CENTER FOR CLIMATE CHANGE AND SUSTAINABLE ENERGY POLICY

CENTRAL EUROPEAN UNIVERSITY

Employment Impacts of a Large-Scale Deep Building Energy Retrofit Programme in Poland

Executive summary

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Poland is approaching a decisive stage for the future of its energy system. The energy intensity of its economy is still significantly higher than the EU27 average: Poland uses more than twice the energy a typical Member State needs to produce one unit of output (GDP). There is an urgent need to upgrade Poland's energy system, primarily its electricity and district heating infrastructure; half of which is more than 30 years old and reaching the end of its lifespan. Substantial capital investments are required for the whole energy system. This includes developing new sources of energy (such as shale and other forms of unconventional gas, if their potential is confirmed) along with the infrastructure for carbon capture and storage – to accommodate the continued use of coal for electricity and heat production. However, in the long-term the country's traditional reliance on coal is unsustainable, due to environmental factors and because national production is already failing to meet domestic demand. In 2008, for the first time, Poland became a net importer of coal, and hard coal production is expected to decrease sharply by 2030 (2015 for lignite).

In addition, Poland is facing major challenges from the European economic crisis, despite its better performance compared to other Member States. This means struggling businesses, increasing unemployment and tightening budgets for social welfare spending and energy-related projects and subsidies.

In this context, **buildings are key to both a robust, secure and socially attractive energy infrastructure upgrade. They also provide an alternative path to stronger economic growth. A more robust and cost-effective upgrade of Poland's energy infrastructure offers an avenue for alternative capital investments. This renewal can deliver large demand-side energy cost savings as opposed to an unsustainable and costly expansion and retrofit of the supply-side capacity.** The sustainable demand-side path also comes with significantly more jobs per euro invested, increased social welfare for households, reduced need for energy-related (direct or indirect) subsidies; sustains or creates local businesses, including rural areas; eradicates fuel poverty; and reduces the needs for infrastructure investments, especially with regard to the district heating network.

Buildings are responsible for over 25% of Poland's final energy consumption and constitute the second most demanding end-use sector of the country after industry. At the same time, the building sector is shown to have the largest cost-effective CO_2 mitigation potential at the global scale. This certainly applies to Central and Eastern Europe (CEE) and in particular to countries like Poland, whose building stock ranks among the ten least energy-efficient in the EU. This inefficiency is despite the Thermodernization programme, a government-supported initiative, since the late 1990s has managed to renovate a substantial fraction of the Polish building stock, delivering savings in the range of the 30% of the energy use before retrofit.

The time has come to re-think the direction and ambitions of the Polish energy efficiency policy for the building sector. **Though Poland's achievements in this policy area have been substantial as compared to other countries of the CEE region, failing to increase Poland's ambitions beyond the current Thermo-modernization retrofit programme will lock-in a large fraction of the energy and emissions saving potential of the Polish building stock. This hampers compliance with long-term emission reduction targets.** If, on the contrary, deep energy efficiency retrofits (saving 64% to 89% of the space and water heating energy consumption per floor area unit) are applied, the potential will be largely realized. A stronger retrofit strategy will also advance a broad array of other socio-economic and political agendas; bringing in **co-benefits such as net employment gains, energy poverty alleviation, reduced air pollution, increased energy security, enhanced market value of real estate and provide positive effects to fiscal balance and social security spending.**

In this context, the **goal of the present research is to gauge the net employment impacts of a large-scale, deep building energy-efficiency renovation programme in Poland, with the understanding that the low employment rate of the Polish economy (59.3% of the working age population as an average for 2009-2010) makes this a key entry point for further decision-making.** The study has been commissioned by the European Climate Foundation (ECF), and executed by an international team of experts led by the Center for

Climate Change and Sustainable Energy Policy (3CSEP) of the Central European University.

Table 1: Retrofit programme scenarios

Name	Scenario	Retrofit rate	Type of retrofits	Forecasted completion
S-BASE	**Baseline** scenario with current subsidies	**3% of the non-renovated stock in 2010** - 25 million square meters or 310,000 units per year	*Business-as- usual* thermo-retrofits (30%)	33 years
S-DEEP1	**Deep** retrofit with slow implementation rate	**1.5%** - 16 million square meters or 195,000 dwellings per year	Deep retrofits (64%-89%)	68 years
S-DEEP2	**Deep** retrofit with medium implementation rate	**2.5%** - 26 million square meters or 320,000 dwellings per year	Deep retrofits (64%-89%)	42 years
S-DEEP3	**Deep** retrofit with fast implementation rate	**3.5%** - 36 million square meters or 450,000 dwellings per year	Deep retrofits (64%-89%)	31 years
S-SUB	**Suboptimal** retrofit with medium implementation rate	**3% of the non-renovated stock in 2010** - 25 million square meters or 310,000 dwellings per year	Suboptimal retrofits (50%)	33 years

A basic assumption of this study is employment impacts strongly correlate with the dynamics of investments flows in building energy retrofits. Therefore the study has investigated the impact of specific renovation scenarios characterized by two factors: 1) the type or depth of retrofits and 2) the speed or implementation rate assumed (for an overview of the scenario descriptions see **Table 1**). The focus is on existing residential and public sector buildings, and emphasized scenarios that support deep retrofits (*S-DEEP* scenarios), which bring the buildings as close to passive house standards as realistically and economically feasible (i.e., a consumption of 50 kWh/m^2/year). Two other scenarios – the business-as-usual implementation of the Thermo-modernization programme (*S-BASE*) and an improved version of the former (*S-SUB*) – were also examined for comparative purposes.

