Open Networks Project

Charging Scenarios

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Charging Scenarios Executive Summary

Parties connecting to distribution and transmission networks are generally liable for charges to recover the costs of those assets and also the services associated with operating those networks. Whilst having aligned objectives, transmission and distribution charging methodologies have developed separately. Further at a distribution level there exist differing methodologies for parties connected at different voltage levels.

The root cause analysis contained in this paper specifically looks at whether differences in the charging arrangements between transmission and distribution and within distribution between the EDCM and CDCM, influence customers' economic decisions on where and how to connect to the electricity system. It does not consider other wider network charging issues.

Most decisions on where or how to connect are technical involving an appropriate and practical electrical solution that matches the size of the connection to the voltage level. This technical appropriateness will override most economic decisions.

Where there are technical choices economic differences in charging methodologies may exist and there is then the potential for unintended consequences with parties potentially receiving signals to connect, in a potentially inefficient manner, to a specific network. These inefficiencies can be realised through a higher cost solution being developed and these costs may be borne by the end consumer rather than the connecting customer. Further these areas may become a blocker to efficient co-ordinated development of networks.

The ENA Open Networks Charging workstream has considered a number of areas where such potential differences in treatment may exist. It has developed a range of illustrative scenarios (Appendix 1) to understand the potential difference and areas for potential improvement. These are:

- **Generation specific scenarios** considering parties whose primary purpose is to generate electricity for export on to the electricity transmission and/or distribution systems;
- **Demand specific scenarios** investigating connections importing electricity on to either the electricity transmission or distribution systems; and
- **Storage specific scenarios** looking at connections where batteries or other forms of storage have the ability to store energy for use at a later time when it's needed.

It is recognised that network charging arrangements are a complex subject and that there are many intricacies within both transmission and distribution methodologies. A list of the assumptions made can be found in Appendix 2 of this paper.

Conclusions

The analysis has mainly focused on the first order impact on the charge payer. However lower charges for parties may not provide the optimum efficient solution. Rather this may mean that the others, including the end consumer, are paying a higher proportion of the costs of investment.

The main conclusions drawn are:

- Ofgem's recent determination of CUSC proposals to reduce embedded benefits has reduced the difference between transmission and distribution arrangements. However there remains an incentive for generation parties to connect to distribution networks. Often there is a trade-off between a higher upfront cost and the enduring Use of System liability. A sizeable factor in this is the impact of Balancing Services Use of System (BSUoS) charge recovery.

- Licensable generation connected within a distribution network is liable for both transmission and distribution charges which may discourage such development.
- Parties connecting at HV in Scotland can face charges for relevant transmission reinforcements at 132kV.
- Parties wishing to connect at 132kV face lower charges when the network is a distribution network (as is the case onshore in England & Wales).
- Discounts available for smaller 132kV transmission connected generators help reduce differences but create discrepancies between parties with capacities above and below the 100MW threshold.
- There is less of a difference between transmission and distribution treatment of demand however there is less signal provided to transmission connected parties to reflect the difference in cost between single and double circuit connections.
- EDCM DUoS export charges are calculated at a local level which may result in generation charges or credits dependent upon site specific circumstances. Whereas CDCM DUoS export charges are based on a demand based charging model and the average costs applied will always result in generation credits (which are strongest for non-intermittent units) irrespective of specific network benefit.
- This work is focused on the cost signals for parties seeking to connect. Any future analysis should cover the impact on wider consumers and not simply the connecting party.

Recommendations

- These results and conclusions should be shared with the Open Networks Advisory Group at their July meeting for comment.
- This work should then be fed into Ofgem's proposed Charging Co-ordination Group (CCG) as it will be of benefit to other areas of work including the EDCM/CDCM review, Ofgem's Targeted Charging Review and the National Grid review.
- The Charging Workstream recommends that further analysis of these scenarios and their wider impact is paused pending feedback from the Advisory Group and the CCG. The Charging Workstream will review feedback provided by the CCG and present recommendations on further work to the Steering Group.

