

# The Green Energy Ecosystem of the Future

Investing in the new transport energy ecosystem

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SE

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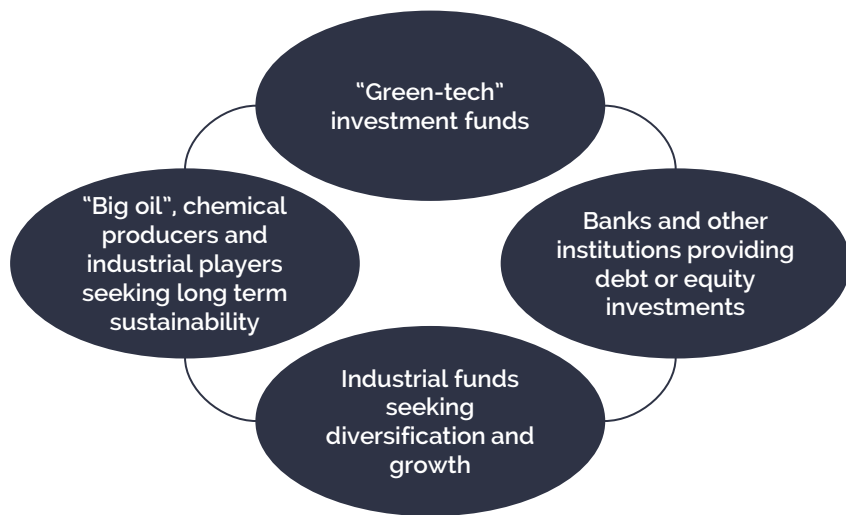
2 An introduction to SE



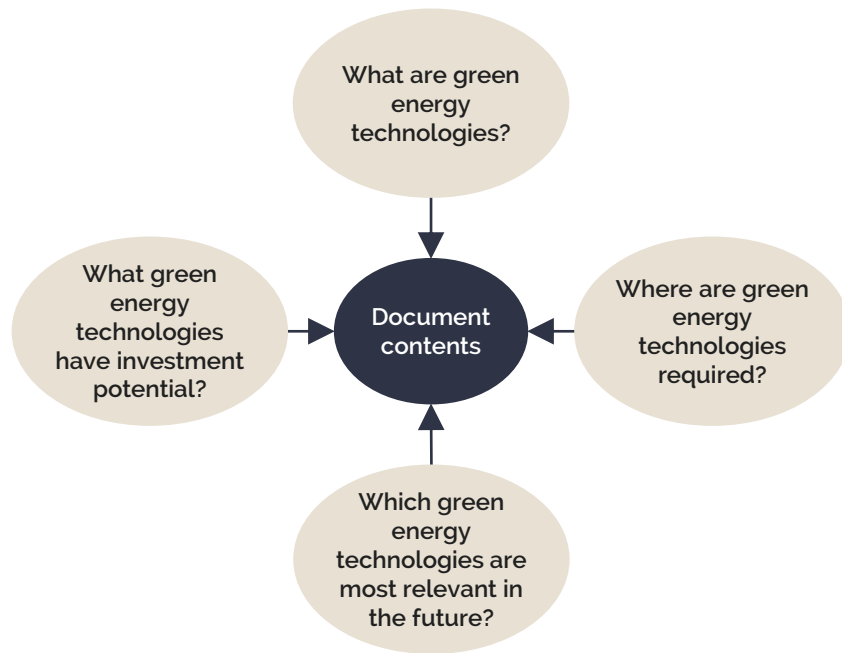
In this document, SE provides a review of green energy technologies and estimates the investment that may be required to meet green energy demand by 2030

## Introduction

Who is the target group of this document?



What questions will be addressed?



