

Regional TIMES model for Norway with high time resolution

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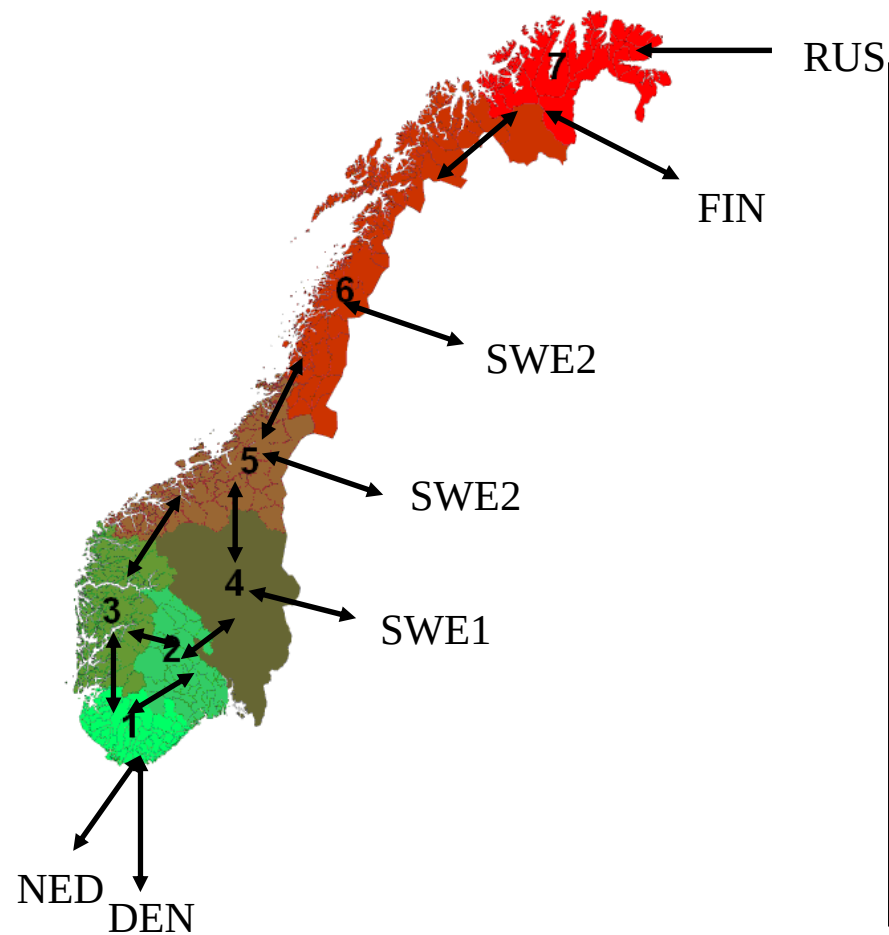
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The Regional Norwegian TIMES model

