Suggested answer for 2022 A-Level Paper 2 Question 3

Street lighting is considered to be a public good. However, there are also negative externalities resulting from the generation of electricity for the lighting on the environment and the effect of bright street lights on wildlife.

a) Explain **two** different reasons for the market failure associated with the provision of street lighting [10]
b) Discuss the extent to which a government should intervene in the market to ensure that the benefits of street lighting can be obtained while minimising the negative impacts. [15]

Part (a) - Question Analysis

Approach	**Command Word**	Explain
	Question Type	Cause and effect
	Start point	1. Public good 2. Negative externalities
	End Point	Market failure
Content and Context	**Content**	• Market failure (allocative efficiency) • Public good (non-rivalrous, non-excludable in consumption) • Negative externalities
	Context	Street lighting, electricity

Introduction

State essay approach: Street lighting is a public good as it non-excludable, non-rivalrous and non-rejectable in consumption. The free market would not provide public good as there is a lack of price signal, leading to a missing market where there is zero allocation of resources. Hence government need to intervene by directly providing the street lights to benefit society. Street lights consume electricity which generates negative externalities, leading to overallocation of resources.

Body Point 1: One reason for the market failure associated with the provision of street lighting is lack of price signal

- Street lighting is non-excludable in consumption. It is impossible or very costly to exclude non-payers from consuming street lighting once it is provided as non-payers could easily enjoy the benefits of street lighting by being near the street lighting. Since those who cannot pay will not be excluded, no one has the incentive to pay for the good. This leads to free-rider problem where everyone will wait for someone else to pay, in hopes of enjoying the marginal benefit from the street lighting without having to pay for it. Hence, there will be no effective demand for street lighting and profit-maximizing firms will make the rational decision not to even enter the market to supply the street lighting. Therefore, if street lighting was left the free market, there would be no resources allocated to its production, leading to a missing market and complete market failure.
- Street lighting is also non-rivalrous in consumption. This means that the consumption by one person does not reduce the amount available to another. When one person stands under the streetlight, the same amount of light is still available to the next user. Therefore, supplying street lighting to an additional user does not require another streetlight to be built. This means

that the marginal cost of providing streetlighting for an additional user is zero. In an allocative efficient market, the price to charge is equal the marginal cost (P=MC), hence the price which consumers should pay is equal to the marginal cost which is zero. In a free market, profit-maximizing firms will not provide their goods at a price of zero. Therefore, no rational private firms would be willing to supply street lighting if the price is zero. If left to the free market, no street lighting will be produced, and there is complete market failure.

Body Point 2: One reason for the market failure associated with the provision of street lighting is presence of external costs.

- Negative externality in production exists when there are costs borne by third parties due to the production of a good or service, for which they are not compensated.
- Electricity is needed for street lighting to provide lighting to the streets. When coal-fired power station produces electricity, its private benefits are the additional revenue from selling electricity. It also incurs private costs such as the costs of providing the electricity grid and wages paid to labor. However, producing electricity by burning coal leads to air pollution which worsen global warming/extreme weather conditions. The firm does not take into account the fact that farmers and fishermen (third parties) have to bear the external cost in terms of making losses due to falling crop yields, fishery stocks and wildlife that are caused by global warming and are not compensated for the financial losses that they suffer.

