The decarbonisation potential of construction machinery

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The CO2 contribution of machinery in construction

The political and policy context

- Following the Paris Agreement, the European Commission presented the European Green Deal, a long term strategy to establish Europe as the world's first climate neutral continent.
- This goal will be achieved by reducing net greenhouse gas (GHG) emissions to zero by 2050, with intermediate milestones leading up to that.
- For the **construction sector, the largest contributor to GHG emissions is CO2**.
- Within the European Green Deal, buildings are singled out as a key element in terms of challenges and opportunities.
- It is estimated that through its life-cycle **the built environment accounts** for approximately 40% of energy consumption and **36% of CO2 emissions in the EU**.

The CO2 contribution of machinery in construction

The role of construction equipment

- The CO2 emissions from using the machinery is only a fraction of the overall CO2 emissions from the construction activity.
- Indeed, it is estimated* that **construction equipment contributes to only 0.5%** of the total greenhouse gas emissions in the EU-27.
- CECE supports the objectives of the European Green Deal and the decarbonisation of Europe by 2050.
- Pushing for ever more sustainable development and growth has become a global task and major challenge for the years to come.
- European construction machinery manufacturers are in a leading position in the development of machinery using low or net-zero CO2 energy carriers.

* https://op.europa.eu/en/publication-detail/-/publication/60e67ef3-f68f-42d0-ba3f-afb053704359

The role of Construction Equipment in decarbonising Europe








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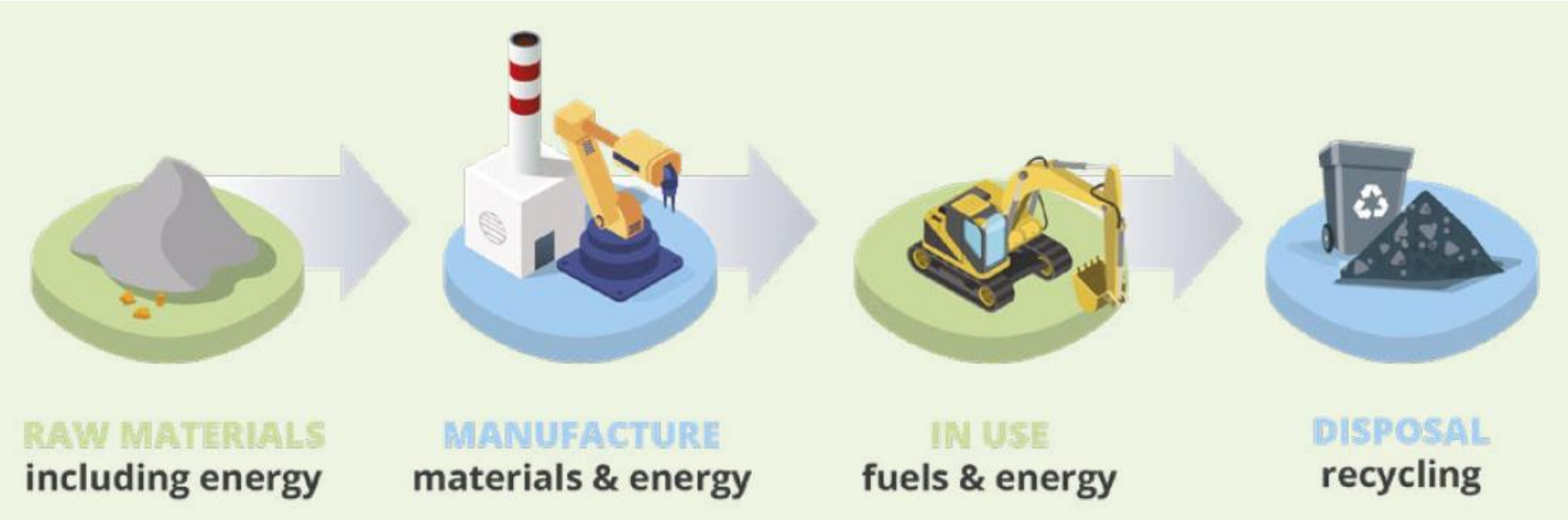
The CO2 contribution of machinery in construction

Facts and figures

Whole life cycle

- To understand the potential of decarbonisation offered by modern machinery, it is important to move from a solely machine-focussed approach to a more holistic view. For a complete understanding of the CO2 emissions from a machine, it is necessary to consider the whole life cycle of construction machinery.



