Building synergies between climate change mitigation and energy poverty alleviation.

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Abstract:
Even though energy poverty alleviation and climate change mitigation are inextricably linked policy goals, they have remained as relatively disconnected fields of research inquiry and policy development. Acknowledging this gap, this paper explores the mainstream academic and policy literatures to provide a taxonomy of interactions and identify synergies and trade-offs between them. The most important trade-offs identified include the potential increase in energy poverty levels as a result of strong climate change action. The most significant synergy was found in deep energy efficiency in buildings. The paper argues that that neither of the two problems – deep reductions in GHG emissions by mid-century, and fuel poverty eradication – is likely to be solved fully on their own merit, while joining the two policy goals may provide a very solid case for deep efficiency improvements. Thus, the paper calls for a strong integration of these two policy goals (plus other key related benefits like energy security or employment), in order to provide sufficient policy motivation to mobilise a wide-scale implementation of deep energy efficiency standards. It also identifies seminal gaps in cost-benefit and policy assessment methodologies that prevent informed decisions towards integrated policy-making that forge the identified synergies on the ground.

Keywords: synergies; energy and fuel poverty; climate change mitigation

Research highlights:

- A taxonomy of interactions between climate change and energy poverty is offered.
- Energy poverty levels may increase as a result of strong climate change action.
- However, strong synergies are offered by deep improvements of energy efficiency.
- Access to modern energy carriers is a key requirement in developing countries.
- Sufficiently solving both problems requires the integration of policy goals.

1. Introduction and aim

Fighting climate change has become one of the most accepted and celebrated environmental policy priorities, resulting in the re-contextualisation of many seemingly unrelated subjects, which are now often presented from this new perspective. However, sometimes the link may be or seems somewhat artificial. And for a lay audience, forging the link between fuel poverty and climate change mitigation may also seem like trying to sell a less *sexy* subject in a more popular packaging.

The main purpose of this paper is to demonstrate that there are not only very strong synergies between the two fields of policy action, but also that it will be very difficult to solve/mitigate either of the two problems without a concerted effort at establishing the policy link between the two areas.

2. Background

Large challenges lie in front of national and global decision-makers as a massive decarbonisation of the world economy needs to be achieved by the middle of the century while improving the life standards of the global population. These challenges are especially difficult in those world regions or societal segments that have less benefited from the developments that have resulted in current GHG atmospheric concentrations. Complex policy frameworks are thus needed to reach a delicate balance between a better satisfaction of the needs of present generations and an effective protection of the rights of future generations to enjoy a stable and safe climate. Additionally, in less affluent geographic and social areas where immediate economic priorities override environmental concerns, climate change alone is often not a sufficient policy goal to be able to mobilise enough political will or adequate action.

In this context, the co-benefits or ancillary benefits of mitigation policies, if these are strong enough, may provide the key entry points to policy-making. If the emission reduction measures can also have substantial positive effects on the welfare of present generations (Pearce, 2000; Markandya and Rübbelke, 2003; IPCC, 2007), these provide additional, or sometimes the main, incentives for decision-makers to engage in more resolute climate action. Conversely, other policy goals may also not score sufficiently high on political agendas in order to mobilise adequate resources for tackling them alone; while if they address a multiplicity of political goals, integrating these may tip the balance in the cost-benefit considerations towards action (EEA, 2005; Lafferty and Hovden, 2003). Therefore, exploring the co-benefits and forging policy synergies offer important avenues into achieving policy goals that otherwise may not seem weighty enough for sufficient societal investments.

Typically, alleviating poverty is not the most obvious area for policy integration with climate change because these two rank high on rather different local political agendas, as well as because of the inevitable societal and private costs of mitigation action. Nevertheless, this paper argues that alleviating one particular type of poverty, fuel poverty, offers strong synergies with climate change mitigation agendas, for two reasons. First, the buildings end-use sector offers the largest and lowest-cost mitigation potential according to global and regional estimates (IPCC, 2007; Ürge-Vorsatz and Novikova, 2008; Eichhammer et al., 2009). Second, a key mitigation strategy to capture these potentials in buildings can also alleviate, or even fully eradicate fuel poverty, providing the ground for successfully aligning short-term social and long-term environmental goals.

