DOCUMENT 2

2. ASSESSMENT AND MONITORING OF OPTIONS

2.1. Assessment of energy efficiency options

Analysis of viable options could be part of regulatory impact assessments or cost-benefit analysis (CBA) preceding political or investment decisions. While conducting comprehensive impact assessments is normally requested by law, in line with the EE1st principle a proper CBA (see below) should become part of preparation of any investment or policy decisions with impact on energy consumption.

CBA can be a stand-alone analysis or a key component of a more comprehensive impact assessment analysis.

In the context of impact assessments, full reflection of the EE1st principle requires looking at various elements covered in these guidelines. These include:

- Consideration of barriers to the application of energy efficiency;
- Definition of objectives that would not exclude energy efficiency solutions;
- Identification of a wide spectrum of options, specifically looking at demand-side solutions and energy efficiency improvements;
- Evaluation of impacts of various options on energy consumption and using up to date projections for energy demand in the assessment;
- Evaluation of costs and benefits of the options from the perspectives of (i) society, (ii) the market actors that implement the energy efficiency plans, and (iii) the final consumer/investor;
- Sensitivity analysis for different discount rates as well as energy efficiency measures pushed to the maximum;
- Evaluation of coherence between of the preferred option with energy efficiency targets and actions;
- Identification of operational steps and objectives that would enable implementation of energy-efficient solutions;
- Setting policy/investment evaluation provisions that would require monitoring of energy savings achieved in a transparent manner e.g. as defined in the methodology for Article 7 of the EED.

In addition, it is important to identify the relevant data sources and indicators for projections regarding future energy demand, measuring impacts on energy savings and monitoring of progress. As data availability and national practices differ, there might be no one source of data. What is crucial is transparency and comparability of indicators and data used.

2.2. Wider impacts

The multiple benefits of energy efficiency can be divided into social, environmental and economic.

Social benefits include improved wellbeing and comfort level, for example because of proper heating and improved indoor air quality in dwellings, which subsequently lead to improved health, both physical and mental. Beside, lower consumption of fossil fuels reduces emissions from power plants and transport, thus reducing the negative impacts of air pollution. Improved efficiency also reduces the energy bill and can increase household income, which could be spent elsewhere. Another important benefit is the alleviation of energy poverty, which continues to be a problem in many countries.

Environmental benefits relate to wider impacts of reduced energy consumption, in particular reduced GHG emissions and reduced air pollution related to energy use. In addition, lower energy demand improves management of energy sources and other resources. It leads directly to savings on energy to be produced (and hence eliminating the negative externalities related to energy supply), in particular savings on fossil fuels. It also reduces the needs for renewables investments to achieve the policy set targets.

Economic benefits can be of both micro and macro scope. Micro impacts are linked to increased industrial productivity because of lower energy spending and increased market value of assets with better energy performance. The macro impacts concern changes in GDP and employment and through impact on energy prices also changes in public budgets.

The positive social and environmental impacts also reduce unemployment and social welfare spending. Other impacts to consider relate to innovation and competitiveness, which can be improved with energy efficient technologies as well as improved energy security through lower import dependency.

2.3. Defining methodology

Defining methodology for quantification of the wider benefits of energy efficiency is challenging and still not well established.

Social impacts

2.3.1. Health and well-being

Human health is one of the most important co-benefits of energy efficiency. To measure and quantify the major positive and negative impacts in improved energy performance of buildings the following aspects affecting health can be considered:

- Temperatures and ability to keep homes adequately warm directly related to energy efficiency improvements in buildings;
- Air tightness levels that are generally increased through energy efficiency improvements and adequate ventilation which needs to be well considered when setting energy efficiency requirements;
- Indoor air quality, resulting from the concentration of major indoor air pollutants (VOC pollutants such as benzene, radon, carbon monoxide, NOx): indoor air quality strongly depends on energy efficiency, even if the links can be either positive or negative, depending on the ventilation level resulting from the efficiency improvements;
- Mould and dampness, generally resulting from the temperature level and the ventilation level of the building;

- Indoor lighting, which is in most cases improved thanks to energy efficiency improvements, and has major impacts on occupants' health and well-being,[1]
- Noise level*:* insulation of *the building envelope*, especially windows, reduces exposure to outdoor noise;
- Use of toxic materials, renovations lead to removal of asbestos and lead as well as installation of safeguards against radon.

