

Energy storage unit as a tool for emergency control on an example of the Russky Island power network

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Rusky Island power network sketch

CHP-1 (Severnaya)

2 x 1,828 MW

CHP-2 (Centralnaya)

5 x 7,04 WM

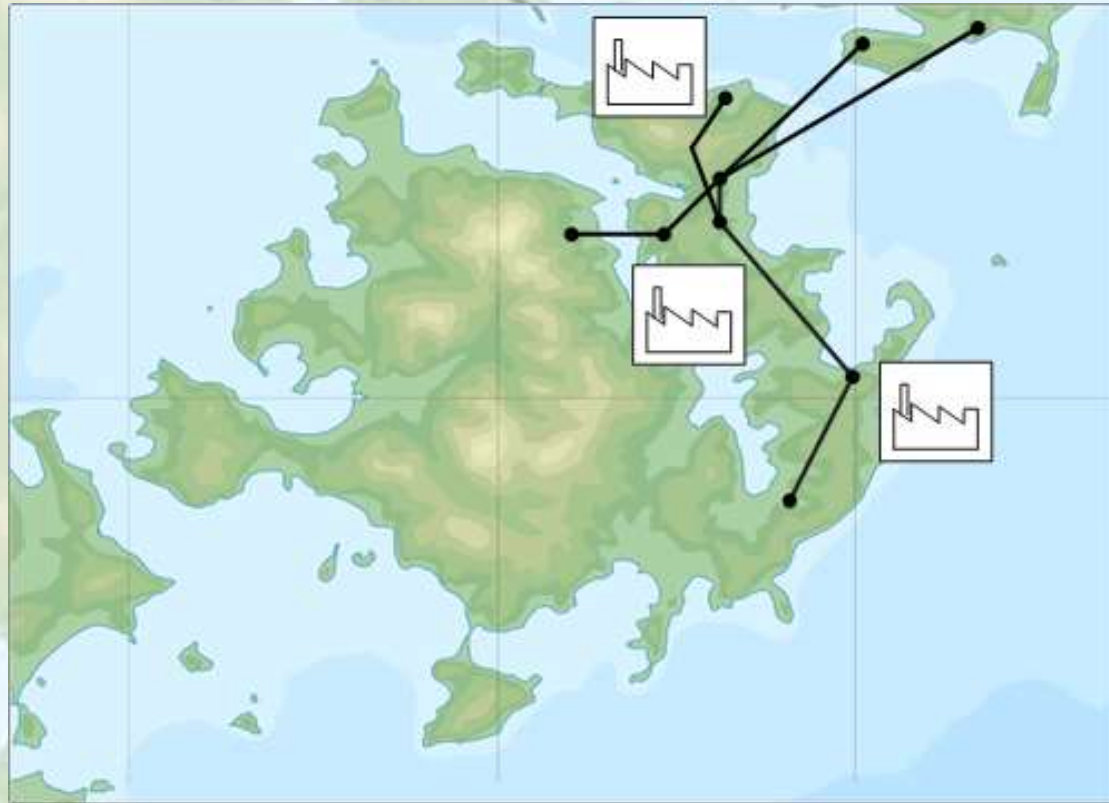
CHP-3 (Okeanarium)

