

Energy Security; a must to have! ,

Can we really re-achieve this position, with our financial,
and societal and personal stress levels intact?

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Johannes Leck, The Australian

SCOPE of Energy Security Factors

A Review covering the depth of 'energy security factors' that must be addressed severally and as systems, to understand where Australia stands re ENERGY.

Some of the factors that must be considered to regain energy security:

- Raw energy sources, deposits, level of development, acceptance and costs,
- The processing of the raw energy sources into useable forms of energy, (remember the 1st and 2nd Laws of Thermodynamics),
- The transport (and reticulation) and storage of such processed energy sources,
- The management of energy wastes from energy collection, processing, use (conversion) and residuals (e.g. ash), and

The cost of energy SHOULD be such that the local power-users (switch-throwers or gas-tap turners) are NOT scared to turn it on.

Certainties and Beliefs and Energy

There is climate change (we started with a 'big-bang' and we will finish with another 'big-bang' or a wack by an oversize comet); it is a certainty,

GHGs are certainly a climate change factor, but are not the only factor (the World happily swings through massive climate cycles thanks to the sun, the moon and variations in our earth's orbit),

We do utilise fossil fuels (FFs). However, all FFs are finite energy resources. Even if we do use such fuels at the present rate, we are not going to exhaust those fuels for a long time (petroleum being the exception), and

Australia has a relatively small carbon footprint and therefore does not seriously jeopardise the world with its fossil fuel production and use.

Discussion Points – The ‘remaining Fossil Fuels - FFs’

- There is an awful lot of coal and carbonaceous shale,
- Oil-shale resources are immense (eg Julia Creek), BUT
- On-shore, good quality liquid hydrocarbons are getting rare,
- Off-shore, high quality natural gas resources are there, if more challenging,
- Methane Hydrates are plentiful but a very ‘difficult to mine’,
- There is an ever-growing demand for asphalt/tars for road repair and construction, and
- Many gas resources offer RENEWABLES co-production scenarios, this being a useful FF extender under some circumstances.

Nuclear Power and Energy

- Nuclear Power generation could be plentiful, especially if the third nuclear cycle (U-233 from Thorium-232) is to be exploited,
- Nuclear Energy as heat will likely have limited direct uses in urban and industrial applications, including transport,
- **Nuclear energy could support renewable power generation**, as a base-load source, including energy supply during diurnal, seasonal and climatic variations in renewables supply, and
- Detlef Sulzer will be taking you through a detailed review of nuclear energy in our next Mining Mondays.

Hydrogen and the Hydrogen Economy

To bring back of 'old memories', my great Hydrogen & the HE presentation:

<https://engineersaustralia.tandfonline.com/doi/full/10.1080/14488388.2022.2046325>

