WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

COMPARISON OF PRICE INCENTIVE MODELS

FOR LOCALLY MATCHED ELECTRICITY NETWORKS

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Contents

1 Glossary

Abbreviation	Term
WPD	Western Power Distribution
VPW	Virtual Private Wire
NRPW	Network Replicating Private Wire
DUoS	Distribution Use of System Charge
CDCM	Common Distribution Charging Methodology
MW	Mega Watt
HV & EHV	High Voltage and Extra High Voltage
LV	Low Voltage
DNO	Distribution Network Operator (e.g. WPD)
RIIO ED1	Revenue = Incentives + Innovation + Outputs, Electricity Distribution 1.
DER	Distributed energy resources

2 Executive Summary

There is increasing interest from a wide range of energy industry stakeholders in the role of peer-to-peer trading and local energy markets as a way to maximise value from our local networks and energy system. One of the drivers is the rapid growth in distributed energy resources (DERs) such as solar PV, batteries and electric vehicles.

This report introduces three market models where local networks could benefit from the value created by better local balancing of demand and supply:

- Network Replicating Private Wires (NRPW)
- Virtual private wires (VPW)
- Locational Distribution Use of System charges

These models provide a financial incentive for customers and generators to enhance their revenue potential by taking action to better match their usage to the needs of the local network. This derives benefit for the local network due to decreased power flows through higher levels of the networks, therefore reducing the need for costly reinforcement.

Network Replicating Private Wires are a current model and provide strong signals to the demand and supply participants to match their loads. However, there is no signal to locate in areas of network need. This model also has downsides in terms of some duplication of DNO network assets and in terms of scalability as few businesses can participate in a NRPW. Since DNOs are largely blind to NRPW arrangements, they cannot plan and manage their networks around them.

This study investigated a new model of a Virtual Private Wire. This model avoided some of the downsides of the NRPW by routing electricity over DNO's networks, avoiding duplication, providing better transparency and generating revenue for DNOs through leasing charges that can benefit both the DNO and wider distribution customer. However, regulatory changes would be needed to implement VPW. The netting off of demand and supply would be done in such a way that avoids the policy costs levied on licensed electricity supplies. As this means that such costs are borne by fewer customers, it is unlikely that support would be forthcoming for the regulatory changes required.

The final model that was investigated was the introduction of locational DUoS charging, where price signals encouraging local matching are sent through different rates for matched and unmatched demand and supply. This model has a different target as it allows anyone to participate and benefit, but the lower financial incentive created means a weaker signal to generators and customers to match locally. This means that it requires significant scaling to deliver greatest system value. There are significant complexities in achieving this. Issues include how to share the value of matching fairly between demand and supply participants and, related to this, how the differential may vary between a demand-dominated and a supply-dominated local area.

Each model investigated has limitations. As such we recommend the investigation of further models, potentially as part of the industry reviews on network charging and access, that can incentivise better local matching and hence contribute to a locally optimised electricity network.

3 Introduction

There is increasing interest from a wide range of energy industry stakeholders in the role of peer-to-peer trading and local energy markets. One of the primary drivers is the rapid growth in distributed energy resources (DERs) such as solar PV, batteries and electric vehicles. As renewable subsidies are being reduced, customers and generators are looking for other ways to maximise their revenue potential.

Distribution use-of-system (DUoS) charges for half-hourly metered customers contain a time-of-use pricing incentive which encourages customers to reduce their demand at peak times. However, the DUoS charging system does not explicitly encourage generation and demand to match locally.

Western Power Distribution (WPD) has commissioned this report to investigate the impact of different models in producing locally optimised electricity networks.

This report introduces three models in which customers and generators could enhance their revenue potential for peer-to-peer trading:

- Network Replicating Private Wires (NRPW)
- Virtual private wires (VPW)
- Locational Distribution Use of System charges

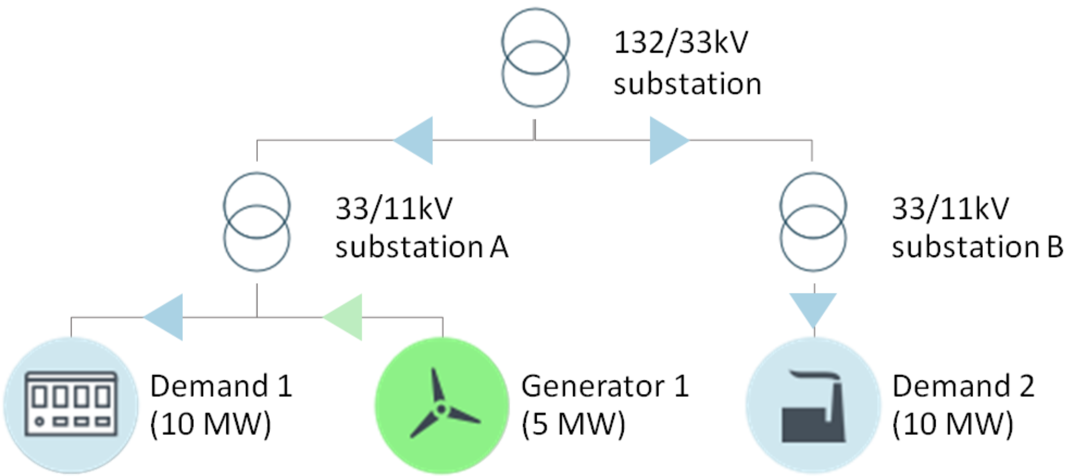
Whilst not an exhaustive list, the three models present a range of options to be compared according to their different practical, commercial and economic characteristics. Of the three models, only NRPWs are currently operating in the market as VPWs and Locational DUoS would require regulatory, legislative or industry code changes.

