Developing and implementing protective measures for ELF EMF

- a public health economics perspective –

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Objectives

1. **Rationale for an economic perspective (WHY?)**

   - Use / distribution of resources in society – how this can effect well-being (e.g. EMF health effects of electricity use)
   - A framework for thinking through different ways of allocating resources – an aid to decision-making

2. **Use of economics in environmental health (HOW?)**

   - Economic evaluation – costs versus benefits of different policies or protective measures

Environmental economics

Aims

- **Articulation of the trade-offs or value choices between the environment and economic activity, with a view to optimising the efficiency of resources**
- **Valuation of the external costs or uncompensated side-effects of human actions (e.g. environmental pollution from flying) – such 'externalities' are an example of 'market failure'**

Valuation

- **Based on individual preferences / choices for the environment (not the environment *per se*), e.g. the economic value ($) a person would be willing to pay to avoid polluted air**
- **'Use' vs 'non-use' value: the value derived from *actual* use of a good or service (like electricity), versus *potential* use (just knowing something is there)**

Analysis

- **Comparison of costs and benefits – with and without intervention**
- **Accounting for differential timing – e.g. investment now, benefits later**
- **Identification of the most efficient choices – but may not be the most socially acceptable!**

Environmental versus health economics

	Environment	Health
Question	What is the desirable degree of environmental protection?	How to maximise levels of health in the population?
Market failures	Externalities (spillover effects)	Unequal information, uncertainty, externalities, imperfect competition
Benefits	Reduced emissions etc.	Lives saved, reduced morbidity
Benefit valuation	Mainly monetary (WTP)	Natural units (e.g. deaths avoided) Summary measures of health (e.g. QALYs)
Economic evaluation (most common mode)	Cost-benefit analysis	Cost-effectiveness or cost-utility analysis

Costs and benefits

Costs

- Implementation costs
- Legal / regulatory costs
- Lost production costs
- Social welfare costs

Benefits

- Reduced emissions
- Reduced deaths / illness
- Enhanced amenities
- 'Process utility'

Benefit valuation

Goal

- **Estimate the aggregated monetary value of positive impacts of the policy on health, productivity and welfare**

Measures

- Marketed goods – use market prices (adjusted as necessary)
- Non-marketed goods – derive imputed prices, e.g. WTP, VOSL
  - How much willing to pay to reduce risk of childhood leukaemia?
  - How much willing to pay to reduce risk of death by X?; i.e. VOSL = WTP/ΔR

Cost valuation

Goal

- **Estimate the 'opportunity cost' associated with a policy**
  (the value of goods & services used in their best alternative use)

Measures

- 'Direct costs' – implementation, compliance, regulation, etc.
- 'Indirect costs' – productivity changes / losses, etc.
- 'Welfare costs' – utility losses

Identifying costs and benefits: EMF example (regulated separation)

	Risk management strategy	Implementation costs (actual)						Welfare costs (imputed WTP)	Beneficiaries (affected population)	Comments	Feasibility
		Government		Firms		Households					
		Policy makers & regulators		*Manufacturers & suppliers*		*Consumers & investors*					
1	Relocate existing homes away from existing power lines	Legal framework & compensation	High	Land restrictions (-) but new business (+) for developers	Low	Uncompensated relocation expenses	Low	Utility of h'holds (risk perception, inconvenience)	Large but not targeted on children (up to 5% of total households?)	Politically sensitive and expensive	Poor
2	Locate new housing away from existing power lines	Legal framework; compensate landowners?	Medium	Land restrictions for property developers	Low	Higher house prices (due to less land availability)	Low		New homeowners (esp. children); some h'holds still exposed	Inequitable (some households still exposed)	Moderate
3	Relocate schools away from existing power lines	Legal & regulatory framework	Medium	Land restrictions for property developers	Low	Higher house prices (due to less land availability)	Low	Utility of h'holds (e.g. inconvenience)	Targeted on children	Politically sensitive, requires transitional investment	Moderate
4	Locate new schools away from existing power lines	Legal & regulatory framework	Low	Land restrictions for property developers	Low	Higher house prices (due to less land availability)	Low		Targeted on children, but existing schools still exposed	Inequitable (some schools still exposed)	Moderate
5	Locate new power lines away from existing houses	Legal & regulatory framework	Low	Re-design network	Medium	Higher electricity prices	Low		Not targeted on children; some h'holds still exposed	Contestable by electricity suppliers	Moderate
6	Locate new power lines away from existing schools	Legal & regulatory framework	Low	Re-design network	Low	None			Targeted on children; some schools still exposed	Possibly contestable by electricity suppliers	Good
7	Relocate existing power lines underground	Legal & regulatory framework, land purchase	High	Engineering works	High	Higher electricity prices	High	Utility of h'holds (risk perception, inconvenience)	Large: not well targeted on children (or even households)	Contestable & expensive	Poor
8	Locate new power lines underground	Legal & regulatory framework	Low	Engineering works	High	Higher electricity prices	Medium		Not well targeted on children (some h'holds still exposed)	Contestable & expensive	Poor

