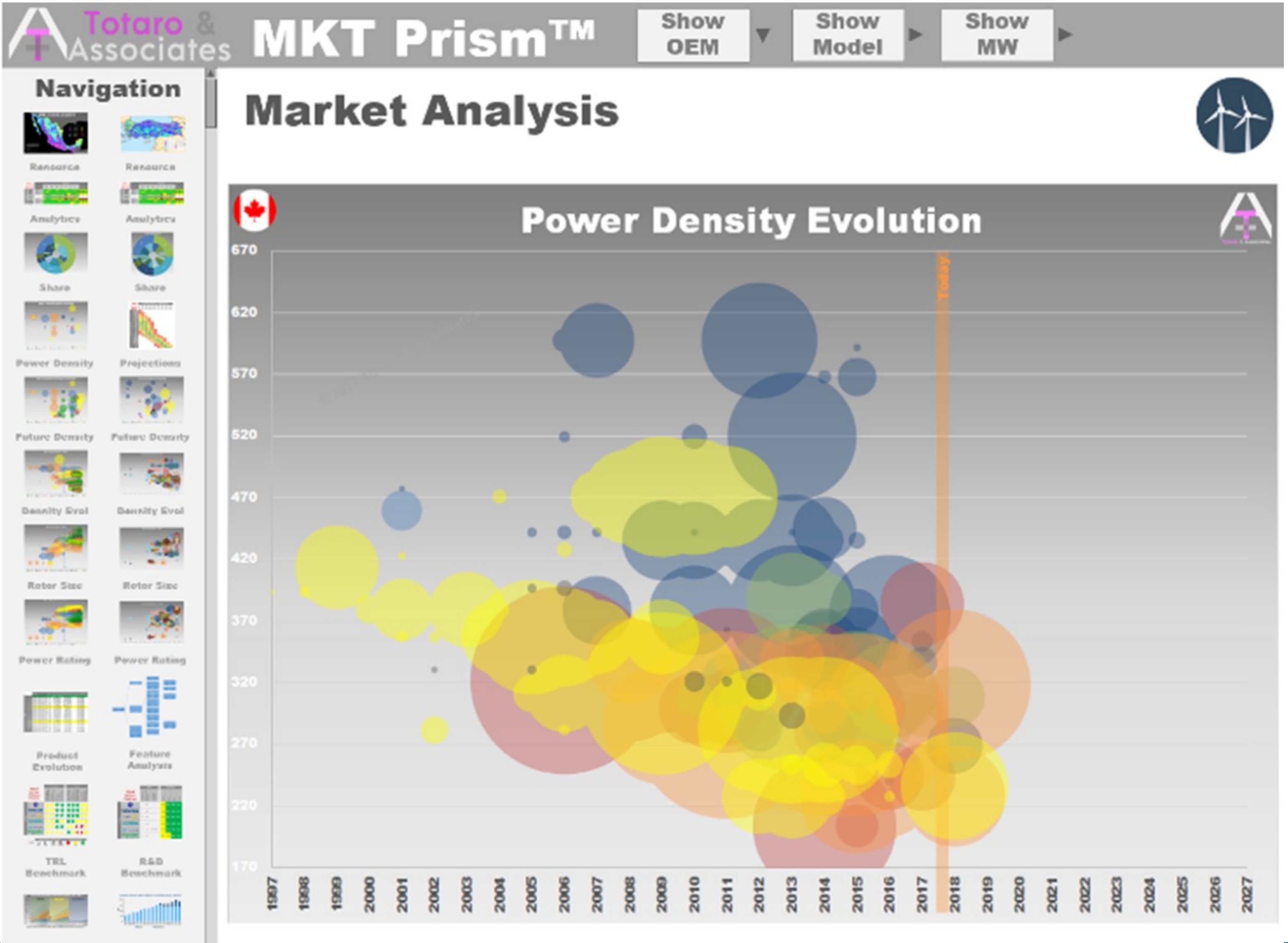
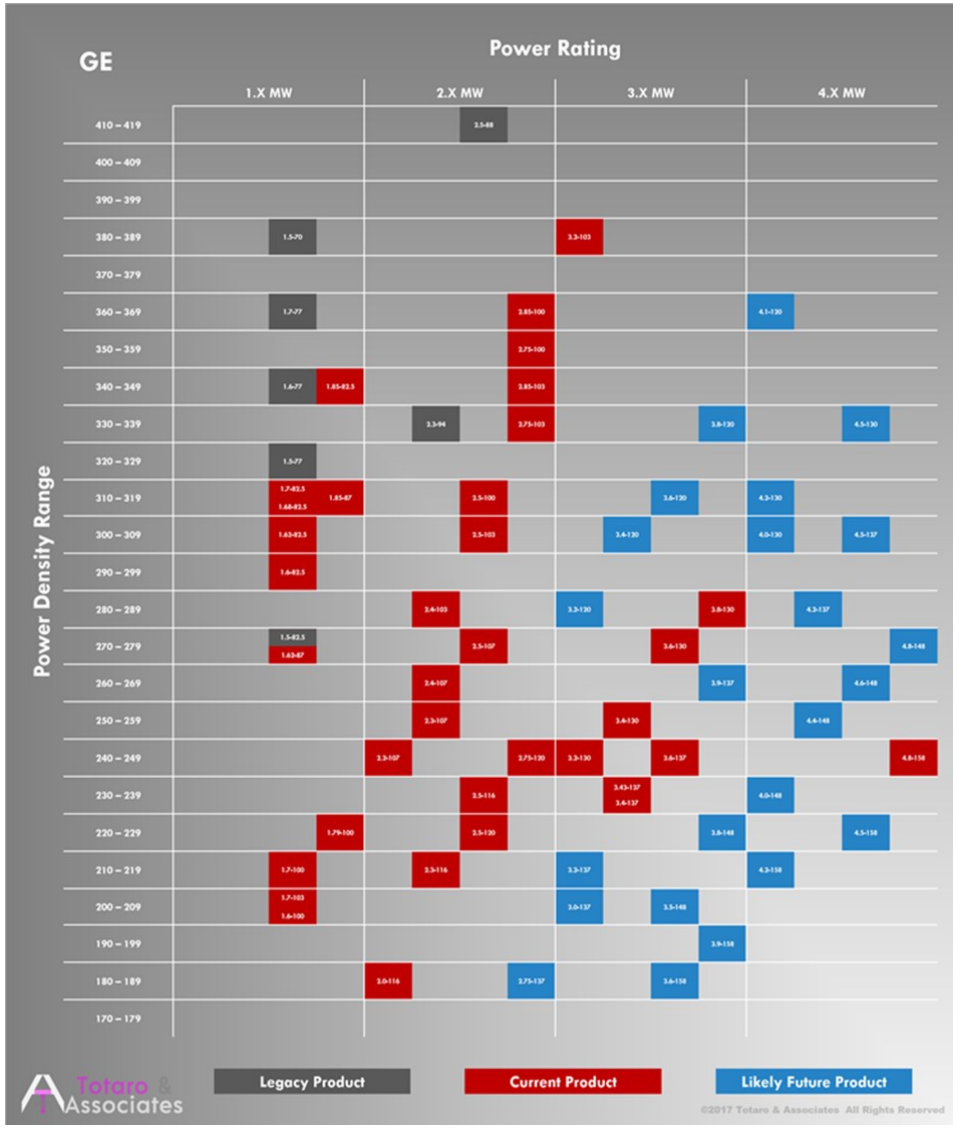
Τεχνολογικές εξελίξεις στις ανεμογεννήτριες & οι δυνατότητες της χώρας να τις αξιοποιήσει