Can Hydrogen replace fossil fuels like Natural Gas (CNG, LNG) & LPG?-

NO

**But HYDROGEN still has roles producing ammonia and petroleum,
and possibly roles in metal smelting.**

Hydrogen Delivery Costs

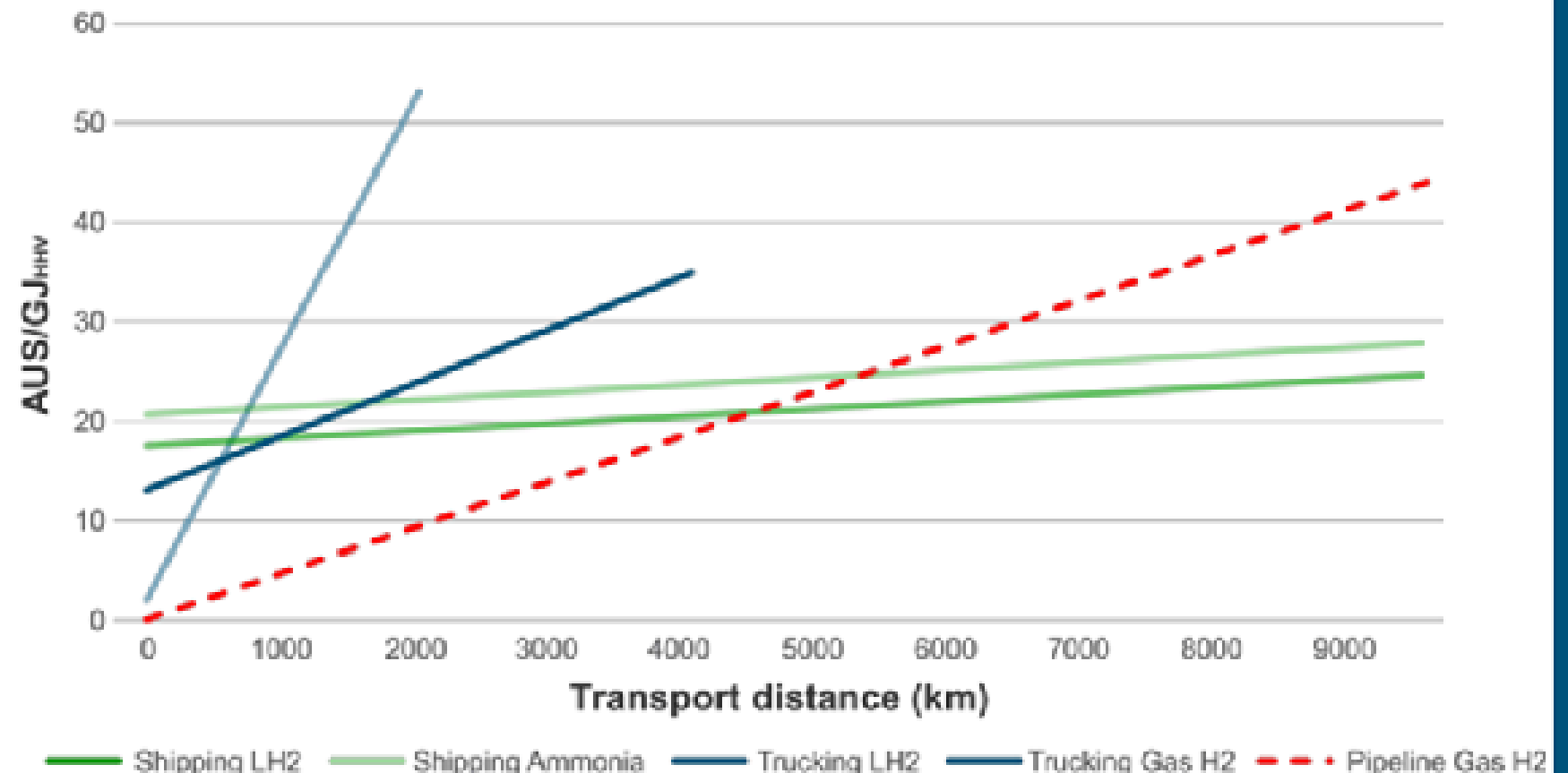
Rystad Energy

- Around 2/3 of the cost of producing green H₂ are the cost of renewables
- Shipping H₂ by boat costs multiples (~\$20/GJ) of shipping the same energy as CH₄ (~\$5/GJ)
- The delivered cost of H₂ is therefore all about the quality of renewable energy **and the cost of delivery**

REALLY ???

Access to markets by pipeline is massively advantaged over seaborne supplies – **Mongolia can supply H₂ to Chinese markets by pipeline**

