Wind Energy and Environmental Protection: Using GIS to Evaluate the Compatibility of Croatian Strategies

Diana Međimorec, Siniša Knežević, Veljko Vorkapić, Davor Škrlec

***Abstract*--The objective of this paper is to show a methodology that could be applied in the analysis of the possibility of realization of wind projects in Croatia with regard to Croatian National Ecological Network (CRO NEN) sites and protected sites.**

The analysis will provide a base model for initial evaluation of the compatibility of current Croatian wind energy and environmental protection objectives. The model could then later be expanded to include some additional variables or be adapted for other technologies, such as solar.

***Index Terms*— energy strategy, environmental protection, geoinformation systems, resource assessment, wind energy**

I. Introduction

CROATIAN Energy Strategy [1], adopted by Croatian parliament in 2009, sets the objective of reaching 1,200 MW of wind energy or an estimated 9-10% of electricity consumption in 2020. The total installed capacity of Croatian power system is now around 4,000 MW [2], and the grid connection limit for wind projects is currently 360 MW. Transmission and distribution grid operators are already working on increasing capacities for acceptance of wind power. However, there are other limitations that could prevent the realization of the 1,200 MW objective.

In 2007, Croatia introduced Croatian National Ecological Network (CRO NEN) [3] that is to be introduced in the EU network of Natura 2000 once Croatia enters the European Union. Natura 2000 is based on EU Birds Directive [4] and Habitats Directive [5], which together establish the areas of special protection of certain species and habitats. Although Natura 2000 does not exclude all human activities on all areas, it is expected that development of wind energy projects would face more restrictions in Natura 2000 areas, namely in habitats important for birds and bats.

The objective of this paper is therefore to show a methodology that could be applied in the analysis of the possibility of realization of wind projects in Croatia with regard to CRO NEN sites and protected sites.

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II. Literature Overview

The research in this paper relies on using geoinformation systems (GIS), where maps showing different variables are overlapped to calculate and show impacts of different variables to wind sites. GIS methods are also generally recommended by the European Commission in their guidance document “Wind energy developments and Natura 2000” [6].

Similar work to this paper was done for the European Union in the EEA Report [7], where wind resource assessment for the entire EU was created and then overlapped with Natura 2000 sites to evaluate what would happen if theoretically all Natura 2000 sites were excluded from wind development (constrained potential). The results showed that there would be only limited impacts, as the onshore technical potential would reduce for 13,7%, which is still more than enough (3-7 times) to cover EU targets for wind energy in 2020 and 2030. EEA Report concludes that the analysis therein is subject to various uncertainties and that more detailed assessments on regional, national or local scale are required. Some countries, such as Scotland [8], France [9], Germany [10] and Denmark [11] have already done similar analysis for onshore or offshore wind development, either on national or local/municipality scale.

The work in this paper will show an approach that could be used in evaluating wind energy with respect to environmental protection objectives for Croatia. Results of the applied approach are hugely dependent on the input data used. The uncertainties of the input data are elaborated in more detail in following chapters and summarized again at the end of this paper.

III. Data acquisition and analysis

The data for analysis was acquired from various sources, and was then compiled together according to the methodology described in section IV.

A. Wind potential

Wind potential was calculated based on average wind speed data for the period 1992-2001 on 80m height obtained from mesoscale meteorological model ALADIN/HR [12]. ALADIN/HR is a Croatian version of numerical mesoscale meteorological model ALADIN (Airee Limitee Adaptation Dynamique Development International). ALADIN is a spectral model with hybrid η coordinate that uses two-time-level semi-implict semi-langrangian scheme [12]. In the DHMZ study [12], average wind speed was calculated using ALADIN/HR for 10m and 80m height above ground. Then the results for 10m height were compared to actual 10m measurements on five meteorological stations in Croatia, representative for different climate regimes, for the year 2001. Results showed that the errors are largest in urban areas, not interesting for wind farm development, where ALADIN/HR overestimated wind speed. Results for flat terrain in eastern Croatia were far more accurate, with underestimation of ALADIN/HR by 1% of annual average wind speed. **For southern Croatia, where highest wind potential is expected, model underestimated the average annual wind speed around 10%, particularly for winter months.** Also, the frequency of stronger winds (above 6 m/s) was underestimated in ALADIN/HR compared to measured data. **The average taken in this paper** is the ten year (1992-2001) average wind speed on 80m, **without any corrections,** so the results **could be considered quite conservative** in terms of average wind speed.

Average wind speed is available for each point in Croatia, defined by WGS84 coordinates with the precision of two decimals (in average around 800 m east-west and 1100 m north-south). Wind speed data was categorized in four different categories, as shown in Table 1. Categorized data were then introduced into AutoCAD MAP 3D GIS software by using ODBC connection and converted to local coordinate system (Gauss-Krueger 5th zone). Data was then exported as .shp and .sdf files to be used in further analysis with AutoCAD MAP 3D and ESRI ArcView GIS 3.2 software.

