International Finance Corporation
World Bank Group

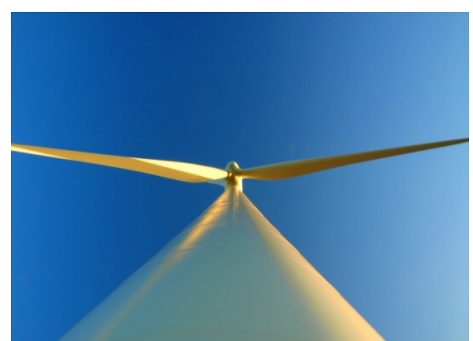
ESMAP
Energy Sector Management Assistance Program

PRESENTATION BY SOREN KROHN

WIND POWER CONSULTANT

APRIL 23, 2014

PUBLIC PROCUREMENT OF WIND ENERGY PROJECTS LESSONS LEARNED



Perspective of Presentation

KEY VANTAGE POINTS:

- Point of view of Government of …, or its national utility
- What the TTL can do in terms of regulatory framework, stuff the Transaction Advisor will take as a fact
- Primarily about procurement of IPP/BOO projects, not EPC

=>

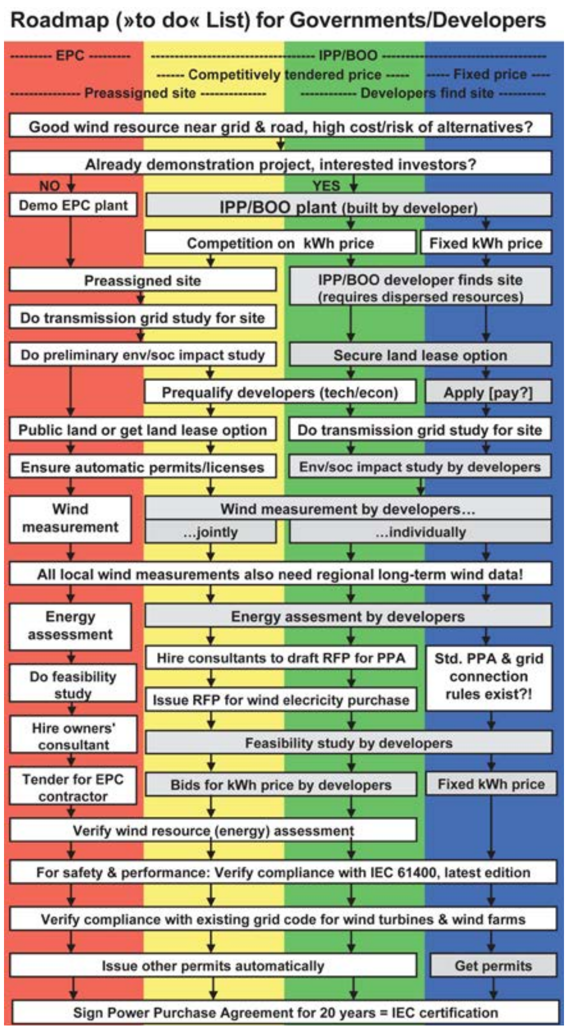
- … i.e. not about how to build a wind farm
(the developer/bidder does that in a BOO project)
- … but about how to make successful wind IPP projects i.e. obtain minimum tariff and minimum risk

Public Procurement of Wind Energy Programs

PRESENTATION CONTENT

- RE policy considerations
- Choice of procurement model & tariff scheme interlinked
- Tariff scheme affects capacity factor & grid use
- Key steps in procurement process depending on scheme
- Essential technical requirements for IPPs
- Importance of Environmental and Social Impact Assessments
- Local content requirement issues