Π.Κ. Χαβιαρόπουλος
Εκτελεστικός Διευθυντής iWind

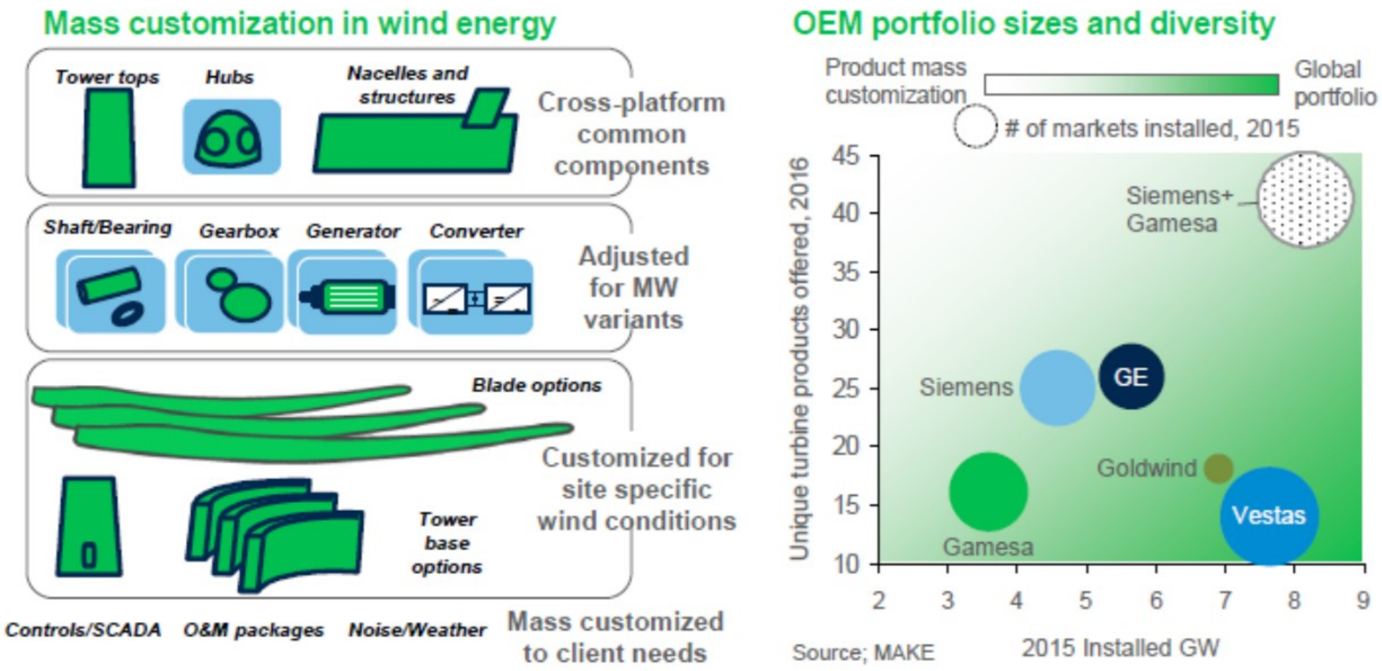
Τάσεις της αγοράς – Ονομαστική ισχύς & Πυκνότητα Ισχύος





Global wind turbine technology trends

Modular product strategies have led to portfolio expansion



Modular product strategies have enabled strategic component re-use across products

Allows for streamlined mass customization to meet global needs and wind conditions

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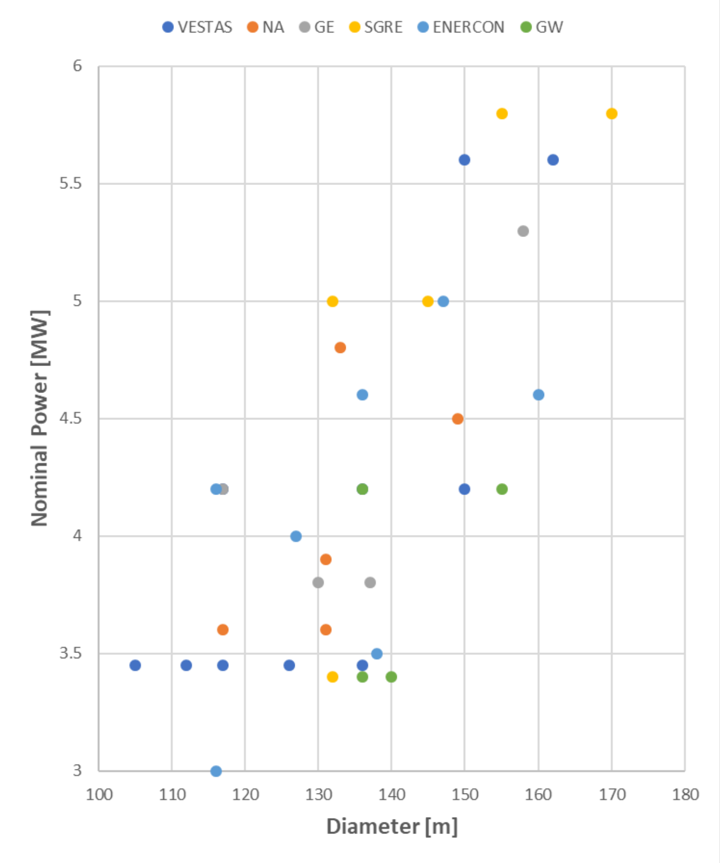
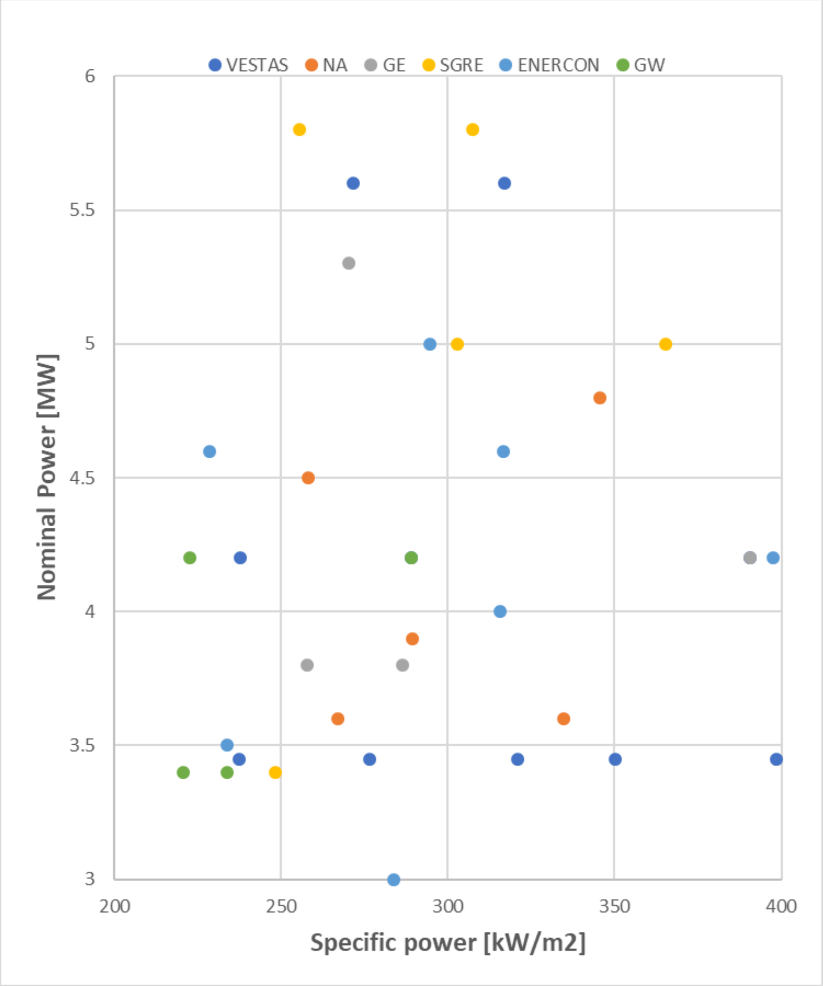
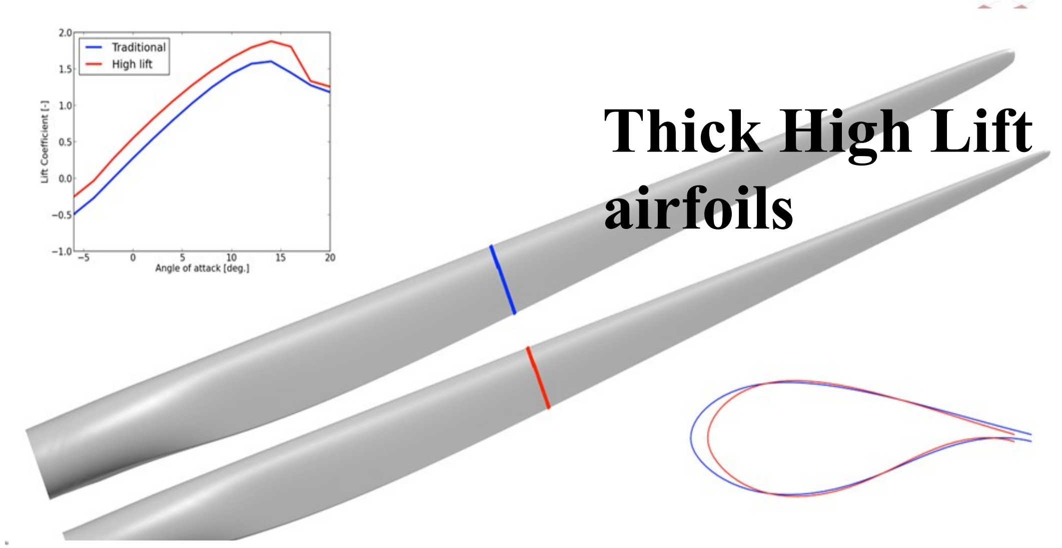
ΚΑΤΑΣΚΕΥΑΣΤΗΣ	ΤΥΠΟΣ Α/Γ	ΙΣΧΥΣ [MW]	ΔΙΑΜΕΤΡΟΣ [m]	Πυκνότητα Ισχύος [W/m2]	ΚΛΑΣΗ IEC	ΥΨΟΣ ΠΛΥΜΝΗΣ [m]	Σύστημα Μετάδοσης	Ελεγχος Ισχύος	Πτερύγια
Vestas	V105	3.45	105	398	IA	72.5	MSG	Pitch (3cyl), VS	
	V112	3.45	112	350	IA/IIA	69/94	HSG	Pitch (3cyl), VS	
	V117	3.45	117	321	IB/IIA	80/91.5/116.5	HSG	Pitch (3cyl), VS	
	V117	4.2	117	391	IB/IIA/S-T	84/91.5	HSG	Pitch (3cyl), VS	
	V126	3.45	126	277	IIB/IIA	87/117/137/147/149/166	HSG	Pitch (3cyl), VS	
	V136	3.45	136	237	IIB/IIIA	82/105/112/132/149/166	HSG	Pitch (3cyl), VS	
	V136	4.2	136	289	IIB/S	site/country specific	HSG	Pitch (3cyl), VS	
	V150	4.2	150	238	IIIB/S	site/country specific	HSG	Pitch (3cyl), VS	
	V150	5.6	150	317	S	105/125/148/155/166	MSG	Pitch (3cyl), VS	
	V162	5.6	162	272	S	119/125/148/166	MSG	Pitch (3cyl), VS	
SiemensGamesa	SG132	3.4	132	248	IA/IIA	84 to 165 & site spec	HSG	Pitch, VS	All GRF
	SG132	5	132	365	IA	84 & site specific	HSG	Pitch, VS	All GRF
	SG145	5	145	303	IIB	90/102/127/ & site spec	HSG	Pitch, VS	All GRF
	SG155	5.8	155	307	IIA	90/102/122/ & site spec	HSG	Pitch, VS	
	SG170	5.8	170	256	IIIA/IIB	100/115/135/165	HSG	Pitch, VS	
General Electric	GE117	4.2	117	391	IA/S (57m/s)	85	HSG	Pitch (el. drive), VS	
	GE130	3.8	130	286	I/IIA	85 to 164.5	HSG	Pitch (el. drive), VS	
	GE137	3.8	137	258	III	85 to 164.5	HSG	Pitch (el. drive), VS	
	GE158	5.3	158	270	IIA	101/121/ hybrid 150/161	HSG	Pitch (el. drive), VS	CRF 2Piece

