

# Renewable Energy Smart Siting

Go Smart to Go Fast

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SEE Renewable Energy Program

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# Global Crisis

Biodiversity  
Loss

Renewable  
Energy  
Transition

Climate  
Change

# Our Priority Conservation Strategies in Europe



**Transformative Protection  
& Management**



**Resilient  
Freshwater**



**Clean Energy  
Transition**

# The Buildout Challenge



**3x** global increase in renewable energy needed by 2030 to stay on track for climate goals



Wind and solar require a lot of land and sea



Potential for widespread buildout conflicts due to environmental and community concerns

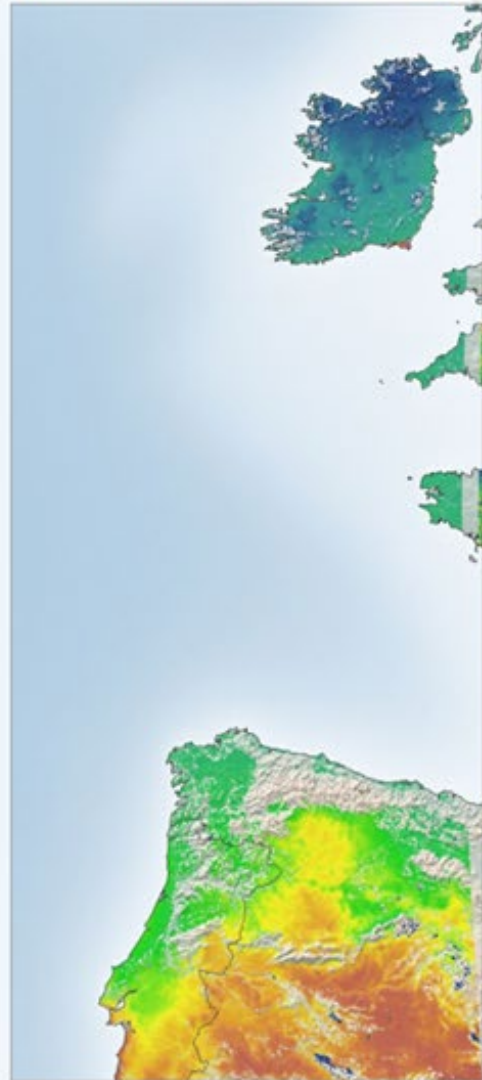


This could slow progress toward a net zero future

Solar Panels and turbines in California.  
April, 2021 Stuart Palley/TNC

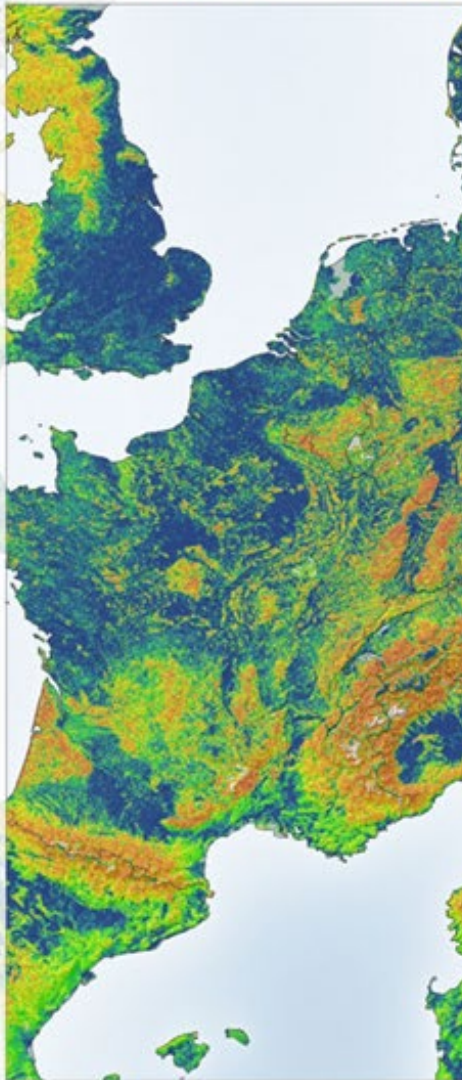
### Solar & Wind Resource

Create development constraint map and estimate resource yield (in GWh) and generate development potential map.



