..

Energy and Carbon Transition

UK Industrial Sites

ENERGY INTELLIGENT SOLUTIONS AND ENDRESS+HAUSER UK
November 2023

T: 0161 286 5000
E: info@uk.endress.com
W: www.uk.endress.com

Endress+Hauser
People for Process Automation

Industrial sites need to reduce carbon emissions to satisfy multiple stakeholders

Executive Summary

Industrial sites in the UK need to respond to the challenges and opportunities associated with the energy and carbon transition:

- High energy and carbon prices which affect profitability and investment
- Volatile energy and carbon prices, which represent a significant risk
- The need to decarbonise to satisfy stakeholder demands, including from customers, staff, investors and regulators
- Complex regulatory requirements associated with decarbonisation and sustainability
- Changes and uncertainties in technologies and solutions associated with energy and carbon, and changes to the cost effectiveness of many of these solutions
- The importance of reliable and available utilities

- The potential to develop low carbon products and services

Actions need to be consistent with the UK's net zero strategy which is constantly evolving and with corporate demands to reduce scope 1, 2 and 3 carbon emissions.

Key actions required by for industry include:

- More aggressive energy efficiency and energy management, with longer payback periods being accepted
- The transition in the medium term from fossil fuels to electrification, and potentially in some circumstances renewable fuels or the use of fossil fuels with carbon capture
- Greater investment in data capture and utilisation to optimise operations and support the design of new low carbon solutions
- Immediate measures to reduce carbon emissions year on year in line with UK targets
- The procurement of 'additional' renewable power from on-site, near-site solar and wind power systems and from PPA agreements.

Technologies and solutions are evolving at pace. Hydrogen and carbon capture, for example, were seemingly distant but can now be expected to become widely available in many areas in the next few years, albeit with specific advantages and disadvantages.

Decarbonisation is a journey. Strategies and actions need to be constantly evaluated and adjusted. Furthermore, industry needs to decarbonise according to an established hierarchy of measures starting with energy efficiency.

This document outlines some of the issues and opportunities and has been developed by Energy Intelligent Solutions with support from Endress+Hauser.

Table of Contents

Introduction

Industrial organisations in the UK are faced with a pressing need to tackle significant issues associated with energy and carbon:

- High and rising energy and carbon prices which affect profitability and investment
- Volatile prices which represent a significant risk
- The need to decarbonise to satisfy stakeholder demands
- Complex regulatory requirements associated with decarbonisation and sustainability
- Changes in technologies and solutions associated with energy and carbon, and the cost effectiveness of many of these solutions
- The importance of reliable and available utilities
- Uncertainties over the future requirements and the pace of change.

The drivers for change, trends in technologies and solutions and the UK Government plans and ambitions for net zero in industry need to be well understood.

For many industrial sites, decarbonisation will require a very significant investment in new plant and systems.

There are some barriers to long term carbon emissions reductions at many industrial sites. These include the need for investments to be cost effective, lack of available capital and constraints associated with the process operations (for example the need for high temperatures) and site locations (many sites are dispersed with limited access to some of the emerging technologies).

An energy and decarbonisation strategy needs to consider the future: the forward prices for energy and carbon, regulations and incentives likely to be adopted, possible changes in technologies and the costs of technologies, and the likelihood of changes to the site operations and associated energy demands (for example changes in production levels).

Because of the uncertainties in the future, any energy/decarbonisation strategy will have risks and uncertainties associated with it and this has to be considered. Strategy needs to be constantly reviewed.

Energy and carbon are clearly in transition. Many organisations are adopting a staged energy and carbon strategy – one where short term 'no regrets' opportunities are implemented but which also includes actions to ensure sites are ready for the new opportunities that will arise. This approach can give organisations time to determine the best course of action to decarbonise the more difficult systems and for technologies and solutions to emerge.

Achieving a balance between decarbonisation and profitability can be a key issue.

Decarbonisation Approach

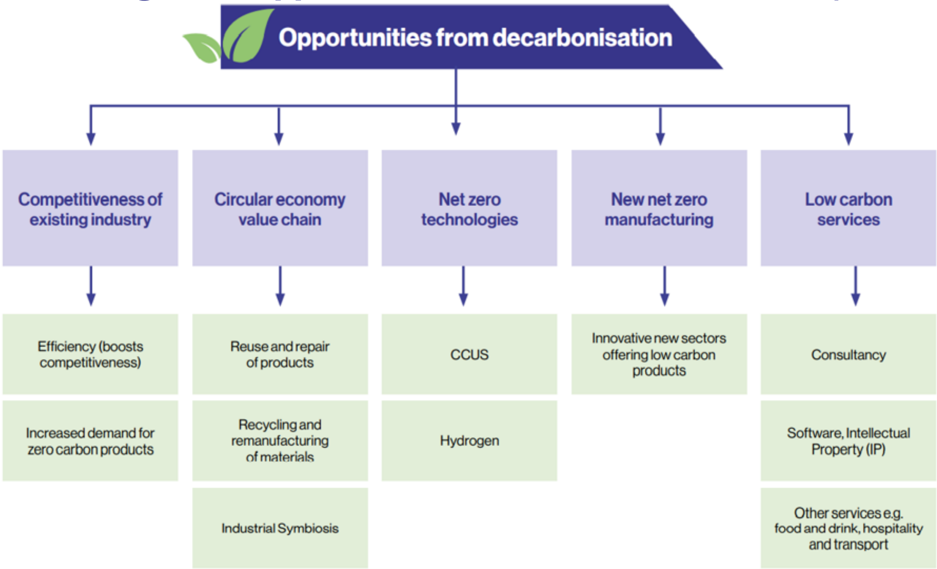
The need to reduce carbon dioxide emissions is clear: to tackle climate change, to satisfy stakeholders and to meet environmental and other regulations.

Carbon emissions associated with the use of energy are increasingly under pressure. The UK has a target to achieve net zero emissions by 2050 as well as challenging interim targets. These targets, according to the Government, will be achieved by *encouraging* changes in energy use in industry through the use of regulations and incentives and by introducing changes to the price of non-renewable energy sources (fossil fuels) and/or the price of carbon. UK strategy is to remove the barriers to decarbonisation for industry.

