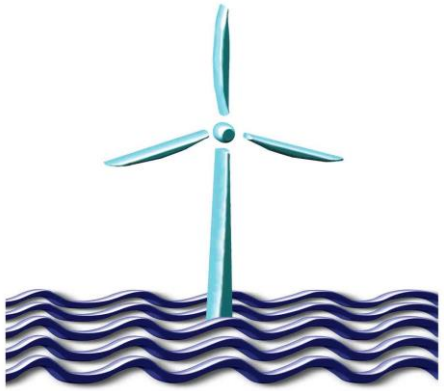

Renewable Energy and Renewable Energy Society

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Introduction

- This presentation will:
  - present environmental impact due to use of fossil fuels and coal power,
  - describe basic renewable energy theory,
  - show advantages of renewable energy,
  - introduce Renewable Energy Society.

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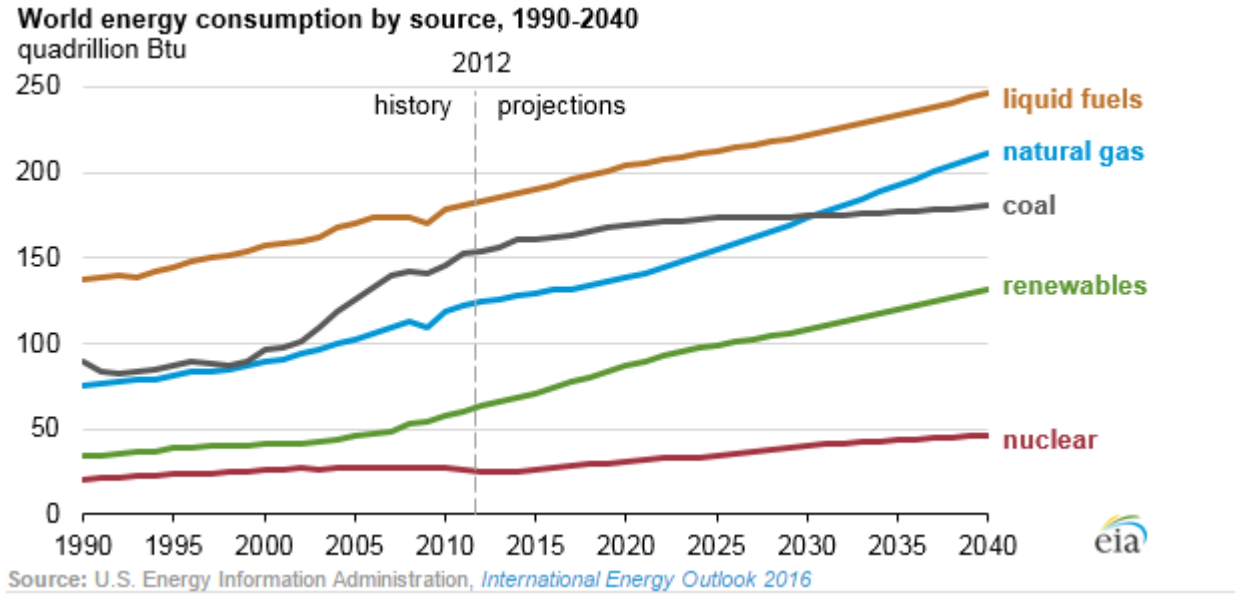
Environmental Impact

- Global warming evidence:
  - Increased temperatures,
  - Melting glaciers in north and south poles,
  - Rising sea levels,
  - Powerful weather disruptions.

