

Visualization of electricity market fundamentals

Case: Nordic market

Intermediate report

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1 CHANGES OF GOALS

There has not been any primary changes of the goals in the project so far.

The primary goal of the project is still to design and implement a fully functional web based market analysis device for the Nordic power market to be used within Fortum.

2 COMPLETED ACTIONS SO FAR

The following actions in the project plan have been completed or started so far:

1. Preparation of project plan
Action completed
2. Planning of the methodological part
Action completed, see appendix C for results.
3. Preparation of the intermediate report
Action completed
4. Planning of the Excel tool
Action completed
5. Implementation of the Excel tool
Action started
6. Planning of the web pages
Action started

Generally, the first part of the project - understanding the fundamentals and the relations between them, as well as identifying key indices - has been completed. This was considered to be the most important part of the project. The results have been satisfactory to good. There are still a lot of things that could be done, but there is not enough time for everything in the scope of this project.

We have identified inter-relations between the key-fundamentals and tested different models for them. Inter-relations between the financial forward-prices and the fundamentals have been scoped out, though. A picture of the identified inter-relations between the fundamentals can be found in appendix B.

The fundamentals have been divided into five different parts: production, consumption, hydrology, exchange and prices. The web-tool will be designed so that pictures can belong to one of these parts. In addition to this, we have also chosen to make a difference between "monitoring" pictures and "analysis" pictures. Monitoring pictures visualises how different variables develop during the current year and how the situation is compared to history. Analysis pictures focuses on the inter-relationships between the fundamentals and might require more time and understanding from the user's point of view. A list of the planned pictures can be found in appendix C.

Of the second part of the project, the planning of the Excel-tool has been completed and implementation of it has started.

The third major part was planning and building the web-pages. Of this part, the planning has started.

3 FUTURE ACTION PLAN

3.1 Identified actions

The identified future actions are in line with the project plan.

5. Implementation of the Excel tool
Action started.
6. Planning of the web pages
Action started.
7. Implementation of the web pages
Action not started.
8. Testing
Action not started.
9. Preparation of the documentation
The documentation of the chosen fundamentals, analysis and visualization methods has been started. The documentation of a user's and developer's manual for both the Excel-tool and the webpages has not been started.
10. Preparation of the final report and seminar presentation
Action not started.
11. Delivery of project results to the customer
12. Seminar presentation

See appendix A for a detailed list of actions and the time needed.

3.2 Timetable

The project has so far been carried out according to the timetable. A picture of the future timetable can be found in appendix A.

3.3 Resourcing

Of the future actions, Tuomas takes responsibility of the documentation of the fundamentals, Pasi takes responsibility of the implementation of the Excel-tool and Vesa takes responsibility of the implementation of the web-pages.

For details, see appendix A.

4 UPDATED RISKS

4.1 Inappropriateness of chosen analytical methods

If the chosen analytical methods are inadequate to capture the relevant characteristics of market data, the accuracy of the results obtained might be poor and even misleading the decision making.

Risk is to be minimized by testing each hypothesis with real market data before considering which methods to include in the final solution.

4.2 Missing of project timetable deadlines

If the planned analysis methods or tool functionality turn out to be inadequate, additional effort must be put to develop adequate methods or tools. The required additional effort might cause delays to the initial project timetable.

Risk is to be minimized by testing each hypothesis as soon as possible with real market data before considering which methods to include to the final solution.

4.3 Unsustainable implementation

If the chosen methods are implemented in a quick & dirty fashion, the resulting tool might be very difficult to maintain and develop further.

Risk is to be minimized by planning and documenting the implementable tool thoroughly according to proper application development discipline before any actual implementation work is carried out.

4.4 Future expansion and development of tool difficult

If the future expansion and development of the tool functionality is not properly taken into account in the implementation planning phase, the enhancement of the tool might be difficult (although the implemented part could be done in a sustainable fashion).

Risk is to be minimized by including the foreseeable future expansion and development needs into the planning and documenting phase according to proper application development discipline.

4.5 Complex and inadequate documentation

If the documentation is too complex and/or inadequate, the existing functionality of the tool might not be possible to clarify. Lack of proper documentation could hinder the future development of the tool as well.

