让我们共同打造气候中和的未来
Building a climate-neutral future together.

中华人民共和国
住房和城乡建设部

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

环能科技 CABR EET

中国建筑节能协会

intep

skat Swiss Resource Centre and Consultancies for Development

Empa

HSLU Lucerne University of Applied Sciences and Arts

Anex Engineers AG

ZEB Talk
中瑞零碳建筑项目主题研讨会

In-depth course on thermal area networking
Anergienetz低温区域能源网络

Jakob Scherer, Anex Ingenieure AG

TABLE OF CONTENT

目录

Transformation of the energy supply

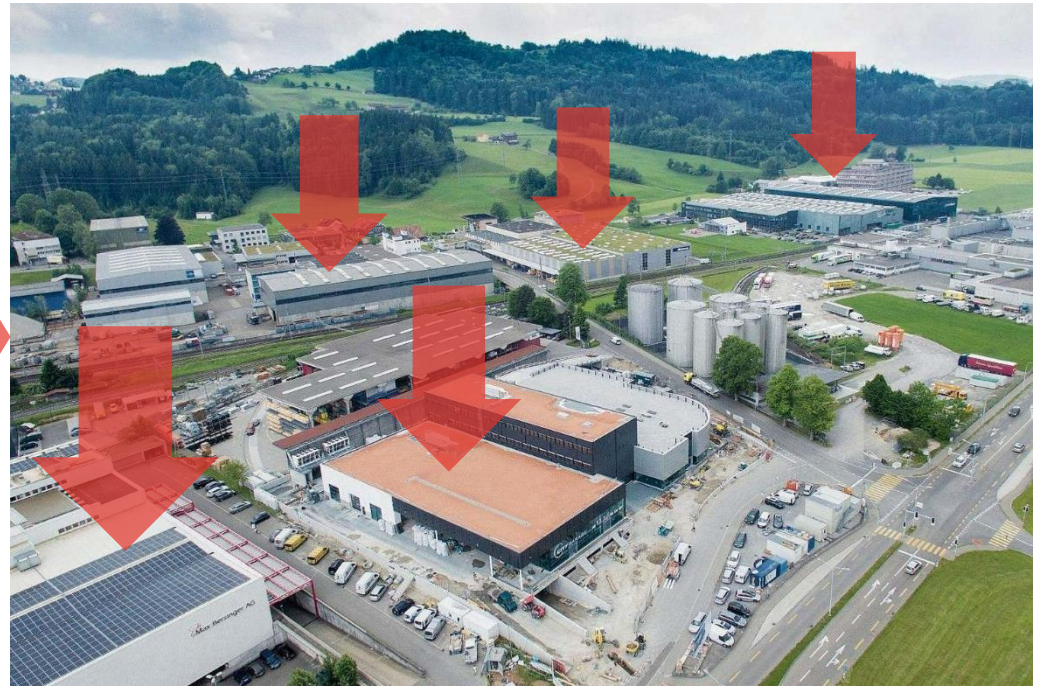
能源供应转型

- Moving away from fossil fuels has become political, climate-related and economic priority
- Consistent utilisation of local energy sources (waste heat, lake water, wastewater treatment plants, groundwater, geothermal energy, etc.)
- Dealing with increasing electrification
- We have to leave the low energy prices known from the past

- 摆脱化石燃料已成为政治、气候和经济方面的优先事项
- 持续利用本地能源来源（废热、湖水、污水处理厂、地下水、地热能等）
- 增加电气化
- 摆脱过去的低能源价格印象

Networking potentials far greater efficiency potential than the sum of individual solutions

网络化的效率提升潜力远超过单独解决方案的总和



- Building-internal heat recovery potential very low due to the process demands
- Usable renewable energy sources limited
- High primary energy requirement 'from the outside'

- 由于工艺需求导致的建筑内部热能回收潜力有限
- 可利用的可再生能源有限
- 高的外部一次能源需求

Networking potentials far greater efficiency potential than the sum of individual solutions

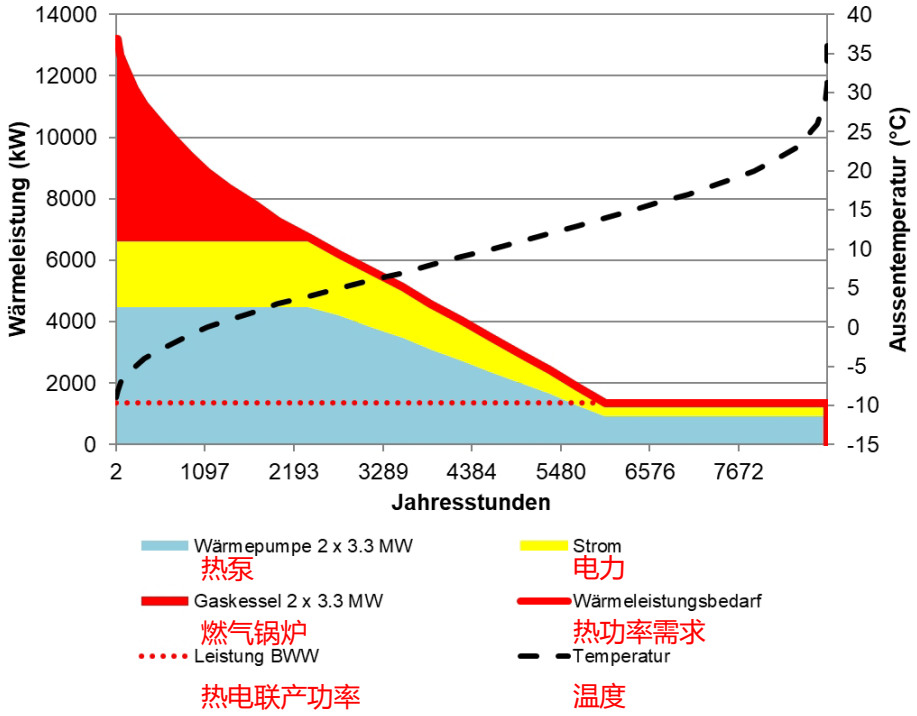
网络化的效率提升潜力远超过单独解决方案的总和

- Cross-building heat recovery potential greater by factors
- More versatile usable renewable energy sources
- Reduction of the Primary energy demand 'from outside'

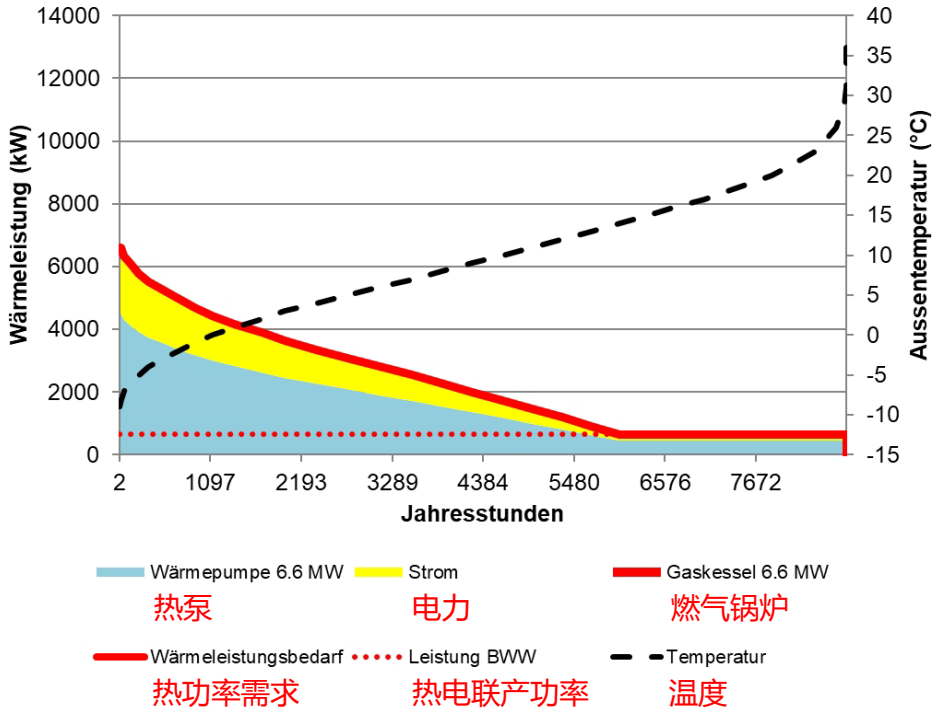
- 跨建筑热能回收潜力大
- 增加多功能可利用的可再生能源来源
- 减少外部一次能源需求

