



Course for green energy devices installer



Content of the course:

The scenario

The renewable energy options for your home

Know to install

Check your quotations for the following

Check planning permission and building warrants

Financial support

Certificate

Conclusion

Scenario

Renewable energy is generated from natural resources such as the sun, wind, and water, using technology which ensures that the energy stores are naturally replenished.

Instead of buying all of your energy from suppliers, you can install renewables technology (also called micro generation and low-carbon technology) to generate your own.



Scenario

What are the benefits of installing renewables?

There are lots of good reasons to use renewables.

You will be:

- making use of secure and local resources
- reducing your dependence on non-renewable energy
- helping to reduce the production of carbon dioxide and other greenhouse gases
- creating new jobs in renewable energy industries
- reducing your energy bills. In some cases you can generate income by selling your surplus energy back to your energy provider.

The renewable energy options for your home

Where do I start with a home renewables systems?

If you're thinking about a home renewables system, here are some important things to think about: ensure your home is as energy efficient as it can be.

This will help you get the most out of your new system. Think about insulating your property wherever you can, and using your appliances, lighting and water more efficiently.

The renewable energy options for your home

What are the renewable energy options for your home? Some technologies have specific requirements for installation:

- Solar PV and solar thermal depends on the way your roof faces.
- Solar thermal, heat pumps and biomass require space inside and outside.
- Hydro requires a nearby stream or river.

This will influence which technology is most appropriate for you. Many people want to save money and reduce their emissions, and it is becoming more possible to achieve both.

The renewable energy options for your home

Other factors can have an impact, for example:

If you need to replace your boiler or central heating system, installing a new biomass boiler or heat pump becomes more cost-effective.

If your priority is to save carbon dioxide, consider wood-fuelled heating, a large wind turbine or a large solar PV system.

If you want to do a bit for the environment but have limited funds, think about a cheaper option such as solar water heating

If you live in an isolated rural property with no mains electricity, you may get the most reliable off-grid supply from hydro or from a mixture of wind and solar PV.



Know to install

There is a lot to consider before and after installing a renewables system, but having one at home will help reduce your energy bills and household carbon footprint.

Our useful guide will help to ensure you cover all important steps for installation, so that you can get the most out of your system.



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Lecture Question

- What are the renewable energy sources? Make a list, as comprehensive as possible.
- What are the environmental impacts of these energy sources?

Renewable Energy Sources

- Radiant solar energy
 - Solar heating (passive and active), solar power plants, photovoltaic cells
- Biomass energy
 - Direct: combustion of biomass
 - Indirect: chemical conversion to biofuel
- Wind energy
- Hydro energy
- Geothermal energy
 - Power plants, direct use, heat pumps
- Ocean energy
 - Tidal; salinity-driven

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Advantages of the Hydro Energy

- Cheap to operate
 - Long life and lower operating costs than all other power plants
- Renewable
- High yield
 - Lower energy cost than any other method
- Pretty plentiful
 - Some countries depend almost entirely on it
- Not intermittent (if reservoir is large enough)
- Reservoirs have multiple uses
 - Flood control, drinking water, aquaculture, recreation
- Less air pollution than fossil fuel combustion

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- Disadvantages:
 - Human population displacement
 - More significant breeding ground for disease
 - Reduces availability of water downstream
 - Ecosystem impacts
 - Barriers to migrating fish
 - Loss of biodiversity both upstream and downstream
 - Coastal erosion
 - Reduces nutrient flow (dissolved and particulate)
 - Water pollution problems
 - Low dissolved oxygen (DO)
 - Increased H_2S toxicity; other DO-related problems
 - Siltation a big problem (also shortens dam life)
 - Air pollution
 - Actually may be a significant source of GHGs (CH_4 , N_2O , CO_2)
 - Decommissioning is a big problem
- The Size Issue
 - Many (most) of the above problems are significantly worse for larger dams
 - However, small dams have shorter lifetimes, less capacity, and are more intermittent

