PROPELLING OUR FUTURE

DARREN VAUX
President of ICOMIA

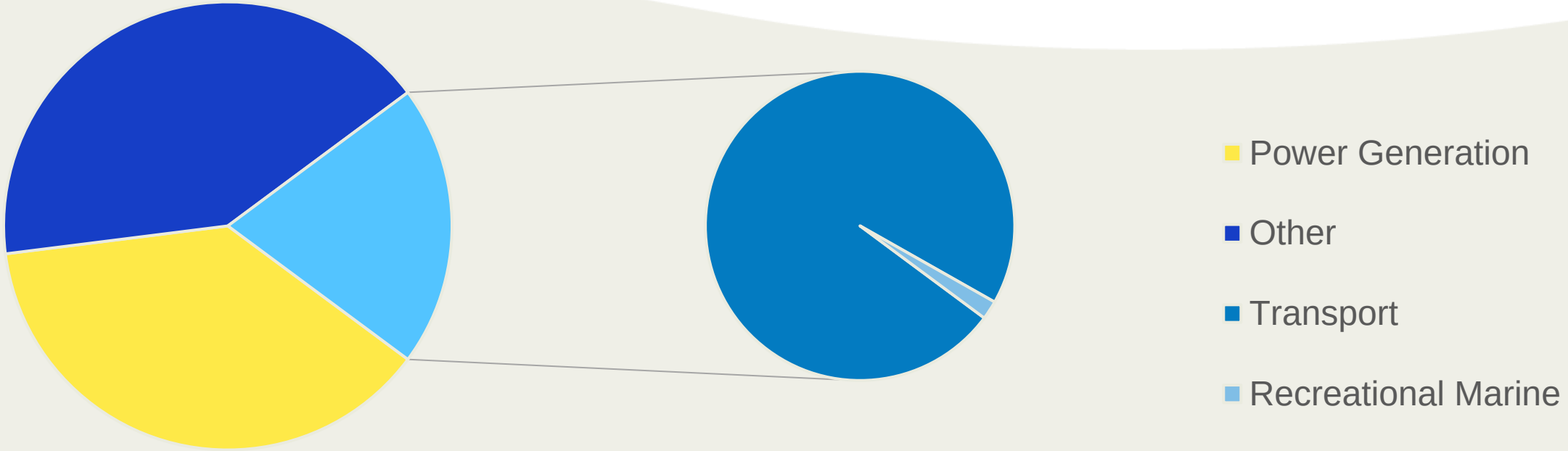
FRANK HUGELMEYER
President of NMMA

RICARDO

ICOMIA
International Council of Marine Industry Associations

1. Signed by 196 countries or parties
2. Global warming of 1.5deg C above pre-industrial levels is the ‘tolerable’ limit
3. **To achieve 1.5deg GHG must peak before 2025 and decline by 43% by 2030**
4. Current forecasts are that we are **not on track** to meet this.

Global Greenhouse Gas (GHG) Emissions



Recreational Marine Industry accounts for less than 0.1% of Global GHG

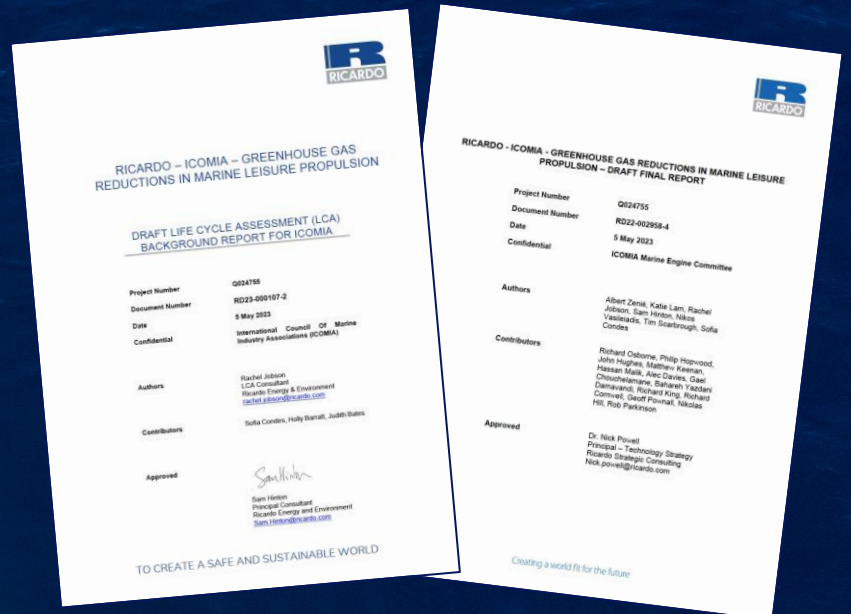
Our Challenge is Perception

PROPELLING OUR FUTURE

ICOMIA International Council of Marine Industry Associations

Boating enriches people's lives

The Ricardo Study


RICARDO – ICOMIA – GREENHOUSE GAS REDUCTIONS IN MARINE LEISURE PROPULSION

DRAFT LIFE CYCLE ASSESSMENT (LCA) BACKGROUND REPORT FOR ICOMIA

Project Number Q024755
Document Number RD23-000107-2
Date 5 May 2023
Confidential International Council Of Marine Industry Associations (ICOMIA)

Authors Rachel Jobson, LCA Consultant, Ricardo Energy & Environment, rachel.jobson@ricardo.com

Contributors Sofia Condes, Holly Barratt, Judith Bates

Approved Sam Hinton, Principal Consultant, Ricardo Energy and Environment, Sam.Hinton@ricardo.com

TO CREATE A SAFE AND SUSTAINABLE WORLD

RICARDO - ICOMIA - GREENHOUSE GAS REDUCTIONS IN MARINE LEISURE PROPULSION – DRAFT FINAL REPORT

Project Number Q024755
Document Number RD22-002958-4
Date 5 May 2023
Confidential ICOMIA Marine Engine Committee

Authors Albert Zeniè, Katie Lam, Rachel Jobson, Sam Hinton, Nikos Vasileiadis, Tim Scarbrough, Sofia Condes

Contributors Richard Osborne, Philip Hopwood, John Hughes, Matthew Keenan, Hassan Malik, Alec Davies, Gael Chouchelamane, Bahareh Yazdani Damavandi, Richard King, Richard Cornwell, Geoff Ponnall, Nikolas Hill, Rob Parkinson

Approved Dr. Nick Powell, Principal – Technology Strategy, Ricardo Strategic Consulting, Nick.powell@ricardo.com

