International Renewable Energy Agency

World Wind Energy Conference

IRENA Project Navigator

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Agenda

- INTRODUCTION TO IRENA‘S PROJECT NAVIGATOR
- CONCEPT OF IRENA‘S PROJECT NAVIGATOR
- EXAMPLE OF THEPROJECT NAVIGATOR TOOL :
    - RISK MANAGEMENT
    - POWER PURCHASE AGREEMENT
    - TECHNICAL CONCEPT ON-SHORE WIND POWER PLANT
- CURRENT STATUS AND NEXT STEPS OF THE PROJECT NAVIGATOR

INTRODUCTION TO IRENA's PROJECT NAVIGATOR

Background

- IRENA's experience so far has shown that projects often have an innovative character due to specific conditions.
- It happens very often that neither the **project developer** nor the **involved governmental administration** has a realistic understanding of the process, the timelines and the necessary work steps to complete a bankable project proposal.
- As a result, this may lead to higher project development costs and a higher risk of project failure.
- Once a bankable project proposal is delivered the further finance process and the potential finance opportunities aren't transparent.

➔ **IRENA/IITC has taken the initiative to make the whole project development process including the funding alternatives more transparent and explicit**

The technology dimension

- Each of the renewable energy technologies (solar, wind, hydro, biomass, geothermal, ocean energy), which we support as IRENA, are exposed to specific but differing **risks** during their lifetime from project identification till plant decommissioning.

- The technical **diversity** and the different project conditions imply varying project designs and especially varying financing concepts.

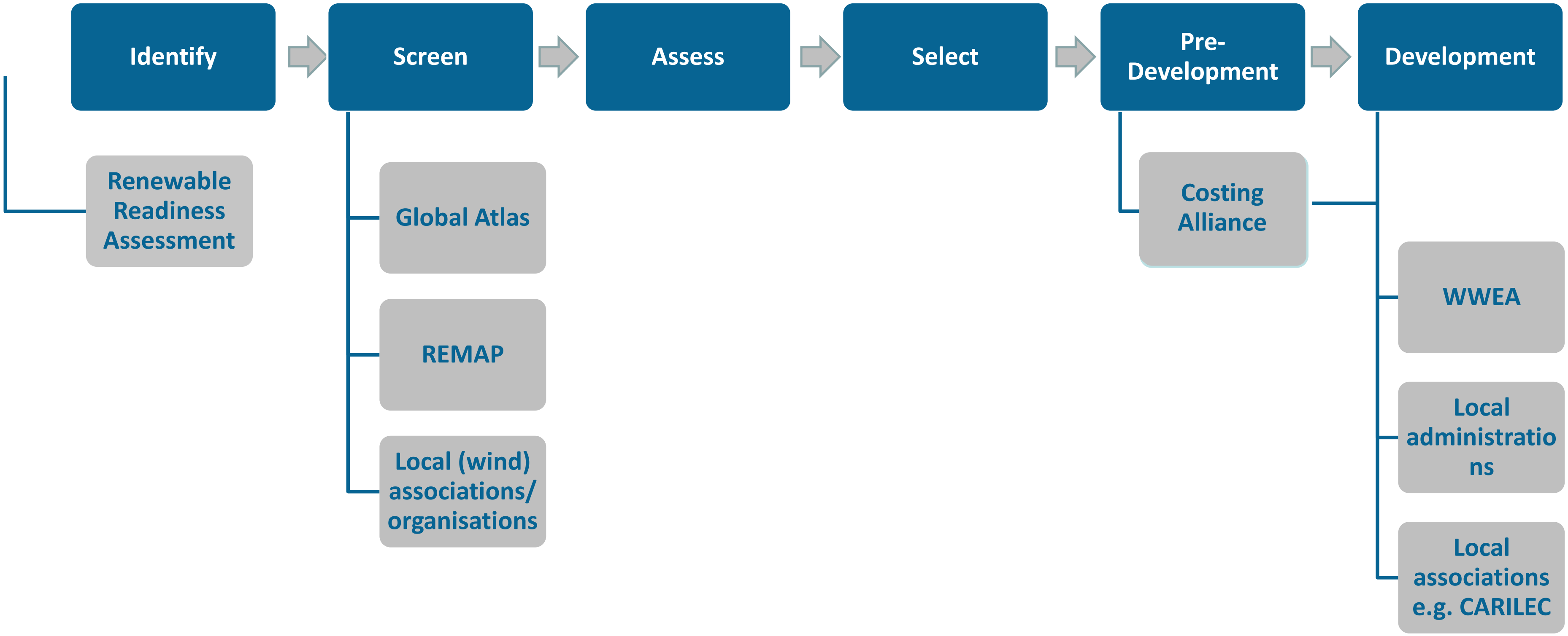
- The technical feasibility study ensures that all the **technical requirements** are fulfilled, and that the chosen technology could be used in an effective and efficient way. However the technical impact and the technical aspects for the financing of the project are obviously not sufficient reflected through technical feasibility study.

- Through all the stages of the development of RET-projects all the related stakeholders, the technical, economic, commercial, organizational and political framework as well the financing of the project needs to be considered.

- In this context, the project development guidelines will look at **technical aspect** of RET and their **impacts** in conjunction with a range of **non-technical** factors for the elaboration of bankable project proposal.

The Project Navigator is a modular approach

The Project Navigator uses a modular approach and can be linked to many activities inside of IRENA as well as outside of the organization.



Focal groups
How they benefit from the Navigator

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Project Developers:

- Indicators of action → How to develop RET projects
- Already advanced projects: Identify needs and gaps
- Indicate funding opportunities
- Capacity building

Administration in member countries:

- Indicators present administrative factors and processes that are essential for RET projects
- Capacity building

Communities/Municipalities:

- Criteria for choosing technologies, locations, consultants etc.
- Capacity building

