Methodology Report Energy Poverty Monitor

CBS Den Haag
Henri Faasdreef 312
2492 JP Den Haag
Postbus 24500
2490 HA Den Haag
+31 70 337 38 00

www.cbs.nl

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Contents

1. Introduction

Energy poverty is defined as a household's lack of access to (affordable) energy supplies (TNO, 2021)[3]. It refers to households whose financial situation and poor condition of their houses prevent them from maintaining a healthy indoor climate. It also refers to households that cannot (financially) keep up with the energy transition, making energy poverty a wide-ranging phenomenon. Both the Netherlands and neighbouring countries are showing increasing interest in this phenomenon.

The European Commission requires member states to focus on energy poverty in their national energy and climate plans and to monitor the size thereof.[1] In terms of monitoring, the choice of indicators and operationalisation is up to the member states themselves. In its working document,[2] the European Commission does, however, provide a description of indicators applied at European level to compare countries such as in the EU-SILC survey.

In 2022, the Ministry of Economic Affairs and Climate Policy requested Statistics Netherlands (CBS) and TNO to develop an Energy Poverty Monitor. TNO's report has been taken as a starting point[3]. The result of this request is a structural Energy Poverty Monitor, which publishes annual figures covering two years ago, an annually updated micro database for in-depth analyses.[4] and a calculation with previous year estimates to provide a more up-to-date overview of energy poverty.

This methodology report describes the operationalisation of the indicators included in the monitor and the underlying calculations.
Chapter 2 explains the indicators for energy poverty. Chapters 3 to 5 inclusive describe the population, operationalisation of the factors and thresholds as well as the source files used. Chapter 5 contains an overview of the annual publications. Finally, Chapter 6 contains an annex that determines the Energy Efficiency (EE) of a house as well as a more in-depth model specification of Energy Efficiency.

[1] EC (2020), Commission Recommendation of 14 October 2020 on energy poverty. Brussels, Belgium: European Commission, C(2020) 9600 final, 14 October 2020.
[2] EC (2020), Commission Staff Working Document European Union Guidance on Energy Poverty. Accompanying the document Commission Recommendation on energy poverty. Brussels, Belgium: European Commission, SWD(2020) 960 final, 14 October 2020.
[3] Mulder, P., F. Dalla Longa, and K. Straver (2021), De feiten over energiearmoede in Nederland. Inzicht op nationaal en lokaal niveau (The facts about energy poverty in the Netherlands. Insight at a national and local level). Amsterdam: TNO.
[4] Microdata: Conducting your own research (cbs.nl)

2. Indicators

In consultation with CBS, TNO developed different indicators of energy poverty in 2021. Three dimensions of energy poverty are taken into consideration: the affordability of energy, the energy efficiency of a house, the options of participating in sustainability. Four basic indicators have been developed based on these dimensions to measure energy poverty, which indicators are further explained in this Chapter:

1. Households with a High Energy Ratio (HER)
2. Households with a Low Income & High Energy Bill (LIHE)
3. Households with a Low Income & dwelling with Low Energy Efficiency (LILEE)
4. Households with a Low Energy Efficiency & Households with Limited Investment Opportunities (LEELI)

Additionally there is a composite indicator:

5. Households with a Low Income and a High Energy Bill and/or dwelling with Low Energy Efficiency (LIHELEE)

This composite indicator is currently the key indicator used to represent the level of energy poverty.

A sixth indicator is still in development. Those are the households with a Low Residual Income (LRI). These are households where the income after having paid the energy bills and, optionally, housing costs, is too low to meet the minimum necessary expenditure for basic living expenses. This gives an indication that arrears may arise in the short term if there are not sufficient reserves. The method for determining the limit value(s) of a Low or too Low a Residual Income is expected to be developed in 2023-2024, building on the collaboration between CBS, SCP and NIBUD.

2.1 Affordability based on income and expenditure: HER, LIHE and LIHELEE

Of those indicators currently included in the Energy Poverty Monitor (October 2023), HER, LIHE and the composite indicator LIHELEE[5] are directly dependent on fluctuations in energy prices.

2.1.1 High Energy Ratio (HER)

The energy ratio is the proportion of income spent on energy costs. Households struggling with energy poverty are those where this proportion exceeds 10 percent. This indicator includes all households belonging to the Energy Poverty Monitor population. See Chapter 3. The HER indicator provides insight into energy poverty in all strata of the population, including households with a high or middle income faced with a high energy bill or one that is too high. Energy poverty can be overestimated by the HER indicator as it also includes those households that have a sufficient income but purposely choose to have a high energy bill, for example due to having a heated pool. On the other hand, energy poverty may actually be underestimated by not factoring in households that consume little energy out of financial need.