2 x 7,04 MW

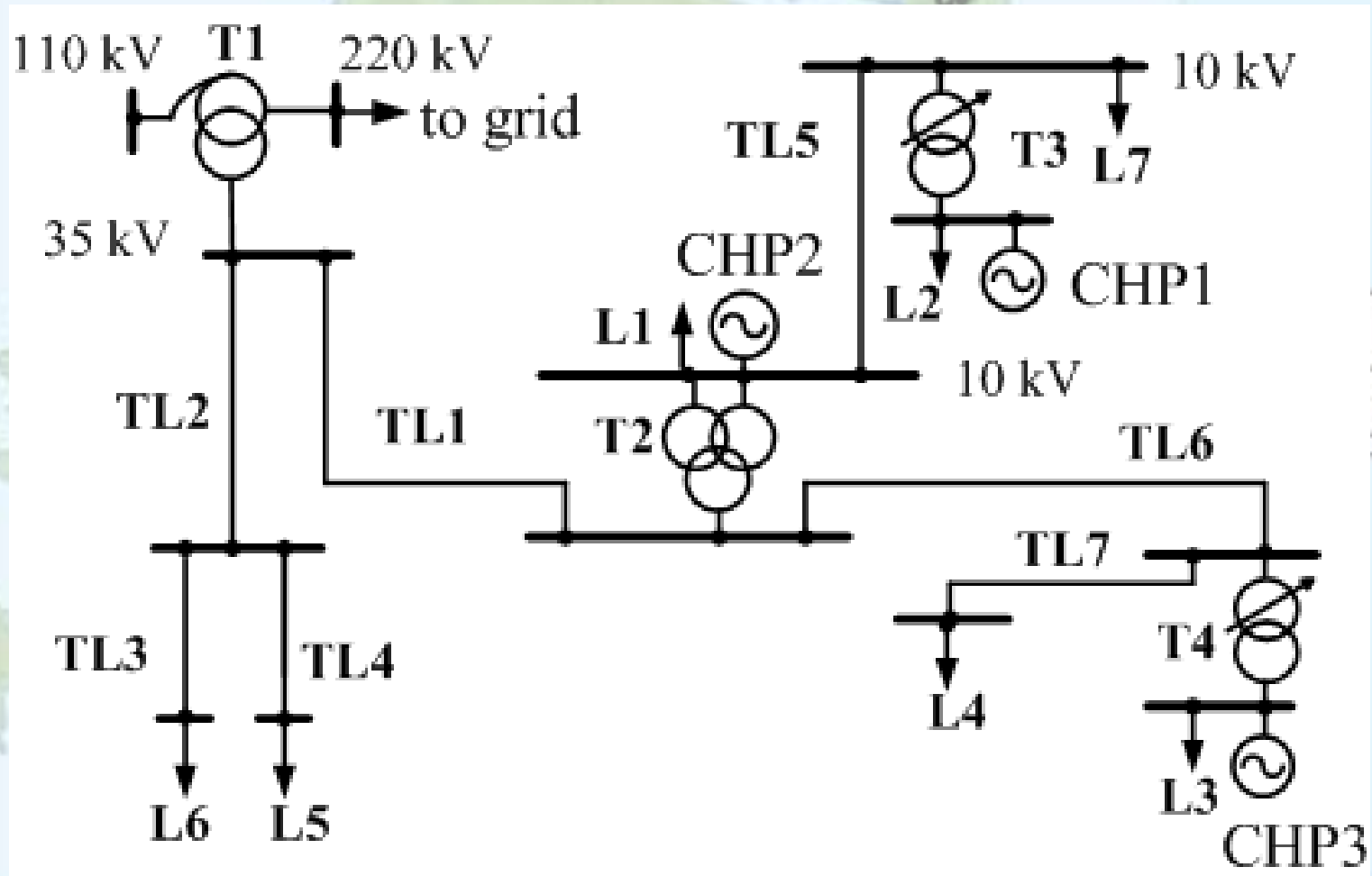
Transmission Lines - 7

Power Transformers - 4

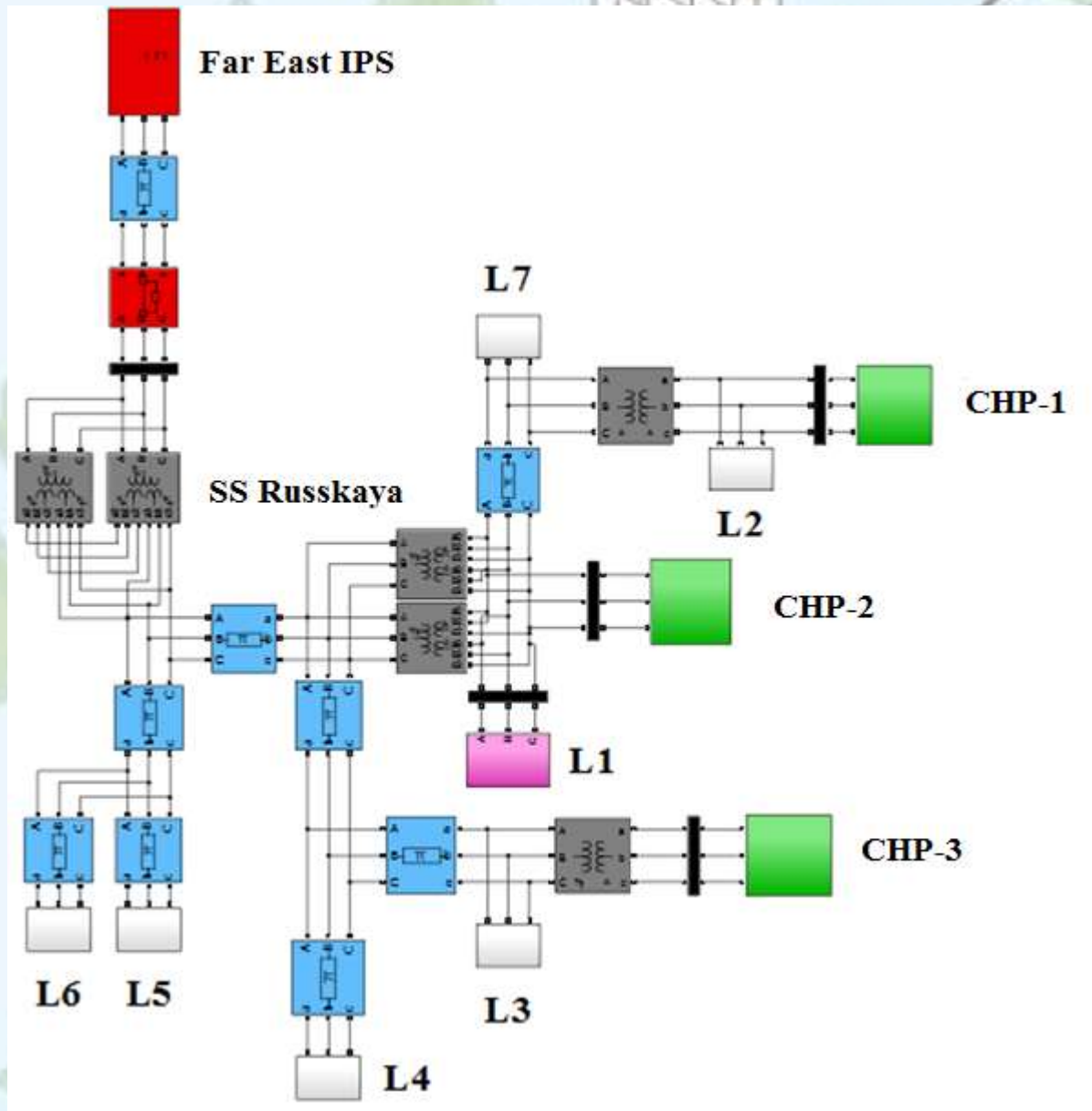
Load Nodes – 7



The current Russky Island power network scheme



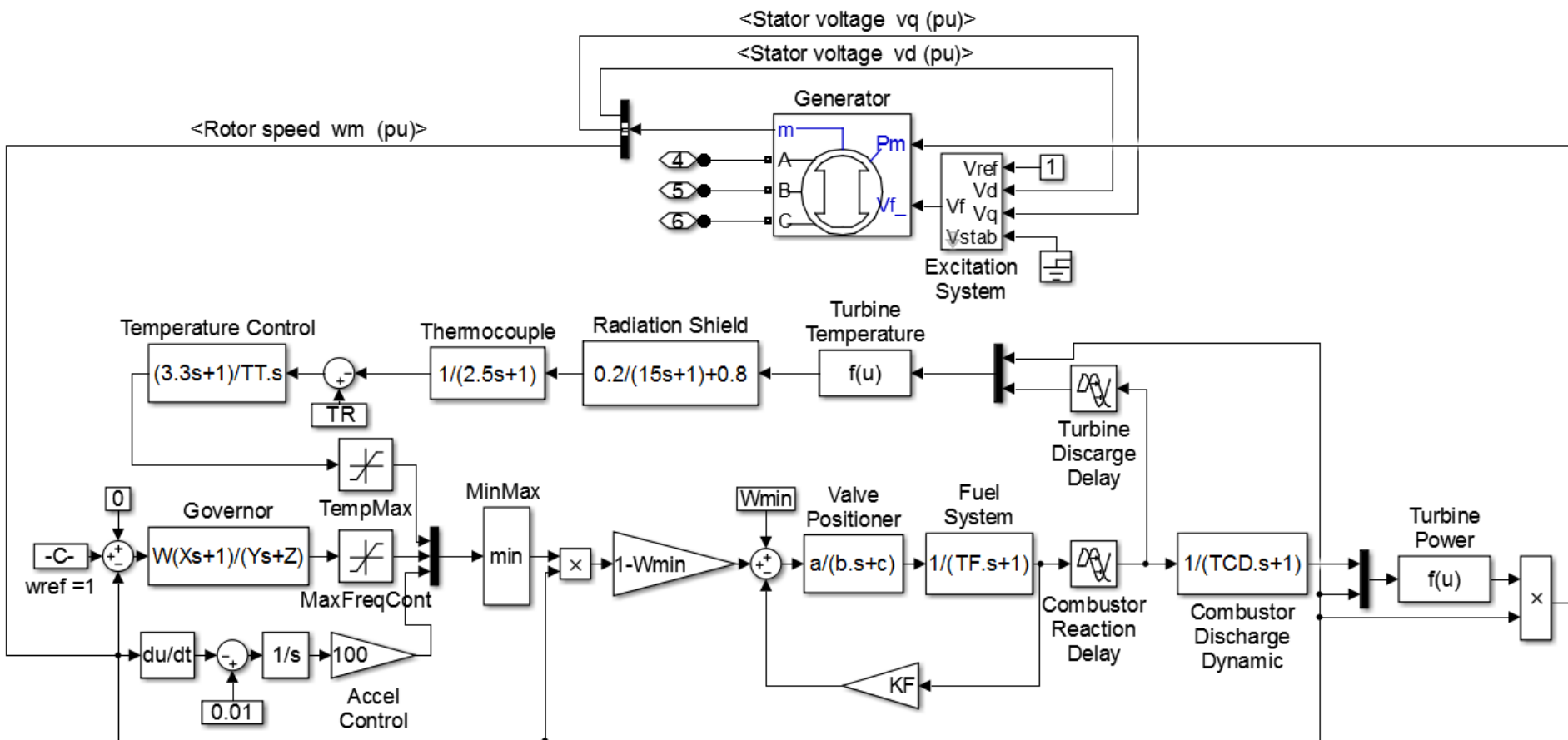
