Energy Efficiency

Campus Kristiansund Internship Program

Kristiansund kommune

Møre og Romsdal fylkeskommune

NEAS

SpareBank 1 NORDMØRE

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Abstract

As the global community increasingly recognizes the urgent need to address climate change and promote sustainable practices, local municipalities like Møre og Romsdal Fylkeskommune play a crucial role in driving regional energy efficiency initiatives. That is why the work on the project was initiated. The goal of the project is to look at and assess the tools needed to monitor and provide a basis for choosing energy efficiency measures. A key focus is the evaluation of these measures using suitable indicators at both regional and municipal levels.

The energy efficiency project undertaken by Møre og Romsdal Fylkeskommune aligns with Sustainable Development Goal 7 (SDG 7) on affordable and clean energy and contributes to related goals such as SDG 9 on industry, innovation, and infrastructure and SDG 11 on sustainable cities and communities. The research employed a comprehensive methodology to investigate energy efficiency indicator development in various countries that already have established indicators. It encompassed document review of IEA, municipality reports, data collection from Statistics Norway (SSB), direct communication with the Norwegian Water Resources and Energy Directorate (NVE), and stakeholder

engagement with energy suppliers (NEAS, Mellom). Document review provided insights into existing frameworks and initiatives, while SSB data offered demographic and economic indicators. Communication with NVE facilitated information on ongoing indicator development, and meetings with energy suppliers yielded detailed energy consumption data. Additionally, email correspondence was utilized to gather further insights.

This multifaceted approach ensured a thorough understanding of the energy landscape and indicator development processes within the target municipalities. The results from the research proposed 44 general indicators that can be measured in the residential, service, transport, and industry sector at the municipality level. Most of these indicators have no available data, and 15 of the indicators are considered most relevant. We also included a list of energy efficiency indicators that has been adopted in other European countries, this data is available in the appendix section.

In conclusion, this project emphasizes the interconnectedness between local efforts and global sustainability goals, underscoring the role of Møre og Romsdal Fylkeskommune in advancing the energy transition. As the development of energy efficiency indicators becomes a key component of the regional strategy, the region not only enhances its own resilience to environmental challenges but also sets an example for other communities aspiring to create a more sustainable and energy-efficient future.

1. Introduction

1.1 Background

Ambitious energy efficiency targets are key to driving Europe's energy transition. By using energy more efficiently, and thereby consuming less, Europeans can lower their energy bills, help protect the environment, mitigate climate change, improve their quality of life, reduce the EU's reliance on external suppliers of oil and gas and support the sustainable growth of the EU economy. To unlock these benefits, energy efficiency needs to be improved across the entire energy supply chain, from production to final consumption. EU energy efficiency measures focus on policy areas with the greatest potential for energy savings and where a harmonised approach across EU countries is needed. This includes industry, the public sector, the construction and renovation of buildings, the transport and energy supply sectors and the introduction of a uniform energy labelling system. The development of energy efficiency indicators is imperative for several reasons. Firstly, it provides a comprehensive understanding of energy consumption patterns, enabling informed decision-making and targeted interventions to optimize energy use. Secondly, such indicators serve as vital tools for monitoring and evaluating the effectiveness of energy-saving measures, facilitating continuous improvement in resource management practices.

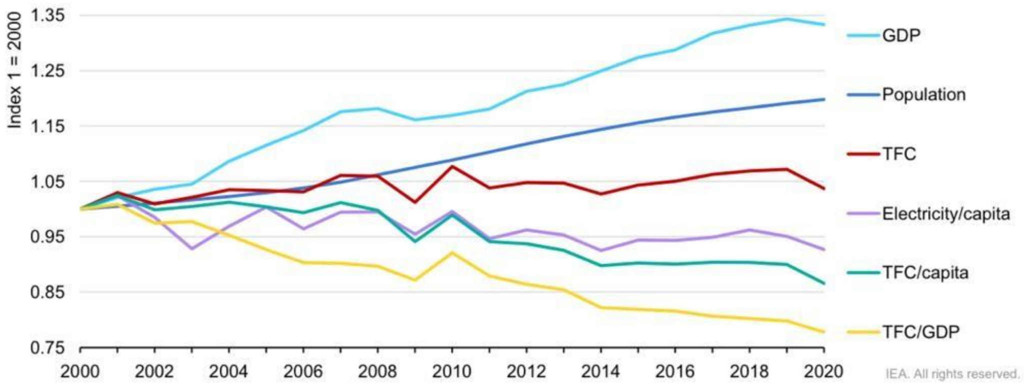
In alignment with SDG 7, which aims to ensure access to affordable, reliable, sustainable, and modern energy for all, and target 7.3 – double the global rate of improvement in energy efficiency by 2030, Møre og Romsdal Fylkeskommune's commitment to developing energy efficiency indicators reflects a proactive approach towards achieving energy sustainability. By fostering efficient energy use within its jurisdiction, the region contributes to the broader global agenda of promoting clean energy and mitigating the impacts of climate change. The work on the project primarily pushed off from the indicator SDG 7.3.1 – "energy intensity measured in terms of primary energy and GDP" in the UN SDG framework. This is calculated as the amount of energy provided to the economy per unit of value of economic output. Megajoules per dollar are used to express it (adjusted for cross-country price differences and inflation) (https://ourworldindata.org/sdgs/affordable-clean-energy). However, the project is dedicated to developing a wholesome and complex set of energy efficiency indicators that will present a multidimensional description of the regional energy profile.

On 25 July 2023, the EU officially concluded the legislative process to strengthen the Energy Efficiency Directive. The updated legislation, including the new binding target, entered into force in all EU countries on 10 October 2023.
This target sets the goal of reducing EU final energy consumption by 11.7% by 2030, compared to the projected energy use for 2030 (based on the 2020 reference scenario). It translates into a primary energy consumption target of 992.5 million tonnes of oil equivalent (Mtoe) and a final energy consumption target of 763 Mtoe by 2030. Compared to the previous targets (1128 Mtoe for primary energy and 846 Mtoe for final energy), the increased targets aim to reduce Europe's 2030 energy use by roughly the equivalent of Spain's current annual energy consumption.

1.2 Energy Efficiency in EU/EEA (Norway)

Energy efficiency indicators are used to assess the progress in energy efficiency and to measure energy savings (ODYSSEE, 2020). In Norway, there has been a notable decoupling of economic growth from energy consumption trends. From 2010 to 2019, the country experienced a 15% increase in GDP, while total final consumption (TFC) decreased by 0.5% (Figure 4.1). This decoupling is further underscored by a reduction in energy intensity, observed in terms of both TFC per GDP (a decrease of -16% from 2010 to 2020 and -5% from 2015 to 2020) and TFC per capita (a -12% change from 2010 to 2020). Notably, electricity consumption per capita remained stable between 2009 and 2019, with increased efficiency offset by higher demand, particularly in the residential sector. The Covid-19 pandemic further contributed to a 3% decline in TFC between 2019 and 2020. Norway's primary objective for energy efficiency is to enhance the overall energy intensity of the economy by 30% by 2030 compared to 2015.

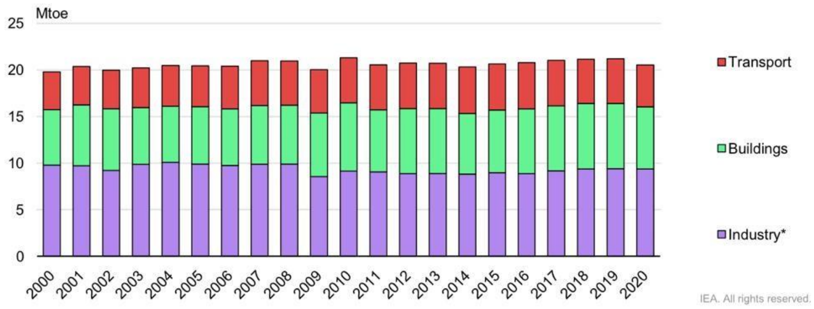
Fig 1.1 Energy demand and drivers in Norway, 2000-2020



Source: IEA, 2022

Total Final Consumption (TFC) in Norway stood at 20.5 Mtoe in 2020, maintaining a relatively stable trend over the past decade. It experienced a low point in 2009 amid the financial crisis and reached a peak in 2010, attributed to the recovery and unusually cold weather. In 2020, the industrial sector emerged as the foremost consumer of energy, with buildings and transport following closely behind.

