The Evolution of Energy Efficiency Policy to Support Clean Energy Transitions

International Energy Agency

INTERNATIONAL ENERGY AGENCY

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Introduction

Using energy more efficiently has proven to be an extremely successful and cost-effective way to reduce energy demand. Highly developed and well proven policy instruments already exist to deliver increased energy efficiency, such as Ecodesign in Europe and Japan's Top Runner. These policy tools can also support fuel switching and better demand management, helping to integrate higher volumes of variable electricity supply.

Japan's Ministry of Economy, Trade and Industry, as part of Japan's Presidency of the G7, asked the International Energy Agency (IEA) to examine the evolution of energy efficiency policy in the context of clean energy transitions. The aim is to support discussions among G7 countries to provide insights and direction for the G7 energy and climate agenda.

This brochure outlines how traditional ***energy efficiency policy is evolving*** to address system-wide energy efficiency aspects such as grid flexibility and decarbonisation.

It provides insights into policy developments in major economies and presents the possible impacts from transforming energy efficiency regulations, with examples in three main sectors:

- Demand flexibility in appliances and buildings.
- Vehicle fuel economy standards.
- Industrial energy and carbon reporting.

This brochure is a draft for comment, and intended as a precursor to a longer report that will be published by the IEA later in 2023.

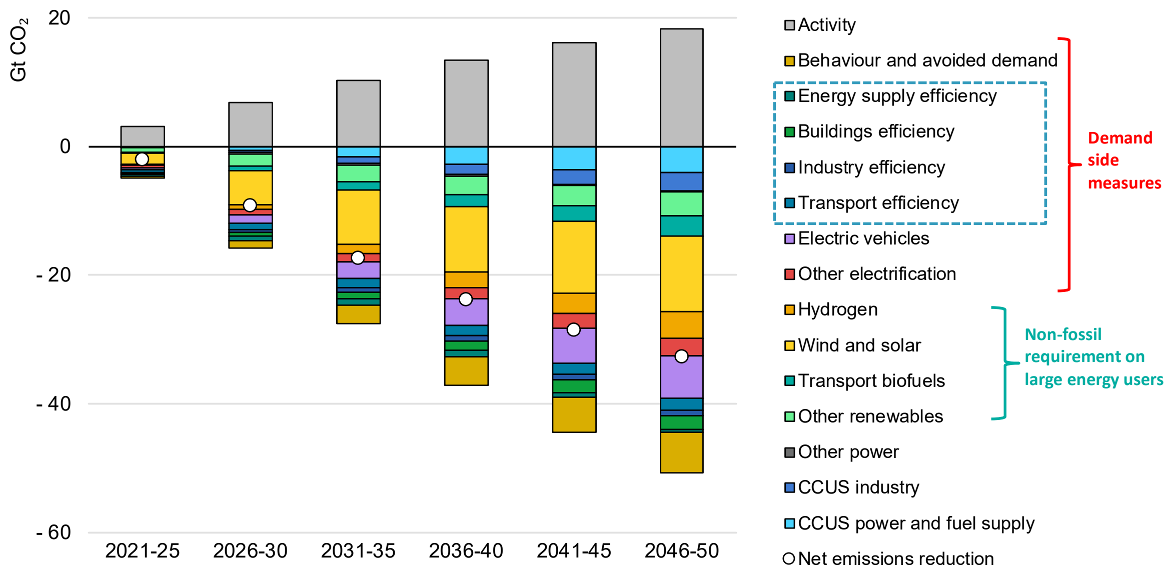
The changing energy system

Over the past few years, the global energy system has seen dramatic changes as it responds to the rebound from Covid-19 and increased supply pressures following Russia's invasion of Ukraine.

At the same time, energy systems are undertaking substantial transformations to fulfil government and society Net Zero climate ambitions.

Under the IEA's Net Zero Emissions by 2050 Scenario – which provides a realistic yet challenging pathway to climate goals - increasing the energy efficiency of end-uses is a key component. In this scenario, energy efficiency efforts are front loaded, as they are based on proven technologies ready to be implemented at low cost.

