

LAND SECTOR

CRITICAL MOMENT?
[PROJECT WAVE] WAR FIGHTING IN EUROPE & PACIFIC

UNINTERRUPTED FUEL SUPPLY
+ WATER SUPPLY
+ RATION SUPPLY

NEW POWER
TAIL PIPE NUMBERS LESS RELEVANT
WHAT IS BEYOND THIS?

MICRO NUCLEAR BEYOND BATTERIES
SMALL IS STILL BIG
50 YEARS POWERING NUCLEAR SUBMARINES

ON PERSON
ON PLATFORM
ON BASE

BATTERIES (CLEARED FOR FLIGHT?)
COMMON ARCHITECTURE
WEAPONS
ROBOTICS
POWER
DATA

HYBRID VEHICLES
HOW DO YOU RETROFIT COMBUSTION TO EV VEHICLES (NOW THAT THEY ARE THE INDUSTRY STANDARD)?

CONVERGENCE
COMPETITIVE ADVANTAGE
ENVIRONMENTAL SUSTAINABILITY

TD6
SUSTAINABILITY
WAVE POWER/SMA

COMPETITIVE ADVANTAGE IS PARAMOUNT

RECRUITMENT? REPUTATION?

AVAILABILITY OF FOSSIL FUELS

SUPPLY CHAINS

REDESIGNING SHIPS IS MORE COMPLICATED THAN JUST BIGGER TANKS

70% REDUCTION IN NEW WARRIORS EXCEPT TO WAR SHIPS
UK APPLIES SAME STANDARDS TO WAR SHIPS

OPERATIONAL CAPABILITY VS ENVIRONMENTAL CONCERNS

DESTINATION ZERO
GREEN HYDROGEN
LONG TERM AIM

ZERO EMISSIONS
BUT BATTERY IS ONLY AS GOOD AS DIESEL IF IT'S MADE WITH FOSSIL FUELS
SMALLER / LIGHTER VEHICLES

IF THE COMBUSTION ENGINE STILL WORKS: WHAT GOES IN?

WE NEED IT ALL AND WE NEED IT NOW!

IMPOSSIBLE TO MAKE DIRTY BOMB

OPTIMISED TO PREVENT THREATS CREATED BY WASTE

GAME CHANGER
POPPY SIZED URANIUM CONTAINMENT WITHIN PARTICLE
NO NEED FOR LAYERS OF CONCRETE

PUBLIC REACTION
NEEDS TO BE ADDRESSED

NO GRID / NO FUEL SUPPLY / ALWAYS ON

NEW REACTOR
LOAD TO LORRY
ANY OUTPUT POSSIBLE
HOTEL OUTPUT
DIRECT TO WEAPON

5 YEARS POWER
NO LIQUID - IMPOSSIBLE TO HAVE MELT DOWN

WE NEED TO KNOW: WHERE AND HOW DO YOU WANT TO USE THIS?

- POWER LEVELS
- DELTABILITY
- APPLICATIONS
- MINING

MARITIME SECTOR

2025+ EMBEDDED DECARBONISATION ADAPTABILITY

COMMERCIAL SHIPPING WILL LEAD THE WORLD
- BIGGER THAN ALL NAVIES PUT TOGETHER

ALSO SERVES AIR FORCE

SAME CHALLENGES
THERE IS A NEED FOR CROSS INDUSTRY CONSULTATION

WHO GETS SUPPLIES AND WHERE?

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OPERATIONAL CAPABILITY VS ENVIRONMENTAL CONCERNS

SPACE WEIGHT
SHIPS DON'T HAVE EITHER!

HARDER TO COMPROMISE AS DIESEL IS REALLY GOOD - EVERYTHING ELSE HAS ISSUES

10 YEARS ORDER TIME FOR NEW NAVY SHIPS

18 MONTHS ORDER TIME FOR COMMERCIAL SHIPS

HARDER TO KEEP UP WITH INNOVATION

DUEL FUEL RENEWABLE AMONIA

RESOURCES | **PRODUCTION + TRANSPORT** | **BUNKERING PORTS (PROVIDE ELECTRIC)** | **FUEL STORAGE**

PORTS 400 AROUND UK

SHORE POWER

COMMERCIALLED
UK GOV POLICY
CLIMATE CHANGE
SHIPPING BEATS RAIL ROAD & AIR EFFICIENCY

TOP PRIORITIES
CLIMATE CHANGE
AIR QUALITY
EMERGENCY

ALTERNATIVE FUELS
- HYDROGEN
- STORAGE & TRANSPORT ISSUES
- AMONIA
- LARGE DEEP SEA VESSELS

UK ISN'T GREAT AT BUNKERING
- LOCAL PLANNING
- ENERGY SUPPLY

THIS IS RADICAL CHANGE
VESSELS NOT READY FOR SHORE POWER

DEMAND ON LOCAL NETWORKS IS A BIG PROBLEM

HUGE VARIATION ON VESSEL TYPES

END TO END GREEN CORRIDORS

SAIL WIND POWER

UNMANNED DRONES

OPERATIONAL ADVANTAGE
RESILIENCE THROUGH SUSTAINABILITY
CLIMATE CHANGE IS A NATIONAL SECURITY ISSUE

THE UK IS GOOD AT THIS STUFF
LOTS OF WORLD FIRSTS HAVE BEEN ACHIEVED!

