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Michael G.
Pollitt

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05 July 2023

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1. Introduction

There has been an unprecedented energy crisis in Europe affecting gas and electricity prices over the period since August 2021. Due to a combination of a faster than expected recovery from the COVID-19 pandemic, combined with an initially low level of gas stocks following the winter of 2021-2021, prices began to rise. This rise was then exacerbated by the build-up to the full scale Russian Invasion of Ukraine on 24th February 2022 and the subsequent disruption of Russian gas exports to Europe. As of the time of writing, gas and electricity prices are expected to remain elevated (i.e., above July 2021 levels) until 2025.[2]

[1] This is based on a talk prepared for the IAEE session on 'Geopolitics, Energy Markets, Decarbonization and the Russian Ukrainian War' at the ASSA Meeting, New Orleans, January 7th, 2023. The author wishes to acknowledge the support of the Centre on Regulation in Europe (CERRE) for related work in Pollitt (2022a), von der Fehr et al. (2022) and Pollitt et al. (2022a). He is grateful for the support of his CERRE colleagues, CERRE members and for many discussions with European energy stakeholders. He also thanks Adonis Yatchew and an anonymous referee for helpful comments on an earlier draft. All errors remain his own.

[2] As of 04 July, 2023, the ICE Dutch TTF Natural Gas futures price exceeds the July 2021 actual level of 37.50 Euro / MWh until Winter 2025. https://www.theice.com/products/27996665/Dutch-TTF-Gas-Futures/data?marketId=5564180 EEX Annual Dutch Power futures are above July 2021 level of 100 Euro / MWh until 2025 (as of 04 July, 2023). See https://www.eex.com/en/market-data/power/futures

This article discusses the lessons of the crisis with a focus on its implications for electricity markets. This is particularly relevant because Europe has had a successful electricity transition based on both increasing the share of renewables *and* increasing the share of gas generation. Thus, gas and electricity markets have become increasingly integrated since 2000.[3] The crisis gives rise to two sets of reflections based on the nature of energy policy in wartime and on the actual policies discussed and implemented during the crisis. The experience is rich because many European countries have faced the same shock and there has been a degree of experimentation, co-ordination and learning.

We will begin by discussing the historical scale of the price shock in section 2. The statistics show that the shock to both gas and electricity prices has been historically unprecedented. In section 3 we will discuss how energy policy is different in wartime. This is important because Europe has been in an energy war with Russia, where Europe has attempted to rapidly reduce both its gas consumption and Russian energy dependency, while Russia has strategically restricted gas exports in an attempt to raise gas prices thereby exercising geopolitical leverage. Section 4 examines European Union (EU) policy responses. The EU is responsible for the European single market in electricity and gas (which also formally includes Norway and effectively includes the UK) and has attempted to co-ordinate the EU-27 responses. Section 5 discusses four good and three bad policy responses observed across Europe during the crisis. Section 6 concludes with lessons for energy and climate policy, arising from this gas and electricity price shock.

2. The historical scale of the 2021-23 energy crisis

Wholesale gas and electricity prices reached prolonged periods of elevated prices not seen before, since the inception of European gas[4] and electricity spot markets.[5] respectively. As an example, the price of natural gas in Great Britain rose from 60 pence per therm in May 2021 to a monthly peak of nearly 460 pence in August 2022. During this period, average monthly prices never fell below 175 pence per therm, see Figure 1. Weekly Russian gas exports to Europe had fallen by 30% relative to a year earlier in the first 8 weeks of 2022, prior to the invasion; by the week of the 8th of September 2022 they were 80% the level of a year earlier.[6]

[3] See rise in share of renewables + gas generation since 2000: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Electricity_and_heat_statistics
[4] The UK's NBP has been operating since the late 1990s. The Dutch TTF gas market began in 2003; see https://www.gasunietransportservices.nl/en/about-gts/gastransport/ttf
[5] Individual country electricity markets began in the 1990s. European electricity market coupling formally began in 2014: see https://www.entsoe.eu/network_codes/cacm/implementation/sdac/
[6] https://www.bruegel.org/dataset/european-natural-gas-imports

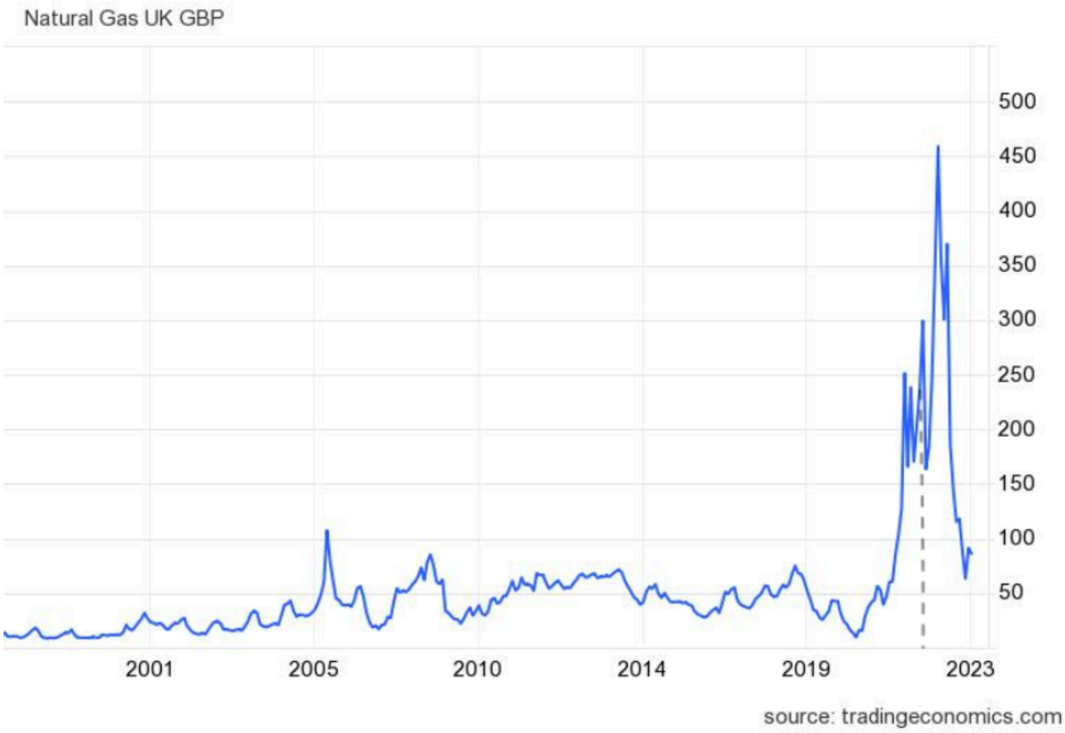


Figure 1: Great Britain Wholesale Gas Price, monthly, pence per therm (Dashed line indicates February 2022)

In Europe, natural gas is the marginal fuel for power generation much of the time. The increased gas prices translated directly into elevated wholesale power prices. The price rose from £65 per MWh on 28 April 2021 to a peak of £580 per MWh on 30 September 2022. Between 1 October 2021 and 31 January 2023, daily prices never fell below £140 per MWh (see Figure 2).

