Temperature products

How to trade temperatures?

Design workshop for configuration, trading and delivery of temperature products as exchange traded products

Sirko Beidatsch, Natural Gas Markets

Essen, 06/02/2018

pegas is the gas trading platform of eex group, operated by powernext

Why are we here today?

- Increasing need in the EU energy business to hedge also temperature risks
- Our chance to develop an European answer for temperature products
  - Input parameter (temperature, traded hubs/market area, load profiles, prices), which match with EU standards and are available for free (incl. historical data)
  - Tradability, which allows easy usage of temperature products by many players
  - Liquidity, which brings decentralised trading interests together in a few products
  - Settlement, which minimise manual efforts per deal on customer side
  - Transparency, which increase trust and sustainability of different stakeholder (trader, decision maker in own companies, regulator) into temperature trading
- Involvement of the whole range of interested parties from now on
  - In 2016/17 already first bilateral discussions with interested customers taken place
    - Initial feedback was used to create a common understanding for temperature trading and to develop first ideas for a few simplified and standardised products
    - This made it possible, that we can now discuss product ideas with the whole range of different stakeholders and class your appreciated customer feedback
  - Enables prevention of avoidable risks in the product design and settlement process

Agenda

- Status quo – temperature hedging today in Europe
- Presentation of possible temperature products
- Proposals for standardisation of input parameter
- Proposals for contract details and settlement
- Summary and outlook

Importance of temperature trading

Revenue = business success

Around 80% of all business is directly or indirectly affected by weather.
Weather influence business of around 450 billion € worldwide.*

Agriculture
- Hedging against crop failures due to heat, cold or frost

Clothing & Sports goods producer
- Hedging against sales risks for production of seasonal goods (e.g. skis, swimwear, sun glasses)

Tourism & Entertainment
- Hedging against weather-related use of ski areas, cinemas, lidos

Construction and trade
- Hedging against weather-related downtimes, outages and delays

Automobile manufacturer
- Hedging against sales risks for production of seasonal goods (e.g. summer/winter tire)

Transport
- Hedging against weather-related delays and outages

Energy industry
- Hedging against weather-related sales risks of power, natural gas, heat and cold

Food & Beverage industry
- Hedging against sales risks for production of seasonal goods (e.g. ice-cream, mulled wine)

Finance & Insurance
- Hedging of weather-related investments and insurances

Weather derivatives (thereof ca. 95% temperature derivatives) enables stable revenues, balance sheet protection and increase of „shareholder value".

* Presentation by Mark Stephens-Row, The Weather Company, given at the Swiss Re 7th Annual Weather and Energy Conference, 07.07.2017

Market structure for temperature products

How were temperature deviations hedged today?

- No hedge – simply ignoring of market price risks
  - Underestimation of importance for business success
  - Missing experiences, trust and transparency for trading, clearing and settlement
  - Possible as long as profit margins still allow forwarding of extra costs to end customers
- Hedge via bilateral or broker trading
  - Heterogeneous, individual and non-standardised products - limited number of counterparts
  - Restricted availability, access and transparency for temperature and price data
  - High costs for initiating, execution and settlement of deals

Primary market - Hedger

- Trading for minimization/avoidance of temperature risks in the core business field
  - Energy supplier, construction companies, leisure parks, farmer, tourism, food and beverage industry
- Increase in trading of temperature products
  - Almost each trade triggers for hedging purposes at least one transaction in the secondary market

Secondary market - Investors/(Re) insurers

- Arbitrage trading
  - Trading of price differences - Intermediaries
  - Frequent opening/closing of positions for risk minimisation and profit maximisation
  - Banks, investment funds, (re) insurances, energy companies with weather desks, international active companies, arbitrageurs
- Trading of temperature products established

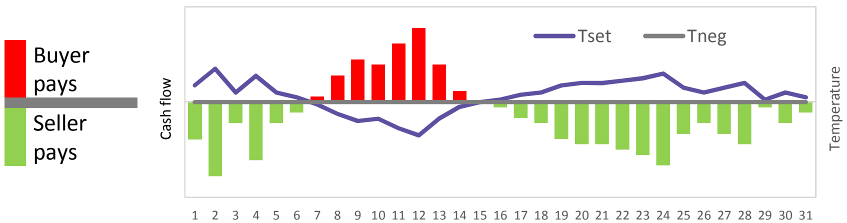
Agenda

- Status quo – temperature hedging today in Europe
- Presentation of possible temperature products
- Proposals for standardisation of input parameter
- Proposals for contract details and settlement
- Summary and outlook

Temperature products for discussion today

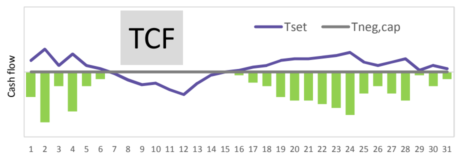
Temperature Future (TF)

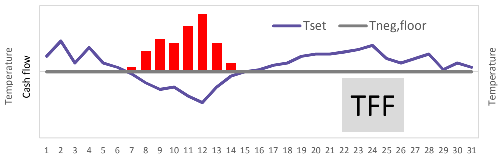
- Trading of temperature risks
  - Financial future with cash settlement
  - Cash flows inside the delivery period for **all** daily differences between traded and realised temperature



Temperature Cap/Floor Future (TCF/TFF)

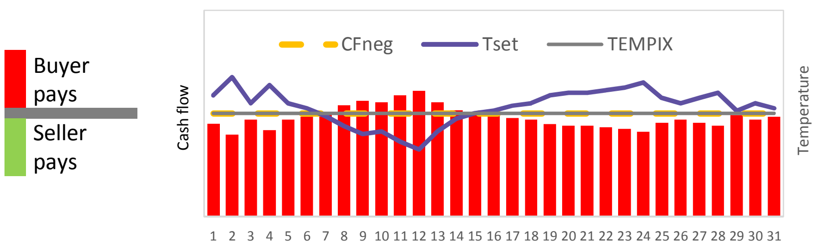
- Single-side hedge against temperature risks
  - Financial future with cash settlement
  - Cash flows inside the delivery period for daily differences between traded and realised temperature, if:
    - TCF/TFF above/below traded temperature





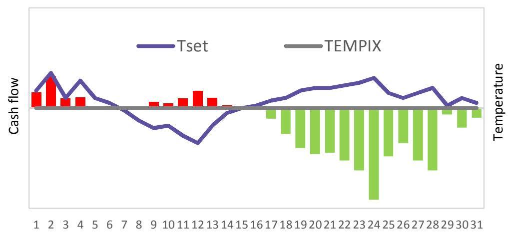
Temperature Gas Future (TGF)