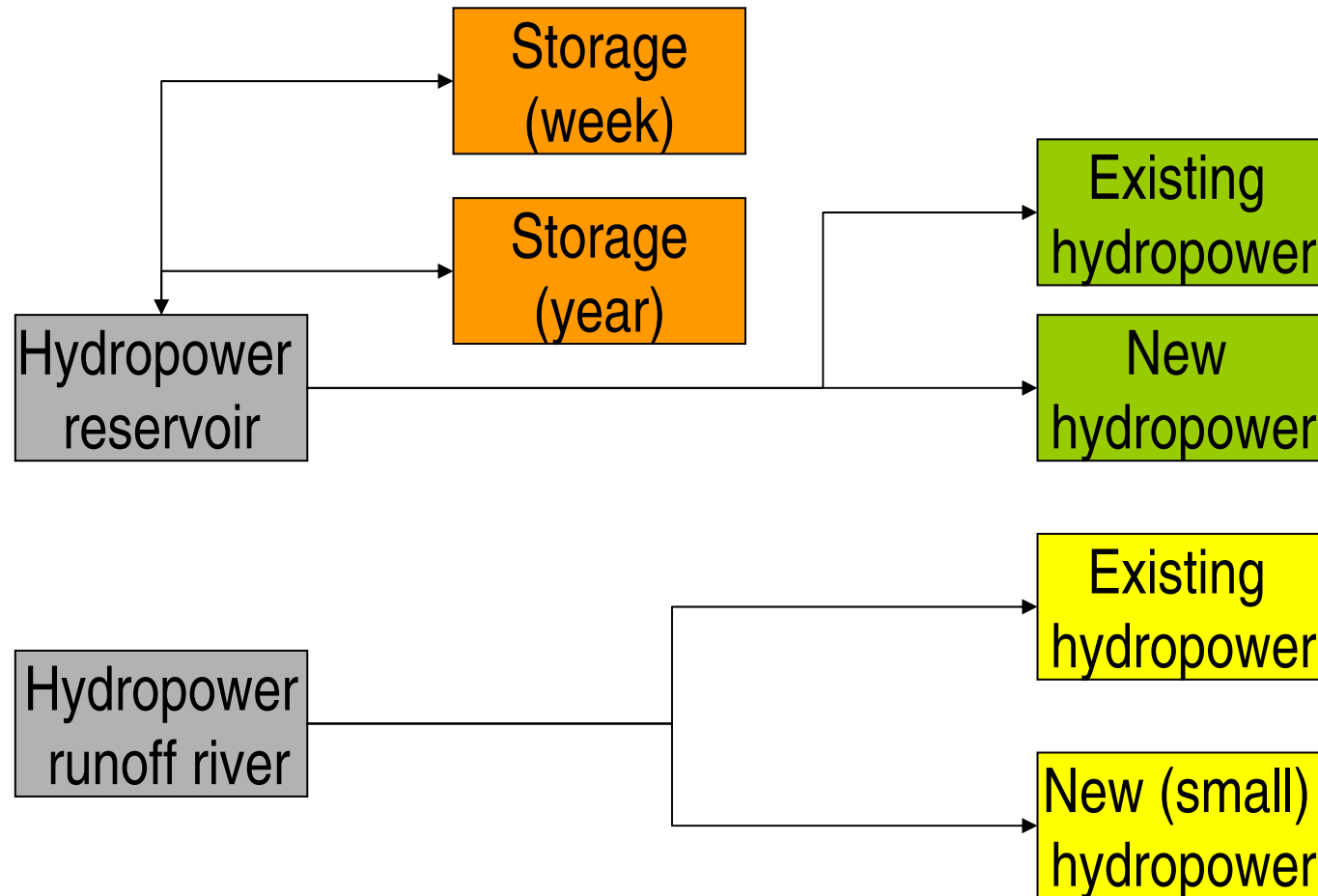
- Detailed demand side modelling (25 sub-sectors)
- High time resolution (260 time slices annually)
- Short analysing period 2009-10
- Regional structure (7 regions)
- Exchange of electricity between regions
- The model could be used with or without heat and power production in connection with power market model

Times model- regions



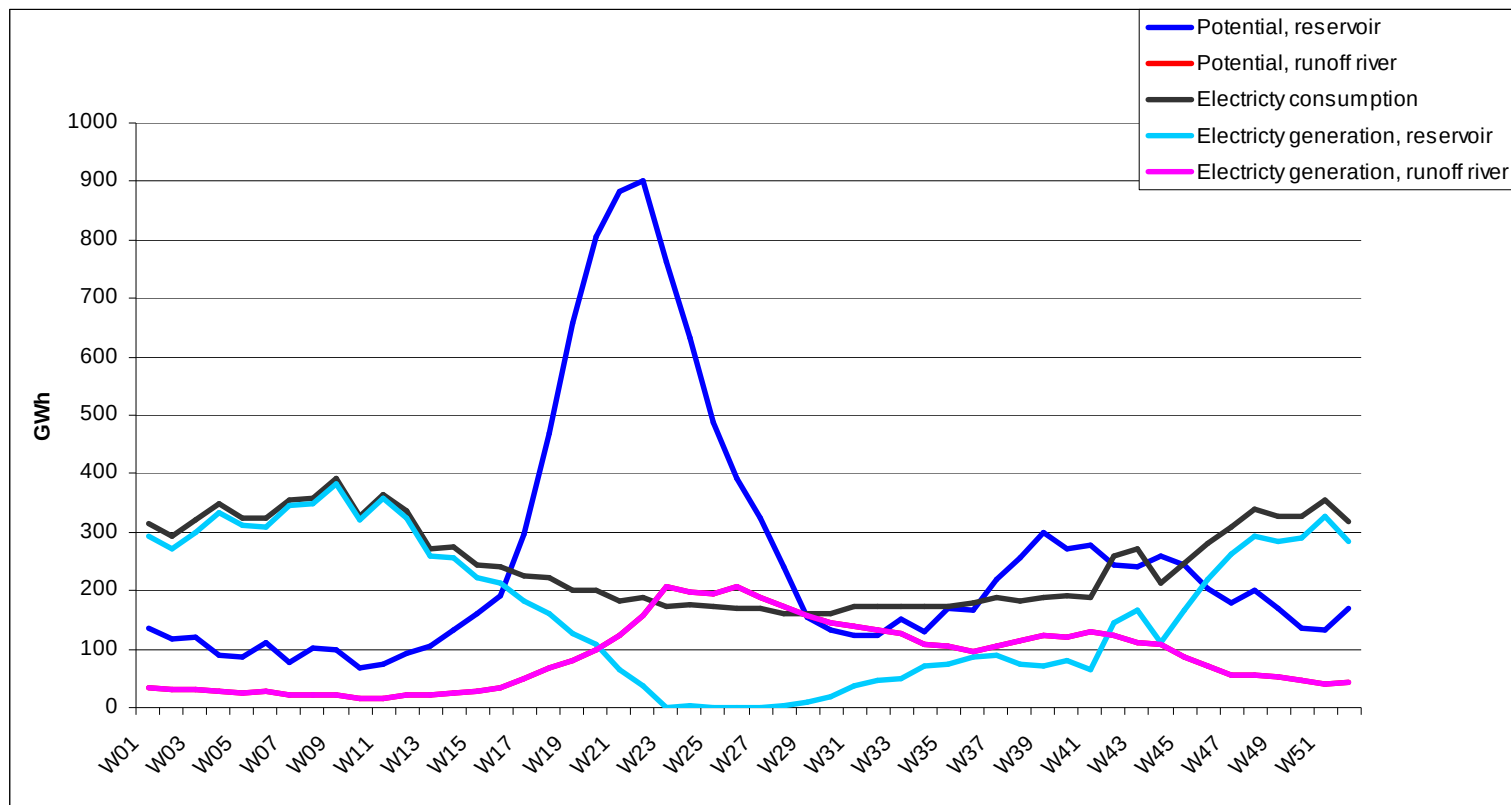
1	South
2	Central
3	West
4	East
5	Mid
6	North
7	Finnmark