4 Locally matched electricity networks

For our purposes, we define a locally optimised electricity network as one where demand and generation that are served by the same part of the distribution network are netted off each other within the same settlement period reducing flows to/from the wider distribution network and the GB transmission network.

This increased local matching can bring benefits to the distribution network, and eventually to all electricity customers, by reducing power flows at higher levels of the network. Lower flows through these levels of the network can help avoid or defer the need for network reinforcement. Lower flows can also help reduce distribution losses, and can facilitate cheaper and faster connections to the network.

4.1 Example local matching network diagram



In this example we focus on one 132/33kV substation and the flow on this network during one half hour when all three grid customers are operating at full capacity. During this half hour, the total electricity consumption is 20MW (from Demand 1 and Demand 2). The export from Generator 1 is 5MW, which is locally matched with 5MW of consumption by Demand 1. The flow through the 132/33kV substation is 15MW.

4.2 Incentives for increasing local matching

Incentives targeted at increased local matching can work in two ways:

- By encouraging demand or generation to shift their time of operation to different times of the day so that they are more closely aligned with each other.
- By encouraging demand or generation to connect to parts of the network that are dominated by the other – therefore offering the scope for additional local matching. For instance, encouraging new generation to connect to parts of the network that

predominantly serve demand customers may provide additional opportunities for local matching.

4.3 Quantifying the benefits of local matching

As part of this study we have looked at the potential benefits of increased local matching leading to reduced power flows at higher voltage distribution assets (above 22kV).

In its submissions to Ofgem’s RIIO ED1 price control review, WPD predicted that it would need to invest £224.5 million between 2015 and 2023 to create additional network capacity at voltages above 22kV (i.e. 132kV and EHV). This need for additional capacity was driven by WPD’s forecast that peak demand flows would increase by up to 2 per cent a year across its four network areas.

This figure of £224.5 million (or £28 million a year on average) indicates the potential savings available from initiatives such as local matching that can reduce or delay this growth in peak flows such that the forecast increase in network capacity is no longer needed.

Other sources of value would come from reduced system losses due to reduced peak time flows through network assets. Our modelling suggests that if 10 per cent of demand from LV and HV half hourly metered customers is matched with local generation (leading to a 5% reduction in peak time power flows through EHV and 132kV network levels), customers in the WPD areas could save £1 million per year on avoided generation through reduced losses, and an additional £0.2 million in avoided carbon costs.

These figures are intended to be indicative rather than firm forecasts, and further analysis would be needed to validate these numbers.

See Appendix A for further information on the modelling of DUoS and local matching models.

5 Review of different pricing models

5.1 Current network charging methodology

The current methodology used to set DUoS charges for most demand and generation customers is the Common Distribution Charging Methodology (CDCM). This allocates the DNO's costs to each network level, and then allocates the costs at each network level to demand users based on their assumed used of each network level and their estimated contribution to the maximum load on the network as a whole.

As part of this allocation, the CDCM assumes by default that demand users connected at each level are supplied from the transmission exit point using every network level between the transmission exit point and the network level to which the user is connected.

The CDCM includes DUoS credits for generators (intermittent and non-intermittent) which are paid for each unit of electricity exported to the distribution network. DUoS credits are calculated using the same cost allocation methodology as for demand. In principle, this is broadly equivalent to treating distributed generation as negative demand for charging and cost allocation. This covers forward-looking costs but not residual charges.

The current system of generation credits in the CDCM assumes that distributed generation always offsets demand at higher network levels. Some generation does indeed offset demand on the local distribution network. However, generators connected to generation-heavy areas of the network, and generation that occurs at times when demand is low relative (i.e. outside peak demand hours) are less likely to offset any demand. This means that demand customers could be funding credits to generators even when they provide no benefit to the network, or even, add to the cost of operating the network.