Dimensioning of heating network and source output

供热网络和热源输出的大小确定



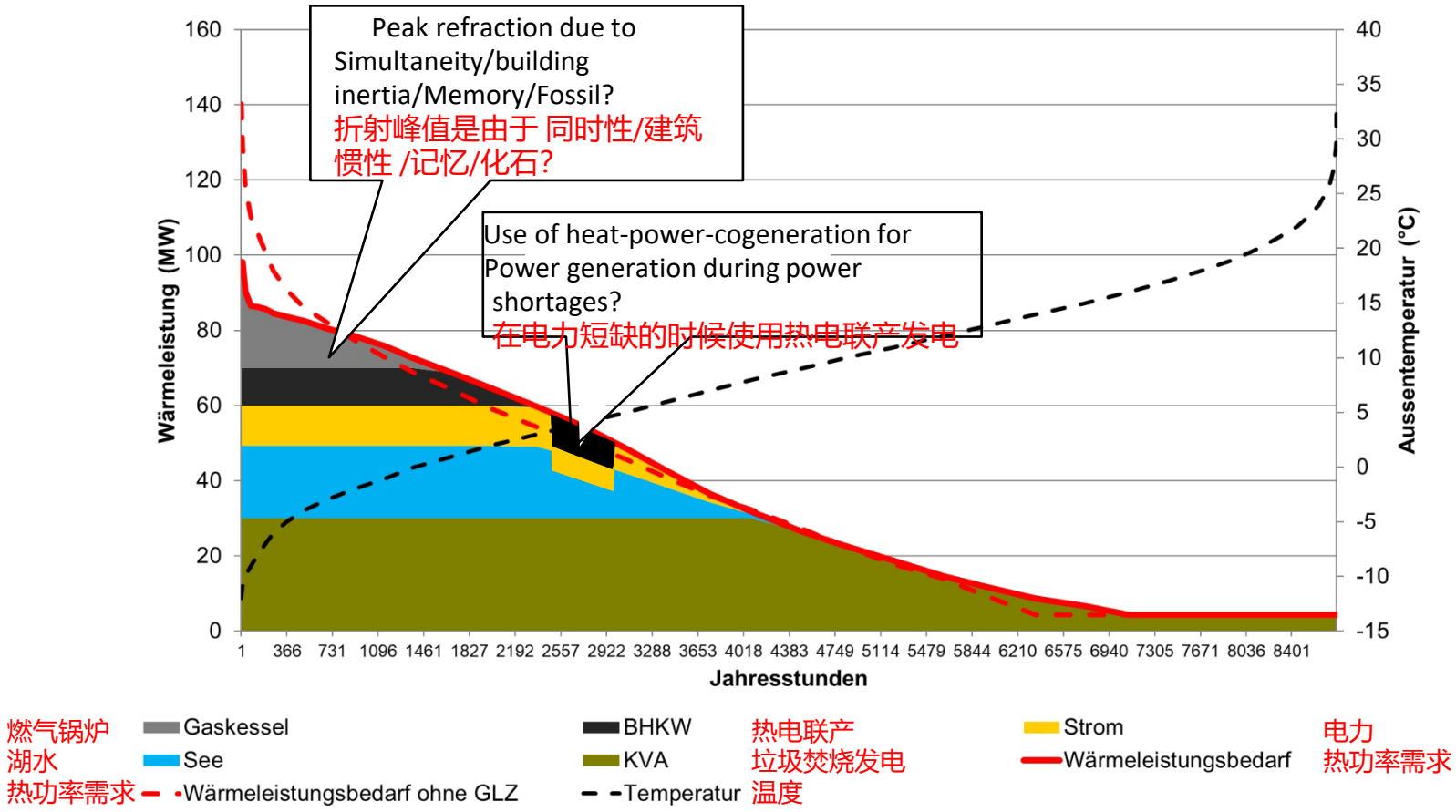
Bivalent system 双值系统



Monovalent system 单值系统

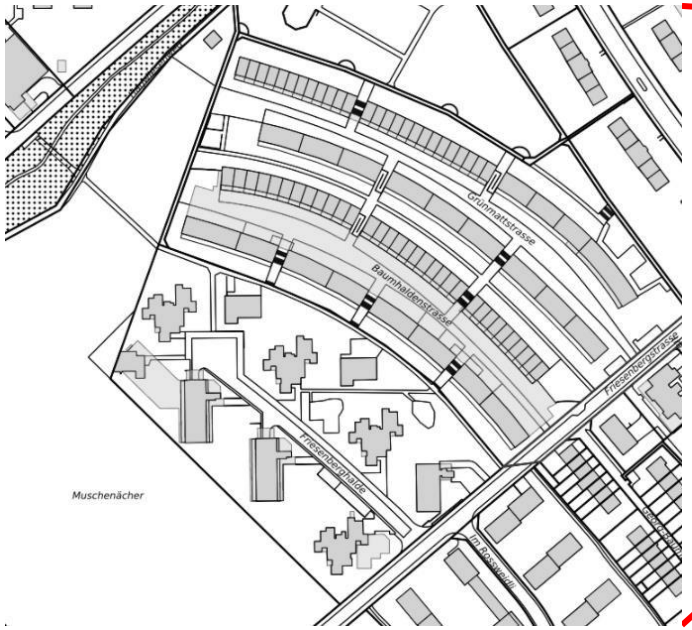
Dimensioning of heating network and source output

供热网络和热源输出的大小确定



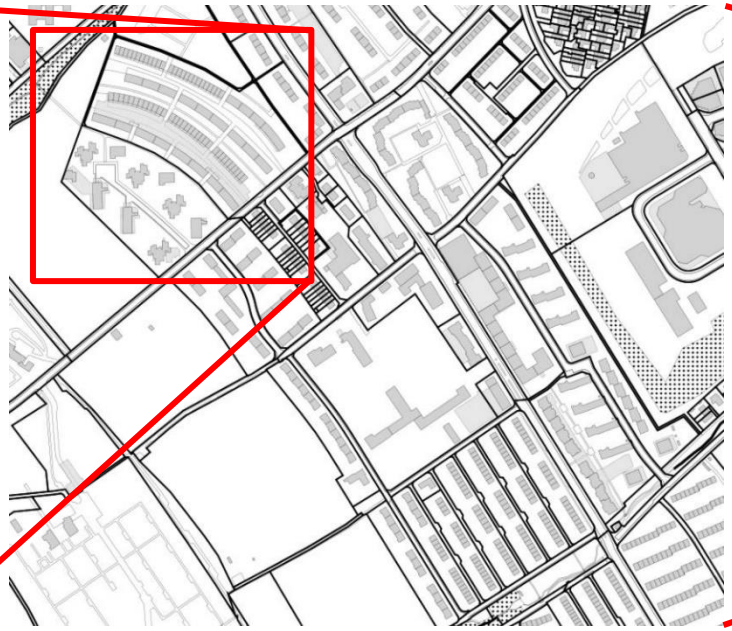
Site development

场地开发



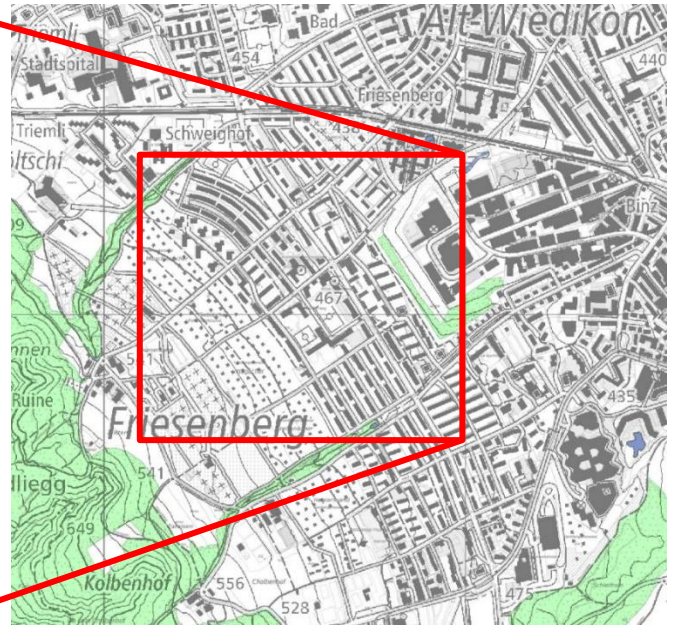
Site with focus on group with residential buildings
Limited options for heat supply

以住宅楼群为重点的场地供热选择有限



Expand focus to a larger area.
Range
of options can be expanded

将焦点扩大到更大范围



Variety of user profiles (housing, office, ...)
Connection density
Storage options

建筑类型多样化（住宅、办公室.....）
连接密度
储能选项

(Waste) heat sources

（废）热源

可以覆盖的住宅单元数量（一个符号代表100个住宅单元）

供热和制冷的符合曲线（蓝色：制冷需求，红色：供暖需求，绿色斜线：余热潜力）

Nutzung 来源	Leistungsbereich Abwärme 废热功率范围	Anzahl Wohneinheiten, die versorgt werden können (1 Symbol = 100 Wohneinheiten*)	Lastprofil Wärme- und Kältebedarf (blau: Kältebedarf, rot: Wärmebedarf, grün schraffiert: überschüssige Abwärme)
Abwärme Dienstleistungsgebäuden und Verkaufsflächen (Klimakälte) 办公楼和商业建筑（有制冷需求）的废热	0 2.5 5 MW		P Jan Jul Dez 一月 七月 十二月
Abwärme aus Laboren mit erhöhten Anforderungen an die Raumkonditionen (Temperatur und Feuchtigkeit) 对温度和湿度有较高要求的实验室的废热	0 2.5 5 MW		P Jan Jul Dez 一月 七月 十二月
Abwärme aus Industrieprozessen 供热生产过程中的废热	0 2.5 5 MW		P Jan Jul Dez 一月 七月 十二月

(Waste) heat sources

（废）热源

可以覆盖的住宅单元数量（一个符号代表100个住宅单元）

供热和制冷的符合曲线（蓝色：制冷需求，红色：供暖需求，绿色斜线：余热潜力）

Nutzung 来源	Leistungsbereich Abwärme 废热功率范围	Anzahl Wohneinheiten, die versorgt werden können (1 Symbol = 100 Wohneinheiten*)	Lastprofil Wärme- und Kältebedarf (blau: Kältebedarf, rot: Wärmebedarf, grün schraffiert: überschüssige Abwärme)
Abwärme aus Rechenzentren 数据机房中的废热	0 2.5 5 MW		P Jan Jul Dez 一月 七月 十二月
Kondensationswärme bei Rauchgas, v. a. Holzheizanlagen 烟气冷凝过程中的废热	0 2.5 5 MW		P Jan Jul Dez 一月 七月 十二月
Abwärme aus Kunsteisbahnen 人造滑冰场过程中的废热	0 2.5 5 MW		P Jan Jul Dez 一月 七月 十二月

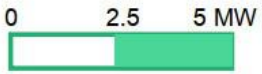
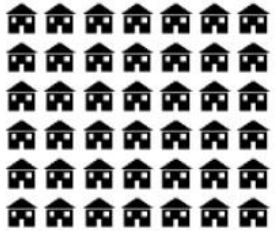
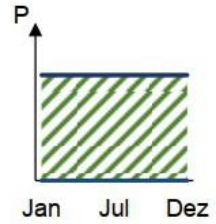
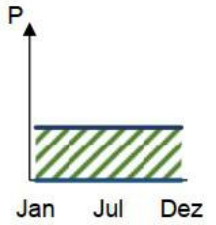
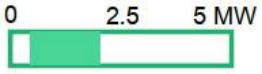
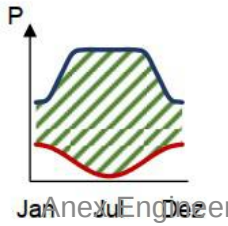
10

