Microscale Wind Resource Mapping using Multiple Masts Calculation CFD/Linear Wind Flow Modeling for Semi-Complex Terrain in Southern Thailand

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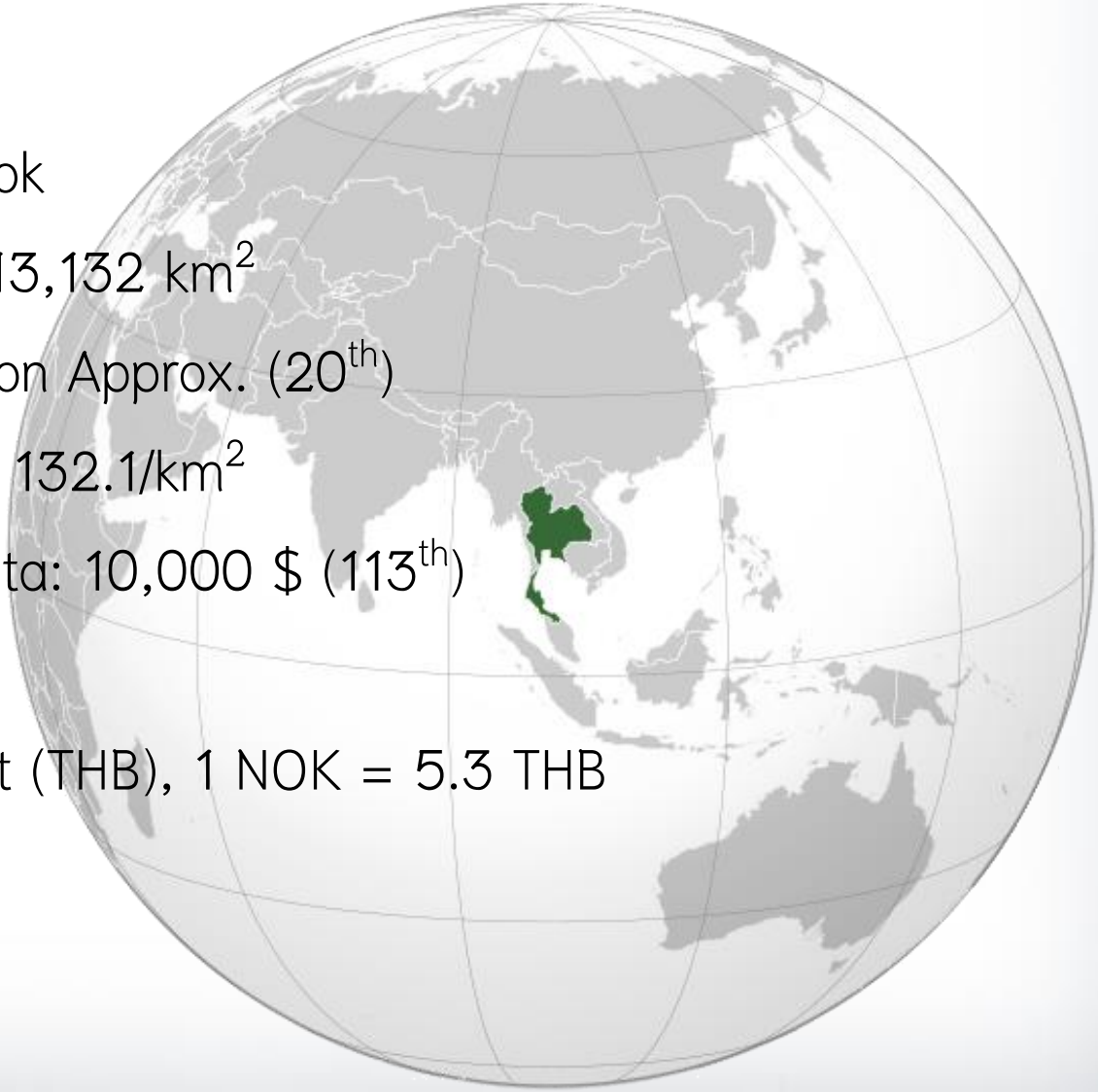
Topics

- Thailand and energy outlook
- Current situation of wind power development in Thailand
- High resolution wind atlas for southern Thailand
- Microscale wind resource mapping using multiple masts calculation CFD/Linear wind flow modeling for semi-complex terrain in southern Thailand

Thailand and Energy Outlook

Thailand

- Capital City: Bangkok
- Total Area: Land 513,132 km^2
- Population: 67 Million Approx. (20th)
- Population Density: 132.1/km^2
- 2013 GDP per Capita: 10,000 $ (113th)
- Time Zone: UTC+7
- Currency: Thai Baht (THB), 1 NOK = 5.3 THB



Energy Outlook for Thailand

- Energy consumption in Thailand relies on crude oil and LNG (11,201 ktoe), natural gas (2,581 ktoe) and coal (2,017 ktoe), accounting for 81.9% of the energy consumption.
- For power generation, fossil fuel accounted for 74.9% of the consumption.
- To reduce imports of foreign fossil fuel for power generation, the exploitation of wind energy to produce electricity is one of the key components in the development of the renewable energy policies.

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Current Situation of Wind Power Development in Thailand

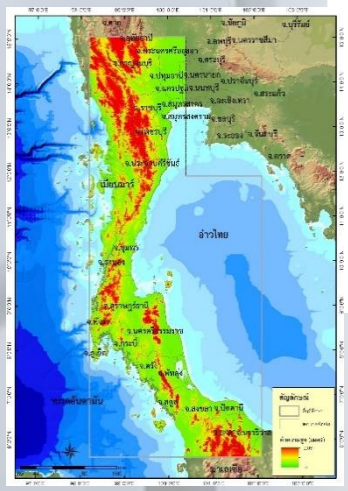
Wind Power Development in Thailand

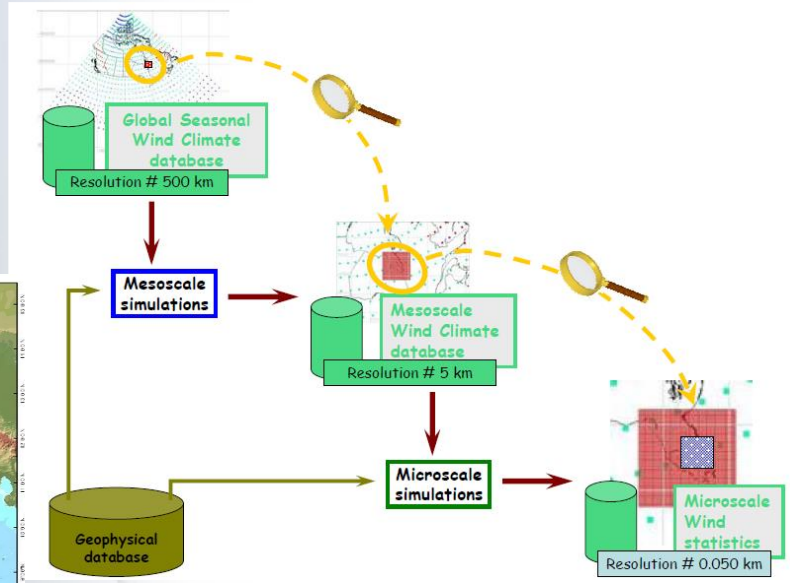
- At present, DEDE, MoE has targeted the wind power in Thailand for 1,800 MW within 2025 to reach 25% RE for national power generation.
- Financial incentives were provided through Adder, revolving fund & tax exemption program (BOI).
- Currently, the installed capacity of wind power is 220 MW approx.
- More than 1,5xx MW is still missing to be fulfilled.
- Most of the existing projects were set up for the demonstration purpose, there were few commercial SPP and VSPP projects.