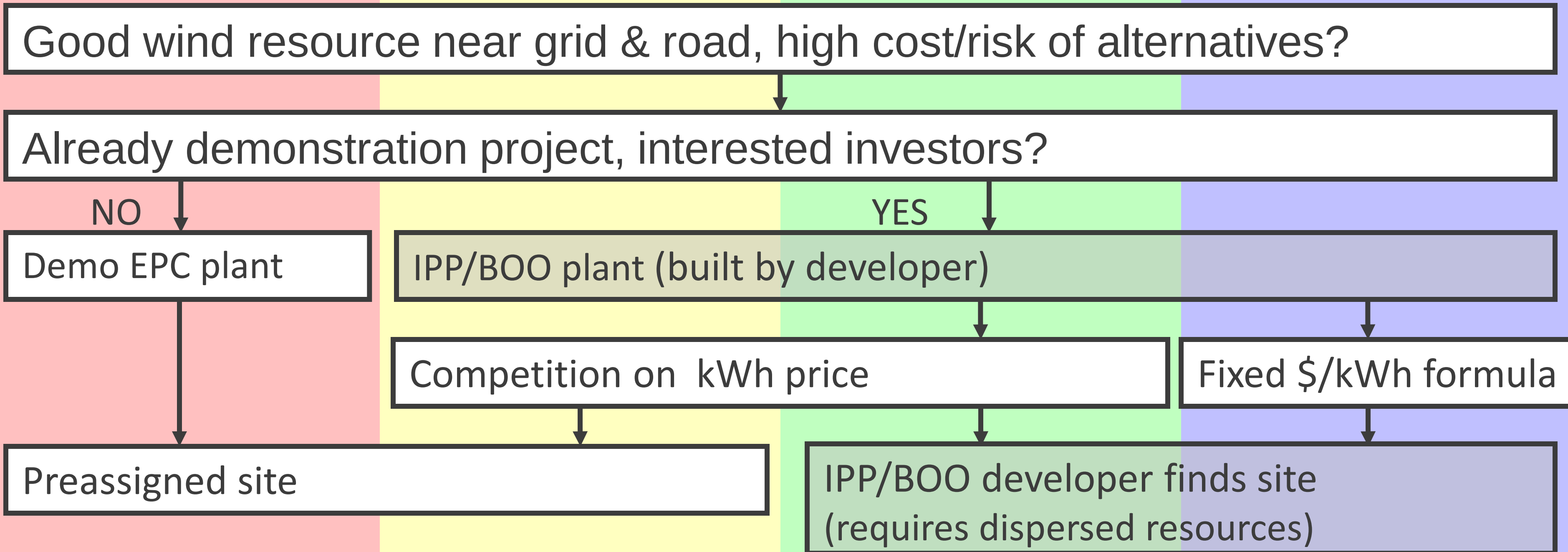
Roadmap variants:
(white – govt. action)
(grey – developer action)



- Who does what steps…
  i.e. government or developer?
  …depends on
  tariff scheme & siting scheme
  and their interaction

- 1 EPC (demo project) – red
- 2 Competitive tenders on preselected sites – yellow
- 3 Competitive tenders on sites found by developers – green
- 4 Feed-in tariff schemes – blue
- 5 Negotiated deals (depends…)

Roadmap (»to do« List) for Governments 1



Denmark	Denmark offshore		Denmark onshore
Egypt	Egypt	Egypt	Egypt
Germany			Germany
Mexico	Mexico	Mexico	
		Ontario	Ontario
Québec		Québec	
Syria	Syria		
Thailand			Thailand
Yemen	Yemen		
			Kenya, Vietnam

Choice of Tariff Scheme in a Developing Country

IMPORTANT POLICY CONSIDERATIONS PART 1

Competitive Bidding

Market determines price

… minimizes rent (no windfall profits for developers)

… allows choice between pre-selected or dev. selected sites

… allows transmission planning & optimization (MA, QC examples)

… not a problem who pays for transmission and other elements

… transparent scheme, no need for special tax incentives etc.

Feed-in Tariff (FIT)

Market determines MW volume

… hard to estimate efficient pricing model in advance

… developers select sites, not suitable w/concentrated resource

… puts pressure on transmission planning, grid congestion queue?

… must plan who pays for any cost element including grid

… incentives important, zoning issues critical, corruption prone

Choice of Tariff Scheme in a Developing Country

IMPORTANT POLICY CONSIDERATIONS PART 2

Competitive Bidding 2

… incomplete regulation (e.g. grid code) can be solved ad hoc by »regulation by contract«

… public land lease can be integrated in process and can be non-exclusive (QC example)

… permitting process (must be) integrated in RFP and quasi-automatic

... MW volume is controlled

Feed-in Tariff (FIT) 2

… requires complete and transparent regulatory scheme

… competition for scarce physical resources (transmission grid, public land leases)

… competition for regulatory resources (permits) –resource lock-up by unqualified bidders

… if tariff scheme is profitable queuing or quasi-market rationing develops

Choice of Tariff Scheme

IMPORTANT POLICY CONSIDERATIONS PART 3

Predetermined sites

- Stepwise development, no prior experience with wind IPP
- Control volume and transmission grid expansion
- Wind resources well mapped and good resources highly concentrated (e.g. Egypt)
- Requires thorough pre-development, i.e. preliminary resource measurements, site selection, ESIA, logistics survey
- Often used to separate markets

