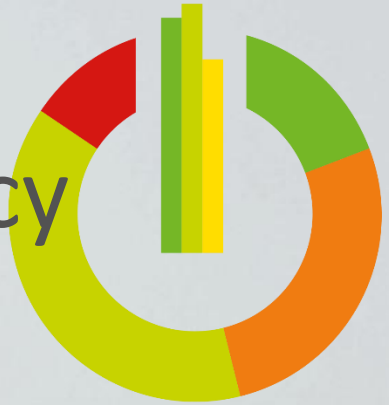
Demand response: An option for energy efficiency networks?

需求响应：能效网络的一种选择？



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Fraunhofer ISI

The Fraunhofer Gesellschaft at a glance
弗劳恩霍夫研究所简介

- Leading organization for applied research in Europe
  欧洲领先的应用科学研究机构
- International collaborations with excellent research partners and innovative companies around the world
  与世界各地的优秀科研伙伴和创新公司进行国际合作
- > 70% privately financed
  超过70%的经费来自私营领域

25 527 Staff
25 527 名雇员

72 Institutes and Research Facilities
下设72家研究院所和单位

2,3 Billion Euro
Budget

23亿欧元
的预算

Fraunhofer IMWS

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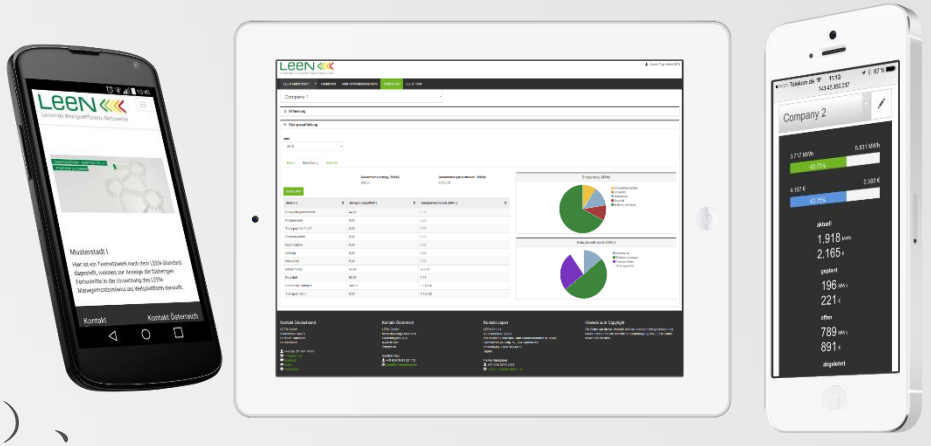
LEEN is a spin-off of Fraunhofer Society established in 2009
LEEN公司创建于2009年，是弗劳恩霍夫协会的衍生公司

LEEN currently operates or supervises networks in Germany, Austria, Belgium, Ukraine, Jordan, Nigeria
LEEN目前在德国、奥地利、比利时、乌克兰、约旦、尼日利亚运营或指导能效网络

LEEN has developed **leenize**,
an online solution for
auditing (ISO 50001) and
central planning and monitoring
of energy efficiency measures
at any number of company sites.
This includes energy efficiency networks.

