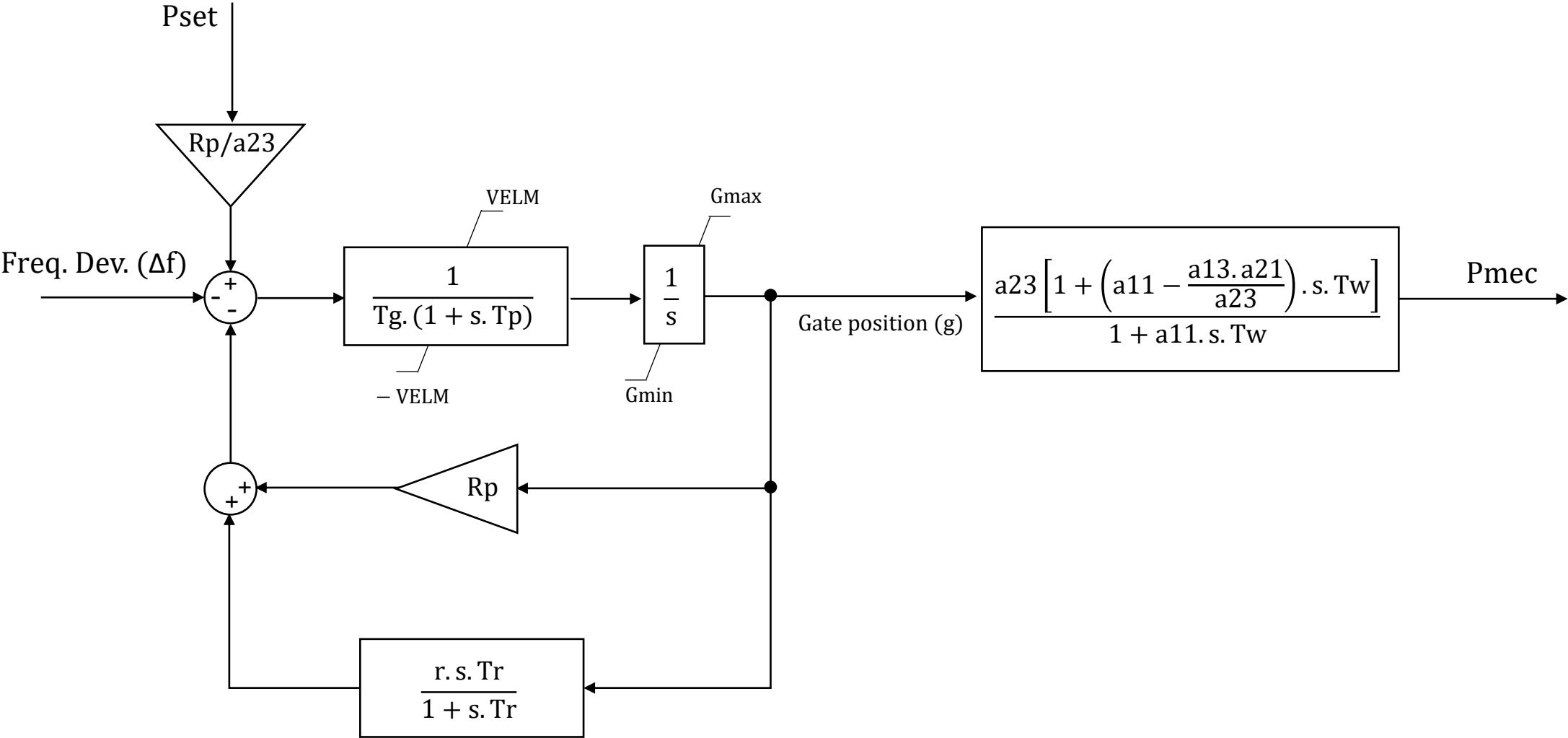


Grand Maison – Fixed speed model (with and without SPPS and HSC)*

Block Diagram for FCR and aFRR provision (based on IEEEG3 model)



* With and without SPPS and performing hydraulic short circuit (HSC)

Grand Maison – Fixed speed model (with and without SPPS and HSC)*

Input signals and output signals (based on IEEEG3 model)

Input signals:

- Δf – grid frequency deviation from setpoint, given by $f_{\text{grid}} - f_{\text{set}}$ (p.u.)
- P_{set} – active power setpoint (p.u.)

Output signals:

- P_{mec} – mechanical power (p.u.)

