

Integrating Wind Power Plants control in Automatic Generation Control

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Abstract

This work emphasis on the integration of wind power plants (WPPs) into the automatic generation control (AGC) of the power system. The proposed coordinated control strategy between combined heat and power plants (CHPs) and WPPs is described and exemplified for the future Danish power system, where 50% of electricity production has to be supplied by wind power. The investigation results of the proposed control strategy shows that the WPPs can help actively the AGC and reduce the real time power imbalance in the power system by down regulating their production, when CHPs are unable to provide the required response.

Objective

- WPPs active participation in the secondary active power balance control
- Coordinated control strategy for the AGC between the CHPs and WPPs in order to improve the active power balance in the power system with minimum secondary dispatch cost
- Exemplify the proposed strategy on future power system with large scale integration of Wind power, e.g. the case of Danish power system as in 2020

Approach

- ❖ Power system model has been developed in the DigSilent power factory that includes dynamic features relevant for long term simulation studies
- ❖ Power system model includes aggregated models for CHP, DCHP and WPP, along with the interconnection with NORDEL and CE power systems
- ❖ SimBa, the hour-ahead power balancing model, provides the generation and exchange plan for the power system, where CHP, DCHP and interchange uses HA plan and WPP generates the available power
- ❖ Coordinated AGC controls the real time power imbalance by manoeuvring the set-points of CHP and WPP through secondary dispatch, if the HA wind power forecast differs from the available power