Calculation model



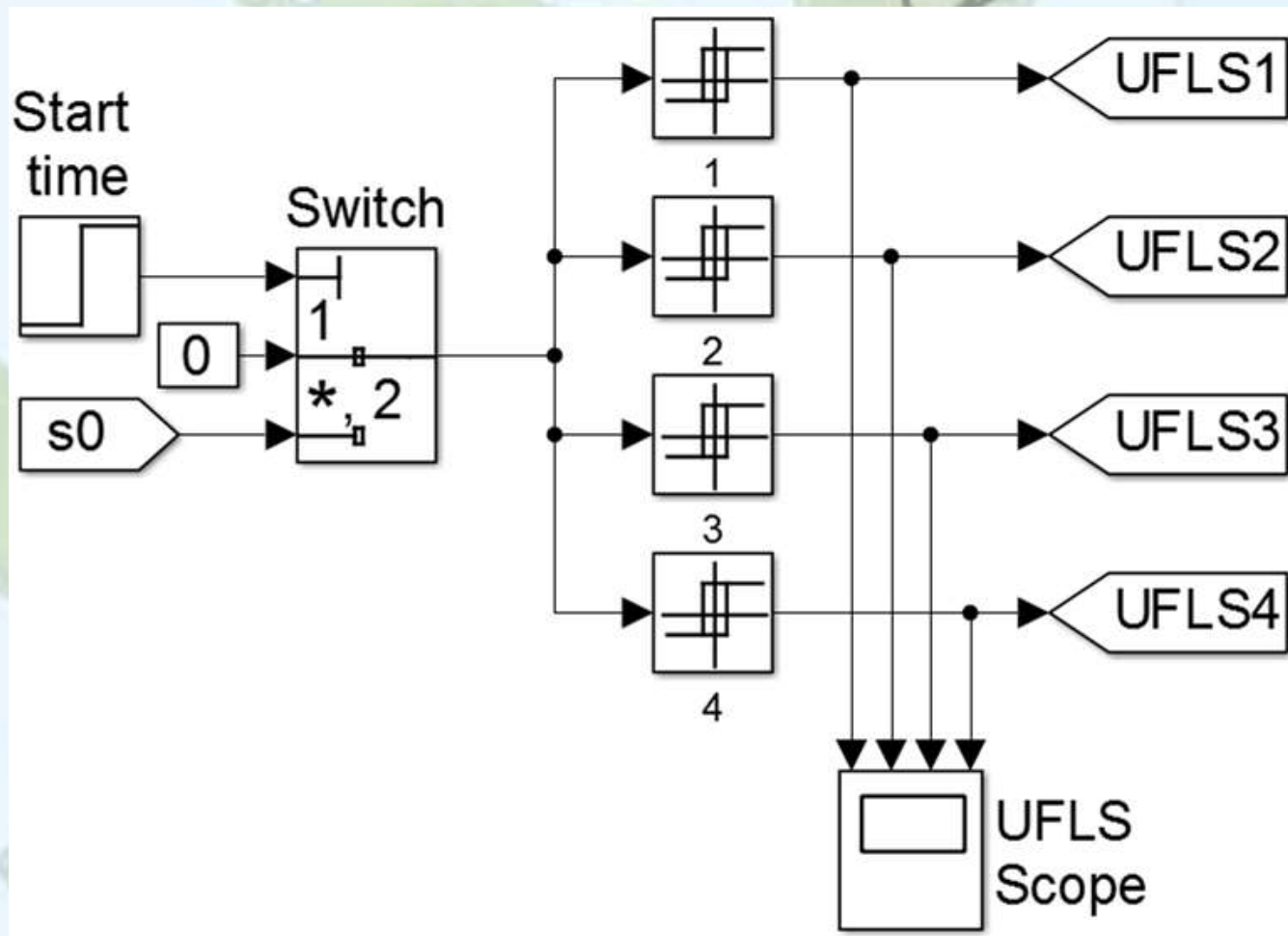
Parameters of the basic condition

Generation			Load	
Station	Installed power, MW	Operating power, MW	Node	Load power, MW
CHP-1 - G	2 x 1,828	2 x 1,828	L1	20,0
CHP-1 - D	2 x 1	0	L2	1,75
