

FINANCE MODELING OF A FLOATING OFFSHORE WIND PROJECT IN SOUTH KOREA WITHOUT GOVERNMENT SUBSIDES

AS.425.800.82.FA22: RESEARCH DESIGN FOR CAPSTONE PROJECTS IN ENERGY AND ENVIRONMENTAL SCIENCES



ENERGY POLICY AND CLIMATE
JONG MIN LEE
MENTOR: GEORGY XYDIS
FALL 2022

1. PROJECT GOALS

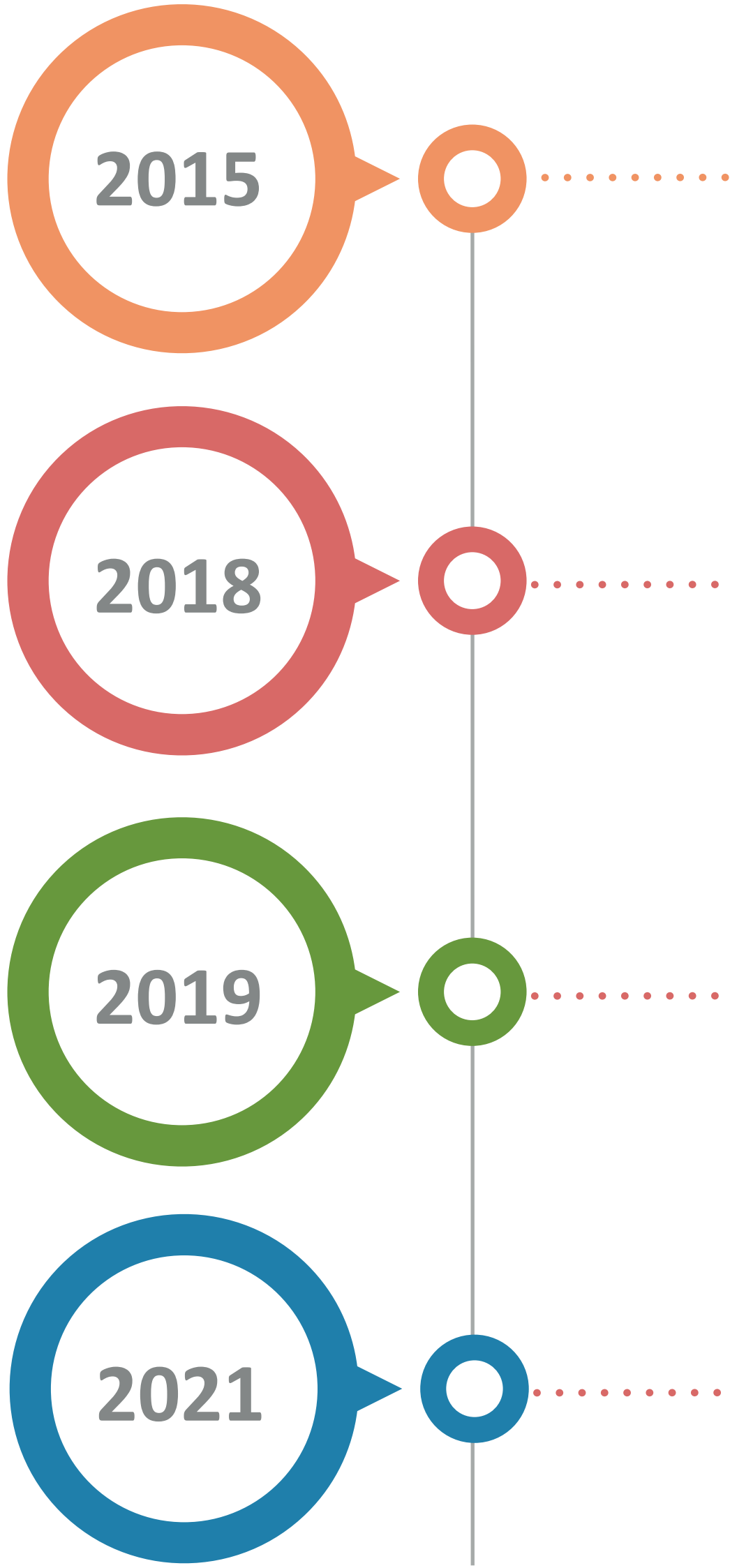
TO IDENTIFY A FLOATING OFFSHORE WIND FARM IN KOREA CAN GENERATE PROFITS WITHOUT THE GOVERNMENT'S SUPPORT

TO EXAMINE HOW THE FEASIBILITY OF THE PROJECTS SHIFTS DEPENDING ON THE PROJECT PARAMETERS

TO DISCUSS THE VIABILITY AND PROFITABILITY OF SCENARIOS BASED ON AN INDEX-BASED COMPARISON



2. BACKGROUND



Response to the Paris Agreement

2030 target of reducing GHG emissions by 37% from BAU levels (851 million tons)

Basic Roadmap for Achievement of the 2040 National GHG Reduction Goal

Domestic reduction from 25.7% to 32.5%, based on the target of 37% from BAU levels