Financing Sector

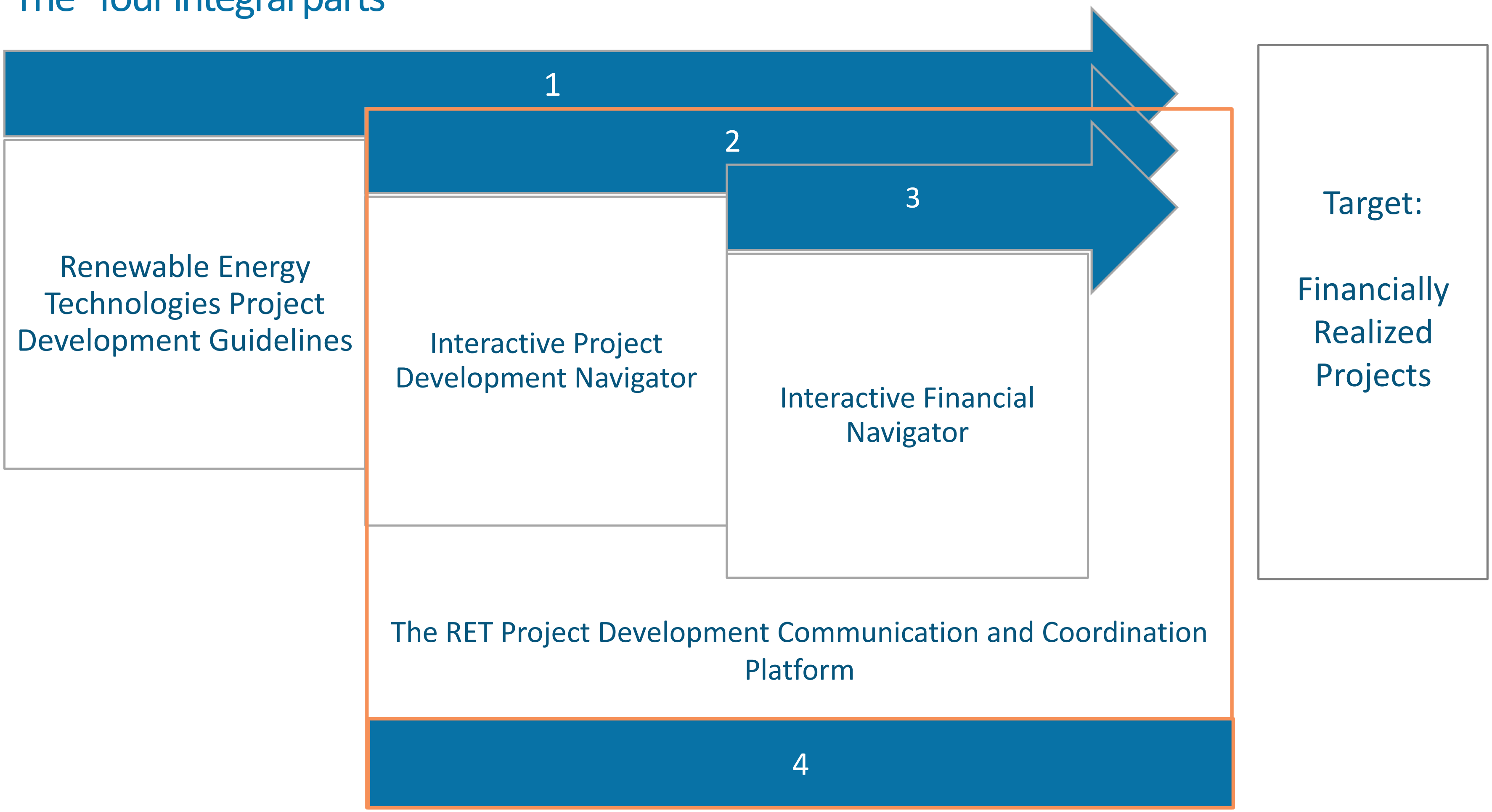
- Globally identify attractive Renewable Energy Technology Projects

Sources:
http://conserve-energy-future.com/Images/SolarEnergy_Advantage.jpg
http://www.fcaministers.com/wp-content/uploads/2012/05/administration.jpeg
http://www.ecodyfi.org.uk/images/turbineandshareholders.jpg
http://dqbasmyouzti2.cloudfront.net/content/images/articles/coins-310x224.png