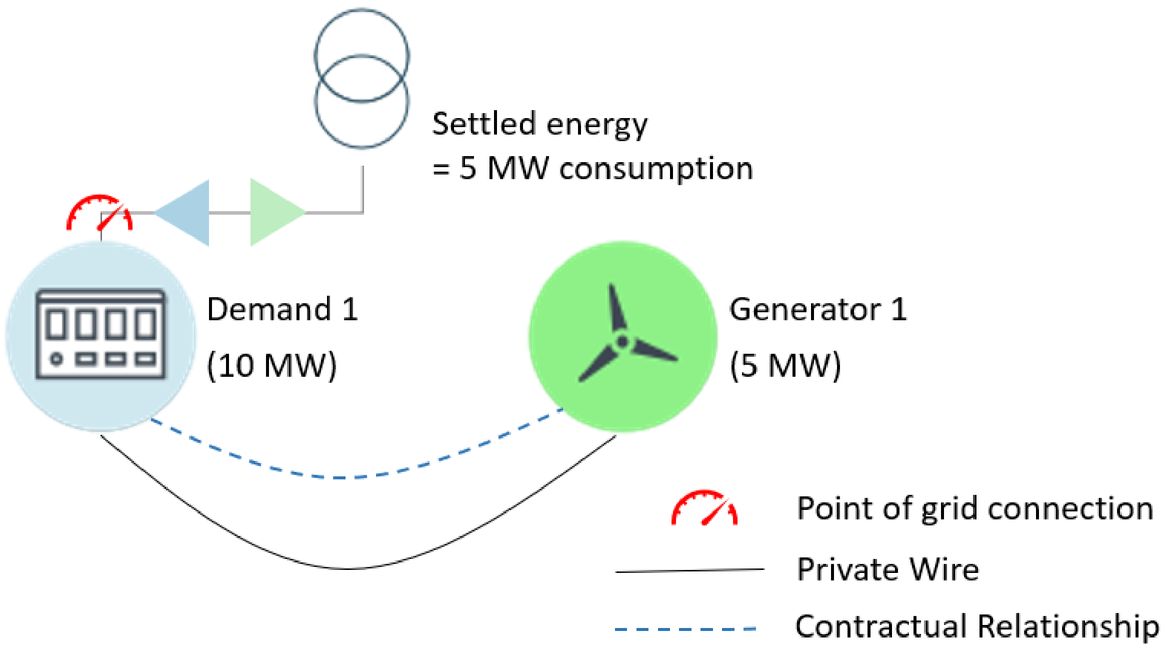
5.2 CDCM local matching impact

- The relatively simple DUoS methodology across a network region makes it easy to manage cost and charging.
- However, participants at a local level have minimal price signals on how it might be beneficial to shift demand or generation in response to more local needs or balancing.
- They also do not benefit from any reduction in network reinforcement costs that the matching of consumption and local generation may already have saved.
- For the network, the current methodology may produce higher net power flows through the distribution and transmission network than may be possible. As a result, long term investment in network capacity (or local flexibility markets) may be needed.

6 Network Replicating Private Wires

6.1 Introduction to private wires

In a private wire arrangement, a generator supplies electricity directly to the consumer via a privately-owned wire. The arrangement allows exemption from the environmental charges levied on licensed electricity supplies (eg FiT levy, CfD levy, Climate Change Levy, etc) and network charges (for use of the transmission and distribution systems) for the proportion of generated electricity that is supplied as part of the private wire arrangement. Network and environmental charges and levies are only applicable for the element of demand met through imported supply. In this sense, it's the only existing model that provides a price incentive for local matching.



6.2 Network replicating private wires

Legally, the concept of 'private wires' derives from the Electricity Act and can cover a wide number of different practical arrangements, including self-supply. See Appendix C for more information on the legal definition for Private Wires.

For this study, we are focusing only on a subset of private wires of a significant size that replicate existing distribution assets, and are in locations with spare network capacity. These sites potentially add costs to the system and follow the conditions below:

- There is an arrangement involving at least two parties, a generator (G) and at least one customer (C), for the supply of electricity by G to C;
- G and C are not the same entity (i.e. we are not dealing with 100% self-supply);

- There are distribution assets (under 132kV) assets (private wire) that connect G and C which are not part of the local licensed Distribution Network Operator's network and these are owned by one or both parties;
- G sells power to C but benefits from a supply licence exemption;
- As applicable, G and/or C benefit(s) from a distribution licence exemption;
- There is a Power Purchase Agreement (PPA) between G and C.
- Sites are of a significant size (e.g. are half-hourly metered).

6.3 Understanding the market for NRPW

This study took both a qualitative and quantitative approach to understanding the existing market and potential growth for NRPW. To establish a high-level estimation of the likely number of these NRPW currently in existence we carried out interviews with ten industry experts and cross referenced this with data from WPD's export and import customers in the South West license area.

We found that given the commercial benefits of private wires, installing a private wire between a local demand customer and distributed generation will be something that both parties would wish to explore. However, few exist in practice. This is due to the contractual complexities which include arranging supply and distribution licence exemptions, up-front costs and barriers to laying a private wire and, crucially, the credit or investment risk profile of the demand customer. Only a limited number of customers (such as utilities) can support a contract covering over a decade.

As subsidies for renewables have decreased, the economic rationale for installing a private wire has increased, particularly for those installed on the same site or 'behind-the-meter'. But for private wires that link two different sites, complexities with the arrangements remain. Market participants interviewed expect private wires that replicate network assets to experience modest growth.

Based on the high level quantitative analysis, and interviews with market participants, we came to an estimate that two percent of generation and demand sites that generate and/or import above 100 kW have NRPW and that this may grow to around five per cent over the next decade. However, given the challenges with gathering this data these estimates have a high degree of uncertainty.

For further information on a market analysis of NRPW, see Appendix B

6.4 NRPW impacts

Benefits

- A key benefit to both participants is the exemption from supply and distribution licenses for the matched generation. This provides savings to the demand customer and extra revenue to the generator.

- New generation can be built to supply under a private wire in areas of constrained network capacity.

Challenges

- For demand and generator, this model requires significant upfront investment.
- There is also significant risk for the contracting parties. This is mainly based on the longevity of the contract required.
- For the DNO, a NRPW can replicate the current grid, causing economic inefficiencies through duplication of investment. There is also a loss of visibility that may impact network planning.
- For the network, the netting off demand and supply means the demand customer pays less of the policy charges applied per unit of electricity, this could increase the costs levied on remaining customers.

