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Interim report

Identifying and supporting vulnerable households in light of rising fossil energy costs

by:
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Abstract: Identifying and supporting vulnerable households in light of rising fossil energy costs

The study explores the concept of energy poverty and vulnerability within the German context, emphasizing the impact of rising energy costs and low energy efficiency of buildings on energy poor or vulnerable households. Vulnerability, in this setting, refers to the risk households face due to external factors, such as increased energy prices and the lack of resources to improve energy efficiency in their homes. As climate goals drive energy prices up, particularly through mechanisms like carbon pricing, lower-income households, often reliant on fossil fuels and lacking funds for energy efficiency upgrades, are disproportionately affected. The report, therefore, advocates for climate policies that account for social impacts and offer adaptation support.

Germany currently lacks a standardized definition and robust indicators for energy poverty, viewing it as part of general poverty rather than as a distinct structural issue. This perspective limits the effectiveness of targeted interventions. Although Germany has measures like the "Stromspar-Check" for low income households to address behavioural energy savings, these are insufficient to address deeper, structural inefficiencies. The EU's Energy Efficiency Directive, however, requires a portion of energy savings to be directed specifically toward vulnerable groups. The Social Climate Plans, to be submitted in 2025, mandates EU member states to define energy poverty and vulnerability, develop indicators to identify these groups and design policies and measures that support these groups to transition to climate-friendly technologies.

The study estimates around 3 million households to be vulnerable with respect to increasing fossil energy or CO_2 prices. This corresponds to about 10% of all 30 million households using fossil fuels for heating. More than 80% of these vulnerable households live in multi-family buildings, almost all of them as tenants. It should be noted that in this study, in light of carbon pricing systems only households using fossil fuel-based heating are considered. These households make up about 75% of all households in Germany.

A socially differentiated program for energy-efficient building renovation, similar to the French MaPrimeRénov' program, could support these households. This program would offer targeted subsidies, helping households save energy and transition to renewable energy sources. By adapting a similar program, Germany could enhance its current policies, shifting from basic income support to a targeted, efficiency-focused approach that promotes sustainable energy use and mitigates social inequality.

In conclusion, the study calls for clear definitions, comprehensive data, and indicators, as well as a targeted subsidy program to effectively address energy poverty and vulnerability. Only with these measures can Germany ensure a socially equitable energy transition.

Kurzbeschreibung: Identifizierung und Unterstützung vulnerabler Haushalte angesichts steigender fossiler Energiekosten

Steigende Energiepreise, ein schlechter energetischer Zustand des Gebäudes und ein geringes Einkommen können dazu führen, dass Haushalte nicht in der Lage sind, ihren Energiebedarf zu decken, ihre Wohnungen angemessen zu heizen oder ihre Energierechnungen zu bezahlen. Diese Haushalte werden als energiearme oder auch vulnerable Haushalte bezeichnet. Eine einheitliche Definition von Energiearmut oder Vulnerabilität gibt es in Deutschland bisher jedoch nicht.

Die vorliegende Studie widmet sich daher den Konzepten der Energiearmut und Vulnerabilität, stellt Definitionen und Indikatoren vor und betrachtet Politiken und Maßnahmen zur Unterstützung betroffener Gruppen. Die Studie hebt dabei hervor, dass Energiearmut nicht als Teil der allgemeinen Armut zu verstehen ist, sondern als eigenes strukturelles Problem zu betrachten ist. Energiearmut wird durch mehrere Faktoren verursacht: Haushalte leben in

ineffizienten Gebäuden, Energiepreise steigen und ihr Einkommen ist gering. Das Konzept der Vulnerabilität geht darüber hinaus und bezieht weitere Faktoren mit ein, bspw. inwiefern Haushalte durch CO_2-Kosten betroffen sind und über Investitionsmöglichkeiten für Effizienzverbesserungen oder neue Heizungen verfügen. Ungefähr 75% der Gebäude in Deutschland werden fossil beheizt, so dass die Heizkosten mit dem CO_2-Preis ansteigen, wenn keine Investitionen in die Senkung fossiler Energiebedarfe durchgeführt werden.

Unter Betrachtung verschiedener Indikatoren kommt die Studie zu dem Schluss, dass in Deutschland etwa 3 Millionen Haushalte vulnerabel in Bezug auf steigende Energiepreise sind. Dies entspricht etwa 10 % aller 30 Millionen Haushalte, die fossile Brennstoffe zum Heizen verwenden. Mehr als 80 % dieser vulnerablen Haushalte leben in Mehrfamilienhäusern, fast alle von ihnen sind Mieter*innen. Es sei darauf hingewiesen, dass in diese Studie im Kontext der CO_2-Bepreisung durch den nationalen Emissionshandel oder den ETS 2 nur Haushalte berücksichtigt werden, die mit fossilen Brennstoffen heizen.

Eine wichtige Aufgabe für soziale Klimapolitik ist es daher, Maßnahmen und Instrumente bereitzustellen, die es energiearmen und vulnerablen Haushalte ermöglichen, ihren fossilen Energiebedarf zu reduzieren. Diesen Ansatz verfolgt auch der Klima-Sozialfonds, der im Zusammenhang mit dem neuen europäischen Emissionshandel für Gebäude und Straßenverkehr eingeführt wird. Er legt den Schwerpunkt darauf, vulnerable Gruppen zu unterstützen, in klimafreundliche Technologien oder Maßnahmen zu investieren bzw. daran teilzuhaben.

Die Studie beleuchtet verschiedene Instrumente zur Unterstützung vulnerabler Haushalte und befasst sich vertieft mit dem Ansatz einer sozial gestaffelten Förderung für energetische Gebäudesanierung am Beispiel des französischen MaPrimeRénov'-Programms. Ein solches Programm könnte auf Deutschland übertragen werden und würde vulnerablen Haushalten mit höheren Zuschüssen helfen, Energie einzusparen und auf erneuerbare Energiequellen umzusteigen. In der Studie werden die dafür nötigen Investitionen, der Förderbedarf sowie die Energiekosteneinsparungen abgeschätzt. Mit einer sozial gestaffelten Förderung könnte Deutschland seinen derzeitigen Förderansatz verbessern und von einer reinen Einkommensunterstützung für vulnerable Haushalte zu einem zielgruppenorientierten Ansatz übergehen, der eine nachhaltige Energienutzung befördert und soziale Ungleichheiten verringert.

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Abbreviation	Explanation
ANAH	National Housing Agency
EPBD	Energy Performance of Buildings Directive
EVS	Expenditure Survey
FPEER	Fuel Poverty Energy Efficiency Rating
LIHC	Low-Income High-Cost
LILEE	Low Income Low Energy Efficiency
NECP	National Energy and Climate Plan
SCF	Social Climate Fund
WPB	Worst Performing Buildings

Summary

The study on energy poverty and vulnerability delves into the crucial relationship between climate policy and its distributional impacts. As governments pursue ambitious climate goals, often through mechanisms such as carbon pricing, the effects of these policies are disproportionately felt by low-income and other vulnerable households. These groups are particularly at risk because they often rely on fossil fuels and often lack the financial resources to invest in energy efficiency improvements. For this reason, comprehensive climate policy must account for social effects and must increase the adaptability of households. This report focusses on those groups that are affected the most by rising energy prices.

We address the issue of energy poverty and vulnerable households, discuss definitions and indicators and look into policies and measure to address vulnerable groups so they receive support to transition towards climate-friendly technologies and behaviour and become resilient towards rising energy prices. Our analysis is on Germany. Though we draw from policy examples from France and apply it to the German setting.

What is energy poverty and vulnerability? The study begins by contextualizing energy poverty and vulnerability. Energy poverty is understood in this study as a household's lack of access to essential energy services while vulnerability is understood as a broader state of being at risk of experiencing harm because of changes in external settings or environments. Applied to the energy context, vulnerability might translate into households being vulnerable to rising energy prices with the risk of not being able to afford basic energy needs and lacking the means to do something about it.

The concept of vulnerability is used in the context carbon pricing within the EU (ETS-2) and the Social Climate Funds which will be set up to address and alleviate the effects on vulnerable groups. The reasons for vulnerability are multifaceted. Vulnerable households are households with low or medium low income. Rising energy costs, driven by carbon pricing or other climate initiatives, can significantly increase the cost burden of basic needs such as heating, electricity, and mobility. Also, structural effects such as low building energy efficiency contribute. Energy poor or vulnerably households live in less energy-efficient homes and lack the means to improve their living conditions, making them more susceptible to rising energy prices. If policies implemented to reduce fossil fuel consumption increase prices, the financial burden on low-income households will grow, leading to greater social inequality unless policies simultaneously support the transition to climate friendly technologies or behaviour or compensate for the additional costs.

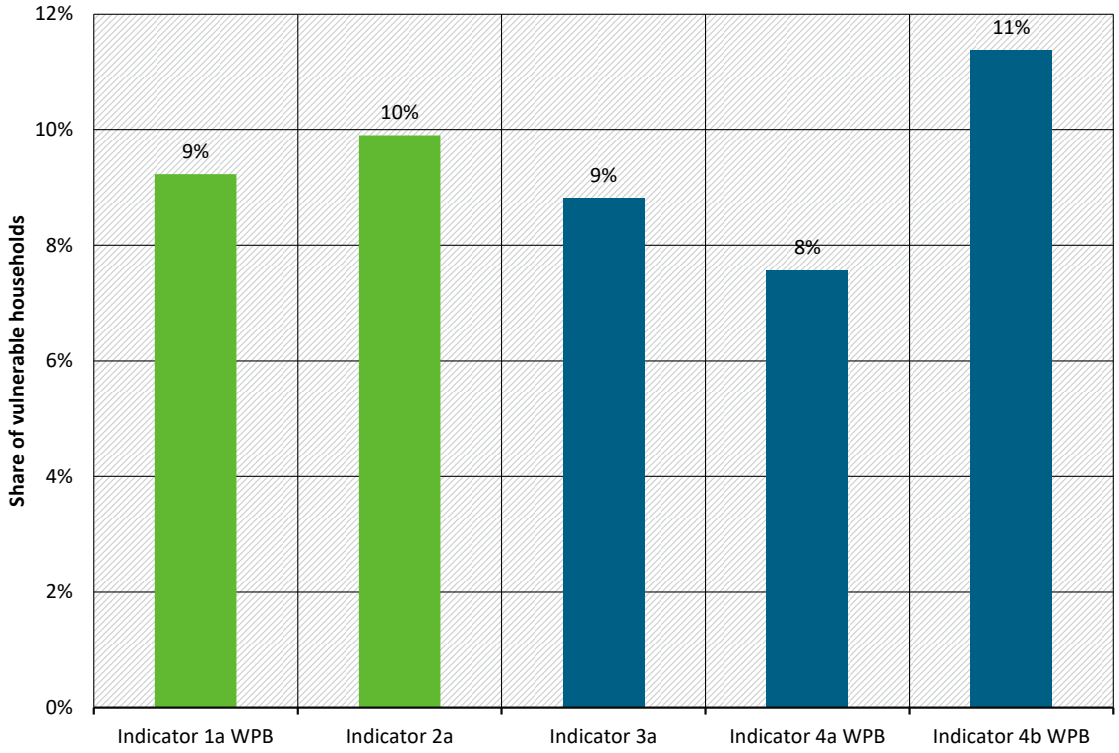
What is the current state of discussion with regards to energy poverty and vulnerability in Germany? In Germany, the study identifies a significant policy gap. There is no standardized definition of energy poverty or vulnerability, nor are there comprehensive indicators to measure the extent of the problem. In Germany energy poverty so far has largely been viewed as a subset of general poverty, rather than as a distinct structural problem requiring specific policy interventions. This is reflected in the German National Energy and Climate Plan (NECP) which makes reference to the social welfare system as a means of supporting households with their housing costs. This approach, however, is seen as unsustainable and insufficient in the long term. Direct income support alone does not address structural issue and does not enhance the resilience of households against rising fossil fuel prices nor does it promote their inclusion in the energy transition.

This lack of clarity of energy poverty and vulnerability in Germany hampers the ability of policymakers to design and implement targeted interventions. Although some measures are in

place, such as the Stromspar-Check (Energy Savings Check), which focuses on raising awareness and encouraging behavioural changes in energy consumption, these initiatives are not sufficient to address the structural issues faced by vulnerable households. The report highlights the urgent need for a shift in perspective, suggesting that Germany align its policies with the evolving requirements at the EU level. For instance, the new Energy Efficiency Directive provides a definition for energy poverty and mandates that a portion of energy reductions be specifically targeted at vulnerable groups. The forthcoming Social Climate Plans, due in 2025, will also require Member States to define energy poverty and vulnerability, to develop indicators to identify these groups and design measures to support decarbonization in these groups. These requirements are seen as crucial steps toward ensuring that climate policies support the transition of those who are most affected.

How many households in Germany are energy poor or vulnerable to rising energy costs?
One of the key contributions of the study is its effort to quantify the extent of vulnerability in Germany in relation to heating energy costs, which is a major concern in light of existing national carbon pricing and the forthcoming introduction of the new EU emissions trading scheme for heating and road transport, and given the country's reliance on fossil fuel heating systems. The study estimates the number of households that are vulnerable to rising heating costs applying various indicators and combinations of indicators. It analyses four indicator groups with a total of 11 variations and finds that a number of indicators that combine the three main causes of energy poverty, i.e. low income, high energy expenditure and very low energy efficiency, arrive at a comparable number of vulnerable households (compare Figure 1). Based on these findings, about 3 million households in Germany are identified to be vulnerable with respect to increasing fossil energy or CO_2 prices. This corresponds to about 10% of all 30 million households using fossil fuels for heating. More than 80% of these vulnerable households live in multi-family buildings, almost all of them as tenants. It should be noted that in this study, in light of carbon pricing systems only households using fossil fuel-based heating are considered. These households make up about 75% of all households in Germany. The study looks at vulnerability with respect to fossil heating costs and does not consider potential vulnerability with respect to electricity or mobility needs.

Figure 1: Overview of share of vulnerable households for the derived indicators



Source: Calculation based on Oeko-Institut's SEEK model. Data sources, see chapters below. Values are provided for the year 2023, exceptions see chapter 3.2. Only households heating with fossil fuels are considered.

Note: Indicator 1a WPB = Absolute low income, relative high energy expenditure and very low energy efficiency(=worst performing buildings - WPB); Indicator 2a = In comparison to median low income and high energy expenditure; Indicator 3a = Absolute low income combined with EPOV indicator hidden energy poverty; Indicator 4a/b WPB = Absolute income threshold (4a decile 1 to 3 and 4b low taxable income plus WPB = very low energy efficiency), for detailed information see chapter 3.2.

What is the purpose of vulnerability indicators? The study reflects on the purpose indicators might be used for. Indicators can estimate the size of the affected group, provide insights into how much funding is needed to target the group, or act as proof of eligibility (compare Figure 2). The indicators covered in the study primarily fulfil the first and second purpose giving an indication of the size of the issues and providing some indication of the funding needed to support this target group. Such complex indicators might, however, not be useful when it comes to households themselves needing to prove their eligibility for receiving support measures, which is usually done only via income statements. For the purpose of estimating the size of the affected group, providing insights into funding needs and monitoring the group, the study recommends using a combined indicator that covers low income, high fossil heating energy expenditure burden (more than twice the median = 2M) and low building efficiency (due to lack of data approximated in the study by high heating energy consumption per sqm). With respect to proving eligibility of households when applying for use of policy measures the study recommends keeping it simpler to reduce administrative burden and have households submit tax returns or income statements and energy performance certificates or heating bills to prove low efficiency of their building.

Figure 2: Purpose of energy poverty or vulnerability indicators

Source: Own illustration.

All in all, the study highlights the importance of a clear and consistent definition of energy poverty and vulnerability, as well as the need for reliable data and indicators to track the progress of policy interventions.

How might a socially differentiated energy efficient buildings program in Germany look like? The study moves on to examine several possible approaches for addressing vulnerable households in the residential building sector, drawing on international examples, most notably from France. One of the central case studies is the MaPrimeRénov' program, a French funding scheme that provides socially differentiated (income dependent) financial support for energy efficiency improvements based on household income. The program is particularly notable for its emphasis on inclusivity, offering higher levels of financial support to low-income households to ensure that they are not excluded from the energy transition. Additionally, the funding rates within the French funding scheme reflects the level of efficiency improvement from the original inefficient state opposed to Germany where funding rates for full energetic refurbishment depend on the targeted energy efficiency level after refurbishment. The study advocates for an approach in Germany similar to the French one, proposing the development of a socially differentiated, income depending, funding program for energy efficiency improvements in the residential sector. Such a program would go beyond the current income bonus for heating replacement and focus on full refurbishment and the efficiency gain that can be achieved. It would target vulnerable groups, particularly those reliant on fossil fuel heating, and would provide a significant boost to efforts to reduce vulnerability while also promoting energy efficiency and reducing carbon emissions.

The study includes a quantitative assessment of such a socially differentiated program for Germany, using the vulnerability indicators developed earlier. This analysis provides valuable insights into the potential scale of such a program and the number of households that could benefit from targeted interventions. The findings suggest that about 3 millions of German households would be eligible for support, thereof about 2.4 million in multi-family buildings and about 0.5 millions in single/two-family homes. Inspired by the French program, the study

calculates investment costs, fundings needs and energy cost savings for these households in Germany. The calculations are to be considered indicative and not exact cost estimates as a number of assumptions have to be taken in applying the French funding idea. The study assesses the costs and savings if all apartments and houses of vulnerable households were to be energetically retrofitted. This means that in multi-family houses where vulnerable and non-vulnerably households mix, we only consider the costs of vulnerable households' apartments, thus only a share of the building. We do not assess the costs of renovating the entire building. In our calculations, we assume a funding rate of 80% of eligible investment for vulnerable groups (or tenants letting to vulnerable groups) including a maximum ceiling for eligible investment. We assume that at least two efficiency classes can be improved, so that a target efficiency standard of B/C (German standard EH-70) can be achieved. A summary of the calculations can be found in the following Table 1.

In summary, funding needs to improve energy efficiency in apartments of vulnerable households in multi-family buildings would be about 72 billion EUR and to retrofit single or two family houses about 51 billion EUR. If the efficiency retrofits were to be done within the time frame of the Social Climate Fund, i.e. over a time span of eight years between 2026 and 2032, it would be about 9 billion EUR per year for apartments of vulnerable households in multi-family buildings and about 6.4 billion EUR per year for single/two family homes of vulnerable households.

Applying the French funding ceiling (maximum expenditure of 55,000 EUR net is eligible for funding) to the analysis for German building renovation, the funding need reduces to 26 billion EUR in total or 3.3 billion EUR per year (over an eight-year time span) for vulnerable households in single/two family homes. We only consider households that heat with fossil fuels and are vulnerable with respect to rising fossil energy costs, including carbon pricing, as defined through our indicators.

The volume available to Germany from the Social Climate Fund is about 1 billion EUR per year and will not be sufficient to fund such a socially differentiated investment program for vulnerable households. Restructuring of the current national efficient buildings programme or using additional funding from ETS2 revenues would be options to finance the socially-differentiated energy-efficient buildings programme.

Table 1: Synthesis table of funding need for vulnerable households for energy retrofit to German efficiency class EH-70, inspired by the French MaPrimeRénov' program, assuming a funding rate of 80% of eligible investment costs

No. of vulnerable households*	Investment costs in EUR	Funding rate for refurbish-ment to efficiency class EH-70 in %	Max. eligible expenditure ceiling per unit (as in the French MaPrimeRénov' program) in EUR	Funding need (considering funding rates and max. eligible expenditure ceiling) in EUR	Effective funding rate (considering max expend. ceiling)
Total: 3 million households					
thereof in multi-family buildings: 2.4 million households	90 billion EUR (11 billion EUR p.a. within the SCF time frame**)	80%	55,000 EUR per unit (net) for increase of two efficiency classes***	72 billion EUR (9 billion EUR p.a. within the SCF time frame)	80%
thereof in single/two family houses: 0.5 million households	64 billion EUR (8 billion EUR p.a. within SCF time frame**)	80%	55,000 EUR per unit (net) for increase of two efficiency classes***	26 billion EUR (9 billion EUR p.a. within the SCF time frame)	41%

Source: Calculation based on assumptions and calculations as laid out in the study (Oeko-Institut). Only households with fossil fuel are taken into consideration. For detailed information see chapters 3.2 and 4.1.3.

*Average value of five compound indicators with low income and high fossil energy consumption as shown in section 4.2.2.

** Assuming all investment were to be done within the time frame of the Social Climate Fund between 2026 and 2032, i.e. within eight years.

*** Based on the French MaPrimeRénov' programme, which defines a maximum expenditure limit of EUR 55,000 (net) per unit for an energy efficiency improvement of two levels

Energy costs savings that would be induced by the energy retrofit can amount to about 2 billion EUR per year for vulnerably households in apartments in multi-buildings, corresponding to savings of about 830 EUR or about 60% of the heating costs per year per household. For vulnerable households in single/two family homes the energy cost savings amount to about 0.9 billion EUR per year, corresponding to savings of about 1,880 EUR or 60% of heating costs per year per household. Such savings occur annually over the lifetime of the retrofit, e.g. for about 35 years.

The study emphasizes the need for a comprehensive and sustained effort to support these households, both to alleviate their current energy burden and to help them transition to more sustainable and efficient energy systems.

What are the policy recommendations for Germany? In terms of policy recommendations, the study outlines several key areas where action is needed. First, Germany must develop a clear definition of energy poverty and vulnerability, along with robust indicators to measure these conditions. This will enable more targeted policy interventions and ensure that the most vulnerable households receive the support they need. Second, there is a need for developing policies and measures that support vulnerable households in their energy transition, away from using fossil fuels to using renewable energy and foremost to using less energy via receiving support for energy efficiency improvement. For this, a socially differentiated funding program to

support extensive energy efficiency improvements in the residential building sector is urgently needed. This program should prioritize low-income households and those living in energy-inefficient homes, particularly those reliant on fossil fuel heating systems. Third, the study recommends that Germany expand its use of informational campaigns and advisory services, such as the Energy Savings Check, to help vulnerable households reduce their energy consumption through behavioural changes and small-scale improvements. Finally, the study calls for greater regulatory oversight in the rental sector, where many low-income households are tenants in multi-family houses and are unable to make decisions about energy efficiency improvements.

One of the major challenges highlighted by the study is the need for reliable data and indicators to track the progress of policy interventions. Without accurate and up-to-date information on the extent of energy poverty and vulnerability, it is difficult to design effective policies or assess their impact. The study notes that while household survey data is readily available in Germany there are still significant gaps in building stock data. For instance, there is limited data on the energy performance of the country's building stock and a lack of data that links the building's energy performance with socio-economic data of residents. This lack of data makes it difficult to know which buildings vulnerable households live in and assess the scale of the energy efficiency improvements needed to reduce energy poverty and vulnerability. The study calls for greater investment in data collection and analysis, in particular a building stock registry is needed that allow for links with households' survey data. The study also calls for the development of new tools and methodologies to better understand the complex dynamics of energy poverty and vulnerability.

In conclusion, the study presents a comprehensive analysis of the challenges and opportunities associated with addressing energy poverty and vulnerability in Germany. It highlights the need for a more targeted and socially inclusive approach to climate policy, one that ensures that vulnerable households are not left behind in the transition to a low-carbon economy. By adopting a socially differentiated funding program for energy efficiency improvements, expanding informational campaigns, and strengthening regulatory oversight, Germany can make significant progress in reducing energy poverty and promoting a more just and equitable energy transition. However, these efforts will require sustained political will, robust data and indicators, and close collaboration between national and EU policymakers. Only by taking these steps can Germany ensure that its climate policies are not only environmentally effective but also socially equitable.

Zusammenfassung

Die vorliegende Studie befasst sich mit dem Zusammenspiel von Energiearmut, Vulnerabilität und Klimaschutz. Während Regierungen ehrgeizige Klimaziele verfolgen und dabei Preisinstrumente, wie die Bepreisung von CO_2-Emissionen einsetzen, sind die Auswirkungen dieser Politiken unverhältnismäßig stark bei einkommensschwachen und anderen benachteiligten Haushalten zu spüren. Diese Gruppen sind besonders gefährdet, da sie häufig auf fossile Brennstoffe angewiesen sind und oft nicht die finanziellen Mittel haben, in Energieeffizienzmaßnahmen zu investieren. Deshalb muss eine umfassende Klimapolitik soziale Effekte berücksichtigen und die Anpassungsfähigkeit der Haushalte erhöhen. Dieser Bericht konzentriert sich auf die Gruppen, die am stärksten von steigenden Energiepreisen betroffen sind.

Wir befassen uns mit dem Thema Energiearmut und vulnerablen Haushalten, diskutieren Definitionen und Indikatoren und untersuchen Politiken und Maßnahmen zur Unterstützung benachteiligter Gruppen, um sie bei der Umstellung auf klimafreundliche Technologien und Verhaltensweisen zu unterstützen und sie gegenüber steigenden Energiepreisen widerstandsfähig zu machen. Unsere Analyse konzentriert sich auf Deutschland, wobei wir uns jedoch auch auf politische Beispiele aus Frankreich stützen und diese auf den deutschen Kontext anwenden.

Was ist Energiearmut und Vulnerabilität? Die Studie beginnt mit der Kontextualisierung von Energiearmut und Vulnerabilität. In dieser Studie wird Energiearmut als der fehlende Zugang zu grundlegenden Energiedienstleistungen verstanden, während Vulnerabilität als ein weiter gefasster Zustand verstanden wird, in dem die Gefahr besteht, aufgrund von Veränderungen der äußeren Rahmenbedingungen oder des Umfelds Schaden zu erleiden. Übertragen auf den Energiekontext könnte Vulnerabilität bedeuten, dass Haushalte durch steigende Energiepreise gefährdet sind, sich möglicherweise grundlegende Energiebedürfnisse nicht mehr leisten können und keine Möglichkeiten haben, dem entgegenzuwirken.

