The Danish Model :

A Relevant Approach For

Developing Countries ?

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APPENDIX:

1.0: Introduction:

It is widely held that economic development in many so-called developing countries, has not in reality, taken place. It is likewise noted that increased environmental problems are arising in many countries, and not only in developing countries. All evidence points to the unescapable fact that the planetary biological-chemical/physical life-support systems/conditions for human existence are in the process of being seriously undermined.

And yet human [economic] development is an unescapable fact. Are solutions available to combine this development, in such a way that the very basis for life is not too seriously disturbed. It is the theme of this short paper, that perhaps [and yet perhaps not so unusual], part-solutions can often be found in unlikely places, - by a study/re-study of certain development traditions in other countries that hitherto have been largely overlooked.

It is today normal practice when undertaking a course of -" development studies ", that a student will examine relationships concerning peasant farmers in Central America, or anthropological/organizational problems concerning fishery in Sri Lanka, etc. Few consider how one's own native area developed, and if there are relevant lessons to be learnt, and applied.

It is my belief that there are perhaps some solutions to some of the above global problems. Evidence indicates that development of de-central access to renewable energy and power technology, will greatly contribute to local empowerment. This local empowerment can only increase participation and cooperation, - contributing to the prevention of over-extraction of the local resource base, - increasing local living standards.

It should be strongly emphasized, that there are few areas of the planet, where renewable energy supply solutions are not feasible. It is however, a question of which technology or technologies is/are the most suitable, - combined with local knowledge, -
[also a highly relevant function of availability and price].
Certain technologies may perhaps be seen to be the optimal, but due to high-price are in reality non-available, certainly to those who have perhaps the greatest need.

Extensive and personal field experience in different countries, suggests that a careful study of Danish historical experience, may indicate certain socio-industrial and business development possibilities in de-central energy-supply/end-use, that may prove capable of replication in other countries, - that perhaps on first consideration would seem greatly dissimilar.

The successful Danish historical experience indicates that the dissemination of energy technology was effectuated by a combination of the above mentioned socio-industrial tradition combined with local enthusiasm and a strong desire to experiment and learn, - driven by a real need [resulting from energy/environmental necessity], under a favorable political umbrella and protection. All of which, resulted in a dynamic popular social and business environment, with as is well-known, at present app. 70% of the world market for wind-energy transfer machines, [wind-turbines].

If there are possible/potential solutions available - why are these not being effectuated on a massive scale ? I do not believe that there is such global ignorance of the importance of renewable energy and power technology as is often commonly claimed.

As the phrase says, - "The problem gives the solution", so the problem, and the perhaps thereby given solution must therefore be: -

What measures or steps can be taken to <u>enable</u> possible solutions to be - <u>implemented, and disseminated.</u>

It is the purpose of this paper to attempt to further illustrate some of the relevant inspirational sources for this Danish development, and to perhaps suggest certain possible methods to enable and ensure successful transfer of the application of some of these methods.

Of necessity, it is unavoidable, to discuss, comment and consider certain aspects of specific technology, in both historical and present-day context.
[Likewise kindly consult the Appendix for further information].

2.0: The Danish Model:

- A relevant approach for development?

Modern management studies reveal major transformations in organizational structures in most industrialized western countries. The Ford-Taylor model [1] is being replaced by flexibility and rapid adaptation to change. " Factories, thus became a collection of rather small mini-factories, organized internally to create a continuous flow through different forms of manufacture ". - " Thus factories have been transformed into production laboratories ". - " Danish factories introduce CNC-based technologies at the factory floor, without elaborate hierarchies of planners and programmers ". [2]

" Looking into their internal organization, these enterprises [The large Danish industrial firms of Burmeister & Wain, Sabroe etc. from 1900 onwards], exposed their true identity: a conglomerate of smaller craft shops working together in a pattern much more similar to that - of a building site than a mass production plant after principles which were later to be completed by Ford ". [2]

" Danish skilled workers could build a ship or a huge marine engine without being subjected to control and coordination by large bureaucracies as in other countries ". [3]

" The educational system of artisans thus did not only shape industrial organization within big enterprises, it also determined their comparative advantages ". [2]
These transformations are most noticeable in Denmark - [4][5], now a world-leader in - many of the most important future-relevant technologies.

[1]   Ford model - the technology of mass-production using the moving assembly line. Each worker carrying out a repetitive job function.
Taylor model - time/motion studies leading to the development of piece work for production increase.

[2]   Technological Innovation and Organizational Change. Kristensen, [& Borum eds.] Denmark [DK] 1989 87-7034-252-0 [see also Karnøe's paper in same book].

[3]   Dansk Teknik. Lichtenberg   Copenhagen DK 1942.

[4]   Denmark; - lacking traditional raw-materials, with a history of very severe energy - ecological/economic disasters, the two most well-known and relevant being the energy crisis in the 1600's - ["small ice-age" - 1550-1850], and the 1970's.

[5]   Skov, Læ og Klima. [Forests, Shelter-belts, & Climate] C.F. Jensen DK 1951 & 1960
The Danish Revolution 1500-1800. Th. Kjærgaard Cambridge Univ. Press UK 1994   0-521-44267-2

The term Kristensen uses - " Production Laboratories ", is an adapt expression. This is likewise reflected in Peter Senge's choice of title for his book from 1990: -

" The 5th. Discipline,-The Art and Practice of the Learning Organization" or, "The art of seeing the forest and the trees".

Senge's thesis is that for new technologies or new " breakthroughs " to occur, certain " component technologies ", converge to give a synergy effect to existing structures that empower/enable potential learning organizations:

1: Systems thinking - to see through complexity to underlying structures generating change.

2: Personal mastery - discipline of continually clarifying and deepening our personal vision, and of seeing reality objectively.

3: Mental models - how we understand the world, and how we take action.

4: Building shared vision.

5: Team learning.

" Systems thinking is the fifth discipline. It is the discipline that integrates the disciplines, fusing them into a coherent body of theory and practice ". Or how to distinguish high, from low-leverage changes/possibilities in highly complex situations.
P. Senge USA 1990. 0-385-26094-6 pages 5-16. & 128.

2.1: The La Cour Inspirational Tradition:

Denmark's Edison - Poul La Cour, born near Æbeltoft in 1846 - died in Askov 1908, internationally famous as the pioneer of both the theory and practice of large-scale de-central wind electrical power generation and co-generation systems.
Poul La Cour's theoretical writings on wind-energy remained unsurpassed until the works of Betz and Hütter in the late 1920's and 1930's.

The Danish State in a most rapid administrative procedure, - granted finance for the establishment of a " research station for windmills " at Askov in Southern Jutland.
In 1895 La Cour's wind mill was not only supplying electricity to the small town of Askov, but was also using electrolysis to produce hydrogen for lighting purposes.
[a technology that even today amazes scientists, technicians and politicians].

A so-called combined cycle power station was established in 1902 which functioned until 1958. [6] In 1903 the Danish Wind Electricity Society - DVES, was established.
After La Cour's death in 1908, his yearly 4 month courses for rural electricians started in 1904, were continued by his colleagues. The 1910 course study schedule was from 8 AM until 6 PM - 6 days a week for 3 months. The students had the following backgrounds: 7 had previously worked in machine shops or with blacksmiths, 4 were farm workers, 3 had worked with traditional wind-mill builders, one was a former engineering student, another a dairy technician, and a joiner/cabinet-maker.

