Technical and Economic Feasibility of Hydro-Diesel Village Grids for Rural Electrification in Laos

presented by

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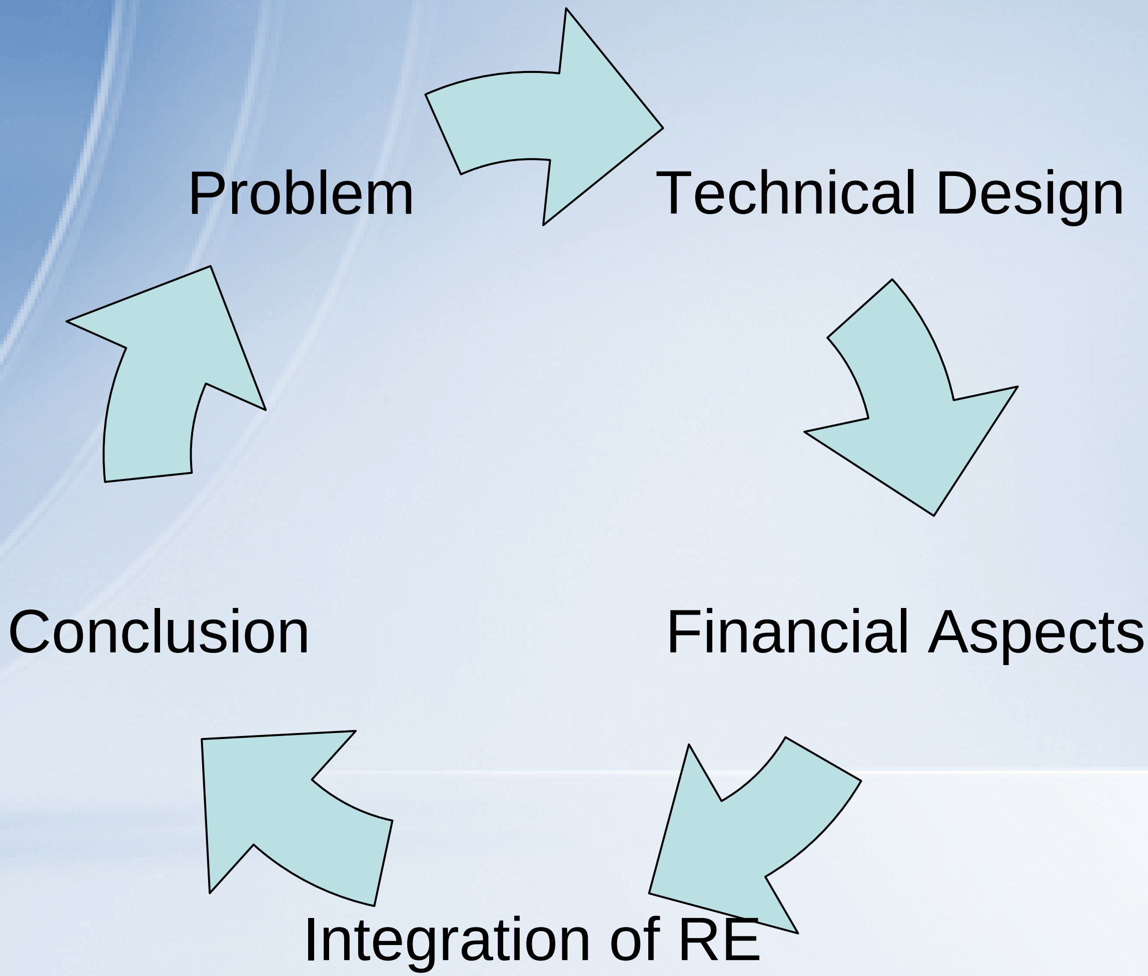
Structure



