Assessing the impact of high energy prices on the economic potentials for energy savings in the EU

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Content

List of most common abbreviations

BCM - Billion cubic metres

BOE - Barrel of oil equivalent

EED – Energy Efficiency Directive

FEC - Final energy consumption

GHG – greenhouse gas

MWh - Mega-Watthours

NCV - Net calorific value

PEC - Primary energy consumption

REF2020 - EU Reference Scenario 2020

REF2007 – EU Reference Scenario 2007

TCE - Tonne of coal equivalent

Mtoe – Million tonnes of oil equivalent

1. Introduction

The level of energy savings which can be realised through energy efficiency investments that are economic, the so-called economic potential, plays an important role in informing the setting of the EU's energy efficiency target level. Achieving a target in line with the economic potential should be feasible while maximising the economic, societal and climate benefits.

Energy prices are one very important factor in assessing the economic potential. Energy prices increased strongly over the last months, linked to a new level of Russian aggression and invasion of Ukraine. They are likely to remain higher than projected for the EU.

This paper provides a **sensitivity analysis of the impact of higher energy prices on the economic energy saving potentials**.

It aims at supporting the recast of the Energy Efficiency Directive (EED)[1] currently discussed in European Parliament and Council.

It is based on the update of the economic potential in a report by Stefan Scheuer Consulting and Fraunhofer ISI, published October 2021[2]. The report assessed the Fit for 55 package published by the Commission in July 2021[3].

The assessment of the economic potentials was based on energy price projections provided in the EU Reference Scenario 2020 (REF2020) which was published by the European Commission in 2021.

2. Energy prices projections for 2030 in the EU 2020 reference scenario and recent energy price developments

The EU Reference Scenario 2020 (REF2020) referred to the following assumptions on fossil fuel prices (Table 1) and on (wholesale) electricity prices (European Commission, 2021)[4].

The gas, coal and electricity prices show a relatively stable evolution up to 2030, while oil prices are seen as increasing but not higher than 2010 levels. The year 2020 is particular in those tables, given the strong dip in energy prices due to the reduced demand of energy following the economic downturn from the Covid-19 pandemic.

[1] European Commission proposal from July 2021 to revise the Energy Efficiency Directive
[2] Scheuer & Fraunhofer ISI, 2021. Will the Fit for 55 package deliver on energy efficiency targets? A high-level assessment.
[3] The report provides high-level recommendations for strengthening the target ambition and governance and for increasing the synergies with other pieces of the package. In particular it assessed the different governance approaches in EU climate and energy policies; developed an energy efficiency target benchmarking and allocation approach; and updated the EU's and national economic energy savings potentials.
[4] Values are provided in Dollar and Euro per barrel of oil equivalent. For easier comparison with present prices, we added conversions to MWh for gas and to tonnes of coal equivalent to the tables.

Table 1: Fossil fuel prices 2000-2050, EU Reference Scenario 2020 (REF2020)

In $ per boe (barrel of oil equivalent)	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Oil	38.4	65.4	86.7	52.3	39.8	59.9	**80.1**	90.4	97.4	105.6	117.9
Gas (NCV)	26.5	35.8	45.8	43.7	20.1	30.5	**40.9**	44.9	52.6	57	57.8
Gas (NCV) in $ per MWh	*16.3*	*22.0*	*28.1*	*26.8*	*12.3*	*18.7*	***25.1***	*27.6*	*32.3*	*35.0*	*35.5*
Coal	11.2	16.9	23.2	13.1	9.5	13.6	**17.6**	19.1	20.3	21.3	22.3
Coal in $ per tonne of coal equivalent (tce)	*53.7*	*81.0*	*111.2*	*62.8*	*45.5*	*65.2*	***84.3***	*91.5*	*97.3*	*102.1*	*106.8*
In € per boe (barrel of oil equivalent)	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Oil	34.6	58.9	78.2	47.2	35.8	54	**72.2**	81.5	87.8	95.2	106.3
Gas (NCV)	23.4	31.7	40.6	38.7	17.8	27	**36.2**	39.7	46.6	50.5	51.2
Gas (NCV) in € per MWh	*14.4*	*19.5*	*24.9*	*23.8*	*10.9*	*16.6*	***22.2***	*24.4*	*28.6*	*31.0*	*31.4*
Coal	9.9	15	20.6	11.6	8.4	12	**15.6**	16.9	18	18.9	19.7
Coal in € per tonne of coal equivalent (tce)	*47.4*	*71.9*	*98.7*	*55.6*	*40.2*	*57.5*	***74.7***	*81.0*	*86.2*	*90.6*	*94.4*