Modelling hydropower



Hydropower modelling

(Example region 1)



Modelling demand sectors

- Household
 - Existing single/multi family houses
 - New single/multi family houses
 - Cottages
- Agriculture
- Service
 - Construction
 - Education
 - Healthcare
 - Hotels and restaurant
 - Offices
 - Other commercial
 - Road light
 - Wholesale and retail
- Industry
 - Aluminium
 - Chemical industry
 - Metal industry
 - Mining
 - Pulp and paper
 - Refineries
 - Residual industry
- Transport
 - Air transport
 - Cars
 - Freight
 - Other mobile combustion
 - Buses
 - Trains
 - Sea transport

Load profiles- structure

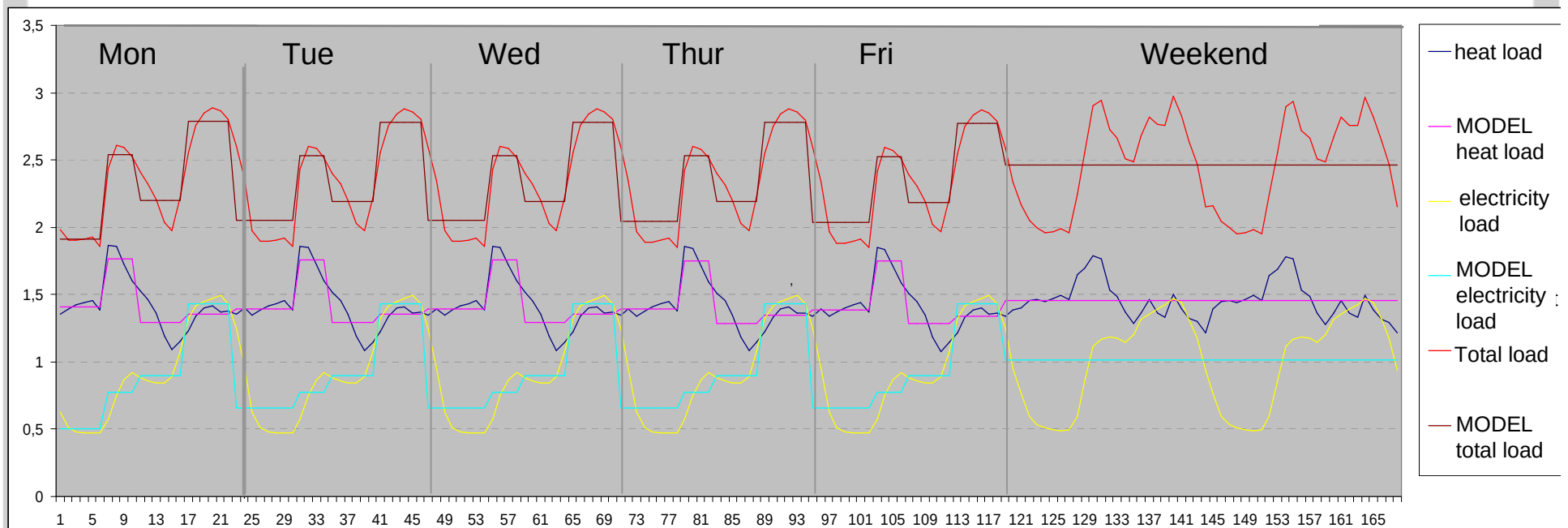
- Five load segments per week
 - Morning, afternoon, evening, night and weekend.
 - In total: $5 * 52 = 260$ load segments

		Hours pr load segment	Hours pr week
Day1	07-11	4	20
Day2	11-17	6	30
Day3	17-23	6	30
Night	23-07	8	40
	23 Friday		
Weekend	23 Sunday	24	48
Sum			168

- Load profiles
 - electricity demand and thermal demand
 - In total: $25 * 2 = 50$ load profiles
 - Each containing 260 load segments.