Creating a world fit for the future

PROPELLING OUR FUTURE

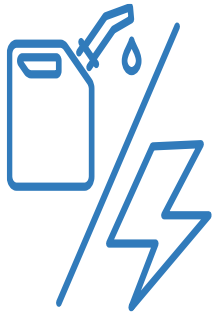
ICOMIA International Council of Marine Industry Associations

Technologies Investigated

Suitability Analysis of 5 Power System Options

Gasoline or diesel ICE

Sustainable drop-in fuel ICE (HVO or E-gasoline)



Hybrid-electric

Battery electric

H_2 ICE or fuel cell

For 9 Craft Categories

Inflatable boat

Runabout / day cruiser

PWC

Inland waterway vessel

Sailing yacht

Fishing boat

Pontoon boat

Displacement motorboat

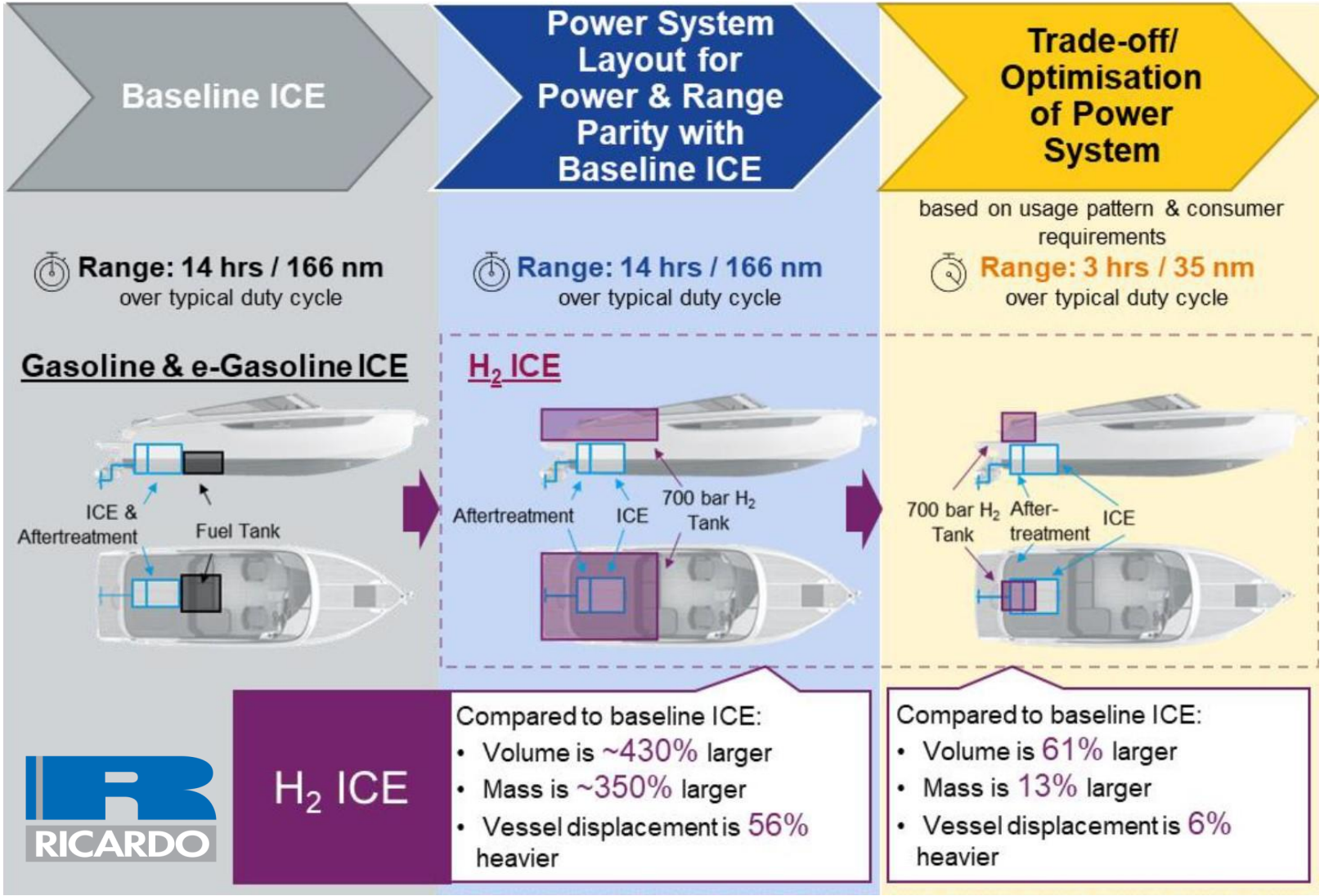
High performance motoryacht

PROPELLING OUR FUTURE | ICOMIA International Council of Marine Industry Associations

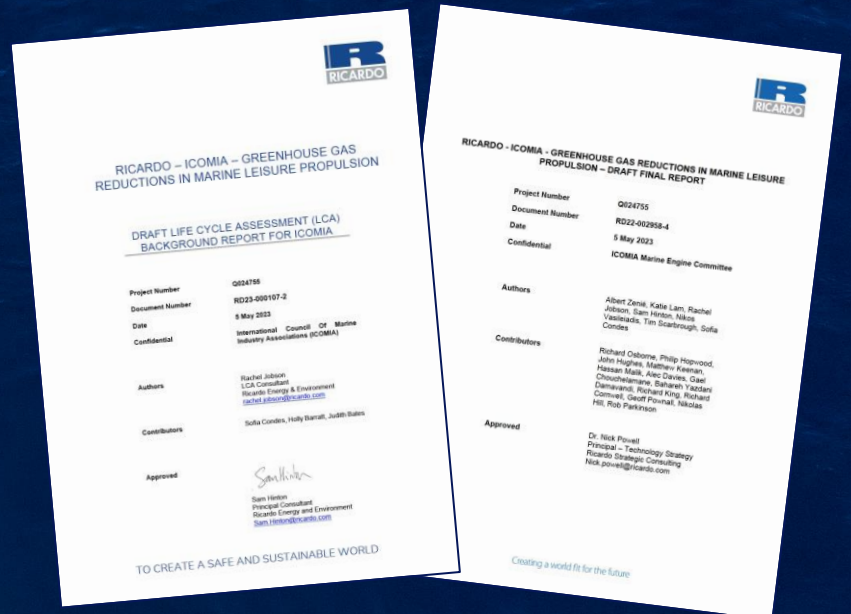
Craft Usage Profile (Baseline)

Craft	Length (m)	Fuel	Power (kW)	Fuel(L)	Engine Hrs pa	Life (Y)
Inflatable Tender	4	Gasoline	30	70	**35**	10
Fishing Boat	5.5	Gasoline	110	170	**35**	38
Displacement Motorboat	14	Diesel	150	1080	**48**	45
High Performance Yacht	19	Diesel	2000	4100	**130**	50
Sailing Yacht	11	Diesel	20	70	**24**	45
Pontoon Boat	7	Gasoline	170	175	**35**	38
Runabout	8	Gasoline	260	270	**43**	30
PWC (Hire)	3.6	Gasoline	155	70	**156**	12.5
Inland Waterway Vessel	10.8	Diesel	42	400	**48**	50

