The future of fuels and powertrains – an energy systems perspective

UniCEG

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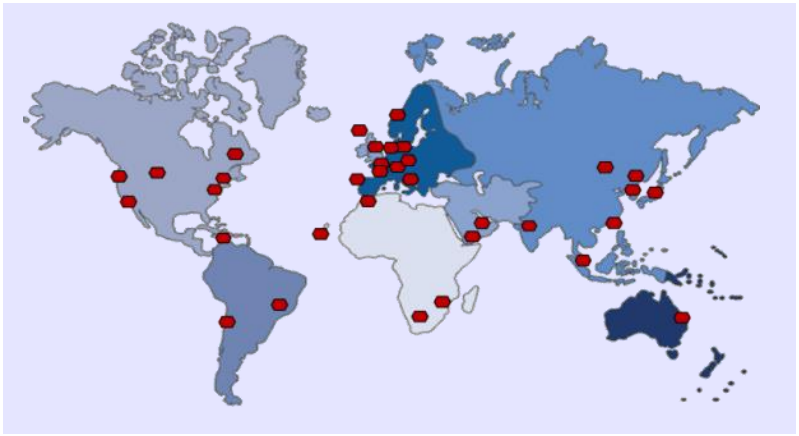
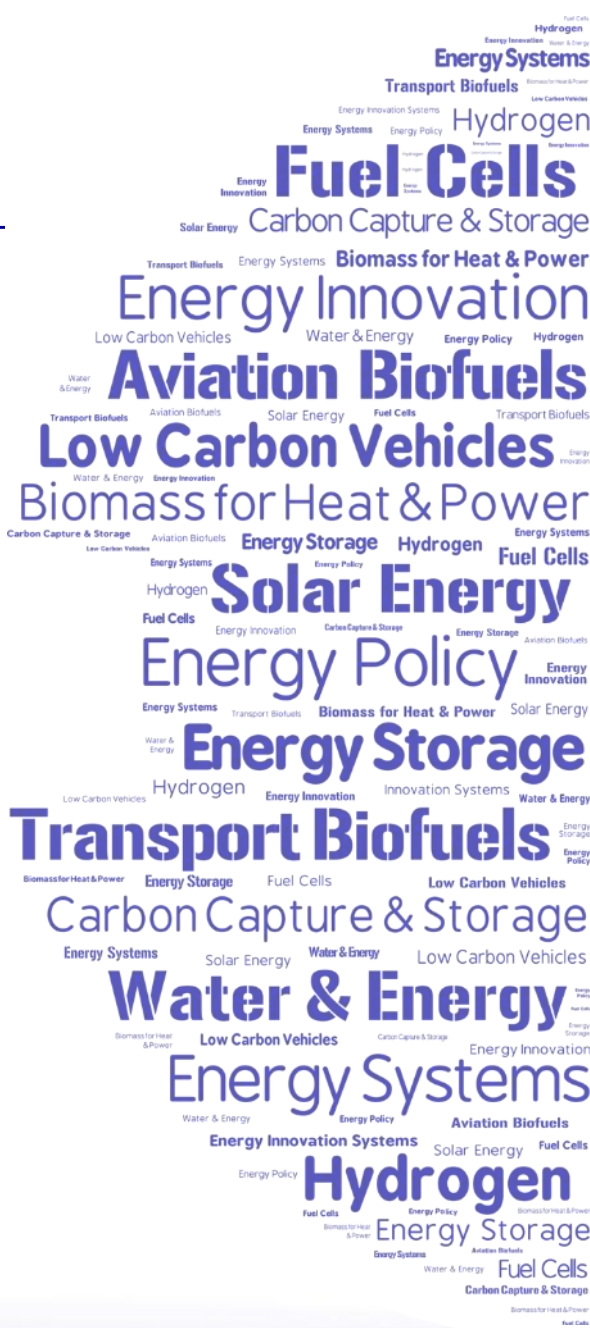
E4tech: Strategic thinking in energy

- International consulting firm, offices in UK and Switzerland
- Focus on sustainable energy
- Established 1997, always independent
- Deep expertise in technology, business and strategy, market assessment, techno-economic modelling, policy support…
- A spectrum of clients from start-ups to global corporations



RWE The energy to lead · IFC · Coca-Cola · iea International Energy Agency · IATA · Goldman Sachs · LONDON · TOYOTA · Linde · bp · DAIMLER · Fraunhofer · NISSAN · ofgem · BRITISH AIRWAYS · CARBON TRUST · CLSA ASIA-PACIFIC MARKETS · e·on · Imperial College London · Unilever · ROLLS ROYCE



Challenges ahead

Important influences on UK energy policy

UN Framework Convention on Climate Change

Paris Agreement

European Commission

European Commission

Other relevant policy domains

- Economic
- Security
- Pollution
- Social
- Local & regional
- …..