Many companies also have targets for carbon emissions reduction, in some cases dictated by customer demands. These include Science Based Targets and can require a rapid reduction in emissions in the near term, and in all cases require a detailed and robust plan.

Decarbonisation is both a challenge and a potential opportunity. The possible benefits include reduced operating costs (compared with business as usual), reduced risks and, potentially, the production of low carbon products to generate additional revenues. The downside may include the need for significant investment. The drivers for decarbonisation determine that actions need to be taken quickly.

The potential growth opportunities from decarbonisation (BEIS, 2021)

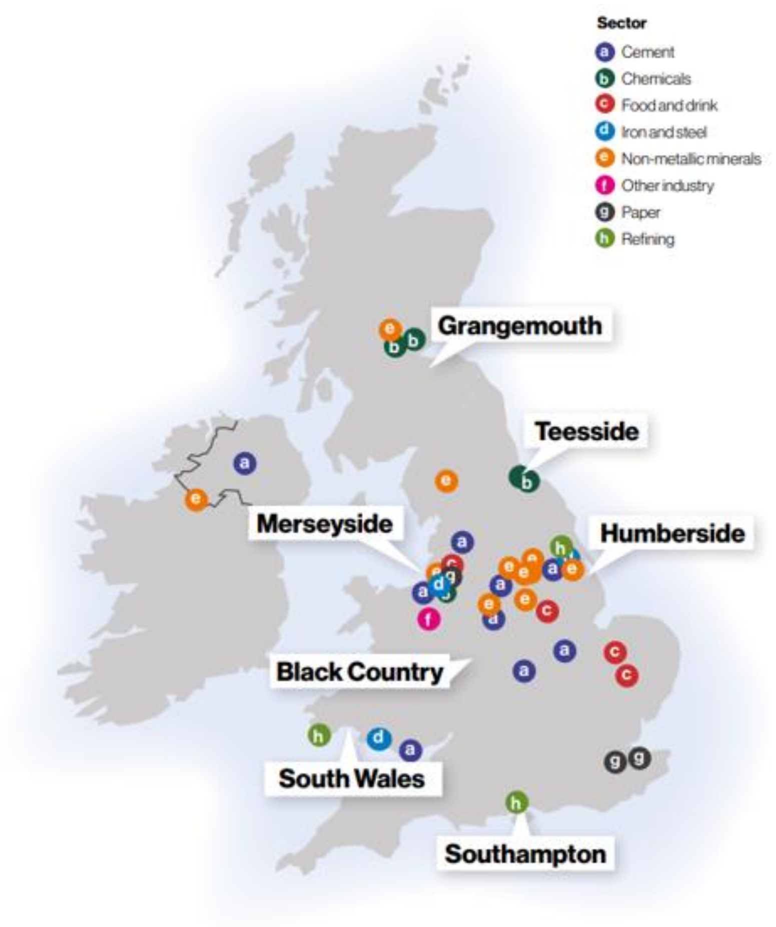


Many industrial sites have large energy bills but are not ‘massive’ energy users (compared to some others in the UK). This presents a barrier to decarbonisation in some cases since many of the new technologies (e.g., hydrogen, carbon capture) are still developing and therefore generally more suited to larger scale deployment at present. This is changing at pace, however.

Decarbonisation Challenges for Industrial Sites (BEIS, 2021)

Segment	Emissions in 2017 ($MtCO_2e$)[20]	Common challenges
Less energy-intensive dispersed sites (food & drink, other industry)	17	Not likely to be geographically concentrated making it harder to access hydrogen and CO_2 networks. Energy costs are a relatively small part of their overall cost base providing less incentive to decarbonise.
Dispersed cement	4	Geographically dispersed and significant distances away from CO_2 transport and storage points. Significant amounts of process emissions requiring CCUS to capture emissions.
Cluster (All sectors except iron and steel within 25km of a cluster)	25	Predominately the petro-chemicals sectors (refineries and chemicals sector), clustered around CO_2 Transport and Storage points
High energy dispersed sites: (ammonia, ethelene, lime, glass, other minerals, paper, refining, other chemicals, non-ferrous metal)	12	Not likely to be geographically concentrated making it harder to access hydrogen and CO_2 networks.
Iron and steel	12	Iron and steel face particular issues with decarbonising blast furnaces and other highly specialised processes.
Total[21]	**71**	

Some of the More Significant Energy Intensive Industrial Sites Within the UK (BEIS,2021)



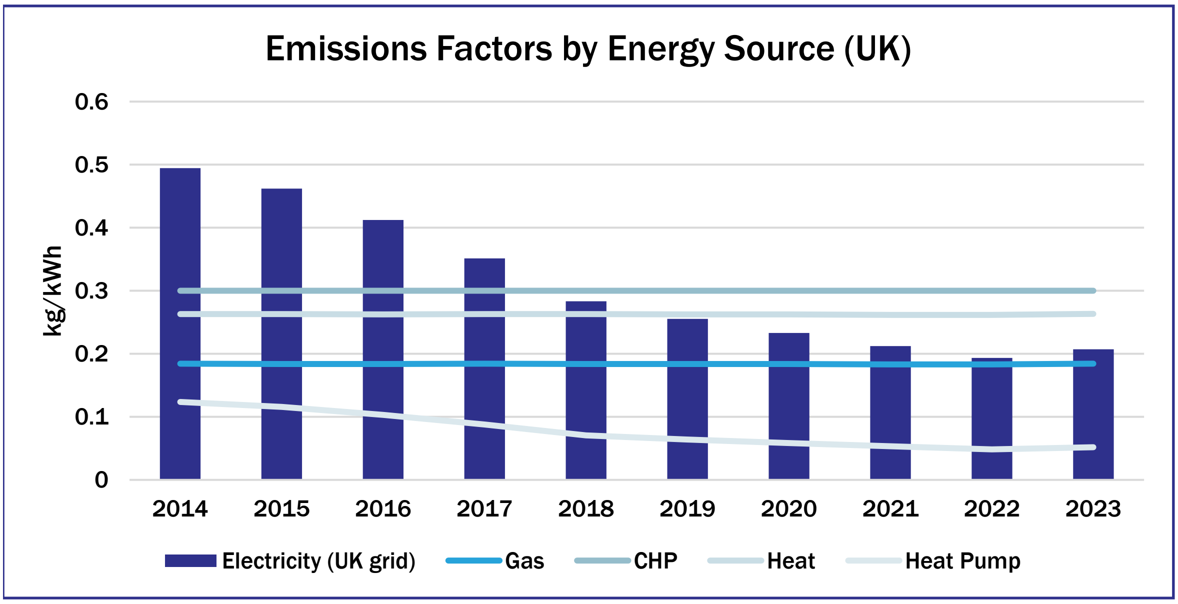
Carbon Intensity and Costs of Fuels and Power

The figure below illustrates the trends in the carbon intensity of energy sources in the UK over recent years.

