Creating sustainable solutions for tomorrow's energy challenges. Today.

creas™

ENERGY CONSULTING

The Opportunity of the Energy Transition to Refining and Petrochemical Companies

Kevin Clarke
Chief Executive Officer

Our Services

- Strategy
- Investor Advisory
- Operational Auditing
- Project Development
- Business Acceleration

creas
ENERGY CONSULTING

Our Clients

- Governments
- Energy and Chemicals Companies
- Banks, Investors, Funds
- Small- and Medium-sized technology enterprises

creas
ENERGY CONSULTING

Our Vision

To provide market leading insight and solutions addressing the opportunities of the **Energy and Digital Transitions** to the Downstream Industries.

creas
ENERGY CONSULTING

Energy Transition

The Tension between Electrons and Molecules

creas
ENERGY CONSULTING

- Most efficient use of Energy will drive maximum electrification (from renewable energy)
- Not everything can be electrified
  - Need a plan for handling resulting CO_2 emissions
- "Efuels" are the answer – (green) hydrogen, methanol, ammonia (plus MCH, DME, others)
  - Opportunity to either displace traditional energy intensive fossil-fuel based production (green ammonia to eco-fertilizers, green methanol to olefins)
  - Drop-in replacement for existing fuel applications (green methanol to gasoline, green DME to diesel)
  - An opportunity to ship green energy globally using existing logistics

- Utility companies are trying to move into the Efuel space
- Oil and Companies are trying to move into the Electricity space
- Plenty of space for innovative, disruptive new entrants

- We argue that Refining and Petrochemical companies are best placed for operating in the Efuel arena
  - Track record in handling high temperature/pressure processes, handling and shipping volatile chemicals
  - Existing energy infrastructure platforms (electricity import/export, water, export logistics, fuel supply, storage facilities, etc.)
  - Highly trained personnel (very safety conscious)
  - Already have a license-to-operate complex process facilities registered with national and regional authorities

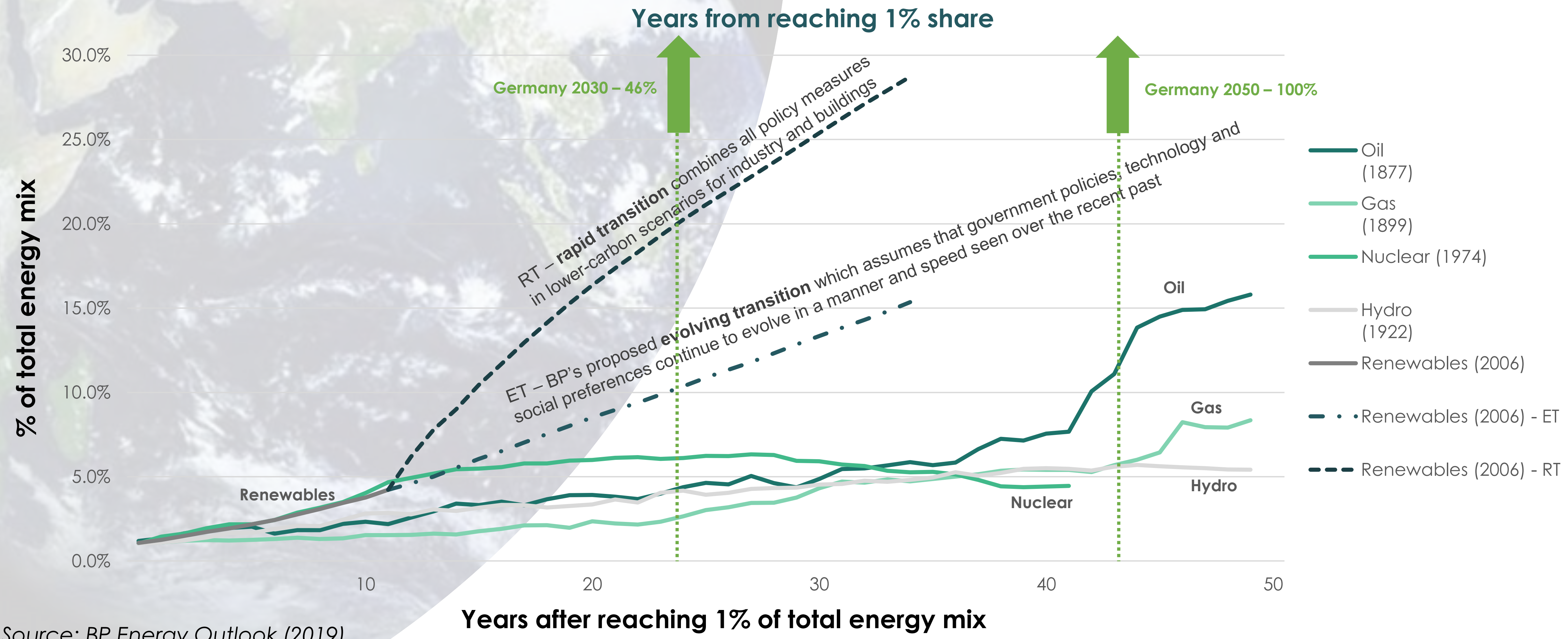
Energy Transition

The Problem with Renewables …

creas
ENERGY CONSULTING

- We need a lot!