This mostly prevails in industrial and transition economies of temperate regions with a cold season[1], where most households have access to gas and electricity but space heating is usually the most expensive item of the domestic energy budget. Nonetheless, the paper argues that it is also important exploring the synergies and trade-offs with other genres of energy poverty, even though traditionally the poverty, energy access and environmental agendas and thus research have been largely disconnected, with some exceptions (Pachauri and Spreng, 2003; Sagar, 2005; Birol, 2007).

[1] In particular, fuel poverty is mostly a European subject (Boardman, 1991; Buzar, 2007c; Morgan, 2008; EPEE project, 2009; EC, 2010), though domestic energy affordability issues are likely to be equally relevant in other large industrial and transition nations and carbon emitters like the USA, China and the Russian Federation.

In spite of that, most of the literature on fuel poverty has focused on its social aspects but has not consistently explored its climate change implications. Acknowledging this gap, this paper also aims at describing and analyzing the functional and policy links between the climate change mitigation and energy poverty alleviation challenges. For that, the typology of the general interactions between these two fields of enquiry is first explored (Section 3). Then, we focus on a particular type of energy poverty: fuel poverty[2], a phenomenon that is mainly resulting from the inability to afford adequate heating for the living space of the household (Section 4). Finally, Section 5 provides a summary of the main conclusions of this analytical review.

3. Exploring the energy poverty and climate change connection

4.1. A taxonomy of interactions

Energy poverty as traditionally been considered and addressed as a sub-problem of general poverty, i.e., mainly related to household income, and thus the issue was not on the energy but only on social agendas. Nevertheless, understanding the roots of energy poverty offers further key opportunities for alleviating it, and places the problem on the energy radar screens. The two further pillars of energy poverty, i.e., energy prices and the energy efficiency of the energy-using capital stock (equipment and infrastructure), are in fact more effective levers for tackling this particular type of poverty. In developing countries, a fourth, and there key, pillar joins the picture: the access to modern energy carriers. These underlying factors of energy poverty provide the analytical framework for this review and offer the ground for the key entry points into policy-making, with a taxonomy offered in Table 1.

4.1. The four pillars

First, as mentioned, low incomes have been regarded as the chief cause of energy poverty and thus its analysis has long belonged to a more general field of inquiry such as the study of poverty and deprivation. However, although the literature and thus documented evidence on this is scarce, this paper argues that solving the energy poverty problem via households' income (e.g., through subsidies to energy costs or fuel payments) is often difficult because extra income may not be prioritised by households to covering energy service needs. They have also been criticised because they are often poorly targeted and become a burden in public budgets (Scott, 1996; Healy, 2004; Boardman, 2010; Tirado Herrero and Ürge-Vorsatz, 2010).

[2] The authors are aware of the apparent terminological confusion existing in this regard: on the one hand, *fuel poverty* is the without doubt the favoured wording in the UK (e.g., Boardman, 1991; DECC, 2009) and Ireland (e.g., MacAvoy, 2007), where the concept originated, for describing the inability to afford enough energy services for the household, namely heating. On the other hand, key references for Central and Eastern Europe (Buzar, 2007a; 2007b; 2007c) and other EU-level institutional sources like Morgan (2008) and EUFORES (2008) refer to the same phenomenon as *energy poverty*. However, other authors speak of *energy poverty* when referring to the lack of access of quality energy carriers, mostly in developing countries (Birol, 2007; Sagar, 2005). For the purposes of this paper, we consider *energy poverty* as a broader concept encompassing all sorts of energy-related deprivation resulting from inadequate levels of energy services consumption in the domestic sphere (be it because of the lack of access to quality energy carriers or the household's inability to afford them) and *fuel poverty* as the mostly heating-related financial incapacity to purchase the energy needed for the household's needs, which is more specific of transition and industrial economies.