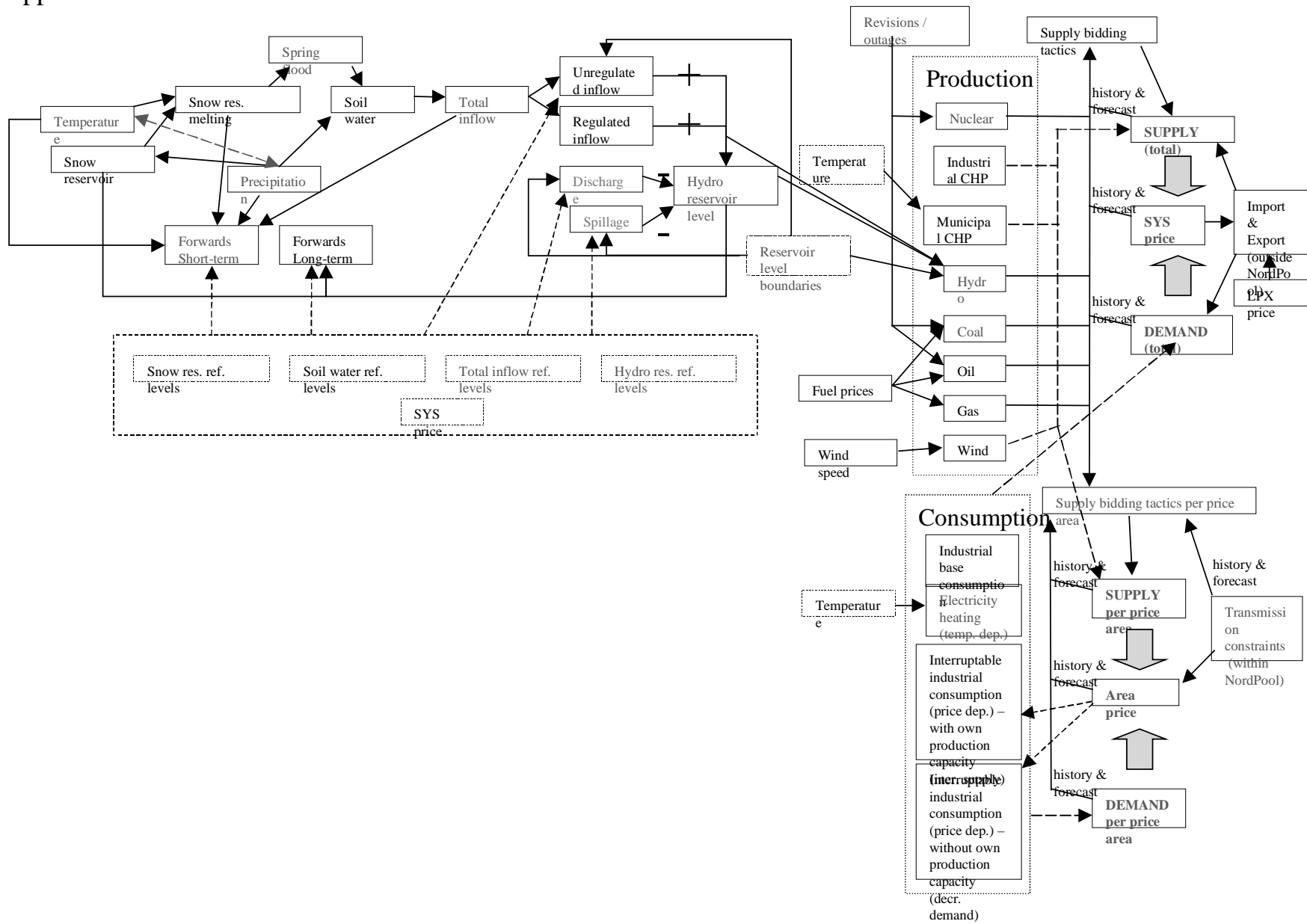
Risk is to be minimized by preparing proper documentation including a user's manual and a developer's manual. Use of tool will be tested within the project by future end-users and developers of the tool.

