University of Nottingham
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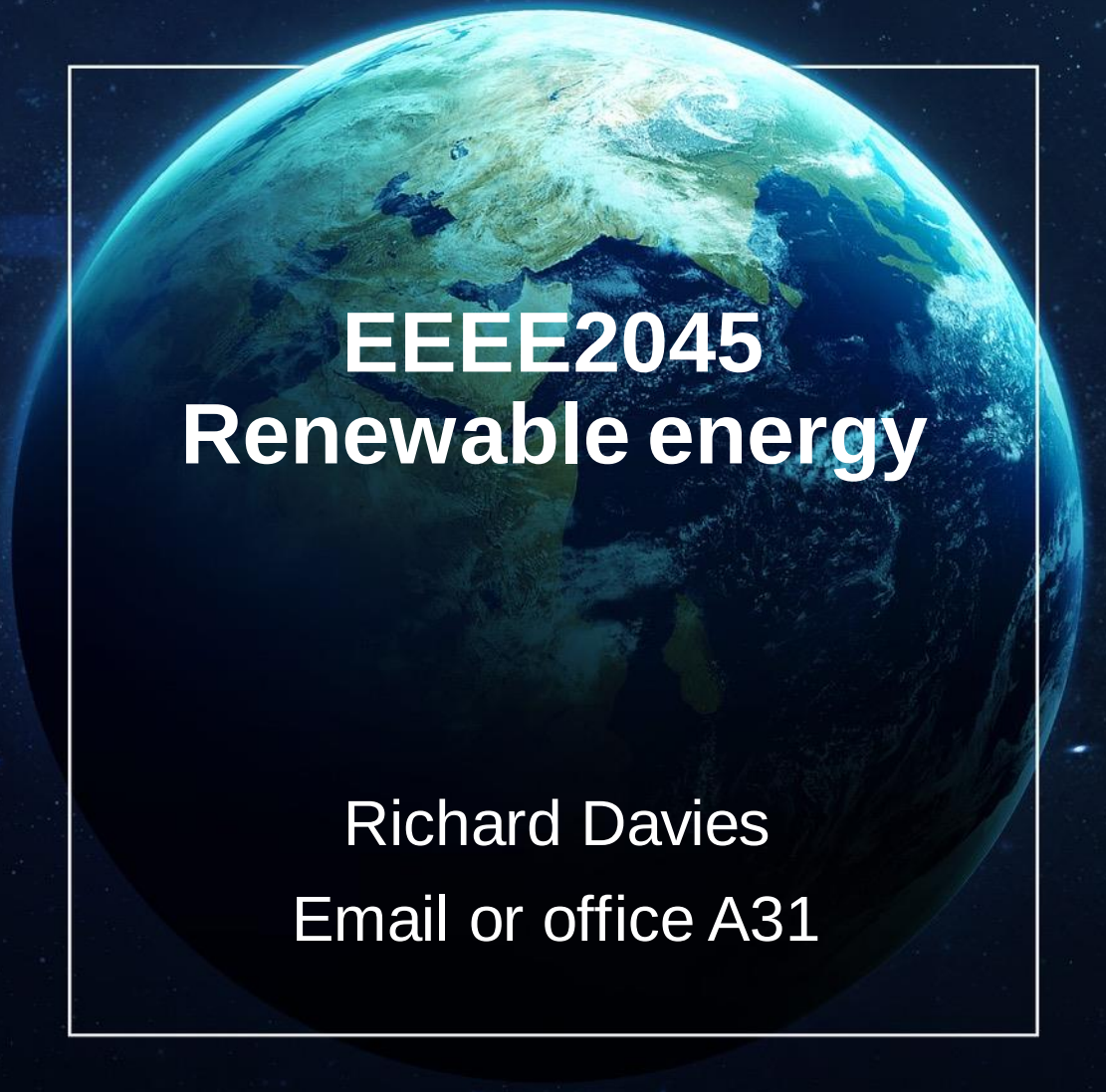

EEEE2045
Renewable energy

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Coursework

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What is the coursework

- An outline study of renewable energy (RE) technology use within an allocated country presented as a technical poster.

