FLUENCE
A Siemens and AES Company

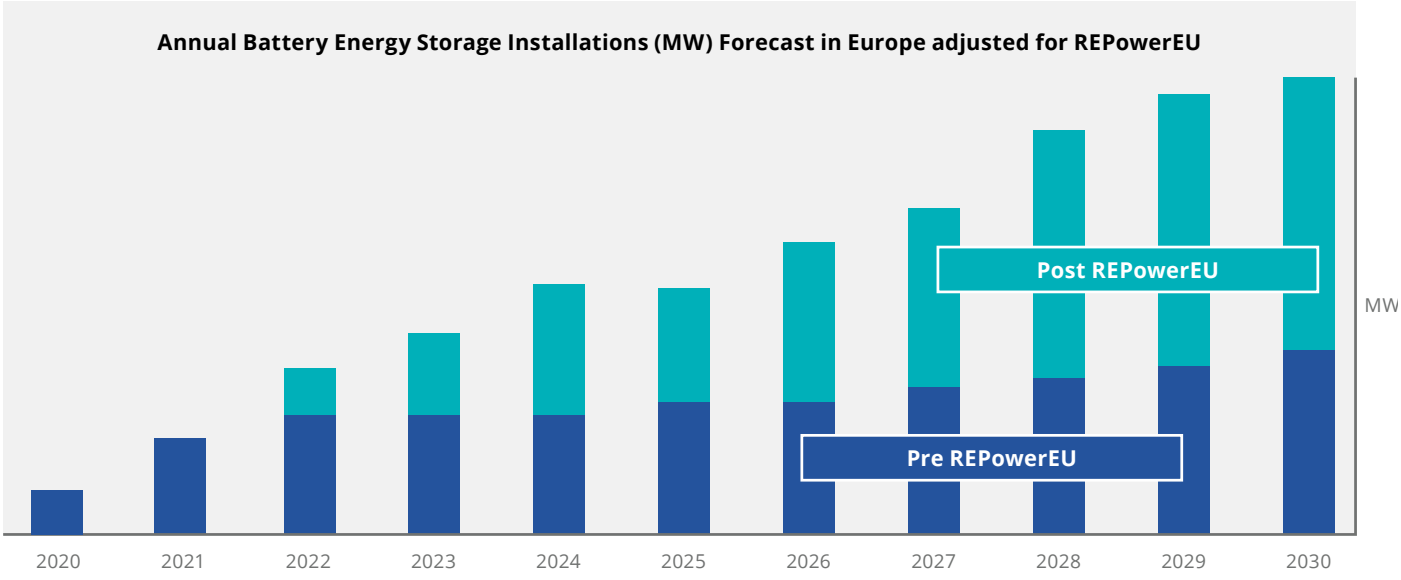
POLICY WHITEPAPER

Reforming Electricity Market Design: Integrating Renewables to Decarbonise the Power Sector

by Julian Jansen, Growth and Market Development Director
Lars Stephan, Policy and Market Development Manager

There is an urgent need to rethink the structure of the European energy system. The current geopolitical situation across the continent, combined with high dependency on imported natural gas, growing electricity demand, and consequently, higher bills for households and businesses needs the immediate attention of policymakers.

The REPowerEU Plan, published in May by the European Commission, aims to increase the security of energy supply by building and connecting more renewable generation to the grid. It includes increasing the target of energy generated from renewable sources to 45 per cent by 2030, up from 40 per cent compared to last year's targets. This would bring Europe's renewable energy generation to 1,236 GW by 2030, including the installation of 320 GW of new solar PV by 2025. As a direct result of REPowerEU, the cumulative solar capacity will surpass electricity demand in several European countries by the middle of this decade.



[1] *Source: Data adapted from range of sources including IHS Markit/S&P Global, BNEF, WoodMac., and Data includes some markets outside of the EU such as the UK*

The Impact of REPowerEU on Energy Storage

This unprecedented acceleration in renewable build-out will result in new challenges for the integration of this additional capacity. Based on the REPowerEU package, market analysts forecast energy storage deployment to double in Europe between 2022-2030. The primary driver behind this is the need for energy storage to provide the flexibility necessary to integrate the increasing levels of renewable generation.

The Need for Targeted Policy for Flexibility Assets

The current European energy policies fail to create a market environment to support the rapid large-scale deployment of new storage projects. For the REPowerEU plan to be successful, it must be accompanied by adequate targets and policy frameworks for the deployment of energy storage and other flexibility technologies. Such frameworks are necessary to enable the safe and efficient integration of renewables into the electric grid, and now is the time to recognise them as pillars of the European energy transition.