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- Advantages of the Wind Energy
 - High net energy yield
 - Renewable and free
 - Very clean source of energy
 - No pollution (air or water) during operation
 - Long operating life
 - Low operating/maintenance costs
 - Can be quickly built; not too expensive
 - Now almost competitive with hydro and fossil fuels
 - Land can be used for other purposes
 - Can combine wind and agricultural farms

Know to install

- Disadvantages
 - Energy storage issues
 - An intermittent source of energy; need backup (eg stored energy) for low-wind days
 - Or must be connected to the electrical grid
 - Only practical in areas that are windy enough
 - Visual pollution
 - Danger to birds
 - New (slow turning) designs largely eliminate this problem
 - Low energy density of wind
 - Must use large areas of land



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- What is biomass Energy?
 - Biomass energy is the use of living and *recently* dead biological material as an energy source
 - Ultimately dependent on the capture of solar energy and conversion to a chemical (carbohydrate) fuel
 - Theoretically it is a *carbon neutral* and renewable source of energy

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- How it works?
 - Traditional: forest management, using wood as fuel
 - Use of biodegradable waste
 - Examples: manure, crop residue, sewage, municipal solid waste
 - Recent interest in agricultural production of **energy crops**
 - Should be high yield and low maintenance
 - Examples: corn, sugarcane, switchgrass, hemp, willow, palm oil, rapeseed, and many others
 - Does not have to be a food crop
 - Recent interest in bioengineered (GM) plants as fuel sources

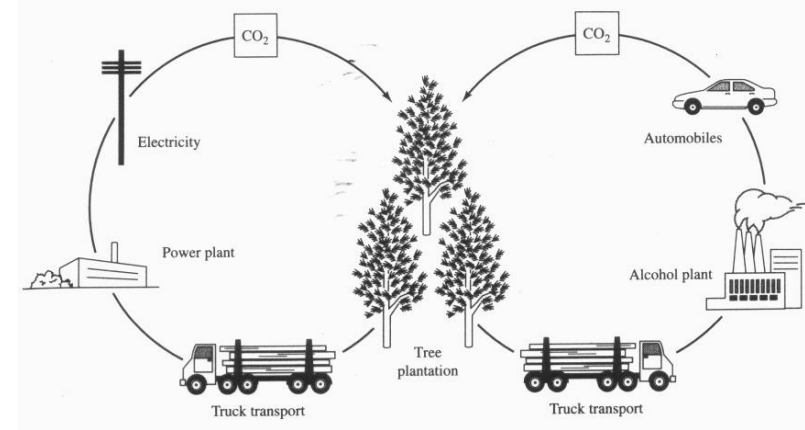


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- Production of a liquid or gaseous ***biofuel***
 - *Biogas* due to the breakdown of biomass in the absence of O_2
 - Includes capture of landfill methane
 - *Bioethanol* from fermentation, often from corn. Cellulosic bioethanol is usually from a grass (switchgrass)
 - *Biodiesel* from rapeseed and other sources

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- Carbon neutral
 - CO₂ ultimately released in energy generation is *recently* captured and so ideally does not change total atmospheric levels
 - *Carbon leaks* can result in a net increase in CO₂ levels
 - Sequestration in soil can result in a net *decrease* in CO₂ levels





Advantages

- Versatile
- Renewable
- No net CO₂ emissions (ideally)
- Emits less SO₂ and NO_x than fossil fuels

Disadvantages

- Low energy density/yield
 - In some cases (eg, corn-derived bioethanol) may yield no net energy
- Land conversion
 - Biodiversity loss
 - Possible decrease in agricultural food productivity
- Usual problems associated with intensive agriculture
 - Nutrient pollution
 - Soil depletion
 - Soil erosion
 - Other water pollution problems



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- How Geothermal Energy works
 - Geothermal power plants
 - Use earth's heat to power steam turbines
 - Geothermal direct use
 - Use hot springs (etc) as heat source
 - Geothermal heat pumps



Know to install

Advantages

- Renewable
- Easy to exploit in some cases
- CO₂ production less than with fossil fuels
- High net energy yield

