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Analyst PRESENTATION

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South Korea Offshore Wind Market Overview

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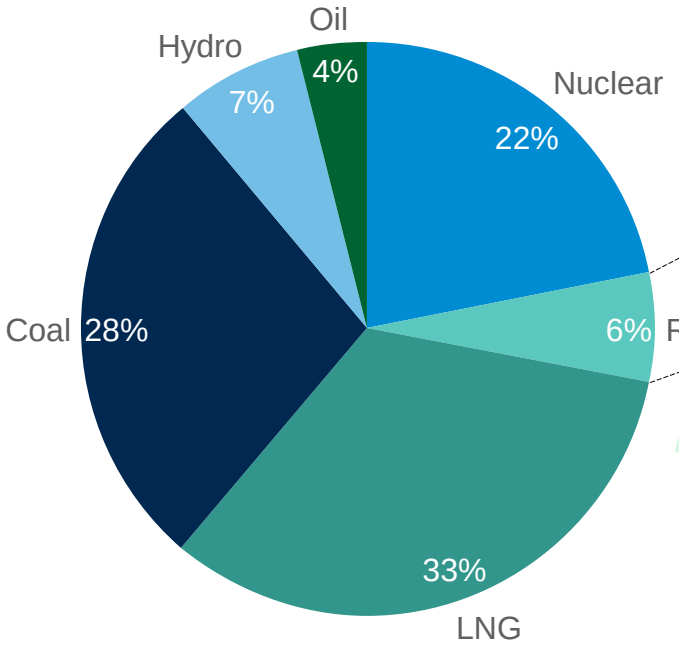
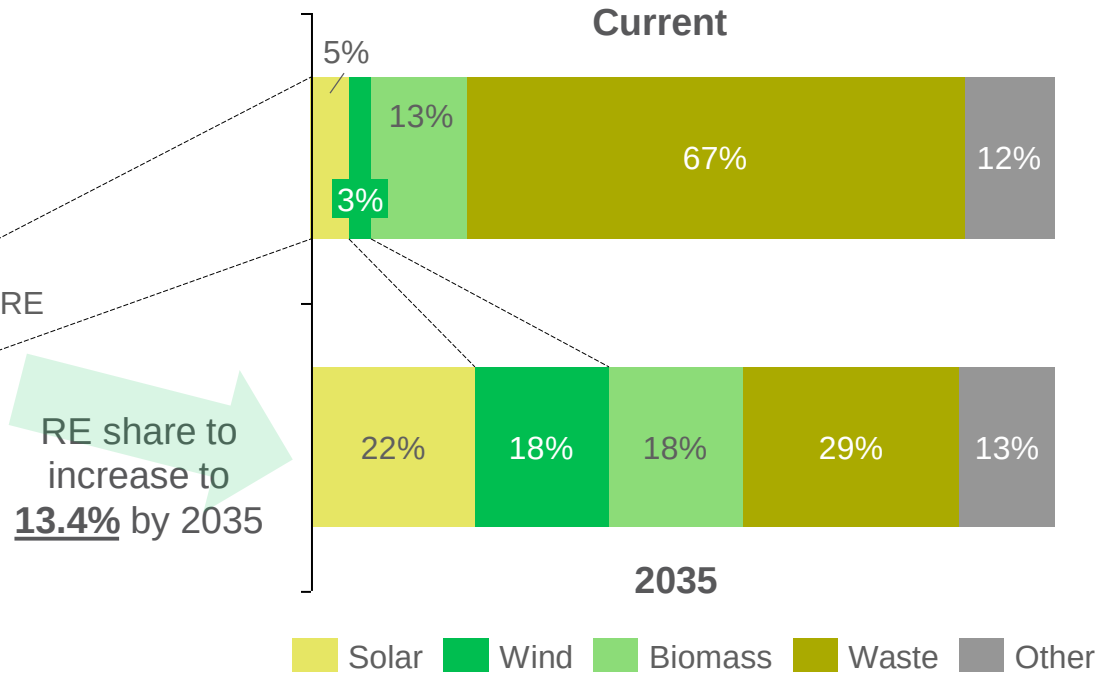


South Korea's RE mix: 2016 and 2035

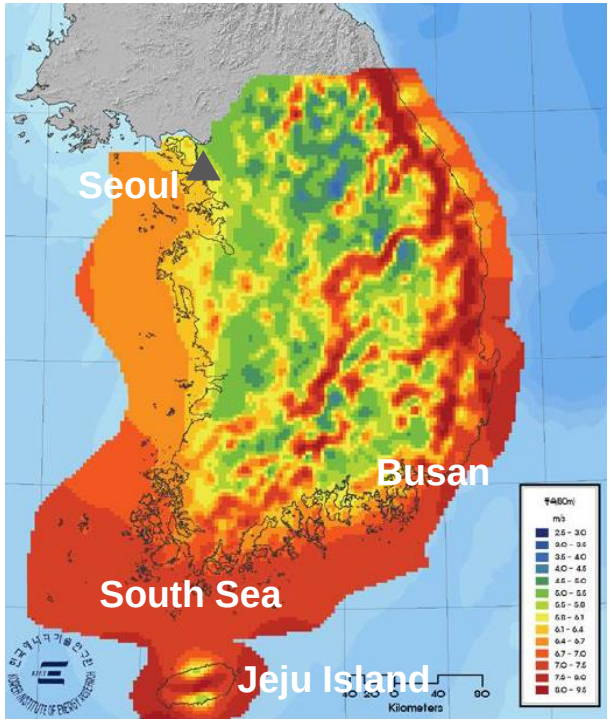


Note: Renewable Energy (RE),
Source: MAKE, Ministry of Trade, Industry and Energy (MOTIE)

