

Potentials of Renewable Energy Sources in Germany and the Influence of Land Use Datasets (Supplementary Material)

Stanley Risch, Rachel Maier, Junsong Du, Noah Pflugradt, Peter Stenzel, Leander Kotzur and Detlef Stolten

General Feature Definition

Table S1

Feature definition. Filename is given if different files are applied for one dataset.

Criterion	Dataset	Filename / Query	Filter or code
Lake	Basis-DLM [1]	ver04_f	OBJART_TXT='AX_Hafenbecken' OR OBJART_TXT='AX_StehendesGewaesser'
	OSM [2] retrieved from Geofabrik [3]	gis_osm_transport_a_free_1	fclass not in ('river','riverbank','drain','canal','tidal_channel')
	CLC [4]		Code_18 in ('512','521')
River	Basis-DLM [1]	gew01_f	OBJART_TXT='AX_Fliessgewaesser' OR OBJART_TXT='AX_Kanal' OR OBJART_TXT='AX_Wasserlauf' OR OBJART_TXT='AX_Gewaesserachse'
	OSM [2] retrieved from Geofabrik [3]	gis_osm_water_a_free_1	fclass='river' OR fclass='drain' OR fclass='canal' OR fclass='tidal_channel' OR fclass='riverbank'
	CLC [4]		Code_18 in ('511','522')
Stream	OSM [2] retrieved from Geofabrik [3]	gis_osm_waterways_free_1	fclass='stream' OR fclass='ditch'
Motorway	Basis-DLM [1]	ver01_l	WDM = '1301'
		ver01_f	OBJART_TXT = 'AX_Platz' and FKT != '5310'
	OSM [2] retrieved from Geofabrik [3]	gis_osm_roads_free_1	fclass in ('motorway','motorway_link')
Primary roads	Basis-DLM [1]	ver01_l	WDM = '1303'
	OSM [2] retrieved from Geofabrik [3]	gis_osm_roads_free_1	fclass in ('primary','primary_link')
Secondary roads	Basis-DLM [1]	ver01_l	WDM = '1305'
	OSM [2] retrieved from Geofabrik [3]	gis_osm_roads_free_1	fclass in ('secondary','secondary_link')

Regional roads	Basis-DLM [1]	ver01_l	WDM != '1301' AND WDM != '1303' AND WDM != '1305'
	OSM [2] retrieved from Geofabrik [3]	gis_osm_roads_free_1	fclass = ('residential', 'tertiary', 'tertiary_link')
Railways	Basis-DLM [1]	ver03_l	OBJART_TXT = 'AX_Bahnstrecke'
		ver03_f	None
		ver06_f	OBJART_TXT = 'AX_Bahnverkehrsanlage'
	OSM [2] retrieved from Geofabrik [3]	gis_osm_railways_free_1	None
Power lines	Basis-DLM [1]	sie03_l	OBJART_TXT='AX_Leitung'
	OSM [2] retrieved from Overpass-Turbo [5] (query on the right)	[out:json] [timeout:250]; area[name="Deutschland"]->.searchArea; (way[power=line](area.searchArea)); (.;>); out meta;	None
Farmland	Basis-DLM [1]	veg01_f	VEG != '1020'
	OSM [2] retrieved from Geofabrik [3]	gis_osm_landuse_a_free_1	fclass='farmland' OR fclass='orchard' OR fclass='vineyard'
	CLC [4]		Code_18 in ('211', '212', '213', '221', '222', '223', '241', '242', '243', '244')
Grassland	Basis-DLM [1]	veg01_f	VEG = '1020'
	OSM [2] retrieved from Geofabrik [3]	gis_osm_landuse_a_free_1	fclass='grass' OR fclass='meadow'
	CLC [4]		Code_18='231'
Forests	Basis-DLM [1]	veg02_f	None
	OSM [2] retrieved from Geofabrik [3]	gis_osm_landuse_a_free_1	fclass='forest'
	CLC [4]		Code_18 in ('311', '312', '313')
Trees	Basis-DLM [1]	veg03_f	OBJART_TXT = 'AX_Gehoeolz'
Residential	Basis-DLM [1]	sie02_f	OBJART = '41001' OR (OBJART='41007' AND FKT in ('1110', '1120', '1130', '1150', '1160', '1170'))
	OSM [2] retrieved from Geofabrik [3]	gis_osm_landuse_a_free_1	fclass='residential' OR fclass='retail' OR fclass='allotments'
	CLC [4]		Code_18='111' OR Code_18='112' OR

