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# The current and next phases of AIM global modelling
## - considering climate change and other environmental conventions -

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AIM ASIA-PACIFIC INTEGRATED MODEL

NIES JAPAN

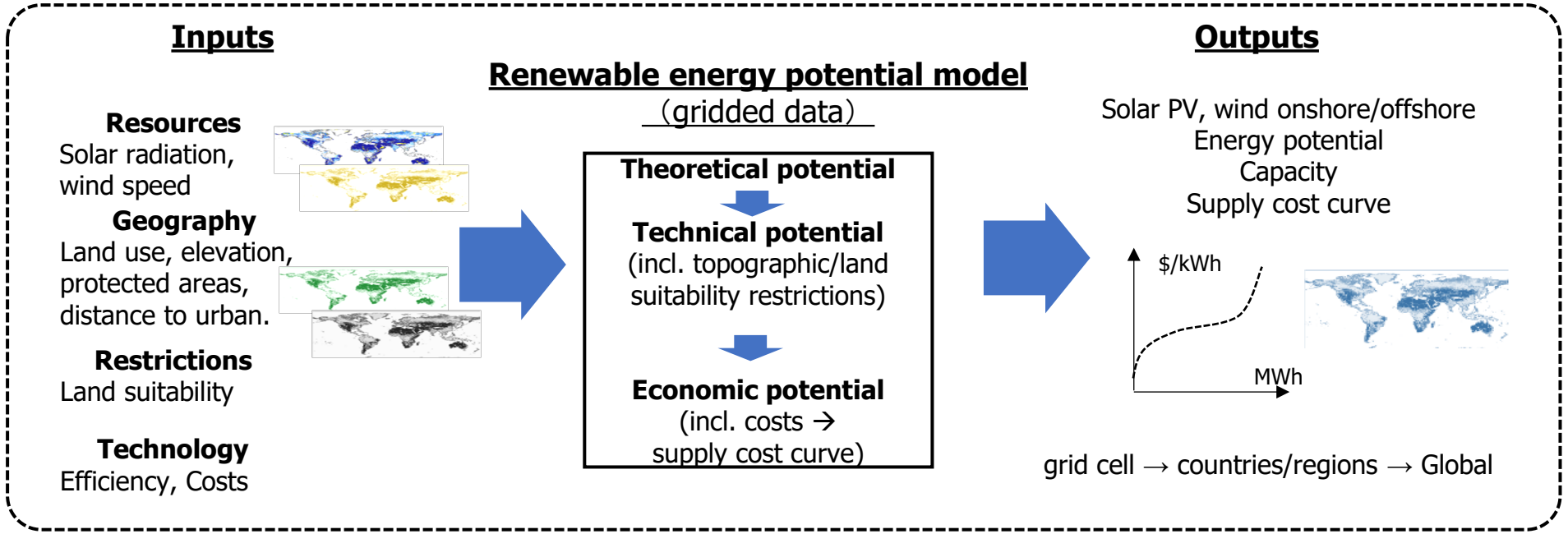
# Topics

1. Global Renewable Energy Modeling
   ~ the current and next phases ~

2. Ongoing discussion on global researches including AIM in the next Five-Year plan of NIES

# Global Renewable Energy Assessment

- Purpose
  - Assess the availability of renewable energy at the global scale: focus on solar and wind energy.
  - Provide insights on the regional distribution and supply costs of renewable energy resources.
  - Assess the effect of constraints and uncertainties on the availability of renewable energy.
- Model
  - Global model based on geo-referenced data (gridded) combining climate, topographic, land cover and other relevant factors.
  - High detail: spatial resolution 0.25 arc-degrees (~28 km), hourly.