Failing to prepare for the build-out of flexibility technologies and grid infrastructure to match the pace of the roll out of renewables will result in increasing congestion on power grids, curtailment of renewable generation, continued CO_2 emissions from the power sector, and increased cost to consumers.

In this white paper, we outline policy proposals that will create a market environment with stronger investment certainty for flexibility assets to foster renewable integration and reduce emissions in the power sector.

Proposal 1

Reforming and decarbonising the capacity mechanisms by

a) Decreasing the existing carbon cap over time

b) Linking capacity mechanism payments to carbon intensity

c) Establishing Longer contracts for new-build low-carbon assets

Proposal 2

Incentivising flexible and low-carbon Peaking Capacity by

a) Establishing mandatory Renewable + Storage auctions

b) Establishing Contract for Difference (CfD) for flexibility and curtailment prevention

POLICY PROPOSAL

Decarbonising Capacity Mechanisms

The Capacity Mechanism (CM) is an integral part of European Electricity Market design as a temporary measure to ensure the necessary means of resource adequacy in the European and national electricity markets. The energy crisis of 2021/2022 as well as extreme climate events in the summer of 2022 have highlighted the need to ensure sufficient generation capacity to meet peak demand in the European power grid.

Whereas the European Union's clear response to the above events is the focus on acceleration of the energy transition as outlined in REPowerEU, CM design needs to be adjusted to go in lockstep with the decarbonisation strategy of European powermarkets and to prevent an unsustainable lock-in effect of carbon intensive thermal generation assets via CMs.

This paper proposes three key changes to the Capacity Mechanism in the regulation on the internal market for electricity:

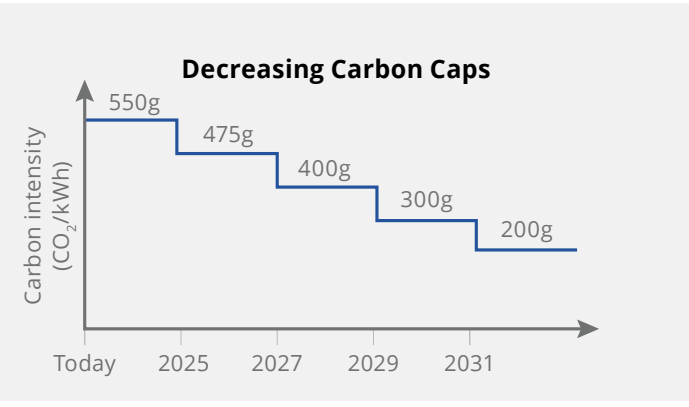
1) Decreasing the existing carbon cap over time
2) Linking capacity mechanism payments to carbon intensity
3) Providing longer contracts for new-build low-carbon assets

The three proposed changes will provide a clear path to owners and operators of existing CM assets as well as clear investment signals for new-build capacity to accelerate the decarbonisation of CM across Europe.

1) Decreasing the existing carbon emission limits in CM over time

In Article 22 (4), the current CM design includes a carbon emission limit, or carbon cap, for assets to participate in the CM. To achieve a phased decarbonisation of generation assets in CMs, the carbon emission cap needs to be reduced progressively in pre-defined time-steps and based on carbon limits for emissions per kWh electricity produced as well as annualised emissions.

The already established approach with CO_2 emissions limits (based on emissions per kWe of electricity produced and as annualized emissions for a plant measured as CO_2 emissions per kWh installed) will provide an incentive to keep higher emitting generators online as back-up generators to stand-by as capacity assets in the short-term, while reducing their operating hours in electricity markets. This ensures Europe makes appropriate use of existing carbon-generation capacity as back-up resource and provides a clear timeframe and revenue slope for legacy carbon-generators and their operators. At the same time, emission caps need to be lowered progressively to ensure a timely market exit of high-carbon emitting assets to enable market integration of new-build low-carbon assets.



2) Link capacity mechanism payments to carbon intensity

In addition to fixed carbon emission limits, CMs should include market-based mechanisms to incentivize low-carbon assets to enter and high-carbon assets to exit CMs. Therefore, we propose scalars for CM payments based on carbon intensity.

