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ENERGY EFFICIENCY – THE FIRST FUEL

"The cleanest energy is that which is not consumed at all."

(Brigitte Zypries, German Federal Minister of Economics and Energy until 2018)

Wind, sun, water – these three natural sources immediately come to mind when the keyword renewable energy comes up. Because every day we drive past solar parks, wind turbines or hydroelectric power plants. They can be touched. Real. And they all contribute to the energy transition.

But there is another area that – unnoticed and silently – has an equally important function in the move away from fossil energy: energy efficiency. It is precisely efficiency-enhancing measures that can make a decisive contribution to achieving global climate targets. An attractive market is emerging for investors. The result is a classic win-win constellation.

Abstract

- Energy efficiency is a key pillar for the energy transformation as it reduces the primary energy consumption.
- In terms of implementation and visibility, it still remains in the shadow of renewable energies.
- Furthermore, energy efficiency would lead to significant synergetic effects in combination with climate-neutral energy production. Exploiting these synergies is essential for achieving climate targets.
- The cost reduction achieved with efficiency measures offer companies significant savings potential. This leads to competitive advantages and lower dependence on volatile energy imports.
- On the one hand, a market for sustainable and attractive investment opportunities is emerging for investors; on the other hand, companies can realize significant savings and at the same time focus the investments in their core business.
- Ongoing innovation and the growing impact of economies of scale are increasing the cost degression of efficient technologies.
- The process is supported by political support and demands.
- The risk-return profile achieved offers attractive opportunities now and in the future.
- The implementation of energy efficiency measures has positive effects on the real economy, investors, society and ultimately on prosperity.
- Energy efficiency is an elementary component in realising the vision of a climate-neutral future.
- Future expansion of measures will support demand flexibilisation, digitalisation and electrification, thus providing the key to the necessary reorganisation of energy supply to enable the decarbonisation of economies.
- Conclusion: There are many obvious reasons to move energy efficiency forward with verve. Why is the momentum not picking up faster?

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1. Are the Paris climate targets achievable?

It is becoming increasingly apparent that actual efforts to transform the energy supply will not be sufficient to achieve the Paris climate goals. What are these goals? Nearly 200 countries agreed in Paris in 2015 to reduce emissions that are harmful to the climate. By doing so, the states wanted to limit global warming to well below 2° C compared to pre-industrial levels in order to avoid irreversible damage. While more recent studies even warn of a warming beyond 1.5° C, reaching the 2° C mark seems unlikely.

The forecast shows that all measures must be exploited and all potentials and synergy effects must be realized in order to prevent further global warming. The public discussion in the context of the energy turnaround focused primarily on wind, hydro and solar power. Their increased use should make it possible to avoid burning fossil resources in the future. However, this is a too one-dimensional view. The success of the energy system transformation and the climate neutrality that the European Union is striving for depends on several factors - namely on a transformation that is fine-tuned and synergetically controlled.

In addition to the essential expansion of renewable energies, increasing energy efficiency is one of the most important prerequisites for achieving climate targets after all. However, the topic as such is hardly visible and its implementation is still limited - despite significant cost advantages and despite possible synergy effects in interaction with renewable energy. To enhance efforts in this area, it is essential to increase visibility and priority.

However, the topic is not entirely new: as early as 2016, the energy ministers of the G7 reaffirmed that energy efficiency is the key to decarbonizing the economies and should therefore be considered as "first fuel".[1] First fuel in this context means that efficiency measures reduce energy consumption and these savings can be used elsewhere. The International Energy Agency (IEA) estimates that – in addition to planned emission reductions – half of the global CO2 reduction can be achieved cost-effectively through efficiency measures. Related to Europe this potential amounts to 76%.

2. Energy efficiency, an introduction

By definition, energy efficiency refers to measures whose implementation results in the same or better performance with less energy consumption. According to the laws of economics, scarcity of energy makes it necessary to relate the input to the output in order to maximize the respective benefit. This means that with a fixed energy input the maximum output is aimed at, or with a fixed output the energy input is minimized.

An illustrative example of this is the use of energy-saving lamps, which is now mandatory. Whereas conventional incandescent lamps convert electrical energy into desired lighting and undesired heat, the energy requirement for efficient light sources is reduced due to lower heat losses for the same lighting. However, this simple, obvious and at the same time economically sensible change had to be brought about through a law. The principle of voluntariness would not have worked here because energy-saving lamps consume less energy but are more expensive to buy. This contradiction is often encountered when it comes to energy efficiency. Our society is not willing and used to look beyond investment returns of 3 to 5 years. We have been used to think short term. In this case, it is only legal compulsion that leads to the desired goal.