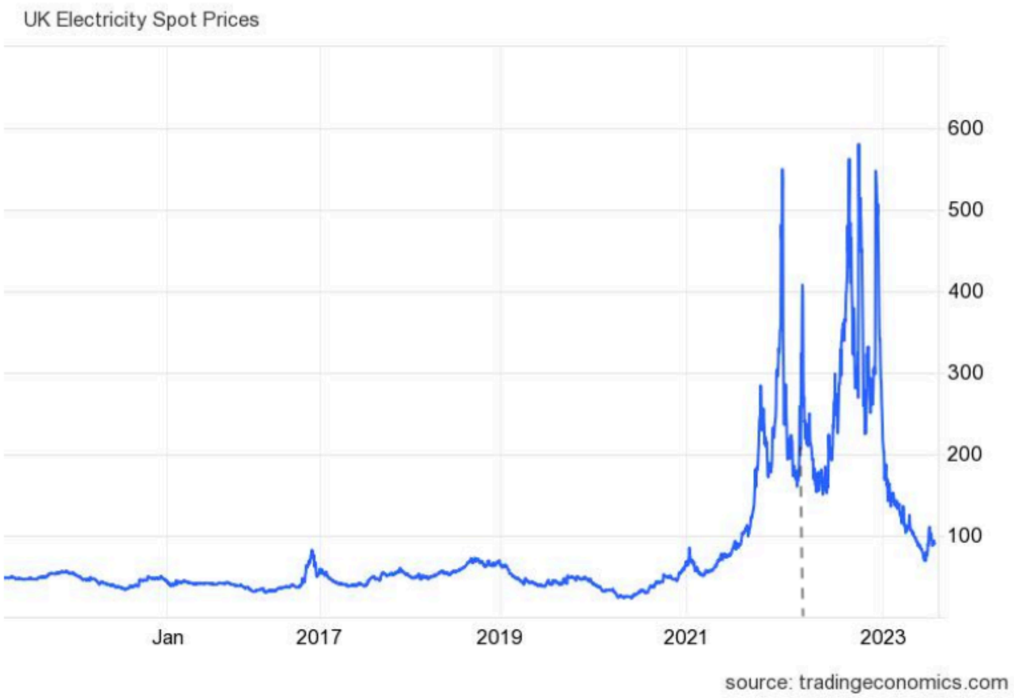


Figure 2: Great Britain Wholesale Electricity Price, daily, £ per MWh (Dashed line indicates week of 24 February 2022)

The impact of such large and sustained rises in wholesale gas and electricity prices on both industrial and residential gas and electricity retail prices could be expected to be profound. A key indicator of this can be seen in the impact on the energy price cap calculated by Ofgem for household gas and electricity prices[7]. This sets the maximum tariff for energy suppliers on the basis of forward prices.

[7] See https://www.ofgem.gov.uk/information-consumers/energy-advice-households/check-if-energy-price-cap-affects-you

Price cap period	Oct 2019 – Mar 2020	Apr 2020 – Sep 2020	Oct 2020 - Mar 2021	Apr 2021 – Sept 2021	Oct 2021 - Mar 2022	Apr 2022 – Sep 2022	Oct 2022 – Dec 2022	Jan 2023 – Mar 2023	Apr 2023 - Jun 2023	Jul 2023 – Sep 2023
Calculation Date	August 2019	February 2020	August 2020	February 2021	August 2021	February 2022	August 2022	November 2022	February 2023	May 2023
Electricity Standard Credit 3100 kWh										
Wholesale Elec Cost	220.8	213.2	186.3	221.4	277.9	515.3	1154.5	1597.2	1090.0	493.3
Electricity Total	**652.5**	**654.4**	**634.9**	**691.8**	**749.5**	**1059.2**	**1795.6**	**2280.2**	**1780.5**	**1143.3**
Gas Standard Credit 12000 kWh										
Wholesale Gas Cost	230.8	206.3	145.1	187.1	276.5	586.8	1376.8	1631.9	1133.4	572.3
Gas Total	**552.0**	**533.1**	**467.6**	**510.5**	**596.6**	**998.0**	**1893.0**	**2172.1**	**1636.8**	**1023.1**

Source: Ofgem[8]

Table 1: Ofgem price cap calculation for electricity and gas in £ for standard annual consumption

Table 1 shows the evolution of this calculation. Wholesale costs rose by a factor of 8.7 for gas and 7.2 for electricity between price cap period April to September 2021 to price cap period October to December 2022. This would have translated to a 325% rise in gas bills and 220% rise in electricity bills. However, the government capped the combined default price rise to a mere 108% through the introduction of the Energy Price Guarantee from 1 October 2022,[9] which aimed to limit combined standard electricity and gas bills to £2500, by which point most households had defaulted on to these capped tariffs. This cap was put in place to July 2023. A parallel scheme for businesses, the Energy Bills Discount Scheme, was also introduced.[10]