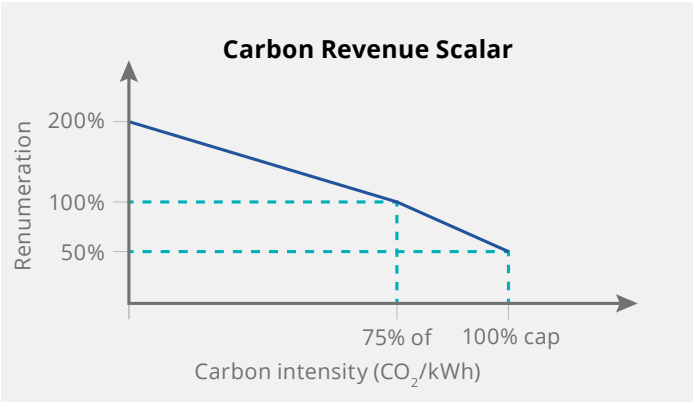
CM payments should be structured as follows:

a) 200% payments of CM clearing price to assets that emit zero carbon

b) 100% payment of CM clearing price to assets that emit 75% of the maximum allowed carbon emissions within each timeframe as defined in Article 22 (4)

c) 50% payment of CM clearing price to assets that emit the maximum allowed carbon emission within each timeframe as defined in Article 22 (4)

De-rating of assets depending on certain characteristics, such as availability is a common theme in implementation of CM across Europe. A scalar based on carbon intensity is therefore in line with existing CM implementation.



3) Provide longer contracts for new-build low-carbon assets

To incentivize new build of low-carbon assets and their integration into CMs, we propose to provide multi-year contracts to these assets. This will provide revenue certainty and therefore increase low-interest rate capital availability to those projects.

We propose to provide CM assets that emit a maximum of 10% of the carbon emission limit for the respective year, as defined in Article 22 (4) with long-term contracts of at least 15 years.

Providing long-term contracts for certain assets is a CM design mechanism that is already implemented in various member states. Basing long duration contracts on carbon intensity is therefore in line with existing mechanism and targeted at the decarbonization of the CM.

The detailed changes for Article 22 of the Regulation 2019/943 on the Internal Market for Electricity can be found in Annex1.

POLICY PROPOSAL

Building Flexible and Low-Carbon Peaking Capacity

Peaking capacity is defined as power generation assets that generate electricity during peak demand periods and is differentiated from so-called base-load capacity that operates continuously in power markets. Peaking plants only operate for a limited number of hours per day or even per month and do so at a low asset capital cost and a high marginal cost. In Europe, these assets have traditionally been oil or diesel-fueled power plants or Open-Cycle Gas Turbines (OCGT). Electricity generated from these assets is typically the most expensive in the market and their price-setting nature coupled with high gas prices results in the high electricity prices currently observed in Europe.

Fast-ramping peaking capacity will be critical in the future as a corner-stone flexibility option for the integration of large amounts of volatile renewable energy. Peaking capacity reserves ensure sufficient capacity to supply power during peak demand periods. Today's reliance and focus on gas-based peaker plants comes with the risk of a carbon lock-in of generation-emitting assets, including import dependency on natural gas.

In a future electricity system that is based on renewable energy, it is essential to decarbonize Europe's peaking power capacity. At the same time, surplus renewable generation (meaning renewable generation above the instantaneous load) must be stored and shifted from periods where production is higher than demand into periods where renewable generation is not sufficient to supply the full load. This can be achieved with a range of low-carbon flexibility options, including demand response and energy storage. However, today's reality is that this energy is instead being curtailed, thus wasted.

Existing pumped-hydro resources in Europe already function as low-carbon peaking capacity in our power grid, reducing overall energy cost by shifting renewable electricity from daytime periods with low wholesale market prices to periods with high wholesale prices during evening high-demand periods. Hence, this concept is not new to European power markets, and we need to define policy to accelerate the integration of a new generation of flexible and low-carbon peaking capacity.

This paper proposes two key changes to the electricity market design that will enable flexibility options via market mechanism to balance generation and demand on the grid, reducing curtailment of renewables and replacing peaking capacity with low-carbon peaking capacity. These market design options include:

1) Mandatory Renewable + Storage auctions
2) Contract for Difference (CfD) for flexibility and curtailment prevention

The two proposed market design options will provide a clear path and investment incentives to accelerate the focus on flexible and low-carbon peaking capacity, unlocking socio-economic savings for European energy consumers.

1) Mandatory Renewable + Storage auctions

The balancing of generation and demand in renewable-driven power systems can take place at various locations in the grid: connection with load, with generation, or via stand-alone assets in the power grid. The future energy system will require an optimised mix of flexibility options at all locations throughout the power grid.

