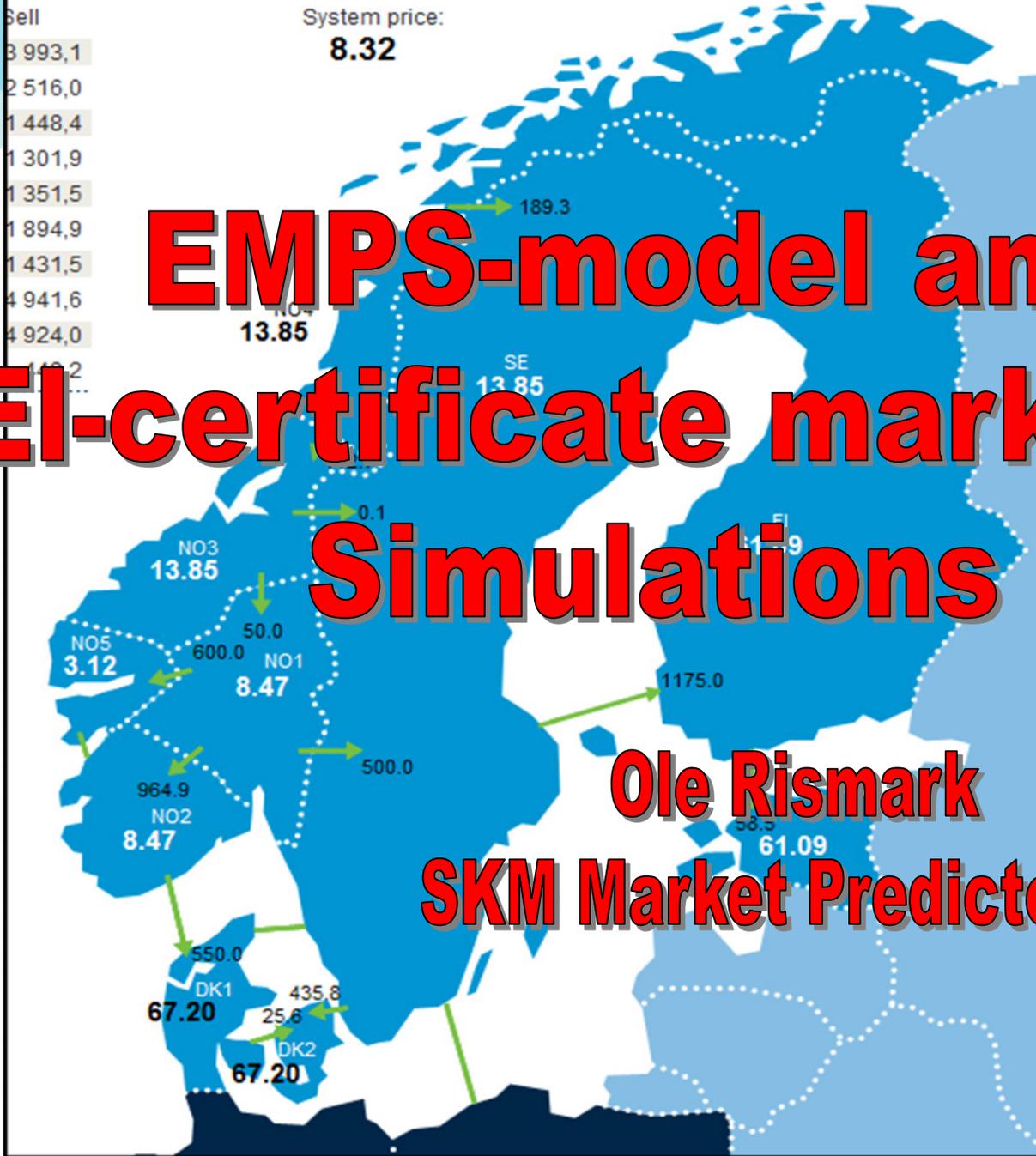




Sell
8 993,1
2 516,0
1 448,4
1 301,9
1 351,5
1 894,9
1 431,5
4 941,6
4 924,0
119,2
...