NDC Target Updates

To reduce GHG emissions by 24.4% from 2017 levels and 26.3% from 2018 levels

2030 NDC Upgrade Plan

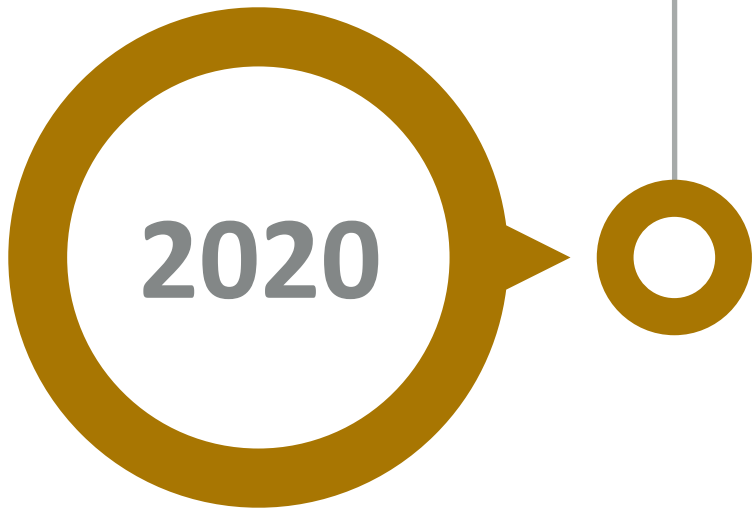
To reduce GHG emissions by 35% or more from 2018 levels by 2030

2. BACKGROUND_Cont.



RE3020 (Renewable Energy 3020 Implementation Plan)

The government’s goal by 2030 of generating 20% of power with renewables



Offshore Wind Power Development Plan in Win-Win Partnership with the Fishery Industry along with Residents

- Plan for Offshore Wind Power Generation in collaboration with Local Residents and the Fishing Industry
- Plan to Install 12GW of offshore wind power by 2030

2. BACKGROUND_Cont.

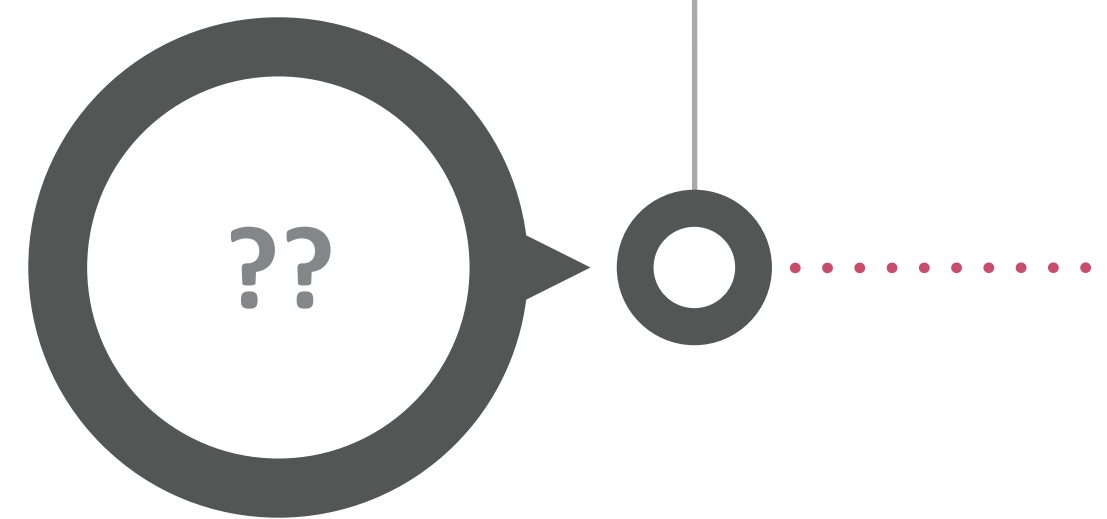
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REC (Renewable Energy Certificates)

A market-based instrument to provide an economic incentive

- SMP: System Marginal Price
- REC Price: REC*REC Weight
- Total income = SMP + 1REC



No Subsidies

- Business Feasibility
- Voluntary Participation of Power Generation Companies
- Subject to change, depending on the internal and external political circumstances

Category	Value	Unit
1 USD to KRW	1201.4	KRW ¹
Base Year	2025	year
Wind Farm Capacity	495	MW
Number of WTG	33	EA
WTG Capacity	15	MW
Net Capacity Factor	39.53	%
Distance to Grid	70	km
Water Depth	150	m
CapEx-Wind	5,050 million	KRW/MW ²
OpEx-Wind	81 million	KRW/MWh-year ³
DevEx-Wind	80,000 million	KRW
AbEx-Wind	72.5 million	KRW/WTG
CapEx-PEM Electrolyser	700	USD/KW ⁴
OpEx- PEM Electrolyser	14	USD/KW ⁴
System Lifetime	20	Years ⁴
Lifetime Stack	80,000	Hours ⁴
CapEx-Stack Replacement	400	USD/KW ⁴
PEM Efficiency	0.058	MWh/Kg of H ₂ ⁴
Running Hours	8	Hours/day
Capacity Factor	33	%
Hydrogen Price	6000	KRW ⁵
Transport (Ammonia) by ship	1800	KRW/Kg of H ₂ ⁶
Corporate Tax rate	25	% ⁷
Depreciation Schedule: Straight-line 20-year	5	%/year ⁸
Equity	30	%
Debt	70	%
Pre-tax debt rate	6	%
Dept term	15 years	Years
Inflation	2.3	% ⁹
Equity rate	7	%
WACC	6.74	%