The combination of flexibility options, such as energy storage with renewable generation assets, creates socio-economic benefits in the power system that are currently not accurately captured and rewarded. Some of these benefits include:

- Higher utilisation of grid connections, resulting in lower requirements for grid extensions
- Higher grid utilisation, resulting in lower grid fees
- Reduction of renewable curtailment
- Increased investments in renewable assets by reducing exposure to negative or low-price periods (renewable cannibalisation effect)
- Acting as dispatchable assets, feeding electricity to the grid when the residual load (load minus renewable generation) is highest
- Energy storage adding capability to provide system services and other grid benefits such as active voltage and reactive power management, frequency regulation and inertia services, and short-circuit contributions

As some of the above-mentioned benefits are renumerated or can be capitalised upon, others such as prevention of renewable curtailment or increasing transmission utilisation are not incentivised in most markets. Creating policy and market mechanisms to reward hybrid assets for these contributions would require complex market design and renumeration mechanisms.

We therefore recommend a more practical approach: Build-up of renewable + storage capacities in member states via mandatory co-location auctions. These auctions could take different forms:

- **As auctions for co-located assets,**
- **As minimum shares for co-located assets to be awarded in renewable auctions, or**
- **As stand-alone storage auctions, if operated as part of a renewable portfolio**

Such auctions have not yet been widely introduced in Europe, but have proven as a successful approach in examples such as Germany's Innovation Auctions.

Member states should define how the hybridisation of renewable assets with storage could best be incentivised by:

- Adjusted/higher renumeration for power produced under auction mechanisms
- Faster access to grid connections
- Reduced cost for grid access and/or lower grid fees, or
- Other suitable mechanisms

At the same time, member states could define operating guidelines for hybrid assets awarded under renewable + storage auctions to ensure they provide additional, non-renumerated benefits to the grid, such as:

- Requirement to cap solar peak feed-in
- Ban on exporting power to the grid from storage during periods of local grid congestion or negative wholesale market prices
- Other guidelines to define grid-beneficial usage of co-located assets

It is important to clearly define such regulation and not disadvantage or prevent co-located assets from participating in certain electricity market segments. It is critical to enable a market-driven approach that allows investors and asset owners to find the best locations and business cases for co-located assets.

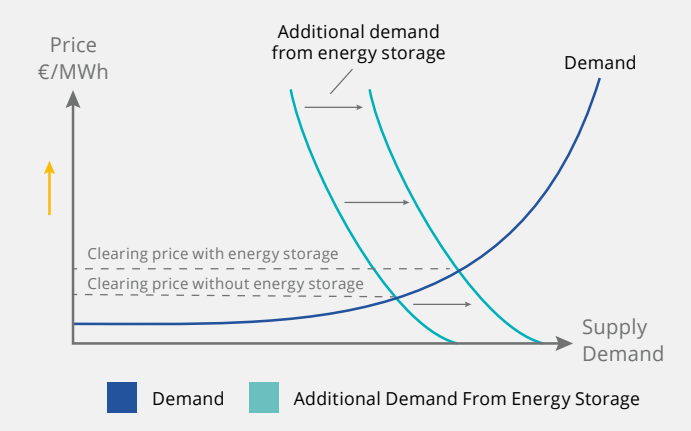
2) Contract for Difference (CfD) for flexibility and curtailment prevention

Low-carbon and flexible peaking capacity can be provided by a range of technologies. For example, energy storage can store excess electricity during periods with high renewable generation and low wholesale market prices, typically during noon time, and discharge during high price periods, which typically overlap with evening periods of low renewable generation. A good example for this flexibility provision is pumped-hydro plants (PHP), a well-established technology and business case in European power markets.

The business case of energy-shifting, and thereby providing low-carbon peaking capacity, is based on price differentials in wholesale markets between different price periods. It is often referred to as energy arbitrage.

