ΕΛΕΤΑΕΝ

Ελληνική Επιστημονική Ένωση Αιολικής Ενέργειας

Wind Energy in Greece

Current Status, Developments, Market & Technology Trends

Panagiotis Ladakakos

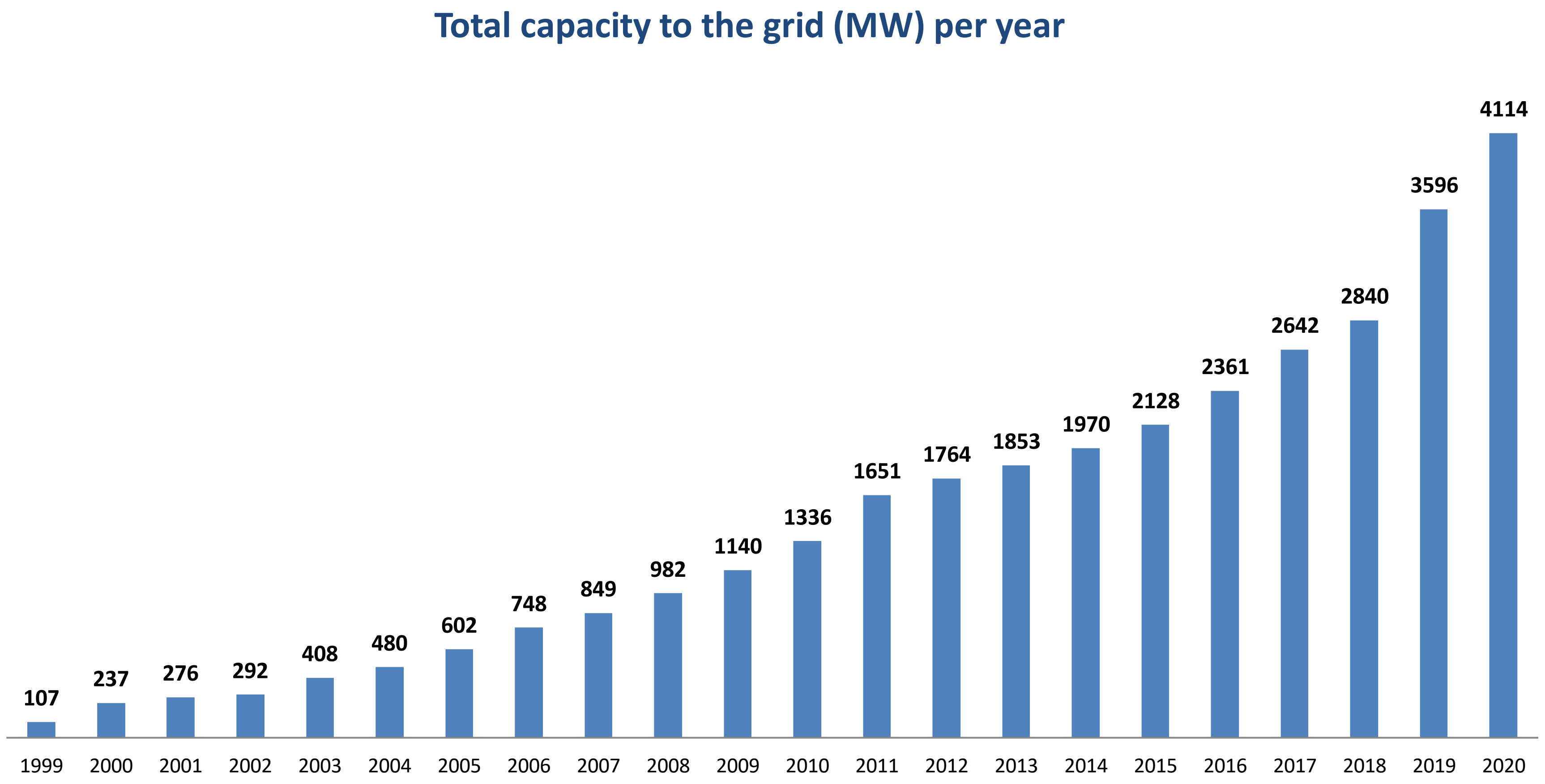
28 June 2021

1

Wind Energy Development

- Current situation
- 2030 targets

Evolution of Wind Energy in Greece

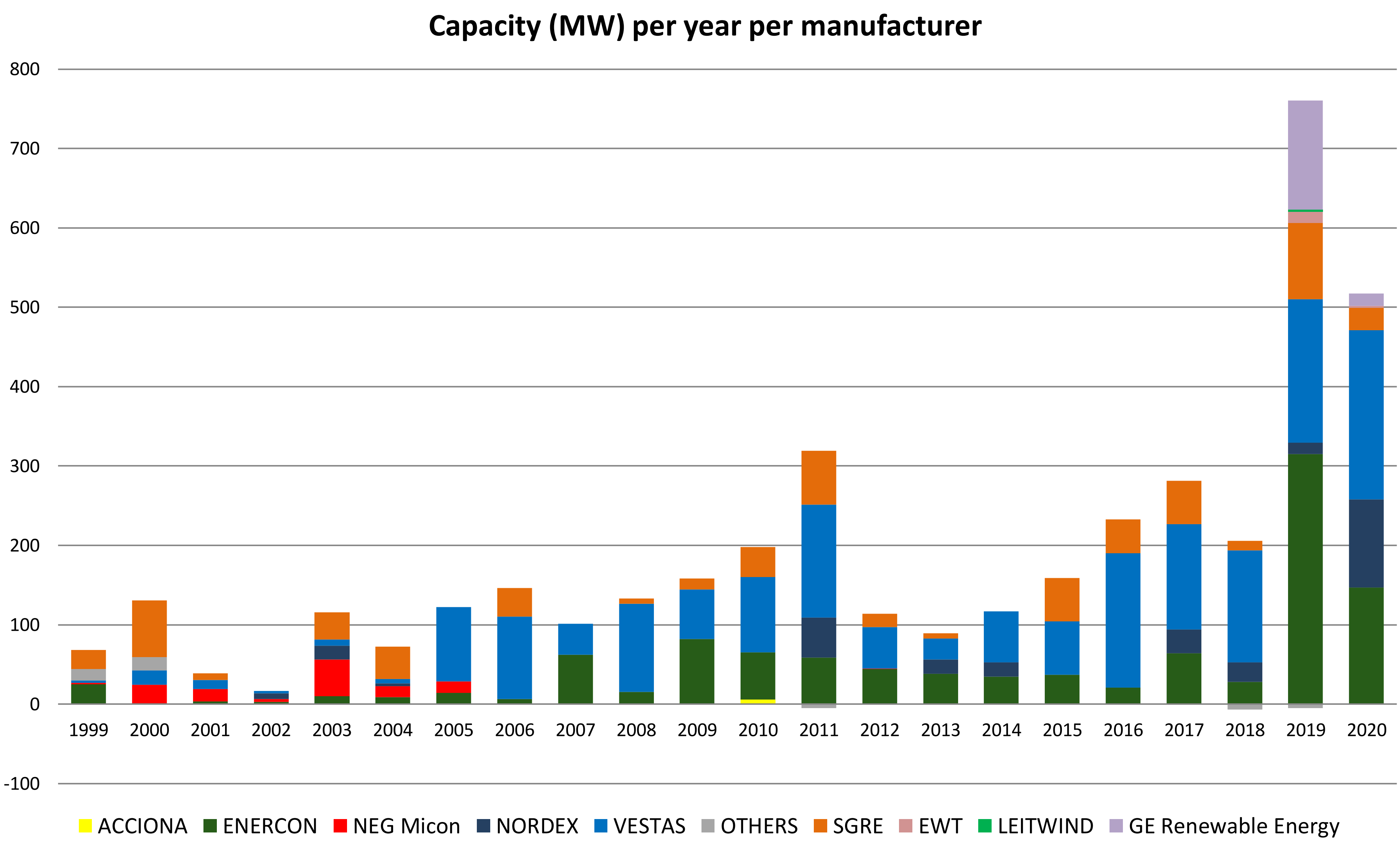


Source: HWEA, Wind Statistics 2020

Total installed wind capacity (end 2020)

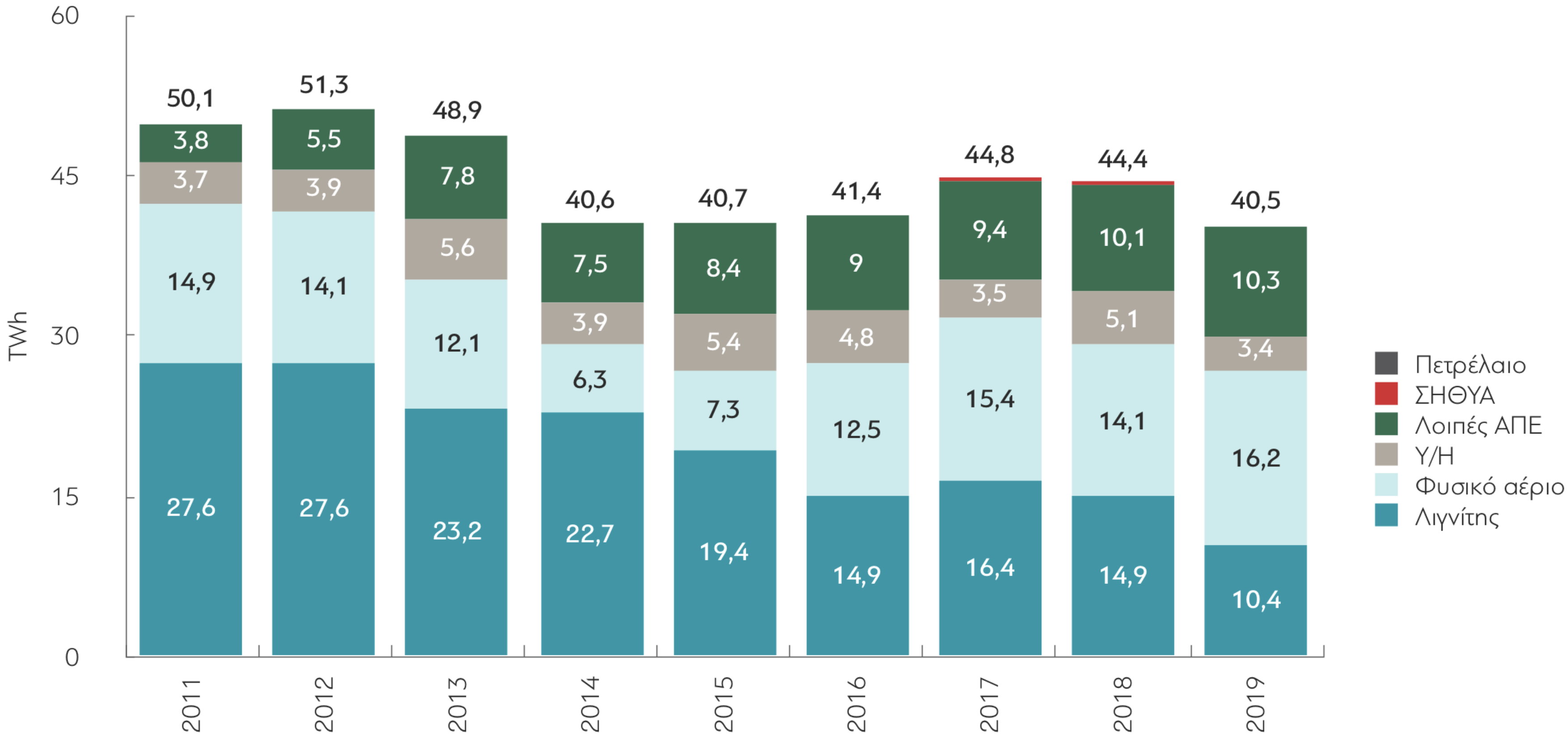
4.114 MW

Wind energy in Greece, 1999-2020



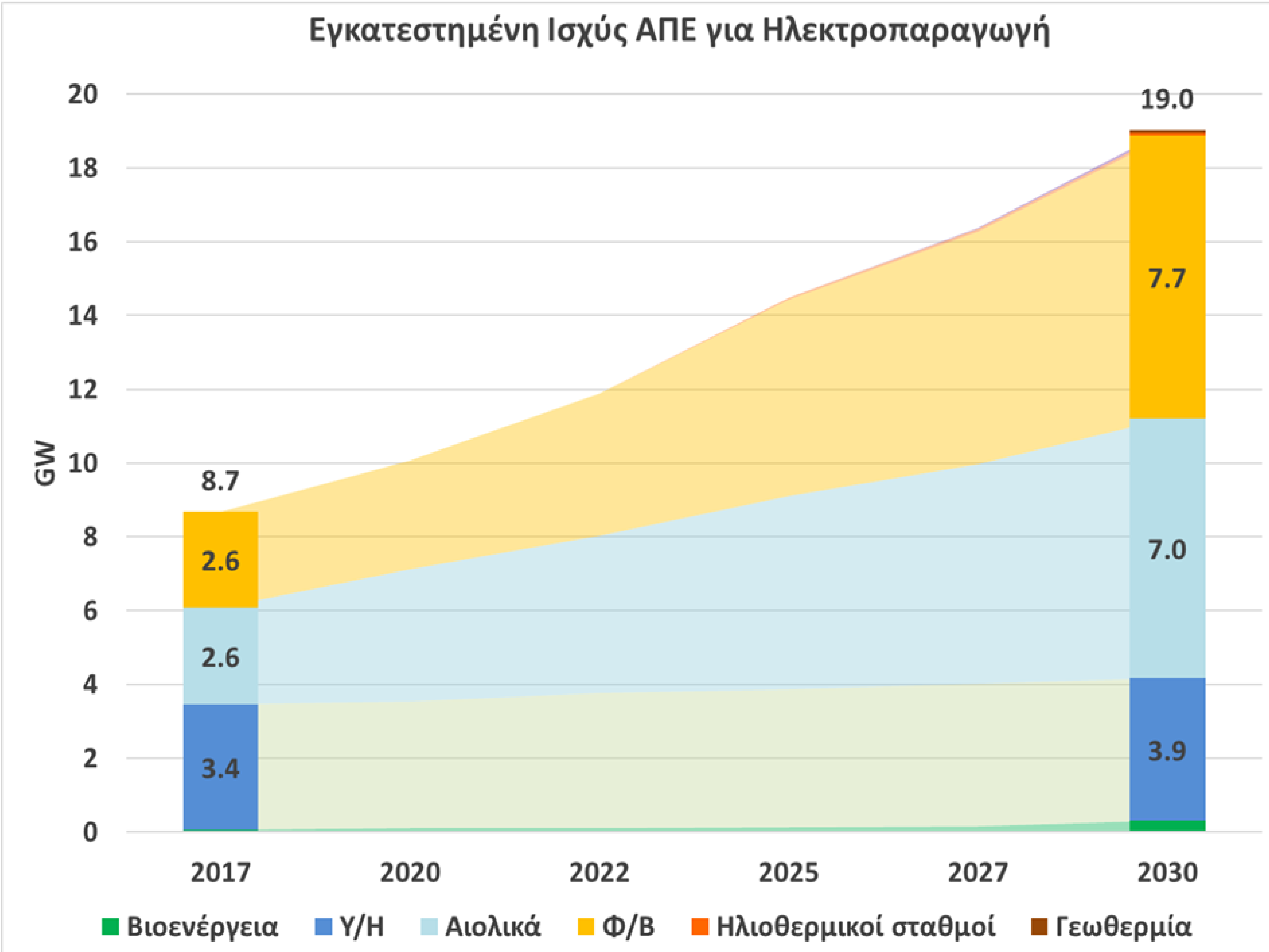
Electricity production in Greece (interconnected System)