LEEN开发了**Leenize**应用，它是可以为多个企业的现场能效措施提供审计（ISO 50001）、集中规划和监控的在线解决方案，其中包括能效网络



- 注：LEEN——Learning Energy Efficiency Networks 能效学习网络

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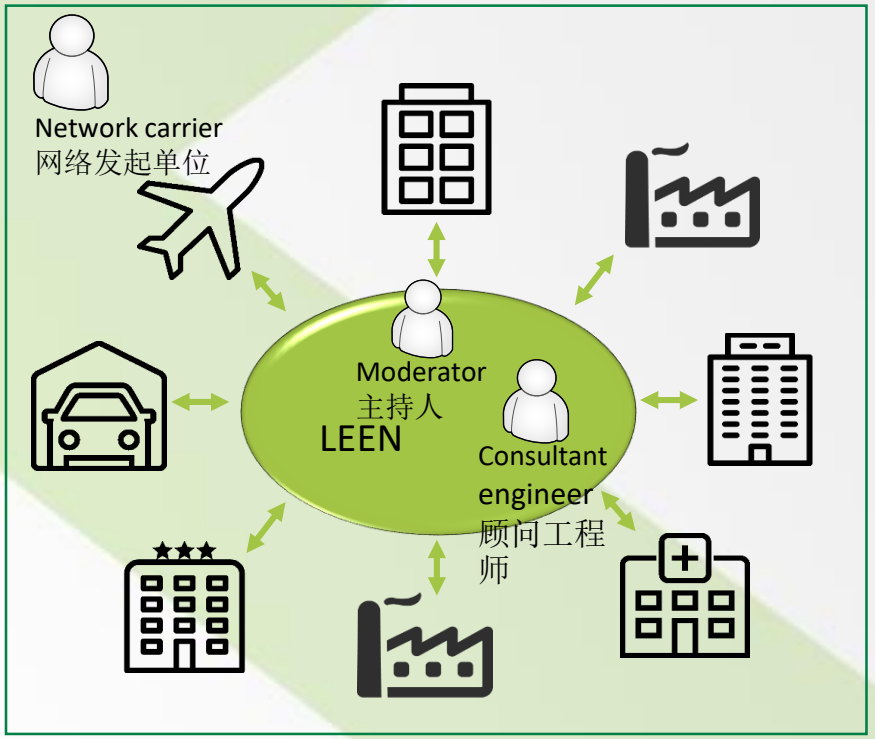
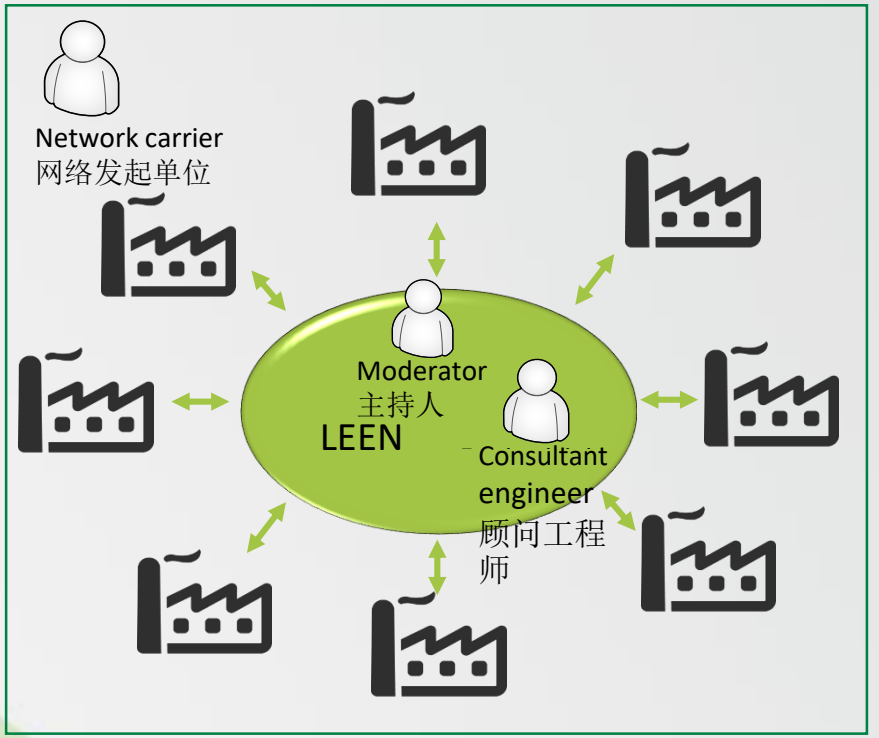
Typical network types
典型网络类型

