

FACULTY OF SCIENCE

DEPARTMENT OF GEOGRAPHY, ENVIRONMENTAL MANAGEMENT & ENERGY STUDIES											
	MODULE	ENS0037 ENERGY ECONOMICS									
	CAMPUS	АРК									
	EXAM	NOVEMBER 2019									
DATE	15 NOVEMBER	2019	SESSION	08:30 – 11:30							
ASSESSOR(S)			MS LUNGILE MASHELE								
EXTERNAL MODERATOR			JOANNE CALITZ								
DURAT	TION 3 HOUF	RS	MARKS 100								

NUMBER OF PAGES: 4 PAGES

INSTRUCTIONS:

Please answer ALL QUESTIONS. Each answer should be in the form of a comprehensive <u>essay</u>, with sketches and diagrams where these may be appropriate to <u>enhance</u> your answer. Alternatively, you may provide your answer in point form. PLEASE NOTE THIS IS UNITED STATES DATA.

Lungile Mashele

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QUESTION 1

Ankerlig is a diesel-fired plant that Eskom occasionally utilises in order to meet demand. The plant can run 24 hours a day, 365 days a year with a power rating of 2400kW. In March 2019 however, the plant ran for only 31 days, 20 hours a day at a power rating of 2400kW.

- Calculate the March 2019 capacity factor for Ankerlig 85%
- Why was the March 2019 capacity factor so high/low? High – stage 4 loadshedding
- Calculate the annual capacity factor assuming the run time was 6 hours a day for 216 days in the year.
 14.79 or 15%
- Convert the amount of electricity (MWh) produced by Ankerlig in 2019 assuming a run time of 5 hours a day for 216 days for a 1338MW installed capacity 1 445 040MWh

QUESTION 2

[20%]

Looking at the graph below:

1. Explain the concept of levelised cost and the typical inputs used to derive hydro levelised cost.

LCOE can be defined as the **ratio** of the **present value** of the sum of all the costs incurred over the **lifespan** of the power plant to the total power generated over the life span of the power plant.

Overnight capital cost O&M cost expenditure (fixed and variable) Fuel cost expenditure (hydro) Financing

2. What are the limitations of the LCOE method?

An LCOE analysis does not, however, adequately provide the cost of implementing specific projects, which will in any case be determined by the price set by the regulator. Moreover, the LCOE methodology has the same limitations as other analytical instruments, including:

Market realities and risks such as uncertainties and pricing are not reflected;

The generation cost provided refers to plant level and excludes transmission and distribution costs;

No indication is provided of a technology's effect on energy security or environmental sustainability;

No indication is given of the stability of a technology's production cost and, therefore, its potential contribution to overall cost stability is unknown.

 How do regional differences play a role in determining LCOE? Regional LCOE is also influenced by: Whether a country is a technology manufacturer or an importer Transport costs with regards to fuel i.e. coal New fuel technologies i.e. shale gas, oil sands

 Given the increase in the CSP LCOE, is there a future for CSP in South Africa? Substantiate your answer using the CSP allocation in the 2018 draft IRP. It depends

CSP was removed from the IRP

It has high tariffs and LCOE

CSP is expensive globally

High R&D cost

CSP companies closing down

CSP prices may come down once it reached peak of technology learning curve CSP can be considered when looking at other variables such as storage, CO2



[20%]

QUESTION 3

Looking at the graph below:

- 1. Define capacity factor.
 - The capacity factor is the ratio of the amount of power generated by a unit for a period of time (typically a year) to the maximum amount of power the unit could have generated if it operated at full output, non-stop.
- Explain why onshore and offshore wind have such varying levelised costs. Given the LCOE also explain which of the two technologies you would choose. Overnight costs, transmission costs, excavation costs, O&M, wind speeds Based on LCOE would choose onshore - cheapest

- 3. Explain why the capacity factor for the conventional combined cycle below, is higher than that of Ankerlig in the Western Cape.
- CCGT uses gas, Ankerlig uses diesel, CCGT is used as baseload or mid merit
 4. Explain the "techno-spread" phenomenon using the capacity factors of solar and wind.

Wind in winter and solar in summer, tracking of capacity factors, average capacity factor of 35%

Plant type	Capacity factor (%)	Levelized capital cost	Levelized fixed O&M	Levelized variable O&M	Levelized transmis- sion cost	Total system LCOE	Levelized tax credit ¹	Total LCOE including tax credit		
Dispatchable technologies										
Coal with 30% CCS ²	85	61.3	9.7	32.2	1.1	104.3	NA	104.3		
Coal with 90% CCS ²	85	50.2	11.2	36.0	1.1	98.6	NA	98.6		
Conventional CC	87	9.3	1.5	34.4	1.1	46.3	NA	46.3		
Advanced CC	87	7.3	1.4	31.5	1.1	41.2	NA	41.2		
Advanced CC with CCS	87	19.4	4.5	42.5	1.1	67.5	NA	67.5		
Conventional CT	30	28.7	6.9	50.5	3.2	89.3	NA	89.3		
Advanced CT	30	17.6	2.7	54.2	3.2	77.7	NA	77.7		
Advanced nuclear	90	53.8	13.1	9.5	1.0	77.5	NA	77.5		
Geothermal	90	26.7	12.9	0.0	1.4	41.0	-2.7	38.3		
Biomass	83	36.3	15.7	39.0	1.2	92.2	NA	92.2		
Non-dispatchable technologies										
Wind, onshore	41	39.8	13.7	0.0	2.5	55.9	-6.1	49.8		
Wind, offshore	45	107.7	20.3	0.0	2.3	130.4	-12.9	117.5		
Solar PV ³	29	47.8	8.9	0.0	3.4	60.0	-14.3	45.7		
Solar thermal	25	119.6	33.3	0.0	4.2	157.1	-35.9	121.2		
Hydroelectric ⁴	75	29.9	6.2	1.4	1.6	39.1	NA	39.1		

QUESTION 4

In March 2019, South Africa experienced one of the worst stages of loadshedding – stage 4 loadshedding.

- 1. Discuss what loadshedding is. System constraint, threat to entire system or network, possibility of complete blackout, managing total grid collapse, managing 50Hz, exceeded reserve margin
- Name 5 likely reasons why South Africa experienced stage 4 loadshedding. Maintenance on plants (planned and unplanned) Cahora Bassa line destroyed in hurricanes Coal quality being supplied Sabotage on plants Boiler tube leaks
- Name 5 possible implications for a factory owner who was affected by loadshedding.
 Shut down of factory, staff leave early Loss of revenue Inability to meet orders

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Late deliveries, late payments, contract default Use of generators means increased cost Can't pay salaries, staff layoffs Factory shut down

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QUESTION 5

- 1. Discuss, using a formula, how annual electricity revenue is calculated by the Regulator. Give an example or a brief explanation for each cost item.
- 2. Explain the two models for the annual revenue profile over the full operational life of a power station
- 3. Motivate which of the annual revenue profile models discussed in part 2 of this question is more suitable for the South African situation.

[20]

TOTAL [100%]