### Conflicts Index (0-1)

Create Conflicts layer incorporating Landcover and Protected Areas conflicts.



### Establish RE development targets & scenarios

Prioritize areas by resource (descending) or by conflict (low-high) based on scenario.

#### Targets set by 3 Pathways:

Stated Policy

Technology Driven

System Change

#### Select under 2 Scenarios:

##### BAU

Select by GWh (descending)

##### Low-Conflict

Select by Conflict score (ascending) and then by GWh (descending)

### Select potential development footprints

To meet targets by Pathway under BAU or Low-conflict scenarios.

● Solar  
● Wind



frontiers

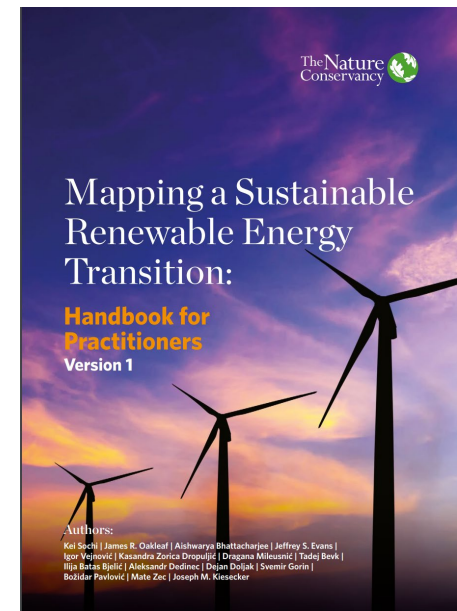
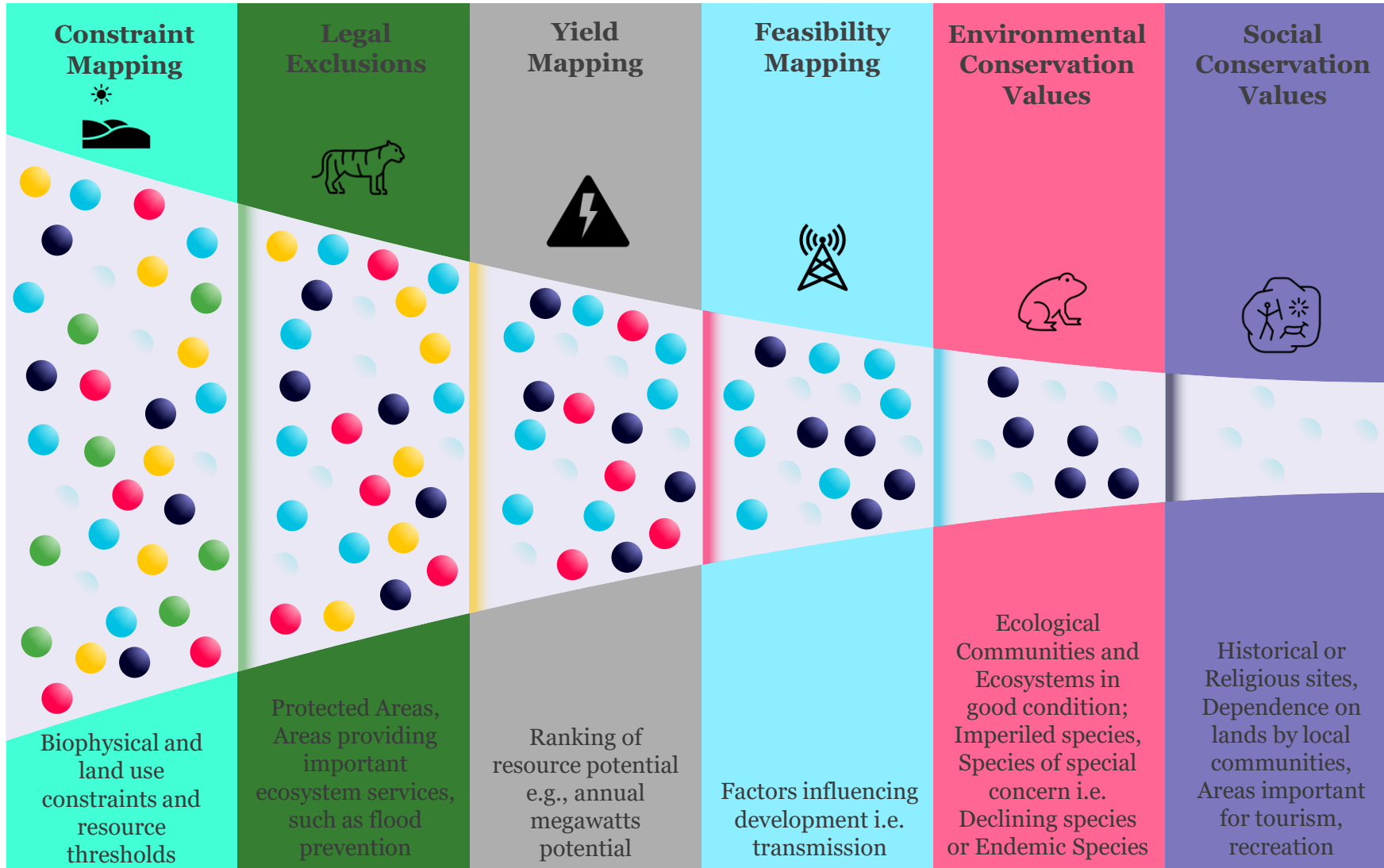
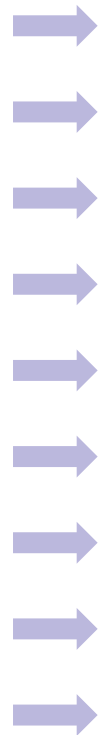
Frontiers in  
Environmental Science



