CAPE Green Engineering Unit

Renewable Energy
Energy Conservation
Energy Efficiency

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Our lives are built around fossil fuels:
Centralised electricity supply
Centralised fuel supply for transportation
Industrial and agricultural equipment are fuelled by fossil fuels
It is wasteful, polluting, and dominated by a few powerful players
Significant embedded infrastructure and cost barriers prevent new entrants and alternative solutions reaching scale
Established ‘proven’ solutions are preferred over innovative alternatives
Centralised delivery model; electricity flows from 1 large power station to thousands of customers.
This places a physical and psychological distance between communities and where their energy comes from.
Access to energy and the benefits it can bring is inequitable and regressive
Profits flow out of the communities that use the energy

https://www.youtube.com/watch?v=KEeH4EniM3E
Increase in consumption of fossil fuels. Most recent times, greater increase in the use of natural gas
Very minimal increase in the use of renewables
1. World includes international aviation and international marine bunkers.
2. In these graphs, peat and oil shale are aggregated with coal.
3. Includes geothermal, solar, wind, tide/wave/ocean, heat and other sources.
Emmissions raised from 14,000Mt of CO2 in 1971 to 32,000Mt of CO2 in 2017

1. World includes international aviation and international marine bunkers.
2. CO2 emissions from fuel combustion are based on the IEA World Energy Balances and on the 2006 IPCC Guidelines, and exclude emissions from non-energy.
3. In these graphs, peat and oil shale are aggregated with coal.
4. Includes industrial waste and non-renewable municipal waste.
Why Do CO₂ Emissions Matter?

CO₂ is a green house gas which contribute to global warming which has lead to changes in our climate.

https://youtu.be/n4e5UPu1co0
Which Climate Impacts have you observed?

https://www.youtube.com/watch?v=ioWuEJZ77Mk

Increase in the number of warm days and nights
Decrease in the number of cool days and nights
More intense hurricanes
Greater number of heavy rainfall events in a short time
Increased Flooding
Increased incidents of drought
Coral Bleaching
Green Engineering is built on the principle of sustainability.

Designs and development are conducted with consideration being given to all 3-tiers of sustainability

That is, sustainable development.

We will, therefore, design in such a way that we meet our needs without hampering the ability of our children and our children’s children to provide for their own needs.
The use of Renewable Energy is one way to help us accomplish this. The sun is the ultimate source of energy for most renewable energy technologies.

Solar Thermal driven by the heat energy from the sun
https://commons.wikimedia.org/wiki/File:Zaragoza_DIY_SHW_system.jpg
Solar PV extracts energy from the light (photons) provided by the sun
https://pxhere.com/en/photo/708107
Wind energy driven by uneven heating of the earth’s surface which as it blows over the ocean/sea leads to wave energy
https://pxhere.com/en/photo/30068
The sun drives the water cycle which gives rise to rivers and hydropower
The heating of the ocean’s surface gives rise to the temperature difference that fuels Ocean Thermal Energy Conversion (OTEC) We also may extract energy in the form of kinetic energy from waves and tides.
https://pxhere.com/en/photos?q=ocean
Photosynthesis, which derives energy from the sun gives rise to biomass

Geothermal energy, energy from the earth’s core
https://pxhere.com/en/photo/1347318
OTEC is still in the research phase within the region, though it theoretically has promise.

Geothermal, Wind Hydro Power are more likely to be implemented at utility scale. However, you may find residential, commercial and industrial installations of solar PV and thermal and bioenergy.
75 rooms * 2750 Watts x 3 hours = 618,750 Wh/day

= 618,750 Wh / 1,000 = 618.75 kWh/day

= 618.75 kWh * 365 days = 225,843.75 kWh/yr

= 225,843.75 kWh/1699.4kWh/boe = 133 boe/yr

In the Caribbean, Solar Thermal technology is applied for heating purposes and not for electricity generation since our weather does not allow for electricity generation from solar thermal to be possible. Solar Thermal for electricity production will more likely be found in desert like climates where they receive significant amounts of direct radiation, without the interference of cloud cover.

The International Energy Agency (IEA) has announced that Barbados is the number one country in the world in British Thermal Unit per thousand penetration in 2017. Barbados achieved this position in 2015.

To measure the efficacy of various energy saving measures, they are often expressed as Barrel of Oil Equivalent. That is, the energy consumed or saved is compared to the energy in one barrel of oil, 1699.4 kWh.

Let’s look at the example of a small boutique hotel with 75 rooms.
Solar PV Installations

1.6 MW = 1.6 MW * 1,000 = 1,600 kW

= 1,600 * 6h = 8,000 kWh per day

= 8,000 kWh * 365 = 2,920,000 kWh/yr

= 2,920,000 kWh/yr / 1699.4 kWh/boe = 1,718.3 boe/yr


Picture: Grand Palladium Resort and Spa, a 1,000 room hotel was projected to save over US$600,000 in energy cost per year from the installation of a 1.6MW solar Photo Voltaic (PV) power plant.

Throughout the region, because of our year round consistent sunny weather, this lends itself to widespread applications of solar PV installations given a consistent solar insolation for approximately 12 hours per day.
Biological energy (bioenergy) is derived from non-fossil organic (living or recently living) matter and its metabolic by products.

Typically starchy and cereal crops are used to produce ethanol by fermentation. Biodiesel is extracted from oily plants and seeds, animal fats and waste vegetable oils. Biogas, which is mostly composed of methane, is generated during the anaerobic decomposition of organic matter, usually municipal solid waste (MSW) and sewage. Other organic by-products of industrial and manufacturing processes could also be considered biofuels when used for energy or electricity, e.g. bagasse produced from sugar production.

In the region, bioenergy is primarily used in transportation (ethanol blends), by industries which produce biological waste sugar (bagasse), agriculture (biogas from plant and animal waste)

Due to available amounts, banana and sewer waste were selected to describe a best-practice bio-gas system in Belize.
A 2017 report estimates 232 MWh of power, 328 MWh of heat and 3,766 ton of hot water will be produced yearly by establishing a central digester using banana waste, and 192 MWh of power, 270 MWh of heat and 3,106 ton of hot water will be produced yearly by establishing a biogas plant using sewer waste in Belmopan. (Source: https://renewableenergycaribbean.com/2017/02/27/study-on-biomass-and-waste-in-belize/)
Pros and Cons of Renewables

- relatively expensive to use
- relatively high area needs
- solar, wind and wave power are intermittent in nature
- high share of renewables needs high share of storage in the electricity system
- available for another five billion years (on this planet)
- no additional GHG emissions (if done well)
- environmentally friendly in most other aspects
- the annual solar energy income is about 10,000 times the present world energy consumption
https://www.youtube.com/watch?v=--lBz3DdVgU

Energy Conservation – using less energy
Energy Efficiency – Doing more with the same amount of energy
What observations of renewable energy, energy conservation and efficiency measures have you made in your case studies?

- Making use of Daylight
- Inverter A/C Units
- Central HVAC Systems rather than Split units
- Water recycling
- Water Harvesting
- Occupancy sensors

How were these energy measures maintained?
Did the company have an energy manager?
What would be the benefit of having an energy manager?
Were there any standards being used as guidelines for the energy measures like ASHRAE, Green Globe, LEED?
Have you implemented any energy conservation or energy efficiency measures in your home?
https://www.youtube.com/watch?v=5VMXL3IEYTI&list=PLACD8E92715335CB2&index=8
An example of a Green Energy System