System price:
8.32

EMPS-model and Ei-certificate market Simulations



Ole Rismark

SKM Market Predictor AS

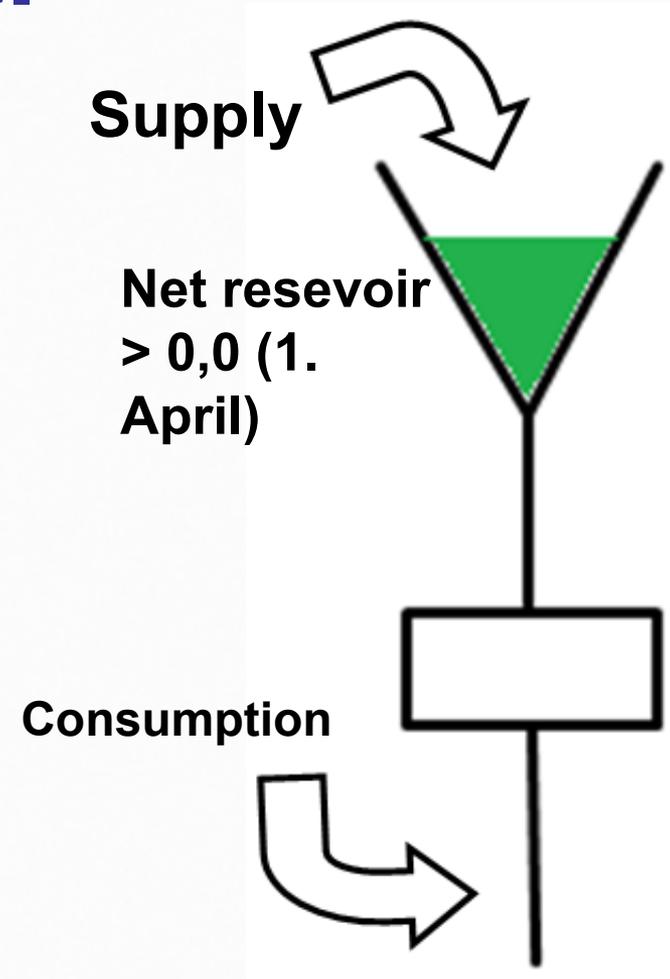


El-certificate in the EMPS-model

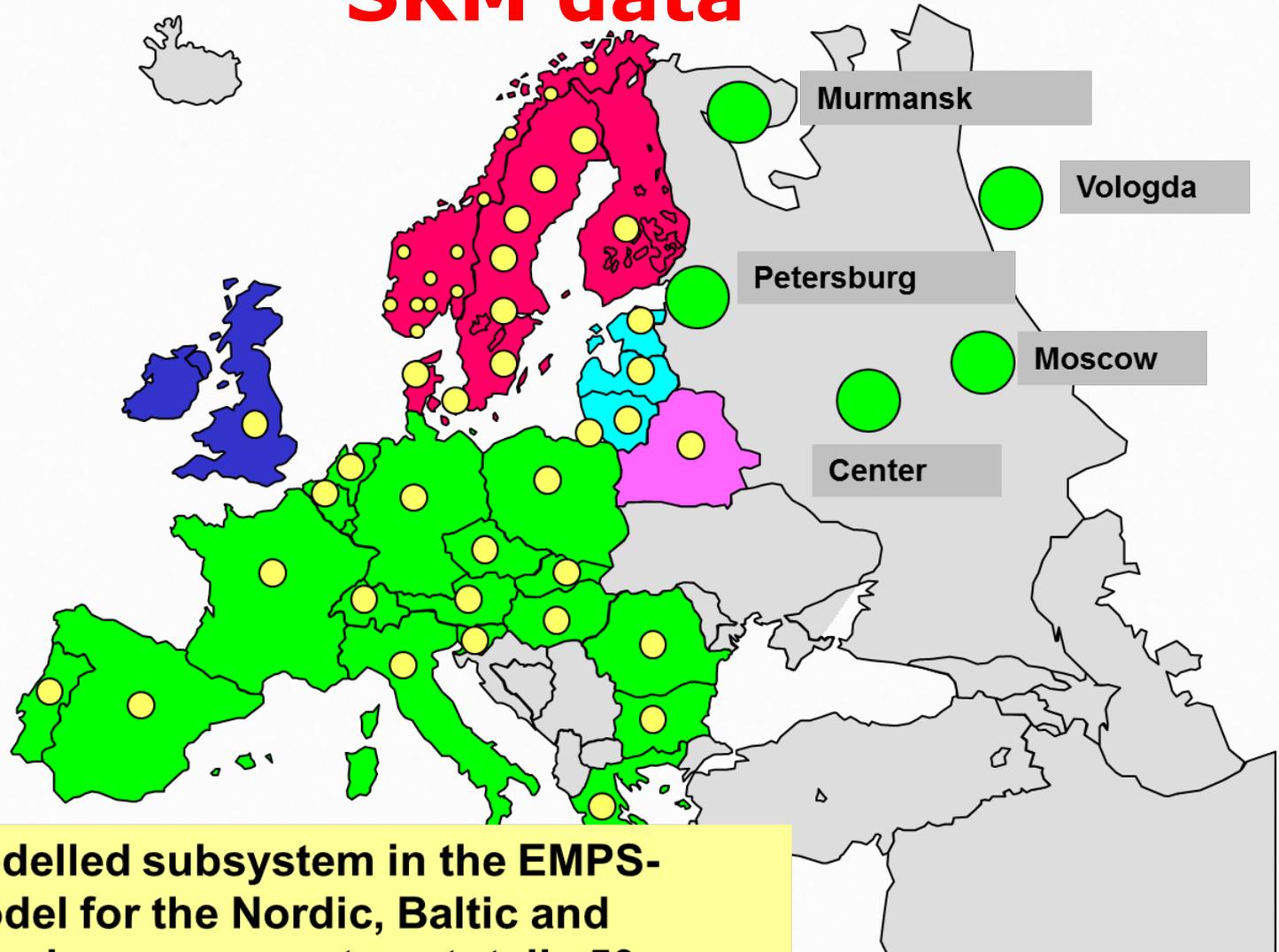
- **Model concept/structure**
 - Elcertificate marked is one green area
 - Supply : Wind, Hydro, Bio and solar
 - Demand : Quota for consumption
- **SKM model and input data**
 - Simplified area model
 - El-certificate market data
 - Model input, challenges
- **Simulation results**
 - Price forecast
 - Balances
 - Volatility in wind and hydro

