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国家能源局
National Energy Administration

Flexibility Technologies and Measures in the German Power System 德国电力系统灵活性技术和措施

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dena
German Energy Agency

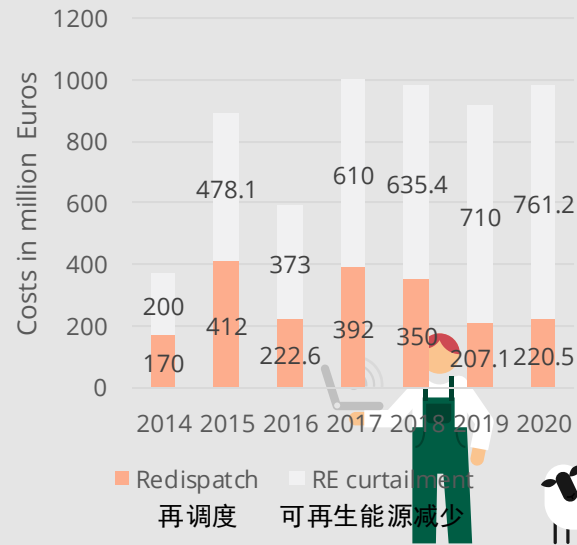
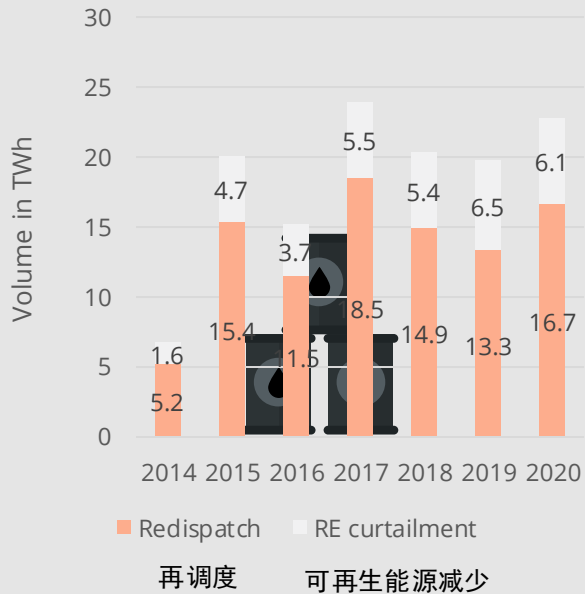
Demand for flexibility 灵活性需求

Demand for short-term localised flexibility depends on the percentage of grid bottlenecks

对短期本地化灵活性的需求取决于电网瓶颈的占比

Indicators: volume and costs of redispatch and curtailment

指标：再调度和弃风弃光的数量和成本



Flexibility options and their significance in the German context 灵活性选择及其在德国的意义

Provider of the service 服务提供方	Receiver of the service 服务接收方	Measures & technologies 措施和技术		Functions in the system 系统功能
Consumers or plant operators 消费者或电厂经营者	Balancing group managers (BRPs), DSOs or TSOs BRP、DSO或TSO平衡组管理者（平衡责任方） 配电系统运营商或输电系统运营商	Technical flexibility options 技术灵活性	Retrofit of conventional power plants, incl. cogeneration (CHP plants) Retrofit of biomass- and biogas-operated power plants 传统电厂的改造，包括生物质热电联产电厂和沼气电厂的改造 Pumped-storage systems 抽水蓄能系统 Batteries 电池 PtX电转X	User-related functions 用户相关功能 Market-related functions 市场相关功能
		Demand-side flexibility (DSF) options 需求侧灵活性	Industry 行业 SMEs 中小企业 Households 家庭	
DSOs and TSOs unilaterally or through cooperation 配电系统运营商和输电系统运营商单方提供或合作提供	DSOs and TSOs unilaterally or through cooperation 配电系统运营商和输电系统运营商单方提供或合作提供	System operation 系统操作	Redispatch 再调度 Curtailment 弃风弃光 Grid expansion 电网扩容 Advanced forecasting of RE generation 可再生能源发电的高级预测 Higher utilisation of the existing grid 提高现有电网的利用率 Cooperation between DSOs and TSOs 配电系统和输电系统运营商之间的合作 Cooperation and coordination between TSOs 输电系统运营商间的合作与协调 Cross-border power exchange 跨境电力交易	Grid-serving functions 电网服务功能 Grid-serving market-related functions 服务市场相关功能
Regulatory agencies and the legislator 监管机构与立法机构	Consumers, BRPs, DSOs or TSOs 消费者、平衡责任方、配电系统运营商或输电系统运营商	Market design 市场设计	Increasing granularity in the power market 电力市场辅助服务的频率越来越高 Ancillary services 辅助服务 Support schemes 支持计划	

