Profile contracts for retail customers

Analysis of a tariff that incentivizes demand response while hedging customer bills

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Preview

We start by showing

- The problem with fixed electricity prices in retail markets

We present

- An electricity tariff that combines flexibility incentives and cost stability

We find out

- The new tariff makes customer electricity bills similarly stable as a fixed tariff while providing full demand response incentives from spot prices

The tariff dilemma

Integrating large volumes of RES requires demand response from flexible loads

- Efficient incentives requires variable short term price signals

It is desirable to protect consumers against price uncertainty

- 2022 EU energy crisis (higher average electricity prices)
- 2021 Texas energy crisis (extremely high spot prices)

We need a tariff that integrates both stability and efficient incentives

- Borenstein (2007) translated the concept of risk hedging instruments to electricity markets to shield against volatile real-time prices

Best of both worlds: Profile contracts

Fixed tariffs

- Stable bills
- No incentives (load-shifting / load-reduction)

Real-time tariffs

- Transmits incentives
- High volatility & cost risks

Profile contracts

- Fixed price for pre-procured profile
- Spot price deviations

Profile contracts

Hedging component

- Consumers pre-procure an energy volume
- Distributed to individual hours through a profile
- At a fixed price

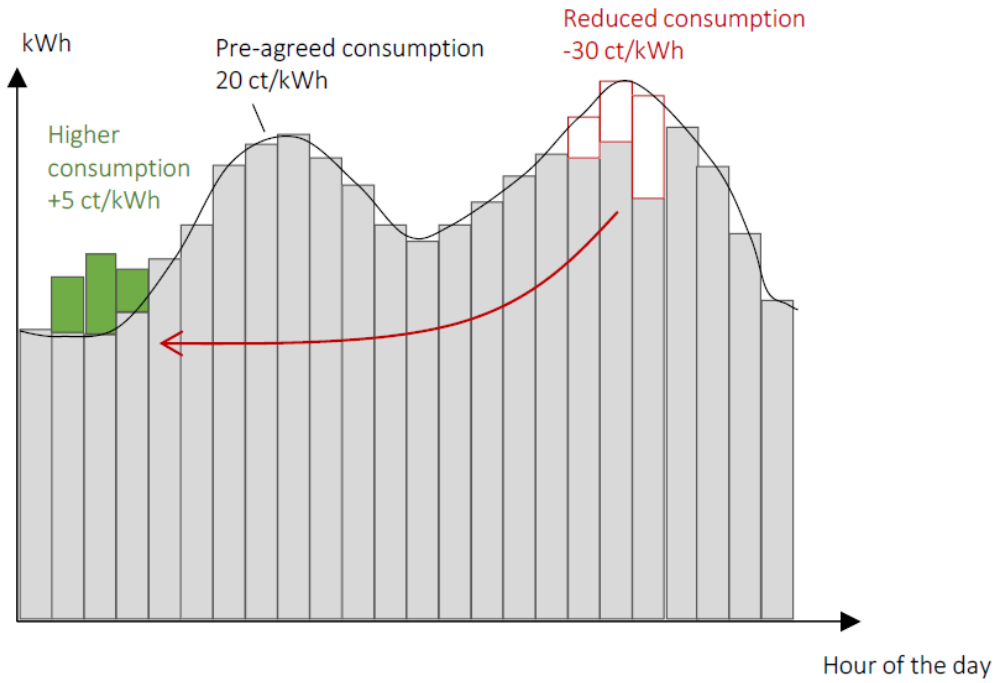
Hourly deviations from pre-agreed profile (+ or -)

