Energy Sufficiency

european council for an energy efficient economy

Capturing the multiple energy efficiency benefits of non-energy decisions

Stockholm workshop report

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eceee's energy sufficiency project is funded by the KR Foundation.
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Introduction

This report considers how we can use the multiple benefits of energy efficiency to persuade people who are making non-energy decisions to include energy efficiency investment in their projects. For example, how we can use the comfort and health benefits of a more energy efficient building to persuade building owners to increase energy efficiency when they refurbish their buildings. It is based on discussions at a workshop, hosted by the Swedish Energy Agency and eceee, in Stockholm on 13th December 2017.

The report aims to answer a number of key questions:

- When can we increase energy efficiency by valuing its multiple benefits?
- Which benefits are important to decision-makers?
- Can we quantify these benefits? And what tools do we have to do this?
- How do we present the benefits to decision-makers, whether or not we can quantify them?

The workshop and this report are also a contribution to eceee's work on energy sufficiency. This wider project, funded largely through a grant from the KR Foundation, is investigating how we can design policy to encourage reduced energy use through changes in the quantity or nature of energy services demanded. This report will help to identify situations when such a change in the quantity or nature of energy services demanded may be viewed as a positive thing by the energy service user: for example where a switch from car travel to walking leads to direct personal health benefits and improvements in air quality, as well as reducing energy demand.

The multiple benefits of energy efficiency

Improved energy efficiency can have many benefits, in addition to reduced energy demand. These can be environmental (e.g. reduced greenhouse gas emissions or improved air quality), social (e.g. better health and wellbeing, reduced fuel poverty, increased employment), or economic (e.g. increased asset values, improved productivity, increased GDP). The most comprehensive study of these benefits so far has been carried out by the International Energy Agency (IEA). Their 2014 report, 'Capturing the Multiple Benefits of Energy Efficiency'[1], presents this work.

[1] http://www.iea.org/publications/freepublications/publication/Captur_the_MultiplBenef_ofEnergyEficiency.pdf

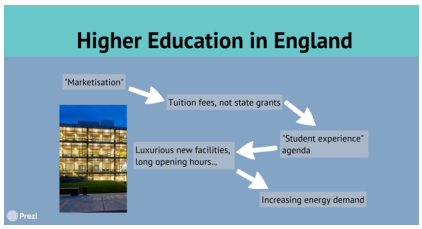
When can we increase energy efficiency investment by valuing its multiple benefits?

We should be able to increase investment in energy efficiency by persuading people to think about benefits from reducing energy use when they are making decisions for non-energy reasons. This applies to a wide range of everyday decisions, but also to larger decisions on projects and policies. The decisions are many and varied: the 'Invisible Energy Policy' project at the DEMAND centre in the UK[2] is looking at a range of these decisions and Sarah Royston, from the project team, presented some thoughts from the project at the workshop.

The examples of non-energy policies and trends given in the presentation demonstrate the range we have to consider. These included: air pollution control; planning; heritage protection; the Common Agricultural Policy; defence, and digitalisation.

Sarah expanded on one example of a non-energy policy decision in the UK that is having a significant impact on energy use: how higher education organisations in England are funded (see Case study 1, below).

Case study 1: Higher education funding decision increases energy use in university buildings and student accommodation



The UK Government has pursued a policy of 'marketisation' of higher education in England. This means that a significant proportion of funding for universities now comes from tuition fees paid by students, rather than from state grants. This has led to the development of a 'student experience' agenda, with universities paying attention to the results of student surveys. This in turn has led to development of luxurious new living accommodation and other facilities and extended opening hours for key university buildings (with some libraries, for example, remaining open 24 hours a day, 7 days a week). Increased living space, with more provision for IT and other technologies, increases energy use, as does increased opening hours in key buildings.

Practically, we need to choose which non-energy decisions we want to try and influence. Decisions that could have a large impact on energy use, and situations where energy efficiency clearly has benefits that will be of interest to the decision-maker, are a good place to start. At the workshop, we considered this question, and developed lists of key decisions at the national, regional, organisational and personal levels.