Electricity has reduced in carbon intensity with the introduction of low carbon power (solar, wind, biomass and nuclear) and grid electricity is now a low carbon energy source competing with gas and other fossil fuels. This downward trend is set to continue, especially with the plans for offshore wind power. The Government has promised zero carbon electricity from the UK grid by 2035 and this will underpin electrification as an approach to decarbonise.

Electricity use in heat pumps, where one unit of electricity can produce typically 4 units of heat (depending on the heat source and sink temperatures), can be very low carbon even now and in the future will be a very effective use of low carbon power. This explains the drive to replace low temperature heating with heat pumps throughout the country.

Trends in Carbon Intensity (kgCO2e/kWh) of Energy Sources in the UK



The figure also shows the approximate carbon intensity of steam (or heat generally) allowing for the estimated, typical inefficiencies of an industrial steam system and boilers. Heat at the point of use tends to be relatively high carbon.

The figure also shows the approximate carbon intensity of energy from combined heat and power (CHP) solutions, revealing the trend from a carbon reduction technology in 2014 to generally a carbon neutral or carbon increasing technology in 2023 and beyond.

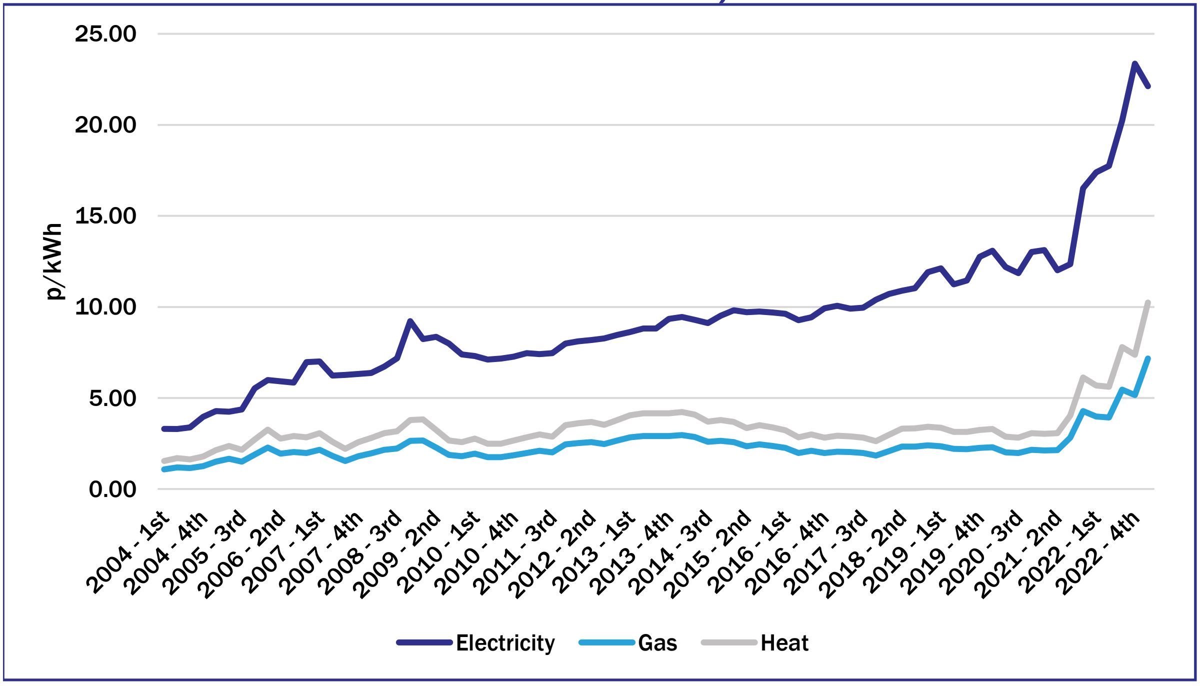
While gas fired CHP can increase carbon emissions at a site level and also increases the demand for fossil fuels, at present CHP systems usually replace electricity that would otherwise come from gas fired power plant in the UK. In the short term (next 5 years), therefore, it is unlikely that gas fired CHP solutions will have a negative impact on the overall UK electricity system (i.e. will not interfere with the operation of renewables plant) and, on balance, will be positive for the UK as a whole (for electricity network support and for carbon emissions). This is the reason why there is continued support for ‘good quality CHP’ in the UK which includes exemption from the Climate Change Levy for the gas used.

By 2035 however, and possibly much earlier, CHP using gas will not be viable (because of the impact on carbon emissions) unless with an associated carbon abatement technology.

CHP, fired with natural gas/fossil fuels, can only be regarded as a solution to reducing the costs of electricity and heat and a generally near neutral carbon technology for industry for the short/medium term, and some organisations will no longer implement new gas/fossil fuel fired equipment.

The costs of energy and carbon are expected to rise and are volatile. Trends in the average prices of energy in the UK are illustrated in the figure below. Prices of gas and electricity at the time of writing are circa 5p/kWh and 25p/kWh which is considerably higher than prices in 2020.

