Medium-term asset valuation using flow-based modelling approach

- Marc Hasenbeck, Dr. Erik Schreck
Montel Risk
23/01/2025

...

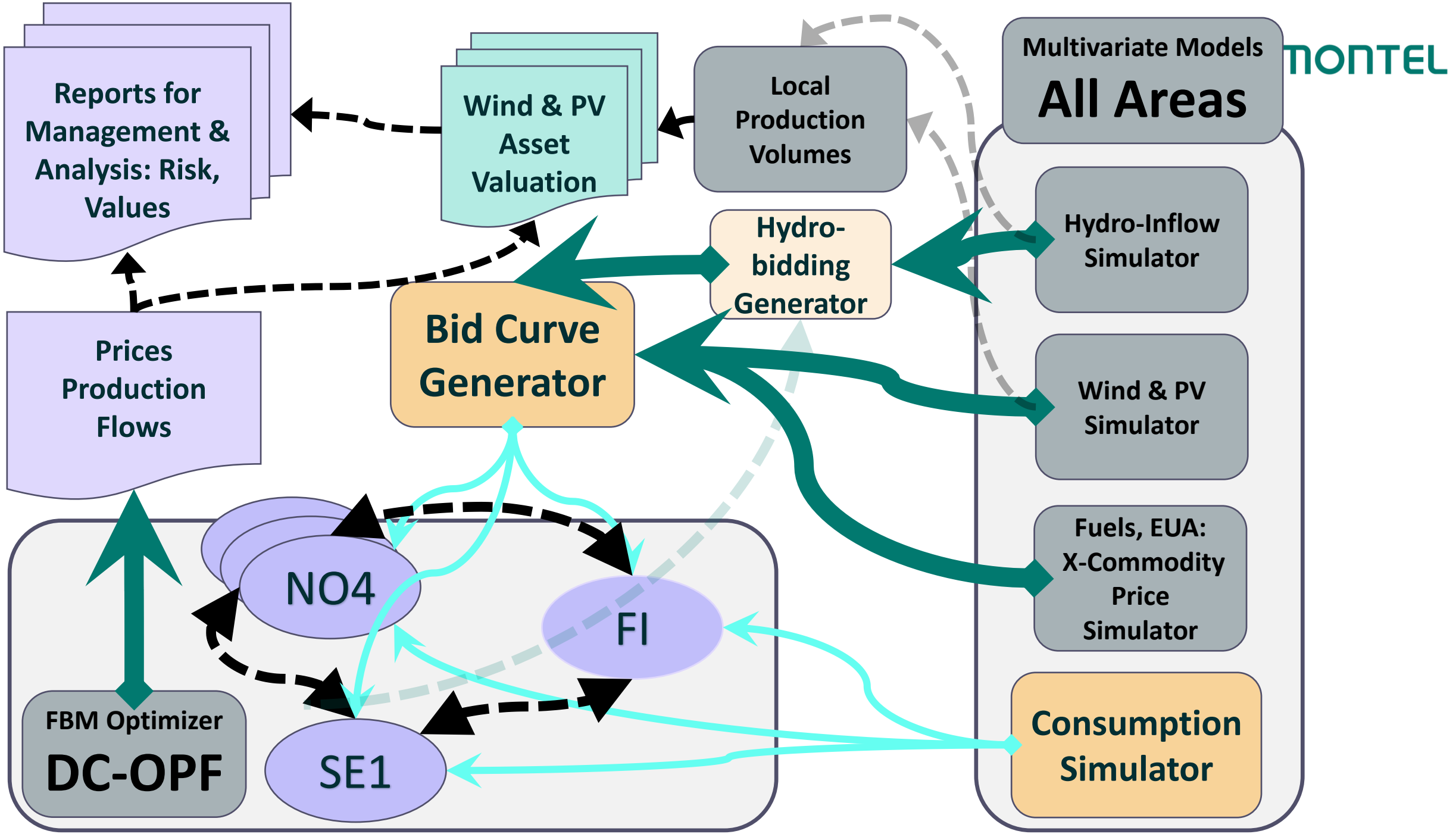
Agenda

- Goals of the Model
- Setup of the Model Components & Inputs
- Calibration of the Model
- Expectations & Simulations

...

FBMachine – Goals for our Model

- **Risk management for portfolios**, whereby the assets might be arbitrarily mixed. Assets are defined via
  - Locations: all Nordic areas, neighbor countries
  - Underlyings: spot or futures
  - Contract/Real asset
    - Futures positions, several maturities and delivery terms
    - Spot positions, like open positions after hedging
    - Wind & PV parks (e.g. PaP, baseload, …) → hourly price volume risk figures for exact locations
    - Several hydro dependent assets
    - Can be extended with batteries
  - Purposes
    - Hedging
    - VaR – short run daily risk management
    - PaR – cashflow risk over all delivery periods up to 5 years
    - Valuation and sensitivities


Reports for Management & Analysis: Risk, Values
Wind & PV Asset Valuation
Local Production Volumes
Multivariate Models
All Areas
MONTEL
Hydro-bidding Generator
Hydro-Inflow Simulator
Bid Curve Generator
Prices Production Flows
Wind & PV Simulator
Fuels, EUA: X-Commodity Price Simulator
NO4
FI
SE1
FBM Optimizer
DC-OPF
Consumption Simulator

