Study on the environmental impact of high voltage overhead lines and underground cables (380 kV)

Customer: German Federal Ministry of Environment (BMU)

apl. Prof. Dr.-Ing. Karsten Runge

Presentation at RGI Cable Workshop, 13.02.2013

Purpose, methods and contents

- Synopsis of the environmental effects of different grid technologies at the 380 kV level based on compressed and comprehensible presentations

- Synoptic literature study based on:
  - environmental and nature conservational studies,
  - technical descriptions as well as
  - adequate environmental impact studies (EIS)

- Structure based on the EU Environmental Impact Assessment Directive:
  - human beings, fauna and flora,
  - soil, water, air, climate and landscape,
  - material assets and cultural heritage,
  - as well as interactions.

Workflow

- Research on environmental impacts of various cable and overhead line variants (typical natural areas in Germany)
- Generalized ratings of effect intensities, period of effectiveness, spatial extension as well as sensitivity of potentially concerned natural assets
- Evaluation of possibilities for avoidance, mitigation and compensation
- Working out a checklist on environmental impacts

Human health: Diverging risiko perception

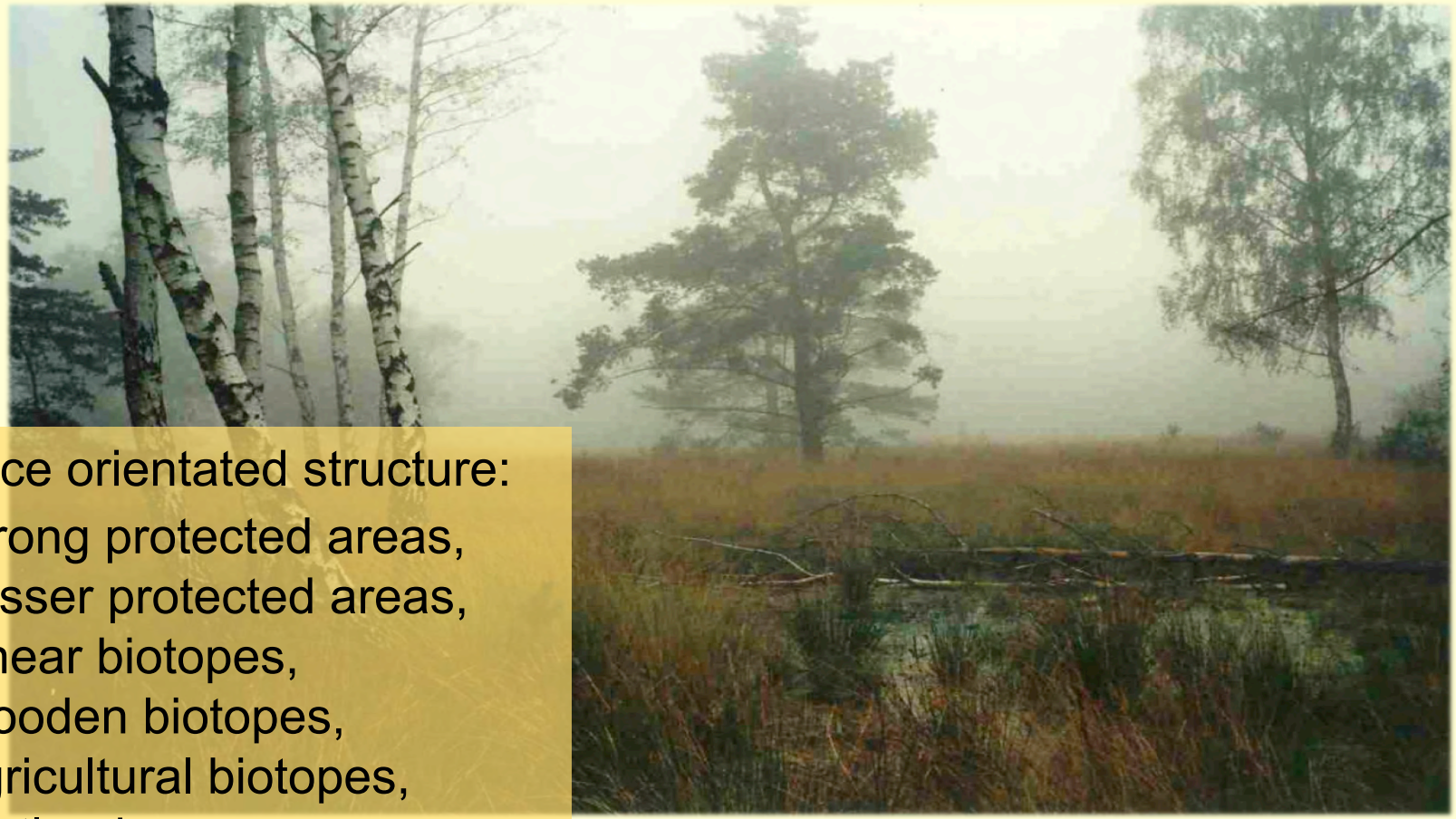
Institution / Regulation (Year)	Application Area	[Hz]	[V/m]	[µT]
Germany				
26th Ordinance of the Federal Immisson Control Act	Population, commercial plants, constant exposure	50	5.000	**100**
	Population, commercial plants, short-term exceedance		10.000	200
Bremen (Senator für Arbeit, Frauen, Gesundheit, Jugend und Soziales)				
Planning recommendation for health protection of low frequency constructions (2004)	Population, constant exposure high voltage power lines	50		**0,3**
North Rhine-Westfalia (Min. für Umwelt u. Naturschutz, Landwirtschaft und Verbraucherschutz)				
Minimum distance recommendation (2004)	Population, constant exposure high voltage power lines	50		**10**