Developers find sites

- Prior experience with wind IPPs, regulatory framework OK
- Transmission grid planning & costing procedure in place
- Wind resource large and dispersed
- Developers take care of pre-development, sufficient regulatory & administrative capacity available
- Open to all qualified developers

Standard Tariff Scheme in Wind PPAs

Applies to all tariff system types

- 20 year term (certified technical lifetime)
- Payment for energy only, (even if no variable costs!)
- Hard currency unless local long-term capital market
- Single tariff (regardless of peak/off-peak)
- No indexation, except for O&M
  (local wages + imported spare parts)
- Priority dispatch, i.e. take-or-pay contract
- Compensate generator fully for planned as well as unplanned grid interruption
- If predetermined site, compensate for unplanned…
  … EIA issues, e.g. birds (change of law)
  … upstream »wind theft«

Tariff Schemes and Bid Criteria Create Incentives

TARIFF DETERMINES OPTIMAL CAPACITY FACTOR & EFFICIENCY OF TRANSMISSION GRID USE

Table 1. Wind Energy Royalty Scheme (Nominal Rules)

Full load hours/year MWh/MW/year	= Capacity factor MWh/MW/8760	Marginal royalty rate for tranche	Maximum cumulative royalty at top end of interval Full load hours/year
< 2500	<28.5%	0%	0
2500-3000	28.5%-34%	10%	50
3000-3500	34%-40%	20%	150
3500-4000	40%-45.7%	40%	350
4000-4500	45.7%-51.4%	60%	650
>4500	>51.4%	80%	...

Table 3. Wind Turbine Selection for a Site in an IPP/BOO tender [8]

Type	kW	Rotor diam m	Hub height m	MWh/year	Full load hours MWh/MW	Capacity factor MWh/MW/8760	Turbine price M EGP	Project investment M EGP	Investment EGP/MWh/yr
V90-3.000	3000	90	80	7,088.58	2,363	27.0%	18.5	22.2	3,132
V90-3.000	3000	90	90	7,496.98	2,499	28.5%	19.5	23.4	3,121
V112-3.000	3000	112	94	10,383.68	3,461	39.5%	27.2	32.64	3,143
V90-1.800	**1800**	**90**	**80**	**6,046.65**	**3,359**	**38.3%**	**15.5**	**18.6**	**3,076**

Table 4. Wind Turbine Selection for a Site Under Royalty Scheme

Type	kW	Rotor diam m	Hub height m	MWh/year	Full load hours MWh/MW	Capacity factor MWh/MW/8760	Turbine price M EGP	Project investment M EGP	Investment EGP/MWh/yr
V90-3.000	3000	90	80	7,088.58	2,363	27.0%	18.5	22.2	3,132
V90-3.000	**3000**	**90**	**90**	**7,496.98**	**2,499**	**28.5%**	**19.5**	**23.4**	**3,121**
V112-3.000	3000	112	94	10,383.68	3,319	37.9%	27.2	32.64	3,278
V90-1.800	1800	90	80	6,046.65	3,237	37.0%	15.5	18.6	3,192