Local matching impact

- A NRPW provides very strong price signals to encourage local matching of demand and generation.
- However, there are issues with this model in terms of accessing the full value that local matching that may provide. There are currently no incentives to locate in areas with most value and so NRPWs may or may not be located in areas with capacity constraints. This creates a risk that NRPWs may provide benefits to the two parties involved but not to the system as a whole.

7 Virtual Private Wire

An alternative model to encourage local matching is a Virtual Private Wire. We have defined this as a similar arrangement to a NRPW but using licensed distribution network assets in place of investment in a physical private wire.

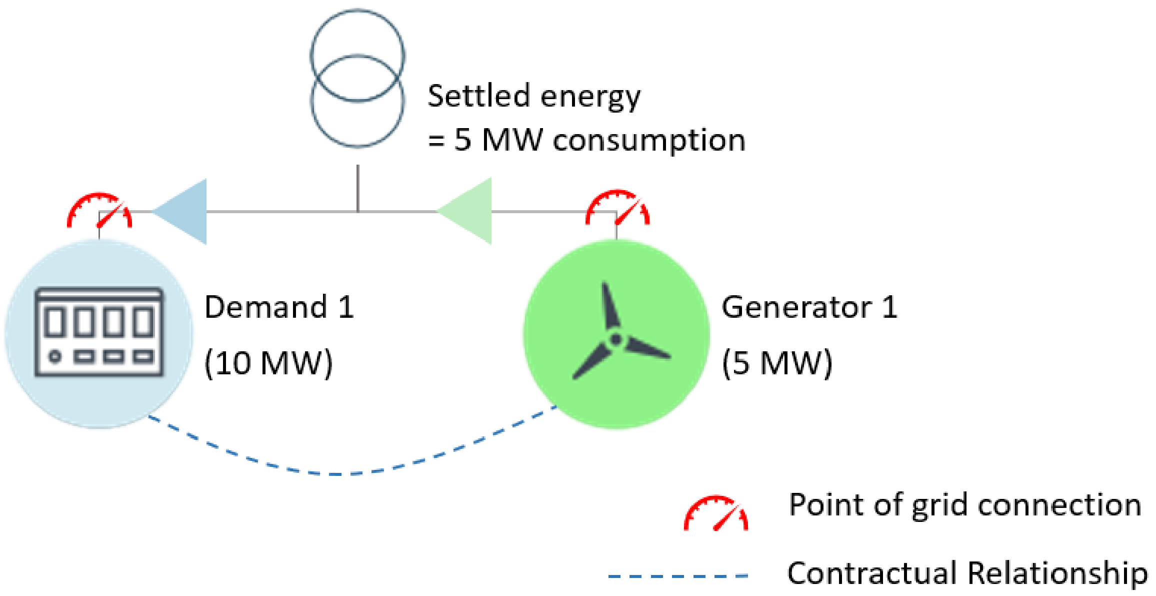
7.1 Virtual Private Wire description

As per a Network Replicating Private Wire model:

- There is an arrangement involving at least two parties, a generator (G) and at least one customer (C), for the supply of electricity by G to C;
- G and C are not the same entity (i.e. we are not dealing with 100% self-supply);
- G and C are not on the same site;
- There is a Power Purchase Agreement (PPA) between G and C
- G sells power to C but benefits from a supply licence exemption;

Crucially, as with a NRPW, import and export settlement metering would be the net of the two sites. For this to be possible, the following would also be needed:

- Licensed distribution network assets are utilised to connect them (by allocating spare capacity through a leasing arrangement or otherwise);
- A bespoke distribution exemption (exempting the DNO from aspects of their license) would be required



7.2 Understanding the potential for VPW

Interviews with market participants carried out for this study suggests that there would be significant levels of interest in a VPW model from both demand customers and generators where NRPW have not proven practical.

The VPW model used for this study has the same characteristics as the Network Replicating Private Wire model but for the fact that it makes use of spare capacity on a licensed distributor's network (under a lease or some other arrangement) to enable supply between a generator-supplier and its customer(s) who are not on the same site as each other. It assumes that the significant commercial advantage of licence exempt supply (avoiding policy charges imposed on licensed supplies) can be made available to a supplier even though they use the licensed distributor's network.

7.3 Legal barriers

The VPW is an unproven model, but we expect several legal and regulatory hurdles before it could be deployed.

Route 1: Class C supply license exemption:

Ownership by the licensed distributor of those network assets prevents use of the 'private wire' limb of the Class C supply licence exemption (referred to in section 8.1) and the fact that generator-supplier and its customer(s) are on different sites prevents use of the 'same site' limb of the Class C exemption (see 8.1). To use the Class C supply licence exemption would, therefore, require a change in law to broaden its reach.

Route 2: Class A small supplier exemption

An alternative would be to consider the Class A small supplier exemption. However, this requires that all electricity supplied is generated by the supplier (which would be hard to guarantee in practice) and also limits supply to never more than 5MW (of which no more than 2.5MW can be domestic supply).

Ofgem consent

Under either of these supply licence exemptions, use of the licensed distributor's network would itself require the consent of Ofgem to a disposal of part of the licensed distributor's regulated asset base and may require amendment of the Electricity Act and/or standard licence conditions (or a derogation from them). For further information see Appendix D

7.4 Impact of Virtual Private Wires

Benefits

- For demand and generator this model does not require the upfront investment costs of a NRPW arrangement and is therefore more accessible but some risks and contractual costs will remain.