Regional区域网络



Sectoral (including in-house)部门网络（包括内部）



How it works – an overview
工作流程——概览

LEEN energy audit^{plus}
(6 to 12 month)
LEEN能源审计plus
6-12个月

List with measures including technical and economical evaluation

If required: audit report

If required: ISO 50001

Common target setting on:

- Energy reduction
- CO_2 reduction

措施列表
包括技术与经济评估
如果需要：审计报告
如果需要：ISO 50001
共同目标设定：
- 节能
- 减排

Network meetings
(3 to 4 years)
网络会议
3-4年

Team building process by moderated meetings

- Site visits
- Presentations from experts
- Experience exchange on planned and realized measures

通过主持会议促进团队建设过程
- 现场参观
- 专家报告
- 计划中的和已实施措施的经验交流

Hotline
热线

Annual monitoring of measures
措施实施的年度监控

Communication of network activities
网络活动的交流

- Conducting energy audits: Identifying and evaluating saving potentials (lead: consultant engineer)
  进行能源审计：识别和评估节能潜力（负责人：咨询工程师）
- Conducting network meetings: Experience and knowledge exchange to speed up the implementation (team building process) (lead: moderator)
  举办网络会议：交流经验与知识，加快实施（团队建设过程）（负责人：主持人）
- Implementing measures (lead: participants)
  实施措施（负责人：参与方）
- Public relation: Advertising the network and its participants (lead: network carrier)
  公共关系：宣传网络及其参与者（负责人：网络发起单位）

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Network development in Germany
能效网络在德国的发展过程

The German development of energy efficiency networks took place in three phases

德国能效网络的发展主要分为三个阶段

2001 – 2008:	Single networks were conducted; no general structure 进行了单一的网络运转，没有通用的架构
2009 – 2014:	30 pilot network project; development of a systematic approach to set up und conduct networks (LEEN concept 30个网络的试点项目，开发了一个系统性的方法用以建立和运行网络（LEEN的概念）
Since 2015	Energy Efficiency Networks Initiative established: 22 industrial organisations agreed to establish 500 networks until 2020 自2015年能效网络倡议建立以来，已有22家行业组织同意到2020年之前建立500个网络
2019	250 networks operating or already finished 250个网络正在运行或者已经运行结束

Requirements: LEEN and network initiative
要求：LEEN和网络倡议

Element **元素**	**LEEN** **能效学习网络**	**Network initiative** **网络倡议**
Audit 审计	Audit according ISO 50002* 根据ISO 5002进行审计	no audit required* 无需审计
Run time 运行时间	3 to 4 years 3到4年	2 years 2年
Target setting 目标设定	Common 常规的	Individual 单独的
Monitoring 监测量	Measures based monitoring for each participant 措施基于对每个参与者的监测	External monitoring 外部监测
Minimum no of participants 最低参与人数	10	5

* Large companies (EU definition) are required to conduct an energy audit or introduce the ISO 50001 大型公司（欧盟定义）需要进行能源审计或引入ISO 50001标准

Results 结果

Evaluated monitoring reports 对监测报告的评估		
Companies 公司	No	210
Measures 措施	No	1,980
Total consumption 能耗总计	GWh/a	14,100
Total energy saved 节能总计	**GWh/a**	**870**
Electricity 电能	GWh/a	340
Natural gas 天然气	GWh/a	275
Gasoline 汽油	GWh/a	80
District heat 集中供热	GWh/a	39
Others 其它	GWh/a	85

Average yearly efficiency increase German industry: 0,9%/a
德国工业年度能效提升： 0.9%/年

Average yearly efficiency increase networks: 2,2%/a
网络企业年度能效提升： 2.2%/年

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Profitability of realized measures
已实施措施的盈利能力

▪ Energy savings 10 companies 10家企业的能源节约	1.4 million €/a 140万欧元/年
▪ Total investment 10 companies 10家企业的总投资	2.4 million € 240万欧元
▪ Average pay back period 平均投资回收期	1.7 years 1.7年

