

The Golden Rules for Hydrogen Blending – it’s not crazy

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CNG Services Ltd

Low Carbon Innovations

cng services Ltd

Over the next 20 years, CSL's projects will contribute towards a CO₂ emissions saving of.....

17,500,000 tonnes

Celebrating over 16 years of innovation in gas

- CNG Services Limited (CSL) provides consultancy, design and build services to the biomethane industry, all focused on reducing Greenhouse Gas (GHG) emissions
- In the past 10 years our efforts have produced a material impact with an estimated 20 year project life reduction in CO₂ emissions of 17,500,000 tonnes through:
 - Biomethane injection into the gas grid
 - Running trucks on Bio-CNG
 - Acting as developer and design and build contractor for the Highlands CNG Project
- Working on a number of Biomethane, H₂ and CCUS innovation projects including:
 - Biomethane from manure with CCS
 - Biomethane direct into the NTS
 - Green H₂ into the NTS and Hydrogen Business Model Projects
 - Reverse Compression to Create Capacity for Biomethane Injection
- CSL is an ISO 9001, 14001 and 45001 approved company and has also achieved Achilles certification. CSL is GIRS accredited for design and project management and has been certified as a competent design organisation for high pressure UK onshore natural gas works by DNVGL



Golden Rule 1 – Don't be Crazy

- Don't assume that people who want to generate electricity and then make Green H2 and inject into the gas grid are crazy. They might be, but to find out if they are, there are 7 critical questions:

Q1 – can you sell the electricity it to an I&C or domestic customer for 25 - 35 p/kWh

- This can be via a direct wire from the wind farm to the house or a factory or via the electricity grid, both are great
- This is very profitable because the electricity is priced as if was made from natural gas. It's a particularly good idea if you have an onshore wind turbine in the Scottish Highlands. Do this before anything else as its incredibly lucrative and you are probably a lunatic if you don't do it
- Selling electricity direct or via the grid is the Michelin Star restaurant option, sell a meal for £250 instead of blending all the food into a gloop and selling it for 10 p to make Biogas

Q2 – can you use the electricity to charge a battery?

- If, for whatever reason, the domestic heat pumps or I&C customer does not want your electricity, then use that electricity to charge a battery
- Once the battery is charged, truck it down to England and empty the battery into the electricity grid where it can be used for all sorts of things
- Moving batteries by road is actually a good idea as the charged battery is heavy and it can roll down the hills to England, when its empty, send the light load back north (the Swiss do this all the time)

Note – I am not crazy and appreciate you can charge a battery and not move it which is just a variant of Q1. But mostly, you don't use the battery where you charge it, you move it, whether in your i-phone or your Kia EV6 that I have. This is the Q2 option

Swiss truck charges as it goes down the mountain



The dump truck, at 45 tons, ascends the 13-percent grade and takes on 65 tons of ore. With more than double the weight going back down the hill, the beast's regenerative braking system recaptures more than enough energy to refill the charge the eDumper used going up.

If you can sell renewable electricity for a gas linked price, do it. If you don't, you are crazy

Golden Rule 2 – Minimise the Crazy

If you get to Q3 it means you are not completely crazy but you are not out of the partially crazy wood just yet

Q3 - can you make Green H2?

- This relies on water which should be ok in the Highlands, so there is a good chance you can make Green H2 if you have electricity that you can't sell at a gas linked price

Q4 – ok, you have now made Green H2, what can you do with it? Well, given you are not completely crazy, sell it directly to a customer for 10 p/kWh

- You would actually be crazy not to do this as its the DESNZ Hydrogen Business Model and the customer ,may only have to pay a gas linked price of say 4 p/kWh
- Note – the H2 is generally not 'firm' and the customer stays connected to the gas grid for Dunkelflaute days
- This use of Green H2 as a 2020's version of a British Gas Long Term Interruptible Contract
- Not crazy at all

Q5 – if there are no local consumers for the Green H2, can you move it by road?

- A 15 MW electrolyser will make around 100 million kWh/annum of Green H2. To move this energy by road:
 - If it was natural gas at 250 bar it would need around 1,000 truck movements
 - For H2 at 350 bar it would need around 2,500 truck movements
 - The natural gas grid back up at around 1,000 scmh will generally be delivered in a small diameter pipeline
 - No company on planet earth moves H2 by road for bulk supply to I&C customers (its just not a thing)
- Only move Green H2 by road to supply a H2 fueled vehicle which uses trailer pressure (ahead of installing electrolyser on site)

Moving H2 by road is crazy



This is also crazy, but higher up



In GB, you can move H2 in lots of ways but if its not via a pipeline, its generally crazy