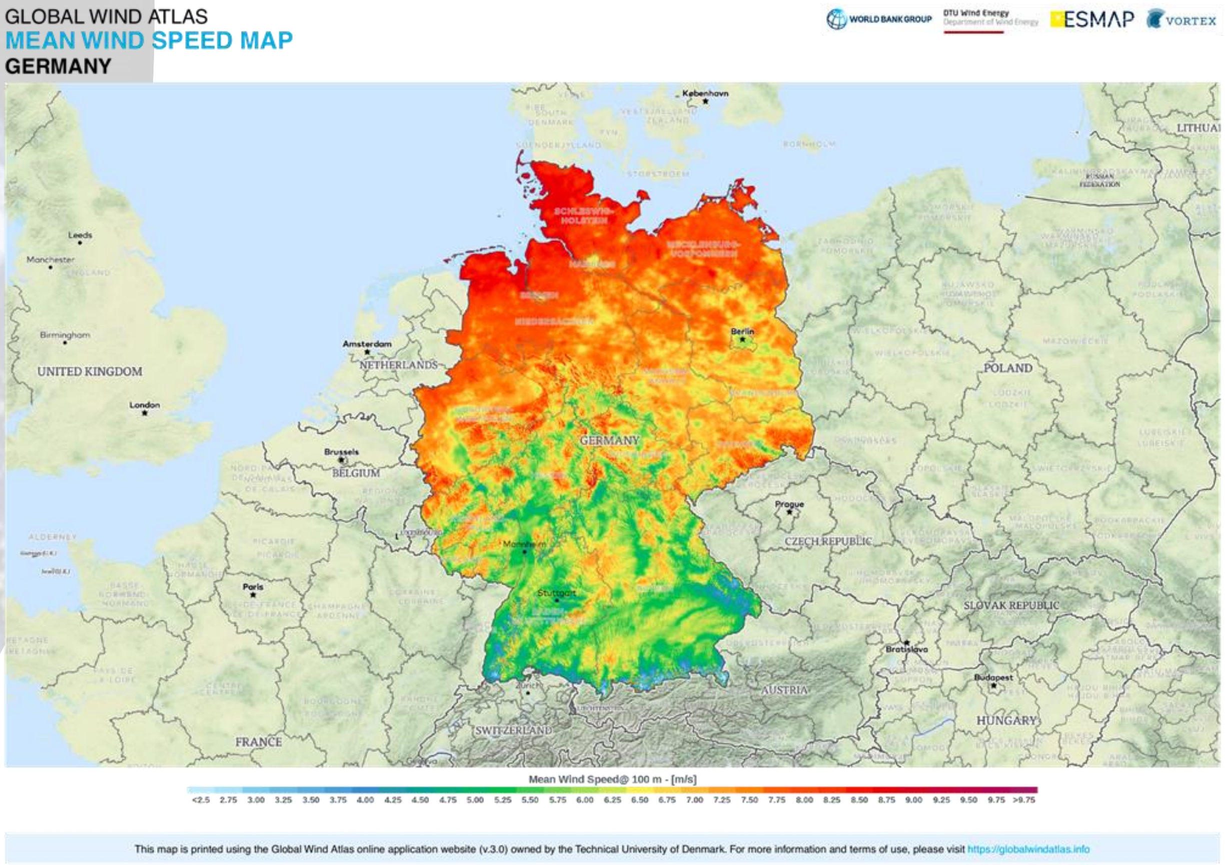
Historical Perspectives:
Speed of penetration of new energy sources in global systems



Source: BP Energy Outlook (2019)

The Problem with Renewables … variability by season and by geography

creas ENERGY CONSULTING



- Solar better potential in the South
- Onshore wind power better in the North

- **No 'one size fits all' solution, optimum renewable mix is geographically dependent**
- **Storage is essential to cope with seasonal variations**

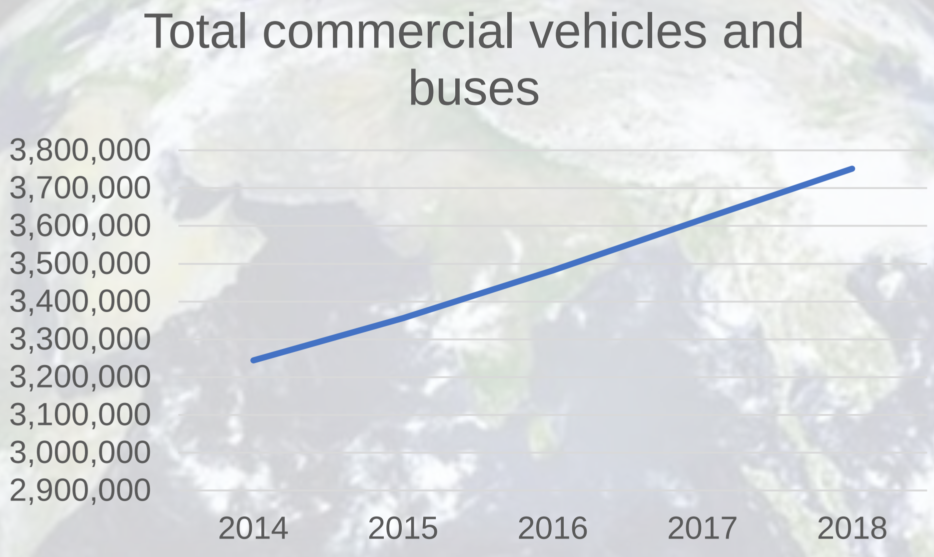
Sources: Solar Atlas / Wind Atlas

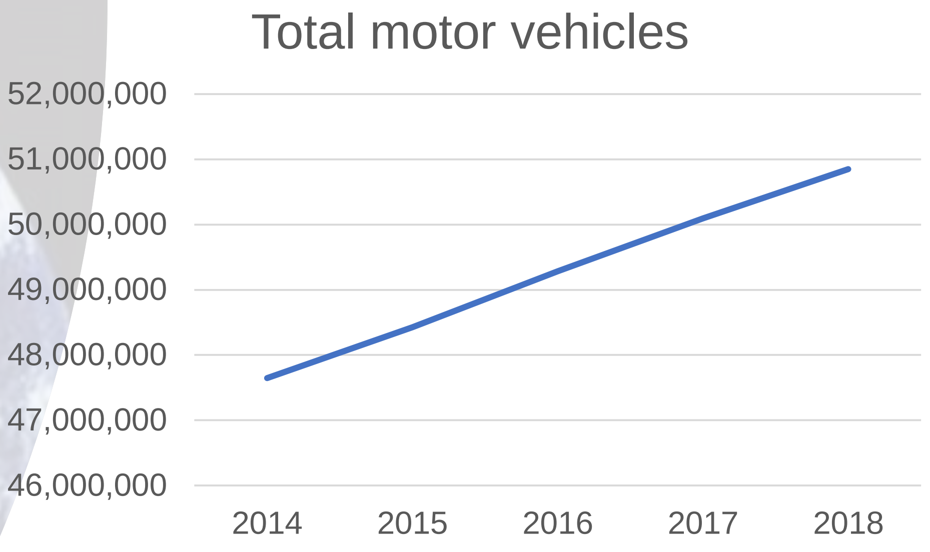
Energy Transition

How fast could the transition be?