# Global Renewable Energy Assessment

## ～ Cumulative global technical potential by capacity factor grades, and spatial distribution～

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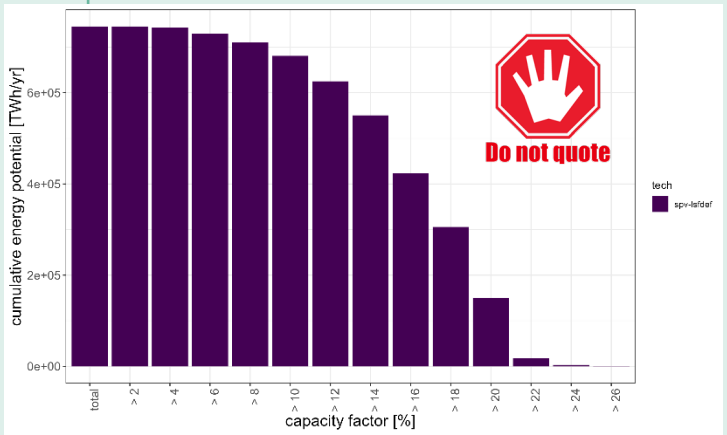
### Solar PV


Spatial distribution of the energy potential [TWh/yr].




Cumulative global energy potential by capacity factor grades.

- High-grade energy potential (capacity factor >20%) is 20% of the total.
- Large potential in Africa, Middle East, Central Asia and Oceania.

### Wind: onshore

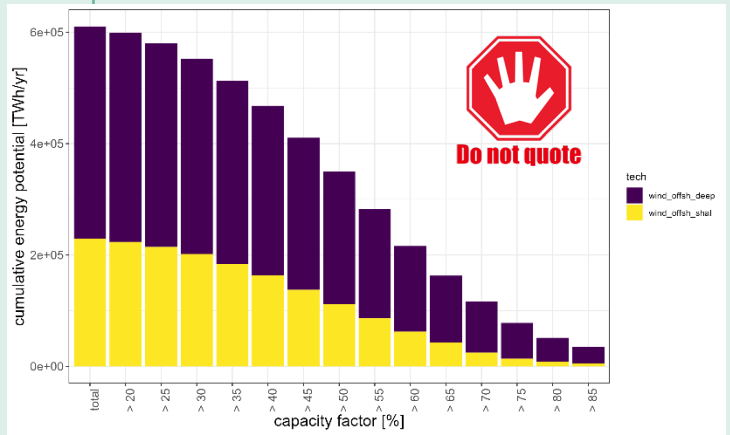

Spatial distribution of the energy potential [TWh/yr].


Cumulative global energy potential by capacity factor grades.

- High-grade energy potential (capacity factor >32%) is 7% of the total.
- Large potential in Africa, Middle East, Central Asia, Oceania, Latin America, USA and China.

### Wind: offshore


Spatial distribution of the energy potential as capacity factor [%].




Cumulative global energy potential by capacity factor grades.

- High-grade energy potential (capacity factor >40%) is 77% of the total.
- Large potential in EU, Central Asia, Canada, Oceania, Latin America, USA and Southeast Asia.

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# Global Renewable Energy Assessment