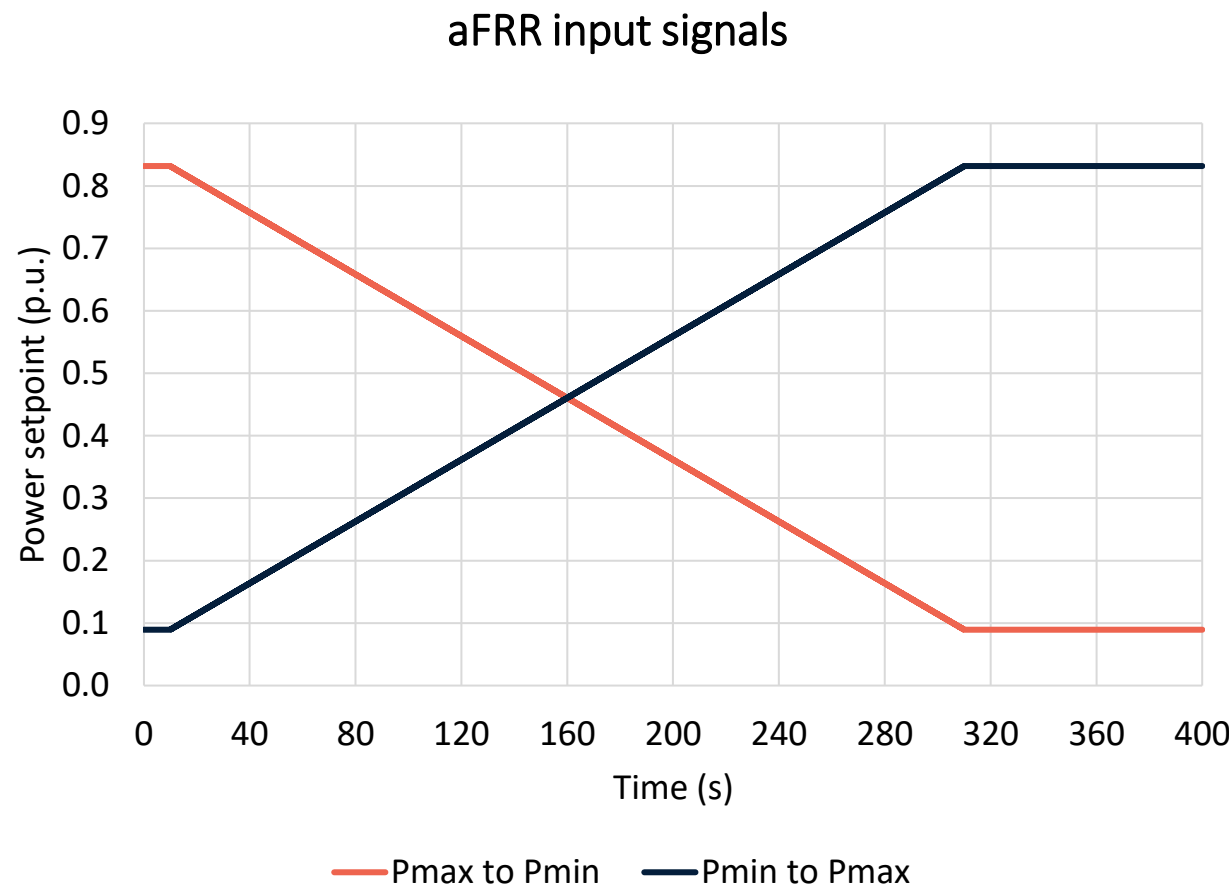