Energy Density - How each technology impacts the craft



The Results



RICARDO – ICOMIA – GREENHOUSE GAS REDUCTIONS IN MARINE LEISURE PROPULSION

DRAFT LIFE CYCLE ASSESSMENT (LCA) BACKGROUND REPORT FOR ICOMIA

Project Number	Q024755
Document Number	RD23-000107-2
Date	5 May 2023
Confidential	International Council Of Marine Industry Associations (ICOMIA)
Authors	Rachel Jobson LCA Consultant Ricardo Energy & Environment rachel.jobson@ricardo.com
Contributors	Sofia Condes, Holly Barratt, Judith Bates
Approved	Sam Hinton Principal Consultant Ricardo Energy and Environment Sam.Hinton@ricardo.com

TO CREATE A SAFE AND SUSTAINABLE WORLD

RICARDO - ICOMIA - GREENHOUSE GAS REDUCTIONS IN MARINE LEISURE PROPULSION – DRAFT FINAL REPORT

Project Number	Q024755
Document Number	RD22-002958-4
Date	5 May 2023
Confidential	ICOMIA Marine Engine Committee
Authors	Albert Zeniè, Katie Lam, Rachel Jobson, Sam Hinton, Nikos Vasileiadis, Tim Scarbrough, Sofia Condes
Contributors	Richard Osborne, Philip Hopwood, John Hughes, Matthew Keenan, Hassan Malik, Alec Davies, Gael Chouchelamane, Bahareh Yazdani Damavandi, Richard King, Richard Cornwell, Geoff Pinnell, Nikolas Hill, Rob Parkinson
Approved	Dr. Nick Powell Principal – Technology Strategy Ricardo Strategic Consulting Nick.powell@ricardo.com

Creating a world fit for the future

PROPELLING OUR FUTURE

ICOMIA International Council of Marine Industry Associations

Task 1

Decarbonisation Options
Overview of each propulsion system type including systems required, impact on craft, infrastructure required and fuel supply options

Task 2

Greenhouse Gas Life Cycle Assessment (LCA)
Lifecycle assessment to ISO 14044 and 14067 including manufacture, use phase and end of life for energy converters and energy carriers

Task 3

Total Cost Of Ownership
Purchase cost and operational costs including energy and maintenance for energy converters, energy carriers and new infrastructure

Task 4

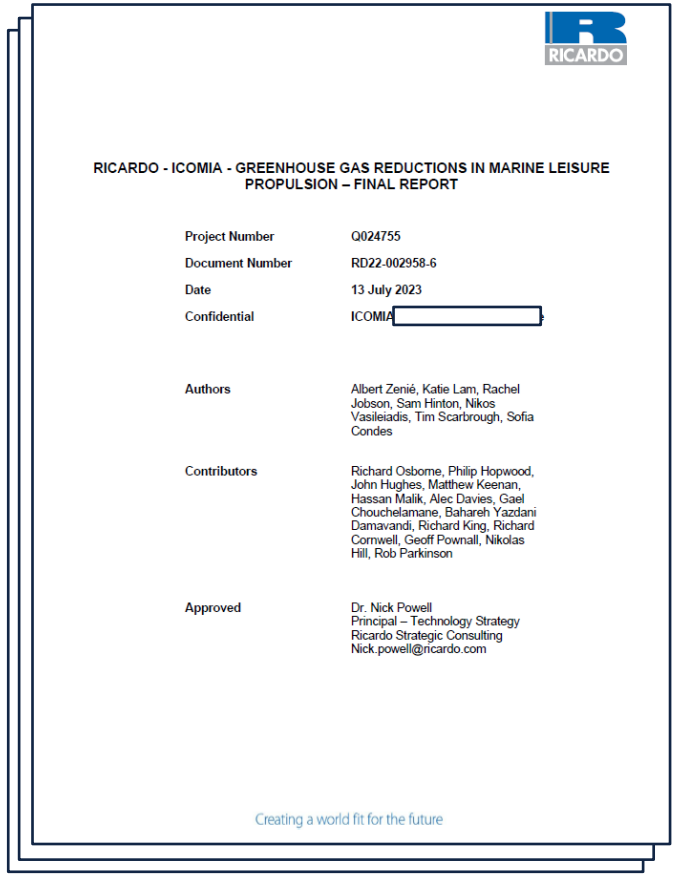
Boat Power Systems Implications
Analysis of life expectancy, maintenance requirements, performance, safety and commercial availability

Task 5

Infrastructure Implications
Analysis of life expectancy, safety, expected availability of fuels or energy

Task 6

Suitability And Ranking
Overall suitability of different options for each craft type and usage case



RICARDO - ICOMIA - GREENHOUSE GAS REDUCTIONS IN MARINE LEISURE PROPULSION – FINAL REPORT

Project Number	Q024755
Document Number	RD22-002958-6
Date	13 July 2023
Confidential	ICOMIA [redacted]
Authors	Albert Zenié, Katie Lam, Rachel Jobson, Sam Hinton, Nikos Vasileiadis, Tim Scarbrough, Sofia Condes
Contributors	Richard Osborne, Philip Hopwood, John Hughes, Matthew Keenan, Hassan Malik, Alec Davies, Gael Chouchelamane, Bahareh Yazdani Damavandi, Richard King, Richard Cornwell, Geoff Pownall, Nikolas Hill, Rob Parkinson
Approved	Dr. Nick Powell Principal – Technology Strategy Ricardo Strategic Consulting Nick.powell@ricardo.com