Das Konzept der Vulnerabilität wird im Zusammenhang der CO_2-Bepreisung innerhalb der EU (ETS-2) und des Sozialen Klimafonds verwendet, der eingerichtet werden soll, um die Auswirkungen auf vulnerable Gruppen anzugehen und abzumildern. Die Gründe für Vulnerabilität sind vielschichtig. Vulnerable Haushalte sind Haushalte mit niedrigem oder mittlerem Einkommen. Steigende Energiekosten, verursacht durch die CO_2-Bepreisung oder andere Klimaschutzmaßnahmen, können die Kostenbelastung für Grundbedürfnisse wie Heizung, Strom und Mobilität erheblich erhöhen. Strukturelle Effekte wie eine geringe Energieeffizienz von Gebäuden tragen ebenfalls bei. Energiearme oder vulnerable Haushalte leben in weniger energieeffizienten Wohnungen und verfügen nicht über die Mittel, ihre Lebensbedingungen zu verbessern, was sie anfälliger für steigende Energiepreise macht. Wenn Maßnahmen zur Verringerung des Verbrauchs fossiler Brennstoffe zu Preissteigerung führen, steigt die finanzielle Belastung einkommensschwacher Haushalte, was zu größerer sozialer Ungleichheit führt, sofern nicht gleichzeitig Maßnahmen ergriffen werden, um den Übergang zu klimafreundlichen Technologien oder Verhaltensweisen zu unterstützen oder die zusätzlichen Kosten zu kompensieren.

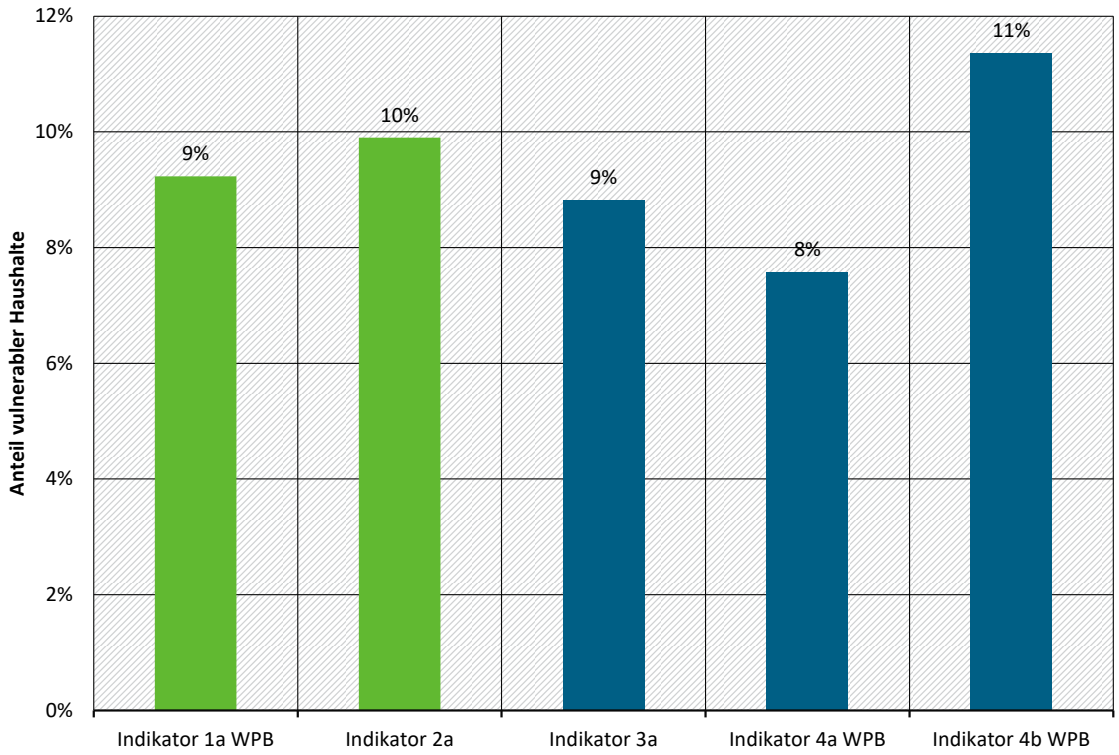
Wie ist der aktuelle Stand der Diskussion bezüglich Energiearmut und Vulnerabilität in Deutschland? In Deutschland weist die Studie eine erhebliche politische Lücke auf. Es gibt weder eine standardisierte Definition von Energiearmut oder Vulnerabilität noch umfassende Indikatoren zur Messung des Ausmaßes des Problems. In Deutschland wurde Energiearmut bisher weitgehend als ein Teilbereich der allgemeinen Armut betrachtet und nicht als ein eigenständiges strukturelles Problem, das spezifische politische Interventionen erfordert. Dies

spiegelt sich im Nationalen Energie- und Klimaplan (NECP) wider, der auf das Sozialsystem als Mittel zur Unterstützung von Haushalten bei ihren Wohn- und Heizkosten verweist. Dieser Ansatz wird jedoch als nicht nachhaltig und langfristig unzureichend angesehen. Direkte Einkommensunterstützungen allein beheben keine strukturellen Probleme und stärken weder die Widerstandsfähigkeit der Haushalte gegenüber steigenden Preisen für fossile Brennstoffe noch fördern sie die Einbeziehung in die Energiewende.

Dieser Mangel an Klarheit über Energiearmut und Vulnerabilität in Deutschland erschwert es den politischen Entscheidungsträgern, gezielte Maßnahmen zu konzipieren und umzusetzen. Obwohl einige Maßnahmen, wie der Stromspar-Check, zur Sensibilisierung und Förderung von Verhaltensänderungen im Energieverbrauch ergriffen wurden, reichen diese Initiativen nicht aus, um die strukturellen Probleme vulnerabler Haushalte zu lösen. Der Bericht unterstreicht die dringende Notwendigkeit eines Perspektivwechsels und schlägt vor, dass Deutschland seine Politik mit den sich entwickelnden Anforderungen auf EU-Ebene in Einklang bringt. So enthält die neue Energieeffizienz-Richtlinie eine Definition für Energiearmut und schreibt vor, dass ein Teil der Energieeinsparungen speziell auf energiearme Haushalte ausgerichtet sein muss. Die in 2025 anstehenden Klima-Sozialpläne werden die Mitgliedstaaten ebenfalls dazu verpflichten, Energiearmut und Vulnerabilität zu definieren, Indikatoren zur Identifizierung dieser Gruppen zu entwickeln und Maßnahmen zur Unterstützung der Dekarbonisierung in diesen Gruppen zu konzipieren. Diese Anforderungen gelten als entscheidende Schritte, um sicherzustellen, dass Klimapolitik den Übergang der am stärksten Betroffenen unterstützt.

Wie viele Haushalte in Deutschland sind energiearm oder durch für steigende Energiekosten gefährdet? Einer der wichtigsten Beiträge dieser Studie ist das Bemühen, das Ausmaß der Vulnerabilität in Deutschland in Bezug auf die Heizenergiekosten zu quantifizieren, was angesichts der bestehenden nationalen CO_2-Bepreisung und der bevorstehenden Einführung des neuen EU-Emissionshandelssystems für Wärme und Verkehr sowie der Abhängigkeit des Landes von fossil beheizten Systemen von großer Bedeutung ist. Die Studie schätzt die Zahl der Haushalte, die durch steigende Heizkosten gefährdet sind, anhand verschiedener Indikatoren und Kombinationen von Indikatoren. Sie analysiert vier Gruppen von Indikatoren mit insgesamt 11 Varianten und kommt zu dem Schluss, dass eine Reihe von Indikatoren, die die drei Hauptursachen von Energiearmut, d.h. niedriges Einkommen, hohe Energiekosten und sehr niedrige Energieeffizienz, kombinieren zu einer vergleichbaren Anzahl vulnerabler Haushalte führen (siehe Abbildung 3). Auf der Grundlage dieser Ergebnisse werden etwa 3 Millionen Haushalte in Deutschland als vulnerabel gegenüber steigenden fossilen Energie- oder CO_2-Preisen identifiziert. Dies entspricht etwa 10 % der 30 Millionen Haushalte, die fossile Brennstoffe zum Heizen nutzen. Mehr als 80 % dieser vulnerablen Haushalte leben in Mehrfamilienhäusern, fast alle als Mieter*innen. Es ist darauf hingewiesen, dass in dieser Studie angesichts der CO_2-Bepreisung nur Haushalte berücksichtigt werden, die mit fossilen Brennstoffen heizen. Das sind etwa 75 % aller Haushalte in Deutschland. Die Studie befasst sich mit der Vulnerabilität in Bezug auf fossile Heizkosten und berücksichtigt nicht die potenzielle Vulnerabilität in Bezug auf Strom- oder Mobilitätsbedürfnisse.

Abbildung 3: Überblick: Anteil vulnerabler Haushalte für die jeweiligen Indikatoren



Quelle: Berechnung basierend auf Oeko-Institut's SEEK Modell. Datenquellen: siehe jeweilige Kapitel. Werte sind für das Jahr 2023, Ausnahmen siehe Kapitel 3.2. Nur fossil heizende Haushalte.

Anmerkung: Indikator 1a WPB = Absolut geringes Einkommen, relative hohe Energieausgaben und sehr geringe Energieeffizienz; Indikator 2a = Vergleich zum Median niedriges Einkommen und hohe Energieausgaben; Indikator 3a = absolut geringes Einkommen in Verbindung mit EPOV-Indikator versteckte Energiearmut; Indikator 4a/b WPB = absolute Einkommensgrenze (4a Einkommensdezile 1 bis 3 and 4b niedriges zu versteuerndes Einkommen plus WPB = sehr geringe Energieeffizienz), für Detailinformation siehe Kapitel 3.2.

Welchen Zweck erfüllen Vulnerabilitätsindikatoren? Der Zweck von Vulnerabilitätsindikatoren ist vielfältig. Sie dienen dazu, die Größe der betroffenen Bevölkerungsgruppe abzuschätzen, den Finanzbedarf zur Unterstützung dieser Gruppe einzuschätzen oder als Nachweis der Anspruchsberechtigung zu fungieren (siehe Abbildung 4). In dieser Studie werden die Indikatoren hauptsächlich dazu verwendet, die Größenordnung des Problems zu bestimmen und den Finanzbedarf für die Unterstützung der Zielgruppe abzuschätzen. Komplexe Indikatoren sind jedoch möglicherweise nicht geeignet, wenn Haushalte ihre Anspruchsberechtigung für Unterstützungsmaßnahmen nachweisen müssen – dies erfolgt in der Regel nur durch Einkommensnachweise. Für die Abschätzung der Größe der betroffenen Gruppe, die Einschätzung des Finanzierungsbedarfs und die Überwachung der Zielgruppe empfiehlt die Studie die Verwendung eines kombinierten Indikators. Dieser sollte niedriges Einkommen, hohe Ausgaben für fossile Heizenergie (mehr als das Doppelte des Medianwerts = 2M) und geringe Gebäudeeffizienz umfassen (aufgrund fehlender Daten im Rahmen der Studie angenähert durch einen hohen Heizenergieverbrauch pro Quadratmeter). Hinsichtlich des Nachweises der Anspruchsberechtigung von Haushalten bei der Beantragung von Maßnahmen empfiehlt die Studie eine einfachere Dokumentation, etwa durch Einkommenssteuererklärungen oder Energieausweise / Heizkostenabrechnungen, um den administrativen Aufwand gering zu halten.

Insgesamt betont die Studie die Bedeutung klarer und einheitlicher Definitionen von Energiearmut und Vulnerabilität sowie die Notwendigkeit zuverlässiger Daten und Indikatoren, um den Fortschritt politischer Maßnahmen zu verfolgen.

Abbildung 4: Zweck von Energiearmuts- und Vulnerabilitätsindikatoren

Quelle: Eigene Darstellung, Öko-Institut.

Wie könnte ein sozial differenziertes Programm für energieeffiziente Gebäude in Deutschland aussehen? In der Studie werden mögliche Ansätze zur Unterstützung vulnerabler Haushalte im Wohngebäudesektor in Deutschland untersucht, wobei internationale Beispiele, insbesondere aus Frankreich, herangezogen werden. Eine der zentralen Fallstudien ist das MaPrimeRénov'-Programm, ein französisches Förderprogramm, das sozial differenzierte (einkommensabhängige) finanzielle Unterstützung für Maßnahmen zur Energieeffizienzverbesserung auf Grundlage des Haushaltseinkommens bietet. Das Programm zeichnet sich besonders durch seine Betonung der Inklusivität aus, da es einkommensschwachen Haushalten eine höhere finanzielle Unterstützung bietet, um sicherzustellen, dass sie nicht von der Energiewende ausgeschlossen werden. Darüber hinaus spiegeln die Fördersätze innerhalb des französischen Förderprogramms das Niveau der Effizienzverbesserung gegenüber dem ineffizienten Ausgangszustand wider - im Gegensatz zu Deutschland, wo die Fördersätze für die vollständige energetische Sanierung vom angestrebten Energieeffizienzniveau nach der Sanierung abhängen. Die Studie plädiert für einen ähnlichen Ansatz in Deutschland wie in Frankreich und schlägt die Entwicklung eines sozial differenzierten, einkommensabhängigen Förderprogramms für Energieeffizienzverbesserungen im Wohnbereich vor. Ein solches Programm würde über den derzeitigen Einkommensbonus für den Heizungstausch hinausgehen und sich auf die vollständige Sanierung und den damit erzielbaren Effizienzgewinn konzentrieren. Es würde auf vulnerable Gruppen abzielen, insbesondere auf diejenigen, die auf fossile Brennstoffe angewiesen sind, und würde einen wesentlichen Beitrag zur Verringerung der Vulnerabilität leisten und gleichzeitig die Energieeffizienz und CO_2-Minderung fördern.

Die quantitative Bewertung im Rahmen der Studie deutet darauf hin, dass etwa 3 Millionen deutsche Haushalte von einem solchen Programm profitieren könnten, davon etwa 2,4 Millionen in Mehrfamilienhäusern und etwa 0,5 Millionen in Ein- oder Zweifamilienhäusern. Angelehnt an das französische Modell werden in der Studie die potenziellen Investitionskosten, der Finanzierungsbedarf und die Energiekosteneinsparungen für diese Haushalte in Deutschland berechnet. Dabei ist zu beachten, dass diese Zahlen eher als Richtwerte zu verstehen sind und keine exakten Kostenschätzungen darstellen, da bestimmte Annahmen erforderlich waren, um das französische Förderkonzept anzuwenden. Die Studie berechnet die Kosten, wenn alle Wohnungen und Häuser vulnerabler Haushalte energetisch saniert würden. In Mehrfamilienhäusern wurden dabei nur die Kosten für die Wohnungen vulnerabler Haushalte berücksichtigt und nicht das gesamte Gebäude. Ausgehend von einer Förderquote von 80 % der förderfähigen Investitionen für vulnerable Gruppen (oder Vermieter, die an vulnerable Gruppen vermieten) und einer Deckelung der förderfähigen Investitionen wird in der Studie eine Verbesserung von mindestens zwei Effizienzklassen angenommen, wodurch ein Ziel-Effizienzstandard von B/C (deutscher Standard EH-70) erreicht werden kann. Eine Zusammenfassung dieser Berechnungen findet sich in Tabelle 2.

Um die Energieeffizienz in Wohnungen vulnerabler Haushalte in Mehrfamilienhäusern zu verbessern, wären etwa 72 Milliarden Euro erforderlich, und für die Sanierung von Ein- oder Zweifamilienhäusern vulnerabler Haushalte etwa 51 Milliarden Euro. Würde die Effizienzsanierung innerhalb des Zeitrahmens des Sozialen Klimafonds durchgeführt, d. h. über einen Zeitraum von acht Jahren zwischen 2026 und 2032, läge der jährliche Finanzierungsbedarf bei etwa 9 Milliarden Euro für Wohnungen vulnerabler Haushalte in Mehrfamilienhäusern und etwa 6,4 Milliarden Euro für Ein- und Zweifamilienhäuser vulnerabler Haushalte.

Wendet man die französische Förderobergrenze (maximal 55.000 EUR netto sind förderfähig) auf die Analyse für die deutsche Gebäudesanierung an, reduziert sich der Förderbedarf auf insgesamt 26 Mrd. EUR oder 3,3 Mrd. EUR pro Jahr (über einen Zeitraum von acht Jahren) für vulnerable Haushalte in Ein- und Zweifamilienhäusern. Dabei berücksichtigen wir nur Haushalte, die mit fossilen Brennstoffen heizen und im Hinblick auf steigende Kosten für fossile Energieträger, einschließlich der CO_2-Bepreisung, gefährdet sind, wie durch unsere Indikatoren definiert.

Das für Deutschland verfügbare Volumen aus dem Klima-Sozialfonds beträgt etwa 1 Milliarde Euro pro Jahr und wird nicht ausreichen, um ein solches sozial differenziertes Investitionsprogramm für vulnerable Haushalte zu finanzieren. Zusätzliche Mittel durch Umstrukturierung der aktuellen Gebäudeförderung (BEG) oder aus den weiteren ETS2-Einnahmen wären daher zur Finanzierung erforderlich.

Tabelle 2: Synthesetabelle: Förderbedarf für vulnerable Haushalte für energetische Sanierung auf Effizienzklasse EH-70, inspiriert vom französischen sozial differenzierten Förderprogramm MaPrimeRénov' Program, unter der Annahme einer Förderquote von 80% der förderfähigen Investitionskosten

Anzahl vulnerabler Haushalte *	Investitionskosten in EUR	Förderquote für Sanierung auf Effizienz-klasse EH-70 in %	Max. förderfähige Ausgaben pro Wohneinheit (wie im französischen MaPrimeRénov' Program) in EUR	Förderbedarf (unter Berücksichtigung der Förderquote und der max. förderfähigen Ausgaben) in EUR	Effektive Förderrate (unter Berücksichtigung der max. förderfähigen Ausgaben)
Gesamt: 3 Millionen Haushalte					
davon in Mehrfamilienhäusern: 2.4 Millionen Haushalte	90 Mrd. EUR (11 Mrd. EUR p.a. im KSF-Zeitrahmen**)	80%	55 000 EUR pro Wohneinheit bei Verbesserung von zwei Effizienzklassen***	72 Mrd. EUR (9 Mrd. EUR p.a. im KSF-Zeitrahmen)	80%
davon in Ein- und Zweifamilienhäusern: 0.5 Millionen Haushalte	64 Mrd. EUR (8 Mrd. EUR p.a. im KSF-Zeitrahmen**)	80%	55 000 EUR pro Wohneinheit bei Verbesserung von zwei Effizienzklassen***	26 Mrd. EUR (9 Mrd. EUR p.a. im KSF-Zeitrahmen)	41%

Quelle: Darstellung basierend auf Annahmen und Berechnungen in dieser Studie (Oeko-Institut). Nur fossil heizende Haushalte. Für Detailinformationen siehe Kapitel 3.2 und 4.1.3.

* Durchschnitt von fünf kombinierten Vulnerabilitätsindikatoren wie in Abschnitt 4.2.2. erläutert.

** Unter der Annahme, dass alle Investitionen innerhalb des Zeitrahmens des Klima-Sozialfonds durchgeführt würden, also zwischen 2026 and 2032, d.h. innerhalb von acht Jahren.

*** Basierend auf dem französischen MaPrimeRénov' Programm, das eine Obergrenze für die förderfähigen Ausgaben in Höhe von EUR 55 000 (netto) pro Wohneinheit für Energieverbesserung von zwei Effizienzklassen vorgibt.

Die Energiekosteneinsparungen, die durch die energetische Sanierung entstehen würden, können sich für vulnerable Haushalte in Wohnungen in Mehrfamilienhäusern auf etwa 2 Mrd. EUR pro Jahr belaufen, was Einsparungen von etwa 830 EUR oder etwa 60 % der Heizkosten pro Jahr und Haushalt entspricht. Für schutzbedürftige Haushalte in Ein-/Zweifamilienhäusern belaufen sich die Energiekosteneinsparungen auf etwa 0,9 Mrd. EUR pro Jahr, was einer Einsparung von etwa 1 880 EUR oder 60 % der Heizkosten pro Jahr und Haushalt entspricht. Diese Einsparungen ergeben sich jährlich über die gesamte Lebensdauer der energetischen Sanierung, d. h. über etwa 35 Jahre.

Die Studie unterstreicht die Notwendigkeit umfassender und nachhaltiger Anstrengungen zur Unterstützung dieser Haushalte, sowohl um ihre derzeitige Energiebelastung zu verringern als auch um ihnen beim Übergang zu nachhaltigeren und effizienteren Energiesystemen zu helfen.

Welche Politikempfehlungen ergeben sich für Deutschland? Im Hinblick auf Politikempfehlungen identifiziert die Studie mehrere zentrale Bereiche, in denen Handlungsbedarf besteht. Erstens muss Deutschland eine klare Definition von Energiearmut

und Vulnerabilität entwickeln sowie robuste Indikatoren zur Messung dieser Zustände schaffen. Dies ermöglicht gezieltere politische Interventionen und stellt sicher, dass die am stärksten betroffenen Haushalte die Unterstützung erhalten, die sie benötigen. Zweitens müssen Strategien und Maßnahmen entwickelt werden, die vulnerable Haushalte bei der Energiewende unterstützen, weg von fossilen Brennstoffen hin zu erneuerbaren Energien und vor allem zu einem geringeren Energieverbrauch durch verbesserte Energieeffizienz. Dazu ist ein sozial differenziertes Förderprogramm für umfassende Energieeffizienzsteigerungen im Wohngebäudebereich dringend erforderlich. Dieses Programm sollte einkommensschwachen Haushalten und Haushalten in energetisch ineffizienten Häusern, insbesondere solche, die auf fossile Heizsysteme angewiesen sind, Priorität einräumen. Drittens empfiehlt die Studie, dass Deutschland den Einsatz von Informationskampagnen und Beratungsangeboten wie dem Strom-Sparcheck ausweitet, um vulnerable Haushalte dabei zu unterstützen, ihren Energieverbrauch durch Verhaltensänderungen und kleinere technische Verbesserungen zu senken. Schließlich fordert die Studie eine stärkere regulatorische Kontrolle im Mietwohnungssektor, wo viele einkommensschwache Haushalte in Mehrfamilienhäusern zur Miete wohnen und nicht in der Lage sind, Entscheidungen über Energieeffizienzverbesserungen zu treffen.

Eine der größten Herausforderungen, die in der Studie hervorgehoben wird, ist der Bedarf an zuverlässigen Daten und Indikatoren, um die Fortschritte politischer Maßnahmen zu verfolgen. Ohne genaue und aktuelle Informationen über das Ausmaß von Energiearmut und Vulnerabilität ist es schwierig, wirksame Maßnahmen zu entwickeln oder ihre Wirkung zu bewerten. Die Studie stellt fest, dass in Deutschland zwar Daten aus Haushaltserhebungen leicht verfügbar sind, es aber immer noch erhebliche Lücken bei den Daten zum Gebäudebestand gibt. So gibt es beispielsweise nur wenige Daten über die Energieeffizienz des Gebäudebestands in Deutschland und es fehlen Daten, die die Energieeffizienz der Gebäude mit den sozioökonomischen Daten der Bewohner verknüpfen. Aufgrund dieses Datenmankos ist es schwierig festzustellen, in welchen Gebäuden vulnerable Haushalte leben, und den Umfang der Energieeffizienzverbesserungen abzuschätzen, die zur Verringerung der Energiearmut und der Gefährdung erforderlich sind. In der Studie werden größere Investitionen in die Datenerfassung und -analyse gefordert, insbesondere wird ein Gebäudekataster benötigt, das eine Verknüpfung mit den Haushaltsdatenerhebungen ermöglicht. Die Studie fordert auch die Entwicklung neuer Instrumente und Methoden, um die komplexe Dynamik von Energiearmut und Vulnerabilität besser zu verstehen.

Zusammenfassend stellt die Studie eine umfassende Analyse der Herausforderungen und Möglichkeiten dar, die mit dem Umgang mit Energiearmut und -gefährdung in Deutschland verbunden sind. Sie unterstreicht die Notwendigkeit eines gezielteren und sozial integrativen Ansatzes in der Klimapolitik, der sicherstellt, dass benachteiligte Haushalte beim Übergang zu einer klimafreundlichen Wirtschaft nicht zurückgelassen werden. Durch die Einführung eines sozial differenzierten Förderprogramms für Gebäudesanierung, die Ausweitung von Informationskampagnen und die Stärkung des regulatorischen Rahmens kann Deutschland bedeutende Fortschritte bei der Verringerung von Energiearmut und einer gerechteren und sozial ausgewogeneren Energiewende erzielen. Diese Bemühungen erfordern jedoch anhaltenden politischen Willen, solide Daten und Indikatoren sowie eine enge Zusammenarbeit zwischen nationalen und EU-Entscheidungsträger*innen. Nur durch diese Schritte kann Deutschland sicherstellen, dass seine Klimapolitik nicht nur ökologisch wirksam, sondern auch sozial gerecht ist.

1 Introduction

In general, households with lower income have a much smaller ecological footprint than higher income groups, while at the same time experiencing a much higher burden of environmental crises. They are highly affected by the consequences of climate change and the scarcity of resources (Beermann et al. 2021). This offers an opportunity for a socio-ecological transformation that reduces social inequalities and increases the quality of life.