Appendix 1 – Illustrative Charging Scenarios

Generation Specific Scenarios

1. 30MW Intermittent Generation

This example seeks to demonstrate the differing network charges faced by a 30MW generation project which could connect to either distribution or transmission networks in England & Wales or Scotland. Examples provided for:

- 33kV Distribution connection in Scotland
- 132kV Transmission connection in Scotland via 33 kV transmission circuit including transformation.
- 33kV Distribution connection in England & Wales
- 275kV Transmission connection in England & Wales via 33 kV transmission circuit including transformation

	Comparison of 30MW Generators (Transmission and Distribution, and Scotland and England &Wales)							
	30MW Distribution Connection (33kV Scotland) Intermittent Generation		30MW Transmission Connection (132kV Scotland) Intermittent Generation		30MW Distribution Connection (33kV E&W) Intermittent Generation		30MW Transmission Connection (E&W) Intermittent Generation	
Connection Charges	Upfront charge	Annual charge	Upfront charge	Annual charge	Upfront charge	Annual charge	Upfront charge	Annual charge
Distribution Connection Charge	£3,450,000				£3,450,000			
T Connection charges (sole use)			£3,000,000					
Generator owned assets (indicative costs)							£3,000,000	
Total Associated Connection Charge	**£3,450,000**	**£0**	**£3,000,000**	**£0**	**£3,450,000**	**£0**	**£3,000,000**	**£0**
Distribution UoS Charges								
Total Import Charge		£1,000				£1,000		
Total Export Charge		£100,000				£40,000		
Total DUoS Charges		**£101,000**		**£0**		**£41,000**		**£0**
Transmission UoS Charges								
TNUoS (Wind)		£0		£250,000		-£40,000		-£50,000
Locational		£0		£650,000		-£20,000		£0
Non- Locational		£0		-£50,000		-£20,000		-£50,000
Small Gen Discount				-£350,000				
BSUoS (Wind)		-£200,000		£200,000		-£200,000		£200,000
Total T UoS		**-£200,000**		**£450,000**		**-£240,000**		**£150,000**
TNUoS (CHP)		£0		£350,000		-£100,000		-£20,000
Locational		£0		£750,000		-£50,000		£30,000
Non-Locational		£0		-£50,000		-£50,000		-£50,000
Small Gen Discount				-£350,000				
BSUoS (CHP)		-£200,000		£200,000		-£200,000		£200,000
Total T UoS		**-£200,000**		**£550,000**		**-£300,000**		**£180,000**

	30MW D Connection (33kV Scotland) Intermittent Generation		30MW T Connection (132kV Scotland)		30MW D Connection (33kV E&W) Intermittent Generation		30MW T Connection (E&W) Intermittent Generation	
	Capital Charge	Annual Charge	Capital Charge	Annual Charge	Capital Charge	Annual Charge	Capital Charge	Annual Charge
Total Wind	**£3,450,000**	**-£99,000**	**£3,000,000**	**£450,000**	**£3,450,000**	**-£199,000**	**£3,000,000**	**£150,000**

Connection Cost Assumptions

- At Transmission (Scotland): As a smaller intermittent generator it is assumed that the 33kV circuit and associated 33/132kV transformer, connecting the generator to the main transmission system, are categorised as connection assets. Connection assets are paid for in full by the connecting party.
- At Transmission (England & Wales): As a smaller intermittent generator it is assumed that the 33kV circuit connecting the generator to the main transmission system is categorised as a customer owned asset. The 33/275kV transformer is classified as a connection asset. As above, connection assets are paid for in full by the connecting party.
- At Distribution (both Scotland and England & Wales) customers will pay for the 33kV extension assets connecting the generator to the distribution system. The cost of reinforcement assets is paid by the customer on an apportionment basis, based on the calculation contained in the common connection charging methodology (Required Capacity/New Network Capacity x100%). In this example, the total cost of the reinforcement assets is £2m and the new network capacity 50MW. Accordingly, the customer is only liable

to pay £1.2m (30/50 x £2m). For a similar £2m reinforcement at Transmission, the reinforcement costs would be socialised across the wider customer base.

Transmission Charging Assumptions (TNUoS and BSUoS)

- The variation in TNUoS charges in the transmission connected example is due to the locational element.
- These scenarios also show the impact of the Ofgem's recent determination of CMP 264&265.
- BSUoS based on an average annual load factor for wind.

Distribution Use of System (DUoS) Charging Assumptions

- The import charges reflect a relatively small agreed capacity (as is typical for most intermittent generators) for start-up purposes.
- The export charges reflect the differences between DNO areas in respect of income recovery.
- There are no locational credits as this is an intermittent generator.

Conclusions

Even accounting for the recent Ofgem decision on TNUoS embedded benefits (CUSC modification proposal CMP 264/265) there is still a difference between the ongoing annual charges between Transmission and Distribution in this example. Further conclusions are shown below.