Land use and Europe's renewable energy transition: identifying low-conflict areas for wind and solar development

# Low Conflict Siting

Siting Criteria



# Smart siting methodology

Stakeholder Engagement



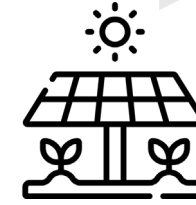
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3



4



## Mapping Constraints

- Legally protected areas
- Biophysical constraints
- Economic constraints
- Existing infrastructure

## Assessing Development Potential

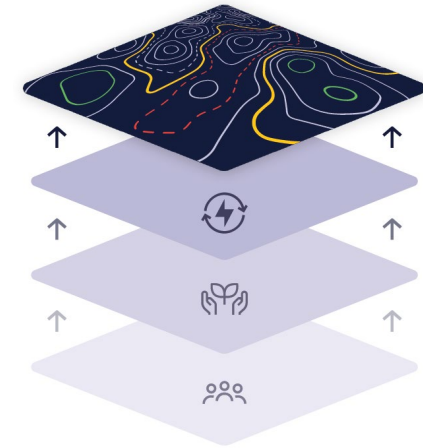
- Resource potential
- Distance from grid and roads
- Grid capacity
- Proximity to load centers

## Identifying Natural, Cultural and Socio-Economic Values

- Areas of ecological value
- Cultural-historic values
- Settlements
- Tourist and recreational areas
- Agricultural land
- Forests
- Areas of landscape value

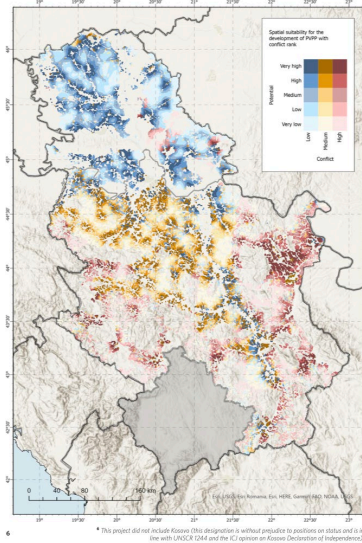
## Bringing All the Information Together

