electricity north west

Bringing energy to your door

Long-term forecasting of reactive power demand in distribution networks

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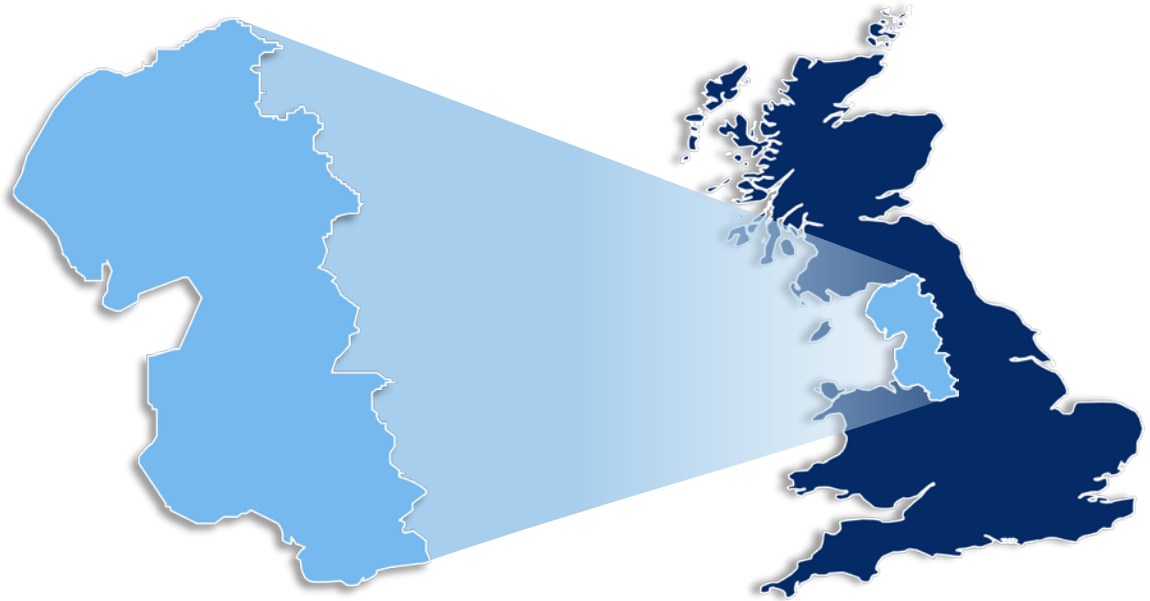
Introducing Electricity North West

4.9 million

2.4 million

25 terawatt hours



£12 billion of network assets

56 000 km of network ● 96 bulk supply substations
363 primary substations ● 33 000 transformers

Our heritage

1948	1990	1995	2000	2007	2010
Electricity national-isation: North West Electricity Board	Privatisation: Norweb plc	North West Water takeover of Norweb: United Utilities	Norweb supply business sold	Sale of United Utilities Electricity to private investors	Acquisition of UU Electricity Services:

RIIO regulatory framework

RIIO =

Revenue = Incentives + Innovation + Outputs

ED1 = Electricity Distribution

14 DNO areas

Eight years

£1.8 BILLION Total to be spent on the network 2015 - 2023

£24.6 BILLION Total to be spent on the network 2015 - 2023

£10 Resulting annual average savings in consumer bills

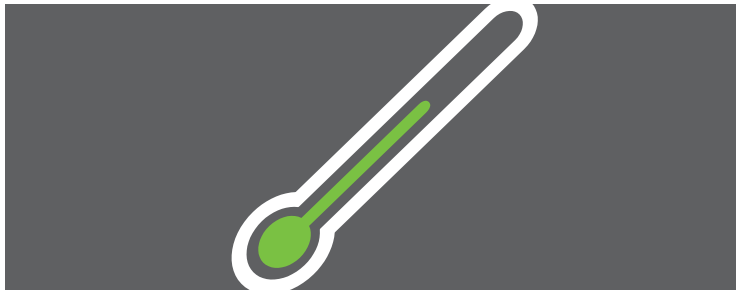
8% The power distribution part of a dual fuel bill

30% Network reliability increase since 2002

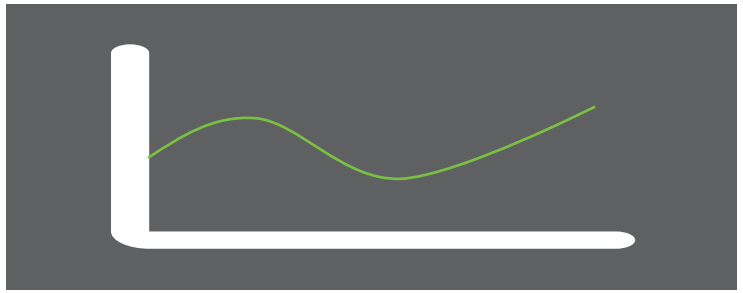
online available: www.ofgem.gov.uk/publications-and-updates/infographic-how-ofgems-network-price-control-proposals-riio-ed1-will-affect-you

The need for our network

Views of future demand and generation affect our plans for network capacity



Thermal ratings of equipment – forward and reverse power flows



Allowed range of voltage around statutory limits – demand, generation, reactive

Fault-level ratings for network protection

Standards of security of supply including asset redundancy, automation, generation contribution and demand response

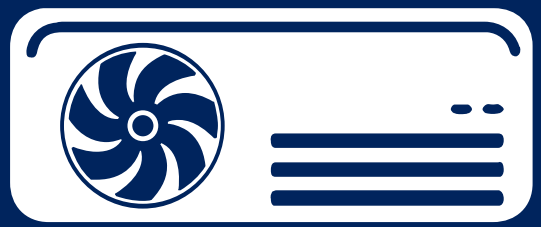
Many ways to meet customers' capacity needs

