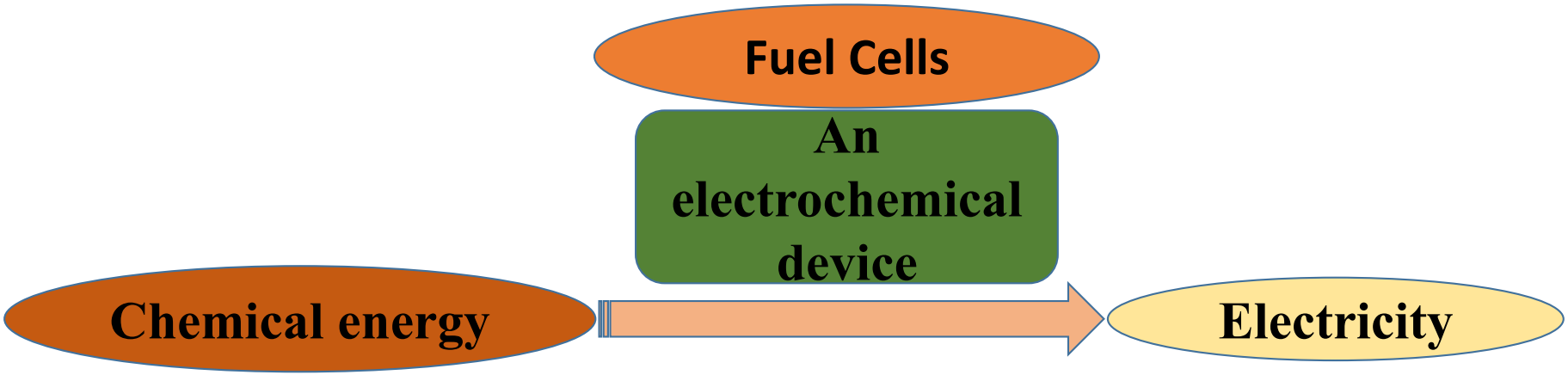
Fuel Cells

A fuel cell is an electrochemical device that converts the chemical energy of a fuel into electricity without involving a combustion cycle.



Fuel Cells

- **A fuel cell consists of two electrodes, namely an anode and a cathode.**
- **Anode is positively charged and cathode is negatively charged in an electrolytic cell.**
- **The reactions that produce electricity take place at the electrodes.**
- **Every fuel has an electrolyte, which carries electrically charged particles from one electrode to the other, and a catalyst, which speeds the reactions at the electrodes.**
- **In fuel cells, hydrogen is used as the most common fuel, but hydrocarbons, such as natural gas and alcohols like methanol, are sometimes used.**

Fuel Cells Versus Traditional Electricity Generation

✓ **Fuel cells work on the principle of direct energy conversion in single stage to obtain electrical energy from chemical energy as follows:**

$$\text{Chemical energy} \rightarrow \text{Electrical energy}$$

- **It does not involve the burning of fuel, but electrical energy is directly obtained from chemical energy by electrochemical process.**

✓ **Traditional or conventional method of electrical energy conversion is an indirect method of energy conversion and involves intermediary conversion to energy forms and finally to electrical energy as follows:**

$$\text{Chemical energy} \rightarrow \text{Heat} \rightarrow \text{Mechanical energy} \rightarrow \text{Electrical energy}$$

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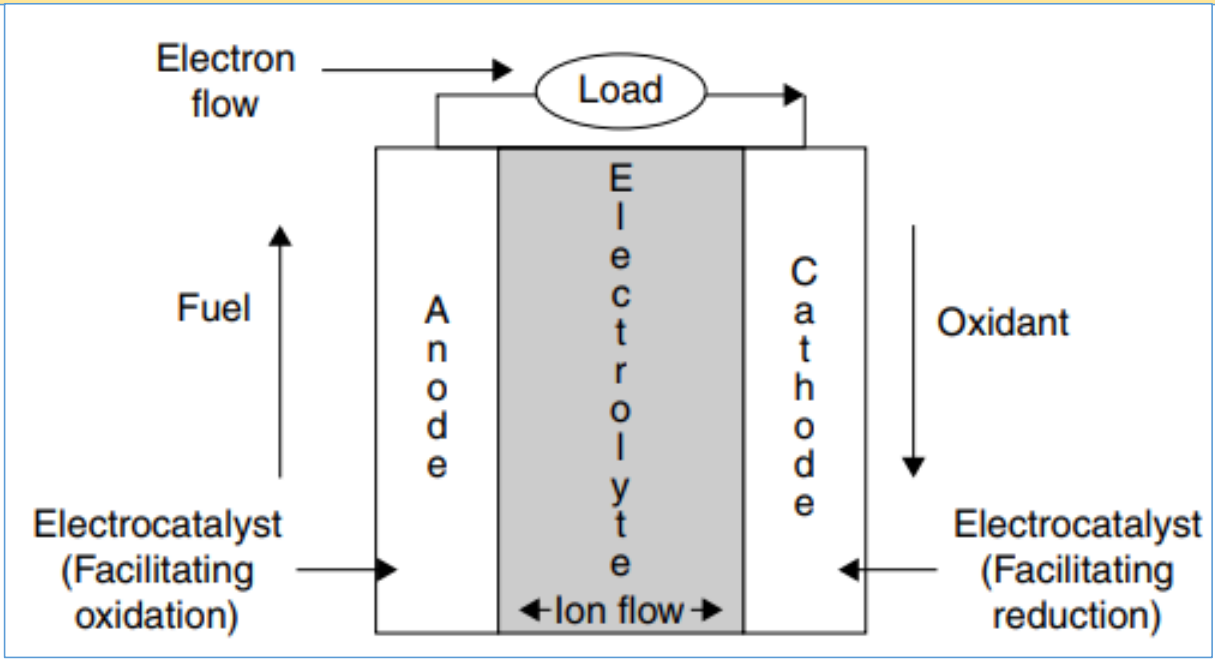
Chemical energy → Heat → Mechanical energy → Electrical energy

- **Fossil fuels and nuclear fuels are burnt to produce heat and high-pressure steam. The high pressure steam expands in a turbine which starts rotating and ultimately drives the coupled electrical generator to convert mechanical energy into electrical energy.**

Schematic of fuel cell



The schematic diagram of fuel cell is given in Figure. It consists of the following parts:

1. **Anode: It is a positive electrode and facilitates electrochemical oxidation of fuel.**
2. **Cathode: It is a negative electrode and promotes electrochemical reduction of oxidant.**
3. **Electrolyte: It is a solution of liquid, gases with salts and carries electrically charged particles between them.**

Performances of Fuel Cells Versus others

- **The single-stage direct energy conversion of chemical energy to electrical energy in fuel cell is a highly efficient process than three-stage conversion of chemical energy into electrical energy in traditional methods that involve combustion or burnings.**
- **The energy release by chemical reaction in fuel cell is a function of change in Gibbs free energy.**
- **The Carnot law and efficiency of heat engine is not applicable to fuel cell.**
- **The maximum theoretical efficiency of fuel cells is much higher than conventional indirect methods of conversion.**
- **Fuel cells have less environmental damage than conventional methods of electrical generation.**