

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



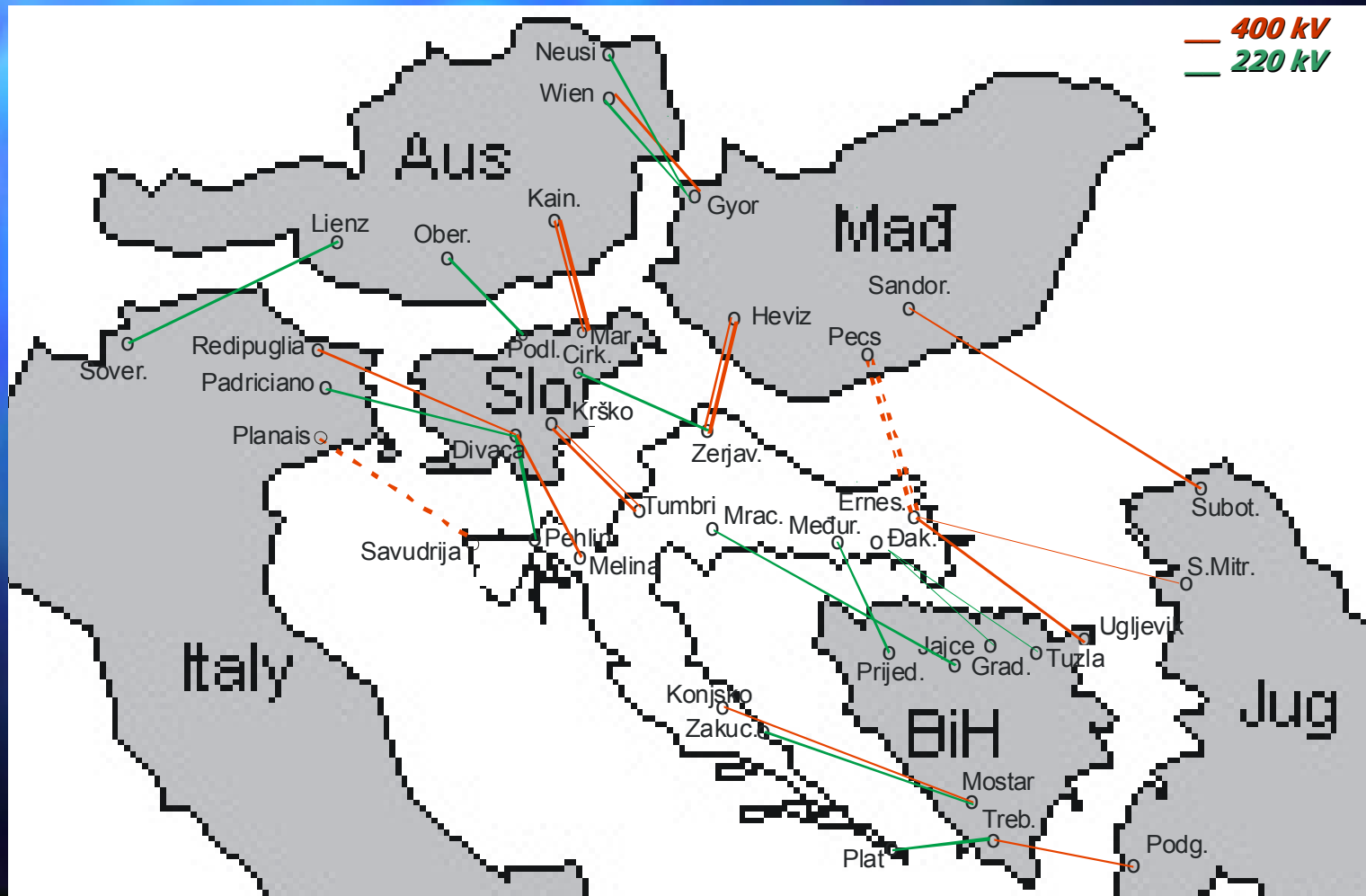
CROATIAN POWER SYSTEM TECHNICAL DATA

POPULATION	- 4.5 mil.
AREA	- 56 538 km²
TOTAL DEMAND	- 14.8 TWh (2002)
PEAK LOAD	- 2685 MW (2002)
INSTALLED GENERATING CAPACITY	- 4796 MW (650 MW out of HR)
HYDRO POWER PLANTS CAPACITY	- 43% of installed capacity
IMPORT	- 24% of total demand (2002)