creas
ENERGY CONSULTING

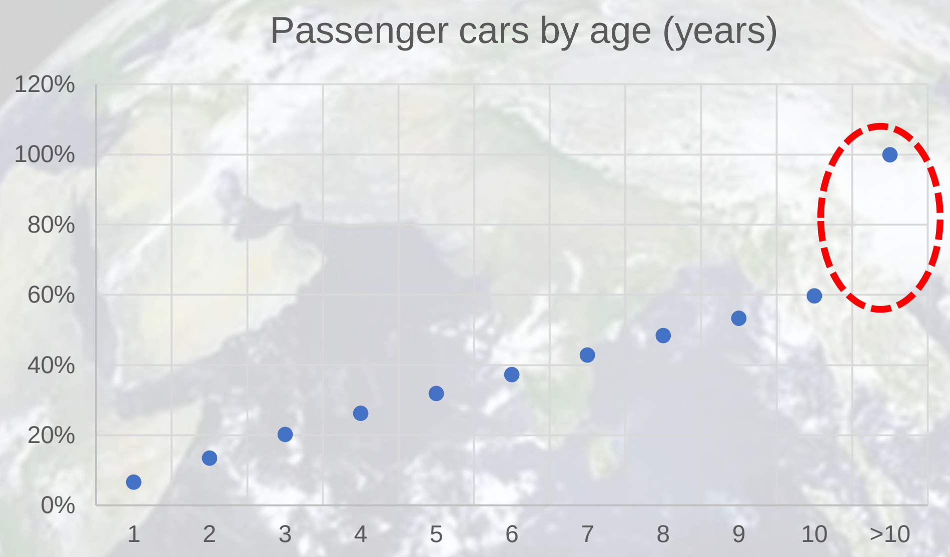
Total vehicle numbers - Germany

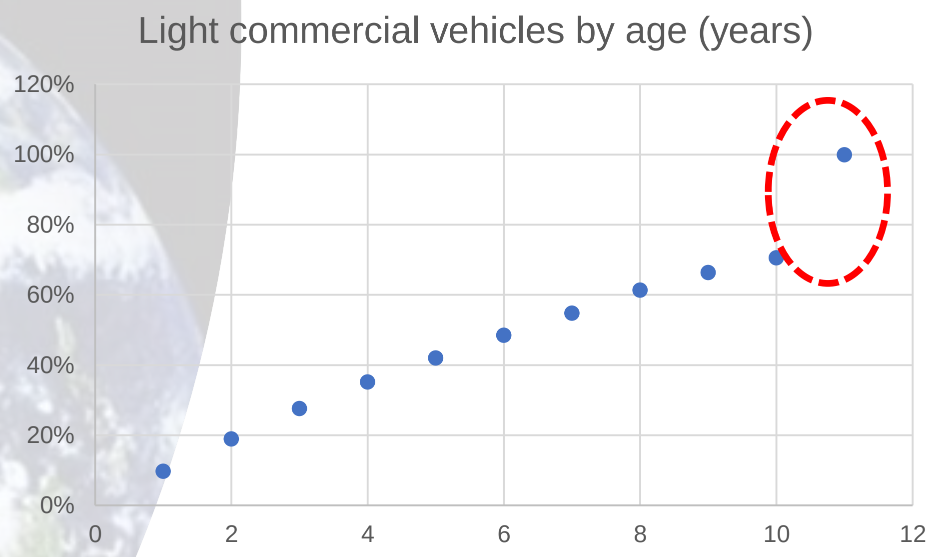


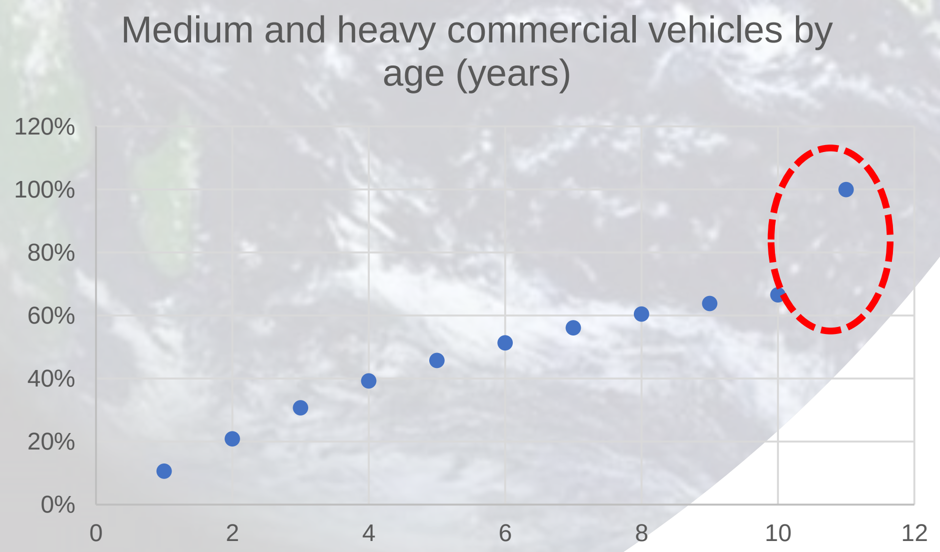


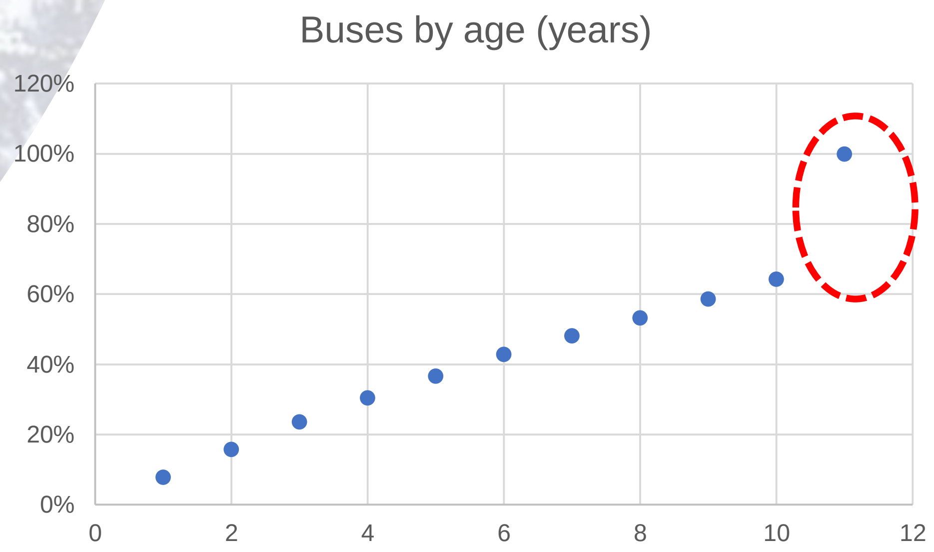
- Recent history shows continuous upward trends for all types of vehicles
- Disruption to this pattern could come from the ban on fossil-fuel based vehicle sales and bans within major cities coming into effect, as well as EU legislation to drive down average carbon emissions of new vehicle sales by each manufacturer