# Political and economical factors are changing the energy ecosystem, with decarbonisation and energy independence as the key focus areas



## Current Situation – Climate Change & Energy Independence

A near unanimous declaration of a climate emergency and industry must make it a priority focus

Turbulent political and economic events have raised the profile of energy independence

Because of this, change is no longer evolutionary but has to become disruptive

### Drivers

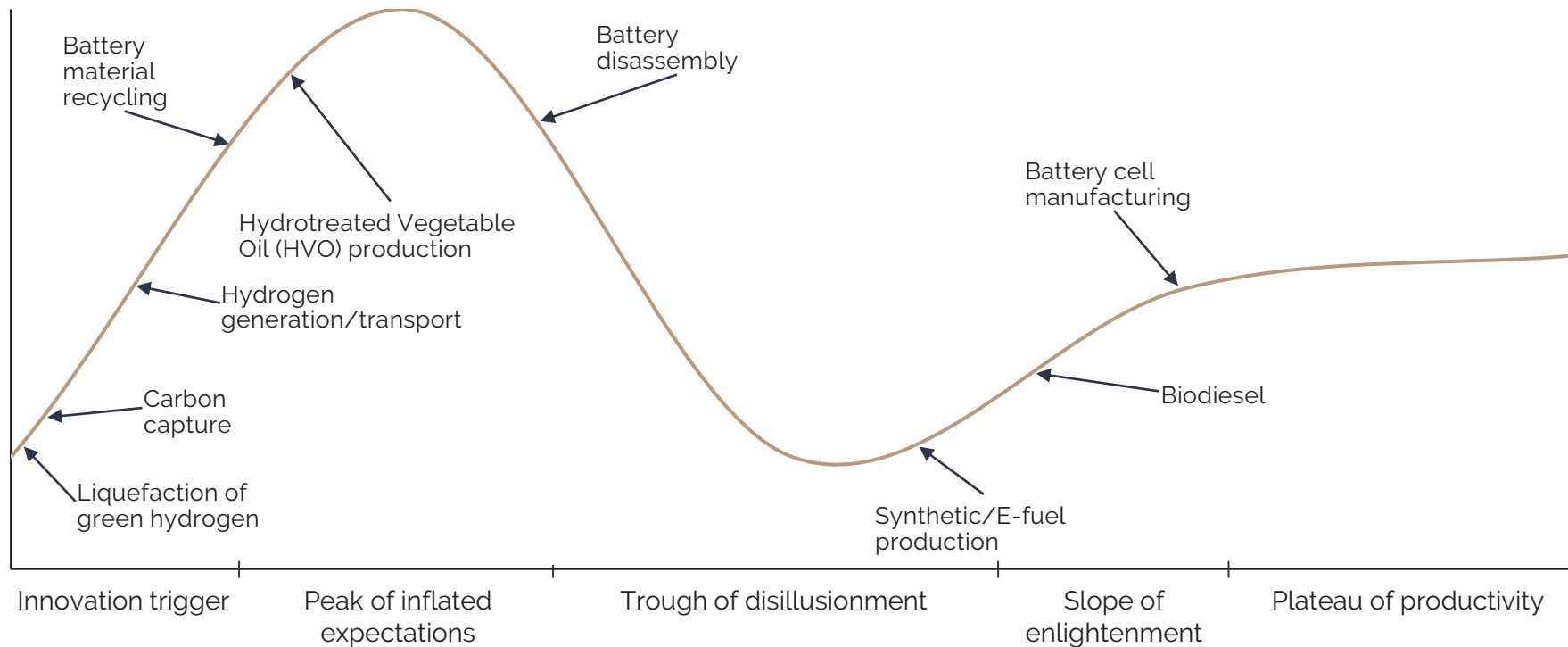
- Climate change, caused by greenhouses gases, is driving a reduction in the use of carbon based fuels across all sectors
- The Paris Climate Agreement seeks to limit the global warming effect to a value considerably below 2°C pre-industrial levels
- The current political and economic environment is changing, the reliance on energy imports has highlighted the importance of energy independence

### Solutions

- Renewable energy generation is at the centre of the decarbonisation shift and will continue to grow until 2030
- Green technologies are required to transfer renewable energy from its production site to the points of consumption
- Four key technologies are emerging
  - Battery
  - Green hydrogen
  - Bioenergy/Biofuel
  - E-fuel / Synthetic fuel

Climate action means that green energy technologies are rapidly passing through innovation trigger points and are progressing through the hype cycle

