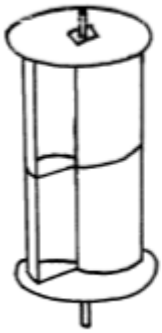
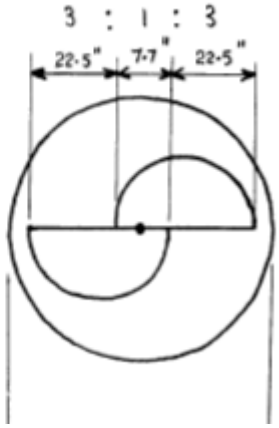
Wind Generator
Savonius Type 12V – 200 Watt

VERSION 1.0





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Introduction

About the publisher

Richard Jemmett's keen interest in the generation and use of energy has helped to shape his formal career and provide an incentive to write on the subject. He graduated from the University of Leeds in 1980 with a degree in fuel and energy engineering and has held various positions within energy and consultancy companies working in the UK, Europe the Middle East and Asia. He is a Board Director of two energy related companies and a past president of the Institution of Gas engineers and Managers

He has written many articles, essays, and conference presentations on utility industry strategy, energy industry development, energy market deregulation, renewable energy, distributed generation and high reliability organisational design.

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Introduction to the Savonius wind turbine

Wind units can be divided into two major types, horizontal axis and vertical axis machines.

Horizontal machines some times known as HAWT (Horizontal Axis Wind Turbines) are the traditional conventional design, they consist of a rotor with one to twenty blades driving a generator or a pump either directly or through a gearbox, chain or belt system. A tail vane or fantail is required to direct the machine into the wind.

They are usually more efficient than vertical axis units known as VAWT (Vertical Axis Wind Turbines). Savonius and Darius are two designs of vertical axis machines. This type of unit is often not situated on a tower and does not have to be directed into the wind. Materials and construction are usually cheaper than horizontal axis machines. The Savonius windmill was the brainchild of Sigrid Savonius of Finland. The racing driver of the 1930s said the secret of a good machine was to "add lightness and simplicate". A simple unit can be made by attaching two halves of vertically split oil barrel to a vertical axis this produces a low speed high torque unit that can be used for pumping water and through a gearing mechanism, generating electricity. This design also has the advantage of an aerodynamic effect called the "magnus principal", suction is formed by the air moving over the convex face of the rotor. This means that there is force acting on the face of the rotor pulling it into the wind.

The most ubiquitous application of the Savonius wind turbine is the Flettner Ventilator which is commonly seen on the roofs of vans and buses and is used as a cooling device. The ventilator was developed by the German aircraft engineer Anton Flettner in the 1920s. It uses the Savonius wind turbine to drive an extractor fan. The vents are still manufactured in the UK by Flettner Ventilator Limited.
Small Savonius wind turbines are sometimes seen used as advertising signs where the rotation helps to draw attention to the item advertised.

About these plans

This plan was developed to make use a car alternator maybe not the best generator but certainly widely available. The plan was originally written Peter Hanbury in the 1970s with the rights for reproduction bought by Richard Jemmett (then Jemmett Engineering) in the 1980s. Since then many hundreds have been sold and successfully built. The plan is in its original form and may be a little difficult to read but if you have any difficulties after printing please email me plans@onetoremember.co.uk

200 WATT SAVONIUS WIND GENERATOR

This plan gives details of how to construct a 200W wind generator for 12v battery charging using a Savonius Rotor.

The Savonius Rotor is a vertical axis wind turbine developed by the Finnish engineer S.J. Savonius during the years 1925-28.
Although of lower efficiency and speed than propeller designs it has the advantages of simple construction, low cost and does not require heading into the wind.

These plans should serve only as a guide as it is necessary for the constructor to use his own judgment depending upon the engineering facilities available and the allowable cost.

The rotor is constructed from two 45 gallon oil drums which drive a car alternator or dynamo.
The 12 volt output is used to charge one or more heavy duty batteries.
If 240 volt AC power is required a transistor inverter or rotary converter may be added to the system.

The performance of the wind generator will depend upon the quality of construction and components used, but typically the generator should start charging at 15 mph wind speed and produce 200 watts at 32 mph wind speed.

This performance is satisfactory for high wind areas, but for low wind areas the 15 mph cut in speed is rather high.
This cut in speed can be reduced by either using a larger rotor, or using a low speed alternator. (see Appendix)

SAVONIUS ROTOR RPM

The Savonius Rotor has a typical tip speed ratio of 1. This means that the rotor tip travels through the air at the same speed as the wind.

The rpm for any wind speed or rotor diameter can easily be calculated as follows :-

$$RPM = \frac{V \times 60}{D \times \pi}$$

where V = Wind speed in ft/second
D = Diameter of rotor in ft
π = 3.142

e.g. If wind speed = 15 mph = 22 ft/second
and rotor diameter = 3 ft

Then $RPM = \frac{22 \times 60}{3 \times 3.142} = 140$ rpm

This is an average rpm and in practice the rotor will run about 30% faster with no load and 30% slower on full load.

GEARING

A car alternator does not start to charge a 12v battery until 1000 rpm is reached and a car dynamo until 1200 rpm is reached.

This means that the rotor will require gearing up by 8:1 for a car alternator and 9:1 for a car dynamo.

At 15 mph "cut in" speed the generator rpm will be as follows :-

Car Alternator 140 x 8 = 1120 rpm

Car Dynamo 140 x 9 = 1260 rpm

Car alternators usually have a $2\frac{1}{2}$ inch pulley so that a $2\frac{1}{2}$" x 8 = 20" diameter large pulley will be required. Car dynamos usually have a 3 inch pulley so that a 3" x 9 = 27" diameter large pulley will be required.

VEE BELT GEARING

This is a cheap and robust form of gearing and has an efficiency of about 85% at full load.

At part load however the frictional losses are quite high and the efficiency drops considerably.

Two disadvantages of vee belt are that it requires regular tension adjustment and is also prone to slip under wet conditions.

If vee belt is used a single large pulley should be used to keep power loss to a minimum.

TIMING BELT GEARING

Timing belt gearing or toothed belt gearing is a very efficient form of gearing.

On full load efficiency is 90-95% and even on part load it is still very good.

It requires no regular maintenance, is none slip and silent.

The belt itself is quite cheap, but the gears can be expensive particularly large diameter ones.

It is possible to use a large diameter flat pulley in place of gear wheel to keep the cost down.

Alternatively, two stage gearing can be used if an extra lay shaft and bearings are fitted to the wind generator.

Timing belt $\frac{3}{4}$ inch wide is recommended.

CHAIN GEARING

This is an efficient type of gearing and bicycle or motor cycle chain could be used.

Lubrication is essential and also protection from the weather.

GEAR BOX

A gear box is the most efficient and reliable form of gearing and usually used on professionally built wind generators.

The problem for diy constructors is to find a box with the desired ratio and power rating.

It is always worth looking for a suitable secondhand gear box and some types of industrial power tools have a gear box of the right sort of ratio.

ESTIMATED POWER OUTPUT

The estimated power of a Savonius Rotor can be calculated as follows :-

$P = 0.00087\ A\ V^3$ where A = Frontal area of rotor in sq. ft
V = Wind speed in mph
P = Watts power (shaft hp)

Note: 746 watts = 1 hp

e.g. If Rotor area (A) = 18 sq. ft (Two oil drums approx.)
and Wind speed (V) = 32 mph

Shaft hp = $0.00087 \times 18 \times 32^3$
= 513 watts

But the gearing will probably not be better than 85% efficient and the generator better than 50% efficient.

So the estimated electrical output at 32 mph will be :-

$513 \times 0.85 \times 0.50 = 218$ watts

At low wind speeds the efficiency of the gearing and generator will tend to be worse and it must not be forgotten that the first 30 watts generated is required to supply the field coil of the alternator/dynamo before any power is available for battery charging.