The subjects taught were:
- Physics - Chemistry.
- Electro-technology.
- Mechanical physics and the theory of machines.
- Mathematics and arithmetic.
- Free-hand drawing, draftsmanship, geometry and projection.
- Danish and German.
- Bookkeeping.

The course ended with a practical project. [7]

Courses were held until 1918. Despite great demand and success, they were finally " forced out into the cold ", by trade-guild organizational resistance concerning status and qualifications of urban electricians. - However, in 1919 the official commission for electricity supply in Opland Fylke in Norway requested places for several students. [8]

[6]   Combined-cycle; f.ex. combining a wind-mill/wind-turbine with a liquid fuel engine - powering a generator.

[7]   Ørebæk Electrical Works was taken under contract:
- Power Station with 8kW. dynamo.
- Control -boards, switches and systems.
- Errection of transmission-net; - 2750 kg. of wire/8800 meters in length.
- 200 lamps and 9 electric-motors installed for the consumers.

[8] Forsøgsmøllen i Askov, [Experimental wind-mill at Askov] H.C. Hansen, Kolding Denmark 1981.

One of the students from the first short rural electrician course of summer 1904, was so-called " Electrical Engineer " J. Juul, - later employed by the Danish generating and supply company - SEAS. Juul's technological level at the end of the 1950's was so advanced that he was only surpassed many years later during the 1980's.

Juul is remembered for the design and construction of the 200kW. " Gedser Mill", the world's first modern, reliable wind-turbine. In operation from 1955 - 1967, and later from 1977, - operated under Danish & USA-NASA research contract.
[nacelle; - now at the Danish Electrical Museum at Tange Lake in Central Jutland].

3.0: The Re-discovery Period: [see this paper page 34].

During the re-discovery phase from 1968 - 1978, three unusual groups in Denmark, cooperated to lay the foundations of what has now become the modern wind-turbine industry, [and later in fact, - the entire Danish renewable energy industry]:

1: Alternative energy enthusiasts, grass-root groups / alternative “life-styler's”.

2: School teachers, Peoples' High-School teachers, etc.

3: Local small-scale machine shops and blacksmiths supplying agriculture.

With the development of glass-fiber technology in the construction of the " Tvind " wing, the avai8lability of simple electronic steering systems [developed by students from the Danish Technical University], and a favorable political situation. All components were available for a synergy effect enabling an industrial " take-off " to be made. [9]

[9] F.Ex.
A small 20 - 30 kW. Riisager-type wind-turbine, with wooden blades similar to the Gedser-Mill design. =>
Add glass-fiber blades, and simple electronic steering systems, =>
thereby giving, a reliable, cost-effective and marketable wind-turbine. =>
Resulting in the large-scale California sales-adventure.

4.0: Hetzler's Theory of Socio-technics:

Professor Stanley A. Hetzler in his [in western countries], overseen book,- " Applied Measures for Promoting Technological Growth " USA 1973, 0-7100-7502-2 - has as his theme the role of " Socio-technics ": - This is the belief or understanding that:

" technology is a social form: a body of knowledge; - a set of attitudes and habits in the population, and a method of organization for production ". [page 10]

" A changing technology inevitably forces change in a society's attitudes and values. It is conversely held that: Attempting to promote technological advancement by beginning measures which are intended first to instill the appropriate attitudes and values will avail little or nothing ". [page 3]

" A massive indoctrination of a population in power technology will lead a society into sustained technological growth within 35 years, or a trifle short of 2 generations ". [page 93]

A key remark is his observation, " A new tool simply brought in with the expectation that the superiority of its characteristics will make itself manifest, and the device is " left to demonstrate itself ", - it will go unused. Each culture has its particular points of emphasis and it is at these points that innovation is most likely to occur ". [page 134]. [10]

The often used, - classic example of the correctness of Hetzler´s above statement, is the example of Tibet; The most vital function in Tibet was spiritual duties and contact with the eternal; - leading to mechanization of these functions, - with the prayer-wheel.

[10] For a comprehensive theoretical - but less programmatic discussion, with many actual and relevant illustrative examples - consult: " Diffusion of Innovations " E.M. Rogers USA 1962/95 0-02-926671-8
For a many thousand-year historical perspective ; -
Guns, Germs and Steel. Jared Diamond Jonathan Cape London UK 1997 0-224-03809-5
Also consult: - The extensive & useful discussion of transactive/innovative planning for development ; -
Retracking America. John Friedman Anchor Press/Doubleday New York USA 1973 0-385-00679-9

4.1: The Role of the Innovator - Entrepreneur in the Development-phase:

Both Hetzler and Karnøe discuss the relevance of Schumpeter [1911/34 and 1939 and 1942] and the theory [and place], of the innovator-entrepreneur in industrial/national development, and the thereby following discussion of the real dynamics of economic and technological development.

[Schumpeter's influence was most noticeable in Japan and the SE Asian countries in the 1930's]. [11][12][25]

4.2: Top-down vs. Bottom-up Praxis-approach:

The case presented by Karnøe [note 2 & 12 & page 26 of this paper], in his analysis of the development of the Danish wind-turbine industry is most convincing, - although almost completely ignored by practitioners of development studies. The success of the Danish entrepreneural wind-turbine industry is the exact opposite of the development efforts made by the USA and West Germany.
[In both these cases vast state funds were spent to develop large-scale so-called power station size Mega-turbines, that is wind-turbines with a capacity of; -
800 kW. to 3 MW. - with a complete lack of success].

This approach was based on what is called a top-down approach, while the Danish development was based on a bottom-up strategy, as previously illustrated. One must however note that the favorable Danish political situation, enabled the establishment of the " Wind-testing Station " at RISØ, - at first staffed with a couple of young engineering graduates, in a far corner of the Danish atomic-energy research station at RISØ. [now the world's most important testing station for wind-turbines].

[11] Michael Porter in " The Competitive Advantages of Nations " UK 1980/90 and " The Technological Dimensions of Competitive Strategy " UK 1983, has further developed the Schumpeter tradition of the innovator-entrepreneur.

[12] Devendra Sahal however, in his paper " Technology Guideposts and Innovation Avenues ", - Research Policy USA 1985, 14 (2) - [see Karnøe 89], & [Karnøe 91], discusses the influences of structural innovations, or as later described by Senge - " component technologies ".

RISØ played a vital coordinating role in the " sharing " of ideas, and in the supply of engineering suggestions/advice, [statics, aerodynamic forces etc.], to the more unsophisticated machine-shops, [f.ex. - Bonus produced irrigation systems, Nordtank produced metal tanks, for transport of liquids, and Vestas produced agricultural equipment - farm trailers etc.].

However the success of the Danish wind-turbines was precisely in their general lack of sophistication, and their construction's massiveness. All factors contributing to reliability and therefore real cost-effectiveness,
[as demonstrated in the large-scale Californian tax-avoidance investment purchases of the 1980's].