3. METHODS

PROJECT PARAMETERS & ASSUMPTIONS

- THE CAPACITY OF THE OWF
- REC WEIGHT CALCULATIONS
- COSTS
- TAXATION AND FINANCING
- GREEN HYDROGEN

3. METHODS_Cont.

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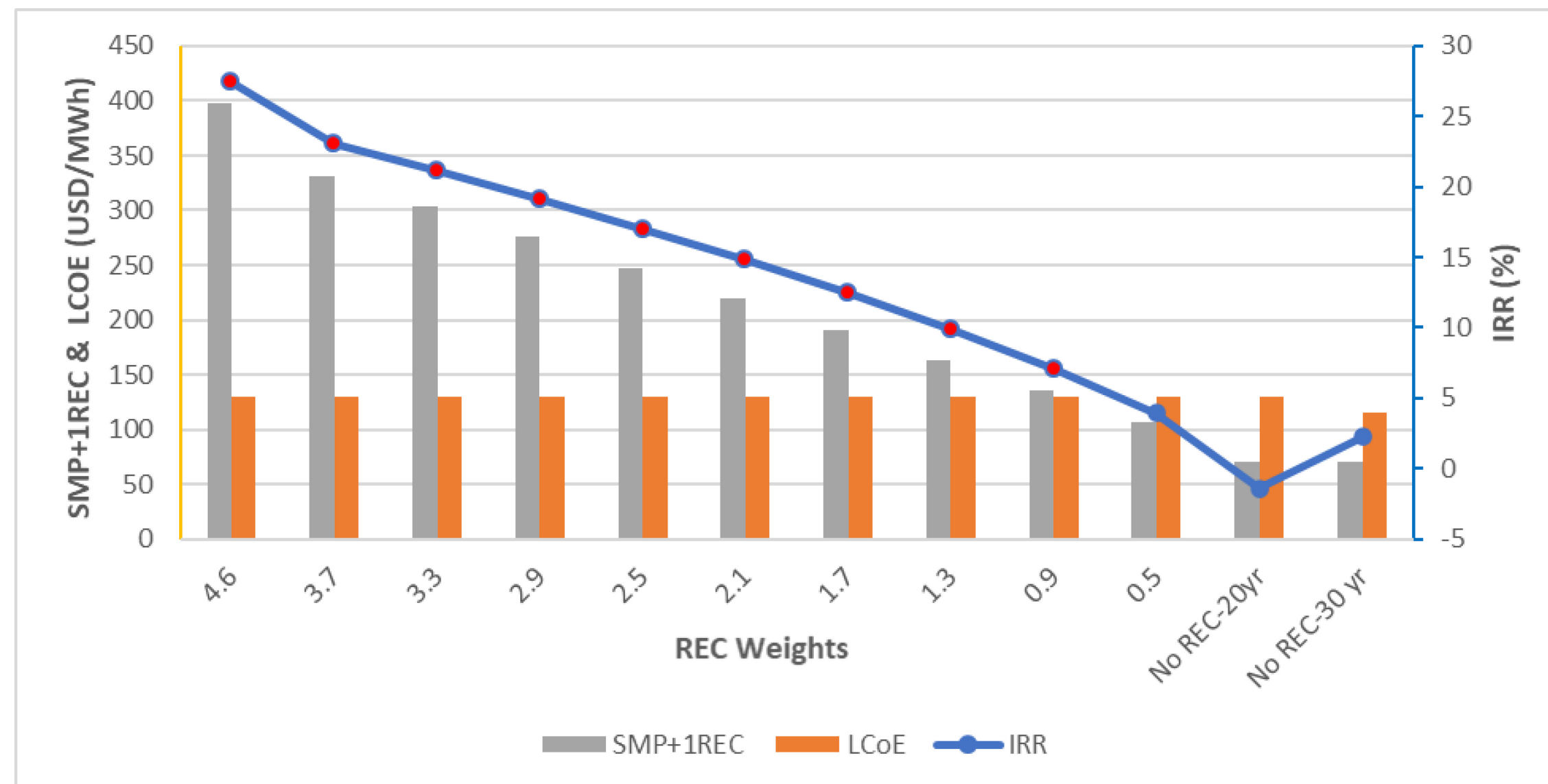
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4. RESULTS & DISCUSSION