Creating a world fit for the future

558 Page Report

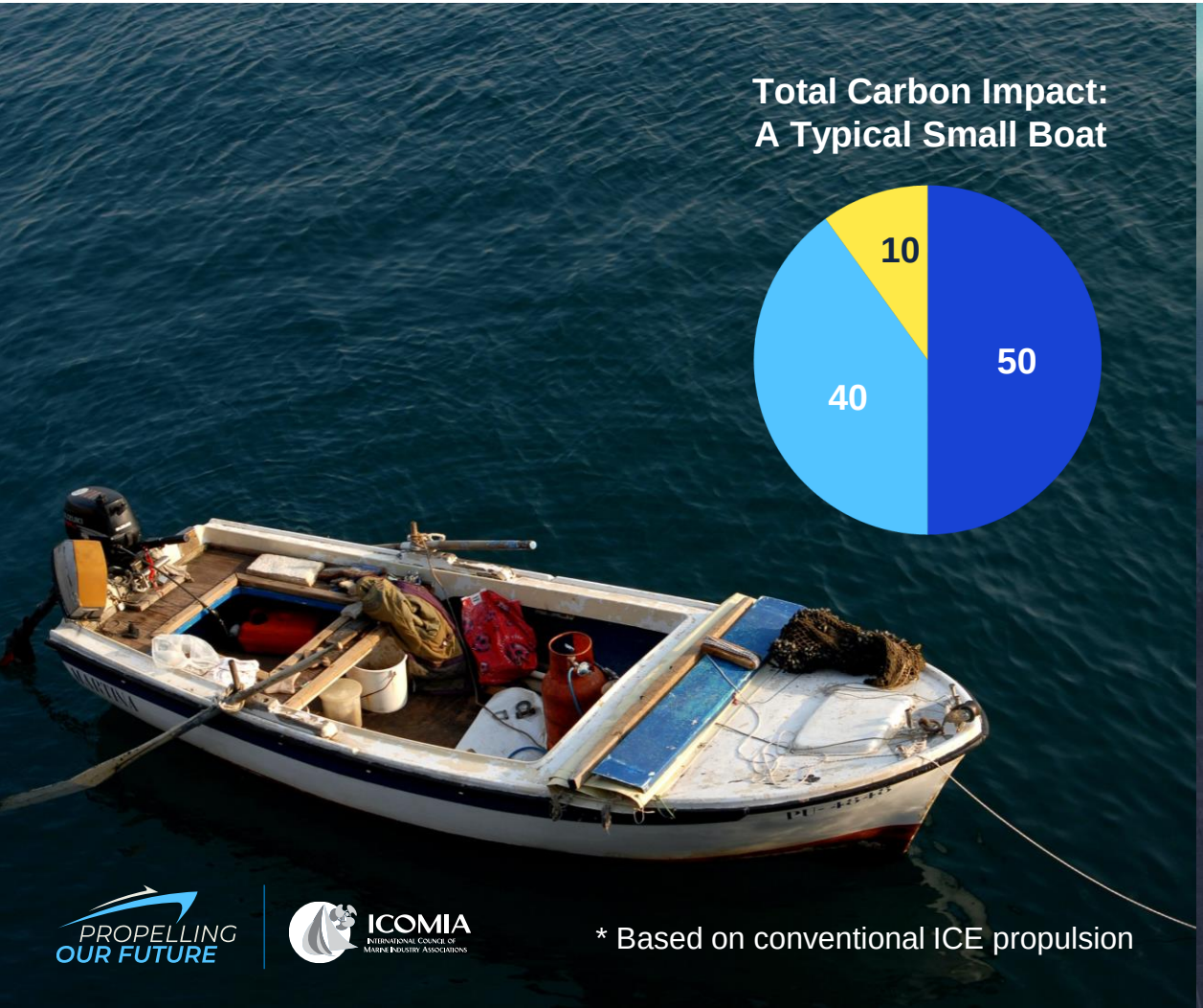
PROPELLING OUR FUTURE | ICOMIA International Council of Marine Industry Associations

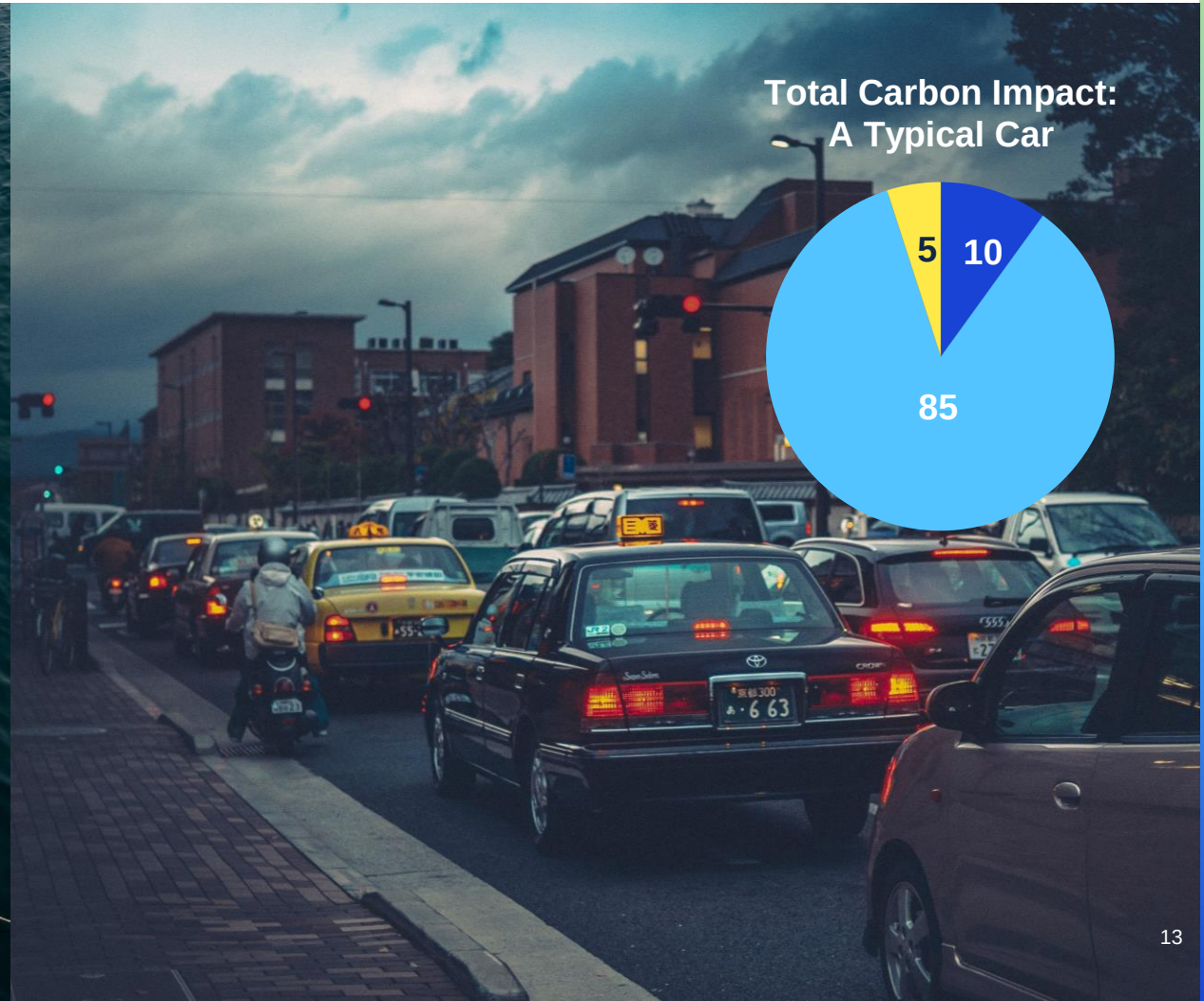
Key Finding

There is **“no one size fits all”** solution to reduce the carbon emissions of propulsion

