

Additional Assistance in Renewable and Small-scale De-central Energy Issues:

Please note that only a limited quantity - but useful and relevant sources are given - in an attempt to provide really useful material in a sea of - "information". I can recommend subscribing to [among others] - the three good and free newsletters from AEI [nr. 2], Tesol [nr. 3] and ReFocus [nr.6].

RE - sites, information, magazines and newsletters:

- 1: www.crest.org or www.repp.org
- 2: www.altenergy.org
- 3: www.tecsol.fr
- 4: www.ens.dk
- 5: www.homepower.com
- 6: www.re-focus.net.com
- 7: www.google.com => a good search engine for energy technology
- 8: www.villageearth.org/atnetwork/atsourcebook/index.htm
- 9: www.journeytoforever.org/at.html
- 10: www.vita.org
- 11: www.carebridge.info

Wind:

- 1: www.windmission.dk/workshop/specialissue.html
- 2: www.windpower.dk
- 3: www.windmesse.de
- 4: www.telosnet.com/wind
- 5: www.picoturbine.com
- 6: www.bergey.com
- 7: www.synergypowercorp.com
- 8: www.otherpower.com

Water:

- 1: www.powerpal.com
- 2: www.waveenergy.dk

Biomass:

- 1: www.btgworld.com
- 2: www.biogas-zentrum.de
- 3: www.woodgas.com & www.gocpc.com
- 4: www.elsbett.com & www.elsbett.de
- 5: www.biodiesel.org
- 6: www.gtba.cnvce.cnr.it/

Solar:

- 1: www.varmtvandfrasolen.dk
- 2: www.arcon.dk
- 3: www.bpsolar.com
- 4: www.cenergia.dk
- 5: www.ises.org
- 6: www.norcal solar.org/resources/linksotherrenewables.htm

Suppliers:

- 1: www.conrad-electronic.com
- 2: www.realgoods.com
- 3: www.grenaa-marine.dk
- 4: www.bigfrogmountain.com
- 5: www.rpc.com.au

Further information - from John Furze – March 2003.

It is important for all students of “development” to grasp and fully understand the importance of local de-central “micro-grid” power systems - as illustrated and described in the previous distributed material and not allow themselves to be seduced by the apparent simple solutions offered by the proponents of - SHS – Solar Homes Systems - small individual systems of PV-cells powering a couple of 20 watt lights and possibly a radio for a couple of hours each night.

That is electrical micro-grid power supply systems – mainly supplied [if at all possible] by one of the several different types of wind turbines, - as for.ex. - Potential up-scaling of simple technology as exemplified by the sail-windmill technology - or by one of the many different types of smaller-scale micro wind-turbines such as the Marlec or Bergey or special low wind speed models such as those from the www.synergypowercorp.com - supplemented by small diesel or spark-ignition engines powering electrical generators. In addition to supplementary inputs from other sources – such as solar PV cells – bio-mass energy systems and of course small scale hydro - if available.

Likewise expect further development of Stirling engine [both bio-mass and solar powered] and teflon-component steam engine technology.

That is - a whole range of different small renewable or perhaps “sustainable-type” power inputs to a common micro-grid.

As previously mentioned – it is possible to run diesel engines on the vast numbers of different types of non-refined “cold-pressed” plant oil – see f.ex. “Handbook of Agricultural Energy Potential of Developing Countries” [5 vols] – James A. Duke CRC Press Boca Raton Florida USA 1987. [ISBN 0-8493-3640-6 / Lib. of Congress catalogue nr. – TP360.D85 1987 333.79’38 85-31392 - unfortunately there is no copy registered or available at present in DK]. Likewise consult CD-4.

A: Either convert the engine along the lines as developed by Elsbett in Germany – www.elsbett.com - or f.ex. see the book “Energie Insel” by Wolf-Rüdiger Weiss – obtainable from either - www.oekobuch.de - or from www.conrad-electronic.com

B: Or convert the fuel – a simple procedure for doing this is shown on my CD’s in the file “Extra Files”.

It is also possible to adapt a spark-ignition engine to either use methane from bio-gas production or to use alcohol. Procedures for the production of the later are covered in CD-4 and bio-gas is extensively covered in CD-3 – where much can be learnt from the low-cost development at the UTA in VietNam and the low-cost collective group approach by the individual farmers in Germany. [Two CD's from the UTA - showing plastic-bag construction methods – are obtainable from Frands Dolberg or from John Furze]

The so-called “waste-products” from alcohol and from cold-pressed plant-oil – are highly valuable as a feed stock for animals and the “waste slurry” from bio-gas production can either be used in ponds as a feed-stuff for the further cultivation of lemma or algae or duckweed or else used as a valuable fertilizer for the fields.

Spark-ignition engines can likewise readily be adapted for the use of gasification systems – see CD-4 and also CD-3 in the file “Engines”. It should be noted that most of the robust Russian and previous CMEA countries engines are highly suited to these modifications – likewise the GM – Opel Bedford 6 cylinder in-line engines. Small diesel engines suitable for modification are f.ex. small Japanese, Italian, Chinese micro tractor-engines and Indian Lister models. Likewise at this time modification-kits can now be purchased for several different models of pick-up engines – Toyota, Isuzu etc.

Concerning water treatment – as mentioned during my lecture – a successful solution to the energy problem also offers successful solution models to the many problems of water supply, removal, disposal, treatment, sewage, etc etc. Expect further interesting development of previous historical systems using solar-thermal for pumping, cooling etc. Kindly further consult the files “Compost systems” – Low-cost Plastic Bio-digesters” and “The Integrated Farming System” on CD-3 and the solar files on CD-2. In addition I can highly recommend the essential book – Permaculture. Bill Mollison, Island Press Washington USA 1990 - ISBN 1-55963-048-5.

I enclose an interesting relevant energy matrix from Gill Wilkins – for further information kindly contact – gill.wilkins@aeat.co.uk

I also enclose a further file – a paper written for “ReFocus” for the World Wind Energy Conference held last year in Paris – concerning discrete wind energy technology for urban environments.

As Denmark – at the present time is still the world leader in the development and production of large-size wind energy technology – it is perhaps relevant to illustrate a rough disposition of the future tendencies and categories in wind technology:

1: Micro wind turbines up to 250 Watts and from 500 Watts to 1.5 kW.

2: Large micro wind turbines – up to 10 kW.

3: Special urban-type systems from 100 watts up to 10 [possibly 25 kW]
– both vertical axis and horizontal axis models.

The next three model-types [4-6] are unfortunately largely neglected –
although the need is great.

4: Small wind turbines – from 20 kW – 80 kW.

5: Small medium wind turbines from 150 – 250 kW.

6: Medium wind turbines from 300 – 750 kW. [see above].

7: Mega-Watt size wind turbines from 750 kW – [at present 2.5 MW]
Mega-Watt wind turbines will mainly be used for offshore power
generation and are expected to increase in size up to about 10 MW within
the next 10 years or so.