- The key benefit to both participants of exemption from supply and distribution licenses and the associated revenue opportunities also remains.
- The removal of duplication of assets means system costs are optimised compared to NRPW. In addition the lease cost reduces passes costs from the wider customer to the VPW operator.

Challenges

- For the wider customer although there is additional lease income for the DNO, policy costs imposed on electricity customers will still increase compared to the bas scenario as the matched supply is still supply exempt.
- Regulatory changes to enable VPW would be difficult to achieve given that avoidance of policy costs issue could be resisted by the regulator.

Local matching impact

- A wider number of participants could allow more local matching value to be realised than in NPRW or the current methodology.
- For the network this would mean a reduction in flows due which may save cost / network reinforcement if the loads are well matched.

8 Locational DUoS charges

A further model was developed as part of the study where DUoS charges are used to incentivise local matching.

8.1 DUoS Model summary

We have developed two models for how DUoS charges and credits can be used to provide an incentive for local matching by explicitly recognising the value it can bring to the network. These are for illustrative purposes only, to understand the impacts for different participants. Further work is necessary before firm proposals for methodology changes can be put forward under industry governance processes.

The options we explore are targeted at half hourly metered commercial demand users and all generation users.

8.2 Locational DUoS Model 1

This approach involves modifying the CDCM to take better account of actual network usage, i.e. by recognising that locally matched electricity does not use network levels higher than the level at which matching takes place.

In this model, demand that is locally matched with generation would not attract costs attributable to network levels above the level of matching. All other demand (i.e. unmatched demand) would attract costs attributable to all network levels above the level of connection. This is illustrated in the figure below. The primary substation on the right has no generation, hence any demand required requires flows through the whole network. The matched demand on the other primary only utilises the 11kV network.

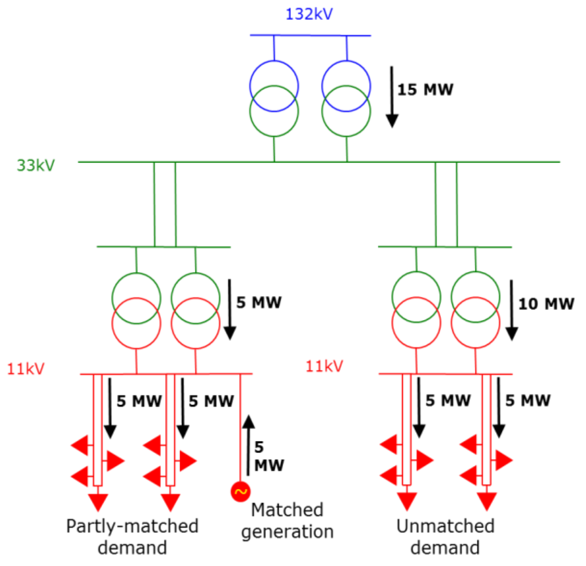


Figure 1: Stylised network diagram illustrating the concept of local matching

In theory matching could happen at any level of the network. The modelling for the report was based on either matching at HV or EHV level. if local matching was considered at the HV level, the local matched demand DUoS charge would consider the costs at the LV, HV/LV and HV network levels only, whereas, if matching was considered at the EHV level, local matched demand DUoS charge would consider also EHV network level costs. So, the local matching discount would be lower, but the amount of a customer's demand that is matched might increase. The local matching discount would be dependent on the DUoS charges in the region the customer is located in.

DUoS credits would no longer be paid to generators. As such, for this model to work, some way of sharing the saving given to matched demand with matched generation would be needed. The principle would be that in demand-heavy areas generators would be able to negotiate a larger share of the DUoS reduction available for matching, whereas in generation-heavy areas, demand users would be able to take a relatively larger share.

Removing universal generation credits means that the total network revenue that would be raised from demand users would be lower. Therefore the impact of the change on unmatched demand (including domestic demand tariffs) would be small. There may also be additional future benefits from the matching feeding into lower network costs.

8.3 Locational DUoS Model 2

In this model, all current CDCM DUoS charges and credits remain the same, so generators continue to receive the generation credit, and DUoS charges for generators and non-matching demand remains the same. However, it is recognised that there are benefits to the network from increased local matching, as described earlier in this report, and so locally matched demand would be eligible for a discount against their tariff.

In the short term the DNO revenue recovered would be lower but the DNO allowed income methodology would allow that revenue to be recovered in the medium term. In the longer term lower reinforcement requirements should lead to lower prices for all.

8.4 Impact of Locational DUoS charges

Benefits

- Any participant in a local area can participate at little/no cost.
- There is no policy cost avoidance issue for the regulator.
- Benefit levels can be set to reflect the value of the services that local matching will provide to a local area according to their needs.
- The locational DUoS methodology has different implications for different renewable generation technologies depending on their generation profile and flexibility. It may help to encourage co-location of renewables with storage to provide flexibility for generators to maximise their matched DUoS payments.

Challenges

- The price signals for local matching are likely to be smaller and therefore less effective in achieving network savings.
- Potential high complexity of administration.
- If the charges are set based on current cost recovery targets, then the net impact is movement of costs from some customers to others, meaning that there will be some network customers who will be charged more than currently to give other customers lower rates for matched generation.