Implementation in the EMPS-model

- **Certificates in a new reservoir**
 - + Optimal use of certificate in the reservoir
 - + Stochastic Hydro and Wind implemented
 - + Use of existing structure in the model
- **Certificate price a function of**
 - Certificate in the reservoir
 - Expected value of penalty
- **Operation model**



EMPS-modellen and Subsystem SKM data

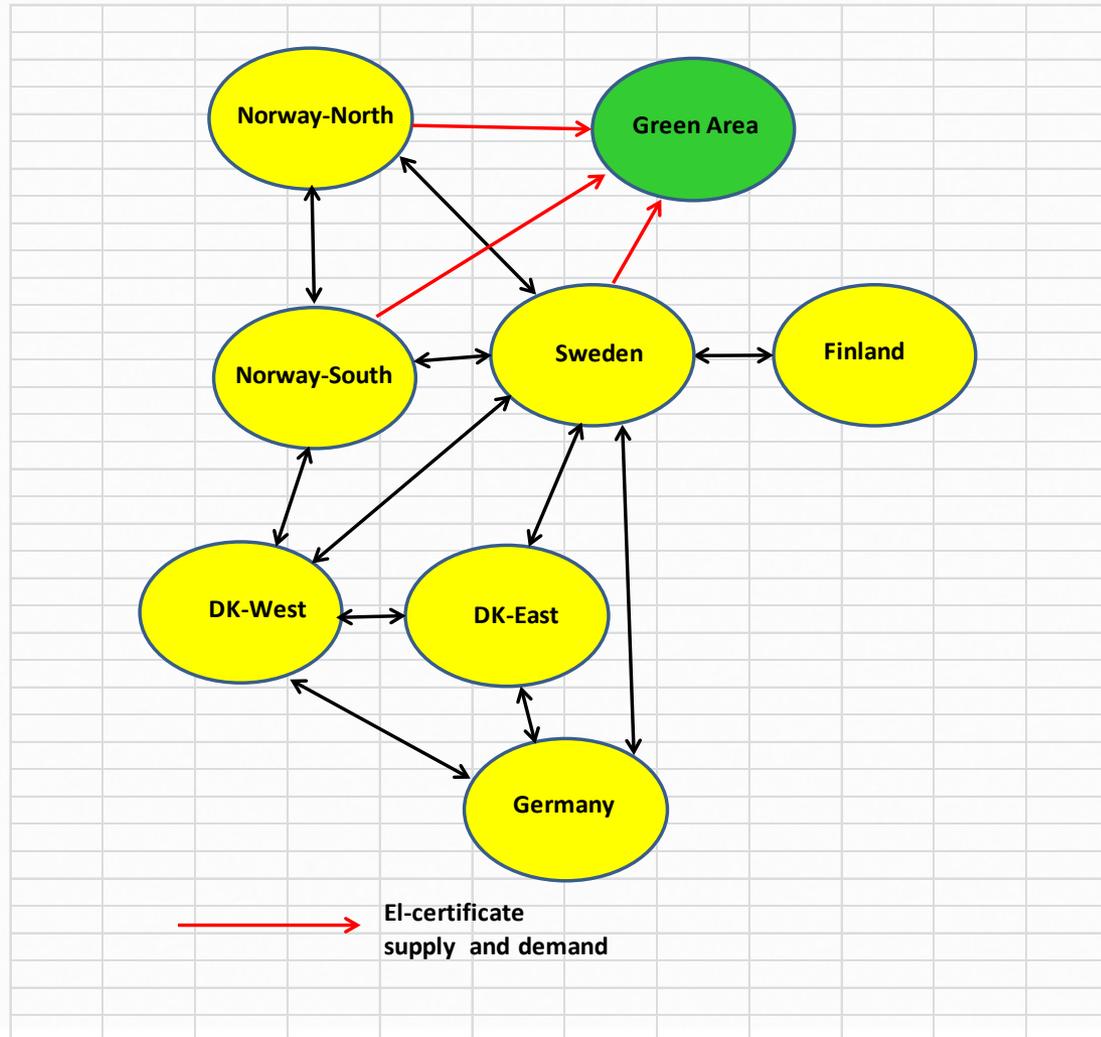




El-certificate market and prices

- **Time demanding to implement all data for the elcertificate market**
- **SKM have created a simplified model with 7 subsystem**
 - **Gives not correct area prices, but correct certificate price**
 - **Bio is the only price dependent production**
 - **Consumption modulled with a certain price dependency**

Modelling of power and el-certificate marked





Modelling of el-certificate market

El-certificate supply and demand, price dependent to some extent

- Biomass, marginal price decided by a lot of uncertain parameters
 - Transport cost
 - Availability of Biomass
 - Labour cost +++
- Electricity demand dependent of price
- Hydro and Wind in principle not dependent of price as marginal cost are very low



