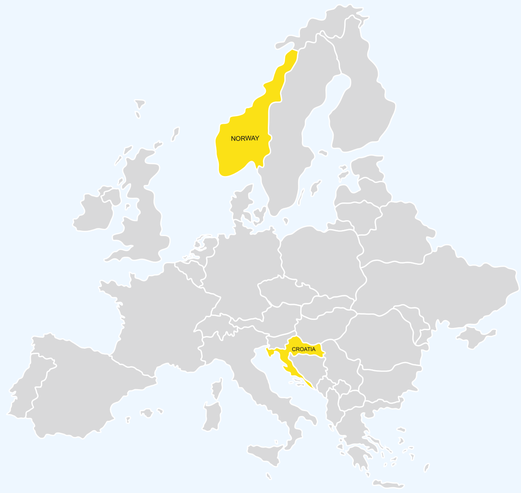
Transnational experience exchange between countries towards speeding up EU renewable transition: Example of Norway-Croatia



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Project duration: 2023. - 2024.
Project partners: Faculty of Engineering, University of Rijeka, Croatia, Norwegian Research Centre NORCE, Grimstad, Norway

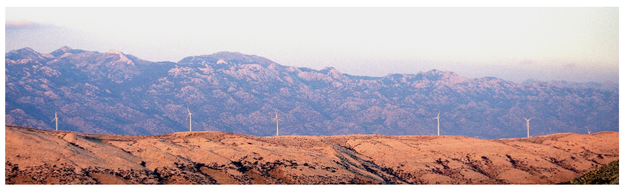
Introduction:

The RePowerEU plan has a plan for an increase of wind energy to 480 GW by 2030 and 300 GW from offshore wind farms to achieve goals of climate neutrality by 2050. Due to Croatia's substantial dependence on nautical and coastal tourism and great concern regarding the negative environmental impact, the installation of offshore wind farms has not been previously conducted. However, due to increased demand for renewables the potential of offshore energy resurfaced.The recent Action Plan for the uptake of Offshore Renewable Energy Sources in Croatia (May, 2023) estimated offshore wind potential at 25 GW and identified more than 29 000 km^2 of area available for offshore renewables. The main problem is that Croatian legislation is not prepared for such installations and currently, the available capacity of the grid is not sufficient for large projects at sea. Examples of good practice can be found in countries which have vast experience in offshore energy harvesting, such as Norway. Bilateral actions between countries can help in establishing dialogue and suggesting most suitable solutions. Norway's vast experience in offshore engineering and pioneering developments in offshore wind,make it a suitable partner in joint innovation and a resource for tried and tested best practices.

As an outcome of collaborative research, the work outlines the required evaluations in Croatian context, in terms of the social, environmental, legislative and technical aspects that are to be considered towards large scale integration of wind energy into the Croatian grid and identifies necessary grid improvements to achieve a reliable and sustainable grid of the future.

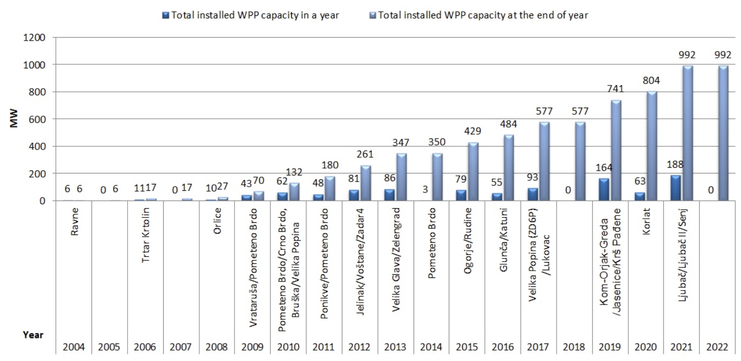
Wind potential in Croatia

- The first wind farm in Croatia was built in 2004 (WPP Ravne 1 - island Pag).



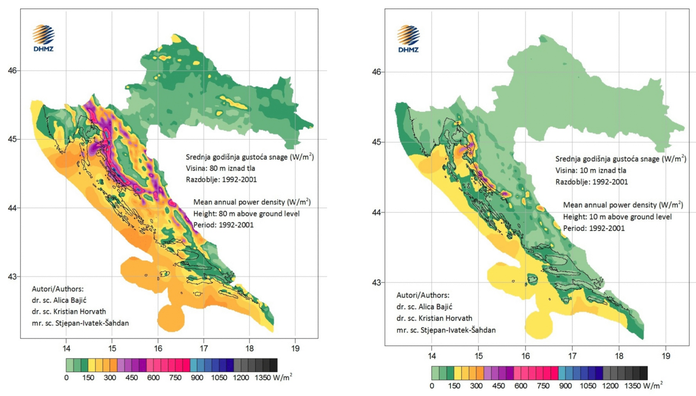
Wind farm Ravne 1 - island Pag, Author Timur V. Voronkov - Self-photographed, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=15718382

- In 2022. there were 25 wind power plants with a total installed capacity of 834.15 MW.