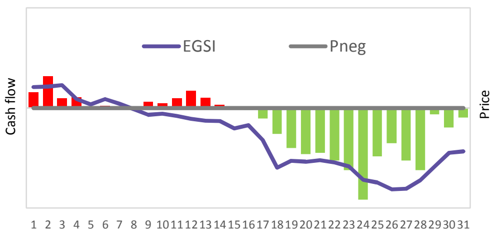
- Hedge against temperature related risks for gas sales (volume hedge) → fixed specific gas price
  - Physical future with delivery at the VTP
  - Delivery volumes & buyers payments are calculated via standardised load profile (SLP) and daily realised temperature differences from temp.-index (TEMPIX)



Temperature Gas Price Swap (TGPS)

- Hedge against temperature related risks for gas sales **and** gas prices (cross hedge)
  - Financial future with cash settlement
  - Cash flows are calculated via SLP, daily differences of realised temperature and reference price (EGSI) from temperature index (TEMPIX) and traded price





How to make temperature products tradable?

Direct trading of temperatures

- Inside the order book all temperatures are traded with absolute values in °C as price (°C ≡ €)
- Direct tradable temperature products:
  - Temperature Future (TF) - financial fulfilment
  - Temperature Cap Future (TCF) - financial fulfilment
  - Temperature Floor Future (TFF) - financial fulfilment
- Example: order book of a Temperature Future
  - Buyer enters for 800 June contracts at expected Ø-temperature of 20.24 °C the price (bid) of 20.24 €
  - Seller enters for 1,700 June contracts at expected Ø-temperature of 20.61 °C the price (ask) of 20.61 €

	Germany				Open	
	Qty	Bid	Ask	Qty	Last	TQty
①	② …	③ …	③ …	② …	④	⑤
Jun 16	800	20,24	20,61	1.700	20,52	1.000
Jul 16	4.200	23,15	23,40	300		

① Name of the delivery period
② Quantity of requested/offered TF per day (≡ €/day)
③ Price for buy/sell of Temperature Future in € (≡ Temperature in °C)
④ Price of last traded Temperature Future on a trading day
⑤ Sum of all traded TF for the delivery period on a trading day

Trading of temperatures via other products (indirect/implicit)

- Inside the order book all temperatures are priced & traded indirect via other products in €/MWh
- Reference temperature for trading is TEMPIX
- Indirect tradable temperature products:
  - Temperature Gas Future (TGF) - physical fulfilment
  - Temperature Gas Price Swap (TGPS) - finan. fulfilment
- Example: order book of a Temperature Gas Future
  - Buyer enters for 10 June contracts of a temper.-related gas future the price (bid) of 12.850 €
  - Seller enters for 2 June contracts of a temper.-related gas future the price (ask) of 12.900 €

	NCG				Open	
	Qty	Bid	Ask	Qty	Last	TQty
①	② ..	③ …	③ …	② …	④	⑤
Jun 16	10	12,850	12,900	2	12,875	8
Jul 16	90	11,925	12,275	50		

① Name of the delivery period
② Volume of requested/offered TGF per hour (≡ MWh/h)
③ Price for buy/sell of Temperature Gas Future in €/MWh
④ Price of last traded Temperature Gas Future on a trading day
⑤ Sum of all traded TGF for the delivery period on a trading day

Agenda

- Status quo – temperature hedging today in Europe
- Presentation of possible temperature products
- **Proposals for standardisation of input parameter**
- Proposals for contract details and settlement
- Summary and outlook

Overview: Input parameter for temperature trading

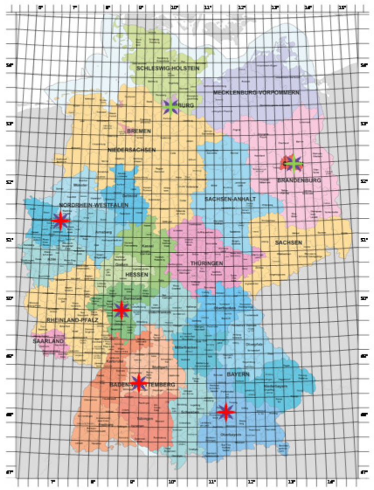
- Temperature data
  - Settlement temperature – T_{set}
  - Temperature Index – TEMPIX → only needed for settlement of TGF and TGPS
- Volume data
  - Load profile data – SLP
  - Settlement volume – V_{set}
  - Trading volume – V_{neg}

  (Load profile data and Settlement volume: only needed for settlement of TGF and TGPS)
- Price data
  - Settlement price – EGSI → only needed for settlement of TGPS
  - Trading price – P_{neg}
- Settlement formulas for:
  - Temperature Future (TF)
  - Temperature Cap/Floor Future (TCF/TFF)
  - Temperature Gas Future (TGF)
  - Temperature Gas Price Swap (TGPS)

Temperature data 1/5

Settlement temperature – T_{set}

- One settlement temperature per day and market
- Based on weighted grid point temperatures of reference locations per market
  - Daily grid point temperatures are forecasted by ECMWF* in the 0:00 z run on D-1 (day before delivery) for time points 0:00, 6:00, 12:00, 18:00 (each UTC) on D
  - Used grid point temperature : $T_{grid} = \frac{(T_0+T_6+T_{12}+T_{18})}{4}$
  - Weighting of reference locations per market / market areas – example Germany
    - 25% Berlin, 15% Hamburg, 15% Essen, 15% Frankfurt, 15% Stuttgart, 15% Munich
    - $T_{set,Ger} = 0{,}25 \times T_{Ber} + 0{,}15 \times T_{Ham} + 0{,}15 \times T_{Ess} + 0{,}15 \times T_{Fra} + 0{,}15 \times T_{Stu} + 0{,}15 \times T_{Mun}$
    - Proposal for weighting reference locations according most reasonable meteorological and geographical criteria (population density, hinterland)



- Settlement temperatures will be calculated from a service provider by order and specification (see above) of EEX Group
  - T_{set} will be published daily for free at EEX Group according EU standard in °C (with one decimal) with recent and historical data

* ECMWF = European Centre for Medium-Range Weather Forecasts – http://www.ecmwf.int/

Temperature data

Proposal: Grid points of reference locations per gas market

Hub	GASPOOL		NCG				Germany					
Refer. location	Hamburg	Berlin	Essen	Frankfurt	Stuttgart	Munich	Hamburg	Berlin	Essen	Frankfurt	Stuttgart	Munich
Weighting	35%	65%	25%	25%	25%	25%	15%	25%	15%	15%	15%	15%
Latitude*	53.50°	52.50°	51.50°	50.00°	48.75°	48.25°	53.50°	52.50°	51.50°	50.00°	48.75°	48.25°
Longitude*	10.00°	13.50°	7.00°	8.50°	9.25°	11.75°	10.00°	13.50°	7,00°	8.50°	9.25°	11.75°