Modelling of hydro power, chalanges

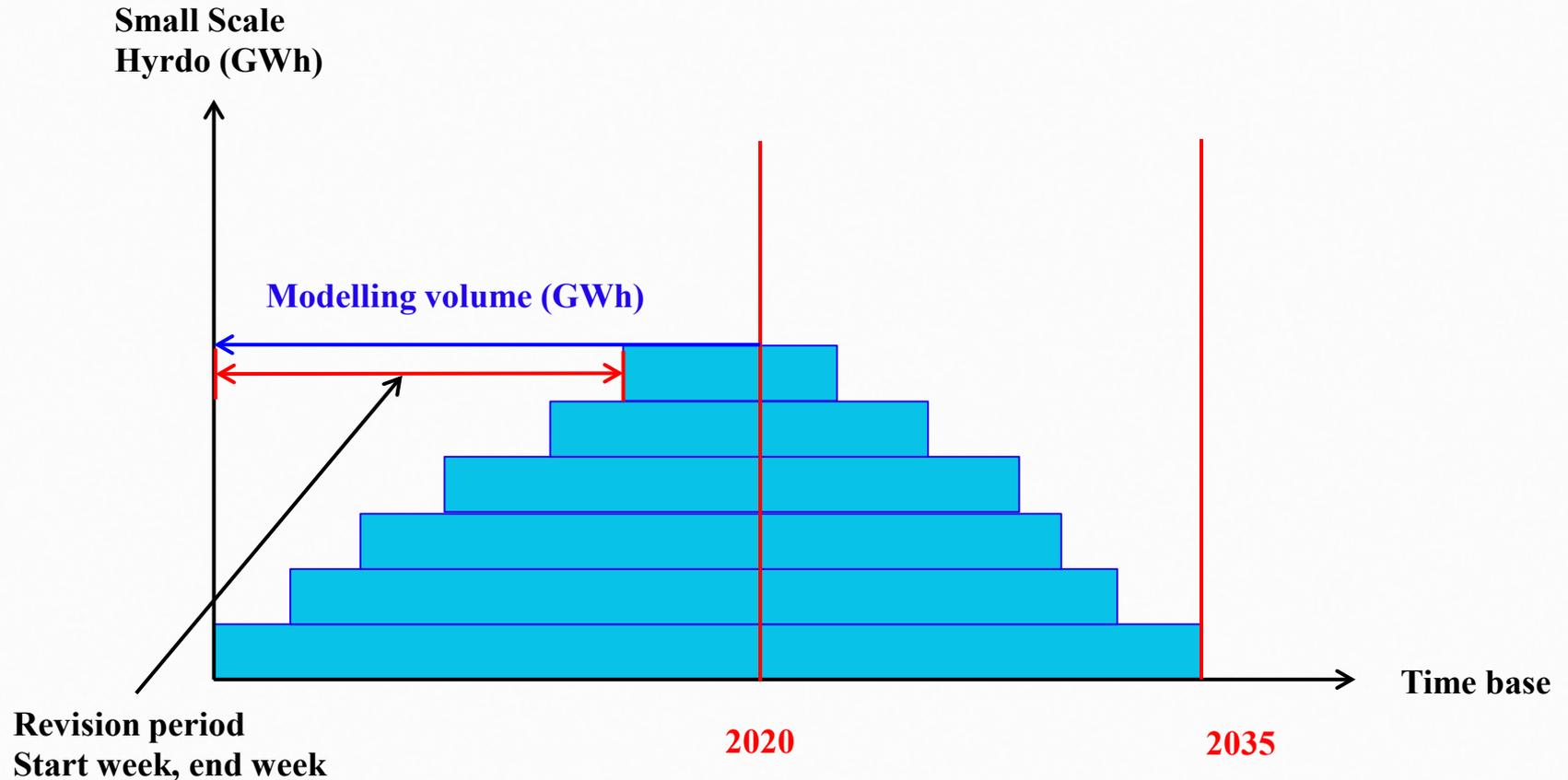
- **Hydro power and elcertificate :**
 - **Hydro power has to be modelled at module level, leading to some chalanges :**
 - **Hydro power getting elcertificate are mostly small scale hydro power, impossible to model all plants (hundres of plants)**
 - **Aggregated moldules are used for each area (SKM have 6 different modules), stepwise development modeled by means of revisions (revisjonplan.stas)**
 - **Different inflow series used to take take care of variation in inflow in different areas of Norway.**
 - **Phaseout of hydro power (after 15 years), end week and percent of total hydro power**



Modelling of wind power, challenges

- **Wind power and certificate market :**
 - **Time series for wind power are scaled to take care of increasing capacity**
 - **Wind speed from NASA (downloaded from internet) used to take care of stochastic wind production.**
 - **Phaseout of certificate wind taken care of by means of end week and percent**

Small scale Hydro power in the elcertificate market towards 2035, principle scheme





