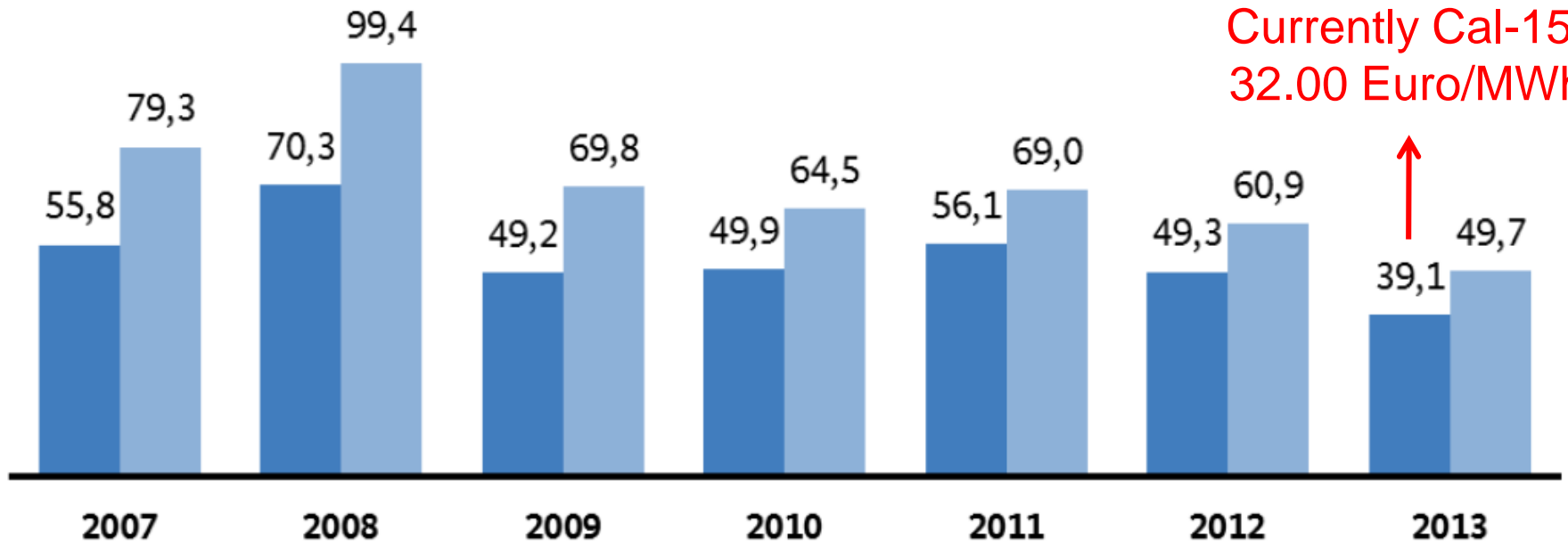


***A parsimonious fundamental model for
wholesale electricity markets - Analysis
of the plunge in German futures prices***

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Enerday Dresden, April 17, 2015