OECOS

Human health:
References by the Commission on Radiological Protection

- Take measures to **minimise electric, magnetic and electromagnetic fields to best available technology -** particularly in those areas where people spend a significant amount of time.
- **Keep immissions** from stationary energy supply plants **below existing limits of overall exposure** in areas where people spend a significant amount of time.
- **Establish monitoring systems for** relevant immissions from electric, magnetic and electromagnetic fields**.**
- **Enhance the information of citizens and inclusion of representatives of the communities when planning** stationary plants causing electromagnetic fields.
- **Do not max out limiting tresholds.**

Biodiversity:
Impacts on protected areas and biotopes



Interference orientated structure:

- Strong protected areas,
- Lesser protected areas,
- Linear biotopes,
- Wooden biotopes,
- Agricultural biotopes,
- Wetlands,
- Drylands.

Wetlands:
High to very high potential for conflicts (excerpt)

	Threat Status	Regenerability	Trend	§ 30 BNatSchG
Treeless, oligo- to mesotrophic fens and swamps	1	H	negative	x
Grasslands of wet to semi-humid sites (Molinion; Cnidion dubii)	1	D	negative	x
Salty grasslands of the interior land	1	H	?	x
Raised bogs	1	N	negative	x
Transitional moores	1-2	N	negative	x
Oligotrophic sedge fens	2	D	negative	x
Reeds (Mariscteum serrati)	1-2	D	negative	x
Reeds (Scirpo-Phragmitetum)	2-3	D	?	x

Source: BfN 2006. 1: threat of complete destruction, 2: critically endangered; H: hardly regenerable, D: difficult to regenerate , N: not regenerable.

Impacts on plants and animals

Interference orientated structure:

- Amphibians and reptiles,
- Bats,
- Protected mammals,
- Mollusca, dragonflies, beetles and butterflies,
- Avifauna,
- Protected plants.

Threats on protected species by underground transmission

Phase	Threat	Ferns	Seed plants	Mollusca	Dragonflies	Beetles	Butteflies	Fish	Amphibians	Reptiles	Bats	Mammals	Rest- and breeding Birds
Con-struction	1 Killing	x	x	x		x			x	x	x	x	x
	2 Disturbance			x		x			x	x	x	x	x
	3 Propagation		-	-	-	x	-		-	-	x	x	x
	4 Destruction	x	x										
Plant/ Operation	1 Killing												
	2 Disturbance								-	-		-	-
	3 Propagation												
	4 Destruction												

-: unspecific risk, x: specific risk

Threats on protected species by overhead transmission

Phase	Threat	Ferns	Seed plants	Mollusca	Dragonflies	Beetles	Butteflies	Fish	Amphibians	Reptiles	Bats	Mammals	Rest- and breeding Birds
Con-struction	1 Killing	x	x	x		x			-	-	x	-	-
	2 Disturbance			x		x			x	x	x	x	x
	3 Propagation		-	-	-	-	-		-	-	x	x	x
	4 Destruction	-	-										
Plant/ Operation	1 Killing												x
	2 Disturbance	-	-			-			-	-		x	x
	3 Propagation								-	-	-	-	x
	4 Destruction												