Table 1 – Categorization of wind speed data (ws=wind speed)

Category	A	B	C	D
Definition	ws≥8 m/s	6≤ws<8m/s	4≤ws<6m/s	ws<4m/s

It is important to note that these data poses a serious limitation for this analysis, as it does not represent a proper wind atlas for Croatia. **For actual decision making purposes, a wind atlas for Croatia should be created in order to evaluate the wind potential accordingly.**

B. Land cover

Wind farms can only be built on land that is suitable for such constructions. That means that unsuitable land cover should be excluded from calculation of wind potential. Initial analysis included land cover data from CORINE Land Cover database, but then even more suitable data was found in the form of official data from Croatian State Institute for Nature Protection – National Habitat Classification (NHC) [13]. NHC data is obtained in GIS format (.shp) and is presented in a form of 60554 polygons assigned one of 109 categories covering all Croatian land. Habitat types in fact give information on the land cover, so each habitat type (land cover type) is evaluated as suitable or unsuitable for wind farms. In general, suitable areas are the ones outside urban areas or water bodies and rivers, with no vegetation, or vegetation up to 5 m high.

Figure 1 shows the combination of land cover map and the wind speed map of Croatia.

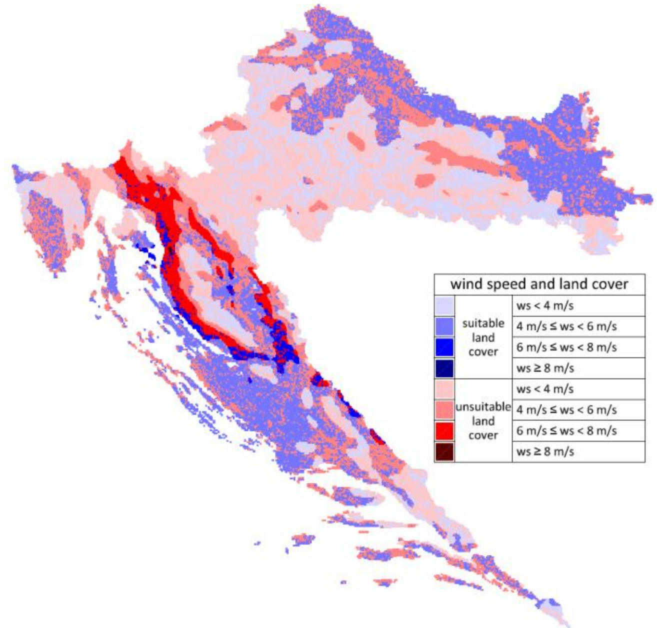

Figure 1 - Land cover and wind speed map

C. Protected areas

The data on protected areas in Croatia were obtained from Croatian State Institute for Nature Protection in GIS format suitable for analysis.

Figure 2 shows the protected areas (red tones). All protected areas are regarded as unsuitable for wind farms.

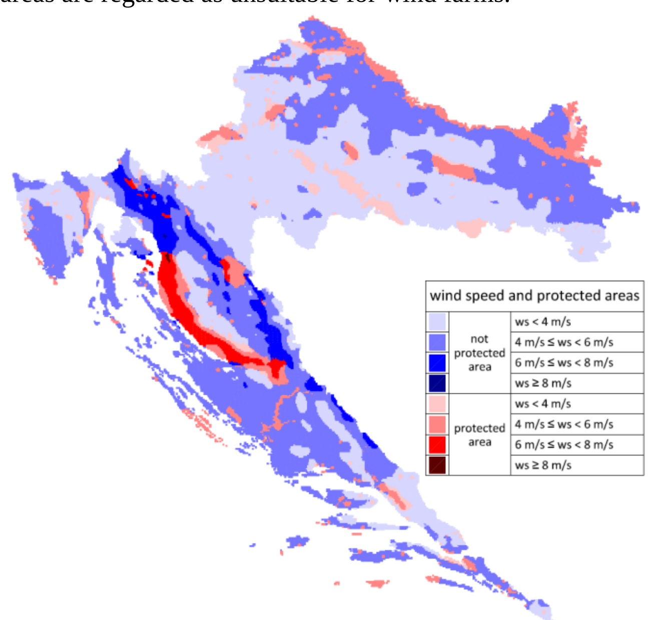

Figure 2 – Wind potential and protected areas

Protected areas are categorized in 8 types (parks, reserves etc.). There are 281 protected areas presented as polygons and 183 presented as points, for which 1500 m buffer is considered.