South Korea's future energy plan is based on expanding renewable energy, especially solar and wind, to counter reduction in future share of fossil fuel energy sources

Rich offshore wind potential in South Korea

South Korea wind speed map at 80m height



8.0+ m/s
6.5-7.9m/s
<6.49m/s

Source: MAKE, KIER

South Korea wind potential

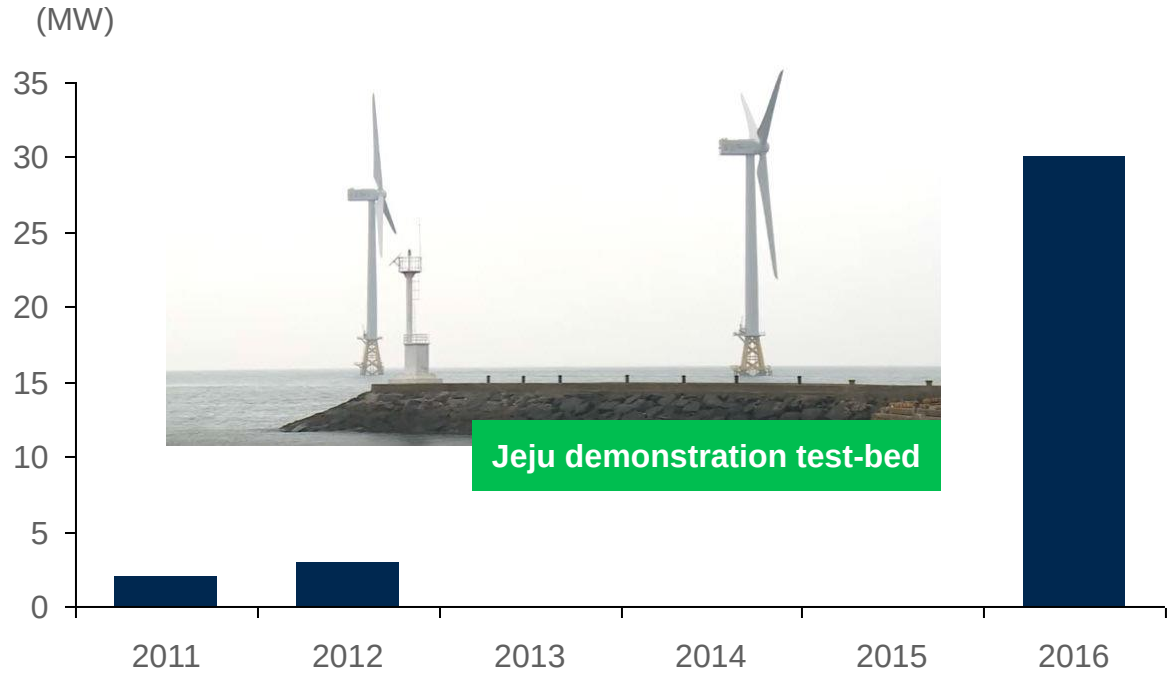
Type	Technical potential	Market potential	2035 target
Onshore	45GW	8.5GW	2.2GW
Offshore	**76GW**	**19.5GW**	**10.6GW**

- ***Average South Sea offshore conditions***:
  - Wind speed >7.0m/s at 80m height
  - Distance from shore ~10km
  - Water depth 5-30m
  - Wind power density 500W+ per square meter

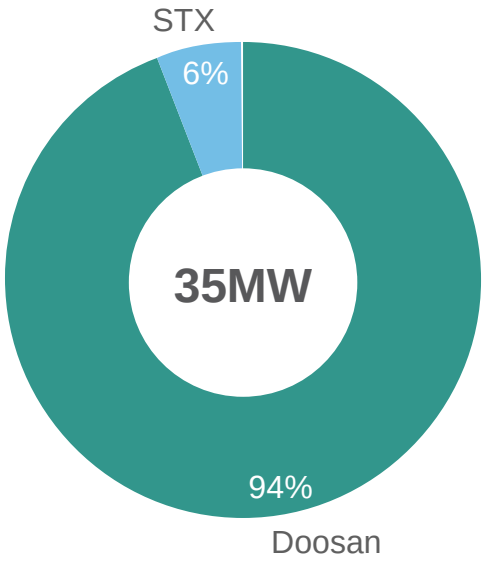
With high wind speeds particularly in the Southwest, government plans for around 10GW of potential offshore development clustered around that region in addition to Jeju Island