[5] See the description under LIHE and LILEE.

2.1.2 Low income, high energy bill (LIHE)

According to the LIHE, households with a low income and a high energy bill are considered to be struggling with energy poverty. A low income is understood to mean an income up to 130 percent of the low-income threshold, excluding households with a financial wealth in the top-ten percent of the Netherlands. Households have a high energy bill, adjusted for household size, if the energy bill exceeds the average energy bill of a one-person household in a house with energy label C in 2019. For the years following 2019, the average energy bill will be adjusted for inflation.

A positive aspect of LIHE is that this indicator only includes those households that have both low income and high energy costs, and therefore no households facing high energy costs but having a relatively high income. At the same time, this can be considered to be a drawback as this indicator only focuses on low-income households. Like HER, LIHE underestimates the energy poverty as it mostly fails to incorporate those households that consume energy below the average due to financial problems.

2.1.3 Low Residual Income (LRI)

As described earlier in this Chapter, the LRI indicator will also be added to the Energy Poverty Monitor in the future. This, too, is an indicator that falls under the dimension of 'affordability based on income and expenditure'. By focusing on the residual income as opposed to the energy ratio, the energy poverty will not be overestimated as a result of households consciously choosing to pay a high energy bill and being able to afford it. They will notably not have a low residual income. Added to this, an indicator based on Residual Income takes the household composition and its associated minimum expenditure into account, whereas the Energy Ratio does not.

2.2 A dwelling's energy efficiency: LILEE

While the previous indicators mostly define energy poverty as a payment problem, the LILEE indicator shows those households that are vulnerable for having a low income, according to the same definition applied by LIHE, and live in poorly energy-efficient houses. This includes households that can pay their energy bills, but may experience problems in living comfort due to low energy efficiency, for example because the house is difficult to heat or can only be heated at high cost.

Unfortunately, there are no good comprehensive register data on dwellings' energy efficiency. The data available from the energy label database is incomplete, and many labels are outdated, which is why we complement these data with an estimate based on relevant housing characteristics. See Chapter 4.

A house is labelled 'Low Energy Efficient' if the average energy bill for houses sharing the same characteristics, such as dwelling type, energy label or year of construction, exceeds the median energy bill of all houses in the Netherlands with the same surface area. This roughly corresponds to houses with energy labels D, E, F or G.

One of the drawbacks of LILEE, is that it is by definition insensitive to the impact of changes in energy consumption and energy prices on energy poverty; indeed, actual energy consumption plays no role in this indicator. A practical drawback of the LILEE indicator is that there is no solid and full information available about the energy efficiency of houses, given that the energy label database is incomplete, not representative and not up to date, meaning that the energy efficiency of a house can presently only be estimated. See Chapter 4 for the calculation. As with LIHE, average-income or high-income households, which may also be at risk in the event of large price increases, are not included in LILEE.

2.3 Opportunity to participate in sustainability: LEELI

This final indicator comprises households living in poor energy efficient houses with little investment opportunities, preventing them from being able to make their houses more sustainable themselves. LEELI offers insight into the unequal opportunities to participate in the energy transition. It is assumed that all tenants have limited investment opportunities, as participation in the energy transition depends on the lessor's preparedness and ability. In principle, owner-occupiers can decide to make their houses more sustainable, however, they must have sufficient financial resources. Households with a combined financial wealth and a house's surplus value of less than €40,000 or with an income below 130 percent of the low-income threshold and financial wealth below the top-ten percent of the Netherlands are classified as households with limited investment opportunities according to this indicator's demarcation.

This indicator is more wide-range than the LILEE indicator, as this indicator also comprises those households in the middle or upper income bracket. A key advantage of the LEELI indicator is that it provides insight into unequal opportunities to participate in the energy transition. While these households rarely struggle with payment problems, they do run the risk of being left behind in the energy transition. The inability of these households to make their houses more sustainable may eventually lead to payment problems for some of them, for instance in the event of rising gas prices. The main drawback of this indicator is the same as of the LILEE indicator, i.e. that in the absence of complete and up-to-date data on energy labels, a house's energy efficiency can only be measured on the basis of a model. In addition, the method for demarcating and estimating financial margin among homeowners is still very rough. For example, it takes no account of existing fixed overhead, nor is any dependency on other households within a homeowners association taken into account (as in the case of tenants, dependency on the lessor). Finally, the amount of investment required is assumed to be constant regardless of a dwelling's energy status.