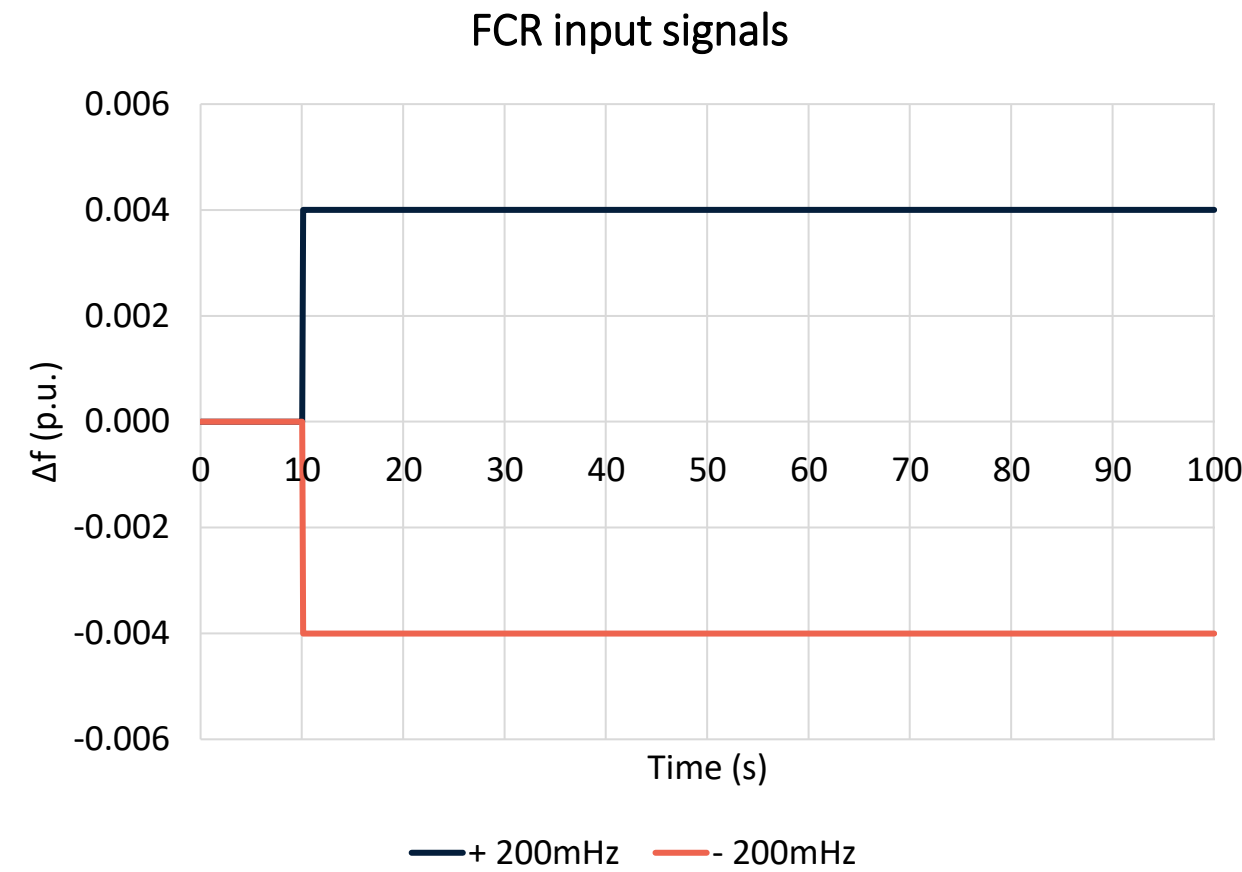
Parameters:

- R_p – permanent droop (p.u.)
- r – transient speed droop (p.u.)
- T_r – governor time constant (s)
- T_p – pilot value time constant (s)
- T_g – gate servomotor time constant (s)
- $VELM$ – gate velocity limit (p.u./s)
- T_w – water starting time constant (s)
- a_{11} , a_{13} , a_{21} and a_{23} – penstock coefficients
- G_{max} – maximum gate opening (p.u.)
- G_{min} – minimum gate opening (p.u.)

* With and without SPPS and performing hydraulic short circuit (HSC)

Grand Maison – Fixed speed model (with and without SPPS and HSC)*

FCR and aFRR input signals



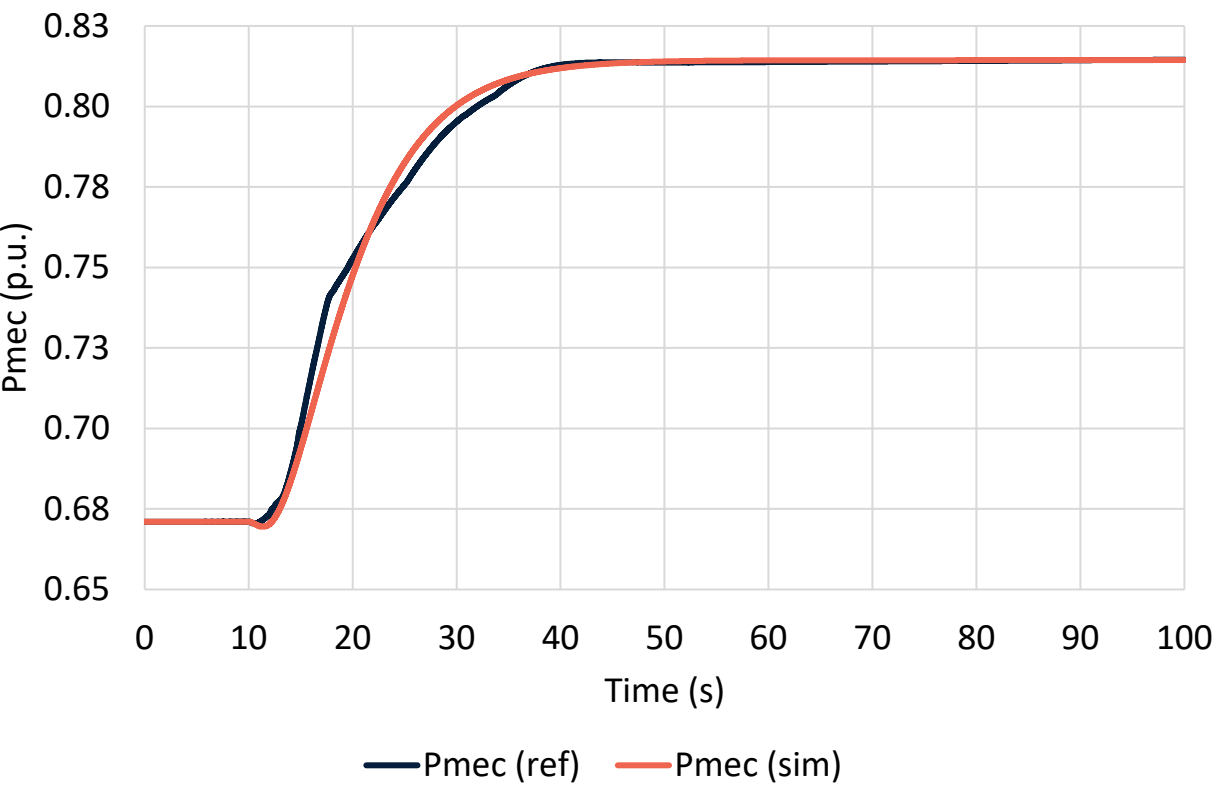
* With and without SPPS and performing hydraulic short circuit (HSC)

