



Croatian TSO activities and projects related to Smart Grids

Damjan Medimorec, M.Sc.

Assistant CEO for Institutional and International Affairs

HEP-Operator prijenosnog sustava d.o.o. (HEP-OPS)

***Workshop for preparation of Croatian Technology
Platform for Cooperative RES and Smart Grids***



TRANSITION OF CROATIAN LEGAL FRAMEWORK FOR ENERGY (ELECTRICITY)

- 3 main steps – as a follow up of EU Energy “packages” (Energy Act, Energy Regulation Act, Electricity Market Act, Gas Market Act) :
 1. 2001 - HEP-Transmission and CROISMO (ISO)
 2. 2004 (and 2007) – HEP-OPS (TSO) and HROTE (MO)
 3. 2012/2013 – HOPS (ITO) and HROTE
- New Electricity Market Act (aligned with EU 3rd package) came into force on 2nd March 2013

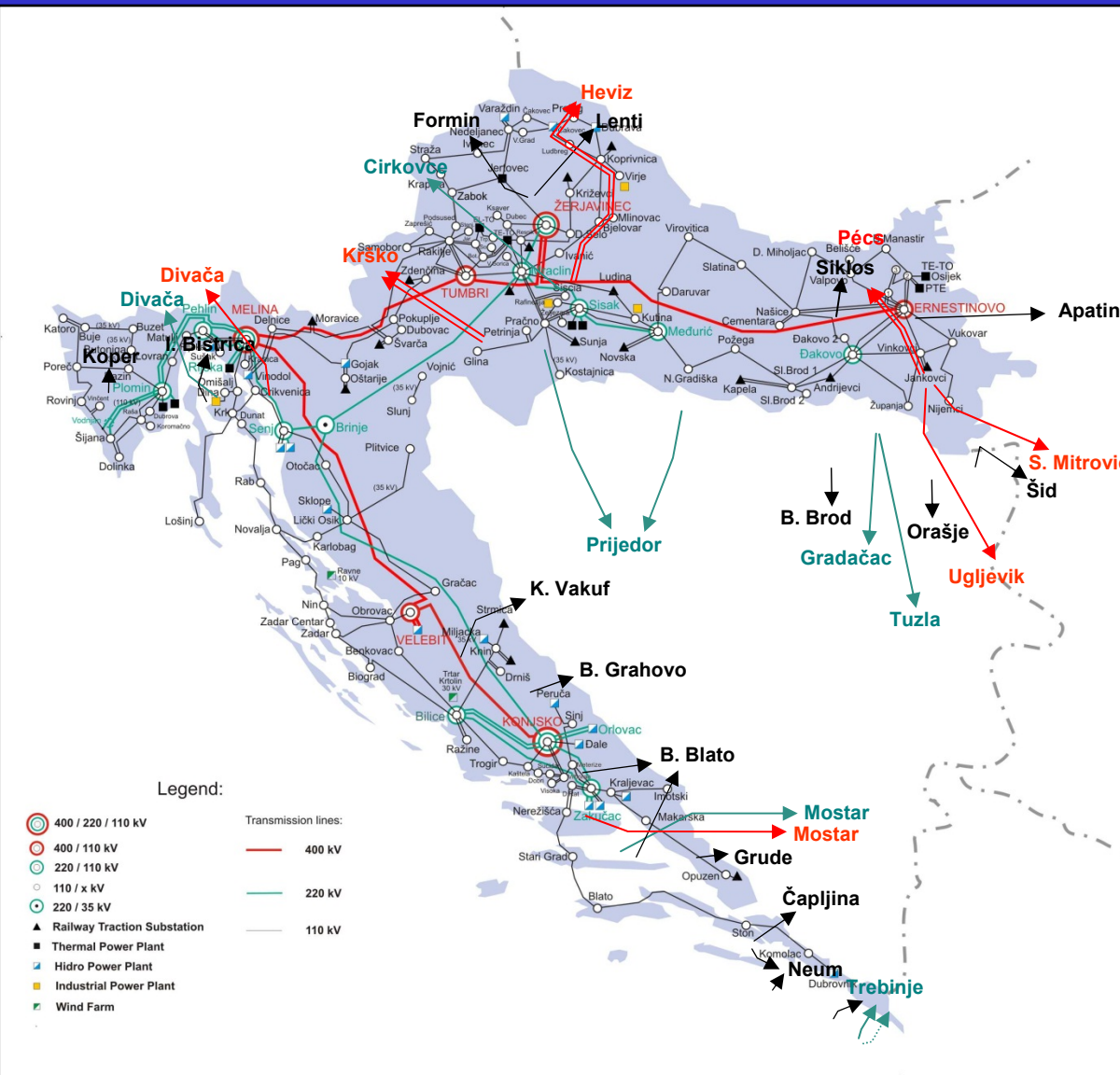


MAIN NEW LEGAL OBLIGATIONS FOR CROATIAN TSO

- Transformation with transfer of assets according to ITO model
- ITO certification - aimed to be launched during summer 2013
- Update & completion of by-laws
- Completion of Power system control modernisation project
- Large-scale RES (mainly wind) grid and system integration
- Refurbishment of ageing transmission facilities and new construction to enhance SoS and market integration
- Establishment and development of Croatian power exchange (together with HROTE) and realisation of market coupling
- Continuing participation and active role in European TSO associations, initiatives and companies, as well as other relevant EU and regional co-operation (projects etc.)



HEP - OPERATOR PRIJENOSNOG SUSTAVA d.o.o. CROATIAN ELECTRIC SYSTEM



Peak load: **3193 MW**

Total demand: **17.5 TWh**

(Domestic) Installed generation capacities: **4268 MW**

HPPs – 49 %

TPPs – 47 %

Wind+other RES – 4 %

Total generation : **9,9 TWh**

Note: Data as of 31st December 2012

Voltage level	Line length (km)	Substation (number)	Installed transform capacity (MVA)
400	1.247	5	4.100
220	1.273	6	2.120
110	4.828	122	4.961
MV	203	-	-
TOTAL	7.488	133	11.181



CROATIAN TSO AND SMART GRIDS (1)

- Different angle than from "last mile" service provider (only 11 customers directly connected to Croatian transmission grid)