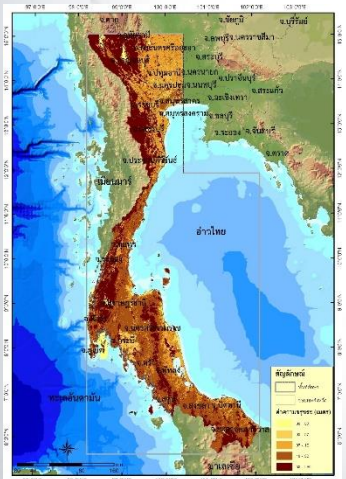
Wind Power Development in Thailand

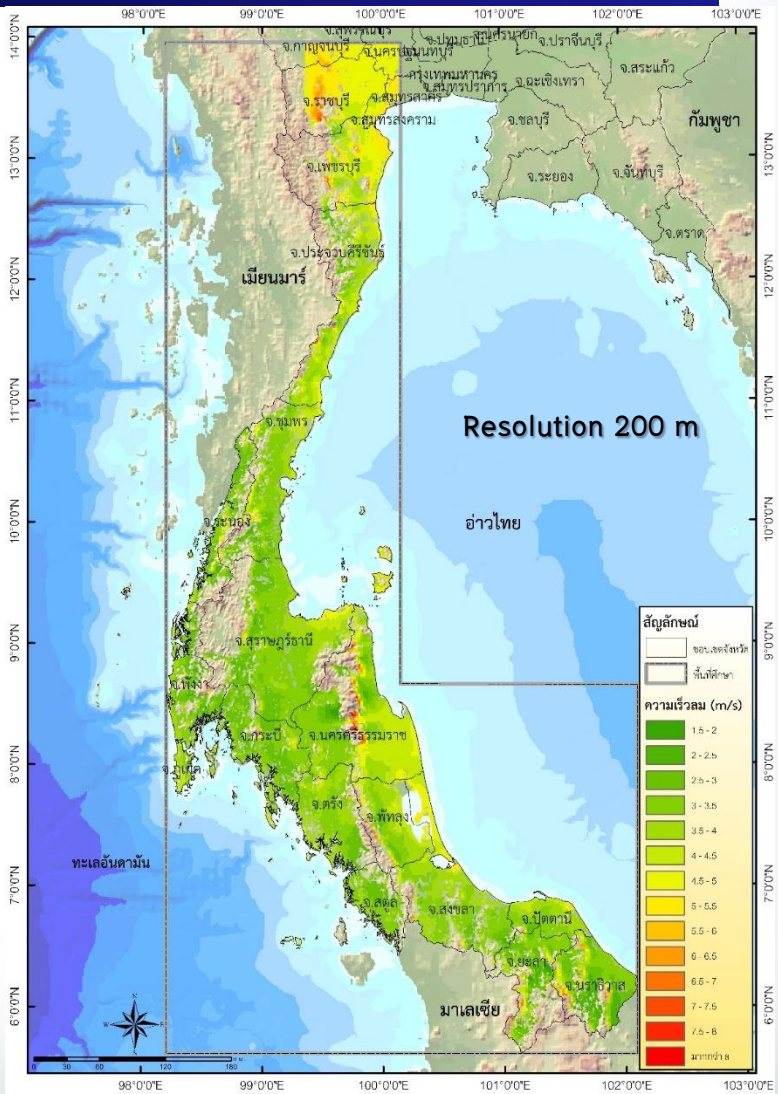
High Resolution Wind Atlas for Southern Thailand

