Ocean Energy
Fostering a Blue Economy

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"Marine Renewable Energies – Fast-Advancing Technologies and Promising Oportunities "
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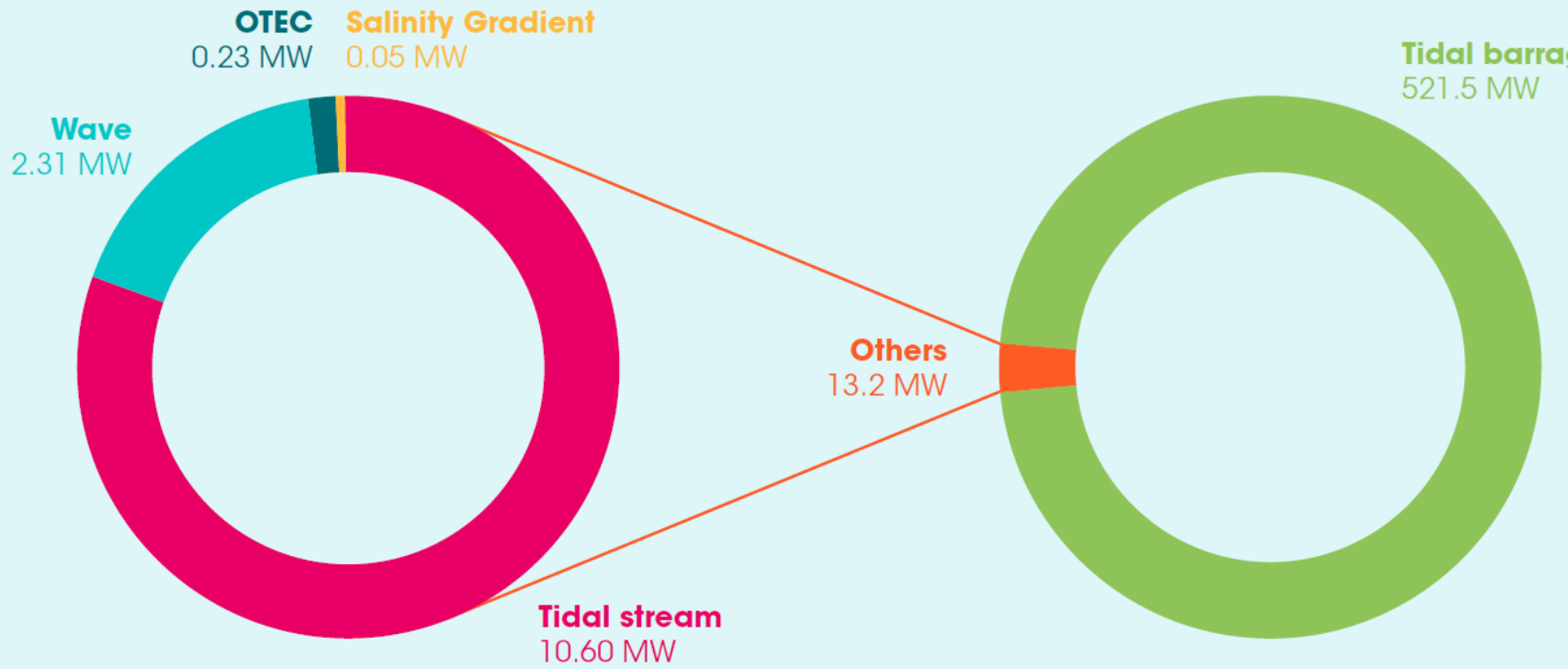
Status Ocean Energy markets

Figure S1: Ocean energy deployment excluding tidal barrage (MW)

Figure S2: Total ocean energy deployment (MW)