Source来源: EnBW Sales GmbH

Profitability: typical dates per company
盈利能力：每个公司的典型数据

- 10 to 15 profitable measures
  10到15项可盈利的措施
- 1,000 to 10,000 MWh/a energy savings
  1000到10000 MWh/年的节能量
- 300 to 3,000 t/a CO_2 reduction
  3000到3000吨/年二氧化碳减排量
- 200,000 to 2 million Euro investments
  二十万到两百万欧元的投资
- 60,000 to 600,000 Euro/a energy cost savings
  六万到六十万欧/年的能源成本节约

- Internal rate of return: >30%
  内部收益率大于30%
- Energy efficiency is a business not a cost factor
  能效是盈利的生意而绝非是成本因素

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Sample measure: IT service provider
简单的测算：IT服务供应商

Ventilation通风:	Re-construction of the ventilation system 重建通风系统	
Investment总投资:	157,000 Euro 15.7万欧元	
Annual savings年节约:	Electricity电力:	820 MWh/a
	CO_2减排:	379 t/a
	Energy costs 能源成本节约	98,400 Euro/a
Profitability盈利性:	Pay back回收期: 1,6 a（1.6年）	
	Internal rate of return: 63 % 内部收益率	

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Tire manufacturer: given situation
轮胎制造商：现状

- Energy consumption Base year 2008: 70,000 MWh
  2008年基准年的能耗：7万 MWh
- CO_2 emissions base year: 26,000 t
  基准年二氧化碳排放：2.6 万吨

Audit 审计

- 20 measures were identified and evaluated
  识别和评估了20项措施
- 15 measures were classified as profitable
  15项措施被认为是可以盈利的
- Total saving potential profitable measures: 4,000 MWh/a
  可盈利措施的节能潜力为：4000 MWh/年

Measures identified during audit: red highlighted
能源审计中识别的措施：红色标记
Additional measures: green highlighted
其它措施：绿色标记

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Tire manufacturer: 2009
轮胎制造商：2009年

Implemented measures 实施的措施	Electricity 电力 [MWh]	Nat. gas 天然气 [MWh]	District heat 管网热力 [MWh]
Outside lighting parking and weighbridge (trucks) 室外停车场和地磅（卡车）区域照明	4,9		
Lighting in workshop area 工厂车间的照片	47,8		

Tire manufacturer: 2010
轮胎制造商：2010年

Implemented measures 已实施的措施	Electricity 电力 [MWh]	Nat. gas 天然气 [MWh]	District heat 管网热力 [MWh]
Use of waste heat for hot water (process and domestic) 余热制备热水（工艺或生活用热水）		134,9	510,2
Supply air for compressed air system 为空压系统供气	20,0		
Use of waste heat from tire production for hot water – part 1 利用轮胎生产过程的余热来制备热水——第一部分			580,0
Variable speed drive for Compressed air refrigeration dryer I 压缩空气冷冻式干燥机的变频改造 I	59,9		
Lighting packaging area 打包区域照明改造	29,0		
Lighting control area 控制室照明改造	60,0		
Lighting tyre cooking area 轮胎蒸煮区照明	79,0		
Lighting work over area 工作区域照明	11,0		
New Burner and O2 control at steam boiler 蒸汽锅炉的烧嘴更换和加装氧气控制	350,0	668,1	
Insulation pipes and valves 阀门和管道的保温			69,8
Heat recovery at 4 compressors used for heating system and hot water 4台空压机余热回收用于采暖和热水制备		200,0	500,0
Reducing pressure in compressed air system at off production time 减少停产状态下空压系统的压力	20,0		
New heating circulating pumps 新型供热循环泵	36,0		
Insulation of steam reduction station 蒸汽降压站的保温		150,0	
Optimization of heat distribution for new heat demand 根据新的用热需求优化热力分配			430,0