Table 1. Taxonomy of interactions between energy poverty and climate change: its problem areas and measures for their alleviation.
Source: own elaboration

Link between energy poverty and climate change	Impact on energy poverty	Impact on climate change-related emissions	Nature of the interaction	Potential policy leverage
PROBLEM AREAS OF CC AND EP				
Warming climate	↓ Reduces heating-related fuel poverty		Trade-off	CC is not a right lever to reduce fuel poverty
	↑ Increases warming-related energy poverty		**Synergy**	**A desirable synergy is the controlled climate warming -> controlled warming related EP**
Energy poverty - *inability to afford sufficient energy services*		↓ Reduced emissions	Synergy, but undesirable	No policy leverage
Energy poverty - *disproportional costs for energy services*		↑ Increased emissions (as compared to equal energy service provided by efficient equipment)	**Synergy**	**Desirable synergy is in controlled EP -> reduced emissions**
MEASURES TO COMBAT ONE OF THE PROBLEM AREAS				
Fuel payments or social subsidies to help with poverty in general	↓ Reduces it - temporarily	↑ Increases emissions through increased energy consumption	Trade-off	Not the optimal policy response, better alternatives exist
Energy price subsidies	↓ Reduces it - temporarily	↑ Increases emissions through increased energy consumption and resulting energy inefficiency	Trade-off	Poor response to energy poverty alleviation both from long-term fuel poverty and CC perspectives, alternatives exist
Improved efficiency of energy-using equipment, buildings and infrastructure	↓ Reduces it; could eliminate fuel poverty completely in some areas	↓ Reduces emissions through improved efficiency, despite potential increases in service levels	**Synergy**	+ **Strong synergistic policy leverage**

Improved energy access	↓ Eliminates some energy poverty (when it is only from the deprivation of access to energy services)	↑ Increases emissions through greater energy use	Trade-off	No leverage - emissions cannot be controlled through limiting access
Reduced heat islands	↑ Increased winter energy poverty	↑ increased emissions	Synergy	No policy leverage: fuel poverty should not be controlled through heat islands
	↓ Decreased cooling-related energy poverty	↓ Reduced emissions	**Synergy**	+ **Strong policy synergy**
Climate (heat) resilient architecture	↓ Decreases cooling-related energy poverty	↓ Reduces emissions	**Synergy**	+ **Strong policy synergy**
Increased cooling to adapt to warming climate	↑ Increases energy poverty	↑ Increases emissions	Synergy	Poor response to warming, synergy is in finding alternative responses to cooling as an adaptation measure

Energy prices are another level through which energy poverty has been traditionally addressed. Many countries and jurisdictions have attempted to address energy poverty and spur development through subsidised energy prices or tariff policies. Nevertheless, this is a double-edged sword, and subsidised energy prices need to be very carefully used in addressing energy poverty since they can in fact be counterproductive in the long-run for solving the problem, potentially *locking-in* households in energy poverty, and becoming the chief cause of later energy poverty when general poverty has been alleviated. This is because lower-than-real energy prices provide wrong economic signals and thus result in a capital stock whose efficiency is lower than that justified by economic rationality considerations. Finally, when the subsidies are weaned, the low-efficiency equipment and infrastructure results in energy costs that are far higher on a lifecycle basis than if they were optimised at the time of investment, forcing households into unnecessarily high energy expenditures. In the case of long lifetime energy-using equipment and infrastructure, this can lock households into unnecessarily high expenditures for as long as decades.