Disadvantages

- Not available everywhere
- H₂S pollution
- Produces some water pollution (somewhat similar to mining)



Know to install

How radiant solar energy works

- Solar power plants
 - Steam produced to turn turbine
- Solar heating
 - Active and passive systems
- Photovoltaic cells
 - “Solar batteries” use special semiconductors



Know to install

Advantages

- Renewable and free
- High energy yield
- A very clean source of energy
 - No air/water pollution during operation
- Low operating costs
 - Will pay for themselves over time

Disadvantages

- Intermittent source
 - Energy storage issues
- Low energy density
 - Requires pretty much land

Know to install

Lecture Questions about hydrogen economy

- What is the hydrogen economy?
- Explain how the hydrogen economy could potentially serve as the basis for a renewable energy system that emits little or no air pollution

Definition

- *The Hydrogen Economy* is a hypothetical large-scale system in which elemental hydrogen (H_2) is the primary form of energy storage
 - Fuel cells would be the primary method of conversion of hydrogen to electrical energy.
 - Efficient and clean; scalable
 - In particular, hydrogen (usually) plays a central role in transportation.

Potential Advantages

- Clean, renewable
- Potentially more reliable (using distributed generation)

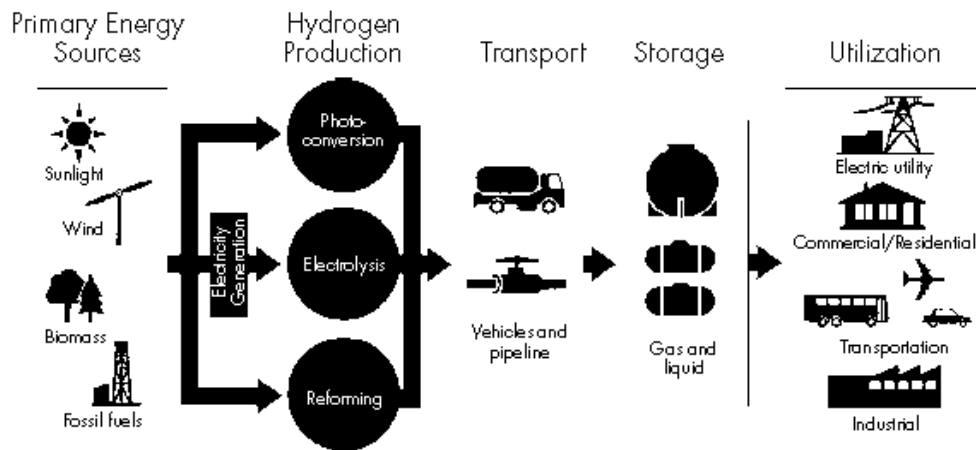
BUT many roadblocks *including potential showstoppers*

- Poses great technological challenges for efficient hydrogen production, storage, and transport

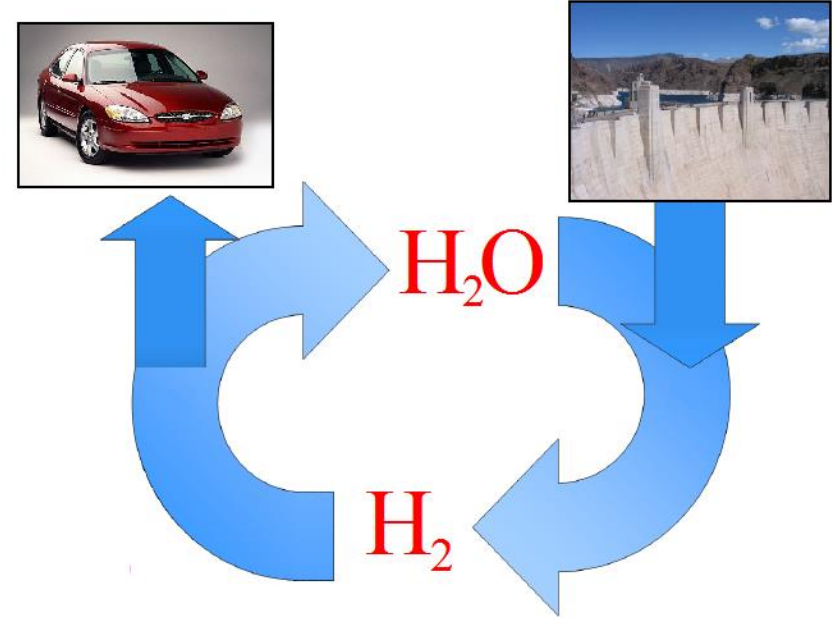
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Components of the hydrogen economy, Infrastructure needs