Grand Maison – Fixed speed model without SPPS

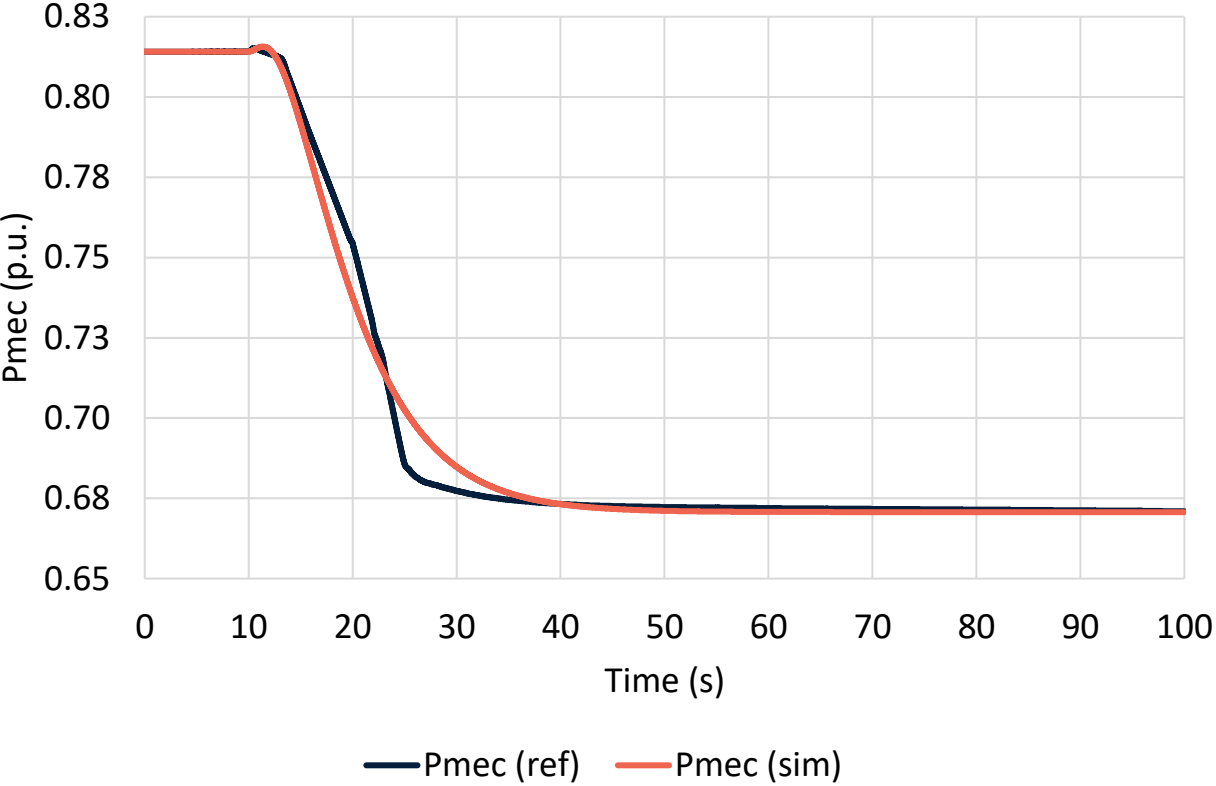
FCR service provision

Turbine mode

Frequency deviation: -200 mHz



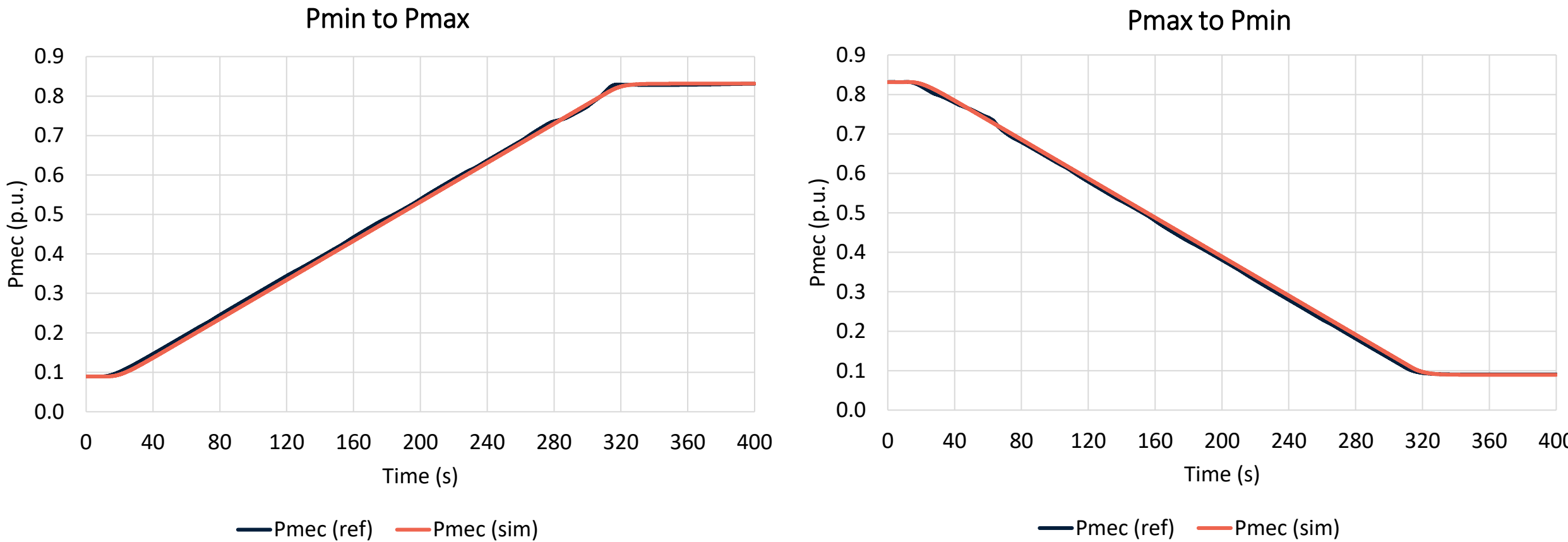
Frequency deviation: +200 mHz



Grand Maison – Fixed speed model without SPPS

aFRR service provision

Turbine mode



Grand Maison – Fixed speed model (with and without SPPS)