- Required effort: about 16 hours of independent research, review work and report writing (poster).

- Released: 6/2/23
- Submission: 16/3/23

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What is the coursework

- Everyone is allocated a different country - Create an original poster that discusses the current renewable energy portfolio of that country.
- Identify and discuss the drivers and changes in the past decade.
- Provide technical details of the RE technology and define the key parameters that are enabling this technology to exist.
- Describe the RE technology and the conversion system used.
- Consider the operational requirements as well as the limitations of the available RE technology both today and in the future.

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- Not a sales poster, not a top trump poster. It should contain regulatory, policy, technical or scientific information.
- Can look at corridors in engineering for examples. Typically, from PhD or researchers but consider the style and how information is presented. Not the same topic but technical information is summarised and presented.
- As well as to research and gain wider knowledge, one challenge of this coursework will be to identify the relevant information, condense and present it.

Introduction - Energy review of the territory

- What technologies are options and why – characteristics.
- May find energy policies such as electrification of transport or heating. Any promised targets or COP26/COP27?
- Can give it regional context e.g., compare to neighbour regions
- How has it changed - share of energy generation for the last few years or decades
- From this section identify one or more technologies to focus on

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Requirements and system technical review

- Should be a technical section of the technology or country overall
- You will need to identify and describe the enabling technologies, such as power electronics, motors and drives.
- Include any system requirements such as voltage, power or energy levels.
- Consider any reliability and intermittency complications. Will energy storage be needed?
- Consider the scale of the system - how many needed or planned?
- Can identify and relate to specific examples if available, e.g. Tesla energy in Australia, Ivanpah Facility in US, PS10 in Spain.

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Technology description– explain one or more technologies or a recent or upcoming installation or project

- Technical section - of the system specifics
- Description of the RE technology - can use an example system or project as reference.
- Describe the operation of the technology and the the equipment.
- Further information - efficiency, downsides?
- If using research projects do not focus on theoretical studies. Must relate to practical real-world systems.

Conclusions and territory technology roadmap

- Future for energy in the territory.
- Expansion plans or progress towards targets for energy make up. Is it half-way to deploying a largescale scheme or about to start one?
- Any specific policy or plans for the future, e.g., any targets or goals such as for 2030 or 2050, carbon use in general or specific renewable energy goals? Represented in COP26/27?

- What is the likely RE contribution in 10 years time?

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Assessment criteria

- Renewable energy technology review in the assigned territory (15%)
- Technical review, requirements and key elements of the RE conversion system (25%)
- Description of the RE electrical system and justification of technology used (25%)
- Technology roadmaps and potential growth/expansion (15%)
- Quality, impact and structure of the poster (10%)
- Formatting, language, and references (10%)