-: unspecific risk, x: specific risk

Conflicts between avifauna and overhead transmission

HIGHEST PRIORITY

Birds Directive Sites (SPA)

RAMSAR Sites

Breeding areas of collision-endangered large birds with threatened or rare occurances (Anh. I VSchRL)

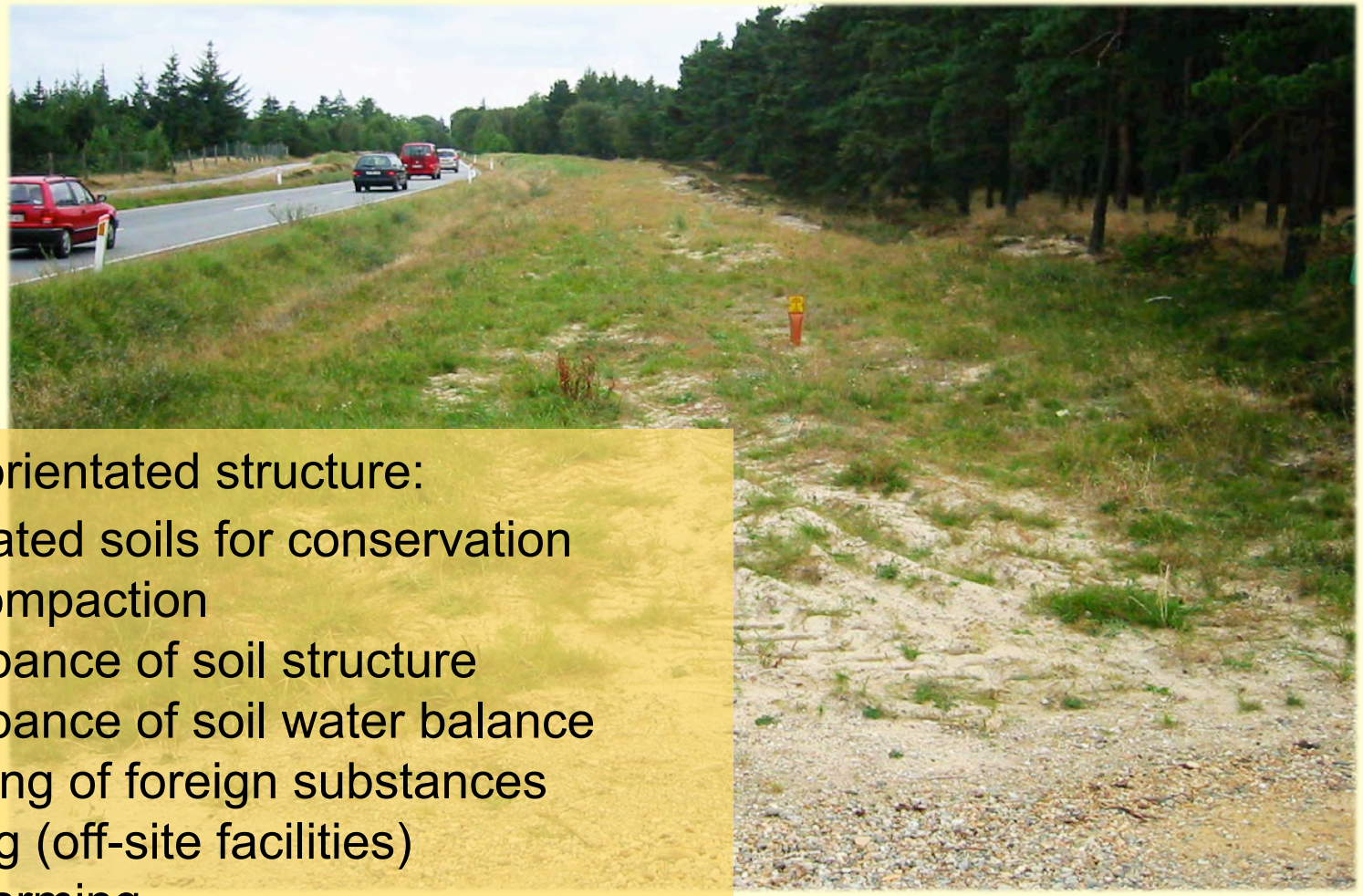
Focus areas of collision-endangered meadow breeders (some Anh. I VSchRL)

