SUSTAINABILITY ASSESSMENT OF WIND ENERGY IN LATVIA: SUSTAINABILITY SWOT AND MULTI-CRITERIA ANALYSIS

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DOUBLE DIPLOMA PROGRAMME, 2021
RIGA TECHNICAL UNIVERSITY,
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INTRODUCTION

ONSHORE vs OFFSHORE WIND

Looking at the Latvian NECP2030, the policy makers have highlighted the necessity to grow the share of RES in the total energy generation up until 2030. NECP2030 emphasizes wind energy, however it is inconclusive where the priority should lie. The recently signed memorandum of understanding between Latvia and Estonia with an aim to assess various sites in the Baltic sea for wind farm construction could be perceived as a signal from the Latvian government that time and energy will be invested in developing offshore wind energy fist.

AIM OF THE WORK

GOAL:

The goal of this master's thesis is to assess and compare onshore and offshore wind energy in terms of various aspects of their performance, based on the policies and measures outlined in the Latvian National Energy and Climate Plan (NECP2030).

The results may provide recommendations for policy makers in defining the renewable energy policy focus and a framework for further wind energy assessment.

METHODOLOGY

The assessment of onshore and offshore wind energy is done using the combination of sustainability strengths, weaknesses, opportunities and threats (sSWOT) analysis and multi criteria decision analysis (MCDA).

