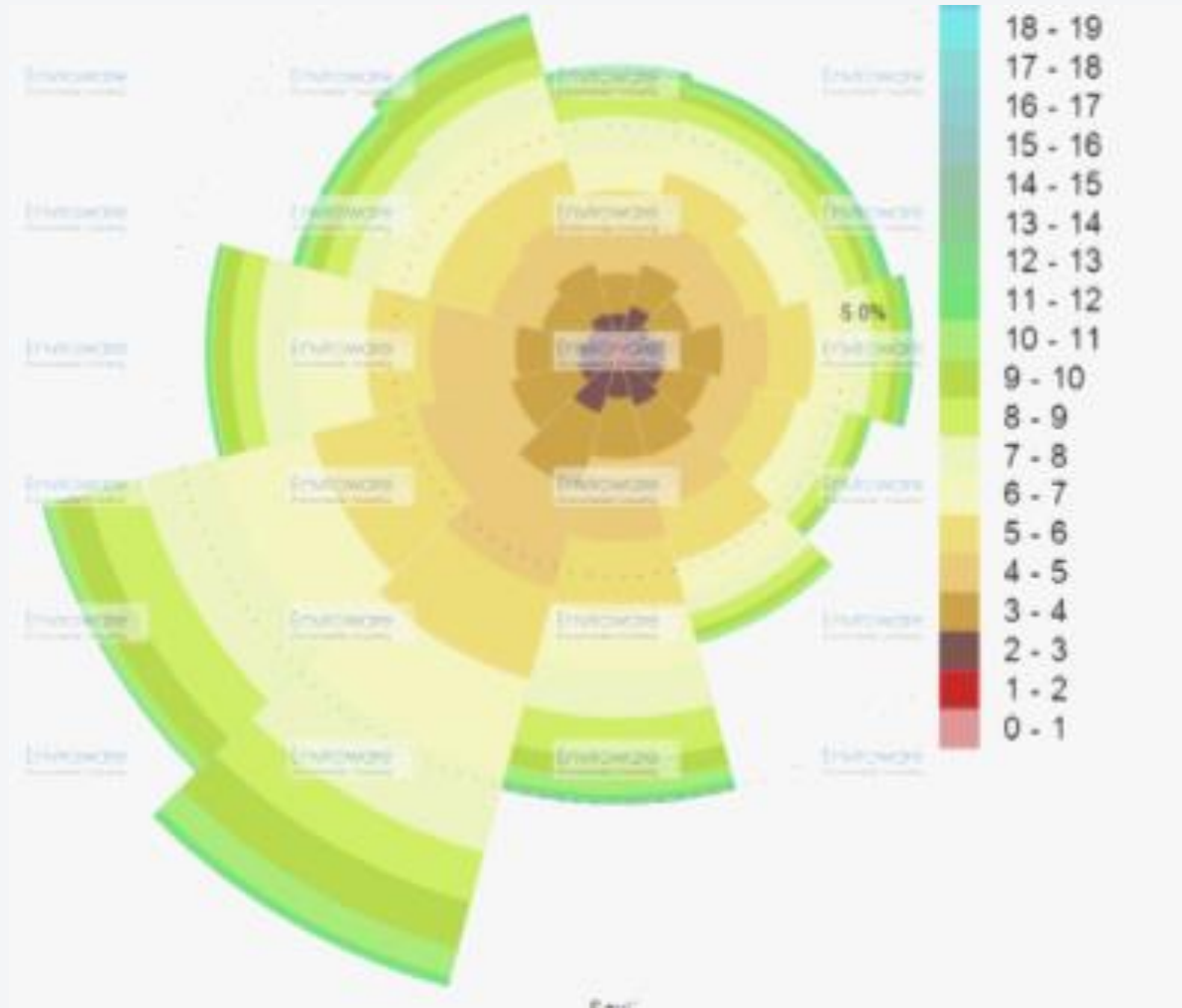




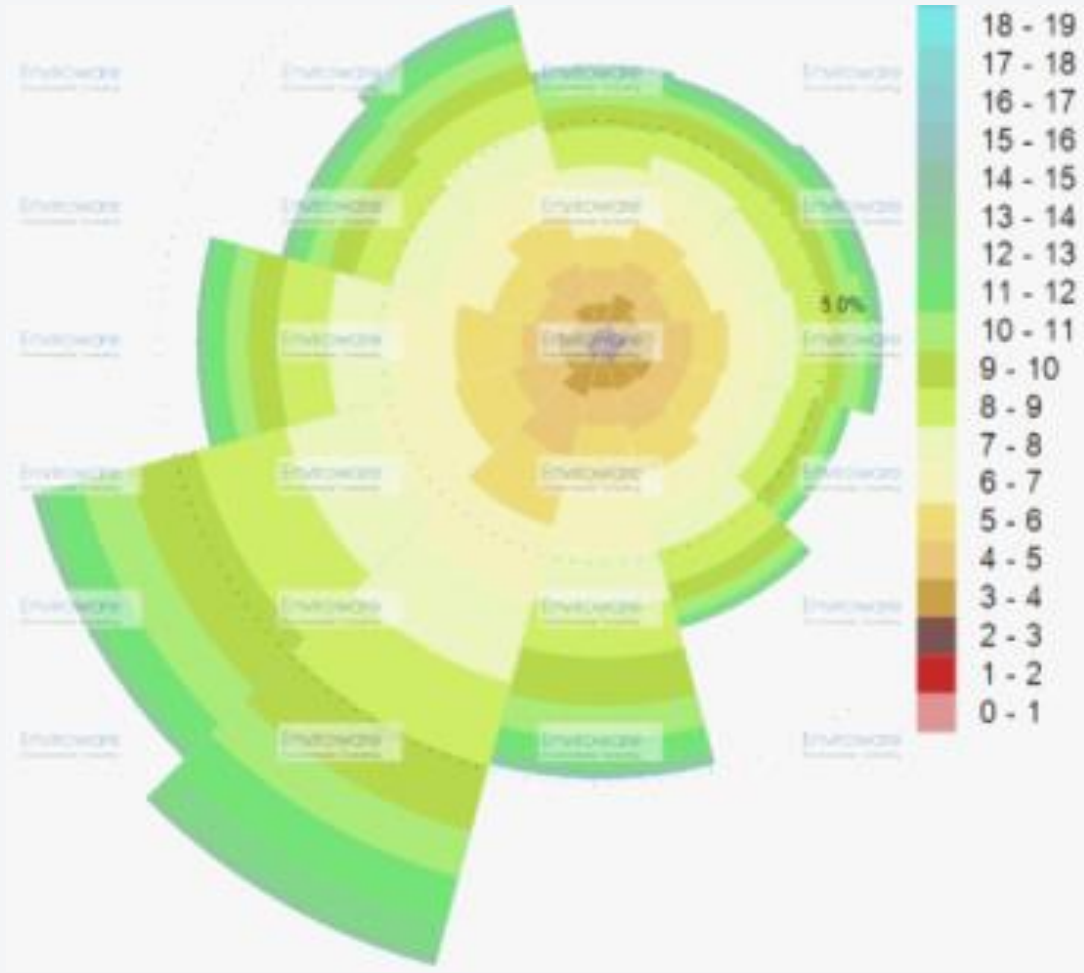
# Wind Speed Analysis

## SOLOVETSKY ISLANDS

SOLOVETSKY ISLANDS



Mean wind speed 10 m - 5,7 m/s