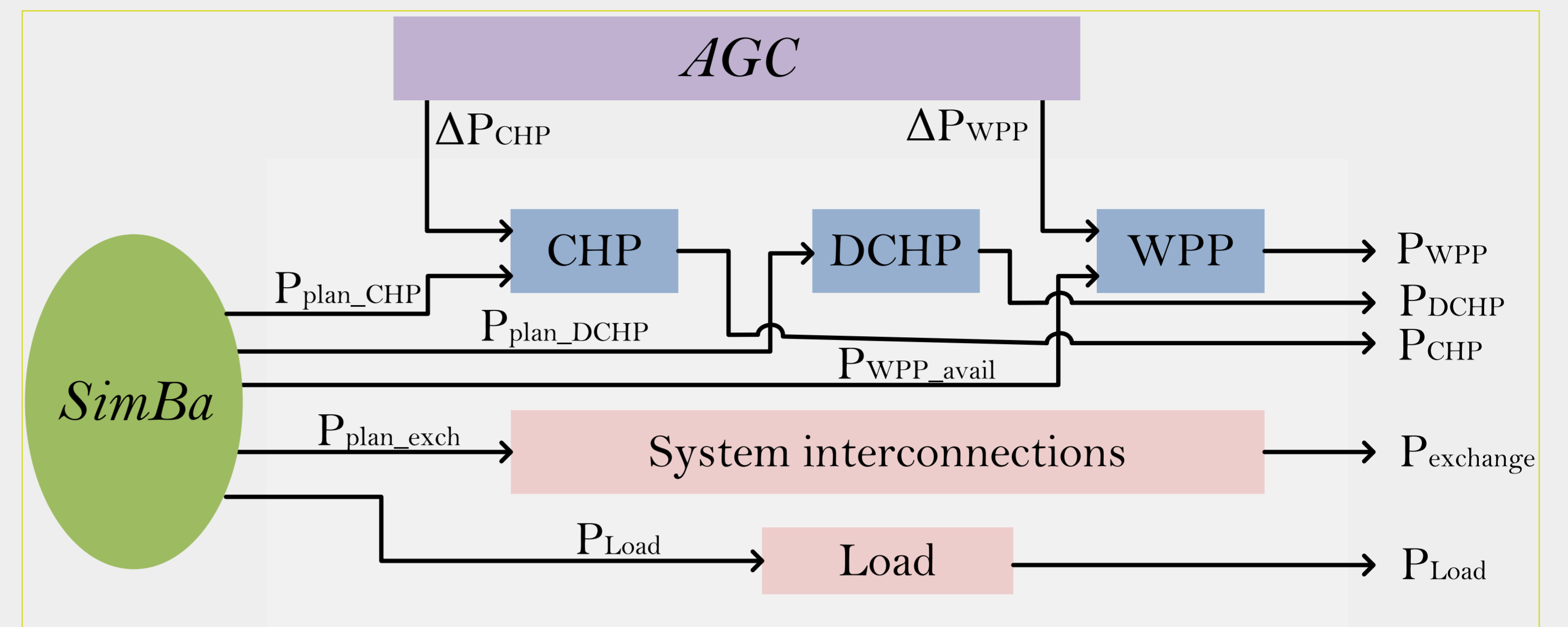


Figure 1: Inputs and Outputs of the Dynamic power system model

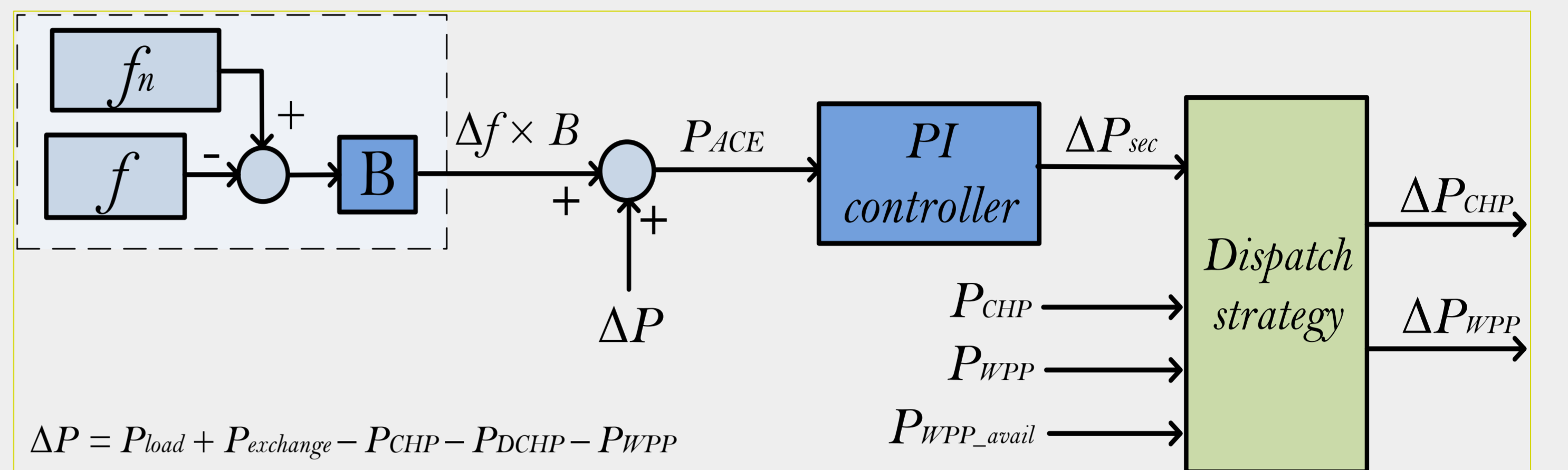


Figure 2: AGC and dispatch strategy model

Dispatch Strategy

if $\Delta P_{sec} \geq 0$

minimize $C = C_{P_{WPP}} \cdot \Delta P_{WPP} + C_{P_{CHP}} \cdot \Delta P_{CHP}$:: positive cost function

Subject to

$$\Delta P_{CHP} \leq \Delta P_{CHP_UpLim} (+90 \text{ MW})$$

$$P_{CHP} \leq P_{CHP_max}$$

$$\Delta P_{WPP} \leq P_{WPP_avail} - P_{WPP}$$

$$P_{WPP} \leq P_{WPP_avail}$$

if $\Delta P_{sec} < 0$

maximize $C = C_{P_{WPP}} \cdot \Delta P_{WPP} + C_{P_{CHP}} \cdot \Delta P_{CHP}$:: negative cost function