FCR service provision

Pump mode

No capability to comply with service requirements

Grand Maison – Fixed speed model (with and without SPPS)

aFRR service provision

Pump mode

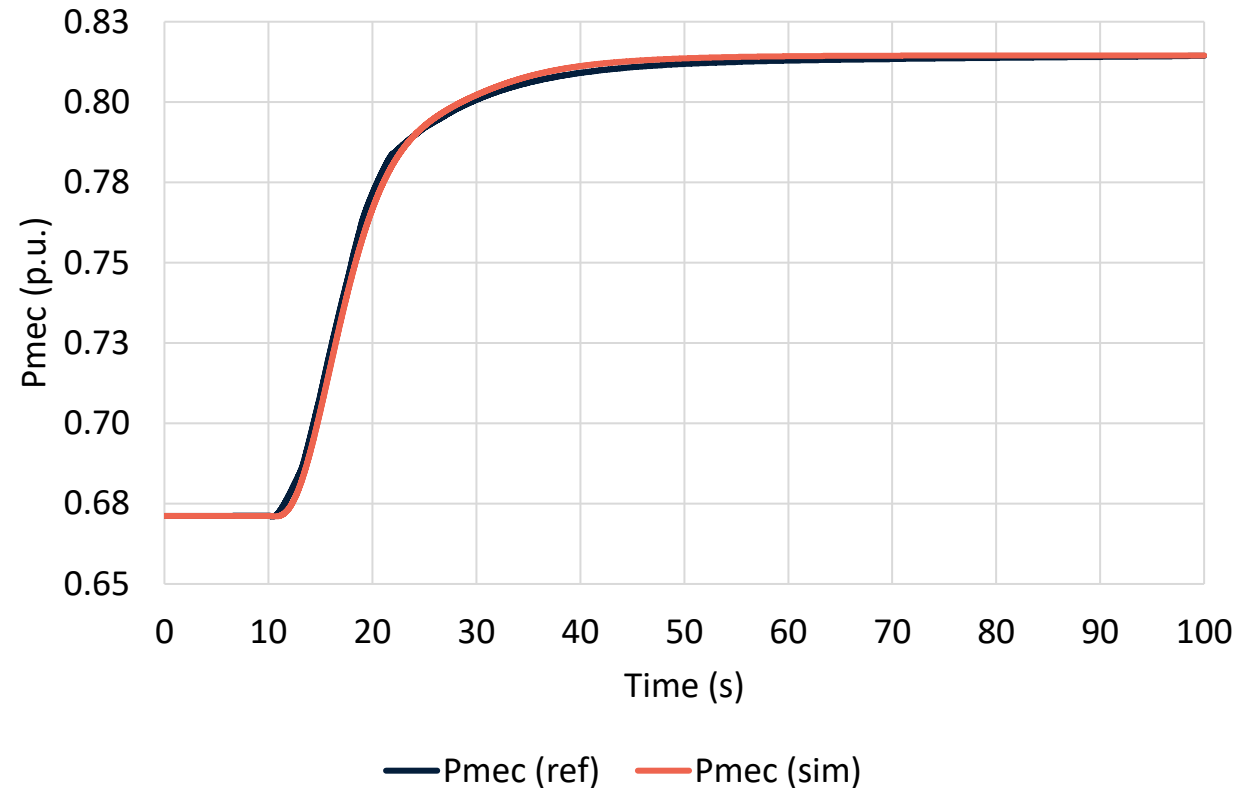
No capability to comply with service requirements

