ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
Υπουργείο Παιδείας,
Έρευνας και Θρησκευμάτων

Co-funded by the
Erasmus+ Programme
of the European Union

2nd Junior High School of Amaliada

ERASMUS+ PROGRAMME KA 2 STRATEGIC PARTNERSHIP "European Schools Go Green" 2017 - 2020

Panagiotis Psychogios teleconference Interview video

Renewable energy – Wind Turbines – Wind Farms

Panagiotis Psychogios

videoconference-Interview

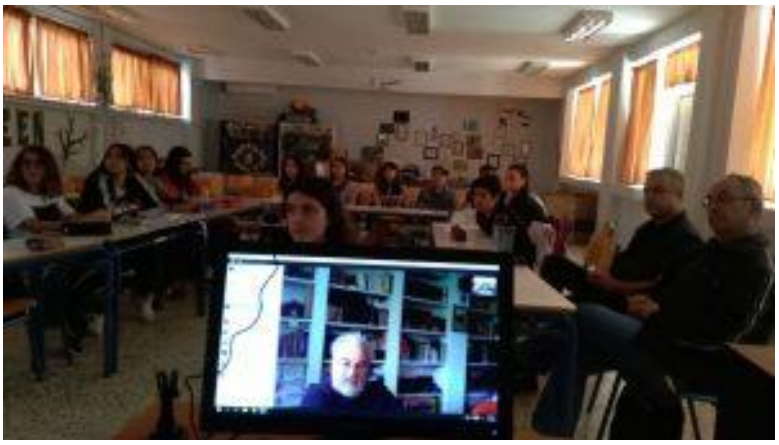
transcript in English

As part of this last year of our three year Erasmus+ project work, students of 2nd Junior High School of Amaliada, Greece, present interviews by scientists, experts, politicians, activists and political scientists in 2019- 2020. Our students interviewed last year (2019) Mr Panagiotis Psychogios about manifacture, installation , use, maintenance and

transportation etc of renewable energy wind turbines. Panos Psychogios as a very skilled and experienced civil engineer is very often responsible for the biggest arrays of large turbines, known as wind farms, who are becoming an increasingly important source of intermittent renewable energy and are used by many countries as part of a strategy to reduce their reliance on fossil fuels.

Panos Psychogios is a Civil Engineer and the director at PPsEngineering* . Experienced Director with a demonstrated history of working in the civil engineering industry. Skilled in AutoCAD, Geotechnics, Cost Management, Earthworks, and Steel Structures. Strong professional with a MS focused in Civil Engineering from National Technical University of Athens.

**PPs is a leading Structural Consulting Engineering firm known for its innovative and quality work. They have an established and extensive presence both in Greece, and abroad, having undertaken numerous large and complex projects in the greater Balkan and European area.*



The interview - teleconference with Mr Panagiotis Psychogios.
Mr Psychogios is live from his office almost 300klm away, and we are in our Erasmus multi-purpose specially equipted classroom of our school , students and teachers of the Erasmus team

Mr Panagiotis Psychogios was very happy to give this interview after we contacted him, and we had a wonderful and inspiring one hour teleconference connecting our Erasmus+ multi-purpose room in our school with the office of Civil Engineer and Expert on Wind Farms constructions Mr Panagiotis Psychogios 300 klm far from Amaliada.
It is always wonderful to have such great personalities and specialists in our school!
Even through a screen!

Students and teachers of our school's Erasmus team enjoyed it a lot!

It was so interesting that students kept him for more than an hour online through a teleconference platform to ask him all that they wanted and had prepared. He was so enthousiastic on answering in as many details as he could even in a not so good quality connection, that he gave us so many amazing information we think everybody will be very interested in this interview. We learned so many things we would never have guessed ! He was very warm and also congratulated our students for their interest and their work in the project and was very glad to see and talk to them even through a web cam. We all felt very happy and honoured to have him in our school even only through in a big screen!

(That is why the students during the video look up to the right – left for the viewer- as they were watching Mr Psychogios talk in the big screen in our multi-purpose room!

The full video, which is in Greek, is published on our "European Schools Go Green" youtube channel. Here follows a transcript , freely translated in English, with all of the questions of students and Mr Psychogios answers.

Thank you so much Mr Panagiotis Psychogios!!!!