## ~ Technical potential under combined effects of topographic and land suitability restrictions ~

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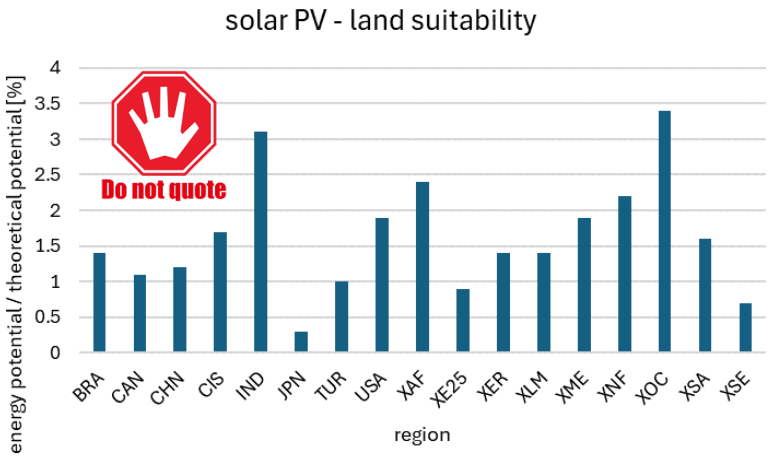
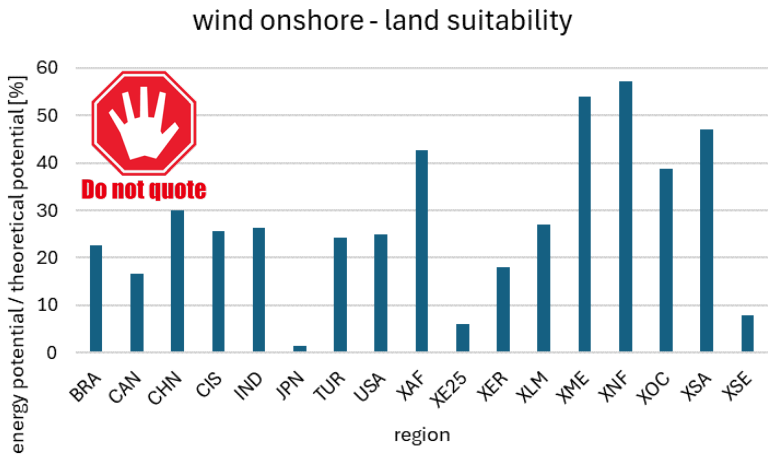
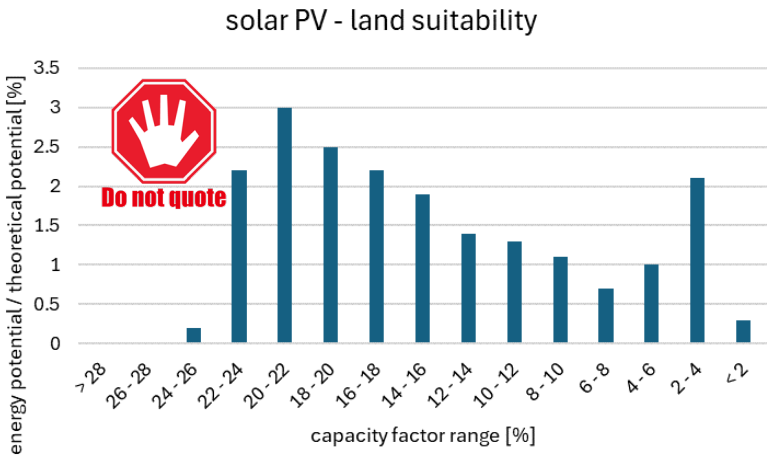
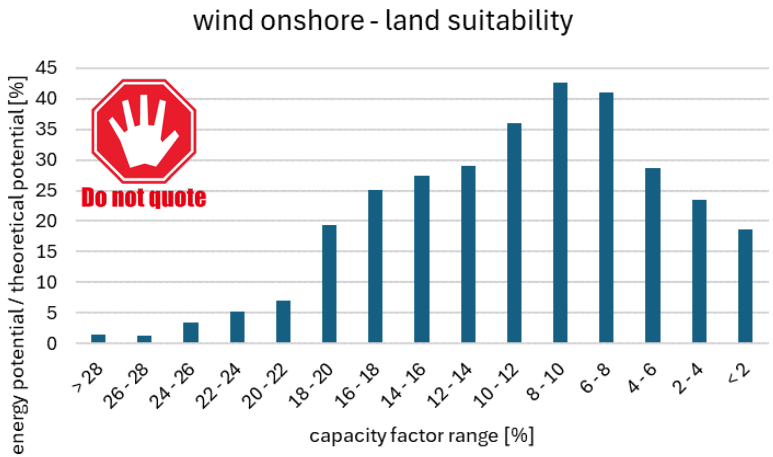
technical potential as fraction of the theoretical potential (%)

| | Solar PV | Wind: onshore |
|---|---|---|
| by region |  |  |
| by capacity factor ranges |  |  |









- Restrictions reduce the global solar PV potential by 98%, major effect in Japan, EU, Southeast Asia; grades of low capacity factor.
- Global onshore wind potential decreases by 70%; major effect in Japan, EU, Southeast Asia, grades with high capacity factor.

