HERC Health Economics Research Centre

Using cost-effectiveness analysis to influence health policy: the example of radon control

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Introduction

- Radon policy interesting public health question
  - WHO: International Radon Project (2007)
  - EU: RADPAR project (2012)
  - USA: EPA review
  - UK: Health Protection Agency, & Department for Environment, Food and Rural Affairs (DEFRA)
- Raises economic as well as health questions
- My interest in this:
  - Member of UK Advisory Group on Ionizing Radiation (AGIR) radon sub-committee
  - Member of EU project (RADPAR) on radon
  - Member of WHO IRP

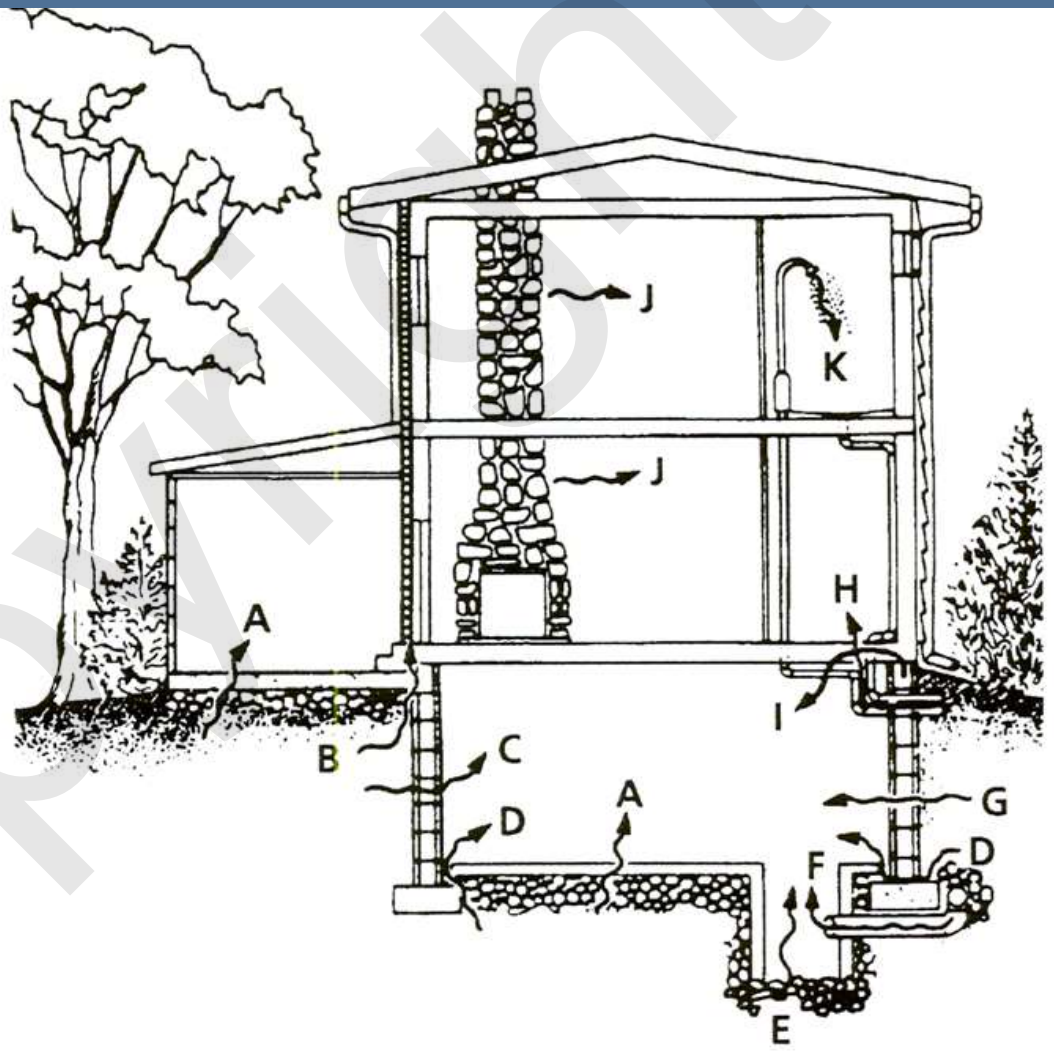
What Is Radon?

- A naturally occurring gas: radioactive decay process: uranium > radium > radon
- Inert, cannot be seen or smelled
- Enters atmosphere from the soil; disperses in open air or can concentrate in buildings
- Radioactive radon decay particles easily inhaled, potentially causing lung cancer
- Measured in Bq/m^3 - becquerels per cubic metre

  (radon disintegrations per second per cubic metre of air)

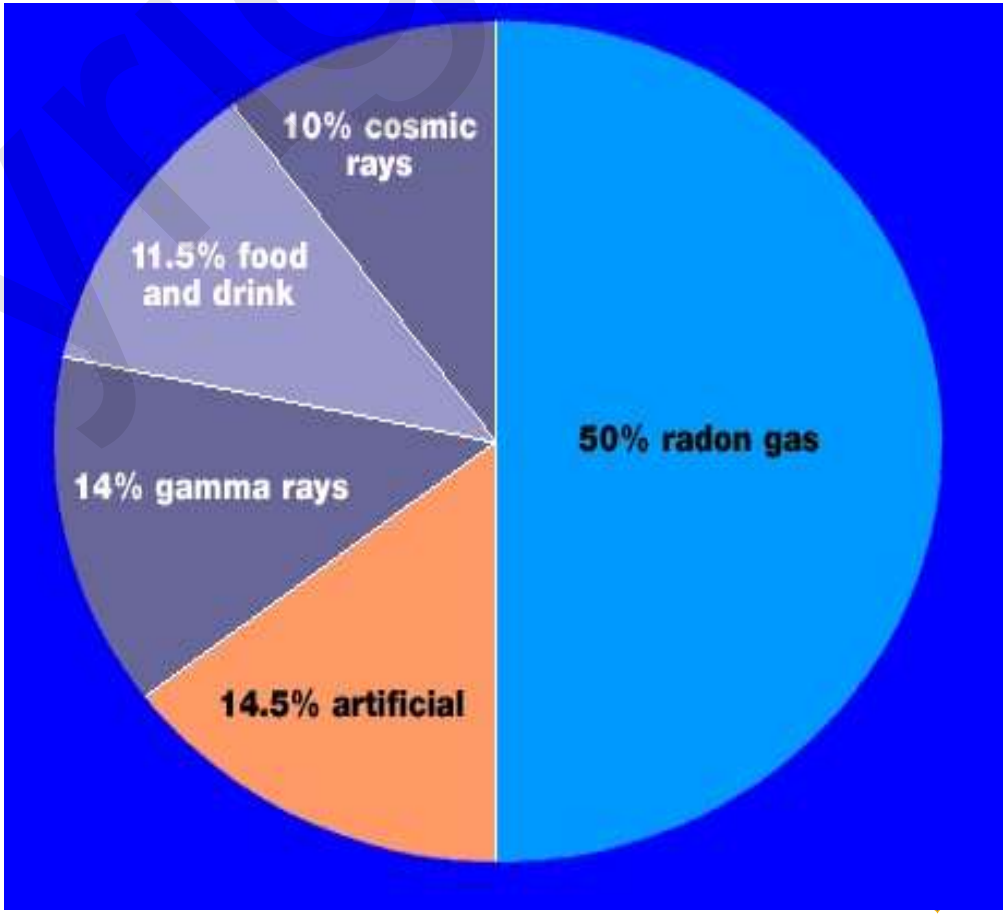
How radon enters your house

A. Cracks in concrete slabs
B. Spaces behind walls
C. Pores and cracks in concrete blocks
D. Floor-wall joints
E. Exposed soil, as in a sump
F. Drain to open sump
G. Mortar joints
H. Loose fitting pipes
I Open tops of block walls
J. Building materials - rocks
K. Water (from some wells)



Typical sources of radiation exposure

- **Natural Sources: 85%**
  - 50% radon gas from the ground
  - 14% gamma rays from the ground & buildings
  - 11.5% food and drink
  - 10% cosmic rays
- **Artificial Sources: 15%**
  - 14% medical
  - <0.1% nuclear discharges
  - <0.1% consumer products
  - <0.2% fallout
  - 0.3% occupational



