Sustainable Sea Transport in the Pacific Islands

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Sustainable Sea Transport Research Programme

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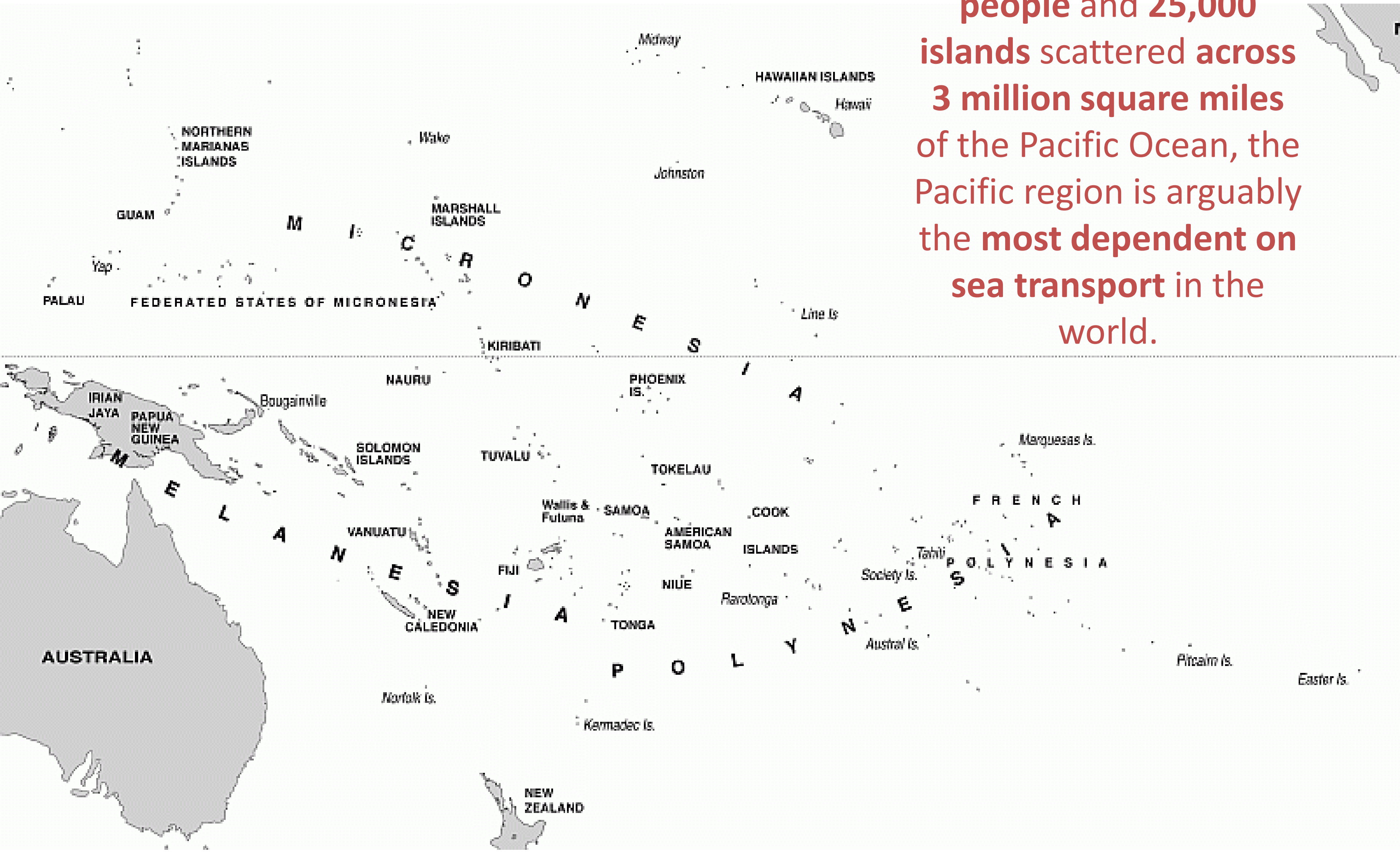
The Pacific region