Offshore wind development is only just beginning

Existing installed offshore capacity by YE2016



Turbine OEM offshore market share



Source: MAKE

Despite a slow start, South Korean is starting to emerge as a viable offshore market in Asia Pacific being the first to complete a true offshore utility scale project outside China

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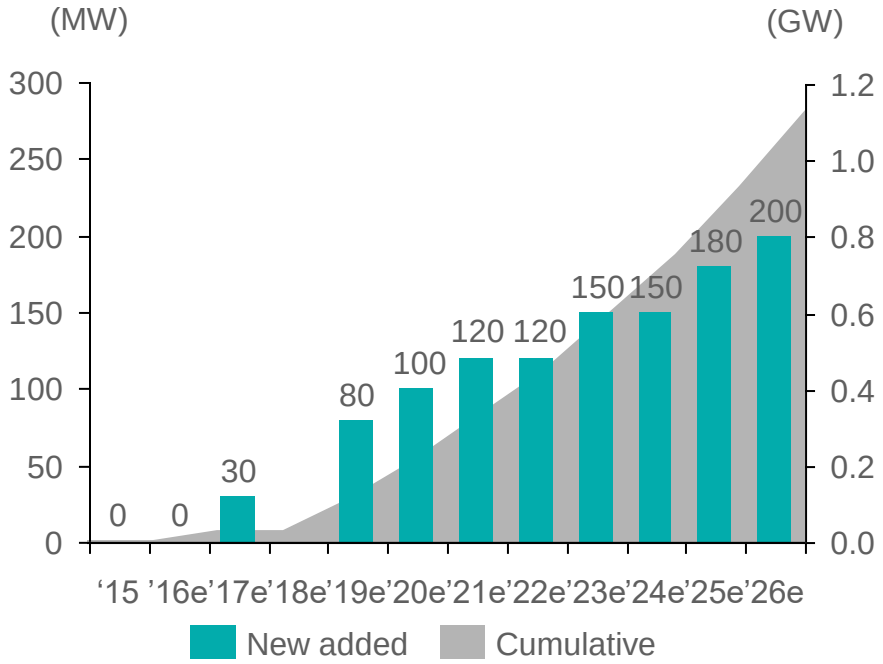
Offshore wind outlook

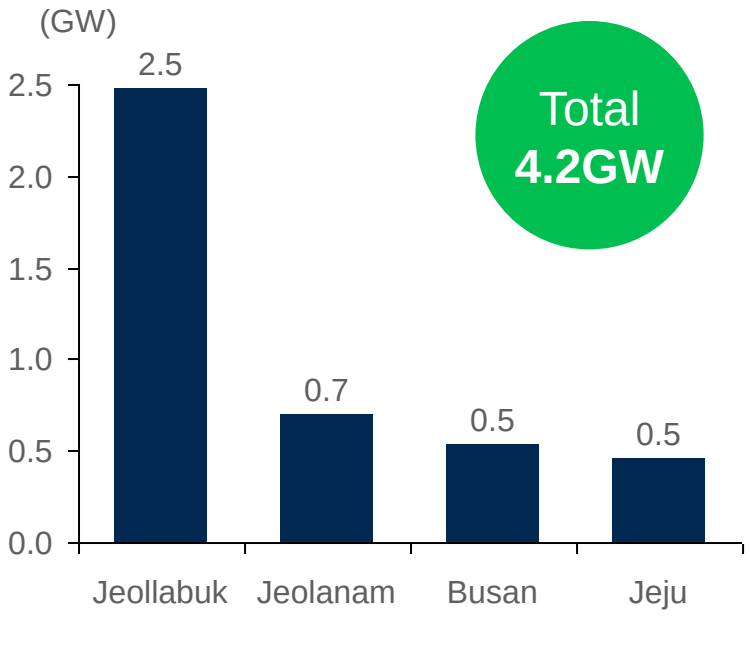
South Korea offshore wind outlook: 1.1GW expected by 2026

South Korea offshore wind outlook, 2015-2026e



Note: MAKE forecast is based on grid-connected capacity, not installed
Source: MAKE