The EU directive on energy efficiency allows member states to set concrete targets for final energy consumption, energy intensity or primary energy consumption.

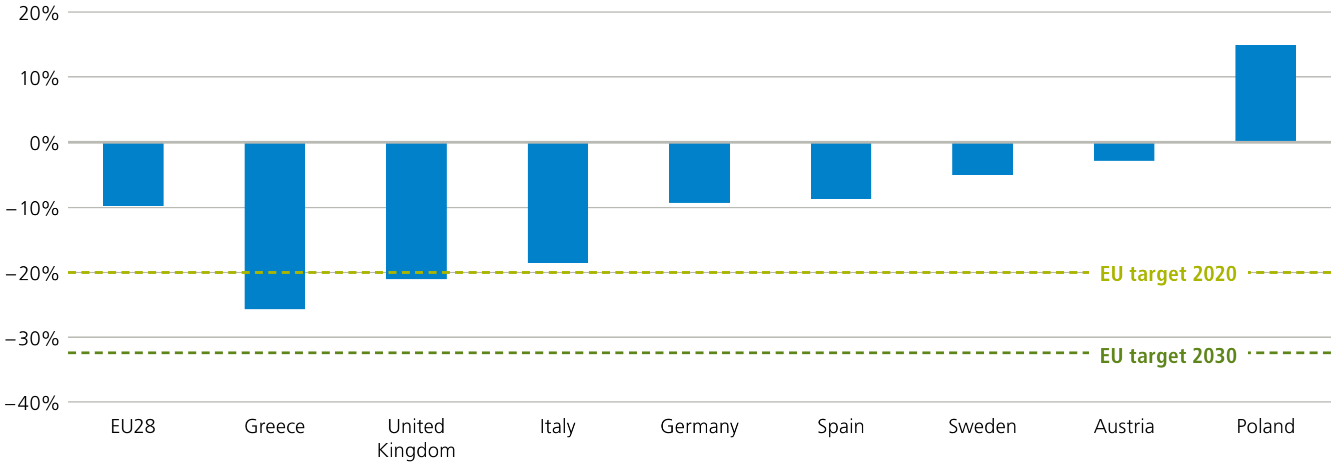
However, final energy consumption only covers two-thirds of the energy sources consumed in the EU, as it does not take into account losses during energy production and transportation. On the other hand, energy intensity - i.e. consumption in relation to gross domestic product - is also influenced by energy-independent factors such as productivity. Ideally, energy efficiency targets are measured in terms of primary energy consumption. Primary energy consumption measures the energy supplied to the system. For example, production in coal-fired power plants is measured by the use of coal as an energy source. Since the efficiency of such plants accounts for only 30 to 40 percent, it becomes clear which part of the supplied energy is lost through heat, namely: 60 to 70 percent. If the waste heat from these power plants is used as district heating, there is a significant efficiency gain. Therefore, with energy efficiency measures substantial cost savings can be achieved, while at the same time also reducing the emission of climate-damaging substances. The result is a classic win-win situation.

[1] G7 Kitakyushu Energy Ministerial Meeting, 2 MAY 2016, http://www.g7.utoronto.ca/energy/160502-statement.html

3. The strategy of the European Union

Energy efficiency is an important cornerstone of the energy system transformation, and most stakeholders agree on this. In the public debate, however, the main interest is focused on the expansion of renewable energies. The IEA, for example, estimates that under the existing policy two-thirds of the potential lying in efficiency is not being exploited.[2] Specially formulated targets are not being met by the majority of member states. Figure 1 shows that the EU target of a 20% reduction in primary energy consumption will be missed significantly. The total reduction of the EU member states (EU28) amounts to only 10%.

Figure 1:
Efficiency gains in relation to primary energy consumption in 2018 of EU member states concerning respective targets[3]