			Code_18='133' OR Code_18='141' OR Code_18='142'
Inner areas	Basis-DLM [1]	sie01_f	None
Outer areas	Basis-DLM [1]	sie02_f	OBJART = '41001' OR (OBJART='41007' AND FKT in('1110', '1120', '1130', '1150', '1160', '1170'))
Buildings residential	Hausumringe [6]		GFK IN ('31001_1000', '31001_1010', '31001_1020', '31001_1021', '31001_1022', '31001_1023', '31001_1024', '31001_1025', '31001_1210', '31001_3064', '31001_3066', '31001_2070', '31001_2071', '31001_2072', '31001_2074')
Buildings health treatment	Hausumringe [6]		GFK IN ('31001_3240', '31001_3241', '31001_3242', '31001_3051', '31001_3052')
Buildings mixed	Hausumringe [6]		GFK IN ('31001_1100', '31001_1110', '31001_1120', '31001_1121', '31001_1122', '31001_1123', '31001_1130', '31001_1220', '31001_1221', '31001_1223')
Buildings all	Hausumringe [6]		None
Camping	Basis-DLM [1]	sie02_f	FKT = '4330'
Industrial/ Commercial	Basis-DLM [1]	sie02_f	OBJART = '41002'
	OSM [2] retrieved from Geofabrik [3]	gis_osm_landuse_a_free_1	fclass in ('commercial', 'industrial')
	CLC [4]		Code_18='121'
VOR	OSM [2] retrieved from Overpass-Turbo [5] (query on the right)	[out:json] [timeout:250]; area[name="Deutschland"]- >.searchArea; (node[airmark=beacon](area.search Area)); (.;>); out meta;	"beacon_typ" in ('VOR', 'VOR-DME', 'VOR/DME', 'VOR;DME' , 'VOR;TACAN') or "type" in ('VOR/DME') or "beacon_t_1" in ('VOR', 'VOR;TACAN')

D-VOR	OSM [2] retrieved from Overpass-Turbo [5] (query on the right)	[out:json] [timeout:250]; area[name="Deutschland"]->.searchArea; (node[airmark=beacon](area.searchArea)); (.;>); out meta;	"beacon_tpy" in ('DVOR', 'DVOR/DME' , 'DVOR;DME' , 'DVOR;TACAN' , 'DVORTAC') or "beacon_t_1" in ('DVOR', 'DVOR-DME' , 'DVOR/DME' , 'DVOR;DME')
Seismic station	BGR [7]		None
Airports	Basis-DLM [1]	ver04_f	ART in ('5510', '5511', '5512') OR NTZ in ('2000', '3000') AND ZUS IS NULL
	OSM [2] retrieved from Geofabrik [3]	gis_osm_transport_a_free_1	fclass = 'airport'
	CLC [4]		Code_18='124'
Airfields	Basis-DLM [1]	ver04_f	ART in ('5520', '5540', '5550') AND (ZUS IS NULL or ZUS = 'None')
	OSM [2] retrieved from Geofabrik [3]	gis_osm_transport_a_free_1	fclass = 'airfield' OR fclass = 'apron'
Military	Basis-DLM [1]	geb03_f	ADF = '4720'
Mining	Basis-DLM [1]	sie02_f	OBJART = '41005' OR OBJART = '41004'
	OSM [2] retrieved from Geofabrik [3]	gis_osm_landuse_a_free_1	fclass = 'quarry'
	CLC [4]		Code_18='131'
Recreational	Basis-DLM [1]	sie02_f	OBJART = '41008'
Cemetery	Basis-DLM [1]	sie02_f	OBJART = '41009'
Birds protected areas (SPA)	WDPA [8]		DESIG_ENG = 'Special Protection Area (Birds Directive)'
Nature reserve (NSG)	WDPA [8]		DESIG_ENG = 'Nature Reserve'
	Basis-DLM [1]	geb03_f	ADF = '1621'
	OSM [2] retrieved from Geofabrik [3]	gis_osm_landuse_a_free_1	fclass='nature_reserve'
National park	WDPA [8]		DESIG_ENG = 'National Park'
	Basis-DLM [1]	geb03_f	ADF = '1670'
	OSM [2] retrieved from Overpass-Turbo [5] (query on the right)	[out:json] [timeout:250]; area[name="Deutschland"]->.searchArea; (node["boundary"="national_park"](area.searchArea);	

