UNIVERSITY OF Southampton
School of Civil Engineering and the Environment

Talk

Risk Management and Resolution Strategies for established and novel Technologies in the low head, small Hydropower Market

Patrick Wiemann, 13/06/2008

Overview

1. **Introduction**
   - **Potential**
   - **Market**
   - **Problem and Motivation**
2. Risk Management
   - Risk Identification
   - Risk Analysis
   - Risk Resolution
3. Case Study
4. Conclusions and Discussion

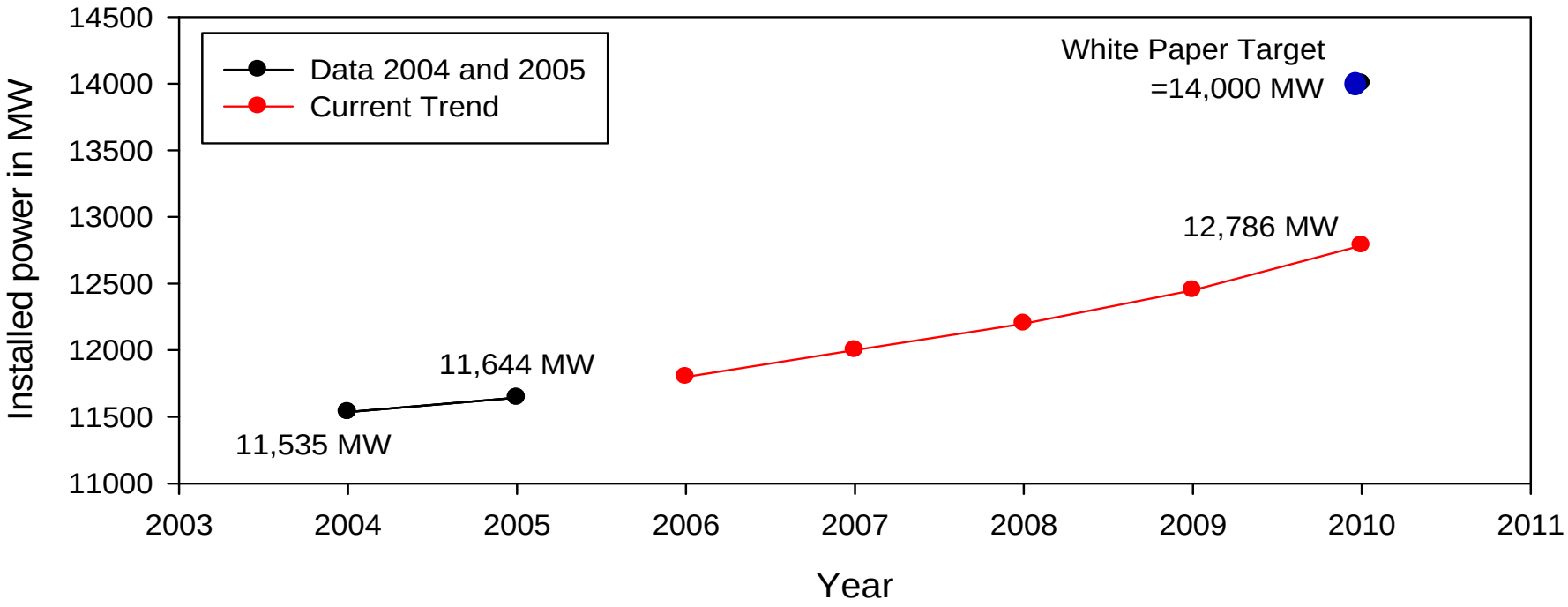
Potential



Case Study *Stadtwerke Munich*: (Third biggest energy company in Germany)

