Africa Energy Efficiency Policy in Emerging Economies Training Week

Nairobi

18-22 March 2024

Africa Energy Efficiency Policy in Emerging Economies Training Week

Industry

Nairobi
18-22 March 2024

International Energy Agency

Electrification

Patrick Crittenden, Sustainable Business Group & Corine Nsangwebusinge, IEA

Nairobi, 20 March 2024

Course objective

To enhance your ability to

- design
- implement, and
- evaluate energy efficiency policies and programmes for industry.

Course objective

How to make the case for industrial energy efficiency policy

How to develop ‘policy packages’

How to implement

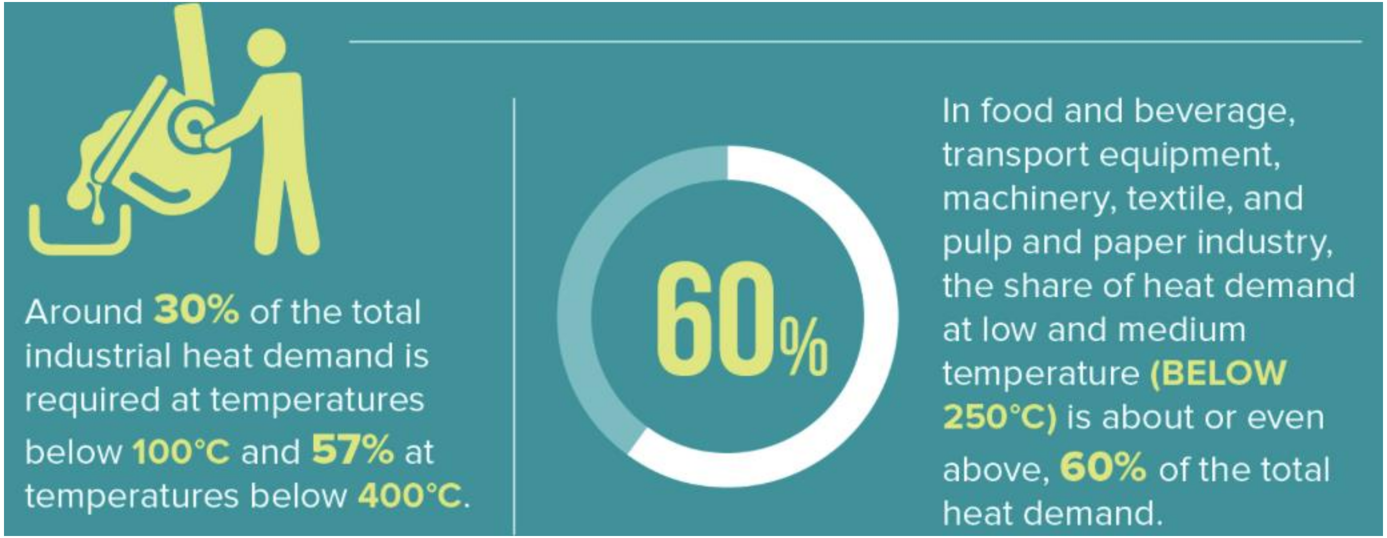
How to evaluate and scale-up

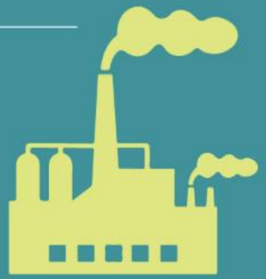
→ Develop your skills & knowledge

to deliver

industrial energy efficiency policies & programmes


Over 50% of final energy demand globally is for heating. Around half of that is for heating demands in the industry sector.


Around 30% of the total industrial heat demand is required at temperatures below 100°C and 57% at temperatures below 400°C.
60%
In food and beverage, transport equipment, machinery, textile, and pulp and paper industry, the share of heat demand at low and medium temperature (BELOW 250°C) is about or even above, 60% of the total heat demand.



Some of the **ELECTRIC END-USE TECHNOLOGIES THAT CAN PROVIDE HEAT** to manufacturing processes are electric boilers, heat pumps, induction heating, Radio frequency heating, microwave heating, electric infrared heating, UV heating, Electric arc furnace, electric induction melting, plasma melting, and Electrolytic reduction.

Presentation structure: seizing the opportunities of electrification in industry

1. What is electrification and what is its importance in NZE?
2. How much of the industrial sector that can be electrified and what levels of energy efficiency can be achieved?
3. What are the technologies available that can be used in industrial electrification?
4. What are the barriers to electrification?
5. What are the approaches being taken to industrial electrification?
6. What are the opportunities and potential benefits?
7. Policy Packages Approach

8. Industrial Heat pumps

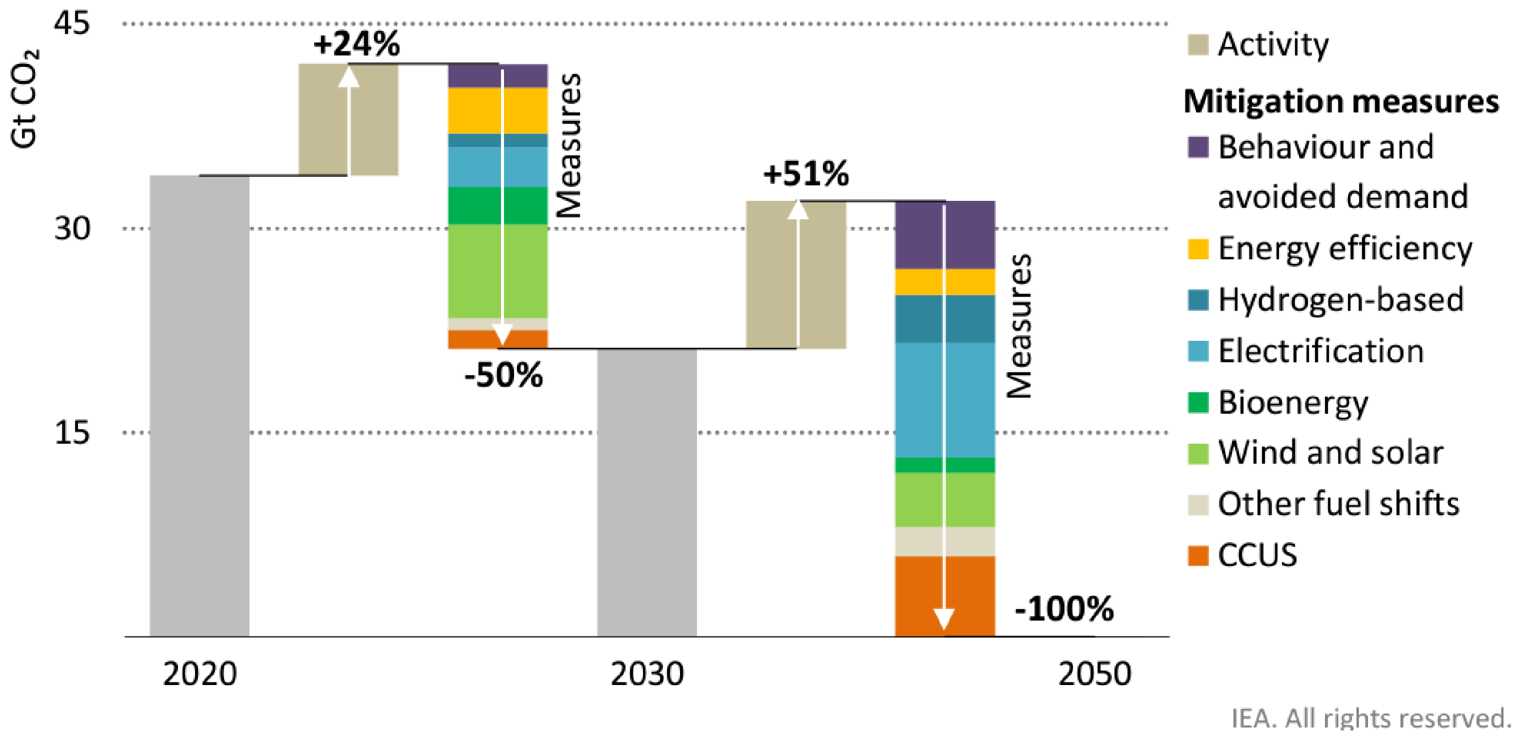
1. What do we mean by ‘electrification’

- Electrification — the substitution of fossil fuels for electricity, with opportunities ranging from the implementation of commercially available solutions to experimenting with emerging technologies.

- Electrification – needs the availability of an electrical source.

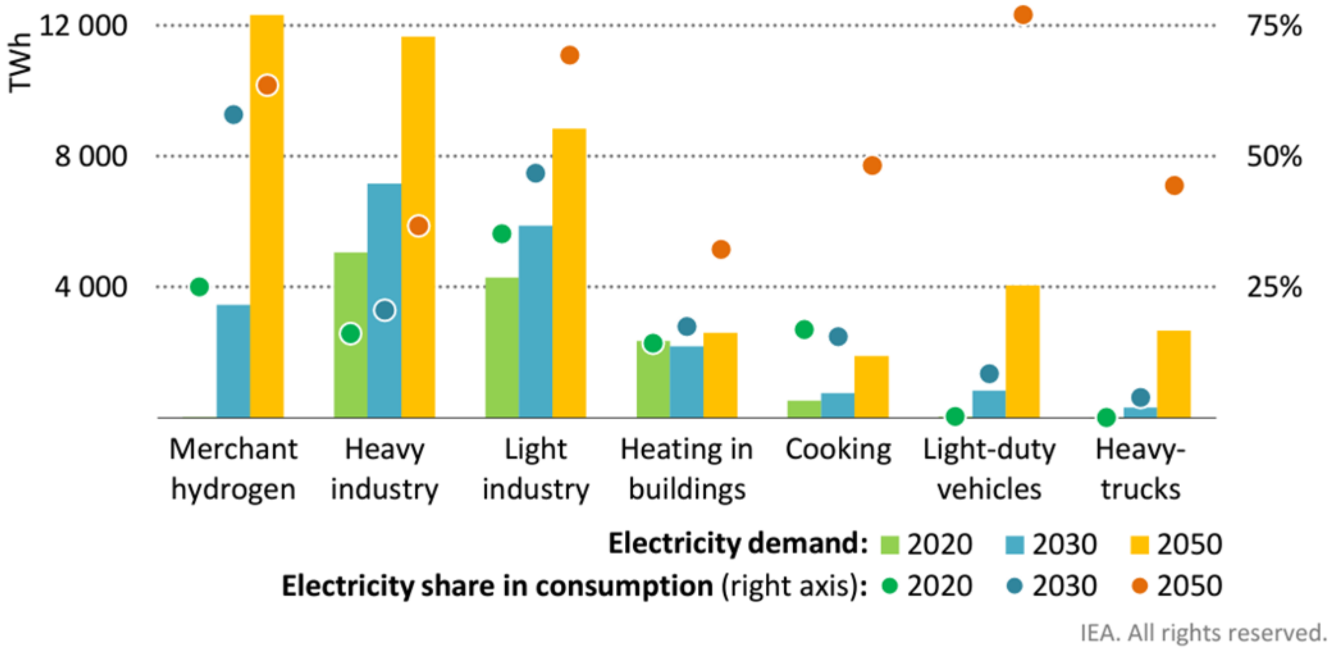
- Electrification – can be ‘cleaner’ energy depending on the source of generation of the electricity and the efficiency of the technology.

1. Emissions reductions by mitigation measure in the NZE, 2020-2050



Solar, wind and energy efficiency deliver around half of emissions reductions to 2030 in the NZE, while electrification, CCUS and hydrogen ramp up thereafter

1. Global electricity demand and share of electricity in energy consumption in selected applications in the NZE



Global electricity demand more than doubles in the period to 2050, with the largest rises to produce hydrogen and in industry

1. Key global milestones for electrification in the NZE

Sector		2020	2030	2050
Share of electricity in total final consumption		20%	26%	49%
Industry				
Share of steel production using electric arc furnace		24%	37%	53%
Electricity share of light industry		43%	53%	76%
Transport				
Share of electric vehicles in stock:	cars	1%	20%	86%
	two/three-wheelers	26%	54%	100%
	bus	2%	23%	79%
	vans	0%	22%	84%
	heavy trucks	0%	8%	59%
Annual battery demand for electric vehicles (TWh)		0.16	6.6	14
Buildings				
Heat pumps installed (millions)		180	600	1 800
Share of heat pumps in energy demand for heating		7%	20%	55%
Million people without access to electricity		786	0	0

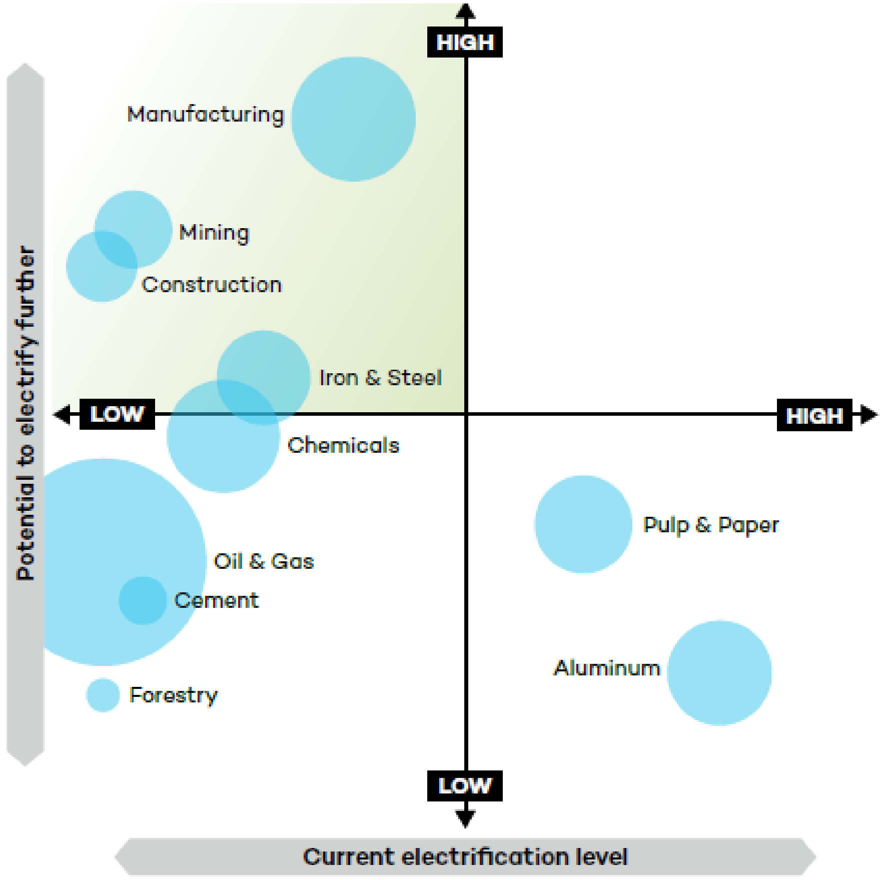
2. Introduction to electrification in the industrial sector

- Heat represents two-thirds of all energy demand in the industrial sector, and one-fifth of energy demand across the globe (IEA, 2018)

- Electrifying industrial processes offers the simultaneous benefits of directly **reducing fossil fuel demand**, increasing **process efficiency** and potentially supplying the remaining energy demand with **increasingly low-carbon electricity**.

- Electrification can offer industry the potential for new business models because of increased flexibility in location and sizing of plants when compared with fuel combustion-based processes.

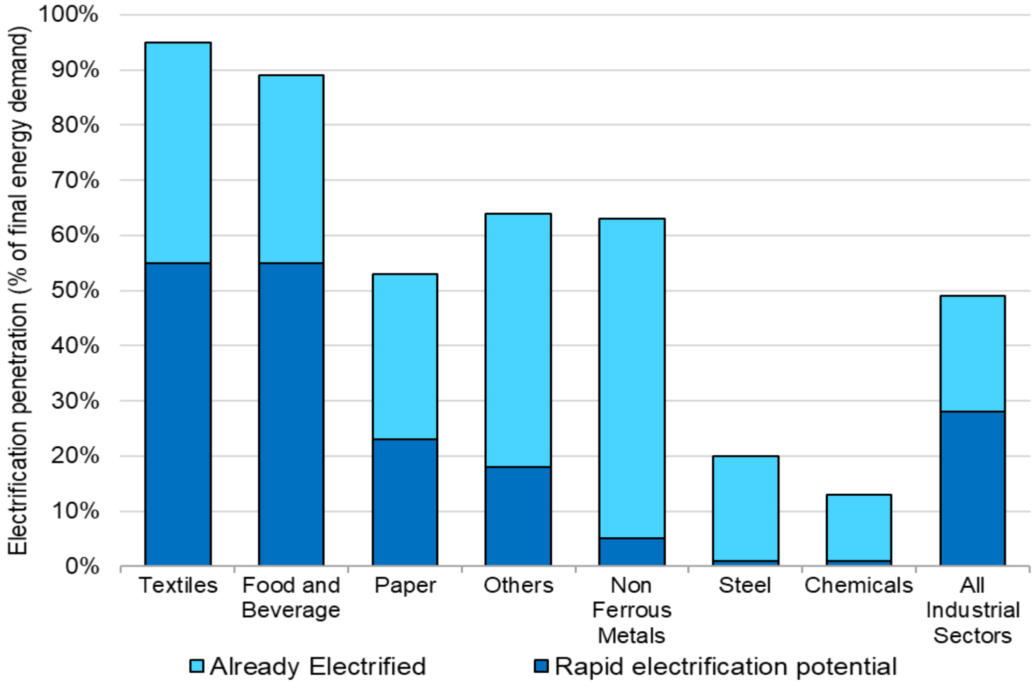
2. Opportunities in industry



Note: Bubble size reflects current total energy consumption.
Source: Produced by Dunsky Energy + Climate Advisors for Electrifying Canada, 2022.
Data sources: Langlois-Bertrand et al., 2021; Natural Resources Canada, 2020.

Graphic from
[Electrifying Canada]

2. Potential for Rapid Electrification of industry

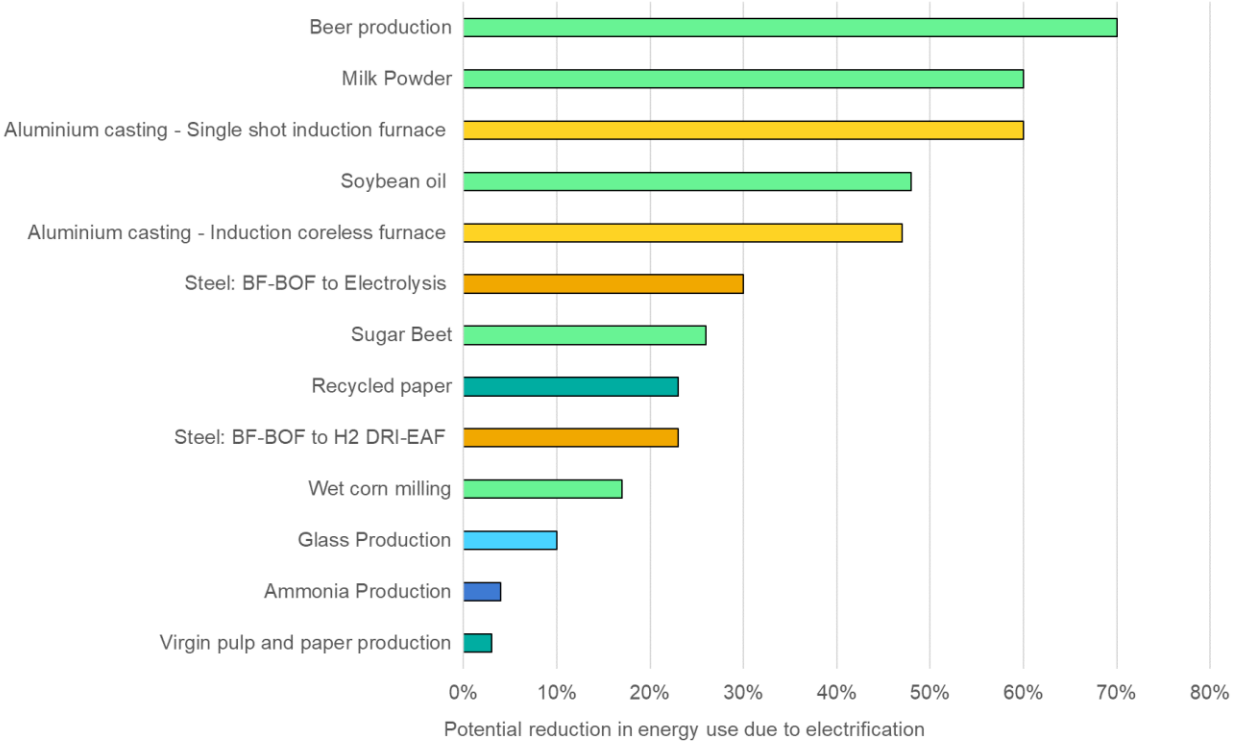


There is great potential for the rapid electrification of industry, with several options available in the short term.