ROTOR CONSTRUCTION (see Figs 1 & 2)

The rotor blades are constructed from two 45 gallon drums, bisected lengthwise and welded together to form two troughs.
These troughs are mounted between two end plates made from plywood 48 inches diameter.

The dimensions for mounting the drum halves are given in Fig. 1.
The ends of the oil drums are simply bolted to the wooden discs with 3/8 inch bolts, washers and nuts.

The shaft through the centre of the rotor is 1¼ inch I.D. mild steel tube (e.g. water pipe).
This should extend about 6 inches beyond either end of the plates.
To secure the shaft to the end plates, two flanged collars are used. They should be a close fit onto the shaft.
They are bolted to the plywood with 4 bolts, and after inserting the shaft are drilled and secured to it with a ¼ inch bolt, spring washer and nut.

To support the rotor shaft 3 self aligning ball bearings are required. One at the top of the rotor, one at the bottom of the rotor and a third at the bottom of the output shaft.

Two adaptors have to be made to fit the two ends of the rotor shaft to the bearings. (See Fig.2)
The lower adaptor shaft must be long enough to give a reasonable distance between the two bottom bearings.

Before mounting the rotor in the frame it must be carefully balanced to avoid vibrations at high speeds.
This is easily done by placing the assembled rotor horizontally on two level staight edges and adding weights to the circumference in the centre of the rotor, until perfect balance is achieved.

FRAME CONSTRUCTION (See Fig. 3)

The frame consists of five pieces of 6 inch by 4 inch timber. The joints must be securely bolted with gusset plates to make it as stiff as possible.
Alternatively it can be constructed of steel channel.

It must be steadied with guy wires, securely anchored to the ground and tensioned by turnbuckles.

The lower cross member should be 6 feet or more above the ground.

THE GENERATOR

A car alternator or car dynamo can be used with this wind generator. Unlike a car however, an alternator does not have an great advantage over a dynamo when used on a geared wind generator.

CAR ALTERNATOR

Advantages:	Requires slightly lower gearing. Good bearings
Disadvantages:	Does not self excite (requires manual or automatic exciting) Efficiency only fair.

CAR DYNAMO

Advantages:	Efficiency good. Cheap and reliable. Self excites.
Disadvantages:	Bearings not as good as alternator. Requires slightly higher gearing.

Voltage Regulation

With small wind generators it is often better not to use a voltage regulator as this reduces the power output. It depends upon how many batteries are used and what type.

If only small batteries are used then a voltage regulated circuit must be used to avoid over charging and possibly damaging the batteries.

If large batteries are used then an un-regulated circuit is best, since the full output of the generator will be incapable of raising the charging voltage above 14 volts. Hence the charging current will never be enough to damage the batteries.

Generator matching

It is most important to match the size of generator as close as possible to the rotor.
If a generator too large is fitted, the power will be much reduced as the rotor will be over loaded and stall in a similar fashion to a petrol engine.

To obtain the best output for a given wind speed, it is necessary to vary both the gear ratio and field current of the generator.

USING A CAR ALTERNATOR

The most suitable car alternator to use is the Lucas 17ACR which is now fitted to most British cars. It is a 36 amp alternator and starts to charge at 900 rpm.
Other ACR alternators which can be used (though less suitable) are the 15ACR (28 amp), 16ACR (34 amp) and 18ACR (43 amp).

Voltage regulated version (see Fig. 4)

This version is wired basically the same as the alternator on a car.
The output voltage is regulated to 14.2 volts by the transistor regulator fitted on the back of alternator.

To start the alternator charging, the field must be excited by operating the press button when the alternator is running at 900 rpm or above.

Instead of the button an automatic system can be used. Three possible methods are:-

Electronic pulse unit.

Centrifugal switch.

Wind operated switch.

To keep voltage drop to a minimum, the alternator should be wired to the battery with 30 amp cable.

Un-regulated version (see Fig. 5)

This version requires the wiring on the alternator to be modified.
The regulated is disconnected by wiring a shorting link from the LHS slip ring terminal to earth (case) and by disconnecting the regulator wire to the rectifier.
Finally the RHS slip ring wire is connected to the centre rectifier output.
This effectively connects the field across the alternator output.

To stop the field slowly discharging the battery when the alternator is not charging, a blocking diode is fitted in the ground control unit.
A 30 amp 50 volt silicon diode is used and mounted as shown in the bottom RHS of Fig. 7.

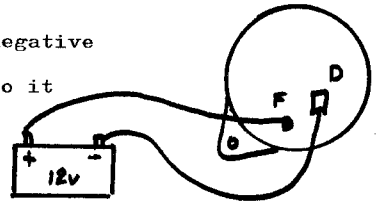
As before the alternator is excited with a press button or an automatic switch.

The alternator must not be run without a battery connected on either version unless a short circuit is put across the alternator output.

USING A CAR DYNAMO

The most suitable car dynamos to use are Lucas C40 or C41 (22 amp) or Lucas C40LO or C41LO (25 amp).
These dynamos start to charge at 1100-1200 rpm and are self exciting.
However before use they must have the field polarised, negative earth is normal.

To polarise the dynamo to negative earth.
Connect a 12v car battery to it as shown for 2-3 seconds.



Voltage regulated version (see Fig. 6)

This version is wired basically the same as a dynamo on a car.
The wiring diagram shows a C40 dynamo and regulator box from a Mini car. (other dynamos are the same or similar)
It is recommended that a fuse is fitted as shown.

Car dynamos must be driven in the direction of the arrow marked on the case

Un-regulated version (see Fig. 7)

This version is very simple to wire up and requires no regulator box.

The field is connected directly to the dynamo output by wiring a link between the F and D terminals.

To stop the battery slowly being discharged by the field a blocking diode is fitted.

The diode, ammeter and fuse are mounted in the ground control unit.
The diode (30 amp, 50 volt) is mounted as shown on an insulated aluminium sheet.

As with alternators, the dynamo must not be run without a battery connected unless a short circuit is put across the dynamo output.

CONVERTING 12v DC TO 240v AC

Rotary Converter

A rotary converter is a DC motor and alternator combined in one machine. It is robust and reliable and gives a sine wave output suitable for any type of equipment.
Its main disadvantages are that quite a lot of power is consumed by it even when giving no output and it is relatively noisy.

Square Wave Inverter

This is the cheapest type of inverter and normally uses a transistor circuit and transformer to produce 240v AC.
It is efficient and quiet in operation but has the disadvantage that the square wave output is not very suitable for some equipment (Induction motors and TV).
Also the cheaper quality inverters are easily damaged by overloading.

Sine Wave Inverter

Similar to square wave inverters they can however be used with any equipment and are probably the ideal means of producing 240v from 12v. Unfortunately they are expensive.

STORAGE BATTERIES

Lead Acid - car type

Car batteries are the cheapest form of storage battery. However they are designed to give very high starting current and are not very suitable for the charge and discharge characteristics of a wind generator.
Life expectancy is only 2-3 years.

Lead Acid - Heavy duty

Similar to car batteries but with heavy plates and with special separators. Life is 8-10 years and efficiency 70-75 per cent. Cost is approximately 50% higher than car batteries.

Lead Acid - Tubular type

Special lead acid batteries in which the positive plates consist of a number of tubes.
Efficiency is about 80% and life expectancy 12-15 years.
Cost is approximately 40% higher than heavy duty type.

Nickel Iron - Nife type (also Nickel Cadmium -Nicad)

A very robust alkali battery which can stand high charging and discharging. Life expectancy is 15 years or more.
These are expensive batteries but can sometimes be obtained for a reasonable price from XWD sales.

APPENDIX

3 OIL DRUM SAVONIUS ROTOR

If three oil drums are used istead of two for the rotor, the power available will be increased by 50%.

In terms of performance the generator could be expected to produce about 300 watts output and start to charge a battery at 13-14 mph wind speed.