Forecasting reactive power (Q)

Reactive power (Q) demand in UK	Long-term forecasting of Q demand
Critical at transmission-distribution (T-D) interfaces	Limited works
Acute Q decline during minimum load (P)	REACT project (2013-2015) First approach using network and demand data
Challenges to maintain transmission voltages	ATLAS project (2015-2018) Enhanced approach, more extensive network modelling

Two related NIA projects

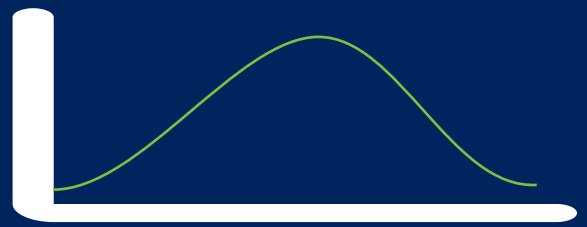
Demand Scenarios with Electric Heat and Commercial Capacity Options



Winter / summer peak load

April 2015 - October 2016

ATLAS
(Architecture of Tools for Load Scenarios)



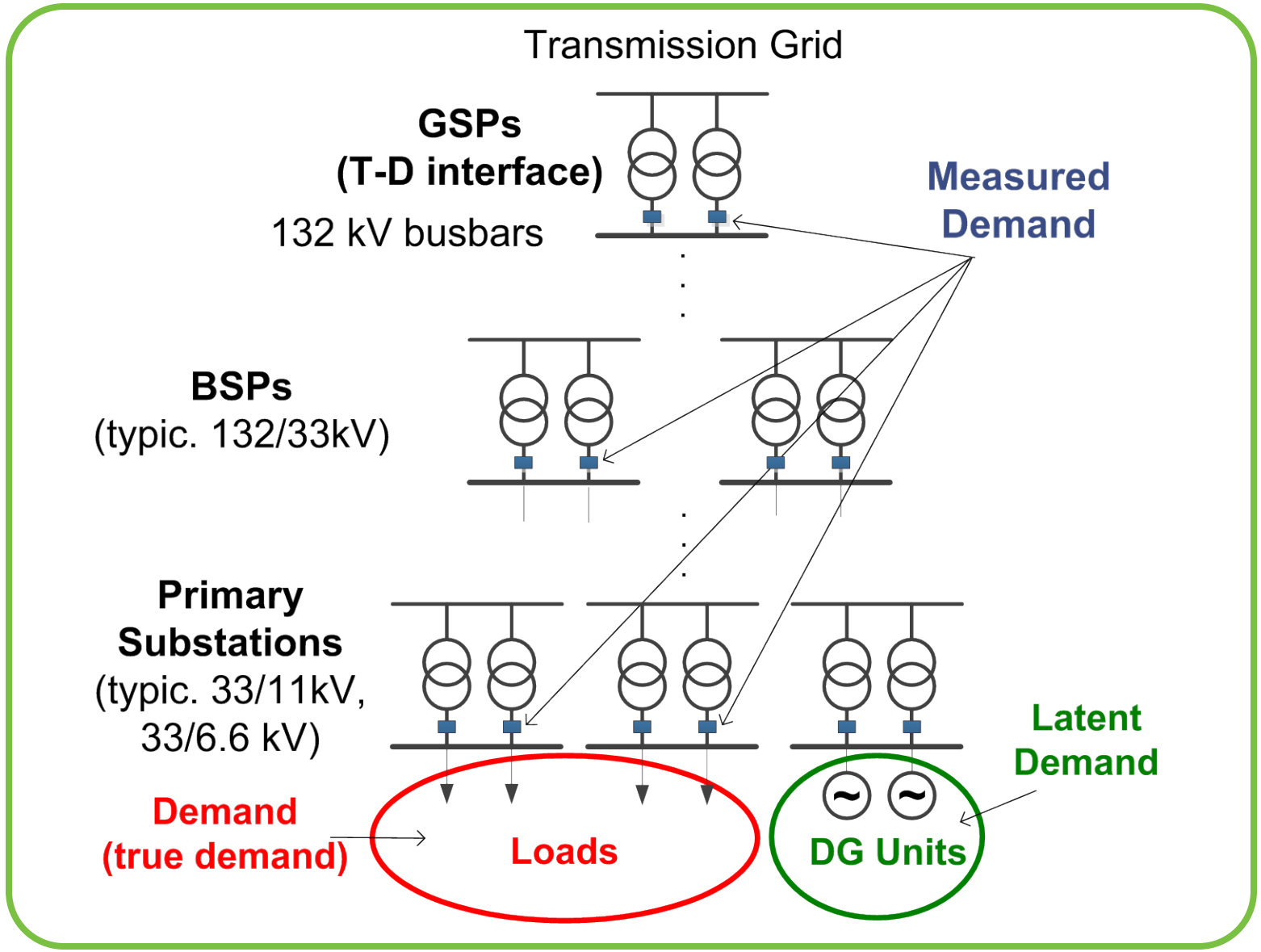
Half-hourly through year

Seasonal peak and minimum

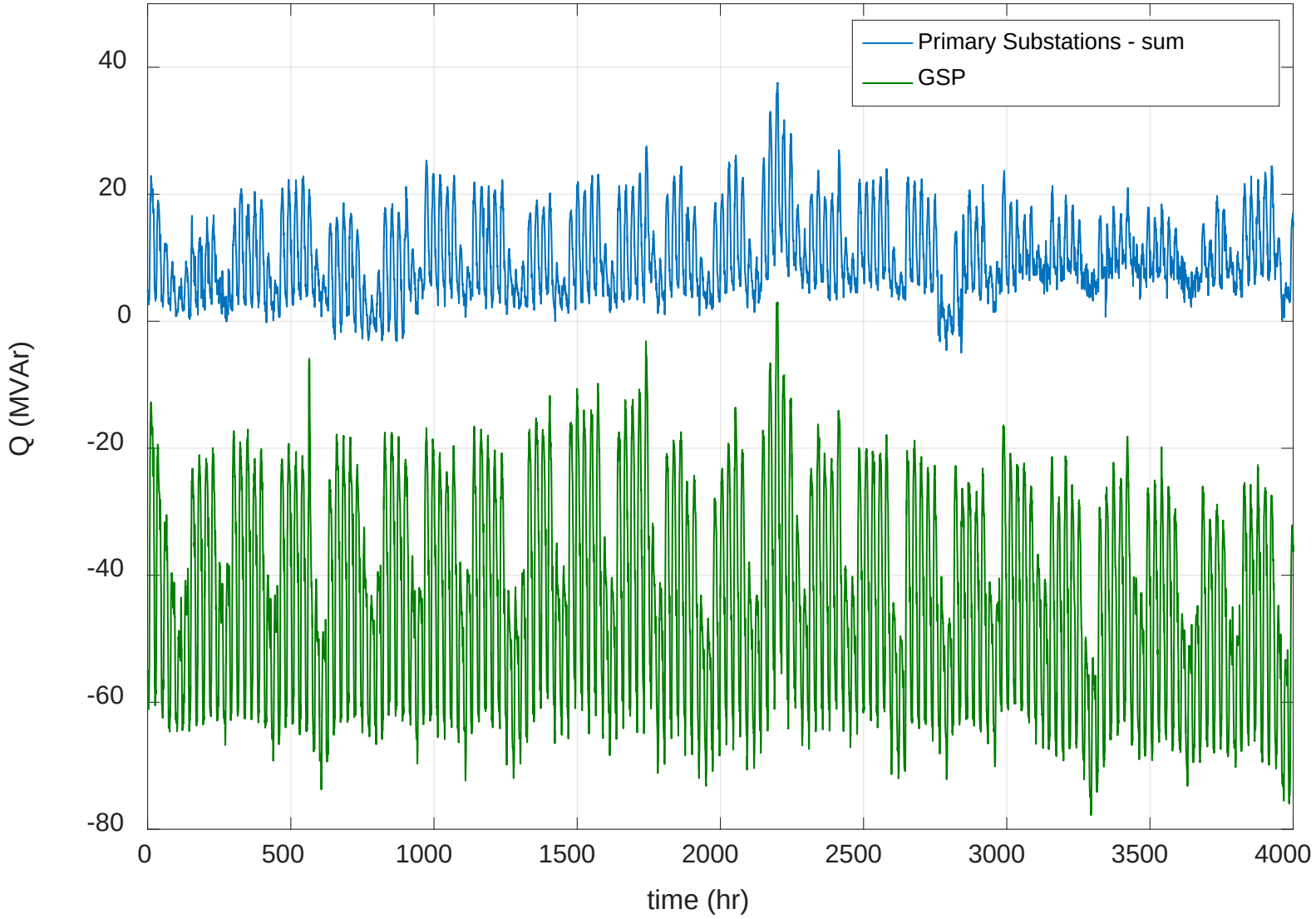
P and Q, then S and load factor

November 2015 – December 2017

Distribution networks in the UK



Monitored reactive demand



Inductive primaries, but capacitive GSPs (i.e., Q exports to transmission)

Interaction of demand & generation with distribution networks → significant effects on Q exports