Source: HPA, UK

Radon levels in various countries

Country	Average indoor radon level, Bq/m^3	Percent of homes above 200 Bq/m^3	Action level - existing homes (Bq/m^3)	Action level - new homes (Bq/m^3)
Austria	99	12%	400	200
Czech Republic	118	12%	400	200
Finland	120	12%	400	200
Germany	49	1.63%	100	100
Ireland	91	7%	200	200
Switzerland	75	6%	1000	400
UK	20	0.40%	200	200
Worldwide average	39			

Source: WHO, IRP Final Report, 2007

Evidence on health effects of radon: European Pooling Study

- Individual data from 13 case-control studies of residential radon & lung cancer in 9 European countries
  - 7,148 cases & 14,208 controls
  - Stratified for study, age, sex, region of residence, smoking
- Risk of lung cancer increased by 16% (95% c.i. 5%, 31%) per 100 Bq/m^3 increase in radon
  - Results consistent with a linear dose-response relation
  - No evidence of a "threshold" dose

Darby S, Hill D, Auvinen A, Barros-Dios JM, Baysson H, Bochicchio F et al. Radon in homes and risk of lung cancer: collaborative analysis of individual data from 13 European case-control studies. BMJ 2005;330: 223-6.

Proportional and absolute risk….

- Proportional increase in risk similar:
  - by age
  - between men and women
  - for non-smokers, ex-smokers, current smokers
- But absolute increase in risk very different:

Cumulative absolute risk of lung cancer by age 75

Bq/m^3:	0	100	400	800
Never-smokers	0.41%	0.47%	0.67%	0.93%
Cigarette smokers	10.1%	11.6%	16.0%	21.6%

How many lung cancer deaths radon cause?

- European Union - about 20,000 annually (Darby 2004)
- USA - about 21,000 annually (EPA 2003)
- UK – c. 1,100 annually

Table 2 | Numbers of deaths from lung cancer in United Kingdom, 2006, by cause

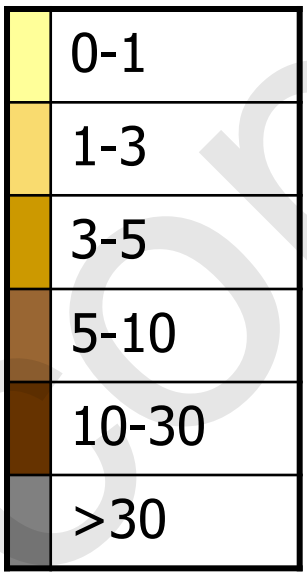
Cause	No (%) of deaths from lung cancer	Deaths from lung cancer		
Not active smoking or indoor radon	4664* (13.6)			
Radon but not active smoking	157† (0.5)			
Active smoking and radon‡:		3.3% due to radon§	85.9% due to active smoking	86.4% due to active smoking or radon
Current smokers	532 (1.6)			
Former smokers	421 (1.2)			
Active smoking but not indoor radon	28 376 (83.1)			
Total No of lung cancer deaths¶	34 150 (100)			

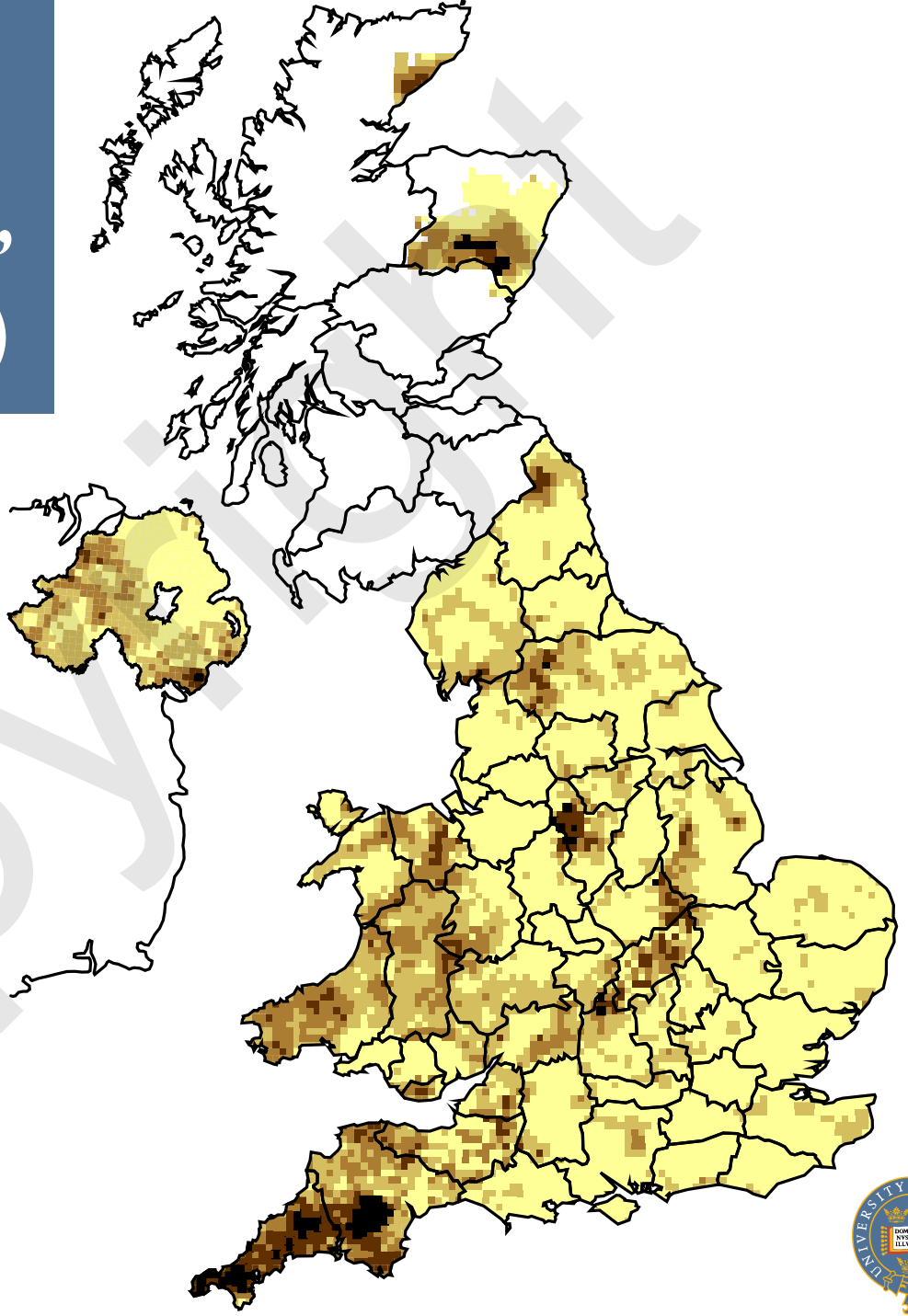
Source: BMJ 2009

Historic UK radon control policies – (not informed by economic analysis)