Source:The independent Transmission System Operator in Croatia (HOPS)

WPPs in Croatia have low geographical dispersion - 19 out of 22 WPPs are located in the area with similar wind climate



Wind farms on islands

- From 2007 to 2013 WPP building was forbidden on the islands by the Law on Spatial Planning.
- Currently WPPs can be built on islands but 1000 m away from the shoreline - this is limiting since most islands have average an width of up to 10 km.
- Building is forbidden for all renewable energy power plants that can be visible from the sea.
- Wind potential has been identified for islands Krk, Cres,and Pag however there are no WPP projects.

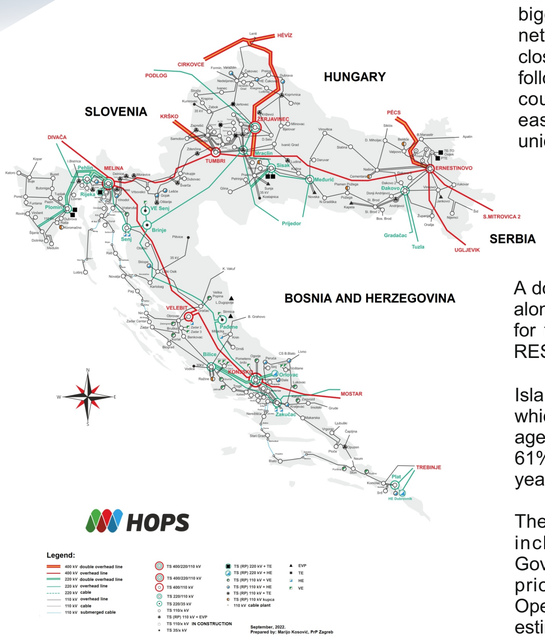
"Action Plan for the uptake of Offshore Renewable Energy Sources in Croatia" by RES Croatia, May, 2023. identified more than than 29 000^2 km of area for offshore renewables. Areas as potential offshore installation locations are depicted in figures.

Zone of medium impact on the landscape and seascape with depths up to 60 m

Zone of low impact on the landscape and seascape with depths up to 60 m

Offshore potential

Technical issues



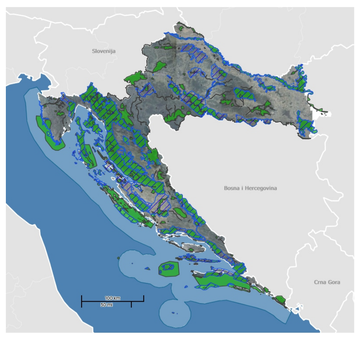
Unfavorable shape of the power grid is one of the biggest problems. Highest voltage level transmission network in the Republic of Croatia does not have a closed loop but is more of a radial character since it follows the longitudinal topology follows the shape of the country with two prominent branches: southern and eastern, with an island connection that represents a unique example in Europe.

A dominant number of RES projects are being developed along the coast and in the hinterland, which is unfavorable for the connection due to the extremely small variety of RES locations.

Islands are connected to mainland with submarine cables which average lifespan is between 30 and 35 years. The age of the network is a significant problem as more than 61% of the lines are older than the expected lifetime of 40 years.

The project of replacing 110 kV submarine cables is included in the List of Strategic Projects of the Government of the Republic of Croatia and represents the priority plan of the Croatian Transmission System Operator (HOPS) in the period until 2024. This investment estimated at 58 million EUR.

Environmental issues and social acceptance



Natura2000 protected areas in Croatia.

Source: Institute for Environment and Nature at the Ministry of Economy and Sustainable Development (2024): Bioportal – Natura2000. Available at http://www.bioportal.hr/. Accessed: 6.1.2024.

Lubenice, island Cres

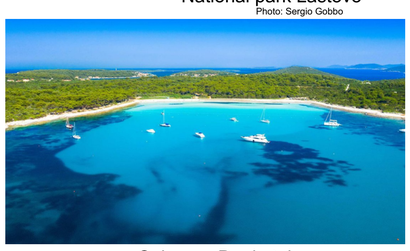
Island Vis Photo: Aleksandar Gospić

Croatia has a large number of protected natural areas and its tourism is largely focused on natural beauty and well-preserved areas. Since tourism is a major industry of country's economy (accounts for around 20% in gross domestic product (GDP)), therefore there is often a lot of opposition to interventions in nature. Large part of Croatia coast is under Natura 2000 protection with 3 National parks (Brijuni, Kornati, Mljet) and 2 nature parks on islands (Lastovo, Telašćica).

National park Lastovo
Photo: Sergio Gobbo

Island Korčula

National park Kornati



Sakarun, Dugi otok

Photos: Croatian National Tourist Board(CNTB)

Possible solutions

Knowledge exchange of scientific research

• Bird colision

Researchers [1] estimated 140,000 to 328,000 birds are killed every year in collisions with wind turbines. **Croatia has large Natura 2000 protected areas for bird habitats so bird collision concerns have already stopped or slowed down some projects.** Painting of turbine blades has been shown to reduce collisions [2] but is not as efficient during the low lights [3]. Garcia-Rosa and Tande, 2023 [3] proposed an active concept - bird detection and tracking based on LIDAR or camera so trajectory movement can be calculated and small adjustments to the rotor speed can be implemented for collision avoidance. Ornithology researchers from Cornell, New York proposed that radar signals used for rainfall monitoring are used to prepare bird mitigation maps so wind farm operators can stop or slow down wind turbines [4].