Source: European Commission (2021)

Table 2: (Wholesale) electricity prices 2015-2050, EU Reference Scenario 2020 (REF2020)

In € per MWh	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
(Wholesale) electricity prices				26	24		**24**		24		25

Source: European Commission (2021)

Present price levels are considerably higher, see the following graphs for crude oil (Figure 1), natural gas (Figure 2), coal (

Figure 3) and wholesale electricity (Figure 4). This was partly triggered by the war in Ukraine, but in most cases, prices started going up before the war, due to the uptake in worldwide activity, resource scarcity and carbon pricing.

Figure 1: Evolution of crude oil prices 2017-2022 in $/boe (West Texas Intermediate WTI)[5]

[5] The West Texas Intermediate (WTI) benchmark for US crude is the world's most actively traded commodity. Crude Oil prices displayed in Trading Economics are based on over-the-counter (OTC) and contract for difference (CFD) financial instruments.

Source: Trading Economics April 2022, https://tradingeconomics.com/commodity/crude-oil

Figure 2: Evolution of Dutch TTF natural gas prices in €/MWh2017-2022[6]

Source: Trading Economics April 2022, https://tradingeconomics.com/commodity/eu-natural-gas

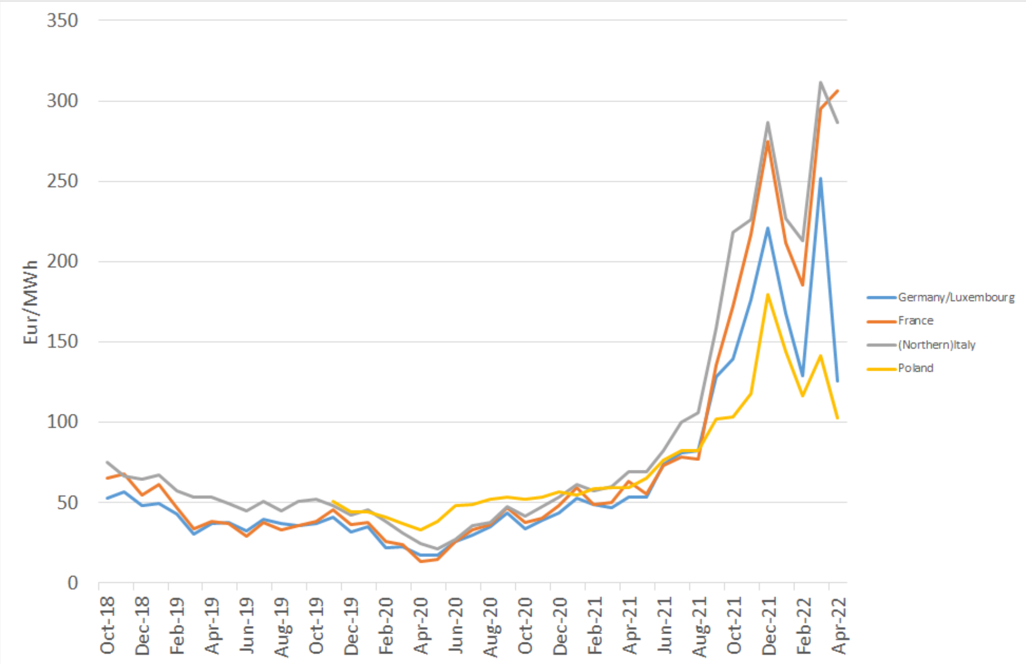
Figure 3: Evolution of coal prices in $/tce 2017-2022[7]

Source: Trading Economics April 2022, https://tradingeconomics.com/commodity/coal

[6] Dutch TTF Gas is a leading European benchmark price

[7] Coal futures are available for trading in the Intercontinental Exchange and on the New York Mercantile Exchange. The standard GC Newcastle contract weights 1,000 metric tonnes. Coal is the major fuel used for generating electricity worldwide. Coal prices are based on over-the-counter (OTC) and contract for difference (CFD) financial instruments.