5.0: The FOT - Concept:

Are there usable operative lessons for other countries in the above mentioned factors ?:-

A: The Danish socio-educational tradition, and the La Cour inspired educational/praxis approach to de-central renewable energy development. [13]

B: The thinking behind the concept of the " Learning Organization " - that is; - systems thinking. [14]

Following the thinking of Hetzler and others, I suggest that an effective understanding of the reality of the interconnection of these two concepts should result in what I have previously called " FOT " - Future Oriented Technology.

[13][14] See this paper page 3. See also; - " Technology & Organization." H. Scarbrough & J. M. Corbett Routledge UK 1992 0-415-05941-0 .
I prefer to use instead of the term/terms " system thinking ", the expression - T D [D] I S A - Total Dynamic [Dialectical] Integrated System Approach. I believe that the use of the more complex expression demonstrates/implies the more complex, involved/integrated and relevant biological and chaotic approach to the reality - of the " Real World ".

The FOT-concept is based on three main factors:

1: Education; basic-knowledge of science-technology, both specific and general.

2: " Research ".

3: Production.

6.0: The Growing NEED [and request] for the Danish De-central Technological Know-how Approach:

It is a global necessity that humankind is enabled/empowered with the ability to work today, - to fulfill the needs of tomorrow. There is a general demand from most developing countries that the technologies and production know-how of de-central energy technology be freely transferred. F.ex. - This was a salient part of the Final Declaration from the Small Island States - participating and following the UN - Social Conference in Copenhagen March 1995. [15]

Likewise at the UN Climate Conference in Berlin, a month later in April 1995, a list of " 10 Key Demands " - was signed by all relevant German NGO's: -

§ 2. The support and broad introduction of renewable energies.

§ 9. Environmentally sound technologies must be supported. The transfer of new environmentally sound technologies to developing countries has to be guaranteed.

[15] § 4. The massive transfer and adoption of ecologically-safe and sustainable methods of power generation for all nations, including the use of renewable energy sources where available and appropriate, such as: solar, wind, bio-mass, thermal, and hydro-electric.

§ 6. -- technologies that are now in use in certain developed countries for water- saving must be shared as an absolute priority.

INSNI - Copenhagen 1995.

I fully agree with the then Danish Minister for Development, - Helle Degn, in an interview given at the UN Conference on Population in Cairo in September 1994, -
[in translation]
" If we cannot give them [people in developing countries] development possibilities, then they will start to move, and one cannot blame them. The Hunger-March has started ".
Politiken newspaper, Denmark 9 Sept. 1994. [16]

Denmark is indeed the leading country in most future-relevant renewable energy technologies [wind, has been mentioned, but also bio-mass, solar, and wave-power]. Yet how has Denmark administered these talents/ " pound of flesh ". Where are the factories or production systems for energy-transfer equipment in developing countries ?

There is Danish production under joint-venture/DANIDA form, of wind-turbines in India, and in China. In the ASEAN area, Danish business was not interested in establishing production. In the former CMEA countries, in spite of many requests, - no production.
[In the Ukraine production has commenced of a not-so reliable US wind-turbine -
The US parent company has now gone into liquidation and the assets are in the process of being sold - [April-May 1997].

Large Danish sales have been made in the USA, India and W. Europe. [App. 60-70 % of total world production].

6.1: Danish Developmental Constructional Constraints:

There are several problems involved in this discussion:
A: Danish DANIDA cooperation limitations.
B: Danish IFU and IØ limitations.
C: Size and capacity of Danish energy firms/enterprises.

Ad A:
The Danish state cooperation organization - DANIDA, has chosen a strategy of assistance to a defined/limited number of countries called - " Program-cooperation

[16] Hunger March refers to - "The March", a BBC-TV drama future documentary from 1990.
A copy is available for loan from Mediateket: Fax +45 3315 6243 E-mail <ms@ms-dan.dk>

countries ", - instead of perhaps the more relevant [intelligent ?] approach of cooperating with other countries in the areas in which Denmark has specialized.

An OECD-DAC report: " The manner in which Danish development-aid is carried out, and the following results, can contribute to dispel confusion and cynicism concerning the role of aid and it's effectiveness " [17], - would appear to make everyone happy and sweep any existing problems under the available carpets. Further reports from external consultants however [18], clearly demonstrate that; in spite of clear Danish parliamentary directives DANIDA has consistently failed to deliver.

" No attempts to include energy conservation and energy efficiency in Danida's support to the energy sector in either Nicaragua or Burkina Faso were identified ".
[[18] vol 1. page 63]

" Sustainability issues in the energy sector have been manifested primarily in terms of technical, managerial, and financial concerns and not environmental considerations ". [[18] vol 1. page 64]

There is unfortunately no definition of the use of the term " technical ", in the report. The report names no examples of what it considers as the transfer of de-central environmentally sound renewable energy technology, apart from traditional support to Danish industry in the sale of wind-turbines.
[Normally it can be stated that it is not advisable for a developing country to directly purchase sophisticated large wind-turbines from Denmark, as the pay-back time for the investment would be too long, even though cost of de-central el. can be as high as, - $ 1 USD/kWh].

<u>Ad. B and C:</u>
Apart from DANIDA, there is another Danish semi-state organization concerned with financing projects in developing countries: IFU - Investment Fund for Developing Countries, and the IØ - Investment Fund for Eastern Europe, evolved from IFU in 1989. These funds were established with a transfer of a Danish special coffee tax from 1967 - 1978 - [further transfer of funds prevented by Danish membership of EU].

[17] Yearly Report - Danida DK 1995 [page 24, in Danish].

[18] Evaluation Report on Environment and Development Danida 1996 2 vols..

[field work was undertaken in 5 program countries - Burkina Faso, India, Viet Nam, Tanzania, & Nicaragua].

The purpose of IFU was set out in an Act of Parliament 10 June 1971 - " For the purpose of promoting economic activity in developing countries, IFU has been created to promote investments in these countries in collaboration with Danish trades and industries ".
However in the real world; - investments are mainly restricted to large-scale Danish joint-venture cooperation especially in agro-technology and brewing.

Investments in renewable energy-transfer machine production, are not capital intensive, but must be considered as long-term high-risk capital investments. Both factors which IFU/IØ is not equipped to cater to, as minimal investments required are app. just under $ one million USD's. [19]

Likewise the requirements for possible further financial investment from both the Danish and foreign joint-venture partners, effectively prevent the participation of the majority of Danish energy-transfer machine production enterprises, on a broader scale. [20]

[A typical Danish wind-turbine company will have a total staff of between 30-250 and a total yearly turnover of about $ 40-60 million USD's - the majority of wind-turbine production firms assemble components supplied by specialist contractors - tower, blades, generator, transmission, hydraulic steering, electronic steering and systems].

6.2: Quasi-NGO-type Danish State-financed Energy and Development Organizations:

Perhaps aware of the non-transference of renewable energy technology, strong Danish political support from the liberal Radical and moderate left SF parliamentary parties together with finance, has been given in an attempt to solve these problems. -
A Center for renewable energy was supported in Western Jutland, and despite seemingly intensive activity it is difficult for many to see any concrete results.

