

5<sup>th</sup> February 2020



Comhairle Ceantair  
**Lár Uladh**  
**Mid Ulster**  
District Council

To: Councillor Gildernew )  
Councillor Graham )  
Councillor McAleer )  
Councillor McGuigan ) Mid Ulster District Council  
Councillor Robinson )

Mr A Cassells

Councillor Clarke )  
Councillor Fitzgerald )  
Councillor Garrity )  
Councillor Rainey ) Fermanagh & Omagh District  
Councillor Thompson )

Ms A McCullagh

Dear Sir/Madam

**Re: Tullyvar Landfill Site Joint Committee Meeting**

A meeting of the Management Committee for the development of Tullyvar Landfill Disposal Site will be held in the Office at Tullyvar Landfill Site on **Wednesday 12<sup>th</sup> February 2020 at 10.30am.**

1. Confirmation of Minutes of Meeting held on Wednesday 9<sup>th</sup> October 2019 (copy herewith)
2. Matters Arising from the Minutes
3. Solar Panels Proposal (report attached)
4. Financial Matters
  - 4.1 2020/21 Draft Budget
  - 4.2 Management Accounts
5. Update from Head of Environmental Services/Site Manager's Report



6. Any Other Business
7. Date of Next Meeting  
- Wednesday 10<sup>th</sup> June 2020 (AGM)

Yours faithfully

**Andrew Cassells**

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Director of Environment & Property

Copy:      A Tohill  
              K O'Gara  
              M McAdoo  
              A McIlwrath  
              K McGowan



**MINUTES OF TULLYVAR JOINT COMMITTEE MEETING HELD ON WEDNESDAY  
9<sup>th</sup> OCTOBER 2019 AT 10.30AM AT TULLYVAR LANDFILL SITE**

**PRESENT:**

**FERMANAGH & OMAGH:** Councillor Rainey (Chair)  
Councillor Fitzgerald, & Thompson

**MID ULSTER:** Councillors Gildernew, McAleer, McGuigan & Robinson

**OFFICERS:** A Cassells, M McAdoo, K McGowan, K O’Gara &  
A McIlwrath

**APOLOGIES:** Councillors Clarke & Graham  
Mr Hegarty

***Meeting commenced at 10.30am***

**1. CONFIRMATION OF MINUTES – 12<sup>th</sup> JUNE 2019 (ORDINARY & AGM)**

The above minutes were adopted.

Proposed by Councillor Thompson  
Seconded by Councillor McGuigan and agreed.

**2. CHAIRMAN’S REMARKS**

The Chair thanked Members for his Election in his absence and thanked Councillor McAleer, Vice Chair, for chairing the previous meeting.

**3. MATTERS ARISING**

**3.1 Farm Plastics**

A Cassells advised that the acceptance of farm plastics at the CA Site was primarily an issue for MUDC, the matter would be considered as part of the current review of the Waste Policy which would be brought before the Environment Committee.

K O’Gara referred to the significant costs involved in handling and treatment of farm plastics. The Chair suggested the cleanliness of the material also proved problematic.

**3.2 Landfill Capacity Report**

A Cassells updated on the biennial review of the Landfill Capacity report as circulated to Members. In summary it was noted that there was sufficient landfill void until 2028, with the caveat that all Councils will meet their targets and no other issues or changes in law arise.

It was noted the main purpose of the report was to determine when Tullyvar would need to develop Cell 4. Based on the report it was confirmed there was no immediate need to develop Cell 4 but Members could defer the decision for the next two years and review thereafter. It was confirmed that a one year contract works period would be required to develop the Cell.

K O'Gara referred to the Drummee Site and confirmed capacity to July 2021. He indicated that Tullyvar was a valuable asset with grid connection and ideal road infrastructure.

Following query on the gas production, the Site Manager advised that there remained an 8 year gas production expectation dropping off over successive years. Noted there existed the opportunity to import gas in the future.

In light of Brexit, it was confirmed that MUDC did have contingency landfill options in Ballymacombs with approximately 40,000 tonnes of void capacity.

Following query from the Chair in relation to incinerator ash, it was confirmed that bottom ash or fly ash could be landfilled.

#### **4.0 FINANCIAL MATTERS**

##### **4.1 Update – Financial Reporting**

Noted this matter would be considered under the Site Manager's report.

#### **5.0 UPDATE FROM THE SITE MANAGER**

The Site Manager's Report was considered, copy attached as appendix one, reference being made to the undernoted:

##### **5.1 Operational Issues**

Members noted the reduction in the gas generation due to the ongoing capping contract works.

Members were informed of the mothballing works carried out to date and further planned works over the next 2-3 months.

