Financial Contract for Differences

A novel support contract for renewables and nuclear

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Financial contracts for differences: The problems with conventional CfDs in electricity markets and how forward contracts can help solve them

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ABSTRACT

Contracts for differences are widely seen as a cornerstone of Europe's future electricity market design. This paper is about designing such contracts. We identify the dispatch and investment distortions that conventional CfDs cause, the patches used to overcome these shortcomings, and the problems these fixes introduce. We then propose an alternative contract we call "financial" CfD. This hybrid between conventional CfDs and forward contracts mitigates revenue risk to a substantial degree while providing undistorted incentives. Like conventional CfDs, it is long-term and tailored to technology-specific (wind, solar, nuclear) generation patterns but, like forwards, decouples payments from actual generation. The proposed contract mitigates volume risk and avoids margin calls by accepting physical assets as collateral.

1. Introduction

Europe's energy crisis has triggered an intense discussion about electricity market reform, and contracts for differences (CfDs) are at the center of discussions. Commentators and policymakers have suggested that these long-term contracts should become a cornerstone of the EU's future power market.

In general, CfDs are financial contracts that specify payments from the buyer to the seller if, at maturity, the price of an underlying asset is below the agreed-upon strike price and a reverse payment otherwise. Such derivatives are used in foreign exchange, security, and commodity markets and are commonly traded between commercial entities.

In electricity markets, contracts for differences conventionally refer to long-term contracts between an electricity generator and a government; this is also how the European Commission uses the term in its recent legislative proposal. A traditional CfD such as the one applied to offshore wind in the United Kingdom (UK Government, 2014) uses the spot price as underlying and applies the payment only to the electricity actually produced by a specific asset, such as a wind park. This "weighting" of price spreads with production volumes sets electricity CfDs apart from those used in security and commodity markets, and from electricity forward contracts (which are contracts for differences between the spot and the forward price). It also makes these contracts more complex than many people realize, both in terms of incentives and risk allocation. This paper identifies problems with CfDs and proposes a new contract design to overcome them.

The main objective of CfDs has been to mitigate price risk for investors. Reducing price risk lowers the cost of capital and, hence, levelized energy costs (Gohdes et al., 2022). CfDs can be seen in the tradition of support schemes for renewable (and sometimes nuclear) energy, and hence an alternative to feed-in-tariffs, feed-in-premiums, and renewable portfolio standards (Newbery, 2023). In Europe, after being first introduced in the United Kingdom in 2014, many countries have used CfDs in recent years (Kröger et al., 2022), including Denmark, Greece, Hungary, Poland (Szabó et al., 2021), and Ireland (Government of Ireland, 2019). Outside Europe, Australia and Canada are among the countries using them (Australian Energy Council, 2019; Hastings-Simon et al., 2022). While some use the "conventional" British design, others have adapted the contracts significantly. The fact that CfDs, unlike most other support schemes, generate public income in times of high electricity prices has made them attractive to policymakers, particularly since the onset of the energy crisis (European Commission, 2023). In the current reform debate, they are increasingly seen as a cornerstone of electricity markets rather than just a support policy (Fabra, 2023). Some have proposed applying them to a broader set of technologies to include existing assets and impose them against the plant owner's will.

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Contracts for Differences

Long-term contracts to support generation investment

- Removing price risk to reduce capital costs
- Difference payments: Support at low prices, clawback at high
- There are many different CfD specifications (conventional & tweaks)