4.6 Personnel risks

If crucial parts of the project workload are scheduled for a small set (e.g. one individual) of people, the possible unexpected unavailability of these resources might cause severe problems like delays in project timetable, additional costs etc.

Risk is to be minimized by dividing the workload evenly among project group and preparing proper follow-up documentation of the work done so far throughout the project.

Appendix B



Appendix C

Production monitoring pictures

Total production (weekly level)

- areas: Sweden, Norway, Finland, Denmark, System
- total per production type (per area): hydro, oil, coal, CHP, wind, nuclear, gas
 - previous year (2002)
 - current year (2003)
 - average of 96-02 (preferably from market lifetime)
 - min of 96-02 (preferably from market lifetime)
 - max of 96-02 (preferably from market lifetime)
 - max capacity of current year (oil, coal, nuclear, gas)

Percentage of total production

- areas: Sweden, Finland, Denmark, System
- per production type (per area): hydro, oil, coal, CHP, gas
 - previous year (2002)
 - current year (2003)
 - average of 96-02 (preferably from market lifetime)
 - min of 96-02 (preferably from market lifetime)
 - max of 96-02 (preferably from market lifetime)

Production analysis pictures

Temperature dependent production

- per area: Sweden, Denmark, Finland
- production type: CHP
- picture type: scatter plot
 - whole history
- current year different colour than older history
- regression equation with coefficients in the picture, also R2

Correlation between system price and fuel price

- area: system
- fuelprices: coal, oil
 - whole history

Price dependent production, areaprice

- per pricearea: Norway, Sweden, Denmark, Finland, system
- production type: hydro, coal, oil, gas
- picture type: scatter plot
 - whole history
- current year different colour than older history
- regression equation with coefficients in the picture, also R2

Price dependent production, marginalprice=areaprice - fuelprice

- per pricearea: Sweden, Denmark, Finland, system
- production type: coal, oil, gas
- picture type: scatter plot
 - whole history
- current year different colour than older history
- regression equation with coefficients in the picture, also R2

Hydrology monitoring pictures

- Precipitation
 - everything per area: Norway, Sweden, Norway+Sweden
 - density + cumulative pic (for one calendar year period)
 - previous year (2002)
 - current year (2003)
 - average of 61-90 (preferrably from market lifetime & long history)
 - min of 96-02 (preferrably from market lifetime & long history)
 - max of 96-02 (preferrably from market lifetime & long history)
- Inflow
 - everything per area: Norway, Sweden, Norway+Sweden
 - density + cumulative pic (for one calendar year period)
 - previous year (2002)
 - current year (2003)
 - average of 50-2000 (preferrably from market lifetime & long history)
 - min of 96-02 (preferrably from market lifetime & long history)
 - max of 96-02 (preferrably from market lifetime & long history)
- Water reservoir level
 - everything per area: Norway, Sweden, Norway+Sweden
 - density pic in 2-axis (% & TWh) (for one calendar year period)
 - previous year (2002)
 - current year (2003)
 - average of 90-02 (preferrably from market lifetime & long history)
 - min of 90-02 (preferrably from market lifetime & long history)
 - max of 90-02 (preferrably from market lifetime & long history)
- Snow reservoir level
 - everything per area: Norway, Sweden, Norway+Sweden
 - density pic (for one calendar year period)
 - previous year (2002)
 - current year (2003)
 - average of 61-90 (preferrably from market lifetime & long history)
 - min of 90-02 (preferrably from market lifetime & long history)
 - max of 90-02 (preferrably from market lifetime & long history)
- Soil water level
 - everything per area: Norway, Sweden, Norway+Sweden
 - density pic (for one calendar year period)
 - previous year (2002)
 - current year (2003)
 - average of 61-90 (preferrably from market lifetime & long history)
 - min of 90-02 (preferrably from market lifetime & long history)
 - max of 90-02 (preferrably from market lifetime & long history)

Hydrology analysis pictures

Output data - correlation analysis

- Common time granularity: weekly level
- History correlation between inflow and precipitation, soil water, snow reservoirs & temperature
 - areas: at least Nor+Swe
 - 2-axis format (snow in TWh, others in % of normal; set all zero levels coincide)
 - chronological development 2000_01 -> (preferably from market lifetime & long history)