### Hype Cycle – Growth of Green Commodities



# Four key technologies are emerging for the transfer and consumption of green energy; they also allow energy to be stored for later use



## Green Energy Ecosystem

### Battery



- Batteries store energy at the points of production and use and have potential cross-sector use
  - Propulsion batteries in transport; agriculture; construction; mining; eVTOL; personal mobility
  - Backup power in power generation to be used as peaking power plants
    - For storage of energy when renewable energy production is low
    - For supply of energy when energy consumption is high

### Bioenergy/Biofuel



- Sustainable biofuels are made primarily from waste and residue
- The waste is processed to produce several fuels including hydrotreated vegetable oil, ethanol, methanol or biodiesel
- The fuel can be consumed in internal combustion engines in multiple sectors

### Green hydrogen



- Green hydrogen is hydrogen generated by renewable energy resulting in a zero-carbon fuel
- Hydrogen is transported as compressed gas, liquid or processed into ammonia for transport
  - May become ubiquitous as a green energy storage vector
- Fuel cells and green gas internal combustion engines are used to consume the fuel

### E-fuel / Synthetic fuel



- Hydrogen and carbon are processed via Fischer-Tropsch to produce a liquid hydrocarbon based fuel
- The resultant fuel can be gasoline, diesel, gas, or kerosene
- The fuel is chemically identical to existing crude oil-based fuels and can therefore be easily introduced into existing infrastructure

# Green energy technologies have multi-sector use cases; our assessment of suitability is driven by the use case energy demand and technical alignment

## Green Energy Applications

	Battery	Green H <sub>2</sub>	E-fuel	Biofuel
Automotive	●	●	●	●
Medium duty / commercial	●	●	●	●
Motorcycle	●			
Heavy duty	◐	●	●	●
Construction	◐	●	●	●
eVTOL	●			
Agriculture	◐	●	●	●
Aviation			●	◐
Mining	◐	●	●	●
ebike / Powered two-wheeler	●			
MaaS / AD	●			
Marine		●	●	●
Rail		●		●

AD: Autonomous driving;

