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Profitability of a Hydro Power Producer Bidding in Multiple Power Markets

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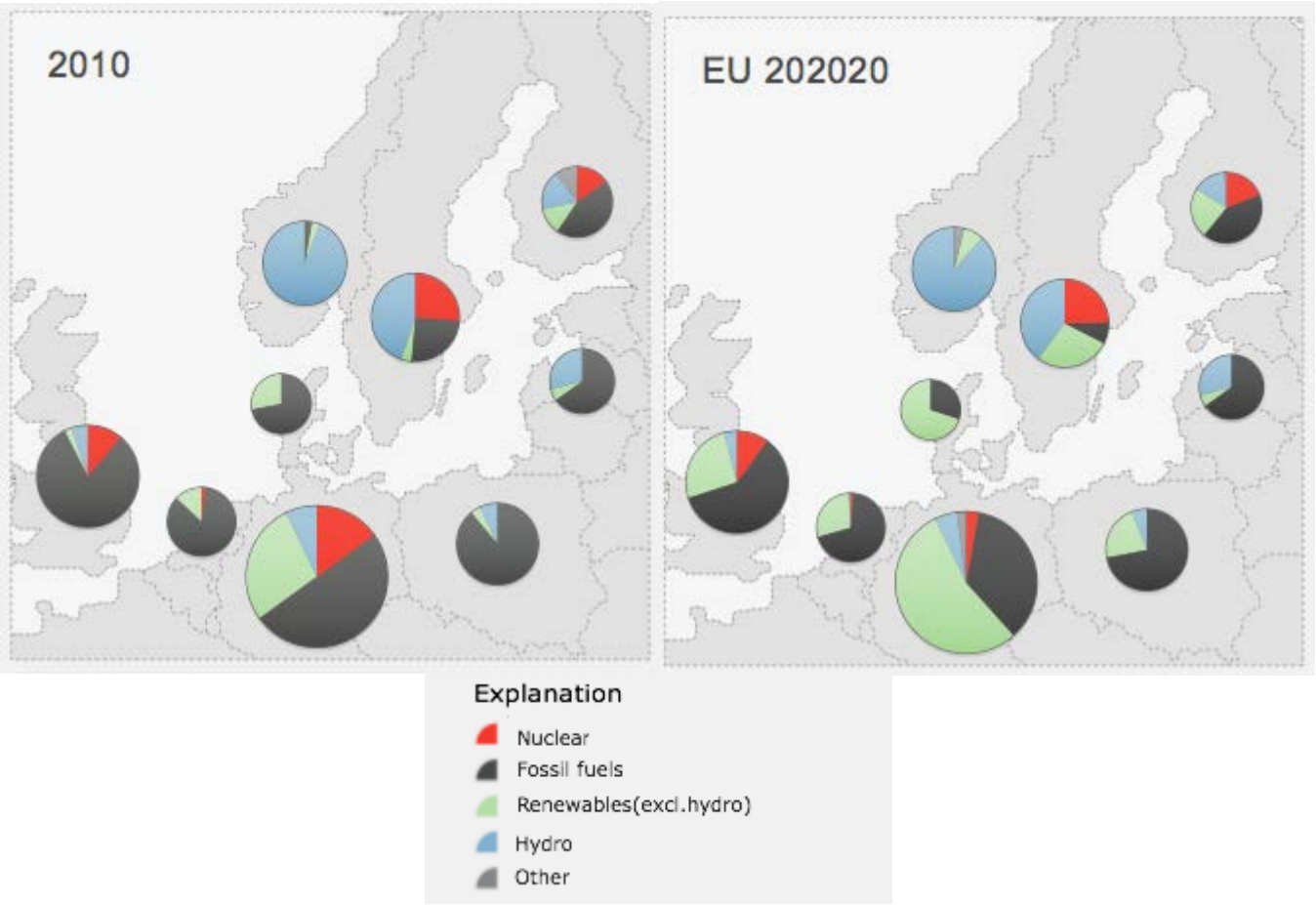
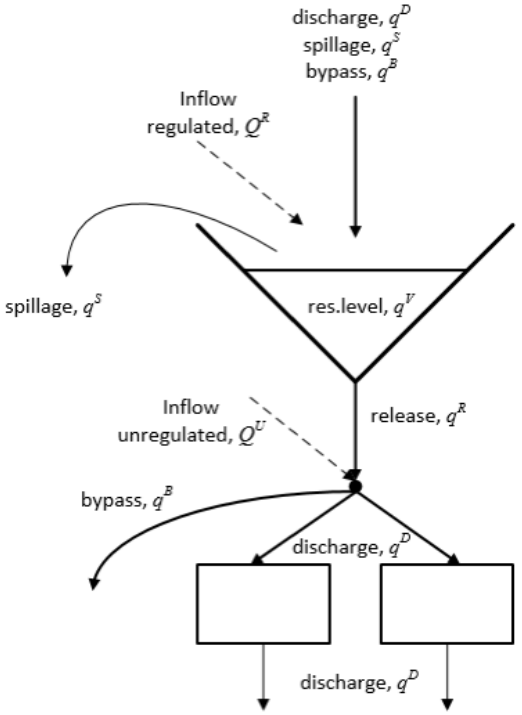
Introduction