- Optimal locations for solar and wind development



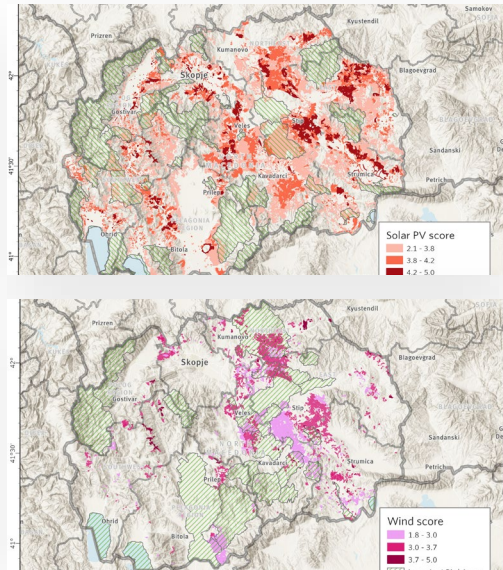
# Siting exercises conducted

Results Map 1: Suitability for PV Solar in Serbia (Development potential vs Conflict potential)\*



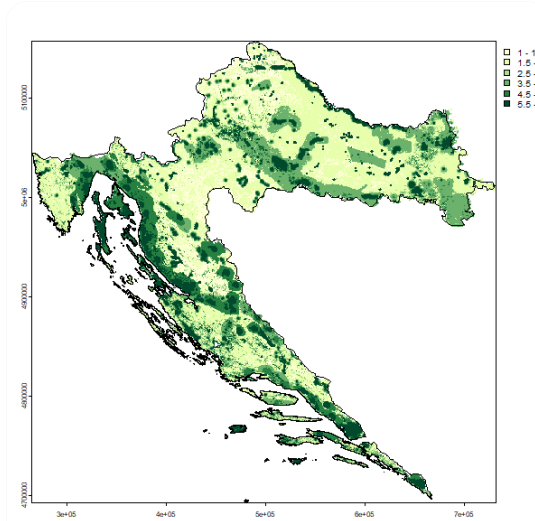
## Serbia

- 100 solar locations, 1 GW total capacity



## North Macedonia

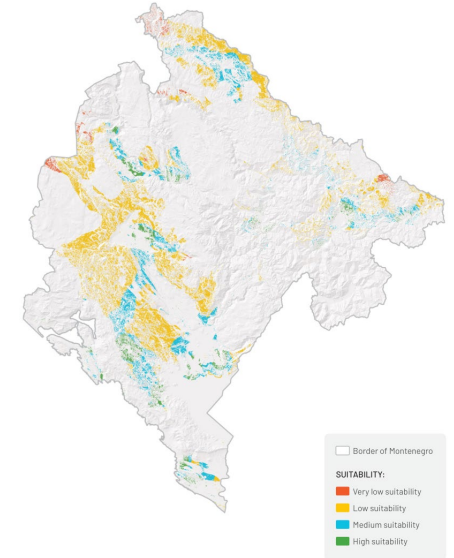
- Focus on degraded & barren lands



## Croatia

- Focus on species sensitivity

Low-conflict map: Solar powerplant development for connection to the distribution grid



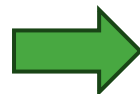
## Montenegro

- National-level RE priority areas
- Includes detailed grid capacity analysis

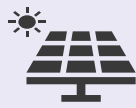
# Data requirements

## Complexity of data collection:

- **37 different datasets**
- **Many institutions involved across different sectors** (energy, environmental protection, biodiversity, agriculture, forestry, mining, spatial planning, culture, water management, land registry...)