##### **5.2 Financial Matters**

Given the reduction in site operations, the Site Manager confirmed that going forward bi-annual management accounts would be tabled for Member

consideration. The first 6 months management accounts would be presented to the Joint Committee in February along with the 2020/21 budget for approval.

### **5.3 Landfill Tax Reclaim**

The Site Manager referred to the substance of the claim and advised Members that the reverse fluff layer was cherry picked waste creating a semi engineered material which it could be argued should not be subject to landfill tax. It was noted, if the tribunal was not successful there would be no further progress beyond this stage.

### **5.4 Phase 4 Capping**

As per the report, the Site Manager confirmed that the contract was awarded to CivCo and was due for completion in March 2020.

### **5.5 Wetlands Scheme**

Following query, the Site Manager confirmed the wetlands project had been very successful highlighting to Members the wide range of vegetation on the ponds and the extent of wildlife, birds and vertebrae attracted to the site.

Councillor Thompson paid tribute to the Site Manager for the management of the site.

### **5.6 Adoption of Report**

The Site Manager's report was adopted.

Proposed by Councillor Thompson  
Seconded by Councillor Fitzgerald and agreed.

## **6.0 DATE OF NEXT MEETING**

It was agreed to convene the next meeting on **Wednesday 12<sup>th</sup> February 2020 at 10.30am at Tullyvar Landfill Site.**

***Meeting ended at 11.05am***





**TULLYVAR JOINT COMMITTEE – 9<sup>th</sup> OCTOBER 2019****SITE MANAGER'S REPORT****1. Site Operational Update**

Between June and September approx. 220 tonnes of leachate per week was discharged to Cookstown Sewage Treatment Works. This is lower than normal for this time of year due to use of the sites Integrated Constructed Wetlands (ICW) which has reduced the need for tankering.

The electricity generation plant is currently operating at approx. 320kW (40% Capacity). This is much lower than normal, due to most of the wells in Cell 1 being temporarily disconnected to facilitate site capping works. The capping works were planned so as to disrupt the gas field as little as possible and the work has been phased to ensure a majority of the wells are reconnected as quickly as possible.

Mothballing works completed over the last few months include the preparation of the regulation layer on Cell 1 and excavations at the SW corner of the site to prepare for the installation of a drainage line from the base of Cell 4 to the settlement pond & discharge point. Further works to be completed over the next few months include regrading works which will prepare Cell 4 for either lining or restoration and also reduce erosion and eliminate any unsafe rock faces.

**2. Financial Matters**

Due to the streamlining of operations at Tullyvar the site no longer operates a separate financial system from Mid Ulster District Council. Previously, the site had its own accounting software and engaged the accountant Cavanagh Kelly to assist with the sites bookkeeping. However, for efficiency during the mothballed period the site now processes all orders / payments through the main Council software package. This means that going forward there will not be a set of payments presented under the Financial Matters section of the agenda and will instead be replaced with bi-annual management accounts. The first 6 months management accounts shall be presented at the next Joint Committee meeting in February along with the 2020/21 budget for approval.

**3. Landfill Tax Reclaim**

As agreed at the Joint Committee meeting on the 11<sup>th</sup> May 2016 the site has submitted claims with HMRC for the reclaim of Landfill Tax monies paid on material used in construction of the sites reverse fluff layer. The claim covers the period from July 2012 to March 2018 and currently totals approx. £3M. The claim will now join a number of other claims currently being managed by KPMG through the appeals process. The appeal to the Upper Tier Tribunal is to commence on the 18<sup>th</sup> November 2019 and Members will be kept apprised of the ruling once it has been published. A further fee of £10,000 is now due for payment to cover KPMG and legal fees associated with the case.

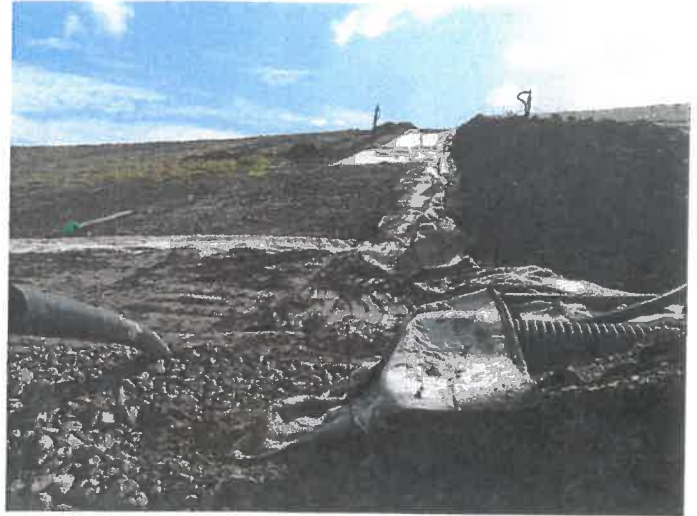
#### **4. Phase 4 Capping**

Works commenced in early October on the Phase 4 Capping of the site. The works consist of the installation of a composite capping system over an area of approximately 17,000m<sup>2</sup> of which approx. 10,500m<sup>2</sup> will be final capping and restoration and the remainder as an interim cap. The interim cap while serving a similar purpose to the final cap is designed to be cheaper to install, utilise leftover geotextiles from the previous capping operation while still being able to be upgraded to a permanent cap with minimal additional works should Cell 4 not be developed.