Διάγραμμα Παραγωγή ηλεκτρικής ενέργειας στο Διασυνδεδεμένο Σύστημα, 2011-2019

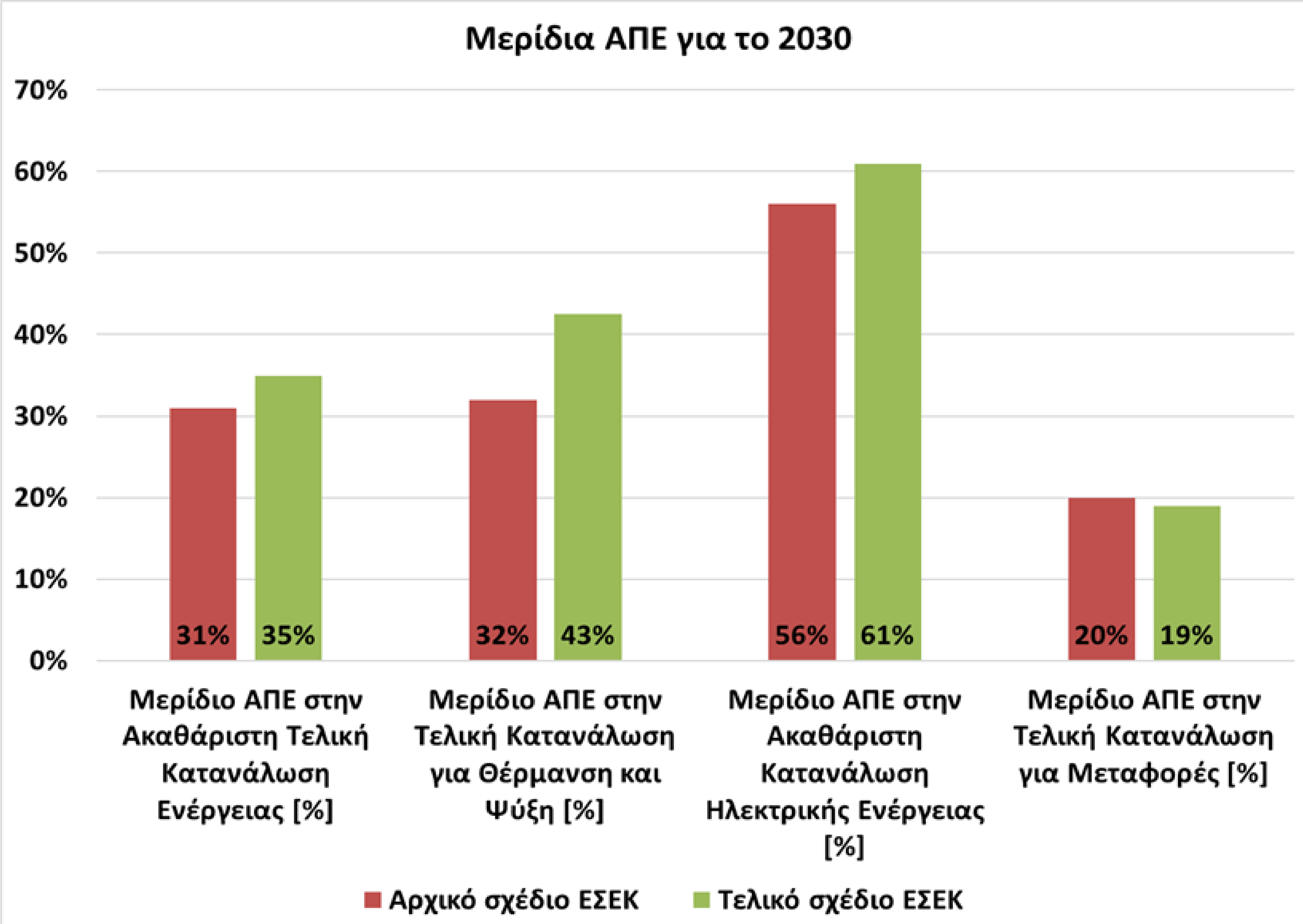


Πηγή: ΑΔΜΗΕ, ΔΑΠΕΕΠ, ΛΑΓΗΕ.

Still we have a long way to go…



The new National Climate & Energy Plan, 2030



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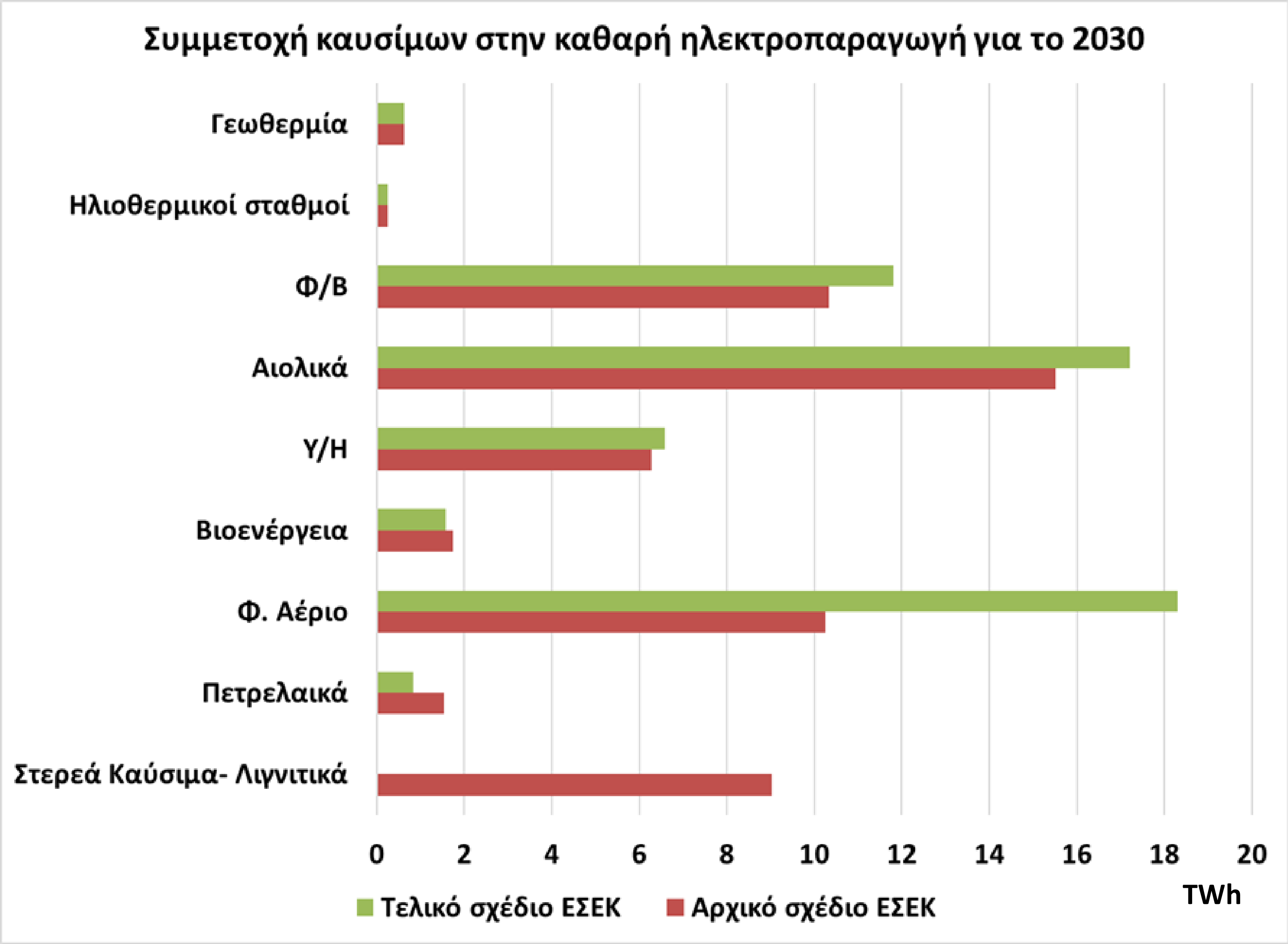

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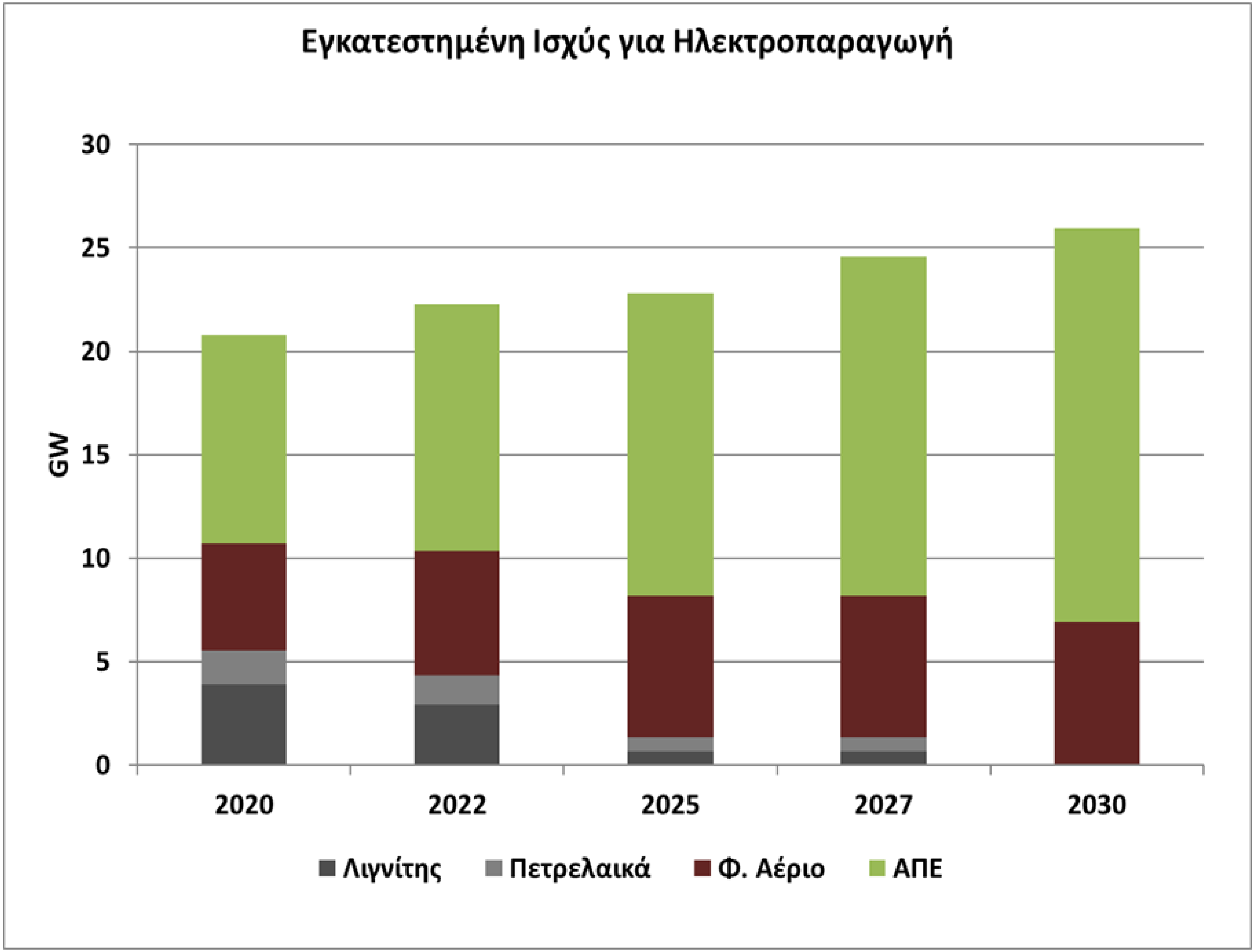