Other modifications recommended are:-

1. Rotor Uprate the rotor shaft and bearings by 20% diameter.

2. Gearing Increase the gear ratio to Alternator 9:1 and Dynamo 10:1.

3. Generator Due to the greater power output an Alternator is preferable to a Dynamo.

4. Brake A brake to stop the rotor in gale force winds is strongly recommended and is a good idea for the two oil drum rotor also.

ELECTRONIC PULSE UNIT

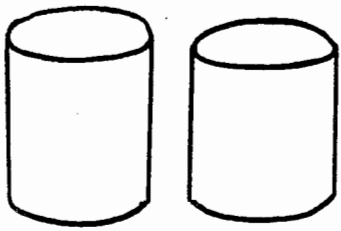
One of the most reliable methods of exciting the alternator is to use an electronic pulse unit.
This sends a half second pulse of current every 20 seconds from the storage battery to the alternator field.
This ensures that when the alternator is running fast enough to start charging the field will excite.
Battery consumption is negligible.

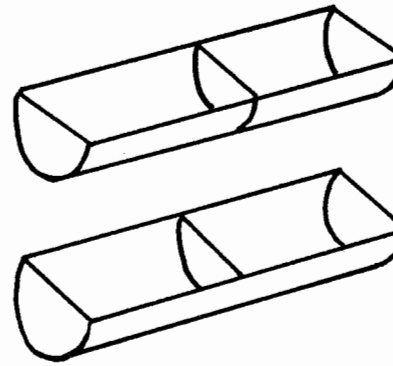
SERIES FIELD RESISTOR

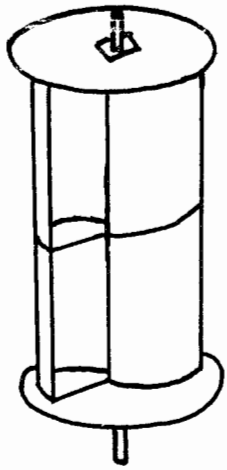
Good performance from a wind generator depends upon matching as close as possible the power output of the rotor to the power input of the generator.
While it is not easy to vary the size of generator or gear ratio, the output and hence input power can be simply varied by changing the field current.
This is easily done by connecting a resistance in series with the field coil.
For the alternators and dynamos mentioned the value of resistance required will be between 1 and 2 ohms.
Experimentally a 5 ohm 25 watt rheostat can be used to find the best resistance value. This can be replaced then by a 10 watt wire wound resistor.
This modification is normally fitted on an un-regulated alternator or dynamo. i.e. in place of shorting link on the alternator and in place of the wire linking the 'D' and 'F' terminals on the dynamo.

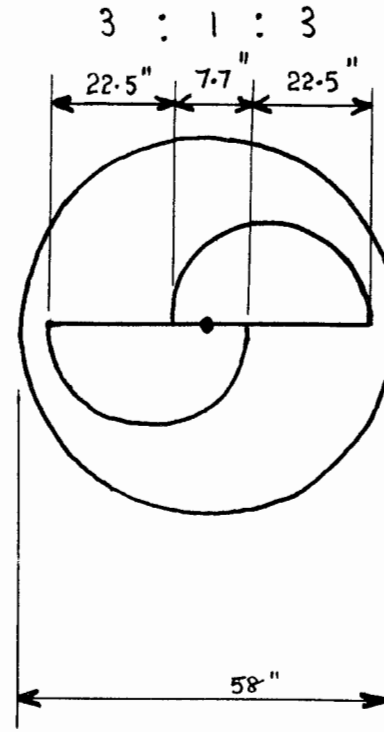
FIG. 1

ROTOR CONSTRUCTION





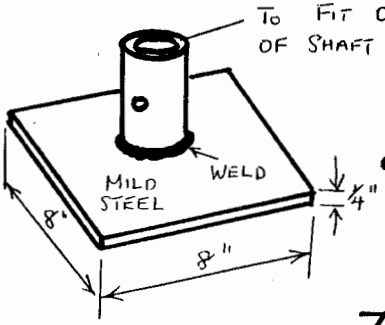


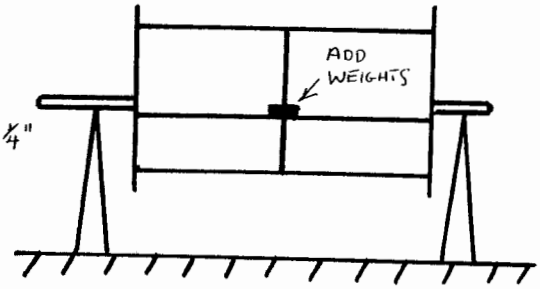


Note: For different rotor diameters always keep the same rotor proportions.
i.e. 3:1:3