D. National Ecological Network

The data on Croatian National Ecological Network (CRO NEN) was obtained again from Croatian State Institute for

Nature Protection in GIS format suitable for analysis. Data is divided in (1) Special Protection Areas (SPAs), in conformity with EU Birds Directive and (2) Special Areas of Conservation (SACs) to be designated for other species (habitats), in conformity with EU Habitats Directive. In analysis, special consideration was given to areas where some of the species listed in Annex II (*Bird species considered to be particularly vulnerable to wind farms*) and Annex III (*Bat behaviour in relation to wind farms*) of EU guidance document "Wind energy developments and Natura 2000" [6] exist. Complete list of bird and bat species reviewed and respective SACs and SPAs is in the Annex at the end of this paper.

In Croatia there are 41 SPA areas, out of which only one is "point" area. SACs are more numerous; 599 polygonal areas and 911 "point" areas. All "point" areas are later analysed using 1500 m buffer.

E. Other data

Additional data that were used in the analysis are geographical data about land and islands in Croatia, used in order to calculate wind potential in designated areas.

The analysis was meant also to include the data from the Registry of renewable energy sources and cogeneration [14], maintained by Ministry of Economy, Labour and Entrepreneurship, but the data was not acquired by the time of this analysis. Obtaining this data would give the analysis additional value, as all registered wind projects would be overlapped with wind data, land cover data and CRO NEN data.

IV. Calculating Wind Potential - Methodology

Using the datasets described in the previous chapter, the preparation of the final dataset was done in following steps:

1. overlaying of ALADIN/HR raster with Croatian territory (intersect operation) in order to reduce the number of raster points in analysis and visualisation
2. adding information to ALADIN/HR raster points from overlaying polygons (identity operation) – information on:
    a. type of land (island or mainland)
    b. type of land cover (habitat class)
    c. type of protected area (or *null* if the point is outside of protected area)
    d. type and area of SPA (or *null* if the point is outside of SPA)
    e. type and area of SAC (or *null* if the point is outside of SAC)

Prior to any overlay analysis "point" areas were represented with 1500 m buffer around the point. All overlay analyses were done using ESRI ArcView GIS 3.2.

The resulting dataset is further used for querying (using MS Access) and visual representation (using Autodesk AutoCAD MAP 3D).

The results of queries are number of points in certain categories (wind speed, land cover type, protected area, etc.). In order to assess the energy potential the following assumptions are made:

- 4.78 MW per resource point:
    - one ALADIN/HR raster point represents the area[1] of around 0.88 km^2
    - 2 MW, 80 m hub-height wind turbines are assumed
    - one wind turbine "occupies" 0.36 km^2
    - number of turbines per resource point – 2.43
- average power curve (averaged from 10 different wind turbine types in the 2 MW class, Figure 3),
- Rayleigh wind speed distribution for all resource points.

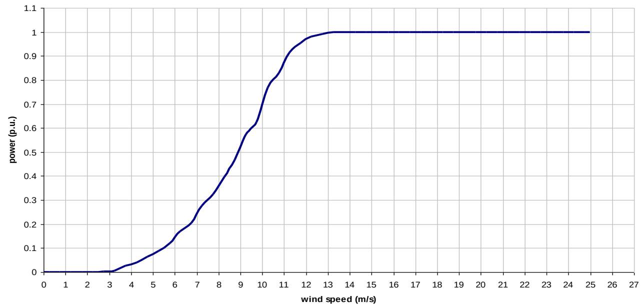

Figure 3 – Power curve of an "average" wind turbine

With the two latter assumptions production can be calculated for any average wind speed. Production is determined for one- year period and is expressed in Full Load Hours (FLH[2]), Figure 4.

It should be noted that **this kind of energy yield estimation can be used only for rough assessments on a broader area**. For more accurate results, detailed parameters of the wind farm location and the project should be known, namely real long term wind speed distribution, specific wind turbine height and power curve.

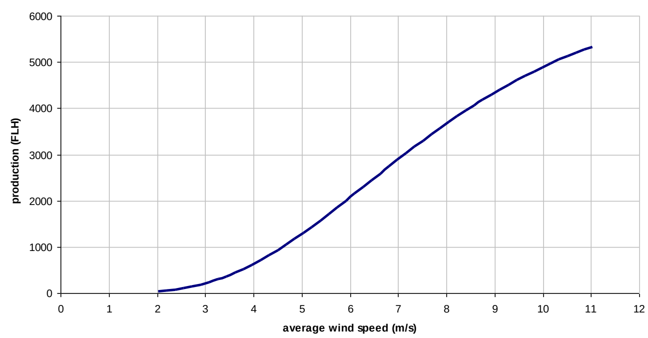

Figure 4 – Productivity as a function of average wind speed

As it can be seen on Figure 4, the production and therefore profitability largely depend on the wind speed parameters – there is significant difference in production between average wind speed of 6 m/s and 8 m/s. In that sense, the 2 m/s wind speed categories do not provide enough accuracy in estimating production. In order to improve the accuracy of production estimation, the 2 m/s bins are divided into 0.2 m/s sub-bins

[1] ALADIN/HR raster grid is not rectangular, so the cell area had to be averaged using the number of raster points over Croatian mainland (60897) and the mainland area of Croatia (53327 km^2).