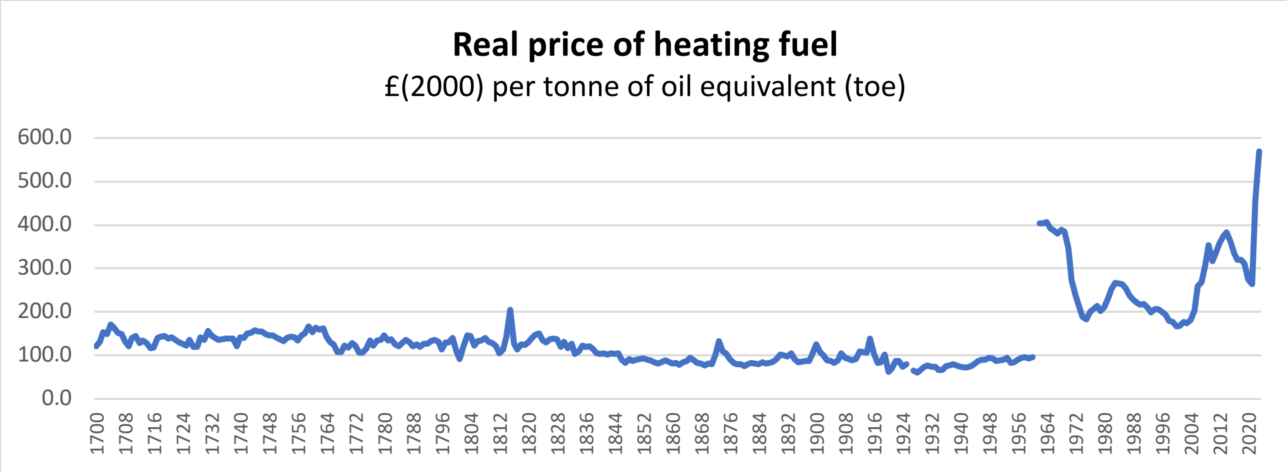
In addition, to the implementation of Energy Price Guarantee, the UK government also implemented a significant programme of direct fiscal support for higher energy bills, some of which resulted in lower calculated bill rises.[11] In spite of this, as a result of the crisis, annual real retail gas price rises exceeded those of any time in recorded history. Figure 3 shows that price of heating fuel for households rose to the highest level since 1700. Between 2021 and 2022 the real rise was 73%: this was higher than the previous highest year (2006) in which it was 28%.

[8] Source: https://www.ofgem.gov.uk/publications/default-tariff-cap-level-1-july-2023-30-september-2023 See Model - Default Tariff Cap Level v1.18.

[9] See Pollitt et al. (2022b).

[10] See: https://www.gov.uk/guidance/energy-bills-discount-scheme

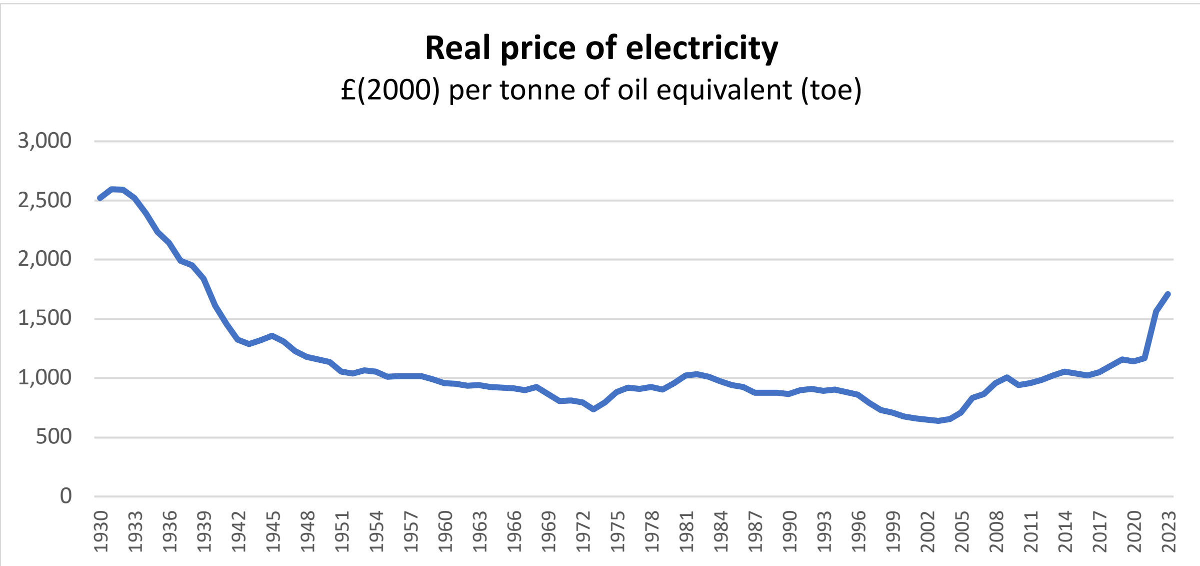
[11] See: https://www.gov.uk/government/publications/government-support-for-the-cost-of-living-factsheet/government-support-for-the-cost-of-living-factsheet



Source: Fouquet (2020), updated to May 2023 using ONS data.

Figure 3: UK retail heating fuel prices are higher than at any time since 1700

Real retail electricity prices also recorded the largest annual rise between 2021 and 2022 (33%). The previous largest annual real rise since 1931 was 18% (also in 2006). Prices returned to levels not seen since 1940, at the end of the initial period of mass household electrification (see Figure 4).



Source: Fouquet (2020), updated to May 2023 using ONS data, Energy Trends March 2023.

Figure 4: UK retail electricity prices at levels not seen since period of mass electrification

Not surprisingly these ultra-high price rises have produced measurable impacts on gas and electricity demand. Domestic gas demand in the UK fell 19% in 2022 and electricity demand fell 5.9% in 2022.[12] The declines might have been higher still in the absence of the direct fiscal support received by households for energy bills.[13] The impacts on industry are harder

[12] Source: Department for Energy Security and Net Zero (2023).

[13] The UK Office for National Statistics (ONS) calculates energy price inflation on the basis of average unit price paid and hence must determine whether a bill rebate is a (negative) tax change or a price reduction. Tax rebates, *per se*, do not affect prices.

to discern given the recovery from the pandemic, changing industrial structure and the timing of energy supply contract renewals.

The energy bill shock is macro-economically significant. Direct energy price inflation made a 2.59% contribution to local peak UK consumer price inflation of 11.1% (in October 2022).[14] The quarterly terms of trade effect on the UK from higher energy prices on the real domestic income has been almost as great at the first oil shock and calculated (by the UK Office for National Statistics) at around 2% of GDP.[15] Many other European countries have experienced similar or even larger negative terms of trade effects.[16] It is worth noting that the US and Canada have benefited from positive terms of trade impacts.

The UK has not been alone in experiencing the energy price shock. The EU-27 and Norway are explicitly in a single wholesale gas and electricity market, while the UK and Switzerland are implicitly part of this single electricity market. European wholesale gas and electricity prices have been similarly affected and countries across Europe have experienced similar pressure to raise domestic gas and electricity prices and/or provide fiscal support to households and businesses. Eurostat records that across EU-27 countries gas bills for households went up 45%[17] and electricity bills went up 21%[18] between the second half of 2021 and the second half of 2022 (in nominal terms).