Weekly load profile - example

- Households
 - Mid February (week 7)



Data sources load profiles

- Building sectors: household and services
 - Thermal demand and electricity demand based on (Pedersen, 2007)¹
 - Estimated load profiles based on measured data from buildings in Norway.
 - Profiles are dependent on outdoor temperature.
- Industry and street lighting
 - No profile
 - Tested against measured electricity consumption from Skagerak Energi
 - Data were processed by T.Ericsson at Statistics Norway (SSB)
- **Transport**
 - No profile

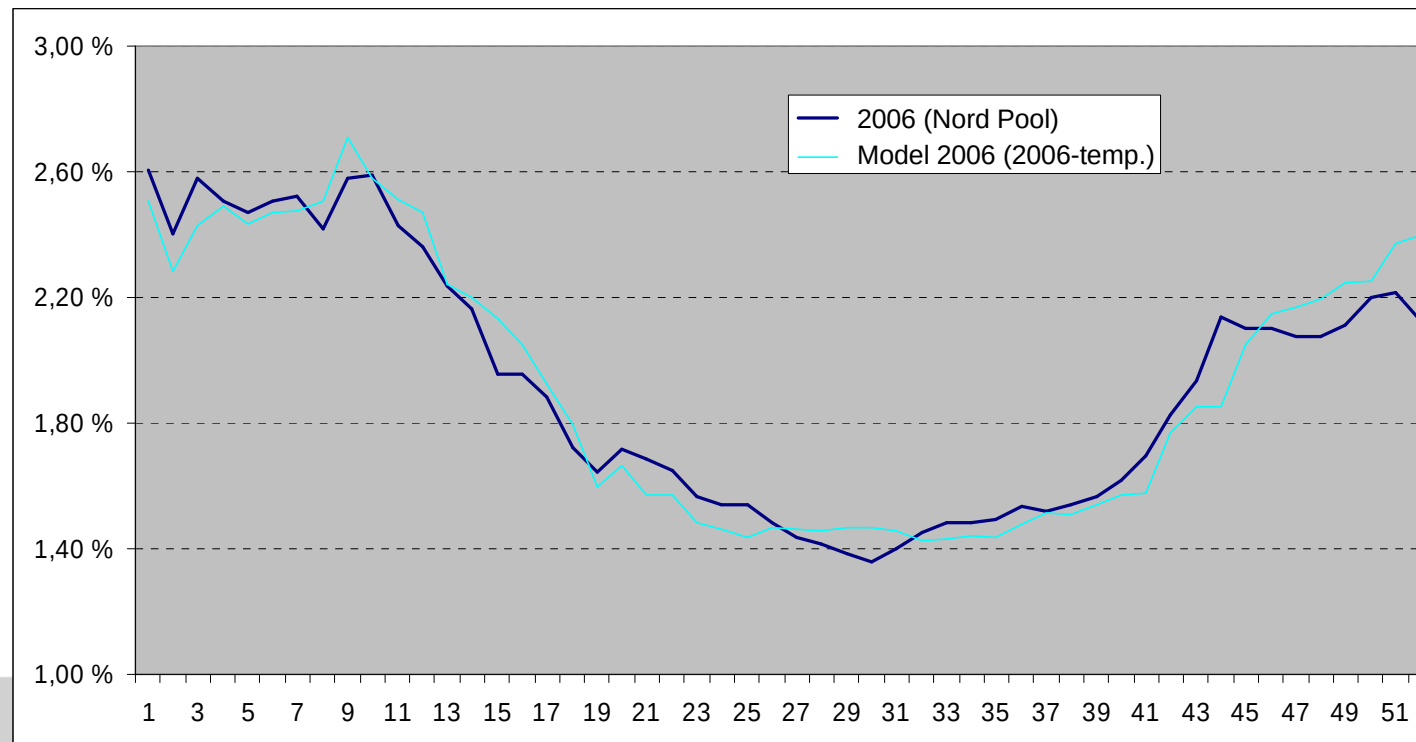
¹ Pedersen, L., 2007 "*Load Modelling of Buildings in Mixed Energy Distribution Systems*", Doctoral thesis, The Norwegian University of Science and Technology (NTNU)

Methodology- load profiles

- 1) Testing on 2006-data
 - MODEL:
 - Daily outdoor temperature in 2006 in 7 regions in Norway
 - This gave an estimated load profile in 2006 for Norway
 - electricity consumption was extracted
 - Testing against hourly national electricity consumption from Nord Pool ASA in 2006
 - Result: calibrated profiles
- 2) Load profile for an average year
 - Replacement of 2006-temperatures with "normal"-year temperatures
 - Gives load profile for an average year.
 - Testing against temperature-corrected electricity demand in 2006.