National decisions

The five areas of national decision-making noted most often in the discussions were tax, industrial policy, spatial planning, infrastructure investment and health. Also noted during

[2] For an overview, see: http://www.demand.ac.uk/research-projects/invisible-energy-policy/ and for more detail see: https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2017/2-policy-governance-design-implementation-and-evaluation-challenges/invisible-energy-policy-a-new-agenda-for-research-and-intervention/ and http://www.ukerc.ac.uk/publications/impact-of-non-energy-policies-on-energy-systems.html

this discussion was the importance of the regulation of energy costs and of the methodologies used to determine cost-effectiveness of energy efficiency investments and hence the appropriate level of ambition for energy efficiency. Immigration policy was also noted as something that would have a large impact on energy use, but also something that was 'non-negotiable' (i.e. not something that we could / should be trying to influence to support energy efficiency aims).

Tax

There are existing tax policies, for example company car taxation or carbon taxation, that may affect energy use. There are also taxes that could be used to promote greater investment in energy efficiency, such as property taxes linked to the energy efficiency of the property, or income tax allowances linked to investment in energy efficiency technologies. Finally, there are potential tax systems that would promote broader objectives that could also have energy impact, for example business taxes that promoted the circular economy.

Industrial policy

Industrial policy may influence energy use by driving innovation rates, and also by determining the physical location of business investment if it is linked to a localisation agenda.

Spatial planning

Where there is a national framework for spatial planning, this can influence energy use significantly. It is an important area to focus on as it has long term impacts and affects many people. No-regrets policies are needed to avoid 'lock-in' of high energy design or technology options. Spatial planning that takes into account energy implications can have many positive effects, on health, access for all, equality, air quality, and mitigation of peak demand for infrastructure.

Infrastructure investment

Infrastructure planning and investment can affect energy use in many sectors, for example through its influence on preferred transport solutions or its impact on access to, and quality of, wifi networks.

Health

A number of aspects of health policy are important. Fundamentally, the way health objectives are set, financed and measured, will influence how action on health interacts with energy use: a focus on improving public health will be a greater driver for action on healthy homes than a focus on numbers of patients per week seen by each medical professional. Linked to this, if health and wellbeing are prioritised, this could drive the development of building regulations for healthy homes, which would in turn promote energy efficiency.

Regional decisions

Spatial and urban planning is important at the regional level too, as is schools policy and potentially some aspects of the equalities agenda and other local authority priorities.

Spatial and urban planning

Local spatial planning can influence transport needs and decisions, work patterns (including working from home), and the potential for local food production, all of which affect energy use.

Example: urban planning for air quality improvement

Many city authorities are concerned about the health effects of local air pollution, and much of this pollution comes from car travel in the urban area. Planning for air quality improvement can have a significant impact on energy use but, if reduced energy use is not one of the aims of the policy, an opportunity can easily be missed.

Policies and plans to reduce air pollution could focus on banning the most polluting vehicles from the roads. This may simply result in a switch from diesel vehicles to petrol or hybrid vehicles, and there may be little or no impact on overall energy use. Alternatively, the policies could focus on reducing the use of private cars, and encouraging walking, cycling and the use of public transport.

These alternative policy approaches will not only improve air quality and reduce energy use, they will also tackle congestion and – where walking and cycling are promoted – contribute to health improvement not only through better air quality but also through greater physical activity.

Schools policy

Schools policy can influence energy literacy, through requirements and recommendations for what is included in the curriculum. Less obviously, policy on choice of schools can affect energy use. In many countries, including Sweden and the UK, there is an emphasis on diversity of provision and parental / student choice of school. This can lead to increased distances travelled to school and more travel at peak times, both of which increase energy use.

Other local authority priorities

A number of other examples were suggested, where local authority decisions could affect energy use. For example, if a council was focused on equalities in an area where women cycled more than they drove cars, they may choose to clear snow from cycle paths before clearing it from roads, hence encouraging more cycling. Similarly, a council with a sustainability focus may include energy efficiency requirements in its procurement policies. On the other hand, a council with a focus on its own status might choose to commission a spectacular but high energy new building rather than a low-energy, sustainable one.

