

# 德国风电并网标准

## Regulation of Grid Integration in Germany

### 针对电网运营商的风电并网责任与激励措施

Duties and Incentives for TSOs for Grid Integration of Wind Power

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# 德国风电并网标准 **Regulation of Grid Integration in Germany**

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# 简介 Introduction

- 德国和欧盟都致力于增加可再生能源的开发利用。  
Germany and the EU aim to strongly increase their use of renewable energies
- 德国：2020年，可再生能源发电量至少占电量供应的30%，并在其后保持逐年增长。  
Germany: The share of renewable energy sources in electricity supply to at least 30 percent by the year 2020 and to continuously increase that share thereafter.
- 可再生能源发电机组享受优先并网待遇。  
Priority connection to the grid systems of installations generating electricity from renewable energy sources
- 发电机组的结构和发电特性不同于常规机组；可再生能源发电具有分散性、波动性且远离负荷中心的特点。  
Generating structure and generating performance different from conventional generating facilities; generation from renewables: dispersed, volatile, far from consumers

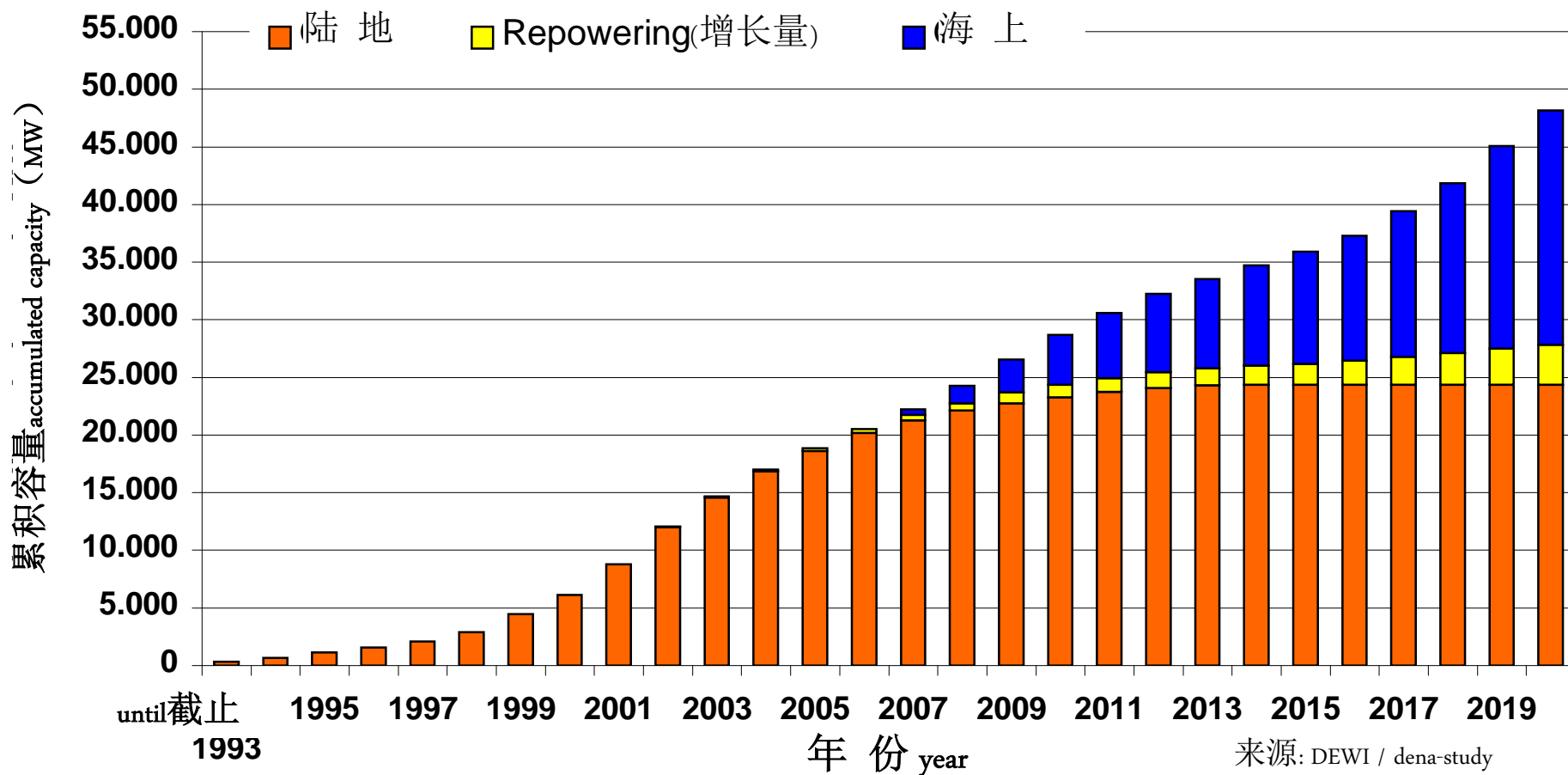
➤ 可再生能源发电尤其是风电并网的相关规标准。  
Regulations for grid integration of power generation from renewables, in particular from wind power

