UK Energy Research Centre
Technology and Policy Assessment report

The Rebound Effect

Key issues, main findings

Steve Sorrell

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Overview

- The UKERC study
- Understanding rebound effects
- Estimating rebound effects
- Other evidence for rebound effects
- Conclusions, research needs and policy implications

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Our question

"The concept of a nontrivial rebound effect…..is without basis in either theory or experience. It is, I believe, now widely accepted to be a fallacy whose tedious repetition ill serves rational discourse and sound public policy" (Lovins, 1988)

OR

"With fixed real energy prices, energy efficiency gains will increase energy consumption above what it would be without these gains)" (Saunders, 1992)

What is the evidence that improvements in energy efficiency will lead to economy wide reductions in energy consumption?

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Our approach

- In-depth and comprehensive review of available evidence, drawing upon over 500 studies
  - Informed by ‘systematic review’ techniques
- Rebound effects hard to measure, so emphasis on clarifying theoretical and methodological issues
- Wide ranging, including issues such as the relationship between energy consumption and economic growth

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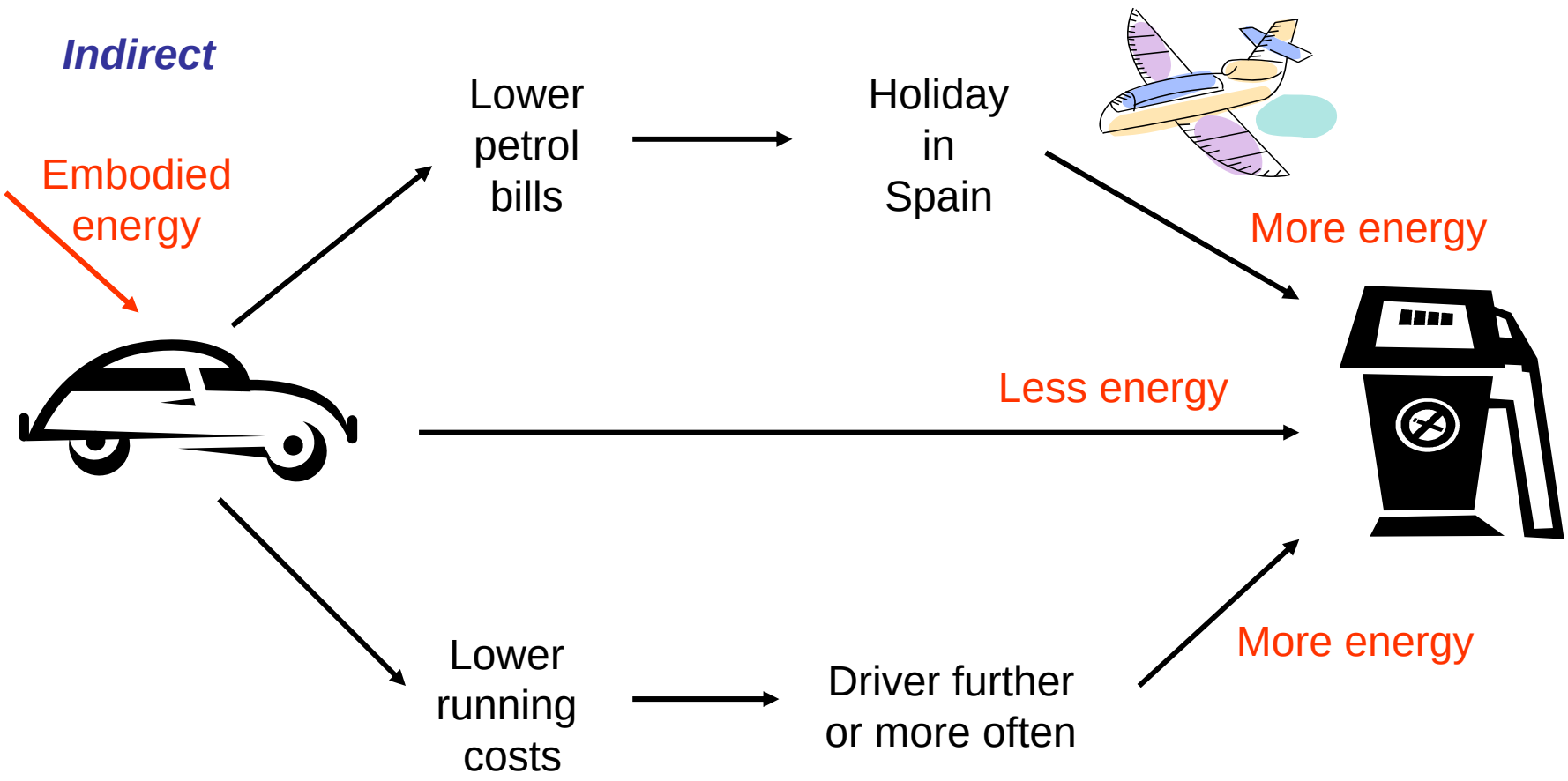
Rebound effects - consumers