Vehicles by age - Germany



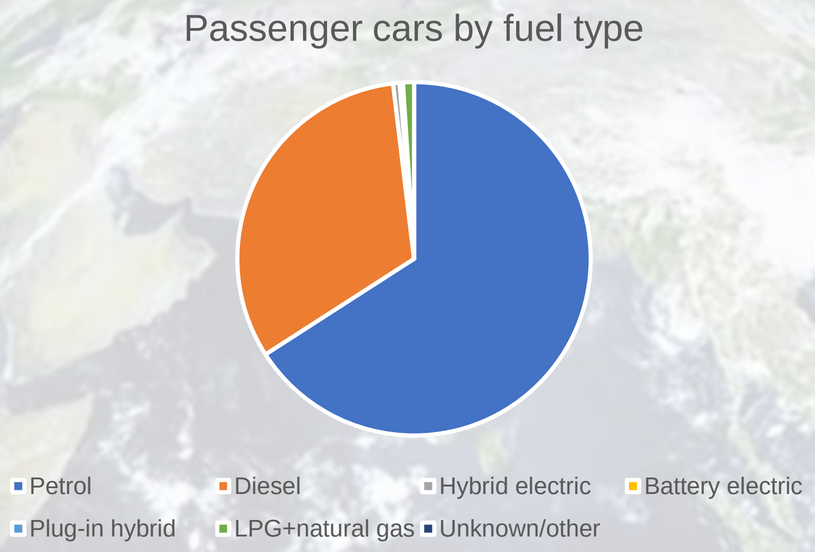


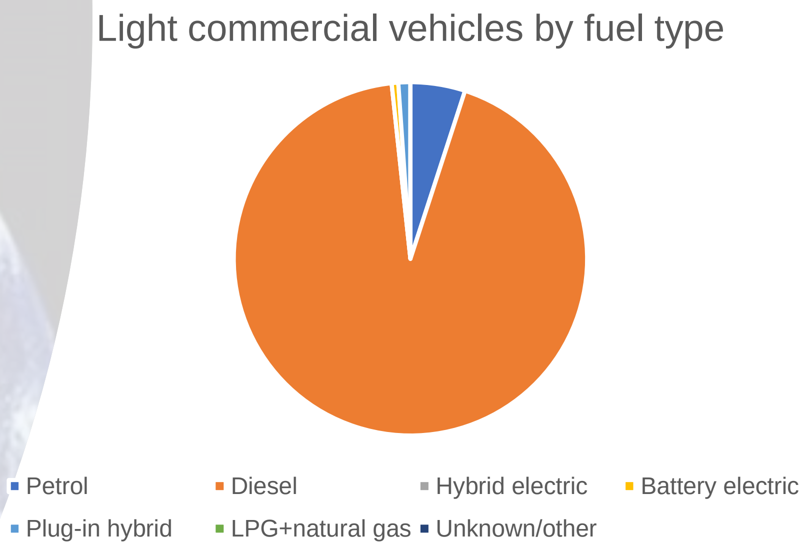


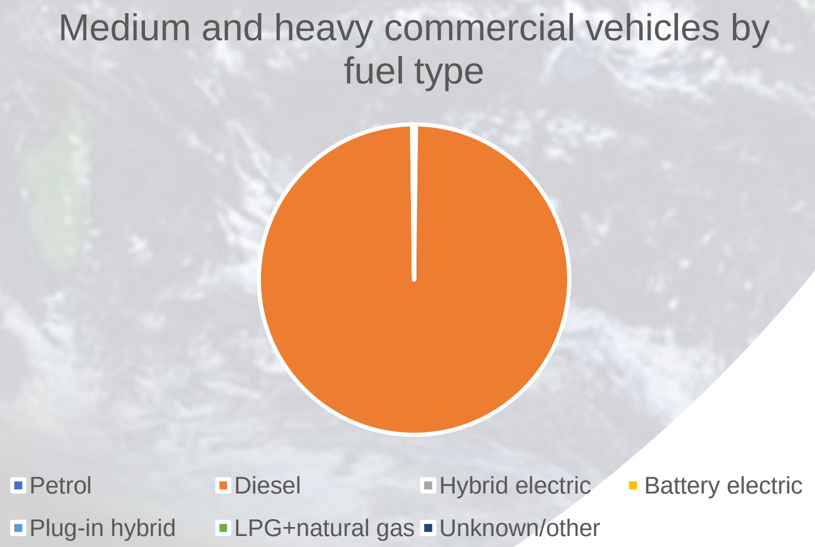


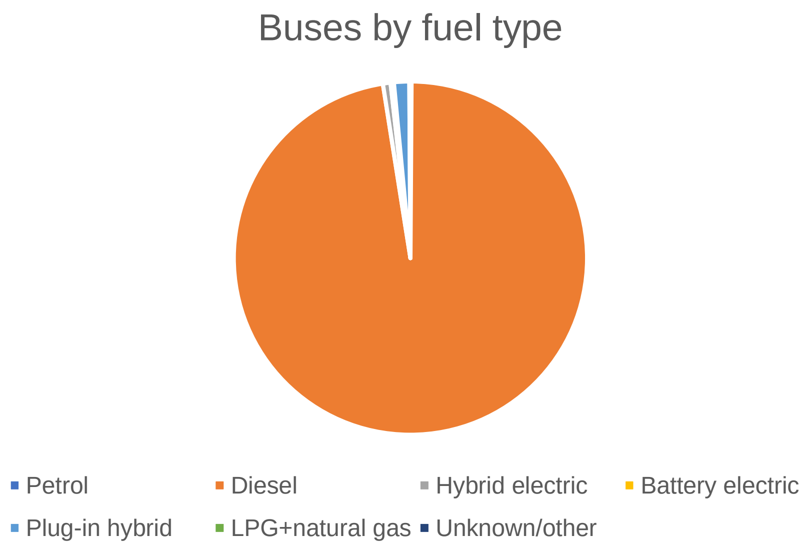
- Approximately 40% of all vehicle types are more than 10 years old
- 19 million cars and 1 million light vehicles, 400,000 medium/heavy trucks and 30,000 buses