Description of scenarios	**Charges impact on customer**	**Cost Signals to Customer**	**Cause of issue?**
D connection Scotland vs E&W	Annual charges lower in E&W	Slight incentive to connect in E&W	Regional differences in both TNUoS & D charges
T Connection Scotland vs E&W	Annual charges lower in E&W	Incentive to connect in E&W	Regional differences in TNUoS
Scotland, D connection vs T connection	Overall network charges are lower for D connection rather than T.	Incentivises for connection to D rather than to T	Lower level of annual network costs paid by D connected generation than T connected generation (including system operation)
E&W, D connection vs T connection	Overall network charges are lower for D connection rather than T.	Incentivises for connection to D rather than to T	Lower level of annual network costs paid by D connected generation than T connected generation (including system operation)

2. 99 & 100MW Intermittent Generation

Licensable generators (generally of capacity greater than 100MW) are liable for transmission charges whether they connect to distribution or transmission networks. This example seeks to explore the impact of a capacity change from 99MW to 100MW on an intermittent generator's network charge liability. Examples provided are:

- 99MW (132kV) Transmission connection in Scotland
- 99MW (132kV) Distribution licence exempt connection in England & Wales
- 100MW (132kV) Transmission connection in Scotland
- 100MW (132kV) Distribution licensable connection in England & Wales

	Comparison of 99MW and 100MW Generators							
	99MW T Connection (132kV Scotland) Intermittent Generation		99MW D Connection (132kV E&W) Intermittent Generation		100MW T Connection (132KV Scotland) Intermittent Generation		100MW D Connection (132kV E&W) Intermittent Generation	
Connection Charges	**Upfront charge**	**Annual charge**	**Upfront charge**	**Annual charge**	**Upfront charge**	**Annual charge**	**Upfront charge**	**Annual charge**
Distribution Connection Charge			£9,700,000				£9,700,000	
T Connection charges (sole use)	£2,000,000				£2,000,000			
Generator owned assets (indicative costs)								
Total Associated Connection Charge	**£2,000,000**	**£0**	**£9,700,000**	**£0**	**£2,000,000**	**£0**	**£9,700,000**	**£0**
Distribution UoS Charges								
Total Import Charge				**£1,000**				**£1,000**
Total Export Charge				**£100,000**				**£100,000**
Total DUoS Charges		**£0**		**£101,000**		**£0**		**£101,000**
Transmission UoS Charges								
TNUoS (Wind)		£800,000		-£150,000		£1,950,000		£1,600,000
Locational		£2,100,000		-£70,000		£2,150,000		£1,800,000
Non-Locational		-£200,000		-£80,000		-£200,000		-£200,000
Small Gen Discount		-£1,100,000						
BSUoS (Wind)		£650,000		-£650,000		£650,000		£650,000
Total T UoS		**£1,450,000**		**-£800,000**		**£2,600,000**		**£2,250,000**

	99MW T Connection (132kV Scotland) Intermittent Generation		99MW D Connection (132kV E&W) Intermittent Generation		100MW T Connection (132KV Scotland) Intermittent Generation		100MW D Connection (132kV E&W) Intermittent Generation	
	Capital Charge	Annual Charge	Capital Charge	Annual Charge	Capital Charge	Annual Charge	Capital Charge	Annual Charge
Total Wind	**£2,000,000**	**£1,450,000**	**£9,700,000**	**-£699,000**	**£2,000,000**	**£2,600,000**	**£9,700,000**	**£2,351,000**

Connection Cost Assumptions

- At Transmission (Scotland): the 132kV bay at the windfarm site is classified as connection assets and will be paid for in full by the connecting party. The 132kV circuit connecting the generator to the main transmission system and associated works at the GSP are all treated as infrastructure assets and will be recovered through TNUoS charges.
- At Distribution (England & Wales): all of the 132kV assets to be installed for the generator are treated as extension assets and will be paid for in full by the connecting party.

Transmission Charging Assumptions (TNUoS and BSUoS)

- The variation in TNUoS charges in the transmission connected example is due to the locational element.
- These scenarios also show the impact of the Ofgem's recent determination of CMP 264&265.
- BSUoS remains constant in both scenarios.
- Generators connected to the transmission system with a commercial capacity (TEC) of less than 100MW are eligible for a discount on their TNUoS. This is referred to as the 'small generator's discount'.