Planned projects by provinces/area

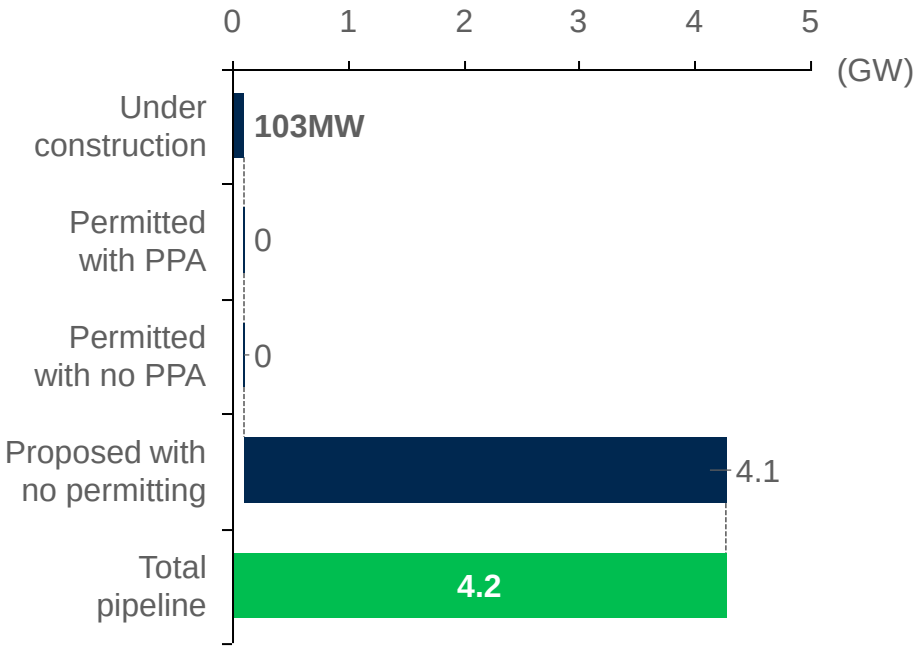


Source: MAKE, MOTIE

Large market potential given size of planned projects (e.g. 2.5GW Southwest project in Jeollabuk) but MAKE outlook is still cautious due to delays and missed offshore targets

South Korea offshore wind project pipeline

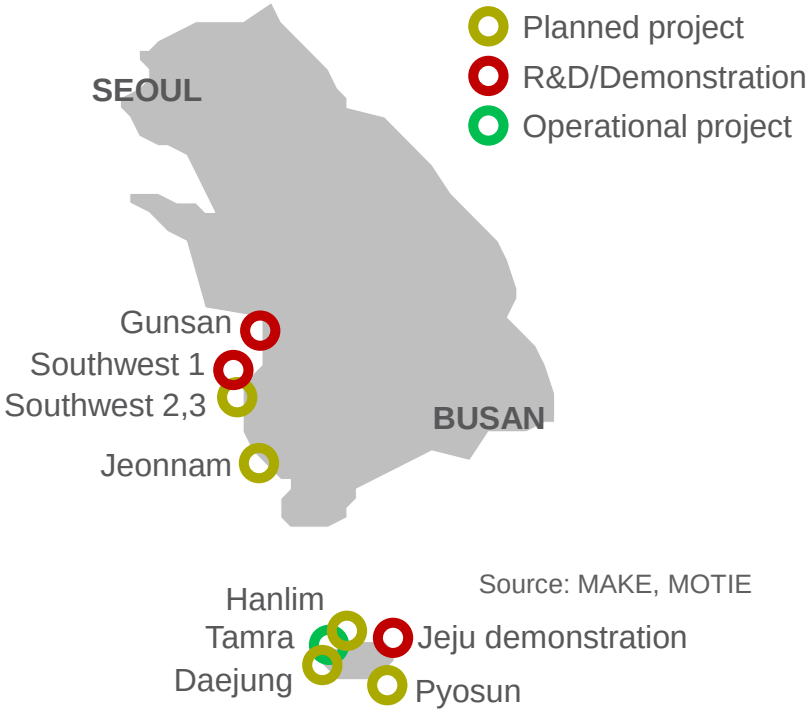
South Korea offshore wind project pipeline