(Waste) heat sources

（废）热源

可以覆盖的住宅单元数量（一个符号代表100个住宅单元）

供热和制冷的符合曲线（蓝色：制冷需求，红色：供暖需求，绿色斜线：余热潜力）

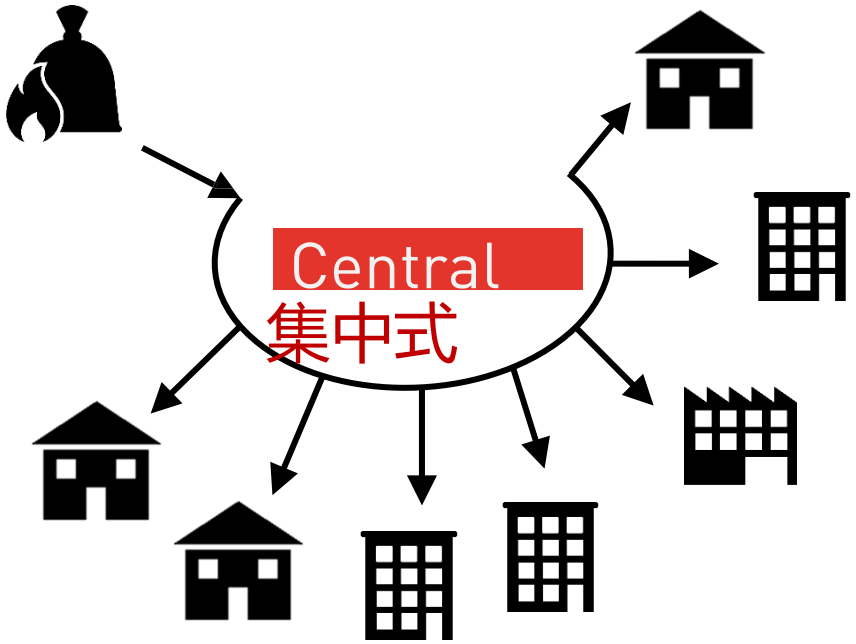
Nutzung 来源	Leistungsbereich Abwärme 废热功率范围	Anzahl Wohneinheiten, die versorgt werden können (1 Symbol = 100 Wohneinheiten*)	Lastprofil Wärme- und Kältebedarf (blau: Kältebedarf, rot: Wärmebedarf, grün schraffiert: überschüssige Abwärme)
Seewasser 湖水			
Grundwasser 地下水			
ARA ARA过程中的废热			

Centralised and decentralised networks

集中式和分布式网络

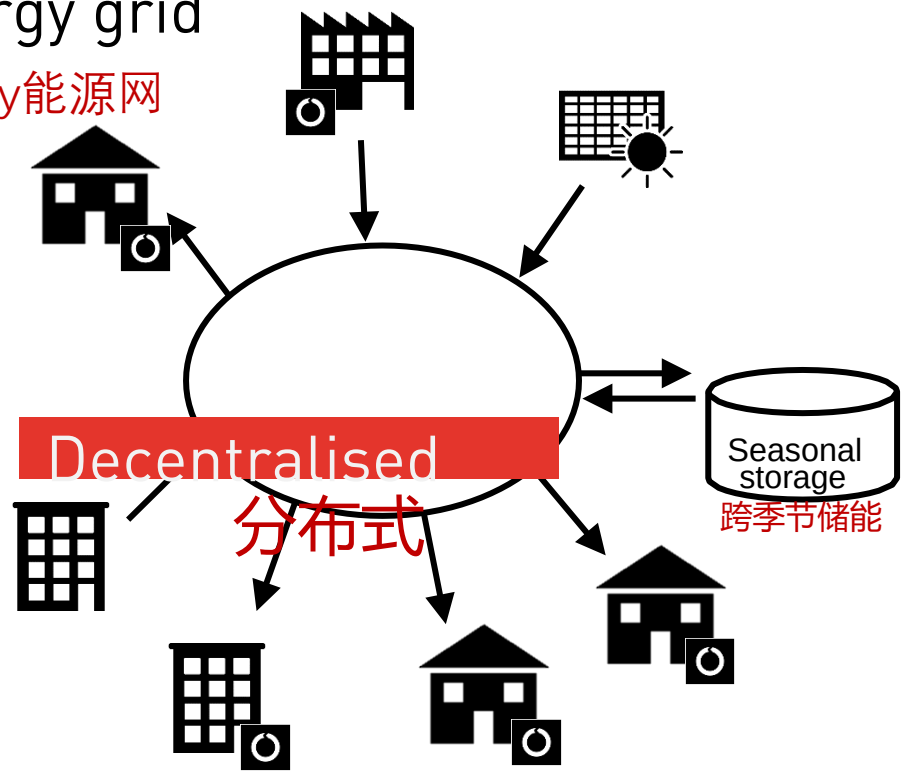
District heating network

区域供热网络



Anergy grid

Anergy能源网



Centralised and decentralised networks

集中式和分布式网络

Centralised networks 集中式网络

- Usually a large, local energy source (e.g. waste incineration plant, wood-fired heating centre)
- Homogeneous user structure (e.g. residential areas)
- High energy value
- High distribution temperatures /Useful energy
- Heat transfer via heat exchanger

- 通常是大型本地能源来源（如垃圾焚烧厂、木材供热中心）
- 均匀的用户结构（如住宅区）
- 能源价值高
- 分布温度高/能源利用率高
- 通过热交换器传热

Decentralised grids 分布式网络

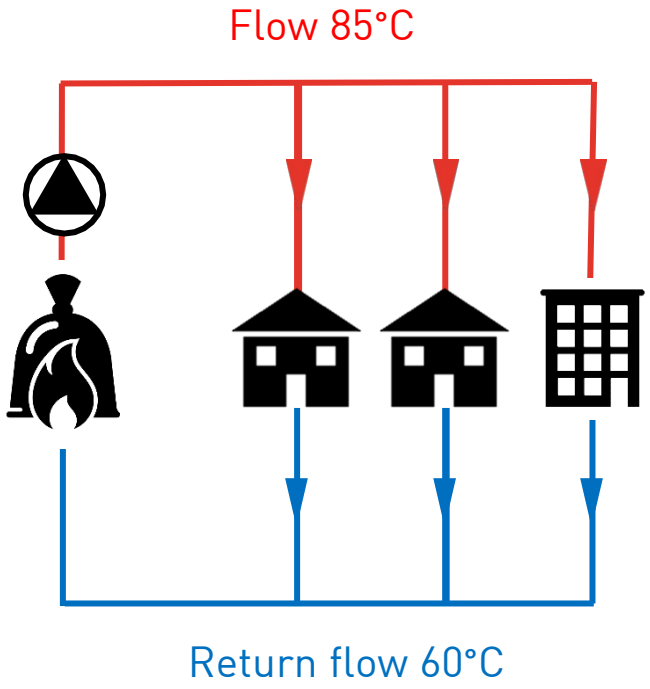
- Usually several decentralised heat sources / cooling users (e.g. data centres, service buildings, light industry)
- Heterogeneous user structure
- Relatively low energy value
- Low distribution temperatures / anergy
- Heat treatment with heat pumps

- 通常有多个分散的热源/冷却用户（如数据中心、服务楼宇、轻工业等）
- 不均匀分布的用户结构
- 能源价值相对较低
- 分布温度/能量较低
- 使用热泵进行热处理

Centralised and decentralised networks

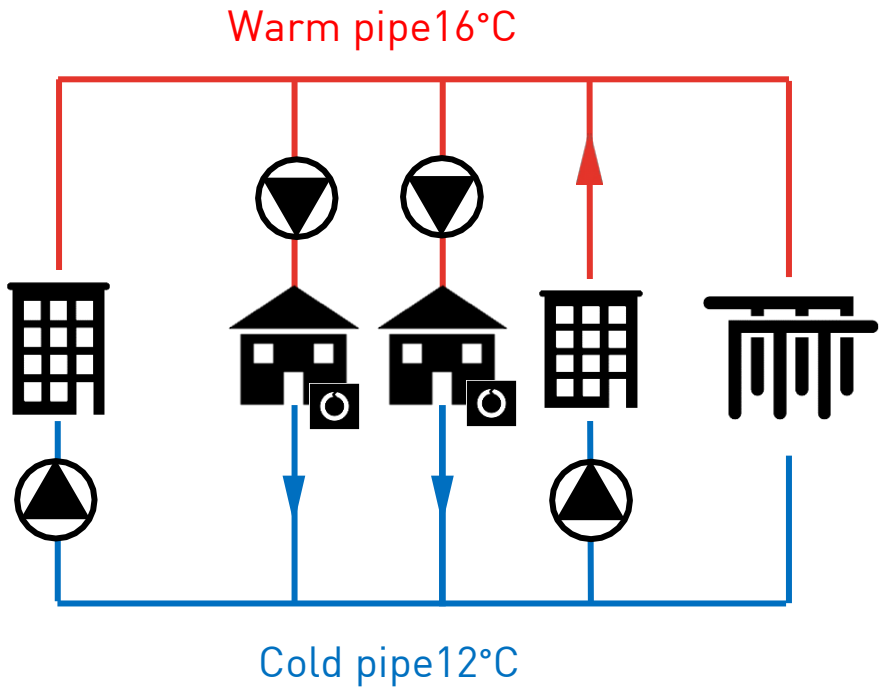
集中式和分布式网络

Directional district heating network (directional) 区域供热管网（定向）



Anergy grid bidirectional (non-directional)

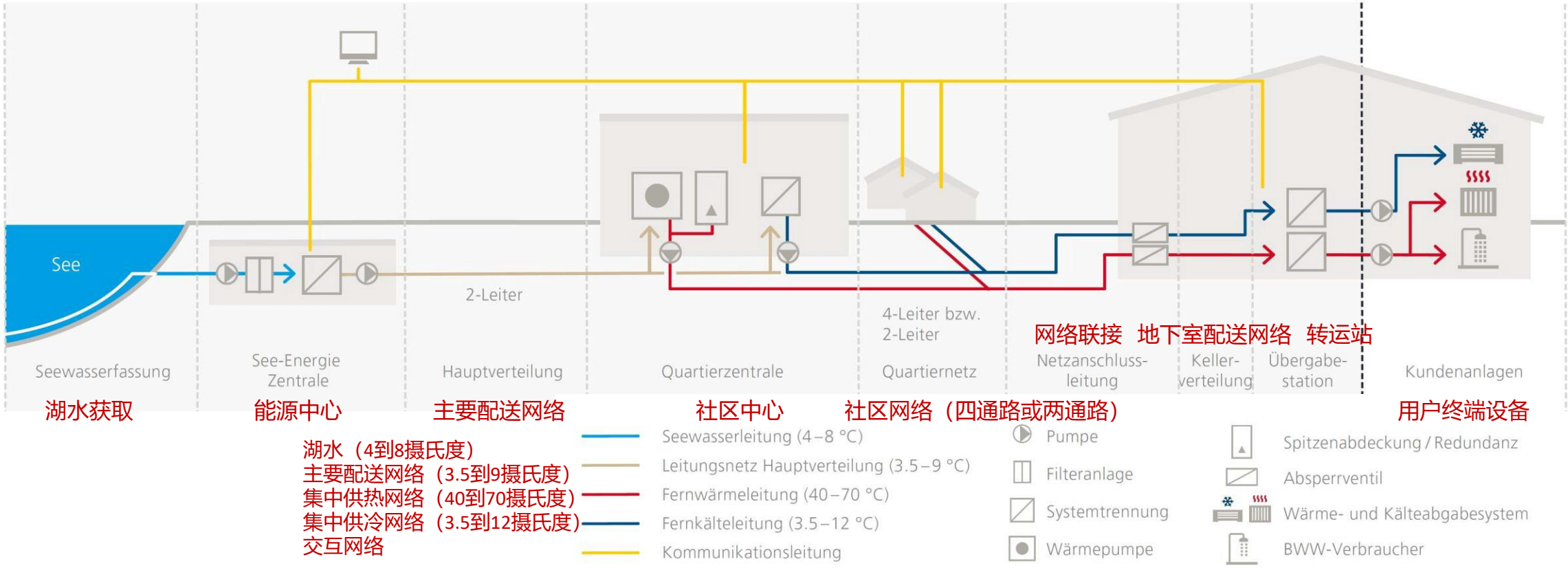
能量网格
双向（非定向）



Hydraulic switch (geothermal probes, seawater, groundwater, ...)