General Approach to Technical Requirements

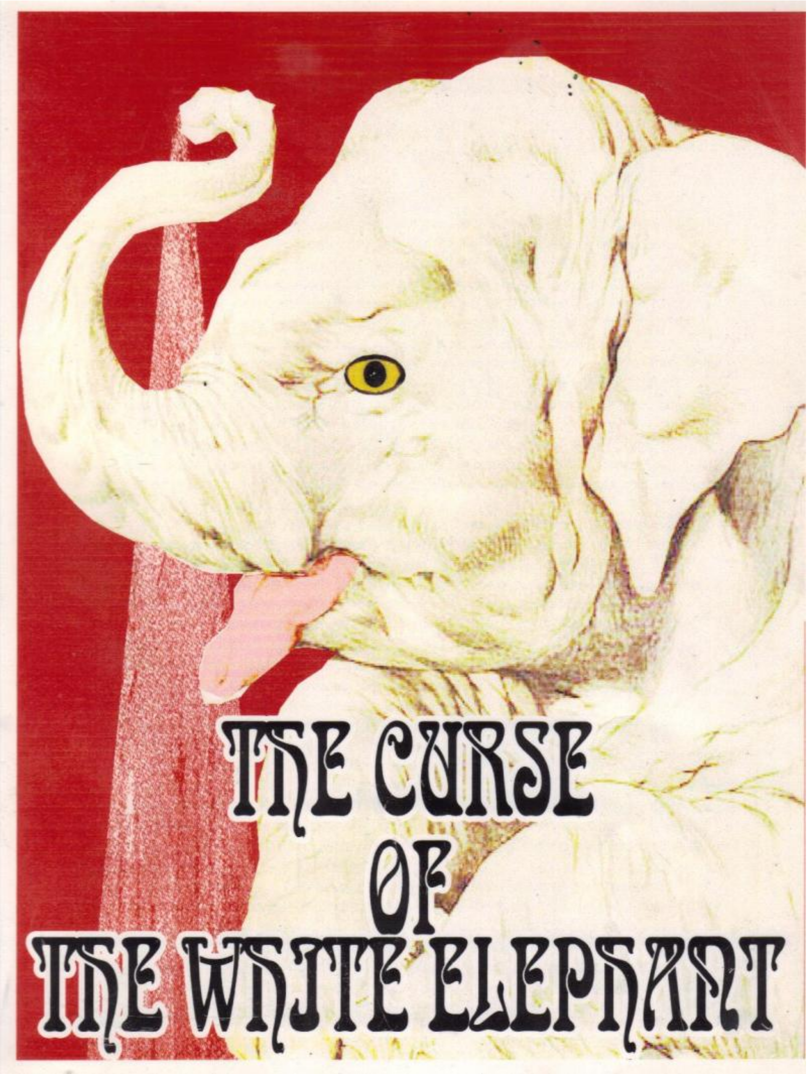
GENERAL POLICY CONSIDERATIONS – REGARDLESS OF TYPE OF IPP/BOO SCHEME

Minimize technical requirements

- Experienced developers know how to build wind farms efficiently

Use wind industry best practice standards

- Don't apply loose norms to attract competition; serious developers & manufacturers are attracted by solid norms that keep out non-serious actors



Technical Problem Example: Improper O&M

Met mast with loose guy wires & tilted anemometers, Al Mokha, Yemen

Wind Resource Assessment Requirements

ESSENTIAL TECHNICAL REQUIREMENTS TO REDUCE PROJECT RISK

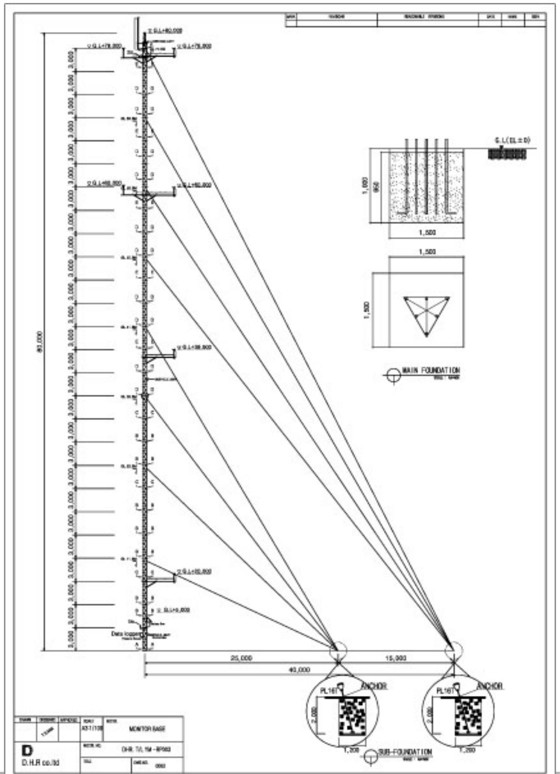
- Wind Resource Risk must be carried by the developer, in order to incentivize efficient site selection, site layout, technology choice, and proper O&M
- Very limited scope for government or RFP employer to measure site wind resource (but plenty of scope for long-term regional measurements by government)
- Demand bankable measurements, i.e. instruments mounted in accordance with IEC 61400-12-1, MEASNET calibrated First Class instruments with redundancy, post campaign calibration, 95% data recovery, cellular or satellite data collection, full mast documentation & O&M history log, verification by accredited consultant, WAsP software modeling, experienced modeler…
  + Sufficient duration depending on long-term data quality & number of masts depending on site topography complexity. Need WB standard TOR!

