Isolated Systems with Wind Power
An implementation strategy

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Background

- **A large potential world wide with**
  - large wind resources
  - high production costs
  - remote and isolated villages with local power supply systems
- **Prototypes of systems for more than 15 years and know-how exists on design, but**
  - few replications
  - immature technology
  - no consensus on configurations
  - project failures for non-technical reasons
- **But best practices for project implementation are missing in terms of**
  - overview of methodologies and tools
  - documented examples of cases and potential locations
  - functional outlines of guidelines based on practical experience
  - realistic implementation strategies aimed at market creation

Project Overview

- **Danish Energy Agency Energy Research Programme (EFP) Grant No. 1363/97-0022**
- **National Renewable Energy Agency (NREA) subcontracted for measurements in Egypt**
- **Project period 1997 - 2001.**
  - Extensions of the practical execution of measurements in Egypt
  - Adaptation to international developments (e.g. IEC/PAS 62111)
- **Project budget 2.501 mill. DKK**
  - EFP97 Grant 1.680 mill DKK
  - Risø financing 0.821 mill DKK
- **Project based on Risø National Laboratory experience**

Project Results

- **Main Umbrella Report (R-1256)**
- **Topical Reports**
  - Review of Relevant Studies of Isolated Systems (R-1109)
  - Results from Measurements in Egypt (R-1240)
  - Inventory of Isolated Systems in Egypt (I-1703)
  - Implementation Guideline Report (R-1257)
  - Outline of an Implementation Strategy (R1256)
- **Conference Papers**
  - European Wind Energy Conference (Nice, 1999)
  - International RE Island Conference (Bermuda, 2000)
  - European Wind Energy Conference (Copenhagen, 2001)
- **Development opportunities**

Implementation Guideline Report (R-1257)

Contents

Guidelines R-1257 Contents

1 Introduction
2 State of the Art - Technology
3 State of the Art – Economics
4 Fact Finding
5 Project Feasibility Analysis
6 Environmental Impact Analysis
7 Institutional and Legal Framework
8 Financing
9 Implementation

State of the art outline (R-1257)

2 State of the Art – Technology

2.1 State of the Art – Concepts & implementations
2.2 Categorised Power Systems

3 State of the art - Economics

3.1 COE in isolated systems
3.1.1 COE from the wind turbine (including costs of any support technology) compared to the avoided costs due to fuel saving in the existing diesel system.
3.1.2 COE based on total cost of electricity including capital cost of the alternatives analysed.
3.2 COE from WT's. Grid connected WT's of the order 0,04 USD/kWh
3.3 Typical electricity production costs of a WD system
3.3.1 Low values of the order 0,20 USD/kWh
3.3.2 Medium values of the order 0,45 USD/kWh
3.3.3 High values of the order 1,0 USD/kWh.

Categorisation of Systems (R-1257)