4.1 Comparison of SMP + 1REC, LCoE and IRR at different RED weights



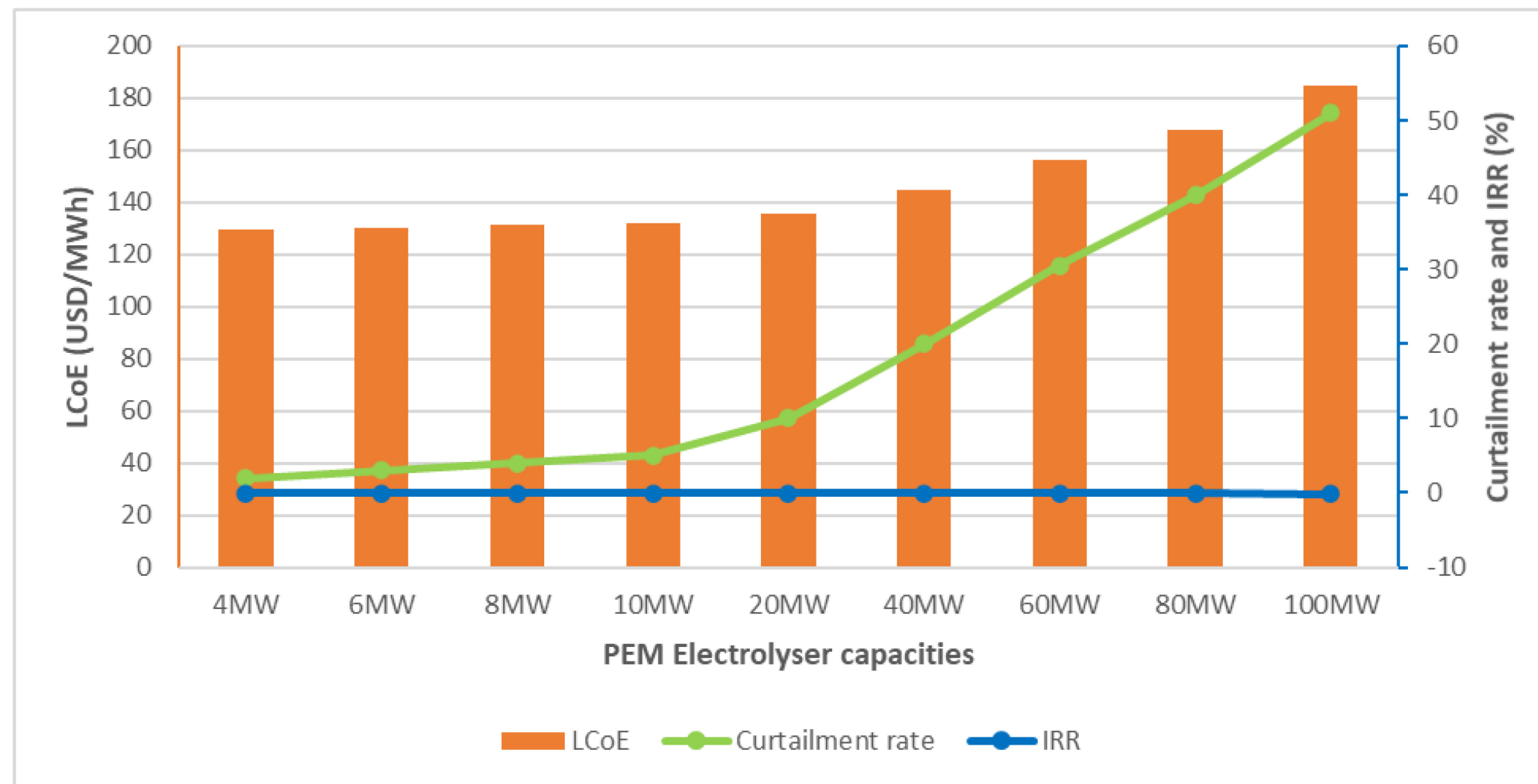
SMP+1REC, LCoE and IRR at different REC Weights

- The limit for the maximum value of the combined weight not specified
- At 4.6 REC weight, the SMP + REC is USD 397.46 per 1 MWh : 5.7 times higher than the monthly SMP (USD 69.84 per 1 MWh)
- The expected IRR is 27.45% at 4.6 REC weight
- The expected IRR is 12.46% at 1.7 REC weight : Business feasibility is sufficient
- A need to adjust the calculation method of the REC weight by comparing the profits of the demonstrations complex