[19] F.ex. a turn-key project for the establishment of a complete production factory for solar collectors, using the most advanced and effective technology, in a Caribbean country, had a budget of under $ 450 thousand USD's, and this figure could have been reduced by 30-50 %

[20] IFU - is generally willing to be flexible on the issue of the minimal investment limits, - with renewable energy projects. However more emphasis is hereafter placed on the requirements for possible further financial inputs.

Following the UN Rio Conference in 1992, - the FEU - Forum for Energy and Development, was established under a DANCED grant, to act as an umbrella organization to cater to the Danish QUANGO/NGO's in their declared and presumed wish to incorporate environmental and renewable energy technologies.

Several interesting reports have been produced, including an interesting critical analysis and recommendations over MS-aid programs in W. Africa. [21] In the light of the demands from developing countries, and Hetzler's remarks on page 7 of this paper, FEU - although, a structure with possible considerable potential, cannot now be said to be responding to the real requirements. There are perhaps, too few people involved, many of whom wearing different inter-changeable caps. This is a very strong hindrance for new thinking, and genuine financial, democratic and transparent participation. [22][23][24]

7.0: The FOT-concept and the Joint-venture Learning Organization - " Production - Laboratory ":

If it is to be considered that the above mentioned combination of the " Danish Model " combined with the thinking behind the modern interpretation of the learning -

[21] Sustainable Energy Options in MS's Programs. FEU 1996.

[22] Pacific-Danish Environmental Educational & Action Program - Program identification mission to Cook Islands, Western Samoa & Fiji. August 1995. FEU November 1995.

[23] Three evaluation reports have been commissioned by FEU, Two semi-external - [a,b], and a rather critical semi-internal - [c]. The two semi-external reports are most interesting reading, and they are favorable towards FEU: [all in Danish].

a: Dansk Bistand til Bæredygtig Energiudvikling. CASA 1996.

b: Bæredygtig Energi i Dansk Udviklingsbistand. Rambøll 1996.

c: Evaluerings Rapport. FEU May 1996.

[24] For further information concerning developing countries own perspective of their needs/priorities, consult f.ex. :

a: Strategic Plan for Scientific Research. Burkina Faso 1995.

b: Programa de Desarrollo de las Fuentes Nacionales de Energia. Consejo de Ministros Cuba 1993.

c: Rethinking Development Assistance. K.Kozloff World Resources Instute Washington DC. USA 95.

organization [FOT], is a relevant approach. There is then given the problem of transferring and " developing ", the FOT-concept in the context of a developing area. Educational systems, combined with production are typical in the education of engineers and apprentices in N. Europe and the former CMEA countries, [Anton Makarenko - 1888-1939, should perhaps be mentioned], but since La Cour's day have not been considered in the context of energy development and the diffusion of production know-how. Schools and colleges, even in N. Europe, much less in many other countries, are not normally considered as factories, with the thereby following industrial-type budgetary requirements.

Few developing countries have the budgetary reserves to have so-called adventure-capital to invest in renewable energy transfer machine - production organizations, - even though many are aware of the necessity.
In other words: - learning organizations must be re-examined in the light of possible un-orthodox business-type joint-venture structures. Finance and technological inputs, and inspiration, - must come from donor countries, to be jointly combined with local know-how [knowledge] and enthusiasm.

The previously considered two widely different concepts:

A: Production => work for wages.

B: Study => status => administrative employment. - must be re-considered.

A new concept of cooperative empowerment/teamwork; -

[that is the concept of participation <u>must be moved on</u> to the role of partnership - that is participation in the whole process]

Combined with cooperative dynamic entrepreneurial drive; -
- must be cultivated. [25]

[25] For a full discussion, consult; " Appropriate Technology " Nicolas Jéquier [ed.] OECD Paris [Enlarged report of a conference held in 1974] 1976(74) 92-64-11492-0. For a critique of the individual entrepreneur, consult - " Sociology of Development " Andre Gunder Frank Zenit Press Sweden 1969.

Following observation and experience, it is very clear that actual financed trial studies must be carried out of the: -

FOT- educational => training => production => dissemination concept.

Studies must be taken concerning legal and financial boundaries and advantages. The structure of ownership being in the hands of a humanitarian fund-structure must be further investigated. Such a construction enables a possible donor country to retain budgetary support and control. As previously mentioned, the finance - as cash-required, for energy transfer machine production, is limited and yet large financial sums must exist as bank-credit for LC's for transfer-payments for component supplies.

7.1: Successful Marketing [Dissemination] requires Local Participation - [Involvement] in the Whole Process:

And in marketing the possible products, these too have unique qualities that pose difficult financial problems. Renewable energy transfer equipment is mainly characterized by high initial sales cost => low running cost.
[Although the cost of de-central energy [where available] in many areas is app. -- $ 1 USD/kWh. - usage is often made of liquid-fuel generators, with high running costs, and limited life, instead of the usage of other more suitable technologies such as solar or wind].
Marketing operations must take these factors into account. Arrangements such as demonstration projects, subsidies, possible financing of leasing/sales arrangements, and regular and extra maintenance schedules must be taken into account.
In other words, a market must be " cultivated ", and developed in coordination with the local-defined; - de-central needs.

7.2: Local Production ? - Of what - by whom and for whom:

" Graduates ", from the learning organization, must be trained and be enabled to establish themselves as entrepreneurs in local areas.

The efforts made in Burkina Faso to disseminate solar-cooker technology have been unsuccessful, but were local rural women involved in production ? - Were local handicapped ? - NO !

Not only could the particular chosen technology be criticized, [a parabola-reflector-type. - The Indian/Swiss - Ghosh type or the US - Maria Telkes design would be more suitable]. But to even contemplate; - that the introduction of a new and strange technology involving radical changes in women's household labour chores/duties could be introduced under a " top-down approach ", without women [the principal users] having a stake in the operation; - can bring nothing but failure. [26][27]

The technology of the so-called gasifier thin sheet-metal cooking stove [gasifier technology was used to power 50% of all trucks in Europe during WW 2. - using small blocks of wood, - a present-day useful technology in de-central combined-cycle heat and power generating stations], with a 50 % saving on fuel use, and with the ability to burn other material such as grass, - is a relatively simple operation for any tin-smith. A local production at a larger village level [or small town], of some; - 2 - 6 units/day/person, should present no great or unsurmountable problem.

Water pumping is also a great problem in many areas; - yet again, - the simple technology of the hydraulic-ram pump is available. [A 200 year-old, non-moving-part pump technology].

[26] " The technology has run into difficulties, concerning the daily use. Women in a large project, soon lost interest in solar-cookers, because they demanded a change of routines, and that no user-instruction had followed with the cookers ".

" Energy and Development " no. 1. 1997 FEU DK.

[27] "Apparently powerful interventions, such as the provision of improved cooking-stoves and planting trees will not have a major impact as long as large distortions in energy use and supply exist. They will not work at all unless, users are involved from the beginning in defining the problem, through to the development and application of solutions".

" A reduction in the amount of external energy available to a household translates into pressure on the energy levels of women themselves ".