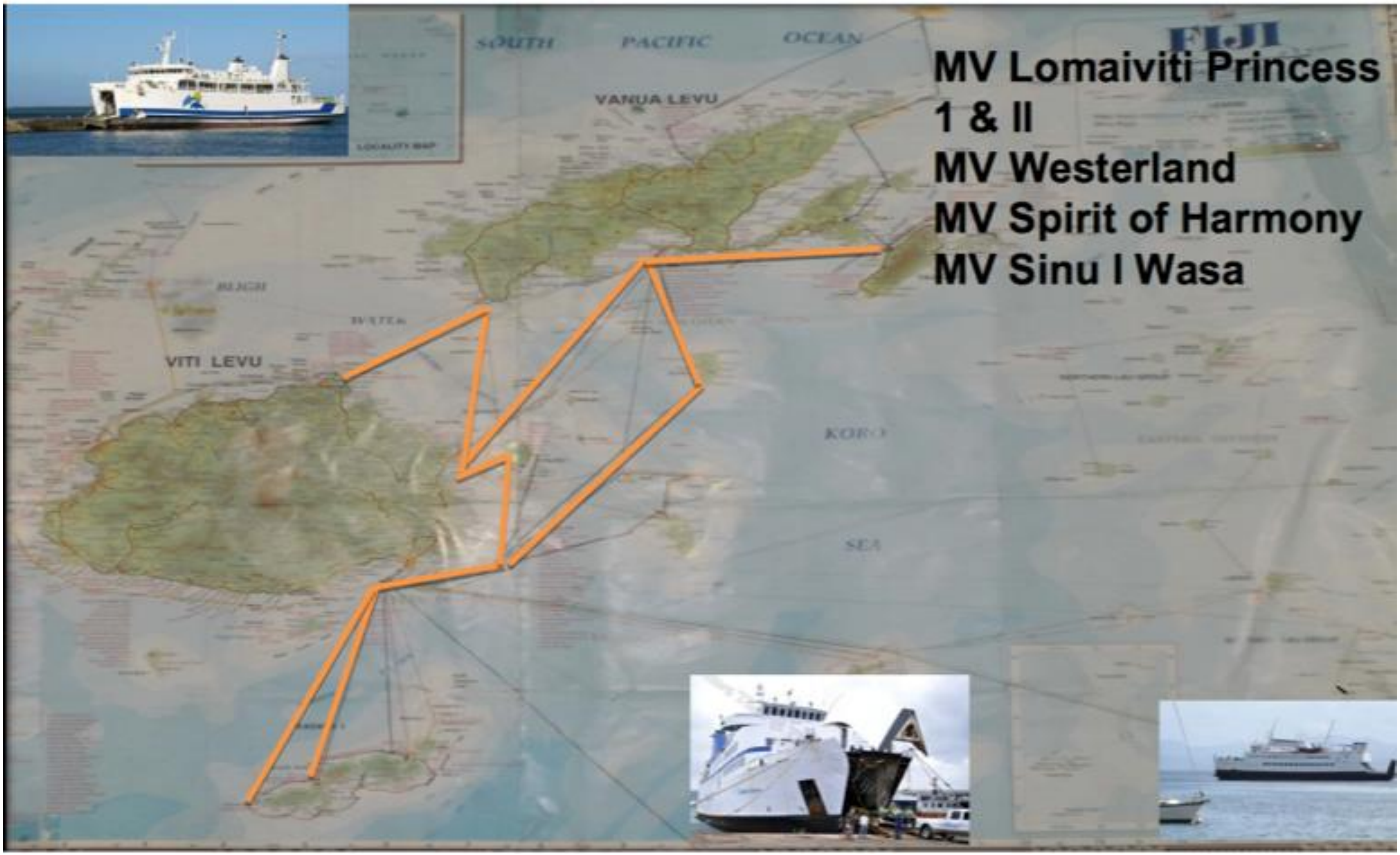


Around **10 million people** and **25,000 islands** scattered **across 3 million square miles** of the Pacific Ocean, the Pacific region is arguably the **most dependent on sea transport** in the world.

Sea transport issues in the Pacific

- The unique characteristics of Pacific island shipping:
  - long distances, thin routes, minute economies, low cargo volumes, high freight rates, financing barriers, and high infrastructural costs
- There has been a long history of the region struggling to find long-term, sustainable, and cost-viable solutions for sea transport, even in periods of relatively low energy costs – particularly true for domestic shipping
- Ships are often old, poorly maintained and inefficient
- Fossil fuel is often the largest single operating cost for shipping operators. Long distances and small loads make many routes unviable and uneconomical.