Hub	TTF		CEGH			TRF				
Refer. location	Amsterdam	Eindhoven	Vienna	Innsbruck	Klagenfurt	Paris	Strasbourg	Nantes	Lyon	Toulouse
Weighting	35%	65%	50%	25%	25%	45%	15%	10%	20%	10%
Latitude*	52.25°	51.50°	48.25°	47.25°	46.75°	48.75°	48.50°	47.25°	45.74°	43.75°
Longitude*	4.75°	5.50°	16.50°	11.5°	14.25°	2.25°	7.75°	-1.50°	5.00°	1,50°

Hub	NBP				PSV		
Refer. location	Glasgow	Manchester	Birmingham	London	Milan	Rome	Catania
Weighting	15%	20%	20%	45%	50%	35%	15%
Latitude*	55.75°	53.50°	52.50°	51.50°	45.50°	41.75°	37.50°
Longitude*	-4.25°	-2.25°	-2.00°	-0.25°	9.25°	12.50°	15.00°

* Coordinates of grid points, which will be used for determination of temperatures for reference locations

Temperature data 3/5

Proposal: Grid points of reference locations per power market

Market	Germany						Spain				Czech	
Refer. location	Hamburg	Berlin	Essen	Frankfurt	Stuttgart	Munich	Madrid	Barcelona	Seville	Bilbao	Prague	Brno
Weighting	15%	25%	15%	15%	15%	15%	40%	25%	20%	15%	70%	30%
Latitude*	53.50°	52.50°	51.50°	50.00°	48.75°	48.25°	40.50°	41.50°	37.50°	43.25°	50.00°	49.25°
Longitude*	10.00°	13.50°	7.00°	8.50°	9.25°	11.75°	-3.75°	2.00°	-6.00°	-3.00°	14.50°	16.50°

Market	The Netherlands		Austria			France				
Refer. location	Amsterdam	Eindhoven	Vienna	Innsbruck	Klagenfurt	Paris	Strasbourg	Nantes	Lyon	Toulouse
Weighting	35%	65%	50%	25%	25%	45%	15%	10%	20%	10%
Latitude*	52.25°	51.50°	48.25°	47.25°	46.75°	48.75°	48.50°	47.25°	45.74°	43.75°
Longitude*	4.75°	5.50°	16.50°	11.50°	14.25°	2.25°	7.75°	-1.50°	5.00°	1.50°

Market	UK				Hungary		Italy		
Refer. location	Glasgow	Manchester	Birmingham	London	Budapest	Szeged	Milan	Rome	Catania
Weighting	15%	20%	20%	45%	70%	30%	50%	35%	15%
Latitude*	55.75°	53.50°	52.50°	51.50°	47.50°	46.25°	45.50°	41.75°	37.50°
Longitude*	-4.25°	-2.25°	-2.00°	-0.25°	19.25°	20.25°	9.25°	12.50°	15.00°

* Coordinates of grid points, which will be used for determination of temperatures for reference locations

Temperature data 4/5

Temperature index – TEMPIX

- One TEMPIX per delivery period and market
- Arithmetic mean of temperatures from 10 historical delivery periods
  - Example December 17 - arithmetic mean of 10 below-mentioned delivery periods:
    - Dec. 06, Dec. 07, Dec. 08, Dec. 09, Dec. 10, Dec. 11, Dec. 12, Dec.13, Dec. 14, Dec. 15
    - $TEMPIX_{DP} = \frac{\sum_{x-11}^{x-2} T_{DP,x}}{10}$; DP… Delivery period, T… Temperature, x… Delivery year
  - Delivery period temperatures are the mean of all settlement temperatures T_{set}
    - Ex: $T_{December,15}$ - arithmetic mean of settlement temperatures from 1^{st} until 31^{st} Dec. 2015

- TEMPIX will be calculated from a service provider by order and specification (see above) of EEX Group
  - TEMPIX will be published daily for free at EEX Group according European standard in °C (with two decimals*) with recent and historical data

* Rounding according commercial rules to two decimals

Temperature data

TEMPIX – visualised calculation for December 2017*

			Grid point temperature - 01. December 2015					
Reference	**Grid point**		**Forecast (with 0:00 z run at ECMWF on 30. Nov.)**				**Final***	**Weighting for market/Hub**
Location	Latitude	Longitude	0:00	6:00	12:00	18:00	Ø	Germany
Hamburg	53.50°	10.00°	5.4	6.4	6.0	5.3	5.8	15%
Berlin	52.50°	13.50°	5.4	6.3	6.0	5.4	5.8	25%
Essen	51.50°	7.00°	6.0	6.5	6.1	5.4	6.0	15%
Frankfurt	50.00°	8.50°	5.8	6.3	5.9	5.2	5.8	15%
Stuttgart	48.75°	9.25°	5.4	5.9	5.5	4.8	5.4	15%
Munich	48.25°	11.75°	5.2	5.7	5.3	4.6	5.2	15%

* Arithmetic mean of temperatures from 4 time-points per day

$$Settlement\ Temperature\ (T_{set}) = \sum (T_{final} \times Weighting_D)$$

Settl. Temperature (T_{set}) - December 2015	
Delivery Day	**Germany**
01.12.2015	5.4*
02.12.2015	5.6
…	…
31.12.2015	4.1
Delivery period temperature*	**6.24**

* Sum product of final grid point temperatures and weighting
** Arithmetic mean of delivery day temperatures

TEMPIX - December 2017	
Delivery Month	**Germany**
December 2006	5.43
December 2007	5.66
…	…
December 2015	6.24
$TEMPIX_{Dec\ 17}$*	**4.92**

* Arithmetic mean of 10 historical temperatures of the same delivery period

* All shown temperatures inside the table are used for illustration only and do not yet correspond to realistic temperatures – correct figures available once customer feedback is positive and demand sufficient

Volume data

1/2

Trading volume – V_{neg}

- TF and TCF/TFF: corresponds to number of traded contracts (# ≡ €/day)

	Germany				Open	
	Qty (V_{neg})	Bid	Ask	Qty (V_{neg})	Last	TQty
…	② …	…	…	② …		
Jun 16	800	20,24	20,61	1.700	20,52	1.000
Jul 16	4.200	23,15	23,40	300		

② Quantity of requested/offered TF per day (≡ €/day)

- TGF and TGPS: corresponds to traded volume (MW or MWh)