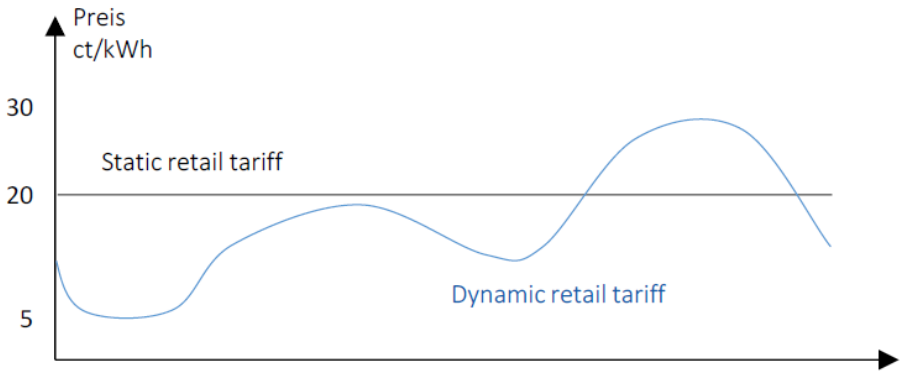
- At spot prices

Advantages

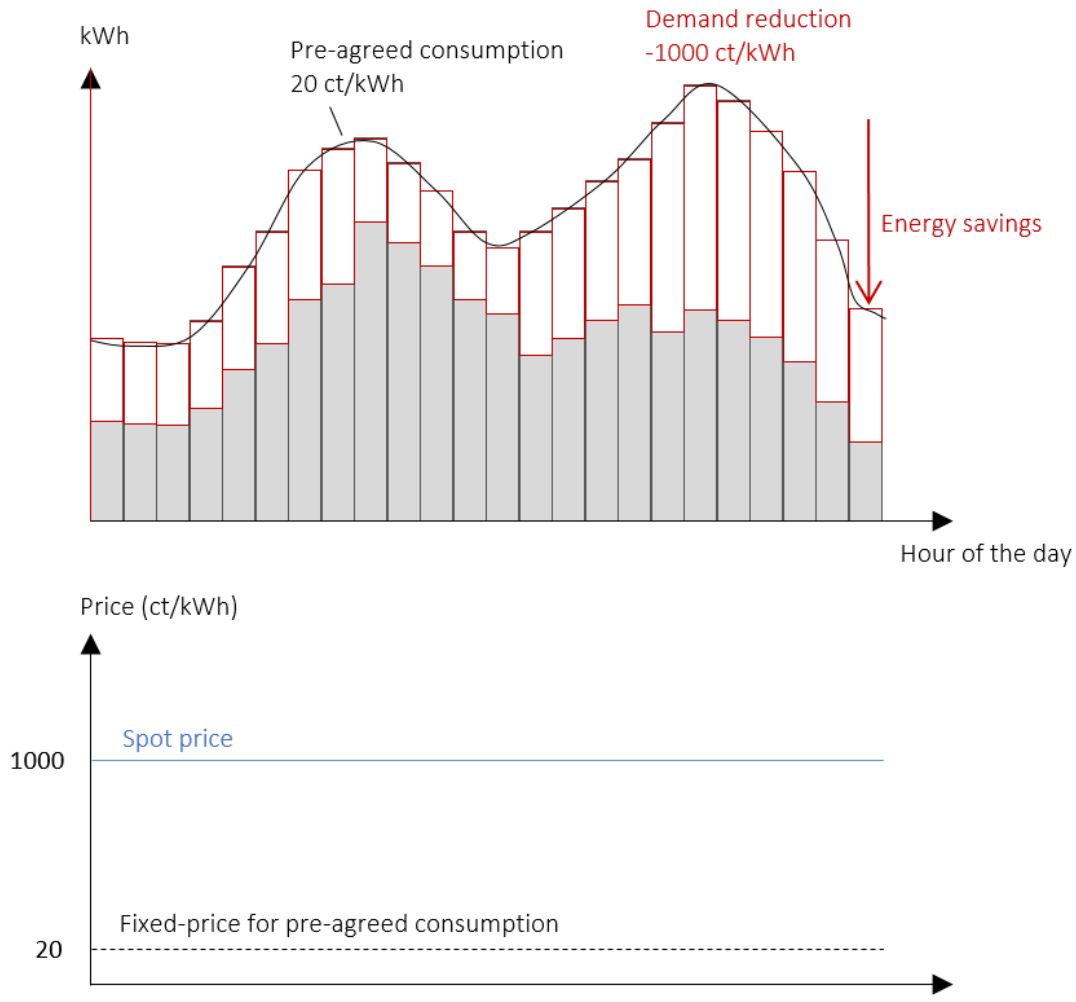
- Incentives for load-shifting
- Stable electricity bill

Incentives for load shifting





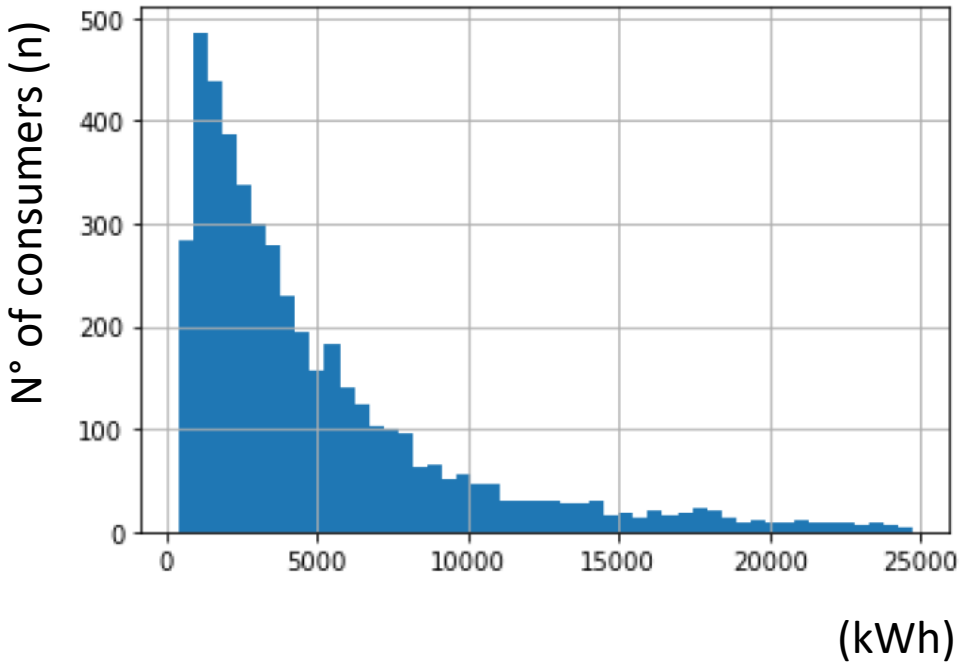
Incentives for situational energy saving



Quantitative assessment: Data

CKW dataset

- Swiss regional electricity utility
- Two year hourly electricity demand of 4958 anonymous consumers
- Consumption data for 2021 and 2022



Profile contracts components: Volume

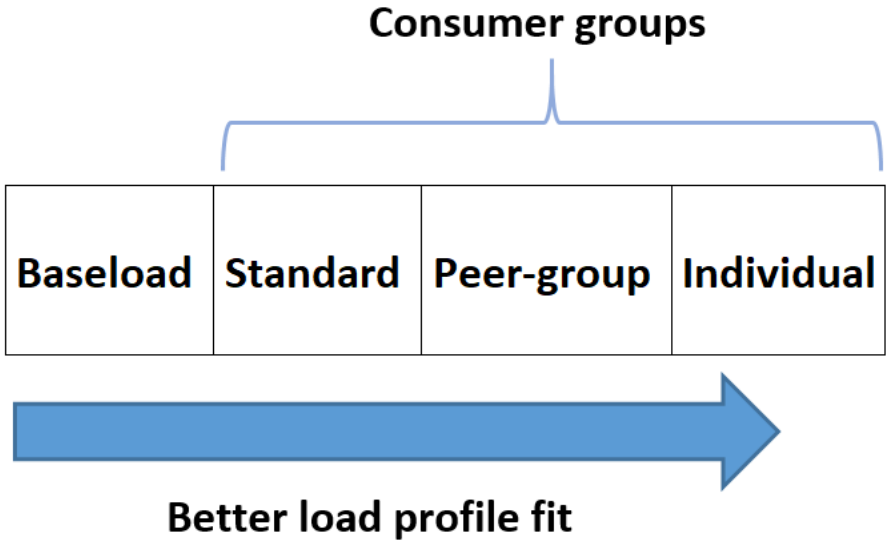
The desired amount of annual energy consumption to be hedged