Fig. 1.2 Total final consumption by sector in Norway



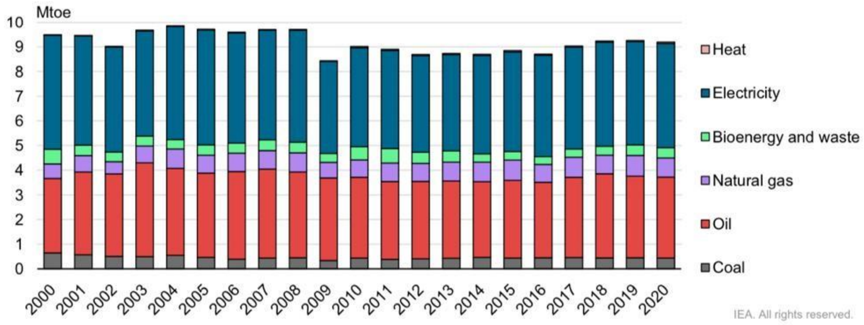
The figures displayed above indicate that Norway's GDP increased by 15% between 2010 and 2019 while total final consumption was stable signifying a decoupling of economic growth and energy demand.

1.2.1 Industry

The industrial sector holds the highest Total Final Consumption (TFC), accounting for 46% of energy consumption in 2020. The energy demand in the industry, including non-energy use, was 9.4 million tonnes of oil equivalent (Mtoe), a mere 2% increase from 2010. In the same year, electricity was the primary energy source in the industry, constituting almost half (45%) of the consumption (Figure 4.3). However, fossil fuels, including oil, natural gas, and coal, still play a significant role, satisfying 48% of the sector's energy demand. The chemical and petrochemical sector is the largest energy consumer among Norwegian industries, comprising 39%, reflecting the country's close ties to oil and natural gas production and refining. Other sectors contributing to TFC include non-ferrous metals (20%), non-metallic minerals (9%), iron and steel (8%), construction (8%), paper (6%), food and tobacco (4%), and wood (3%).

The energy intensity of the industry sector declined from 1990 to 2014, partly due to a shift toward less energy-intensive and more efficient industries. However, recent data indicate an increase in energy intensity between 2014 and 2020. This is primarily attributed to heightened production in energy-intensive industries and decreased production in less energy-intensive oil service industries.

Fig 1.3 Total final consumption in industry by source in Norway, 2000-2020



Source: IEA, 2022

Policies and measures in the industry sector

Norway has developed a robust base of energy-intensive industries, particularly in metals and chemicals, owing to its low energy costs from renewable sources. The government envisions continued growth in these sectors, including the establishment of additional metals facilities, battery factories, data storage, and hydrogen production. To support industrial growth, there is an anticipation of increased demand for renewables-based electricity and a reduction in fossil fuel usage, complemented by enhanced energy efficiency measures aimed at lowering greenhouse gas emissions.

An exemplary case is the Hydro Aluminium Karmøy plant, operational since 2018, which is 15% more energy efficient than the global average and boasts the world's lowest CO_2 footprint, drawing power from hydropower sources. The government further anticipates decarbonizing existing industrial processes through electrification and the establishment of Carbon Capture, Utilization, and Storage (CCUS) sites.
Norway's major energy-intensive industries fall under the EU Emissions Trading System (ETS), where carbon pricing signals are expected to motivate energy savings, given that approximately 20-30% of input costs are attributed to energy.

Between 2003 and 2018, Enova, a governmental entity, supported energy efficiency initiatives in the industry, providing substantial funding and facilitating 705 projects. Although Enova shifted its focus to emissions reductions since 2019, it continues to support waste energy utilization, resulting in substantial energy savings. Additionally, Enova supported the implementation of energy management systems in industry and transportation between 2012 and 2018, contributing to 764 projects. As of 2020, 42 Norwegian enterprises across 82 sites were certified with ISO 50001 for energy management.

Funding for Enova is derived from the Climate and Energy Fund, part of the national budget, providing clear financial projections for four years. Enova, with flexibility in fund allocation, appears adequately funded to fulfill its mandate. It also serves as a key source of information on energy efficiency across sectors, exemplified by the Enova Kunnskap information platform introduced in 2020.

The Forskningssenter for Miljøvennlig Energi (FME) HighEFF, a collaborative project funded from 2017 to 2025, focuses on developing knowledge and technology to enhance energy efficiency and reduce emissions in Norway's major industries. There is no available information stating that this project has formulated energy efficiency indicators for industry. It rather focuses on research conducting research with national and international industrial partners on how to address global warming by improving energy efficiency beyond the business as usual.

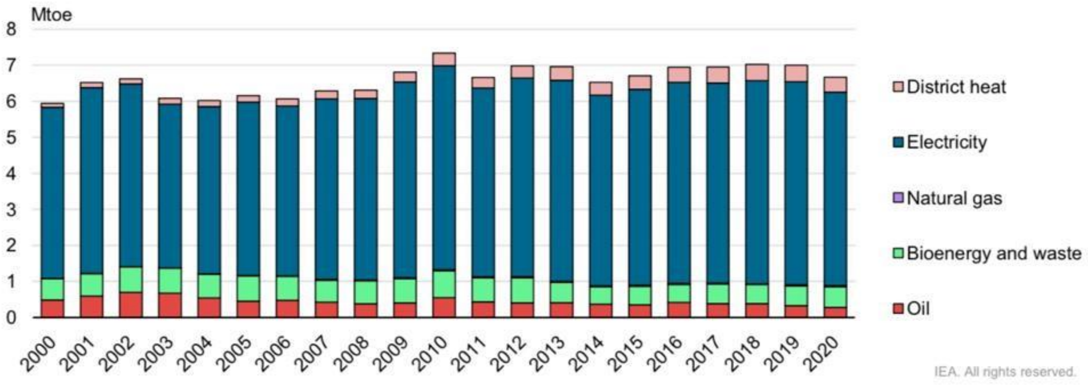
Norway is gearing up to implement the 2012 EU Energy Efficiency Directive (EED), requiring mandatory energy audits for companies consuming more than 5 GWh per year. The EU's 2018 update includes a headline energy efficiency target of 32.5% for 2030. In 2023, the EU revised this directive to ensure an additional 11.7% reduction in energy consumption by 2030.

1.2.2 Buildings and Heating

In 2020, the buildings sector comprised 32.5% of Total Final Consumption (TFC). This sector encompasses residential buildings (57% of buildings TFC in 2019) and service sector buildings (43%). The energy consumption in this sector has varied over the past decade, influenced by winter temperatures, as most of the energy demand in buildings is attributed to space heating (Figure 1.4).

Electricity covers the largest share of energy consumption in buildings (81% in 2020), playing a crucial role in both residential buildings (84% of residential buildings' TFC) and service sector buildings (76%) (Figure 1.4). The second-largest energy source for buildings is bioenergy (8.6% in 2020), primarily used in the residential sector, where it accounts for 13% of TFC. Although oil has nearly been phased out in the residential sector, its use in service sector buildings has slightly increased in recent years, constituting 10% of service sector TFC in 2020, mainly in the defense sector. District heat supplied 6.2% of buildings' TFC, predominantly in the service sector. Energy demand in buildings witnessed a 7.3% increase between 2014 and 2019.

Fig 1.4 Total final consumption in the building sector by source



Source: IEA, 2022

Policies and Measures in the Building Sector

Norway has set a goal to reduce energy consumption in existing buildings by 10 terawatt-hours (equivalent to 0.86 million tonnes of oil) by 2030, compared to 2015 levels. The Ministry of Petroleum and Energy (MPE) developed a plan to achieve this target and boost local electricity production in buildings, and the plan was released in October, 2023.
As of 2021, Norway's building stock comprised 4.2 million buildings, with 66% constructed before 1990. Residential buildings totalled 1.6 million, including 2.6 million dwellings, along with 0.5 million cabins and part-time dwellings. Non-residential buildings, including those without heating, numbered around 1.5 million. The key energy efficiency strategy involves adopting building codes, last updated in 2017 to passive house standards, 20-25% stricter than previous requirements. These codes apply to new buildings or major renovations, requiring a lower total net energy need or adherence to specific energy standards for components.