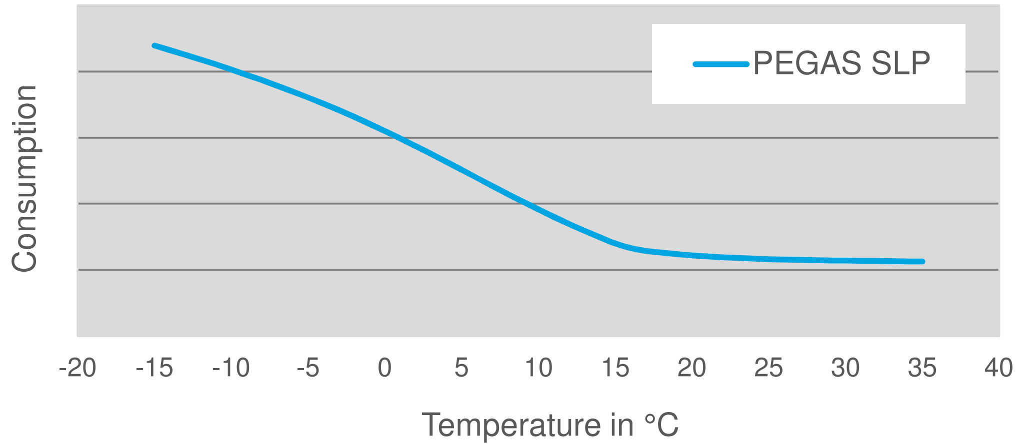
	NCG				Open	
	Qty (V_{neg})	Bid	Ask	Qty (V_{neg})	Last	TQty
…	② …	…	…	② …		
Jun 16	10	12,850	12,900	2	12,875	8
Jul 16	90	11,925	12,275	50		

② Volume of requested/offered TGF per hour (≡ MWh/h or MWh (France))

Volume data 2/2

Settlement volume – V_{set}

- TF and TCF/TFF: corresponds to number of traded contracts (#) ≡ V_{neg}
- TGF and TGPS: result of temperature driven adjustments of V_{neg}
  - By use of **one** PEGAS **SLP** to describe relation between temperature and demand
  - Proposed **SLP** (**S**tandardised **L**oad **P**rofile) for PEGAS: SigLinDe for Germany
  - SigLinDe - Combination of a sigmoid (**Sig**) and linear (**Lin**) function to mirror at best temperature driven gas demand of an average **household** in Germany (**DE**)
  - Notification of settlement volume towards customer from 9 am (CET) on D-1



$$V_{set} = V_{neg} \times \frac{SLP_{PEGAS}(T_{set})}{SLP_{PEGAS}(TEMPIX)}$$

Price data

Trading price – P_{neg}

- TF and TCF/TFF: corresponds to traded temperature in °C in order book

P_{neg}

	Germany				Open	
	Qty	Bid	Ask	Qty	Last	TQty
…	…	…	…	…	④	
Jun 16	800	20,24	20,61	1.700	20,52	1.000
Jul 16	4.200	23,15	23,40	300		

④ Price of last traded Temperature (Cap/Floor) Future on a trading day

- TGF and TGPS: corresponds to traded gas price in order book

P_{neg}

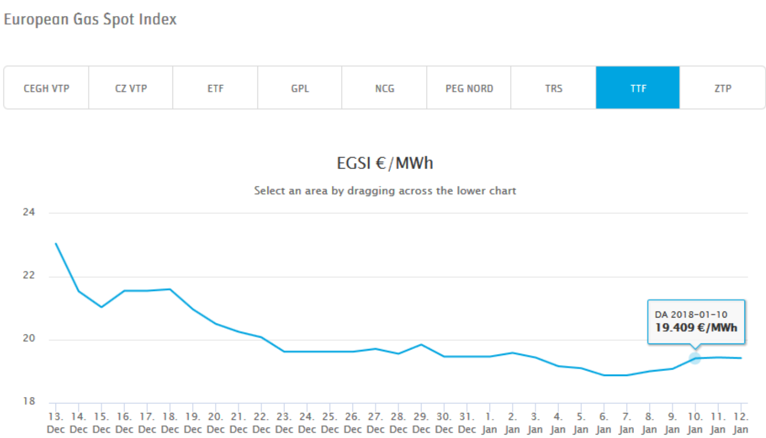
	NCG				Open	
	Qty	Bid	Ask	Qty	Last	TQty
…	…	…	…	…	④	
Jun 16	10	12,850	12,900	2	12,875	8
Jul 16	90	11,925	12,275	50		

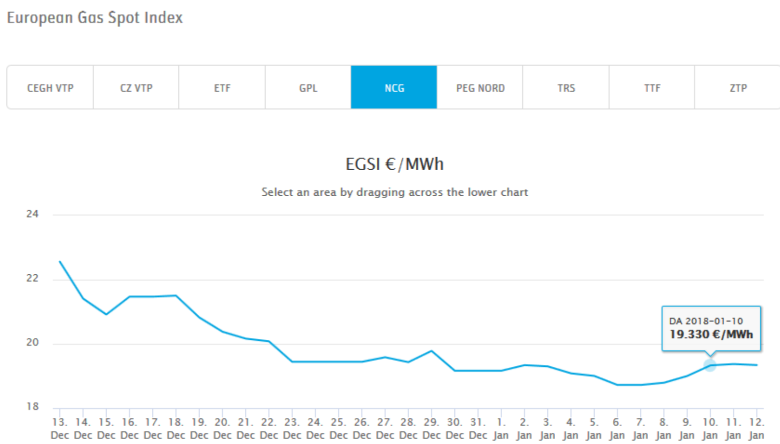
④ Price of last traded Temperature (Cap/Floor) Future on a trading day

Price data 2/2

Settlement price – P_{set}

- TF and TCF/TFF: corresponds to temperature (T_{set}) in °C for delivery day (D)
  - Settlement temperature: forecast run by ECMWF from 0 am (UTC) on D-1
  - Publication of settlement temperature/price from 9 am (CET) on D-1 on homepage
- TGF: corresponds to traded price (P_{neg})
- TGPS: corresponds to reference price per delivery day – EGSI
  - EGSI – **E**uropean **G**as **S**pot **I**ndex – uniform calculation for PEGAS markets:
    - Volume weighted mean of all trades per delivery day, which are executed in **Day-Ahead** and **Weekend** products between 8-18 CET on the **last** exchange trading day before delivery
  - Publication of EGSI every business day at 6.45 pm (CET) on homepage





