Hybridization of wind and solar, how to handle icing and curtailment

Sigbjørn Grini and Dina Martinsen

Norconsult

Wind and solar hybrid projects

Energy yield assessments

Ice risk

Engineering services

Forecasting

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Wind and solar hybrid projects

Energy yield assessments

Ice risk

Engineering services

Forecasting

Typical meteorological years

IceRiskSolar

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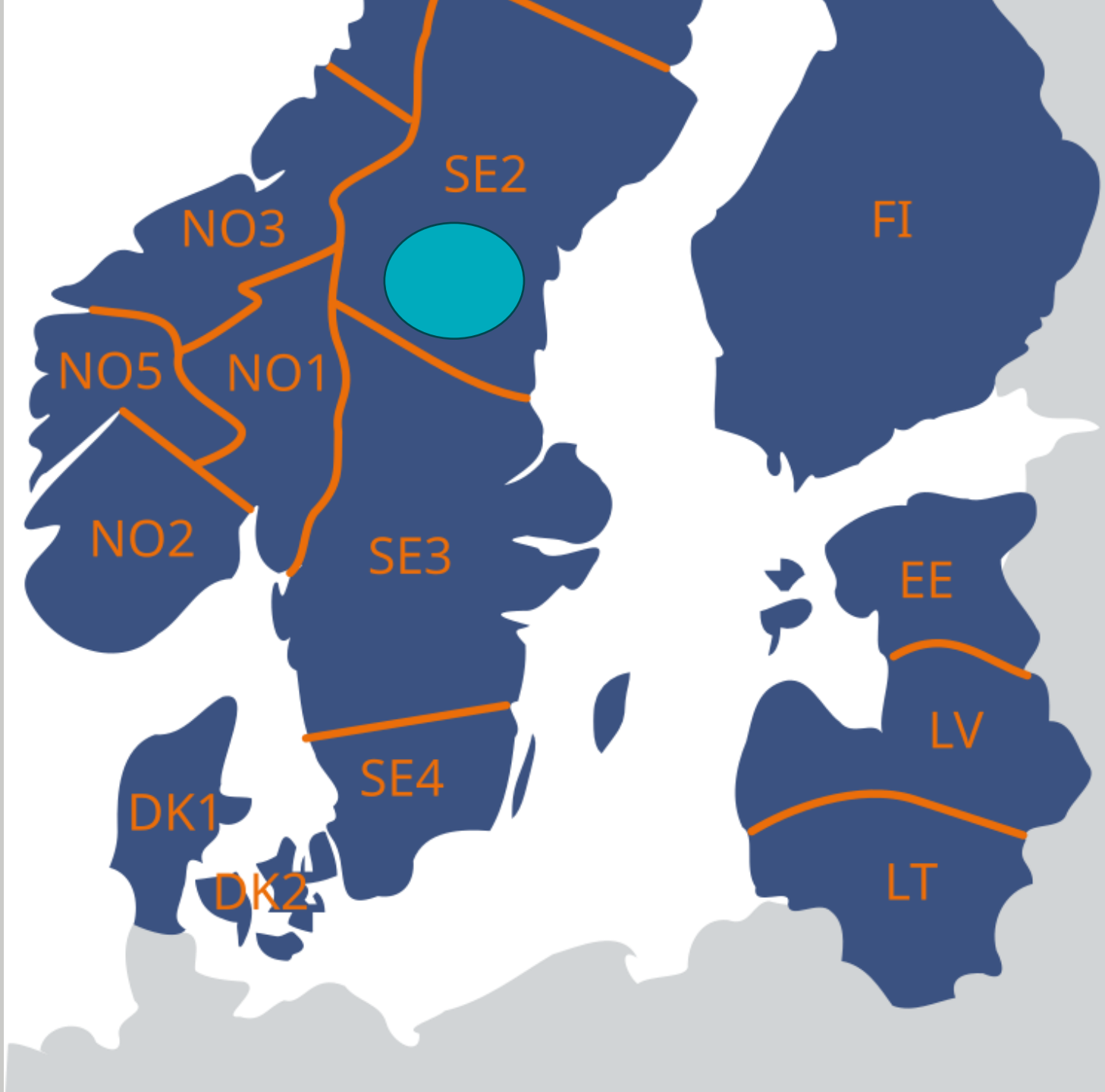
Example hybrid project

Located in SE2

Hourly data

Existing wind project 50 MW, want to expand with solar south-faced

50 MW grid capacity



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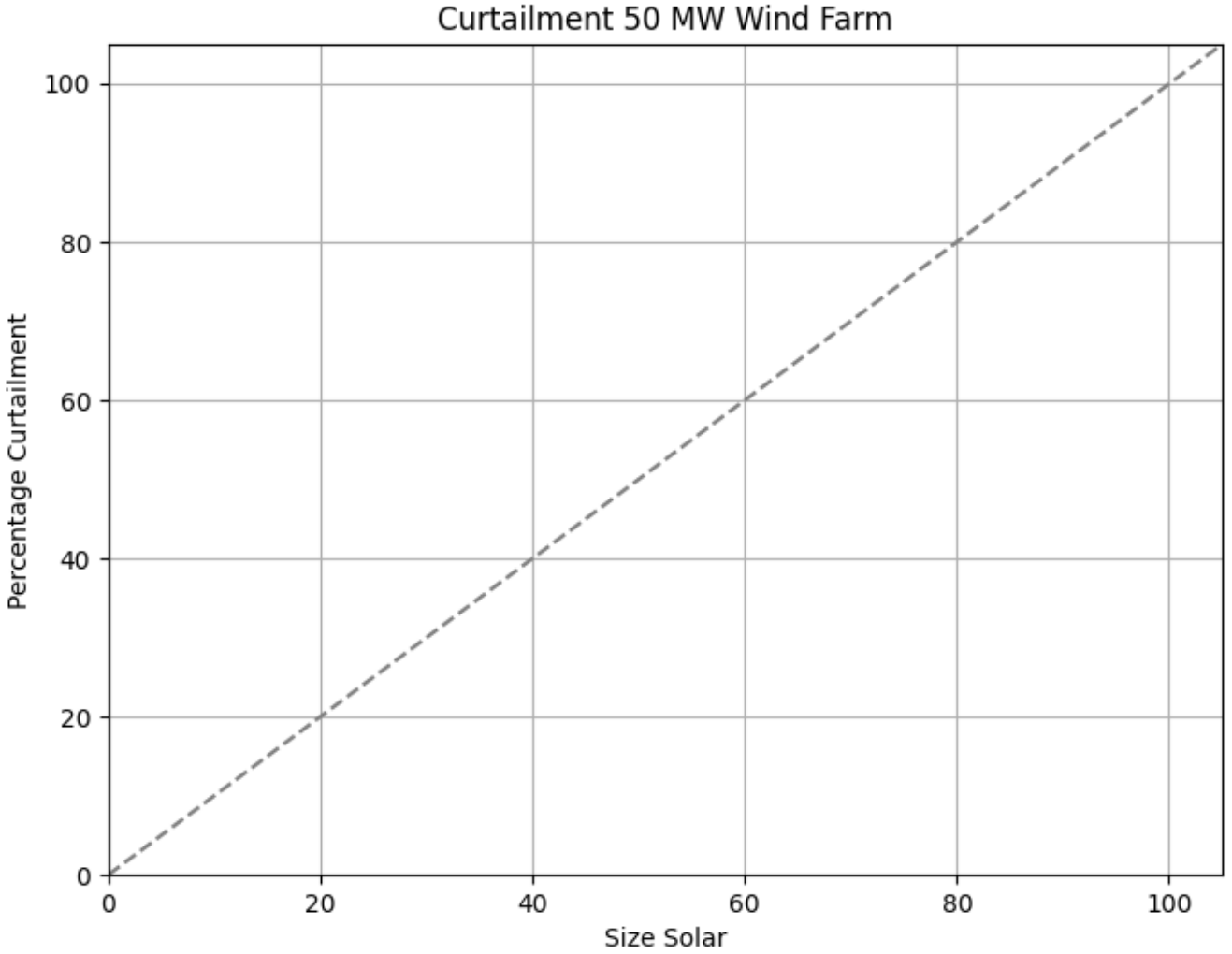
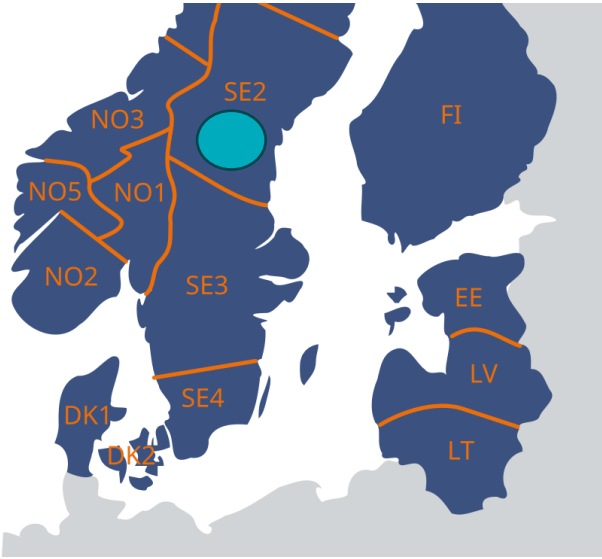

Curtailment 50 MW Wind Farm
Percentage Curtailment
Size Solar
0
20
40
60
80
100


SE2
NO3
FI
NO5
NO1
NO2
SE3
EE
LV
SE4
DK1
DK2
LT

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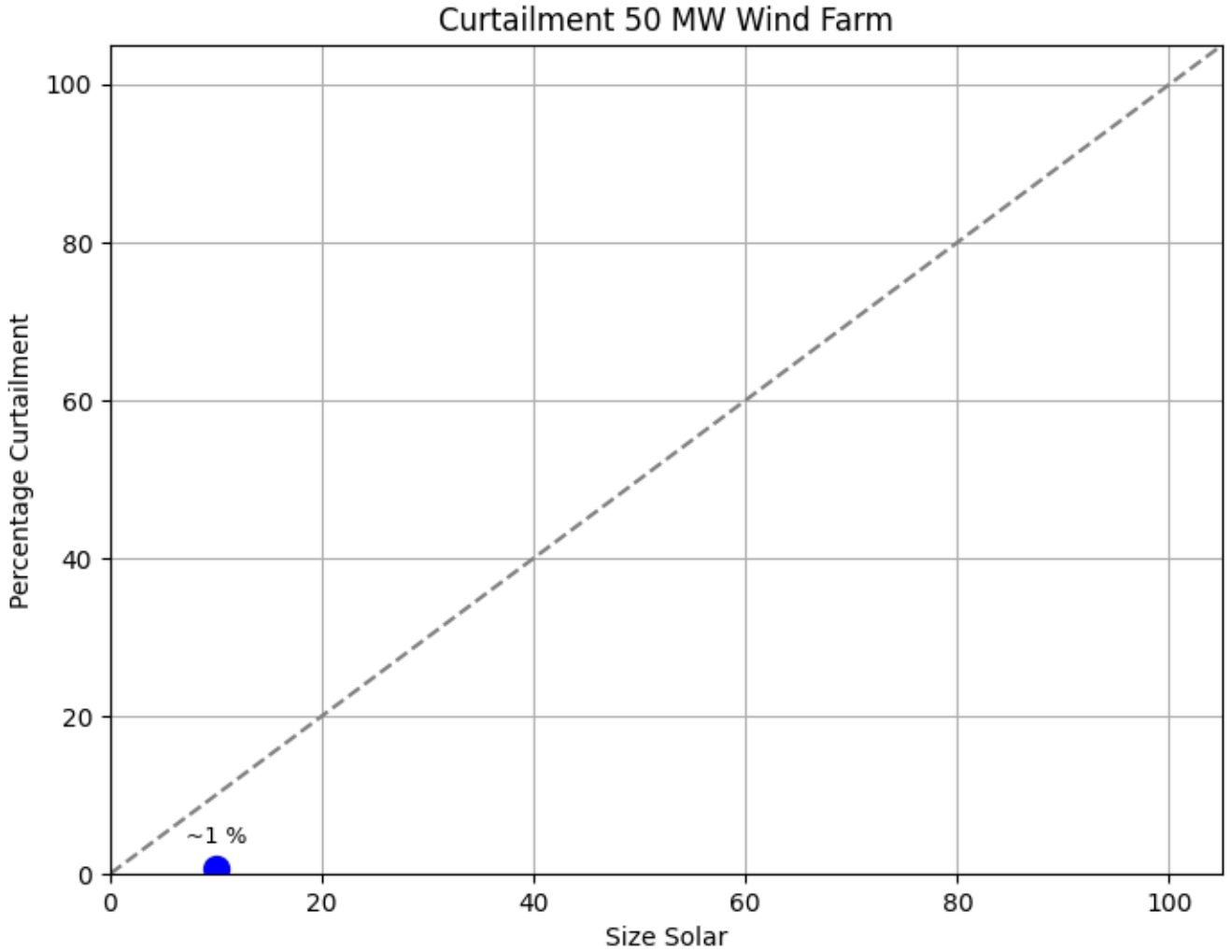
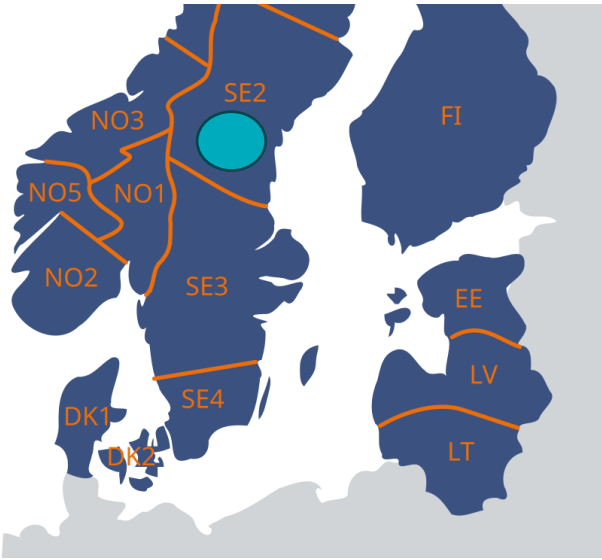