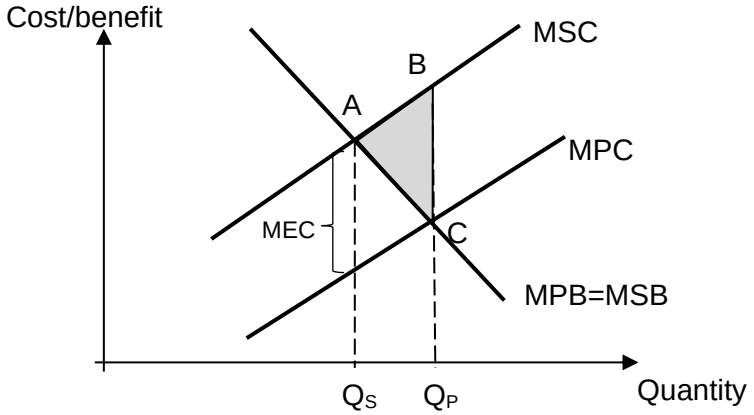

Figure 1: Negative externality in production of coal-fired electricity

- Due to the negative externality in production, the social costs of producing electricity are higher than the private cost (MSC>MPC). In Figure 1, the MSC lies above the MPC by a vertical distance equal to marginal external cost (MEC). Assuming no positive externalities, the marginal private benefits (MPB) is equal to marginal social benefits (MSB). In the pursuit of self-interest, the firm considers only its private benefits and private costs when producing coal-fired electricity. This leads to the market equilibrium output QP, where MPB=MPC. However, the socially optimal output is given by QS, determined by the intersection of the MSB with the MSC. Since Q_P>Q_S, the firm over-produces coal-fired electricity, leading to an over-allocation of resources. Between Q_P and Q_S, marginal cost to society is greater than marginal benefit to society. This means that societal welfare could have been improved by reducing quantity of coal-fired electricity to the socially

optimal output of Q_S. This forgone societal welfare is the deadweight loss (area ABC), leading to allocative inefficiency and hence market failure.

Conclusion

Therefore, there is a missing market for street lighting without government intervention as it is a public good. However, when government step in to provide street lighting, negative externalities would be generated from the generation of electricity, leading to over-allocation of resources in the market for coal-fired electricity. Therefore, a government should intervene in the market in a way that the benefits of street lighting can be obtained while minimising the negative impacts.

Mark Scheme B

Level	Knowledge, Understanding, Application, Analysis	Marks
L3	Full display of AO1, AO2 and AO3 skills: For an answer that shows well-developed explanation of two reasons why the market fails in the provision of street lighting • clear and accurate explanation of how street lighting leads to complete market failure due to non-excludable and non-rivalrous in consumption and how negative externalities in electricity generation leads to over-production • supported with appropriate diagrammatic analysis • supported with relevant examples	8-10
L2	Uneven display of AO1, AO2 and AO3 skills: For an answer that shows under-developed explanation of why the market fails in the provision of street lighting • lacks depth of analysis (i.e., limited effective use of relevant economic analysis or gaps in diagrammatic analysis) • lacks scope in explaining either public good or negative externalities • lacks relevant examples	5-7
L1	Limited display of AO1 and AO2 skills: For an answer that shows limited knowledge of why the market fails in the provision of street lighting • listing of points, unexplained statements, or descriptive response • many conceptual errors (i.e., mix up non-rivalrous and non-excludable etc) • irrelevant response such as on positive externalities or imperfect information • smattering of points	1-4

b) Discuss the extent to which a government should intervene in the market to ensure that the benefits of street lighting can be obtained while minimising the negative impacts. [15]

Part (b) - Question Analysis

Approach	**Command Word**	Discuss the extent
	Start point	Direct provision to solve the problem of public good and subsidies in the market of 'green' energy to mitigate the negative impacts from negative externalities.
	End Point	Whether the government should intervene in the market to correct market failure
Content and Context	**Content**	HL framework for policies in solving market failure caused by public good.
	Context	Street lighting, 'green' energy, coal-generated electricity

Introduction:

With the presence of complete market failure in the market for street lighting, government intervention can help to solve the problem of market failure to reach allocative efficiency. However, the simultaneous existence of spillover costs from negative externalities in the provision of street lightning complicates the situation. Hence, the extent to which a government should intervene depends on the associated costs and benefits as well as other limitations of intervention.

Body Paragraph 1: The government should intervene in the market through direct provision to solve the problem of market failure caused by public good.

How direct provision works to solve market failure on public goods.