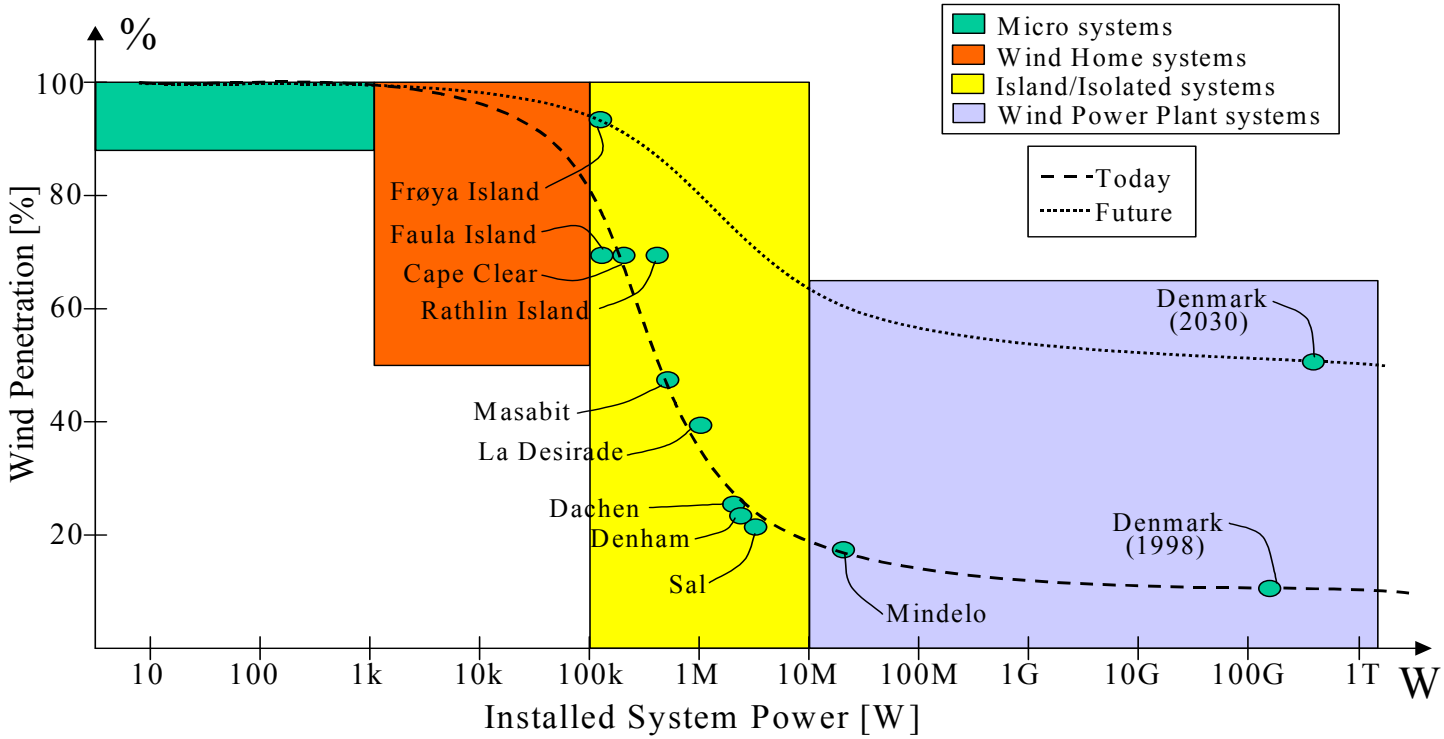

Figure 1. Present time and future development of the Wind energy penetration vs. the Installed system power.

System categorisation:

- <1kW: Micro systems:
- 1-100kW: Wind home systems:
- 100-10MW: Island/Isolated systems:
- >10MW: Wind Power Plant systems:

Fact finding outline (R-1257)

Feasibility Study Outline (R-1257)

EIA Outline (R-1257)

Institutional & legal Outline (R-1257)

Financing outline (R-1257)

8 Financing 34

8.1 Project outline description
8.2 Proposed time schedule for implementation
8.3 Project investment including breakdown in major items
8.4 Relevant economical and financial key figures or indicators for the project
8.5 Draft PPA or other evidence of potential income
8.6 Cost of land (if applicable) and access right / roads
8.7 Environmental scoping report / statement

Implementation outline (R-1257)

9 Implementation 35

9.1 Responsibilities during installation
9.2 Capabilities during operation
9.3 Implementation Schemes (turnkey, BOOT, etc.)
9.4 Engineering design of WD Plant
9.5 Identification of local specialists
9.6 Assessment of the need for Ex-pats
9.7 Logistics of spare parts, fuel and lubrication oil
9.8 Establishment of an O&M organisation
9.9 Monitoring and reporting

Keys to Success (R-1257)

The main issues identified, which should be considered pre-conditions for achieving successful wind power projects in isolated power systems may be summarised as follows

- Updated versions of relevant international standards – including the one for decentralised power systems with renewable energies as now initiated within IEC – should be applied
- Best practice guidelines for project implementation with common references and based on updated experience from recent projects should be applied
- The wind power project in the isolated system in question should be part of a concerted action in a national and international programme rather than an individual project
- The wind power technology applied in a small to medium size system should follow simple and proven approaches, e.g. by repeating and/or downscaling pilot and demonstration systems with positive track records, which may have been developed from filtering down from large-scale systems any technological achievements adaptable to smaller systems
- Small systems should be developed and specified to be rugged technology applicable for remote communities

Keys to Success cont'd (R-1257)