Carbon Footprint in Each Stage of Life

Manufacture Usage End of Life





PROPELLING OUR FUTURE

ICOMIA International Council of Marine Industry Associations

* Based on conventional ICE propulsion

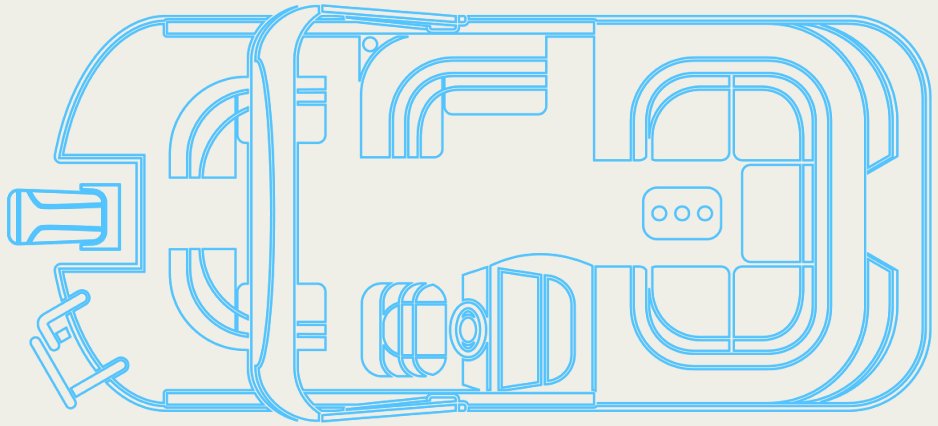
What the majority of cars are doing right now…

What the majority of boats are doing right now…

PROPELLING OUR FUTURE

ICOMIA
International Council of Marine Industry Associations

Pontoon Boat

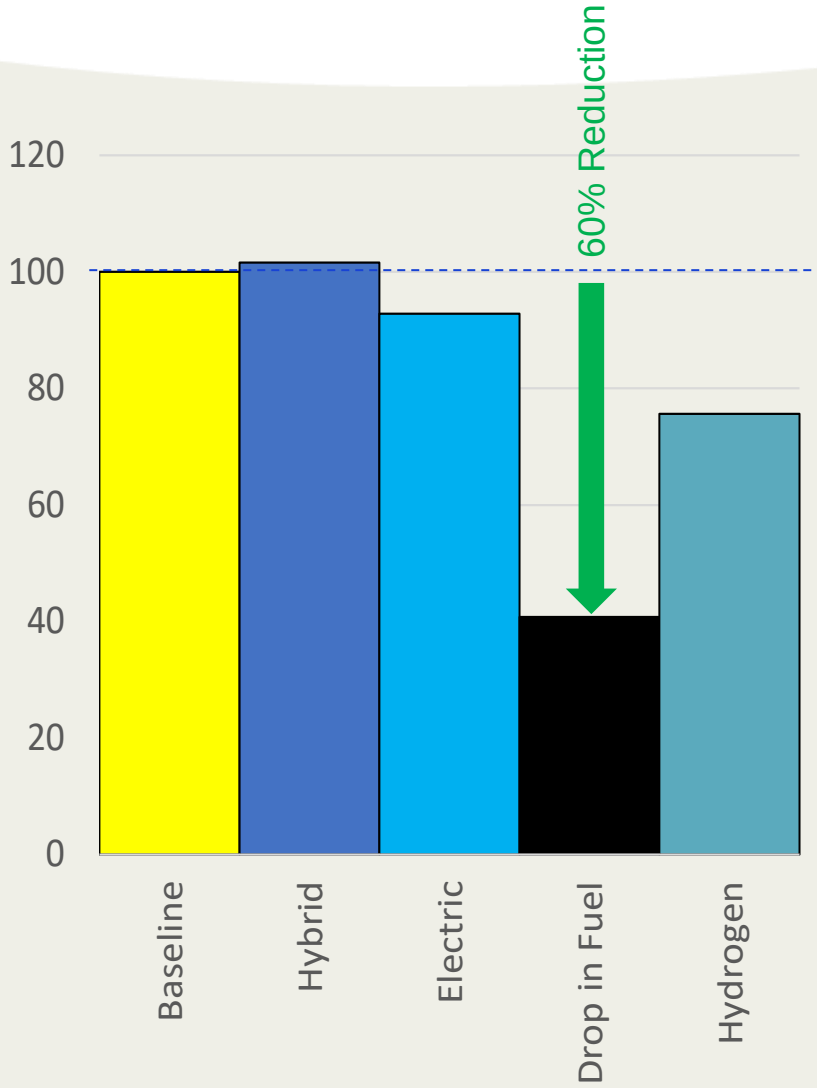


Use Case Assumptions

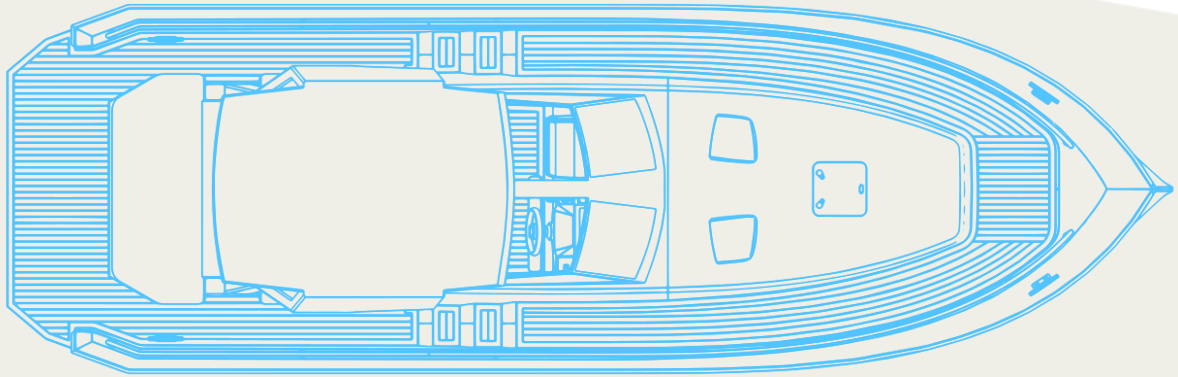
Annual Utilisation (hours)	35
Lifespan (years)	38

Results

- Switching to sustainable marine fuel would have the biggest impact.
- Benefits of other technologies restricted by low utilisation scenarios.