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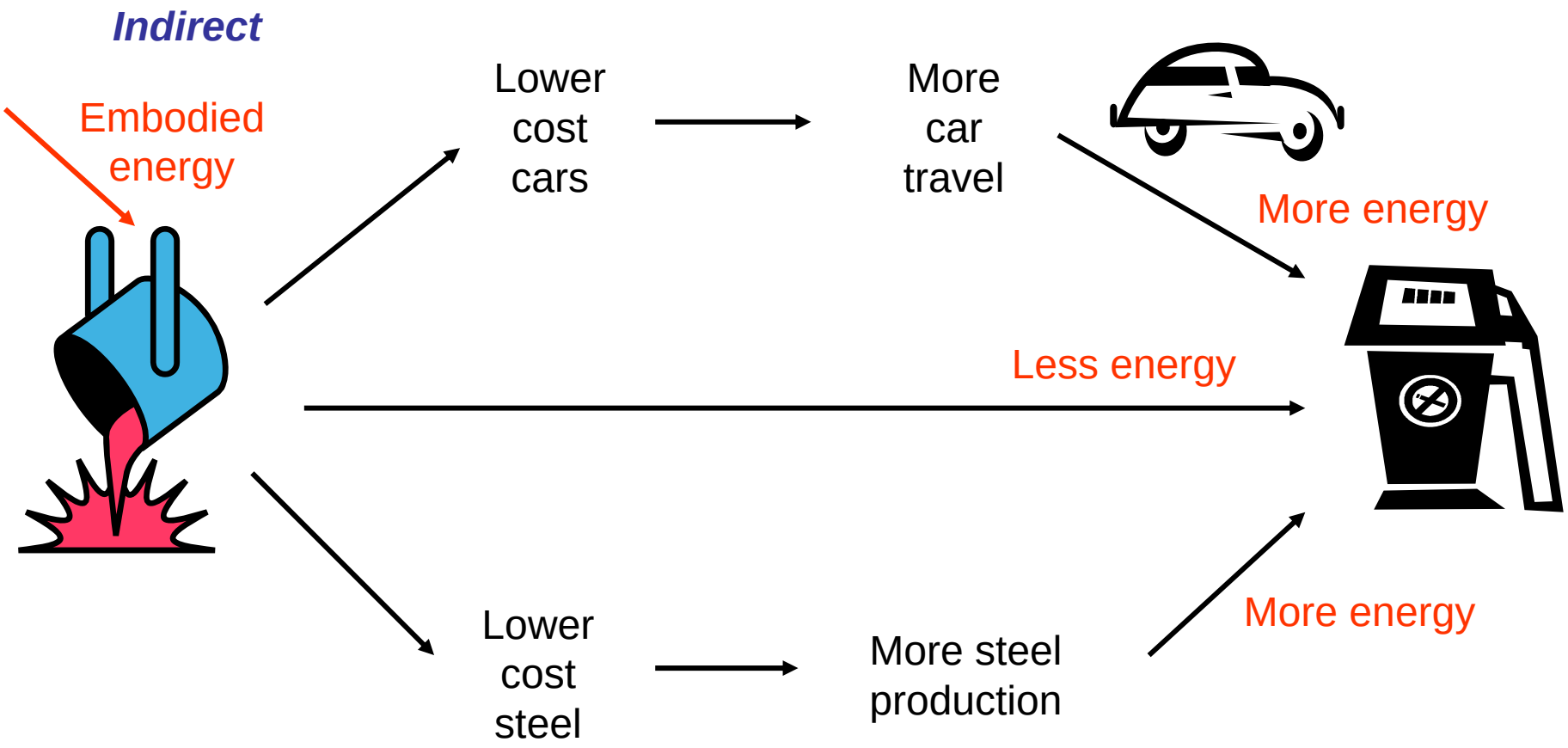
Rebound effects - producers