Works completed to date include the excavation of the anchor trenches to expose the existing site lining and capping systems, installation of a bund for stability and drainage purposes, the installation of a French drain adjacent to the existing wetlands and the laying of approx. 1,000m<sup>2</sup> of geotextiles and protection layer sub-soils. Progress has been hampered due to the wet weather over the previous few weeks limiting the work that can be done of the steep slopes.

Progress has also been made on the new groundwater drainage line which is being installed on the floor of the unlined Cell 4 to prevent flooding and reduce costs during the mothball and aftercare period. This line will take groundwater away from the floor of Cell 4 to the existing settlement pond before discharging into the adjacent Hadden's Burn, without the need for pumping. Approx. 1/2 of the drainage line is complete and 2 manholes have been installed.

The works were awarded to CivCo for a total price of £488,810.50 plus VAT and a 10% contingency. The first payment has been certified by the Council's consulting engineers, WDR & RT Taggart's, for the sum of £86,645.99 and covers some of the initial works and the supply and delivery of the geotextiles and drainage materials to site. CivCo are acting as main contractor but the majority of the works are being completed on site by their sub-contractor, Contract Ground Services. The standard of work completed to date has been good and, weather depending, the works are due for completion in March 2020. A selection of photos showing the work to date have been included overleaf.



Pictures showing the stripping back of restoration soils from existing cap to expose the GCL layer and then the application of GCL to Phase 4 with a 300mm overlap.



Pictures showing the drainage layer geocomposite placed over the top of recently laid GCL and the application of a 300mm deep layer of protection material.



Pictures showing the installation of drainage between the Phase 4 cap and the existing wetlands (left) and the drainage line / manholes from the unlined Cell 4 and the settlement pond / discharge point (right).





## TULLYVAR SOLAR FARM BUSINESS CASE



Comhairle Ceantair  
**Lár Uladh**  
**Mid Ulster**  
District Council

**16092 – Mid Ulster Consultancy Services**

Version 02 – June 2019

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**TULLYVAR SOLAR FARM BUSINESS CASE**

16092 – Mid Ulster Consultancy Services  
Version 02  
June 2019

**TITLE**      **Tullyvar Solar Farm Business Case****PROJECT**      16092 – Mid Ulster Consultancy Services**CLIENT**      Mid Ulster District Council**DATE**      June 2019**STATUS**      Final**VERSION**      02**AUTHOR**      A Thompson, D McGuigan**WDR & RT TAGGART****DOCUMENT CONTROL**

REVISION	DESCRIPTION	STATUS	DATE	BY	CHECKED	APPROVED
00	Draft	Draft	11/02/2019	DMG	AT	AT
01	Final	Final	16/03/2019	DMG	AT	AT
02	Final Report	Final	18/06/2019	DMG	AT	AT



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Appendix B	Financial Calculations
Appendix C	Solar Panel Technical Specification
Appendix D	Power Output Calculations







# 1 Introduction

An economic appraisal was undertaken in early 2019 for the viability of the development of a solar farm at Tullyvar Road, Aughnacloy, Co Tyrone, the site of a mothballed landfill. The appraisal was commissioned by Mid Ulster District Council (MUDC hereafter).

The scheme presents a unique opportunity whereby the 'spare' proportion of the grid capacity currently serving the landfill gas engine can be utilised.

## 1.1 Strategic Context

Renewable energy can be generated from a number of sources, including solar, biomass, wind, tidal and wave / hydro. With increased developments and innovation across the renewables industry, the UK can progressively lessen its dependency on fossil fuels as a form of generating electricity.

The Renewable Energy Directive has set an overall target for Europe to achieve 20% of the cumulative energy consumption via renewable sources by 2020, with the UK required to source 15% of its energy from renewable sources by the same date. A revised target for 2030 requires member states to achieve a cumulative 32%<sup>1</sup> energy consumption from renewable sources. Following the UK's departure from the European Union in March 2019, these targets are expected to be transposed into UK statute, although this is set to be confirmed within the withdrawal agreement.