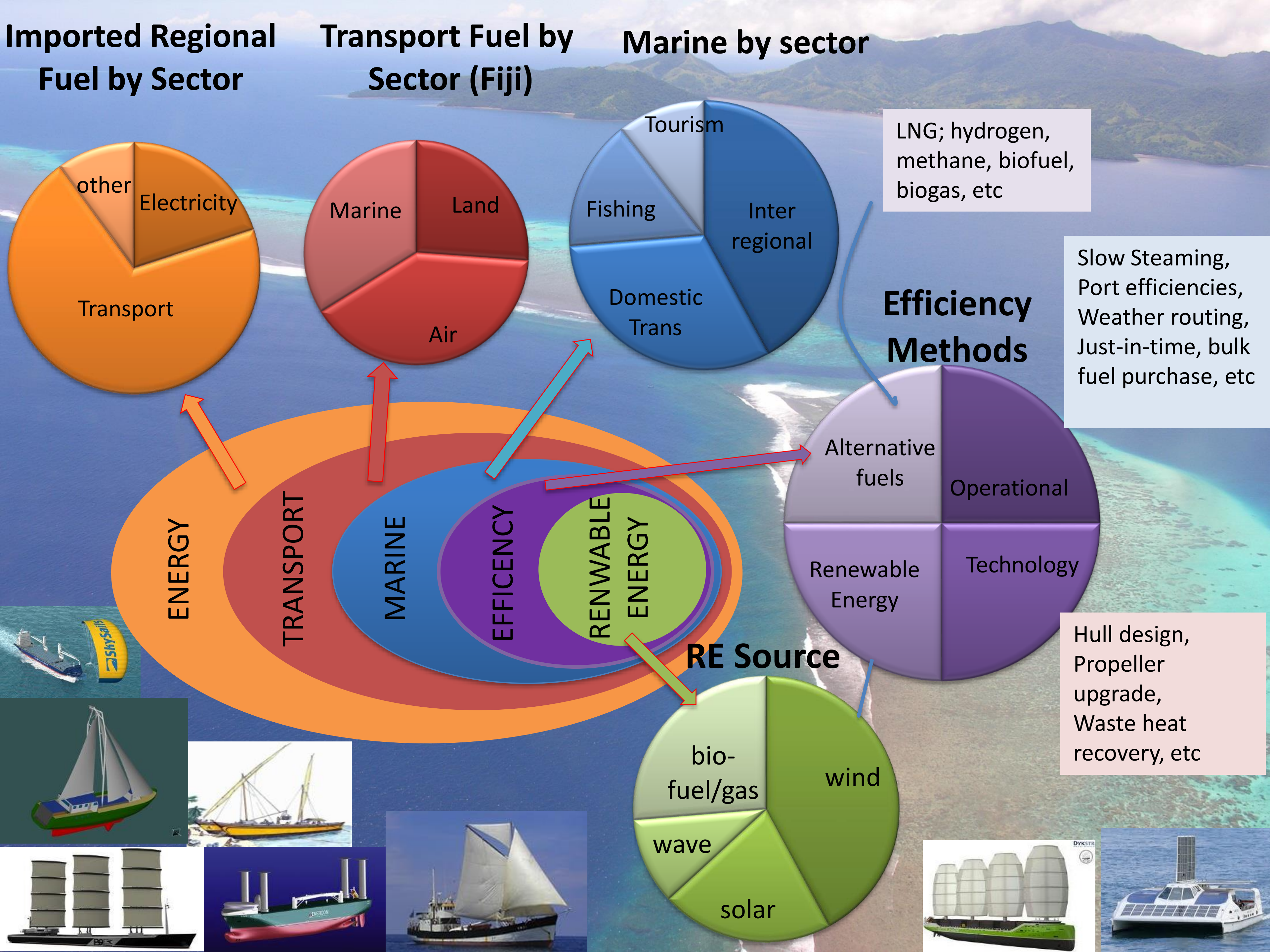
Fiji economic shipping routes



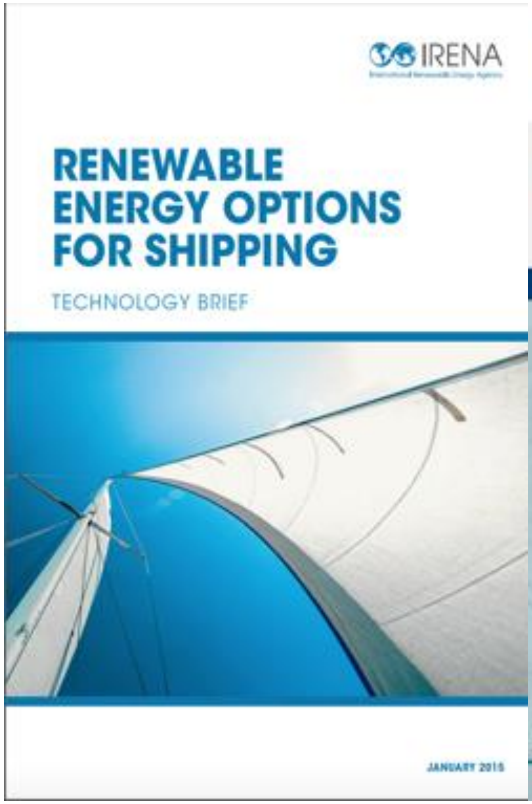
Fiji uneconomic shipping routes

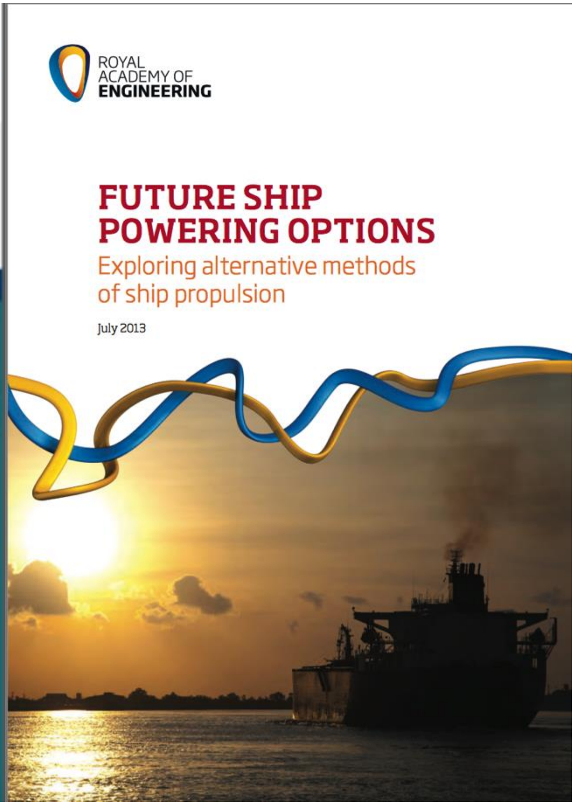
…Sea transport issues in the Pacific

- The Pacific region is extremely dependent on imported fossil fuel, which represents a major drain on economies.
- The transport sector (land, air and marine) is the largest user of fossil fuels, accounting for at least 70% of all PICs use.
- Electricity generation, in comparison, uses around 20% of fossil fuel. Most efforts to introduce low carbon alternatives have focused on electricity generation
- The need to decarbonise Pacific island transport has yet to be addressed.


Imported Regional Fuel by Sector
other
Electricity
Transport
Transport Fuel by Sector (Fiji)
Marine
Land
Air
Marine by sector
Tourism
Fishing
Inter regional
Domestic Trans
LNG; hydrogen, methane, biofuel, biogas, etc
Slow Steaming, Port efficiencies, Weather routing, Just-in-time, bulk fuel purchase, etc
Efficiency Methods
Alternative fuels
Operational
Renewable Energy
Technology
Hull design, Propeller upgrade, Waste heat recovery, etc
ENERGY
TRANSPORT
MARINE
EFFICENCY
RENWABLE ENERGY
RE Source
bio-fuel/gas
wind
wave
solar
SkySails