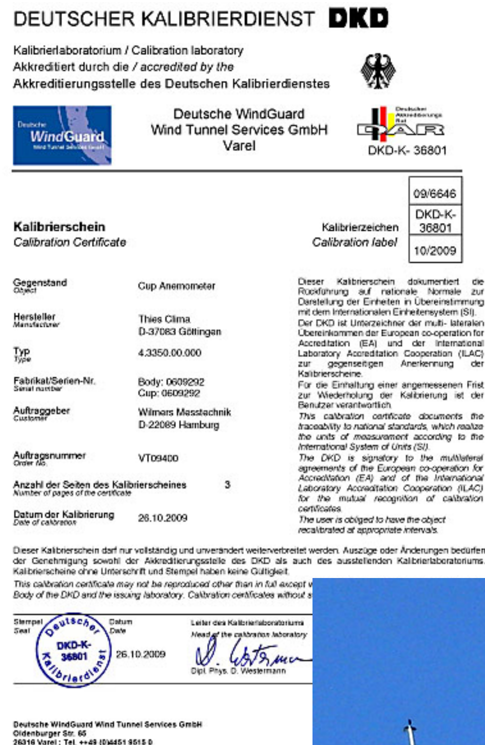
Correct Meteorology Mast Example

80 M METEOROLOGY MAST WITH SATELLITE COMMUNICATION, GULF OF SUEZ , EGYPT

Mast and its O&M Documentation + Raw Data

ESSENTIAL TECHNICAL REQUIREMENTS TO REDUCE PROJECT RISK





DEUTSCHER KALIBRIERDIENST **DKD**

Kalibrierlaboratorium / Calibration laboratory
Akkreditiert durch die / *accredited by the*
Akkreditierungsstelle des Deutschen Kalibrierdienstes

Deutsche WindGuard
Wind Tunnel Services GmbH
Varel

DKD-K- 36801

Kalibrierschein
Calibration Certificate

Kalibrierzeichen
Calibration label

09/6646
DKD-K-36801
10/2009

Gegenstand *Object*	Cup Anemometer
Hersteller *Manufacturer*	Thies Clima D-37083 Göttingen
Typ *Type*	4.3350.00.000
Fabrikat/Serien-Nr. *Serial number*	Body: 0609292 Cup: 0609292
Auftraggeber *Customer*	Wilmers Masstechnik D-22089 Hamburg
Auftragsnummer *Order No.*	VT09400
Anzahl der Seiten des Kalibrierscheines *Number of pages of the certificate*	3
Datum der Kalibrierung *Date of calibration*	26.10.2009

Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).
Der DKD ist Unterzeichner der multi- lateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine.
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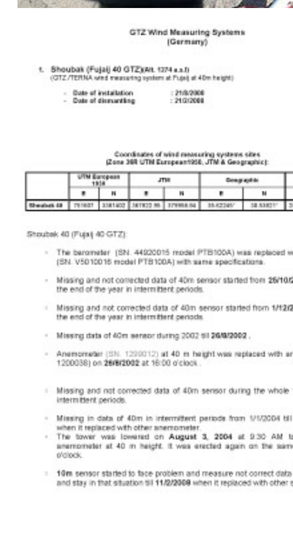
Stempel *Seal* — Deutscher Kalibrierdienst DKD-K-36801
Datum *Date* 26.10.2009
Leiter des Kalibrierlaboratoriums *Head of the calibration laboratory*
Dipl. Phys. D. Westermann

Deutsche WindGuard Wind Tunnel Services GmbH
Oldenburger Str. 65
26316 Varel ; Tel. ++49 (0)4451 9515 0



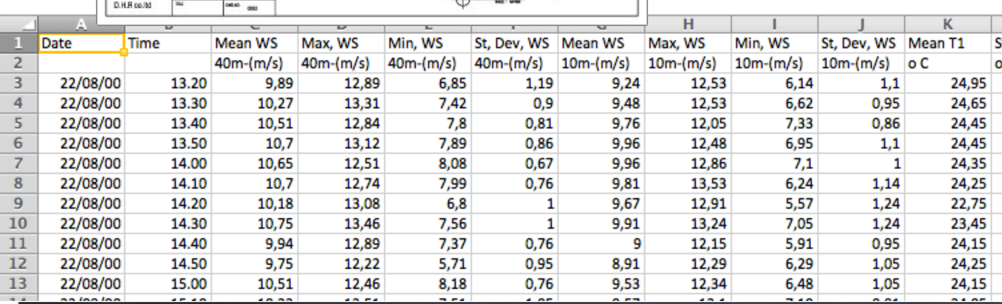
GTZ Wind Measuring Systems
(Germany)

1. Shoubak (Fujaij 40 GTZ)(Alt. 1374 a.s.l)
(GTZ /TERNA wind measuring system at Fujaij at 40m height)

Coordinates of wind measuring systems sites
(Zone 36R UTM European1950, JTM & Geographic):

Shoubak 40 (Fujaij 40 GTZ):