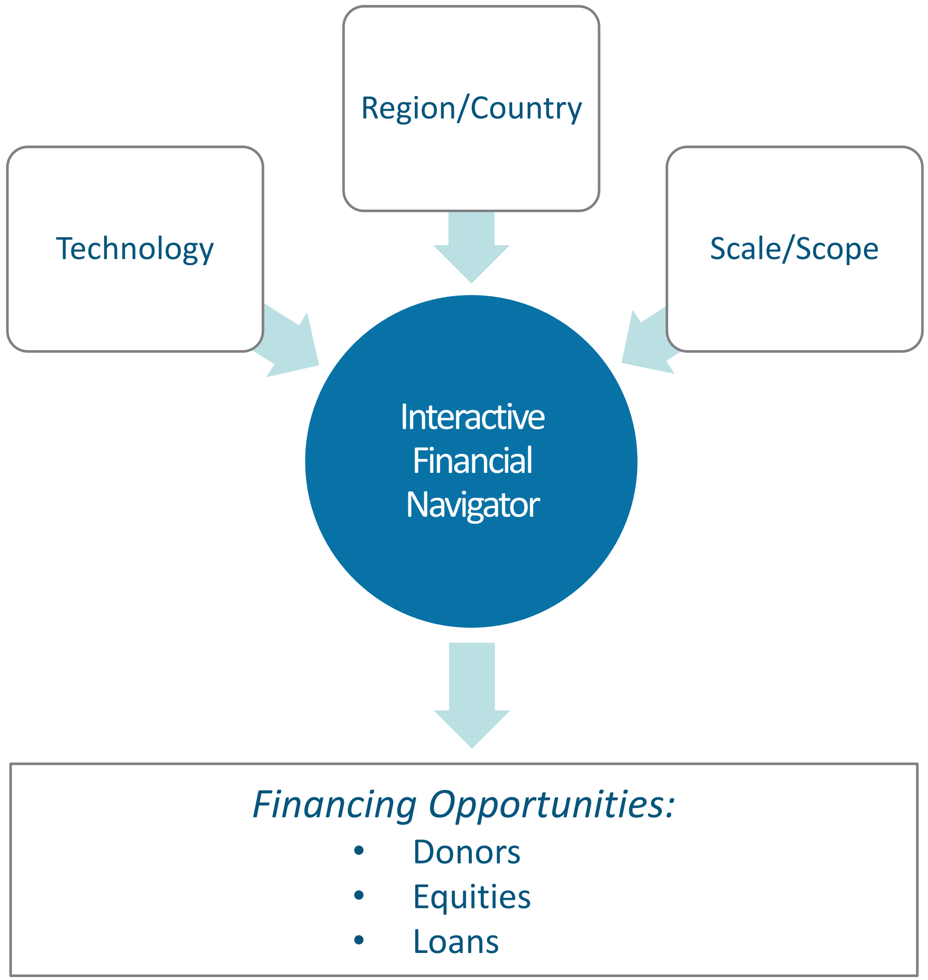
CONCEPT OF IRENA‘s PROJECT NAVIGATOR

Concept & Design

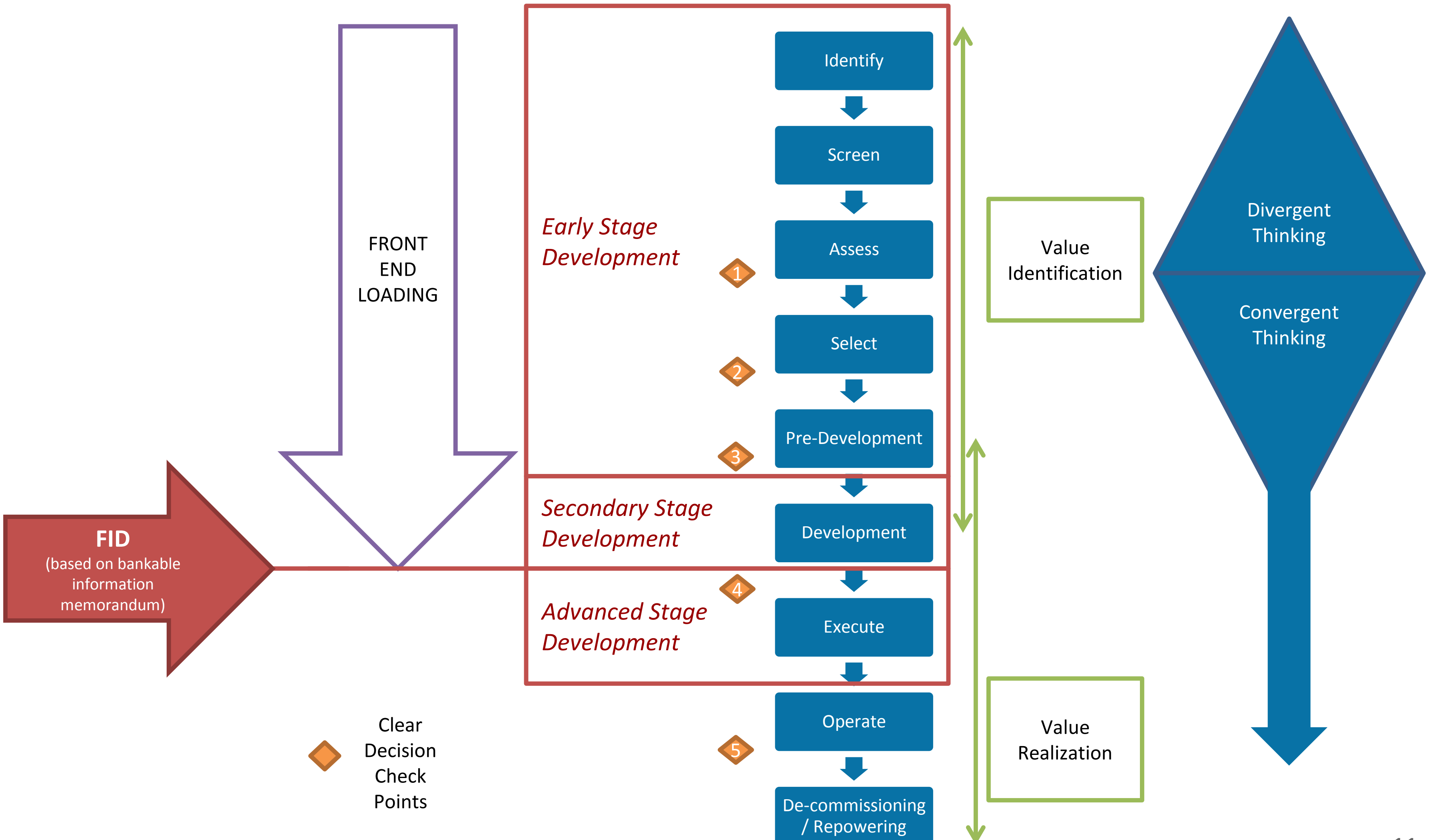
The "four integral parts"



Interactive Financial Navigator



Process Overview



Phases description structure

➔ **To assure an uniformly view over all phases of the RET-project development process, we use the following structure:**

- Definition
- Objectives / Action Plan
- Tools
- Examples & case studies

EXAMPLE OF THE PROJECT NAVIGATOR TOOL:

RISK MANAGEMENT

Pre-Development

➢ ***Objectives / Action Plan:***

- Obtain relevant project data for preparation of technical concept and contractual structure

  - ✓ Stakeholder analysis
  - ✓ TECOP-Assessment
  - ✓ Critical Success Factors (Critical Chain)
  - ✓ Brief Project Profile
  - ✓ Viability analysis

➔ "Starting the project Pre-Development by analyzing the stakeholders and their context helps ensure that the project is adapted to the needs and capacities. But in many cases it is useful to start with the problem in order to identify all the stakeholders concerned."

Identify
↓
Screen
↓
Assess
↓
Select
↓
Pre-Development
↓
Development
↓
Execute
↓
Operate
↓
De-commissioning / Repowering

Sources:

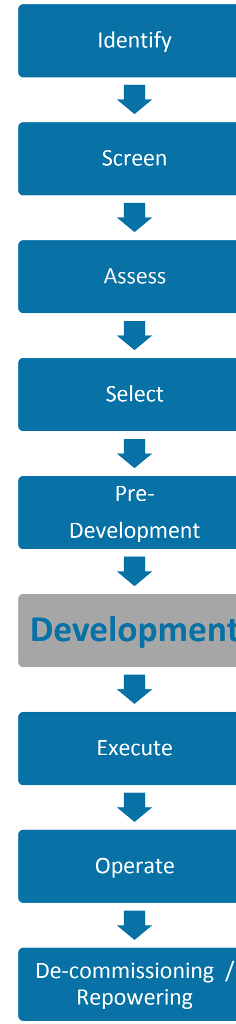
Adapted from: International Labour Organization/International Training Centre(ILO/ITC). 2010. *Project Design Manual.* P. 25

Development(Example)

- ***Tools:***
    - **Risk evaluation & management**-Method:

The method consist of the following elements, performed in the following order:

1. Identify, characterize, and assess threats
2. Assess the vulnerability of critical assets to specific threats
3. Determine the risk (i.e. the expected likelihood and consequences of specific types of attacks on specific assets)
4. Identify ways to reduce those risks
5. Prioritize risk reduction measures based on a strategy



Sources:
Wikipedia: Risk Management Method. April 1, 2013. April 04, 2013 <http://en.wikipedia.org/wiki/Risk_management#Method>

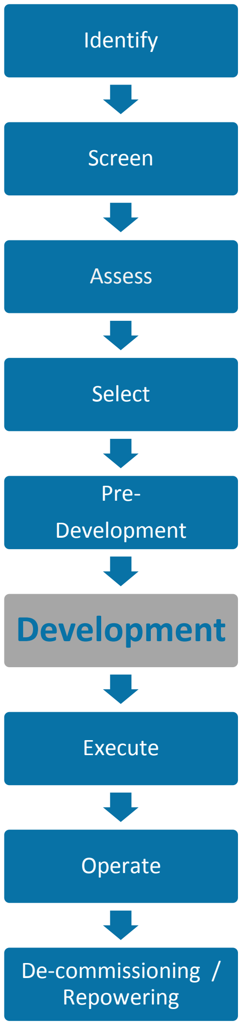
Development(Example)