Distribution Use of System (DUoS) Charging Assumptions

- The import charges reflect a relatively small agreed capacity (as is typical for most generators) for start-up purposes.

- The export charges reflect the differences between the 99 and 100MW capacities. There are no locational credits as this is an intermittent generator.

Conclusions

The classification of licensable generation provides an incentive for developers to build generators with capacity less than 100MW and potentially to connect to distribution networks. The difference in classification of 132kV networks in GB could lead to unintended signals as to location for projects. Further detail is provided in the table below.

Description of scenarios	**Charges impact on customer**	**Cost Signals to Customer**	**Cause of issue?**
99MW 132kV, T connection in Scotland vs D connection in E&W	E&W D connection face larger upfront charge, however have lower ongoing liability for use of system charges	Longer-term Incentive for D connection in E&W rather than T in Scotland	Transmission boundary difference between Scotland and E&W and licensing arrangements
100MW 132kV, T connection in Scotland vs D connection in E&W	E&W D connection face larger upfront charge, and have similar ongoing charge liabilities	Incentivises T connection in Scotland	D connection in E&W liable for both transmission and distribution Use of System charges
Scotland 132kV T connection, 99MW vs 100MW	99MW generator has lower TNUoS liability due to small generator discount.	Incentivises connection under 100MW	Small gens discount
E&W 132kV D connection, 99MW vs 100MW	Difference in TNUoS & BSUoS liability	Incentivises connection under 100MW	Licensable generation classification

3. 1GW Non-Intermittent Generation

This example seeks to understand the network charges faced by a generator with a portfolio of smaller units with an equivalently sized larger transmission connected unit. Examples provided are:

- 33x30MW (33kV) Distribution connections in England & Wales
- 1x1GW (400kV) Transmission connection in England & Wales

	Comparison of 33x30MW and 1x1GW			
	33x30MW D Connections (33kV E&W SSE) Non-Intermittent Generation		1x1GW T Connection (400kV E&W SSE) Non-Intermittent Generation	
Connection Charges	**Upfront charge**	**Annual charge**	**Upfront charge**	**Annual charge**
Distribution Connection Charge	£113,850,000			
T Connection charges (sole use)				
Generator owned assets (indicative costs)			£40,000,000	
Total Associated Connection Charge	**£113,850,000**	**£0**	**£40,000,000**	**£0**
Distribution UoS Charges				
Total Import Charge		**£30,000**		
Total Export Charge		**-£3,050,000**		
Total DUoS Charges		**-£3,020,000**		**£0**
TNUoS (CHP)		-£6,250,000		-£3,950,000
Locational		-£4,800,000		-£2,300,000
Non-Locational		-£1,450,000		-£1,650,000
BSUoS (CHP)		-£7,350,000		£7,350,000
Total T UoS		**-£13,600,000**		**£3,400,000**

	33x30MW D Connections (33kV E&W SSE) Non-Intermittent Generation		1x1GW T Connection (400kV E&W SSE) Non-Intermittent Generation	
	Capital Charge	Annual Charge	Capital Charge	Annual Charge
Total CHP	**£113,850,000**	**-£16,620,000**	**£40,000,000**	**£3,400,000**

Connection Cost Assumptions

- It is assumed that the transmission connected project would have zero connection charges and would self-build and own its connection into the transmission network. These costs are included for full comparison.
- The upfront connection charges at distribution are reflective of the significant extension assets that are required to be installed and paid for by the developer seeking connections of multiple generator sites.

Transmission Charging Assumptions (TNUoS and BSUoS)

- The variation in TNUoS charges in the transmission connected example is due to the locational element.
- These scenarios also show the impact of the Ofgem's recent determination of CMP 264&265.

Distribution Use of System Charging Assumptions (DUoS)

- The import charges reflect a relatively small agreed capacity for start-up purposes.
- The export charges reflect the locational credits.

Conclusions

It can be seen that there are significantly higher connections costs for this arrangement at Distribution level where at Transmission, even though the connections cost are not as high, the ongoing annual charges are much higher for TNUoS whereas at DUoS is showing credits (this is best case scenario where all generators receive credits which may not always be the case).