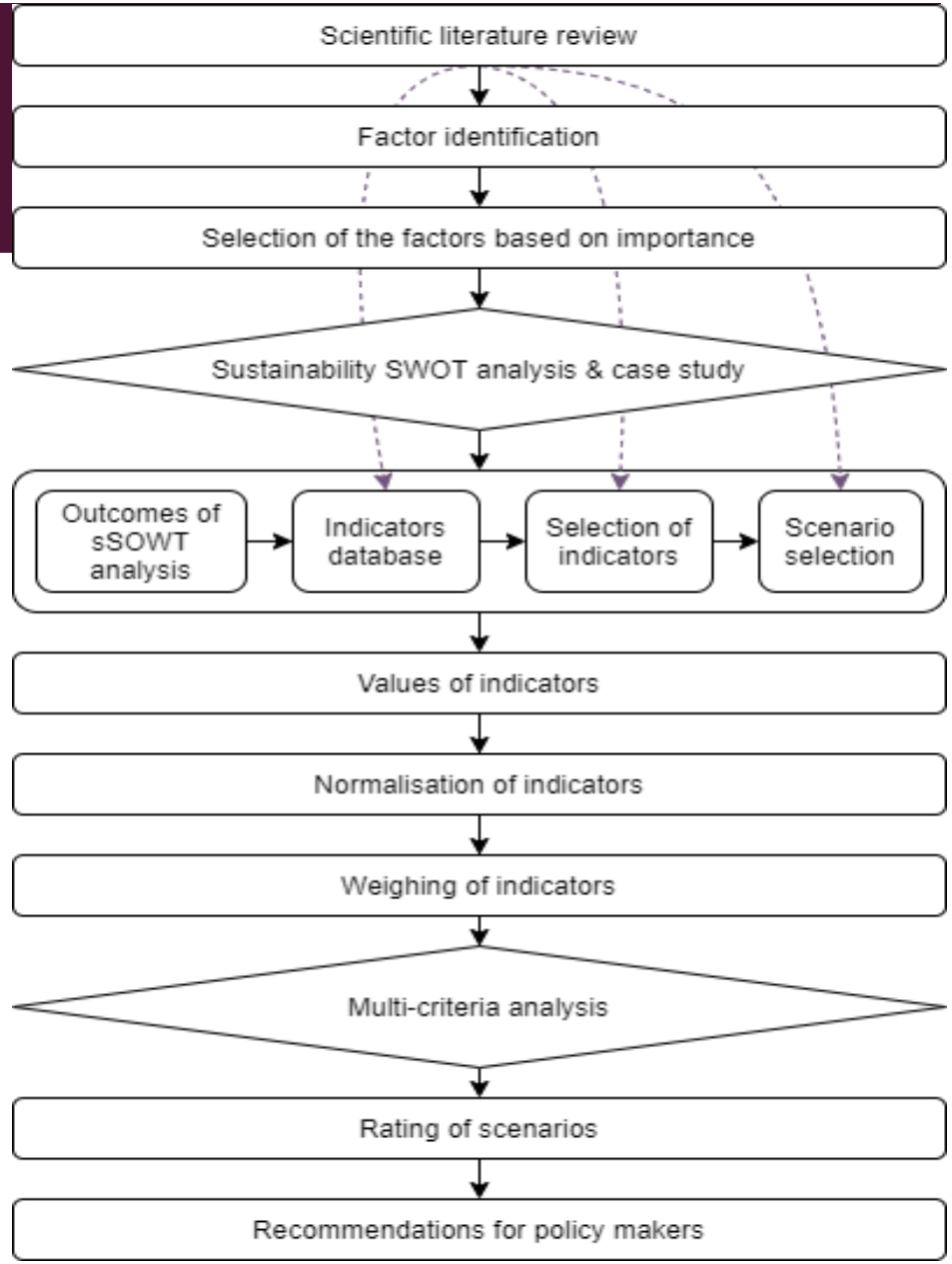


Figure 1 Concept of the overall methodology

PROCESS

Environmental & Social Challenges & Big Trends	Strengths, Opportunities, Weaknesses & Threats		Prioritization & Action
Challenges	S Strengths	W Weaknesses	Prioritise
Trends	O Opportunities	T Threats	Action

sSWOT

Criteria for MCDA

i1 Levelised cost of electricity (LCOE)
i2 Weighted average total installed costs
i3 Capacity factor
i4 Energy output
i5 Sound power
i6 CO_2 saving
i7 Community investment possibility
i8 Perceived impacts
i9 Jobs
i10 Income to land owners