Tire manufacturer: 2011
轮胎制造商：2011年

Implemented measures 已实施的措施	Electricity 电力 [MWh]	Nat. gas 天然气 [MWh]	District heat 管网热力 [MWh]
Use of waste heat from tire production for hot water – part 2 轮胎生产余热进行热水制备——第二部分			580,0
Replacement of mercury discharge lamps by LEDs in production area I 用LED替代生产区域水银蒸汽灯 I	6,0		
New lighting system in production area II 生产区域安装新的照明系统 II	312,0		
New lighting system in shipping building 发货区安装新照明系统	52,0		
New lighting system in warehouse 仓库安装新照明系统	16,7		

Tire manufacturer: 2012
轮胎制造商：2012年

Implemented measures 已实施的措施	Electricity 电力 [MWh]	Nat. gas 天然气 [MWh]	District heat 管网热力 [MWh]
Replacement of cold water pump 更换冷却水泵	33,6		
Variable speed drive for Compressed air refrigeration dryer II 压缩空气冷冻式干燥机的变频改造 II	40,0		
New compressor 新压缩机	721,0		
Insulation of valses and pipes in boiler house 锅炉房阀门和管道保温改造		70,0	
Staff training to reduce compressed air leakages 员工培训以降低压缩空气泄露	100,0		
Replacement of CFL lamps by LEDs at advertising board (roof) （房顶）广告牌用LED灯替换CFL（紧凑型荧光灯）灯	23,0		
Staff training to reduce steam leakages at steam presses 员工培训，以减少蒸汽压机的蒸汽泄露		150,0	