		relation["boundary"]="national_park"](area.searchArea);) (. _;>); out meta;	
FFH	WDPA [8]		Desig='Site of Community Importance (Habitats Directive)'
Biosphere (core zones)	BFN [9]	Bio_Zonierung2021_3035	ZONIERUNG = 'Kernzone'
Biosphere (Maintenance zones)	BFN [9]	Bio_Zonierung2021_3035	ZONIERUNG = 'Pflegezone'
Biosphere (Development zones)	BFN [9]	Bio_Zonierung2021_3035	ZONIERUNG = 'Entwicklungszone'
Nature park	BFN [9]	Naturparke2021	None
Ramsar	WDPA [8]		Desig='Ramsar Site, Wetland of International Importance'
Protected landscapes	WDPA [8]		DESIG_ENG = 'Landscape Protection Area'
Water protection (I&II)	BfG [10]	AM_drinkingWaterProtectionArea-DE	WSG_ZONE in ('1' , '1A' , '1B' , '2' , '2A' , '2a' , '2b' , '2B' , '2B1' , '2B2' , 'GW_I' , 'GW_II' , 'I' , 'II' , 'IIA' , 'IIB' , 'IIC' , 'qual I' , 'qual II' , 'TWS I' , 'TWS II' , 'TWS II/1' , 'TWS II/2' , 'TWS II/3' , 'Zone I' , 'Zone II' , 'keine Angabe')
	LFU-RP [11]		SCHUTZZO_1 in ('Zone I' , 'Zone II' , 'Zone II A' , 'Zone II S')
	LUBW [12]		ZONE in ('Zone I und II bzw. IIA' , 'Zone IIB')
Historical	OSM [2] retrieved from Geofabrik [3]	gis_osm_pois_a_free_1	fclass IN ('archaeological', 'monument', 'memorial', 'castle')
Buildings commercial	Hausumringe [6]		GFK IN ('31001_2000', '31001_2010', '31001_2020', '31001_2030', '31001_2040', '31001_2050', '31001_2051', '31001_2052', '31001_2053', '31001_2054', '31001_2055', '31001_2056', '31001_2060', '31001_2070',

			'31001_2071', '31001_2072','31001_2073', '31001_2074', '31001_2080', '31001_2081','31001_2082', '31001_2083', '31001_2090', '31001_2091','31001_2092', '31001_2093', '31001_2094')
Mixed usage	Basis-DLM [1]	sie02_f	OBJART = '41006'
	OSM [2] retrieved from Geofabrik [3]	gis_osm_landuse_a_free_1	fclass='farmyard'
Slope	EU-DEM v1.1 [13]		None
Birds protected areas (SPA)	WDPA [8]		DESIG_ENG = 'Special Protection Area (Birds Directive)'
Nature reserve (NSG)	WDPA [8]		Desig='Naturschutzgebiet'
National Park	WDPA [8]		Desig='Nationalpark'
Marine protected areas	WDPA [8]		Desig='Baltic Sea Protected Area (HELCOM)' OR DESIG='Marine Protected Area (OSPAR)'
Sea depth	ELC Inspire [14]		None
Border	VG250 [15]	VG250_STA	GF = 4
Sea border	CONTIS Administration [16]	Boundaries	None
	VG250	VG250_STA	GF !=4
Offshore Military**	Raumordnungsplan AWZ [17]	Defence	None
	CONTIS Administration [16]	Military_Practice_AreaPolygon	None
Offshore Pipeline	CONTIS Facility [18]	PipelinesLine	None
Offshore Data Cables	CONTIS Facility [18]	Data_CablesLine	status = 'inUse'
Offshore HV Cables	CONTIS Facility [18]	High_Voltage_CablesLine	status != 'Unknown' and status != 'OutOfUse'
Offshore Platforms	CONTIS Facility [18]	PlatformsPoint	status != 'Decommissioned'
Priority Shipping Areas	Raumordnungsplan AWZ [17]	Shipping	Type = 'priority area'
	Niedersachsen LROP 2017 Neubekanntmachung [19]	LROP2017gesamt_Schifffahrt_A	ZVS_Text = 'Vorranggebiet Schifffahrt'

Landesraum- entwicklungsprogramm Mecklenburg- Vorpommern 2016 [20]	Gebiete_fuer_Schifffahrt_LEPMV2 016	festlegung = 'Marines Vorranggebiet Schifffahrt'
Fortschreibung des Landesentwicklungs- plans Schleswig-Holstein 2010 (2. Entwurf 2020) [21]	LEP_SH Entwurf 2020 Teil C Hauptkarte Shapefile vorrang_schifffahrt	None

**CONTIS Administration for Military in Federal States Sea, ROP for Military in EEZ

Evaluation of land use data sets (Section 2.2)

Table S2

Exclusions for evaluation of land use datasets

Criterion	Dataset	Buffer
Airfields	variable	1500 m
Airports	variable	6000 m
Forests	variable	0 m
Industrial/Commercial	variable	2H
Lakes	variable	100 m
Mixed used areas	variable	2H
Residential areas	variable	3H
Rivers	variable	100 m
Airfields	variable	1500 m
Biosphere (core zones)	BFN [7]	300 m
Birds protected areas (SPA)	WDPA [6]	300 m
D-VOR	OSM [2]	10000 m
FFH	WDPA [6]	300 m
National Park	WDPA [6]	300 m
Nature reserve (NSG)	WDPA [6]	300 m
Protected Landscapes	WDPA [6]	0 m
Seismic stations	BGR [5]	1000 m
Slope > 17°	EU-DEM v1.1 [16]	0 m
VOR	OSM [2]	15000 m

