The Challenge of Powering a Sustainable World

Lecture 2: The Nuts and Bolts of Generating Electricity

We live in a world that is rich in energy. Whether it be the natural daily energy flows of sun, wind and water, or the energy concentrated and stored by nature over geological time scales, mankind has continuously sought out new methods of extracting and converting energy into forms that are better suited to our human needs. Even as we probe the most innermost workings of the atom in search of limitless clean energy, in many parts of the world we still continue the millennia old process of burning wood to meet our energy needs. Indeed we have developed an "energy mix" consisting of a broad spectrum of technologies, both old and new, to ensure the security of energy supply, utility, and sustainability of our energy future.

In this lecture we will examine the principal technologies we use to generate electricity in our modern world, and, by having a better understanding of their capabilities and limitations, make better decisions on energy supply as we work towards a net zero future.

As with any new subject matter, acquainting yourself with topic specific terms will be helpful.

Dispatchable Electricity: A source of electricity that can be turned on, turned off, or throttled at will by the operator.

Load Following: An electricity generating technology that is capable of adjusting its output, in real time, to match electricity demand.

Ramp Rate: The rate that Dispatchable power can be increased or decreased. Usually expressed in % per minute.

Base Load: Is the "always on" demand on the electricity grid.

Peak Load: is all electricity demand in excess of Base Load. Peak load varies throughout the day and the seasons.

Variable Generation: is electricity fed into the grid in unpredictable amounts and at unpredictable times.

Hot Standby: Thermal generating sources kept warm shorten start-up and response time when power is needed quickly

Capacity Factor: is the ratio of the quantity of electricity produced by a source to the maximum the source is capable of producing. e.g.

$$\frac{12\ \text{MWh}}{48\ \text{MWh}} = 0.25 = 25\%\ \text{Capacity Factor}$$

Further reading/watching
Learn more about wind turbines https://riskengineers.com/wind2/

Learn more about hydro power in Ontario https://www.opg.com/powering-ontario/our-generation/hydro/

An easy guide to understanding fusion https://www.youtube.com/watch?v=N4yWhA1mVxA