Average Annual Prices of Energy for UK Manufacturing (excluding CCL and UK ETS Carbon)



Electricity prices include payments for the transmission and distribution of power, for support for investment in UK low carbon power and to fund electricity network support. These non-commodity prices account for a significant proportion of the overall price and partly explain the relatively high price of power in the UK. It is recognised that UK electricity prices are high relative to other (competing) nations for this reason and also because of the market arrangements, and this is accepted as an issue of significance for industry and decarbonisation by the Government in recent strategy papers.

The Government may well seek to increase the price of gas relative to power over the next decade (through the transfer of taxes from electricity to gas potentially).

For the evaluation of projects and the development of a strategy, it is the future prices of energy that are important, however, and these are uncertain:

- Upward drivers of electricity prices include increased demands due to electrification and the need for considerable improvements in renewable/low carbon power generation and transmission/distribution/energy storage infrastructure. Lower prices may be driven by electricity market reform and the decarbonisation agenda, and by the increased availability of lower cost (renewable energy/wind turbine) power plants
- Gas prices may be driven up by the decarbonisation agenda (carbon prices) and availability, and down by the switch to renewable alternatives
- Renewable electricity (solar PV) prices are circa 9p/kWh (plus non-commodity charges where the power is delivered using the grid). The price of renewable fuels is likely to be high but subsidised for some organisations by Government to enable competition with natural gas

The relationship between the price of gas and the price of power in the UK is important. As gas prices rise, power prices tend to rise since a significant proportion of UK power is generated using gas. Over the coming years, but not in the short term, this link is expected to be weakened by the decarbonisation of power and fuels, and strengthened by the increased demand for power as the UK electrifies heat and transport.

The table below shows an assessment of the current costs of alternative low carbon energy sources. These figures have a degree of uncertainty, especially where the low carbon fuel is created from a fossil fuel (e.g. blue hydrogen from methane where the price of the hydrogen will be linked to the price of the methane).

Low carbon sources are not all zero carbon – there is concern over the emissions associated with ‘blue' hydrogen for example (related to the loss of methane upstream of the hydrogen production).

The prices are the levelised costs – the costs taking account of the capital and operating costs spread over the period of the investment – e.g. 20 years.

In summary, this analysis shows some of the key challenges:

- Energy prices are volatile and difficult to predict, and it is the future prices that are critical for the energy and decarbonisation strategy
- Electricity has a low carbon intensity and heat pumps especially are low carbon heat sources
- Electricity is expensive in the UK
- Gas for industrial heat is increasingly high carbon, but gas has been very low-cost relative to electricity. This will change in the medium term
- Using gas to generate power and heat (CHP) remains carbon neutral only in specific circumstances, and gas fired CHP can only be regarded as a transitional solution and should be implemented alongside other carbon reduction measures
- Low carbon power can be relatively cheap
- Renewable fuels are relatively expensive and there are concerns about the supply chain
- Hydrogen is expensive and is likely to be restricted in availability in the medium term (to larger industrial clusters)
- Nuclear heat and power (SMR) is likely to be restricted initially to sites close to existing nuclear installations
- There are plans to reduce the barriers to the use of low carbon energy and these are likely to include higher carbon prices and incentives for the use of hydrogen, for example.

Low Carbon Energy Sources – Prices and Assessment

Energy Source	Estimated Cost p/kWh *	Applications	Comments
Offshore Wind **Power** (North Sea or similar)	10	Power supply to the grid. Large industrial users and hydrogen production	Significant opportunity to take advantage of wind speeds, eg North Sea
On site /near site renewable **Power** (solar and wind)	10	Power supply to individual sites and hydrogen production for site use	Need to match to site demands
Nuclear Power (SMR)	7	Power supply to the grid, hydrogen production, power and heat supply direct to larger industrial sites and for district heating	Stakeholder concerns in some cases, requires appropriate locations
Nuclear Heat (SMR)	3	Heat from SMR nuclear power plant	By-product from the production of nuclear power
Biomethane	5	Via the gas grid and on site fuel production, generated from waste	Requires supply of suitable waste or biomass. Limited supply in future possibly
Biogas	5	On site fuel production – used for heat and power generation	Requires supply of suitable waste. Limited supply in future possibly
Blue Hydrogen	12	For industrial use mainly	Large scale industrial clusters with access to carbon capture and storage
Green/Pink Hydrogen	12	For industrial use and transport mainly	Requires low cost renewable/low carbon power
Biofuels	12	Transport and supply of energy to remote locations	Requires a secure and sustainable supply
Biomass	6	For industrial heat and power	Requires a secure and sustainable supply