Organisational decisions

Key decisions made by organisations include building renovation and investment in process improvement. Other aspects of organisational decision-making that could have an influence are how start-ups, mergers and acquisitions are regulated, re-branding decisions, and policies on commuting, travel and procurement.

Building renovation

Building renovation projects will to some extent tend to improve energy efficiency, since new building envelope elements will tend to be more efficient than the ones they replace. However, decisions on space per person or the level of ancillary facilities provided could increase overall energy use. On the other hand, refurbishment decisions driven by a desire to improve thermal comfort, daylighting and ventilation will tend to drive energy use down.

Process improvement

Security and safety objectives, or a desire to improve productivity, can lead to decisions to invest in changes to processes and equipment. These decisions offer a key opportunity to increase the energy efficiency of the processes concerned.

Other aspects of decision-making

Organisations may have commuting and business travel policies that affect travel energy use by favouring more or less efficient options. Similarly they may choose to include

sustainability criteria in their procurement policies, which could affect energy use by their suppliers. Re-branding decisions could include a focus on sustainability or, more simply, a decision to improve store-front lighting and hence investment in LEDs. Finally, procedures and regulations governing start-ups, mergers and acquisitions could potentially include requirements for minimum levels of energy efficiency.

Personal decisions

Individual decisions on home refurbishment, vacation planning, or diet can affect energy use. Similarly, more focus on choosing suitable living spaces for different life stages (moving in to smaller or larger accommodation when required) could improve the energy efficiency of the building stock overall. This leads us on to other social trends that will be affecting energy use, such as digitalisation, globalisation, increasing food waste, or the use of services like Uber. But these larger trends, though important, are less easy to influence, and therefore not the place to start promoting the multiple benefits of energy efficiency.

Which benefits are important to decision-makers?

Having identified some of the key decisions that we may want to influence, we need to think about which benefits are of most interest to the decision-makers. Promoting the overall argument about multiple benefits, as set out in the IEA report, paints a very broad picture that may not be relevant to the decision in question. We need to focus on a small number of key benefits that are most salient to the decision maker.

Example: building refurbishment

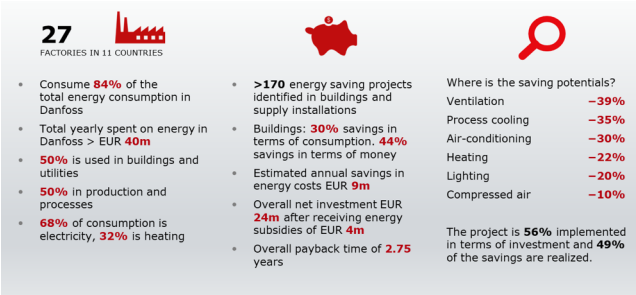
Across Europe, refurbishment of buildings is an important market, involving significant investment and employment. Refurbishment work is generally undertaken to update a building, to rectify wear and tear, or to improve its value. Only a very small minority of projects are for the purpose of improving the energy performance of the building. Because energy performance is not a driver for these projects, they can often miss very cost effective opportunities to reduce energy use. The extent of existing activity and the size of the missed opportunity for energy performance improvement suggest that this is one area we should focus on.

There are a number of different decision-makers involved in refurbishment work, including homeowners, commercial property owners, architects and project designers, project managers, and various building tradespeople. The homeowner and commercial property owner groups can be broken down further into groups such large public and private sector landlords, small private sector landlords, and owner-occupiers, each of which will have different drivers for carrying out work.

For each of these decision-makers, it is easy to see that there are benefits of energy efficiency that may be attractive to them: for example large scale social housing providers will like the health and affordable warmth benefits for their tenants; if the housing is owned by a local authority, the employment effects of the additional work will also be of interest. Companies will be interested in how improved energy efficiency can contribute to productivity.

Alix Chambris, from Danfoss, presented three case studies illustrating how her company has used salient benefits to encourage energy efficiency investment. Starting first with Danfoss' own operations, she explained the drivers for a corporate global programme for energy saving.