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CROATIAN TRANSMISSION SYSTEM - interconnections





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CROATIAN TRANSMISSION SYSTEM



Legenda:

- | | | | |
|---|--------------------------------------|---|-----------------|
|  | 400 kV vod |  | 400/220/110 kV |
|  | 220 kV teški vod |  | 400/110 kV |
|  | 220 kV dvosistemski vod |  | 220/110 kV |
|  | 110 kV (240 mm ²) |  | 110/x kV |
|  | 110 kV teški vod |  | EVP |
|  | 110 kV dvosistemski vod |  | TE |
|  | 110 kV (150 mm ² i manje) |  | HE |
|  | 110 kV kabelski vod |  | Industrijska TE |



TRANSMISSION SYSTEM DEVELOPMENT

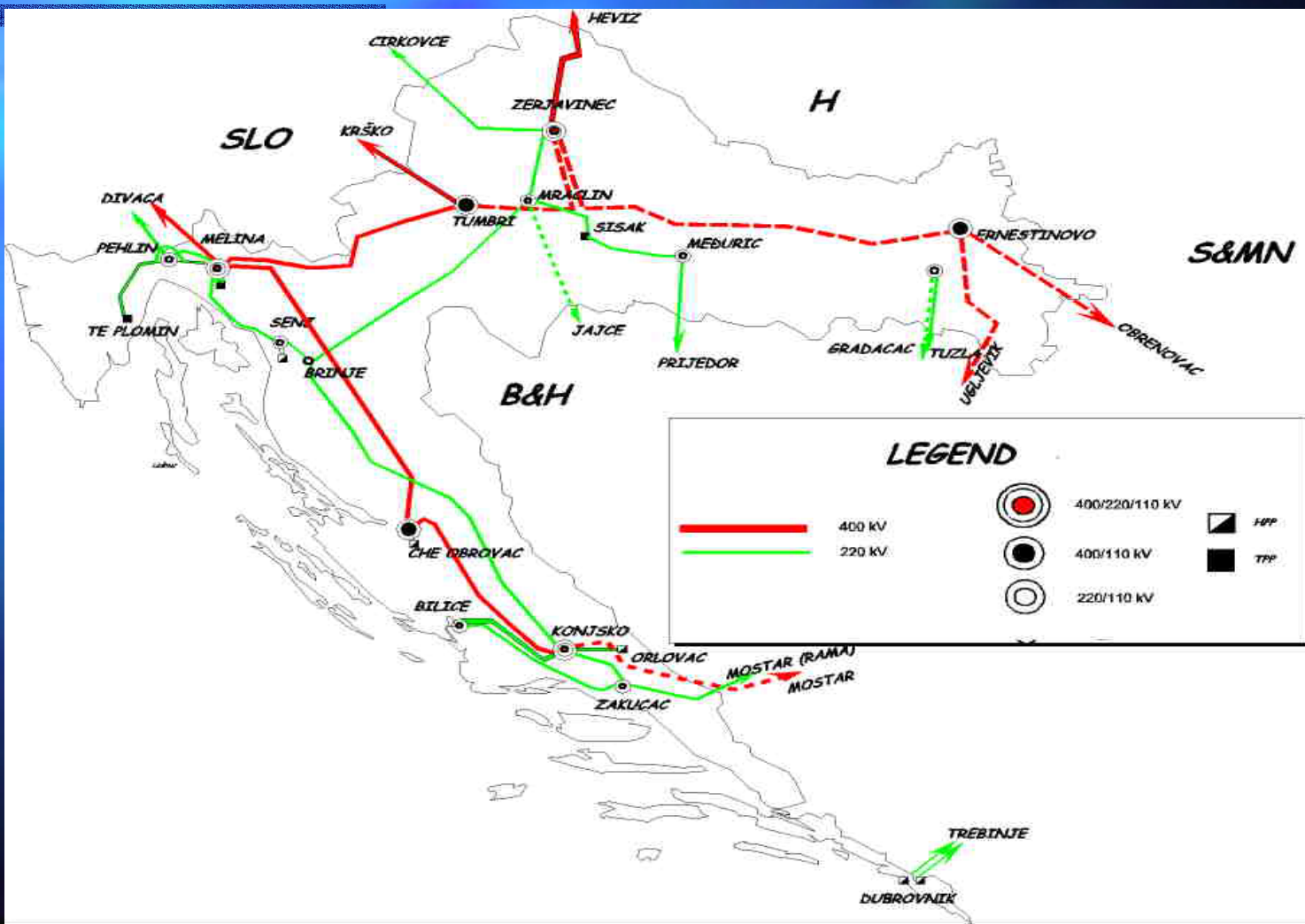
Thermal ratings of total installed interconnection capacities, TIIC (MVA)