Demand side measures play a significant role in the IEA Net Zero Scenario, 2021-2050



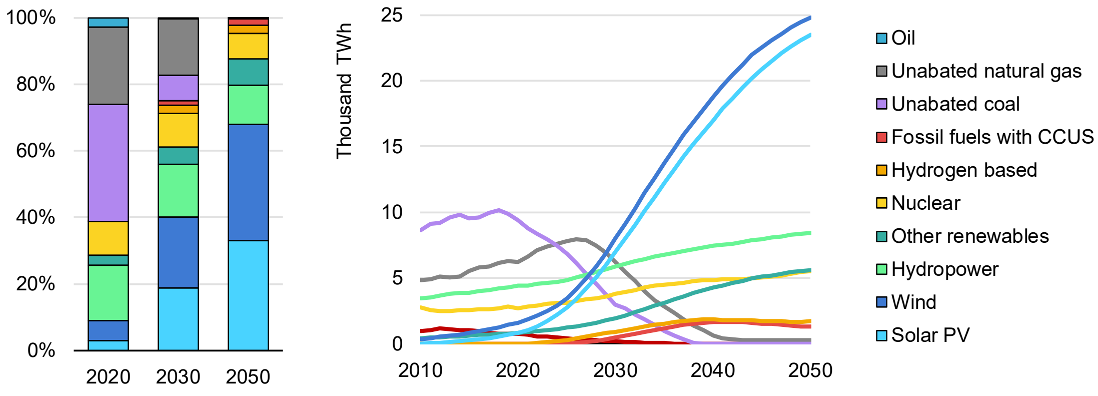
Source: IEA (2021) Net Zero by 2050.

Other demand side measures are also key to clean energy transitions, especially those that electrify end-uses, particularly vehicles and heat pumps for space and industrial process heating.

In addition to mitigating climate change, reduced energy demand improves energy security and lowers bills for energy consumers.

Clean energy transitions also involve the progressive replacement of fossil fuels by renewable electricity. Solar and wind energy are predicted to become the largest installed capacity source for global electricity grids within 5 years. By 2050, under the Net Zero Scenario, these two technologies, driven by much lower installation and running costs, will be the worldwide dominant source of electricity.

Changes in world electricity sources, IEA Net Zero Scenario, 2010-2050



Source: IEA (2022), World Energy Outlook.

However, increased deployment of such renewable forms of energy will make electricity supply more variable, and therefore increased flexibility will be required to keep the grid operating effectively.

This flexibility will be partly provided by reserve generation and storage; for example, batteries will provide close to a quarter of the flexibility needed in 2050 in advanced economies and only slightly less in emerging market and developing economies. However, demand response will provide the greatest proportion of flexibility needed to ensure the grid operates effectively and efficiently.

Demand response flexibility can be implemented more rapidly and at a lower cost than most other flexibility options.

In summary, demand side policy, which includes energy efficiency policy, needs to evolve to help deliver clean energy transitions, through the promotion of:

- **Fuel switching**, especially from fossil fuel-based end-uses to electricity-based alternatives, with technologies such as EVs and heat pumps.
- **Increased flexibility** of electricity demand to better match variable supply. Being able to shift demand in time, without loss of service, will be a valuable contribution to energy system efficiency.

Without demand response, clean energy transitions could adversely affect the integrity and stability of the electricity grid. However, traditional energy efficiency policies are evolving to support fuel switching and make demand more flexible.

Regulations that were previously based on minimising energy use have changed over time to focus on reducing carbon emissions. For example, fuel economy standards are increasingly based on (tailpipe) greenhouse gas (GHG) emissions rather than vehicle energy efficiency, providing incentives for electric vehicles (EVs). Similarly, energy efficiency policies are beginning to include and address flexibility and grid considerations. For instance, some US states have peak demand targets as part of their energy efficiency obligations.