Grand Maison – Fixed speed model with SPPS and HSC*

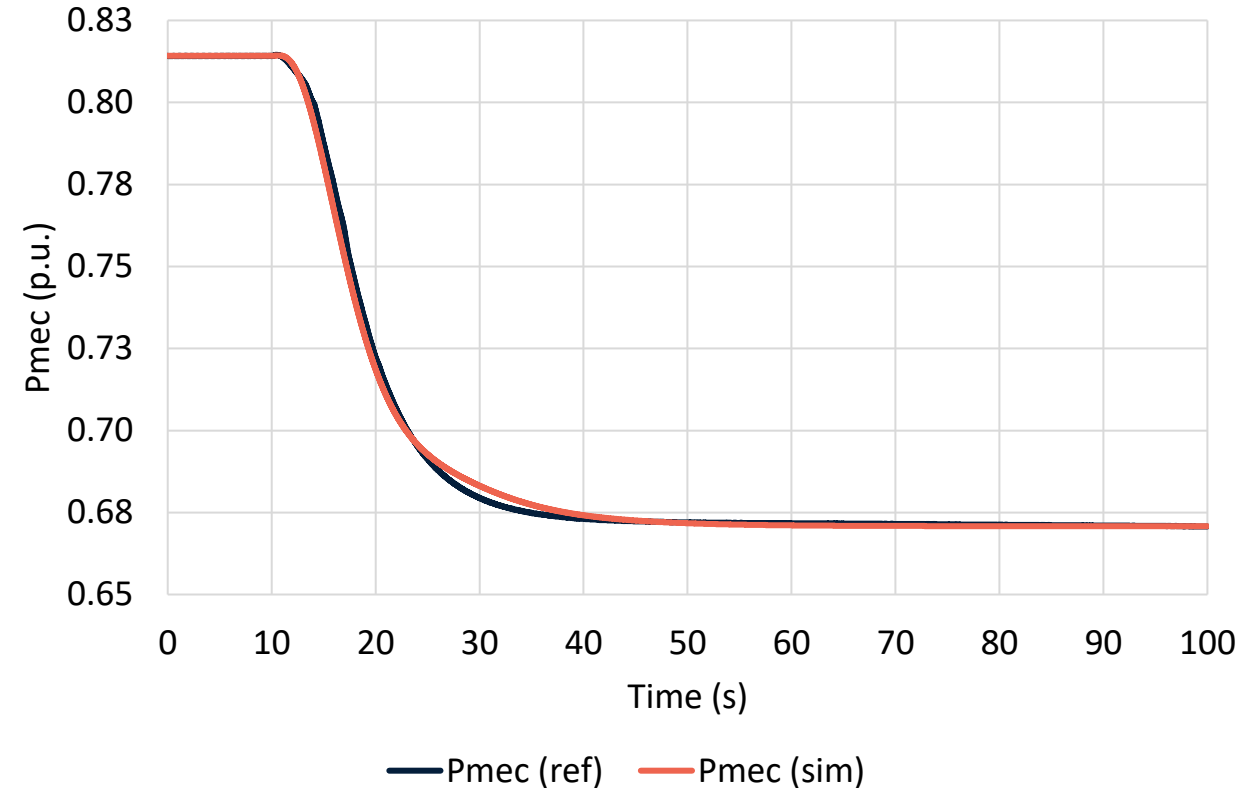
FCR service provision

HSC mode

Frequency deviation: -200 mHz



Frequency deviation: +200 mHz



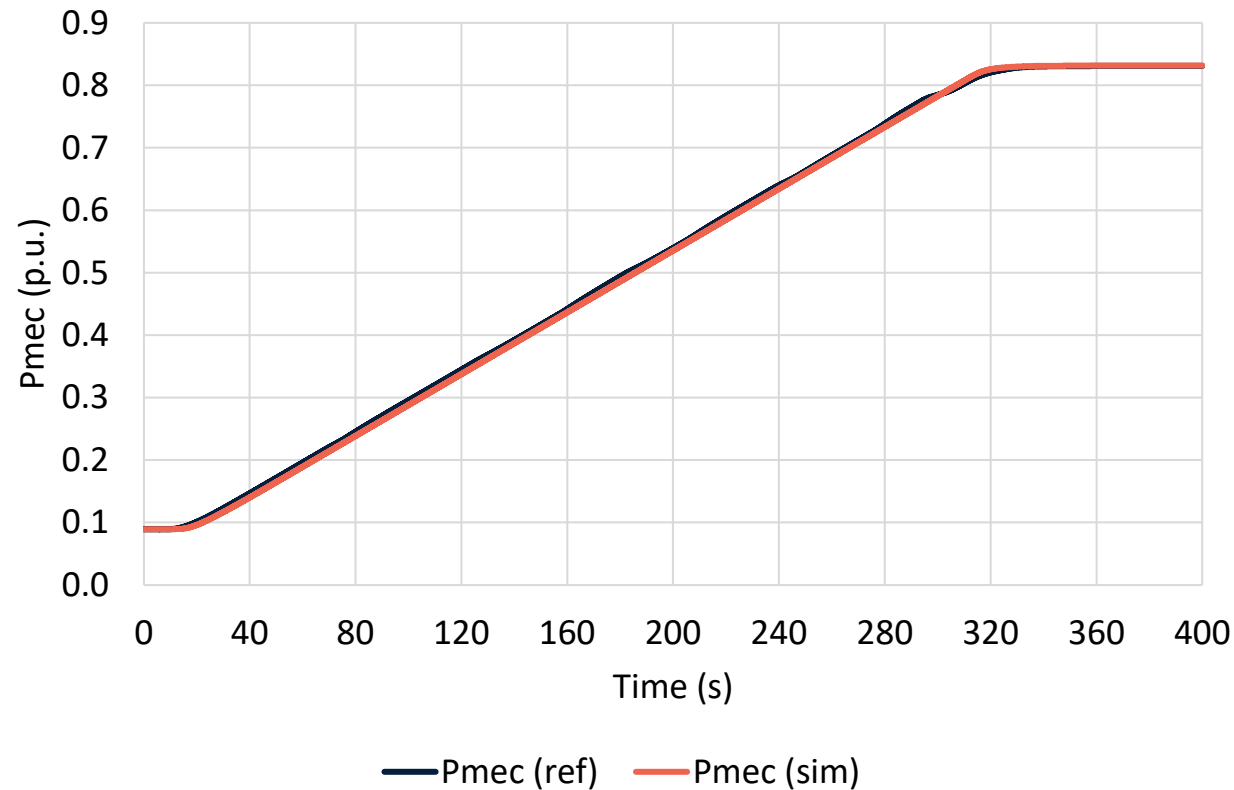
* Performing hydraulic short circuit (HSC)