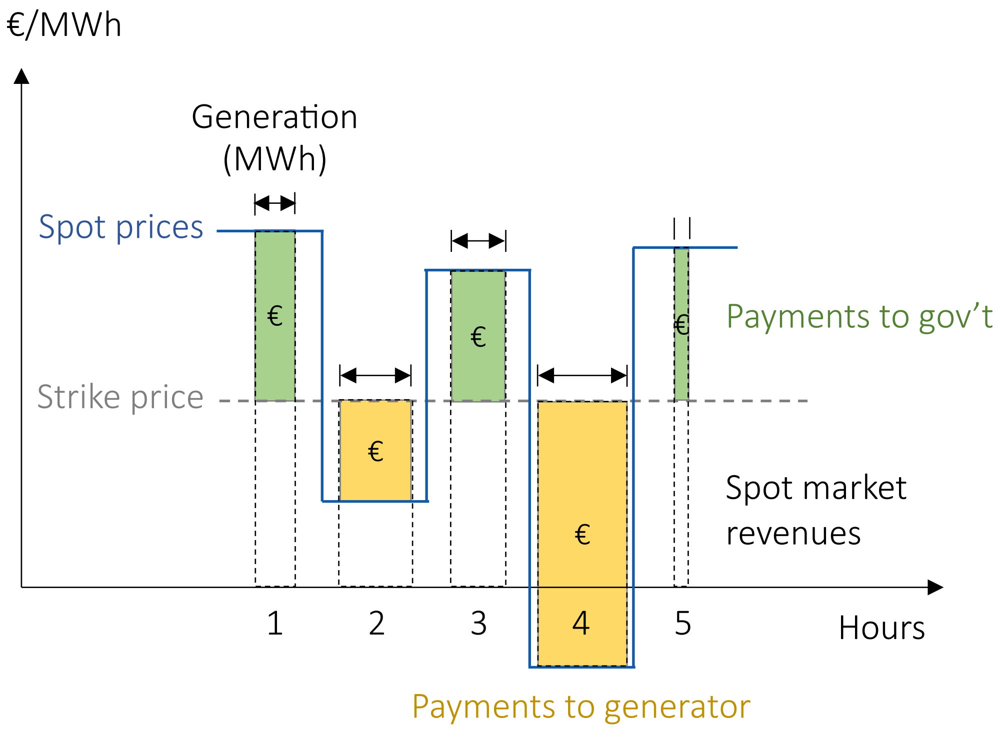
The simplest, UK-style "conventional" CfD

1. Fixed strike price, e.g. based on an initial auction
2. Underlying: hourly day-ahead price
3. Linked to a specific physical asset, "as produced"

The hour-by-hour payment

- Payment (€) = price difference (€/MWh) x quantity (MWh)
- Payment = (strike price – day ahead price) x produced volume

Strike price | Underlying | Weights (physical production of an individual asset)



Spot market revenues and CfD payments result in a stable net price earned that is equal to the strike price.

Three problems with the conventional CfD

1. Produce-and-forget incentive: produce as much as possible- regardless of value

- **Investment**: no system-friendly renewables (like higher capacity factors, west-facing solar)
- **Maintenance**: not during seasons of low demand
- **Dispatch**: no curtailment if price < variable cost

2. Intraday / balancing distortion

- Adjust bids in market stages that follow the day-ahead auction
- Inflate bids at clawback times; lower bids at subsidy times

3. Volume risk unhedged

- The price hedge deletes the negative price/volume correlation of power markets

Tweaking CfDs

1. Longer reference period
    - E.g. yearly or monthly capture prices
    - New problem: Distorted day-ahead bids
    - Fixing this causes further problems

2. Contracts for part of a difference
    - Such as 80% rather than 100%
    - Bad trade-off: Risk mitigation vs. incentives

3. Upper and lower strike price
    - Introducing a “dead band”
    - Bad trade-off as well
    - Price risk inside collar difficult to hedge

Financial CfD

A financial contract

- A contract that specifies financial payments btw gov't and generator
- No delivery of MWh – physical sales through the spot market

Payment from gov't to generator

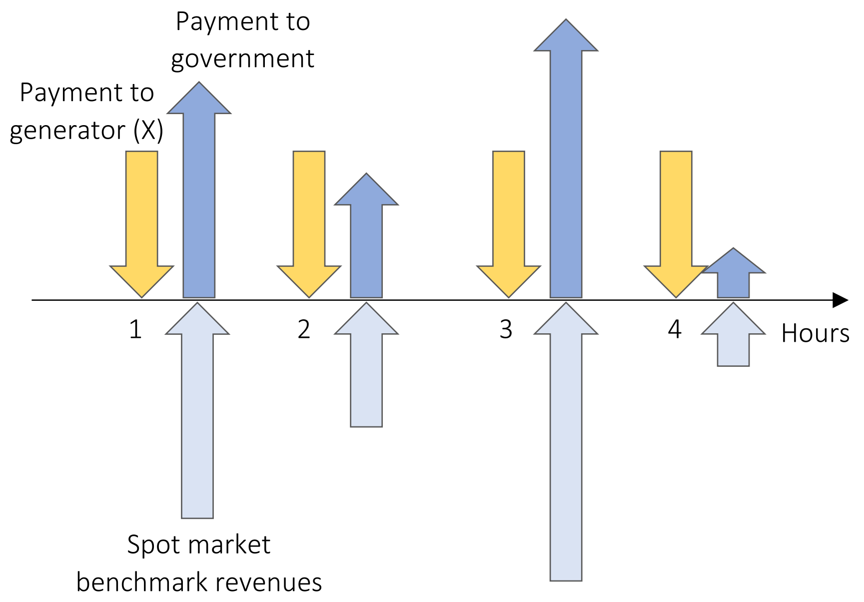
- Fixed hourly payment of X €/MW for 20 years
- X determined through competitive auction