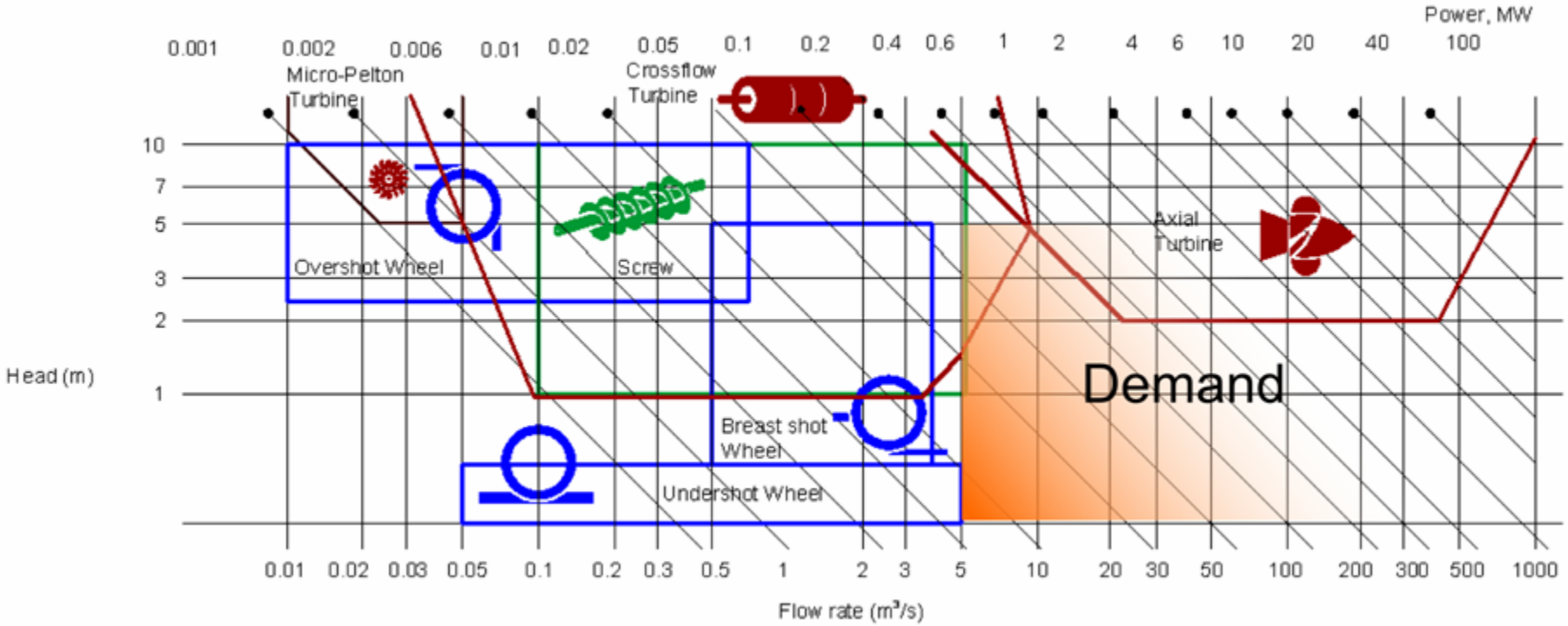
- Flow **30 m^3/s**
- Energy with Head of 1.06 m: **1,857,000 kWh**

Market development of small hydropower



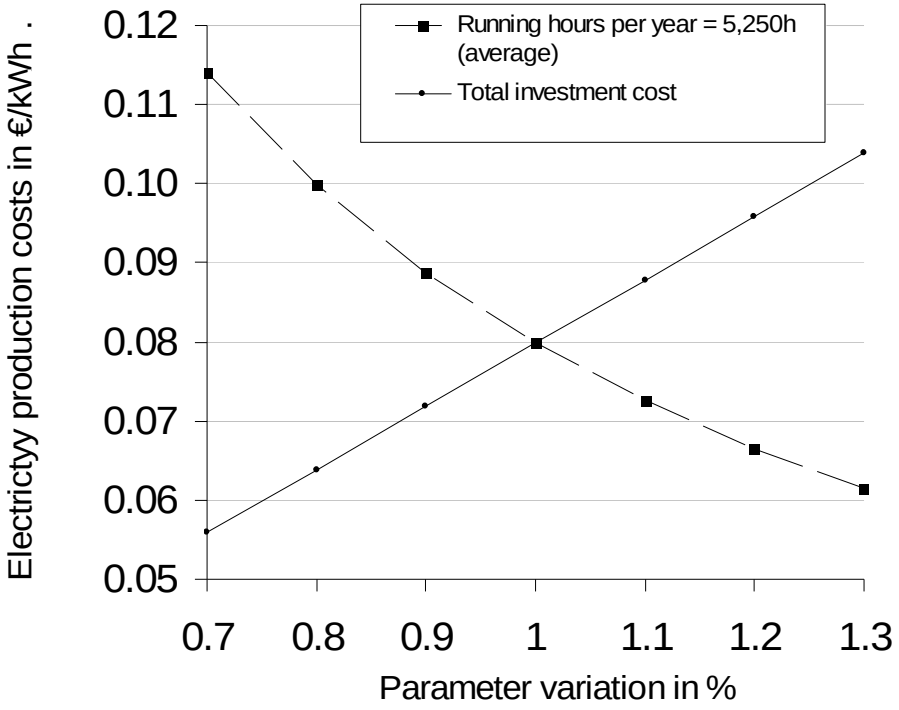
- The market growth of small hydropower in Europe was only **0.95%** installed power from 2004 to 2005.
- The ambitious target of 14,000MW **cannot** be reached with **current market growth**.