Note: Pipeline only includes projects which have been publicly announced

Source: MAKE, Companies

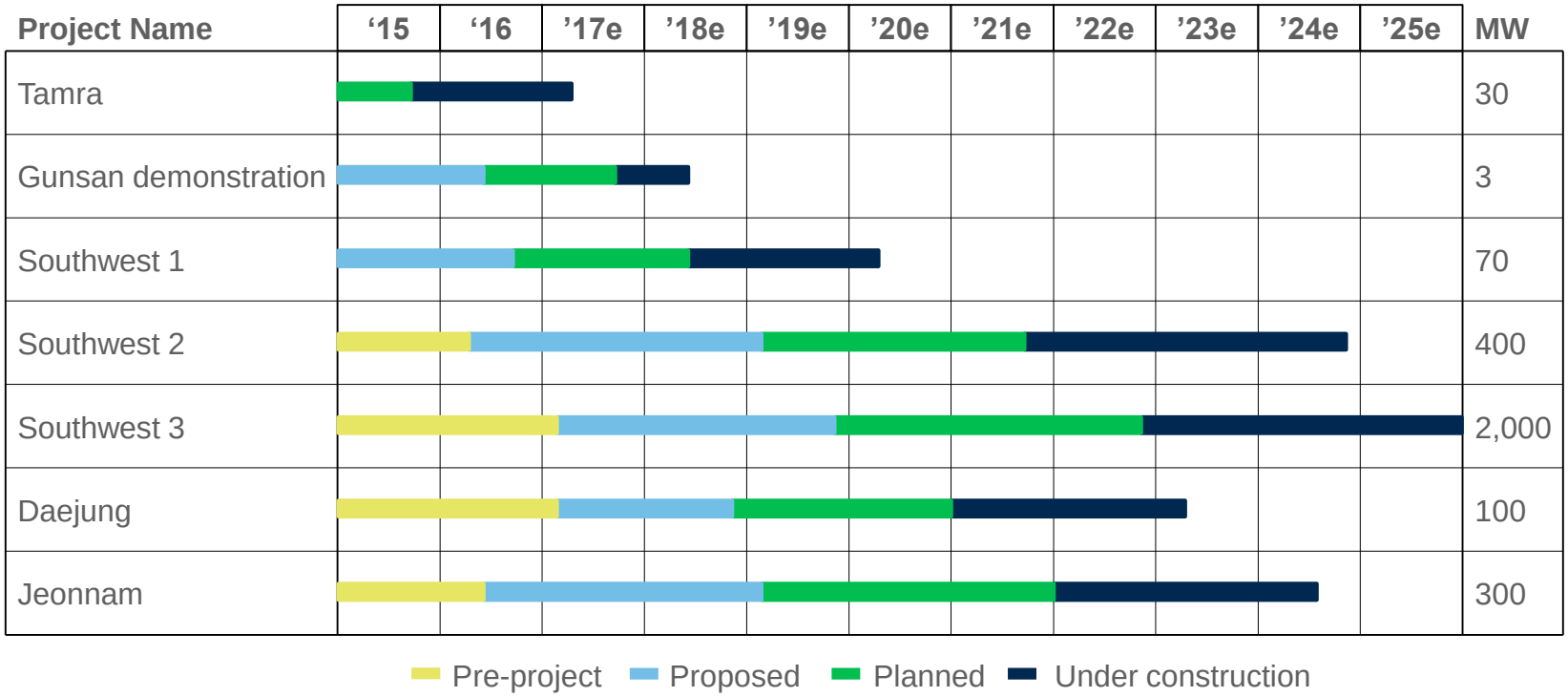
Selected announced projects in pipeline



Source: MAKE, MOTIE

Largest announced offshore pipeline in Asia Pacific (excluding China) though the majority are still in early planning stages and focused on Southwest region

South Korea offshore selected wind project pipeline and estimated development schedule, 2015 to 2025e



	Pre-project	Proposed	Planned	Under construction
Phase	Prospecting stage	Early development stage	Final development stage	Execution stage
Project probability	0-10%	10-30%	40-95%	95-100%

Note: Apart from Tamra, all other projects’ development schedules shown are estimates.
Source: MAKE, Companies

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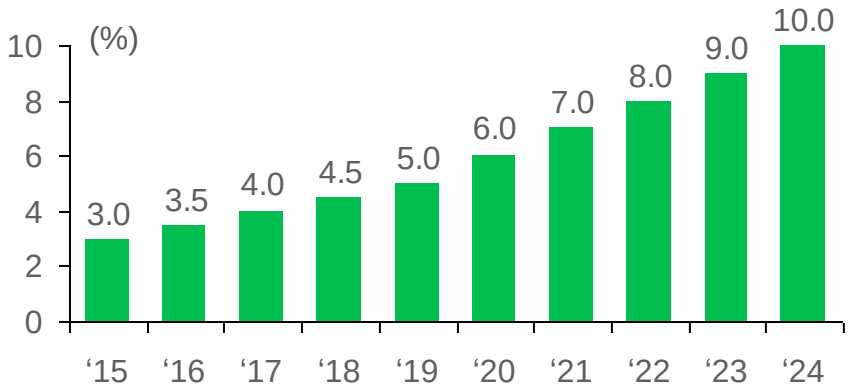
Market conditions