- The more a consumer hedge, the less the exposure to price risk
- The reference energy volume can be obtained from the consumer's historical consumption

Profile contracts components: Shape

Exposure to spot prices can be reduced based on how we distribute the total hedged volume across time

- Differentiating between consumer groups
- Accounting for exogenous drivers



Quantitative assessment: Methodology

$$expected\_bill_{year} = consumption_{year-1} * avg\_spotprice_{year-1}$$

$$absolute\_bill\_deviation_{year} = bill_{year} - expected\_bill_{year}$$

$$relative\_bill\_deviation_{year} = \frac{absolute\_bill\_deviation}{customers\_average\_annual\_consumption}$$

Quantitative assessment: Methodology

Hedge profile scenarios

- Fixed tariff
- Spot pricing
- Fixed volume & ex-ante individual profile
- Fixed volume & ex-ante default profile
- Fixed volume & ex-post default profile

Scaling scenarios

- Standard
- Individual

Limitations

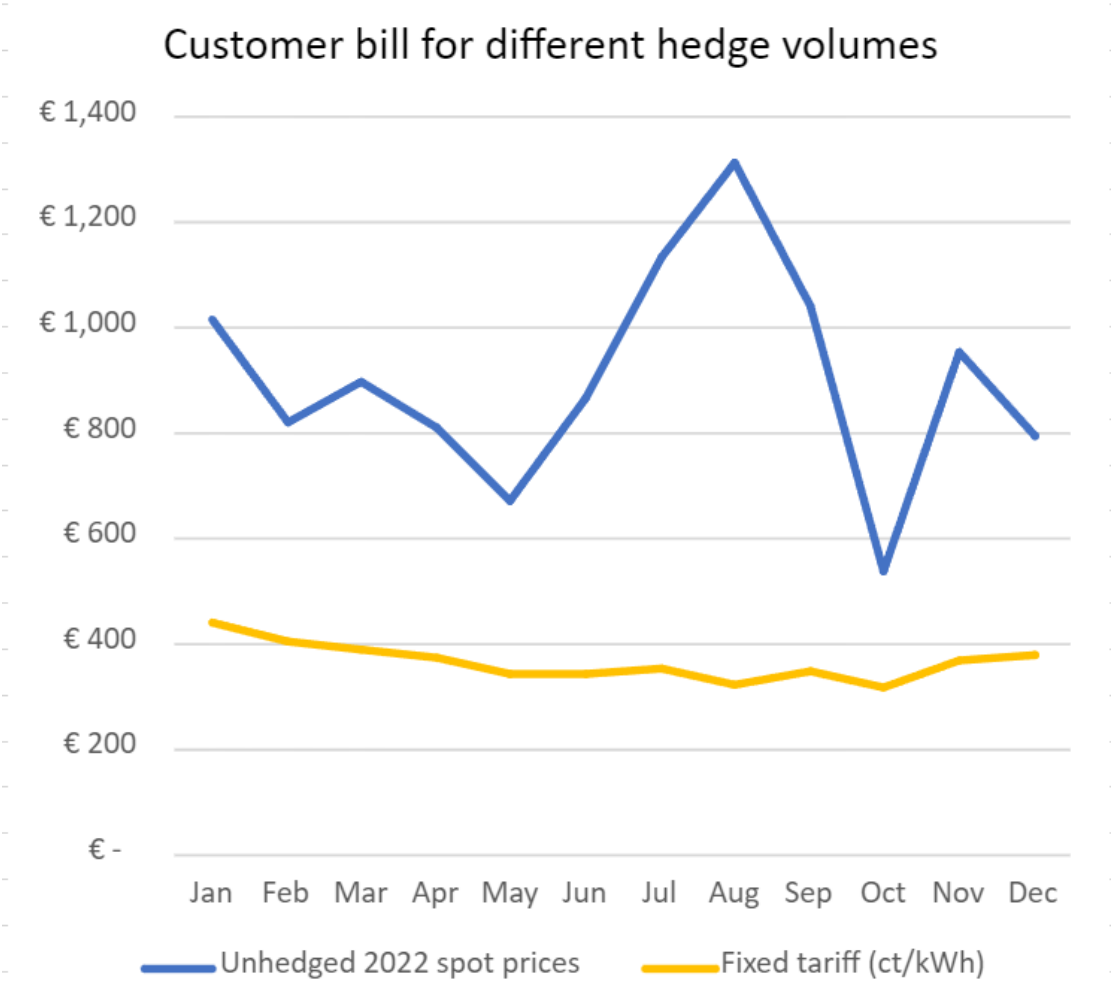
We use metered data from households, which are not exposed to the simulated tariffs

- No feedback effect between the tariff and the level of consumer demand

Additionally

- Lack of weather years with significant cold spells
- No consumer type distinction
- No demand asset description