Problem
Technical Design
Financial Aspects
Integration of RE
Conclusion

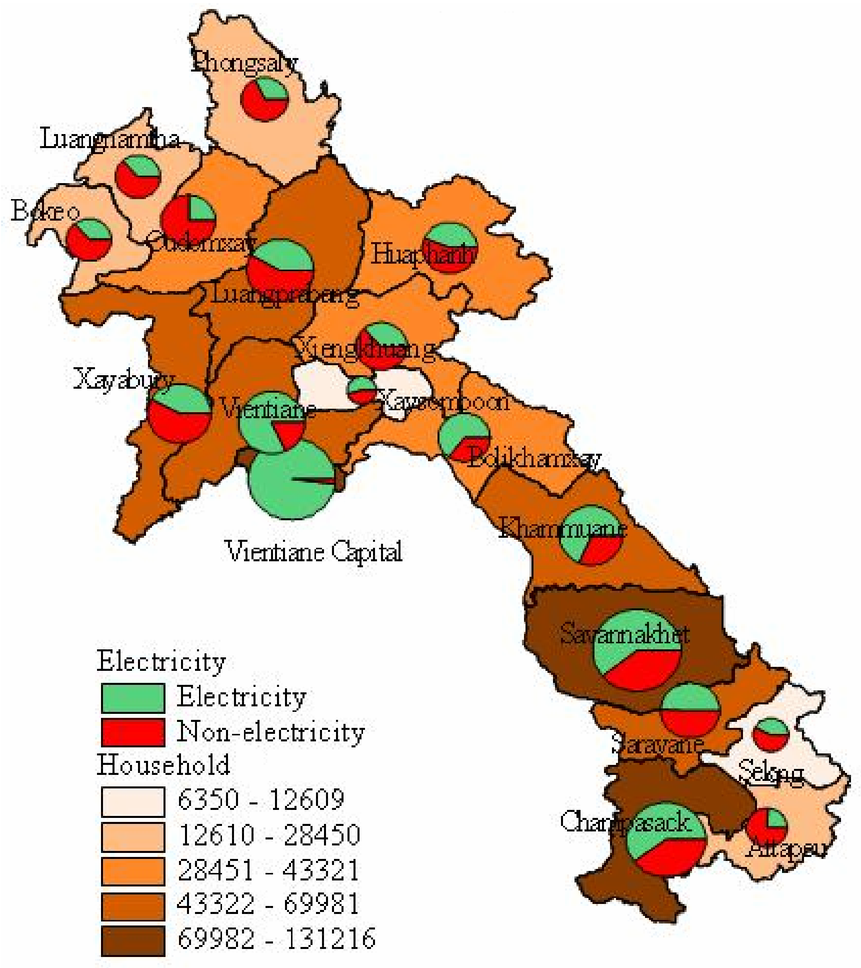
General Problem in Laos

- 70% of Lao terrain is mountainous
- 68% of total land is covered with forests
- **40%** of population **no access** to electricity

- Small communities in remote areas
- Distant from the national grid

- Inefficiency of national grid extension
  - Impact on Lao environment
  - Uneconomic expenditure

Electrification map on Laos



[Source: National Statistic Centre of Lao, 2005, chapter 8]

Political Situation

- Development Goal to achieve **90%** of electrification rate **by 2020**
- Government supports private enterprises by tax incentives

Possible Solution

- Electrification by hybrid Village-Grid

⬇

- Lower impact on Lao environment
- Income generation due to productive application
- Reduce migration into cities

Goals of study

- Is an investment feasible for **P**rivate-**E**nergy-**P**roviders?
  - Costs?
  - Profitability?
  - Optimization?
  - Operation strategy?