The following photos of wind turbines and farms , which are also included in our video, are kindly provided by mr Panagiotis Psychogios

Start of video:

Mr Panagiotis Psychogios is presenting himself and his work on wind turbines and wind farms study and construction. He also explains, giving some general information on wind turbines production, that they are getting bigger as time passes, and that wind turbines' wings (blades) size is relevant to the amount of energy they can produce. So they make them taller to be able to make the blades bigger as well. But as all wind turbines get bigger, the bigger the problems get concerning installation, wind farms licences, , maintenance, mechanical and functional problems etc.
Last wind farm Mr Panagiotis Panos had constructed (during this interview in 2019) was 130 m tall, high as a small skyscraper, so the foundation needed a very large area.

Student Pavlina Dalamara asked what is the economical cost of a wind turbine construction, installation and operation in comparison with the expected profit later from the energy production.

Mr Panagiotis Psychogios says that the cost is relevant to the amount of energy it produces in Mega Watts. It is more or less something about 1 euro per Watt. For example one wind turbine that produces 3,5 Mega Watts costs approximately 3.500.000 euros. But it is interesting that smaller wind turbines cost actually more, as the smaller they get the more expensive their parts are because they are more difficult to be constructed, and as we get less energy production the cost ends up higher. The profit of wind farms needs very complicated calculations, and it varies as it depends foe example on the price the electric energy is sold to the network, on the changes in energy demand, the local network grid and systems, the different time of day and night needs etc.
One advantage is that you can turn off remotely the wind turbine if the energy demand is low to prevent it from working for no reason. *Mr Psychogios also suggests to students to study Energy Engineering as it is a most promising profession.* Companies that istall wind farms are always calculating in detail their investment before they proceed to wind farms construction. The wind farms life is unfortunately now only 8 to 14 years as the wind turbine after 20 years of use is becoming very expensive to maintain.

Student Katerina Dimitrakopoulou is asking where the wind turbines are being constructed and what materials are used exactly.

Mr Panagiotis Psychogios says that for the construction of wind turbines many different materials are used for the numerous parts. The foundation made of reinforced concrete, the tower made of steel, the engine nacelle made of steel containing the generator and gear box are made of steel and copper and other materials, the blades are made of carbon fibers and plastic and many many more special materials are used for all the electronic systems and wires inside, and for all kinds of the other different parts. In Greece there is Wind Turbines production firm that constructs turbines , and all others are imported by countries like Spain, USA, Italy, Denmark and many firms around the world.

Dionyssia Makarouni asked if now there is wind turbines manufacturing industry in Greece and if their production is similar to other foreign industries.

Mr Panagiotis Psychogios says that there is one at least (2019) Greek firm , one which was the first and had its main large wind turbines production unit based in the city of Tripolis. It designs and manufactures wind farms, and they were the first to do it in Greece. (Today there are some others with smaller wind turbines production too) Mr Psychogios added that it is a mistake that in Greece we do not produce and install small wind turbines, to use in areas where houses are away from energy networks and grids. We prefere to buy small wind turbines from China. It is very easy to construct a small wind turbine, he insists. And as in the past many farm houses around the Greek country used small home-made wind turbines to pump water, for wind mylls etc, Mr Psychogios says that it is a pity not to make

more now, as of course we need only a rotor which is moved by the wind and a stator to support it. The magnetic field that they produce is something that can be proven easily in a simple school experiment, and very usefull knowledge.

Evi Iliopoulou asked how exactly the large wind turbines are being transported.

Mr Psychogios says that the transportation is a very big and complicated issue as they are very large. They use special vehicles and platforms for the blades and other parts transportation. The mountains in Greece are very high and have such complex geomorphology, roads are full of turns etc that specialists on the wind turbine parts transportation are first investigating, calculating and studying the areas. It is so difficult that even new roads must be constructed, make exhisting roads larger and turns wider, prepare special areas for the vehicles to make difficult manoevres, cut trees etc The vehicles are enormous, because the parts like towers and engines nacelles (which are like… little houses) weight around 45 tones. The country and even national roads in Greece are not big enough for them! National roads bridges are too low (5 meters top) for the parts to pass beneath. So it is better to use open large roads leading to ports, so that the parts are transported on ships and on specially prepared roads up to the high mountains.

Kaouki Matina asked what is inside a wind turbine.