Formulas for settlement of temperature products

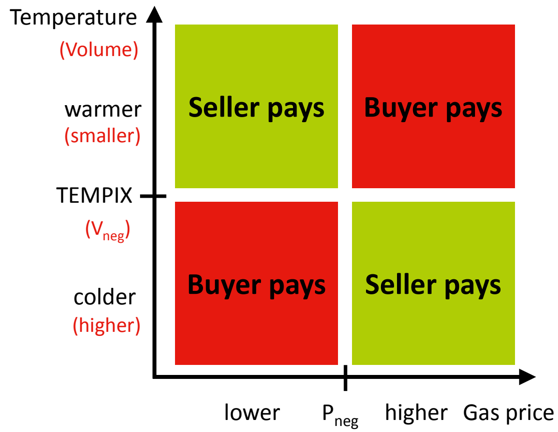
Cash flow from buyer to seller or backwards

- Temperature Future
  - Cash flow = $\sum (P_{neg} - P_{set}) \times V_{set}$
    - Negative cash flow → seller pays; positive cash flow → buyer pays

- Temperature Cap/Floor Future
  - Cash flow = $\sum (P_{neg} - P_{set}) \times V_{set}$
    - Cap future: for all days, if $P_{set} > P_{neg}$
    - Floor future: for all days, if $P_{set} < P_{neg}$
    - Negative cash flow → seller pays; positive cash flow → buyer pays

- Temperature Gas Future
  - Cash flow = $P_{neg} \times \sum V_{set}$
    - Always positive cash flow → buyer pays, but level is dependent from temperature

- Temperature Gas Price Swap
  - Cash flow = $\sum ((P_{neg} - P_{set}) \times (V_{set} - V_{neg}))$
    - Negative cash flow → seller pays
    - Positive cash flow → buyer pays



Agenda

- Status quo – temperature hedging today in Europe
- Presentation of possible temperature products
- Proposals for standardisation of input parameter
- **Proposals for contract details and settlement**
- Summary and outlook

Proposal: Specification of temperature products

<table>
<tr><th></th><th>Temperature Future</th><th>Temperature Cap/Floor Future</th><th>Temperature Gas Future</th><th>Temperature Gas Price Swap</th></tr>
<tr><td>Fulfilment</td><td colspan="2">Financial (cash settlement)</td><td>Physical</td><td>Financial (cash settlement)</td></tr>
<tr><td rowspan="2">Underlying</td><td colspan="2" rowspan="2">Settlement temperature = Settlement price</td><td colspan="2">Settlement temperature, temperature index – TEMPIX</td></tr>
<tr><td></td><td>Spot market index – EGSI</td></tr>
<tr><td rowspan="2">Markets/Market areas*</td><td colspan="2" rowspan="2">Germany, France, Italy,
The Netherlands, Austria, UK</td><td colspan="2">CEGH, GASPOOL, NBP, NCG, PEG-N, PSV, TTF</td></tr>
<tr><td></td><td>Germany</td></tr>
<tr><td>Delivery periods*</td><td colspan="2">7 days, 4 weekends, 4 weeks, 6 months, 4 quarters,
2 seasons, 1 calendar year</td><td colspan="2">6 months, 7 quarters, 2 seasons, 1 calendar year</td></tr>
<tr><td>Contract volume</td><td colspan="2">1 contract = 1 €</td><td colspan="2">1 contract = 1 MW x number of hours per delivery period</td></tr>
<tr><td>Pricing</td><td colspan="2">€/Contract (= °C) with two decimals</td><td colspan="2">€/MWh with three decimals</td></tr>
<tr><td>Minimum price tick*</td><td colspan="2">0.01 €/Contract (= 0,01 °C)</td><td colspan="2">0.005 €/MWh</td></tr>
<tr><td>Trading time</td><td colspan="4">Exchange trading and trade registration of non-exchange trades: 8 am – 6 pm CET</td></tr>
</table>

* What is needed and sufficient for the **launch?** - Less or more possible on market demand

Proposal: Financial and physical delivery process

Day before delivery (D-1) | → **Delivery day (D)**

0.00 am (UTC)	8.00 am (CET)	9.00 am (CET)	6.00 pm (CET)	0.00 am	6.00 am (CET)
Start of 0.00 am run for determination of forecasted grid point temperature for the next delivery day	Determination of settlement temperature and settlement volume** for the next delivery day	Publication of settlement temperature, settlement volume as well as nomination for the next delivery day	Publication of settlement price*** (EGSI) for the next delivery day		Physical delivery****
				Cash settlement for financial and payment for physical temperature products for the delivery day	
ECMWF*	EEX Group				

- From 0 am (UTC) on the day before delivery – forecast run by ECMWF*
- From 8 am on the day before delivery (D-1)
  - Processing of forecast temperature for determination of settlement temperature and settlement volume
- From 9 am on the day before delivery (D-1)
  - Publication of settlement temperature and settlement volume for the delivery day
    - Financial Temperature (Cap/Floor) Futures: Settlement temperature (T_{set}) ≡ Settlement price (P_{set})
    - Physical Temperature Gas Future: Delivery volume (V_{set}) = f (T_{set}); Nomination on behalf of customer
    - Financial Temperature Gas Price Swap: Settlement volume (V_{set}) = f (T_{set});
- From 6 pm on the day before delivery (D-1)
  - Temperature Gas Price Swap: Publication of settlement price (≡ EGSI) for the delivery day
- From 6 am on the delivery day (D)
  - Temperature Gas Future: Physical delivery of gas according to the nomination for the delivery day

* ECMWF = European Centre for Medium-Range Weather Forecasts – http://www.ecmwf.int/

** For fulfilment of Temperature Gas Future and TGPS; *** For fulfilment of TGPS; **** For fulfilment of Temperature Gas Future

Agenda

- Status quo – temperature hedging today in Europe
- Presentation of possible temperature products
- Proposals for standardisation of input parameter
- Proposals for contract details and settlement
- **Summary and outlook**

Benefits from exchange traded temperature products

Improvements by standardisation, simplification and transparency

1. Standardisation enables trading in price transparent exchange order books
2. Clearing enables full automatized physical and financial settlement of trades
3. Usage of standardised temperature data in °C instead relative HDD/CDD
   - Stronger acceptance in Europe due to better fitting with European weather standards
   - Higher transparency, easier replicable and usable by trader
4. Transparency inside usage, calculation and publication of data
   - Temperature Index (TEMPIX), Settlement Temperature (T_{set}), Settlement Price (EGSI)
   - All underlying data (recent and historical) will be available for free
5. Usage of temperature data only from well-credited independent ECMWF*
   - Grid point temperatures are European standard, reliable, fail-safe and market proved
6. Application of **one** market temperature per market – e.g. Germany, Italy, TTF
   - Harmonised calculation based on ECMWF grid point temperatures forecasts
   - Pooling of liquidity of temperature products on the VTP
7. Application of **one** market proved standard load profile for household customers
8. Extension of temperature products to other markets/customers easily possible