Curtailment 50 MW Wind Farm
Percentage Curtailment
Size Solar
0
20
40
60
80
100
~1 %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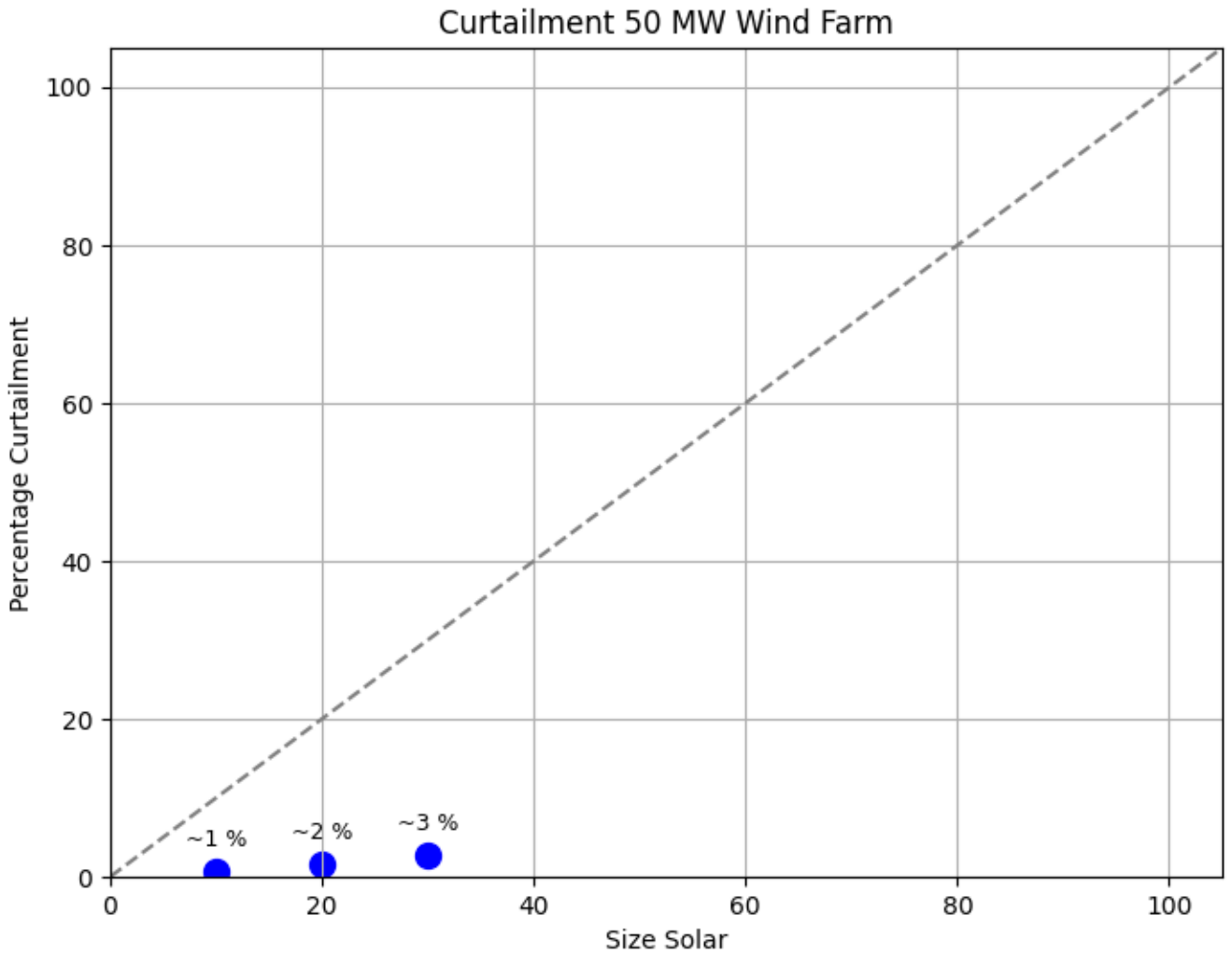
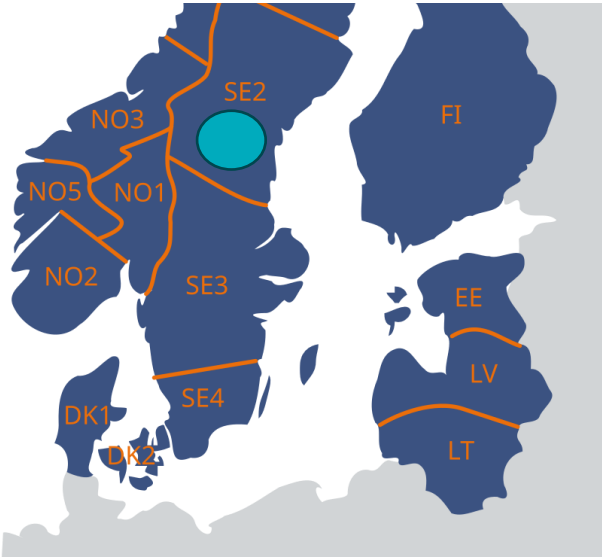

Curtailment 50 MW Wind Farm
Percentage Curtailment
Size Solar
0
20
40
60
80
100
~1 %
~2 %
~3 %


SE2
NO3
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SE3
EE
LV
SE4
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DK2
LT

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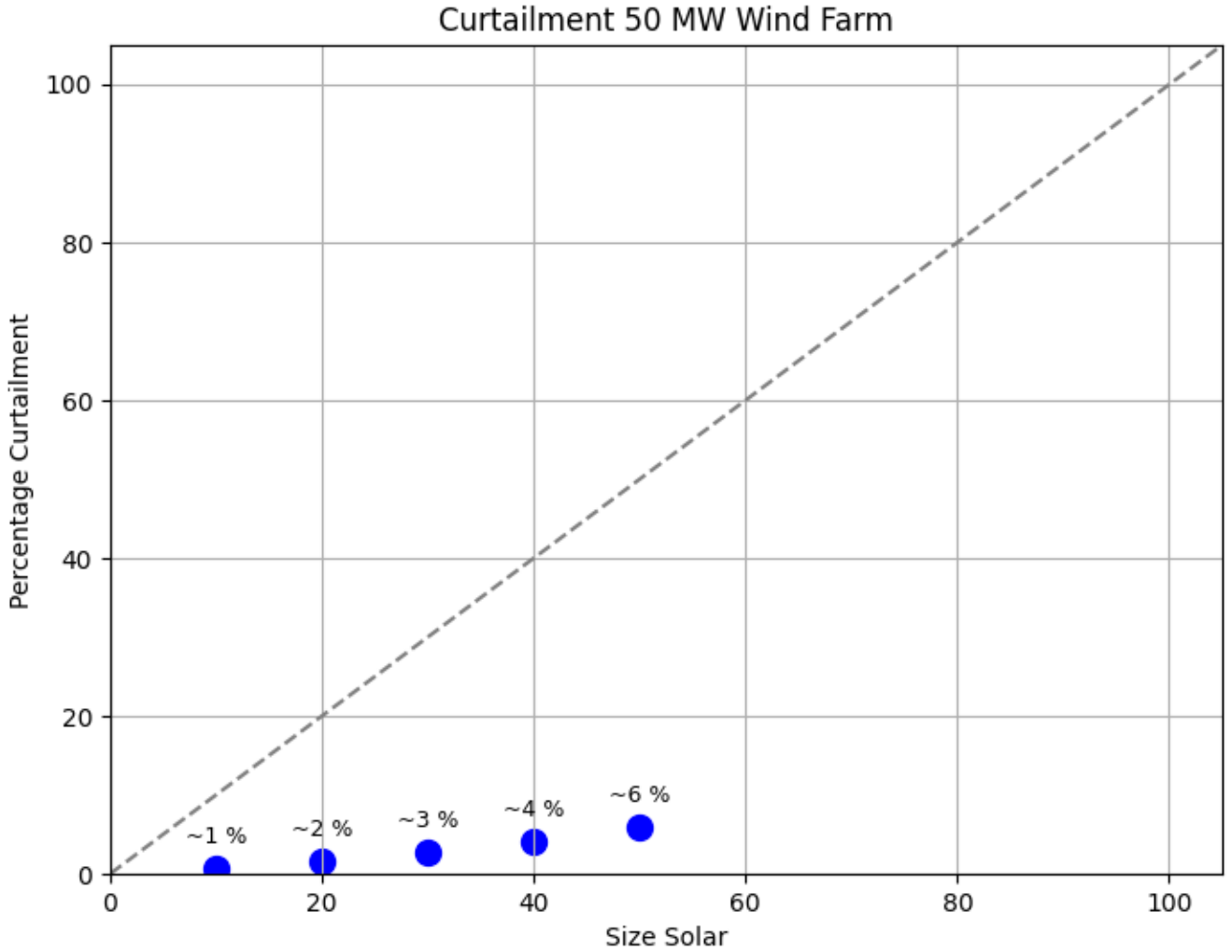
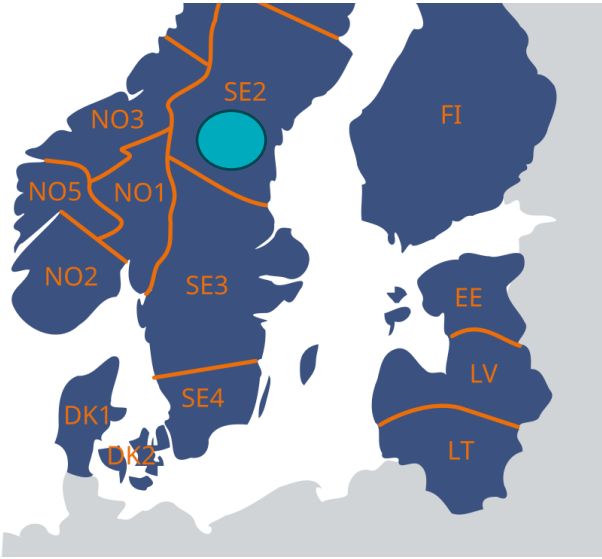