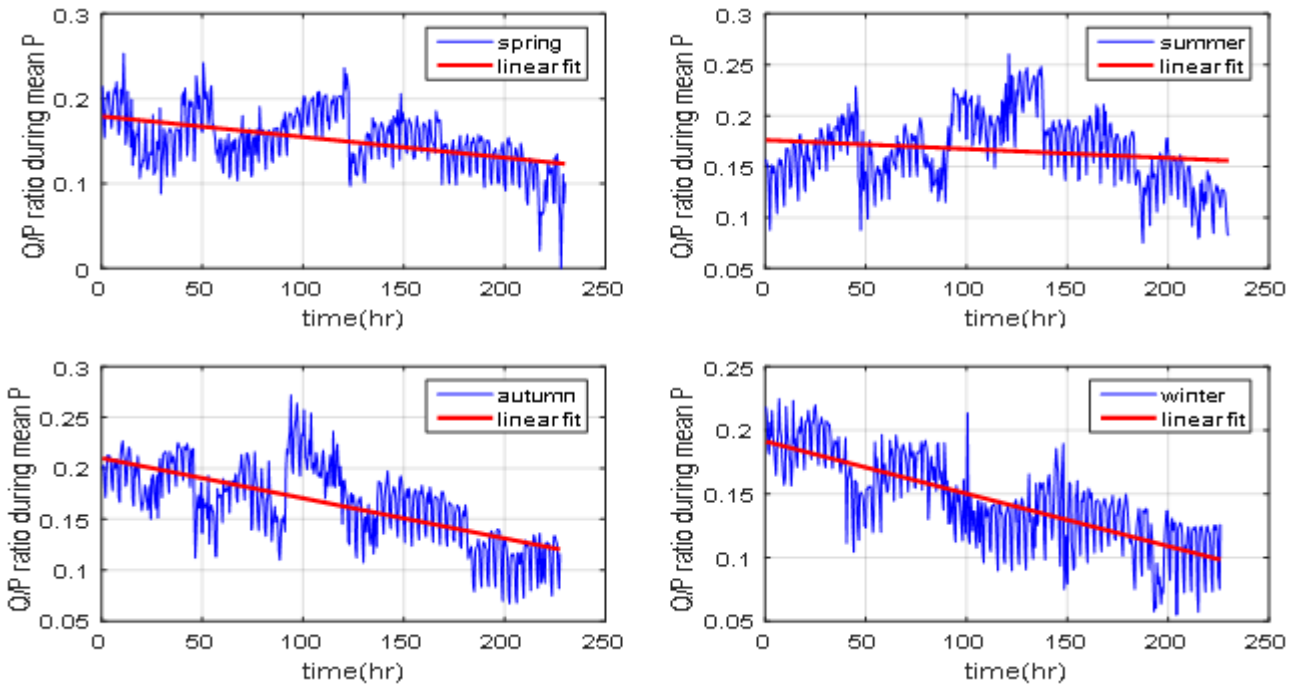
Proposed methodology

Scenario based

Time-series network modelling T-D interface to primary substations Half-hourly resolution in analyses	Effects of low carbon technologies (LCTs), econometrics, demographics, renewables	Use of forecasted P demand and generation Focus on periods of peak & min P demand

Future Q at primary substations – no network modelling

- Assessment using future P at primary substations (EELG model) and trends in Q/P ratio
- Q/P ratio trends
  - historical FY12 to 16 measured P and Q demand
  - seasonal trends
  - individual linear trends
    - min/mean/max daily P
  - future Q/P ratios
    - half-hourly for whole year
    - per GSP