[2] Number of Full Load Hours is a theoretical number of hours of operation on full capacity that would result in same energy yield as operating normally in one year.

and each sub-bin is given certain percentage that determines the share of sub-bins in a certain bin. Using these shares, average (weighted) productivity for each wind speed category can be determined, Table 2. The shares are calculated on a basis of all ALADIN/HR wind speed data.

Table 2 also shows the productivity in FLH for different average wind speeds - red colour indicates the productivity levels regarded as unprofitable, while the green ones that are regarded as profitable.

It should be noted that the profitability, as well as the sole feasibility will strongly depend on other factors like:

- terrain orography (too steep or too complex sites are usually unsuitable for wind farms),
- grid connection possibility (vicinity of connection point, system regulation capabilities/limitations),
- access roads and paths, etc.

Any of these factors can make a project in A or B category area unfeasible, or make a project in category C feasible. However, in this analysis the above criteria are not analysed and it is assumed that only profitable projects will be realised, so only categories A and B (with wind speed over 6 m/s) contribute to the final wind energy resource.

Table 2 – Shares of wind speed in specific wind speed categories

C			B			A		
wind speed (m/s)	FLH	Share in C	wind speed (m/s)	FLH	Share in B	wind speed (m/s)	FLH	Share in A
4.0[3]	609	0.05	6.0	2002	0.51	8.0	3568	0.68
4.2	707	0.10	6.2	2148	0.19	8.2	3698	0.30
4.4	812	0.10	6.4	2296	0.09	8.4	3824	0.03
4.6	924	0.11	6.6	2443	0.07	8.6	4066	0.00
4.8	1043	0.10	6.8	2590	0.05	8.8	4182	0.00
5.0	1167	0.10	7.0	2880	0.04	9.0	4294	0.00
5.2	1297	0.13	7.2	3022	0.03	9.2	4402	0.00
5.4	1570	0.13	7.4	3163	0.01	9.4	4507	0.00
5.6	1712	0.11	7.6	3300	0.01	9.6	4607	0.00
5.8	1856	0.08	7.8	3436	0.00	9.8	4703	0.00
Weighted average	**1203 FLH**			**2211 FLH**			**3613 FLH**	

According to this methodology, the wind energy resource (in GWh) is determined multiplying the total installed capacity on category A and B with the appropriate number of full load hours (FLH).

V. Results

The dataset created using the described methodology allows a number of different criteria combinations to be analysed using queries. In this section, only the most relevant results are presented.

All the queries exclude islands as suitable areas for wind farms. According to the ALADIN/HR model, on islands there is only negligible wind resource in categories A and B on suitable land cover. Also, in Croatia the Act Physical Planning and Construction [15] does not allow for wind farms to be built on islands. Having that in mind, island areas are excluded from further analysis. However, it is authors' opinion that larger islands should be regarded as potential areas for wind farms.

Explanation of different scenarios examined with criteria and results are given below.

A. Scenario 1

Scenario 1 (Figure 5) included wind resource on mainland, on suitable land cover; outside protected areas.

Scenario 1 can be considered a scenario with environmental restrictions only in protected areas, such as national parks or nature reserves. Therefore, in terms of these analyses this is the scenario showing **maximum theoretical potential**. Calculation (Table 3) showed that theoretical installed capacity, with assumptions explained in previous chapters is **3,143 MW**, and possible theoretical annual electricity generation of 6,949 GWh. For comparison, current installed capacity of all power plants in Croatia is around 4,000 MW and annual consumption amounts to approximately 19,000 GWh.