3. Population

The Dutch population of households at the start of the reporting year forms the basis of the population. However, part of the population falls outside the scope of the Energy Poverty Monitor because of conceptual or practical reasons:

- Population in institutional households, meaning only private households form part of the population.
- Households that share a house, such as communal groups. In this case it is not clear how much energy was consumed by which household and households' financial sources would have to be taken together to assess energy affordability.
- Households with no known or no full annual income[6]. After all, no statements can be made on the affordability of the energy bill. Such households also include students, as student households often involve income transfers from parents which are not recorded.
- Households of which the energy consumption is not known. This represents a very limited number of households as since the renewal of the *energy consumption of dwellings* statistics in 2021, energy consumption is available for almost all houses.
- Households living in a residential object which the Basic Register of Addresses and Buildings (BAG) does not consider to be properties with a residential function, such as companies or berths and moorings. For these properties, the quality of energy consumption information is often poorer or lacking. Also non-residential properties often have multiple functions making it difficult to only attribute the energy consumption to the households in question.

From the total eight million private households in the Netherlands, about seven million households are included as a population for which energy poverty can be derived. The exact number differs from year to year, but it is in this order of magnitude.

[6] Recent or temporary migration plays a major factor in the lack of income data. This could relate to asylum status holders, but also, for instance, to international students.

4. Operationalisation

This Chapter describes the operationalisation of the indicators[7], concepts and thresholds needed to arrive at the Energy Poverty Monitor.

4.1 Definitions

4.1.1 Energy consumption

CBS has information on the consumption of electricity and, if applicable, natural gas for almost all dwellings. This information is based on the Standard Annual Consumption (SAC) of all natural gas and electricity connections of the national grid which CBS receives from the grid operators.

CBS calculates the Standard Annual Consumption of natural gas (in m^3/year)[8] down to the actual gas consumption in a year. By taking the actual gas consumption as a starting point for calculating the energy costs, the income and energy cost indicators reflect the fact that in a cold year the energy bills will be higher and therefore more households will struggle to pay energy bills.

CBS does not have any information on the annual consumption at the level of individual dwellings for district heating. Heat consumption is therefore approximated by estimating equivalent gas consumption (in m^3/year) based on the natural gas consumption of comparable dwellings. This is also referred to as imputation[9]. If district-heated dwellings also have an observed gas supply, the estimated heat supply is reduced by the observed gas supply.

CBS makes use of the Standard Annual Consumption for electricity (in kWh/year) up and till the 2020 reporting year. The Standard Annual Consumption overestimates the electricity supply to dwellings with self-generated electricity, as for most dwellings the old meter (running back on feed-in) has been replaced by a smart meter over the course of time. From the 2021 reporting year, these Standard Annual Consumptions were gradually replaced by the Standard Annual Purchase (SAP) and feed-in is recorded separately as the Standard Annual Input (SAI). Once netting is phased out, the difference in costs and revenues between purchased and redelivered electricity can also be taken into account.

Up to and including the 2020 reporting year, the Standard Annual Consumption thus overestimates for electricity, as known in the micro files, the actual net supply of electricity, and thus the energy bill’s amount, of electricity. Therefore, a model-based estimation of redelivery was made for the 2019 and 2020 reporting years based on available information on solar installations present and the observed redelivery factors in 2021.

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[7] LRI has not yet been included in this methodology document as it is still being developed.

[8] The Standard Annual Consumption of natural gas is the expected annual consumption of gas at a connection in a standard year. A standard year being the period from 1 January to 31 December of a single year with average climate conditions. The Standard Annual Consumption is based on the actual consumption as measured and corrected for temperatures.

[9] CBS currently makes use of an imputation model that determines the average consumption of a dwelling based on the following housing characteristics: type of dwelling, surface area and energy label. In the absence of a registered energy label, it is based on year of construction in combination with type of dwelling. At present, the imputation model does not take account of the spread of natural gas consumption within a group of dwellings with comparable characteristics. As a result, extremely high or low consumption is less common. This could potentially bias the number of households faced with energy poverty according to certain indicators.

4.1.2 Energy bill

The average energy bill is calculated based on the annual consumption of natural gas and the net electricity supply as well as the average energy prices for consumers in the reference year. Given the fact that there are no good average prices yet for heating and district-heated dwellings may not have higher energy costs than comparable dwellings on natural gas according to the No-More-Than-Other principle, heat consumption (in Joules) is converted into m^3 of natural gas equivalents[10]. The energy bill of these dwellings is calculated according to the gas prices. The calculation includes both a temperature-adjusted and a non-temperature-adjusted version.

Calculation:

- Multiplying the average variable supply cost including taxes (Dutch VAT, energy tax (EB) and Sustainable Energy Surcharge (ODE levy) for natural gas and electricity with the respective net supplies;
- Adding the fixed transport costs and supply cost[11];
- Deducting the energy tax refund, also known as the tax credit.

All tariffs are calculated inclusive of Dutch VAT.