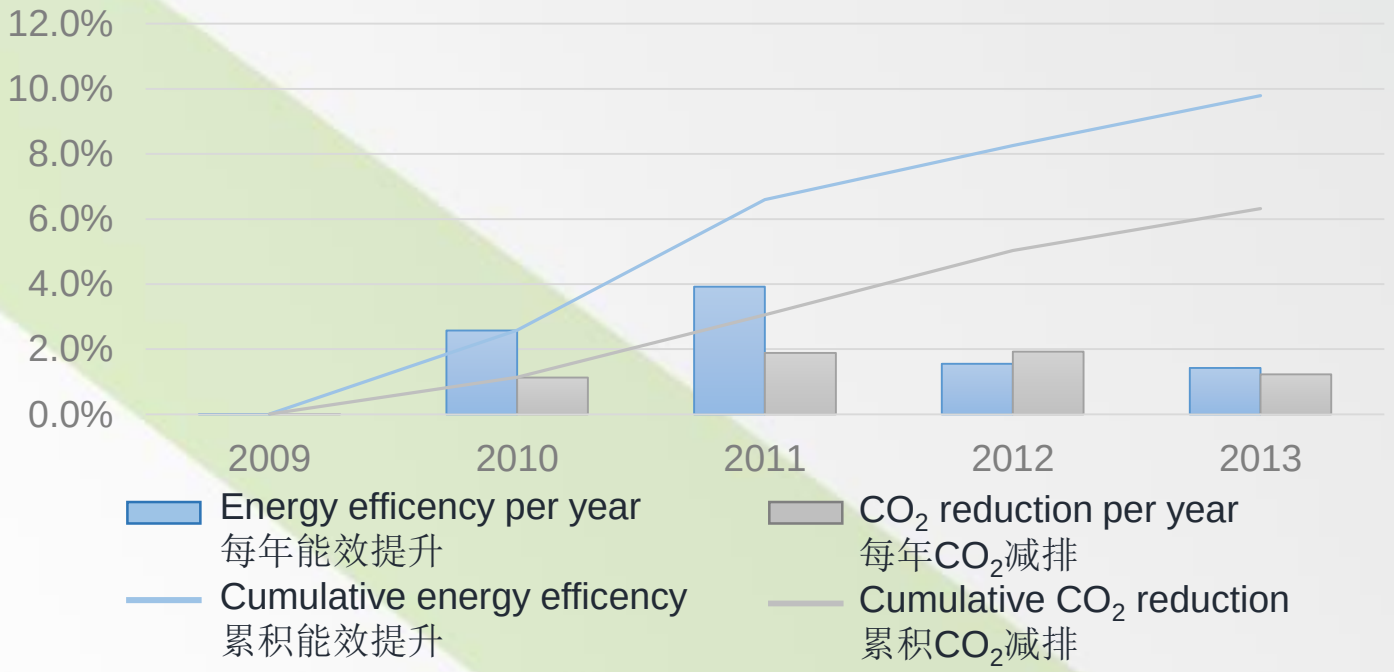
Tire manufacturer: 2013
轮胎制造商：2013年

Implemented measures 已实施的措施	Electricity 电力 [MWh]	Nat. gas 天然气 [MWh]	District heat 管网热力 [MWh]
New ventilators in production hall 生产车间安装新的通风设备	43,2		
Heating of thermal oil via heat pump instead of steam 用热泵替代蒸汽给导热油加热		400,0	
Reconstruction of heating system in reduce inlet temperature (office building) （办公楼）供热系统改造，降低入户温度			216,0
New water pump for heating system 供热系统采用新的水泵	70,0		
Of grid compressor for carbon black transportation (reduced pressure) 离网压缩机（独立的）进行炭黑输送（降低压力）	100,0		
2 new hot water pumps in production area 再生产区域采用2台新型热水泵	80,0		
Replacement of halogen lamps by LEDs in hallways 用LED等替换走廊的卤素灯	3,0		
Installation of compressed air controller 安装压缩空气控制器	50,0		

Tire manufacturer: overall monitoring results (2009 – 2013)
轮胎制造商：整体监测结果（2009年 - 2013年）

37 measures implemented (11 out of the audit report)
已实施37项措施（其中11项不包含在审计报告中）

Energy & CO_2 saved until 2013 至2013年减少的能耗与CO2排放		Profitability 盈利能力	
▪ Electricity电力:	2,370 MWh/a 兆瓦时/年	▪ Total investment总投资:	940,000 EUR 欧元
▪ Natural gas天然气:	1,770 MWh/a 兆瓦时/年	▪ Savings节省:	490,000 EUR/a 欧元/年
▪ District heat集中供热:	2,890 MWh/a 兆瓦时/年	▪ Payback回收:	1.9 years 年
▪ CO_2 reduction CO2减排:	1,560 t/a 吨/年	▪ IRR内部回报率:	52%



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Switzerland: a specific case
瑞士：一个独特的案例

- First network in 1987 (Energy Model Zurich, 8 participants)
  第一个网络成立于1987年（苏黎世能源模型，8个参与者）
- Introduction of CO_2 tax in 2000 (currently at 96 CHF per ton)
  2000年引入碳税（目前96瑞士法郎每吨）
- CO_2 tax not applicable to network participants (only if they are implementing measures)
  碳税不针对网络参与方（仅在他们实施了节能措施的情况下）

Further European countries
其它的欧洲国家

- Sweden 瑞典
  - 40 networks for mainly medium sized companies
    40个能效网络，主要是中型规模公司参与
  - centralized organization led by the Swedish Energy Agency using mainly the LEEN approach
    由瑞典能源署牵头集中组织，主要使用LEEN的方法
- UK 英国
  - few online SME and public sector carbon networks operated by the Carbon Trust
    由碳信托基金（Carbon Trust）运营的碳网络，在线的中小企业和公共机构很少
  - few networks but aiming at the energy sector and end-use households
    少量的网络，但是针对能源领域和终端家庭用户
- France 法国
  - few pilot networks were conducted by EdF
    Edf主导了少数试点网络
- Belgium 比利时
  - single network operated be icleantech using the LEEN approach
    Icleantech利用LEEN的方法运行了唯一一个网络