# 风力发电 Power generation from wind power

## Prognose Windenergieentwicklung in Deutschland bis 2020

(kumulierte Leistung)

对2020年以前发展态势的预测 Forecast of development until 2020



# 风电并网的基础 Basics of grid integration of wind power

## ■ 法律基础 **Legal Basis**

- 可再生能源法：2009年1月1日颁布实施，取代2004年旧法。  
Renewable Energy Source Act: Entered into force on 1 January 2009, replaces the previous act of 2004

## ■ 标准背景 **Regulatory Background**

- 补偿机制法案：2009年7月17日颁布实施。  
Equalisation Scheme ordinance: Entered into force on 17 July 2009
- 补偿机制实施法案：2010年2月27日颁布实施。  
Equalisation Scheme Execution Ordinance: Entered into force on 27 February 2010

## ■ 并网导则 **Grid Code**

- 输电导则 2007：德国输电网运营商(TSO)的电网与系统规程；  
Transmission Code 2007: Network and System Rules of the German Transmission System Operators
- 高压和超高压电网中的可再生能源发电设备。  
Renewables-based generating facilities on the HV and EHV grid

# 风电并网的基础 Basics of grid integration of wind power

- 可再生能源法： 2009年1月1日颁布实施，取代2004年的旧法。

Renewable Energy Source Act: Entered into force on 1 January 2009, replaces the previous act of 2004:

- 并网、电量收购、输电、配电

**Connection, purchase, transmission and distribution**

- 总则、扩容和上网管理、成本

General provisions; Capacity expansion and feed-in management; Costs

- 电价 **Tariffs**

- 关于电价的总则和特殊条款

General and special provisions regarding tariffs

- 补偿机制 **Equalisation scheme**

- 透明度 **Transparency**

- 通知和公布义务、增量成本、来源保证和禁止多级销售

Notification and publication obligations, differential costs, Guarantee of origin and prohibition of multiple sale

- 法律保护 and 正式程序 **Legal protection and official procedure**

# 可再生能源法 Renewable Energy Sources Act (1)

## ■ 并网与电量收购、输配电 Connection and purchase, transmission & distribution

- 电网运营商义务：让（可再生能源）发电设备并网（并网点）。  
Obligation of the grid system operators to connect the installation to their grid (grid connection point)
- 可再生能源发电运营商有权利选择其他的并网点。  
Installation operators entitled to choose another grid connection point
- 一般来说，并网工程费用应该由可再生能源发电运营商承担。  
The grid connection costs generally to be paid by the installation operator (ENWG § ...)
- 电网运营商有权利为可再生能源发电指定其他的并网点。  
Grid system operators entitled to assign the installation a different grid connection point
- 当只有采取电网优化、升级或扩建措施才有可能实现电量收购时，电网运营商有义务采取上述措施。 Obligation also apply where the purchase of the electricity is only made possible by optimising, boosting or expanding the grid system
- 电网运营商有义务全额收购、传输和配送可用电量（available quantity of electricity）。  
Obligation of the grid system operators to purchase, transmit and distribute the entire available quantity of electricity

# 可再生能源法 Renewable Energy Sources Act (2)

## ■ 扩容和上网管理 **Capacity expansion and feed-in management**

- 电网运营商有义务进行电网优化、升级和扩建，以确保电量的收购、传输和配送。  
**Obligation of grid system operators to optimise, boost and expand their grid systems to guarantee the purchase, transmission and distribution of electricity**
- 如果电网扩容经济上不合理，则不应强制电网运营商执行。  
**Grid system operator not be obliged if capacity expansion economically unreasonable**
- 电网运营商未履行其义务时应对造成的损失进行赔偿。  
**Compensation for the damage by the grid system operator in case of violation of his obligations.**
- 对于装机容量超过100kW的可再生能源发电，应配置上网功率远程控制设备。  
**installations with a capacity of over 100 kilowatts to be provided with remote control of the infeed power**
- 针对已建可再生能源发电为期5年的0.7欧分系统服务补贴将于2011年1月1日更新。  
**System services bonus for a period of five years by 0.7 cents for existing installations retrofitted till 01.01.2011**
- 系统发生过载时，电网运营商可对装机容量超过100kW的可再生能源发电采取控制措施。  
**Grid system operator take technical control over installations over 100 kW in case of system overloading;**
- 电网运营商对可再生能源发电运营商进行的补偿；这部分费用可分摊至电费中。  
**Compensation of the installation operators by the grid system operator; revolving of the charges on the grid charges**

# 可再生能源法 Renewable Energy Sources Act (3)

## ■ 付款要求、直销与电价 **Payment claims, Direct selling & Tariffs**

- 电网运营商有义务根据电价相关条款向可再生能源发电运营商支付电费。  
Obligation of grid system operators to pay installation operators tariffs according to the “special provisions regarding tariffs“
- 可再生能源发电运营商可以直接向第三方售电，但需与电网运营商签订月度协议。 Direct selling by the installation operators may sell the electricity to third parties on a monthly agreement with the grid system operator
- 不同类型的可再生能源发电有不同的电价，例如：  
Various tariffs for the different kinds of renewable energy sources, i. e.
  - 水电 Hydropower
  - 生物质能 Biogas
  - 地热能 Geothermal energy
  - 风能, 陆地 Wind energy, onshore
  - 风能, 海上 Wind energy, offshore
  - 太阳能 Solar radiation