Case study 2: Danfoss global programme for energy saving



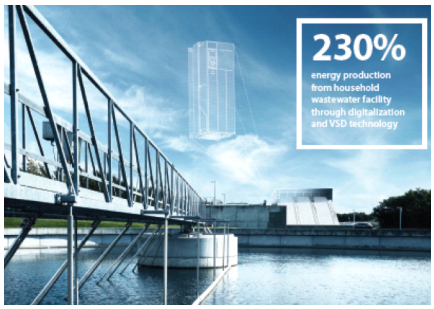
The Danfoss global energy saving programme will improve energy productivity by 67%, for a net investment of €24m. The savings on energy costs amount to less than 0.001% of turnover and, based on this factor alone, the CEO would have prioritised other investment projects.

However, the company's business model and brand are focused on energy efficiency and this, combined with a corporate climate commitment influenced by the political context, regulatory framework and peer pressure in the lead up to the Paris climate talks, meant that the programme has Board support and funding.

Side benefits including reduced sickness and increased employee satisfaction are recognised, but there are no plans to quantify them.

Alix then moved on to explain how appropriate use of multiple benefits arguments helped persuade a local authority to invest in energy efficiency at its waste water treatment plant, and a hotel to invest in a low-energy refurbishment.

Case study 3: Marselisborg waste water treatment plant



Water treatment facilities can be responsible for between 30% and 50% of a local authority's energy bill. However, energy bill savings alone were not the primary driver for investment in energy efficiency in this waste water treatment plant. Robust evidence (from 112 systems in 10 different countries) that efficient, variable speed drives deliver greatly enhanced pressure management, was a persuasive argument. This enhanced pressure management reduces pressure in the system, reducing breaks in pipework and water leakage, extending asset lifetimes and reducing network-related complaints.

Case study 4: Crowne Plaza Copenhagen Towers

Following a low energy refurbishment, this hotel has 77% lower electricity demand and 25% lower water consumption than comparable hotels using more conventional technology.

The high energy performance is an integral part of the hotel's branding, and other benefits that helped drive the decision to invest in the refurbishment are increased indoor air quality due to better ventilation, less noise from the HVAC system, reduced maintenance costs and longer lifetime for the HVAC equipment.

Multiple benefits arguments can also be used to persuade homeowners to invest in energy efficiency. Danfoss, Grundfos, Velux and Rockwool work together on 'BetterHome', a business model that offers renovation projects to homeowners. As part of the BetterHome process, installers discuss with the householder their view on the quality of the building components in their home, the quality of their indoor air and their lighting, and also their level of thermal comfort[3].

Following this presentation, we then split into groups to discuss what might be the persuasive arguments to use with national, regional and organisational decision-makers. These initial discussions produced the following suggestions.

National

For industrial policy, links need to be made with competitiveness, productivity and innovation. It will be important to consider how the multiple benefits arguments link to the whole innovation system and to official and unofficial rules that govern industrial policy.

The arguments to drive planning policy towards greater energy efficiency are perhaps clearer than in some other policy areas: attractive cities, economic development, greater equality, and links to the localism agenda are all salient here.

Tax policy is difficult: negative public reactions to increased taxes are an issue, as are long-standing subsidies for fossil fuels that is may be difficult to change.

Regional

Here, the focus of the discussion was planning policy. Arguments proposed included equalities, attractive places to live, increased property values linked to sustainable transport systems, increased employment and greater happiness. Energy efficiency decisions need to be understood to be 'no regrets' because of the long-term nature of planning policies.

Organisational

Financial aspects (rate of return, profitability) of investments are important here. But links to the company brand and competitiveness aspects (e.g. benchmarking against other companies in the same sector) are also useful.

[3] BPIE have written a case study on this business model, which can be found here: http://bpie.eu/publication/boosting-renovation-with-an-innovative-service-for-home-owners/

There was further discussion of key messages in the final session of the day, reported below in the section on presenting the benefits to decision-makers.

Can we quantify these benefits? What tools already exist?

Ideally, we would like to be able to quantify each of the benefits of energy efficiency, both in terms of its physical impact (reduced emissions or improved health, for example) and also in monetary terms. This is not always easy and sometimes not possible with current data and understanding.

