

Cost Implications and Policy Development



The Cost of Energy

Before the tragedy of Ukraine at any rate ...

Use	“Retail Price”
Gas (heat for most in the UK)	5ppKwH
Electricity	20ppKwh
Road Transport fuel	40-50ppkWh

(Approximately)

- Prices are significantly different depending on the type of energy supply and what we use it for
- Prices for electricity have been long-linked to underlying fossil fuel prices ...
- That price linkage will be broken in time as fossil energy is eliminated from our energy system – but that seems unlikely to happen for quite a while yet



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Marine transport fuel	20-30ppkWh

(Approximately)

- Carrying less taxation and generally employing larger and more efficient engines, the ppkWh cost of marine transport fuel is significantly lower than road transport and not hugely dissimilar to electricity costs
- But there are always losses involved in changing one form of energy to another and the losses involved in making green hydrogen from green electricity are not trivial



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(Approximately)

- Fuel Cell technology shows native conversion efficiencies exceeding all but the largest and most efficient internal combustion engines with heat recovery and auxiliary steam generation
- But the efficiency advantage offered by cell technology will not off-set the conversion losses involved in making hydrogen



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(Approximately)

- And thus, when we switch to renewables for marine transport energy, the fuelling cost must rise
- But by how much ...?
- You'll see our own numbers later, ranging from fossil + 33% to + 100% ...
- (Don't try working that out on retail prices as some have done = 4-5 fold cost increase)
- ... but it's hard to say really other than it will certainly be more expensive than today



The Cost of Energy

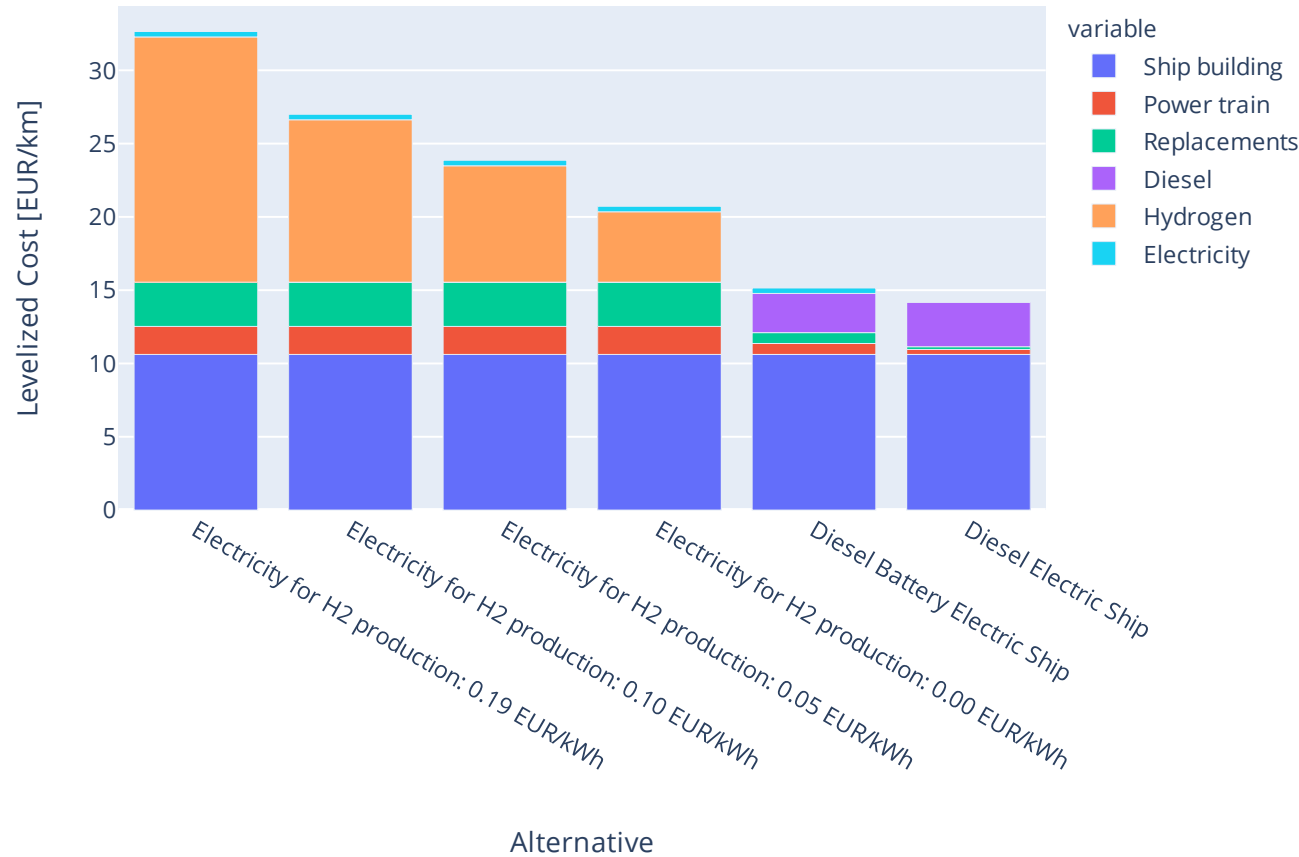
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(Approximately)