# 可再生能源法 Renewable Energy Sources Act (4)

## ■ 补偿机制 **Equalisation scheme**

- 全国范围的补偿机制 Nationwide equalisation scheme
  - 交付给输电网运营商 Delivery to transmission system operator
  - 输电网运营商支付电价 Tariffs paid by transmission system operator
  - 补偿机制在输电网运营商之间实行 Equalisation amongst transmission system operators
  - 交付给电力供应商 Delivery to suppliers
- 全国范围补偿机制的法案延伸-补偿机制法案  
*Ordinance on the Further Development of the Nationwide Equalisation Scheme – Equalisation Scheme Ordinance*
- 对于电力密集企业的特殊补偿机制  
Special equalisation scheme for electricity-intensive enterprises

# 全国范围补偿机制的延伸

## Ordinance on the Further Development of the Nationwide Equalisation Scheme

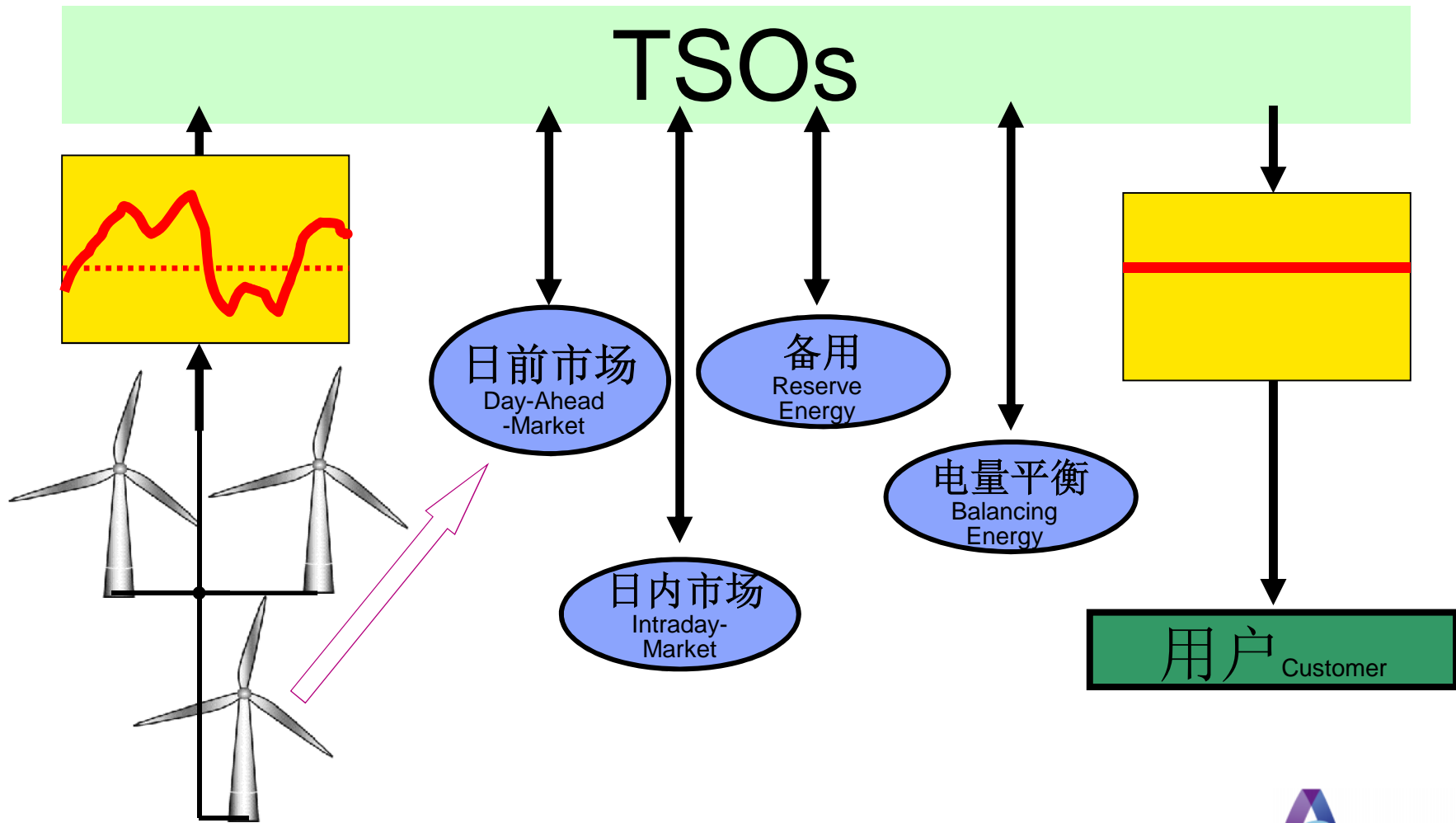
### 补偿机制法案 Equalisation Scheme Ordinance – AusglMechV