High Resolution Wind Atlas

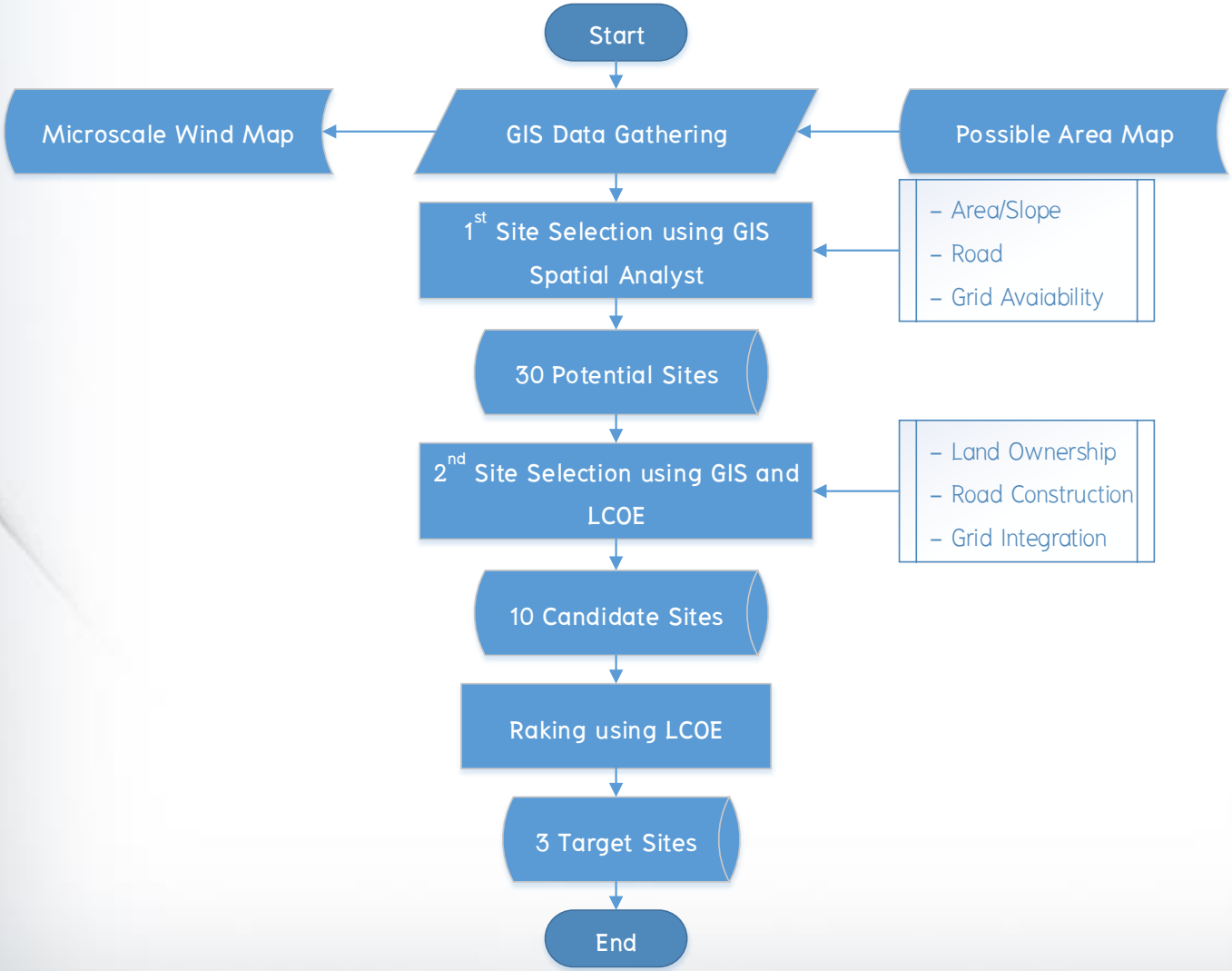








Site Selection



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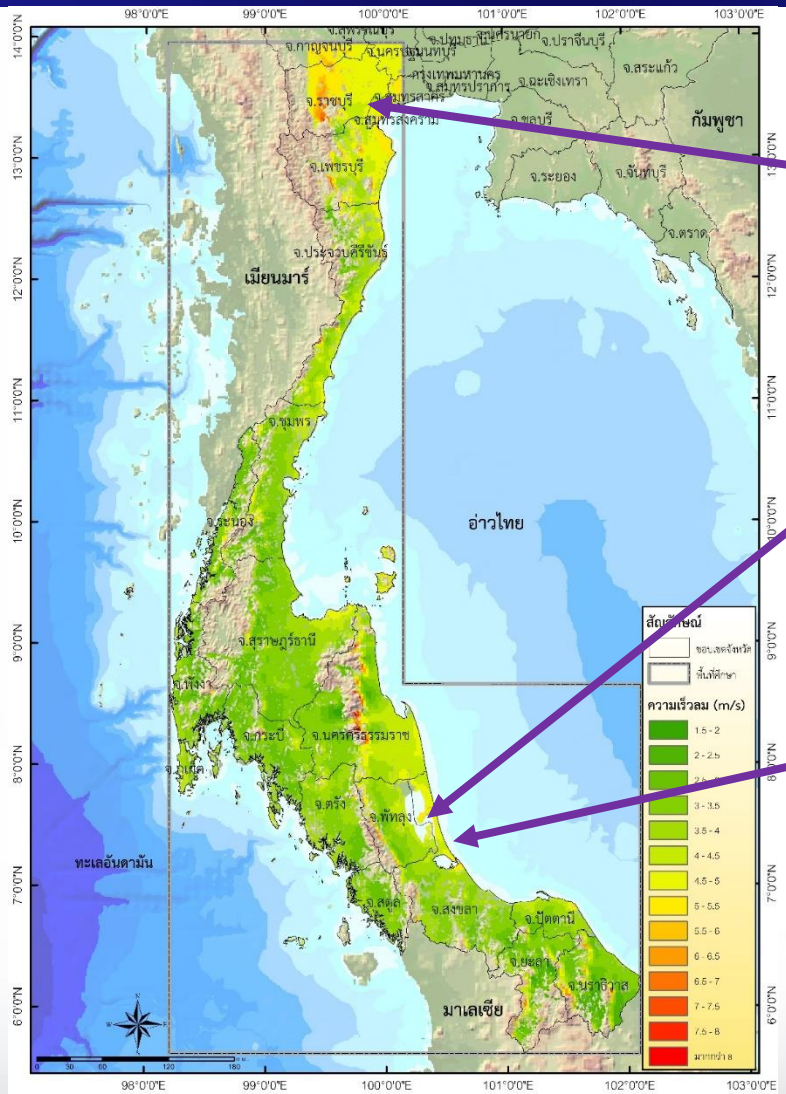