**** excludes the non-commodity charge which would apply where the UK grid is used*

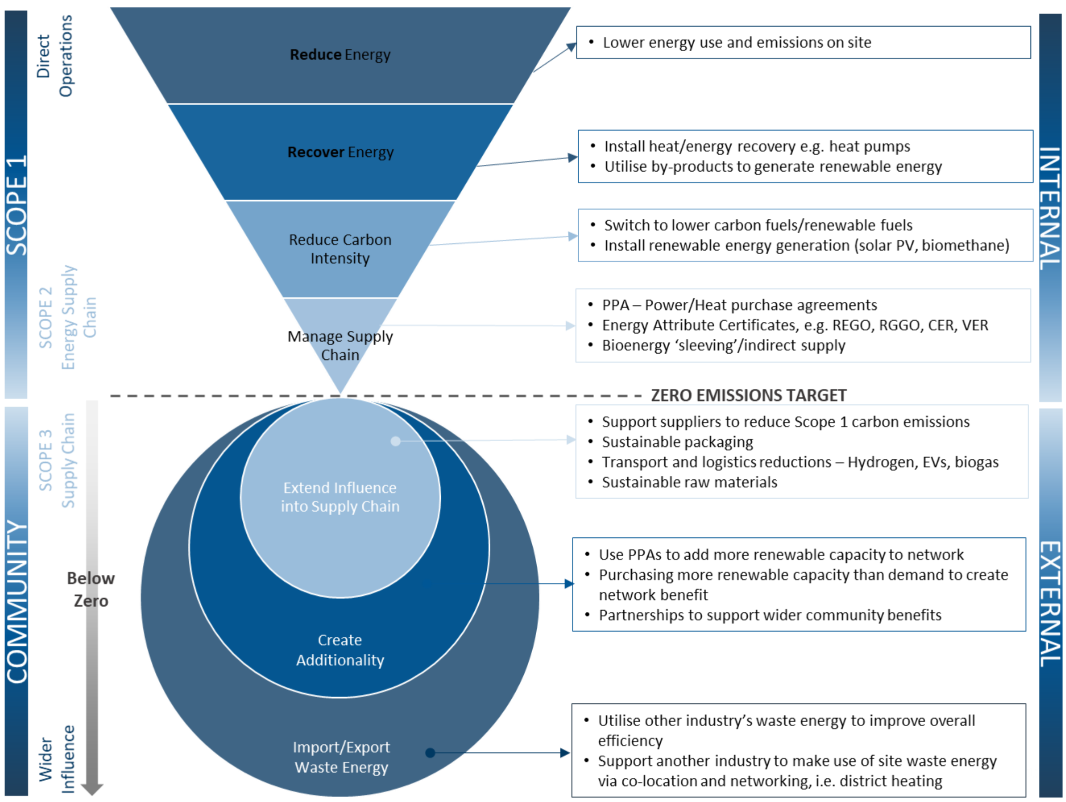
Approach to Decarbonisation

There is an established hierarchy for carbon emissions reduction strategies which all industrial companies should adopt. This is to achieve maximum carbon emissions reduction overall, but also represents a strategy that reduces risks:

- On-site de-carbonisation pathways must begin with reducing use and recovering energy on site. Measures include heat recovery, higher efficiency equipment, improved control and management, heat pumps and similar. Given the risks (for example of rising energy prices) and the uncertainties (for example in the costs and availability of low carbon energy) this step should have a higher priority than previously. In other words, longer term investments to reduce energy demands on site should now be considered and all new investments should have a much greater emphasis on energy efficiency.

- The next step is switching to lower carbon fuel and electricity to reduce the carbon intensity of remaining energy needs, for example by installing renewable power generation or similar (on site or near site). This should ensure additionality.
- De-carbonisation then expands to the energy supply chain (and to the total supply chain), for example the purchase of renewable power and gas from third party owned assets, for example North Sea wind power. Again, this should ideally be 'additional. Offsets and similar are a final step.

De-carbonisation Hierarchy – On-Site, then Near-Site, then Off-Site



Some further key principles for on-site de-carbonisation are:

- Improve energy efficiency, accepting longer payback periods
- Reduce or eliminate the use of fossil fuels as far as possible
- Reduce or eliminate the use of power from non-renewable sources
- Reduce and reuse waste (heat and other wastes) as far as possible

With de-carbonisation, the objective is to identify the strategy that achieves the carbon reduction targets set by the company that works best for the site. This differs from conventional energy efficiency studies where the aim is to find cost effective investments. There may be no return for de-carbonisation other than the achievement of the net zero goal (and the associated spin-off benefits this might deliver). This means that energy efficiency projects with extended payback periods may now be reconsidered since they should be compared with the cost of alternative solutions rather than on the basis of the individual project return.

There are multiple technologies to be considered that are in line with these principles. Many of these are well established and can be implemented with confidence. These include energy efficiency measures such as variable speed drives on pumps and fans with variable demand, high efficiency motors and drives, insulation of pipes and vessels, heat recovery, heat pumps, absorption chilling, digital energy management solutions, and solar and wind energy.

Other technologies and solutions are less well established, including the use of alternative fuels such as hydrogen. In some cases, the costs of solutions are falling, or expected to fall, as uptake increases. Some technologies are innovative and require pilot trials, including hydrogen fired CHP for example. These technologies and solutions are developing quickly.

Resilience and Flexibility

While any strategy for utilities needs to address costs and carbon emissions, resilience and flexibility are also highly important:

- Utilities need to be constantly available to avoid interruptions to production and also for the safety and security of the site
- Utilities systems need to be able to adapt to changes in demands

UK Strategy – Trends, Issues & Opportunities

It is recommended that the actions companies take in the UK to reduce carbon emissions are consistent with Government policies and take advantage, where possible, of the likely incentives.

The UK has plans for the achievement of net zero. The plans are constantly evolving and it is important to continue to follow and analyse the opportunities.

The UK is regarded as a world leader in its actions associated with the fight against climate change. In 2019, the UK became the first major economy in the world to pass laws to end its contribution to global warming by 2050. Reaching this target will require extensive, systematic change across all sectors, including industry. It is recognised that getting this change right is vital as the products made by industry are critical to life in the UK, and the sector supports local economies across the country.

The UK has an ambition for decarbonising industry in line with net zero: the target for industry is emissions will need to reduce by at least two-thirds by 2035 and by at least 90% by 2050, including 3 MtCO2 captured through Carbon Capture, Usage and Storage (CCUS) and around 20 TWh of switching to low carbon fuels by 2030. It is recommended that sites set carbon reduction targets at least consistent with the UK plans.

The Government stated aim is to drive industrial decarbonisation by addressing barriers, mitigating carbon leakage risks, and with the Government playing a key role in the delivery of large infrastructure projects.

The UK intends to position itself as a climate leader whilst ensuring UK industry retains its competitive advantage, by working with industry to enable decarbonisation utilising a range of policy approaches, and mitigating against the risk of carbon leakage through levers that grow the market for low carbon products and reduce differences in climate policy between trading partners.

The Government intends to support existing industry to decarbonise and to encourage the growth of new, low carbon sectors in the UK by:

- using carbon pricing as a tool to send a clear market signal, providing certainty for investors.

- providing funding to support deployment and use of CCUS and low carbon hydrogen infrastructure
- establishing policies to ensure uptake of fuel switching
- taking initial steps to create a market for negative emissions technologies
- establishing a targeted approach to mitigating carbon leakage

Without a clear demand for low carbon industrial products, industry risks being undercut by cheaper, high carbon alternatives after decarbonising. Government plans to take action to support low carbon manufacturers by creating demand and developing the market for low carbon industrial products, without significantly impacting end-consumers financially.