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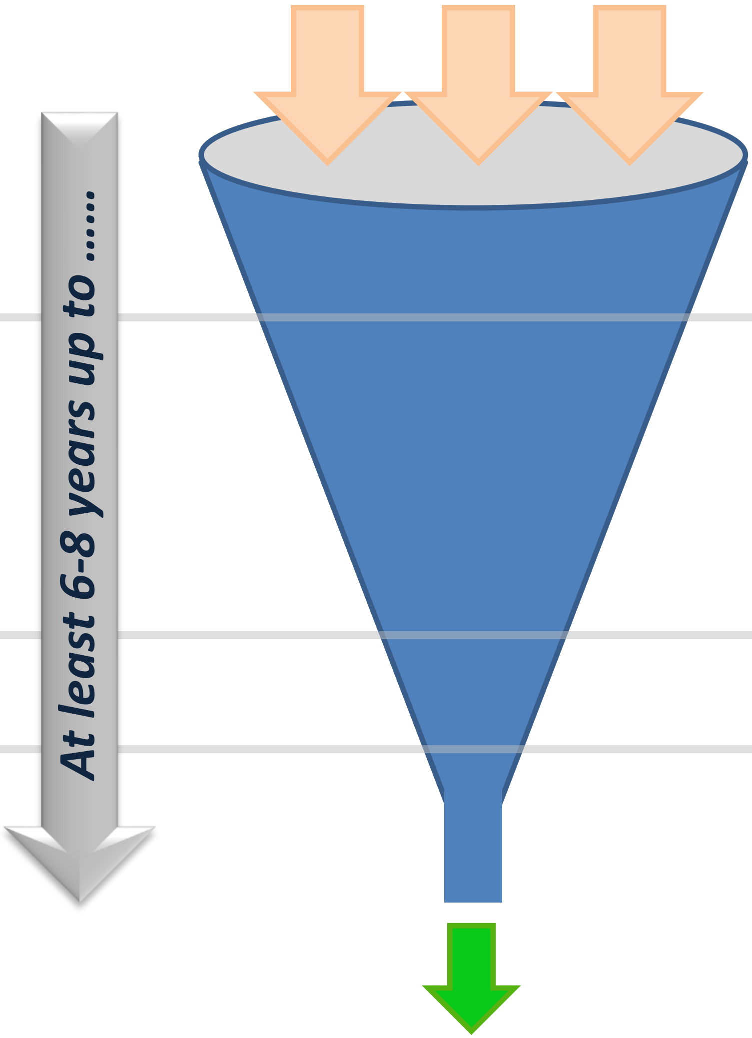
Licensing milestones
Legislation framework

Wind Energy Development in Greece

Projects under development



Successful projects

Milestones

Production License

EIA approval

Binding Grid Connection Offer

Installation License

Success factor: 3,14%

New installation and operation licenses June 2012 – Nov 2017 as per the under development projects of June 2012

A complete legislation framework …

2008 Spatial Framework for RES

2010 MD 37338/2010 for SPAs (characterization species)

2011 Law 4014/2011 (environmental licensing)
Law 3937/2011 for the protection of biodiversity

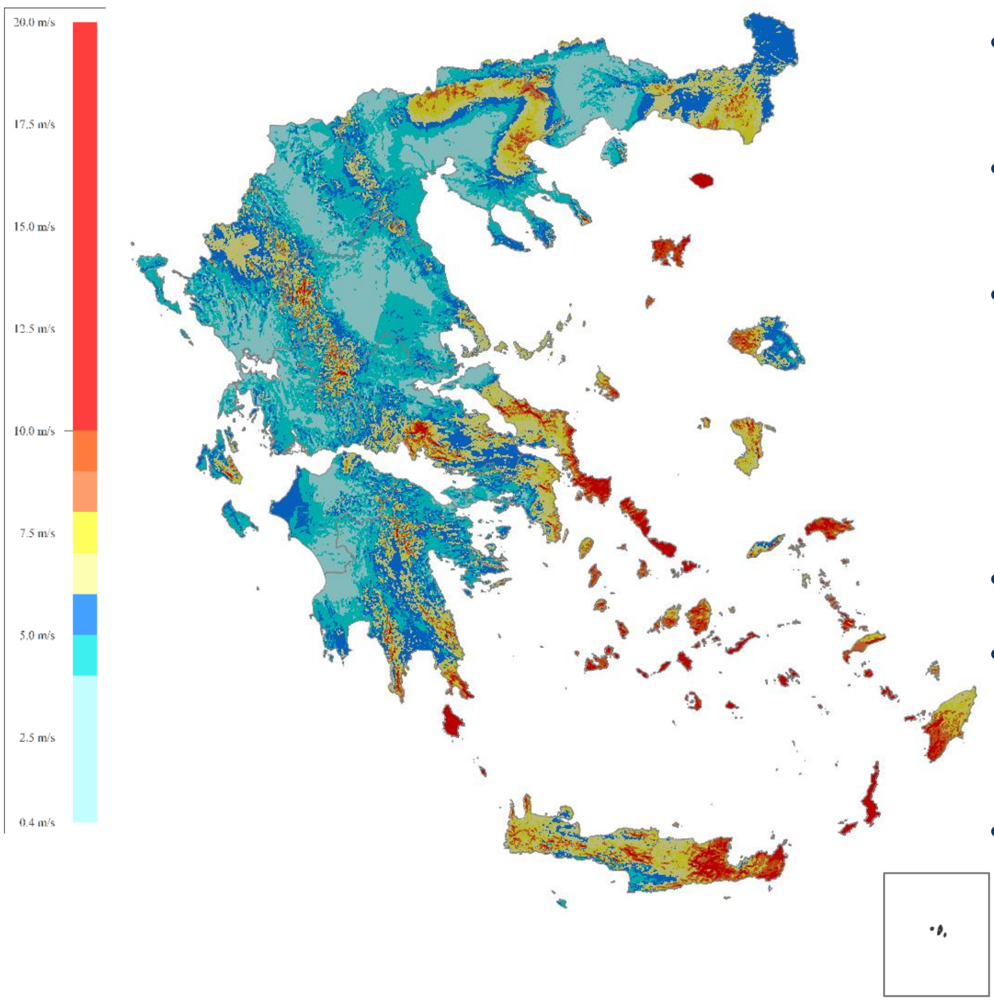
2012 MD 8353/2012 for SPAs (mitigation measures)

2013 MD 167563/2013: new procedure for environmental licensing

2014 MD170225/2014: specifications of environmental studies
Law 4280/2014 (new forestrial Law): reforestation of equal area

… in line with EU legislation

Spatial Framework for RES



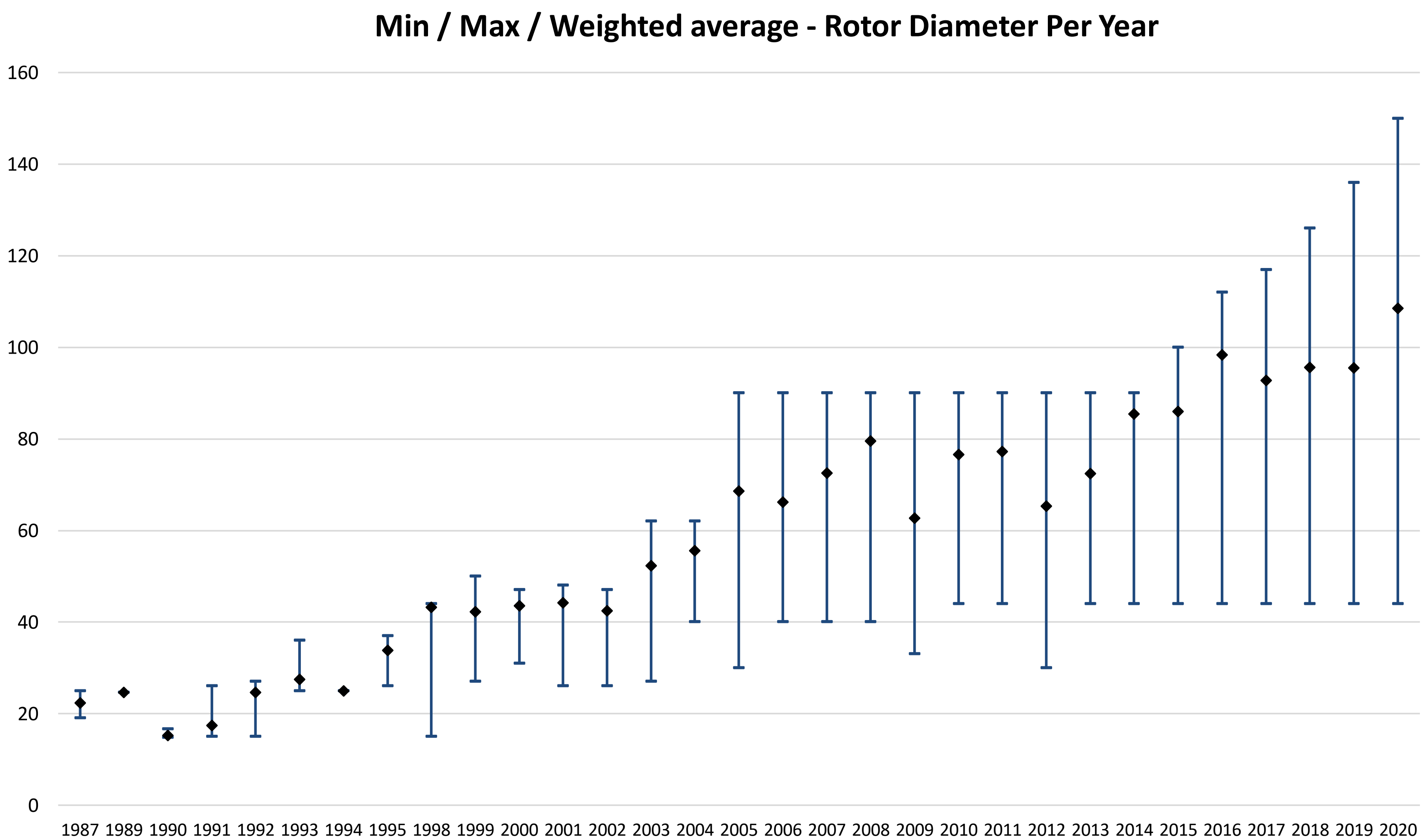
- Approved after Strategic Environmental Assessment
- Approved by the Council of State in plenary session (Dec.1422/2013)
- Legal basis for several decisions of the Council of State
- Main characteristics:
  - Strict rules and restrictions (exclusion zones, min. distances etc)
  - Transparency and equal treatment for every project
- A dynamic framework
- Its consequences are continually adjusted to the application of the legislation for the protective areas
- Indicatively, the legislation foresees the process for new NRs and Strict NRs, which – according to the Spatial Framework- are exclusion areas

MD 49828/2008 (OG 2464B)