Motivation: German wholesale power prices have dropped



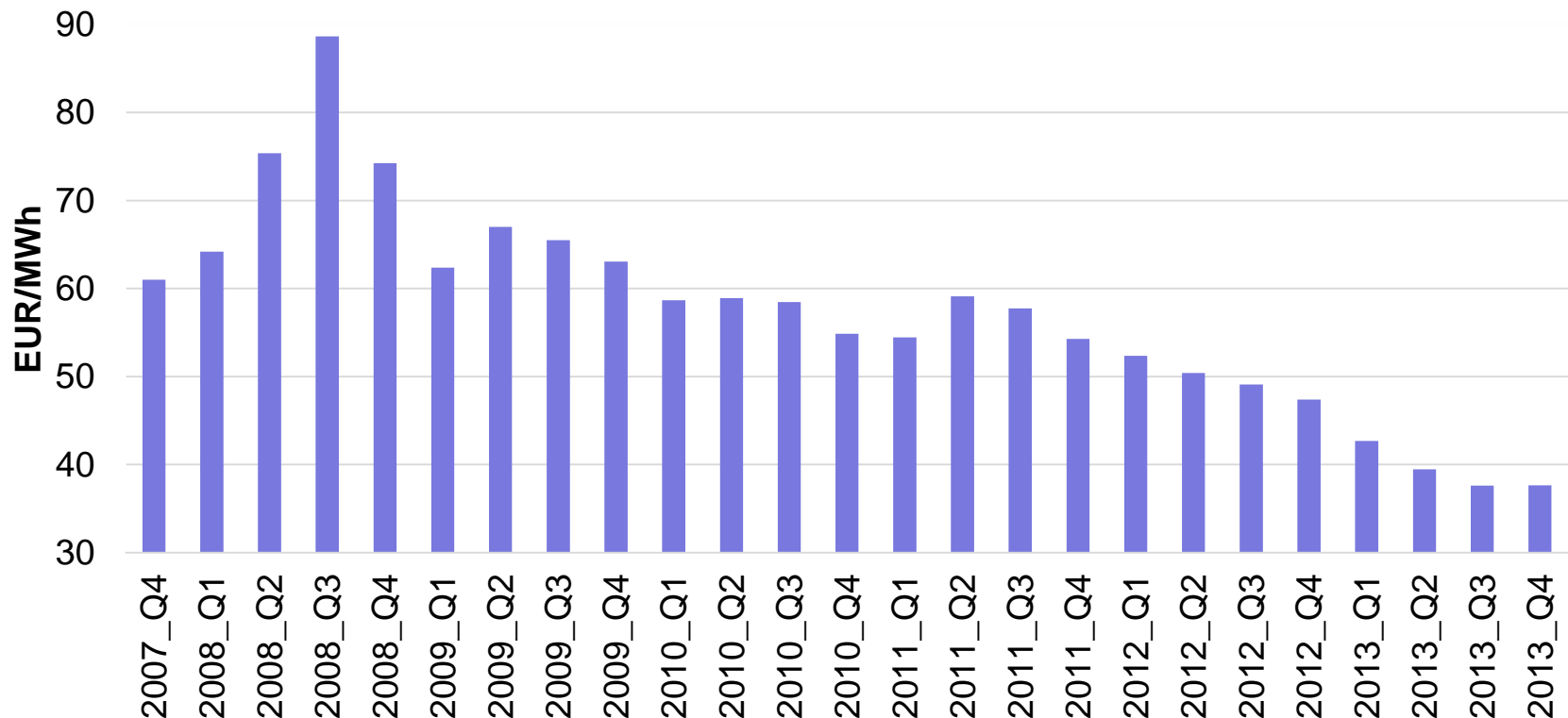
Currently Cal-15:
32.00 Euro/MWh

■ Phelix-Base-Year-Future ■ Phelix-Peak-Year-Future

Source: BNetzA (2014)

- Power prices declined by up to 40 %
- Apparently only brief impact of nuclear policy reversal after Fukushima

Second look: a steep decline in the value of the Cal-14 future



- How did expectations change between 2007 and 2013?
- Is this development driven by the increase in renewable generation?

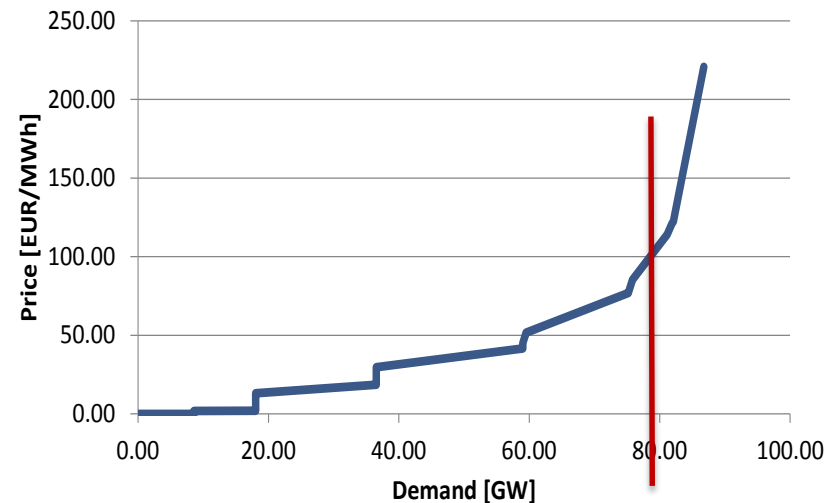
Question: What has happened in the meantime?

