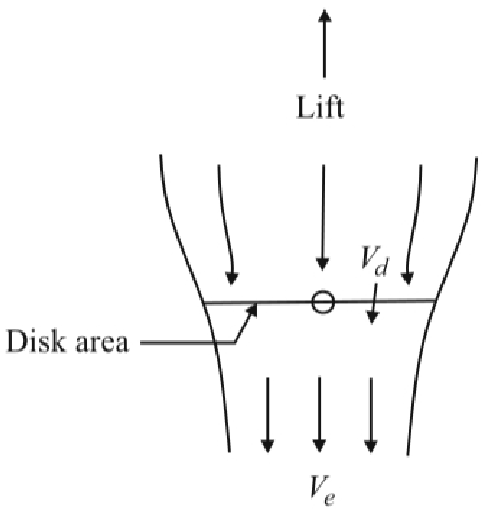
Powered Lift



For an un-ducted rotor, ambient air is sucked into the disk defined by the spinning fan, and passes through it with a velocity v_d and continues to accelerate to a final exit velocity v_e. It is well known and easily proved that:

$$v_d = \frac{v_e}{2} \tag{6.7}$$

and the mass flow is:

$$\frac{\mathrm{d}m}{\mathrm{d}t} = \rho A v_d = \frac{1}{2}\rho A v_e \tag{6.8}$$

where A is the area of the disk, so the lift of the disk is:

$$L = \frac{\mathrm{d}m}{\mathrm{d}t} v_e = \frac{\rho A v_e^2}{2} \tag{6.9}$$

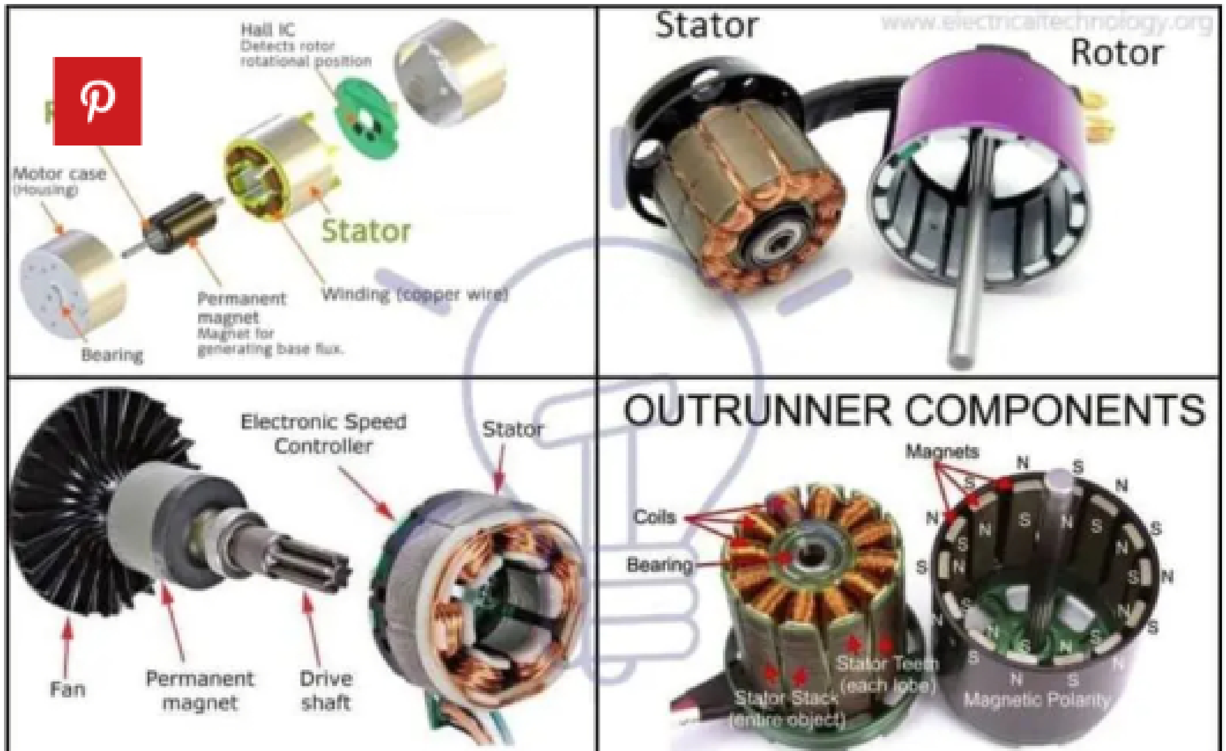
The induced power is:

$$P = \frac{1}{2}\frac{\mathrm{d}m}{\mathrm{d}t} v_e^2 \tag{6.10}$$

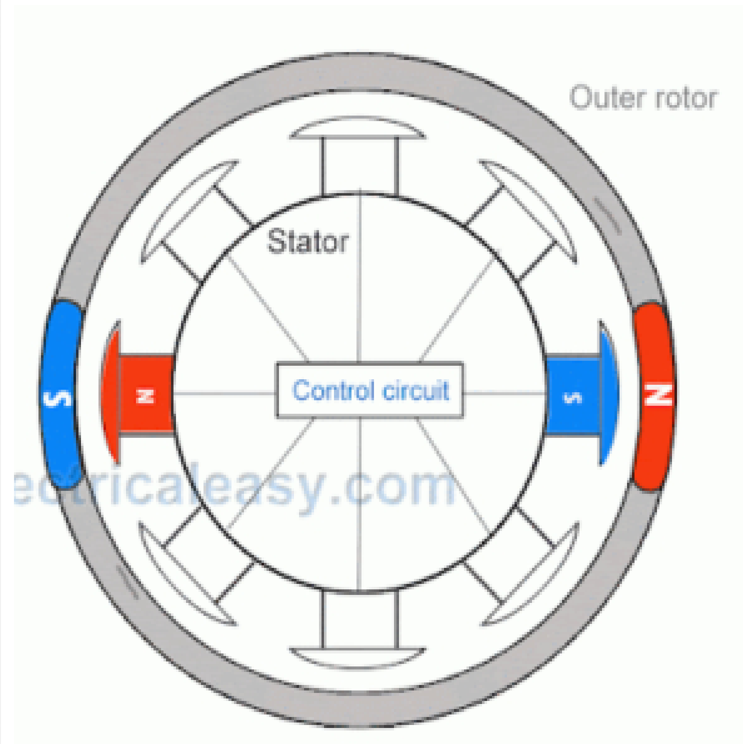
and by substituting for $\mathrm{d}m/\mathrm{d}t$ from Equation (6.8) and for v_e^3 from Equation (6.9), we find that:

$$P = \frac{L^{3/2}}{\sqrt{2\rho A}} \tag{6.11}$$

Brushless DC motor



Construction of BLDC Motor



Construction:BLDC motor consists of two main parts a stator and a rotor. Permanent magnets are mounted on the rotor of a BLDC motor, and the stator is wound for a specific number of poles. Also, a control circuit is connected to the stator winding. Most of the times, the inverter/control circuit or controller is integrated into the stator assembly.

Working:Stator windings of a BLDC motor are connected to a control circuit (an integrated switching circuit or inverter circuit). The control circuit energizes proper winding at the proper time, in a pattern which rotates around the stator. Permanent magnets on the rotor try to align with the energized electromagnets of the stator, and as soon as it aligns, the next electromagnets are energized. Thus, the rotor keeps running.

Batteries

The key characteristics of a battery are as follows:

- Capacity—The electrical charge effectively stored in a battery and available for transfer during discharge. Expressed in ampere-hours (Ah) or milliampere-hours (mAh).
- Energy Density—Capacity/Weight or Ah/weight.
- Power Density—Maximum Power/Weight in Watts/weight.
- Charging/Discharging rate (C rate)—The maximum rate at which the battery can be charged or discharged, expressed in terms of its total storage capacity in Ah or mAh. A rate of 1C means transfer of all of the stored energy in 1 h; 0.1C means 10% transfer in 1 h, or full transfer in 10 h.

Battery types

6.4.5.1.1 Nickel–Cadmium Battery

The nickel–cadmium (NiCd) battery uses nickel hydroxide as the positive electrode (anode) and cadmium/cadmium hydroxide as the negative electrode (cathode). Potassium hydroxide is used as the electrolyte. Among rechargeable batteries, NiCd is a popular choice but contains toxic metals. NiCd batteries have generally been used where long life and a high discharge rate is important.

6.4.5.1.2 Nickel–Metal Hydride Battery

The nickel–metal hydride (NiMH) battery uses a hydrogen-absorbing alloy for the negative electrode (cathode) instead of cadmium. As in NiCd cells, the positive electrode (anode) is nickel hydroxide.

The NiMH has a high-energy density and uses environmentally friendly metals. The NiMH battery offers up to 40% higher energy density compared to NiCd. The NiMH has been replacing the NiCd in recent years. This is due both to environmental concerns about the disposal of used batteries and the desirability of the higher energy density.

6.4.5.1.3 *Lithium-Ion Battery*

The lithium-ion (Li-ion) battery is a fast growing battery technology because it offers high-energy density and low weight. Although slightly lower in energy density than lithium metal, the energy density of the Li-ion is typically higher than that of the standard NiCd. Li-ion batteries are environmentally friendly for disposal.

Li-ion batteries typically use a graphite (carbon) anode and an anode made of $LiCoO_2$ or $LiMn_2O_4$. $LiFePO_4$ also is used. The electrolyte is a lithium salt in an organic solvent. These materials are all relatively environmentally friendly.

Li-ion is the presently used technology for most electric and hybrid ground vehicles and its maturity and cost are likely to be driven by the large commercial demand.

6.4.5.1.4 *Lithium-Polymer Battery*

The lithium-polymer (Li-poly) battery uses $LiCoO_2$ or $LiMn_2O_4$ for the cathode and carbon or lithium for the anode.