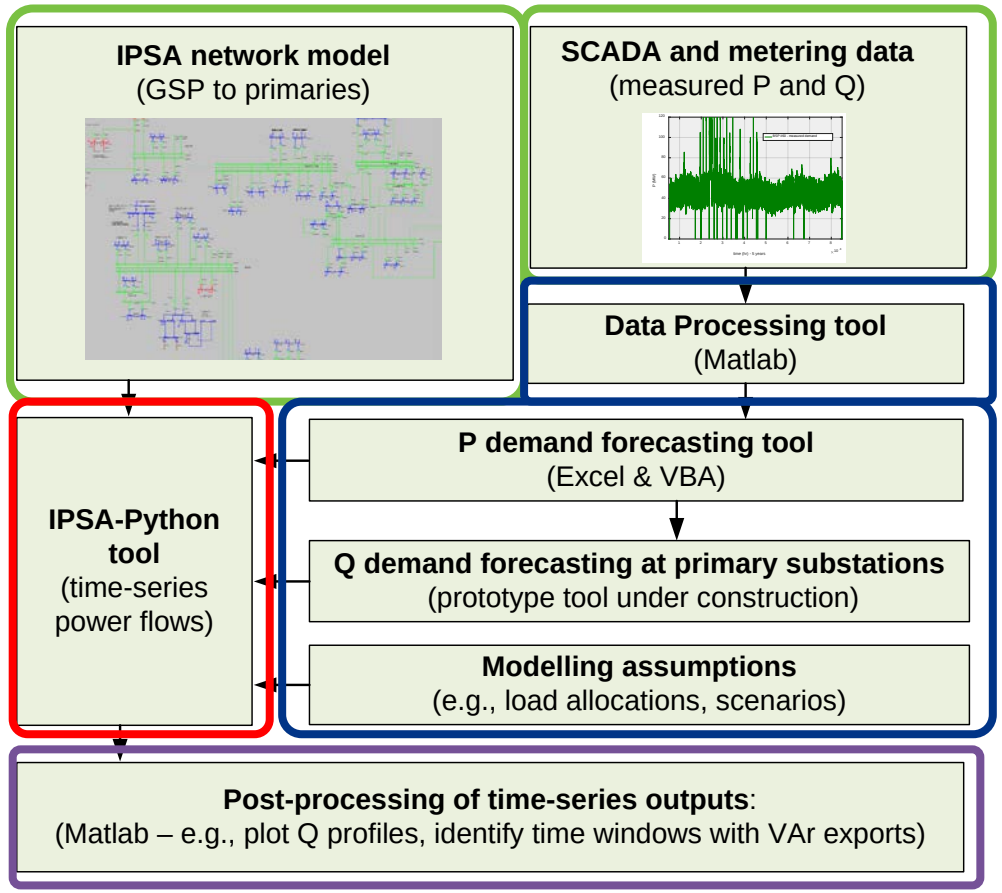


Implementation of proposed methodology

Inputs

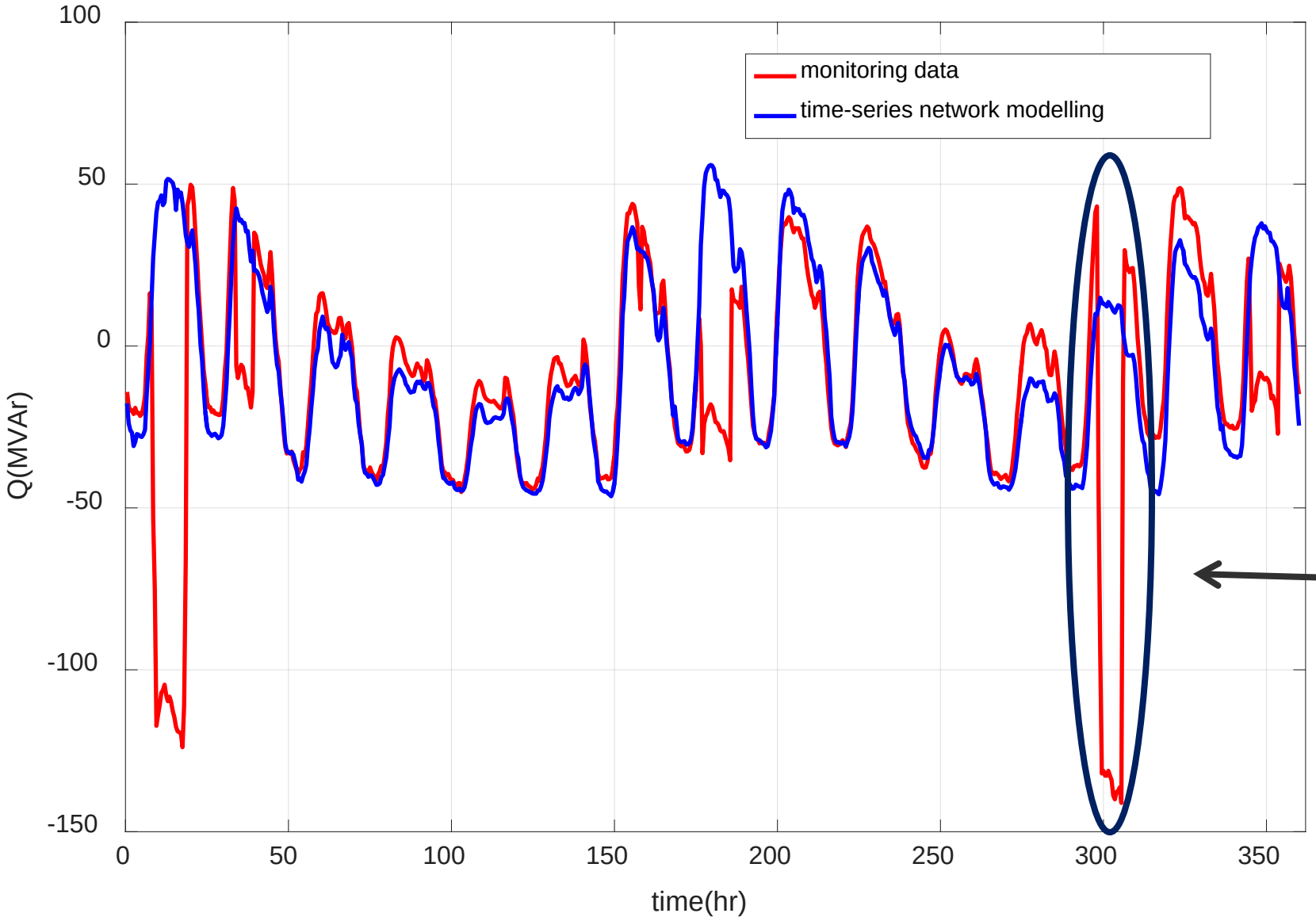
Time-series network modelling

Outputs



Processes & modelling assumptions

Challenges to validate the Q forecasting tool

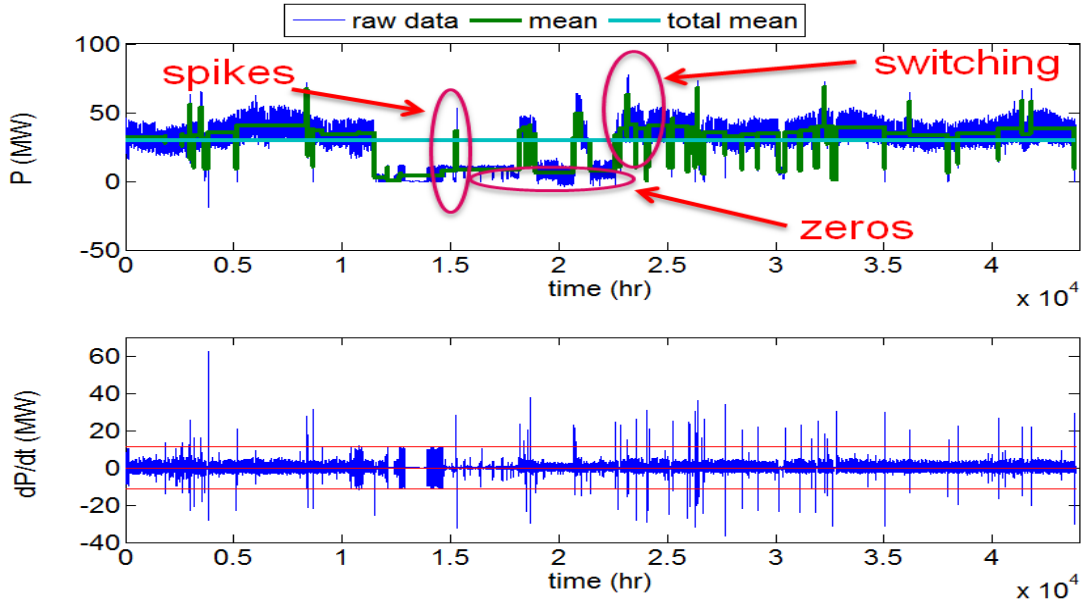


