
Lecture 21

Renewable Energy

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What is Sustainability?

**The ability of humanity to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.
[Bruntland, 1987]**



Relevant Questions

- **Is the present existing society Sustainable?**
- **What are the problems with present energy used?**
- **How can change be driven?**
- **What are the Consequences of No action?**



Progressing toward an asymptotic world

- **World's Population** 6,891,600,000 [Wikipedia]
- Population expected to reach between 8 and 10.5 billion in the year 2050
- **Billions of vehicles**
- **Lots of Energy Consumption**



What is the Primary source of Energy

- **Fossil fuels** originate from the anaerobic decomposition of dead organisms.
- They mainly consist of carbon molecules.
- Fossil fuels types are coal, petroleum, and natural gas.



What is the Primary source of Energy

- Fossil fuels are considered as non-renewable energy resources.
- This is due to the fact that it takes millions of years for them to be generated. Moreover, we are depleting them faster than they can be made.
- Fossil Fuels are employed in the Industrial and Automotive Sectors.



What is the Primary source of Energy

- The Energy Information Administration estimated in 2007 that the worldwide primary sources of energy are composed of:
 - petroleum 36.0%
 - coal 27.4%
 - natural gas 23.0%
 - So 86.4% of fossil fuels for world energy consumption



Why are fossil fuels the Primary Source

- Abundant
- Cheap

However

Burning of fossil fuels releases around 21.3 billion tones of (CO₂) into the atmosphere per year

Leading to Global Warming since CO₂ is a green house gas.





Solution

- Invest in Renewable Energy Projects

What is Renewable Energy

Renewable energy is energy which comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable. [Wikipedia]



Renewable Energy Advantages and Challenges

Advantages

1. Sustainable: Never Run Out
2. Reduce Cost of Operation
3. Minimal Pollution to the Environment
4. Economical Benefits to secluded Regions
5. No Fossil Fuels Used



Renewable Energy Advantages and Challenges

Challenges

1. High Installation Costs
2. Difficulty to produce high quantity of Energy
3. Reliability of Supply



Renewable Energy Advantages and Challenges

In 2008, about 19% of worldwide energy consumption is from renewable resources.

Renewable Sources Tackled in this Lecture

1. PhotoVoltaics (PV) Systems
2. Wind Turbine Systems



PV Systems

Photovoltaics (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. [Wikipedia]

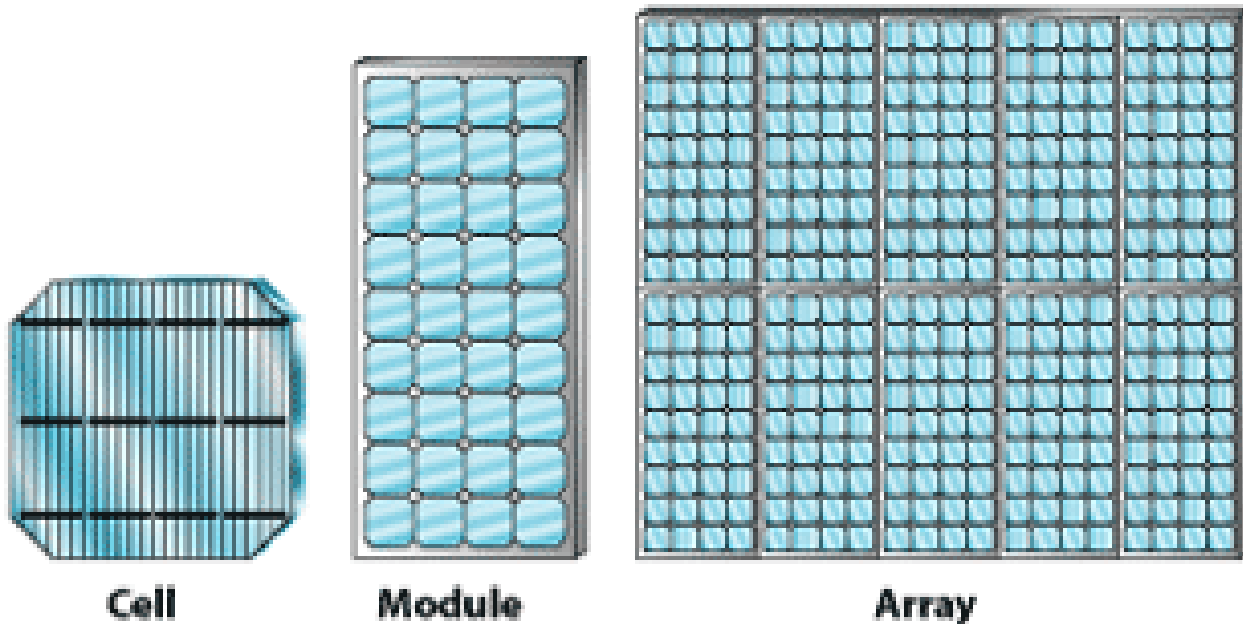
PV Employ:

1. Solar Array Consisting of Solar Cells
2. Cells are usually made of Silicon highly doped in Boron (p-type) and Phosphorus (n-type)



PV Systems

The solar array is composed of several modules each of which consists of a set of cells.



PV Systems



Nellis Solar Power Plant at Nellis Air Force Base in the USA.

These panels track the sun in one axis

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PV Systems

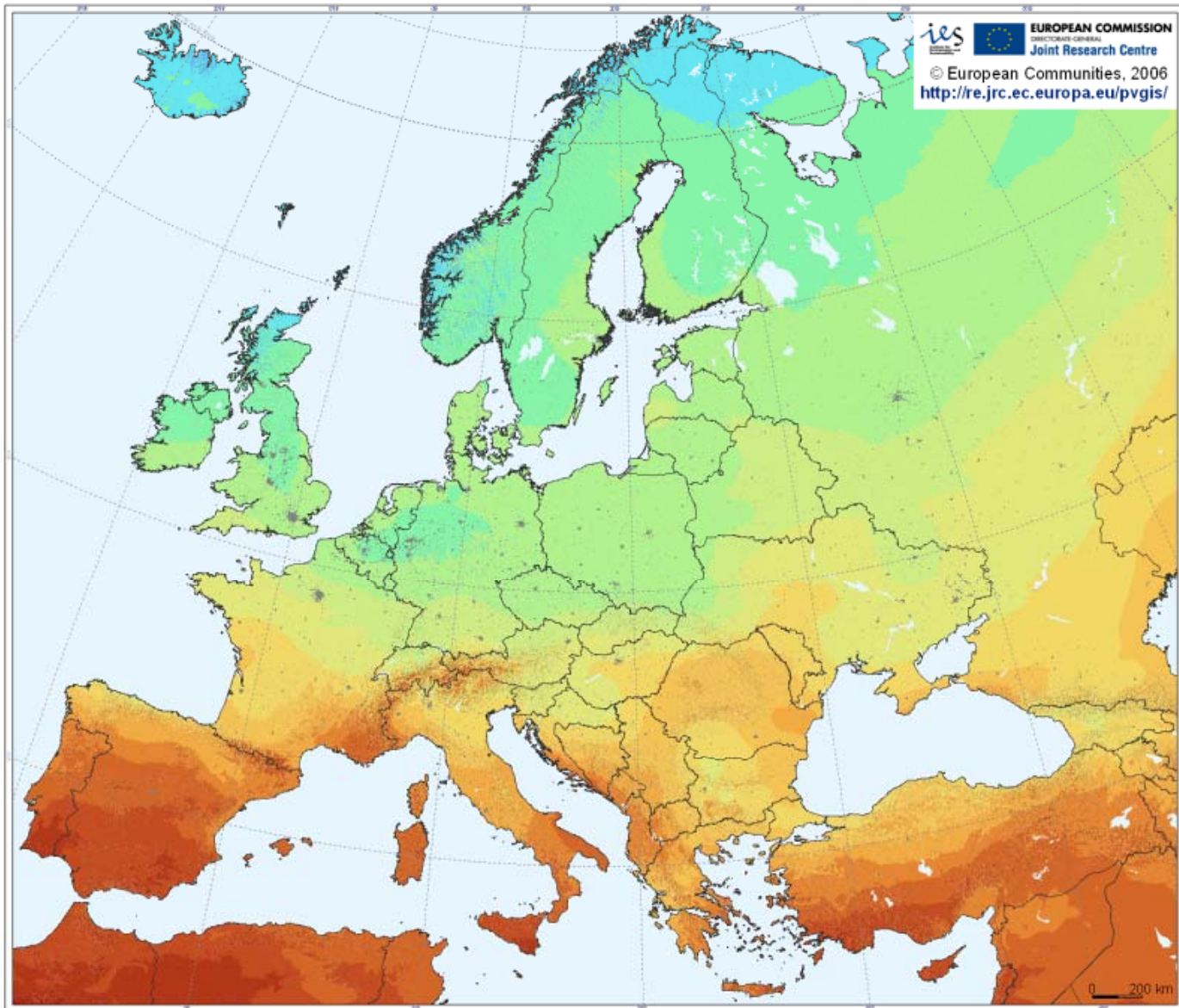


Photovoltaic system 'tree' in Styria, Austria



PV Systems

Photovoltaic Solar Electricity Potential in European Countries



Map of solar electricity potential in Europe.



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PV Systems

World's largest photovoltaic power stations (50 MW or larger)

Country	Peak Power (MW)	Notes
Canada	97	Constructed 2009-2010
Italy	84.2	Constructed 2009-2010
Germany	80.7	Phase I completed 2009, phase II and III 2010
Italy	70	Completed November 2010
Spain	60	Completed September 2008
Germany	53	Completed in 2009
Spain	50	231,653 crystalline silicon modules, Suntech and Solaria, opened 2008

[Wikipedia]



PV Systems: Topaz Solar Farm 550MW

1. California
2. Cost over \$1 billion
3. Construction Starts in 2010
4. Generation of Electricity in 2013



PV Systems: In Buildings

1. Integrated in Buildings
2. Mounted on them or on ground
3. Measuring units is in KW
4. Sufficient to cover the energy consumption of the building