Evolution of energy efficiency policies to support fuel switching and demand response

	Regulation	Incentives	Information
Buildings	**Building codes** ↪ Solar PV ↪ Demand response ↪ Smart EV charging **MEPS for appliances** ↪ Demand response	**Energy Efficiency Obligations** ↪ Carbon-based obligations ↪ Peak demand targets	**Energy Performance Certificates** ↪ Fuel to GHG
Transport	**Fuel economy standards** ↪ Fuel to GHG ↪ ICE phase-out ↪ EV bonus ↪ EV to Grid bonus	**Demand incentive schemes** ↪ Subsidies directed to EVs ↪ EV charger subsidies	**Energy label** ↪ Fuel to GHG ↪ EV to Grid bonus
Industry	**Industry agreements** ↪ Energy to GHG ↪ Electrification (e.g., heat pumps) ↪ DR requirements	**Subsidies, grants** ↪ Carbon-reduction based	**Energy and carbon reporting** ↪ Adding GHG reporting ↪ DR reporting

The following sections show examples in three areas: demand response requirements to improve grid flexibility for buildings, vehicle fuel economy-related regulations in transport, and reporting systems in industry.

Demand response requirements in buildings and equipment

Regulators in a growing number of countries are contending with how best to include demand response functional requirements into policies for products and buildings. Flexible demand, where customer end-uses are controllable and shiftable over time, makes the grid more secure and improves system-wide energy efficiency.

To unlock this potential from flexible demand, appliances and buildings need to enable demand response. Whether automated or remotely controlled, open communication protocols are necessary to allow different actors (such as distribution operators, suppliers, and energy service companies) to exchange information. While some simple approaches, such as radio teleswitches to control water heaters, have been common for some time, improved communication protocols and processes are now creating significant new opportunities at ever lower costs. Utilities or aggregators can communicate in real time with appliances, through an intermediate control device such as home energy management systems or smart meters, either directly modifying its operation, or sending information (price signal, power carbon intensity) to prompt an action by the appliance.

Ideally, demand-response ready equipment should be able to send and receive data using a standardised protocol, enabling interaction between different technologies and manufacturers. This would allow consumers to choose control devices, connect them to each other easily and change them if needed.

Several countries have already begun introducing policies to promote such control, both for energy-using products and buildings. Examples are listed below, including countries that are at the forefront of exploring this issue, including Australia, European Union, the United Kingdom and the United States.

Example of policy measures to promote demand response

Country	End-use	Policy, description	Status	Type
European Union	Building	**EPBD - Smart Readiness Indicator.** Quantifying the energy flexibility capability of buildings and representing it in a meaningful way for stakeholders.	Planned	Information
United States, California	Building	**2022 Building Energy Efficiency Standards** Requirements to install demand response automated systems for heating and cooling, as well has lighting using OpenADR, a common open standard for two-way communication	In force	Regulation
United Kingdom	All appliances	**Smart Systems and Flexibility Plan.** Mandate for large domestic-scale appliances to be interoperable with DSR service providers.	Planned	Regulation
European Union	All appliances	**Code of Conduct for the energy smart appliances manufacturers.** Aiming at developing of Interoperability requirements.	Planned	Regulation
Australia	Air conditioners	**GEMS.** Requirements for room air conditioners to publicly register if they are “demand response ready”. Separately, from July 2023, only air conditioners that meet the demand response capability requirements can be connected to the South Australian electricity distribution network.	In force	Regulation
Australia	Air conditioners	**PeakSmart Air Conditioning.** Electricity distribution network operators in Queensland offer rebates for customers who install an air conditioner with digital demand response controls.	In force	Incentive
South Korea	Buildings and appliances	**Energy Pause programme** for residential demand response for small consumers and individual households below 200 kW. Various resources such as smart lighting and smart appliances have been participating in 2022.	In force	Incentive

Policy developments which promote automated demand response, such as the examples above, are dependent on underlying communication protocols and rules. A selection of key norms and standards to support control and demand response is listed below. The development of such standards is key to the uptake and deployment of flexible demand.