Especially at a time where a lot of emphasis is placed on meeting ambitious climate goals and implementing corresponding measures, the principles of a "Just Transition" which implies that we "leave no one behind" need to be at the forefront of climate policy development and implementation, which is also a central component of the European Green Deal (EC n.d.). Indeed, often there are negative distributional effects of environmental policies. For example, carbon pricing policies tend to burden low-income and other vulnerable households disproportionally, because they are more reliant on fossil fuels and additional costs put a greater burden on them in relation to their income. Often these households do not have sufficient resources to make significant changes themselves and funding programs targeted to their needs are lacking e.g., low-income households are unable to finance energy efficiency renovations or switching to a non-fossil fuelled heating system even if general funding programs are in place. Or these households are not in a position to make decisions on their home refurbishment, e.g. because they live in rented apartments or houses. If energy and climate policy increase the costs of living (including food, mobility, and housing) without enabling and increasing the capacity for households to adapt to these changes, social inequalities become exacerbated[1].

This does not mean that the ambitions of these policies should be lowered, but it does necessitate a recognition of possible regressive distributional effects and where social inequalities are being widened. This can then allow for progressive solutions that go beyond a siloed social policy approach, meaning that income compensation alone through social welfare payments for example is not enough in this context. It requires a socially responsible environmental policy, that is target group-specific, that strengthens a household's scope for action and their ability to react to ambitious climate goals through changes in their behaviour and investments, and that takes into account the restrictions, budgetary, lack of funding, decision-making, and other wise, these groups face.

Within this field, the residential housing sector plays a significant role, because housing costs make up a large share of household expenditure and rising cost burdens can be observed amongst low-income groups. At the same time, there is a need for transformation in this sector requiring energy efficiency improvements through deep renovations and a move away from fossil fuelled heating. This can lead to a variety of negative distributional effects, since the investments needed for these transformations will only be possible for those with higher income and wealth. Without a suite of measures in this area, vulnerable households will be excluded from this transformation resulting in higher energy and housing cost-burdens and potential carbon lock-in, further widening the gap.

In order to develop and implement such measures those households who require the most support need to be identified. In Germany, there is currently no set definition of vulnerability or energy poverty and there is no common indicator being used to measure the levels of vulnerability or energy poverty. Especially in light of rising energy costs, we identify this to be a significant gap in Germany's current energy and climate policy that needs to be addressed.

[1] For more information, see https://www.umweltbundesamt.de/themen/nachhaltigkeit-strategien-internationales/umweltpolitik-sozialvertraeglich-gestalten.

Equally, there are very few policies currently in place that address vulnerable groups specifically. The German National Energy and Climate Plan (NECP) mentions the Stromspar-Check (Energy Savings Check), which is primarily an awareness instrument focused on behavioural changes with additional small investment support for appliances and lighting in the fields of electricity, heating and water. Additionally, the NECP refers to the social welfare system as a way of financially supporting households with their housing costs. Direct income support is, however, not a sustainable form of support that does not increase resilience of households against rising fossil energy prices or fosters inclusion in the energy transformation. A change in perspective is therefore needed.

This aligns with the requirements brought forward on the EU-level. The new Energy Efficiency Directive requires a share of the reduction of energy use to be attained in vulnerable groups, for example. The upcoming Social Climate Plans that need to be submitted in June 2025 require a clear definition of energy poverty and vulnerability alongside indicators for these groups and the Energy Performance Building Directive requires energy efficiency improvements and decarbonisation to be carried out in homes of vulnerable households.

These are all big tasks ahead that are crucial for the socio-ecological transformation in the residential building sector. In this report we offer an overview of the current discussions on vulnerability on the EU-level and put this into the German context. The report also offers support in defining and measuring vulnerability with a specific focus on the fossil heating sector in Germany and provides some first steps towards the development of targeted policy measures.

This report is structured as follows. First, we provide some context for the energy poverty and vulnerability discussion, before going into various definitions of energy poverty and vulnerability brought forward in EU documentation and current indicators. We then put different indicators into practice in Germany focussing on heating energy and households with *fossil* fuel-based heating, i.e. households which are affected the most by carbon pricing. We estimate the number of households vulnerable to rising heating costs in Germany according to different measurement approaches. This gives an indication of the magnitude of the households to be addressed through policy instruments, for example within the Social Climate Plan under the Social Climate Fund Regulation (Publications Office of the European Union 2023c) or within other socially targeted energy transition and climate change policies. The report then proceeds with a reflection on possible approaches to address vulnerable groups within the residential building sector, with a particular focus on the set of measures introduced in France including the MaPrimeRenov program. The aim is to examine the possibility of a socially differentiated funding program for improving energy efficiency in the residential buildings sector in Germany inspired by the French renovation program. We then carry out a quantitative assessment of such a program for Germany by applying our vulnerability indicators as the target group for the program. The report finishes with a set of insights and conclusions.

2 Defining and measuring energy poverty and vulnerability

The terms energy poverty and vulnerability are often used interchangeably. In the literature, (Thomson et al. 2017; Simcock et al. 2018; Sareen et al. 2020; Bouzarovski et al. 2021) however as well as in a policy context, such as the Social Climate Fund (SCF) Regulation (Publications Office of the European Union 2023c), it is apparent that vulnerability and energy poverty are and need to be differentiated. In this chapter, we therefore take a closer look at definitions of both energy poverty and vulnerability. We first look at definitions and measurement in EU regulations and then move on to look at the state of progress in the German policy setting. To this point, there is no definition of energy poverty or vulnerability available in Germany.

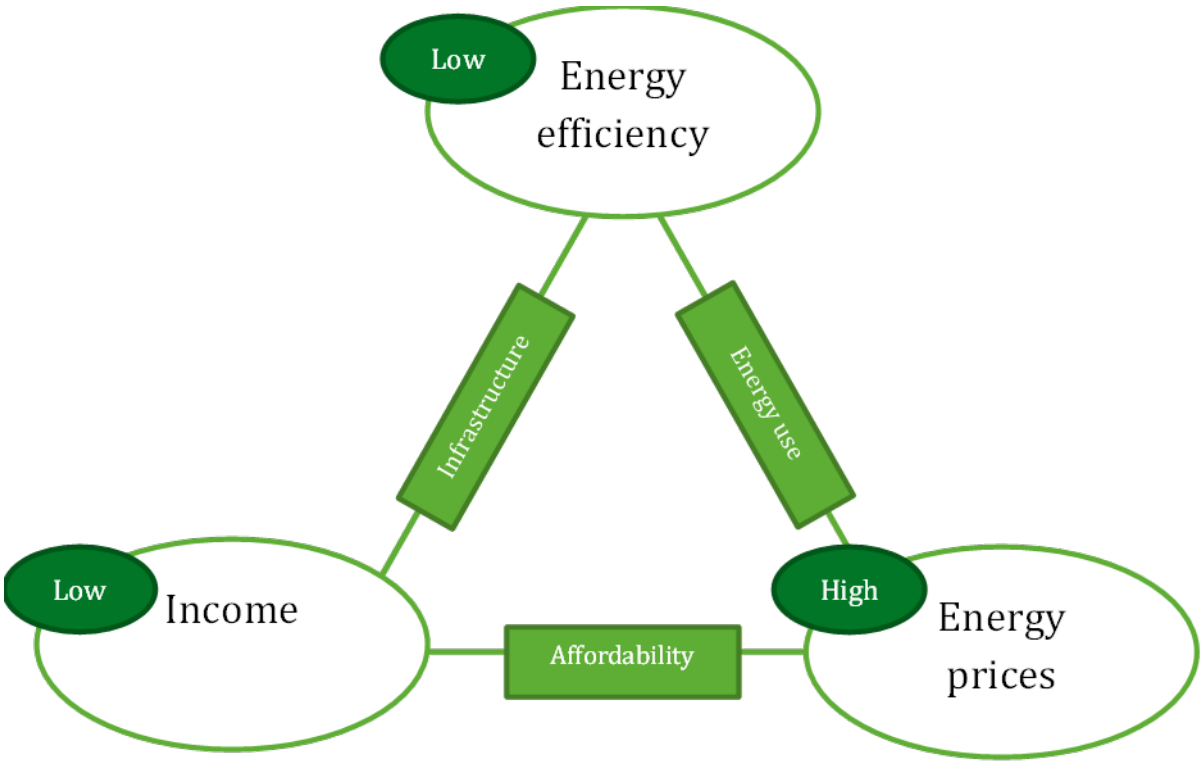
2.1 Energy poverty and vulnerability in EU regulations and recommendations

Energy poverty is generally understood as the inability of households or individuals to meet their basic and essential energy needs or to meet these needs at reasonable costs. At the EU level the concept of energy poverty was introduced in 2009 (Publications Office of the European Union 2009) and has since made its way into several key directives and regulations highlighting the EU's commitment to combating energy poverty. Most recently, the Commission published a new Recommendation on energy poverty (Publications Office of the European Union 2023a) as well as an companying guidance document (EC 2023). The recommendation acknowledges that energy poverty is a multidimensional phenomenon that is caused by "high energy expenditures in proportion to the household budget, low levels of income, and low energy performance of buildings and appliances". This definition includes the three main drivers of energy poverty also identified in the literature: high energy cost, low income, and low energy efficiency (Tews 2013 see also Boardman 1991).

To sum up, there are three key factors which underpin energy poverty (Figure 5). High energy prices can lead to an increase in absolute energy expenditures necessary to achieve adequate levels of heating and electricity use. Especially rising energy prices above normal or previous levels can lead to significant additional pressures for households (Bollino and Botti 2017). This coincides with low income and inefficiency, with low income and high energy prices being defined as constitutive factors, while inefficiency is defined as the main structural cause (Tews 2013). Low income levels, regardless of energy prices, can also lead to high cost burdens as shown in the figures above, where even low absolute energy expenditures can lead to high cost burdens. Finally, low levels of energy efficiency also increase cost burdens because more energy is required to satisfy basic energy needs, e.g. achieve adequate levels of warmth and electricity use for a household.

At the intersection of low energy efficiency and low income lies the issue of infrastructure. The quality and status of the building stock is the cause of low energy efficiency and low levels of income (and/or wealth) mean that households are not able to invest into energy efficiency upgrades. It is related to the tenure system and housing characteristics, for example. When low income and high energy prices coincide, this is an affordability issue related to income, energy bills, and energy consumption (levels). Finally, in a situation of low energy efficiency and high energy prices energy use patterns are affected related to the type of energy consumption and the heating system, for example.

Figure 5: The energy poverty triangle



Source: Own compilation based on Dobbins (2022)

The revised Energy Efficiency Directive (Publications Office of the European Union 2023b) provides a first EU-wide definition of energy poverty as follows:

- "'energy poverty' means a household's lack of access to essential energy services, where such services provide basic levels and decent standards of living and health, including adequate heating, hot water, cooling, lighting, and energy to power appliances, in the relevant national context, existing national social policy and other relevant national policies, caused by a combination of factors, including at least non-affordability, insufficient disposable income, high energy expenditure and poor energy efficiency of homes" Art. 2 (52)

The definition thus accounts for all factors of the energy triangle. Other EU regulations, such as the Social Climate Fund Regulation (Publications Office of the European Union 2023c), and the Energy Performance of Buildings Directive (EPBD) refer to this definition of energy poverty in the Energy Efficiency Directive.

The Social Climate Fund Regulation (Publications Office of the European Union 2023c), as well as the revised Energy Poverty Recommendation (Publications Office of the European Union 2023a) as well as the companying guidance document (EC 2023) also include mentions of vulnerability. Vulnerability, in general, refers to a broader state of being at risk of experiencing harm because of changes in external settings or environments. Applied to the energy context, vulnerability might translate into being vulnerable to rising energy prices with the risk of not being able to afford basic energy needs and lacking the means to do something about it. Households or individuals who already experience energy poverty are considered vulnerable (as further external changes can deepen their level of energy poverty), as well as households that may not yet be in a situation of energy poverty but will be significantly affected by energy price

increases and thus are vulnerable to slipping into energy poverty. These groups are often particularly vulnerable because they do not have the financial means to invest into non-fossil heating infrastructure or do not have the autonomy to do so (e.g. when renting and unable to move). This is echoed in the SCF definition of vulnerable households with regards to CO_2-pricing:

- "'vulnerable households' means households in energy poverty or households, including low income and lower middle- income ones, that are significantly affected by the price impacts of the inclusion of greenhouse gas emissions from buildings within the scope of Directive 2003/87/EC and lack the means to renovate the building they occupy" Art. 2 (10)

These various EU documents emphasizes and to a certain extent stipulate the need for defining, measuring, reporting, and tackling energy poverty providing guidance and recommendations. The implementation of the recommendations – i.e. mapping and tackling energy poverty – is the responsibility of the Member States. Member States are encouraged to record whether a significant number of households are living in energy poverty and to take appropriate measures to reduce or prevent energy poverty. If levels of energy poverty are considered "significant", Member States have to provide data in their National Energy and Climate Plans showing how many households are affected by energy poverty. Due to this ambiguity of what constitutes a significant number of energy poor households the extent to which energy poverty is defined as a national problem is at the discretion of the individual Member States. The EU recommendations on defining and addressing energy poverty are reflected to very different degrees in Member States' policies (Bouzarovski et al. 2021). In addition, the National Energy and Climate Plans must describe the measures and instruments to reduce energy poverty. Only about half of the Member States specify explicit targets to address energy poverty and quantify these targets (Noka and Cludius 2021).

Art. 8 (3) of the Energy Efficiency Directive specifies that the share of cumulative final energy savings for these groups should be the share of households affected by energy poverty as estimated in the National Energy and Climate Plans. If a country has not estimated a share of energy poverty, the Directive specifies how the share is to be calculated. This is to be the arithmetic mean of four indicators recommended in the Energy Poverty Recommendation: a) the inability to keep housing adequately warm, b) utility bill arrears, c) the total number of people living in housing with a leaking roof, damp in the walls, floors, foundations or rot in the window frames or floor, d) the rate of people at risk of poverty.

Article 3 of the Energy Efficiency Directive stipulates that people affected or threatened by energy poverty should benefit from the application of the "energy efficiency first" principle. Specifically, it points out (paragraph 23): "People facing or risking energy poverty, vulnerable customers, including final users, low- and medium-income households, and people living in social housing should benefit from the application of the energy efficiency first principle. Energy efficiency measures should be implemented as a priority to improve the situations of those individuals and households and to alleviate energy poverty, and should not encourage any disproportionate increase in housing, mobility, or energy costs. A holistic approach in policy making and in implementing policies and measures requires Member States to ensure that other policies and measures have no adverse effect on those individuals and households."

2.2 Energy poverty and vulnerability in German policy making

In the German National Energy and Climate Plan (BMWK 2022b) no sperate recognition or policies related to energy poverty are described. Instead, reference is made to the German social benefits system, which has energy-related components that provide a comprehensive framework to support low-income households. The updated draft (BMWK 2023) does not

provide a definition of energy poverty or mention additional policies beyond the energy advice schemes already outlined in the last NECP. Energy poverty was not conceived as a problem in its own right but merely as a problem of poverty that would be comprehensively addressed within the framework of a fundamental poverty reduction policy. This position has been held by all previous federal governments since 2012. Tews (2013) criticizes this, arguing that energy poverty cannot be reduced solely to poverty. It is a structural problem of low-income households, whose energy needs can only be covered at disproportionately high costs or are not sufficiently covered (i.e. underusing of energy). Thus, simply increasing social transfers would not solve the problem of low-energy households in the long term. Instead, the central cause of high energy costs in vulnerable households, high energy consumption needs (driven by low energy efficiency), should be addressed. Reducing energy consumption through efficiency gains or fuel switch leads to cost savings and should therefore be addressed by the federal government as an important starting point for reducing energy poverty. In addition, not all low-income households receive social transfer payments or transfer payments only partially take energy expenditure into account.

With the introduction of the Social Climate Fund and the need to develop a Social Climate Plan, there is now a renewed necessity to define the number of households affected by energy poverty and vulnerable to it as a result of the ETS2. Equally, the revised Energy Efficiency Directive requires to demonstrate the application of the efficiency first principle to people facing or risking energy poverty and vulnerable groups. The share of the required energy savings achieved among people affected by energy poverty or vulnerable groups shall at least be equal to the proportion of energy poor households which needs to be defined and reported in the NECPs.

Considering that distributional impacts of rising energy prices demonstrate that a whole range of households are affected by high energy prices and affected by low-income (Schumacher et al. 2022b; Beznoska et al. 2023; Kenkmann et al. 2024). It is there essential for Germany to swiftly establish a definition and measurement for energy poverty and vulnerability, and to introduce or reshape policies and measures that help these groups to sustainably reduce their energy burden.

3 Putting indicators into practice: Calculating combined indicators that measure vulnerability with respect to rising energy costs in Germany

The aim of this chapter is to consider different ways of measuring vulnerability. This requires first establishing indicators or a set of indicators which are then operationalised so that they can be calculated with appropriate data and their values be interpreted. In the context of energy poverty and vulnerability, it is important to define ex-ante what purpose these indicators will serve. Indicators can be used either for the monitoring of energy poverty and vulnerability or can be used in policy design to describe a specific target group and provide eligibility criteria. The main questions related to the function of an indicator are the following:

- Affected groups: How many households and individuals are affected? Which groups are particularly affected?
- Funding: How much (public) money is needed to support vulnerable households and individuals?
- Eligibility: How can households and individuals prove their vulnerability status?

Each question is important. Without knowing how many households or individuals are affected it is not possible to derive funding needs and select the necessary scope of a policy program. Neither will it be possible to monitor the effects of a program. Without suitable eligibility criteria programs cannot be implemented in a targeted way.

Operationalizing indicators does not only depend on these questions and their purpose but also very much on the availability of data, system boundaries (e.g. whether heat, power and transport is included or only one or two of these energy uses), time horizon (ex-post, ex-ante) and more. Each indicator or set of indicators has specific advantages and disadvantages relating to these factors. It is thus important to note that different indicators might be useful depending on their purpose and question at hand.

The EU Energy Poverty Advisory Hub (EC 2022) is working with a set of four individual indicators to monitor energy poverty across all MS (see Box 1 below for more details). This includes two expenditure based indicators and two self-reported indicators. These were initially developed by the EU Energy Poverty Observatory (Thema and Vondung 2020). These indicators serve the purpose of monitoring and individual indicators, rather than a combined indicator, were chosen to reflect the multiple and varying facets of energy poverty. It also reflects the data availability and quality at EU-level. These indicators are used as a starting point to further discuss possible indicators in Germany.

Box 1 – Energy Poverty indicators based on EPOV and EPAH

Prior to the development of these indicators, limited data availability and a lack of consensus around measuring energy poverty hindered the widespread uptake of the concept of energy poverty (Thomson et al. 2017). This was led by the Energy Poverty Observatory, which uses the following four main indicators[2]:

The self-reported indicators:

[2] For more information and technical details with respect to data see Thema and Vondung (2020).

- Ability to keep home adequately warm – based on the EU-SILC[3] survey question: Can your household afford to keep its home adequately warm? The indicator captures the share of population not being able to keep their home adequately warm.
- Arrears on utility bills – based on the EU-SILC survey question: In the past twelve months, has the household been in arrears, i.e. has been unable to pay the utility bills (heating, electricity, gas, water, etc.) of the main dwelling on time due to financial difficulties? The indicator gives the share of population having arrears on utility bills.

The expenditure-based indicators

- M/2: Absolute (equivalized) energy expenditure below half the national median – estimated based on data from the HBS[4] The indicator covers households with energy expenditure below half the national median value. It aims to capture underconsumption of energy services in comparison to the national median of energy expenditures.
- 2M: Share of (equivalized) energy expenditure (compared to equivalized disposable income) above twice the national median – estimated based on data from the HBS. The 2M indicator aims to capture the burden that energy bills put on households relative to their disposable income, using the national median as a reference point.

These work alongside 19 other, secondary indicators as a measure of energy poverty (see Vondung, 2019). In their recent publication, EPAH reorganize the original 28 EPOV indicators into 21 indicators in total (Gouveia et al. 2022). They also integrate results from a report from the EU's Joint Research Centre (JRC) on energy poverty (Koukoufikis and Uihlein 2022). In this report energy poverty levels were assessed based on the EU SILC database with additional disaggregation levels such as levels of urbanization density and dwelling types. They also present data both in terms of household and population units. From 2019 onwards the EPAH dashboard now reflects these additional indicator analyses conducted by the JRC. The report by the JRC is also expected to be updated annually or as new data becomes available.

In this chapter, we introduce and discuss possible indicators for Germany. Keeping in mind that energy poverty and vulnerability is caused by at least three factors: low income or financial endowment, high energy expenditure and low energy efficiency/high energy need, we focus on indicators that reflect on these three aspects. This implies that we focus on compound indicators, i.e. combinations of individual indicators. To put our insights into practice and gain a deeper understanding of different approaches, we select a number of indicators and apply them to Germany using national data. In this report we **only focus on fossil heating**, as these are the households that will be particularly affected by carbon pricing in the building sector. We show the differences in how many households are captured through different forms of measurement. These indicators can then be taken forward to determine for what groups policies and measures can and should be designed and implemented.

3.1 Comparison of possible indicators

Developing an indicator that addresses all three causes of energy poverty or vulnerability with respect to energy or carbon pricing involves combining various individual indicators, defining relevant thresholds, including relevant target group specific components, and combing these in a

[3] This is the EU Statistics on Income and Living Conditions: https://ec.europa.eu/European/web/microdata/European-union-statistics-on-income-and-living-conditions

[4] This is the Household Budget Survey: https://ec.europa.eu/eurostat/web/household-budget-surveys

way this is meaningful for the national context. An overview of possible indicators (and components) are listed in Table 3. They include the following categories and indicators.

- **Financial and expenditure indicators** with components that narrow down the target group related to income and wealth components. These are related to three categories: income, wealth, and expenditures. In terms of income this refers to available household income. In terms of wealth, this relates to the financial savings available to a household for bigger investments. Expenditures relate both to absolute expenditures, as well as expenditures in relation to available household income. Arrears on utility bills can also be used as a proxy to determine whether a household can (not) afford their expenditures on energy costs.
- **Energy indicators** may be related to energy use and energy need. The indicators can include modelled energy need, but most often they refer to energy use. If available, energy efficiency ratings or energy performance certificates can be used. If information on energy need or buildings energy characteristics is not available for all buildings and households as it is the case in Germany, specific energy use might act as proxy of energy efficiency, whereby certain consumptions or needs are defined as high (e.g. heat consumption of over >160 kWh/sqm useful floor area corresponding to energy efficiency class F and worse in Germany which can be considered a worst performing building - WPB)[5] and hence correspond to very low or low energy efficiency. It needs to be noted that the proxy value might be high because of low energy efficiency of the buildings and thus high energy needs or because of high energy consumption. These two effects cannot be disentangled. Other proxies of energy use and self-reported indicators can also be used as measures for energy needs or use.

For each individual indicator we derive threshold values, some specifically for Germany as they depend on the national context. Some of these individual indicators also only work in combination, e.g. high absolute e**nergy** expenditures need to be combined with a low-income indicator to exclude households who have are not financially burdened by high consumption.

Table 3: Summary of potential types of financial and energy-related indicators to measure energy poverty or vulnerability to rising energy costs

Financial and expenditure indicators			Energy indicators	
Income	**Wealth**	**Expenditure**	**Energy efficiency**	**Energy use/need**
Income deciles … 1-3 … 1-5	Absolute wealth: < 50.000 Euro < 100.000 Euro	High absolute energy expenditures … above median	Energy efficiency rating … D and worse	Modelled energy need

[5] The German building energy law differentiates energy use per sqm useful floor area and energy use per sqm living floor area. Useful floor area includes common areas such as buildings entrance halls, staircase, basement etc. which the measurement for living floor area does not include. Most EU Member States only report energy use per sqm living floor area. Thus, in order to be consistent with the buildings law and arrive at comparable numbers to other EU Member States, we need to convert the threshold into a value per sqm living floor. The building energy law provides conversion factors differentiated by housing type (§82, No. 2 GEG https://www.gesetze-im-internet.de/geg/__82.html). The threshold of >160 kWh/sqm useful floor area converts into >210 kWh/sqm living floor in single/double family buildings and more than 190 kWh/sqm in multi-family buildings. These thresholds are likely to fall into the worst performing building category and can thus be considered as living in a very inefficient building. Buildings can also be considered as inefficient if they fall into categories D and E. In these cases, other benchmarks for energy use per sqm would need to be defined, e.g. energy consumption of more than 100 kWh/sqm useful floor area would correspond to efficiency class D and worse.

Financial and expenditure indicators			Energy indicators	
			… F and worse	
Income below median … less than 60 % … less than 60 % after expenditures (energy & living)	Savings quota: <3 % <5 %	Low absolute energy expenditure: … below half of median		(Very) high energy consumption … >160 kWh/sqm useful floor area (or 100 kWh/sqm useful floor area)* … Fossil energy consumption >160 kWh/sqm useful floor area (or 100 kWh/sqm useful floor area)
Low taxable income	Credit exposure ratio	High relative energy expenditure: … 10 % of income … above median … above 2x median		Inability to cover needs … ability to keep home adequately warm
		Inability to cover costs … arrears on utility bills		

Source: Own compilation (Oeko-Institut)

Note: * More than 160 kWh/sqm useful floor (this is about more than 200 kWh/sqm living floor) corresponds to German energy efficiency class F and worse; more than 100 kWh/sqm useful floor (equivalent to 120 kWh/sqm living floor in multi family homes and 135 kWh/sqm living floor in single/double family houses) corresponds to German energy efficiency class D and worse.