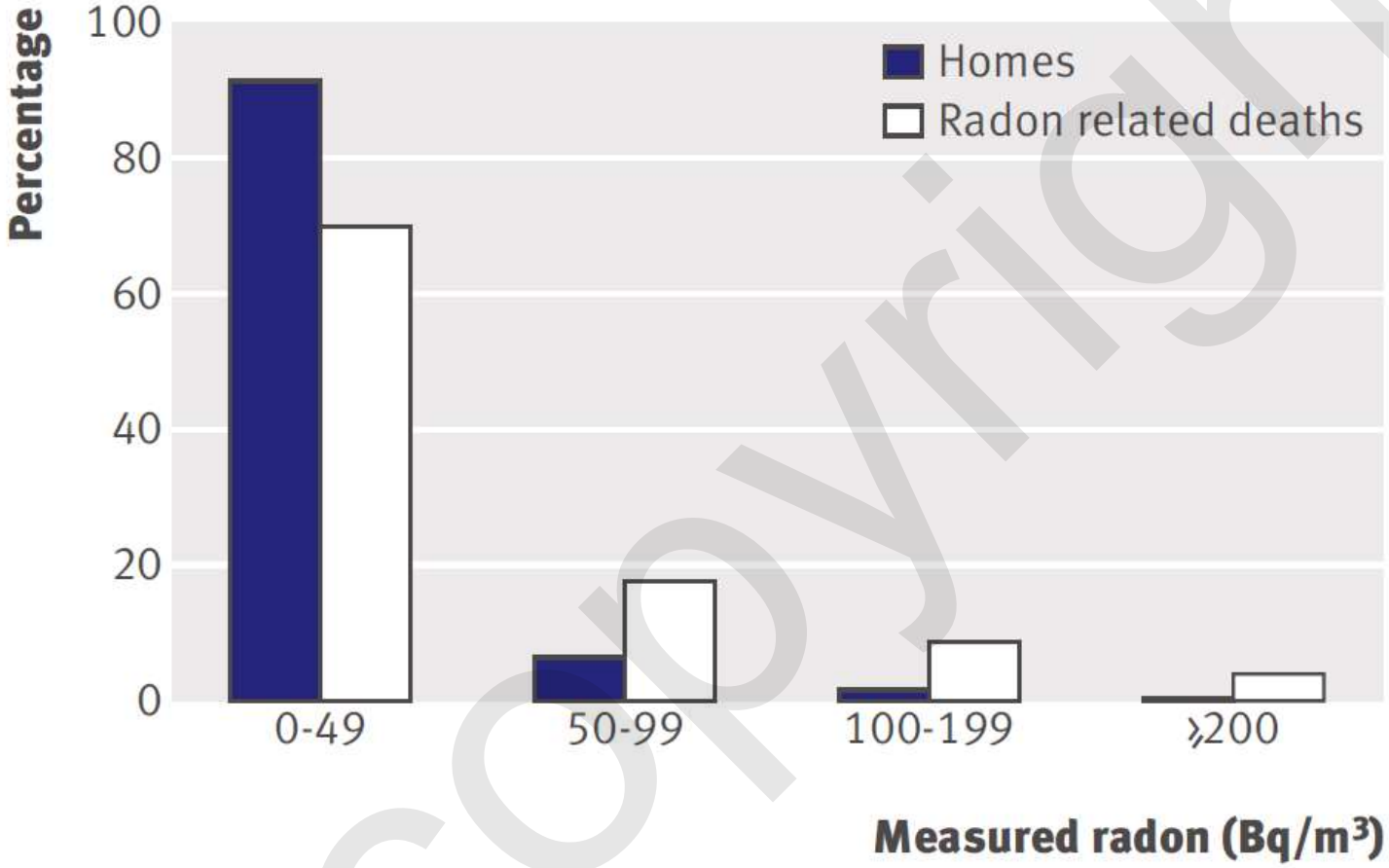
- Action Level (AL) set at 200 Bq/m^3 in 1990
- New Homes:
  - In areas where <3% above AL: do nothing
  - 3-10% of homes above AL: basic measures – membrane
  - ≥ 10% above AL: "full measures": membrane plus sump/pipe
- Existing homes:
  - ≥ 5% above AL: free testing. If above AL, encourage householder to remediate
- Radon Affected Areas:
  - >1% of measurements above AL. Standing advice to homeowners to measure radon concentration in home at own expense and remediate if above AL

% of homes above Action Level (HPA, Radon Atlas, 2007)





Distribution of measured radon concentrations & radon-related deaths, UK



- 0.4% of homes & 4% of radon related deaths above AL
- 75% of radon related deaths outside radon affected areas

Source: BMJ 2009

Economic evaluation of radon prevention and remediation

- Rationale: radon prevention and remediation primarily about health risks / benefits – lung cancer
- Wide consensus in Europe, N America, elsewhere, on methodology for economic evaluation of health interventions: *cost-effectiveness analysis*
- Therefore, radon programmes potentially suitable candidates for application of same methods

What is Economic Evaluation?

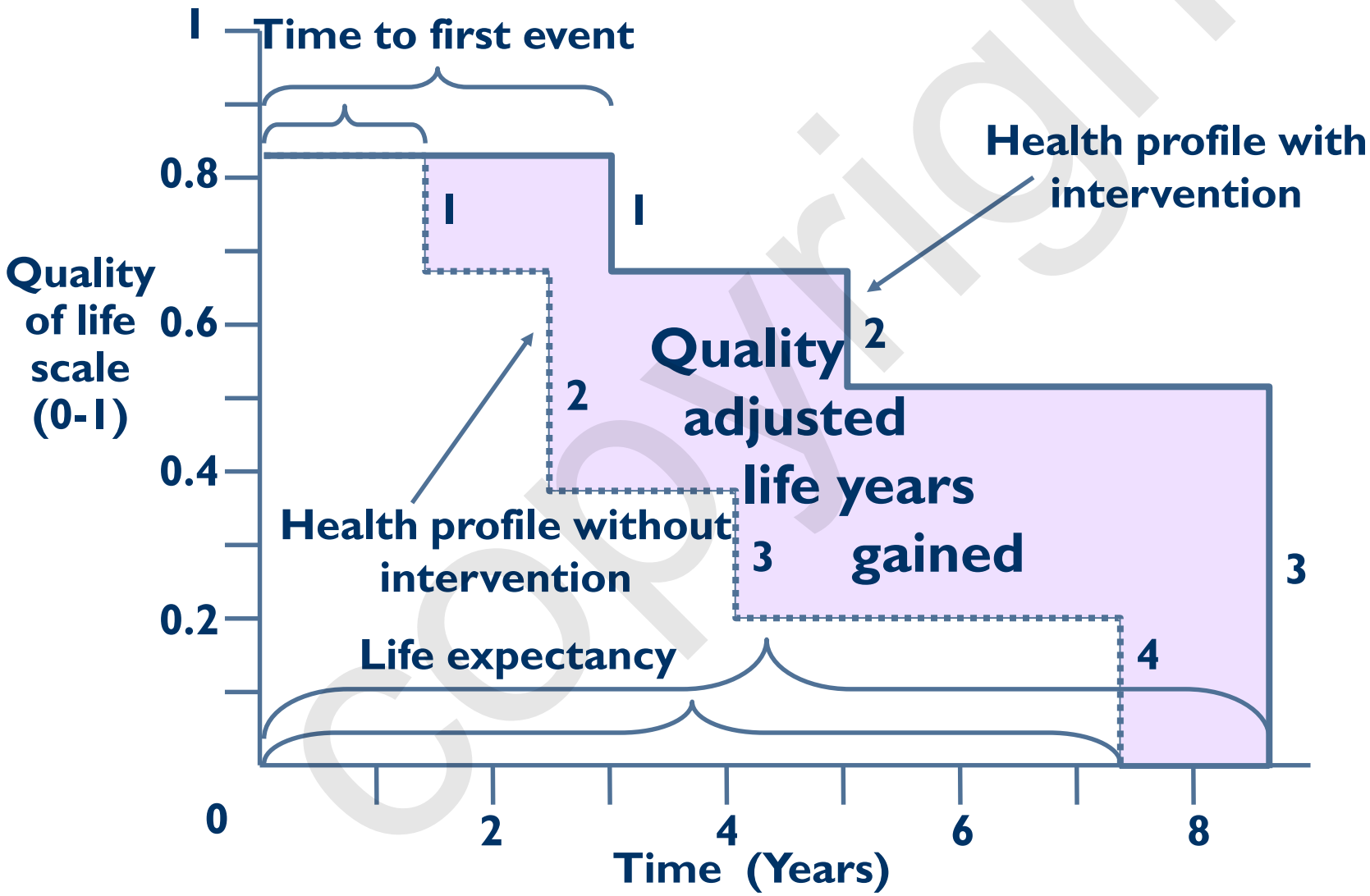
- **Premise**: scarce (health care) resources
- **Aim**: to maximise health gain with the available resources
- **Method**: compare costs and outcomes of interventions
- **Definition**: "The comparative analysis of alternative courses of action in terms of both their costs and their consequences" (Drummond *et al*, 2005)

- Explicit way for making choices
- Alternative allocation system to a market
- …or choice based on need, discrimination (by age, geography, smoking status), personal merit, social esteem, lottery