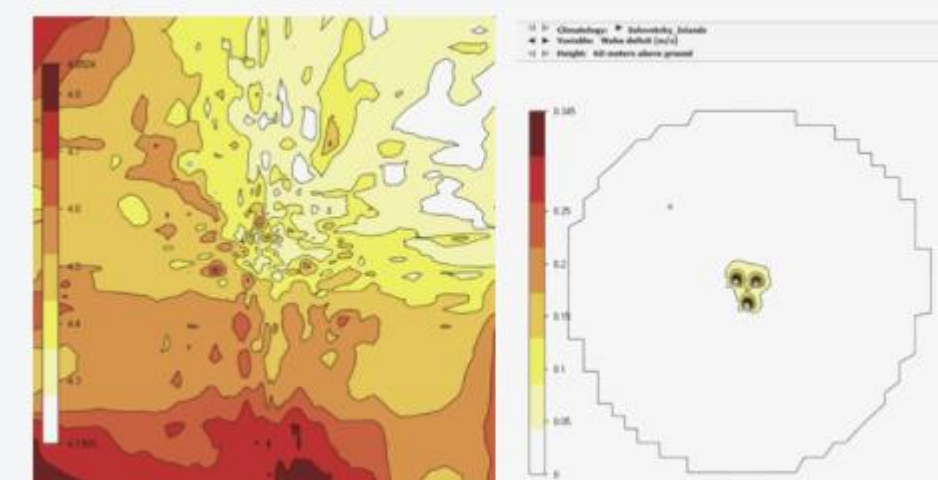
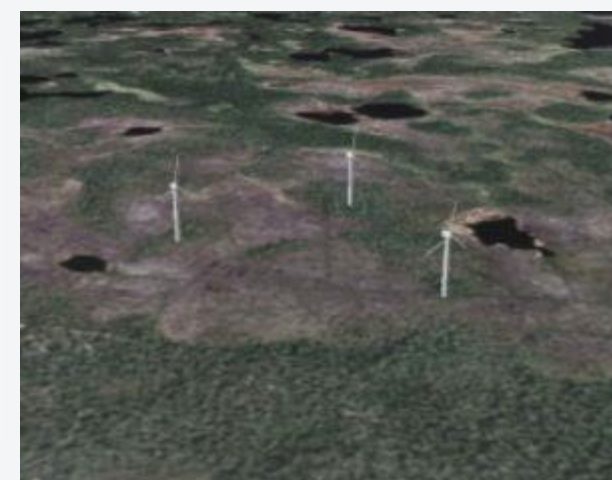
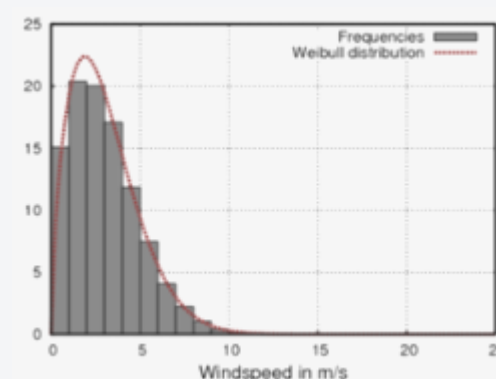
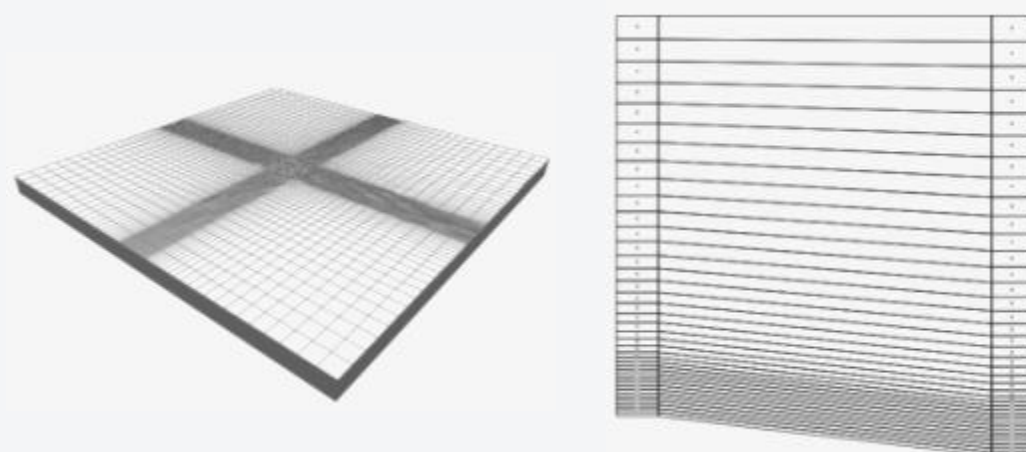