2020 Climate & Energy Package
2030 Climate & Energy Framework

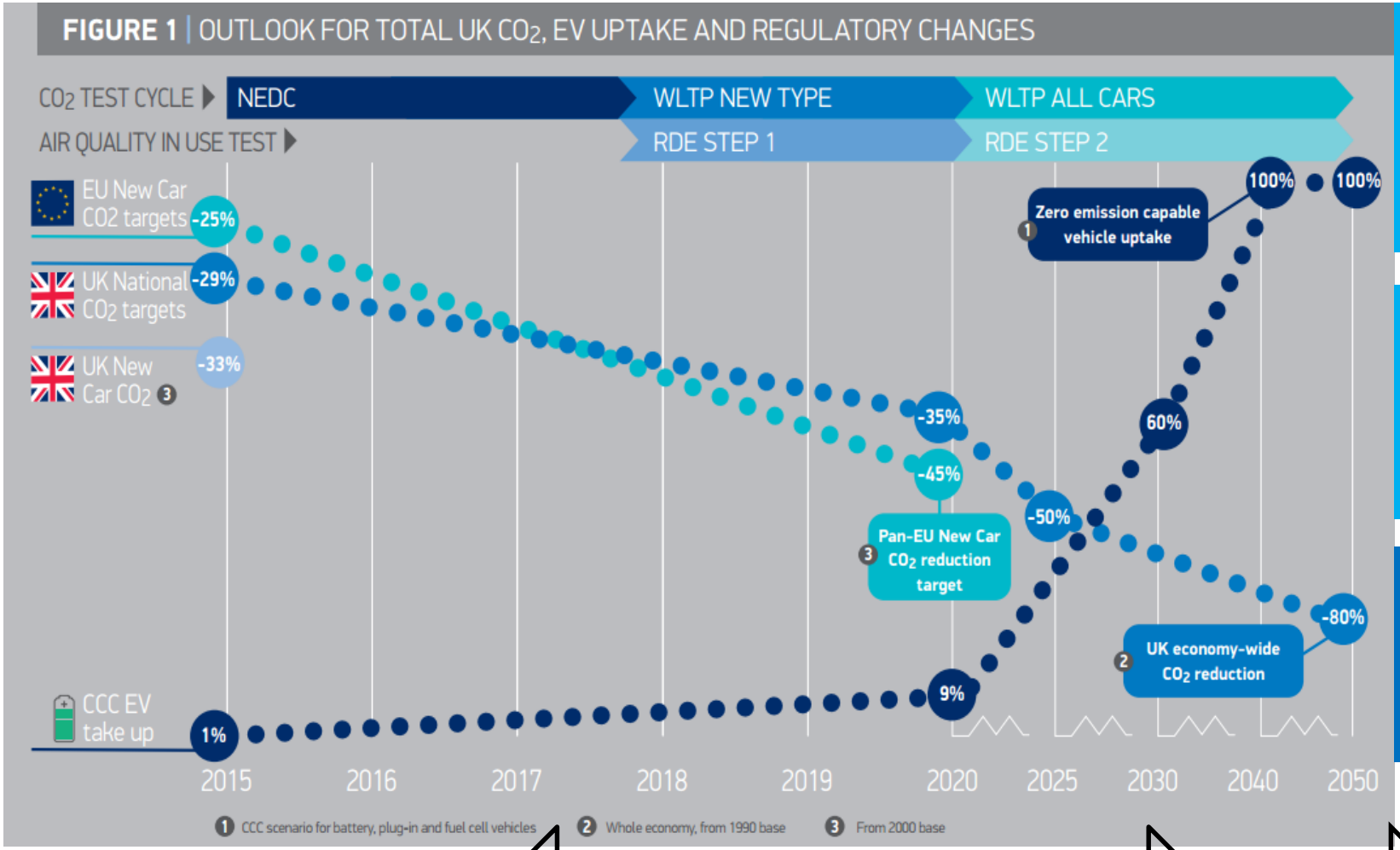
Committee on Climate Change

Committee on Climate Change

Carbon Budgets

UK Government

80% GHG reduction from 1990 baseline. Road transport, especially LDV will have to make strong contributions



Transport means "in use"