- Despite the efficiency of fuel cell modules themselves, for as long as green electricity remains more expensive than fossil fuels (prices linked due to market structure), green hydrogen will be a more expensive marine transport fuel to use than today's current marine fossil fuels
- The only short-term means of escaping that reality for the time-being, to some extent at least, is to make the green electricity yourself and indeed to own and operate the whole fuel supply chain – vertical integration
- But not everyone can do that and the model won't work everywhere



The Cost of Energy



- Conventional vs Hydrogen shows capital and maintenance costs are not hugely different
- The difference is the cost electricity used to make the hydrogen

Older HySeas III levelized cost of ownership modelling (newer comes later)



Implications

- **There is no present day financial justification/business case for the marine sector to switch to zero carbon green fuel**
- Any business trying to do so in the face of fossil-based competition would be in a lot of trouble – they could not compete
- In policy terms, delivering the green transition in the marine sector will take a carefully thought-out carrot & stick approach
- Clearly something must be done to incentivise and protect early green marine movers from fossil-competition



Silver Bullets ...?

- There is much talk of green ammonia becoming *the* zero carbon marine fuel – rather than hydrogen ...
- ... But it's more complicated than that - and part of the issue is our persistent desire to find silver-bullet solutions
- Fossil fuels have been a silver-bullet solution to energy provision – or so we thought until we began to realise the climate implications of their use
- **It is not the case** that we can wisely expect to find another single fuel type which will be such a silver bullet solution for transport fuels



Silver Bullets ...?

- To make green ammonia, you must first make ... green hydrogen
- We need more plant and more energy to make green ammonia from green hydrogen
- Meaning that green ammonia will necessarily be more expensive than green hydrogen
- How much more expensive ...?
- ... Jury is out on that one for the moment, but c.+20% is probably a fair estimate



Silver Bullets ...?

- Evidently c.+20% on operating fuel/energy cost is no small matter
- It would clearly make sense to use the green hydrogen as a marine fuel, where we can, if we're having to make it anyway
- And perhaps you can see a model emerging ...
- ... The same fuel production facility could well be producing and supplying both green hydrogen and green ammonia



Silver Bullets ...?

- What about battery-only vessels ...?
- Such vessels already exist and are in service where the duty-cycle of those vessels make sense
- Energy conversion losses are much lower for the battery cycle than anything possible with green hydrogen or ammonia – it will always be better/most cost-effective to use battery where we can
- But batteries are heavy per unit energy stored and bulky – they are only able to store sufficient energy for a rather limited number of short-range light-vessel operations



A New Hierarchy?

