SEM PLEXOS model validation 2010-2011

Presentation to SEM participants

Date: 08 March 2010

Client: Regulatory Authorities

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Agenda

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- Introduction
- Calibration of backcast model
- Validation of forecast model
- Recommendations
- Next steps

Introduction

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- Objectives
  - Calibration of PLEXOS against actual half hourly ex post data on unit schedules, shadow prices, uplift and system marginal prices
  - Validation of the PLEXOS model input data, for Q4 2010 and calendar 2011
  - Recommendations on PLEXOS model settings for simulating ex post unconstrained schedules

- Redpoint's SEM and PLEXOS background
  - 2007 model validation exercise in conjunction with KEMA
  - 2009 priority dispatch and curtailment study in conjunction with Skyplex

Key messages

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- Overall good fit
  - Prices
  - MSQs
  - Over-commitment no longer an issue
- Very good response from the market participants – thank you!
- PLEXOS 5 upgrade
- Recommend a new Moyle approach

Summary of Process

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Calibration

- Develop backcast model
- Data cleansing and formatting
- Liaison with Energy Exemplar

Validation

- Generator and SEMO data
- Comparison to previous validated data set, similar SEM plant, internal benchmarks, Commercial & Technical Offer data

Recommendations

- RR and MIP
- Moyle
- Price takers

Calibration of backcast model

Key changes

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- Move from PLEXOS 4 to PLEXOS 5.104
  - PLEXOS 4 support is not continuing indefinitely
  - Energy Exemplar development focus is on PLEXOS 5
- What's changed in P5?
  - Improvements to Rounded Relaxation algorithm
    - Reduction in Uplift
    - Reduction in plant at MSL
  - Mixed Integer Programming now faster (~3-4 hours for a 2 year backcast model)
- Contact with Energy Exemplar throughout process has led to SEM-specific changes
  - Irish SEM start state definition
  - Flexibility on multi-band commercial offers
  - Application of mark ups to multiple load points (only relevant in forecast model)
- GB market price calibration exercise
- Wheeling charges to reflect risks/costs of trading across Moyle
- Peat modelled as price taker, with actual availability used as rating

GB calibration

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- Aim
  - Get Moyle flows and impact on SMP correct under multiple fuel price scenarios
- Reality of Moyle usage
  - Gate closure
  - Capacity holders
- Challenges
  - Price setting in GB not formulaic
  - GB generation dataset not publicly available
  - Approach needs to be able to support multiple fuel price scenarios in the forecast model
  - Fixing Moyle flows is not the solution
    - Poorer SMP fit

GB calibration

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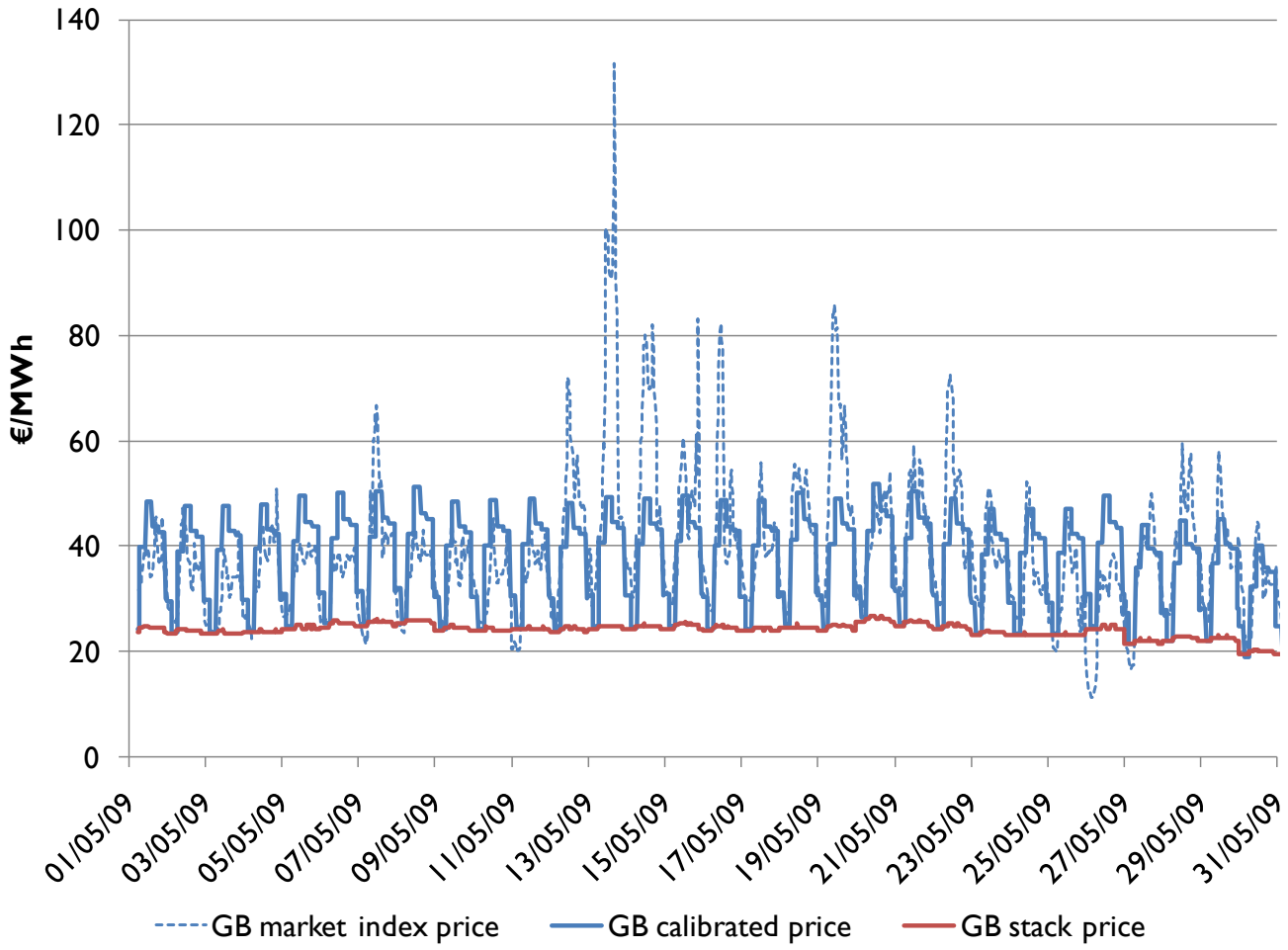
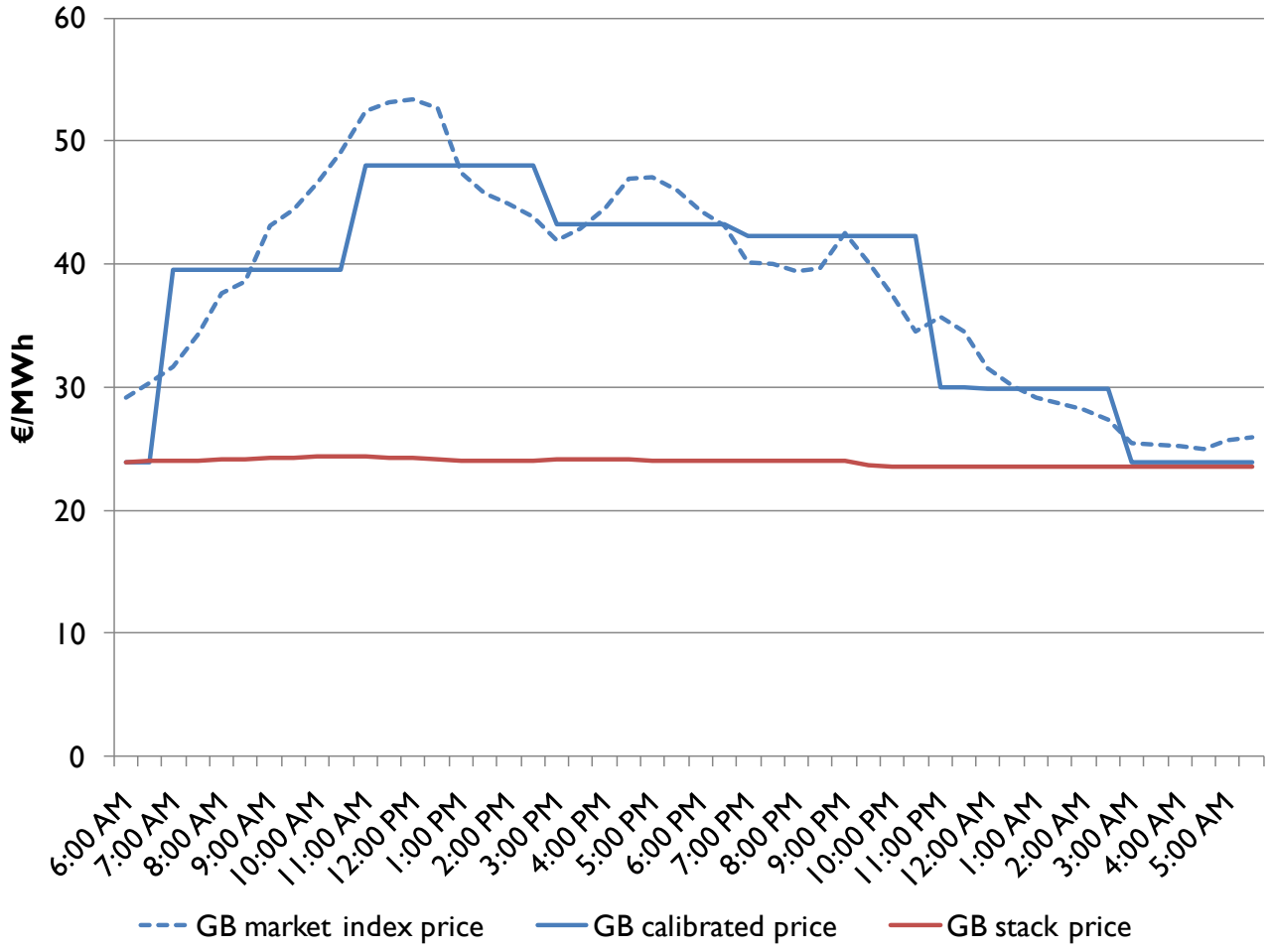
- Limitations of previous approach
  - Maintenance of GB stack
  - Lacked GB price mark-up above SRMC
  - Derating of intermittent generators

- Thinking behind the calibration
  - Backcast model dispatched against 4 hour average GB index price produced reasonable price and interconnection flows
  - GB is a gas dominated market, historic correlation between gas and power price

GB calibration



GB calibration – Shape May 2009



GB calibration

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- Process
  - Theoretical GB generator parameters are defined over 4 hour EFA blocks for both summer and winter
  - Use the theoretical GB parameters and a daily gas and carbon price to create a calculated GB price series
  - Using MS Excel Solver, optimise the difference between the calculated GB price series and the 4 hour average GB index price
  - Attach these parameters to the single theoretical GB generator in the model

- Potential areas for further investigation
  - Appropriate block size to use for the optimisation of the GB parameters
  - Most appropriate optimisation horizon

Wheeling charges

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- Revise numbers to reflect the pricing difference between GB and SEM not captured in the PLEXOS optimisation