Profile contracts: Exemplary consumer



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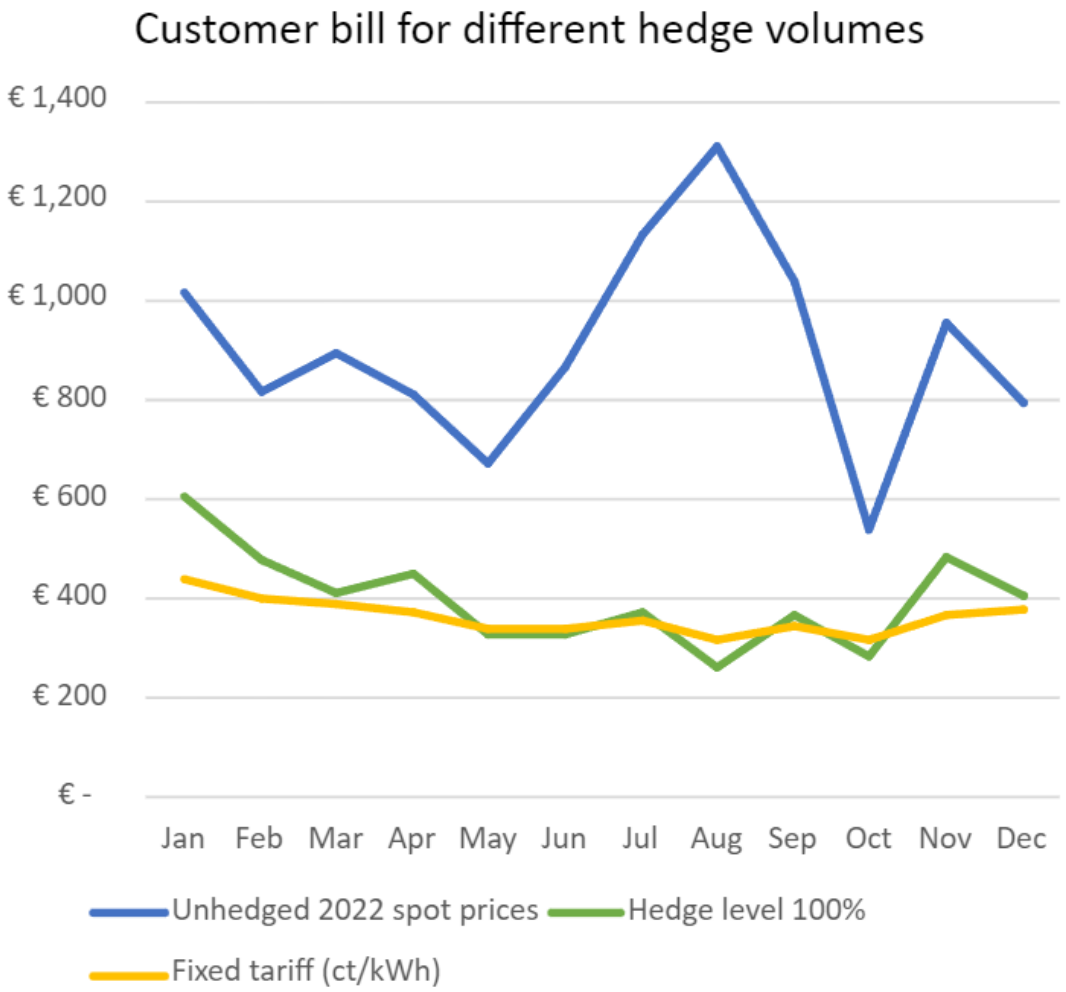

