PANEL 4
Electric AC Highspeed Rail Services

Railenergy Final Conference

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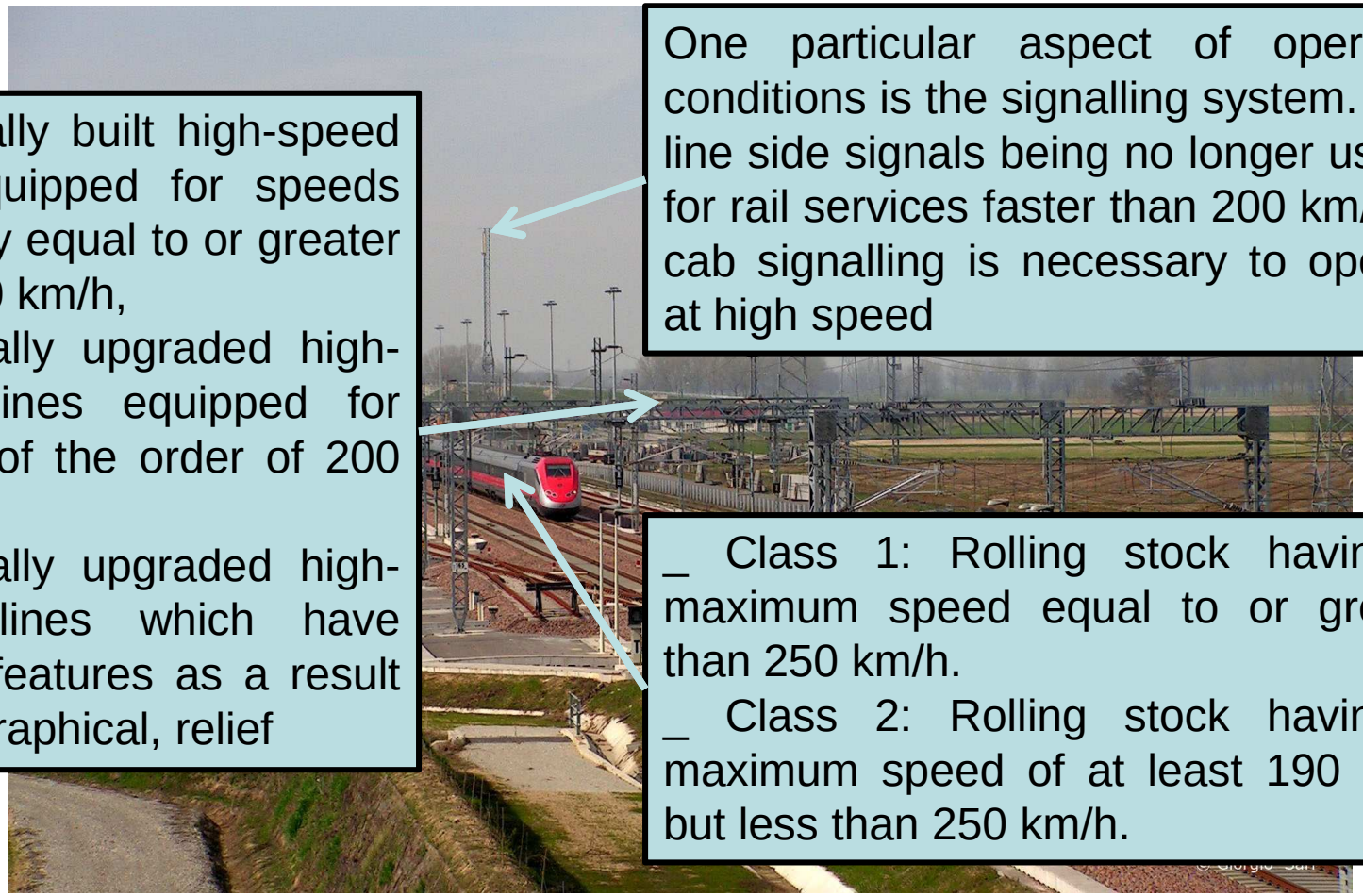
Introduction to Electric Highspeed Rail Services

High-speed rail (HSR) is a type of passenger rail transport that operates significantly faster than the normal speed of rail traffic

_ specially built high-speed lines equipped for speeds generally equal to or greater than 250 km/h,
_ specially upgraded high-speed lines equipped for speeds of the order of 200 km/h,
_ specially upgraded high-speed lines which have special features as a result of topographical, relief



One particular aspect of operating conditions is the signalling system. With line side signals being no longer usable for rail services faster than 200 km/h in-cab signalling is necessary to operate at high speed

_ Class 1: Rolling stock having a maximum speed equal to or greater than 250 km/h.
_ Class 2: Rolling stock having a maximum speed of at least 190 km/h but less than 250 km/h.