Incl. aviation & shipping

LDV elect. focus

Source: SMMT

2-3 cycle plans → Adoption

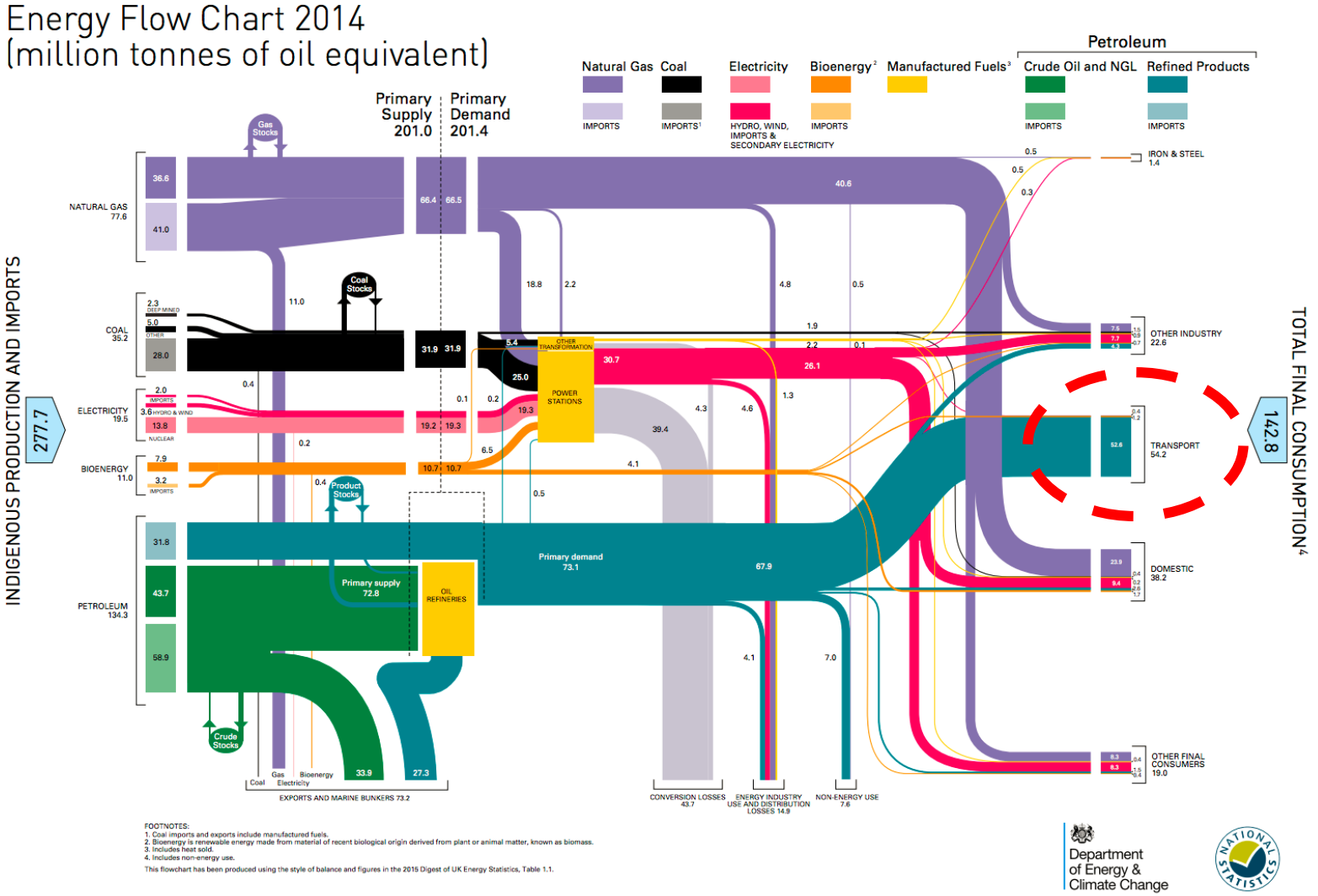
Transport as part of the energy system

A systems approach is required to overcome this challenge

Focus area

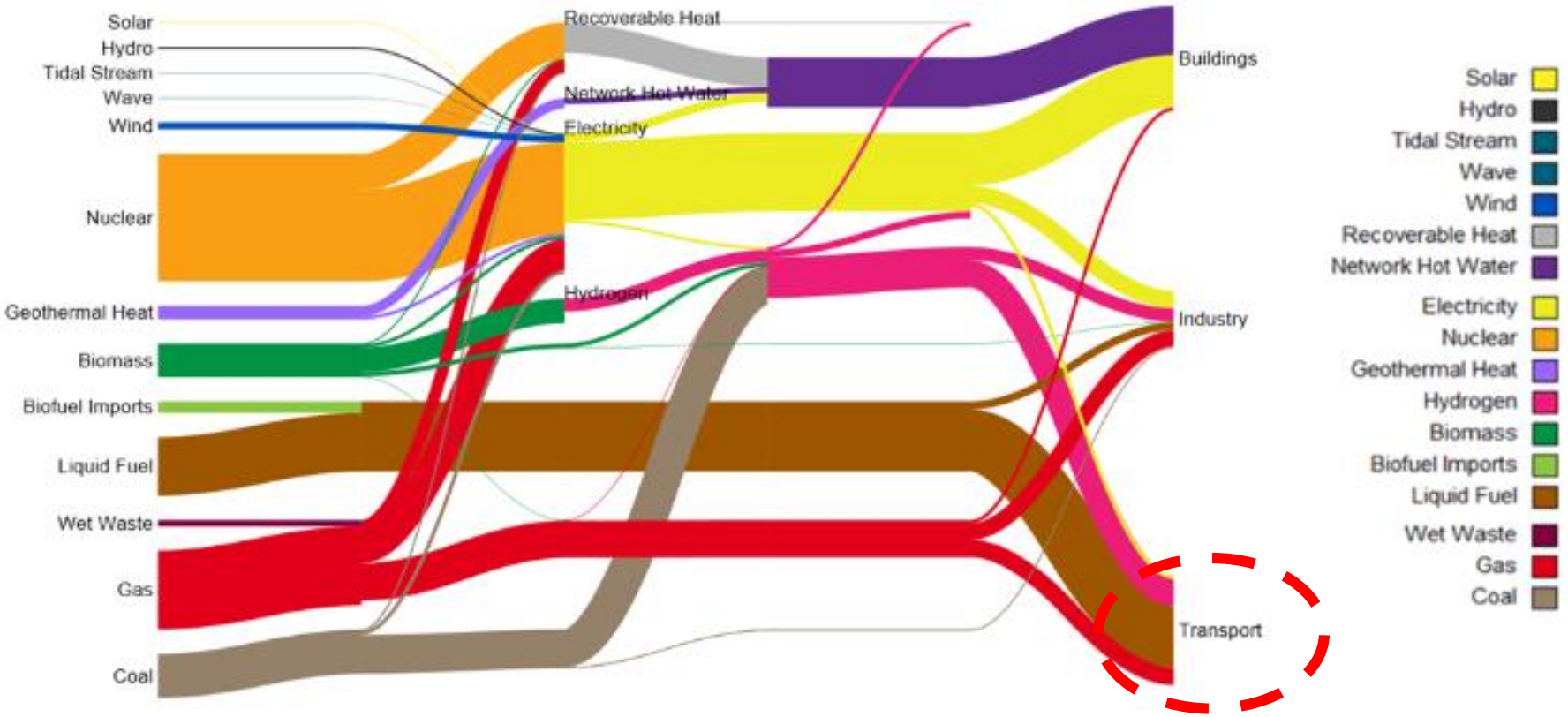
Source: ERTRAC

Transportation uses about 40% of all energy and will increasingly become an integral part of the energy system