Changing the Boundaries. Janice Jiggins Island Press Washington DC USA 1994 1-55963-259-3 pages 100-101

8.0: The Importance of the Ability to See [and Understand - J.F.], both the Forest and the Trees: **[P. Senge - op. cit. p. 128]**

Following his return from Burkina Faso in 1996, the Danish minister for development Poul Nielson, on being asked; -

" Why no Danish DANIDA wind-turbine project in Burkina Faso ? " -
Replied; - That he had been informed by his advisers, that the wind regime in Burkina Faso was such that the installation and operation of Danish wind-turbines would not be a good,- paying investment. [28]

This could apparently be seen to be the correct answer. However the question must be asked; - were the minister's advisers aware of the possible alternatives in this particular technology ? - If not; - Why are they in a such a position that they are offering the minister misleading advice ?
[There is not only a Danish wind-turbine designed for de-centralized electrical power at low wind-speeds, but also, an Australian model for el. power generation under extremely low wind-speeds; - app. 2½ - 6 m/sec].

A modern Danish wind-turbine under average Danish wind conditions, produces electricity at a cost of app. $ 0.035 USD - $ 0.05 USD/kWh.
However; - it should be remembered that in many areas of the world electricity has a real cost of - $ 1.00 USD/kWh.
There is therefore more-than-enough room, for so-called, - " machine in-efficiency ", - real cost-effectiveness. [29]

As Jéquier concludes in his closing comments; -
" Appropriate Technology " - [I, would perhaps prefer the use of the term " necessary or correct or suitable - technology ",- if a term is at all required, - the use of the former phrase has perhaps unfavorable semantic tones]. - " If it is to succeed, must not only be competitive today, economically technically, and culturally, with existing technologies:
It must also have what might be called an evolutionary capacity. The problem is not merely to develop new technologies to meet an immediate need, but also to build up an innovative capability, or innovation system. What international technology transfers can do is to introduce new ideas, new forms of knowledge and new ways of doing things.

But what they cannot do [30], is to help build up within the importing country the entrepreneurial and innovative basis which in the long run will ensure the widespread diffusion of appropriate technology ". [25][31][32]
[Likewise consult; - Hetzler, page 7 in this paper]

9.0: Present-day [1997] - Preliminary-Conclusion:

It cannot be expected that a renewable energy-environmently-friendly - energy-transfer-equipment-production technology / learning organization / dissemination operation in any country can possibly be economicly viable during the first 2½ - 3½ years [and possibly even longer], of any operation. [33]

There is therefore an urgent need for " humanitarian-type " foundation structures, functioning as new-type joint-venture business-learning operations in various combinations of NGO's, [popular and transparent organizations], GO's and dynamic development-oriented private enterprise.

Financed [or part-financed], and supported with high-risk venture-capital and expertise, from a country with a " development - profile ", such as Denmark,
[or perhaps rather similar], - where this course of development has already been practiced with success.

In a certain respect Denmark must carry this problem, or assist in fulfilling this role.
I have difficulty in seeing other possibilities, - The Netherlands perhaps, or perhaps Sweden, or Norway ? - But could even a multilateral UN or EU program in this field be imagined without at least a large element of Danish " know-how " in an initial start-phase; - This would be most unlikely.

There are many, - I personally know many, - both veteran and young, - engineers, technicians and specialists, who look for opportunities to " participate " in the people-oriented processes similar to the previously outlined Danish -" experience ". [34]

How the Danish people and Denmark as a nation will react to this; - must we explain to our grandchildren. [35]

[28] Statement at a small seminar on sustainable energy in Danish development assistance, & presentation of [22a] & [22b] , on board the ferry-boat " Sjælland ", 26 March 1996.

[29] Paul Gipe, in his essential book, - on business considerations of wind-power:
" Rule nr. 1. - for wind-turbines, - They must be reliable.
Rule nr. 2. - They must be cost-effective. Efficiency is important, but it is not the sole criteria, for judging the performance of a wind-machine ".
Wind Power for Home & Business Paul Gipe USA 1993 0-930031-64-4 pages 73 and 76.

[30] That is: "Be easily transferred and create an environment for innovation". Dolberg 1997.

[31]

	Criteria of Competitiveness of Appropriate Technology:	
	Competitiveness vis à vis traditional tech.	Competitiveness vis à vis modern tech.
Engineering efficiency		
Economic viability		
Social acceptability		

Jéquier OECD 1976. [25]

[32] Appropriate technology, should be neither a second best, nor an outmoded technology, but a solution that fits best the local requirements. A successful innovation policy, would probably include some of the following 4 elements:

A: Reviving an old technology.

B: Adaptation of a current technology.

C: Inventing new technologies.

D: Improving a traditional technology.

M.M. Hoda. AT Development Unit, Gandhi Institute of Studies, Varanasi India. [See Jéquier 25]

[33] See CASA report 1996 [22a], page 41 for extra commentary.

[34] See Pretty and Chambers's schematized new parameters for behavior, - page 21.

[35] Interesting parallel comments have been made by " Danish-Grand-Old-Man " - Eng. Haldor Topsøe DK 92 87-12-02318-3 " Horisonten Rundt " [All around the Horizon - in Danish].

EXTRA COMMENTS AND NOTES:

Despite many requests, global international mass-production and dissemination of sol-cells for electrical power generation has not yet occurred. Sol-cell production is at present a virtual quasi-monopoly production by Siemens, and some production from Japan. [36]

[36] EC study report on Japanese Alternative Energy Program.
Otto Leistiko DTH [DTU]. DK 1992.

[37] A promising Danish development in sol-cell technology, has recently ceased due to bankruptcy, - [Sol-El.].

[38] 400 thousand systems are at present installed world-wide. Price per unit:
$ 7.15 USD/Wp. - $ 23 USD/Wp. [Watt-peak]. - S.E. Ladefoged FEU. 1997.

[34] Changing professionalism:

	FROM THE OLD PROFESSIONALISM	TO THE NEW PROFESSIONALISM
Assumptions about reality.	Assumption of singular, tangible reality.	Assumption of multiple realities that are socially constructed.
Scientific method.	Scientific method is reductionist and positivist; complex world split into independent variables and cause-effect relationships; researcher's perceptions are central.	Scientific method holistic and post-positivist; local categories and perceptions are central; subject-object and method-data distinctions are blurred.
Strategy and context of inquiry.	Investigators know what they want; pre-specified research plan or design. Information is extracted from respondents or derived from controlled experiments; context is independent and controlled.	Investigators do not know where research will end; it is an open ended learning process. Understanding and focus emerges through inter-action; context of inquiry is fundamental.
Who sets priorities? Relationship between all actors in the process.	Professionals set priorities. Professionals control and motivate clients from a distance; they tend not to trust people [farmers, rural people etc.] who are the object of inquiry.	Local people and professionals set priorities together. Professionals enable and empower in close dialogue; they attempt to build trust through joint analyses and negotiation; understanding arises through this engagement, resulting in inevitable interactions between the investigator and the " objects " of research.
Mode of working. Technology or services.	Single disciplinary - working alone. Rejected technology or service assumed to be the fault of local people or local conditions.	Multi-disciplinary - working in groups. Rejected technology or service is a failed technology.
Career development.	Careers are inwards and upwards - as practitioners get better, they become promoted and take on more administration.	Careers include outward and downward movement; professionals stay in touch with action at all levels.