John Furze – Aarhus Denmark – 16 March 2003

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*Energy FOR Poverty
Reduction. Draft Matrix:
Energy and the International
Development Targets:*

IMPORTANCE OF ENERGY TO ACHIEVING THE TARGET			
TARGET	Fundamental	Directly contributes	Indirectly contributes
A reduction by one half in the proportion of people living in extreme poverty by the year 2015	<ul style="list-style-type: none"> • Modern energy supplies are necessary for economic growth • Clean, efficient fuels reduce the large share of household income spent on cooking, lighting and keeping warm 	<ul style="list-style-type: none"> • Access to reliable energy services enables enterprise development • Lighting permits income generation beyond daylight hours • Increased productivity from being able to use machinery 	<ul style="list-style-type: none"> • Employment creation in local energy service provision and maintenance, fuel crops, etc.
Universal primary education in all countries by 2015	<ul style="list-style-type: none"> • Availability of modern energy services frees girl's time from helping with survival tasks (gathering firewood, fetching water) 	<ul style="list-style-type: none"> • Good quality lighting permits home study • Electricity in schools allows evening classes and helps retain teachers, especially if their accommodation has electricity. • Electricity enables access to educational media and communications in schools and at home, which increase education opportunities and allow distance learning. 	<ul style="list-style-type: none"> • Energy can help create a more child friendly environment (access to clean water, sanitation, lighting and space heating/cooling), thus improving attendance at school and reducing drop out rates. • Access to electricity provides the opportunity to use electrical equipment for teaching e.g., overhead projector, computer, printer, copier
Demonstrated progress towards gender equality and the empowerment of women by eliminating gender disparity in primary and secondary education by 2005	<ul style="list-style-type: none"> • Availability of modern energy services frees young women's time from survival activities (fuel gathering, cooking inefficiently, fetching water, crop processing by hand, manual farming work) 	<ul style="list-style-type: none"> • Good quality lighting permits home study • Electricity in schools allows evening classes and helps retain teachers especially if their accommodation has electricity. • Electricity enables access to educational media and communications in schools and at home, which increases educational opportunities and allows distance learning. 	<ul style="list-style-type: none"> • Reliable energy services offer scope for women's enterprises • Street lighting improves women's safety
A reduction by two-thirds in the mortality rates for infants and children under age 5 and a reduction by three-fourths in maternal mortality - all by 2015	<ul style="list-style-type: none"> • Indoor air pollution from traditional fuels causes significant numbers of premature deaths amongst children and mothers 	<ul style="list-style-type: none"> • Gathering and preparing traditional fuels exposes women and children to health risks and reduces time spent on childcare • Modern energy safer (less house fires) 	<ul style="list-style-type: none"> • Electricity enables pumped clean water and purification • Latrines for biogas production improve sanitation
Access through the primary healthcare system to reproductive health services for all individuals of appropriate ages as soon as possible and no later than 2015		<ul style="list-style-type: none"> • Electricity in health centres enables night availability, helps retain qualified staff and allows equipment use (e.g., sterilisation, medicine refrigeration) 	<ul style="list-style-type: none"> • Electricity enables access to health education media
The implementation of national strategies for sustainable development by 2005, so as to reverse current trends in the loss of environmental resources at both global and national levels by 2015	<ul style="list-style-type: none"> • Traditional fuel use contributes to erosion, reduced soil fertility and desertification. Can become more sustainable through substitution, improved efficiency and energy crops • Using cleaner, more efficient fuels reduce GHG emissions 	<ul style="list-style-type: none"> • Mitigate increased pollution as economy grows with cleaner fuels and energy efficiency • Increased agricultural productivity from being able to use machinery 	<ul style="list-style-type: none"> • National sustainability aided by greater use of indigenous renewable energy sources instead of imported fossil fuels as economy grows • Rural energy services enable non-farm based enterprise and processing of non-timber forest products



Stealth wind turbines

Designs and technologies to reduce visual pollution

Protests are increasingly heard from many countries concerning visual pollution from tall wind turbine towers and it is indeed true that most modern megawatt-size models with tower heights of 50-70 meters certainly stand out in the landscape. As the siting of onshore wind farms begins to encroach on the urban environment, visual pollution protests and objections are no doubt going to continue and to hinder some projects. Raising awareness of the benefits of wind farms and increased public acceptance is half of the battle in getting projects approved, but are there other less visually imposing designs and technologies that could be implemented in certain cases? John Furze from the University of Aarhus, Denmark discusses some of the relevant modern technological solutions that could help resolve or alleviate some of the pressing visual pollution issues of wind turbines.

It is possible to design and build visually satisfying large power pylons where the power transmission cables are not buried. The latest pylon designs erected by Fingrid are arguably majestic and sculptural (Figure 1). Given the abundance of huge electricity pylons strewn over the countryside of most developed countries one might pose the question why not install wind turbines on the many pylons? Indeed this question has been discussed on many previous occasions. Brave wind mill enthusiasts often have had fantasies of large propeller-type rotors on top of standard pylons – often without in any way understanding the enormous turbulent - non-steady-state-flow aerodynamic forces exerted on a wind turbine in operation. But are there wind turbine designs that could be incorporated unobtrusively into the environment in certain cases?

Wind turbines: Not in my backyard

Many protests levelled at wind turbines are more often than not made on a NIMBY (Not-in-my-back-yard) basis, while the long lines of tall power grid pylons criss-crossing the landscape are often more or less accepted as a necessary, although perhaps unpleasant fact of life. The large number of recently and rapidly erected mobile telephone towers have likewise been largely installed with few negative remarks in many European countries although there is growing opposition to this unchecked growth in the UK and some other countries. However power transmission and the whole grid system together with pylon and tower technology itself has perhaps not evolved to the extent necessary to effectively meet the public demands for power generation and reliable power supply without visual and indeed other forms of environmental pollution.

Wind turbine and tower designs

During the period of the re-formulation of the concept of the modern wind turbine (the so-called 4th period 1968-1978) many attempts were made to combine elegant tower constructions with different types of wind energy systems. During the late 1960's - Director Jean Fischer from the Danish firm of F.L. Smidth presented a proposal for a series of 130 meter-high concrete towers with a series of Darrieus (Figure 2) troposkein-shaped vertical axis rotors built in to the tower structure. Each tower would produce 1.2 MW and they were seen as a serious counterweight to proposals from supporters for the possible introduction of nuclear power stations in Denmark. On a different level attempts were often made to introduce the so-called shrouded or diffuser wind systems suitable for mast-head use.



Figure 1: Finnish "Simikurjet" [plougtail birds] electrical pylons near Helsinki - Finnish Power Grid Plc. (photograph by Juhani Eskelinen)



Figure 2: An example of a Darrieus wind turbine. This is a 60kW model at a test site at Sandia Laboratories (Photo: US Department of Energy)

The first modern wind turbine towers were built in the 1960-70s following the then usual tower technology - a lattice construction, later a tripod and finally the modern tall slender tower of steel or spun concrete. Nowadays, a recent project financed by the European Union and carried out by designer and millwright Claus Nybroe on behalf of BONUS-Energy has demonstrated the improved effectiveness of the so-called "stealth technology camouflage" in wind turbine tower colour-schemes in a serious attempt to counter possible visual pollution. Likewise the well-known differentiated colour schemes for the slender German Enercon wind turbines are also considered effective (Figure 3).

Helical wind generator designs

In Finland two different companies Oy Windside Production Ltd. and Shield-Jaspira, each representing a different manufacturing philosophy, provide interesting wind turbine options with a range of modern helical-screw-type cylindrical rotors. The versatile designs could be unobtrusively retrofitted to many existing structures.

Oy Windside Production Ltd has since 1982 maintained a small basis production of high-cost highly-reliable helical wind generators for small-scale power generation intended for use under not only hard environmental conditions but also capable of producing small quantities of usable power under low wind-speed conditions (Figure 4). The company has also a long track record of small-scale production of beautiful, silent-running and expensive "urban architectural structures". One example is a recent project of two



Figure 3: Close up of an Enercon wind turbine. The Green coating fades towards the middle of the tower, so that the bottom matches the green of the countryside, while the top matches the sky. (Photo courtesy of Enercon)

25 kW rotor-units driving a common 50 kW generator for heating purposes at a large shopping centre near Turku (Figure 5).