Measuring outcomes

- **Natural units**
  - cases detected (breast cancer screening);
  - cases prevented (cholesterol level lowering drugs);
  - symptom-free days (asthma treatment);
  - life years gained (LYG)
- **Quality Adjusted Life Year (QALY)**
  - considers impact on length and quality of life
  - comparable across interventions
- **Disability Adjusted Life Year (DALY)**

Using QALYs to Measure Health Gain



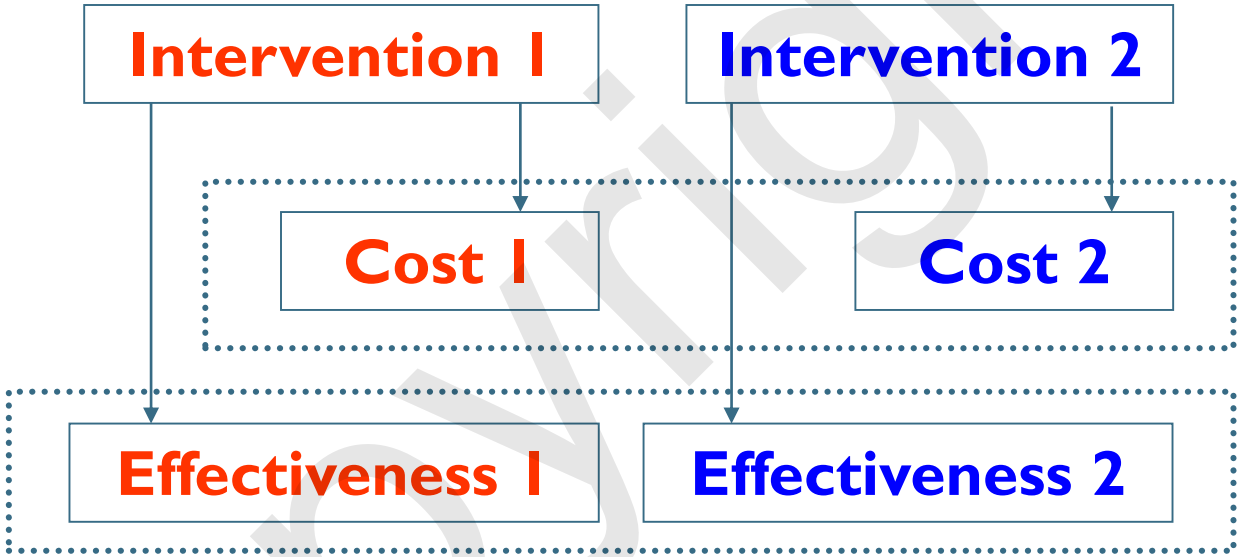
Measuring costs: what should be included?

- **Economic (opportunity) cost is different from accounting cost**
- **Opportunity cost:** The potential benefits which are sacrificed when resources are committed to one purpose rather than another
  - So the opportunity cost of investing in a healthcare intervention is the health benefit that could have been achieved had the money been spent on the next best alternative intervention
  - *Example: Informal carers*

- **Perspective**

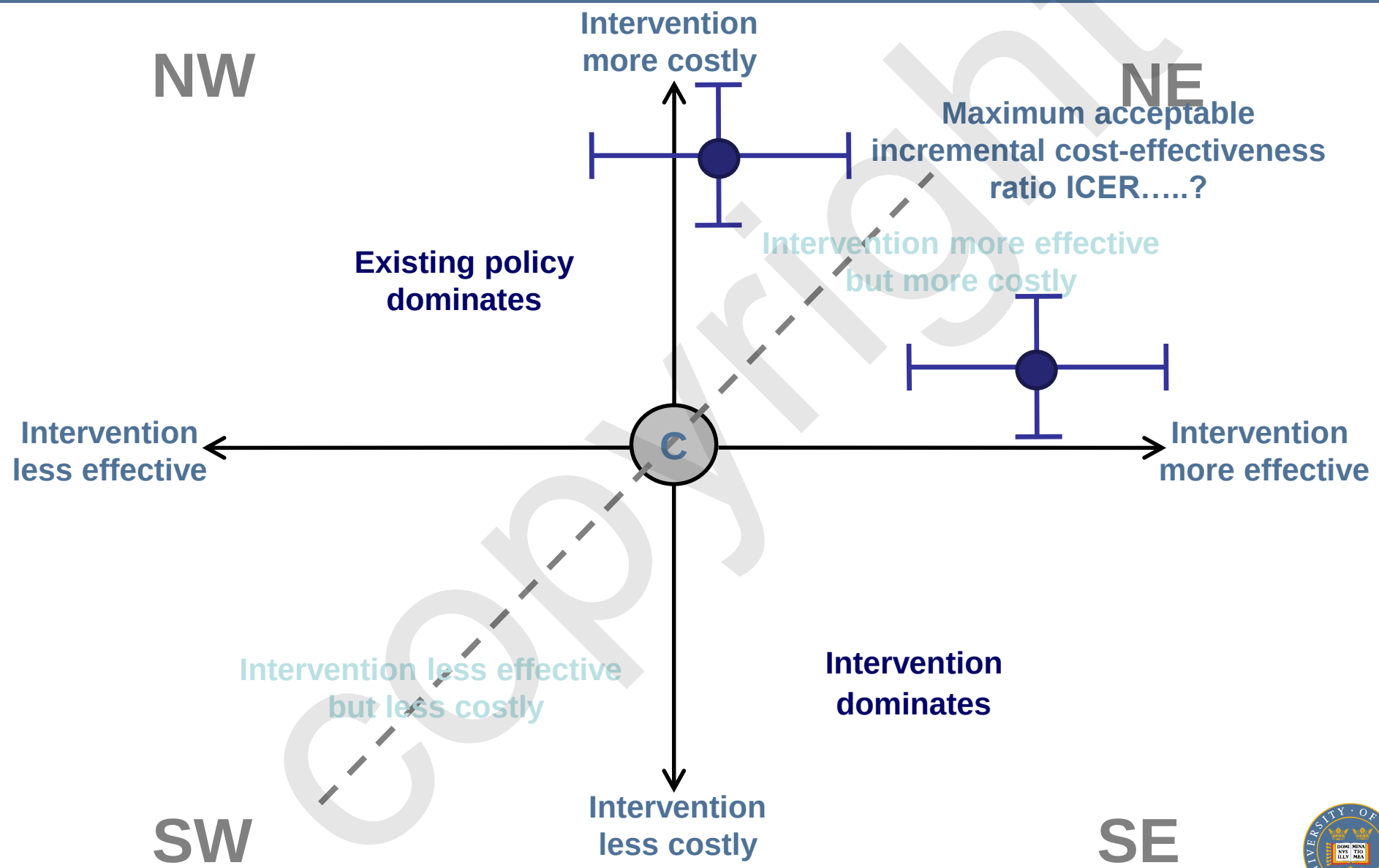
  Affects what costs are included
  - Cost to the individual
  - Cost to the health provider
  - Cost to the government
  - Cost to society

Combining cost and outcome data in a cost-effectiveness framework



$$\text{Incremental cost-effectiveness ratio (ICER)} = \frac{\text{Cost 1 - Cost 2}}{\text{Effect 1 - Effect 2}}$$

The cost-effectiveness plane



Cost-effectiveness of radon: 2 main questions

1. What is cost-effectiveness of installing preventive measures in new homes?
   a) All new homes, or targeted?

2. What is cost-effectiveness of remediating existing homes?
   a. How does this compare with other health interventions?
   b. To what level of risk is it cost-effective?

What is viewed as cost-effective?