Mean wind speed 50 m - 7.1 m/s



# Modeling

## WINDSIM SOFTWARE



3D model of the terrain

Generation of the wind  
field and park design

Results



Remoteness from cultural and historical sites

Open area without trees

Short distance from the roads

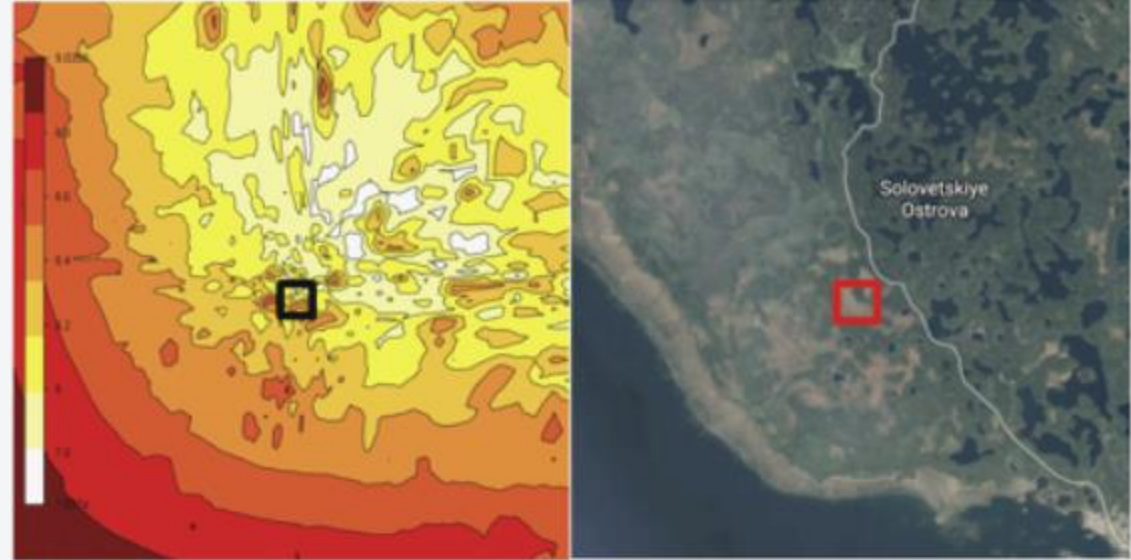


# Modeling

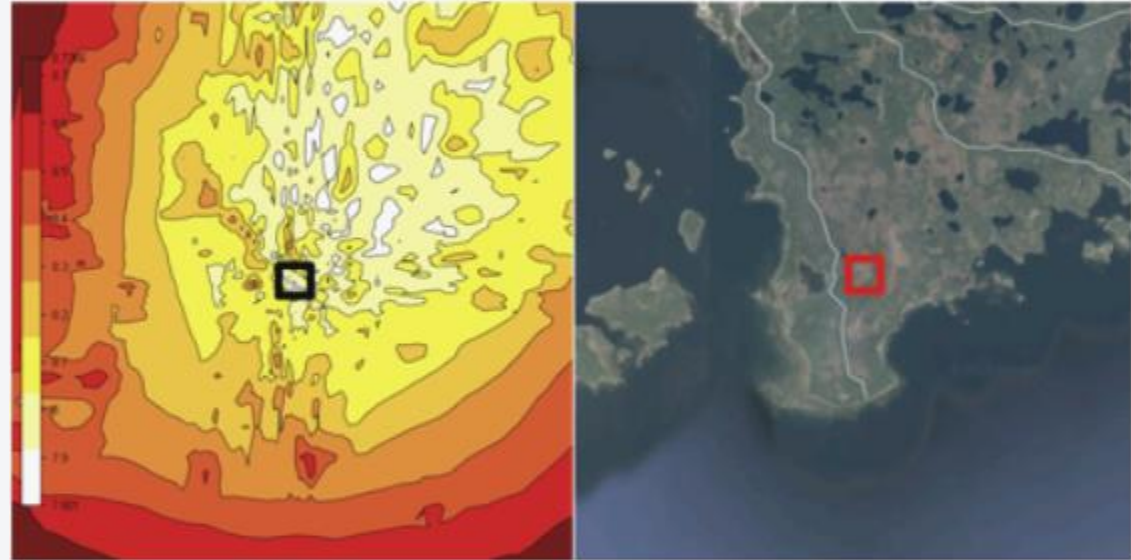