- ***Tools:***
  - **Risk evaluation & management**-Principles:

The International Organization for Standardization (ISO) identifies the following principles of risk management:

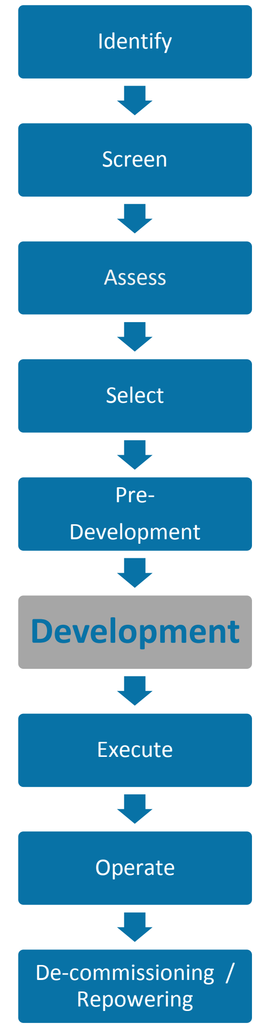
→ Risk management should:

- create value – resources expended to mitigate risk should be less than the consequence of inaction, or (as in value engineering), the gain should exceed the pain
- be an integral part of organizational processes
- be part of decision making process
- explicitly address uncertainty and assumptions
- be systematic, structured and timely
- be based on the best available information
- be tailorable (appropriate to the organization and to the organization's stakeholders, context and risk profile)
- take human and cultural factors into account
- be transparent and inclusive
- be dynamic, iterative and responsive to change
- facilitates continual improvement and enhancement
- be continually or periodically re-assessed



Sources:
- Adapted from: InConsult 2009. *ISO 31000 Overview and Implications for Managers.* P. 3-7
- Adapted from: Wikipedia: Risk Management Method. April 1, 2013. April 04, 2013 <http://en.wikipedia.org/wiki/Risk_management#Method>

Development(Example)



- ***Tools:***
  - **Risk evaluation & management**-Process:

- Completion risk
- Operating risk
- Market and revenue risk
- monetary risk
- increase of the interest rate risk
- Force majeure
- resource risk
- ...

...

Sources:
- H_DA: Energy management - Student case studies (2012)

Development(Example)

➢ ***Tools:***

- **Risk evaluation & management**-Process:
  Exp. : Operating risk (PV solar plan)

•Generation loss due to material wear and material or human error

•Remaining residual risk, no absolute assurance possible

•Supervision of the construction
•Selection of high-quality materials.
•Manufacturer warranties
•Maintenance control

•High quality construction, good maintenance
•Plant requierment oriented operating

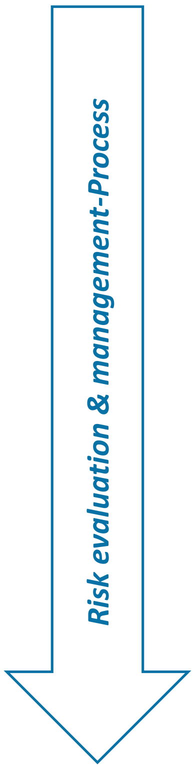
Identify → Screen → Assess → Select → Pre-Development → **Development** → Execute → Operate → De-commissioning / Repowering

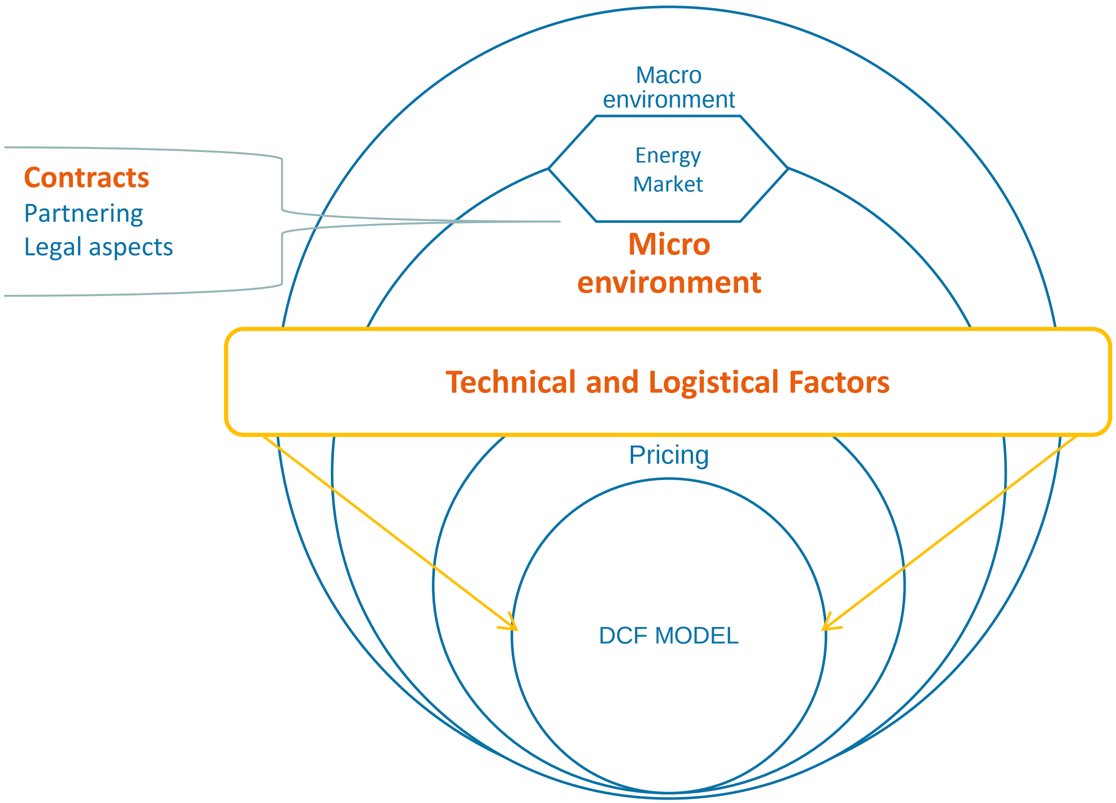
Sources:
- H_DA: Energy management - Student case studies (2012)

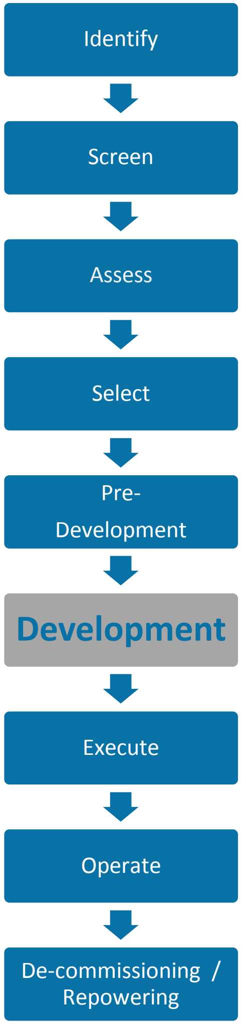
EXAMPLE OF THE PROJECT NAVIGATOR TOOL:

POWER PURCHASE AGREEMENT

Development







Everything needed for the implementation of a project is arranged clearly for the parties that conduct the implementation.