…To something like this

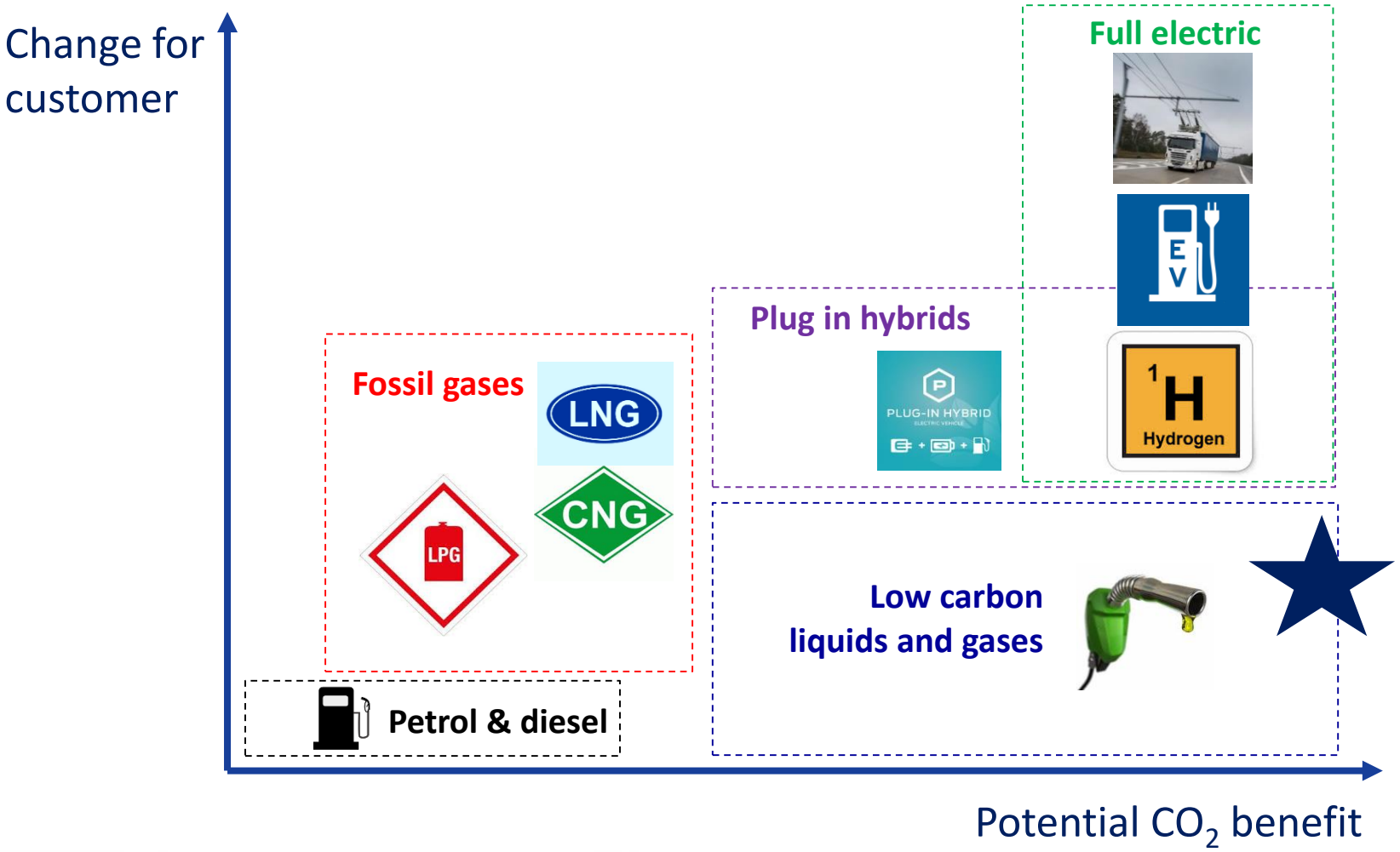
ETI 2050 scenario



Source: ETI

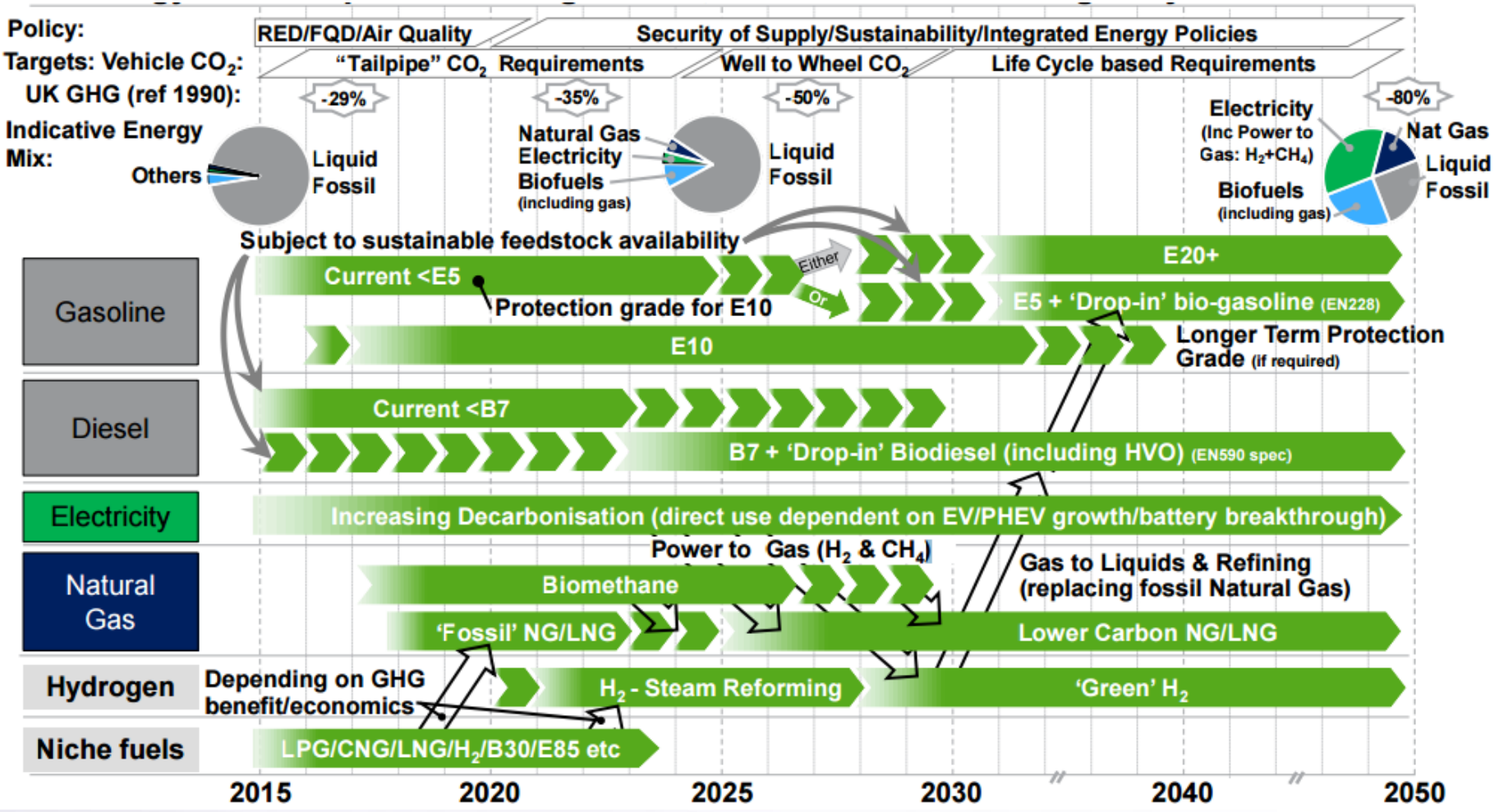
What is required?

Efficiency alone cannot deliver major decarbonisation so alternative energy vectors vital, but most require change



Energy transition is unlikely to be simple. We might move from 1 feedstock, 2 fuels to multiple feedstocks and fuels

UK Automotive Council Energy & Fuels Consensus Roadmap



Beside electrification, low carbon fuels (and ICEs) have a very important role to play in decarbonising transport.

Electrification & low carbon fuels are **NOT** mutually exclusive!

Questions that would need to be answered:

- What fuels?
- For what sectors?
- And in this forum, what thermal propulsion systems?