The research has demonstrated that **up to 84% of energy used to heat Polish buildings, and corresponding CO_2 emissions – can be avoided by a wide-spread deep retrofit program involving Poland's buildings.** The research also highlights the risk of implementing less ambitious renovation programmes. If the purpose of refurbishments is keeping today's shallow energy efficiency targets or are improved to just suboptimal level (i.e., reducing 50% of present energy use), this results in a significant ***lock-in* effect. This means that if the renovation programme *cherry-picks* by harvesting only the lowest hanging fruit (i.e., it implements only those measures with the shortest payback period, like replacing windows or partially improving building insulation), Poland's ability to meet long-term, emission reduction targets (e.g., 50 to 85% of the year 2000 global carbon emissions by 2050, as recommended by IPCC) will be jeopardized.** Since heating-related emissions are difficult to mitigate other than by addressing them in buildings themselves, when a building has already undergone a renovation it is difficult and inefficient to implement yet another retrofit to capture the remaining, non-captured energy saving potential.

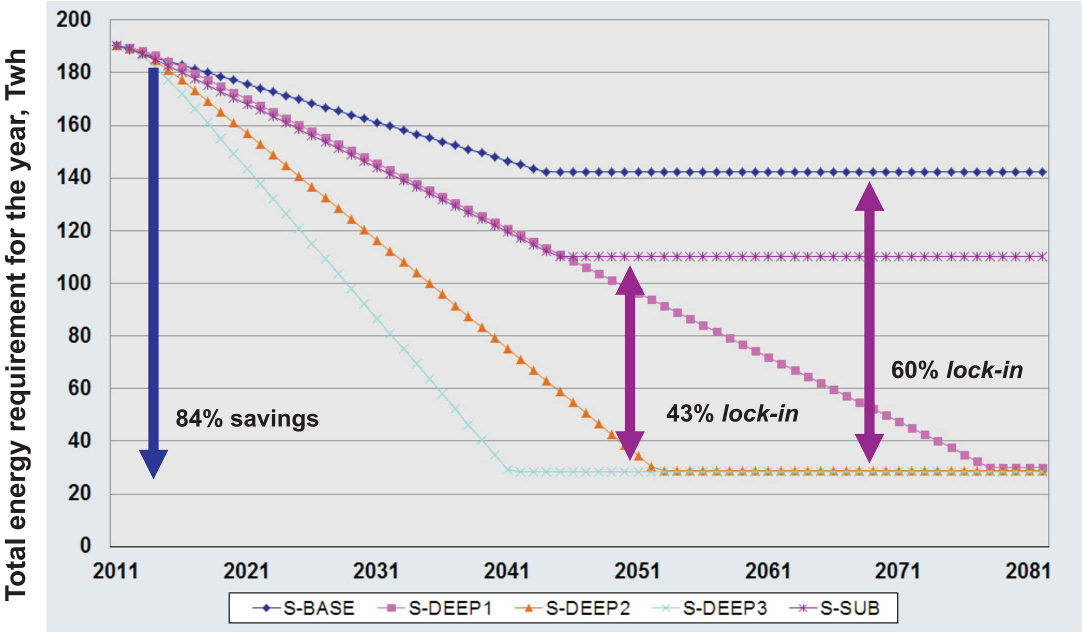

Figure 1: Annual total energy requirement (TWh/year) of the Polish building stock for all scenarios considered

As can be seen in **Figure 1, base and suboptimal renovation scenarios save only 25% to 42% of final heating energy use, locking in between 60% to 43% of the 2011 heating-related emissions in buildings when fully implemented.**

As for the employment effects, the results of the study clearly indicate that **adopting a high efficiency standard close to passive house results in substantially higher employment benefits**, this is compared to the business-as-usual (continuation of the Thermo-modernization programme, *S-BASE*) and suboptimal (improvement to 50% energy savings, *S-SUB* scenario) renovation alternatives. In particular, the research (see **Figure 2**) has demonstrated that a **deep renovation programme** in Poland **will create by 2020 around 250,000 net additional jobs per year, as opposed to the approximately 40,000 forecasted in the suboptimal scenario.**