- Basic maps
  - Topographic maps (1:25,000 and 1:50,000)
  - Orthophoto imagery
  - Web-accessible basemaps
  - Digital Elevation Model (DEM)
- Legally defined constraints of space usage converted into maps
  - Transmission grid (110 kV, 220 kV and 400 kV, existing and planned)
  - Distribution grid (35 kV)
  - Substations
  - Existing and planned road infrastructure
  - Railways
  - Zones of sanitary protection
  - Rivers
  - Lakes
  - State borders
  - Protected areas
  - Areas of cultural and historical significance
  - Areas of touristic significance
  - Telecommunication infrastructure
  - Settlements
  - Airports
  - Areas of military interest
- RES potential maps
  - Global solar irradiation (250x250 m resolution)<sup>2</sup>
  - Average wind speed and continuity at an altitude of 100 m (50x50 m resolution)<sup>3</sup>
- Natural values
  - Legally protected areas in the third protection zone (National Parks, Nature Parks, Natural Monuments, etc.)
  - Emerald Network areas
  - Important Bird and Biodiversity Areas (IBA) and Special Protection Areas (SPA)
  - Ramsar wetlands
  - Proposed Natura 2000 Type A and B habitats, and Natura 2000 priority habitats for the EU
  - Areas proposed for protection
  - Bat-relevant habitats
- Cultural values
  - Religious sites
  - Potential cultural heritage sites
- Socio-economic values
  - Settlements designated as urban areas (based on the Spatial Plan of Montenegro)
  - Other/rural settlements (based on the OSM/Google Maps), including:
    - Settlements within the areas of special purpose spatial plans (referring to coastal zones and national park territories)
    - Settlements outside the areas of special purpose spatial plans
  - Tourist-recreational areas (ski resorts)
  - Agricultural land (arable land, meadows and pastures)
  - Forest land (high forests, types of coppice forests, shrubland, barren land)<sup>4</sup>
  - Web-available data related to landscape values (Flickr API)



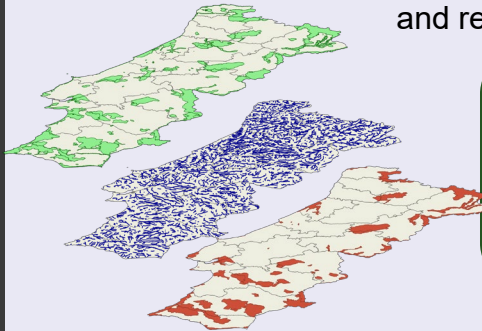
## STEPS 1 + 2 ENERGY MAPPING



Identifying lands that are suitable and feasible for wind or solar development, based on economic and administrative factors, biophysical constraints, and potential energy yields.

### STEP 3a: ENVIRONMENTAL VALUES

Identify areas that meet the criteria for low environmental-conflict development, through mapping elements of conservation or biodiversity interest and relevant to the landscape.



Ecosystems or land cover classes, and broad-level ecosystem processes, that serve as a representative proxy for key biodiversity elements in a study area.

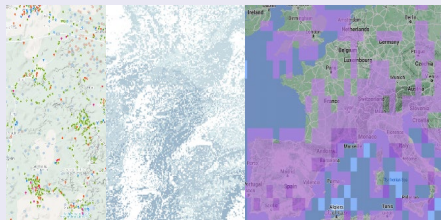


COARSE

Species or trait-based criteria, for pre-selected priority species, to account for important areas for particularly threatened or endangered species.

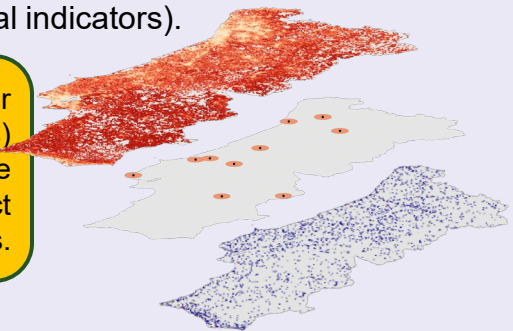


FINE



### STEP 3b: SOCIAL VALUES

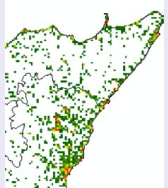
Identify areas that meet the criteria for low social-conflict development, through mapping elements that represent social dimensions (e.g., cultural, economic, and ecological indicators).



Often secondary data (e.g., demographic or agricultural census, peer-reviewed datasets) aggregated to larger scales that demarcate areas of societal importance or impact from land-use tradeoffs.



Information that captures individual level preferences and place-based values, by leveraging spatially oriented data derived from public participation and engagement at a local scale.