Local matching impact

- Larger volumes of local matching but with lower price signals may provide less value than the VPW model. However, this would need further investigation potentially as part of the potentially as part of the industry reviews on network charging and access.

9 Case study – Overview of Models

To investigate the impacts of the different models, this section explores the different options from the perspective of the consumer.

The impacts on costs and income for various parties will depend entirely on circumstances of the demand and generator network users, their capacities, generation type and profiles. This case study represents a specific model made with a large number of assumptions to illustrate how value may change and results should not be taken out of this context. Further information on how it has been developed can be seen in Appendix A.

9.1 Premise for the case study

A large energy consumer with 4.5 MW capacity connection on the 11kV in the WPD South West network is looking at options for reducing their energy spend into the future. Their energy usage is difficult to reduce without significant investment; however, a percentage of use could be shifted around a 24 hour period. It is not feasible for the demand customer to have energy generation on-site. They would like to have additional reputational benefits from procuring electricity from a renewable energy source.

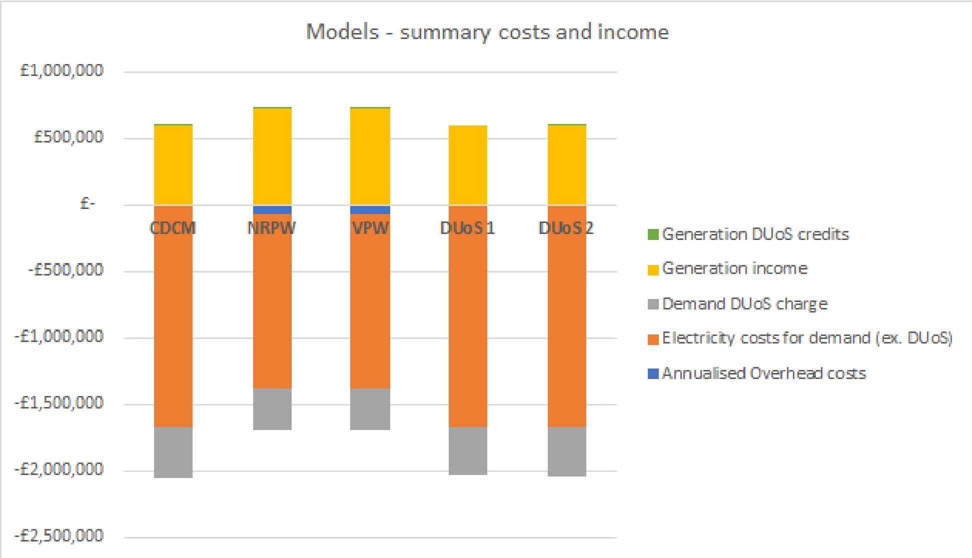
A generator with 4 MW wind capacity is looking to maximise income.

9.2 Case study results

The below chart summarises the costs and income that each party could receive under the models described including the base case of the current charging regime. The highlighted cells demonstrate changes against the base case, with green cells highlighting increased income or decreased costs against base case, and red cells highlighting decreased income or increased costs against base case.

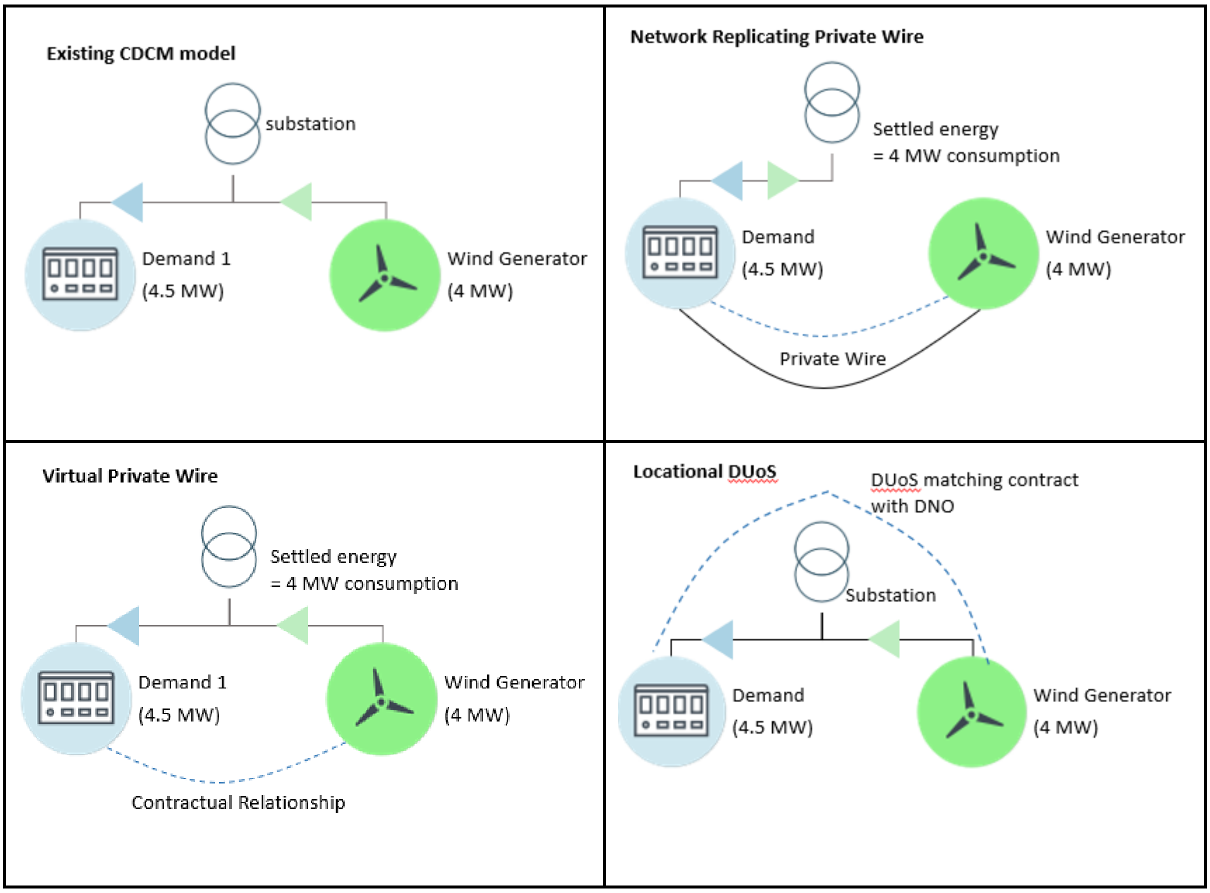
Total annual demand (kWh)	20,000,000
Total annual generation (kWh)	5,000,000
Total matched demand (kWh)	4,500,000
Red DUoS matched demand (kWh)	285,000