There are many considerations when choosing an alternative fuel. A stakeholder perspective

Fuel & vehicle suppliers

- Fuel production & distribution
- Vehicle & engine design
- Economics

Users

- Convenience
- Vehicle performance and lifetime
- Vehicle operating costs

Society & policymakers

- GHG performance
- Other environmental and social impacts
- Competing demands for upstream resources

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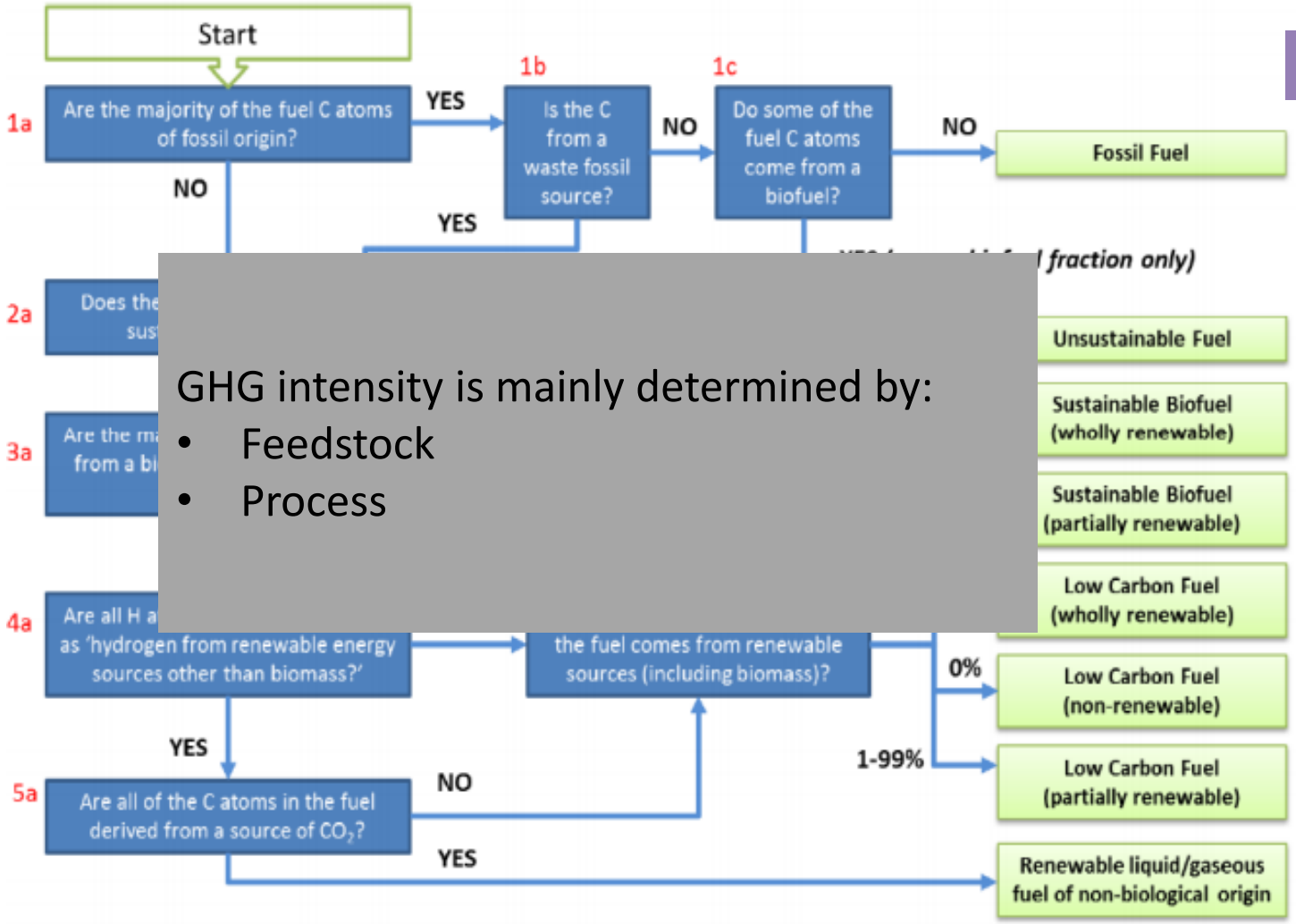
There are many low carbon fuels classified by the level of renewability of their components.



GHG intensity is mainly determined by:

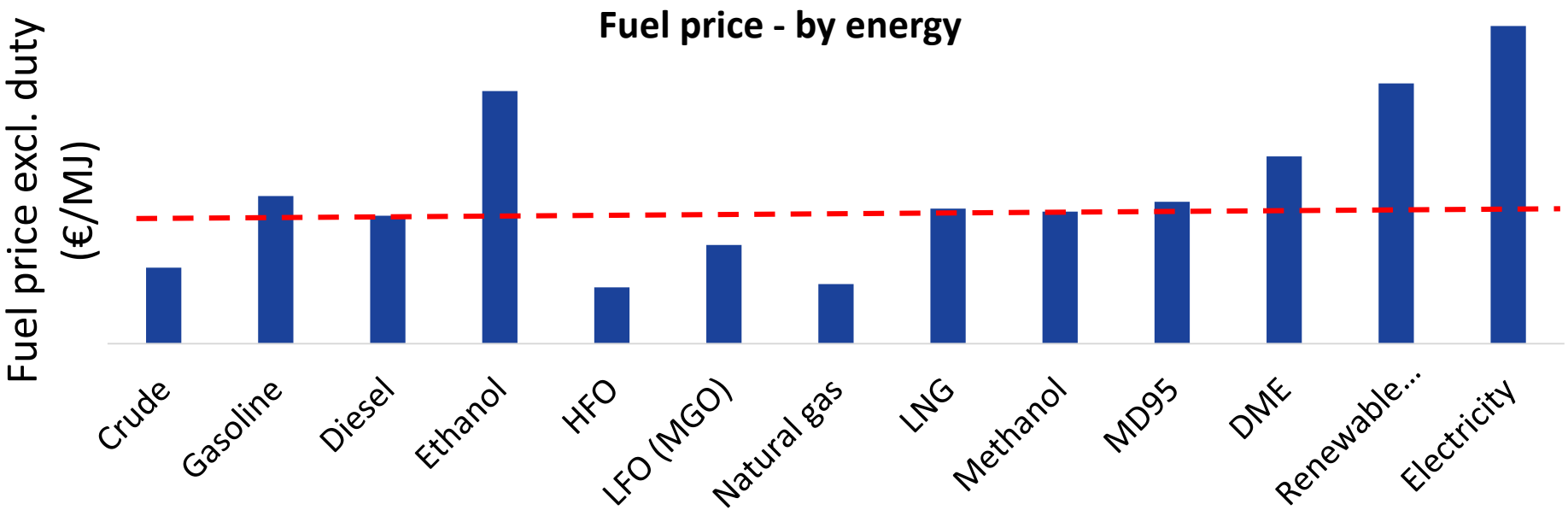
- Feedstock
- Process

Examples
Diesel, gasoline, Natural Gas
Fuels <50-60% GHG saving*
Ethanol, biogas, methanol HVO, FAME
Enerkem (alcohols, diesel)
Chemrec (DME), BioMCN (methanol)
Lanzatech (Ethanol, jetfuel)
CRI (methanol), Audi e-gas

Source: E4tech and Ecofys Novel Low Carbon Transport Fuels and the RTFO: sustainability implications, 2015

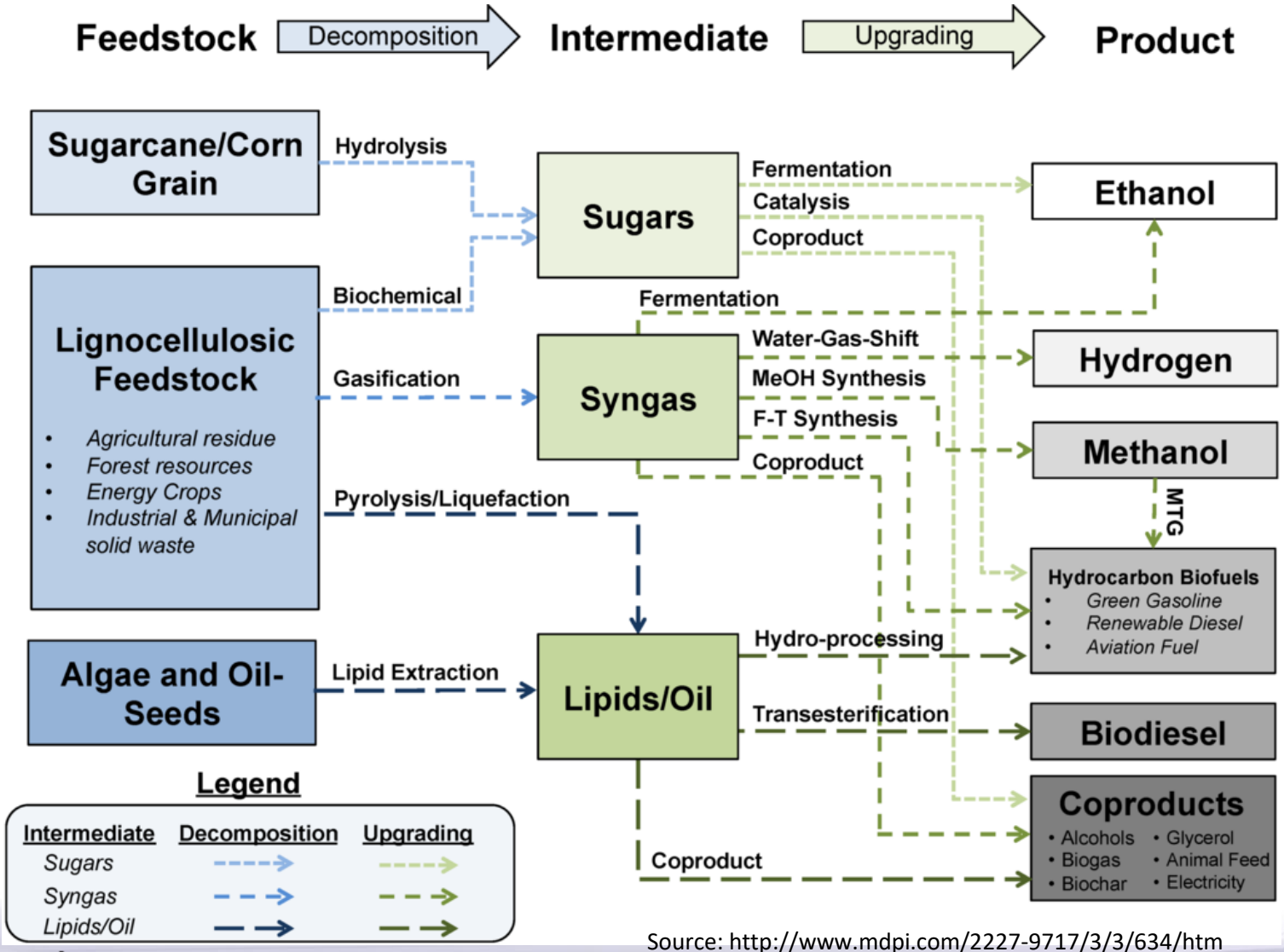
*50% from 2017. 60% for new build plants from 2018