Displacement Motorboat

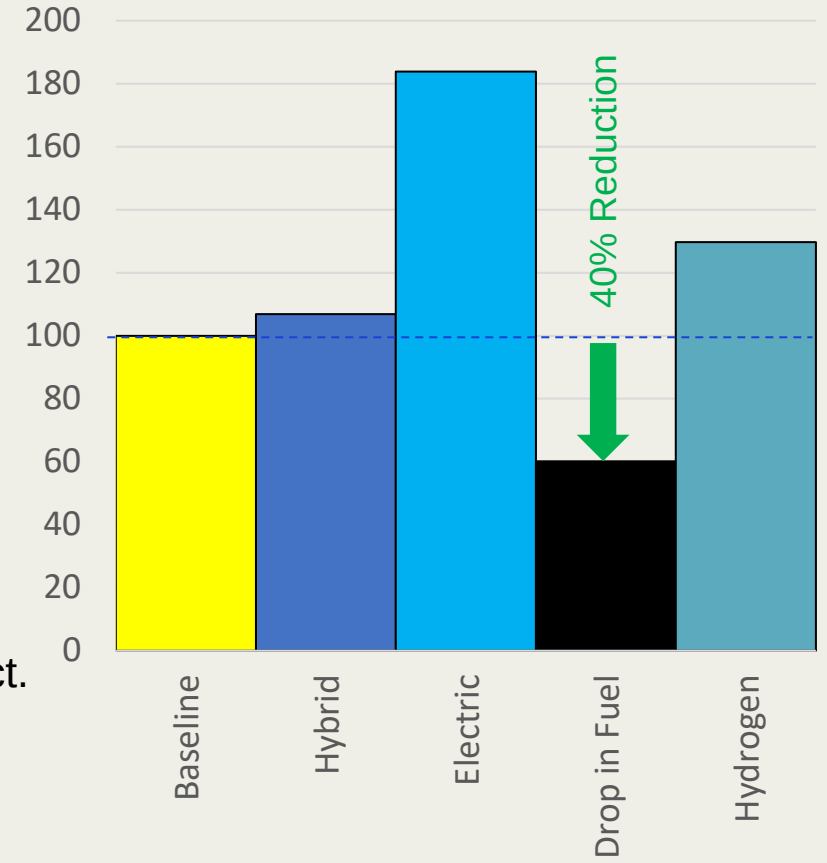


Use Case Assumptions

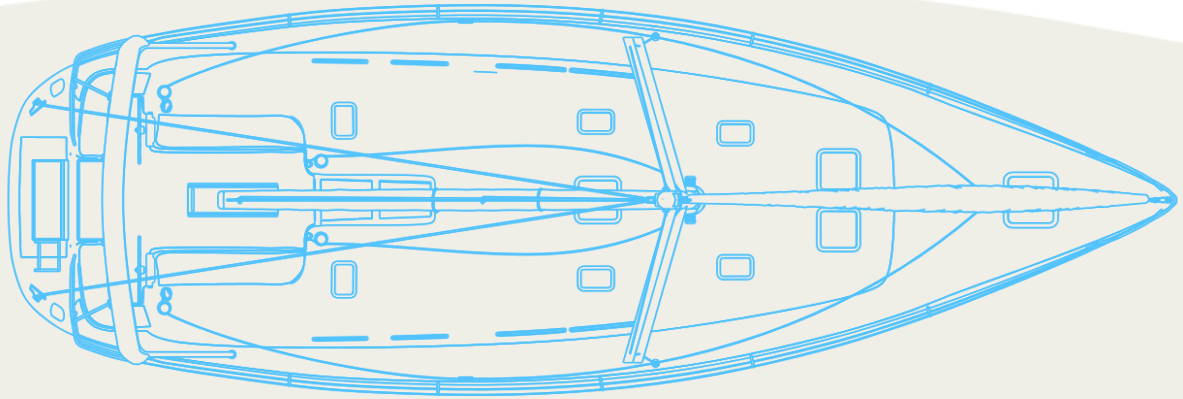
Annual Utilisation (hours)	48
Lifespan (years)	45

Results

- Switching to sustainable marine fuel would have the biggest impact.
- Electric propulsion would present too great of range compromise.