Vehicles by fuel type - Germany



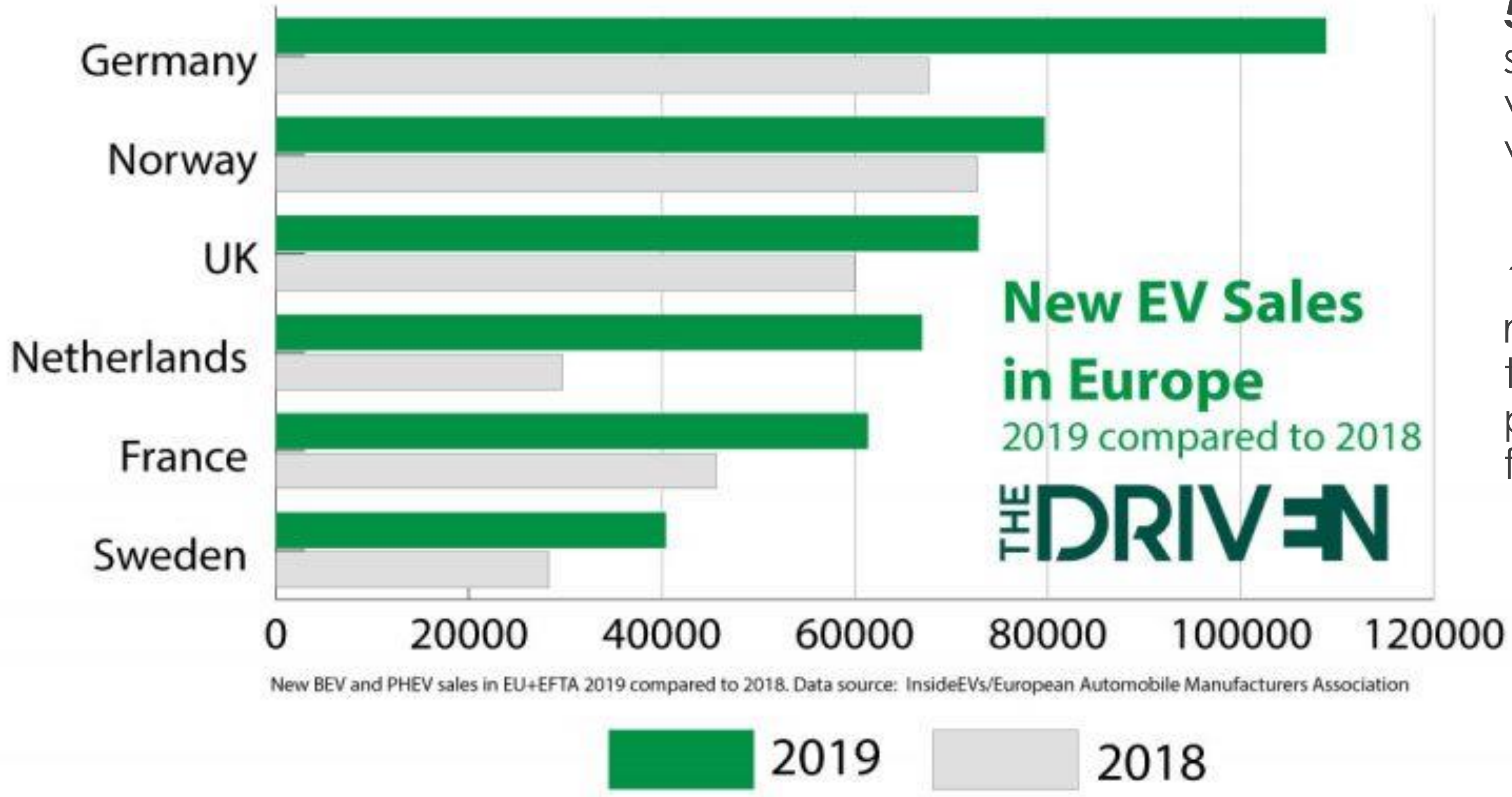






- Diesel and gasoline-fuelled vehicles predominate the vehicle fleet in all classes
- Gasoline is the majority fuel for passenger cars
- Others are diesel led