Finding the right degree of decentralisation

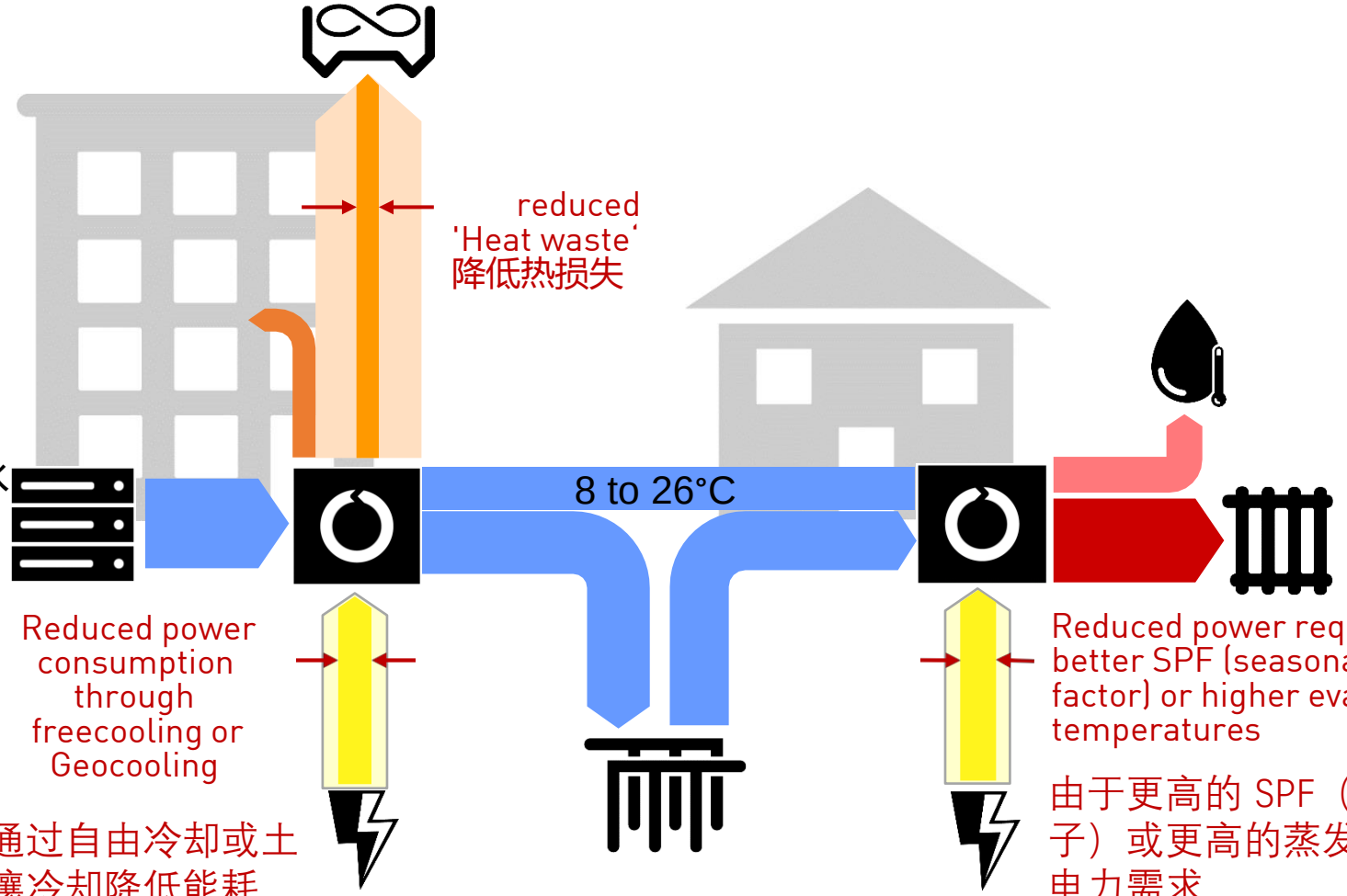
找到分布式的合理使用范围



Decentralised networks
Operating principle

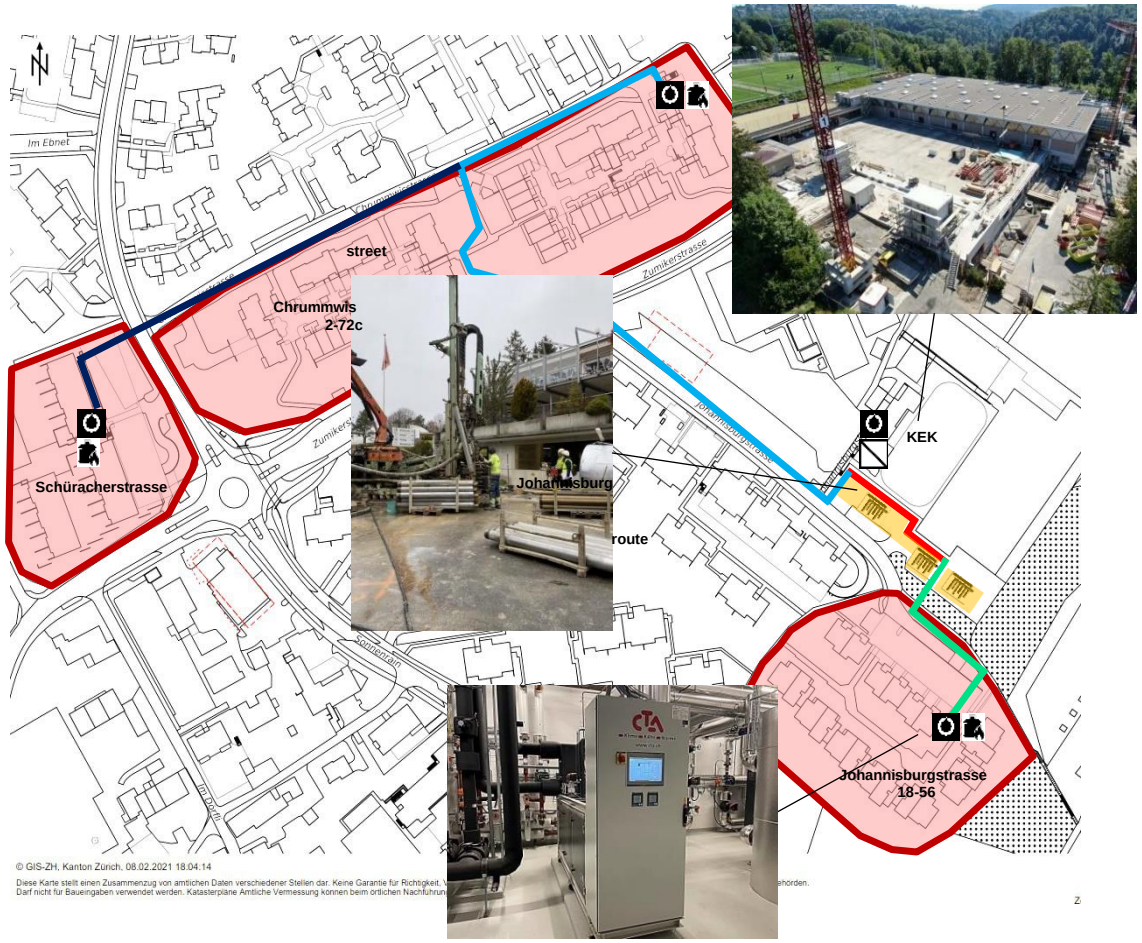
分布式网络运行原理

- Cold 冷
- Electrical energy 电力
- Waste heat 废热
- heating (60°C) 热
- Domestic hot water 40°C 热水



Example: Küsnacht artificial ice rink - Anergietz KEK

案例：Küsnacht 人工溜冰场



- Supply 270 flats with waste heat from the KEK ice rink
- Reduction of 600 tonnes of CO2 /a (100 return flights to Sydney or 500 times around the world by car)
- Win-win for KEK and heat consumers:
- - Substitution of 200,000 litres of heating oil per year
- -Complete recooling to the anergy network, no more
- recooling to the outside air
- -No water treatment, no noise
- Project costs approx. CHF 4 million (geothermal probes, pipeline network, energy centres, planning)
- Planning period feasibility to service: 3 yrs.

- 利用溜冰场的废热为 270 个公寓供热
- 每年减少 600 吨CO2排放（相当于100 次往返悉尼的航班或 500 次环游世界的汽车旅行）
- 实现溜冰场和用户的双赢：
  - 替代每年200,000 升的取暖用油
  - 对能源网络进行制冷，无需再冷却外部空气
  - 无需水处理，无噪音
- 项目成本约为 400 万瑞士法郎（地热探针、管网、能源中心、规划）
- 从可行性研究到投入使用的规划期： 3 年