# Global Renewable Energy Assessment

## ~ Economic potential in the world: supply-cost curves for solar PV, onshore wind ~

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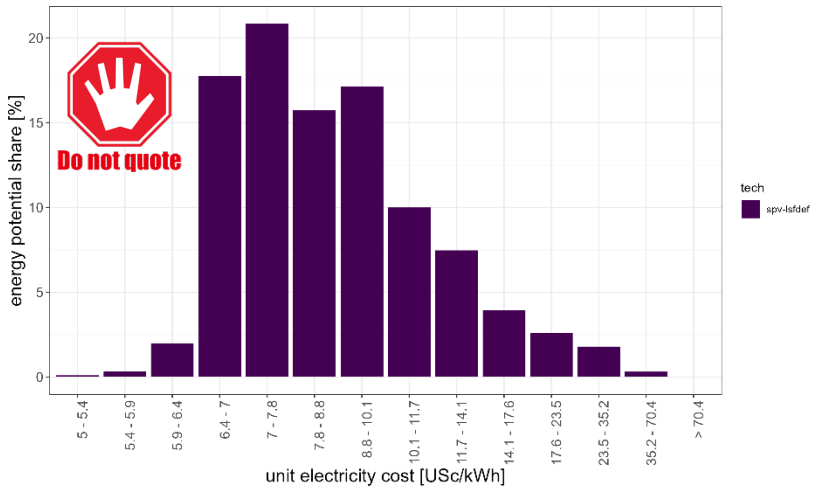
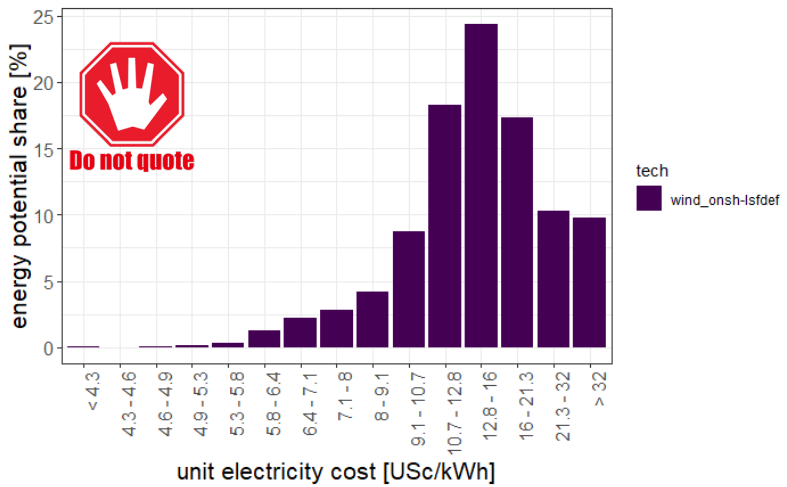
| | Solar PV | Wind: onshore |
|---|---|---|
| Potential share by unit cost |  |  |
| Cumulative potential cost curve | | |





- Solar PV economic potential mostly between 6~12 USc/kWh, 550.5 PWh/yr below 10 USc/kWh.
- Wind onshore economic potential mostly between 11~21 USc/kWh, 81 PWh/yr below USc/kWh.