* ECMWF = European Centre for Medium-Range Weather Forecasts – http://www.ecmwf.int/

Indicative roadmap for temperature products

Timeline	EEX Group	
2016 / 2017	▪ First discussion with key customer and weather specialists about needed products and possible improvements for temperature trading ▪ Development of a business concept for exchange trading and settlement of standardised temperature products	✔
Today 06.02.18	▪ 1st design workshop - Launch of public consultation to possible temperature products at EEX Group ▪ Collection and discussion of first customer feedback	✔
Q1 + Q2 / 2018	▪ Collection of further customer feedback via bilateral meetings and calls ▪ Possible adjustments to product design, trading and settlement processes	
Q3 / 2018	▪ Based on customer feedback, eventually 2nd design workshop for temperature products at EEX Group ▪ Based on customer feedback, provision of finalised concept to EEX Group management for approval	
Only if EEX Group management approves business concept/case and customer demand is given, the following milestones are possible		
Q4 / 2018	▪ Start of implementation of temperature products at EEX Group according concept ▪ Selection of service provider for temperature data according EEX specification ▪ Start to call market maker for temperature products	
Q1 / 2019	▪ Information into the market about launch date and needed steps on customer side via press release, customer and clearing information but also sales channels of EEX Group ▪ Signing of market maker contracts	
2019	▪ Go-Live of exchanged traded temperature products at EEX Group	

Thank you

Sirko Beidatsch
+49 341 2156 223
Sirko.Beidatsch@eex.com

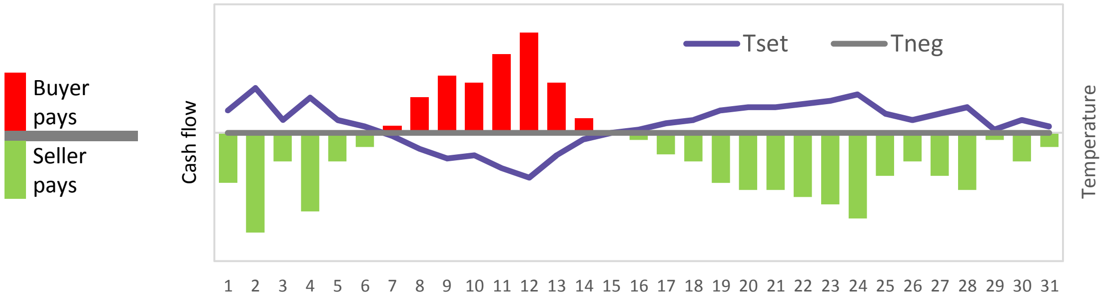
pegas is the gas trading
platform of eex group,
operated by powernext

Example: Trading of Temperature future

Hedge of gas sales revenues of a municipality against a warmer than expected October

Municipality fears that the next October could be warmer than average (12°C) and thereby less natural gas for heating will be sold. To limit the potential financial loss, a share of the initial expected sales revenues for temperatures not higher than 12 °C should be hedged with 1,000 Temperature Futures.

- Buying of 1,000 October future for 12 € (≡ 12 °C)
- October is with Ø 12.26 °C about Ø 0.26 °C warmer than expected; meaning Temperature hedge leads to cash flows to municipality
  - CF =∑ Δ Price x Volume = - 8.0 x 1,000 € = - 8,000 € → Profit for municap



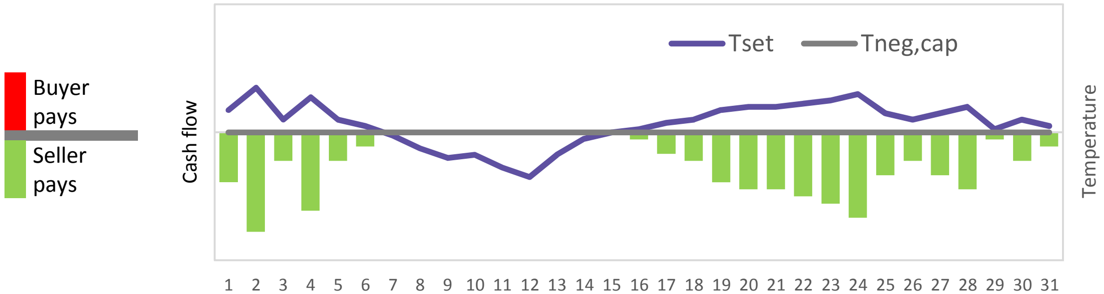
Oct.	Settl. Temp.	Δ Temp. = Δ Price
Day	°C	°C
1. Oct	12.7	-0.7
2. Oct	13.4	-1.4
3. Oct	12.4	-0.4
4. Oct	13.1	-1.1
5. Oct	12.4	-0.4
6. Oct	12.2	-0.2
7. Oct	11.9	0.1
8. Oct	11.5	0.5
9. Oct	11.2	0.8
10. Oct	11.3	0.7
11. Oct	10.9	1.1
12. Oct	10.6	1.4
13. Oct	11.3	0.7
14. Oct	11.8	0.2
15. Oct	12.0	0.0
16. Oct	12.1	-0.1
17. Oct	12.3	-0.3
18. Oct	12.4	-0.4
19. Oct	12.7	-0.7
20. Oct	12.8	-0.8
21. Oct	12.8	-0.8
22. Oct	12.9	-0.9
23. Oct	13.0	-1.0
24. Oct	13.2	-1.2
25. Oct	12.6	-0.6
26. Oct	12.4	-0.4
27. Oct	12.6	-0.6
28. Oct	12.8	-0.8
29. Oct	12.1	-0.1
30. Oct	12.4	-0.4
31. Oct	12.2	-0.2
	Total:	-8.0

Example: Trading of Temperature Cap Future

Hedge of gas sales revenues of a municipality against a warmer than expected October

Municipality fears that some days of the next October could be warmer than average (12°C) and thereby less natural gas for heating will be sold. To limit the potential financial loss, a share of the initial expected sales revenues for these days should be hedged with 1,000 Temperature Cap Futures.

- Buying of 1,000 October future for 12 € (≡ 12 °C)
- There are temperature overruns on 22 October days; meaning temperature hedge leads only on these days to cash flows to municip.
  - CF =∑ Δ Price x Volume = - 13.5 x 1,000 € = - 13,500 € → Profit for municip.