Curtailment 50 MW Wind Farm
Percentage Curtailment
Size Solar
0
20
40
60
80
100
~1 %
~2 %
~3 %
~4 %
~6 %


SE2
NO3
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LV
SE4
DK1
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LT

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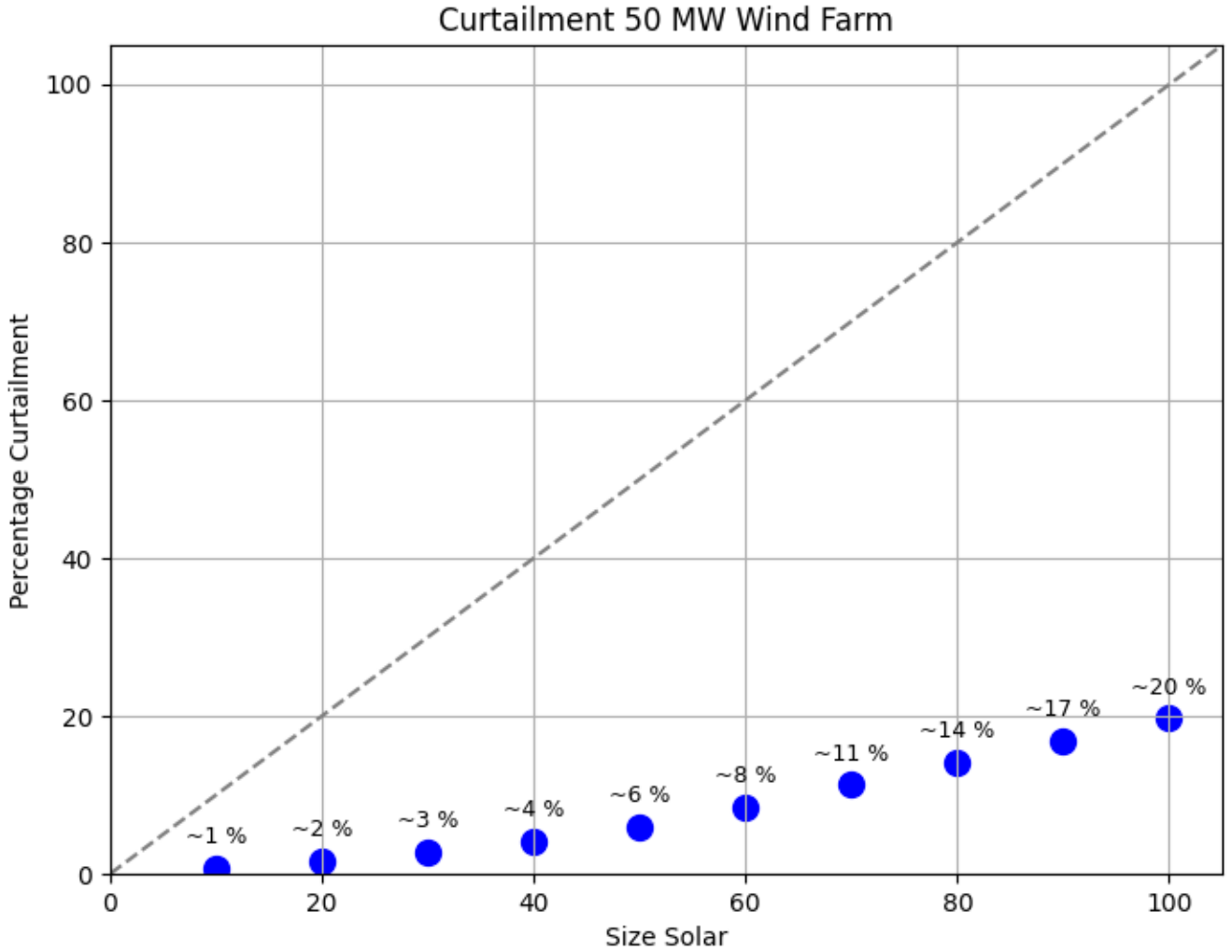
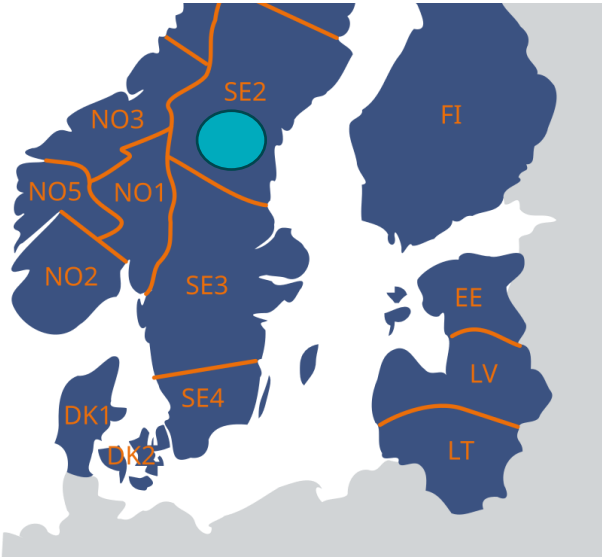

Curtailment 50 MW Wind Farm
Percentage Curtailment
Size Solar
0
20
40
60
80
100
~1 %
~2 %
~3 %
~4 %
~6 %
~8 %
~11 %
~14 %
~17 %
~20 %


SE2
NO3
FI
NO5
NO1
NO2
SE3
EE
LV
SE4
DK1
LT
DK2

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Energy yield assessment for adding 50 MW solar

- 50 MW wind + 50 MW solar
- PVsyst or similar software

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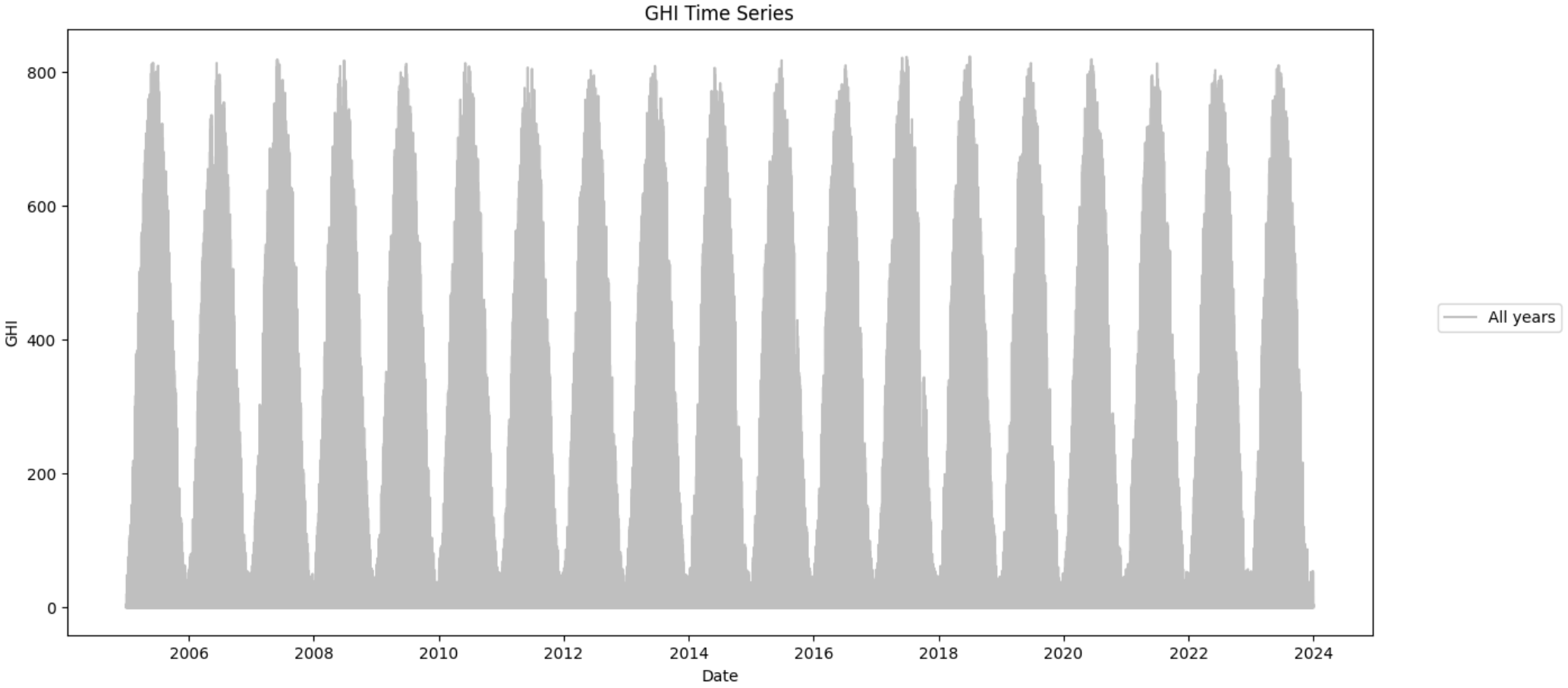
Solar resource time series