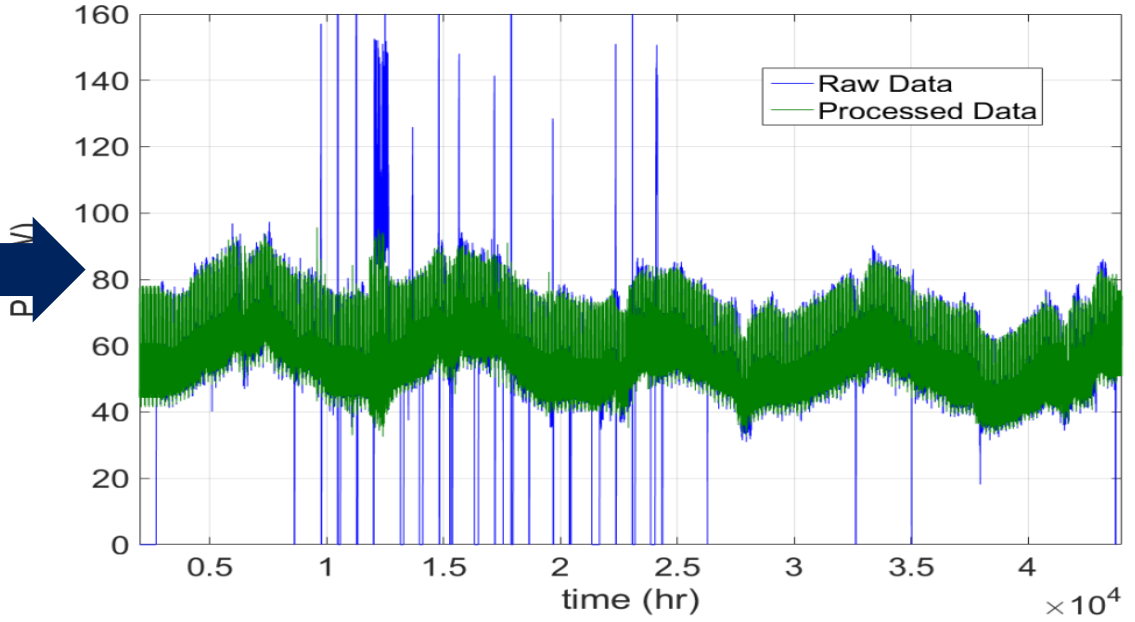
Critical network data: e.g. TSO controlled capacitors

Validation of Q forecasting tool – automated processing imperfect monitoring data

Identification of Data Problems

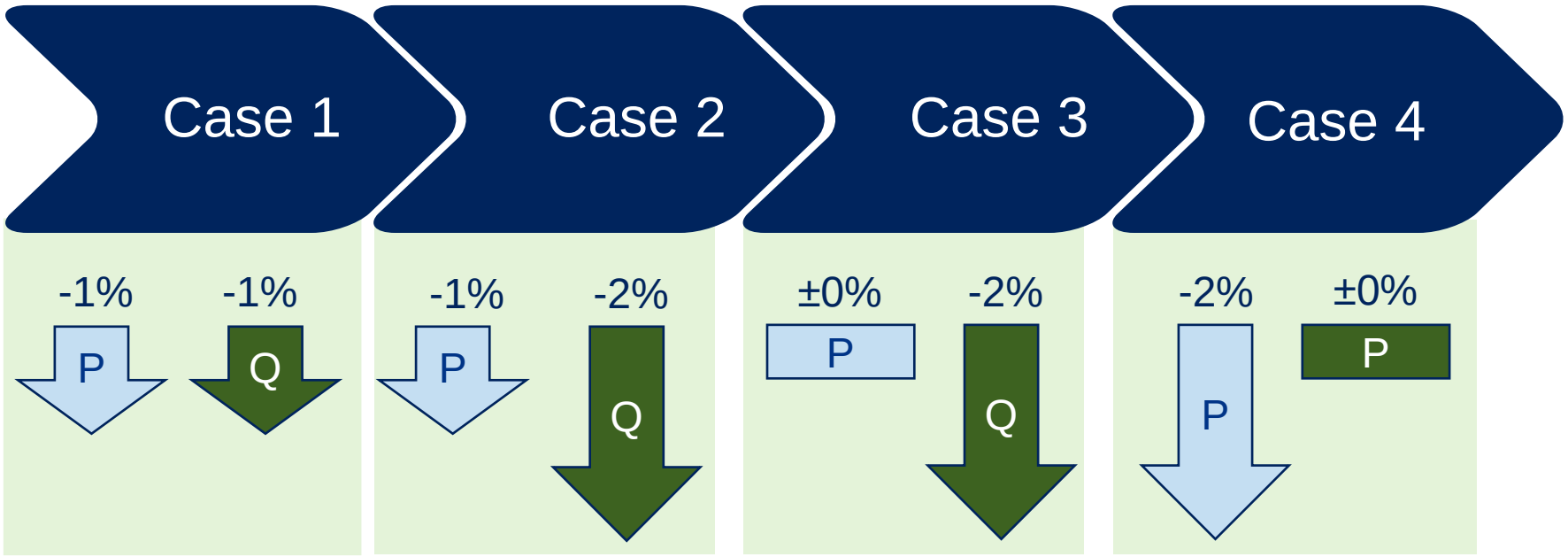
Data Corrections (Half-hourly & daily analyses)