The diversity of industry means that decarbonisation of the sector will be achieved through a combination of different technologies and measures. Specific plans include:

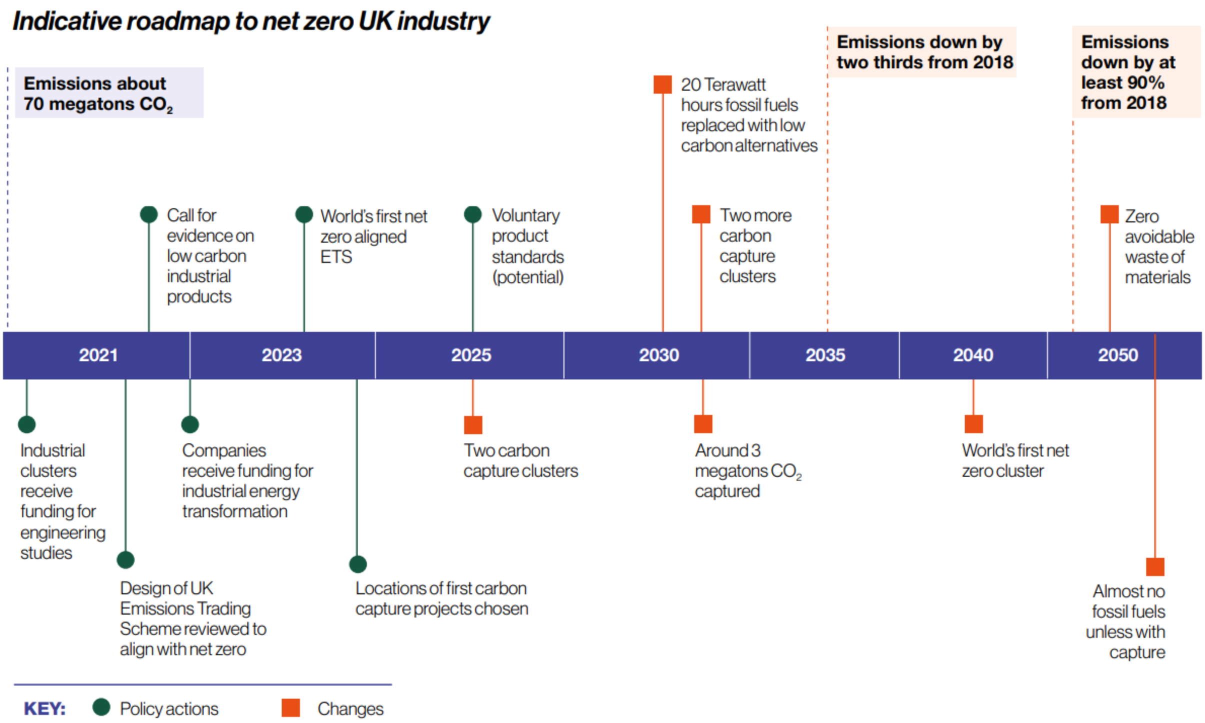
- supporting deployment of CCUS on industrial sites in clusters to capture and store around 3 MtCO2 per year by 2030
- supporting increasing amounts of fuel switching to low carbon hydrogen during the 2020s
- supporting low-regret fuel switching to electrification in industry during the 2020s
- reviewing the most appropriate use of bioenergy in industry
- working with industry to understand what is required to make sites retrofit-ready
- reviewing policies to address specific barriers faced by less energy-intensive, dispersed industrial sites
- improving co-ordination between decarbonisation and environmental policies to meet a common sustainability agenda.

Energy and resource efficiency measures, which reduce the level of energy and materials used in producing industrial goods, will be crucial to getting industry to net zero. Improvements in energy and resource efficiency will play a particularly significant role in reducing industrial emissions in the 2020s, leading the way in widespread emissions reductions while infrastructure for the deep decarbonisation options is built up throughout the decade.

Plans include:

- supporting sites to install energy management systems
- improving heat recovery and reuse across sites, particularly in sites with high operational temperatures
- helping less energy-intensive, dispersed industrial sites improve energy efficiency through the adoption of technologies available in the market with low payback times
- supporting increased resource efficiency and material substitution within industry, by driving the transition towards a circular economy model and increasing reuse, repair and remanufacturing.

Indicative Roadmap to Net Zero for Industry (BEIS, 2021)



Decarbonisation also creates challenges for industry. Many essential low carbon technologies are in earlier stages of development, and not yet deployed regularly at a commercial level. Low carbon manufacturing will also be more expensive for some sectors, leading to an increase in their costs, and therefore risking a reduction in their competitiveness. This creates a risk of “carbon leakage”. The Government plans to work with industry to overcome these barriers in the coming decades. Any action taken will need to be consistent with international obligations, both under

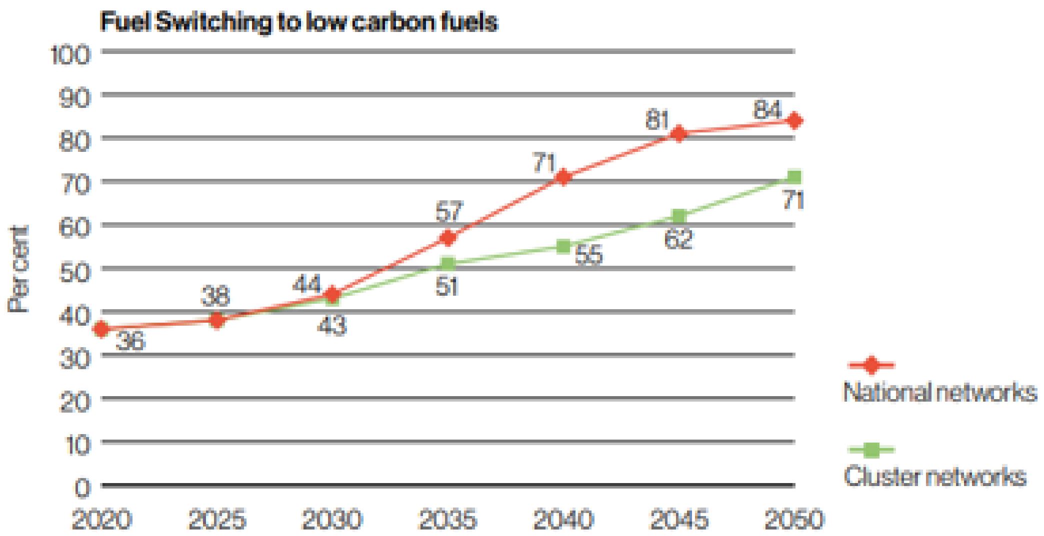
the Paris Agreement and wider international trade rules. To meet net zero, modelling shows industrial emissions will need to fall by at least 90% by 2050, equivalent to taking all the cars off the roads today. Any remaining emissions will need to be offset by separate methods, such as planting trees and capturing carbon from the air. All industrial sectors will need to act to meet this challenge. The vision is to transform how industry uses energy and makes products, and rethink the way consumers buy industrial products.