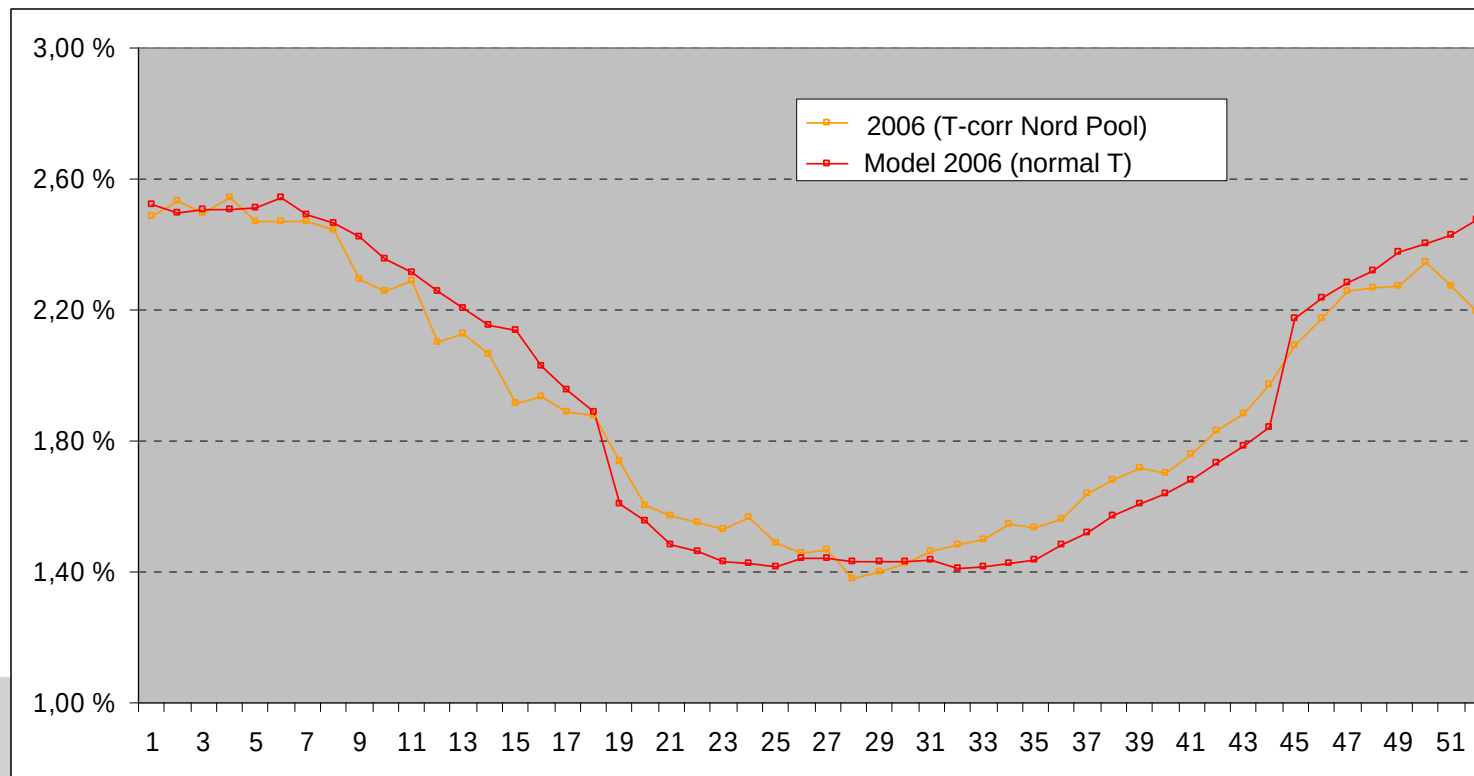
1) Testing on 2006-data

- Weekly electricity demand in 2006
 - National electricity demand 2006 (NordPool ASA)
 - Modelled load profile with temperatures in 2006