Onshore wind potential (Section 2.3)

Table S3

Onshore wind exclusions (R: Radius, D: Diameter, H: Height)

Criterion	Dataset	S1	S2	S2a	S2b	S3
Airfields	Basis-DLM [1]	individual*	1500 m	1500 m	1500 m	1500 m
Airports	Basis-DLM [1]	individual*	6000 m	6000 m	6000 m	6000 m

Biosphere (core zones)	BFN [9]	individual*	0 m	0 m	0 m	500 m
Biosphere (Development zones)	BFN [9]	individual*	Not excluded	Not excluded	Not excluded	500 m
Biosphere (Maintenance zones)	BFN [9]	individual*	Not excluded	Not excluded	Not excluded	500 m
Birds protected areas (SPA)	WDPA [8]	individual*	300 m	300 m	300 m	500 m
Border	VG250 [15]	individual*	100 m	100 m	100 m	100 m
Buildings commercial	Hausumringe [6]	individual*	2H	2H	2H	3H
Buildings health treatment	Hausumringe [6]	individual*	1000 m	1000 m	1000 m	1000 m
Buildings mixed usage	Hausumringe [6]	individual*	3H	3H	3H	3H
Buildings residential	Hausumringe [6]	individual*	3H	3H	3H	1000 m
Camping	Basis-DLM [1]	individual*	3H	3H	3H	1000 m
Cemetery	Basis-DLM [1]	individual*	0 m	0 m	0 m	0 m
D-VOR	OSM [2]	individual*	10000 m	10000 m	10000 m	10000 m
Farmland	Not excluded	Not excluded	Not excluded	Not excluded	Not excluded	Not excluded
FFH	WDPA [8]	individual*	300 m	300 m	300 m	500 m
Forests	Basis-DLM [1]	individual*	Not excluded	Not excluded	0 m	0 m
Grassland	Not excluded	Not excluded	Not excluded	Not excluded	Not excluded	Not excluded
Historical	OSM [2]	individual*	1000 m	1000 m	1000 m	1000 m
Industrial/Commercial	Basis-DLM [1]	individual*	2H	2H	2H	3H
Inner areas	Basis-DLM [1]	individual*	1000 m	1000 m	1000 m	1000 m
Lakes	Basis-DLM [1]	individual*	100 m	100 m	100 m	100 m
Military	Basis-DLM [1]	individual*	0 m	0 m	0 m	0 m
Mineral extraction	Basis-DLM [1]	individual*	0 m	0 m	0 m	0 m

Mixed usage	Basis-DLM [1]	individual*	2H	2H	2H	3H
Motorway	Basis-DLM [1]	individual*	40 + R	40 + R	40 + R	40 + R
National park	WDPA [8]	individual*	300 m	300 m	300 m	500 m
Nature park	BFN [9]	individual*	Not excluded	Not excluded	Not excluded	0 m
Nature reserve (NSG)	WDPA [8]	individual*	300 m	300 m	300 m	500 m
Outer areas	Basis-DLM [1]	individual*	3H	3H	3H	1000 m
Power lines	Basis-DLM [1]	individual*	100 + D	100 + D	100 + D	100 + D
Primary roads	Basis-DLM [1]	individual*	20 + R	20 + R	20 + R	20 + R
Protected landscapes	WDPA [8]	individual*	Not excluded	0 m	Not excluded	0 m
Railways	Basis-DLM [1]	individual*	100 + D	100 + D	100 + D	100 + D
Ramsar	WDPA [8]	individual*	Not excluded	Not excluded	Not excluded	0 m
Recreational	Basis-DLM [1]	individual*	0 m	0 m	0 m	0 m
Regional roads	Basis-DLM [1]	individual*	R	R	R	R
Rivers	Basis-DLM [1]	individual*	100 m	100 m	100 m	100 m
Secondary roads	Basis-DLM [1]	individual*	R	R	R	R
Seismic station	BGR [7]	individual*	1000 m	1000 m	1000 m	1000 m
Slope >17°	EU-DEM v1.1 [13]	individual*	0 m	0 m	0 m	0 m
Stream	OSM [2]	individual*	0 m	0 m	0 m	0 m
VOR	OSM [2]	individual*	15000 m	15000 m	15000 m	15000 m
Water protection (I&II)	Processed (s. Table 1)	individual*	50 m	50 m	50 m	50 m