3.2 Indicator combinations to define vulnerable households in Germany

Based on this summary of individual indicators four variations of compound indicators were chosen to provide exemplary analyses of vulnerability in Germany and provide an initial comparison of how different variations and thresholds influence the number of households that are captured by composite indicators. Choices were made based on the current status quo of commonly used indicators to show a variety of different approaches and also based on data availability (limiting the possibility of modelling energy needs for example). How these were defined is detailed in Section 2. In summary, the following combinations were chosen to give a range and exemplary insights. Each indicator and its operationalization is described in more detail within the following sub-chapters:

- Indicator group 1: **Absolute low income/wealth, relative high energy expenditure, and low energy efficiency**
  - Considers households with high relative energy expenditures and high energy consumption (proxy for very low energy efficiency, i.e. worst performing building) and includes an income/savings threshold.
- Indicator group 2: **In comparison to median low income and high energy expenditure (+ low energy efficiency)**

- Considers households with low income (less than 60 % of median income after expenditures[6]) and varies both relative/absolute energy expenditure plus high energy consumption (proxy for very low energy efficiency = worst performing building)

► Indicator group 3: **Absolute low income combined with EPOV indicators (expenditure-based and self-reporting)**

- Considers households with low to middle income (deciles 1-5) and varies energy expenditures (M2) and energy use/needs (Inability to keep home warm).
- This indicator group specifically aims to capture hidden energy poverty.

► Indicator 4: **Absolute income threshold only** (+ low energy efficiency)

- This indicator was chosen because falling into the lowest income deciles is one way in which households can easily prove their vulnerability status and thus eligibility for certain support measures. An approach including the first three income deciles has been taken in the "Sauber Heizen für Alle" program in Austria for example. In Germany, a heating replacement program puts a benchmark for a social funding bonus at a maximum of 40,000 EUR taxable household income per year. This indicator can be combined with high energy consumption (proxy for very low energy efficiency = worst performing building).

Table 4 gives an overview of the indicators considered for defining the number of vulnerable households in Germany. It displays both the number of households considered vulnerable to each of the individual indicators and then the overlap, i.e. the number of households that is considered vulnerable based on the composite indicator.

In this overview we only consider *heating* energy consumption and expenditure and only households with *fossil* fuel-based heating. Heating in Germany is still dominated by fossil fuel technology. Carbon pricing and rising prices for fossil fuels thus have pronounced effects on heating costs. Relevant climate policies aim to reduce fossil fuel consumption and specifically target the move away from fossil heating, for example[7]. The groups defined to be affected by vulnerability here therefore correspond to the target groups affected by carbon pricing for heating and give indications for the vulnerable groups covered within the Social Climate Fund Regulation. They do not necessarily cover all energy poor households.[8]

[6] This is considered the „at risk of poverty"-threshold.

[7] Households with direct electric heating are also included for the same reason, however, they have a very small share in Germany. Direct electric heating mainly consists of old electric night storage heaters that are very inefficient. Direct electric heating does not include heat pumps.

[8] For example, a household may not be heating with a fossil fuel heating system, meaning that the carbon price/tax would not increase their costs, but due to persisting energy inefficiencies of their home may still have high energy expenditures and a high relative burden in relation to their energy consumption.

Table 4: Composite indicators for vulnerable households in Germany (only households with fossil fuel-based heating)

Indicator and No. of Households (HH)*	Financial indicators			Energy indicators	Over-lap
	Income	**Wealth**	**Expenditure**	**Energy use / need**	
Indicator 1: *Absolute* low income/savings, relative high energy expenditure and low energy efficiency					
Indicator 1a	Decile 1-5		Share of energy expenditure above twice the median (2M)	Fossil energy consumption >160 kWh/sqm useful floor area	
No. of HH (m)	*16.14*		*6.96*	*5.94*	***2.84***
Indicator 1b		Savings quota <3 %	Share of energy expenditure above twice the median (2M)	Fossil energy consumption >160 kWh/sqm useful floor area	
No. of HH (m)		*11.12*	6.96	5.94	**1.86**
Indicator 2: In comparison to median low income and high energy expenditure (+ low energy efficiency)					
Indicator 2a	Less than 60 % of median income after expenditures		Absolute (equivalized) energy expenditures above median		
No. of HH (m)	*5.87*		*16.54*		***3.05***
Indicator 2b	Less than 60 % of median income after expenditures		Relative energy expenditures above median		
No. of HH (m)	*5.87*		*17.04*		***4.99***
Indicator 2c	Less than 60 % of median income after expenditures		Relative energy expenditures above median	Fossil energy consumption >160 kWh/sqm useful floor area	
No. of HH (m)	*5.87*		*17.04*	*5.94*	*1.55*
Indicator 3: Absolute low income combined with EPOV indicators (expenditure-based and self-reporting)					
Indicator 3a	Decile 1-5		M/2		
No. of HH (m)	*16.14*		*4.95*		***2.71***
Indicator 3b	*Decile 1-5*			Inability to keep home adequately warm	
No. of HH (m)	*16.14*			*2.66*	***1.55***
Indicator 4: Absolute income threshold only					

Indicator and No. of Households (HH)*	Financial indicators			Energy indicators	Over-lap
	Income	Wealth	Expenditure	Energy use / need	
Indicator 4a	Decile 1-3 (net equivalent income)				
No. of HH (m)	***10.05***				
Indicator 4a WPB	Decile 1-3 (net equivalent income)			Fossil energy consumption >160 kWh/sqm useful floor area	
No. of HH (m)	*10.05*			*5.94*	***2.33***
Indicator 4b	Taxable household income below 40,000 Euro				
No. of HH (m)	***16.27***				
Indicator 4b WPB	Taxable household income below 40,000 Euro			Fossil energy consumption >160 kWh/sqm useful floor area	
No. of HH (m)	*16.27*			*5.94*	***3.50***

Source: Own calculation, references and detailed explanation see following sections (Oeko-Institut)
Note: * Only households that use fossil fuels are considered as these are households that will be affected the most by rising energy prices or carbon pricing.
Source: Calculation based on Oeko-Institut's SEEK model using the German Income and Expenditure Survey (EVS 2018) of the German Statistical Offices and the EU-SILC (2021).

In the following sub-chapters, we discuss each of the indicators in more detail and provide the number of households covered by each indicator as well as the overlap for the composite indicator. Important methodological aspects are laid out in the following box.

Box 2: Methodological notes

The calculations in this chapter are all based on the German Income and Expenditure Survey (EVS 2018), with the exception of indicator 3b, which is calculated using the EU-SILC database. We update the expenditures and incomes observed in the EVS 2018 to the year 2023 based on the energy prices and inflation factors (BMWK 2022a; TGA+E 2022; BNetzA 2023; Destatis 2023; BDEW 2023; 2024). Income deciles reflect net equivalence incomes based on the new OECD scale and with the same number of persons in each decile.

For the energy indicators, we use information on energy expenditures from the EVS and convert them to physical energy use by applying the relevant prices. In the EVS, households report their expenditures over a whole quarter. Some households pay for their heating energy regularly across the whole year. This usually includes households that rent and pay a monthly fee to their landlords, some tenants also have direct contracts with the heating energy providers. Households that own the flat or house they live in, usually pay a monthly fee for gas, district heating or electricity (e.g. heat pumps) used as a heating source. If households use oil, coal, or biomass for

heating their home, they often have irregular expenditures. That is why, for our analysis, that focuses on fossil heating energy sources, we base the analysis on gas-consuming households (about 50 % of all households in Germany) that have regular expenses and scale results up to all households using fossil fuels for heating. The assumption then is that oil- and coal-using households have similar energy consumption patterns per sqm as natural gas-using households. With this approach, we derive information on energy consumption per households.

To arrive at a proxy indicator for energy efficiency, we divide energy consumption by square meter living space or useful floor area (kWh/sqm). Households with very low energy efficiency are then considered to be households with energy use per sqm that corresponds to energy efficiency class F and worse, i.e. using more than 160 kWh/sqm useful floor area. We consider this to be the case for households in worst performing buildings. Given the assumptions that need to be taken to arrive at this proxy and the fact that energy use does not necessarily reflect energy needs or the technical efficiency of the building, the proxy needs to be treated carefully. To date, data on building efficiency is not available for all German buildings, neither does the existing scattered data on energy performance certificates of buildings allow a link with household income. The proxy is thus currently the best approach to build an indicator of building energy efficiency that can be linked with household income and energy expenditure.

Related to the estimation of the individual indicators, some additional methodological points need to be considered. For all of the indicators that are estimated related to the population median, this median is calculated using the weighting factors of the EVS. All indicators using income and expenditures are calculated applying OECD equivalence weights. This is most important for absolute indicators, such as the M/2 and one variant of the LIHC indicators (DBEI 2020; Thema and Vondung 2020).

3.2.1 Indicator 1: *Absolute* low income/savings, *relative* high energy expenditure, and very low energy efficiency

Indicator 1 is based on discussions around the definition of energy poverty and indicators used to assess vulnerability with respect to energy or carbon pricing in the context of the SCF. Schumacher et al. (2022a) developed a suggestion for a vulnerability indicator to be used in the context of the SCF and carbon pricing.

Indicator 1 combines the three elements as laid out in the energy poverty triangle (compare Figure 5)

- High energy expenditure: Number of households whose share of (equivalized) energy expenditure (compared to equivalized disposable income) is above twice the national median (2M indicator). The indicator aims to capture the burden that energy bills put on households relative to their disposable income, using the national median as a reference point. The 2M indicator is used widely at EU-level to define energy poverty (see Box 1 on EPOV and EPAH indicators)
- Very low efficiency/high energy: Number of households whose fossil fuel use (per sqm) is more than twice the national median (>160 kWh/sqm useful floor area = worst performing building). Note: As mentioned above, we use specific energy use derived from energy expenditure data within the Germany income and consumption survey (see Box 2 “Methodological Notes” above) as a proxy of very low energy efficiency AND
- Low income: Number of households which are in the first five income deciles (below the median). Note: As mentioned above, we only consider households heating with fossil fuels.

This is to cover the target group affected by climate policy aiming to reduce fossil fuel consumption. A variation is given in Indicator 1b where low savings rather than low income is included.

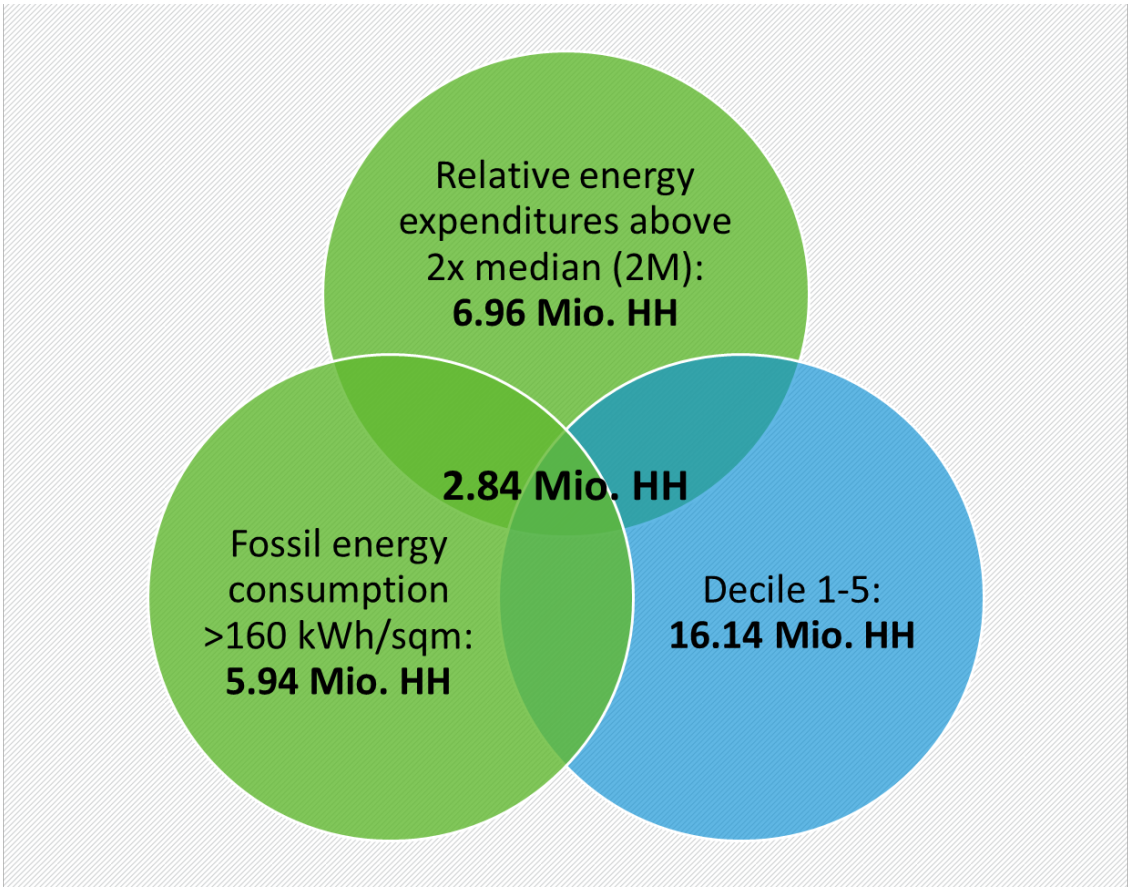
The combination of these elements thus considers households to be vulnerable to rising heating costs due to carbon pricing if they live in inefficient, fossil-fired homes, use a high proportion of their total expenditure for heat, and are in the lower half of the income distribution. The combination of these three factors ensures that the definition only includes households that suffer from high energy expenditures due to a lack of efficiency and households for which a high proportion of energy expenditure is a burden (lower income groups). In other words: Households that have high energy consumption due to large living space or high room temperatures but are well equipped to cover these costs due to a high remaining household budget are excluded. It should be noted that here and for the following indicators we only consider very low energy efficiency, such as in worst performing buildings. Households that live in inefficient but not highly inefficient (WPB) buildings might still be affected and it can be argued that the benchmark should rather be set at a lower energy efficiency threshold, e.g. corresponding to German efficiency class D or E and worse. The number of affected households would then be higher as more households fall into these categories[9]. In this study, however, we focus on those with very low energy efficiency approximated by very high energy consumption per square meter.

Indicator 1a: low income, high relative energy expenditure, low energy efficiency

Using Indicator 1a in Germany, 2.84 million vulnerable households using fossil fuel-based heating are identified. About 5.94 million households have a very high fossil heat consumption/sqm, 6.96 million households have high relative expenditures for fossil heat and 16.14 million households with fossil fuel-based heating are within the lower income half. In combination with the criterion of the lowest five income deciles, the three indicators result in the intersection of **2.84 million** vulnerable households (Figure 6). This indicator does not, however, capture those households that have low energy expenditure because they are constraining their energy use (hidden energy poverty, compare indicator 3a).

[9] More than 50% of German buildings fall into energy performance category E and worse with energy consumption per square meter useful floor area being higher than 130 kWh/sqm (https://www.wohngebaeude.info/daten/#/heizen/bundesweit;main=allgemein;sub=verteilung). The number of affected households could thus double compared to the case if only highly inefficient energy efficiency of buildings would be considered (WPB).

Figure 6: Number of vulnerable households according to the indicator 1a



Source: Calculation based on Oeko-Institut's SEEK model using the German Income and Expenditure Survey (EVS 2018) of the German Statistical Offices. Values are provided for the year 2023.

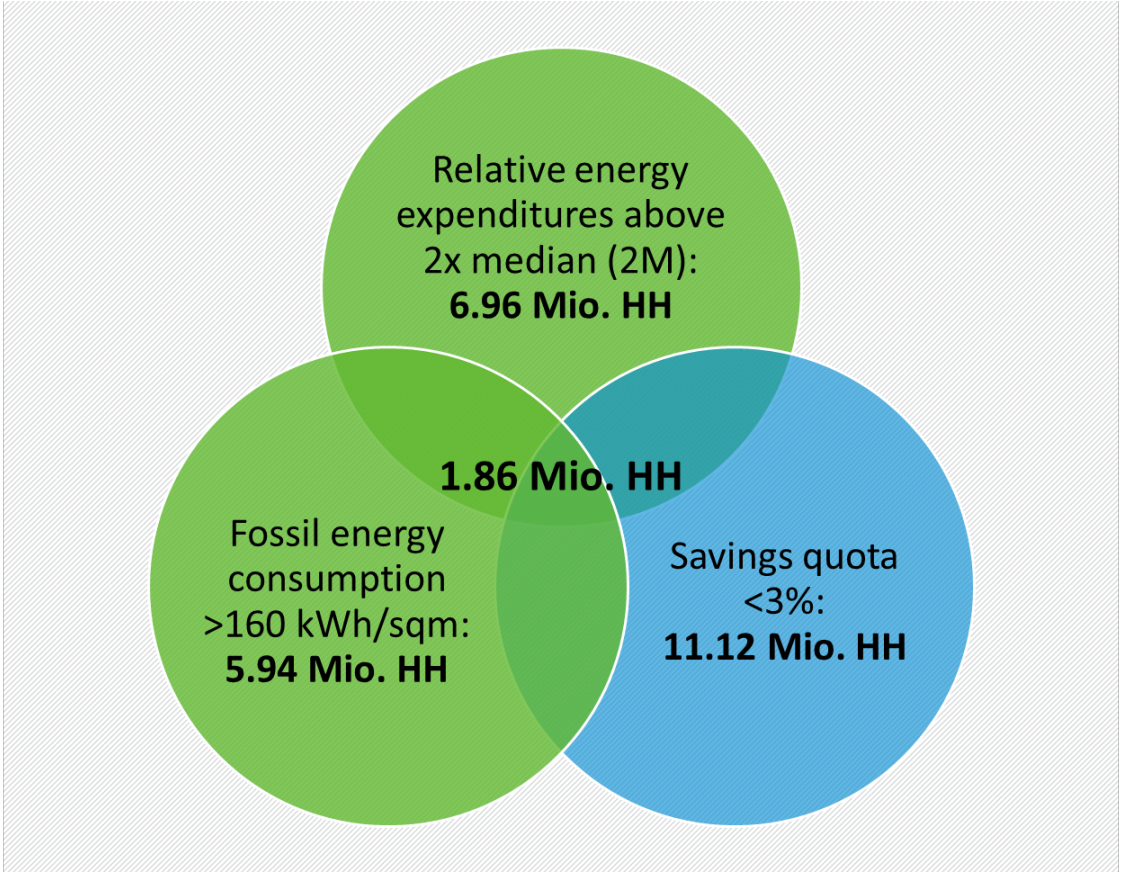
Indicator 1b: Low savings rate, high relative energy expenditure, low energy efficiency

Another variation of this indicator is to set a maximum savings quota instead of looking at the first five income deciles. This is based on the idea that households are likely to make use of their savings for investment in energy retrofit. If a specific share of income can be saved in a year, we assume that some savings are available which could potentially be used for investments. If households are not able to save a share of their income, it is likely that all their income is used for daily needs and expenses. We thus assume, they are not wealthy enough to pay for investment or credits associated with investment (see also Dobbins 2022). We assume a savings quota of 3 % as a threshold[10]. The savings quota measures yearly total savings in relation to available household income. In the past, households in the fifth income decile had a savings quota of around 3 % (based on 2013 data; Späth and Schmid 2016). In Germany this condition applies to 11.12 million households (Figure 7). Although the average savings quote in Germany is around 11 % in 2022 (Statista 2023), research indicates that households in the bottom half of the income distribution are not able to build up savings (Peichl and Schüle 2021).

Combined with the other two conditions (2M and very high fossil energy consumption) **1.86 million** vulnerable households are identified when applying Indicator 1b.

[10] It might be noted that savings are more relevant for homeowners to undertake investment in energetic refurbishment than for tenants.

Figure 7: Number of vulnerable households according to the indicator 1b



Source: Calculation based on Oeko-Institut's SEEK model using the German Income and Expenditure Survey (EVS 2018) of the German Statistical Offices. Values are provided for the year 2023.

3.2.2 Indicator 2: *In comparison to median:* low income and high energy expenditure

Indicator 2 scales income and energy expenditure to median values. Indicators 2a, 2b and 2c represent variations of the Low-Income High-Cost (LIHC) Indicator (see box below) (DBEI 2020). The original LIHC indicator is modelled based on energy needs and from this derives energy costs necessary for covering those needs. In our application we use actual expenditures to calculate the variations of the indicator, because the data necessary to model energy needs is not available at a national level in Germany. A variation of the LIHC indicator can be applied to Germany whereby the income threshold is not defined by the 2M indicator and an income decile cut-off but rather as those fossil fuels using households with an income below 60 % after energy expenditures. This is similar to the indicators used to measure "at risk of poverty".

Box 3: Low Income, High Cost indicators

Another well-known indicator that is similar to the one developed above was developed in England, often considered a pioneer in defining and addressing energy poverty in Europe. Previously, the Low Income High Cost indicator (LIHC) was used (see Hill 2011). Using this indicator, a household is considered in energy poverty if:

- Required fuel costs were above average (the national median) AND
- When residual income falls below the poverty line after these required fuel costs are spent.

The LIHC combines data on household income, household energy requirements, and fuel costs to determine levels of energy poverty. In doing so, the cost of energy is not based on actual expenditures but on modelled required energy needs and the costs associated with these needs. Household energy requirements are modelled based on the size of the property, the number of occupants (and occupancy patterns), energy efficiency, and fuel mix. While for Germany we cannot model required fuel costs due to a lack of data, the approach that considers low incomes and high costs along a threshold can be applied.

The LIHC has since been replaced be the Low Income Low Energy Efficiency (LILEE) indicator, which adds the dimension of energy efficiency. For this indicator the required fuel costs are still modelled, and a new approach for measuring low energy efficiency is developed. For this element a Fuel Poverty Energy Efficiency Rating (FPEER) system is introduced that is based on the assessment procedure for determining energy performance of residential buildings in the UK. The FPEER is therefore closely related to the Energy Performance Certificates.

These particular indicators therefore take into account required household energy, rather than actual expenditures. This is because England has a very comprehensive database on all dwellings in the country that make this possible (Thomson et al. 2017). Equally, this approach makes generalized assumptions about required heating needs (and households being able to meet these) and binds energy efficiency in the housing stock to energy efficiency ratings, which may not accurately reflect the efficiency standards. Nonetheless, the English indicator is one of the only examples in which energy needs are explicitly integrated into the measurement. Due to the lack of similar data in Germany, this is currently not possible and capturing energy needs remains a major shortcoming of possible indicators. One central aim of a needs-based approach is that it also captures households who are underspending on their energy need. This is often referred to as “hidden energy poverty” (Karpinska and Śmiech 2020; Eisfeld and Seebauer 2022). In our approach for Germany, we therefore consider other ways to capture this phenomenon beyond modelling energy needs.

A variant of the low income high cost indicator is also presented in a recent study by (Grimm et al. 2023). They assess the risk of energy poverty based on absolute high energy costs measured as expenditure on energy of more than 10 % of net income and low income expressed as income of less than 80 % (and alternatively 60 %) of median net equivalent income. The approach does not reflect on energy needs nor does it take into account whether energy costs are high because of low efficiency of buildings. Furthermore, the absolute 10 % threshold does not allow a comparison to energy expenditure of other households and reflect on whether energy expenditure is higher or lower than the median.

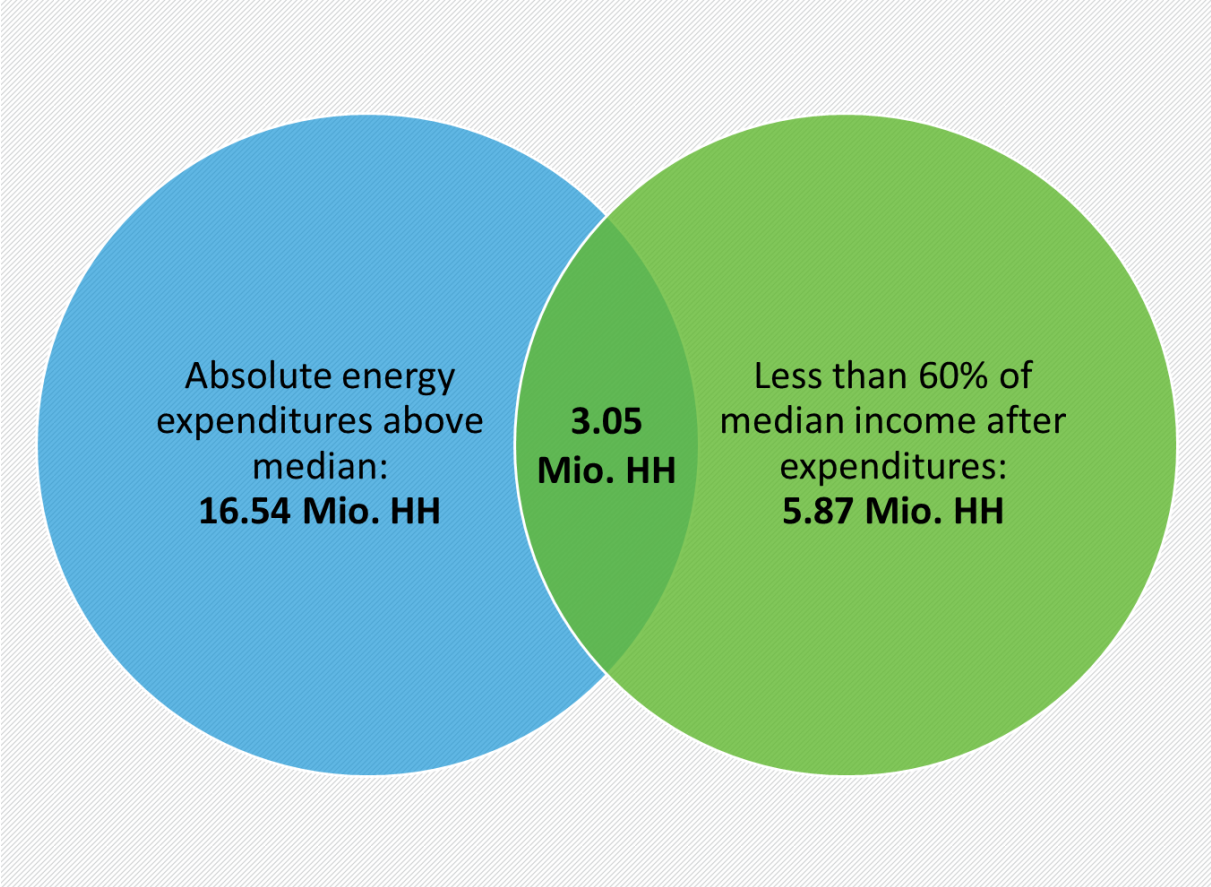
Indicator 2 a: low relative income, high absolute costs

In version 2a of the indicator low income is combined with high absolute costs, both compared to the median:

- (Equivalized) absolute energy expenditures above the national median AND
- less than 60 % of (equivalized) median income after expenditures.