Sailing Yacht

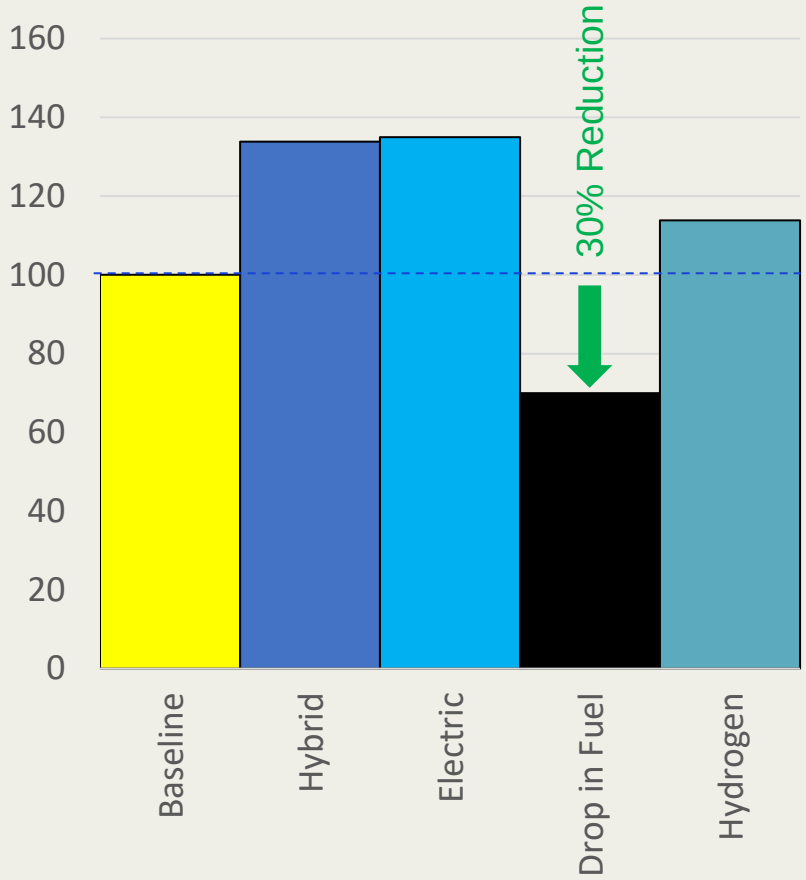


Use Case Assumptions

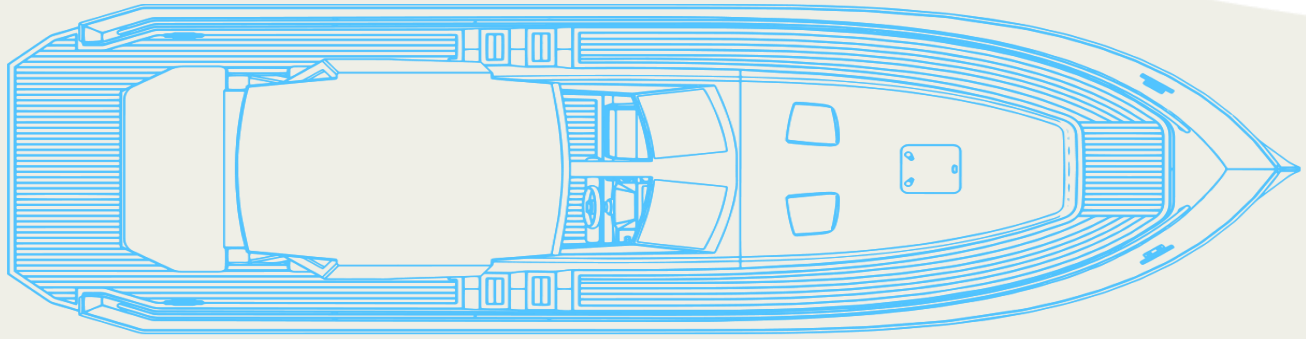
Annual Utilisation (hours)	24
Lifespan (years)	45

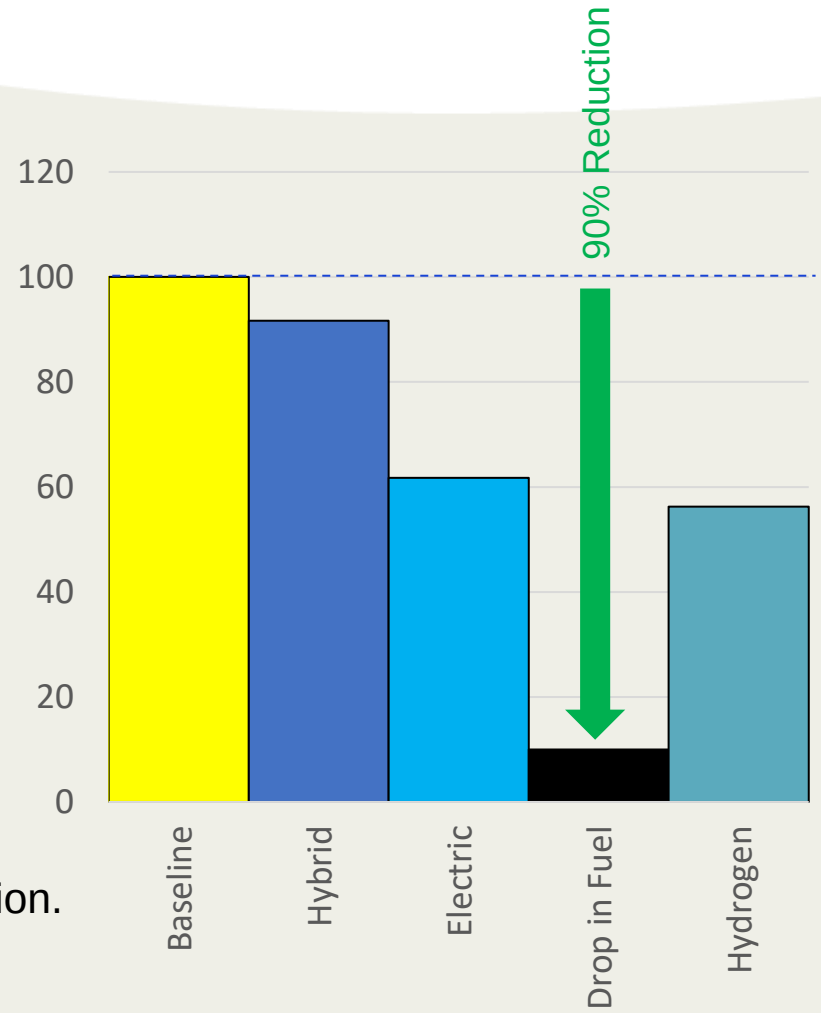
Results

- Sustainable marine fuel would have the biggest impact.
- The long life and low annual engine hours make it impossible to offset the manufacturing impact of other technologies.



High Performance Motoryacht





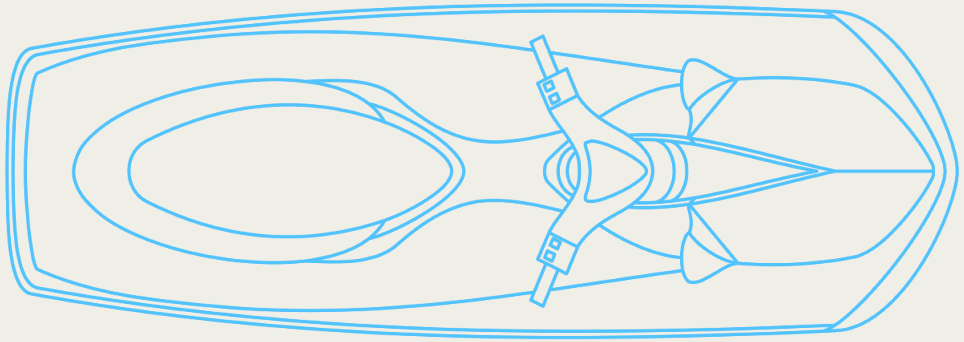
Use Case Assumptions

Annual Utilisation (hours)	130
Lifespan (years)	50
LOA	<20m

Results

- All alternative technologies could present an opportunity.
- Hydrogen presents an interesting opportunity given the high utilisation.
- Sustainable marine fuel presents the biggest carbon reduction.