Mr Psychogios says the towers are empty, they contain only steel ladders , a very hard and long way up especially in the highest wind turbines. If you have to climb that up it will certainly leave you breathless and needs a lot of patience. It also sometimes contains a small assisting lift , only for heavy tools and equipment parts, as 130 meters is a long climb with tools to do the maintenance. Those lifts are not made to be used by humans. The tower starts at the bottom from a room with 4,5 meters diameter and ends up high in a 2,5 meters diameter space.

Student Georgia Vassilopoulou asked about the dimensions of the wind turbines and the amount of the energy production.

Mr Psychogios explains again that the amount of energy produced depends on the total diameter of the circle the wings make. The wider it is, the bigger the amount of energy production. The biggest electricity company of Greece had first installed wind turbines with 15 meters diameter only in the past. Today their diameter is around 100 meters! The tower dimensions depend on the length of the wings. It is of course dangerous to be close to the ground, as wind changes closer to earth and loses energy, so other kind of wind power moves the upper parts of blades and parts that are lower turn with different wind power too. That is dangerous for the blades to fail. It is better to construct very high towers in order to use the wind equally during the wings rotation. The higher away from the ground the blades are, the better.

The concrete foundations have 20 m diameter and are 3,5 m high. Usually the soil and ground of the mountains is good for the stability of foundations. But the dynamics change all the time so it needs very good foundations and careful safety issues management. That is why for example when the wind is too hard the wind blades stop working automatically as it is dangerous. It is possible that the blades touch the tower so the whole turbine is destroyed within seconds ,as you can see in many fail videos in the internet. The tower tube starts at the bottom from a diameter from 2 to 4,5 meters and ends up high to 2,5 meters. The tower tube walls are made of steel 2,5 cm thick. That makes the tower very heavy. The diameter and the thickness of the tube is getting a little smaller as we go up, as the air pressure is lighter than closer to the ground. It is very complicated for the specialists to calculate everything and combine all the engineering and mechanic functions properly. But it is simpler for the rest of us to understand how it basically works comparing it to a …simple straw. Also the wind bends not only the tower but the blades as well, and not in the same way, so the engineer has to calculate everything in detail to prevent the blades from hitting the tower.

Eytychia Georgakopoulou asks where the wind farms are constructed and how the areas where the wind farms are installed are selected.

Mr Psychogios explains that there are many laws and restrictions concerning wind energy development. The areas selected are defined on a special official map according to all wind farms laws and national and international policies. There is a national plan with many restrictions. The wind turbines are not affordable if installed one by one, so the 40-50 Mega Watts wind farms are usually the best solution. If a wind turbine produces around 1,5 Mega Watt , we need 20 wind turbines for a wind farm. If it produces 4 to 5 Mega Watts we need 10 etc. We need constant medium stable wind flow, so we prefere high mountains, large valleys and close to the sea areas where the wind finds no obstacles. The blades start to turn when wind has a speed of 3 meters per second (12 km per hour), as the most they can support is a a speed of 20 m per second. If the wind is faster the turbines stop turning automatically as it becomes dangerous. So not all areas are suitable for wind farms anyway. Before installing wind farms, a little very high wind turbine is testing the wind flow of the area examining and measuring the wind conditions for one or two years! Wind farms are very expensive projects to take risks. Many laws and restrictions are limiting the possible areas too: Distance from houses, environmental issues etc

Danai Apostolopoulou asked how long it takes to construct a wind turbine.

Mr Panagiotis Psychogios says that you get a turbine one year after you order it. But to get the licences to construct a wind farm it takes much more, 3 to 10 years, and even up to 100.000 pages of applications forms , licences and certificates. The bureaucracy is enormous and the application procedures are very long. Usually it takes 7 years. First it needs an application for the selected area, as many of the areas are public property and part of the country's natural forests etc An application procedure to get permission to use 10 square km for each wind turbine, complied environmental laws, archaeological sites distance restrictions, public and local authorities, prefectures and municipalities agreement etc… For example Mr Psychogios has spent for all this procedure even up to 12 years for one project. Further more the construction can not take place during winter time as mountains weather does not allow it. The total wind farm installation and roads preparations and construction takes approximately 2 years. One very difficult part is also the connecting the wind farm with the right high voltage electricity network which usually is not close to the mountain tops etc But Mr Psychogios says that if you want to install a small wind turbine in your house is much easier !!!

Nikos Aivaliotis asked how many wind farms are there in our country and what are the plans for the future.