3rd Rank

Ratchaburi Province

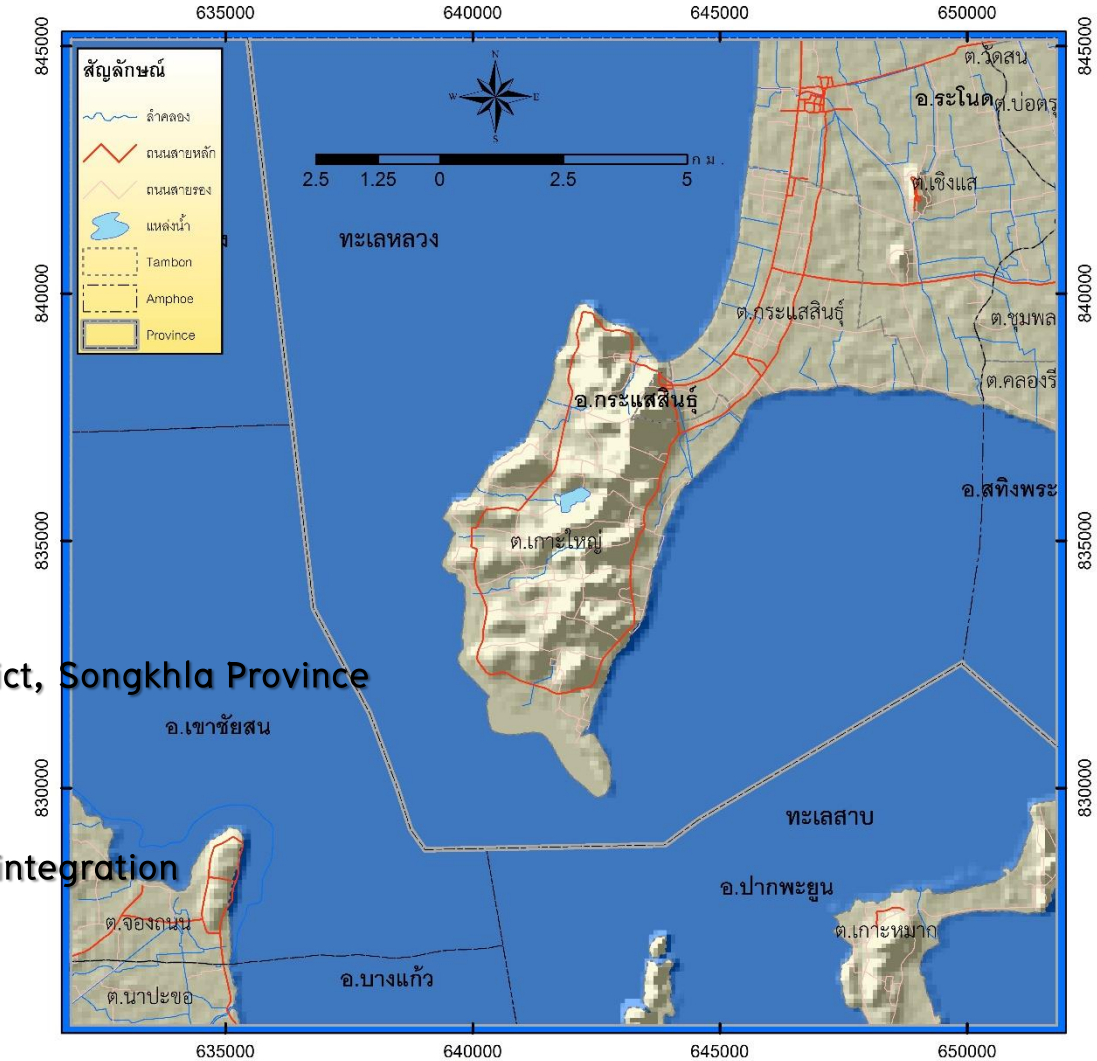
1st Rank

Songkhla Province

2nd Rank

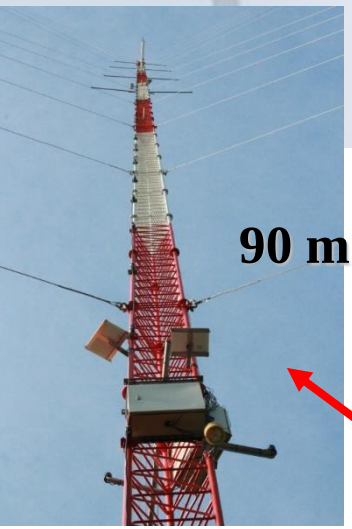
Songkhla Province

Koh Yai Project



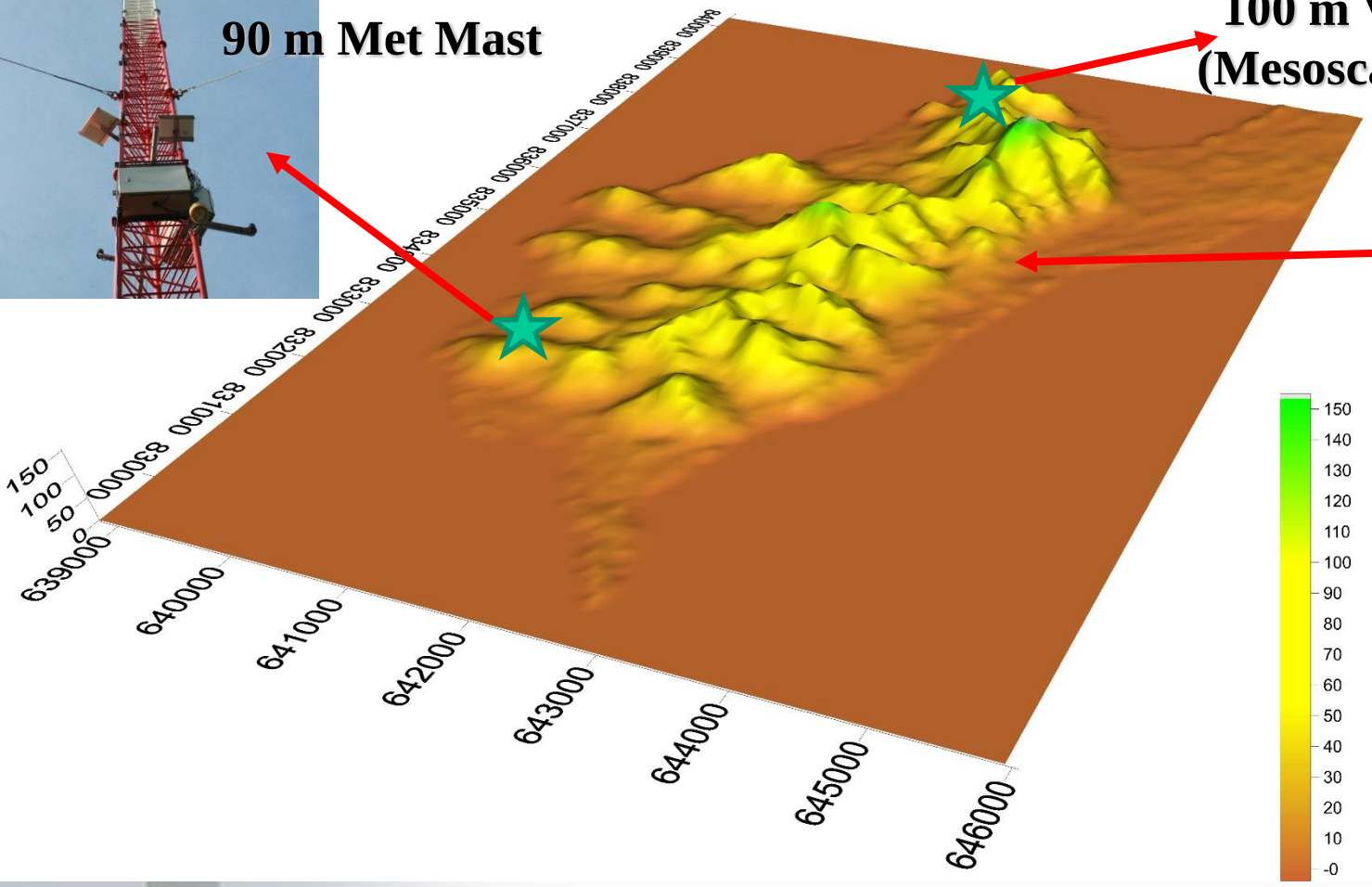
- Koh Yai Sub-District, Krasaesin District, Songkhla Province
- Elevation 150 m asl.
- Main road
- 33 kV distribution line for wind farm integration
- Land use permission

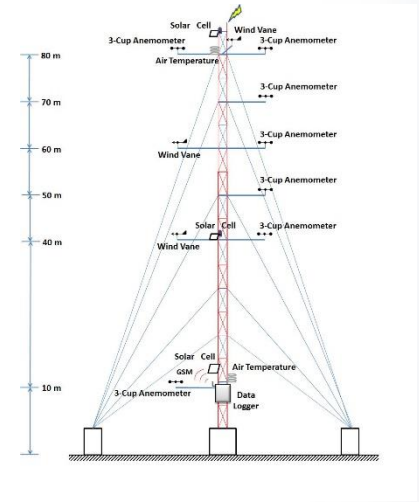
Koh Yai WRA



90 m Met Mast

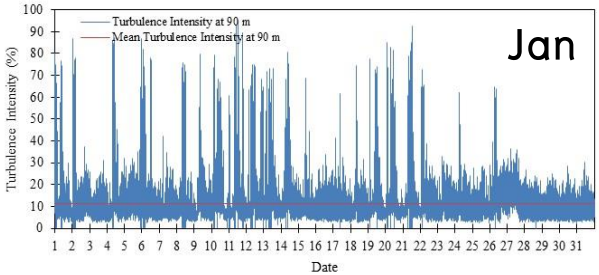
100 m Virtual Met Mast
(Mesoscale MC2 modeling