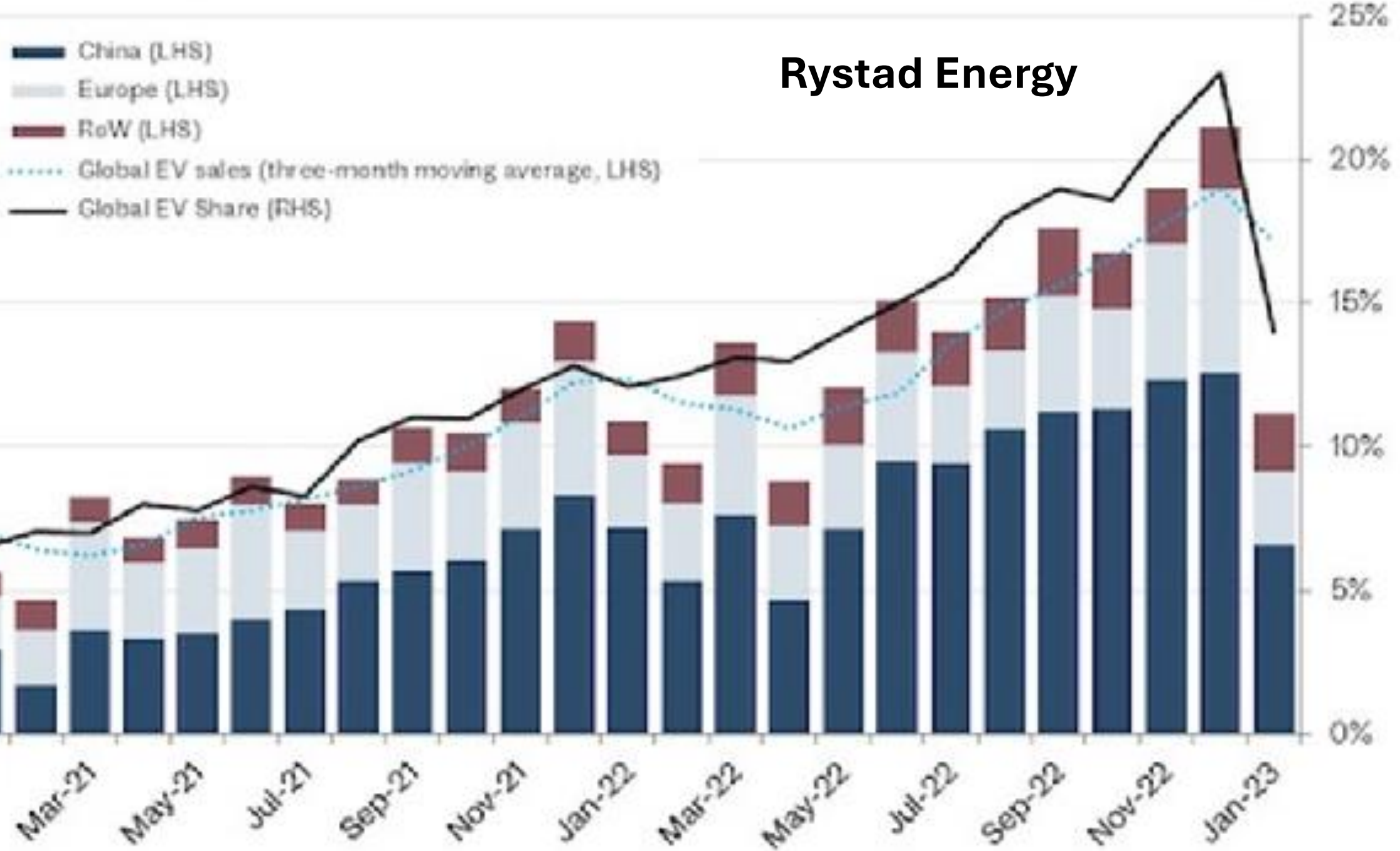
Cost of gas-to-gas hydrogen transportation, including conversion and reconversion - 2030s
For hydrogen production of ~15PJ/year