Note: The difference to 100% is electrification potential that requires more complex systemic process changes.

Source: Schneider Electric Sustainability Research Institute (2022), as modified by the IEA.

2. Potential energy savings from electrification of industry



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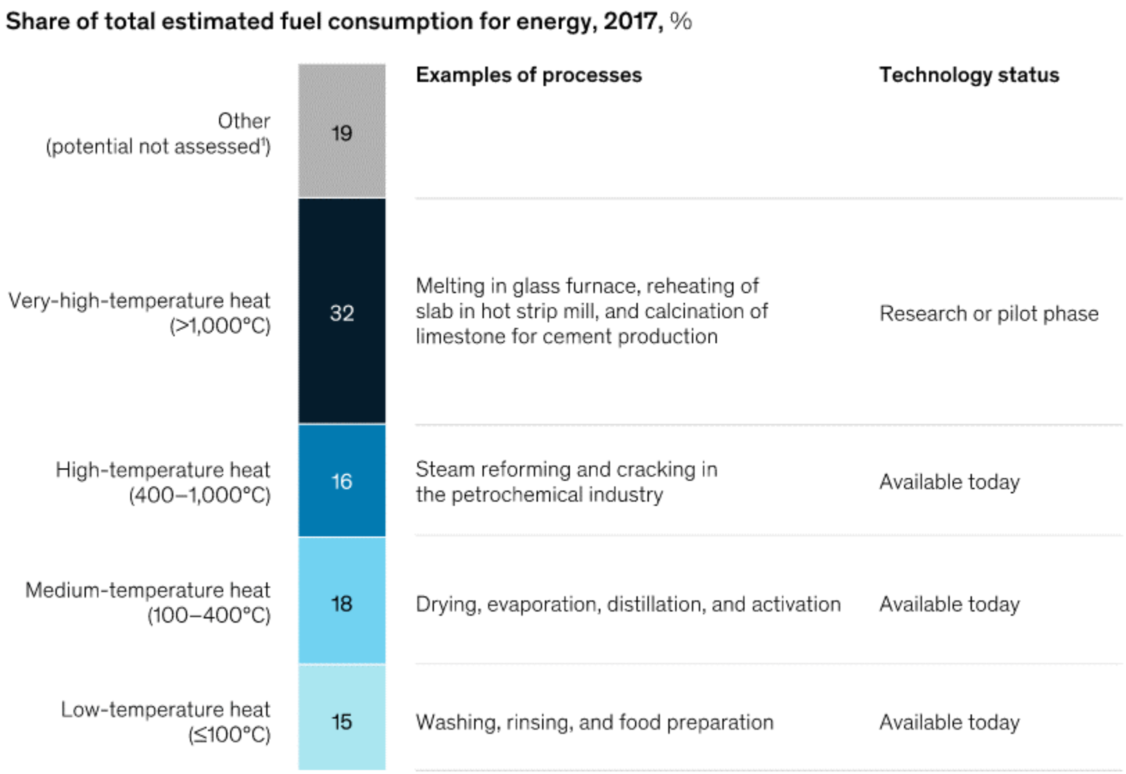
3. Mckinsey ‘Plugging in: What electrification can do for industry’



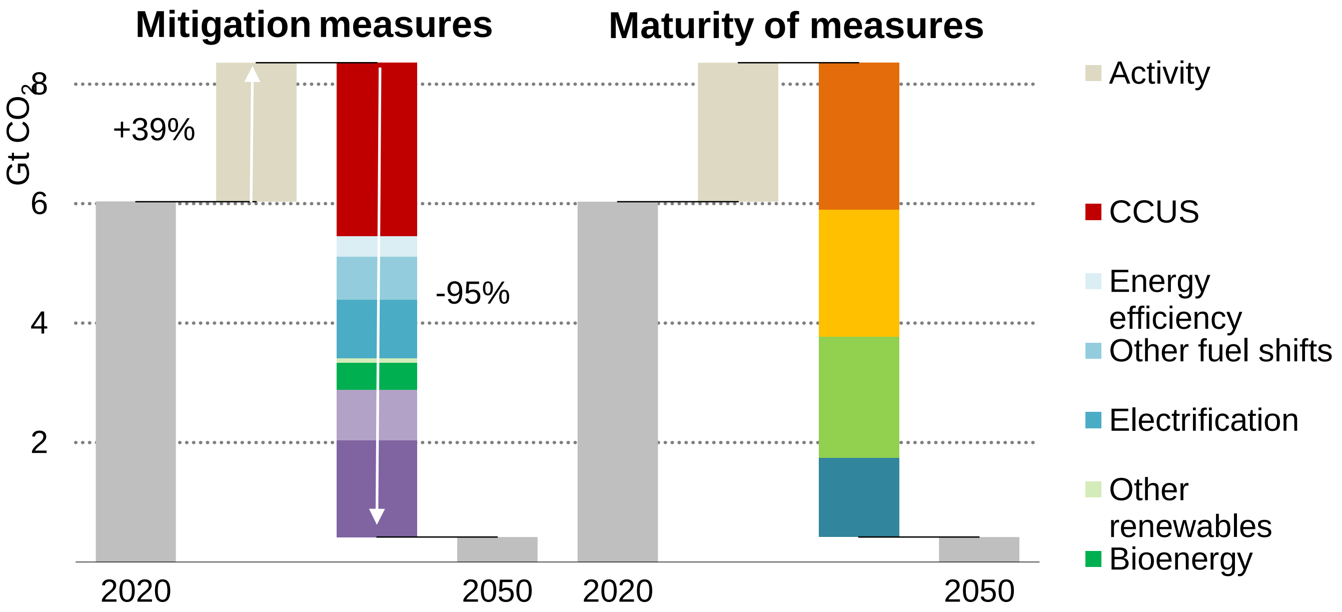
2017, estimated that almost half of the fuel consumed for energy can be electrified with technology that was available then

3. Industrial processes for potential electrification along with temperature levels and applicable technologies

Sector	Process	Typical operating temperature (°C)	Applicable technologies
Several Sectors	Hot water	20-110	Commercially available heat pump
	Preheating	20-100	Commercially available heat pump
	Washing/cleaning	30-90	Commercially available heat pump
	Space heating	20-80	Commercially available heat pump
Food and beverage	Low temperature drying and dewatering	30-90	Electric fluidized bed dryer, Electric rotary dryer, Vacuum belt dryer, Electric ring dryer, mechanical dewatering (beet pulp)
	Washing	60-90	Commercially available heat pump
	Pasteurizing	60-80	Commercially available heat pump, Microwave pasteurizer
	Boiling	95-105	Commercially available heat pump or in development high temperature heat pump
	Sterilization	110-120	In development high temperature heat pump, Infrared sterilization, Microwave sterilization
	High temperature process	120 - 250	In development very high temperature heat pump, Infrared sterilization, Microwave sterilization
Textiles and leather	Coloring	40-160	Commercially available heat pump or in development high/very high temperature heat pump
	Drying	60-130	Commercially available heat pump or in development high temperature heat pump
	Washing	40-110	Commercially available heat pump or in development high temperature heat pump
	Bleaching	40-100	Commercially available heat pump or in development high temperature heat pump
Metals	Melting/Furnace	600-1300	Induction coreless furnace, Induction one shot furnace, Electric arc furnace, Plasma melting
Chemicals	H_2 production	>200	Electrolysis
	MeOH synthesis	200-300	Electric boiler
Pulp and paper	Drying	60-90	Infrared dryer
Glass	Melting	1400-1600	Electric fore heaths
	Annealing	450-480	Electric annealing lehr

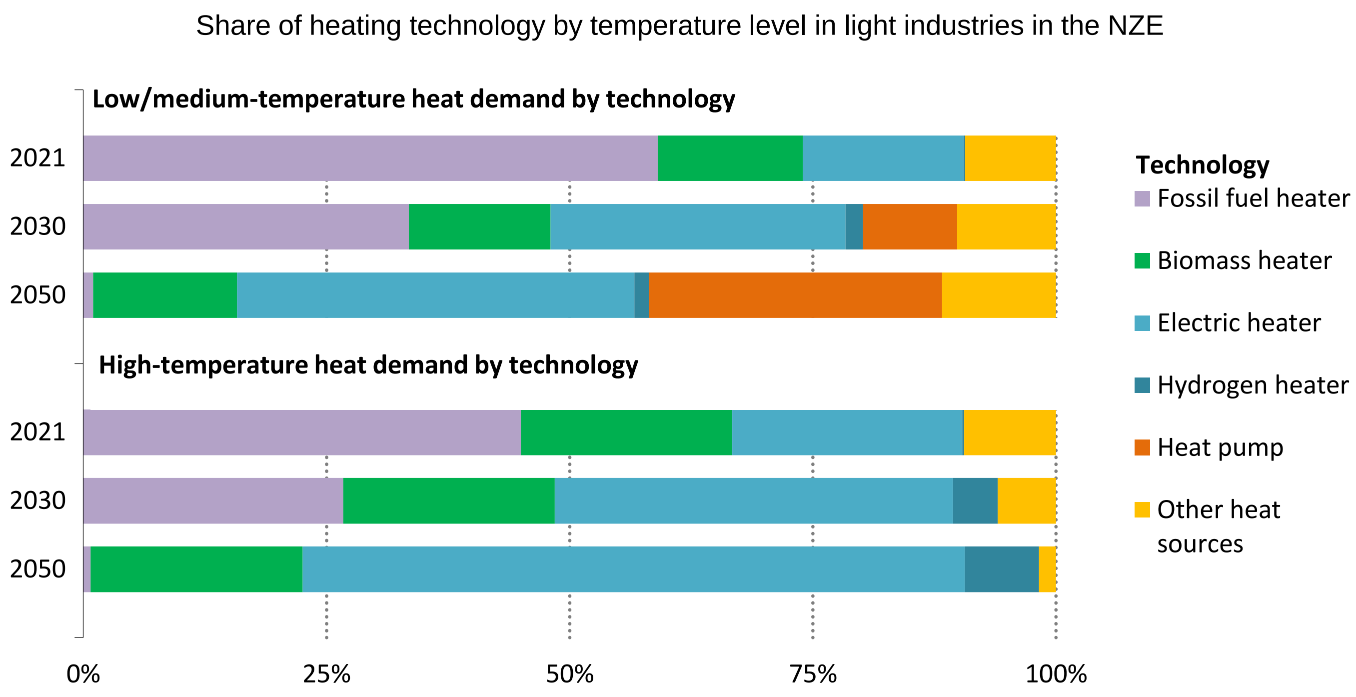
3. Addressing CO_2 emissions from heavy industry

Global CO_2 emissions reductions in heavy industry by mitigation measure and technology maturity category in the NZE



An array of measures reduces emissions in heavy industry, with innovative technologies like CCUS and hydrogen playing a critical role

3. Evolution of heating technologies in light industries



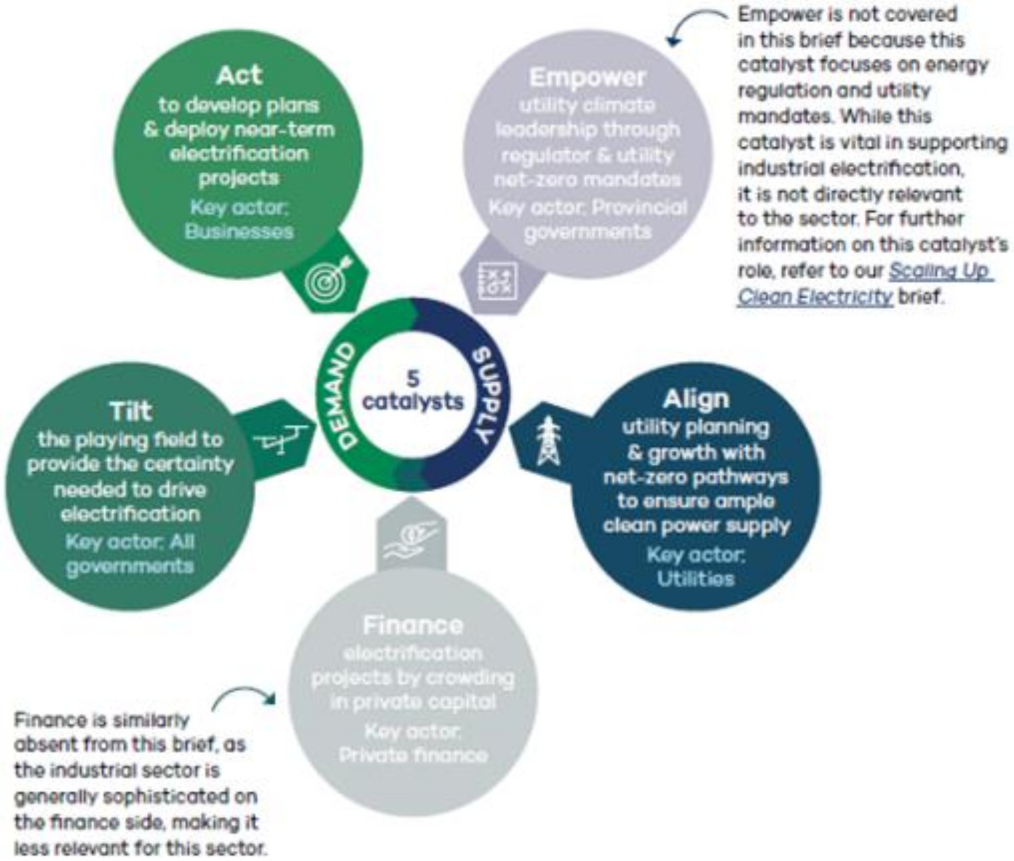
The share of electricity in satisfying heat demand for light industries rises from less than 20% today to around 40% in 2030 and about 65% in 2050

4. Barriers to industrial electrification

Main barriers identified:

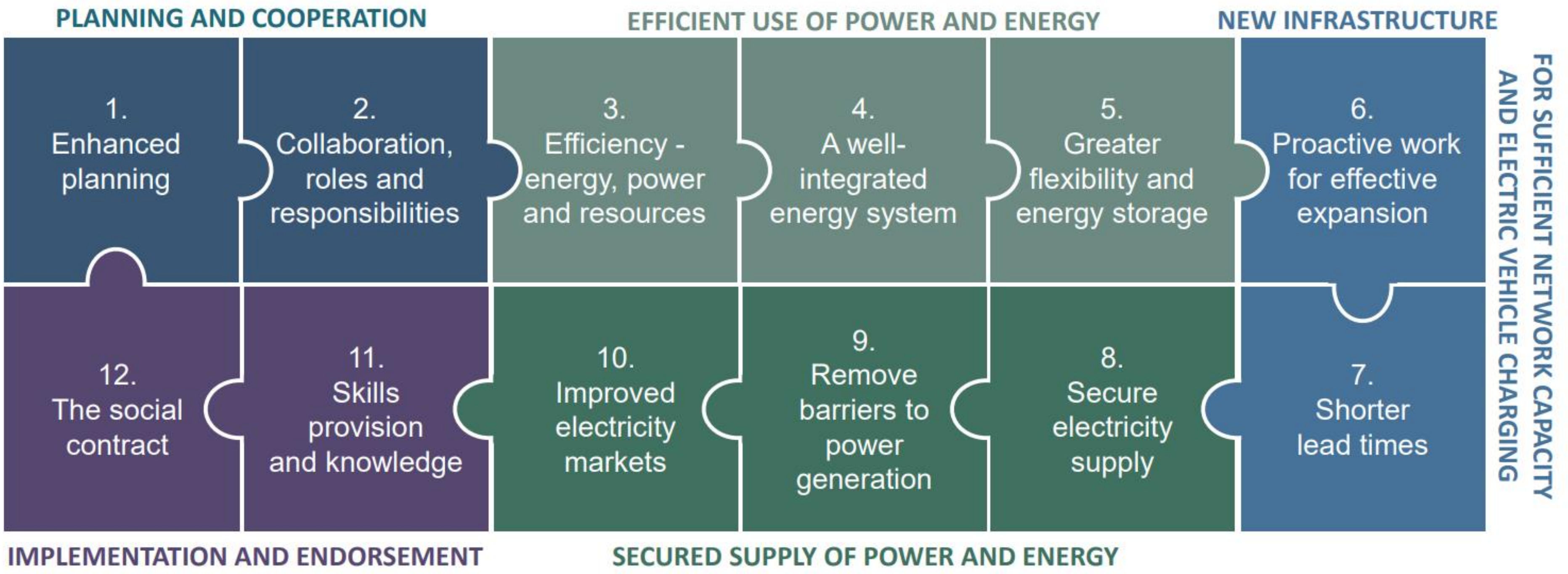
1. Technical readiness
2. Lack of confidence in the availability and reliability of electricity
3. Cheaper fossil fuel creates a challenging business case
4. Lack of data
5. Lack of case studies/good examples
6. Harmonisation of data communication protocols
7. Information and knowledge barriers
8. Supply chains
9. Barrier of capital cost
10. Reluctance to disrupt the process
11. Access to electricity and/or reliable electricity

5. Approaches: Example a - Electrifying Canada



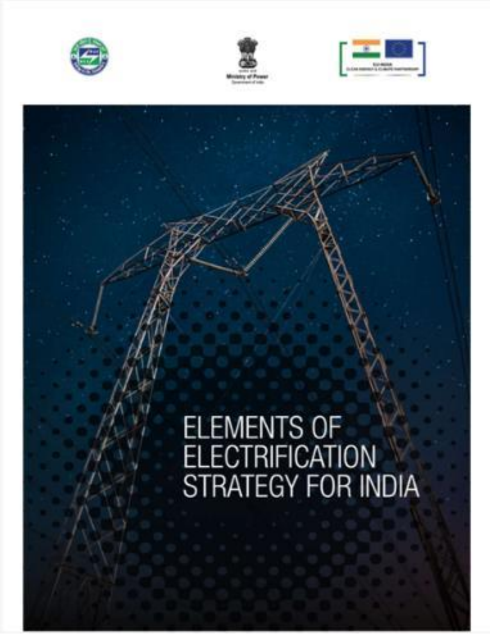
i. **Act** to electrify industrial processes via near term plans.
ii. Empower
iii. **Align** Utility Planning and growth with Net-Zero Pathways to ensure ample clean power supply for industrial electrification
iv. Finance
v. **Tilt** the Playing Field Toward Decarbonization by Improving Carbon Pricing Certainty

5. Approaches: Example b - National Electrification Strategy Sweden



5. Approaches: Example c – Elements of Electrification Strategy for India

1. Prioritising energy efficiency in industrial processes
2. Direct electrification of industrial processes wherever possible
3. Renewable Hydrogen based and Power-to- X based industrial processes



6. Opportunities and benefits (some)

Directly energy efficiency related:
- Increased efficiency
- Increased security of supply
- Reduced energy bills
- Reduced carbon emissions

Non directly energy efficiency related:
- Lower local pollution
- Less regulation of emissions
- Increased integration with the electricity grid (demand side response)
- Energy storage solutions
- Increased localised production – value added at local level
- Distributed utilities

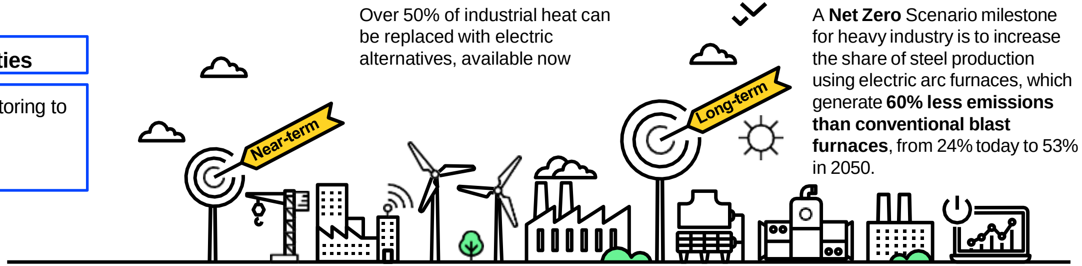
Synergy with other advances in industrial sector:
- Data generation and energy management systems
- Digitalisation
- Process integration/optimisation
- Auto generation

7. Policy Packages Approach

Immediate opportunities

Using metering and monitoring to target opportunities for electrification of industrial processes.