Total fiscal support for energy bills across Europe has been recorded at 758 bn Euros since September 2021[19]. This has ranged from 9% of GDP in Slovakia, with a further 18 countries committing above 3% of GDP (the UK is close to 4%). Given that a lot of this funding is effectively to support direct gas consumption and gas-produced electricity production, this constitutes a huge subsidy to fossil fuels. Indeed, Europe's fiscal subsidies to energy are higher than the $532 bn of global fossil fuel subsidies reported by the IEA in 2021.[20]

3. What wartime energy policy teaches us about how to respond to an energy crisis

Both Pollitt (2022a) and Stiglitz (2022) make the point that energy policy should be different in wartime! While the market is a wonderful institution for human flourishing, in wartime, markets may not work well in delivering desirable outcomes for society. This is especially true in energy when international trade is disrupted by war.

The experience of how energy policy operated during World War Two (WW2) in the UK is informative. The fundamental problem in wartime is how to match demand to supply while not allowing prices to rise excessively. As can be discerned from Figures 3 and 4, the period

[14] See: https://www.ons.gov.uk/economy/inflationandpriceindices/bulletins/consumerpriceinflation/october2022#consumer-price-inflation-data

[15] See: https://www.ons.gov.uk/economy/grossdomesticproductgdp/articles/thepurchasingpowerofgdpuk/2022

[16] The negative terms of trade effect is larger in Germany, Italy, Spain and the Netherlands (ONS, 2023).

[17] Source: Eurostat series NRG_PC_202.

[18] Source: Eurostat series NRG_PC_204.

[19] Sgaravatti et al. (2021) updated to 24 March 2023 record the evidence on the scale of the fiscal interventions across Europe.

[20] See: https://www.iea.org/topics/energy-subsidies

1939-45 is not characterized by notable rises in real heat and electricity prices (indeed real electricity prices fell during WW2). The British wartime economists who worked tirelessly to set wartime prices and rations in WW2, helped produce and allocate scarce resources, maintained the morale of the population and, in turn, helped win the war.[21] Similarly, failure to properly manage fuel shortages is costly for governments. The post-WW2 1947 fuel crisis, during which low coal stocks resulted in electricity blackouts, contributed to a reputation for economic incompetence[22] for the incumbent Labour Party which kept them out of office from 1951 to 1964.[23]

Inspired by the wartime experience of the UK we suggest five policies which make sense in the current crisis.

A significant programme of coordinated demand reduction

The fundamental problem driving the energy crisis has been the lack of supply of gas for heating and electricity. This parallels the problem faced by the UK at start of WW2 when the UK needed to conserve its coal stocks for war production which entailed the need to reduce the use of coal for domestic heating. Within days of the start of WW2, ration coupons had been issued for household use of coal (Shin and Trentmann, 2019). This strategy was successful in limiting coal use in a household setting.

What the gas shortage in Europe implied was a significant programme of demand reduction with monitoring and incentives to comply. This needed to take the form of limiting the use of electricity and gas in non-essential settings. Thus, commercial buildings and government offices should have had restrictions on maximum winter thermostat settings and lower bounds on on air conditioning settings which were significantly lower than in previous years. There should have been bans on open doors to commercial buildings in winter. Buildings should have been encouraged to go dark at night. Some European countries did take these sorts of policies more seriously than others, France launched a national plan to explicitly avoid winter power cuts in October 2022.[24] A reasonable target should have been to reduce weather corrected demand by at least 15% through such measures alone. The advantage of such targets is that they induce reductions in demand which translate to higher price elasticity of demand. This allows a smaller retail and wholesale price rise to induce a given demand reduction. In 2003, New Zealand ran a 'Target 10' public advertising campaign to reduce electricity use by 10% due to the need to address a shortage of water in its hydro dams (the target was achieved in a month).[25]

The emerging evidence is that demand did fall due to high prices. Demand fell substantially for households in the UK.[26] It also fell in other European countries, Ruhnau et al. (2023) found weather corrected gas demand in Germany fell by 23% in the second half of 2022.

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[21] See Cairncross (1995) for a discussion of their activities.
[22] For an example of contemporary reaction to the 1947 fuel crisis, see: https://gcgosling.wordpress.com/2021/05/10/labour-and-its-rivals-in-bristol-some-historical-perspective/
[23] Though they did win a slim majority in 1950 (Robertson, 1987).
[24] https://www.reuters.com/business/energy/france-launches-energy-savings-push-avoid-winter-power-cuts-2022-10-06/
[25] See IEA (2005)
[26] See Department for Energy Security and Net Zero (2023).

The IEA estimates that total European gas demand fell 13% in Europe, with demand in industry falling 25% and in buildings by 20%, with the aggregate impact being reduced due to low hydro and nuclear output.[27] Ember (2023) estimates that total EU-27 electricity demand fell by 7.9% in the final quarter of 2022. In the UK the figure was 5.8% lower in Q4 2022 than Q4 2021.[28]

A target to reduce gas demand specifically

In the UK during WW2 the specific energy issues were the need to reduce imported oil demand and to reduce domestic consumption of coal. This led to rationing of petrol and domestic coal, both of which reduced the need to import fuel for non-essential purposes. In both cases domestic demand for petrol and coal were controlled without the need for severe price rises though there were some increases especially towards the end of the war, when non-price demand restraint began to wane.[29] However electricity was not rationed and domestic and farm consumption rose 10% p.a. between 1939 and 1946 (Fouquet, 2020), contributing to coal shortages and electricity power cuts in 1947.

In the present crisis the problem is gas demand which needs to be targeted specifically. Energy intensive industrial output should not be protected where such goods can be imported cheaply from countries with much lower energy prices. This is because energy intensive imports are a natural substitute for the inability to import energy directly. Thus, if a significant part of European gas demand is going to production of aluminium or chemicals then a sensible strategy in the energy war is to import these energy intensive products and reduce their production.[30]

We also need to encourage energy use when wind and sun are available and should move to a system where we discourage energy use specifically on low wind (and low sun) days. We should encourage use of appliances and charging during these times. The European energy system is increasingly weather dominated at weekends, where demand is much lower but sun and wind availability do not decline. One of the lessons from the energy supply crisis is the need to shift industrial production to weekends, because this provides better matching of supply and demand.[31]

The need for a 'Dig for Victory' in Energy

A wartime reduction in energy supply can be met with increased home production of energy. Europe needs a collective 'dig for victory' with accelerated investment in energy.

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[27] See: https://www.iea.org/commentaries/europe-s-energy-crisis-what-factors-drove-the-record-fall-in-natural-gas-demand-in-2022

[28] Source: Table ET 5.2 March 2023.

[29] Discussed in Shin and Trentmann (2019).

[30] EU-27 production of iron, steel and ferro-alloys dropped 18.3% between Q4 2021 and Q4 2022 and production of aluminium dropped 15.7% between Q4 2021 and Q4 2022. Source: Eurostat STS_INPR_Q.