MONTEL

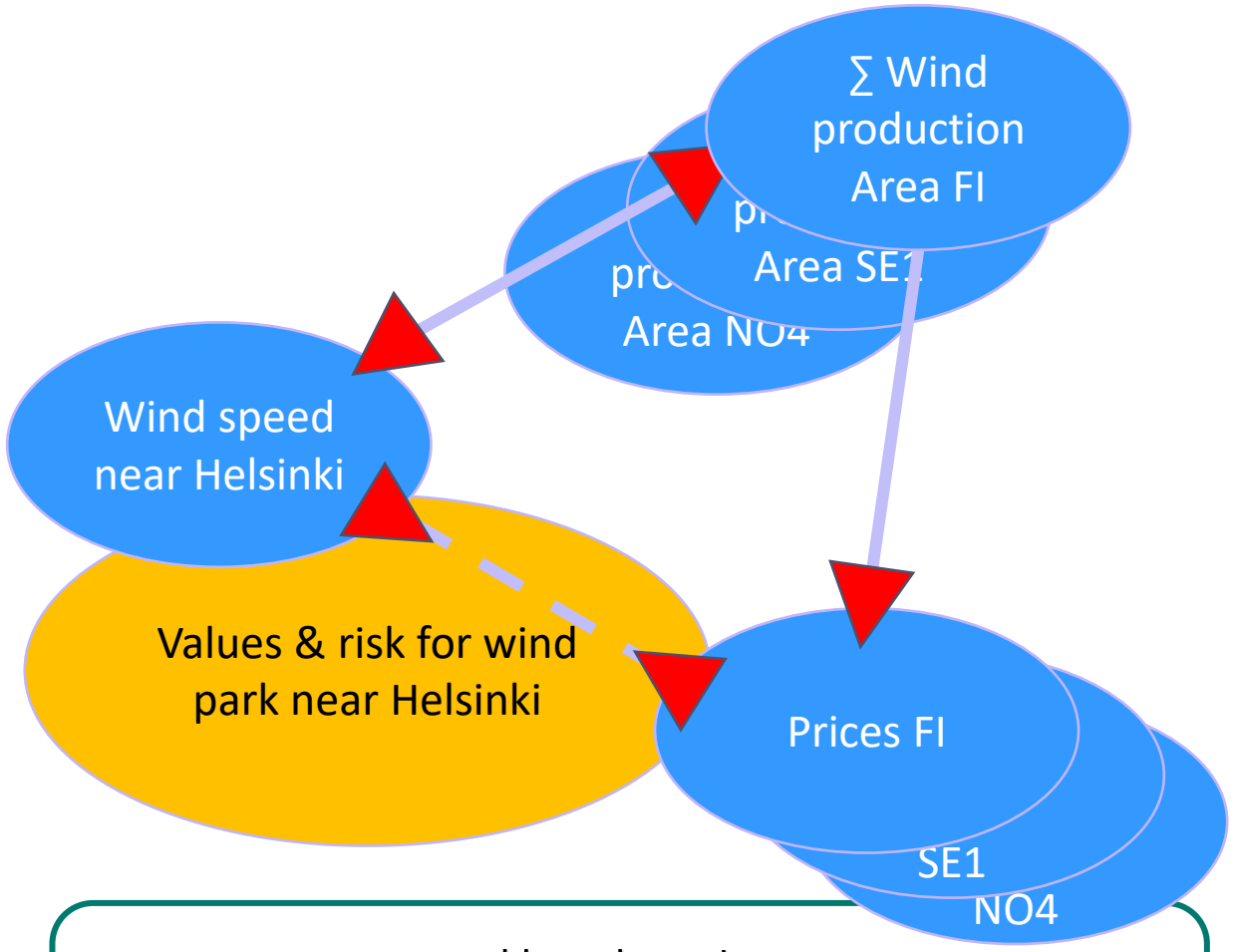
Multivariate Modelling

- We setup a model to capture and simulate the timeseries driving our simulation target
  - from PCA-analysis we get good insights and usefully composed timeseries
- These timeseries are parameterized applying a Kalman Filter
  - Identification of latent factors
    - Short run
    - (Mid run)
    - Long run
  - Pros
    - Better prognosis due to separation of persistent und fluctuant states
    - Good insights and control over large multivariate systems
    - Term structure dynamics can be caught

...

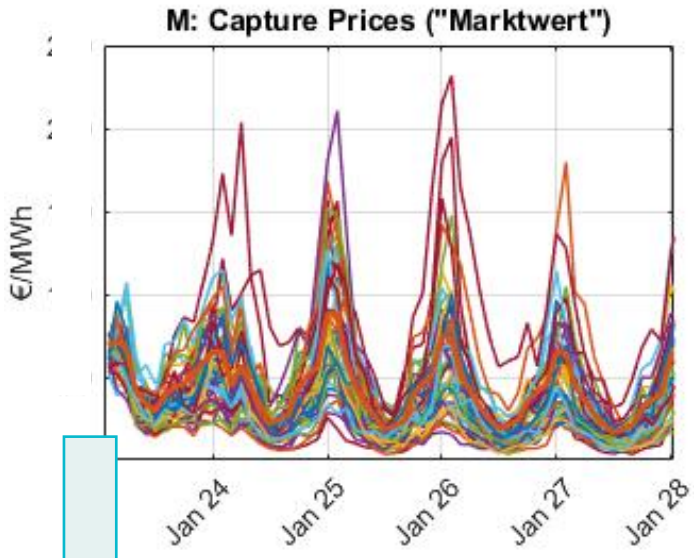
Windmodels

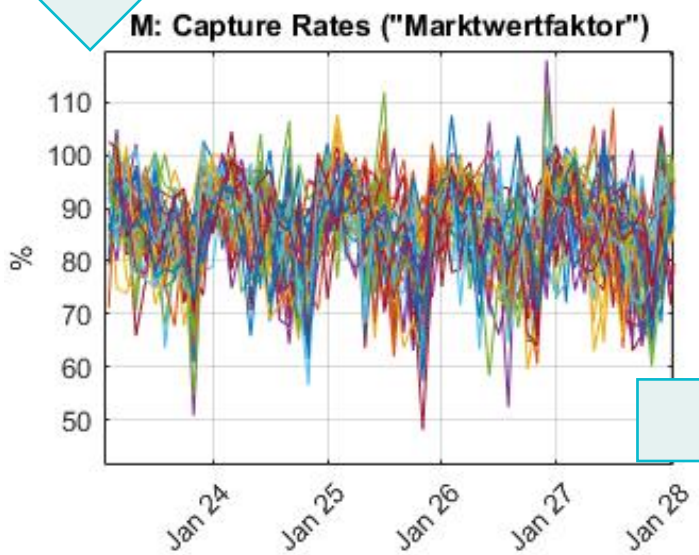
- Locations and areas → all are coupled
- Hourly resolution
- Customer's location downloaded via API in background
- Every requested location is coupled to each other and with distinct areas
- Wind production from areas are coupled to prices
- **Volumes from customer's wind park in SE1 are now coupled with Prices in SE1 → Cannibalism modeled: Wind ↑ (↓) → Prices (↑)**