Approach of study

- Micro power optimization tool **HOMER**
- **D**iscounted **C**ash **F**low method

Availability of:

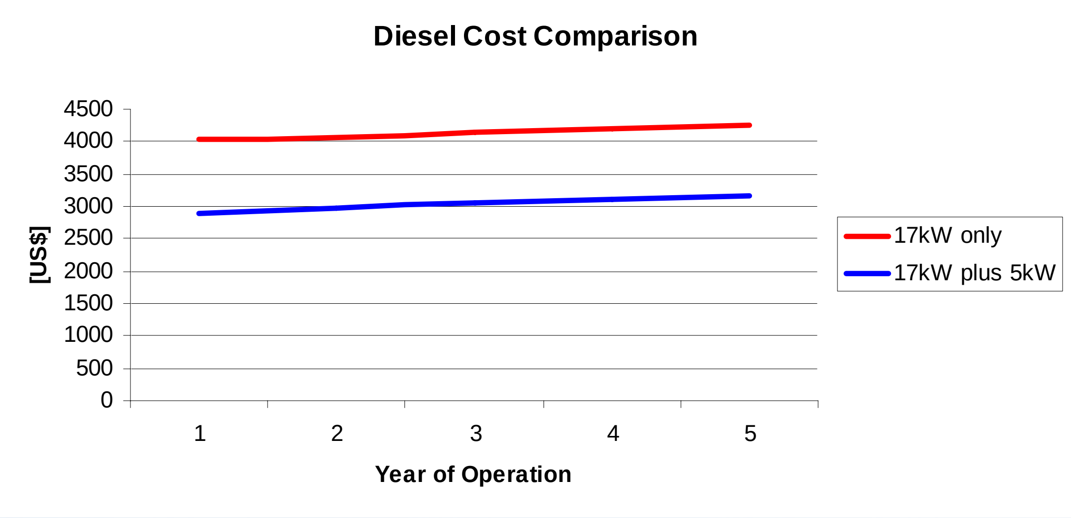
- Financial data of the pilot project
- Geographical resource data
- Load profile with future power consumption

System Configuration

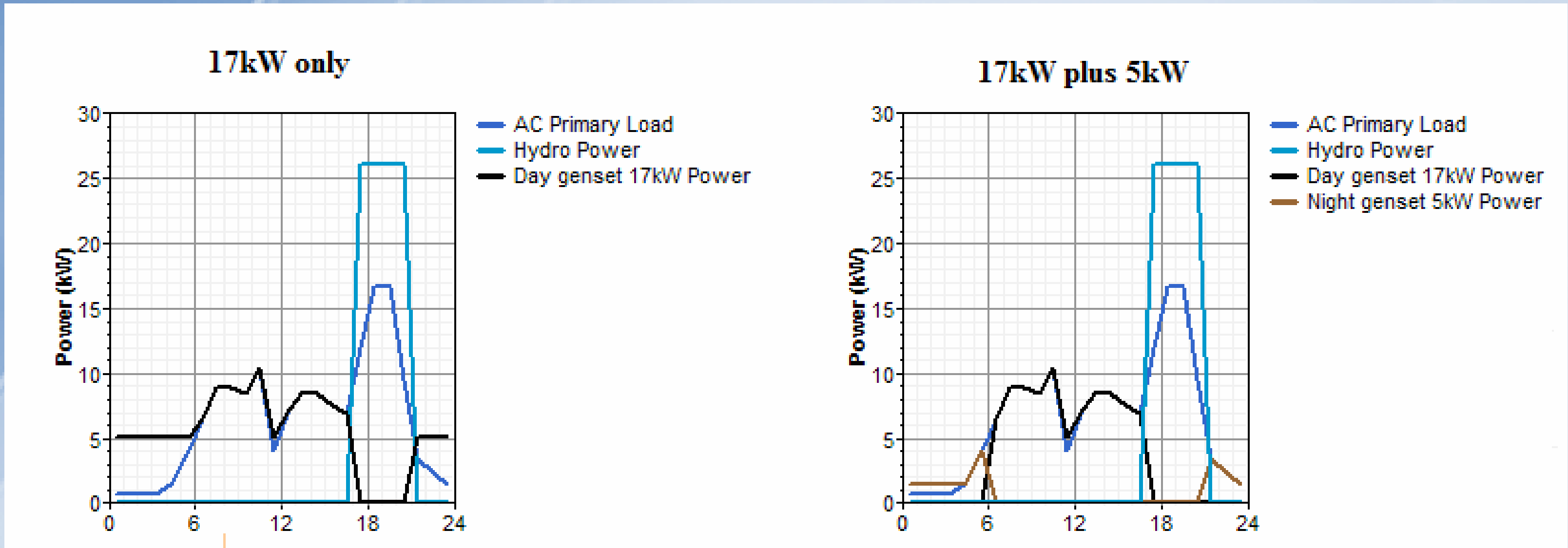
- Designed to meet peak load
  - 26kW micro-hydro power
  - 17kW diesel generator (daytime)
  - Upgrade to 20kW in year 10
- Cost reduction
  - 5kW diesel generator (nighttime)
  - Minimum supply security