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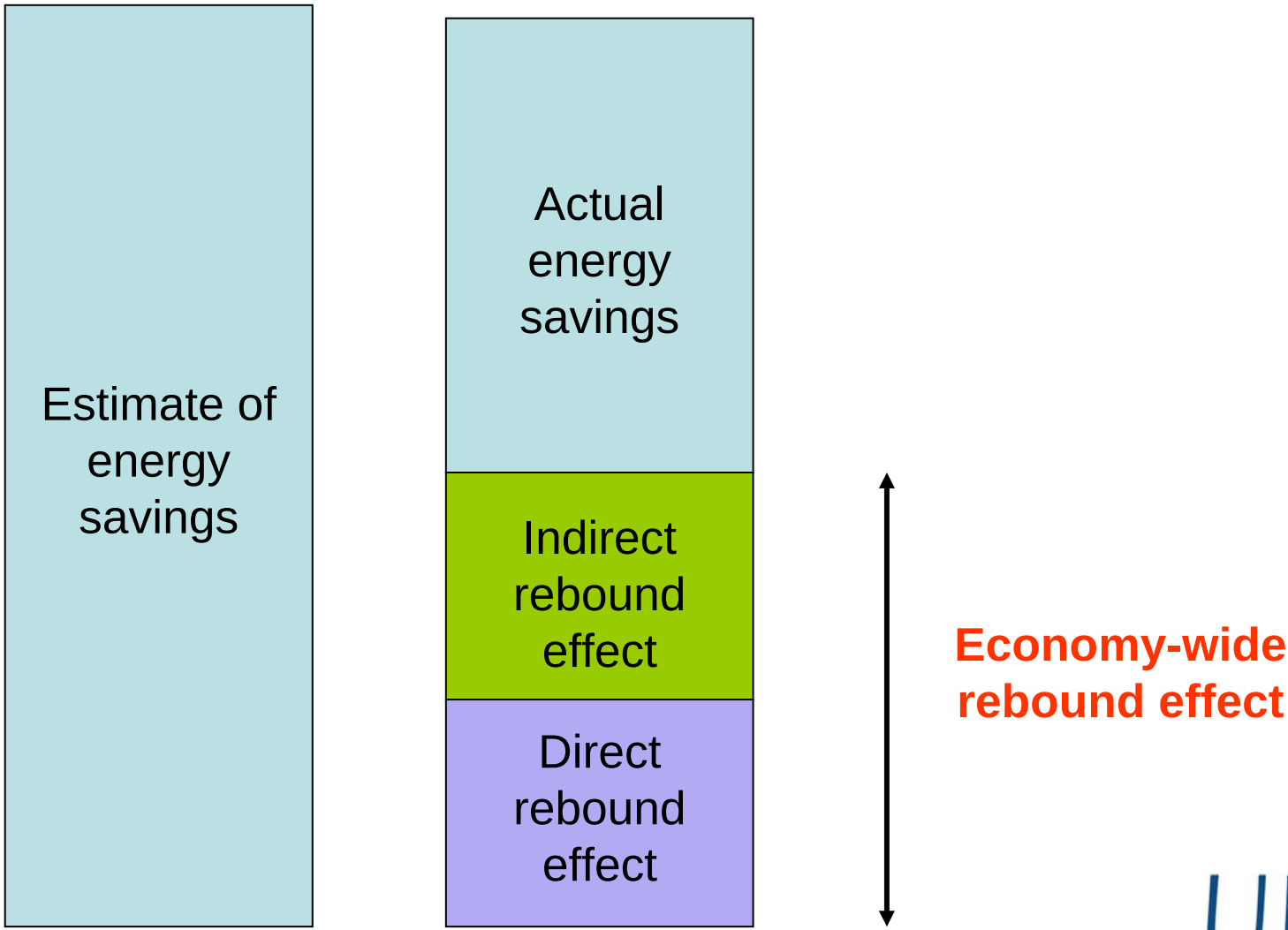
Economy-wide rebound effect