→ All contracts must be ready to be signed after the development phase!

Contracts

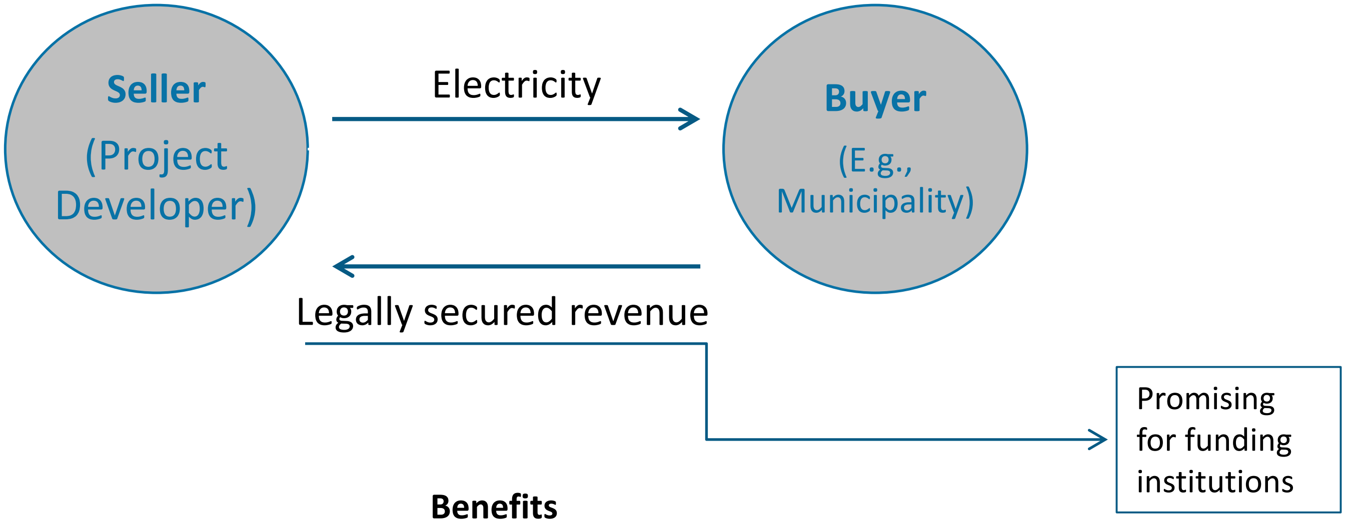
- Definition
- How does the Agreement work?
- Benefits & Risks for the involved parties
- Structure
- Typical legal terms
  - Why are they part of the Agreement?
  - What is usually the content of each section?
- Templates/ Example contracts

Sources:
- Adapted from: Windustry. May 17, 2013. http://www.windustry.org/community-wind/toolbox/chapter-13-power-purchase-agreement>

PPA

Focus on PPA:

- Long-term: 10- 20 years



Benefits

- Secures long-term revenue
- → Lower risk
- → Attractive to funding institutions
- Especially in case of no feed-in tariffs

- Secured supply
- Cleary established and fixed costs
- No up-front costs for buyer
- Seller is responsible for equipment O&M costs

Often: combination of tax credits, rebates and carbon credits available to both parties

Sources:
- The Partnering Initiative: The Benefits and Risks of Partnering. March 12, 2013 <http://thepartneringinitiative.org/w/who-we-are/philosophy-and-approach/the-benefits-and-risks-of-partnering>

PPA

Typical architecture of a PPA

1. Interpretation and defined terms
2. **Sale and purchase of energy**
3. Term
4. Currency, Payments and Billing
5. Pre-operation obligations
6. Interconnection
7. Metering
8. Operation and Maintenance
9. Mutual warranties and covenants
10. Defaults and termination
11. Force majeure
12. Indemnification and liability
13. Insurance
14. Resolution of disputes
15. Notices
16. Miscellaneous Provisions

Typical legal terms

- Why are they part of the Agreement?
- What is usually the content of each section?

PPA

2. Sale and Purchase of Energy

Why: Ensure the utilities supply and the developers incoming cash flows

Standard content:

- **Sale to utility:**
  - **Take-or-pay**
  - **Net energy output**
- **As available Energy Take**
- **Sale to Developer**
- **Energy price**:

Always include arranged percentage of variation!

How a price formula works:

Components change→ Power price adjusts after an arranged period of time

→ New Price = $Base\ Price\ (0.6\frac{New\ Pellet\ price}{Base\ pellet\ price} + 0.4\frac{New\ price\ Parameter\ x}{Base\ price\ parameter\ x}\ldots)$

Example: 1 (0.6* 1.2/1.0+0.4 * 1/1) =1.12

- Example for pricing in a PPA:

Component	Base Price (?USD/kWh)	Adjustment Basis (%)	Adjustment Frequency
Base Price (?/kWh)	2.9	1.5%/a	6 months
Base O&M Charge (USD/a)	2000	2%/a	
Fixed Energy Charge → Helps cover fixed costs (USD/a)	5000		