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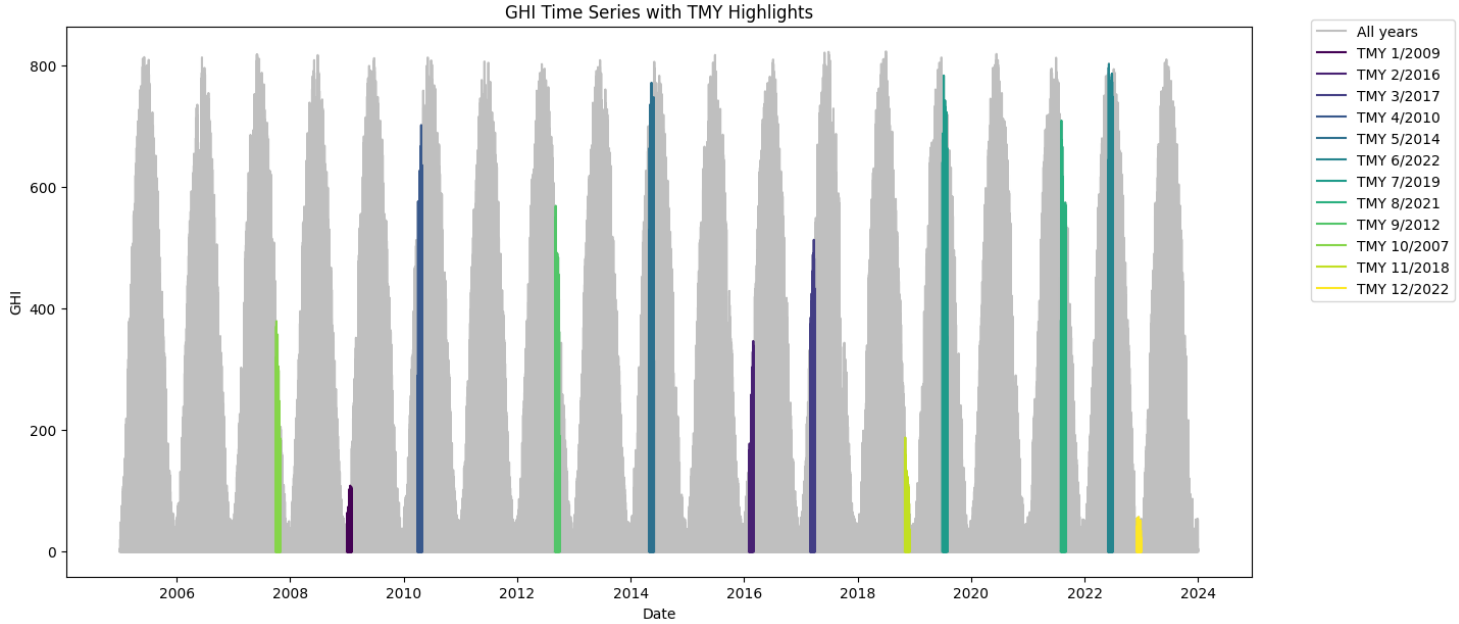
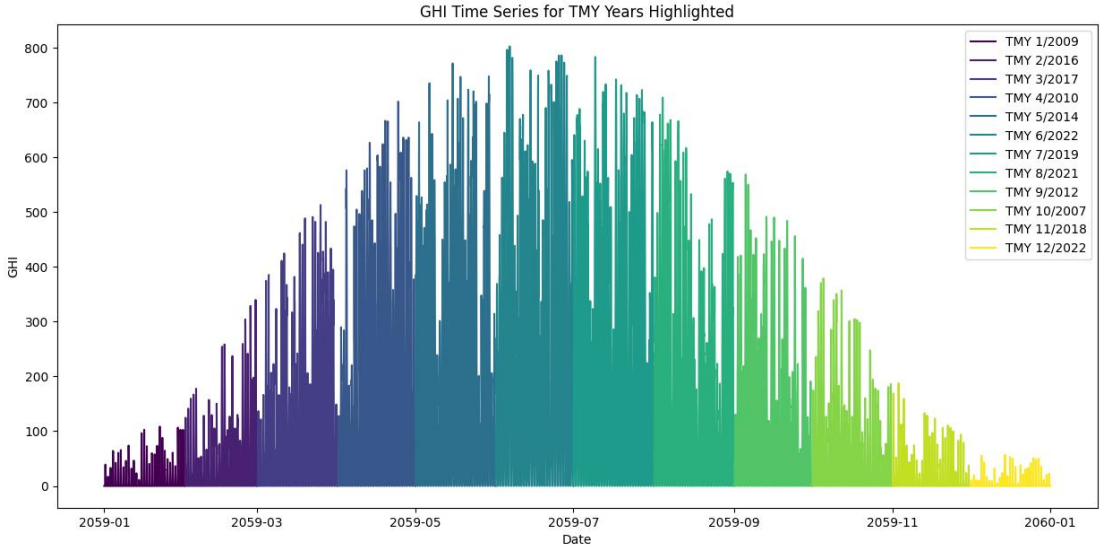
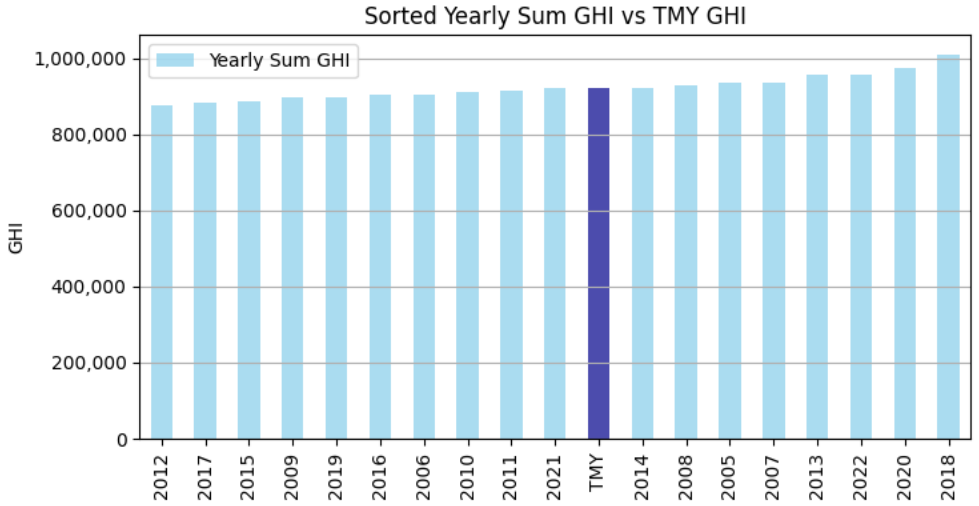
Solar TMY







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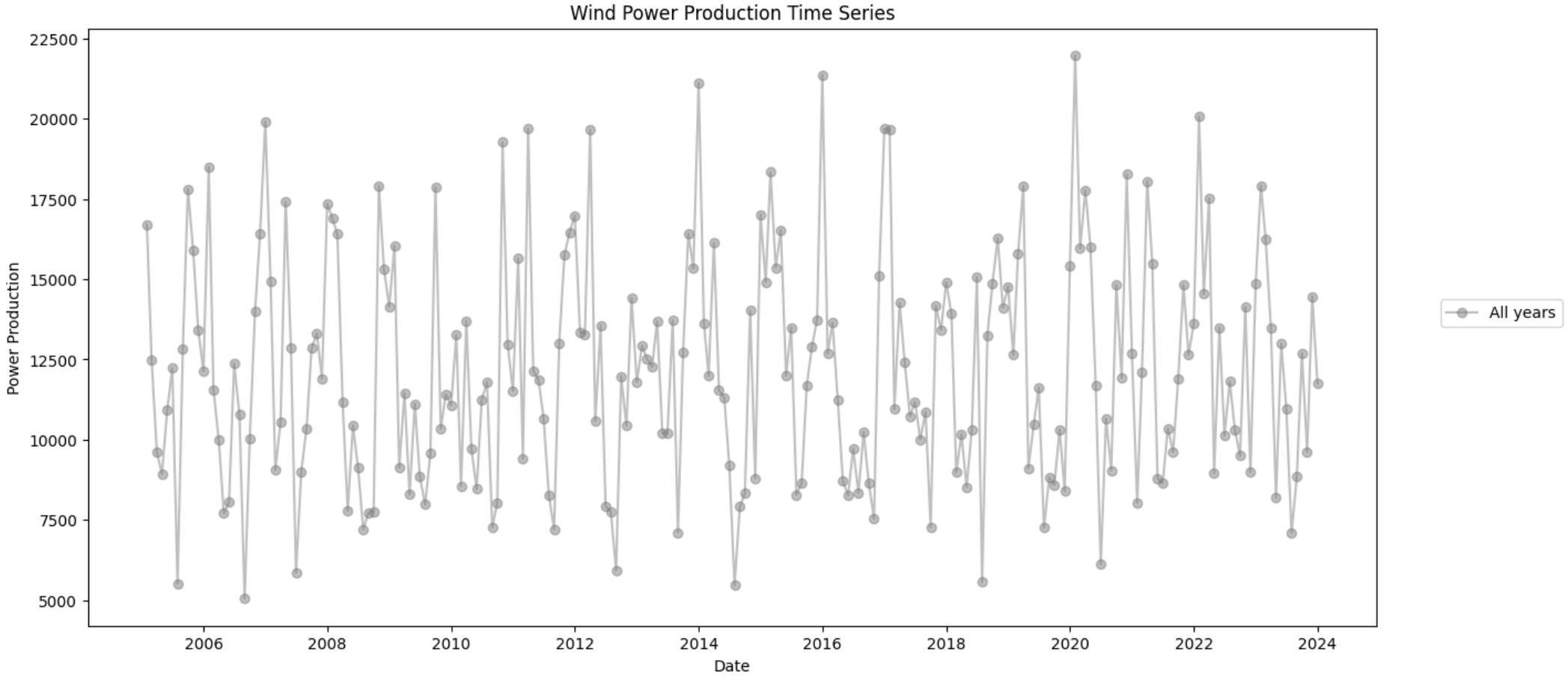
Wind power time series



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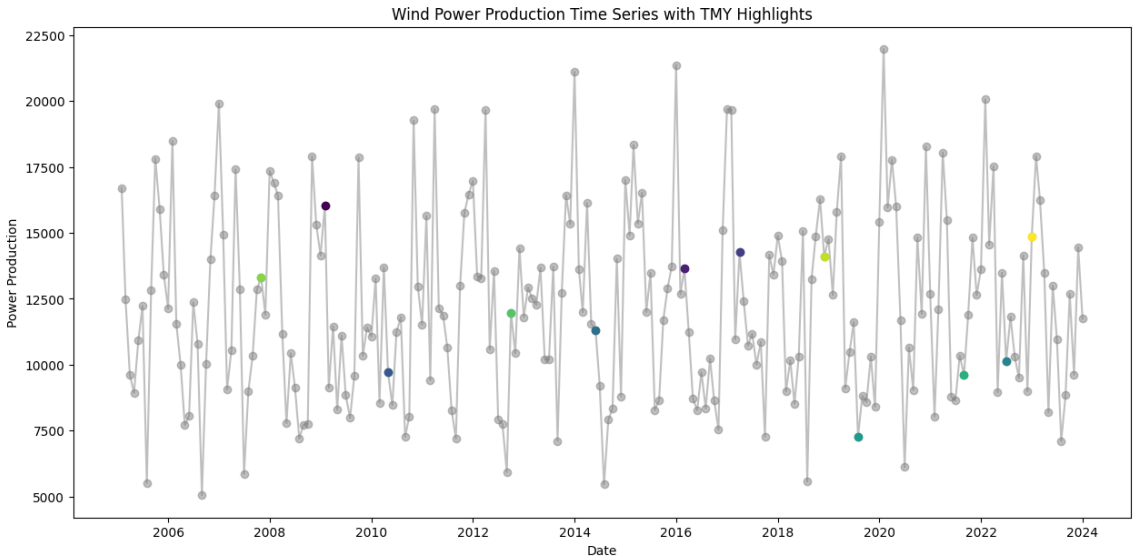
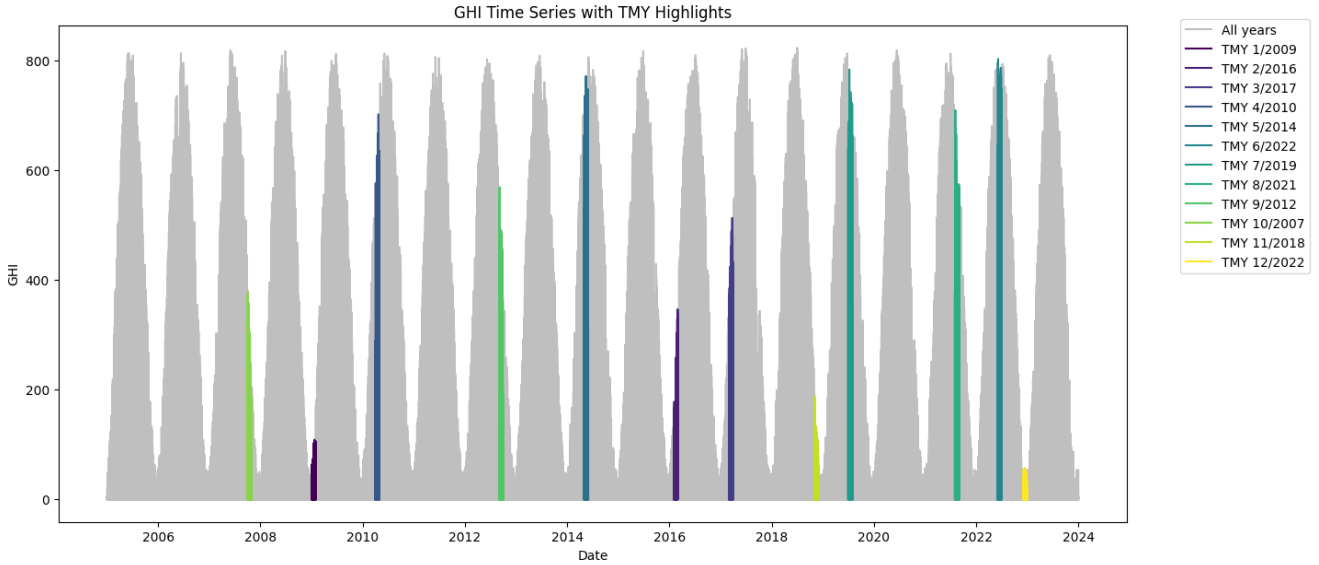
End-game: Common wind and solar TMY