 - use 4 week moving average (4 last weeks)
 - one pic for deviation from average level (average = time horizon shown)
- Spot PRICE
 - areas: at least SYS
 - density pic (for one calendar year period)
 - previous year (2002)
 - current year (2003)
 - average of 96-02 (preferably from market lifetime)
 - min of 96-02 (preferably from market lifetime)
 - max of 96-02 (preferably from market lifetime)
- History correlation between Spot & inflow
 - areas: at least SYS & Nor+Swe
 - 2-axis format
 - chronological development 1996_01 -> (preferably from market lifetime)
 - one pic for abs data and another for deviation from average level (average = time horizon shown)
 - show zero deviation level in deviation pics (use similar color than corresponding deviation)
- History correlation between Spot & water reservoir level
 - areas: at least SYS & Nor+Swe
 - 2-axis format
 - chronological development 1996_01 -> (preferably from market lifetime)
 - one pic for abs data and another for deviation from average level (average = time horizon shown)
 - show zero deviation level in deviation pics (use similar color than corresponding deviation)
- History correlation between hydro production & inflow
 - areas: at least Nor+Swe
 - 2-axis format
 - chronological development 1997_01 -> (preferably from market lifetime)
 - one pic for abs data and another for deviation from average level (average = time horizon shown)
 - show zero deviation level in deviation pics (use similar color than corresponding deviation)
- History correlation between hydro production & Spot
 - areas: at least Nor+Swe & SYS
 - 2-axis format
 - chronological development 1997_01 -> (preferably from market lifetime)
 - one pic for abs data and another for deviation from average level (average = time horizon shown)
 - show zero deviation level in deviation pics (use similar color than corresponding deviation)
- History correlation between hydro production & water reservoir level

- areas: at least Nor+Swe
- 2-axis format
- chronological development 1997_01 -> (preferably from market lifetime)
- one pic for abs data and another for deviation from average level (average = time horizon shown)
- show zero deviation level in deviation pics (use similar color than corresponding deviation)

Output data - leverage analysis via simple regression

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- Leverage of precipitation, soil water, temperature & snow reservoir on inflow
 - Fit model to available history data using regression: $\text{Inflow}(t) = \text{Inflow_ave}(t) + b1 * \text{Precip_dev}(t) + b2 * \text{Soil_water_dev}(t) + \text{Melting_Season}(t) * [b3 * \text{Temp_dev}(t) + b4 * \text{Snow_Res}(t)]$
 - Picture for fitting History
 - model outcome
 - realized value
 - average value
 - the estimated regression coefficients into the Picture as text box or something
 - calculate the explanatory power of fitted model
 - how much (%) variation model explains: $R^2 = (\text{Syy} - \text{SSE}) / \text{Syy}$; $\text{Syy} = \text{sum}[(Y_i - Y_{\text{ave}})^2]$ {quickly: $R^2 = (\text{correl}[Y_{\text{realized}}, Y_{\text{model}}])^2$ }
 - how much variation each factor explains: start with model $Y(t) = Y_{\text{ave}}(t)$ ($R^2 = \dots$) => add factors one by one => changes in R^2 give effect of each added factor..
 - Leverage of inflow & water reservoir on Spot
 - Fit model to available History data using regression: $\text{Spot}(t) = \text{Spot_ave}(t) + B1 * \text{Inflow_dev}(t) + B2 * \text{Water_dev}(t)$
 - Picture for fitting History
 - model outcome
 - realized value
 - average value
 - the estimated regression coefficients into the Picture as text box or something
 - calculate the explanatory power of fitted model
 - how much (%) variation model explains: $R^2 = (\text{Syy} - \text{SSE}) / \text{Syy}$; $\text{Syy} = \text{sum}[(Y_i - Y_{\text{ave}})^2]$ {quickly: $R^2 = (\text{correl}[Y_{\text{realized}}, Y_{\text{model}}])^2$ }
 - how much variation each factor explains: start with model $Y(t) = Y_{\text{ave}}(t)$ ($R^2 = \dots$) => add factors one by one => changes in R^2 give effect of each added factor..
 - Leverage of spot, inflow & water reservoir on hydro production
 - Fit model to available History data using regression: $\text{HydroProd}(t) = \text{HydroProd_ave}(t) + B1 * \text{Spot_dev}(t) + B2 * \text{Inflow_dev}(t) + B3 * \text{Water_Res_dev}(t)$
 - Picture for fitting History
 - model outcome
 - realized value
 - average value
 - the estimated regression coefficients into the Picture as text box or something
 - calculate the explanatory power of fitted model
 - how much (%) variation model explains: $R^2 = (\text{Syy} - \text{SSE}) / \text{Syy}$; $\text{Syy} = \text{sum}[(Y_i - Y_{\text{ave}})^2]$ {quickly: $R^2 = (\text{correl}[Y_{\text{realized}}, Y_{\text{model}}])^2$ }
 - how much variation each factor explains: start with model $Y(t) = Y_{\text{ave}}(t)$ ($R^2 = \dots$) => add factors one by one => changes in R^2 give effect of each added factor..