Estuaries in littoral zones

Established sleeping sites of collision-endangered large birds with threatened or rare occurances (Anh. I VSchRL), if outside EUV/RAMSAR

Established feeding grounds collision-endangered lresting birds with threatened or rare occurances (Anh. I VSchRL),), if outside EUV/RAMSAR

Protected asset - Soil



Interference orientated structure:

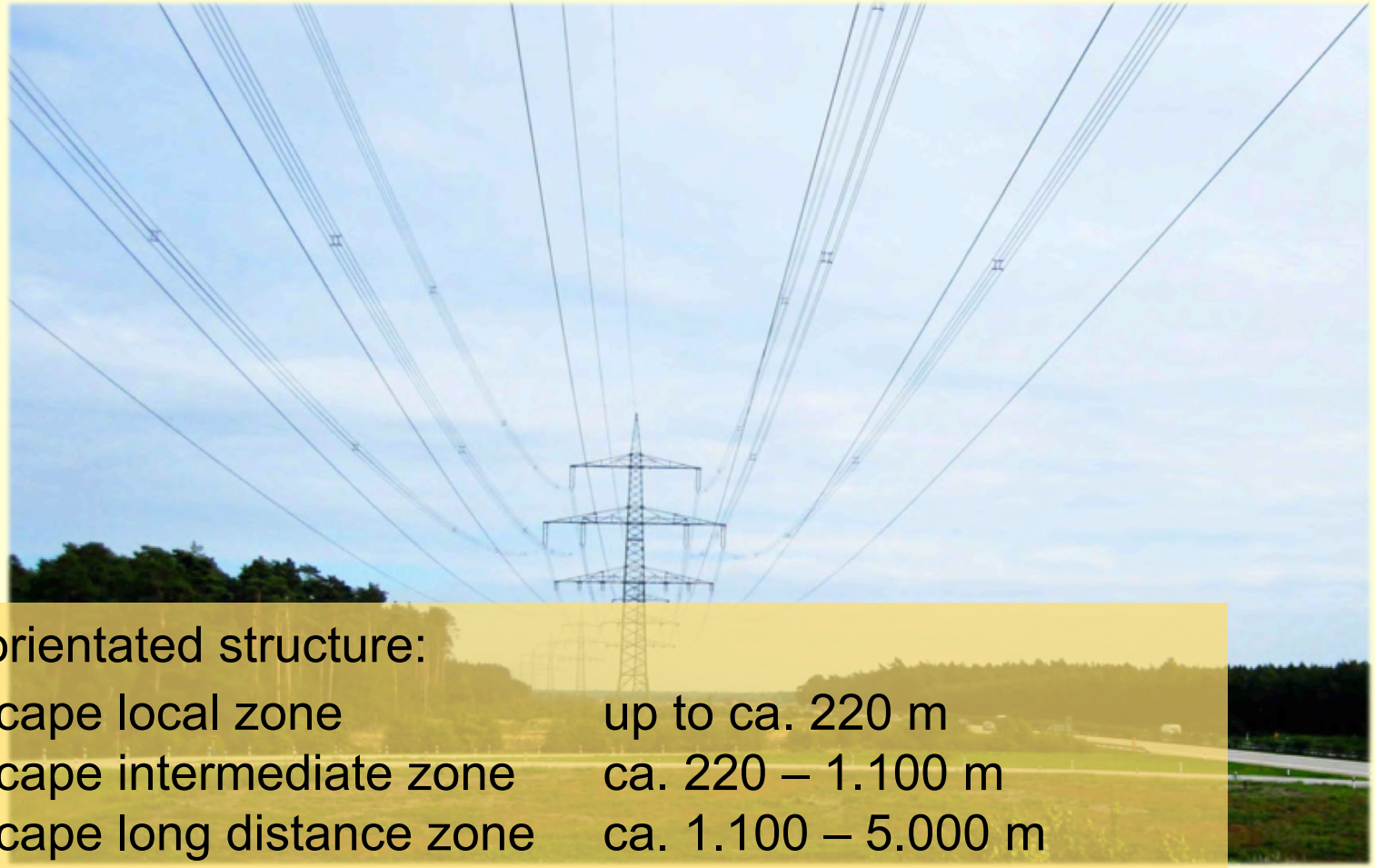
- High rated soils for conservation
- Soil compaction
- Disturbance of soil structure
- Disturbance of soil water balance
- Dumping of foreign substances
- Sealing (off-site facilities)
- Soil warming