* see Table 4

Table S4
Exclusions for scenario 1

Criterion	Dataset	SH	HH	NI	HB	NW	HE
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Airfields	Basis-DLM [1]	1750 m	1750 m	1750 m	1750 m	1750 m	1750 m
Airports	Basis-DLM [1]	6000 m	6000 m	6000 m	6000 m	6000 m	6000 m
Biosphere (core zones)	BFN [9]	0 m	0 m	0 m	0 m	0 m	0 m
Biosphere (Development zones)	BFN [9]	Not excl.	Not excl.	0 m	Not excl.	Not excl.	Not excl.
Biosphere (Maintenance zones)	BFN [9]	Not excl.	Not excl.	0 m	Not excl.	Not excl.	0 m
Birds protected areas (SPA)	WDPA [8]	300+R	300 m	Not excl.	Not excl.	300 m	Not excl.
Border	VG250 [15]	100 m	100 m	100 m	100 m	100 m	100 m
Buildings health treatment	Hausumringe [6]	3H	3H	3H	3H	3H	1000 m
Buildings mixed usage	Hausumringe [6]	3H	3H	3H	3H	1000 m	1000 m
Buildings residential	Hausumringe [6]	3H	3H	3H	3H	1000 m	1000 m
Camping	Basis-DLM [1]	3H	3H	3H	3H	3H	3H
Cemetery	Basis-DLM [1]	0 m	0 m	0 m	0 m	0 m	0 m
D-VOR	OSM [2]	10000 m	10000 m	10000 m	10000 m	10000 m	10000 m
Farmland	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.
FFH	WDPA [8]	200+R	200 m	Not excl.	Not excl.	300 m	Not excl.
Forests	Basis-DLM [1]	0 m	0 m	0 m	0 m	Not excl.	Not excl.
Grassland	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.
Historical	OSM [2]	0 m	0 m	0 m	0 m	0 m	0 m
Industrial/Commercial	Basis-DLM [1]	2H	2H	2H	2H	2H	1000 m
Inner areas	Basis-DLM [1]	800 m	3H	3H	3H	1000 m	1000 m
Lakes	Basis-DLM [1]	50 m	50 m	50 m	50 m	50 m	50 m

Military	Basis-DLM [1]	0 m	0 m	0 m	0 m	0 m	0 m
Mineral extraction	Basis-DLM [1]	0 m	0 m	0 m	0 m	0 m	0 m
Motorway	Basis-DLM [1]	40+R	40+R	40+R	40+R	40+R	40+R
National park	WDPA [8]	300+R	0 m	0 m	0 m	300 m	0 m
Nature park	BFN [9]	Not excl.	Not excl.	Not excl.	0 m	Not excl.	Not excl.
Nature reserve (NSG)	WDPA [8]	200+R	300 m	0 m	0 m	300 m	0 m
Outer areas	Basis-DLM [1]	3H	3H	3H	3H	1000 m	1000 m
Power lines	Basis-DLM [1]	2R	2R	2R	2R	100+2R	2R
Primary roads	Basis-DLM [1]	20+R	20+R	20+R	20+R	20+R	20+R
Protected landscapes	WDPA [8]	Not excl.	Not excl.	Not excl.	0 m	0 m	Not excl.
Railways	Basis-DLM [1]	2R	2R	2R	2R	100+2R	2R
Ramsar	WDPA [8]	300+R	500 m	Not excl.	0 m	Not excl.	Not excl.
Recreational	Basis-DLM [1]	0 m	0 m	0 m	0 m	0 m	0 m
Regional roads	Basis-DLM [1]	R	R	R	R	R	R
Rivers	Basis-DLM [1]	50 m	50 m	50 m	50 m	50 m	50 m
Secondary roads	Basis-DLM [1]	R	R	R	R	R	R
Seismic station	BGR [7]	1000 m	1000 m	1000 m	1000 m	1000 m	1000 m
Slope >17°	EU-DEM v1.1 [13]	0 m	0 m	0 m	0 m	0 m	0 m
Stream	OSM [2]	0 m	0 m	0 m	0 m	0 m	0 m
VOR	OSM [2]	15000 m	15000 m	15000 m	15000 m	15000 m	15000 m
Water protection (I&II)	Processed (s. Table 1)	50 m	50 m	50 m	50 m	50 m	50 m

SH=Schleswig-Holstein; HH=Hamburg; NI=Lower Saxony; HB=Bremen; NW=North Rhine Westphalia; HE=Hessen