A progress report published in 2017 indicates that the UK was at that point achieving approximately 9.3% of the 2020 15% target, signifying that the UK as a whole have an extra 5.7% of renewable energy consumption to achieve in order to successfully reach the target. Additional investment in the development of renewable energy sources is therefore essential in the UK's effort to reduce its reliance on fossil fuels.

This report considers the optimisation of the area available for a ground mounted solar array. The UK Solar PV Strategy Part 1: Roadmap to a Brighter Future (Department of Energy and Climate Change) recommends a density of 1MW over 2.4ha for ground mounted arrays. Based on a potentially suitable area of approximately 0.6ha, the maximum installed capacity would therefore be no greater than 250kW. Please refer to drawing 16092-14-001 for indicative suitable areas on which to install a solar array.

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<sup>1</sup> European Commission – Renewable energy: Moving towards a low carbon economy  
<https://ec.europa.eu/energy/en/topics/renewable-energy>



## 1.2 Case Study

### 1.2.1 Netley, Hampshire

UK based resource management company Veolia, has recently installed a solar farm at Netley Landfill in Southampton as part of their landfill restoration programme. Having worked in conjunction with specialist partners REG Power Management and Ethical Power, the solar farm at Netley Landfill can currently produce up to 5MW of electricity thus providing power for approximately 13,000 homes annually. Plans are in place to increase the generation capacity up to 12MW, providing power for an additional 18,500 homes. Mark Partridge of REG Power Management states:

*"This will contribute to both of our aspirations related to landfill after-care management, climate change and the circular economy."*<sup>2</sup>

Veolia is currently undertaking research into the viability of replicating the above across a number of other landfills and brownfield sites. This is alongside the work undertaken to improve biodiversity across numerous landfills via habitat creation and enhancement, and planting of flora to protect the UK's ecological heritage. This can be done on land that may otherwise be disregarded for the purpose of built development.

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<sup>2</sup> Veolia UK – Press Release  
<https://www.veolia.co.uk/press-releases/life-left-landfill>



## 2 Options Appraisal

### 2.1 Objectives

The key objective of this appraisal is to assess the economic viability of the deployment of a solar farm at Tullyvar Landfill.

### 2.2 Options

The options considered in the economic appraisal are outlined in Table 2.1 below:

**Table 2.1 Overview of Options**

Overview of Options	
1	Do Minimal – Retain situation as is, with a proportion of electricity generated from the existing landfill gas engine
2	Optimisation of suitable land available for the installation of a solar array

The 'Do Minimal' option assessed was consistent with HM Treasury Green Book Guidelines, providing an auditable base case against which other options may be evaluated.

In order to provide an assessment of the potential cost benefits in relation to the current conditions of electricity generation, the decline in landfill gas production was examined in relation to the point at which the performance of the engine will no longer be viable, whereby electricity will cease to be generated via this method.



## 3 Monetary Assessment

### 3.1 Introduction

The options outlined below are being assessed from a monetary perspective in order to ascertain the benefits of the scheme in the long run. Although the economic projections consider the economic cost and benefit of each option, they do not consider a quantifiable assessment of the non-monetary impacts of each option.

Table 3.1 below outlines the parameters applied to the considered options:

**Table 3.1 Options**

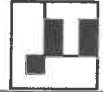
Option	Description
Option 1 – Do Nothing Approach	No further action taken at Tullyvar Landfill. The landfill gas engine will be used as a supplementary electricity source until the point at which the decline in landfill gas production results in the termination of electricity production from the engine. No additional costs are associated with this option other than those already existing.
Option 2 – Optimise Suitable Area for Installation of a Hybrid Solar Array	Area of approximately 0.6ha suitable for an array of installed capacity no greater than 250kW. Costs will account for PV panels, battery storage, inverters, ground mounting equipment and other associated infrastructure only. Using a hybrid solar system, energy output will be used to supplement the existing electricity sources utilised to power the site offices etc., with any surplus energy generated from the solar panels during the day stored in the batteries to allow use of this energy during periods of lesser sunshine or when the panels are not generating.

### 3.2 Assumptions

The current standard rate of electricity from the market leader is 16.82p/kWh. Data obtained from the Office for National Statistics indicates that over the past 25 years, the average increase in the price of electricity is approximately 3.9% per annum. Adopting the same trend over a further period of 25 years could potentially result in a price rate of 42.13p/kWh in 2043.