Notably, a ban on fossil fuel heating systems in new buildings began in 2017, and as of January 1, 2020, the use of mineral oil for heating is also prohibited. These measures aim to shift towards alternative heating technologies like heat pumps, biofuels, and direct electrical heating. Natural gas is permitted in existing buildings but is limited in usage. New installations for natural gas heating are not allowed.

Since 2010, energy performance certificates are mandatory for buildings and dwellings built, leased, or sold, promoting awareness of energy performance and improvement possibilities. Enova manages various programs focusing on market transformation for energy efficiency, with recent changes targeting emission reduction and the transition to a low-emission society. Enova provides information and advisory services for businesses, municipalities, and households, offering a free advisory service and guidance on smart building renovations.

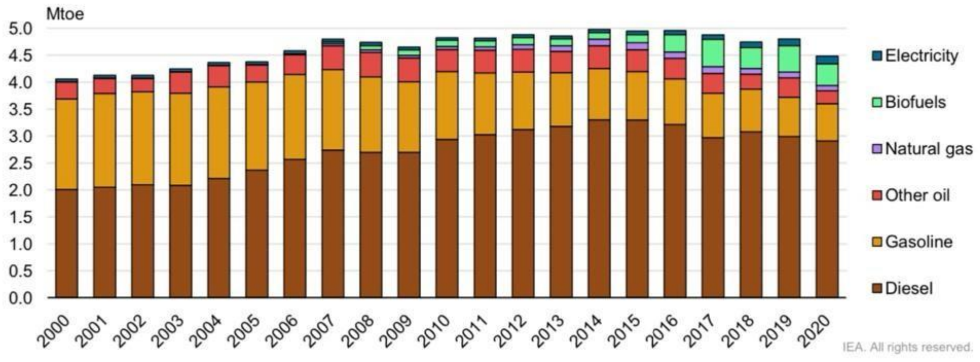
In response to high energy prices, the government allocated NOK 100 million (EUR 10 million) to fund energy efficiency measures in municipal social homes through Enova. The scheme aims to enhance the energy performance of public housing, reducing electricity bills for low-income families and contributing to the broader goal of reducing energy use in existing buildings.

1.2.3 Transport

Energy demand in the transport sector had 22 % share of the TFC (4.5 Mtoe) in 2020. Energy consumption in this sector witness a slight decline (-1%), although it peaked at 5 Mtoe in 2014 (Fig 1.5). In the period of 2019 to 2020, the sector's Energy demand reduced by 7 % due to the covid-19 pandemic. Oil products constitute 86 % of the transport sector's energy demand, placing it the second lowest share among IEA countries after Sweden. The consumption of diesel and gasoline in 2020 was 65% and 15% respectively. Diesel is largely used in the road transport sector (Representing 71 % of the Transport sector's TFC) and domestic transportation. It peaked at 3.3 Mtoe in 2014 and has been reducing (3.0 Mtoe in 2019 and 2.0 Mtoe in 2020).

Previously, electricity usage in the transport sector was dominated by Rail transport, the surging of Electric Vehicles has been increasing demand for this energy source. Electricity contributed to 2.9% of road transport demand in 2020, making it the highest among IEA members, and 3.2 % of the overall transport demand. Biofuel's share of 9% in the transport demand makes it the second highest among IEA countries after Sweden, and almost trebling after 2010.

Fig 1.5 Total final consumption in transport by fuel in Norway, 2000-2020



Source: IEA, 2022

Policies and Measures in the Transport Sector

In the transport sector, which accounts for 21% of total demand, Norway is pursuing an ambitious policy on EVs, through vehicle taxation. Fossil fuel cars are subject to a registration tax upon purchase. Furthermore, fossil fuel cars are subject to a CO2 tax and road use tax on gasoline and diesel. In contrast, zero-emission vehicles (ZEVs) are heavily subsidised in Norway. Support includes a reduced annual road tax; zero VAT; exemption from the one-off registration tax; as well as reduced toll road, ferry and parking fees. In addition, plug-in hybrid vehicles (PHEV) have for several years benefited from a reduced one-off registration tax. As such, Norway had the highest share of EVs globally (including both pure battery and PHEVs) in both car stock (22%) and car sales (86%) in 2021. Tax expenditures for EV incentives were around NOK 18.7 billion (EUR 1.9 billion) per year, or NOK 6 200 (EUR 620) per tonne of saved CO2. Based on progress to date, the Norwegian Source: IEA, 2022

1.3 Energy Mix in Norway

Hydropower accounts for most of the Norwegian power supply, and the resource base for production depends on the precipitation in a given year. This is a significant difference compared to the rest of Europe where security of supply is mainly secured through thermal power plants, with fuels available in the energy markets. (Energifakta Norge / Energy Facts Norway, 2023)

At the beginning of 2023, there were 1,769 hydropower plants in Norway, with a combined installed capacity of 33,691 MW. In a normal year, the Norwegian hydropower plants produce 136.49 TWh, which is about 88% of Norway's total power production. Norway has more than 1240 hydropower storage reservoirs with a total capacity of 87 TWh. The 30 largest reservoirs provide about half the storage capacity. Total reservoir capacity corresponds to 70% of annual Norwegian electricity consumption (Energifakta Norge / Energy Facts Norway, 2023).

At the beginning of 2023, there were 65 wind farms in Norway, with an installed capacity of 5073 MW. This corresponds to about 16.9 TWh in a normal year and about 11% of Norwegian production capacity. (Energifakta Norge / Energy Facts Norway, 2023). Norway's thermal power plants accounted for about 1.5% of the total production capacity in 2023. Many of the power plants are located in large industrial installations that use the electricity generated themselves. Hence, production often depends on the electricity needs of the industry. These power plants use a variety of energy sources, including municipal waste, industrial waste, surplus heat, oil, natural gas and coal. There are 30 thermal power plants in Norway, with a total installed capacity of about 642 MW. (Energifakta Norge / Energy Facts Norway, 2023)

At the beginning of 2023, the total installed capacity of solar power was 299 MW in Norway. In 2023, more than 90% of the installed capacity was connected to the Norwegian power grid. About 5% of the solar power in Norway had an installed capacity of more than 50 kW in 2023. In 2023, most of the solar power in Norway is installed on the roofs of households and industry, and primarily cover their own consumption. As of 31 March 2023, there are no dedicated solar power plants in Norway. During 2022, approximately 153 MW of new solar power was installed in Norway. (Energifakta Norge / Energy Facts Norway, 2023)

2. Measurement of Energy Efficiency in EU/EEA

Energy efficiency indicators are used to assess the progress in energy efficiency and to measure energy savings (ODYSSEE, 2020).

Based on our research, we classified the indicators into two main types: 1. Broad indicators, and 2. Narrow indicators.

1. Broad indicators: These indicators provide a general overview or summary of a particular concept or phenomenon. They often cover a wide range of factors and may not provide detailed insights into specific aspects. Due to their general nature, broad indicators are often used for initial assessments or to provide a general understanding of a situation or trend. Examples of broad indicators are those measured by power suppliers in the county (NEAS, Mellom).

2. Narrow indicators: These indicators focus on specific aspects or components of a phenomenon. They offer detailed and specific information about a particular aspect, which enables deeper analysis and understanding. Narrow indicators are more suitable for in-depth analysis or targeted interventions. They allow researchers or analysts to focus on specific areas of interest and develop more precise strategies or solutions.

2.1 Importance of Energy Efficiency Indicators

Energy efficiency indicators have multiple objectives, among which the 10 most important are:

- Organise information on energy consumption, through the data template and ODYSSEE data base gathering all the data needing to monitor energy efficiency in a country.
- Help to understand trends on energy consumption and energy efficiency.