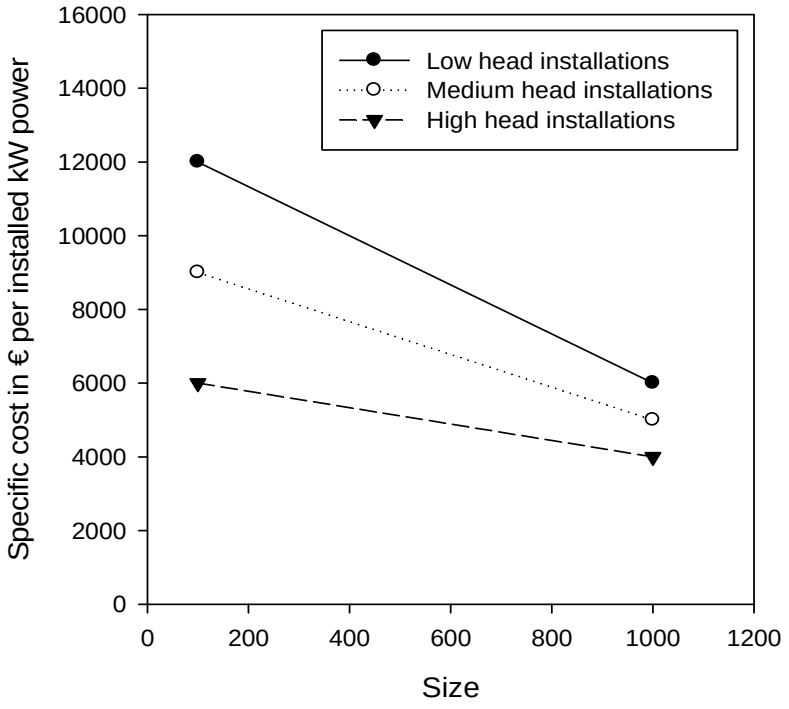
Overview established technologies



- Overview of established hydraulic machines regarding **operating heads and flow rates**.
- **Demand** highlights where **new technologies** may emerge in the near future.

Research problem





- **High sensitivity** of low head hydropower projects.
- Specific investment cost per installed kW of power for low head is **significantly higher** than for high head installations**.**

Research problem and Motivation

1. **Raising funds and gaining investor** confidence are one of the main hurdle.
2. The uncertainties involved in hydropower are **not well understood** by financiers.
3. There is **little investment in research** in non-equipment areas.
4. There are **technological challenges** in exploiting the remaining hydropower potential, composed **mainly of low-head and very-low-head sites.**