- Transmission metering system and remote control already have full coverage for number of years
- Additional advanced features to make them "smarter" are in different phases of implementation, particularly through EMS/SCADA modernisation project, but also in framework of RES integration and asset management (e.g. condition based maintenance)
- Resources for R&D limited for number of reasons, therefore only a few projects could be considered somewhat as "pilot" projects:
 - through co-operation with Croatian (National) Scientific Foundation /WAMS – Wide Area Monitoring System/
 - through co-operation with TSO community (ENTSO-E) in FP7 framework (Pegase – see summary on following slides)



CROATIAN TSO AND SMART GRIDS (2)

- As founding member of ENTSO-E (2008), HEP-OPS is witnessing development of dedicated ENTSO-E R&D activities following its obligations related to R&D from 3rd EU energy package, set out in ENTSO-E R&D Roadmap 2013-2022
- HEP-OPS is aiming to take more active role in upcoming preparation of new ENTSO-E Implementation Plan (for 2015-2017)
- HEP-OPS is open for R&D co-operation on national, regional and EU level including smart grids topics that are in its responsibility, provided financing is secured following regulatory approval or through other sources
- Possible additional topics related to smart grids (including eventual pilot/demonstration/lighthouse projects) :
 - Energy storage
 - Power load control
 - Improved defense and restoration plan
 - ...



R&D Pegase project

– participation of HEP OPS

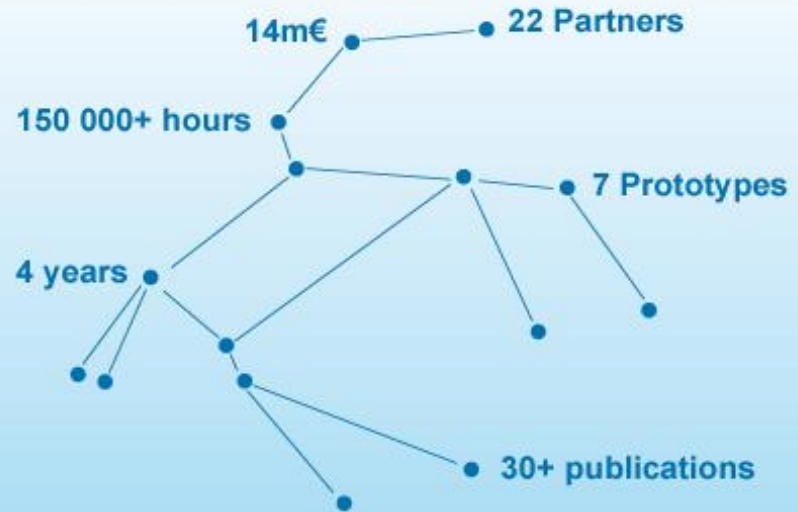
- Motivation for HEP OPS participation was to get in touch with new technologies and the latest achievements in power system applications development
- For consortium it was important to have TSO-s in order to test on real problems and situations
- HEP OPS participated for the first time in FP7 projects
- FP7 platform proved to be an excellent opportunity for R&D project cooperation of universities, TSO-s and other companies (particularly efficient way for including small TSOs)