PV Systems: In Buildings

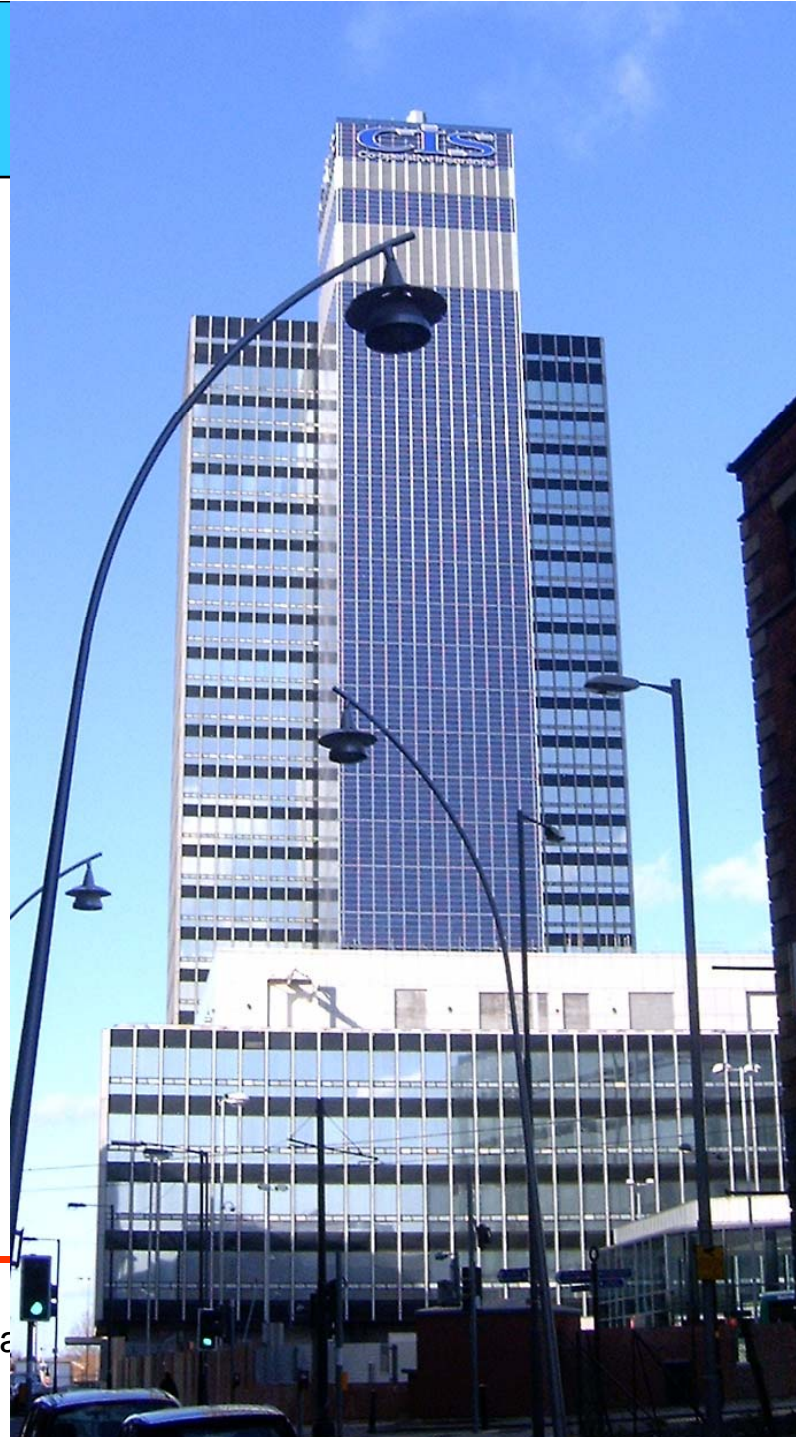


Photovoltaic