- Provide market insights on the penetration of end-use equipment and energy efficient technologies.
- Benchmarking of energy efficiency performance of countries through cross-country comparisons, a crucial question in international negotiations on climate change.
- Monitoring of the targets set at the national and international levels in energy efficiency and CO2 abatement programmes.
- Policy monitoring to evaluate the impacts of measures so as to justify the public money spent to support these programmes and to plan future measures and actions.
- Measure the long-term impact of measures as these energy efficiency indicators can feed the technico-economic demand forecasting models needed, that are characterised by a high level of disaggregation (end-uses).
- Improve the dissemination of the progress achieved on energy efficiency, through dedicated indicators and tools.
- Help measuring the multiple benefits of energy efficiency.
- Setting energy efficiency targets.

2.2 Factors that Prevent Efficient Measurement of Energy Efficiency Indicators

Efficient measurement of energy efficiency indicators is crucial for informed decision-making and sustainable resource management. However, several factors hinder this process, posing challenges to accurately assess energy consumption and identify areas for improvement. The following factors contribute to the complexity of measuring energy efficiency indicators:

- Availability of Data: Access to comprehensive data is essential for precise measurement of energy efficiency. Unfortunately, existing data often remains at a general or aggregate level, lacking details needed to pinpoint specific areas of energy loss. To address this limitation, there should be investment in more measuring points, together with technology or Artificial intelligence (AI) that measure specific units such as energy consumed in cooking, heating, and appliances. Although, measuring minute factors incur significant costs, hindering widespread adoption.

- Methodology Variation and Coherent Datasets: Discrepancies in measurement methodologies and data coherence present challenges in accurately assessing energy efficiency indicators. Even when utilizing similar input data, results published by different institutions may vary significantly. For instance, power suppliers (NEAS, Mellom) may measure similar parameters, yet output disparities arise due to factors like weather variations impacting raw materials at different times. This inconsistency complicates comparisons and compromises the reliability of energy efficiency assessments.
- Industry Structure and Production Methods: Diverse industry structures and production methodologies further complicate energy efficiency measurement. Variations in production methods, such as electric or oxygen steelmaking, significantly influence energy consumption patterns. Additionally, factors like outsourcing of sub-processes, choice of raw materials (virgin/recycled), and product mix (bulk/specialized) contribute to the complexity of energy usage evaluation. Understanding and accounting for these intricacies are essential for accurate energy efficiency assessments.

In conclusion, addressing the aforementioned factors is imperative to enhance the measurement of energy efficiency indicators. By overcoming these challenges, stakeholders can make more informed decisions, optimize resource utilization, and foster sustainable development.

3. Energy Efficiency Situation

3.1 In Norway

The Norwegian government is committed to the achievement of the 30 percent improvement in energy efficiency in the overall energy intensity. As part of achieving this, the government has tasked the NVE to explore the possibilities of achieving the goal of reducing 10 TWh of energy consumption in buildings by 2030. In addition, NVE has also been challenged by the government to reduce the electricity consumption by 10TWh thereby turning more focus on power consumption. These findings will be very instrumental in directing government policy in having less energy consumption in buildings and fast-tracking the energy transition quest. The Ministry of Petroleum and Energy serves as the main state institution which is tasked with steering the government's energy efficiency policies. NVE collaborates with the government to monitor investments in energy efficiency and related activities. Sector ministries are charged with the overall monitoring of energy efficiency in their respective sectors.

The support schemes implemented by the government in ensuring energy efficiency are enormous including collaborations with Enova and Husbanken. It is focused on promoting innovative solutions, exploring and developing new markets and providing support to improve on energy efficiency in the country. The government has targeted to increase the investment with Enova by 180 million NOK in 2024, which will help improve energy efficiency and have a more flexible energy system. In addition, the government has made plans on increasing the Housing Bank's Subsidy scheme for rental housing, care homes and nursing homes to be raised to a total of NOK 300 million by 2024. This support seeks to raise the energy standard in the municipal housing stock. With this support, households with lower incomes can equally afford energy efficient housing.

Current status from NVE

While making this report, NVE was contacted by phone and email to know current progress at national level. They stated that "We are currently working on developing the indicators, so for the moment there aren't any indicators. We have had meetings with Finland and hope to collaborate with other countries who already measure energy efficiency and tailor them to suit Norway's standard." - Erik Jonas Sandgren (Senior adviser NVE). Our research at the county level is an important contribution to NVE's indicator development strategy.

3.1.1 National Objectives on Energy Efficiency

To ensure energy efficiency in Norway, the government has set some objectives which are sought to be achieved by 2030. These objectives are implemented by The Ministry of Petroleum and Energy, Sector Ministries, Municipalities, and other agencies. The government monitors plans being implemented on energy efficiency. The following objectives have been adopted by government to ensure energy efficiency in Norway:

- Strengthen efforts to reach the target of 30 percent improved energy intensity from 2015 to 2030.
- Investigate the consequences of a target of 10 TWh reduced electricity consumption throughout the building stock from 2015 to 2030.
- Regular reporting of status with particular attention to energy use in construction and industry will contribute to achieving the target.
- Potentials and possible measures for energy efficiency improvement in various sectors shall be made possible.

3.1.2 Role of Municipalities

Municipalities in Norway like the central government, have an important role to play in the energy efficiency pursuit. Most of the municipalities in Norway are engaged in responsibilities such as municipal planning, building ownership, and facilitating development in the various spaces. The government acts as a pacesetter by setting guidelines for municipalities to adopt and prepare action plans that consider energy efficiency in all its activities. This approach helps put all municipalities in a direction that will achieve the overall goal of the country. The action plans prepared by municipalities focused on the aspects of the economy such as Transport, Agriculture, Industry, and construction. These plans consider the national objectives which have been set by the Norwegian government. The government monitors these plans to ensure coherence with the overall plans of the nation and sector ministry. The plans prepared by the government and municipalities are in line the European Union's directives on Energy Efficiency.

As a part of the efforts to ensure energy efficiency in Norway, More øg Romsdal county has developed and proposed 40 indicators for energy efficiency from the residential, service, transport, and industry sector. These indicators were derived from International Energy Agency (IEA) document and similar indicators used by other countries around the world. These indicators will make it possible to monitor the energy consumption in the region as well as policies which are being implemented. The indicators focus on 4 sectors in the region which are: Residential, Industry, Service and Transportation.

3.2 Kristiansund

In Kristiansund, existing data related to energy efficiency is found in the United for Smart and Sustainable Cities (U4SSC) report and documentation from energy suppliers within the municipality. The U4SSC framework is a comprehensive guideline fostering collaboration and innovation among cities worldwide to implement smart and sustainable solutions for urban development. Over the years, the U4SSC has developed Key Performance Indicators (KPIs) to measure progress and effectiveness in achieving sustainable development goals.

The U4SSC framework categorizes all KPIs into 3 dimensions:

- Economy.
- Environment.
- Society and culture.

Indicators related to energy are in the environment category.

The U4SSC developed its indicators based on the following criteria which include:

- Fully meeting the aligned SDG(s)
- Performance compared with other international and transnational targets (e.g OECD, European commission)
- Performance against a UN agency's goals (e.g. International Telecommunication Union)

- Evaluation of city performance using UN and other international statistical data
- Performance measured versus leading city performance globally.

  The table below shows the indicators on energy currently measured in the Kristiansund based on the U4SSC standards. Some of these indicators do not appear on the energy supplier's (NEAS) list of indicators.

Table 1: U4SSC indicators on energy currently measured in Kristiansund. (Source: U4SSC report, 2022).

Indicators	Values
Renewable energy consumption	100%
Electricity consumption	14,031 kWh/yr./capita
Residential thermal energy consumption	0.76Gj/yr./capita
Public building energy consumption	187.40 ekWh/m2/yr
Percentage of smart meters installed	99%

In Kristiansund, 99% of the buildings have smart meters installed which enables easy measurement of energy use over a period of time. Smart electricity meters are components of modern electricity infrastructure designed to improve efficiency, reliability, and monitoring capabilities within the electrical grid. These smart meters also make it possible to determine peak hours and identify trends and patterns in energy usage which can be used to develop personalized recommendations for consumers to optimize their energy usage further.