Recent Studies on RE for International Shipping





Wind Energy – Soft Sails

Dystra - Ecoliner

B9 Ship

Neoliner

GreenHeart

CargoProa

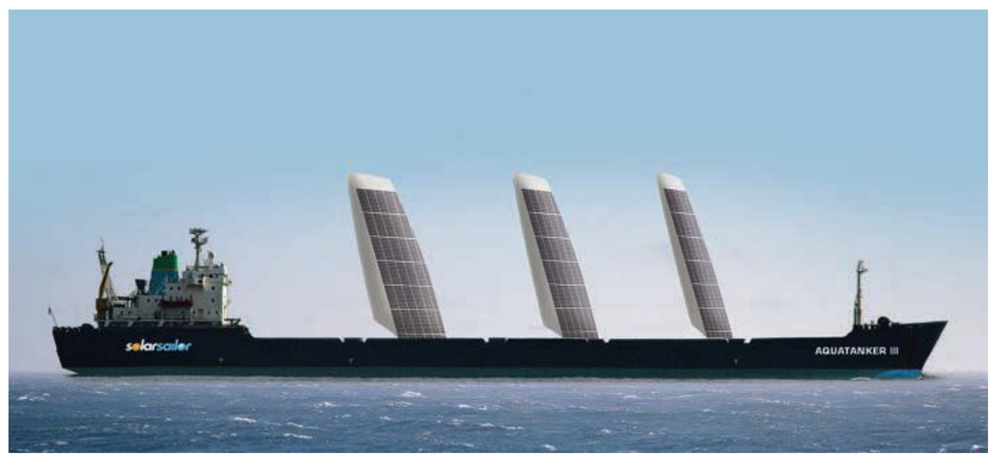
Cargo Catamaran

Wind Energy – Fixed Sails

Tokyo Wind Challenger

Shin Aitoch Maru

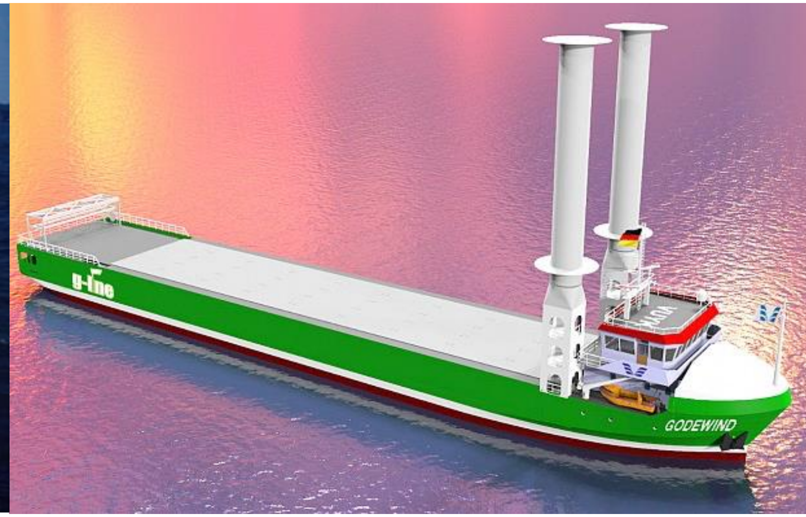
Windship



OCIUS Wind Solar

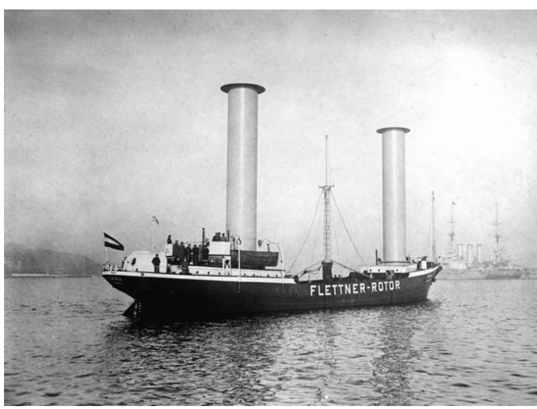
Wind Energy – Rotors

Alycone



Wind Hybrid Coaster

Flensburg UniCat



Baden Baden

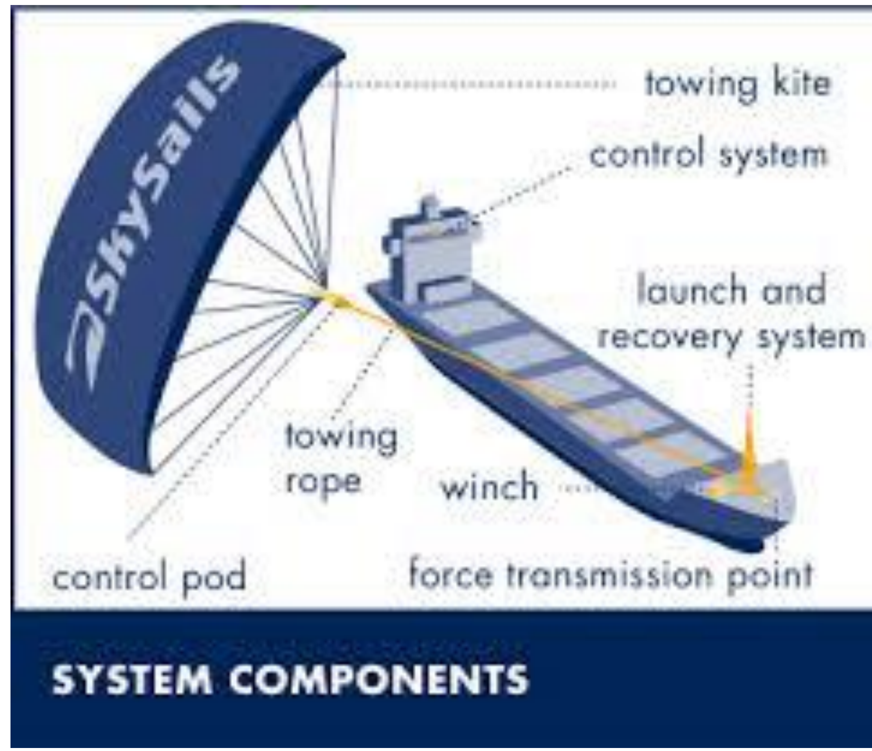
Barbara

E Ship 1

Wind Energy – Kite Sails

SkySails GmbH

KiteShip of Martinez

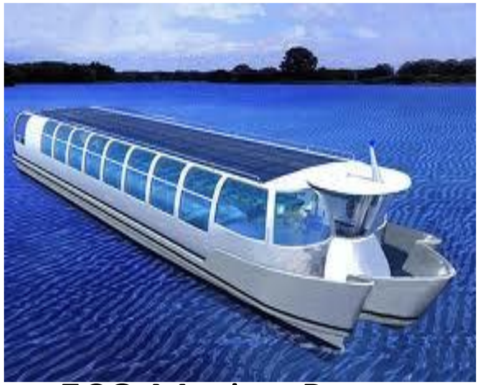


Solar Energy

- Major advances in electricity land based use and electric motor technology.
- Potential for short range transport especially passenger and tourism – OCIUS = commercial proof of concept.
- Potential for auxiliary propulsion to wind powered propulsion – battery storage major limiter
- Potential for ancillary onboard power – especially freezers and in port power for small scale ships