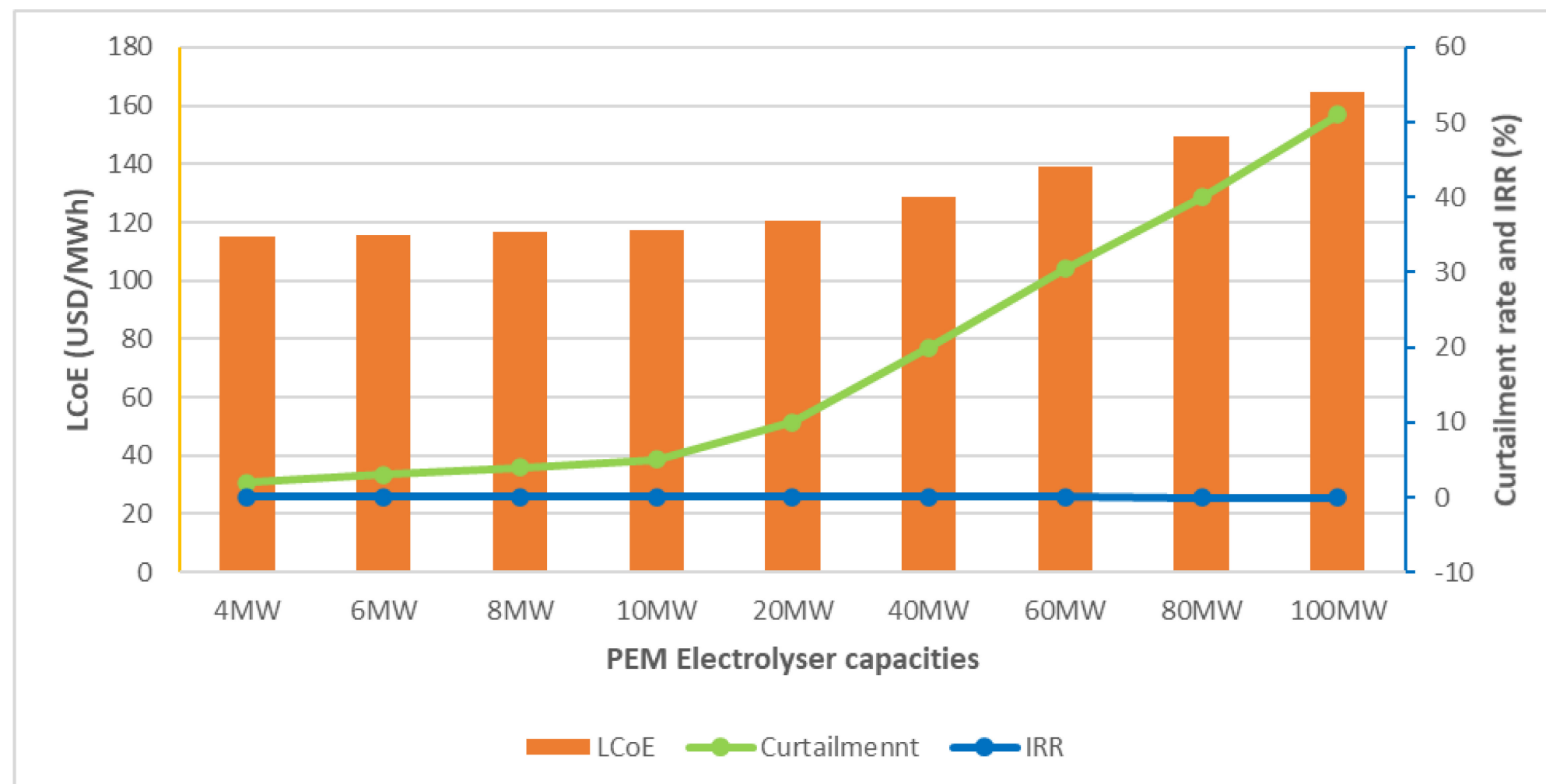
4. RESULTS & DISCUSSION_Cont.

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4.2 Cost of a floating offshore wind project in combination with a green hydrogen



LCoE, Curtailment rate and IRR at different PEM Electrolyser capacities- 20 years of operation



