Wind Energy in Latin America
Challenges and Solutions

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Overview

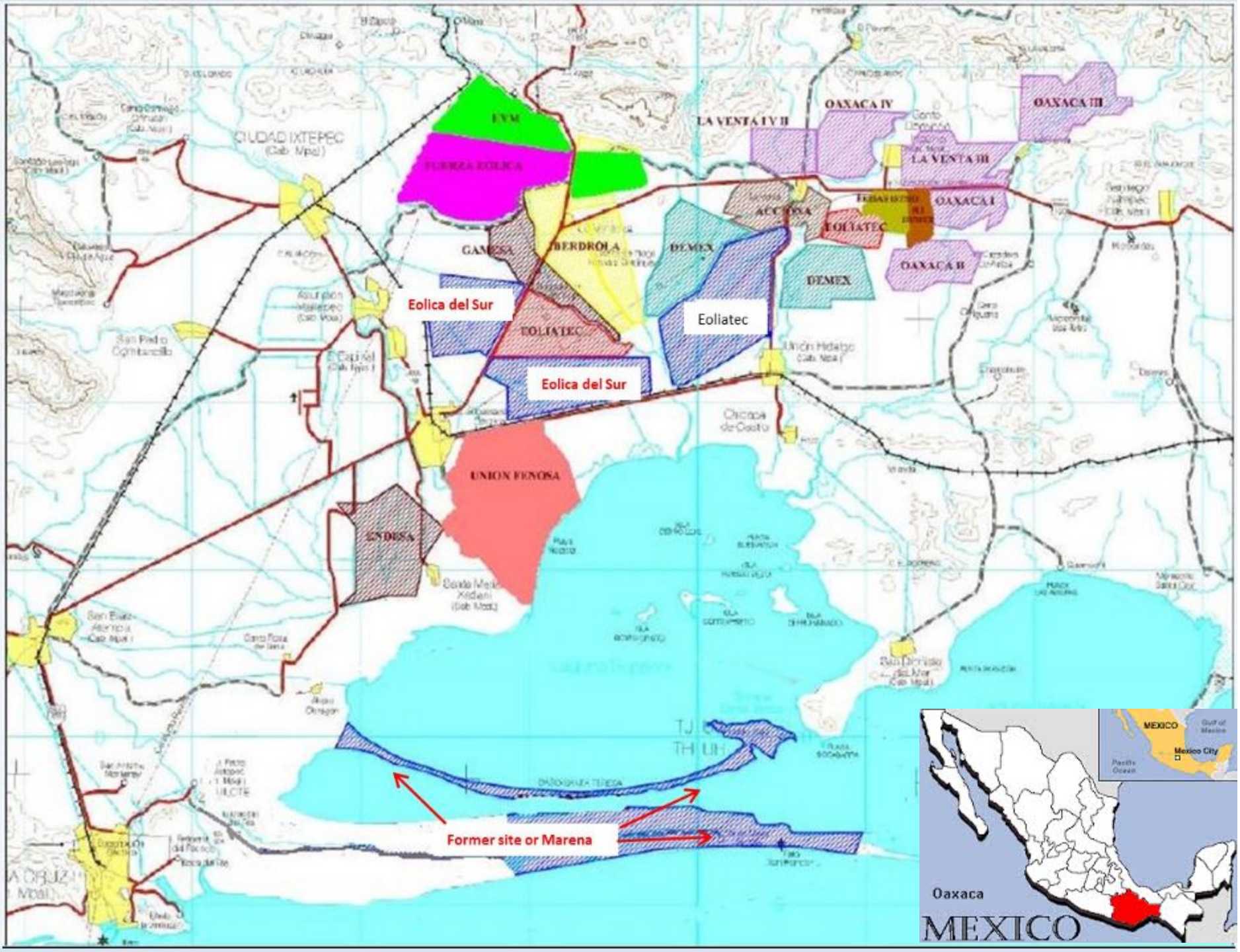
- The Bank has made a commitment to invest 25% of total lending to support climate change initiatives, renewable energy, and environmental sustainability by 2015.