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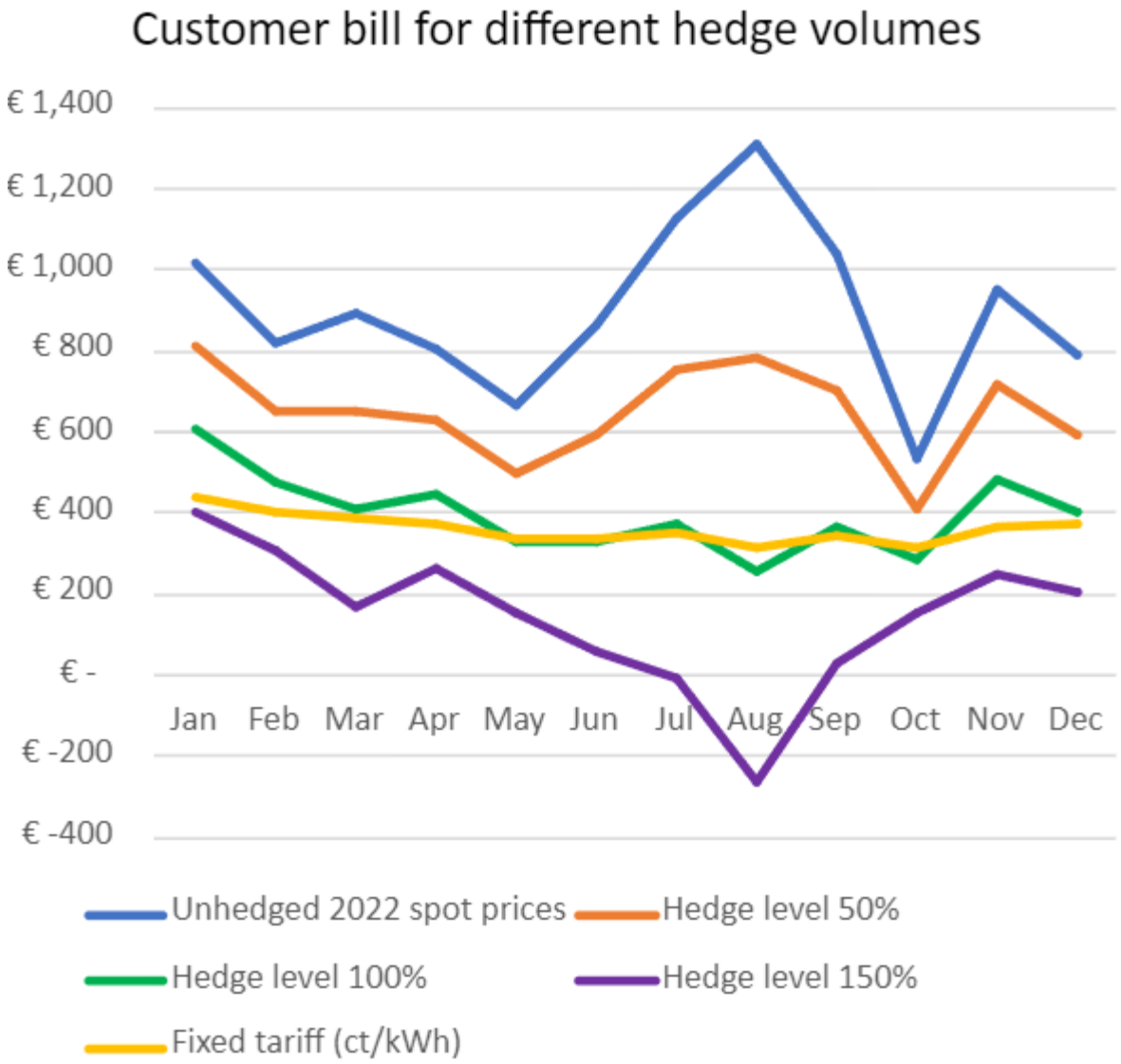
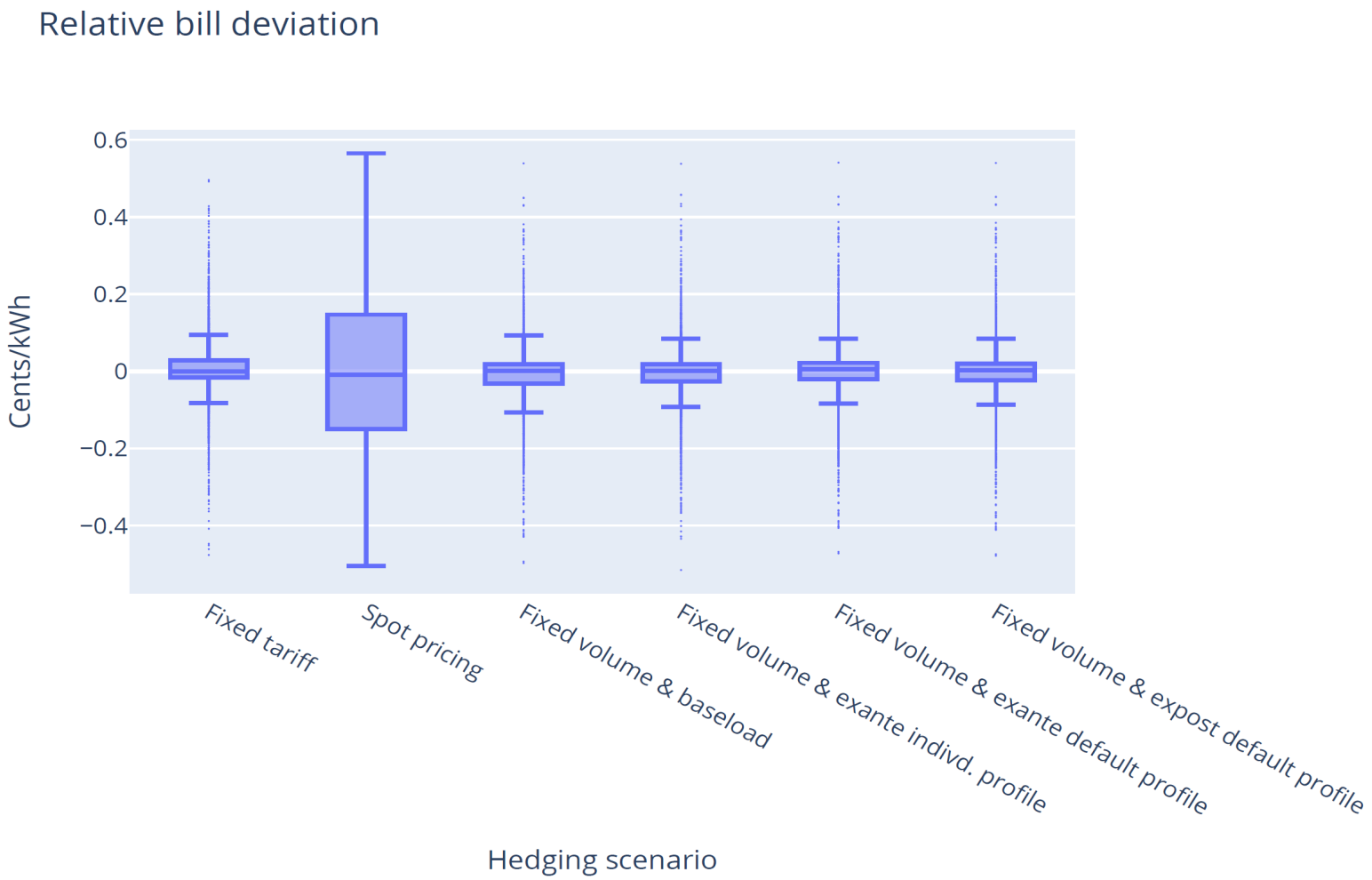


Quantitative assessment: Results



Quantitative assessment: Results

Statistics	Fixed tariff	Spot pricing	Fixed volume & baseload	Fixed volume & ex-ante indiv. profile	Fixed volume & ex-ante default profile	Fixed volume & ex-post default profile
count	9274	9274	9274	9274	9274	9274
mean	0.007	-0.001	-0.008	-0.005	0	-0.003
std	0.06	0.157	0.062	0.06	0.06	0.06
min	-0.476	-0.504	-0.497	-0.515	-0.472	-0.478
25%	-0.016	-0.15	-0.032	-0.026	-0.02	-0.023
50%	0	-0.009	0.001	0.001	0.005	0.002
75%	0.028	0.147	0.018	0.018	0.022	0.02
max	0.496	0.565	0.539	0.538	0.541	0.54

Conclusions

Our analysis suggests that profile retail contracts could effectively

- Improve bill stability significantly compared to real-time pricing
- Protect consumers from price-surges (e.g. during energy crises)
- Expose consumers to full incentives

Thank you for your attention!