The average energy tariffs are taken from the monthly CBS publication: StatLine - Average energy tariffs for consumers (cbs.nl). This is a new table as of June 2023, due to changes in the underlying data and associated methodology for calculating average energy tariffs. Prior to June 2023, only prices of new contracts were observed. Now both the new as well as the ongoing contracts concluded earlier are included in the calculation of the average monthly tariffs. The new observation is available as of the 2021 reporting year. For more information: CBS switches to new method for calculating energy prices in the CPI.

Please note that by using average energy tariffs, households with favourable or unfavourable energy contracts may face higher or lower actual energy bills than the calculated amount.

4.1.3 Income

Standardised disposable income

Standardised disposable household income is used to classify households by level of income. The disposable income is the gross income less

- the income transfers paid such as alimony from a former spouse,
- income insurance premiums such as contributions paid for social insurance and premiums for public or private insurance schemes relating to unemployment and occupational disability, and for old age and surviving dependants,
- premiums due under the Health Insurance Act,
- taxes on income and wealth.

The standardised disposable income is the disposable income adjusted for differences in household size and composition (to normalise). This adjustment takes place on the basis of equivalency factors.[12] With the help of the equivalency factors, all incomes are reduced to

[10] This is based on the caloric value of natural gas (31.6). See the InfoMil (Ministry of Infrastructure and Water Management): 1 GJ = 31.6 m3, or 1,000 GJ = 31,600 m3.

[11] If a dwelling does not have a natural gas or heating connection, the fixed costs for natural gas will not be included in the calculation.

[12] The equivalency factors are included in the two-yearly publication of *Material well-being in the Netherlands.* See: Material well-being in the Netherlands 2022 | CBS (in Dutch only)

incomes of a one-person household. This makes prosperity levels of households mutually comparable, and this determines whether households have a low or high income.

Payment budget
The payment budget is used for the energy ratio and the residual income. The payment budget is the net income from present or past employment, from capital and benefits, hence after deducting taxes and other contributions. Unlike disposable income, this does not include expenses, such as mortgage interest and contributions paid under the Health Insurance Act, or compensations for expenses, such as allowances and tax refunds for owner-occupied housing. As such, the concept is broadly applicable to various affordability studies. The energy ratio is the net energy cost expressed as a percentage of the payment budget. The residual income is the payment budget minus the net energy cost.

To calculate the energy ratio and the residual income, the cost and specific compensation for costs must be strictly separated. However, disposable income also includes items such as mortgage interest deductions and added energy surcharges. This would result in a distortion of the outcomes if the net energy ratio or the development thereof is calculated. In order to prevent this, we use the so-called payment budget, a variation of the disposable income excluding all expenditure-related items. Additionally, households with a very low or negative income are given a lower limit herein, so that we can calculate a meaningful value of the ratio for these groups as well.

4.1.4 Energy efficiency

Energy efficiency will measure a dwelling's energy efficiency status. A well-known measure for energy efficiency is the energy label. However, the energy label has two major drawbacks: many dwellings do not have a label, and the ones that do, often have one that is not up-to-date. As an example, owner-occupied dwellings are given a label at the time they are being sold, while those dwellings are often made more sustainable after the sale. Consequently, the label is already obsolete a year after the sale. Another shortcoming is that the calculation method in the energy label makes a large number of assumptions, for example, that people heat all rooms at a certain temperature, or that ventilation is used correctly. In practice, it turns out that these assumptions are difficult to uphold.

This is why we developed a model for the Energy Poverty Monitor. Houses consume less energy as they are better insulated, generate their own energy, or, for example, make smart use of incidence of light. These are important aspects of the energy efficiency of houses. The energy consumption, however, also depends on the size of the dwelling or the number of people living in it, though these characteristics are irrespective of a dwelling's energy efficiency. Below are a few examples to show the difference between housing characteristics which may or may not be linked to energy efficiency:

- If households consume less energy because they start wearing warm sweaters and turning down the thermostat, that does *not* improve energy efficiency.
- If more people are going to live in a house, this would increase the energy bill, however, this does not mean that the house also becomes less energy efficient.

A dwelling's energy efficiency therefore measures the average amount of energy consumed by a certain type of dwelling, with normal use and a standard surface area.

CBS determines the energy efficiency of dwellings by means of the following three steps:

1. *Estimating the model.* First, an analysis is made of the relationship between housing characteristics and the energy amount[13]. The result of this step is a calculation model used to calculate the average energy amount for a dwelling with comparable characteristics.
2. *Calculating the theoretical energy amount.* The second step is to calculate an estimated average energy amount for each dwelling based on the model from step 1. This calculation does not make use of the actual surface area of a dwelling, but a hypothetical surface area of 100 m^2. As a result, the measure does not depend on the size of the dwelling.
3. *Deriving the LEE.* If a dwelling's theoretical energy amount exceeds the threshold value for the lower energy efficiency, the dwelling is then referred to as LEE. See Chapter 4.2.4 for the determination of the threshold value.