Solar Sailor/OICUS

Solar Sailor/OICUS

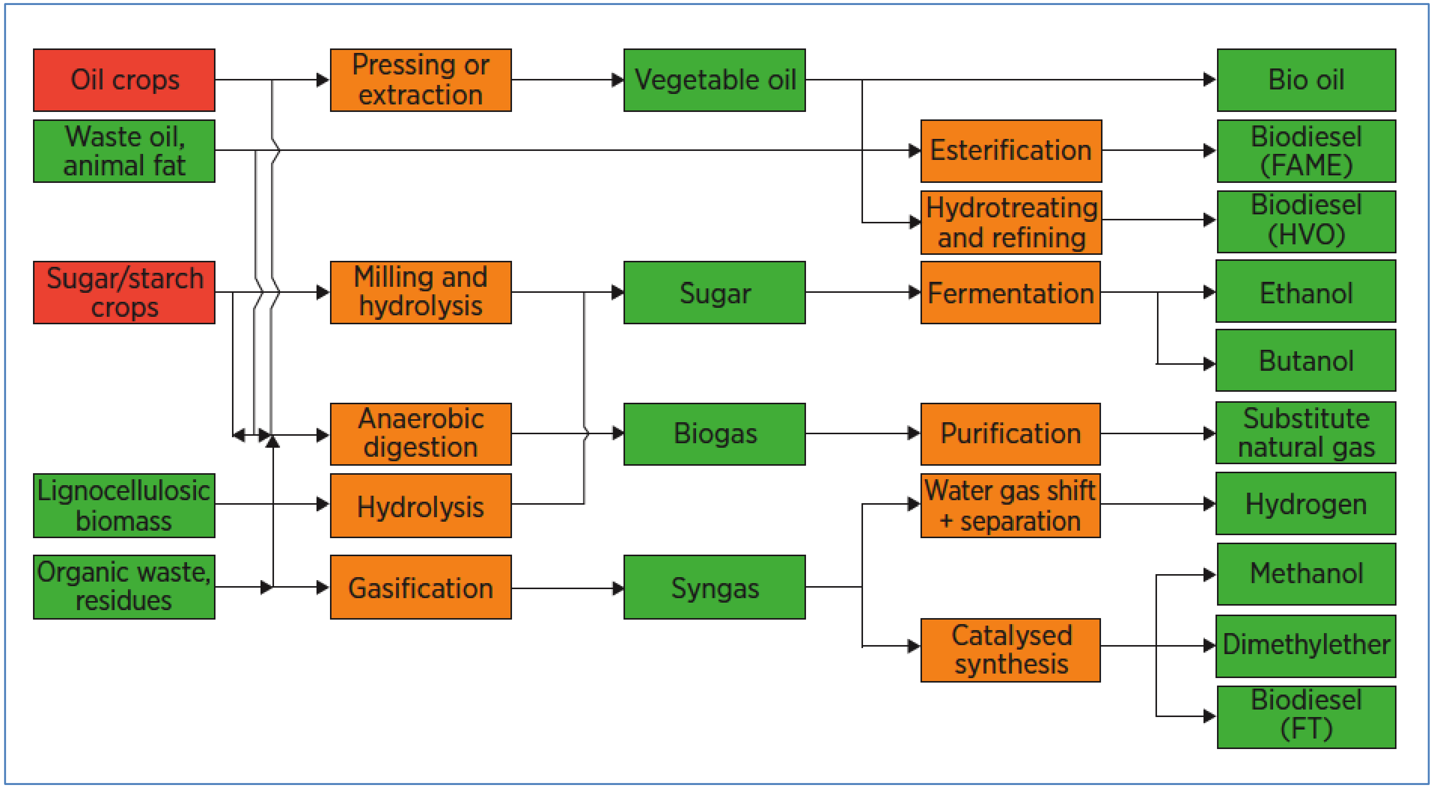


ECO Marine Power

CRAIN Technology

Biofuels

Summary of pathways for conventional & advanced biofuels production



Source IRENA 2015, *Adapted from Ecofys, 2012*

Biofuels

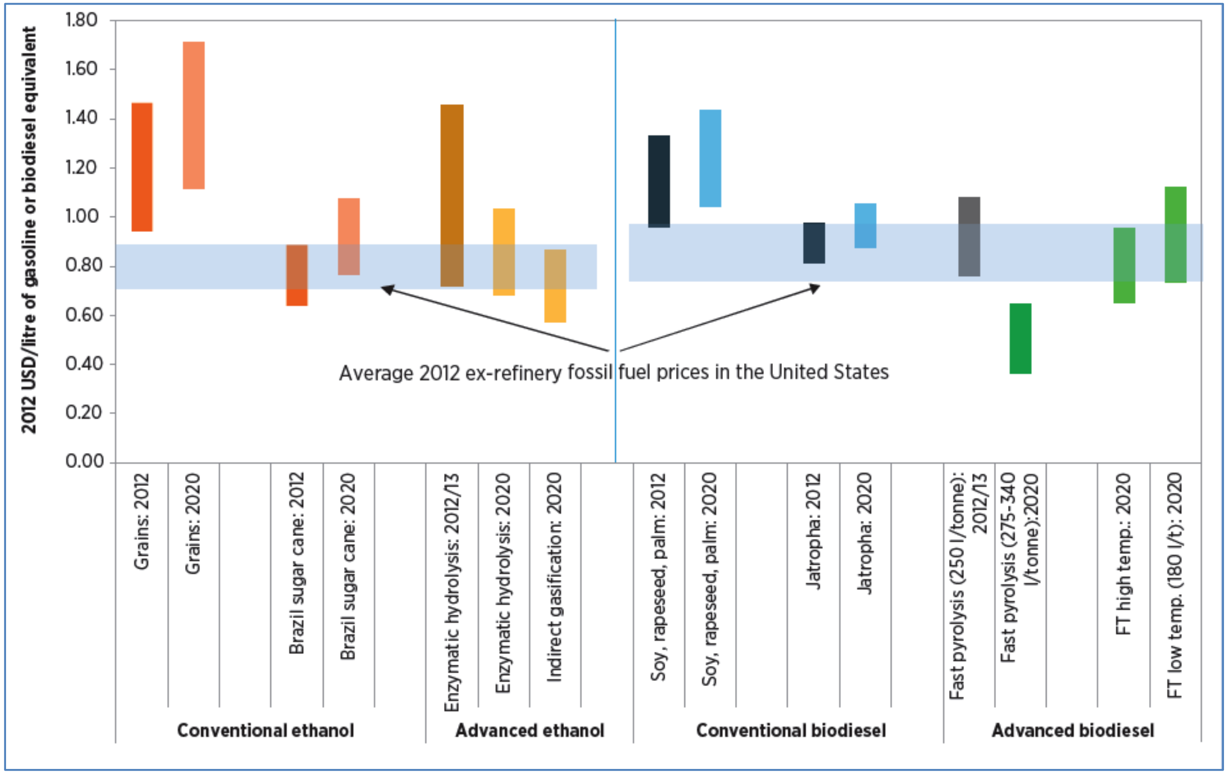
Summary of applications and issues for biofuels in shipping

Aspect	Biofuel			
	Biomass to liquid (advanced biofuels – e.g. via Fischer-Tropsch process)	HVO/ SVO/ FAME	Dimethyl ether (DME)	Liquid biomethane (LBM)
Engine and fuels system cost	Drop-in	Drop-in	Storage	Dual fuel cryotanks
Projected fuel cost	Refining	Land use	Infrastructure	Infrastructure
Emissions abatement cost				
Safety-related cost			Ventilation	Pressure / Temperature
Indirect cost		Water, energy, land and food nexus	Cargo space	Cargo space

Source IRENA 2015, Adapted from IEA-AMF, 2013

Biofuels

Production costs for conventional and advanced biofuels, 2012 and 2020



Source IRENA 2015, Adapted from IEA-AMF, 2013

Current viability of selected biofuels for the shipping sector

	Engine Applications	
	Drop-in fuel	Comment
Diesel cycle	Biodiesel (FAME)	• High availability and variety of feedstock • Land use and food nexus issues for conventional biodiesel production • Standard well-understood specifications • Bio-fouling potential • Requires anti-corrosion seals and components in engine • Suitable for low to medium speed propulsion (e.g. small carriers and cargo ships)
	Straight vegetable oil (SVO)	• Up to 100% replacement possible • Cheap and readily available • High viscosity requires pre-heating • Can be used in dual engines • Suitable for low-speed propulsion of all vessel sizes
	Hydro-treated vegetable oil (HVO)	• Very high quality for shipping • High energy content • Land use and food nexus issues depending on feedstock used • Suitable for medium-speed propulsion of all vessel sizes
	Dimethyl ether (DME)	• High potential • Challenges with stability and storage • Limited availability, but can be produced from ethanol using on-board alcohol to ether (OBATE) technology • Requires fuelling infrastructure and anti-corrosion seals and components in engine • Takes up cargo space • Suitable for low-speed propulsion of all types of vessels
	Biomass-based Fischer-Tropsch diesel	• Can use residues for feedstock • Limited availability, depends largely on gasification • Not yet commercially viable • Can be used for medium-speed propulsion of all vessel sizes
	Pyrolysis oil	• Low cost and high availability potential • Corrosive • Low heating value and high viscosity • Difficult to store • Suitable for low-speed propulsion of all types of vessels

Source IRENA 2015

Projects undertaken in the mid 1980s showed strong potential, were achievable with relatively minimal financial investment, and were only curtailed because of the global fall in oil prices