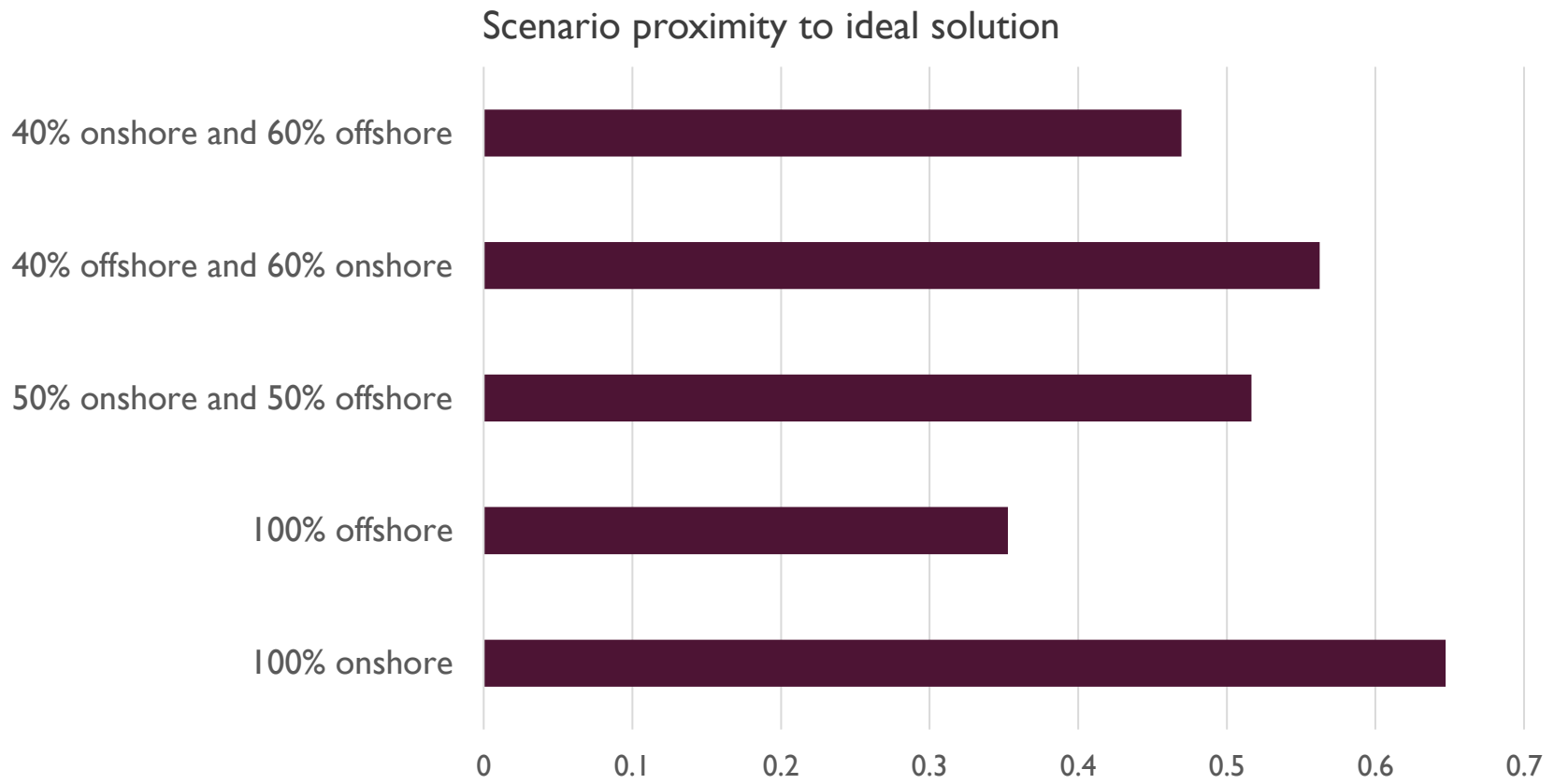
PROCESS

MCDA

		Normalised decision matrix						Weighted decision matrix				
		rai1	*rai2*	*rai3*	*rai4*	*rai5*		*vai1*	*vai2*	*vai3*	*vai4*	*vai5*
		100% Onshore	100% Offshore	50% onshore and 50% offshore	40% offshore and 60% onshore	40% onshore and 60% offshore	Weight (based on expert opinion)	100% Onshore	100% Offshore	50% onshore and 50% offshore	40% offshore and 60% onshore	40% onshore and 60% offshore
LCOE	EUR/MWh	0.251	0.613	0.432	0.395	0.468	0.110	0.028	0.067	0.047	0.043	0.051
WEIGHTED AVERAGE TOTAL INSTALLED COSTS	USD/kW	0.222	0.688	0.398	0.363	0.433	0.120	0.027	0.083	0.048	0.044	0.052
CAPACITY FACTOR	%	0.402	0.491	0.446	0.437	0.455	0.110	0.044	0.054	0.049	0.048	0.050
ENERGY OUTPUT/ YEAR/ 800 MW	GWh	0.373	0.517	0.445	0.430	0.459	0.120	0.045	0.062	0.053	0.052	0.055
SOUND POWER	db	0.351	0.468	0.468	0.468	0.468	0.080	0.028	0.037	0.037	0.037	0.037
CO2 SAVING FROM 800 MW	metric t/year	0.373	0.517	0.445	0.430	0.459	0.120	0.045	0.062	0.053	0.052	0.055
COMMUNITY INVESTMENT POSSIBILITY	10-yes, 0-no	0.750	0.075	0.375	0.450	0.300	0.080	0.060	0.006	0.030	0.036	0.024
PERCIEVED IMPACTS	%	0.649	0.196	0.423	0.468	0.377	0.040	0.026	0.008	0.017	0.019	0.015
JOBS / 800 MW	number	0.241	0.620	0.430	0.392	0.468	0.110	0.026	0.068	0.047	0.043	0.051
INCOME TO LAND OWNERS / 800 MW	EUR	0.418	0.476	0.447	0.441	0.453	0.110	0.046	0.052	0.049	0.049	0.050

RESULTS

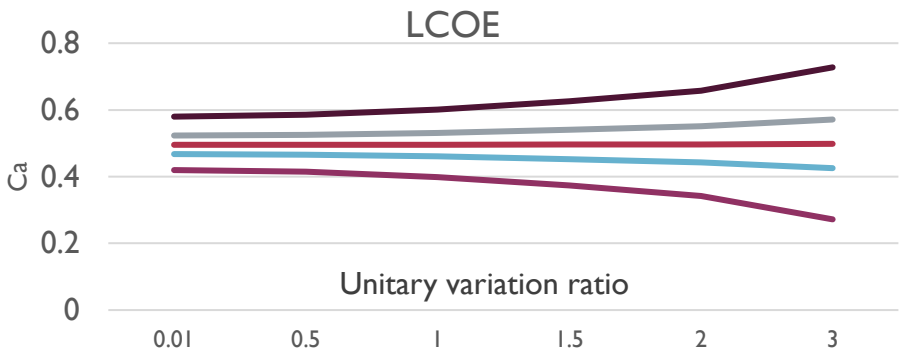
Multi-criteria decision analysis (MCDA)