- The barometer (SN. 44920015 model PTB100A) was replaced w... (SN. V5010016 model PTB100A) with same specifications.
- Missing and not corrected data of 40m sensor started from 25/10/... the end of the year in intermittent periods.
- Missing and not corrected data of 40m sensor started from 1/12/... the end of the year in intermittent periods.
- Missing data of 40m sensor during 2002 till **26/8/2002** .
- Anemometer (SN. 1299012) at 40 m height was replaced with ar... 1200038) on **26/8/2002** at 16:00 o'clock .
- Missing and not corrected data of 40m sensor during the whole ... intermittent periods.
- Missing in data of 40m in intermittent periods from 1/1/2004 till ... when it replaced with other anemometer.
- The tower was lowered on **August 3, 2004** at 9:30 AM t... anemometer at 40 m height. It was erected again on the sam... o'clock.
- **10m** sensor started to face problem and measure not correct data ... and stay in that situation till **11/2/2008** when it replaced with other s...



Date	Time	Mean WS 40m-(m/s)	Max, WS 40m-(m/s)	Min, WS 40m-(m/s)	St, Dev, WS 40m-(m/s)	Mean WS 10m-(m/s)	Max, WS 10m-(m/s)	Min, WS 10m-(m/s)	St, Dev, WS 10m-(m/s)	Mean T1 o C	St... o...
22/08/00	13.20	9,89	12,89	6,85	1,19	9,24	12,53	6,14	1,1	24,95	
22/08/00	13.30	10,27	13,31	7,42	0,9	9,48	12,53	6,62	0,95	24,65	
22/08/00	13.40	10,51	12,84	7,8	0,81	9,76	12,05	7,33	0,86	24,45	
22/08/00	13.50	10,7	13,12	7,89	0,86	9,96	12,48	6,95	1,1	24,45	
22/08/00	14.00	10,65	12,51	8,08	0,67	9,96	12,86	7,1	1	24,35	
22/08/00	14.10	10,7	12,74	7,99	0,76	9,81	13,53	6,24	1,14	24,25	
22/08/00	14.20	10,18	13,08	6,8	1	9,67	12,91	5,57	1,24	22,75	
22/08/00	14.30	10,75	13,46	7,56	1	9,91	13,24	7,05	1,24	23,45	
22/08/00	14.40	9,94	12,89	7,37	0,76	9	12,15	5,91	0,95	24,15	
22/08/00	14.50	9,75	12,22	5,71	0,95	8,91	12,29	6,29	1,05	24,25	
22/08/00	15.00	10,51	12,46	8,18	0,76	9,53	12,34	6,48	1,05	24,15	

Turbine Technology Requirements: No Prototypes

ESSENTIAL TECHNICAL REQUIREMENTS TO REDUCE PROJECT, HEALTH & SAFETY RISKS

- Turbines must be fully production certified by an accredited entity in accordance with IEC 61400-1 latest edition as fit for purpose in the site environment
- Turbine must be certified to meet known climate requirements that exceed the standard classes, e.g. fully operational at ambient temperatures of 45°C or -30°C, at mean wind speeds above class I, typhoons, earthquakes
- Turbine model must have been used in at least two commercial wind farms of at least 20 MW each for at least 1-2 years with an availability rate of at least 95%
- Turbine must be compliant with grid code requirements (from major markets, say, Germany , Spain, Denmark)