Figure 4: Evolution of electricity whole sale prices in Germany/Luxembourg, France, (Northern Italy), Poland 2018-2022[8]



Source: SMARD Electricity Market data, https://www.smard.de/home/

Table 3 shows the comparison of present energy price levels with the 2030 price projections in the EU Reference Scenario 2020.

Table 3: Comparison of present energy price levels with the 2030 price projections in the EU Reference Scenario 2020

Energy carrier	Energy Prices April 2022*	Ratio energy prices April 2022/ EU REF2020 projected for 2030	Share (2019) of energy carrier n EU Final Energy Consumption**
Oil ($/boe)	98	**1.23**	43.2%
Gas (NCV) (€/MWh)	103	**4.63**	25.5%
Coal ($/tce)	292	**3.46**	4.6%
Wholesale electricity (€/MWh)	126	**5.25**	26.7%
Weighted average		***3.27***	***100.0%***
* based on https://tradingeconomics.com/ and www.smard.de			
** ODYSSEE database, www.odyssee-mure.eu (sum of oil, gas, coal and electricity, excluding heat and biomass)			

Source: own calculations based on European Commission (2021); tradingeconomics.com; ODYSSEE-MURE database www.odyssee-mure.eu; SMARD Electricity Market data, https://www.smard.de/home/

While oil prices have been increasing comparatively moderately by around a quarter, the prices of natural gas, coal and wholesale electricity have been multiplied by factors of 3.5 to 5.3. The price increase in wholesale electricity follows the increase in gas prices, as natural gas is still setting the electricity prices in the margin. Even with higher expected shares of renewables, which are

[8] own calculation of monthly averages of hourly wholesale prices, published by SMARD Electricity Market data, https://www.smard.de/home/

frequently cheaper than gas, this will still be valid, as long as natural gas remains among the power supply options in Europe. **In a weighted average of oil, gas, coal and electricity, today's price is 3.3 times higher than the price projections for 2030.**

This increase is not expected to be only temporarily, due to the fundamental change in energy sourcing the EU's Member States are undertaking in order to phase out Russian energy imports, which make up around 50% of total imports. One could argue that the shift in global supply structures would, at the end, be neutral for energy prices, as Russian gas and oil would be taken up by other countries worldwide, notably by China, India or Pakistan[9]. However, these restructuring efforts require substantial new infrastructure investments and may possibly not be realised with the expected speed until 2030. There will also be an increasing price driver on gas from carbon pricing schemes, which are arising in a number of countries including in China. These factors indicate that there could be a definite upward pressure on gas and oil prices as compared to EU REF2020 projections (although strong savings on natural gas will also dampen the possible rising prices).

3. Scenario assumptions for the analysis

The scenario assumptions are similar to the ones described in Scheuer/Fraunhofer ISI (2021). Differences are introduced with respect to the energy prices. We consider two scenarios for the increase in prices:

1) **moderate price increase compared to 2030 projections**, assuming an increase by 30% (as observed today for oil as compared to the 2030 projections) and