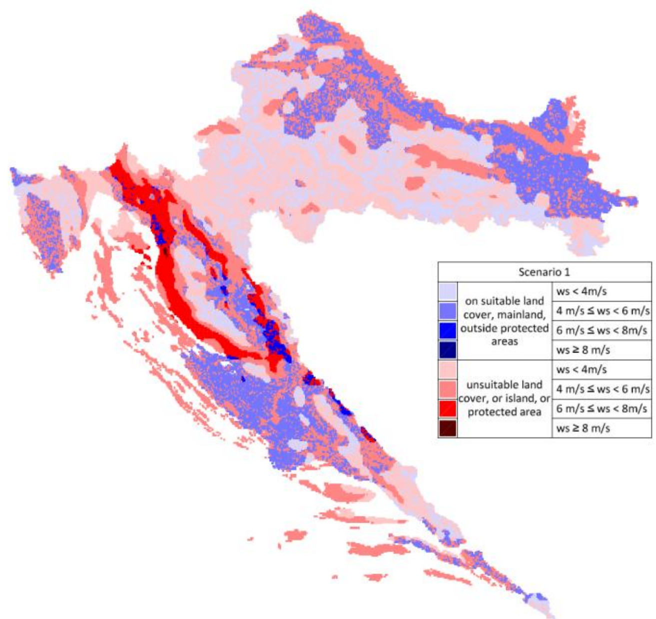

Figure 5 – Scenario 1

Table 3 – Scenario 1

Scenario	Wind speed	Total area (km^2)	Possible installed capacity (MW)	Possible annual production (GWh)
1	A	0	0	0
	B	566	3,143	6,949
	C	11,762		
	D	9,455		
Total A+B		**566**	**3,143**	**6,949**

B. Scenario 2

Scenario 2 (Figure 6) included wind resource on mainland, on suitable land cover, outside any kind of protected areas, SACs and SPAs.

Scenario 2 shows **"minimal" theoretical potential**, or potential that exists if all the locations with any kind of environmental protection would be completely excluded. It is

[3] the listed wind speed is the middle of 0.2 m/s bin

visible from Table 4 that this potential amounts to **1.051 MW**. Scenario 2 also shows the amount of wind potential "lost" if such a strict environmental policy is enforced. As it is visible from Table 4, around 2.100 MW of possible installed capacity or around 4.700 GWh of possible annual production lie in excluded SPA and SAC areas. That is around 2/3 of the potential evaluated in Scenario 1. It is important to note once more that this evaluation does not include other variables such as grid connection or access roads or similar.

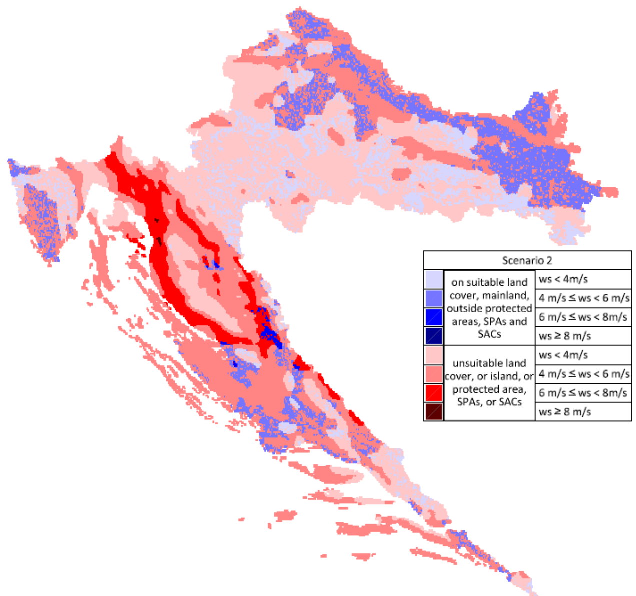

Figure 6 – Scenario 2

Table 4 – Scenario 2

Scenario	Wind speed	Total area (km^2)	Possible installed capacity (MW)	Possible annual production (GWh)
2	A	0	0	0
	B	189	1,051	2,324
	C	7,774		
	D	6,464		
Total A+B		**189**	**1,051**	**2,324**

C. Scenario 3

Scenario 3 (Figure 7) includes wind resource on mainland, on suitable land cover, outside protected areas and SACs and SPAs that inhabit species for which there is <u>evidence **or** **indications** of risk or impact by wind farms</u> (according to *Wind energy developments and Natura2000* [6], *Annex II., XX*). This also includes areas with species for which there is evidence on substantial risk of impact. Any kind of SPA or habitat with area below 20 km^2 is also excluded. This automatically excludes all point type SPAs and SACs. SPAs and SACs selected according to this criterion are denoted as SPAs(1) and SACs(1).

Although this is a less restrictive scenario than Scenario 2, the increase in potential is not significant, only around 10% or **1.129 MW** in total, as it can be seen in Table 5.