Annex 7.1 contains a detailed description of the different steps.

4.1.5 Investment opportunities

Investment opportunities are calculated by taking the sum of the financial wealth and the surplus value of the dwelling. In determining the surplus value, only households with an income exceeding the income threshold (i.e. 130 percent of the low-income threshold) are included.

The means to invest may come from two sources: personal financial reserve or a loan. Subsequently, the sum of these two should be sufficient to pay for a sustainable home improvement.

- The financial reserve must be available in order to be included. This includes the financial wealth, i.e. bank accounts, savings accounts and investments.
- A loan often requires security. We take the dwelling's surplus value to determine the security.
- As to loans, households must be able to repay the money, which is why we apply a minimum income to be eligible for a loan or additional loan.

4.1.6 Wealth

A cap on wealth is applied in addition to the income limit to prevent very wealthy households with temporary or administratively low incomes from being classified as struggling with energy poverty. Households with wealth exceeding this limit do not suffer from energy poverty. This application uses the property excluding the owner-occupied dwelling, called payment reserve. Comparable to the payment budget, this excludes all components related to expenditure. The purpose of applying the payment reserve is to exclude wealthy households in the assessment of energy poverty. This mostly relates to households of entrepreneurs, former entrepreneurs and pensioners for whom income is not a fair indication of structural spending potential.

[13] We use the energy amount as this includes both the consumption of natural gas and electricity, and both can make a difference for the energy efficiency.

4.2 Threshold values

4.2.1 (High) energy bill

The energy bill, as described in Chapter 4.1, is normalised to a one-person household.[14]

The threshold value for the energy amount is then calculated by taking the median temperature-adjusted energy bill of actual one-person households living in a house with energy label C. [15] If a household's normalised energy bill lies above the median, it is considered to be a 'high energy bill'. The threshold value is set at 2019 data and is €1,213.32. The threshold values for the subsequent reporting years are based on the established threshold value for the 2019 reporting year, adjusted for inflation[16].

4.2.2 (High) energy ratio

A threshold value of 10 percent is applied for the energy ratio. In this regard, we concur with publications of the European Commission and the Netherlands Environmental Assessment Agency (PBL)[17]. An energy ratio exceeding 10 percent is considered to be a 'high energy ratio'. Thus, where the limit for a high energy bill increases with inflation, the same is not true for the energy ratio limit.

4.2.3 (Low) income

With regard to low incomes, the threshold of 130 percent of the low-income threshold is applied. The low-income threshold is a fixed amount representing an equal purchasing power for all years and all types of households. The limit is derived from the income support level for a single person in 1979, when it was highest in purchasing power. This limit has been adjusted for multi-person households to size and household composition using the equivalency factors. Given that the low-income threshold is only indexed for price developments, this criterion is ideal for comparisons over time.

4.2.4 (Low) energy efficiency

Houses are considered low energy efficient if the normalised expected energy bill is higher than the median normalised energy bill in 2019, which is the threshold value. This threshold value is deliberately independent of energy price or temperature, as the focus of this indicator is on the long-term effects of a poorly-performing dwelling on energy bills.

The threshold value is established at dwellings and prices of 2019. The threshold values for the subsequent reporting years are based on the established threshold value for the 2019 reporting year. In calculating LEE, the energy amounts are calculated using the 2019 prices, making inflation adjustment unnecessary.

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[14] The equivalency factors used in the Energy Poverty Monitor equal those factors that are used to calculate the standardised household income. See Chapter 4.2. and the annual publication of *Material well-being in the Netherlands.* The formula to calculate the factor is listed in the 2020 edition: Material well-being in the Netherlands 2020 | CBS (in Dutch only)

[15] The reason for referring to the temperature-adjusted energy bill is that there is no temperature effect in the reference year.

[16] Based on StatLine - Annual rate of change CPI; since 1963 (cbs.nl).

[17] PBL (2018), Meten met twee maten. Een studie naar de betaalbaarheid van de energierekening van huishoudens (*Double standards: A study into the affordability of household energy bills*). The Hague: PBL.

Upon the request of the Ministry of the Interior and Kingdom Relations, CBS also calculates an additional classification for LEE, namely Extremely Low Energy Efficiency (ELEE). This involves dwellings of which the normalised expected energy bill in the respective reference year drops below the limit of the lowest 15% in the 2019 base year.