- Wind energy development in expansion in LAC

BUT…no free lunch…

Today's talk:

- Problems encountered in Mexico
- Complex issues = no magic solutions
- Our approach → adaptive management
- Presentation of the post contruction monitoring protocol


EVM
FUERZA EOLICA
CIUDAD IXTEPEC
(Cab. Mpal.)
LA VENTA I V II
OAXACA IV
OAXACA III
LA VENTA III
OAXACA I
OAXACA II
ACCIONA
EOLIATEC
DEMEX
GAMESA
IBERDROLA
Eolica del Sur
Eoliatec
Eolica del Sur
UNION FENOSA
ENDESA
Former site or Marena
MEXICO
Mexico City
Oaxaca
MEXICO

Projects in operation			
Project name	**Developer**	**Start date**	**MW**
La Venta	CFE	1994	1.6
La Venta II	CFE	2006	83.3
Parques eolicos de Mexico	Iberdrola	2009	79.9
Eurus, phase I	Cemex/Acciona	2009	37.5
Eurus, phase II	Cemex/ Acciona	2010	212.5
Bii Nee Stipa I	Iberdrola	2010	26.4
Electrica Valle de Mexico	EDF	2010	67.5
Fuerza Eolica del Istmo	Penoles	2011	50
Fuerza Eolica del Istmo II	Penoles	2012	30
La Venta III	CFE/Iberdrola	2012	102
Oaxaca I	CFE/EYRA	2012	101
Oaxaca II, III and, IV	CFE/Acciona	2012	306
Bii Nee Stipa II	Gamesa/Enel	2012	74
Piedra Larga, phase I	Renovalia/ Demex	2012	90
Eoliatec del Istmo	EDF	2012	163.4
Bii Nee Stipa III	Gamesa/Enel	2012	70
Piedra Larga	Demex	2012	90
Eoliatec del Pacifico	Eoliatec	2013	160
Bii Hioxio	Union Fenosa	2014	227.5
Sub-total			**1,972.6**
Projects in development/construction			
Bii Stinu	Eoliatec del Istmo	2015	164
EES	Eolica del Sur	2016	396
Bii Nee Stipa	Cisa-Gamesa	2016	288
Desarollos Eolicos Mexicanos	Renovalia	2017	227.5
Zapoteca de Energia	Alesco S.A. de C.V.	2017	140
Sub-total			**1215.5**

The Problems…

After three years of post construction data (2 wind farms):

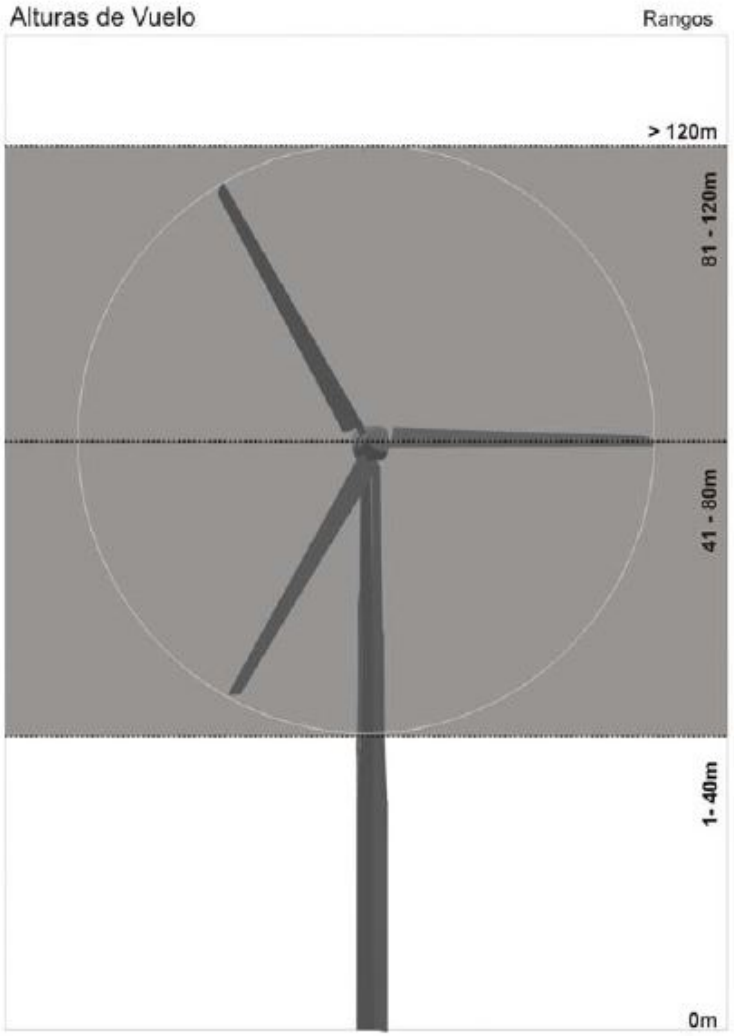
- **Significant** level of birds and bats fatalities
- Impacts predictions in EIA were totally wrong…
- Mitigation measures not adequate

Why….we missed it?