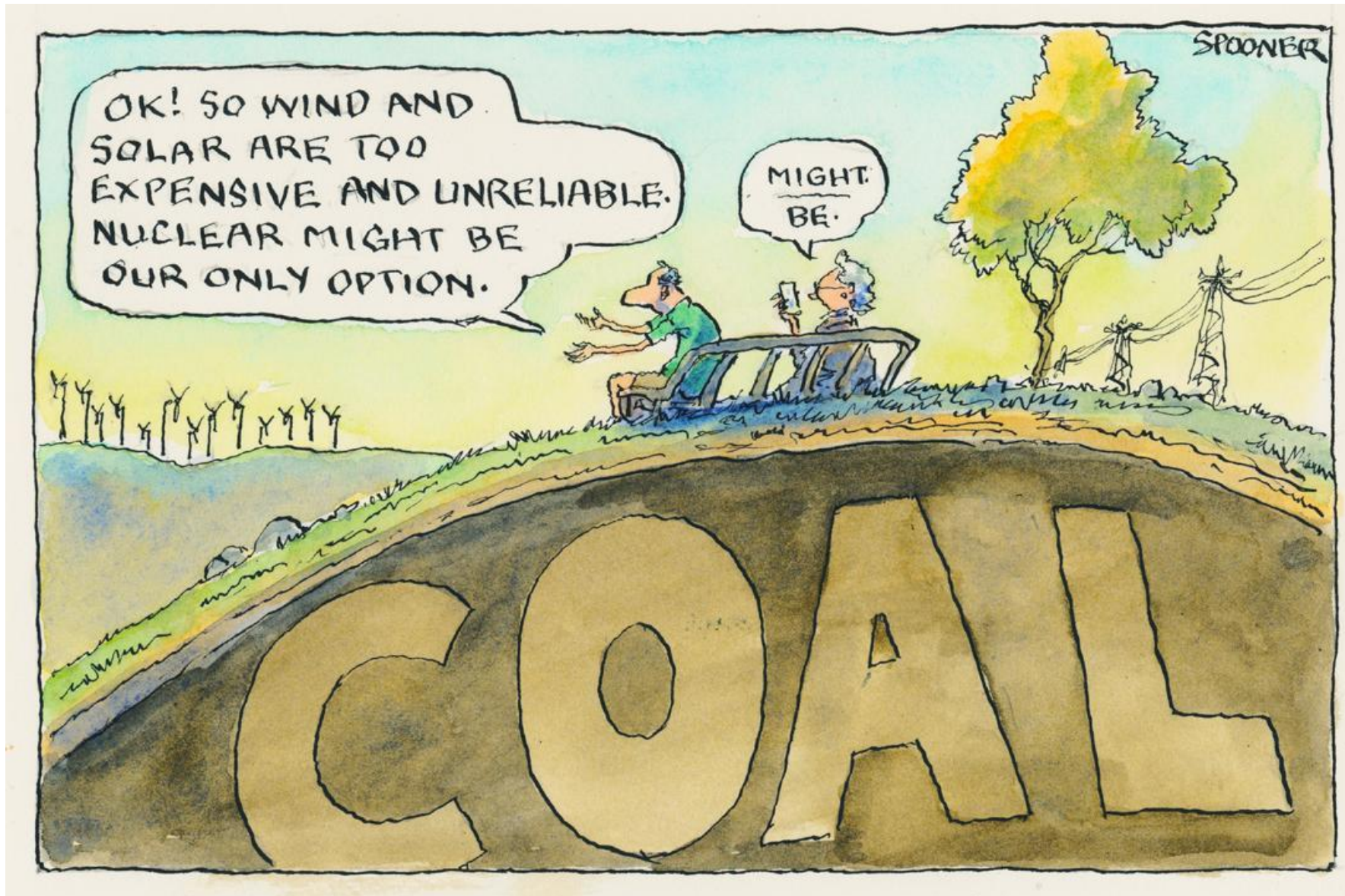


Meeting the motility energy demand – the continued role of liquid (and gaseous) gaseous fuels

- Greens demand for switching from gasoline, diesel, LFO, BFO, LPG, Av-gas, and methane (in its various forms, CNG - pipeline, CNG – in cylinders/bottles and importantly for the wellbeing of Australia, LNG), so they promote **green electric power - EVs**, but
- On the grapevine: The reliability of EVs is not good, the availability of EVs is poor, the use of Lithium-ion batteries continues to be hazardous, and having the power grid as the source of energy is challenging an already over stretched power system, but
- Are there existing situations where EVs ‘shine’? Probably, in tightly populated regions with mature power grids with excess capacity.

Rystad Energy





John Spooner, The Australian

The Ongoing Life of COAL as a Fuel

- John Spooner has it partially right, coal as a source of carbon is not finished (there is plenty to won), but the easy won high quality coal is becoming harder to find,
- Lower quality coal is only used with an increase in emissions,
- Environmental concerns will make the using that lower grade coal problematical, and make the international coal flow difficult,
- Coal project developments now carry high political and economic risk; finding investors for fossil fuel development is tough, but
- So could coal be a source of high-grade carbon – possible?

MC's experience with 'demineralised-coal' in the 1980s.

CARBON – an increasingly useful material

- Sources: Coal (lignite, torbanite, carbonaceous shale, oil-shale ..),
but demineralised coal has not been a great success,
- From the cracking of methane; the hydrogen likely be useful, the carbon,
 - Carbon for specialist uses can be split from methane, with hydrogen being a useful second product,
$$\text{CH}_4_{(g)} \rightarrow \text{C}_{(s)} + 2\text{H}_2_{(g)}, \Delta H = 74.85 \text{ kJ/mol of CH}_4$$
 - Produced from laser or other high temperature cracking process, and
- The carbon will be needed for steel (cementite Fe_3C – iron carbide) and SG cast iron production as a reductant, even if the iron ore is smelted using hydrogen, and
- Are there other advanced uses such as carbon fibres, Buckminster Balls?