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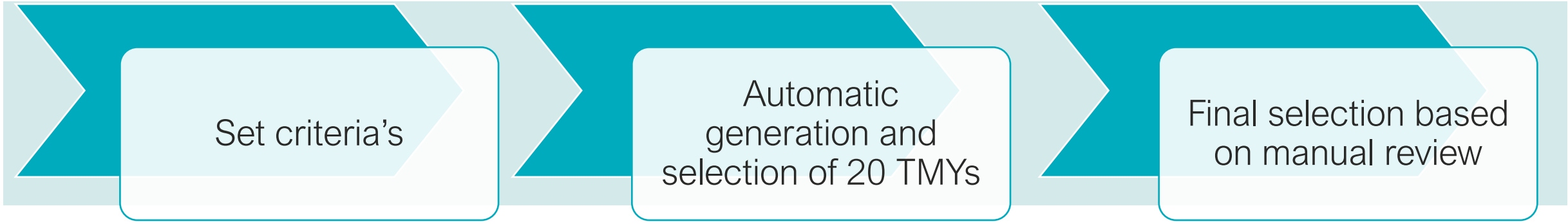
Norconsult hybrid TMY methodology



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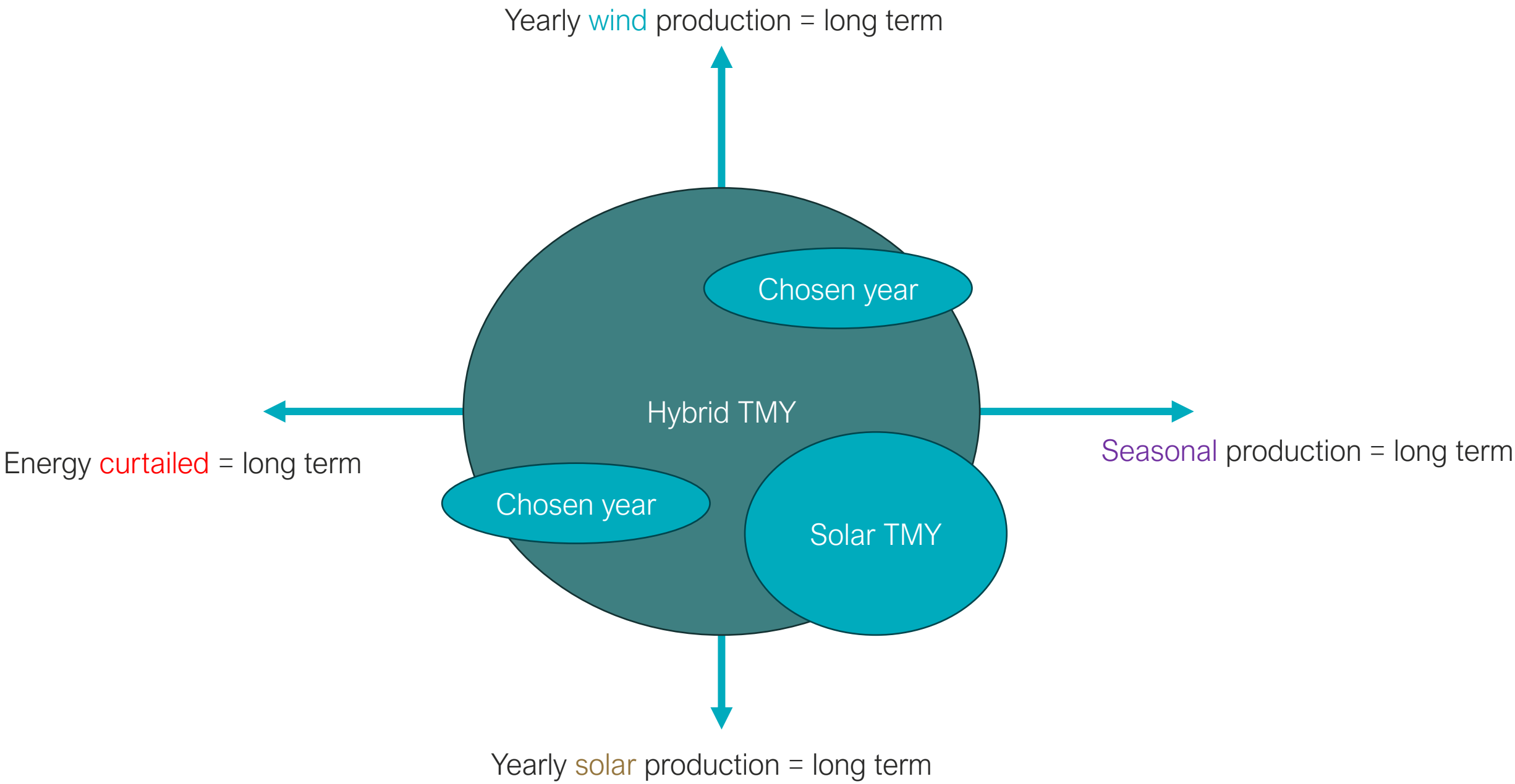
Yearly wind production = long term
Chosen year
Hybrid TMY
Energy curtailed = long term
Seasonal production = long term
Chosen year
Solar TMY
Yearly solar production = long term

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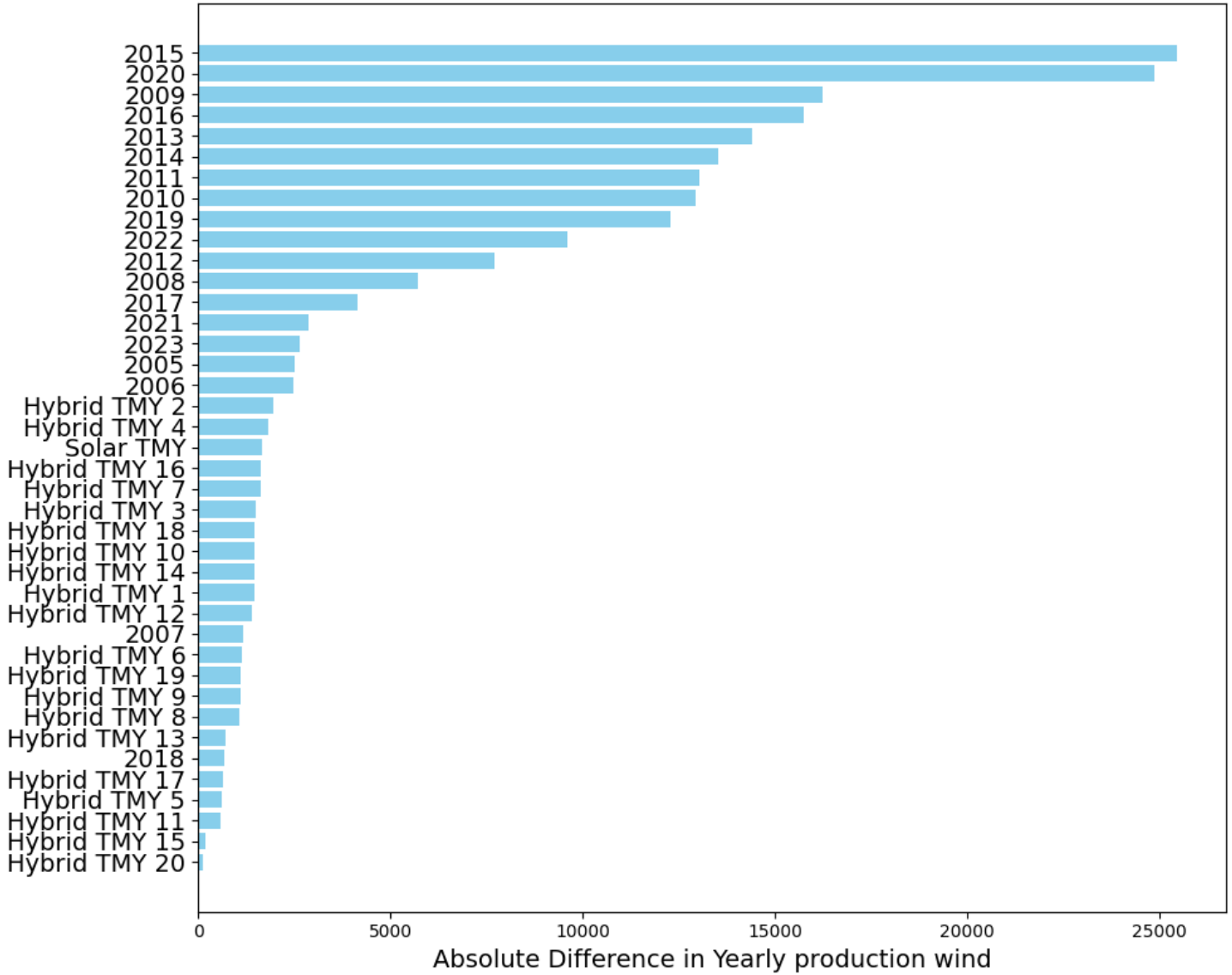
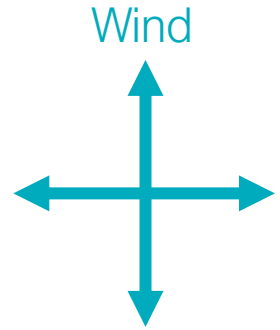
Evaluate possible TMYs based on criteria's

- 20 hybrid TMYs with Norconsult methodology, «Hybrid TMY 1, Hybrid TMY 2»
- 1 Solar TMY based on conventional methodology
- Each of the years in the timeseries from 2005 to 2023

Yearly wind production = long term





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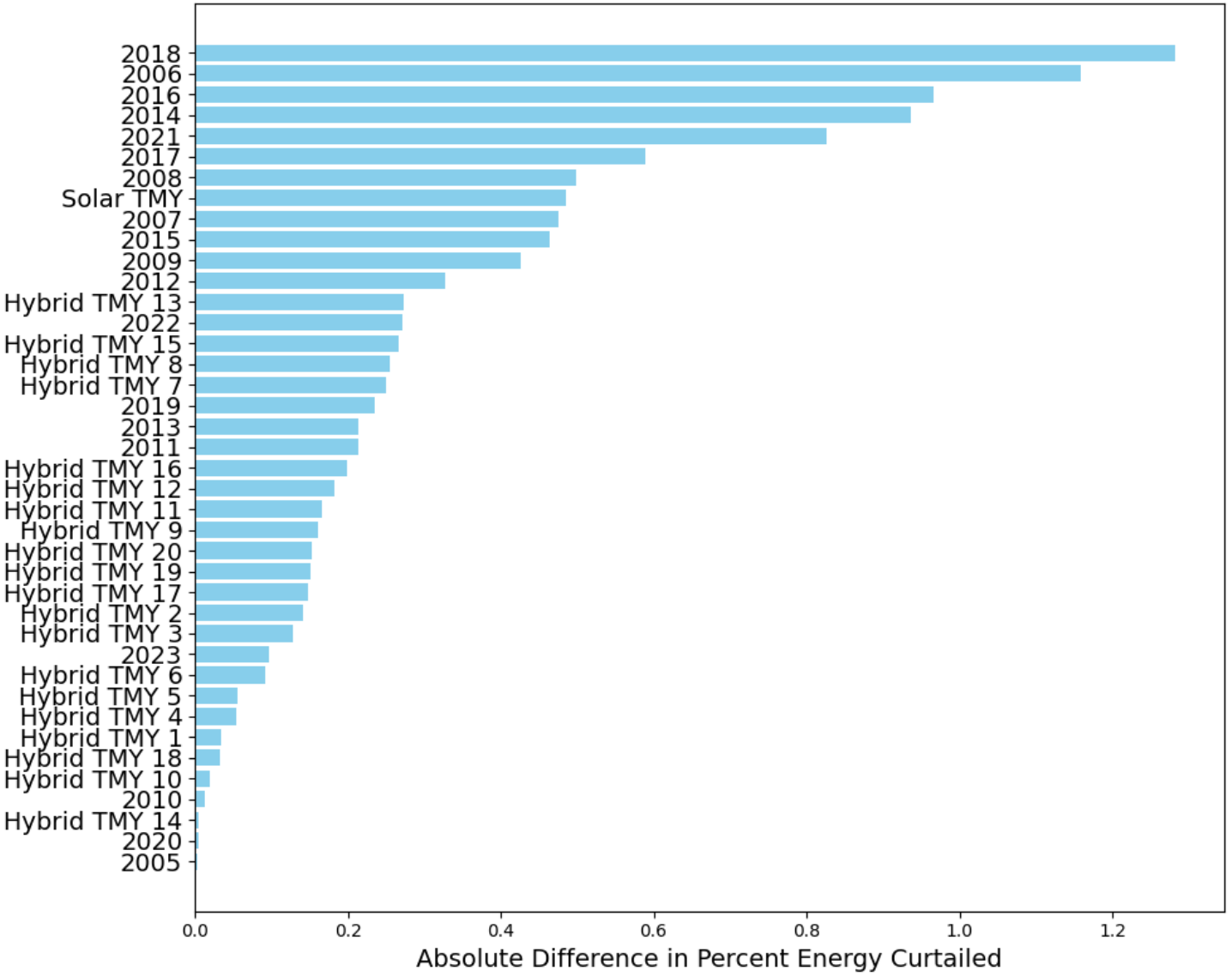
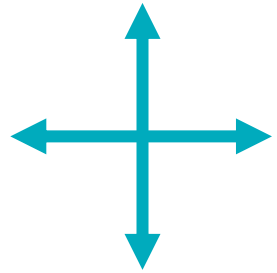
Energy curtailed = long term