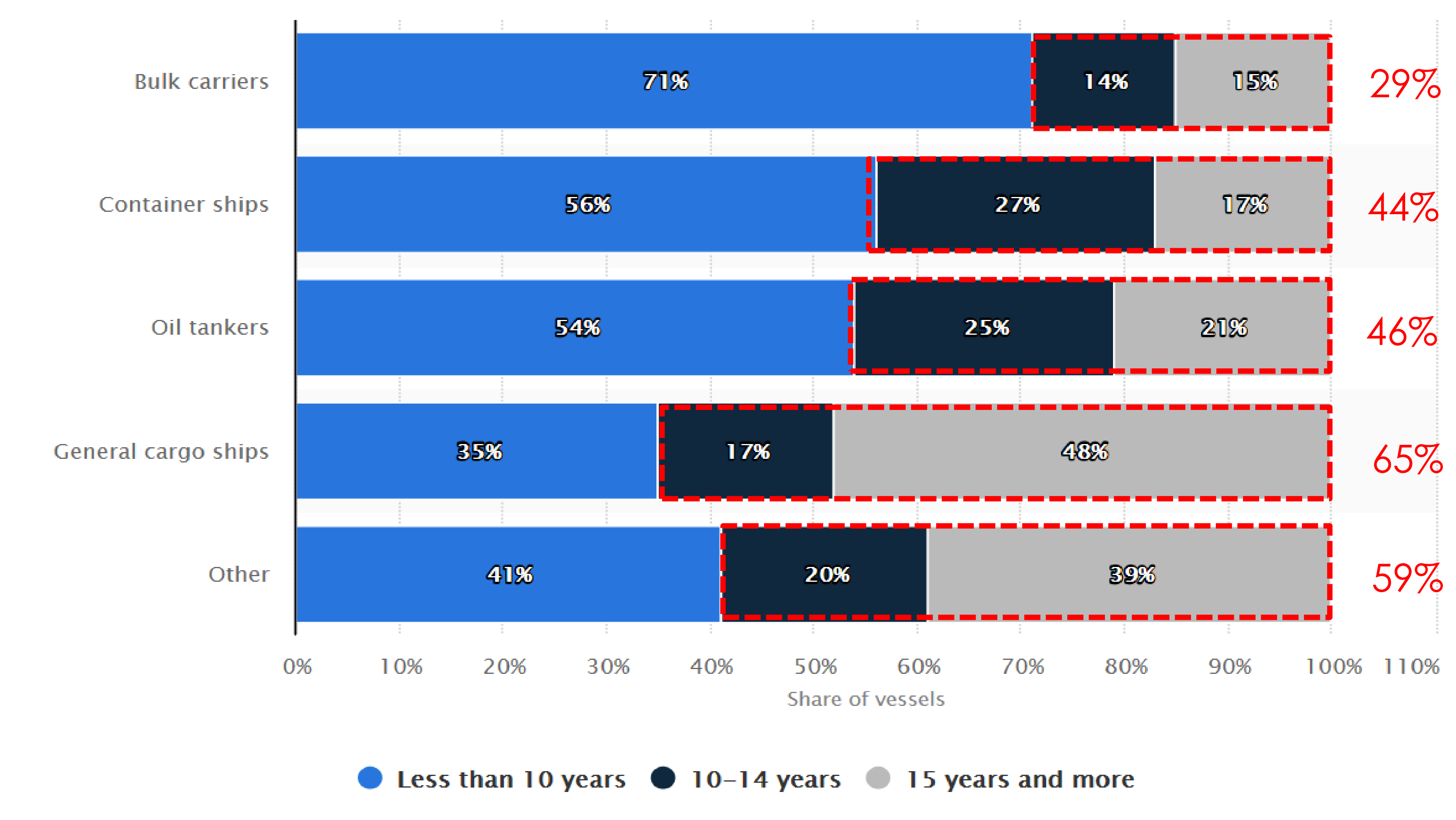
Electric cars in Europe



Germany saw a **59% increase** in sales of electric vehicles in 2019 versus 2018

110,000 new EVs represent 0.2% of the total German passenger vehicle fleet

Age distribution of world merchant fleet in 2019, by vessel type



- Significant proportion of the world's shipping fleet is over 10 years old
- Slow vessel turnover rate makes fuel switching a long-term activity
- IMO2030/50: investment decisions are being made today for vessels that will still be operating in 2030+

Source: Statista

Energy Transition

The Opportunity for Refining …

creas ENERGY CONSULTING

creas ENERGY CONSULTING

- Declining demand for transport fuels:
  - Residue first (IMO, electrification of industry)
  - Then diesel (car bans in major cities, electrification)
  - Then gasoline (phase-out of fossil-fuel vehicle manufacturing)
  - Then jet fuel (competition from biojet, synthetic jet, hydrogen, methanol, ammonia, …)
- Ongoing demand growth for petrochemicals (but pressure from bioplastics and circular economy drivers)
- Ongoing demand growth for bio-based fuels replacing fossil-based
- High conversion refinery, lower crude throughput
  - Multiple trains to single train operations
  - Lighter feedstocks to avoid production of residue and diesel

The Opportunity requires different thinking…

creas ENERGY CONSULTING

Non-recyclable plastic, used tyre crumb

Full range naphtha

Light crude / condensate

Municipal solid waste

External sources of carbon dioxide

Renewable Energy

Recycled Plastic

Bio-feedstocks

Modified (Scaled-down) Refining Complex, Petrochemicals integration

Future Refining-to-Energy Platform Evolution

Biofuels

Electrolysis

Carbon Capture

Waste-to-Energy/Fuel

Methanol and/or Ammonia

Conventional jet fuel

Bio-/synthetic jet

Bio-/synthetic diesel (Conventional diesel)

Green Oxygen

Mixed and/or green power export

Green methanol to bunkers, mogas drop-in, chemical feedstock, synthetic animal feed protein