Description of scenarios	**Charges impact on customer**	**Cost Signals to Customer**	**Cause of issue?**
Distributed portfolio v larger transmission connected project	Higher upfront charge faced by D projects though may have overall advantage across life of project	Incentive for distributed portfolio overall (although balanced to a degree by initial investment)	Difference in charging methodologies

4. 10MW Intermittent Generation ('one voltage rule')

This example is aiming to show the potential impact of the difference in the transmission boundary between Scotland and E&W (132kV is a transmission voltage in Scotland and a distribution voltage in E&W) on distribution connections at 11kV. Examples provided are:

- 11kV Distribution connection in Scotland triggering 132kV Transmission reinforcement
- 11kV Distribution connection in England & Wales triggering 132kV Distribution reinforcement

	Comparison of 11kV triggering 132KV reinforcements in Scotland and E&W			
	10MW D Connection (11kV Scotland triggering 132KV T reinforcement) Intermittent Generation		10MW D Connection (11KV E&W triggering 132kV D reinforcement) Intermittent Generation	
Connection Charges	**Upfront charge**	**Annual charge**	**Upfront charge**	**Annual charge**
Distribution Connection Charge	£1,000,000		£1,000,000	
T Connection charges (sole use)	£700,000			
Generator owned assets (indicative costs)				
Total Associated Connection Charge	**£1,700,000**	**£0**	**£1,000,000**	**£0**
Distribution UoS Charges				
Total Import Charge		**£1,000**		**£1,000**
Total Export Charge		**-£200,000**		**-£200,000**
Total DUoS Charges		**-£199,000**		**-£199,000**
Transmission UoS Charges				
TNUoS (Wind)		£0		-£10,000
Locational		£0		-£4,000
Non-Locational		£0		-£6,000
BSUoS (Wind)		-£200,000		-£200,000
Total T UoS		**-£200,000**		**-£210,000**

	10MW D Connection (11kV Scotland triggering 132KV T reinforcement) Intermittent Generation		10MW D Connection (11KV E&W triggering 132kV D reinforcement) Intermittent Generation	
	Capital Charge	Annual Charge	Capital Charge	Annual Charge
Total Wind	**£1,700,000**	**-£399,000**	**£1,000,000**	**-£409,000**

Connection Cost Assumptions

- The 'one voltage rule' is contained within the distribution common connection charging methodology. This states that the DNO will fully fund reinforcement carried out greater than one voltages level above the voltage at the point of connection to the existing distribution system.
- The point of connection associated with the generator is at 11kV. In both examples the generator connection triggers upgrades on the 132kV system.
- In Scotland the cost of the 132kV transmission system reinforcement are directly chargeable to the DNO. The one voltage rule does not apply to transmission assets. The DNO will therefore pass these costs directly to the generator as part of its connection charge.
- For an 11kV connection in E&W, the one voltage rule will apply as a result of 132kV being designated as a distribution voltage. Accordingly, the costs of the 132kV distribution system reinforcement will be borne by the DNO/DUoS customers.

Transmission Charging Assumptions (TNUoS and BSUoS)

- The variation in TNUoS charges in the transmission connected example is due to the locational element.
- These scenarios also show the impact of the Ofgem's recent determination of CMP 264&265.

Distribution Use of System Charging Assumptions (DUoS)

- The import charges reflect a relatively small agreed capacity for start-up purposes.
- The export charges are based on CDCM average tariffs and will therefore always be credits under the current methodology.
- Difference in tariffs between Scotland and England and Wales reflect different costs in DNOS areas.

Conclusions

The 'one voltage' rule disadvantages projects connecting in Scotland which impact 132kV reinforcement. Conversely if these costs are triggered by these parties in E&W also, is it right that they are recovered from other customers on a socialised basis?

Description of scenarios	Charges impact on customer	Cost Signals to Customer	Cause of issue?
10MW D 11kV connection triggering 132kV reinforcement, Scotland vs E&W	The Scotland example need to contribute to 132kV reinforcement, but not required for E&W example. In E&W these costs are picked up on a socialised basis by consumers	More beneficial for a generator to connect in E&W	The one voltage rule causing different impact on Scotland and E&W due to difference in transmission boundary

Demand Specific Scenarios

This scenario aims to show the impact of the requirement for additional security of supply by a demand customer requesting a double circuit connection at 132kV. Double circuit tends to be the norm for demand connections. Examples include:

1. 30MW Demand (single versus double circuit connection)

- 132kV Transmission single-circuit connection in Scotland
- 132kV Transmission double-circuit connection in Scotland
- 132kV Distribution single-circuit connection in England & Wales
- 132kV Distribution double-circuit connection in England & Wales