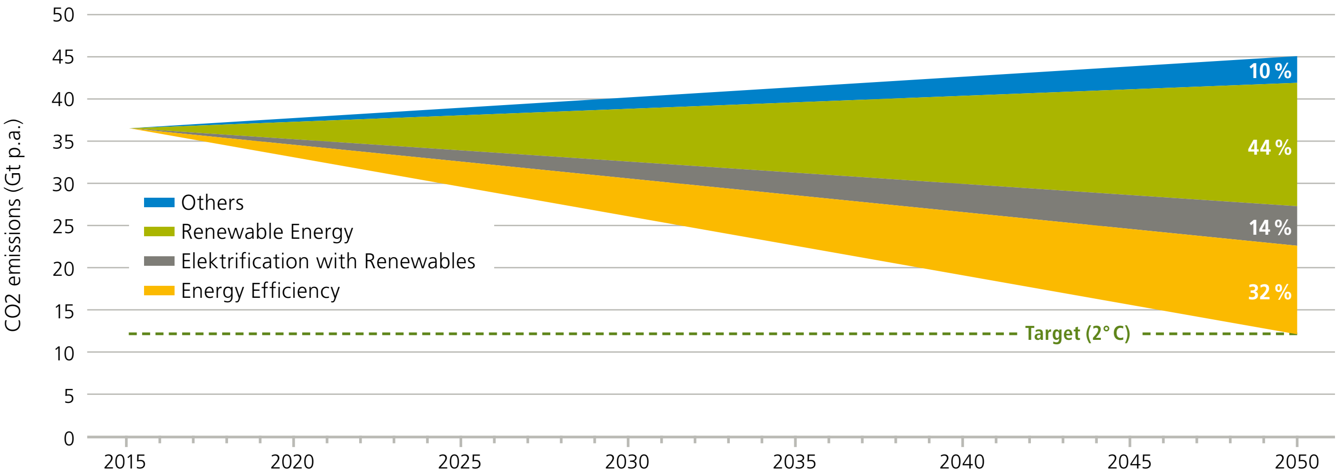
Under the slogan "energy efficiency first", the European Commission is trying to accelerate the efforts of the member states. The aim is to establish energy efficiency as an independent energy source, so to speak.[4] In addition to the binding target – to reduce primary energy consumption by 32.5 percent by 2030 – numerous support measures are offered and educational work is carried out. The potential to reduce CO2 emissions cost-effectively makes economic sense and is also essential for achieving climate targets. In addition, it also makes an important contribution to the framework conditions for energy system transformation, where the focus is on the security of supply and affordable access to energy.

4. Synergy effects of renewable energies and energy efficiency

In order to achieve the goal negotiated in the Paris Climate Convention – to limit global warming to below 2°C compared to the pre-industrial age – it is necessary to limit global annual emissions to a maximum of 12 gigatonnes (Gt) of CO2.[5] However, current trends are still far way from this objective. On the contrary: due to the long term trend of global growth and the resulting prosperity, increases in emissions are still being observed. Without concrete measures to prevent this development, it will continue over the next 30 years. With unforeseeable but drastic consequences for the climate.

[2] *IEA (2019)*
[3] *Eurostat (2020)*
[4] *EC (2020)*
[5] *IRENA (2017), in accordance to IEA*

Figure 2: Technology-based CO2 savings potential[6]



According to a study by IRENA[7], 90% of the required CO2 reductions could be achieved by the increased use of renewable energies and an expansion of energy efficiency. Figure 2 illustrates how emissions would rise to 45 Gt CO2 per year in the reference case – and how the Paris targets could still be achieved through decisive and controlled action.

The measures can even be achieved cost-effectively. While the relative costs of expanding or replacing conventional thermal power plants with renewable energies are already partly negative[8] in most regions, efficiency measures tend to undercut these costs. Depending on regional conditions – especially raw material and emission prices – renewable energies are highly competitive – which is why they have continued their triumphant advance in recent years.

Onshore solar and wind power plants are already the cheapest sources of energy generation in most regions. For this reason, the relative costs of expanding them can become negative (compared to the costs of adding conventional plants). The costs of energy efficiency measures especially in the cross-sectional technologies (nearly in all businesses broadly applicable established technologies, e.g. LED lighting), are still well below those for renewable energies, i.e. clearly in the negative range due to the achievable savings relative to conventional alternatives.[9]

LED vs. light bulb:
The substitution of old lighting systems with LEDs illustrates the facts of relative negative investment costs. While the acquisition costs for LED lamps are many times higher compared to other alternatives, this difference is already put into perspective by the longer service life (service life: incandescent lamp ≈ 1,000 h / energy-saving lamp ≈ 10,000 h / LED ≈ 50,000 h). An approx. 70% to 90% lower power consumption of LED lights thus leads to significant cost savings in the long term. The highlight: this reduces the relative costs of replacing conventional light with LEDs into the negative cost range.

The negative externalities of conventional energy production (air pollution, climate change, ...) are not included in these calculations. Their influence would further improve the analysis considerably.

Ultimately, it's not about one or the other. Energy efficiency and renewable energies are not in competition with each other. The two factors complement each other and together they could achieve considerable synergy effects and thus reduce the costs of the entire energy system.