The IEA work on multiple benefits includes analysis of benefits for macroeconomic development, public budgets, health and wellbeing, industrial productivity and energy delivery. These are considered areas where the evidence is sufficient to begin robust analysis of the effects. To take just one example, health and wellbeing, the IEA report discusses current estimates of health benefits in terms of Quality-Adjusted Life Years and US$, from householder and health system perspectives. It also describes the methodologies uses to estimate health impacts and refers to tools such as the UK's 'Health Impacts of Domestic Energy Efficiency Measures' model. The tools and techniques it describes may be very useful at the national policy level but may not be the most appropriate options for discussions about single projects.

In the UK, official policy assessment may quantify health, comfort, air quality and emissions reduction benefits, but not employment, energy system, and GDP effects. Productivity benefits of thermal comfort have been estimated in the US, but there is little information as yet on the asset value benefits of improved energy efficiency.

There is little or no evidence to suggest that there are tools to help quantify benefits at the project level, so the remaining discussion in this section will focus on quantifying benefits at the policy / national level.

Wolfgang Eichhammer, from the Fraunhofer Institut, presented work that he is involved in to add a 'multiple benefits' tool to the ODYSSEE-MURE database of EU energy efficiency policies. The tool categorises the benefits as environmental, social or economic. Each of these categories has subcategories (for example, within social benefits: living comfort, alleviation of energy poverty, health and well-being, and disposable household income). Figure 1, overleaf, illustrates the categories and subcategories covered by the work.

For each sub-category, an indicator is developed, using information compiled from a variety of data sources. The aim in this phase of the work is to enable users to see estimates of the benefits of existing energy efficiency policies. It is currently aimed at policy-makers, but it may be expanded in future to provide indicators at the project level. The project collects the best available data, but the quality is variable. However, the tool does include detailed information about how the indicators are calculated.

The tool is available on the ODYSSEE-MURE website[4].

[4] http://www.odyssee-mure.eu/data-tools/multiple-benefits-energy-efficiency.html

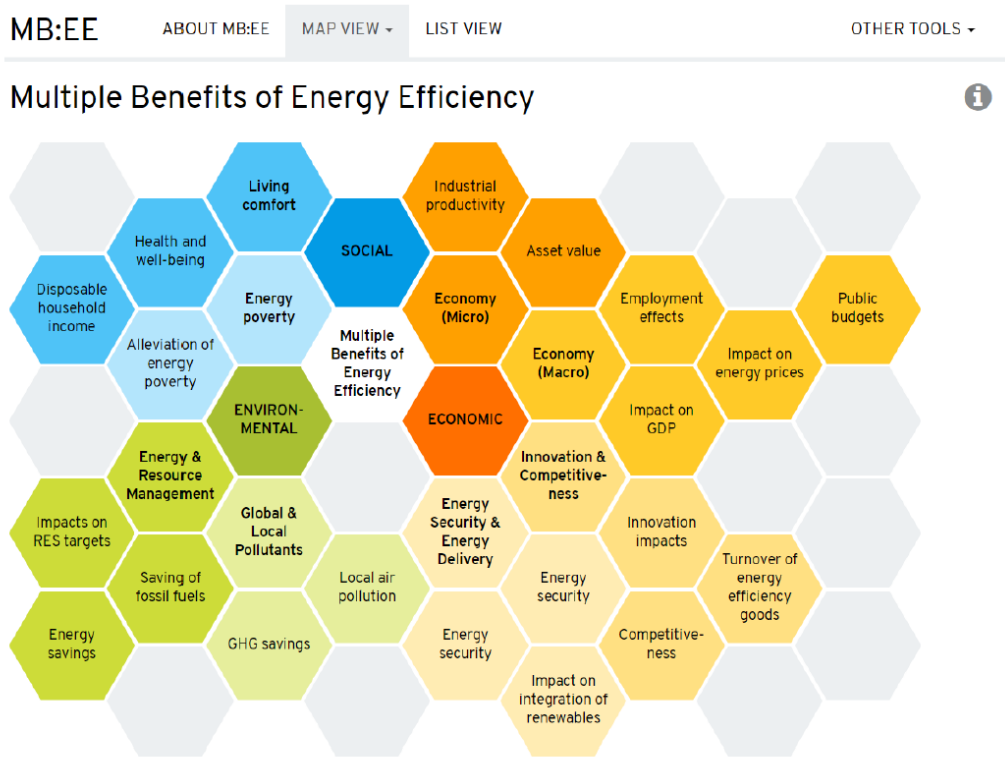


Figure 1: MB:EE in ODYSSEE-MURE

Workshop attendees also discussed their views on which multiple benefits can be quantified at this point in time, split into groups considering environmental, social and economic benefits.