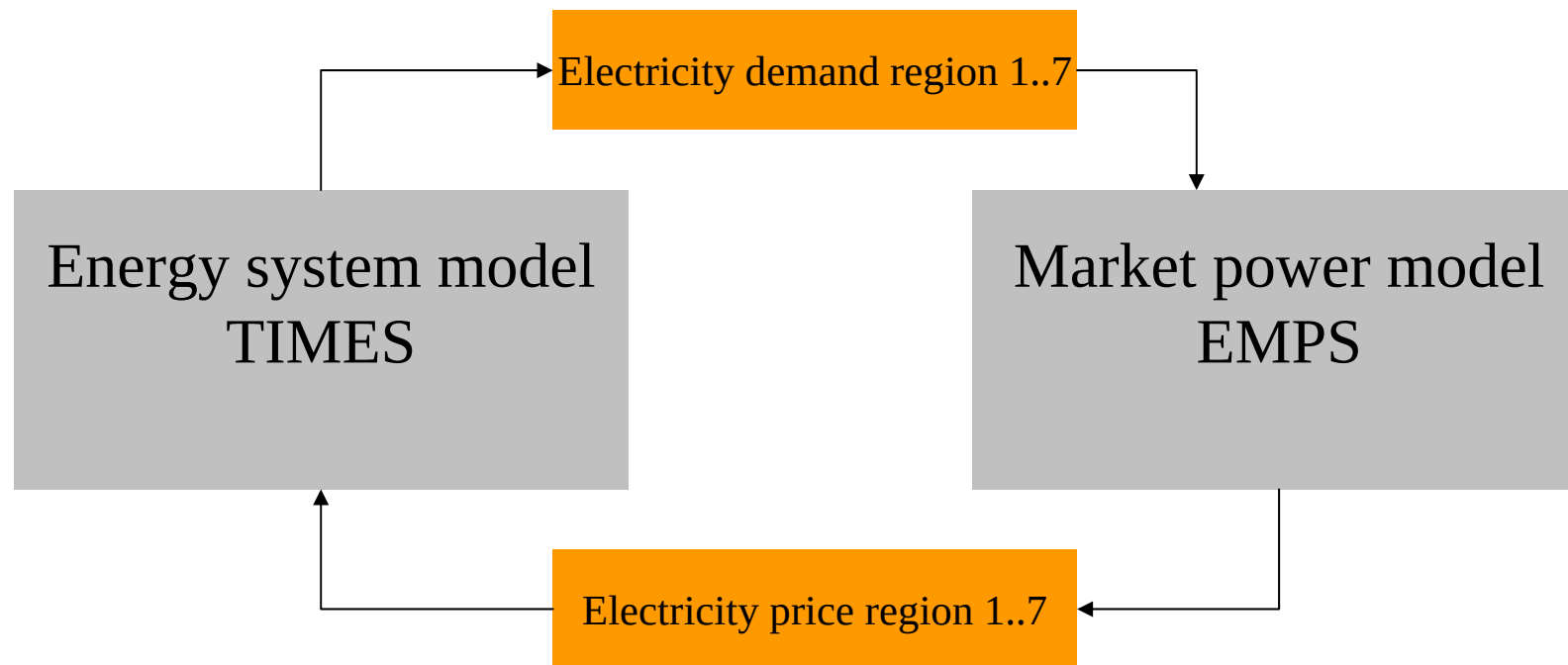


2) Load profile for average year

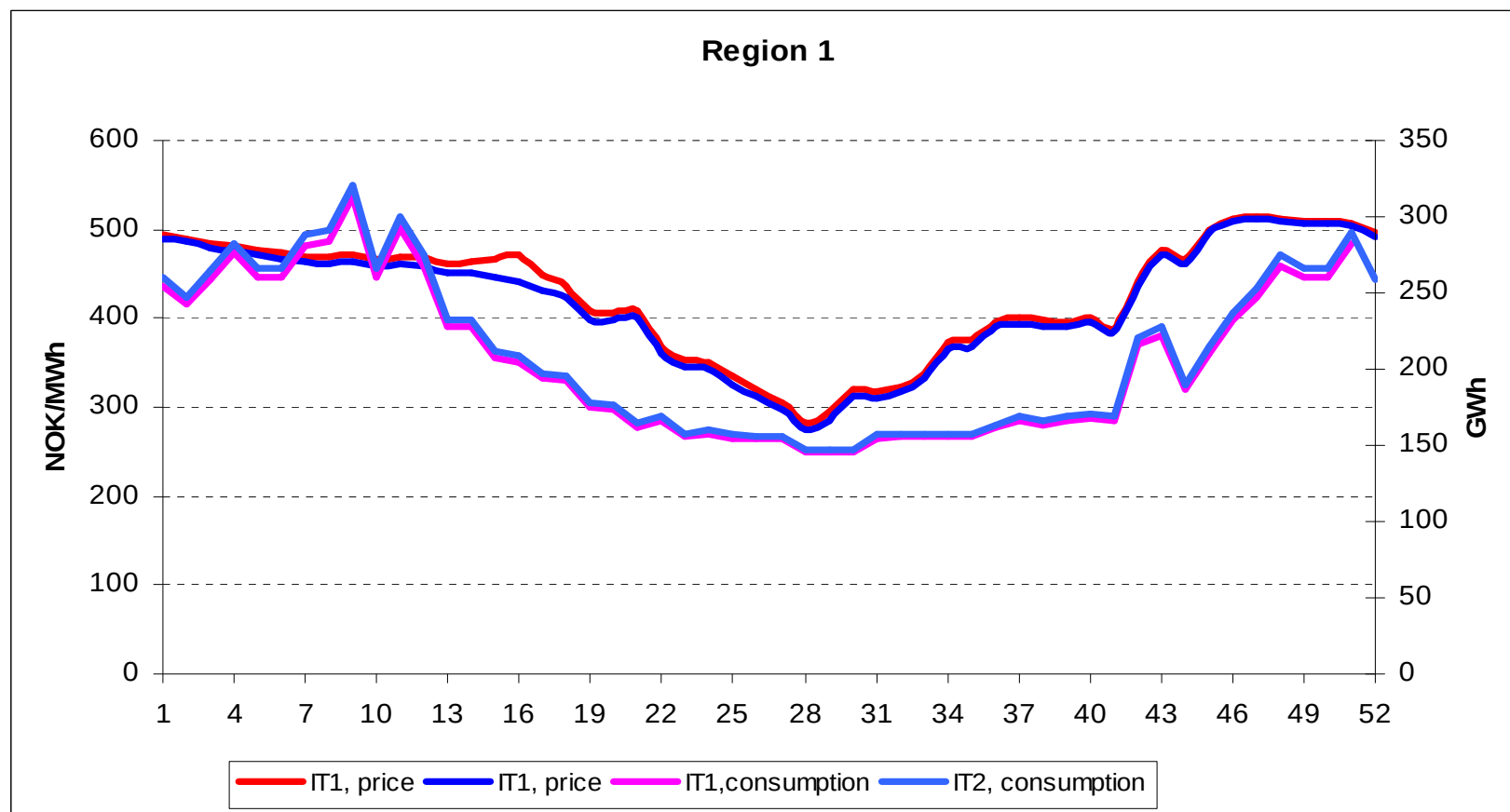
- Weekly load i 2006 as percentage of total load
 - Temperature corrected electricity demand in 2006.
 - Modelled load profile with "normal" outdoor temperature