Overview European Highspeed Rail Services

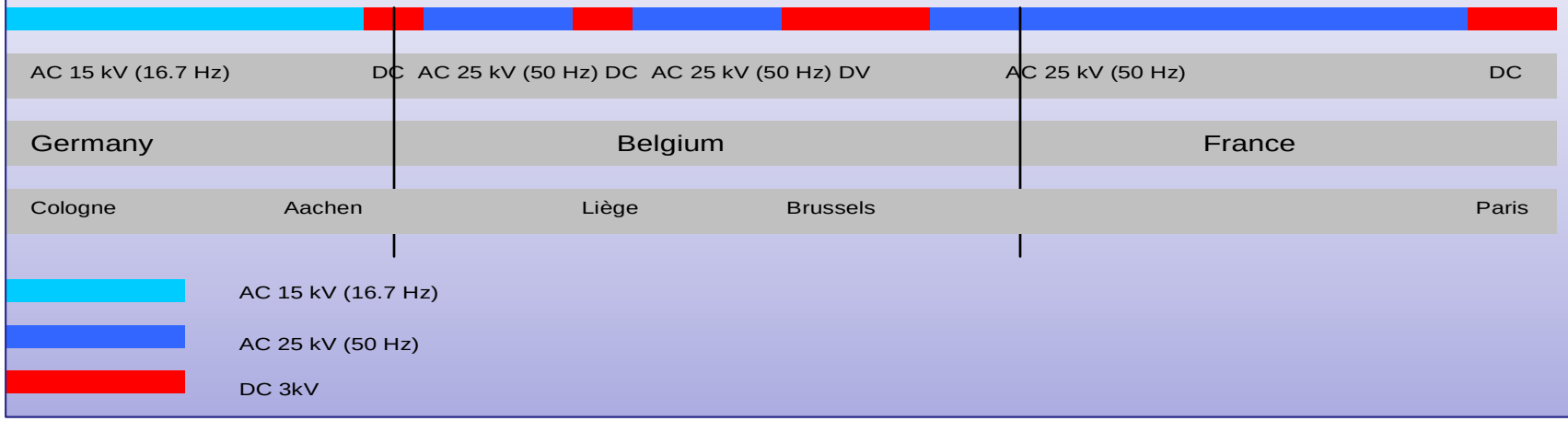
The current European high-speed network comprise approximately 7.000 km with high speed services mainly operating on AC

- ***AC 15 kV (16.7 Hz)***
- ***AC 25 kV (50 Hz, single feeding 1 x 25kV)***

European HS Network

In certain areas high speed trains share the network with conventional rail and run on the DC network.

Example: Thalys Service form Cologne (Germany) via Brussels (Belgium) to Paris (France)



How will the market change?