[31] A good recent example of this was in Japan following the Fukushima crisis in 2011, which removed most of Japan's nuclear power plants from the electricity system, where industrial production was reduced during the week and increased at the weekends to make better use of the available electricity capacity. In summer 2011, Tokyo reduced electricity demand by 18%, following the Fukushima Crisis in March 2011 (Kimura and Nishio, 2016).

For instance, the government should encourage the installation of PV on private homes and commercial buildings. A remarkable feature of the crisis is the widespread failure across Europe to prioritise short term investments to increase supply or reduce demand, especially in light of the enormous direct fiscal support costs incurred above. Wind installed capacity increased only slightly in 2022 on 2021.[32] Solar capacity did however increase by 41.4 GW which was 45% higher than in 2021.[33]

On the supply side, in the UK, the historic peak monthly residential solar PV installations was 57k in Nov 2011. During September 2021 the rate was 8k, but in April 2023 it had still only risen to 13k. Total PV installation reached an annual rate of 4000 MW in 2014-15 (April-March). However, it was only 753 MW in 2022-23. From April 2011 to March 2012, the UK installed c.270,000 PV systems on roof tops (1% of all households), following the implementation of a generous Feed-in-Tariff. By contrast, from April 2022 to March 2023, the UK only installed c.141,000 PV systems on domestic rooftops.[34]

Similarly, there should be an active programme of energy efficiency advice and interventions. Peak installations of Energy Efficiency measures in the UK were at 825k a year (to Sept 2014). However, there were only 167k measures in the year to December 22.[35] This was actually lower than the previous year.

Drawing on lessons from wartime and weather induced crises in hydro systems, consumers should be encouraged to switch off devices where possible at home and at work; turn down or off radiators in rooms we are not in. We should reward and encourage efficient use of public spaces to keep warm. With more coordination, we could even switch off clock changes to save daylight across Europe![36] Local authorities could also be encouraged to unblock planning permissions for local energy schemes. Citizens should be encouraged to call out inefficient use of energy in workplaces and public buildings and bureaucratic objections to energy production, such as restrictions on the installation of solar panels on historic buildings with no visual impact.

While the UK did not run a national advertising campaign to reduce gas demand during the winter of either 2021-22 or 2022-23, the system operator (NG ESO) did team up with a number of electricity suppliers to trial a new Demand Flexibility Service.[37] This scheme paid households for reducing their electricity demand (relative to previous consumption) during specific periods with 24 hours-notice. This did result in substantial additional demand response from up to 3% of all households, in return for payments of 5 to 10 times the regulated retail tariff.

Fair pricing is essential in wartime

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[32] Source: WindEurope.
[33] Source: SolarPower Europe.
[34] See https://www.gov.uk/government/statistics/solar-photovoltaics-deployment
[35] Household Energy Efficiency Release Tables. See: https://www.gov.uk/government/statistics/household-energy-efficiency-statistics-headline-release-february-2023
[36] Chong et al. (2011) discuss the benefits of this in the UK.
[37] See Centre for Net Zero (2023).

In wartime, the solution to shortages cannot simply be higher prices for essential commodities such as energy. We need a fair pricing scheme for energy, which also encourages energy saving. Wartime rationing of coal and petrol via coupons was the cutting edge way to accomplish this objective in 1939-45.

An intelligent modern way to effectively give a ration of energy is via a rising block tariff. Under such as scheme households (and businesses) can be given a fixed amount of energy at a lower tariff rate and then have additional amounts at higher (possibly market determined) prices. Alternatively, reducing the standing charge for electricity and gas by a fixed amount is economically equivalent to doing this (though it might not be as clear a signal to reduce energy consumption). The fixed allocation of energy can be varied by household characteristics, such as number of children, seniors or vulnerable adults, by linking the energy company billing system with social security records.[38]

This could be individually based on last year's consumption whereby the lower price block is applied to a fixed percentage of last year's consumption. If this was, say, set at 80%, with the final 20% being exposed to a market determined price which would effectively give each household a target of reducing energy consumption by 20% to help alleviate the crisis. As an example of how far from doing this the UK's actual intervention was: wholesale gas prices were calculated to be 13.4 pence per kWh for January – March 2023,[39] while the Energy Price Guarantee tariff was 10.7 pence per kWh;[40] wholesale electricity prices were calculated to be 51.4 pence per kWh for January – March 2023[41], while the Energy Price Guarantee tariff was 35.84 pence per kWh[42]. Thus, marginal energy was under-priced by the order of 25%.

Wartime profits must be regulated

Some higher prices are inevitable in wartime, especially in wholesale markets. This will generate windfall profits for those lucky enough to still be able to access cheaper sources of supply (i.e., intra-marginal producers). While such profits can bring forth extra investment, the extent to which they do clearly depends on the uncertain continuation of high prices, especially after the inevitable delay between an investment decision and commencement of production. One of the lessons from WW2 was the need to tax war profits appropriately. Both Maynard Keynes and John Hicks did not shy away from assuming that existential threats in wartime demanded high taxes (Keynes, 1940, Hicks et al., 1941).

The extreme nature of the effect of the energy crisis has created huge windfall profits. There is a need to regulate returns across the entire electricity and gas supply chain. State owned energy systems allow this to be done naturally as all domestic revenue accrues to the state. Privately owned energy systems should acquiesce in windfall profits taxation for

[38] This may require appropriate permissions to be granted, in the face of privacy concerns.
[39] Average wholesale cost in Table 1.
[40] Excluding VAT, Standard Credit. See https://www.gov.uk/government/publications/energy-price-guarantee-regional-rates/energy-price-guarantee-regional-rates-january-to-march-2023
[41] Average wholesale cost in Table 1.
[42] Excluding VAT, Standard Credit. See https://www.gov.uk/government/publications/energy-price-guarantee-regional-rates/energy-price-guarantee-regional-rates-january-to-march-2023

the sake of long-run stability and corporate social responsibility to support society in times of crisis. Without doing this the *ex post* political reckoning could be profound and the calls for nationalising or crippling ongoing regulation are likely to continue. In the UK, nationalisation of coal and electricity sectors followed WW2.

Such profit control could be done by using the audited asset values of licensed electricity and gas companies and only allowing regulated rates of return across all assets. The overall budget envelope should be set for the entire onshore electricity and gas sectors, on the assets dedicated to the satisfaction of national demand. There would need to be some detailed accounting to distribute this across generation assets, network assets and retail supply businesses. These values could be used to set average prices for all consumers, including businesses. Short term markets should continue to operate to maintain the real time efficiency of matching supply to demand, but all current long term contracts could be temporarily suspended (or subject to high taxation).