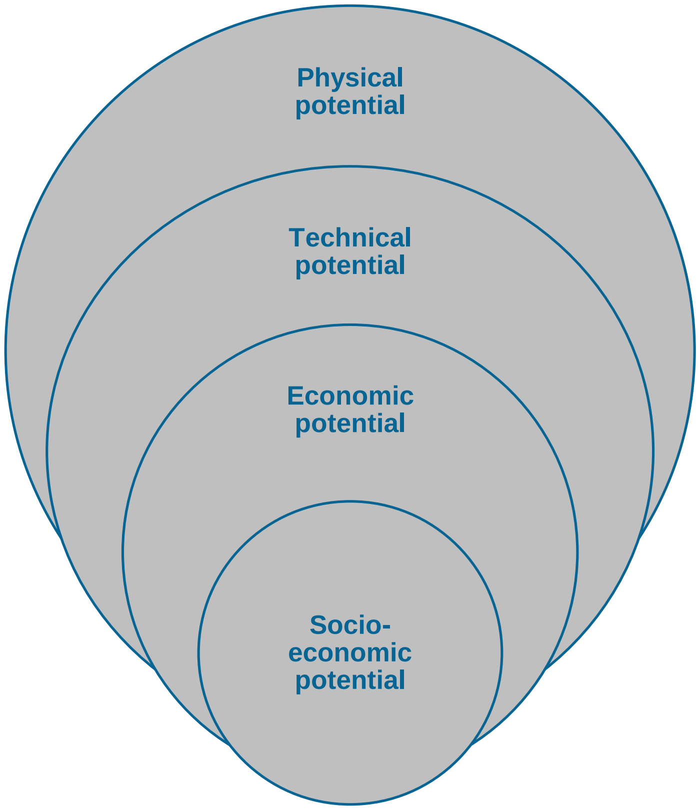
EXAMPLE OF THE PROJECT NAVIGATOR TOOL:

TECHNICAL CONCEPT

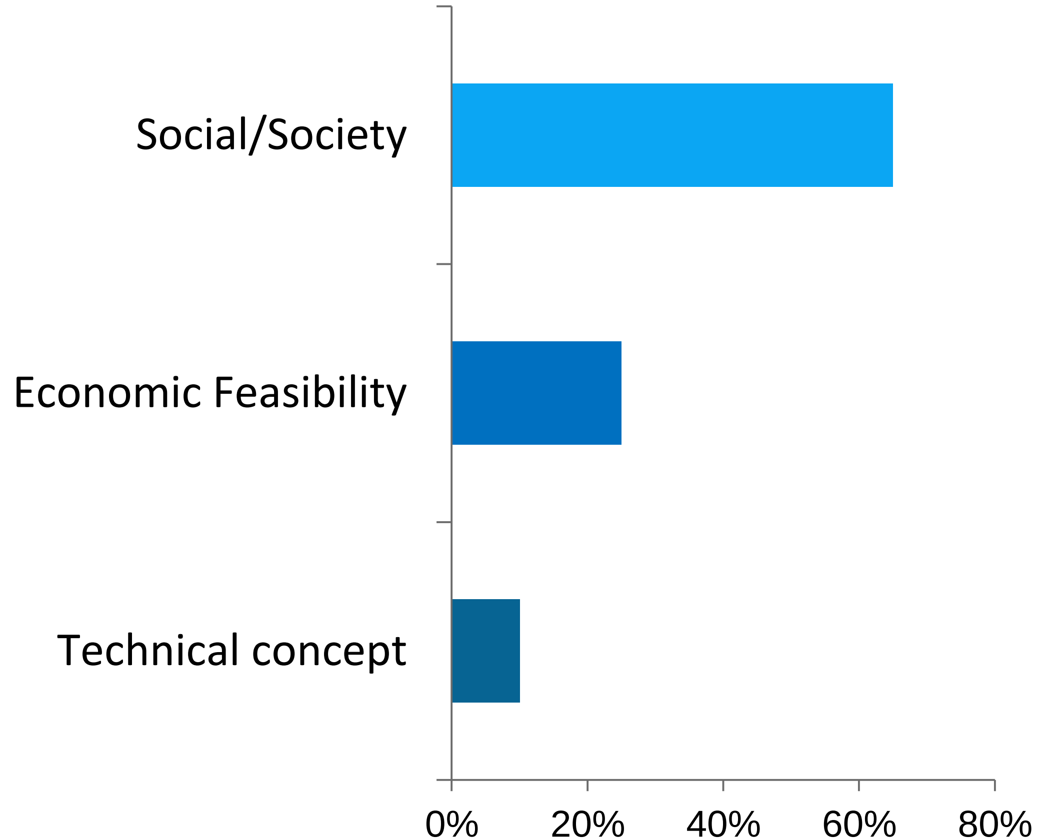
ON-SHORE WIND POWER PLANT

Potential of RET projects

Potential of projects



Reasons for failing projects



Technical Concept

Importance of well conducted Technical Concept:

- Use the **right technical equipment for the specific circumstances** and current existing technical framework

  → Make **maximum use** of the investment:

    - O&M
    - Efficient technology→ Efficient harvesting of the power given in the wind
    - Long operating life

- **Funding Institutions** only want to invest in promising projects

  → Experts check it with due diligence

Problem and solution:

The structure and content of the technical concept varies strongly between the technologies.

→ Navigator can not give detailed universal solutions for all projects, but:

- Suggests the first required actions
- Provide advice and examples
- First overview on typical elements → Raise awareness of important factors/issues
- Suggest various service providers, consultants and experts can help to go more into detail when it comes to the single aspects of a technical concept.

Technical Concept
Wind On-shore

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Site & Resource Assessment

- Wind resource
- Local climate
- Available Area
- Land use
- Topography
- Land cover
- Geotechnics
- Geopolitics
- **Environmental impact assessment**

- Grid Connection
- Accessibility
- Traffic Management and construction

Technology Assessment

- Type, Structure and unit size of Turbines
- Rotor & Rotor Blades
- Electronic Equipment
- Electrical Control System
- **Mechanical Control System**
- Efficiency and Performance
- Training and Service Requirements
- DC/AC System
- Internal Wind Park Cabling

- Sufficient distance between Turbines
- Nacelle, Tower and Foundation
- Decommissioning

Logistic & Construction

CURRENT STATUS AND NEXT STEPS OF THE PROJECT NAVIGATOR

Deliverables and expected added values

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- <u>Deliverables:</u>

<u>*Planned in 2013*</u> <u>*(Up to 2 Regions and 2 RE Technologies)*</u>	<u>*Outlook until 2015*</u> <u>*(Global, all 6 RE Technologies)*</u>
• Completion of the Development Phase • Completion of the Guidelines • 2 Technical Concepts (from Hydro, PV, CSP, Biomass, Wind, Geothermal, Ocean) • Expert Workshops • Up to 5 Pilot Projects • Completion of the Financial Navigator Data base • IT-Implementation of the Project Navigator and the Financial Navigator • Concept for the RET Project Development Communication and Coordination Platform (Online Platform)	• The RET Project Development Guidelines; • The Project Development Navigator; • The Project Financing Navigator; and • The RET Project Development Communication and Coordination Platform • 5 pilot projects

- <u>Expected added Values:</u>
  - More successfully realized RET Projects
  - Less stranded RET Project proposals
  - Effectively reduced costs for RET project development
  - Early access to RE financing sources
  - Higher transparency of financing requirements and procedures for RET Projects
  - Quality improvement and assurance for RET project development
  - Capacity building in RET project development skills

Thank you for your attention !