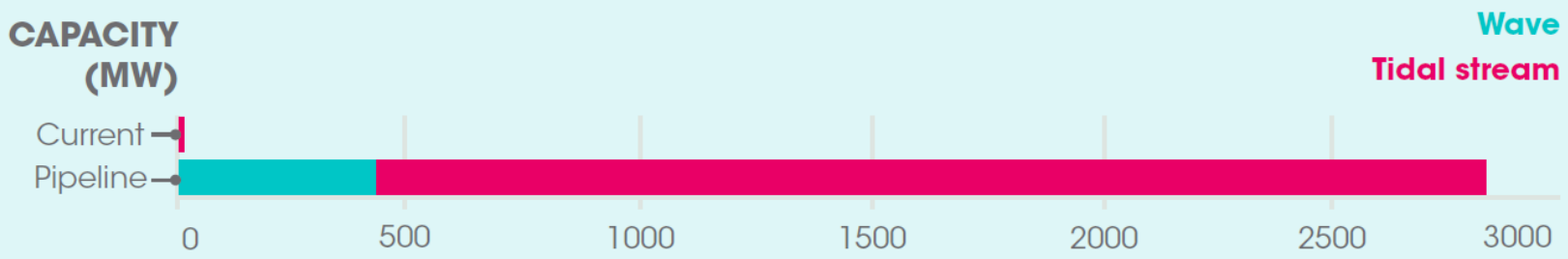
Source: *IRENA ocean energy database*

Source: IRENA (2020), Innovation Outlook: Ocean Energy

Outlook Ocean Energy markets

Current pipeline of projects

Figure S3: Active and projected tidal stream and wave capacity beyond 2020



Note: *While their capacity is too small to appear on this chart, additional projects are planned for the other ocean energy technologies beyond 2020. For example, a 2 MW ocean thermal energy conversion plant and a 1 MW salinity gradient energy plant are planned in the Netherlands (Johnson, 2019).*

Source: *IRENA ocean energy database*

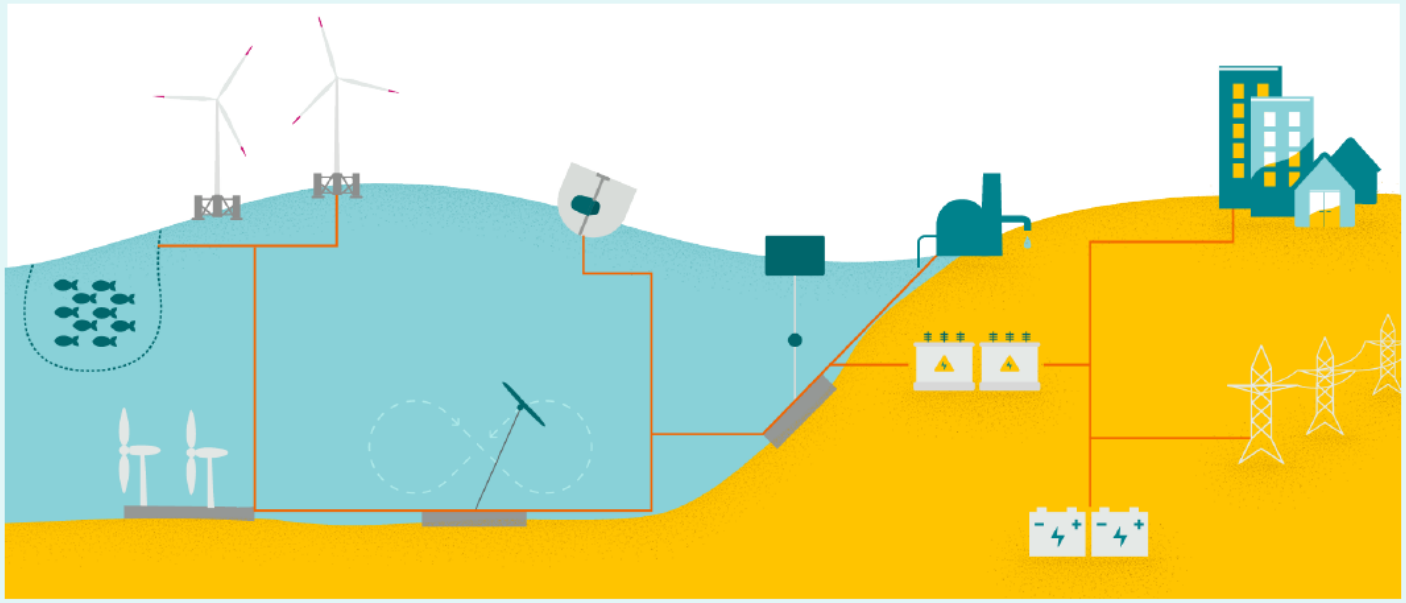
Market outlook

- **2030 – 10 GW**
- **2050 – 100 GW**

Source: IRENA (2020), Innovation Outlook: Ocean Energy

Innovative Business Model 1: Offshore renewables powering a Blue Economy

Figure 33: Ocean energy coupled with other renewable energy sources to power the blue economy