Subject to

$$\Delta P_{CHP} \geq \Delta P_{CHP_LowLim} (-90 \text{ MW})$$

$$P_{CHP} \geq P_{CHP_min}$$

$$P_{WPP} \leq P_{WPP_min}$$

where,

$C_{P_{WPP}}$ = Power generation cost from WPP

$C_{P_{CHP}}$ = Power generation cost from CHP

P_{WPP_min} = minimum generation level of WPP

P_{CHP_min} = minimum generation of CHP

P_{CHP_max} = maximum generation of CHP

Simulation Results – Eastern Denmark

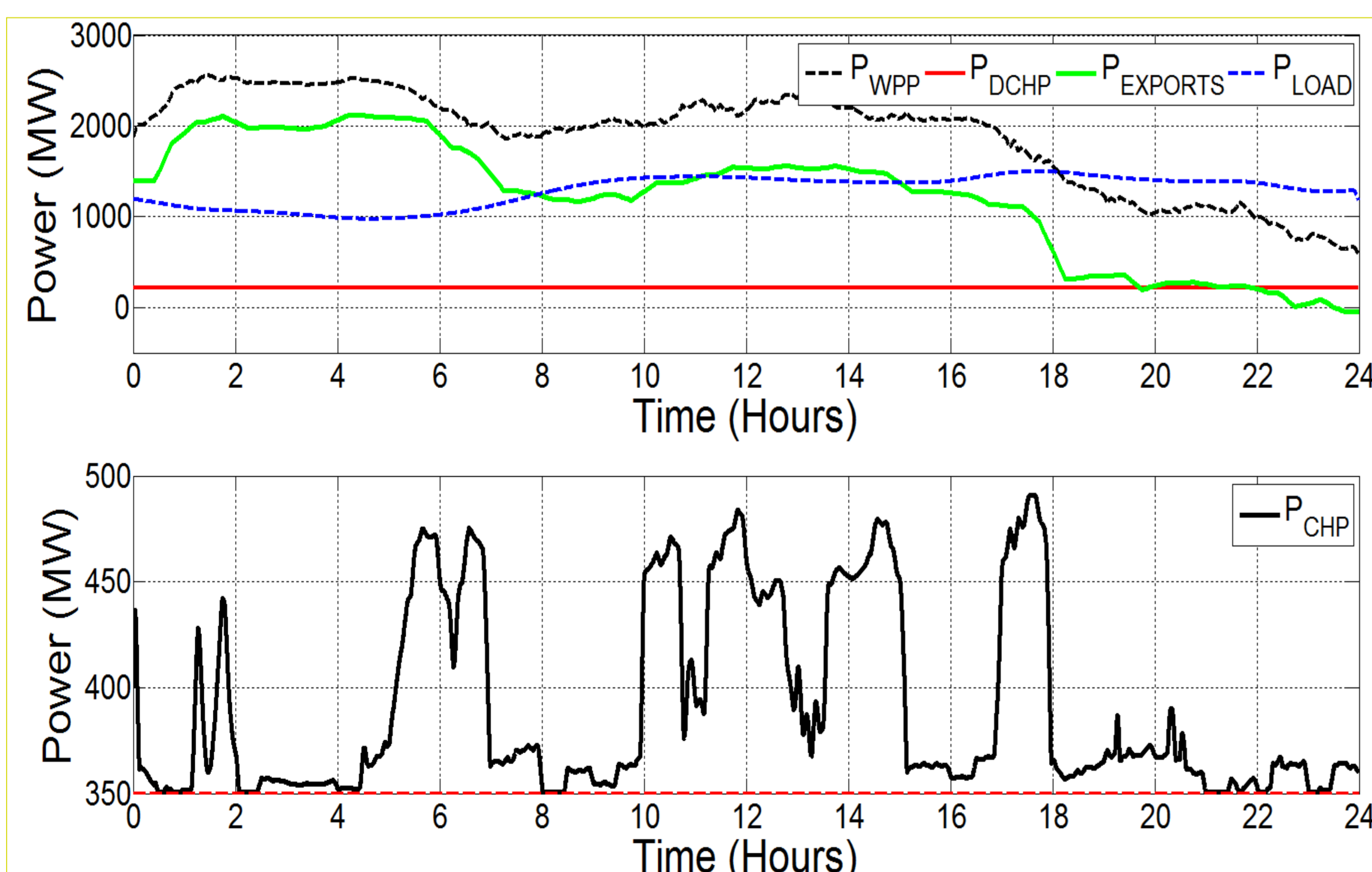


Figure 3: Eastern Denmark – Top: Wind Generation, DCHP Generation, Net Export Power and Load Demand; Bottom: CHP Generation