CURRENT

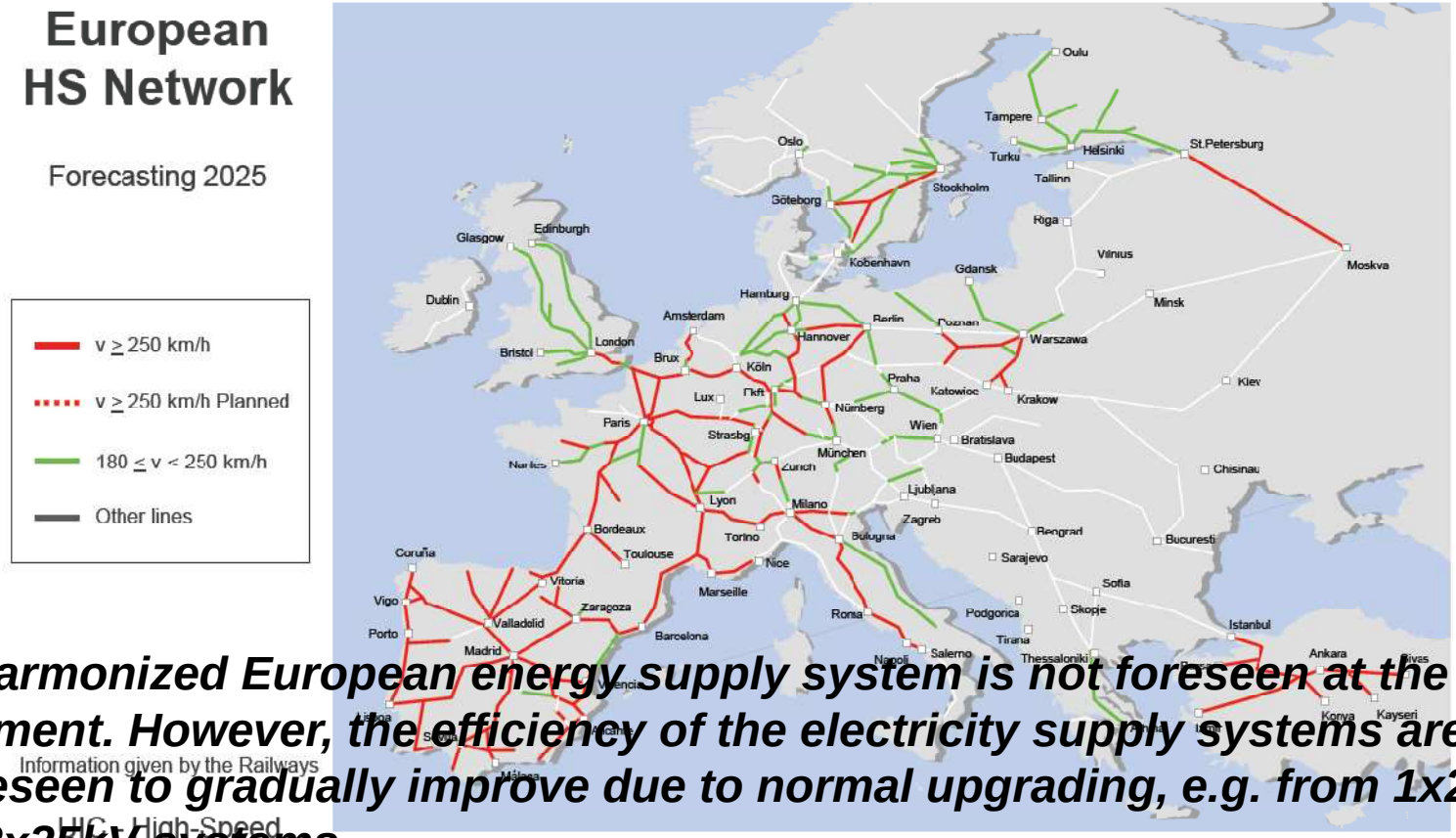
- *7 thousand km of lines*
- *Domestic (France, Italy, Spain) more than international market but …*
- *… main international connections competing with air transport services*

FUTURE

- *A transeuropean network will be completed in the future (10-15 years)*
- *Important national components will still remain*

Overview European Highspeed Rail Services

The European high speed rail network is expected to grow significantly including Eastern Europe and to become an interoperable pan-European rail network.



A harmonized European energy supply system is not foreseen at the moment. However, the efficiency of the electricity supply systems are foreseen to gradually improve due to normal upgrading, e.g. from 1x25kV to 2x25kV systems.

Focus on Trenitalia Highspeed Rail Services

59 ETR 500
Freccia Rossa
Max speed: 350 km/h

12 ETR 600
Freccia Argento
Max speed : 250 km/h

15 ETR 485/ 9 ETR 460
Freccia Argento
Max speed : 250 km/h

5 ETR 470
Interoperable IT-CH
Max speed : 250 km/h

7 ETR 610
Interoperable IT-CH-DE
Max speed : 250 km/h

- ***2008*** — ***83***
- ***2010*** — ***107***

Tender for 50 new HS trains

New UE interoperable rolling stock

to be delivered by the end 2014

ETR 1000 FLEET

- ***2017*** — ***150***

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Focus on Trenitalia
Highspeed Rail Services

the FRECCIAROSSA network

Number of daily links

- 68 Milan - Rome
- 35 Milan - Naples
- 14 Turin - Rome
- 4 Milan – Salerno

No - stop links

- 2h 45' Rome Tib. – Mi Rog.
- 2h 59' Rome Term. – Milan C.le.