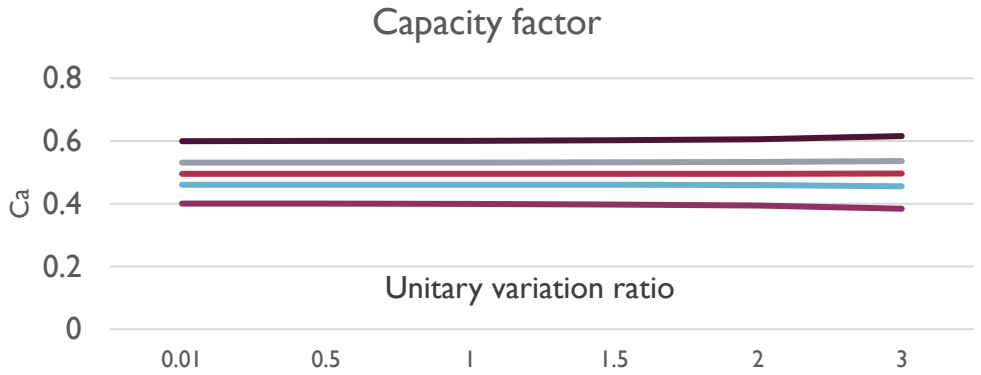


RESULTS

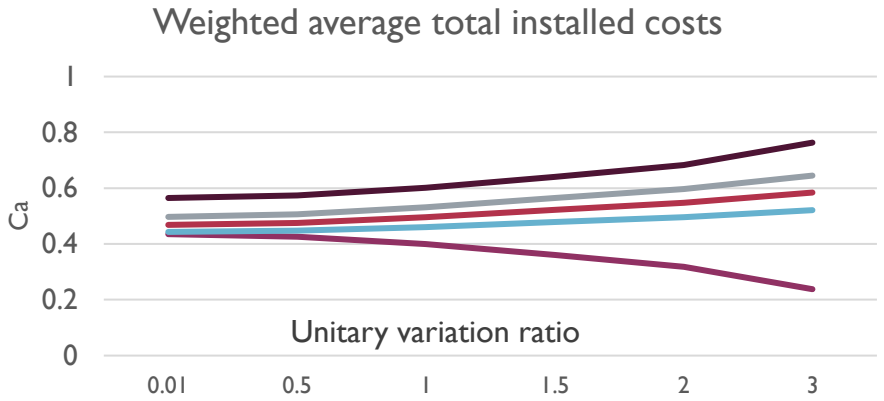
Multi-criteria decision analysis (MCDA)

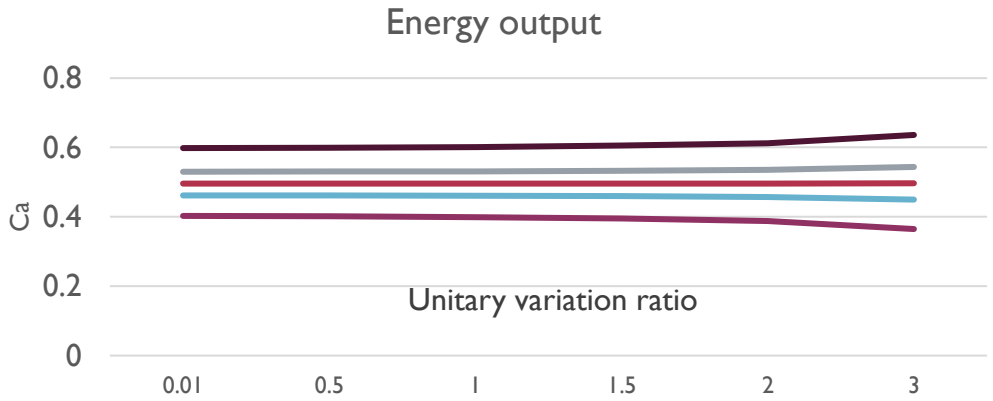
Sensitivity analysis





100 % onshore
100% offshore
50% onshore and 50% offshore
40% offshore and 60% onshore
40% onshore and 60% offshore