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Back-up

Development

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- ***Tools:***
  - **Environmental Impact Assessment**

Categories of environmental impact:

- Eco- System
- Health and comfort
- Culture

Impact on flora and fauna

→Differs with the vegetation and wild life of the given areas

- Flora: During construction or as a result of construction
- Wild life: Birds
  - Collisions with the turbine
  - Scaring birds off
  - → Prevent troubles with the public

Source: http://cdn.greenoptimistic.com/wp-content/uploads/2012/04/turbines-birds.jpg

- Examine regional/local land-use plan→ Bird sanctuary/nature protection area? → Usually regulations regarding distances
- Does a directive on conservation of wild birds exist?
- Requirements like species protection assessment? → Field mapping of wild life, (Area for breeding, bird migration, endangered species…)

Sources:
Adapted from: Wizelius, T. *Developing Wind Power Projects, Theory & Practice*. Earthscan. London, 2007. P.155-160

Development

- ***Tools:***
  - **Environmental Impact Assessment**

Sound propagation

- Mechanical noise from nacelle
- Aerodynamic noise from rotor blades
- Emission vs. imission

→Strict regulations that differ between countries/states have to be met to get the needed permissions!

Shadows/ Reflections

- Flickering due to the blade's movement
- Moving from west to east during the day
- Map different zones for shadows and reflections to illustrate the impact

Visual impact on the landscape

- Individual opinion depends mostly on the local general view on wind power
- Turbines are visible up to a distance of 400 times the hub height

  → If the hub height is 80 m, one can see the turbine from a distance up to 32 km!
- Illustrate visual impact from different views in the area

- **Every country or state has different regulations and distances that have to be met!**

Sources:
Adapted from: Wizelius, T. *Developing Wind Power Projects, Theory & Practice*. Earthscan. London, 2007. P.158 - 166

Development

- ***Tools:***
  - **Environmental Impact Assessment Document**

Demanded by many countries for projects above a certain size.

- 2 or more possible options for siting, one of them the zero-option
- Present in a comparable way

Levels of impact described in the EIA Document:

1. Present situation
2. Impact (Change, consequences)
3. Precautions

<u>Construction</u>
<u>Operation</u>
<u>Restoration</u>

Levels need to be considered regarding all impacts

Sources: http://csmres.co.uk/cs.public.upd/article-images/Single-turbine.jpg

Sources:
Adapted from: Wizelius, T. *Developing Wind Power Projects, Theory & Practice*. Earthscan. London, 2007. P.260-264

Development

- ***Tools:***
    - **Environmental Impact Assessment Document**

The EIA document should include the following sections:

- Introduction
- Summary
- Project description
- **Consequences**
- Sound propagation
- Safety
- Nature
- **Visual impact**
- Recreation
- Cultural heritage
- **Comparative assessment**
- **Precautions**
- Conditions, follow- up and inspection
- Public consultation
- Sources
- Appendices

Consequences of each option on: health/safety, environment, recreation, cultural heritage and natural resources

Visual impact: Use photomontages to show how the turbine will look from different viewpoints in the area. Zones of visual impact can be calculated and shown on maps.

Comparative assessment: Underline the preferred option, backed by convincing arguments. The zero-option should describe the area in a 25-years window and not just the direct impact.→ Imply negative impact e.g. if power is not generated by wind, but by fossil fuels.

Precautions: What measures could be taken to minimize/prevent impacts mentioned in the sections?

Sources:
Adapted from: Wizelius, T. *Developing Wind Power Projects, Theory & Practice*. Earthscan. London, 2007. P.261-264

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Development

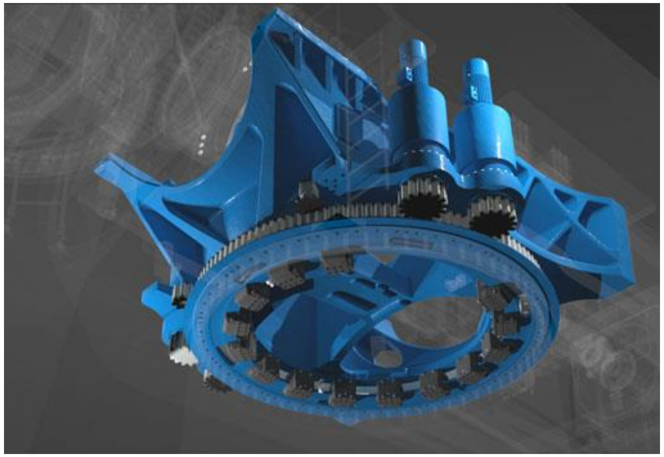
- *Tools:*
  - **Mechanical Control System-Operational Control**

Yaw system

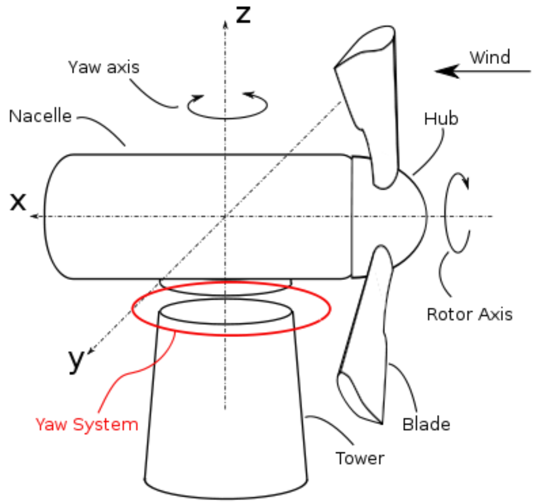
- The rotor should always be perpendicular to the wind
- Wind vane shows what direction the wind is coming from

→ Signal to yaw motor

→ Turn the nacelle



Source: http://www.nordex-online.com/microsites/delta/content/turbine/features/nordex_yaw_system.jpg



Source: http://en.wikipedia.org/wiki/Yaw_drive

- Improves the power output → Evaluate: Additional investment costs and additional O&M costs in relation to optimised energy harvest
- Usually used for large-scale projects

Sources:
Adapted from: Wizelius, T. *Developing Wind Power Projects, Theory and Practice*. Earthscan. London,2007. P.95-66,111-113

Development

- **_Tools:_**
  - **Mechanical Control System→ Operational Control**

Operational control: Rotor blade control

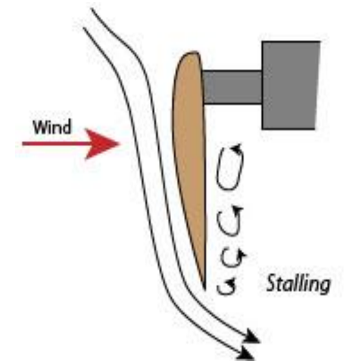
- Control system collects data about the wind speed from the anemometer to
  - Keep the rotational speed at a constant level→ keep the power generation at a constant level
  - Stop the turbine from rotating too fast in high speeds → Prevent damage