Payment from generator to government

- Revenues of a reference generator (price x volume)
- Price: Day-ahead price
- Volume: reference profile (e.g., a weather model)

Resulting payments

- Low-price or low-wind hours: net payment from gov't to generator
- High-price or windy hours: net payment from generator to gov't



Reference profile

Payments to government are not the *actual* revenues

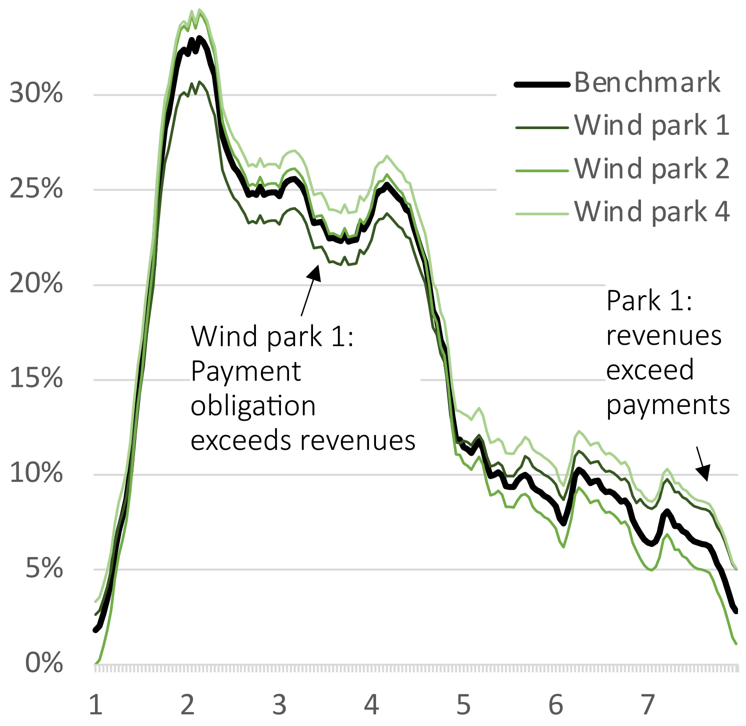
- Benchmark / yardstick revenues derived from a reference production profile
- Payments are decoupled from asset
- Imperfect match results in (minor) basis risk

Reference profiles for wind and solar

- A mathematical model that derives reference output from weather data
- A sample of actual physical wind / solar farms
- The aggregate wind / solar generation of a bidding zone

Reference profile for nuclear

- Base
- Essentially, a long-term base forward contract



Benchmark profile vs. individual wind parks (illustration).

Desirable properties of the financial CfD

Revenue risk hedged

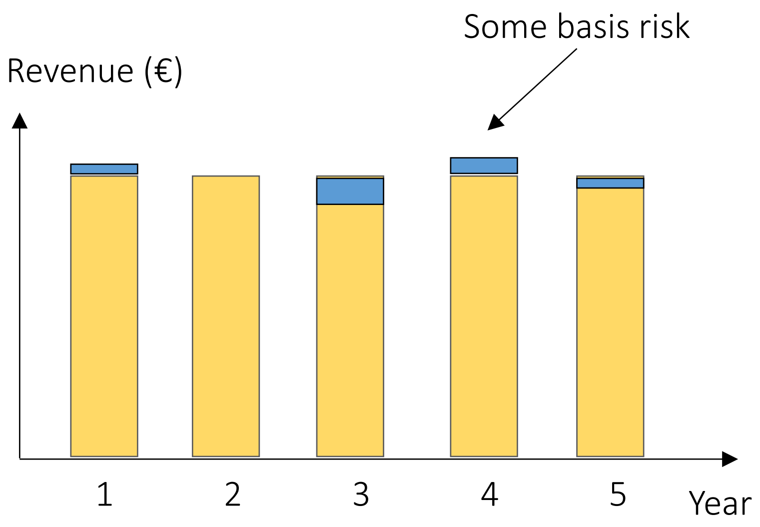
- Not only price risk, but also volume risk mitigated
- The same income every hour (+/- basis)