SBB Werkstadt Areal Zurich - Groundwater utilisation

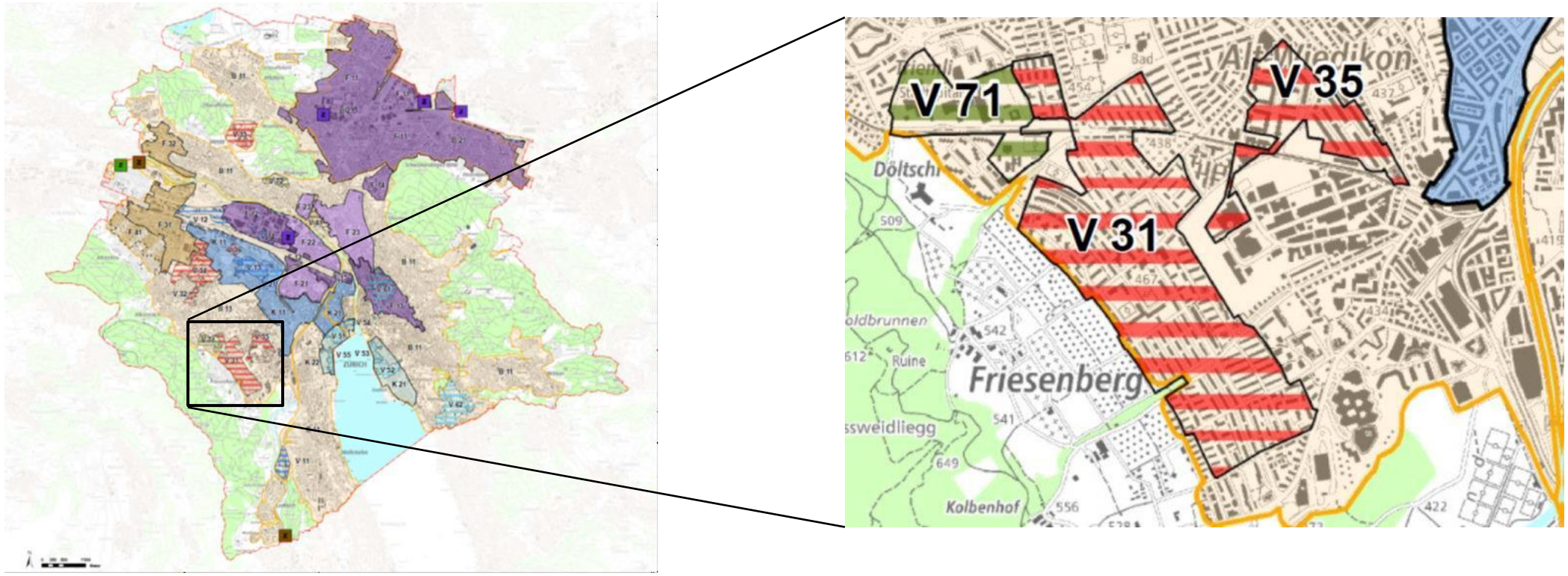
苏黎世 SBB Werkstadt Areal - 地下水利用

- Heating/DHW output
  - Requirement for domestic system according to planning: 686 kW
  - Installed capacity of heat pumps: 360 kW
  - -› 53% Simultaneity floor heating, DHW ventilation
- Learning:
  - Questioning dimensioning pays off
  - Negotiations with HVAC engingeers of building is important

- 供暖/热水产出
  - 家用系统需要 686 千瓦
  - 热泵安装功率 360 千瓦
  -> 仅需所需功率的53%，同事用于地暖、热水和通风
- 经验：
  - 对规模的疑虑得到了解决
  - 与楼宇暖通空调工程师的协同非常重要

Example of decentralised grid
Anergienetz Friesenberg

分布式网络案例
Friesenberg



Family Home Cooperative Zurich

苏黎世家庭住宅合作社

- 5,500 inhabitants5 500 名居民
- 2,300 residential units (terraced houses and flats) 2,300 个住宅单元（联排别墅和公寓）
- 190,000 m2 energy reference area 190,000 平方米能源参考面积
- 35 GWh/a Heat requirement35吉瓦时/年的热量需求

Swisscom Binz

瑞士电信Binz 分公司

- 瑞士电信在瑞士的四个主要地点之一
- 数据中心制冷需求（2020 年）：2.3 兆瓦，20 吉瓦时/年
- 可扩展至 4.0 兆瓦，35吉瓦时/年

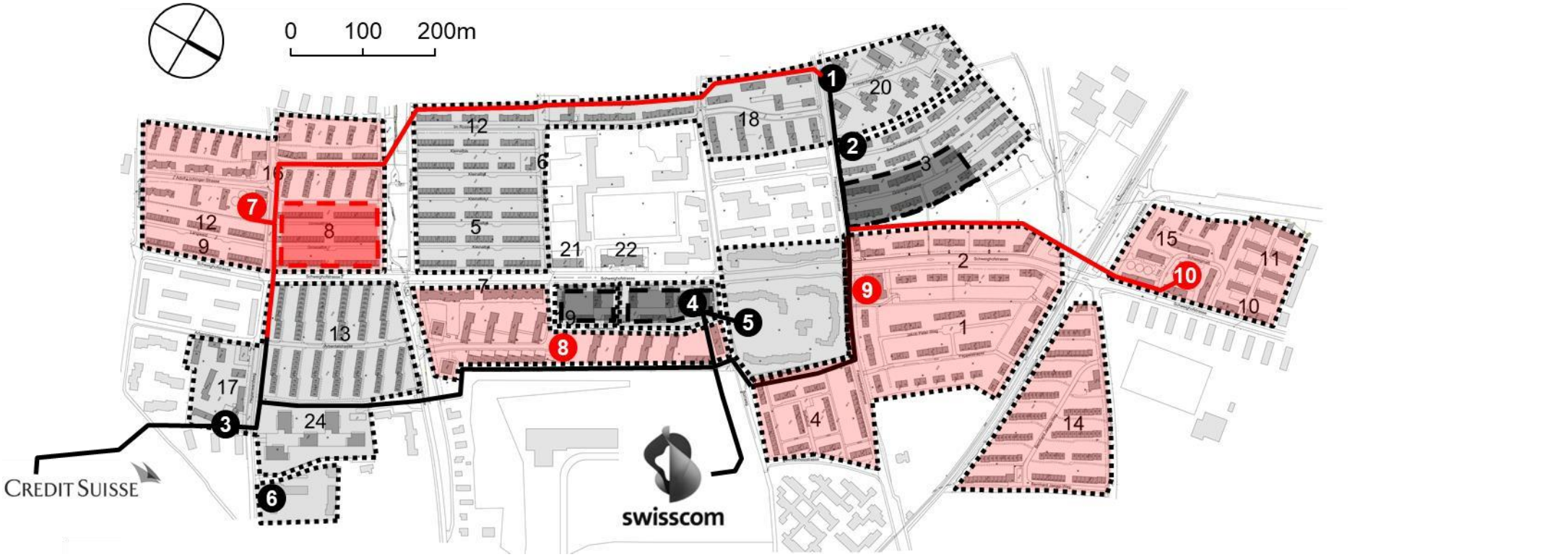
Credit Suisse Uetlihof

瑞士信贷 Uetlihof

- Building area the size of 36 football pitches 建筑面积相当于 36 个足球场
- 8,300 jobs 8300 个工作岗位
- 3,300 menus daily 每天 3,300 份菜单
- 6,600m^2 Data centre 6600 平方米的数据中心
- 900 parking spaces 900 个停车位

Friesenberg anergy network

Friesenberg能源网络



Friesenberg anergy network

Friesenberg能源网络

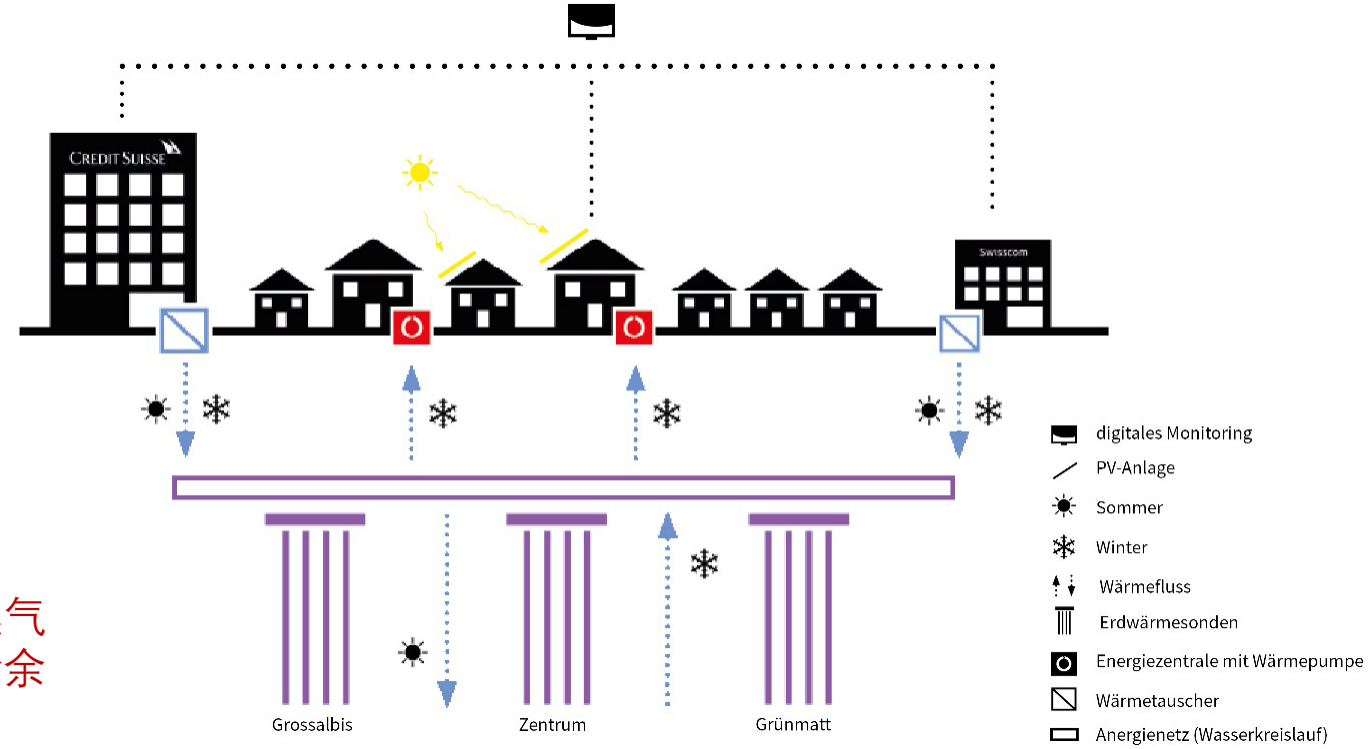
- https://www.youtube.com/watch?v=DhGk2vA_vHQ

Anergy network Friesenberg - How it works

Friesenberg能源网络的运作

- Use of waste heat from Swisscom and Credit Suisse data centres
- Oil and gas only necessary for peak loads in old buildings
- Store excess waste heat in summer with more than 330 geothermal probes (250m) and extract it in winter