Simulation results, case study

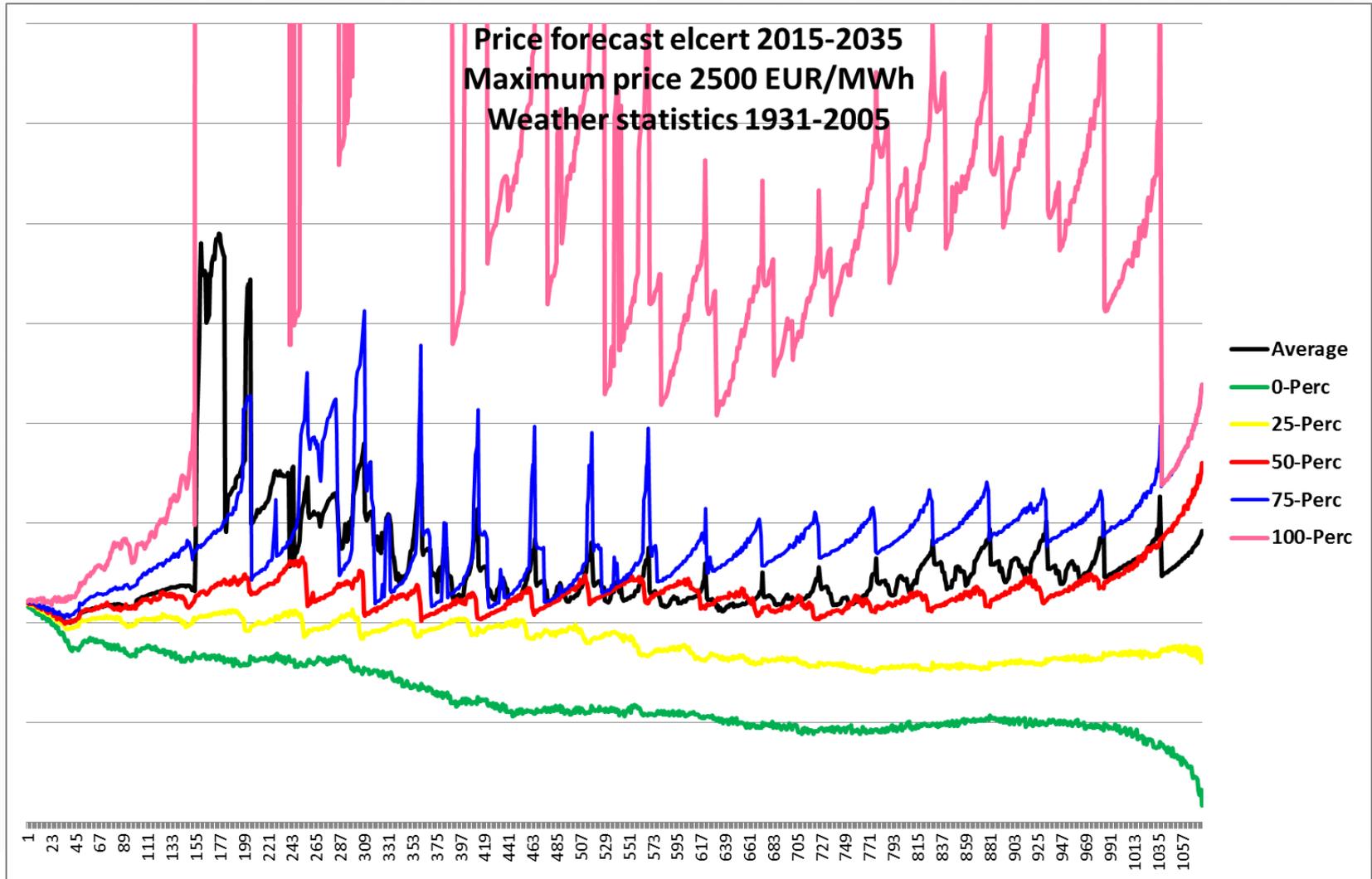
- **Investment time base for wind, hydro and bio are estimated of an SKM-model developed for el-certificate market**
- **198 TWh accumulated plus transitional arrangements (both Norway and Sweden) for the whole period assumed to be covered by supply side**
- **Simulation results**
 - **Price**
 - **Balances**
 - **Volatility in wind and hydro**