3

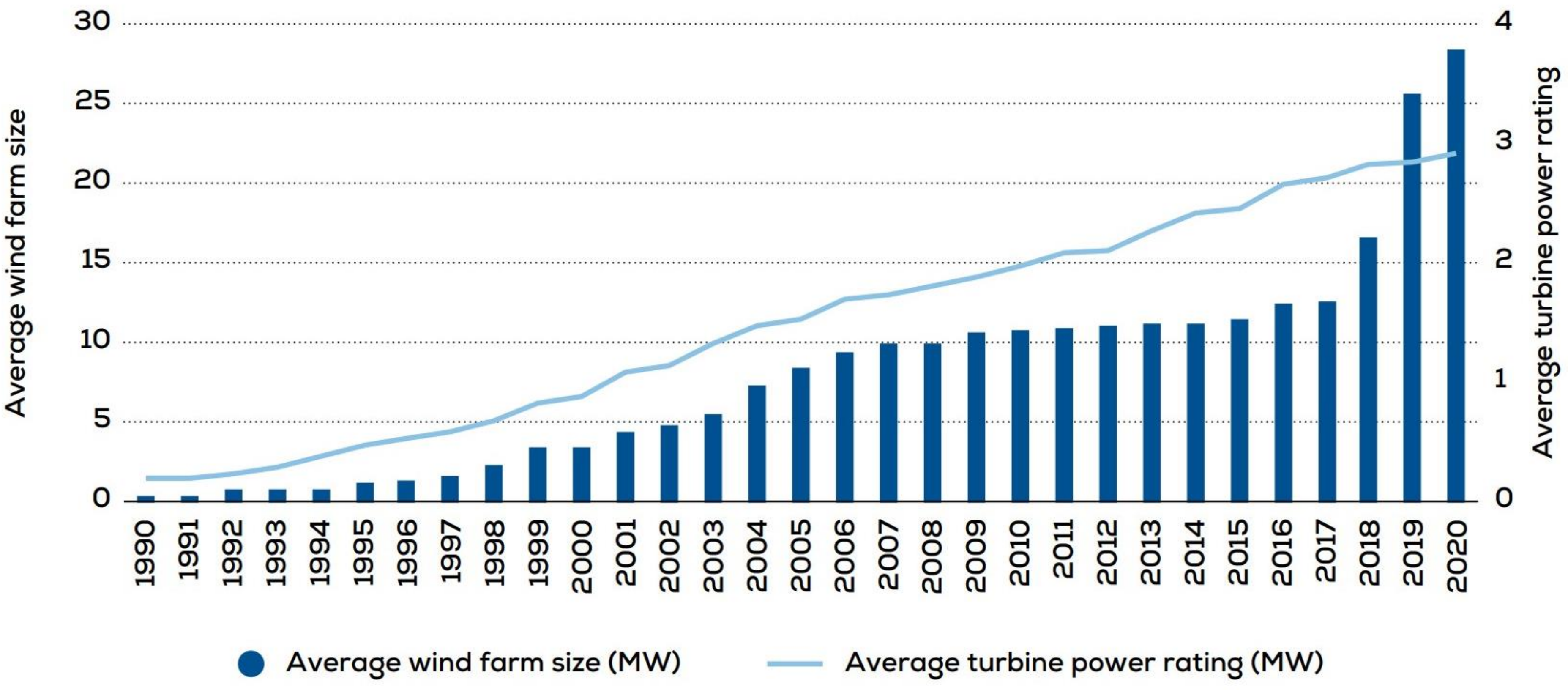
Technology Trends

Greece: Evolution of installed WEC characteristics



Onshore wind farm and turbine size in Europe

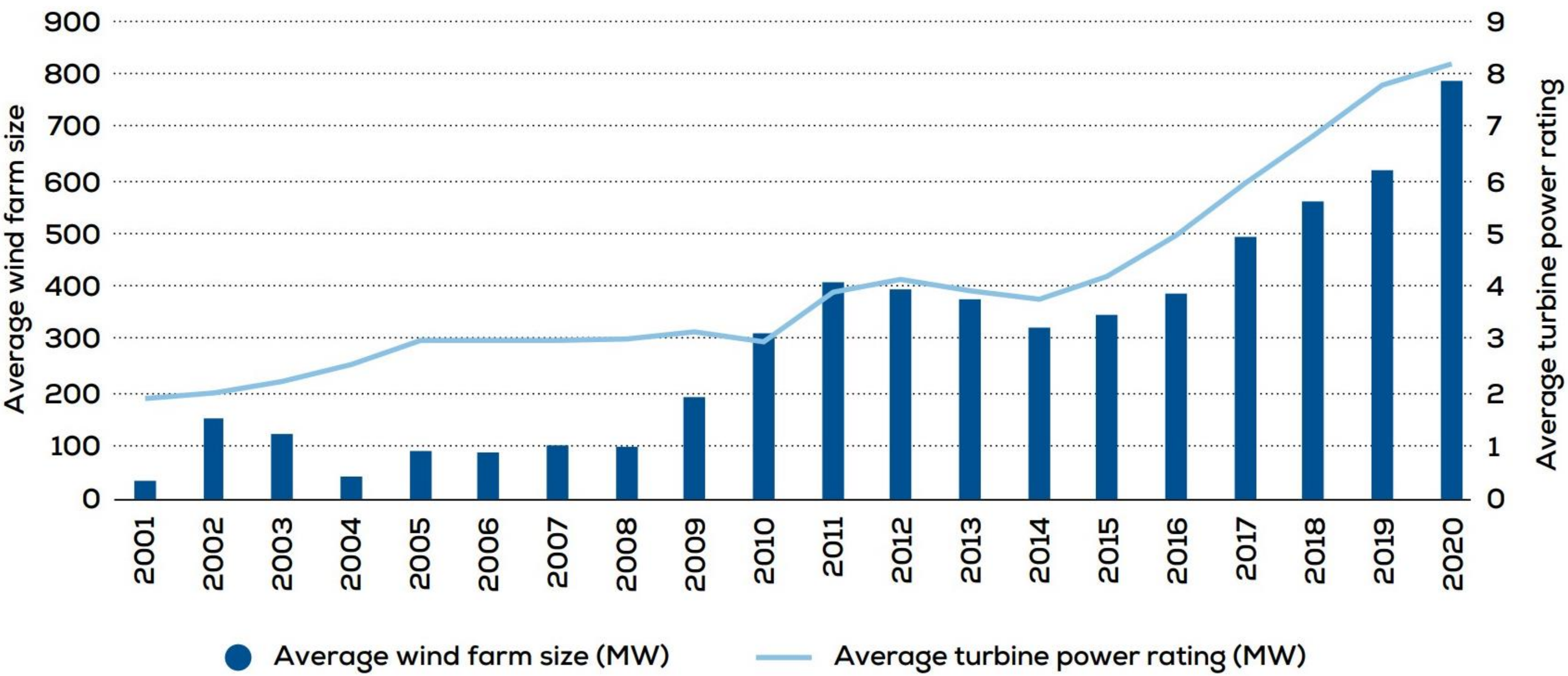
Average annual installed wind farm size and average turbine power rating for onshore wind in Europe



Source: ETIP Wind, Wind Europe, Fit for 55, set for 2050 report

Offshore wind farm and turbine size in Europe

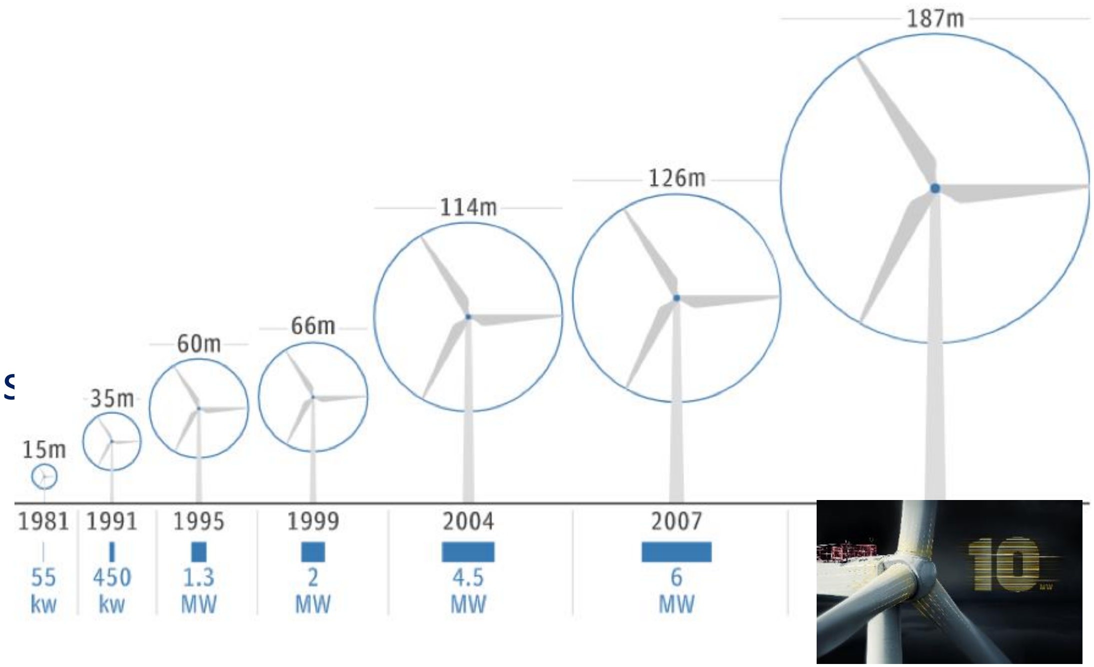
Average annual installed wind farm size and average turbine power rating for offshore wind in Europe



Source: ETIP Wind, Wind Europe, Fit for 55, set for 2050 report

Wind turbine technology trends

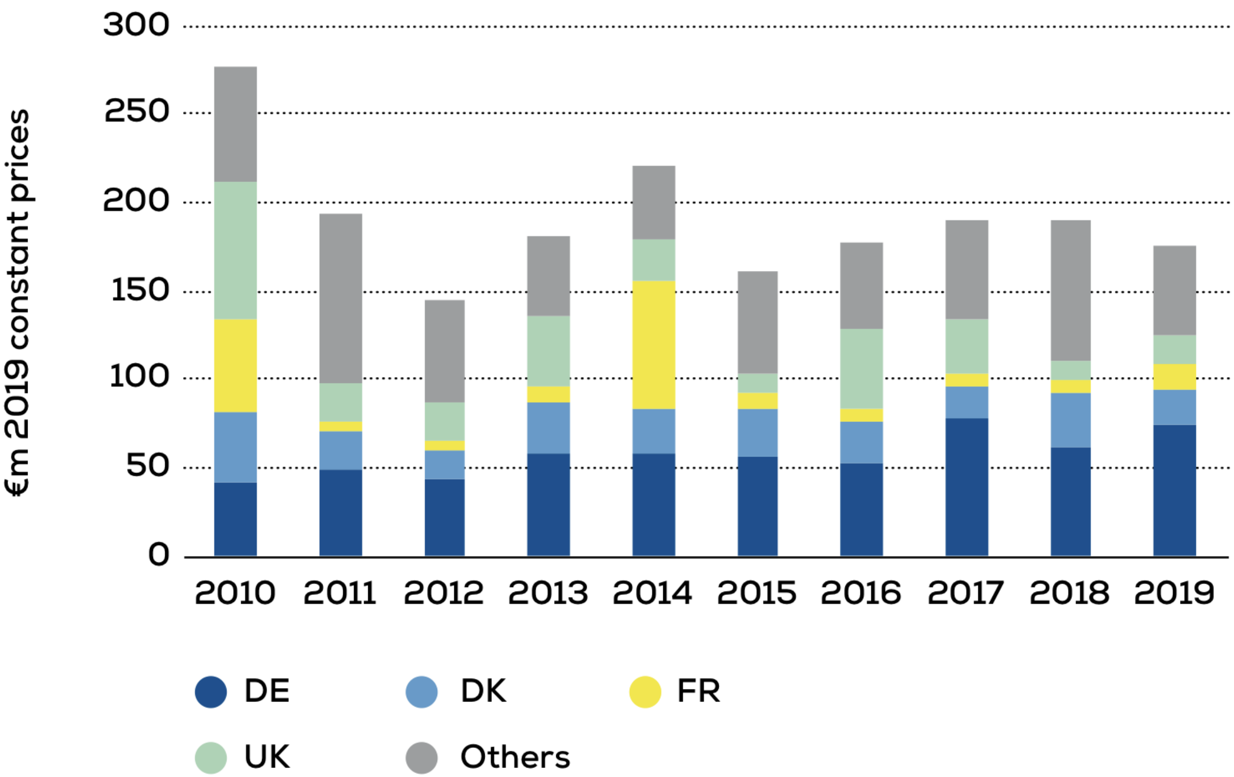
- Bigger rotors!
- WTGs focused in low wind areas
- No more WTGs below 3MW
- Onshore >4MW >140m rotor
- Offshore >10MW >160m rotor
- European industry still dominates but..
- China is coming..
- Digitalization & Big Data
- Need for endless R&I

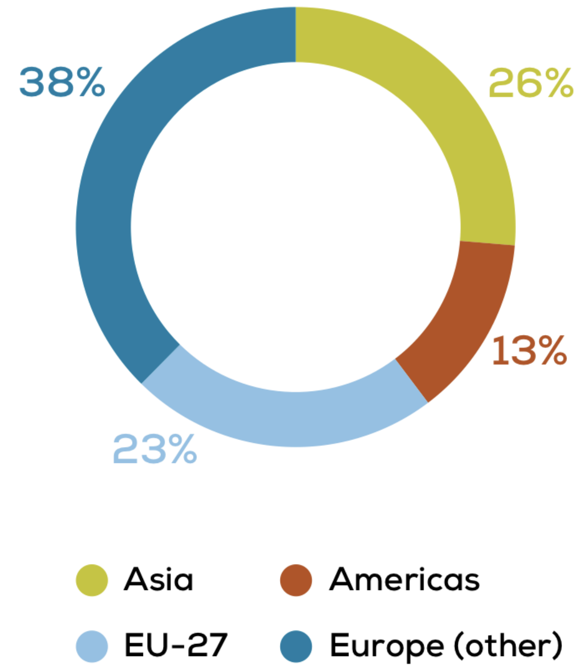


4

need for endless R&I

EU is still the leader in R&I in wind energy



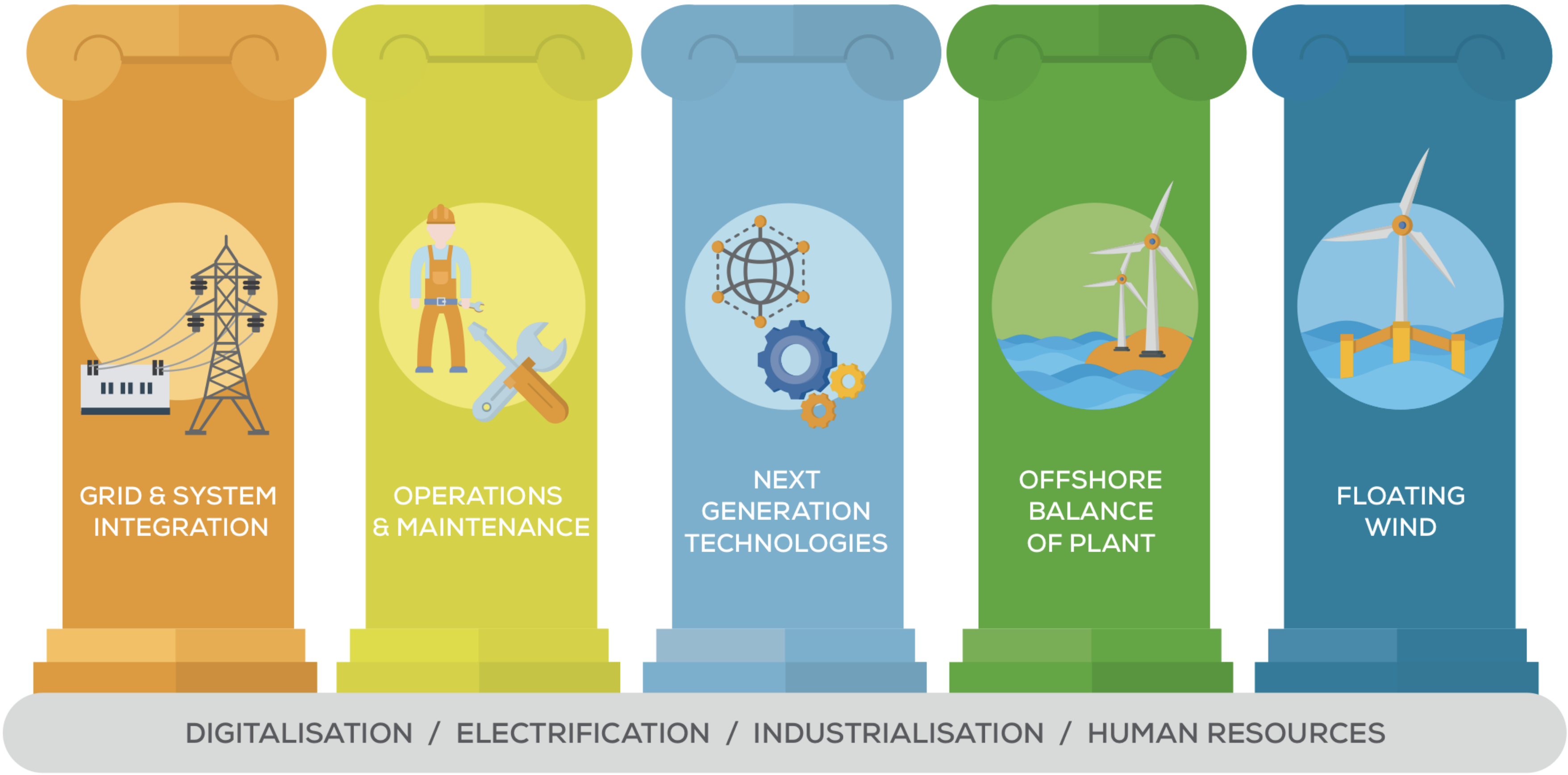


Public funding for wind energy research & innovation in the EU-28[116].