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Opening remarks
开幕词

Currently there is no practical experience with demand response as a topic within energy efficiency networks in Germany and abroad (except peak load management)
目前德国和国外能效网络中，还没有需求响应相关的实践经验（峰值负荷管理除外）

A single network integrating the question of demand response was planned, but was halted due to a restructuring process of the network carrier.
曾计划建设整合需求响应相关问题的单一网络，但由于网络发起单位的重组过程而停滞。

The presentation cannot give right now an answer if the network approach is useful to support DR strategies.
该报告现在无法回答网络方法对于需求响应策略的支持是否有用这一问题

Having the experience of energy efficiency networks it seems to be clear that the outstanding driver for DR will be profitability. Hence, frame conditions must be set accordingly.
拥有能效网络的经验，我们清楚地看到，需求响应优秀的驱动力是有利可图的。因此，必须相应地设置框架条件。

Demand response – company perspective
需求响应——企业视角

Do I have an energy consumption that can be shifted?
我有能耗可以转移吗？

- processes that are not time-critical　　工艺中时间并非关键特性
- processes whose products can be stored　　工艺中产品可以储存
- Processes with slow emerging effects　　工艺中紧急情况只会缓慢发生

If yes 如果是:

1. How big is it?
   能耗有多大？
2. How easy can the shifting process be established (fully automated)?
   转移过程的难易程度（全自动）？
3. How long is the maximum time period of the shift (minutes, hours, days, weeks)?
   转移周期最长多久（分钟、小时、天、周）？
4. Is it profitable?
   是否有利可图？

Demand response – company impressions
需求响应——企业印象

Asking network companies about DR
向网络公司询问有关需求管理的问题

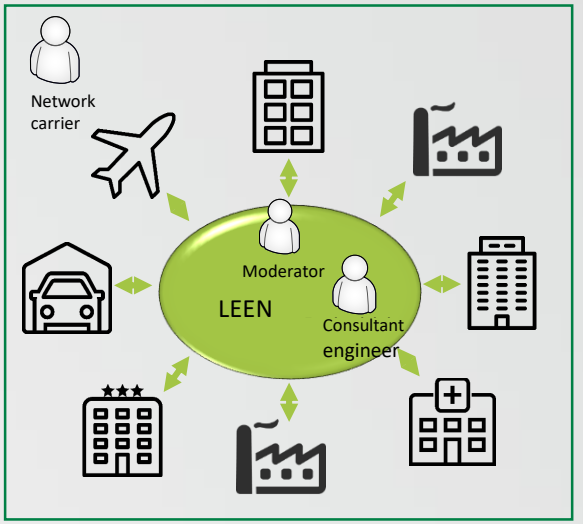
- All network companies know about peak load management
  所有参与网络的公司都了解峰值负荷管理
- Hardly any company knows the general concept of demand response
  几乎没有公司了解需求响应的通用概念
  - Never heard of it 从未听说过: 48%
  - Heard about, but no action 听说过，但未采取行动: 42%
  - Checked DR options 核验过需求响应选项: 6%
  - Conduct DR 进行过需求响应: 4%

  (survey in the service sector 服务业统计调查)
- Industrial companies are more open minded towards the DR concept
  工业企业对需求响应方案持更加开放的心态
  - Industry: If we have a profitable potential, we would be willing to use it
    工业：如果我们有盈利潜力，我们愿意使用它
  - Service: Only, if it works full automated and does not interfere with our service
    服务业：仅当它完全自动化运行并且不会干扰我们的服务时，才会使用
- Industry: If core business is affected there is a favour for a manually controlled process
  工业：如果核心业务受到影响，则倾向于手动流程控制