Shield as designer and producer of the Jaspira range of horizontal vertical axis rotors have chosen another and different path to that of Oy Windside Production Ltd. Their helical design-shape is perhaps at first sight rather similar to the Windside models. The Windside rotors are produced from glass-fibre formed in molds - similar to glass-fibre boat-building techniques; while however the Jaspira rotors are produced from one-piece metal sheets formed by CNC machine-tools on the basis of a computer program readily adaptable for rapid alterations in the chosen parameters. (Figure 6)

Lower cost production of rotors in this manner, combined with effective outsourced slow-running generator production has resulted in considerable price reductions. The approximate cost of between 1.25 - 1.7 Euros/per nominal installed Watt can now be achieved, thereby enabling the massive cost-effective mounting of unobtrusive silent-running models almost anywhere there is an available mast or pillar or side of a building or even for permanent or short-term tree-trunk attachment. Rotors mounted or attached to the side of an existing mobile telephone mast will merely resemble from the ground the familiar long black oblong antennas already fixed in place. Much larger and more powerful helix rotor systems could simply and at low-cost be retro-fitted onto many of the already existing strings of power pylons or the smaller models can be clamped on the sides of normal wooden telephone poles.

Shield has previously visualized their market as basically similar to that of Oy

Windside Production Ltd.- however mainly concentrating on small scale de-central power supply in isolated areas - power supply for on-board ship and marine-use and for emergency power-supply for lifeboats and military purposes. A more careful study of the true implications of the economic costs - installed costs per unit and the power production curve greatly expands the perspectives for the uses of this technology into new and perhaps unexpected spheres.

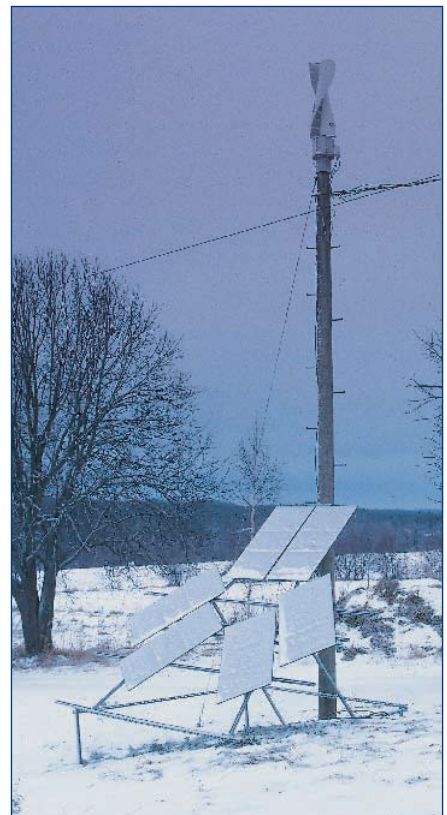


Figure 4: Windside-rotor on wooden mast at Keuruu in Finland - photograph by Arvi Karhumaki



Figure 5: Twin 25 kW Windside-rotors powering a common 50 kW generator for heating use at Raisio shopping centre near Turku in Finland (Photograph from Oy Windside Production Ltd. Finland)

Both Shield, Oy Windside Production Ltd and others, point out that one of the main advantages of the vertical axis horizontal rotor technology, especially in the more advanced helical shape, is the ability to receive power inputs from turbulent and gusty wind coming from rapidly changing directions as is common in modern urban environments. And as the cut-in wind speed is much lower, the rotors are more effective at harvesting relatively low urban wind speeds.

This approach results in real cost-benefit trade-offs and may fully warrant the large-scale introduction and use of small-scale VAWT's (vertical axis horizontal rotor wind turbines) without suggesting any obstacles to the large-scale deployment of MW-size wind turbines in good offshore conditions or in other suitable and acceptable sites. Nor indeed to the on-land erection of more efficient modern small and medium wind turbines with 15-35 meter tower heights with the thereby reduced visual pollution impact as is being seriously considered in several EU countries.

Such large, not to say massive, numbers of small unobtrusive silent-running generators strung up or perhaps just hung up, all over the place, do of course provide certain problems concerning the linking, inter-collection and distribution of the produced power, using separate local lower voltage line systems, distinct from a high-voltage

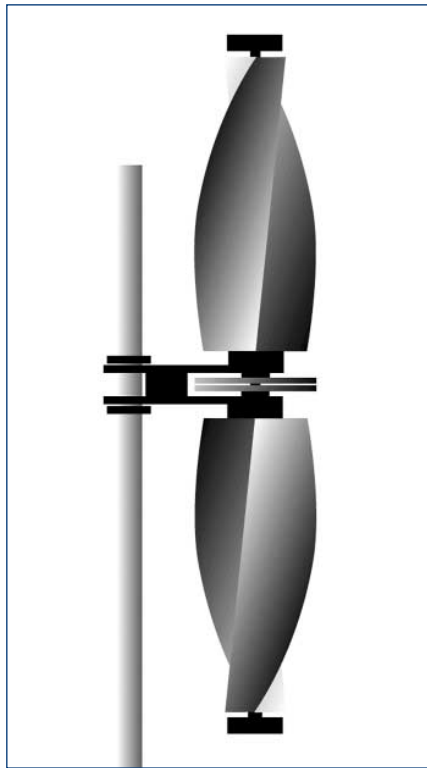


Figure 6: Computer generated image of the Shield-Jaspira rotor for use in a variety of applications - including even for hand-held mobile use.

pylon grid distribution system. However many power specialists do not visualize any real problem in that respect. Power electronics has come a long way since 1904 when Prof. Paul La Cour was building and implementing his 120 V DC wind turbine/petroleum-motor combined power-stations providing electricity and hydrogen-gas for the de-central micro-grid systems in small Danish countryside towns.

About the author

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Further reading and information

- a: Natural Energy and Vernacular Architecture. Hassan Fathy. University of Chicago Press, Chicago/London 1986.
- b: The Green Imperative. Victor Papanek. Thames and Hudson Publishers London 1995.
- c: Radical Technology. Peter Harper [ed.] Wildwood House Ltd, London/Random House Publishers USA. 1976.
- d: The Autonomous House. Brenda and Robert Vale. Thames and Hudson Publishers London 1975.
- e: The Owner-built Home. Ken Kern USA 1972/75.
- f: Sunshine Revolution. Harald Røstvik. SUN-LAB Publishers USA/Norway 1991/92.
- g: www.mnal.no/nabu & alice@gaiarkitekter.no
- h: Living Spaces. Thomas Schmitz-Günther [ed.] Könemann Verlag Cologne, Germany 1998/1999.
- i: An interesting account of John Berton's integrated system of wind generators and PV, installed on his off-grid town-house in Chicago can be found in Home Power Magazine # 80 - December 2000/January 2001 - see www.homepower.com - & also JBerton55@cs.com
- j: For similar and lower-cost Danish experience - Lars Campradt - Energy Adviser - S.W. Jutland Energy and Environment Office - campradt@mail.tele.dk
- k: For German readers - several photographs, illustrations and wiring diagrams for off-the-shelf modern micro wind generators shown in combination with PV systems etc - in different urban environments in addition to other de-central stand-alone systems - are presented in two comprehensive do-it-yourself handbooks by Bo Hanus. Both vertical axis and horizontal axis rotor-types are illustrated in these two useful books, but unfortunately, - not the more advanced and more efficient modern Finnish vertical axis helical-shaped horizontal rotor designs.
- "Windgeneratoren Technik" 1997 and "SolarAnlagen" 1996 - Bo Hanus - Franzis' Verlag, Feldkirchen Germany. These books are available from: www.conrad-electronic.com, www.franzis.de or www.bol.de
- l: See also or contact: Ecotools Sustainable SA. Biel Switzerland - www.ecotools.net & Solavent - Freiburg Germany - Fax: + 49 (0)761 709647 - solavent@t-online.de

De-central Power for Development - Initial Texts:

Pages:

- 02-10: Forsøgsmøllen [Danish State Experimental Wind Testing Station].
Paul La Cour. Copenhagen Denmark. 1900/1904.
- 11: Wind Power for Home and Business [page 242]. Paul Gipe.
Chelsea Green Publishing / Real Goods. USA. 1993.
- 12-13: Pages from Rainbow Power Company Catalogue.
Rainbow Power Company. Nimbin Australia.