PWC – High Utilisation Rental

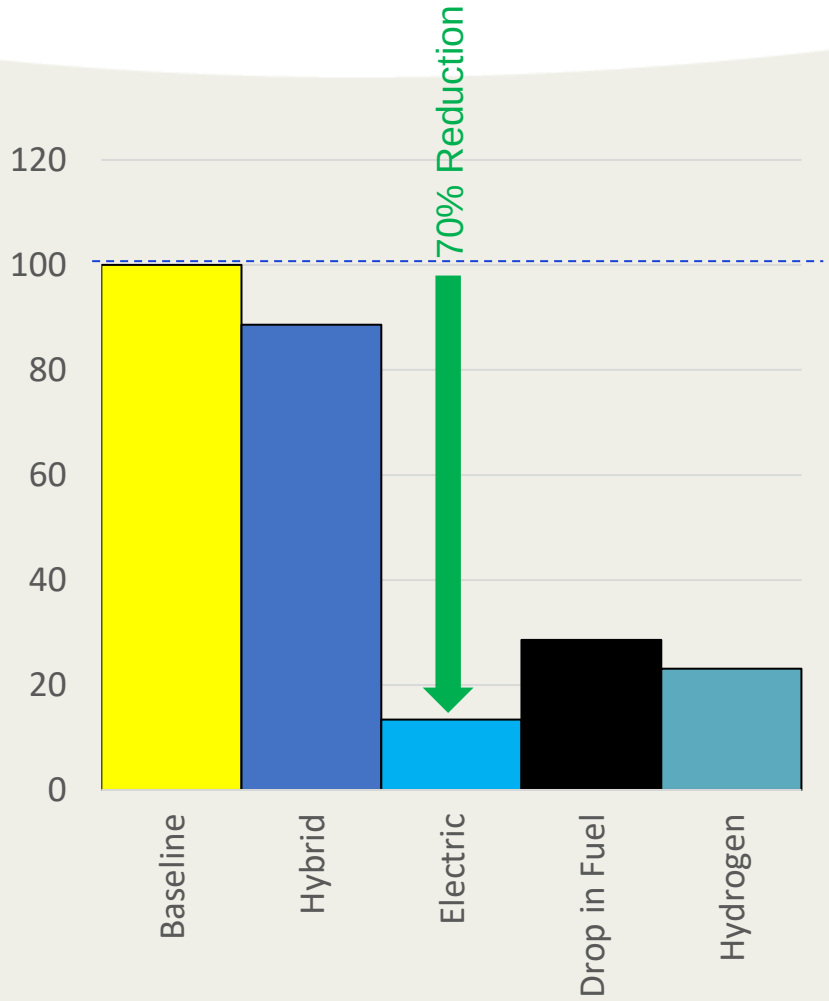


Use Case Assumptions

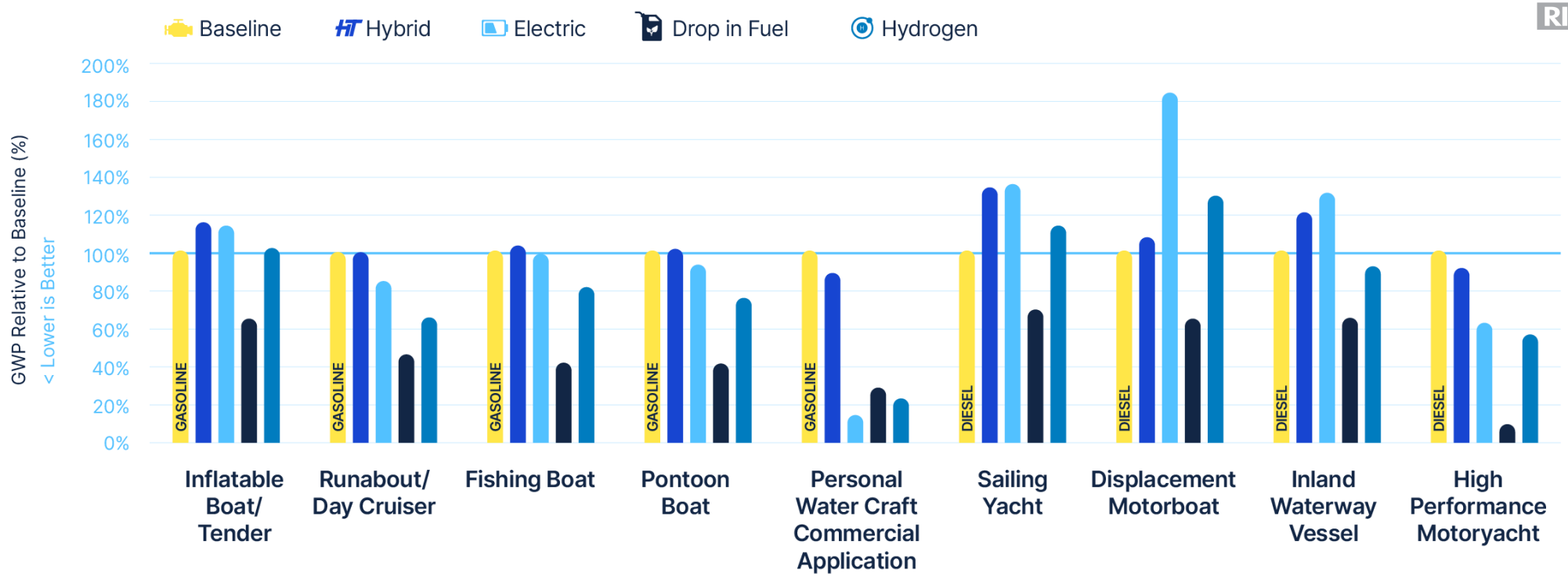
Annual Utilisation (hours)	156
Lifespan (years)	12.5

Results

- An electric propulsion system produces the highest carbon reduction.
- Modelled on a very high utilisation of a commercial use case.
- Assuming that a range reduction is not a limitation.



Key Findings



	Inflatable Boat/ Tender	Runabout/ Day Cruiser	Fishing Boat	Pontoon Boat	Personal Water Craft Commercial Application	Sailing Yacht	Displacement Motorboat	Inland Waterway Vessel	High Performance Motoryacht
Annual utilisation (h)	35	43	35	35	156	24	48	48	130
Lifetime (y)	10	30	38	38	12.5	45	45	50	50

Figure 2 - Lowest global warming potential (GWP) for each propulsion system relative to the baseline ICE of each craft in 2035 ($kgCO_2eq/vh$). Lower values result in lower CO_2 emissions over the lifetime of the craft.

Production of hydrotreated vegetable oil(HVO) for diesel powered boats assumed to be produced from waste feedstocks such as cooking oil. All sources of electricity are zero fossil fuel.

Decarbonisation Conclusions

1. There is **“no one size fits all”** solution
2. LCA analysis is critical to achieving carbon reduction as there is significant CO_2 in the supply chain of materials & energy
3. Sustainable fuels are the leading path to meet the Paris Agreement for the existing and new fleet based on current technology
4. Current electric propulsion & H2 technology are only a solution for specific use cases
5. R&D and technological advancement are required for new & alternative technologies to be competitive (Range, Performance, Price, CO2)
6. Global safety protocols/standards are required for new technologies

Next Steps & Questions

Join us here at **11:45 tomorrow** when our technical leads offer a deeper discussion on the technical and data aspects of the report