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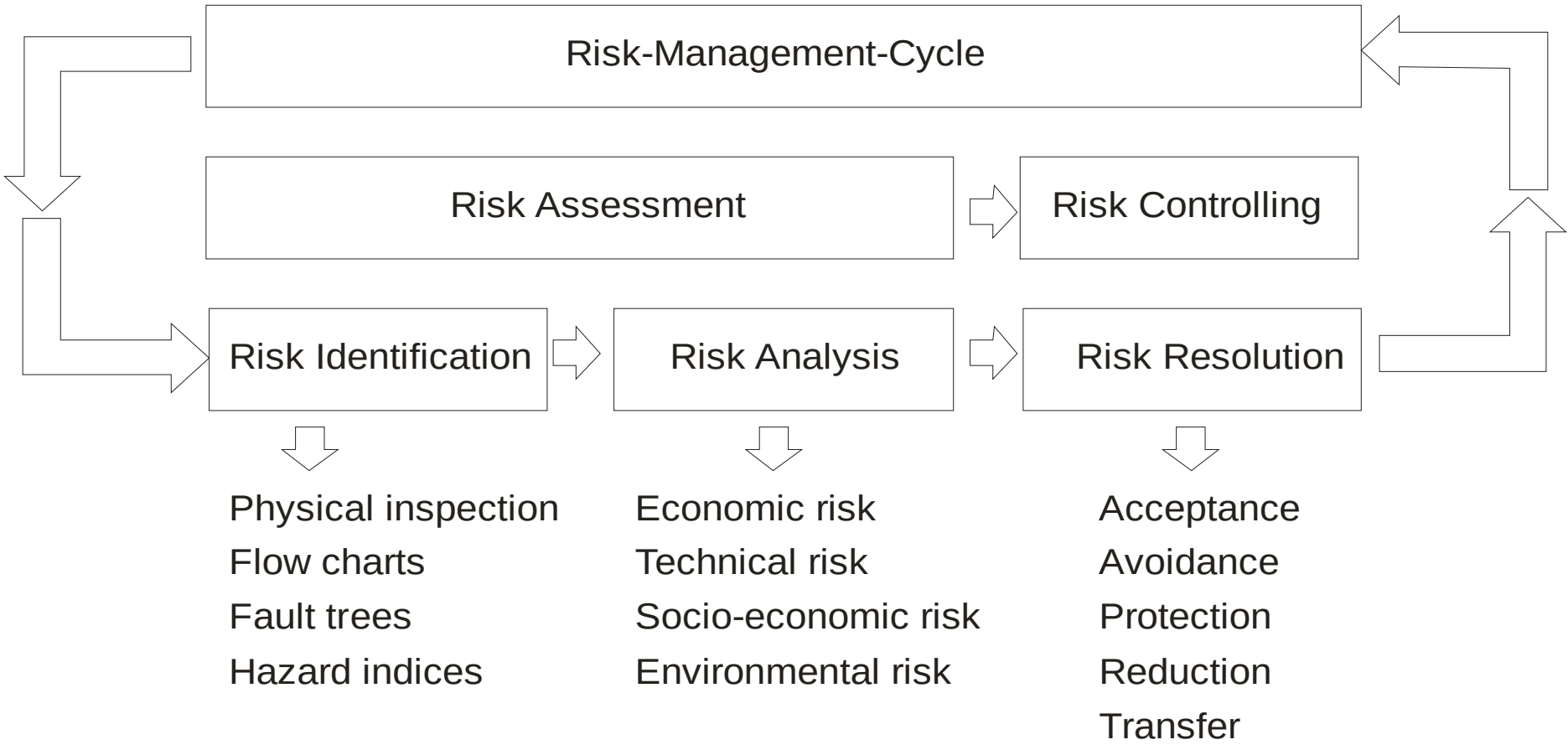
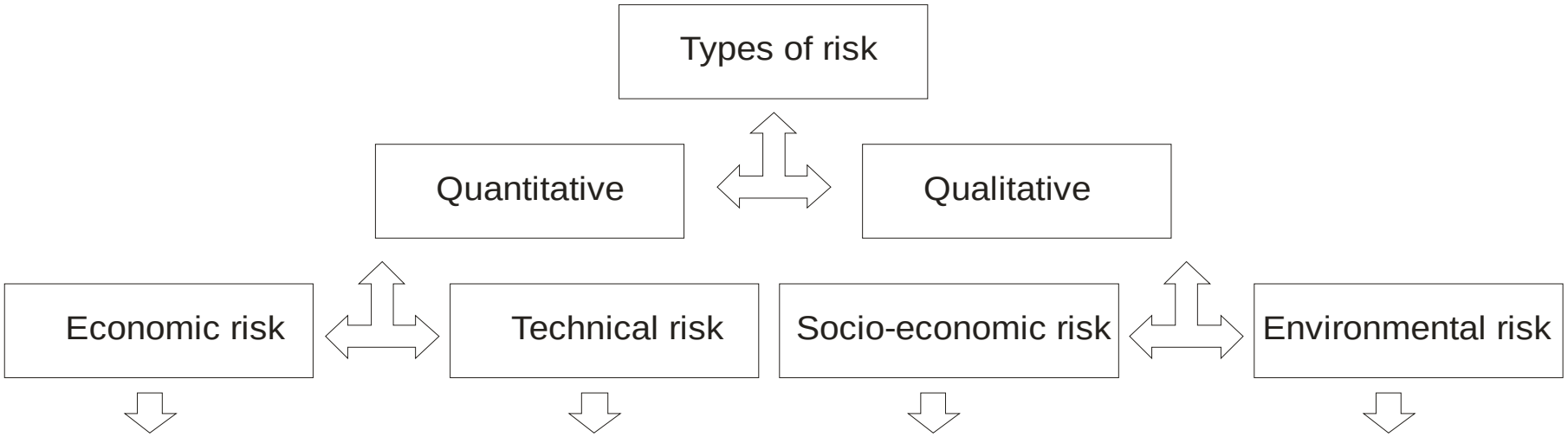
Process of the Risk-Management-Cycle