The positive impacts of energy efficiency improvements are reflected in the reduction of cardiovascular diseases, respiratory diseases (asthma, infectious diseases, allergies, etc.), lung cancers, and cognitive and mental health impairment. Both chronic and acute respiratory disease may occur because of exposure to indoor air pollution from space heating systems and fuels; as well as asthmas and allergies from moulds that flourish in damp and poorly heated homes; and stroke and cardiovascular disorders from exposure to temperature extremes.[2]

Specific health outcomes may be difficult to identify, and thus are often measured in terms of terms of overall mortality or morbidity, as evidenced by doctor visits, hospitalization and days off from work or school, or by risk factors, e.g. thermal conditions, noise, etc.

Using an approach based on coefficients health benefits of energy efficiency and the impacts in terms of air quality can be translated into economic terms (e.g. health costs associated with illnesses).

2.3.2. Energy poverty

When examining the benefits of energy efficiency programmes concerning energy poverty alleviation, impact assessments should focus on achieved or projected energy cost savings for vulnerable households or increased indoor comfort levels within their dwellings. Ability to increase indoor temperature to more comfortable levels has multiple health benefits, as living in cold and poorly ventilated homes is linked to a range of health problems.

Retrofits and other energy efficiency improvements that enable energy poor households to improve indoor temperatures may have positive impacts on mental health and incidences of cardiorespiratory diseases, and can thus help reduce health inequalities.

2.3.3. Environmental impacts

Energy efficiency improvements can positively affect the environment in several quite different respects:

- Energy and climate change – Measures to improve energy efficiency naturally lead to reductions in energy demand and thus consumption of fossil fuels. Reduced consumption of fossil fuels implies reduced emissions of greenhouse gases.
- Sustainable consumption and production (SCP) - This category comprises items such as the emission of local air pollutants and consumption of materials. Energy efficiency could potentially reduce the level of emissions of sulphur, particulates and

[1] Hector Pollitt, Eva Alexandri et al. (2017), *The macro-level and sectoral impacts of Energy Efficiency policies*.
[2] WHO (2011), Health in the green economy : health co-benefits of climate change mitigation- housing sector, https://www.who.int/publications/i/item/9789241501712

other pollutants that are damaging to human health. Energy efficiency measures may also imply increases in Domestic Material Consumption when measures such as building retrofits are undertaken.

- Natural resources – Improved energy efficiency leading to reduced energy demand could lead to reductions in water demand and land use by the power generation sector.

The specific indicators to be used to measure those impacts include:

- Reductions in greenhouse gas emissions;

The relationship between energy savings and CO2 emissions is relatively straightforward when looking at energy carriers. Usually a linear approach is applied using fixed coefficients of units of CO2 per unit of fuel consumption. There are two ways of doing this: either deriving the coefficients from historical data or using published coefficients (e.g. from the IPCC).

Table 1: Average emission coefficients in the EU related to net calorific value (NCV)

	Average emission factors (t CO2 / TJ)	Average emission factors (t CO2 / TJ)
Crude oil	73.3	3.07
Natural gas Liquids	64.2	2.69
Motor gasoline	69.3	2.90
Gas/Diesel oil	74.1	3.10
Anthracite	98.3	4.12
Coking coal	94.6	3.96
Lignite	101	4.23
Natural gas	56.1	2.35
Peat	106	4.44

Source: Commission Regulation (EU) No 601/2012, Annex VI

Regarding energy savings of electricity, the relation between energy savings and GHG emission reduction can be estimated based on GHG intensity of electricity generation: 287 g CO2 eq/1 kWh (3.34 t CO2 eq/toe).[3] The national intensities would differ depending on the share of renewable energy and fuel mix used for power generation.[4] Similarly, GHG intensity of derived heat production can be calculated: 253 g CO2 eq/1 kWh (2.95 t CO2 eq/toe) for EU27 based on 2018 data.

It might be also interesting to have estimates for energy savings achieved in the buildings sector. Again, it can be derived from the GHG intensity in buildings, which in 2018 at EU27 level was at around 222 g CO2 eq/kWh (or 2.58 t CO2 eq/toe). Therefore, saving 1 kWh of energy could be translated into 222gCO2 eq GHG emissions saved. Again, the values would be different at the national level.

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[3] Using the EEA methodology and carbon inventories of the UNFCCC. Based on 2018 data.
[4] Cf. Agora Energiewende (2021), *The European Power Sector in 2020. Up-to-Date Analysis of the Electricity Transition*

- Reductions in emissions of local air pollutants (Sulphur dioxide - SO2, Nitrogen oxides – NOx, Volatile organic compounds – VOCs, Particulate matter with a diameter of less than 10 µm - PM10, Particulate matter with a diameter of less than 2.5 µm - PM2.5)

Avoided air pollution emissions depend on the scale of energy savings, the fuel type saved, technology, air pollution control equipment.

It is quite common for emissions of SO2 and NOx to be converted to monetary terms. Usually most of the cost is attributed to healthcare and loss of productivity. However, it is important to avoid double counting of the health impacts related to reduction of air pollution.