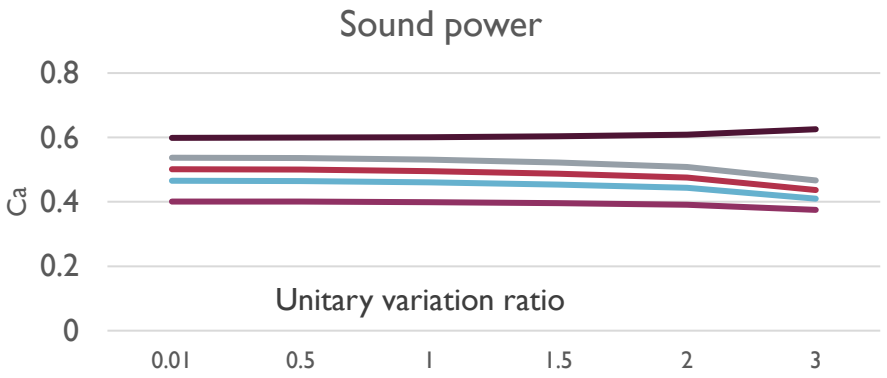




RESULTS

Multi-criteria decision analysis (MCDA)

Sensitivity analysis



100 % onshore
100% offshore
50% onshore and 50% offshore
40% offshore and 60% onshore
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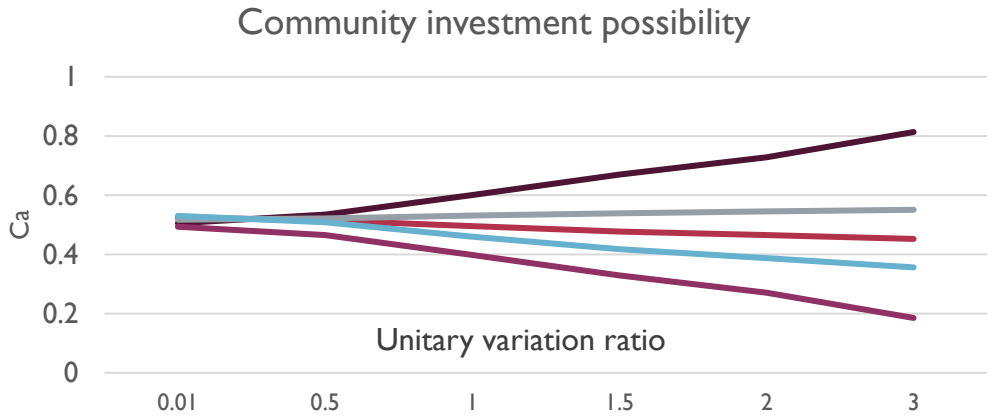
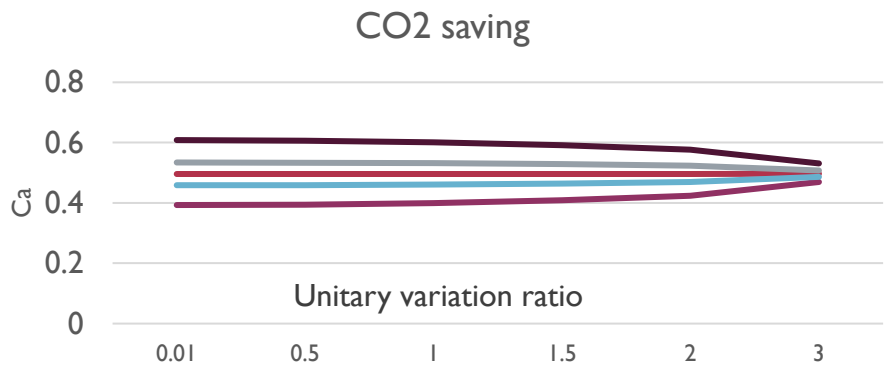
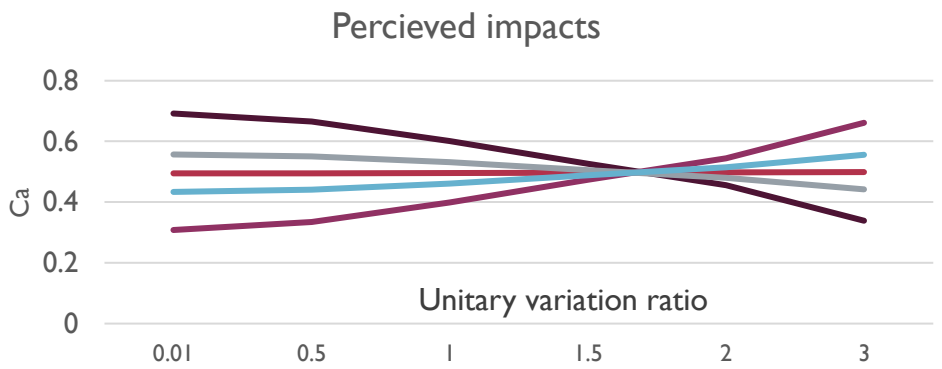
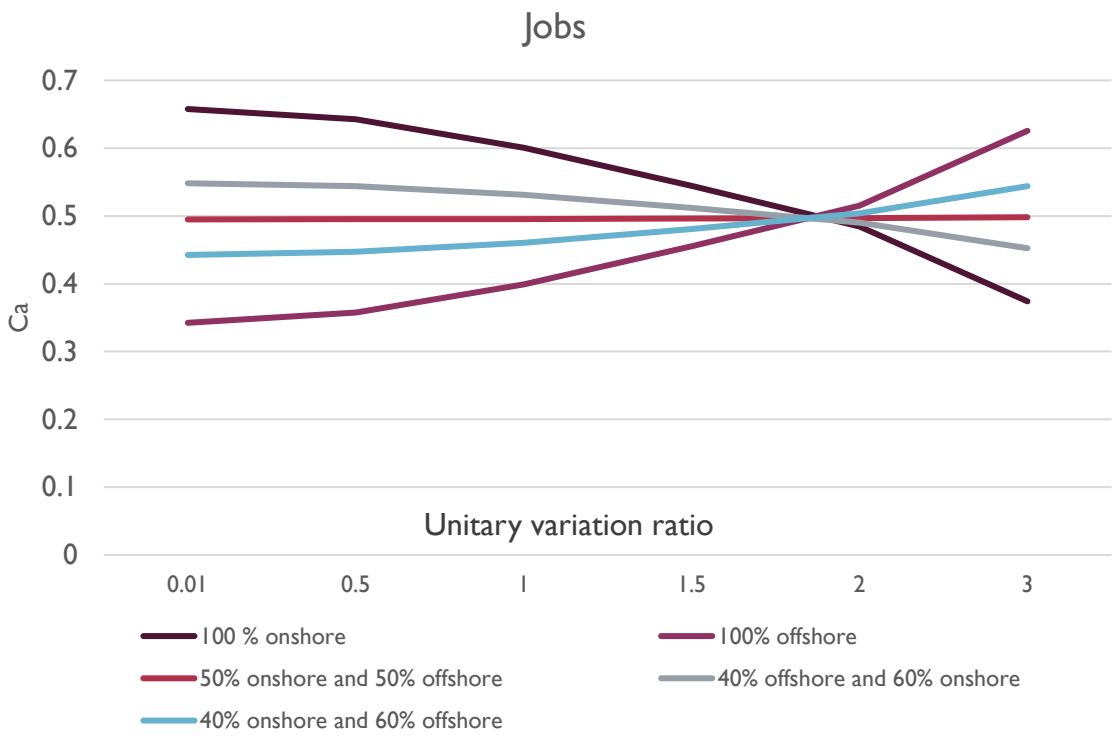






RESULTS

Multi-criteria decision analysis (MCDA)
Sensitivity analysis



CONCLUSIONS

- Literature analysis has identified 4 major groups of aspects impacting wind energy investment decision in Latvia: economic, social, technological and environmental.
- sSWOT analysis narrowed down the most important factors of wind energy which then helped the author to select 10 criteria for MCDA analysis.
- The results of the MCDA TOPSIS analysis show that onshore wind energy, based on the selected criteria, is the most suitable type of wind energy for Latvia. Factors such as energy price, investment amount, community investment possibility favour onshore wind energy, however, factors for the likes of sound power, jobs, CO2 savings and other favour offshore wind energy.
- Sensitivity analysis show that weighted average total installed costs, community investment possibility, perceived impacts and jobs are the most sensitive to slight changes.
- Identification of more criteria and their values in a further research will provide more precise results.