System Optimization

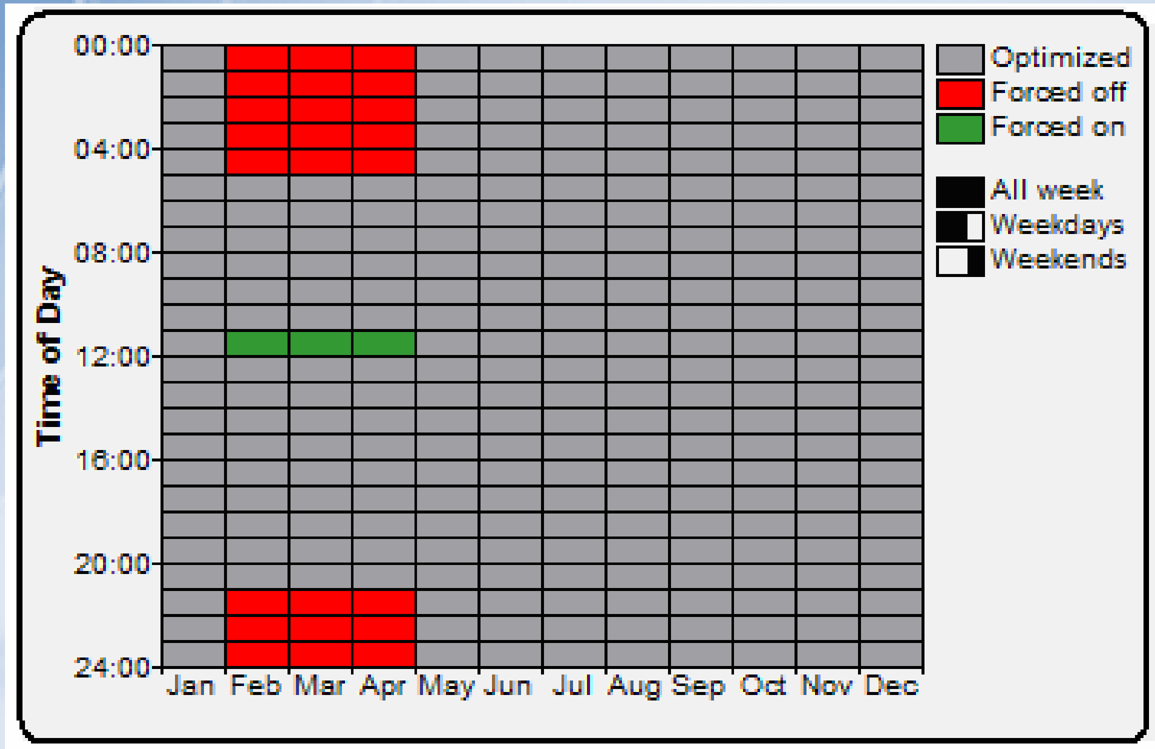
- Prevention of “Wet-Stacking”
- Higher generator efficiency
- Longer generator lifetime
- Tremendous savings of diesel fuel!