OPERATIONAL ADVANTAGE
RESILIENCE THROUGH SUSTAINABILITY
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NATO APPROVED 7 TYPES OF SAF

HYDROGEN
DOES NOT LIKE TO BE COMBUSTED
IT'S NO GOOD FOR FAST JETS

COMPUTER ELECTRIC
ADDITIONAL SAF

BATTERY ELECTRIC
100M HYDROGEN AIRCRAFT

HYDROGEN ARE BIG!
MOSTLY FUEL

DRIVE PERSEAT
HYDROGEN ROUTES DON'T EXIST

AVIATION SECTOR

50% GOV GHG EMISSIONS
42% RAF

NEAR IMPOSSIBLE TO RETRO FIT ANYTHING

H2O VAPOR
CONTRAILS
CO2 VISIBILITY!
LOW VISIBILITY!
COMPETITIVE ADVANTAGE!

GAS WILL BE THE FUEL TYPE FOR THE NEXT 100 YEARS
WHAT TYPE OF FUEL IS THE QUESTION

INDUSTRY CHANGE MET BY RAF

WE OPERATE DIFFERENT
- LONGER SERVICE TIME
- MORE INVESTMENT IN R&D

COMPETITIVE ADVANTAGE IN CONFLICT!

MOVE TO SAF
1st TIME VOYAGER RUNNING 100% SAF

INTEND TO FOLLOW 1st TRANSATLANTIC FLIGHT

GLOBAL AWES
GOVERNMENT
INDUSTRY
ACADEMIA

20% - RETHINKING CAPABILITIES
30% - EFFICIENCY IMPROVEMENTS
50% - SAF
1% - ZERO EMISSIONS
20% - CARBON REMOVAL

50% BY 2050

WHERE DOES SAF COME FROM?
CURRENTLY LITTLE INDUSTRY
LONG TERM SUPPLY

KICKSTARTING AN INDUSTRY

ENCOURAGING INVESTMENT
ADVANCED FUEL FUNDING
£165M AVAILABLE

REGULATION AND BALANCE

INDUSTRY PARTNERS
HEFA
ALCOHOL
CASIFICATION
POWER TO LIQUID - LONG WAY OFF YET

CREATING DEMAND
RAI BEST FUELS FORWARD

USED BY ALL/ASAP
MIGRATES DOWN A GOOD JOB

CREATION OF COMMERCIAL MARKET
CREATION OF NEW INDUSTRY

UK GREEN JOBS
PRICE STABILITY

OPERATIONAL ADVANTAGE
RESILIENCE THROUGH SUSTAINABILITY
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THE QUICKEST WAY TO IMPROVE IS TO REPAIR OLD AIRCRAFT

FASTER'S FASTER
MORE EFFICIENT
EASER'S REPAIRS
LESS FUEL

HYDROGEN AIRCRAFT
MOSTLY FUEL

DRIVE PERSEAT
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UK HAS CLEARED ALL 7 FUELS FOR MILITARY USE

USA HAS ONLY CLEARED 2

ARE ELECTRIC JETS REALLY POSSIBLE?
F35 ALREADY EXISTS
F-CAT

FOOD IS FUEL!
NO CURRENT TOOLS TO DETERMINE THIS
COMMERCIAL AIRSANE DOES THIS!

FULL LIFE CYCLE CONSIDERATION

CATEGORY MANAGEMENT IS NEEDED FOR ALIGNMENT

FUEL PRODUCTION AT BASE IS THE BEST WE CAN AIM FOR!

WHAT ARE THE LINKS BETWEEN AVIATION AND MARITIME FUELS?

USING WASTE HAS WIDER IMPLICATIONS

UK DIFFERENT CONTEXT

Q&A

WHAT WILL IT TAKE TO BE READY?

TRAINED OPERATORS WILL BE NEEDED
ON
OFF
WE'RE GOT TO KEEP IT SUPER SIMPLE

- STANDARDS
- PEOPLE SKILLS
- SHIFT OF FOCUS
- PREDICAMENT

OPTIMISED COMBUSTION ENGINES ARE MAKING HUGE PROGRESS ALREADY

THERE IS NO SILVER BULLET! BUT THERE ARE OPTIONS

GAINS VS RISK
HOW TO APPROACH PUBLIC PERCEPTION

USE CASES
IS SINGLE FUEL DEAD?
HOW MUCH WILL IT COST?
DO WE SHARE THIS TECHNOLOGY?

WHAT ABOUT THERMOCHEMICALS?
ALSO NO CONCEPT OF MELT DOWN

ADDITIONAL INCREMENTAL CHANGES
THREE CHANGES

BIG CHALLENGES + OPPORTUNITIES

HERE NEEDS TO BE CROSS-FUNCTIONAL DISCUSSION
WHERE WHEN YOU NEED IT MOST

OPERATIONAL CAPABILITY IS NO 1

ADAPTABILITY IS A COMPETITIVE ADVANTAGE

POWER SPEED

HERARCHY OF FUEL TYPES
F17
NGO

HOW DO WE GET ALIGNMENT?
DESIGNED TODAY FOR TOMORROW'S NEEDS

50 YEARS SHIP'S LIFETIME

SHIFTING INFRASTRUCTURE
NAVY MUST SHIFT TOO

LESS RELIABLE NICHE FUEL SYSTEMS
THE FUTURE IS PROMISING
NEAR TERM IS TROUBLING

CAN A SHIP POWER A PORT?
- CAN COMMERCIAL USE NUCLEAR?
- WHAT ARE THE IMPLICATIONS?
- MULTIPLE REGULATORS ON SHIP / IN PORT / VARYING GOVS

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