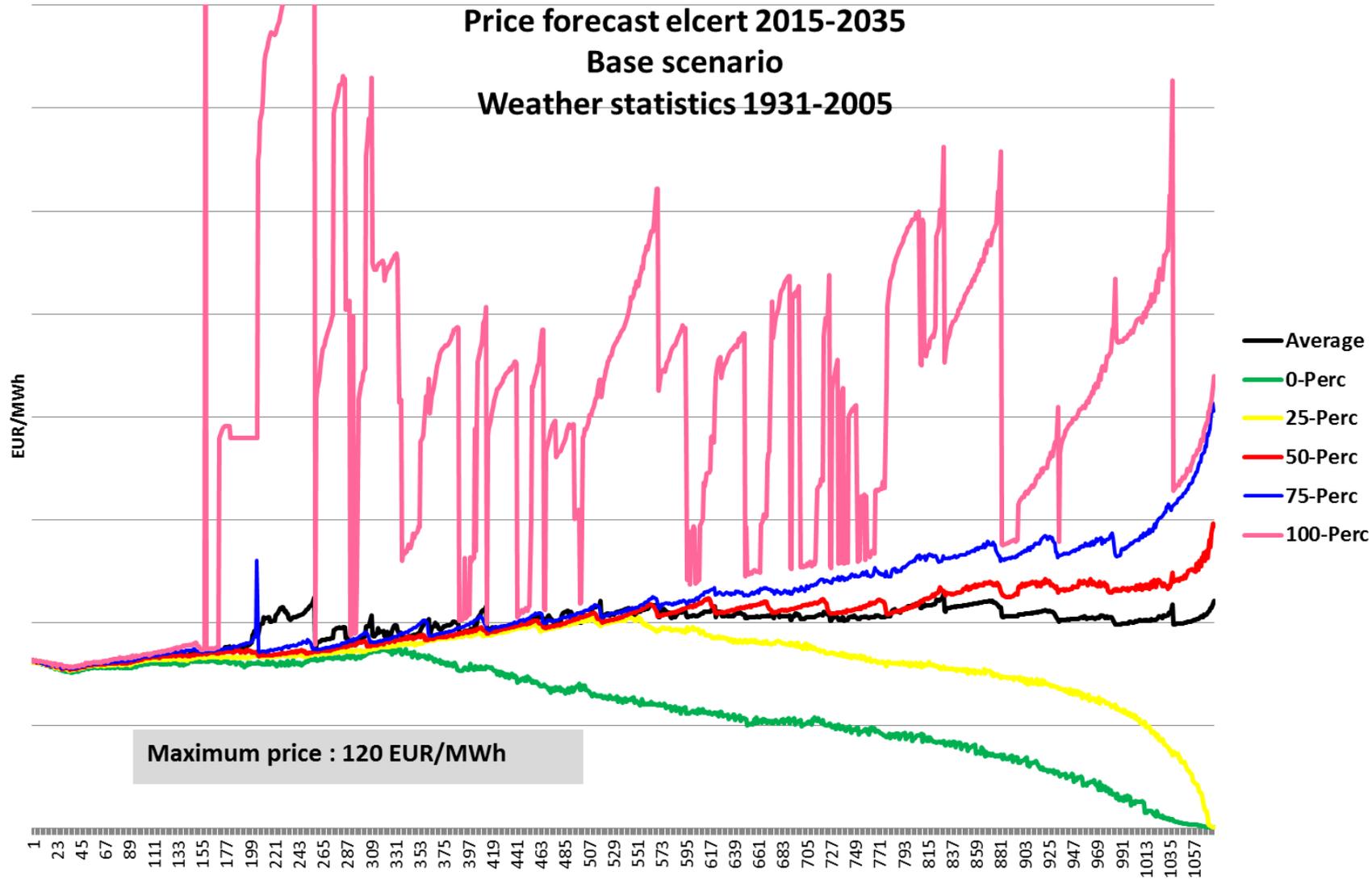
Analysis input assumptions

- **Penalty = $1.5 \times$ (average price last year)**
- **Price last year**
- **Price this year until start week**
- **Endprices in year 2035 (or end year) at certain reservoir levels.**
- **Maximum el-certificate price**