	Comparison of 30MW Demand Connections							
	30MW T Connection (132kV Scotland) Demand - single circuit		30MW D Connection (132kV E&W) Demand - single circuit		30MW T Connection (132kV Scotland) Demand - double circuit		30MW D Connection (132kV E&W) Demand - double circuit	
Connection Charges	**Upfront charge**	**Annual charge**	**Upfront charge**	**Annual charge**	**Upfront charge**	**Annual charge**	**Upfront charge**	**Annual charge**
Distribution Connection Charge			£4,450,000				£6,250,000	
T Connection charges (sole use)	£1,400,000				£2,100,000			
Generator owned assets (indicative costs)								
Total Associated Connection Charge	**£1,400,000**	**£0**	**£4,450,000**	**£0**	**£2,100,000**	**£0**	**£6,250,000**	**£0**
Distribution UoS Charges								
Total Import Charge				**£270,000**				**£290,000**
Total Export Charge				**£0**				**£0**
Total DUoS Charges		**£0**		**£270,000**		**£0**		**£290,000**
Transmission UoS Charges								
TNUoS		£650,000		£800,000		£650,000		£800,000
Locational		-£100,000		£50,000		-£100,000		£50,000
Non-Locational		£750,000		£750,000		£750,000		£750,000
BSUoS		£150,000		£150,000		£150,000		£150,000
Total T UoS		**£800,000**		**£950,000**		**£800,000**		**£950,000**

	30MW T Connection (132kV Scotland) Demand - single circuit		30MW D Connection (132kV E&W) Demand - single circuit		30MW T Connection (132KV Scotland) Demand - double circuit		30MW D Connection (132kV E&W) Demand - double circuit	
	Capital Charge	Annual Charge	Capital Charge	Annual Charge	Capital Charge	Annual Charge	Capital Charge	Annual Charge
Total Charge	**£1,400,000**	**£800,000**	**£4,450,000**	**£1,220,000**	**£2,100,000**	**£800,000**	**£6,250,000**	**£1,240,000**

Connection Cost Assumptions

- At 132kV Transmission: connection charges apply only to sole use assets. It is assumed that the connecting circuit is infrastructure and therefore costs are recovered through TNUoS.
- At 132kV Distribution: the customer will pay for the full cost of the extension assets associated with both the single circuit and double circuit connection options.

Transmission Charging Assumptions (TNUoS and BSUoS)

- TNUoS charges for demand are based on 14 zonal charges and there is no difference between the double and single circuit connections.
- It is assumed that the distribution connected demand is indirectly exposed to both TNUoS and BSUoS.

Assumptions for Distribution Use of System (DUoS) charging

- Import charge reflects the additional charges for the sole use assets.

Conclusions

Higher costs are borne by demand customers connecting to distribution networks that require additional investment for a secure connection. This is not the case for transmission use of system charges and, due to the more shallow connection charging regime, means the differential is less for transmission connected parties.

Description of scenarios	**Charges impact on customer**	**Cost Signals to Customer**	**Cause of issue?**
Single circuit and double circuit connection to increase security of supply resulting in a firm connection	Initial upfront and ongoing cost are more expensive for a firm connection at distribution but not at transmission	Higher if more security required for distribution connection; not as great for transmission	Limitation to granularity for demand TNUoS signal

Storage Specific Scenarios

This example aims to demonstrate the differences between the two distribution methodologies. Where CDCM is average LV and HV charges and EDCM are site-specific

1. EDCM versus CDCM Storage

- 5MW EDCM connection
- 5MW CDCM connection

	Comparison of EDCM v CDCM			
	5MW EDCM Storage Connection (33kV E&W)		5MW CDCM Storage Connection (11kV E&W)	
Connection Charges	**Upfront charge**	**Annual charge**	**Upfront charge**	**Annual charge**
Distribution Connection Charge	£1,500,000		£800,000	
T Connection charges (sole use)				
Generator owned assets (indicative costs)				
Total Associated Connection Charge	**£1,500,000**	**£0**	**£800,000**	**£0**
Distribution UoS Charges				
Total Import Charge		**£30,000**		**£100,000**
Total Export Charge		**£9,000**		**-£50,000**
Total DUoS Charges		**£39,000**		**£50,000**
Transmission UoS Charges				
TNUoS		-£15,000		-£15,000
Locational		-£8,000		-£8,000
Non-Locational		-£7,000		-£7,000
BSUoS		£15,000		£15,000
Total T UoS		**£0**	**£0**	**£0**

	5MW EDCM Storage Connection (33kV E&W)		5MW CDCM Storage Connection (11kV E&W)	
	Capital Charge	Annual Charge	Capital Charge	Annual Charge
Total Storage	**£1,500,000**	**£39,000**	**£800,000**	**£50,000**

Connection Cost Assumptions

- The 5MW EDCM connection comprises the installation of 33kV extension assets. The customer will pay the full cost of these extension assets.
- The 5MW CDCM connection comprises the installation of 11kV extension assets. The customer will pay the full cost of these extension assets.
- The additional costs of assets at 33kV are reflected in the comparison of connection costs.