CHP-2 - G	5 x 7,04	3 x 7,04	L3	7,0
CHP-2 - D	2 x 1	0	L4	2,38
CHP-3 - G	2 x 7,04	1 x 7,04	L5	3,0
CHP-3 - D	2 x 1	0	L6	8,0
Total, MW	58,9	31,8	L7	2,5
			Σ	44,6
Import, MW			12,8	

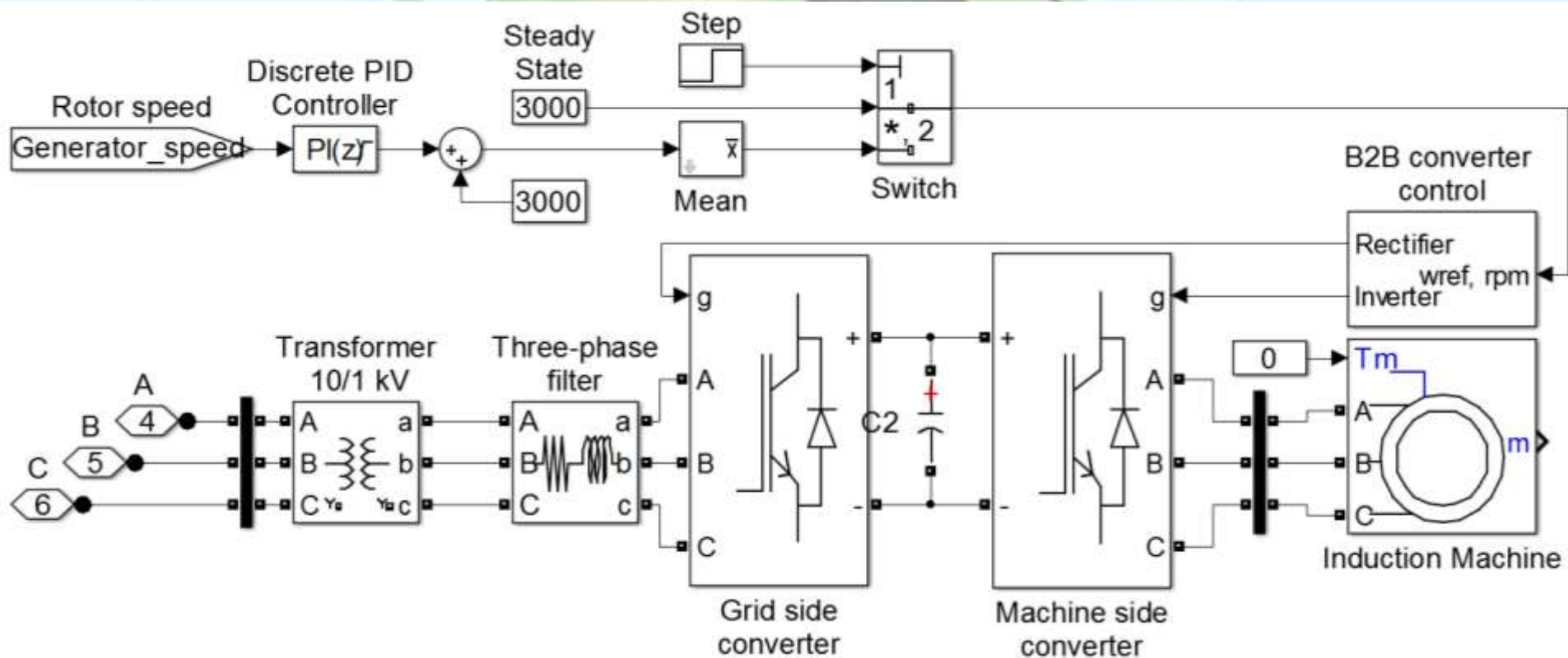
Generator and Rowen's gas turbine models