Curtailment



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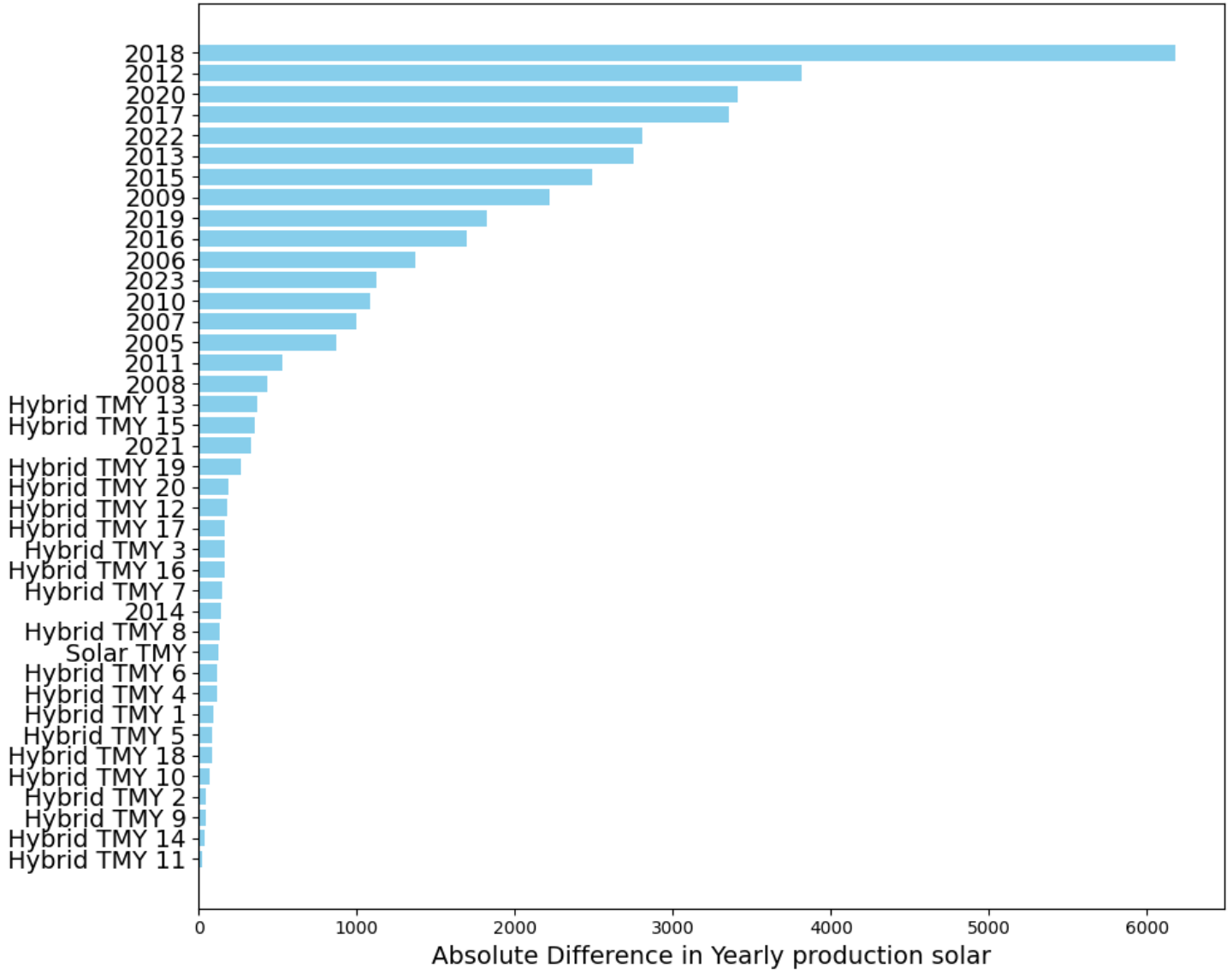
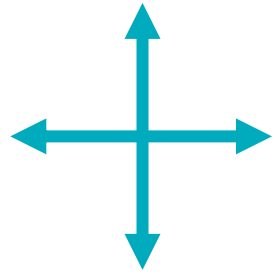
Yearly solar production = long term





Solar

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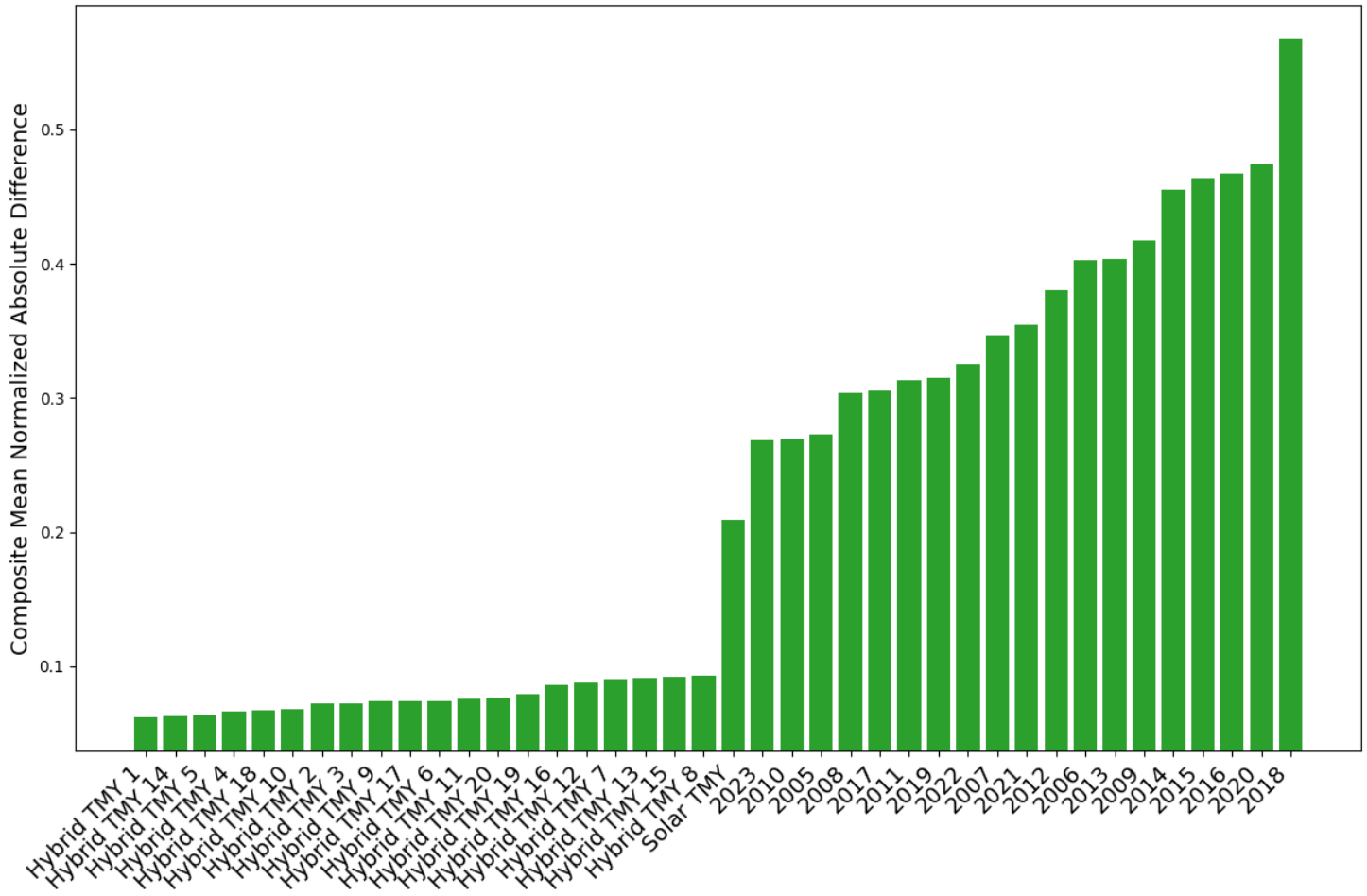
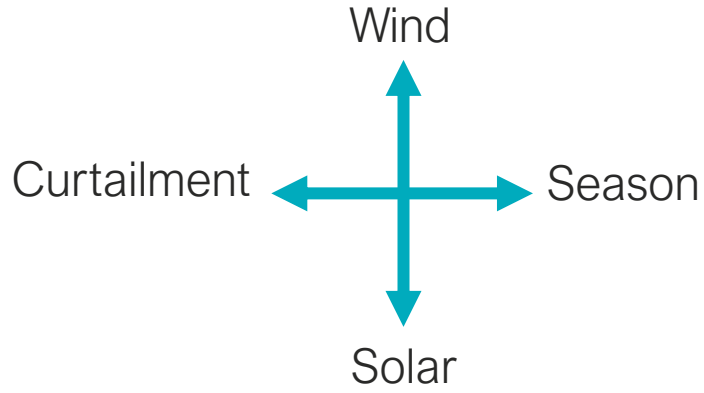
Composite mean





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Ice throw in hybrid wind and solar projects