[6] *IRENA: Synergies between renewable energy and energy efficiency (2017)*
[7] *International Renewable Energy Agency*
[8] *Negative relative costs: if the costs of adding one unit of energy production compared to the costs of adding one additional unit of energy production based on conventional technology becomes cheaper the relative costs of the new production becomes negative.*
[9] *IRENA: Synergies between renewable energy and energy efficiency (2017)*

For example, efficiency measures and the resulting lower energy demand increase the share of renewable energies in a region's overall electricity mix. Meanwhile, the expansion of renewable energy reduces primary energy consumption, as there is no heat loss due to renewable energy production. The efficiency of wind and solar power plants is accordingly 100%, compared to an effectiveness of only 30 to 40% of coal-fired power plants. Therefore 2 to 3 times less PEC is used per unit power generation from renewables.

Example electric motor:
In terms of efficiency, electric motors are far superior to combustion engines, which require two to three times as much primary energy, assuming the electricity was generated by renewables. In addition, they can perform work in a completely climate-neutral manner by using renewable energy sources. Increased use of electric motors in combination with batteries could reform not only mobility but also many industrial processes and building equipment.

A coordinated expansion of energy efficiency and renewable energy – focusing on the synergy effects – provides the key to decarbonize the economies. Moreover, the transformation can be achieved cost-effectively. Given the advantages, the question arises: why is the momentum in implementation still restrained?

5. Advantages from the company's perspective

Under current conditions, the industry in Europe has a cost-efficient savings potential of **20 to 40 percent** of primary energy. Cost-efficient means: **short amortization periods** or immediate cost savings when **outsourcing (contracting)** the implementation of measures. A corresponding reduction in energy costs thus leads to competitive advantages. In addition, cost savings and income can be generated by fitting PV systems to already built-up areas such as the roofs of factories, promoting **self-sufficient energy generation** and increasing the **sale of surplus capacity**. The decisive factor in this orientation is the prevailing level of energy prices.

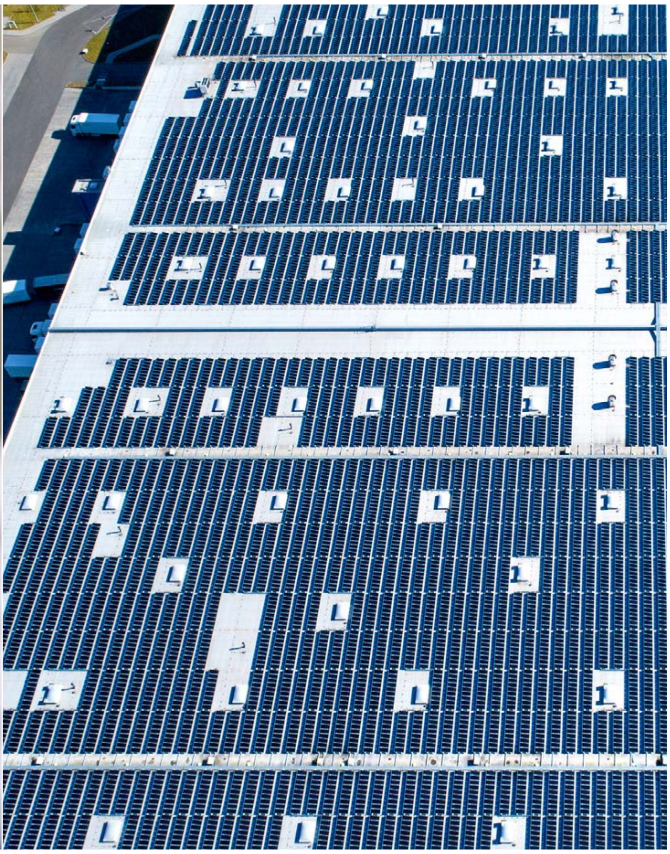


Figure 3:
Spot prices for electricity in Europe 2019 (EUR/MWh)[10]