Environmental

At the national/global level, environmental impacts of changes in energy use are well quantified. Hence, benefits such as reductions in greenhouse gas emissions, nitrogen oxides, sulphur oxides, toxic chemicals such as lead and mercury, and radiation, should be relatively straightforward to quantify in physical terms. The monetary value of avoided greenhouse gas emissions should also be quantifiable.

At the local or regional level, it may be possible to quantify benefits such as reductions in noise and light pollution, although only in physical terms rather than as a monetary amount.

Social

Energy poverty is quantified in Eurostat data in and UK fuel poverty statistics. In some countries, the proportion of disposable income spent on fuel is also recorded. It is not clear whether these data are sufficient to estimate the impacts of an individual policy.

There are estimates of the health impacts of energy efficiency improvements (see above), both in terms of reduced incidence of ill-health and the financial benefits this provides to national health services. There are also thermal comfort models in use all over the construction industry, but the group questioned here how temperature limits (what is too hot, what is too cold?) should be decided. Other suggestions were for randomised control trials of educational performance in well and badly lit schools, building user surveys on thermal comfort, and monitoring of indoor air quality and daylight levels.

The employment impacts of energy efficiency investments have been estimated, including in large scale EU studies[5]. However, many of these estimates are now rather old and may not be particularly persuasive for national decision-makers. It may be more interesting to focus on impacts on local employment, and on jobs at different skill levels.

Other social impacts identified by the group, without comment on quantification, included: access to services (mobility), social security and trust (perhaps indicated by numbers of shops in a local area), control over equipment and comfort, communication and access to the digital world, geopolitical security, working conditions, and productivity (perhaps indicated by output per person per hour or by absence/presence at work).

The group considering quantification of social benefits expressed concern about the extent to which these benefits can be expressed in monetary terms and what 'gets lost' if the financial value of benefits is all that is presented.

The group also mentioned a number of potential 'dis-benefits' of increased energy efficiency that should be considered. These included: isolation due to digitalisation; job losses, and insecurity as a result of loss of control / hacking of digital systems.

Economic

The group discussing economic benefits noted that it is difficult to quantify benefits in the economy as the dynamics of the system are complex, and traditional indicators do not allow the isolation of individual benefits. We need to understand at what levels benefits can and cannot be quantified. Ongoing work on tools in this area within Swedish energy companies was also noted by the group.

In terms of asset values, in Sweden there is evidence showing a link between higher energy efficiency and higher asset value in commercial buildings, but nothing similar for residential buildings (where location seems to dominate in determining price differentials). In the UK, there is some evidence for residential buildings.

How do we present the benefits to decision-makers, whether or not they can be quantified?

The above summary suggests that we are not yet good at quantifying the full range of energy efficiency benefits at all scales. But we need to be able to describe the relevant benefits of energy efficiency improvements to decision-makers. This applies equally to benefits that can be expressed as financial values, those that can be quantified but not translated into a money equivalent, and those that cannot (yet) be quantified.

The Swedish Energy Agency and its contractor WSP have developed a visualisation tool that allows presentation of this type of overall picture. Erika Broqvist and Agneta Persson presented the tool at the meeting (see Figure 2, below).