- Government should provide street lighting using its resources to finance or pay for it.
- The government will have to make an estimate of the marginal social cost and marginal social benefit of street lighting and provide an amount equivalent to the socially optimal amount, Qs.
- In order to solve the problem due to street lighting being a public good, the government would have to provide these goods at zero cost (no charge for residents) to consumers to ensure allocative efficiency. Because of its non-rivalrous characteristic, the price charged must be zero to equal marginal cost. (P=MC. Since MC=0 ➔ P=0)

- Direct provision of these public goods by the government should be done because the non-excludable nature of street lighting (and resulting lack of a price signal) leads to profit-motivated private producers being unwilling to provide these goods.
- An example of this would be the street lighting is provided by the Singapore government such as the Land Transport Authority (LTA). Because of the existence of complete market failure in public goods, free government provision of street lighting is vital to ensure that the socially desirable quantity can be reached.

Limitations for direct provision due to public goods

- **Imperfect information** - Government may not accurately determine the socially optimum level (the right amount to provide) of public good. The under or over provision of public goods may result because of the absence of an effective demand function to indicate to the government how much to produce. This is due to the free-rider problem.

- The government would not know how much consumers truly value the public good as there is an absence of price signal with is useful for evaluating whether to provide the public good and in what quantities. Should the government under-provide or over-provides a public good, deadweight losses will result. If the resulting size of the DWL is more than the initial DWL when there was complete market failure, government failure would then occur.

Intermediate evaluation

- On the context that Singapore is a country that is more data savvy, the data collection to determine the socially optimum level of provision of the public good would be more accurate. Hence, the amount of provision of street lighting would be accurate.

- Instead of being the producer, the government could provide the funding and outsource the production and maintenance of the public goods to private producers by awarding them contracts or to fully fund private companies. These private producers are more efficient in minimizing costs as compared to the public sectors since costs have a direct effect on profitability.

- In order mitigate the problem of cost inefficiencies, there could be a system of checks by the government. This ensures that the case of government failure would be reduced.

Body Paragraph 2: Government should intervene because of possible unintended consequences of negative externalities when street lighting is provided.

How subsidies on green energy works to solve the problem of negative externalities.

- The government could possibly subsidize the production of 'green' energy which eventually would allow for street lighting to be provided.
- With subsidies provided in the market of 'green' energy, there will be a reduction in the unit cost of production, lowering MEC. Producers would be incentivized to switch to using 'green' energy instead of using fossil fuels for the generation of coal-fired electricity. As a result, this reduces pollution caused by carbon emissions in the production of energy using fossil fuels.
- An example of this is Singapore being one of the most solar-dense cities around the world where Solar energy is used widely as a source of 'green' energy.
- As a result, this reduces the marginal external cost generated from the negative externality in the market for electricity.
- Producers will reduce its output level to the socially optimum output Qs from Qp as they switch away to 'green' energy. Hence, allocative efficient output is achieved, and the initial deadweight loss of ABC is eliminated.