- Production
- Storage
- Delivery
- End use



Know to install Hydrogen as a Transportation Fuel



Know to install

- Fossil Fuels
 - Steam Reforming of Natural Gas
 - Combination of methane and steam produces hydrogen gas
 - Carbon monoxide is also produced
 - The “water gas shift” reaction can produce further hydrogen from the carbon monoxide. *Carbon dioxide is produced too.*
 - Most economical; main current method
 - Carbon sequestration one method to reduce CO₂ emission
 - Partial Oxidation (POX) of Hydrocarbons
 - HC partially oxidized to produce hydrogen and carbon monoxide
 - Coal Gasification
 - Gasified at high temps, then processed
 - Can also be used to get hydrogen from biomass

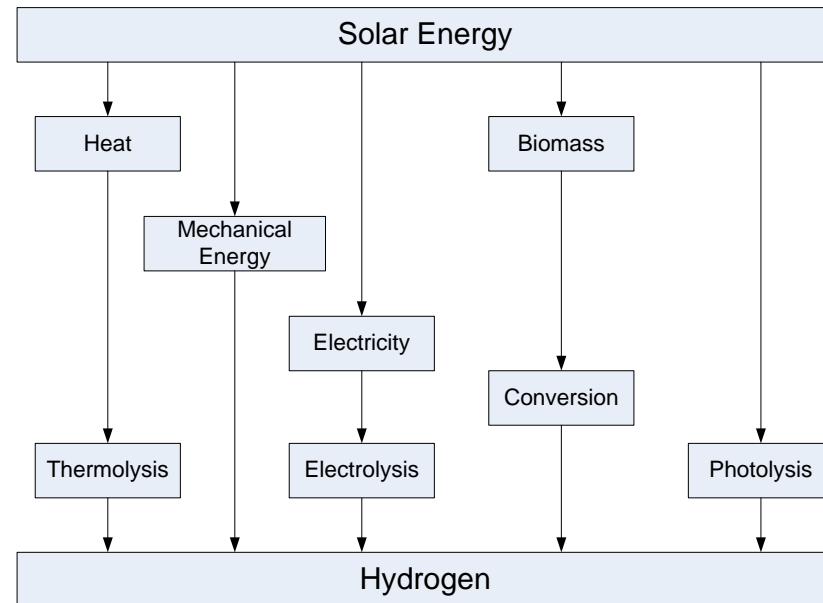


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- Electrolysis
 - Efficiencies 70-85%
 - Produces highest purity of hydrogen
 - Currently, the electricity consumed is usually worth more than the hydrogen produced
- Experimental methods
 - Biological hydrogen production
 - Direct photolysis
 - Thermolysis

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Renewable Solar Paths to Hydrogen





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- Large-Scale Stationary Storage
 - Underground in depleted oil/gas fields, aquifers, caverns
- Intermediate- and Small-Scale Stationary/Mobile Storage
 - The focus of most current research
 - As a liquid
 - Advantage: higher energy density, cheaper transport
 - Disadvantage: economic/energy cost of liquefaction is significant
 - As a compressed gas
 - Probably best short-term method, particularly with advanced materials to decrease weight

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Advantages

- Rapid charging/discharging
- Lower costs than liquid storage

Disadvantages:

- Low energy density, Probably still acceptable for motor vehicles
- Safety (esp public perception)
- Metal hydrides
 - Hydrogen is absorbed under pressure, released when heated
 - Less filling pressure needed
 - Low energy density, long recharge time, expensive
- Experimental Methods
 - Improved hydrides; carbon nanotubes; many other materials (eg conversion to ammonia)

Know to install

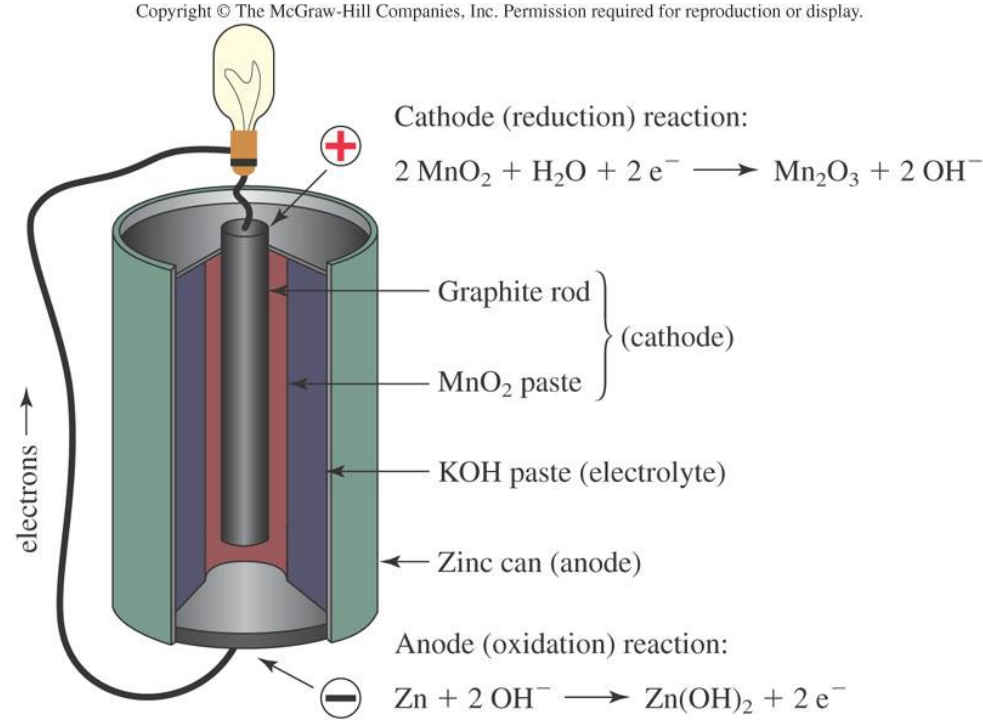
Lecture Questions about chemical batteries

- What are batteries and how do they work?
- What's the difference between a “regular” and a “rechargeable” battery? Why are rechargeable batteries sometimes referred to as “storage” batteries?
- Chemical batteries are based on reduction-oxidation (redox) reactions, which are reactions where electron transfer occurs.
 - The oxidation half-reaction occurs at the *anode*
 - Electrons flow from the anode, through an external circuit, and to the *cathode*, where the reduction half-reaction occurs