Source: Pretty and Chambers 1993 - quoted in " Regenerating Agriculture " - page 201.
Pretty UK 1995 1-85383-198-0.

See also: " Capitalism, Socialism & the Environment " Hugh Stretton [& Paul Streeten]
UK 1976 0-521-21057-7 [DK 1978 87-17-02280-0]

NB: " Absence of any awareness of alternatives makes for absolute acceptance of established theoretical tenets, and removes any possibility of questioning them ".
Robin Horton - African Trad. Thought & Western Science. - in " Africa " Vol. 37 UK 1967.
[quoted in David Dickson - " Alt. Tech. & the Politics of Tech. Change " p. 62 UK 1974].

Burkina Faso

As an integral component of a " total capacity enhancement " in the electrical supply of Burkina Faso, it is suggested that an alternative approach would be an advisable supplement. -
The implementation of the concept of the development, production and integration of FOT - Future Oriented Technology.

Due consideration should be paid not only to an integrated supply side management, but also to demand side management. For example effective electricity saving is more socio-valuable than mere increased supply. Water saving through the use of more efficient equipment saves electricity for water pumping.

It is suggested that it is vital that power production should be de-centralized as far as possible due to the high costs of grid extension.

It is therefore vital that a local industry or industries be established to produce power production [energy-transfer] equipment.

Such industries should be established on a small-scale basis founded on the Danish model.
A combined small production should be commenced as a learning/production training project. - The concept of the Learning Organization or the " learning by doing " - approach.

However it is essential that such an enterprise should be established as a legal production entity. That is a limited; - share owned company.

To ensure effective operation it is of course essential that both technology and funding in the vital start phase should be supplied from the Danish donor. However assistance is also required in the further, consolidation phase. Such assistance is best furthered by the use of a fund structure, thereby giving --
[as a theoretical example]:

Energy Company in Burkina Faso:

3 local organizations => 48 % - shares
1: Local small firm
2: NGO
3: GO

Danish side => 48 % + 4 % - shares

Social fund registered in Burkina Faso with 48% shares
4 % special shares freely given by Danish side to other different local NGO's, etc.

It is suggested that such an organization in the training/production start phase should produce energy production/energy saving equipment:

Hydraulic ram pumps
Solar collectors
Low wind speed sail wind mills
Low wind speed wind-turbines 4kW. & 11kW.

Following a consolidation phase it should then be considered, to produce larger wind-turbines - copies of the widely-sold, - successful & reliable Danish 1980's technology of 55kW. & 100kW. adapted for low wind speed.

Other technologies could also be considered:
Total water systems, toilets, shower heads, taps, plant-based water treatment systems etc.

Concerning: Technical - choice of technology.

Burkina-Faso lies mainly in a low-wind-speed zone, apart from a few special areas.
As the main difficulty at the present time is solving the problem of power supply in off-grid and de-central areas, the choice of technology must be strongly connected with the ability to pay for both the equipment, and thereafter the running costs/maintenance, or the purchase of the supply of power: In short; the total market situation. [This will be more fully elaborated upon in the next section].

The whole question of energy supply - energy saving is also a vital issue.
[Supply - End-use / Energy Service Concept].
It is no secret that large areas of the planet are also areas of low-wind-speed zones. It is therefore surprising, that at present, only two types of wind-machines specifically designed for electrical power generation under low-wind-speed conditions are at present being produced and marketed;
- the " Windflower " from Denmark, and the - " Survivor " from Australia. - [see annex].

The need in Burkina-Faso, as regards wind energy machines, - is for several different types:
1: Small wind-turbines [so-called micro-turbines] for agricultural use, powering electrical fences etc. - with a capacity from 60W. - 600 W.
2: Small wind-turbines for de-central battery charging, - capacity from 1.5 kW. to 4 kW.
3: Small wind-turbines for de-central power, - capacity 11kW. - 22 kW.
4: Reliable small/medium wind-turbines of 55 kW. and 150 kW.
[Danish types from the 1980's -- as also Iran has recently demonstrated with their recent purchases].
5: " Sail wind-mill " types as developed by the churches in Gambia should also be produced.

Concerning: Marketing and sales.

It is vital that sales must be made in the local currency - otherwise it would be impossible to realize any form of sales under market conditions.
However there are some further aspects that should be considered:
Any effectively managed sales organization would have no difficulty in selling at a price fixed in kind, - f.ex. in agricultural produce, such as coffee or bananas.

A cost-breakdown for a 4 kW. wind-turbine gives a necessary $ USD. import component price of app. $ 4-500 USD.

It would be naive to expect that a production enterprise could at once commence to assemble and produce wind-turbines for an expectant market. Of course the marked must be " cultivated " and developed.
A sales, and an erection and maintenance staff must be built up, this allows time for the correct procedures to be introduced, even though energy and enthusiasm are present.

The most effective marketing plan would be as follows:
1st: Micro-turbines.
2nd: Small wind-turbines, 1.5 kW. - 4 kW. units.
3rd: 11 kW. - 22 kW. units.
This would in addition enable the production technology to be completely mastered, in complete harmony with the market strategy. In other words, a step by step approach.

It is essential that other types of energy saving equipment be assembled, produced and marketed and sold.
It is necessary that the small staff of workers/tradesmen, and technicians be fully employed. This therefore means all staff must participate in production of different equipment during the initial start phase.
It is clear that such diversified production for sale would continue, at a later stage although in different job-shops.

<u>Budget input for proposed operation: Year 0 - Year 1½ [3 periods of 6 months.]</u>

A: [*] Contribution for establishment of proposed Fund in Burkina-Faso.	**$ 500 ,000.00 USD.**
B: Burkina Faso partners. This includes the different institutions as mentioned above, and also some form of " profit-sharing " bonus for workers/staff. Input as <u>equivalent</u>; - buildings, machine-tools, trucks, locally-found or produced material, labour salaries:	**$ 500,000.00 USD.**

<u>NB. - App. figures:</u>

Cost of import of components for small-scale assembly and production of wind-turbines.	**$ 50,000.00 USD.**
Import of components for solar-collectors:	**$ 50,000.00 USD.**
Import of glass for collectors and sol-cookers	**$ 50,000.00 USD.**
Factory training in DK, for solar collectors.	**$ 10,000.00 USD.**
Technical assistance from Denmark, - training in B-F.	**$ 25,000.00 USD.**
Danish Commercial and Technical Student Training Program in B-F.	**$ 30,000.00 USD.**
Transport costs in B-F. [Fuel/maintenance]	**$ 20,000.00 USD.**
Travel and transport costs in B-F. for personnel.	**$ 10,000.00 USD.**
Extra costs - app. 30 %	**$ 75,000.00 USD.**
Sub total:	**$ 320,000.00 USD.**
Salary $ bonus in first period - $ 80 USD /person/month Total staff app. 40 - 60	**$ 65,000.00 USD.**
[#] Subsidy to sales operation in first period.	**$ 80,000.00 USD.**

Total expenses in first period - app. $ 465,000.00 USD.

Expected sales income in first period. ---------

After 2 years of operation expenses and income are expected to balance, - "Breakeven Point". However in the short run it would be impossible to cover repayment of a cash outlay [over this period], of - app. $ 450-500,000 USD.