Using the indicator 2a in Germany, 3.05 million vulnerable households with fossil fuel-based heating are identified as vulnerable to high heating energy costs. About 16.54 million households have absolute (equivalized) heating energy expenditures above the national median and almost 5.87 million German households with fossil fuel-based heating have less than 60 % of the median income at their disposal after expenditures (Figure 8).

Figure 8: Number of vulnerable households according to the indicator 2a



Source: Calculation based on Oeko-Institut's SEEK model using the German Income and Expenditure Survey (EVS 2018) of the German Statistical Offices. Values are provided for the year 2023.

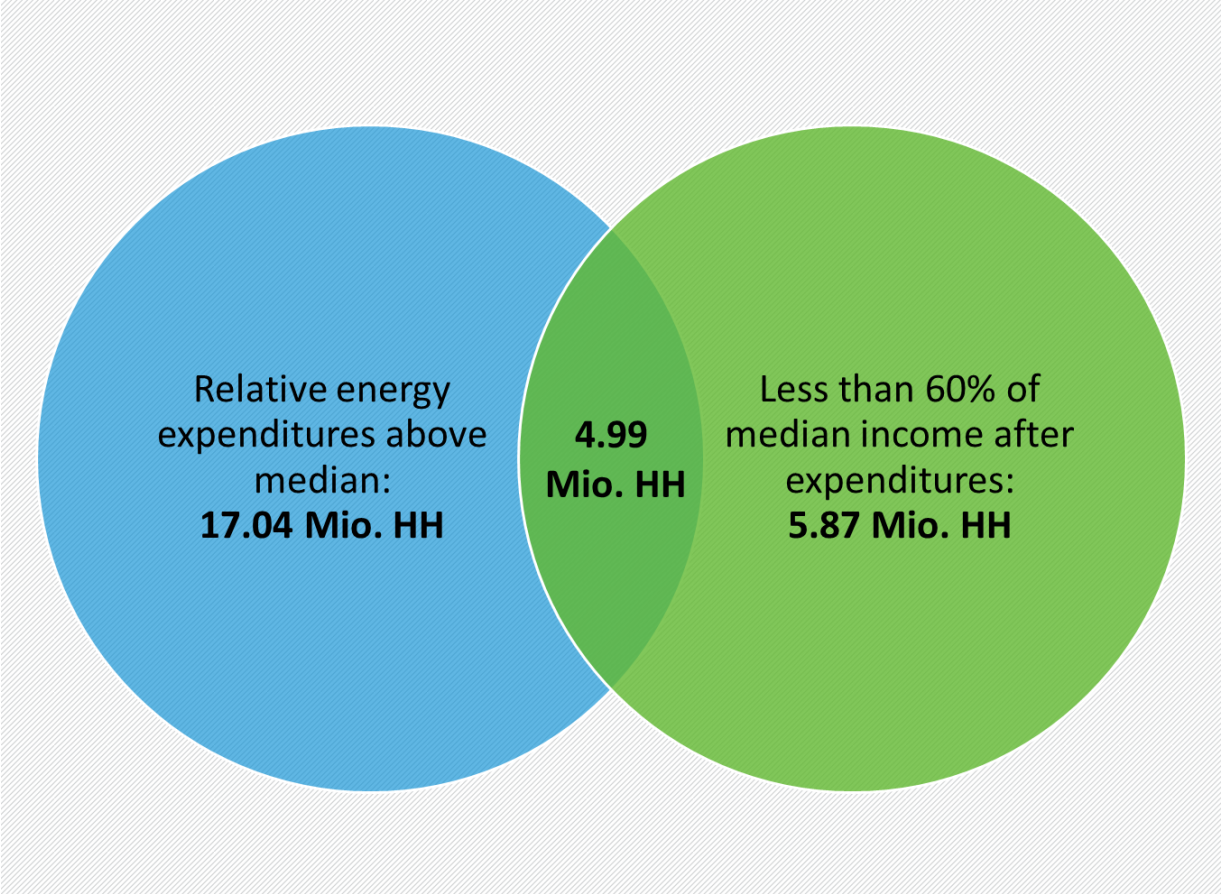
Indicator 2b: low relative income, high relative energy costs

In a slight variation of this indicator, indicator 2b considers relative energy expenditures rather than absolute expenditures.

- (Equivalized) relative fossil fuel energy expenditures above the national median AND
- less than 60 % of (equivalized) median income after expenditures.

When combining these two elements, indicator 2b on German households results in around 5 million households with fossil fuel-based heating that could be identified as vulnerable (Figure 9) The total number of households with high heating expenditures above the national median is slightly higher when taking relative rather than absolute expenditures into consideration. Interestingly, the increase in the overlap between the two indicators (2 million) is higher than the difference of the element that was varied from indicator 2a to 2b, i.e. absolute to relative high heating expenditures (0.6 million). This indicates that a substantial number of households do not fall in the combination of absolute high energy expenditure and low income, but rather into the combination of high expenditure burden for energy and low income. From this we conclude that high relative expenditures are a better indicator for vulnerability that should be combined with some income or wealth indicator.

Figure 9: Number of vulnerable households according to the indicator 2b



Source: Calculation based on Oeko-Institut's SEEK model using the German Income and Expenditure Survey (EVS 2018) of the German Statistical Offices. Values are provided for the year 2023.

Indicator 2c: low relative income, relative high energy costs and low energy efficiency

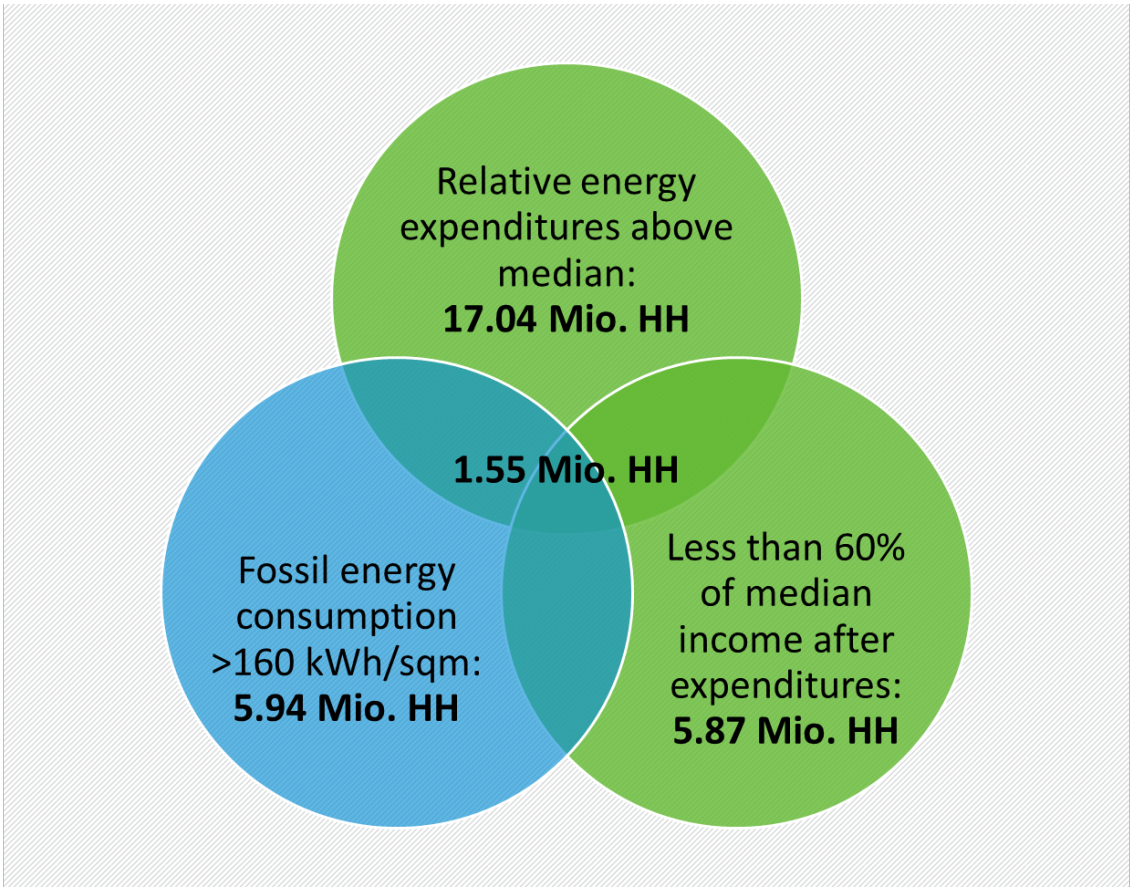
In indicator 2c an additional condition is added whereby households with high fossil heating consumption are also considered. The additional factor is the same as in indicator 1 and reflects on the energy efficiency of the building that households live in. As data on building efficiency by income group is not available, we use energy consumption per square meter as a proxy.

This indicator therefore includes next to financial conditions (income and burden) also energy efficiency conditions and covers therefore all three aspects of the energy poverty triangle. The following conditions for measuring vulnerability to high energy costs are included:

- less than 60 % of median income after expenditures AND
- relative energy expenditures above the national median AND
- fossil fuel consumption (per sqm) more than twice the median (>160 kWh/sqm)

The combination of all three conditions results in 1.55 million German households with fossil fuel-based heating that are considered vulnerable.

Figure 10: Number of vulnerable households according to the indicator 2c



Source: Calculation based on Oeko-Institut's SEEK model using the German Income and Expenditure Survey (EVS 2018) of the German Statistical Offices. Values are provided for the year 2023.

3.2.3 Indicator 3: Absolute low income *combined with EPOV indicators* (expenditure-based and self-reporting)

Indicators 3a and 3b are combined in such a way that they would capture 'hidden energy poverty'. This refers specifically to households who significantly underspend on energy and therefore are assumed to not be able to afford to cover their energy needs.

These low absolute energy expenditures are covered by the M/2 indicator, an expenditure-based indicator developed by the EPOV and in use currently by EPAH:

- M/2: Absolute (equivalized) energy expenditure below half the national median - estimated based on data from the HBS. The indicator covers households with energy expenditure below half the national median value. It aims to capture underconsumption of energy services in comparison to the national median of energy expenditures.

This is combined with a low-income threshold (1-5 income decile) to ensure that high income households who live in energy efficient dwellings and therefore have low absolute energy expenditures are excluded from this group.

Alternatively, if households report that they are not able to keep their homes adequately warm this is also an indication that they are not able to cover their energy needs. By introducing an income threshold (1-5 income decile) households that are assumed to have the potential to increase their energy spending or make energy efficiency improvements are excluded.

Indicator 3a: low income, low energy expenditure (hidden energy poverty)

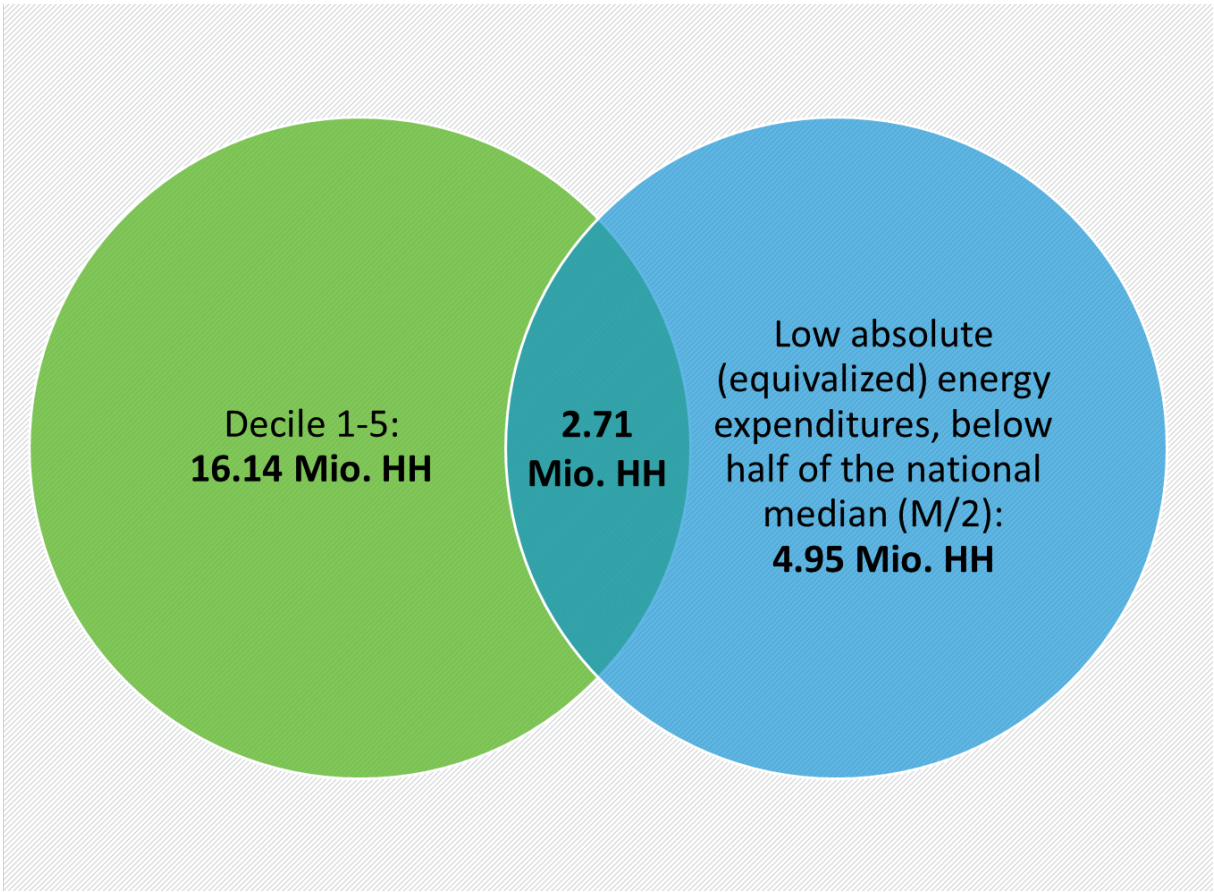
The following conditions for measuring vulnerability are included in the indicator 3a:

- household is in the first five income deciles (below the median) AND
- M/2: Low absolute (equivalized) energy expenditures, below half of the national median.

Low absolute (equivalized) energy expenditures, below half of the median, apply to about 4.95 million households in Germany. Combined with the condition of fossil fuel using households within income decile one to five (16.14 million), this indicator leads to an overlapping amount of 2.71 million households defined as vulnerable.

This implies that about 2.7 million households might possibly suffer from hidden energy poverty because they have low income and exceptionally low energy expenditure which might result from energy savings beyond the level that would be needed to keep the home comfortably warm.

Figure 11: Number of vulnerable households according to the indicator 3a



Source: Calculation based on Oeko-Institut's SEEK model using the German Income and Expenditure Survey (EVS 2018) of the German Statistical Offices. Values are provided for the year 2023.

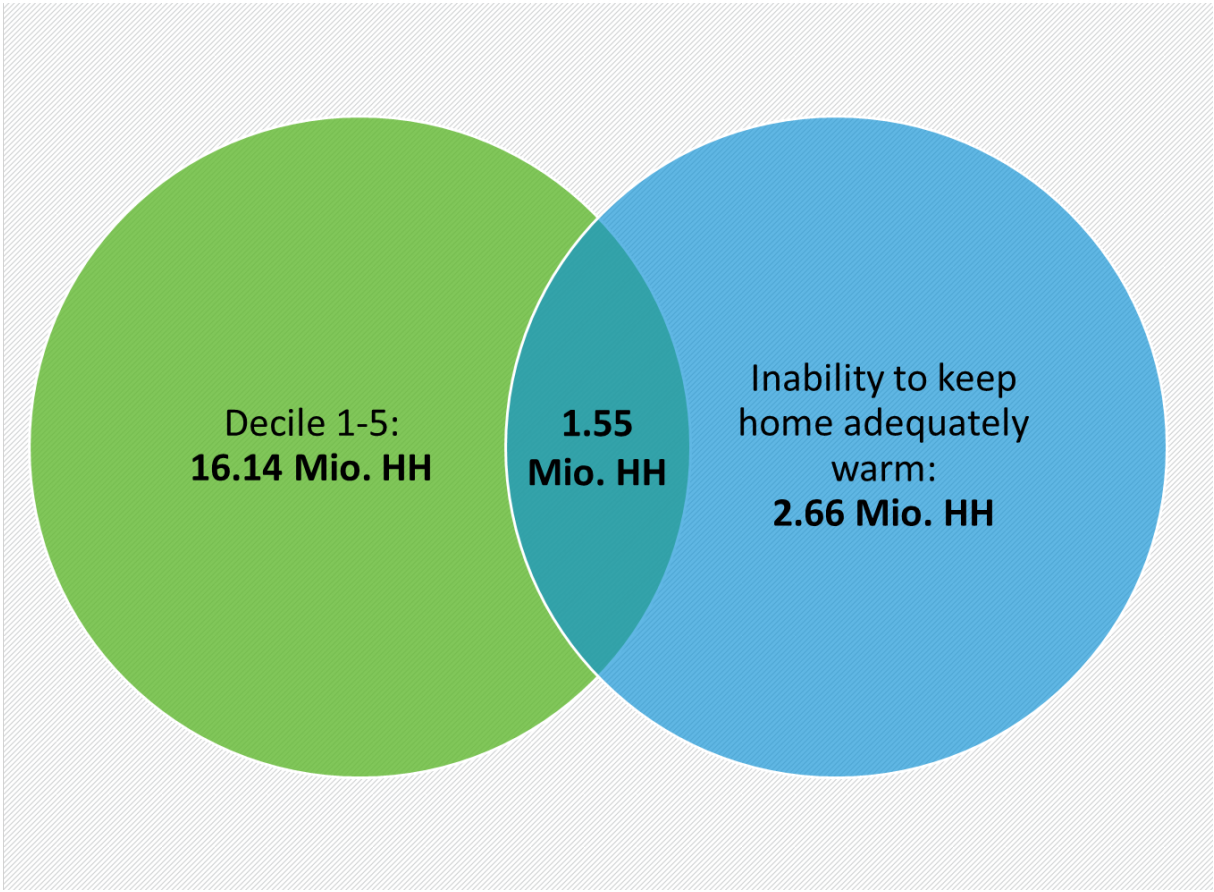
Indicator 3b: low income and inability to keep home warm

In a variant, indicator 3b accounts for households that report to not be able to keep their home adequately warm in addition to low income. Specifically, it includes:

- Ability to keep home adequately warm – based on the EU-SILC[11] survey question: Can your household afford to keep its home adequately warm? The indicator captures the share of population not being able to keep their home adequately warm AND
- household uses fossil fuel-based heating and is in the first five income deciles.

When combining the condition of households in Germany that have an income within decile one to five (16.14 million) with households' (in)ability to keep home adequately warm (2.66 million, corresponding to about 7 % of all households), around 1.55 million households would be considered vulnerable (Figure 12). Again, only households using fossil fuels are included.

Figure 12: Number of vulnerable households according to the indicator 3b



Source: Calculation based on Oeko-Institut's SEEK model using the German Income and Expenditure Survey (EVS 2018) of the German Statistical Offices and the EU-SILC (2022). Income values are upscaled to the year 2023, values for the indicator "inability to keep home adequately warm" refer to the year 2022. Only households heating with fossil fuels are included.

3.2.4 Indicator 4: Absolute income threshold only

Often when designing policy measures to address vulnerable households, complex composite indicators are impractical and cannot easily be applied. Taking a straightforward income approach is often more suitable. Therefore, this indicator only includes

- Indicator 4a: households with fossil fuel-based heating that have a low **income within the first to third decile**, which applies to around 10 million households in Germany, and

[11] This is the EU Statistics on Income and Living Conditions: https://ec.europa.eu/European/web/microdata/European-union-statistics-on-income-and-living-conditions

- Indicator 4b: households with fossil fuel-based heating whose **taxable income is below 40,000 Euro per year**, which applies to 16.27 million households or about 40% of all German households, thereof 13.4 million households are within the first five income deciles and 9.4 million within the first three income deciles[12]. Out of these 16.27 million households, about 30% (i.e. 4.34 million) own and live in a single or two family house (called owner-occupiers in the following, see also chapter 4.1.3).

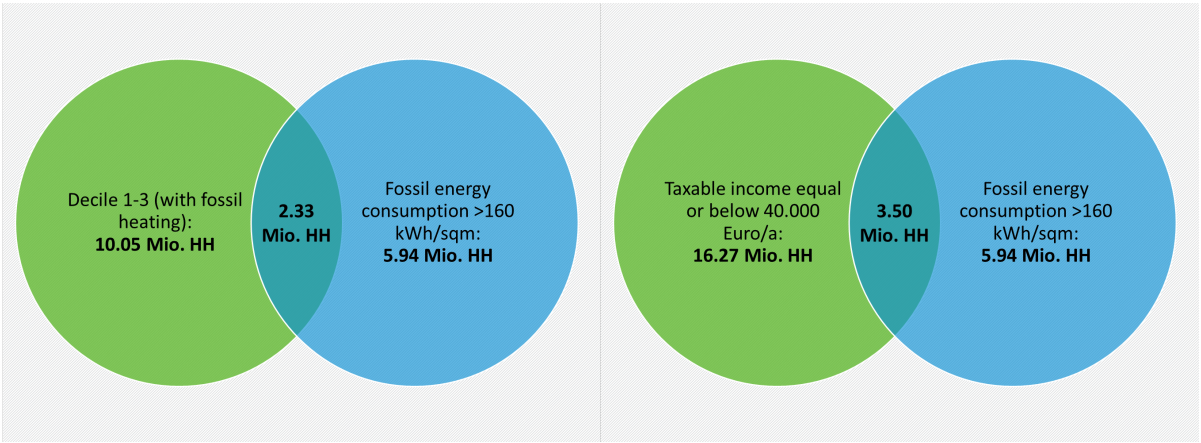
The 40,000 Euro taxable income benchmark is currently used for the social bonus within the German funding scheme for heating replacement. This low and middle income-based approach yields the largest number of vulnerable households.

Figure 13: Number of vulnerable households according to the indicators 4a and 4b

Source: Calculation based on Oeko-Institut's SEEK model using the German Income and Expenditure Survey (EVS 2018) of the German Statistical Offices and the EU-SILC (2022). Income values are upscaled to the year 2023. Only households heating with fossil fuels are included.

Combining the income-based indicators with very low energy efficiency using the proxy approach described above (see see Box 2 "Methodological Notes") with a benchmark of energy consumption per square meter above 160 kWh/sqm, reveals for indicator 4a about 2.33 million households and for 4b about 3.5 million households to be living with low income and with poor energy efficiency.

Figure 14: Number of vulnerable households according to the indicators 4a and 4b for WPB



[12] Information on taxable income is not directly available from the German income and expenditure survey. We derive proxy scaling factors based on the German tax statistics (Fachserie 14 Reihe 7.1) as follows: Taxable income = 85% of gross income from employment plus 85% rental income plus 80% of retirement/pension income.

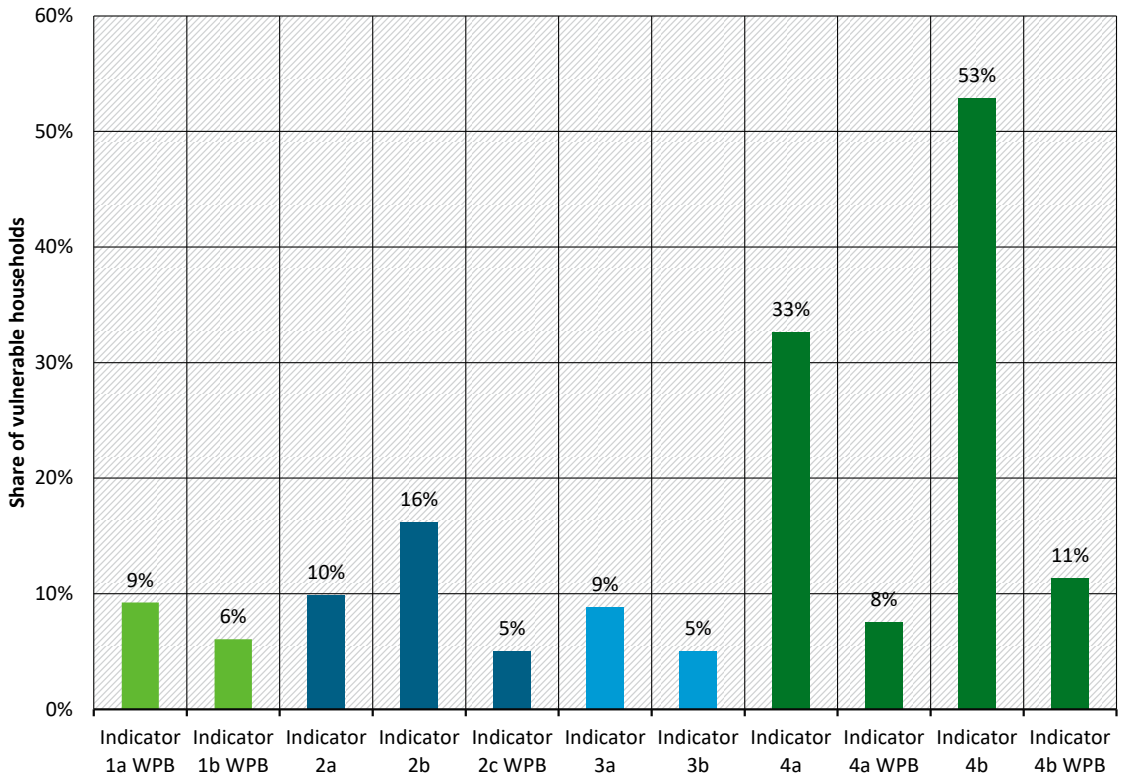
Source: Calculation based on Oeko-Institut's SEEK model using the German Income and Expenditure Survey (EVS 2018) of the German Statistical Offices and the EU-SILC (2022). Income values are upscaled to the year 2023, values for the indicator "inability to keep home adequately warm" refer to the year 2022. Only households heating with fossil fuels are included.