Interconnection	TIIC (MVA); 2003	TIIC (MVA); 2005
HR-HUN	1318	2636
HR-B&H	1512	4898
HR-SLO	4635	4635
HR-S&MN	/	1318
TOTAL	7465	13487



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

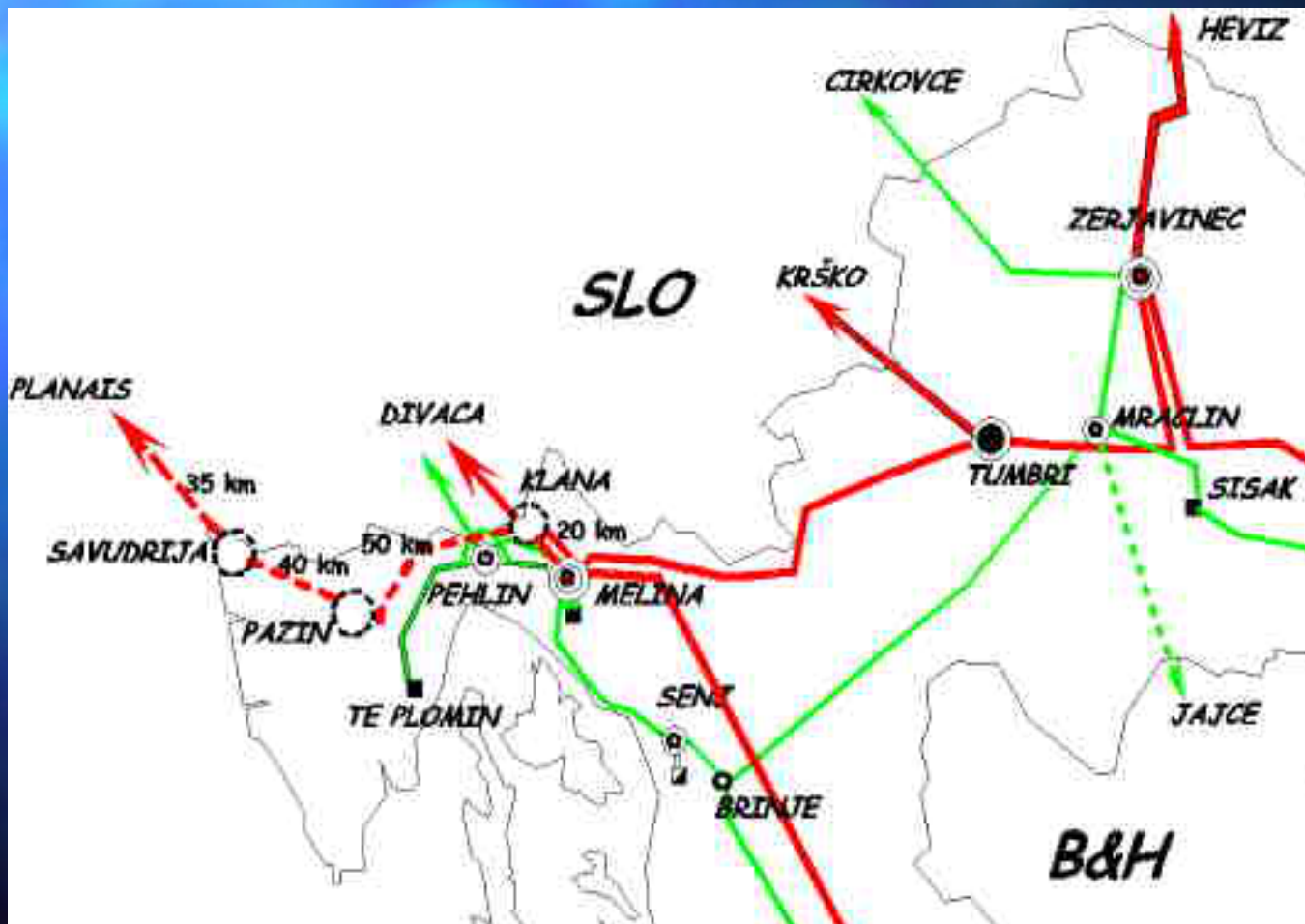


HR – ITA INTERCONNECTION (2)

- **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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