All distortions avoided

- Produce and forget → full spot price incentives
- Intraday / balancing distortion → undistorted bids
- Suboptimal maintenance → full maintenance & availability incentives
- Day-ahead distortion → undistorted bids

No tweaks needed

- No complicated rules to suspend payments under certain conditions



Very stable total revenues

Collateral

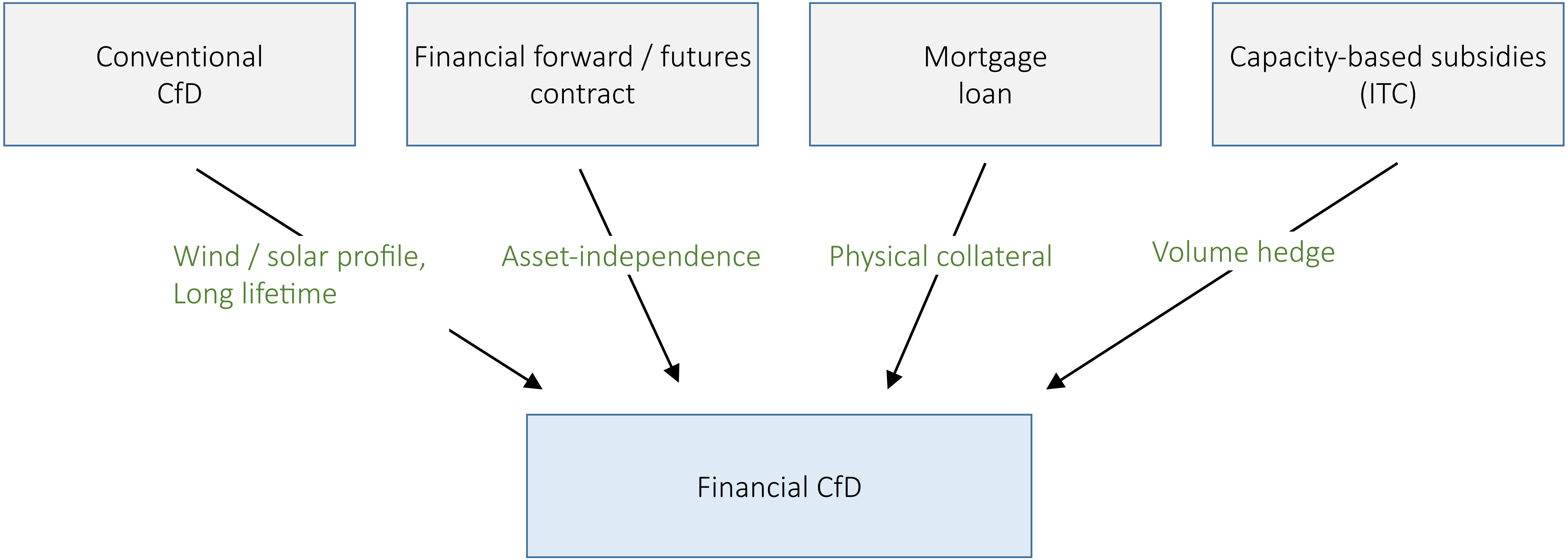
Collateral is required

- Otherwise generators have an incentive to default on the contract at times of high prices
- Like in futures / forwards