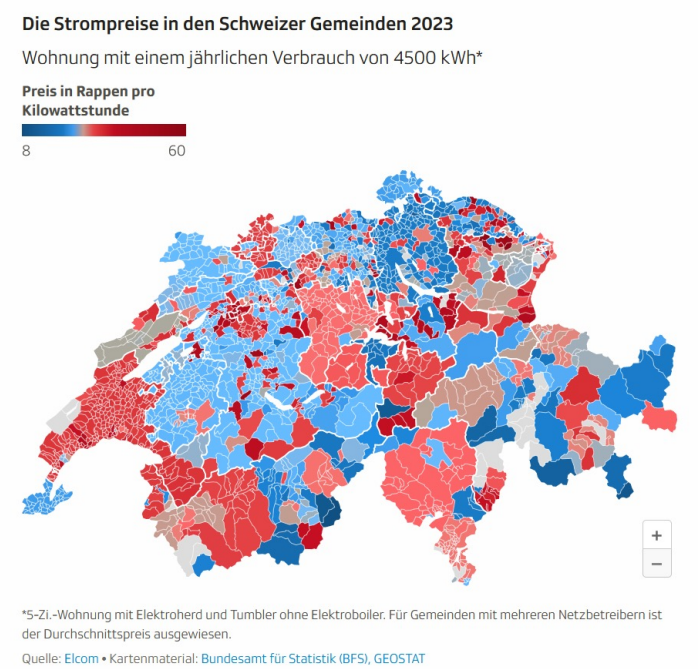
Device suppliers in a monopoly context

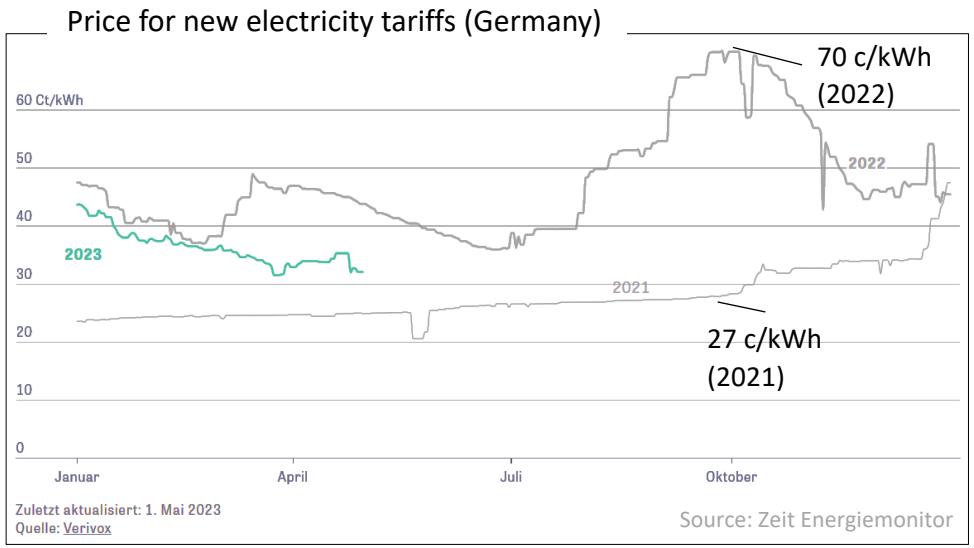
Back-up slides

Electricity cost stability: Monopoly vs. retail

Swiss electricity prices increased rather moderately

- Swiss tariffs remained more stable than Germany's (CH +5.8 Rp to 26.95 Rp./kWh for 2023)
- Some utilities hedge longer than others (own generation assets)





No price signals for consumers

Monopolist retailers kill the price signal

- Wholesale prices don't propagate to retail prices (or to a very limited extent only)

Demand response is beneficial both societally and individually:

1. It makes individual electricity use cheaper ("there's money on the table")
2. It makes the system more reliable, less resource-intensive and cheaper

Quantitative assessment: Methodology

We simulate different hedging strategies to investigate the hypothetical impact on electricity bills and per unit average costs

- We compare the deviation between expected bill and realized bills for different scenarios
- We are only interested in the energy component of retail prices
- We assume the hedge price to be the average spot price of the *other* year

The realized electricity bill is the sum of two components

- Hourly costs for the hedged amount at the agreed price
- Hourly spot costs that apply to the hedge profile deviations (+ or -)

We analyze how well the hedging function works in keeping bill deviations small

Protection from high energy costs

Retail monopoly protected Swiss citizens from high electricity prices in crisis

- Massive wholesale price increases
  - +425% for CH for Q3 year-on-year
- Consumers' retail rates remained rather stable in CH
  - CH +5.8 Rp to 26.95 Rp./kWh for 2023 (70 c/kWh in Germany)

Long-term hedges

- Most utilities hedge long-term
- Own generation assets; longer term forward contracts, etc.
  - Their customer base is stable – unlike in competitive markets

Put simply: The retail monopoly is good for electricity cost stability

Incentives from prices

Demand reactions can take different forms

1. **Energy saving**: Save more energy in an energy crisis (“price level effect”)
2. **Demand shifting**: Time your demand to low-price periods (“price structure effect”)
3. **Re-scheduling of demand**: (Re-)plan when to consume (“trading time effect”)