solar panels on a house roof.



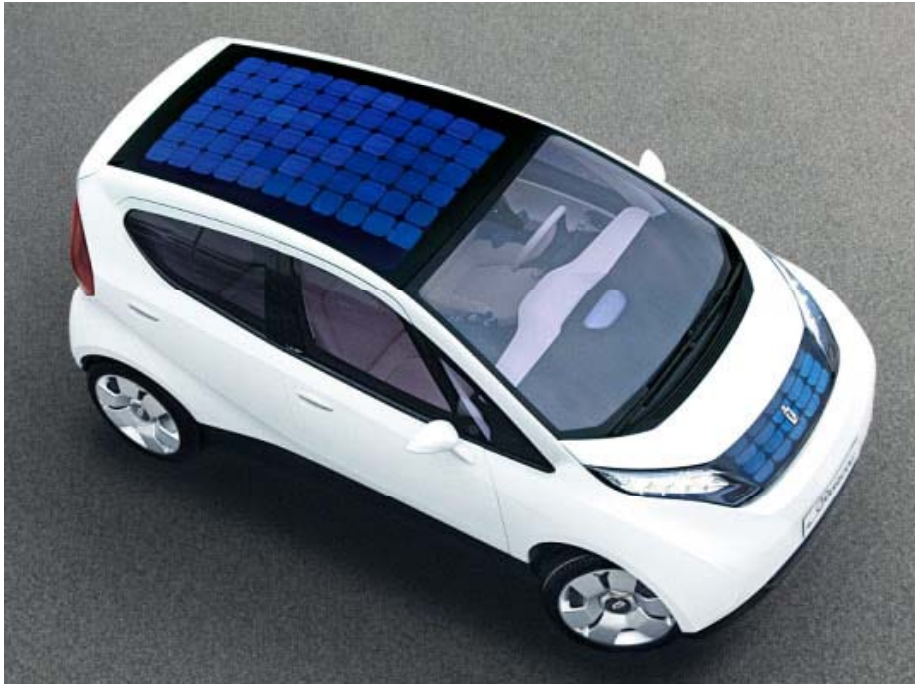
PV Systems:

The CIS Tower in England was clad in PV panels at a cost of £5.5 million. It started feeding electricity to the National Grid in November 2005



PV Systems: Solar Vehicles

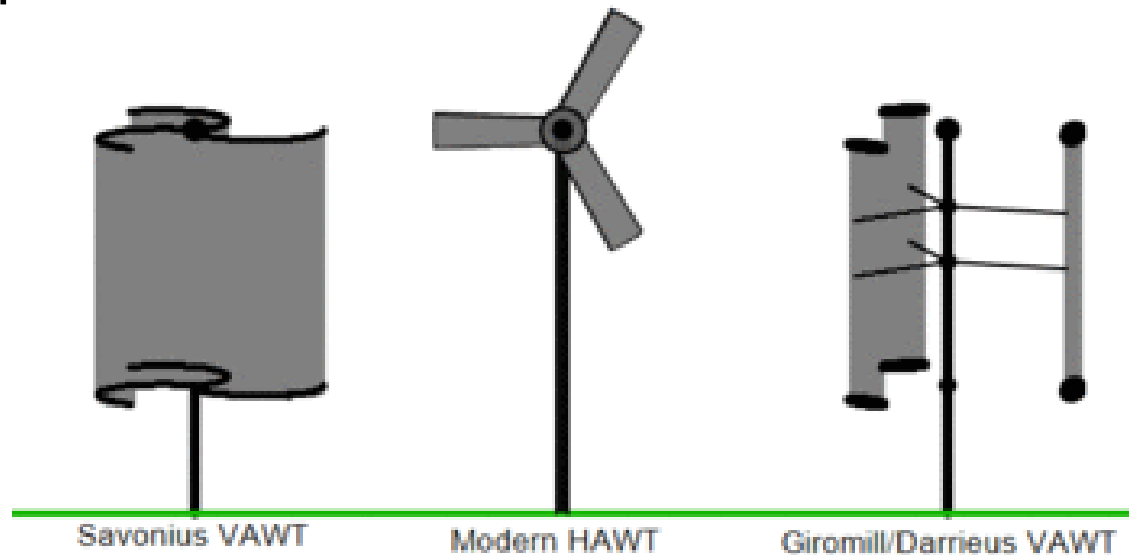
A **solar vehicle** is an electric vehicle powered by solar electricity.



WT Systems

A **wind turbine** is a device that converts kinetic energy from the wind into mechanical energy. [Wikipedia]

Types of WT- Wind turbines can rotate about either a horizontal or a vertical axis, the former being both older and more comr