Range	Duty	Energy storage	Energy Cost
Short	Light	Battery	Least Expensive
Medium	Medium	Hydrogen	More expensive
Long	Heavy	Ammonia	Most expensive

- It is impossible really to sum up all vessel types and duties in a simple table such as that above
- But it does give a general picture of where the marine sector is very likely to end up in terms of how vessels are “fuelled”



Silver Bullet to a New Hierarchy

Range	Duty	Energy storage	Energy Cost
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- And what is all of that predicated on ...?
- ... The provision of green electricity!
- Because conversion cycle losses are unavoidable, ***it is impossible*** for those means of powering marine transport to be cheaper than green electricity itself



New Hierarchy

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- **If there is one thing which policy-makers/governments should do to assist the marine sector in decarbonising ...**
- **... It is to focus on massively increasing the provision of green electricity in order to drive down its price!**



New Hierarchy

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- But it is also about coming up with other means by which the marine sector will be able to minimise its green fuel/energy costs
- There are all sorts of system and other business costs relating to electricity which can and **must** be looked at by policy-makers



A New Hierarchy

Range	Duty	Energy storage	Energy Cost
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- Demand for electricity is often lower than green generation capacity – how can excess capacity be aggregated and delivered at very low cost for green fuels production?
- That is a question which goes far beyond marine energy – what we are discussing in the marine context is Energy Storage
- Some clever policy/market structuring thought on that issue in particular is sorely needed



How to get there ...?

- Where all of this ends up does seem to be becoming clear
- In the sunny uplands ...
- Electricity will much cheaper than it is today (relatively to other options)
- We will have a remarkably upgraded transmission network and be able to get power from *primary sources* to *storage* and final *demand* as required
- But getting to that destination is another matter entirely



How to get there ...?

- This is not a space in which customer sentiment can choose greener over dirtier
 - In terms of ferries, passengers have little or no choice as to operator/vessel type
 - In terms of freight - there are no direct public customers – and hard-nosed business decision rule, costs matter
- ... Without appropriate waterborne decarbonisation policy, regulations and incentives, change will be impossibly slow – this needs to be driven from the centre



Sticks - Regulation

- At some point the registration and usage of new fossil-fuelled vessels should be prohibited – just has been done with the sale of new road vehicles in the UK and elsewhere
- A clear road map needs to be produced in conjunction with the marine sector, laying out the timescale over which the transformation will happen
- Clarity regarding time-scales is critical to ensure the sector can plan



Sticks - Regulation

- The possibility of green marine corridors and ports should be seriously explored
- A green corridor/port prohibits the use of fossil-fuelled vessels on a given route or in and around a given port
- Green corridors and ports allow transformation to begin on a smaller scale and without impacting the entire marine sector simultaneously

- This model has been under discussion among the Baltic nations for some time
- It requires very careful thought and planning – to avoid the risk of traffic continuing to use much the same amount of, or indeed more, fossil fuel but using alternative routes/ports
- Effective monopoly routes could make good initial targets – for instance, services to domestic islands



Early Starters - Carrots

- Early adopters face the worst of all situations
 - In the earliest phase of the transition – ship design and building costs will be higher as the space develops
 - Fueling production and dispensing infrastructure will have to be built from scratch and without the economies of scale expected from the existing fossil fuel experience
- What to do ...?



Early Starters - Carrots

- Incentives will be needed to encourage early adopters
- They must be protected from lower cost fossil competition
- This will tend to be easier on routes which are already effective monopolies and are likely to remain as such



Early Starters - Carrots

- Any and all of the usual fiscal and monetary incentives may be appropriate
 - Capital grants and additional tax allowances
 - Loan guarantees
 - Local business rates reliefs/exemptions (particularly around fuel production facilities)
 - Simplified planning process (fuel production facilities)
 - Specific Tax Credits against increased fuelling costs – or direct subsidy



Carrots and Low Hanging ...

- Domestic Ferry services probably are the best place to start
 - Those are often *effective monopolies* in any case
 - Many are public-owned
 - Private-owned services should be treated equally to public-owned in terms of incentives
- Inland waterway services should also be looked at in this context
 - How much carbon and other pollutants are emitted by the fleet of water-taxis traversing the Thames in Central London?
 - And London is hardly alone in that – many rather large vessels act as water trains/taxis on many of Europe’s major rivers and larger lakes



Starting Gun

- These are arguably very early days in greening the waterborne sector
- The technology is only now beginning to be proven and to become available
- As such, this is ***exactly the right time*** for policy-makers to be doing their best thinking – in conjunction with sector expertise
 - to come up with a roadmap for the sector
 - to lay out what must change and by when (legislation/regulation)
 - to shape the most suitable type of incentives to get this change properly started



Cash on the move ...