● Key application

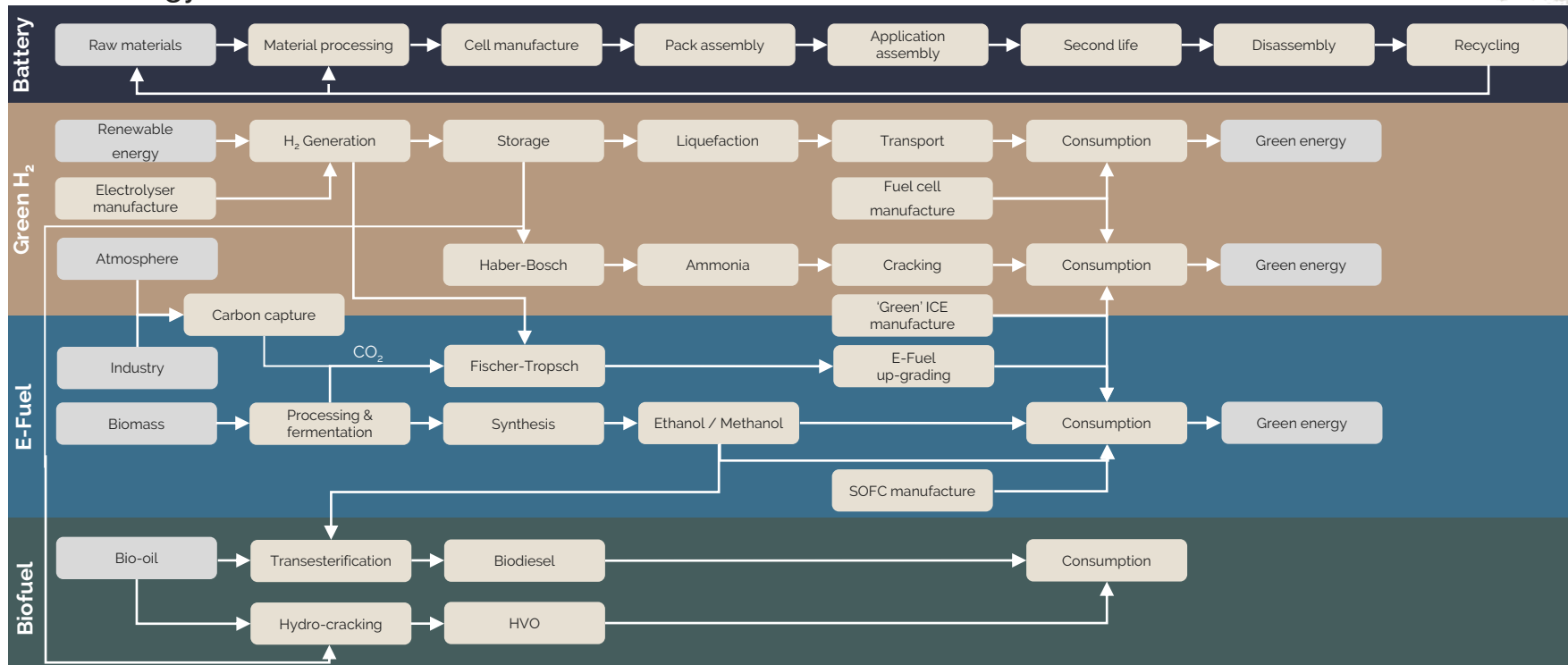
● Suitable application

◐ Suitable application for some use cases

# Decarbonisation in Europe will require investment in every step of a complex energy sector value chain to ensure supply can support demand