The UK has implemented additional profits taxes in the face of the crisis. These include a 35% supplementary tax on North Sea oil and gas production profits[43] and a 45% supplementary tax on electricity generation.[44] These are useful measures but their ultimate incidence remains unclear. What is much clearer is that the scale of the macro fiscal crisis facing the UK has been worsened by the unprecedented levels of unfunded fiscal support for the energy prices.

4. The EU Response to the Crisis

This has been an European energy crisis, affecting most of the 50 (or so) European countries.[45] Individual countries have taken the lead on retail market responses. However there has been attempt to coordinate responses across EU countries. The development of a single market in energy has been a flagship programme of the 27 countries of the European Union.[46] In addition, Norway is formally part of the single market in energy (as part of its wider membership of the EU single market). Meanwhile, the UK was in full compliance with the rules of the single market, on its formal departure from the EU on 31 December 2020 and remains closely aligned with the EU on energy policy via the terms of the EU-UK Trade and Co-operation Agreement.[47] Thus the energy policy of the EU is important for Europe as a whole. EU policy is something of a compromise between the competing national interests of different members states. Therefore we discuss this below.

The emergency response

[43] https://www.gov.uk/government/publications/changes-to-the-energy-oil-and-gas-profits-levy
[44] https://www.gov.uk/government/publications/electricity-generator-levy
[45] Europe consists of around 50 countries. The EU-27 includes a majority of the countries and the population. Parts of Russia and Turkey are formally in the European continent.
[46] See Pollitt (2019) and Chyong (2019).
[47] See Pollitt (2022b).

The EU has been attempting to co-ordinate a short run response to the energy crisis. With respect to electricity, it adopted three emergency measures (via the EU Council Regulation adopted on 6 October 2022).[48] These consisted of:

1. A target **reduction in total electricity demand of 10%**, with a target 5% reduction in electricity consumption during peak hours during the period 1 December 2022 to 31 March 2023 (member states must identify peak hours representing at least 10% of all hours over this period).

2. '**A cap on market revenues from infra-marginal generation technologies'** (EU, 2022, p.5). This would include renewables, nuclear and lignite. The cap is 180 Euros / MWh but may be adjusted depending on the generation technology. This cap would be applied to 'realised revenue'.

3. A **temporary solidarity contribution** based on taxable surplus profits made in the fiscal year 2022 and/or 2023). This would be made on crude petroleum, natural gas, coal, and refinery companies. This would contribute to a fund at the European Union level. Only profits which are 20% higher than the level of the four years from 2018 would be subject to additional taxation. The minimum tax rate would be 33% on these additional profits, though higher tax rates could be applied. The tax rate would be applied to 2022 and 2023 profits. Revenues from the cap and solidarity contributions should be recycled to household and industrial customers.

Longer-term electricity market design change proposals

Alongside these emergency measures in electricity the EU has been bringing forward net zero policies to accelerate the reduction in EU gas imports and the switch to alternative fuels such as hydrogen and biomethane, via a package of measures known as REPower EU.[49] One specific debate has been about the redesign of electricity markets in light of the crisis. The EU Market Design Proposals (of 14 March 2023)[50] put forward changes to the existing Electricity Directive, Electricity Regulation and Regulation on Wholesale Energy Market Integrity and Transparency (REMIT), all of which govern the current electricity market, its regulation and the monitoring of cross-border competition.

On the wholesale market, the EU Commission is seeking to encourage the use of long-run contracting between generators and consumers to protect against rises in prices and to lock in the price of some low cost non-fossil fuel generation within the calculation of individual electricity bills (see European Commission, 2023c, p.23ff). To do this Commission is proposing that individual member states of the EU (MSs) need to encourage the private power purchase agreement (PPA) market. Large energy consumers, such as energy intensive industrial users, might be able to secure access to wind and solar generation at fixed prices in this market. However, the Commission is also proposing that all public support for new non-fossil fuel generation should be subject to a 2-way contract for difference (CfD). This

[48] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32022R1854
[49] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en
[50] See European Commission (2023a, b, c).

would ensure that all government guaranteed CfDs would automatically hedge consumers against fossil fuel price spikes. Other proposals include the encouragement of increased market liquidity via trading of longer-term financial transmission rights; the use of a capacity market; design of peak shaving product by the system operator (similar to the NG ESO Demand Flexibility Service product); the use of national flexibility markets for demand response and storage to improve markets for ancillary services; and enhanced market transparency rules under REMIT. The detailed implementation of much of the above is delegated to member states.

On the retail market, the EU Commission is concerned with the breakdown of retail competition during the crisis. Widespread price intervention has led to the suspension of the operation of the market, with a reduction in switching rates between suppliers. What did not work well was the degree of hedging offered by retail contracts and the lack of financial regulation of competitive challengers to incumbent vertically integrated retailers with their own electricity generation. The Commission proposes that consumers be offered multiple contracts, including a fixed price contract alternative.[51] This is because too many consumers were exposed to contracts which tracked the wholesale price directly (i.e., could be adjusted up at short notice). It is also seeking to formalize what government intervention measures are appropriate and when they can be implemented in the future.

In the future, member states must implement a two tier pricing scheme in interventions. Regulated tariff interventions should introduce rising block tariffs which restrict regulated prices to 80% of the median consumption for households and to 70% of historical consumption for SMEs.[52]

Emergency interventions on retail prices can occur subject to three conditions:

'Very high prices in wholesale electricity markets at least two and a half times the average price during the previous five years occur which are expected to continue for at least 6 months; Sharp increases in electricity retail prices of at least 70% occur which are expected to continue for at least 6 months; The wider economy is being negatively affected by the increases in electricity prices' (European Commission, 2023c, p.89).

Such measures sensibly seek to limit retail market interventions to the extreme situations witnessed in the current crisis, but also to ensure that marginal prices are market reflective across Europe and that nations can only differentiate on the size of the fixed subsidy they give to electricity consumers. This avoids the wide increase in dispersion of marginal price impacts we have seen in the crisis, though average prices could still vary widely.