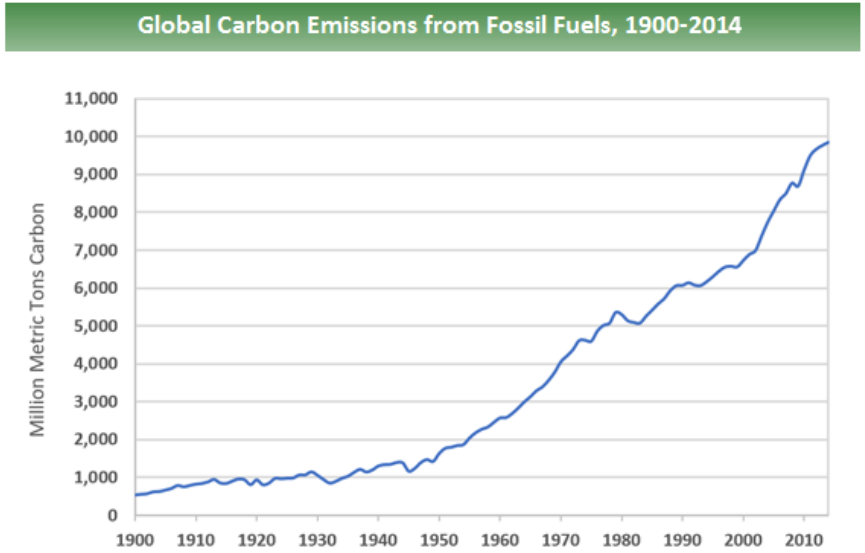
World Energy Increase

- EIA (Energy Information Administration) predicts an increase of world energy demand by 48 % by 2040: https://www.eia.gov/todayinenergy/detail.php?id=26212



Increase in Carbon Dioxide Emissions

- Carbon Dioxide emissions are increasing (Environmental Protection Agency): https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data



Source: Boden, T.A., Marland, G., and Andres, R.J. (2017). Global, Regional, and National Fossil-Fuel CO2Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001_V2017.

Energy

- Kinetic energy is given by:

$$E_{kinetic} = \frac{1}{2}mv^2$$

- Rotational energy of disk or propeller equals to:

$$E_{rotational} = \frac{1}{2}\left(\frac{mr^2}{2}\right)\left(\frac{v}{r}\right)^2 = \frac{1}{4}mv^2$$

Where: E = Energy (J), r = Radius (m), v = Velocity (m/s), m = Mass (kg)

Carnot Efficiency

- Carnot efficiency of steam plant (coal, gas, nuclear or geothermal):

$$\eta(Carnot) = \left(1 - \frac{T_{cold}}{T_{hot}}\right) \times 100$$

Where: $\eta = Carnot\ Efficiency$ (%), T_{cold}= Cold Temperature (Kelvin), T_{hot}= Hot Temperature (Kelvin).

Overall Efficiency

- Overall Efficiency (coal, gas, nuclear or geothermal):

$$\eta(overall) = \eta_{boiler} \times \eta_{turbine} \times \eta_{generator}$$

$$\eta(overall) = \frac{Thermal\ Energy}{Chemical\ Energy} \times \frac{Mechanical}{Thermal\ Energy} \times \frac{Electrical\ Energy}{Mechanical} \times 100$$

Efficiency

- In this presentation we will mostly cover the theory behind ideal renewable energy generators.
- In non ideal cases you have to multiply power generated by various efficiency coefficients to obtain the actual power generated.
- However, efficiency can be improved through research and increasing the amount of generators can overcome the problem with low efficiency.

Efficient Building Design

- R-60 or higher insulation for the roof,
- R-30 to R-43 insulation for the walls,
- Insulated glass, triple paned, super windows,
- Air tight house,
- Windows facing east, west or south (no north facing windows),
- Stone floor and wall for heat storage,
- Energy efficient lighting,
- Solar cells and solar hot water on roofs.

Microgrid and Decentralized Energy Exchange

- Microgrid is an interconnected network of multiple energy sources and loads that are either connected to power networks or disconnected (islanded).
- Microgrid is connected to share power and disconnected (islanded) to prevent failure of the whole system.
- Decentralized Energy Exchange (DeX) is used to share and control power with generators that are not providing enough power due to weather conditions. Like no wind no power from wind generators or cloudy days no power from solar cells. This prevents power system disturbances: https://www.csiro.au/en/Research/EF/Areas/Electricity-grids-and-systems/Intelligent-systems/Virtual-power-station

Solar Energy

- Solar power density on earth surface is given by:

$$\frac{P}{A} = \frac{Power\ From\ The\ Sun}{Surface\ Area\ of\ Sphere\ of\ the\ Radius\ Size\ of\ Earth\ Distance\ from\ Sun}$$

$$\frac{P}{A} = \frac{3.8\times10^{26}\ W}{4\pi\times(1.49\times10^{11}\ m)^2} = 1367\ W/m^2$$

- Total power incident on earth is equal to:

$$P_{total} = (Power\ Density\ From\ the\ Sun) \times \pi \times (Earth\ Radius)^2$$

$$P_{total} = \left(1367\frac{W}{m^2}\right) \times \pi \times (6.371\times10^6\ m)^2 = 1.73\times10^{17}\ W$$

Solar Energy

- The total power incident on earth is very high which shows high potential of solar energy on earth.
- Northern parts of Australia have very high potential for solar energy generation.