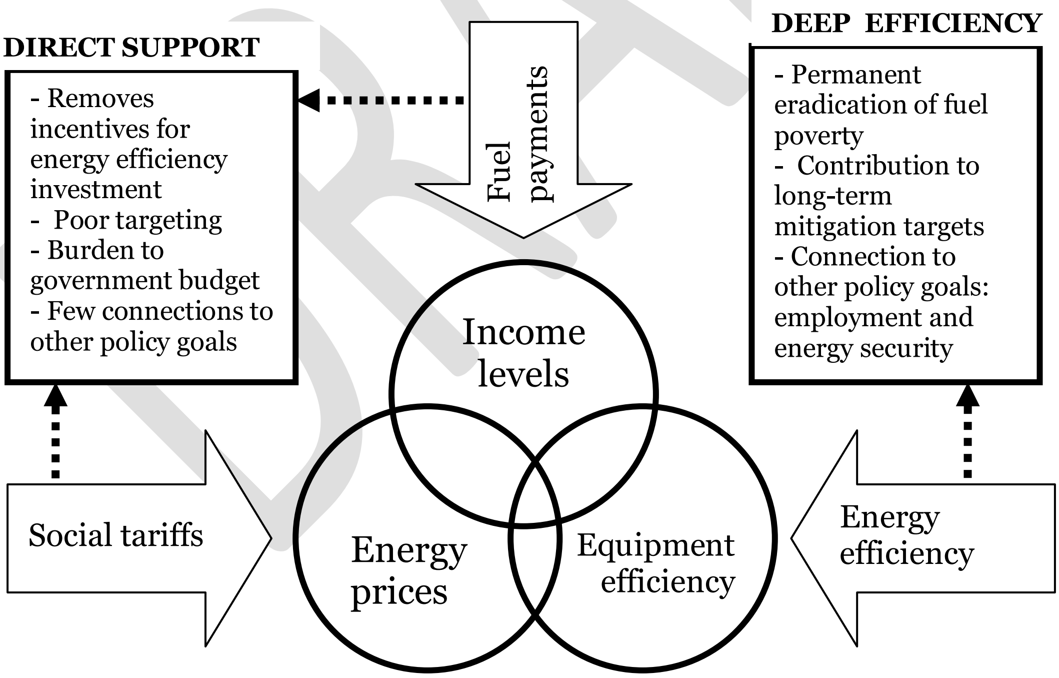
A prime example how an attempt to guarantee widespread access to low-cost energy services through subsidised prices can result in long-term energy poverty even after general poverty is alleviated is the case of the former communist countries. In this region, low energy prices during sustained periods of time have resulted in the construction of buildings and infrastructure with poor energy performances. As a result, per capita energy consumption in this region became one of the highest in the world at the end of the 1980s (EIA, 2004), while the residents enjoyed low levels of affluence. After energy price subsidies were lifted, fuel poverty is suspected to be commonplace (Boardman, 2010), even where deep levels of general poverty are not present. In this way, currently carbon emission (in the buildings sector) and high fuel poverty rates in this region can be attributed to the subsidised energy prices that were characteristic of communist regimes until the 1980s (World Bank, 2000; Ürge-Vorsatz et al., 2006; Buzar, 2007c).

Conversely, energy prices, if properly managed, are a powerful tool of demand-side climate policies. Following this rationale, they are expected to increase in real terms as we progress towards a carbon-constrained (and possibly also fossil fuel supply-constrained) economy and therefore may become an important driver of fuel poverty rates in the future. Trade-offs between climate change mitigation and fuel poverty alleviation goals are then expected, and a potential conflict between the welfare of future vs. present generations will arise unless energy poverty is addressed through its other levers. In summary, there may be significant trade-offs between these two policy approaches. If the chief tool to tackle climate change is through carbon pricing, this will raise energy poverty levels. Conversely, if energy poverty is tackled through energy subsidies, this will raise energy consumption levels as a result of inefficient capital stock and thus increase emissions.