FP7 Pegase project facts

The PEGASE project has produced new tools to enhance the cooperation among transmission system operators for the real-time control and operational planning of the Pan-European transmission network. New powerful algorithms and full-scale prototypes have been developed that run the whole European Transmission Network model for state estimation, dynamic security analysis, steady state optimization and dispatcher training simulator.

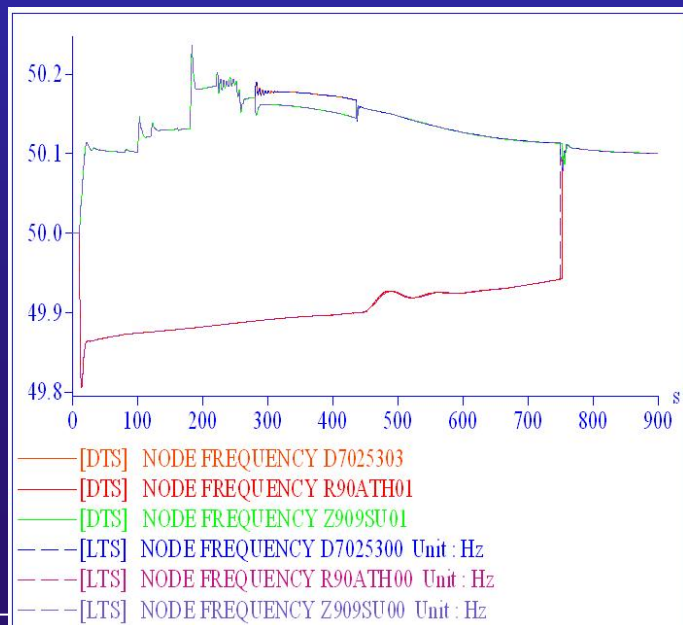
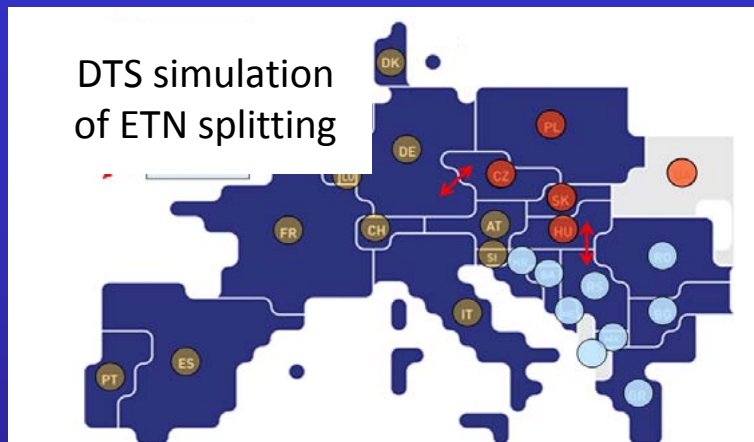
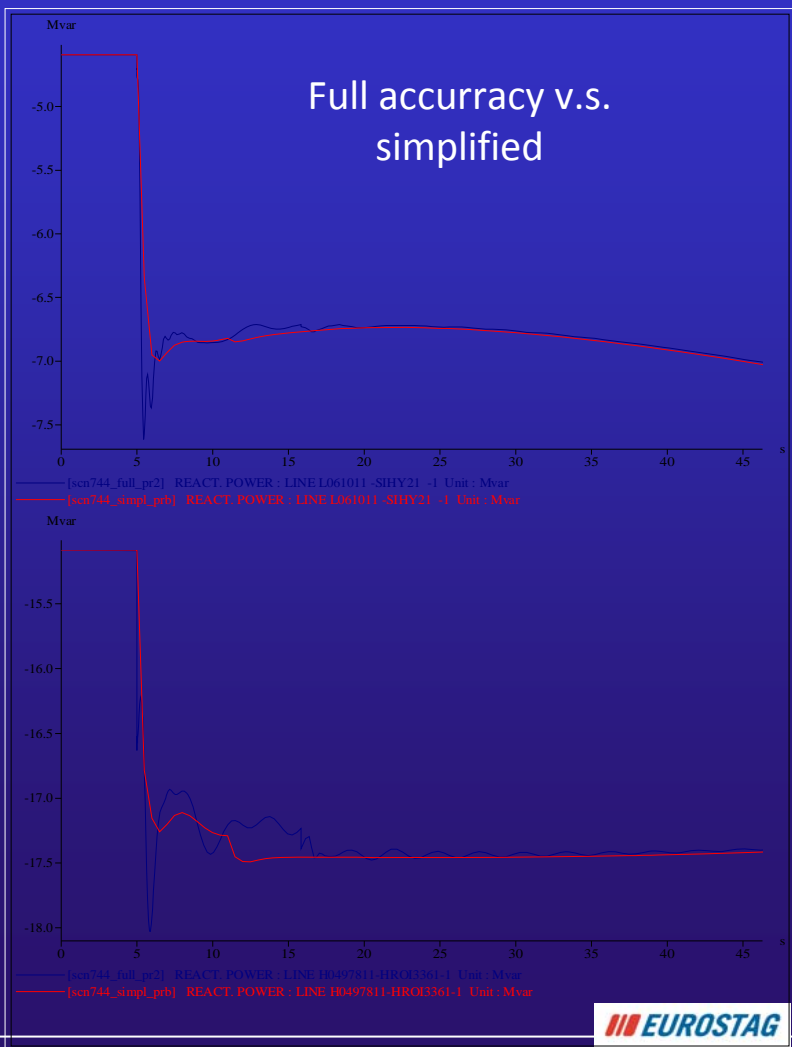
PEGASE is a four-year R&D project funded by the 7th Framework Program of the European Union. It is implemented by a consortium composed of 22 Partners which includes Transmission System Operators (TSOs), expert companies and leading research centres in power system analysis and applied mathematics.