Solar Energy Efficiency

Type of Solar Energy	Efficiency (%)
Thermal Parabolic & Tower	25
Thermal Dish	31.25
Photovoltaic (crystalline silicon)	18 – 23
Photovoltaic (3D cells)	26 - 50

Solar Thermal Energy

- The power of conduction of heat equals to:

$$P = \frac{kA(T_{hot} - T_{cold})}{l}$$

Where: P = Power (W), T_{hot} = Hot Temperature (°C), T_{cold} = Cold Temperature (°C), l = Length (cm), A = Surface Area (m^2), k = Thermal Conductivity ((W×cm)/(m^2×°C))

Solar Thermal Energy

Material	Thermal Conductivity ((W×cm)/(m^2×°C))
Aluminium	20,100
Iron	4,600
Concrete	170
Brick	71
Water	60
Glass	59
Air	2.3

Solar Thermal Energy

- Convection is heat transfer via the matter or fluid movements.
- Power density through radiation is given by:

$$\frac{P}{A} = \varepsilon\sigma T^4$$

Where: T = Temperature (Kelvin), A = Surface Area (m^2), ε = Emissivity, σ = Stefan- Boltzmann Constant = 5.670367×10^{-8} W$m^{-2}K^{-4}$

- http://physics.bu.edu/~duffy/py105/notes/Heattransfer.html

Solar Thermal Energy

- That means power is proportional to the quadratic power of temperature which is a very big number.
- We have massive power to harness.

Hydroelectric Energy

- The potential energy of water equals to:

$$E = mgh$$

Where: E = Energy (J), m = Water Mass (kg), g = Acceleration Constant (m/s^2), h = Height of the Dam (m)

Hydroelectric Energy

- Power of hydroelectric power plant:

$$\mathrm{P} = \frac{E}{t} = \frac{1}{2}\left(\frac{m}{t}\right)v^2 = \frac{1}{2}\rho\phi v^2 = \left(\frac{m}{t}\right)\mathrm{gh} = \rho\phi g h$$

Where: P = Power (W), ϕ = Water Flow Rate (m^3/s), ρ = Water Density (kg/m^3)

m = Mass (kg), g = Gravitational Acceleration Constant (m/s^2), h = Height of the Dam (m)

- Hydroelectric power calculator:

http://www.engineeringtoolbox.com/hydropower-d_1359.html

Hydroelectric Energy

- Dams with great heights can generate high power,
- Power output also increases with water mass or density.

Wave Energy

- Wave energy per unit length for one full wave is given by:

$$\frac{E}{l} = 2\frac{m}{l}g\Delta h = 2\left(\frac{\rho A\lambda g}{\pi}\right)\left(\frac{\pi A}{4}\right) = \frac{1}{2}\rho A^2\lambda g = \frac{A^2 g^2 \rho T^2}{4\pi}$$

Where: $\frac{m}{l} = \frac{\rho A\lambda}{\pi}$, $\Delta h = \frac{\pi A}{4}$ and $\lambda = \frac{gT^2}{2\pi}$

Where: E = Energy (J), A = Wave Amplitude (m), λ = Wave Length Per Period (m/rad), h = Height of the Wave (m), g = Gravitational Acceleration Constant (m/s^2), T = Time Period (s), ρ = Water Density (kg/m^3), l = Total Wave Length (m)

- Power equals to:

$$\frac{P}{l} = \frac{A^2 g^2 \rho T}{4\pi} = \frac{H^2 g^2 \rho T}{16\pi}$$

Where: Power (W), H = 2A = Total Displacement (m)

Wave Energy

- High waves and turbulent weather will generate high power because the wave height will be high,
- Also greater power is obtained with longer waves that have long time periods.