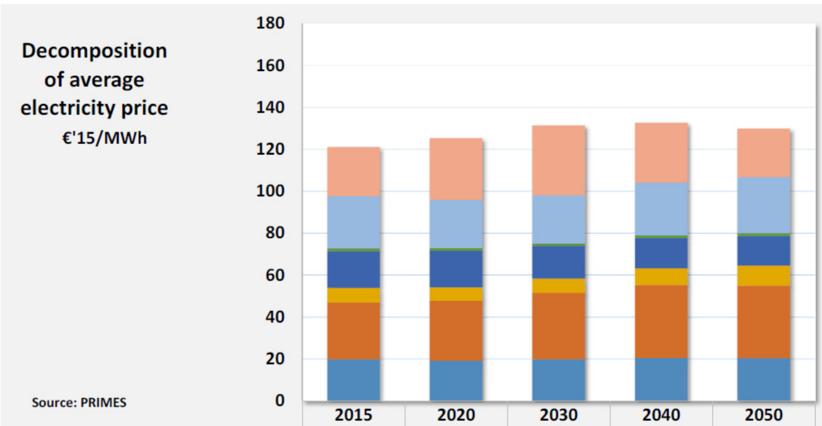
[9] Under plans previously drawn up, Russia aimed to supply China with 38 bcm of gas by pipeline by 2025 (Power of Siberia pipeline), ramping up from 5 bcm in 2020. In February 2022, Russia and China agreed on a new pipeline, which would add a further 10 bcm. Gazprom on March 1 announced it had begun taking concrete steps toward the construction of the Power of Siberia 2 pipeline, which would pass through Mongolia and have an annual capacity of around 50. These projects would expand pipeline capacity between the countries to over 100 billion bcm a year -- equivalent to almost half of China's imports. China imports about 40%, the biggest portion, of its LNG from Australia. Just over 10% comes from the U.S. China seeks imports from Russia, in order to diversify supplies and render the countries less exposed to supply concentration. The expansion benefits Russia as well. The country supplied between 170 bcm and 200 bcm of natural gas to Europe through pipelines in recent years. The new and expanded links with China are expected to help offset the decrease in exports from Russia to Europe over the war in Ukraine. Still, obstacles remain. Power of Siberia sent 10 billion cu. meters of gas to China last year, less than 30% of its total capacity. The shortfall is attributed to limited transportation capabilities on the Russian side. Gas for export to China and to Europe are also extracted at different locations, with no pipelines connecting them. There needs to be massive investments in pipelines and other facilities in order to divert natural gas meant for export to Europe to China. Also the dependence of China on critical IT products from the US is a barrier to built up the link Russia-China rapidly (Source: summarised from https://asia.nikkei.com/Business/Energy/China-turns-to-Russian-gas-to-curb-dependence-on-Quad-members).
Concerning India, Gazprom had given up on the construction of pipelines to India and Japan in 2021, considering politics and cost factors. LNG projects in the Far East remain an option for Russia (Source: https://www.seetao.com/details/86540.html). Pakistan has plans to finalise a Russian-built gas pipeline despite international pressure to isolate Moscow economically (Source: https://www.ft.com/content/9294890a-593c-442b-bc53-13099d14d36f).

2) **high price increase compared to 2030 projections**, assuming an average increase by 100% compared to the REF2020 scenario[10], i.e. a doubling of projected energy prices in 2030 (while today's observed energy prices even more than tripled on average).

A doubling of wholesale energy prices does not mean that the prices for consumers will double. This is illustrated with the different components contributing to electricity prices (Figure 5). Wholesale prices of electricity are essentially composed of fuel costs and other variable costs (including related charges like carbon costs on fossil-generated electricity). The wholesale price component in the 2030 projections represents around 15% of the total electricity prices while grid costs, capital costs, fixed costs and taxes on electricity represent major other cost components. A factor of 2.8 increase in wholesale prices would increase average prices for the consumer by a bit more than a quarter. The same is valid for transport fuels which have high tax components.

Some sectors are more impacted by increases in average electricity prices. Figure 6 shows the differentiation by sector. It can be seen that in particular the industry sector is more strongly impacted by rising wholesale prices, as the charges on electricity in industry are considerably lower than for households and services. Hence, increasing electricity prices set proportionally higher incentives to improve energy efficiency. However, it can also be expected that part of the industrial sector, the more energy-intensive industries, would be more strongly shielded from price increased, as compared to smaller industries, services and households.