Industrial Decarbonisation Policies in the 2020s (BEIS)

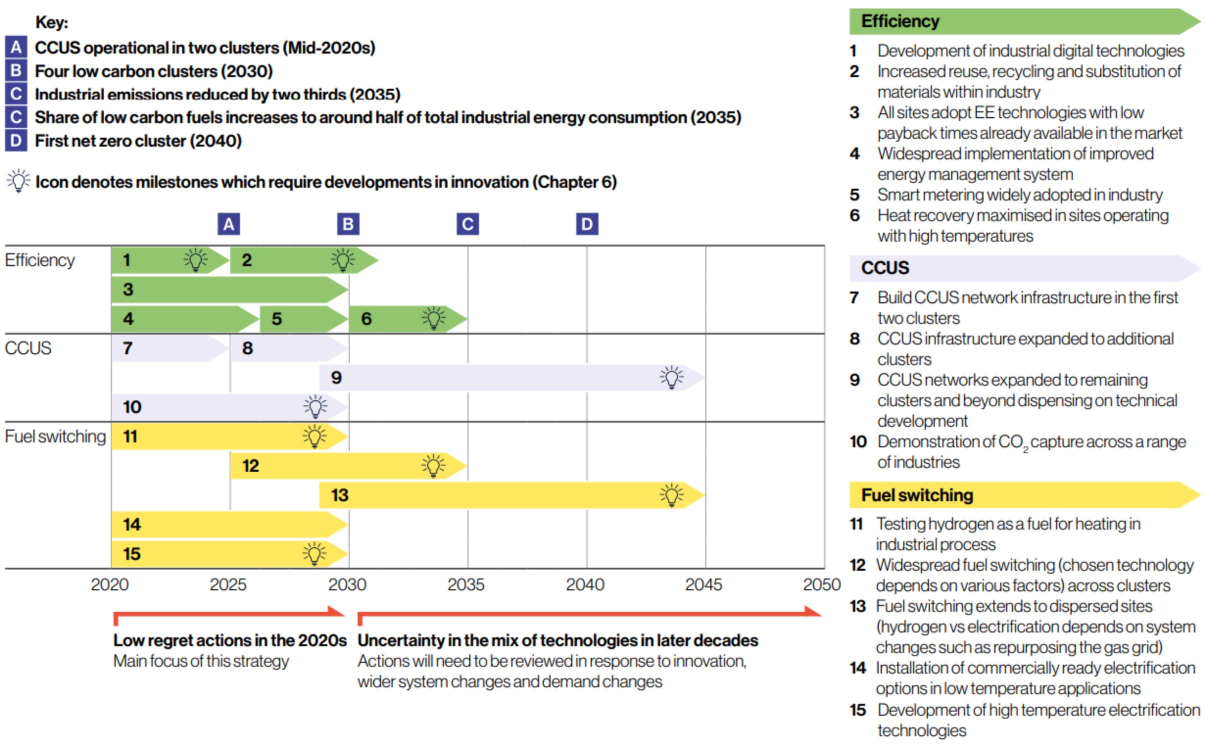
Policy Category	2010s	2020s
Carbon Pricing[1]	UK Emissions Trading Scheme | **£309 million (2019)**	
	Climate Change Levy | **£510 million (per year)[3]**	
Competitiveness Support[2]	UK ETS Free Allowances | **£1.05 billion (2019)**	
	Financial relief for energy-intensive industries (electricity costs) | **£470 million (per year)**	
	Climate Change Agreements | **£200 million to £300 million (per year)**	
Demonstration Funding[2]		IETF[4] | **£315 million**
		IDC[5] | **£170 million**
	Energy Innovation Programme | **£505 million**	Net Zero Innovation Programme | **£1 billion**
		Transforming Foundation Industries | **£66 million**
Deployment Funding[2]		CCUS/Hydrogen Business Models | **TBC**
	Renewable Heat Incentive | **£684 million (per year)[6]**	
		Net Zero Hydrogen Fund | **£240 million**
		Clean Steel Fund | **£250 million**
	Industrial Heat Recovery Support | **£18 million**	
Infrastructure[2]		CCUS Infrastructure Fund | **£1 billion**
	Heat Network Improvement Programme | **£320 million**	
Demand-side[1]		First DSP[7] introduced | **TBC**

Fuel switching requires industrial processes to switch from fossil fuels such as natural gas to low carbon energy such as electricity, biomass and hydrogen. The proportion of industrial energy consumption that is projected to switch to low carbon fuels between 2020 and 2050 is shown in the chart below.