Fællesdriftens Omfang. De fleste Lægfolk har den Opfattelse, at Elektriciteten med Lethed lader sig fordele over store Strækninger. Man kender jo Telegrafens Virksomhed i tusinde Miles Afstand, og man har læst om milevis Kraftflytning ved Niagara og andensteds. Og dog er det her, at Vanskeligheden har ligget for, at Landet kan blive delagtig i Byernes Fordele paa Elektricitetens Omraade. — Havde det været en simpel Sag at befordre Elektriciteten gennem en Ledning eller to ud paa Landet eller fra en Centralstation paa Landet ud i forskellige Retninger, vilde den for længe siden have været der. Men med den elektriske Spænding, som bruges i danske Købstæder, og som alene synes tilladt langs danske Landeveje *), vilde allerede en Forplantning paa nogle faa

*) Ved Anlægget i Askov har saaledes Sogneraadet efter Anvisning fra Amtsvejsinspektoren fastsat som højere Grændse for Elektricitetsspændingen langs Sognevejene \pm 110 Volt.

Tusinde Alen til en enkelt Gaard være upraktisk eller i hvert Fald forbunden med et urimelig kostbart Ledningsnæt.

Tænker man f. Eks. paa en Gaard, der ligger blot 1000 Meter fra en Centralstation, hvorfra Gaarden alene skal forsynes med Elektricitet med en Spænding paa 110 Volt, og vil man f. Eks. kunne drive en Tærskemaskine à 3 HK med Strømmen, da maatte der bygges en Linie med 2 Kabler paa 50 □ mm. Tværsnit, hvad der vilde koste over 2000 Kr. (foruden selve Motoren og Ledningsnættet paa Gaarden); og man vilde dog have et Spændingstab paa 20—30 Volt, et Energital paa over 20 %. Samtidig Brug af Elektricitet til Lys vilde være umulig, da Lyset vilde være ganske utilfredsstillende; og selv naar der ikke bliver tærsket, vil man ikke kunne tænde en halv Snes Lamper, før Spændingstabet er generende m. H. t. Lysstyrken.

Har man en Spænding paa 220 Volt at gaa ud fra, vil man kunne nøjes med to Ledningstraade paa 20 □ mm.; men selve denne Linie vil dog koste over 1000 Kr., og ved nævnte Tærskning vil man lide et Spændingstab paa mere end 22 Volt, hvilket dog her kun er et Energital paa 10 %; men heller ikke her vil man kunne have noget tilfredsstillende Lys ved Siden af hint Arbejde.

Fremgangsmaaden ved Niagara og andensteds for at naa ud paa saadanne og større Afstande er da den, at man anvender Elektricitet ved meget høj Spænding; men bl. a. fordi den er livsfarlig, maa den først transformeres, inden den kan bruges paa Gaarden. Dette vilde, selv om saa høj Spænding ved Lov blev tilladt her i Landet, imidlertid blive altfor omstændeligt for Danmarks spredte Befolkning, og det kan næppe tænkes anvendt, inden denne er bleven mange Gange saa talrig, saa at den transformerede Elektricitet kan fordeles til mange paa et Sted, uden at den derefter skal sendes ud gennem ret lange Ledninger.

Der bliver derfor herved Landet indtil videre næppe nogen anden Fremgangsmaade end den, at der oprettes smaa Fællesværker paa Steder, hvor der bor flere i Nærheden af hinanden, og Gaardværker paa enkelt liggende Gaarde.

Det ovenfor beskrevne Værk har godtgjort, at et Fællesværk kan være baade praktikabelt og rentabelt.

Der er for Tiden en Mellemting mellem et Fællesværk og et Privatværk under Opførelse i Vallekilde, hvor Ejerne af Højskolen d'Hrr. *Pool* og *Niels Hansen* lader opføre et lignende Værk som det i Askov, baseret paa Vindkraft og med Petroleum i Reserve,

Betydningen af landlige Elektricitetsværker. Bortset fra den Behagelighed og Nytte, som er knyttet til det elektriske Lys, og som er af ikke mindst Værd i Stalde og Lader, kan man sammenfatte den Nytte, der kan ventes af landlige Elektricitetsværker, i to Hovedgrupper:

- 1) til Drift af *Landbrugsmaskiner* og
- 2) til Ophjælpning af landligt *Haandværk* og *Husflid*.

Om det i nogen nær Fremtid vil lønne sig at bruge Elektricitet til egentlige Markarbejder, er vist tvivlsomt. Saadanne Anordninger findes ganske vist paa nogle tydske Godser og andre Steder, hvor man med store Omkostninger har etableret Værker og Ledningsnæt med høj Spænding og Transformatorer under Ledelse af Ingeniører ell. lign. Hvorvidt saadanne — man kan vel sige — storindustrielle Anlæg paa Landbrugets Omraade betaler sig, maa staa hen; men i hvert Fald har de næppe synderligt Ærinde til danske Forhold.

Det ligger m. H. t. vort Landbrug betydelig nærmere at tænke paa de Arbejder, der er at udføre paa Gaarden selv: Tærskning, Rensning, Hakkelseskæring, Kageknækning, Roeraspning, Pumpning m. m. Denne Slags Arbejder kan udføres ved Elektromotorer med langt større Bekvemmelighed og Jevnhed end med de i Landbruget almindeligst anvendte Drivkræfter; og der kan ingen Tvivl være om, at man mere og mere vil tage Elektromotorerne i Brug, tilmed fordi de saa let kan anbringes uden at stille de Krav til udstrakte Transmissioner, som er uadskillelig knyttet til mekaniske Drivkræfter.

I Byernes Industri mærkes en Bevægelse bort fra de mekaniske Transmissioner til en elektrisk Anordning, hvorved der fra en Dynamo fordeles Strøm til forskellige Elektromotorer, der driver

hver sin Arbejdsmaskine; og dog befinder disse sig forholdsvis langt mere samlet paa Værkstedet end Arbejdsmaskinerne i en Gaard.

Dertil kommer, at det lille Landbrugs to hyppigste Kraftkilder, Vindmotoren og Hestegangen har en umaadelig langsom Bevægelse, den første en Snes Omdrejninger i Minuten, den sidste lige ned til 3. Da Arbejdsmaskinerne ofte kræver stor Omdrejningshastighed, f. Eks. en Tærskemaskine, 1200 Omdrejninger, bliver Transmissionerne fra de langsomme Kraftmaskiner saare omstændelige og kraftspildende.

Kan man derimod faa Elektricitet fra et Fællesværk, indskrænker Gaardanlægget sig til et næppe synligt Ledningsnæt med Lamper og et Par Elektromotorer, der kun fylder lidt. Den ene er faststaaende og bestemt til at drive Tærskemaskine. En anden mindre, som man ret let kan flytte omkring med, hvis man ikke foretrækker at anskaffe 2 eller 3, kan drive lettere Arbejdsmotorer.

Har man derimod ingen Adgang til Elektricitet, f. Eks. fordi Gaarden ligger for enligt, bliver Spørgsmaalet, om det kan lønne sig at anlægge et lille Elektricitetsværk for Gaarden alene.

Paa Grundlag af de ovenfor beskrevne Erfaringer kan man med temmelig stor Sikkerhed angive Indretningen af et saadant Gaardværk og beregne Anlægsomkostningerne derved.

