

Environmental impacts of wind power (onshore & offshore)

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One of 4 1.3MW turbines, Westmill Cooperative
Windfarm, near Oxford, UK: a typical setting

<http://www.westmill.coop>



- The impacts considered are from installed wind turbines on windfarms
- Manufacture is not considered here, which relates to standard industrial practice for engineering structures
- 'Wind Energy The Facts' analyses and quantifies environmental factors by formal mechanisms of Life Cycle Assessment (LCA: ISO 14040-44 etc) and External Costs; essential for governmental policy

Planning and operation

- Environmental factors are of major importance
- Impacts are both positive and negative
- Aim to reduce the -ve, increase the +ve
- Both the public and the site staff appreciate good environmental practice
- Much environmental knowledge is gained from Windfarm Environmental Impact Assessment, EIA, *e.g. bird behaviour, public perception, noise reduction, sympathetic design*

Classes of impact in general

- Chemical *e.g. air and water pollution, climate-change emissions*
- Physical *e.g. noise, collision, radar, TV*
- Biological *e.g. infertility*
- Ecological *e.g. flora, fauna, agriculture*
- Psychological *e.g. visual effects on humans*

Impacts are

- Positive (+) i.e. benefits, and so welcome by all

*e.g. generate electricity,
abate emissions from substituted fossil fuels,
provide jobs*

- Negative (-) and so unwanted

e.g. associated acoustic noise

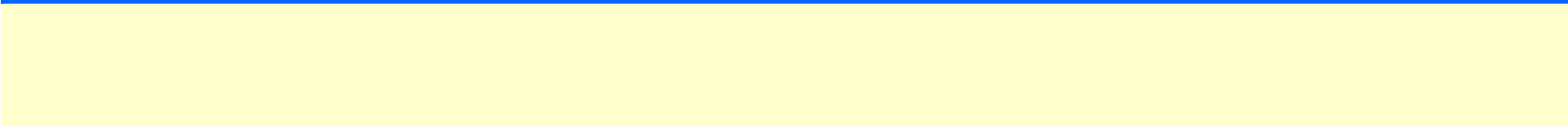
- Neutral (o) and so unnoticed

e.g. foundations

Area of impact

- GLOBAL, *international*
e.g. climate change
- REGIONAL, *governmental*
*e.g. employment, investment,
bird population, radar*
- LOCAL, *community , site specific*
e.g. noise, visual impact, sunshine flicker

	Global	Regional	Local
chemical			
physical			
ecological			
psychological (human only)			



Chemical impacts:

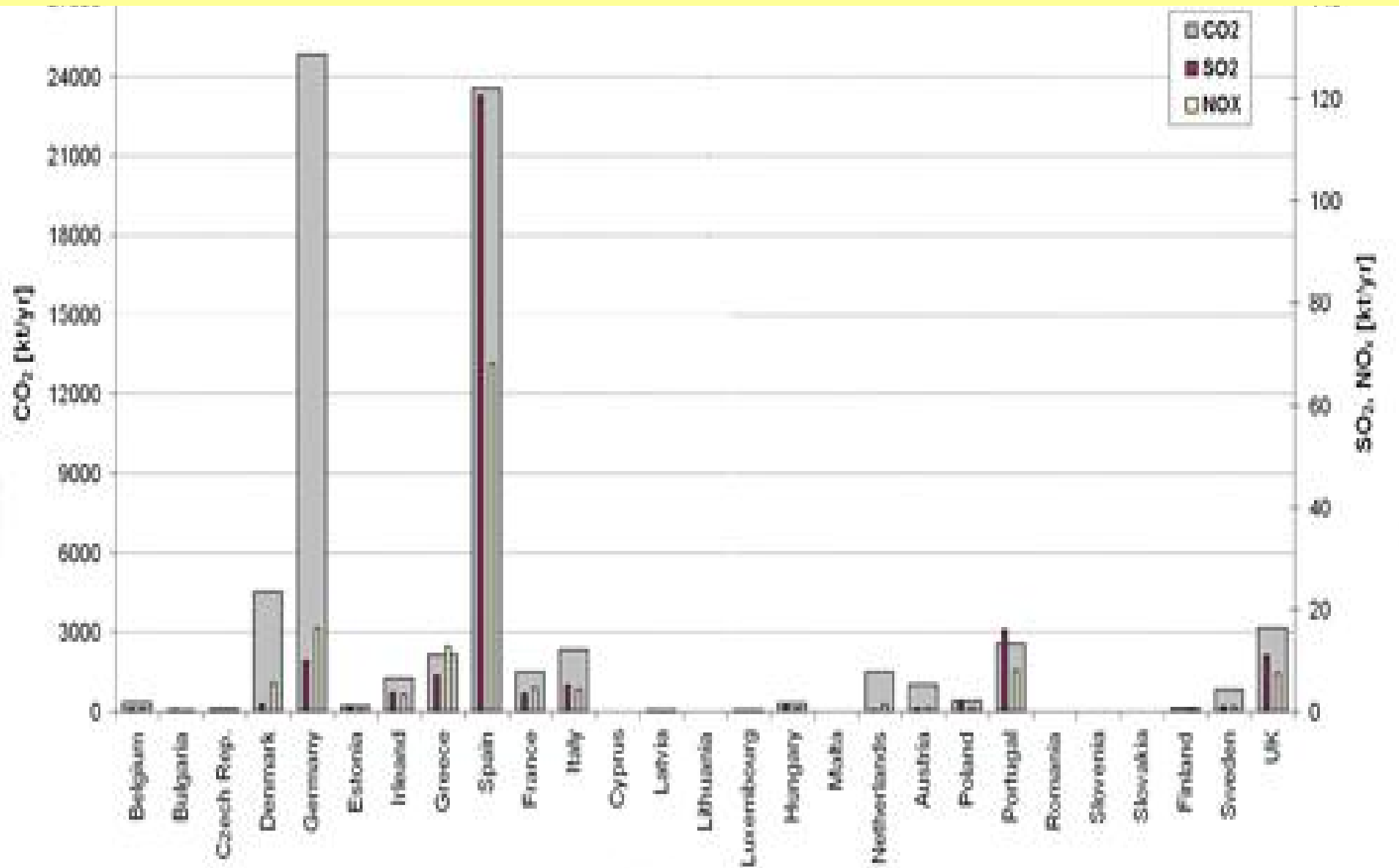
CO₂ abatement from reduced electricity generation from fossil fuels

- Abatement of fossil CO₂ is the most significant impact (+ve, benefit) because of Climate Change and national reduction targets
- World wind capacity now ~130 GW, abating ~160 Mt CO₂ /y (~ 55Mt coal/y)
- Carbon trading is '*internalising this externality*'

Other chemical impacts

- +ve : SO_2 , NO_x , wastes, ash and other abated chemicals, especially if coal plant is marginalised
- +ve: abated cooling water if thermal plant marginalised
- +ve: abated extraction, transportation, logistics and fuel of fossil fuels
- +ve: abated ill-health from pollution

Avoided emissions from wind power in the EU in 2007: *Wind Energy The Facts, part 5 ch 5*



Physical impacts: acoustic noise outside the turbine

- -ve, annoying to everyone and a sign of inefficiency (so *< 40 dBA outside nearest house*)
- Mechanical noise, e.g. from gearboxes, is now largely eliminated
- Blade-generated noise is intrinsic, but decreased by accurate angle of attack and efficient blade profiles
- Pulsation of blade noise by tower-passing and wind shear is intrinsic

Physical impact: visibility

- Turbine rotors need to be high and in open country, so always potentially visible
- Reduce near-zone visibility by careful siting
- Choose colours, finishes etc to reduce visibility
- Few large turbines better than many small (cheaper, more spaced ~5 diameters, slower rotation)

Middelgrunden windfarm, off Copenhagen: artistic design inspiration



Physical impacts:
electromagnetic radiation,
predominantly line-of-sight interaction

- TV (easily solved with local boost transmitter not in line-of-sight)
- Microwave (avoid line-of-site turbines)
- Radar (may be a real difficulty for air traffic controllers; special software removes signals)

Ecological harmony is 'of the essence' of
sustainability,
i.e. 'what wind power is all about'