Travelling time

- 37' Bologna - Firenze
- 60' Turin – Milan
- 70' Rome – Naples
- 4h 10' Milan – Naples
- 4h 10' Turin - Rome

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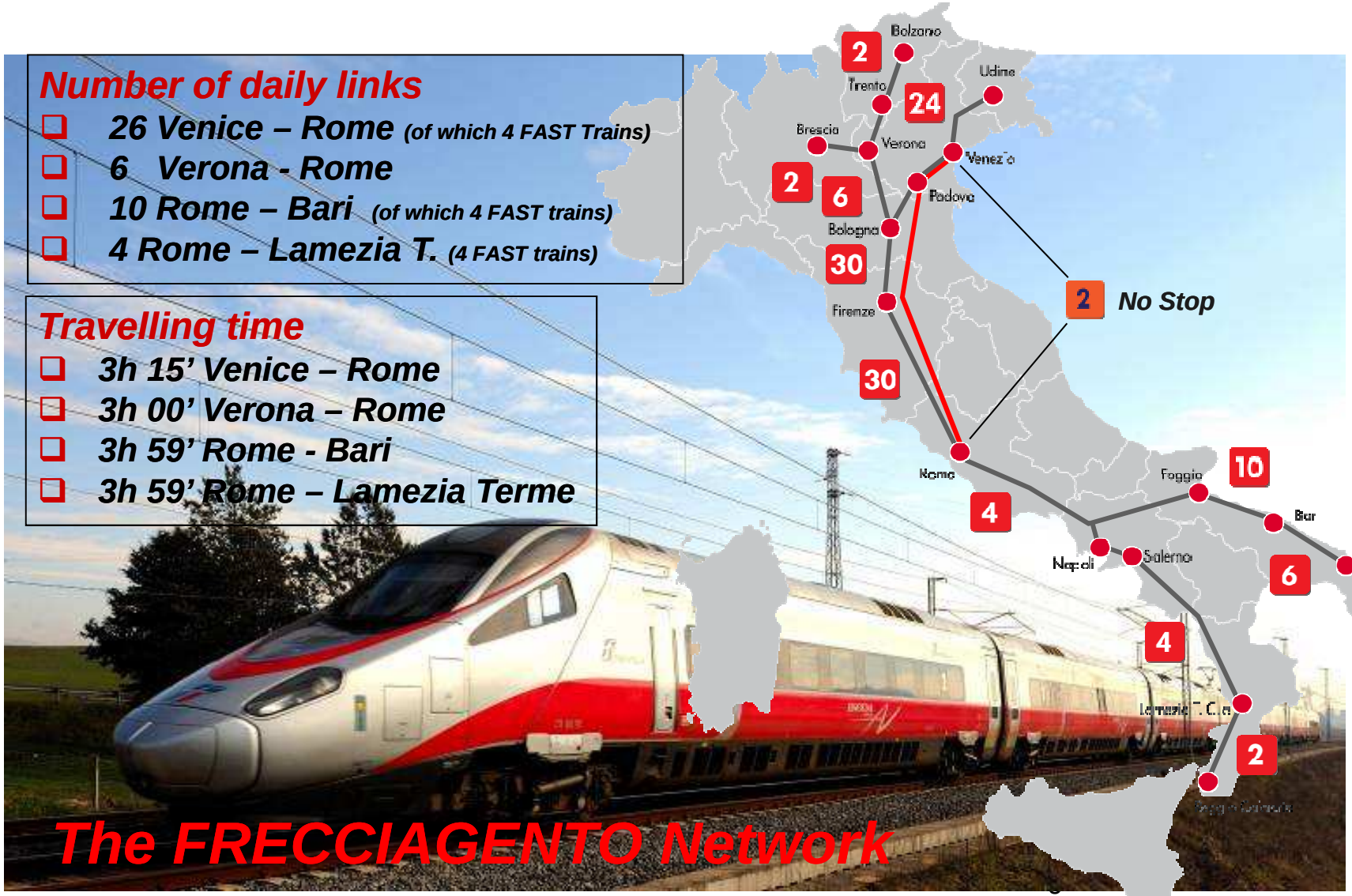
Highspeed Rail Services