No cash margin calls

- Instead: new built physical turbine

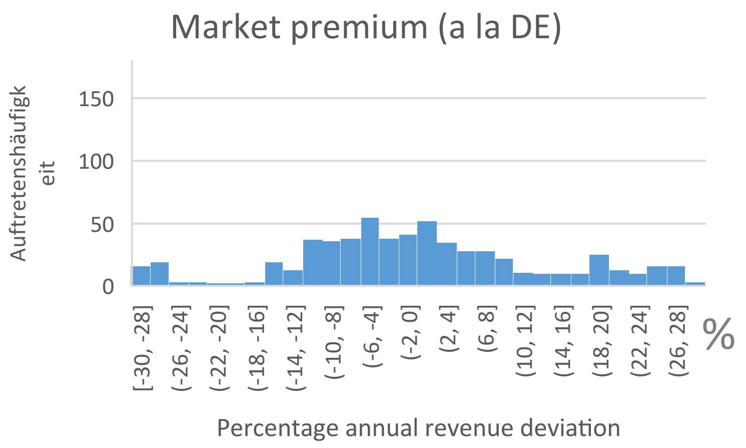
The four parents of the financial CfD

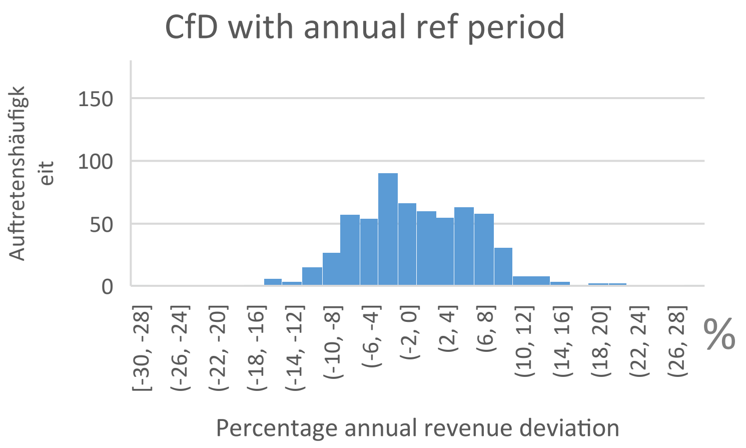


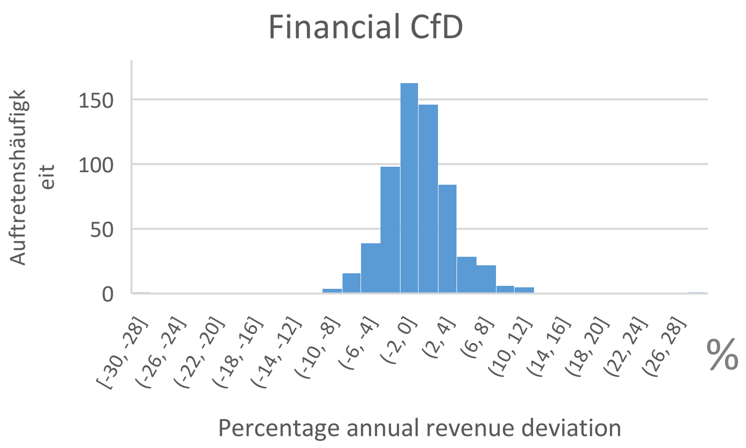
Backup

Yearly wind revenue deviation from plant-specific mean

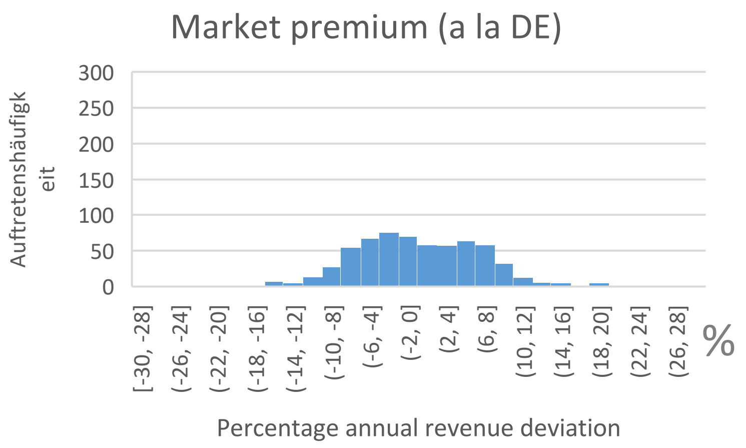
(1) Target revenue: 34 EUR/MWh · 2360 h = 80.240 EUR/MW