PROJECT	Description	Outputs	Agencies	Comments
Fiji soft sail retrofit (1984-1986)	Auxiliary rig retrofitted to two government vessels of ~300t. Rigs built and installed in-country	Fuel savings 23-30%, but also 30% engine/prop wear reduction, greater stability, incr passage times. IRR on best route = 127%, average route = 33%	ADB, Southampton University, McAllister Elliot	Southampton University collated historical wind data for all Fiji routes and produced fuel saving ratios for all routes.
Lau Passenger / cargo (1984-2006)	50 ton primary sail powered trading vessel, designed and built on Kabara by local builders (1984-87). First of 3 planned vessels to service Lau and Lomaiviti Groups.	*Tai Kabara* became the main vessel operating on the Sth Lau route until she was scuttled in 2006. Used local materials wherever possible.	European Union	Construction of the other two ships was cancelled when the oil crisis abated.
Ha'apai Freighter	Needs assessment and design analysis led to commissioning of build plans for a 100 ton energy efficient freighter	Needs assessment, transport census and full build plans for a 100 ton energy efficient freighter.	UNESCAP, UNCTAD, UNDP, ADB	Vessel never constructed due to end of crisis. Similar needs assumed today.
SCF/Jim Brown	Save the Children Fund Tuvalu employed catamaran designer Brown to develop locally built boats for Tuvalu/Kiribati	A range of designs and processes for locally built/operated catamarans for artisanal and commercial fishing and local and inter-island transport. Training of local shipwrights. Local materials favoured	SCF	This project closely associated with the FAO/UNDP project. Local build/materials used wherever possible. Fuel savings of up to 60%.
FAO/UNDP (1982-1989)	A multi-county fisheries programme to develop RE artisanal and small-scale commercial vessels for local community benefit.	A portfolio of 10 designs from single dugouts to 11m trimarans. 350 vessels built in 8 countries. Demonstrated need for vessels to be affordable and locally appropriate.	FAO UNDP	Uptake ceased with end of project and falling fuel prices. Communities with 'living tradition' of sail had greatest uptake.

Fiji Govt Shipping Service
Soft Sail Retrofit Trials 1984-86

- Fiji – 330 islands, 100 inhabited. Many routes classed "uneconomic". Longest route 1000km+
- Auxiliary sail rigs designed and installed on 2 government inter-island ferries, *Na Mataisau* (274 gt) and *Cagidonu* (300 gt).
- Experiment overseen by Southampton University and paid for by ADB ($US40,000).
- 23-30% fuel savings, 30% reduced engine wear, increased stability, increased passenger comfort
- Folding prop would have greatly increased fuel savings.
- IRR 123% on best routes, IRR 35% average routes.
- In 1985 , *Na Mataisau* escaped developing cyclone under only sail power and saved life of Fiji PM.
- Extensive project data recorded by Southampton.

Global case for low carbon shipping

- International shipping is undergoing an unprecedented search for efficiency of fuel use, driven primarily by:
  - fluctuating but escalating fuel costs
  - international agreements to reduce GHG emissions
  - increasing awareness of the environmental and public health risks associated with shipping

- IMO's 2014 GHG study forecasts shipping CO_2 emissions to increase by 50% to 250% by 2050, which would then represent between 6% to 14% of total global emissions, under 'business as usual' conditions.

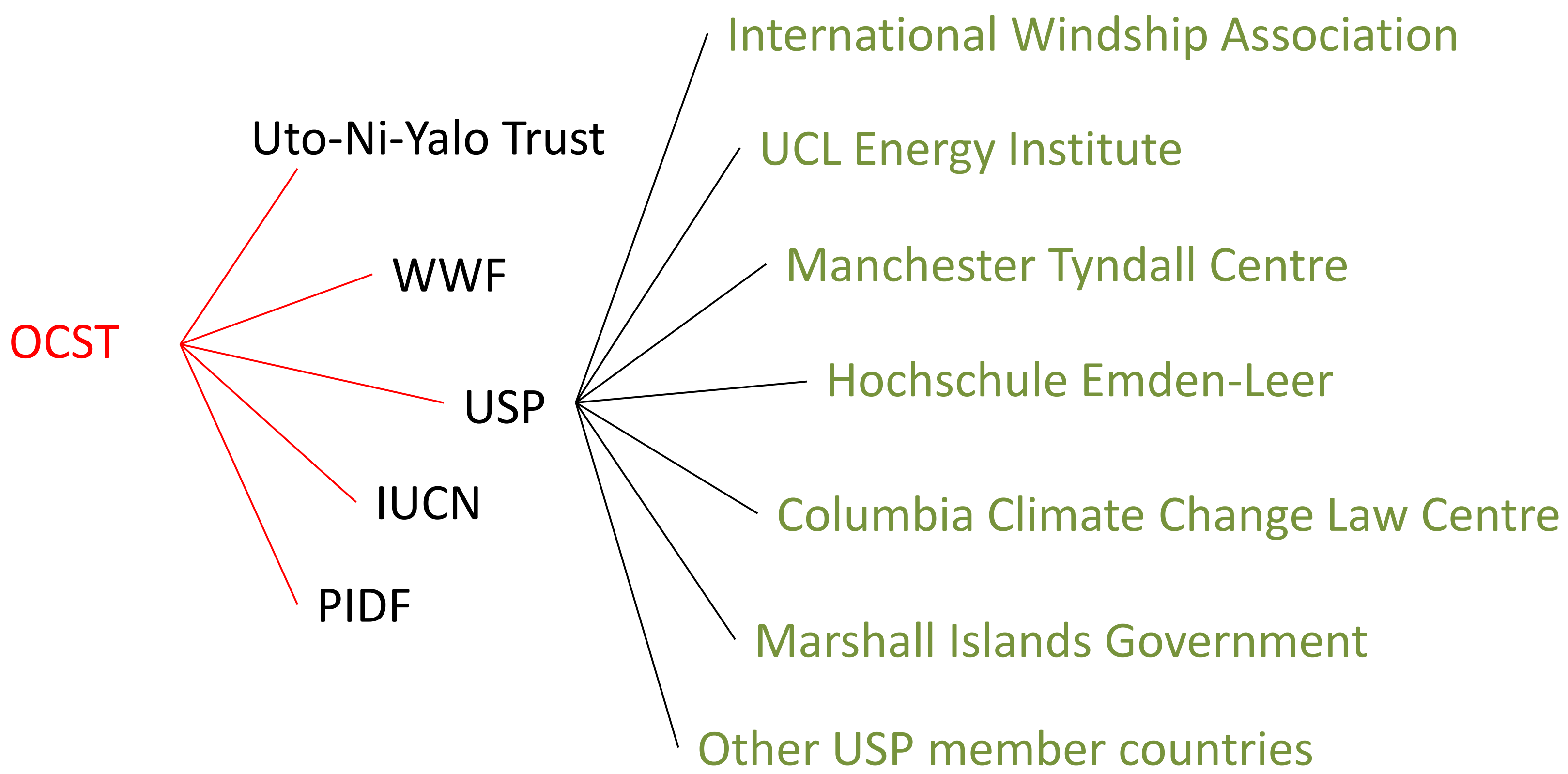
- Rapid advances in technology:
  - ship designs (especially hull, waste heat recovery and propeller related technology)
  - use of alternative fuels such as LNG and methane and renewable energies, including wind power (kite sails, soft sails, fixed wing sails and rotors)
  - photovoltaics
  - biofuels