www.fp7-pegase.eu

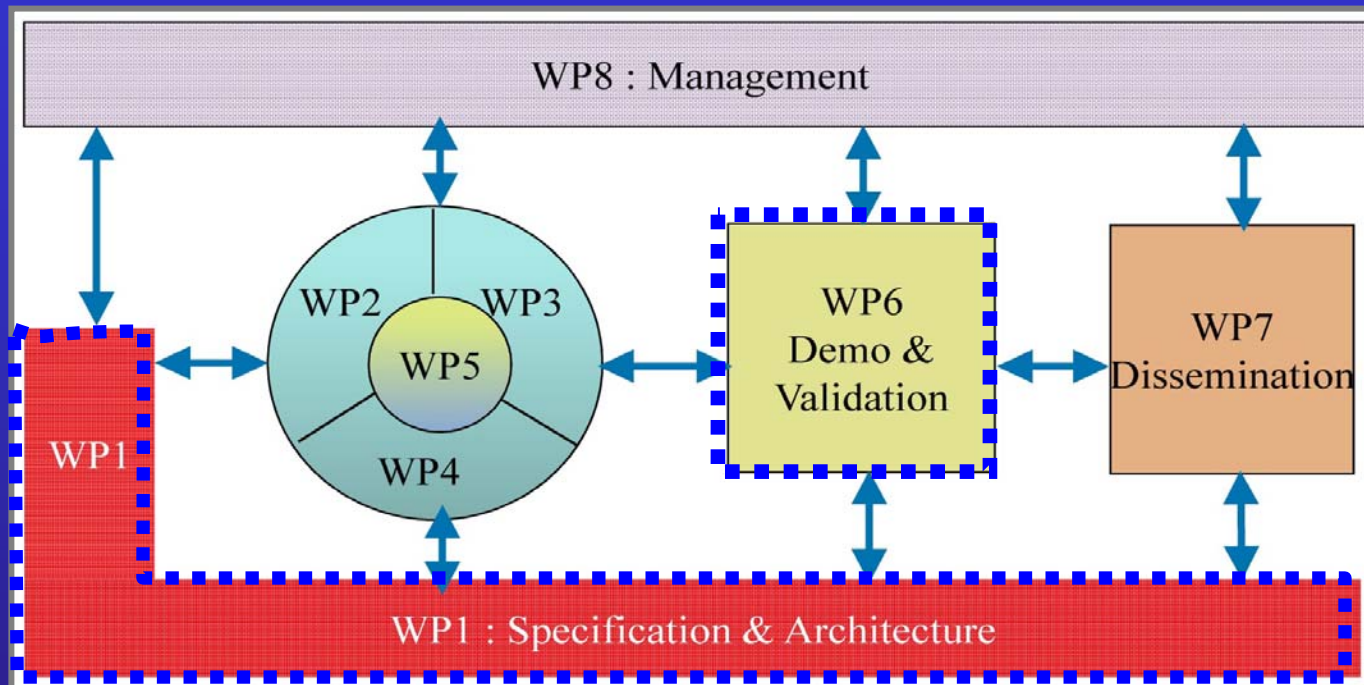


FP7 Pegase project - results





HEP OPS contribution – WP1 & WP6









- WP1 – defining needs from TSO point of view
- WP6 – testing and validation
 - Implementation of the test scenarios on predefined models