- Factors
  - SEM Capacity payments
  - TNUoS
  - Risk premium

- Assumed values
  - Wheeling charge from SEM to GB: 13.2 €/MWh
  - Wheeling charge from GB to SEM: -0.4 €/MWh

Backcast results

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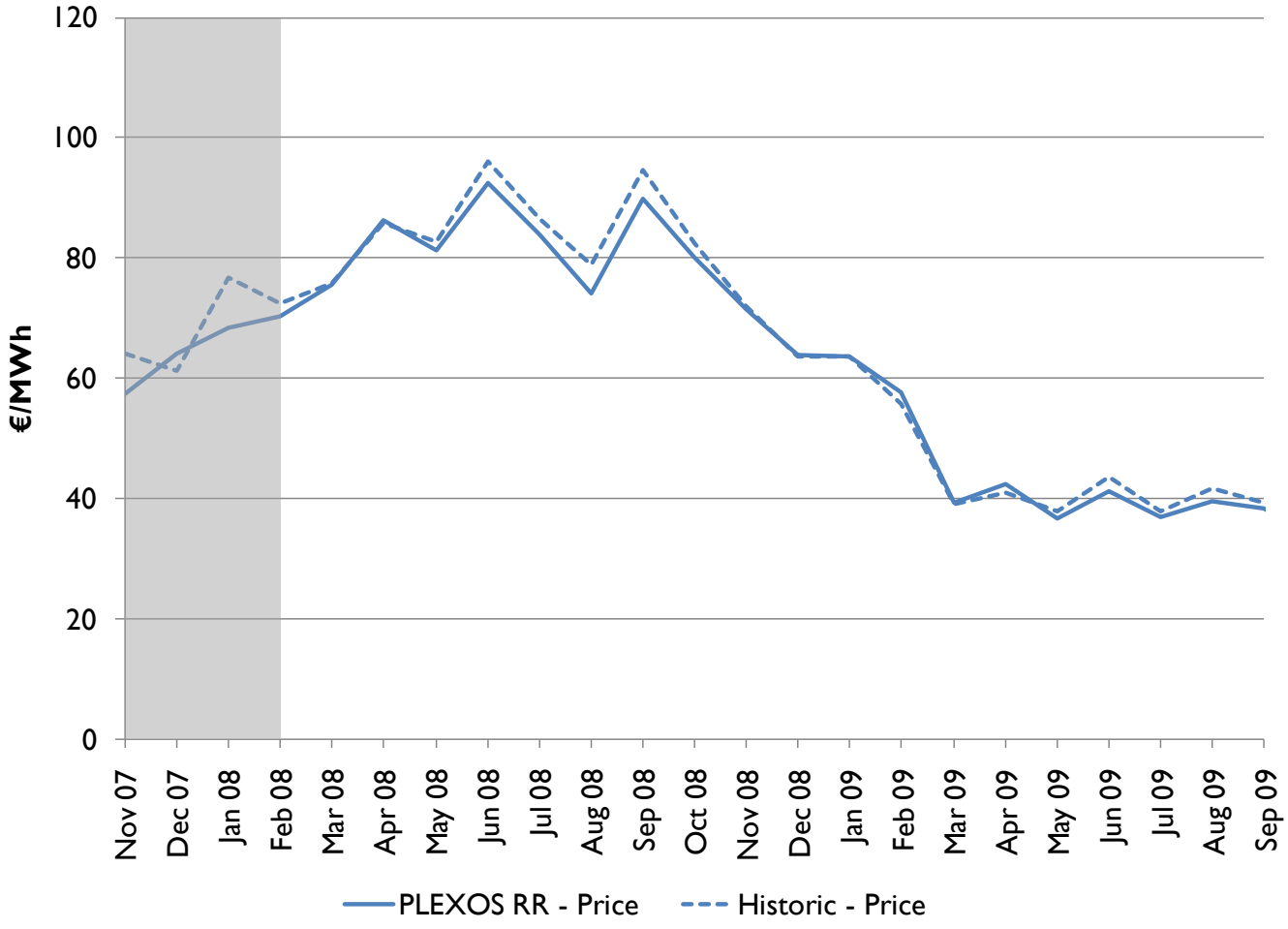
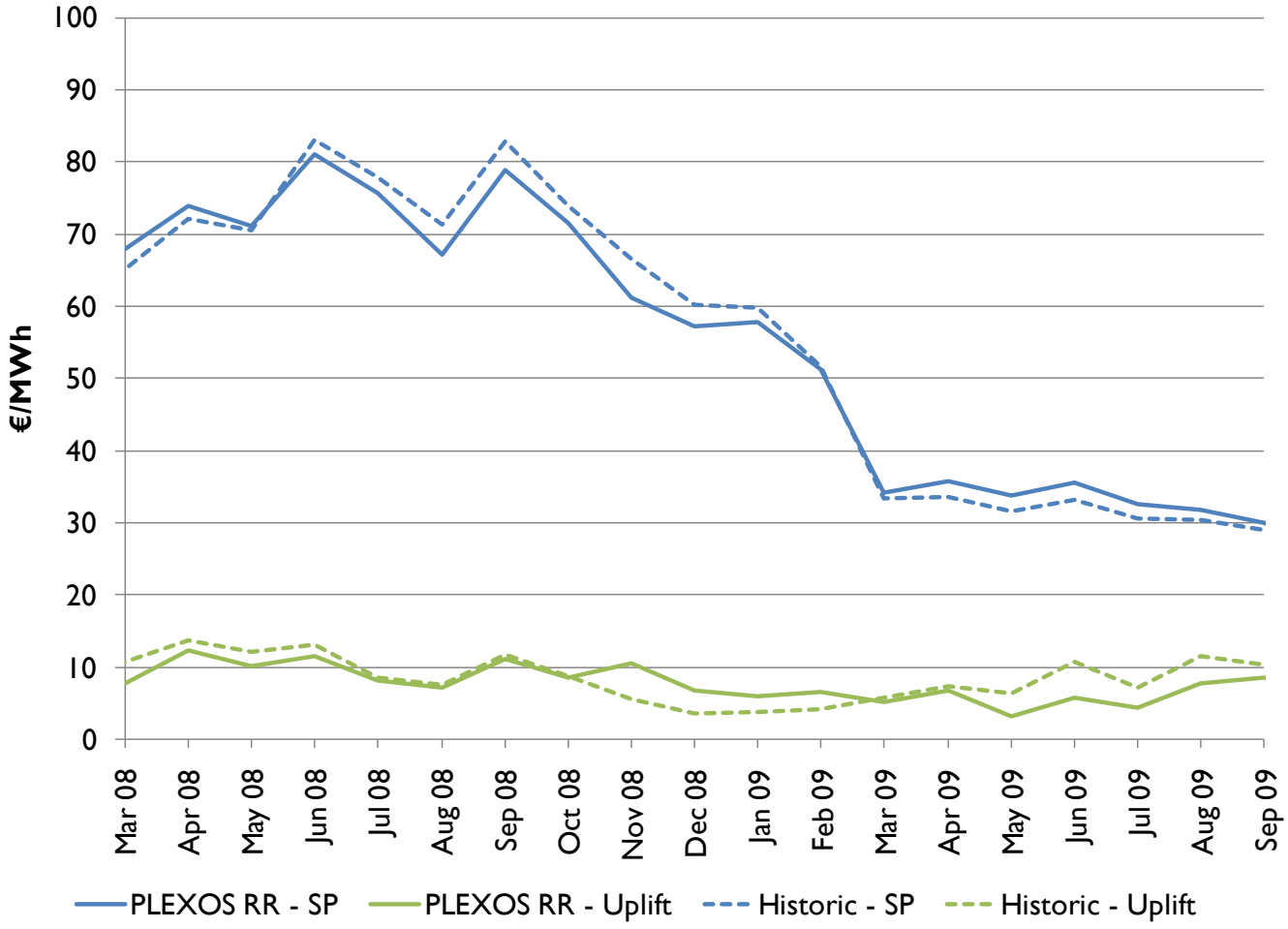
- Monthly SMP, SP & Uplift
- DC pricing blocks
- Shape of SMP, SP, Uplift
- MSQs
- Special cases
  - Interconnection flows
  - Hydro
  - Pumped Storage