Mr Psychogios says that now (2019) our energy production by wind farms nationally is soon going to be around one Giga Watt. He points that we have very good sea winds so we can continue on sea wind farms . Sea farms are the future and they are installed on special sea platforms ,150 m high above sea level, and it is easier to obtain permissions for that. They are like ships with anchors , difficult and complicacted to construct and operate but it seems it is the future. Bureaucracy is always a problem though. We now produce 700 Mega Watts (2019) and 230 Mega watts are programmed to be produced the next two years (2020-2021). 700 Mega Watts is close to the energy produced by large Power Plants like the one in Megalopolis, Greece, which produces electricity from coal and lignite for all of southern Greece and the islands. But one significant difference is that wind farms are not always producing stable energy ,so their power is not always accepted by the network. The wind farms are working approximately 2.000 hours per year. Wind Farms are also tested for 5 to 6 months by the electricity network companies before allowing connecting to it. Mr Psychogios says that he is now (2019)constructing an 11 wind turbines wind farm on Acarnanian Mountains, Greece, with 45 Mega Watts capacity . In 2018 it was stopped by an early winter snow, and work continued in summer 2019. Also as Greece's possible wind farms installations areas are not so many, the future of Greece's wind power is in the sea. The goal of renewable Energy production in Europe is 20 per cent by 2021 but now we are at 18 % (2019). Mr Psychogios says that until 2021 we will be able to produce 20% of the country's energy needs by renewable energy sources only.

Efi Tarama asks why the parts of wind turbines are not carried up to the mountains by helicopters, so that we do not have to deal with all the transportation and road constructions problems.

Mr Psychogios replies that the parts of the wind turbines are very large and heavy. If wind flow change suddently while a helicopter carries a part it is very dangerous. Helicopters can carry great weights, and some times have carried small parts, but not the wind turbines large parts. The parts of the wind turbines are so large because we need to minimize and limit the assembly time and procedures. Smaller parts would make it more complicated and much more expensive because of the isolated areas they have to be taken. In some places though smaller wind turbines parts are carried by helicopters and installed when there is no other transportation option.

Theodosis Bobis asks what is Greece 's use of renewable energy compared to other countries.

Mr Psychogios repeats that the goal of renewable Energy production in Europe is 20 per cent by 2021 but now we are at 18 % (2019). Mr Psychogios says that until 2021 we will be able to produce 20% of the country's energy needs by renewable energy . Many countries though are already there. Germany's goal for example is to close down all Nuclear Power Plants and

replace their production with renewable energy sources. Enormous solar power plants are being developed there and very large wind farms require less bureaucracy than here. Here it is most common that the habitants object to wind farms installations. In Germany they install wind farms in the valleys and cultivate the fields beneath at the same time. All countries who havesigned Kyoto Protocol are trying to reduce gas emissions and turn to renewable energy sources. England is another different example as it is a low land and they may have many rains but no high mountains, so water power plants are not applicable. So they use mostly the sun (but how much sun can we find in north countries usually?) and the wind. So each country has to find special unique combinations and solutions. It is very difficult. Italy , France and Spain are not so ready for their renewable energy capacity goals. Denmark is one of the first who have succeeded, mostly based on wind farms as the north countries do not have a lot of sunlight. North countries lack sunlight, center of Europe lacks wind power too. Usually we have more wind power near sea. So the economical criteria are very carefully examined according to each country's geomorphical and weather profile.

John Ntousas asked what impact do wind farms have on plants and animals of the areas they are installed

Mr Psychogios says that plants are not so affected as they can grow again after the foundation construction. Animals and birds are easily used to the wind turbins sounds too.. The turbines sound like an air condition unit when working, 60 decibel in a 100 meters distance and a repeated "tak" sound. Birds though are in danger, that is why wind turbines are not allowed to be installed in wild birds migration flyways. The birds can not calculate the blades turning speed and blades may hit them. Unfortunately some birds are killed by wind turbines. Some maintenance workers have calculated 20 small birds hit by turbine blades in a big farm per month. Birds can not avoid the blades as they can not avoid some times cars etc.

Mr Grigoris Vassilopoulos asked if we can install a small wind turbine in our school, based on the energy study we conducted and the school model we constructed with our school's "green" energy modifications proposal, as part of our Erasmus+ project work. We had calculated that we needed 5 KW wind turbine capacity and that in the area we have winds of 3m per second. Mr Vassilopoulos also asked if Mr Psychogios has installed wind turbines in schools and if wind energy is used more than solar energy in Greece. He also asked if we can store energy from wind farms.