Global funding for wind energy research & innovation in 2019[117].

Source: ETIP Wind, Wind Europe, Fit for 55, set for 2050 report

The five pillars of wind energy R&I

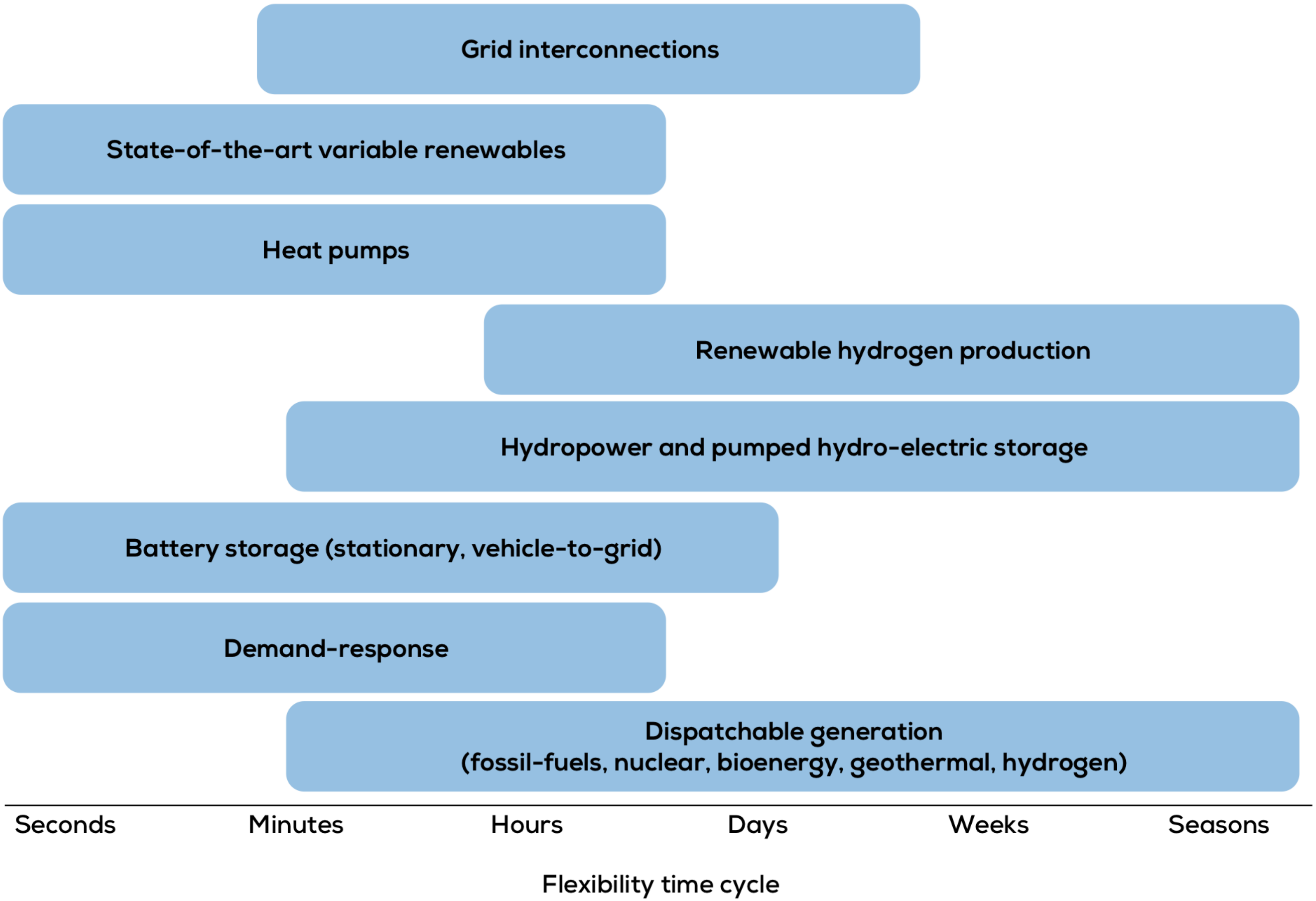


The five pillars of wind energy research & innovation. Source: ETIPWind, 2018, Strategic Research & Innovation Agenda.

5

a couple of things more
re. technology trends...
besides wind turbines

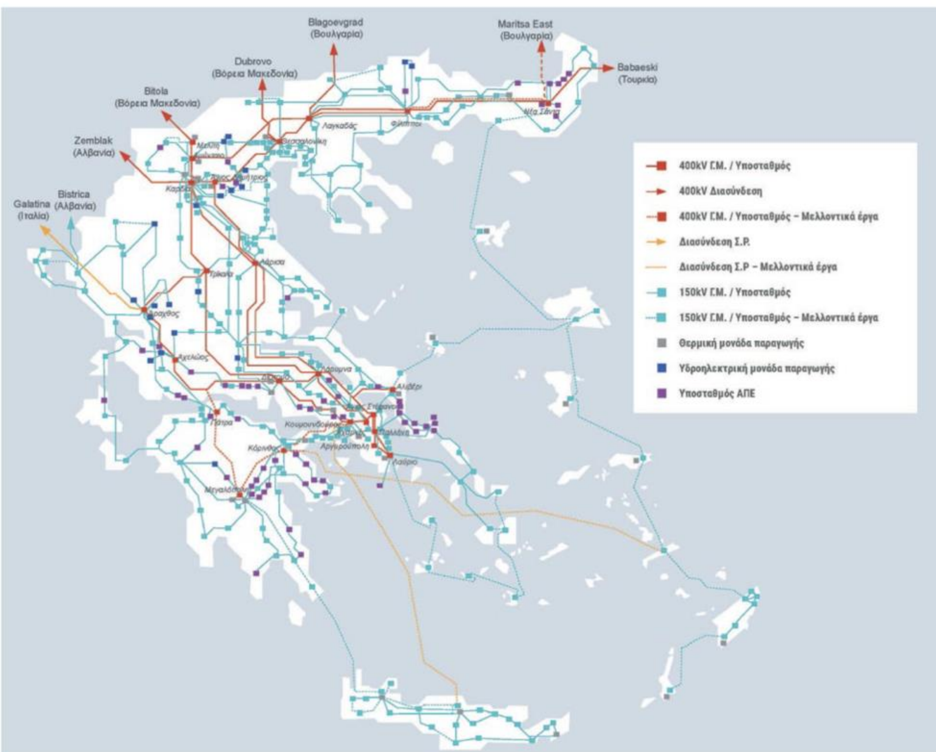
Large RES penetrations need Storage & Flexibility



Grid optimisation technologies

Old passive networks must be upgraded and updated with new grid technologies!

Διάγραμμα Ελληνικό Διασυνδεδεμένο Σύστημα Μεταφοράς Ηλεκτρικής Ενέργειας, Απρίλιος 2017



Source: IPTO/ADMIE

Advanced monitoring	• Dynamic Line Rating • Substation Fleet Digitalisation • Asset Performance Management
Advanced system operation control devices	• Phase-Shifting Transformer • Solid-State Transformer • Static Synchronous Series Compensator • Modular Power Flow Control Technology • Thyristor-controlled Series Compensator • Static Synchronous Compensator • Static VAR Compensator • Adaptive Protection Scheme • Synchronous Condensers
Advanced converter technologies	• Grid-forming capabilities • Black-start
Line and voltage upgrades	• High Temperature Low Sag conductors • Voltage uprate
DC transmission	• HVDC technology • AC TO DC line upgrade • Superconductor

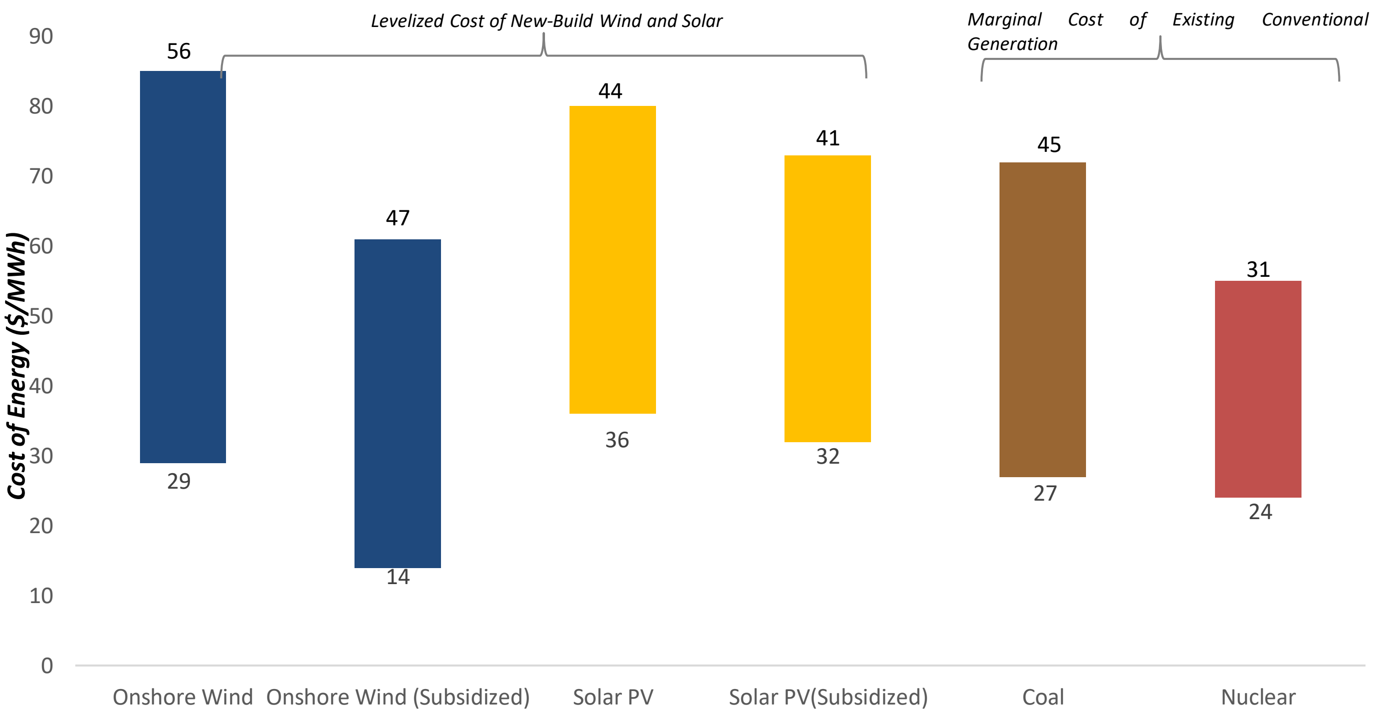
Source: ETIP Wind, Wind Europe, Fit for 55, set for 2050 report

6

Wind energy market: Cost figures & prices evolution

WIND ENERGY IS A COST COMPETITIVE TECHNOLOGY.. (1)