En firvinget Mølle anbringes paa et slankt Stativ lidt fra Gaarden (jfr. S. 91). I et Rum forneden i Stativet befinder Vippeforlag (S. 94), Dynamo og Selvfafbryder (S. 93) sig, og herfra gaar et Par Ledninger ind i Gaarden. Her findes en Akkumulator til 45 eller 60 Volt Spænding, et Ledningsnæt med Lamper i Stuehus og Udhuse, en større Elektromotor til de større Arbejder og en eller to mindre til de smaa. Akkumulatoren er stor nok til at holde ud med Lys og Smaaarbejder 4—5 Døgn; men for Tilfælde af længere Vindstiller findes der ved Møllen en Hestegang, der kan drive Dynamo. Under almindelige Forhold vil der da meget sjelden appelleres til Hestene (jfr. S. 98). Derimod maa de sværere Arbejder som Regel kun udføres i Blæst, i hvert Fald ikke i ret mange Timer; thi ellers tømmes Akkumulatoren. Men der stilles betydelig mindre Fordringer til Blæstens Beskaffenhed ved denne Drift, end hvor en Mølle direkte trækker Maskinerne. For det første vil stærk Blæst eller Storm ikke levere mere Elektricitet end normal Blæst (jfr. S. 94—97), og dernæst løber Elektromotoren med samme Hastighed altid — selv om Vinden rent forsager, da

Strømmen i dette Tilfælde kommer fra Akkumulatoren, der i det hele enten modtager det Overskud, som Vinden giver, eller yder det Underskud, som behøves ved upaalidelig Vind. Kort sagt en Vejrmølle vil med elektrisk Drift kunne bruge baade stærkere og svagere Vind end med mekanisk. Og en Hovedsag, saavel for Tærskemaskiner som for de andre Maskiner, er, at de ved saadan Drift gaar fuldkommen jevnt.

Ligeledes kan Omkostningerne ved et saadant Anlæg temmelig sikkert beregnes. For en almindelig Bondegaard vil de kunne anslaaes omtrent saaledes:

Mølle og Hestegang.....	c. 1300 Kr.
Dynamo	500 -
Automat, Strømtavle, Ledningsnæt	500 -
Akkumulator	500 -
2 Elektromotorer.....	700 -
Ialt...	3500 Kr.

Betydeligt vanskeligere er det at bedømme den Nytte, man kan have af et saadant Værk.

Hvad Lyset angaar, vil man nok kunne angive Værdien af den Petroleum, som vil spares. Vanskeligere bliver det at vurdere den øvrige Bekvemmelighed og Brandsikkerhed, som opnaas. Heller ikke ved nogen, hvor længe det vil vare, inden Brandforsikringselskaberne tager tilstrækkelig Hensyn til, at der ikke findes Petroleum i Gaarden. Vistnok har den famøse Kortslutning givet mange en Forestilling om, at Elektricitet skal være ligesaa farlig; men hvem der kender lidt til Sagen, vil vide, hvor vanskeligt det kan være ligefrem med sin bedste Villie at faa Elektriciteten til at tænde Ild paa.

Aller vanskeligst er det dog at anslaa Værdien af de Arbejder, som et saadant Gaardværk vil komme til at udføre. Meningerne herom er saare delte. Man kan træffe paa én, der siger, at man kan godt nøjes med sin gamle Hestegang, og at Hestene alligevel ikke har stort andet at bestille om Vinteren. En anden siger: jo, jeg sætter nok Pris paa at kunne skaane mine Heste, især i daarligt Vejr, og Manden, der gaar og driver dem. Desuden vil Arbejdet gaa ganske anderledes præcist og kvikt fra Haanden med den jevne og uforstyrrede elektriske Drift.

Ligesom Folk af Naturen er meget forskellig oplagte til at bruge Maskiner, saaledes vil det uden Tvivl ogsaa gaa her, at man vil være ulige godt skikket til at drage Udbytte af saadanne Anlæg

i det egentlige Landbrugs Tjeneste, og kun Fremtiden vil vise, hvor hurtigt de vil udbrede sig.

M. H. t. landligt *Haandværk og Husflid*, da vil disse faa betydelig lysere Udsigter derved, at Landbefolkningen i Landsbyer o. l. Steder faar Adgang til Benyttelsen af Elektricitet, og heraf tør man maaske vente et ikke ubetydeligt socialt Gode.

En Egn kan være for tyndt befolket, en anden for tæt. I hin kan man ikke støtte hinanden ved saadanne Fællesforetagender, som man kunde have stor Nytte af — simpelt hen fordi man bor for spredt til at kunne bruge Fællesskabet. Man maa nøjes med tarveligere Kommunikationsmidler; man maa hjælpe sig selv med alt muligt, hvorved Arbejdet bliver mindre nyttegørende, end hvor Arbejdets Deling praktiseres. — Men en Egn kan ogsaa være for stærkt befolket: man kan ikke komme til Arbejdet for hinanden, saa at dettes Løn nedsættes, og man konkurrerer med hinanden om Livsfornødenhederne, hvorved Prisen paa disse stiger.

Ikke desmindre foregaar der stadig en stærk Indvandring fra Land til By. Byerne har haft mange Fordele at byde paa, navnlig fremkomne ved de store Virksomheder, som Naturforskningens Fremskridt har muliggjort. Mange er derfor blevne lokkede fra Land til By ved Udsigt til bedre Fortjeneste og bekvemmere Liv; og dog erkendes det af alle, at i det hele og store har denne Vandring været til liden Baade saavel for By som for Land: hin er bleven for stærkt befolket, dette for afbefolket. Og hvad selve Indvandrerne angaar, saa kan det jo ganske vist være gaaet mangen enkelt godt; men naar den øjeblikkelige Forhøjelse i Løn afløses — som tit er sket — af Arbejdsløshed, er dog Ombytningen for de fleste et mere end tvivlsomt Gode. De landlige Arbejdsvilkaar, selv om de gennemgaaende er tarveligere, er dog mindre svingende og derfor mere trygge at leve under, og egentlig Nød kendes kun i langt ringere Grad paa Landet end i Byerne.

Dog kender Smaafolk paa Landet en aarlig Periode m. H. t. Udkommet. Om Sommeren vil enhver kunne faa Arbejde, og der kunde endda bruges mere Arbejdskraft, end der findes; men om Vinteren er det smaat nok; og da Arbejdsdagen tilmed er kort, bliver Lønnen ringe.

Her er et Punkt, hvor der vilde vindes meget, om det kunde forbedres, og hertil faas nogen Udsigt ved de landlige Elektricitetsværker.

Allerede nu drives der nogen Husflid. En og anden erkender,

at selv om Fortjenesten ikke er stor, er det dog en bedre Anvendelse af den lange Vinteraften at gøre noget nyttigt end at døse den hen. Men kunde nu en lille Elektromotor bevirke, at et Menneske kunde bruge sin Vinteraften til noget, der gav virkelig god Fortjeneste, da vilde der her være en ganske anden Opmuntring til dens rette Afbenyttelse.

Hvilke Arter af Husflid der kan tænkes at udvikle sig under dette Synspunkt, er ikke let at forudse. Tiden vil vise det, naar først Betingelserne (Elektriciteten) er tilstede; men for blot at tage et Eksempel: naar en Væver kan passe to Maskinvæve, drevne af en Elektromotor og derved udføre omtrent 6 Gange saa meget som en Væver med sin Person alene, saa vil han ogsaa kunne fortjene noget, der paa en kendelig Maade kan suplere Daglejen; ja, det kan være, at han *om Vinteren* helt trækker sig over paa denne Virksomhed og overlader Daglejerarbejdet til andre, som derved faar mere Adgang til Arbejde paa den daarlige Aarstid.

Arbejdsforholdene paa Landet er til Lykke for Landboerne i Forvejen mere stabile end i Byerne; men kunde de blive endnu mere stabile derved, at den aarlige Periode i Arbejdsmængde paa nævnte Maade reguleredes, vilde meget være vuudet.

Ogsaa almindeligt Haandværk og Lilleindustrien, som i Byerne er bleven mere og mere slugt af Storindustrien, har i det hele holdt sig mere paa Landet, fordi dette daarligt kan undvære at have Haandværkere direkte ved Haanden, og fordi Livsvilkaarene paa Landet stiller mindre Fordringer til Udkommet; men der er ikke Spørgsmaal om, at en billig Hjælpekraft, der ingen Ting koster uden i selve de Øjeblikke, hvor den arbejder, vil være af uskatteilig Værdi for mangan en Haandværker.