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Key points

- Rebound effects depend upon how ‘energy efficiency’ is defined
- Rebound effects need not be small just because the share of energy in total costs is small
  - *Example*: Energy efficiency improvements in commercial buildings improved labour productivity by 16% (labour costs 25 times greater than energy costs)

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Evidence for direct rebound effects

- Largely confined to personal transport, space heating, space cooling and other consumer energy services in OECD
- Various regions, time periods, data types, methodological approaches and measures
- 15 quasi-experimental studies of space heating
  - Many methodologically weak
- 31 ‘econometric’ studies using secondary data sources
  - Most rely upon estimates of price elasticities
  - Several of these may overestimate the effect

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Conclusions on direct rebound effects

- Long run effect less than 30% for personal transport, space heating & space cooling
- Much smaller for most other consumer energy services
- Expect to decline in future as demand saturates and income increases
- *But*:
  - Only limited time periods studied
  - Marginal consumers ignored
  - Only subset of variables measured
  - Virtually no studies of producers and/or households in developing countries

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Evidence for indirect & economy-wide rebound effects

- Only a handful of studies, focusing upon different regions and different types and sizes of energy efficiency improvement
  - Diverse results from embodied energy studies (up to 170%)
  - 8 CGE studies. All >37% and four >100%
  - Barker *et al.* ~26% for UK economy, but could be an underestimate
- Results sensitive to a number of assumptions
  - e.g. varying elasticity of substitution between energy and non-energy inputs from 0.1 to 0.7 increased rebound effect from 7% to 60%
- Variety of methodological weaknesses

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Conclusions on indirect / economy-wide rebound effects

- Insufficient basis to draw any general conclusions
- Effect depends on nature and location of energy efficiency improvement
- Values >50% should give cause for concern
- All assume ‘pure’ energy efficiency improvements
- Needs more systematic investigation

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Evidence for backfire

- Economic history
- Historical relationships between energy productivity and total factor productivity
- Econometric evidence for ‘energy using’ technical change
- Neoclassical production and growth theory
- Decomposition analysis
- Estimates of the income elasticity of energy demand
- Econometric studies of the scope for substitution between energy and other inputs
- ‘Ecological’ alternatives to conventional growth models that give energy a disproportionate role

“..it is energy that drives modern economic systems rather than such systems creating a demand for energy”

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Illustration: energy and total factor productivity

- Argument:
  - Growth in total factor productivity routinely exceeds growth in energy productivity
  - Energy productivity improves while energy consumption increases
- Problems:
  - Relationship varies between different countries and sectors and over time
  - Derives largely from changes in energy quality
  - Need not apply to all sources of energy productivity improvement
- Implications:
  - Critical role of ‘high quality’ energy in facilitating technical change & boosting productivity

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Conclusions on backfire

- Theoretical arguments are stylised and restrictive and frequently rely upon questionable assumptions
- Empirical evidence is indirect, suggestive and in some cases flawed
- Hence, the backfire ‘hypothesis’ is not verified
- Arguments and evidence should nevertheless be taken seriously
- Underlying theme is the disproportionate contribution of energy to economic growth