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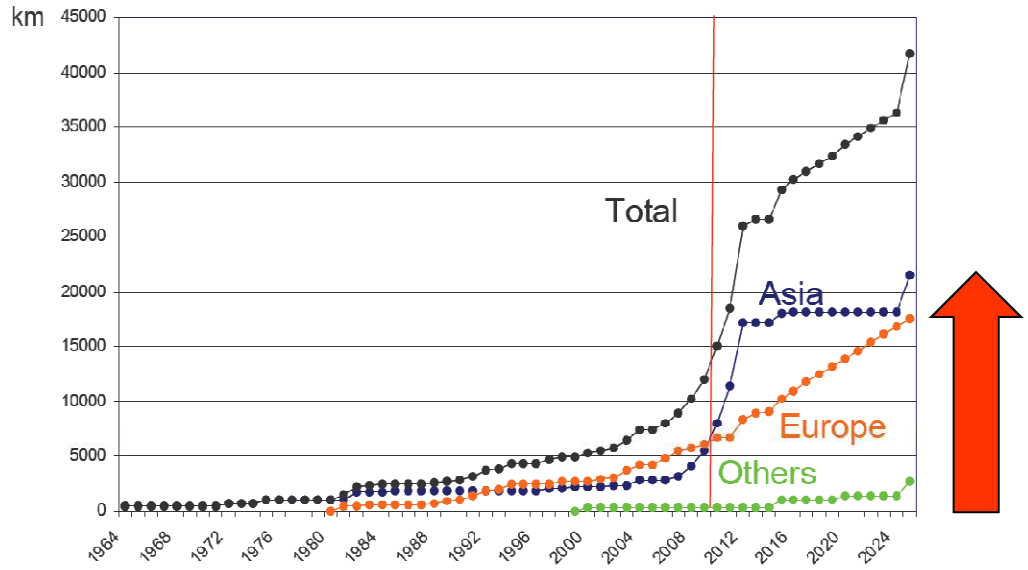
Energy Efficency vs Highspeed Rail Services Evolution

Expected evolution of the world HS network



Huge increase in Europe & Asia of HS network (forecast to 2025)

Europe	from **7.000 Km** to **18.000 Km**	**157%**
Asia	from **7.000 Km** to **22.000 Km**	**214%**
Worldwide	from **15.000 Km** to **42.000 Km**	**180%**

Energy Efficency vs Highspeed Rail Services Evolution

Increase HS **NTWs** + **Services**

↓

Huge Impact on Energy Consumption

High Importance of Railenergy **Ambitions !!!**

Europe	from **7.000 Km** to **18.000 Km**	**157%**
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Energy Efficency vs Highspeed Rail Services Evolution

Focus on important activities performed during the RAILENERGY PROJECT

Measure to Increase the Energy Efficiency

- **Medium Frequency Traction Transformers**
- **Energy Efficiency in Operation**

Then will follow an overview about the Ambitions & Recommendations for RAILENERGY technology for HS Rail Services

Ambitions & Recommendations

Converter control technology is very promising for upgraded and new vehicles - losses reduction in traction inverter and motor during coasting phase (software)

- ❑ Saving potential is independent on power supply type (applicable for all electric traction)
- ❑ It is influenced by the percentage of coasting.

AC 15kV	AC 25kV	DC 3kV
1-4%		

MV Load Management is highly promising - control loads of cooling systems especially when maximum performance is not required (software)

- ❑ for refurbishment → requiring software changes only
- ❑ detailed investigation of hardware changes are required

AC 15kV	AC 25kV	DC 3kV
2-4%		

Reduced Line Impedances **Could be promising if increased capacity is needed – increasing conductivity either by enlarge the cross section or using an additional conductor**

- ❑ the benefit in applying this technology needs a specific calculations about energy/copper price ratio. Today lifetime energy losses are not integrated into the standard dimensioning process for new and upgraded infrastructure systems

→DC

- ❑ Saving Potential:

DC 3kV
1-4%

→AC

- ❑ Saving Potential

AC 15kV	AC 25kV
1-2%	0,05-0,5%

For AC Technology Simulated in UC 1.1 & 1.2:

AC 15kV	AC 25kV
1,5%	0,06%

Ambitions & Recommendations

Superconducting transformers and inductances could be promising – reduce loss using High-Temperature Superconductor

- ❑ Furter studies are necessary to validate the Saving Potential.

➡ Technology Simulated in UC:
Considerable Saving Potential

AC 15kV	AC 25kV
6%	4,1%

Medium frequency energy distribution is an interesting technology - exchange classical transformer with 4quadrant converter

- ❑ Saving Potential

AC 15kV	AC 25kV
3-5%	2-4%

For AC Technology
Simulated in UC 1.1 1.2:

AC 15kV	AC 25kV
4,3%	2,2%

The End

Thank you!

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