Collar flange

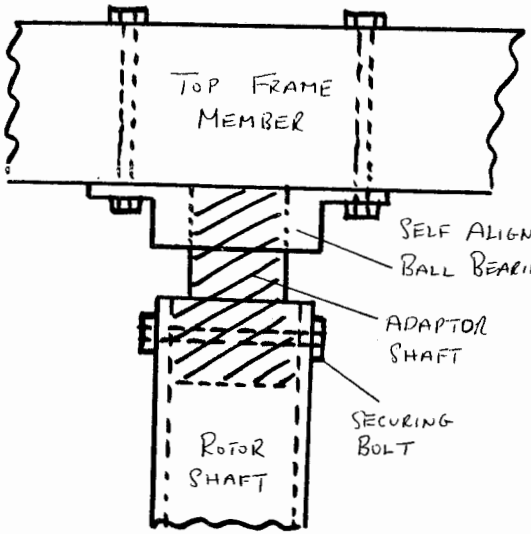
FIG. 2





Method of balancing rotor

Top rotor bearing assembly



Bottom rotor bearing assembly

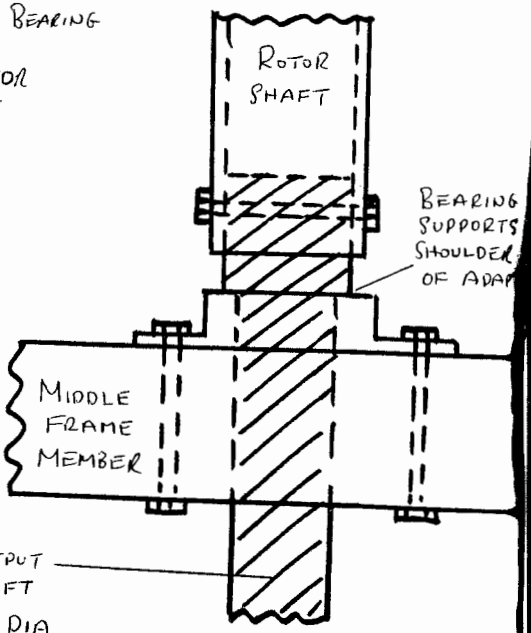


FIG. 3 - FRAME AND GENERAL LAYOUT

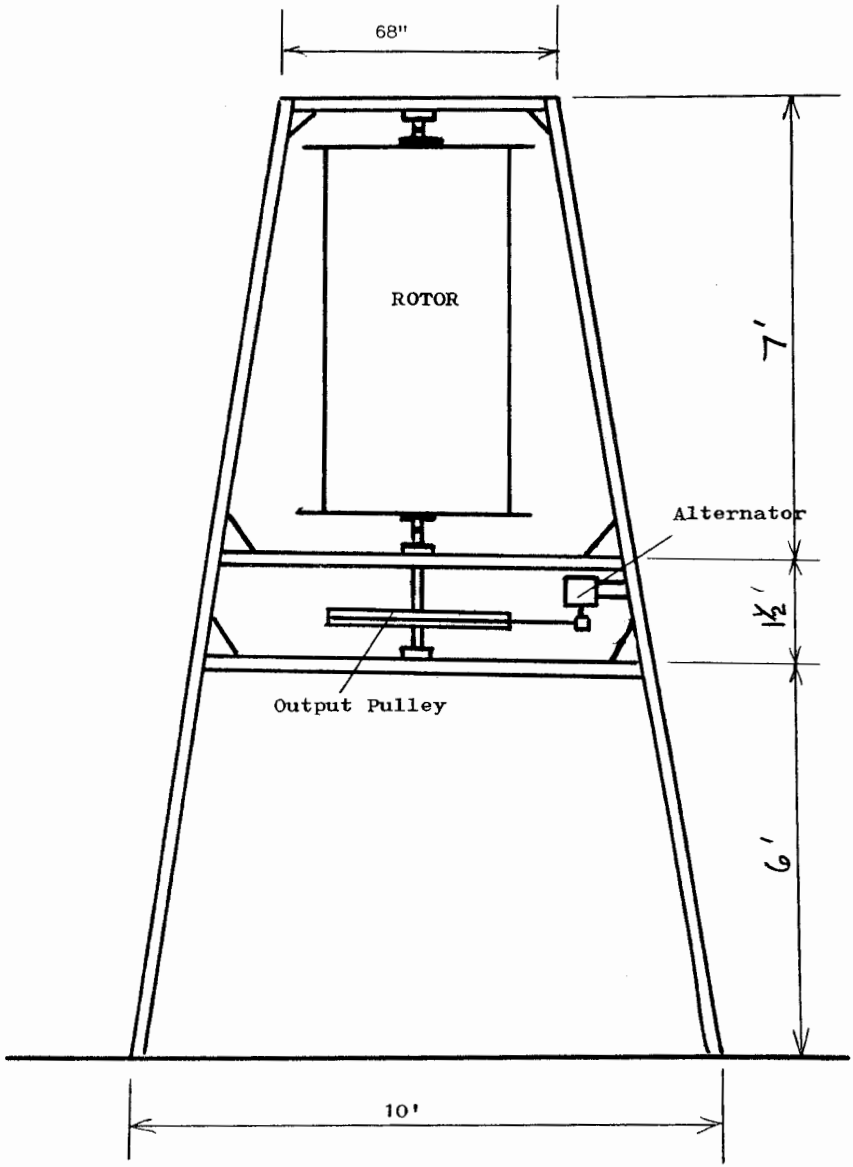


FIG. 4 -- 12 VOLT REGULATED VERSION WIRING DIAGRAM - ALTERNATOR

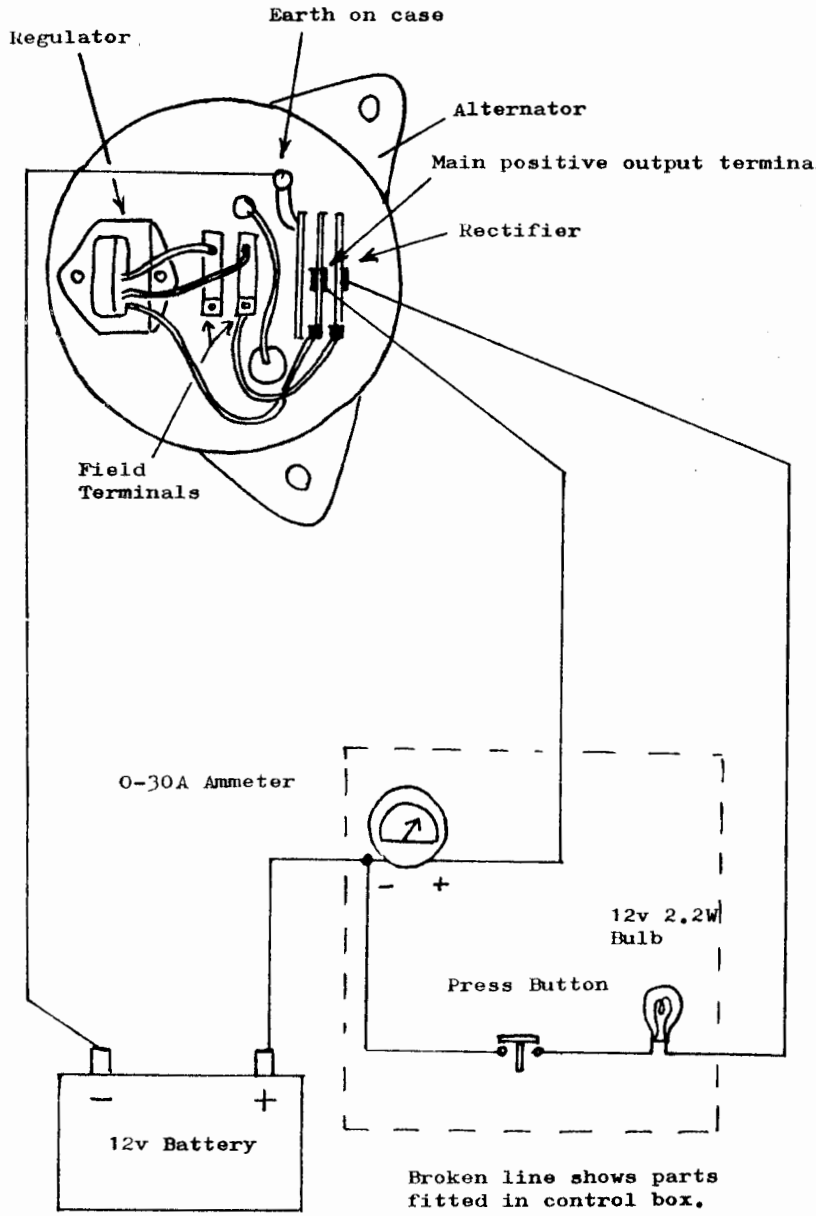


FIG. 5 -- 12 VOLT UN-REGULATED VERSION WIRING DIAGRAM

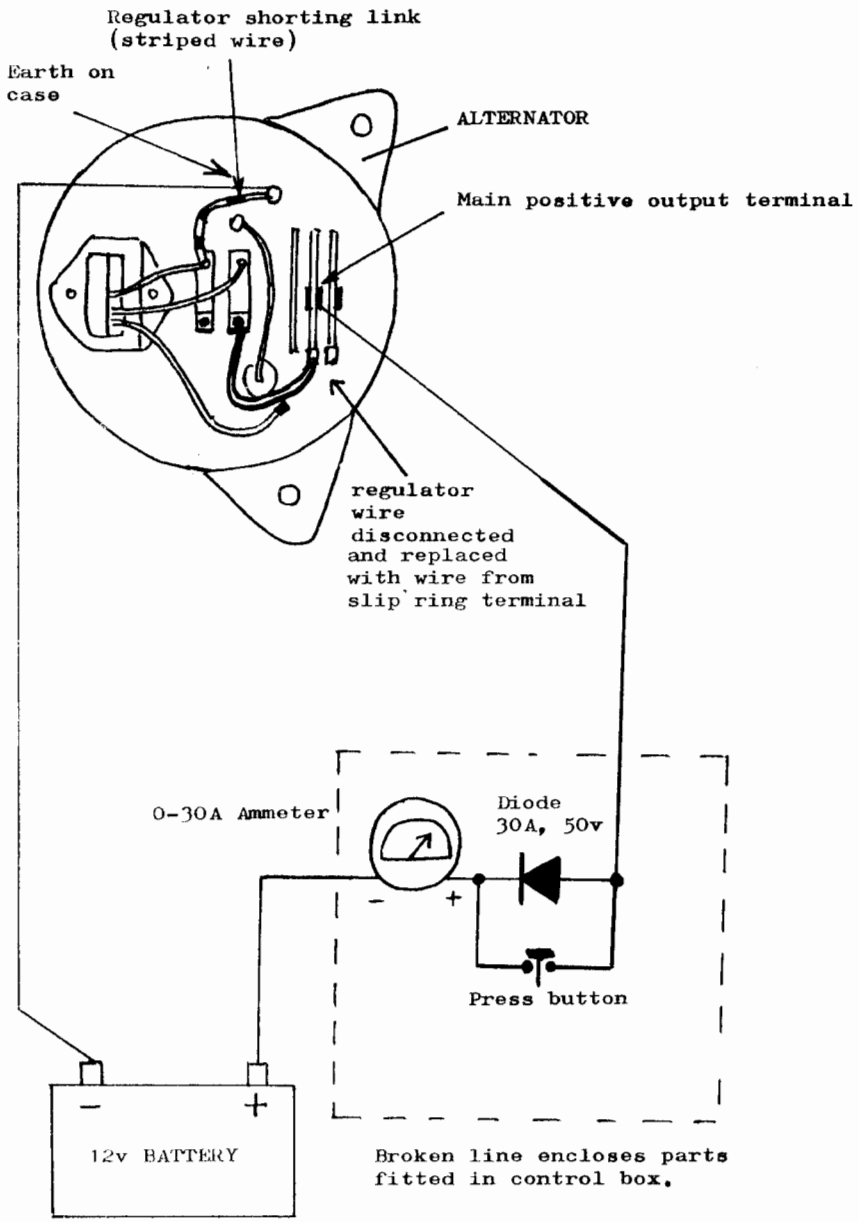


FIG. 6 - GENERATOR WIRING DIAGRAM

VOLTAGE REGULATED VERSION