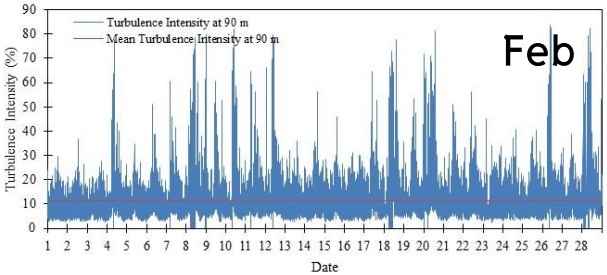


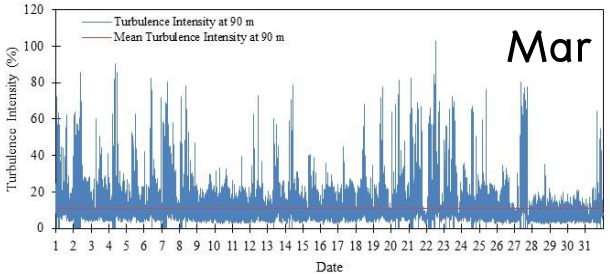


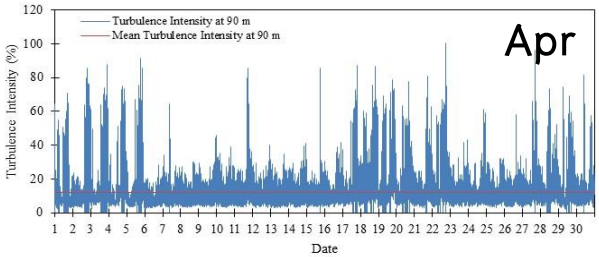
40 m Met Mast

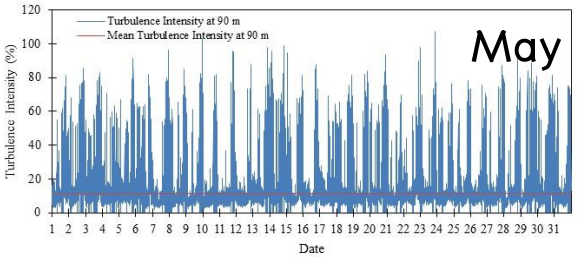
Turbulence Intensity 2011

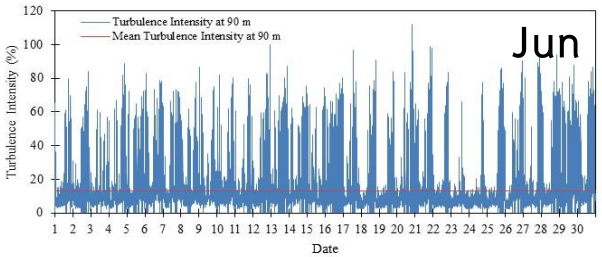


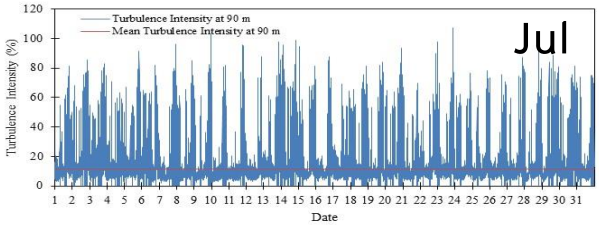


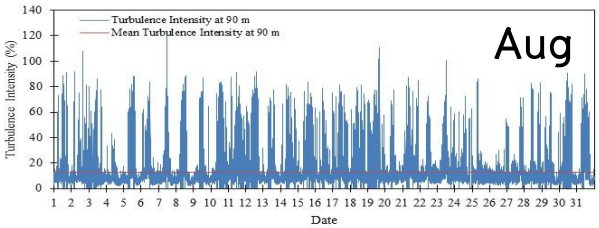


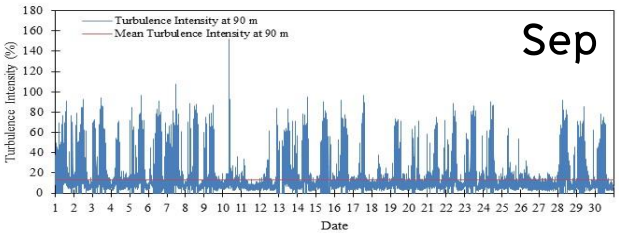


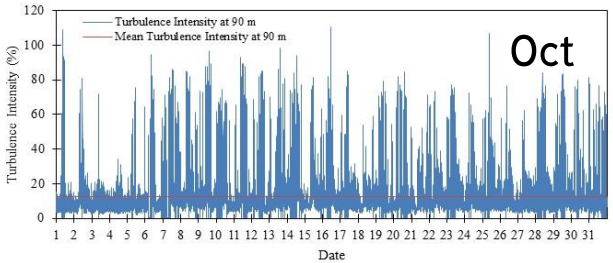


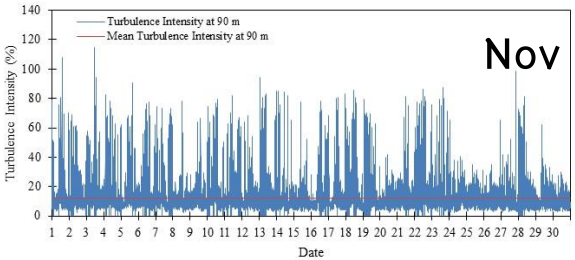