Dette ses allerede nu paa enkelte Steder, hvor et landligt Maskinværksted har forsynet sig selv og dernæst sine Omgivelser med Elektricitet, frembragt af Værkstedets Dampmaskine; men efterat det har vist sig, at Elektricitetsværker baserede paa Vindkraft er rentable paa ethvert Sted, hvor der blot er tilstrækkelig Brug for dem, vil en Fremvækst af saadanne ogsaa af denne Grund finde Sted.

Personlige Betingelser for landlige Elektricitetsværker. Medens Driften af et Vindelektricitetsværk er ganske automatisk, saa at Pasningen indskrænker sig væsentlig til Smøring og noget Tilsyn, er det nødvendigt, at den, der skal passe Værket, tilegner sig nogen Fortrolighed med det. Det er en lignende Fordring, som i saa mange andre Henseender stilles til Landboere fremfor til Købstadfolk. Medens sidstnævnte simpelthen køber sine Havesager, Æg o. l. og sender Bud efter en Haandværker, naar der er et eller andet, der skal gøres i Huset, osv., maa Landboen selv forstaa sig noget paa hine Sagers Tilvirkning og paa Reparationer, som det ellers ikke faglig er hans Sag at udøve, — noget, der forøvrigt gør Livet righoldigere paa Landet.

Og Kendskab til Elektriciteten til Husbehov er slet ikke vanskeligere end alt det andet. Det viser sig tværtimod, at den fornødne Fortrolighed ret hurtig kan tilegnes, ja, alt tyder paa, at de, der faar med den at gøre, finder et vist Behag deri. Det er nemlig saa langt fra, at man her faar med noget hemmelighedsfuldt og uforstaaeligt at gøre, at det vist kan siges, at man i ingen anden Virksomhed har med saa simple Love at gøre som her. Intet andet Sted slaar alt til med Tal og Maal som her.

Men helt fremmed har denne Sag hidtil været for næsten alle udenfor Fagmændenes Række, og der er derfor ganske naturligt bleven spurgt efter Vejledning og forlangt smaa Kursus for Folk, der interesserede sig derfor, og som skulde have med Elektriciteten at gøre.

I den Anledning har jeg paa Forsøgsmøllen, som egner sig godt dertil, afholdt nogle Elektricitetskursus, hver Gang paa c. 1 Uge, nemlig i Oktbr. 1901, i Marts 1902, i Oktbr. 1902, i April 1903 og næste Kursus er bestemt til 24.—30. Septbr. d. A. Kursus er beregnet paa at give den fornødne Forstaaelse og Vejledning til Behandling af smaa Elektricitetsværker, hvad der har vist sig gør ligt i den forøvrigt ret korte Tid.

Største Delen af Deltagerne har været Mejeribestyrere, og jeg skylder Forstander *Niels Pedersen*, Ladelund, og Statskonsulent *Bøggild* Tak for den Interesse, de har vist dette Foretagende ved baade at opmuntre mig til at holde Kursus, og Folk til at benytte dem, ligesom ogsaa *det kgl. Landhusholdningsselskab* har ydet adskillige Mejeribestyrere Understøttelse til at gennemgaa Kursus.

At Flertallet af Deltagerne har været Mejeribestyrere, hænger naturligvis sammen med den Kendsgerning, at der allerede nu er

foretaget adskillige elektriske Lysanlæg paa Mejerier. Disse er af mange Grunde selvskrevne til at gaa i Spidsen paa dette Omraade. Drivkraften til Ladning af Akkumulatorer haves her daglig, saa at Akkumulatoren ikke behøver at være stor, og saa at sige gratis, da Spildedampen er næsten ligesaa god til Pasteurisering som Kraft-dampen.

Den Tanke kunde nu ligge nær og har sikkert været fremme hos adskillige, at Landets talrige Mejerier med de derværende Dampmaskiner kunde tænkes at blive naturlige Udgangspunkter for smaa landlige Elektricitetsværker; men som de ovennævnte Herrer stadig har haft Øje for; Elektricitetsanlægget er i høj Grad at anbefale for Mejeriet selv paa Grund af dets Renlighed, gode Oplysning og Økonomi; men det vilde være en uheldig Forstyrrelse for Mejeriets Drift, om det skulde befatte sig med en saadan Biforretning som den at være Elektricitetsleverandør.

Dertil er desuden Mejeriets Dampmaskine ogsaa i Reglen for lille; men foruden den Hær af Dampskorstene, som Mejerierne har plantet ud over vort Land, vil der nu forhaabentlig komme en tilsvarende Hær af Vejrmøller med tilhørende Elektricitetsværker.

Village power systems must meet standards for ruggedness and reliability similar to those in telecommunications. Though the weather may not be as demanding as that found on a wind-swept mountaintop, Third World villages are distant in both time and space from the technical support and spare parts found in the developed world.

The benefits of providing even small amounts of power to remote villages are magnified because so little electricity is needed to raise the quality of life. Two 7-meter turbines, which would supply only two homes with electric heat in the United States, can pump safe drinking water for a village of 4000 in Morocco.

The typical village system might use two or more wind machines, batteries, inverter, and backup generator (see Figure 11-8). And like hybrid home light plants, village power systems could also include a solar array. The key is to use as much power as possible directly, instead of storing it in batteries and running it through an inverter. This reduces both initial cost

VILLAGE ELECTRIFICATION

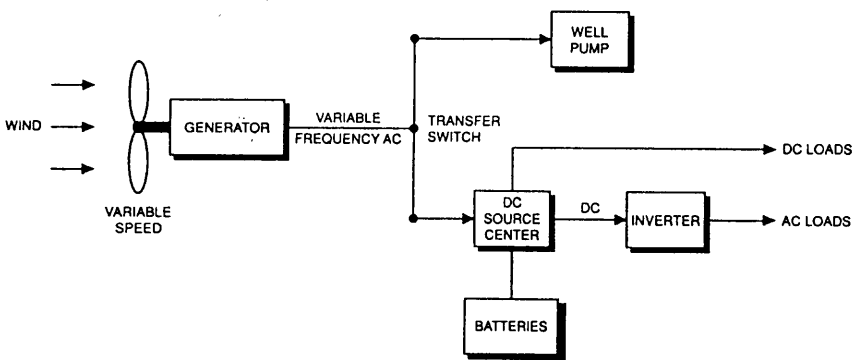


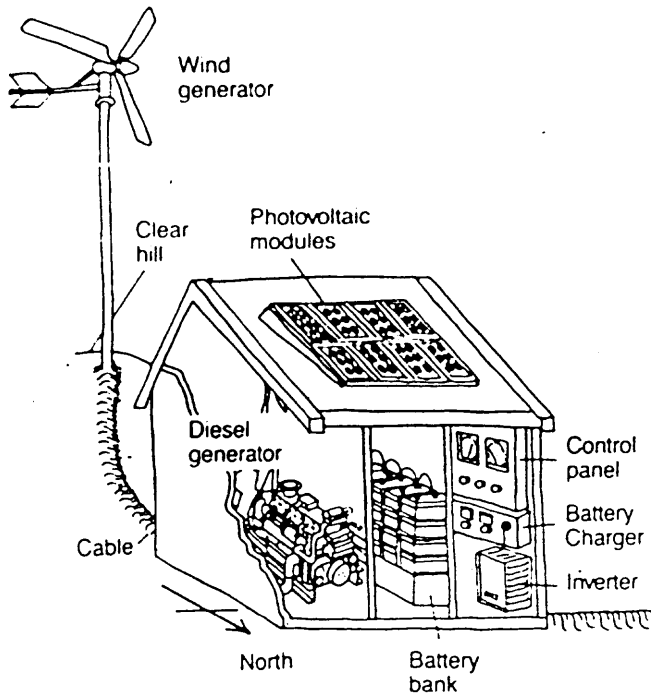
Figure 11-8. One scheme for using small wind turbines to serve a variety of loads in a village electrification program.

and complexity, while delivering more of the wind system's energy to do useful work.