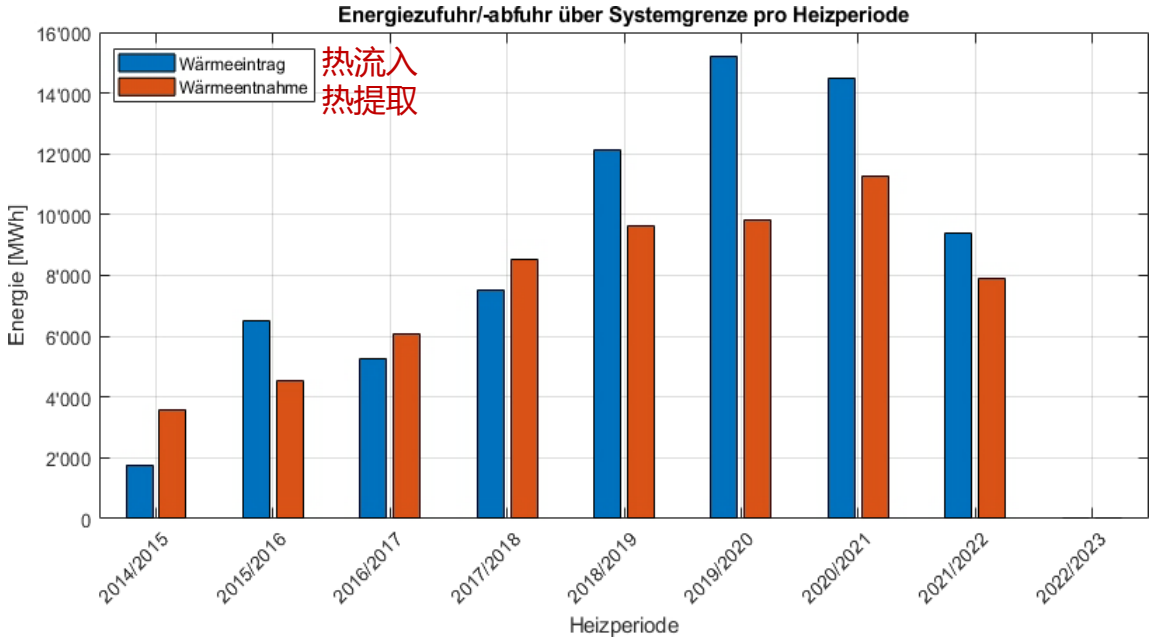
- 利用瑞士电信和瑞士信贷数据中心的余热
- 只有在建筑负荷处于峰值时才需要使用石油和天然气
- 利用 330 多个地热探头（250 米）在夏季储存多余余热，在冬季提取余热



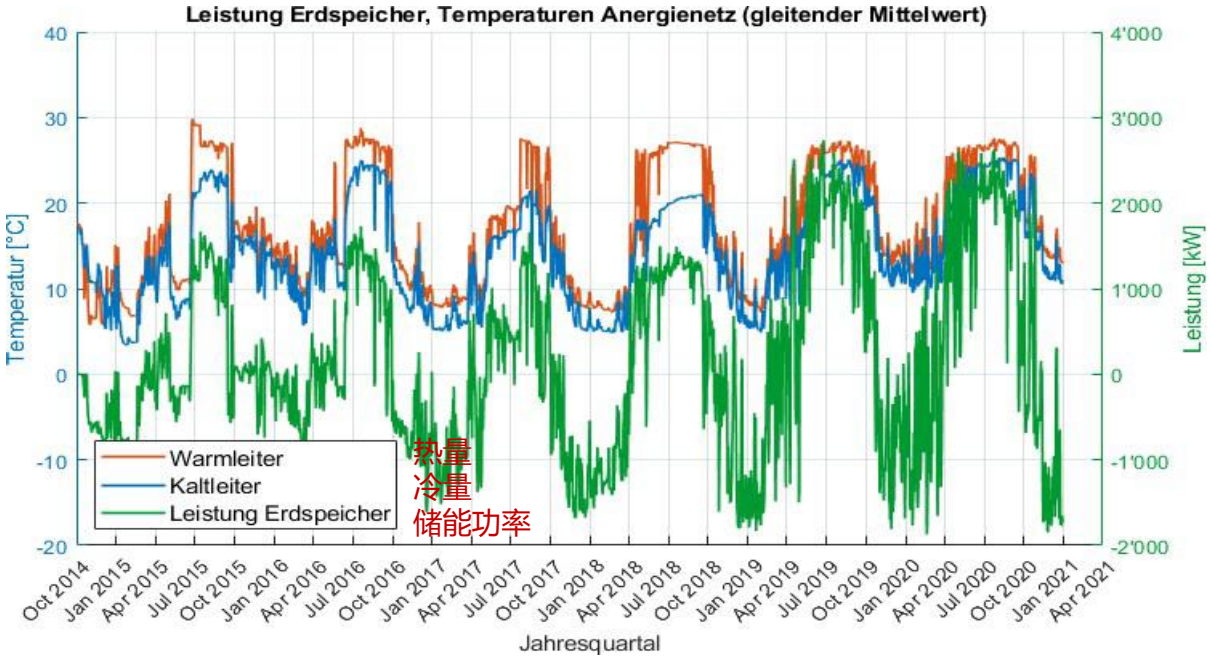
Temperature development / power Anergy network

温度开发/功率 能源网络

每个供暖季能源流入和流出

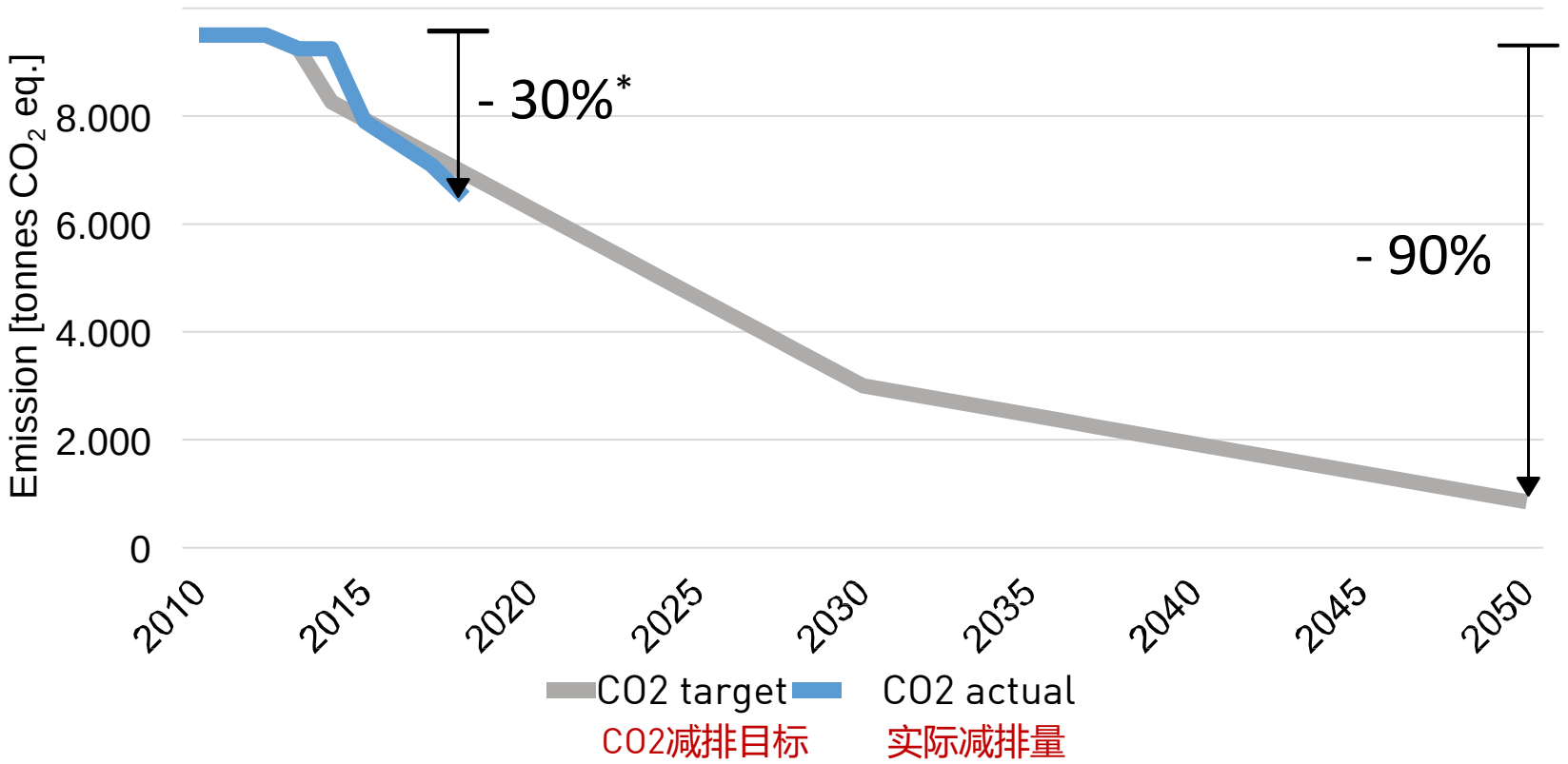


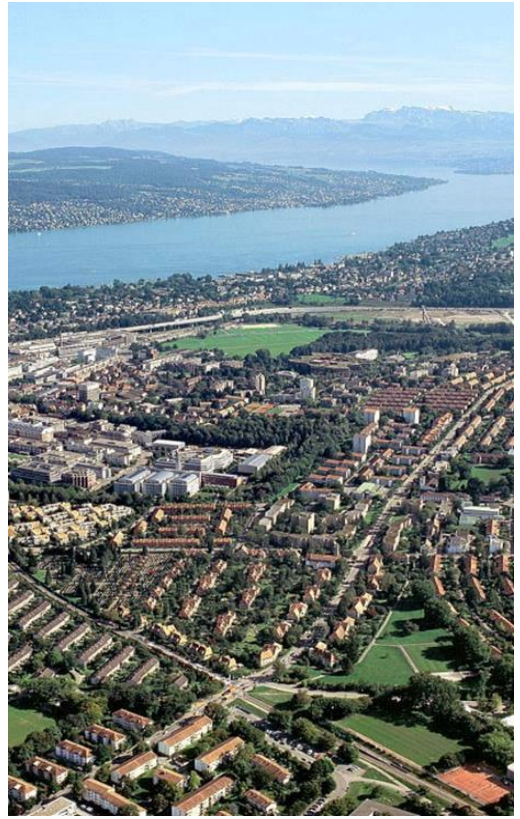
地下储能功率，Anergy能源网络温度



Reduction path CO2 eq emissions FGZ

减少二氧化碳当量的路径





* 13% AWN Credit Suisse, 13% AWN Swisscom and 3% due to refurbishments and replacement building

其中，13%减排量来自瑞士信贷，13%和瑞士电信， 3% 因翻修和更换楼宇所致

Increased efficiency through networking

通过建立网络提高效率

- Reduction of electricity requirement for cooling by 10 to 20% (depending on cooling temperature level or whether free cooling via anergy grid is possible)
- This partially compensates for the additional electricity demand for heat pumps
- Reduction in water requirement (fully demineralised) for hybrid recooling
- Savings in operating costs
- Better operational management of existing drycoolers (night-time operation of drycoolers limited/reduced due to noise, higher availability)

- 冷却所需的电力减少 10%至 20%（取决于冷却温度水平或者是否可以通过Anergy能源网络进行自然制冷）
- 这部分补偿了热泵的额外电力需求
- 减少混合再冷却过程对水的需求（去矿物质）
- 节省运行成本
- 改善现有干式冷却器的运行管理（由于噪音，干式冷却器的夜间运行受到限制，可用性提高）