Turbine Certification Requirement Example

Dust Protection, air-conditioned kiosk for electronics (max 45°C), Egypt

Wind Farm Performance Requirement Examples

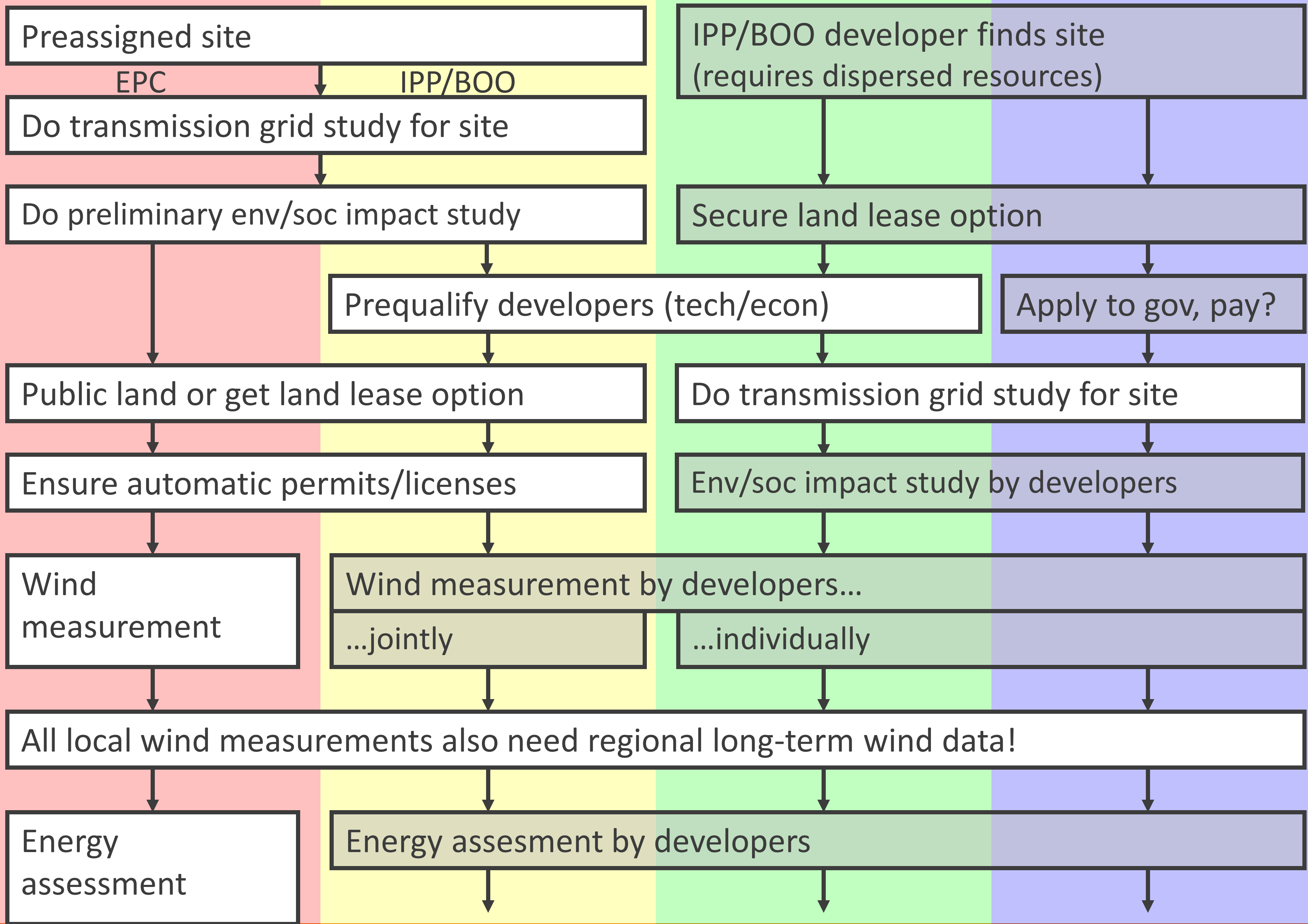
ESSENTIAL TECHNICAL REQUIREMENTS TO REDUCE PROJECT RISK AND STABILIZE GRID

- Guaranteed availability
  (SCADA access to all turbines to know availability rate)
- Guaranteed wind farm power curve
  (Upstream meteorology mast to verify performance)

  …both sanctioned by liquidated damages

- Maximum ramp rate, e.g. 10 MW/min
- Ability to curtail production 0-100% by remote control
- Grid code requirements, e.g. fault ride though, voltage, frequency, reactive power control, harmonics