Ecological impact

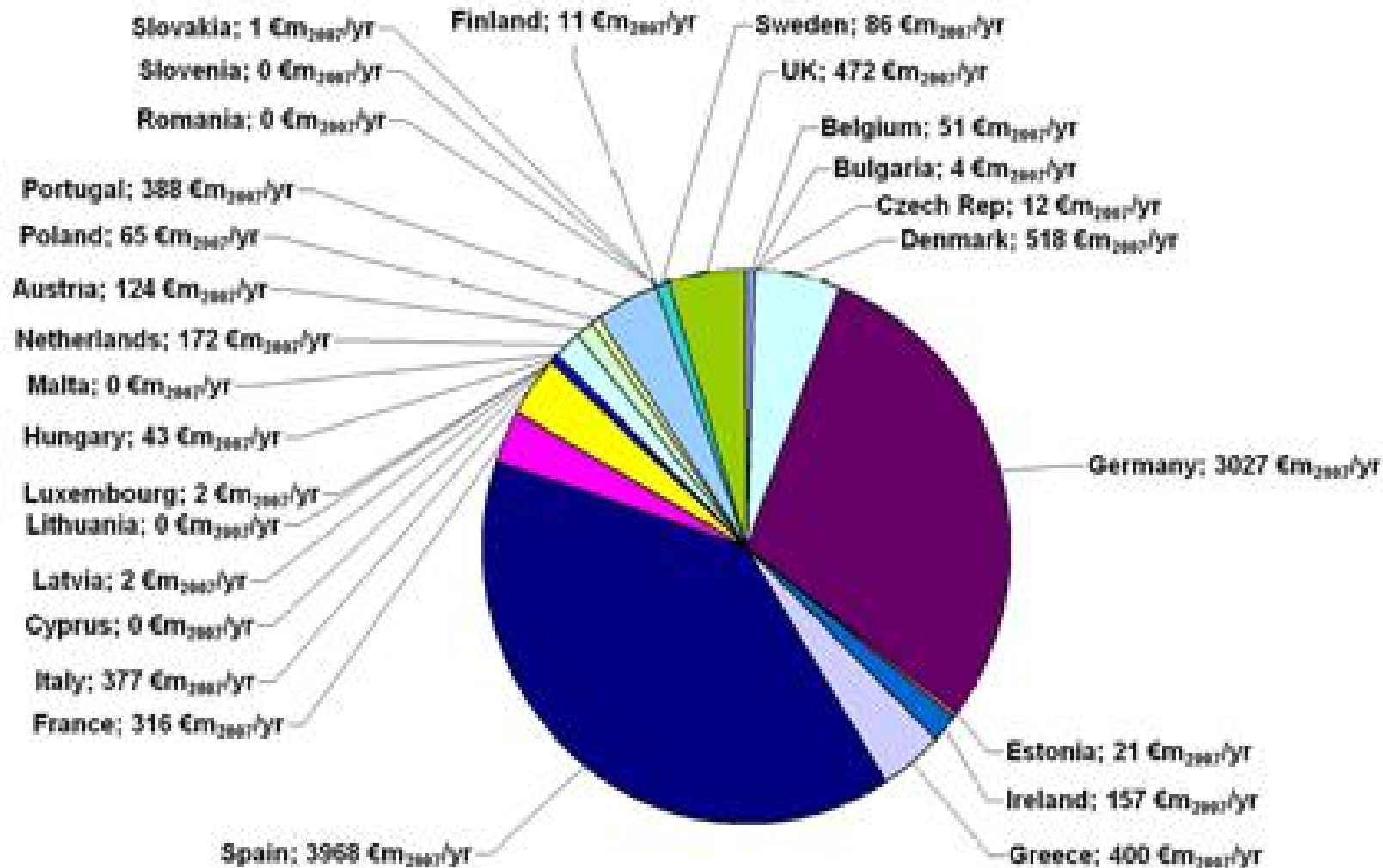
- -ve Bird and bat strike (but does it effect species population?)
- -ve Disruption at installation
- -ve No trees
- +ve Windfarm space is secured
- +ve Ecocompensation (*e.g. ponds, low vegetation for fauna & flora, marine fish breeding*)
- Decommissioning & removal are easy

Psychological impact

- Psychological factors are real and require sympathy
- Each person is different
- Understanding, association, 'ownership' and time make these impacts more positive
- Only humans notice visual impact, which may be positive, but is often negative
- 'Landscape', 'countryside', 'industrial' are complex terms