- Impacts on ecosystem (including impacts on water consumption)

Ecosystems can suffer negative impacts in case the critical loads are exceeded for absorption capacities of pollutants, such as reduced vegetation growth, changing properties of water bodies, changing soil mineral composition, reduction in agricultural harvests. GAINS models looks at two types of ecosystem impacts – acidification due to sulphur deposition and eutrophication due to nitrogen deposition.

Power generation has impacts on water consumption, which is mainly used for cooling. It is possible to estimate water consumption by the power sector by converting from generation in GWh to cubic metres of water. Renewable technologies usually are allocated values of zero in because they do not use water in generation, but water may be used in their production.

Table 3: Water withdrawals by generation technology

	Water withdrawals m^3/MWh
Natural gas	1.16
Hydro	0.00
Nuclear	5.01
Wind	0.00
Biomass	3.99
Geothermal	0.00
Coal	4.57
Solar PV	0.00
Solar CSP	0.00

Source: Macknick et al (2011)

It is also possible to estimate impacts approach on land use requirements by the power sector, in terms of number of square kilometres required per GW of capacity, or GWh of generation. However, results tend to be dominated by changes in biomass use (which has a far larger land requirement than any other generation technology). [5]

[5] Cf Vasilis Fthenakis, Hyung Chu Kim (2009), *Land use and electricity generation: A life-cycle analysis*, https://www.sciencedirect.com/science/article/pii/S1364032108001354

2.3.4. *Economic impacts*

The economic impacts of energy efficiency investments are usually assessed with a help of macroeconomic models, which need to take some assumptions no the way economy functions. The main drivers determining the macroeconomic effects of energy efficiency measures come from investments in energy efficiency technologies and services on the one hand and the reduction of energy cost and on the other hand.

The investments needed to bring about improvements in energy efficiency boost employment and economic activity in the short run, if undertaken when the economy operates at less than full capacity. It is worth considering that energy efficiency investments, however, can displace spending from other parts of the economy (crowding out effect), which at least partly counters the positive effects. Moreover, rebound effects, which lead to increases in energy demand because of positive economic impacts of implementing energy efficiency, mean that the expected energy savings and economic impacts are not fully realised.[6]

Effects from energy cost reduction stem from the fact that energy savings reduce spending on energy and increase the disposable income of households or profits of companies. These could increase consumption or reinvested stimulating increase in economic activity. Besides, a reduction in energy imports could boost local demand by increasing spending on goods and services that are produced domestically.[7]

Energy efficiency improvements also have effects on public budgets. While public investment or subsidies for energy efficiency imply higher public spending, there is also potential for cost savings with improved energy performance in the public sector. In addition, the positive employment and output effects result in an increase in tax revenue. Other changes, such as disposable income through energy savings, foregone energy taxes through energy savings and unemployment schemes, can also be been considered.[8]

In addition, it is worth considering productivity indirect impacts coming from social or environmental impacts of energy efficiency, e.g. through improved health. These affect also employment and output in the long-run employment.[9]

2.4. EE1st test for energy infrastructure investments

Following the requirement of the proposal for the TEN-E regulation to implement the EE1st principle when assessing the infrastructure gaps, development of a specific energy efficiency first test for energy infrastructure planning could be of help to DSOs, TSOs and energy companies. It would need to build on the ACER framework guidelines incorporating the EE1st principle.

The aim of such test is to analyse if in a given context an alternative or a different, a more energy efficient technology or approach could be implemented. Such a test should in particular be applied in the context of planning or investments of energy infrastructure where

[6] Hector Pollitt, Eva Alexandri et al. (2017), op. cit.
[7] Sibylle Braungardt, Johannes Hartwig et al. (2015), *The macroeconomic benefits of ambitious energy efficiency policy – a case study for Germany*
[8] Helge Sigurd, Næss-Schmidt et al. (2018), *Macro-economic impacts of energy efficiency*. COMBI, WP6 Macro-economy. Final report.
[9] Ibid.

demand side solutions could be considered as viable alternatives, but need to be properly assessed.

When planning transmission and distribution energy network TSOs and DSOs the objective is to identify projects, which would deliver energy to final consumers at minimal costs. These costs relate normally to investment and operating costs of network assets. A dedicated EE1st test would help TSOs and DSOs consider better energy efficiency solutions and incremental costs incurred for the procurement of demand side resources as well as the environmental and socio-economic impacts of different network investments and operation plans. This requires a shift from the narrow economic efficiency perspective to maximised social welfare. The latter would still assume that TSO and DSO business should remain financially viable and earn adequate return.