 - Calculations on developed prototypes
 - Results interpretation: quality assessment, performance measurement
 - Testing report for each scenario

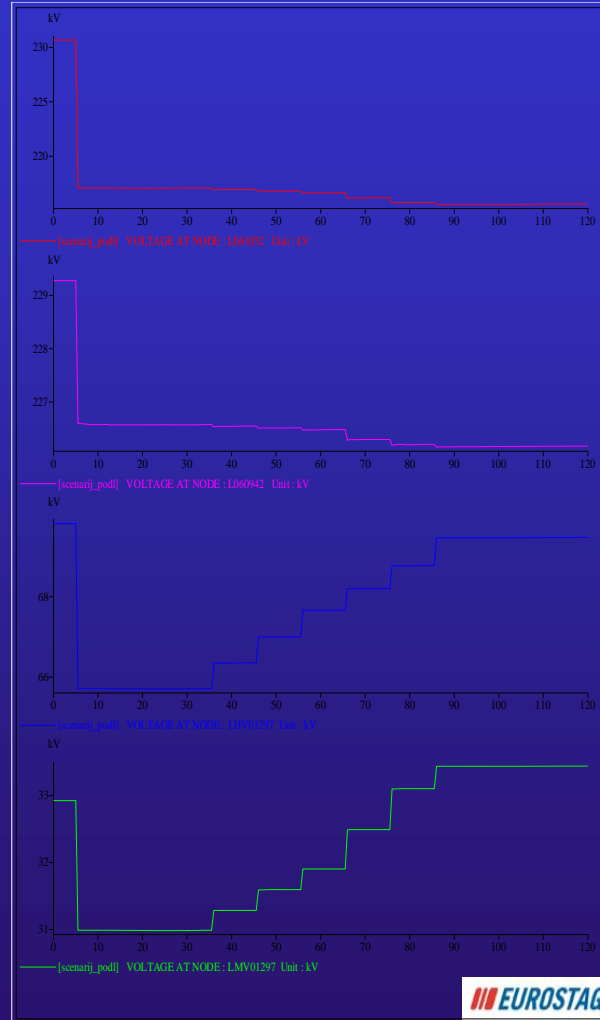
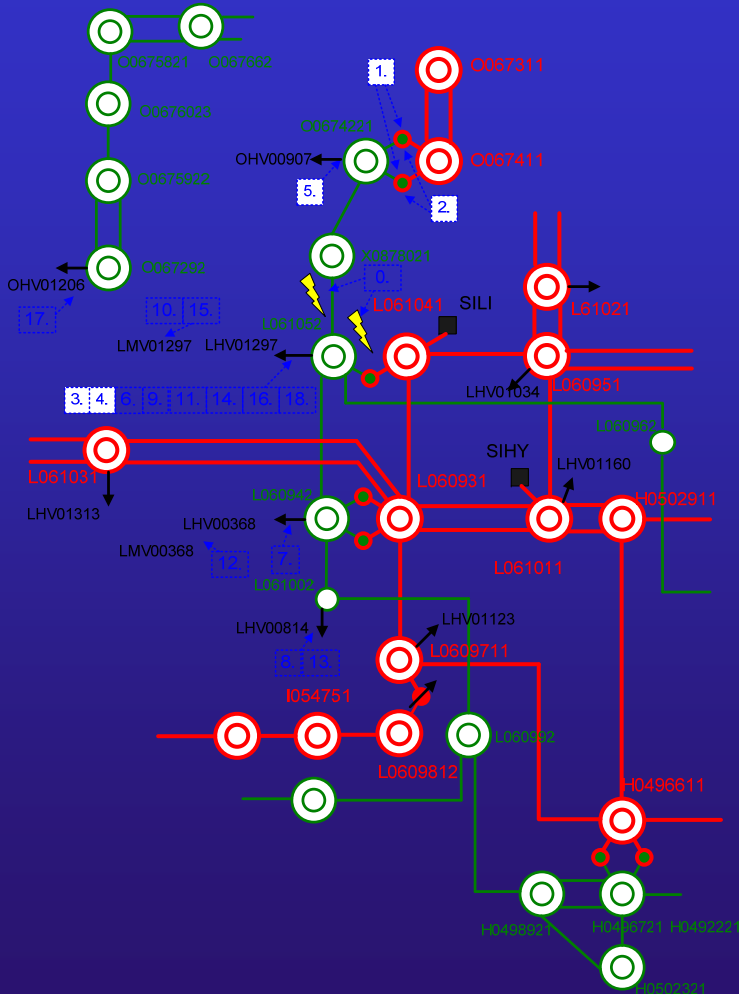