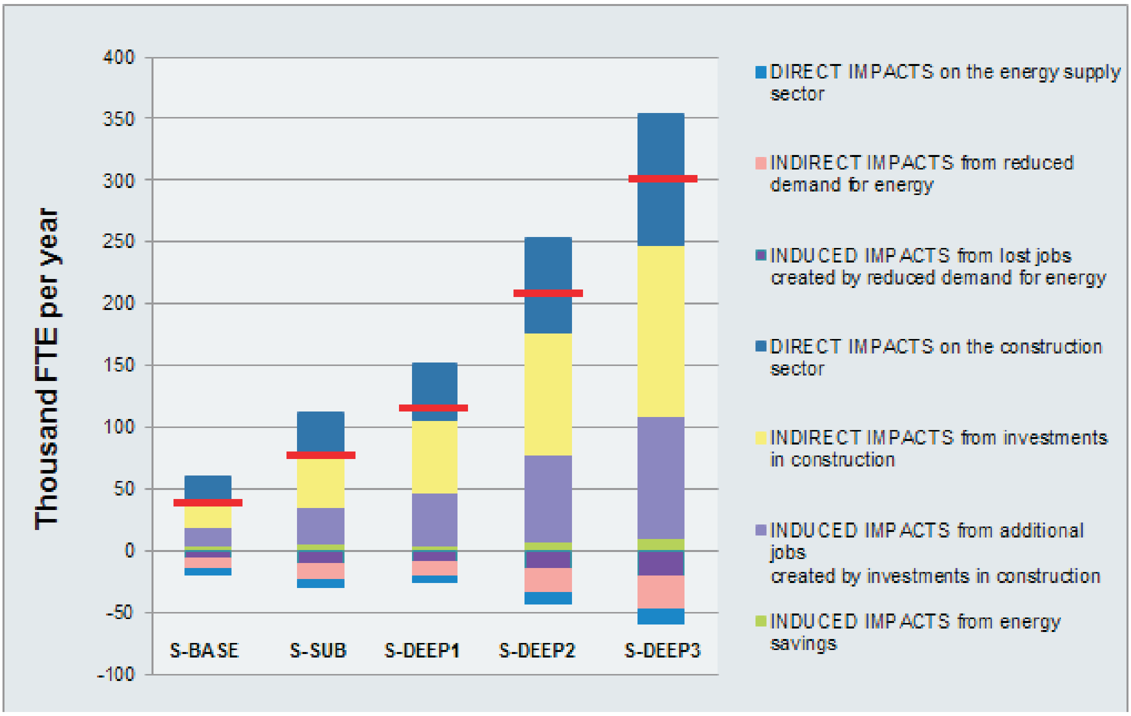

Figure 2: Total impacts for the renovation scenarios in 2020, by type of impact. The size of the net impact is marked with the red crossing line

The peak figures for the creation of employment happen in 2016, when some 340,000 additional jobs are created by the most ambitious deep renovation scenario (*S-DEEP3*). These figures include the workforce losses in the energy supply sector and deduct the net jobs estimated for *S-BASE* scenario (i.e., the ones currently generated by the Thermo-modernization programme and other non-State supported individual retrofits). The net positive net results on employment levels are obtained because the labour intensity of the economic sectors benefits from retrofits (e.g., construction), this is substantially greater than the labour intensity of those impacted negatively (e.g., energy supply).

It is important to highlight that **a large fraction of the total employment gains is due to the indirect effects on sectors that supply the construction industry and to the induced effects of the increased purchasing power of Polish households:** in 2020, 75% to 80% (depending on scenarios) of the gross positive employment created are indirect and induced jobs outside the construction sector. In addition, **forecasted layoffs in the mining and quarrying sector** – a particularly sensitive sector for Poland in this regard – **only accounting for a small fraction of total job losses (a maximum of 6% of gross job losses** in 2020).

From the perspective of the retrofit rate, **a more gradual implementation (i.e., *S-DEEP1*) is associated with less intense shocks in the labour market**, and can avoid some of the bottlenecks in the supply of labour, materials and capital described in our qualitative analysis. It also ensures that the reduction in net jobs created – due to the learning factor-based reduction in the cost of retrofits and the job losses due to the energy savings – is smoother than in a more accelerated timeframe.

On the qualitative aspects of new job creation, the **length of the programme ensures employment created is long-term.** Over time a substantial reduction in the number of net jobs created by the programme is expected as a result of energy savings and the learning factor. The fact that the whole building stock is considered for renovation implies **new jobs are likely to be distributed throughout the country** as renovations are usually carried out by local small and medium enterprises.

In addition to significant energy savings, carbon emission reductions and employment effects, deep retrofits carry a large number of important co-benefits. These co-benefits demonstrate **the role of building efficiency in improving the financial stability of government budgets as well as the wellbeing of both Polish householders and public building users.** Since these co-benefits are often provided to a lesser extent (if at all) by supply side investments, they also reveal reducing energy demand of buildings offers an economic and socially attractive alternative for upgrading Poland's heating-related capital stock.

In particular, retrofitting Poland's buildings is expected to have a positive impact in terms of:

FISCAL EFFECTS, SOCIAL SECURITY SPENDING and NEW BUSINESS OPPORTUNITIES: the on-going sovereign debt crisis experienced by Euro area Member States serves as a powerful reminder that maintaining the balance between government revenues and expenditures is crucial to ensure the overall stability of a national economy. In this sense, the demonstrated positive effects on employment rates of retrofitting Poland's buildings are expected to have also **positive fiscal impacts** in two ways: i) they **reduce government expenditures in the form of unemployment benefits, social welfare payments** (such as for households having difficulty with covering their energy expenditures), **health care costs (i.e., reduced energy poverty- and air pollution-related morbidity, see next) and operation costs (i.e., energy bills) of public buildings;** and ii) they **enhance government revenues in the form of additional personal income tax and VAT collection**, though a certain decrease in revenues associated with lower energy consumption (VAT and other taxes levied to utility companies and energy products) also has to be accounted for. The existing evidence, though still scarce, suggests a net positive impact on state coffers: a recent study of the fiscal effects of energy efficiency investments of the KfW Bankengruppe in Germany found for each Euro invested public authorities get back 4 to 5 Euros in the form of additional contributions and taxes paid by firms and employees, including reduced public expenditure on unemployment and social benefits. In Hungary, an *ex ante* assessment of a hypothetical state-funded residential energy efficiency investment programme has estimated that the additional State revenues (VAT, personal income tax and social security contributions) derived from the additional investment and consumption more than compensates the expenses incurred by the State (subsidies and reduced VAT collection from energy savings).