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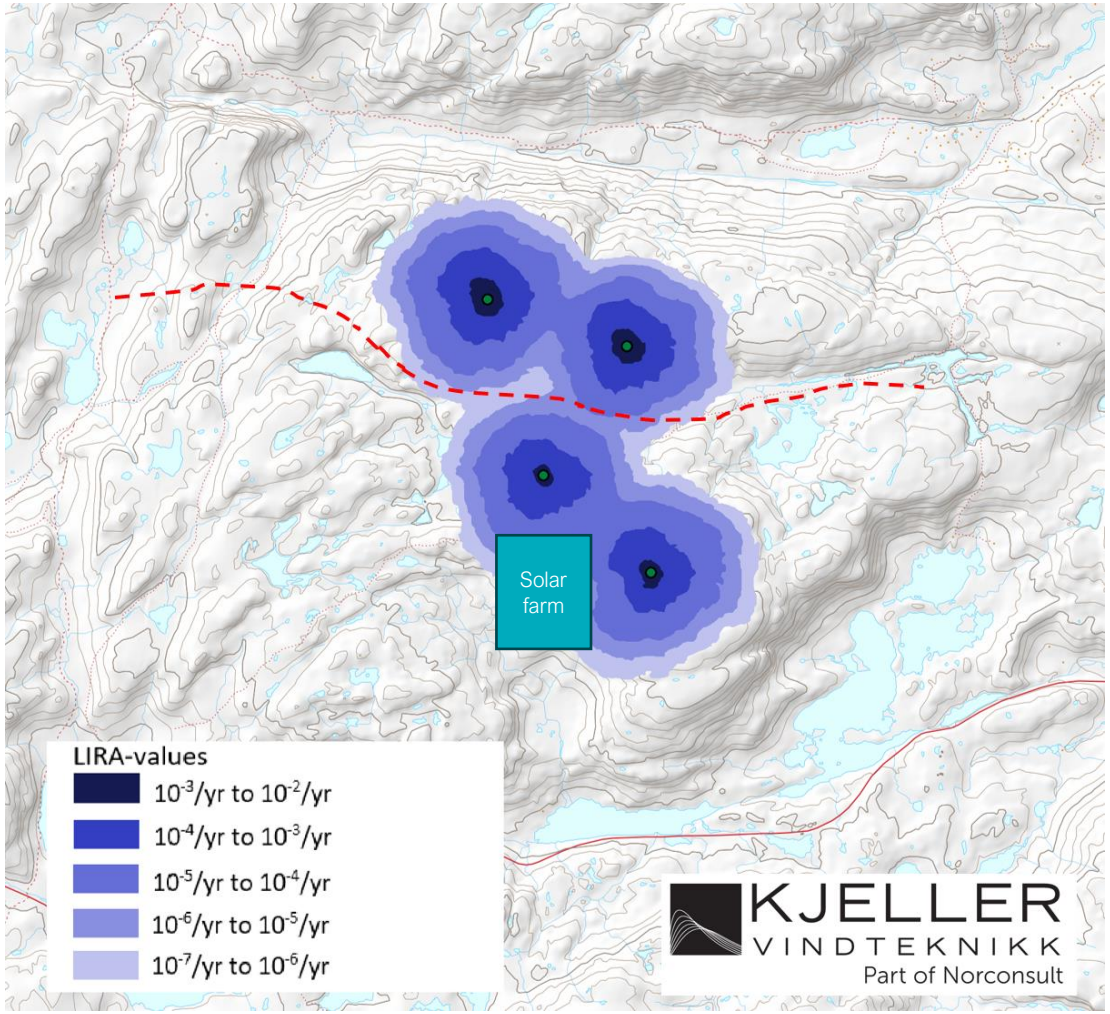
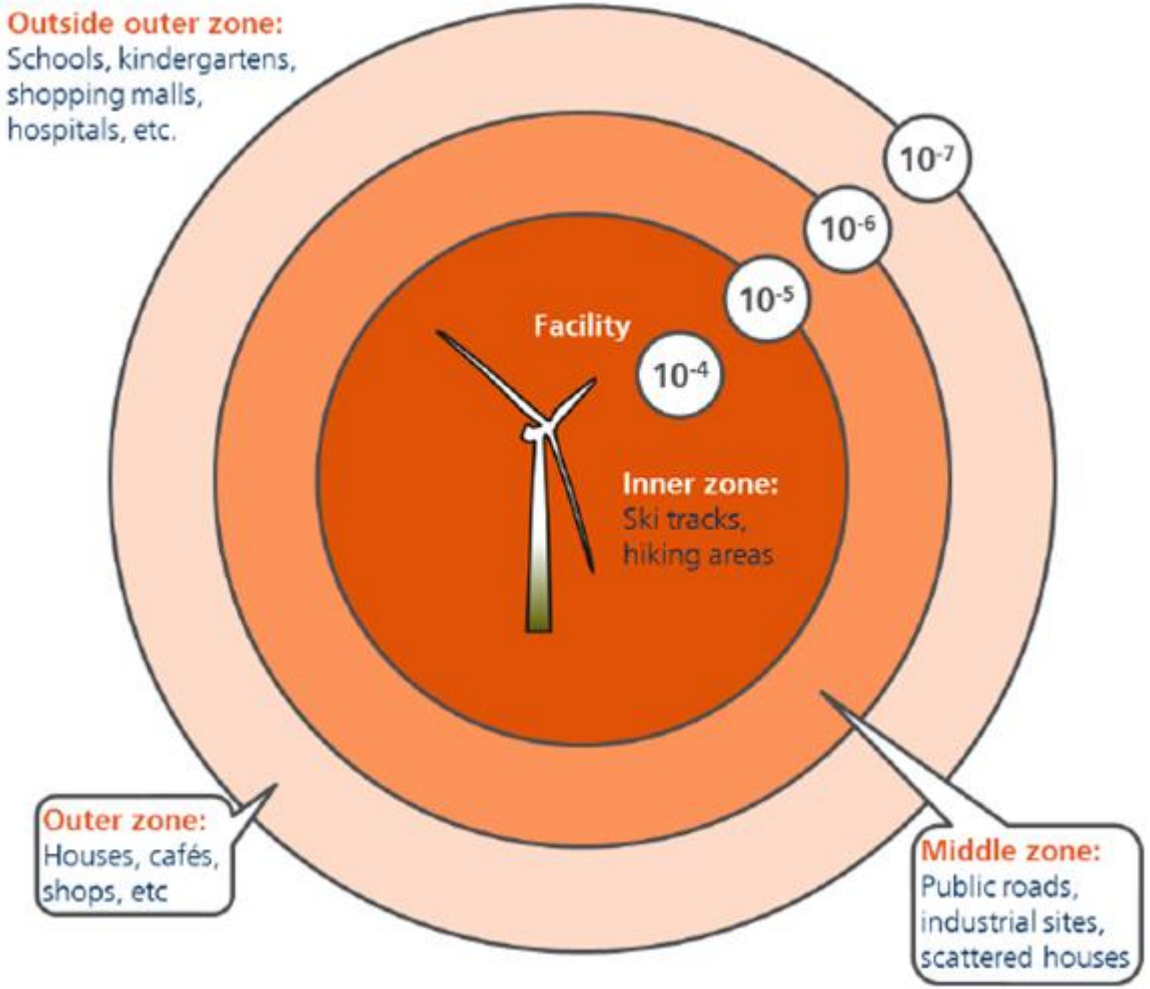
Wind projects and Ice Risk - IceRisk Solar





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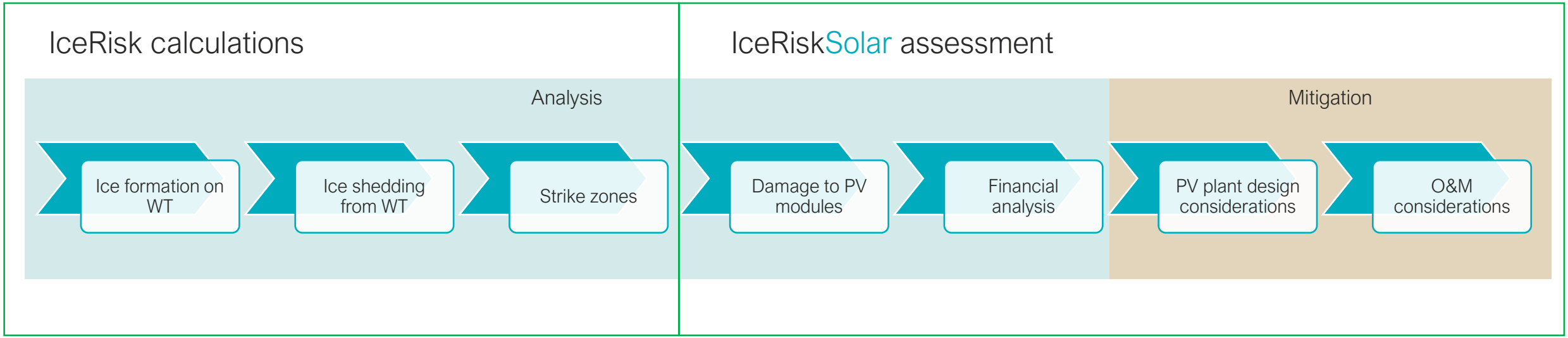
Methodology



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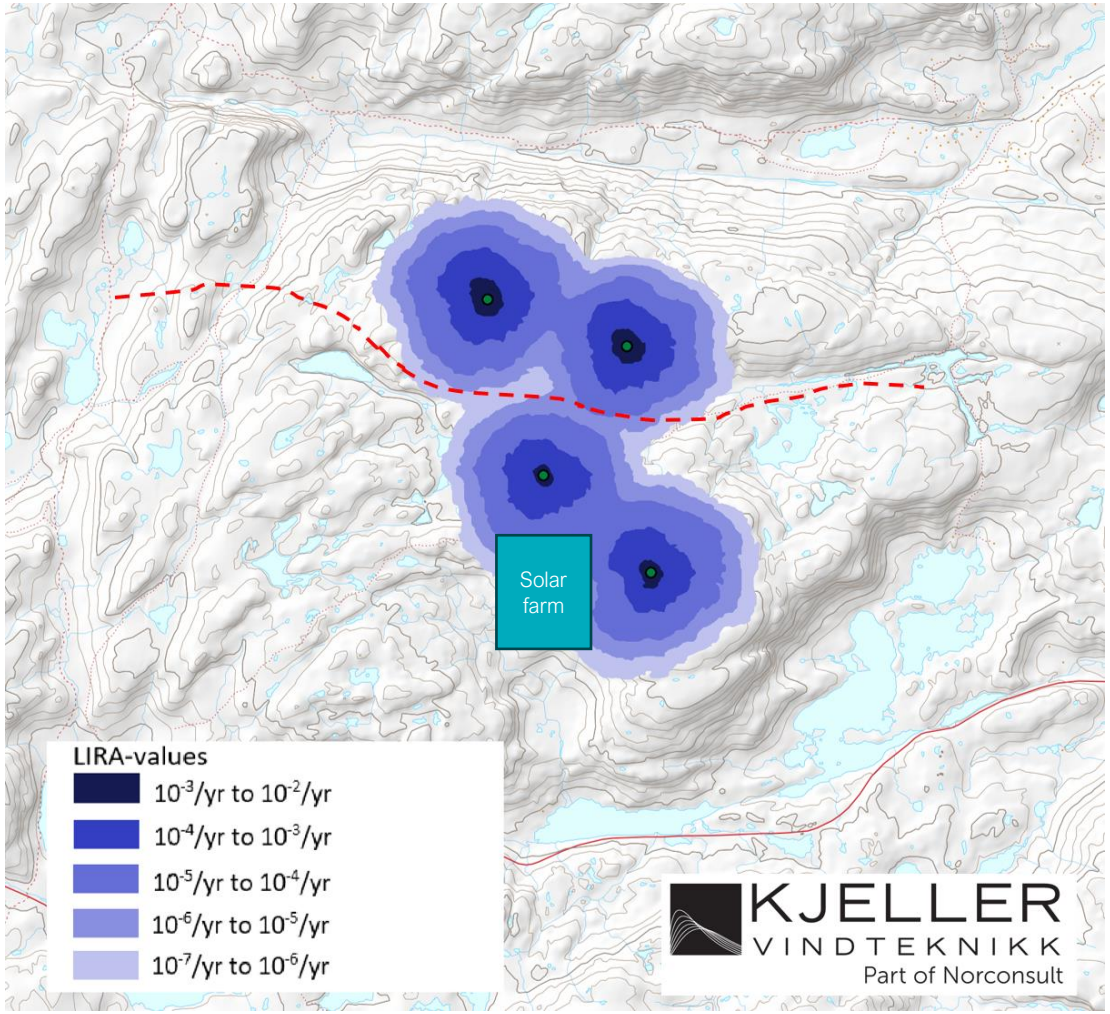
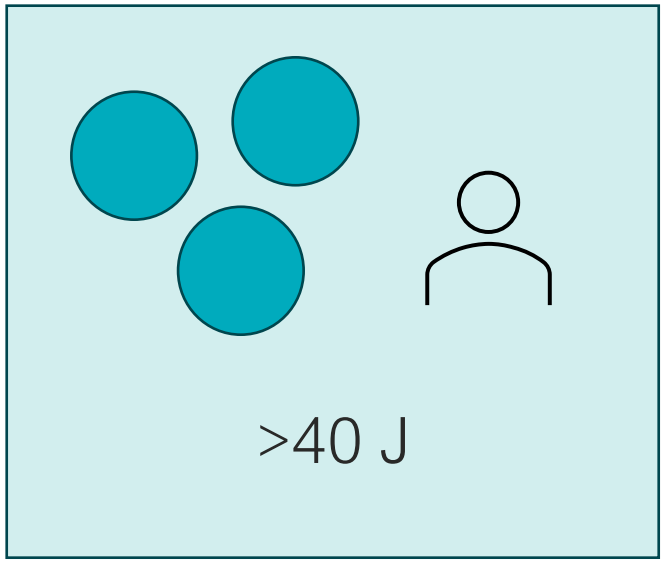
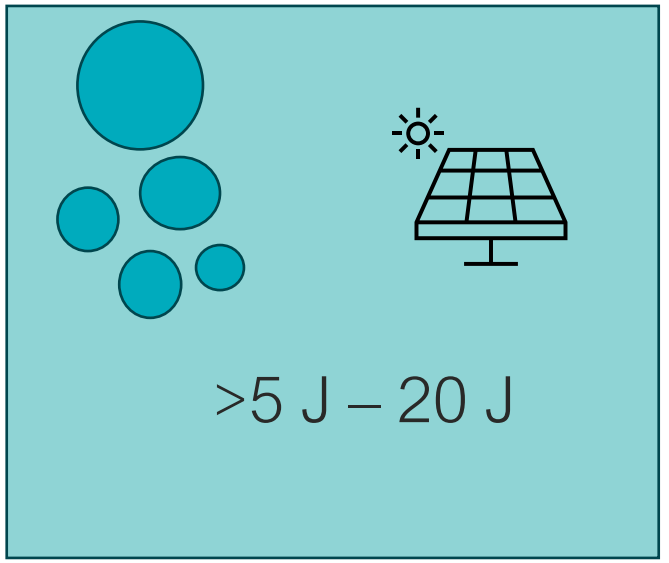
Hybrid solar and wind = IceRisk**Solar**