The third pillar of energy poverty, and thus lever for its solution, is the efficiency of the energy-using capital stock. As demonstrated above, this can be a sole cause of energy poverty, even in the absence of high generic poverty. In other cases, this can offer a solution to energy poverty and as such contribute to the alleviation of general poverty. However, for this lever to make a marked difference in energy poverty levels, the efficiency levels of the state-of-the-art and the prevailing equipment or stock in use needs to be substantial, such as in the case of many buildings and heating equipment in heating-dominated climates in transition economies where as high as 90% energy savings can be achieved through state-of-the-art (see Hermelink, 2006). In areas where energy use is dominated by equipment where efficiency improvements do not offer such large savings potentials, such as some electricity-using appliances, improving the efficiency of the stock is still important but cannot be considered as the single lever to address energy poverty. This is the case in many developing countries that do not concur substantial heating expenses but rather other energy end-uses dominate.

For the case of fuel poverty, this leaves the energy performance of the dwelling as the key factor to take or keep households out of it while contributing simultaneously to reducing GHG emissions (see Figure 1). But other important priorities can be addressed as well, as there is evidence about significant net employment creation and energy dependency reduction effects of investing in buildings energy efficiency (Wade et al., 2000; Asia Business Council, 2007; Li, 2008; Pollin et al., 2009; Ürge-Vorsatz et al., forthcoming2).

Figure 1. Contributing factors and policy entry points to fuel poverty and their relation to climate change mitigation.
Source: own elaboration after Diczfalusy (2011)



Finally, access to modern energy carriers like natural gas or electricity is also a very important determinant of energy poverty. Without such access, households are forced to spend a disproportionately large amount of resources (financial or and material) on meeting basic energy service needs, which may constitute a significant part of the household resource expenditures, e.g., women and children in some poor areas needing to spend up to 8 hours per day for collecting sufficient fuelwood for satisfying their daily cooking needs (World Bank, 2008). The disproportionality of energy costs (including non-financial aspects) in areas without access to modern energy carriers may in part originate from the fact that many traditional fuels are utilised with much lower efficiencies – and, also very importantly, at much higher levels of pollution such as indoor smoke – than those designed for modern carriers, needing significantly more energy input for the delivery of the same service. Beyond the amount of household resources it takes to meet energy service needs, energy poverty for such population segments also manifests itself in the limitation in the type and extent of energy services that can be provided from traditional energy carriers, i.e., mostly thermal energy and some poor quality lighting. As a result, even households that could financially afford more energy services are deprived of them, thus being in any case *energy-service poor*.

However, though in this case an enlarged supply capacity enabling wider access to quality energy carriers is part of the solution, energy efficient equipment and infrastructure should also be a strong component of the solution. Otherwise, once previously unsupplied households are physically connected to grids, they will be able to afford lower levels of energy services to which they now have access than using efficient equipment. This can, thus, later reproduce the fuel poverty phenomenon of industrial nations and transition economies.

As a final remark, it can be noted that even though most connections between climate and fuel poverty issues are drawn on the mitigation side, adaptation aspects may become increasingly important: milder winters in temperate regions will have positive fuel poverty alleviation effects and the increase of temperatures in the warm season could make the so far unexplored *summertime* fuel poverty (Healy, 2004) a more relevant aspect of the energy deprivation challenge. Cooling-related fuel poverty may have both trade-offs and synergies with climate change mitigation, also depending on the route of the solution. If the main adaptation method is increased air conditioning, this will have detrimental effects on both fuel poverty and climate change mitigation. If the eradication of heat islands and climate resilient building design are the solutions emphasised, however, cooling-related energy poverty can be prevented through climate action.