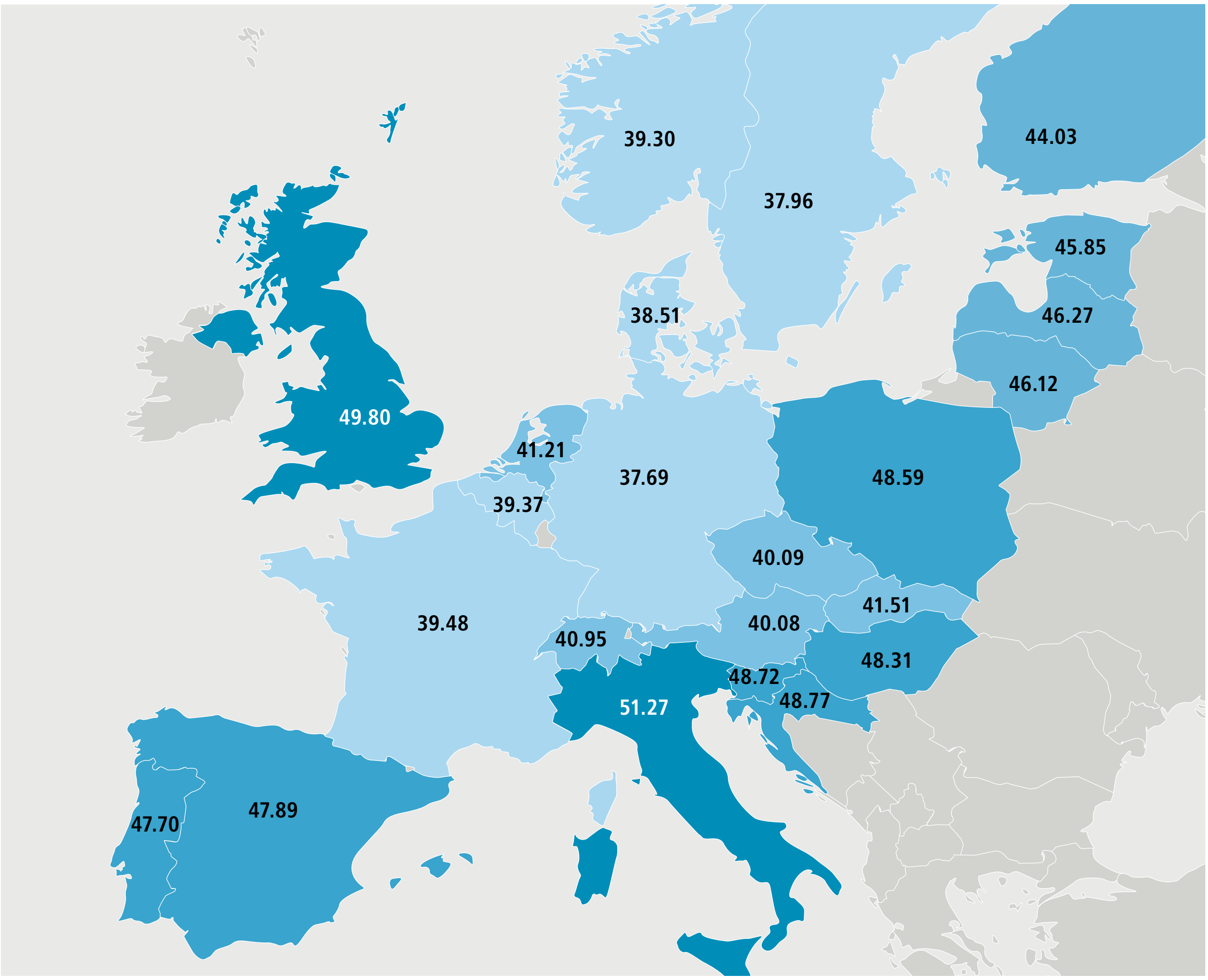


Figure 3 illustrates the significant differences in European electricity prices. Countries with the highest electricity prices – UK and Italy – represent strong incentives for significant savings. Both countries are increasingly exploiting this potential. The UK and Italy play a pioneering role in achieving the targets within the EU. Furthermore, the figure shows that there is a north-south divide in Europe. Especially for Southern European companies, this results in a high potential to save costs. However, this is only one of the incentive factors. The electricity prices shown are solely based on their quotation on the stock exchange. Other price-determining components – such as taxes and grid fees – are added.

[10] *Entsoe (2020)*

Composition of the electricity purchase price:
The overall costs are far higher than the stock market prices and thus put regional differences into perspective. In Germany, for example, the stock exchange price represents only a quarter of the purchase price.[11] The remaining 75% is made up of grid fees, taxes and the EEG levy.

Electricity is traded on the European Energy Exchange **(https://www.eex.com/de/)**

Surveys show, however, that companies shy away from the high initial investment in energy-efficient technologies. Instead, they prefer to use available equity and debt capital for investments in their core business. In addition, several EU member state governments also have doubts about the implementation of the EU Commission's "Energy Efficiency First" approach. They fear disadvantages from the resulting burdens on the economy.[12] In order to dispel these concerns, the advantages must be better presented and appropriate framework conditions must be created in order to use the existing potential in a competitive manner.