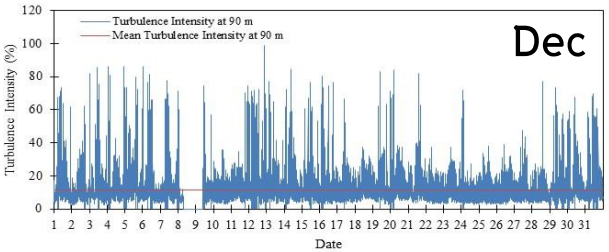




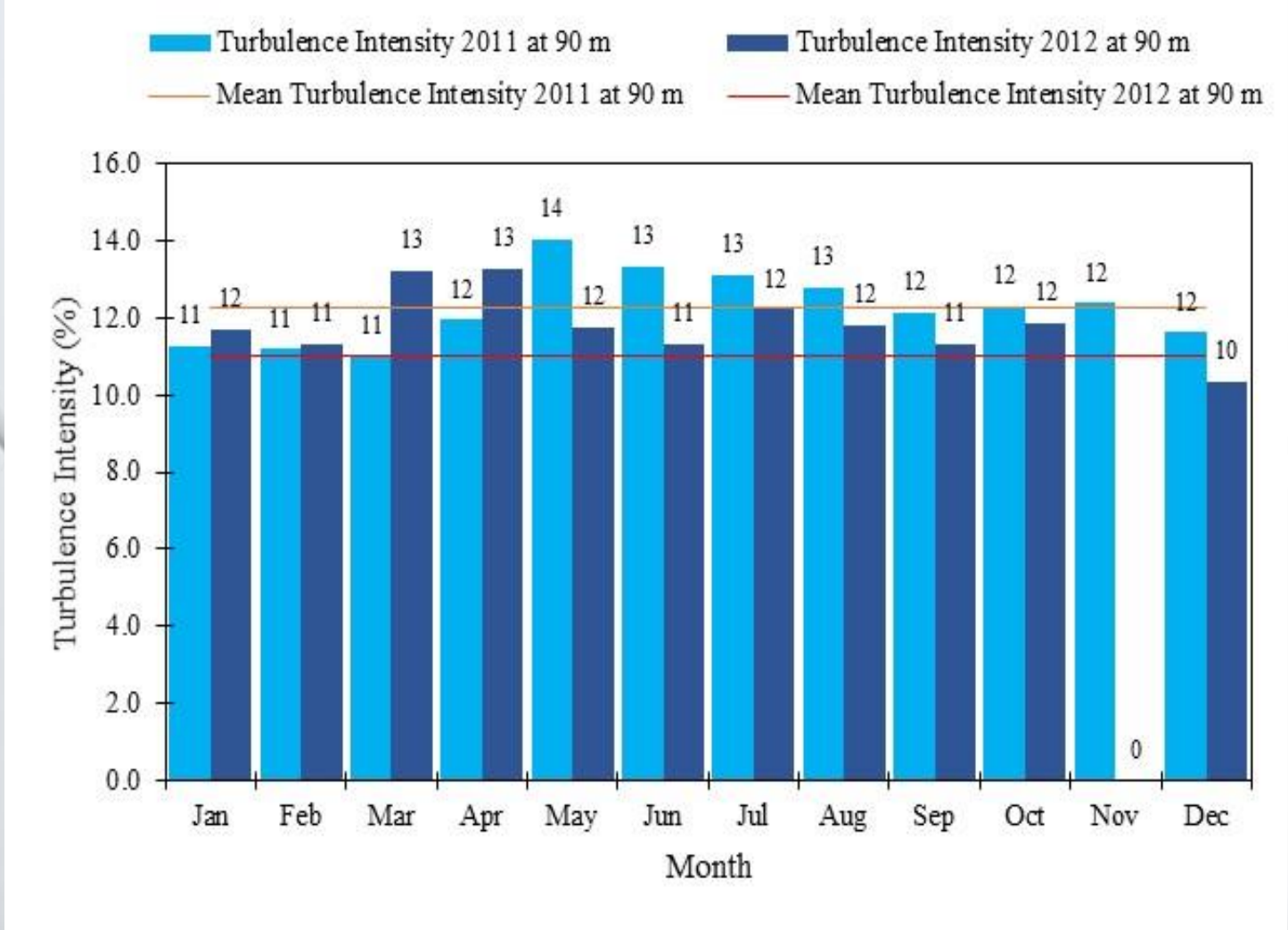








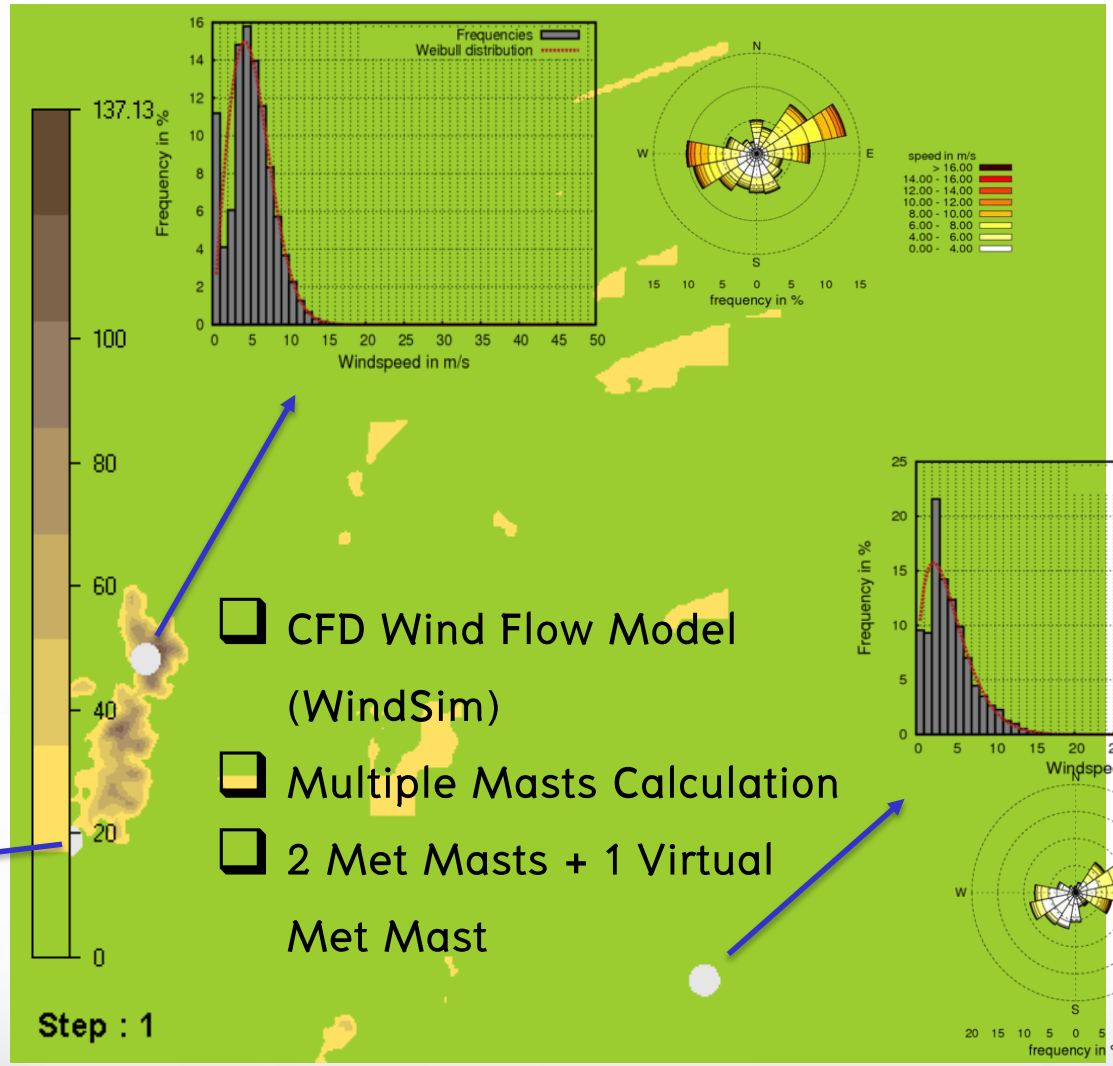
Turbulence Intensity



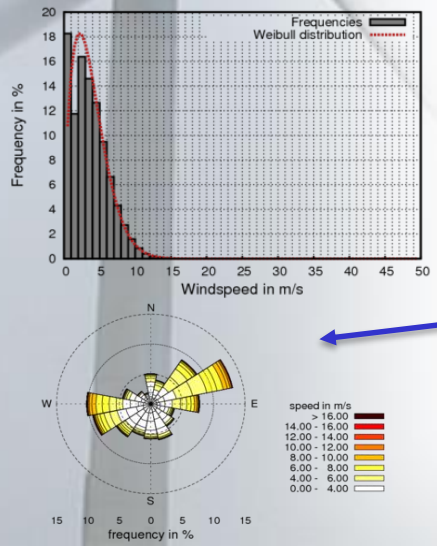
WTG IEC Class

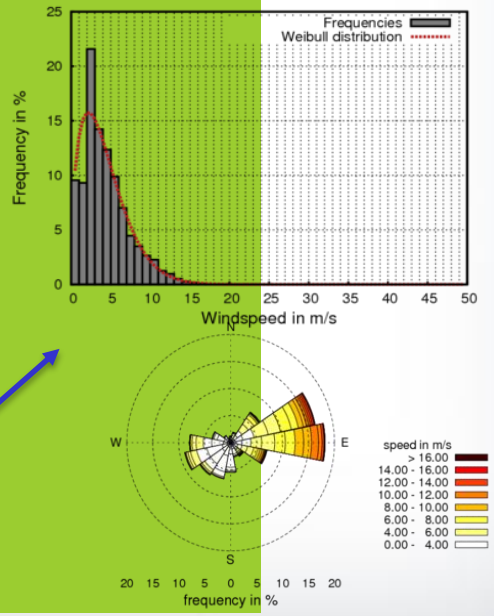
- IV C
- T.I. 12%

Multiple Masts Calculation WindSim



- CFD Wind Flow Model (WindSim)
- Multiple Masts Calculation
- 2 Met Masts + 1 Virtual Met Mast





Terrain Properties

Parameter	Status
Automatic Gridding	True