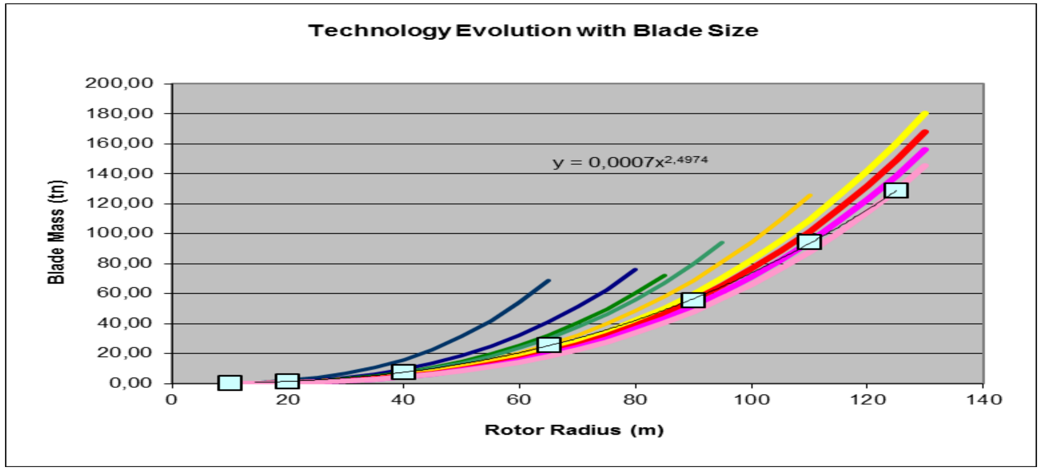


ΚΑΤΑΣΚΕΥΑΣΤΗΣ	ΤΥΠΟΣ Α/Γ	ΙΣΧΥΣ [MW]	ΔΙΑΜΕΤΡΟΣ [m]	Πυκνότητα Ισχύος [W/m2]	ΚΛΑΣΗ IEC	ΥΨΟΣ ΠΛΥΜΝΗΣ [m]	Drive train	Power Control	Blades
Enercon	E115	3	116	284	IIA	92/122/135/149	ELDD	Pitch, VS	
	E115 EP3	4.2	116	397	IA	67/87/92/122/135/149	ELDD	Pitch, VS	
	E126 EP3	4	127	316	IIA	86/116/135	ELDD	Pitch, VS	
	E136 EP5	4.6	136	317	IA	109/120/132/155	ELDD	Pitch, VS	
	E138 EP3	3.5	138	234	IIIA	80/110/130/131/160	ELDD	Pitch, VS	
	E147 EP5	5	147	295	IIA	126/132/143/155	ELDD	Pitch, VS	
	E160 EP5	4.6	160	229	IIIA	120/143/166	ELDD	Pitch, VS	
Nordex	N117	3.6	117	335	IIA	91 to 141	HSG	Pitch, VS	Hybrid
	N131	3.6	131	267	II	84 to 134	HSG	Pitch, VS	Hybrid
	N131	3.9	131	289	III	84 to 134	HSG	Pitch, VS	Hybrid
	N133	4.8	133	346	I/II	78/83/110	HSG	Pitch, VS	Hybrid
	N149	4.5	149	258	II/III	105/125/164	HSG	Pitch, VS	Hybrid
Goldwind	GW136	3.4	136	234	III	100/120	PMDD	Pitch, VS	
	GW136	4.2	136	289	II	100/121	PMDD	Pitch, VS	
	GW140	3.4	140	221	III	100/122	PMDD	Pitch, VS	
	GW155	4.2	155	223	III/S	100 & site spec	PMDD	Pitch, VS	