Goal: Reconstruction of Q4 2007 and Q4 2013 prices for Cal-14

- Use of a parsimonious fundamental model
- Determine 2007 and 2013 expectations for fundamentals' values in 2014
- Decomposition of price impacts due to changes in
 - Renewable penetration
 - Conventional capacities
 - Fuel prices
 - CO2 prices
 - Demand

Parsimonious fundamental model

- Computation of expected hourly prices
 - Demand side
 - Hourly demand profile with constant shape scaled with annual demand
 - Subtraction of renewable hourly profiles scaled with annual amounts
 - Supply side
 - Piecewise linear supply stack
 - Based on estimates of minimum and maximum efficiency per technology class
 - Correction for must-run, partly temperature dependent CHP production
 - Exports/Imports
 - Regression-based hourly estimates: demand, RES infeed, baseload plant availability
- Intersection of supply and demand yields price, as set by the marginal plant



Reconstruction of expectations

- Demand
 - Extrapolation of demand growth of preceding three years
- Renewables
 - Mid-term forecasts of grid operators
- Conventional capacities
 - BMU Leitstudie 2007, manually adjusted for nuclear phase-out
- Fuel and CO2 prices
 - Myopic expectations beyond the far end of the forward curve

Information basis:		Q4 2007	Q4 2013
Expectation for:		2014	2014
Load	TWh	643,8	603,7
Solar	TWh	5,93	36,60
Wind	TWh	53,92	56,28
Cap	GW	120,6	117,1
Coal	EUR/MWh	10,19	8,70
Gas	EUR/MWh	27,31	29,37
CO2	EUR/t	24,92	4,90