Primary policy driver relies on forcing more RE on large IPPs

Renewable Portfolio Standard (RPS) obligations



REC multiplier for wind power

Energy	Onshore	Offshore <5km	Offshore >5km
Wind	**1**	**1.5**	**2**

Note: Offshore refers to distance to grid connection

Source: MAKE, MOTIE

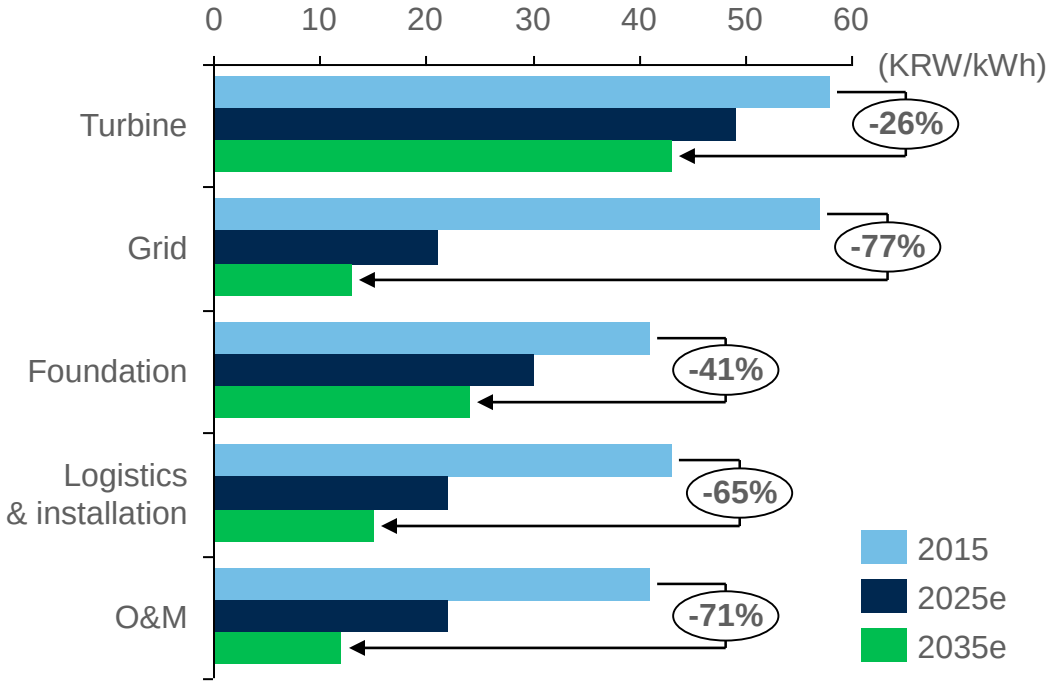
Requirements of South Korea's RPS system

- The RPS scheme requires any power producer with over 500MW of capacity to gradually increase their share of RE in their generation portfolio
- Power producers receive one Renewable Energy Certificate (REC) for every 1MWh generated - though different RE sources have a higher weighting (e.g. multiplier)
- Failure to comply will result in penalty charge of 150% of average REC price though it can be deferred up to 3 years at maximum 20% of mandatory supply

South Korea is the only market in Asia Pacific that relies on RPS system instead of a FIT for offshore projects as a policy driver

South Korean offshore wind costs need to drop significantly

South Korea LCOE offshore estimates



Source: MAKE, MOTIE

- Offshore cost estimates are still very high as they are extrapolated from demonstration units
- Given high cost of offshore LCOE, developers would much prefer a fixed guaranteed price rather than reliance on fluctuations in REC prices and electricity tariff
- Ideally, the government envisions offshore project costs to drop to around USD 3 million per MW in the long term once demonstration projects are completed to be a sustainable RE source

Expectations are that offshore LCOE in South Korea will drop by 40% by 2025 and 55% by end of 2035 with cost reductions gained from experience and economies of scale

Local conditions suit offshore growth but need more experience

Key market drivers and barriers for South Korea offshore

Market drivers

Key factors are in place (political will, wind resource, capabilities)…

- Long term national energy plans support more wind power
- Parts of local supply chain are already integrated with global offshore wind supply chain (e.g. cables, towers, forgings) and testing facilities are already available
- Strong maritime and manufacturing capabilities
- Rich offshore wind resources

Development barriers

…but still in relatively early stages of development

- Local turbine OEMs turbine portfolio is behind mainstream EU specifications (e.g. local turbine size is still 3MW)
- Limited construction experience for large capacity turbines (e.g. 5MW+ class) and no vessels to handle large scale projects
- Difficult compensation negotiations with local fisheries

Source: MAKE

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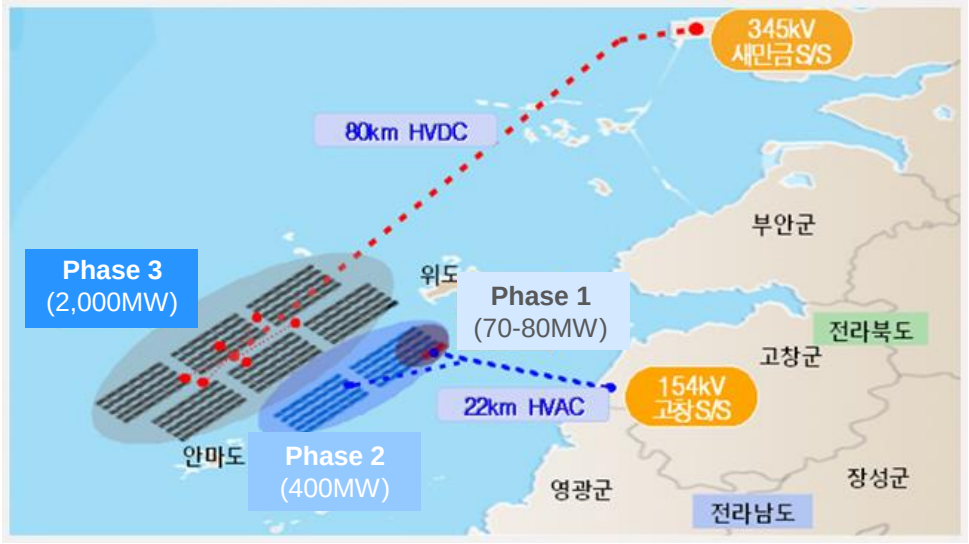
Key players / project