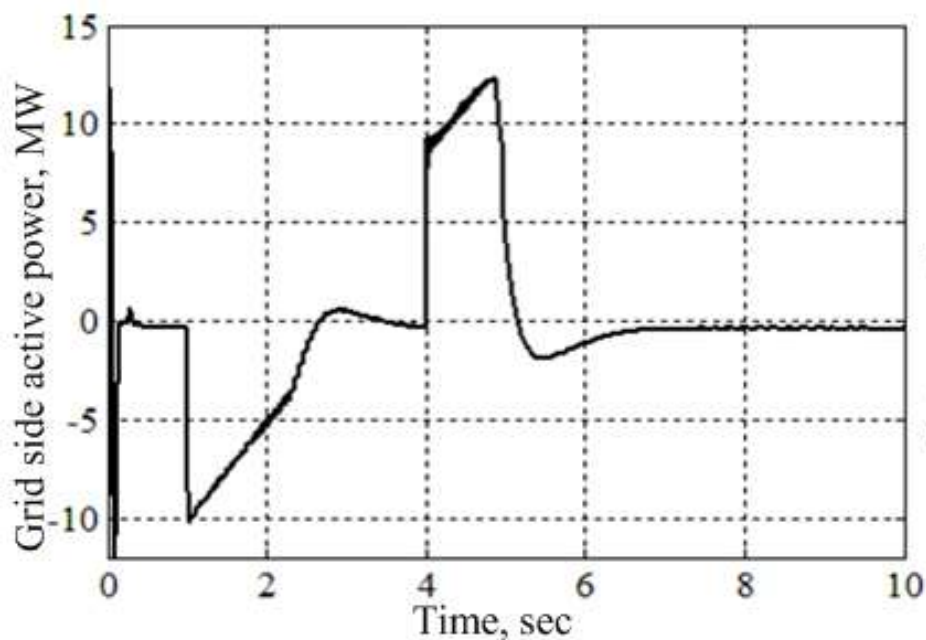
UFLS Simulink model



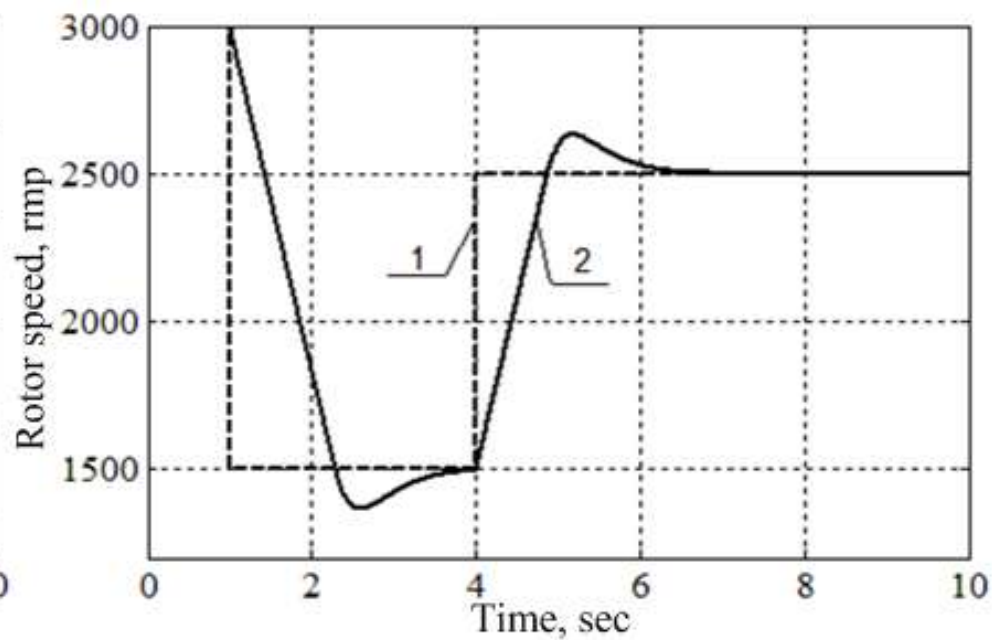
Flywheel energy storage model



Flywheel energy storage response



Produced (negative) and consumed (positive) FESS active power

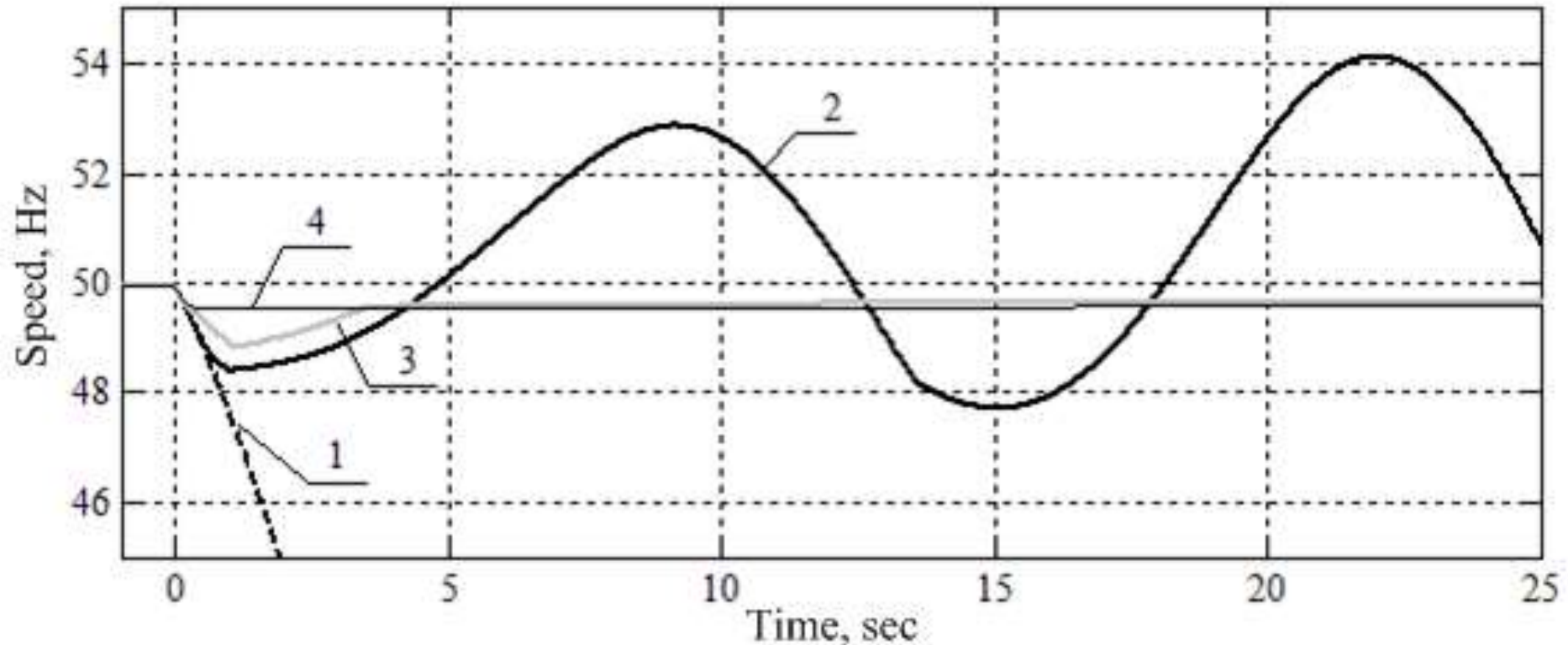


FESS response to a speed reference change: 1 – speed reference, 2 – actual speed