- In UK, if cost-effectiveness ratio probably below £20,000/QALY, likely to be acceptable use of NHS resources
- Above this, other factors become more relevant: uncertainty, innovative nature of technology, other treatment options, particular features of target patients
- Above £30,000/QALY, these other factors have to be increasingly strong
- (NICE Guide to the Methods of Technology Appraisal)

Basic process: spreadsheet-based model

Outcomes

Calculate radon level in homes before & after action

Calculate lifetime lung cancer risk before & after action, from age/sex specific rates, adjusted for smoking status and competing risks

Estimate quality adjusted life years gained:

1) Average no. in home
2) Mean age at lung cancer death, adjusted for sex, smoking status
3) Age/sex specific popn. health status

Costs

Calculate costs of finding homes, using radon level, test acceptance & remediation rates

Calculate costs of prevention / remediation measures

Calculate costs / savings of averted lung cancer cases, added life expectancy

Calculate cost-effectiveness
One-way and probabilistic sensitivity analyses

Radon prevention in new homes: costs

- Installation of basic measures in new homes:
  - Gas-resistant membranes
  - Air bricks in suspended floors
  - + Sumps, pipework, if 10% of homes likely to be above Action Level
  - + electric fans in selected homes, with capital, maintenance, replacement and running costs
- Medical treatment costs
  - Anticipated savings from reducing number of lung cancer cases
  - Likely health care costs of added life expectancy

Radon prevention in new homes: outcomes

- Primarily survival gain from averting radon-induced lung cancer cases
  - life years & quality adjusted life-years gained
- Estimates derived from residential case-control studies, collated in 2005 European Pooling Study

Preventive action in all new homes in areas where 3% of homes likely to be above 200 Bq/m^3

Description	New homes*
Lifetime cumulative risk of death from lung cancer (% per person)	
Pre-preventive action	6.38‡
Post-preventive action	6.14
Health gain per 1000 households remediating	
Lung cancer deaths averted	5.7
Total life years gained	76.2
Total life years gained—discounted	39.9
Total QALYs gained	59.6
Total QALYs gained—discounted	31.2

Preventive action in all new homes in areas where 3% of homes likely to be above 200 Bq/m^3

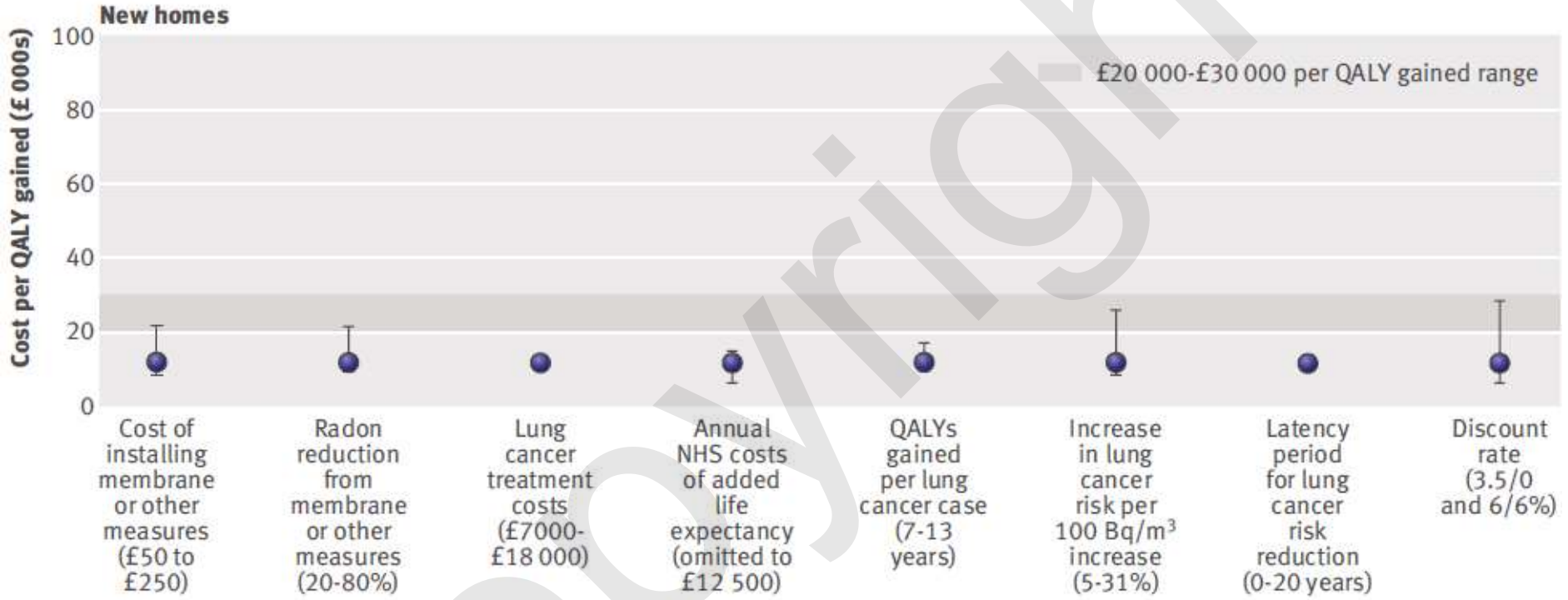
Description	New homes*
Resource use and costs per household remediating	
Radon prevention cost	100
No of invitations to measure	—
Invitation costs	—
No of radon measurements	—
Radon measurement cost	—
Radon remediation cost¶	—
Subtotal: invitation, measurement, and remediation costs¶	100
NHS lung cancer treatment costs averted¶	29
Other NHS costs incurred by added life expectancy¶	177
Net cost¶—societal:	248
To NHS	148
To Health Protection Agency	—
To households	100
Cost effectiveness¶	
Cost per life year gained—societal	6226
Cost per QALY gained—societal:	7953
To NHS	4752
To homeowners,** and to Health Protection Agency and government departments††	3201

Preventive action in all new homes in areas with varying radon levels

Mean indoor radon concentration in local area (Bq/m3)	Cost (£) per QALY gained (discounted)	% of national housing stock in areas with mean at or above this value
10	21 400	87.5
20	13 100	39.6
30	10 300	16.7
36*	9400	10.3
40	8900	7.6
50	8100	3.7
52†	8000	3.2
60	7500	1.9
64‡	7400	1.5
70	7100	1.0
80	6800	0.6
87§	6700	0.4
90	6600	0.4
Entire UK:		
21	11 400	100

£1 (€1.1; $1.5).
*1% of measurements ›200 Bq/m^3.
†3% of measurements ›200 Bq/m^3,
‡5% of measurements ›200 Bq/m^3.
§10% of measurements ›200 Bq/m^3

New homes: Sensitivity to changes in main parameter values of installing basic preventive action in all new homes



Cost-effectiveness of installing full preventive measures in new homes: ie basic measures, plus sump and pipework in areas where 10% of homes are likely to have measured radon concentrations above 200 Bq m^{-3}, then testing all new homes in such areas once completed to find those which still have radon levels above 200 Bq m^{-3}, and installing and activating electric fans in 100% of those homes

Initial	Direct*
Lifetime cumulative lung cancer risk (%)	7.57
Post-remediation	
Lifetime cumulative lung cancer risk (%)	6.07
Health gain per household remediating	
Lung cancer cases averted	0.04
Total life years gained	0.48
Total life years gained – discounted	0.25
Total QALYs gained	0.37
Total QALYs gained – discounted	0.20
Resource use and costs per household remediating	
Number of sumps and pipeworks fitted during construction	55
Cost of fitting sumps and pipework during construction	£5,486
Number of invitations to test	55
Invitation costs	£91
Number of radon tests	55
Radon testing cost	£2,304
Radon remediation cost - discounted	£1,642
Sub-total: invitation, testing & remediation costs - discounted	£9,522
NHS lung cancer treatment costs averted	£605
NHS lung cancer treatment costs averted - discounted	£180
Other NHS costs incurred by added life expectancy- discounted	£1,108
Net cost - discounted - societal	£10,450
Net cost - discounted - to NHS	*£928*
Net cost - discounted - to households	*£9,522*
Cost-effectiveness	
Cost per life year gained -discounted	£41,891
Cost per QALY gained - discounted - societal	£53,507
Cost per QALY gained – discounted - to NHS	*£4,752*
Cost per QALY gained - discounted - to households	*£48,755*

Q.: Is it ever cost-effective to install full preventive measures in new homes?