Source: IRENA (2020), Innovation Outlook: Ocean Energy Technologies

Examples

Table 8: Examples of ocean energy developers focusing on powering the blue economy

	POWER	DESALINATION	COOLING (SWAC)	OIL AND GAS	AQUACULTURE	SHIPPING/PORTS	AUV CHARGING	Developer
Wave	✓				✓			SINN Power
								AWS Ocean Energy
								WavEC
								Albatern
								Aqua Power Technologies
								GIEC
								Japanese Consortium
Tidal	✓				✓			Sustainable Marine Energy
Wave	✓			✓	✓			Ocean Harvesting
Wave	✓			✓				Wave for Energy
								Hann-Ocean
								Floating Power Plant
Wave	✓			✓			✓	Ocean Power Technologies
Wave	✓	✓						Resolute Marine Energy
								Carnegie Clean Energy
								Wavepiston
								GIEC
Wave		✓						Atmocean
								NRELUS National Renewable Energy Laboratory
Tidal	✓					✓		EMEC (through hydrogen)
OTEC	✓	✓						NIOT OWC
OTEC	✓		✓					Makai
OTEC	✓	✓	✓					Bardot Ocean
								Bluerise
OTEC	✓	✓	✓		✓			Bretagne Ocean Power
Other						✓		GEPS Techno

Note: *SWAC = seawater air conditioning; AUV = autonomous underwater vehicle*

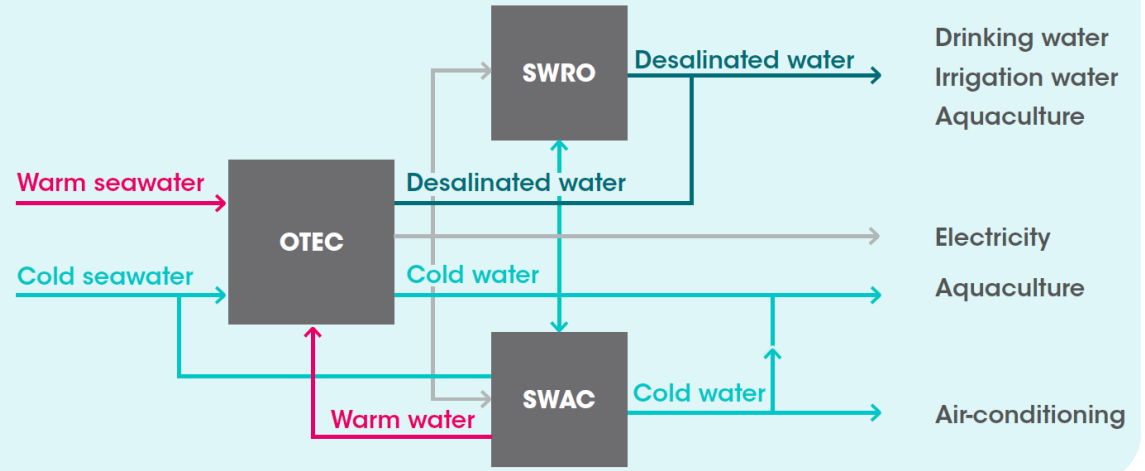
Source: *IRENA ocean energy database*

Source: IRENA (2020), Innovation Outlook: Ocean Energy Technologies

Example 1 - OTEC coupled with cooling and water desalination in islands

OTEC: electricity (kWh) + other revenues

Figure 38: Ways of coupling OTEC, desalination, cooling and aquaculture



OTEC technical potential in the Caribbean

Country	Maximum Technically Exploitable Resource (MW)					Average electrical demand (MW)
	Fixed offshore wind	Floating offshore wind – conventional	Floating offshore wind – deep sea	OTEC	Total	
Antigua & Barbuda	4 935	1 477	11 718	100	18 230	38
The Bahamas	10 955	6 321	16 723	220	34 219	220
Barbados	0	112	7 063	140	7 315	104
Grenada	2 618	476	7 196	110	10 400	25
Jamaica	1 211	1 848	9 709	180	12 948	498
Saint Kitts & Nevis	399	196	9 135	40	9 770	24
Saint Lucia	105	224	4 025	90	4 444	46
Saint Vincent & the Grenadines	3 227	385	3 017	70	6 699	17
Trinidad & Tobago	16 597	12 460	4 963	50	34 070	1 064
Total	**40 047**	**23 499**	**73 549**	**1 000**	**138 095**	**2 036**