Key developer

한국해상풍력(주)
Korea Offshore Wind Power

- Korea Offshore Wind Power (KOWP) is a special purpose company set up by six power companies of Korea Electric Power Corp (KEPCO), the largest utility in country
- KOWP's goal is to build the 2.5GW Southwest project to be done in three phases with construction of first phase to start in 2017
- Awarded EPC contract to Doosan Heavy and Hyundai Engineering & Construction for Phase 1

Southwest 2.5GW project outline



	Phase 1	Phase 2	Phase 3
Purpose	Demonstration	Build track record	Large scale deployment
Cost (USD)	384 million	1.8 billion	8.9 billion
Completion	**By 2018**	**By 2020**	**2020+**

Source: KOWP

KOWP is aiming to be one of the largest offshore developers in the world but progress has been slow and initial target deadlines have been revised

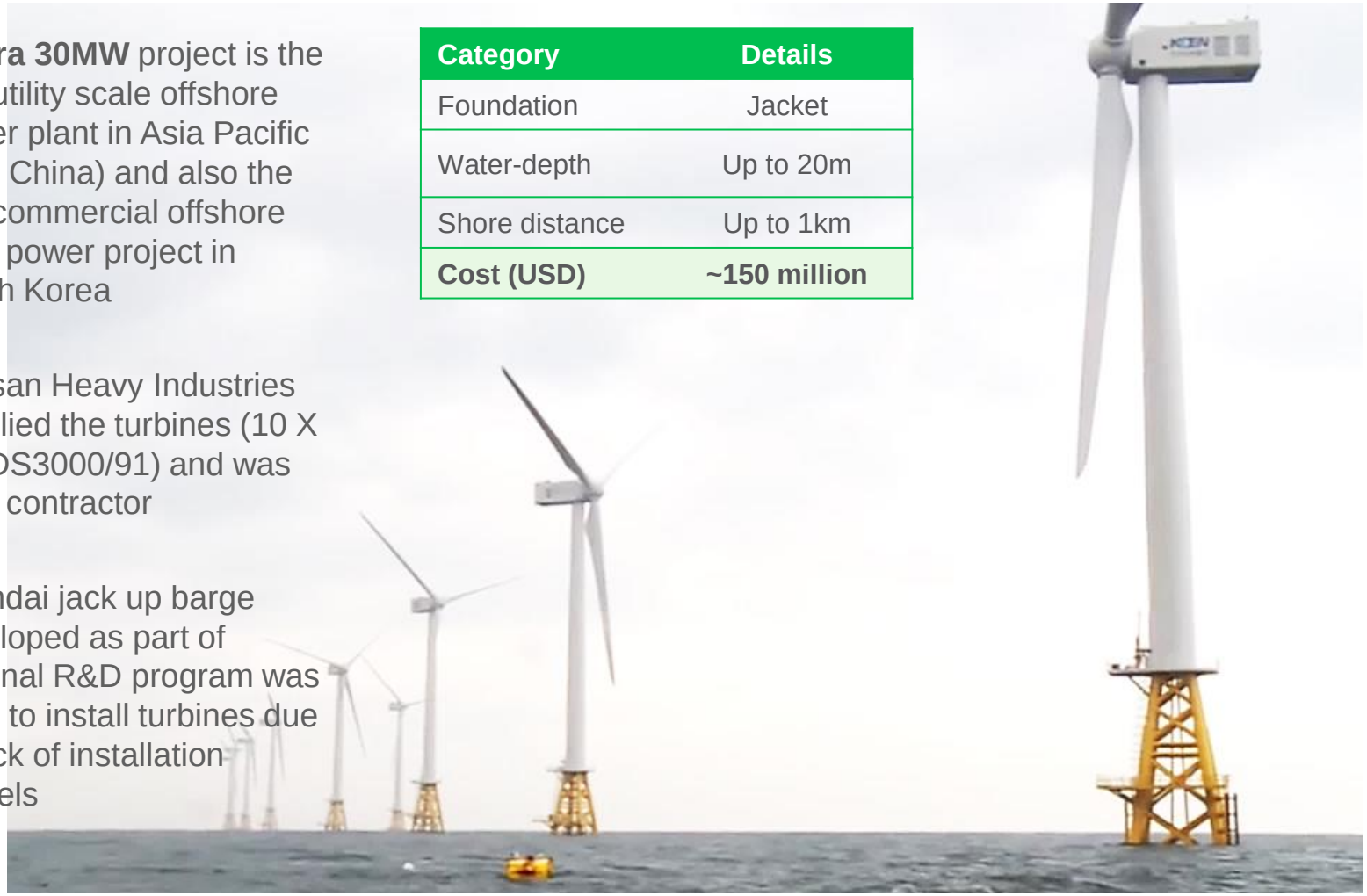
Key project

- **Tamra 30MW** project is the first utility scale offshore power plant in Asia Pacific (exc. China) and also the first commercial offshore wind power project in South Korea