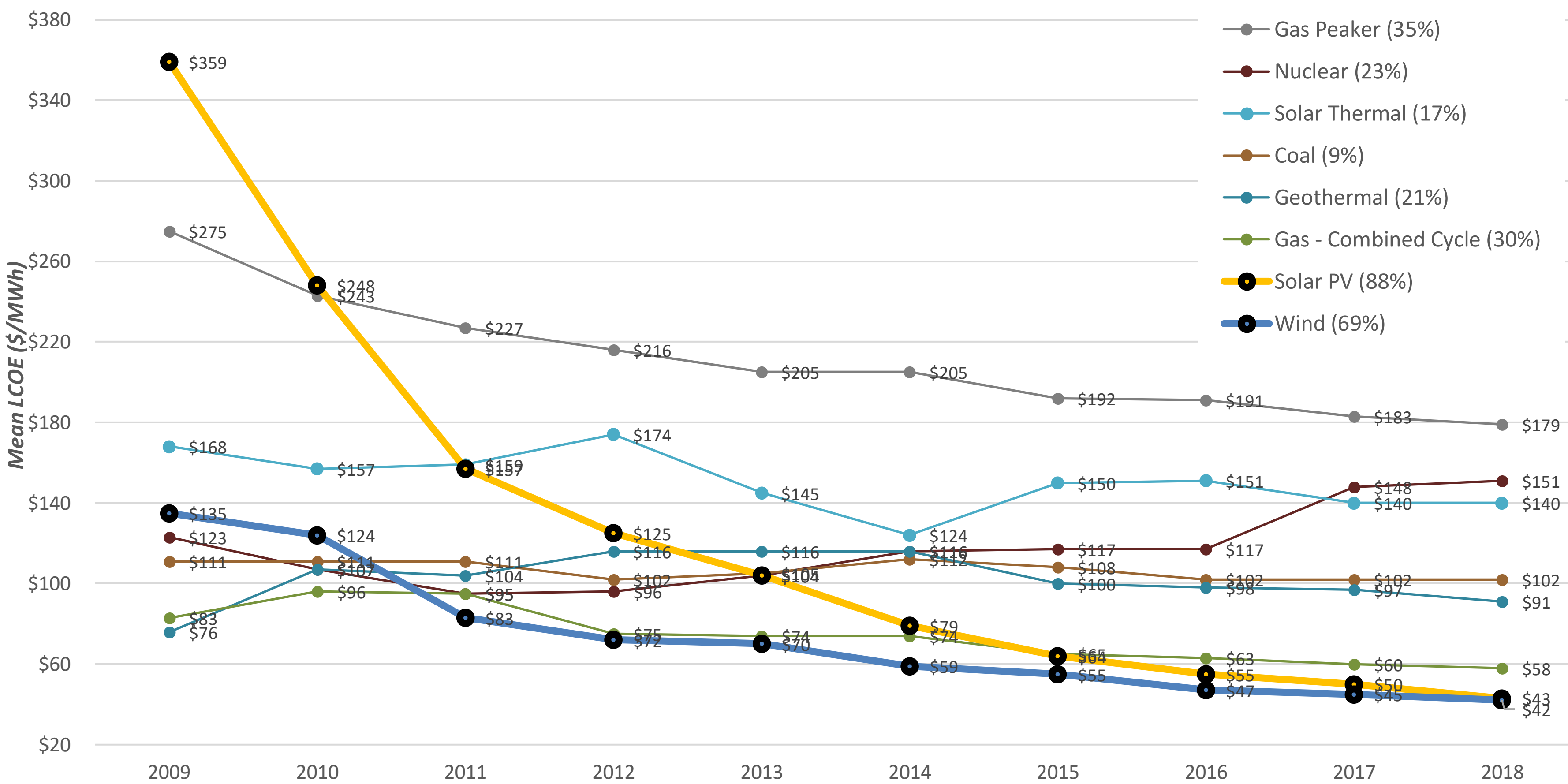
LCOE of RES in comparison of conventional power units



Source: LAZARD' S LEVELIZED COST OF ENERGY ANALYSIS - VERSION 12.0

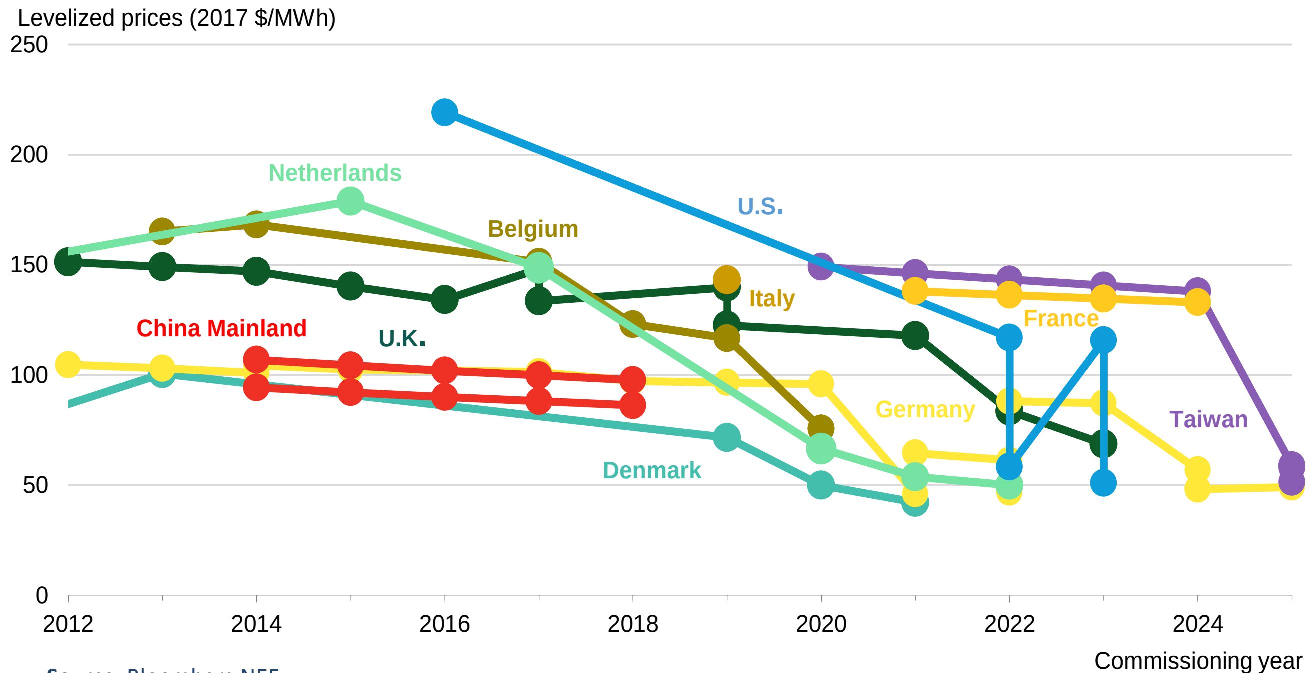
WIND ENERGY IS A COST COMPETITIVE TECHNOLOGY.. (2)

LCOE Historical evolution of power production technologies



Source: LAZARD' S LEVELIZED COST OF ENERGY ANALYSIS - VERSION 12.0

Offshore wind LCOE (bottom fixed)



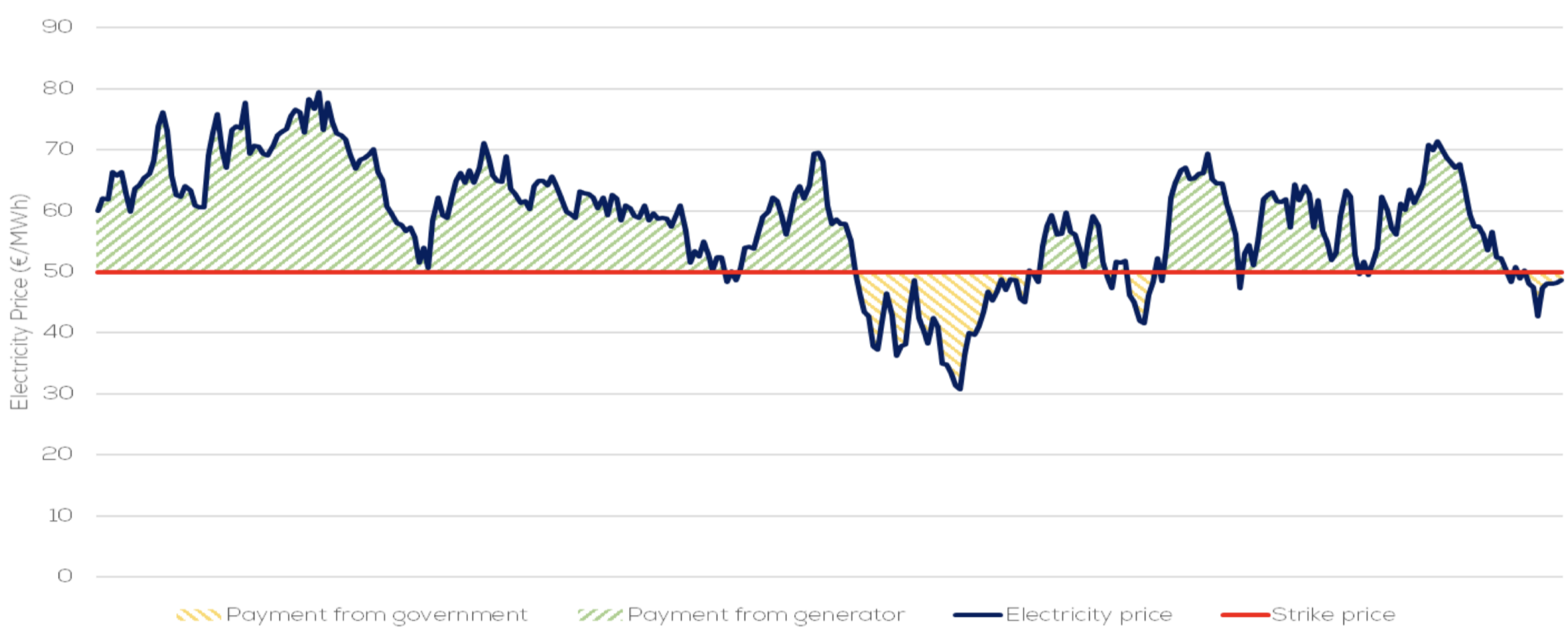
Source: Bloomberg NEF

The cost reduction journey of bottom fixed offshore wind provides confidence for similar floating wind LCOE decrease

2-sided CfDs is the current trend

- ✓ support for RES without subsidies
- ✓ protection for consumers from paying increased costs when market prices are high
- ✓ visibility and certainty for the wind farm developer and the supply chain
- ✓ much lower borrowing costs
- ✓ unlocks capital to finance the transition at lower cost and further reduce electricity prices.

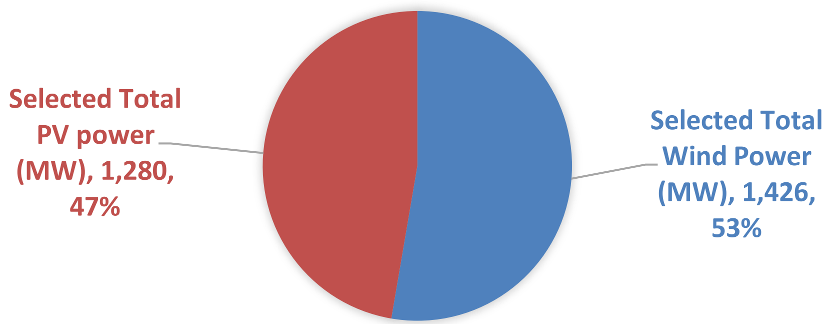
Structure of 2-sided Contract for Difference



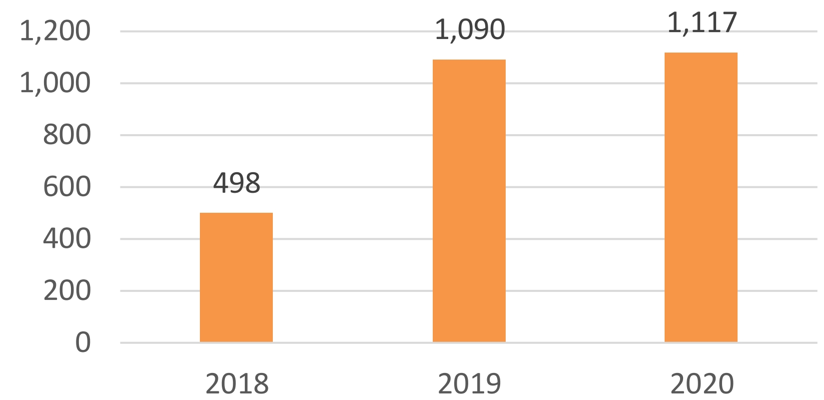
Main facts of the 13 Auctions conducted in the period 2018-2020

- More than 2.705MW of PV and Wind projects were selected in 13 conducted auctions

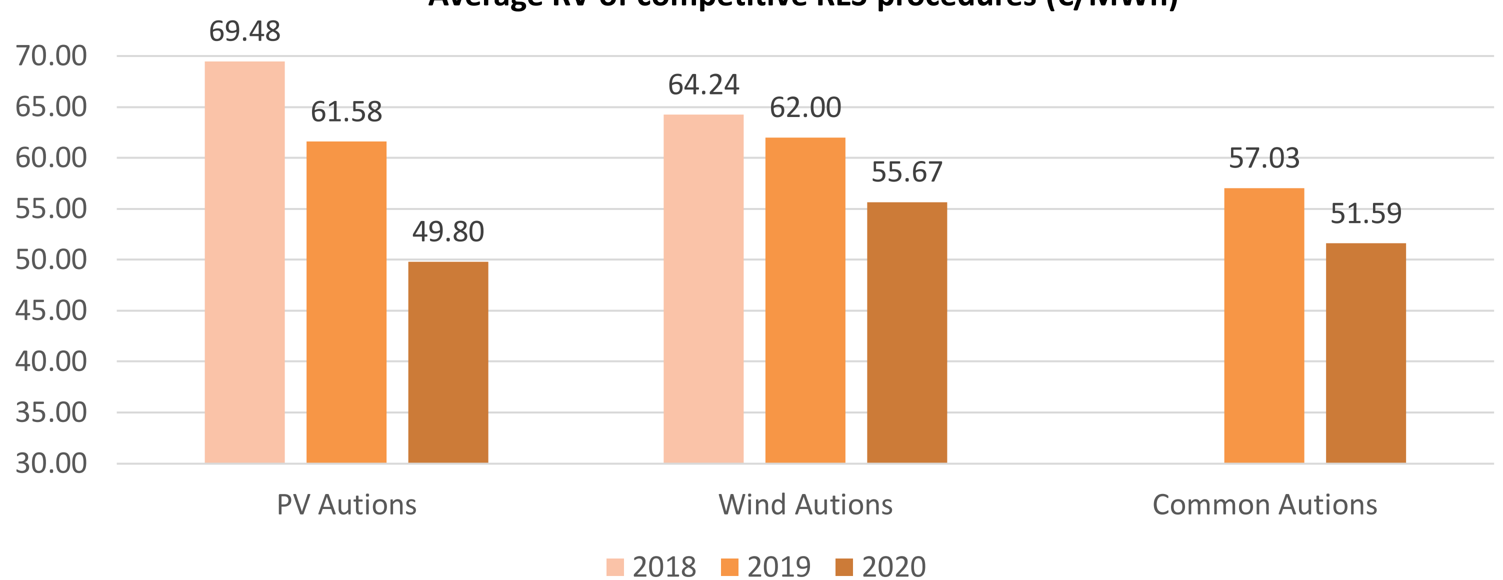
POWER SELECTED THROUGH AUCTION PROCEDURES IN THE PERIOD 2018-2020 (MW)



POWER SELECTED THROUGH AUCTION PROCEDURES PER YEAR (MW)



Average RV of competitive RES procedures (€/MWh)



Expected plan for new auctions

RECENT DEVELOPMENTS

Auction's procedures

Based on the Ministry's announcements: Extension of the tender procedures for wind onshore and PV projects up to 2024 at the latest, for 2.1 GW in total

Next auction

In December 2020 the last common auction was announced under the current regime, through which 350 MW of power will be auctioned in May 2021

New auction scheme

Based on the Ministry's announcements, the new scheme will incorporate improvements in its architecture compared to the existing one.