Criterion	Dataset	RP	BW	BY	SL	BE
Airfields	Basis-DLM [1]	1750 m	1750 m	1750 m	1750 m	1750 m
Airports	Basis-DLM [1]	6000 m	6000 m	6000 m	6000 m	6000 m
Biosphere (core zones)	BFN [9]	0 m	200 m	0 m	0 m	0 m
Biosphere (Development zones)	BFN [9]	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.
Biosphere (Maintenance zones)	BFN [9]	0 m	Not excl.	Not excl.	0 m	Not excl.
Birds protected areas (SPA)	WDPA [8]	Not excl.	700 m	10H	200 m	Not excl.
Border	VG250 [15]	100 m	100 m	100 m	100 m	100 m
Buildings health treatment	Hausumringe [6]	800 m	3H	3H	3H	3H
Buildings mixed usage	Hausumringe [6]	3H	3H	3H	3H	3H
Buildings residential	Hausumringe [6]	3H	3H	10H	3H	3H
Camping	Basis-DLM [1]	3H	3H	3H	3H	3H
Cemetery	Basis-DLM [1]	0 m	0 m	0 m	0 m	0 m
D-VOR	OSM [2]	10000 m	10000 m	10000 m	10000 m	10000 m
Farmland	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.
FFH	WDPA [8]	Not excl.	Not excl.	Not excl.	200 m	Not excl.
Forests	Basis-DLM [1]	Not excl.	Not excl.	Not excl.	Not excl.	0 m
Grassland	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.
Historical	OSM [2]	0 m	0 m	0 m	0 m	0 m
Industrial/Commercial	Basis-DLM [1]	2H	2H	2H	2H	2H
Inner areas	Basis-DLM [1]	1100 m	3H	10H	3H	3H

Lakes	Basis-DLM [1]	50 m	50 m	50 m	50 m	50 m
Military	Basis-DLM [1]	0 m	0 m	0 m	0 m	0 m
Mineral extraction	Basis-DLM [1]	0 m	0 m	0 m	0 m	0 m
Motorway	Basis-DLM [1]	40+R	40+R	40+R	40+R	40+R
National park	WDPA [8]	0 m	200 m	0 m	0 m	0 m
Nature park	BFN [9]	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.
Nature reserve (NSG)	WDPA [8]	0 m	200 m	0 m	200 m	0 m
Outer areas	Basis-DLM [1]	3H	3H	3H	3H	3H
Power lines	Basis-DLM [1]	2R	2R	2R	2R	2R
Primary roads	Basis-DLM [1]	20+R	20+R	20+R	20+R	20+R
Protected landscapes	WDPA [8]	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.
Railways	Basis-DLM [1]	2R	2R	2R	2R	2R
Ramsar	WDPA [8]	Not excl.	Not excl.	Not excl.	0 m	Not excl.
Recreational	Basis-DLM [1]	800 m	0 m	0 m	0 m	0 m
Regional roads	Basis-DLM [1]	R	R	R	R	R
Rivers	Basis-DLM [1]	50 m	50 m	50 m	50 m	50 m
Secondary roads	Basis-DLM [1]	R	R	R	R	R
Seismic station	BGR [7]	1000 m	1000 m	1000 m	1000 m	1000 m
Slope >17°	EU-DEM v1.1 [13]	0 m	0 m	0 m	0 m	0 m
Stream	OSM [2]	0 m	0 m	0 m	0 m	0 m
VOR	OSM [2]	15000 m	15000 m	15000 m	15000 m	15000 m
Water protection (I&II)	Processed (s. Table 1)	50 m	50 m	50 m	50 m	50 m

RP=Rhineland Palatinate; BW=Baden Wurttemberg; BY=Bavaria; SL=Saarland; BE=Berlin;

Criterion	Dataset	BB	MV	SN	ST	TH
Airfields	Basis-DLM [1]	1750 m	1750 m	1750 m	1750 m	1750 m
Airports	Basis-DLM [1]	6000 m	6000 m	6000 m	6000 m	6000 m
Biosphere (core zones)	BFN [9]	0 m	500 m	0 m	1000 m	0 m
Biosphere (Development zones)	BFN [9]	Not excl.	500 m	Not excl.	1000 m	0 m
Biosphere (Maintenance zones)	BFN [9]	Not excl.	500 m	Not excl.	1000 m	0 m
Birds protected areas (SPA)	WDPA [8]	Not excl.	500 m	Not excl.	Not excl.	Not excl.
Border	VG250 [15]	100 m	100 m	100 m	100 m	100 m
Buildings health treatment	Hausumringe [6]	3H	1000 m	3H	1200 m	3H
Buildings mixed usage	Hausumringe [6]	3H	800 m	3H	3H	3H
Buildings residential	Hausumringe [6]	3H	800 m	3H	3H	3H
Camping	Basis-DLM [1]	3H	3H	3H	3H	3H
Cemetery	Basis-DLM [1]	0 m	0 m	0 m	0 m	0 m
D-VOR	OSM [2]	10000 m	10000 m	10000 m	10000 m	10000 m
Farmland	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.
FFH	WDPA [8]	Not excl.	500 m	Not excl.	Not excl.	Not excl.
Forests	Basis-DLM [1]	Not excl.	0 m	0 m	0 m	0 m
Grassland	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.
Historical	OSM [2]	0 m	1000 m	1000 m	0 m	0 m
Industrial/Commercial	Basis-DLM [1]	2H	2H	2H	2H	2H
Inner areas	Basis-DLM [1]	1000 m	1000 m	3H	1000 m	1000 m