Targeted Area (Bq/m³ mean indoor radon concentration prior to installation of basic preventive measures)	Cost (£) per quality adjusted life year gained (discounted)						
	Action level (Bq/m³ measured value)						
	25 Bq/m³	50 Bq/m/³	100 Bq/m³	150 Bq/m³	200 Bq/m³	300 Bq/m³	400 Bq/m³
20	**£185 400**	£697 600	£5 628 300	£24 606 300	£77 942 900	£460 322 100	£1 809 163 900
30	**£82 700**	£134 700	£547 900	£1757 500	£4 532 700	£20 158 200	£64 846 100
36*	**£67 200**	£85 000	£249 800	£693 500	£1 638 500	£6 493 300	£19 286 700
40	**£61 000**	£69 200	£169 400	£430 600	£966 200	£3 587 800	£10 197 500
50	£51 000	**£49 300**	£84 900	£176 500	£352 100	£1 135 200	£2 942 600
52†	£49 500	**£46 800**	£76 000	£151 800	£295 600	£926 700	£2 360 400
60	£44 900	**£40 200**	£54 900	£96 100	£172 200	£490 400	£1177 900
64‡	£43 000	**£38 000**	£48 500	£80 200	£138 400	£377 000	£882 000
70	£40 500	**£35 000**	£41 000	£62 400	£101 400	£257 500	£578 000
80	£37 100	**£31 500**	£33 500	£45 500	£67 900	£154 600	£325 800
87§	£35 000	***£29 600***	*£29 800*	£38 000	£53 500	£113 000	£227 800
90	£34 300	*£29 000*	***£28 800***	£36 000	£49 700	£102 400	£203 200
100	£32 100	*£27 100*	***£25 700***	£30 000	£39 000	£73 100	£136 900

A.: Only in relatively high radon levels & if Action Level is reduced

Radon remediation in existing homes: costs

- Invite homes to test
  - ~ 30% accept
- Test to identify homes over AL
- Suggest those over AL remediate
  - ~ 20% (based on Devon/Cornwall data) will do so
- Remedial work
  - capital, maintenance, replacement and running costs: based on average costs in sample of 943 homes that remediated: (Naismith et al 1998)
- Lung cancer treatment & added life expectancy costs
  - National estimates

Radon remediation in existing homes: outcomes

- Primarily survival gain from averting radon-induced lung cancer cases
  - expressed in terms of life years gained & quality adjusted life-years gained
- Derived from:
  - European pooling study
- Lung cancer rates for UK 2006, and 2005 English life tables, adjusted for smoking status

Inviting existing homes to test & remediate, areas where 5% of homes are over current Action Level

Description	Existing homes†
Lifetime cumulative risk of death from lung cancer (% per person)	
Pre-preventive action	7.82§
Post-preventive action	6.19
Health gain per 1000 households remediating	
Lung cancer deaths averted	39.0
Total life years gained	516.9
Total life years gained—discounted	270.8
Total QALYs gained	404.7
Total QALYs gained—discounted	212.0

Inviting existing homes to test & remediate, areas where 5% of homes are over current Action Level

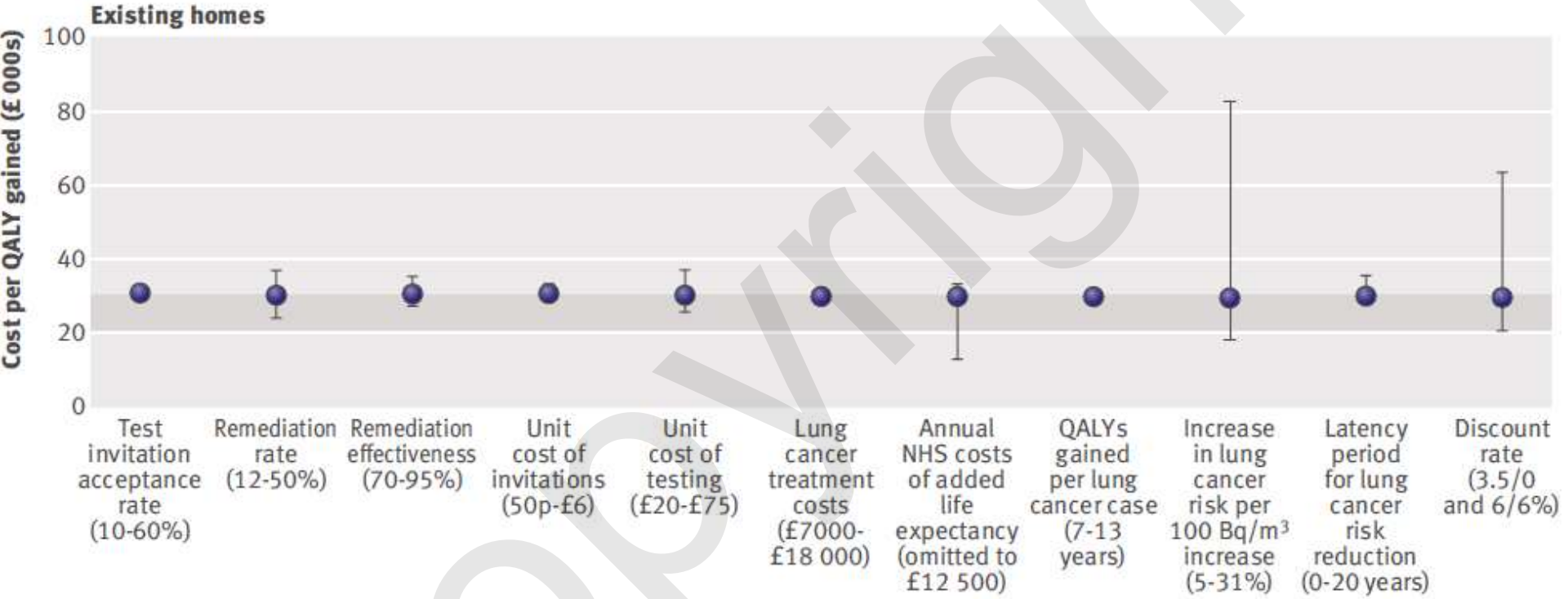
Description	Existing homes†
Resource use and costs per household remediating	
Radon prevention cost	—
No of invitations to measure	333
Invitation costs	550
No of radon measurements	100
Radon measurement cost	4200
Radon remediation cost¶	2051
Subtotal: invitation, measurement, and remediation costs¶	6801
NHS lung cancer treatment costs averted¶	195
Other NHS costs incurred by added life expectancy¶	1203
Net cost¶—societal:	7809
To NHS	1008
To Health Protection Agency	4750
To households	2051
Cost effectiveness¶	
Cost per life year gained—societal	28 833
Cost per QALY gained—societal:	36 829
To NHS	4752
To homeowners,** and to Health Protection Agency and government departments††	32 077

Q.: Is it ever cost-effective to find and remediate existing homes?

Targeted area (Bq/m3 mean indoor radon)	Cost (£) per QALY gained (discounted)						
	Action level (Bq/m3 measured value)						
	25 Bq/m3	50 Bq/m3	100 Bq/m3	150 Bq/m3	200 Bq/m3	300 Bq/m3	400 Bq/m3
20	85 200	105 600	285 200	744 300	1 682 500	6 271 900	17 840 700
30	60 600	56 900	86 100	159 700	293 800	851 800	2 056 100
36*	53 100	47 200	58 900	93 400	154 700	395 900	885 400
40	49 300	43 000	49 200	71 600	111 500	264 300	564 600
50	42 200	36 200	36 200	44 900	61 200	121 700	233 900
52†	41 000	35 100	34 400	41 600	55 400	106 500	200 200
60	37 200	31 900	29 800	33 400	41 300	70 600	123 300
64‡	35 600	30 700	28 200	30 700	36 800§	60 000	101 100
70	33 400	28 900	26 000	27 400	31 500	47 600	76 100
80	30 400	26 600	23 500	23 700	25 900	35 500	52 500
87¶	28 500	25 200	22 100	21 800	23 200	29 900	42 000
90	27 900	24 700	21 700	21 300	22 400	28 400	39 200
100	25 900	23 200	20 300	19 500	20 100	23 900	31 200

A.: Only in relatively high radon levels & if Action Level is reduced

Existing homes: one-way sensitivity analysis, at reduced Action Level (direct risk)



Existing homes: cost-effectiveness for different groups, at reduced Action Level (direct risk)