## Green Energy Value Chain

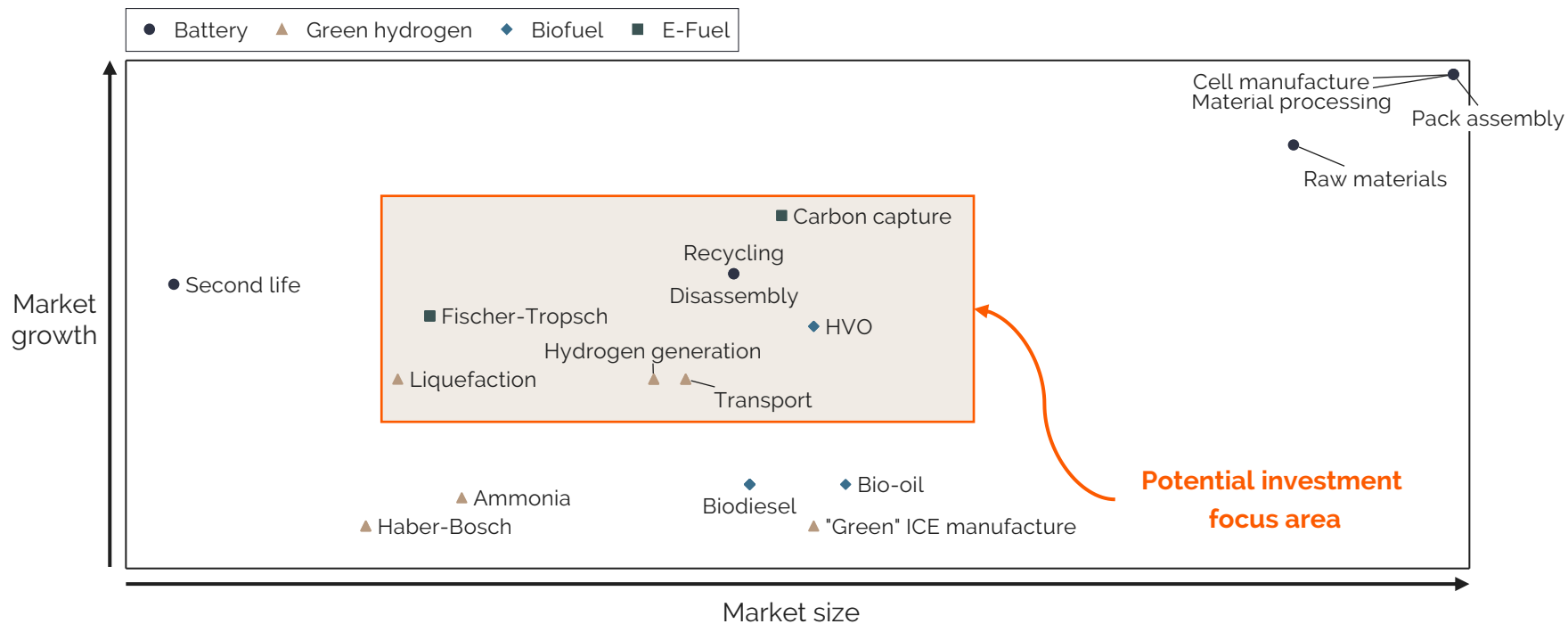




Green energy markets are expected to grow significantly by 2030 with some clear opportunities for investment in high growth potential technologies



## Green Energy Technology Market Size and Market Growth



Early investments in new energy technologies have already been made; liquefaction technology needs to be scaled, requiring major investment...



## Example Investments in Green Energy Technologies

### Battery recycling



Glencore investment in Li-Cycle Holdings

€190  
million

- Glencore will supply Li-Cycle with all end-of-life lithium-ion batteries
- This is a prime example of vertical integration within the battery supply chain
- Technology maturity:

Low |—————| High

### Hydrotreated Vegetable Oil (HVO) production



Brazil BioFuels investment in HVO facility

€300  
million

- The new HVO production facility will be built and is scheduled to open in Q1 2025
- The annual production capacity is estimated at 500 million litres of green diesel
- Technology maturity:

Low |—————| High

### Synthetic/E-fuel production



Porsche investment in HIF Global LLC

€70  
million

- HIF Global LLC is a holding company for e-fuel production in North America, Australia and Chile
- Other partners include Siemens Energy and ExxonMobil
- Technology maturity:

Low |—————| High

### Liquefaction of green hydrogen



Plug Power's investment in Joule Processing LLC

€150  
million

- Joule's cryogenic process technology is to be applied to hydrogen liquefaction
- The liquefaction process will be integrated into Plug Power's in-development green hydrogen plant
- Technology maturity:

Low |—————| High

...however, a full decarbonisation of the European transport system will require significant further investment



## Key Investment Areas for Private Equity to 2030

### Battery recycling



Investment required by 2030

**€18 - €23  
billion**

- Battery recycling is required to bridge the expected raw material supply gap as demand for batteries grows
- SE forecasts that a 60% recycling rate in Europe is required to bridge the supply gap

### Hydrotreated Vegetable Oil (HVO) production



Investment required by 2030

**€7 - €11  
billion**

- “Drop in” replacement fuels desirable in applications where electrification is challenging
- Strong growth in demand is expected in heavy duty applications such as trucks

### Synthetic/E-fuel production



Investment required by 2030

**€23 - €28  
billion**

- Immature technology; investment required to industrialise production
- Strong demand forecast in aviation as current alternative fuel technologies are not compatible with existing operations