5. Observations on Responses to the Crisis

Three observations about the nature of the crisis

Wholesale markets have worked as intended in Europe and it is difficult to imagine anywhere else in the world (except perhaps Texas or parts of Australia) where they would

[51] See European Commission (2023c, p.78).
[52] See European Commission (2023c, p.80).

have survived such an exceptional stress test (they did not in California). They would definitely not have survived in China or South America. In the California power crisis of 2000-2001 average monthly power prices rose by 285% between 1999 and 2000, before rising again by another 117% for the first seven months of 2001.[53] This is only slightly higher than Great Britain experienced between 2020 and 2021 and for the whole of 2022 (Figure 2). The California crisis involved prices above $100 / MWh for 13 months. Great Britain has experienced prices above £100 / MWh for 21 months (August 2021 to April 2023). While the electricity price rise was proportionately higher and the real prices were somewhat higher in California,[54] European wholesale markets for both gas and electricity have remarkably survived an exceptionally long period of high prices. By contrast, California's power exchange collapsed in January 2001 after a stress test lasting 8 months.

Wholesale prices have been exceptionally high and if anything above net zero consistent levels. For instance, a 300 Euro carbon price,[55] would only have raised electricity prices by 120 Euros / MWh by 2050. Electricity prices in the UK rose by nearly 400 Euros / MWh at their peak. The crisis is only partially a wake-up call for net zero. While the EU ETS carbon price has been elevated by the crisis, this has simply risen to a net zero consistent level.[56]

Retail markets have not survived during the crisis and there are lessons about the nature of regulation of retail markets. However, they have survived better in some markets than others. The UK has seen a remarkable decline in the number of household energy retailers (from 49 in June 2021 to 22 in December 2022).[57] This was the result of an exceptional cocktail of a poorly designed price cap, implicitly subsidized and lightly regulated new entrants, and a support scheme which undermined competition by causing all consumers to default to a single regulated contract.[58]

Three economic principles in thinking about crisis lessons

Markets are servants - not masters - of the modern capitalist economy. **We should distinguish between the truly exceptional wartime situation, where certain aspects of the market need to be temporarily suspended** on the grounds of fairness and information efficiency (the balance of public and private information). It is simply unrealistic to expect citizens and their politicians to accept market outcomes when real prices rise in traditionally price regulated industries at rates never before experienced.

First order partial electricity price effects are highly misleading, especially if calculated with reference to short run market prices. Thus, high initial market prices do not translate well to ultimate impact and welfare. Wage effects, investment incentives, tax systems, insurance mechanisms and price incidence effects all lead to ultimate impacts which are very different from the first order effects. For example, higher energy prices can lead to

[53] See Joskow (2001).
[54] $100 in 2001 translates to around £134 in 2022 (at inflation of 65% and at an exchange rate of $1.23 to £1).
[55] As suggested by Chyong et al. (2021) in their modelling of decarbonisation of the European energy system.
[56] A price of 80 Euro in 2022 is consistent with a target real price of 300 Euro in 2050, assuming the real price rises at a 5% real interest rate.
[57] https://www.ofgem.gov.uk/retail-market-indicators
[58] Discussed in National Audit Office (2022).

higher real wages and employment.[59] This is because high energy prices may cause capital and labour to be substituted for energy driving up employment and real wages.

Dismantling a market simply because it is exhibiting high prices is not the intelligent response of economists. Don't panic when prices go up! The principle of targeting means that correction of underlying distortions and using the tax and benefit system to address distributional concerns[60] remains the most effective long run response in energy and environmental markets.

Observations on European responses to the crisis

There has been a general confusion about short run wartime measures and long-term interventions. It is important to distinguish between the two, especially in light of the long-run investment impacts of short-term interventions and to commit to removal of wartime measures as soon as practicable. The EU has helpfully time limited its additional profits levies to 2022 and 2023, the UK government has unhelpfully extended its special taxes to 2028.

There has been pressure to intervene directly on market prices. While much of this has been, admirably, resisted so far by the European Commission, some very bad suggestions for direct price interventions have been implemented or remain under discussion, as we shall see below.

There has been a surprising lack of immediate policy focus on addressing the underlying causes of the supply and demand imbalance. This has reflected the general failure of European governments, with some exceptions, to see the crisis as an opportunity to rapidly advance low carbon investments, energy efficiency measures, more intelligent demand management and diversification of sources of gas. A good indication of this is the failure to earmark some significant part of short run support to these measures.

Four good ideas arising from the crisis

1. The German Gas and Heat Commission (which reported finally on 31 October 2022)[61] proposed **giving a discount on the first 80% of baseline household gas consumption and maintaining the market price on the last 20%.** This was an excellent idea which was implemented by the German government. A similar scheme could easily have been implemented for electricity consumers. This scheme targets support through bills in a way that reduces average prices (and inflation), is household specific, and maintains marginal investment incentives.

2. **Two-way government backed CfDs for new low carbon power lock in fixed prices for the initial period of the life of a renewables project.[62]** These are a good idea when combined with auctions for projects because they lower the cost of capital and

[59] See for example Keane and Prasad (1996).
[60] For a discussion of targeting in the context of energy and climate policy see McKitrick (2015).
[61] ExpertInnen-Kommission Gas und Warme (2022).
[62] See Gross et al. (2022) and Pollitt et al. (2022a).

total energy system cost. They can be allocated to household consumers and/or energy intensive industry. This would follow the Low Carbon Contracts Company set up in the UK, where CfD contracts are currently reducing the calculated price cap price.[63]

3. **High prices have encouraged retailer experimentation with targeted payments for reducing consumption at specific times of grid stress**. In Great Britain, Octopus Energy (a supplier) and NG ESO designed a Demand Flexibility Product which notifies consumers a day ahead of stress periods during which reductions in their normal consumption is rewarded with high per kWh payments. The response windows are 1-2 hours with payments of £2 to £4 per kW response. One million households registered to receive on average a payment of £0.90 per hour of response. This generated 87MW of response or 18% demand reduction among those actually participating.[64]

4. **A short-term profits tax on windfall additional generator profits.** To the extent that this does not tax marginal investment, is short-lived and replaces less sensible price capping this is a good idea in the exceptional circumstances of the crisis. The EU-27 and the UK have implemented such measures, as we see above.

Three bad ideas arising from the crisis

1. **Cap the price at the international gas hub (TTF in Amsterdam).** This was actually proposed by 20 energy economists[65] and implemented as a 180 Euro cap on the average 3 day-price of the front month gas contract at the TTF[66] and subsequently on all European gas hubs. The inevitable result: the market operator (ICE) proposed moving the price hub to London.[67] A good first year economics undergraduate should have been able to predict this result! This was a somewhat quirky idea which seemed to be based on a strategic trade argument that by committing to a lower price Europe would force Russia (and other international gas suppliers) to accept a binding price cap and continue to supply Europe with gas. The problem with such strategic trade arguments is that the optimal response in a repeated game may be to withhold gas and force the abandonment of the price cap. Indeed, Paul Krugman (an originator of the theory of strategic trade) argues that strategic trade arguments are much weaker than free trade arguments in practice (Krugman, 1993).