5.1 Energy Efficiency Measures – Realising current and future potential in companies

Whereas in the past the energy transition was mainly related to the energy sector, the focus is increasingly shifting to so-called sector coupling. This means that in addition to the pure generation of energy and the associated emissions, the industry, building and transport sectors are increasingly being considered. Challenge of energy efficiency is that many few investments make the difference and therefore need multiple parties to pull on one and the same string.

Example buildings:
The building sector is responsible for 40% of energy consumption in Europe. As the largest sectoral energy consumer, buildings also account for 36% of climate-damaging emissions. Especially because some of the existing buildings in the EU are very old – 35% of the buildings are more than 50 years old – there is massive potential to reduce energy consumption through renovation.[13]

Energy-efficient electrification offers an opportunity across all sectors to increase the use of renewable energies and reduce emissions accordingly. Including the building and transport sectors in emissions trading or pricing emissions – as already announced in Germany – will significantly strengthen the incentives for energy-efficient action.

„Only when emissions have a price will our behavior change."

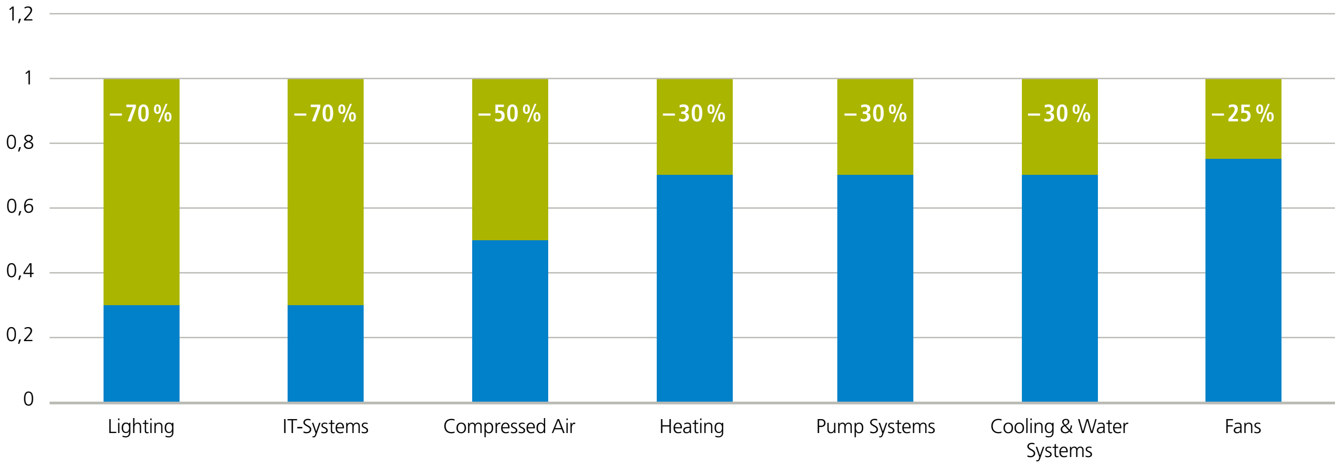
(Ursula von der Leyen; President of the European Commission in her speech opening the plenary session of the European Parliament; 16.07.2019)

[11] *Bundesnetzagentur (2019)*
[12] *https://euobserver.com/energy/141148*
[13] *https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en#:~:text=Buildings%20are%20responsible%20for%20approximately,building%20stock%20is%20energy%20inefficient.*

5.1.1 Cross-cutting technologies

Implementing energy efficiency in very specific technologies is often very complicated because it is the companies themselves who know their industry best. Cross-cutting technologies, on the other hand, are applications with broad fields of application across all industries. These include building technologies such as heating and lighting, electric motors, drives and compressed air. Figure 4 illustrates the high savings potential that lies in the respective technologies.

Figure 4: Savings potential in cross-sectional technologies[14]



This applies to all industries: the use of energy-efficient lighting and IT systems offers the highest savings potential. Replacing old lighting elements in conjunction with intelligent control methods and reorganizing IT systems can result in savings of up to 70 percent. Electrically driven elements such as motors, compressed air systems, pumps and fans also represent widely required basic technologies. The associated drive of processes and the provision of energy are often associated with the resulting highest energy demand in companies. Cross-cutting technologies illustrate the overall savings potential that can be achieved in companies. In addition, the wide distribution of these cross-sectional technologies forms the basis for dynamic courses of technical progress and the resulting cost degression. There are numerous solutions available for optimizing energy efficiency in these areas.