### Liquefaction of green hydrogen



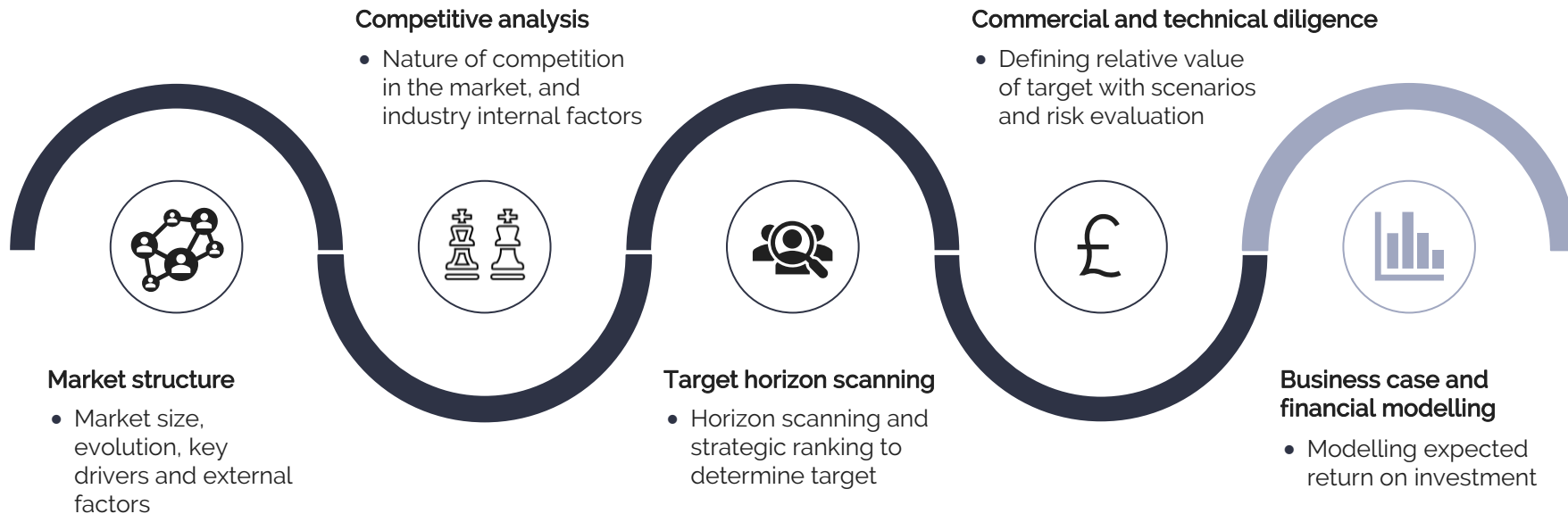
Investment required by 2030

**€9 - €10  
billion**

- Green H<sub>2</sub> will be produced when renewable energy generation is peaking, meaning H<sub>2</sub> production may exceed demand
- This will require safe storage of green H<sub>2</sub> at production location

Our screening and acquisition process provides an in-depth analysis of the risks and opportunities allowing certainty in the final investment decision

## SE Approach to Screening and Acquisition



SE supports investors in green energy technology through expert technology and market insights to diversify investment portfolios, identify new growth opportunities and reduce transaction risk

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SE is an international management consulting firm, specialising in the automotive, mobility and clean energy industries



Who are we?



A unique team of consultants with a technology-driven mindset. Our expertise is in strategic positioning, innovation, transformation, turnaround and cost management



Key topics are decarbonisation, technology and digitalisation  
Award-winning consulting approach and experience