Tidal Energy

- Energy of tidal energy generator equals to:

$$E = mg\left(\frac{h}{2}\right) = V\rho g\left(\frac{h}{2}\right) = 2Ah\rho g\left(\frac{h}{2}\right) = Ah^2 g\rho$$

Where: E = Energy (J), m = Mass (kg), h = Tidal Range (m), A = Basin Area (m^2), V = $2Ah$ = Volume (m^3), $m = V\rho$, ρ = Water Density (kg/m^3), g = Gravitational Acceleration Constant (m/s^2)

- Power equals to:

$$P = \frac{Ah^2 g\rho}{T}$$

Where: Power (W), T = Tidal period (s)

Tidal Energy

- The power is proportional to the square of tidal range which shows how powerful tidal power really is,
- Greater water density will increase power output for hydro, wave and tidal power generators.

Geothermal Energy

- Energy of geothermal power plant is given by:

$$E = c_p F \Delta T \eta - P$$

Where: E = Energy (J), c_p = Specific Heat of the Working Fluid (J/kg/K), F = Production Well Flow Rate, $\Delta T = Sensible\ Heat = T_{reservoir} - T_{rejection}$(Kelvin), η = Efficiency, P = Parasitic Losses (J)

- http://www.garnautreview.org.au/update-2011/commissioned-work/potential-of-geothermal-energy.pdf
- https://chem.libretexts.org/Textbook_Maps/General_Chemistry_Textbook_Maps/Map%3A_Chemistry_(OpenSTAX)/05%3A_Thermochemistry/5.1%3A_Energy_Basics

Geothermal Energy

- The equation on the previous slide shows that energy is proportional to temperature difference. This difference increases in underground temperature which is very high.

- Thus geothermal energy is very efficient way to generate power.

Wind Energy

- Wind energy from ideal wind turbine equals to:

$$E = \frac{1}{2}mv^2 = \frac{1}{2}d^3\rho v^2$$

Where: E = Energy (J), ρ = Air Density (kg/m^3), v = Wind Speed (m/s), d = Rotor Radius (m)

- Power equals to:

$$P = \frac{E}{T} = \frac{1}{2}d^3\rho v^2\frac{v}{d} = \frac{1}{2}d^2\rho v^3 = \frac{1}{2}\rho A v^3$$

Where: Power (W), T = Time Period (s) = $\frac{d}{v}$, A = Area (m^2)

Wind Energy

- Renewable Energy Society published a paper in October 2015 newsletter stating the relationship between wind speed and power generated by wind turbine,

- More turbulent weather caused by climate change which result from coal power stations will generate an enormous amount of power due to cubic relationship between wind speed and power generated.

About Renewable Energy Society

- Renewable Energy Society (RES) was founded on 23 July 2012 by Dr Mark Glickman to promote renewable energy, renewable energy research and minor projects in Australia to increase renewable energy generation from about 10 % to 100 %.
- In early 2013 Dr Mark Glickman gave up being as director to concentrate on his studies and his engineering consulting work.
- Since then CEO of Renewable Energy Society was Celso Ampalayo (photo shown on the right) who does art in his spare time (two paintings shown on the right).
- Currently Renewable Energy Society has over 900 members in Australia, India, Philippines, China, Russia, Canada, USA, United Kingdom (UK), Ireland, France, Germany, Israel, South Africa, Argentina and Brazil.
- Most members are in Australia, India, Philippines, China and Russia.
- Renewable Energy Society has over 100 volunteers from Australia, India, Philippines, Canada and Russia.

Directors and Members

- RES Directors are in the Philippines (Nova Muscosa Amplayo – Volunteer Coordinator, Herminio Muscosa Amplayo – Vice President, Ponciano Muscosa Amplayo - Treasurer) and India (Pritam Rath – Best Author in 2012 – Photo taken under Patterson train station, Melbourne, Victoria, Australia):