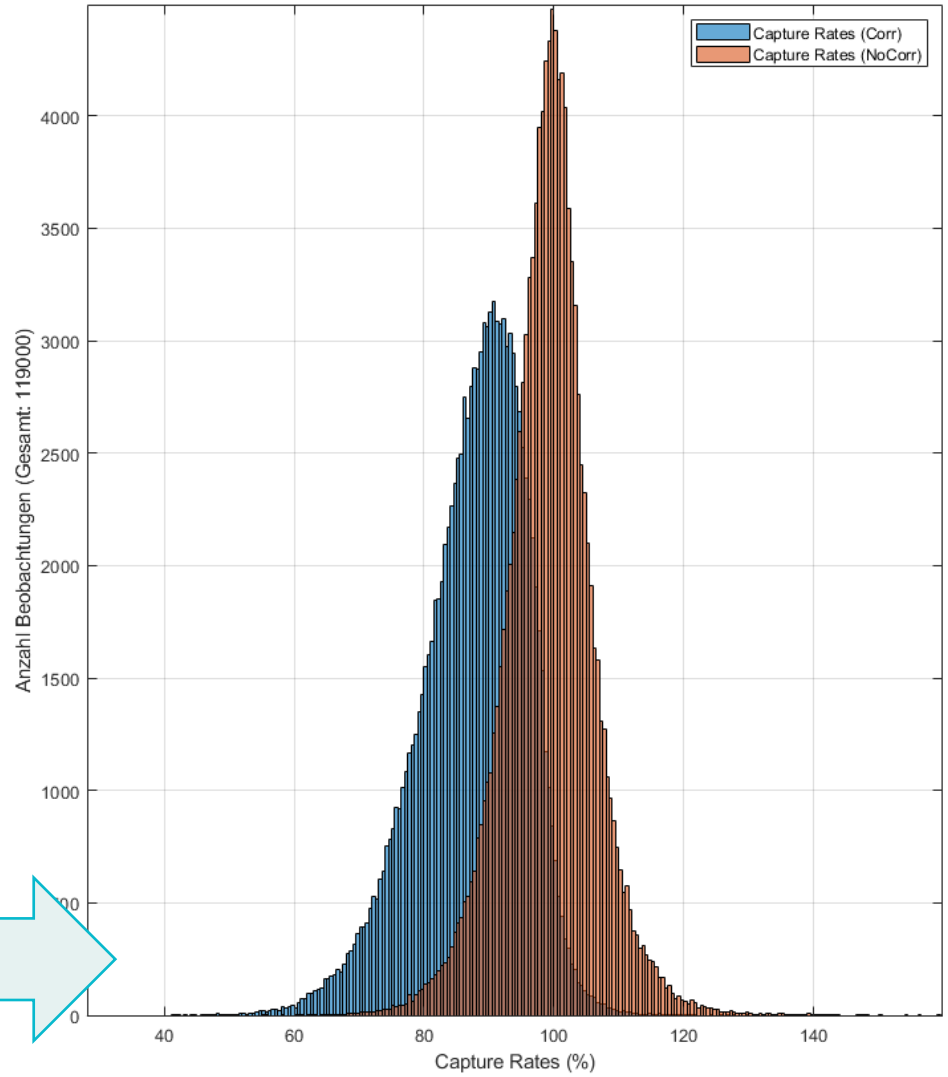


Flow Based & Regeneratives

- Several hundred hourly paths can be used to derive multiple figures.
  Right: monthly capture rates from local volumes and aggregated area production
- Further examples of nonlinear assets which can be analyzed and tracked are hydro reservoirs or CHPs







...

Overview: Analogues Components

- Modelbox “Inflows”
  - analogues “Wind”
- Modelbox “Consumption”
  - analogues “Wind”

User Inputs: Consumption
- Mid-/Long-Run paths for zones

- Modelbox “Fuels”
  - Coal, Gas, Oil, EUA
  - Volatility and correlation term structure
  - Recent price term structures of commodities und emissions

Overview: Further Components

- Links
  - Switch on/off
- Stack-System
  - Separate modules for endogenous water values

User Inputs: Links

- Timeseries for capacities (→ Also simulations/endogenous dynamics will be possible)
- Reactances (PTDFs)

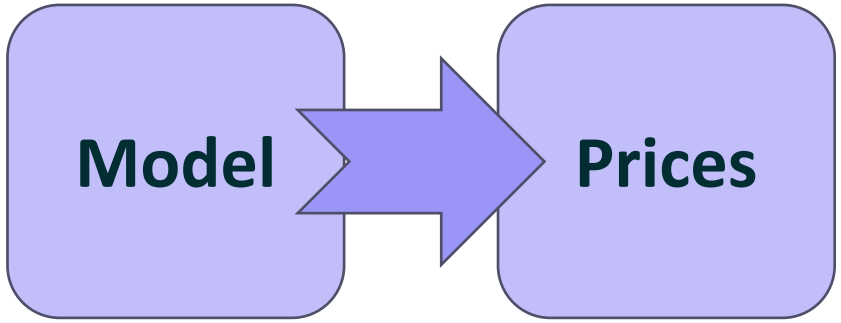
User Inputs: Stacks

- Generation Types
- Capacities (as timeseries analogues Remit)