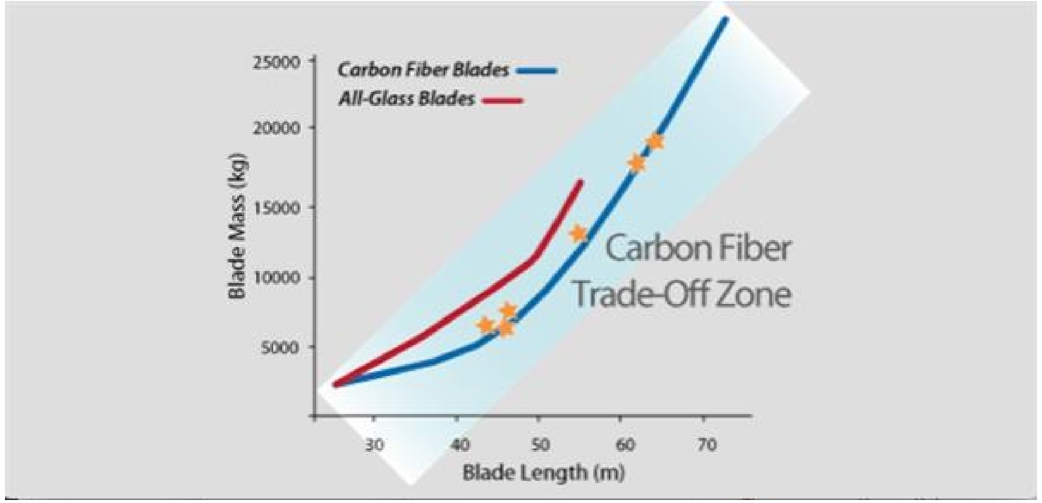


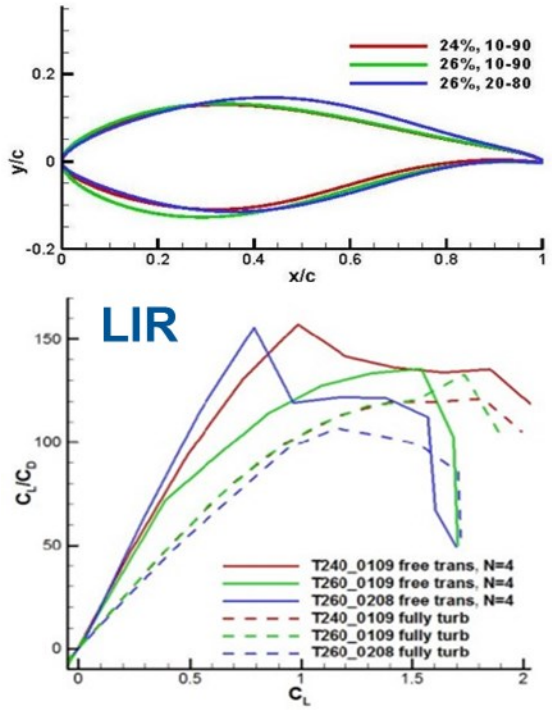


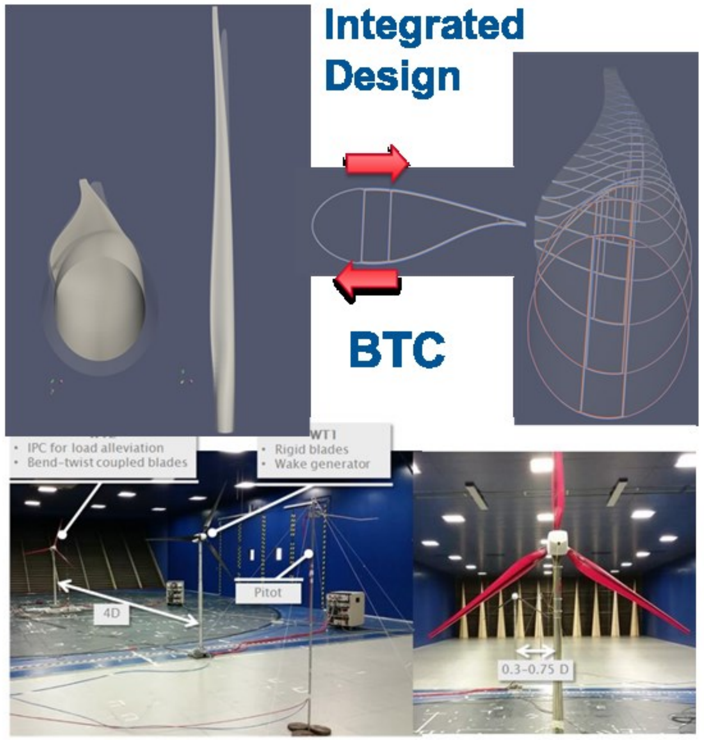
Source DTU IE Report 2014

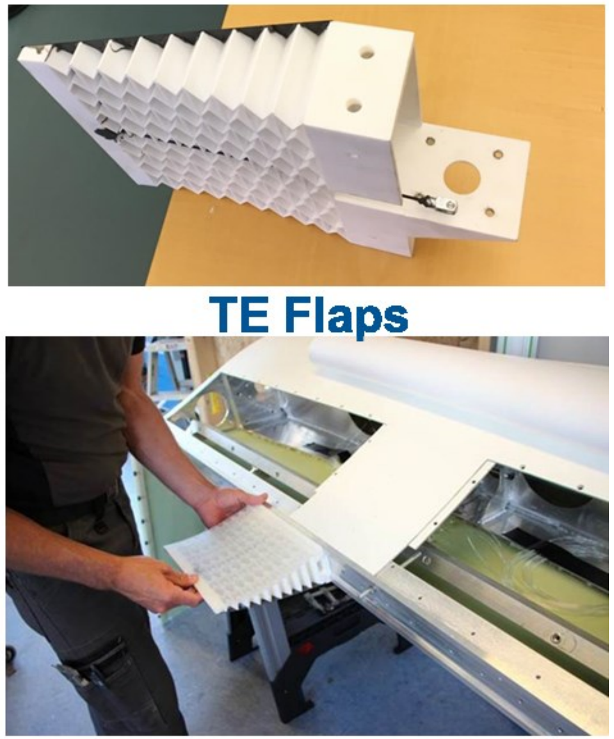


CRES



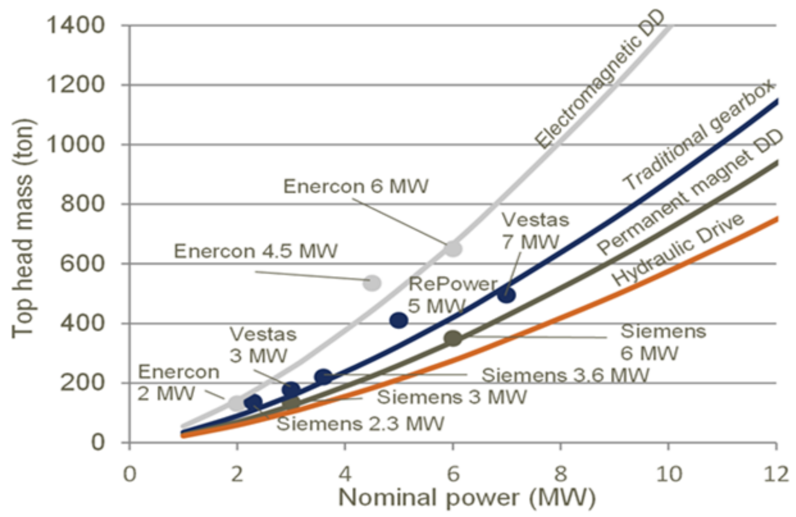




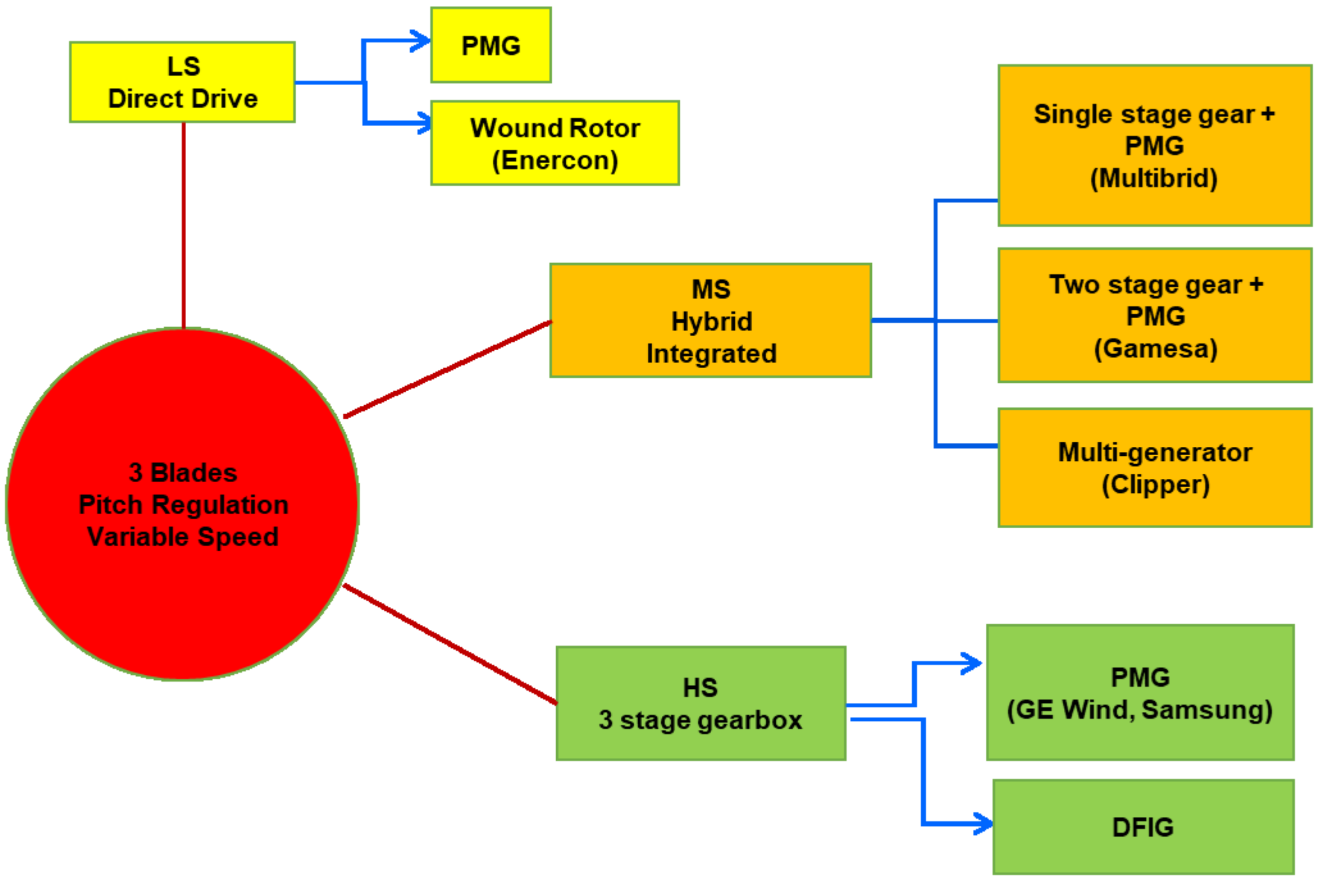


- Ο δρομέας αν και έχει μικρή συμμετοχή στο κόστος της θαλάσσιας Α/Γ έχει την κύρια ευθύνη της ενεργειακής παραγωγής
- Μεγάλοι δρομείς με περιορισμένα/μειωμένα φορτία αποτελούν ζητούμενο για τις μεγάλες θαλάσσιες Α/Γ. Αυτό επιτυγχάνεται με το δχεδιασμό δρομέων μειωμένης επάγωγής (LIR), την αεροελαστική σύζευξη βαθμών ελευθερίας (BTC) και τον ενεργητικό αεροδυναμικό έλεγχο (π.χ. Με πτερύγια καμπυλότητας, flaps)