The table below shows the indicators currently measured in Kristiansund. The data on energy consumption provided by energy suppliers in Kristiansund can significantly enhance energy efficiency efforts. By analyzing consumption trends, benchmarking across different sectors, and pinpointing areas with high energy usage, targeted interventions can be implemented to improve efficiency, such as upgrading appliances or optimizing heating systems. Additionally, this data informs policy development, public awareness campaigns, and long-term planning efforts for sustainable development. By leveraging this data effectively, Kristiansund can achieve cost savings, environmental benefits, and a higher quality of life for its residents through enhanced energy efficiency measures.

The verification of data in this document was conducted using information made available by the city's KPI data and by interviewing city stakeholders. The total consumption of energy is measured in kWh and is calculated by (Wattage × Hours Used Per Day) ÷ 1000 = Daily Kilowatt-hour (kWh) consumption, 1 kilowatt (kW) = 1,000 Watts. This is multiplied by the number of days you use the appliance during the year for the annual consumption in kWh per year. The highest consumption is from the households' sector with a value of 128,149,467 and the lowest consumption is from the agriculture sector with a value of 1,027,281.

Table 2: Broad Indicators currently measured by energy suppliers in Kristiansund based on different sectors and the total consumption in 2022. (Source: NEAS, 2022)

Sector	Indicator	Total Consumption (kWh)
	Total Consumption (PowerBi)	278,491,942
Agriculture	Agriculture, forestry and fishing	1,027,281
	Greenhouses and greenhouses	
Industry	Mining operations	
	Extraction of crude oil and natural gas	4,300,567
	Oil and natural gas services	816,025
	Production of chemical raw materials	
	Food industry	8,874,351
	Other industry	5,857,551
	District heating	
Services	Building and construction activities	3,783,646
	Merchandise trade, rep. of motor vehicles	21,437,802

	Other transport and storage	17,947,103
	Mail and distribution	98,415
	Accommodation and catering business	7,659,171
	Information and communication	2,526,950
	Financial.. insurance and pension	1,752,228
	Turnover and operation of real estate	17,712,196
	Professional, wit. and technical service	4,800,752
	Commercial service Provision	2,478,389
	Service provision otherwise	1,198,775
Public	Public administration and defence	21,337,297
	Street and road lights	887,692
	Instruction	4,493,735
	Health and social services	12,462,482
	Artistic activity, library, sport and leisure	3,799,581
	Activities in medl.org.	3,368,229
	Prod. and distr. of electricity	1,580,501
	Water supply, drainage and sanitation	411,902
	Undefined (summarized in public)	4,582
Households	Households	127,707,413
	Cabins and holiday homes	442,053
	Annual consumption 2022 [kWh]	
	Total sum	278,766,669
	Total Industry	19,848,494
	Total Trade and services	81,395,427
	Sum public	48,346,001
	Total Agriculture	1,027,281
	Total Household	128,149,467

3.3 Suggested Indicators from Our Research Including its Advantages and Disadvantages

Our research includes identifying indicators that are narrow and facilitates the detection of subtle changes or trends within specific domains, enabling stakeholders to implement focused interventions and develop strategies for maximum impact, ultimately driving improvements with precision and efficiency. We have suggested 44 indicators in total. Full list of description, unit of measurement, advantages, disadvantages, and current availability of data is included in the appendix section (Appendix 1).

However, we recommend 15 indicators should be prioritized within the municipality. These indicators in the table below were prioritized based on ease of getting data, robustness of data, applicability to municipality, technology available to measure the data, and technical skills available to measure the data.

Table 3: 15 energy efficiency indicators that should be prioritized.

	Sector	Indicator
1.	Indicators in the Residential Sector	Space heating energy consumption per dwelling
2.		Space cooling energy consumption per dwelling with air conditioning (A/C)
3.		Water heating energy consumption per dwelling
4.		Lighting energy consumption per dwelling
5.	Indicators in the Service sector	Space heating energy consumption per value added
6.		Space cooling energy consumption per value added
7.		Water heating energy consumption per value added
8.		Lighting energy consumption per value added
9.	Indicators in the Transport Sector	Unit consumption of energy of road transport per equivalent car
10.		Unit consumption of gasoline of road transport per equivalent car

11.	Unit consumption of diesel heavy vehicles
12.	Unit cons. of buses per vehicle
13.	Unit consumption of domestic water transport
14.	Share of public transport in passenger transport
15.	Share of rail & water in goods transport

Potential Opportunity and Action Overview

Norway is a country with abundant energy resources and a strong commitment to climate change mitigation and environmental sustainability. However, Norway also faces significant challenges in meeting its ambitious targets for reducing greenhouse gas emissions and transforming its energy system. As a major producer and exporter of oil and gas, Norway needs to balance its economic interests with its climate goals and its role as a global energy supplier. Moreover, as a large consumer of energy, Norway needs to ensure that it has enough clean and affordable electricity to power its industries, transport, and households.

One of the key solutions to these challenges is energy efficiency. Energy efficiency can help Norway reduce its energy demand, lower its emissions, improve its energy security, and create new jobs and value. Energy efficiency can also enable Norway to leverage its renewable electricity system to decarbonise other sectors through electrification. Norway has already made significant progress in improving its energy efficiency, but there is still a large potential for further savings and benefits.

This chapter of the report aims to provide an overview of the current status, trends, and policies of energy efficiency in Norway, with a focus on the main sectors of buildings, transport, and industry. The chapter is based on the analysis of data and information from various sources, including the action plan "Kraftløftet" by LO (Norwegian Confederation of Trade Unions) and NHO (Confederation of Norwegian Enterprise), IEA (the International Energy Agency), and the general findings and recommendations from the ODYSSEE-MURE project.

4. Energy Efficiency Initiatives

4.1 ODYSSEE-MURE. How First Comes Energy Efficiency? Assessing the Energy Efficiency First Principle in the EU Using a Comprehensive Indicator Approach

This paper centers on one of the fundamental concepts in energy policy and planning – the energy efficiency first (EE1) principle. This principle emphasizes that demand-side energy efficiency measures should be prioritized over supply-side options (such as building new power plants) whenever they are less costly or deliver more value than the alternatives. In other words:

Start with Efficiency: Before investing in new energy supply infrastructure, consider energy-saving measures that reduce demand. These can include better insulation, efficient appliances, and smart grid technologies.

Cost-Effectiveness: Evaluate energy projects based on their cost-effectiveness. If an energy efficiency measure provides greater benefits at a lower cost than a supply-side option, it should take precedence.

Multiple Benefits: Recognize that energy efficiency offers multiple benefits, including reduced greenhouse gas emissions, improved air quality, and economic savings. These benefits extend beyond just energy consumption.

Holistic Approach: Apply the EE1 principle across all stages of energy planning, from policy development to project implementation. Consider the long-term impact on energy systems and the environment.
By prioritizing energy efficiency, it is possible to achieve sustainable and resilient energy systems while minimizing environmental impact.
Some practical recommendations to enhance the implementation of the energy

efficiency first (EE1) principle are:

Comprehensive Cost-Benefit Analysis: Decision-makers should conduct thorough cost-benefit analyses when evaluating energy efficiency measures. This includes considering both direct and indirect benefits, such as reduced emissions, improved health, and economic savings.

Equal Comparison of Demand-Side and Supply-Side Options: When assessing energy projects, ensure that demand-side solutions (such as energy conservation and efficiency) are compared on equal terms with supply-side options (such as new power plants). This prevents bias and promotes a fair evaluation.

Addressing Market Distortions: Identify and address market barriers that hinder the adoption of energy efficiency measures. These may include subsidies for fossil fuels, lack of information, or regulatory obstacles.

Monitoring and Verification: Establish robust monitoring and verification mechanisms to track the effectiveness of energy efficiency policies. Regular assessments will help identify areas for improvement and ensure compliance.

Promoting Sufficiency and Behavioral Change: Encourage energy sufficiency by promoting responsible consumption patterns. Public awareness campaigns and incentives can drive behavioral change and reduce energy waste.

Inclusive Decision-Making: Involve stakeholders from various sectors (industry, government, civil society) in decision-making processes related to energy efficiency. Their insights and collaboration can lead to more effective policies.
It is worth mentioning that implementation of the EE1 principle requires a holistic approach, involving policymakers, industry players, and citizens.