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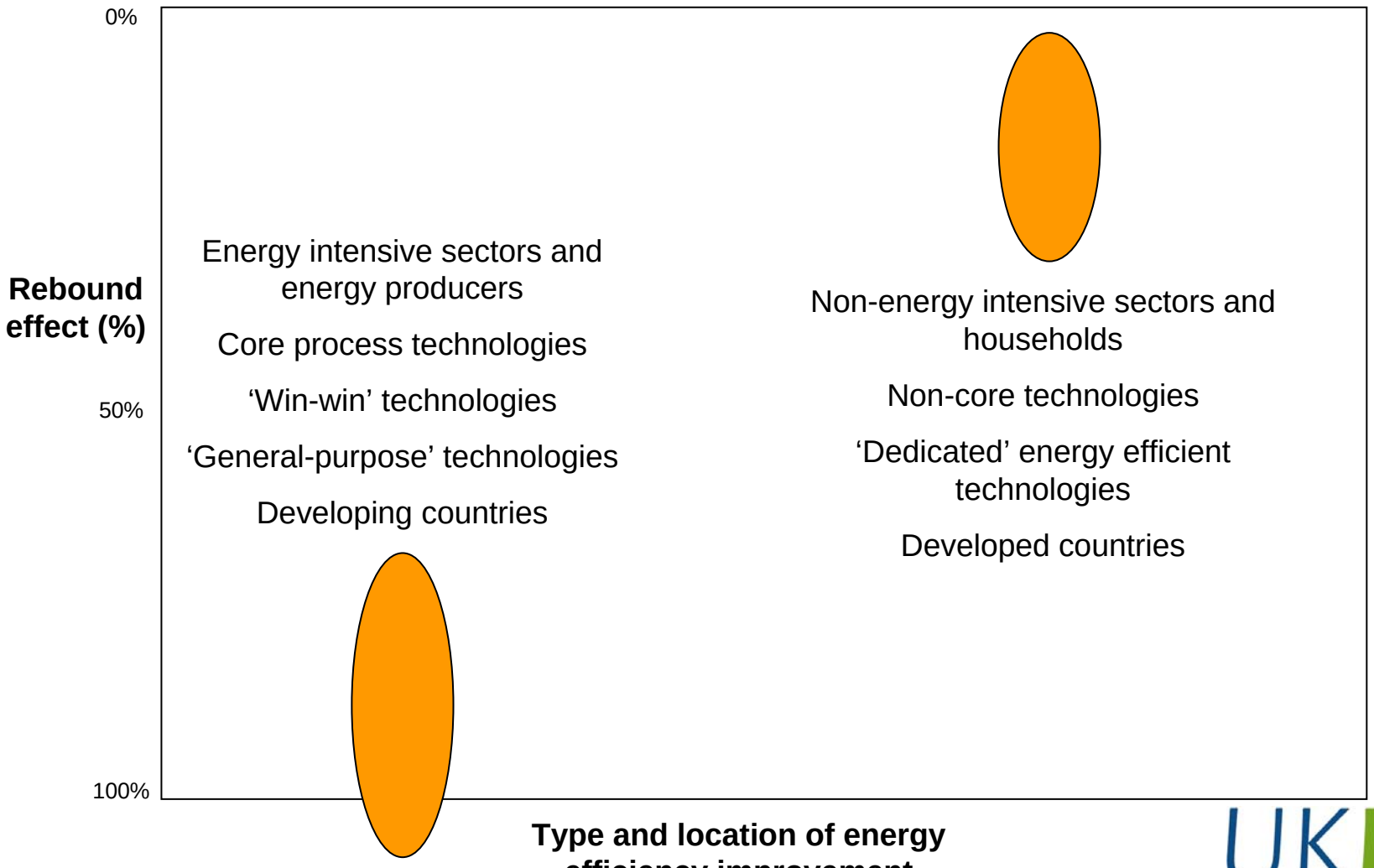
A way forward



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Conclusions

- Rebound effects are significant, but they need not make energy efficiency policies ineffective
- For consumer energy services in OECD countries, direct rebound effects are unlikely to exceed 30%
- There are very few quantitative estimates of economy-wide effects, but several studies suggest that these may exceed 50% in some cases
- The evidence and arguments used in support of the backfire hypothesis are insufficient to demonstrate its validity, but nevertheless pose an important challenge to conventional wisdom

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Research needs

- Research on direct rebound effects needs to improve in rigour and expand in scope
- Quantitative estimates of indirect and economy-wide rebound effects are feasible and should be pursued
- Our understanding of the contribution of energy to economic growth needs to be greatly improved

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Policy implications

- The potential contribution of energy efficiency policies needs to be reappraised
- Rebound effects should be taken into account when developing and targeting energy efficiency policy
- Rebound effects may be mitigated through carbon taxes and emission caps

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