Demand response – regional networks
需求响应——区域网络

Relevant aspects of regional networks
区域网络的相关方面

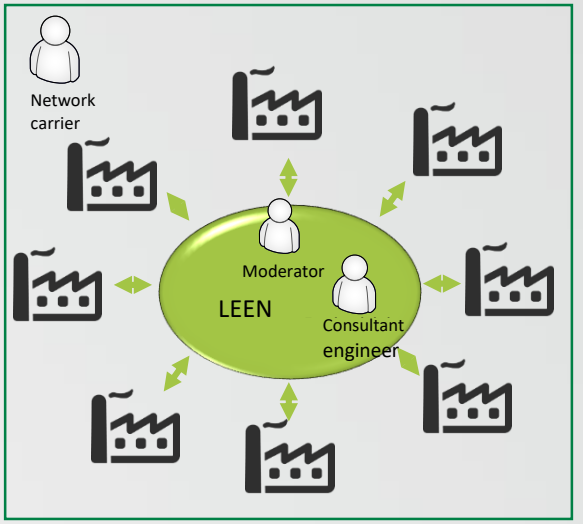
- Structure of load profiles are probably different
  负载配置的结构可能不同
- The companies are located in one region
  这些公司位于同一区域
- The relevance of DR for single participant probably differ
  需求响应的相关性对单个参与者来说可能不同



Demand response – sectoral networks
需求响应——行业网络

Relevant aspects of sectoral networks
行业网络的相关方面

- Structure of load profiles is probably similar – limited flexibility?
  负载配置的结构可能类似——灵活性有限？
- The companies are not necessarily located in one region
  这些公司不一定位于同一区域
- If network related DR requires revelation of a production process competition might be a problem
  如果网络相关的需求响应涉及到生产过程，那么竞争可能是一个问题



Demand response – local optimization
需求响应——局部优化

Local optimization: The network optimizes the aggregated load profile
局部优化：网络优化了聚合的负载配置

- Driver: cost optimization
  驱动因素：成本优化
- Optimal network profile does usually not lead to an overall optimization of the demand for a given supply structure
  最佳网络配置通常不会导致对给定供应结构需求的整体优化

=> Not a promising approach for the integration of RES
=> 不是一种前景广阔的可再生能源并网方法

Demand response – global optimization
需求响应——全局优化

Global optimization: The network optimizes according to the requirements of the electricity market

全局优化：根据电力市场的需求进行网络优化

- Driver: cost optimization
  驱动因素：成本优化
- The network carrier (utility) can act as an aggregator
  网络发起单位（公用事业）可以作为集约商
- The network offers a comparable large flexibility potential: Interesting partner for aggregators
  网络提供了相当大的灵活性潜力：对集约商感兴趣的合作伙伴

=> Promising approach for the integration of RES, if an according legal frame work is given

=> 如果有相应的法律框架，那么这是可再生能源并网非常有前景的方法

Networks in industrial parks operating with a energy service provider seem to be an ideal partner for DR.
与能源服务提供商合作的工业园区网络似乎是需求响应理想的合作伙伴。

General conclusions on networks and DR
关于网络和需求响应的一般性结论

- Networks are an interesting partner to establish DR
  网络将是建立需求响应很好的合作伙伴
  - They have overcome many of the obstacles for energy efficiency (e.g. lack of information, energy is just a cost factor)

    他们已经为提高能效克服了很多的障碍（例如：缺乏信息，能源是成本因素的观念）
  - They might offer large DR potentials compared to single companies

    与单一的公司相比，他们能够提供更大的需求侧响应的能力
  - They are used to work for a common goal

    他们习惯于为共同目标奋斗

General conclusions on networks and DR
关于网络和需求响应的一般性结论

- Requirements for introducing DR to networks
  向网络中引入需求响应的要求
  - There must be business model trusted by the companies
    必须有被公司信任的商业模式
  - Clarity of regulation, incentives and practical information are essential
    规则的明确，激励措施以及实用的信息都是至关重要的

DR can become a product for networks like energy efficiency measure already are

需求响应可以成为网络的一个产物，如同那些能效措施一样

Many thanks for listening! - 非常感謝

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Q&A
问答环节

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