Examples of standards and norms to control and monitor equipment

Region	Name	Description	Type
European Union	Norm EN 50631-1:2020: European Norm	Describes the necessary control and monitoring for household appliances.	Norm
United Kingdom	PAS 1878:2021	Requirements and criteria for electrical appliance to be classified as energy smart.	Norm
Australia	AS 4755 – Demand Response Standard	Demand response capability and modes of appliances and smart device.	Standard
United States	ANSI/CTA-2045	Specifies a modular communications interface to facilitate communications with residential devices for applications such as energy management.	Standard
International	IEC 62746-10-1	Open automated demand response system interface between the smart appliance, system, or energy management system and the controlling entity.	International Standard
United States, California	Senate Bill 49 – The Flexible Demand Appliance Standards	Authorises the Energy Commission to adopt standards for appliances to facilitate the deployment of flexible demand technologies.	Bill

Vehicle fuel economy-related regulations

The transport sector plays its role in moving towards Net Zero through improved efficiency, decarbonised fuel and greater electrification. In the IEA's Net Zero scenario, electric cars make up 20% of all cars on the road in 2030 compared with 1% today. The adoption of electric cars is already rapidly increasing. In 2022, nearly one in eight every cars sold globally was electric, with unit sales doubling between 2020 and 2021.

Currently, fuel economy standards for cars exist in over forty countries, covering more than 80% of new vehicle sales worldwide. Fuel economy standards, which have developed over time, have increasingly included provisions to facilitate the uptake of EVs and vehicles using other alternative fuel sources. Regulatory approaches have included:

- Zero emission accounting – EVs/ hydrogen vehicles are treated as having zero (tailpipe) emissions.
- Additional counting – each EV / hydrogen vehicle can be counted 'more than once' using multipliers/ super credits (with terminology differing by country).

Combining these two provisions increases their contribution to overall compliance, as the impact of an EV being counted as zero emissions is multiplied. In effect, the production of electricity/hydrogen vehicles therefore makes compliance with regulation relatively easier.

The table below summarises the approaches used in selected countries. The mechanisms of zero emission accounting and additional counting (multipliers/super credits) have been used in six out of the seven G7 countries, with additional counting, being phased out over time. Increasingly, there is a move to phase out conventional vehicles, and require that all new sales be zero emission vehicles.

Broader accounting, for example recognising upstream electricity emissions (well-to- wheel) is used by two of the G7 countries. "Life Cycle Analysis (LCA)'' is a way to assess the environmental impact of all stages of a vehicle's life. Increased understanding of upstream and downstream impacts of products and fuels helps ensure that emission savings are optimised throughout the life cycle. LCA will increase in importance as vehicles and the fuel mix change.

While ever more stringent regulations have resulted in vehicles becoming more efficient, gains have been offset by vehicles becoming larger and more powerful. Globally, these shifts have eroded up to 40% of improvements in fuel economy between 2010 and 2019. For electric vehicles, the increasing size of vehicles has implications for batteries, with average battery sizes increasing by 60% between 2015 and 2021, having knock-on implications such as increased demand for metals used in batteries.

Vehicle fuel economy-related regulations approaches used in selected countries

Electric vehicle inclusion in regulation	Standard type	Measures to facilitate EVs				Measures to capture impacts		Measures to achieve EV targets	
		EVs are treated as zero emissions /zero energy use		Inclusion of EVs has additional weighting		Accounting of (upstream) electricity related GHG emissions		ZEV mandates or mandate style approaches	
		Current /Historic	Future	Current /Histori c	Future	Current /Historic	Futur e	Current /Historic	Future
Canada	GHG emission limits	✓	✓ limit	✓		✓ once cap reached	✓		✓ State level
EU (inc. France Gernamy Italy)	CO_2 emissions	✓	✓	✓					✓
Japan	Fuel efficiency standards top runner approach			✓	✓ (revision)				
United Kingdom	CO_2 emissions	✓	✓	✓					✓
United States	Fuel economy standards and GHG emission limits	✓	✓ limit	✓		✓ once cap reached	✓		✓ State level

Source: IEA analysis based on ICCT (2018), Modernizing vehicle regulations for electrification.

The greatest efficiency gains are achieved by policy packages that combine regulation, information and incentives.