First best

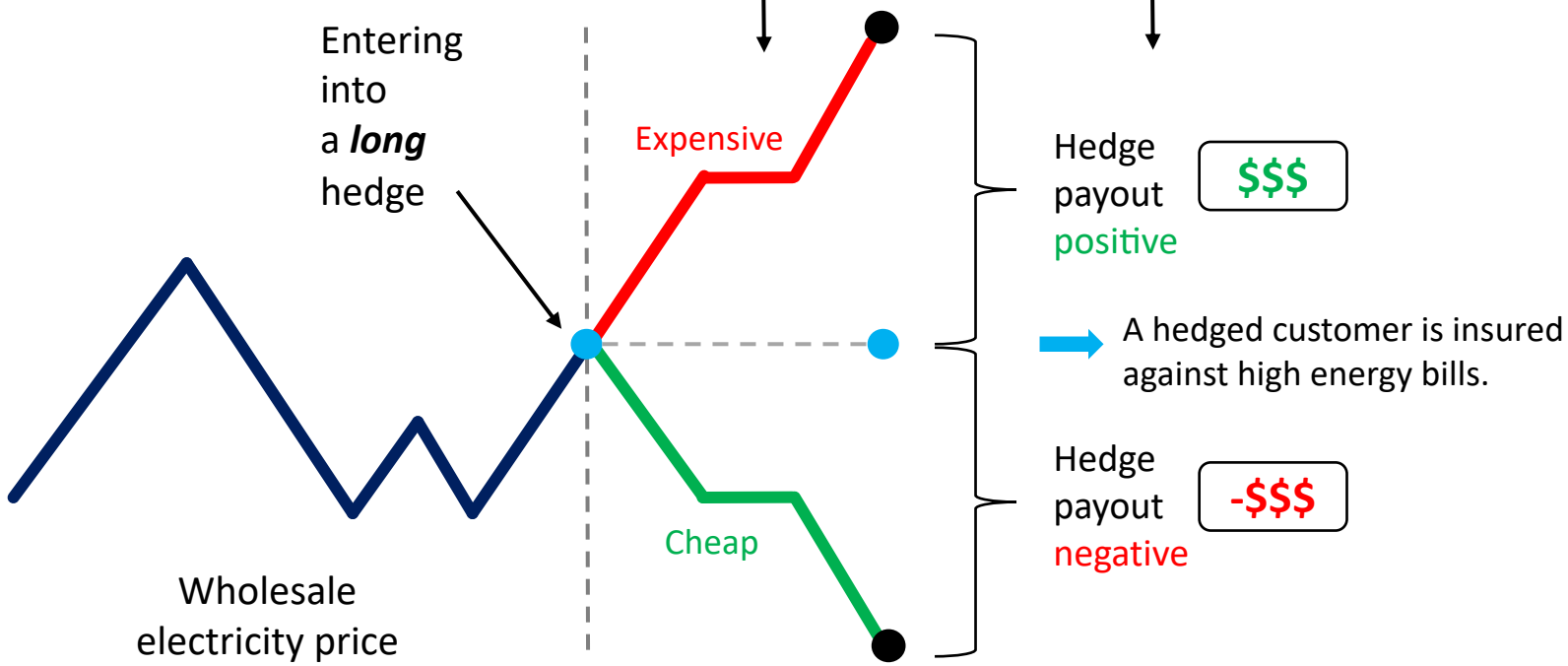
- …is when all demand reactions are fully incentivized (none muted)

Best of both worlds: Profile contracts with hedging

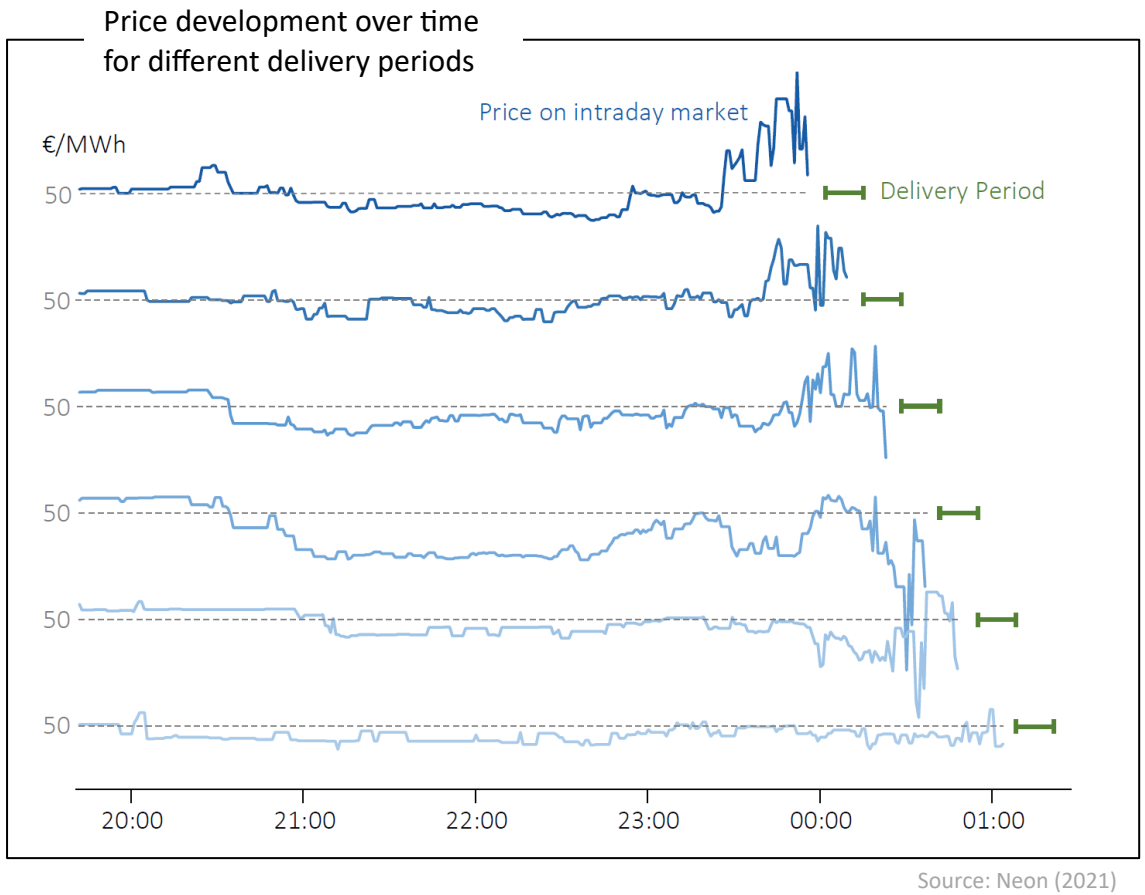
The demand side engages in ***long*** **hedges**