- Μέθοδοι ολοκληρωμένου αεροελαστικού σχεδιασμού με σημαντικό αριθμό βαθμών ελευθερίας για εξωτερική γεωμετρία και εσωτερική δομή αναπτύχθηκαν και εφαρμόστηκαν κατά κόρον

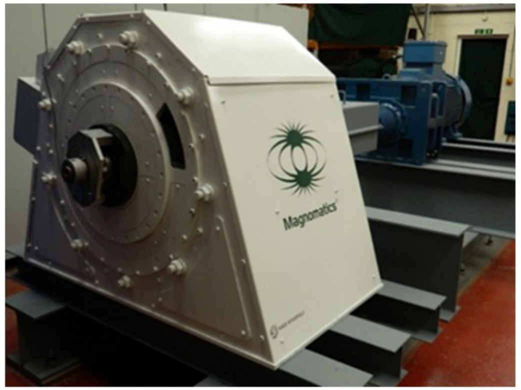
Τεχνολογικές τάσεις – Σύστημα μετάδοσης



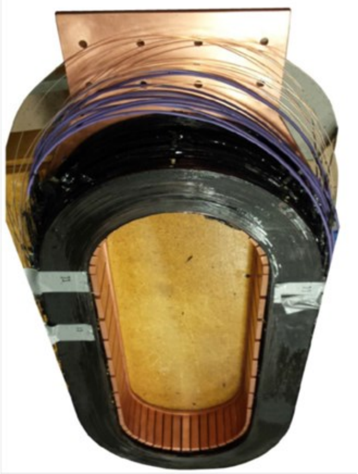
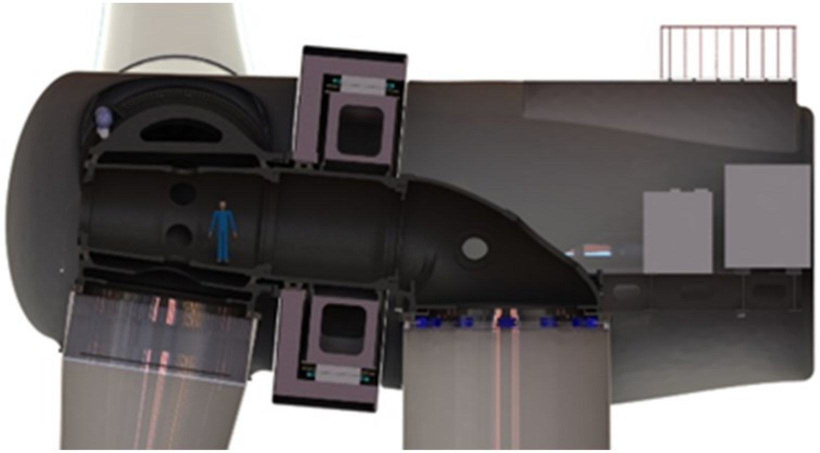
Source BGM Cons



Τεχνολογικές τάσεις – Σύστημα μετάδοσης

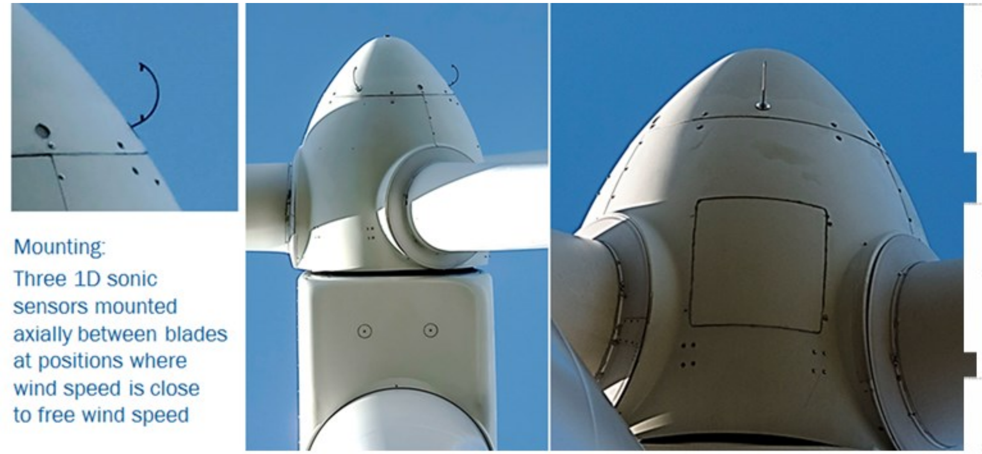



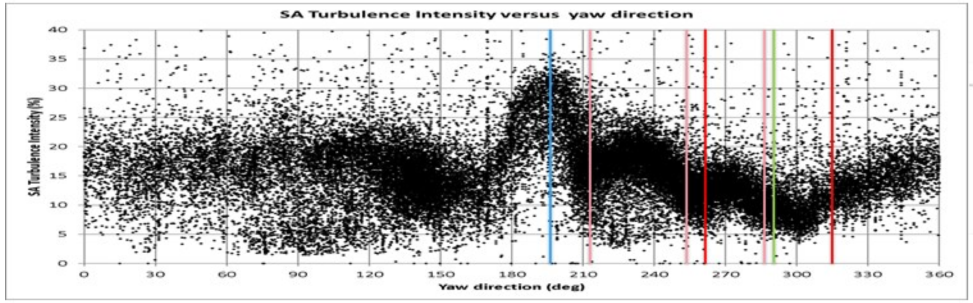

Pseudo-magnetic direct drives (5,16 and 200 kNm demonstrators)