#### ■ 基本原则: Basic principles:

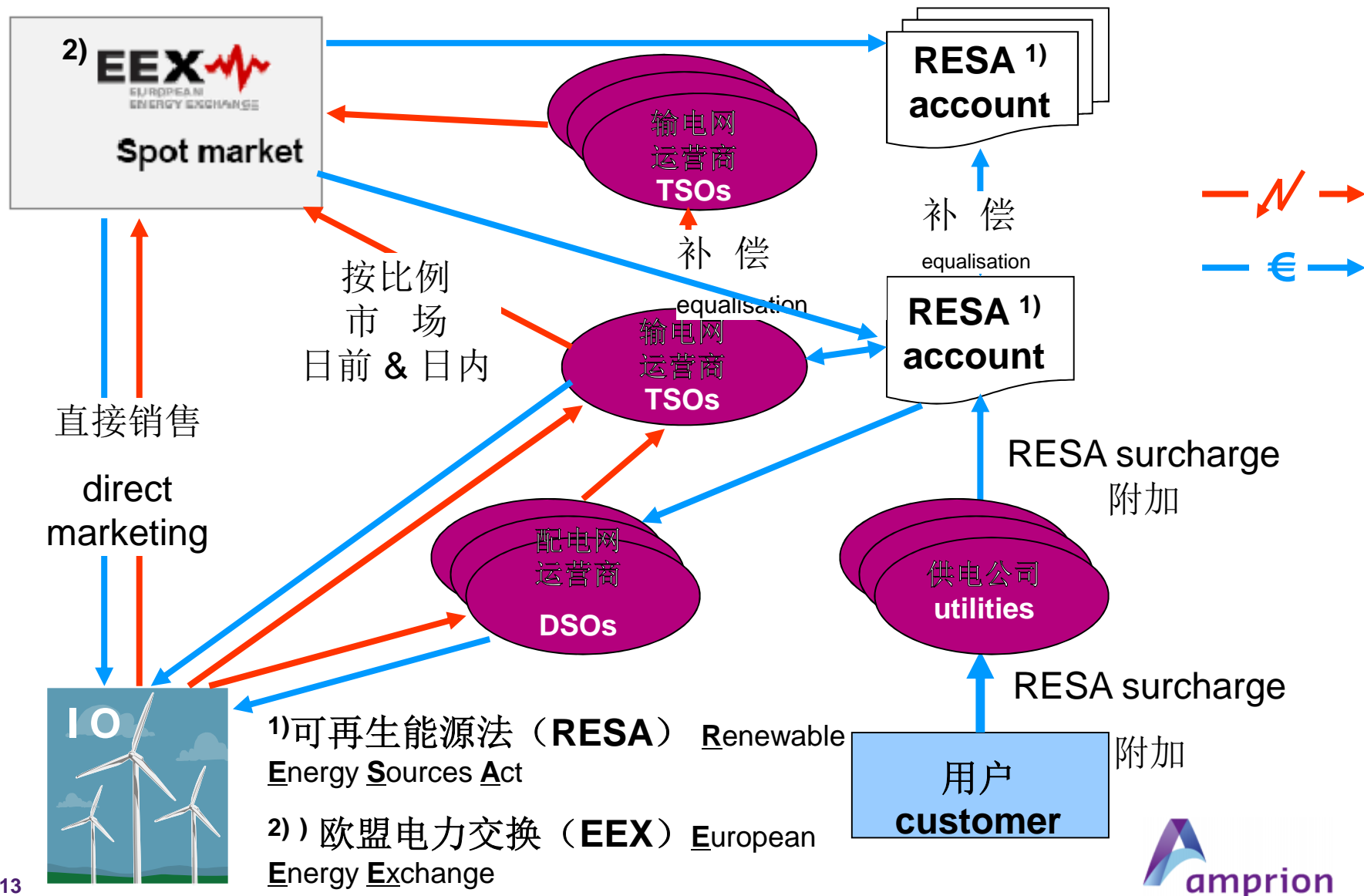
1. 不强制输电网运营商向下一级（下游）供电公司输电。 The transmission system operators are not obliged to transmit the electricity to downstream utility companies.
2. 不强制供电公司向其常规的输电网运营商购电和支付电费。 The utility companies are not obliged to purchase and pay tariffs for electricity from their regular transmission system operators
- 可再生能源发电电量计入总的电力输送总量。 The electricity generated by renewable energy is integrated in the electricity delivery in total
3. 电网运营商有义务进行电量的市场交易。 The transmission system operators are obliged to market the electricity
4. 电网运营商可以要求供电公司向其支付因为输送电力至终端用户所产生的费用-可再生能源附加。 The transmission system operators can claim reimbursement from the utility companies for delivering electricity to final consumers EEG surcharge

# 德国输电网运营商（TSO）的角色 Role of the TSOs in Germany

输电网运营商有义务收购和出售电量，并进行电量平衡 TSOs are obliged to take off the energy, bring it to market and balance the infeed