In addition, **increase in employment rates triggered by retrofits will help buffer the pressure on Poland's public pension funds**, which are likely to increase in the mid-term because of demographic changes. In a context of constrained government budgets and an ageing population, increasing employment rates in Poland stands out as one of the few long-term strategies for ensuring the sustainability of public pension systems.

Finally, a large-scale retrofit programme will create a broad range of **new business opportunities** along the supply chain of retrofits, many of them involving local entrepreneurs and located in rural areas. Being a first mover in supplying large-scale deep retrofits may also help developing industries potentially become future exporters of retrofit materials and technologies to the Central and Eastern European region and beyond. This would further enhance Poland's production and employment levels and contribute to reduce its trade balance deficit.

REDUCED AIR POLLUTION: Poland has one of the most coal-dependent economies in the world. In the building sector nearly 45% of the energy consumed in buildings for space and water heating is directly provided by this cheap and very polluting fossil fuel, either through direct use or through district heating plants. Since coal's emission intensities of non-GHG pollutants (i.e., NO_x, SO_x, PM and NMVOC) are up to several hundred times bigger than those of cleaner fuels, **Poland is currently the largest SO_x emitter and the second largest emitter of PM_{10} and $PM_{2.5}$ of the EU.** When compared to those aggregated figures, the model's results indicate that current heat consumption in buildings is responsible for 43% of Poland's total annual SO_x emissions and 62% of PM_{10} emissions.

Though the use of coal makes Poland a less energy dependent country, it also results in significant impacts on the human health and the environment. The coal-related emissions of harmful pollutants cause, among others, **the acidification and eutrophication of ecosystems, plant damage, respiratory and cardiovascular health problems and reduced lung function. Additionally, the benzo(a)pyrene (BaP) – a compound specifically related to coal and biomass combustion – causes cancer in humans** and is known to be a problem in areas where domestic coal and wood burning is common like Western Poland, the Czech Republic and Austria. These emissions result in substantial costs to the society in the form of direct welfare loss (i.e., pollution-related morbidity and premature mortality) and additional health care system and social security costs (i.e., hospitalization and treatment, sick leaves and working days lost, etc.). A recent study by the European Environment Agency (EEA) on air pollution has found Poland is the EU Member State with the second largest human health and ecosystems damage (5 to 13 billion Euros per year) from industrial facilities – including power plants – after Germany.

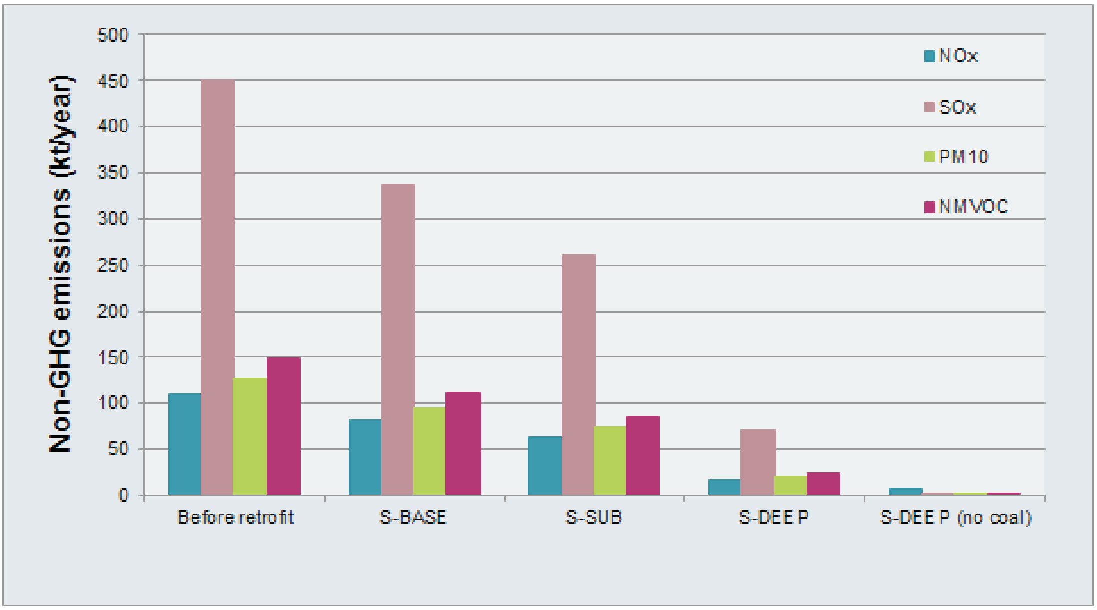

Figure 3: Estimated total non-GHG emissions (1000 t per year) of the building sector before and after the retrofit of all buildings (by scenarios)[1]

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[1] *S-DEEP2 scenario is shown as representative of S-DEEP scenarios.*

Deep retrofitting the Polish building stock has substantial positive effects on human health and the ecosystems because it reduces 84% of the estimated 2010 total non-GHG emissions associated with energy use in the building sector. If retrofits are complemented by a phase-out of coal (i.e., assumed to be substituted by natural gas), this would lead to nearly zero non-GHG emission levels once all buildings are retrofitted (see **Figure 4**). This means avoiding 43% and 62% of Poland's total (i.e., building and non-building related) current SO_x and PM_{10} emissions once all buildings are retrofitted.