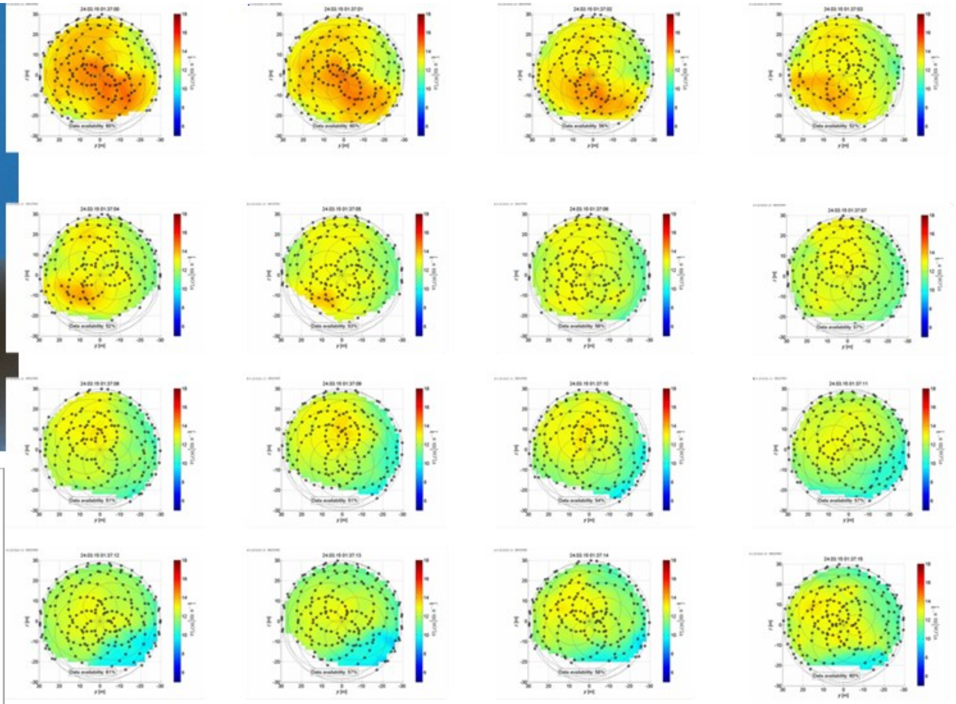



High-temperature Superconducting generators, MgB2 race track coil & 20MW concept

Τεχνολογικές τάσεις – Ελεγχος φορτίων / ισχύος







2D rotor plane wind fields @ 400 measurement points per sec

- Αισθητήρες ταχύτητας ανέμου Spinner Anemometer and Spinner Lidar
- Ανεξάρτητος έλεγχος βήματος και πτερυγίων καμπυλότητας Individual Pitch Control (IPC), Individual Flap Control (IFC) και συνδυασμός τους
- Αυτόματος έλεγχος σε ακραίες τιμές ατμοσφαιρικής τύρβης
- Έξυπνη διακοπή λειτουγίας με χρήση TE Flaps

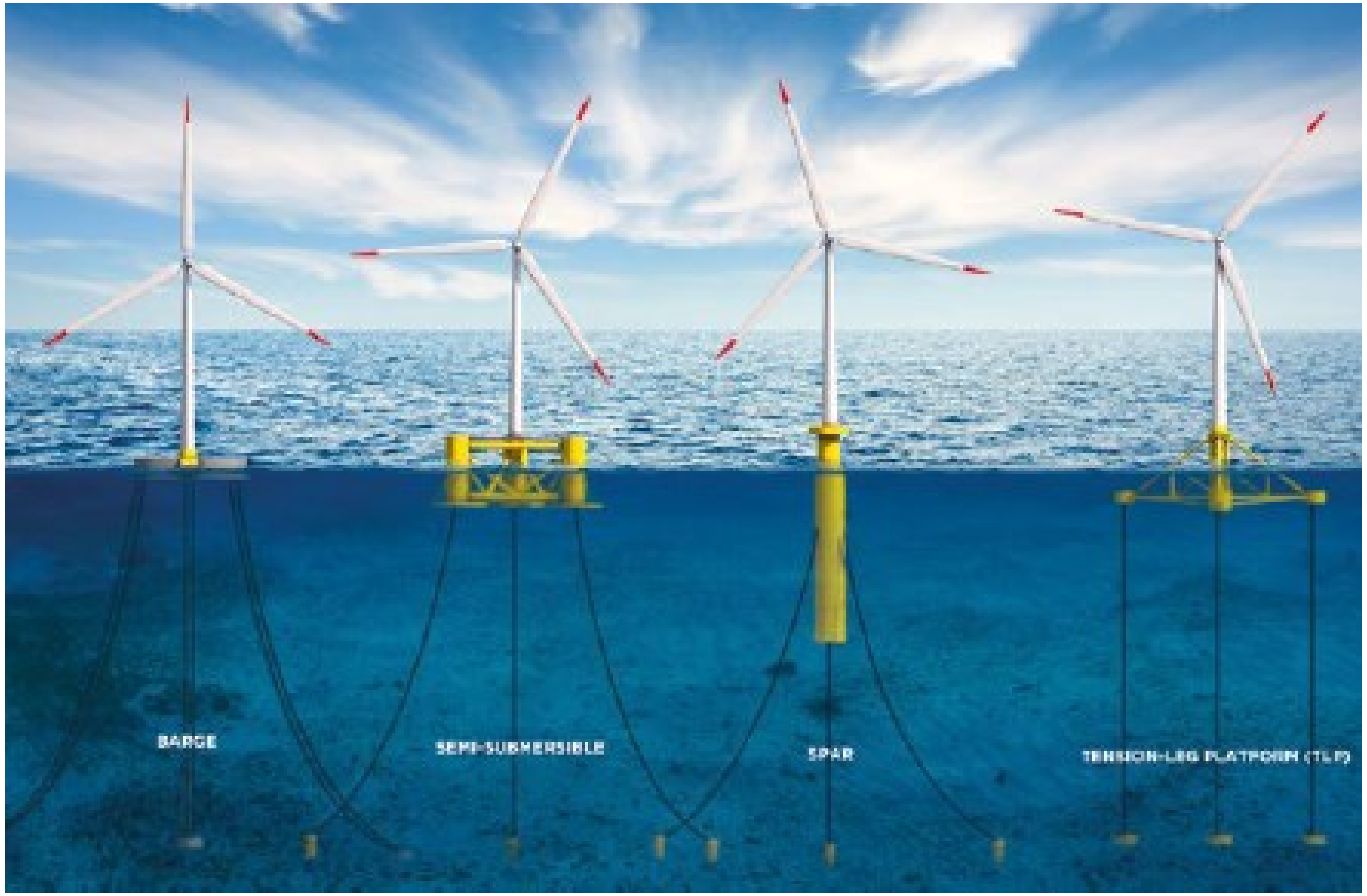
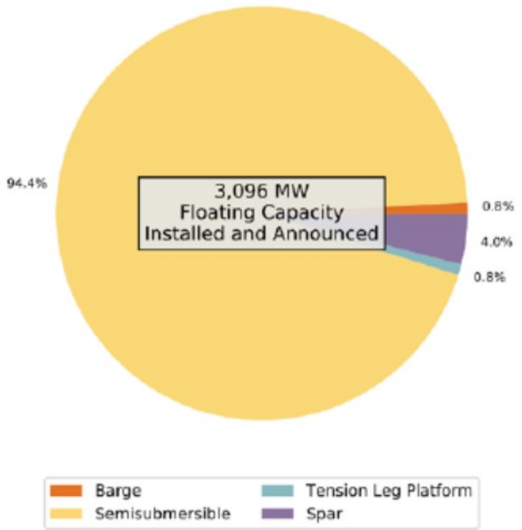