[5] http://www.ukace.org/wp-content/uploads/2012/11/ACE-Research-2000-04-National-and-Local-Employment-Impacts-of-Energy-Efficiency-Investment-Programmes-Volume-1-Summary-Report.pdf

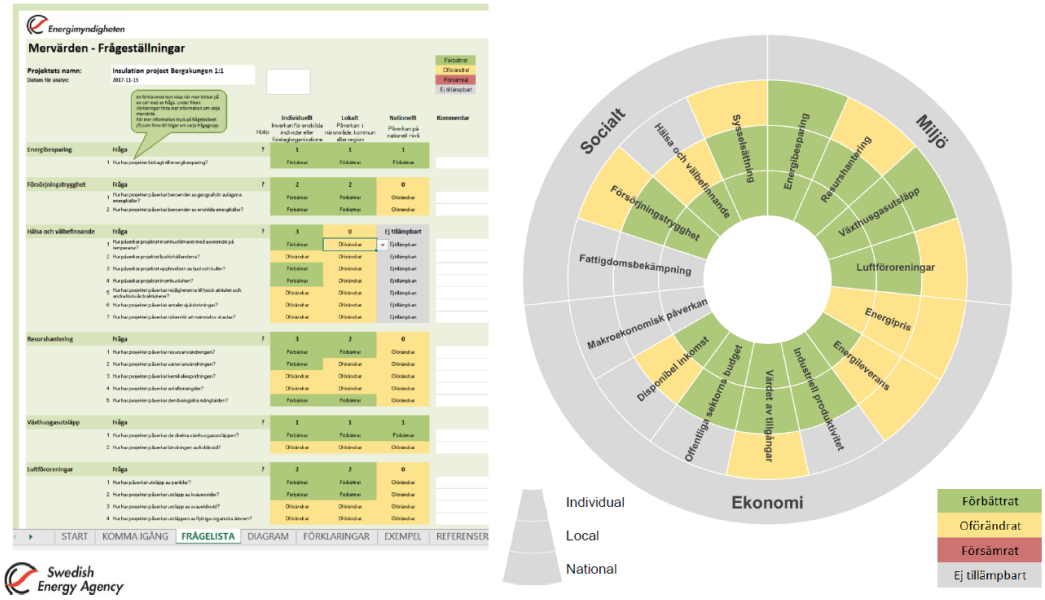


Figure 2: the Swedish Energy Agency visualisation tool

The tool enables multi-criteria analysis of the potential benefits of planned and future projects, for a range of environmental, social and economic benefits. Impacts are considered at individual, local and national levels, making the tool potentially applicable at a project level as well as a policy level.

Following piloting[6] and a second phase of development, the tool has been tested by a group of users in local and regional government administrations. The projects analysed included retrofits to municipal, school and residential buildings, personal and goods transport sustainability projects, public lighting upgrades, and a strategic approach to improved competitiveness in Swedish municipalities.

Results from this testing suggest that the model is usable and that visualisation in this way does aid decision-making even if the additional benefits cannot be quantified in monetary terms. Further work is needed to consider whether there is double-counting across some of the separately presented benefits, and also whether presenting each benefit as equally important (as the current visualisation does) is the best option.

Other organisations are also 'visualising' multiple benefits for use at the policy level. For example, Renovate Europe has produced a series of infographics on the benefits of improved buildings energy efficiency, which mix quantified outcomes with more descriptive information[7].

As a final task during the workshop, participants were asked to think about how they would persuade a series of people (a Prime Minister or municipal Mayor; a CEO or civil service department head; and a home-owner or landlord) to invest in energy efficiency. This brought together the earlier discussions on what messages were important to them and how these could best be presented. We also considered *who* could most effectively persuade these people to act.

[6] For more information on the results of the pilot phase, please see: https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2017/2-policy-governance-design-implementation-and-evaluation-challenges/seeing-is-believing-8211-visualizing-helps-realize-the-hidden-benefits-of-energy-efficiency/

[7] http://renovate-europe.eu/media-centre/infographics/

Prime Minister or Mayor

These decision makers were seen to be driven by risk avoidance, a desire to make a difference, and also a desire to be re-elected. For a liberal leader, energy efficiency can be presented as demonstrating vision, sustainability and green credentials. For a conservative leader, it can be presented as helping to preserve cultural heritage, renewal of infrastructure and future proofing. For all leaders, it needs to be shown to give visible results and impacts.

The most relevant benefits here are energy security, increased quality of life, increased employment, competitiveness and export capacity, a strong economy and increased taxes, and attractiveness of the country / local area to citizens and businesses. Avoided risks, such as flooding, unemployment, or poor air quality, can also be persuasive messages.