Computational experiments

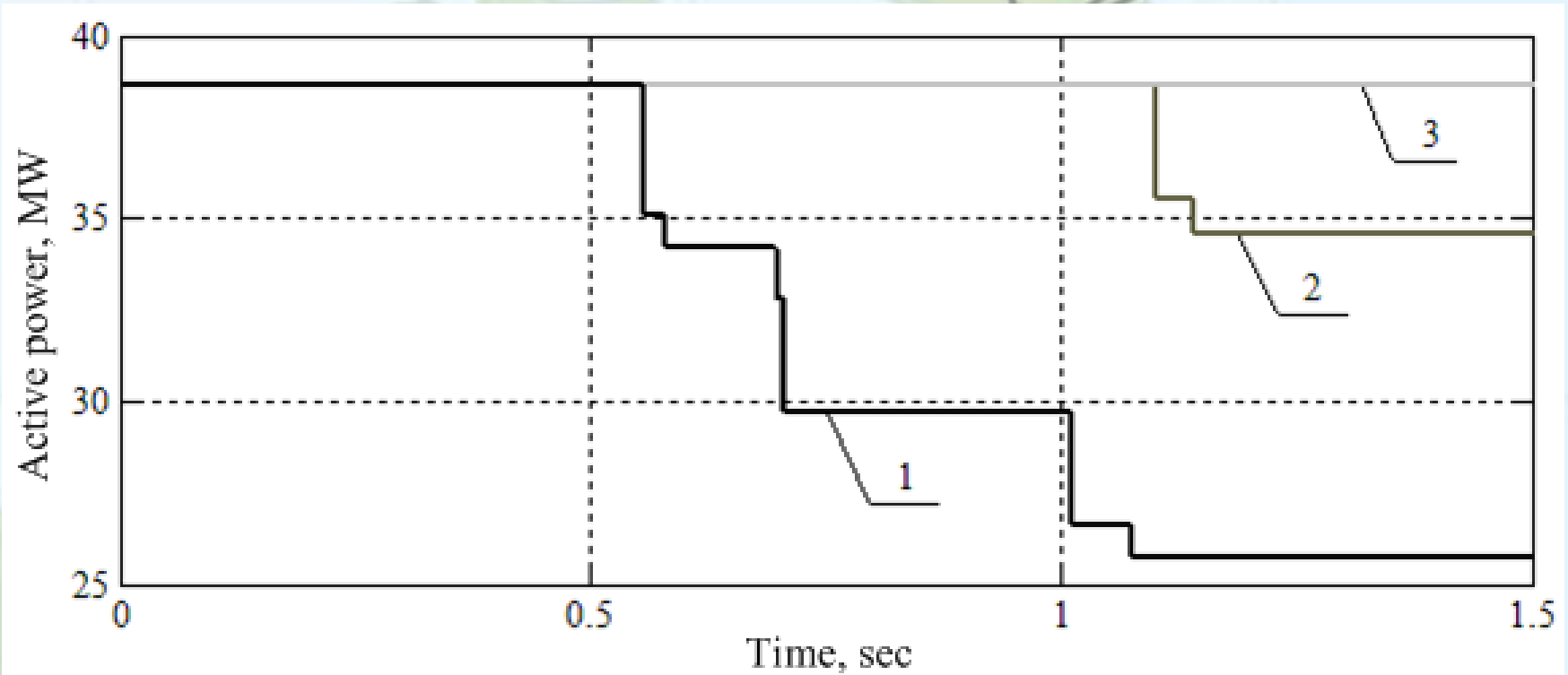
- Investigation of the effect of Flywheel energy storage action in the Russky Island power network with emergency disconnection from the Far East Interconnected Power System
- Investigation of the effect of Flywheel energy storage action in the Russky Island power network to the allowable automatic reclosing dead time