Supporting PICs transition to low carbon sea transport futures

USP
PACIFIC CENTRE FOR ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

- **Sustainable Sea Transport Research Programme (established in 2013)**
  - train current and future PIC capacity
  - macro and micro economic analyses
  - carbon management policy for transport emissions
- **Regional Research & Education Strategy (RRES)**
  - Long term regional strategy
  - Prepare country plans for transition to low carbon
  - Provide strong country support - quality research & practical trials
- **Oceania Centre for Sustainable Transport (OCST)**
  - Portal for knowledge, research, networking, exchange
  - Multi-partner – IUCN, WWF, PIDF - from village to global
- **International research partnerships**
  - with Centres of Excellence – UCL, Tyndall, MARIN, Emden, Columbia
  - Post graduate and expert exchange – build long term PIC capacity

Oceania Centre for Sustainable Transport



Oceania Centre for Sustainable Transport website http://pace.usp.ac.fj/ocst

OSST-RRES Country Programme Framework: Fiji

	Policy								Economics							Heritage			Practical Trials				Teaching			Additiona[l] Research
	Strategic				Infrastructure				Fiji route case Studies				International route case Studies										Practical	Theory		
	International	Regional	National	Agency	Qualifications	Survey	Licensing	Finance: Tax, Insurance	Sth Lomaivitu	Kadavu	Lau	Rotuma	Central Polynesia	MSG	Micronesia	Traditional Knowledge	Vessel construction	Voyaging	SVV (Sustainable Village Vessels)	100 ton cargo/pax	200-300 ton freighters	Retrofitting Sail/Rotor rigs		Undergraduate (Dip, Bachelors)	Postgraduate (Dip, Masters, PhD)	
Relevant Plans	IMO regulations – MARPOL Annex VI and assocaited MDM/MBIs; FATS, National Transprot Plans.	Pacific Plan; Regional Transport Action Plan; Regional Energy Action Plan; etc	Transport, Energy, Climate Change; economic Development policies/plans,	World Bank; ADB; UNESCAP; UNDP; Bilateral donor Strategies; etc	Master/crew. Intentional standards, MSAF standards	MSAF regulation	MSAF, FIRCA												Design, Build, Pilots, Ops, Ownership/Management models	Design, Build, Pilots, Ops, Ownership/Management models	Lease Pilot for Trials. Ownership/Management models	Sail and Rotor designs, testing	Seafaring, Construction, Naval Architecture, Engineering, Survey, Heritage)	Economics, Marine Studies, Physics, Technology, Climate Change, Law, Pac Studies, History		Data collection (all sectors), MARPOL Annex VI, Carbon Trading (financial mechanisms), Flettner technology, Electric motors, Franchise/Subsidies, emerging technologies
Scoping (current, gap analysis, needs analysis)																										
Research/ Action/ Project Plan																										
Monitoring and Reporting Framework																										

Lessons learnt and way forward

- Past trials have left a portfolio of analyses and vessel designs that demonstrated that in times of high fuel cost, use of renewable energy technologies achieved significant results for modest investment. There have since been enormous advances in low carbon technologies for shipping.

- Policy and financing have been identified in both Pacific and international studies as the primary barriers to practical implementation. These issues are complex and require a re-evaluation of previous approaches.

- Low carbon shipping offers multiple economic, environmental, social, and cultural benefits. It offers a future where fleets of smaller but sustainable new ships could replace single, aged, large vessel operations currently used.

- The field is emergent with increasing numbers of organisations and individuals developing designs for small sail and solar freight carriers, with strong potential application in local transport and tourism sectors.

- Revitalising pride in the Pacific's seafaring heritage as master voyagers, innovators and naval designers is a key vector for encouraging uptake.

Uto ni Yalo

Photo courtesy: Uto Ni Yalo Trust

- a return to the art of traditional voyaging, training and nurturing training future generations of voyagers
- reviving and sustaining traditional canoe building, sailing, skills and customs.

Sailing to spread the message of stepping up global action on oceans and climate change

Thank you!