Energy Institute “Hrvoje Pozar”
Zagreb, CROATIA

THE ELECTRICITY SYSTEM IN CROATIA
AND POSSIBLE INTERCONNECTIONS
WITH ITALY

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OBJECTIVE

Croatian power system characteristics and interconnection possibilities between Croatia and Italy

ELABORATION

Croatian power system development;
Preliminary analysis of new interconnections between Croatia and neighboring systems;
Croatian transmission system throughput for new interconnection to Italy;

RELATED WORK

‘POSSIBILITIES FOR NEW CROATIAN INTERCONNECTIONS TO HUNGARY AND ITALY’, Energy Institute “Hrvoje Pozar”, 2000
‘PRELIMINARY ANALYSIS OF CROATIAN TRANSMISSION SYSTEM THROUGHPUT FOR 500 MW OF DIRECT TRANSFER TO ITALY (SAVUDRIJA-PLANAIS)’, Energy Institute “Hrvoje Pozar”, 2003
BRIEF OUTLINE OF THE PAPER

INTRODUCTION

CROATIAN POWER SECTOR ORGANIZATION

TECHNICAL DATA

CROATIAN POWER SYSTEM TECHNICAL DATA

SYSTEM DEVELOPMENT

SHORT AND MID-TERM DEVELOPMENT OF CROATIAN POWER SYSTEM

STUDY REFERRED TO HR-ITA INTERCONNECTION

THROUGHPUT CAPABILITIES OF CROATIAN TRANSMISSION NETWORK

CONCLUSIONS
INTRODUCTION

CROATIAN ENERGY SECTOR ORGANIZATION

- ENERGY DEVELOPMENT STRATEGY - 1998
- ENERGY SECTOR RESTRUCTURING CONCEPT - 2000
- ENERGY LAW - 2001
- CROATIAN ENERGY REGULATORY COUNCIL - 2001
- CROATIAN POWER COMPANY (HEP) UNBUNDLING - 2002
- ISO MODEL - 2003
- MARKET OPENING FOR CUSTOMERS $E_{\text{year}} > 40$ GWh - 2004
<table>
<thead>
<tr>
<th><strong>CROATIAN POWER SYSTEM TECHNICAL DATA</strong></th>
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<tbody>
<tr>
<td><strong>POPULATION</strong></td>
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<tr>
<td><strong>AREA</strong></td>
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<tr>
<td><strong>TOTAL DEMAND</strong></td>
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<tr>
<td><strong>PEAK LOAD</strong></td>
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<tr>
<td><strong>INSTALLED GENERATING CAPACITY</strong></td>
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<td><strong>HYDRO POWER PLANTS CAPACITY</strong></td>
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<td><strong>IMPORT</strong></td>
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CROATIAN TRANSMISSION SYSTEM - interconnections
CROATIAN TRANSMISSION SYSTEM

Legenda:
- 400 kV vod
- 220 kV teški vod
- 220 kV dvosistemska vod
- 110 kV (24U mm²)
- 110 kV teški vod
- 110 kV dvosistemska vod
- 110 kV 150 mm² (manje)
- 110 kV kabelski vod
- 400/220/110 kV
- 400/110 kV
- 220/110 kV
- 11Uk kW
- EVP
- TE
- HE
- Industrijska TE
## TRANSMISSION SYSTEM DEVELOPMENT

### Thermal ratings of total installed interconnection capacities, TIIC (MVA)

<table>
<thead>
<tr>
<th>Interconnection</th>
<th>TIIC (MVA); 2003</th>
<th>TIIC (MVA); 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR-HUN</td>
<td>1318</td>
<td>2636</td>
</tr>
<tr>
<td>HR-B&amp;H</td>
<td>1512</td>
<td>4898</td>
</tr>
<tr>
<td>HR-SLO</td>
<td>4635</td>
<td>4635</td>
</tr>
<tr>
<td>HR-S&amp;MN</td>
<td>/</td>
<td>1318</td>
</tr>
<tr>
<td>TOTAL</td>
<td>7465</td>
<td>13487</td>
</tr>
</tbody>
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Sinergy 2003
WHAT IS DONE IN CROATIA FOR UCTE RECONNECTION

- Croatia managed and self-financed reconstruction of crucial infrastructures:
HR – ITA INTERCONNECTION (1)

REFERENCES:

- “TRANSIT POSSIBILITIES THROUGH CROATIAN TRANSMISSION NETWORK IN SHORT AND MID-TERM PERIOD” Energy Institute “Hrvoje Pozar”, 2000, study commissioned by HEP

- “POSSIBILITIES FOR NEW CROATIAN INTERCONNECTIONS TO HUNGARY AND ITALY”, Energy Institute “Hrvoje Pozar”, 2000, study commissioned by HEP

- “PRELIMINARY ANALYSIS OF CROATIAN TRANSMISSION SYSTEM THROUGHPUT FOR 500 MW OF DIRECT TRANSFER TO ITALY (SAVUDRIJA-PLANAIS)”, Energy Institute “Hrvoje Pozar”, 2003
HR – ITA INTERCONNECTION (2)

- New SS Klana interpolated in existing interconnection line Melina (HR) – Divaca (Slo)

- Additional internal 400 kV line in Istria (90 km), SS Pazin 400/110 kV and SS Savudrija 400 kV

- Submarine interconnecting cable HR-ITA Savudrija – Planais DC or AC (35 km)
HR – ITA INTERCONNECTION (3)
STUDY RESULTS (1)

- analyzed time horizon set to year 2005

- studies performed using PTI PSS/E software package

- European power system modeled from Portugal to Greece

- two types of interconnection Savudrija (HR) – Planais (ITA)
  analyzed: DC and AC equipped with phase-shifter
STUDY RESULTS (2)

- steady state analysis

- 56 analyzed scenarios including transits to Italy from: Slovakia/Germany, Ukraine and Bulgaria

- maximum possible transit SK/D – ITA due to limitation in Croatian power system set to 800 MW – 2400 MW

- maximal possible transit UKR – ITA due to limitation in Croatian system set to 400 MW – 1300 MW
STUDY RESULTS (3)

- maximum possible transit BG – ITA due to limitation in Croatian system set to 300 MW – 1000 MW

- only 3 scenarios found restrictions in Croatian power system to transit 500 MW to Italy through interconnection Savudrija – Planais

- short-term planned investments in Croatian power system solve those restrictions
STUDY RESULTS (4)

- Loop flows HR-ITA-SLO-HR increases with increasing of Slovakia / Germany - Italy power exchange

- All results referred to Croatian power system capabilities neglecting influence on neighboring systems
CONCLUSION

- Croatian power system is able to support 500 MW transit from North/East Europe to Italy

- Precondition for HR-ITA interconnection is reinforcement of internal Croatian 400 kV network in Istria region

- Official short-term plan of HEP network development till 2007 does not include mentioned investments

- Legislative framework in Croatia expected to be completed with respect to merchant lines

- Strong private initiative needed
FUTURE WORK

- Clear legislative definition of merchant lines in Croatian power system (Croatian Energy Regulatory Agency)

- Detailed static and dynamic analysis, pre-feasibility study

- Detailed financial analysis of HEP position

- Investment plan

- Co-operation with neighboring system operators (GRTN, ELES)

- Additional study report to existing one on HR-ITA submarine DC interconnection over mid Adriatic Vir(HR)-Candia(ITA) published by Energy Institute HRVOJE POZAR in 2000
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