Source: *Johnston, 2019*

Source: IRENA (2020), Innovation Outlook: Ocean Energy

Innovative Business Model 2: Hybrid electricity generating systems

IRENA
International Renewable Energy Agency

Table 7: Projects coupling ocean energy with other renewable energy sources

	SOLAR	WIND	FLOATING WIND	PUMPED HYDRO	STORAGE	MICROGRID	HYDROGEN	Examples	Country	Status
Tidal		✓					✓	BIG HIT / Surf 'n' Turf	Scotland	In operation
Tidal					✓			Bluemull Sound Shetland	Scotland	In operation
Tidal	✓				✓			San Antonio	Philippines	Research
Tidal	✓	✓			✓	✓		PHARES Ushant Island	France	Planning
Tidal				✓				KIOST	Republic of Korea	R&D
Wave	✓	✓			✓	✓		King Island	Australia	Planning
Tidal					✓	✓		KIOST	Republic of Korea	R&D
								Dent Island	Canada	Test completed
Wave	✓				✓	✓		Garden Island	Australia	Planning
								KIOST	Republic of Korea	R&D
Wave			✓					Canary Islands	Spain	Research
								Bombora and MEECE	Wales	Research
Salinity							✓	REDstack	Netherlands	Planning
Wave	✓							GEPS Techno		Full-scale testing
								Eco Wave Power		Installed (Gibraltar and Israel)
								Wave for Energy		WEC full-scale testing completed
								GIEC		Open-sea testing completed
Wave	✓				✓			Ocean Power Technologies		Full-scale deployment announced
Wave	✓	✓						SINN Power		WEC prototype testing completed
Wave			✓					Floating Power Plant		Previous model testing completed
		✓						Marine Power Systems		WEC 1:4 scale testing completed
								Seabased		WEC tested, wave-wind resource assessment conducted
								Havkraft		WEC full-scale testing completed
Wave					✓			BOLT Lifesaver		Small-scale testing completed
Tidal					✓		✓	HydroWing (Tocardo Turbine)		Patenting

Note: *WEC = wave energy converter*

Source: *IRENA ocean energy database*

Source: IRENA (2020), Innovation Outlook: Ocean Energy Technologies

Example 2: Tidal energy + solar PV & wind for green hydrogen production (floating wind explored)