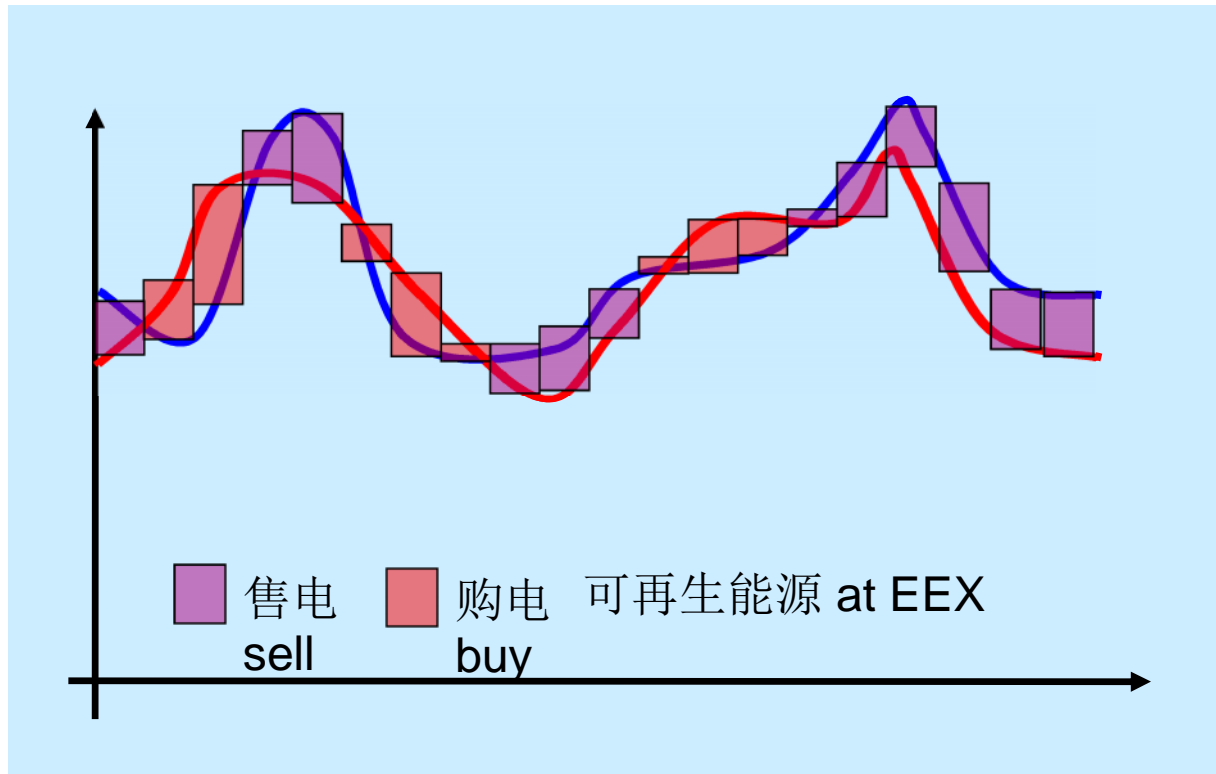
# 补偿机制于2010年开始执行 Equalisation Scheme started in 2010



# 补偿机制实施法案 Equalisation Scheme Execution Ordinance (AusglMechAV)

- 2010年2月1日由联邦电力网络管理局颁布实施： Entered into force by the Federal Network Agency in Feb. 2010:
  - 日前（DA）市场和日内（ID）市场 Day ahead (DA) and intra day (ID) marketing
  - 市场活动的透明度和可再生能源法（RESA）附加  
Transparency of marketing activities and Renewable Energy Sources Act (RESA) surcharge
  - 告知义务 Notification obligations
  - 对最佳市场交易方式的激励措施  
Incentives for best possible marketing

# 对形成风电最佳市场交易方式的激励措施



— 日内预测(实际成本)  
intraday prognosis (actual costs)

— 根据日前预测进  
行的交易  
marketing accord. day-  
ahead prognosis

如果每年的实际成本(-)小于个体化成本  $\Rightarrow$  所降低成本的25%的补贴

If actual costs per year (-) < individual base value  $\Rightarrow$  bonus of 25 % of cost reduction