4. Deep energy efficiency: a silver bullet for solving fuel poverty and fighting climate change?

This section focuses on the strongest synergy between climate change mitigation and fuel poverty alleviation: building energy-efficiency in climates requiring significant heating services in the cold season. Today's design, know-how and technologies can ensure that state-of-the-art buildings use as little as one-fifth to one-tenth of the heating energy required by conventional buildings. In today's state-of-the-art buildings, heating costs can be minimal, if not fully eliminated (many buildings in temperate climates have already been constructed without heating systems and with only small backup heaters). Therefore, very high-efficiency new construction and retrofitting of the existing building stock to high performance levels can potentially eliminate fuel poverty as it is believed that only by *fuel poverty-proofing* the residential stock (i.e., making it so energy efficient that even the lowest income households can afford a satisfactory level of energy services) it is possible to eradicate it in the long term (DTI, 2006). At the same time, since in temperate climates heating can constitute a dominant part of the residential energy consumption, such buildings also can save a significant amount of GHG emissions. For instance, the Global Energy Assessment has demonstrated that approximately 43% of the 2005 global final heating and cooling energy use can be eliminated by 2050 through the widescale adoption of such buildings, despite the over 120% increase in floor area as well as significant improvement in service levels projected for the same period (Ürge-Vorsatz et al., forthcoming1).

Recognising the link between building efficiency, social welfare and climate change mitigation, policy efforts have accelerated in many countries to ensure energy-efficient new construction (such as the Energy Performance of Buildings Directive, or EPBD, in the EU) as well as the implementation of energy-efficient building refurbishments. However, many of these efforts mandate or aim at reaching thermal efficiency levels that are far from the state-of-the-art. This has been shown to lead to a substantial *lock-in* of emission and carbon saving potentials (see Korytarova and Ürge-Vorsatz, 2010; Ürge-Vorstaz et al., forthcoming1; Ürge-Vorsatz et al., forthcoming2;). While the *lock-in* effect is the most concerning for climate change mitigation because of the urgency of reducing emissions, it also applies to fuel poverty eradication: if the maximum possibilities to reduce energy expenditures are not exploited through state-of-the-art retrofits, these opportunities will be gone for many decades to come as it is highly uneconomic or even technologically unfeasible to capture the remaining saving potential that has been left in the building through a suboptimal[3] construction or retrofit. If only suboptimal retrofits are applied, fuel poverty will not be eliminated, and the rate of its alleviation is often less than the rate of energy savings. This is partially because in some cases energy costs have a large fixed cost component (such as standing fees), and thus even a large energy saving may only reduce energy costs by marginal amounts. In contrast, if heating systems are virtually eliminated in deep retrofits, these fixed costs also disappear, potentially making heating costs negligible or non-existent (in the case of compact multifamily units with significant heat gains such as many operating equipment). Nevertheless, such deep, state-of-the-art retrofits are associated with very significant investment needs that make the task very challenging from a policy perspective, especially because due to the long payback times, and they will not take place on a private investor or market basis in spite of the large societal benefits that can be expected. As estimates from the Global Energy Assessment indicate, a worldwide adoption of state-of-the-art buildings will require 14 trillion USD and result in over 57 trillion USD global savings until 2050 in energy cost reductions alone (Ürge-Vorstaz et al., forthcoming1).

Because of the *lock-in* effect, it is important to very carefully consider the strategy to retrofit the building stock - i.e. the depth (i.e., targeted specific energy consumption level after retrofit or for the new dwelling) and breadth (i.e., fraction of the stock to be acted on) of it. Lower depth and larger breadth may sound politically more attractive, and the challenges of the large individual investment needs are also significantly lower, but such strategies result in substantial locked in emissions as well fuel poverty levels. Therefore, the

[3] Suboptimal in the sense that these technologies, which are not as advanced as state-of-the-art, do not fully realize the total energy and carbon savings potential of the building stock.

sustainable solution maybe to *wait out* until a complex, deep retrofit can be performed on a building rather than force large-scale, superficial renovations.