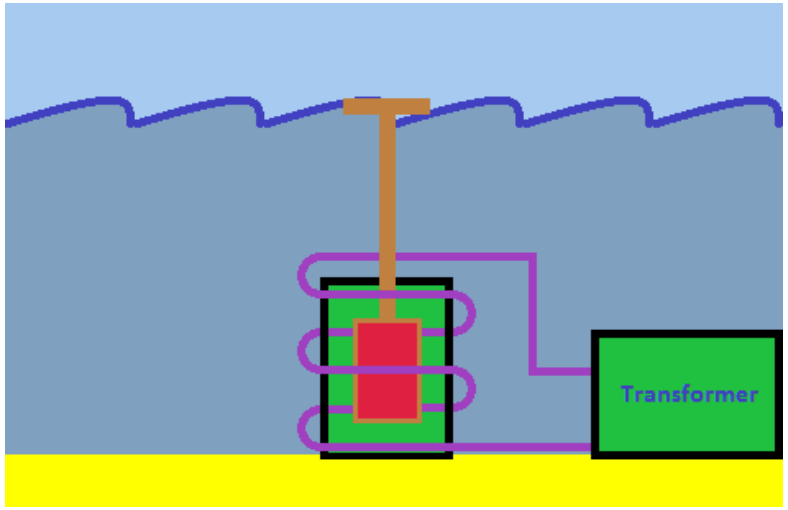

Renewable Energy Society Research

- Discrete Power Converter by Dr Alexander Kornich in Abbotsford, British Columbia, Canada, http://dpc-renewable-energy.com:

- Dr Alexander Kornich wants to obtain funding build a large life scale model of his invention.

Renewable Energy Society Research

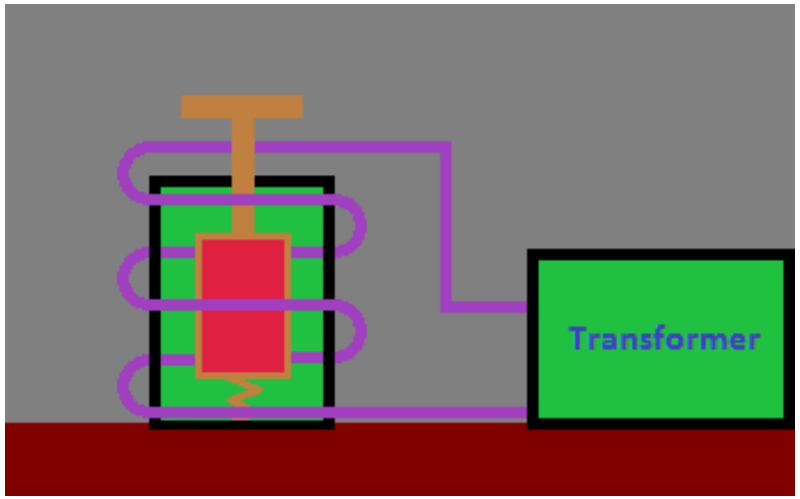
- Wave Power Permanent Magnet Tubular Linear Motion Generator by Nova Muscosa Amplayo:



- The red rectangle is a magnet moving up and down with waves due to floating material on the sea surface to generate power via induced magnetic fields.

Renewable Energy Society Research

- Wave Power Permanent Magnet Tubular Linear Motion Generator 2 by Nova Muscosa Amplayo:



- The device is placed inside a ship and as the ship moves up and down due to waves the device generates power.

Renewable Energy Society Research

- An idea of using a linear motion to generate power from waves was presented in:
  - Joseph Prudell, Martin Stoddard, Ean Amon, Ted K. A. Brekken, Annette von Jouanne, "A Permanent-Magnet Tubular Linear Generator for Ocean Wave Energy Conversion,“, IEEE Transactions on Industry Applications, 7 September 2010.
  - C. L. Haitao Yu, Bang Yuan, Minqiang Hu, Lei Huang and Shigui Zhou, "A permanent magnet tubular linear generator for wave energy conversion," Australian Institute of Physics (AIP) - Journal of Applied Physics., 2012.
- Renewable energy society needs volunteer researchers to further develop this project.

Research and Industry Partnership

- Hydro drive research project was about a company in Thailand owned by Keith Bulman wanting to start production of hydrogen cars in Australia, in 2012.

- Unfortunately this project was cancelled before the end of 2012 due to high costs of manufacturing in Australia.

BBQ Sausage Sizzle Fundraising Events at Officeworks Stores

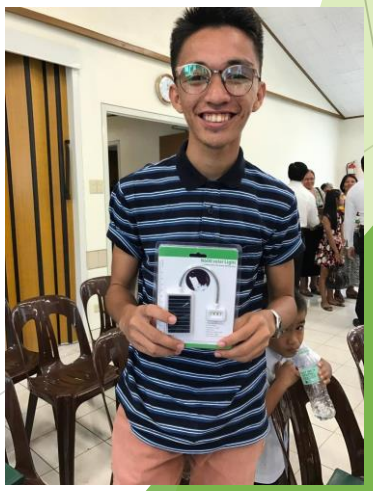
- Officeworks Carnegie (21 February 2016), Masters Home Improvement Store (in 17 July 2016) in South Oakleigh (closed down), Officeworks Chadstone (11 December 2016 and 8 January 2017) all in Victoria, Australia:

Festival Stalls to Promote Renewable Energy

- Celebrate Mooroolbark Festival, The Basin Festival Stalls in March 2016 (first two photos respectively). Maroondah Festival and Eltham Festival Stalls in November 2016 (last two photos respectively):

Parcels With Renewable Energy Devices to Third World Countries

- Send and received renewable energy items, Calamba, Misamis Occidental, Philippines:



Green Lendings on kiva.org Website

- Animal Sales - Rancho Caporal Group from Fresno Nichi Mexico, Renewable Energy Products - Sikubora Limited from Arusha, Tanzania and Renewable Energy Products - Kalonda Energy Group from Kalomo Zambia.

Environmental Conferences and Exhibitions

- Renewable Energy Society is organising Environmental Exhibitions and Environmental Conferences with Save Resources and Mental Health Week to promote and discuss the environment and current environmental issues.

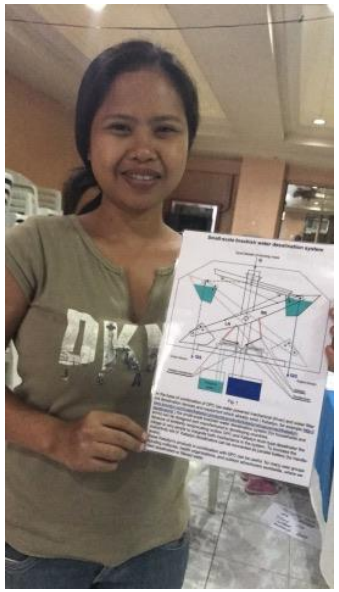
- To register or submit speeches go to: environmentalconferences.weebly.com

- To register or submit art work go to: enviroexhibitions.wixsite.com/home

  or environmentalexhibitions.yolasite.com

Environmental Exhibition – Cebu City 2017, Cebu, Philippines

- Photos from the exhibition on Saturday, 20 May 2017:



Environmental Exhibition – Cebu City 2017, Cebu, Philippines

- Photos from the exhibition:

- Exhibition organiser Nova Muscosa Amplayo hotel manager Gilda Miciano Himalaloan shown on the right.

Awards – Our Best Volunteers and Contributors

- Best Volunteer Recruitment Organisation Award in 2016: Deakin University from Geelong, Australia; Best Contributor from 2012 until 2017: Alfred Glickman from Melbourne, Australia; Best Graphic Designer in 2015: Nicole Allen from Melbourne, Australia and Best Volunteer in 2014: Nova Muscosa Amplayo, Calamba, Misamis Occidental, Philippines:

Conclusion

- This presentation showed the basic theory behind renewable energy and its advantages,
- Importance of renewable energy implementation was explained,
- Short history of Renewable Energy Society was presented,
- What Renewable Energy Society does was also explained,
- Photo of me at Renewable Energy Society Deakin University Careers Fair in August 2016 shown on the right.

References

- Renewable Energy Systems, Lecture Notes, Dr Mohammad Taufiqul Arif, Deakin University, 2014.
- https://www.eia.gov/todayinenergy/detail.php?id=26212
- https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data
- https://www.csiro.au/en/Research/EF/Areas/Electricity-grids-and-systems/Intelligent-systems/Virtual-power-station
- http://physics.bu.edu/~duffy/py105/notes/Heattransfer.html
- http://www.engineeringtoolbox.com/hydropower-d_1359.html
- http://www.garnautreview.org.au/update-2011/commissioned-work/potential-of-geothermal-energy.pdf
- https://chem.libretexts.org/Textbook_Maps/General_Chemistry_Textbook_Maps/Map%3A_Chemistry_(OpenSTAX)/05%3A_Thermochemistry/5.1%3A_Energy_Basics
- J. P. M. S. E. A. T. K. A. B. A. V. Jouanne, "A Permanent-Magnet Tubular Linear Generator for Ocean Wave Energy Conversion,“, IEEE Transactions on Industry Applications, 07 September 2010.
- C. L. Haitao Yu, Bang Yuan, Minqiang Hu, Lei Huang and Shigui Zhou, "A permanent magnet tubular linear generator for wave energy conversion," Australian Institute of Physics (AIP) - Journal of Applied Physics., 2012.