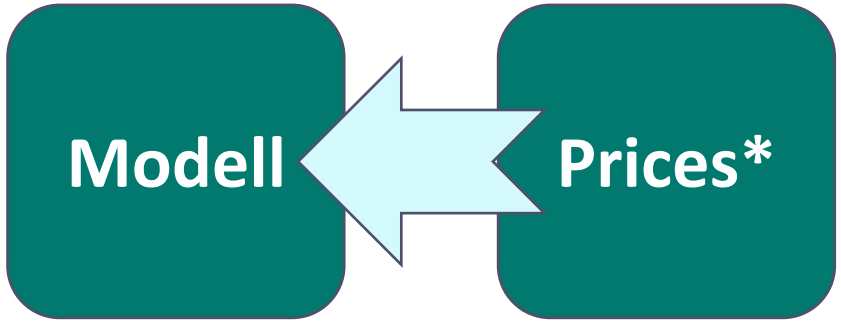
MONTEL

... The Mark-2-Market Mode ...

- Mark-to-Model



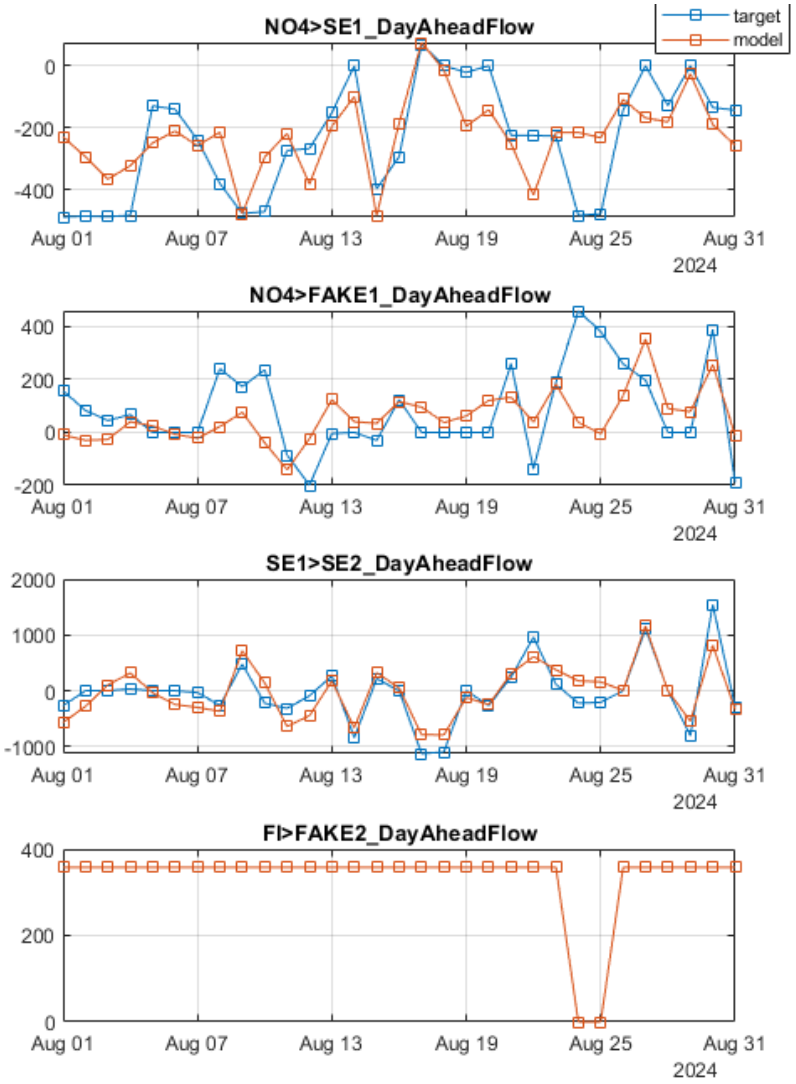
- Mark-to-Market

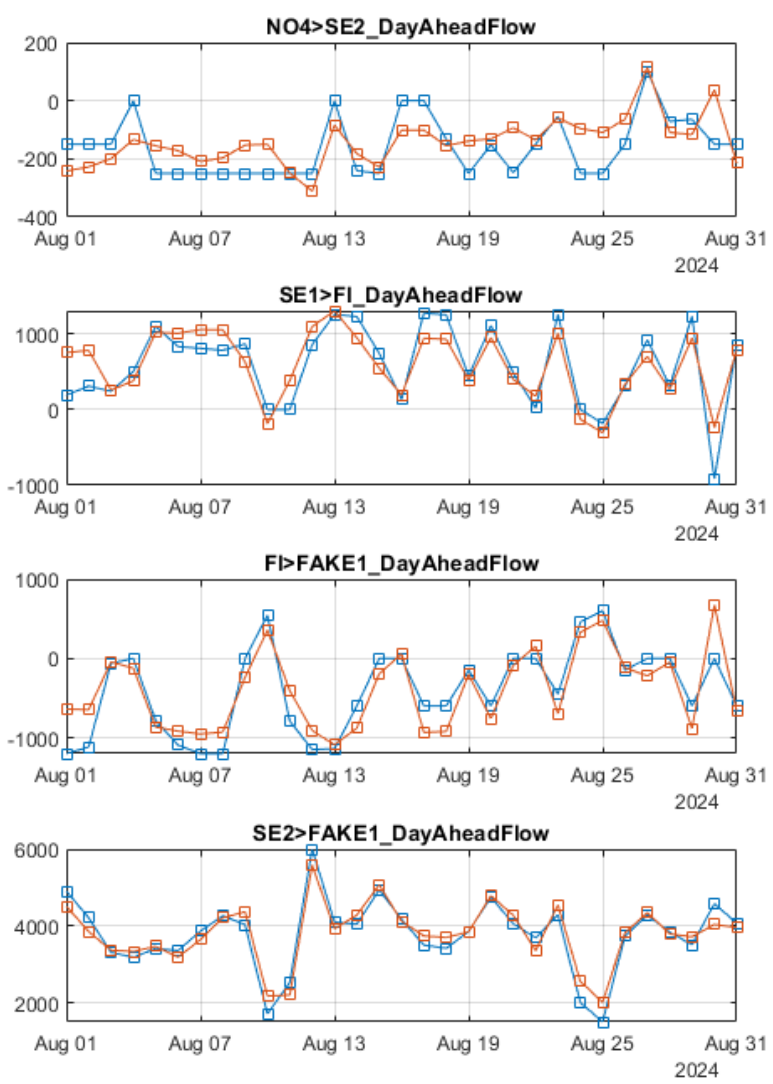


  - (*) e.g. Recent market prices

Dealing with „Reactances“

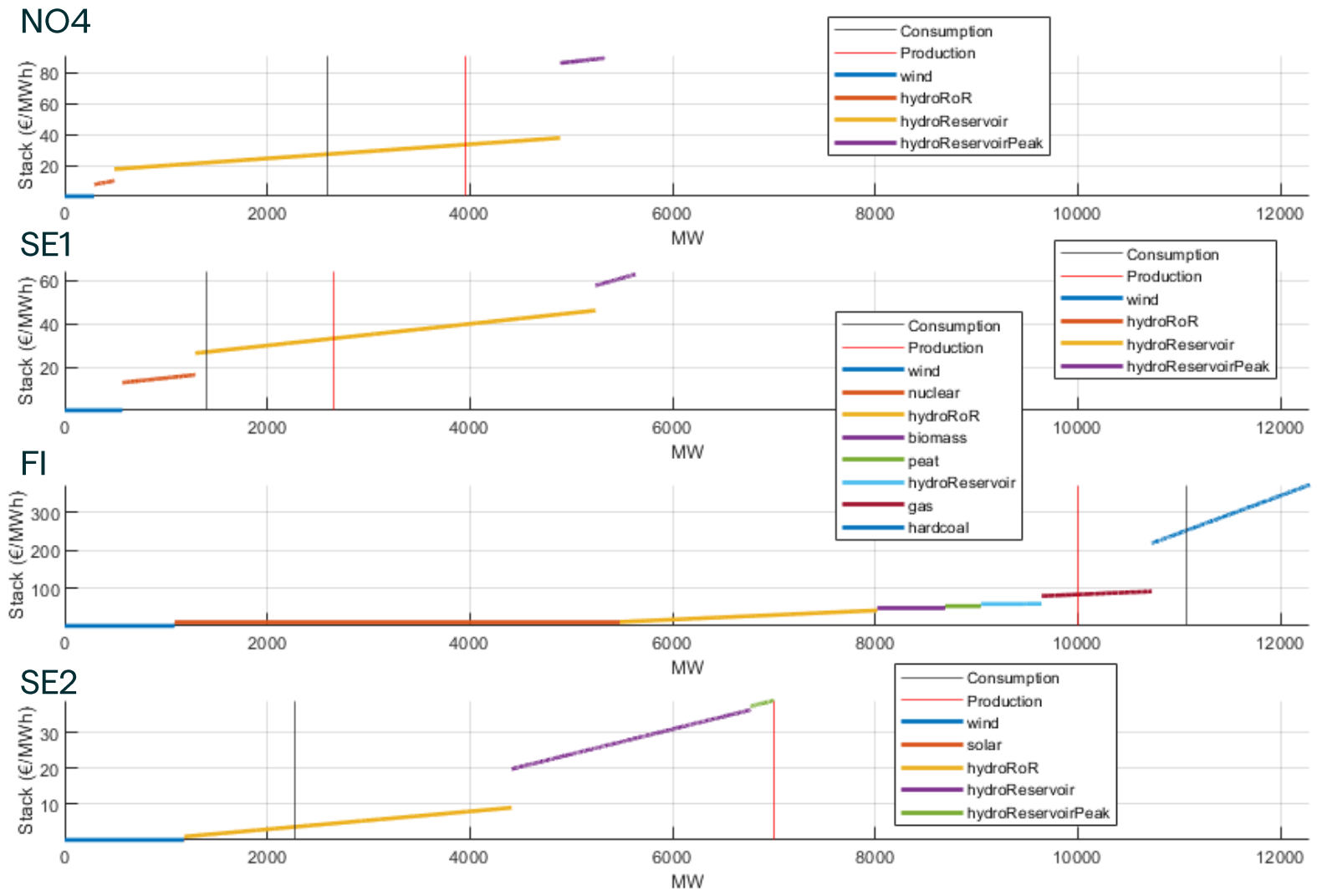
- Reactances are a crucial part of the model
- Reactances directly influence the ways power flows through the network
- We are taking sets from Nordpool actuals for
  - Flows
  - Consumption
  - Calibration
- Following we determine the reactances which fit the observed flows best in our network under consideration
- Note
  - Plots show hour 12 for 1 month
  - Reactances are then used within the model
  - Fake 1 is meant is cumulative output to SE3