Industry (innovators and exporters), the media, citizens (groups and individuals) and accountability monitors (NGOs) could all present these messages to political leaders.

CEO or Head of Department

A Chief Executive may be persuaded by reputational drivers (personal or corporate). The media or business associations could present energy efficiency as something that improves a CEO's personal reputation; customers could demand it as part of brands they prefer; customers and NGOs could describe it as part of corporate social responsibility ('think of the children / save the world'). More negatively, the Board could define it as a way for the CEO to avoid losing their job!

In business administration terms, energy efficiency investment can be presented as a way to ensure higher product quality (by the production manager); a way to become more competitive, increase market share and profits, and increase exports (by peers, by finance directors, by trade organisations); or a way to increase productivity by improving the working environment (by a business advisor).

Energy efficiency may also be presented as a way to improve employee satisfaction and make recruitment and retention easier, a way to reduce future risks or a way to access lower cost finance for broader investment projects.

Senior civil servants will respond to many of the same benefits, expressed slightly differently: popularity with the public, happy employees, and social responsibility may all be drivers. Meeting departmental targets, out-performing other departments and securing a promotion may also be effective messages, delivered by peers or politicians.

Home-Owner or Landlord

Home-owners may be influenced by neighbours talking about their positive experiences of a more energy efficient home (a healthier, happier family, comfort, a feeling of more light and space) or simple envy related to new energy technologies.

Estate agents and mortgage lenders could encourage increased investment through links to increased property value and access to finance at lower interest rates.

Family doctors may be able to persuade people to take action if they suggest that energy efficiency will help improve their health.

There will be a role for energy agencies and advisors to explain benefits such as future proofing and weather proofing, as well as lower energy bills. Tradespeople can sell benefits of individual technologies such as the lower maintenance, increased comfort and increased property value associated with improved windows. And energy companies could offer 'holistic' packages to attract new customers, offering energy efficiency improvements as well as fuel supply.

Public sector landlords will be interested in arguments about improving their stock and reducing fuel poverty. All landlords could be motivated by the chance to win an award; the chance to increase rents, and the likelihood of fewer complaints from tenants.

Summary

The workshop has identified a number of decisions that could be influenced by multiple benefits arguments. At the national policy level, these include spatial planning, infrastructure investment health and industrial policy, and possibly also tax policy. At the regional level, spatial and urban planning are key, together with schools policy. For organisations, decisions to refurbish buildings and improve processes are important. For individuals, the most obvious single decision is on building refurbishment, although a broader look at social trends and their drivers is also needed.

At the present time, there are few well developed quantification tools. There is interesting work within the IEA and also by the ODYSSEE-MURE project, and the latter will soon produce a tool that can be used to look at national policies and programmes.

The extent to which quantification is important in persuading any given decision-maker remains an open question. For quantification to be persuasive, the data and methods used must be robust, and at the present time the quality of both remains very variable. There are also valid concerns that a focus purely on quantification may mean that some important benefits (particularly some social benefits) are not considered. As an alternative, the Swedish Energy Agency visualisation tool has been well received as a decision-making aid within local authorities and could be developed for use in decisions at other levels.

Despite the difficulty in defining, quantifying and presenting many of the benefits, it is clear that this is an important and useful area for further work, as the arguments that may persuade decision-makers are varied and often not linked to the benefit that is easiest to define: lower energy costs.

Acknowledgements

I would like to thank the Swedish Energy Agency and the KR Foundation for supporting the work on this paper, and also the attendees at the workshop, for their time and expertise. Particular thanks to Carlos Lopes, and Nils Borg and his colleagues at Borg & co, for organising the workshop; to Argyris Oraiopoulos (UK ACE) for workshop note-taking and additional research; and to Sarah Royston (University of Sussex), Alix Chambris (Danfoss), Wolfgang Eichhammer (Fraunhofer Institut), Erika Brokvist (Swedish Energy Agency) and Agneta Persson (Anthesis) for their presentations at the workshop. Copies of these presentations are available alongside this report.