- Doosan Heavy Industries supplied the turbines (10 X WinDS3000/91) and was EPC contractor

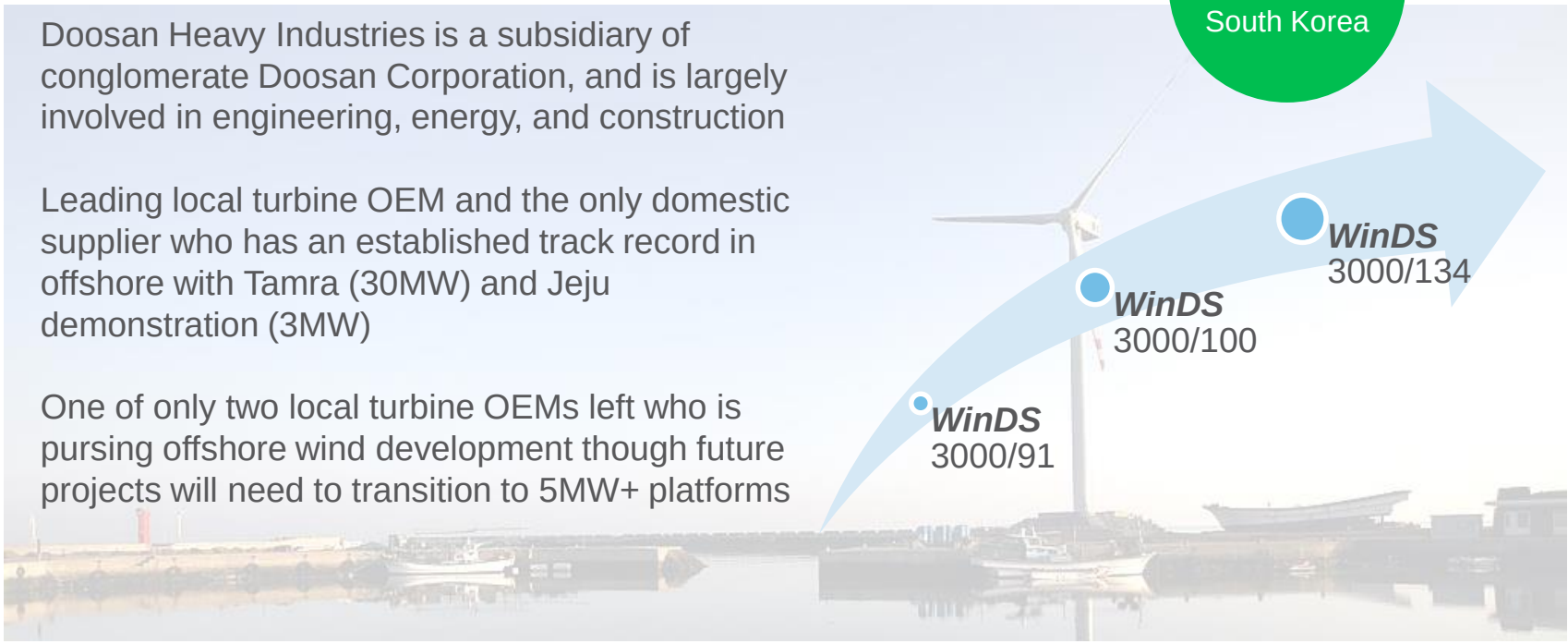
- Hyundai jack up barge developed as part of national R&D program was used to install turbines due to lack of installation vessels

Category	Details
Foundation	Jacket
Water-depth	Up to 20m
Shore distance	Up to 1km
Cost (USD)	**~150 million**



Selected key turbine OEMs

- Doosan Heavy Industries is a subsidiary of conglomerate Doosan Corporation, and is largely involved in engineering, energy, and construction
- Leading local turbine OEM and the only domestic supplier who has an established track record in offshore with Tamra (30MW) and Jeju demonstration (3MW)
- One of only two local turbine OEMs left who is pursing offshore wind development though future projects will need to transition to 5MW+ platforms



Being able to do EPC, supply turbines, and biggest track record for domestic turbine OEM in South Korea has enabled Doosan to be preferred supplier for local developers

Selected key turbine OEMs

HYUNDAI HEAVY INDUSTRIES GROUP

- One of only two domestic turbine OEMs to have built a 5.5MW prototype turbine that was jointly designed with AMSC-Windtec
- Hyundai Heavy Industries is the largest shipbuilding company in the world
- Heavy losses in ship-building is making company reconsider pursuing offshore wind

HQ5500-140

HYOSUNG

- Hyosung Power is part of Hyosung Corp., a major conglomerate involved in construction, heavy industries and machinery
- 5MW offshore prototype turbine was designed with Aerodyn (though it was erected onshore)
- Limited track record in wind (22MW) but is investing in offshore projects in Jeju Island

HS139-5MW

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