IRENES
Interreg Europe

European Union

ANALYSIS AND MAPPING OF TRADE-OFFS BETWEEN RENEWABLE ENERGY AND ECOSYSTEM SERVICES

FIVE CASES FROM THE IRENES INTERREG PROJECT

Università Iuav di Venezia

SPECIAL ISSUE / AGENDA SETTING

PROJECT NAME: IRENES – Integrating RENewable energy and Ecosystem Services in environmental and energy policies
The project started on 1 August 2019 and ends on 31 July 2023
Project type: Interreg Europe

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PROJECT OBSERVER: Interreg Europe, European Union, European Regional Development Fund

LANGUAGE: English

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GRAPHIC DESIGN: Stefano Mandato with Silvia Casavola

PROJECT FUNDS: Interreg Europe, European Union, European Regional Development Fund
The total budget is € 1,781,783 (of which ERDF: 1,514,515.55)

ISBN 9788889405451

SUPPORTED BY
Interreg Europe
European Union | European Regional Development Fund

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Under the principles of knowledge sharing and mutual learning, throughout the processes, the teams from the five countries and case studies met and exchanged their findings, challenges, lessons learned. Similarities and differences between the individual case studies emerged. This final section collects some general findings from this process, looking at all the work presented in this technical report at a glance.

Looking at the outputs provided, the **UK** team provided maps and tables comparing electricity generation outputs for renewables (including siting constraints) with percentages of land in different natural assets. These were compared to classify areas based on their generation potential and natural assert indicators. In **Estonia**, the type of output for the trade-offs analysis were maps representing overlaps between various degrees of overall supply of ES (represented as hot and cold spots) and two categories of wind-speeds. According to the resulting categories, areas of potential trade-offs and synergies are highlighted. The **German team** produced maps of the vulnerability of the landscape (based on environmental protection and policy constrains more that strict ES provisioning indicators) for wind and solar energy (four classes). The **Romanian team** produced maps representing overlaps between various supplies of ES (the 4 main categories: supporting, regulating, provisioning, and cultural) and different types of RES.

Overall, we can say that only Estonia focused on one RES, while other countries addressed and compared a set of RES. This is due to a different state of the art and policy demand. Thus, while Estonia was already wind-energy oriented, other countries were more interested in comparing alternatives or identified a possible set of solutions to combine.

Regarding the types of ES addressed, while Romania addressed all ES, organizing them in the four categories, all other countries target only ES of interest for their contexts. Regarding the indicators and proxies for ES, instead, while Estonia, Romani and Italy adopted indicators for ES mapping from the ES literature, Germany and UK also adopted information and data for environmental protection, resources mapping and other policy-related categories as proxies for Es provisioning. On one hand, the choice of the UK and Germany makes information more decision-makers friendly, while triggering the risk of providing lower accuracy, while Estonia, Romania, and Italy, adopt data which are not already familiar to planners and decision-makers, but ensure a higher level of accuracy.

Bringing together results from the five analysis, **THE RES-ES MATRIX (here below)** presents a snapshot of trade-offs between RES and ES analysed in this work. The **RES-ES Matrix** considers the Renewable Energy sources analysed, RES, as columns, and the Ecosystem Services, ES, as rows, placing each region into the cell matching the specific combinations of RES/ES used in the region's case study. The **RES-ES Matrix** offers a synthetic comparison of the case studies along

RES ES	SOLAR	ONSHORE WIND	BIOMASS
Habitat	Lower saxony (DE), Veneto (IT), East Anglia (UK)	Lower saxony (DE), East Anglia (UK)	Veneto (IT), East Anglia (UK)
Soil provisioning Provisioning Services	Lower saxony (DE), Romania	Lower saxony (DE), Romania	Romania
Spiritual value Cultural services	Lower saxony (DE), Romania	Estonia, Lower saxony (DE), Romania	Romania
Fodder/bioenergy from grasslands		Estonia	
Agriculture, Food Production in general (including Edible mushrooms and Bilberries production)	Veneto (IT), East Anglia (UK)	Estonia (Including Edible mushrooms, Bilberries production)	Veneto (IT)
Water regulation Water Provisioning	Veneto (IT), Lower saxony (DE)	Lower saxony (DE)	Veneto (IT)
Aesthetic values	Veneto (IT)		Veneto (IT)
Timber production	East Anglia (UK)	East Anglia (UK)	East Anglia (UK)
Passive recreation, Active recreation	East Anglia (UK)	Estonia, East Anglia (UK)	East Angla (UK)
Microclimate regulation, Global climate regulation,	Veneto (IT)	Estonia	Veneto (IT)
Pollination		Estonia	
Genetic resources in grasslands, Genetic resources in mires, Genetic resources in forests		Estonia	

these two RES/ES dimensions and providing an opportunity for further collaborative learning from partners' activities. The **RES-ES Matrix** also represents a first step for future work, aiming at exploring similar Matrices, and associated regional mappings within them, according to different combinations of the relevant dimensions. In this way, the REM provides an opportunity to go beyond simplistic Geographical mapping exercises, moving towards conceptual maps, whose dimensionalities represent concepts rather than geographic coordinates, and where geographies are mapped into these concept spaces. In these conclusions the REM also included as a third dimension, whether a case study also accounted for policy and legal constraints. This third dimension, being summarised by a yes or no binary variable, was initially introduced by adding colour coding to the entries of the REM. However, since all case studies accounted for policy and legal constraints, there was no variability along this dimension, hence all entries remained in one colour only.

RES-ES Matrix (REM) considers the Renewable Energy sources analysed, RES, as columns, and the Ecosystem Services, ES, as rows, placing each region into the cell matching the specific combinations of RES/ES used in the region's case study. All entries are in black colour since all case studies accounted for policy and legal constraints.

Overall, strengths from the results relate to: i) quantification of suitable land for RES(s) (Italy and Romania); ii) Combination of multiple ES in one map, highlighting multi-functionality of landscapes (all the five cases); iii) technical information that match needs and language of the policy-making (Estonia, Germany, and Italy); Comparison of impacts by different types of RES (UK, Germany, Italy, and Romania); very fine resolution of maps (Estonia); specific target on the local scale (UK); and alignment with supra-local objectives of nature conservation, which can thus be more easily incorporated into decision-making at the local level (Germany).

Similarly, limitations relates to: i) adoption of some not yet validated models for trade-off analysis (Estonia); ES maps representing one static point in time (all the five cases); the use of proxies such as assets providing ES rather than the actual ES themselves (UK and Germany); the use of nation-wide geodata (Germany and Romania); final maps presenting average trade-off values (average among all ES considered) that may lead to choices that trigger serious trade-offs with one specific ES (Italy and Romania).

To conclude, the work opens up to future research (based on limitations and missed opportunities to further investigate), but also brings to some policy recommendations. Among these, the whole consortium agrees in stating that other uses of land, and benefits arising from them, need to be recognised when considering the potential for renewable generation. The application of an ES approach and the adoption of ES-related analysis, represent promising tool for pursuing such goal. The ES trade-off maps produced and presented in this report, do not simply aim at highlighting vulnerable areas to safeguard from RES development. Thus, maps also highlight areas where renewable generation could be prioritised, and potential synergies to (between RES and ES) to promote. In addition, when comparison among different RES occur, it is not a matter of setting overall preferability of a specific type of RES. Hence, they can be combined and make it possible to integrate the expansion of the two energy sources wind and solar energy in a regional concept. Different types of RES can be developed together and complement each other according to the natural yield potential of a region.

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