4.2 LO and NHO Kraftløftet

Kraftløftet (The Power Lift) is a report from LO and NHO, two Norwegian organizations that represent workers and employers, describing their energy initiative. The initiative aims to increase the access to renewable power in Norway to meet the climate goals, ensure competitive electricity prices, and create new jobs and value.

The report explains the importance of energy for society and economy, and the need for a transition to a more sustainable and low-emission energy system. It highlights the role of renewable power as the key to reducing emissions and creating new opportunities for industry and innovation. It also warns about the risks of not having enough power supply, such as higher prices, lower competitiveness, and social inequality.

Moreover, the report presents the results of 11 regional power studies that show the status, needs, and potential for new power production, grid capacity, and energy efficiency in each region. The regional power analysis reveals the following findings:

- Power demand is increasing rapidly: The analysis shows that there are applications for 140 TWh of increased power consumption, which would double Norway's power production. The demand is highest in the industry, both existing and new, and exceeds the available network and production capacity.
- Power supply is insufficient and uneven: The analysis shows that the potential for new power production is less than the mapped power demand, but still large enough to meet the Energy Commission's recommendations. However, this requires that more of everything is done, with the possibilities that exist, and that the implementation takes place at the necessary pace.
- Power grid is bottlenecked and outdated: The analysis shows that many businesses that want network connection are now rejected because there is no available capacity in the network for the next ten years. The network companies' connection obligation cannot currently be implemented for 2/3 of the requested new power consumption.

- Power prices are volatile and uncertain: The analysis shows that a more weather-dependent power system will lead to greater variation in power prices in the future. If we do not succeed in increasing power production and dampening price peaks, it will lead to increased economic and social inequality, and delay the pace of the climate transition.

  Power production and consumption are interdependent: The analysis shows that the power situation varies greatly between regions, and that there is a need for better coordination and cooperation between power producers, consumers, network companies, and authorities. The power balance in one region affects the power balance in another, and the power system must be seen as a whole.

The report proposes a comprehensive action plan for how to increase the power supply in Norway, based on the recommendations from the Energy Commission and other relevant sources. The key recommendations and actions are:

- Increase power production from renewable sources: The main measure is to increase the power supply, through more renewable production, better network, and a boost for energy efficiency. Some places have opportunities in insulation, heat pumps, district heating or solar panels on the roof. Other places have new larger water, wind or solar power production.
- Improve power grid capacity and efficiency: The network development must be accelerated, and the recommended measures in Statnett's prioritized power corridors must be implemented as soon as possible. In addition, the capacity of the existing network must be utilized better, among other things through increased use of new technology and digital tools.
- Streamline power concession processes and reduce conflicts: The concession processes must be smoother and conflicts reduced through dialogue and knowledge that builds common understanding. It is possible to increase social acceptance and trust in the difficult decisions that must be made, and we propose several measures that will contribute to this.
- Strengthen power security and international cooperation: In a very turbulent geopolitical world, Norway's vulnerability has increased. Measures that weaken the

importance of international cooperation must be avoided. Our largest emission cuts occur through the export value of Norwegian solutions internationally. To maintain competitiveness, we must satisfy customers abroad with products with low and lower carbon footprints than alternative suppliers.

- Integrate power, climate and industrial policies: The energy and climate policy must be more closely linked to the industrial policy and security policy than we have seen so far. Norway must take responsibility for developing our opportunities for (new) value chains in European relevant industrial scale. This requires clear prioritization and facilitation of framework conditions from the Norwegian authorities, including better conditions for publicly financed capital access that triggers the large private investments that are necessary.

4.3 LO and NHO Kraftløftet Møre and Romsdal

https://www.lo.no/contentassets/d760d8ebcd27421481e666c4fae8af01/kraftloftet-more-og-romsdal--regionalt-kunnskapsgrunnlag.pdf

This is a regional report for Møre og Romsdal Fylke. Regional reports are prepared by LO and NHO's regional offices, with the help of THEMA Consulting Group, to provide a factual basis and facilitate local and regional mobilization and support for increased power supply.

According to the paper, Møre og Romsdal faces a precarious situation when it comes to its power supply. The key points are:

- Large and Growing Power Deficit: The region experiences a significant shortfall in electricity production compared to its demand.
- Heavy Reliance on Imports: To meet its energy needs, Møre og Romsdal heavily depends on imported electricity from other regions.
- Competitiveness and Job Risks: This dependence poses risks to the region's economic competitiveness and the availability of employment opportunities.

- Green Transition Challenges: Additionally, relying on external sources hinders the region's transition toward cleaner, more sustainable energy sources.
  A working group, led by LO and NHO locally, has put forth measures to address these challenges:
- Enhanced Power Production: Encourage more local power generation within Møre og Romsdal and explore opportunities for renewable energy projects such as wind, solar, and hydropower.
- Network Development: Improve the existing power infrastructure to enhance reliability and capacity, as well as invest in grid expansion and modernization.
  Energy Efficiency: Promote energy-saving practices across sectors (businesses, public institutions, and households). Efficient utilization of existing resources can help offset the power deficit.

In conclusion, collaborative efforts are underway to bolster Møre og Romsdal's energy infrastructure, ensuring a sustainable and resilient power supply for the region.

4.4 LO and NHO: «Strategi for energieffektivisering og lokal solkraft» (Strategy for Energy Efficiency and Local Solar Power)

A more thorough look into the Kraftløftet initiative is presented the "Strategi for energieffektivisering og lokal solkraft" report. The document is a strategy for energy efficiency and local solar power production, developed by LO and NHO in Norway.
The strategy is based on the recommendations of the Energy Commission, which warned about the need for more renewable energy to meet the climate goals and support green industry. The strategy proposes sector-specific goals and public policies for energy efficiency and solar power in buildings and industry, with the aim of improving the power balance by 2030 and beyond. The strategy suggests the following goals:

- Energy use in buildings should not exceed 69 TWh in 2030.
- At least 5.5 TWh of annual solar power production from buildings by 2030.

- Energy efficiency in industry should be based on indicators such as energy intensity, freed energy or reduced emissions.

The strategy also recommends various measures and incentives to overcome the barriers and challenges for energy efficiency and solar power. They can be broken down into several categories:

- Information measures: These include more user-oriented energy labeling of buildings, public disclosure of Elhub data (only for commercial buildings), and visibility of installed production capacity and expected energy production on the building's energy certificate.
- Regulatory measures: These include developing stricter energy requirements in the technical regulations (TEK), with adapted levels for renovations, requirements for energy management and energy audit in larger commercial buildings, clearer energy requirements in public procurement, facilitation for interaction between power and heat for heating of buildings, introduction of minimum requirements for energy performance in all existing buildings, and requirement for individual measurement of heat in new and existing buildings.
- Economic measures: These include increased rights-based support for existing buildings (all building categories) for all forms of energy efficiency measures (e.g. through Enova and Husbanken), gradual phase-out of economic support in line with goal achievement, exploration of alternative financing solutions, implementation of new financing solutions, introduction of Enova support for batteries and storage in buildings and for battery service companies (for sale of battery service to grid companies), and adjustment of income frame calculation, so that grid companies are compensated for additional costs due to increased share of plus customers.
- R&D/Piloting: These include Enova/Innovation Norway, Norwegian Catapult (Siva), craftsman support, new financing solutions, and capacity building for piloting of new technology.

4.5 «Handlingsplan for energieffektivisering i alle deler av norsk økonomi» (Action Plan for Energy Efficiency in all Parts of the Norwegian Economy)

The Norwegian Ministry of Petroleum and Energy (now the Norwegian Ministry of Energy) developed a document titled "Action Plan for Energy Efficiency in All Parts of the Norwegian Economy". The document presents the government's measures and goals to promote more efficient and flexible use of energy in various sectors, such as industry, building, transport, agriculture, and finance.

While the document does not explicitly mention energy efficiency indicators, it emphasizes several key points related to energy efficiency:
The government aims to enhance the energy intensity of the mainland economy by 30% from 2015 to 2030.

The government has tasked the NVE to explore the possibilities of achieving the goal of reducing 10 TWh of energy consumption in buildings by 2030. However, NVE has also been challenged by the government to reduce the electricity consumption by 10TWh thereby turning more focus on power consumption.