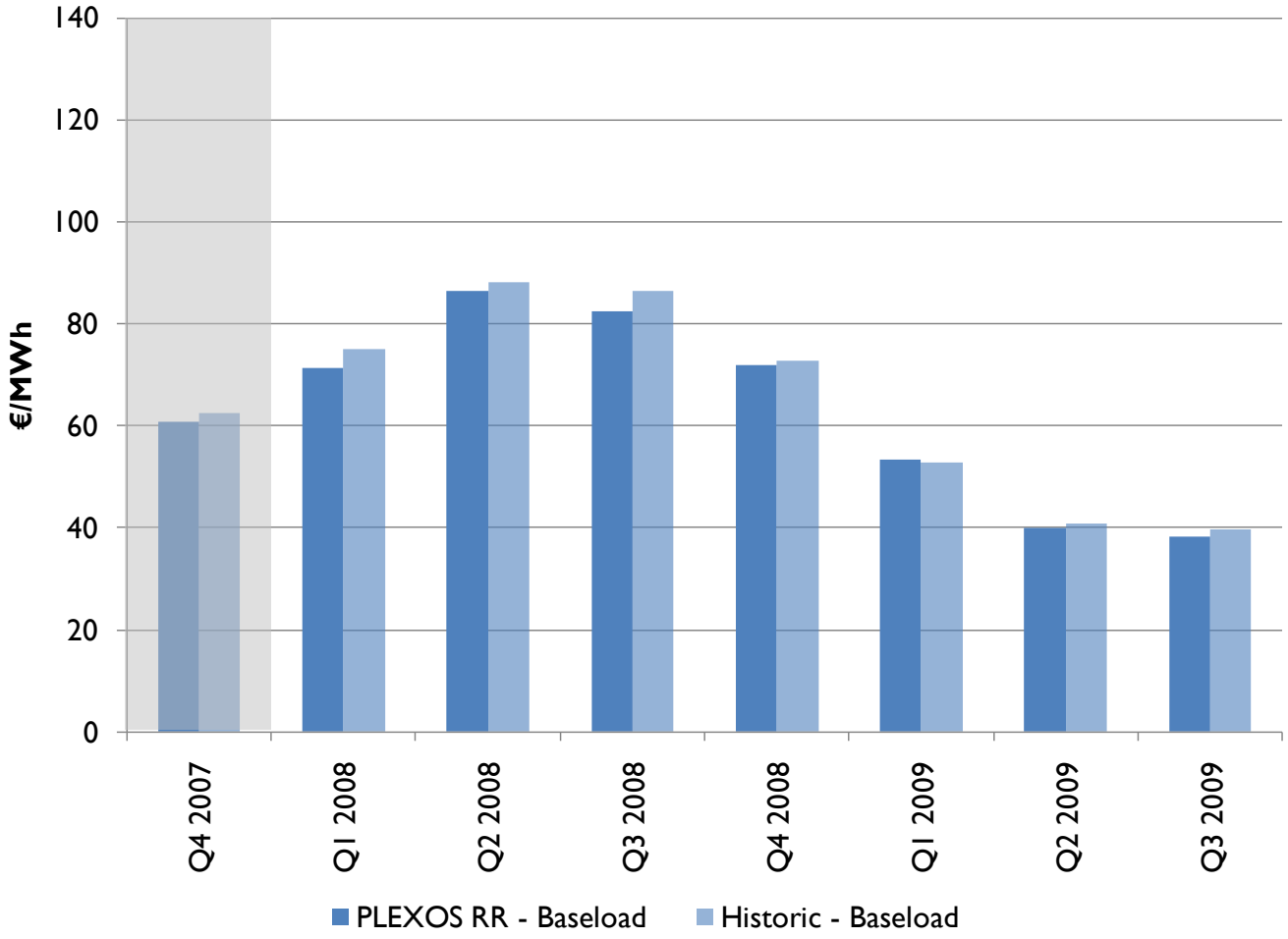
Backcast results – Monthly SMP



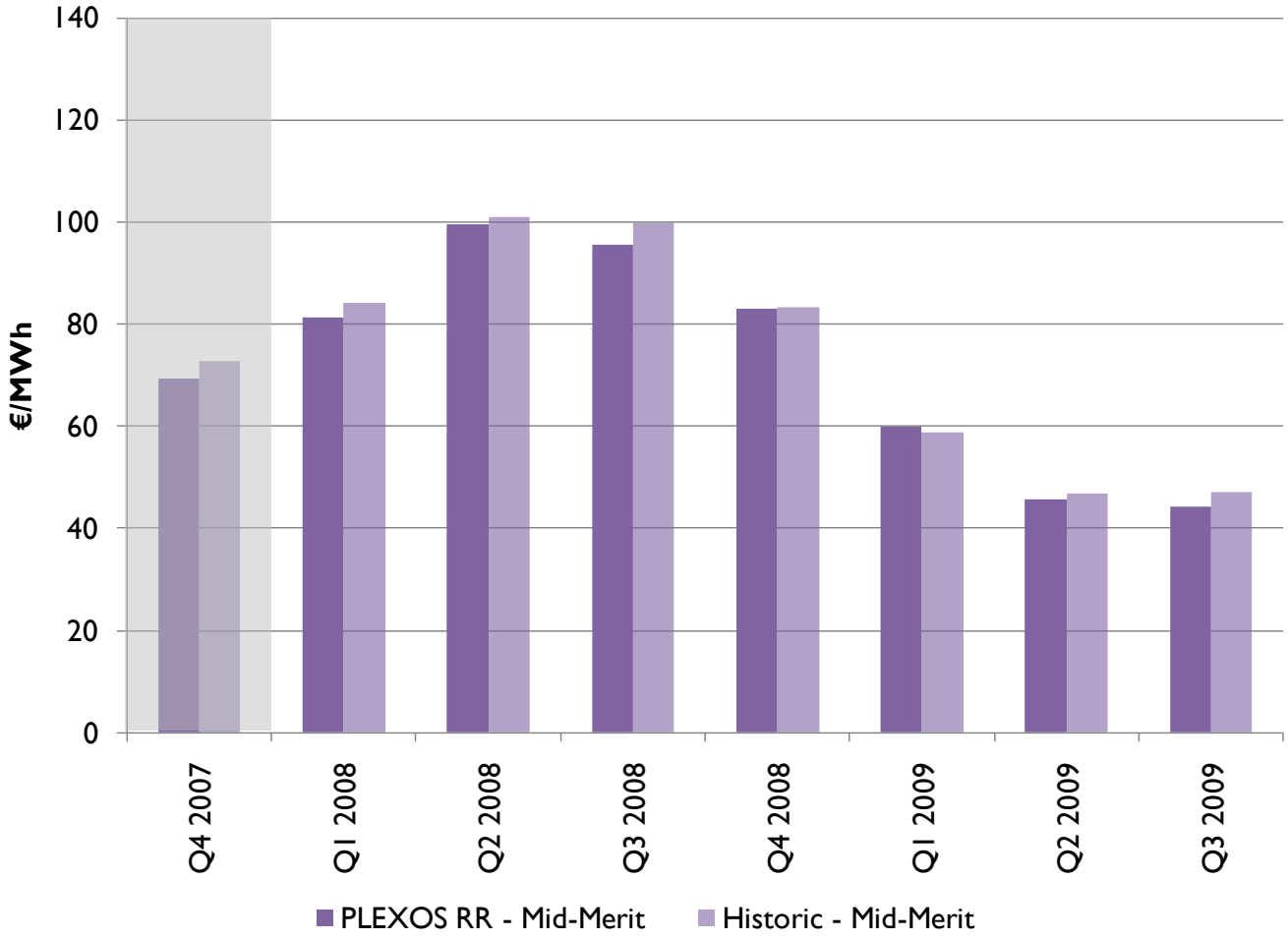
Backcast results – Monthly SP & Uplift



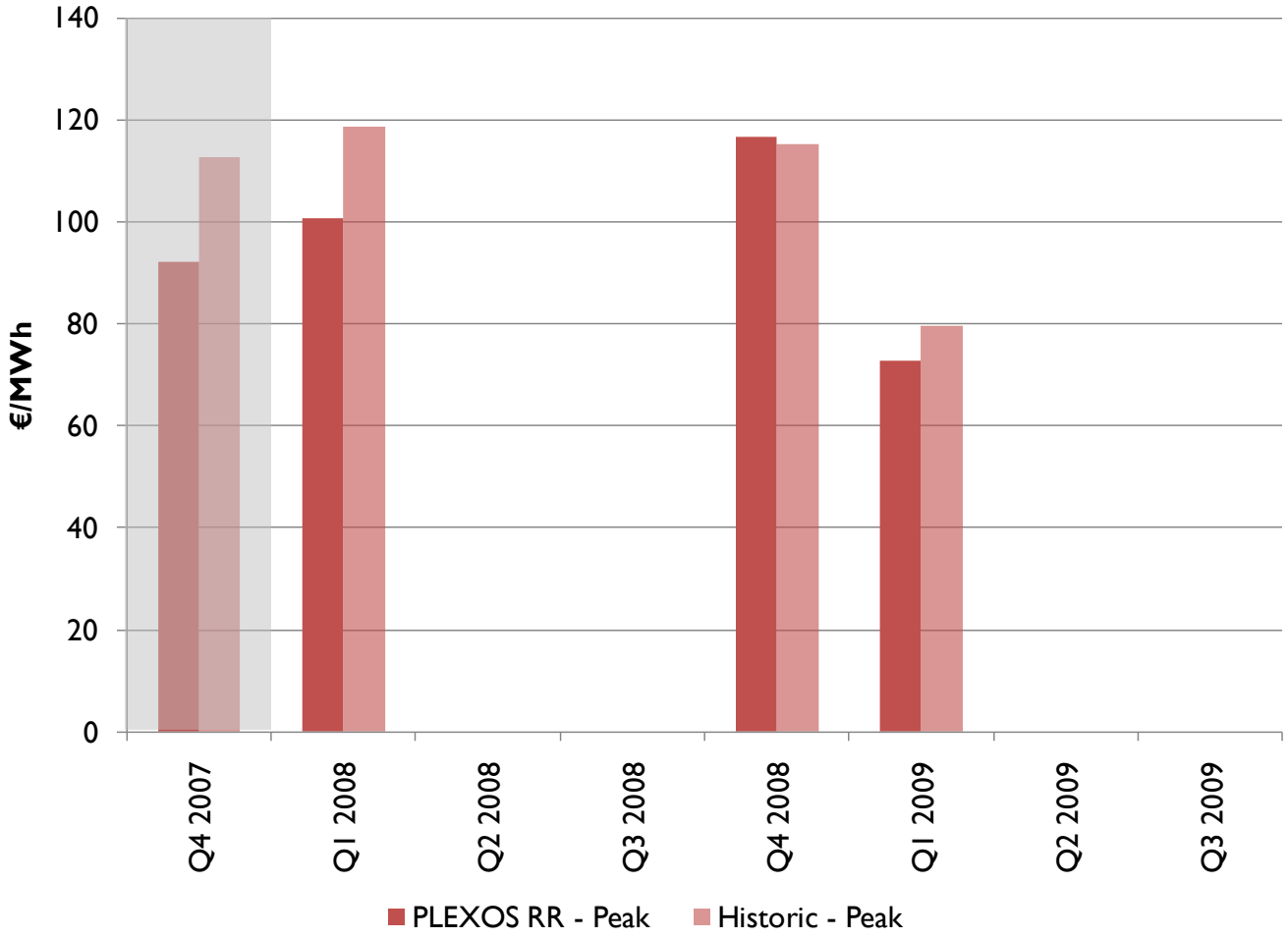
Backcast results – DC price: Baseload



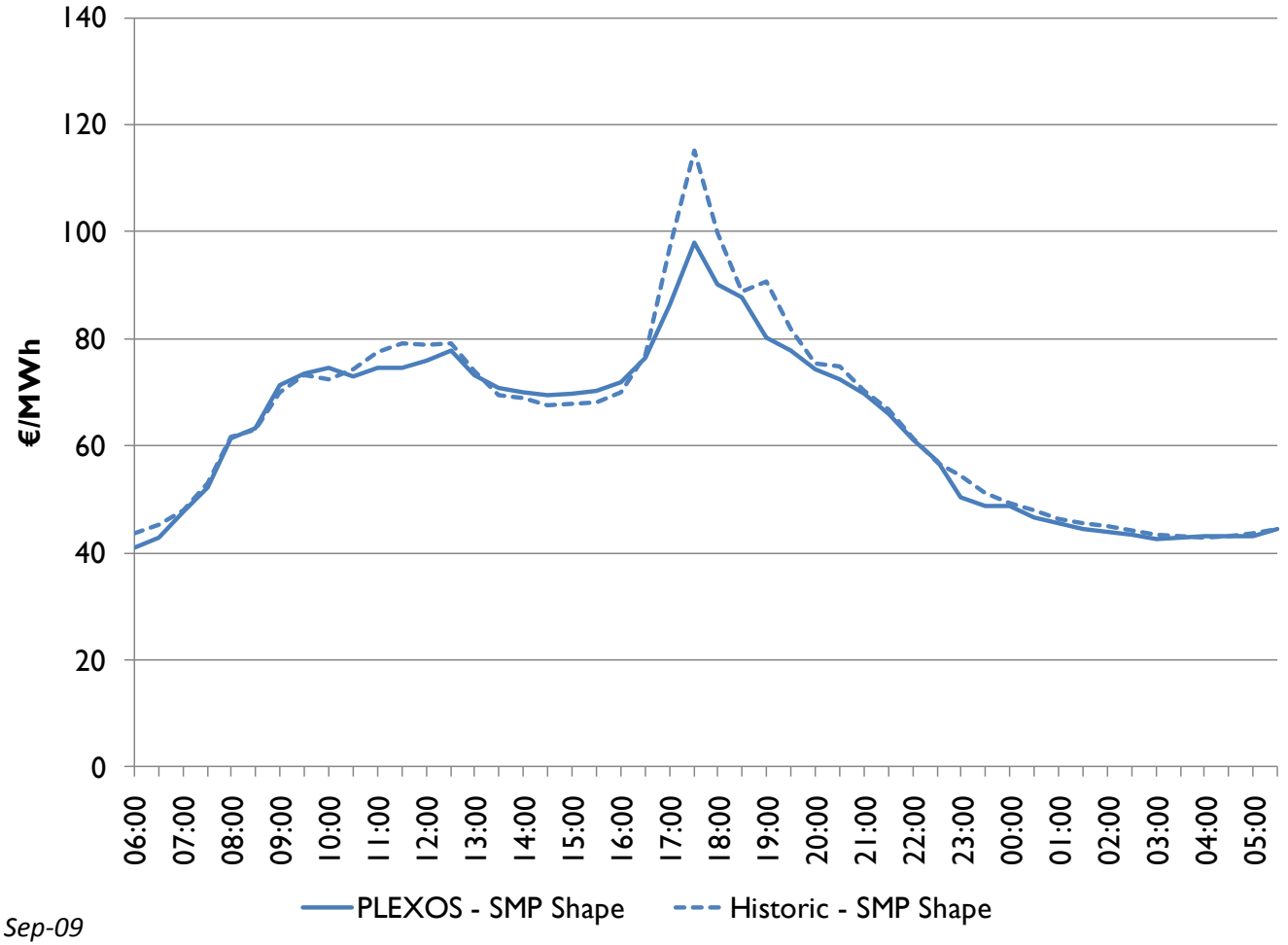
Backcast results – DC price: Mid-Merit