### STEP 4: BRINGING IT TOGETHER

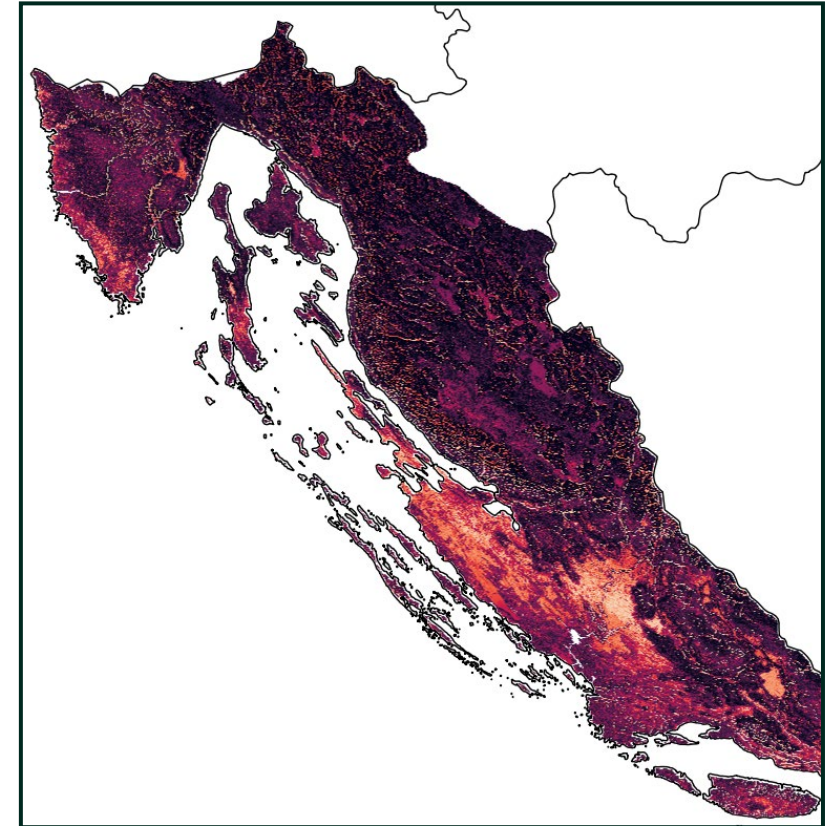
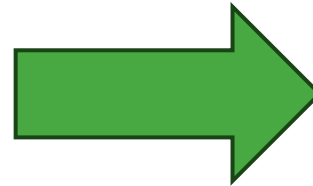
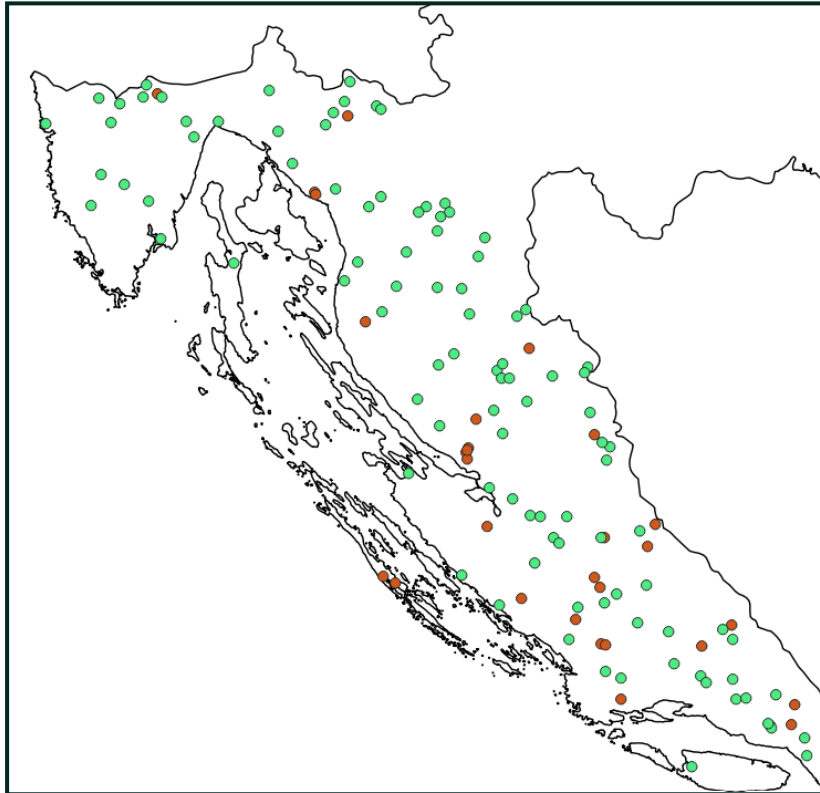


Evaluating the “low-conflict” areas identified (steps 1-3) against national or regional energy targets, estimated land requirements, and possible development scenarios. This will help practitioners determine whether development targets can be completely met on low-conflict areas alone. If necessary, further siting decisions can also benefit from this examination of the scale and tradeoffs in potential impacts to known “high value” areas of environmental and social importance.