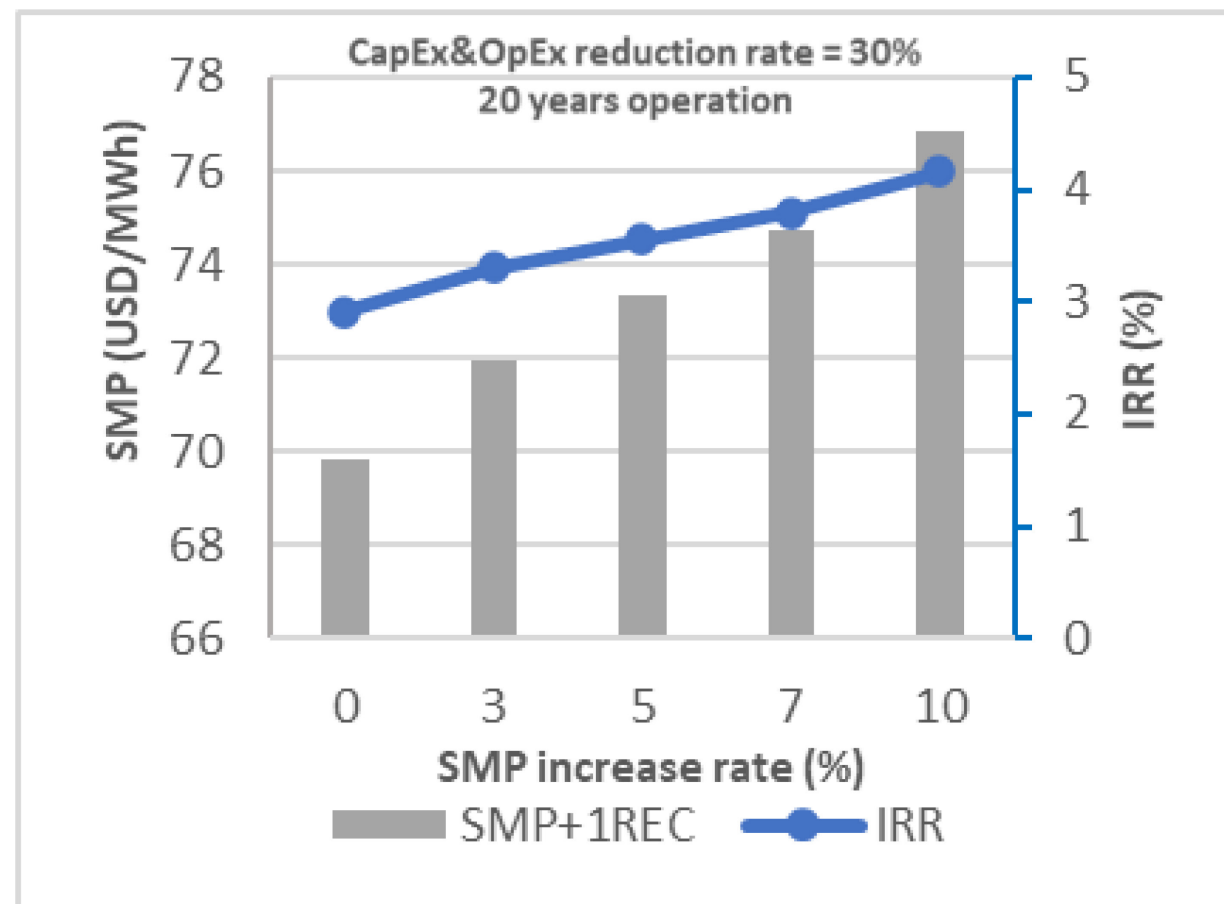
Curtailment rate and IRR at different PEM Electrolyser capacities- 30 years of operation

- An increase of the LCoE of the overall project and a decrease of the IRR with an increase in the capacity of the PEM electrolyser & H2 production
- The capacity of the PEM electrolyser varies depending on the curtailment rate of OWF
- Using 1 MWh electricity
-> 17.24 kg of H2 (corresponding to about 103,448 KRW)
- Excluding the ammonia transport cost (1,800 KRW/kg H2)
-> 72,414 KRW
- Less than the SMP: 83,910 KRW/MWh