Backcast results – DC price: Peak

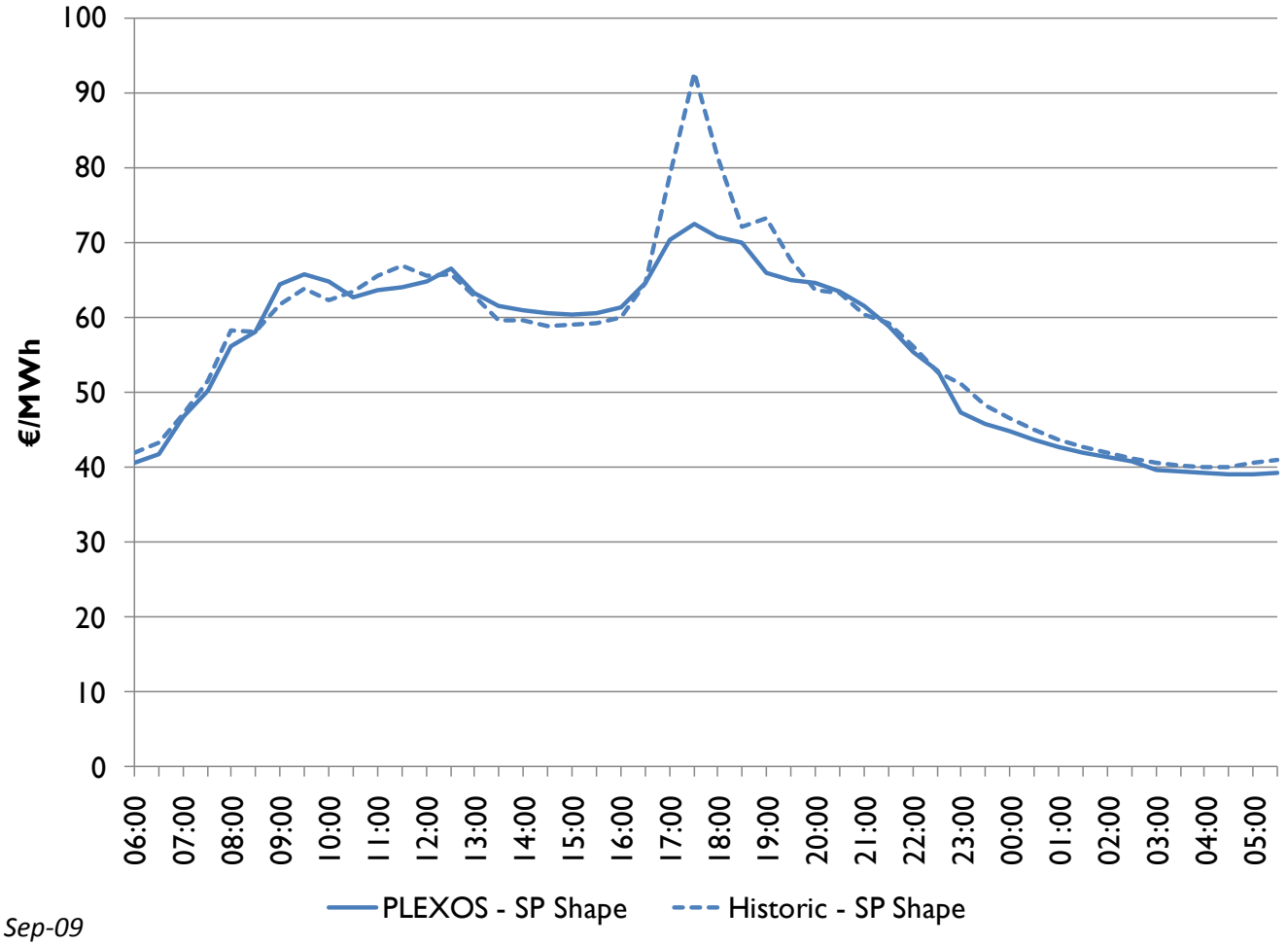


Backcast results – SMP shape



Covers Nov-07 to Sep-09

Backcast results – SP shape



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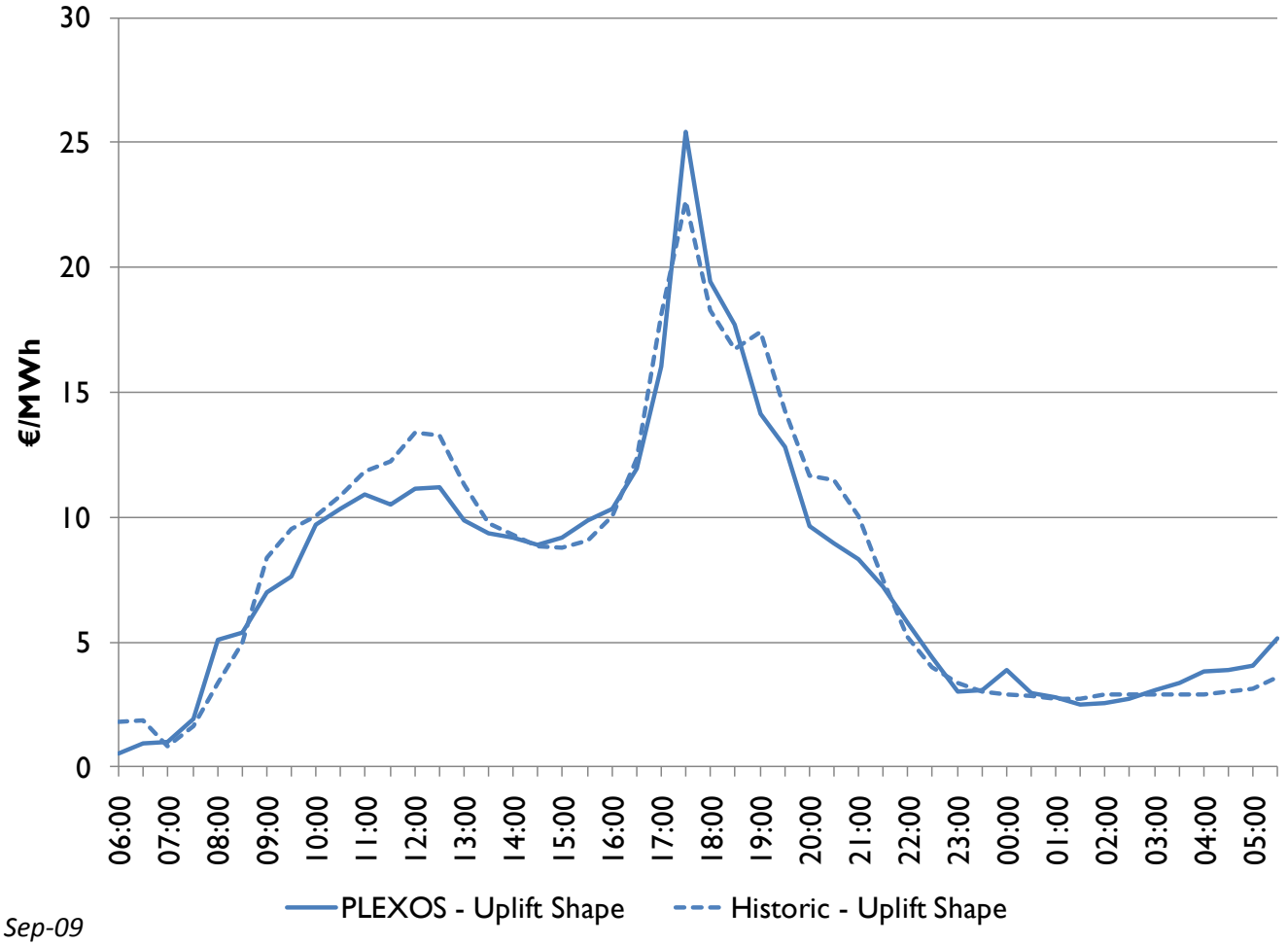
Backcast results – Uplift shape