Over 50% of industrial heat can be replaced with electric alternatives, available now



A **Net Zero** Scenario milestone for heavy industry is to increase the share of steel production using electric arc furnaces, which generate **60% less emissions than conventional blast furnaces**, from 24% today to 53% in 2050.

REGULATION

- **Minimum Energy Performance Standards** for key equipment,, can drive up overall industrial efficiency levels.
- **Regulation to reduce energy use** extends beyond technology to target areas such as research and development, energy auditing, mandatory consumption reporting, energy management systems, and upskilling of the workforce.
- **Energy management systems**: to ensure best practices are in place
- **Harmonisation of data communication protocols** will be critical to enable data reporting on electrification and

INFORMATION

- To make society more aware of electrification and its possibilities, some countries have **launched information and education campaigns**, eg Australia and India.
- Recently Sweden published **a strategy** solely focused on electrification and how to further enable it. It focuses on expanding the capacity of the grid, further development of the EV charging network and the wind energy sector. Similarly Japan also published a comprehensive response to power shortages.
- Harmonisation of **data communication protocols** to enable data exchange between stakeholders and devices

INCENTIVES

- Canada and Australia have started to **fund smart- and micro-grid** demonstration projects, with the aim of improving the resilience and reliability of the electricity supply.
- Many regions are working **to strengthen their electricity network.** In the last few years, numerous governments have created funds or frameworks to achieve this, for example India, the European Union, Hungary and the United States.

8. Electrification of Industrial processes through Heat Pumps

- Heat pumps **transport heat from one place to another** and are particularly useful as they can transport heat from a cooler place to a hotter place.

- As heat pumps **only transport energy**, rather than convert one form of energy to another, they can be extremely energy efficient, with their coefficient of performance (COP) typically being greater than three. This is equivalent to an electrical energy efficiency of 300% or more.

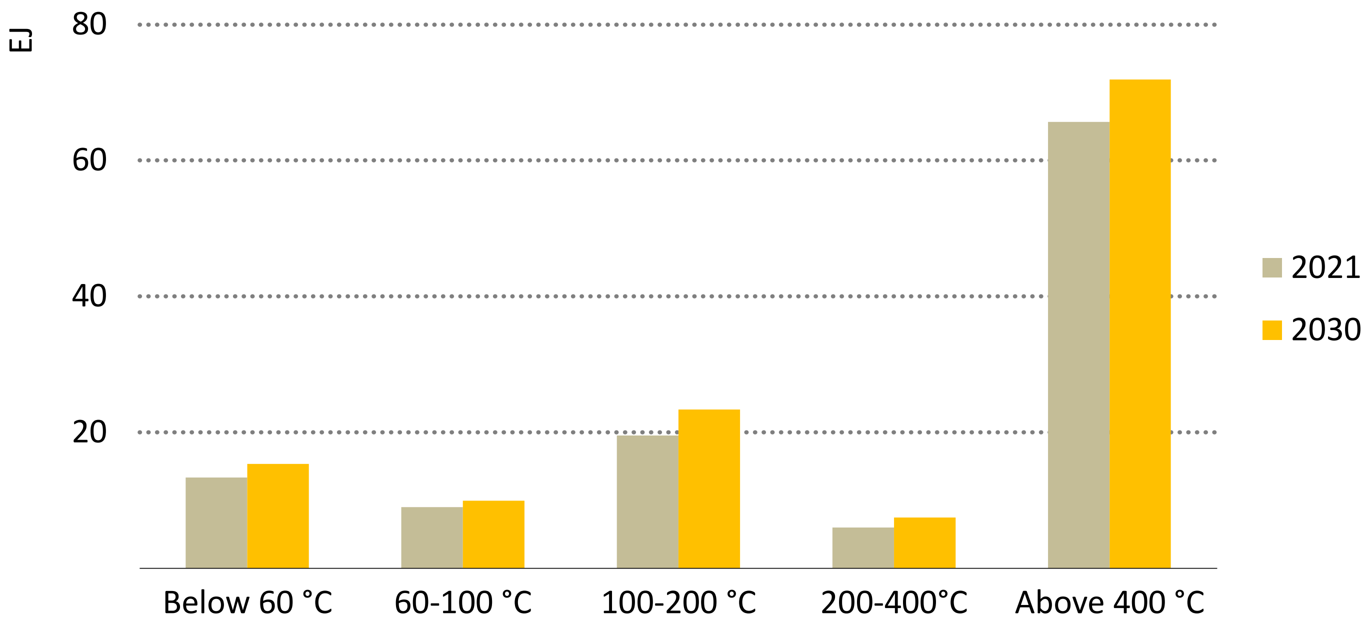
- The **high efficiency of electric heat pumps** provides opportunities for reducing greenhouse gas emissions by reducing the amount of energy needed to provide heating and cooling services, as well as fuel-switching to electricity from fossil fuel energy sources.

- Adoption of heat pump technology also unlocks the potential to deliver **heating and cooling services with near-zero greenhouse** gas emissions by integrating heat pumps with renewable energy.

- **Current adoption of heat pump technology is mixed**. For some applications – such as refrigeration –heat pump penetration is near-universal. In others – like industrial processes requiring heat above 90ºC, uptake is at an embryonic stage.

8. Heat pumps in industry

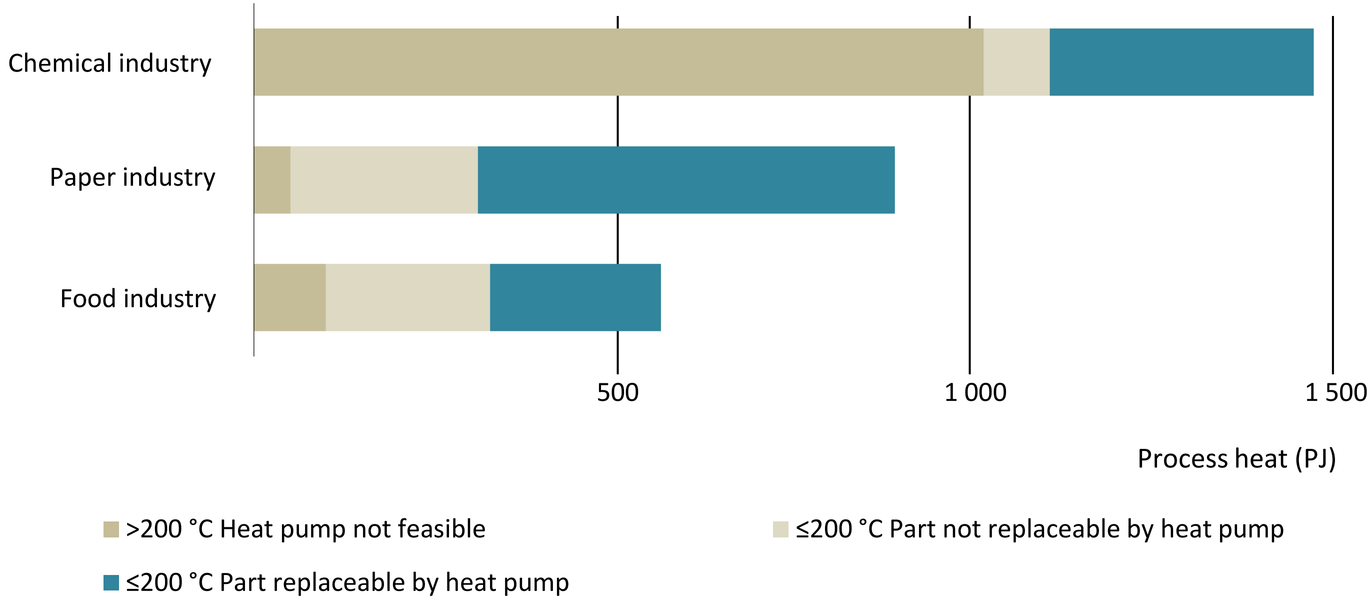
Global industrial process heat demand by temperature level in Announced Pledges Scenario



Process heat demand in all temperature ranges is rising until 2030.
Demand for decarbonisation of lower temperatures is already high, and will keep on rising.

8. Heat pumps potential for heat production

Industrial gas and process heat demand by temperature level and heat pump replacement potential in Europe, 2019

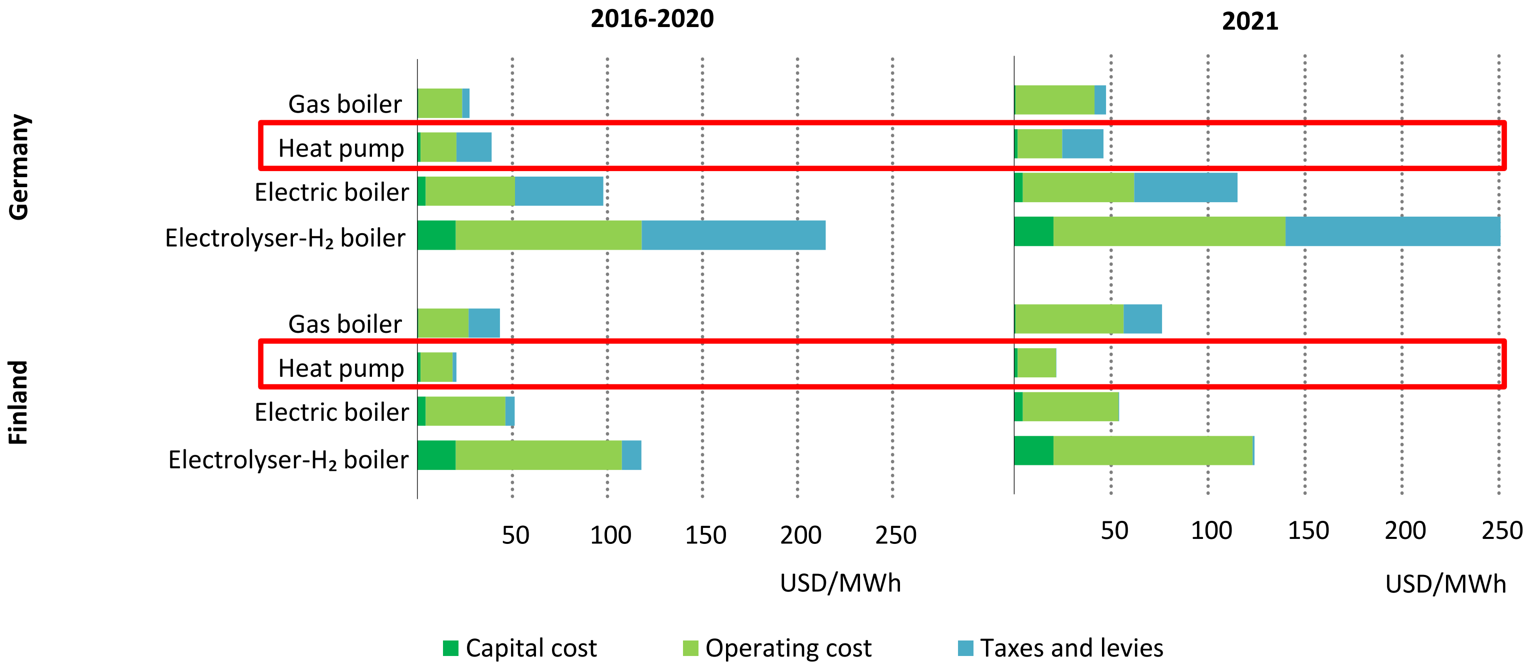


Source: IEA analysis based on Marina et al. 2021

The food and paper industries are prime candidates for deploying industrial heat pumps on a large scale. Europe has a potential of 3000 industrial heat pumps with combined capacity of 15 GW in these industries.

8. Upfront costs and levelised cost

Average levelised cost of production of industrial heat in Germany and Finland



Recent gas price increases and tax changes have made heat pumps the cheapest solution for producing industrial heat in Germany and Finland

8. Possible policy packages

- **Regulation:**
  - Energy management systems: to ensure best practices are in place
- **Information**
  - Guidelines for users on heat pumps use, financial gains
  - Capacity building and development of skills
  - Demonstration projects as template for certain processes
- **Incentives**
  - Financial instruments to reduce upfront costs and accelerate deployment
  - Electricity tariffs to motivate fuel switching and account for flexibility

International collaboration supports knowledge and data sharing and generation, as well as accelerating standard harmonisation across countries.

Upskilling, knowledge-sharing and R&D can play an important role in the longer term to enhance the performance of heat pumps, in particular in cold climates and for geothermal units.

5 steps to support change

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pril

1. Reduce ROI hurdles: Energy savings / carbon savings certificates
2. Create awareness and learning opportunities: Scoping studies + funded feasibility studies
3. Remove (perceived) barriers for changing: Funded feasibility studies
4. Help first movers adopt the technology: Co-funding grants
5. Socialise the learnings: Knowledge-sharing & training

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

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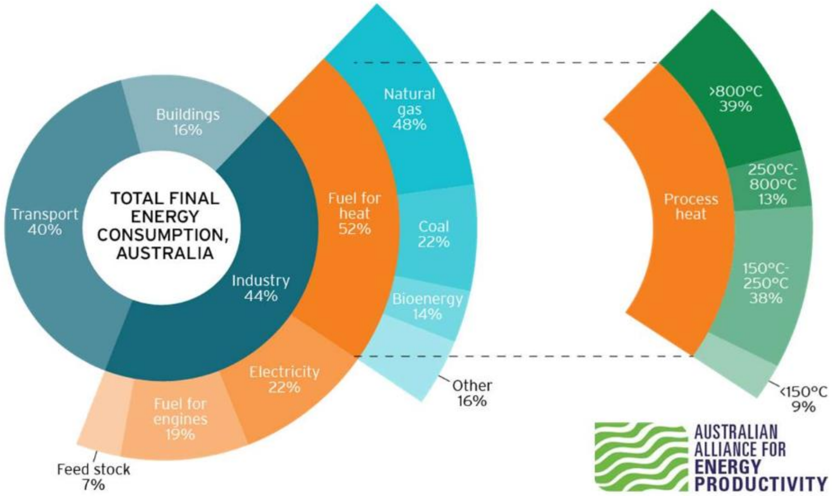
A2EP Renewable heat feasibility studies

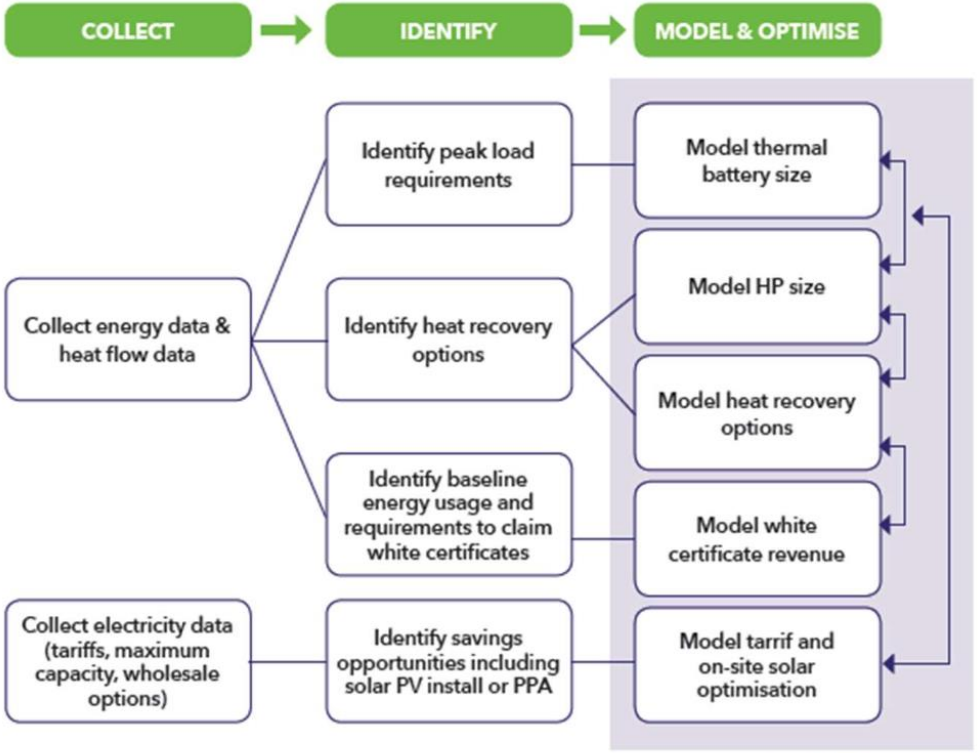
- AU$2m program funded by Australian Renewable Energy Agency
- Completed in two phases from 2018 to 2021
- 20 pre-feasibility & 7 feasibility studies completed across food, beverage and industrial sectors
- Assessed feasibility of renewable heating methods: heat pumps, solar thermal, biogas and geothermal

Australian Government
Australian Renewable Energy Agency
ARENA



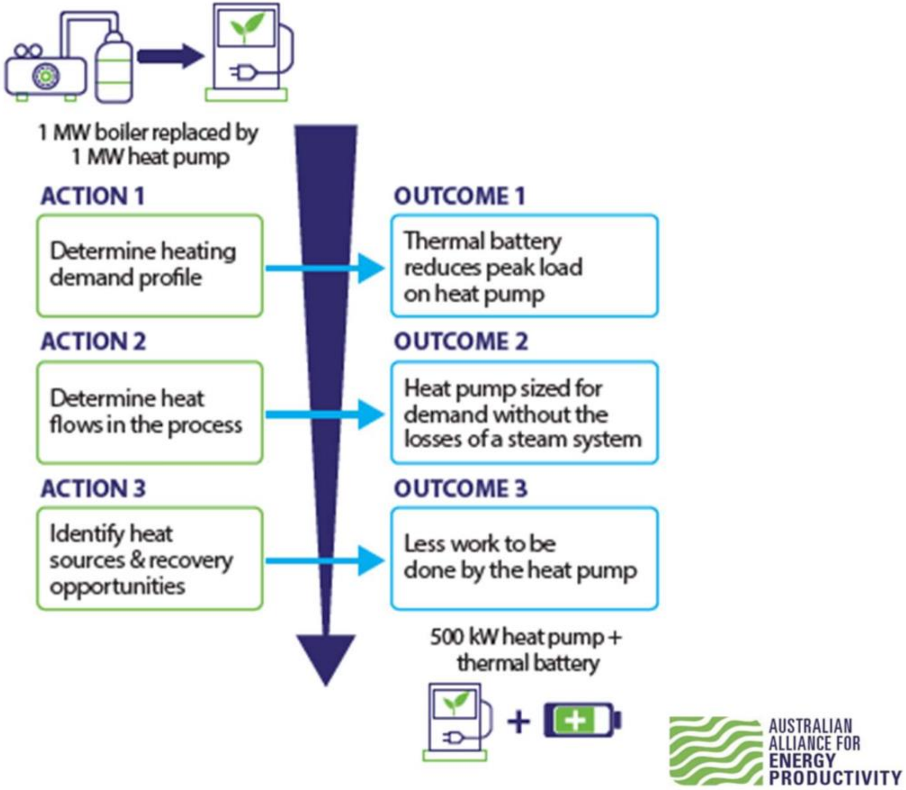
AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