Risk Identification



Economic risk	Technical risk	Socio-economic risk	Environmental risk
Cost overruns risk	Weather risk	Changes in law	Flood risk
Price risk	Breakdown risk	Changes in taxation	Noise risk
Inflation risk	Performance risk	Political Force majeure	Water quality
Damage to third party	Risk of innovation		Meeting obligations
Completion risk	Force majeure		Fish impact

Legend: No insurance or limited cover available, Insurance cover available

Risk Analysis

- **Intuitive approach:** Add an item for "unforeseen costs" (the traditional approach for accounting risk).
- **Sensitivity analysis** (probably the most common way of handling project risk in practice).
- **Statistical methods**, for example probabilistic risk analysis using the Monte-Carlo Simulation (MCS) method.

Risk Resolution Strategies

- **Risk transfer**, which is a strategy to shift the risk to another person, group, or organization.
- **Risk reduction** through mitigation, prevention, or anticipation.
- **Risk research, e.g. dynamic performance risk** can be mitigated by analyzing the present performance of previous projects of a chosen project developer.

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Case Study

- We focus on **weather risk** through variation of rainfall and the choice between alternative technologies.
- The case study will consider two scenarios:
  1. Under **low flow volatility**, which means relatively low weather risk, and
  2. Under **high flow volatility**, which means relatively high weather risk.

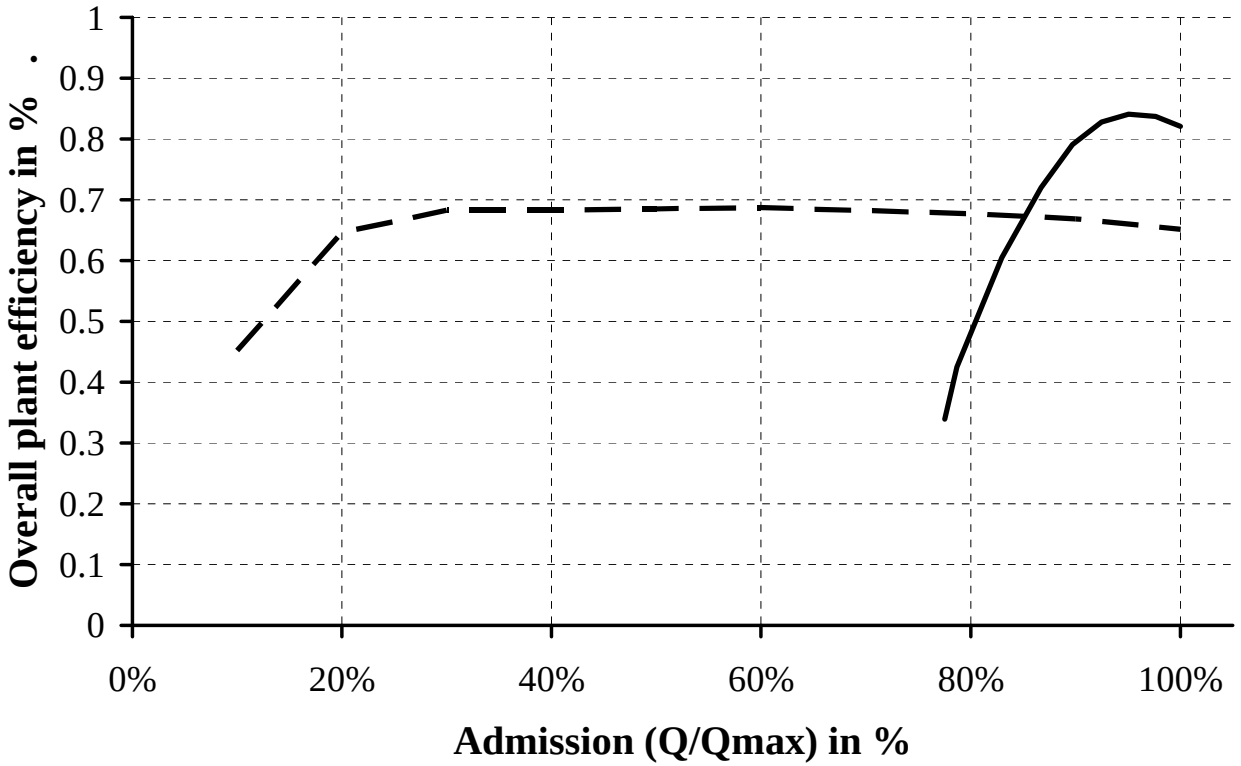
Turbines

- *Crossflow*- and *Kaplan-turbines* are appropriate for operation with **low heads for a wide range of flow rates**.
- The maximum efficiency of *Crossflow*- and *Kaplan-turbines* is **between 80 and 93%.**