Grand Maison – Fixed speed model with SPPS and HSC*

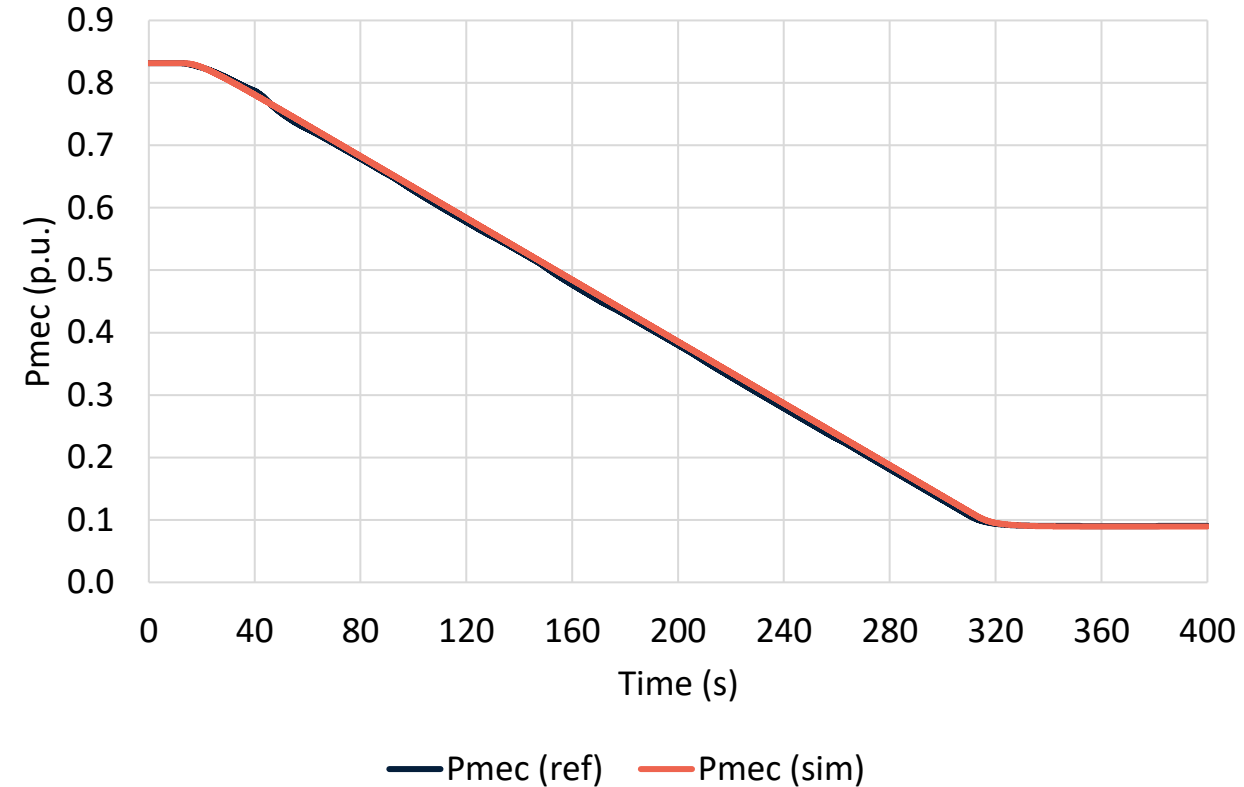
aFRR service provision

HSC mode

Pmin to Pmax



Pmax to Pmin



* Performing hydraulic short circuit (HSC)