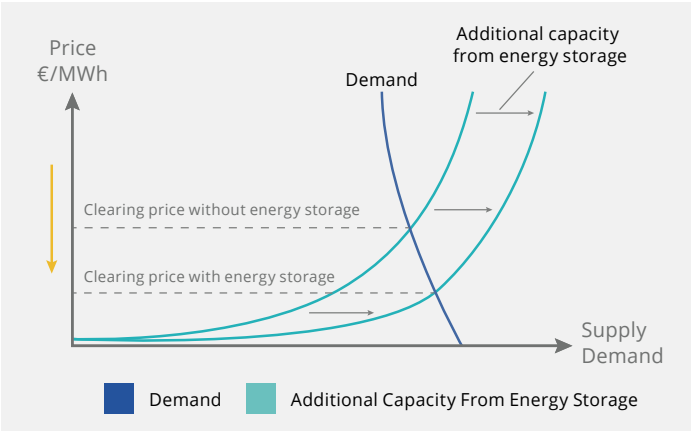
Importantly, shifting electricity from low to high price periods has the wider socio-economic benefit of reducing the overall cost of electricity. Additional energy consumption during low price periods moves clearing prices in wholesale markets only slightly (graph - A). Moving this electricity as additional supply into high price periods has a strong effect on dampening prices during those periods, as it replaces high-cost peaking plants (graph - B). As the lower clearing prices apply to all energy traded in a given period, arbitrage operations of flexibility assets result in overall system optimization and lower the cost of electricity to consumers. The investment case for wholesale arbitrage with storage has strengthened in the current energy market environment, defined by higher electricity prices and higher intraday volatility since Q3 of 2021. In the long term, high shares of volatile renewable generation will drive intra-day volatility further, with the effects of REPowerEU accelerating this development.

But despite the positive outlook, the business case of flexible assets has a major shortcoming from an investor perspective: they are fully merchant and depend on forecasted wholesale market volatility. This does not provide secure long-term revenues and thus such assets are less bankable compared to assets with long-term price guarantees or floors. This reduces access to low-cost capital funding for developers and owners of flexibility assets. Reducing revenue risk for flexibility assets will attract broader investments, reducing cost and increasing availability of capital. This will be critical to achieve an accelerated buildout of flexibility technologies needed to integrate the increasing amount of renewable energy in our power system.



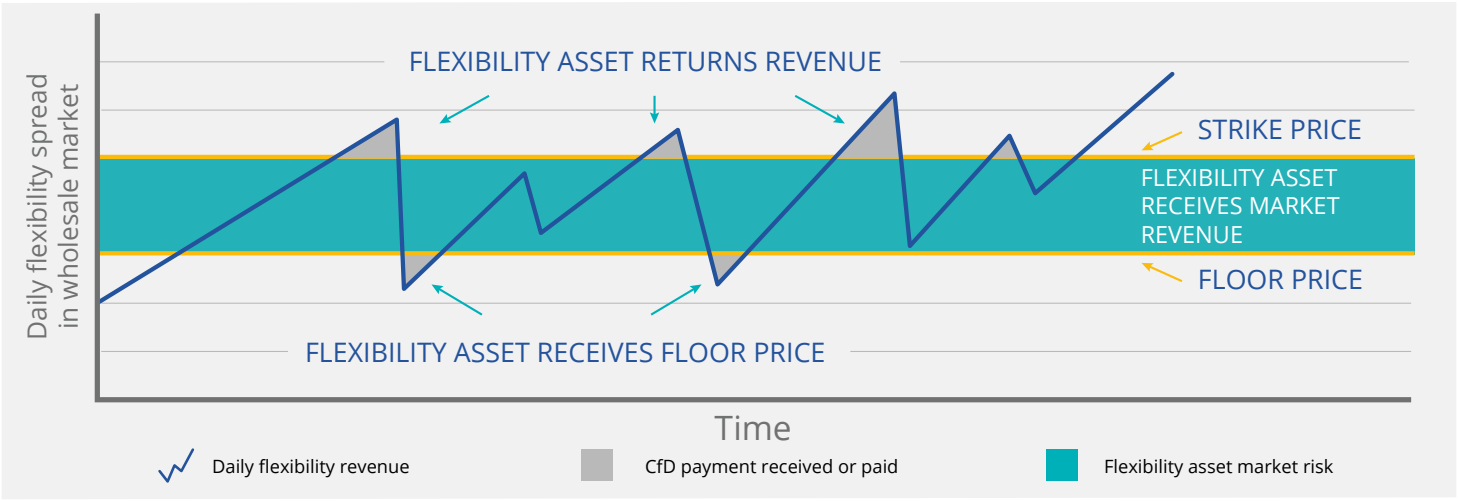
Graph - A

ENERGY STORAGE CHARGES DURING LOW PRICE PERIODS



Graph - B

ENERGY STORAGE REDUCES COST DURING HIGH PRICE PERIODS



To accelerate investments into flexible capacity, we propose a Contract for Difference (CfD) structure for energy shifting. It will provide long-term revenue certainty by providing a revenue floor for the provision of daily peak demand power, while also capping revenues above a certain strike price threshold.