# Global Renewable Energy Assessment

## ～ Economic potential by region: supply-cost curves for solar PV, onshore wind ～

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Solar PV

Wind: onshore

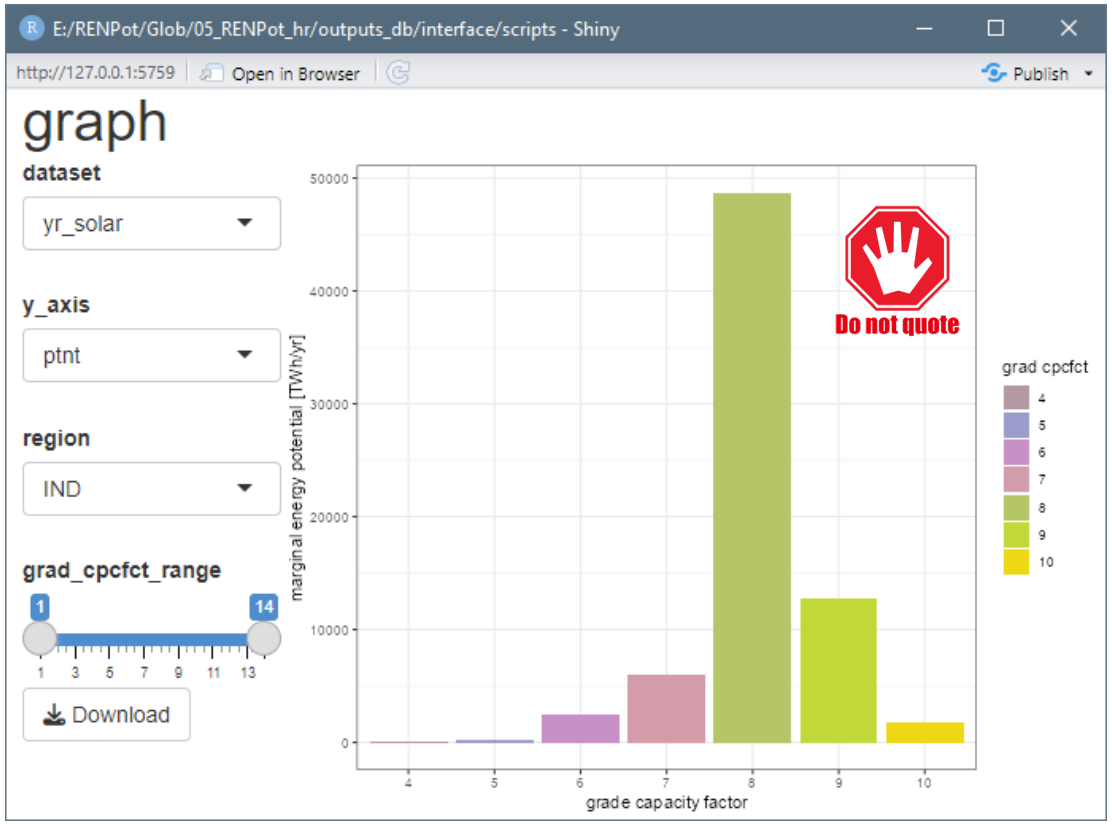
- Solar PV potential available in large amounts at almost all regions.
- Wind onshore potential is less available than solar PV, large amounts at Australia, Canada, Russia, USA, Africa (XAF), Central Asia (XCS).

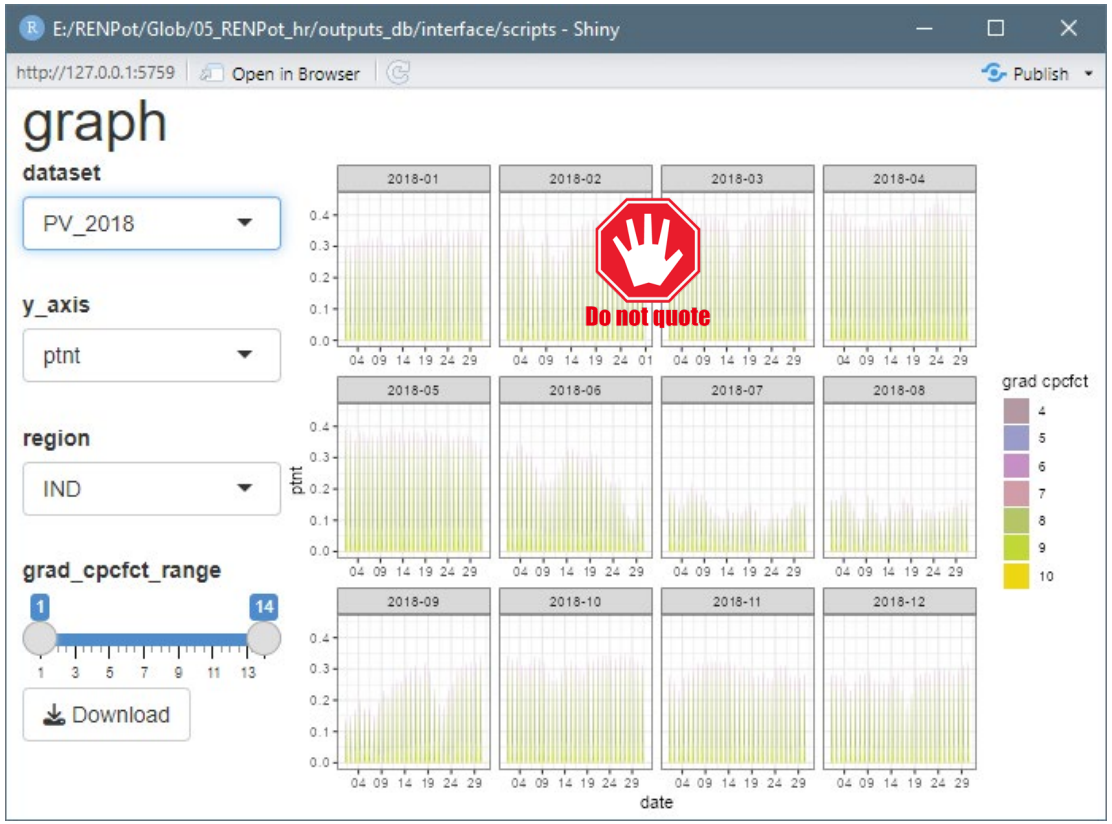
* Regions without values (Solar PV: KOR, Wind onshore: MYS, THA) due to availability of potential at one single grade of unit supply cost or only at the lowest grade (lowest capacity factor).