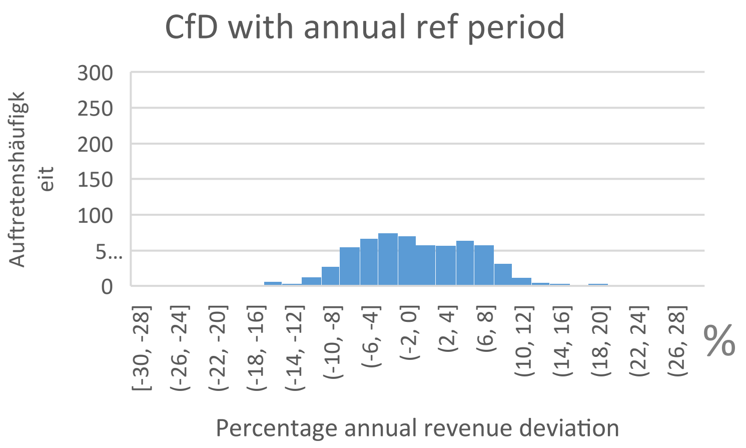


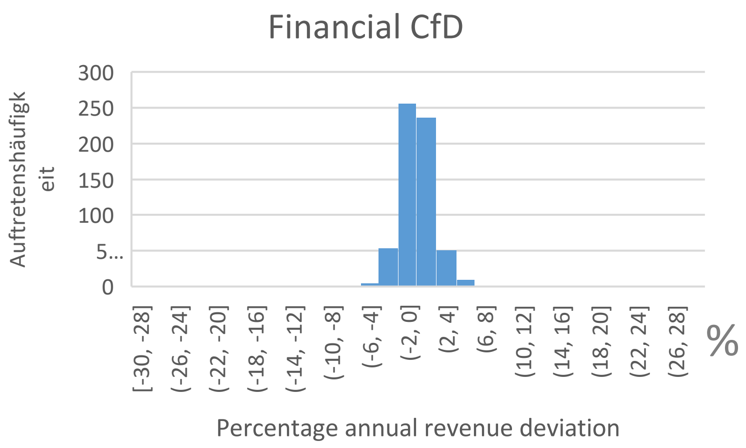




(2) Target revenue: 70 EUR/MWh · 2360 h = 165.200 EUR/MW







All graphs based on 100 wind power plants, 6 years.
Assumption: Total revenue overall all years same for all plants, i.e. “right amount of support”.
Market premium and “CfD with annual ref” are equal for high target revenue, as MP always subsidizes.

Intraday and balancing distortion

Distorted short-term markets

- After the day-ahead market has cleared, the CfD payment is fixed
- Thus, generators price it into their bids on intraday and balancing markets
- Prices on these markets are thus distorted
- Since payments are tied to output, generators can avoid payments by manipulating dispatch

High prices: prices are inflated further

- When price are high, the payment goes from generator to gov't (like a tax)
- Inflated intraday / balancing prices, withholding of capacity
- Spills back to day-ahead (and financial) markets through arbitrage