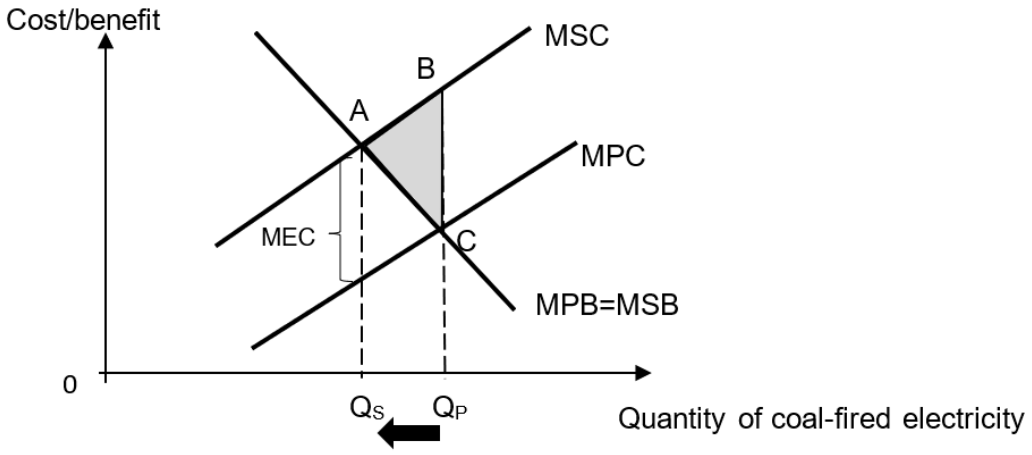

Figure 1: Reducing negative externalities in the market of coal-fired electricity.

Limitations of subsidy due to the presence of negative externalities

- **Effectiveness of the subsidy** - It is dependent on the openness and willingness of producers to switch to 'green' energy. Should the producers not switch to it, it would not necessarily solve the root cause of the problem and there will still be negative externalities generated in the market of coal-fired electricity.
- **Difficult to give an accurate valuation** - The main problem of using subsidy is a lack of information of how much to subsidize in the market for 'green' energy. Hence, the government may not have the ability to accurately quantify the amount of external costs generated from producing coal-fired electricity. This is because the damage from pollution is extremely difficult to assess, especially so in monetary terms.

- An over-estimation or under-estimation of the size of the external cost would lead to over- or under- subsidy provided, which would mean either a less than (due to overestimation) or more than social optimum level of output that is produced.

- **Government budget constraint** – The direct provision of street lighting would increase government expenditure, which may require raising taxes and increasing tax burden on its citizens. Additionally, spending on public goods incurs opportunity cost, e.g., new healthcare or educational facilities foregone.

Intermediate evaluation

- Being a relatively wealthier nation, Singapore would have sufficient budget in spending on these subsidies and hence solving the limitation on the constraint from the government's budget.

- **Recommendation** – External costs generated from producing coal-generated electricity could be lowered when countries tap into alternatives methods such as energy-efficient street lighting system (e.g., LED). This lowers the demand for coal-generated electricity.

Overall Conclusion/ Evaluation [1m]

- **Stand** – Given the multi-faceted nature of the problem, the government should intervene in the market of street lightning through direct provision and complementarily, providing subsidies in the market for 'green' energy.
- However, although there are benefits to implementing the policies, the government should be aware of the limitations and unintended consequences that the policies bring.
- It would be vital for them to constantly weigh the benefits and costs from having the public good being provided.
- Should the Singapore government recognize that the benefit from having the public good provided is more than the costs of providing it, then the government can produce the public good either through direct or joint provision. However, they would have to complement this policy to mitigate the unintended consequences caused by the provision of street lightings.
- The government also must be sensitive of the ever-changing nature of this problem and assess the appropriateness of the different policies that is implemented in Singapore's context.

Mark Scheme

Levels	Descriptors	Marks
L3	Displays full slew of skills across AO1, AO2 and AO3: • A balanced and well-developed answer • Correct application of various policies to solve market failure caused by public goods and negative externalities with economic analysis of how the policies work. • Accurate and fully labeled diagrams. • Use good, contextualised examples to support analysis.	8-10
L2	Displays AO1, AO2 and AO3 skills: • An under-developed response • Inconsistent of application of various policies to solve market failure caused by public goods and negative externalities with economic analysis of how the policies work. • Incorrect diagrams drawn. • No examples given.	5-7
L1	Uneven display of AO1 and AO2 skills: • Many conceptual errors • No economic framework in analysis • Superficial explanation • Question requirement is not addressed	1-4
	Evaluation	
E3	Well-reasoned judgements: • A well-reasoned judgement about the appropriateness of different policies in removing market failure due to public goods and negative externalities. • Good explanation and contextualisation of the limitations of the analysis	4-5
E2	Largely unexplained judgements: • Some attempt to explain their judgement on the different policy measures	2-3
E1	An unsupported judgement: • Mere evaluative statements or judgements that are neither supported nor relevant to any specific context	1