Hydrodynamic Screw

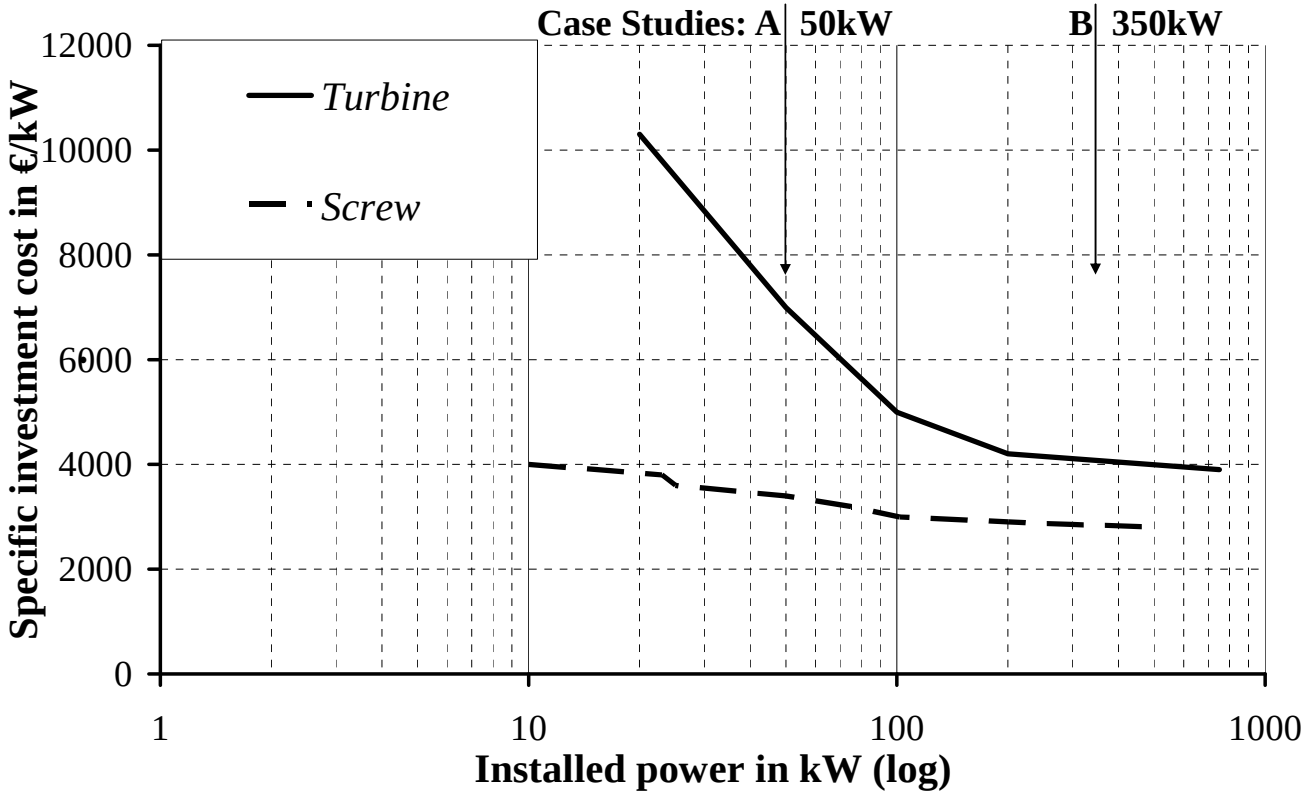

- The **Screw** can use water flows of **0.1-5m³/s** and **heads up to 10m**, with power capacities from 3 kW **to 300 kW**.
- The screw reached an efficiency of 60% at 20% of max. flow and **70%** for **60-100%** of maximum flow.