An integrated design approach overcomes high electricity to gas price ratios



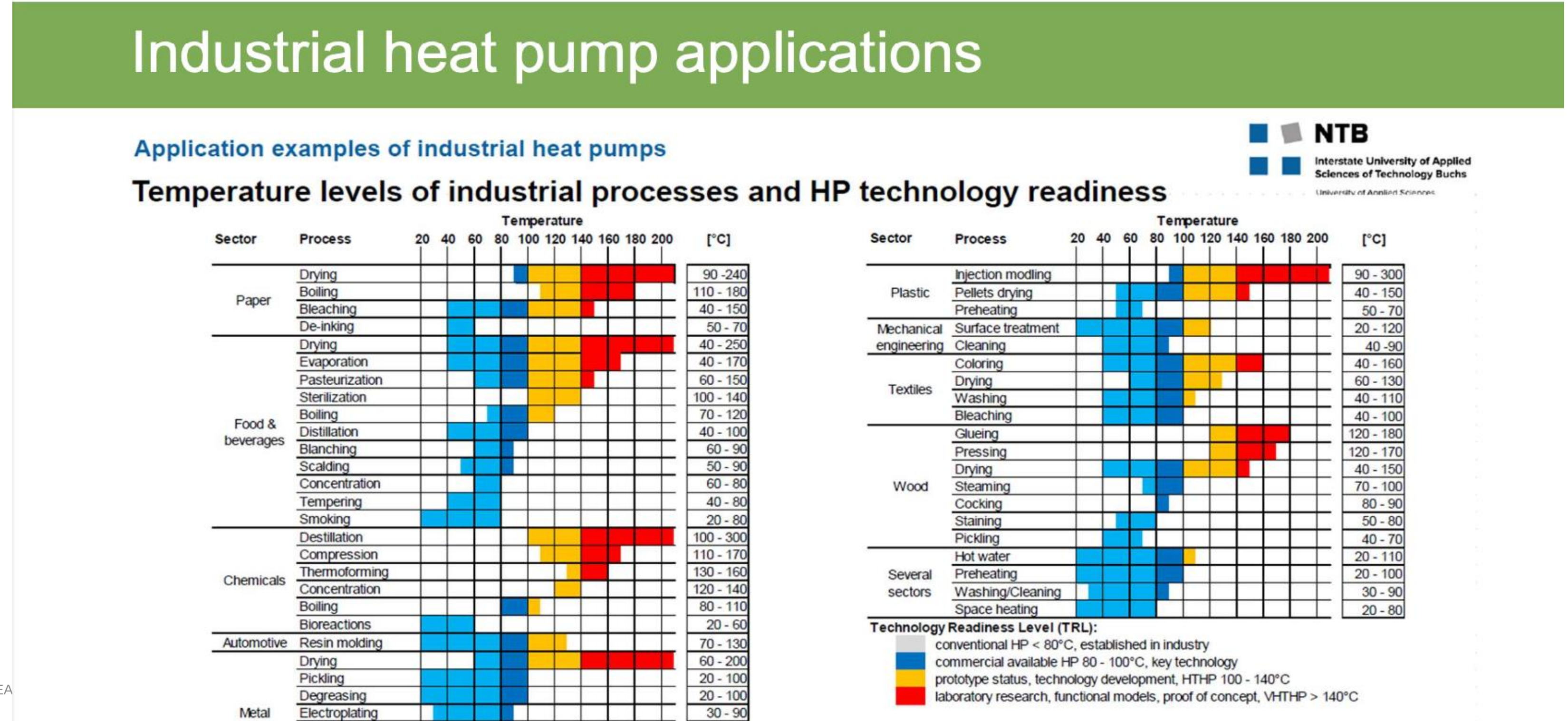
- Right-size the heat pump, don't go for a like-for-like replacement.

- Expect the heat pump to be <50% of the nameplate capacity compared to the steam boiler it replaces.



Jarrod Leak Doc …

- Decarbonisation with industrial heat pumps: Policy & program update from Australia Jarrod Leak, Chief Executive Officer, Australian Alliance for Energy Productivity 6 April 2022



Jarrod Leak Doc …

- Decarbonisation with industrial heat pumps: Policy & program update from Australia
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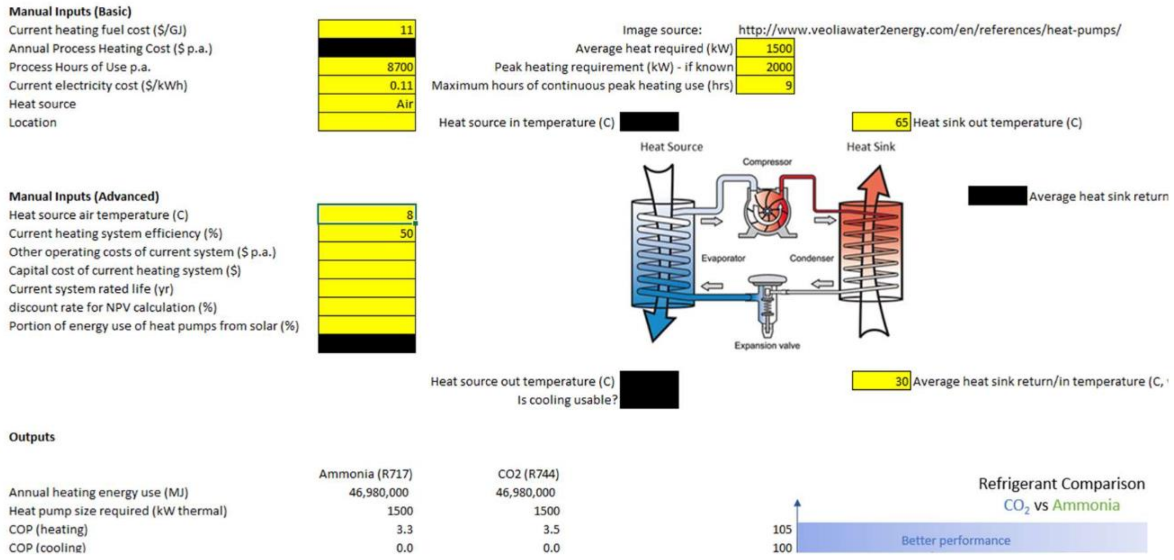
Heat pump selection tool



Basic sizing tool developed to give quick CAPEX and OPEX guide

- Decarbonisation with industrial heat pumps: Policy & program update from Australia Jarrod Leak, Chief Executive Officer, Australian Alliance for Energy Productivity 6 April 2022

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Introductory roundtable

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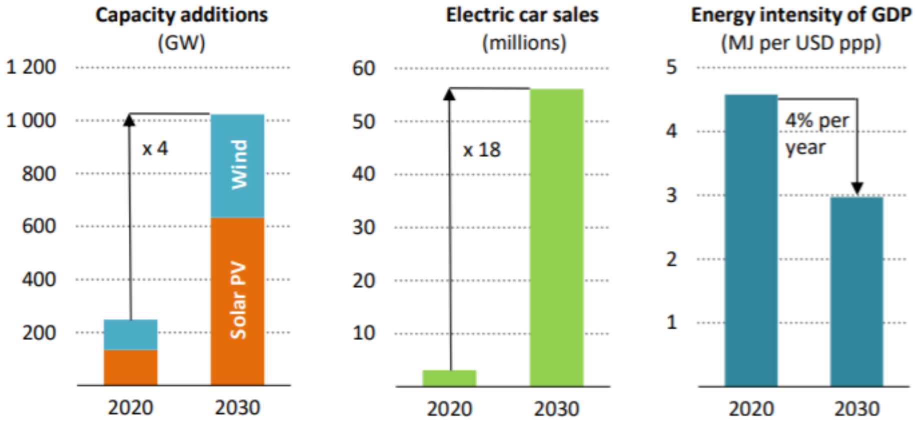
Digital is key for net zero pathways

Net Zero Emissions by 2050 Scenario (NZE) milestones:

- Yearly **wind and solar PV capacity** additions **>1 000 GW** by 2030;
- **5 million heat pumps** installations/month in NZE by 2030
- **100 million buildings** with residential PV by 2030
- **All new** buildings **zero-carbon-ready** by 2030

Key clean technologies ramp up by 2030 in the net zero pathway



Note: MJ = megajoules; GDP = gross domestic product in purchasing power parity.

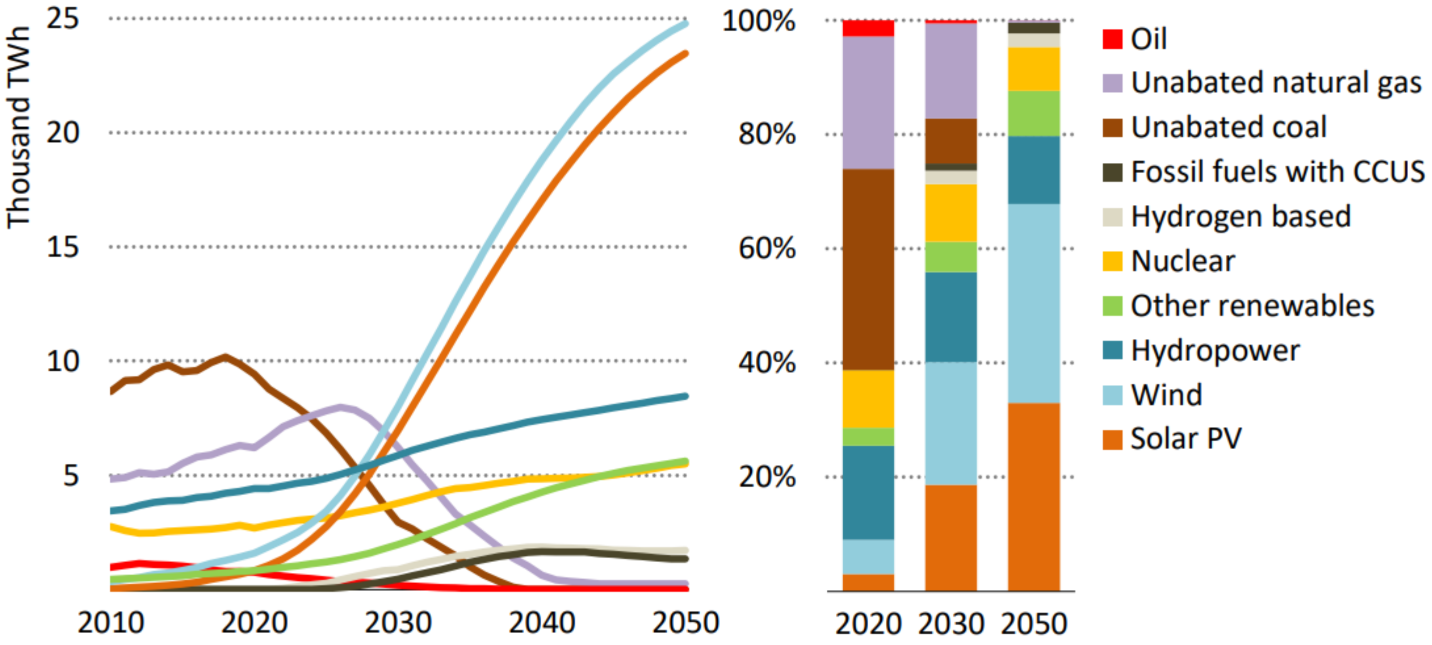
These massive changes will require more flexibility. In the NZE:

- **>500 GW** of demand response brought to market by 2030;
- **Tenfold increase** in global inventory of **flexible assets** by 2030

https://www.iea.org/reports/demand-response
https://www.iea.org/reports/world-energy-outlook-2021
https://www.iea.org/reports/net-zero-by-2050

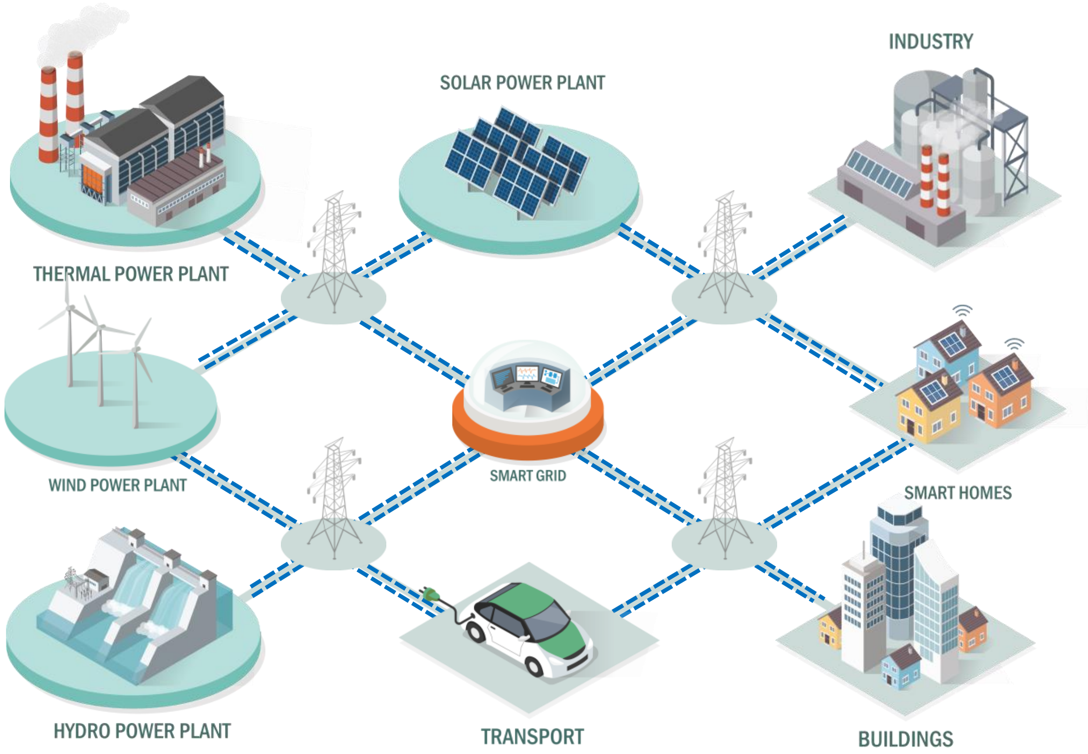
The share of renewables in total generation rises to ~90% in 2050

Global energy generation by source in the Net Zero Scenario



Variable renewables, especially wind and solar, are set to become the largest capacity on the electricity grid, and the key electricity source in the NZE Scenario. Flexible demand will be essential for system optimisation.

The power sector needs to change



Traditional system

Centralised / dispatchable

High inertia and stability

Central planning

One way flows of energy and communication

Closed networks, few devices

New system

Decentralised / variable generation

Low system inertia from rotating machines

Multiple actors / competitive markets

Two way flows of energy and communication

Open networks and many devices

Changing climate patterns

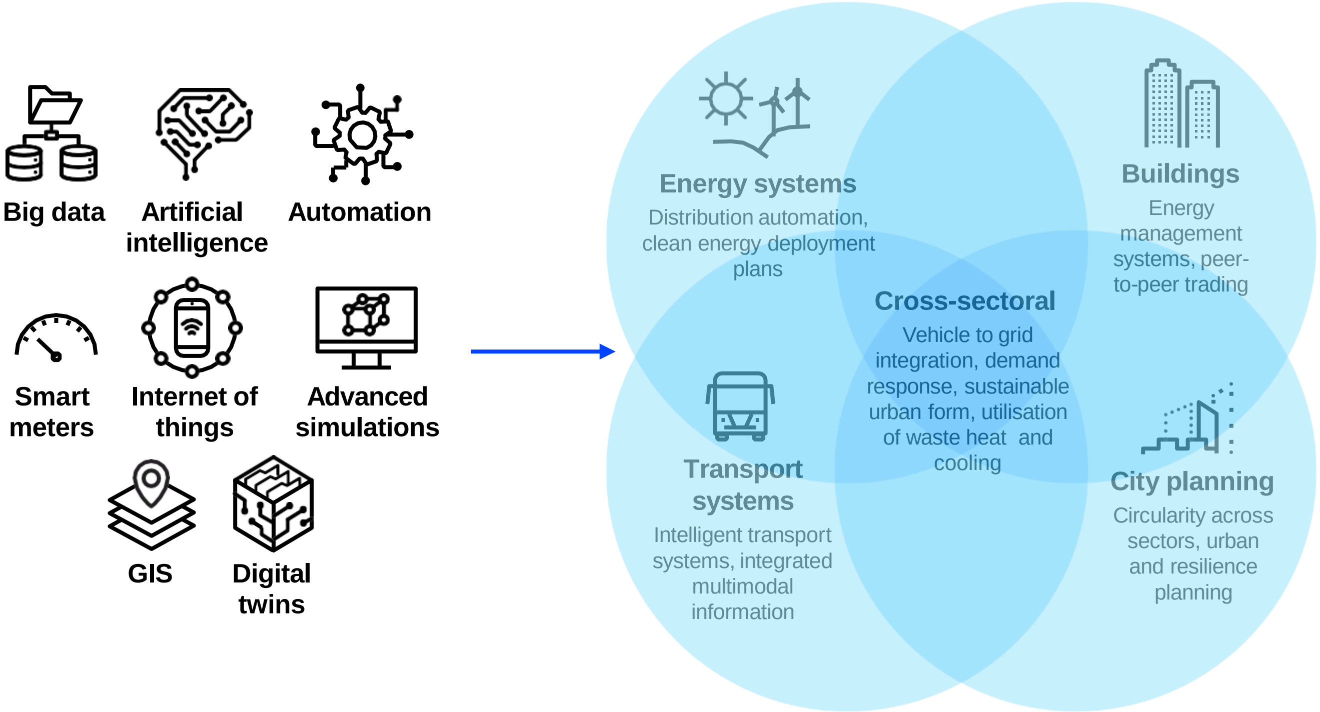
A deep transformation of energy systems, with electricity at the centre

Electricity systems are transforming → More flexibility is needed, with active participation of consumers → Digitalisation is key, enabling policies are crucial.