# Bridging the data gap

**Problem:** Lack of systematically collected fine filter species data

**Solution:** Species distribution modelling (SDM)



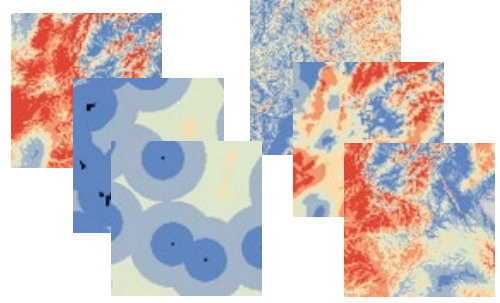


# Development potential modelling

Presence/Absence Data



Spatial Parameter Data

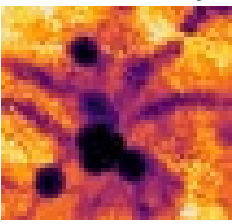


Sample Data



FID	Shape	Present	All...	MjrUA_D	PGHSL20	PP_ESW_	Rlrd_Ds	Rd_AM_D	Rd_PO_D	Slp100_	Sbs_A_D	Sbs_M_D	TrnsL_D	W_CFI	Wn_NEPS
0	Point	1	0	15985	0	34262.277344	14661	0	2103	2.957762	4299.045898	19799	5328	0.525821	3184.453369
1091	Point	1	0	62572	3.438066	3219.978027	1601	880	1294	2.252716	1995.874878	8246	1115	0.470687	2837.812744
1092	Point	1	0	62450	0	3104.641113	1701	830	1201	2.758319	1933.13208	8107	1201	0.471227	2837.638672
2571	Point	1	0	0	0	15960.842773	2491	257	2786	4.185968	2772.090088	7213	942	0.525624	3021.010498
2582	Point	1	0	1521	0	12056.479492	6506	283	283	13.168546	4179.08252	5401	0	0.496454	2621.057373

Future Development Probability



Probabilistic Random Forest Model

Run & Validate Model



Fit model to select parameters



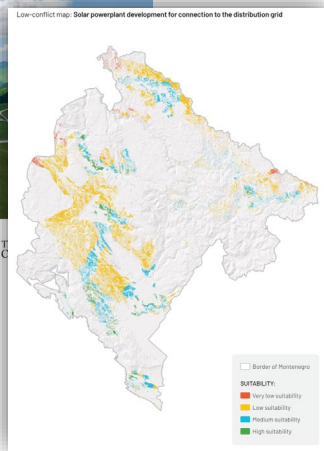
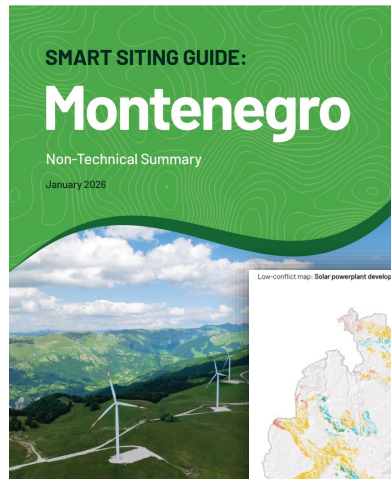
Parameter Selection/Importance  
(TNC Tools, Evans et. al, 2010)



FID	Shape	Present	All...	MjrUA_D	PGHSL20	PP_ESW_	Rlrd_Ds	Rd_AM_D	Rd_PO_D	Slp100_	Sbs_A_D	Sbs_M_D	TrnsL_D	W_CFI	Wn_NEPS
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# Results: Montenegro



**17x**  
capacity increase

Only at low-conflict locations, the study identifies a capacity approximately **17 times larger** than the current installed capacity of all power plants in Montenegro.