Note: Some control boxes have a 'B' terminal instead of 'A1' and 'A'. Wire 'B' the same as 'A1'.

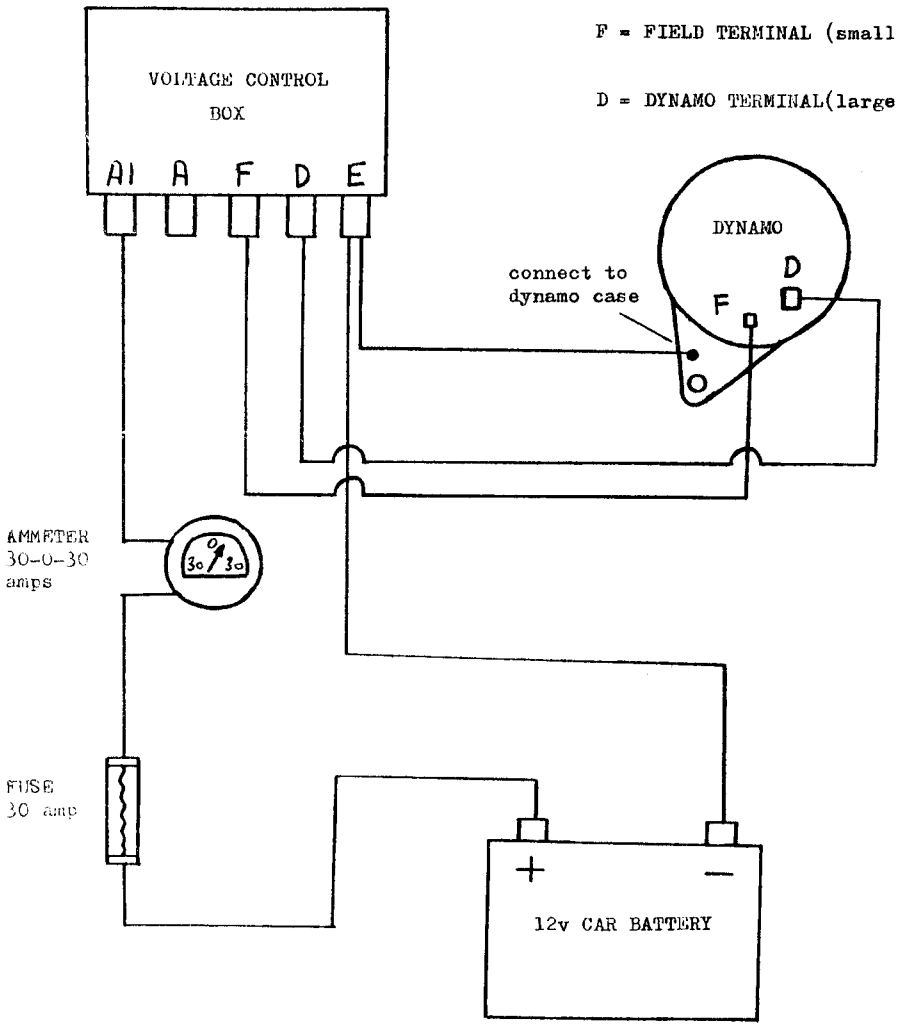
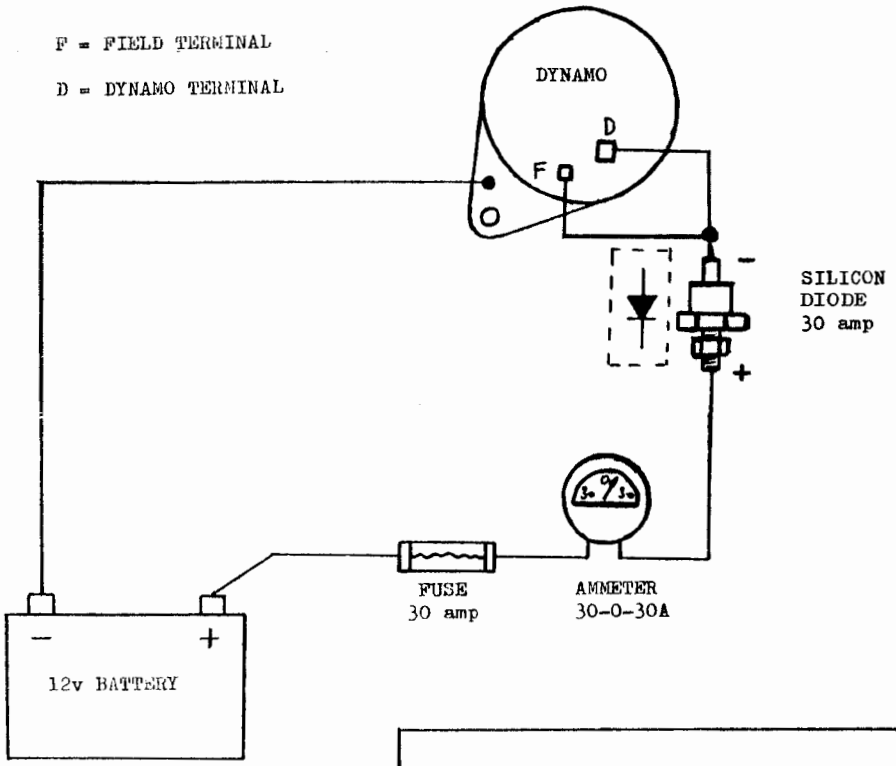
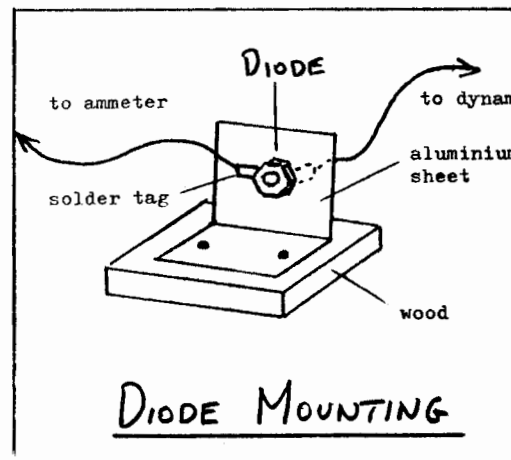


FIG. 7 - GENERATOR WIRING DIAGRAM

UN-REGULATED VERSION





DIODE MOUNTING

NOTICE

The information contained in this guide has been given in good faith and is believed to be accurate at the time of writing. Whilst every effort has been made to obtain the correct information, no liability can be accepted for any information that is incorrect or misleading.