- **Digitalisation** can help leverage opportunities:
  - Create a more interconnected and responsive electricity system
  - Support carbon emissions reduction
  - Help to minimise system cost and need for new investment
  - Improve stability, resilience and security
  - Enhance quality of power supply

Implementing right policies, digital technologies and new business models is key to enable transformation

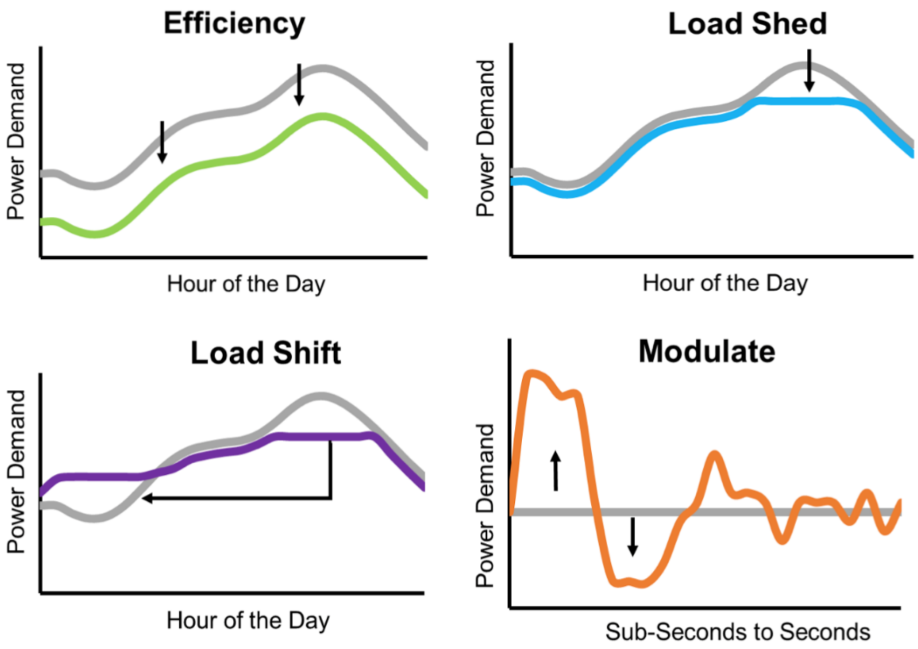
Digitalisation opens opportunities for system-wide efficiency



Digitalisation, with the right policies, enables a progression to optimising the efficiency of the whole energy system

Grid services of efficient grid-Interactive buildings

- **Efficiency**: the ongoing reduction in energy use while providing the same or improved level of building function.
- **Load Shed**: the ability to reduce electricity use for a short time period and typically on short notice.
- **Load Shift**: the ability to change the timing of electricity use. In some situations, a shift may lead to changing the amount of electricity that is consumed.
- **Modulate**: the ability to balance power supply/demand or reactive power draw/supply autonomously in response to a signal from the grid operator during the dispatch period.
- **Generate**: the ability to generate electricity for on-site consumption and even dispatch electricity to the grid in response to a signal from the grid.



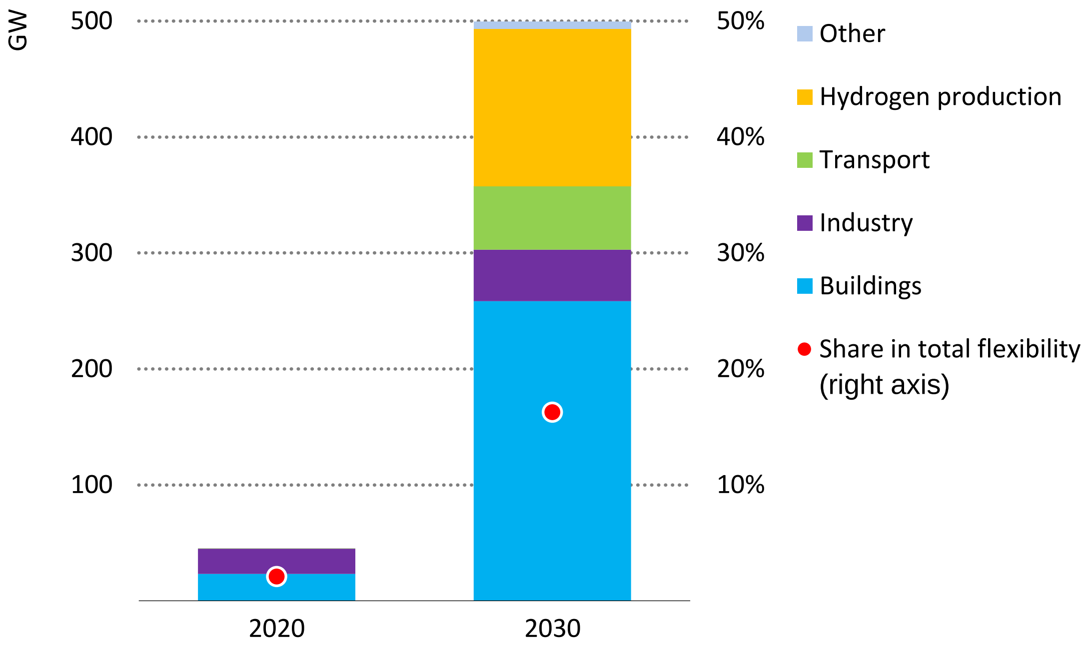
Source

Interesting fact

From 2010 to 2017, over 250 TWh of variable renewable electricity was curtailed globally, (~180 Mt CO_2 emissions) equivalent to annual Spain’s electricity demand

In net-zero scenario, demand-response availability increases tenfold in the next ten years, mostly coming from buildings

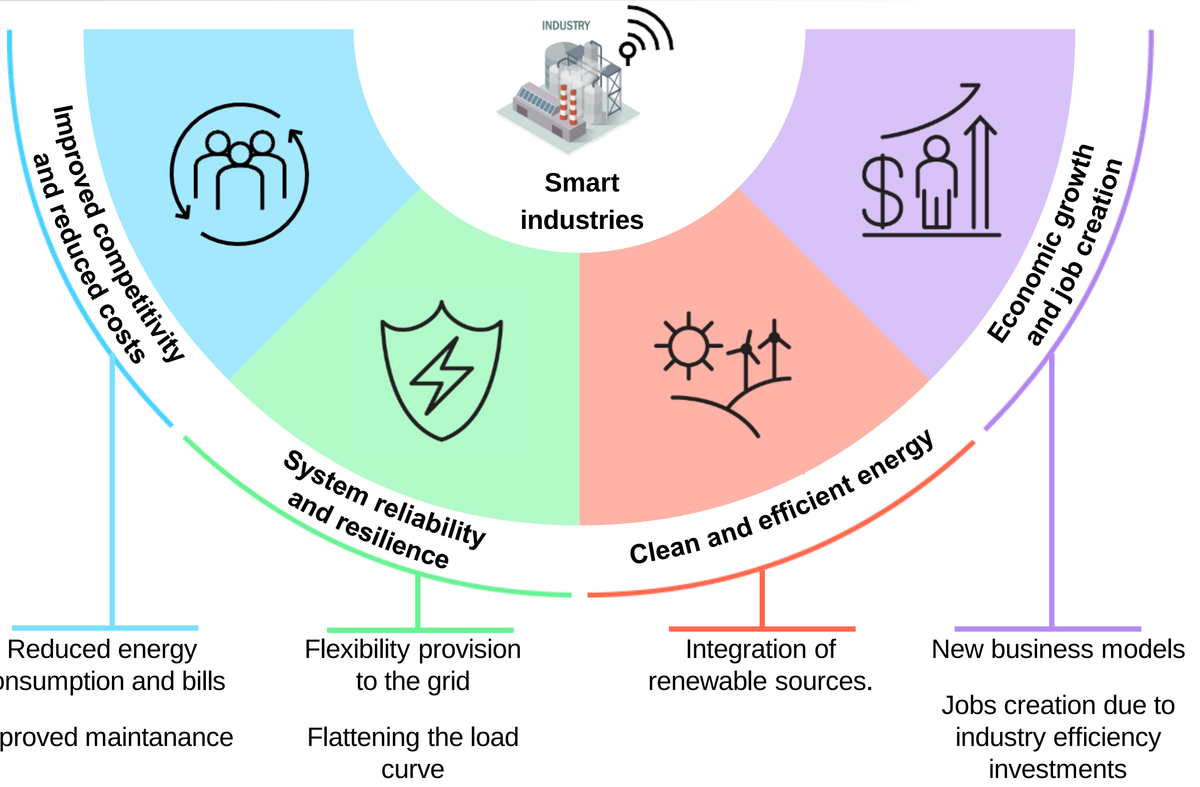
Demand response availability at times of highest flexibility needs and share in total flexibility provision in the Net Zero Scenario, 2020 and 2030



Actions taken in this decade to open markets to demand-side participation, encourage new business models and establish controllability standards for equipment and appliances. Industry flexibility doubles by 2030 to reach 45 GW

https://www.iea.org/reports/demand-response

Smart technologies in buildings can bring a wide range of benefits



Policy, regulatory, technology and investment context needed to accelerate power system decarbonisation and digitalisation and effective utilisation of demand side resources, incl. industry

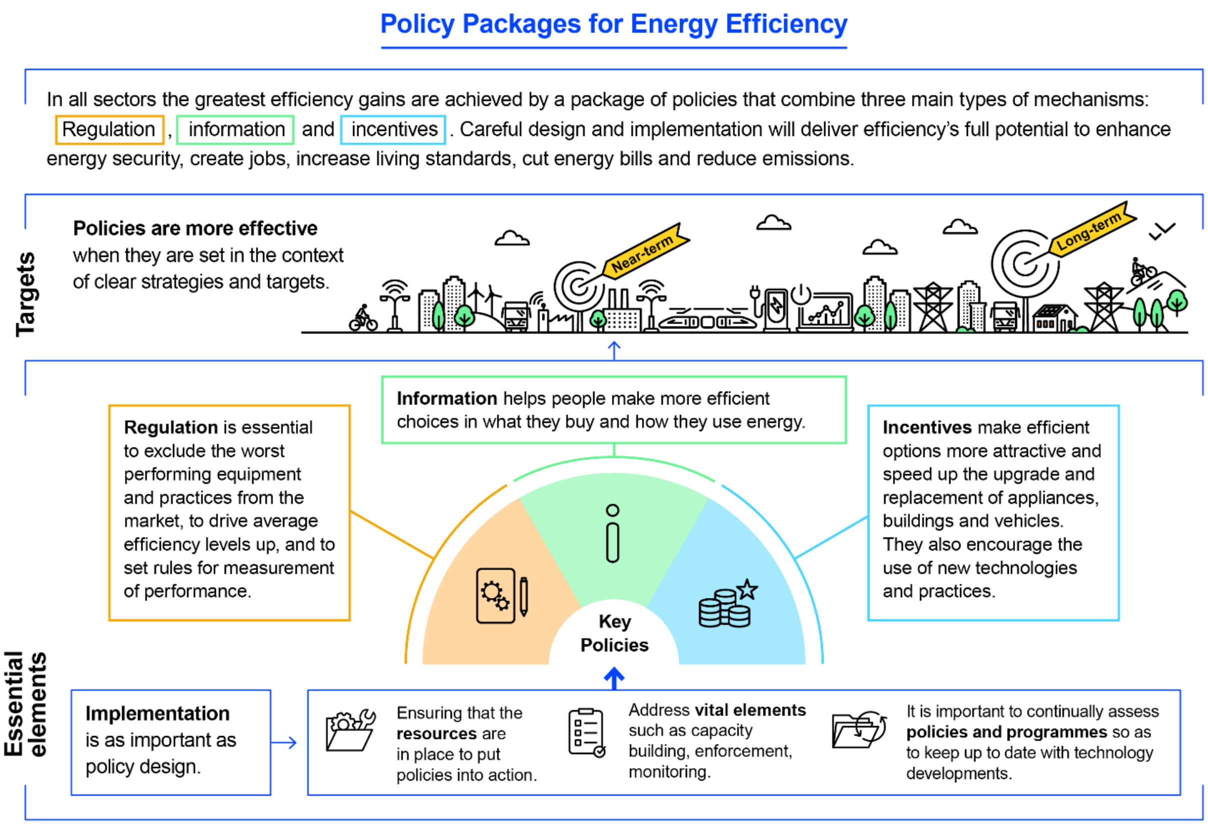
Policy package is needed for efficient grid-interactive industry

Regulations to

- allow participation of aggregators in electricity markets
- allow industry to provide services to the central/ local grids
- mandate smart meters and smart grid infrastructure
- establish rules on data collection, cybersecurity and privacy

Supportive policies to

- Measures to monetise demand response capacities from the industry
- Encourage industry to adopt new behaviours and seize opportunities
- Strong communication campaigns to explain this new dimension of activities



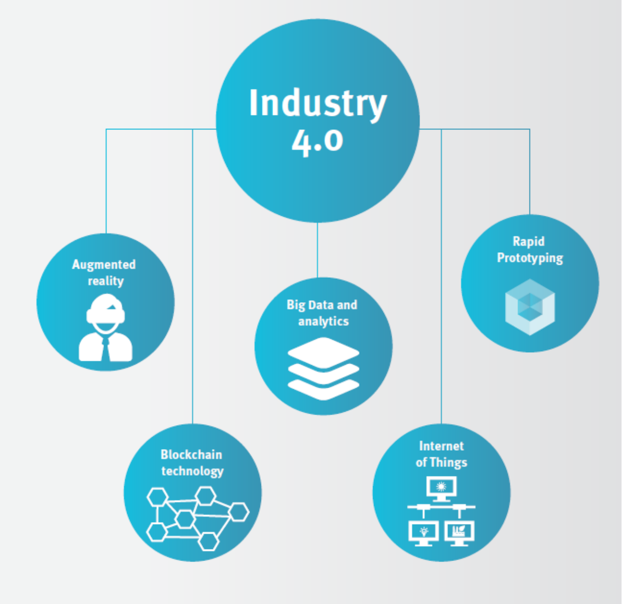
In the past …

- Lack of technology to measure and track energy use
- Limited consolidation of data
- Limited real time data
- Limited granular data

- Difficult to identify energy efficiency opportunities
- Difficult to assess results of energy efficiency
- Managing energy ‘in the dark’

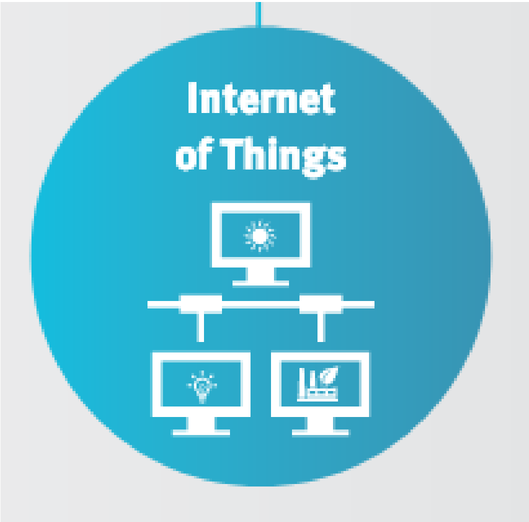
Today

- Technologies that have the potential to revolutionise industry and deliver significantly better energy efficiency



Link

Internet of Things (IoT)



What is it?

- IoT is the interconnection via the Internet of computing devices embedded in everyday objects. This enables them to send and receive data.

Leverage for energy efficiency

- Cheap, easy and fast sensors
- More targeted data and information to support decision making
- Opportunity to automate decision making

IoT in Manufacturing

Case study - Refrigeration

Leveraging Technologies

MAINLINE solutions

- US ice cream cake producer installed CCP Technologies (ASX:CT1) wireless LPWAN automated IoT monitoring and analytics solution.
- Case study: a small walk-in freezer was shown to be sub-optimal due to high frequency and high temperature defrost cycling (8 cycles per 24 hours up to -11ºC). The running cost of the freezer was $372.30 per month.
- The defrost cycle frequency was reduced to three cycles per 24 hours and the peak defrost temperature was reduced to -14ºC.

- This adjustment reduced the power cost from $372.30 per month to $244.13 per month, a saving of $128.17/month (52%).

Big Data and Analytics

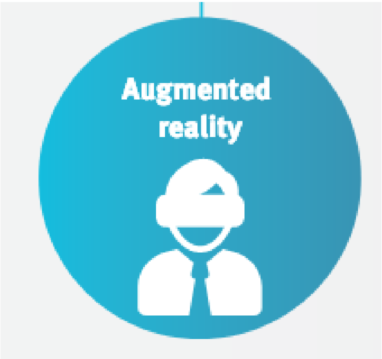
What is it?

- Sets of data characterized by high volume, high velocity and high variety

Leverage for energy efficiency

- Identify complex energy use trends in operational sites, across industry sectors and across supply chains

Augmented reality



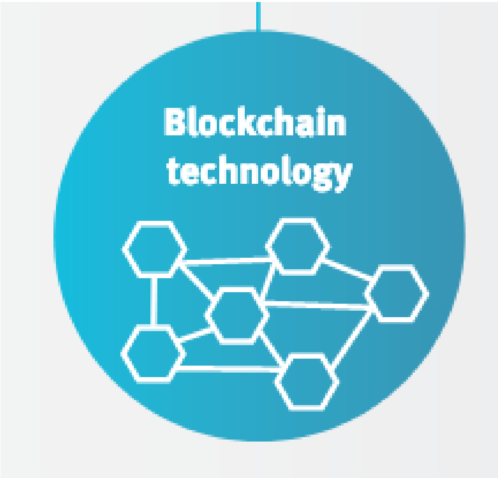
What is it?

- A technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.

Leverage for energy efficiency

- Connect with service experts to develop feasible maintenance solutions without requiring experts to physically travel to the customer
- Train local workforces in different regionals
- Visualise where energy wastage occurs across a site

Blockchain



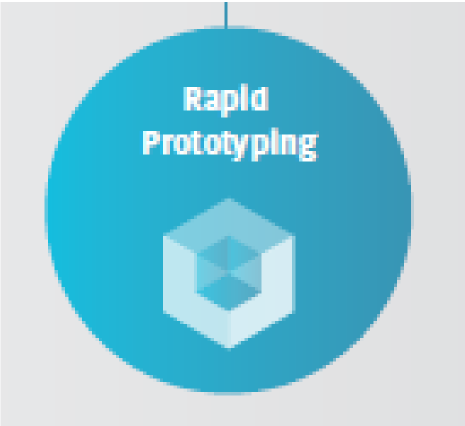
What is it?

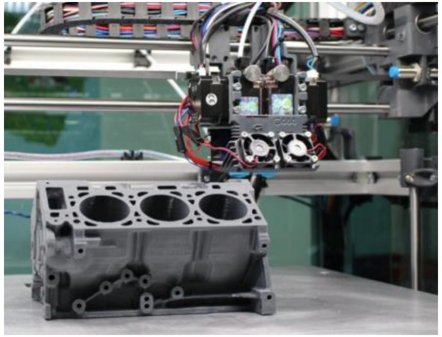
- a system in which a record of transactions made in bitcoin or another cryptocurrency are maintained across several computers that are linked in a peer-to-peer network.

Leverage for energy efficiency

- Could support ‘trading’ in energy efficiency
- Build confidence in energy efficiency achieved across a supply chain

Rapid prototyping





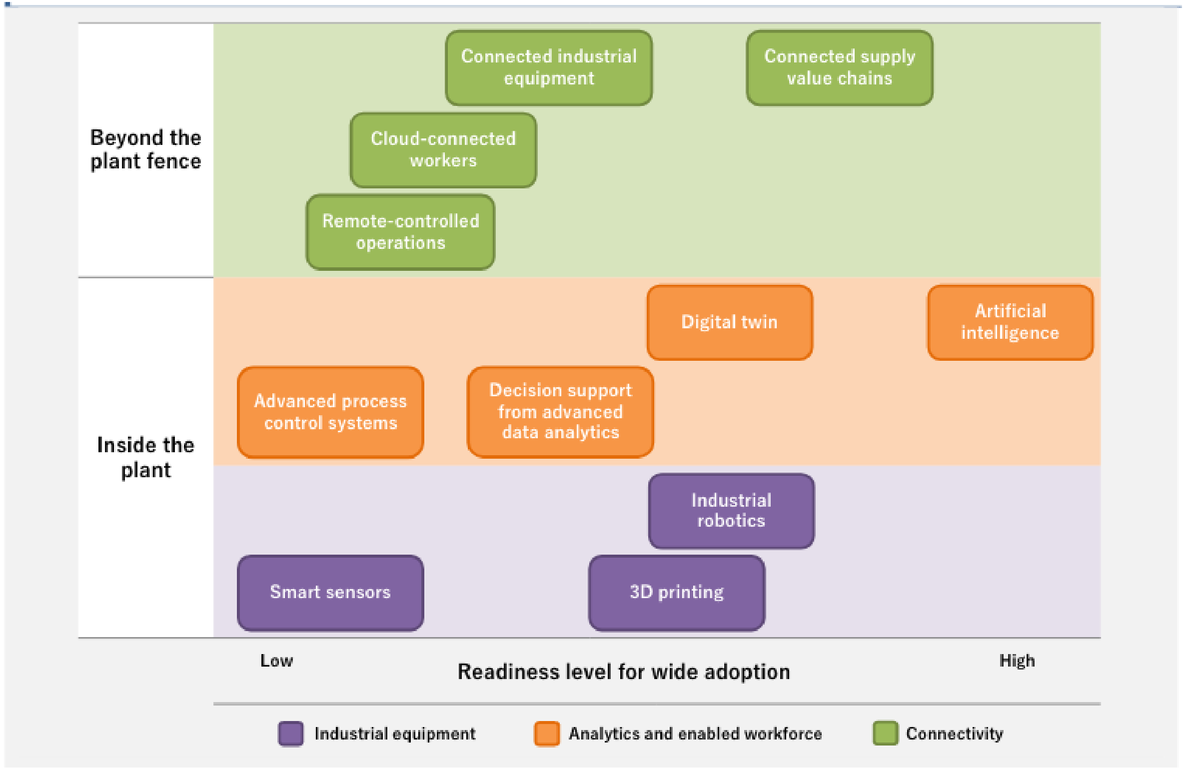
What is it?