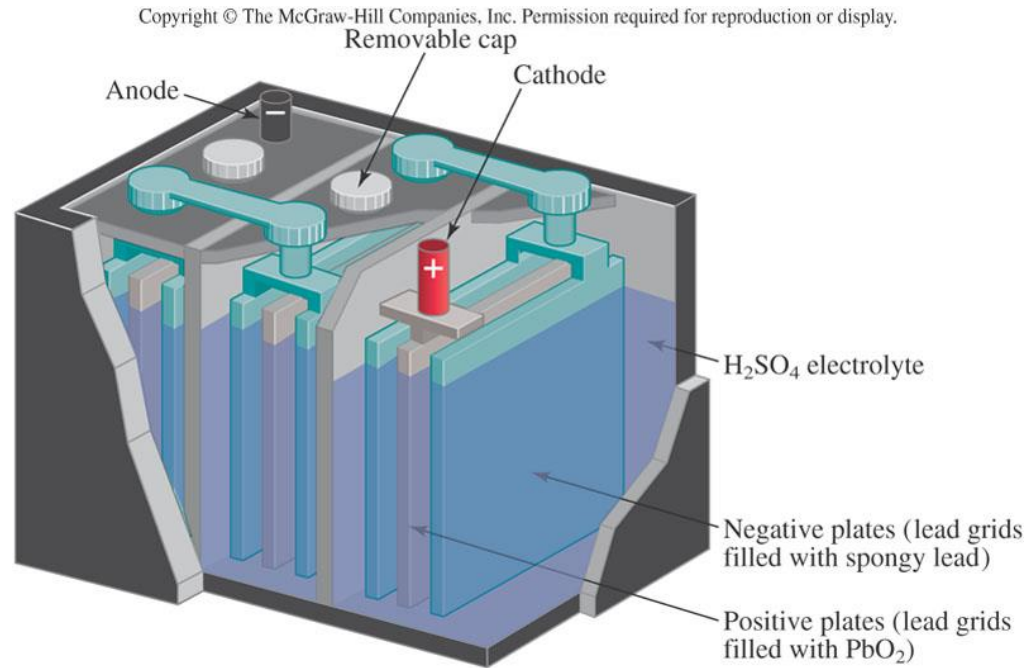
Know to install

- Chemical batteries are a very efficient method of generating electricity
 - Efficiencies of 80% are regularly achieved
 - Significantly (2-3 times) more efficient than heat engines
- Rechargeable batteries can be hooked up to an external source of electricity to regenerate the redox reactants through electrolysis.
 - Rechargeable batteries thus provide a means of storing electricity in chemical form. They are thus sometimes called *storage batteries*.