Lakes	Basis-DLM [1]	50 m	50 m	50 m	50 m	50 m
Military	Basis-DLM [1]	0 m	0 m	0 m	0 m	0 m
Mineral extraction	Basis-DLM [1]	0 m	0 m	0 m	0 m	0 m
Motorway	Basis-DLM [1]	40+R	40+R	40+R	40+R	40+R
National park	WDPA [8]	0 m	1000 m	0 m	0 m	600 m
Nature park	BFN [9]	Not excl.	500 m	Not excl.	Not excl.	0 m
Nature reserve (NSG)	WDPA [8]	0 m	500 m	0 m	200 m	300 m
Outer areas	Basis-DLM [1]	3H	800 m	3H	3H	3H
Power lines	Basis-DLM [1]	2R	2R	2R	400 m	2R
Primary roads	Basis-DLM [1]	20+R	20+R	20+R	20+R	20+R
Protected landscapes	WDPA [8]	Not excl.	Not excl.	Not excl.	500 m	Not excl.
Railways	Basis-DLM [1]	2R	2R	2R	400 m	2R
Ramsar	WDPA [8]	Not excl.	Not excl.	Not excl.	Not excl.	Not excl.
Recreational	Basis-DLM [1]	0 m	1000 m	0 m	0 m	0 m
Regional roads	Basis-DLM [1]	R	R	R	R	R
Rivers	Basis-DLM [1]	50 m	50 m	50 m	50 m	50 m
Secondary roads	Basis-DLM [1]	R	R	R	R	R
Seismic station	BGR [7]	1000 m	1000 m	1000 m	1000 m	1000 m
Slope >17°	EU-DEM v1.1 [13]	0 m	0 m	0 m	0 m	0 m
Stream	OSM [2]	0 m	0 m	0 m	0 m	0 m
VOR	OSM [2]	15000 m	15000 m	15000 m	15000 m	15000 m
Water protection (I&II)	Processed (s. Table 1)	50 m	50 m	50 m	50 m	50 m

BB=Brandenburg; MV=Mecklenburg-West Pomerania; SN=Saxony; ST=Saxony Anhalt; TH=Thuringia

Offshore wind potential (Section 2.4)

Table S5

Pre-selected areas for offshore wind

Scenario	Dataset	File name	Filter
S2 Legislation	Raumordnungsplan AWZ [17]	OffshoreWindEnergy	None
	Landesraumentwicklungsprogramm Mecklenburg-Vorpommern 2016 [20]	Gebiete_fuer_Windenergieanlagen_LEPMV2016	None
	Niedersachsen LROP 2017 Neubekanntmachung [19]	LROP2017gesamt_windenergie	None
S3 Restrictive Legislation	Raumordnungsplan AWZ [17]	OffshoreWindEnergy	Type = 'priority area' OR Type = 'conditional priority area'
	Landesraumentwicklungsprogramm Mecklenburg-Vorpommern 2016 [20]	Gebiete_fuer_Windenergieanlagen_LEPMV2016	festlegung != 'Marines Vorbehaltsgebiet für Windenergieanlagen'
	Niedersachsen LROP 2017 Neubekanntmachung [19]	LROP2017gesamt_windenergie	zvs_text = 'Eignungsgebiet Windenergienutzung'

Table S6

Offshore wind exclusions

Criterion	Data set	S1	S1a	S2	S3
Birds protected areas (SPA)	WDPA [8]	0	0	Not excluded	Not excluded
Border	VG250 [15]	15000 m	15.000 m	Not excluded	Not excluded
Data Cables	CONTIS Facilities [18]	500 m	500 m	500 m	500 m
HV Cables	CONTIS Facilities [18]	500 m	500 m	500 m	500 m
Marine protected areas	WDPA [8]	0	0	Not excluded	Not excluded
Military	Processed (s. Table 1)	0	Not excluded	Not excluded	Not excluded
National Park	WDPA [8]	0	0	Not excluded	Not excluded
Nature reserve (NSG)	WDPA [8]	0	0	Not excluded	Not excluded
Pipeline	CONTIS Facilities [18]	500 m	500 m	500 m	500 m
Platforms	CONTIS Facilities [18]	500 m	500 m	500 m	500 m

Priority Shipping Areas	Processed (s. Table 1)	500 m	500 m	Not excluded	Not excluded
Sea border	Processed (s. Table 1)	500 m	500 m	Not excluded	Not excluded
Sea depth	ELC Inspire [14]	1000 m	1000 m	Not excluded	Not excluded
Seismic Stations	BGR [7]	1000 m	1000 m	Not excluded	Not excluded

Open-field photovoltaic potential (Section 2.5)

In scenario S1 Side Strips of the open-field photovoltaic potentials, the side stripes along motorways and railways are considered as pre-selected areas. The area of the side strips are defined by extracting the line features from Basis-DLM [1] and buffering these with half of their width. For motorways either the given width of Basis-DLM [1] (key: BRF) is used or a default width of 40 m is assumed. The area of railways is defined with a default width of 10 m.