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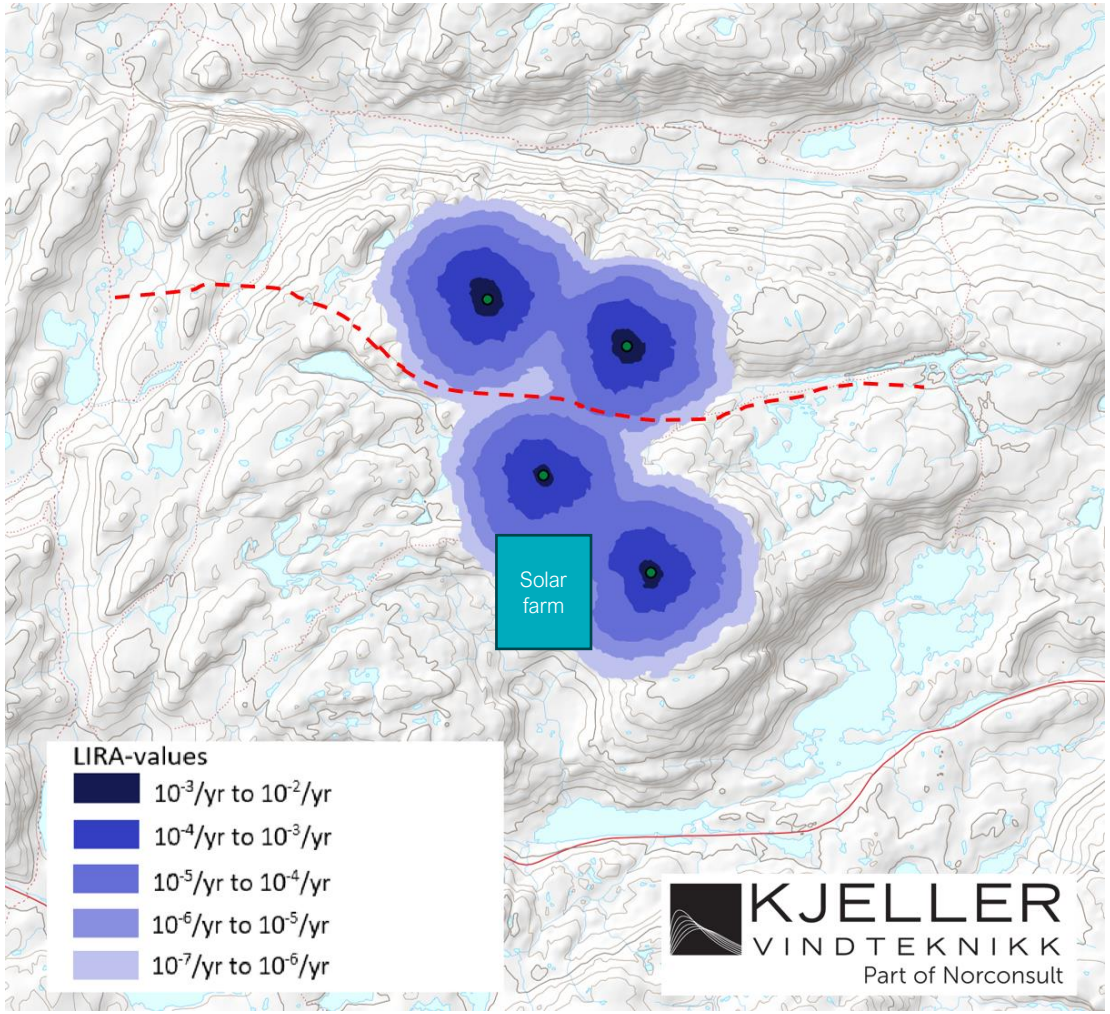
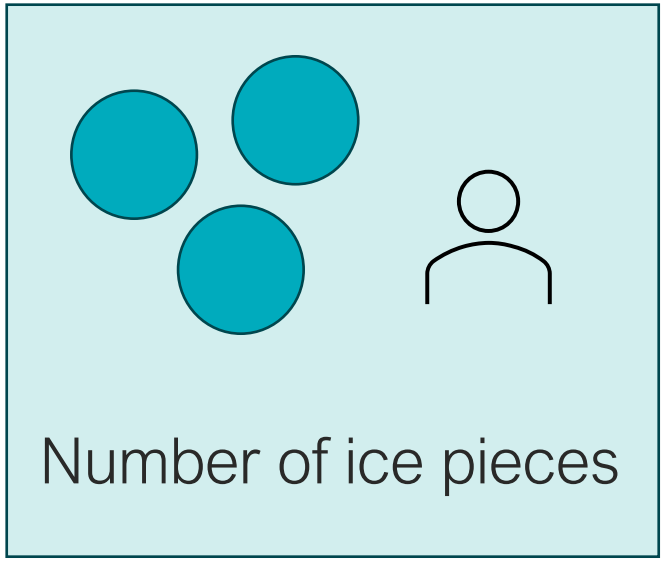
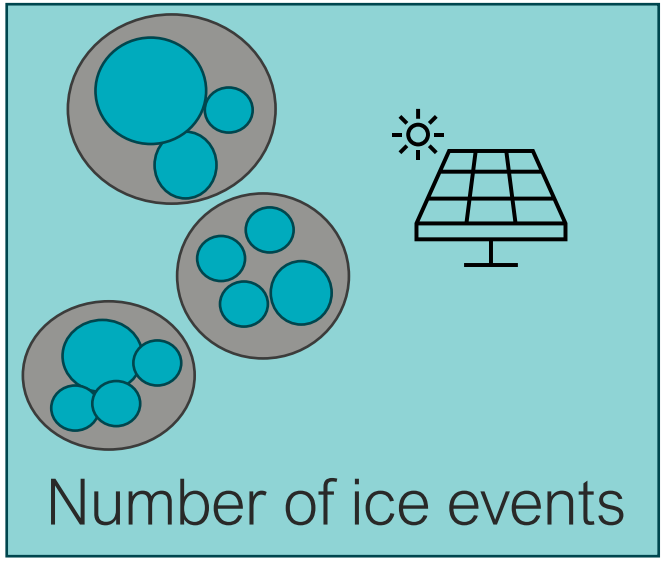
Hybrid solar and wind = IceRisk**Solar**







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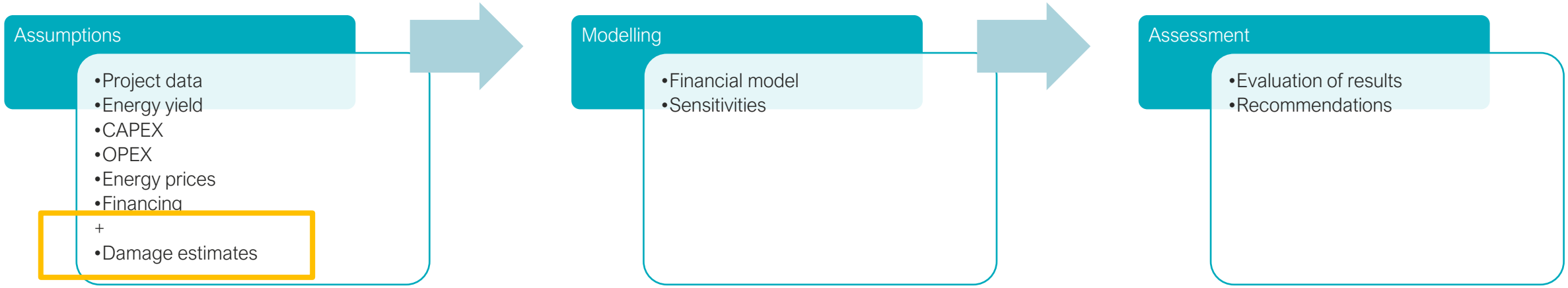
Financial analysis



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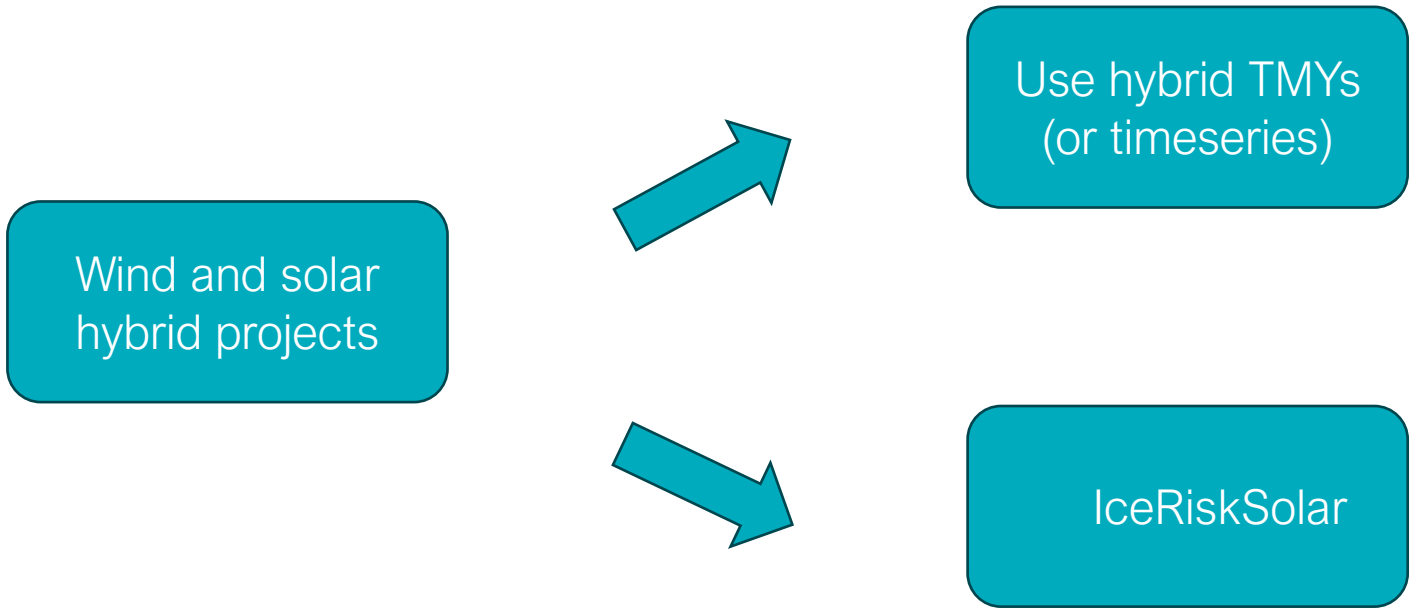
Summary



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Every day we improve everyday life