Refinement Type	No refinement
Maximum Number of Cells	1,000,000
Height Distribution Factor	0.1
Orthogonalize 3-D grid	False
Number of Cell in z direction	20
Smoothing type	No smoothing
Forest	Disregard Forest

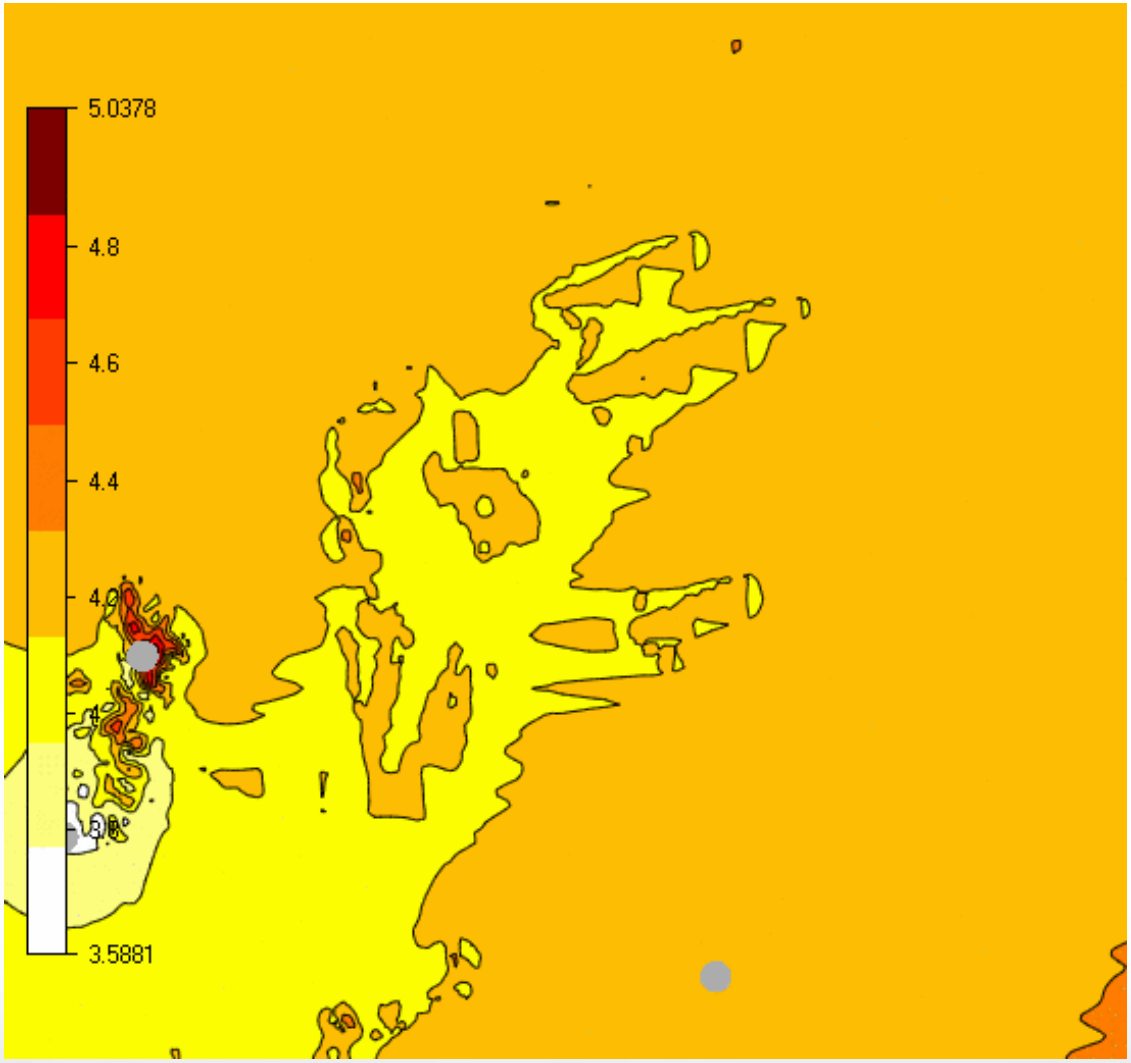
Wind Field Properties

Parameter	Status
Number of sector	16
Air Density	1.225
Boundary condition at top	Fixed pressure
Turbulence model	Standard k–epsilon
Solver	GCV
Number of iteration	200
Convergence wizard	False
Convergence criteria	0.001