Mr Psychogios says that the horizontal axis wind turbines (HAWT) are better than vertical axis ones to use in urban areas. For example in Singapore they have installed wind turbines high up between skyscrapers. He answered that he has not installed any wind turbines in schools in Greece and that the only ecological project in schools he has participated in is an eco-roofs project, terrace gardens which act as a natural filter and source of clean air. He also said that 3 m per second wind speed in our school' s area is very good for a small wind turbine, as small turbine function start from 1,8 m per second speed. But the energy

production will be smaller, as for the capacity of 5KW we need constant wind speed of 12 m per second maximum, 40 klm per hour. He says too that wind power is used more than solar power, as wind power produces 700 MW and solar power around 500 MW). But solar power plants were easily installed and they produce consistent energy. Wind farms are also very far away from electricity network so it is much more expensive to connect it to the electrical grid. Mr Psychogios answered regarding the possibility of energy storage that now it is almost impossible. We are however working on projects on energy storage, like "Amari hybrid Energy Project" system that combines wind energy and hydro pumped storage technology in Crete and "Tilos Project" hybrid power system project in Tilos island with electricity generation and energy batteries storage from renewable sources.

(The Tilos project is something we worked on during our Erasmus+ project in our school too)

Katerina Andreou thanked Mr Psychogios for this interview and asked what is the reason we do not use renewable energy as much as we should, if it is really economical and if we are going to use it more in the future. She also asked if the wind turbine on our "green" school energy model would be better to be a horizontal one.

Mr Psychogios says that renewable energy use is very complicated but not totally ecological of course as it needs many fuels uses and gases emissions and material waste etc just to make the parts of a wind turbine for example or any renewable energy plant. The most ecological energy is Nuclear Fusion, the attempt to replicate the processes of the Sun on Earth. Fusion is the process that drives our Sun. Hydrogen atoms crash together and break their atomic bonds and fuse to helium. As hydrogen is everywhere it is very cheap and the energy production is cheap and limitless.
(Fusion differs significantly from nuclear fission, which has been the only way of getting electricity from atoms)
But getting to producing energy by fusion is yet extremely difficult. Nevertheless it will solve all the world's energy problem. He also answered about the horizontal wind turbine on our school roof as a much better option than a vertical one. As even a small vertical wind turbine with 5 MW capacity needs a tower at least 25 meters high, the horizontal one needs no more than a roof to be installed. But the horizontal will need a higher cappacity around 7,5 to 8 MW in order to achieve the same result.

Mr Psychogios concluding congratulated us for our work and our very interesting Erasmus+ project "European Schools Go Green", and said that he may have given much more information than the students can absorb and retain and evaluate during the one hour teleconference, but all these issues are so much more complicated than people think that it is impossible to give simple answers and characterize something as right or wrong or suggest the perfect solution, as it needs difficult studies and research. He also suggested that it would be great to work on zero energy buildings so that he can help us on that too!!!

We thanked him again a lot for his help and his warm collaboration, for all the details and information on Wind Farms construction that we never even had guessed.

Panagiotis Psychogios/ PPS engineering Honors & Awards (a small selection):

- Architectural Praise for the Cultural municipal cultural center of Heraklio Crete
- Architectural Praise for the Configuration of the Landscape at the Municipal park of Trikala
- 2ndational Architectural award for the "Square configuration and construction of a 400 places sub parking lot at Psila Alonia municipality of Patras"
- 2nd' National Architectural award for the Municipal Cultural Center of Kalamata
- 2nd' National Architectural award for the Municipal building of NEA Smirni
- 1st' National Architectural award for the Municipal building of Corinth
- 1st' National Architectural award for the Public Library of Pyrgos Elias
- 1st' National Architectural award for the "Construction of 12 ministerial offices in Athens"
- 1st' National Architectural award for the "Telogleio institution Art Gallery and Museum Thessaloniki"
- 3d' National Architectural award for the Office Building of the "Panagia of Tinos Convent"

Organizations:

- Earthquake Planning and Protection Organization (EPPO) of Greece
- European Centre on Prevention and Forecasting of Earthquakes
- Municipality of Levadia Water and Waste Co
- Municipality of Levadia Boeotia
- Public Hospital Building co

Some more information collected during our Wind Farms study:

Exclusion Zones for Wind Energy:

• *Strict Nature Reserves & Nature Reserves*
• *National Park core zones, Aesthetic Forests*
• *Priority habitats of Natura 2000 (Dir 92/43/EEC)* (Expansion of Natura 2000 Network - version 30, December 2017) >27% of the land area of the country belongs to Natura 2000 network .
• *Ramsar Wetlands*
• *Sacred monuments of the world cultural heritage & other monuments of major importance*
• *Inside town plans and settlements' boundaries before 1923 or under 2000 residents*
• *Organized touristic areas and other production sectors etc, theme parks, tourist ports*
• *Quarries and surface mining and extractive zones*
• *Bathing water of Ministry for Environment relevant program*
RES Spatial Planning article 6 & L.3937/2011 for biodiversity conservation

Environmental classification of Wind Farms according to impacts:

Category A
«potential for significant impacts»
Category B
«local, non-significant impacts»
*0,02 MW < P < 5 MW**
Category A1
P ≥ 60 MW
or P>30 MW @ N2000
or HV line ≥ 20 km
Category A2
5 MW < P < 60 MW
and HV line < 20 km
** Exception include projects with P<0,02MW (e.g. within Natura 2000, near the seaside, next to other RES projects)*

Natura Network 2000: www.ypeka.gr
Studies for Natura 2000 sites:
http://www.ypeka.gr/Default.aspx?tabid=539&language=el-GR

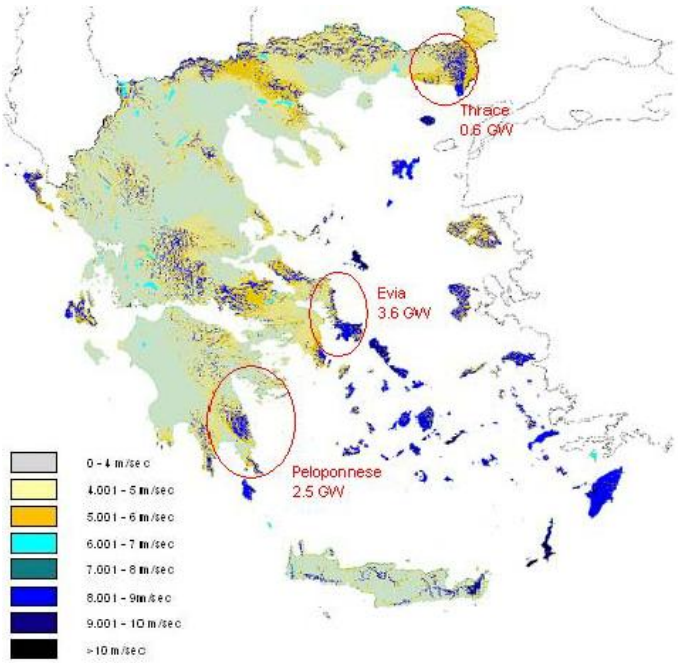
Important Bird Areas:
http://www.ornithologiki.gr/page_in.php?sID=68
Information on a set of Protected Areas *(Natura 2000, Ramsar Wetlands, small island wetlands, wildlife shelters, etc.):*
http://oikoskopio.gr/map/ (WWF)
EU Guidance document:
Wind energy developments & Natura 2000
Demonstration of good practices to minimize impacts of wind farms on biodiversity in Greece *, LIFE12 BIO/GR/000554:*
http://windfarms-wildlife.g

Here you can see the ***geoinformation maps*** *with all necessary data:*

http://www.rae.gr/geo/?lang=EN

http://www.rae.gr/geo/?tab=panel-1391

A big discussion has started, and what we surely understood during this project is that we always have to consult with the experts to form an opinion, or just publish all the important information that scientists and experts shared with us to make this discussion even more important. We are also very intrigued to keep searching for answers as this discussion was very inspiring. And one conclusion which is difficult to manage but students and teachers really changed after embrassing it: There are no easy answers and black-and-white truths. When dealing with scientific matters, protection of our life and planet , as well as studying technological evolution and industrial future, there are so many complicated factors to study that we really need to improve our communication and collaboration skills to have positive results in all areas.



Wind Potential and geographical distribution of applications for wind farms ©Nikos D. Hatziargyriou
https://www.researchgate.net/publication/224652007_Wind_power_in_Greece_-_Current_situation_future_developments_and_prospects

Check here more useful and interesting data and charts:

https://ourworldindata.org/energy

https://ourworldindata.org/renewable-energy

https://en.wikipedia.org/wiki/Wind_power_in_Greece

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