Power Output



Operation Strategy

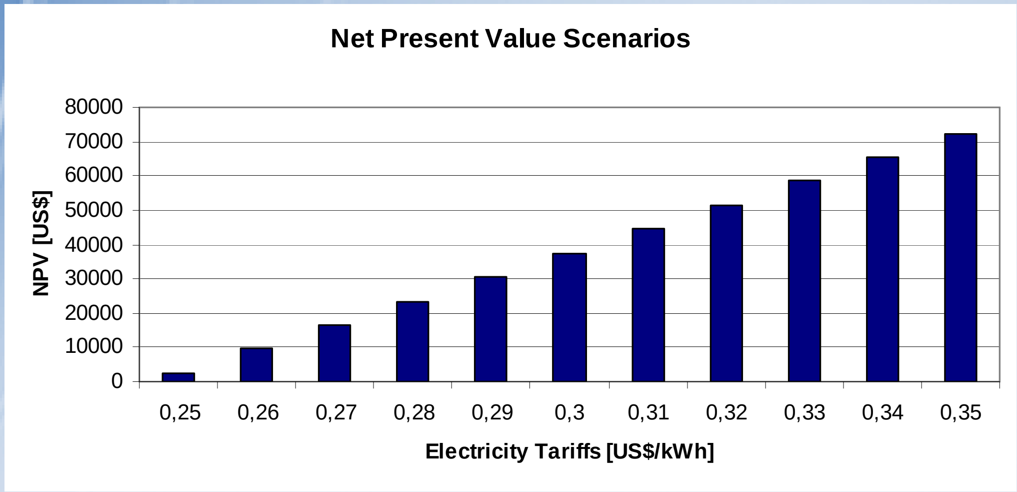


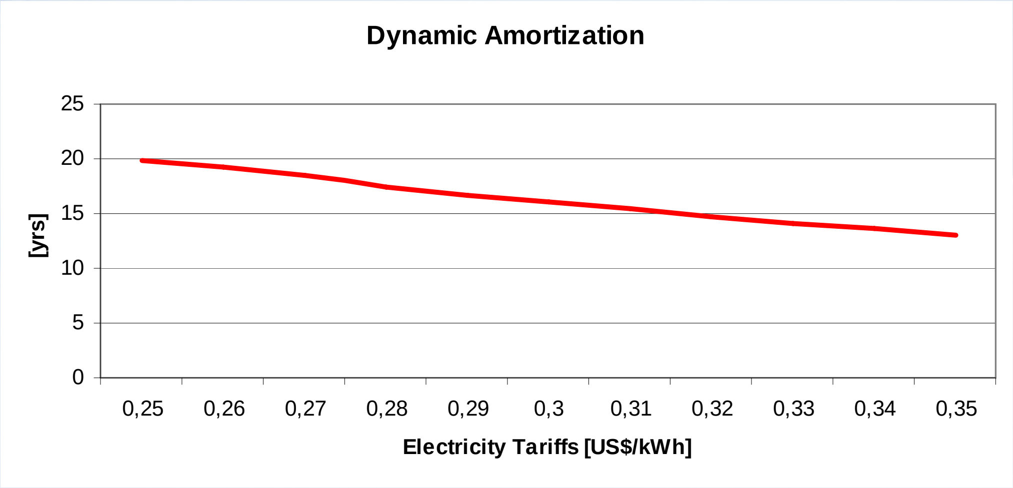
Project Costs

- Initial investment of about **130.000US$**
- LCC at a Net Present Value **70.000US$**
  - Fuel Costs at a price of 1US$/L
  - Operation & Maintenance Cost
  - Costs for system upgrade