In summary, this leads to the crucial importance of policy integration. Because the investment costs and policy efforts are so substantial for large-scale, deep retrofits of the building stock, neither fuel poverty eradication nor climate change mitigation alone will be enough to mobilise sufficient policy effort for making it happen, even though this path has been shown to be highly cost-effective from a societal perspective for mitigation purposes. Fuel poverty alleviation alone has also not been sufficient reason for engaging in a deep renovation strategy either. In contrast, if several of these policy goals are considered together, and the political and financial resources for several policy fields are joined, this might tip the expenditure-benefit[4] balance in favour of action. Therefore, it is more likely that one of the most promising measures to fight climate change and fuel poverty will take place if their synergy (and perhaps further synergies such as with energy security) is forged through strong policy integration. For such an integration to be effective, however, significant progress is also needed in research and methodologies. Today, cost-benefit assessments on which policy decisions are based on typically consider direct costs and benefits only for single policy fields. In ideal policy-preparatory assessments full costs and benefits, going beyond the single policy fields and just direct impacts needs to be considered. This requires a major advance in presently used methodologies to quantify and monetise co-benefits as well as co-costs (transaction costs, policy implementation costs, risks, etc.), as well as to their summation accounting for all synergies and trade-offs.

5. Conclusions

This paper has explored the functional and policy interactions between fighting climate change and alleviating energy poverty. For that, it has reviewed mainstream scientific and policy-relevant literature in both domains in order to identify trends, key elements, synergies and potential trade-offs, and provided a taxonomy of these interactions.

The conclusions reached refer primarily to residential consumers and buildings in industrial and transition economies, where a considerably large potential for cost-effective mitigation lies, and where the inability of some households to afford an adequate level of energy services (fuel poverty) has distinct public health and social welfare implications. However, the paper has also addressed the issue of energy deprivation at a global level (energy poverty), which in many developing regions is linked to the lack of access to modern energy carriers. Thus, it has also called for more research on the synergies between other forms of energy poverty than just those linking heating-related fuel poverty and climate change mitigation.

The most important trade-offs identified in the paper include the potential increase in energy poverty levels as a result of strong climate change action inevitably increasing energy prices, which points at an impending conflict between the welfare of present and future generations. If the internalization of the external costs of carbon emissions is not offset by efficiency gains, the burden

[4] By expenditure it is not only financial costs that are considered, but political, policy and other resources that need to be invested for such a widescale deep retrofit path to be implemented.

of mitigation will be disproportionately felt by those worse-off members of society who are still unable to provide enough energy services to their households.

The most significant synergy is offered by the improved energy efficiency of buildings. As argued, ensuring high efficiency standards is the only option for aligning strong energy poverty alleviation and climate change mitigation goals. In comparison, direct support measures implemented as fuel allowances or social tariffs do not provide a long term solution to the energy deprivation challenge – in fact, they will *lock-in* households in energy poverty – and do not reduce carbon emissions either.

This analytical review has explored in more depth the strongest synergy that is offered by these two areas of policy action: eradicating fuel poverty in industrial and transition economies through energy efficiency. The paper has argued that the synergy in this particular case is so strong that neither of the two problems – deep reductions in emissions by mid-century, and the elimination of fuel poverty – is likely to be solved in such countries fully on their own merit; while strong integration of these policy goals, with the potential addition of other key related policy goals such as energy security or employment, is likely to tip the cost-benefit balance and provide sufficient policy motivation to mobilise wide-scale, deep energy efficiency efforts. Thus, an essential message carried by this review is the importance of integrating seemingly unrelated policy goals and joining the resources for their solution.

The paper has also identified seminal gaps in knowlegde and methodology that presently prevent such informed decisions in integrated policy-making which can forge this synergy on the ground. Only by ensuring that the consideration of the various co-benefits are appropriately integrated into policy assessment methods and decision support tools, and thus policy-makers are aware of the synergistic economic and social benefits of reaching these various policy goals simultaneously through ambitious energy efficiency programmes will the needed transformation be realised.

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