The challenge of conflicts of interest between the parties

各方利益冲突的挑战

Heat supplier / cooling utilisation

- Would like to have a refrigeration supply that is as reliable and uninterrupted as possible
- Would like to be free in his entrepreneurial decision for his production plant that generates waste heat (location, time, capacity)
- May want compensation for waste heat or reserves the right to do so if a market for waste heat develops

Heat consumer / cooling supplier

- Cannot offer a guarantee for uninterrupted cold delivery
- Would like the longest and most constant Guaranteed supply of waste heat

- Would like the waste heat to be as cheap/free as possible for affordable heat generation costs

供热单位/冷消费

- 希望获得尽可能可靠和不间断的制冷供应
- 希望能自由决定产生余热的生产设备（地点、时间和容量）
- 希望获得余热补偿，或保留在余热市场发展时获得补偿的权利

热消费/供冷单位

- 无法保证不间断供冷
- 希望获得最长久、最稳定的余热供应保证
- 希望余热尽可能便宜/免费，以降低制热成本

Solution approach for conflicts of interest

解决利益冲突的方法

- In future, anergy networks with the integration of localised waste heat can increasingly be created by the public sector or local energy supply companies (on a larger scale)
- Anergy grid owner/operator builds compensation systems (probes, recoolers) outside city centres as a possible solution for densely built-up inner cities
- Fee for heat extraction (heating purpose) or heat input (cooling purpose) in depending on the respective (seasonal) supply and demand
- Uncertainty how many customers will connect: If necessary, assumption of a risk guarantee by the public sector

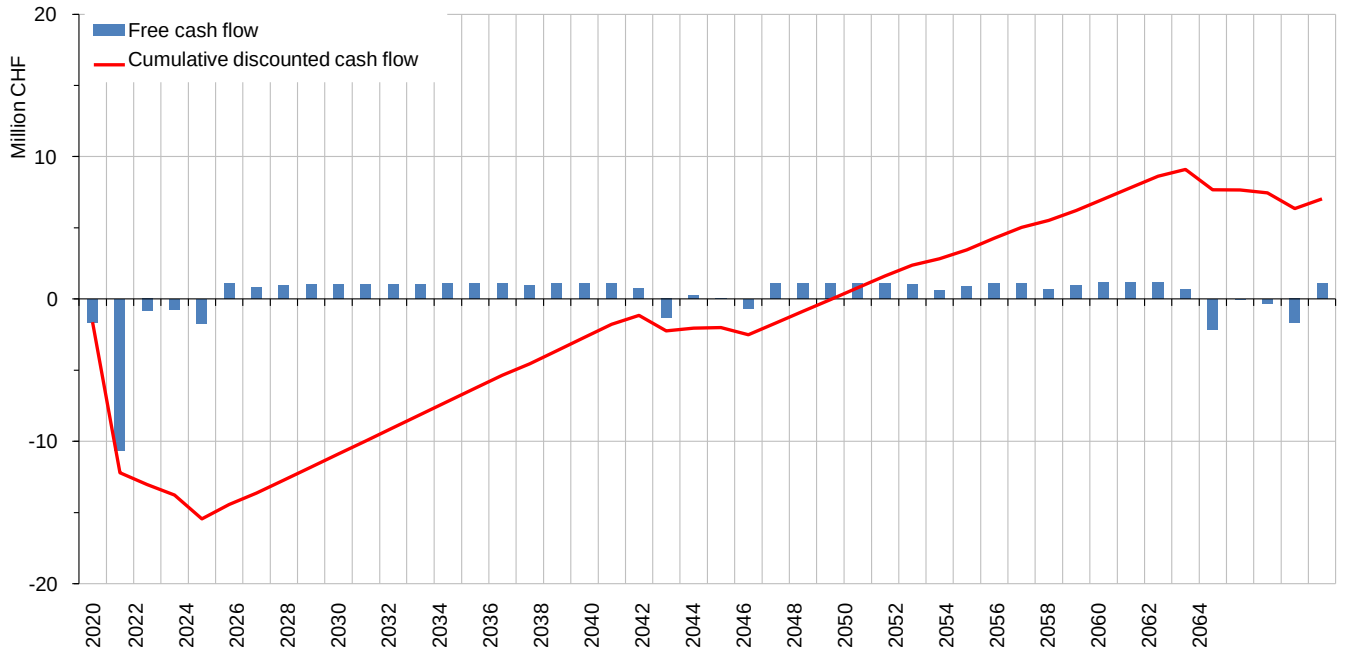
- 公共部门或地方能源供应公司（在更大范围内）将整合本地余热，建立能源网络
- 建立能源网络所有者/运营商在市中心以外建立补偿系统（探头、再冷却器），为建筑密集的内城提供解决方案
- 根据各自的（季节性）供需情况，收取热量提取（供暖）或热量输入（制冷）的费用
- 对热量获取（供暖）或热量输入（制冷）收费
- 针对不确定会有多少用户接入的风险，必要时由公共部门进行风险担保

Influencing factors

影响因素

- Connection density (energy per metre of grid/pipe)
- Connection rate (rate of users connecting to the network)
- User load profile (band load / peak load)
- Questioning requested demand quantities (kW)
- User temperature requirement (SPF heat pumps,Discounted cash flow cooling temperature level)
- Network temperatures
- Energy prices (i.e. electricity)
- Subsidies
- Business model (payback, IRR)

- 连接密度（每米的电网/管道的能量）
- 连接率（连接到网络的用户比率）
- 用户负载状况（带状负载/峰值负载）
- 询问需求量（千瓦）
- 用户温度要求（热泵、贴现现金流，冷却温度水平）
- 网络温度
- 能源价格（如电价）
- 补贴
- 商业模式（投资回报率、收益率）



Energy grid GSG - Industrial area Gossau St. Gallen Gaiswerwald

能源网络 GSG - Gossau St. Gallen Gaiswerwald 工业区

The challenge

- Involvement of 17 private
- companies
- Cross-community
- Low energy prices
- Short access routes
- High waste heat density (enormous, unutilized waste heat potential)

挑战

- 17 家私营公司
- 跨社区
- 能源价格低
- 通道较短
- 废热密度高（巨大的未利用余热潜力）

Energy grid GSG

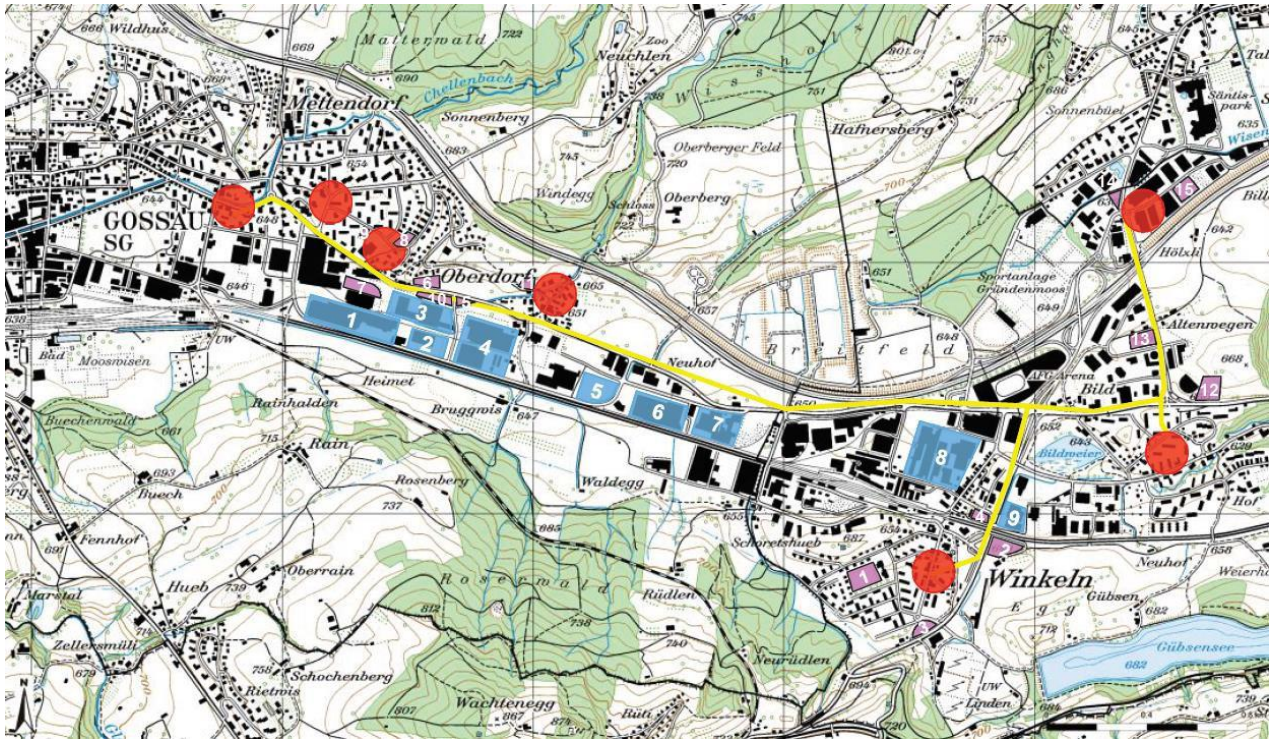
能源网络 GSG

Solution

- GSG Energy Network Association as a joint platform for companies and the public sector
- Energy as a core topic
- Realisation of anergy network as Private-public partnership)