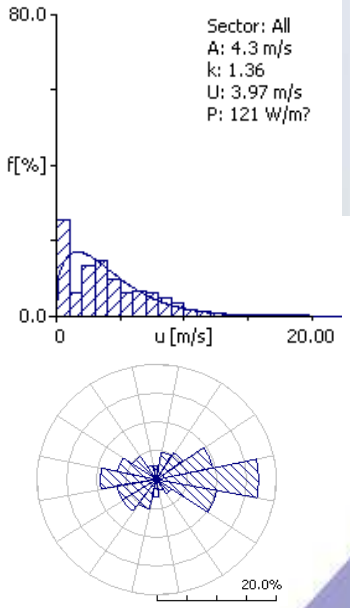
Wind Resource Properties

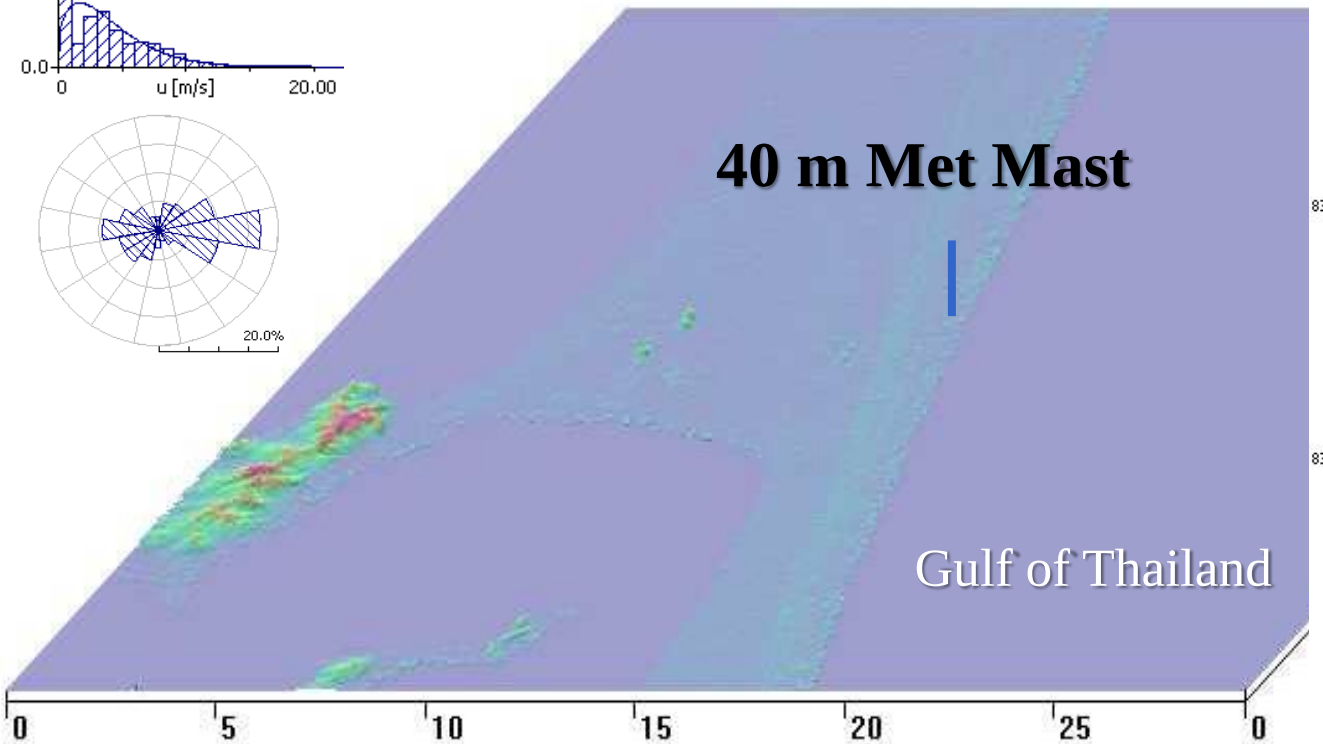
Parameter	Status
Wake model	1
Cross checking wind speed	False
Cross checking wind speed st. dev	False

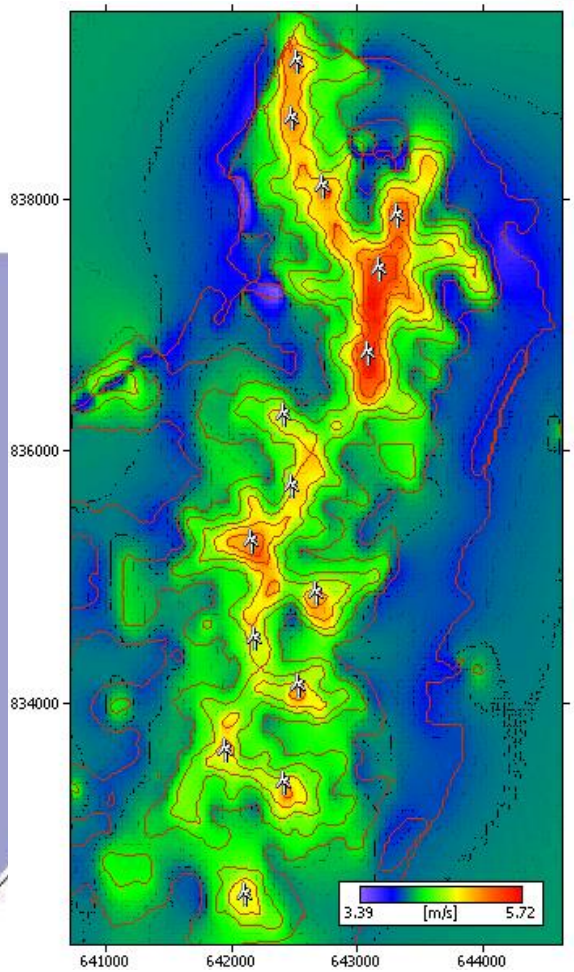
Microscale Wind Resource Mapping: CFD Model



Microscale Wind Resource Mapping: Linear Model







Zone 47 x=640734 y=826053

Zone 47 x=670300 y=826053

Koh Yai Wind Farm

- 10 sets of 2.0 MW WTG
- Installed Capacity 20 MW
- Grid Integration 33 kV

AEP & C.F.

No.	Model	AEP (GWh/Year)				C.F. (%)			
		Hub Height	100 m	110 m	120 m	Hub Height	100 m	110 m	120 m
1	I	35.82	36.78	38.72	38.72	20.44	21.00	22.10	22.10
2	II	31.82	33.72	35.56	37.21	18.16	19.24	20.30	21.24
3	III	37.25	37.25	39.44	39.44	17.01	17.01	18.01	18.01
4	IV	31.04	31.91	33.77	33.77	16.87	17.35	18.35	18.35
5	V	35.33	36.55	39.05	40.99	16.13	16.69	17.83	18.72
6	VI	27.16	28.85	30.57	30.57	15.50	16.47	17.45	17.45
7	VII	11.17	12.26	12.85	13.63	15.00	16.47	17.26	18.31
8	VIII	28.49	30.29	32.18	33.87	14.14	15.04	15.97	16.81
9	IX	35.83	36.55	38.92	41.06	13.63	13.91	14.81	15.62
10	X	22.19	24.47	26.12	27.63	10.13	11.17	11.93	12.62

20 MW Wind Farm

Wind Resource

No.	Wind Resource Modeling	Mean Wind Speed (m/s)
1	NCEP/NCAR + MC2 Mesoscale Modeling	5.30
2	CFD Modeling	5.03
3	Linear Modeling	5.72

Future Works

- CFD model will be run with more realistic cases in order to obtain higher accuracy wind resource and energy production.
- To this end, air density, refinement and forest properties will be applied in the CFD modeling.
- Time series data of observed wind speed will be used as an input instead of *.wws.
- Mesoscale coupling microscale CFD modeling will be applied for developing high-resolution wind atlas for 3 southernmost provinces of Thailand.

Acknowledgement

PEA
PROVINCIAL ELECTRICITY AUTHORITY

Research
Center
Energy
Environment

THAKSIN UNIVERSITY

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Thank You for Your Attention