<u>ENERGY POVERTY ALLEVIATION:</u> according to Eurostat, **22% of the Polish population (8.6 million people) stated that they were unable to afford to keep their home adequately warm during the cold season** as an average for 2005-2010. In the same period, **nearly 17% the population (6.4 million people) stated to be in arrears on utility bills.** These figures are well above the EU27 average and indicate **that a large fraction of Poland's households struggle to cover their domestic energy needs**, which results in dwellings heated to substandard levels, a higher incidence mental and physical diseases, energy poverty-related excess winter mortality and financial imbalances for utility companies. Like air pollution, energy poverty also increases health care system and social security costs: in the UK, a study has estimated that the excess cold hazard costs of energy inefficient homes (F- and G-rated) to the National Health System (NHS) amounts to € 225 million (L192 million) per year.

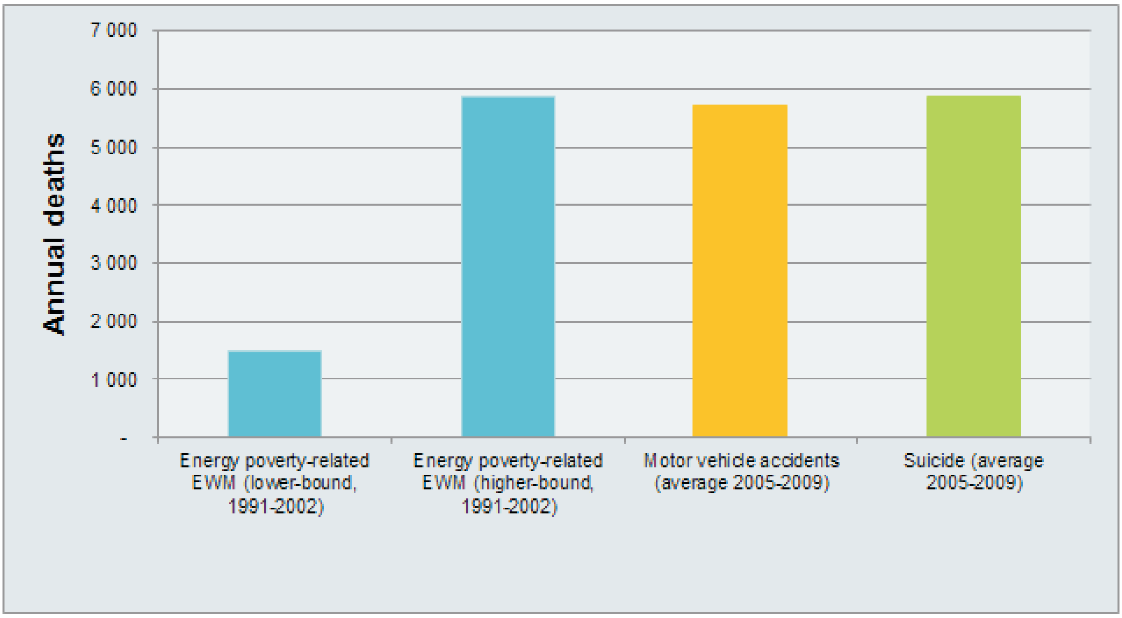

Figure 4: Comparison of energy poverty-related excess winter mortality (EWM) and mortality caused by motor vehicle accidents and sucides[2].

Some initial calculations made for this report indicate that **up to nearly 6,000 excess winter deaths – an amount comparable to the annual number deaths from road traffic accidents or suicide – can be avoided yearly** by ensuring sufficient indoor thermal comfort levels of Polish dwellings. In that sense, **deep retrofitting Poland's residential buildings may eventually eradicate energy poverty and its related excess winter mortality, whereas suboptimal retrofits will take only partial steps towards alleviating this problem.**

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[2] *The reported lower-bound and higher-bound estimates correspond to the 10%-40% range of excess winter deaths that can be attributed to fuel poverty according to the literature*

INCREASED RENTAL AND RESALE PRICE OF PROPERTIES: Compared to similar units, retrofitted buildings have a number of advantages that make them more attractive to buyers of the housing rental and sale markets, thus increasing their market prices. To illustrate, a hedonic price analysis of the Dutch housing sector – an early adopter of the EU EPBD energy labeling system – recently found out that **A-labelled homes (similar to the ones that result of the implementation of deep retrofits) obtained a 12.1% price premium in transaction prices as compared to similar G-labeled homes.** On the contrary, F-labeled properties only received a 1.7% premium as compared to G-labelled homes.