HEP OPS contribution – WP1 & WP6

SUMMARY TABLE

	 STATE ESTIMATION	 STEADY STATE OPTIMIZATION	 TIME DOMAIN SIMULATION	 DISPATCHER TRAINING SIMULATOR
 NEW GENERATION OF GROUND BREAKING ALGORITHMS	<ul style="list-style-type: none"> ■ New mathematical decomposition for multi-area schemes ■ Algorithms mixing conventional and phasor measurements ■ Local state estimation at the substation level ■ Optimal placement of additional Phasor Measurement Units 	<ul style="list-style-type: none"> ■ Treatment of potentially huge number of contingencies ■ Treatment of discrete variables in very large power system 	<ul style="list-style-type: none"> ■ Fine grain parallelization ■ Direct and iterative linear algebra ■ Domain decomposition methods ■ Multirate ■ Localization ■ Step size control 	
 PROTOTYPES DEMONSTRATED ON PAN-EUROPEAN SYSTEMS	<ul style="list-style-type: none"> ■ Hierarchical two-step state estimation prototype ■ Phasor data concentrator prototype ■ Test case characteristics: 9200 nodes, 14000 lines, over 50000 measurements,... ■ TSO testers: REE (Spain), REN (Portugal) and TEIAS (Turkey) 	<ul style="list-style-type: none"> ■ Iterative security constrained optimal power flow prototype ■ Discrete variable prototype ■ Test case characteristics: 9200 nodes, 14000 lines, 1500 generation nodes,... ■ TSO testers: SO-UPS (Russia), TEIAS (Turkey), HEP (Croatia), Transelectrica (Romania) and RTE (France) 	<ul style="list-style-type: none"> ■ Full accuracy simulation prototype ■ Simplified simulation prototype ■ Test case characteristics: 16000 nodes, 13000 lines, 9000 transformers, 3000 synchronous generators, 700 wind farms,... ■ TSO testers: SO-UPS (Russia), TEIAS (Turkey), HEP (Croatia), Transelectrica (Romania), RTE (France) and LITGRID (Lithuania) 	<ul style="list-style-type: none"> ■ Dispatcher training simulator prototype ■ Test case characteristics: 24000 busbars, 12500 lines, 3800 generators,... ■ Validated by all TSOs of the Consortium

HEP OPS contribution – WP6 example



Busbar outage analysis:

- Voltage drop
- Generator response
- Over 20 transformer tap changes
- PST transformer tap changes
- Impact and changes in several TSO-s



Lessons learned & conclusions

- Possibility for using advanced applications (including developed prototypes) and tools including developed model of complete ETN,
- Education for employees – several workshops/courses,
- New skills acquired by HEP OPS employees (dynamics, DC transmission, transformer saturation, etc.),
- “know-how” for EU projects – application, reporting, ...

- R&D Pegase project removed many technical barriers related to large scale network calculations
- Outcomes of the project can be applied in the real operation (TSO regional security co-operation /e.g. TSC/ for facilitation market development and RES integration)
- HEP OPS participation was efficient especially in testing and verification activities



THANK YOU FOR ATTENTION !

www.hep.hr/ops

damjan.medjimorec@hep.hr

Soon at:

www.hops.hr

damjan.medimorec@hops.hr