Consumption monitoring pictures

Total consumption (weekly level)

- areas: Sweden, Norway, Finland, Denmark, System
- previous year (2002)
- current year (2003)
- average of 96-02 (preferably from market lifetime)
- min of 96-02 (preferably from market lifetime)
- max of 96-02 (preferably from market lifetime)
- min consumption calculated based on regression model and min temperatures
- max consumption calculated based on max temperatures
- average consumption calculated based on average temperatures

Temperature (weekly average)

- areas: Sweden, Norway, Finland, Denmark, System
- previous year (2002)
- current year (2003)
- average of 96-02 (preferably from market lifetime)
- min of 96-02 (preferably from market lifetime)
- max of 96-02 (preferably from market lifetime)

Consumption analysis pictures

Temperature dependent consumption, temperature

- areas: Norway, Sweden, Denmark, Finland, system
- picture type: scatter plot
 - whole history
- current year different colour than older history
- christmas weeks with different colour than history
- midsummer weeks with different colour than history and christmas
- regression equation with coefficients in the picture, also R2

- Leverage of Temperature on Consumption

- areas: Norway, Sweden, Denmark, Finland, system
- Fit model to available History data using regression:
- Picture for fitting History
 - model outcome
 - realized value
 - average value
 - the estimated regression coefficients into the Picture as text box or something
 - calculate the explanatory power of fitted model
 - how much (%) variation model explains: $R^2 = (S_{yy} - SSE) / S_{yy}$; $S_{yy} = \sum[(Y_i - Y_{ave})^2]$ { quickly: $R^2 = (\text{correl}[Y_{realized}, Y_{model}])^2$ }
 - how much variation each factor explains: start with model $Y(t) = Y_{ave}(t)$ ($R^2 = \dots$) => add factors one by one => changes in R^2 give effect of each added factor..

Long-term trend of consumption

- areas: Norway, Sweden, Denmark, Finland, system
- whole history

- realised consumption
- normalised consumption = realised consumption corrected to normal temperature using the regression model and temperature minus normal temperature
- 52-weeks moving average of normalised consumption
- average on realised consumption for calendar year (same curve for each year)

Exchange monitoring pictures

Weekly net exchange per area

- areas: Sweden, Norway, Finland, Denmark, System
 - previous year (2002)
 - current year (2003)
 - cumulative previous year
 - cumulative current year
 - max import/week as straight line
 - max export/week as straight line

Weekly net exchange between areas

- areas: Sweden-Finland, Sweden-Norway, Germany - Sweden, Germany-Denmark
 - previous year (2002)
 - current year (2003)
 - cumulative previous year
 - cumulative current year
 - max import/week as straight line
 - max export/week as straight line

Exchange analysis pictures

Net sales between areas, price difference

- areas: Germany - Sweden (price difference: LPX - Swe price), Germany - Eltra (price diff: LPX - DK1 price), Sweden - Norway (price diff: Swe price - No price), Finland - Sweden (price diff: Swe -Fin)
- picture type: scatter plot
 - whole history
 - current year different colour than older history
 - previous year with different colour than history
 - regression equation with coefficients in the picture, also R2