Distribution Use of System Assumptions (DUoS)

- The import charges at CDCM reflect that there are more assets and voltage levels utilised and are average charges. At EDCM the charges are more locational.
- The export charges reflect that there will always be credits at CDCM whereas at EDCM there may or may not be a credit, but there will always be a charge to reflect the sole use asset.

Conclusions

- It is likely to cost customers more to connect at EHV voltages (EDCM) rather than at HV or LV voltages (CDCM). EDCM DUoS charges are calculated at a local level which may result in generation charges or credits dependent upon site specific circumstances. Whereas CDCM DUoS charges are based on a demand based charging model and the average costs applied will always result in generation credits for export.

Description of scenarios	**Charges impact on customer**	**Cost Signals to Customer**	**Cause of issue?**
The EDCM is used to calculate charges to users connected at extra high voltage (EHV), or connected at high voltage (HV) and metered at a distribution primary substation.	Biggest impact is in the connection charges at the distribution EHV voltages.	Both receive import charges and export credits at distribution and embedded TNUoS credits are very similar	
The CDCM is used to calculate charges to users who are connected to the LV and HV levels of the distribution network	Cheaper to connect and no significant difference in total ongoing charges	Both receive import charges and export credits at distribution and embedded TNUoS credits are very similar	

2. 99 & 100MW Storage

The purpose of this example is to demonstrate that storage is generally treated in the same way as other generation but that the cost to connect at distribution can be higher.

- 99MW (132kV) Transmission connection in Scotland
- 99MW (132kV) Distribution unlicensed connection in England & Wales
- 100MW (132kV) Transmission connection in Scotland
- 100MW (132kV) Distribution licensable connection in England & Wales

Comparison of 99MW and 100MW T&D Storage								
	99MW T Connection (132kV Scotland) Storage		99MW D Connection (132kV E&W) Storage		100MW T Connection (132KV Scotland) Storage		100MW D Connection (132kV E&W) Storage	
Connection Charges	**Upfront charge**	**Annual charge**	**Upfront charge**	**Annual charge**	**Upfront charge**	**Annual charge**	**Upfront charge**	**Annual charge**
Distribution Connection Charge			£7,050,000				£7,050,000	
T Connection charges (sole use)	£2,950,000				£2,950,000			
Generator owned assets (indicative costs)								
Total Associated Connection Charge	**£2,950,000**	**£0**	**£7,050,000**	**£0**	**£2,950,000**	**£0**	**£7,050,000**	**£0**
Distribution UoS Charges								
Total Import Charge				**£600,000**				**£600,000**
Total Export Charge				**£50,000**				**£50,000**
Total DUoS Charges		**£0**		**£650,000**		**£0**		**£650,000**
Transmission UoS Charges								
TNUoS		£500,000		-£300,000		£1,650,000		-£60,000
Locational		£1,850,000		-£150,000		£1,850,000		£140,000
Non-Locational		-£200,000		-£150,000		-£200,000		-£200,000
Small Gen Discount		-£1,150,000						
BSUoS		£600,000		£250,000		£600,000		£600,000
Total T UoS		**£1,100,000**		**-£50,000**		**£2,250,000**		**£540,000**

	99MW T Connection (132kV Scotland) Storage		99MW D Connection (132kV E&W) Storage		100MW T Connection (132KV Scotland) Storage		100MW D Connection (132kV E&W) Storage	
	Capital Charge	Annual Charge	Capital Charge	Annual Charge	Capital Charge	Annual Charge	Capital Charge	Annual Charge
Total Storage	**£2,950,000**	**£1,100,000**	**£7,050,000**	**£600,000**	**£2,950,000**	**£2,250,000**	**£7,050,000**	**£1,190,000**

Connection Cost Assumptions

- At Transmission (Scotland): the 132kV bay at the windfarm site is classified as a connection asset and will be paid for in full by the connecting party. The 132kV circuit connecting the generator to the main transmission system and associated works at the GSP are all treated as infrastructure assets and will be recovered from all customers via TNUoS.
- At Distribution (England & Wales): all of the 132kV assets to be installed for the generator are treated as extension assets and will be paid for in full by the connecting party.