With regards to Option 2, the following parameters have been assumed:

- The costs are based on the provision of Intenergy solar panels installed in 2019;
- Panel size of a 250W module are 1,650mm x 995mm;



- Average efficiency of panel type is 18% based on manufacturer guidelines;
- Maximum power output calculated using photovoltaic software, including annual irradiation on tilted solar panels (see Appendix D);
- Power output drops approximately 1% per annum over a 25 year performance warranty;
- Costs associated with planning applications and labour / installation of Option 2 are not accounted for within the financial assessment; and
- Power required at Tullyvar Landfill falls by 15% in 2020 following the final capping and closure of the site.

### 3.3 Financial Assessment

#### 3.3.1 Option 1

With no additional costs associated with Option 1, the running costs are as per the existing arrangement with the landfill gas engine and standard rate for electricity supply. Forecasted costs for the supply of electricity at Tullyvar Landfill can be found in Appendix B.

#### 3.3.2 Option 2

Initial set up costs of Option 2 are much greater. The infrastructure required to implement an array of this scale would include 1,000nr 250W panels and frames, adjustable ground mounting kits, PV inverters, up to 300kWh battery storage and cables etc., the total cost of which would be approximately £400,000 excluding VAT. A typical technical specification for a 250W solar panel is included in Appendix C.

#### 3.3.3 Potential Savings

Recent utility bills indicate that the electricity consumption at Tullyvar Landfill is approximately 326,755kWh over the past 12 months. Based on the provision of 1,000nr 250W panels, the maximum power output was estimated to be within the region of 220,000kWh (Appendix D), decreasing by approximately 1% per annum to 175,000kWh by 2043 in keeping with the manufacturer's performance warranty. Units required after solar generation therefore increase at this rate, as the efficiency of the panels decrease. In line with the assumption that the level of power required at Tullyvar Landfill will fall by 15% in 2020, the solar panels could potentially contribute towards 78% of the electricity consumed at Tullyvar Landfill per annum.

Table 3.2 below indicates the potential savings over the next 25 years. Further details can be seen in Appendix B.



**Table 3.2 Forecast Annual Costs**

Year	Units Required	Rate (£/kWh)	Option 1 Costs	Power from Solar Generation	Units Required After Solar Generation	Option 2 Costs	Cost Difference
2019	326,755	0.1682	£54,960	221,636	105,119	£17,680	£37,280
2020	326,755	0.1748	£57,105	219,420	107,335	£18,760	£38,345
2021	277,742	0.1816	£50,430	217,226	60,516	£10,990	£39,440
2022	277,742	0.1887	£52,400	215,053	62,688	£11,825	£40,575
2023	277,742	0.1960	£54,440	212,903	64,839	£12,710	£41,730
2024	277,742	0.2037	£56,665	210,774	66,968	£13,640	£42,925
2025	277,742	0.2116	£58,770	208,666	69,076	£14,615	£44,155
2026	277,742	0.2199	£61,065	206,579	71,162	£15,645	£45,420
2027	277,742	0.2284	£63,445	204,514	73,228	£16,725	£46,720
2028	277,742	0.2373	£65,920	202,469	75,273	£17,865	£48,055
2029	277,742	0.2466	£68,490	200,444	77,298	£19,060	£49,430
2030	277,742	0.2562	£71,160	198,439	79,302	£20,320	£50,840
2031	277,742	0.2662	£73,935	196,455	81,287	£21,640	£52,295
2032	277,742	0.2766	£76,820	194,490	83,251	£23,025	£53,795
2033	277,742	0.2874	£79,815	192,546	85,196	£24,485	£55,330
2034	277,742	0.2986	£82,930	190,620	87,122	£26,015	£56,915
2035	277,742	0.3102	£86,160	188,714	89,028	£27,620	£58,540

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Year	Units Required	Rate (£/kWh)	Option 1 Costs	Power from Solar Generation	Units Required After Solar Generation	Option 2 Costs	Cost Difference
2036	277,742	0.3223	£89,520	186,827	90,915	£29,305	£60,215
2037	277,742	0.3349	£93,015	184,959	92,783	£31,070	£61,945
2038	277,742	0.3480	£96,640	183,109	94,633	£32,930	£63,710
2039	277,742	0.3615	£100,410	181,278	96,464	£34,875	£65,535
2040	277,742	0.3756	£104,325	179,465	98,277	£36,915	£67,410
2041	277,742	0.3903	£108,395	177,670	100,071	£39,055	£69,430
2042	277,742	0.4055	£112,620	175,894	101,848	£41,300	£71,320
2043	277,742	0.4213	£117,015	174,135	103,607	£43,650	£73,365

The cumulative costs of the price difference between Option 1 and Option 2, indicate that a payback term of approximately 10 years can be expected. Over the course of a 25 life span of the solar panels, MUDC could potentially save in the region of £1million. It is considered that a payback period of 10 years would not represent an overly attractive investment.