Golden Rule 3 – Never ask Chat GPT for a H2 image

Chat GPT was asked to produce a CGI of a H2 Pipeline



Are we tH2ere yet? - generated using ChatGPT

Dear Chat GPT

Next time when you are asked to produce a H2 pipeline, please search on the words "tiny molecule", "avoid flanges", "buried pipeline", "bloody idiot"

To the right is what a H2 pipeline actually looks like



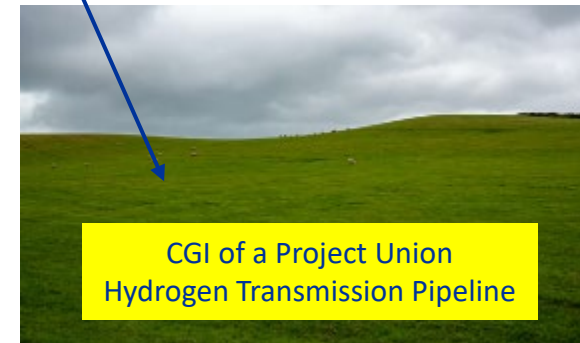
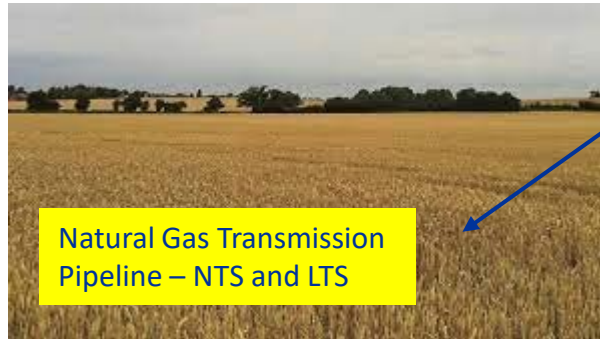
We know where Chat GPT got the idea from



H2 CGI is completely crazy

Golden Rule 5 – When you cannot sell H2 directly to a factory, you can inject the H2 into the gas grid and its not crazy at all

- To recap, if no direct electricity use, if no remote electricity use, and if there may not even be electricity grid capacity
- And, if there is no direct local use for the Green H2 that you can make
- We know that you cannot cannot (sensibly) move Green H2 via airship or road
- So, given all that, ideally move the Green H2 via a new buried pipeline, like this one in the National Gas Project Union
- But that will take time and to start, inject into an existing gas pipeline like this one



- Each 1 kWh of Green H2 blended into the Transmission Pipeline displaces 1 kWh of imported LNG but with no GHG emissions at all and avoiding GHG from gas exploration, gas production, gas processing, gas transportation, gas liquefaction, LNG shipping to UK, LNG boil off, LNG re-gasification and from burning the natural gas at the end of its journey
- There are no downsides in blending H2 into the gas grid, only upsides



You are crazy if you do not do this
GB has 800 TWh/annum of natural gas demand which is like a big blending tank, perfectly designed to create a “renewables to electrolysis” supply chain

And finally

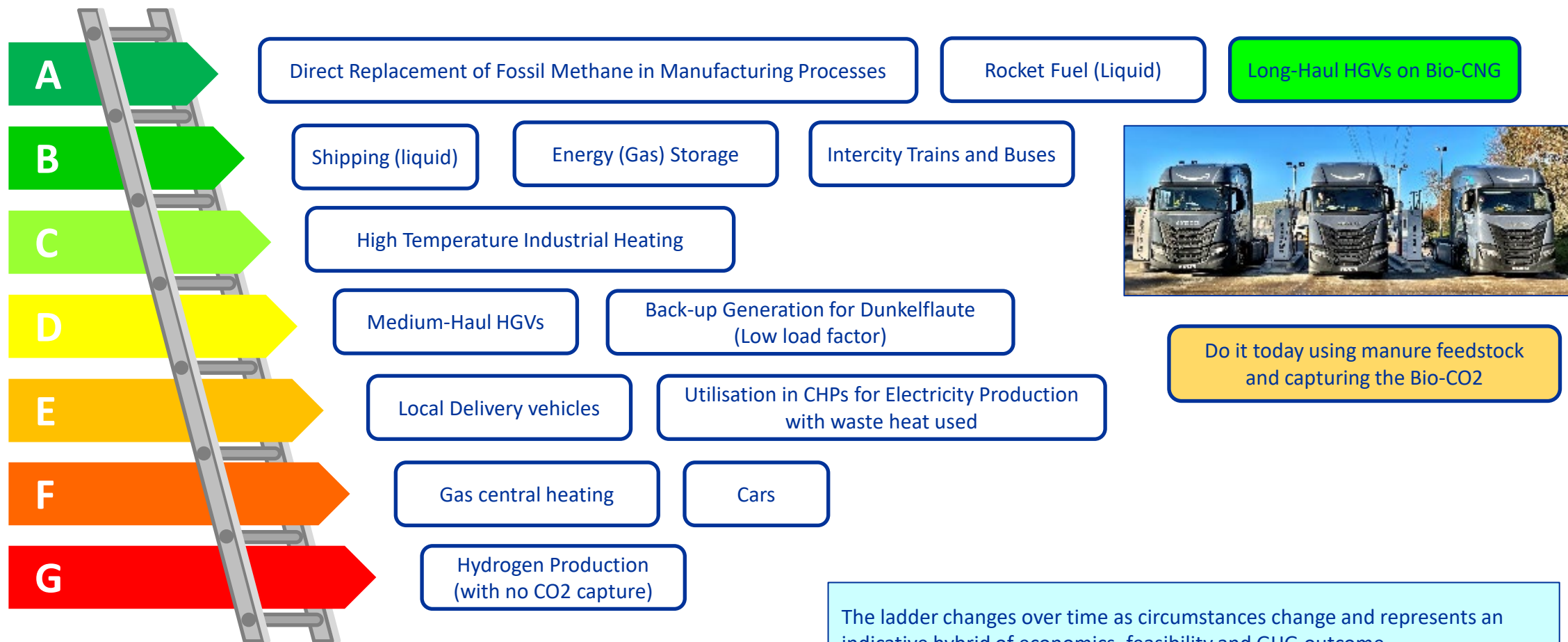
“The Ladders”