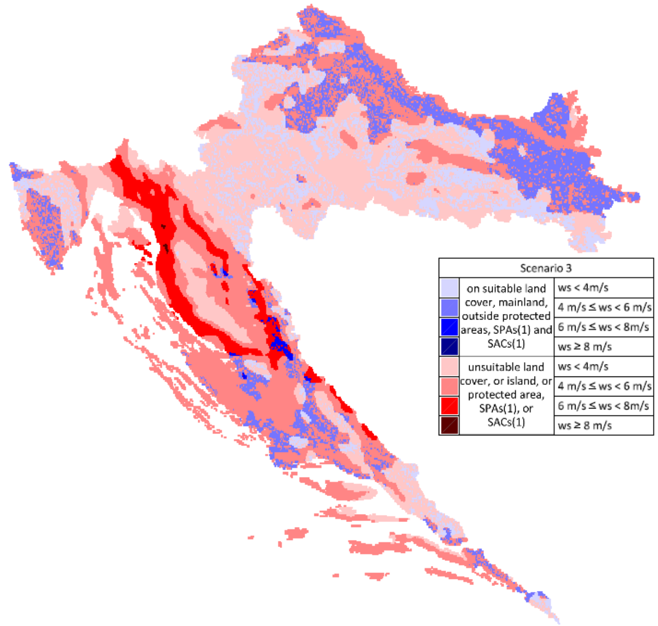

Figure 7 – Scenario 3

Table 5 – Scenario 3

Scenario	Wind speed	Total area (km^2)	Possible installed capacity (MW)	Possible annual production (GWh)
3	A	0	0	0
	B	203	1,129	2,496
	C	8,365		
	D	7,376		
Total A+B		**203**	**1,129**	**2,496**

D. Scenario 4

Scenario 4 (Figure 8) includes wind resource on mainland, on suitable land cover, outside protected areas and SACs(1) that inhabit species endangered by wind farms and SPAs(2) that inhabit species for which there is <u>evidence on **substantial** **risk** of impact</u> by wind farms (according to *Wind energy developments and Natura2000* [6], *Annex II., XXX*). Any kind of SPA or habitat with area below 20 km^2 is also excluded. The difference between Scenarios 3 and 4 is therefore only in SPA areas.

This is even less restrictive scenario than Scenario 3, and it shows that around 750 MW of possible installed capacity and around 1.700 GWh of annual production lie in areas without substantial risk of impact, but with evidence or indications of risk or impact by wind farms (SPA(1) - SPA(2)). Table 6 shows total calculated potential therefore to be **1.892 MW**.

Although wind speed category C is not considered feasible, it is important to note a significant difference in suitable/unsuitable C category areas in Scenarios 3 and 4. That difference is "situated" mostly in the Zadar, Šibenik and Split hinterland in the south of Croatia.

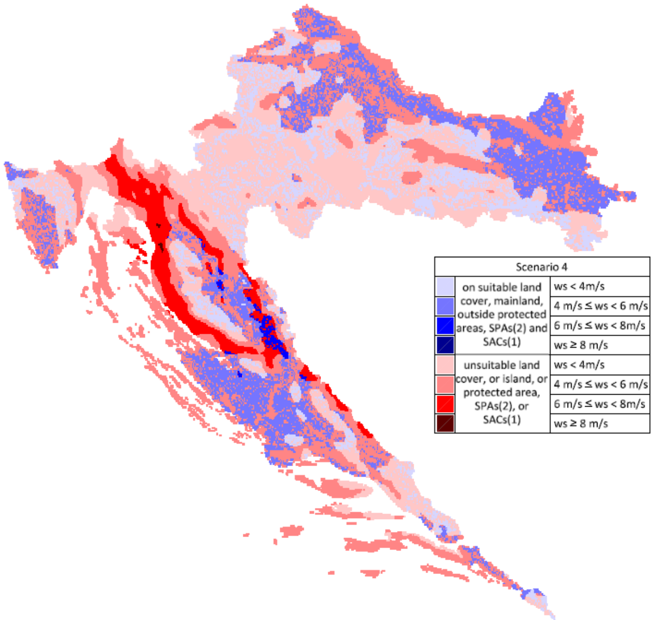

Figure 8 – Scenario 4

Table 6 – Scenario 4

Scenario	Wind speed	Total area (km^2)	Possible installed capacity (MW)	Possible annual production (GWh)
4	A	0	0	0
	B	341	1,892	4,185
	C	10,586		
	D	7,963		
Total A+B		**341**	**1,892**	**4,185**

VI. Key Findings and Recommendations

Having in mind that the resulting potential calculated in scenarios 1 – 4 is still theoretical, as it would be further reduced due to other constraints (grid connection, orography, access…), the results show rather scarce wind potential in Croatia.

However, one of the most important inputs for these calculations are wind speed data derived from ALADIN/HR mesoscale model, which seems to significantly underestimate the wind speed in Croatia. According to ALADIN/HR relatively low percentage of Croatian area has an average annual wind speed over 6 m/s at 80m a.g.l., most of it in Velebit region (approximately the area from Senj to Zadar on Figure 9) and Kvarner hinterland (approximately the area from Rijeka to Senj on Figure 9). There are very few areas in A or B category in a part of Croatia south of the city of Zadar (Figure 9). According to the methodology and criteria presented in this paper, almost no feasible wind potential would be found there.