Website links

Energybook and associated websites

http://www.energybook.co.uk
A great website developed by the author of this guide it provides lots of information on renewable energy and sustainable living

http://www.wxtrade.com
The energybook marketplace - buy and sell renewable energy and sustainable living products for free. Hundreds of great products.

http://www.ometoremember.co.uk
Web based bookshop selling fiction and non-fiction books including renewable energy books.

Wind energy associations

ANEV - associazione nazionale energia del vento (I)
AWEA - American Wind Energy Association (USA)
APPA - Asociación de Productores de Energías Renovables (ES)
Austrian Wind Energy Association (A)
AUSWEA - Australian Wind Energy Association (AUS)
BWE - Bundesverband Wind Energie e.V., German Wind Energy Association (D)
BWEA - British Wind Energy Association (GB)
CANWEA - Canadian Wind Energy Association (CAN)
Les Compagnons d'Eole (B)
DV - Danmarks Vindmølleforening - Danish Wind Turbine Owners' Association (DK)
Dansk Selskab for Vindenergi (DK)
EOLE (CAN) (pour les francophones)
Estonian Wind Power Association (EST)
EWEA, European Wind Energy Association (EU)
Finnish Wind Power Association (FIN)
Global Wind Energy Council (GWEC)
Vindkraftföreningen Finland, Finnish Wind Energy Association (Swedish language)
IWEA, Irish Wind Energy Association (IE)
New Zealand Wind Energy Association (NZ)
PEE - Plataforma Empresarial Eólica (ES)
South African Wind Energy Association (ZA)

Suisse-Eole (CH)
Syndicat des Energies Renouvelables (FR)

Magazines and information services

Windpower Monthly Good international coverage of the wind business.
WindStats Newsletter Articles plus loads of statistics on wind energy production in many parts of the world.
Wind Directions is the magazine of the European Wind Energy Association, published six times a year, giving current developments and news on the wind energy industry in Europe.
Windpower Monthly publishes news and critical analyses of key issues about wind power and its markets. Includes The Windicator, the renowned page of market indicators, giving a country by country breakdown of installed capacity.
New Review is the Quarterly Newsletter for the UK New and Renewable Energy Industry, principally covering: wind, solar, biomass and hydro energy developments. Produced by ETSU on behalf of the DTI.
WindStats Newsletter is a quarterly international wind energy publication with news, reviews, wind turbine production and operating data from over 12,000 wind turbines, plus much more.
Renewable Energy World accentuates the achievements and potential of all forms of renewable energy sources and the technologies being developed to harness them. In this on-line version there are full text selected articles, abstracts, back issue information, and links to all of the other renewable energy information sources at James & James including its international database of renewable energy suppliers and services.
Renew On-Line is an edited, text only, version of parts of the News sections of RENEW, the journal of NATTA, the independent national UK Network for Alternative Technology and Technology Assessment. Members include the Energy and Environment Research Unit (EERU) and the Open University.
CADDET provides international information on renewable energy on full-scale commercial projects which are operating in the member countries, currently Australia, Belgium, Denmark, Finland, Japan, The Netherlands, Norway, Sweden, United Kingdom, United States and the European Commission (DGXVII - Energy). The CADDET programme covers the full range of renewable energy technologies.
EuroREX (European Renewable Energy Exchange) is an on-line commercial information service and newsletter created by a network of energy experts from 30 European countries. Its aim is to provide up-to-date information on renewables directly from professionals working in the field. European Renewable Energy exchange
Solstice is the Internet information service of the Renewable Energy Policy Project and the Center for Renewable Energy and Sustainable Technology (REPP-CREST). Sustainable energy and development information as well as renewable energy, energy efficiency and sustainable living
World-wide Information System for Renewable Energy (WIRE).
Wind Engineering. A bi-monthly journal which publishes technical papers on all aspects of wind energy systems.

Places to visit in the United Kingdom

The Centre for Alternative Technology in Wales is an educational charity striving to achieve the best cooperation between the natural, technological and human worlds. CAT tests, lives with and displays strategies and tools for doing this. CAT has it's own wind turbine as part of their work for a sustainable future.
The EcoTech Centre at Swaffham in Norfolk is an educational charity which aims to stimulate and inform people about the need for sustainable development. The Centre grounds include organic gardens, a biomass power station and one of the largest wind turbines in the world.
The Earth Centre at Doncaster encompasses a range of environmental exhibitions and activities. Tel 01709 512000 for further information.

The Gaia Energy Centre in Cornwall is a centre for the promotion of, and education about, renewable and sustainable energy and energy conservation.
Many wind farms have visitor centres or opportunities to see the turbines at closer range. Specific details can be found in our map of wind farms of the UK.

Scientific and research institutions

The Wind Turbine Research Group at Cranfield Universtity.
Institute for Wind Energy at Delft University of Technology in The Netherlands.
National Wind Technology Center at The National Renewable Energy Laboratory. The U.S. Department of Energy's premier laboratory for renewable energy and energy efficiency research, development and deployment.
Risoe National Laboratory Wind Energy and Atmospheric Physics department.The research of the department aims develop new opportunities for industry and society in the exploitation of wind power and to map and alleviate atmospheric aspects of environmental problems in collaboration with the National Environmental Research Institute.
The Netherlands Energy Research Foundation ECN is the leading institute for energy research in the Netherlands. Research is carried out under contract from the government and from national and foreign organisations and industries. ECN's activities are concentrated in six priority areas: solar energy, wind energy, biomass, clean fossil, energy efficiency, and policy studies.
Wind Energy Technology at Sandia National Laboratories. Applied research in aerodynamics, structural dynamics, fatigue, materials, manufacturing, controls, and systems integration to understand unsolved technology problems and to provide better design tools. New efforts investigate how rare atmospheric events can impact wind turbine long-term structural integrity and how advanced data handling techniques can be successfully applied to the difficult field environment of operating wind turbines.
Electric Power Research Institute (EPRI) - science and technology solutions for the global energy industry.

General wind power links

www.countryguardian.net
Country Guardian is a UK conservation group focused on the environmental damage caused by commercial windfarms in areas of national or local landscape value. It is not opposed to wind energy as such, but in practice almost all onshore sites which are windy enough are environmentally sensitive.
www.cefncroes.org.uk
Cefn Croes Wind Farm Campaign - An American backed company, the Renewable Development Company (RDC), wishes to build Britain's largest wind power station yet in the heart of Mid Wales. RDC proposes to build 39 enormous turbines on Cefn Croes, a wild expanse of upland above the villages of Cymystwyth.
www.world-nuclear.org/info/inf10.htm
Renewable Energy and Electricity - good article on the alternatives to fossil fuels in electricity generation - Technology to utilise the forces of nature for doing work to supply human needs is as old as the first sailing ship. There is a fundamental attractiveness about harnessing such forces in an age which is very conscious of the environmental effects of burning fossil fuels.
www.cprw.org.uk/press/pressind.htm
Campaign for the Protection of Rural Wales - Index of Press Notices - Includes several press notices on the subject of wind turbines in Wales.
www.natwindpower.co.uk/northhoyle/northhoyle.htm
National Wind Power (NWP) is proposing to develop a wind farm off the North Wales coast. The proposed project, known as North Hoyle Offshore Wind Farm (North Hoyle), is situated 4-5 miles off the coast between Prestatyn and Rhyl and will consist of 30 wind turbines with a total installed capacity of between 60-90MW.

http://news.bbc.co.uk/hi/english/uk/wales/newsid_1432000/1432541.stm
Wind farm plans scrapped - Company withdraws its plans for 26 turbines - Controversial plans for a £30m wind farm development on Denbigh Moors have been scrapped after rare birds were found on the site.