Figure 5: Components of projected electricity prices in EU Reference 2020

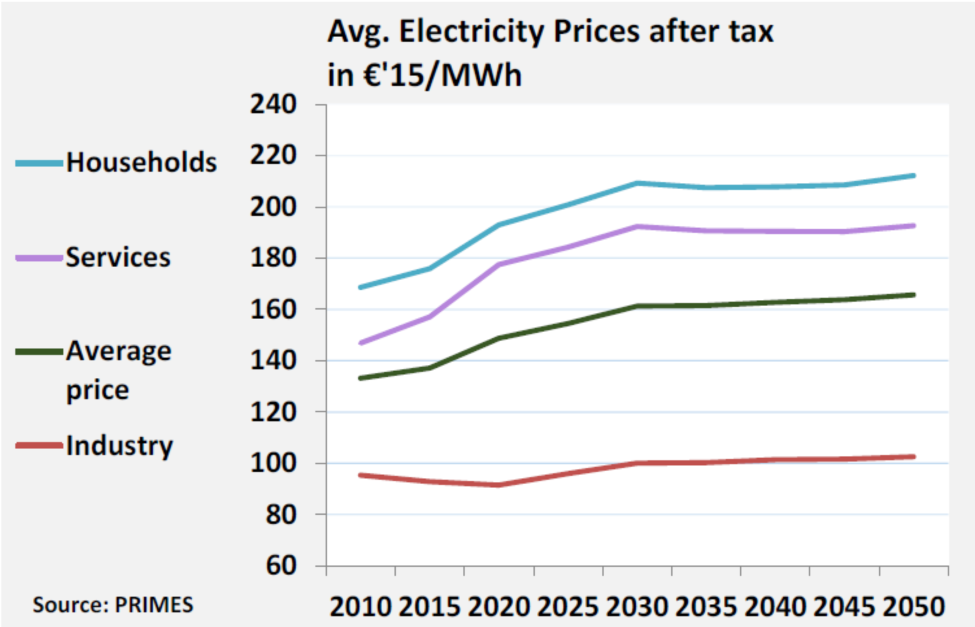


	2015	2020	2030	2040	2050
Annual capital cost	23	29	33	29	23
Fixed costs	25	23	23	25	27
Variable costs	1	1	1	1	1
Fuel costs	18	17	16	15	14
Tax on fuels and ETS payments	7	6	7	8	10
Grid costs	27	29	32	35	34
Excise tax and VAT on electricity	20	19	20	21	20
Average price of electricity (after tax)	146	151	158	159	161

Source: European Commission (2021)

[10] For oil this implies a limited increase compared to the 2030 projections like for the moderate price increase compare to 2030 projections: For natural gas, coal and electricity price increases are differentiated with factors of 1.9 (coal), 2.5 (gas) and 2.8 (electricity).

Figure 6: Projected electricity prices in EU Reference 2020 by sector



Source: European Commission (2021)

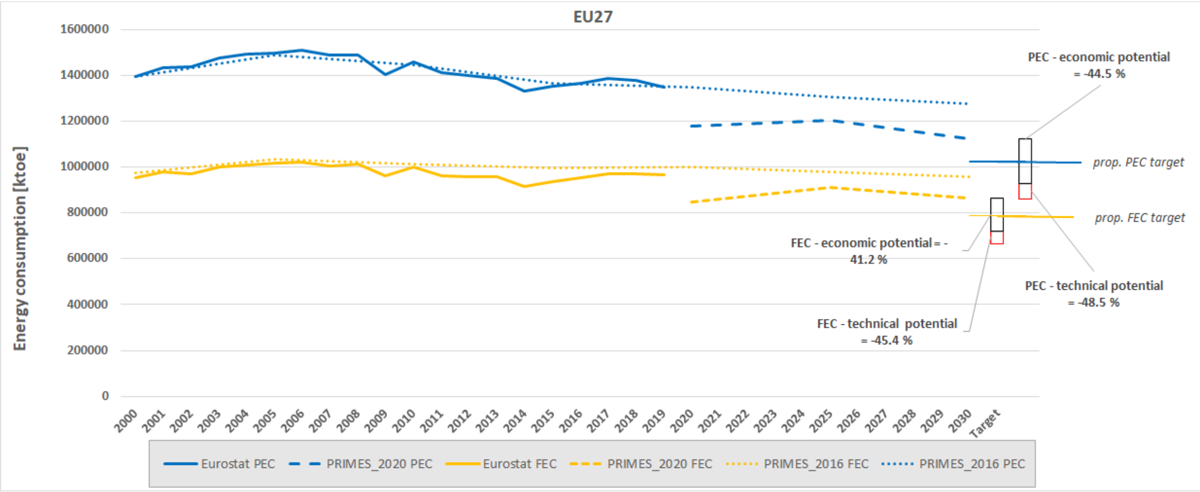
4. Impact of higher energy prices on economic potentials

Figure 7 shows the impacts of the energy price increase on energy saving potentials in 2030 compared to projected electricity prices in EU Reference 2020.