Changing the rotation speed of generator rotor (Island work)



1 – without control actions, 2 – UFLS action, 3 – UFLS + ES=6 MW action, 4 – UFLS + ES=14 MW action

UFLS Action (Island work)



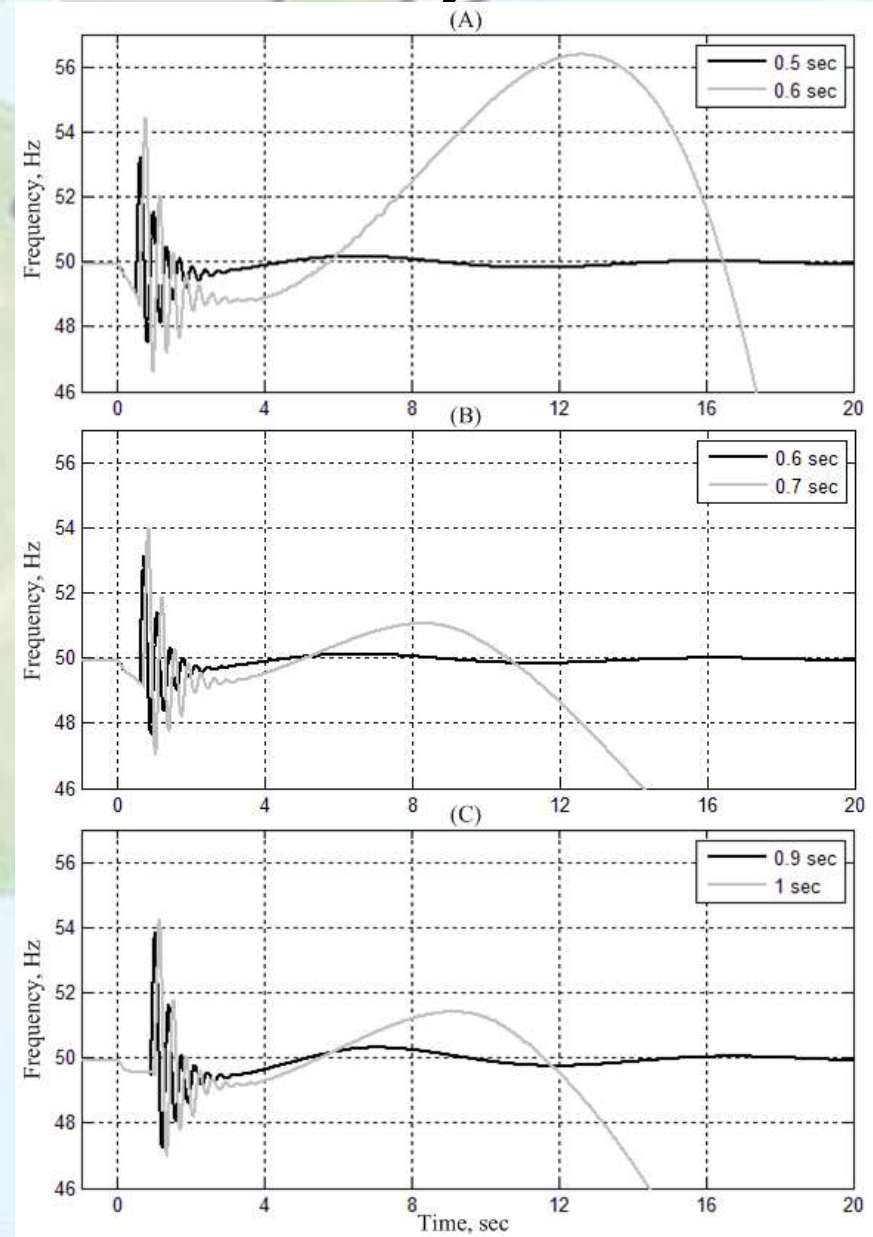
1 –UFLS action, 2 – UFLS + ES=6 MW action, 3 – UFLS + ES=14 MW action

Rotation speed of the generator rotor (Successful reclosure)