- Levelized Electricity Costs of **0.229US$/kWh**

Project Profitability





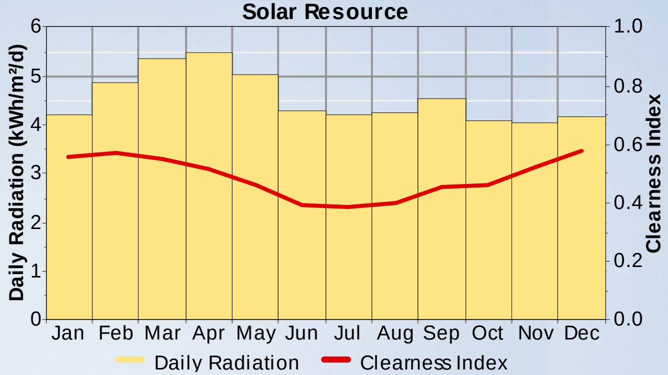
Increase of Profitability

- Demand Side Management

- Integration of renewable energy sources:
  - Solar Power
  - Wind Power
  - Biofuel

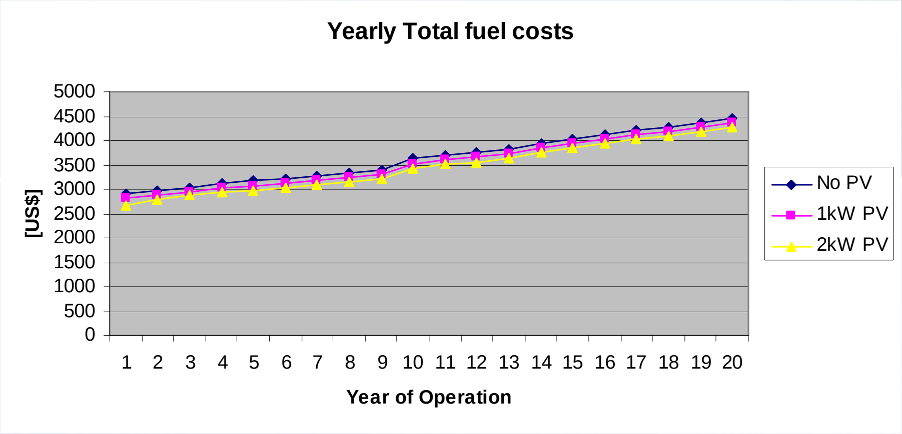
Solar Power