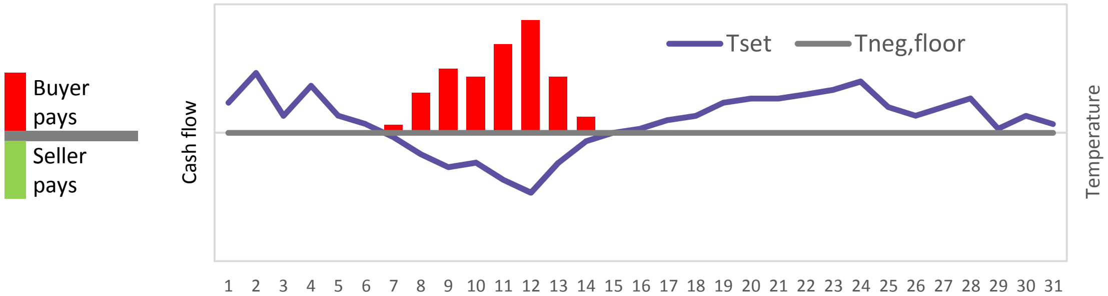
Oct.	Settl. Temp.	Δ Temp. = Δ Price
Day	°C	°C
1. Oct	12.7	-0.7
2. Oct	13.4	-1.4
3. Oct	12.4	-0.4
4. Oct	13.1	-1.1
5. Oct	12.4	-0.4
6. Oct	12.2	-0.2
7. Oct	11.9	underrun
8. Oct	11.5	underrun
9. Oct	11.2	underrun
10. Oct	11.3	underrun
11. Oct	10.9	underrun
12. Oct	10.6	underrun
13. Oct	11.3	underrun
14. Oct	11.8	underrun
15. Oct	12.0	underrun
16. Oct	12.1	-0.1
17. Oct	12.3	-0.3
18. Oct	12.4	-0.4
19. Oct	12.7	-0.7
20. Oct	12.8	-0.8
21. Oct	12.8	-0.8
22. Oct	12.9	-0.9
23. Oct	13.0	-1.0
24. Oct	13.2	-1.2
25. Oct	12.6	-0.6
26. Oct	12.4	-0.4
27. Oct	12.6	-0.6
28. Oct	12.8	-0.8
29. Oct	12.1	-0.1
30. Oct	12.4	-0.4
31. Oct	12.2	-0.2
	Total:	**-13.5**

Example: Trading of Temperature Floor Future

Hedge of power sales revenues of a power producer against a colder than expected July

Power producer fears that some days of the next July could be colder than average (20°C) and thereby less power for air conditions will be sold. To limit the potential financial loss, a share of the initial expected sales revenues for these days should be hedged with 1,000 Temperature Floor Futures.

- Selling of 1,000 July future for 20 € (≡ 20 °C)
- There are temperature underruns on 8 July days; meaning temperature hedge leads only on these days to cash flows to power producer
  - CF =∑ Δ Price x Volume = + 5.5 x 1,000 € = + 5,500 € → Profit for producer



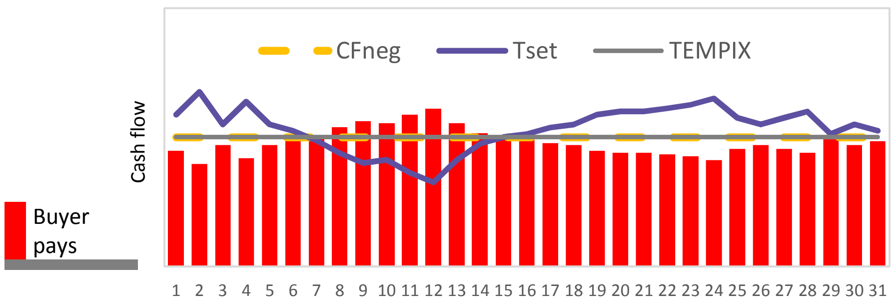
Oct.	Settl. Temp.	Δ Temp. = Δ Price
Day	°C	°C
1. Jul	20.7	overrun
2. Jul	21.4	overrun
3. Jul	20.4	overrun
4. Jul	21.1	overrun
5. Jul	20.4	overrun
6. Jul	20.2	overrun
7. Jul	19.9	0.1
8. Jul	19.5	0.5
9. Jul	19.2	0.8
10. Jul	19.3	0.7
11. Jul	18.9	1.1
12. Jul	18.6	1.4
13. Jul	19.3	0.7
14. Jul	19.8	0.2
15. Jul	20.0	overrun
16. Jul	20.1	overrun
17. Jul	20.3	overrun
18. Jul	20.4	overrun
19. Jul	20.7	overrun
20. Jul	20.8	overrun
21. Jul	20.8	overrun
22. Jul	20.9	overrun
23. Jul	21.0	overrun
24. Jul	21.2	overrun
25. Jul	20.6	overrun
26. Jul	20.4	overrun
27. Jul	20.6	overrun
28. Jul	20.8	overrun
29. Jul	20.1	overrun
30. Jul	20.4	overrun
31. Jul	20.2	overrun
	Total:	**5.5**

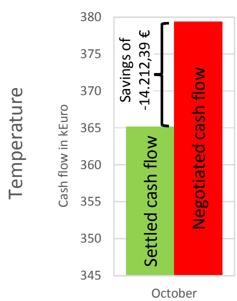
Example: Trading of Temperature Gas Future

Hedge of gas sales revenues of a municipality against a warmer than expected October

Municipality fears that the next October could be warmer than average (12°C) and less natural gas for heating to household customers will be sold. To hedge these gas sales risk already by the gas procurement for household customers, whose demand follows a temperature related standardised load profile (SLP), a Temperature Gas Future of 30 MW should be bought to the historical Ø-Temperature (TEMPIX).