Without control actions

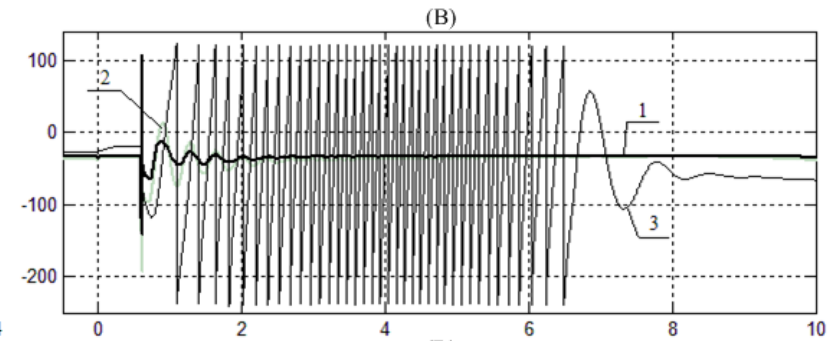
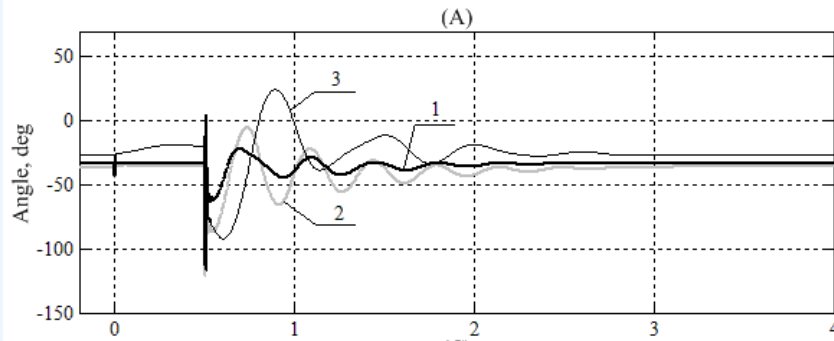
Flywheel energy storage power
6 MW action

Flywheel energy storage power
14 MW action

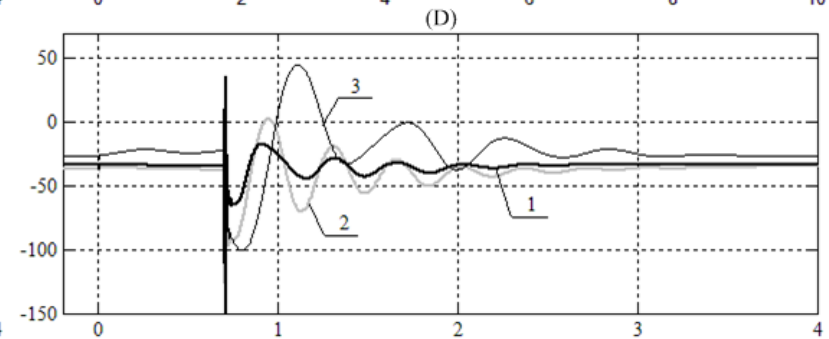
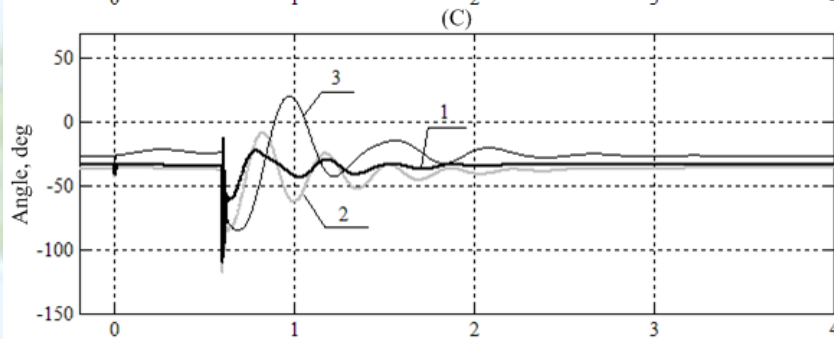


Angle differences with successful reclosure

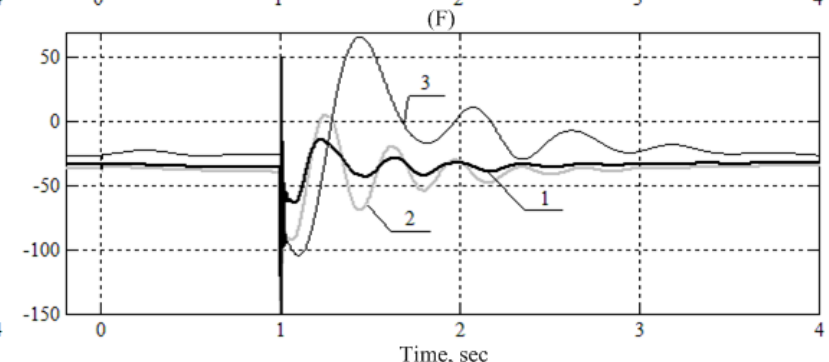
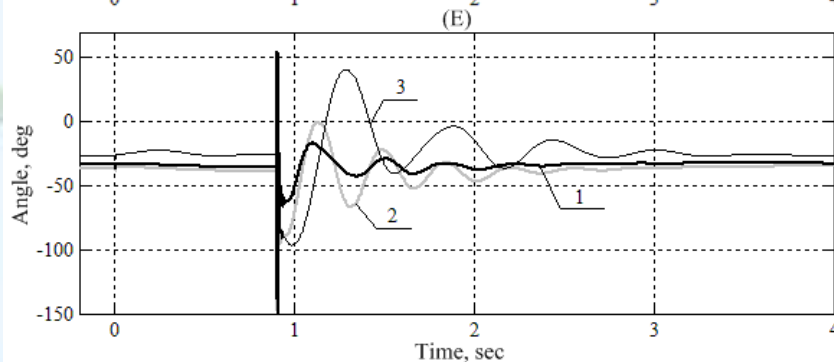
Without
control
actions



FES power
6 MW
action



FES power
14 MW
action



Conclusion

- ✓ UFLS can pass with less tripping electricity consumers as result of emergency control with using the energy storage
- ✓ Energy storages increase the allowable automatic reclosing dead time

Directions of further research

- ✓ Trapeznikov's Institute of Control Sciences RAS has offered a new method named by sub-Gramian's method that can be used for improvement of assessment of small-system stability analysis in power grid
- ✓ Study with sub-Gramian's method of the Russky Island Power Network stability will become the next step in this work



Thank you for your attention

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