5.1.2 Decentralised in-house energy production

Based on the actual trend of increased decentralized power generation, renewable systems, energy efficiency and small power generators become more important. System efficiency is increasingly becoming the focus of debate. In particular photovoltaic systems can contribute significantly to the decentralized approach. Existing surfaces, such as roofs, can be used to generate electricity. This means that there are no additional costs for the area and land consumption is limited. The technological progress achieved in the past and the associated cost reductions promise short payback periods and thus favorable access to renewable energy. Any excess capacity that arises can be fed into the grid, which can generate corresponding additional income. From the point of view of efficiency, an additional burden on the grid is avoided because: Savings of electricity downstream of the meter compared to direct consumption of locally generated, clean energy cause the same effect from the perspective of public power supply. Avoiding transport-related energy losses also contributes to the efficiency of energy produced and consumed in-house. Corresponding implementations offer cost-efficient possibilities to increase energy efficiency.

[14] *German Federal Ministry of Economics and Energy (2020)*

5.1.3 Classification of sectoral fields of action

In addition to overarching measures within the cross-sectional technologies, there are a large number of sector-related implementation options, whose investment requirements are generally more than compensated in the long term by savings. Regardless of the negative externalities avoided, such as air pollution, whose inclusion would significantly improve the assessment, substantial individual benefits are generated.

Thus, corresponding efficiency strategies lead to competitive advantages through the realizable savings on the cost side of companies. In addition, the individual and overall economic dependence on raw material imports is also significantly reduced. Especially in the European context, import dependence and the associated high volatility is a constant factor of uncertainty. This could be significantly reduced by the influence of energy efficiency measures. Table 1 shows a selection of sector-related efficiency measures.

Table 1: Energy efficiency categories by sector[15]

Industry	Efficient pumps, compressors, motors and fans
	Heat and process integration
	Heat pumps
Energy	Build out renewable energy
	Higher-efficiency NGCC plants[16]
	Switch from coal to gas power plants
Buildings	Building envelope
	Efficient lighting
	Efficient appliances
	Heat pumps
Transport	Further penetration EVs
	Indirect electrification through synthetic fuels

5.1.4 Contracting – savings from day 1

Especially for small and medium-sized enterprises, expenditures compete with investments in the core business. Investments in energy efficiency are often postponed despite the benefits and direct savings that ensure associated payback. So-called contracting offers ideal conditions for reconciling these competing objectives. Contracting is the transfer of the implementation of energy efficiency measures to a specialized service provider, which takes over the optimization of the facilities as well as the financing and implementation of energy-efficient measures. This approach offers the opportunity to benefit from the savings directly after the implementation.

The relative negative costs of energy efficiency measures enable a constellation in which all actors can generate benefits.

1. Companies realize cost savings through energy efficiency measures from day 1, as the savings exceed the costs for service providers. This does not reduce the available investment scope for the core business. Furthermore, contracting does not lead to a burden on the balance sheet that could affect refinancing conditions.

2. The energy service provider generates income from the implementation of the measures.

3. Investors are offered promising, seminally investment opportunities with attractive returns.

4. Society benefits from the reduction of negative external effects, while an additional macroeconomic growth effect is achieved, which in turn leads to a positive influence on the labor market.

The cost-efficiency already achieved will be significantly enhanced by ongoing innovation, the use of economies of scale and the expansion of the use of efficient technologies. These framework conditions and good future prospects mark an attractive point of entry that promises stable earnings for all market players.

[15] *IRENA: Synergies between renewable energy and energy efficiency (2017)*
[16] *Natural gas combined cycle plants (significantly improved efficiency through use of waste heat)*

6. Demand flexibilization, digitization and electrification

The central point in the energy transition is the security of supply, which is influenced in particular by the weather-dependent feed-in of renewable energies. The change from demand-driven to flexible, weather-dependent energy production requires adjustments in all areas. The implementation of energy-efficient measures, supported by digitalized applications and processes, can make an essential contribution here and improve system efficiency in the long term. The reorganisation of the systems will gain relevance in the future in order to realise the vision of a climate-neutral future.