It is interesting to compare these results with the current situation in wind energy in Croatia. As a first source of information, the data from RES&COGEN Registry (Registry) (14) are used. The Registry only shows an indicative list of projects as application to the Registry is a prerequisite for the start of wind measurements. According to the Registry from March 2011 there are 141 indicative wind farm projects totalling 6,311 MW of installed capacity, which is significantly more than the resulting 1,900 MW determined in Scenario 4. Furthermore, around two thirds of the total registered capacity (109 projects of around 4,605 MW) is situated in the four southern counties (Zadarska, Splitsko-dalmatinska, Šibensko-kninska and Dubrovačko-neretvanska), which according to results presented here have very little feasible potential. It is also interesting to note that out of 88 MW of wind farms currently operating in Croatia, more than half are situated exactly in the area that are now in C category according to the ALADIN/HR data.

Figure 9 – Map of Croatia showing major cities and county limits

These findings indicate that the presented results most probably underestimate the wind potential in Croatia, especially having in mind this methodology is not taking into consideration technical constraints like grid connection possibility, orography, access, etc.

Regarding CRO-NEN sites, especially SPAs that occupy a large part of Croatian costal area that is at the same time most suitable for wind development, judging by the interest of investors that registered their wind projects in the Registry, it would be reasonable to assume that wind farm projects can find a suitable part in this, rather vast, SPA area. Thus, during the process of selecting location of wind farms, particularly within CRO-NEN, special consideration should be given to the habitats that are of importance for **threatened** bird and bat species, such as rivers, wetlands, cliffs, forest edges etc., instead of just completely excluding the entire SPA area for development of wind projects. One possible solution is implementation of Strategic Environmental Assessment (SEA) and Ecological Network Impact Assessment (ENIA), that is already prescribed by Croatian regulations primarily in development of physical plans so that negative impacts of wind farms to birds and bats would be minimised and areas where construction of wind farms is (not) allowed would be more accurately defined. Competently selected areas would define clear rules for project developers as well as increase assurance of project realisation.

VII. Conclusion

The purpose of this paper was to present a methodology that could be useful for analysing available wind energy potential from the aspect of environmental or any other kind of restrictions and influential factors.

Although some results are presented, they do not constitute a solid basis for decision-making as they are based on wind speed data that significantly underestimate wind potential. Creation of wind atlas for Croatia, based on wind atlas methodology, or even CFD models would give much more detailed and accurate information on actual wind potential available. **Authors expect that wind potential calculated through wind atlas would be substantially higher than calculated based on ALADIN/HR model results**.

Depending on the level of detail and the scope of considered factors, this kind of methodology can be used in analysing national or regional wind energy strategies, network expansion plans, national or regional physical planning, project portfolio planning, etc.

This approach could also be used in evaluation of sites for solar plants, as they are still not as numerous as wind farms, so there is still chance for better and strategic approach in planning those sites.

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IX. Biographies

Diana Međimorec (maiden name Ognjan), IEEE Member, was born in Zagreb, Croatia in 1983. She graduated in 2006 in the field of energy technologies on Power systems department of the Faculty of Electrical Engineering and Computing (FER), University of Zagreb. In 2006 she received the award from Croatian energy society for excellent success in studies and exceptional thesis. After working one year abroad, Diana started her part-time PhD study again at FER, Zagreb in 2007 where she focuses on research in the field of wind energy. Diana is also a full time employee of HEP-Renewable energy sources Ltd. where she works on development of renewable energy projects, with special emphasis on wind projects.

Siniša Knežević was born in Osijek, Croatia in 1979. He graduated in 2002 in the field of energy technologies on Power systems department of the Faculty of Electrical Engineering and Computing (FER), University of Zagreb. In 2003 he received the award from Croatian energy society for an exceptional thesis. His professional experience started in 2003 working for Croatian DSO. In 2007 Siniša moves to HEP-Renewable energy sources Ltd. and starts working on development of RES projects. In 2008 he joined the researcher team in Energy institute Hrvoje Požar where he is focused on technical consultancy services and research in the field of wind energy.

Veljko Vorkapić was born in Zagreb, Croatia in 1978. He finished Biology-Ecology at the Faculty of Science, University of Zagreb, Croatia in 2003. In 2005 he finished MSc Environmental Change and Management at Oxford University, UK. His professional experience started in 2005 working for Ekonerg Ltd. mainly on EIAs and climate change issues. Since 2009 he is a researcher in Department of Renewable Energy Sources and Energy Efficiency, Energy Institute Hrvoje Požar where he focuses on environmental assessment of energy sector and biomass projects.

Davor Škrlec, IEEE member. Professor of the University of Zagreb, employed at the Department of Power Systems, Faculty of Electrical Engineering and Computing. In 1990 he received his MSc degree and in 1996 his PhD degree in electrical engineering from the University of Zagreb, Faculty of Electrical Engineering and Computing. Research and professional interests include: planning and operation of electrical power networks, distributed energy resources, power systems economics, and geographic information system applications in the power utilities. He has published more than 50 papers from his area of interest and he is author and co-author of several professional books. He is a principal investigator and project leader of several projects funded by industry and government. Core activities within the research activities are focussed on optimal planning and operation of active distribution networks and micro grids. He is active member of IEEE, CIGRE and CIRED.