It is expected that there will be on hand the remaining app. $ 50,000.00 USD.'s in the fund construction, as a possible cash-credit in the expansion period following from the first 2-year start-up phase.

After 2 years of operation, and as the different aspects of the project are expected to be consolidated, a qualitative jump in technology should be made to construct 55 kW. and 150 kW. wind-turbines. Likewise assembly and sales of solar-cell systems should be considered, possibly in a joint-venture with Ghana, Zimbabwe, and South Africa.

[*] This could be a Burkina-Faso national contribution to enable the project to start. [Aid monies could be sought from Denmark, either before the project starts or while the project is under-way, - as a " help for self-help "].

[#] Includes funding for demonstration units, purchase assistance subsidy [as part of initial market-strategy], seminars, training, pr-material, etc.

<u>Annex - [as illustrations of possible technology production types/choices].</u>

1: 60 Watt micro wind-turbine, the MARLEC from the UK [also produced in Mongolia].

2: Australian-type low-wind-speed wind-turbines.

3: Danish low-wind-speed wind-turbines.

4: Indian/Swiss Ghosh-type solar-cooker, for tropical areas. Sales price app. $ 4 - 6 USD. [can also be made cheaper - $ 3 USD.].

5: USA-type gasifier cooker, - sales price app. $ 4 - 6 USD. A simple technology which offers a 50 % saving in fuel for household cooking use.

6: Hydraulic-ram pump for water pumping, - sales price app. $ 15 USD.

7: Gambian church " sail wind-mill ", - for water-pumping.

8: Solar hot-water heating systems.

9: Sale of water-saving devices [taps, shower-heads, toilets, etc.]. Construction of plant-based water-treatment systems.

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c: S. Houmøller E-mail - houmoller@dk-teknik.dk d: Bio-Raf, Bornholm Denmark.
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4: Prof. T. Reed, Bio-Mass Energy Foundation Golden Co. USA. E-m. ReedTB@Compuserve.com
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For Medium-size Systems: - "Danish Bio-Energi" Issue nr. 28/1996 p.10. - nr. 30/96 p.12. & nr. 32/97 p.10. E-mail - biopress@post4.tele.dk
- Prof. H. Stassen, BTG University of Twente Netherlands.
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- Dr. Bo Göhl FSP: E-mail - fspzim@harare.iafrica.com
- Dr. E. Murgueitio: E-mail - cipav@cali.cetcol.net.co
- Prof. Preston: E-mail - thomas.preston%sarec%ifs.plants@ox.ac.uk
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1: Prof. Thomas L. Crisman, University of Florida Gainesville Florida USA
2: Prof. P. D. Jenssen, Agricultural University of Norway E-mail - petter.jenssen@itf.nlh.no
3: Beth Josephson, Center for Rest. of Waters Falmouth Ma. USA E-mail - bjosephs@mbl.edu
4: Angus Marland, Watershed Systems Ltd. Edinburgh Scotland Fax: +44 [0]31 662 46 78
5: Alexander Gudimov, Murmansk Marine Biological Inst. Russia E-mail - vladimd@fifo.hsf.no
6: François Gigon, NATURA Les Reussilles Switzerland Fax: +41 [0]32 97 42 25
7: Carl Etnier, Stensund Ecological Center Trosa Sweden Fax: +46 15 65 32 22
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NB: It should be noted that a comprehensive multimedia6 program on renewable energy on 3 CD's, is issued by the Danish Technological Institute. E-mail - infove@dti.dk
- The Danish branch organization for heat and ventilation: CD - "Multi-Sol", showing mounting/assembly work processes for solar-collectors. http://www.vvsu.dk
- During 1998, a CD on access to wind-energy info. - should be issued under a common EU project, with as the coordinating Danish partner; - Handelshøjskole in Århus DK.
- A CD with a database on Renewable Energy is available from UNESCO-Publishing Paris.
- An energy/development CD-library is available from Belgium. E-mail - humanity@innet.be http://www.oneworld.org/globalprojects/humcdrom

Plus:

- Rainbow Power Company Catalogue, Ninbin NSW 2480 Australia. Fax: + 61 66 89 11 09.
- Catalogue from Real Goods Co. Ukiah CA 95482-3471 USA. Fax: + 1 707 468 94 86 E-mail - realgood@well.sf.ca.us
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Description	Speed knots	Mean speed knots	Beaufort force	MPH	km/h	m/s	Weather forecast
Calm	< 1	0	0	0.5	1.0	0.2	Calm
Light air	1-3	2	1	2.3	3.7	1	Light
Light breeze	4-6	5	2	5.7	9.3	2.6	-
Gentle breeze	7-10	9	3	10.4	16.7	4.6	-
Moderate breeze	11-16	13	4	15.0	24.0	6.7	Moderate
Fresh breeze	17-21	19	5	22.0	35.2	9.8	Fresh
Strong breeze	22-27	24	6	27.6	44.5	12.4	Strong
Near gale	28-33	30	7	34.5	55.6	15.4	-
Gale	34-40	37	8	42.6	68.6	19.0	Gale
Strong gale	41-47	44	9	50.6	81.5	22.7	Severe gale
Storm	48-55	52	10	60.0	96.4	26.8	-
Violent Storm	56-63	60	11	69.0	111.2	31.0	-
Hurricane	64-71	68	12	78.3	126.0	35.0	-

RELATIONSHIP BETWEEN GRIGGS-PUTNAM INDEX [G] & ANNUAL MEAN WIND SPEED [V] - IN m/sec.

G	V [m/sec]	MPH #	W/sq.m. *	Batelle Class
0	< 3	< 7	< 50	0
1	3 - 4	7 - 9	50 - 80	0 - 1
2	4 - 5	9 - 11	80 - 125	1 - 2
3	5 - 6	11 - 13	125 - 250	2 - 4
4	6 - 7	13 - 16	250 - 400	4 - 6
5	7 - 8	16 - 18	400 - 600	6 - 7
6	8 - 11	18 - 25	600 - 1600	7 - 9
7	> 11	> 25	> 1600	9 - 10

See also:
A: A Handbook on the use of Trees for Wind Power Po- ential. E.W.Hewson, Wade N.T.I.S. USA 1979
B: Siting Handbook for * Small Wind-energy Conversion Systems. [PNL-2521 Rev. 1.] Nat. Tech. Info. Service USA Dept. of Commerce Springfield VA 22161 USA
C: Wind-Atlas computer- program. RISØ National Laboratory Roskilde Denmark