Know to install The Alkaline Battery



Know to install The Lead Storage Battery

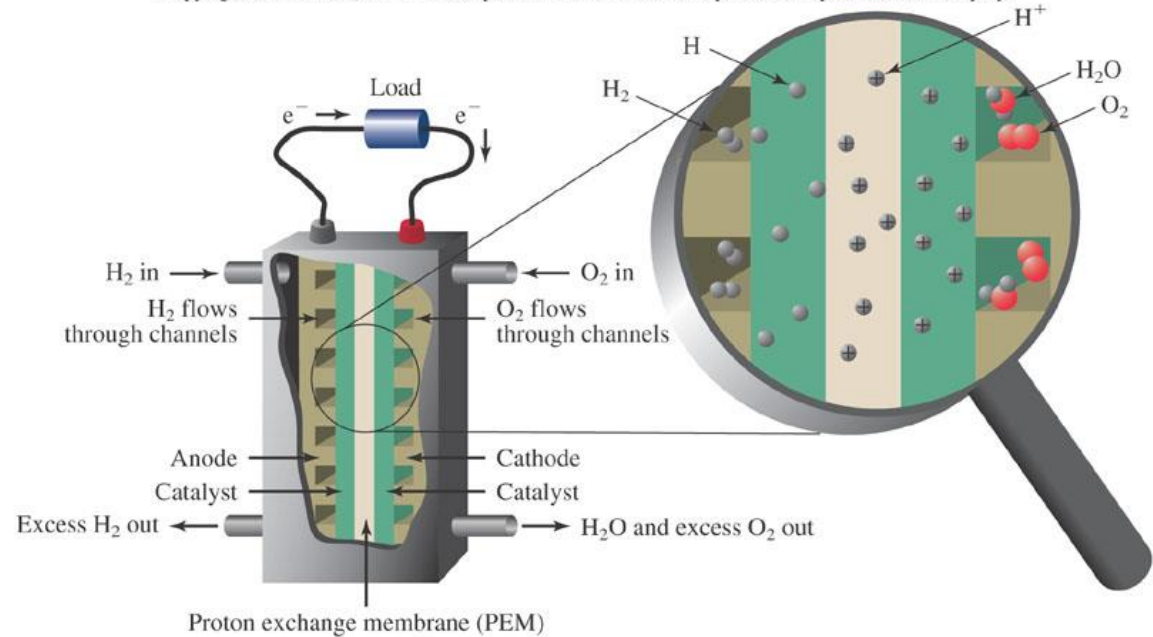


Know to install

- *Lecture Questions about fuel cells*
 - What is a fuel cell and how does it work?
 - What is *distributed generation*?
 - A fuel cell is basically a battery in which the reactants are continually supplied to the electrodes, and the products are continually removed.
 - Much more efficient (2-3 times) than heat engines at generating electricity
 - Most common type of fuel cells based on hydrogen (there are others)
 - Fuel cells are *scaleable*
 - Large ones can power homes or neighborhoods
 - Small ones can be used in appliances
 - Distributed generation is a decentralized power system consisting of hydrogen generators and fuel cells

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Know to install A Hydrogen Fuel Cell



Know to install

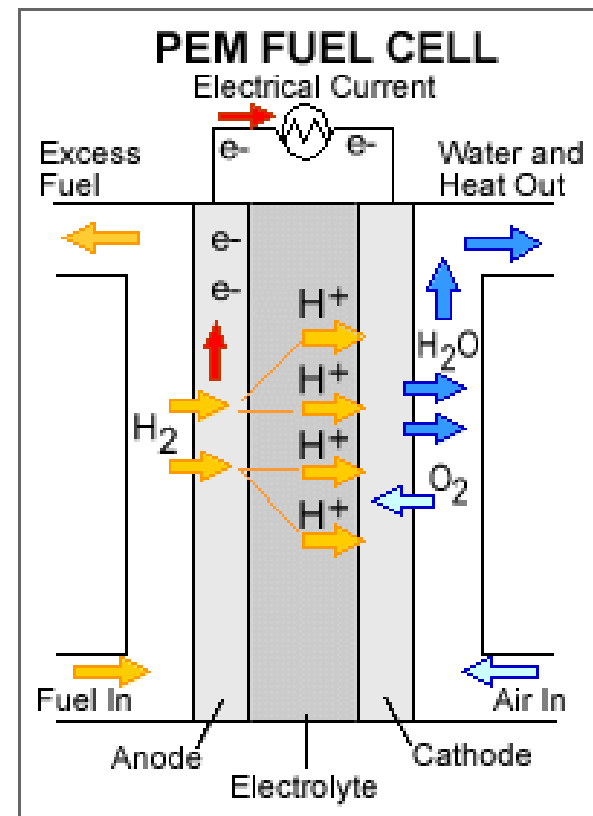
Hydrogen Fuel Cells: Scalable

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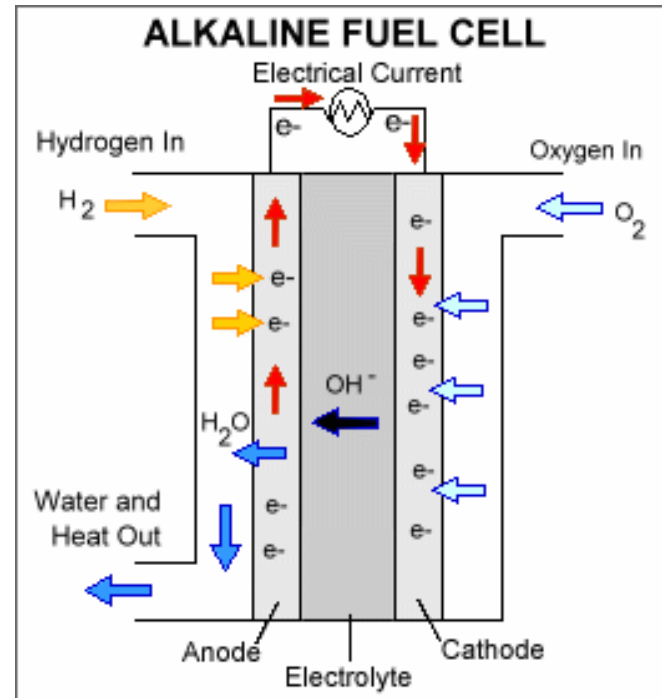
Know to install

Polymer Electrolyte Fuel Cell



Know to install

Alkaline Fuel Cell (AFC)



Know to install

Find a reputable installer

We recommend you use an installer who is certified under the Microgeneration Certification Scheme (MCS) and uses MCS-certified products.