Protected asset - Soil: Warming during operation

Soil warming depends on:

- Leg depth,
- Cable insulation,
- Bedding,
- Arrangement of cables,
- Distance among the cables,
- Thermoconductivity of the ground,
- Cable profile,
- Working load of the cable.

Visual impacts



Interference orientated structure:

- Landscape local zone — up to ca. 220 m
- Landscape intermediate zone — ca. 220 – 1.100 m
- Landscape long distance zone — ca. 1.100 – 5.000 m
- Residential areas local zone — up to ca. 220 m

Evaluation framework of impact checklist

Duration Expansion Intensity	Sensitivity of the asset: Very high	High	Intermediate	Low
Very high	- -	- -	-	*
High	- -	- -	*	+
Intermediate	-	-	+	+
Low	*	+	+	++
Insignificant	+	+	++	++

++	Well suitable (few to none impacts on the environment)
+	Suitable (insignificant impacts on the environment)
~	Under particular circumstances suitable (impacts can be minimised)
-	Less suitable (expected significant impacts on the environment)
- -	Not suitable (expected permanent significant impacts on the environment)
/*(....)	Suitabilty after mitigation

Checklist example: Visual impact (cable 380 kV)

	Construction	Site & Operation
High-valued landscape Local zone (up to ca. 220 m)	**-/*~**	**-/*~**
	Usually reasonable impacts. To some extent avoidable or diminishable.	Impact on woods by 12 m - 25 m wide corridor, mitigation possible via ecological management measures in the corridor.
High-value d landscape Intermediate zone (ca. 220 m - 1.100 m)	**-/*~**	**-/*+**
	Usually reasonable impacts. To some extent avoidable or diminishable.	Impact on woods by 12 m - 25 m wide corridor, mitigation possible via ecological management measures. Low impact after mitigation.
High-valued landscape Long distance zone (ca. 1.100 m - ca. 5.000 m)	**+**	**+/*++**
	Insignificant impact.	Impact on woods by 12 m - 25 m wide corridor, mitigation possible via ecological management measures. Marginal impact after mitigation.
Residential areas Local zone (up to ca. 220 m)	**~**	**+**
	Reasonable impact.	No impact in general.

Classification for underground and overhead transmission

	Quantity of ratings									
	cable					Overhead line				
	- -	-	~	+	++	- -	-	~	+	++
Health and wellness		1		1	2		1	2	1	
Landscape				3	1		3	1		
Plants and animals			2	2			1	1	2	
Protected areas			2				2			
Biotopes		1	1	1			1	1		1
Soil		2	1					2	1	
Groundwater, Surface water		3	1					3	1	
Cultural and other factual assets			1	1	1		1	2		
Total		**7**	**8**	**8**	**4**		**9**	**12**	**5**	**1**

Recommendations

- Negative **environmental impacts are found both at overhead lines and underground cables** in construction and operation phase. On the other hand a large repertoire on avoidance and mitigation measures is known.
- The **greatest chance to avoid impacts** exists in an early corridor improvement. Thus the importance of a strategic environmental assessment during primary planning phases is crucial.
- Existing impacts by railways, roads, power lines and pipelines **can be bundled, but possible impact overloads have to be recognized.**
- Impacts by **magnetic or electric fields** can be minimised through **maximisation of effect distances.**
- When laying high voltage cables, utilize best available technology to keep **warming at a low level.**

Thank you for your attention

www.gbv.de/dms/clausthal/E_BOOKS/2012/2012EB137.pdf

apl. Prof. Dr.-Ing. Karsten Runge
OECOS GmbH
Bellmannstr. 36 – D 22607 Hamburg
Tel. +49 (0)40 89070622
Fax +49 (0)40 85500812
Web: www.oecos.com
Email: runge(at)oecos.com