



## **Germany's Renewable Energy potential:**

*A geospatial analysis of limiting factors and necessary measures on the path to mid-and long-term renewables targets*

Study abstract – May 2020

# Executive Summary

## 1 Germany has a geo-technical supply potential from wind and solar of close to 1800 TWh/a in 2040, about three times its current power demand

- Solar PV: Biggest potential with ~1000 TWh/a, Levelized Cost of Electricity (LCOE) are competitive and do not vary much by location
- Wind onshore: Potential of ~ 420 TWh/a, with steepest increase in LCOE across location, meaning site quality will increasingly matter
- Wind offshore: Potential of up to ~350 TWh/a

## 2 The economic renewable potential in 2040 including merchant capacities reaches a maximum of about 30 - 40% of the geo-technical potential

- Availability of sites does not remove cannibalisation risk for renewables
- Good quality onshore sites become a scarce resource under merchant buildout with low cost of capital

## 3 Reaching mid- and long-term renewable targets will likely require a shift to solar and wind offshore

- External studies suggest distance rules may constrain potential for wind onshore in an extreme scenario to ~10% - 40% of the geo-technical potential
- If onshore bottlenecks remain in place, reaching 65% RES target in 2030 would require a challenging 9 - 11 GW of solar additions per year
- To achieve Net Zero in 2050, onshore bottlenecks can be offset by higher wind offshore and solar PV buildout

# Study focus: Potential of renewable energy sources (RES) in Germany and technology-specific market barriers

Our analysis  
provides answers  
to three key  
questions

## Geo-technical RES potential

**1** How large is the geo-technical RES potential in Germany for solar PV, onshore and offshore wind?

## Economic RES potential

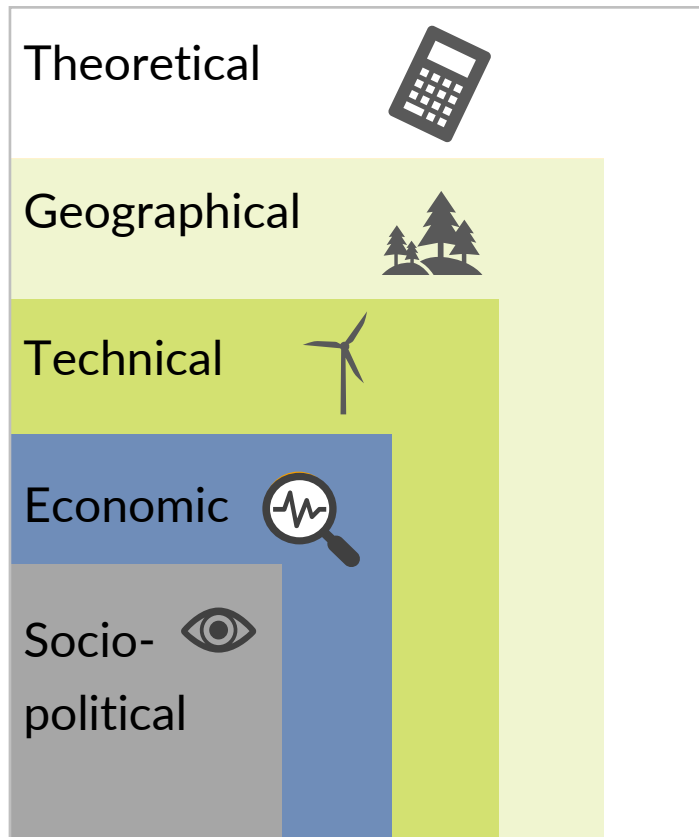
**2** What sets the limit for the economic RES potential – cannibalization or site availability?

## Barriers & the road towards 2050

**3** Can the 65% RES target in 2030 and Net Zero in 2050 be reached despite social-political barriers?

# Several factors have to be taken into account to calculate the actual usable potential of RES

## Renewable potential concepts



## Definition

Total physical energy potential

Potential on available land area

Potential given technical requirements

Potential considering economical and market factors

Potential given social acceptance, political processes & administrative hurdles

## Important constraints

- Land area
- Natural resources

- Protected zones
- Infrastructure, buildings
- Slope, elevation

- Spacing requirement
- Wake effects
- Conversion efficiency

- CAPEX & OPEX
- WACC
- Capture prices

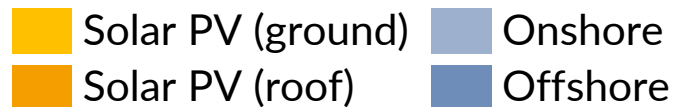
- Minimum distance rules
- Public acceptance
- Planning and grid expansion
- Administrative processes