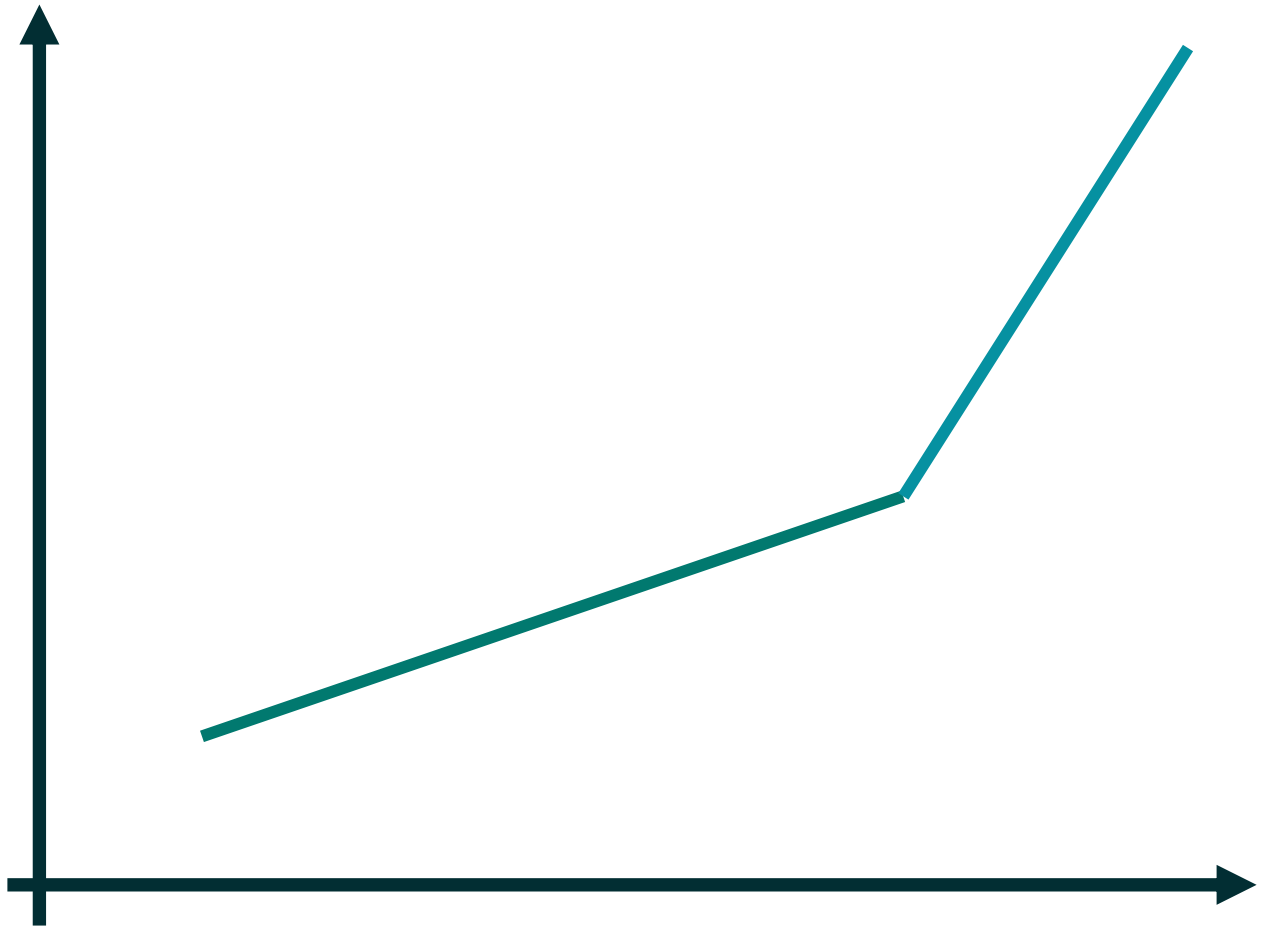
Solver & Optimizer

- Right: Examples at a certain day (see load and production)
- Calibration 1 month sample
- Note that
  - there are multiple possibilities to define segments
  - Stack parameters can be fixed as needed