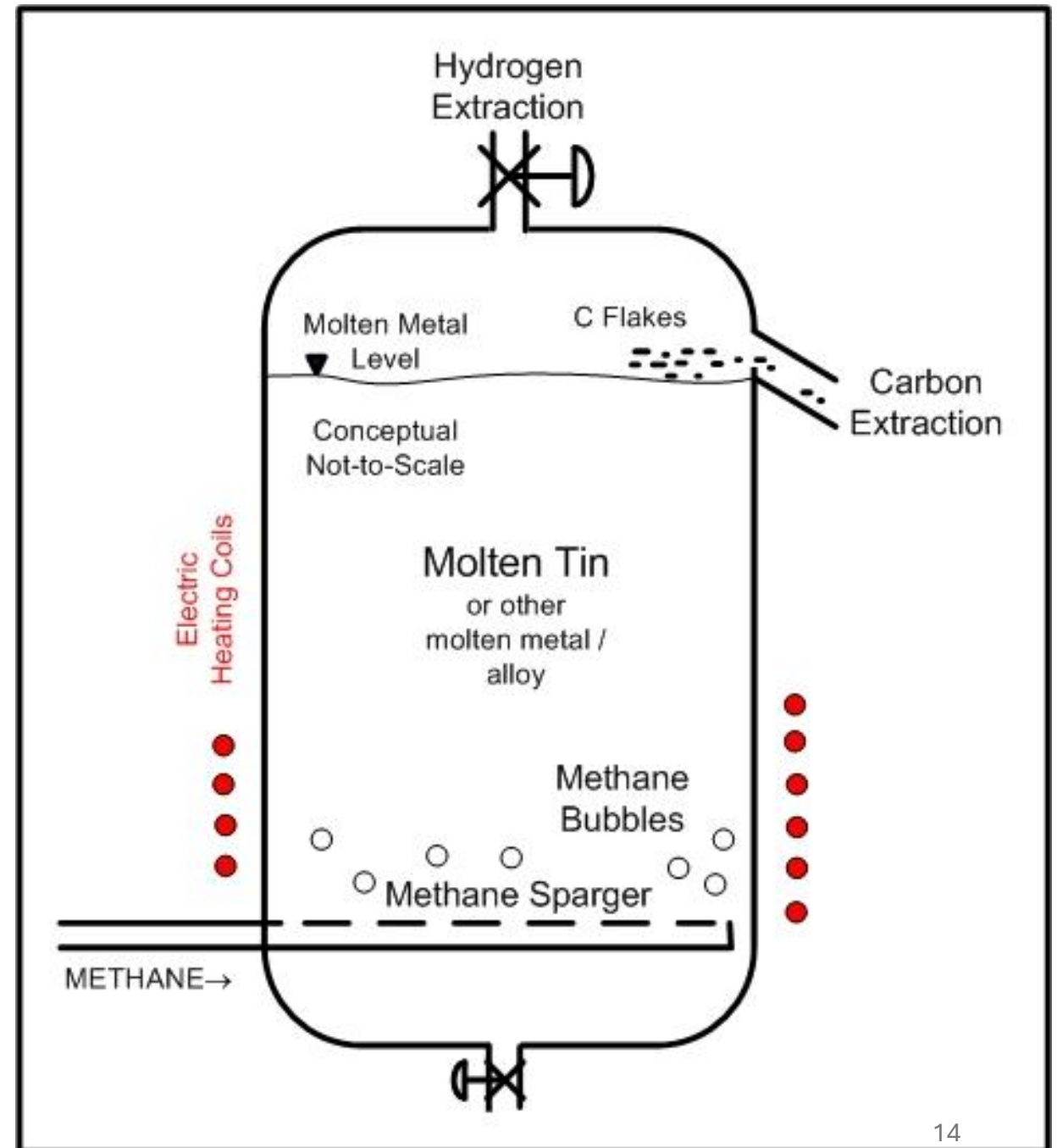
Explaining



A schematic indicating the main features of the methane cracker.

The process will likely be expensive in terms of fuel consumption however the value of the carbon product may meet the high fuel costs. This will depend on which allotrope of carbon is produced, its purity and value.

This is for the future, and will require RD&D.



How it works?