The use-phase for construction machinery

CECE's 4 pillars approach

MACHINE EFFICIENCY

Integration of optimised machine components (e.g. powertrain, hydraulics, tyres...)

OPERATION EFFICIENCY

Operators trained for intelligent machine use, skilled teamwork and effective management

PROCESS EFFICIENCY

Optimal workflow including the choice of best suitable machine or combination of connected machines

ALTERNATIVE ENERGY SOURCES

Use of bio- or synthetic fuels, electric drives, hydrogen, ammonia, etc.

Energy carriers offering low or net-zero CO2 solutions

Classification

For the construction machinery sector, existing and potential energy carriers can be classified as:

- **Hydrocarbon fuels** - that are divided into:
  - ✓ Conventional **fossil fuels** (e.g. diesel, petrol, methane)
  - ✓ **Bio and synthetic fuels** (e.g. biodiesel, ethanol, paraffinic fuels, biomethane, methanol)
- **Non-hydrocarbon fuels** (e.g. hydrogen and ammonia)
- **Electricity** (e.g. stored in batteries or provided via an external cable)

When comparing energy carriers, their contribution for decarbonisation should be assessed on the basis of a full life cycle analysis (e.g considering production, distribution and storage).

Energy carriers offering low or net-zero CO2 solutions

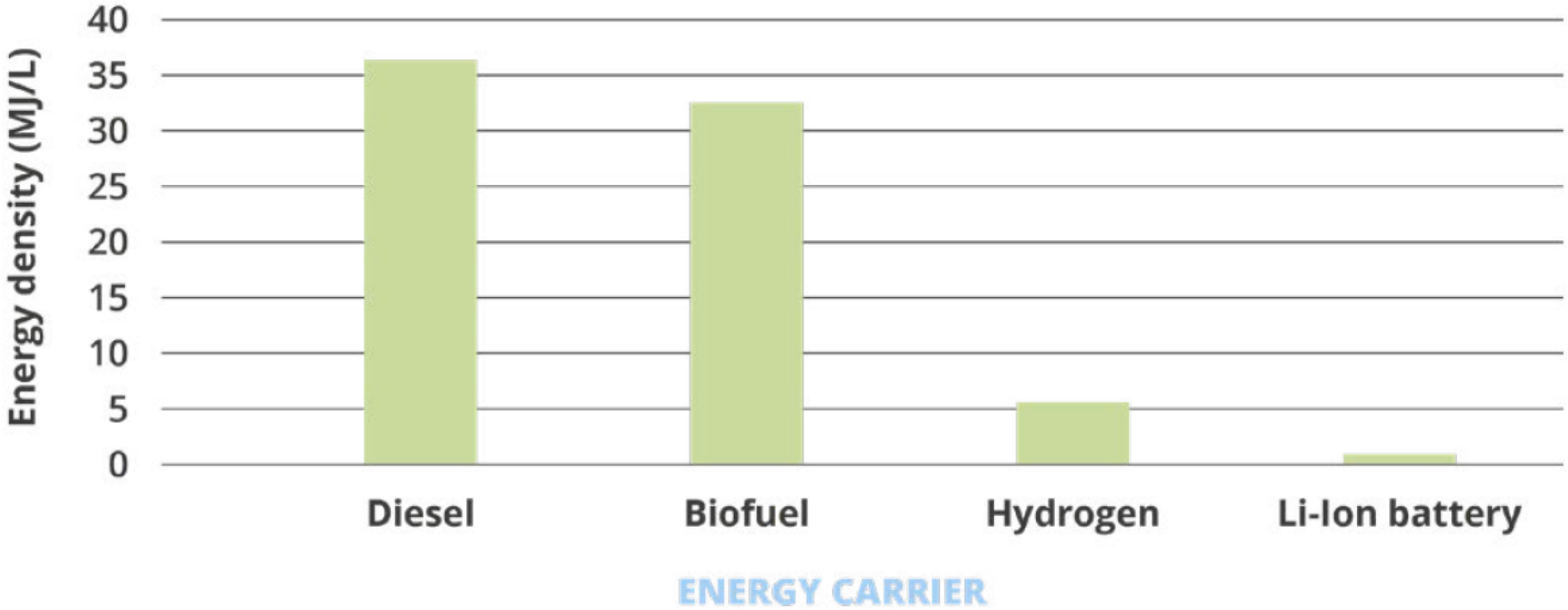
Energy density

Practical considerations

- An important measure of an energy carrier for mobile machinery is its **energy density** - both by volume and by mass, as this factor is critical for design and usage feasibility and the dimension of the storage system.
- As the energy density reduces, the size of the energy storage on the machine must increase to enable the machine to retain the same ability to work, or alternatively, the duration of use of the machine must decrease.
- The carbon footprint (CF) of the energy carriers depends on the origin of the material, extraction, processing, storage, distribution, etc. and each of these carriers can vary from net-zero to very high net carbon emissions.

Energy carriers offering low or net-zero CO2 solutions

Energy density



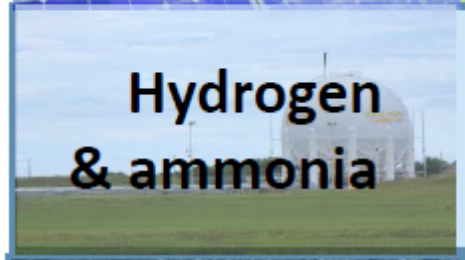
Energy carriers offering low or net-zero CO2 solutions

Technologies for net-zero energy carriers

- The choice of energy carrier plays a key role for decarbonisation.
- The available technologies with the potential of net-zero carbon emissions:
  - ✓ Internal Combustion Engine (ICE) using synthetic or bio-fuels;
  - ✓ Fuel Cell, using hydrogen, plus battery and electric motor;
  - ✓ Battery plus electric motor;
  - ✓ Off-board power supply plus electric motor

A matrix of different energy carriers for net-zero solutions

Energy density matrix

	Challenges	Converter	Examples
 Electricity	Battery size, cost, raw materials and recycling Charging availability and time Connection to supply grid	Electric motor	Low, intermittent energy use; Established sites
 Hydrogen & ammonia	Supply infrastructure High pressure on board storage Cost and availability	Fuel cell or combustion engine	Medium, more continuous energy use
 Bio & Synthetic fuels	Efficiency of synthetic fuel production Material availability for biofuels	Combustion engine	High, continuous energy use; Remote sites

Opportunity for battery electric and hydrogen energy carriers

Low power, low energy consumption, short intermittent use

Limited Opportunity

Greatest Opportunity

Multiple, short term or remote sites

Fixed or long term sites

Least Opportunity

Limited Opportunity

High power, high energy consumption, continuous use

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Technology selection for construction machine applications and uses

Practical implementation

Taking into account those constraints in the use of the electricity and hydrogen carriers it is necessary to consider the broader range of net-zero carbon energy carriers for use in construction activities.

- A high energy consumption, continuous operation task in a remote area requires a high-density energy carrier, that can be efficiently delivered to the site. In this case the solution could be the use of an internal combustion engine with net-zero carbon high density fuel.
- A low energy consumption, intermittent operation task in an urban location could be best served by a battery electric machine using net-zero carbon generated electricity.
- A high energy consumption, continuous operation task on a confined site might need a internal combustion engine and net-zero carbon high density fuel on a remote location, but could use direct electric if the site was located close to a grid substation.
- A high or low energy consumption, continuous or intermittent operation task in multiple, short term or remote sites may still require an internal combustion engine with net-zero carbon high density fuel.