- Computer modelling…doesn't work
- Flight altitude versus collision risk zone…unreliable data
- Flight movements very dynamic and changing
- Presence of other wind farms influence the flight patterns …?

Flight altitude and collision risk assessment…

Category	Flight altitude interval	Collision risk
1	1 - 40 m	No risk
2	40 - 80 m	No risk
3	80 - 120 m	Risk
4	120 - 160 m	No risk
5	Above 160 m	No risk



The findings

The facts:

- 80% of the fatalities occurs over two weeks in October
- 75% of these, 1-3 days within the passage of a cold front
- 90% at nighttime
- less than 5% or turbines responsible of more than 60% of the fatalities

The puzzle:

- How to detect flocks of birds in low visibility conditions?
- Birds still do collide with fixed structures…does shutdown really works ?
- What is an acceptable threshold of mortalities ?
- How to monitor impacts on the flyway corridor?
- How to find out if other wind farms alters the flight path ? (avoidance)
- How to convince clients…when knowing that ultimate objective will unlikely works ?
- How to be better prepared in advance to manage this issue for a new project in the same area ?

Adaptive management

Steps:

- Evaluate post construction monitoring data
- Determine if additional measures are warranted

Decision guided by the following triggers:

a) *IUCN red list status of impacted taxa;*

b) *Other national or international conservation listing status of impacted taxa;*

c) *Potential for impacted species to experience population level impacts as a result of the observed mortality;*

d) *The observation of species or risk issues at the site that were not identified during the preconstruction risk assessment and which warrant significant consideration with respect to environmental impacts; and*

e) *Fatality impacts significantly high.*

Corrective Action Plan, wind farm Mexico, Fall 2014

- Shutdown trial of 3 selected turbines
- Remove all white lights on the turbines/substation
- Test sound devices on 3 turbines
- Stop the free-wheeling on all turbines
- Install the Anabat on 5 turbines
- Cut in speed adjustments trial
- Increase maintenance of artificial water ponds
- Thorough monitoring to assess efficiency of measures
- Cost: 50-60K

Preventive measures…trying to see ahead the problems

Mitigation measures	Project phase	Comments
EES will purchase the software "Increased Cut-In Wind Speed" (ICIWS) produced by Vestas	Pre-construction	ICIWS is a software solution designed by Vestas to reduce the wind farm mortality rate for bats, while having the smallest possible impact on energy yield and profits.
EES will purchase the Obstacle Collision Avoidance System (OCAS) produced by Vestas	Pre-construction	OCAS is a low-energy radar system sited at the wind power plant that activates the lights when an aircraft is operating in the vicinity of the farm.
EES will continue to undertake pre-construction studies on birds and bats.	Pre-construction	These studies will be used to identify presence of species of concern, evaluate their behavior and use of the site and, to evaluate risk.
EES will install mitigation devices such as the aerial marker spheres (orange balloons) on the guy wires of the meteorological towers.	Pre-construction	Increasing the visibility of the guy wires will contribute to limit fatalities. The spacing between the spheres should be about 100 m.
EES will install on each nacelles only red blinking light. No steady white burning light will be installed on the nacelles.	Construction	It has been documented that steady burning white light confuse night flying birds and cause collisions. This type of light also attracts insects which attracts bats.

Preventive measures

EES will install a lighting system on the two substations (El Espinal and Juchitan) that is carefully designed.	Construction	Lights should be downward facing. An operational system should be implemented to ensure that the strict minimum of steady white lights required per Mexican regulations are left on at night.
EES will only keep the strict minimum numbers of met. towers (masts)	Construction	Unnecessary met towers should be dismantled once all the wind speed data had been gathered.
EES will install line marking devices on the transmission line 230 kV -115 kV segment under its responsibility.	Construction	It has been documented that birds do usually collide with the highest component of the transmission line with the earth wire (also called shield or ground wire). Increasing the visibility and thickening of this wire is key in reducing fatalities. Suspended fixed devices such as the Firefly should be privileged and installed each 15-20 m apart on the earth wire.
EES will implement a post-construction monitoring protocol of birds/bats fatalities for an initial duration of three years following the start of operation.	At the start of operation	The results will help to determine the patterns of birds/bats fatalities such as problematic turbines, highest periods of fatalities, species affected etc. Overall, results will help to refine the mitigation measures and the need to implement additional one.
EES will proceed to regular maintenance of artificial pond of water near the turbines.	Throughout operation	Water bodies attract birds and bats, maintenance of ponds created by heavy rain accumulation will be conducted.