4.2.5 (Limited) investment opportunities

The threshold value for households with limited investment opportunities is set at €40,000 in 2019, with a €30,000 margin for sustainability improvements and a €10,000 buffer. The threshold value is established at 2019 data. The threshold values for the subsequent reporting years are based on the established threshold value for the 2019 reporting year (€40,000), adjusted for inflation[18].

The threshold only applies to households not having a low income combined with assets exceeding the wealth limit and owner-occupied households with a surplus value on the house. All other households are covered by 'limited investment opportunities'. The options for tenants to make their homes more sustainable are limited altogether, given that participation in the energy transition depends on the lessor's preparedness and ability. This is why tenants are also by default covered by 'limited investment opportunities'. In principle, owner-occupiers can decide to make their houses more sustainable. However, they must have sufficient financial resources to do so.

4.2.6 (High) payment reserve

The wealth limit is the 90th percentile of the amount of assets excluding the dwelling (or payment reserve) of all households within the Energy Poverty Monitor population for the 2019 reporting year. Households with a payment reserve higher than the 90th percentile have a 'high payment reserve'. The threshold values for the subsequent reporting years are based on the established threshold value for the 2019 reporting year (€232,541), adjusted for inflation[13].

The Energy Poverty Monitor combines the threshold value for the income with a wealth limit to establish the 'Low-income' households, in such a way that households with high equity and a low income are not classified as low-income households.

4.3 Indicators

4.3.1 High Energy Ratio (HER)

The high energy ratio is the energy bill divided by the payment budget. See 4.1.3. For this purpose, the non-temperature-adjusted energy bill is used to keep as near as possible to the actual costs.

To prevent non-logical values, the energy ratio is capped at 0 at the bottom and 1 at the top. However, because of the tax credit, the energy bill may be negative in very exceptional cases; due to the capping at the bottom, such households get a ratio of 0. In addition, the energy bill may exceed the payment budget; due to the capping at the top, such households get a ratio of 1.

To determine whether a ratio is high, we use the limit value as described in Chapter 4.2.2.

[18] Based on StatLine - Annual rate of change CPI; since 1963 (cbs.nl).

4.3.2 Low income, high energy bill (LIHE)

This indicator selects those households with an income below the income limit, a wealth below the wealth limit and an energy bill exceeding the threshold value. See Chapter 4.2 for the respective limits/thresholds.

4.3.3 Low income, low energy efficiency (LILE)

This indicator selects those households with an income below the income limit, a wealth below the wealth limit and a house with an energy efficiency below the threshold value. See Chapter 4.2 for the respective limits/thresholds.

4.3.4 Low energy efficiency, limited investment opportunities (LELI)

This indicator selects those households with dwellings with an energy efficiency below the income threshold and little investment opportunities. See Chapter 4.2 for the respective limits/thresholds.

4.3.5 Low income with high energy bill and/or with low energy efficiency (LIHELEE)

This indicator selects those households with an income below the income threshold, a wealth below the wealth limit and

- an energy bill exceeding the threshold value and/or
- a house with an energy efficiency below the income threshold.

This indicator is an amalgamation of LIHE and LILEE.

See Chapter 4.2 for the respective limits/thresholds.

5. Source files

5.1.1 Woonbase

Woonbase records who lives in which dwelling with which household members during a year, specified by various characteristics of persons, households and dwellings. CBS has developed Woonbase based on integral data sources, in collaboration with the Ministry of the Interior and Kingdom Relations.

Each year, Woonbase consists of one key file, three population files (persons, households and dwellings) and three associated characteristics files[19]. Various financial data of households are available as an 'Extra characteristics file'. CBS offers these files via 'Remote Access' ('RA') to researchers with an RA authorisation[20].

By making use of Woonbase, the Energy Poverty Monitor aligns with recent, integrally available figures on the housing market.

5.1.2 Energy consumption of private homes

This file contains connection-level data on natural gas and electricity supplies to and the presence of district heating at private homes. This file is enriched with information about the presence of solar panels (solar PV) and types of main heating system which is used to determine the energy consumption of dwellings.[21]

5.1.3 Other source files

In addition to above core data sources, the following data are also used:

- StatLine table Average energy tariffs for consumers (cbs.nl)
- Dwellings' energy label database of the Netherlands Enterprise Agency (RVO)
- Household income
- Household wealth

[19] For more information, please visit: https://www.cbs.nl/en-gb/our-services/customised-services-microdata/microdata-conducting-your-own-research

[20] For more information, please visit: https://www.cbs.nl/en-gb/our-services/customised-services-microdata/microdata-conducting-your-own-research

[21] Method of energy supplies via the national grid: https://www.cbs.nl/en-gb/our-services/methods/surveys/brief-survey-description/supply-of-electricity-and-natural-gas-via-the-national-gridt

6. Publication

The annual publications on energy poverty consist of:

- a structural Energy Poverty Monitor, which annually publishes figures covering two years ago (led by CBS),
- an annually updated micro database for in-depth analyses from researchers of organisations with an institutional authorisation for access to the Remote Access environment[22] (led by CBS), and
- a calculation with previous year estimates to provide a more up-to-date overview of energy poverty (led by the Netherlands Organisation for Applied Scientific Research (TNO)).