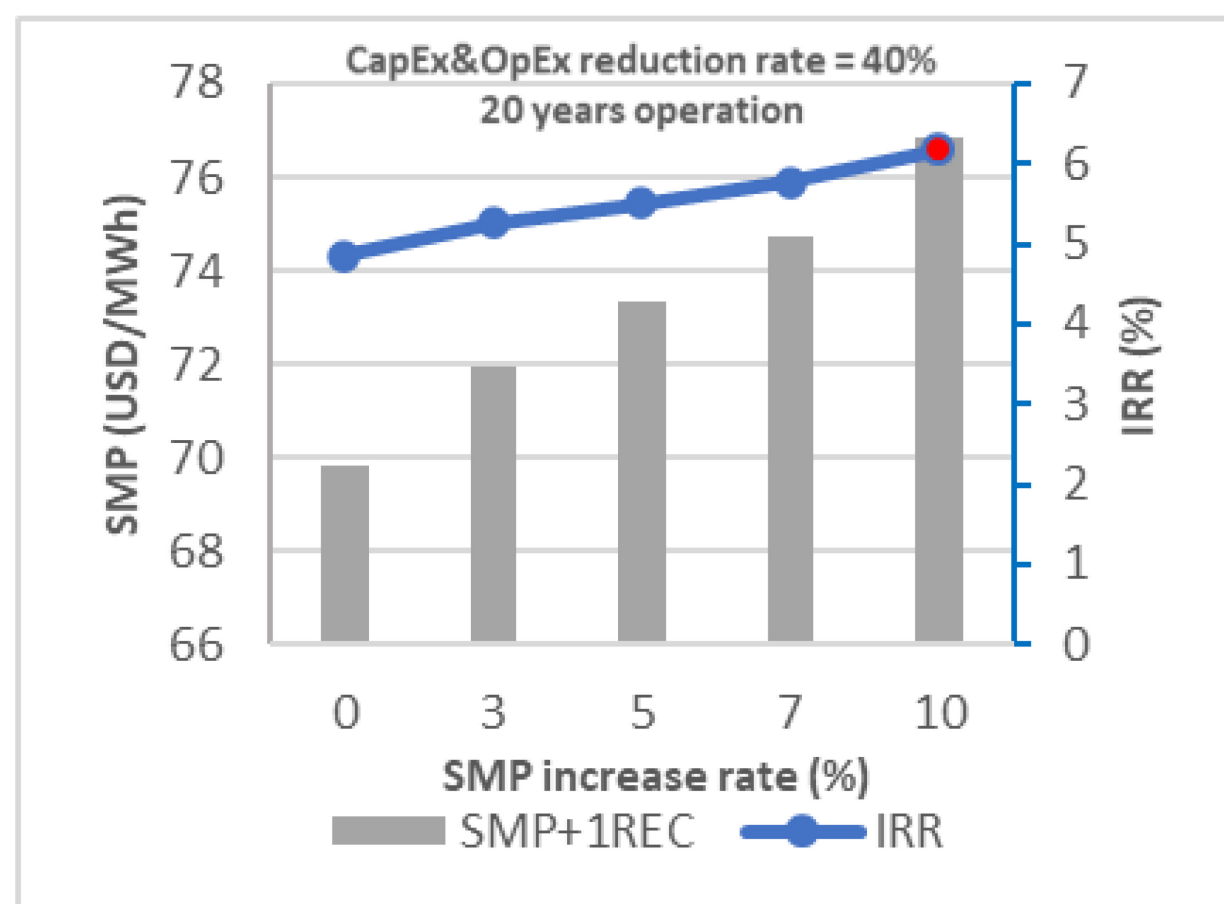
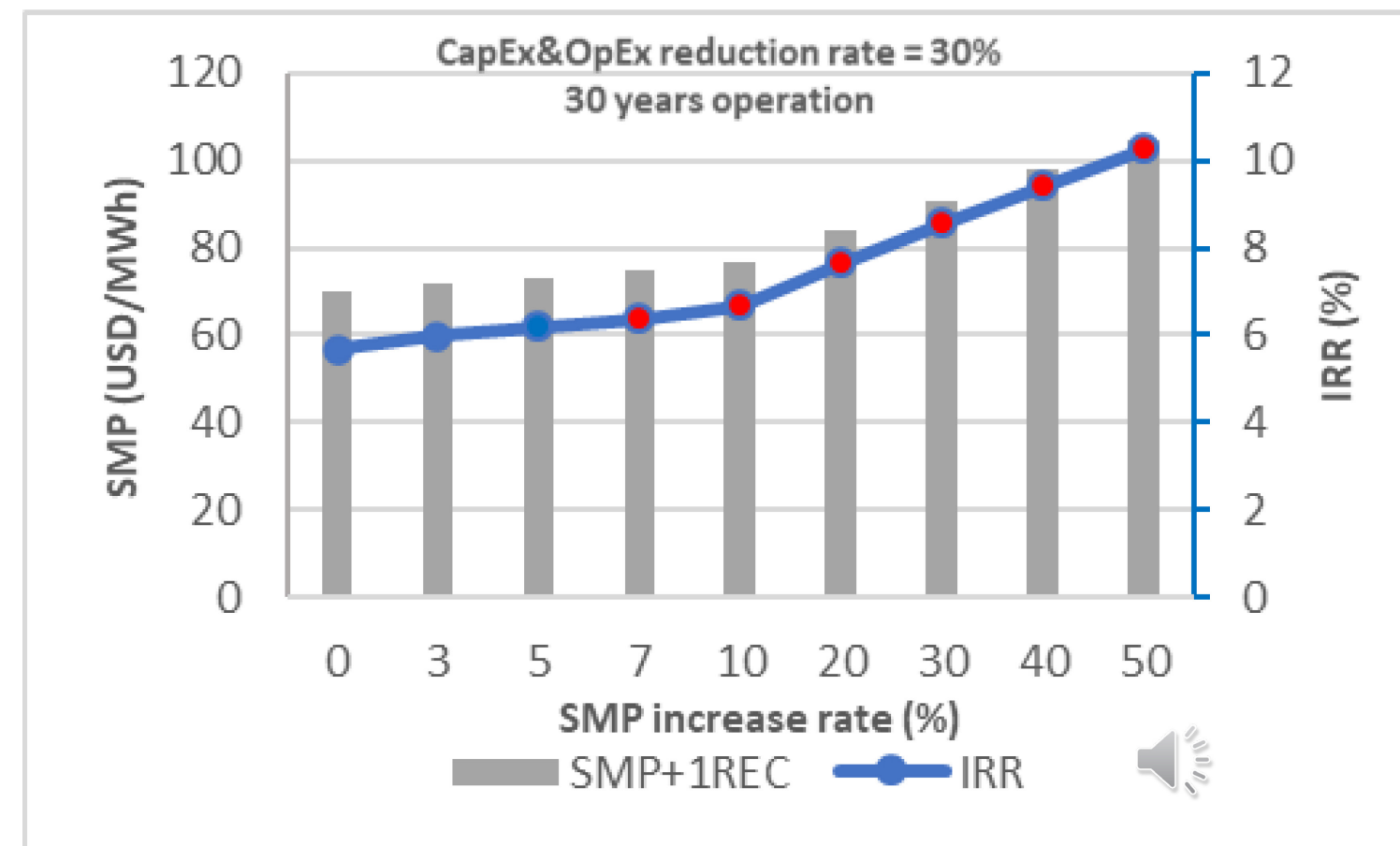
4. RESULTS & DISCUSSION_Cont.