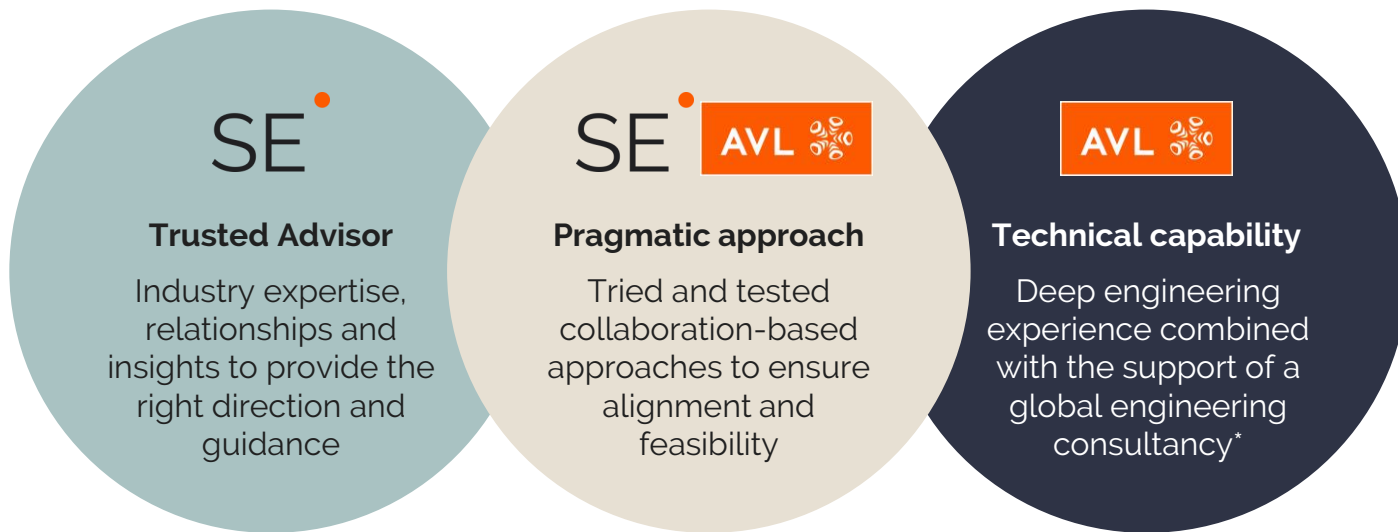


Member of the AVL Group with offices in Germany, UK, China, U.S.

SE provides a unique combination of technical industry knowledge and pragmatic collaboration methods that deliver implementable solutions



## Our Value Proposition



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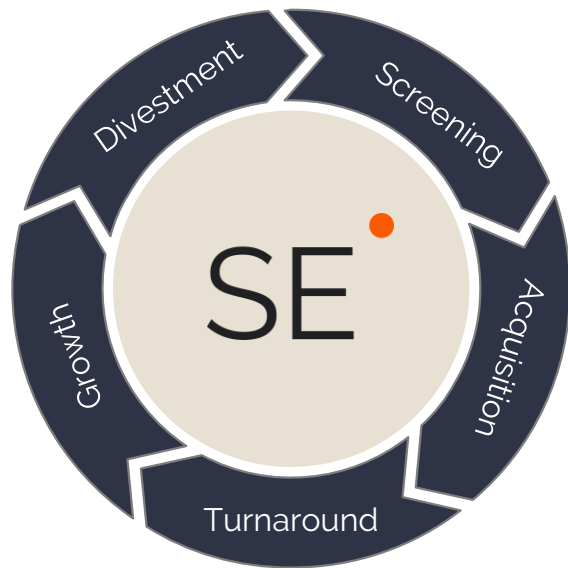
**Your trusted advisor in the transport, clean energy & mobility industries - delivering real implementable solutions**

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\*Strategy Engineers is part of the AVL Group of companies

We understand the investment community and can “translate” technical and engineering insights into actionable language to support investors

## Value Creation Cycle



### Our end-to-end capabilities

- SE supports investors through all phases of the value creation cycle from screening through to divestment
- Areas of expertise
  - Screening: Finding the right targets in the market place
  - Acquisition: Completing due diligence to support evaluation
  - Turnaround: Managing organisational transformation
  - Growth: Driving growth of the business
  - Divestment: Planning and prioritising exit strategies
- Our experience with the investment community allows us to provide actionable insights to drive successful decision in complex and evolving markets

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**We offer end-to-end investor support for all investment and acquisition requirements**

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If you would like any additional information or would like to discuss the contents of this paper, reach out to our experts



### 1. SE guides clients and helps them solve challenges related to revolutionary changes in the mobility and green energy sectors

1. There are a number of fast growing segments within green energy ecosystem that may provide strong returns
2. However, there are also major risks associated with investing in overvalued “bubbles” in the market, or in targets without the requisite technology or market presence
3. A trusted and capable advisor can help you make the right decisions and succeed in your investment goals

### 2. SE is uniquely suited to provide advice you can trust with our leading techno-commercial capabilities and experience

1. Our leading techno-commercial capability combines top strategic management consulting expertise with AVL's technical excellence
  - a) SE offers leading commercial-minded strategic management consulting
  - b) AVL is the world's leading independent engineering service provider
2. We have a unique combined value proposition
3. SE has significant experience delivering successful M&A projects to clients and can be trusted to provide the guidance you need

### 3. You can be sure that SE is the best advisor for clear strategic direction – do not hesitate to speak with our expert authors today



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#### Best Consultants in a row!



# End of Document

Contact us if you have any questions