TABLE 2
Floating offshore wind projects in Europe

PROJECT NAME	CAPACITY	COUNTRY	EXPECTED COMMISSIONING DATE
Dounreay Tri	2 x 5 MW	Scotland	2018
Gaelectic	30 MW	Ireland	2021
Hywind Scotland	30 MW	Scotland	2017
WindFloat Atlantic	30 MW	Portugal	2018-2019
Kincardine	48 MW	Scotland	From 2018
French pre-commercial farms	4 x 25 MW	France	2020
Antlantis / Ideol project	100 MW	UK	2021

Source: WindEurope



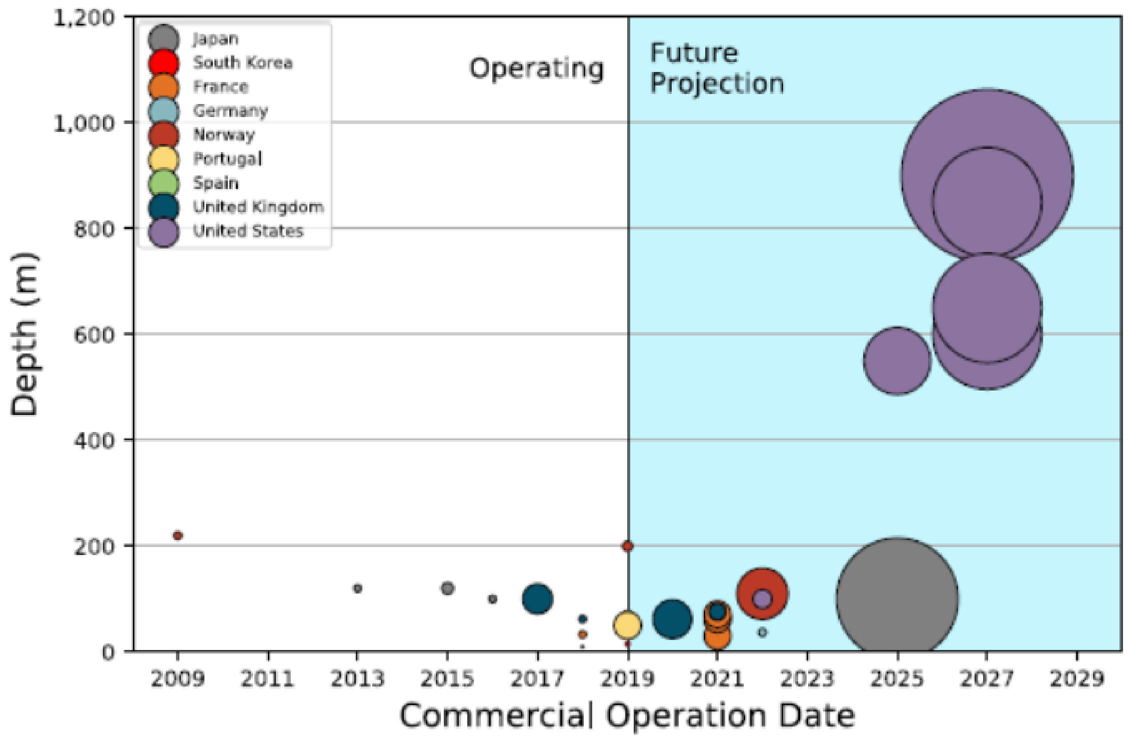


Figure 18. Global floating offshore wind pipeline

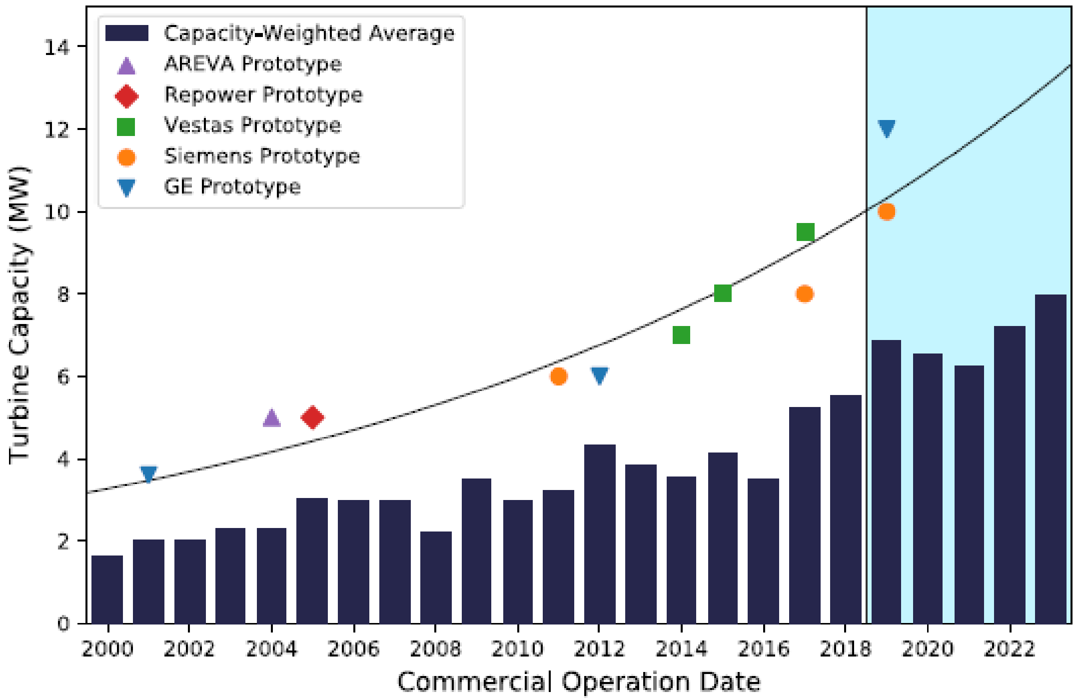
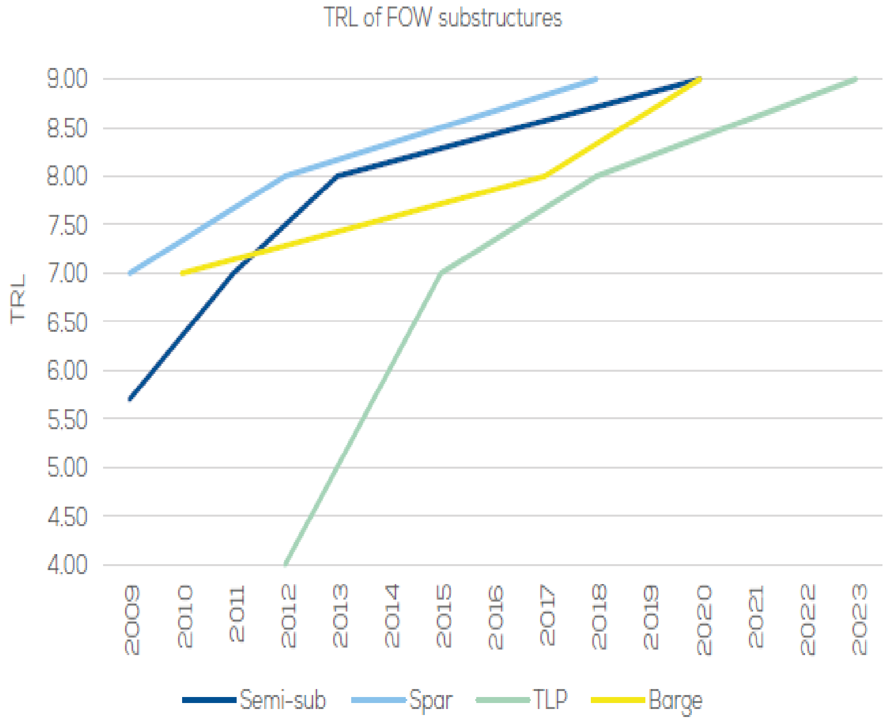