Also when looking at system reliability the EE1st test would require bigger focus on network operation to ensure reliable supply, quality and consumer satisfaction. Energy efficiency and demand side solutions can defer capital intensive network assets, if accompanied with right scrutiny.

The test could become an intrinsic part of assessment of network planning projects and its application should be scrutinised by national regulators.

2.5. Approval and monitoring

2.5.1. Defining supervisory competences

Setting obligations and providing guidance and incentives should help prioritise energy efficiency. However, as is the case with other policies and objectives, it is important that there be subsequent review of decision-making processes where the EE1st principle could have been applied. Particularly in situations where there are strict requirements or where energy efficiency is a preferred approach, there might be a need for some form of approval or verification of projects or investments of market entities.

The aim would be to check if planning and decision taking processes of market entities properly incorporated various steps of the EE1st principle, in particular regarding methodology for CBA. This compliance check should also evaluate if there are potential conflicts between intended projects and possible incorporation of the EE1st principle and how these projects would contribute to the policy targets. The final verification should also check if the best option has been chosen from the societal perspective.

It is recommended that the application of the EE1st principle be verified by a dedicated structure with clearly defined competences and powers. Energy regulators are key entities supervising energy markets and infrastructure investments. Thus, they are also natural candidates to monitor the application of the EE1st principle by regulated entities. This role could be shared with energy agencies or other structures in other areas. Given that the EE1st principle should be integrated into the existing infrastructure planning and energy system related decisions, there is no need for a new supervisory body, but rather for a clear definition of competences in monitoring of the implementation of the EE1st principle of the existing supervisors of energy markets.

The verification should cover the way impact assessments and CBA methodology are applied, in particular in relation to the assessment of wider benefits of energy savings, the application of EE1st tests, if prescribed, the quality of data used and indicators used, the remaining barriers and limitations. A dedicated structure could also help better monitor and evaluate the implemented policies. Furthermore, a dedicated reporting on implementation of the EE1st principle and best practice would further promote energy-efficient solutions.

2.5.2. Monitoring of implementation

The modalities for monitoring should be defined when setting the conditions for specific projects, their selection and approval. All investments supported with public funds or regulated under law if having impact on energy demand should have clearly defined indicators and methodology for ex-ante assessment of impacts on energy consumption and ex-post evaluation of the results and impacts after their implementation

- Indicators

When defining monitoring indicators it is key to consider:

- Individual actions or programmes should be monitored with detailed result indicators in terms of energy savings delivered. The contribution to an overall target for energy consumption is a welcome auxiliary indicator, but requires additional information how it was calculated;
- Energy savings should be specified in absolute terms for the covered period or the last year of the duration of the action;
- If the savings are measures as cumulative or total savings or a reduction in energy consumption;
- Additionality of the impacts of the proposed measures to the already existing ones needs to be always looked at when estimating the impacts in terms of energy savings;
- Estimates of the expected energy savings should preferably follow the measurement methods established under Article 7 (see section 7.1 of Commission Recommendation (EU) 2019/1658[10]);
- Identification of investment costs together with the indication of the investment costs per energy saved.

    - Reporting

Any major decision that significantly affects energy consumption should be properly monitored by a competent entity. Given the wide scope of possible application of the EE1st, it is useful to set some indicative thresholds which would help identify which decisions and projects should be closely monitored. At national level, these thresholds could be set looking at national or sectoral energy consumption or the level of public funding involved. This threshold could be set in absolute or relative terms for both inputs and outputs of a decision. Major decision could mean:

- Any decision that over its lifetime would lead to a change in energy consumption of more than [1%] of the sector's (at level 2 of NACE classification) energy consumption.
- Any investment or financing scheme with public funds above [EUR 50 million].

This does not preclude that impacts on energy consumption should – where possible and not too burdensome – be monitored for decisions and investments, where formal reporting, audit or monitoring are already in place.

[10] COMMISSION RECOMMENDATION (EU) 2019/1658 of 25 September 2019
on transposing the energy savings obligations under the Energy Efficiency Directive

- Evaluation

Furthermore, it is useful to pay attention to ex-post evaluations of the real impacts on energy consumption, because they also affect applicability of the proposed solutions in the future. There are many impacts affecting workability of energy efficiency solutions. These are linked to external factors, but also behaviour or rebound effects. Without proper analysis of those factors, it is difficult to improve the implementation of energy efficiency measures. This leads to a gap between the real and observed savings and, consequently, affects the perception of energy efficiency as a viable solution, in particular regarding its cost-effectiveness. Ex-post evaluation with properly defined scope, looking at real impacts on energy demand and possible factors affecting them should be envisaged from the very beginning when preparing and approving energy related decisions.