That the price of the dwelling as an asset increases as a result of the intervention is important because it provides an additional financial incentive for households to participate in the programme and for maintaining the energy efficiency gains achieved with the retrofits: **households will not only be saving money while living there but can also sell or rent their property at a better price.**

ENERGY SECURITY: even though natural gas only supplies 8.2% of the heat consumed by the building stock, a large fraction of it (69%) is imported. Deep renovation programmes thus allow Poland to significantly reduce natural gas imports and thereby improve energy security: **by 2030, the reduction in natural gas imports delivered by the most ambitious deep renovation scenario S-DEEP3 will be considerably higher (77% of the average imports of the 2006-2009 period) than those achieved by the baseline scenario (21%) – see Figure 5.** Though the expected exploitation of domestic shale gas reserves will help to further reduce gas imports, efficiency in buildings is likely to be the cheapest and cleanest way to reduce imports even in light of this possible alternative.

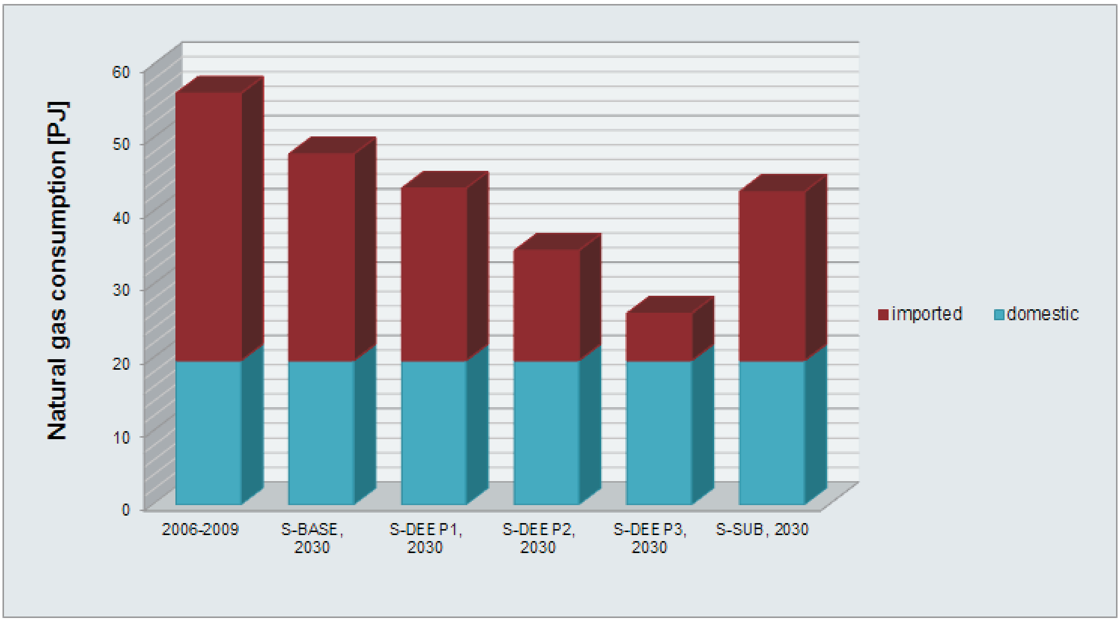

Figure 5: Natural gas saved in the year 2030 by retrofit scenarios

The results indicate that **more ambitious retrofits** (in terms of the depth of the retrofit and implementation rate) **deliver larger energy saving benefits but also entail larger investment costs.** The corresponding annual investment needs are thus appreciably higher for *S-DEEP3* (8.4 to 3.9 billion Euros per year) than for the less accelerated scenarios (*S-DEEP2*: 6 to 2.5 billion Euros per year; *S-DEEP1*: 3.6 to 1.3 billion Euros per year).

Cumulative investments vs. cumulative savings (undiscounted, Billion Euros 2010)		**2025**	**2050**	**2080**
S-DEEP1	Cumulative investment costs	-40	-85	-124
	Cumulative energy saving benefits	7	67	246
	Undiscounted net benefits	**-34**	**-18**	**122**
S-DEEP2	Cumulative investment costs	-66	-140	-146
	Cumulative energy saving benefits	11	111	332
	Undiscounted net benefits	**-55**	**-29**	**186**
S-DEEP3	Cumulative investment costs	-92	-164	-164
	Cumulative energy saving benefits	15	145	367
	Undiscounted net benefits	**-77**	**-19**	**203**
S-SUB	Cumulative investment costs	-28	-71	-71
	Cumulative energy saving benefits	8	69	182
	Undiscounted net benefits	**-21**	**-2**	**111**

Table 2: Cumulative investment costs and energy saving benefits (undiscounted)

From a total investment cost perspective, a more gradual implementation of a deep renovation programme is preferred. Due to the relative inexperience with deep renovation know-how and technologies, initially these will undoubtedly be more expensive than after a learning period when experience accumulates and more mature markets and competitive supply chains are established. Thus a more aggressive renovation programme (i.e., 450,000 units per year, *S-DEEP3*) will result in higher total costs – 164 billion Euros, which compares to 146 and 124 billion Euros of *S-DEEP1* and *S-DEEP2* scenarios. These costs can be shared by building owners, the government and even utility companies, with additional sources of capital like the sale of CO_2 quota and revenues from EU ETS auctions, helping to meet the financing needs of the program (see financing options in **Section 6**). Besides, a careful implementation can minimize total costs, i.e., building types with a lower cost per sqm. (e.g., multi-family units built in 1945-1970) can be retrofitted first and then proceed with more expensive typologies (e.g., single-family units from 1971-1988) at later stages, once the learning factor has effectively reduced the cost of retrofits.