Consider the Mexican village of Xcalac on the Yucatan Peninsula. There Bergey Windpower installed a hybrid power system using both solar and wind energy. Bergey erected Mexico's first wind farm, a 60-kilowatt array of six wind turbines, each 7 meters in diameter. They tied the wind turbines and a 12-kilowatt PV array into a large battery bank, and fed output from the batteries to a 40-kilowatt inverter. The entire \$500,000 system offset the construction of a proposed \$3.2 million power line to the remote village.

If power is used directly to pump water, grind grain, or run other loads not dependent on utility-grade electricity, the need for batteries is diminished. The batteries and inverter then need to be sized only for those loads that must use constant-frequency AC. In a concept conceived by Bergey Windpower the output from the wind turbine is manually switched from the direct loads, such as water pumping, to the batteries and inverter as needed. For example, the operator monitors the water level in a storage tank and the batteries' state of charge to determine where the power should be directed. The operator is also responsible for starting the backup generator when the power system can't meet demand. Eliminating automatic switches decreases the likelihood that a minor component could fail and imperil the entire system. It also ensures that one person is always responsible for operation of the power system.

Remote Area Power Supply



Supplying utility-grade AC power to large stations, remote villages, resorts or commercial enterprises can pose a number of difficulties. Diesel generators have a high running cost as opposed to the high capital cost of installing a large solar array with battery backup. The convention has been to use diesel generators but these usually do not incorporate a battery storage so the generator must be running to have any power. Stations with refrigeration usually run their generator for 10 to 24 hours per day. Those without refrigeration would run it for several hours per night to provide for lighting and television. The problem with such a system is that it wastes fuel.

The system must be sized to cope with heavy demands put on it by a user (eg welding). This load is called the peak load. As well as the peak load, it must also be able to handle the very short term, but very high surge loads caused when an electric motor (such as a freezer, washing machine or pump) starts up. These short term surge loads are often five times higher than the actual power used in normal operation. For most of the time the actual power being used is much less than the peak load that the system was designed to handle.

Diesel Generators

A diesel generator, as the main or back-up power supply, invariably has to be able to handle such peak loads. If, on the other hand, a diesel generator is too lightly loaded it can cause damage to the diesel engine and cause expensive repairs. In some cases a dummy load is turned on (any appliance or equipment to use power) to protect the diesel engine. This load increases fuel consumption for little or no benefit to the consumer. Both oversizing and under-utilization cause fuel wastage.

Generators also require routine maintenance during operation by ensuring regular oil-, air- and fuel filter changes, as well as routine service and operation to manufacturers' specifications. To ensure regular engine operating temperature, the engine must be run with a minimum load of 30%, but ideally with a load of 70-80%. Running of the engine on a low load for long periods will result in carbonization, cylinder bore glazing and poor fuel economy. Engine life will be severely shortened. Well loaded, the engine may achieve 20% - 30% conversion of fuel to shaft power, the remainder is lost as engine heat, exhaust heat, unburnt fuel and noise. Engine protection circuits are included in most diesel-generator systems to ensure the unit will not run in a faulty condition.

The design life of a generator is limited. A diesel generator has a life expectancy of some 10,000 hours before a major engine overhaul is required (typically costing about 50% of the initial cost).

Petrol Generators

Petrol engines in comparison are more light weight, less robust and high revving. The spark ignition system makes for a more portable power supply. However, the system is inherently unsuitable for a continuous stationary power supply. Petrol engines have an expected service life of some 1,000 hours. The engine limitations mean that the generator sets are usually small (0.5 to 8 kVA). Many petrol generators can be converted to run off LP gas which should increase the engine service life and reduce pollution level.

A Hybrid System

The use of a hybrid system, using a generator, solar panels (or wind and hydro) together with a battery bank can give you 'the best of both worlds'.

Generator and Battery Power

The generator lowers the capital cost of the system. The use of a large battery charger powered by the generator to charge batteries can load the generator to make it more efficient and the stored power in the batteries will cut down on generator use. The use of a battery bank can cut fuel costs by 65% to 70%. The use of solar panels to also charge the batteries can further cut down on operating costs.

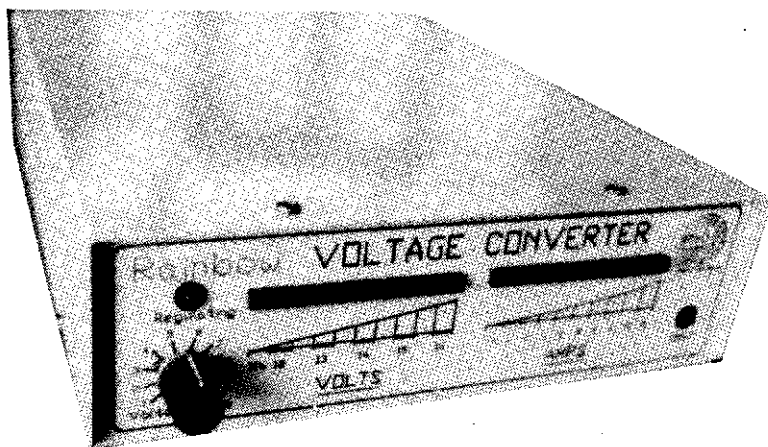
A large inverter connected to the battery bank provides 240 volt power 24 hours per day or while the generator is switched off. Australian made inverters are available in many sizes including 2, 5, 10, 15 and 25 kVA.

Designed to your Specifications

Our staff can design such a system to meet your requirements. We can supply a generator to suit your situation. In such a system we would normally recommend a generator run on diesel or LP gas.

RPC Microgrid

(100V DC)



Where there is a requirement for a number of small power systems (eg dwellings) within a few kilometres of each other, it is now possible for each dwelling to have its own power autonomy while sharing generation and surplus power. This century old idea now has a new viability thanks to the invention of a wonderful new transistor, the power mosfet, and a magnet which does not conduct electricity, ferrite.

It is based on a 100 volt DC power distribution and generation system with 12V or 24V battery banks at individual sites (eg house sites). Voltage converters act as two way interfaces between the battery banks and the 100 volt distribution lines. Arrays of panels along with other energy sources (eg shared hydro, wind turbine or back-up generator) provide the power source. The individual 12V or 24V battery banks can also be boosted with their own dedicated solar panels.

A Microgrid can mean more effective outlay of capital through shared resources, greater overall efficiency by better utilisation of available power and greater freedom of choice with such things as placement of solar panels (eg if dwellings happen to be in shaded areas).

Public and Private Interests

One big advantage of a microgrid system is sociological. There is a clear interface between the microgrid which would typically be in public control (village council, body corporate, company, etc) and everything on the other side of the DC/DC converter could be private and run without reference to the operation of the microgrid. The consumer has free choice of earthing, voltage, amount of storage, whether to have an inverter, private generation capacity, or co-generation. Any consumer cannot exhaust public stores of power or have it entirely to themselves. It can allow any consumer to use what is surplus to requirements of other consumers.

The RPC Microgrid

The RPC microgrid is designed for 100 volts DC and to transport average rather than peak power. Also it has quite relaxed voltage constraints, remaining functional for levels between 70 and 130V DC. Wires can be sized at a compromise between power wasted and capital invested. Peak power is supplied by local batteries. If the grid is powered from renewable energy sources, local batteries can supply the loads during periods of low wind or sunshine.

What the Voltage Converter Does

DC/DC converters are used in computer power supplies, optimisers, LCBs (pump maximisers), and some inverters.