3.3 Insights on indicators

The analysis shows a range for the number of households with fossil fuel-based heating vulnerable to rising energy costs or prone to energy poverty depending on the chosen indicator or indicator combinations. Figure 15 provides an overview of the share of vulnerable households with fossil fuel-based heating across indicators. In relation to the total number of households with fossil fuel-based heating, the share of vulnerable households ranges from about 5 % to more than 53 %. On average across all compound indicators, i.e. except the mere income based indicators 4a and b, a share of about 9 % of households can be considered vulnerable. Within this share of vulnerable households, less than 1 % to about 14 % are owner occupiers with fossil fuel-based heating.

Taking the subgroup of about 12 million owner-occupied households in Germany heating with fossil fuels (rather than looking at the total of 30 million households in Germany heating with fossil fuels) the share of vulnerable households within the subgroup of owner-occupied households is significantly higher ranging from about 1 % to 37 %. Homeowners are thus relatively more prone to be vulnerable than tenants although they represent a much smaller group. For more details on homeowner versus tenant households, see chapter 4.1.3.

Figure 15: Overview of share of vulnerable households for the derived indicators



Source: Calculation based on Oeko-Institut's SEEK model, data sources, see chapters above. Values are provided for the year 2023, exceptions see chapter 3.2. Only households heating with fossil fuels are considered.

Note: Indicator 1a/b WPB = Absolute low income (1a)/savings (1b), relative high energy expenditure and low energy efficiency; Indicator 2a/b/c = In comparison to median low income and high energy expenditure (Indicator 2c plus WPB = low energy efficiency); Indicator 3a/b = Absolute low income combined with EPOV indicators (3a hidden energy poverty expenditure-based and 3b inability to keep home warm self-reporting), Indicator 4a/b = Absolute income threshold (4a decile 1 to 3 and 4b low taxable income plus WPB = low energy efficiency), for detailed information see chapter 3.2.

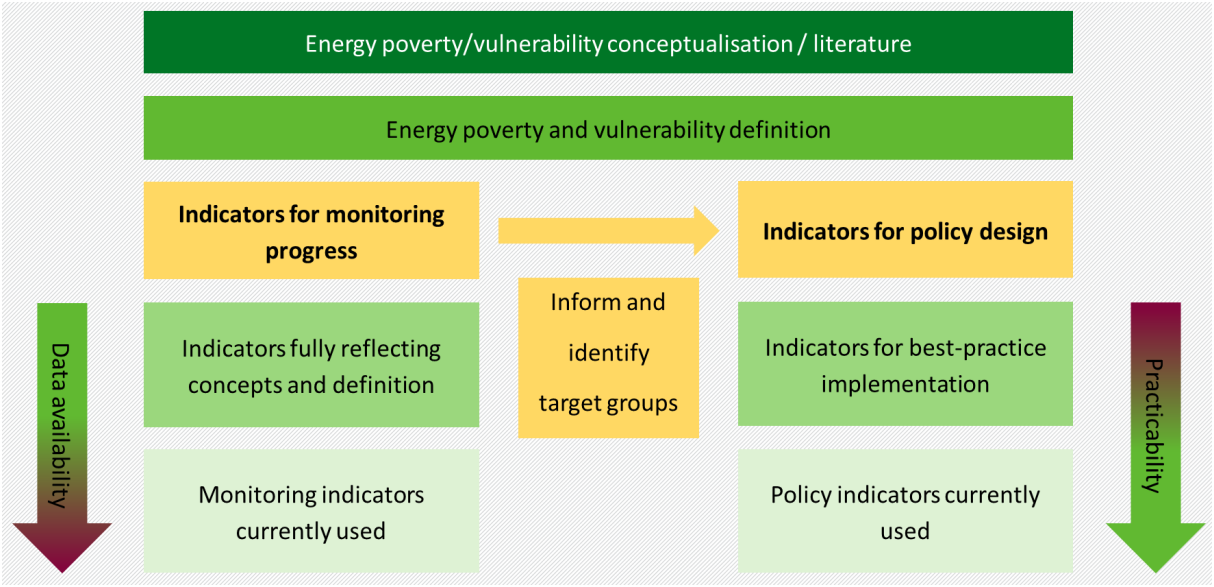
Some observations can be highlighted:

- Expenditure approaches, both in terms of high absolute and relative energy expenditures, yield a high number of households. This indicates that it is important to include an additional income threshold to narrow this group down further. Relative income thresholds (as used in indicators 2a, 2b, and 2c) show a much lower number of households than absolute thresholds, i.e. income deciles.
- Expenditure values should always be compared to the median as a benchmark. Relative energy expenditure is better suited to identify vulnerable households than absolute energy expenditure. In combination with low income, it shows that absolute high energy expenditure (compared to the median) rarely occurs whereas high relative energy expenditure and low income is more prominent and results in a higher cost burden.
- Income thresholds are important because they filter out high income households that may live in inefficient buildings and/or have high energy expenditures because of their energy consumption patterns. High consumption or overconsumption is also an important issue that needs to be addressed, but this is not the focus of the vulnerability discussion here.
- Using savings quotas instead of absolute income yields a smaller pool of affected households (Indicator 1b). Savings might be more relevant when it comes to households making investments into energy efficiency or renewable based heating to reduce fossil fuel consumption. This, however, is less relevant for the high number of renting households who regardless of their savings are not able to make significant changes to the energy efficiency levels to the building stock.
- Adding an indicator that reflects the energy efficiency of the building is important to identify those vulnerable households in need of energy retrofit. Indicators 1 a, b, c as well 2c include energy consumption per square meter as a proxy for low energy efficiency. In combination with a high share of energy expenditure and low income/savings rate, they arrive at 1.7 to 3 million households to be vulnerable with respect to heating, corresponding to 5 % to 10 % of the 30 million households in Germany that heat with fossil fuels. However, operationalizing an indicator that accounts for building efficiency is challenging because of the lack of data (see Box 2). Our proxy of energy consumption per sqm does not single out hidden energy poverty and might mix energy efficiency with underconsumption.
- Hidden energy poverty is covered in Indicator 3a which combines low income with energy expenditure that is lower than half the median and indicates underconsumption. The combination reveals about 3 million households to be vulnerable with respect to heating, corresponding to about 10 % of all households.
- Mere income-based indicators, such as Indicator 4 a and b, give a rather high share of vulnerable households compared to the compound indicators that combine various factors. Combining income-based indicators with high energy consumption per square meter shows that about one fourth to once fifths of low-income households live in very low energy

efficiency buildings (WPB). This should be kept in mind when deciding on a suitable indicator.

Ultimately, the measurement approach depends on the aim of the indicator. In other words, whether the indicator is developed for monitoring and benchmarking purposes (predominantly on a national or inter-national scale such as the EU) or for the local-scale delivery of policy.

Figure 16: Schematic overview: Purpose and operationalisation aspects of indicators



Source: Own compilation (Öko-Institut)

Figure 16 provides a schematic overview differentiating the aim of indicators and highlighting aspects for operationalising them. The most important first step, which is still missing in Germany, is to develop a definition of energy poverty and vulnerability. As outlined in chapter 2, definitions for both these terms are already proposed in EU regulations and recommendations. They might be used as such in Germany. Additional sub-definitions might be needed to account for different energy services, i.e. electricity, heating or mobility and whether only services using fossil fuels are taken into consideration or all energy services.[13] Based on these definitions, indicators will be needed for

- Monitoring purposes: Monitoring indicators aim to identify and quantify the affected group(s). They take account of the number and kind of households or individuals at risk of energy poverty or vulnerability and give an indication of how much and what kind of support is needed to alleviate the situation. Furthermore, they are essential for monitoring progress over time to evaluate whether support measures work and reach the right target group. Monitoring indicators thus need to cover the affected target group in a consistent way and in as much detail as possible. Challenges often arise in terms of data availability to provide proper quantification of such indicators. Measurement of building efficiency is one example, where no information is currently available in Germany for the entire building stock, but such information on energy efficiency combined with household income would be needed to accurately assess the share of vulnerable households living in inefficient and fossil heated buildings.

[13] Within this report, we only consider heating energy and households heating with fossil fuels. This is to be in line with the Social Climate Fund Regulation. For application to the Energy Efficiency Directive, all energy services should rather be taken into account.

- Policy design: Indicators for policy design could in a perfect world correspond to indicators used for monitoring. In practice, however, policies need to be based on indicators that use easily accessible, administrable, and verifiable data and do not need any further calculations, simulation, or modelling to arrive at or compare to benchmarks. Offices or agencies in charge of verifying eligibility of households to be vulnerable need to keep their administrative burden low and ensure consistency in their approach only relying on official documents. In practice this means that often only income as shown on tax returns or pension statement can be used and possibly also energy bills. Proxys for energy efficiency, such as energy use per square meter, could also be inferred from the energy bills but would need to be calculated. Income related benchmarks have been applied, for example, to set eligibility for funding for replacement of heating systems in Germany and Austria. Job centres in Germany also check heating energy bills of social transfer recipients to estimate the heating allowance that can be provided. In general, heating bills are issued once a year[14] in Germany and give information on heating costs, the amount and kind of heating energy used, and the square meter size of the unit. Beyond transfer payment recipients, information from energy bills have not yet been used in Germany to check vulnerability. They should be taken into consideration as additional eligibility criteria.

Sareen et al. (2020) argue that existing indicators, such as those provided by EPOV and EPAH (see beginning of Chapter 3) can be primarily used for country comparisons but are often of limited use for national policy makers. On the other hand, composite indicators are harder to institutionalize because of their complexity. It is important to recognize the multidimensionality of energy poverty so that support schemes to alleviate energy poverty can actively target households. A reduction of the complexity of the phenomenon risks missing opportunities for local action and regional assessments (ibid.). As an object that policy acts on, energy poverty becomes whatever is measured. But measurement cannot be perfect and so there will always be aspects of energy poverty or vulnerability that policy does not tackle.

[14] Different intervals, such as monthly or quarterly bills are also possible.

4 Policies and measures to address vulnerable groups

There are different ways in which vulnerable and energy poor households can be supported. Measures and policies usually address one of the three causes of energy poverty, meaning they either focus on reducing energy prices, provide income support, or aim to improve energy efficiency. Targeted energy price reductions may come in the form of social tariffs for certain groups, income support may be given through targeted social welfare payments to support households with their electricity and gas bills, and energy efficiency measures can include both informational campaigns for behaviour change and financial support for renovations.

Generally, targeting the energy efficiency dimension offers the most long-term and cost-effective way of reducing vulnerability and energy poverty, because it makes households more resilient against rising energy prices or carbon costs. It also means that households are included in the energy transition, aligning with the “leave no one behind” principle of the EU Green Deal.

Across EU MS a range of measures have already been implemented that target vulnerable households (Hesse et al. 2023). These are either financial, informational, or regulatory.

Financial instruments include both direct income support and programs that provide funding support for energy efficiency renovations. Particularly during the energy price crisis, many governments introduced additional payments to support households with their energy bills. These were often, however, not specifically targeted at low-income or otherwise vulnerable households, e.g. the energy allowance for employees in Germany (Schumacher et al. 2022b; Beznoska et al. 2023; Kenkmann et al. 2024)). These payments were introduced on top of existing financial support. In France, for example, the "Energy Cheque” is a direct-income support payment for very low-income households or other vulnerable groups (e.g. those living in residential or long-term care facilities) to support them with their energy bills. This is a payment between 48 and 277 Euro depending on income and size of households. Similar electricity and gas support payments are available in Ireland as well.

Other financial instruments are those programs that offer support for renovations. These are most effective at mitigating energy poverty and vulnerability when they are targeted at these affected households. The “I am Saving” Program in Greece, for example, offers grants to households undergoing energy efficiency renovations. Since 2021, a certain percentage of beneficiaries of the program have to be energy poor households. They therefore received higher levels of grant support. In Ireland, the energy efficiency grant system is targeted at low-income households in particular and offers fully-funded energy renovation support. Funding has been increased year on year due to the high demand for these grants (Hesse et al. 2023). The MaPrimeRénov’ program in France has also been in place for many years, in various iterations, providing grants which increase for lower-income households (see below for more detail, section 4.1). In Germany, a program for efficient buildings supports different kinds of energy refurbishment for building owners, ranging from individual single measures, such a heating replacement or roof insulation, to full energetic refurbishment. The program is open for all building owners, i.e. owner-occupied buildings and rented buildings. The recently introduced heating replacement program provides for the first time a social bonus for low-income household whose taxable income is below 40,000 EUR per year on top of the basic funding that applies to all building owners[15]. However, for full refurbishment and efficiency measures, there is no comparable socially differentiated funding scheme.

[15] See https://www.energiewechsel.de/KAENEF/Redaktion/DE/Foerderprogramme/beg-em-privat.html#foerderung-heizungstausch

Informational campaigns also help to improve energy efficiency in households through behavioural changes. Programs like the Stromspar-Check (Energy Savings Check) in Germany, for example, provides peer-to-peer support for low-income households[16]. A trained advisor gives advice on electricity and heating usage and may offer some small changes, such as changing light bulbs or switches. Additionally, the program provides financial support for replacing inefficient refrigerators. The Energy Savings Check is very similar to the SLIME program in France (Eden et al. 2023), where local advisors identify energy poor households and provide advice to these households regarding their energy use . Such advice centres may also be organised locally, as is the case with the Energy Advice Points in Barcelona.

Further **regulatory measures** can also be useful to further incentivise energy efficiency renovations. Especially in the rental sector, measures such as mandatory minimum energy efficiency standards can be effective. These were introduced in France and are being discussed in Ireland.

In this chapter, we focus on applying one of these existing instruments, MaPrimeRénov', to the German context. This program was chosen as an example of a long-term financial measures that addresses the energy efficiency dimension of energy poverty and vulnerability. The program has been in place for several years, has been evaluated, and is a good example for targeting grants towards low-income households. This program is also accompanied by a range of additional measures, which we discuss briefly. An overview of all measures under the umbrella of the RenovFrance program can be found in the Appendix (Table 11). The final section therefore shows the grants and funding needs in Germany for full refurbishment based on MaPriméRénov' approach by applying the indicators from Chapter 3.

4.1 Focus: MaPrimeRénov' and accompanying programs in France

Housing policy in France is coordinated by the National Housing Agency (ANAH) that is funded by the Ministry of Ecological Transition. Since 2011 they have been developing and implementing public funding schemes that provide financial support for households to conduct energy efficiency renovations.

The program Habiter Mieux was first put into implementation in 2011 and was targeted specifically at households with low and middle incomes. The program was funded by the National Housing Agency (ANAH), partially through ETS revenue, but also by energy suppliers through white certificate sales, and other smaller revenue sources. Initially, ANAH provided two different sets of funding through the Habiter Mieux program. First, through Habiter Mieux Agilité (running from 2018-2020), funding was offered for single renovation measures and through Habiter Mieux Serenité, for a set of renovation measures or a full renovation. This was all funding reserved for those household with low or middle income.

In 2020, Habiter Mieux Agilité was replaced by the MaPrimeRénov' program, which was extended to all owner occupiers regardless of income in 2020, with the financial support provided being reduced as income increased. It was further extended to landlords in 2021. In 2022, the funding schemes for energy renovations were streamlined and Habiter Mieux Serenité was subsumed under MaPrimeRénov' as MaPrimeRénov' Serenité. Since 2024, the MaPrimeRénov' Serenité program is known as MaPrimeRénov' Parcours. The aim of this restructuring was to encourage more comprehensive renovations rather than individual measures (Republique Francaise 2024b). These programs are no longer exclusively targeted at low-income groups but differentiate levels of support via income. Households are categorized by

[16] https://www.stromspar-check.de/

their income[17] and based on the size of the household. The income ceiling for those households living in the most densely populated area of France (Ile de France) are higher than the rest of France. Households are categorized into five groups: very low (very modest) income, low(modest) income, intermediate income, and high income. The programs differentiate between the level of financial support provided based on the extent of work conducted. In the following sections, more details about the type of support offered is included.

In 2023 the FranceRénov' website was launched which collates all programs and information on renovation support available in France (for a comprehensive overview of all programs available through FranceRénov' see Appendix A). FranceRénov' includes an advice hotline and advice centers across the country. There are currently 570 FranceRénov' advice centers across France.

Additional support is provided through the Mon Accompagnateur Rénov' during the course of the renovations. This is a dedicated case officer that supports households throughout the entire process including technical support (advice for the work, carrying out the energy audit, etc.), financial support (financing plan, help to understand quotes, etc.), and administrative and social support (identification of housing and personal needs, assistance with administrative procedures, etc.). This is an optional support that households can take advantage of.

Evaluations provide information on the uptake of the program. Between 2011-2021 in the Habiter Mieux and MaPrimeRénov' Serenite programs 503.856 homes were renovated (Republique Francaise 2022). 82 % of beneficiaries were owner occupiers (over two thirds of which were households with very low income), 10 % were landlords, and 8 % owner communities. On average around 41 % energy savings per home were achieved, as measured through the reduction of energy bills. Between 2011 and 2020, annual CO_2-savings of 333,000 t CO_2 were achieved. Most of the work was carried out on homes that were built before 1975 (78 %) and half of the buildings were in energy efficiency bands F and G prior to the renovation work.[18] 44 % of the buildings saw an improvement of two energy efficiency bands due to the subsidized work.

In 2022, around 34,000 owner-occupiers received grants under the MaPrimeRénov' Serenite program (ONPE 2023). Over 70 % of these were households with very low income. On average 29.000 Euro were invested per home, resulting in average energy savings of 51 %.

A flash audit (Cour de Comptes 2021) of the MaPrimeRénov' scheme, that is not only targeted at low-income groups, for the period between January 2020 and June 2021 showed that almost 300.000 renovation applications were granted. The audit showed that applications were being primarily made for single renovation measures. Two thirds of these were works to change heating system, while the rest were for insulation work.

The majority of work carried out between 2020-2022 under the MaPrimeRénov' program were conducted for houses built prior to 1975, just as in the precedent evaluation period (Republique Francaise 2023). Almost 80 % of all properties supported through the MaPrimeRénov' Serenite program during this period were built prior to 1975. The majority of work carried out was related to changes in the heating system (67 %) and 20 % related to insulation work. This is consistent with the findings of the flash audit of the period prior and indicates that the program is effective in offering incentives for heating system changes. 96 % of the heating systems installed through MaPrimeRénov' in 2022 were for decarbonised heating systems. Between 2020-2022 annual energy reductions of 6,89 MWh/a were recorded for the MaPrimeRénov'

[17] Basis for this is the households taxable net income (in French revenus fiscaux de reference = reference tax income). For income ceilings, compare Appendix.

18 Energy efficiency band G equals energy use >420 kWh/sqm and band F equals 330 to 420 kWh/sqm, compare https://www.inc-conso.fr/content/logement/le-diagnostic-de-performance-energetique-dpe-1?lang=en

program per building. Additional 19,5 MWh/a per building for the MaPrimeRénov' Serenite program. During this time, 2.3 billion Euro in subsidies were paid out through the MaPrimeRénov' program between 2020-2022[19].

A survey evaluation of the MaPrimeRénov' program (Anah 2023) was carried out in 2022. This indicated that households were more likely to conduct higher quality and more ambitious work more quickly due to the program. Overall, 88 % of survey respondents were satisfied with the scheme and households were extremely satisfied with the work conducted. 72 % of respondents noticed a reduction in heating costs since the work was carried out. Almost 70 % said that they would not have carried out the same renovation work if they hadn't received public support. Survey recipients were overall satisfied with the contact at the advice center and 74 % found that the process of applying for and claiming the grant was simple. Only around 30 % used the additional advisory services (Mon Accompagnateur Rénov'). Of those that did use this service, 86 % were satisfied with the support they received.

Nonetheless, the landscape of actors involved in the implementation of the MaPrimeRénov' programs is large and diverse. This means that it is not always very straightforward for households to navigate this. For example, in the Paris region several mediators are involved in delivering various aspects including the identification of households and conducting the renovation work.

4.1.1 Support for owner occupiers

Along with other programs under the FranceRenov scheme (compare Appendix A) the MaPrimeRénov' program has undergone a number of changes in 2023. The scheme is divided into two parts: MaPrimeRénov' pour une rénovation par geste which focusses on heating technology replacement and MaPrimeRénov' Parcours pour une rénovation d'ampleur which focusses on full buildings renovation. The funding strategy in France continues to be based on the approach "the lower the income, the higher the funding". Thus, both programs provide socially differentiated financial support dependent on households' reference tax income.

MaPrimeRénov' (pour une rénovation par geste = individual renovation measures)

The scheme MaPrimeRénov' pour une rénovation par geste offers financial aid for the priority installations of low-carbon heating systems or domestic hot water systems. Additional insulation work may be carried out by households but is not a necessary requirement. If the property is an apartment, then it is not compulsory to change the heating system. The property must be at least 15 years old and be occupied as a main residence. All recipients can also take advantage of the additional advice (Mon Accompagnateur Rénov').

This program supports those homeowners who fall into the categories very low (they call it very modest), low (modest), and intermediate income. Higher income households are not eligible. Financial support for heating technologies is given as a fixed amount, e.g. support for an air/water heat pump is at 3.000 Euro for intermediate income households and 5.000 Euro for households with very low (very modest) income. For thermal insulation fixed amount of funding is offered by square meter and differs by kind of measures and again by income group.

[19] Compared to the German funding program for efficient building which provided about 17.7 billion Euros of funding for efficiency renovation in the residential sector in 2022 and achieved about 14 700 GWh of final energy savings in 680 000 funding cases (i.e on average 21 MWh per case), the French program is of substantially smaller size. However, only about 4% of the applicants in Germany were households with very low income (net income up to 24 000 Euros p.a.). For information on the Germany program see Heinrich et al. (2024).

From July 2024 all properties with an energy label F or G, the worst-performing buildings, will be re-directed to the MaPrimeRénov' Parcours for their energy renovations, meaning they will have to carry out more comprehensive renovations.

MaPrimeRénov' Parcours (pour une rénovation d'ampleur = major renovation)

The MaPrimeRénov' Parcours program supports households undertaking more ambitious renovations. The renovations must lead to an increase of at least two energy efficiency classes[20], must include at least two different types of insulation work, and the program does not support the installation of fossil-fuel heating systems (existing oil or coal-based heating systems must be replaced as well). An energy audit carried out at the beginning of the project serves as the basis for assessment. Renovations may be carried out in two steps over a period of max. 5 years if the building was initially classed as G, F, or E. In this instance, it is a requirement that households take advantage of the case officer through Mon Accompagnateur Rénov'.

The grant is calculated as a percentage of total costs of the eligible work. A 10 % bonus is applied to those buildings of energy label of F or G that reach an energy label D after the work is completed. The aid can be combined with other support programs[21] but is capped for all household groups except for those on very low-income as per the table below.

In some regions a "Territories of Zero Energy Exclusion" has been set up. In these regions the additional funding that households have to provide themselves is covered by this program.

Table 5: Level of funding provided based on income group

<table>
<tr><th></th><th>Max. expenditure (excl. VAT) per unit</th><th>Very low income</th><th>Low income</th><th>Middle income</th><th>High income</th></tr>
<tr><td>Gain of 2 energy classes</td><td>40,000 €</td><td rowspan="3">80 %</td><td rowspan="3">60 %</td><td>45 %</td><td>30 %</td></tr>
<tr><td>Gain of 3 energy classes</td><td>55,000 €</td><td rowspan="2">50 %</td><td rowspan="2">35 %</td></tr>
<tr><td>Gain of 4 energy classes</td><td>70,000 €</td></tr>
<tr><td colspan="2">WPB bonus</td><td colspan="4">+10 %</td></tr>
<tr><td colspan="2">Cap of funding</td><td>100 %</td><td>80 %</td><td>60 %</td><td>40 %</td></tr>
</table>

Source: Republique Francaise (2024b). Please note: Households with low or very low income can receive an advance of up to 70% fot he amount of their grant before carrying out the work.

A comparison to current funding schemes in Germany for efficient buildings is available in Section 4.1.3.

20 The program does not specify the percentage of energy savings, only the jump between energy efficiency classes. When looking at the energy efficiency bands, the lower the initial energy efficiency class the higher the energy efficiency gains need to be to move between bands. For example, to move from Class F to D energy efficiency must improve by around 50 % if the building is on the lower end of the F-band; if the building is on the higher spectrum of the F band energy efficiency gains of 30 % are necessary to improve to band D.