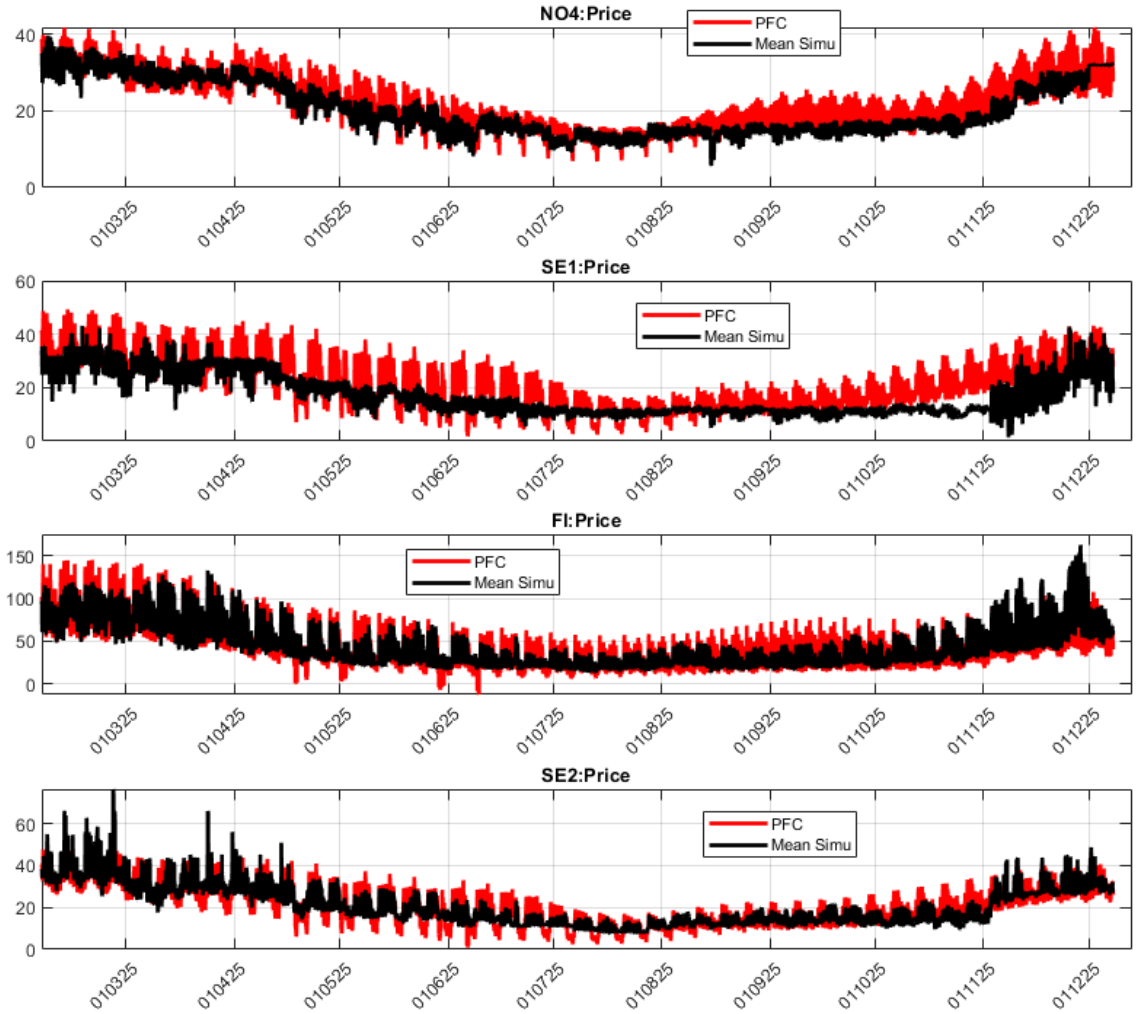
Step forward: Water Values

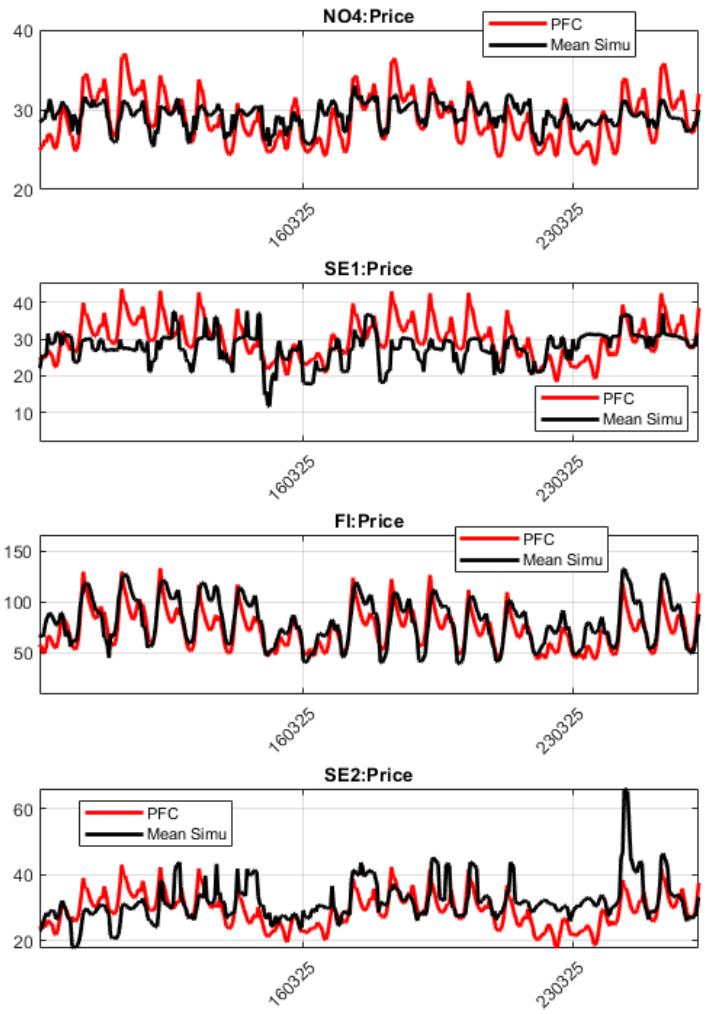
- In Mid- and Long run reservoirs are expected to be in steady state
- When fitting to the Price Forward Curve we get the expected value for the mid- and long run reservoirs (green lines)
  → Note: Calibration is done on equilibrium path (expected fundamentals and prices)



Fitted Model: Expectations

- Fit of the model against HPFCs settlement 22.11.2024
- Black: Expectation as calculated from several simulation paths
- Red: HPFCs
  - Note that HPFCs are based upon all tradable futures products concerning to an area
  - The patterns are based on 2 years of actual data, so it's to be understood as an orientation

