Spark-Spread & Clean Spark (Beginner’s Guide)

What this is: a short, plain-English explainer of spark spreads for gas-fired power plants, how to include carbon costs (clean spark), and how the repo’s script classifies regimes, flags discontinuities, runs a toy backtest, and does a small sensitivity. Use this to build intuition; it is not trading advice.

Spark spread measures the margin a gas plant earns from selling 1 MWh of power after paying for fuel. Clean spark subtracts carbon (emissions allowance) cost as well.

Units used throughout: €/MWh for power and gas; €/tCO2 for carbon allowances (EUAs).

Formulas (per MWh of electricity):

$$\text{Gross spark} = \text{Power} - \text{Heat-rate} \times \text{Gas}$$

$$\text{Clean spark} = \text{Gross spark} - \text{Emission-factor} \times \text{EUA}$$

Heat-rate is the amount of gas energy (in MWh) needed to produce 1 MWh of electricity. Lower heat-rate means better efficiency. Emission-factor is tonnes of CO2 per MWh of electricity produced.

Numbers & Intuition (using the default config)

Default assumptions in config.yaml: heat_rate = 1.9 MWh_gas per MWh_power (≈53% efficiency) and emission_factor = 0.35 tCO2 per MWh_power.

Example calculation: Suppose power = 100 €/MWh, gas = 40 €/MWh, EUA = 80 €/t. Gross spark = 100 − 1.9×40 = 24 €/MWh. Clean spark = 24 − 0.35×80 = −4 €/MWh. Interpretation: once carbon is included, that simple setup would be uneconomic on a spot basis. If power rises, gas falls, or EUAs fall, the clean spark improves.

How spreads move:

• Power leg: demand (temperature, weekday vs weekend), outages, nuclear/hydro/wind availability, interconnector flows, policy.

• Gas leg: storage level, LNG inflows, pipeline outages, weather, industrial demand, global gas balances.

• Carbon leg (EUA): policy expectations, macro risk, power/industrial demand, hedging flows.

Heat-rate sensitivity: a lower heat-rate (more efficient plant) multiplies the gas cost by a smaller number, raising the spark for the same fuel and power prices.

Tip: Think of clean spark as a three-leg tug-of-war: power (+), gas (− via heat-rate), and EUAs (− via emission-factor).

Percentiles, Regimes & Discontinuities

Percentiles: The script ranks today’s clean spark against the last N years (lookback_years in config). It shows where today sits in history as a percentile in [0, 100].

Regimes (configurable):

• Tight : percentile > pct_high (e.g., >70%).

• Neutral: between pct_low and pct_high (e.g., 30–70%).

• Loose : percentile < pct_low (e.g., <30%).

Why percentiles? They are scale-free and easy to compare across regions or time, even if absolute prices drift.

Discontinuity flag: Daily change in clean spark (d_clean) is compared to its recent volatility. If |d_clean| > 2 × std(d_clean) over the last 60 days, the day is flagged. This is a simple way to highlight unusual moves (e.g., a big outage, sudden gas shock, or EUA gap).

On the chart: today’s value and percentile are annotated; a 30–70% band is shaded for quick context.

Sensitivity, Betas & Toy Backtest

Sensitivity grid: For small shocks to each leg (Δpower, Δgas, ΔEUA from config.scenario), the tool recomputes clean spark. This shows which leg dominates near today's levels.

Betas (one-line OLS): Fit Δclean_spark ≈ a + b1·Δpower + b2·Δgas + b3·ΔEUA on recent daily changes. The signs should align with intuition: b1 > 0, b2 < 0 (scaled by heat-rate), b3 < 0 (scaled by emission-factor). Magnitudes help you gauge which variable currently 'matters most'.

Toy rules-based backtest (on clean spark, not tradable PnL):

• Enter long when the percentile crosses up through entry_percentile (e.g., 70%).

• Exit to flat when it crosses down through exit_percentile (e.g., 50%).

• Risk control: if drawdown from entry exceeds stop_atr × ATR of d_clean (rolling window), the position stops out.

PnL proxy: daily PnL = change in clean spark (a simple proxy to keep the logic transparent and <200 lines).

Limitations, Caveats & A Handy Template

Limitations:

• Educational only. The PnL proxy is not a tradable backtest; it ignores carry, shape, contract rolls, and plant constraints.

• No shaping by hour/season; daily spot approximations can diverge from prompt futures and actual dispatch economics.

• Heat-rate and emission-factor are simplified single numbers; real fleets vary by plant and operating point.

Bias & Invalidator (edit for your note):

• Bias: Stay constructive on spark when clean spread is above the 70th percentile with EUAs stable and gas not rallying.

• Invalidator: Turn neutral/defensive on a drop back below the 50th percentile or a +€10/MWh gas rally without power following.

Further reading (to build intuition):

• Heat-rate and plant efficiency (EIA/Wikipedia).

• Clean spark spread concept (industry primers).

• ATR and basic volatility concepts (Wilder/technical primers).