Case example – functions of LSBs in the German power system

案例研究——LSB在德国电力系统中的功能

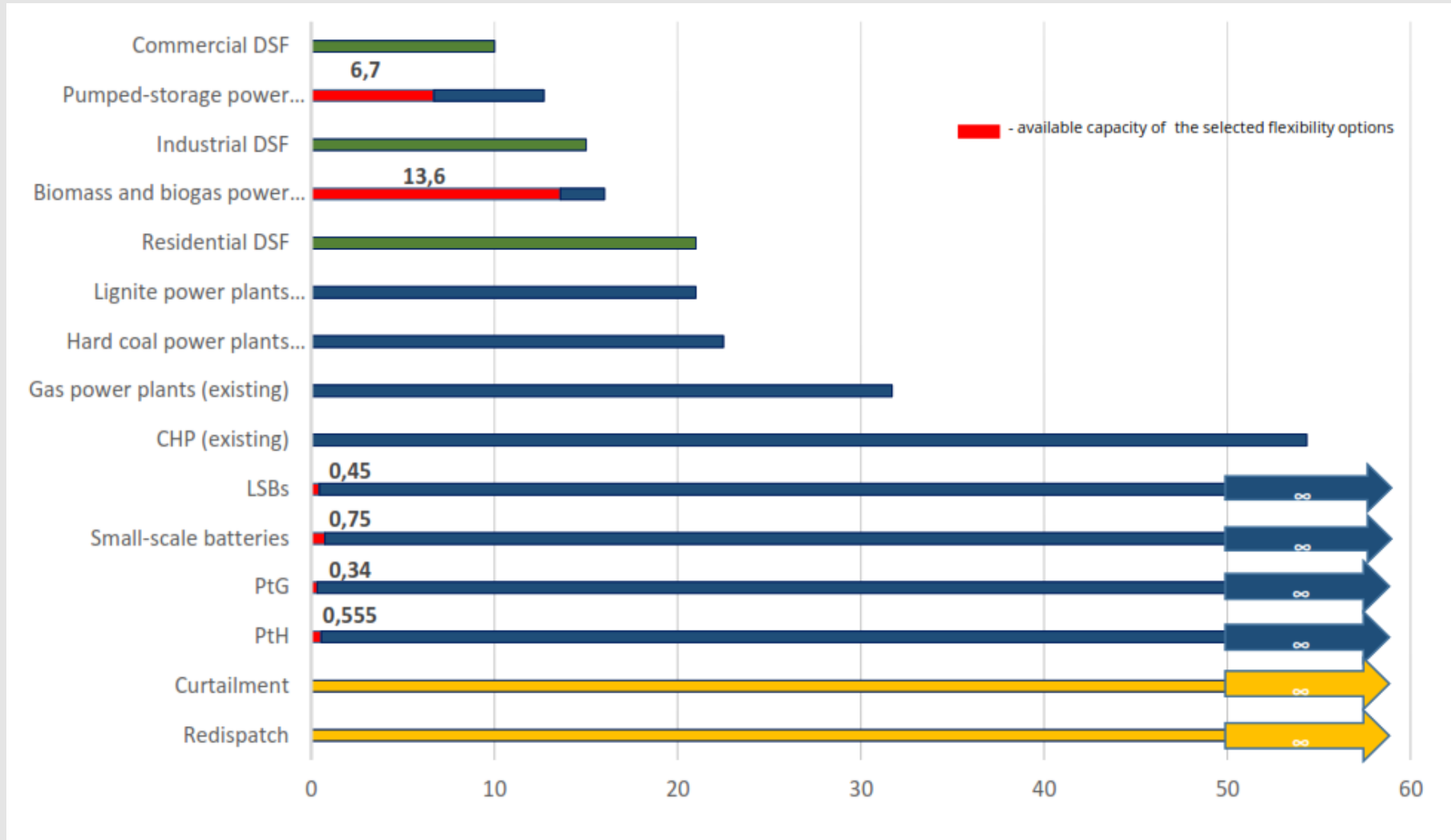
User-related functions 用户相关功能		Market-related functions 市场相关功能		Market-related grid-serving functions 市场相关电网服务功能	
<p>Increasing level of self-sufficiency 增加自给自足的能力</p> <p>Reduction of electricity costs 减少电力成本</p>	<p>Area-wide solutions* 区域解决方案*</p> <p>On-site battery for PV/wind park or conventional power plants (absorbing otherwise curtailed/ redispatched energy) 用于光伏/风力电场或传统电厂的电池储能 (吸收被迫放弃/再调度的能源)</p> <p>Optimisation of electricity grid charges based on different provisions related to tariff discounts 基于与电价折扣相关的不同规定来优化电网收费</p>	<p>Peak or load shifting 峰值或负荷转移</p> <p>Peak or load shaving 调峰或降低负荷</p>	<p>Spot market trading (arbitrage) 现货市场交易 (套利)</p> <p>Integration into virtual large-scale battery or VPP 融入虚拟大电池或虚拟电厂</p>	<p>Ancillary services 辅助服务</p>	<p>Black start capability 黑启动能力</p> <p>Provision of primary control energy 提供一次控制能源</p> <p>Integration into virtual large-scale battery or VPP 融入虚拟大电池或虚拟电厂</p> <p>Grid boosters 电网超级电池</p>