The concept is based on methane bubbling in a molten medium to produce hydrogen (and solid carbon)

- While methane bubbles are rising, they decompose under the high-temperature effect of the melt (Sn, Bi, Al, etc.),
- H₂ leaves as the effluent gas while carbon particles float at the melt surface, driven by buoyancy forces, so
- Consequently, reactor blockage due to carbon deposition on the reactor walls can be efficiently prevented.

Methane Cracking For Hydrogen Production, Malek Msheik et al, 2021, Energies

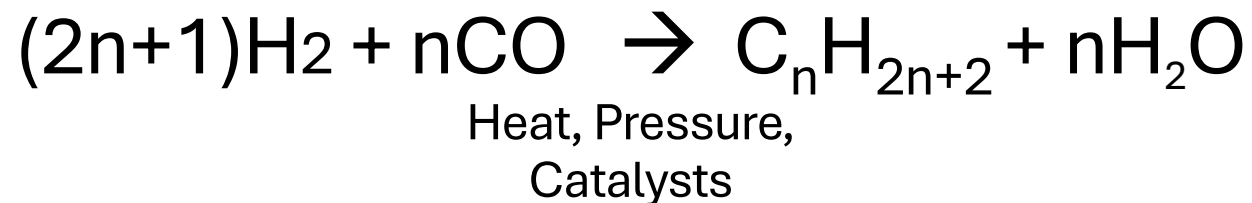
Energy for Power & Energy for Motility

- Power supply for motility, industry, commerce and meeting urban demand, are often competitive and sometimes complementary,
- Motility has been supported by the development of the petroleum industries but now some societies are looking for green energy complemented by new and extended electric power generation and reticulation – new and expanded GRIDS!
- An example of the change is the proposed development of motility based on EVs (cars first, utility vehicles) that are fed electric energy through the transmission and reticulation grids, grids that are stressed already in Australia,
- DISCUSSION ANYONE?

Recreating the Australian Petroleum Industry using unconventional feedstocks

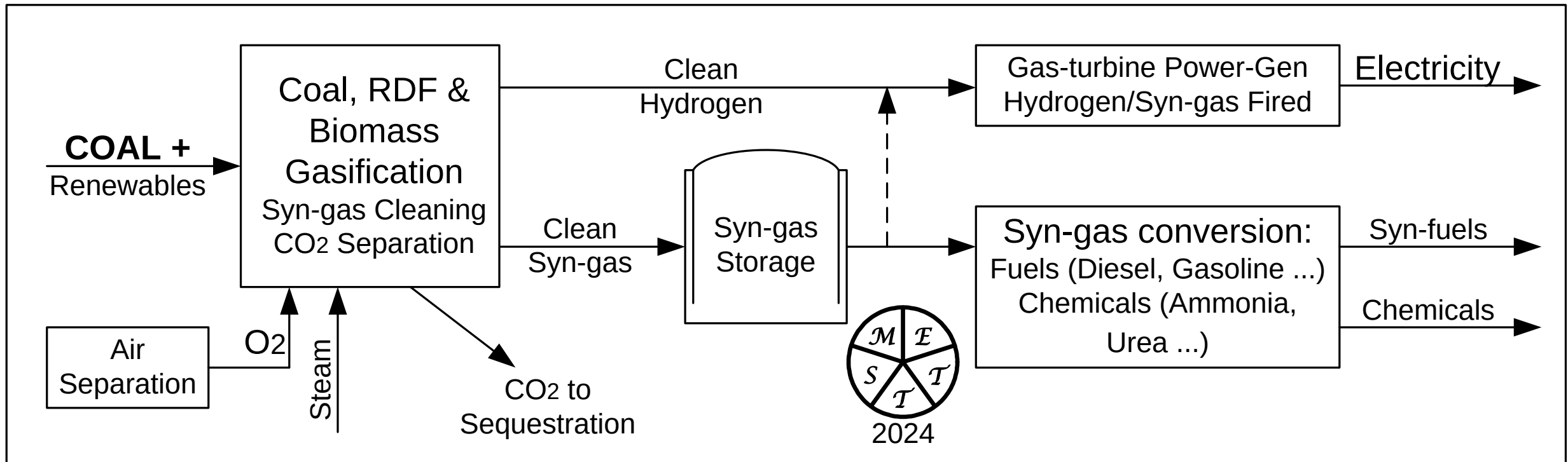
Replacing traditional DIESEL, LFO, M&HFO, asphalt, AV-gas varieties etc with **syn-gas** products is possible, but technically challenging and carries some risk.