Corporate PPAs in Greece – Questions & Challenges

QUESTIONS & CHALLENGES

Structural

- Counter party (Large consumers and/or suppliers)
- Duration
- Combination with balancing responsibilities
- …………

Market of PPAs

- Demand
- Liquidity
- Competition
- …………

Institutional

- Wholesale market design
- Forward market
- Auctions
- …………

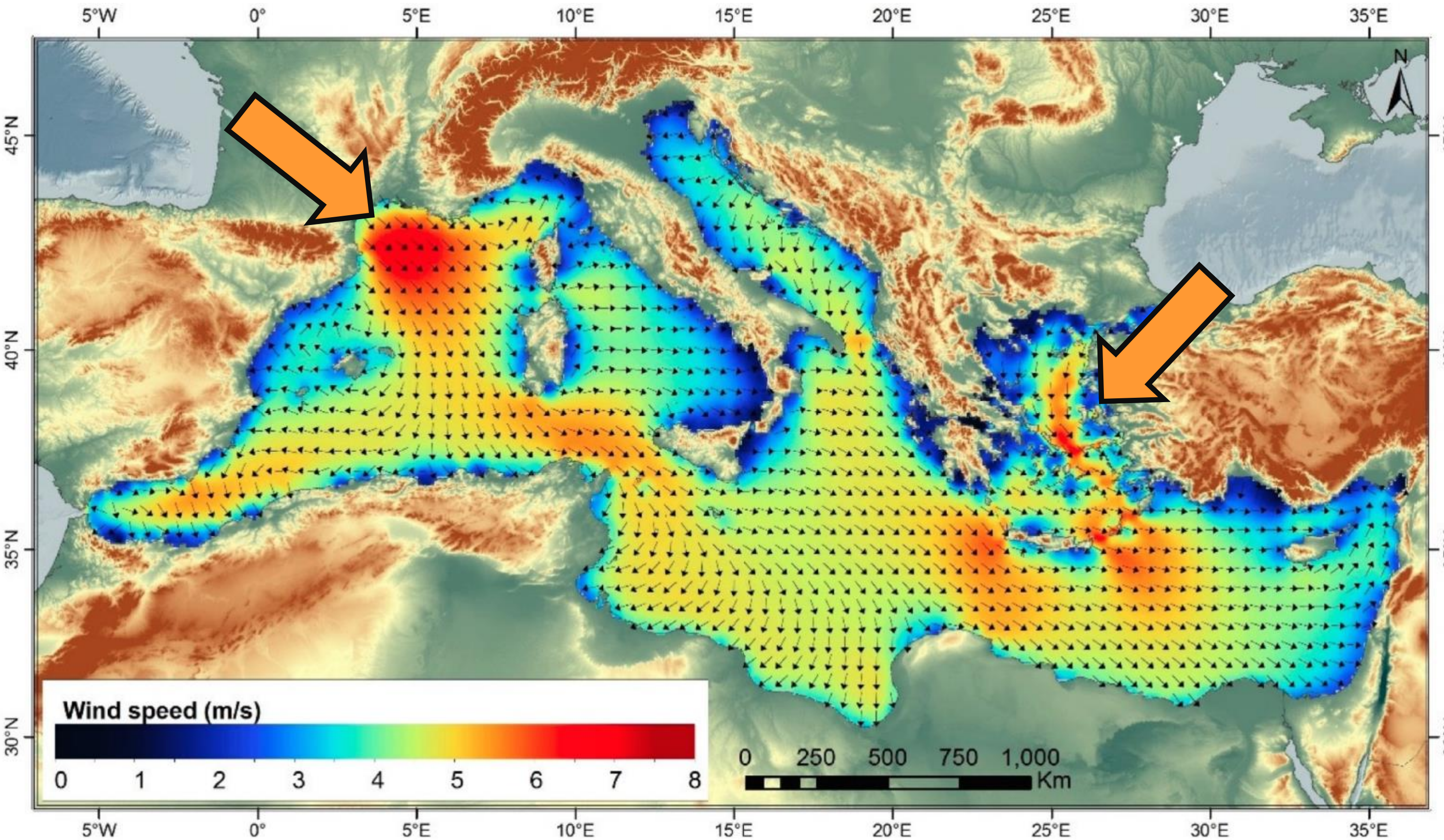
Financing

- Project finance – Sponsor's support
- Cost, term
- …………

7

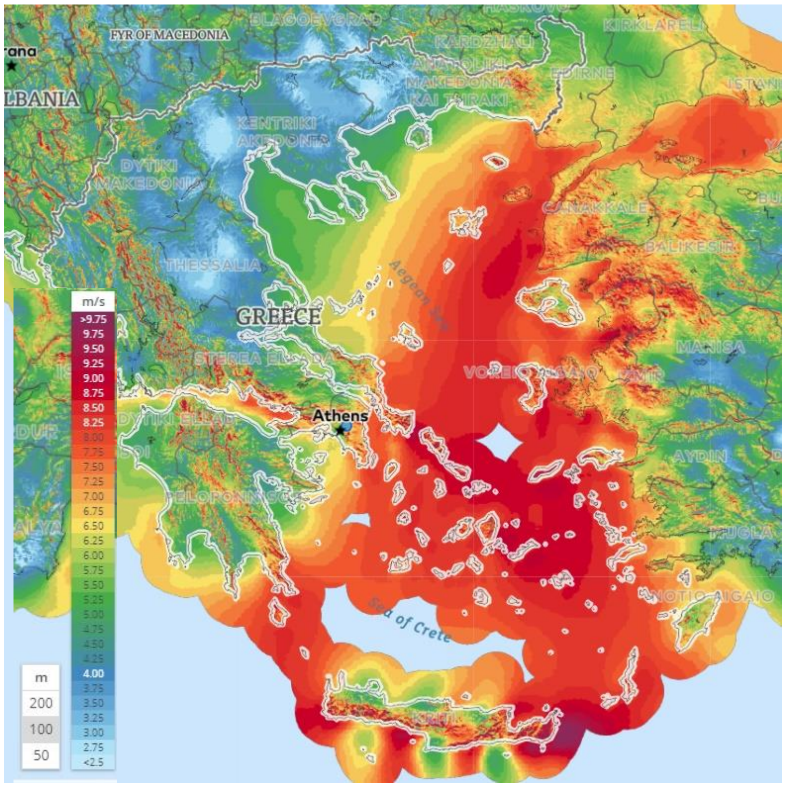
The next frontier: Floating offshore wind

The opportunity of the Greek seas



Source: Marine Renewable Energy in the Mediterranean Sea: Status and Perspectives, Soukissian et. al., energies, 2017

The unexploited winds of the Aegean sea



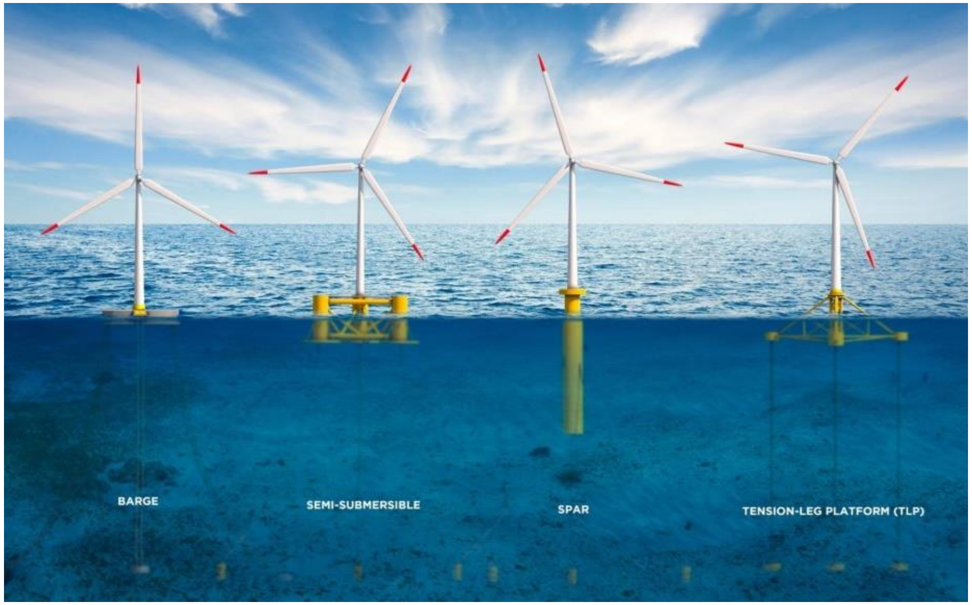
Main challenges for Offshore wind in Greece

- Depth of waters
- Transmission Capacity
- Infrastructure (ports, shipyards)
- Licensing constraints
- Political - Geostrategic constraints
- Costs

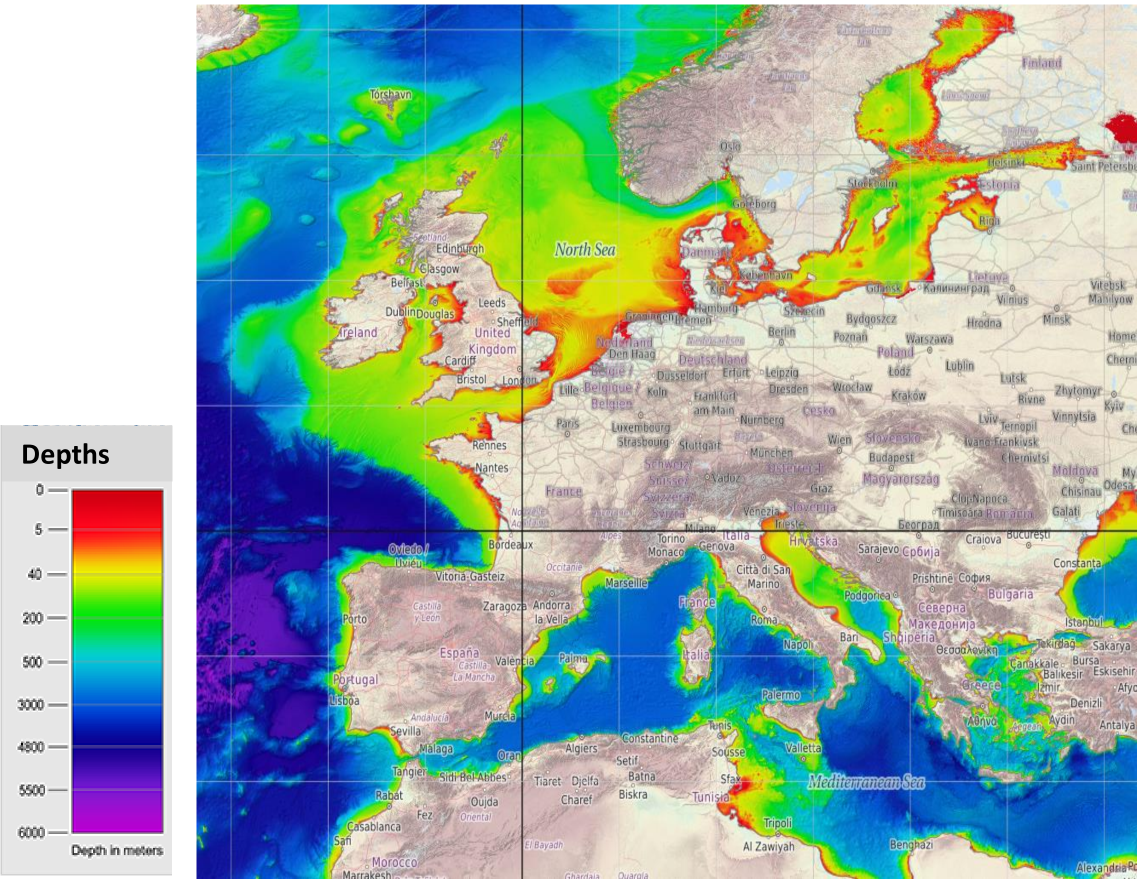
Source: https://globalwindatlas.info

Offshore wind in Greece – Floating is a game changer

- **Rapid developments** in technology, costs, projects
- Exploitation of **domestic experience** & local industrial base (shipyards, cables etc.)
- Significant **domestic value** (WTGs less than 40% of CAPEX)
- **Opportunity** & need for Greece