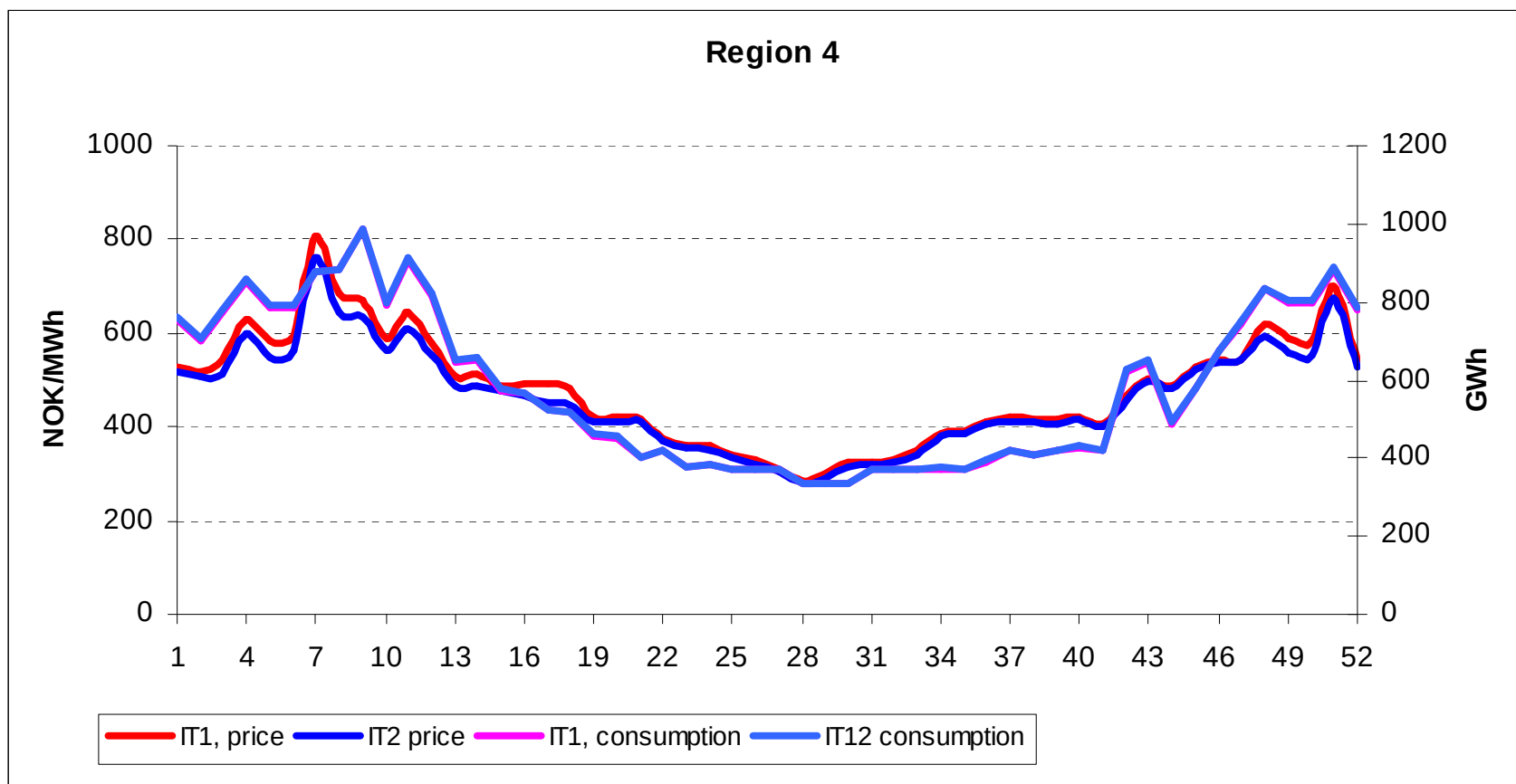
Interaction between TIMES and EMPS model