2. **Cap the price of gas sold to power station operators in order to reduce the marginal price in the power market.** This might protect household consumers on default spot price linked contracts. This was proposed and implemented by Spain, and amazingly approved by the EU. The inevitable result: the burning of significantly

[63] See Ofgem's Model - Default Tariff Cap Level v1.18, *op. cit*.
[64] See Centre for Net Zero (2023).
[65] Fabra et al. (2022).
[66] See https://www.consilium.europa.eu/en/press/press-releases/2022/12/19/council-agrees-on-temporary-mechanism-to-limit-excessive-gas-prices/
[67] See: https://www.reuters.com/business/energy/ice-open-london-gas-hub-creating-route-around-eu-price-cap-2023-01-27/

more gas in power plants and reversing of power flows from Spain to France and Morocco.[68] There was a market design flaw in the default household tariff design, where the system would inevitably collapse (or lead to the implemented distortion) under a sustained price rise.

3. **Cap the intramarginal price of low carbon generation in order to lower the price charged to customers via the tariff model.** This proposal is in the spirit of proposals for two market solutions in the electricity spot market, with one price for on demand (fossil fuel) power and one price for 'as available' power (intermittent renewable generation).[69] The idea that power produced from different sources is not the same in real time is fundamentally wrong and undermines investments in relieving network constraints, efficient maintenance, storage and self-use.[70] In addition, as low carbon renewable generation is only around 40% of all consumption in the EU-27[71] and because the implemented cap is likely to be high lowering this component may in the end only marginally reduce bills.

6. Concluding thoughts

Energy Market Lessons

Wholesale electricity and gas markets work in delivering energy security! Europe's efforts to create genuine single markets in electricity, gas and carbon have proved their worth in the crisis. The European experience is that short-term wholesale markets for electricity, gas and carbon work best over a wide area! Markets deliver security of supply by raising prices in times of scarcity, creating profits for some, and leaving some market parties exposed to unhedged high prices or certain customers' inability to pay. Europe should therefore complete and extend the markets it has.

The distributional impact of high prices on European households and industry and the short-run impact on the competitiveness of national industries is a major concern. Given the prolonged very high prices, intervention of some kind became inevitable. Even countries (notably the UK and Norway)[72] that initially tried to give income subsidies and not regulate prices have now done so (though at a high price level). The crisis has also highlighted the link between energy prices and general inflation, suggesting that an additional reason to suppress short-run retail prices is the need to mitigate a shock to general inflation that might trigger a wage-price spiral. Thus, we have learned once again that retail energy markets are always going to be subject to close political oversight.

Lessons for global climate policy

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[68] See von der Fehr et al. (2022).
[69] See Keay and Robinson (2017), Grubb and Drummond (2018) and Council of the European Union (2022).
[70] See Pollitt et al. (2022a) for a discussion.
[71] See https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable_energy_statistics#Wind_and_water_provide_most_renewable_electricity.3B_solar_is_the_fastest-growing_energy_source
[72] See von der Fehr et al. (2022) for a discussion of policy responses in Norway and the UK.

The crisis is a wake-up call to pay attention to the price impact of net zero policies, where tight linkages between power, heat and transport prices are the consequence of sector coupling *and* high unit prices of energy are also to be expected. Reducing fossil fuel dependency, means increasing weather dependency, as reduced gas supplies have exacerbated the effect of low wind and low hydro output (Ember, 2023).

Russia has permanently raised the global cost of gas by increasing the need for increased use of LNG (and also by reducing international investment in Russian gas production capacity). This has implications for the use of gas globally, but also for the cost of blue hydrogen (produced from natural gas) and hence synthetic fuels produced from hydrogen. For instance, China now faces a more expensive gas-based transition with uncertain effects for its climate policy. China will doubtless be wary of relying on Russian gas, given the German experience of the need for a rapid painful war-induced exit from Russian gas dependency.

Perhaps more importantly the undermining of world order reduces the prospects for market based decarbonization based on clear definitions of internationally tradeable property rights and reliable international monitoring of the quality of environmental goods (such as carbon, renewables, green and blue hydrogen). Gas was, arguably, the first globally traded 'low carbon' fuel, whose trade was massively increased in Europe by climate policy. The crisis highlights the long-term risks associated with reliance on global supplies from unfriendly nations.

Climate change per se is not the biggest short-term existential threat the world faces. Climate scientists were always incorrect to exaggerate the relative existential risk and the relative marginal cost of risk mitigation of climate change compared to other existential risks (e.g., nuclear war, AI, pandemics etc.). Energy security is back, at least for some while, as the top energy policy priority among the three energy policy priorities of energy security, price competitiveness and environmental impact.

Some reflections on the crisis and its implications for energy economics

What any energy crisis tends to reveal is the need for more, not less, orthodox economic theory to inform energy policy. Wider, deeper, more global markets are the best way to mitigate country specific supply risks *ex ante*. Actually, responding to price spikes by reducing demand and increasing supply are the sensible responses *ex post*. The sad thing is the world often insists on testing the opposite on the real world economy, e.g. by taking actions which increase demand and reduce supply in the face of price spikes.[73] Economists should stand against such theoretically groundless actions.

Sensible economic arrangements in energy markets can be dismantled quickly. Some bad ideas are circulating in Europe and some of them have actually been implemented. Economic advice needs to pass a Krugman test: is the economic theory on which it rests sensible in the real world? Hence it should pay attention to materiality, precedent, history, political science and other markets. The three bad ideas we highlighted were all suggested

[73] For a nice analysis of how this worked in the crisis, see Perkins and Rainaut (2023).

by otherwise sensible economists but are not at all obvious in the light of theory and are only likely to be overall beneficial in a particular set of circumstances.

What the crisis highlights is the need to pay more attention to the distribution of the cost of net zero. For instance, there is some cheap decarbonization based on low cost wind or solar locations, but only the rich (individuals and oligopoly companies) may have direct access to this type of decarbonisation. How to capture locational rents from cheaper low carbon sources and how to distribute these efficiently (and to whom) is an under-researched area.

There is a need for research on retail tariff regimes that can cope with net zero. We have had a taste of a market where wholesale prices fluctuate based on weather in real time. What is clearly required is the achievement of much deeper demand response to mitigate supply reductions.[74] The crisis illustrates that we are some way from working out how acceptable retail competition can be achieved in a net zero energy system.

[74] As discussed in Pollitt (2021).

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