WIND PARK LOCATIONS



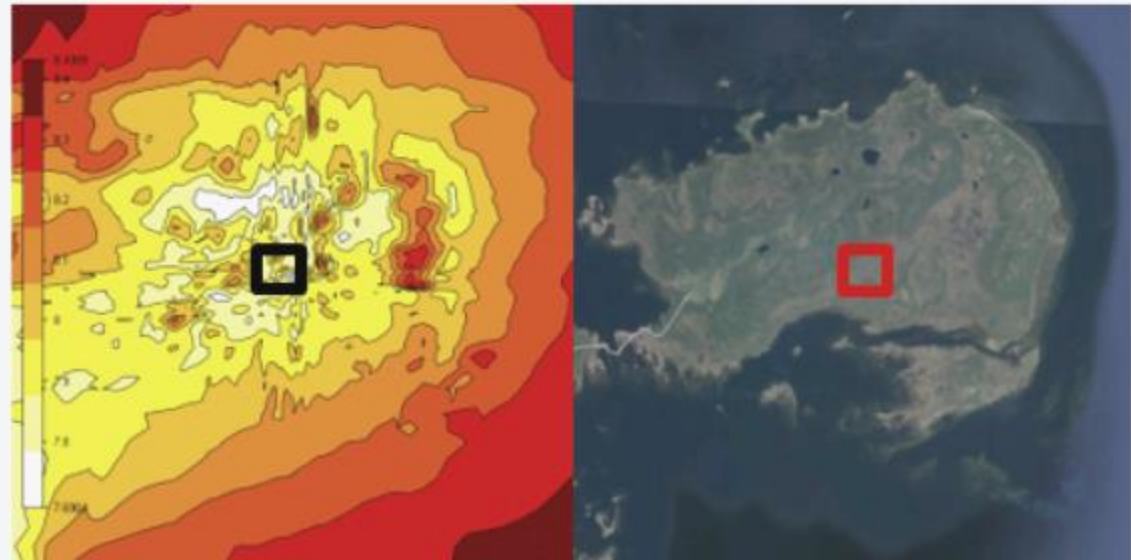
# WIND RESOURCE MAPS



Location 1

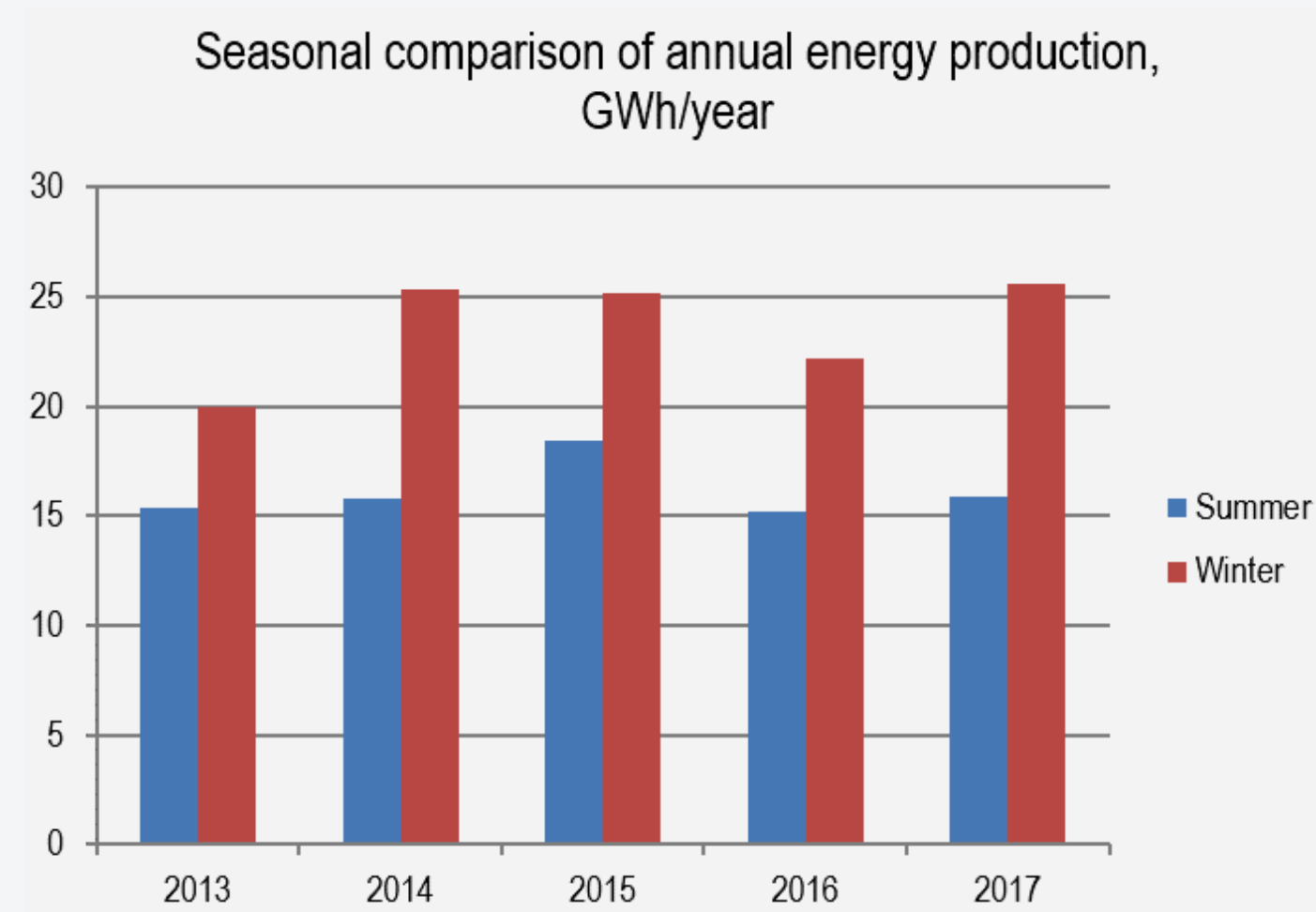
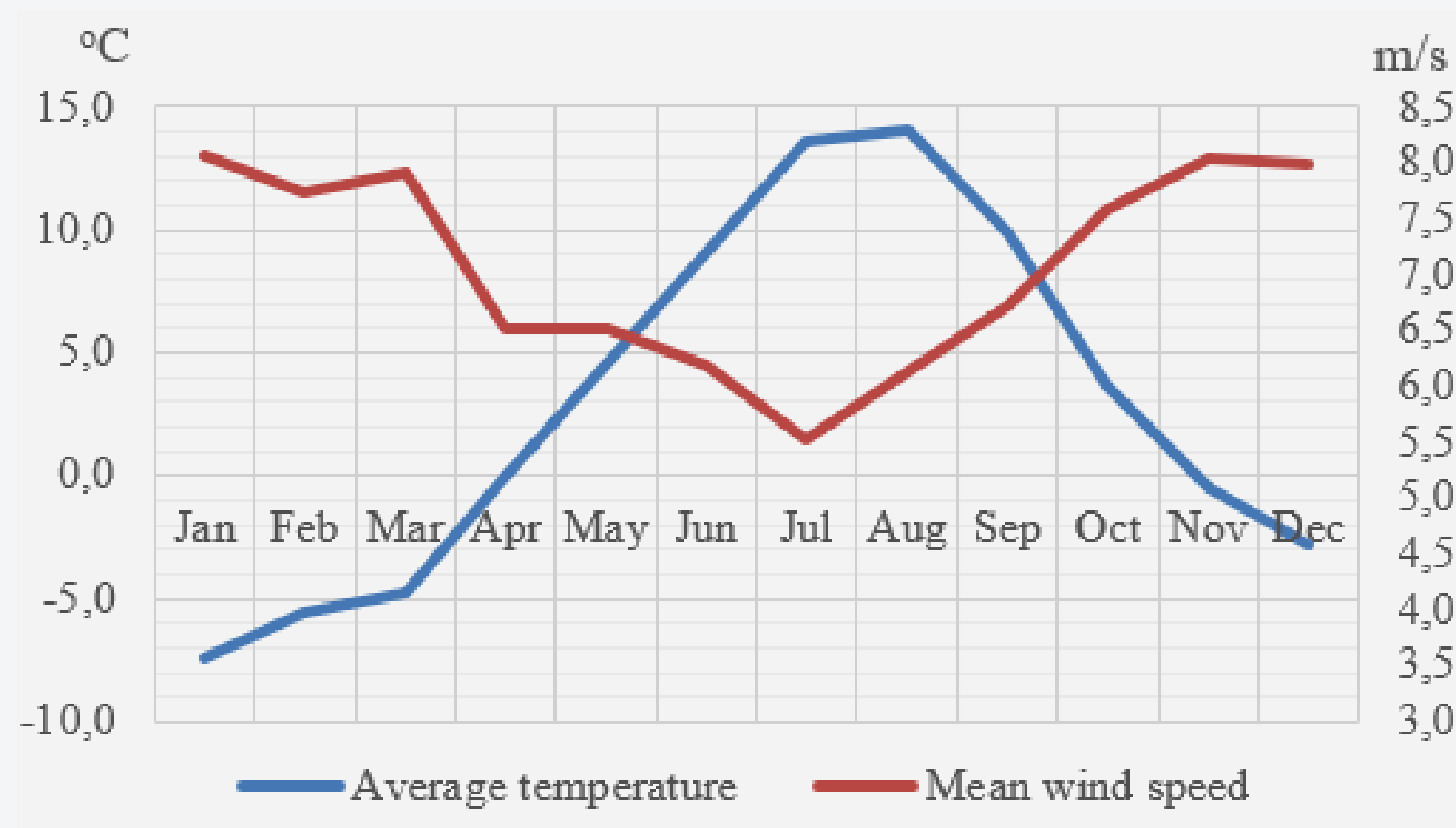