In scenario S2 and S3 areas with poor soil quality are used as pre-selected ones. These are defined by the overlap of the Soil Quality Data SQR [22] and farmland areas, identified by Basis-DLM [1] (File: veg01_f; Filter: VEG='1010'). The resulting areas are named “Processed SQR” in the following.

Table S7

Pre-selected areas for open-field photovoltaic

Scenario	Preselected Area		Dataset	File name	Filter	Distance
S1 Side Strips	Railways	Included	Basis-DLM [1]	ver03_1	ZUS != '2100' OR ZUS is null) AND HDU_X = 0 AND BKT='1100'	200
		Excluded	Basis-DLM [1]	ver03_1	ZUS != '2100' OR ZUS is null) AND HDU_X = 0 AND BKT='1100'	15
	Motorway	Included	Basis-DLM [1]	ver01_1	(ZUS != '2100' OR ZUS is null) AND HDU_X = 0 AND WDM = '1301'	200
		Excluded	Basis-DLM [1]	ver01_1	(ZUS != '2100' OR ZUS is null) AND HDU_X = 0 and WDM = '1301'	15
S2 Poor Soil	Farmland	Included	Processed SQR		<i>Values < 30</i>	
S3 Combination	Railways	Included	Basis-DLM [1]	ver03_1	ZUS != '2100' OR ZUS is null) AND HDU_X = 0 AND BKT='1100'	200
		Excluded	Basis-DLM [1]	ver03_1	ZUS != '2100' OR ZUS is null) AND HDU_X = 0 AND BKT='1100'	15
			Processed SQR		<i>Values > 40</i>	

Motorway	Included	Basis-DLM [1]	ver01_1	(ZUS != '2100' OR ZUS is null) AND HDU_X = 0 AND WDM = '1301'	200
	Excluded	Basis-DLM [1]	ver01_1	(ZUS != '2100' OR ZUS is null) AND HDU_X = 0 and WDM = '1301'	15
		Processed SQR		<i>Values > 40</i>	
Farmland	Included	Processed SQR		<i>Values < 30</i>	
	Excluded	Basis-DLM [1]	ver03_1	ZUS != '2100' OR ZUS is null) AND HDU_X = 0 AND BKT='1100'	200
		Basis-DLM [1]	ver01_1	(ZUS != '2100' OR ZUS is null) AND HDU_X = 0 AND WDM = '1301'	200

Table S8
Open-field photovoltaic exclusions

Criterion	Dataset	S1	S2	S3
Birds protected areas (SPA)	WDPA [8]	0 m	0 m	0 m
Border	VG250 [15]	100 m	100 m	100 m
Buildings all	Hausumringe [6]	0 m	0 m	0 m
Camping	Basis-DLM [1]	10 m	10 m	10 m
Cemetery	Basis-DLM [1]	0 m	0 m	0 m
FFH	WDPA [8]	0 m	0 m	0 m
Forests	Basis-DLM [1]	10 m	10 m	10 m
Historical	OSM [2]	0 m	0 m	0 m
Industrial/Commercial	Basis-DLM [1]	0 m	0 m	0 m
Inner areas	Basis-DLM [1]	0 m	0 m	0 m
Lakes	Basis-DLM [1]	10 m	10 m	10 m
Military	Basis-DLM [1]	0 m	0 m	0 m

Mineral extraction	Basis-DLM [1]	0 m	0 m	0 m
Motorway	Basis-DLM [1]	See Table 7	200 m	See Table 7
National park	WDPA [8]	0 m	0 m	0 m
Nature reserve (NSG)	WDPA [8]	0 m	0 m	0 m
Outer areas	Basis-DLM [1]	0 m	0 m	0 m
Power lines	Basis-DLM [1]	20 m	20 m	20 m
Primary roads	Basis-DLM [1]	22.5 m	22.5 m	22.5 m
Railways	Basis-DLM [1]	See Table 7	200 m	See Table 7
Recreational	Basis-DLM [1]	0 m	0 m	0 m
Regional roads	Basis-DLM [1]	22.5 m	22.5 m	22.5 m
Rivers	Basis-DLM [1]	10 m	10 m	10 m
Secondary roads	Basis-DLM [1]	22.5 m	22.5 m	22.5 m
Slope >10°	EU-DEM v1.1 [13]	0 m	0 m	0 m
Stream	OSM [2]	10 m	10 m	10 m
Trees	Basis-DLM [1]	10 m	10 m	10 m

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