- Modelling assumptions, input data and methodology applied for the feasibility study and system design should reflect the true hardware reality for the types of systems in question
- No experimental systems should be installed at rural remote communities unless previously tested and documented at test benches prepared to serve as experimental facilities
- The industry offering small wind turbines (10 - 300kW) for hybrid system applications should be seen to have a long-term commitment in this business, which in turn means that a sufficiently large market should have emerged to attract interest even from some of the large wind turbine manufacturers
- Ownership should be clear with a built-in interest identified to ensure long-term financing of operation, maintenance and re-investments needed
- It should be possible to establish an organisation with the necessary capacity for implementation, operation and maintenance, which will require for the local community the availability of back-up from central relevant national or regional organisations
- A sufficiently detailed feasibility study must have been performed

Implementation Strategy (R-1256

Strategy Outline

Outline of an Implementation Strategy (R-1256)

- **Manufacturer's preferences for an implementation strategy:**
- **Main objectives should be**
  - Short term: Use standard wind turbines for decentralised power supply in developing countries
  - Long term: Substantial contribution from wind energy to decentralised power supply in developing countries in combination with other RES
- **A market should be established (money & time scale) that makes it attractive for the RE resource base to think & act strategically, i.e. develop products & market**
- **The "Danish Strategy" for implementation of wind energy is applicable for isolated systems with wind power also in developing countries**

Outline of an Implementation Strategy (R-1256)

- **An action plan should build on the experience with the successful Danish strategy for development and application of wind energy in Denmark**
  - Clear, long term energy policy goals + financial incentives
  - A precondition for the provision of financial incentives should be a steadily improved technical/economic performance
- **Main components of a strategy**
  - Establish positive track record by strict enforcement of SR&R technology and realistic institutional conditions
  - Establish clear & realistic best practices including operational accept criteria for projects on isolated systems with wind energy
  - Continuous & consistent monitoring of projects to establish technical/economic/organisational track record

Development opportunities

- **Isolated systems**
  - task force (International)
  - system developments (EFP)
- **Energy sector development programmes (Danida, WB, etc)**
- **Joint international guideline development**
  - EDF initiative (IEC/PAS 62111)
  - Joint Coordination Group “Decentralised Renewable Energy Systems (DRES)” formed 2001. The JCG is expected to be an international focal point for isolated RE systems guidelines
    - Part A: Project Implementation Guidelines, several versions for different types / classes of systems
    - Part B: IEC Standards, unique, all Part A guidelines refer to one and the same set of RE system standards in Part B.
  - Participation from TC82/TC88/TC21 initially. More are expected to follow

Main Project Outputs

- **A very large amount of literature was found,** but no significant reference presents methods or tools that contradict the philosophy of Risø's methodology such as it is implemented in the WINSYS model and the associated practices.
- **Extensive measurements were made in Egypt** on three different sizes & types of systems. Apart from providing concrete case data the measurements indicate that in most cases the load patters are sufficiently well represented by their probability distributions
- **An inventory of more than 50 isolated systems in Egypt was established.** The finding of most immediate impact is that electricity in smaller communities is offered only part of the day and night, which is a major problem if wind power is to become an economically competitive option
- **An outline of a project implementation guideline was established and reported.** A common best practice guideline should be developed as a living document, addressing a number of key issues identified in the guideline report
- **A project implementation strategy proposed previously (1996) to Danida was reviewed and revised.** According to the proposed strategy a market approach is needed to mature the technology, and a programme approach is needed to mature the project implementation practices. These findings still stand.

Conclusions & Recommendations

Main recommendations for further development of the use of wind power in isolated island power systems are

- to join forces in development of international standards for decentralised power systems with renewable energies as now initiated within IEC
- to develop best practice guidelines as living documents with common references and based on updated experience from recent projects
- to develop the use of wind power in isolated systems as concerted actions in national and international programmes rather than as individual projects
- to develop wind power in small to medium size systems following simple and proven approaches, e.g. by repeating and/or downscaling pilot and demonstration systems with positive track records
- to filter down from the large-scale systems any technological achievements adaptable to smaller systems
- to invest research and development in small systems to support development of rugged technology applicable for remote communities
- to use modelling assumptions from the hardware reality for the types of systems that will be applied
- to install experimental systems only at test benches prepared to serve as experimental facilities
- to encourage the industry to offer small wind turbines (10 - 300kW) for hybrid system applications – large wind turbine manufacturers need to give priority to allocation of production line capacity for small machines