Specifications

- Power shared between consumers;
 - Will operate with the line between 70 and 130 volts;
 - Short circuit proof;
 - Protected against reverse polarity of both battery and distribution line;
 - Input/output isolation to 5000 volts;
 - Adjustable regulation of battery charge;
 - Will run without a battery;
 - Will deliver amps into a battery which is flat;
 - All day efficiency above 80% (as against peak efficiency);
 - Integral voltmeter and ammeter;
 - Lightning resistant;
 - No holes in the case (vermin proof);
 - 12 or 24 volt models available;
 - 10 amp charge rate at full line voltage;
-

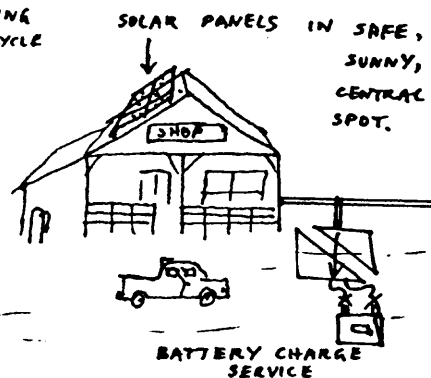
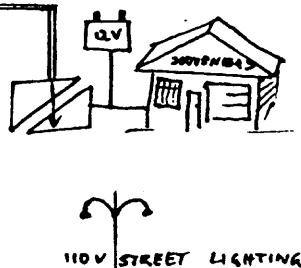
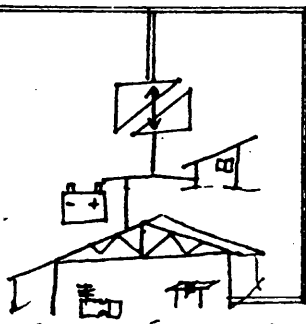
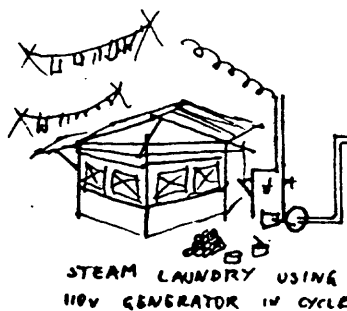
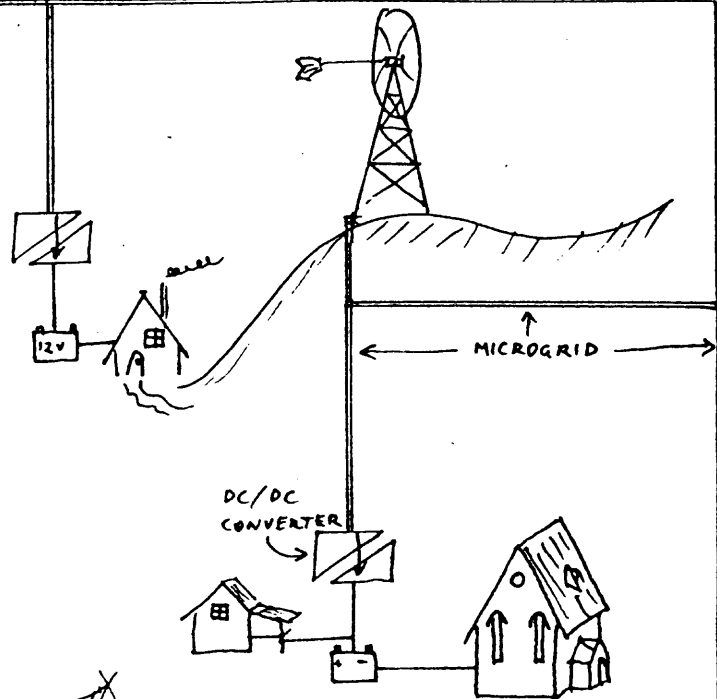
Development of Microgrid

After experience of running grids on 32V AC, 60V DC, 100V DC, and 240V AC we have decided that 100V DC is the best standard because:

- it suits transistors well;
- the voltage is high enough to keep wire size reasonably small;
- it is covered by Extra Low Voltage wiring standards; and
- being DC it is far easier to feed power into the grid without worrying about phase or stability.
- Faults do not take out the whole system. They simply isolate sections of it;
- Fault finding is easy;
- Alteration is easy, and
- Expansion is easy.

A disadvantage of DC is that transformers cannot be used to simply convert voltage up and down again to transmit power long distances.

This has now changed with the advent of modern power electronics and we now have the DC/DC converter which is the equivalent of the transformer, but can actually do more because the ratio of input to output voltage is not fixed and can be continuously varying according to requirements. Behaviour under fault conditions can also be configured so that the system is self managing.



110V WORKSHOP GENSET KEPT LOADED BY A GRID

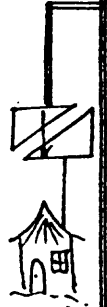
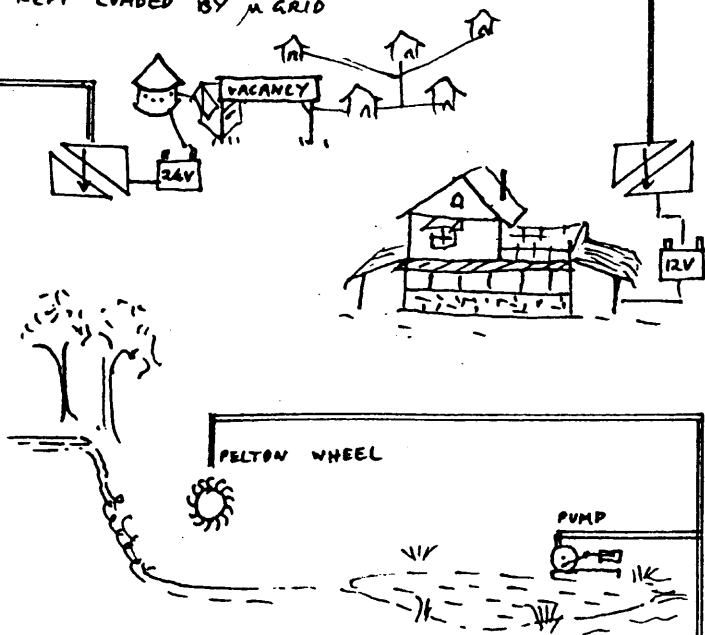
Energy Sources and Locations

Methods of powering a 100V microgrid include arrays of solar panels, a 110 volt generator, 110 volt version of RPC micro-hydro unit, 110 volt wind turbine, a rectifier from a bigger minigrid, the mains grid, or any combination of the above! Note that some of these generators may need a linear shunt regulator to clamp the voltage at 140 in the event of production exceeding demand. This could be a load such as a hot water heater. The geographical layout of the power sources/loads is flexible to suit the site, up to about 2 km.

The loads, as well as the points of generation, can be anywhere required as long as the conductor cross-section is appropriate to the current flowing in that section of the grid. This is one of the key practical advantages of the system.

Disadvantages of AC distribution

The mains power in eastern Australia is an example of a very large AC grid. Such a grid must be sized to supply peak loads to remote areas with 5% voltage tolerance. This means it uses very thick cable, very high voltage, and lots of capital outlay.



Possible Energy-related Scenario's:

A:

- Small town – app. 5000 pop. – isolated, - however road / track communications
- Farming, some small hand-manufacture
- Semi-arid dry-land area / low rain
- River flows app ½ year
- Fields higher than river
- Adequate but limited deep well year-round water supply
- Low wind speed area
- Suggest solutions for low-cost energy, power, construction and transport.

B:

- Smaller city – pop. App. 200 – 300.000 - Province capital
- Tropical area
- Good sun and rain
- Road and river communications – 500 kms to capital city and export harbour
- Moderate-Low wind speed – inland area
- Large local trade and semi mono-culture agro-export
- Small local production – metal industry and agro industry
- Suggest solutions for low-cost energy, power, construction and transport

C:

- Refugee-camp for 20.000 => ½ million refugees in South Eastern Europe / CIS – following war type situation – now quiet. – with reasonable transport communications
- Continental climate
- Urgent need for hospital
- Urgent need for transport
- Urgent need for construction
- Lack of all material needs – plenty of local refugee manpower.
- Suggest energy, power, construction and transport, => future possibilities / work opportunities

D:

- Refugee-camp for ½ million refugees in Africa
- As above.
- 1: - Arid area 2: - Tropical area