- High solar radiation during dry season
- No significant fuel savings

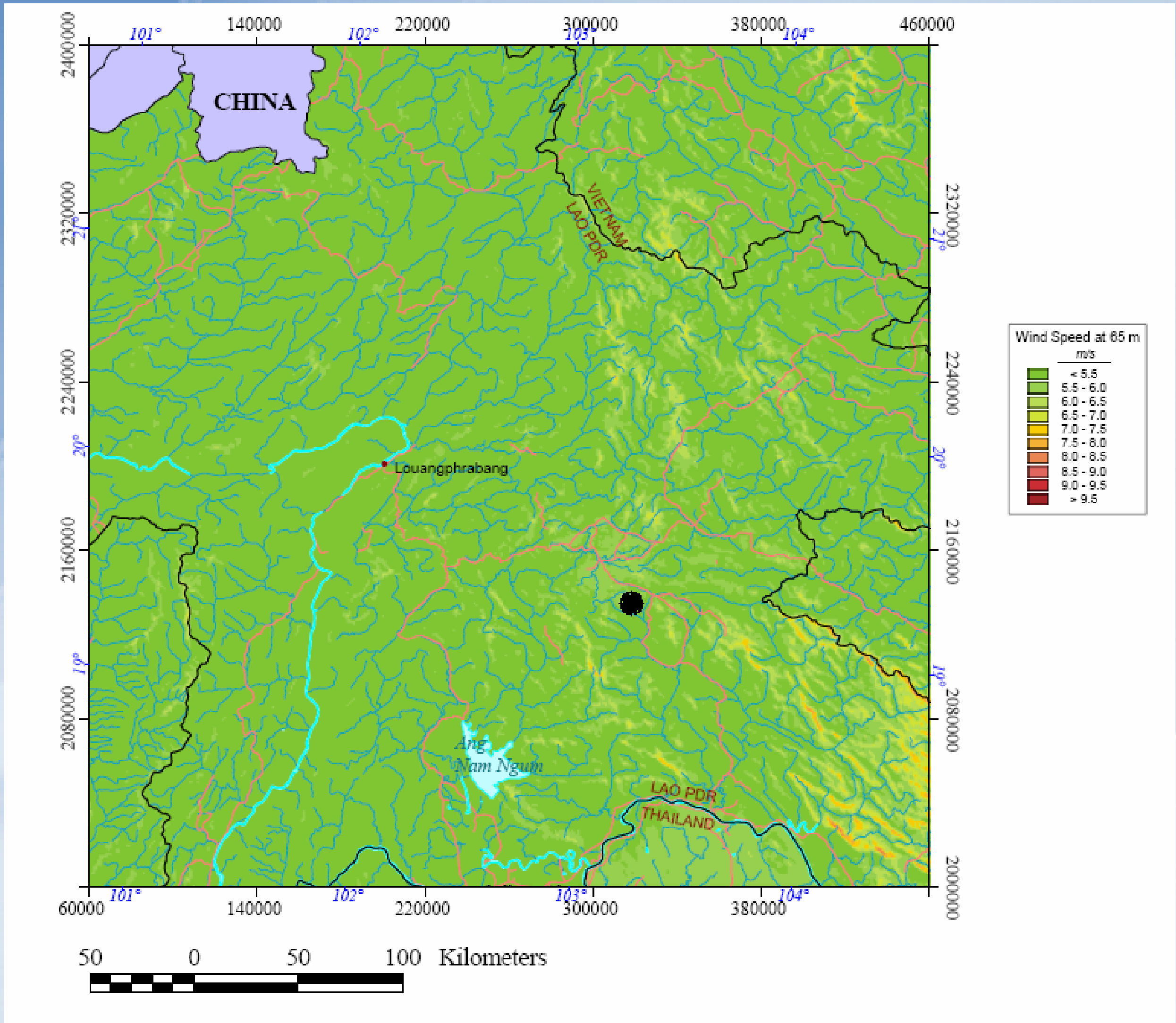


[Source:www.eosweb.larc.nasa.gov]

Integration of batteries?



Wind Resource



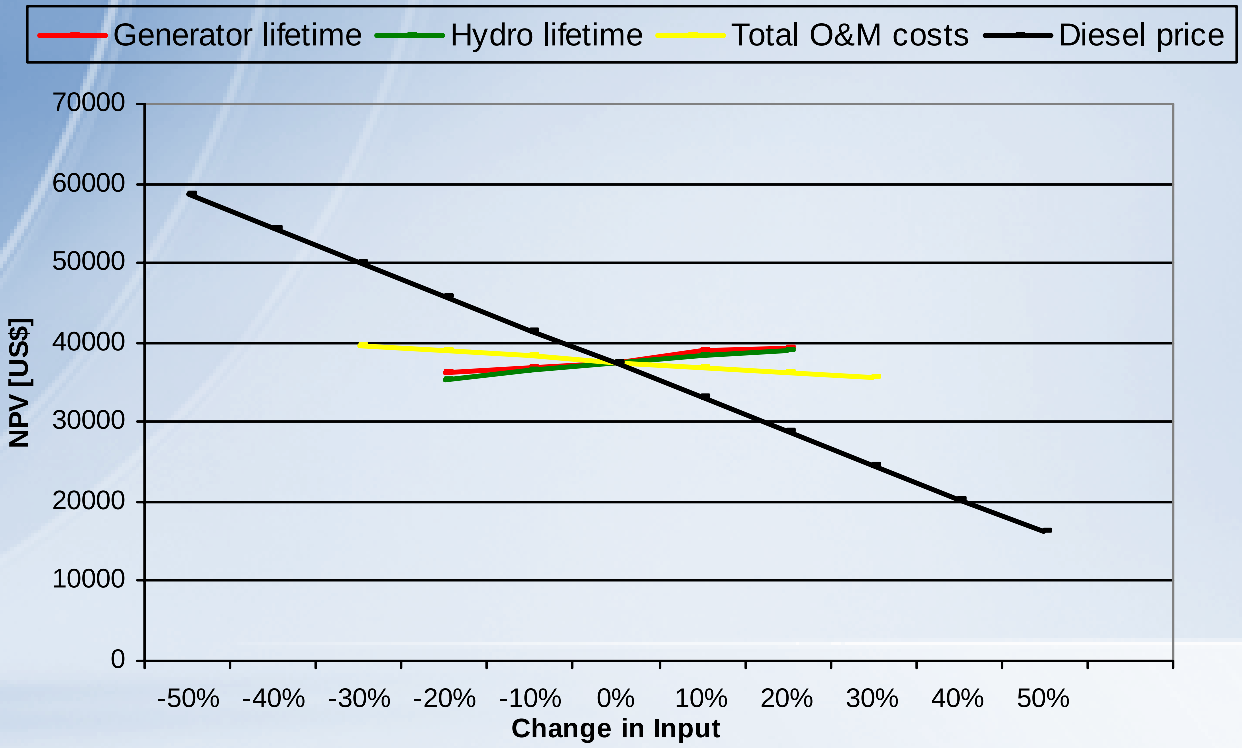
[Source: Wind Energy Resource Atlas of Southeast Asia, 2001, p.52]