- Buying of 30 MW October for 17 €/MWh at TEMPIX = 12°C (Ø-temperature of the delivery period across 10 years)
- October is with Ø 12.26 °C about Ø 0.26 °C warmer than expected; meaning applied standard load profile enables reduced, temperature adjusted gas delivery volumes and cash flows to the seller
  - CF = Price x ∑ Settl. Volume = 17 €/MWh x 21,483,61 MWh = + 365,221.32 €
  - Savings munic.: 17 €/MWh x (21,483.61 MWh - 22,320 MWh) = - 14,212.39 €





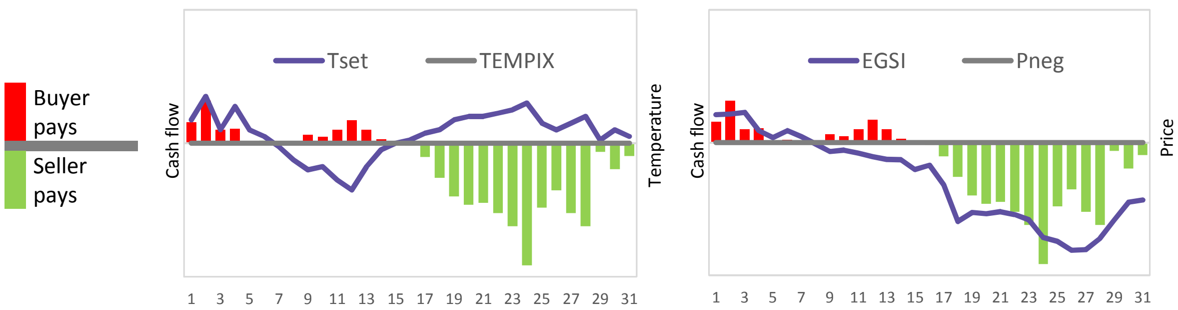
Oct.	Settl. Temp.	Settl. Volume
Day	°C	MWh
1. Oct	12.7	644.56
2. Oct	13.4	571.71
3. Oct	12.4	676.57
4. Oct	13.1	602.61
5. Oct	12.4	676.57
6. Oct	12.2	698.17
7. Oct	11.9	730.95
8. Oct	11.5	775.34
9. Oct	11.2	809.14
10. Oct	11.3	797.83
11. Oct	10.9	843.36
12. Oct	10.6	877.98
13. Oct	11.3	797.83
14. Oct	11.8	741.97
15. Oct	12.0	719.97
16. Oct	12.1	709.05
17. Oct	12.3	687.35
18. Oct	12.4	676.57
19. Oct	12.7	644.56
20. Oct	12.8	634.00
21. Oct	12.8	634.00
22. Oct	12.9	623.48
23. Oct	13.0	613.02
24. Oct	13.2	592.26
25. Oct	12.6	655.18
26. Oct	12.4	676.57
27. Oct	12.6	655.18
28. Oct	12.8	634.00
29. Oct	12.1	709.05
30. Oct	12.4	676.57
31. Oct	12.2	698.17
	Total	**21,483.61**

Example: Trading of Temperature Gas Price Swap

Hedge of revenues from gas sales and price of a municipality against a warmer than expected October

Municipality fears that the next October could be warmer than average (12°C) and less natural gas to lower prices for heating to household customers will be sold. To hedge these gas sales and price risks by the gas procurement for household customers, whose demand follows a temper.-related SLP, a Temperature Gas Price Swap of 30 MW should be bought to the historical Ø-Temperature.

- Buying of 30 MW Swap @ 17 €/MWh and at a TEMPIX (temperature index) of 12°C
- October is with Ø 12.26 °C about Ø 0.26 °C warmer than thought and reference price (EGSI) with Ø 15.84 €/MWh less expensive; meaning hedge via swap leads to cash flows to the municipality
  - CF = ∑ (Δ Price x Δ Volume) = -1.947,45 €; → CF negative
  - CF negative (-) → seller pays, CF positive (+) → buyer pays



Oct.	Settl. Temp.	Δ Price	Δ Vol.	Daily CF
Day	°C	€/MWh	MWh	€
1. Oct	12.7	-0,835	-75,44	62.99
2. Oct	13.4	-0,853	-148,29	126.49
3. Oct	12.4	-0,903	-43,43	39.21
4. Oct	13.1	-0,360	-117,39	42.26
5. Oct	12.4	-0,149	-43,43	6.47
6. Oct	12.2	-0,355	-21,83	7.75
7. Oct	11.9	-0,169	10,95	-1.85
8. Oct	11.5	0,043	55,34	2.38
9. Oct	11.2	0,276	89,14	24.60
10. Oct	11.3	0,233	77,83	18.13
11. Oct	10.9	0,320	123,36	39.48
12. Oct	10.6	0,431	157,98	68.09
13. Oct	11.3	0,513	77,83	39.93
14. Oct	11.8	0,523	21,97	11.49
15. Oct	12.0	0,819	-0,03	-0.02
16. Oct	12.1	0,683	-10,95	-7.48
17. Oct	12.3	1,284	-32,65	-41.93
18. Oct	12.4	2,387	-43,43	-103.66
19. Oct	12.7	2,113	-75,44	-159.40
20. Oct	12.8	2,146	-86,00	-184.56
21. Oct	12.8	2,084	-86,00	-179.23
22. Oct	12.9	2,172	-96,52	-209.64
23. Oct	13.0	2,327	-106,98	-248.94
24. Oct	13.2	2,867	-127,74	-366.23
25. Oct	12.6	2,979	-64,82	-193.10
26. Oct	12.4	3,252	-43,43	-141.22
27. Oct	12.6	3,231	-64,82	-209.43
28. Oct	12.8	2,889	-86,00	-248.46
29. Oct	12.1	2,336	-10,95	-25.59
30. Oct	12.4	1,800	-43,43	-78.17
31. Oct	12.2	1,733	-21,83	-37.83
			Total:	**-1,947.45**

Further details to SLP PEGAS

- SLP PEGAS should reflect consumption of an average household customer
  - Proposal for weighting of main groups of household customer
    - 2/3 SigLinDE of a one family house (DE_HEF33) and
    - 1/3 SigLinDE of a multiple family house (DE_HMF33)

  - $$SLP_{PEGAS} = \frac{2}{3} \times SigLinDE_{DE\_HEF33} + \frac{1}{3} \times SigLinDE_{DE\_HMF33}$$

  - $$V_{set} = V_{neg} \times \frac{SLP_{PEGAS}(T_{set})}{SLP_{PEGAS}(TEMPIX)} = V_{neg} \times \frac{\left(\frac{A}{1+\left(\frac{B}{T_{set}-40}\right)^{C}} + D + \max(m_{\mathrm{H}} \times T_{set} + b_{\mathrm{H}}; m_{\mathrm{W}} \times T_{set} + b_{\mathrm{W}}) \right)}{\left(\frac{A}{1+\left(\frac{B}{TEMPIX-40}\right)^{C}} + D + \max(m_{\mathrm{H}} \times TEMPIX + b_{\mathrm{H}}; m_{\mathrm{W}} \times TEMPIX + b_{\mathrm{W}}) \right)}$$

Profile	A	B	C	D	m_H	m_W	b_H	b_W	T_0	F
DE_HEF33	1.6209544	-37.1833141	5.6727847	0.0716431	-0.0495700	-0.0022090	0.8401015	0.1074468	40	1
DE_HMF33	1.2328655	-34.7213605	5.8164304	0.0873352	-0.0409284	-0.0022320	0.7672920	0.1199207	40	1