- In France, fiscal incentives have contributed to CO_2 emissions of new passenger cars sold being around 9% lower than the EU average. The bonus-malus scheme was strengthened further in 2020, with the maximum 'penalty' for consumers of new high emitting vehicles being doubled to EUR 20 000.
- In Germany, from 2020 vehicles with high CO_2 emissions have been taxed more heavily.
- In Kenya, a combination of regulations (such as age limits on vehicle imports) and financial incentives has resulted in average vehicle efficiency being 25% higher compared to comparable countries.
- In New Zealand, registration shares of electric vehicles increased to highs of 5% to 15% after the introduction of a bonus-malus scheme.
- In Norway nearly 90% of vehicle sales are now electric, reflecting the use of broad range of incentives alongside regulatory and information approaches.
- In France, advertising of the most polluting vehicles will be banned from 2028.

Industry reporting systems

The industrial sector is challenging to decarbonise, with processes as diverse as the economy itself and each company guarding its proprietary methods. Solutions for energy efficiency and decarbonisation are subsequently highly individual. The challenge for policymakers is therefore to incentivise industrial decisions that set a path towards higher energy efficiency and decarbonisation without hurting competitiveness and innovation.

A core requirement for any successful policy decision-making is reliable information. As large industries are among the biggest energy consumers in most economies, the influence and impact of industrial policy decisions is significant. For several decades, G7 countries have been using reporting systems where industries above a certain threshold must regularly report their energy consumption to a government body. This information helps ensure consistency, accuracy, and reliability of national energy balances, and is used by governments to make informed decisions on policy.

In the context of increasingly stringent measures to mitigate climate change, industry reporting has put a stronger focus on GHG emissions accounting to monitor improvement over time. Furthermore, progressively more governments are putting in place public disclosure obligations that can increase transparency in company activities.

Finally, the data collected can be used in a wider scope of policy design and decision making. For example, in the areas of energy security and climate impact where energy demand management and efficient use of energy, enabled through data led decisions, play a crucial role.

Industrial reporting polices can include measures for capacity building in energy and emissions reporting, along with the reporting framework itself. This can help increase the reliability of the data collection and reporting, benefiting both the organisation, at site performance level, and the overall industrial sector, in terms of assessment, benchmarking and competitiveness.

Japan is in the process of developing an updated industrial reporting scheme that features demand response provisions, explicitly addressing the challenges of peak electricity demand in industrial energy consumption. The following table provides an overview of major industrial reporting schemes in G7 countries and beyond.

Overview of industry reporting schemes in G7 countries and further examples

Country	Short name	Start year	Status	Reporting threshold level**			Threshold metric			Metric reported			Demand Response Provision	Public Disclosure
				Site	Organisation (National)	Organisation. (Global)	CO_2	Energy cons.	Energy prod.	CO_2	Energy cons.	Energy prod.		
Australia	NGER	2007	In force	✓	✓	✓	✓	✓	✓	✓	✓	✓	No	Yes
Canada	GHGRP	2004	In force	✓			✓			✓			No	Yes
Japan	ECA	1993*	In force	✓	✓			✓		✓	✓		**Yes (revision)**	Yes
Korea	GHG-ES	2011	In force	✓	✓		✓			✓	✓		No	Yes
	ECR	1980	In force	✓				✓			✓		No	No
United Kingdom	SECR	2019	In force	✓				✓		✓	✓		No	Yes
United States	GHGRP	2009	In force	✓	✓	✓	✓			✓			No	Yes
California	CA-GWSA	2006	In force	✓			✓			✓			No	Yes
South Africa	NGERs	2011	In force	✓				✓		✓			No	No

*: The start year of Japans ECA refers to the previous legislation. Japan's updated industrial reporting scheme is currently under development and will feature a demand response provision.
**: The threshold defines the level at which an organisation begins to be obligated by the reporting scheme.

From Brochure to Full Report

This brochure provides some examples of how energy efficiency policy is already evolving to support clean energy transitions.

It was drafted in advance of the G7 ministerial discussions in April 2023 - a longer report will be developed and published later in 2023, which will:

- provide further examples, with suggestions as to which approaches are working well within its context, and within a policy package framework.
- summarise the benefits of further adoption on such policies which are increasingly optimising system-wide efficiency, beyond end-use efficiency.

This longer report will also include direct comments and feedback from the G7 members. For further details and to provide comments, please contact energy.efficiency@iea.org.

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