SYNTHESIS GAS (syn-gas) is Hydrogen & Carbon Dioxide

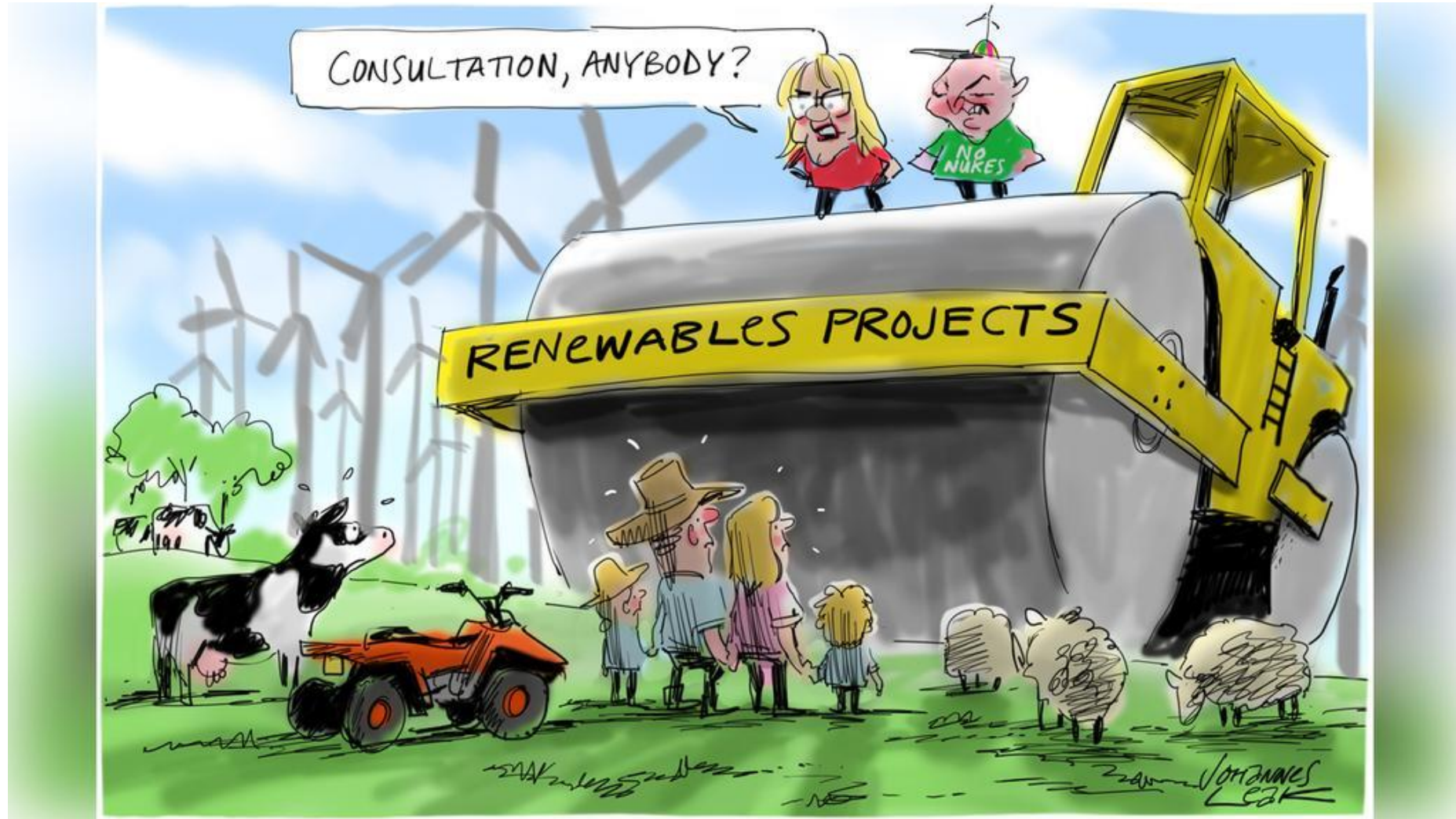


C_nH_{2n+2} is Petroleum (for Gasoline $n=8$)

Stretching the Fossil Fuels with Renewables



Our energy future in the hands of those that 'know'!



Thanks to Johannes Leck

**Thanks, and may we all
have a bright energy future!**