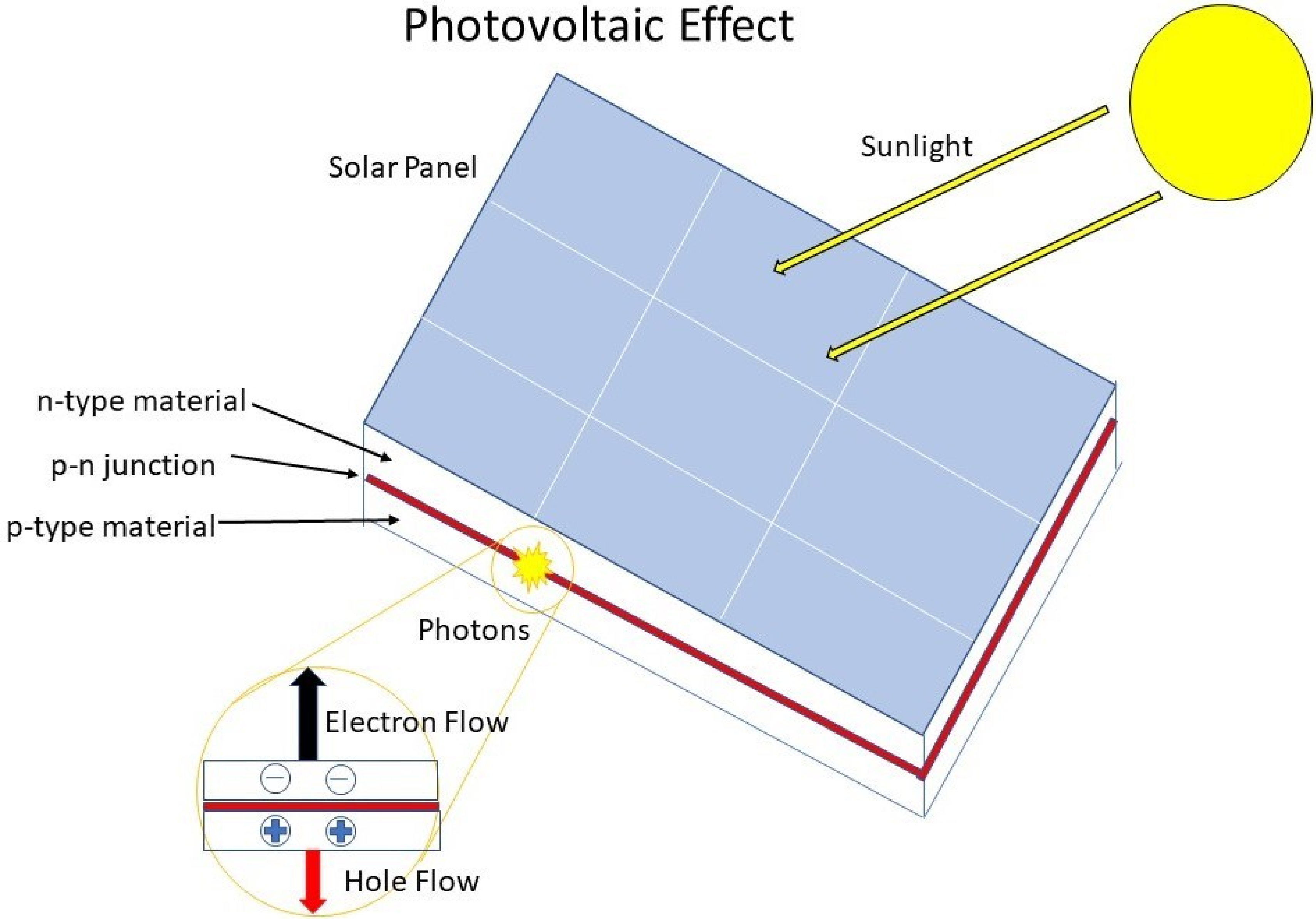
The Li-poly battery is different than other batteries because of the type of electrolyte used. The polymer electrolyte replaces the traditional porous separator, which is soaked with a liquid electrolyte.

The dry polymer design offers simplifications with respect to fabrication, ruggedness, safety and thin-profile geometry. The major reason for switching to the Li-ion polymer is form factor. It allows great freedom to choose the shape of the battery, including wafer-thin geometries.

Solar Cells

- The basic principle of a solar cell is that a photon from the sun (or any other light source) is absorbed by an atom in the valence band of semiconductor material and an electron is excited into the conduction band of the material. In order for this to happen, the photon must have enough energy to allow the electron to jump through an “energy gap” that separates the conduction band from the valence band and is due to quantum mechanical effects that create “forbidden” energy states in a crystalline material.

Photovoltaic Effect



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- The most common type of solar cell is a silicon positive-intrinsic-negative (PIN) diode.
- This is created by doping small amounts of selected impurities into a silicon crystal so that it has somewhat higher energy bands than pure silicon (positive doped or “P” material) and then adding additional doping to the surface of the crystal that lowers the energy bands near the surface relative to the undoped material (negative doped or N material). In the region where the doping is intermediate, the energy bands pass through the levels of pure silicon, and the crystal is neither positive nor negative, but “intrinsic” or “I” material
- The doping of the junction creates a potential difference in the crystal that causes the electron to move toward the surface and contact on the “N” side and the hole to move to the surface and contact on the P side, so that if these two contacts are connected through a load, a current will f l ow through that load