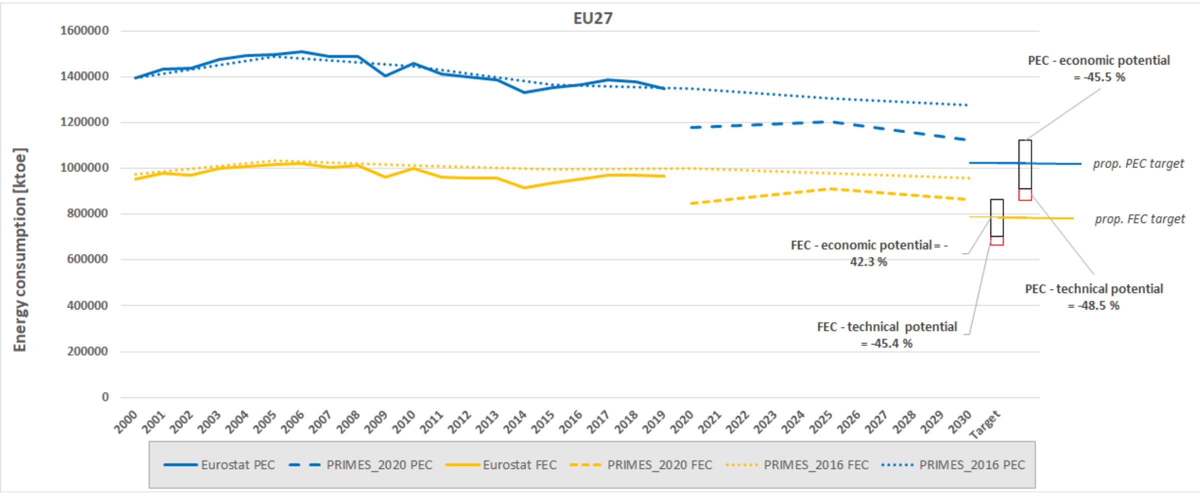
The graphs "a-c" in Figure 7 also show the historical evolution of Primary and Final Energy, the PRIMES 2020 and 2016 projections, as well as the proposed PEC and FEC targets from Art. 4 EED. It can be seen, across the three graphs that parts of remaining technical potentials become economic with the increasing energy prices in the scenario with 30% price increase as compared to 2030 projections, while they become economic with doubling of wholesale energy prices.

Figure 7: Impacts of energy price increase on energy saving potentials in 2030 compared to projected electricity prices in EU Reference 2020 (part a). Part b: energy price increase by 30% (compared to projection), Part c: energy price increase by 100% (compared to projection)

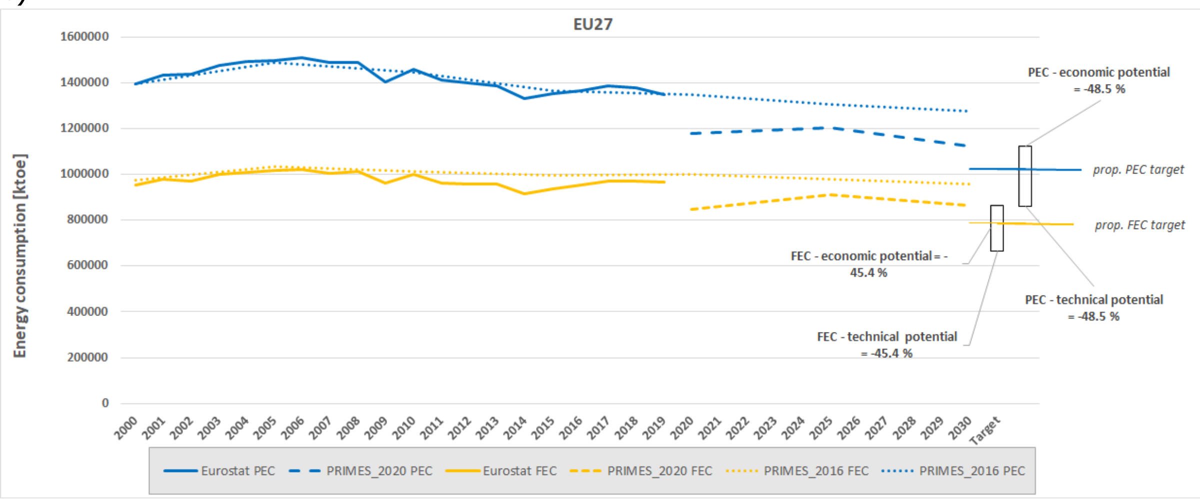
a)



b)