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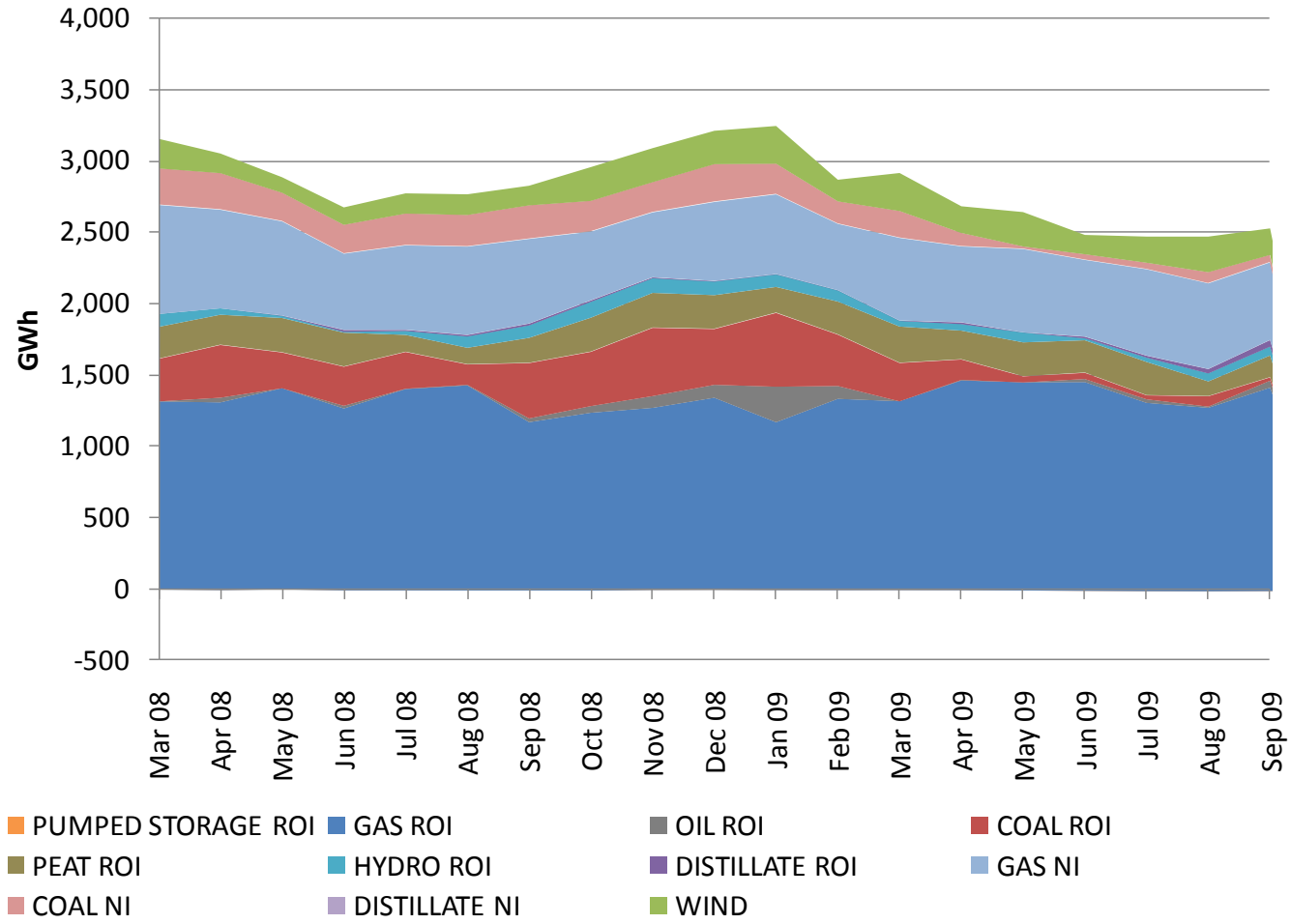
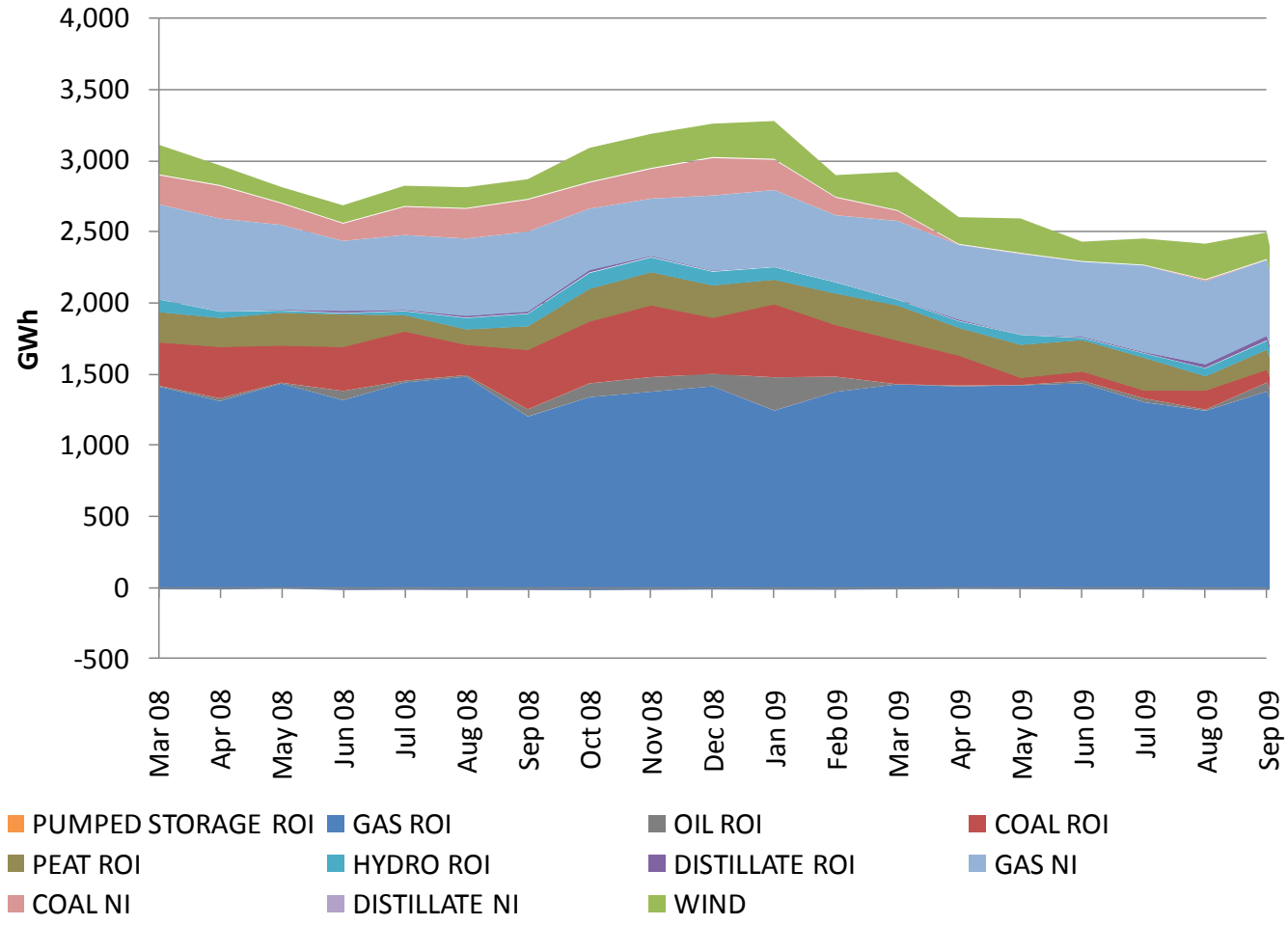
Backcast results – PLEXOS MSQ



Backcast results – Historic MSQ



Backcast results – PLEXOS vs Historic MSQ

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Unit	Cap. Fac. Delta	Av MW Delta
PBC	-15%	-72.2
K2 Coal 220	12%	28.5
B31	11%	27.5
B32	10%	26.8
K1 Coal 220	11%	25.3
AD1	-5%	-12.0
HNC	-2%	-10.1
MP3	-3%	-9.6
CPS CCGT	3%	9.4
MP2	-2%	-9.2
B10	9%	9.2
MP1	-3%	-8.2
NW4	3%	6.2
HN2	-1%	-5.8
PB1	-5%	-5.2
DB1	1%	4.9
ED1	0%	4.9
MRC	4%	4.9

Unit	Cap. Fac. Delta	Av MW Delta
continued…		
PB2	-3%	-3.0
WO4	2%	3.0
B4	1%	2.7
TB4	-1%	-2.4
SK3	1%	1.0
AT1	-1%	-0.9
B5	1%	0.9
LR4	1%	0.9
SK4	1%	0.9
B6	0%	0.8
GI3	-1%	-0.8
TY	1%	0.8
AT4	-1%	-0.7
NW5	0%	-0.5
TB3	0%	-0.3
AT2	0%	0.3
RH2	0%	-0.1

Unit	Cap. Fac. Delta	Av MW Delta
continued…		
TB1	0%	-0.1
RH1	0%	-0.1
TP1	0%	-0.1
GI1	0%	-0.1
AP5	0%	-0.1
KGT4	0%	-0.1
KGT3	0%	0.0
TB2	0%	0.0
GI2	0%	0.0
CGT8	0%	0.0
TP3	0%	0.0
BGT2	0%	0.0
BGT1	0%	0.0
KGT1	0%	0.0
KGT2	0%	0.0
Wind SEM	0%	0.0
PB3	0%	0.0

Covers Nov-07 to Sep-09

Backcast results – PLEXOS vs Historic Commitment

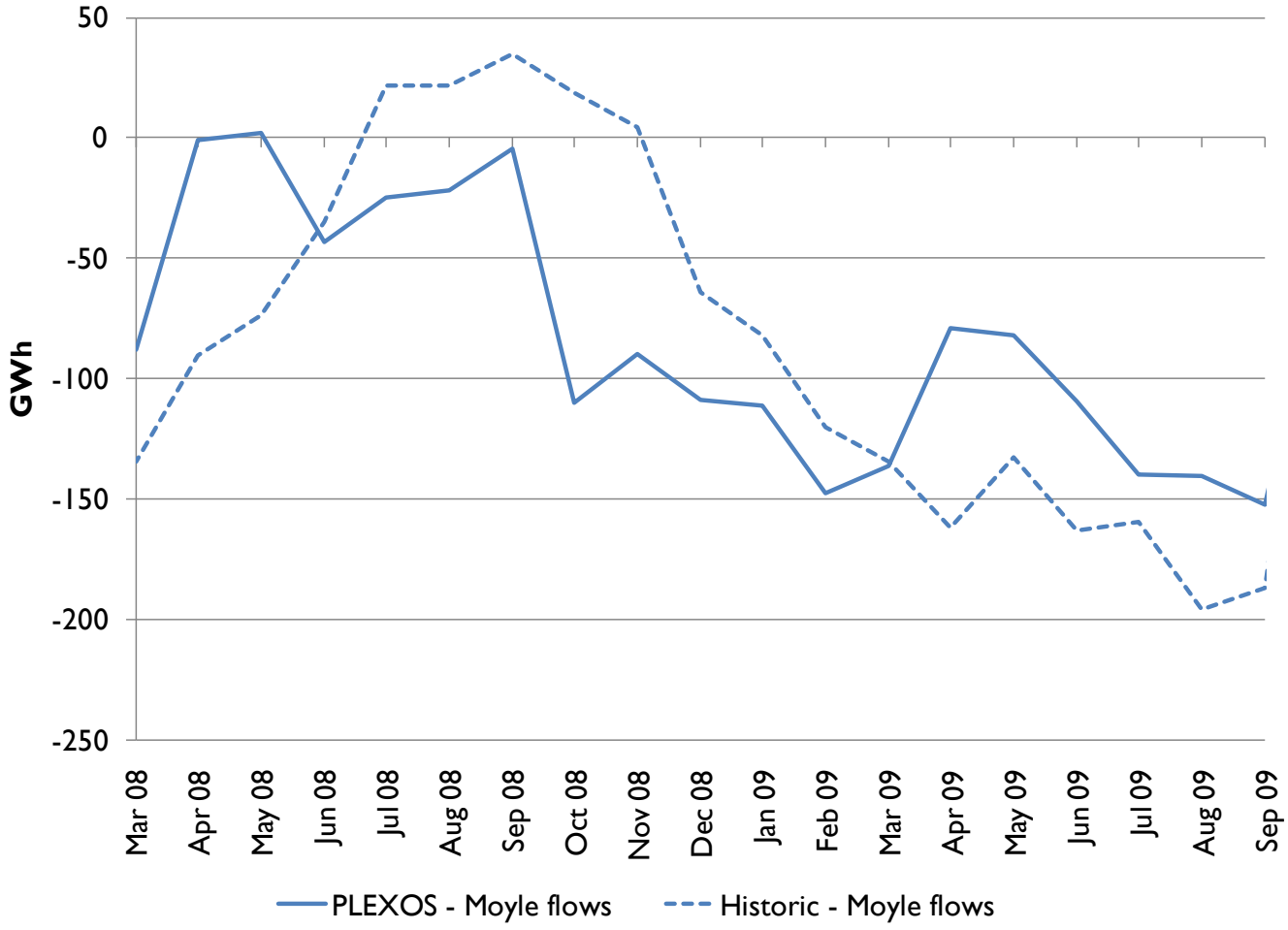
Unit	% Hist periods at MSL	% PLEXOS periods at MSL	Delta
AD1	11%	5%	-5%
B10	14%	10%	-4%
PBC	15%	11%	-4%
CPS CCGT	5%	2%	-3%
PB1	4%	2%	-2%
MRC	3%	1%	-2%
MP2	10%	9%	-1%
K2 Coal 220	3%	2%	-1%
PB2	3%	1%	-1%
MP3	12%	11%	-1%
B4	2%	3%	1%
TY	1%	3%	1%
NW4	1%	0%	-1%
B5	0%	1%	1%
K1 Coal 220	2%	1%	-1%
MP1	8%	8%	1%
WO4	3%	3%	0%
B32	6%	6%	0%