- Group of complementary technologies such as computer aided design and 3D printing used to rapidly product parts and prototypes

Leverage for energy efficiency

- Mass customization of energy efficient technologies
- Improve the energy efficiency of production elements in various ways such as reducing weight, increasing durability and increasing strength

Application of digital technologies and strategies in industry



Digitalization in industry can take diverse forms, ranging from automated equipment to connecting industrial operations based in different locations.

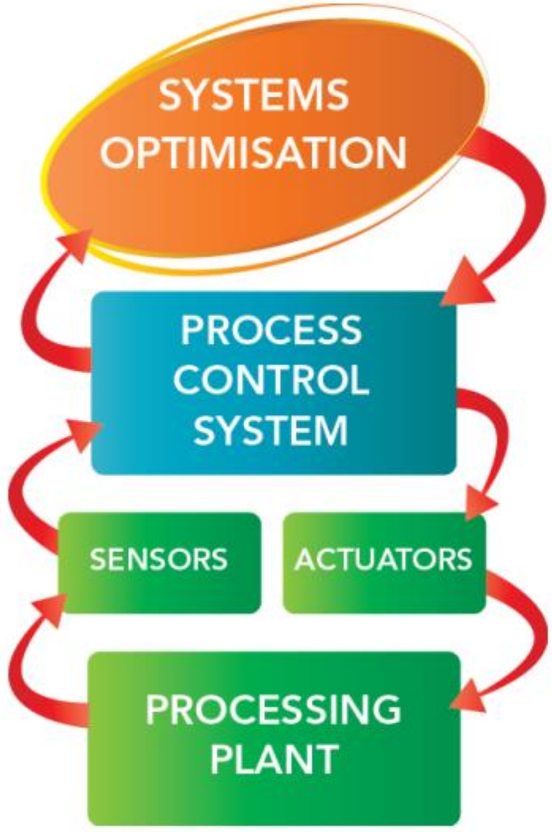
How digitization can deliver energy efficiency at the plant level

- Real time data
- Device – equipment level data
- System level data
  - Production line
  - Whole site
- Sensors tracking and alerting for leaks or subpar operation
- Automated adaptation to conditions (e.g. weather)
- Software that audits equipment and systems
- Condition monitoring library

Equivalent to many energy managers!

Systems optimisation examples

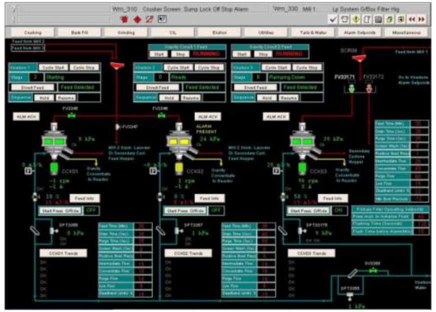
- Energy use and process data in real time
- Data used to manage and optimise productivity and quality
- Multiple benefits
  - ✓ Increased output
  - ✓ Increased energy efficiency
  - ✓ Reduced energy cost
  - ✓ Increased product quality
  - ✓ Emissions reduction
  - ✓ Reduced environmental impact
  - ✓ Improved occupational health and safety



Link

Case Study: Anglo Gold Ashanti (mining)

- Systems optimisation project implemented to improve productivity and reduce downtime
- Had systems to collect data, but it had never been analysed
- Multi-step process:
  - ✓ Understand systems in place
  - ✓ Identify opportunities for improvement
  - ✓ Train operators about how to use existing equipment



CASE STUDY

Source: DRET 2013

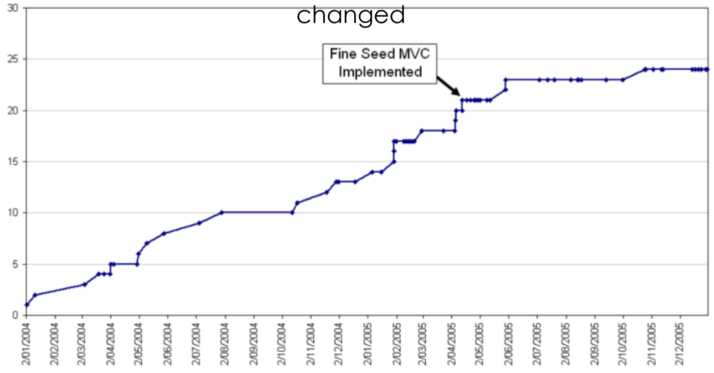
Case study: Worsley Alumina (resource processing)

- Implementation of advanced control systems (multi-variable control)

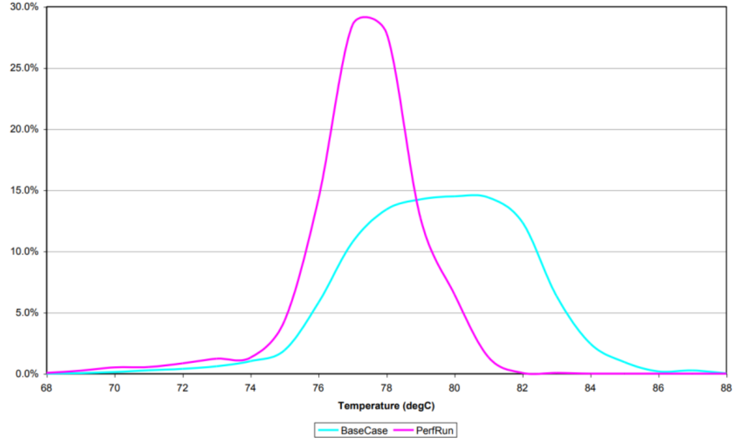
- Multi-step process:
  - ✓ Mandate from senior management
  - ✓ Front-end study
  - ✓ Progressive roll-out across plant to improve confidence

- Benefits:
  - ✓ Reduced operator intervention in process
  - ✓ Reduced maintenance costs and improved reliability
  - ✓ Increased productivity and efficiency
  - ✓ 3,000 more tonnes alumina per year from the same energy use
  - ✓ 7 month payback

Number of seed pumps changed



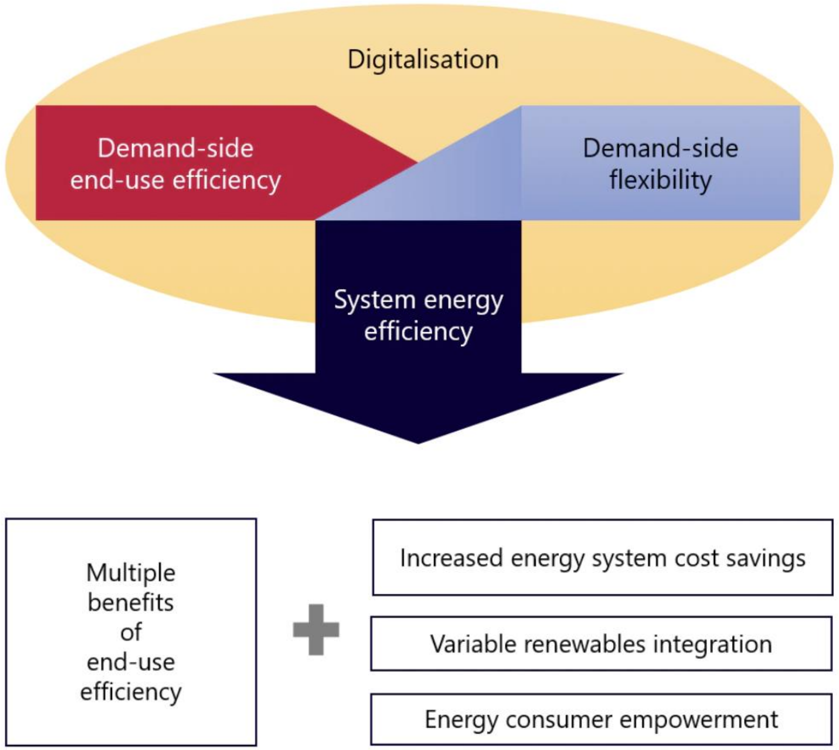
Spent liquor temperature before (blue) and after optimisation (pink)

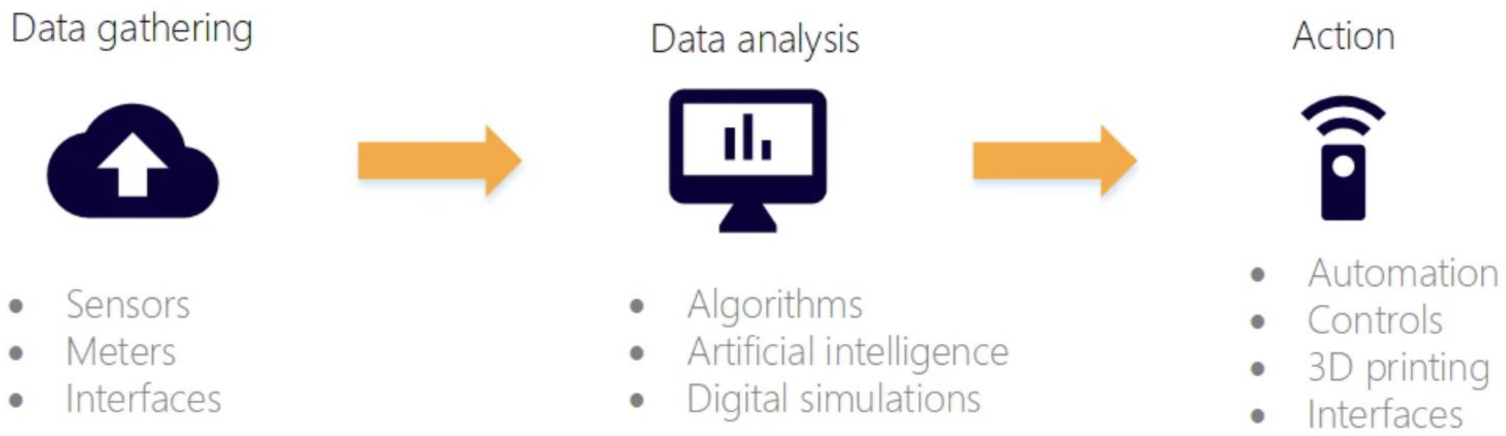


Source: DRET 2013

What do you think?

- What are the emerging technologies that are likely to have an impact in your country context?
- What do you see as the key opportunities to promote these and other technologies?
- What do you see to be the key challenges?


Digitalisation
Demand-side end-use efficiency
Demand-side flexibility
System energy efficiency
Multiple benefits of end-use efficiency
Increased energy system cost savings
Variable renewables integration
Energy consumer empowerment


Data gathering
Data analysis
Action
• Sensors
• Meters
• Interfaces
• Algorithms
• Artificial intelligence
• Digital simulations
• Automation
• Controls
• 3D printing
• Interfaces

Why AI and energy are the new power couple

Vida Rozite, Energy Policy Analyst
Jack Miller, Energy Efficiency Policy Analyst
Sungjin Oh, Energy Analyst
Commentary — 02 November 2023

Cite Share

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Nairobi

18-22 March 2024

Africa Energy Efficiency Policy in Emerging Economies Training Week

Industry

Nairobi
18-22 March 2024

International Energy Agency

Programme design exercise

Patrick Crittenden, Sustainable Business Group & Corine Nsangwebusinge, IEA

Nairobi, 20 March 2024

Learning outcomes

This session will focus on developing your capabilities to:

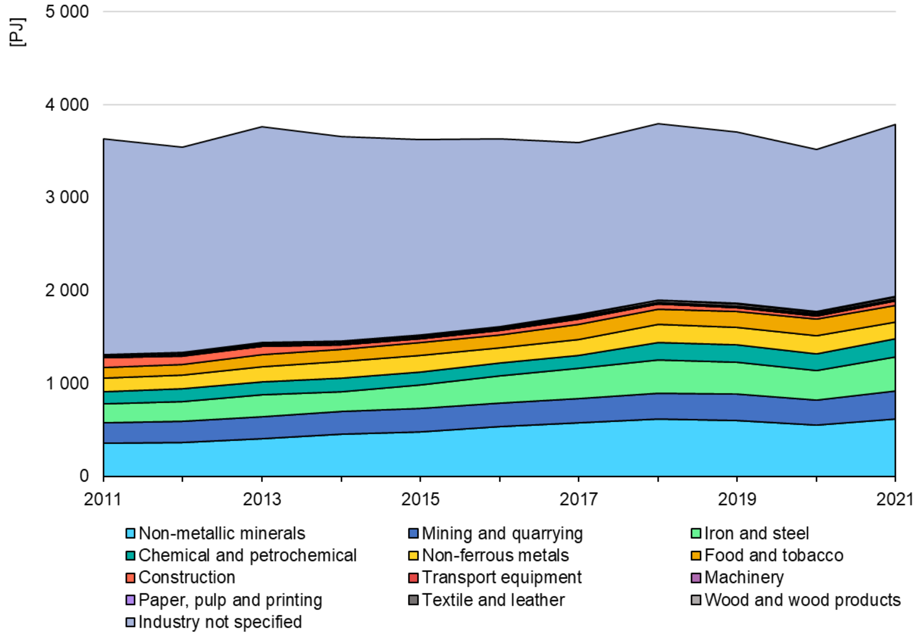
- Apply a systematic and structured approach to the design of industrial energy efficiency policy and programmes

Keep in mind – this is an opportunity to:

- Learn from your peers
- Discuss new ideas
- Explore combinations of measures to form a policy package

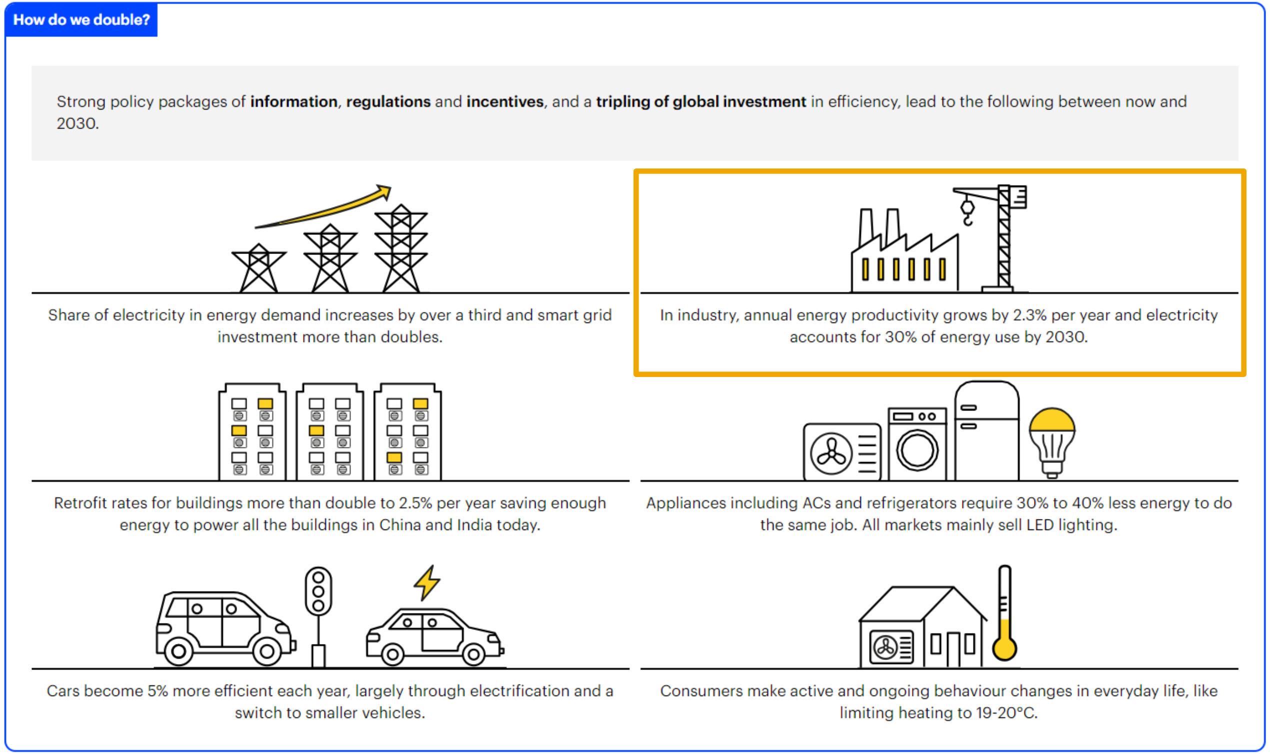
An overview on African Industry

Energy consumption in industrial sub-sectors in Africa, 2011-2021



Overall consumption of the industrial sector grew by 4% in the last decade.

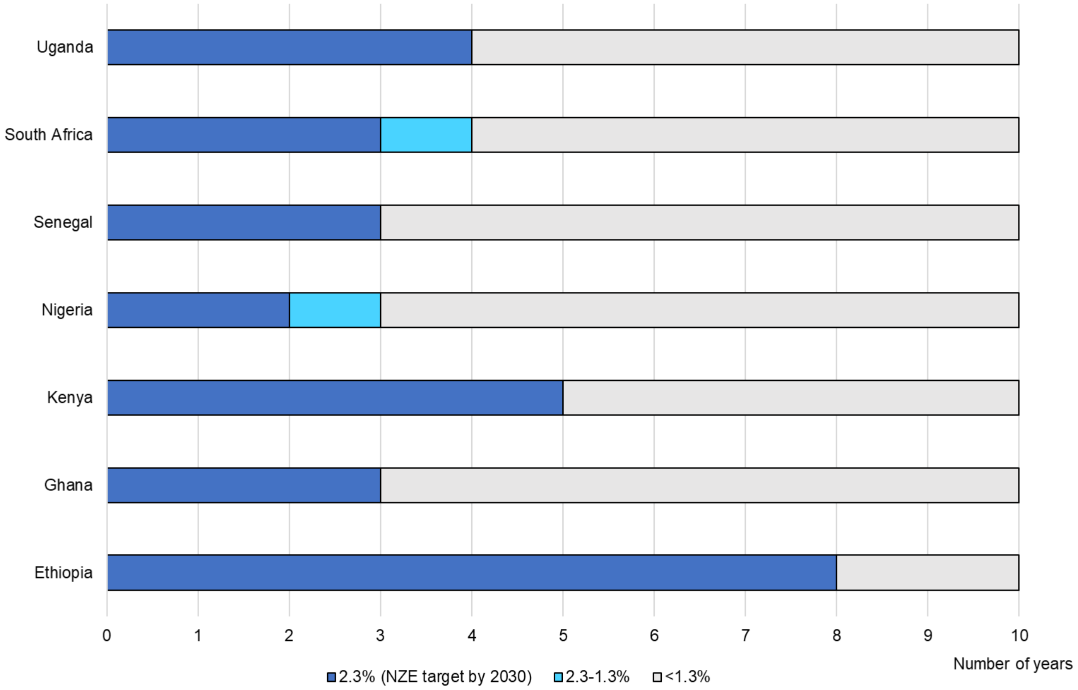
An overview on African Industry



Industry has a target of 2.3% improvement in energy intensity by 2030 in the NZE Scenario.