Blue / Green / Mixed Olefins

Blue / Green / Mixed Aromatics

DME to aerosols, LPG replacement, Diesel drop-in

Blue / Green / Mixed Hydrogen

Food grade carbon dioxide

Green Ammonia, Eco-Fertilizers

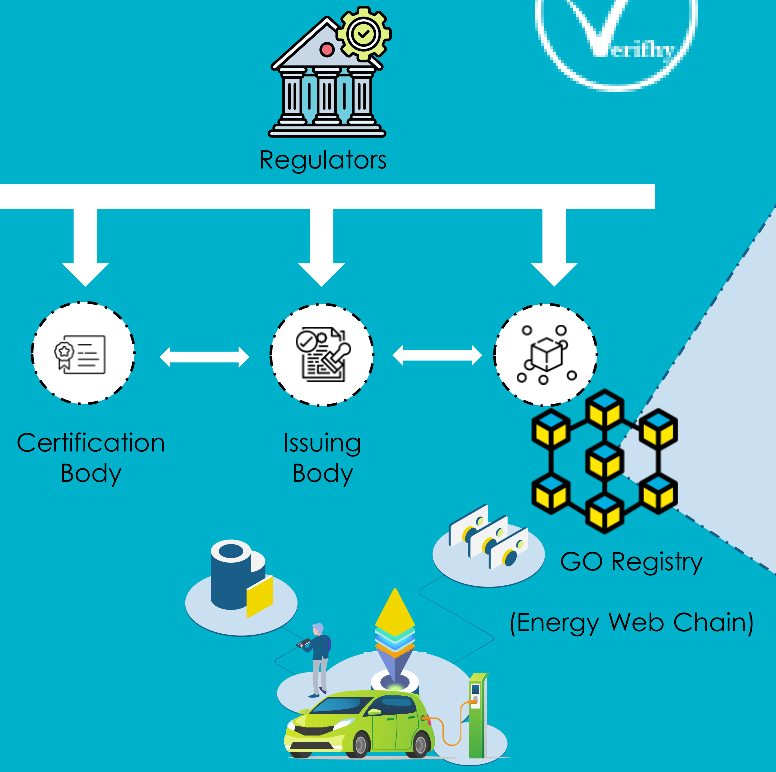
Energy Transition

Tracking the green, blue and grey products
from production to end user

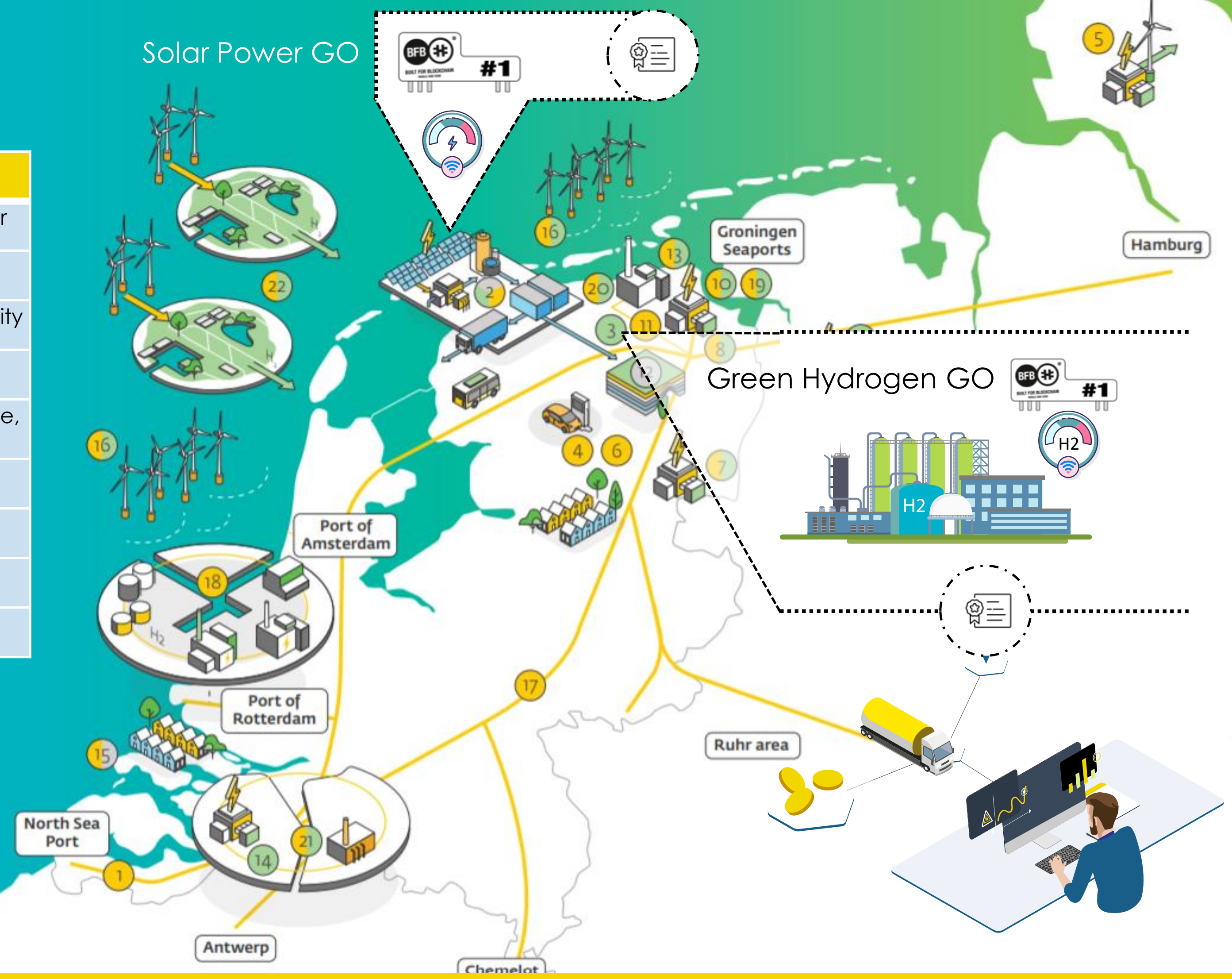
Guarantee of Green Origin certified on Blockchain
www.verifhy.app

creas
ENERGY CONSULTING

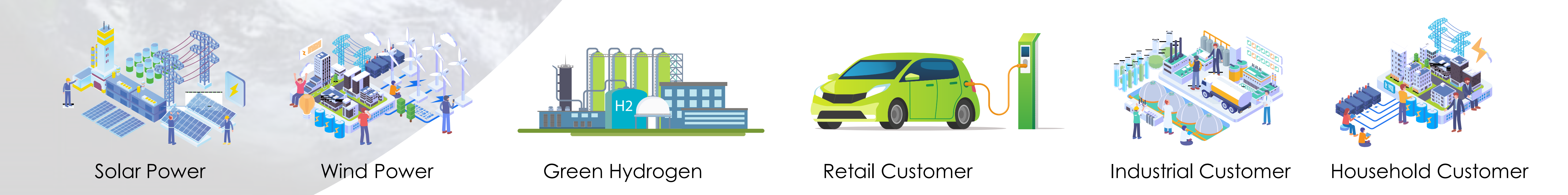
creas ENERGY CONSULTING



Data Field
Certificate Number
Device ID
GHG Emission Intensity
Amount
Start Date, Stop Date, Date of Issue
Capacity
Production Date
Auditor Data
Audit Report ID



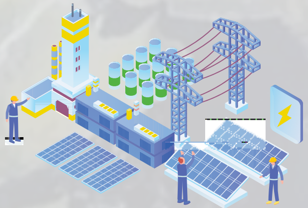
Registry Service for Guarantees of Origin (GO)



CHAIN OF CUSTODY

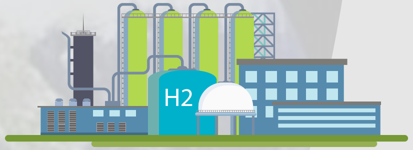
Solar/Wind Power > Green Hydrogen > Customer