Unit	% Hist periods at MSL	% PLEXOS periods at MSL	Delta
continued…			
GI3	0%	0%	0%
SK3	1%	1%	0%
SK4	1%	1%	0%
B6	1%	1%	0%
DB1	1%	1%	0%
TB1	0%	0%	0%
HNC	1%	1%	0%
GI1	0%	0%	0%
AT2	0%	0%	0%
TB3	3%	3%	0%
KGT1	0%	0%	0%
KGT2	0%	0%	0%
B31	6%	6%	0%
TP1	0%	0%	0%
HN2	1%	1%	0%
TB4	2%	2%	0%
LR4	1%	0%	0%

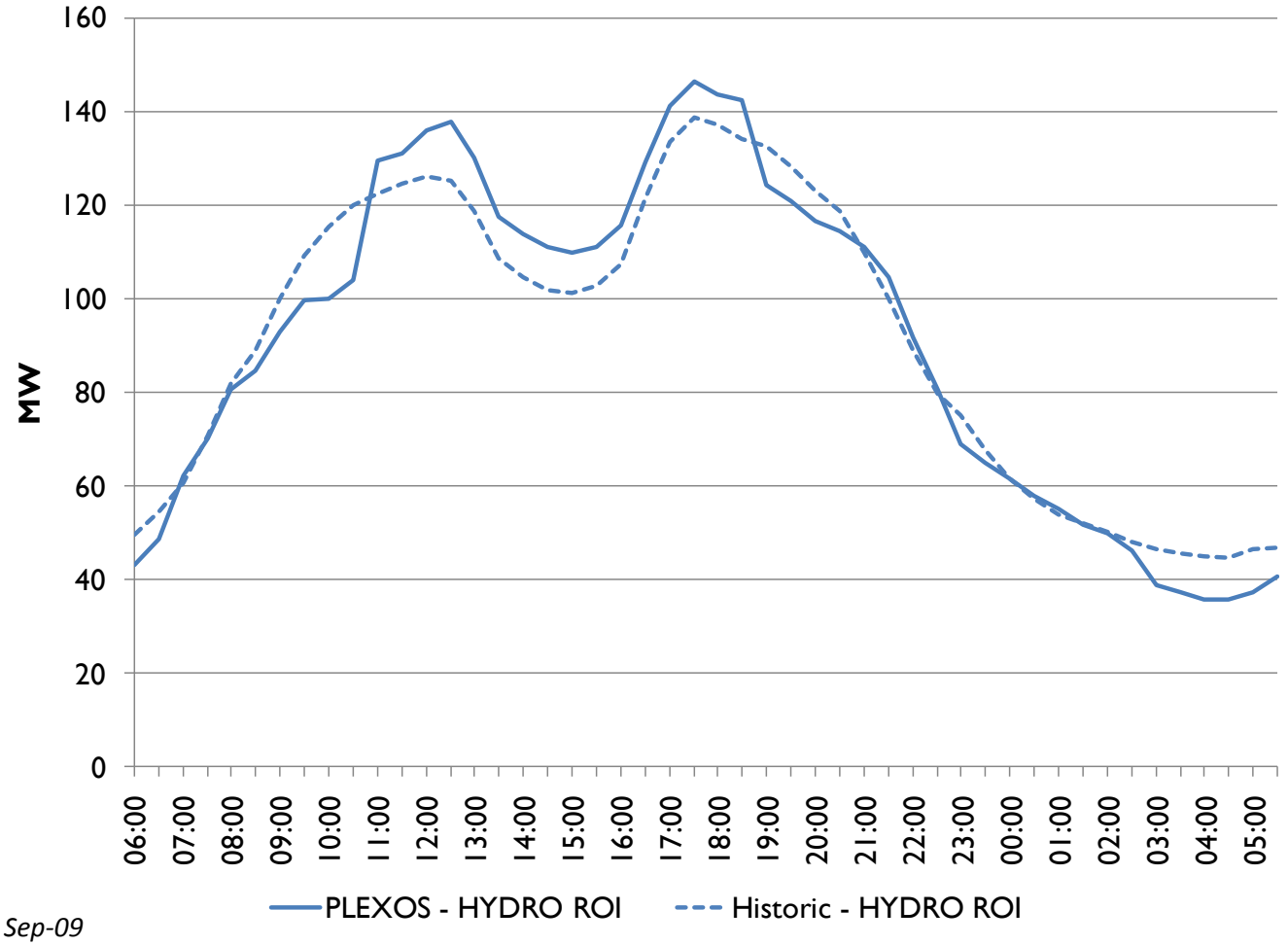
Unit	% Hist periods at MSL	% PLEXOS periods at MSL	Delta
continued…			
GI2	0%	0%	0%
RH1	0%	0%	0%
TB2	0%	0%	0%
RH2	0%	0%	0%
AT4	0%	0%	0%
BGT1	0%	0%	0%
BGT2	0%	0%	0%
AP5	0%	0%	0%
PB3	0%	0%	0%
ED1	1%	1%	0%
AT1	0%	0%	0%
NW5	0%	0%	0%
TP3	0%	0%	0%
CGT8	0%	0%	0%
KGT3	0%	0%	0%
KGT4	0%	0%	0%
Wind SEM	0%	0%	0%