Global challenge for floating wind - Huge potential

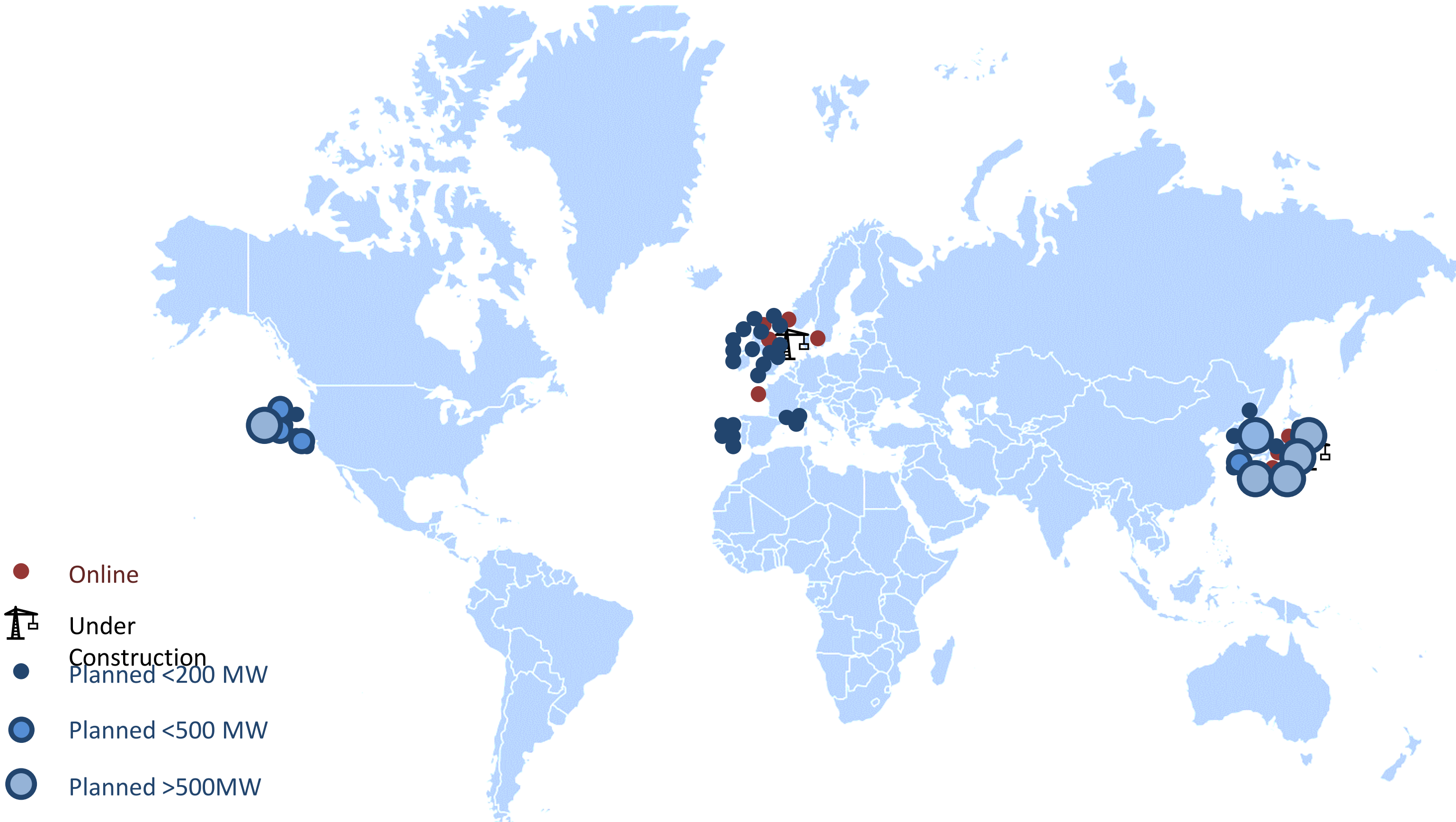


Source: EMODnet

Country/ Region	Share of offshore wind resource in +60m depth	Potential for floating wind capacity
Europe	**80%**	**4.000 GW**
USA	60%	2.450 GW
Japan	80%	500 GW

Source: CarbonTrust

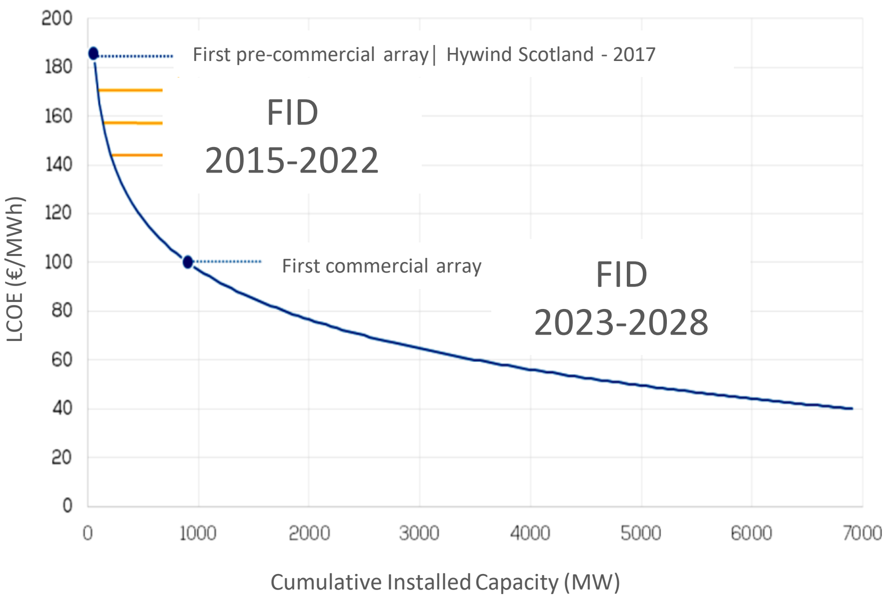
Overview of floating wind today



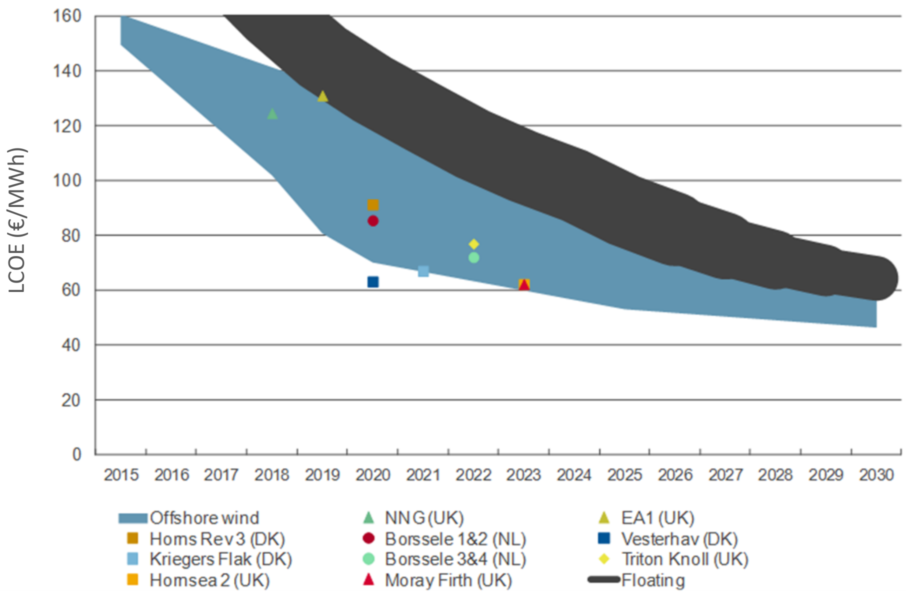
Source: Wind Europe

Floating wind LCOE

LCOE decrease depending on capacity



Floating wind reaching parity with bottom fixed



Source: Wind Europe and BVG Associates

Basic questions for the design of a regulatory framework for the development of wind offshore in Greece

1. **Allocation of sea areas**: How does an investor secure the (exclusive?) right to develop and implement the project in a marine area?
2. **Development & Licensing of a sea area:** Who is responsible during the various stages of the design, engineering and licensing of a wind offshore project? Which permits?
3. **Grid connection right**: How and at what stage is it secured?
4. **Grid connection works:** Who designs, licenses, builds, pays, owns and operates?
5. **Remuneration scheme:** How and when is compensation and/or the operational aid determined?

What remuneration scheme for offshore wind?

Special auctions for **offshore wind?**

Auctions for offshore in **grid hubs** where the TSO provides connection capacity?

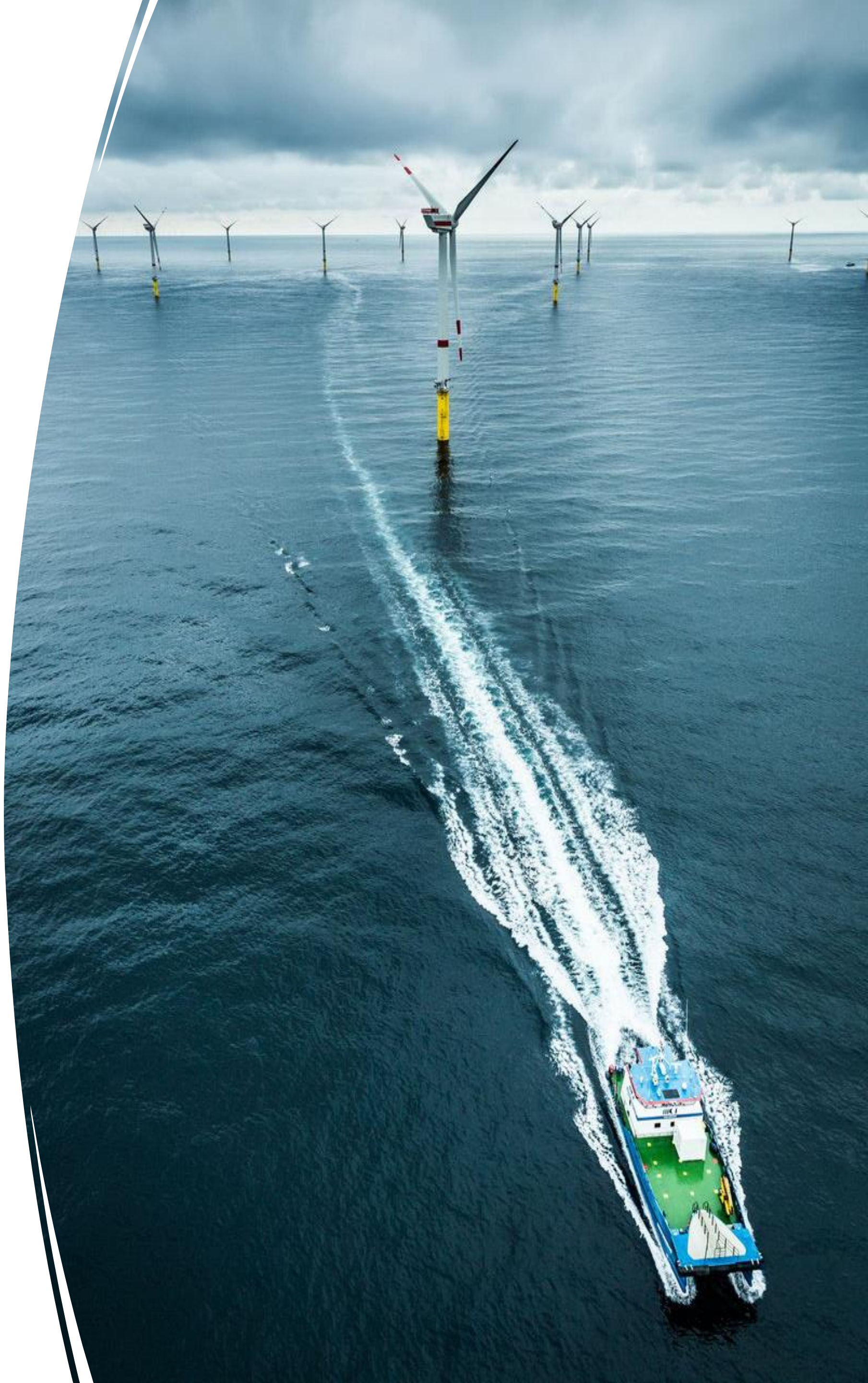
Common auctions with onshore wind and/or other RES with spe premium for offshore?

Administrative remuneration (e.g. Individual notification or oth process)?

Unsolicited proposals could also be a tool?

Some recommendations for Greece to keep the momentum:

- Set long term ambition goals with clear volumes and schedule
- Screening for exclusion zones (marine traffic, firing ranges, sensitive areas etc.)
- Finalize the revision of the RES Spatial plan incl. the Greek seas & the Maritime planning
- Early engagement of HTSO for developing Transmission water infrastructure
- A Pilot Auction for large scale commercial project(s) could be a catalyst



Last but not least: The geostrategic parameter

Territorial waters of 6 nautical miles

- Offshore wind gives the opportunity to exploit the **unexploited territorial seas**
- **Electrical interconnection** in the Aegean
- Greece **producer & exporter** of Green Energy
- Contribution to the European Strategy for **Energy Independence**
- Attraction of large **foreign investors/** investments
- **Geopolitical** empowerment and **sustainable** development

Source: Angelos Syrigos, Assis. Professor, Panteion Univ., Kathimerini, Special Edition 2018

HWEA

Hellenic Wind Energy Association

THANK YOU!