Roles and responsibilities of different departments and agencies are clarified to strengthen energy efficiency efforts.
Increased funding for Enova and Husbanken supports energy efficiency and flexibility measures.
DiBK (Direktoratet for byggkvalitet) is requested to review energy requirements in building regulations and improve energy labeling for buildings.
Information, competence, and innovation play crucial roles in achieving energy efficiency.
While specific indicators are not explicitly mentioned, these actions demonstrate the government's commitment to promoting energy efficiency in Norway.

4.6 IEA Energy Efficiency 2023

Energy Efficiency 2023 is the IEA's primary annual analysis on global developments in energy efficiency markets and policy. The report highlights several key indicators and points related to energy efficiency:

- Primary Energy Intensity:
  Definition: Primary energy intensity measures the amount of primary energy (such as oil, gas, electricity) required to produce a unit of economic output (e.g., GDP).
  Significance: A decrease in primary energy intensity indicates improved energy efficiency. It means that economies are producing more value (output) with less energy consumption.
- Energy Intensity by Sector:

  Industry: Energy intensity in industrial sectors varies significantly. Energy-efficient technologies and practices can lead to substantial reductions in energy use.
  Buildings: Improving energy efficiency in buildings (residential, commercial, and public) is crucial. Measures include better insulation, efficient lighting, and smart heating/cooling systems.
  Transport: The transport sector also plays a vital role. Electric vehicles, efficient public transportation, and modal shifts contribute to lower energy intensity.
- Policy Measures:
  Energy Efficiency Policies: Governments worldwide are implementing policies to promote energy efficiency. These include building codes, appliance standards, and incentives for energy-saving technologies.
  Appliance Labeling: Clear labeling helps consumers choose energy-efficient appliances.
  Financial Incentives: Subsidies, tax breaks, and grants encourage investments in energy-efficient solutions.
- Technological Advancements:
  Smart Technologies: The adoption of smart meters, home automation, and industrial automation enhances energy efficiency.
  Renewable Energy Integration: Integrating renewables (solar, wind) into the energy

mix reduces reliance on fossil fuels.

Digitalization: Data analytics and digital tools optimize energy use.

- Challenges and Opportunities:

  Climate Crisis: Energy efficiency remains critical for achieving climate goals. It reduces greenhouse gas emissions.

  Economic Resilience: Improving energy efficiency enhances economic resilience by reducing energy costs and dependence.

  Equity and Access: Policies must ensure equitable access to energy-efficient technologies for all.

- Net Zero Roadmap:

  The IEA's goal is to achieve global net-zero emissions by mid-century. Doubling the rate of average global primary energy intensity improvement is essential. This requires bold policy actions, innovation, and investment.

4.7 Comprehensive Survey of Energy Efficiency Strategies and Initiatives

Policy and Principle Implementation:

Energy Efficiency First Principle:

- Prioritize demand-side measures.
- Conduct comprehensive cost-benefit analyses.
- Address market distortions.
- Promote sufficiency and behavioral change.
- Foster inclusive decision-making processes.
- Ensure equal comparison of demand-side and supply-side options.
- Action Plan for Energy Efficiency in All Parts of the Norwegian Economy:
- Enhance energy intensity reduction.
- Reduce electricity consumption in buildings.

- Clarify roles and responsibilities.
- Increase funding for energy efficiency projects.

Infrastructure Development and Enhancement:

Kraftløftet Initiative (LO and NHO):

- Increase renewable power production.
- Improve power grid capacity and efficiency.
- Streamline power concession processes.
- Strengthen power security and international cooperation.
- Regional Reports (Møre og Romsdal Fylke):
- Enhance local power production.
- Develop power grid infrastructure.

Sector-Specific Goals and Strategies:

Strategi for Energieffektivisering og Lokal Solkraft:

- Set sector-specific energy efficiency and solar power goals.
- Implement information, regulatory, economic, and R&D measures.

Monitoring, Evaluation, and Reporting:

IEA Energy Efficiency 2023 Report:

- Monitor primary energy intensity and energy intensity by sector.
- Implement energy efficiency policies, appliance labeling, and financial incentives.
- Embrace smart technologies, renewable energy integration, and digitalization.
- Address challenges related to climate crisis, economic resilience, and equity.

In summary, energy efficiency indicators provide insights into progress, challenges, and the path toward a sustainable energy future. Policymakers, businesses, and individuals must prioritize energy efficiency to address both environmental and economic imperatives.

4.8 Conclusion

In conclusion, this report has addressed the need for energy efficiency indicators in Kristiansund, as requested by the county council. The initial purpose of this report was to develop measures to increase energy efficiency, with the need to establish reliable indicators to measure their effectiveness at both county and municipal levels within the residential sector, service sector, transport sector and industry sector.

Throughout our analysis, we have identified the importance of having indicators. These indicators serve as valuable tools for monitoring the impact of implemented measures and guiding future policy decisions. By providing a framework for measurement, they enable stakeholders to assess the effectiveness of interventions and allocate resources effectively. While our efforts have led to the development of potential energy efficiency indicators tailored to the Kristiansund municipality, we acknowledge the challenge of data availability. However, we have outlined possible strategies to address this issue, such as leveraging existing datasets, implementing monitoring programs, and promoting data sharing among relevant stakeholders.

Moving forward, it is imperative for the county administration and other relevant bodies to prioritize the 15 indicators suggested and intensify data collection efforts to support the implementation of energy efficiency measures effectively. This may involve investing in data infrastructure, enhancing data collection methodologies, and fostering collaboration among stakeholders to ensure the availability of accurate and up-to-date information.

In conclusion, while we have made progress in developing energy efficiency indicators for Kristiansund, there is still work to be done to ensure their successful implementation. By addressing data challenges and adopting a proactive approach to monitoring and evaluation, we can enhance our ability to measure and improve energy efficiency outcomes, ultimately contributing to a more sustainable future for Kristiansund municipality.

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Appendix I

Full list of indicators, description, unit of measurement, advantages and disagvantages:

[Final version of possible indicators - 23.4.2024.xlsx]

Appendix II

Proposed indicators at municipality level:

A total of 44 indicators have been proposed. The table below shows that indicators are categorized on a scale of 1 to 3, where 1 represents "highest priority indicators", 2 represents "medium level of priority" and 3 represents "lowest priority indicators". Prioritization was determined by factors such as data accessibility, data reliability, relevance to the municipality, available technology for measurement, and expertise in measurement. Many unit activities were assigned a priority of 3 due to uncertainties regarding what qualifies as an activity.

		Indicator	Definition/ Description	Ranking
Indicators in the Residential Sector	Space Heating energy Consumption	Space heating energy consumption per capita	Space heating energy consumption per capita refers to the average amount of energy consumed for heating purposes per person in a specific geographic area	2
		Space heating energy consumption per dwelling	Refers to the average amount of energy consumed for heating purposes in a specific housing unit	1
		Space heating energy consumption per floor area	refers to the amount of energy consumed for space heating within a building relative to its total floor area.	3

	(idem per floor area heated)		
Space cooling energy consumption	Space cooling energy consumption per dwelling with air conditioning (A/C)	Refers to the average amount of energy used for cooling purposes in a specific housing unit that is equipped with air conditioning systems.	1
	Space cooling energy consumption per floor area of dwellings with A/C	a metric that quantifies the average amount of energy used for cooling purposes in residential buildings, specifically those equipped with air conditioning (A/C), relative to the total floor area of these dwellings.	3
Water Heating energy Consumption	Water heating energy consumption per capita	refers to the average amount of energy used for heating water per person in a specific population	2
	Water heating energy consumption per dwelling	refers to the average amount of energy used for heating water in a specific housing unit	1
Lighting energy consumption	Lighting energy consumption per capita	Refers to the average amount of energy used for lighting purposes per person in a specific population	2