www.offshorewindfarms.co.uk
With the first offshore wind turbines in the UK already generating electricity at ~5p per unit, the further development of the offshore wind industry is an exciting prospect, and one which will see significant growth over the next decade.
www.cru.uea.ac.uk/~mikes/norfolk/wind/
Norfolk wind turbines - A total of 853 turbines currently produce 405 megawatts of electricity in the UK, enough to meet the needs of quarter of a million homes annually (BWEA). Norfolk generates 5.25 megawatts (about 1.3% of total UK production, versus about 1.2% of UK population.)
www.britishwindenergy.co.uk
British Wind Industry Association - With a membership of over 500, including more than 180 corporate members, generating an annual turnover of 1,000,000 ecus, the BWEA is uniquely placed to consolidate and extend the wind energy industry in the UK.
www.windpower.org
Danish Wind Industry Association - read about Wind Energy - More than 100 animated pages and calculators on wind resources, wind turbine technology, economics, and environmental aspects of wind energy in the Guided Tour section.
www.indianwindpower.com
Indian Wind Turbine Manufacturers Association - Power generation from wind has emerged as one of the most successful programmes in the renewable energy sector, and has started making meaningful contributions to the overall power requirements of some States.
news.bbc.co.uk/hi/english/uk/england/newsid_1777000/1777268.stm
Wind farm closed after blade snaps - The blade sits at the top of a 93-metre-high column. A turbine propeller blade has folded in half at the UK's first electricity-generating offshore wind farm, at Blyth, in Northumberland.
www.dti.gov.uk/renewable/wind.html
Introduction - Wind represents a vast source of energy which man has harnessed for over 2000 years. As the UK is the windiest country in Europe, wind power is one of the UK's most promising renewable energy technologies and already provides electricity for nearly a quarter of million homes.
www.natwindpower.co.uk/
As environmental protection and sustainable development are now top priorities world wide, we all need to consider carefully how the energy that we consume should be produced.
www.cprw.org.uk/wind/windindc.htm
Campaign for the Protection of Rural Wales - Wind Power Generation - CPRW's View: In the process of encouraging renewable energy Government policies on wind power fail to provide sufficient recognition of the the need to conserve the landscape and environment of rural Wales.
www.scotland.gov.uk/news/2001/06/se1472.asp
Scottish Executive - UK'S FIRST WIND TURBINE FACTORY TO BE BUILT IN THE HIGHLANDS - The UK's first wind turbine factory will be built in Scotland, Highlands and Islands Minister, Alasdair Morrison announced today. The facility at Machrihanish, near Campbeltown will create 124 direct jobs and 44 indirect for the local economy.
www.foe.co.uk/pubsinfo/infoteam/pressrel/2001/20010619115149.html
Friends Of the Earth welcomes UK's first wind turbine factory - 19 Jun 2001- 'Swords into ploughshares' as military base becomes renewable energy plant - Friends of the Earth today warmly welcomed the announcement by the Scottish Executive and Danish firm Vestas Wind Systems of the UK's first commercial scale wind turbine plant.
www.guardian.co.uk/Archive/Article/0,4273,4195427,00.html
MoD tries to veto wind farm sites - Trade department's expansion of renewable energy undermined by its backing for RAF objections to onshore and offshore plants
www.cprw.org.uk/press/pn250102.htm

Cefn Croes Ceredigion: Conservation groups call for Public Inquiry into UK's biggest wind power station. Today, six major conservation bodies, with a joint membership in Wales of many thousands, sent a letter to The Rt. Hon. Patricia Hewitt MP, Secretary of State for Trade and Industry protesting "in the strongest possible terms" about the declaration of the Energy Secretary.

education.guardian.co.uk/higher/engineering/story/0,9840,653199,00.html

Cold blow - Wednesday February 20, 2002 - For some, they are blights on a glorious landscape; for others, they mean clean energy and economic lifelines for rural communities. John Vidal looks at the battle over windfarms in mid-Wales.

www.sustdev.org/energy/articles/energy/edition2/index.shtml

An Assessment of the Impact of Wind Turbines on Birds at Ten Windfarm Sites in the UK by Ruth Thomas, University College London, UK

American Wind Energy Association (AWEA)

Since 1974, AWEA has advocated the development of wind energy as a reliable, environmentally superior energy alternative in the United States and around the world. AWEA's **Green Power Factsheets** provide answers to basic questions about Green Power, including what it is, the rationale for purchasing it, and procedures for buying it.

Choosing a Home-Sized Wind Generator

The August/September 2002 issue of **Home Power Magazine** is a must-read for anyone contemplating installing a wind generator. Home Power leads the reader through all the steps necessary to arrive at the answer to this key question about wind systems: which one should you choose. The entire 17-page article can be downloaded from Home Power's website.

Consumer's Guide to Renewable Energy in Arkansas

While intended for Arkansas residents and businesses, much of the information presented in this publication also applies to residents in other states. Includes useful information on solar, wind, and renewable fuels.

Electric Power Research Institute (EPRI) is recognized as a world leader in creating science and technology solutions for the energy industry and for the benefit of the public. EPRI's technical program spans virtually every aspect of power generation, delivery, and use, including environmental considerations. The organization serves more than 1,000 energy organizations worldwide and draws on a global network of technical and business expertise to help solve energy problems.

Energy Resources Research Laboratory (ERRL)

The ERRL at Oregon State University has managed the data collection, quality assurance, and analysis for the Bonneville Power Administration's wind energy resource studies since 1978 and manages other data management activities for transmission line research. It maintains a large data base of wind data for the Pacific Northwest. This web page summarizes the wind statistics of the five Bonneville Power Administration's long-term wind monitoring sites in the Pacific Northwest.

Guided Tour on Wind Energy

Switch to the UK flag for the English website. Want to know where wind energy comes from? Want to learn about the Coriolis Force, global winds, geostrophic wind, wind speed measurement, the wind rose, wind shear, and wind shade? Need to find a wind shade calculator, information about wind turbine components, rotor blades, and wind energy economics? Answers to all your questions about wind energy can be found at the Danish Wind Turbine Manufacturers Association's Guided Tour on Wind Energy. The website includes wind resource calculators and features more than 100 animated pages on wind resources, wind turbine technology, and economics. Each of the nine tours is a self-contained unit, so you may take the tours in any order.

Minnesotans for an Energy-Efficient Economy (ME3) website provides many pages of wind energy information, including a wealth of links to utilities, research and other organizations, wind industry companies, federal government resources and wind energy publications and miscellaneous information.

Montana Wind Energy Atlas

The Montana Wind Energy Atlas is a comprehensive analysis of wind energy data available as of 1987. Data collected by a variety of public and private organizations at 158 wind monitoring sites around Montana were reviewed. Data from 56 sites are analyzed in the Atlas. Information on the sites and the data collection programs is included. While more data have been gathered since the Atlas was published, it remains the only publicly available collection of data from numerous sites. These historical data should be useful for preliminary

identification of potential sites. The Atlas is available on line at the Montana Department of Environmental Quality Energize Montana website.

National Wind Coordinating Committee (NWCC)

A U.S. consensus-based collaborative formed in 1994, NWCC identifies issues that affect the use of wind power, establishes dialogue among key stakeholders, and catalyzes appropriate activities to support the development of an environmentally, economically, and politically sustainable commercial market for wind power. NWCC members include representatives from electric utilities and support organizations, state legislatures, state utility commissions, consumer advocacy offices, wind equipment suppliers and developers, green power marketers, environmental organizations, and state and federal agencies.

Wind Energy Basics

Provides information about wind, including how wind turbines work, advantages and disadvantages of its use, wind energy use throughout history, U.S. wind energy resource potential, and current research and development.

Renewable Resource Data Center (RReDC)

Provides information on several types of renewable energy resources in the United States, in the form of publications, data, and maps. An extensive dictionary of renewable energy related terms is also provided. The News section announces new products on the RReDC, which is supported by the U. S. Department of Energy's Resource Assessment Program and managed by the Photovoltaics Technology Division of the Office of Energy Efficiency and Renewable Energy.

Small Wind Electric Systems – A Montana Consumer's Guide (PDF)

Learn about small wind systems and whether one is right for you in a this new booklet published jointly by the U.S. Department of Energy, the National Center for Appropriate Technology, and the Montana Department of Environmental Quality. The booklet includes a wind resource map of Montana, an explanation of state incentives for installing a wind system, and a list of contacts for more information.