Long **benefits** when prices rise

The beauty of hedging
Undistorted incentives + cost insurance



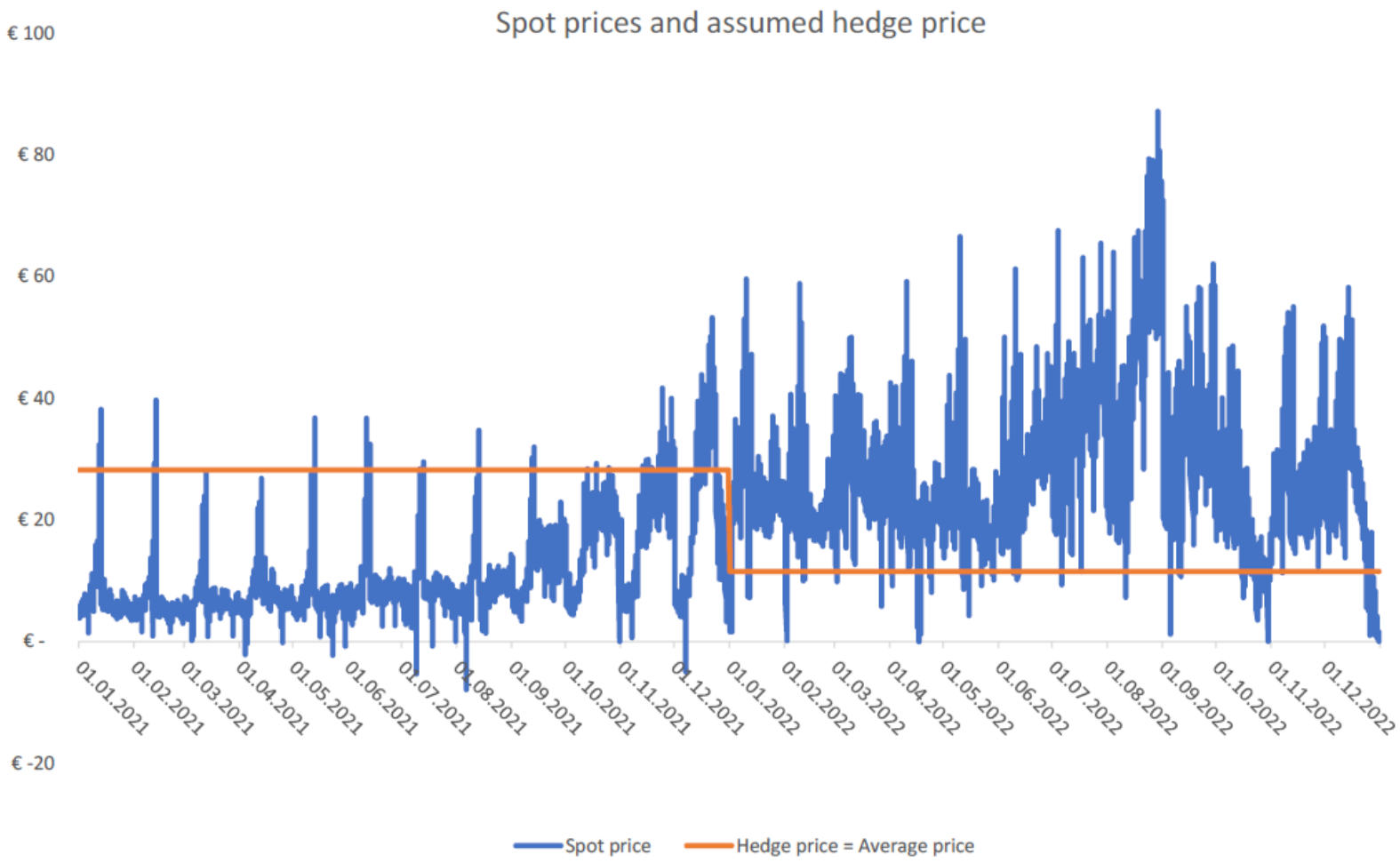
Profile contracts components: Real time price



Source: Neon (2021)

- Consumers can lock in cheapest hours early
- And then re-optimize once cheap hours change
- Even in real-time they can re-schedule
- Most of this will happen automatically in the background
- Helps the system cope with unforeseen situations
- “Option value”

Spot prices and assumed hedge prices



Limitations

The simulated customers are not subject to profile contracts

- No price reaction in their demand
- It would be beneficial to include such reactions to quantify the full benefit of the scheme

Due to limitation to a two year dataset, we cannot make final conclusions on the impact of scaling on hedging volumes

Grouping customers types could increase the benefits of the tariff scheme

- Based on device ownership or consumption profile

Profile contracts components: Scaling factor

Profile contracts could still leave consumers exposed to considerable risk

- Years when customers consume more than their long-term avg demand, prices will tipically be higher
- In the case of unforeseen events (extreme weather, wars, etc)
- Hedged volume is likely to be insufficient precisely when prices are high

To deal with this risk, consumers may want to over-hedge

- In lower than avg years, consumers will be stranded with additional costs
- The amount of over-hedging is difficult to know for a consumer

Instead of consumers defining their over-hedged volume, it would be beneficial to scale it as a function of different external factors