Covers Nov-07 to Sep-09

Backcast results – Interconnection

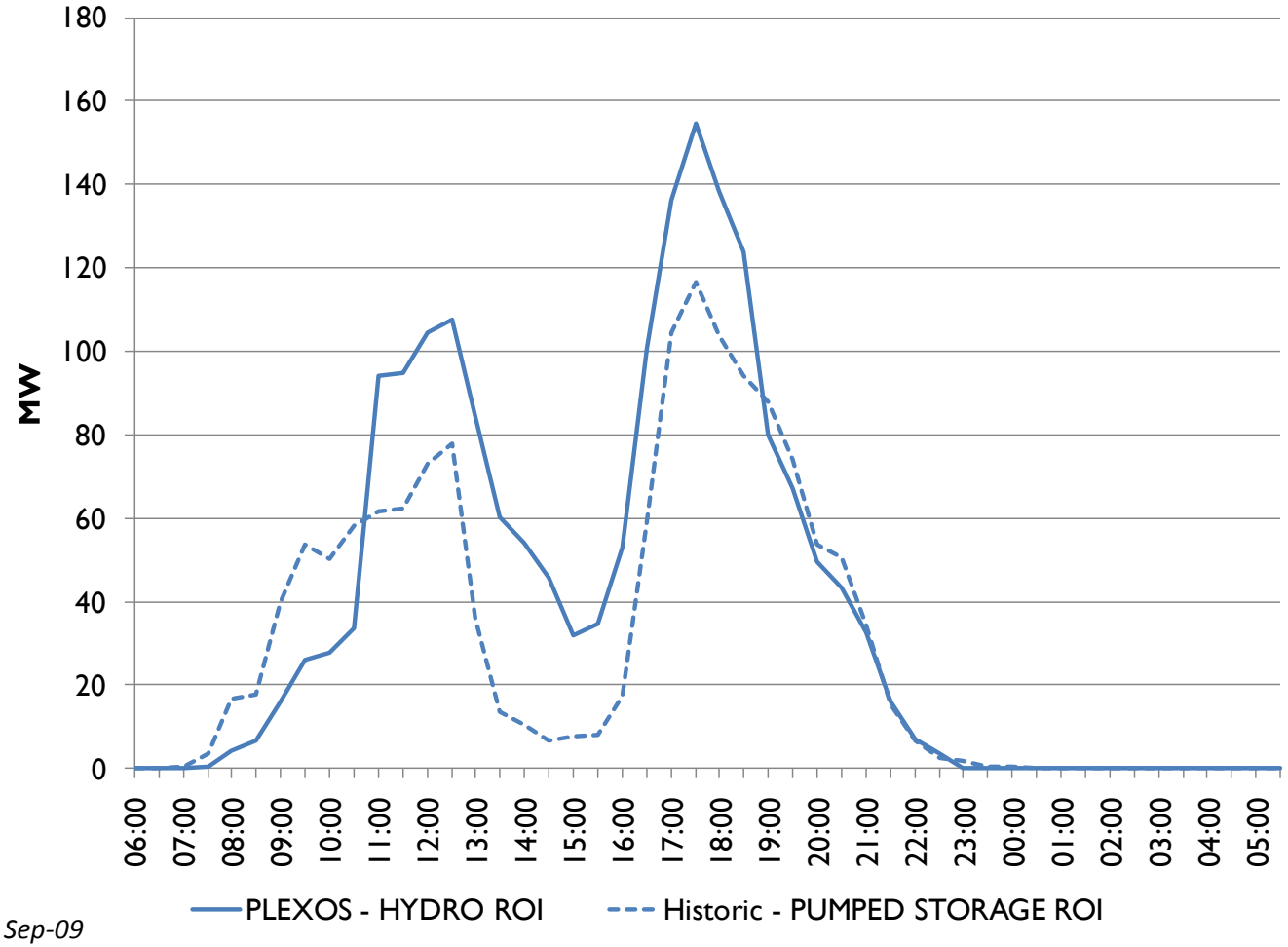


Backcast results – Hydro shape



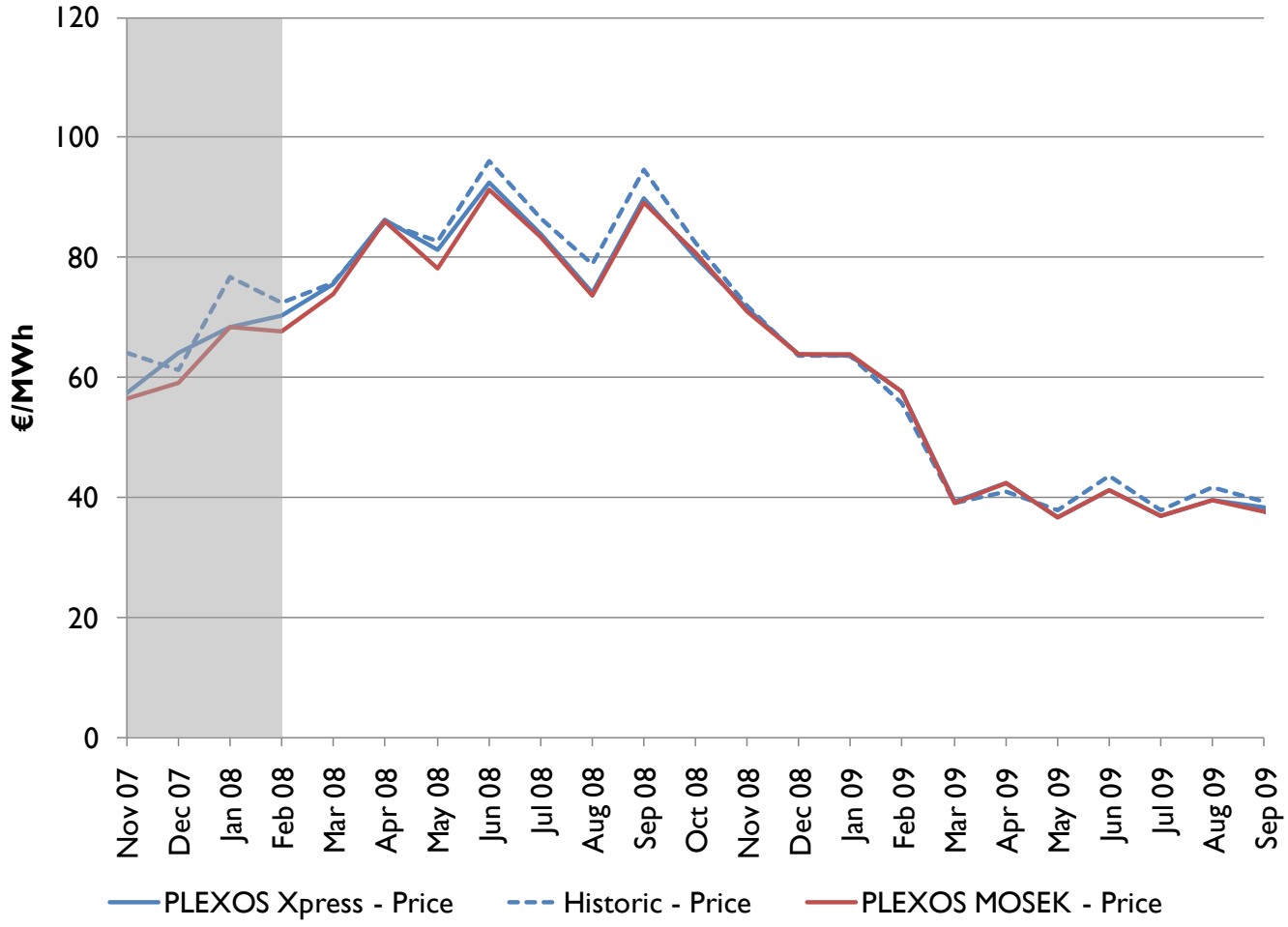
Covers Nov-07 to Sep-09

Backcast results – Pumped storage shape

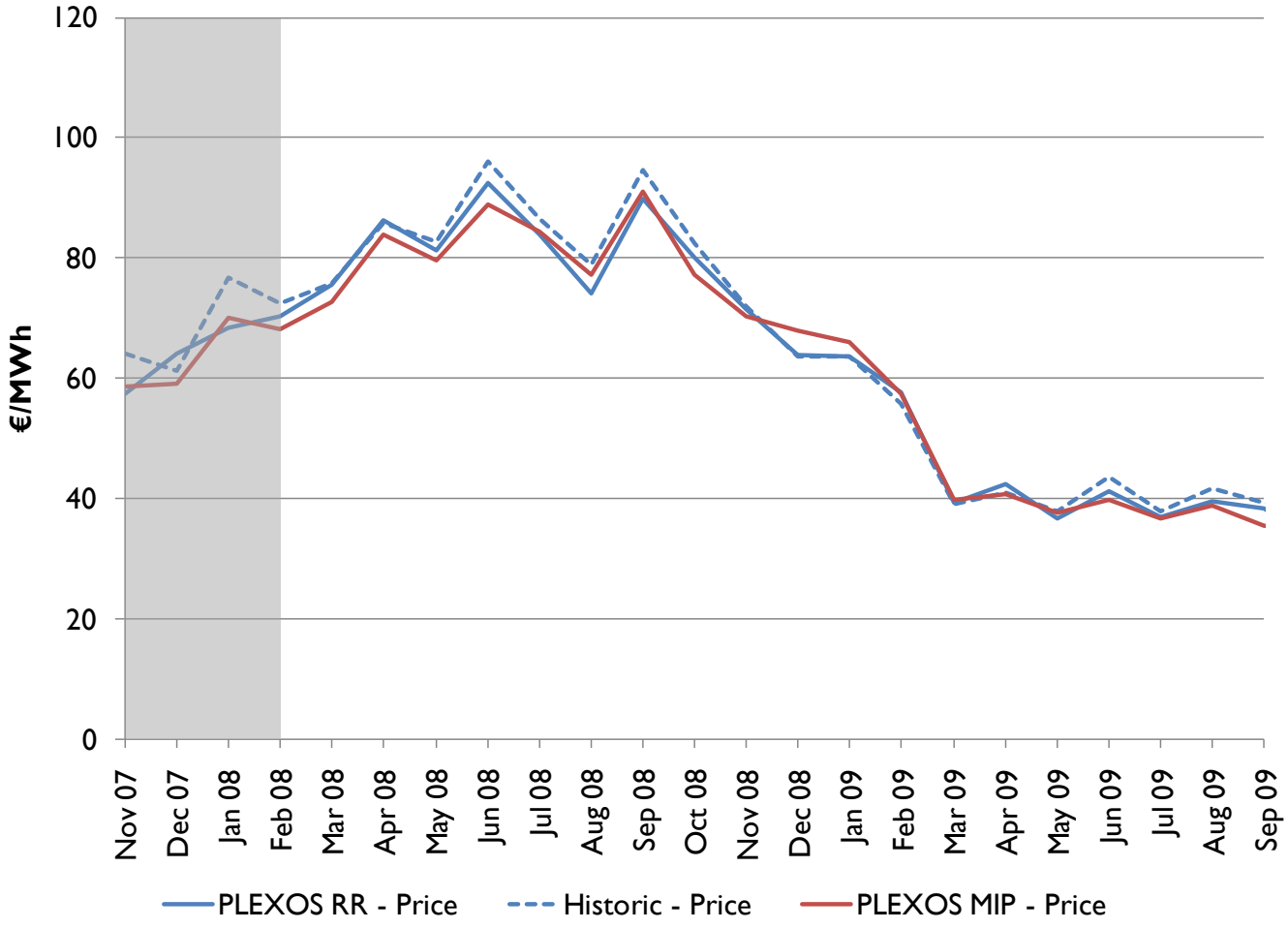


Covers Nov-07 to Sep-09

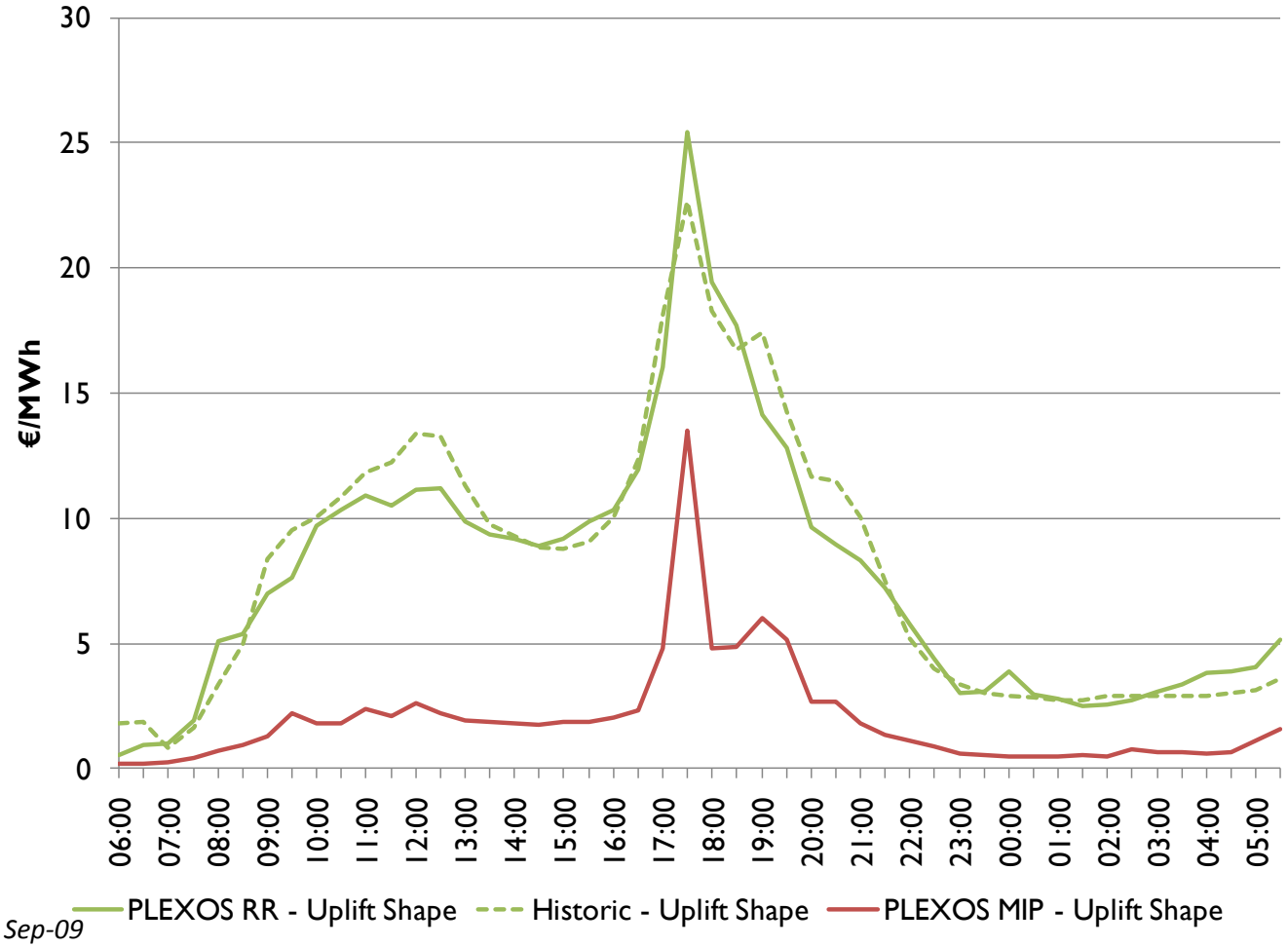
Backcast sensitivities / setting testing
MOSEK RR vs Xpress RR: Average SMP



Backcast sensitivities / setting testing
MIP vs RR: Average SMP



Backcast sensitivities / setting testing
MIP vs RR: Uplift shape



Covers Nov-07 to Sep-09

Backcast sensitivities / setting testing

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- Tested RR rounding setting
  - Lower RR settings cause a lower price, increasing the delta between PLEXOS and historic
  - Higher RR settings increase the number of price cap events due to lack of unit commitment
  - Recommend RR = 5

- Start cost states
  - In rounded relaxation mode, PLEXOS uses a simplified treatment of multiple start states
  - Recommend continued use of single start state

Validation of forecast model and data

PLEXOS forecast model

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- Forecast model builds up generator offers from
  - Heat rate curve (no load and incremental heat rates)
  - Variable O&M costs in €/MWh, as appropriate
  - Delivered fuel prices, based on index price + cost of carbon plus transport & excise adders
  - TLAFs