# Global Renewable Energy Assessment

## ～ Dashboard of renewable energy database ～






- Interactive interface to select, display and download output data from the model.
- Currently under revision, based on both annual and hourly output data by country.

# Global Renewable Energy Assessment

## ～ New onshore wind technology: Airborne wind energy system (AWES) ～

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Assessment of the global theoretical and technical energy potentials of onshore airborne wind energy systems

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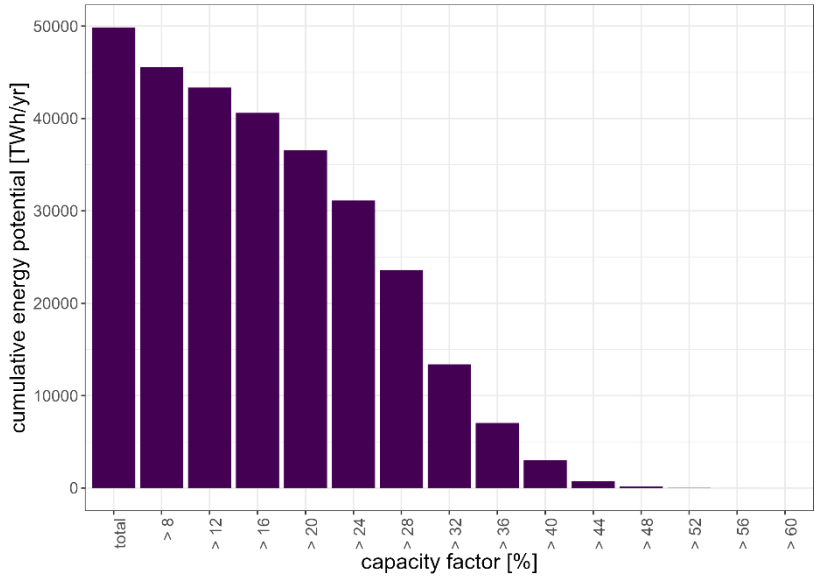
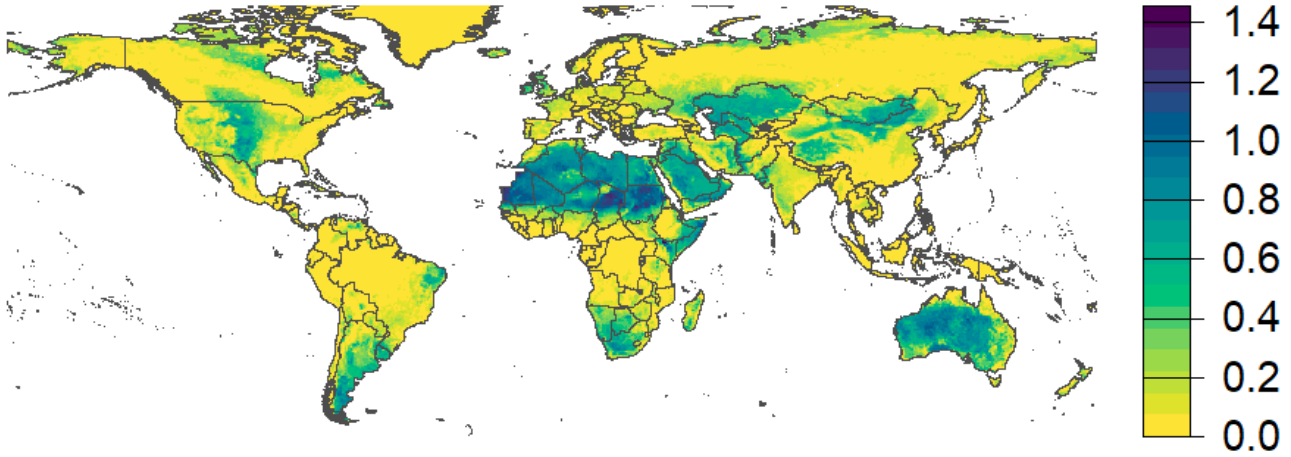
Airborne wind energy system in operation (SkySails PN-14). SkySails Power. https://skysails-power.com/wp-content/uploads/sites/6/2022/09/SkySailsPower_Flyer_SKS_PN_14.pdf