Location 2



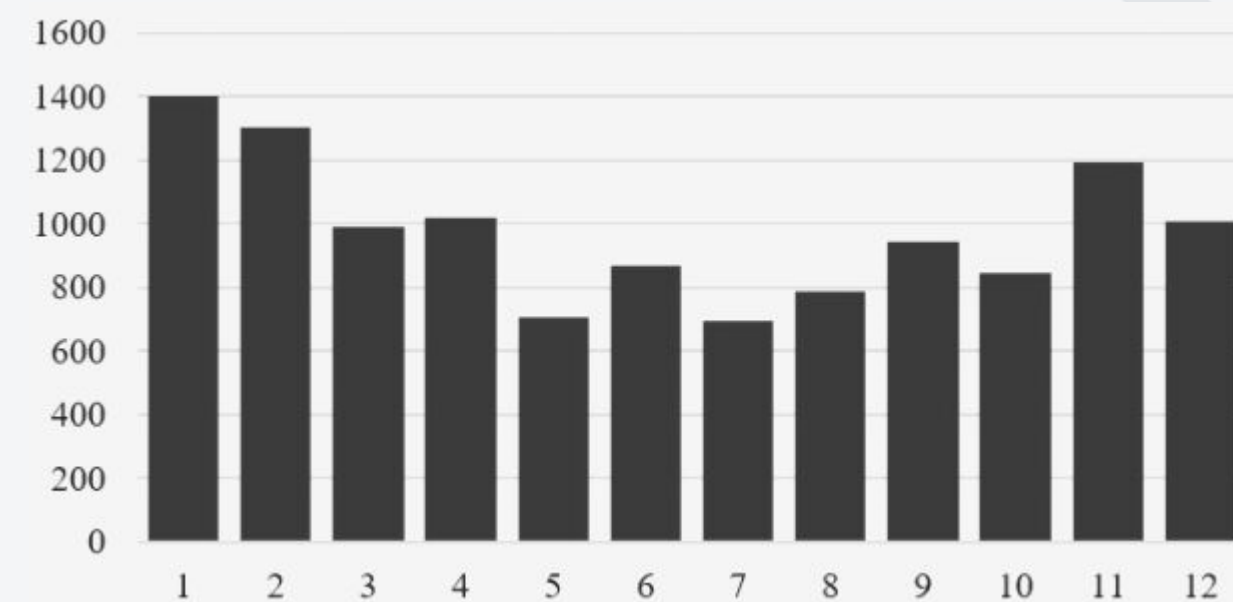
Location 3





# Modeling

## SEASONAL COMPARISON



Average monthly electrical power, kW (2016)

Average temperature:  
Summer +9,2°C;  
Winter -3,5°C.