Stall controlled rotor blades:

Design of the blade

- uses angle that gives enough lift to get the rotor moving at small wind speeds
- creates turbulences in case of wind speeds above the nominal level

→ Blades can not be adjusted mechanically



Source: http://www.greenrhinoenergy.com/renewable/wind/wind_technology.php

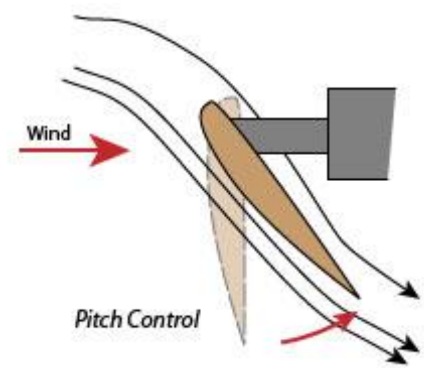
Pitch controlled rotor blades:

Signal by control system to turn rotor blades

- Turn blades to get rotor started at low wind speeds
- Wind speed above the nominal level?

→Blade turns out of the wind

→ Rotor stops moving



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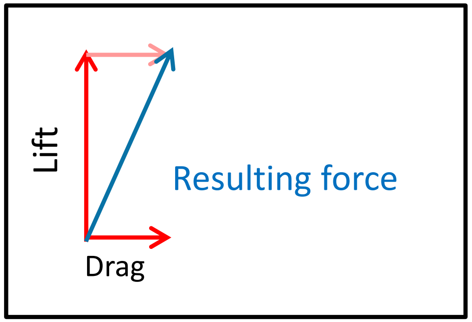
Adapted from: Wizelius, T. *Developing Wind Power Projects, Theory and Practice*. Earthscan. London,2007. P.95-66,111-113

Source: http://www.greenrhinoenergy.com/renewable/wind/wind_technology.php

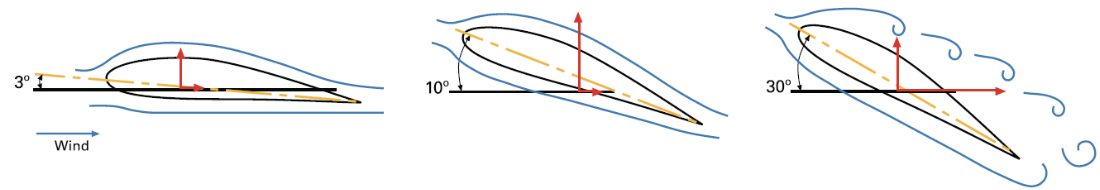
Development

➤ ***Tools:***

- **Mechanical Control System→ Operational Control – Pitch controlled rotor blades**

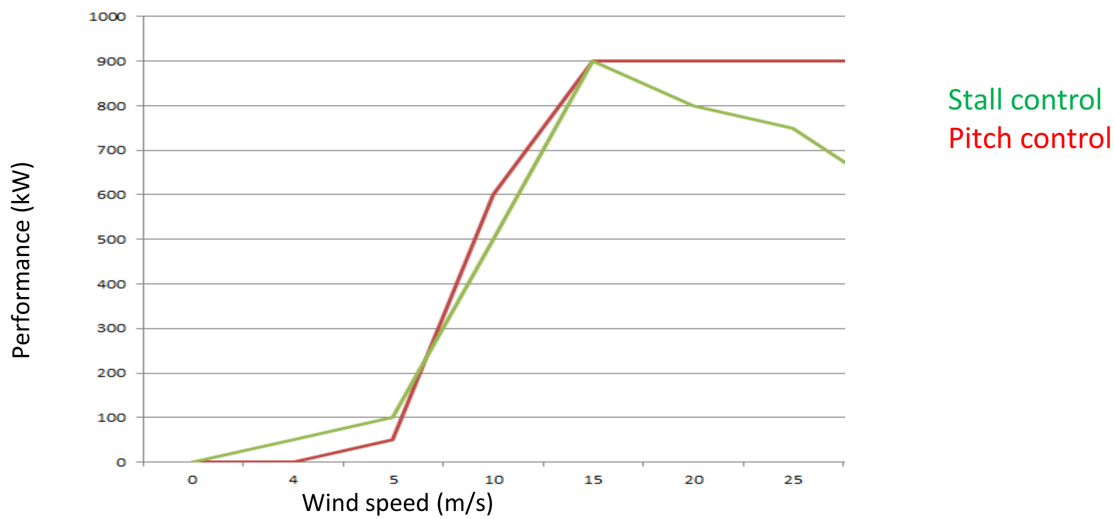


Optimize Lift-Drag ratio



Source: http://www.gurit.com/files/documents/2_aerodynamics.pdf

Adapt the angle of attack to keep the generated power at a constant level



Sources:
Adapted from: Wizelius, T. *Developing Wind Power Projects, Theory and Practice*. Earthscan. London,2007. P.95-66,111-113

Development

- ***Tools:***

  - **Mechanical Control System→ Operational Control**

Stall control vs. Pitch control

<u>Advantages</u>
- Rotor starts turning at low wind speed
- No control system needed

<u>Disadvantages</u>
- No control during operation
- Difficult to design
- Maximum performance can’t exactly be forecasted
- After reaching its maximum the performance decreases

<u>Advantages</u>
- Blades can be turned to start at low speed
- Blade can turn out of the wind to stop the turbine
- The optimal rotational speed can be kept even in wind speeds above the nominal level
- When reaching its optimum the performance stays at a constant level
- In too high wind speeds blades turn out of wind to prevent damages

Disadvantages:
- Costs

- Optimization:

Additional costs vs. energy output

Sources:
Adapted from: Wizelius, T. *Developing Wind Power Projects, Theory and Practice*. Earthscan. London,2007. P.95-66,111-113

Development

➢ ***Tools:***

- **Mechanical Control System-Operational Control**

- **Surveillance**:
  - Temperature in Gearbox and Generator
  - Pressure in hydraulic systems
  - Vibration in machine components and rotor blades
  - Voltage and frequency in generator and grid

  In case of fault: Turbine stops and the system sends alarm to the operator → Restart / → Repair

→ Data are saved to enable a detailed analysis later on

- **Operations follow up**:
  - The system collects, processes and presents data in readable form
  - Data: Wind speed; outages; production…

Sources:
Adapted from: Wizelius, T. *Developing Wind Power Projects, Theory and Practice*. Earthscan. London,2007. P.95-66,111-113

Source materials

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- http://www.ecodyfi.org.uk/images/turbineandshareholders.jpg
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