Economic modeling of EMF health (and other) impacts: an example (von Winterfeldt et al)

OVERALL ANALYSIS:
Transmission Line Retrofit
Analytica Model TR-69
(Costs are per Mile for 35 Years)

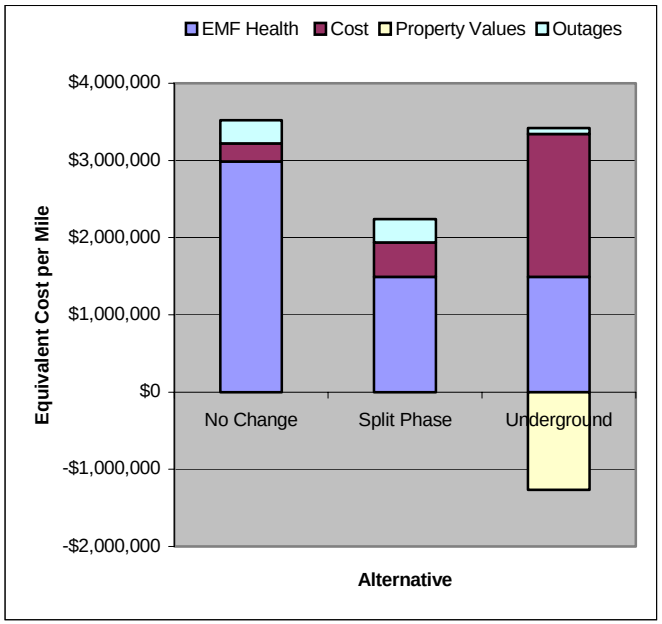
CAUTION:
The sliders are set in the middle of the scale. These values may not be reasonable. For reference, the analysis base case values are in clolumn B.

Total Equivalent Cost per Mile (35 Years)

Alternatives	No Change	Split Phase	Underground
EMF Health	$2,987,589	$1,494,025	$1,493,007
Cost	$233,512	$444,576	$1,848,486
Property Values	$0	$0	-$1,264,000
Outages	$300,973	$300,973	$78,365
Total	**$3,522,074**	**$2,239,575**	**$2,155,858**
TPC	$0	$313,084	$1,570,140

USER SELECTIONS

Economic Assumptions	Base	User	Min	Range	Max
% of TPC Financed	80%	50.0%	0%		100%
Interest Rate	10%	10.0%	0%		20%
Discount Rate	3%	5.0%	0%		10%
Facts					
Probability of Hazard	?	0.5	0		1
Risk Ratio	?	2.5	1		5
Mitigation Effectiveness					
Split Phasing	96.4%	50.0%	0%		100%
Undergrounding	90%	50.0%	0%		100%
Total Project Cost Multiplier					
Split Phasing(1=155K)	1	1.5	0		3
Undergrounding (1=$775K)	1	1.5	0		3
Property Values (1=$840K)	1	1.5	0		3
Values					
One Life-Year Lost	$100K	$250,000	$0		$500K
One Non-Fatal Cancer	$300K	$250,000	$0		$500K
One Alzheimers' Case	$200K	$250,000	$0		$500K
One Person-Outage Hour	$10	$10	$0		$20
One Contingency	$10K	$50,000	$0		$100K



USER SELECTION OF CRITERIA **Yes=1**

General	Base	No=0
Health	1	1
Total Project Cost (TPC)	1	1
Operations and Maintenance	1	1
Conductor Losses	1	1
Property Values	1	1
Outages	1	1
Property Values as Benefits	1	1
Health Endpoints		
Brain Cancer - Fatal	1	1
Brain Cancer - Non Fatal	1	1
Leukemia - Fatal	1	1
Leukemia - Non Fatal	1	1
Breast Cancer - Fatal	1	1
Breast Cancer - Non Fatal	1	1
Alzheimers' Disease	1	1
Other Disease - Fatal	0	0
Other Disease- Non Fatal	0	0