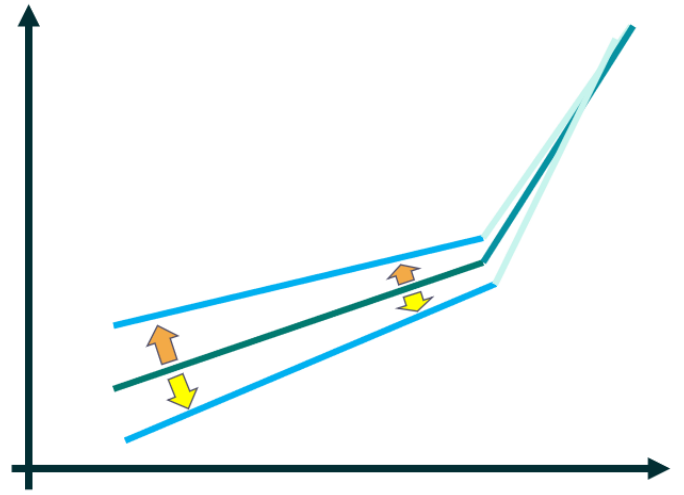


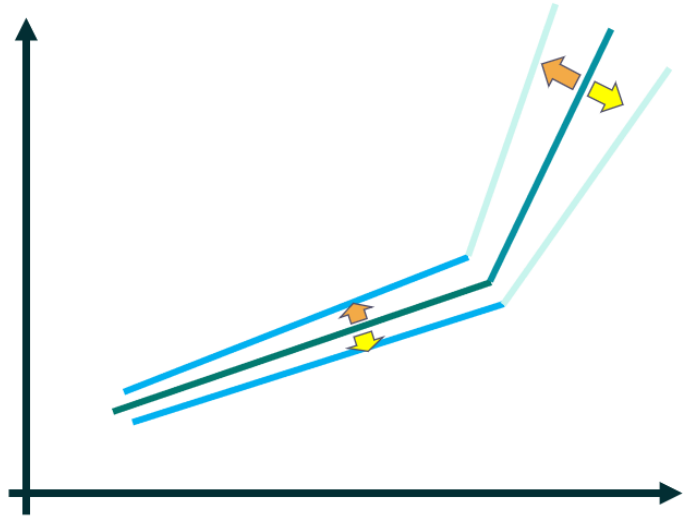


MONTEL

Water Value Simulation

- In every simulation path at any time there will be distinct reservoir states.
- The value of waters for each path is derived via calculating a delta on the fair value (expectation).
- The delta depends on e.g.
  - marginal price of mid-segment, might be coal or gas from same simulation set
  - Recent level of reservoirs

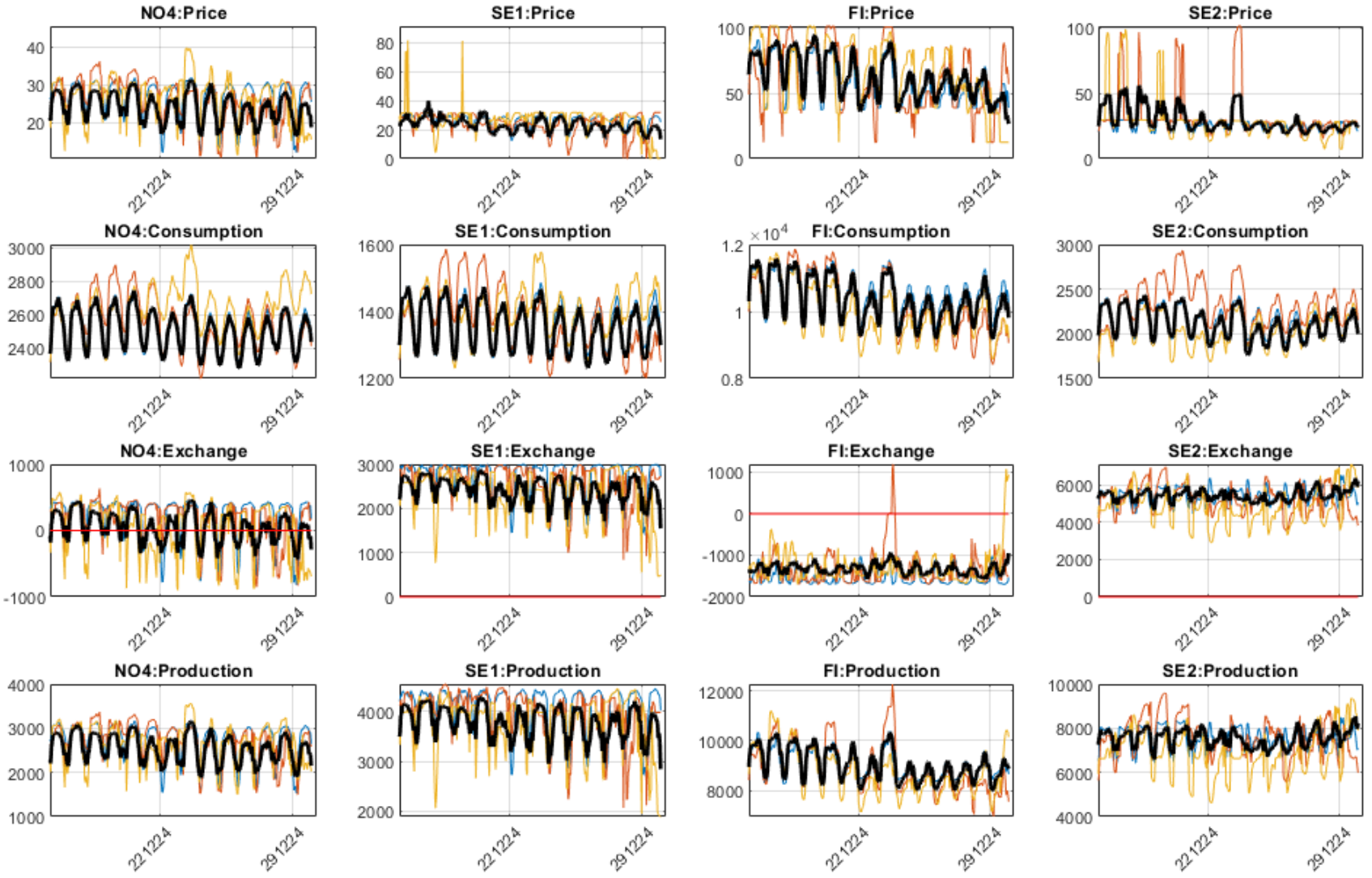




MONTEL

Fitted Model: Simulations

- Simulation for 4 areas
  - Prices
  - Consumption
  - Exchange
  - Flows
- Means over all paths over a certain period of time which represents the delivery period of a tradable futures contract ends up in a mean being identical to the quoted futures price



...

MONTEL

End

Current Topology

- Blue zones are fully modelled (stacks, consumption & wind simulations)
- Yellow “fake” zones represents boundaries to other parts of the network
- Power which is entering and leaving the topology is modelled with fake zones