Roadmap (»to do« List) for Governments 2

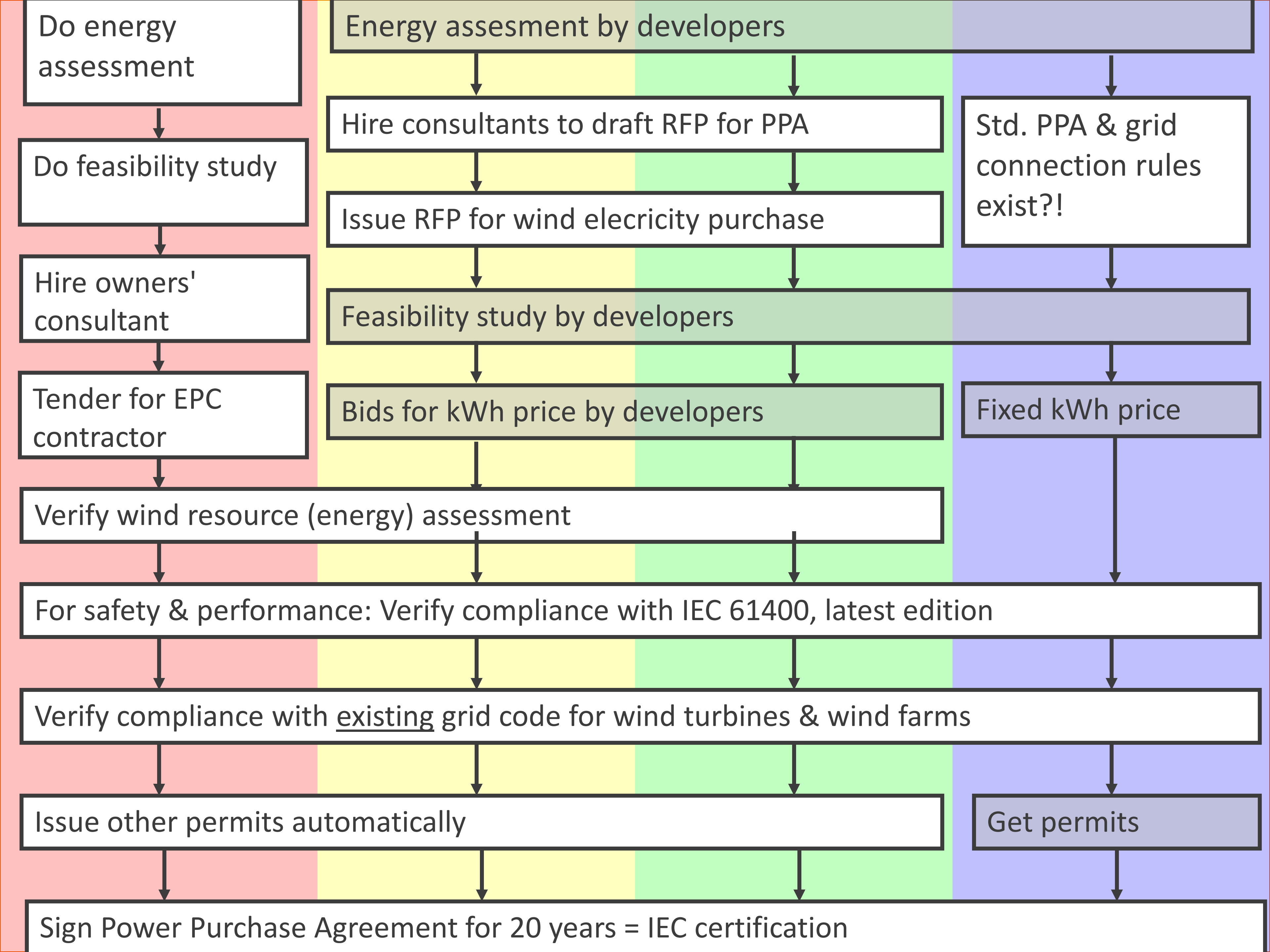


Examples of Importance of ESIA <u>Before</u> Bidding

For competitively tendered projects on preselected sites

- Property rights and localization of residences must be determined before bidding.
  … if not: Project had to be moved after winning bidder had been selected.

- Full bird study (both spring and autumn) with <u>operational</u> recommendations (turbine free zones, bird corridors, shutdown on demand) required – if in critical zone.
  … if not: Bids were not comparable since bidders planned siting differently and accounted differently for expected energy losses. Rebid required.


Do energy assessment
Energy assesment by developers
Hire consultants to draft RFP for PPA
Std. PPA & grid connection rules exist?!
Do feasibility study
Issue RFP for wind elecricity purchase
Hire owners' consultant
Feasibility study by developers
Tender for EPC contractor
Bids for kWh price by developers
Fixed kWh price
Verify wind resource (energy) assessment
For safety & performance: Verify compliance with IEC 61400, latest edition
Verify compliance with existing grid code for wind turbines & wind farms
Issue other permits automatically
Get permits
Sign Power Purchase Agreement for 20 years = IEC certification

Local Content Requirements

Typical issues – why it rarely happens (except in Morocco now)

- All countries want to do this – and base it on exports(!)
- Requires a critical mass of about 1000 MW
- Requires that all orders go to a single manufacturer
- Requires a stable, long pipeline of orders, min. 5 years
- Time horizon beyond 2-3 years requires bid price indexation
- Rotor blades: Require specialized equipment, raw materials imported.
- Forget generators and gearboxes (regional volume needed)
- ISO 9000 series certification of supply chain required
- Foundations, roads, electrical works: Locally procured anyway
- Towers: Economic to manufacture locally anyway (>100 MW)

La Venta II, Oaxaca, Mexico

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SOREN KROHN, WIND POWER CONSULTANT

SK@SKPOWER.NET

+1-202-468-2902

Thank You.

The World Bank | 1818 H Street, NW | Washington DC, USA
www.esmap.com | esmap@worldbank.org