On the benefits' side, a more ambitious implementation rate results in a faster harvesting of energy saving benefits: by 2080, the total accumulated undiscounted net benefits of *S-DEEP3* amount to 203 billion Euros, whereas *S-DEEP2* and *S-DEEP1* generate 186 and 122 billion Euros each. **All in all, these results indicate that in the long-term, the energy saving benefits accrued through retrofits surpass investment costs, and that deep retrofits are preferable to suboptimal from an undiscounted private costs vs. benefits perspective (see Table 2).** Among deep scenarios, a more ambitious retrofit rate delivers more undiscounted net benefits and is a preferable alternative as long as the potential negative effects described in **Section 3** (e.g., destruction of the previously created employment because of the learning factor, bottlenecks in the supply of labour, capital and materials) are dealt with. Because of the existing trade-offs, ***S-DEEP2*** **scenario can be suggested as a rate of retrofit that maximizes net benefits without compromising the feasibility of the programme or creating imbalances in the labour and other markets affected by the retrofits.**

A careful of review of these economic results, which are less appealing than the ones obtained for the preceding Hungarian study, concluded that that among all the model parameters the main difference has to do the with the fuel mix: most Polish buildings use coal (either directly or as district heating), a cheaper fuel than natural gas, for heating. This is the key factor which makes deep retrofits look relatively less attractive than suboptimal ones in Poland. If Poland had substituted coal as a heat source by natural gas (as Hungary did in the 1990s), net economic benefits would be achieved much earlier (before 2050). This conclusion, obtained as a by-product of the comparison of both studies, indicates that **a coal-based economy is less likely to adopt energy efficiency measures because it has fewer incentives to do so.**

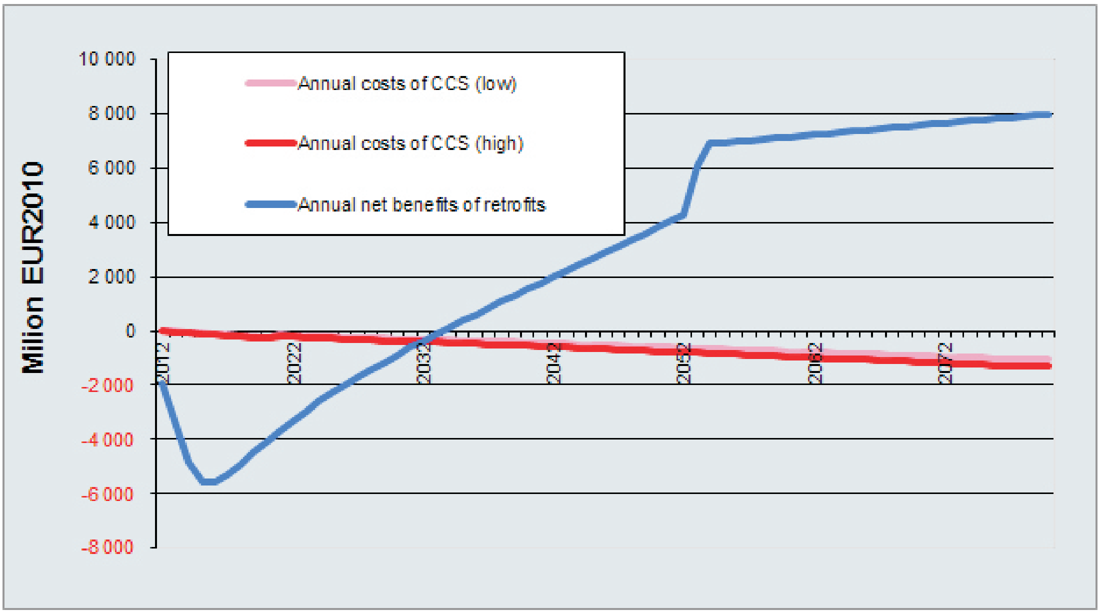

Figure 6: Annual costs of capturing through CCS the same amount of CO_2 as the S-DEEP2 scenario (low- and high-bound estimates) vs. annual net benefits of retrofits in *S-DEEP2*)[3].

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[3] *Ürge-Vorsatz, D., Arena, D., Tirado Herrero, S., Butcher, A.C., 2010. Employment Impacts of a Large-Scale Deep Building Energy Retrofit Programme in Hungary. 3CSEP / Central European University Budapest, Hungary.*

However, **when compared to alternative mitigation strategies, building retrofits are a more cost-effective solution in Poland.** If the amount of carbon emissions avoided by the retrofits until 2080 were to be mitigated in power plants through CCS (carbon capture and storage, a relevant alternative mitigation option according to Poland's energy strategy), this would be achieved at a higher cost. As shown in **Figure 6**, in the short-term CCS mitigates the same amount of CO_2 as the *S-DEEP1* scenario at a lower cost than retrofits. However, from 2030 onwards the situation is the opposite because of the cumulative effect of energy saving benefits and from 2034, only annual net benefits are delivered by building retrofits (similar results are obtained for the other two deep scenarios). It must also be noted that CCS – unlike energy efficiency retrofits – increases the production cost of coal-based energy (electricity, in this case) between 20 to 90% and does not bring as many co-benefits.