WT Systems – Horizontal Type



11x 7,5 MW WindFarm Belgium July 2010



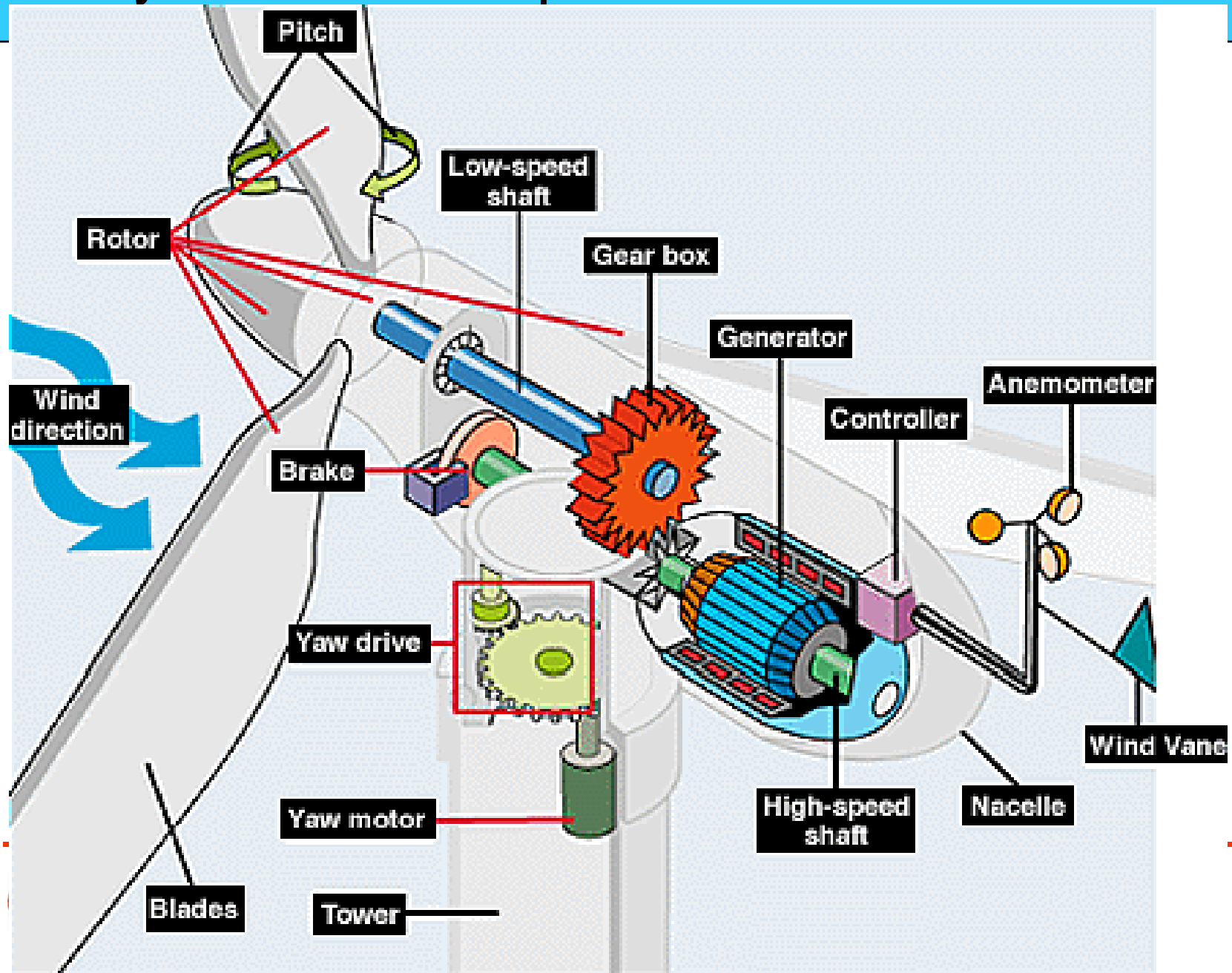
WT Systems – Vertical Type



Darrieus wind turbine of
30 m in the Magdalen
Islands



WT Systems – Components of Horizontal WT



Hybrid Systems

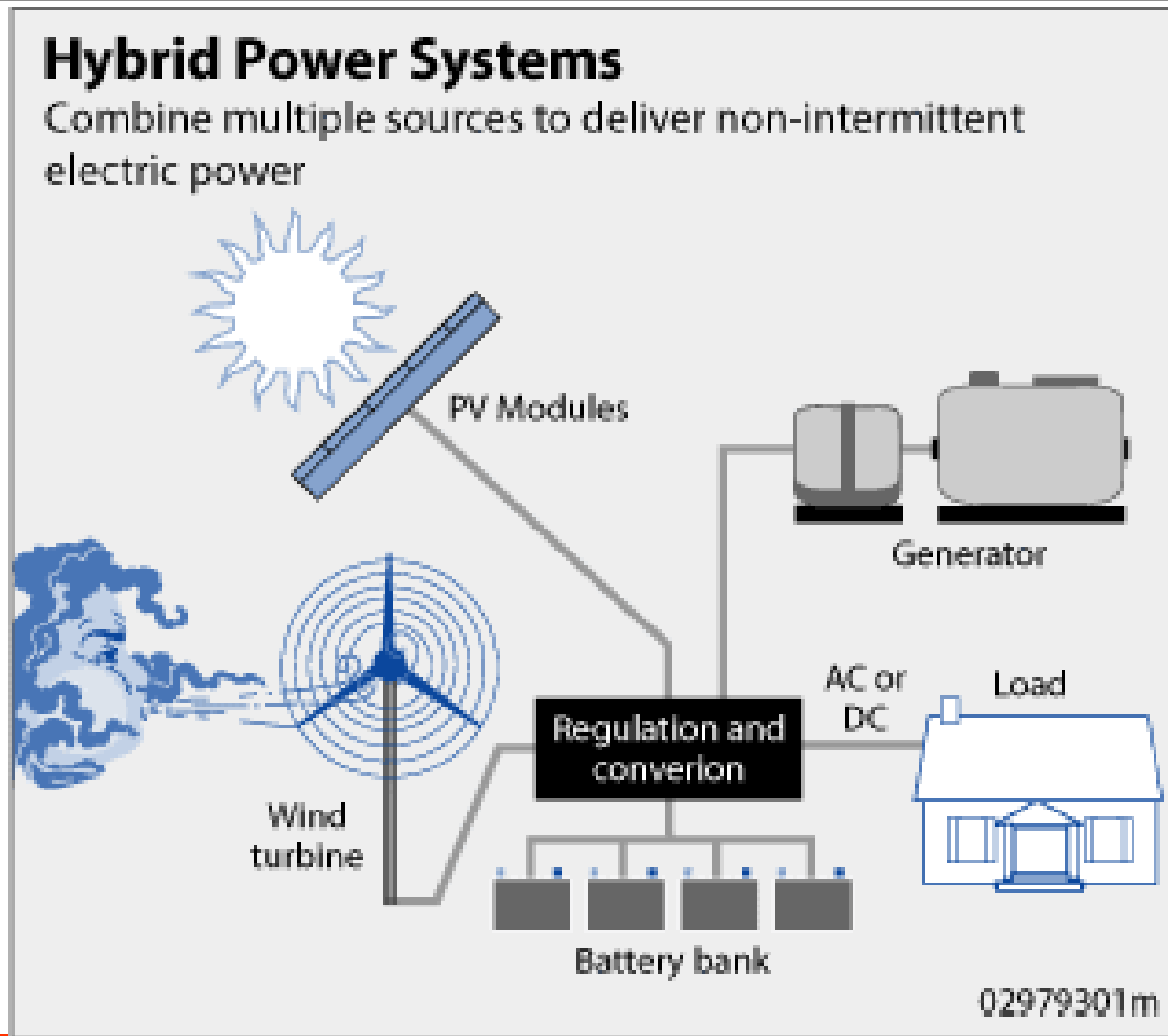
Systems that employ renewable and non-renewable energy resources.

Criteria

1. More Sustainable than Non-Renewable Resource
2. More Reliable than Renewable Resources



Hybrid Systems



Power Courses Offered at ECE

- EECE 370: Electric Machines and Power Fundamentals
- EECE 471: Fundamentals of Power System Analysis
- EECE 473: Power Electronics
- EECE 475: Industrial Electrification
- EECE 476: Power System Protection and Switchgear
- EECE 670: Power System Planning
- EECE 671: Environmental Aspects of Energy Systems
- EECE 672: Energy Planning and Policy
- EECE 675: Renewable Energy Systems
- EECE 677: Electric Power System Operation & Control
- EECE 678: Advanced Power System Analysis



Thank you !!!!!!!

Questions ??????????