Cumulative global technical energy potential by capacity factor grades




Annual energy potential of onshore AWES (TWh/y)

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# Global Renewable Energy Assessment
## ～ Future Research Directions ～

1. **Refinement of the current model**
   - ☐ including additional restrictions: distance to roads and electricity network
     (Note: the constraints currently being considered are “solar radiation”, “wind speed”, “land use type”, “elevation”, “land suitability”, “technology efficiency and cost”, “distance to urban”)
   - ☐ Increasing temporal coverage: from 1 year to ~ 10 years

2. **Expansion of the scope of analysis**
   - ☐ Sensitivity analysis of key elements: technology performance and costs, land suitability
   - ☐ Effects of specific constraints: distance to infrastructure, protected area

3. **Expansion of the scope of technologies**
   - ☐ Airborne wind energy: offshore applications
   - ☐ Floating solar PV
   - ☐ Green hydrogen (including green ammonia)
   - ☐ Agro-photovoltaics

4. **Linkages between climate change convention and other environmental conventions**
   - ☐ Consideration of expanding protected areas for nature conservation and biodiversity
   - ☐ Effects of circular economy (especially PV recycling)

# Ongoing discussion on global researches including AIM in the next Five-Year plan of NIES

# International Environmental Conventions and Action Plans

One of the roles of global models is to indicate broad directions toward achieving internationally agreed targets.
(In-depth and country-specific contexts are more appropriately addressed by national and sectoral models)

Research areas covered by special research program

Research areas covered by AIM and NIES

| | Protocol / agreement | By when? | What goals & visions we must achieve globally ? |
|---|---|---|---|
| **Climate change convention** | Kyoto protocol<br>Paris agreement | Immediately<br>2050 – 2055<br>2095 – 2100 | Peak out GHG emissions<br>Global $CO_2$ net zero<br>Global GHG net zero |
| **Biological diversity convention** | Nagoya protocol<br>Cartagena protocol | 2030<br><br>2050 | Conserve 30% of land and marine areas<br>Restore 30% of degraded terrestrial and marine ecosystems<br>Restore nature & reduce extinction risk of all species by 90% |
| **Circular economy action plan (incl plastics treaty)** | | | (Under discussions) |
| **Transboundary air pollution convention** | Sofia protocol<br>Helsinki Protocol<br>Gothenburg Protocol etc | –<br>2040 | Achieving WHO Air Quality Standards<br>Halving the health impacts of air pollution (relative to 2015) |
| **Nitrogen management action plan** | | –<br>2030 | National Action Plan for Sustainable Nitrogen Management<br>Halving global nitrogen waste |
| **Minamata convention on mercury** | | | (Under discussions) |
| **~~~** | | | |

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## Timing is important!

Thank you for your attention!