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“Stability and Control of Microgrids”

Abstract. With the advances in power electronic technologies inverter-based autonomous power grids become a natural choice for independent power supply. Such small-scale grids are usually referred to as microgrids. Proper control of such grids, especially the implementation of power sharing and voltage support is a challenge when the system is in an off-grid mode. One of the natural choices is to organize control of such microgrids in a way similar to conventional power systems expecting that all the methods employed for secure control of power systems can be directly transferred to microgrids.

In the present work we show that there is a distinct qualitative difference between large-scale power systems and microgrids and that in most cases the rules for stability of microgrids are exactly the opposite to those known for decades in large power systems with many aspects of microgrids stability being counterintuitive at the first glance. We specifically explore the interaction of modes with different timescales and show that the fast transient (mostly electro-magnetic phenomena) play essential role in the dynamics of slower modes. We present a systematic procedure for proper model order-reduction and present a physical description of interaction of modes with different timescales.

Besides the microgrids, other projects realized under the MIT-Energy Systems CREI collaboration will be briefly discussed:

- Electro-mechanical oscillations source identification;
- New methods for approaching the frequency stability problem in power systems;
- Real-time load composition restoration.

Bio. Petr Vorobiev obtained a PhD degree in theoretical physics from Landau Institute RAS in 2010 (supervisor Vladimir V. Lebedev). His thesis was dedicated to dynamic phenomena in composite systems, mainly to interaction of electromagnetic field with nano-structured media.

For the period of 2010 to 2013 Petr has been a postdoctoral associate at Landau Institute and at the same time held the position of The Deputy of "Physics and Technology of Nanostructures" Chair at the Departments of General and Applied Physics of Moscow Institute of Physics and Technology. Since 2015 he is a postdoctoral associate at MIT Mech E department.

Since 2014 he was involved in research in the field of power systems, mainly, but not limited to, the stability and control of power systems. The scope of his interests incorporates the fields of power systems small signal stability, advanced methods of frequency control, proper modelling and control of microgrids, dynamic load model identification.

Besides the research activities Petr is extensively involved in Skoltech education process and has co-developed and delivered three courses, namely: "Physics and Technology of Energy Systems", "Intro to Power Systems" and "Electric Machinery".