21 See https://france-renov.gouv.fr/ for an overview.

4.1.2 Support for landlords

MaPrimeRénov' and MaPrimeRénov' Parcour

Landlords may also take advantage of the MaPrimeRénov' and MaPrimeRénov' Parcour programs under the condition that they rent out the property for at least six years otherwise grants received must be repaid for each year not let.

During the evaluation period 2020-2022 (Republique Francaise 2023), around 15.500 and another 4.100 homes owned by landlords received funding from the MaPrimeRénov' and Habiter Mieux programs respectively. In total 136 million EUR in funding was provided by the two programs. 39 % of landlord recipients from the MaPrimeRénov' Program had very low income. The majority of recipients renovated houses (81 %) rather than apartments (19 %).

Loc'Avantages

Loc'Avantages is another funding scheme within the FranceRénov' program (for an overview of schemes within the FranceRénov' program compare Annex A). Loc'Avantages offers a tax reduction on the gross income from the rented property for landlords that rent their properties to tenants with low income Various types of renovations are possible as coordinated by ANAH. Landlords benefit from a tax reduction calculated on the gross income from the rented property (from 15 % to 65 %), depending on the rent charged and other factors, such as the use of a rental intermediation scheme. For energy efficiency work 25 % of the total cost (max 15.000 Euro) is covered provided the thermal performance increases by 35 % and achieves at least an energy level of D. They must also use the designated case officer through the Mon Accompagnateur Rénov' scheme. The program can be combined with other grants up to the cap outlined in Table 5.

Landlords are obligated to rent out their property to a tenant with low income, cap their rents based on local rent ceilings and sign a commitment agreement with ANAH setting out the terms and conditions of the tenancy.

Between 2020-2022 annual energy savings of 23 MWh/a were attributed to the Loc'Avantages program (Republique Francaise 2023). Around 10,000 agreements were signed under this program in 2022 (ONPE 2023). In half of the properties energy renovations have already taken place. The majority of these were financed through the MaPrimeRénov' Serenite program. On average, 63.000 Euro were invested per home delivering average energy savings of 64 %. Of all the homes that received funding, three quarters were rated in the energy efficiency bands F or G prior to the work done and no homes remained in these two energy efficiency bands once the work was completed.

Denormandie

This scheme offers tax reductions for landlords in 222 participating towns[22] in France who carry out renovations on their properties.

They must rent out their property on a long-term basis (6, 9 or 12 years). Renovations must result in energy performance improvements of at least 30 % and include at least two of the following types of work: change of boiler, thermal insulation of attic spaces, changes in the hot water production system, thermal insulation of windows. After the work is carried out that building must have an energy class of at least E. Rents of these dwellings are then capped.

[22] Those covered by the Action Coeur de Ville Plan. These are towns where the need for housing renovation is particularly acute, and which have signed an agreement to revitalize the area.

4.1.3 Zero-rate eco loan

Both owner occupiers and landlords with no means to finance energy efficiency improvements can make use of a zero-interest loan. It aims to finance the remaining cost of energy-efficient renovation work eligible for the MaPrimeRénov' program. The zero-interest loan can be up to 50,000 Euros to finance the outstanding costs after taking into account the amount of MaPrimeRénov' assistance. The loan can be repaid over a period of up to 20 years. The loan also simplifies the process from the applicant's bank. The MaPrimeRénov' notification is sufficient proof for the bank which will then analyse the repayment capacity.

4.2 Grants and funding needs in Germany for full refurbishment based on MaPriméRénov' approach

Currently, funding for energy efficiency refurbishment in Germany is available through the federal funding scheme for efficient buildings. The program includes funding for individual measures, e.g. floor or roof insulation, heating replacement, and full energetic refurbishment. At the beginning of 2024, a program for heating replacements was introduced that for the first time in Germany provides socially differentiated funding in buildings energy performance. Next to a basic funding rate of 30% of eligible expenditure, an additional bonus of 30% is available for owner-occupied homes with low or lower-middle income, i.e. a taxable income up to 40,000 EUR per year. Owner-occupiers can also apply for a speed bonus if they replace old and inefficient heating (plus 20%). Funding for heating replacement is capped at 70% of eligible expenditure.[23]

For full refurbishment or other individual measures, there is no comparable socially differentiated funding scheme. Funding for full refurbishment differs by the aspired energy efficiency class, e.g. funding up to 35% of eligible expenditure is possible for reaching very efficient standards (energy efficiency class A – German EH 40 standard) including a 10% bonus if the building is a worst-performing building, and up to 25% for efficiency standard B/C (German EH-70 standard), also including the 10% worst-performing building bonus. Funding is provided in form of a repayment reduction for loans. The maximum amount of loan eligible for receiving the repayment reduction is at 120.000 Euros per unit and 150.000 per unit if renewable heating is installed and sustainability standards are met[24]. The maximum repayment reduction for reaching efficiency class B/C (German EH-70 standard) for a worst-performing building is thus 37.500 Euros.

Evaluations show that in the past, the German funding program for efficient buildings was primarily used by households with higher income, in particular for full refurbishments (Loga et al. 2015; Braungardt et al. 2023). Low-income households rarely made use of the program and if so, only for individual, less expensive measures. Thus, the majority of the funding budget went to higher income households meaning that currently the funding scheme is socially imbalanced.

Reasons for low uptake of funding for low-income households include the following:

- Despite the funding, low-income households might still lack sufficient resources or access to financing options to conduct energetic refurbishment of their buildings. Full refurbishment, in particular, is associated with substantial upfront costs meaning households need to have existing financial resources to benefit from this scheme – even though these costs over time will too a large part of fully be balanced out due to reduced energy costs. Socially differentiated funding and higher funding rates, as in the MaPriméRénov' program, together

[23] Eligible expenditure is capped at 30.000 Euros for heating replacement in single/two-family houses and in multi-family buildings at 30.000 Euro for the first unit, 15.000 Euros each for the 2nd to 6th unit and 8.000 Euros for every additional unit.

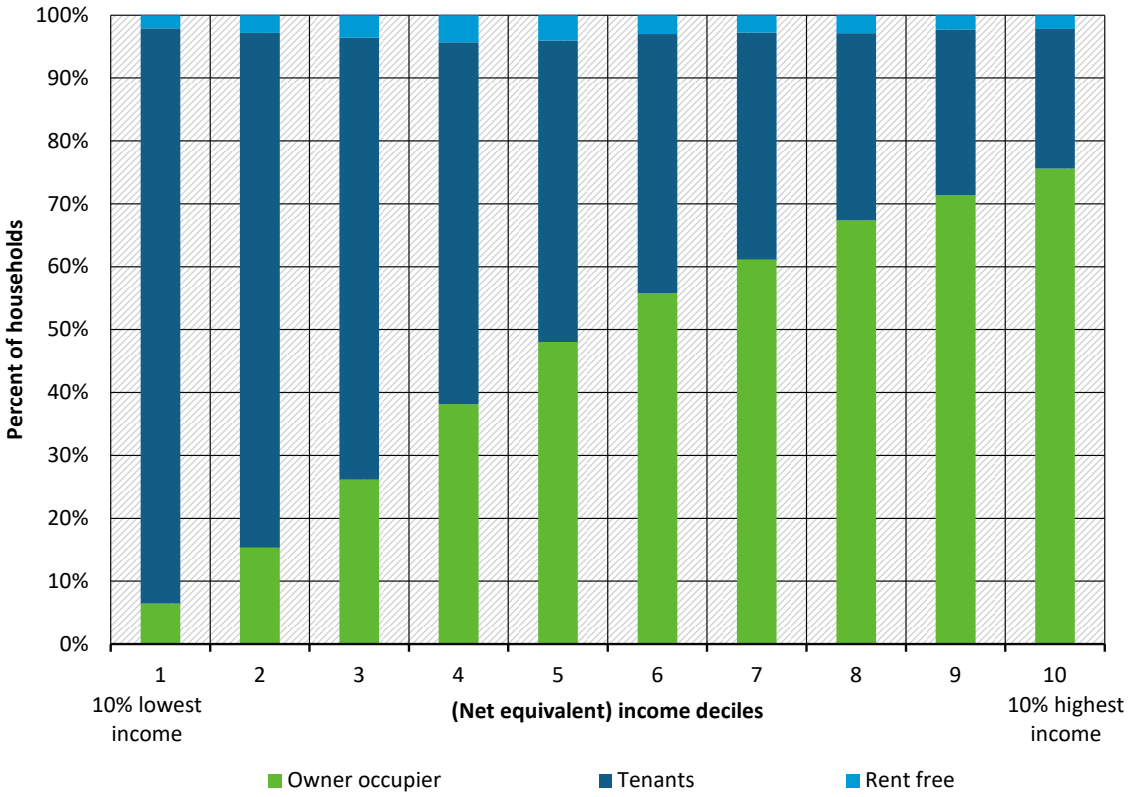
[24] https://www.kfw.de/inlandsfoerderung/Bundesförderung-für-effiziente-Gebäude/

with zero-interest loans for the remaining costs, addresses this barrier as it lowers the upfront capital need for lower income households. Especially the implementation of a case officer (Mon Accompagnateur Rénov') that supports households with grant applications, advice, and information, such as individual refurbishment plans, progress monitoring and more, provides important support to low-income households. No such socially differentiated program for full refurbishment or other individual measures than heating replacement exits in Germany.

- Low-income households in Germany live primarily in rented apartments in multi-family buildings. About 90% of the lowest income decile live in rented apartments whereas in the highest income group only about 25% are tenant households, compare Figure 17. Overall, about 54% of the total 40 million households in Germany live in rented apartments or houses. Tenants, however, do not have an influence on the energy efficiency level of the building they live in. It is up to landlords to take on investment and funding to improve the building. In Germany, landlords can increase rents by 8% of the (energetic) modernisation costs per year to refinance their investment. Public funding needs to be deducted from the modernisation costs before calculating the rent increase. At the same time, tenants benefit from the reduced energy costs. Studies show that the current policy instruments in Germany are not yet able to resolve the tenant-landlord dilemma as the incentives for landlords still do not coincide with favourable decisions for tenants (see for example Cludius et al. 2024)

With low-income households primarily living in rented apartments it is thus important to address landlords to conduct refurbishments. To keep the rent increase manageable, it is equally important to incentivize landlords to make use of the funding programs. The current German funding scheme for full refurbishment is open to landlords and owner-occupiers. However, it does not differentiate by income of owners or tenants. Moreover, landlords often do not make use of funding programs because in many regions rents can be increased more according to market rates without the restriction on rent increase that the use of public funding brings about. It is thus important to design a socially differentiated funding approach for landlords that ensures that rent increases are kept low for vulnerable households after refurbishment (Cludius et al. 2024; Burger et al. 2022; Schumacher et al. 2024b).

Figure 17: Owner status of households in Germany by income (total 40 million households)



Source: Calculation based on Oeko-Institut's SEEK model using the German Income and Expenditure Survey (EVS 2018) of the German Statistical Offices.

Socially differentiated funding schemes not only provide incentives and support for vulnerable groups or for landlords renting to vulnerable groups to conduct efficiency improvements but also keep the overall funding budget in check. To ensure a just transition for everybody, public resources will need to be allocated in a way to make sure they (also) reach those groups that most need support.

To get a better understanding of who would need to be included in a socially differentiated funding program for buildings energy retrofit in Germany and how much funding would be needed in such a socially differentiated program, we conduct an assessment inspired by the French example.

We separate owner-occupier households in single/two-family houses from tenant households in multi-family buildings because of their different situations. Also, energy refurbishment costs differ substantially between single/two-family houses and multi-family buildings. Table 6 provides an overview of the number of vulnerable households in each category and the total living space these households occupy. It confirms that a much larger number of vulnerable households lives in multi-family houses. Depending on the indicator, the number is three to ten times as high compared to vulnerable households in single/two family houses. The table also implicitly reveals the much larger per household-living space in single/two-family houses, e.g. for indicator 1a living space per vulnerable household in multi-family buildings is on average at 64 sqm whereas it is on average at 99 sqm in single/two family houses.

Table 6: Vulnerable households in owner-occupied single/two-family houses and in apartments in multi-family buildings

Vulnerability indicator (see chapter 3.2)	Vulnerable households in multi-family buildings		Vulnerable owner-occupiers in single/two family houses	
	Number of households	Living space of (sqm)	Number of households	Living space of (sqm)
Indicator 1: *Absolute* low income (1a)/savings (1b), relative high energy expenditure and low energy efficiency (WPB)				
1a (WPB)	2 203 087	140 261 824	635 744	62 914 242
1b (WPB)	1 396 790	90 482 698	463 896	49 693 229
Indicator 2: In comparison to median low income and high energy expenditure (+ low energy efficiency = WPB)				
2a	2 688 751	171 523 637	356 355	36 207 529
2b	4 514 521	281 481 370	473 605	48 328 796
2c (WPB)	1 379 386	76 194 498	169 070	14 795 386
Indicator 3: Absolute low income combined with EPOV indicators (expenditure-based and self-reporting)				
3a	2 351 793	149 613 390	360 682	42 636 785
3b	1 420 370	n.a.	133 020	n.a.
Indicator 4: Absolute income threshold only (+ low energy efficiency = WPB)				
4a	8 669 674	569 296 429	1 375 666	147 001 376
4a WPB	1 993 889	117 414 652	334 482	30 332 683
4b	11 923 245	805 045 745	4 344 876	517 363 558
4b WPB	2 701 683	163 058 347	795 890	80 172 722

Source: Calculation based on Oeko-Institut's SEEK model using the German Income and Expenditure Survey (EVS 2018) of the German Statistical Offices. Values are provided for the year 2023. Data on living space is not available in combination with the self-reported indicator on the inability to keep home warm (3b). For detailed information on the indicators see chapter 3.2.

In the following, we calculate investment costs, funding needs and energy savings that would occur if vulnerable households' homes would be energetically retrofitted through a socially differentiated funding scheme. The calculations are based on assumptions for two typical building types and their main characteristics as provided in Table 7.

Table 7: Assumptions on main characteristics of two typical building types in Germany

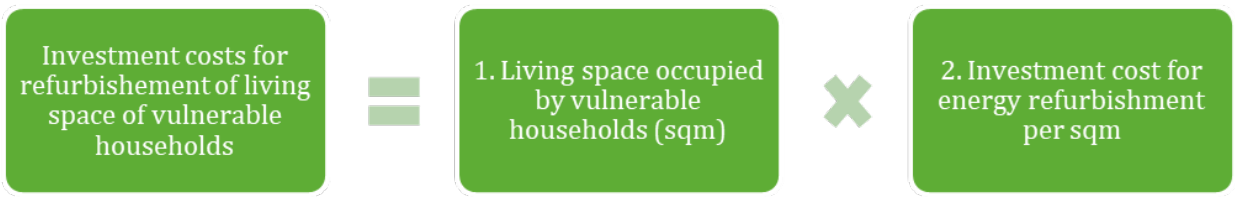
Typical building	Multi-family building (6 units)	Single family house
Built in year	1969 to 1978	1958 to 1968
Assumptions on initial state before energy retrofit		
Heating technology	Natural gas based boiler	
Efficiency class (final energy consumption)	F and worse	F and worse
Assumptions for energy retrofit to improve energy efficiency by at least two efficiency classes to the Germany efficiency house standard EH 70		
Heating technology	Heat pump (air/water)	
Total investment cost (heating technology and insulation)	606 EUR(2022)/sqm living space	1 265 EUR(2022)/sqm living space
thereof energy refurbishment related costs	221 EUR(2022)/sqm living space	489 EUR(2022)/sqm living space
Final energy use (EH 70)	About 77 kWh/sqm living space per year, thereof 49 kWh/sqm ambient heat and 27 kWh/sqm electricity	104 kWh/sqm living space per year, thereof 67 kWh/sqm ambient heat and 37 kWh/sqm electricity

Source: Loga et al. (2015), Hinz (2015), BKI (2023), BBSR - Bundesinstitut für Bau-, Stadt- und Raumforschung 2017 (2017), Stuible et al. (2017). For more information see Schumacher et al. (2024a) which uses the same sources of information.

4.2.1 Investment costs

For each of the vulnerability indicator described and quantified in Chapter 3.2 and summarized in Table 6, investment needs are calculated and shown in Table 8. We derive the total amount of investment that would be needed to refurbish the entire living space of vulnerable households, see Figure 18. For one and two-family houses this corresponds to the number of buildings that would need retrofitting. For multi-family houses, it does not correspond to the number of buildings as buildings might be occupied by vulnerable households along other households. If investment costs for all multi-family buildings that are inhabited by at least one vulnerable household were to be calculated, the amount would be substantially higher. Our approach might be a restriction as it does not show the total amount of investment needed to refurbish all buildings occupied by vulnerable households. However, our focus is to look at vulnerable households only. Other households might be able to carry out investments or absorb higher rent that might accompany a refurbishment. We aim to avoid mixing their costs with those of vulnerable households.

Figure 18: Calculation of investment needs for energy refurbishment of vulnerable households



Source: Own illustration, Oeko-Institut

As vulnerable households primarily live in rented apartments, it will be up to landlords to undertake the investment. We do not assess whether landlords are of low income or are vulnerable according to our indicators which would give an additional indication for socially differentiated fundings scheme as in the French example. Currently, low income landlords can make use of the German funding program for efficient buildings only in the same way as higher income households.

Table 8 also shows the average annual investment needs if all apartments of vulnerable households were to be retrofitted within the next 8 years until the year 2032. We choose the year 2032 as this corresponds to period of the Social Climate Fund. It is considered highly ambitious to refurbish all units of vulnerable households within the next eight years. The calculation aims to give an indication of the investment needs, it is not supposed to be a projection based on empirical evidence. To assess the annual costs of a refurbishment if all vulnerable households were to be energetically refurbished over the next 21 years, i.e. by the year of Germanys target for climate neutrality in 20245, total investment costs would need to be divided by 21.

If all investment were to be done by 2032, annual investment needs for households in multi-family buildings range from 6 billion EUR per year for indicator 2c (low income compared to median, high relative energy expenditure compared to median and low energy efficiency) to about 21 billion EUR for indicator 2b (equivalized relative fossil fuel energy expenditures above the national median and less than 60 % of equivalized median income after expenditures). For households in single/two family homes the range ist from 2 billion EUR per year for indicator 2c to 13 billion EUR per year for indicator 4bWPB (taxable income up to 40,000 EUR and proxy for WPB). We leave out the mere income based indicators as they do not reflect high energy expenses or low energy efficiency and thus might include households that are not in need of energy retrofit.

Focussing on the Indicators 1a, 2a, 3a, 4a WPB and 4b WPB which are based on a similar problem understanding of vulnerability and include low income and high energy expenditure/low energy efficiency (or extraordinary low energy expenditure), we take the average over these indicators and arrive at average investment costs for vulnerable households:

- in multi-family units of about **90 billion EUR** to retrofit all units and an average of 11 billion EUR per year if retrofits were happening over a span of 8 years until 2032.
- in single/two family homes of about **64 billion EUR** to retrofit all units and an average of 8 billion EUR per year if retrofits were happening over a span of 8 years until 2032.

Table 8: Investment needs for energy retrofit for vulnerable households in owner-occupied single/two-family houses and in apartments in multi-family buildings until 2032

Vulnerability indicator (see chapter 3.2)	Vulnerable households in multi-family buildings		Vulnerable owner-occupiers in single/two family houses	
	Investment cost Billion EUR	Investment cost Billion EUR per year (split over 8 years: until 2032)	Investment cost Billion EUR	Investment cost Billion EUR per year (split over 8 years: until 2032)
Indicator 1: *Absolute* low income (1a)/savings (1b), relative high energy expenditure and low energy efficiency (WPB)				
1a (WPB)	85	11	80	10
1b (WPB)	55	7	63	8
Indicator 2: In comparison to median low income and high absolute (2a)/relative (2b) energy expenditure (+ low energy efficiency = WPB)				
2a	104	13	46	6
2b	171	21	61	8
2c (WPB)	46	6	19	2
Indicator 3: Absolute low income combined with EPOV indicators (hidden energy poverty expenditure-based)				
3a	91	11	54	7
Indicator 4: Absolute income threshold only – decile 1-3 (4a), low/medium taxable income (4b) (+ low energy efficiency = WPB)				
4a	345	43	186	23
4a WPB	71	9	38	5
4b	488	61	654	82
4b WPB	99	12	101	13

Source: Calculation based on assumptions and calculations as laid out in previous tables and sections (Oeko-Institut). For detailed information on the indicators see chapter 3.2.

4.2.2 Funding needs

Next, we calculate the funding need for such a program inspired by the example of the French MaPriméRénov' program. The French program applies socially differentiated funding rates based on income and on the energy efficiency gain achieved as outlined in Table 5. We simplify the analysis and classify all households within our vulnerability indicators as very low-income households and assume that they gain three efficiency classes by improving to the Germany efficiency house 70 standards (corresponds to about class B/C). We apply a high funding rate of 80% (see Table 5) to exemplify the funding needs for such a case.

In a first step we calculate the funding need that arises if units of vulnerable tenants in multi-family houses and vulnerable owner-occupied single/two family households were to be retrofitted. In this step, we do not yet take into account the maximum retrofit spending that is

foreseen in the French program. Our calculations reveal the French spending ceiling is only reached for single/two family units. Units in multi-family houses are generally below the ceiling.[25] In a second step, we then calculate fundings needs taking the ceiling into consideration.

In accordance with investment costs as shown in Table 8, funding needs differ by indicator because of the number of households and square meters of living space of the identified group. The single, mere income-based indicators yield the largest number of households to be vulnerable and would thus require the largest amount of funding. However, as it does not account for any energy related component, it might include households with low energy costs, and households who might already live in efficient buildings. We therefore do not give those merely income-based indicators further attention.

Combining the income-based indicators with high energy consumption as a proxy for worst performing buildings (4a WPB and 4b WPB) reveals total funding needs in the range of 57 to 79 billion EUR for units in multi-family homes, assuming a 80% funding rate, or 7 to 10 billion EUR per year assuming retrofit of all units of vulnerable households to take place within the next eight years up to 2032. Within this range are also Indicator 1a (households with high energy expenditure, very high energy consumption per sqm and within first five income deciles) and Indicator 3a (absolute low income and underspending on energy).

Applying the same funding rate to retrofits of vulnerable owner-occupiers in single/two-family houses yields total funding needs ranging from 15 to 81 EUR if the entire living space of vulnerable households were to be refurbished and supported with a funding rate of 80%. This corresponds to 1.9 to 10.1 billion EUR per year. Again, we leave aside the mere income-based indicators 4a and 4b.

Focussing on the Indicators 1a, 2a, 3a, 4a WPB and 4b WPB which are based on a similar problem understanding of vulnerability and include low income and high energy expenditure/low energy efficiency (or extraordinary low energy expenditure), and taking the average of these indicators, we arrive at funding needs for refurbishing vulnerable households' units

- in multi-family buildings of about 72 billion EUR to refurbish the entire living space of vulnerable households or 9 billion EUR per year over a span of eight years up to 2032;
- in single/two family homes of about 51 billion EUR to refurbish all houses of vulnerable households or 6.4 billion EUR per year over a span of eight years up to 2032.

[25] This applies to the French maximum expenditure ceiling of 55.000 EUR (net) per unit for a gain of three efficiency classes. The German expenditure ceiling is more generous with up to 150.000 EUR loan value per unit (compare beginning of chapter 4.1.3) and is not reached for units in either single/two family houses or multi-family houses.

Table 9: Funding need for energy retrofit inspired by the French MaPrimeRenov programm, assuming a funding rate of 80% for very low income (= vulnerable households)

Vulnerability indicator (see chapter 3.2)	Vulnerable households in multi-family buildings		Vulnerable owner-occupiers in single/two family houses	
	Funding need Billion EUR	Funding need Billion EUR per year (split over 8 years: up to 2032)	Funding need Billion EUR	Funding need Billion EUR per year (split over 8 years: up to 2032)
Indicator 1: *Absolute* low income (1a)/savings (1b), relative high energy expenditure and low energy efficiency (WPB)				
1a (WPB)	68.0	8.5	63.7	8.0
1b (WPB)	43.9	5.5	50.3	6.3
Indicator 2: In comparison to median low income and high energy expenditure (+ low energy efficiency = WPB)				
2a	83.2	10.4	36.6	4.6
2b	136.5	17.1	48.9	6.1
2c (WPB)	37.0	4.6	15.0	1.9
Indicator 3: Absolute low income combined with EPOV indicators (hidden energy poverty expenditure-based)				
3a	72.6	9.1	43.1	5.4
Indicator 4: Absolute income threshold only – decile 1-3 (4a), low/medium taxable income (4b) (+ low energy efficiency = WPB)				
4a	276.2	34.5	148.8	18.6
4a WPB	57.0	7.1	30.7	3.8
4b	390.5	48.8	523.5	65.4
4b WPB	79.1	9.9	81.1	10.1

Source: Calculation based on assumptions and calculations as laid out in previous tables and sections (Oeko-Institut). Only households with fossil fuel or direct electric heating are taken into consideration. For detailed information on the indicators see chapter 3.2.