Dealing with uncertainty

Types of uncertainty

- **Deterministic – i.e. methodological choices such as the discount rate or timescale**
- **Stochastic – i.e. random variability in data parameters of interest**

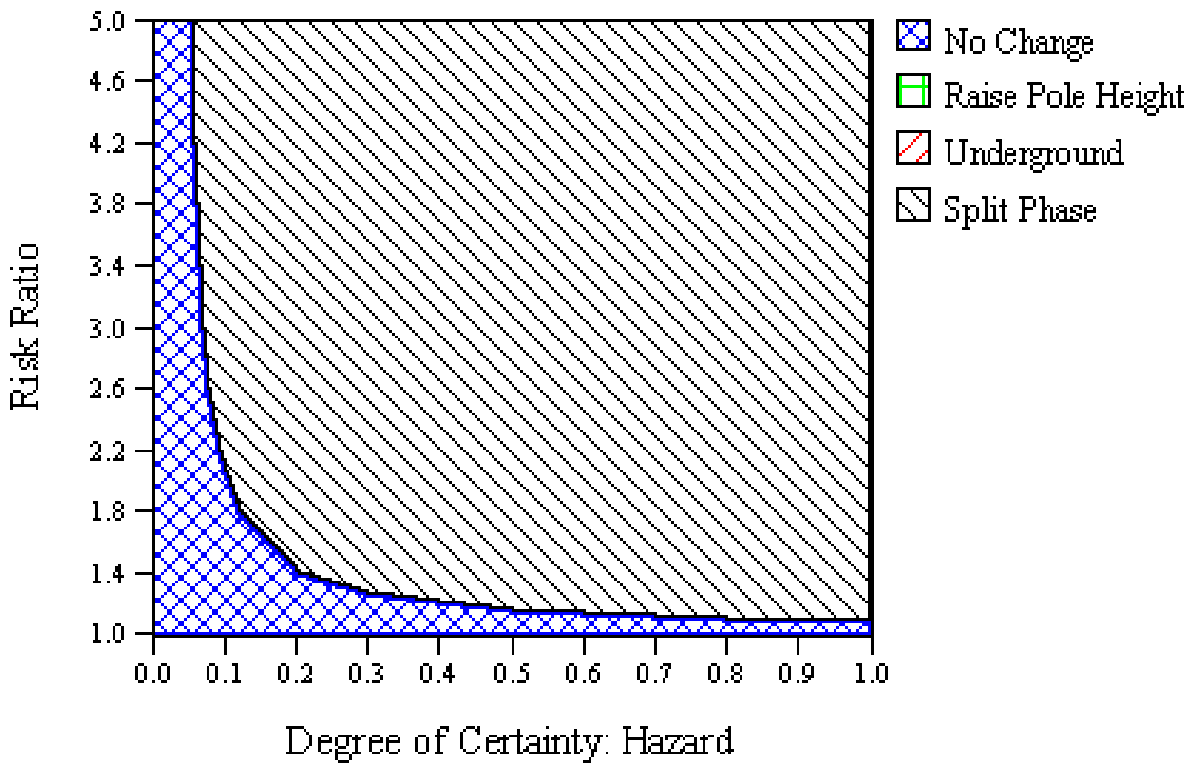
Decision modeling

- **Probability of an event * resource consumption * price = costs**
- **Probability of an event * relative reduction in risk = outcomes**
- **Probabilistic (or deterministic) sensitivity analysis of different scenarios**

Example: Uncertainty about EMF risks

- **probability that the health hazard exists (p) [0 to 1]**
- **degree of seriousness of the hazard (RR) [1 to 5?]**
- **expected population risk**

Sensitivity Analysis of the Probability that EMF Poses a Hazard and the Seriousness of the Hazard (Risk Ratio)



Potential points for discussion

- Evidence for / uncertainty around EMF health effects
- Identification of potential costs to relevant stakeholders (national/local authorities, firms, households)
- Broad classification of protective measures by cost/health impact, e.g. what are potential 'very low cost' versus 'expensive' measures?
- Detailed economic modeling for certain measures (?), including analysis of the sensitivity of results to plausible changes in effect, cost, scope etc.