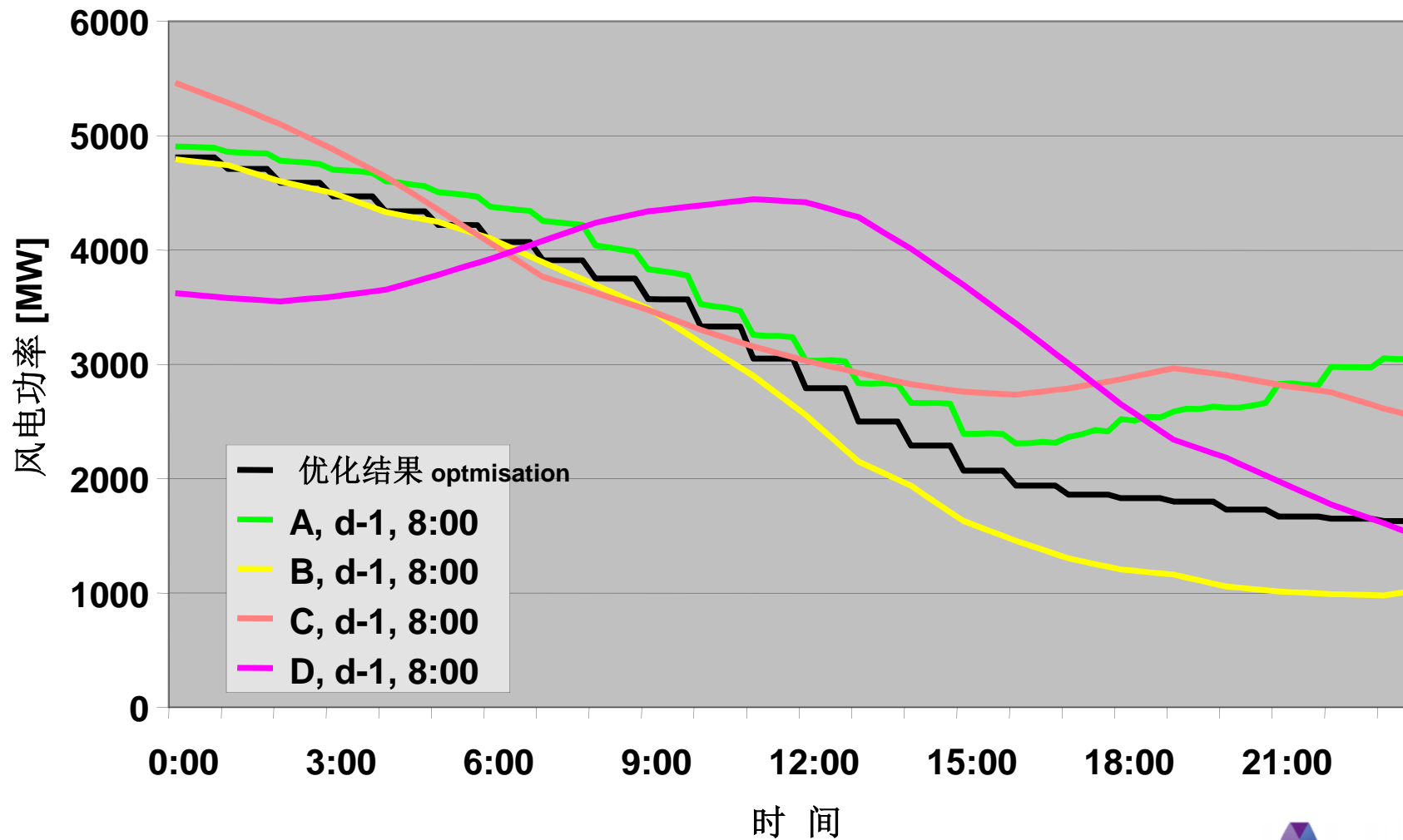
预测过程优化  
Optimisation of prognosis  
process



# 风电预测过程的优化 Optimisation of wind power prognosis process (2)

风电预测，Amprion的研究成果，日前，8:00

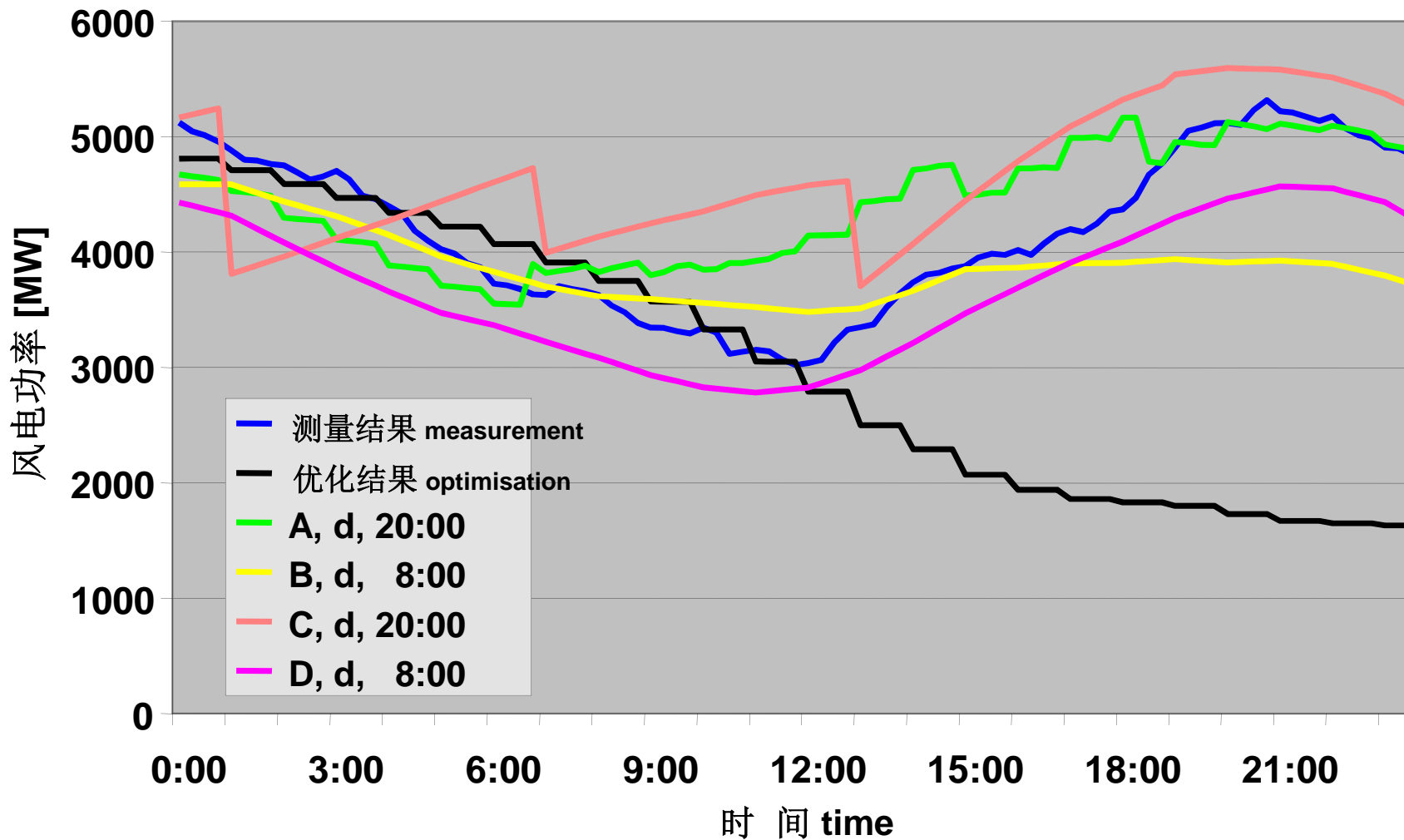
Wind Power Predictions, Amprion Share, Day Ahead, 8:00