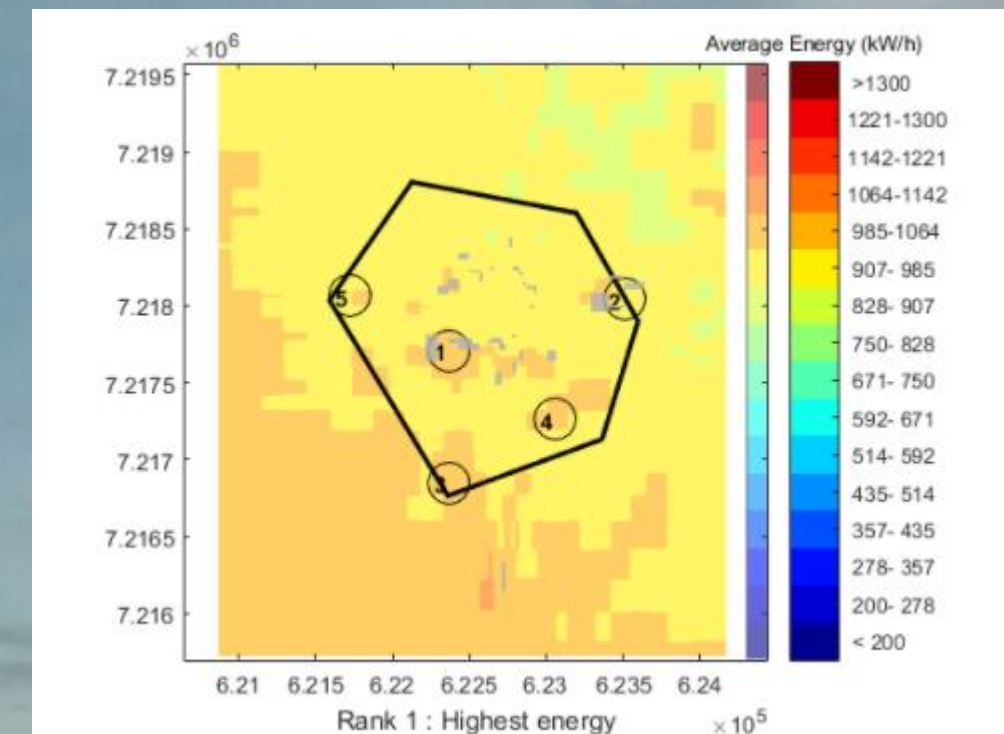
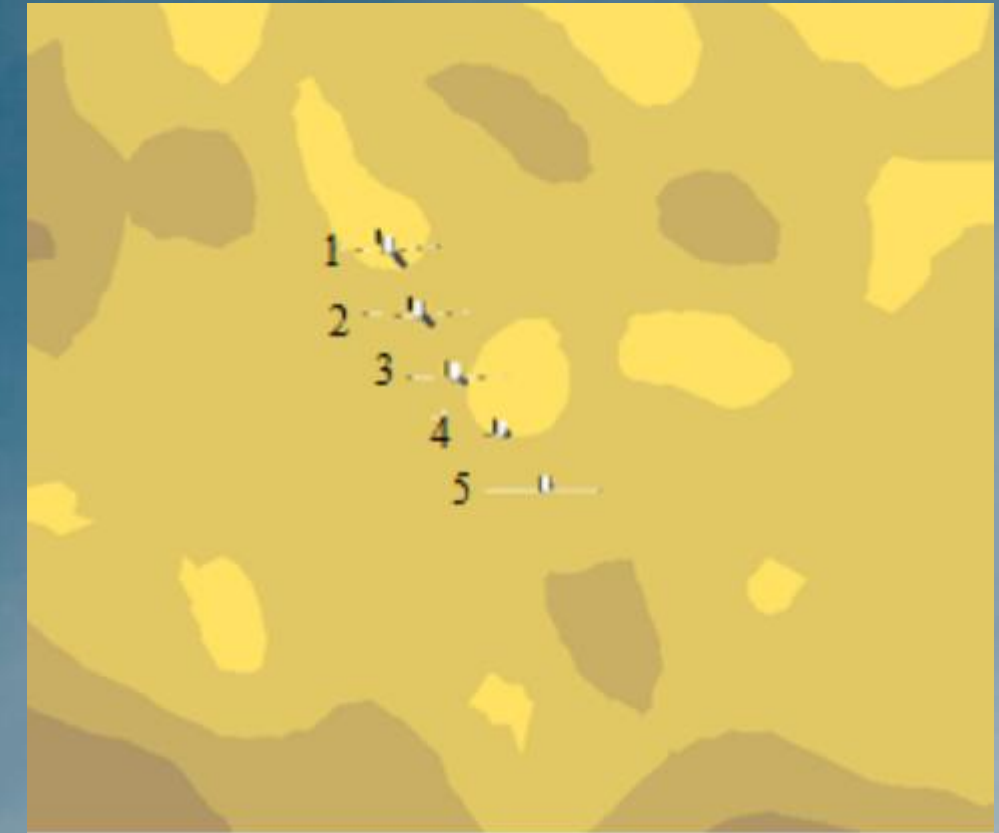