- Costs will rise, but evidently the additional money paid out must go somewhere ...
- ... so, where does it all go?
- Into the accounts and wallets of the organisations and people who are engaged in providing:
 - the additional renewable energy
 - the fuel production, storage and dispensing assets
 - All of the associated additional services required
- And lots and lots of it **goes to government** as ... taxation! (direct and indirect, right up the supply chain and downstream from consequential spend)



Aka ...

- All of those things are Also Known As ... increased domestic economic activity!
 - Increased GDP
 - Increased GVA
 - Increased employment
- The UK *imports* more than a half of its liquid fossil fuels
- If those imports are displaced by *domestic* fuel *production* from domestic renewables, then it stands to reason that a great deal of economic activity will be re-domesticated (as it were)



History Probably Repeats ...

- Some years ago this speaker and Prof Karen Turner FRSE (Univ Strathclyde) noticed something about the UK road transport research space ...
 - There were many models trying estimate ***the cost*** of greening UK road transport
 - But no work at all had been undertaken on what ***the value*** of that transition would be the UK economy – we'd better look at that!
- No surprise that ***the costs*** looked huge, and no surprise that those would worry policy-makers (particularly the Finance ministry!)
- But if you thought those numbers looked big, and worrying – you really want to see the size of the numbers associated with ***the value*** of that transition!
- And that modelling/research work may have rather a lot to do with the impending legislated end of fossil-only vehicle sales in the UK!



History Probably Repeats ...

- Waterborne should learn from the experience of greening road transport wherever possible – and there are some marked parallels
- **Cost** only has real meaning when we understand the **value** of what we get from paying that cost
- It is critical that waterborne looks beyond simply the cost of the green transition and undertakes macroeconomic modelling to estimate the value of the transition
- There is certainly a significant overall economic gain in greening the waterborne sector – and that medium-term gain is one of the most powerful near-term justifications/arguments for government taking the lead in driving this area



Invest peanuts to attract ...

- A European government recently announced funding of ca.£/€20M to support a number of marine decarbonisation development projects
- That money was divided among 20-30 projects - each getting less than £/€1M on average
- Later KM will talk about Li-ion battery banks - how big do you think those battery banks actually are ...? Size of a filing cabinet perhaps? Not even close. It's taken over 10 tonnes of Li-ion batteries ... and at what cost?
- HySeas III has cost over £/€10M to deliver
- Development done properly in commercial scale shipping is very expensive – you don't get much for £/€1M



Invest peanuts to attract ...

- It is critical to support earlier stage development work which will often involve academic research – such support may well involve sums of a £/€1M, or perhaps less for desk work
- But proof of concept at full commercial scale – which is critical in de-risking much greater investment – also needs support and ***at realistic levels***
- As above – there is no private financial investment case for developing green vessels
- The likes of Maersk may well be able to support in their own right, but who else is ...?
- Governments don't tend to like this – but they really do need to pick winners – diluting available funds across too many projects is not likely to yield very much at all



Summary

1. Greening will unavoidably cause waterborne operating costs to rise significantly
2. Green shipping will struggle to compete with fossil-fuelled shipping
3. So, there is no financial case for transitioning to green shipping – but there absolutely is a climate imperative
4. Green shipping will not happen without government (national and supranational) intervention
5. Regulation and Incentives will be required



Summary

6. Green Corridors/Ports may be a good way of beginning in earnest – but will require careful thought to avoid unintended consequences
7. A focus on domestic ferry services may be wise in terms of initial greening investment
8. The right time to develop regulation and support frameworks for greening the marine is ***now***
9. Waterborne greening policy should learn from the experience of greening road transport



Summary

10. This isn't just about increased cost, it's also about increased GDP, GVA and employment – it is essential that macroeconomic modelling is used to establish the likely value of the greening transition – it's probably rather good!
11. Re. this an investment which will pay a return – it is not money lost
12. Development in waterborne greening development at full commercial scale is very expensive - support for such development should reflect that



Food for thought ...



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