# Current geo-technical potential of solar PV, onshore and offshore wind is 1211 TWh/a, 46% increase until 2040

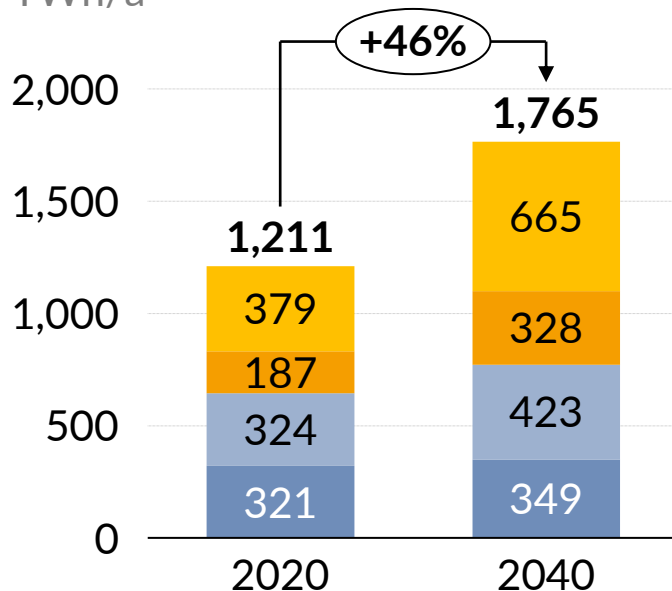


## Geo-technical RES potential

1 How large is the geo-technical RES potential in Germany for solar PV, onshore and offshore wind?



Generation potential,  
TWh/a



### Takeaways

- Solar PV, onshore and offshore wind currently have a geo-technical potential of 1211 TWh/a
- 46% potential increases until 2040 mostly due to
  - increase in module efficiency (solar PV)
  - higher turbine ratings & better turbine design (offshore and onshore wind)
- LCOE vary greatly between sites and technologies:
  - Onshore wind has the steepest LCOE curve due to large variation in full load hours
  - LCOE for solar PV are rather similar across Germany

# Cannibalization of capture prices - not site availability - limits the economic potential of renewables in Germany

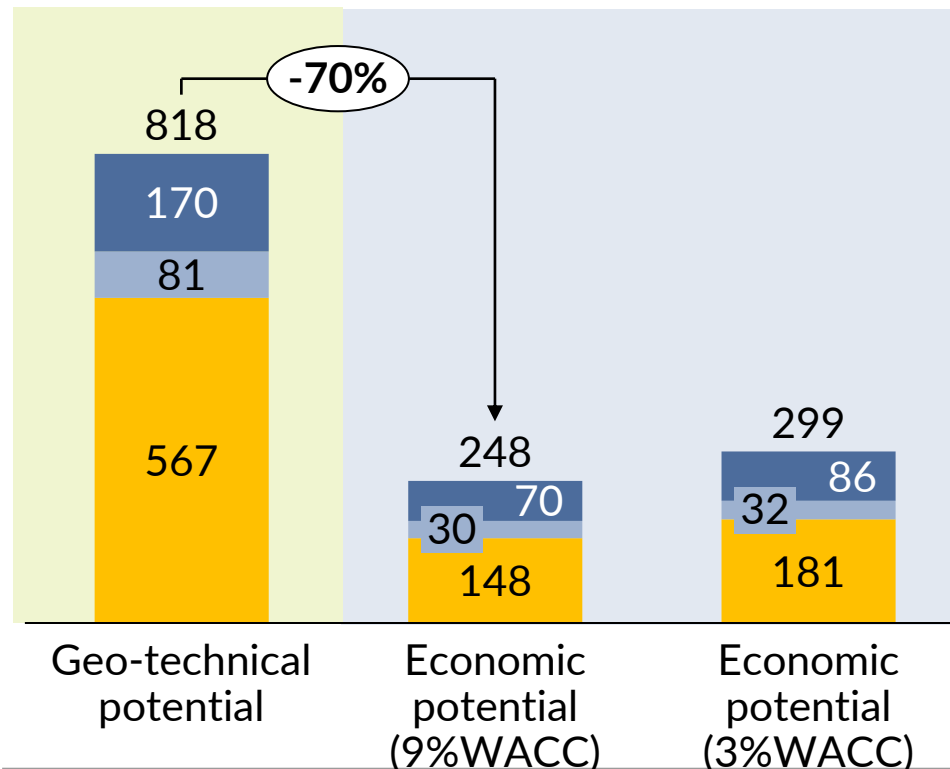
## Economic RES potential



2 What sets the limit for the economic RES potential – cannibalization or site availability?

Capacity in 2040, GW

■ Onshore wind ■ Offshore wind ■ Solar PV (ground)



### Economic RES potential

- Economic potential is driven by capture prices, investment and O&M costs, and capital cost
- At a very low WACC of 3%, the economic potential reaches 299 GW in 2040, roughly a third of the geo-technical potential
- Regional capacity limits do not reduce risk exposure to cannibalization of capture prices

# The 2030 and 2050 target can be reached on alternative RES technology pathways but require additional measures

## Barriers & the road towards 2050

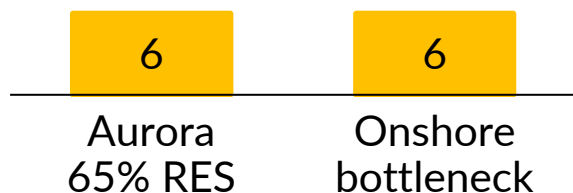


3 Can the 65% RES target in 2030 and Net Zero in 2050 be reached despite social-political barriers?

65% Renewable target in 2030

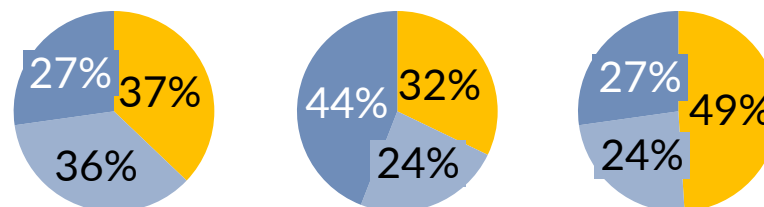
Net Zero in 2050

Required annual solar PV buildout  
GW



Solar PV filling in for onshore wind

Feasible RES generation mix for Aurora Net Zero in 2050



- If onshore bottlenecks remain in place, reaching 65% RES target in 2030 would require a challenging 9-11 GW of solar additions per year

- If onshore buildout remains politically difficult, Net Zero could still be reached by 2050 through higher solar PV or offshore buildout

# Visit our website for more information or directly get in touch with us

## More information on this study

Visit our website:

<https://www.auroraer.com/insight/cost-potential-curves-for-renewables/>



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