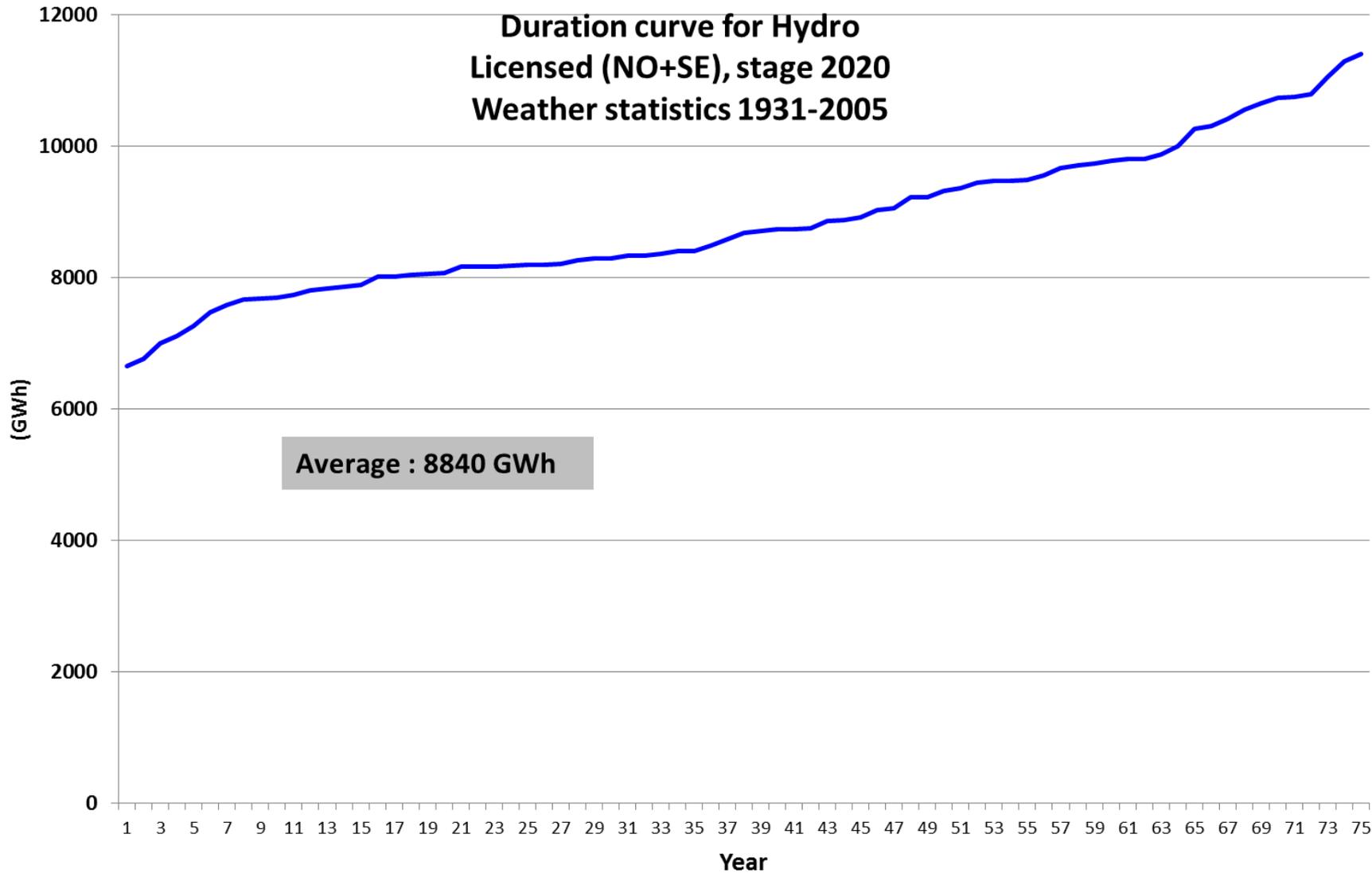
Price forecast



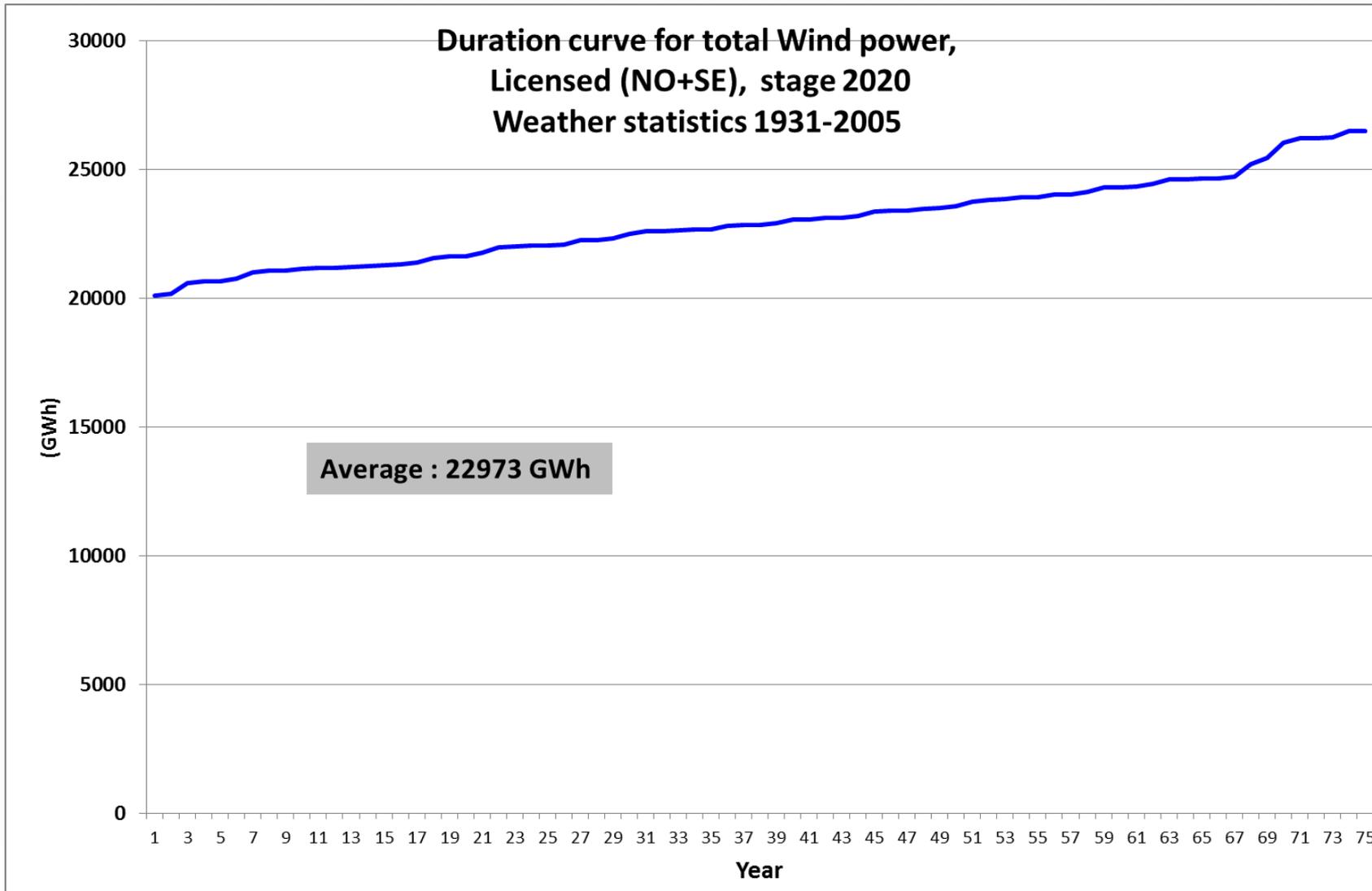
Price forecast



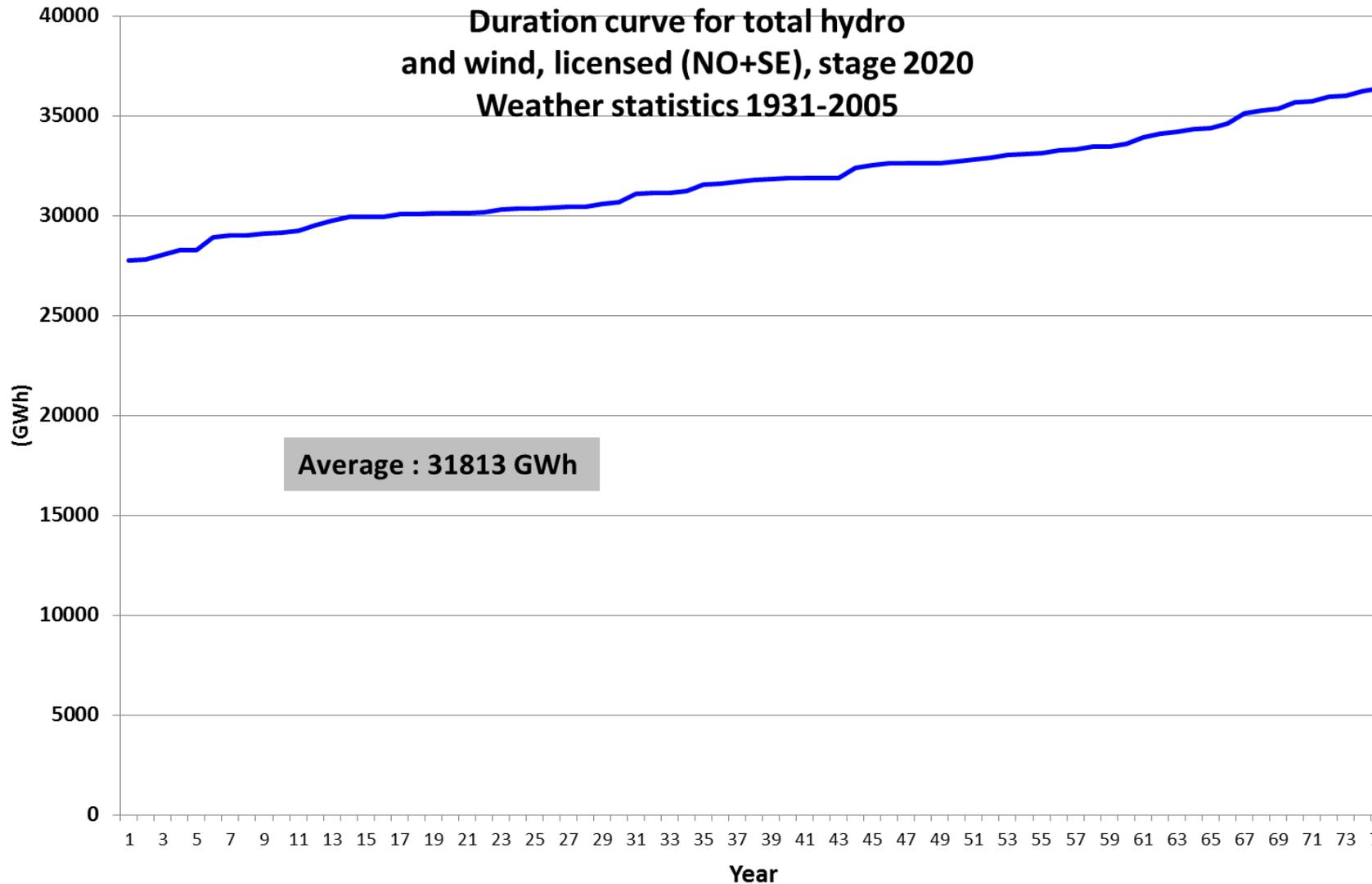
Hydro production variation



Wind production variation



Hydro and wind production, variation





**Thank you for
your attention**