Costs and Income (£)	Base Case	NRPW	VPW	DUoS Model 1	DUoS Model 2
Total capital costs	- 130,000	- 700,000	- 130,000	- 130,000	- 130,000
Annual O&M costs					
VPW leasing costs			- 55,000		
Annualised network/connection costs	**- 10,000**	**- 70,000**	**- 65,000**	**- 10,000**	**- 10,000**
Electricity costs for demand (excluding DUoS)	- 1,660,000	- 1,315,000	- 1,315,000	- 1,660,000	- 1,660,000
Demand DUoS charge	- 385,000	- 310,000	- 310,000	- 365,000	- 370,000
Total Cost - Demand	**- 2,045,000**	**- 1,625,000**	**- 1,625,000**	**- 2,025,000**	**- 2,030,000**
Generation income	590,000	725,000	725,000	590,000	590,000
Generation DUoS credits	20,000	2,000	2,000		20,000
Total Income - Generation	**610,000**	**727,000**	**727,000**	**590,000**	**610,000**
Total annual scheme costs (demand + generatior	**- 1,445,000**	**- 968,000**	**- 963,000**	**- 1,445,000**	**- 1,430,000**



Models - summary costs and income
£1,000,000
£500,000
£-
-£500,000
-£1,000,000
-£1,500,000
-£2,000,000
-£2,500,000
CDCM
NRPW
VPW
DUoS 1
DUoS 2
Generation DUoS credits
Generation income
Demand DUoS charge
Electricity costs for demand (ex. DUoS)
Annualised Overhead costs

9.3 Summaries of the model drivers and impacts



Current DUoS Charging model

- **Demand:** the demand customer has a total demand of 20GWh which it buys directly from the market costing £1,660,000, with an additional £385,000 of DUoS charges for use of the local network. And, whilst red DUoS rates encourage avoidance of regional peak grid demand periods there is no incentive for them to match local generation to manage more local grid constraints.
    - They do not procure renewable electricity.
    - There are no further costs for the demand customer.
- **Generator:** the generator pays £130,000 for a network connection and for its 5GWh of generation receives sales income of £590,000 and receives DUoS credits of £20,000.
- **Local network:** may receive higher flows during peak time than is possible through matching and reduces the spare capacity on the network and potential for new connections.

Network Replicating Private Wire

- **Demand:** the demand customer agrees to purchase electricity directly from a renewable generator at a lower price than the market and for this a 1km private wire is laid. As a result, 4.5GWh of their demand is purchased from the renewable generator. So, their electricity bill for supply from the market falls by £345,000 and their DUoS costs falls by £75,000. They may incur part of the upfront cost to build the private wire. Also:
    - The site has the potential to reduce this further as they work to better match their demand to the generation profile.
    - They can also claim to procure renewable electricity.
- **Generator:** the generator pays for some or part of a private wire to be built, in the model we have assumed this is £700,000 and significantly higher than the network connection. Their generation income increases by £135,000 with DUoS credits falling to £2,000 as they are only received on the non-matched units.
- **Demand and Generator together:** the capital costs of setting up the private wire are high, but the savings on electricity and DUoS costs lead to overall savings on costs and increased income of £482,000 per year, or 11p/kWh of matched demand.
- **Local network:** receives a benefit to the extent to which the matching on the private wire reduces flows through the network at peak time and less associated losses. However also loses some DUoS income from the matched demand and generation.