Funding need with maximum expenditure ceiling

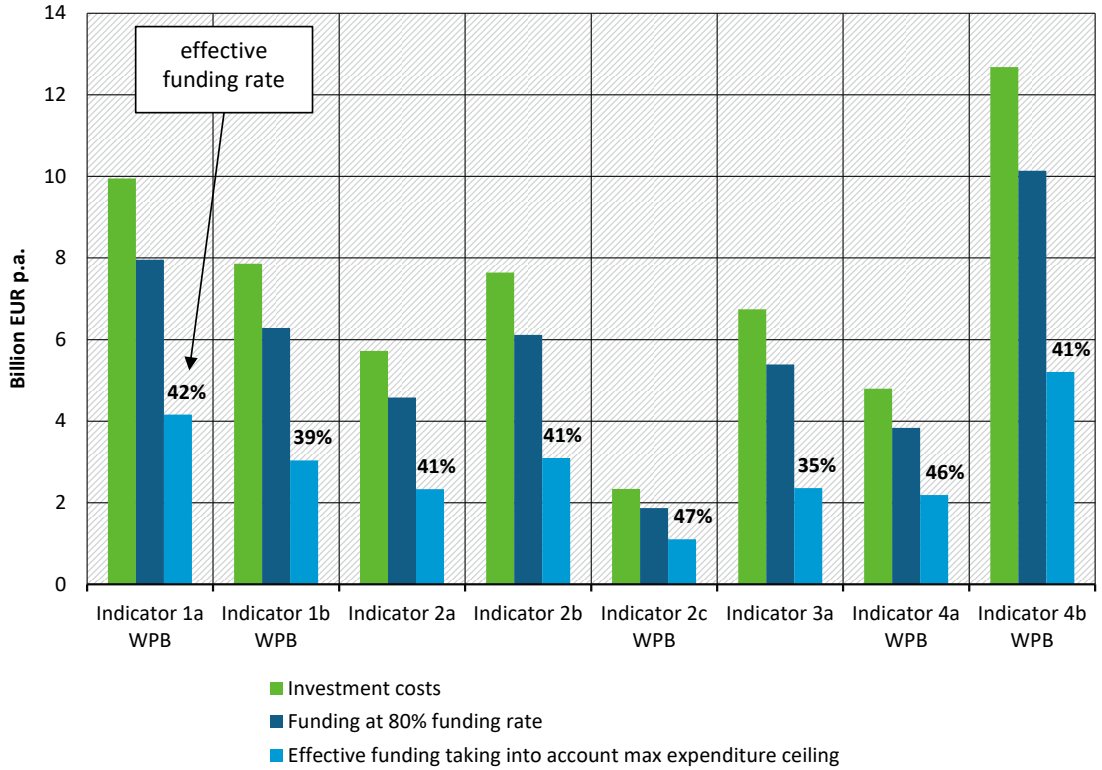
The calculations so far were done without reflecting the maximum expenditure level that funding can be granted for in the French Program. Our assessment, however, reveals that investment costs for retrofitting single/two-family houses usually exceeds the French expenditure ceiling (see Footnote 25). Thus, to be in line with the French MaPrimeRenov Program we cannot assume that the entire funding with an 80% funding rate can be acquired for vulnerable households. In the following calculation, we therefore restrict the amount of funding to the maximum level based of the expenditure ceiling, i. e. 55.000 EUR (net) per unit as shown in Table 5[26]. The results are shown in Figure 19 comparing investment costs, funding with 80%

[26] Adding value added tax, this corresponds to a ceiling of 65,450 EUR. Applying a funding rate of 80% thus funding of 52,360 EUR (gross) per unit can be acquired for refurbishment.

funding rate and funding according to the French expenditure ceiling. The figure also shows the effective funding rate when applying the ceiling. It turns out that for single/two-family houses the expenditure cap translates into effective funding rates of 35% to 42% for vulnerable households.[27] Funding needs for the combined indicators, excluding the mere income-based indicators 4a and 4b, then range from 1.1 (Indicator 2c) to 5.2 billion EUR per year (Indicator 4b WPB).

Taking into account the expenditure ceiling and again focussing on the average of indicators 1a WPB, 2a, 3a, 4a WPB and 4b WPB which are based on a similar problem understanding of vulnerability, we arrive at funding needs for refurbishing vulnerable households' units in single/two family homes of about 3.3 billion EUR per year over a span of eight years until 2032.

Figure 19: Investment cost and funding for vulnerable owner-occupiers in single/two family houses – with and without ceiling on max. expenditure (gain of three energy classes)



Source: Calculation based on assumptions and calculations as laid out in previous tables and sections (Oeko-Institut). In particular, taking into account the expenditure ceiling in the French program of 55,000 EUR (net), compare Table 5. Mere income-based indicators 4a and 4b are not shown. Only households with fossil fuel or direct electric heating are taken into consideration.

[27] This shows the need for additional target group specific financing solutions, because despite the higher funding rate households still need to make own complementary resources available to do the renovation work. These additional own resources might be a challenge. Various studies, for example Czylwik et al. (2023), discuss options to fill this gap for low income households, e.g. specific energy savings loans, energy mortgages or default guarantee provided by the government. In Germany, currently, households with taxable income below 90,000 EUR per year who receive funding through the national program for efficient buildings can apply for low interest supplementary loan (KfW-Kredit Nr.358, 359). However, innovative financial solutions beyond government funding are urgently needed to secure financing of the energy transition of buildings.

Note: Indicator 1a/b WPB = Absolute low income/savings, relative high energy expenditure and low energy efficiency; Indicator 2a/b/c = In comparison to median low income and high energy expenditure (Indicator 2c plus WPB = low energy efficiency); Indicator 3a/b = Absolute low income combined with EPOV indicators (expenditure-based and self-reporting), Indicator 4a/b = Absolute income threshold (decile 1 to 3 and low taxable income plus WPB = low energy efficiency), for detailed information see chapter 3.2.

Funding for such a socially differentiated program might come from the existing German funding program for efficient buildings, which provides the same funding rate to all building owners regardless of income. To reach the energy efficiency standard B/C as applied in our calculations, a 25% funding rate is available if the worst-performing buildings are refurbished. In 2023, 16 billion EUR were made available through the program for efficient buildings in Germany, covering heating replacement, individual refurbishment measures, and full refurbishment to different standards. So far, the funding program has mostly been used by higher-income households in owner-occupied single/two-family houses. It could be restructured without additional budget needs to a socially differentiated funding program which specifically supports vulnerable households while still providing funding for households with medium or higher income.

Specifically for vulnerable households, funding for efficiency improvement might also come from the Social Climate Fund. However, comparing the funding need calculated in this study to the funding available for Germany within the Social Climate Fund shows it will not be sufficient. The volume available to Germany through the Social Climate Fund amounts to 5.3 billion EUR for 2026 to 2032. With the required national co-financing, it will total 7.1 billion EUR, roughly 1 billion EUR per year. Restructuring the current funding program for efficient buildings or using additional ETS2 revenues will be required to finance the socially differentiated energy-efficient buildings program.

4.2.3 Energy savings

The calculations on funding needs were based on the case of a gain of at least three energy classes. In the French example, depending on the energy consumption within an energy class before retrofit, this corresponds roughly to 30 to 50% energy savings (compare Footnote 20). Currently, in Germany funding is not coupled to a minimum efficiency gain. Rather funding rates differ by the targeted efficiency class after retrofit, independent of the initial state. A bonus of 10% is added to the funding if a worst-performing building is retrofitted in Germany.

Energy cost savings can only be roughly assessed. This is because assumptions need to be taken on price developments, no fuel type differentiated information on energy consumption is available for vulnerable households, and specific savings depend on retrofit and behavioural changes. For the example buildings, considered in our analysis (compare Table 7), we assume that the units in multi-family houses can save about 100 kWh/sqm per year by gaining three energy classes through retrofit and units in single/two-family homes about 150 kWh/sqm per year. This reflects current energy consumption of the example building and energy consumption after retrofit that our analysis of investment costs and funding needs is based on (Table 7). We further assume that natural gas prices remain at about 12 ct/kWh in the future, electricity prices for heat pumps at about 34 ct/kWh and heat pumps have an annual performance rate of 2.8 (indicating the relationship of electricity use to produced energy=heat).

After refurbishment of the entire living space of vulnerable households, we estimate a range of energy cost savings for vulnerable households in multi-family units from 1 billion EUR per year for Indicator 2c to 3.6 billion EUR per year for Indicator 2b, and for vulnerable households in single/two-family houses from 0.3 billion EUR per year for Indicator 2c to 1.5 billion EUR per year for Indicator 4b WPB.

Given the assumptions above and focussing again on the average of the combined Indicators 1a, 2a, 3a, 4a WPB and 4b WPB which are based on a similar problem understanding of vulnerability, we conclude for energy cost savings after retrofitting all vulnerable households' units on average

- about **2 billion EUR** energy cost savings per year in multi-family houses, corresponding to savings of about 830 EUR or about 60% of heating costs per year per household,
- about **0.9 billion EUR** energy cost savings per year in single/two family homes corresponding to savings of about 1,880 EUR or 60% of heating costs per year per household.

It is important to note that energy cost savings occur annually over the lifetime of the technology or investment cycle. Heating technology can be assumed to have a lifetime of 25 years, building envelop retrofits a lifetime of 40 years. Given our assumptions on energy prices and taking an average of heating technology and envelop lifetime of 35 years, cumulative lifetime cost savings without any discounting for the average across the more similar combined indicators 1a, 2a, 3a, 4a WPB and 4b WPB amount to

- at **69 billion EUR lifetime energy cost savings** for vulnerable households in multi-family buildings or about 29,000 EUR per household and
- at **33 billion EUR lifetime energy cost savings** for vulnerable homeowners of single/two family houses corresponding to about 66,000 EUR per household.

Because of the rather restrictive and uncertain assumptions based on two typical example buildings in Germany, the calculations can only be considered rough and indicative estimates that need further and more detailed research and should be treated as such.

5 Insights and conclusions

As the overview of EU-level regulations and directives has shown, there is a need to focus on vulnerable groups to ensure that the "leave no one behind" principle is honoured. It is particularly important to avoid carbon lock-ins as these will further exacerbate existing social inequalities in the housing sector. Socially balanced climate policy will need to support households through measures and investments to reduce reliance on fossil fuels and increase energy efficiency. Direct income support to reduce the impact of climate policy is not sufficient and should only be used as a temporary measure until households are able to transition to carbon-free technologies. Providing support for larger renovation measures and the decarbonisation of heating is key to building resilience and fostering and inclusive energy transition.

In Germany, there are currently next to no targeted programs in place that can provide this level of support to vulnerable groups. This is accompanied by a lack of definition of vulnerability or energy poverty and of indicators to capture the phenomenon. Not only do the EU directions require support to be put in place for vulnerable households, a definition and indicators are needed to set a political agenda in this arena, identify the group of affected households, target measures effectively, and monitor progress. In this paper we have taken a significant step towards providing a workable indicator of vulnerability in Germany.

Purpose of vulnerability indicators

When identifying vulnerable groups via indicators it is important to differentiate between the use and purpose of an indicator. Indicators can estimate the size of the affected group, provide insights into how much funding is needed to target the group, or act as proof of eligibility. The indicators covered here primarily fulfil the first and second purpose giving an indication of the size of the issues and providing some indication of the funding needed to support this target group. Such complex indicators are however not useful when it comes to households themselves needing to prove their eligibility for receiving support measures, which is usually done only via income statements (see Indicator 4a and 4b above).

In this study, we have analysed four indicator groups with a total of 11 variations and found that a number of indicators that combine the three main causes of energy poverty, i.e. low income, high energy expenditure and low energy efficiency, arrive at a comparable number of vulnerable households. Based on these findings, we identify about 3 million households in Germany, corresponding to about 10% of households, to be vulnerable with respect to increasing fossil energy or CO_2 prices from the EU ETS2. More than 80 % of these vulnerable households live in multi-family buildings, almost all of them as tenants. It should be noted that in this study, we consider only households using fossil fuel based heating or direct electric heating. These households make up about 75 % of all households in Germany. We only look at vulnerability with respect to fossil heating costs and do not consider potentially vulnerability with respect to electricity or mobility needs. The study can thus be seen in light of the Social Climate Fund which addresses households in energy and transport poverty or vulnerable households and transport users. Energy poverty is also addressed in the EU Energy Efficiency Directive and along vulnerability also in the Energy Performance of Buildings Directive.

Recommendations for vulnerability indicators in this study

We recommend for the purposes of a) estimating the size of the affected group, b) providing insights into how much funding is needed to target the group, and c) monitoring the target group to use Indicator 1a or 4b WPB. Indicator 1a combines low income (decile 1 to 5), high fossil energy expenditure (more than twice the median), and very low building efficiency (here

approximated by very high heating energy consumption per sqm - see Box 2). Indicator 4b WPB is based on a combination of taxable income below 40,000 EUR and very low building energy efficiency. Both indicators are straightforward and do not need additional complex calculations steps. Data on income and energy spending can be derived from the national statistics and tax office. Data on structural energy efficiency is currently still more complex to assess as there is no register for energy efficiency certificates in Germany and many households still have no energy certificates. In our study, we use a proxy of energy consumption per sqm based on microdata calculations. It is foreseen, however, that a detailed register on building energy efficiency in Germany will be established in the near future which would then be a source of information[28]. In our study, we focus on households with very low building energy efficiency, i.e. we develop the proxy to reflect on worst performing buildings. It can be argued that not only households in buildings with very low (class F and worse) but also in buildings with low energy efficiency (class D or E) can be highly affected by high energy prices and subsequent high energy expenditure. It might thus be considered to include those into the group of vulnerable households.

With respect to proving eligibility, we recommend indicator 4b WPB, i.e. the combination of low taxable income and very low energy efficiency. Households can use their tax returns or other income statements as proof of income. If households receive social transfer payments this can be used as a proof as well. In addition, households would need to show their energy certificates. While these are still being established, they could use their energy bills as proof instead. Energy bills issued by landlords for tenants state the amount of energy consumed plus the size of living space. This can be used to derive energy consumption per square meter and would serve as a proxy for energy efficiency of the unit they live in. Alternatively, households can proof that their building qualifies for the worst performing building bonus in the federal funding program for efficient buildings. This requires the building to be built before the year 1957 and if more than 75 % of the outside wall is not energetically refurbished.[29]

A socially differentiated efficient buildings program for Germany

While there is a wide range of possible programs to support vulnerable groups and these are already being implemented across other Member States (e.g. France), our analysis in Germany shows that there is no history of policies particularly aiming to support vulnerable groups. Moreover, the current funding program for efficient buildings is considered socially imbalanced as most of the funding goes to middle and high income homeowners (Knopf et al. 2024; Duncan L. Edmondson et al. 2024; Braungardt et al. 2023). One of the major concerns in Germany is the split incentive of landlords and tenants, where landlords need to be further incentivised to undertake energy efficiency renovations that should ideally benefit vulnerable tenants the most. According to German law, modernization costs can - to a specific extent - be passed on to tenants, while at the same time tenants benefit from reduced heating costs after retrofit. To ensure that housing remains affordable for vulnerable groups the sum of rent and heating costs should not rise after energy retrofit. While there are ideas in Germany to redesign the rental law to ensure that "warm rents" (rent plus heating expenditures) do not increase (Braungardt et al. 2021; Braungardt et al. 2022; Mellwig 2024; Cludius et al. 2024), funding programs also help to keep the rent increase low as funding needs to be deducted from the amount that can be passed through to tenants via rent (Schumacher et al. 2024b).

[28] The governments' coalition agreement stated in 2021 that establishing such a registry should be checked ((2021)).

[29] The installation of thermal insulation after 31 December 1983 is considered an energy-efficient refurbishment - regardless of the type and thickness of the insulation. https://www.kfw.de/inlandsfoerderung/Bundesförderung-für-effiziente-Gebäude/

In our study, we thus focus on socially differentiated funding programs for vulnerable groups, both homeowners and tenants. The FranceRénov' programs, MaPrimeRénov' in particular, serve as a good example for providing comprehensive renovation support and funding. Inspired by the French program, we calculate investment costs, funding needs, and energy cost savings for vulnerable groups in Germany. Assuming a funding rate of 80 % of eligible investment costs and aiming at an efficiency standard B/C (German standard EH-70), we derive funding needs to energetically retrofit apartments of vulnerable households in multi-family buildings of 72 billion EUR[30] and about 51 billion EUR to retrofit single or two family houses that vulnerable households own. If the retrofits were to be done within the time frame of the Social Climate Fund, i.e. over a time span of eight years until 2032, it would be about 9 billion EUR per year for vulnerable households in multi-family buildings and about 6.4 billion EUR per year for vulnerable households in single/two family homes.

Applying the French funding ceiling (maximum expenditure of 55,000 EUR net is eligible for funding) to the analysis for German building renovation, the funding need reduces to 26 billion EUR in total or 3.3 billion EUR per year (over an eight year time span) for vulnerable households in single/two family homes. We only consider households that heat with fossil fuels and are vulnerable with respect to rising fossil energy costs, including carbon pricing, as defined through our indicators. A synthesis overview of these results is provided in Table 10.

[30] Please note that this refers to the refurbishment of the apartments, i.e. living space, that vulnerable households live in and not the entire multi-family building. This is because the number of buildings that vulnerable households live in is unknown. In some multi-family houses, it might be the case that most households are vulnerable, in other buildings it might be only one or two households.

Table 10: Synthesis table of funding need for vulnerable households for energy retrofit to German efficiency class EH-70, inspired by the French MaPrimeRénov' program, assuming a funding rate of 80%

No. of vulnerable households*	Investment costs in EUR	Funding rate for refurbish-ment to efficiency class EH-70 in %	Max. eligible expenditure ceiling per unit (as in the French MaPrimeRénov' program) in EUR	Funding need (considering funding rates and max. eligible expenditure ceiling) in EUR	Effective funding rate (considering max expend. ceiling)
Total: 3 million households					
thereof in multi-family buildings: 2.4 million households	90 billion EUR (11 billion EUR p.a. within the SCF time frame**)	80%	55,000 EUR per unit (net) for increase of two efficiency classes***	72 billion EUR (9 billion EUR p.a. within the SCF time frame)	80%
thereof in single/two family houses: 0.5 million households	64 billion EUR (8 billion EUR p.a. within SCF time frame**)	80%	55,000 EUR per unit (net) for increase of two efficiency classes***	26 billion EUR (9 billion EUR p.a. within the SCF time frame)	41%

Source: Calculation based on assumptions and calculations as laid out in previous tables and sections (Oeko-Institut). Only households with fossil fuel are taken into consideration. For detailed information see chapters 3.2 and 4.1.3.
*Average value of five compound indicators with low-income high fossil energy consumption as shown in section 4.2.2.
** Assuming all investment were to be done within the time frame of the Social Climate Fund between 2026 and 2032, i.e. with eight years.
*** Based on the French MaPrimeRénov' programme, which defines a maximum expenditure limit of EUR 55,000 (net) per unit for an energy efficiency improvement of two levels

Funding for such a socially differentiated programme could come from the existing German programme for efficient buildings, which provides the same funding rate to all building owners regardless of income. To achieve the B/C energy efficiency standard used in our calculations, a 25 % funding rate is currently available in Germany if the worst performing buildings are renovated. In 2023, €16 billion of funding were made available through the Efficient Buildings Programme in Germany. This includes support for the replacement of heating systems, individual refurbishment measures and full refurbishment to various standards. So far, the funding programme has been used mainly by higher-income households, mostly in owner-occupied one- and two-family houses. It could be restructured without additional budget needs to a socially differentiated funding program which specifically supports vulnerable households while still providing funding for households with medium or higher income.

For vulnerable households in particular, funding from the Social Climate Fund could also be used to improve the efficiency of buildings. However, a comparison of the financing needs calculated in this study with the funds available to Germany under the Social Climate Fund shows that the Social Climate Fund will not be sufficient to finance such a socially differentiated investment programme for vulnerable households. The volume available to Germany from the Social Climate Fund amounts to a total of EUR 5.3 billion for the period 2026 to 2032. Together with the required national co-financing, this amounts to EUR 7.1 billion, i.e. around EUR 1 billion per year. Restructuring of the current national efficient buildings programme or using additional

funding from ETS2 revenues would be options to finance the socially-differentiated energy-efficient buildings programme.

Substantial energy costs savings can be achieved through energetic retrofitting. Often enough these savings are not taken into consideration for a cost-benefit assessment as the future development of energy and carbon prices is highly uncertain. In this study, we use rough assumptions and arrive at annual energy costs savings of 3 billion EUR per year once all apartments and houses of vulnerable households have been retrofitted.

Again, it should be noted that we only calculate costs and savings for the living space that vulnerable households live in. For one and two-family houses this corresponds to the number of buildings that would need retrofit. For multi-family houses, it does not correspond to the number of buildings as buildings might be occupied by vulnerable households alongside other households. If costs and savings for all multi-family buildings that are inhabited by at least one vulnerable household were to be calculated, the amounts would be substantially higher. Although it needs to be pointed out that funding for households that are not considered vulnerable would be covered through the existing funding program for efficient buildings albeit with a lower funding rate.

The French MaPrimeRénov' program provides a very good example for a socially differentiated program that could easily be implemented in Germany. However, the French program in our view is not sufficient for addressing landlords that rent to low-income tenants. It requires a six-year rent cap that serves well in the short term but is not sufficient for protecting vulnerable tenants on a long-term basis. With the high share of tenants in Germany, a socially differentiated efficient buildings program in Germany would need to ensure that rents ("warm rents" including heating costs) stay affordable in the long term, thus a longer rent cap after retrofit should be considered. This is particularly important if tenants move out and according to current German law landlords are allowed to increase the rent in line with market prices.

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A Annex: Overview of FranceRénov' programs

Most of the programs in place for energy efficiency renovations in France were cumulated under the umbrella of FranceRénov' in 2023 (Republique Francaise 2024a). This includes the MaPrimeRénov' programs, which have undergone a number of changes over the years, but also a number of other programs. Quite a few of these target low-income households specifically, although the MaPrimeRénov' programs are the most comprehensive. These are listed in the table below and show that France has developed a strong focus on providing support to low-income households and targeting both owner-occupiers and landlords, although to different extents. This is the product of a long-standing commitment to alleviating energy poverty and supporting vulnerable groups in the building sector.

Table 11: Overview FranceRénov' programs for owner-occupiers and landlords

	Focus	Owner	Occupier	Support	Features
MaPrimeRénov' (pour une rénovation par geste)	Heating technology	Low-income owner occupied (up to intermediate income level)		Investment support dependent on income, dependent on technology or renovation measure	Home must be minimum 15 years old
		Low-income landlord (up to intermediate income)	Tenant (all income groups/irrelevant for policy)		Needs to be rented out for at least 6 years; home must be minimum 15 years old
MaPrimeRénov' Parcours (pour une rénovation d'ampleur)	Ambitious renovation, gain of at least 2 efficiency classes	Owner occupied		Investment support dependent on income and ambition level (improvement of min. 2 efficiency classes)	Home must be minimum 15 years old Must be accompanied by supporting case officer, WPB bonus
		Landlord	Tenant (all income groups/irrelevant for policy)		Needs to be rented out for at least 6 years; home must be minimum 15 years old Must be accompanied by supporting case officer, WPB bonus

	Focus	Owner	Occupier	Support	Features
Loc'Avantage	Efficiency gain of at least 35 %	Landlord (all income groups)	Low-income / vulnerable tenants	Tax reduction (15% to 65%), dependent on rent ceiling compared to market rent	Landlords sign agreement setting terms and conditions of the tenancy (level of rent and of tenant's resources), for a period of 6 years, must be accompanied by case officer.
MaPrimeRénov' Co-ownership	Energy renovation of common areas of building (at least 35 % efficiency gain)	Granted to condominium manager and distributed according to percentage of ownership – additional bonus for low-income co-owners		30 % and 45 % of the cost, depending on level of energy renovation required (up to a maximum of 25,000 € per dwelling)	Project management assistance compulsory
Reduced Value added tax	Reduction to 5.5 % VAT for energy efficiency work (from 20 %)	Owner-occupier, landlords, tenants, owners' associations		Reduced VAT	Efficiency improvements defined in tax law, not general maintenance
Energy suppliers grant	Heating and efficiency renovation	Owner-occupiers, landlords, tenants – special help for households in fuel poverty		Grants depending on income and composition of household,	Energy savings obligation scheme – offers advice, diagnostics, subsidised loans and grants for installing efficient heating and hot water equipment and for renovating buildings
Helping hand boost	Heating technology	All households (focus low-income households)		Additional booster grant for replacement of certain heating technology, differentiated by income group	Part of energy savings obligation scheme
Energy cheque	Energy expenses	Low-income households		Direct support with bills or energy renovation	No action required, automatically sent based on tax information

	Focus	Owner	Occupier	Support	Features
Exemption from property tax	Energy renovation	Owner-occupiers, landlords		50 % to 100 % tax exemption	Detailed declaration to tax department on the work done.
Zero-rate eco-loan	Energy renovation	Owner-occupiers, landlords, co-owners		Zero interest loan for remaining costs after assistance through MaPrimeRénov	Up to 50 000 EUR loan, to be prepaid over a period up to 20 years.

Source: Own compilation based on Republique Francaise (2024b).

Income ceilings for very low, low, intermediate and high income are shown in Table 12. The income ceiling corresponds to the "reference tax income" of the people in the household. If they have separate tax notices, the amount to be taken into account is the sum of their "reference tax income".

Table 12: Income ceilings (reference tax income) outside the Île-de-France and Overseas Departments at 1 January 2024

Number of people in the household	Households with very low (very modest) incomes	Households with low (modest) - income	Households with intermediate incomes	Higher-income households
1	17 009 €	21 805 €	30 549 €	over €30,549
2	24 875 €	31 889 €	44 907 €	more than €44,907
3	29 917 €	38 349 €	54 071 €	over €54,071
4	34 948 €	44 802 €	63 235 €	over €63,235
5	40 002 €	51 281 €	72 400 €	over €72,400
per additional person	+ 5 045 €	+ 6 462 €	+ 9 165 €	+ 9 165 €

Source: Republique Francaise (2024b)