All installers or suppliers should be able to provide a detailed breakdown of the specification and costs of their proposed system.

Know to install

They should also be able to:
Explain how they have calculated the size of the
system to be appropriate for your needs.





Know to install

Supply clear information and operating instructions.

- Explain how you should maintain your system.
- Provide an estimate of how much heat and electricity will be generated by any proposed system, and illustrate what this means in terms of your current energy needs.
- Provide an estimate of the savings you could make after installation.

Know to install

Get a quote

We recommend you get at least three quotes from three different installers. Beware of heavy-handed sales techniques, such as pressure to sign on the day, high prices with large discounts for signing on the spot, or bogus monitoring scheme discounts. Don't compare installers on cost alone – the cheapest may not be the most appropriate.

Check your quotations for the following

Check your quotations for the following (1/3):

- Will the installer project manage the whole job or will you need to arrange and pay for other trades such as electricians, plumbers or ground work contractors?
- Do the prices cover the distribution system (radiators and associated pipework) and the safe removal and disposal of any existing equipment, for example your old boiler?
- Do prices cover the cost of commissioning the system? All accredited installers are certified to commission systems once fully installed to ensure that they are fit for purpose.

Check your quotations for the following

Check your quotations for the following (2/3):

- Make sure that you receive a Commissioning Certificate from the installer.
- Available options e.g. size, fuel type, hot water storage, and maintenance cycles.



Check your quotations for the following

Check your quotations for the following (3/3):

- The efficiency values of the system.
- Payment options - your deposit should not be more than 25 per cent of the full cost. You should check that this will be protected with insurance.
- For heating systems, ask whether the cost of integration with your home's heating system, or a proposed heating system, is included.





Check planning permission and building warrants

Depending on the kind of property and installation, you may also need to get planning permission or a building warrant from your local planning authority. Make sure you have the right permissions in place before beginning installation.



Check planning permission and building warrants

You should always check with your local planning department to find out if planning permission or building warrants are required:

Check with your home insurance provider to make sure your policy covers the changes to your home, and make any adjustments you need. Some policies cover the more common systems, such as solar PV.

Financial support

There are many schemes offering financial support and incentives for installing renewables. You may have to apply for funding before proceeding with the installation so it's worth checking beforehand.





Certificate

Once the renewables system has been commissioned you should receive an MCS installation certificate from your installer. MCS requirements state that your MCS installer should have registered your system within ten working days of the system being fully installed. Householders must use an MCS certified installer and product for most funding schemes.



Certificate

You may wish to get a follow-up Energy Performance Certificate (EPC) carried out to update the energy efficiency rating of your property.

An EPC is now required if you wish to rent your property in the UK or sell your house in Scotland. EPCs are also required to pre-qualify for certain government financial incentive schemes for renewables systems and insulation.



Certificate

If you get any energy saving measures retrofitted in your property such as wall, floor or loft insulation which will not be visible, it is very important to keep evidence of this work. Take photos before and after installation, keep receipts of materials and builders' invoices and building warrant plans.

If an EPC surveyor cannot visually see the measure because it's inaccessible they will need to see documentary evidence of the work undertaken in order to validate the EPC.

Certificate

If you do not have evidence of retrofit insulation, this insulation cannot be factored into the EPC rating and will be ignored. Instead the level of insulation will be assumed based on the building's age.

This may significantly affect the EPC energy rating and the rating may not be as high as it could be.





Conclusion

Make sure your installer explains how your system and its controls work before they finish, and that they hand over any manuals that come with the system.

This is a standard part of the installation process and any competent installer should be happy to take you through this.