# 风电预测过程的优化 Optimisation of wind power prognosis process (1)

风电预测和测量, Amprion的研究成果, 典型日, 24:00

Wind Power Predictions and Measurement, AMprion Share, Actual Day, 24:00

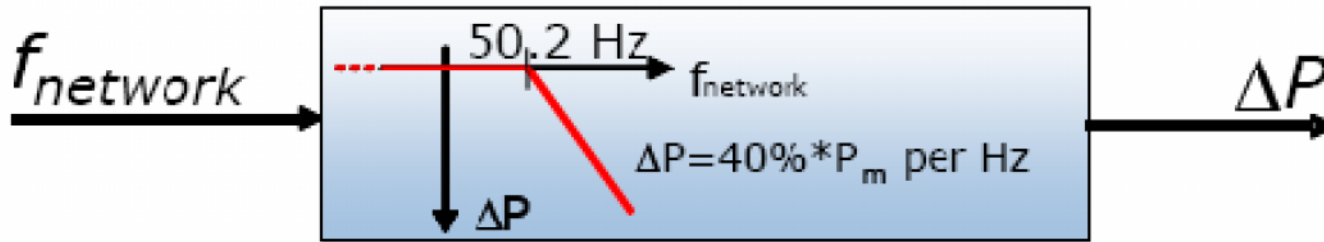


# 输电导则 Transmission Code

§ 关于发电机组并网的特殊要求： Special requirements governing the connection of generating units:

- 针对可再生能源发电机组的要求： Requirements upon generating units using renewable energy sources
  - “可再生能源发电机组并入高压和超高压电网导则 2004-8”的细节要求：  
Further details in "Renewables-based generating units connected to the high and extra-high voltage network - Guidelines, Aug 2004":
    - 系统频率过高时应减少有功出力 **Active power reduction in case of over-frequency**
    - 发生离并网点很近的三相短路故障或对称性电压跌落时，发电机组不能脱网；  
No disconnection of the generating facility in case of three-phase short circuits close to the connection point or symmetrical voltage drops
    - 电网故障时的无功支持和短路期间的短路（无功）功率； **Reactive power supply and short circuit power in case of network faults**
    - 故障后无功消耗方面的暂时限制 发电机组被切除； **Temporary limitation of reactive power consumption after a fault disconnection of the generating facility**
    - 保护装置的特殊调整。 **Special adjustment of the protection devices**