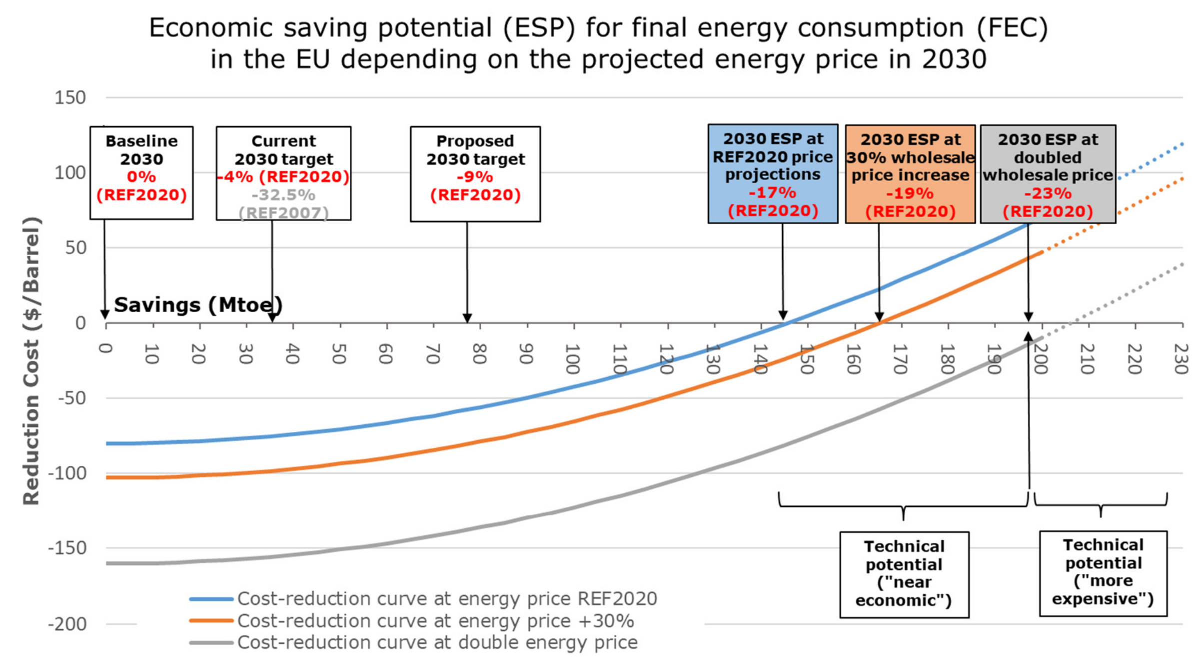
c)



Source: own calculation based on Scheuer/Fraunhofer ISI (2021)

Figure 8 provides additional information on the impacts of increasing energy prices in 2030.

Figure 8: Share of technical potentials becoming economic with increasing energy prices in 2030 (as compared to REF2020 projections)



Source: Fraunhofer ISI/Stefan Scheuer Consulting, Assessing the impact of high energy prices on the economic potential for energy savings in the EU, April 2022

Source: own calculation based on Scheuer/Fraunhofer ISI (2021)

The figure shows the economic potentials in absolute figures (Mtoe) on the horizontal axis. The vertical axis shows the cost of savings. Negative figures imply cost savings. Increasingly the potentials get more expensive, until there are no cost savings any more (see blue curve up to the point where it crosses the horizontal axis). After this point, potentials have to be realised at a net positive cost. This is the range of technical potentials. Economic and technical potentials depend also on the time horizon considered (here for 2030). With longer time horizons (e.g. 2050), potentials get larger due to the longer time period in which reinvestment occurs and due to learning and scale effects.

Typically, analyses of technical potentials do not include extremely expensive potentials but mainly "near economic" potentials, which have a chance to be realised with changing boundary conditions in particular increased energy prices as compared to the initial assumptions. Beyond that point, technical potentials get more expensive (dashed blue line) and are typically excluded from the analysis to keep a conservative view on potentials.