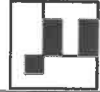


## 4 Non-Monetary Considerations

The installation of a solar array at Tullyvar Landfill could be associated with a number of non-monetary benefits on top of the potential economic factors, namely the following:

- The renewable energy source would aid MUDC's efforts in moving towards a more energy self-sufficient site and contributing towards the targets set under the Renewable Energy Directive;
- Increased self-sufficiency reduces the MUDC's dependency on fossil fuels as a source of energy, therefore contributing to an improved attitude towards climate change and more sustainable ethos;
- Environmentally conscious decision to utilise what would otherwise be a brownfield site; and
- Logistical ease of utilising existing connection to the national grid on site.





## 5 Conclusion

The report considers the development of a solar farm array at Tullyvar Landfill in relation to the potential economic and non-monetary benefits.

Although Option 1 involves zero capital expenditure, the long term energy costs will continue to rise with the industry supply rate increasing with inflation. As a result, there are little to no long term cost savings with regards to Option 1.

The forecast economic benefits outlined in Section 3 above, indicate that the maximum power output of a 250kW array results in a capex return period of approximately 10 years, with an average annual saving in electricity generation requirements of approximately 70% thereafter. Option 2 therefore presents a more energy self-sufficient option during the aftercare period of Tullyvar Landfill. In the long term, Option 2 therefore provides the greatest return in terms of potential cost savings. Over the 25 year life span, the cost savings are in the region of £1million. It is considered that a payback period of 10 years would not represent an overly attractive investment.

It should be noted that capacity for uncontrolled electricity generation and export to the NIE network is now limited and it is difficult to get new grid connections for export of electricity. Therefore, the large export capacity that exists through the current Tullyvar grid connection is a significant asset.



Given the value of the existing grid connection at Tullyvar Landfill, it is advisable that further research is conducted into the viability of implementing alternative renewable applications, including but not limited to: importing biogas for use in the existing gas engine, wind turbines, or an anaerobic digestion plant which has the option to be fed with organic matter collected from MUDC local authority municipal waste collections.

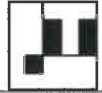


# **Appendix A**

## **Drawings**



<b>KEY:</b>				
		Indicative Solar Panel Area		
Rev/No.	AMENDMENT DETAILS	BY	DATE	
CLIENT -				
Mid Ulster District Council				
DRAWING				
Indicative Areas for Solar Panels				
CONTRACT				
Tullyvar Solar Farm Business Case				
SHEET	DATE	SCALE	DRAWN	CHECKED
A3	11.02.2019	1:2000	DMG	AT
DRG No.				Rev.
16092-14-001				-
Lagonwood House Newforge Lane Malone Road Belfast, BT9 5NX Tel 028 9066 2121 Fax 028 9066 3162 email <a href="mailto:info@wdr-rt-taggart.com">info@wdr-rt-taggart.com</a>				 <b>WDR &amp; RT TAGGART</b>
Architects		Landscape Architects		
Civil Engineers		Town Planning Consultants		
Structural Engineers		Planning Supervisors		
Environmental Engineers		Project Managers		