Integration of Jatropha Fuel

- Oil plant
- Traditional plant in Laos (hedge-,medical plant)

- Fight desertification
  - Slash and burn
  - Agent Orange
- Creation of **local** fuel markets

Sensitivity of fuel price



Mutual advantages of Jatropha

- Income generation for villagers
  → Increases affordability of power consumption

- Substitution of expensive fossil diesel
  → Decrease of LEC

→ **Increase of investment value**

Use of Jatropha oil

- Acquisition of Lister type engine
- Cold pressed
- Non refined
- Simple filtered vegetable oil

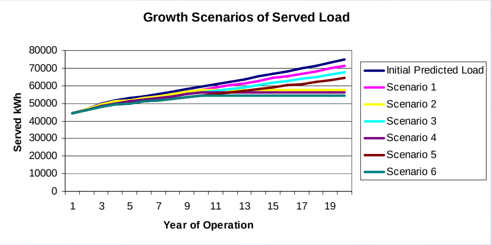
Modifications:

- Use of waste heat (copper spiral)
- Rpm throttle (adjust output to the load)
- Dual fuel-tank system (avoid cold start on v-oil)

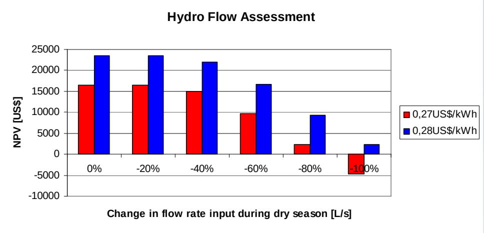
Sensitivity assessment

Possible project abortion?

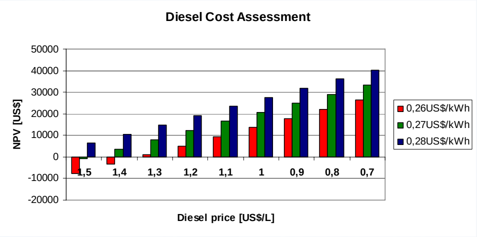
- Scenario of lower consumption



- Scenario of lower flow rate



- Scenario of diesel price



Conclusion

→Investment security at **0.28US$/kWh**

<u>Even if:</u>

- 30% lower growth shifting to constant load
- No hydroelectric power during 3 months
- Rise of diesel price up to 1.5US$/L


Thank You!

Free Cash Flow

- Yearly revenues:
  - Minus LCC
  - Minus System extension costs
  - Minus Corporate tax