# 频率过高时降低有功出力 Active power reduction in case of over-frequency



$P_m$  暂态有功功率

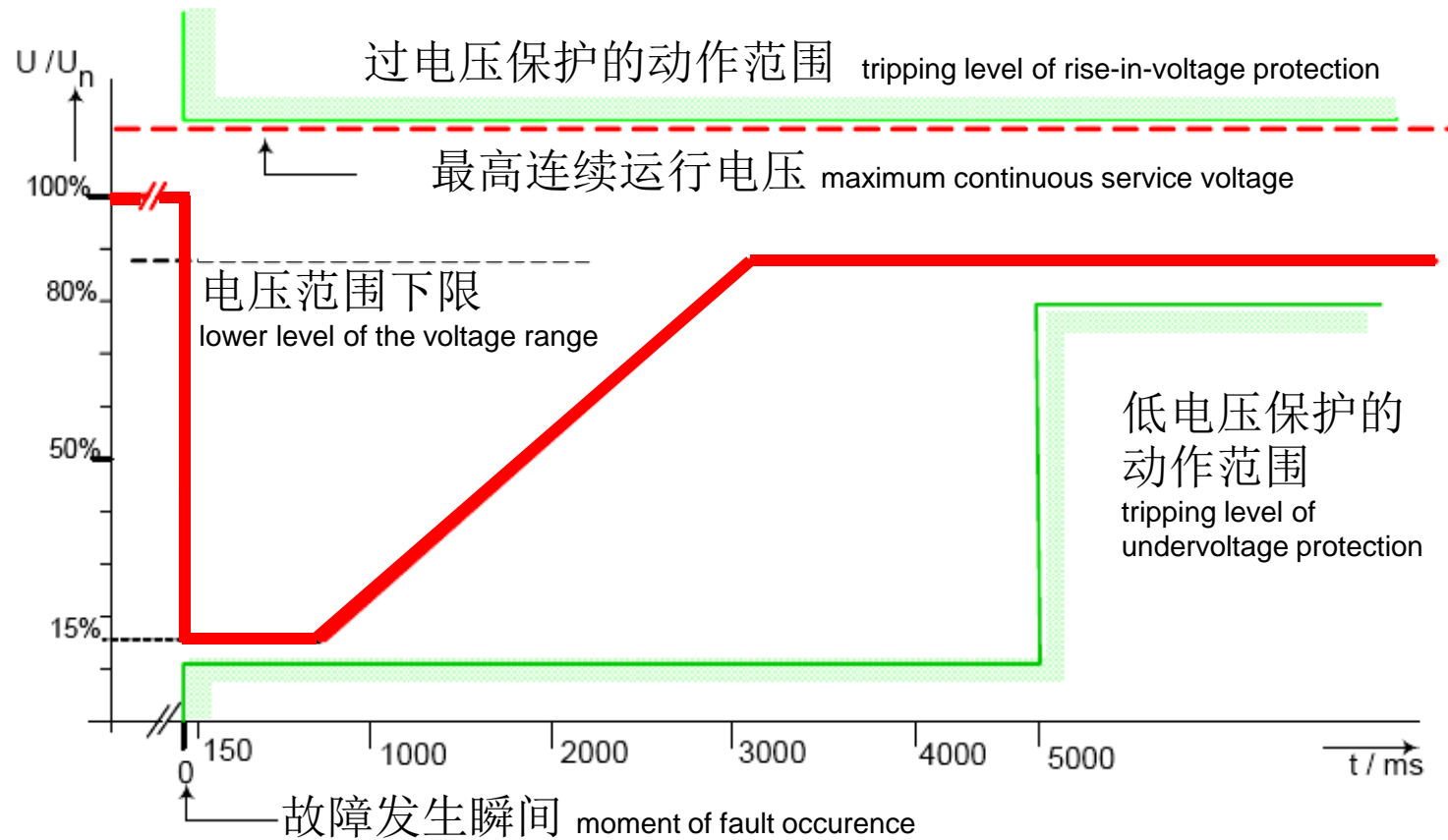
$\Delta P$  有功功率降低值

$f_{network}$  电网频率

频率范围:  $\ni 47.5 \text{ Hz} < f_{network} \leq 50.2 \text{ Hz}$  无限制

$f_{network} \leq 47.5 \text{ Hz}$  and  $f_{network} \geq 51.5 \text{ Hz}$  离网

# 保护装置的特殊调整 Special adjustment of the protection devices



当电压在红线以上时不允许可再生能源发电机组切机

No tripping of renewable based generating facilities at voltages above the borderline

# 结论 Conclusions

- 法律、规程和并网导则是风电并网的基础。

The integration of wind is based on legal, regulatory, grid code background

- 法律基础“可再生能源法”涉及了并网、电量收购、输配电、扩容和上网管理、电费支付、直接销售和电价，并给出了总体的补偿机制。

The legal basis “Renewable Energy Source Act” governs the grid connection and purchase, transmission & distribution, capacity expansion and feed-in management, payment claims, direct selling & tariffs and gives an equalization scheme in general

- 补偿机制法案给出了补偿机制的细节内容，它规定： The equalisation scheme in details is presented in the “Equalisation Scheme Ordinance“. It governs that

- 电网运营商有义务在市场中进行电量交易； the TSOs are obliged to market the electricity
- 电网运营商可以要求供电公司向其支付相关费用。  
the TSOs can claim reimbursement from the utility companies

- 补偿机制实施法案给出了最佳市场交易机制的激励措施；这种方式将促进电网运营商对其预测系统进行优化。

An incentives for best possible marketing is given in the “Equalisation Scheme Execution Ordinance”; by this the TSOs are obliged to optimise their forecast

- 输电导则中包含了对可再生能源发电设备的要求，比如：发生短路故障时的发电机组低电压穿越、无功功率支持、及保护装置特殊调整等等。

The “Transmission Code“ contains requirements upon generating units using renewable energy sources, e. g. no disconnection of the generating facility in case of short circuits, reactive power supply, special adjustment of the protection devices etc.