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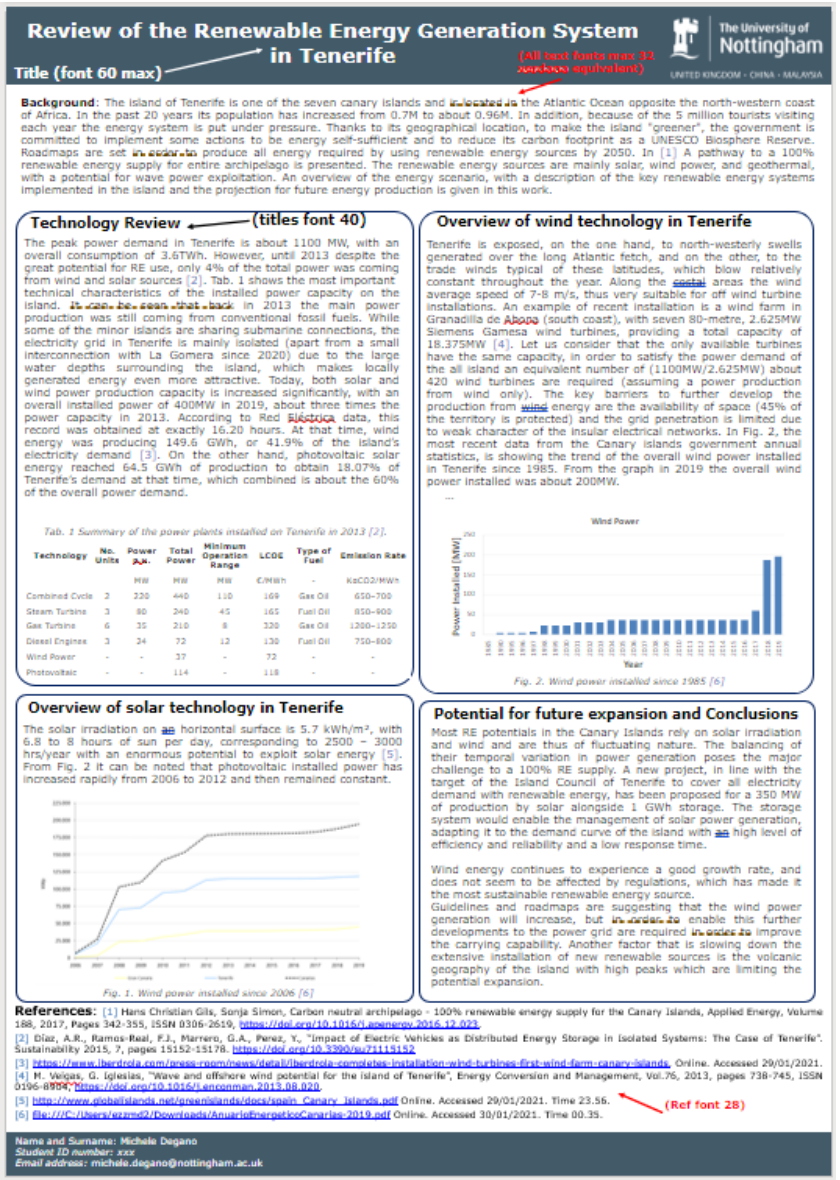
- Save and upload as

EE2045_RE1_[your student number].pdf

- On Moodle
  - Template - Do not have to use but recommended
  - Note font size suggestions – too small or not enough
  - Assignment list
  - Summary of requirements
  - Marking rubric



Review of the Renewable Energy Generation System in Tenerife

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

Title (font 60 max)

(All text fonts max 32 Arial/Calibri equivalent)

Background: The island of Tenerife is one of the seven canary islands and is located in the Atlantic Ocean opposite the north-western coast of Africa. In the past 20 years its population has increased from 0.7M to about 0.96M. In addition, because of the 5 million tourists visiting each year the energy system is put under pressure. Thanks to its geographical location, to make the island "greener", the government is committed to implement some actions to be energy self-sufficient and to reduce its carbon footprint as a UNESCO Biosphere Reserve. Roadmaps are set in order to produce all energy required by using renewable energy sources by 2050. In [1] A pathway to a 100% renewable energy supply for entire archipelago is presented. The renewable energy sources are mainly solar, wind power, and geothermal, with a potential for wave power exploitation. An overview of the energy scenario, with a description of the key renewable energy systems implemented in the island and the projection for future energy production is given in this work.

Technology Review (titles font 40)

The peak power demand in Tenerife is about 1100 MW, with an overall consumption of 3.6TWh. However, until 2013 despite the great potential for RE use, only 4% of the total power was coming from wind and solar sources [2]. Tab. 1 shows the most important technical characteristics of the installed power capacity on the island. It was the case that back in 2013 the main power production was still coming from conventional fossil fuels. While some of the minor islands are sharing submarine connections, the electricity grid in Tenerife is mainly isolated (apart from a small interconnection with La Gomera since 2020) due to the large water depths surrounding the island, which makes locally generated energy even more attractive. Today, both solar and wind power production capacity is increased significantly, with an overall installed power of 400MW in 2019, about three times the power capacity in 2013. According to Red Eléctrica data, this record was obtained at exactly 16.20 hours. At that time, wind energy was producing 149.6 GWh, or 41.9% of the island's electricity demand [3]. On the other hand, photovoltaic solar energy reached 64.5 GWh of production to obtain 18.07% of Tenerife's demand at that time, which combined is about the 60% of the overall power demand.