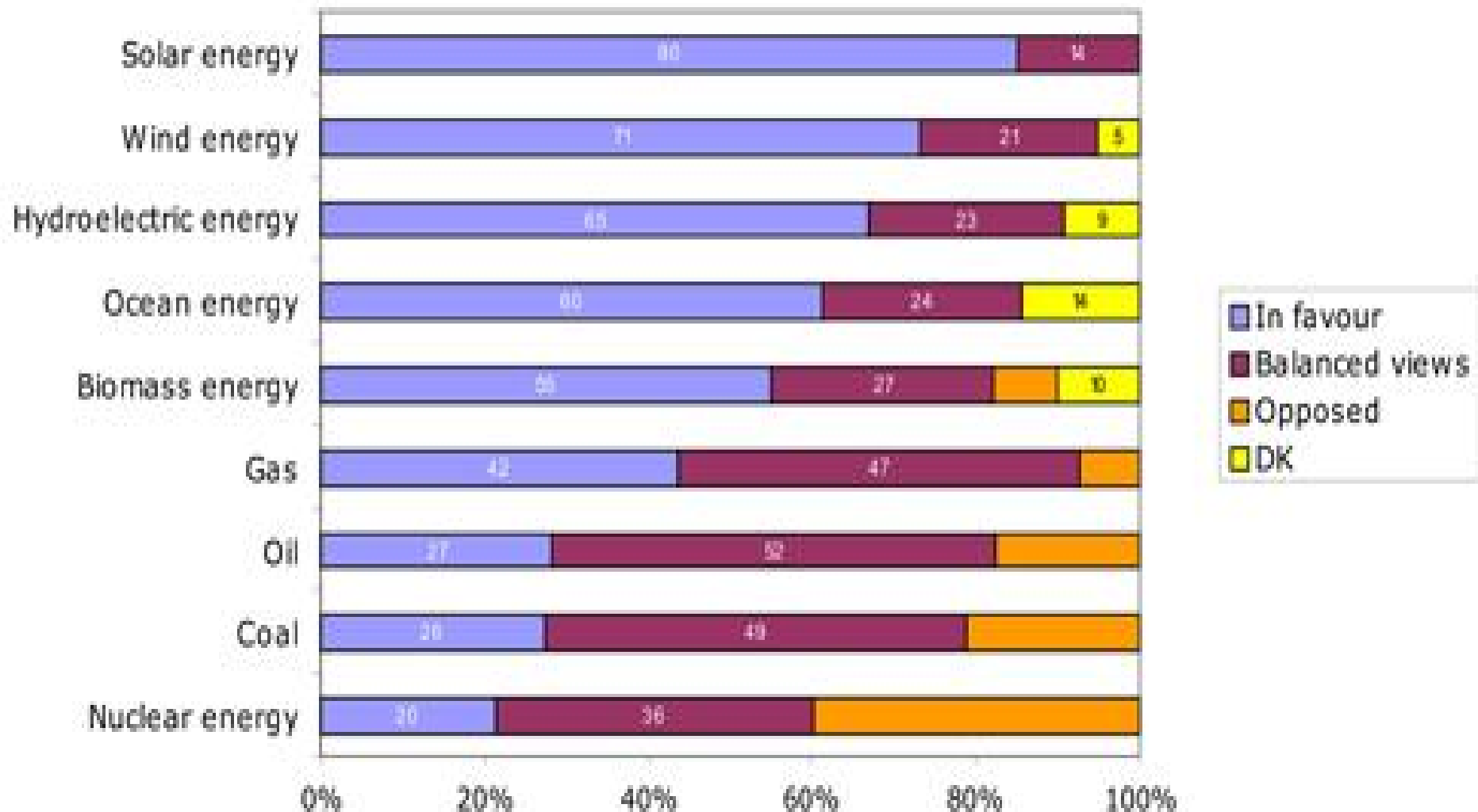
Analysis of impacts by evaluating avoided external costs: *Wind Energy The Facts, Part 5, chapter 5*

Avoided External Costs (Average Values) by Wind Generation in each of the EU7 Member States in 2007



Social attitudes about EU energy sources: vital importance of public acceptance of policy (but anti anything 'in my back yard')

Special EB 262 (EC, 2007) from Wind Energy The Facts, EWEA 2009



	Global	Regional	Local
chemical	+ no CO ₂	+ no SO ₂ , no NO _x	+ No smoke etc + No cooling water + No fuel transport
physical		+ no radioactivity + no wastes - radar - microwave comm	+ open access + grid reinforcing - power variability - acoustic noise - TV - marine collision
ecological	+ climate change abatement -rare species? + sustainability	-bird population? + fish breeding + eco-compensation	+ agriculture OK - bird & bat strike + eco-compensation
psychological (human only)		+ energy security	- visual impact - sunshine flicker o visual impact