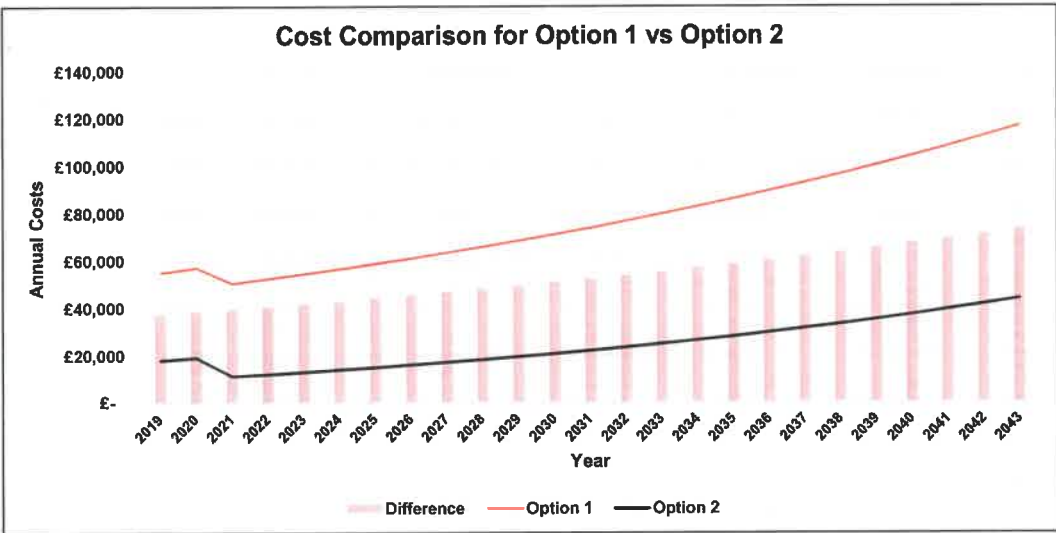
## **Appendix B**

### **Financial Calculations**

\*Solar Installed in 2019

	Units Required	**Units Decrease	Solar Generation	Units Required (After Solar)	£ / kWh	Avg Yearly % Increase	Option 2	Option 1	Cost Difference
							Avg Annual Cost After Solar Installation	Avg Annual Cost (If No Solar In Place)	
*2019	326,755	0%	221,636	105,119	0.1682	3.9%	£ 17,680	£ 54,960	£ 37,280
2020	326,755	15%	219,420	107,335	0.1748	3.6%	£ 18,760	£ 57,105	£ 38,345
2021	277,742	0%	217,226	60,516	0.1816	3.9%	£ 10,990	£ 50,430	£ 39,440
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2023	277,742	0%	212,903	64,839	0.1960	3.9%	£ 12,710	£ 54,440	£ 41,730
2024	277,742	0%	210,774	66,968	0.2037	3.9%	£ 13,640	£ 56,565	£ 42,925
2025	277,742	0%	208,666	69,076	0.2116	3.9%	£ 14,615	£ 58,770	£ 44,155
2026	277,742	0%	206,579	71,162	0.2199	3.9%	£ 15,645	£ 61,065	£ 45,420
2027	277,742	0%	204,514	73,228	0.2284	3.9%	£ 16,725	£ 63,445	£ 46,720
2028	277,742	0%	202,469	75,273	0.2373	3.9%	£ 17,865	£ 65,920	£ 48,055
2029	277,742	0%	200,444	77,298	0.2466	3.9%	£ 19,060	£ 68,490	£ 49,430
2030	277,742	0%	198,439	79,302	0.2562	3.9%	£ 20,320	£ 71,160	£ 50,840
2031	277,742	0%	196,455	81,287	0.2662	3.9%	£ 21,640	£ 73,935	£ 52,295
2032	277,742	0%	194,490	83,251	0.2768	3.9%	£ 23,025	£ 76,820	£ 53,795
2033	277,742	0%	192,546	85,196	0.2874	3.9%	£ 24,485	£ 79,815	£ 55,330
2034	277,742	0%	190,620	87,122	0.2988	3.9%	£ 26,015	£ 82,930	£ 56,915
2035	277,742	0%	188,714	89,028	0.3102	3.9%	£ 27,620	£ 86,160	£ 58,540
2036	277,742	0%	186,827	90,915	0.3223	3.9%	£ 29,305	£ 89,520	£ 60,215
2037	277,742	0%	184,959	92,783	0.3349	3.9%	£ 31,070	£ 93,015	£ 61,945
2038	277,742	0%	183,109	94,633	0.3480	3.9%	£ 32,930	£ 96,640	£ 63,710
2039	277,742	0%	181,278	96,464	0.3615	3.9%	£ 34,875	£ 100,410	£ 65,535
2040	277,742	0%	179,465	98,277	0.3758	3.9%	£ 36,915	£ 104,325	£ 67,410
2041	277,742	0%	177,670	100,071	0.3903	3.9%	£ 39,055	£ 108,395	£ 69,340
2042	277,742	0%	175,894	101,848	0.4055	3.9%	£ 41,300	£ 112,620	£ 71,320
2043	277,742	0%	174,135	103,607	0.4213	3.9%	£ 43,650	£ 117,015	£ 73,365

\*\*Based on assumption that activity will decrease following capping / site closure





## **Appendix C**

### **Solar Panel Technical Specification**

# Intenergy

## Classic Series

### INE-250MB-60

### Eclipse Black

*Monocrystalline Silicon Solar Module*

## Eclipse Black

The Eclipse Black is the only true TRIPLE BLACK module in the market.

UNIQUE

- ✓ Module efficiency 15.82%
  - ✓ Cell efficiency 18.3%
  - ✓ Positive output tolerance of  $-0/+3\%$
  - ✓ 1.8m cable for easy landscape installation
  - ✓ Concealed busbars and solder, offer a uniform, sleek finish
  - ✓ Low-iron tempered glass & high quality EVA and TPT
  - ✓ Integrated bypass diodes to protect the solar cell circuit from hot-spots during partial shading
  - ✓ Anodized aluminium frame improves load resistance capabilities for heavy wind loads
  - ✓ IEC61730 safety rated for high wind pressure, hail impact, snow load and fire, certified against salt mist corrosion
- 12** year manufacturing guarantee  
**12** year performance warranty of 90% of original power output  
**25** year performance warranty of 80% of original output