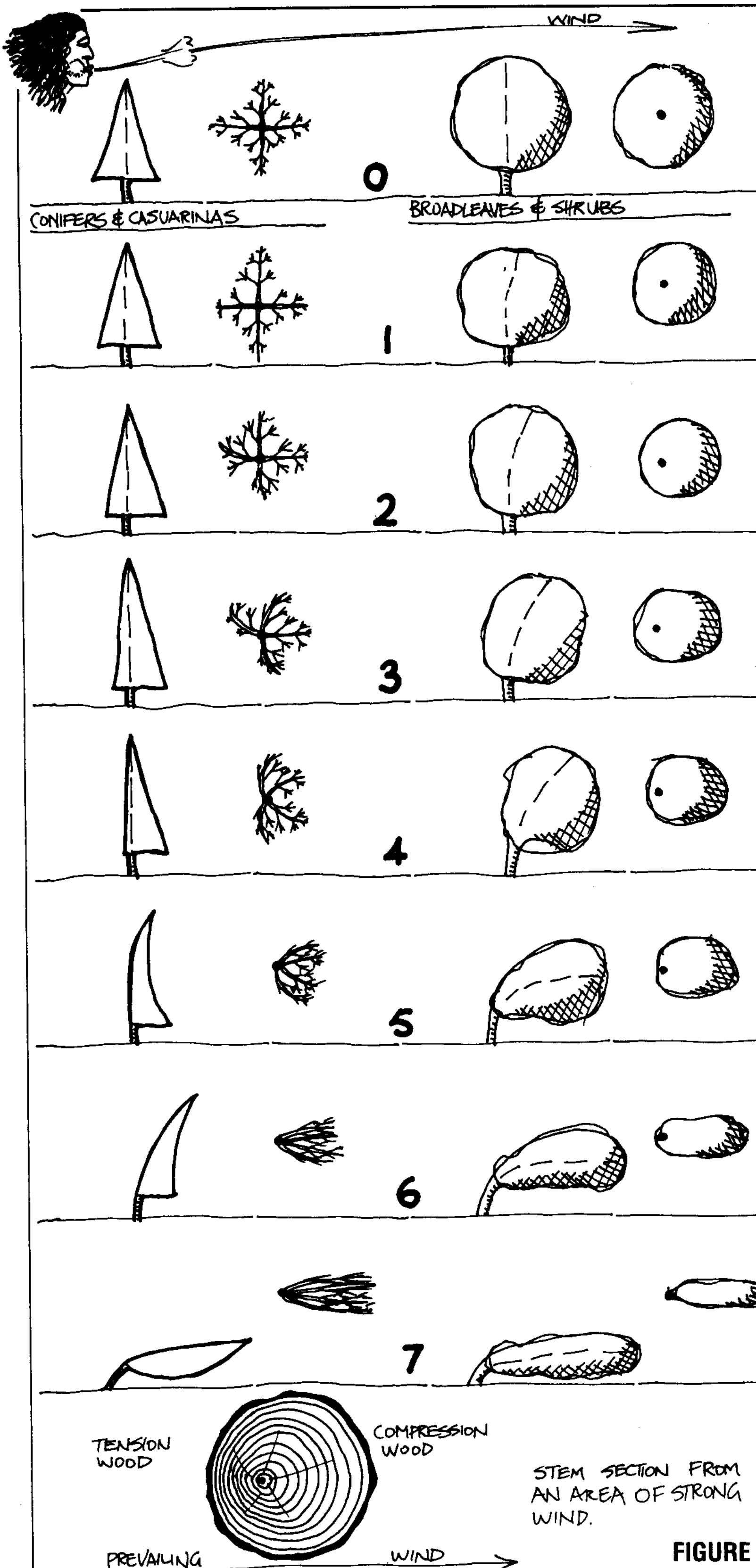
\# Measured at standard height of 10 m. [at 50 m. height => a: wind speed + 26 % b: energy + 100 %].

APPROXIMATE WIND SPEED ENERGY EFFECTS:

A: < 2.5 m/s => Slight effects, no damage to crops or structures.
B: 4.5 - 6.5 m/s => Damage to very susceptible species.
C: 9.5 - 12.5 m/s => Mechanical damage to crops, some damage to structures.
D: 15.5 - 35.0 m/s => Severe structural & crop damage. Damage to some wind-mill types & models.
Most useful wind-turbine electrical energy is produced in wind-sectors B. and C. -
However an Australian model can produce useful electricity at app. 2.5 m/sec.

REDUCTION OF WIND VELOCITY IN FORESTS:

Penetration in meters:	Remaining velocity in % :
30 m.	60 - 80 %
60 m.	50 %
120 m.	15 %
300 - 1,500 m.	Negligible wind.



0
NO EFFECT
No deformations of branches

1
BRUSHING
Branches or needles bent away from prevailing winds. Crown slightly deformed.

2
SLIGHT FLAGGING
Small branches bent. Tree markedly asymmetric.

3
MODERATE FLAGGING
Larger branches bent away from the wind.

4
STRONG FLAGGING
All branches swept to leeward. Tree a "banner".

5
PARTIAL THROW
Trunk bent to leeward but vertical near ground.

6
COMPLETE THROW
Trunk now quite bent to leeward.

7
CARPETING
Tree a creeping shrub–like layer of prostrate growth.

THE ABOVE EFFECTS ARE STANDARD FOR TREES NOT AFFECTED BY SALT, ICE, OR SNOW LOAD.

FIGURE 6.2
WIND EFFECTS ON TREES
As winds cross tree lines they are deflected in a new direction. Trees deform or "flag" permanently in prevailing strong winds and can be used to assess the effects of such winds; they form a site–record of wind history.

Chronology of Wind-turbine Development.

Period nr. 0 **Dutch type, F. Nansen, USA 1894**

Period nr. 1 **La Cour, Denmark 1890 - 1925. La Cour from Askov in Denmark, was the pioneer of modern large-scale wind electrical power generation. - 3kW.- 30 kW. [co-generation systems].**

Period nr. 1.5 **Lykkegaard, Denmark 30 - 75 kW. 1920 - 1945. Series-production period.**

Period nr. 2 **F.L. Smidth, Denmark [60 - 70 kW. with effective gear-box developed from cement-ovens], Hütter in Germany, Darrieus in France, Putnam in USA, and especially, very large-scale mass-production in the USSR. 1930 - 1945. [small wind-generators for battery charging, mass-produced in USA].**

Period nr. 2.5 **J. Juul, Denmark 1950, 13kW.- 45 kW.**

Period nr. 3 **J. Juul, 200 kW. Gedser wind-turbine, 1955 - 1967, and from 1977 [operated under Danish and USA-NASA research contract]. Plus UK and West-Germany. [Gedser was the first modern, reliable wind-turbine].**

Period nr. 4 **Re-discovery phase, 1968 - 1978, USA and Denmark. This phase results in 2 different development strategies: - Top-down, and Bottom-up.**

a: **Mega turbines; Tvind-college in Denmark & official Danish state research program, West-Germany, USA. - [Development of glass-fiber Tvind-wing].**

b: **The Riisager wind-turbines from Denmark, 10kW.- 30kW. These pioneered the development of the cost-effective wind-turbine**

Period nr. 5 **Large-scale Danish commercial development and production; - 55kW.- 100 kW. 1978 - 1985.**

Period nr. 6 **150kW.- 225 kW. 1985.**

Period nr. 6.5 **300 kW. 1991.**

Period nr. 7 **Large-scale production of cost-effective 500 kW. units, Denmark and Germany. 1993. Development of wind-turbines without gear-box, [Ring-generator -- Enercon, Germany]**

There is at the present time [1997] small-scale production in Denmark of Mega-sized wind-turbines, [between 800 kW. and 1.7 MW.]. However great consideration, must be paid to eventual dis-economies of scale, maintenance, siteing, etc. etc.