Figure 23. Average commercial offshore wind turbine rating compared to prototype deployment by year

http:/www.osti.gov/scitech

FIGURE 1

Technology Readiness Level of Floating Offshore Wind substructures



Source: The Crown Estate[1] and WindEurope

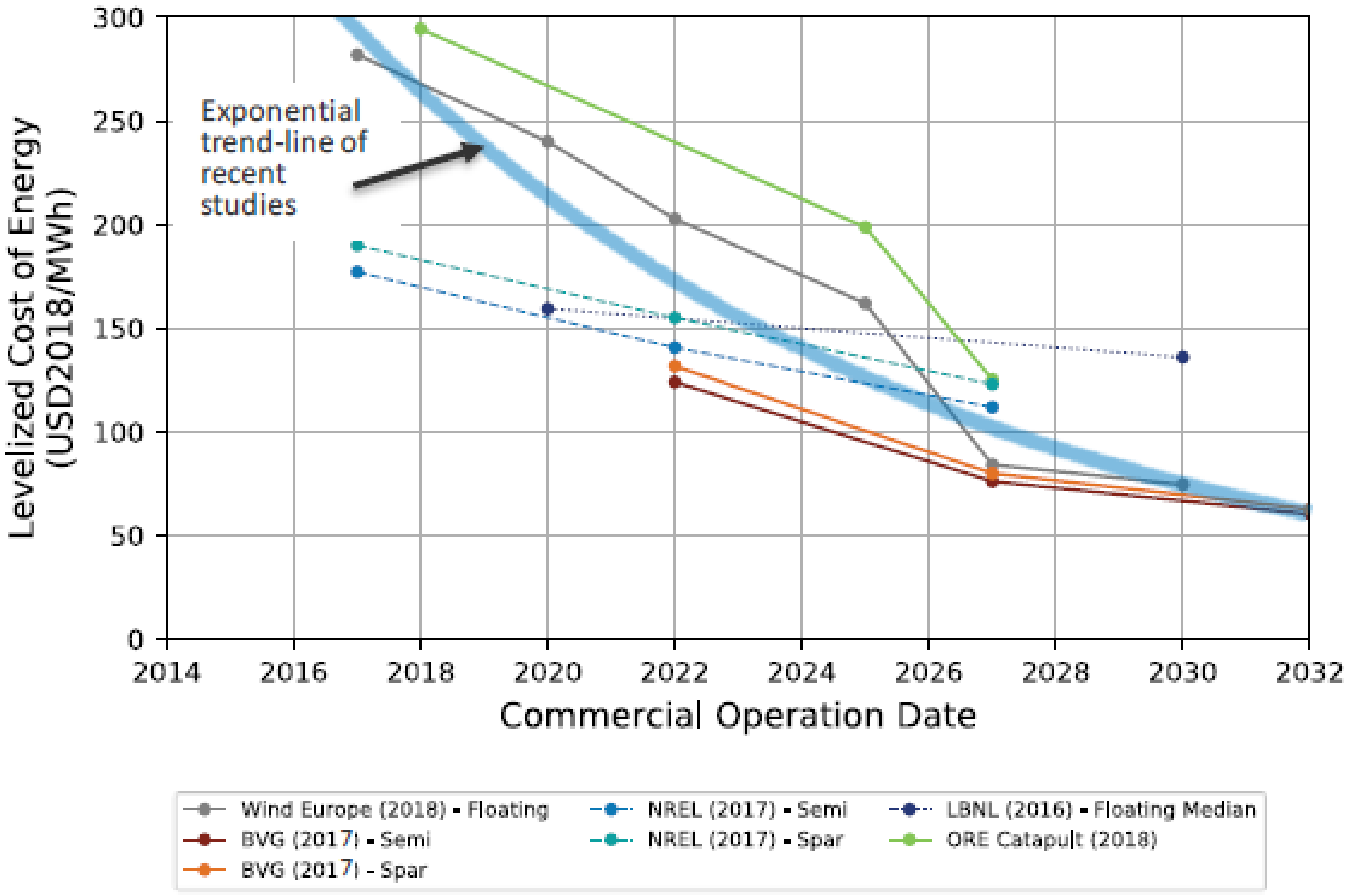
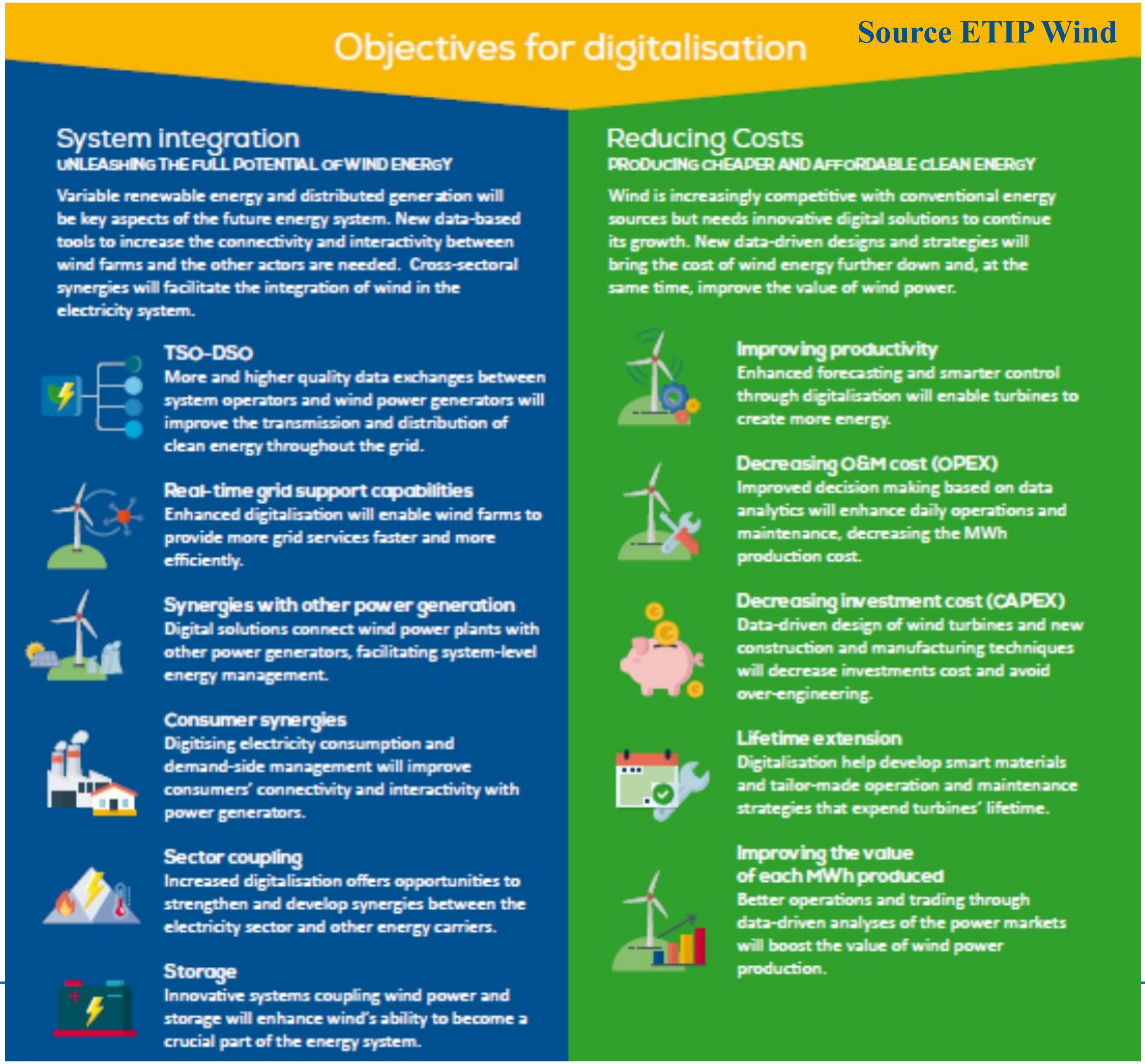


Figure 36. Global LCOE estimates for floating technology[72]

http://www.osti.gov/scitech



- **Digital twins / digital clones**
- **Enhanced forecasting & smarter control**
- **Decision making based on data analytics**
- **Data-driven design decreases CAPEX**
- **Lifetime extension through tailored-made O&M**
- **Better operation & trading**