The revenue floor and strike price are to be defined based on a daily or weekly arbitrage spread or absolute revenue number for flexibility assets in €/MWh. Assets will operate on a merchant basis in the existing markets. The floor price guarantee or strike price would only be applied retroactively, in case flexibility assets are not able to achieve revenues in line with the revenue band. The floor guarantee of an arbitrage spread will provide a bankable baseline revenue that will lower the cost of capital for flexible capacity projects. The cap is to be designed to prevent excessive profits for those assets.

Participation in the flexibility CfD could be linked to a discharge obligation during a pre-defined price peak period, such as during the 4-hour evening price peak. This flexibility CfD could be further amended with a curtailment prevention structure, where flexible assets are awarded an additional premium (in €/MWh) if they charge electricity that would otherwise be curtailed. This structure would provide an incentive to capture otherwise curtailed energy, which in various member states must be compensated via renewable support schemes.

It would also provide a locational price signal and result in flexibility assets to be in renewable energy areas to prevent renewable curtailment. The structure would therefore result in additional socio-economic benefits of reducing network reinforcement and increase the utilisation of existing grid infrastructure.

Contracts for a flexibility CfD could be awarded via auctions for existing and new assets with 10-15 year contracts. This would guarantee the lowest cost of procurement of flexibility assets. An auction mechanism would provide member states with a tool to control and incentivise the amount of flexible peaking capacity required to be integrated in their electricity market. At the same time, assets could be built outside of the CfD structure as well, leaving potential investors the option to pursue fully merchant flexibility assets as well. This would mirror the mechanisms used to procure capacity via capacity auctions in several European markets today.

Technical requirements could additionally be defined in terms of carbon emissions allowed from those assets, including carbon intensity of electricity stored by energy storage assets. Further start-up and ramping requirements could be defined to ensure that such assets have the capability to support steep ramps required for the integration of volatile renewable assets.

Finally, an auction-based market design with a CfD structure can provide additional revenue certainty to investors without resulting in cost to electricity consumers or taxpayers. It will provide revenue certainty for investors, based on price levels that are reflective of the expected long-term price volatility in energy markets.

Annex 1

PROPOSED CHANGES TO REGULATION 2019/943 ON THE INTERNAL MARKET FOR ELECTRICITY

Add new Article 22 (4) c - f

(c) From 2027, generation capacity that emits more than 400g of CO_2 of fossil fuel origin per kWh of electricity and more than 350 kg CO_2 of fossil fuel origin on average per year per installed kWe shall not be committed or receive payments or commitments for future payments under a capacity mechanism.

(d) From 2029, generation capacity that emits more than 300g of CO_2 of fossil fuel origin per kWh of electricity and more than 250 kg CO_2 of fossil fuel origin on average per year per installed kWe shall not be committed or receive payments or commitments for future payments under a capacity mechanism.

(e) From 2031, generation capacity that emits more than 200g of CO_2 of fossil fuel origin per kWh of electricity and more than 150kg CO_2 of fossil fuel origin on average per year per installed kWe shall not be committed or receive payments or commitments for future payments under a capacity mechanism.

(f) From 2033, generation capacity that emits more than 100g of CO_2 of fossil fuel origin per kWh of electricity and more than 50kg CO_2 of fossil fuel origin on average per year per installed kWe shall not be committed or receive payments or commitments for future payments under a capacity mechanism.

Add Article 22 (6):

(6) Capacity Mechanisms shall incorporate sliding renumeration scalars against which all assets will receive a proportional CM payment based on their specific CO_2 emissions. Key guidelines for the carbon renumeration scalar are:

(a) CM assets that emit no carbon per kWh electricity produced shall receive 200% of clearing price payments

(b) CM assets that emit 75% of CO_2 per kWh electricity produced as defined for each time period in Article 22 (4) shall receive 100% of clearing price payments

(c) CM assets that emit 100% of CO_2 per kWh electricity produced as defined for each time period in Article 22 (4) shall receive 50% of clearing price payments

Add Article 22 (7):

(7) Capacity Mechanism assets that emit 10% or less of the maximum carbon cap per kWh of electricity produced, as defined in Article 22 (4), shall be eligible to receive multi-year contracts of at least 15 years.