Model Description

- A short term deterministic model in AMPL
- Maximizes current profits and future water value
- Bidding in the day-ahead and balancing market
- Price taker, risk neutral



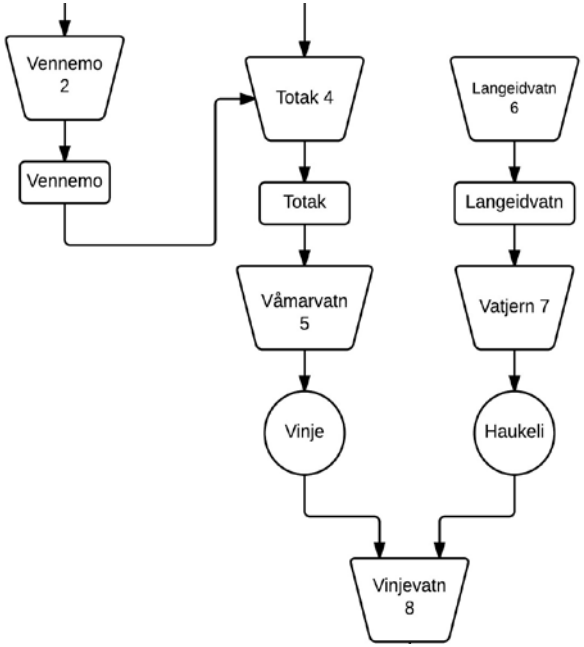
Model Modifications

- RKOM modeled as capacity restriction
- Goal: To find the cost of reserving capactity
- Risk implementation based on safety-first:

$$obj_s \geq Obj_s^{DA} - \lambda, \quad s \in \mathcal{S}$$

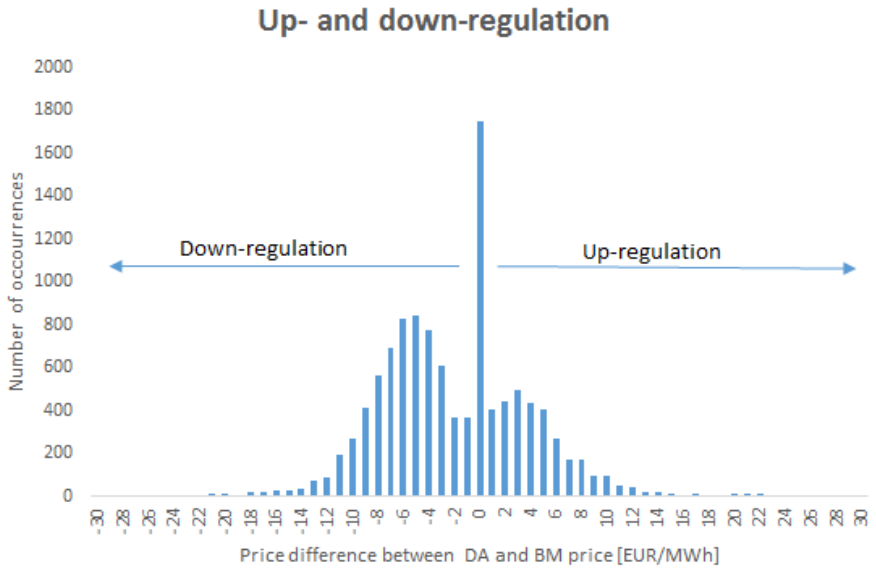
Case Study

- Tokke-Vinje hydro power system
- 11 reservoirs, 8 power plants, 990.4 MW total installed capacity
- Physical data provided
  by SINTEF Energy Research



Price Scenario Generation

- Price input based on historical data
- Price difference between day-ahead and balancing market increased



Results

- Increased profitability by including the balancing market

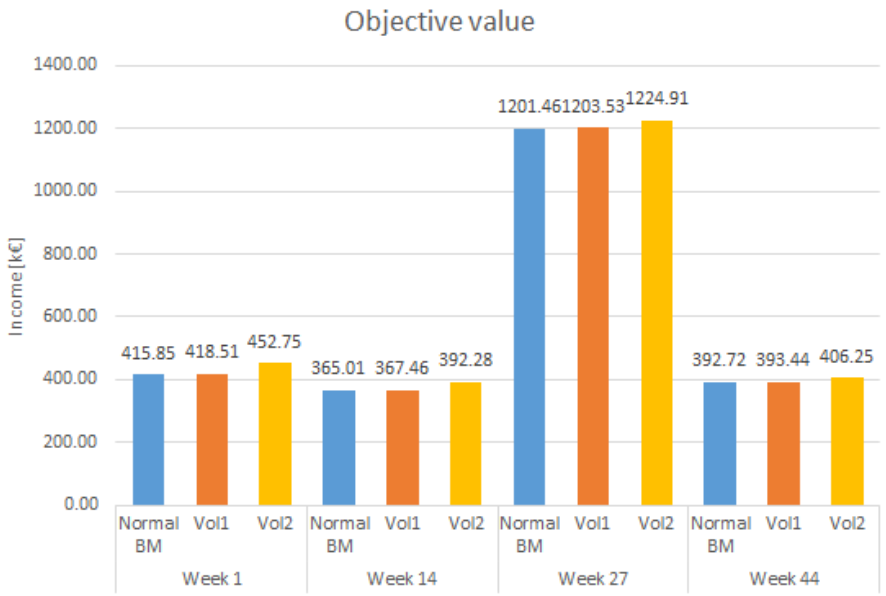
Table 2. Value of objective and contributing factors with BM included. Price input according to the normal case [$\frac{\text{kEUR}}{\text{day}}$].

	Week 1	Week 14	Week 27	Week 44
Spillage cost	0.00	0.00	0.00	0.00
Start up cost	1.16	0.53	1.46	1.02
Day-ahead income	1001.99	935.78	695.43	728.73
Balancing market income	-102.70	-72.47	-18.84	6.88
Increased water value	-481.35	-496.54	526.98	-340.52
Objective	415.85	365.01	1201.46	392.72
Gain from including BM	20.72	20.22	7.74	9.00
as % of original income[1]	5.24%	5.86%	0.65%	2.35%

Results

- Increased profitability by including the balancing market

- Further increase with price volatility



Results

- RKOM not currently profitable

Table 4. RKOM price required to break even for different reserved RKOM capacities.

RKOM volume [MW/h]	P^{RKOM} [EUR/MW/h]
20	7.44
50	7.53
80	7.58

- Risk reduction:
  - 21.50% chance of 20 000 EUR loss
  - 8.7% chance of 1 000 EUR loss
  - Cost: 2 300 EUR in expected income

Conclusion

- RKOM not presently profitable in this case study
- Great profitability potential, increasing with price volatility
- Valuable knowledge as more intermittent generation is expected

Thank you for your attention!

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