Tab. 1 Summary of the power plants installed on Tenerife in 2013 [2].

Technology	No. Units	Power p.u.	Total Power	Minimum Operation Range	LCOE	Type of Fuel	Emission Rate
		MW	MW	MW	€/MWh	-	KgCO2/MWh
Combined Cycle	3	220	440	110	169	Gas Oil	650-700
Steam Turbine	3	80	240	45	165	Fuel Oil	850-900
Gas Turbine	6	35	210	8	320	Gas Oil	1200-1250
Diesel Engines	3	24	72	12	130	Fuel Oil	750-800
Wind Power	-	-	37	-	72	-	-
Photovoltaic	-	-	114	-	118	-	-

Overview of wind technology in Tenerife

Tenerife is exposed, on the one hand, to north-westerly swells generated over the long Atlantic fetch, and on the other, to the trade winds typical of these latitudes, which blow relatively constant throughout the year. Along the coastal areas the wind average speed of 7-8 m/s, thus very suitable for off wind turbine installations. An example of recent installation is a wind farm in Granadilla de Abona (south coast), with seven 80-metre, 2.625MW Siemens Gamesa wind turbines, providing a total capacity of 18.375MW [4]. Let us consider that the only available turbines have the same capacity, in order to satisfy the power demand of the all island an equivalent number of (1100MW/2.625MW) about 420 wind turbines are required (assuming a power production from wind only). The key barriers to further develop the production from wind energy are the availability of space (45% of the territory is protected) and the grid penetration is limited due to weak character of the insular electrical networks. In Fig. 2, the most recent data from the Canary Islands government annual statistics, is showing the trend of the overall wind power installed in Tenerife since 1985. From the graph in 2019 the overall wind power installed was about 200MW.

Fig. 2. Wind power installed since 1985 [6]

Overview of solar technology in Tenerife

The solar irradiation on as horizontal surface is 5.7 kWh/m², with 6.8 to 8 hours of sun per day, corresponding to 2500 – 3000 hrs/year with an enormous potential to exploit solar energy [5]. From Fig. 2 it can be noted that photovoltaic installed power has increased rapidly from 2006 to 2012 and then remained constant.

Fig. 1. Wind power installed since 2006 [6]

Potential for future expansion and Conclusions

Most RE potentials in the Canary Islands rely on solar irradiation and wind and are thus of fluctuating nature. The balancing of their temporal variation in power generation poses the major challenge to a 100% RE supply. A new project, in line with the target of the Island Council of Tenerife to cover all electricity demand with renewable energy, has been proposed for a 350 MW of production by solar alongside 1 GWh storage. The storage system would enable the management of solar power generation, adapting it to the demand curve of the island with as high level of efficiency and reliability and a low response time.

Wind energy continues to experience a good growth rate, and does not seem to be affected by regulations, which has made it the most sustainable renewable energy source.
Guidelines and roadmaps are suggesting that the wind power generation will increase, but in order to enable this further developments to the power grid are required in order to improve the carrying capability. Another factor that is slowing down the extensive installation of new renewable sources is the volcanic geography of the island with high peaks which are limiting the potential expansion.

References: [1] Hans Christian Gils, Sonja Simon, Carbon neutral archipelago - 100% renewable energy supply for the Canary Islands, Applied Energy, Volume 188, 2017, Pages 342-355, ISSN 0306-2619, https://doi.org/10.1016/j.apenergy.2016.12.023.
[2] Díaz, A.R., Ramos-Real, F.J., Marrero, G.A., Perez, Y. "Impact of Electric Vehicles as Distributed Energy Storage in Isolated Systems: The Case of Tenerife". Sustainability 2015, 7, pages 15152-15178. https://doi.org/10.3390/su71115152
[3] https://www.iberdrola.com/press-room/news/detail/iberdrola-completes-installation-wind-turbines-first-wind-farm-canary-islands, Online. Accessed 29/01/2021.
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[6] file:///C:/Users/ezzrm2/Downloads/AnuarioEnergeticoCanarias-2019.pdf Online. Accessed 30/01/2021. Time 00.35.

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