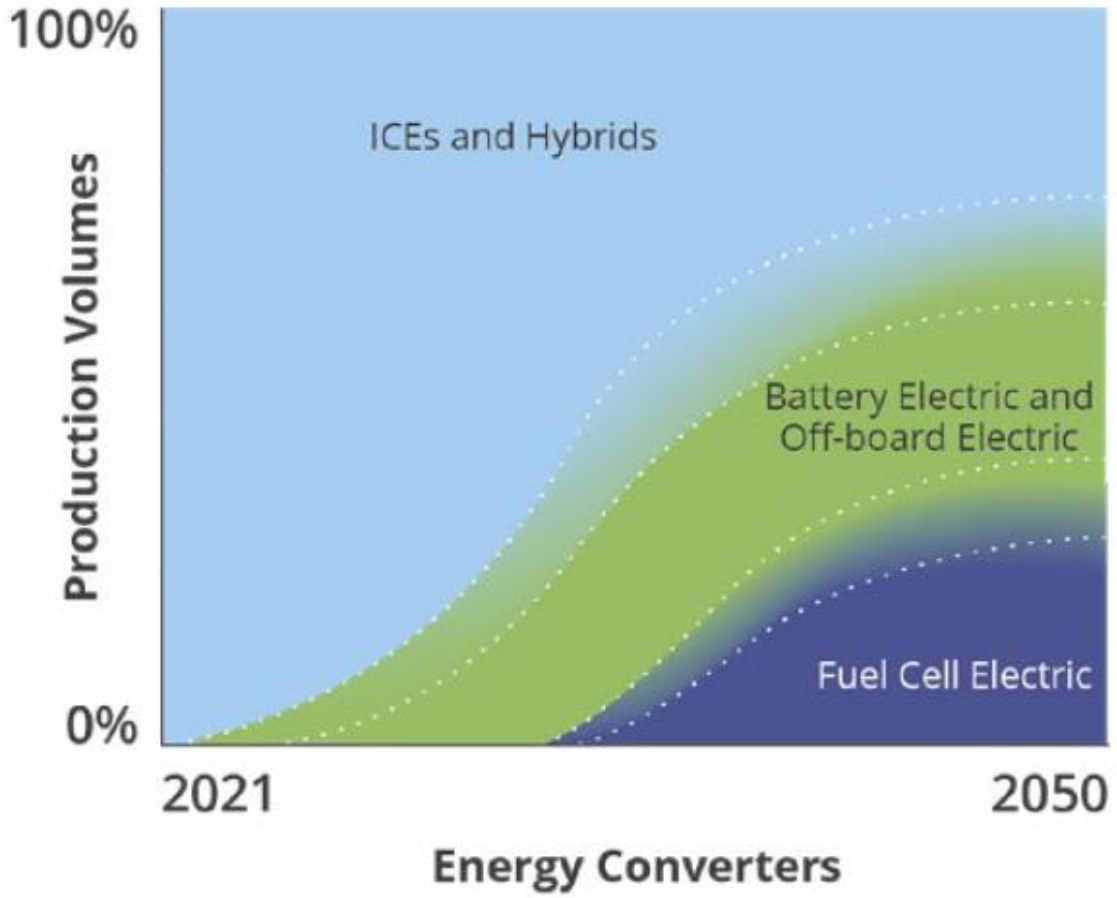
Low or net-zero CO2 enablers

Implementation challenges and how to overcome them

- Produce low or net-zero CO2 **bio and synthetic fuels in sufficient quantities.**
  This is relevant for use in high energy consumption/continuous operation on remote sites but can also play a significant role in the decarbonisation strategy of the legacy fleets.
- **Produce hydrogen** with low or net-zero CO2 footprint **in sufficient quantities** and install effective distribution network.
- **Install sufficient** low or net-zero CO2 **electrical generating capacity and high power distribution network** to support charging of electric battery and the powering of direct electric machines.
- To ensure a **rapid deployment** of low or net-zero CO2 machines, these enablers **need to be industrialised** to give cost-effective solutions for construction activities.
- Long-term commitment to deliver these enablers is necessary for manufacturers and end-users to invest in net-zero carbon construction machinery.

Potential roll-out of energy carriers and converters

Possible timeline



Recommendations

CECE's message to EU policymakers

For a positive contribution of construction machinery to the Green Deal, the EU should:

- Assess decarbonisation of the full life cycle inclusive of the operations involved;
- Be developed in coordination with other regions of the world;
- Ensure the availability of low or net-zero CO2 energy carriers at acceptable costs;
- Incentivise fleet renewal programmes;
- Facilitate decarbonisation of existing machinery by making available low or net-zero CO2 drop-in fuels;
- Develop policy setting technology-independent objectives.

Further information

CECE CO2 position and papers

Please visit the CECE website for further information on the opportunities and challenges of decarbonising the construction equipment fleet:

https://www.cece.eu/environment/co2

Thank you for your attention!

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