Fuel Switching Predictions for Industry (BEIS, 2021)



Overview of Technology Strategy for the UK to 2050 (BEIS, 2021)



A key principle is that resources will be used to best effect in the medium term:

- hydrogen should be limited to high temperature industrial heating, heavy transport, decarbonising remote locations and grid support
- biomass will have strict requirements for sustainability, be limited to use in hard to decarbonise applications and will require carbon capture to achieve negative carbon emissions overall

Solutions and Technologies

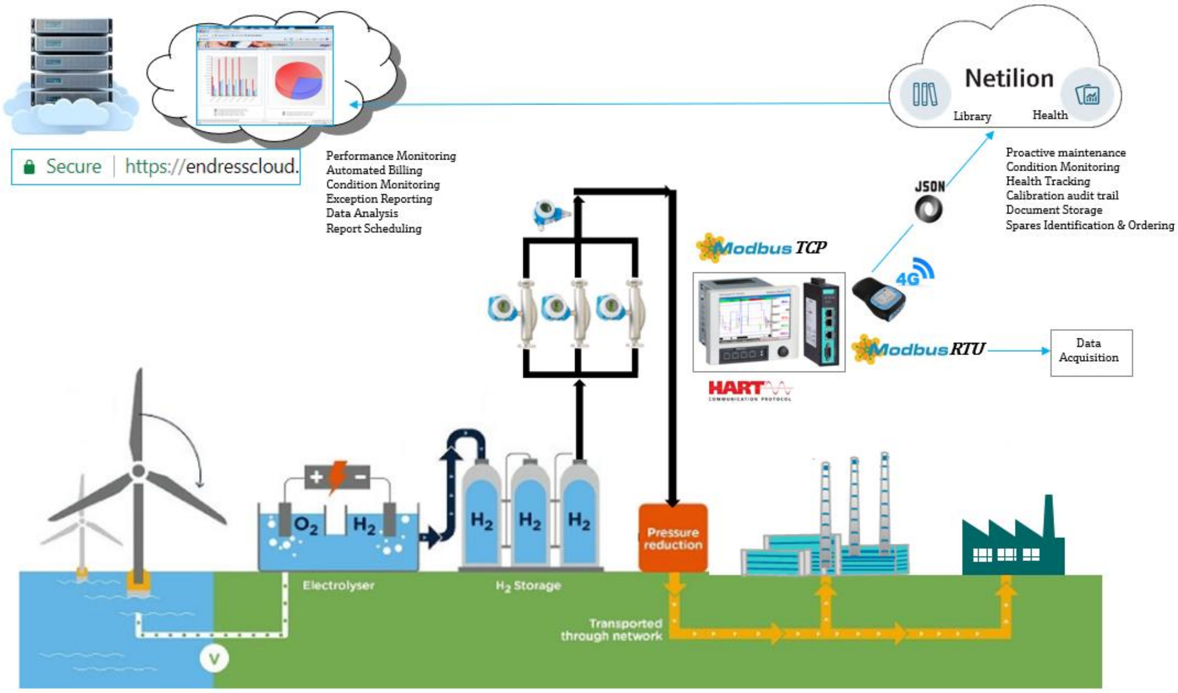
The technologies and solutions for the energy transition are many and varied. More solutions are developing and the costs of the new solutions are falling.

Some examples of solutions to be considered in industry are:

- Energy Efficiency, including a wide range of solutions. Energy efficiency should be accelerated in future to reduce the risks associated with energy and carbon prices
- Electrification, as the grid decarbonises further
    - Heat pumps can be used for an increasingly broader range of applications, from low temperature space and process heat to steam generation
- Heat Recovery
    - Heat integration, using Pinch technology to find the optimum opportunities
    - Heat to power, for example organic Rankine cycles and steam expanders
- Renewable power/low carbon power
    - Wind turbines
    - Solar PV
    - Nuclear, including small modular reactors which can provide low carbon heat and power in specific locations in the medium term
- Renewable fuels and heat
    - Hydrogen, including blue, green and turquoise
    - Biogas/biomethane (from AD and gasification)
    - Biomass with carbon capture
    - Renewable liquid fuels (HVO, bioLNG)
    - Waste heat recovery from others/district heating

- Carbon capture, storage and use, to reduce carbon emissions into the atmosphere
    - Carbon capture as a service, where carbon is transported from a site to be stored
    - Methane pyrolysis, turning methane into hydrogen and solid carbon
    - Biochar from pyrolysis
    - Reaction with minerals
- Greenhouse gas removal techniques to take carbon dioxide out of the atmosphere
    - BECCUS, direct air capture
- Low GWP Refrigerants
    - CO2, ammonia, water, HFOs
- Process change to fundamentally change the energy and carbon demands of a process, to allow decarbonisation to be achieved more easily and to produce low carbon products and services
- Energy management
    - ISO 50001
    - Monitoring and targeting
    - Insights and optimisation
- Demand management
    - Battery storage
    - Management of electricity demands
    - Cold and heat storage
- Digital solutions
    - Data analytics/AI
    - Advanced control
    - Optimisation
    - Digital twins
    - Predictive maintenance

Digital Solutions – Meters to Action



The Decarbonisation Journey

Actions to address the issues and opportunities associated with the energy transition need to continue as technologies, regulations and targets change.

The decarbonisation journey is shown below. The need to constantly review the plans and to maintain momentum and stakeholder commitment is highlighted.

The decarbonisation journey for an industrial company

Phase 1. Initial Assessment	Phase 2. Strategy Development	Phase 3. Project Development, Business Cases, Approvals	Phase 4. Implementation
Aims: Understand objectives, opportunities, issues and constraints Develop an informed plan **Main Tasks:** Understand organisation and sites Identify key issues and opportunities Develop and agree a plan	**Aim:** Development of an agreed decarbonisation strategy (for each site) – solutions, costs, benefits, risks, uncertainties **Main Tasks:** Detailed assessment of operations Identification and analysis of opportunities Understand wider issues and opportunities Develop and agree strategy	**Aim:** Approval for the investment in the proposed solutions at each site **Main Tasks:** Development of the opportunities High level specifications, supplier identification and engagement Evaluation of tenders and contract negotiation Stakeholder alignment Business cases/capital justifications Approvals for investment	**Aim:** Momentum and implementation of identified solutions **Main Tasks:** Stakeholder alignment Engagement with suppliers, consultants, internal departments Technical support Analysis of options Troubleshooting M and V

Phase 5 - Ongoing revision of the strategy and plans

Ensure Momentum and Stakeholder Engagement

It is essential that organisations start the decarbonisation journey, but often the pathways to full decarbonisation are uncertain. Some measures can usually be implemented that are 'no regrets' – these measures are cost effective and/or relevant for all possible future scenarios. Good examples of these are the use of heat pumps for lower temperature heating demands, renewable power generation, energy efficiency and heat recovery.