<p>UPS 不间断电源</p>	<p>Black start capability 黑启动能力</p> <p>Islanding 孤岛化</p>	<p>BRP/compensation energy</p> <p>平衡责任方/补偿能源</p>	<p>Selling electricity to BRPs to compensate for short-term deviations from schedule 向平衡责任方销售电力, 以支撑短期计划外发电</p>		

* Area-wide solutions: Different kinds of energy-related services to supply a housing complex in a certain area. In German: *Quartierlösungen*.

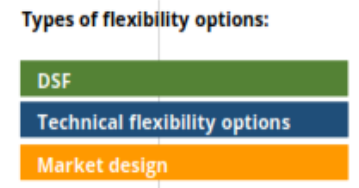
*区域解决方案: 提供不同种类的能源相关服务, 以供应特定区域的住宅区。德语: *Quartierlösungen*。

Potential and implementation of different flexibility options in Germany 德国不同灵活性选择的潜力与实施情况

商业需求侧灵活性
抽水蓄能
工业需求侧灵活性
生物质与沼气发电
居民需求侧灵活性
褐煤电厂
硬煤电厂
气电厂
热电联产
大型电池
小规模电池
电制天然气
电制氢
弃风弃光
再调度



灵活性选择类型
需求侧灵活性
技术灵活性选择
市场涉及



Source: own representation based on Table 13 of the report: dena (2021), „Flexibility Technologies and Measures in the German Power System“. 来源：根据报告表13自制：dena（2021），“德国电力系统中的灵活性技术和措施”。

Thank you for your kind attention!

感谢聆听!

If you have any questions, please contact:

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