**1/3**

of TE Pljevlja capacity can be replaced



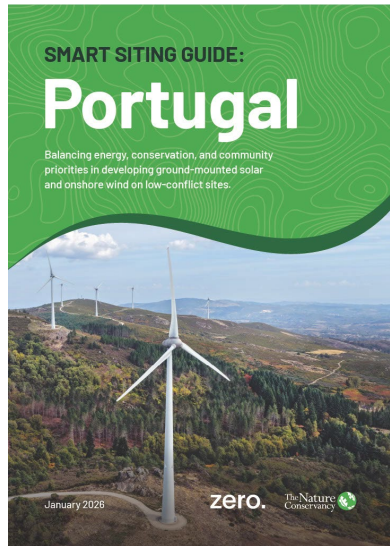
The solar capacity identified **on brownfields** can replace 1/3 of the production from TE Pljevlja.



**2030**  
targets from 1/5  
of the locations

Montenegro can meet its **national energy targets** for 2030 through buildout of solar and wind on just a fraction (one fifth) of the identified low-conflict locations.

# Results: Portugal



**5X**

the low-conflict land needed to meet the **2030 target.**



**70%**

of onshore **wind** energy target can be met on low-conflict sites.

# MEGA Case Example

- **High-level Advisory Committee:** Representatives from all key ministries & institutions
- **Ministry experts embedded:** Energy, environment & spatial planning teams in project
- **Grid capacity modeled:** Bespoke nation-wide transmission capacity model (partnership with national TSO)
- **Public participation tested:** PPGIS tool piloted in Cetinje, Nikšić, Pljevlja
- **Brownfield priority:** 346 MW identified on industrial sites, landfills & quarries



# Implementation & Impact

## Government

RAAs designation, spatial planning integration & auction design

## Grid operators

Update on 10-years development plans, prioritization for refurbishing

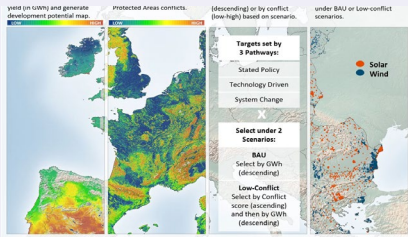
## Developers and financial institutions

Low-risk, conflict-reduced project identification & financing

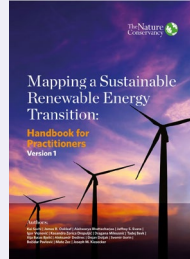
## Communities

Just transition, job creation, nature & livelihoods protected

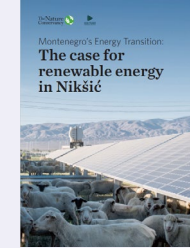
# Resources



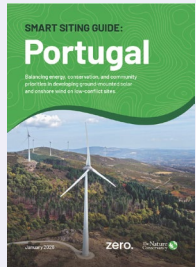
Land use and Europe's renewable energy transition: identifying low-conflict areas for wind and solar development



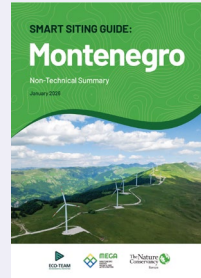
Mapping a Sustainable Renewable Energy Transition: handbook for practitioners



Montenegro's Energy Transition: The case for renewable energy in Nikšić



Portugal Smart Siting Guide



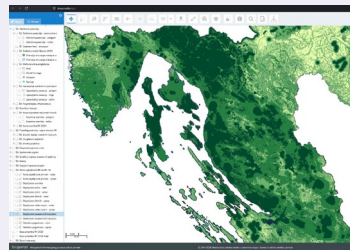
Montenegro Smart Siting Guide



100 Priority Locations for Solar Energy in Serbia



A blueprint for North Macedonia to accelerate its energy transition



Croatian Species Sensitivity maps – integrated into Bioportal



Integrated Renewable Energy Planning in Southeast Europe Pilot project: Integrated Wind and Solar Planning in Zadar County

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