		Lighting energy consumption per dwelling	the average amount of energy used for lighting within a specific housing unit,	1
		Lighting energy consumption per floor area	Refers to the average amount of energy used for lighting within a specific floor area	3
	Cooking energy Consumption	Cooking energy consumption per capita	Refers to the average amount of energy used for cooking purposes per person in a specific population	3
		Cooking energy consumption per dwelling	Refers to the average amount of energy used for cooking purposes in a specific housing	3
	Appliances energy Consumption	Appliances energy consumption per capita	Refers to the average amount of energy used by household appliances per person in a specific population	3
		Appliances energy consumption per dwelling	Refers to the average amount of energy used by household appliances in a specific housing unit	3
	Energy consumption per appliance	Energy consumption per appliance unit	refers to the average amount of energy used by a single unit of a specific household appliance	3
Indicators in the Service sector	Space Heating energy Consumption	Space heating energy consumption per value added	A metric that evaluates the energy efficiency of space heating in relation to the	1

		economic value added, likely in a specific sector or industry	
	Space heating energy consumption per floor area	refers to the amount of energy consumed for space heating within a building relative to its total floor area.	3
	Space heating energy consumption per unit of activity	A measure that evaluates how efficiently energy is used for heating in relation to a specific activity or output	3
Space cooling energy consumption	Space cooling energy consumption per value added	a metric that assesses the efficiency of cooling systems in relation to the economic value added	1
	Space cooling energy consumption per floor area cooled	a metric that measures the average amount of energy used for cooling purposes in relation to the total floor area that undergoes the cooling process.	3
	Space cooling energy consumption per unit of activity	a metric used to measure the amount of heating energy consumed for each specific activity	3
Water Heating energy Consumption	Water heating energy consumption per value added	A metric that evaluates the energy efficiency of water heating in relation to the	1

		economic value added, likely in a service sector	
	Water heating energy consumption per unit of activity	a metric used to measure the amount of water heating energy consumed for each specific activity	3
Lighting energy consumption	Lighting energy consumption per value added	a metric that assesses the efficiency of lighting energy consumed in relation to the economic value added	1
	Lighting energy consumption per floor area	Refers to the average amount of energy used for lighting within a specific floor area	3
	Lighting energy consumption per unit activity	a metric used to measure the amount of lighting energy consumed for each specific activity	3
other equipment energy consumption	Other equipment energy consumption per value added	A metric that assesses the efficiency of energy use by various types of equipment, excluding specific categories like space heating or lighting, in relation to the economic value added.	2
	Other equipment energy consumption per floor area	A metric that assesses the efficiency of energy use by various types of equipment, excluding specific categories like space heating or lighting, in	3

			relation to the size of the space where the equipment is used	
		Other equipment energy consumption per unit of activity	A metric that assesses the efficiency of energy use by various types of equipment, excluding specific categories like space heating or lighting, in relation to a specific activity or output	3
Indicators in the Transport Sector	Road Transport	Unit consumption of energy of road transport per equivalent car	refers to the measurement of energy or fuel consumption in road transportation, expressed in terms of a standardized unit equivalent to that consumed by a typical car.	1
		Unit consumption of gasoline of road transport per equivalent car	relates the total consumption of gasoline to a fictitious stock of gasoline vehicles, measured in terms of a number of equivalent cars.	1
		Unit consumption of cars per passenger-km	The average unit consumption of cars per passenger-km is calculated as the statistical division of the yearly motor fuel consumption of cars divided by the traffic of cars expressed in passengers-km	2
		Specific consumption of motorcycles	refers to the amount of fuel or energy consumed by a motorcycle to cover a specific distance	2

	Unit consumption of diesel heavy vehicles	is equal to the ratio (total diesel oil consumption by road transportation - diesel oil consumption by cars and light vehicles) / (number of diesel trucks + number of diesel buses)	1
	Unit consumption of trucks and light vehicles: total, diesel, gasoline (excluding public transport)	is calculated as the statistical division of the yearly motor fuel consumption of trucks and light vehicles divided by the stock of trucks and light vehicles.	2
	Unit consumption of road transport of goods	It is the ratio between the consumption of trucks and the traffic of goods measured in tonne-km performed by trucks; This indicator provides information on the energy efficiency of the overall transport services.	3
	Unit consumption of trucks per vehicle	fuel or resource consumption of trucks on a per-vehicle basis	2
	Unit cons. of buses per vehicle	the amount of a specific resource (such as fuel, energy, or some other consumable)	1

		used by each individual bus in a fleet	
	Unit cons. of buses per passenger-km	the amount of a specific resource or substance used by buses for every unit of passenger-kilometer traveled.	2
Air Transport	Unit consumption of domestic air transport per passenger	the amount of a specific resource or substance used by domestic air transport for each individual passenger.	2
	Unit consumption of domestic air transport per passenger-km	the amount of a specific resource or substance used by domestic air transport for every unit of passenger-kilometer traveled.	3
Water Transport	Unit consumption of domestic water transport	the amount of a specific resource or substance used by water transport systems within the borders of a specific country.	1
Modal Split	Share of public transport in passenger transport	the proportion or percentage of passenger transportation that is accounted for by public transport in a given area or region.	1
	Share of water in goods transport	the proportion or percentage of goods transportation that is accounted for by water transport combined.	1

Appendix III

Energy Efficiency Indicators reported by various countries (Source: IEA, 2022)

This table below shows the energy efficiency indictors that all IEA countries report on. The data provided focuses on the residential sector, services sector and industry sector. This data helps the IEA to compare energy efficiency of member countries. Although this data is national level data, it would help in identifying the common indicators that countries report on. Despite the numerous indicators IEA has recommended for energy efficiency, only indicators listed above is what majority of member countries have provided data on.

IEA Countries	Sectors IEA Countries Report on	End Use	Energy Indicator
Australia	Residential	Total Residential	Per capita energy intensity (index 2000)
Austria		Total Residential	Per dwelling energy intensity (index 2000)
Belgium		Total Residential	Per dwelling TC energy intensity (index 2000)
Canada		Residential space heating	Per capita energy intensity (index 2000)
Czech Republic		Residential space heating	Per dwelling energy intensity (index 2000)
Denmark		Residential space heating	Per dwelling TC energy intensity (index 2000)
Estonia		Residential lighting	Per capita energy intensity (index 2000)
Finland		Residential lighting	Per dwelling energy intensity (index 2000)
France		Residential appliances	Per capita energy intensity (index 2000)

Germany		Residential appliances	Per dwelling energy intensity (index 2000)
Greece	Service	Total Services	Per value added energy intensity (index 2000 - MJ/USD PPP 2015)
Hungary		Sub-Sector	
Ireland	Industry	Manufacturing [ISIC 10-18; 20-32]	Per value added energy intensity (index 2000 - MJ/USD PPP 2015)
Italy		Paper pulp and printing [ISIC 17-18]	Per value added energy intensity (index 2000 - MJ/USD PPP 2015)
Japan		Chemicals and chemical Products [ISIC 20-21]	Per value added energy intensity (index 2000 - MJ/USD PPP 2015)
Korea		Non-metallic minerals [ISIC 23]	Per value added energy intensity (index 2000 - MJ/USD PPP 2015)
Luxembourg		Basic metals [ISIC 24]	Per value added energy intensity (index 2000 - MJ/USD PPP 2015)
Mexico		Agriculture forestry fishing [ISIC 01-03]	Per value added energy intensity (index 2000 - MJ/USD PPP 2015)
Netherlands		Mining [ISIC 05-09]	Per value added energy intensity (index 2000 - MJ/USD PPP 2015)
New Zealand		Construction [ISIC 41-43]	Per value added energy intensity (index 2000 - MJ/USD PPP 2015)
Norway		Modal/Vehicle Type	

Poland	Transport	Cars/light trucks	Passenger-kilometres energy intensity (index 2000)
Portugal		Cars/light trucks	Vehicle-kilometres energy intensity (index 2000)
Slovak Republic		Freight trucks	Tonne-kilometres energy intensity (index 2000)
Spain		Freight trucks	Vehicle-kilometres energy intensity (index 2000)
Sweden			
Switzerland			
Turkey			
United Kingdom			
United States			
		NB: Norway is expected to report on it but only has data for	Residential: Per capita energy Intensity Service: Per value added energy intensity Transport: Passenger-kilometres energy intensity (index 2000)
		https://energydata.info/dataset/world-energy-efficiency-indicators/resource/192b938b-7df6-4d1d-8fde-2b5eec792d05	