X. Annex

A. List of birds and Special Protection Areas:

Table 7 – Birds – Evidence of substantial risk of impact (Annex II [6] marked with XXX)

Gavia stellata	not listed	HR1000023
		HR 100032
Milvus milvus	not listed	not listed
Haliaeetus albicilla	HR2000465	HR1000001
		HR1000003
		HR1000004
		HR1000005
		HR1000006
		HR1000009
		HR1000010
		HR1000011
		HR1000014
		HR1000015
		HR1000016
Gyps fulvus	not listed	HR1000033
Neophron percnopterus	not listed	not listed
Circaetus gallicus	not listed	HR1000033
		HR1000036
Aquila adalberti	not listed	not listed
Aquila chrysaetos	not listed	HR1000018
		HR1000019
		HR1000027
		HR1000028
		HR1000030
		HR1000033

Table 8 – Birds – Evidence or indications of risk of impact (Annex II [6] marked with XX)

Ciconia ciconia	not listed	HR1000001
		HR1000004
		HR1000010
Anser albifrons	not listed	not listed
Anas penelope	not listed	not listed
Clangula hyemalis	not listed	not listed
Melanitta nigra	not listed	not listed
Circus cyaneus	not listed	HR1000004
		HR1000024
		HR1000026
		HR1000033
		HR1000036
Circus pygargus	not listed	HR1000004
		HR1000010
		HR1000021
		HR1000023
		HR1000024
		HR1000029
Buteo buteo	not listed	not listed
Aquila pomarina	not listed	HR1000006
		HR1000010
		HR1000016
Falco tinnunculus	not listed	not listed
Lagopus lagopus	not listed	not listed
Tetrax tetrax	not listed	not listed
Pluvialis apricaria	not listed	not listed
Vanellus vanellus	not listed	not listed
Gallinago gallinago	not listed	HR1000004
		HR1000021
Numenius arquata	not listed	HR1000023
Sterna sandvicensis	not listed	HR1000023
		HR1000032
		HR1000033
Sterna hirundo	not listed	HR1000002
		HR1000005
		HR1000014
		HR1000033
		HR1000034
Sterna albifrons	not listed	HR1000002
		HR1000014
		HR1000034
Uria aalgle / Alca torda	not listed	not listed
Chersophilus duponti	not listed	not listed
Oenanthe oenanthe	not listed	not listed
Sturnus vulgaris	not listed	not listed

B. List of bats and habitats:

Table 9 – Bats – All species (Annex III [6])

Rhinolophus ferrumequinum	HR2000185
	HR2000035
	HR2000085
	HR2000067
	HR5000022
	HR2000005
	HR2000167
	HR2000189
	HR3000213
	HR2000186
Rhinolophus hipposideros	HR2000185
	HR2000085
	HR2000067
Rhinolophus euryale	HR2000185
	HR2000085
	HR2000023
	HR3000197
	HR2000005
	HR2000167
	HR3000213
	HR2000186
Rhinolophus mehelyi	not listed
Rhinolophus blasii	not listed
Myotis myotis	HR2000174
	HR2000185
	HR2000023
	HR5000022
	HR2000005
	HR2000203
Myotis blythii	HR2000005

	HR2000203
	HR2001114
Myotis punicus	not listed
Myotis daubentonii	not listed
Myotis emarginatus	HR2000185
	HR2000023
	HR2000871
	HR2000167
	HR3000213
Myotis nattereri	not listed
Myotis mystacinus	not listed
Myotis brandtii	not listed
Myotis alcathoe	not listed
Myotis bechsteinii	HR2000580
	HR2000178
	HR2000185
	HR2000878
Myotis dasycneme	HR2000580
	HR2000178
Myotis capaccini	HR2000085
	HR2000592
	HR2000023
	HR2000005
	HR2000167
	HR2000918
	HR2000154
	HR2000020
	HR2000189
Nyctalus noctula	not listed
Nyctalus leisleri	HR5000022
	HR5000037
Nyactalus lasiopterus	not listed
Eptesicus nilssonii	not listed
Eptesicus serotinus	not listed
Vespertilio murinus	not listed
Pipistrellus pipistrellus	not listed
Pipistrellus pygmaeus	not listed
Pipistrellus kuhlii	not listed
Pipistrellus nathusii	not listed
Hypsugo savii	not listed
Plecotus auritus	not listed
Plecotus austriacus	not listed
Plecotus macrobullaris	HR5000022
	HR2000048
	HR2000878
Plecotus kolombatovici	HR2000048
Barbastella barbastellus	HR2000185
	HR2000067
	HR5000022
Miniopterus schreibersii	not listed
Tadarida tenotis	not listed
Rousettus aegipticus	not listed