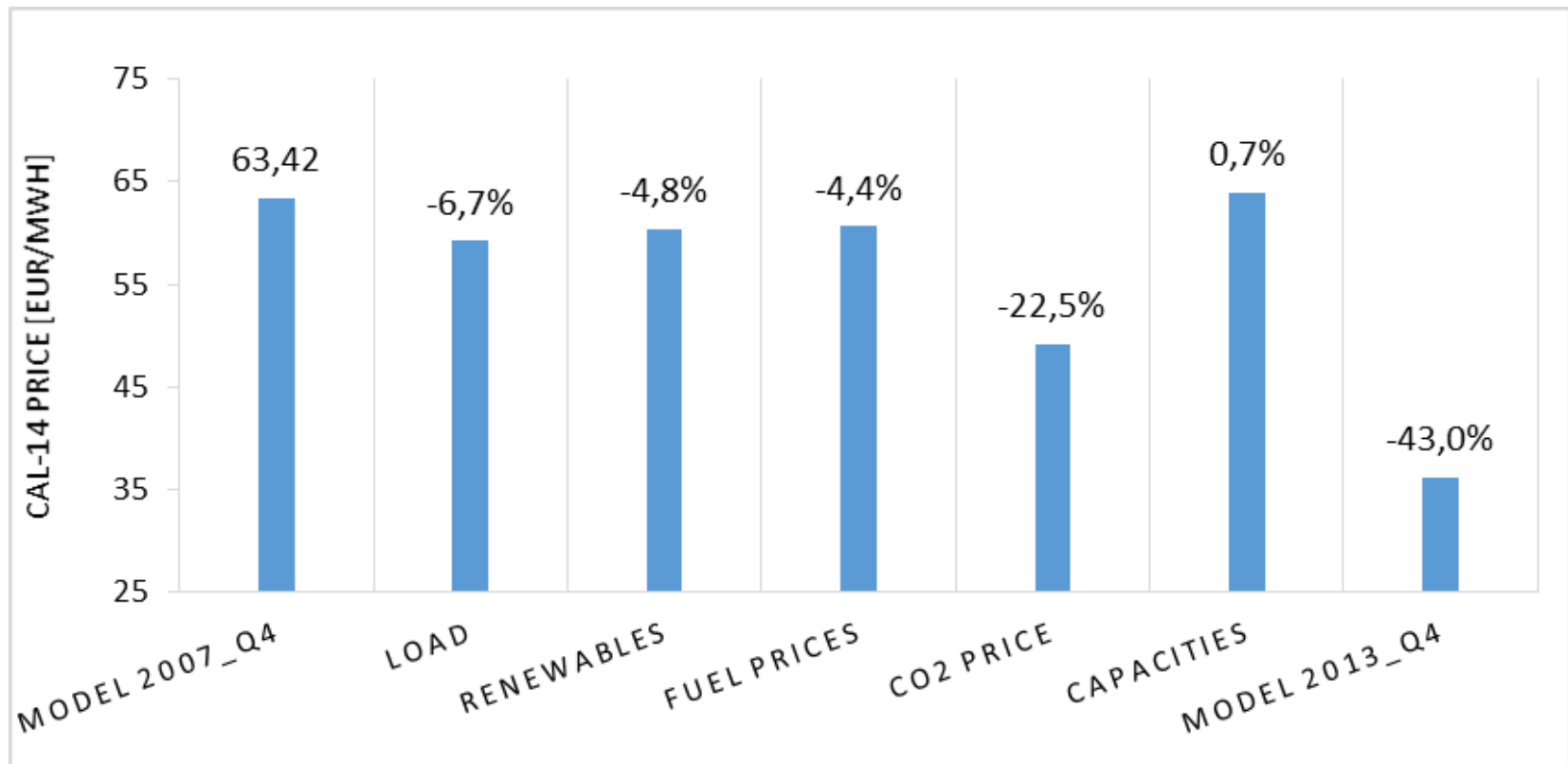
Validation of Parsimonious Model

Information basis	Q4 2007	Q4 2013
Expectations for:	2013	2013

Phelix Base Future	61.30	37.64	EUR/MWh
Fundamental	63.42	36.13	EUR/MWh
Model Price			

Result: impact of expectation changes on base price

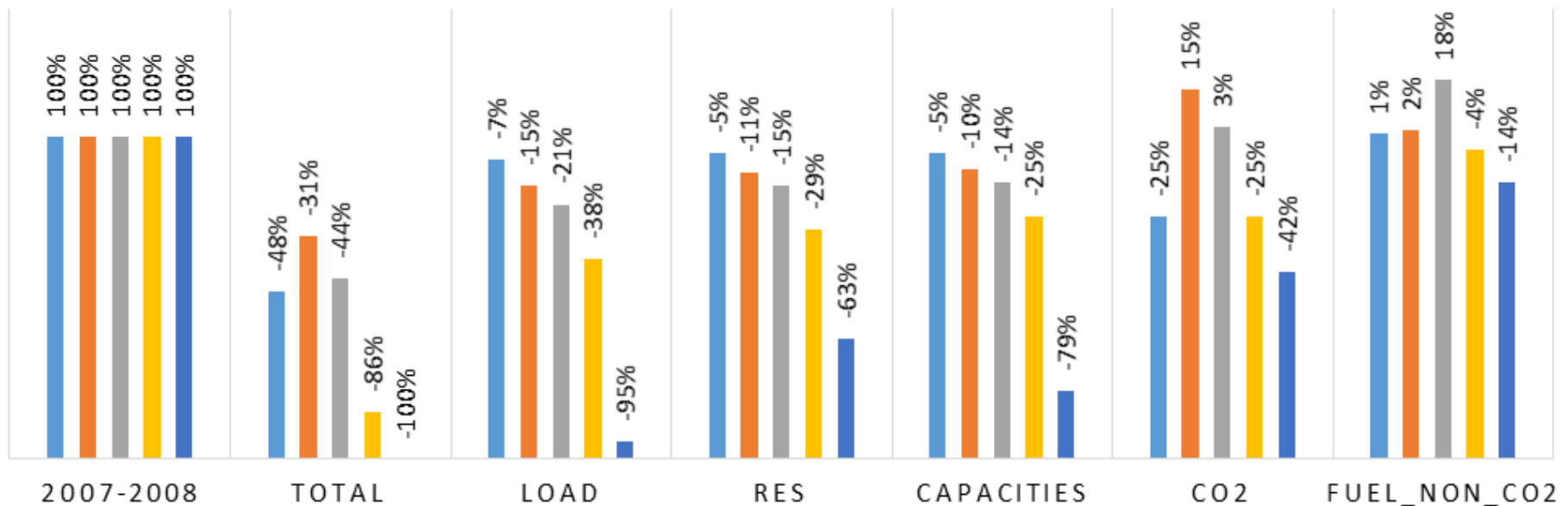
Ceteris paribus approach: individual factor updated from 2007 to 2013 value



Result: operating margins of power plants

- Power plants as strip of European options
- without technical restrictions & personnel costs
- Impact varies across considered factors:

■ Nuclear ■ Lignite ■ Hard Coal ■ Gas (CC) ■ Gas (OC)



Conclusion

- The drop in 2007-2013 wholesale electricity prices driven by fundamentals
 - Model able to capture impact factors and replicate prices
- Analysis of individual factors finds
 - Emission price drop as largest single factor, demand and renewables follow
 - Combined effect of all factors larger than sum of individuals
 - Feedback effect between RES extensions and CO2 price drop?
- Slightly different result for plant operators
 - Load uncertainty large factor, fuel prices impact ambiguous

➤ Source of electricity price drop and loss of plant profitability not equivalent

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Thank you for your attention

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Parsimonious fundamental model - overview