Small Wind Electric Systems – A U. S. Consumer's Guide (PDF)

This guide provides basic information you need to answer those questions and to address the many factors you need to consider to successfully install a small wind energy system and get maximum production.

Small Wind Energy Systems for the Homeowner

This publication will help you decide whether a wind system is practical for you. It explains the benefits, helps you assess your wind resource and possible sites, discusses legal and environmental obstacles, and analyzes economic considerations such as pricing.

Small Wind System Slide Shows

Downloadable slide shows from the American Wind Energy Association.

Solar and Wind Easements

Montana's solar and wind easement provisions allow property owners to create solar and wind easements for the purpose of protecting and maintaining proper access to sunlight and wind. While 32 other states have solar easement provisions, only three other states have created specific provisions for the creation of wind easements. Montana's solar easement law was enacted in 1979 and the wind easement was enacted in 1983. For more information, contact Tom Livers, Montana Department of Environmental Quality, at 406-444-6776.

Utility Wind Interest Group (UWIG)

A non-profit corporation whose mission is to accelerate the appropriate integration of wind power for utility applications through the coordinated efforts and actions of its members, in collaboration with public and private sector stakeholders. Membership is open to utilities and other entities that have an interest in wind generation.

What Landowners Need to Know About Attracting Wind Energy Developers to Their Land in North Dakota

Published by the University of North Dakota at Grand Forks, this brochure can help Montanans faced with questions about developing wind resources on their land. It includes partial lists of nonprofit wind energy contacts, websites, and with landowner information.

AWEA's **Wind Directory**

Search this directory to obtain wind energy services and equipment from companies who have demonstrated a commitment to wind and renewable technology and adhere to AWEA's code of business ethics.

Wind Energy Atlas

Estimates wind energy resource for the United States and its territories and indicates general

areas where a high wind resource may exist. This information is valuable to wind energy developers and potential wind energy users because it allows them to choose a general area of estimated high wind resource for more detailed examination. A siting document, such as that written by Hiester and Pennell (1981), can assist a potential user in going from wind resource assessment to site selection.

Wind Energy Finance Website

Operated by the National Renewable Energy Laboratory, this website allows users to calculate online the cost of electricity generated by a wind system. The website lets users create a new project on screen (or modify an existing project) by entering values for numerous assumptions step-by-step until enough information has been entered to calculate the project cost. Projects added or modified are stored convenience and are available the next time a user logs in.

Wind Energy Potential in the United States

Estimates of the electricity that could potentially be generated by wind power and of the land area available for wind energy have been calculated for the contiguous United States. The estimates are based on published wind resource data and exclude windy lands that are not suitable for development as a result of environmental and land-use considerations.

Wind Potential in the United States: U.S. Wind Maps

Maps showing the U.S. annual wind power resource, annual wind power resource in Alaska and Hawaii and the percent of U.S. land area with an annual wind resource of Class 3 or above.

Wind Powering America

A commitment to dramatically increase the use of wind energy in the United States. This initiative works to establish new sources of income for American farmers, Native Americans, and other rural landowners, and meet the growing demand for clean sources of electricity. Website offers a host of useful information on topics such as wind resource assessment, siting, transmission, economics, utility integration, project development, and policy issues.

Wind Power in Montana

Pages from a Wind Powering America publication that focus on Montana.

Wind Workshop Presentations On Line

Presentation from the Wind Powering Montana Workshop October 3, 2001, in Big Sky. Translated from PowerPoint into viewable web pages.

Windustry

Focuses on economic development from wind energy, valuation of environmental benefits, and distributed generation. Windustry promotes wind energy through outreach, educational materials, and technical assistance to rural landowners, local communities and utilities, and state, regional, and non-profit collaborations. Website features wind basics, wind opportunities, wind turbine sites, a wind calculator, curriculum, resource library, and news and events.

Homebuilt wind turbines

Scoraig Wind Electric

Hugh Piggott's homebuilt wind power homepage. Great information about small-scale wind power--one of the best websites out there. Lots of interesting pages and links. Blade design and construction techniques, Tip Speed Ratio explained in plain english, Rotor design info and other downloads, and pictures and information about Hugh's Brakedrum Windmill. The newest pages of his site describe in detail the axial flux designs that Hugh is building at his seminars now, both an 8-foot dia. and 4-foot dia. model. You can order the plans for these new machines from his site.

WindStuffNow.com

Ed Lenz's excellent homebuilt wind power site. Lots of projects! Alternators from scratch, converting induction motors to permanent-magnet alternators, useful formulas, blade building, 3-phase explained in plain English, inexpensive blade design software, and more. Really cool site, with lots of informative pictures too.

Building a Wind Generator from Scratch

Chuck Morrison's highly informative homebuilt windmill site. A 7ft. rotor with lots of pictures and templates of rotor construction. Powered by a fan motor re-wound into an alternator. Great project!

Andy Little's Homemade Wind Generator
Uses a homebrew PM alternator based on Hugh Piggott's design. In use for pumping water electrically. Lots of photos and information about how it was built, very informative site if you want to build an axial-flux machine from scratch!
Otherpower.com's Homebrew Wind Generators
A collection of all of our experiments with wind power, including our Volvo brake disc wind generator designs. A great resource for the homebrew wind experimentor, with lots of informative photos.
Mike Klemen's Wind Generator Page
Lots of information, photos, maintenance logs, reliability reports, windmill sound clips and data acquisition plots from a variety of working wind installations. A really nice site!
Detronics.net
Wind turbine and wind data acquisition dealer, with a very informative website. He's flying a Bergey XL.1 and a SWWP Air X at his wind test site, and posts the collected monthly data to this site, along with solar data. The numbers show very dramatically how important swept area is!
Paul Gipe's Website
Lots of small- and large-scale wind power articles and information from an expert in the field. Paul Gipe is also an active participant in the AWEA wind Discussion Board, and has written excellent books on the subject.
Airheads -- the GarboGen wind generator
The GarboGen is a wind generator designed by Jerry and built by him and many others worldwide -- made from a surplus garbage disposal motor converted into a permanent magnet alternator, and plastic blades on a metal hub to drive it. Many detailed pictures on the site, and the blades and hubs are available for purchase inexpensively.
Savonious Rotor
Savonious Rotor windmill sketches and information from Australia. This windmill design is built from 55gallon oil drums.
TopGreen.co.uk
Homebuilt brake disc wind turbine information and pictures from the hamlet of Top Green, Sibthorpe, Nottinghamshire. An excellent array of pictures of every step of the construction process.
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The GarboGen is a wind generator designed by Jerry and built by him and many others worldwide -- made from a surplus garbage disposal motor converted into a permanent magnet alternator, and plastic blades on a metal hub to drive it. Many detailed pictures on the site, and the blades and hubs are available for purchase inexpensively.
Steve's Tape Drive Motor Wind Turbine
Lots of great photos and construction details about this working, flying wind turbine made with a tape drive motor as the generator.
Picoturbine.com
Includes a unique educational windmill kit, wind power books, and Savonius rotor simulator software, as well as many links.
Dragonfly Power
Home of the Dragonfly Wind Generator, a very interesting design that uses an automotive alternator and gearing. Neat furling and field control system.
The Back Shed
Homebuilt wind turbine site from an Australian friend from our discussion board. Lots of pictures and construction details, plus kits for sale based on Fisher-Paykel smartdrive motors converted to alternators. The kits take care of the complicated metalworking bits for you. This site is well worth checking out!

http://www.energybook.co.uk
A great website developed by the author of this guide it provides lots of information on renewable energy and sustainable living
http://www.wxtrade.com
The energybook marketplace - buy and sell renewable energy and sustainable living products for free. Hundreds of great products.
http://www.ometoremember.co.uk
Web based bookshop selling fiction and non-fiction books including renewable energy books.