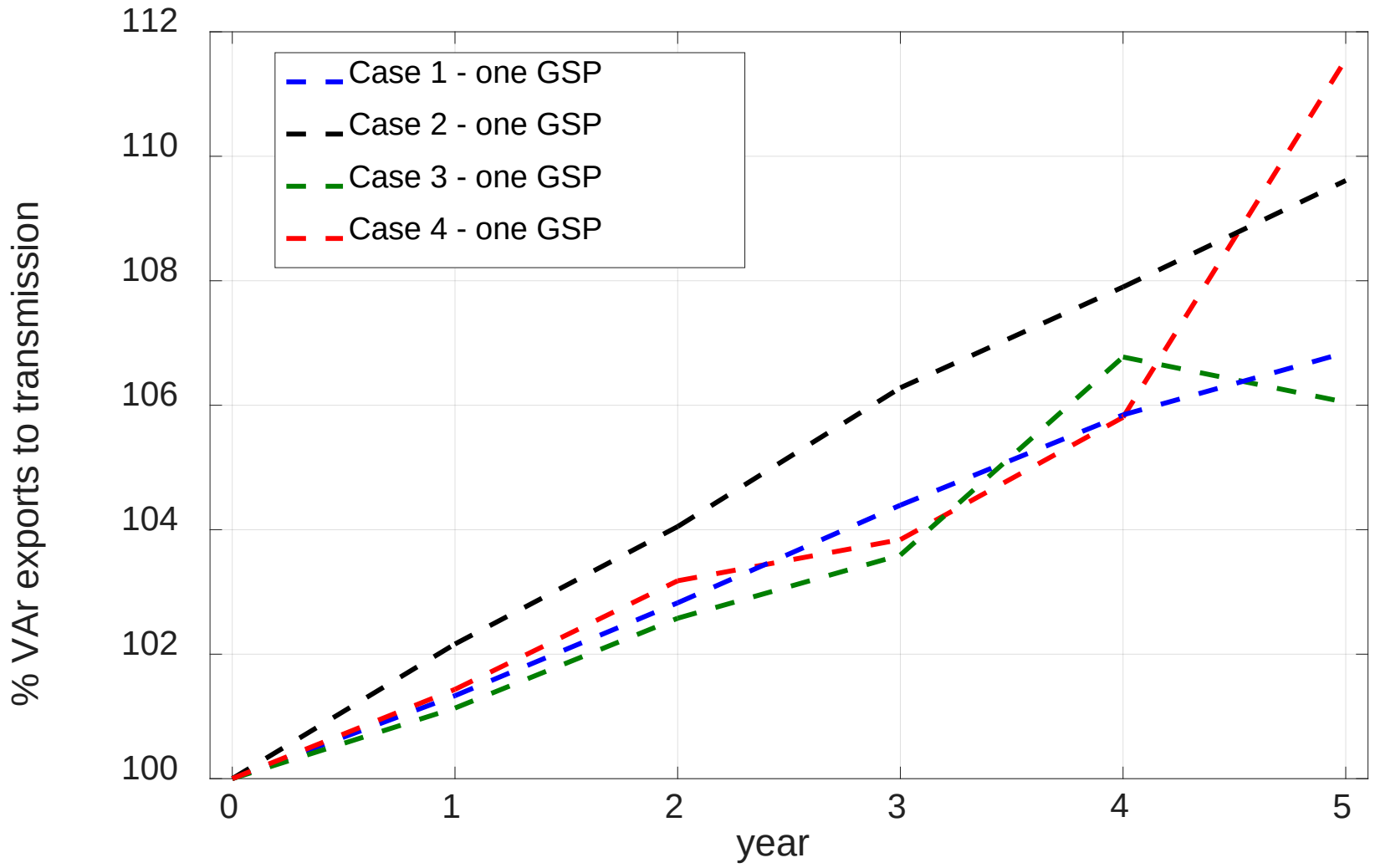


Future scenarios (test cases / not business as usual)