Transmission Charging Assumptions (TNUoS and BSUoS)

- Assume load factor for transmission connected storage is around 10%
- Distribution connected storage would have indirect liability for demand BSUoS charge. This would be calculated by net position between offtake and production for each settlement period.

Distribution Use of System Charging Assumptions (DUoS)

- The import charges reflect agreed capacities which are equal to the agreed export capacity (99 or 100MW respectively) and locational charges in the form of super-red unit charges.
- The export charges reflect agreed capacities which are equal to the agreed import capacity (99 or 100MW respectively) and no generation credits as it is classed as intermittent.

Conclusions

Connection costs are higher for distribution connected projects. Whilst Use of System charges are lower for these customers, the payback period for these parties is longer than for generation counterparts. There is an incentive to remain unlicensed.

Description of scenarios	Charges impact on customer	Cost Signals to Customer	Cause of issue?
99MW (132kV) Transmission Storage connection in Scotland v 99MW (132kV) Distribution Storage connection in England & Wales	A higher upfront connection charge for distribution connected project but lower use of system charges	Provided high upfront cost is not a barrier, then incentive is to connect to distribution network.	Difference in treatment between transmission and distribution charging methodologies
100MW (132kV) Transmission Storage connection in Scotland v 100MW (132kV) Distribution Storage connection in E & W	Higher connection costs for distribution connected project and liability for both T&D use of system charges	Signal to connect to transmission system in Scotland.	Difference in treatment between transmission and distribution charging methodologies

Appendix 2 – Points of clarification

The following points should be noted:

1. The examples in appendix 2 are illustrative only and should not be relied upon.
2. The different transmission and distribution ownership boundaries in Scotland and England & Wales.
    - 132kV is a distribution voltage in England & Wales and a transmission voltage in Scotland.
    - The impact of the different transmission and distribution ownership boundaries on the distribution charging 'one-voltage rule' depending on where they are located. Under the 'one-voltage rule' the distribution business will fund distribution reinforcement carried out at greater than one voltage level above the voltage at the point of connection, this does not apply at transmission.
3. Distribution connected generation is treated as negative demand from an embedded benefits perspective. It is assumed that distribution connected generation in these examples qualifies for embedded benefits from BSUoS and TNUoS as disbursed in full by the relevant Supplier for that site.
4. Transmission connection charges.
    - Transmission connection charges are only applicable to sole use assets.
    - There is the option to choose to pay some or all charge upfront or on annual basis post connection. Default annual period is 40 years. Main choice is between 40 and 25 years.
    - The user will provide security for all H1 costs. Security for A1 costs will only be required where the customer chooses to pay on annualised basis. Provide definitions of cost categories - A1/H1.
    - Whilst generally being super shallow, the depth of transmission connection charges can vary as shown in the examples in Appendix 2. Generally larger conventional generation projects will connect to the main transmission network and have low (or no) connection charges, whilst connection charges for smaller distributed generators can circuits connecting that generator to the transmission system.
    - Generation customers (including storage) can also be liable for local TNUoS charges which recover the costs of local assets to the main transmission system.
5. Locational signals
    - At transmission, for infrastructure assets, locational signals are primarily provided through annual TNUoS charges. For the examples contained in Appendix 2, regional differences in TNUoS charges are provided where applicable but not further considered in the context of this work.
    - At distribution they are contained primarily within the connection charges.
6. For both distribution connections, storage is treated exactly the same as any other connection, i.e. charges will apply against import and export. At the transmission level storage is treated as a form of generation, consistent with its licence.
7. The impact of the two different distribution charging methodologies (CDCM for HV and LV connections and EDCM for EHV designated connections).
8. Under EDCM all connections will attract both increased connection and DUoS charges as a result of additional sole use assets.
9. Under CDCM, additional connection charges will be levied as a result of additional sole use assets but no change in DUoS where average charges are applied.
10. BSUoS charges have been included in the examples for completeness including any embedded benefit arising from BSUoS.
11. 132kv transmission examples are based on onshore projects in Scotland. It is recognised that 132kV is similarly designated as transmission for offshore projects across GB.