References:
[1] Loss, Scott R., Tom Will, and Peter P. Marra. "Estimates of bird collision mortality at wind facilities in the contiguous United States." *Biological Conservation* 168 (2013): 201-209.
[2] May, R., Nygård, T., Falkdalen, U., Åström, J., Hamre, Ø. and Stokke, B.G., 2020. Paint it black: Efficacy of increased wind turbine rotor blade visibility to reduce avian fatalities. *Ecology and evolution*, *10*(16), pp.8927-8935.
[3] Garcia-Rosa, P.B. and Tande, J.O.G., 2023, October. Mitigation measures for preventing collision of birds with wind turbines. In *Journal of Physics: Conference Series* (Vol. 2626, No. 1, p. 012072). IOP Publishing.
[4] Tom Metcalfe. "Wind energy takes a tool on birds, but now there's help", 2018. Online: https://www.nbcnews.com/mach/science/wind-energy-takes-tollbirds-now-there-s-help-ncna866336

Image by May et al. 2020 [3] licensed under CC BY 4.0.

• Marine biodiversity

Installation of the first offshore wind turbines in Croatia can lead to concern regarding marine biodiversity and microplastic pollution. Large-scale offshore wind farms at Southern North Sea II have been investigated in Austrheim et. al. 2022. [1]. Some of the conclusions are that noise during the construction phase can lead to temporary displacement of fish species, but it can be dealt with appropriate mitigation measures. Detailed report on offshore wind farms on marine life has been conducted in [2]. It is noted that current evidence indicates that offshore wind farms do not constitute a significant risk to marine life during operational phase but research needs to follow changes in offshore wind farms which are becoming larger and installed at greater depths. Cumulative effects also need to be evaluated which are location specific. Coexistence between offshore wind energy and fisheries can also be a viable solution, however continued dialogue has been noted as central component [1]. Such investigations can be important for future projects in other countries that plan to develop wind farms, and can be very important for increasing social acceptance.

References:
[1] Austrheim, E., Dahlgren, T.G., Handberg, Ø.N., Hestetun, J.T., Haugland, L.M., Aslesen, S.R. and Navrud, S., 2022. Wind and Fisheries: Desktop Study on the Coexistence Between Offshore Wind and Fisheries in Sothern North Sea II.
[2] Bergström, L., et al. "Effekter av havsbaserad vindkraft på marint liv." Online: https://www. naturvardsverket. se/om-oss/publikationer/7000/978-91-620-7049-6 (2022).

• Microplastics

Increased concern regarding microplastics in marine environment produced false reports that wind turbine blades are shedding dangerous amounts of microplastics and BPA because results were extrapolated from studies without considering the context of research. Although these reports were later disproved [1], the damage was already done to public perception. Therefore, microplastic measurements are needed to provide evidence of environmental impact. During the operation of offshore wind turbines leading edge erosion can occur due to mechanical (abrasion) photochemical (UV light) and physical stress (temperature cycles) so plastic fragments can be released in the surrounding environment. Mooring performed using plastic gears (ropes, pontoons, plastic polymers based antifouling paints) can also be a source. Therefore, monitoring and dispersion modeling is required to understand the sources, transport, occurrence, and fate of small microplastics. Such investigations are conducted in NORCE.

Reference:
[1] "Microplastics and BPA in Wind Turbine Blades, Claims vs. Facts", American Clean Power, 2023. Online: https://cleanpower.org/wp-content/uploads/2023/03/ACP_MicroplasticsFactSheet_March-2023.pdf

Experience exchance through European Commission initiative "Clean energy for EU

The Clean energy for EU islands secretariat is the central platform for the clean energy transition of the more than 2,200 inhabited European islands. It informs about policy and regulatory issues for Europe's island communities and provides dedicated advice for capacity building and clean energy transitioning. Currently, Croatia participates with 11 islands and Norway with the island Eigerøya. Web page: https://clean-energy-islands.ec.europa.eu/

Island Eigerøya

Chosen as demonstration location for ROBINSON Horizon 2020 project (project duration 2020-2024) with the aim to decarbonize the island through developing an intelligent, flexible, and modular Energy Management System (EMS), better integration of Renewable Energy Sources (RES), optimization and validation of innovative technologies, etc.

It has an area of 20 km2 with around 2500 inhabitants (800 households). Almost 100% of electricity is imported from mainland by undersea cable. Results and insights from this project could be implemented in Croatian islands.

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Future direction

The need for the rapid increase of renewable energy share and decarbonization goals require experience exchange about problems, potentials, and possible solutions between countries. As a future direction, establishing new and strengthening existing collaborations can be an essential factor for ultimately speeding up the process of green transition.

CRECI
Iceland Liechtenstein Norway grants
REPUBLIKA HRVATSKA Ministarstvo regionalnoga razvoja i fondova Europske unije
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NORCE