Efficiency curves for *Turbine* and *Screw*



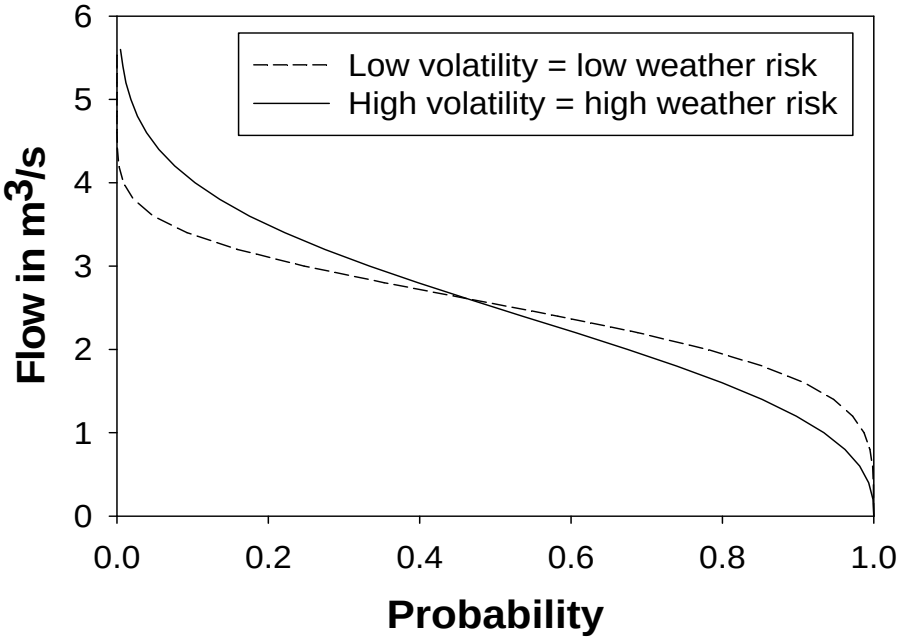
- The *Turbine* efficiency curve is **very tight** around maximum efficiency value of 85%**.**
- The *Screw* has a **very flat** efficiency curve with a maximum efficiency value of around 70%**.**

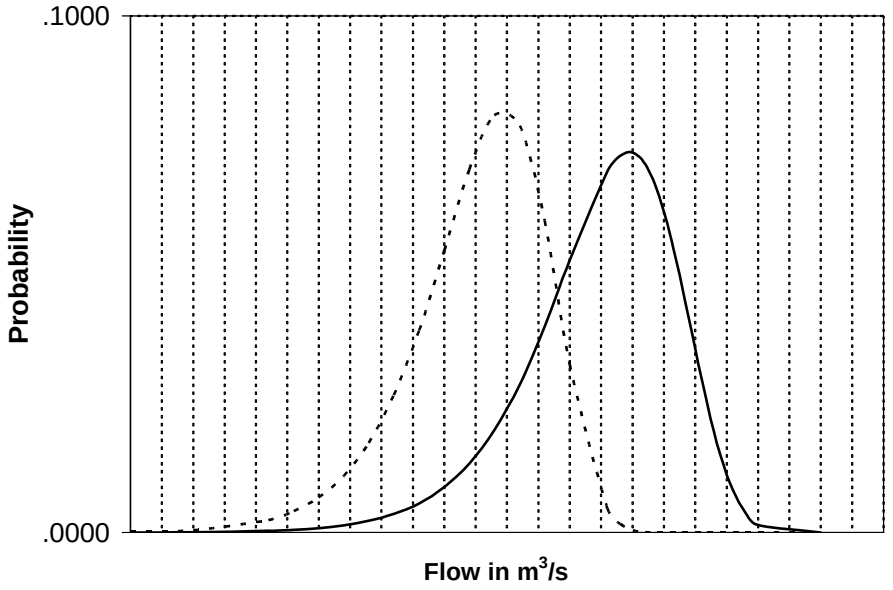
Cost curves for *Turbine* and *Screw*



- Two cases: A for a **50kW** and B for a **350kW** engine.
- The **cases A and B** will be considered under **low** flow volatility and under **high flow volatility**.