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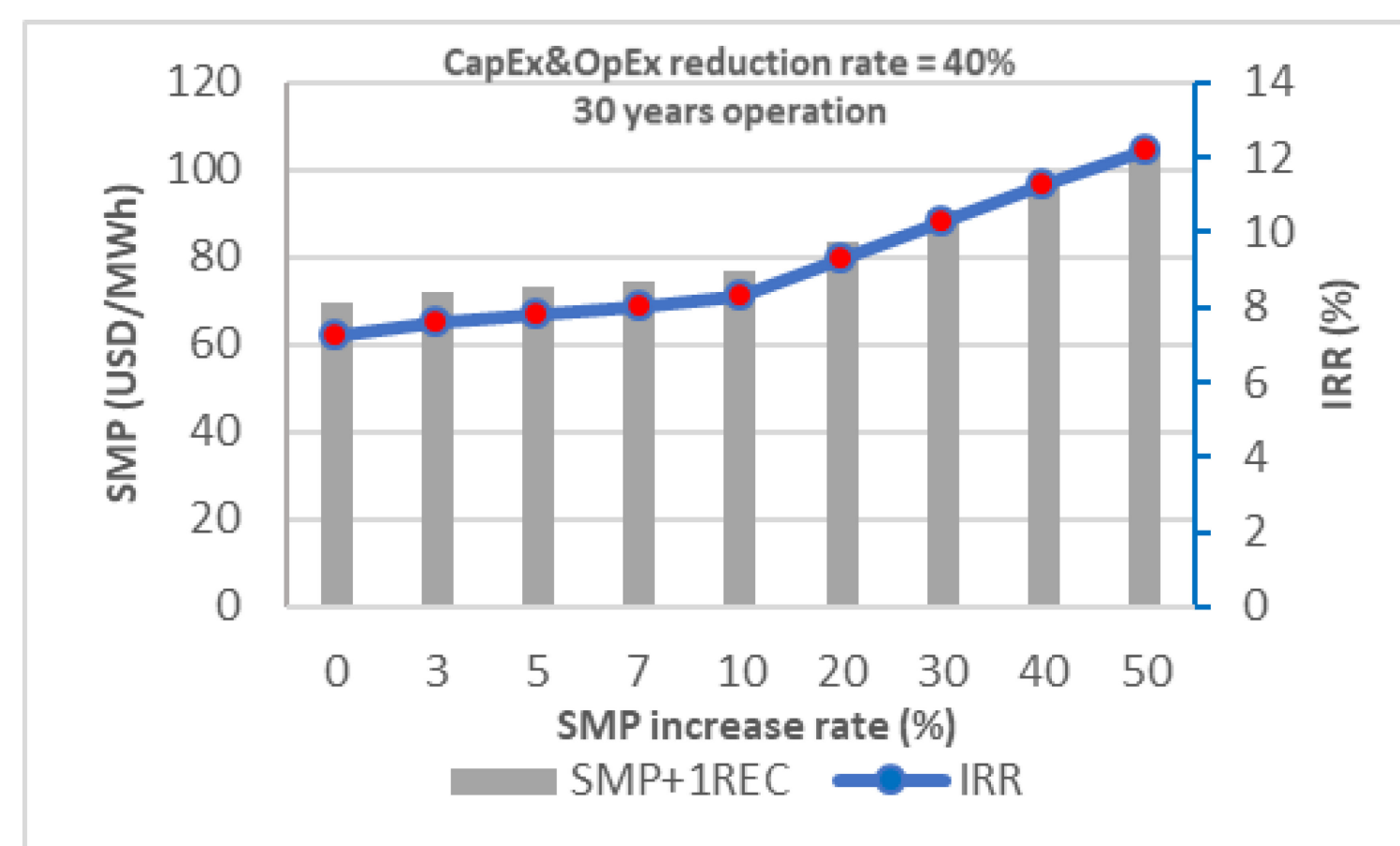
4.3 Cost of a floating offshore wind project in combination with a green hydrogen



If CapEx & OpEx reduction rate = 30%, SMP+1REC and IRR at different SMP increase rate



If CapEx & OpEx reduction rate = 40%, SMP+1REC and IRR at different SMP increase rate



- The factors most directly related to the profitability of OWF: (1) CapEx & OpEx and (2) SMP
- NREL report: a 35% decrease in CapEx from 2019 to 2035
- When the reduction ratios of CapEx & OpEx are 30% : SMP must increase by 11% to achieve and IRR of 6.77% : SMP is 77,513 USD/MWh
- When the reduction ratios of CapEx & OpEx are 40% : IRR of 7.23% without an increase in SMP

THANK YOU

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