Description	Total population*	Never smokers only in household†	Current cigarette smokers only in household‡
Lifetime cumulative risk of death from lung cancer (% per person)			
Pre-remediation	7.13	0.94	28.52
Post-remediation	6.09	0.80	24.81
Health gain per 1000 households remediating			
Lung cancer cases averted	25.1	3.4	89.2
Total QALYs gained§	136.3	20.2	352.3
Resource use and costs per household remediating§			
Invitation, measurement, and remediation costs	3414	3414	3414
NHS lung cancer treatment costs averted	126	17	447
Other NHS costs incurred by added life expectancy	774	110	1870
Net cost—societal	4062	3506	4836
Cost effectiveness§			
Cost per QALY gained—societal:	29 789	173 720	13 727
To NHS	4752	4590	4037
To homeowners, Health Protection Agency, and government departments	25 037	169 130	9690

In fact, differences even greater, as non-smokers at lowest risk are most risk-averse

- Data shows action taken by homeowners found over Action Level in recent years

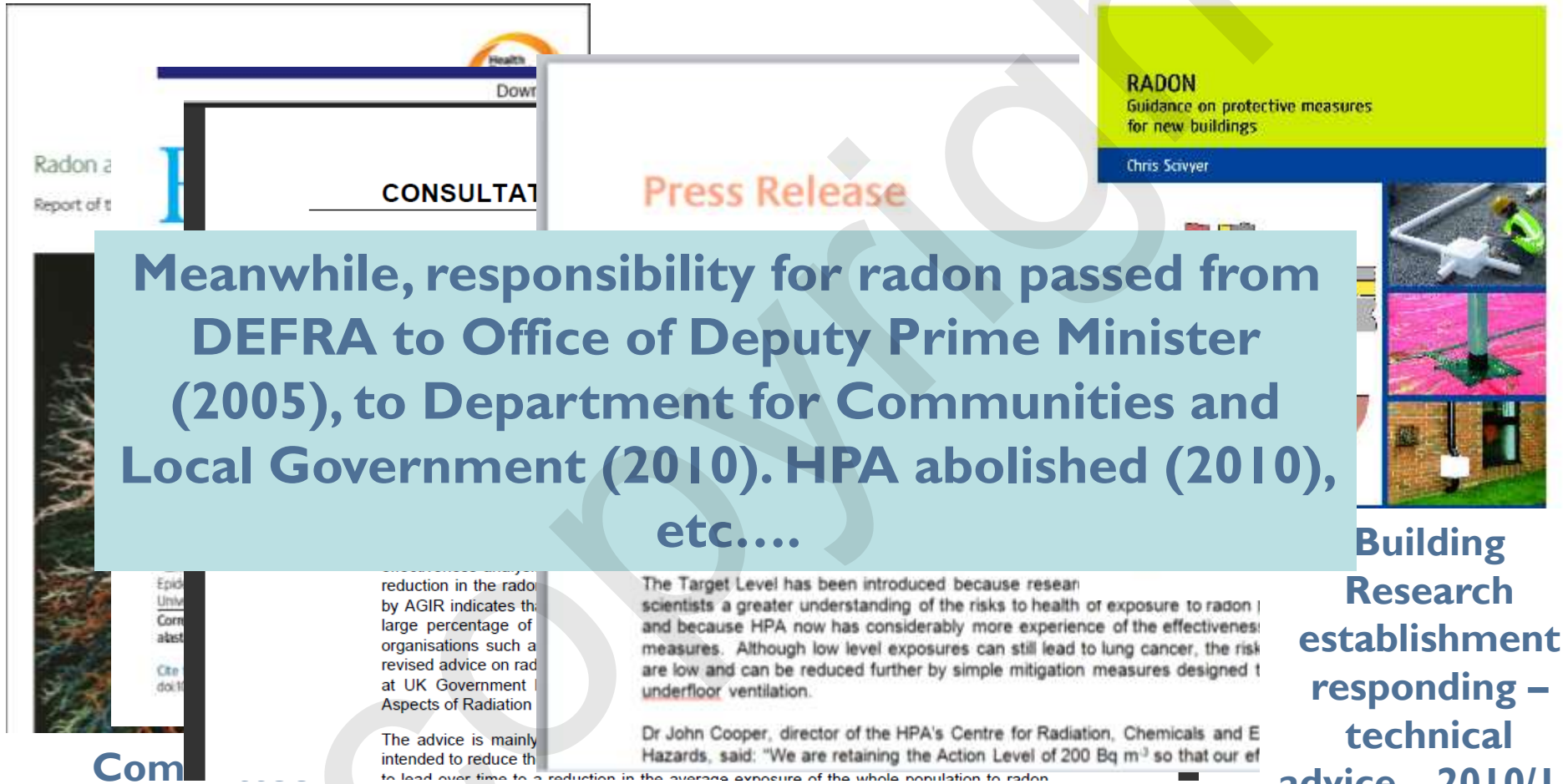
	Current smoker	Non smokers	All
Action	153 (23%)	1075 (33%)	1228
No action	510 (77%)	2138 (67%)	2648
All	663	3213	3876
Odds ratio for Action 95% c.i. P	1.0	1.82 1.41-2.33 <0.01	

- Non-smokers significantly more likely to remediate, despite very low risk levels

If these policies were adopted….

- New homes:
  - Existing policy will have averted 5 lung cancer deaths each year after 10 years of policy, increasing by 0.5 each year
  - Our recommendation (basic measures in whole country) would avert 44 lung cancer deaths each year after 10 years of policy, increasing by 4.4 each year
  - Over 20 years:
    - existing policy averts ~ 115 deaths from lung cancer
    - proposed policy averts ~ 1015 deaths from lung cancer

The policy process….



Meanwhile, responsibility for radon passed from DEFRA to Office of Deputy Prime Minister (2005), to Department for Communities and Local Government (2010). HPA abolished (2010), etc….

Com… formed 2000. Report published June 2009

Academic … publis… January

HPA produces response – goes to consultation, June 2009

New advice issued by HPA, July 2010

Building Research establishment responding – technical advice…2010/11

Do these conclusions vary internationally? RADPAR: 2 main questions

1. What is cost-effectiveness of incorporating basic radon prevention measures in all new houses?
   a) & what if basic radon prevention measures are targeted in areas with high radon levels?
2. What is the cost-effectiveness of remediation programmes in existing houses in targeted areas?

Parameter inputs: basic prevention in new homes

	Whole country				High radon areas			
	Finland	Norway	Ireland	UK	Finland	Norway	Ireland	UK
Reference level, Bq/M^3	200	200	200	200	200	200	200	200
Arithmetic mean radon level in area of interest in Bq/M^3, adjusted for measurement error	117	77	79	21	228	226	135	52
Percent of homes over Reference Level	17.2%	8.38%	8.46%	0.44%	48.3%	36.42%	20.60%	3.00%
Percentage reduction in radon from prevention measures	57%	50%	50%	50%	57%	50%	50%	50%
Average household size	2.59	2.12	2.81	2.40	2.54	2.12	2.81	2.40
Cost of installing membrane/other basic measures	€ 1,000	€ 900	€ 220	€ 120	€ 1,000	€ 900	€ 220	€ 120
Health Service annual per capita expenditure on all other health care during added life expectancy	€ 7,817	€ 7,817	€ 4,000	€ 7,817	€ 7,817	€ 7,817	€ 4,000	€ 7,817
Mean Health Service/hospice treatment cost per lung cancer case	€ 16,840	€ 16,840	€ 20,200	€ 16,840	€ 16,840	€ 16,840	€ 20,200	€ 16,840

What is viewed as cost-effective?

- Depends on level of national wealth, size of budget, and willingness to pay of decision makers
- US: $50,000 per quality adjusted life year gained
- UK: £20,000/QALY
- Finland, Norway, Ireland……€30-40,000/QALY?