Cost effective low carbon fuels are required especially for the heavy duty transport sectors



- Fuel is a significant part of OPEX, which (roughly) increases with duty cycle
- So larger fuel consumers (shipping, aviation and long haul trucking) might not be able to tolerate a large renewability premium

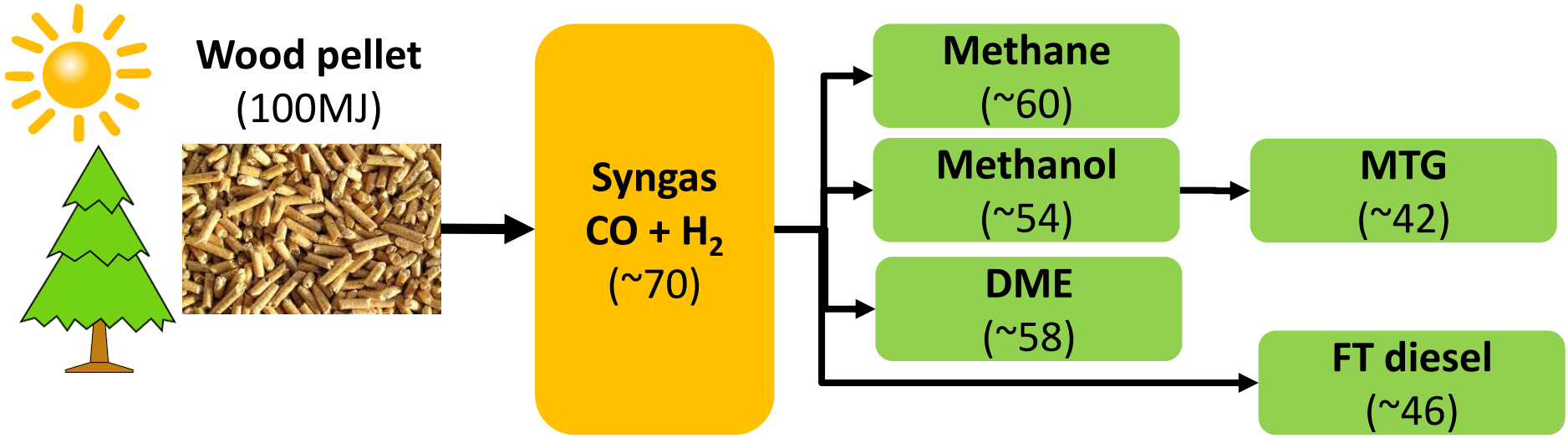
Fuel cost is dictated by feedstock availability and price as well as process. More processing means higher costs



Source: http://www.mdpi.com/2227-9717/3/3/634/htm

Example: Biomass to “fuel”. Each processing step has associated in-efficiencies and costs.

- The effective energy typically reduces with each processing step
- Each processing step also attracts operating costs
- **Therefore increasing the cost of the end-fuel**



Please note these are **indicative** process **energy** efficiencies (LHV) excluding indirect process energy requirements & co-products

Implications

- For alternative fuels there is a trade-off between the level of fuel processing and the cost (and energy efficiency) to make that fuel

- To find suitable transport fuels we need to understand:
  - Availability of feedstock
  - GHG intensity of the process
  - Cost effectiveness of making the fuel

  But also:
  - Competition for feedstock and intermediates, infrastructure, engine technology, etc

The best option for transport might not be best for the whole energy system

Summary & Next steps

Summary:

- ~80% GHG reduction in transport required by 2050
- Most of this reduction will be achieved by changing the energy vector
- Both electrification and low carbon fuels are required and can co-exist
- Transport energy will therefore change and become multi faceted and interlinked with the wider energy system
- The cost of energy for the end-user is an important factor. This limits options

Next step:

- An objective low carbon fuels paper in collaboration with Brighton, Bath & UCL to provide direction

E4tech – strategic thinking in sustainable energy

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