An overview on African Industry

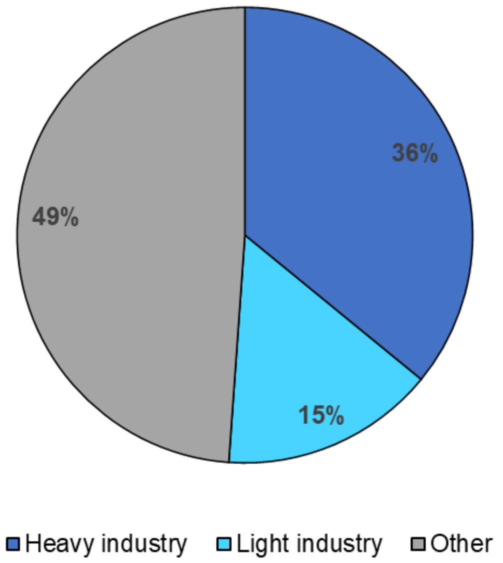
Energy intensity progress in the industrial sector, number of years above 1.3%, 2.3% for selected African countries, 2012-2021



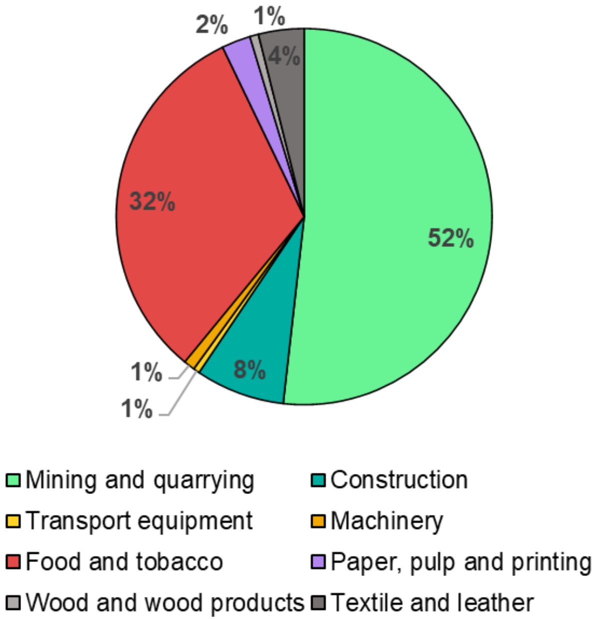
Over the past 10 years, industry in selected African countries has experienced 2.3 % improvement at least twice.

An overview on African Industry

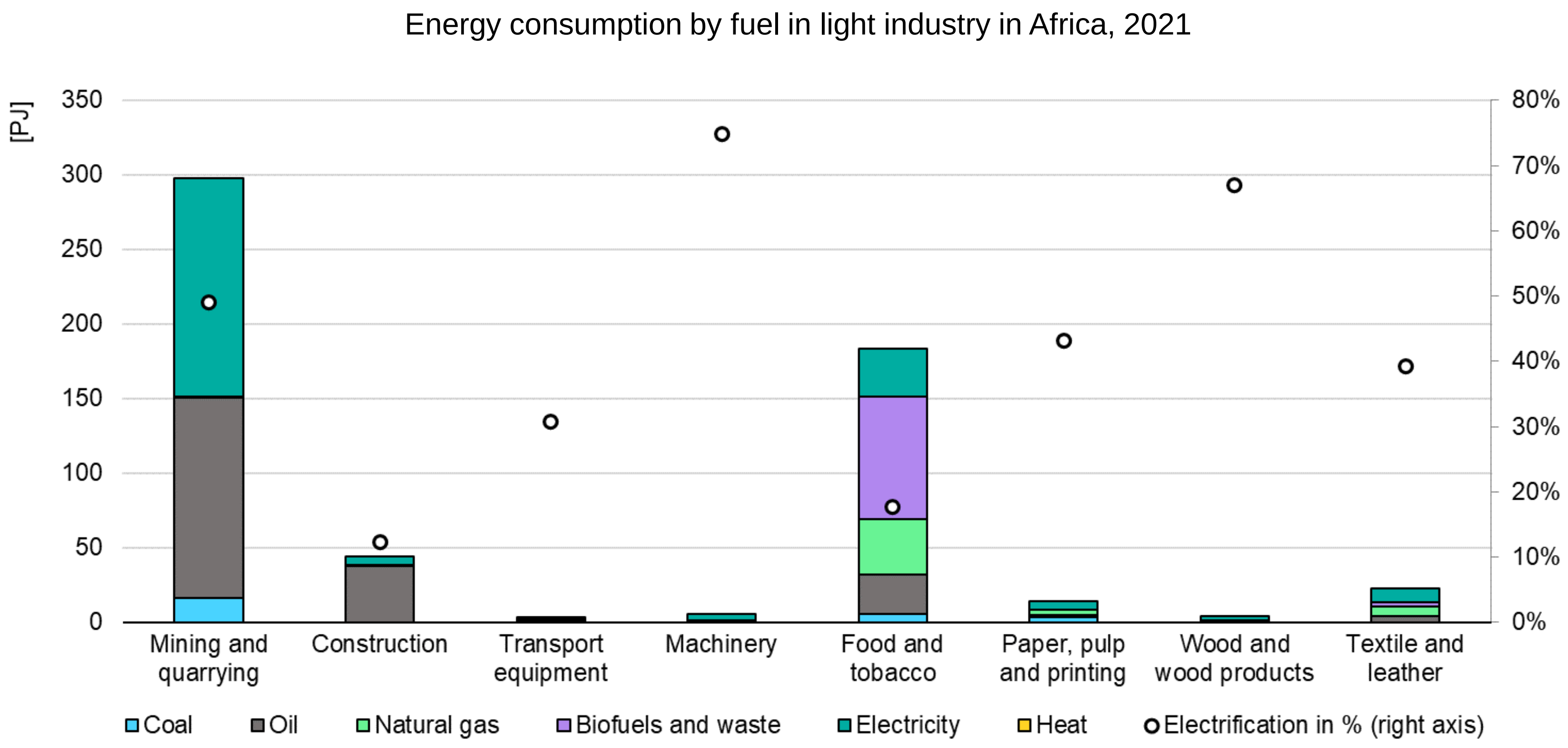
Energy consumption in industry in Africa by sub-sector, 2021



Energy consumption in light industry in Africa, 2021



An overview on African Industry



Instructions

- You have been asked to develop a new industrial energy efficiency programme.
- Working in your allocated group prepare a presentation from your group to your manager. The presentation should be no more than 5 minutes in length. Visual aids such as PowerPoint slides and/or flip charts may be used.

SECTORS

- Mining
- Food processing
- Textiles
- Pulp and Paper

Instructions

- In your presentation, consider to the following questions:
  - What is your programme objective?
  - Why are you targeting your sector?
  - Which stakeholders would you consult and involve?
  - What measures would you include in your programme? (i.e. Regulation, Information and Incentives)
  - What challenges might you face and how will you overcome them?
  - How will you gather data and report progress?
  - How will implement the program to address the inclusive transition?

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Indicators, evaluation & scaling up

Patrick Crittenden, Sustainable Business Group & Corine Nsangwebusinge, IEA

Nairobi, 20 March 2024

Link between training content and objectives

How to make the case for industrial energy efficiency policy →

How to select and design the best measures →

How to implement →

How to evaluate and scale-up →

Develop your skills & knowledge

to deliver

industrial energy efficiency policies & programmes

Learning outcomes

This session will focus on developing your capabilities to:

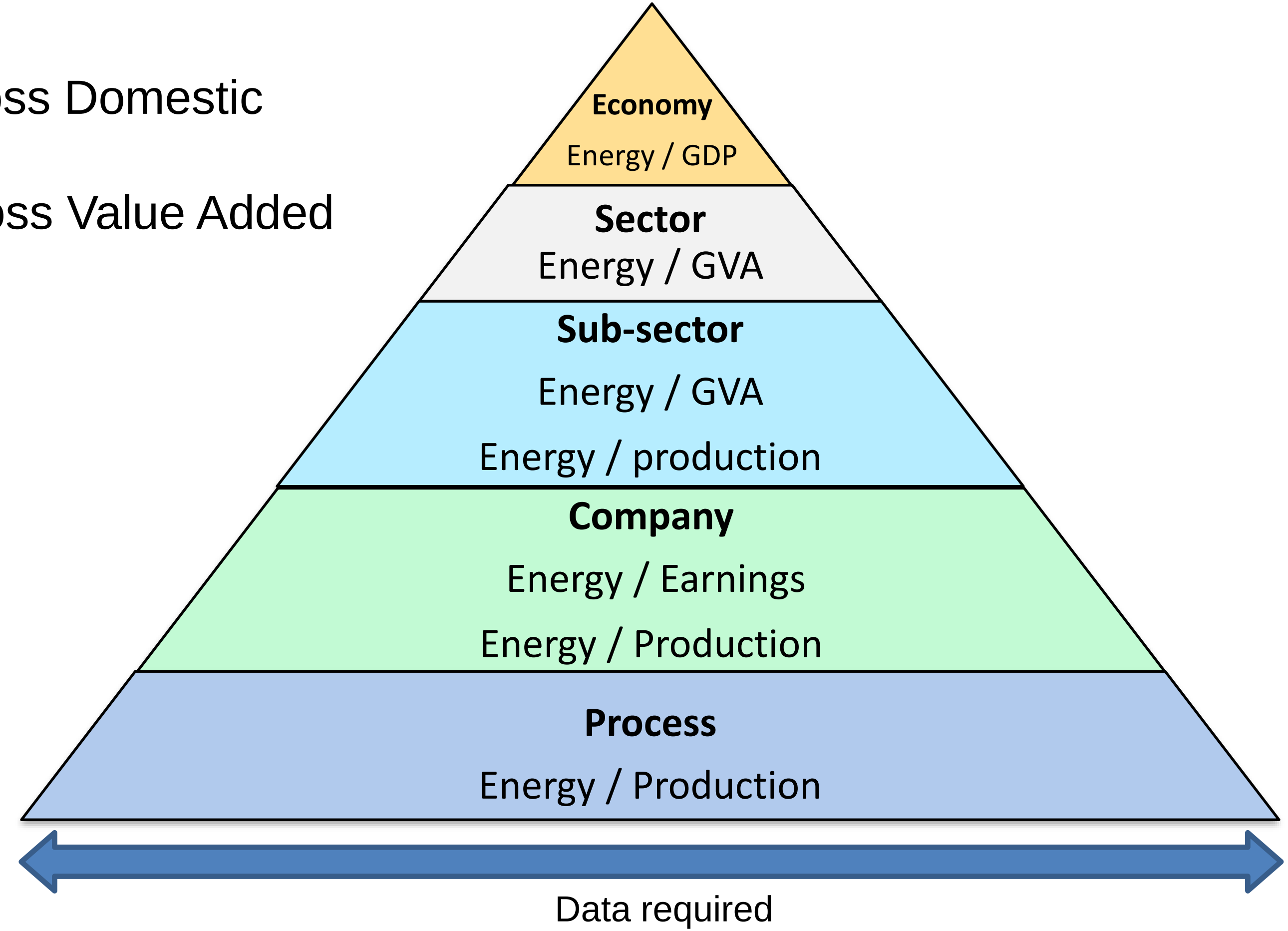
- Understand energy efficiency indicators and how they can be used
- Plan, implement and supervise industrial energy efficiency programme evaluations
- Differentiate between different types of programme impacts
- Draw conclusions from evaluations and communicate the results
- Use evaluation to inform options to expand the scale and reach of successful programmes

Data and indicators underpin policy evaluation

- Establish metrics to track progress and evaluate effectiveness
- Allow for objective judgement of policy/programme
- Data required should be established at start of programme
- Structured collection process is necessary
  - Company reporting is essential
- Provides evidence of policy benefits for other countries

Indicators can be developed at different levels

GDP - Gross Domestic Product
GVA – Gross Value Added



What is an evaluation

- A systematic and **objective** assessment of an ongoing or completed project, programme or policy, its design, implementation and results

- The aim is to determine the relevance and fulfilment of **objectives**, **efficiency**, **effectiveness**, **impact** and **sustainability**

Why evaluate?

- Document and report results and benefits
  - Meet requirements
  - Gain support for programme continuation or expansion
  - Get more companies to participate in the programme
- Identify ways to improve current and future policies or programmes
- Support energy demand forecasting and resource planning

Types of evaluation

- Impact evaluation asks the question: ”what happened?”
  - Includes direct and indirect benefits, energy and demand savings, multiple benefits
- Process evaluation asks the questions: ”what was done and how did we do”
  - Includes operations and scope for improvements, satisfaction levels, participatio
- Cost effectiveness evaluation asks: ”what impact did we have relative to our investment?”
- Market evaluation asks the question” ”what happened in the market?”
  - Including how supply of energy efficiency technologies and services has been affected)

Typically evaluations combine impact + process + cost effectiveness.

Steps in an evaluation

Secure resources (should be done at the outset of the programme)

1. Set the objective and review needs
   - Which audience(s)
   - What are the evaluation questions
   - What do we know
   - What do we need to find out
   - How will we source data

2. Terms of reference

3. Select who will carry out the evaluation

4. Manage the development of the evaluation design
   - Methodologies
   - Scope, boundaries

5. Manage the development of the evaluation work plan

6. Manage the implementation of the work plan, including the production of report(s)

   - Data collection, analysis, synthesis, interpretation

7. Use results, disseminate report and support use of the evaluation

Evaluation examples – assessing net benefits

Ireland SME programme 2007 - 2010	
Participants	1470
Public budget	USD 1.3 million
Average energy reduction per company	10%
Cost per kWh saved to 2020	USD 0.020
Cost per kWh saved to 2030	USD 0.008
Value emission abatement to 2020	USD 44 million
Value of emission abatement to 2030	More than USD 88 million
Emissions abated to 2030	Almost 1800 ktCO_2
Net benefit to society in 2020	USD 178 million
Net benefit to society in 2030	USD 425 million
Net benefit per USD 1 spent by authority to 2020	USD 16.5
Net benefit per USD 1 spent by authority to 2030	USD 36

Evaluation examples – Small incentives big results

Swedish energy management programme 2004-2009	
Participants	100
Tax exemption value	EUR 15 million/year
Expected annual electricity savings	0.6 TWh
Achieved annual electricity savings	1.45 TWh
Measures implemented	1247
Private investment	EUR 70 million
Value of electricity saved per year	EUR 70 million

Link

Scaling up

What does scaling up mean?

- Same sector more companies
- Same companies more implementation
- Same approach different sector
- Same approach more companies
- Using lessons learned to develop new approach to reach more companies and get more implementation
- New and innovative approaches for bigger coverage & greater efficiency

What is the end goal?

- Mainstreaming industrial energy efficiency - to business as usual – and no need for industrial energy efficiency programmes

Perform, Achieve, Trade (PAT) in India

- During first programme cycle, all sectors over-achieved their targets
  - 400 companies from 8 sectors
  - Energy use reduced by 5.3%, target was 4.1%

- Based on results PAT programme now being expanded for 2nd cycle
  - More companies and sectors (621 corporations from 11 sectors)
  - Financial support to encourage greater implementation

After the evaluation – scaling up

Your evaluation shows that your pilot programme is successful and cost effective. You have covered 32 companies and 8% of national industrial energy use. What will you do next?

Upscaling or new approaches to scale up savings

- Standardised projects and solutions
- Integrated programmes
- Streamline admin.
- Energy management for SMEs
- Energy efficiency networks
- Build on successes and expand

- Regulatory approaches - limits, targets
- Remove regulatory barriers
- Make it mandatory

- Project portfolios for investors
- Risk sharing mechanisms
- Energy service companies
- Innovative finance mechanisms
- New business models
- Services instead of energy

- Long term industry technology roadmaps
- Industrial ecology, eco-industrial parks
- Information Communication Technologies
- Promote structural change

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Review

Patrick Crittenden, Sustainable Business Group & Corine Nsangwebusinge, IEA

Nairobi, 20 March 2024

Review and reflect on what you have learnt

INTERACTIVE ACTIVITY

- Form groups .
- Discuss:
  - What session was most useful to you?
  - What would you like to hear more about?
  - What are the top 3 learning points or ‘takeaways’ for you from the training overall?
- We will then go around the room and have everyone share 1 of their learning points.

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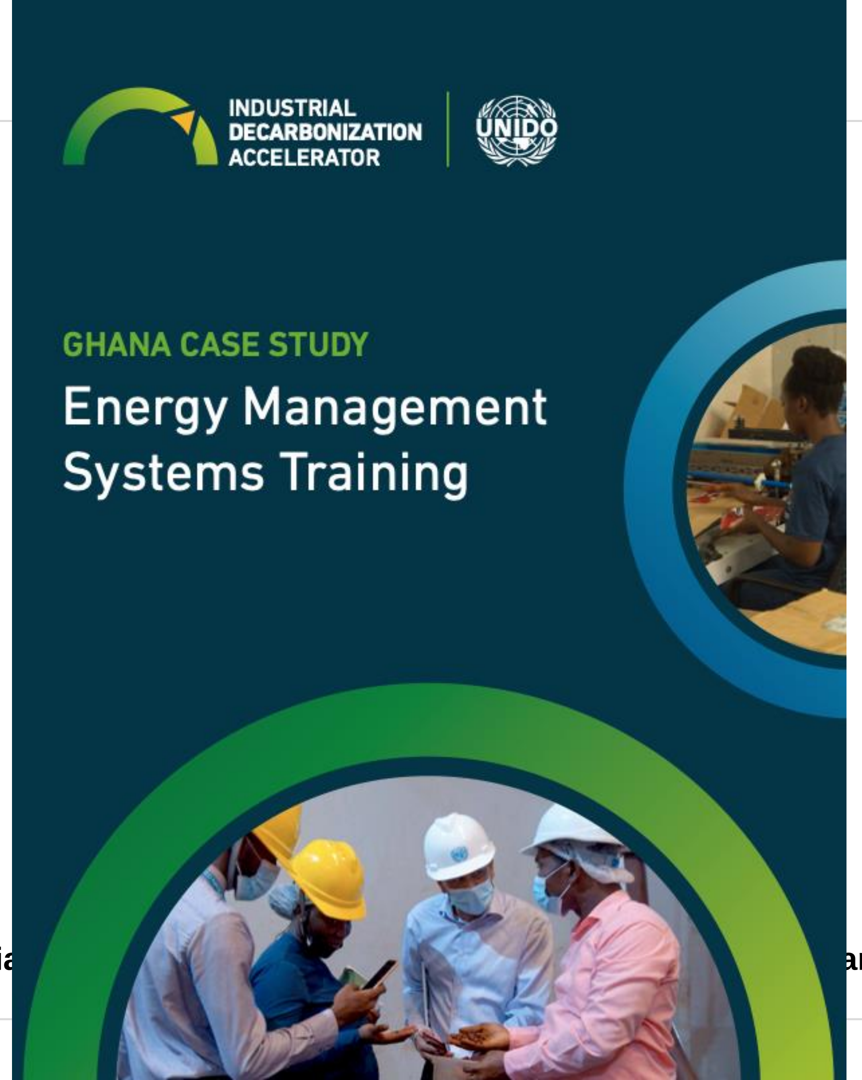
Extra Cases