In addition to the private energy saving benefits, **social (external) benefits such as the positive impacts of avoided emissions need to be accounted for too.** These refer to the increased welfare effects of reduced climate change and of avoided impacts on human health and on ecosystems caused by non-GHG pollutants (NO_x, SO_x, PM and NMVOC). They have been estimated as the avoided external cost of CO_2 and non-GHG pollutants, which were retrieved from IPCC's 4th Assessment Report and the EU's NewExt project. As shown in **Figure 7** (again for S-DEEP1 as a representative of S-DEEP scenarios), social (external) benefits are larger than private energy saving benefits and its incorporation substantially improves the attractiveness of retrofits. A proper assessment in the social cost-benefit analysis framework incorporating additional external benefits (e.g., reduced energy poverty-related excess winter mortality) would likely yield more attractive social cost-benefit ratios.

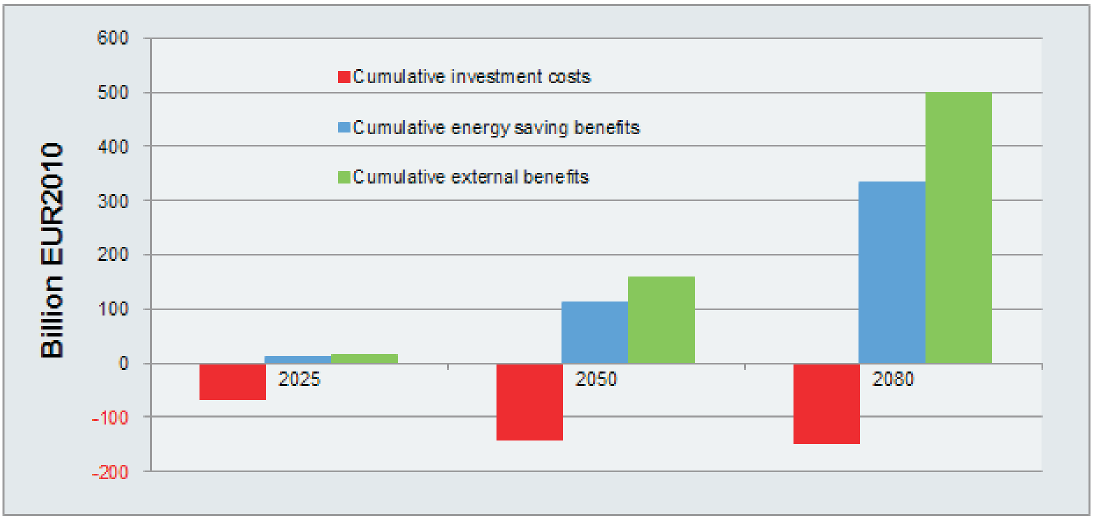

Figure 7: Cumulative investment costs vs. cumulative private energy saving benefits and social external benefits, for different time horizons – undiscounted (*S-DEEP2* scenario).

Even though deep retrofits are expected to generate significant net private and social benefit, the annual investment requirements of the retrofit programme are substantial, amounting to several percentage points of the current Polish government budget. However, the research has also concluded that:

✓ **redirecting the current subsidies to carbon-intensive sectors (i.e., coal mining) and making a wiser use of available EU Structural and Cohesion funds could potentially make available nearly 1 billion Euros per year, an amount that by itself would cover between 25% to 75% of the full annual costs of renovating Polish buildings at a rate of 195,000 units per year (S-DEEP1 scenario);**

✓ innovative financing arrangements such as **pay-as-you-save schemes** (i.e., financial arrangements through which residents re-pay upfront capital costs from their energy bill savings) can leverage the capital needed for financing the programme at the household level. Further research is recommended for devising optimal financing schemes that combine public and private sources of capital;

✓ carbon markets offer another potential source of funding and support for building retrofit projects. In particular, from 2013 Poland will have a new source of carbon revenues, flowing from **mandatory ETS allowance auctions** that can be used to support energy efficiency in buildings;

✓ the existing **energy company obligations** scheme can be improved in order to provide the right incentives for deep energy efficiency, and its timeframe extended beyond 2016 to create the long-term, stable signal needed to develop a robust market;

✓ and the **sale of CO_2 quota** in the form of the AEAs (Annual Emission Allocations) Poland is expected to receive for non-ETS emissions under the EU's Effort Sharing Decision will likely be an additional source of financing in the forthcoming years.

To create the conditions for smooth implementation of t**he retrofits, the public administration should be decisively involved** in the planning and the financing of the retrofit programme. This will promote initiatives that would reduce the risks of supply bottlenecks and ensure that the renovations deliver the expected energy savings in order to guarantee the financial practicability of the intervention.

In conclusion, Polish decision-makers have the power **to provide additional jobs and reduce GHG emissions while greatly reducing the energy costs of households and public buildings, significantly improving air quality, alleviating energy poverty, improving the government's fiscal balance and reducing its natural gas dependency.** When deciding about the upgrade of the current Thermo-modernization programme the results of this study indicate that deep (i.e., passive house-type) renovations deliver substantially more social and economic benefits than suboptimal retrofits. **High efficiency renovations create more jobs, save more energy, reduce more GHG and non-GHG emissions, decrease to a larger extent the energy dependency of the nation and over time eradicate energy poverty.**