Flow duration curves

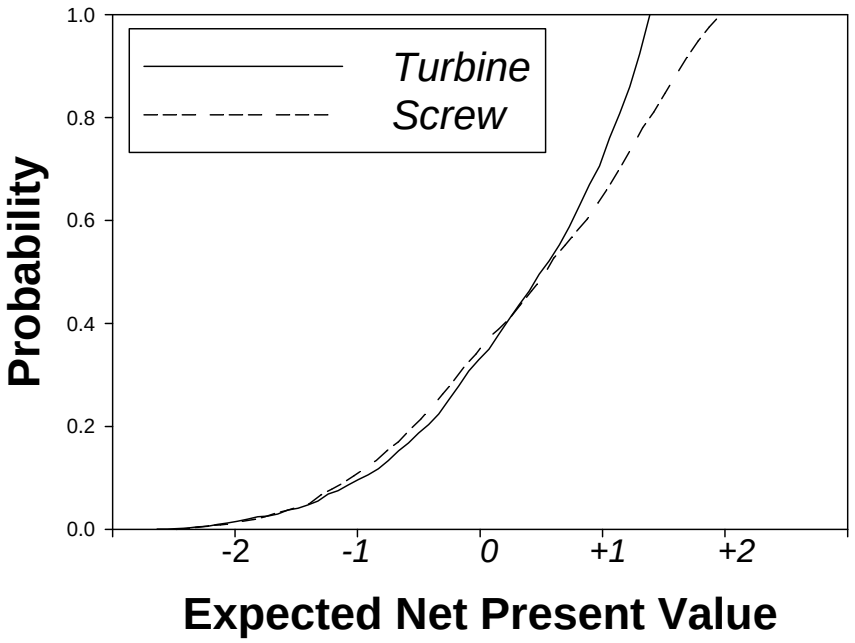




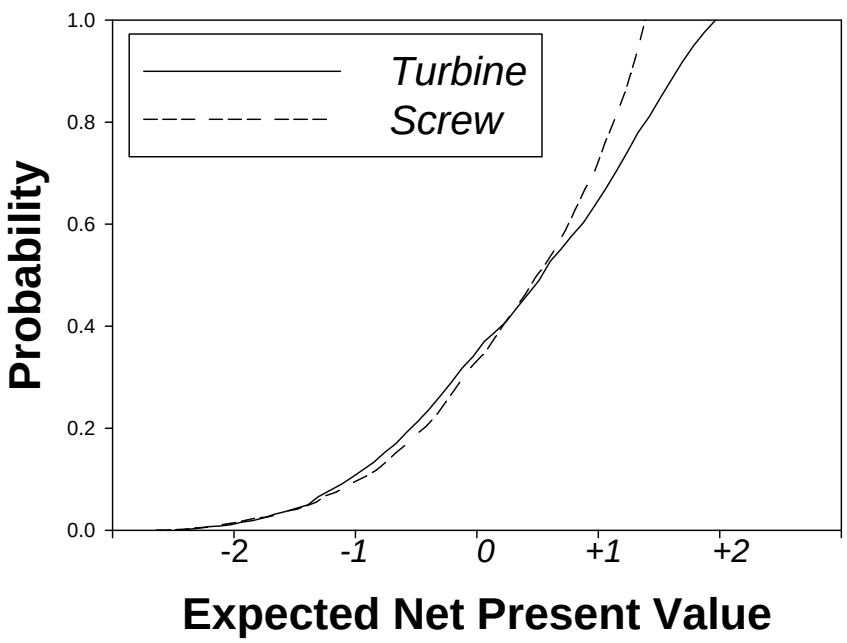
- Key variable is the **weather risk** measured as variability around the mean value of the flow data**.**
- The flow variation from available historical flow data by using the log-normal or the **Gumbel** distribution.

Case Study Results

Case A: Low Volatility and 50kW installed power



Case B: High Volatility and 350kW installed power



Case Study Results

Case A: Low Volatility and 50kW installed power	**Case B: High Volatility and 350kW installed power**
The efficiency advantage of the ***Turbine*** is less important than the cost advantage of the ***Screw***.	The cost (and risk) advantage of the ***Screw*** is less important than the efficiency advantage of the ***Turbine*.**

Case Study Results

- The case study provides some interesting insights into the **importance of considering risk**.

- **Further research** will aim for quantitative results under a combination of several uncertainties**.**

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Conclusions and Discussion

- The low head, small hydro power market is unexploited as a result of the lack of **understanding** of risk, **holding back** technologies development and growth because of low investor **confidence.**
- The use of statistical simulation methods provides comprehensive knowledge on the projects; improve the quality of the decisions that are made and **increase confidence** in the decision**.**

Conclusions and Discussion

- The **key to risk management** is to be aware of all kinds of risk and to develop a plan to eliminate or minimise them in a **cost-effective manner**.
- The **major premise** of risk analysis is the belief that a potential customer can make **better decisions** when provided with a **fuller understanding** of the **implications** of the investment decision.

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Thank you very much for your attention!

Questions?

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