Issue | Transfer | Cancellation | Expiry



Solar Power

Wind Power



Green Hydrogen

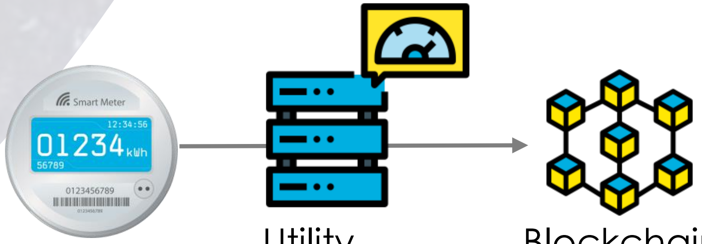
Consider also:

- Mixed biofuels/conventional fuels
- Sustainable/bio-based aviation fuels
- Green methanol
- Green ammonia-based fertilisers

Meter Authentication **01**

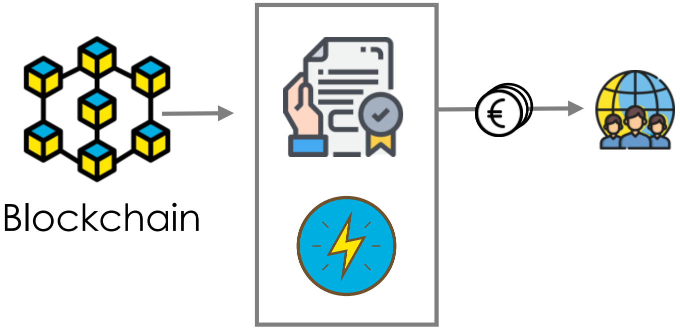
Meter Reading Submission **02**

Guarantee of Origin Issue **03**

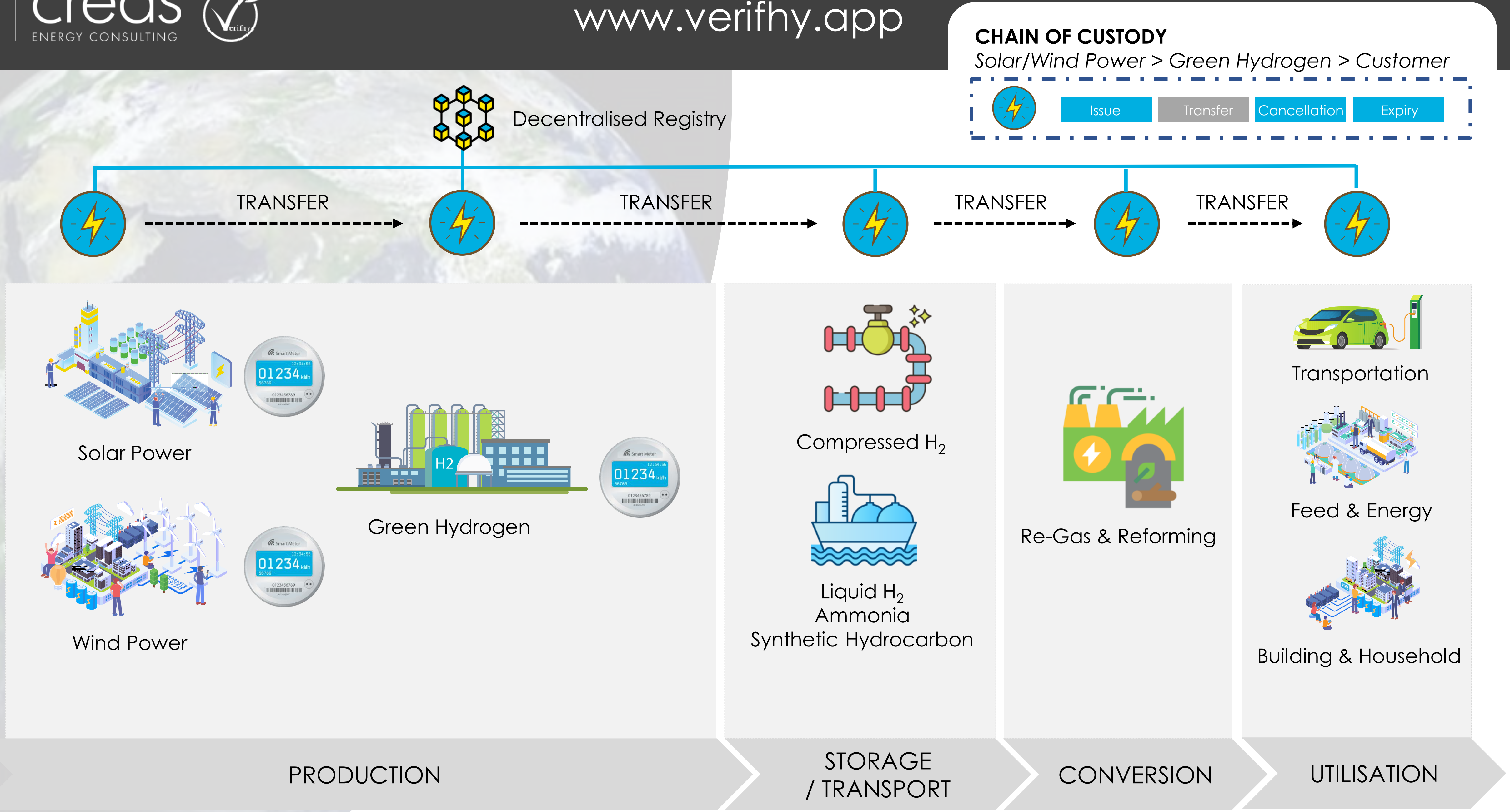


Utility Database

Blockchain



Blockchain


CHAIN OF CUSTODY
Solar/Wind Power > Green Hydrogen > Customer
Issue
Transfer
Cancellation
Expiry
Decentralised Registry
TRANSFER
TRANSFER
TRANSFER
TRANSFER
Solar Power
Wind Power
Green Hydrogen
H2
Compressed H_2
Liquid H_2
Ammonia
Synthetic Hydrocarbon
Re-Gas & Reforming
Transportation
Feed & Energy
Building & Household
PRODUCTION
STORAGE / TRANSPORT
CONVERSION
UTILISATION

Creating sustainable solutions for tomorrow's energy challenges. Today.

creas™
ENERGY CONSULTING

Contact: Kevin Clarke
Kevin.clarke@creas.co.uk
+44 7554 684163

www.creas.co.uk
www.verifhy.app