With increasing energy prices, the cutting point with the horizontal axes moves to the right and economic potentials become larger (yellow line: +30% of wholesale prices in 2030 compared to REF2020; grey line: doubling in wholesale prices in 2030 compared to REF2020).

Figure 8 shows the absolute energy saving potentials in Mtoe final energy demand (FEC), as well the relative potentials compared to REF2020, which is the baseline chosen by the European Commission to express the 2030 targets in its proposal for a recast of the EED from 2021.

Key findings from this study with respect to the increase in saving potentials for final energy demand due to higher wholesale energy price as compared to REF2020 are the following[11]:

- REF2020 sets the starting point as 0% for the economic potential by 2030, which corresponds to 864 Mtoe FEC (29.7% below the old baseline REF2007).
- The current 2030 targets of the EED is 4% below REF2020, which corresponds to 829 Mtoe FEC (32.5% below REF2007).
- The 2030 targets in the proposed EED recast are 9% below REF2020, which corresponds to 787 Mtoe FEC (36% below REF2007).
- With the REF2020 energy prices projections, the economic energy saving potentials lead to 16.9% below REF2020, which corresponds to 718 Mtoe FEC (41.5% below REF2007).
- With 30% increase in wholesale energy prices by 2030 compared to REF2020 (around the current increase in oil prices), the economic potentials increase and lead to 19.1% below REF2020, which corresponds to 699 Mtoe FEC (43.1% below REF2007).
- With doubling of wholesale energy prices compared to REF2020 (equivalent to 60% of the current price increase) all technical potentials become economic and the economic potentials lead to 22.9% below REF2020, which corresponds to 667 Mtoe FEC (45.7% below REF2007). To note: doubling of the whole sale prices does not mean a doubling of prices for the consumer. For example, it would only lead to a 15% increase of average household electricity prices.
- Technical potentials, as discussed in Scheuer/Fraunhofer ISI (2021) and in this study, only include economic and near economic potentials. Technical potentials could further increase if more expensive options or options with higher barriers, e.g. accelerated deployment of skilled labour, excluded by the time, would be included.

Interestingly, the area between the horizontal axis and the blue/yellow/grey curves up to the cut-even points provide the saved energy cost. These are, in the case of the original 2030 price projections 50.6 billion Euro, with 30% increased

[11] Note that the numbers for the EU 2030 targets and economic potentials with REF2020 prices in relation to REF2007 have slightly changed from Fraunhofer ISI & Scheuer 2021, due to changed assumptions about the impact of the new Eurostat method.

prices 73.8 billion Euro and with doubled wholesale prices 143.1 billion Euro. **The higher the energy prices the more important it is to deliver energy savings and increase the target ambition.** The additional total financial savings for energy end users amount to over 90 billion Euro in the doubling wholesale energy price scenario.

Energy savings are sometimes associated with rebound effects: For example, will higher energy prices lead to higher material prices and thus increase the energy efficiency investment expenditures? This may indeed be the case to a limited extent and in the short term, when capacities still need to be adapted. Nevertheless, there are two points to be considered:

- increased material prices constitute only part of the renovation cost, see also Hinz/Enseling (2022) who investigate the economics of ambitious building renovations with increased energy cost in Germany. They conclude for buildings under current very high energy prices that "*even ambitious modernisation is economically more attractive than not modernising. At the same time, a CO_2 reduction of up to 95 % can be achieved*." Therefore, the link between higher energy savings rates and increasing material prices is a weak one.
- second, experiences from other energy saving technologies (e.g. for double and triple glazing or for non-energy related fields) have shown, that the market is able to cope with the increasing cost by increased productivity (e.g. by developing modular solutions for the renovation of buildings) which, at the end, reduces the cost increase through scale and learning effects.

5. Literature

European Commission (2021), Directorate-General for Climate Action, Directorate-General for Energy, Directorate-General for Mobility and Transport, De Vita, A., Capros, P., Paroussos, L., et al., *EU reference scenario 2020 : energy, transport and GHG emissions : trends to 2050*, Publications Office, 2021, https://data.europa.eu/doi/10.2833/35750

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