Patrick Crittenden, Sustainable Business Group

Nairobi, 18 March 2024

Ghana

Case Study



Ghana

https://www.industria **ana_Case-Study.pdf**

Case Study

INDUSTRIAL ENERGY EFFICIENCY PROJECT IN GHANA

Energy Management Systems (EnMS)

CASE STUDY

INDUSTRIAL DECARBONIZATION ACCELERATOR | UNIDO

Cocoa Processing Company Limited
Tema Industrial Area, Ghana

Company size (personnel)
Large
(100 or more)

Sector
Cocoa beans processing into finished and semi-finished products

Utility intervention
Electricity, diesel

Year joined project
June 2021

Date of implementation	Duration
October 2021 to September 2022	12 months

Electrical energy split across CPC plants

Confectionary 36%
Cocoa plant 2 52%
Packaging 2%
Cocoa plant 1 10%

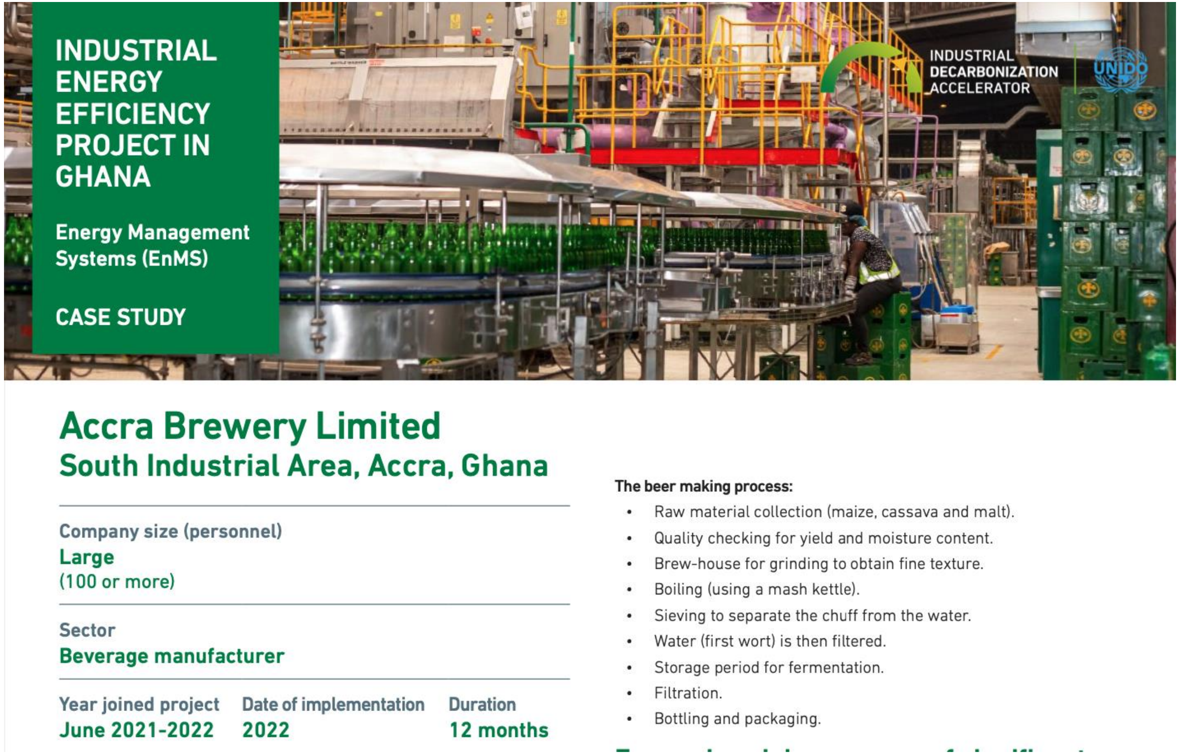
Figure 1: Energy use split across CPC's plants.

Industrial energy efficiency capacity

Ghana

https://www.industrialenergyaccelerator.org/wp-content/uploads/Ghana_-CPC_case-study-April_2023-1.pdf

Case Study


INDUSTRIAL ENERGY EFFICIENCY PROJECT IN GHANA

Energy Management Systems (EnMS)

CASE STUDY

INDUSTRIAL DECARBONIZATION ACCELERATOR

UNIDO

Accra Brewery Limited
South Industrial Area, Accra, Ghana

Company size (personnel)
Large
(100 or more)

Sector
Beverage manufacturer

Year joined project	Date of implementation	Duration
June 2021-2022	2022	12 months

The beer making process:

- Raw material collection (maize, cassava and malt).
- Quality checking for yield and moisture content.
- Brew-house for grinding to obtain fine texture.
- Boiling (using a mash kettle).
- Sieving to separate the chuff from the water.
- Water (first wort) is then filtered.
- Storage period for fermentation.
- Filtration.
- Bottling and packaging.

CASE STUDY


Ghana

https://www.industrialenergyaccelerator.org/wp-content/uploads/Ghana_ABL_case-study-April_2023.pdf

Case Study

Fanmilk Limited
North Industrial Area, Accra, Ghana

Company size (personnel)
Large
(100 or more)

Sector
Food processing company

Year joined project	Date of implementation
June 2021	2021

The bulk of energy comes from electricity from the grid.

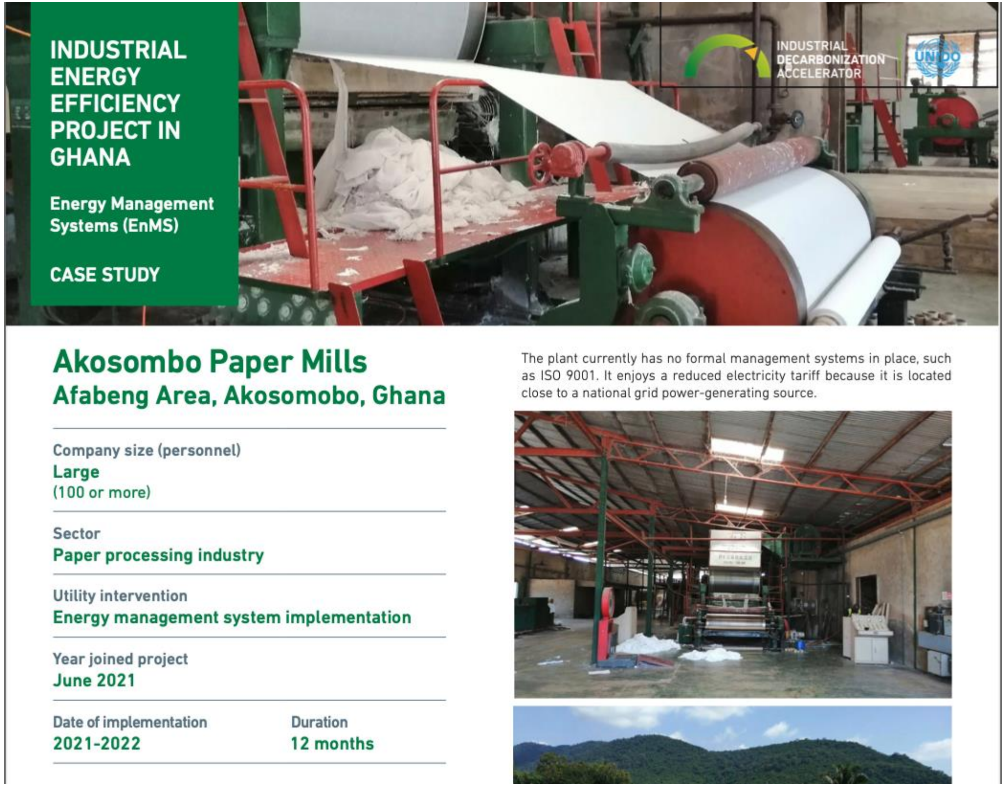
The significant electrical energy users (SEUs) are shown in the graph below (miscellaneous includes the heat pump, motors and pumps). The significant biomass energy user is mainly the steam boiler (figure 1).

Significant energy users

Ghana

https://www.industrialenergyaccelerator.org/wp-content/uploads/Ghana_Fanmilk_case-study-May_2023.pdf

Case Study



INDUSTRIAL ENERGY EFFICIENCY PROJECT IN GHANA

Energy Management Systems (EnMS)

CASE STUDY

Akosombo Paper Mills
Afabeng Area, Akosomobo, Ghana

Company size (personnel)
Large
(100 or more)

Sector
Paper processing industry

Utility intervention
Energy management system implementation

Year joined project
June 2021

Date of implementation	Duration
2021-2022	12 months

The plant currently has no formal management systems in place, such as ISO 9001. It enjoys a reduced electricity tariff because it is located close to a national grid power-generating source.

Ghana

https://www.industrialenergyaccelerator.org/wp-content/uploads/Ghana_case-study-5_2023_Akosombo-Paper-Mills_final.pdf

Case Study

INDUSTRIAL ENERGY EFFICIENCY PROJECT IN GHANA

Energy management System (EnMS)

CASE STUDY

INDUSTRIAL DECARBONIZATION ACCELERATOR

UNIDO

Niche Cocoa Industry Limited
Tema, Ghana

Sector
Food processing industry

Location
Free Zones Enclave, Tema, Ghana

Date of implementation
2021—2022

Duration
15 months (June 2021 to August 2022)

Utility intervention
Energy management system (EnMS) implementation. Compressed air and chiller plant optimisation.

The simplified process employed at Niche's cocoa processing facility is described below.

> The cocoa beans are transported from the storage warehouse, where they are cleaned and other materials are removed from the raw material. Stones and ferrous material are removed. The cleaned beans are then pre-dried and winnowed to remove the shells from the nibs. These are then roasted, and ground to produce cocoa liquor.

> The cocoa liquor is further processed and then packed in cartons for distribution. Some of the cocoa liquor is pressed to extract the cocoa butter. The residue is a solid mass, or cocoa cake. This cocoa cake is further processed and packaged for distribution. Some of the cocoa cake is further processed to produce cocoa powder, which is then refined and packaged for distribution. The cocoa butter is removed from the cocoa mass in a controlled manner to produce cocoa butter of various levels of fat. This is then further processed and packaged for distribution.

Energy breakdown areas of significant energy consumption

Annual energy [kWh]

Ghana

https://www.industrialenergyaccelerator.org/wp-content/uploads/Ghana_case-study-3_2023.pdf

Senegal

Case Study – Sustainable cities initiative for Senegal

CASE STUDY | Promoting renewable energy and integrated waste management in sustainable industrial parks | 5

Key partners

The Ministry of Energy: Responsible for the preparation and implementation of sector policies, strategies and standards. It also grants licences and concessions upon the advice of the Commission of Energy Sector Regulation.

The Ministry of Environment and Sustainable Development - Directorate for the Environment and Classified Establishments (DEEC): Responsible for implementing the government's environmental policy and monitoring the actions of organizations working in the environmental sector.

Bureau de Mise à Niveau des Entreprises du Sénégal (BMN): Part of the ministry in charge of commerce and small and medium enterprises. It has a remit to support industrial upgrading activities in Senegal. The BMN selected the ten pilot projects and contributed 50,000,000 FCFA [around US$80,000] as co-financing to the implementation of this project.

Société Nationale d'Electricité du Sénégal (SENELEC): A state-owned electricity company.

Agence d'Aménagement et de Promotion de Sites Industriels (APROSI): Responsible for the management of industrial parks in Senegal.

"We have been operating in Senegal for many years, so other construction companies look at us very closely to see what we are doing. This will influence them. If they see it in our company, they will want to do the same."

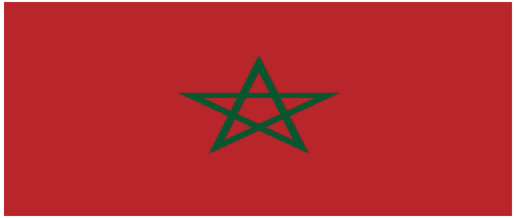
Missira Keita
Head of Sustainable Development at Eiffage Sénégal

"We carried out this project because we understood that it was the only way to ensure the sustainability of the company. On the environmental level it allowed us to manage our waste responsibly, and on the financial level it allowed us to have more control over our production costs and avoid non-quality costs."

Sylla Mariama
CSIP's Deputy General Manager

Senegal

https://www.industrialenergyaccelerator.org/wp-content/uploads/CASE-STUDY_-Senegal_brochure_04.2023.pdf



Morocco

Case Study

CASE STUDY: How 18 Moroccan companies made energy savings of up to 9 %

Accelerating the Uptake of Energy Management Systems by Moroccan Industries

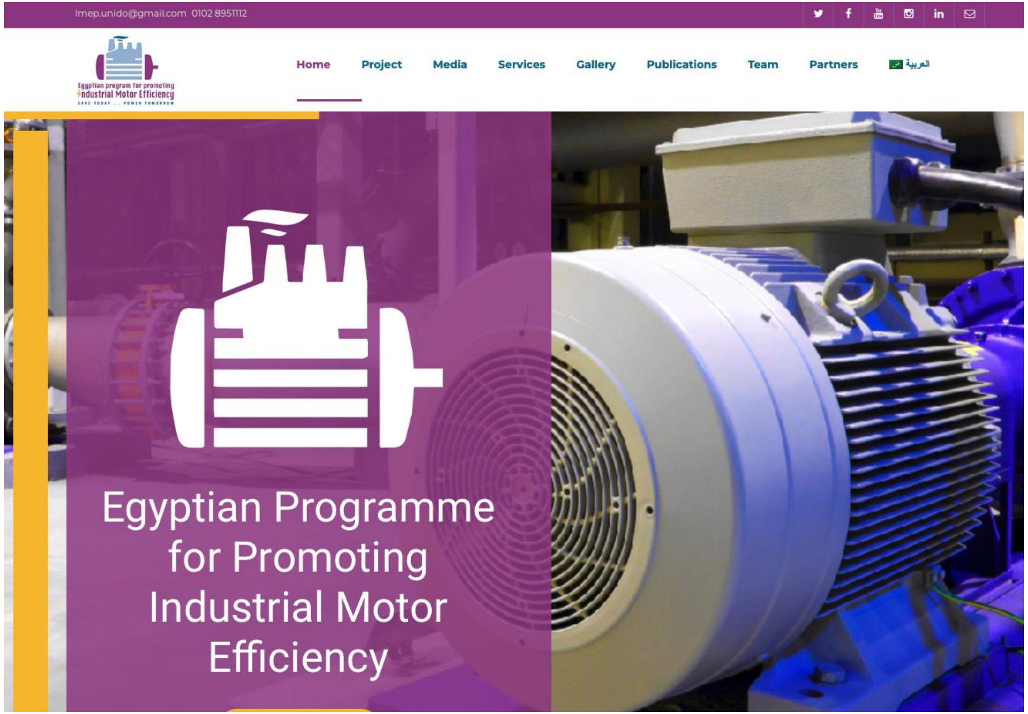
Morocco's industrial sector is on the rise and so is its energy consumption, which has steadily grown over the past years. Helping vital industries – large and small – save and manage energy more efficiently is a national priority for a Government who is determined to reduce its dependency on fossil fuel imports and curb CO2 emissions. Thanks to the training and mentoring provided by the Industrial Energy Accelerator, a group of 18 Moroccan 'flagship companies', 13 energy consultants and nine government officials are now championing an energy efficiency movement across the country and making energy savings.

Morocco

https://www.industrialenergyaccelerator.org/wp-content/uploads/FINAL-WEB-Morocco_Case-Study.pdf

Egypt

Case Study



Egypt

https://www.imeep-eg.org

Case Study

Knowledge is power: widening opportunities for women in energy

Energy can be a notoriously hard sector for women to work in. If we want more sustainable, inclusive outcomes for people and the planet we need to change this. One way to do this is to strengthen the capacity of female engineers to find the solutions needed to decarbonize industry through the use of renewables and energy efficiency measures.

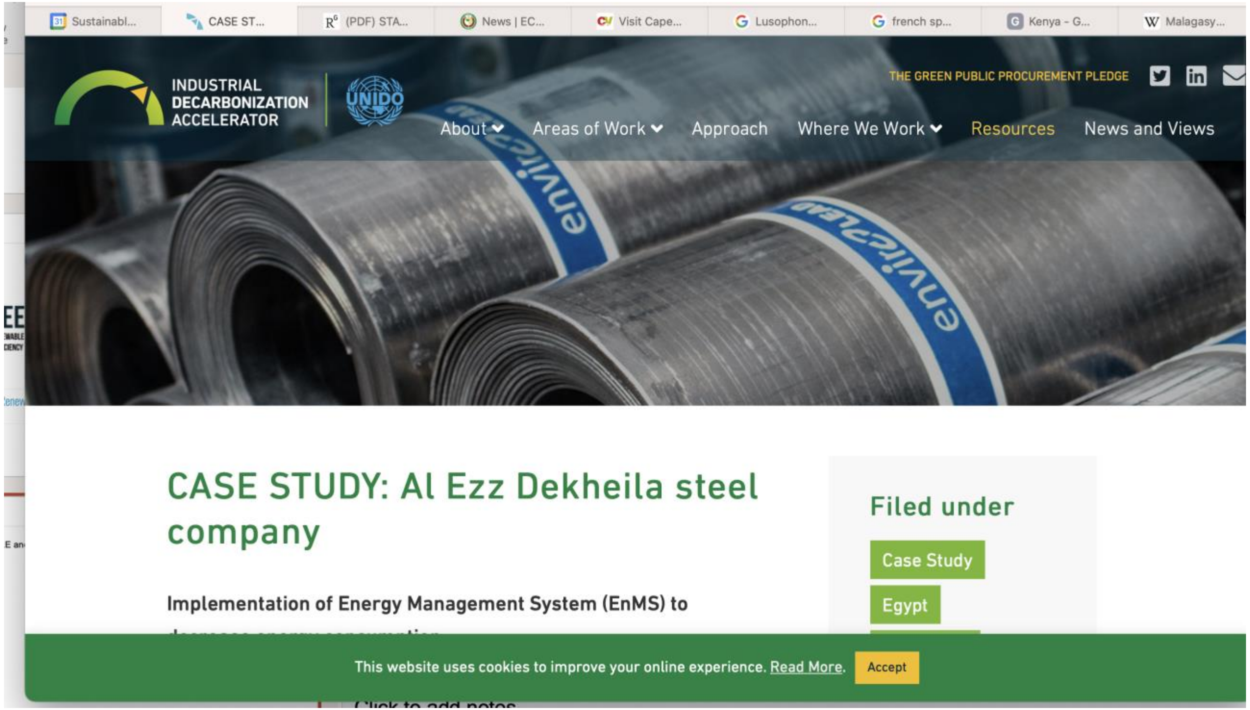
In Egypt, one in five people who participated in UNIDO's introductory course to pump systems optimization, and one in ten of those selected for expert-level training to become UNIDO-qualified experts, were women. These numbers reflect the lower number of female applicants overall. But they represent an important step towards ensuring female engineering professionals get the opportunities and platforms they need to contribute to decarbonization efforts.

CASE STUDY

Egypt

https://www.industrialenergyaccelerator.org/egypt/how-egypts-new-pump-systems-experts-could-save-industry-millions/

Case Study



Egypt

https://www.industrialenergyaccelerator.org/egypt/case-study-al-ezz-dekheila-steel-company/

South Africa

Case Study

EFFICIENCY SOLUTIONS FOR INDUSTRIAL COOLING

CASE STUDY

INDUSTRIAL ENERGY ACCELERATOR

UNIDO

Distell, Adam Tas site

Stellenbosch, Western Cape, South Africa

Sector
Wine Making & Bottling

Intervention
EnMS and system optimization of main cooling plant (primary production)

EnMS and cooling system optimization period
2012-2013

Investment	R956,960
Energy savings per annum	825,760 kWh
Annual financial savings	R700,000
Annual CO_2 emissions reduction	726,133 (kg)
Payback time	1.4 years

CASE STUDY

South Africa

https://www.industrialenergyaccelerator.org/wp-content/uploads/FINAL-13-Jan-case-study.pdf