# Modeling

## OPTIMIZATION

Wind park energy production after optimization increased by

# 16%





# Meteorological mast

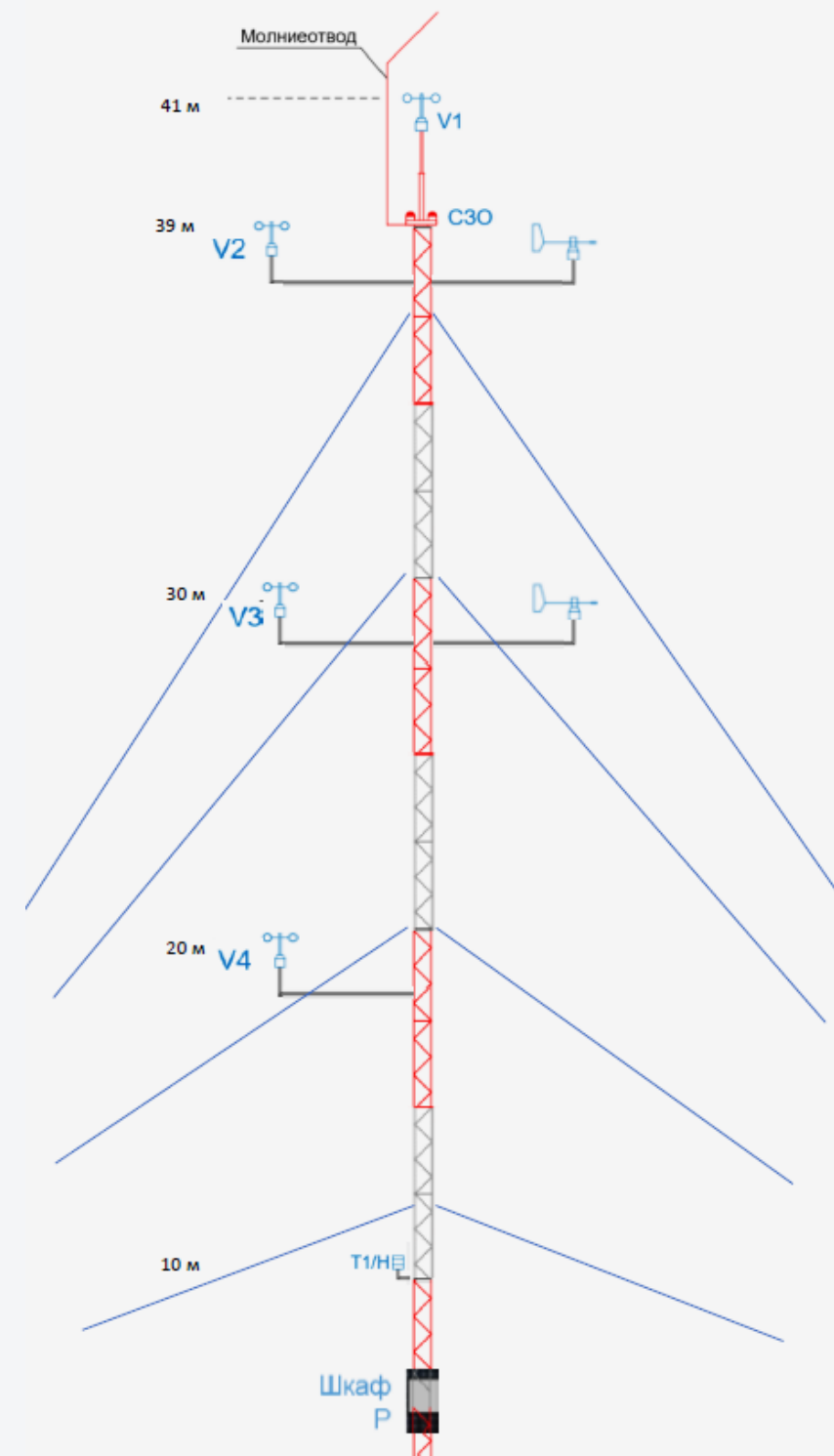
NARFU CAMPUS





# Meteorological mast

## NARFU CAMPUS



- 1) Thies First Class Advanced II Anemometer (MEASNET calibrated) unheated
- 2) Thies First Class Advanced II Anemometer (MEASNET calibrated) heated
- 3) Thies First Class Wind Vane
- 4) Thies First Class Wind Vane – heated
- 5) Barometric Pressure Sensor
- 6) Temperature & Humidity Sensor
- 7) Measurement and Control Datalogger
- 8) Communication module





**Pavel Maryandyshev**

Professor of the department of power  
engineering

**WIND ENERGY FOR THE FAR NORTH**

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**Thank you for your attention!**