Alliance Nationale de Coordination de la Recherche pour l'Énergie

Decarbonization Wedges Exercise

December 2015 – www.allianceenergie.fr

MARINE ENERGIES

1. State of the art and current development

Marine energies involve 3 significant technologies. These three technologies face difficulties related to the environmental loads. Some competition related to the occupation of the maritime space may occur, especially with fisheries and navigation activities.

Technology 1: Marine current power
This technology involves using turbines on the seabed to harness marine currents in order to operate a rotor which converts mechanical energy into electric energy. The predictability of marine currents is an asset for this technology. Furthermore land footprint is low for marine current power technology, and as turbines are not visible, this technology should not raise problems of acceptability. However competition may occur, especially with fisheries and navigation activities.

Technology 2: Wave power
Wave power involves various systems which harness wave energy: overtopping devices, floating bodies and oscillating water columns are the three main principles.

Technology 3: OTEC
Ocean Thermal Energy Conversion involves using thermic gradients (shallow water is up to 20°C warmer than deep water in the intertropical region). Warm shallow seawater causes a liquid to evaporate —either warm water at low pressure or ammonia— and the steam it produces runs a turbine. Cold deep water condenses steam into liquid water again.

Other technologies are in use or under study, but their potential is not significant. This is why tidal energy is not assessed in this template.

2. Maturity level and technological perspectives

Maturity of marine energies

Methodological information:

The maturity level is the TRL, reduced to 5 levels with market deployment enclosed in the higher TRL classes; maturity level scaling: 0 = none; 1 = fundamental research; 2 = R&D; 3 = demonstrator; 4 = low deployment; 5 = large deployment.

	2015	2020	2030	2040	2050
Marine current power	3	4	5	5	5
Wave power	3	3	4	4	5
OTEC	2	3	4	4	5

Potential development of marine energies

Methodological information:

Potential development is measured as the percentage of the technology's contribution to environmental protection. This means evaluating, in terms of carbon emissions and of carbon emissions reduction, to what extent this new technology can contribute to limiting temperature increase to 2°C above pre-industrial level according to the time horizon considered in this study. Potential development scaling: 0 = not significant; 1 = significant (i.e. more than 1% of global emissions reduction) in some countries; 2 = significant on the global scale; 3 = very significant on the global scale (i.e. up to 3% of global emissions reduction); 4 = major technology vs. climate change (i.e. more than 3% of global emissions reduction).

	2020	2030	2040	2050
All technologies	0	1	2	2

These technologies are not mature enough and will not contribute actively to decarbonization before 2030 — however by that time, their deployment will not occur on the worldwide scale.

3. Technological, economic and social bottlenecks

Methodological information:

The following table ranks the bottlenecks according to their impact on the development of the technology. A bottleneck ranking at 6 on the scale will hinder or stall the deployment of the technology compared with bottlenecks ranking at 1; conversely, a bottleneck ranking at 1 will hinder the deployment of the technology much less than bottlenecks ranking at 6. Note that the ranking is relative, meaning that a bottleneck ranking at 6 is not necessarily hard to remove; conversely, a bottleneck ranking at 1 is not necessarily easy to remove. Technologies rank according to: research, finance, regulations, resources & environment, security and acceptability. The table also contains keywords associated with each bottleneck.

Technology		**Research & technological bottlenecks**	**Financial bottlenecks** (investment, risks)	**Regulation & institutional environment**	**Resources & environmental impacts** (including scarcity of raw materials, water, land, climate)	**Safety & security** (impacts on health, people and security assets)	**Socio-technical feasibility**
Marine current power	Rank	6	5	1	4	3	2
	Key-words	Underwater operation Foundations Connections	Production and construction costs	Legislation Use of maritime space	Connections Impact on seabed and seashore	Maintenance Safety of other sea-users	Acceptability
Wave power	Rank	6	5	2	3	1	4
	Key-words	Technical and economic performance	CAPEX, lifetime	Legislation Use of maritime space		Maintenance Safety of other sea-users	Conflicting use
OTEC	Rank	5	6	1	3	2	4
	Key-words	Pipe materials Heat exchanger	Construction costs		Use of maritime space Closeness to intertropical zones		

The most significant bottleneck is high costs. Technological research has to be implemented to identify which technologies are the most efficient for a given cost. Such programs have already been implemented in the U.S.A and in the U.K. Investment costs and funding for these technologies are another bottleneck. If the private sector is the only actor to assume investment risks for short-term projects —short compared to the amount invested—, then such projects will not be economically viable.

4. Potential radical and incremental innovations

Methodological information:

The following table lists the nature of innovations needed to overcome the bottlenecks mentioned earlier. There are two types of innovations: I stands for 'incremental innovation' (i.e. improving existing products and processes) and R stands for 'radical innovation' (i.e. developing new products and processes).

Technology		**Research & technological innovations**	**Financial innovations** (investment, risk)	**Regulation & institutional environment**	**Resources & environmental impacts** (including scarcity of raw materials, water, land, climate)	**Safety & security** (impacts on health, people and security assets)	**Socio-technical feasibility**
Marine current power	I or R	R	I	R	R	I	I
	Key-words	New ideas Control center	Regulatory framework and tariff lines	Support to a technology sector	Marine current power materials, environmental impact of wind farms	Maritime security	Acceptability Industrialization
Waver power	I or R	R	I	R	I	I	I
	Key-words	Recovery processes	New ways of funding				
OTEC	I or R	R	I	R	I	I	I
	Key-words						