4 cases with different demand reduction at primary substations



Future trends in Q exports to transmission



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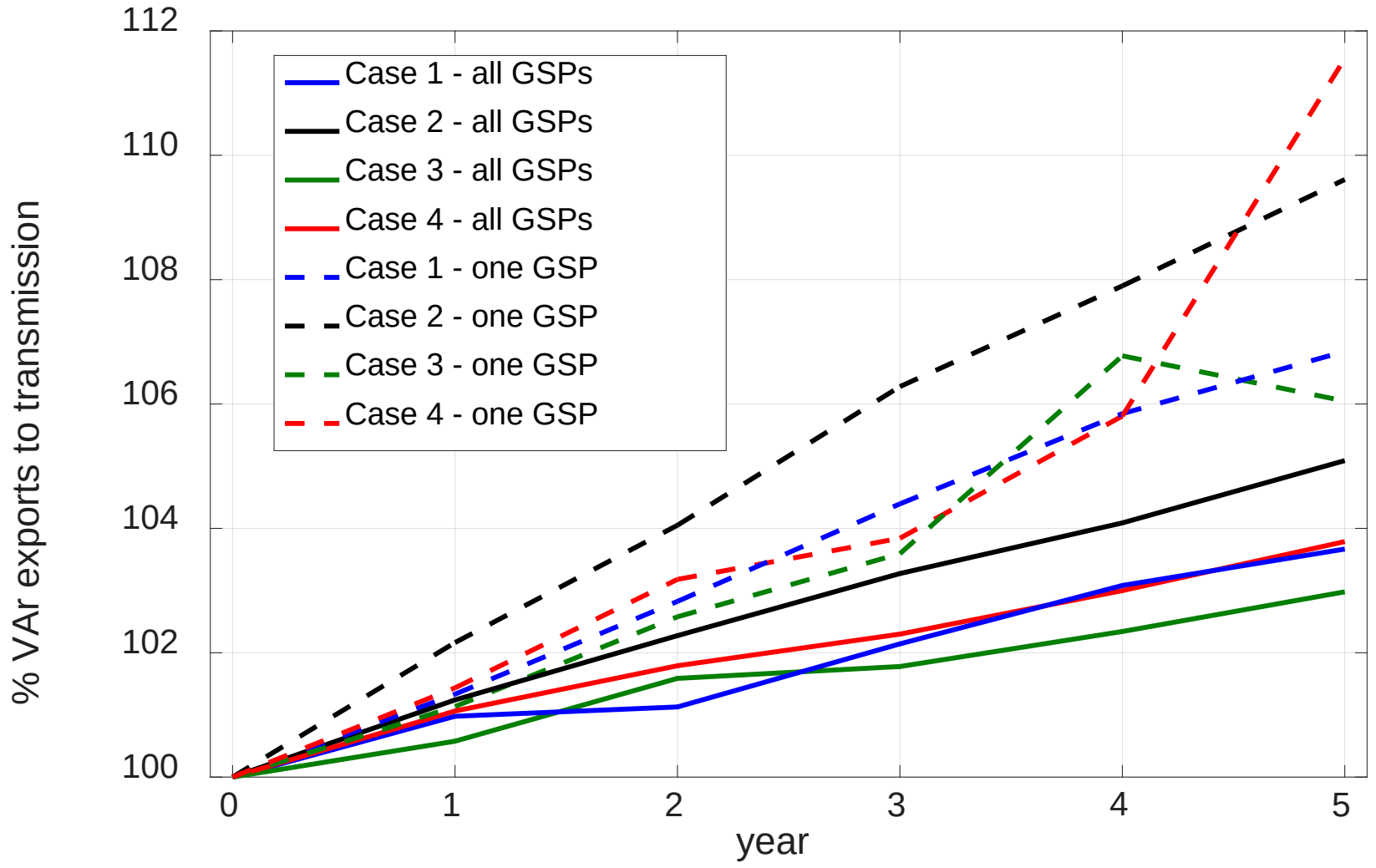
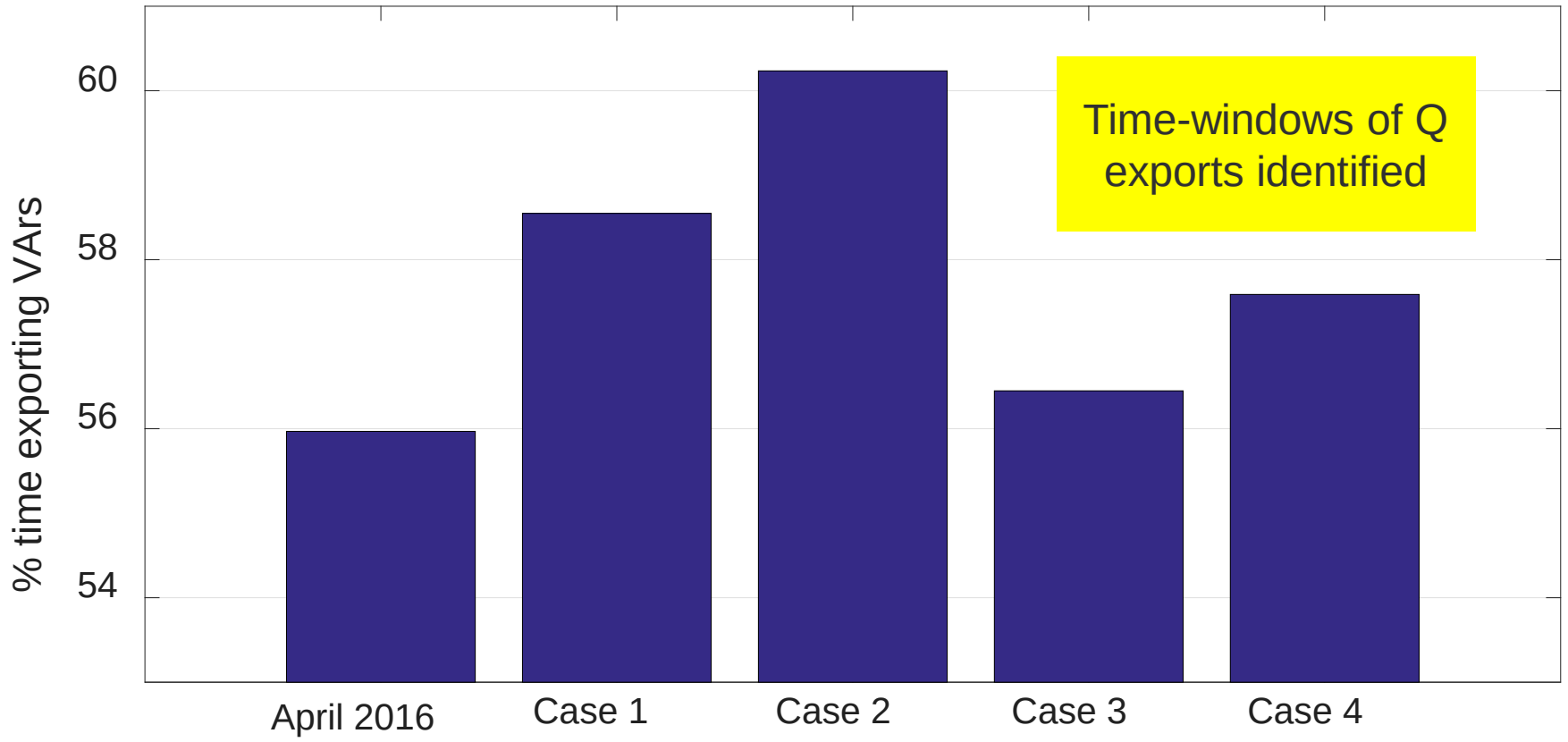


Duration of Q exports to transmission



Conclusions

Proposed methodology for long-term forecasting of Q demand using network modelling

Transition to business as usual using time-series modelling of the whole 132 to 33kV network in North West of England

Practical benefits from time-series network modelling

Time windows of VAr exports to transmission

Future trends in individual and groups of substations

Thank you for your attention! ☺

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