- Start costs calculated from fuel offtake at start and a fixed €/start cost

- Backcast model uses Actual Availability, whereas forecast uses forced outage rates (%) and assumed maintenance schedules
- Special cases follow approach taken for backcast
  - Pumped Storage: optimised by PLEXOS
  - Hydro: run using daily limits
  - Moyle: GB representative price approach implemented
  - Wind: half hourly profiles

Data and assumptions required

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- Validated forecast model required to run to end 2011
- Generator data
  - Heat rates
  - Technical parameters
  - Forced outage rates
  - Start and VOM costs
  - New entrants and retirements
- Half hourly demand assumptions
- Embedded generation
- Wind capacity and profiles
- Transmission Loss Adjustment Factors
- Daily hydro availability limits
- Outage schedules

Generator data

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- Supplied previous validated data to generators and asked for updates where required

- We validated the submitted data by
  - Comparing to last year's validated dataset and understanding the reasons for changes
  - Comparing between groups of similar SEM units
  - Using submitted heat rates, no load heat rates & start costs/start fuel offtake in conjunction with historic fuel & carbon price, create daily offer prices etc and compare to actual market submissions (Commercial Offer Data)
  - Comparing to Redpoint internal benchmarks

Generator data

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- In general changes to submitted data from previous data arose from
  - Reassessment of unit characteristics
  - Changes in operation of units
  - Changes in interpretation of bidding principles, leading to changes in market submissions
    - e.g. Elements included in start costs
  - Clarifications on the form of the data required

- Where major changes to the data arose, we discussed these with the generator involved to understand the justification and considered these to be justified after discussion with the generator involved

- A number of generators caveated their responses e.g. if the generator is not in service yet or if a review of operating parameters is currently underway
  - In these cases we accepted the generator's current best view

Generator data

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- New entrants and retirements
  - Updates to commissioning dates for Aghada and Whitegate CCGTs
  - Confirmed Poolbeg 1&2 retirement dates

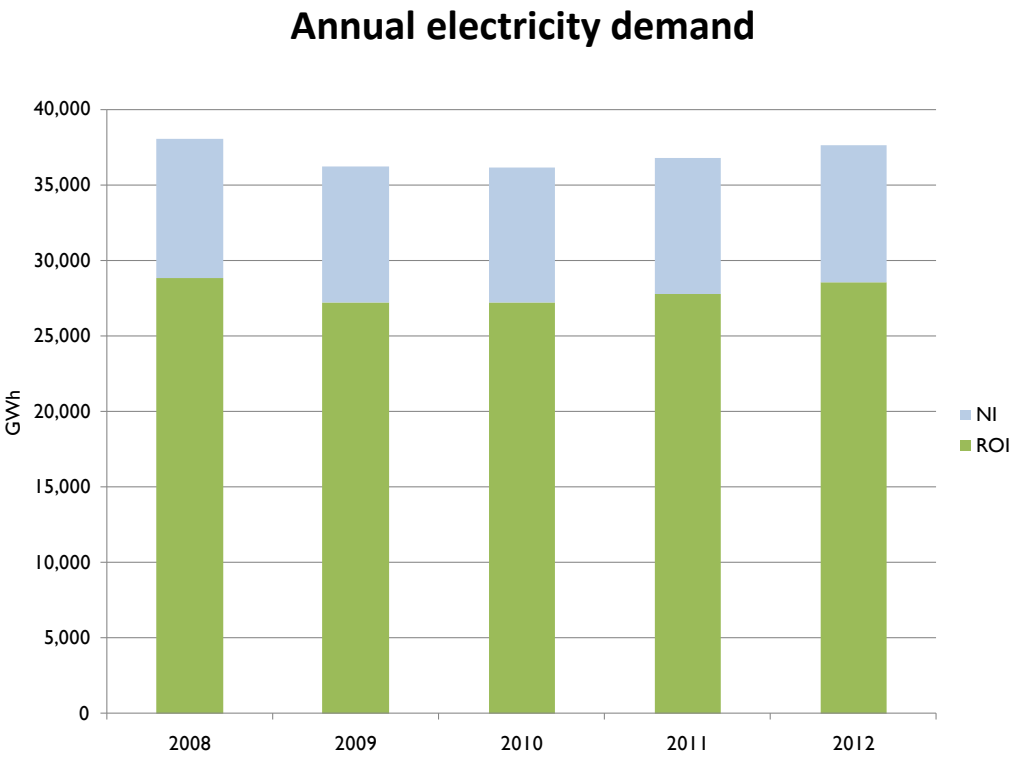
- Discussion with SEMO and participants identified 5 new units that are expected to be commissioned by end 2011

- Generator data for these units is based on expected unit characteristics

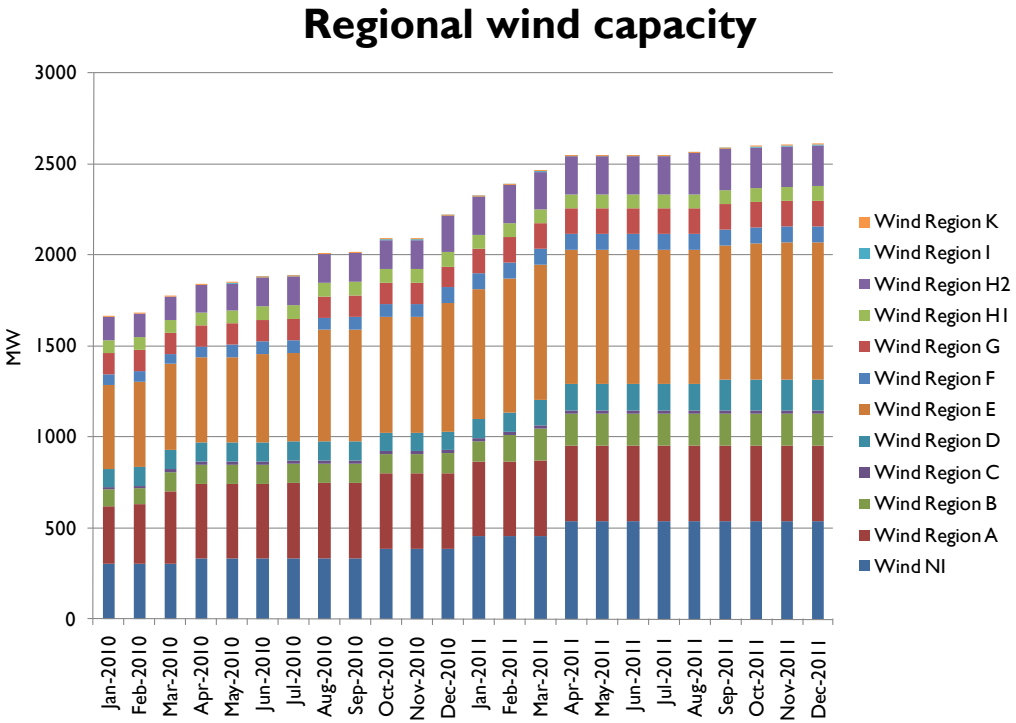
Unit name	Fuel	Assumed Commissioning date	Capacity (MW)
Contour Global Unit 1	Gas	Dec-09	3
Contour Global Unit 2	Gas	Dec-09	3
Cushaling Unit 1	Distillate	Oct-10	56
Cushaling Unit 2	Distillate	Oct-10	56
Meath Waste-to-Energy	Waste	Sep-11	17

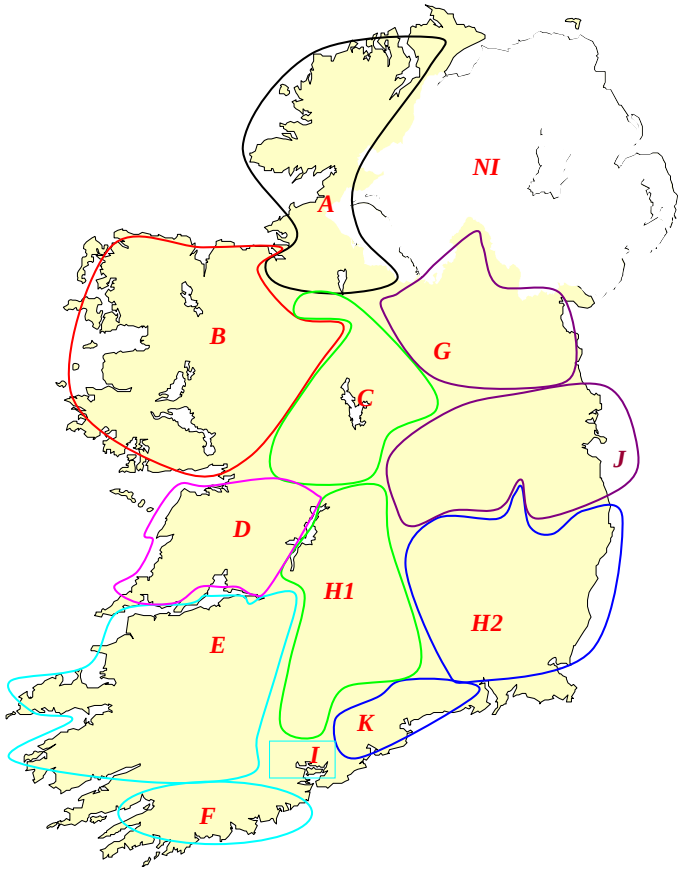
Demand assumptions

- Annual and peak electricity demand based on
  - Eirgrid's median demand forecast from *Generation Adequacy Report 2010-2016*
  - SONI's median demand forecast as published in *Generation Capacity Statement 2010-2016*
- Half hourly profile based on 2007 actual profile



Wind capacity assumptions





- Monthly capacity changes based on agreed connection dates

Wind priority dispatch

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- RAs have been reviewing the principles of priority dispatch and the treatment of non-firm capacity in the market schedule
  - July 2009 consultation paper (SEM-09-073)

- General approach in SEM PLEXOS modelling to date
  - Wind effectively modelled at zero price
  - Non-firm access rules ignored in market schedule

- Priority dispatch for wind requires a different approach
  - Negative offer price or fixed load

Other assumptions

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- SEMO provided us with updated assumptions on
  - Hydro daily availabilities
  - Outage schedules for 2010 and 2011 (including Moyle outages)
  - Typical embedded generation profiles for ROI (excluding wind)

- TLAFs updated based on published TLAFs for 2010 (December 2009) on AIP website
  - 2010 values will be used for 2011, in the absence of updated values

- Fuel prices
  - Recommended fuel price indices unchanged
  - Carbon emission factors unchanged
  - Fuel Adders (Transport costs, Excise) are based on a combination of publically available data and, where appropriate, data supplied by generators

Recommendations

Recommendations

- Treatment of Moyle
  - Use a simplified representation of GB price
  - Use wheeling charges that capture the costs and risks of trading across Moyle
- Use Rounded Relaxation, with the rounding up threshold set to 5
- Use a single (warm) start cost for each unit
- For Predictable Price Taker units (Peat and Waste-to- Energy), remove cost data (heat rates, VOMs and start costs) so output will be determined by availability

Conclusions and next steps

- Thank you for your co-operation and attention
- Report and public versions of the models to be published in the next two weeks
- Questions?


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