The Europe-wide share of renewable energies in gross electricity consumption is developing positively. However, this is put into perspective by a persistently low impact on primary energy consumption. This context can be explained by the necessary reorganization of energy systems to adapt the changing framework conditions. In order to ensure the supply even in times of low renewable production, conventional thermal power plants provide continuous energy to guarantee the baseload. If renewable production increases, coal-fired power plants in particular behave very inflexibly due to high start-up and shut-down costs. This results in overproduction, which has a major impact on primary energy consumption and also causes high energy price volatility. To counteract these developments, it is very important to make demand more flexible in terms of energy efficiency. Potential for flexibilization can be found in many areas. For example, energy-intensive companies such as aluminum smelters or cement works generally have high flexible loads that can be postponed to times of high renewable production. A resulting balance between electricity generation and consumption improves the integration of renewable energies and contributes to the stabilization of grids. Correspondingly intelligent control systems make it possible to establish connections between consumption optimization (energy efficiency) and improvements of the overall system (flexibilization).

Digital applications offer the possibility to recognize and use these system connections. With the help of artificial intelligence and the collection of large amounts of data, implemented energy management systems, for example, can provide important insights and optimize energy consumption in the long term. So-called smart meters - energy meters that provide consumption and the respective costs in real-time - create incentives for consumers to consume energy in cheap hours (periods of high production of renewable energy). At the same time, network operators are enabled to develop pricing models to optimize network utilization. The high speed of data evaluation – partly supported by artificial intelligence – also makes it possible to control decentralized supply via appropriately granular networks. This reduces network expansion costs and prevents transportation losses.

Consumption optimization using the example of Google:[18]

2019 was the third year in a row in which the internet company covered its energy needs completely with renewable energies. This was made possible by a carbon-intelligent computing platform, developed specifically for this purpose. With the help of this system, extensive computing power is only started if the weather conditions guarantee a correspondingly high production from renewable energy sources.

While this approach already makes it possible to shift the computing power to corresponding hours, plans for the future include distributing the computing power across regions to data centers in order to take advantage of regional weather differences and the resulting differences in the production of renewable energy.

In particular the negative correlation between wind and solar production can create advantages here.

The technical possibilities open up the prospect of using decentralized renewable power supply to increase sector coupling - including buildings and transport - and thus weaken the target order of fossil supply. In order to achieve the move away from fossil fuels, increasing electrification will be required in other areas. In the transport sector, this includes the expansion of electric mobility. In this sector, too, the price of electricity will create incentives to shift the charging process to hours of high renewable production and correspondingly lower prices. This will sustainably improve grid stability and the efficient use of renewable resources.

[17] *DENA (2020)*
[18] *https://www.blog.google/inside-google/infrastructure/data-centers-work-harder-sun-shines-wind-blows/*

Electrification - also in connection with the building sector - correlates strongly with the respective energy prices and is therefore already much more advanced in Northern Europe. Digital applications in particular make electrification cost-effective. In addition, the resulting, flexible and price-driven demand can lead to a stabilization of capacity utilization and consequently reduces the volatility of energy prices. As a result, the earnings of producers of renewable energies are stabilized and expansion is subsequently promoted. Any remaining excess capacity can be used for indirect electrification in line with demand. This involves the conversion and thus storage of electrical energy into synthetic fuels and e.g. hydrogen. These energy carriers are available for further use and enable climate-neutral operation.

These interrelationships illustrate the key role of energy efficiency. The synergy effects of renewable energies are used and primary energy consumption and emissions are significantly reduced. Progress in digitization and electrification points the way to reforming the design of production and network capacities in a sustainable manner and adapting them to changing conditions.

7. Conclusion

Energy efficiency is a cornerstone of energy system transformation. In addition to the savings needed to achieve climate targets, synergy effects with renewable energies offer great potential for the decarbonization of the economy. For this reason, the speed of implementation and the visibility of energy efficiency must be accelerated and increased. Only in this way can the limitation of global warming to below 2°C be achieved. In order to achieve this goal, the IEA estimates that from 2035 onwards almost half of global energy investments will have to go into energy efficiency.

Cross-cutting technologies offer enormous savings potential across all sectors. In connection with energy efficiency measures, digital technologies open up the possibility of successfully reorganizing the energy supply. Sector coupling and the associated electrification are necessary in order to achieve a move away from fossil fuels.

Energy efficiency measures offer high potential to generate advantages from a company's point of view. By contracting, savings are possible without tying up capital, while service providers, investors and society also benefit from the measures.

Energy efficiency creates a win-win-win-win constellation.

Gain more insight by visiting our homepage:
https://www.aquila-capital.de/en/energy-efficiency

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A publication of Aquila Capital Investmentgesellschaft mbH. As of August 2020. Author: Peter Schnellhammer