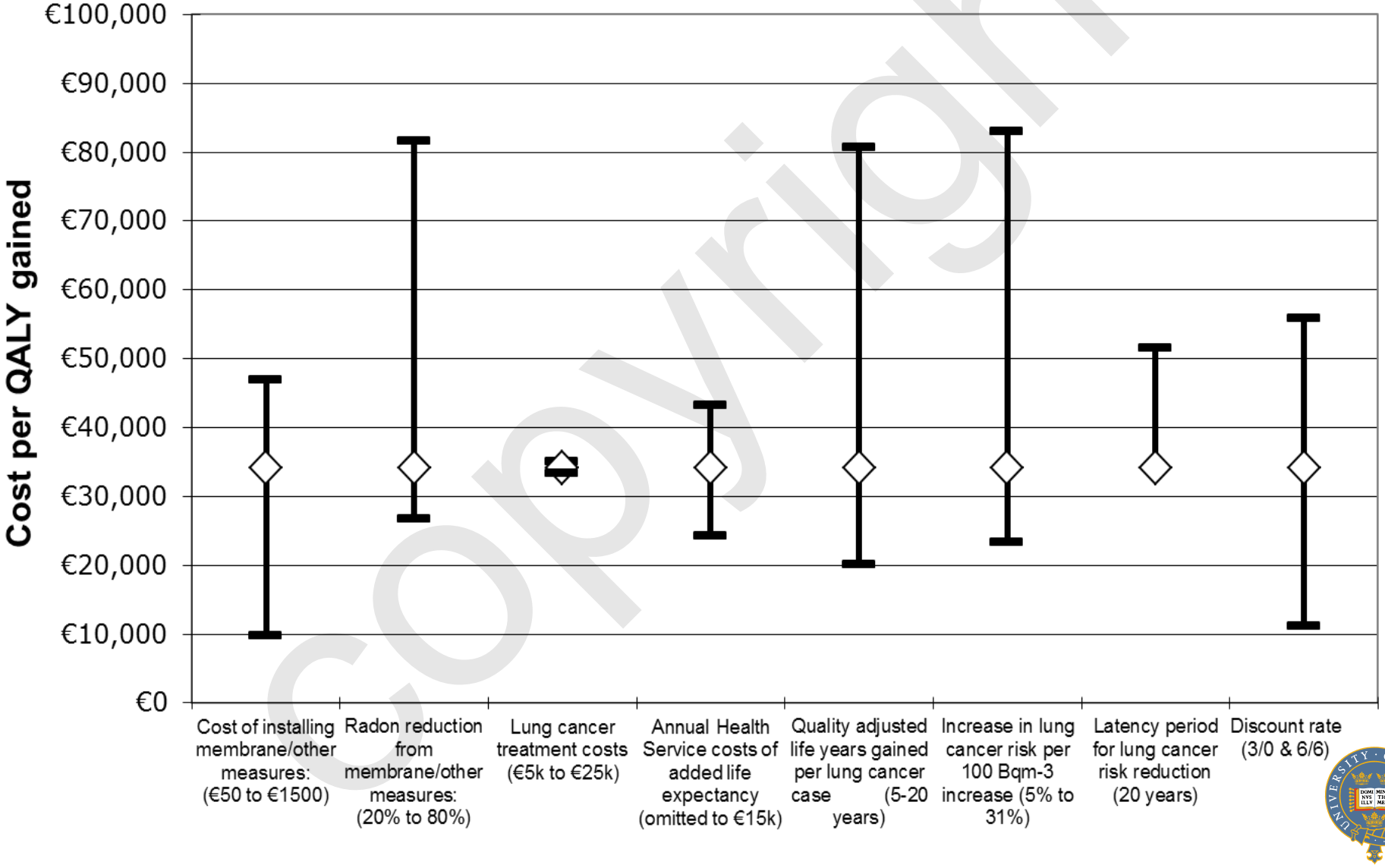
Baseline results: basic prevention in new homes

	Whole country				High radon areas			
	Finland	Norway	Ireland	UK	Finland	Norway	Ireland	UK
Lifetime cumulative lung cancer risk (%)								
Initial	4.46	6.53	6.15	6.10	4.22	7.87	6.62	6.38
Post-prevention	4.07	6.18	5.81	6.00	3.59	6.85	6.05	6.14
Lung cancer cases averted per 1000 houses	10.1	7.4	9.4	2.3	16.0	21.5	16.1	5.7
Total life years gained	151.3	117.6	140.8	30.7	236.0	342.4	240.4	76.2
Total QALYs gained	119.8	92.9	111.8	24.0	186.4	270.6	190.9	59.6
Radon prevention cost	€ 1,000	€ 900	€ 220	€ 120	€ 1,000	€ 900	€ 220	€ 120
Lung cancer treatment costs averted	€ 171	€ 124	€ 191	€ 39	€ 270	€ 362	€ 325	€ 97
Health care costs of added life expectancy	€ 385	€ 299	€ 183	€ 78	€ 601	€ 871	€ 313	€ 194
Incremental cost per QALY gained	€34,110	€38,308	€9,382	€23,727	€24,935	€18,772	€6,876	€14,546

Basic prevention measures in new homes: by smoking status

	Whole country				High radon areas			
	Finland	Norway	Ireland	UK	Finland	Norway	Ireland	UK
Lifetime cumulative lung cancer risk (%):								
Initial								
Never smokers only	0.96	0.96	0.86	0.80	1.10	1.16	0.93	0.84
Current smokers only	26.30	27.03	24.17	24.83	26.42	31.79	25.84	25.87
Post-prevention								
Never smokers only	0.87	0.90	0.81	0.79	0.93	1.00	0.85	0.81
Current smokers only	24.26	25.75	22.98	24.48	22.89	28.21	23.84	25.00
Lung cancer cases averted:								
Never smokers only	2.2	1.1	1.4	0.3	4.2	3.2	2.3	0.8
Current smokers only	52.9	27.1	33.4	8.4	89.6	75.8	56.3	20.7
Incremental cost per QALY gained								
Never smokers only	€117,728	€198,659	€40,987	€112,335	€65,725	€72,354	€25,056	€49,964
Current smokers	€13,037	€17,511	€4,029	€12,926	€10,447	€10,131	€3,108	€9,467

Basic prevention measures in new homes: sensitivity analysis (Finland)



Parameter inputs: remediation of existing homes

	Whole country		High radon areas			
	Norway	Ireland	Finland	Norway	Ireland	UK
Reference level, Bq/M^3	200	200	400	200	200	200
% of homes over Reference Level	8.4%	8.4%	23.2%	36.42%	20.6%	5.0%
% of homes accepting invite to test	67%	2%	4%	67%	2%	30%
Proportion of homes found over action level that decide to remediate	25%	25%	55%	25%	25%	20%
Percentage reduction obtained by remediation measures	80%	92%	52%	80%	92%	85%
Unit cost of radon test	€ 45	€ 54	€ 33	€ 45	€ 54	€ 42
Full remediation cost per household	€ 2,568	€ 4,232	€ 2,921	€ 2,568	€ 4,232	€ 1,545

Baseline results: remediation of existing homes

	Whole country		High radon areas			
	Norway	Ireland	Finland	Norway	Ireland	UK
Incremental cost per QALY gained	€ 45,270	€ 59,800	€ 31,873	€ 23,353	€ 33,200	€ 56,160

And by smoking status……

	Whole country		High radon areas			
	Norway	Ireland	Finland	Norway	Ireland	UK
Incremental cost per QALY gained						
Never smokers only	€ 243,238	€ 358,685	€ 89,472	€ 101,761	€ 190,639	€ 329,931
Current smokers only	€ 20,579	€ 23,268	€ 12,677	€ 12,050	€ 13,230	€ 25,880

RADPAR Conclusions

- Radon policies should use cost-effectiveness evidence
- In new homes:
  - basic measures in all new homes probably cost-effective
  - could be incorporated in national building codes
  - more elaborate measures: need cost-effectiveness
- In existing homes:
  - expensive to find homes & persuade owners to act
  - lifetime remediation costs quite high,
  - cost-effectiveness often borderline, need careful targeting
- Smoking status a key influence on cost-effectiveness
  - Radon policies should link to smoking cessation campaigns

Policy conclusions

- Influencing policy can be a long process:
  - 2000-2014, still not completed!
  - Took time to persuade committees of approach: not used to health economics
- Important to provide clear messages:
  - Eg new homes: install basic preventive measures everywhere
  - Eg existing homes: current policy not cost-effective
- Not always easy to get full policy picture
  - Eg did HPA want to spend more/less on radon work?
  - Do govt. Ministers want to intervene in housing market?
- Academic/scientific credibility important
  - Eg peer-reviewed publications