Corrective/Adaptive measures

ESS will proceed to a selective shutdown of turbines	Operation	This measure will only be implemented if the results of post-construction monitoring demonstrate detrimental effects on birds.
EES will eliminate free- wheeling on selected turbines	Operation	This measure will only be implemented if the results of post-construction monitoring demonstrate detrimental effects on bats.
EES will proceed to adjustments in the increase of the cut-in speed for selected turbines	Operation	This measure will only be implemented if the results of post-construction monitoring demonstrate detrimental effects on bats.

For birds, additional measures will require a mandatory selective shutdown of turbines up to a maximum of 10% of the total number of turbines of the entire Project, for a maximum of 4 hours per day at nighttime between 10pm and 6 am up to a 15 consecutive day's period in the peak migratory period of the fall season between September 15 and October 31 inclusively.

For bats, measures will require to increase the cut-in speed up to 5.5 m/s on up to a maximum of 10% of the turbines for a maximum of 4 hours per day at nighttime between 8pm and 6 am up to a 8 weeks period in the early fall season between August 15 and October 15 and, the permanent elimination of free-wheeling on up to 25% of the turbines.

Post-construction monitoring protocol

- Increasing number of wind power projects
- Need for a standardized methodology accross the region
- Determine with more certainty if fatalities level is problematic
- Contribute to the understanding of cumulative impacts
- Protocol developed is evolving

Post – construction monitoring protocol

Project categorization		Category A				Category B		
Study Duration		**Three Years**				Two Years		
Carcass Search Frequency		Every 1-3 days during principal migratory periods. Daily for one week per month during other times of year, year-round.						
Minimum Number of Turbines Searched	Number of turbines in project →	1–10	11–20	21–40	41–60	61–90	91–120	**121 +**
	Number turbines searched →	all	10 turbines	½ 50% of all turbines	20 turbines	30% of all turbines	30 turbines	**25% of all turbines**
Search area subsampling		Searching restricted to easy to moderate visibility class habitats within a circular area around the base of the tower with a radius equivalent to the height of the tower plus 30 meters.						
Selection of turbines		Homogenous habitats (randomly) Heterogeneous habitats (non-randomly in order to cover all habitat types found within the wind farm)						
Scavenging bias correction		Use a value of $\mathbf{S_c}$ calculated as follows, $\mathbf{S_c} = 1 - \frac{1}{1+p}$ where p = the observed average carcass persistence time of found carcasses at the site						
Detectability bias correction		Use the following values for S_e: 0.6 for small birds and bats, 0.8 for large birds						
Mortality estimator		$\mathbf{C = c / (A * S_c * S_e * P_t)}$						

Implementation challenges

- Consistency throughout the years…is it possible ?
- Correction factors…Are they adequate?
- What is the “fall” pattern? Can ballistic theory help?
- How many hurt but did not dropped dead?
- How many avoided the area ? What is the impact on the migration pattern?

Other issues…Cumulative impacts….