Energy Poverty Monitor

We are developing a consistent set of statistics on energy poverty from this publication, led by CBS. The publication is set up as a set of tables. See Energy Poverty Monitor 2020 (cbs.nl). The set of tables consists of a number of tables with indicators broken down by various background characteristics and region down to neighbourhood level.

Energy Poverty Micro Database

The micro database compiled for the Energy Poverty Monitor consists of both the calculated variables and indicators as well as various background characteristics of households and dwellings. The database contains all variables (created) which have been used in the Energy Poverty Monitor. The micro database is a database which has been encrypted by CBS to prevent disclosure of individual data. This micro database is available via Remote Access and associated conditions to non-CBS related researchers to enable them to work from the same basic data for in-depth analyses. The database can be linked to other CBS micro databases by means of linkable keys.

See also: Customised micro databases

Calculation with previous year estimates

This publication, led by TNO, outlines an up-to-date overview of energy poverty. The estimate is based on incomes, assets and energy consumption from the Energy Poverty Monitor of two years ago, in combination with the energy price and policy measures from the previous year. The methodology corresponds to the publication of the Energy Poverty in 2022 (Netherlands Organisation for Applied Scientific Research (TNO)). The publication is set up as a report, complemented by an interactive map.

[22] Microdata: Conducting your own research (cbs.nl)

7. Annexes

7.1 Determining a dwelling's Energy Efficiency

Stap 1: estimating the model
A regression model is estimated having as a dependent variable the calculated energy bill (see 4.1.1) in the reference year, based on temperature-adjusted energy consumption in the reference year and prices of 2019. The result of this regression analysis is a formula that enables you to calculate an energy amount based on certain housing characteristics for each dwelling.

The independent variables in the model are first of all housing characteristics which are strongly linked to the energy consumption[23], particularly: surface area, year of construction, type of dwelling (e.g. detached, semi-detached, corner house, terraced house, apartment), type of property (e.g. owner-occupied dwelling, corporate rent, other renting/leasing or unknown), energy label (e.g. A, B, C, D, E, F, G, or unknown), type of energy label (included by expert after 2015, or other), heating source (e.g. central heating, block heating, district heating grid, electricity, or a combination thereof), the presence of solar panels.

In addition to the housing characteristics, we also added some characteristics of the residents to better separate the effects of residents and the dwelling. Apartments, for example, have fewer residents than terraced houses on average, resulting in a lower average energy bill. In order to determine the quality, we therefore want to compare an apartment with one resident with a terraced house with one resident. We do so by explicitly including the effect of an extra resident in the model. For that same reason, we include the following residents' characteristics: income (i.e. disposable household income in deciles), age of main resident, number of persons in the household.

As the different housing characteristics and residents' characteristics sometimes interrelate, the regression model also comprises combinations of variables, i.e. interaction terms. See Annex 7.2 for a complete overview of all variables used and a full specification of the model used.

In estimating the model, only those dwellings are included that have been lived in by the same household during the entire reference year.

Step 2: calculating the theoretical energy amount
Once the model has been determined, it can be used to estimate an energy amount for any given dwelling based on the characteristics in the model. This estimate is based on the average energy bill of dwellings with comparable characteristics.

We make an estimate adjusted for surface area and residents to calculate energy efficiency. We do this by including a standard value in the formula as opposed to the actual surface area and residents' characteristics. For surface area, it is 100m2, and for residents, it is one person aged 50-54 with an income in the 4th decile.

To be able to calculate an energy amount in this way, we therefore only need information about the housing characteristics excluding the surface area, i.e. year of construction, type of dwelling, ownership, label, heating and solar pv. That information allows us to estimate the efficiency for all dwellings, including unoccupied dwellings or dwellings with no known energy bill.

[23] CBS is working on a research paper showing what characteristics were examined, and how the current model was derived.

The outcome of above calculation is a normalised expected energy bill. This solely depends on the properties of the dwelling, and is independent of the number of residents or a dwelling's surface area.

Step 3: Deriving the LEE
The final step in the calculation involves translating the normalised expected energy bill into a low energy efficiency (LEE), or an extremely low energy efficiency (ELEE). The threshold values are established in the 2019 reporting year. The houses with the 50% highest estimated energy amounts in 2019 is the LEE limit, and the highest 15% is the ELEE limit.