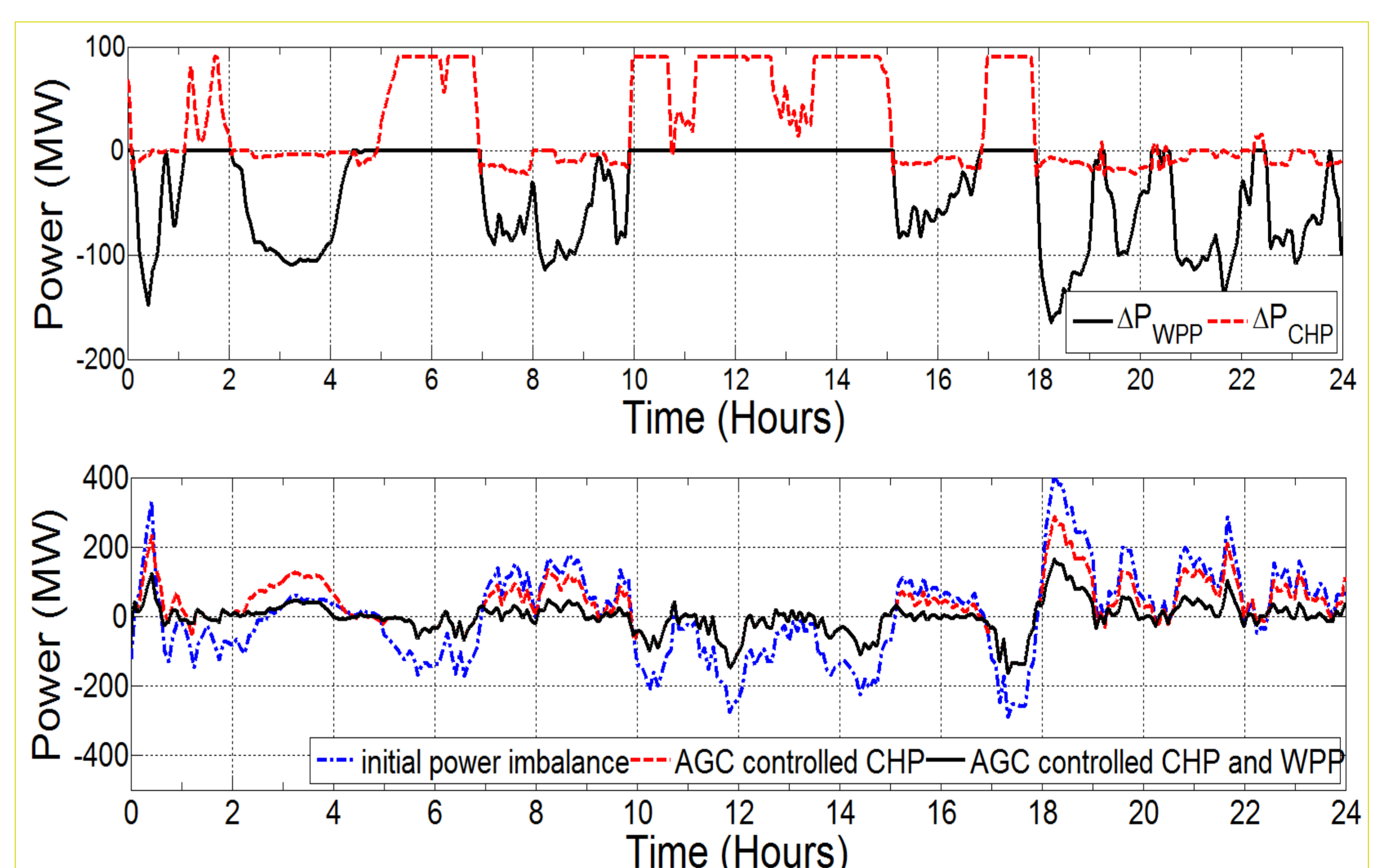


Figure 4: Eastern Denmark – Top: Secondary Dispatch; Bottom: Power Imbalance