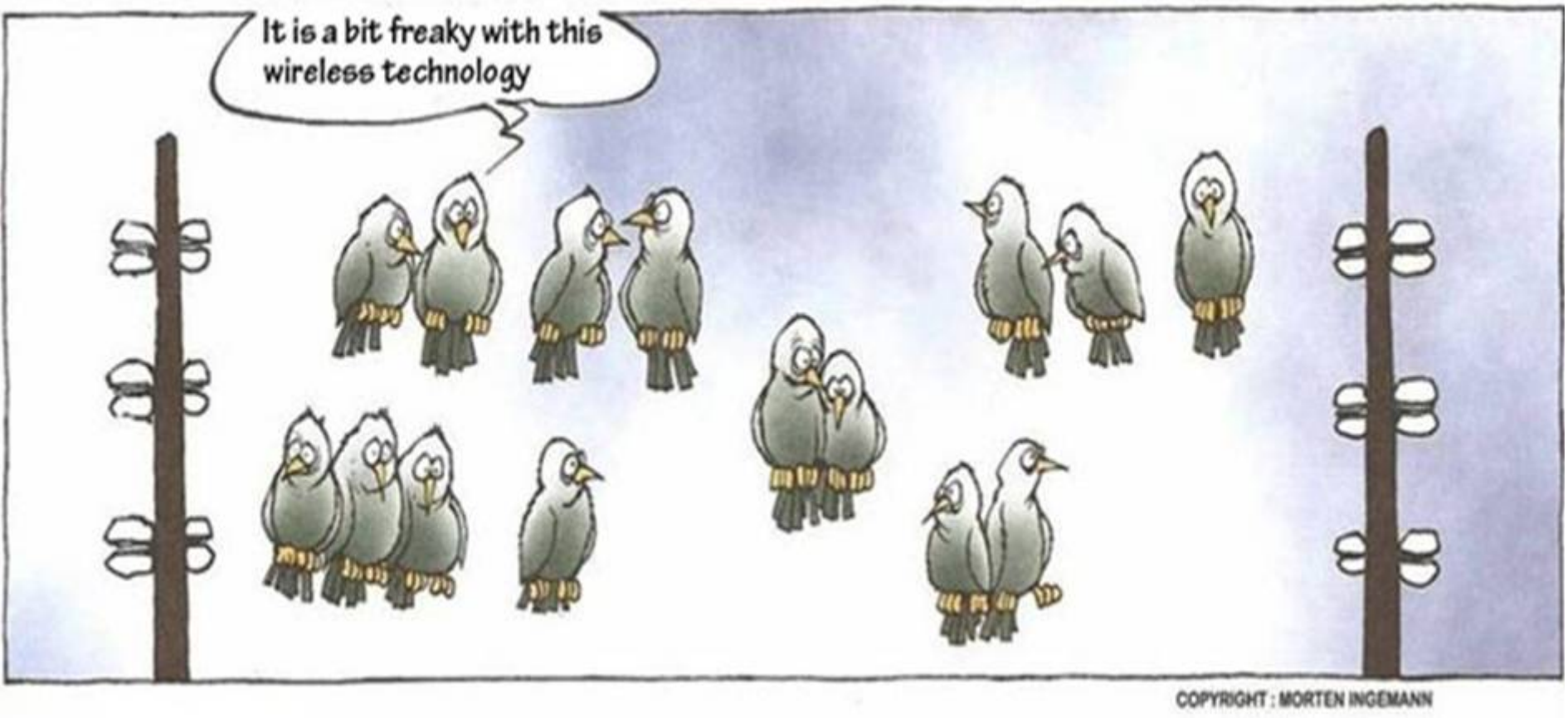
Challenges

- Consistency of methodology
- Reluctance of clients to share data
- Competition between companies
- Absence of regional leadership

Potential solutions…

- Development of a standardized monitoring protocol
- Creation of a database, a web interface
- Support a regional champion
- Reinforce the regulatory framework

Transmission lines…



Transmission lines

Concluding remarks

- Understanding patterns of fatalities help us to refine mitigation measures
- Cost effectiveness is critical
- Project's level of fatalities varies through years
- Lessons learned in 2 wind farms in Mexico benefit all the other wind farms, better projects

Legend

- The statistical equation for the calculation of the estimator is as follows:

$$C = \frac{c}{(Ax * Sc * Se * Pt)}$$

where,

- **C** is the overall estimated fatality rate for the facility, expressed in terms of number of fatalities/MW name plate capacity/year and is calculated separately for birds and bats;
- **c** is the number of carcasses actually found during the standardized searches;
- **A** is the proportion of area under turbines that was searched; determined by dividing the total area actually searched by the total area within radius **x** of all searched turbine towers, where **x** is the height of the turbine tower;
- **Sc** is the proportion of carcasses not removed by scavengers prior to carcass searching; calculated as

- $$\mathbf{Sc = 1 - \frac{1}{1+p}}$$

- where ***p*** is the average number of days that a found carcass persists at the site before being consumed or removed by scavengers
- **Se** is a fixed value representing the proportion of carcasses successfully discovered by searchers during carcass searching, predetermined based on prior empirical studies as a conservative minimum searcher efficiency for substrates of easy to moderate searchability (0.6 for bats and small birds, 0.8 for large birds); and
- **Pt** is the proportion of turbines searched within the overall wind farm (i.e., turbines searched/total number of turbines operating at the wind farm).