Virtual Private Wire

- **Demand:** the demand customer agrees to purchase electricity directly from the generator, but lease grid assets from the local network operator instead of setting up a private wire. The same supply and distribution licence exemptions remain for electricity supplied directly from the generator to the demand customer. They may incur part of the leasing costs, but the upfront cost of a private wire connection is avoided. Their electricity bill and DUoS costs therefore remain the same as the NRPW model. Also:
    - The site has the potential to reduce their electricity bill further as they work to better match their demand to the generation profile and maximise the value of the lease.
    - They can claim to procure renewable electricity.
- **Generator:** the generator also receives the same higher income as the NRPW model.
- The generator and demand customer agree the sharing of the lease cost and DUoS credit through a PPA.
- **Demand and Generator together:** the demand and generator would between themselves pay the network leasing costs, priced based on the DUoS pricing structure. The lease cost would be priced at the regulatory value of the assets and be equal the net of demand DUoS charge and generation DUoS credits for the

capacity required. Cost savings compared to base case would be similar to that of NRPW model.

- **Local network:** the network receives a benefit to the extent to which the matching on the private wire reduces flows through the network at peak time and less associated losses. They also have full visibility of the generation in the network and receive a lease charge, giving them more revenue than the NRPW.

Locational DUoS Charges - Model 1

- **Demand:** in this model the demand customer purchases their electricity directly from the market, but are charged a lower DUoS cost for any demand matched with local supply. The saving is about 0.5p/kWh matched which, assuming 20% of their demand is locally matched, leads to a £20,000 saving compared to base case. Also:
    - The site has the potential to reduce their electricity bill further as they work to better match their demand to the local generation profile.
    - Depending on the generation profile in the area, they may be able to claim they are procuring renewable electricity.
- **Generation:** due to the removal of generation DUoS credits, the generator's income is about £20,000 lower than the base case.
- **Demand and Generator together:** the net of the saving to the demand customer, and removal of the DUoS credit for the generator would mean that the total cost and income when both are considered together would remain the same. The difference would be that as only matched demand receives the saving there is some small incentive to increase local matching. For the saving from demand matching to be shared between demand and generation an arrangement would need to be made.
- **Local Network:** the network works with a local matching platform to match customer and demand profiles and receive data to calculate the appropriate DUoS charges or credits.
- The network now has full visibility of generation and receive the benefit of the matching allowing them to avoid network upgrades. They also have the ability to offer lower cost connections to new customers.

Locational DUoS Charges - Model 2

- **Demand:** the demand customer purchases their electricity directly from the market, but are charged a lower DUoS cost for any demand matched with local supply during red band DUoS periods. The saving is 5.3p/kWh matched demand, which, under the assumption of 15% matched demand gives a saving of approximately £15,000 against base case. Also:

    - The site has the potential to reduce their electricity bill further as they work to better match their demand to the local generation profile.
    - Depending on the generation profile in the area, they may be able to claim they are procuring renewable electricity.
- **Generation:** the generator’s income remains the same as the base case.
- Demand and Generator together: The total cost and income when both are considered together would in this case decrease by £15,000. For the saving from matching to be shared between demand and generation an arrangement would need to be made.
- **Local Network:** the network works with a local matching platform to match customer and demand profiles and receive data to calculate the appropriate DUoS charges or credits.
- the network now has full visibility of generation and receive the benefit of the matching allowing them to avoid network upgrades. They also have the ability to offer lower cost connections to new customers.

10 Conclusions

The existing socialised DUoS charging model does not allow DNOs to maximise the potential value from more local matching of demand and supply. This study looked at a number of ways that effective price signals can be provided to improve the amount matched at a local sub-station level.

The first alternative is an existing solution of a Network Replicating Private Wire. This provides strong signals to the demand and supply participants to match their loads. However, there is no signal to locate in areas of network need. This model has downsides in scalability as very few businesses have the ability to participate in a NRPW. It also has problems through the netting of demand and supply leading to likely addition of cost to the wider distribution customer. There is also some lack of transparency in the arrangement that can impact the ability of the DNO to plan and manage local networks.

The study then explored a new model of a Virtual Private Wire. This model avoided some of the downsides of the NRPW by providing better transparency and compensation through leasing charges that can benefit both the DNO and wider distribution customer. There is also potential to incentivise use of the model in areas of network need. However, the netting off of demand and supply remains a problem in that policy costs levied on unit prices is then borne by fewer customers. There are also regulatory changes required.

The final model that was investigated was locational DUoS charging where price signals encouraging local matching are sent through different rates for matched and unmatched demand and supply. The price differential was estimated using two methods through projected savings from matching. This model has a different profile as it allows anyone to participate and benefit. Weaker price signals lead to lower incentive to locally match for individual customers, but that may be made up for through volume as it allows anyone to participate and benefit.

The below table summarises the impact of the different models on different market actors and drivers.

	DNO impact	Participant impact	Energy system impact	Wider distribution customer	Better local balancing	Rollout potential / Scalability
CDCM socialised DUoS charges	2	2	2	2	1	3
Network Replicating Private Wire	2	3	2	1	3	1
Virtual Private Wire	3	3	2	2	3	2
Locational DUoS charges	3	2	3	3	2	3

Based on this study we recommend there is value in exploring further models that can incentivise better local matching and hence contribute to a locally optimised electricity network. Alternative policy recovery options may remove the barriers to a VPW, however these would also reduce the value of such a scheme. There is likely to be more potential for investigating further the principle of locational DUoS charging with matched and unmatched price signals. However, we acknowledge that there are significant complexities in achieving this. Particular issues include how to share the value of matching fairly between demand and supply participants and, related to this, how the differential may vary between a demand-dominated and a supply-dominated local area.