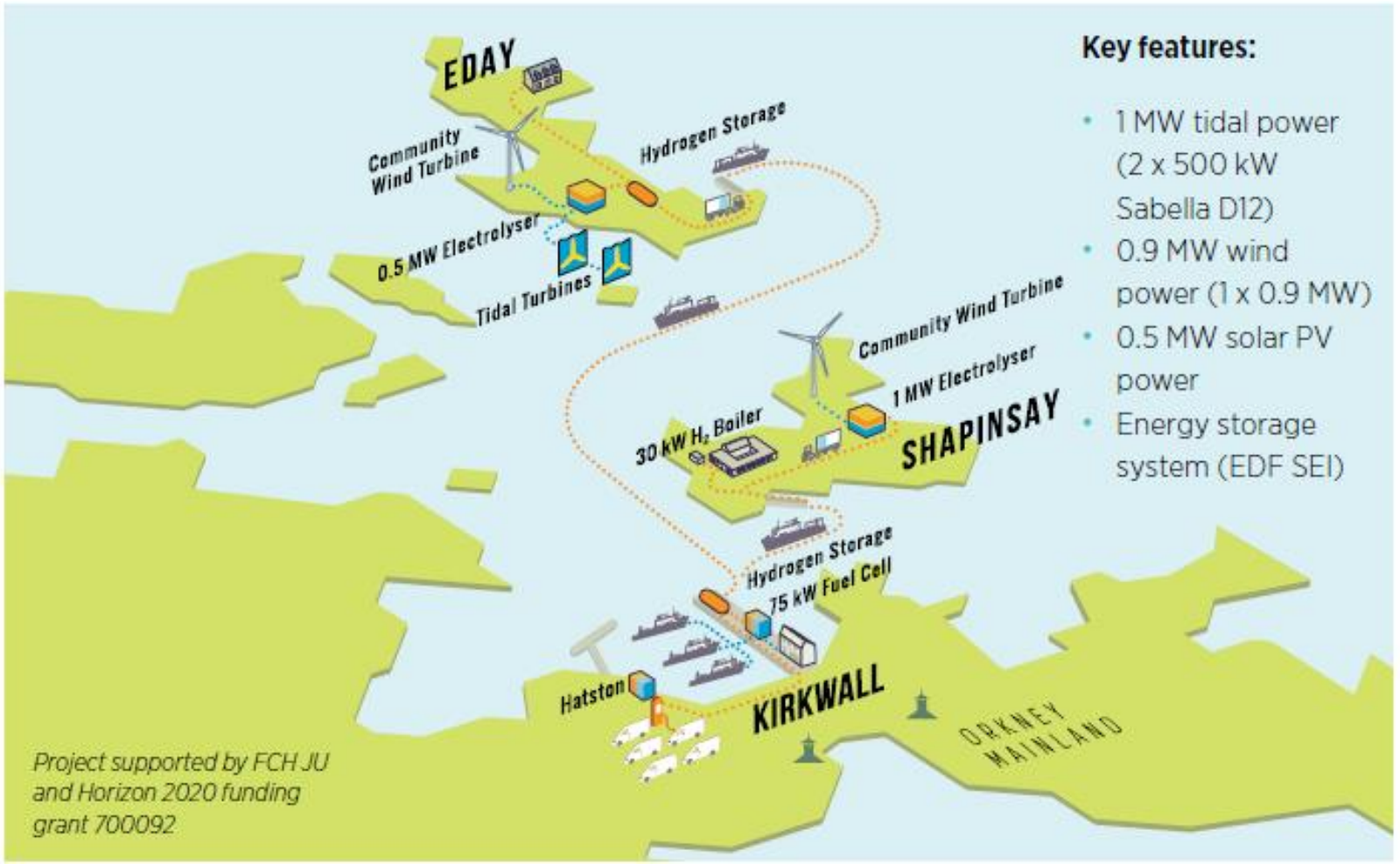


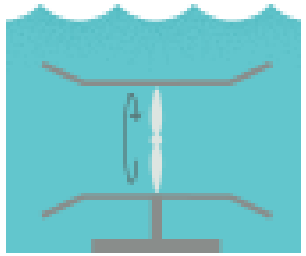
Figure 39: BIG HIT project in Orkney

Image source: *BIG HIT Orkney*

Source: IRENA (2020), Innovation Outlook: Ocean Energy Technologies

Unlocking OE potential

Key Recommendations



Technology:

Technology convergence and standardization

Conduct resource assessment campaigns

Support test centres

Capital grant funding for R&D

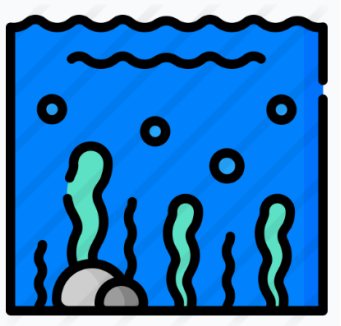
Policy:

Premium price MWh

Promote innovative business models

Compensate additional services (regulation)

Innovative financial structures



Environmental and Social:

Improve access to baseline data

Consult and engage the public

Infrastructure:

Availability of Networks

Engage and inform the emerging supply chain

Synergies with other RE technologies – firm generation

Source: IRENA (2020), Innovation Outlook: Ocean Energy

IRENA Collaborative Framework Ocean Energy & Offshore Renewables

Aim:

- Agency to proactively function as a global network hub
- Facilitate **government peer-to-peer collaboration** and exchange of knowledge

In brief:

- Collaborative Framework on Ocean Energy/Offshore Renewables covers:
  - Offshore and floating wind technology; **ocean energy technologies**; and Floating solar photovoltaic.
- Co-facilitated by the **Kingdom of Tonga and Italy**
- **40 member countries** engaged at last two meetings + engagement from industry associations
- Suggested areas of work include exchange of good practices on: Marine spatial planning; Foster collaborative R&D programmes; Coupling of offshore renewables with power-to-X technologies; and Grid interconnection for offshore generation
- Next meeting after IRENA's Assembly 2022

Thank you

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