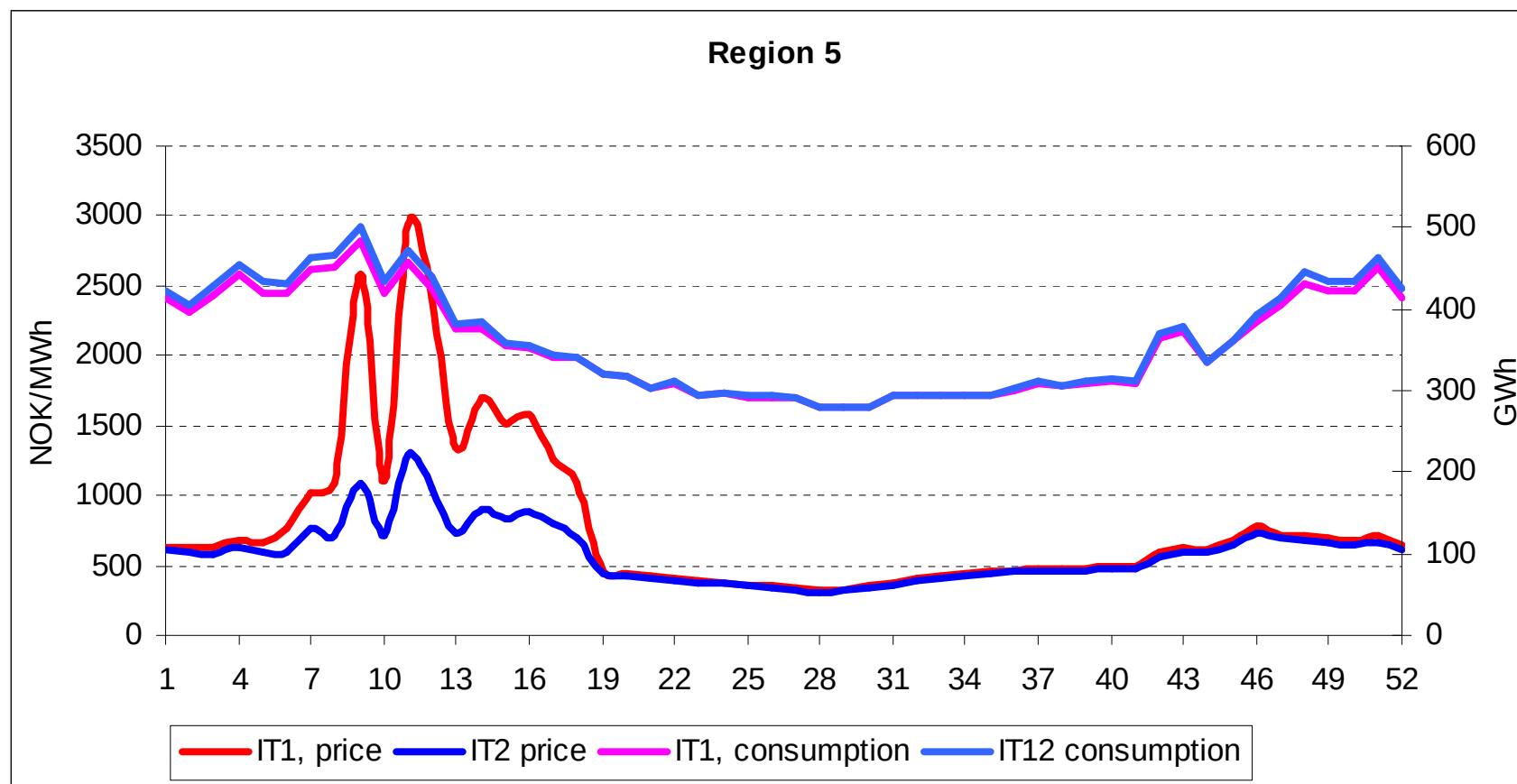
Electricity prices and consumption (R1)



Electricity prices and consumption (R4)



Electricity prices and consumption (R5)



Conclusions

- The first iterations show reasonable responses from the TIMES model to changes in electricity prices
- Different responses in different regions due to existing stock of alternatives
- Options for storage of hydropower (weekly) improves the models in hydropower dominated systems significantly