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# Intenergy

Manufactured by  
**PERLIGHT SOLAR**



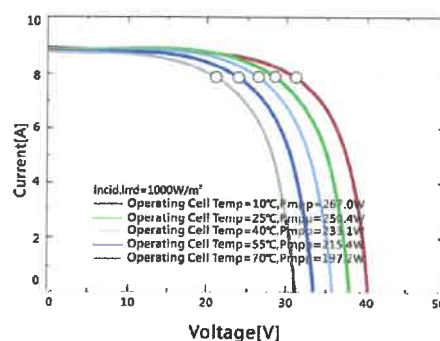
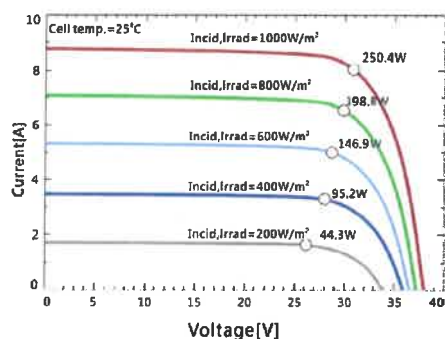
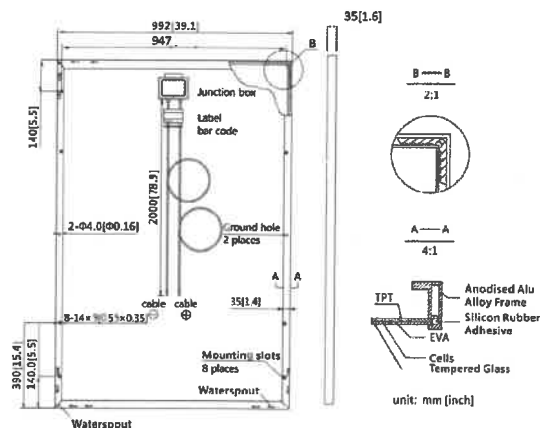
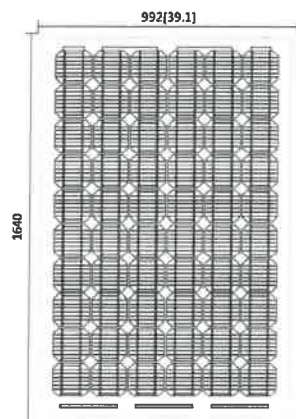
# Intenergy

## Classic Series

### INE-250MB-60

### Eclipse Black

Molycrystalline Silicon Solar Module



Model	INE-ECLIPSE 250MB-60	INE- 250MB-60	INE-250M-60
Pm	250W	250W	250W
Vmp	30.49	30.49	30.49
Imp	8.20	8.20	8.20
Voc	38.00	38.00	38.00
Isc	8.78	8.78	8.78
Max. system voltage	1000V DC	1000V DC	1000V DC

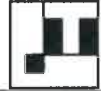
NOCT	45°C±2°C
Isc	0.06%/°C
Voc	-0.34%/°C
Pmax	-0.45%/°C
Power Tolerance	-0/+3%
Working Temperature	-40°C to 85°C

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# Intenergy

Manufactured by  
**PERLIGHT SOLAR**



## **Appendix D**

### **Power Output Calculations**

## Calculation of the solar PV energy output of a photovoltaic system

	Yellow cell = enter your own data
	Green cell = result (do not change the value)
	White cell = calculated value (do not change the value)

Global formula :  $E = A * r * H * PR$

E = Energy (kWh)	221502	kWh/an
A = Total solar panel Area (m²)	1641.75	m²
r = solar panel yield (%)	18%	
H = Annual average irradiation on tilted panels (shadings not included)*	1000	kWh/m².an
PR = Performance ratio, coefficient for losses (range between 0.9 and 0.5, default value = 0.75)	0.75	

Total power of the system 295.5 kWp

Losses details (depend of site, technology, and sizing of the system)

- Inverter losses (6% to 15 %)
- Température losses (5% to 15%)
- DC cables losses (1 to 3 %)
- AC cables losses (1 to 3 %)
- Shadings 0 % to 40% (depends of site)
- Losses weak irradiation 3% yo 7%
- Losses due to dust, snow... (2%)
- Other Losses

	8%
	8%
	2%
	2%
	3%
	3%
	2%
	0%

\*You can find this value on the map below or here : [solar radiation data](#)

You have to find the global annual irradiation incident on your PV panels with your specific inclination (slope, tilt) and orientation (azimut).

More info

Source : [www.photovoltaic-software.com](http://www.photovoltaic-software.com)

Yearly sum of global irradiance