Including the World Premier of the Electricity Ladder

Note – other ladders are available

The Biomethane Ladder

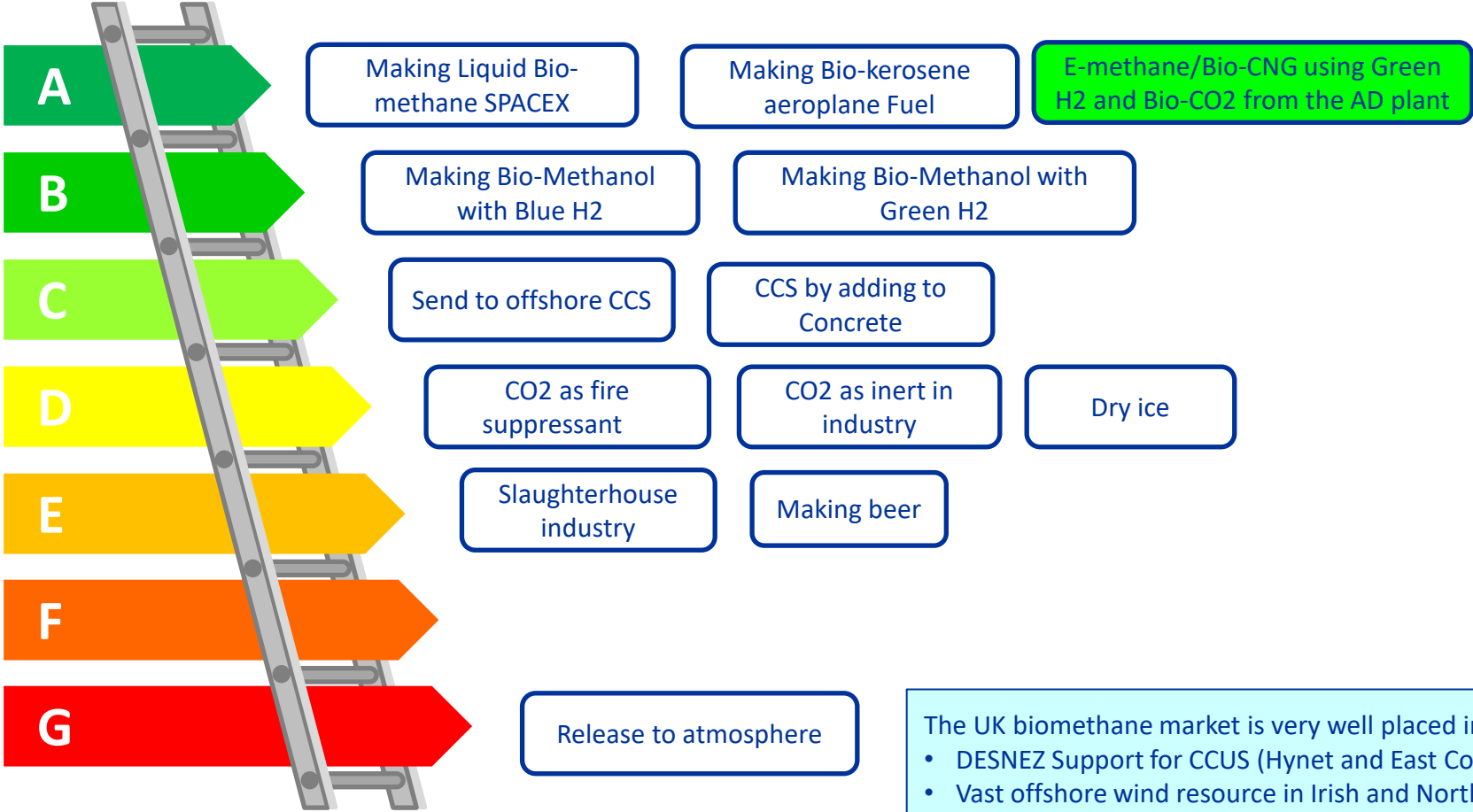
Good options



Poor options

The Bio-CO2 Ladder

Good options



Do it in 2028 with all that manure AD derived Bio-CO2 and offshore wind/solar to H2

Poor options

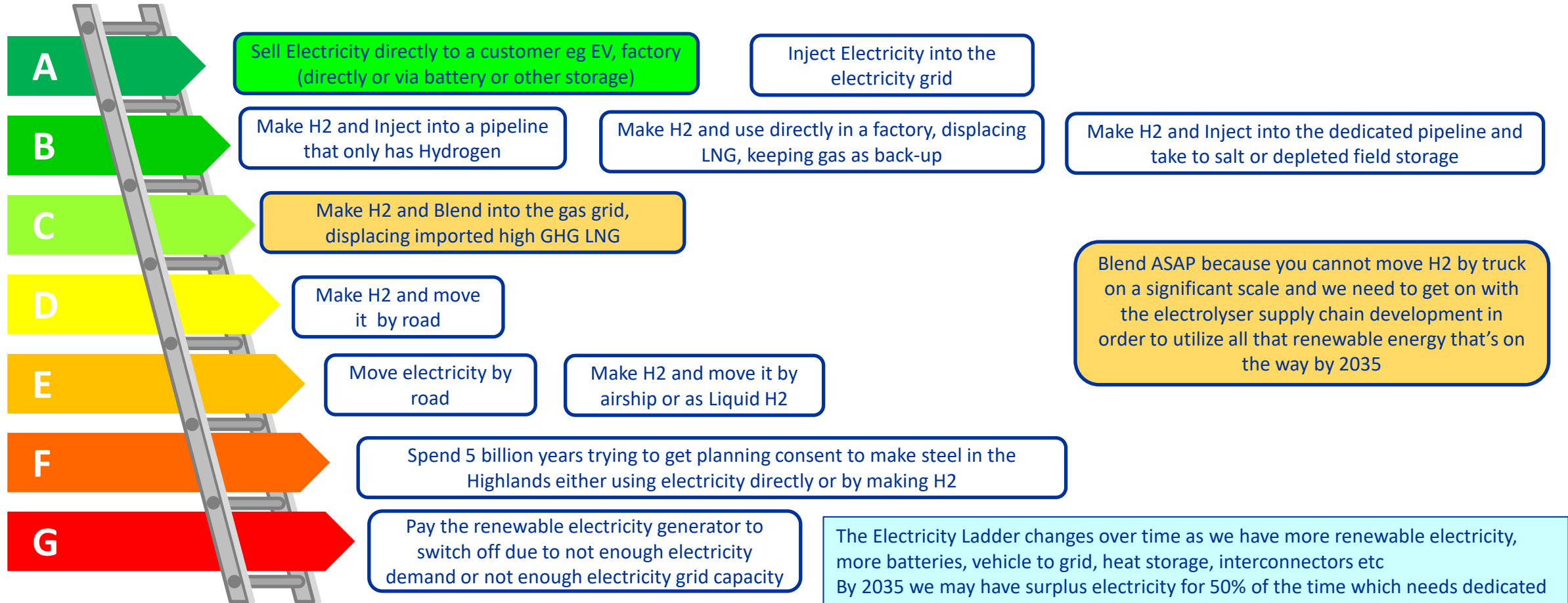
The UK biomethane market is very well placed in Europe because of 3 critical factors:

- DESNEZ Support for CCUS (Hynet and East Coast Clusters)
- Vast offshore wind resource in Irish and North Sea
- Salt strata at these clusters which allows both H2 (and Bio-CO2) to be stored which is critical for premium top rung products

WORLD PREMIER

The Electricity Ladder

Not Crazy



Crazy

The Electricity Ladder changes over time as we have more renewable electricity, more batteries, vehicle to grid, heat storage, interconnectors etc
By 2035 we may have surplus electricity for 50% of the time which needs dedicated H2 pipelines and storage
Until then, make Green H2 and inject into the big fat GB blending tank
Huge potential given likely >500 TWh/annum gas demand for the next 10 years