Low prices: prices are depressed further

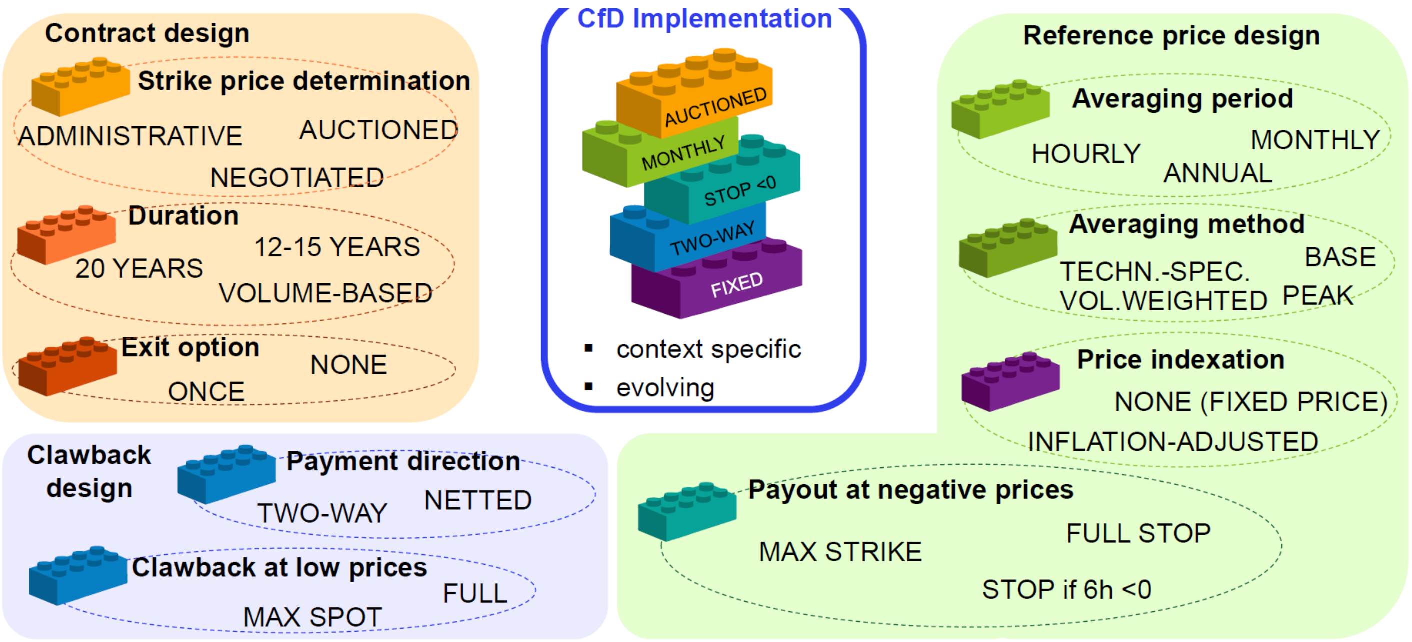
- Same mechanism, opposite sign
- Wind / solar producing at times of negative price

Tweaking CfDs

1. Longer reference period
   - Such as one-month capture prices

2. Contracts for part of a difference
   - Such as 90% rather than 100%

3. Upper and lower strike price
   - Introducing a “dead band”



1. Longer reference periods

The idea: Longer reference period

- New underlying: “reference price”, the average spot price over some time
- E.g., capture price of all onshore wind turbines in a market area during one month; annual base price
- Volumes remain as produced by an individual asset

Payment

- Payment = (strike price – ~~DA price~~ reference price) x produced volume

Different underlying

Objective

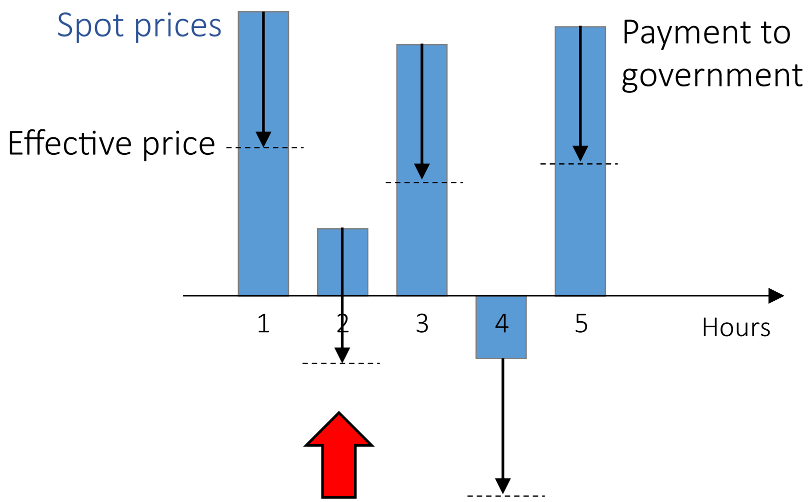
- Providing incentive to produce high-value electricity

Problems

- Pricing in (expected) payments in day-ahead bids

1. Longer reference periods: New problems

High price period



Problem:
Generator curtails during hours when prices are lower than the (expected) payments (underproduction, inflating prices)

Low price period

Problem:
Generator keeps producing despite spot prices drop below variable costs (overproduction, depressing prices)

1. Longer reference periods: Tweaking the tweak

Avoid distortion by introducing exemptions from the payment

- Suspend or reduce payments in hours when it would be distortive

Periods of high prices (tax times)

- Reduce or suspend payments in hours when margin is below expected payment
- Margin = price – variable cost

Periods of low prices (subsidy times)

- Suspend payments in hours when margins are negative

Problem: you need to know the variable cost

- Works reasonably well for wind/solar/nuclear, but not for other plants