The average energy prices of 2019 are used for all reporting years to calculate an energy amount for households in the respective reporting year, to avoid the inflation rate coming to play, and the 2019 threshold values are used to determine whether a dwelling is LEE on the basis of the estimated energy amount. As such, the share of LEE dwellings drops in principle if the energy consumption drops. Dwellings are considered low energy efficient if the normalised expected energy bill is higher in the reference year than the median normalised energy bill in 2019. Both energy bills are based on temperature-adjusted consumption.

Advantages and limitations
The current method has a couple of advantages, but also its limitations.
The advantages:

- The outcome does not depend on random fluctuations in winter weather, as the calculation makes use of the energy amount based on a temperature-adjusted gas consumption.
- The outcome does not depend on the energy prices, because the calculation makes use of the prices in 2019.
- Changes in the energy consumption by means of improved insulation of dwellings are reflected as quality improvement in the calculation.

The limitations:

- However, if the energy consumption changes irrespective of the weather or the dwelling's energy efficiency, this calculation then gives a distorted view. If large groups of households consume more energy, for example, because they spend more time at home or have purchased a bigger television, it mistakenly appears as if the energy efficiency of the houses is declining. If households turn down the thermostat en masse because of environmental concerns or high energy prices, it mistakenly appears as if houses have become more energy efficient.

7.2 Variables and model specifications for energy efficiency

Section 4.1.4 outlines the way in which the energy efficiency is estimated, by means of a model that estimates the energy bill based on housing characteristics. This annex has a full description of the variables used and the model specification.

7.2.1 Model variables

The model to estimate the energy bill contains the following variables:

– Energyamount2019_temp: the calculated energy amount from natural gas and electricity consumption with 2019 prices based on temperature-adjusted gas consumption in the reference year.

- Solarpv: 0/1 variable indicating whether a dwelling has solar PV; from households' energy consumption
- VBOHousingtype: detached house, corner house, semi-detached house, terraced house, multi-dwelling unit, or unknown.
- Year of construction: year in which the dwelling was first completed; capped at 1799.
- label_dik: energy label, yet with the A versions combined, i.e. A+, A++, etc.
- area_p100: the surface area in 100 percentiles, from 1 to 100.
- area_unkn: 0/1 variable which is 1 if the dwelling's surface area is unknown.
- n_persons: the number of persons in the house, capped at the top at 5; based on INHALH
- age_rnd5: the main resident's age from Woonbase, rounded to 5-counts, capped at 25 and 85.
- area_pwl: 20 variables which together represent a piece wise linear (pwl) of the surface area. This means that the relationship between energy bill and surface area is modelled by 20 line segments that connect to each other.
- year of construction_pwl: same as for year of construction.
- TypeOwner_dik: type of owner from Woonbase, but Unknown is then merged with Other renting/leasing.
- Labeltype: categorical variable on label quality; 1=label recorded by expert after 2014, 2=manual label or before 2015, 9=no label.
- Heating: categorical variable for the type of heating, derived from households' energy consumption.
- bestinkh_p10: standardised disposable household income in 10 deciles.

Please note: the categorical variables are converted to a set of dummies in regression. For example, variable label_dik (with categories A, B, C, D, E, F, G, unknown) is converted to eight separate dummy variables label_A to label_G, and label_unknown.

7.2.2 Model specification

A large number of models were tested for this study, each with different variables and interactions. The starting point was the PBL/TNO model with full interaction of year of construction classification, surface area classification, type of dwelling, energy label and type of owner. Ultimately, a model was selected with a good balance between high predictive power (R^2) and relatively few parameters and thus low risk of overspecification (i.e. overfitting).
The ultimate model is a linear function of the model variables and certain interactions between the model variables. The model has the following form, whereby varA*varB represents a full interaction between two variables:
Energyamount2019_temp = z=solarpv*VBODwellingtype + solarpv*yearofconstruction solarpv*label_dik + solarpv*area_p100 + VBODwellingtype*yearofconstruction VBODwellingtype*label_dik + VBODwellingtype*area_p100 + yearofconstruction*label_dik yearofconstruction*area_p100 +
label_dik*area_p100 + solarpv*n_persons solarpv*age_rnd5 + VBODwellingtype*n_persons VBODwellingtype*age_rnd5 + yearofconstruction*n_persons + yearofconstruction*age_rnd5 + n_persons*label_dik n_persons*area_p100 + n_persons*age_rnd5 + label_dik*age_rnd5 + area_p100*age_rnd5 +
area_pwl area_unkn + yearofconstruction_pwl + TypeofOwner_dik + label_dik*labeltype + heating + bestinkh_p10.