解决方案

- GSG 能源网络协会作为企业和公共部门的联合平台
- 能源作为核心主题
- 实现公私合作的能源网络



Optimisation from the building to the site

从建筑到场地的优化

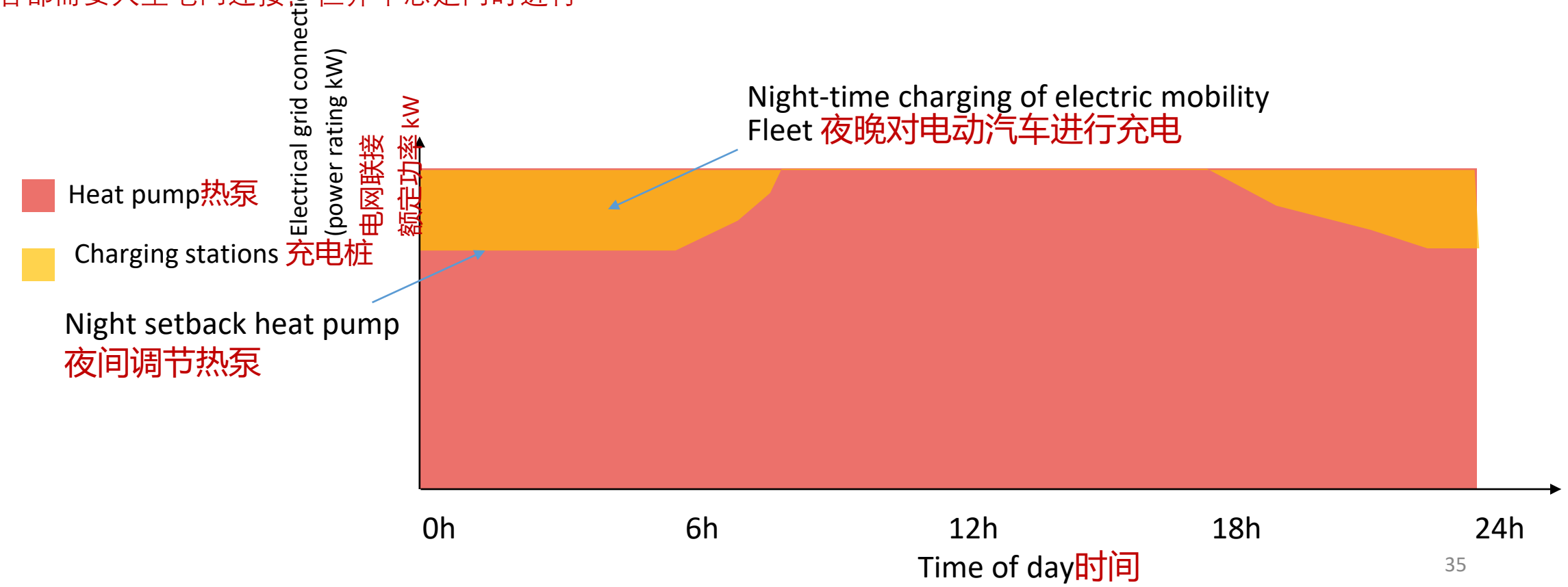
- Internal heat recovery with short-term storage (hours)
- Direct waste heat utilisation between buildings/ in the area
- Storage in the area (days to season)
- Equalisation via additional source / sink

- 带有短期储能功能的内部热回收（按小时）
- 建筑物之间/区域内的直接余热利用
- 区域内储能
- 通过额外的热源/热汇保持冷热平衡

Sector coupling electricity-heat-mobility Business model: Synergies with electromobility

电-热-交通业务耦合：与电动汽车的协同效应

- Both require large grid connections, but not always at the same time
  两者都需要大型电网连接，但并不总是同时进行

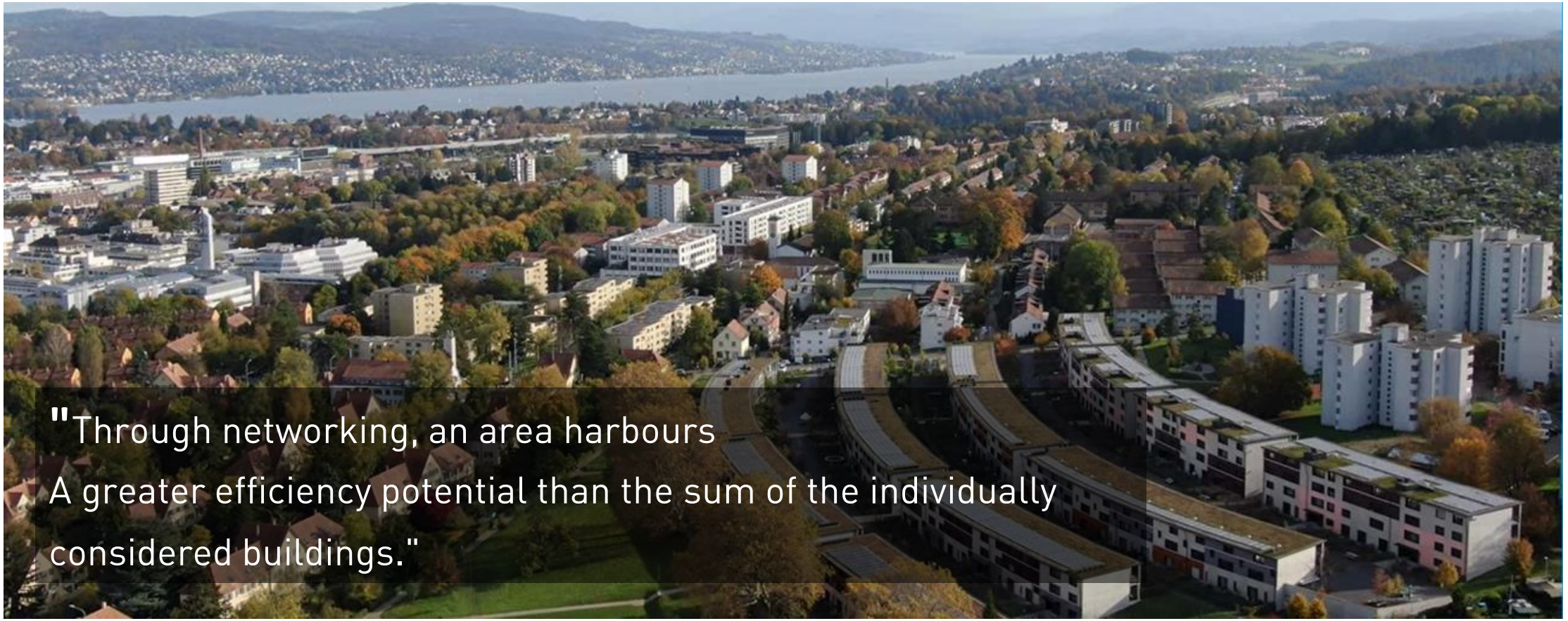


Sector coupling electricity-heat Procedure

电-热部门耦合：程序

- Determine building inertia (cooling as a function of outside temperature and decay time, e.g. by building simulation)
- Calculate potential for savings
- Implement in control system

- 确定建筑物特征（冷却与室外温度和衰减时间的函数关系，如通过建筑物模拟）
- 计算节能潜力
- 在控制系统中实施



“通过联网，比起单独考虑的建筑物节能潜力，地区拥有具有更大的能效提升潜力”

Example of a centralised district heating network

案例：集中式区域供热网络

Initial situation

- Residential areas / service buildings with relatively old buildings and mineral spa
- Almost exclusively heat demand (little cooling demand)
- Local forest, sale of energy wood not attractive

初始情况

- 住宅区/服务楼，建筑相对陈旧，有温泉
- 供热需求（几乎没有制冷需求）
- 当地森林，能源木材的销售没有吸引力

Example of a centralised district heating network

案例：集中式区域供热网络

Solution 解决方案

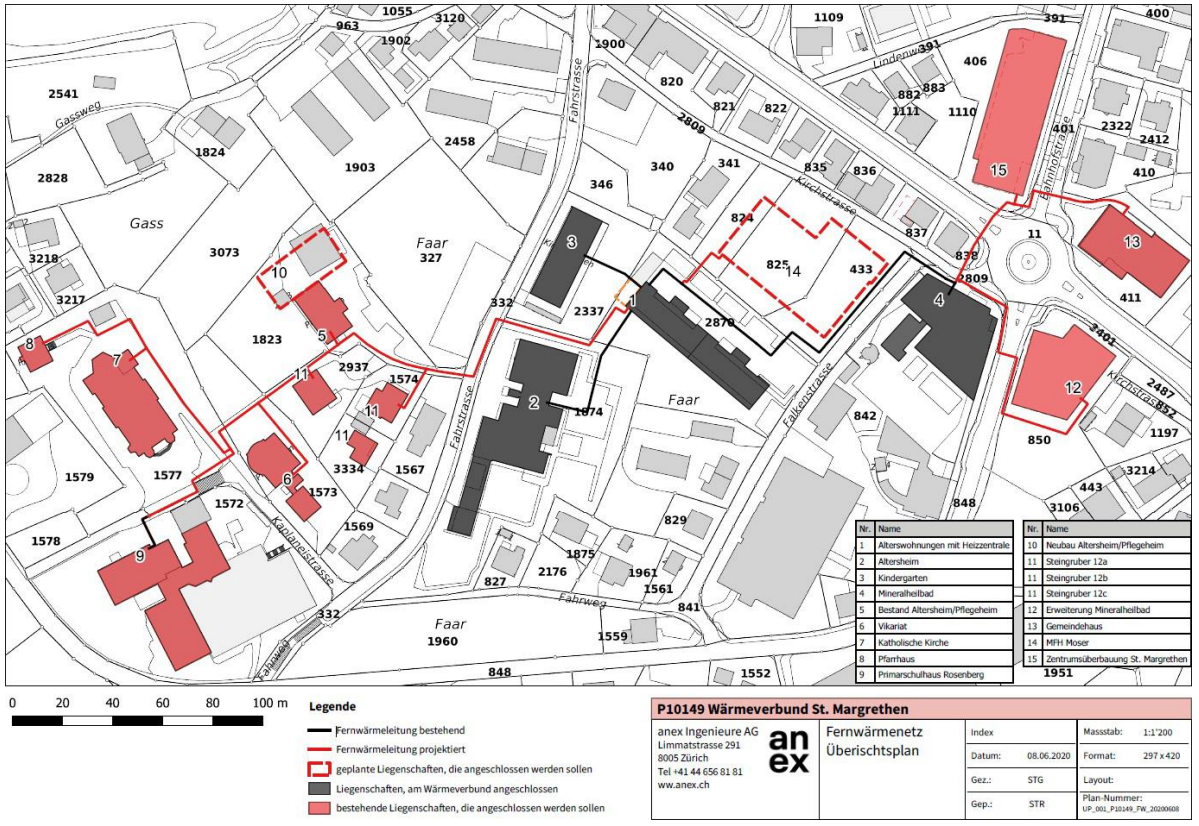
- Wood heating centre with directional district heating network
- Management of local forest

- 带有定向区域供热网络的木材供热中心
- 当地森林的管理

The challenges 面临的挑战

- No cooling /No waste heat utilisation
- Wood logistics
- Wood heating
- Pollutants / particles

- 无冷却/无余热利用
- 木材物流
- 木材供暖
- 污染物/颗粒



Nr.	Name
1	Alterswohnungen mit Heizzentrale
2	Altersheim
3	Kindergarten
4	Mineralheilbad
5	Bestand Altersheim/Pflegeheim
6	Vikariat
7	Katholische Kirche
8	Pfarrhaus
9	Primarschulhaus Rosenberg

Nr.	Name
10	Neubau Altersheim/Pflegeheim
11	Steingruber 12a
11	Steingruber 12b
11	Steingruber 12c
12	Erweiterung Mineralheilbad
13	Gemeindehaus
14	MFH Moser
15	Zentrumsüberbauung St. Margrethen

THANK YOU
感谢您的关注

中华人民共和国
住房和城乡建设部

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

环能科技
CABR EET

中国建筑节能协会

intep

skat Swiss Resource Centre and Consultancies for Development

Empa

HSLU Lucerne University of Applied Sciences and Arts

Anex Engineers AG